Quark Matter 2004

Poster Abstracts

January 2, 2004

Spectra 1 **Sangsu Ryu, Multiplicity Measurement From dAu Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: PHENIX collaboration

Co-authors/Collaboration:

The PHENIX Multiplicity Vertex Detector (MVD) consists of two concentric layers of silicon strip detectors and pad detectors. The MVD covers a large pseudo-rapidity range from -3 to +3 and full azimuthal angle with high granularity. With large pseudo-rapidity and azimuthal coverage the MVD can measure the charged particle multiplicity as well as the pseudo-rapidity distribution of charged particles. These can be compared with various theoretical predictions. During RUN 3 at RHIC the MVD took data for dAu collisions. In this presentation the measurement of the pseudo-rapidity distributions of charged particles with the MVD will be discussed.

Spectra 2 **Abigail Bickley,** **Measuring the Centrality Dependence of Antiparticle to Particle Ratios at PHOBOS**

Affiliation: University of Maryland

Co-authors/Collaboration: Phobos Collaboration

The PHOBOS detector at RHIC is well suited for investigating collisions over a broad range of energies and system sizes. PHOBOS has a two-arm magnetic spectrometer, consisting of planes of highly segmented silicon pads, that provides particle tracking and identification near mid-rapidity. Centrality is well determined in PHOBOS using its 4pi multiplicity detector and newly installed forward calorimetry. With this information it is possible to accurately measure the detailed centrality dependence of antiparticle to particle ratios. Details of the ratios analyses as conducted using the PHOBOS apparatus for a variety of collision systems will be presented.

Spectra 3 **Johan E. Gonzalez, Global Observables in dAu Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: UCLA

Co-authors/Collaboration: STAR

Measurements of global observables such as charged hadron multiplicity and transverse momentum distributions in d+Au collisions at $\sqrt{s_{NN}}$=200GeV can provide a benchmark for phenomena related to bulk matter created in Au+Au collisions. Inclusive transverse momentum spectra of charged hadrons in d+Au collisions were measured using the STAR detector. The centrality and pseudo-rapidity dependence of charged hadron production will be presented and compared to theoretical expectations of parton saturation in the Color Glass Condensate[1] and a perturbative QCD parton model[2]. The implications of these measurements for the underlying dynamics of the nuclear matter created in Au+Au collisions will be discussed.
[1] Dmitri Kharzheev et al.: arXiv:hep-ph/0212316 v2 16 Jan 2003
[2] Xin-Nian Wang: arXiv:nucl-th/0303004 v1 3 Mar 2003

Spectra 4 **Alexander Milov, Centrality Dependence of Charged Particle Multiplicity and Transverse Energy at Midrapidity in Au+Au Collisions at RHIC Energies**

Affiliation: Stony Brook University

Co-authors/Collaboration: (for the PHENIX collaboration)

The PHENIX detector at RHIC measured centrality dependence of charged particle multiplicity and transverse energy. These measurements were carried out on Au-Au collisions at mid-rapidity at $\sqrt{S_{NN}} = 19.6$, 130 and 200 GeV. The results are presented and compared to experimental data from BNL, CERN and other experiments. Comparison to a broad range of theoretical models is also made.

Spectra 5

Alexander Milov, Determination of the Minimum Bias Trigger Efficiency and Centrality Using the Glauber Model and a Negative Binomial Distribution

Affiliation: Stony Brook University

Co-authors/Collaboration: (for the PHENIX Collaboration)

A method to measure efficiency of the Minimum Bias trigger based on the assumptions of the Glauber model and Negative Binomial statistics is presented. Accurate results were obtained for Minimum Biased trigger in Au-Au and d-Au PHENIX runs. The method has been successfully used at different RHIC energies. It also allows for a determination of centrality classes and a calculation of Glauber model variables for each centrality class.

Spectra 6 **Hiroyoshi Hiejima,** **Inclusive η production measurement in pp collisions at $\sqrt{s} = 200$ GeV**

Affiliation: University of Illinois at Urbana-Champaign

Co-authors/Collaboration: PHENIX

η production in p-p collisions has been measured at PHENIX experiment at Brookhaven National Laboratory. As the η has a large $s\bar{s}$ component, η production could provide information complementary to π^0 production. A comparison of the η production cross sections with perturbative QCD calculation could shed new light on the η fragmentation function. Furthermore, the p-p η production data also serve as input for interpreting the d-A and A-A data. We report the inclusive p+p cross-section of η production at mid-rapidity. Comparisons with π^0 production data will be made. Implication on the d-A and A-A η production will be discussed.

Spectra 7 **Martin L. Purschke, Search for K_S^0 and $\omega(782)$ in the π^0 Decay Channels at RHIC**

Affiliation: Brookhaven National Laboratory

Co-authors/Collaboration: for the PHENIX collaboration

The large acceptance electromagnetic calorimeter of the PHENIX experiment at RHIC allows to determine the K_S^0 and $\omega(782)$ from the π^0 decay branches, $K_S^0 \rightarrow \pi^0\pi^0$ (31.4%) and $\omega(782) -> \pi^0\gamma$ (8.7%). Since the π^0 cannot be measured directly, but has to be reconstructed from the decay photons, this analysis has to fight a larger combinatorial background compared to an analysis of the charged pion channels. However, due to the larger coverage of the electromagnetic calorimeter, a larger statistics is available.
The analyis is ongoing for Au+Au collisions at $\sqrt{s_{NN}} = 200A$GeV, and will be extended to the d-Au data taken in 2003.
We will present the method and the current status of the analysis.

Spectra 8 **Mark Harvey, Identified Charged Hadrons at Midrapidity in pp Collisions at RHIC**

Affiliation: Brookhaven National Laboratory

Co-authors/Collaboration: PHENIX Collaboration

The transverse momentum spectra and yields ratios of identified charged hadrons have been measured at mid-rapidity at $\sqrt{s_{NN}} = 200$ GeV by the PHENIX experiment at the BNL Relativistic Heavy Ion Collider (RHIC). Charged hadrons; e.g., $\pi^{\pm}$, $K^{\pm}$, p, and $\overline{p}$ were identified by a high resolution Time-of-Flight scintillator wall.
The p-p invariant cross section of identified charged hadrons provide a baseline measurement for carefully examining the underlying nuclear effects in d-Au and Au-Au reactions. Hence, a detailed study of the nuclear modification factor, R_{AA}, and Cronin effect may be determined by direct comparison to p-p reactions. The spectra and yield ratios will be shown and compared to both the d-Au and Au-Au results as a function of the transverse momemtum.

Spectra 9 **Dipali Pal,** **Study of ϕ Mesons Via the K^+K^- channel in Au+Au and dAu Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: Vanderbilt University, Nashville, TN 37212

Co-authors/Collaboration: for the PHENIX collaboration

The study of ϕ meson production in relativistic heavy ion collisions is important in order to look for possible medium induced effects on vector meson properties and strangeness production. The PHENIX experiment, with its pair mass resolution (comparable to or better than the natural width of ϕ mesons) and hadron particle identification capabilities, has recorded 100 million events in Au-Au (2001) and more than 100 million events in d-Au (2002-2003) collisions at RHIC. The current analysis status from d-Au collisions and its comparison with Au-Au will be presented and discussed.

Spectra 10 **Ron Soltz and Jason Newby,** **Measuring Centrality in dAu Collisions with the PHENIX Forward Calorimeter Detectors (FCAL)**

Affiliation: LLNL

Co-authors/Collaboration: PHENIX

In the 2003 d-Au Run, PHENIX installed a pair of Forward Calorimeters (FCAL) in the RHIC tunnels to measure the forward protons on both sides of the interaction region. Each calorimeter is a 9x10 array of lead scintillator modules, 10x10cm x 5.9 interaction lengths, used previously in the AGS E864 experiment. The calorimeters have been placed adjacent to the outgoing beam pipes for d and Au, 18m from the interaction point. The primary motivation for them is to improve the centrality measurement in d-Au collisions by measuring the energy from ”grey/recoil” and ”black/evaporation” protons of the interacted Au nucleus. Centrality measurements from the FCAL detectors will be presented and compared to similar measurements from other detectors.

Spectra 11 **Camelia Mironov, Charged Kaon Results From dAu and pp Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: Kent State

Co-authors/Collaboration: STAR

As charged Kaons carry a large fraction of the strange quark production in heavy ions collisions, they make a good probe for studying some of the properties of the fireball formed at the impact. We report here some of the measurements made by STAR for both p+p and d+Au collisions at $\sqrt{s_{NN}}$=200 GeV at RHIC: transverse momentum spectra and nuclear modification factors, R_{CP} and R_{AA} . We also highlight the differences between the two data sets and the implications this brings for Au+Au collision analysis.

Spectra 12 **Giorgio Torrieri,** **Model Dependence of Statistical Hadronization Studies**

Affiliation: University of Arizona

Co-authors/Collaboration: Johann Rafelski

The statistical hadronization model has been successfully used to describe both abundance's and spectra of hadrons produced in heavy ion collisions. Yet this model encompasses a wide range of qualitatively and quantitatively different scenarios. Only when a wide momentum acceptance is considered particle production becomes largely insensitive to dynamically effects. But even then important model ambiguities remain. The results for freeze out parameters depend on whether chemical equilibrium for strange and light quarks is assumed, and how one treats the mass spectrum of resonances and their decay branching ratios.
In analyzing spectra or yields within a partial rapidity acceptance window, there are several further model dependencies to be considered since there are choices that must be made regarding both the freeze out hyper surface and collective matter flow.
In this talk, we will identify methods and consider experimental results which can provide us with tools in resolving these ambiguities. We restrict the range of prevailing statistical hadronization scenarios and determine the hadronization parameters and the systematic theoretical model error. In particular, we consider how detection of short-lived resonances, precision spectra of low-p_T particles and study of v_2 is capable of distinguishing between freeze-out scenarios.

Spectra 13 **Madappa Prakash,** **Spectroscopy of Resonance Decays in High Energy Heavy-Ion Collisions**

Affiliation: SUNY at Stony Brook

Co-authors/Collaboration: Peter F. Kolb

Peak positions of resonances and their shapes are beginning to be used to probe the freeze-out conditions in relativistic heavy ion collision and to establish the properties of resonances in a hot and dense medium. We have investigated the invariant mass distributions of the hadronic decay products from resonances with a view to disentangle the effects of thermal motion and the phase space of decay products from those of intrinsic changes in the structure of resonances at the freeze-out conditions [1]. Analytic results of peak mass shifts for the cases of both equal and unequal mass decay products are derived. The shift is expressed in terms of the peak mass and width of the vacuum or medium-modified spectral functions and temperature.

Expected shifts in meson (*e.g.*, $f_0(600)$, $\rho(776)$, $\omega(783)$, $K^*(892)$, and $\phi(1020)$) and baryon (*e.g.*, $\Delta(1232)$, $\Sigma(1385)$, $\Lambda(1520)$, and $\Xi(1530)$) resonances that are helpful to interpret recent measurements at BNL are provided. Although significant downward mass shifts are caused by widened widths of the $\rho-$meson in medium, a downward shift of at least 50 MeV in its intrinsic mass is required to account for the downward shift of 60-70 MeV in the peak of the $\rho-$invariant mass distribution reported in [2]. We argue that the observation of a downward shift from the vacuum peak value of the Δ would distinctly signal a significant downward shift in its intrinsic peak mass, since unlike for the $\rho-$meson, phase space functions produce an upward shift for the $\Delta-$isobar.

[1] P. F. Kolb and M. Prakash, Phys. Rev. C **67**, 044902 (2003).
[2] J. Adams et al., (STAR Collaboration), nucl-ex/0307024.

Spectra 14 **Frederique Grassi, Comparison Between Centrality Classification Using Impact Parameter and the Number of Participants for Spectra**

Affiliation: Instituto de Fisica-USP

Co-authors/Collaboration: C.E.Aguia, R.Andrade, Y.Hama, T.Kodama, T.Osada, O.Socolowski Jr.

The NeXSPheRIO code is a junction of the hydrodynamical code SPheRIO (which solves the hydrodynamical equations using a new method called Smoothed Particle Hydrodynamics) and the NeXus event generator which provides the initial conditions, varying from event to event. Using the hydrodynamical code NeXSPheRIO, we compare predictions as usually done in hydrodynamics, using centrality windows defined through the impact parameter, and as obtainable experimentally, using windows in participant number. For rapidity spectra, the difference between both approaches can be 12%, while for the transverse mass spectra, no sizable difference is seen. Predictions for freeze out temperature of 140 MeV are in reasonable agreement with NA49 Pb+Pb results in its various centrality windows.

Spectra 15 **Subrata Pal,** **Entropy and the Quark-Gluon Plasma at RHIC**

Affiliation: NSCL, Michigan State University

Co-authors/Collaboration: Scott Pratt

The entropy per unit rapidity dS/dy at freeze-out will be estimated from the available experimental data of hadron yields, spectra and source sizes in central heavy ion collisions at RHIC. I will show that the extracted entropy is consistent with lattice gauge theory results for a thermalized quark-gluon plasma formed at RHIC.

Spectra 16 **Sami S. Räasänen, Predictions for Hadron Spectra at the LHC with Constraints from RHIC**

Affiliation: University of Jyv”askyl”a, Department of Physics, Finland

Co-authors/Collaboration: K.J. Eskola, H. Niemi and P.V. Ruuskanen

At collider energies, primary parton production in central *AA* collisions ($A \sim 200$) is expected to be dominated by gluon saturation, which makes the energy and baryon number released into the central rapidities calculable in the pQCD+saturation model [1]. Using $\tau_0 = 1/p_0$, where $p_0 = 1 \ldots 2$ GeV is the saturation momentum, as the formation time of the system, one obtains the initial densities, including their normalizations. Assuming the matter to be approximately thermalized at τ_0, the further evolution can be described by relativistic hydrodynamics [1,2,3]. This pQCD+saturation+hydrodynamics approach has successfully predicted the multiplicities in central Au+Au collisions at RHIC [1,2]. We have also reproduced the bulk properties of the measured pion, kaon and (anti)proton spectra reasonably well [3,4] with a single (high) decoupling temperature $T_{dec} = 150$ MeV, without tuning the initial state. Encouraged by the good description obtained for the RHIC data, we make predictions for the hadron spectra and multiplicities to be measured in Pb+Pb collisions at the LHC [4].

[1] K.J. Eskola, K. Kajantie, P.V. Ruuskanen and K. Tuominen, Nucl. Phys. B 570 (2000) 379 [hep-ph/9909456].
[2] K.J. Eskola, P.V. Ruuskanen, S.S. R”as”anen and K. Tuominen, Nucl. Phys. A 696 (2001) 715 [hep-ph/0104010].
[3] K.J. Eskola, H. Niemi, P.V. Ruuskanen and S.S. R”as”anen, Phys. Lett. B 566 (2003) 187 [hep-ph/0206230].
[4] K.J. Eskola, H. Honkanen, H. Niemi, P.V. Ruuskanen and S.S. R”as”anen, in preparation.

Spectra 17 **Kris Hagel,** **Hadron Production in Baseline Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: Cyclotron Institute, Texas A & M University

Co-authors/Collaboration: BRAHMS Collaboration

Data on hadron production from elementary nucleus-nucleus collisions ($p+p$ and $d+Au$) are very scarce. This deficiency is especially pronounced at forward rapidities. The understanding of elementary nucleus-nucleus collisions at the same nucleon-nucleon center of mass energy as heavy-ion collisions ($Au+Au$) at RHIC forms an important baseline reference for those latter collisions. BRAHMS has the unique ability to measure identified hadrons over a wide range of rapidity and transverse momentum.
Particle-antiparticle ratios of pions, kaons and protons versus transverse momentum from $p+p$ and $d+Au$ collisions at $\sqrt{s_{NN}} = 200$ GeV will be presented for the rapidity range $0 < y < 3$ for data that were taken with the BRAHMS spectrometer during the 2001 and 2003 RHIC runs. Comparisons of both systems to results from $Au+Au$ collisions at the same nucleon-nucleon center of mass energy as well as to theoretical models will be shown. We will also develop the systematics of the $\sqrt{s_{NN}}$ dependence of the $p+p$ data in the forward region.

Spectra 18 **Hironori Ito, Centrality Dependence of Charged Particle Pseudorapitiy Densities for dAu collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: Brookhaven National Laboratory

Co-authors/Collaboration: BRAHMS

Particle multiplicity measurements can yield valuable information concering the reaction dynamics for relativistic heavy-ion collisions, with the pseudorapidity densities expected to reflect the entropy of the system at freeze-out of the initial state. Comparisons of d-Au with Au-Au collisions at RHIC energies may provide a crucial test of saturation models[1]. We have measured charged-particle pseudorapity densities for the d-Au reaction at $\sqrt{s_{NN}}$ = 200 GeV over a wide pseudorapidity range $(-4.7 < \eta < 4.7)$ using several of the global detector subsystems of BRAHMS [2]. Near mid-rapidity $(-2.2 < \eta < 2)$ the particle multiplicities were observed using modestly segmented Si strip detectors and plastic scintillator tiles. At more forward rapidity, arrays of Cherenkov radiators mounted to phototubes were used to determine the charged particle multiplicities, on *both* the d and Au sides of the reaction. A minimum-bias trigger was established using plastic scintillators mounted around the beam pipe at very forward rapidity. We will discuss the centrality dependence of the observed multiplicity distributions and compare the d-Au results with those obtained earlier for Au-Au collisions using the same experimental arrangement [3]. We will also compare recent model calculations to the experimental results.

[1] Dmitri Kharzeev, Eugene Levin, and Marzia Nardi, hep-ph/0212316 (2002).
[2] BRAHMS Collaboration, M. Adamczyk it et al., Nucl. Instrum. Meth., **A499** (2003) 437.
[3] BRAHMS Collaboration, I.G. Bearden it et al., PRL **88** (2002) 202301.

Spectra 19 **Eun-Joo Kim, System, Centrality, and Rapidity Dependence of Identified Charged Hadrons at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: University of Kansas

Co-authors/Collaboration: BRAHMS collaboration

The shapes of the identified hadron p_t spectra from relativistic heavy-ion collisions are expected to preserve some information on the phase of the primordial system [1]. We have measured spectra of identified charged hadrons for pp, d-Au, and Au-Au collisions at $\sqrt{s_{NN}}$ = 200 GeV using the BRAHMS facility. The BRAHMS spectrometers provide wide rapidity and p_t coverage with excellent particle identification [2]. We report on $\pi^{\pm}$, $K^{\pm}$, p and $\overline{p}$ spectra obtained at $y = 0$ and $y = 1$ as a function of centrality. Central Au-Au collisions have been shown to lead to a characteristically different medium than either peripheral Au-Au or d-Au collisions [3]. We will present a systematic study of blast-wave fit parameters [4] for the measured spectra as a function of charged-particle multiplicity, with the multiplicity being related to both the collision centrality and the associated entropy production. Current model calculations will be compared to the experimental results.

[1] Leon Van Hove, in *Proc. of the Topical Conference on High Energy Collisions of Hadrons* CERN, January, 1968 (1968).
[2] BRAHMS Collaboration, M. Adamczyk *et al.*, Nucl. Instrum. Meth., **A499** (2003) 437.
[3] PHOBOS Collaboration, B.B. Back *et al.*, PRL, **91** (2003) 072302; PHENIX Collaboration, S.S. Adler *et al.*, PRL, **91** (2003) 072303; STAR Collaboration, J. Adams *et al.*, PRL, **91** (2003) 072304; BRAHMS Collaboration, I. Arsene *et al.*, PRL, **91** (2003) 072305.
[4] E. Schnedermann *et al.*, Phys. Rev. **C48** (1993) 2462.

Spectra 20 **Kang Seog Lee,** **Analysis of Hadronic Spectra From a Statistical Model**

Affiliation: Chonnam National University

Co-authors/Collaboration:

The statistical model of multiparticle production by Chou, Yang and Yen, which looks similar to the thermal model, is known to account for the single particle distributions in $e^+ e^-$ collisions. In this model the Boltzmann factor is obtained by the Darwin-Fowler method, but the parameter "T" is not the temperature and this model has no concept such as the freeze-out or evolution of the system.
This model is applied to the rapidity and transverse momentum distributions of pions and kaons measured in Pb+Pb collisions by NA49 collaboration. Success of this model would imply that thermalization is not guaranteed even in the case that the thermal models explains the data well. Discussion will be focused on what aspects each models can do better and on what aspect they fail to fit the data. This kind of comparison will help us to know whether the thermalization is reached in the relativistic heavy-ion collisions.

Spectra 21 **Yu-Gang Ma, Temperature Fluctuation and Heat Capacity in Relativistic Heavy-Ion Collisions**

Affiliation: Shanghai Institute of Nuclear Research, Chinese Academy of Sciences

Co-authors/Collaboration:

We used LUCIAE3.0 model to simulate the Pb+Pb and C + C in SPS energy. The heat capacities for different hadrons have been extracted from event-by-event temperature fluctuation in the soft transverse momentum region. It is found that the heat capacities per hadronic multiplicity for various hadrons fall with the increasing of beam energy and impact parameter for a given reaction system. While with the increasing of hadron mass, the heat capacity per hadronic multiplicity rises. In addition, we found that, for a given hadron, the heat capacity per hadron multiplicity is almost the same regardless the size of reaction system. Some discussions were also presented.

Spectra 22

Peter Csizmadia, **Coalescence of Massive Quarks and the Measured Hadron Spectra at Low and Intermediate Transverse Momenta in RHIC Heavy Ion Collisions**

Affiliation: KFKI RMKI

Co-authors/Collaboration: P. Levai

The analysis of the measured hadron ratios and numbers supports the formation of a deconfined state in heavy ion collisions at RHIC energies, which state is dominated by quarks and antiquarks. I show the results of my microscopical quark coalescence model (MICOR), which is able to reproduce many of the measured particle spectra at low momentum, without assuming thermalization processes for final state hadrons. I extend my calculation to higher momentum and display the results of a fully coherent description of hadronization in the momentum window $0 < p_T < 6$ GeV. I can reproduce the anomalous proton to pion, antiproton to pion and Lambda to kaon ratios. Since the coalescence process depends on an effective strong coupling constant, then I can extract a numerical value for it and compare to other effective coupling constant, e.g. obtained in lattice calculations.

Spectra 23 **Chadd Smith, Charged Multiplicity in Heavy-Ion Collisions with the CMS Detector at the LHC**

Affiliation: CMS

Co-authors/Collaboration: CMS Heavy Ion Group

At the LHC, collisions of Pb+Pb at $\sqrt{s_{NN}}$ = 5.5 TeV will extend the energy frontier of heavy-ion physics far beyond what is currently accessible. The CMS detector, although primarily designed for pp physics, demonstrates a strong capability for studying the hot, dense state of matter produced in heavy-ion interactions. Two fundamental observables are the number of primary charged particles produced, N_{ch}, and the pseudorapidity density, $dN_{\mathrm{ch}}/d\eta$. While these global features relate to the system after cooling and hadronization, they offer insight into the initial production and evolution of the hot, dense matter formed in the collision. Measurement of the charged particle multiplicity is therefore a key component of many analyses performed by the CMS Heavy Ion Group, from azimuthal anisotropy in the charged particle density to event-by-event fluctuations which are sensitive to the presence of the quark-gluon plasma (QGP). We have examined the performance of the CMS silicon tracker in the high-multiplicity environment of the LHC, with primary focus on the inner pixel barrels ($|\eta| \leq 2.4$), where the high granularity translates into average pixel occupancies of 2% or less for $dN_{\mathrm{ch}}/d\eta$ = 5000. We present methods for using single-layer pixel hits, two-point tracklets and pixel triplets to measure N_{ch} and $dN_{\mathrm{ch}}/d\eta$ and to determine the primary vertex to within 20 μm.

Spectra 24 **Pasi Huovinen,** **Baryon Production**

Affiliation: University of Jyväskylä

Co-authors/Collaboration: Joseph Kapusta

We develop and solve a network of rate equations for the production of baryons and anti-baryons in high energy nuclear collisions. We include all members of the baryon octet and decuplet and allow for transformations among them. This network is solved during a relativistic 2+1 hydrodynamical expansion of the of the hot matter created in the collision. As an application we compare to the number of protons, lambdas, negative cascades, and omega baryons measured at mid-rapidity in central collisions of gold nuclei at 65 GeV per nucleon at RHIC.

Spectra 25 **Olga Barannikova,** **Probing Collision Dynamics at RHIC**

Affiliation: Purdue University

Co-authors/Collaboration: STAR Collaboration

Measurements of a variety of hadron species ($\pi^{\pm}$, π^0, $K^{\pm}$, K^0_S, K^*, ϕ, p, $\bar{p}$, Λ,$\bar{\Lambda}$, Ξ, $\bar{\Xi}$, $\Omega+\bar{\Omega}$) in pp and Au+Au collisions at 200 GeV by the STAR experiment allow a detailed investigation of the final hadronic state properties of such collisions. These properties may contain important traces from the early, possibly partonic stage of the collisions. For example, the final collective transverse radial flow, due to its cumulative nature, contains any collective flow generated at partonic stages, and particle yield ratios may reflect statistical nature of the hadronization process. We will present a study of particle spectra within the framework of chemical and local kinetic equilibrium models. The extracted chemical and final kinetic freeze-out temperatures, strangeness saturation factor, final collective flow velocity, and the inferred flow velocity at chemical freeze-out will be discussed as a function of centrality. The chemical freeze-out temperature shows little centrality dependence, while the kinetic freeze-out parameters are correlated with centrality: the more central the collision, the lower extracted temperature and the higher collective radial flow velocity. The results seem to reveal the following picture at RHIC: Au+Au collisions of various centralities, despite of different initial conditions, always evolve toward the same chemical freeze-out temperature; chemical freeze-out is followed by cooling and expansion, and a sequential decoupling of particles dictated by their hadronic cross-sections.

Spectra 26 **Levente Molnar,** **Systematics of Global Event Properties for Soft and Hard Event Classes**

Affiliation: Purdue University

Co-authors/Collaboration: STAR

High energy p+p and d+Au collisions provide important references for heavy ion collisions. It is also suggested that they constitute a plausible environment to search for the deconfinement phase transition. Such a phase transition could occur in high multiplicity collisions, but such collisions could also be contaminated by hard-QCD processes. We utilize high p_T hadrons and correlations to select event classes with relatively enhanced soft or hard contributions. In this talk we present STAR results on transverse momentum and rapidity distributions of charged hadrons and identified π, K, p and $\bar{p}$ in p+p and d+Au collisions at $\sqrt{s_{NN}}$=200 GeV. These distributions are studied as a function of multiplicity for minimum bias events as well as for soft and hard events. The results are compared to predictions from a saturation model and a two-component model.

Spectra 27 **Ian G. Bearden, Rapidity dependence of Deuteron and Antideuteron Production in $\sqrt{s_{NN}} = 200$ GeV Au+Au Collisions**

Affiliation: Niels Bohr Institute

Co-authors/Collaboration: BRAHMS collaboration

The yield of light nuclei and anti–nulcei is sensitive to the production of baryons and anti–baryons, the volume of the emitting system at freeze–out, and space–momentum correlations. Measurements of (anti)deuterons thus provide an alternate method to HBT of determining the transverse size of the emitting source.
The BRAHMS experiment is capable of making such measurements over a broad rapidity range. In this talk we will present results in the rapidity range $0 \leq y \leq 1$ obtained with the BRAHMS Mid–Rapidity Spectrometer (MRS).
Preliminary results indicate that the coalescence parameter for d and $\bar{\mathrm{d}}$ are similar and do not change drastically within the first unit of rapidity away from $y = 0$. The BRAHMS results will be compared to other experimental results and model calculations. We will also discuss prospects for measuring (anti)deuterons at rapidities up to $y = 2.3$.

Spectra 28 **Tetsuo Nishikawa, Color Ferromagnetic States and Quantum Hall States of Gluons**

Affiliation: IPNS, High energy accelerator research organization

Co-authors/Collaboration: Aiichi Iwazaki, Osamu Morimatsu and Munehisa Ohtani

We show that quark matter possesses a stable color ferromagnetic phase by forming quantum Hall states of gluons. The phase arises just after the hadronic phase terminates when the chemical potentials are varied. We predicts an observable effect that strong real magnetic field $\sim 10^{15}$ Gauss is generated in the phase. The presence of the strange quark does not affect significantly our results.

Spectra 29 **Birger Back, Systematics of Charged Hadron Pseudorapidity Distributions in High Energy Collisions**

Affiliation: Argonne National Laboratory

Co-authors/Collaboration: PHOBOS Collaboration

In the first three RHIC runs, PHOBOS has measured charged hadron pseudorapidity distributions in Au+Au collisions at $\sqrt{s}$ = 19.6, 56, 130 and 200 GeV. The analysis of the collision energy and system size dependence of these data has shown surprisingly simple scaling rules governing the shape of the pseudorapidity distributions as well as their total integral. In this talk we continue the analysis of particle production with a comprehensive comparison of Au+Au data with new PHOBOS results on charged hadron production in p+p and d+Au collisions at $\sqrt{s}$ = 200 GeV. Using the centrality dependence of the pseudorapidity distributions in d+Au collisions, as well as the dependence on total multiplicity in p+p, we attempt to disentangle contributions to the Au+Au pseudorapidity distributions from the different stages of the collision process.

Spectra 30 **George Stephans, Characterizing Transverse Momentum Spectra in dAu and Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: MIT

Co-authors/Collaboration: Jay L. Kane and the PHOBOS Collaboration

The PHOBOS detector has been used to study the properties of transverse momentum spectra of charged particles emitted in d+Au and Au+Au collisions at $\sqrt{s_{NN}}$=200 GeV. Of particular significance is the detailed understanding of the centrality dependence resulting from the large phase space coverage and multiple centrality-related detectors that comprise the PHOBOS apparatus. These aspects are crucial in the study of d+Au interactions where the fluctuations inherent in such a small system can introduce biases and other complications into the centrality determination.
For Au+Au collisions, the centrality dependence of the shape of the charged particle p_T spectra, as compared to proton-antiproton data, revealed the surprisingly large magnitude of the suppression at high p_T. In the case of d+Au, the quantitative results of the centrality dependence of the spectral shapes (again compared to proton-antiproton) were shown to be in clear contradiction to the predictions of the gluon saturation model. Furthermore, the availability of multiple centrality measures can be used to study the centrality dependence of the spectral shapes over a broad range of interaction conditions. The results of these extensive studies of charged particle yields and shapes of transverse momenta spectra will be presented.

Spectra 31 **Jingguo Ma, ϕ Meson Formation Mechanism and the Nuclear Modification From pp to Au+Au Collisions**

Affiliation: UCLA

Co-authors/Collaboration: STAR

We present the STAR measurement of ϕ meson production from Au+Au collisions in five centrality bins and from non-singly-diffractive p+p collisions at $\sqrt{s_{NN}} = 200$ GeV. The measurement covers rapidity range $|y| < 1.0$ and p_t range from 0.4 GeV/c up to 4.0 GeV/c. ϕ spectra and particle ratios will be presented and compared to results from other energies and colliding systems (e^+e^-, p+p and A+A). The yield ratio ϕ/K^- integrated over p_t is essentially constant vs. centrality, collision energy and colliding system, which suggests that kaon coalescence is unlikely a dominant production mechanism for ϕ.
The ϕ spectra for Au+Au collisions are well described by an exponential m_t distribution while for the p+p data a power-law p_t distribution is favored. The power law distribution in p+p collisions is also observed in the Pythia model, which predicts an important contribution for mid-to-high p_t ϕ production from semi-hard gluon induced $s\bar{s}$ pair production with further string break to produce ϕ and associated kaons. The centrality dependence of the ϕ production in Au+Au collisions at the relevant p_t region indicates that in Au+Au collisions this process does not scale as the number of binary collisions. A comparison of the nuclear modification factors, R_{AA} and R_{CP}, for ϕ, K^0_S and Λ will also be reported. Implications on particle formation mechanisms at intermediate p_t in heavy ion collisions will be discussed.

Spectra 32 **Jennifer L. Klay,** **Heavy Ions at the AGS: An Overview of Recent Results From the E895 Experiment**

Affiliation: Lawrence Berkeley National Laboratory

Co-authors/Collaboration: E895 Collaboration

The E895 Experiment utilized the large-acceptance EOS TPC to study heavy ion collisions at the Alternating Gradient Synchrotron. Through a comprehensive investigation of 2-8 AGeV fixed-target Au+Au collisions, E895 has published excitation functions of numerous observables, including particle flow (directed, elliptic, radial, and longitudinal), spectra, strange particle production and intensity interferometry. In this talk I will present recent analyses of near-threshold multi-strange hyperon production, 4π charged pion production, and comparisons of source-imaging studies using pp, $p\Lambda$ and $\pi\pi$ correlations. Continuing analyses of pion phase space densities and attempts to measure the evolution of the source charge distribution will also be discussed. These measurements provide crucial probes of the properties of hadronic matter under extreme conditions.

Spectra 33 **Michael Murray, Is There One Thermal Source or Many in Au+Au Collisions?**

Affiliation: University of Kansas

Co-authors/Collaboration: BRAHMS

Particle abundances from heavy ion collisions are commonly described in terms of thermal fits. This is normally done using 4π yields but recently, thermal models have been applied to data from narrow regions around $y = 0$. The use of such narrow rapidity regions has been justified by invoking "boost invariance" and assuming that the central rapidity region has zero net strangeness. The success of this approach raises the question of whether strangeness is locally conserved or perhaps "distilled" into regions of high baryon density. The wide rapidity acceptance of BRAHMS' data allows us to test if Au-Au collisions are in global thermal equilibrium or if there are several sources at different rapidities, each of which is in local thermal equilibrium. We searched a large set of model calculations on a two dimensional grid of temperature and baryo-chemical potential to find the best fit to five independent particle ratios at a given rapidity. For all rapidities the fit converges, suggesting that strangeness may be a locally conserved quantity. We will also contrast these results to lower energy work and results from lighter systems.

Spectra 34 **Bjorn Samset,** **System Dependence of Soft Particle Production at $\sqrt{s_{NN}} =$ 200 GeV**

Affiliation: University of Oslo

Co-authors/Collaboration: BRAHMS

To understand the physics of the hot nuclear matter created in $Au+Au$ collisions at RHIC, a baseline of data from cold nuclear matter ($d+Au$) [1] and elementary interactions ($p+p$) at a common energy must be established. With its wide rapidity coverage, the BRAHMS experiment [2] provides a unique perspective on the system dependence of relativistic heavy–ion collisions. We have now explored the p_T and (pseudo)rapidity dependence of particle production from the $p+p$, $d+Au$ and $Au+Au$ [3,4] systems at a common nucleon–nucleon collision energy of $\sqrt{s_{NN}} = 200$ GeV. In this talk, I will discuss particle yields and $\langle p_t \rangle$ from heavy ion collisions as a function of system size. I will present spectra of identified charged particles with $0.5 < p_T < 2GeV/c$ from $p+p$ and $d+Au$ collisions in the rapidity range $0 < y < 1$, and show and contrast the "soft" charged hadron spectra for all three collision systems over the pseudorapidity range $0 < \eta < 3$. The $d+Au$ and $Au+Au$ results will be compared as a function of centrality. All data to be shown were taken with the BRAHMS spectrometer during the 2001 and 2003 RHIC runs.

References

[1] I. Arsene it et al., Phys. Rev. Lett. **91** (2003) 072305
[2] M. Adamczyk it et al., Nucl. Instr. Meth. A **499** (2000) 437
[3] I. G. Bearden it et al., Phys. Rev. Lett. **90** (2003) 102301.
[4] I. G. Bearden it et al., Phys. Rev Lett. **87**, (2001) 112305

Spectra 35 **Haibin Zhang, Δ, K^* and ρ Resonance Production And Their Probing of Freeze-out Dynamics at RHIC**

Affiliation: Brookhaven National Lab / Yale University

Co-authors/Collaboration: STAR

We report the measurement of transverse momentum spectra and invariant mass distribution of Delta(1232) $\rightarrow \pi p$, $K*(892)^{0,\pm} \rightarrow \pi K$ and $\rho(770)^0 \rightarrow \pi^+\pi^-$ in Au+Au, d+Au and pp collisions at $\sqrt{s_{NN}}$ =200 GeV using the STAR TPC at RHIC. These resonances provide sensitive probes to examine the evolution dynamics in the hadronic medium through their decay and regeneration processes. The particle ratios of K^*/K, K^*/ϕ, Δ/p and ρ/π, the K^*, ρ and Δ apparent masses and their dependence on the centrality suggest clear evidences of dynamical interaction and rescattering between hadrons close to freeze-out. The dependence of resonance yields on the strength of their hadronic cross sections and the lifetime between the freeze-outs will also be discussed. In the intermediate p_T, the nuclear modification factors (R_{AA}) of K^* are similar to those of K_S and ϕ and smaller than those of baryons (Λ, p). In the intermediate p_T region, no strong dependence on the particle masses has been seen in the data. The measurement from d+Au collisions will also be contrasted with those from Au+Au and pp collisions.

Spectra 36 **Joseph Sagerer,** **Analysis of Charged Particle Multiplicity in 200GeV pp Collisions Measured with the PHOBOS Detector**

Affiliation: University of Illinois at Chicago, UIC

Co-authors/Collaboration: PHOBOS Collaboration

200 GeV pp collisions at RHIC serve as a baseline for measurements of AuAu and dAu collisions at the same energy. The low-multiplicity pp environment produces particular challenges for triggering and analysis compared to the much higher multiplicities of dAu and AuAu. We have performed extensive Monte-Carlo studies of the PHOBOS trigger response, the various methods of vertex finding, and hit reconstruction. The contribution of these effects to the multiplicity analysis will be presented.

Spectra 37

Rolf Scharenberg, Excitation and Hadronization of Deconfined Hadronic Matter in $p\overline{p}$ Collisions at 1.8 TeV and the Extension to pp Collisions at the LHC

Affiliation: Purdue University

Co-authors/Collaboration: FNAL E-735

In an *inclusive* experiment E-735, a wide range of pseudorapidity densities $1< dN_c/d\eta < 25$ of centrally produced hadrons from $p\overline{p}$ collisions were used to study the excitation of deconfined hadronic matter. Two signals establish the threshold for a fully connected deconfined system. First, the variation of the measured average transverse momentum of pions with $dN_c/d\eta$ and the color string fusion model indicate that a percolation phase transition in the initial $p\overline{p}$ collision occurs for $dN_c/d\eta \geq 7$. Secondly, the variance of the forward- backward charged particle multiplicity also exhibits a significant increase in cluster size at hadronization for $dN_c/d\eta \geq 7$[1]. Above the $dN_c/d\eta$=7 threshold a one dimensional partonic expansion to the hadronization volume $4.4 \leq V \leq 13.00\ fm^3$ has been measured. V is directly proportional to $dN_c/d\eta$. Hadronization for all events above the threshold occurs at a constant energy density of 1.1 ± 0.26 GeV/fm^3 and a constant temperature of 179.5 ± 5 MeV, corresponding to 24 ± 6 quark-gluon degrees of freedom [2].
The extension to p-p collsions at the LHC using the ALICE detector would permit an *exclusive* study of these signals. Here freezeout volumes of $V \leq 40$ fm^3 are expected when $dN_c/d\eta \approx 70$. Further measurement of the cluster distibution at hadronization could distinguish between the different types of phase transitions.
[1] T. Alexopoulos et al. (E-735 collaboration), Phys. Lett. B353 (1995) 155.
[2] T. Alexopoulos et al. (E-735 collaboration), Phys. Lett. B528 (2002) 43.

Spectra 38 **Shengli Huang,** **Soft and Hard Interactions in proton + proton collisions at $\sqrt{s} = 200$ GeV**

Affiliation: USTC, China

Co-authors/Collaboration: STAR

We present a detailed study of particle production at mid-rapidity in proton + proton collisions at RHIC for $\sqrt{s} = 200$ GeV. The transverse momentum, p_T spectra and the mean p_T, $\langle p_T \rangle$, of inclusive hadrons and particle-identified pions, kaons and protons as a function of multiplicity were measured in minimum-bias, ”soft” and ”hard” event classes. It was found that the multiplicity dependence of $\langle p_T \rangle$ in soft events in p+p collisions does not change from RHIC to Tevatron while there is no such scaling behavour in minimum-bias and hard events. The strangeness and baryon production derived from the particle ratios of K/π and $\overline{p}/\pi$ were measured to be different in ”soft” and ”hard” events. These results were compared to model predictions and those from Au+Au collisions at RHIC.

Spectra 39 Peter Christiansen, Stopping in $\sqrt{s_{NN}} = 200$ GeV Au+Au Collisions

Affiliation: Niels Bohr Institute, Copenhagen, Denmark

Co-authors/Collaboration: BRAHMS

The measurement of net–proton rapidity densities dN/dy as a function of rapidity, yields information of the initial scattering between the colliding nuclei, i.e., the stopping. The BRAHMS experiment has the unique capability to study this at RHIC because of the ability to measure proton and anti–proton transverse momentum spectra over a broad rapidity range ($0 \leq y \leq 3$). On this poster we present the net–proton (p-$\bar{\text{p}}$) rapidity distribution for central $Au + Au$ collisions at $\sqrt{s_{NN}} = 200$ GeV. When compared to measurements at lower energies it is clear that the colliding system exhibits a large degree of transparency at RHIC and from the extrapolated rapidity loss it is shown that the previously observed linear scaling of the rapidity loss for energies up to SPS is broken at RHIC.

Flow 1 **Shingo Sakai, Azimuthal Anisotropy of Electrons in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV Measured with PHENIX at RHIC**

Affiliation: Univ. of Tsukuba

Co-authors/Collaboration: PHENIX collaboration

The measurement of electrons and positrons at transverse momenta above 1.0GeV/c allows to study the production of heavy flavor quark-antiquark pairs via the semileptonic decays of charmed particles. The azimuthal anisotropy of high p_T electrons can carry information about the anisotropy of the parent charmed mesons. The observation of charm flow would indicate that collective motion develops already in the partonic phase of the collision.
The PHENIX experiment has the unique capability to measure electrons and positrons at RHIC. In this analysis we study the elliptic flow pattern of inclusive electrons from Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV as function of transverse momentum. To estimate the elliptic flow of electrons originating from charm decays the contributions of all other electron sources, such as Dalitz decays and photon conversions, have to be subtracted. The current status of the analysis will be presented.

Flow 2 **Markus Oldenburg,** **Anisotropic Flow in the Forward Directions**

Affiliation: Lawrence Berkeley National Laboratory

Co-authors/Collaboration: STAR

The STAR Forward TPCs (FTPCs) extend the STAR acceptance for charged particles into the region $2.5 < |\eta| < 4.0$.
We see the first signal of directed flow (v_1) at RHIC energies. While v_1 is consistent with zero in the central rapidity region it rises up to 2,% at pseudorapidities of ± 4. With this signal we can verify that elliptic flow (v_2) is *in-plane*. The measurement of v_2 in the FTPCs confirms the falloff by a factor of about 2 compared to mid-rapidity previously seen by PHOBOS [1].
In addition we look for higher harmonics ($v_n, n > 2$) where in the case of v_4 a signal is seen in the STAR TPC. With the available statistics for the FTPCs we give an upper limit for these harmonics, since the results agree with zero within the errors. However, the falloff of v_4 from mid-rapidity to forward-rapidities appears to be faster than for v_2.
[1] B. B. Back. *et al.*, Phys. Rev. Lett. **89**, 222301 (2002)

Flow 3 **Andrey Kazantsev,** **Elliptic Flow of Inclusive Photons in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV from the PHENIX experiment at RHIC**

Affiliation: RRC "Kurchatov Institute"

Co-authors/Collaboration: PHENIX collaboration

The azimuthal anisotropy of produced particles is believed to be strongly dependent on the reaction dynamics at the early stage of the collision. Anisotropy analyses at $\sqrt{s_{NN}}$ = 200 GeV have revealed significant differences in the $v_2(p_T)$ behavior of charged baryons and mesons. Photon-photon correlations carry information about the neutral pion azimuthal anisotropy and can be studied to very high p_T. The photon elliptic flow coefficients have been obtained to relatively high p_T and for diferent centrality classes via the two-particle correlation method. Identical-p_T and assorted-p_T correlation functions will be presented.

Flow 4 **Hiroshi Masui,** **Measurement of Directed flow in $\sqrt{s_{NN}} = 200$ GeV Au+Au, dAu, pp Collisions at RHIC - PHENIX**

Affiliation: University of Tsukuba

Co-authors/Collaboration: PHENIX

Directed flow pattern in the mid-rapidity region is expected to be sensitive to the formation of Quark Gluon Plasma [1]. Unlike the elliptic flow signal, the strength of the directed flow is very small at RHIC energies, which makes it challenging for the experiments. We present the first RHIC measurement of directed flow of charged hadrons with respect to the reaction plane. The measurement is done at mid-rapidity ($|\eta| < 0.35$) and forward rapidity ($3 < |\eta| < 4$) by studying the charged hadron azimuthal distribution with respect to the reaction plane. The results are obtained as a function of transverse momentum, rapidity and centrality. A systematic study in Au + Au, d + Au, p + p collisions will be presented.
[1] L.P. Csernai, D. Roehrich Phys.Lett. B458 (1999) 454

Flow 5 **Akio Kiyomichi,** **Radial Flow Study from Identified Hadron Spectra in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: RIKEN

Co-authors/Collaboration: for the PHENIX collaboration

Heavy ion collisions at relativistic energy offer the possibility of producing highly compressed strongly interacting matter, which may form the quark gluon plasma (QGP). Identified hadron spectroscopy is an important tool for studying the collision dynamics. The momentum spectra of pions, kaons, and protons are sensitive to the dynamical evolution of the system and carry information about the radial flow velocity (β_T) and thermal freezout condition.
We report the final results on the identified charged hadron spectra and yields in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV, measured by the PHENIX experiment at RHIC. The radial flow velocity and freeze-out temperature (T_{fo}) are extracted using parameterizations within a hydrodynamical framework. The centrality dependence of β_T and T_{fo} will be presented. Implications about the applicability limits of the hydrodynamics description will be discussed.

Flow 6 **Michael Issah,** **Azimuthal Anisotropy Measurements in PHENIX Via Cumulants of Multiparticle Azimuthal Correlations**

Affiliation: Chemistry Department, SUNY Stony Brook

Co-authors/Collaboration: PHENIX

The cumulant expansion of multi-particle azimuthal correlations provides an important method for making detailed studies of azimuthal anisotropy [1]. Such measurements constitute an important prerequisite for a detailed understanding of the mechanistic origin of azimuthal anisotropy at RHIC. An extensive set of such meaurements has been recently carried out at RHIC by the PHENIX collaboration. Several observables such as the scaling properties of the anisotropy and its insensitivity to the p_T range for integrated anisotropy indicate that jets are correlated with the reaction plane. Differential cumulant results obtained for both identified and unidentified charged hadrons produced in $\sqrt{s} = 200GeV$ Au + Au collisions will be presented and dicussed.
[1] Phys.Rev. C64 (2001) 054901

Flow 7 **Debsankar Mukhopadhyay,** **Elliptic Flow of ϕ Mesons in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: Vanderbilt University, Nashville, TN 37235

Co-authors/Collaboration: for the PHENIX collaboration

The ϕ meson is a very sensitive probe for studying the early stage of relativistic heavy ion collisions. The possible elliptic flow pattern in the hot and dense matter created in the high energy collision of two heavy nuclei can be strongly influenced by the formation of the Quark-Gluon Plasma and its strength can depend on the particle species.
The PHENIX experiment at RHIC, with its excellent mass resolution (comparable to or better than the natural width of ϕ mesons) and particle identification capability, can measure ϕ mesons at mid-rapidity.
We present the current status of the v_2 measurements of ϕ mesons by studying their azimuthal distribution with respect to the event reaction plane.

Flow 8 **ShinIchi Esumi,** **Analysis of Event Anisotropy and Azimuthal Pair Correlation: Looking for the Origin of Large v_2 at RHIC**

Affiliation: Inst. of Physics, Univ. of Tsukuba

Co-authors/Collaboration: PHENIX collaboration

Azimuthal anisotropy v_2 for the charged and identified particles were measured at the RHIC energies and found to be larger than for the lower energy heavy-ion collisions and to be approaching to the hydro-dynamical limit at low pt below 2 GeV/c. PHENIX experiment has used two different methods to measure the v_2: a) azimuthal pair correlation and b) with reaction plane at forward rapidities. Detailed comparison of the results from those 2 approaches will be presented in order to understand the source of the possible non-flow contributions. We also intend to combine those 2 methods to make use of both merits: non smeared pair correlation shape from a) and geometric orientation of the interaction zone from b) by measuring the azimuthal particle correlation in the mid-rapidity as a function of the relative pair orientation with respect to the reaction plane defined in the forward rapidities. We will present hadron-hadron and photon-hadron correlation and compare it with the measured v_2 of hadron and photon. The combined analysis will be used to investigate the origin of the large v_2 measured at RHIC energies.

Flow 9 **Bin Zhang, Nuclear Profile Dependence of Elliptic Flow From a Parton Cascade**

Affiliation: Arkansas State University

Co-authors/Collaboration:

We report a study of the profile dependence of elliptic flow from a parton cascade model [1]. The elliptic flow as a function of the relative rapidity density and the minimum bias transverse momentum differential elliptic flow are shown to be insensitive to whether the initial nuclear profile is binary collision scaling or wounded nucleon scaling. The two variables are thus good indicators of final state interactions. This study extends a previous hydrodynamics study [2] to highly peripheral events and the high transverse momentum region.
[1] B. Zhang et al., Phys. Lett. B 455, 45 (1999).
[2] P. Kolb et al., Nucl. Phys. A 696, 197 (2001).

Flow 10 **Chiho Nonaka, Elliptic Flow at RHIC: Fragmentation, Recombination and Hydrodynamics**

Affiliation: Duke University

Co-authors/Collaboration: R.Fries, M.Asakawa, B.Muller and S.Bass

We study the elliptic flow v_2 as a function of the transverse momentum p_T at RHIC in the recombination and fragmentation model and compare to a standard hydrodynamic calculation. We find that the behavior of v_2 as a function of p_T in recombination and fragmentation approach is dominated by the number of valence quarks of the respective hadron, leading to very similar values of the elliptic flow for all mesons and likewise for all baryons, nearly independent of the hadron mass. This feature is opposed to conventional hydrodynamic calculations. In particular we find that ϕ meson is nearly identical to that of kaons above 2 GeV/c. This suggests that the measurement of v_2 for the ϕ and Ω will allow for the unambiguous distinction between parton recombination and conventional hydrodynamics as a source of the elliptic flow. At high p_T the elliptic flow is dominated by fragmentation, leading to a universal curve above 6 GeV/c. The investigation of elliptic flow manifests the structure of hadrons, since v_2 is sensitive to the number of constitution part and fragmentation function in hadrons. Here we focus on Θ which is composed of ($uudd\bar{s}$). We propose that the measurement of v_2 as a function of p_T can reveal the structure of Θ, i.e pentaquark state or KN molecular state.

Flow 11 **Chiho Nonaka, Hydrodynamical Evolution Near Critical End Point and Its Consequences**

Affiliation: Duke University

Co-authors/Collaboration: M.Asakawa

Recently, the possibility of the existence of a critical end point (CEP) in the QCD phase diagram has attracted a lot of attention and several experimental signatures have been proposed. Berdnikov and Rajagopal discussed the growth of the correlation length near the CEP in heavy ion collisions with a schematic argument. However, there has been, so far, no quantitative study on the hydrodynamic evolution near CEP. Here we quantitatively evaluate the effect of the CEP on observables using the hydrodynamical model. First, we construct an equation of state (EOS) with CEP under the assumption that the singular behavior of EOS near CEP belongs to the same universality class as the 3-d Ising model. From the EOS we found that CEP acts as an attractor of $n_B/s = const.$ contours in the T-μ plane. This is very different from the case with the EOS of the Bag model, which is used in most of hydrodynamical models. This suggests that the effect of CEP can appear strongly in the time evolution of system and the experimental observables, and that it is not sensitive to the collision energy. Next, we investigate the time evolution and the behavior of correlation length near CEP along $n_B/s = const.$ trajectories. Furthermore, we also discuss the consequences of CEP in experimental observables such as fluctuations and the kinetic freeze-out temperature.

Flow 12 **Mate Csanad, Understanding the Rapidity Dependence of the Elliptic Flow at RHIC**

Affiliation: ELTE Dpt. of Atomic Physics

Co-authors/Collaboration: Tamas Csorgo, Bengt Lorstad

The ellipsoidally symmetric extension of Buda-Lund hydrodynamic model is shown here to yield a natural description of the pseudorapidity dependence of the elliptic flow $v_2(\eta)$, as determined recently by the PHOBOS experiment for Au+Au collisions at $\sqrt{s_{NN}} = 130$ and 200 GeV. With the same set of parameters, the Buda-Lund model describes also the transverse momentum dependence of v_2 of identified particles at midrapidity. The results confirm the indication for quark deconfinement in Au+Au collisions at RHIC, obtained from a successful Buda-Lund hydro model fit to the single particle spectra and two-particle correlation data, as measured by the BRAHMS, PHOBOS, PHENIX and STAR collaborations [1].
[1] M. Csanad, T. Csorgo and B. Lorstad, Buda-Lund hydro model for ellipsoidally symmetric fireballs and the elliptic flow at RHIC, http://arxiv.org/abs/nucl-th/0310040

Flow 13 **Paul Sorensen,** **Identified Particle Measurements at Intermediate p_T in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: Lawrence Berkeley National Laboratory

Co-authors/Collaboration: STAR Collaboration

Measurements of identified particles over a broad p_T range may provide evidence for the existence of a thermalized partonic state in heavy-ion collisions. Of particular interests is the centrality dependence and the azimuthal anisotropy in the yields of baryons and mesons at intermediate p_T. In this region, the binary collision scaled centrality ratio R_{CP} shows that baryon production increases more rapidly with system size than meson production while the elliptic flow parameter v_2 shows that the azimuthal anisotropy of baryon and meson production is large, with the baryon $v_2 \sim 3/2$ meson v_2. We present K^0_S, and Λ measurements from STAR that establish the particle species dependence of v_2 and R_{CP} up to $p_T \sim 6$ GeV/c along with charged kaon measurements up to $p_T \sim 4$ GeV/c. These measurements also establish the p_T value to which the centrality dependent enhancement of baryon production persists. In a scenario where multi-parton dynamics drive the baryon enhancement, our measurements indicate that single parton fragmentation becomes dominant above $p_T \sim 5$ GeV/c. The significance of the variation of v_2 and R_{CP} with constituent-quark number will be explored along with the evolution of R_{CP} from various centrality intervals. The phenomenology of the hadronization of the bulk partonic matter created in Au+Au collisions at RHIC will be discussed.

Flow 14 **Evgeny Zabrodin, Space-Time Development of Directed and Elliptic Flow at RHIC**

Affiliation: University of Oslo

Co-authors/Collaboration: A. Faessler, C. Fuchs, L. Bravina

Space-time picture of the anisotropic flow evolution in Au+Au collisions at BNL RHIC is studied within the microscopic quark-gluon string model. The directed flow of both mesons and baryons demonstrates wiggle structure with the universal antiflow slope at $|y| \leq 2$ for minimum bias events. Study of the centrality dependence reveals that the effect increases as the reaction becomes more peripheral. Results are compared with the scenario with quark-gluon plasma formation. The development of both components of the anisotropic flow is closely related to particle freeze-out. Our study shows that there is no sharp freeze-out in the system. Hadrons are emitted continuously, and different hadronic species are decoupled from the system at different times. These hadrons contribute differently to the formation and evolution of the elliptic flow, which can be decomposed onto three components: (i) flow created by hadrons emitted from the surface at the onset of the collision; (ii) flow produced by jets; (iii) hydrodynamic flow. Due to these features, the elliptic flows of e.g. pions and nucleons have different transverse momentum dependences. Comparison with predictions of other microscopic and macroscopic models, and experimental data is given. It appears that the centrality, rapidity, and transverse momentum dependences of the elliptic flow of hadrons, predicted by the model, agree well with the experimental data at both RHIC energies, $\sqrt{s} = 130$ and 200 AGeV.

Strange 1 **Frank Simon, Λ Production at High Rapidity in dAu and pp Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: Max-Planck-Institut für Physik, Munich, Germany

Co-authors/Collaboration: STAR

We present first studies of Lambda and Anti-Lambda production in the pseudorapidity region $2.5 < |\eta| < 4$, covered by the forward radial-drift TPCs (FTPCs) in STAR. The FTPCs provide momentum and charge determination but no particle identification, making the use of combinatorial methods and background subtraction necessary for Lambda identification. The Anti-Lambda/Lambda ratio measured at high rapidity will be compared to the ratio obtained with the STAR TPC at mid-rapidity. Differences in the ratio for different collision systems and a possible asymmetry in d+Au collisions will indicate the mechanisms which drive the anti-baryon to baryon ratio at high rapidities.

Strange 2 **Sevil Salur, Status of the Pentaquark Search at $\sqrt{s_{NN}} = 200$ GeV in pp, dAu**

Affiliation: Yale University

Co-authors/Collaboration: STAR

First observations of pentaquarks, a five quark bound system of $uudd\bar{s}$, have recently been reported in photon-nucleus and kaon-nucleus reactions.* The presence of this state was predicted by Diakonov at al. by chiral soliton models of baryons in 1997.**
The high energies and particle densities resulting from collisions at RHIC are expected to favor pentaquark production. The large acceptance of STAR's Time Projection Chamber is ideal for such rare particle searches. The short lifetimes predicted for pentaquarks require that a mixing technique be used to reconstruct the pentaquarks via their decay products. This technique has already been used successfully by STAR to reconstruct and study resonances.
We report on the progress of the pentaquark search by the STAR collaboration in pp, dAu, and AuAu collisions through the decay modes $\Theta^+ \to p + K^0$, $p^5 \to \Lambda + K^+$, and $\Sigma^5 \to \Lambda + \pi^+$. Based on SU(3) predictions these states are three of the highest isospin members of the expected antidecuplet.
*T. Nakano et al. (LEPS Collaboration) Phys. Rev. Lett. 91, 0122002 (2003); S. Stepanyan et al. (CLAS Collaboration) hep-exp/0307018; V.V. Barmin at al. (DIANA Collaboration) hep-exp/0304040
**D. Diakonov, V. Petrov and M. Polakov, Z.Phys. A359 (1997) 305-314

Strange 3 **Marcelo Gameiro Munhoz and Jun Takahashi, Results and Perspectives for Strangeness Reconstruction Using the STAR Inner Tracking Detector**

Affiliation: Universidade de So Paulo

Co-authors/Collaboration: STAR

Strangeness production has always been an important tool for the study of new phenomena in relativistic heavy ion collisions. After the first exploratory phase of RHIC operations, where measurements of the main global observables have already been made, further understanding of the collision dynamics depends on rare probes and high statistics analysis. Strangeness production at high pt, lambda HBT, and detailed studies of the flow of multi-strange baryons are some of the examples of these new studies. The STAR Silicon Vertex Tracker provides high position resolution hits for the thousands tracks produced in a heavy-ion collision at RHIC. Due to its radial proximity to the primary collision point, it enhances the reconstruction yields of secondary decay vertices and improves the signal to noise ratio of strange particle measurements. We present results on strange particle reconstruction including the SVT for p+p and d+Au data. The detector provides an enhancement of the reconstruction efficiency for decaying strange particles such as K0's, Lambda's, Xi's and Omega's. In addition, the momentum resolution improvement enhances the tracking efficiency towards higher momentum. We will also present estimates of the detector performance for the coming Au+Au run at RHIC.

Strange 4 **Mark Heinz and John Adams, Reconstruction and Correction Methods of Neutral Strange Particles in pp Collisions at $\sqrt{s} = 200$ GeV in STAR**

Affiliation: Yale University and University of Birmingham

Co-authors/Collaboration: STAR

We present methods for analysing and correcting reconstructed neutral strange particles in p+p collision data at $\sqrt{s} = 200$ GeV taken using the STAR detector. In particular as the high luminosity of the RHIC proton beams increases the probability of several collisions occurring during the drift time of the STAR Time Projection Chamber, a phenomenon known as ”pile-up”, we present methods for selecting only those tracks which originate from the triggered event. We investigate the performance of the low multiplicity primary vertex reconstruction in p+p collisions and demonstrate methods for estimating particle production from those events where the primary vertex was reconstructed incorrectly or not at all.
Finally we show spectra and multiplicity dependencies for K0Short, Lambda and Anti-Lambda that have been corrected using the above mentioned methods.

Strange 5 **Arkadij Taranenko, Λ and $\bar{\Lambda}$ Production Measured by PHENIX at RHIC**

Affiliation: SUNY Stony Brook

Co-authors/Collaboration: Phenix Collaboration

Enhancements in strangeness production and antihyperon-to-antibaryon ratios are important probes for the high-energy-density nuclear matter created in ultra-relativistic heavy-ion collisions. The PHENIX collaboration has made measurements of antibaryons, Λ and $\bar{\Lambda}$ hyperons in Au+Au collisions ($\sqrt{s_{NN}} = 200$ GeV) over a broad range of impact parameters and transverse momenta. Recent results from these measurements will be presented.

Strange 6 **Mateusz Ploskon,** **Strangeness Production at SIS Energies**

Affiliation: GSI Darmstadt / Frankfurt University

Co-authors/Collaboration: KAOS Collaboration

In-medium modifications of hadrons have been discussed as a signal for the onset of chiral symmetry restoration. The most promising evidence for the antikaon in-medium modifications is the antikaon elliptic flow. The properties of hadrons in dense nuclear matter is essential for understanding of astrophysical phenomena such as the dynamics of a supernova and the stability of neutron stars. A review of the experimental data on the production of kaons and antikaons in heavy ion collisions measured by the Kaos Collaboration are shown along with the recent results.

Strange 7 **Jean Cleymans, Particle Production Systematics in *AA*, *pA* and *pp* Collisions**

Affiliation: Univ. of Cape Town

Co-authors/Collaboration: Krzysztof Redlich

We compare recent experimental data on anti-baryon to baryon ratios in p-p, p-A and A-A collisions with statistical model calculations. The freeze-out temperature is, within experimental uncertainties, independent of the number of participating nucleons and is determined by the collision energy. We discuss the effects of the strangeness content on different particle ratios and make predictions for particle yields in N-N collisions at top SPS energies. We consider the energy dependence of the baryon/antibaryon ratio in p-p collisions in the context of recent results at RHIC. We argue that in the broad energy range from SPS to RHIC the temperatures required to describe particle yields in elementary collisions coincides with the one obtained in A-A collisions. However at mid-rapidity, the baryon densities and the corresponding chemical potentials differ substantially from those obtained from 4π measurements.

Strange 8 **Christopher van Eldik, K^* and ϕ Production in 920 GeV Proton-Nucleus Interactions**

Affiliation: Dortmund University

Co-authors/Collaboration: HERA-B

HERA-B is a fixed target experiment at the 920 GeV HERA proton beam at DESY which uses a variety of nuclear targets. Apart from a running dilepton trigger used to select events containing leptonic J/ψ decays, HERA-B recorded 200 million minimum bias triggers during the last data taking period Nov. 02-Feb. 03.
About 900,000 $K^* \to K\pi$ and 60,000 $\phi \to K^+K^-$ decays taken with the minimum bias trigger in central production ($-0.15 \leq x_F \leq 0.1$, $0 \leq p_T \leq 3.5$ GeV/c) were analyzed. They allow detailed studies of the production mechanisms of strange resonances.
First results from the 2002/2003 data sample are presented, including preliminary measurements of the K^* and ϕ cross sections in proton-nucleus collisions, their dependence on the kinematic variables, and on the atomic mass number.

Strange 9 **Tomi Zivko, Midrapidity Hyperon and Antihyperon Production in 920 GeV Proton-Nucleus Collisions**

Affiliation: J. Stefan Institute, Ljubljana

Co-authors/Collaboration: HERA-B

HERA-B is a fixed target experiment at the 920 GeV HERA proton beam at DESY which uses a variety of nuclear targets. During the last data taking period Nov. 02-Feb. 03, 200 million minimum bias events were recorded.
About 15000 charged hyperons $\Xi^-(1321)$ and 800 $\Omega^-(1672)$ over low background were reconstructed using these data. The high purity of the Ξ^- signal allowed the reconstruction of about 1500 $\Xi^0(1530)$. Preliminary results on the dependence of the production cross sections on target atomic number as well asthe asymmetries in x_F are presented for Ξ and Ω cases.

Strange 10

Karl-Tasso Knoepfle, Search for the $\theta^+(1540)$ State in Proton-Nucleus Collisions at $\sqrt{s} = 41.6$ GeV

Affiliation: MPI Heidelberg

Co-authors/Collaboration: HERA-B

Evidence for the observation of the narrow $\Theta^+(1540)$ resonance, a 1/2+ pentaquark state of strangeness +1, has been reported recently by several collaborations using incident beams of photons, kaons, neutrinos, and electrons. We report on our search for this resonance at HERA-B which is a fixed target experiment at the 920 GeV HERA proton beam at DESY using a variety of nuclear targets. The data sample consists out 200 million centrally produced minimum bias events ($x_F \sim 0$) taken during the data taking period in 2002/03. We discuss details of our analysis of the $\Theta^+ \to pK^0$ decay channel, and present first results including cross section limits for Θ^+ production on carbon and tungsten targets, limits for particle ratios like Θ^+/Λ, and compare our results with theoretical predictions.

Strange 11 **Peter Dinkelaker, System Size Dependence of Strange Hadron Production at the SPS**

Affiliation: Institut fuer Kernphysik Frankfurt

Co-authors/Collaboration: C. Hoehne and I. Kraus for the NA49 Collaboration

It is well known that the relative production of strange hadrons in central Pb+Pb collisions is enhanced over elementary p+p collisions. To study the onset of this enhancement data were taken for different nuclei (C+C and Si+Si) and minimum bias Pb+Pb.
The NA49 collaboration presents data to clarify the system size dependence at 40 and 158 AGeV. New data on the dependence of kaon production on centrality in Pb+Pb collisions at 40 AGeV will be presented. The result will be compared to the centrality dependence of other hadron species at this energy and also at 158 AGeV and the AGS energies. Scaling parameters like the number of wounded nucleons, number of collisions, energy density and collision density are tested for their relevance.
The experimental results will be compared to dynamical and statistical model approaches. In particluar, the statistical model predicts a strangeness enhancement for large systems due to the diminishing constraint from strangeness conservation with increasing volume. A different energy dependence is observed for central Pb+Pb collisions and p+p interactions. The available data will help to identify the possible onset of the observed differences and motivates a detailed energy scan program with light nuclei as a future project at the CERN SPS.

Strange 12 **Ivan Kralik, Hyperon Production in pBe Collisions at 40 GeV/c From the NA57 Experiment**

Affiliation: IEP SAS Kosice, Slovak Republic

Co-authors/Collaboration: NA57

We report results from the NA57 experiment at the CERN SPS on hyperon production at midrapidity in p-Be collisions at 40 GeV/c. Particle yields and M_T slopes are presented. The strange particle yields in p-Be ineractions give the reference points for the measurement of the strangeness enhancement in central Pb-Pb interactions.

Strange 13 **Hui Long, Centrality and Collision System Dependence of Strange Baryon Production at 200 GeV at RHIC**

Affiliation: UCLA

Co-authors/Collaboration: STAR

We present the mid-rapidity pT spectra of strange baryons from Au+Au collisions at $\sqrt{(s_N N)} = 200$ GeV as well as the results from pp and d-Au collisions at the same energy. All presented strange baryon spectra will take into account the corrections from feeddown of multi-strange hyperon decays. The centrality dependence of baryon and meson production at intermediate pT exhibits features consistent with coalescence/recombination models, which predict a strong dependence of particle yields on parton density. These models would also predict an increase of multi-strange hyperon yields if they are formed from bulk partonic matter with higher strange quark content. The strange baryon production from Au+Au collisions will be compared to those from p+p and d+Au collisions at the same beam energy. The participant scaling will be used to examine the degree of enhanced strange baryon yield in Au+Au collisions. The strange baryon enhancement at RHIC is significantly reduced compared to that at CERN SPS energies, indicating that the larger enhancement factor at the low energy might arise largely from strongly non-equilibrated strangeness yield in p+p collisions, referred to as canonical suppression factor in thermal statistical models.
Our measurement of the centrality and collision system dependence of the strange baryon production will shed light on both, the particle formation mechanism and the strangeness equilibration, of the bulk dense matter created in the collisions at RHIC.

Strange 14 **Charles F. Maguire, Measurements of the $\phi \rightarrow K^+K^-$ Decay with PHENIX in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV at RHIC**

Affiliation: Vanderbilt University

Co-authors/Collaboration: PHENIX Collaboration

With a lifetime of 44 fm/c the ϕ meson is an especially interesting probe of the possible production and properties of the Quark-Gluon Plasma in relativistic heavy ion collisions. Potential signatures of in-medium effects are changes in the mass centroid and/or resonance width of the ϕ, or modifications of the observed branching ratios between the K^+K^- and the e^+e^- channels, as a function of collision centrality.
In the RHIC Run 2001/2002 for Au+Au at $\sqrt{s_{NN}}$ = 200 GeV, the PHENIX mid-rapidity spectrometer has measured the production of the ϕ via the K^+K^- channel. Since the spectrometer has a pair mass resolution comparable to or better than the natural width we can study the mass centroid and resonance width variations as a function of centrality. The current status of this analysis will be presented.

Strange 15 **Jens Ivar Jørdre, Kaon Production in Central Au+Au Collisions at $\sqrt{s_{NN}} =$ 200 GeV**

Affiliation: Department of Physics, University of Bergen, Norway

Co-authors/Collaboration: BRAHMS Collaboration

Strangeness production has been proposed as a probe of a QGP state citerafmul. Since the bulk of produced strange and anti-strange quarks are carried by kaons their m_T and rapidity spectra will be studied, and the K/π ratio in central $Au+Au$ collisions will be compared to $p+p$, $d+Au$ and systems at lower energies. BRAHMS has measured $\pi^{\pm}, K^{\pm}, p$ and $\bar{p}$ in a wide rapidity range from central ($y \sim 0$) to the forward region ($y \sim 3.0 - 3.5$). The p_T coverage for identified kaons depends on rapidity and is in the range of $0.3 - 2$ GeV/c. m_T spectra are deduced at the various rapidities. The spectra are extrapolated with appropriate fit functions outside the BRAHMS acceptance, and rapidity densities are obtained by integrating the spectra over the full m_T range. Since $\langle p_T \rangle$ of kaons and protons exhibit a clear depencence on y, blast wave citeschned fits are performed and fit parameters are presented for different rapidities. Rapidity spectra of $\pi^{\pm}, K^{\pm}$ and $\bar{p}$ are extrapolated to 4π on the basis of Gaussian fits, and multiplicities are estimated. Particle ratios at mid-rapidity and in 4π are compared within the context of the thermal model.

Strange 16 **Richard Witt, $\langle p_T \rangle$ Systematics and Tests of m_T Scaling in $\sqrt{s} = 200$ GeV pp and AA Collisions at RHIC**

Affiliation: Yale University / University of Bern

Co-authors/Collaboration: STAR

An enhancement in the number of strange particles produced in relativistic heavy ion collisions is expected to coincide with the formation of a deconfined state of partonic matter [1]. Measurements of transverse momentum spectra for strange particles emerging from p+p collisions are used as a baseline to which similar measurements from heavy ion collisions are compared. In addition, several observations from p+p collisions, such as the variation of $\langle p_{\mathrm{T}} \rangle$ with particle mass and with event multiplicity, are interesting in their own right.
We present measurements of the transverse momentum spectra and $\langle p_{\mathrm{T}} \rangle$ systematics for strange and non-strange particles from p+p collisions at $\sqrt{s_{\mathrm{NN}}}$=200 GeV. We show a dependence of the $\langle p_{\mathrm{T}} \rangle$ with measured charged multiplicity and infer that this is consistent with a jet dominated particle production mechanism in p+p collisions.
We will also demonstrate the ability to scale the transverse mass spectra of various species onto a single universal curve for our p+p data (an effect known as m_{T}-scaling) and the failure of this scaling when applied to our Au+Au data. The results will be discussed within the context of several physical pictures such as statistical modeling [2], gluon density saturation [3], and percolation of color strings [4].
[1] J. Rafelski and B. Mueller, Phys. Rev. Lett. 48, 1066 (1982)
[2] R. Hagedorn, Nuovo Cim. Suppl. 3 (1965) 147 and 6 (1968) 169
[3] J. Schaffner-Bielich et al. nucl-th/0108048
[4] M. A. Braun et al. Phys. Rev. C 65 024907 (2002)

Strange 17 **Christopher Pinkenburg,** **Search for the θ^- with PHENIX**

Affiliation: Brookhaven National Laboratory

Co-authors/Collaboration: PHENIX

There is mounting evidence for the existance of exotic hadrons consisting of 5 quarks. Resonance states have been observed in nK^+ and pK^0_S invariant mass spectra near 1.540 GeV/c^2. These might originate from the decay of a pentaquark state (Θ^+: $udud\bar{s}$). Simple statistical considerations suggest that it is produced quite abundantly in relativistic heavy ion collisions. In addition to identifying charged particles, PHENIX has the ability to detect anti-neutrons with its highly segmented electromagnetic calorimeter. Using these capabilities we can perform a search for the Θ^- in the $\bar{n}K^-$ channel. The current state of this search will be presented.

Corr 1 **Mohamed Abdel Aziz,** **Diffusion and Net Charge Fluctuations at RHIC**

Affiliation: Wayne State University

Co-authors/Collaboration: Sean Gavin

Net charge and baryon number fluctuations can signal quark gluon plasma formation. On the other hand, diffusion and other transport phenomena can dissipate these fluctuations, hiding them from observation. We study the effect of diffusion on net charge fluctuations using a causal relativistic diffusion equation. It has long been understood that diffusive modes in the classic formulation of relativistic hydrodynamics propagate with infinite speed, violating causality. Neglect of this problem is particularly dangerous in describing phase separation, since numerical simulations show that large bubbles can form near the causal limit. We solve the causality problem by using transport theory to develop causal hyperbolic diffusion equations.
We apply the causal theory to study the near equilibrium evolution of net charge and its dynamic fluctuations. Generally, we find that the causal theory limits the effect of dissipation. We then show that 200 GeV Au+Au charge fluctuation data shows features that cannot be described by HIJING and UrQMD simulations, and discuss which features can and cannot be described by diffusion. Early work on this topic was presented in [1].
[1] M. Abdel Aziz, D. Bower and S. Gavin, Proc. 19th Winter Workshop on Nuclear Dynamics, Breckenridge, Colorado, USA, February 8-15, 2003, (EP Systema Bt., Debrecen, Hungary, 2003), 159.

Corr 2 **Richard Hollis,** **PHOBOS Cross Section Determination for $\sqrt{s_{NN}} = 200$ GeV dAu Collisions at RHIC**

Affiliation: University of Illinois at Chicago

Co-authors/Collaboration: PHOBOS Collaboration

Collision centrality plays a crucial role in the study of the physical properties of heavy ion collisions. Through an understanding of the collision geometry, it is possible to study the evolution of the collisions, in terms of the fraction of cross-section observed. PHOBOS has a unique pseudo-rapidity coverage, which enables us to use very different regions of phase space to make this measurement. For the recent deuteron on gold collisions at RHIC, PHOBOS used seven methods to calculate the percentile of cross-section bins, yielding consistent results. We will demonstrate the power of finding this cross-section through these various methods and the physics results from these studies.

Corr 3 **Aneta Iordanova,** N_{part} **Determination and Systematic Studies for** $\sqrt{s_{NN}} =$ 200 **GeV dAu Collisions in PHOBOS.**

Affiliation: University of Illinois at Chicago

Co-authors/Collaboration: PHOBOS Collaboration

The number of participating nucleons and the number of nucleon-nucleon collisions in heavy ion interactions cannot be directly observed. PHOBOS determines these quantities through mapping measured variables to their simulated values and distributions. This procedure enables us to cross-reference results across experiments, independent of the details of the measurement. We will present our method for determining Npart, in $\sqrt{s_{NN}}$ = 200 GeV d+Au collisions, and the systematic errors associated with the resulting values.

Corr 4 **Tomoaki Nakamura,** **Measurement of Fluctuations in Event-by-Event $N_{\mathrm{ch}} - N_{\gamma}$ Balance**

Affiliation: Hiroshima University

Co-authors/Collaboration: PHENIX Collaboration

Event-by-event fluctuations of the balance between the number of charged particles (N_{ch}) and photons (N_{gamma}) have been measured in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV by the PHENIX experiment at RHIC. The aim of this study is to search for a signature of the chiral phase transition. PHENIX has the unique capability to measure N_{charge} and N_{gamma} on an event-by-event basis. Given a multiplicity set (N_{charge}, N_{gamma}) per event, the sizes of fluctuations on the balance in variable space positions and space sizes, were measured by quantifying the fluctuations based upon the simplest binomial hypothesis. The fraction of events to minimum bias events, which have large fluctuations compared to the binomial baseline, was found to be strongly dependent on the number of participants. We will discuss the possible sources of the fluctuations.

Corr 5 **Duncan Prindle,** **Extracting Two-Particle Correlations from Fluctuation Measurements**

Affiliation: University of Washington

Co-authors/Collaboration: Jeff Porter, Tom Trainor

In heavy ion collisions, nonstatistical fluctuations in globally-measured quantities (e.g., total multiplicity, net charge, event-wise $\langle p_t \rangle$) arise from correlations that develop during the collision process. Fluctuation measurements, typically performed using the full momentum-space acceptance of a given experiment, have been proposed to study critical phenomena such as might arise from (local) QGP formation and subsequent hadronization. Two-particle correlations, however, depend strongly on momentum-space differences such as q_{inv} or axial-space differences $(\phi_\Delta \equiv \phi_1 - \phi_2, \eta_\Delta \equiv \eta_1 - \eta_2)$. As a result, fluctuation amplitudes, representing integrals of such correlations, also depend strongly on the size (scale) of momentum-space boundaries: fluctuations are determined by the net correlation strength integrated on difference variables within a boundary scale. In this work we relate this scale dependence of fluctuations directly to two-particle correlations by a Fredholm integral equation, in which the integral is a scale-dependent variance difference and the integrand is a net autocorrelation density distributed on $(\phi_\Delta, \eta_\Delta)$. Autocorrelations are thereby extracted from fluctuation data measured as a function of scale using a standard numerical inversion technique applied to the integral equation. We describe the numerical methods used in this process and provide examples of the technique applied to simulated data from Hijing and Pythia event generators. We compare those results to directly-measured autocorrelations derived more conventionally from ratios of same-event to mixed-event particle pair numbers.

Corr 6 **Duncan Prindle, Large-Scale Two-Particle p_T Correlations in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV Obtained by Inversion of $\langle p_T \rangle$ Fluctuation Scale Dependence**

Affiliation: University of Washington

Co-authors/Collaboration: STAR

We report measurements of large-scale, charge-independent two-particle p_t correlations on axial momentum components (η, ϕ) inferred from event-wise $\langle p_t \rangle$ fluctuation scaling with $p_t \leq 2$ GeV/c in 200 GeV Au-Au collisions. Recently-observed nonstatistical $\langle p_t \rangle$ fluctuations can be attributed to event-wise and/or intra-event variation of a sampled inclusive parent p_t distribution [1]. Variation of excess $\langle p_t \rangle$ fluctuations with binning scale (bin sizes $\delta\eta, \delta\phi$) are simply related to the integral of a two-particle *autocorrelation* distribution which can be numerically inverted to obtain the autocorrelation. From fluctuation scaling measurements we thus obtain p_t autocorrelations on joint difference variables $(\eta_\Delta \otimes \phi_\Delta)$ (em e.g., $\eta_\Delta \equiv \eta_1 - \eta_2$) for a minimum-bias sample of 200 GeV Au-Au collisions. By analogy with inclusive one-dimensional p_t distributions we expect the structure of such p_t autocorrelations to be determined by some combination of temperature and velocity (em e.g., collective flow) two-point correlations on hadronic and prehadronic media. We indeed observe highly structured autocorrelation distributions, minijets being a possible contributing mechanism. We find that with increasing centrality the away-side peak structure is dramatically reduced, while the same-side peak is narrowed on ϕ_Δ and broadened on η_Δ, suggesting substantial alteration of minijet structure by a dissipative medium. Those p_t correlations may provide, through correlation structure of low-p_t hadrons, quantitative new information about response of the medium to minijet 'color probes.'

Corr 7 **Mikhail Kopytine, In-Medium Minijet Dissipation in Au+Au Collisions at $\sqrt{s_{NN}} = 130$ and 200 GeV Studied with Charge-Independent Two-Particle Number Fluctuations and Correlations**

Affiliation: Kent State University

Co-authors/Collaboration: for the STAR Collaboration

Medium effects on charged-particle production from minijets are studied using three complementary analysis techniques. We find significant angular collinearity and number correlations on p_t even at moderate $p_t < 3$ GeV/c. In this p_t range abundant particle multiplicities enable precision measurements of number correlations of non-identified hadrons for kinematic variables (p_t,η,ϕ). Methods include (1) direct construction of two-particle correlation functions, (2) inversion of the bin-size dependence of non-statistical multiplicity fluctuations and (3) two-dimensional discrete wavelet analysis.
Two-particle correlations on p_t exceed expectations from a model of equilibrated events with fluctuating global temperature. A correlation excess at higher p_t is interpreted as final-state remnants of initial-state semi-hard collisions. Lower-p_t correlations exhibit a saddle structure varying strongly with centrality. Variations in the forms and relative strengths of low and high p_t correlations with increasing centrality suggest transport of semi-hard collision products into the lower p_t region as a manifestation of in-medium dissipation of minijets.
Correlations on p_t can be associated with angular correlations on (η,ϕ), using analysis methods (1), (2) or (3). In particular, wavelet analysis (3) is performed in the (η,ϕ) space in bins of p_t (< 2 GeV/c). Observed angular correlation structures include those attributed to quantum correlations and elliptic flow, as well as a localized structure, increasing in amplitude with p_t, and presumed to originate with minijets. That structure evolves with increasing centrality in a way which also suggests dissipation, including an increased correlation length on η which may be related to the influence of a longitudinally expanding medium on minijet fragmentation.

Corr 8 **R. Lanny Ray, The Geometry of Hadronization in Au+Au Collisions at $\sqrt{s_{NN}} = 130$ and 200 GeV Studied with Charge-Dependent, Two-Particle Number Fluctuations and Correlations**

Affiliation: University of Texas at Austin

Co-authors/Collaboration: STAR Collaboration

Charge-dependent (like-sign − unlike-sign pairs) number fluctuations and correlations in Au-Au collisions at $\sqrt{s_{NN}}$ = 130 and 200 GeV reveal large-scale two-particle correlations in the form of autocorrelation distributions on azimuth and pseudorapidity difference variables $\phi_\Delta \equiv \phi_1 - \phi_2$ and $\eta_\Delta \equiv \eta_1 - \eta_2$. We obtain those distributions *via* two analysis methods: 1) direct determination using same-event pair/mixed-event pair ratios and 2) inversion of the scale (bin size) dependence of nonstatistical net-charge fluctuations by a standard numerical technique. The two methods are complementary and permit consistency checks. Dramatic centrality dependence of charge-dependent correlation structure is observed. Structure in the most peripheral Au-Au collisions agrees with that observed in p-p collisions, varying predominantly on η_Δ, and consistent with expectations based on local charge and momentum conservation during fragmentation of one-dimensional color strings (Lund model). Correlation structure for more central Au-Au collisions transitions to a symmetric form on $(\eta_\Delta, \phi_\Delta)$ with reduced correlation length, increased amplitude, and exponential shape, suggesting surface emission from an opaque medium. Variation of charge-dependent correlation structure with transverse rapidity is also studied to compare contributions due to fragmenting longitudinal color strings (p-p) or bulk medium (A-A) and those due to transverse minijets (semi-hard parton scattering).

Corr 9 **Jeff Porter,** **Soft and Semihard Components in pp Collisions at $\sqrt{s} = 200$ GeV**

Affiliation: University Of Washington

Co-authors/Collaboration: STAR

We report measurement of large-scale, two-particle number correlations on momentum components y_t (transverse rapidity with pion mass assignment), η and ϕ for 200 GeV p-p collisions. We observe two distinct contributions to correlation structure: string and minijet (soft and semihard) fragmentation. Those two components are separable on two-particle correlation space $y_t \otimes y_t$, which serves as a cut space for further study of correlation structure in pair-ratio (same-event pairs/mixed-event pairs) distributions on $(\eta \otimes \eta)$, $(\phi \otimes \phi)$ and projections onto joint difference variables $(\eta_\Delta \otimes \phi_\Delta)$ (*e.g.*, $\eta_\Delta \equiv \eta_1 - \eta_2$). Pair-ratio distributions are determined for like-sign (LS) and unlike-sign (US) charge combinations and for charge-independent (CI = LS + US) and charge-dependent (CD = LS - US) combinations. CI and CD correlations for the soft component are in qualitative agreement with Lund-model string phenomenology. CI angular correlations on $(\eta_\Delta \otimes \phi_\Delta)$ for the semihard or minijet component depend strongly on event multiplicity and on $y_t \otimes y_t$ cuts (*i.e.*, minijet angular correlations are strongly dependent on the cut-surviving fragment distribution along the minijet thrust axis). Charge-ordering along the thrust axis, associated with local charge conservation in axial string fragmentation models, is indicated by the structure of minijet-related CD angular correlations. Such detailed studies of p-p minijet structure provide an essential reference for A-A collisions. Direct comparison is made to a similar analysis of Pythia events.

Corr 10 **N.N. Ajitanand, Flavor Composition of Jets From Two Particle Correlations in pp, dAu and Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: SUNY Stony Brook

Co-authors/Collaboration: PHENIX Collaboration

Azimuthal correlation measurements provide a powerful probe for the high energy-density nuclear matter produced in heavy ion collisions at RHIC. Recent measurements of such correlation functions at anisotropy and asymmetry of baryons and mesons with reference to leading high pt hadrons. These differences can provide valuable insights into the relative importance of hadronic and partonic content of flow and jet contributions as well as possible in-medium modifications. Correlation functions for p+p, d+Au and Au+Au collisions as well as jet and flow properties obtained from a deconvolution procedure, will be presented.

Corr 11 **Elena G. Ferreiro,** **Transverse Momentum Fluctuations and Percolation of Strings**

Affiliation: University of Santiago de Compostela, Spain

Co-authors/Collaboration: F. del Moral and C. Pajares

The behaviour of the transverse momentum fluctuations with the centrality of the collision shown by the Relativistic Heavy Ion Collider data is naturally explained by the percolation of color strings. In this framework, the p_T fluctuations are originated by the formation of clusters of overlapping color strings. Each cluster decays into particles with a mean transverse momentum that depends on the number of strings of the cluster, and the area occupied by the cluster. The transverse momentum fluctuations in this approach correspond to the fluctuations of the transverse momentum of these clusters.

Corr 12 **Aram Mekjian, Models of Particle Probability Distributions for High Energy Collisions**

Affiliation: Rutgers University

Co-authors/Collaboration:

Various phenomenological models of particle multiplicity distributions are developed using an approach based on a grand canonical ensemble and Feynman's path integral density matrix approach to statistical mechanics. A wide range of phenomena can be discussed in a unified way. Various processes and effects such as thermal emission from heated hadronic matter, Bose-Einstein enhancement of Poisson distributions, chaotic field emission from Lorentzian line shapes, and signal-noise models with Poisson and negative binomial limiting distributions are developed in this framework. The approach has three parameters: a,x,z. The parameter a plays a role similar to a Fisher critical exponent called tau, well known in describing cluster yiels at a critical point. The importance of the paramter a, or it's equivalent tau, will be discussed. For thermal models, the parameter x can be related to the size of the emitting region and its temperature, while the parameter z involves Boltzmann factors in the mass of the emitted particle. Thermal models applied to RHIC collisions give rise to Gaussian distribtions- a result obtained by recurrence relations that arise in this approach. The width of the Gaussian distribtion is of the order of 10-15% larger than Poisson and this enhancement comes from Bose-Einstein correlations. Moments of the distribtion can be related to sum rules. Moreover, correlations in the density matrix approach can be related to the cycle class decomposition of the symmetric group. Cycles of length 2,3,... result in departures from Poisson statistics. Cycles of length 2 give rise to HBT correlations which will be discussed.

Corr 13 **Jørgen Randrup,** **Spinodal Instability and Phase Separation**

Affiliation: LBNL

Co-authors/Collaboration:

The expansion of strongly interacting matter formed in high-energy nuclear collisions drives the system through the region of energy density where the hadronic-gas and the quark-gluon plasma phases coexist. The associated spinodal instability amplifies irregularities and presents a dynamical mechanism for the phase separation. Using a simple spline technique, we derive an approximate equation of state for the coexistence region and make a quantitative analysis of the resulting spinodal growth, with a view towards utilizing the emergence of spinodal patterns as a diagnostic tool for probing the hadronization phase transition.

Corr 14 **Tapan K. Nayak and Bedangadas Mohanty, Evolution of Fluctuations in Relativistic Heavy Ion Collisions**

Affiliation: Variable Energy Cyclotron Centre, 1/AF Bidhan Nagar, Kolkata 700 064, India

Co-authors/Collaboration: Jan-e Alam

The space-time evolution of the fluctuations in the net baryon number for different initial conditions have been studied. For realistic equation of state (EOS) the initial fluctuation is substantially dissipated at the freeze-out stage. At SPS energies the fluctuations in net baryon number at the freeze-out stage for quark gluon plasma and hadronic initial state is close to the Poissonian noise for ideal as well as for EOS obtained by including heavier hadronic degrees of freedom. For EOS obtained from the parametrization of lattice QCD results the fluctuation is larger than Poissonian noise. It is also observed that at RHIC energies the fluctuations at the freeze-out point deviates from the Poissonian noise both for ideal and realistic equation of state, indicating presence of dynamical fluctuations.

Corr 15 **Wojciech Florkowski,** **Balance Functions in a Thermal Model with Resonances**

Affiliation: INP Cracow /AS Kielce

Co-authors/Collaboration:

We compute balance functions for the pi+ pi- pair production within a thermal approach. Two contributions, from resonances and from the background thermal pions, are considered. The obtained widths of the balance functions compare favorably to the average experimental values, however, we find very weak dependence on the centrality parameter.

Corr 16 **Christian Holm Christensen, Fluctuations in Charged Particle Production in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: Niels Bohr Institute

Co-authors/Collaboration: BRAHMS

Fluctuations in particle production in relativistic heavy ion collisions has received attention as a possible signature for the QGP phase transition [1, 3]. Large fluctuations in the particle production is expected to result from a mixed phase where the active QGP 'droplets' sit in a comparably inactive hadron gas background.
In this talk, the fluctuations in charged particle production in central Au + Au collisions at $\sqrt{s_{NN}}$ = 200 GeV at RHIC, as measured at BRAHMS, is presented. The measurements are done with the central multiplicity array [2] of BRAHMS, consisting of separate silicon strip detectors and scintillator tile elements. The scintillator tiles are used to establish the centrality of the reaction. A fluctuation signal is then determined based on the total energy deposited in the silicon detectors for different pseudorapidity ranges and for different centrality classes. Contrary to the expectations of models that include a mixed phase, preliminary studies show no large scale fluctuations within the systematic errors.
The feasibility of similar studies using the ALICE detector at the LHC will be discussed, in particular with respect to the Forward Multiplicity Detector [4] built at the Niels Bohr Institute.
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Corr 17

Panagiotis Christakoglou, Charge Fluctuations and Correlations in Pb+Pb, Si+Si and pp Collisions at 20-158 GeV Beam Energies at the CERN SPS (NA49)

Affiliation: University of Athens

Co-authors/Collaboration: G. Farantatos , M. Gazdzicki , A. Petridis , M. Vassiliou , J. Zaranek for the NA49 Collaboration

The charge fluctuations and the correlations are studied for p + p , Si + Si and Pb + Pb collisions with the NA49 large acceptance detector at the CERN - SPS.
The measure of charge fluctuations $\Delta\Phi_q$ is studied as a function of the rapidity interval in an energy scan from 20 to 158 AGeV Pb + Pb collisions. The results are discussed in view of their significance as a signal of the deconfinement.
Also , long range charged particle correlations are studied using the Balance Function method. The results on p + p , Si + Si and centrality selected Pb + Pb interactions at 40 and 158 AGeV are presented. The width of the Balance Function decreases with increasing centrality of the collision , which could suggest a delayed hadronization scenario.

Corr 18 **Gopika Sood,** **Fluctuations in Charged Particles and Photons Produced in Pb+Pb Collisions at** 158 *A***GeV**

Affiliation: Physics Department, Panjab University, Chandigarh 160014, India

Co-authors/Collaboration: WA98

The WA98 experiment data have been analysed on an event-by-event basis to look for non-statistical fluctuations in pseudorapidity and in azimuth seperately for charged particles and photons produced in Pb-Pb collisions at the CERN SPS. The photons were obtained from the Photon Multiplicity Detector. The charged particles were measured by the Silicon Pad Multiplicity Detector. The analysis has been carried out on 196K top 15% central events. The Power Spectrum (PS) technique [1] is used to filter out the events with large non-statistical fluctuations. The threshold value for the number of peaks in PS with heights exceeding $\langle\psi(\omega)\rangle + 4 \cdot D_{\psi}(\omega)$ to label an event as exotic having large non-statistical fluctuations was determined using the mixed events [2]. About 2% events have been filtered in the data which have shown large non-statistical fluctuations in azimuthal space for the charged particles in each centrality bin (i.e., top 5%, top 5-10 % and top 10-15%). We have found 0.7% events showing large fluctuations in azimuth for the photons in each centrality bin. Events exhibiting large non-statistical fluctuations in pseudorapidity separately for charged particles (2.98%) and photons (7.14%) have also been found in the top 5% central events. Results have been compared with the mixed events and the simulated events.

References

[1] F. Takagi, Phys. Rev. Lett., 53 (1984) 427; A.C. Das and Y.P. Viyogi, Phys. Lett. B380 (1996) 437.

[2] M.M. Aggarwal, V.S. Bhatia, A.C. Das and Y.P. Viyogi, Phys. Lett., B438 (1998) 357.

Corr 19 **John G. Cramer,** **The Pion Entropy and Phase Space Density of Au+Au Collisions at $\sqrt{S_{NN}} = 130$ GeV at RHIC**

Affiliation: University of Washington

Co-authors/Collaboration: STAR

We present estimates at midrapidity of the source-averaged pion phase space density ¡f¿, the entropy per particle S/N, and the net entropy dS/dy contained by pions in six momentum intervals and seven centrality intervals, for $\sqrt{s_{nn}}$=130 GeV Au+Au collisions at RHIC. These quantities are inferred from measured pi^- momentum spectra and HBT analysis of pion data from the STAR detector. The average phase space density for central collisions is quite high, roughly twice that observed for central collisions at the CERN SPS with $\sqrt{s_{nn}}$=17 GeV Pb+Pb collisions. The S/N is consistent with thermal estimates with a significant pion chemical potential, and dS/dy grows linearly with participant number and shows no evidence of nonlinear growth with increasing centrality.

Corr 20 **Ludwik Turko, Constrained Kinetics and Internal Symmetry Driven Correlations**

Affiliation: University of Wroclaw

Co-authors/Collaboration:

We consider the dynamics governing the evolution of a many body system constrained by a nonabelian local symmetry. Internal microscopic symmetry of a many body system leads to global constraints. The condition to preserve a given representation of the symmetry group of the system leads to new constraints for the kinetic equations. This gives subsidiary correlations which influence particle multiplicities and equilibration of the system. Heavy ion collision is a particular example for such behaviour with strong interaction symmetries taken into account. We obtain explicit forms of the global macroscopic condition assuring that at the microscopic level the evolution respects the overall symmetry.

Corr 21 **Larisa Bravina,** **Freezeout of Hadrons at AGS, SPS, and RHIC: Differences and Similarities**

Affiliation: University of Oslo

Co-authors/Collaboration:

The freeze-out conditions in the colliding system of heavy nuclei at AGS, SPS, and RHIC energies are analyzed within the microscopic transport model. For all energies a clear separation of the elastic and inelastic freeze-out is observed. The system of final particles can be well represented as a core, containing the particles which are still interacting with each other, and a halo, in which the particles have already decoupled from the system. The shapes of the emitting sources are far from the Gaussians. Pions are continuously emitted from the whole reaction volume and reflects the main trends of the system evolution. At RHIC, however, significant fractions of both mesons and baryons are emitted from the surface region within the first two fm/c. The mesons with large transverse momenta are predominantly produced at the early stages of the reaction, whereas the low-p_t component is populated by mesons coming from the decay of resonances. Different species decouple at different times. For instance, strange particles are frozen at earlier times and, therefore, can probe earlier stages of the reaction. Results obtained are compared with the available experimental data and with predictions of other microscopic and macroscopic models. Possible explanation of the HBT puzzle at RHIC is given.

Corr 22 **Claude A. Pruneau,** **Excitation Function of $\langle p_T \rangle$ and Net Charge Fluctuations at RHIC**

Affiliation: Wayne State University

Co-authors/Collaboration: STAR

We will report on our study of the incident energy dependence of $\langle p_t \rangle$ and net charge fluctuations in Au+Au collisions at RHIC. Net charge fluctuations are measured in terms of $\nu_{+-,\mathrm{dyn}}$ and the scaled fluctuations $(dN/d\eta)\nu_{+-,\mathrm{dyn}}$ whereas $\langle p_t \rangle$ fluctuations measurements are based on the variables $\langle \Delta p_{t;i} \Delta p_{t;j} \rangle$, $(dN/d\eta)\langle \Delta p_{t;i} \Delta p_{t;j} \rangle$, and $\sqrt{\langle \Delta p_{t;i} \Delta p_{t;j} \rangle}/\langle p_t \rangle$. Fluctuations were measured as a function of centrality for Au+Au collisions at $\sqrt{s_{NN}}$ = 20,130, and 200 GeV at RHIC using STAR. The scaled net charge fluctuations $(dN/d\eta)\nu_{+-,\mathrm{dyn}}$ exhibit a finite collision centrality dependence but little (if any) beam energy dependence. In contrast, the quantity $(dN/d\eta)\langle p_{t;i} p_{t;j} \rangle$ increases with beam energy, and changes with collision centrality. However, $\sqrt{\langle \Delta p_{t;i} \Delta p_{t;j} \rangle}/\langle p_t \rangle$ show little dependence on beam energy and decreases with increased centrality. We will compare the measurements with predictions from filtered HIJING, URQMD, and RQMD calculations. Comparisons will also be made with similar results from the SPS. Estimates will be presented for the contribution of short range correlations to the measured correlations. The dependence of the mean p_t and charge correlations on the particle pseudorapidities, η_1 and η_2, will be also presented and discussed.

Corr 23 **Jeffery T. Mitchell,** **Simulations of Jet Contributions to Event-by-Event $\langle p_T \rangle$ Fluctuations in Relativistic Heavy Ion Collisions**

Affiliation: Brookhaven National Laboratory

Co-authors/Collaboration:

Event-by-event fluctuations of the average transverse momentum of produced particles near mid-rapidity have been measured by several experiments at RHIC and the SPS. Fluctuations are observed to be in excess of the expectation for statistically independent particle emission in most measurements. The excess fluctuations exhibit a dependence on the centrality and on the p_T range over which $\langle p_T \rangle$ is calculated. This dependence is shown to be well reproduced by a PYTHIA-based simulation with a single varying parameter, which is a hard process probability factor that must be scaled by measurements of the nuclear modification factor R_{AA}, in the case of RHIC results. The simulation results imply that the predominant contribution to the fluctuation excess may be due to jets that are suppressed in the most central collisions at RHIC energies. The simulation will be compared to results from PHENIX, STAR, CERES, and NA49.

Corr 24 **Jean Barrette,** **Microscopic Model Predictions of Charged Particle Fluctuations and Correlations at RHIC**

Affiliation: McGill University, Montreal, Canada

Co-authors/Collaboration: C. Gale,S. Jeon,V. Topor Pop,Q. H. Zhang,J. Heiningen, S. Friedmann

Large Charged particle event-by-event fluctuations have been considered as a possible signature of QGP formation in ultrarelativistic heavy ion collisions. We study the role of fluctuation and correlation measurements in understanding the dissipation properties of a color-deconfined medium using HIJING v1.37 which implements pQCD minijet production together with estimates of effects of nuclear shadowing and jet quenching. For comparison we present also the results obtained with RQMDv2.4 which does not include minijet production but has instead a parton cascade algorithm including enhanced strangeness and baryon production via rope formation as well as final state hadronic interactions(rescattering). Rewriting the charge fluctuations and balance function using the correlation function, the predictions of some Event Generators are discussed and a qualitative comparison with available experimental data is performed. It is found that the charge fluctuations depend only slightly on collision centrality and on the change of reaction energy and also are not strongly affected by the final state interaction included in RQMD. Both model HIJING and RQMD cannot predict the reduction with increassing centrality in the width of the balance function seen in the STAR data. Event-wise mean transverse momentum fluctuations for all charged particles in Au+Au collision at RHIC energies within HIJING v1.37 are also studied and compared to PHENIX data at $\sqrt{s_{NN}}$=200 GeV in order to investigate if combined effects of nuclear shadowing and jet quenching could provide a signature for genuine dynamical fluctuations.

Corr 25 **Madan M. Aggarwal, Event-by-Event Search for Charged-Neutral Fluctuations in the WA98 Experiment at CERN SPS**

Affiliation: Physics Department, Panjab University, Chandigarh 160014, India

Co-authors/Collaboration: WA98

A simple and elegant method has been developed to look into microscopic details of charged-neutral fluctuations in the WA98 experiment in order to study the Disoriented Chiral Condensates (DCCs). The neutral pion fraction, $f \approx \frac{N_{gamma-like}/2}{N_{gamma-like}/2+N_{\rm ch}}$ is calculated for an assumed window in azimuth in each event and its fluctuation is studied. In an event a patch having maximum value of f is referred to as f_{max}. The $N_{gamma-like}$ hits are measured by the photon multiplicity detector and N_{ch} hits are measured by the silicon pad multiplicty detector. A total of 196K events of top 15% centrality have been analysed.
Statistical significance of these events have been studied by comparing with simulated events obtained using the VENUS event generator processed through GEANT 3.21 (referred to as V+G) and with mixed events. It is seen that the f_{max} distribution for the data extends to much larger values than mixed events and V+G events in all the three azimuthal windows(i.e., 40°, 60° and 90°), indicating large charged-neutral fluctuations in data which may have non-statistical origin. Focusing attention on the set of events having $f_{max} > 0.55$, the f-distribution of the immediate preceding and succeeding events in the data in the same $\eta - \phi$ patch shows a behaviour similar to that of generic events. This check excludes possibility of detector artifacts. The events with $f_{max} > 0.55$ are possibly special events having large non-statistical charged-neutral fluctuations and resembling the anti-centauro type events observed in cosmic ray expriments.
The experimental results have been compared with a simple DCC model. The data are found to be closer to the model when momenta of DCC pions are low.

Corr 26 **Joern Putschke, Charged Particle and $\langle p_T \rangle$ Distribution Studies in pp, dAu and Au+Au at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: Max-Planck-Institut fuer Physik

Co-authors/Collaboration: STAR Collaboration

The centrality and η dependence of particle multiplicity density and transverse momenta spectra for the STAR TPC and FTPC acceptance will be reported for p-p, d-Au and Au-Au collisions at $\sqrt{s_{NN}}$ = 200 GeV. The measurements of the centrality dependence of $dN/d\eta$ and transverse momentum spectra from mid-rapidity to forward rapidity in d+Au collisions provide a sensitive tool to understand the dynamics of multi-particle production in the high parton density regime. Also, measurements of the color string density parameter (ρ) inferred from the transverse momentum distributions in the STAR TPC acceptance will be shown. In two dimensional percolation, the critical value of ρ is $\rho_c \simeq$ 1.12-1.20 [1]. For d-Au, ρ is 0.95 while for p-p it is 0.5. In the case of Au+Au, ρ is 1.8, which, in this picture, is above the percolation phase transition, satisfying a necessary condition for forming a connected partonic system that can lead to a QGP phase.
In addition, first results of $< p_t >$ forward/backward and multiplicity correlations in Au+Au, d+Au and pp collisions at $\sqrt{s_{NN}}$ = 200 GeV and their centrality dependence in a wide range of pseudorapidity of approximately 8 units will be shown.
In combination the results are compared with model predictions including the percolation color string approach [2].
[1] M.B. Isichenko, Rev. Mod. Phys. 64, 961 (1992).
[2] M.A. Braun and C. Pajares Eur. Phys. J. C16, 349 (2000)

Corr 27 **Katarzyna Perl[1] and Maciej Rybczynski[2], System size dependence of mean p_T and multiplicity fluctuations at 158 GeV beam energy**

Affiliation: [1]Institute for Experimental Physics, University of Warsaw, Poland and [2]Institute of Physics, Swietokrzyska Academy, Kielce, Poland

Co-authors/Collaboration: NA49 Collaboration

The system size dependence of event-by-event transverse momentum and multiplicity fluctuations of particles produced in A+A collisions at 158 *A*GeV is presented. The final results on event-by-event fluctuations in transverse momentum of forward rapidity charged particles, produced in p+p, C+C, Si+Si and Pb+Pb collisions at 158 *A*GeV are shown. Three different characteristics are discussed: average transverse momentum ($M(p_T)$) of the event, the Φ_{p_T} measure and two-particle transverse momentum correlations. The data are compared with predictions of models. Dynamical fluctuations have been found to be rather small in this kinematic region (all Φ_{p_T} values are below 10 MeV/c). However, a significant system size dependence of Φ_{p_T} measure is observed with a maximum value for the most peripheral Pb+Pb interactions ($N_W \approx 40$). In addition to transverse momentum fluctuations the first results on multiplicity fluctuations as a function of centrality for 158 *A*GeV is presented. The data indicate a non-monotonic dependence with the maximum for semi-peripheral Pb+Pb interactions ($N_W \approx 85$). The experimental results are compared with predictions of the HIJING model of nuclear interactions.

HBT 1

Dmitri Peressounko, Measurement of Direct Photon Correlations in Pb+Pb Collisions at LHC with the ALICE/PHOS Spectrometer

Affiliation: RRC ”Kurchatov Institute”

Co-authors/Collaboration: ALICE

Bose-Einstein correlations of direct photons provide the unique possibility to explore the dynamics of the early stage of ultrarelativistic heavy-ion collisions and the core evolution of the hot and dense system, created in these collisions.
However, measurement of direct photon correlations in ultrarelativistic heavy ion collisions is a very challenging task. The expected strength of the correlation signal will be extremely weak, at the level of 0.1-2%, depending on average transverse momentum of the pair. Extraction of the two-photon correlation function with such aprecision requires a very detailed understanding of the properties of the detector and of the performance of the reconstruction procedure.
Using the AliRoot package, the simulation and reconstruction software of the ALICE experiment, we have evaluated the possibility to measure Bose-Einstein correlations of direct photons with the photon spectrometer PHOS of the ALICE experiment.

HBT 2 **Chia Ming Kuo, Extraction of HBT Parameters Using the PHOBOS Detector**

Affiliation: PHOBOS Collaboration

Co-authors/Collaboration:

The technique of Hanbury-Brown and Twiss (HBT) interferometry is extensively used to provide insight into the space-time evolution of the particle emitting source in heavy ion collisions. The PHOBOS experiment, consisting of a two-arm magnetic spectrometer constructed from silicon detectors, is being used to perform HBT studies at RHIC. This poster will primarily detail the technical aspects of these measurements, including systematic studies of corrections originating from acceptance, detector resolution, and the Coulomb force. A summary of the results of HBT source parameterizations will also be presented.

HBT 3 **David Brown, Three-Dimensional Imaging Analysis of Two-Particle Correlations in Heavy-Ion Reactions**

Affiliation: LLNL

Co-authors/Collaboration: P. Danielewicz, M. Heffner, R. Soltz

We report an extension of the source imaging method for imaging full three-dimensional sources from three-dimensional like-pair correlations. Our technique consists of expanding the correlation data and the underlying source function in spherical harmonics and inverting the resulting system of one-dimensional integral equations. With this method of attack, we can image the source function quickly, even with the extremely large data sets common in three-dimensional analyses. We apply our method to the recently measured E859 Coulomb corrected and un-Coulomb corrected data. We find broad agreement with the Gaussian parameterizations of these correlations, but em without applying an ad-hoc Coulomb correction. We comment how this technique may be applied to resolve the so-called RHIC “HBT-anomaly.”
This work was performed under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.
UCRL-JC-155493-ABS

HBT 4 **Andras Ster, Indication for Quark Deconfinement and Evidence for a Hubble Flow in Au+Au Collisions at RHIC**

Affiliation: MTA KFKI RMKI

Co-authors/Collaboration: M. Csanad, T. Csorgo and B. Lorstad

We describe simultaneously the transverse mass dependence of the HBT radii and the identified single particle spectra of pions, kaons and protons in Au+Au collisions at RHIC, as measured by STAR and PHENIX, using the Buda-Lund hydro model. With the same set of parameters, the model also describes the pseudo-rapidity distribution of charged particles, as measured by PHOBOS and BRAHMS. The agreement with data is achieved with a set of model parameters, that indicate the presence of a hot region with $T > T_{crit}$ in the middle of the reaction, that implies quark deconfinement in Au+Au collisions at RHIC. The results also provide evidence for a fully developed three dimensional Hubble flow in the final state of these reactions.
Refs: 1) M. Csanad, T. Csorgo, B. Lorstad and A. Ster, Proc. ISMD 2003, http://th-www.if.uj.edu.pl/ismd2003/Talks/Ster.ppt
2) T. Csorgo and A. Ster, nucl-th/0207016, Heavy Ion Phys. 17 (2003) 295

HBT 5 **Kenji Morita,** **Is Pion Emission Chaotic at RHIC?**

Affiliation: Waseda University

Co-authors/Collaboration: Shin Muroya and Hiroki Nakamura

We investigate how pions are emitted in the final state of the 130*A* GeV Au+Au collisions at RHIC. By making use of three different models of pion emission, we analyze two- and three-pion correlation data measured by the STAR collaboration. The models give consistent results after long-lived resonance decay corrections for 2π correlation. We show that pion emission at the RHIC energy is mostly chaotic. However, coherence is still needed for an explanation of the data.

HBT 6 **Thomas D. Gutierrez,** **Pion HBT from pp and dAu Collisions at RHIC**

Affiliation: University of California, Davis

Co-authors/Collaboration: STAR

Bose Einstein correlations (HBT) from pions produced in p-p and d-Au collisions at $\sqrt{s} = 200$ GeV are presented using data from the STAR detector at RHIC. System dependence of the spacetime evolution is investigated by comparing HBT results from p-p, d-Au, and heavy ion systems. In particular, radii and chaoticity parameters from one- and higher- dimensional correlation functions are studied as a function of $dN/d\eta$, k_T and η. We will also discuss ongoing investigations of the dependence of HBT parameters on emission angle with respect to the spin axis from polarized proton data, which may reveal polarization-induced asymmetries in the pion source.

HBT 7 **Sandra S. Padula, Two-Q-Boson Interferometry and Generalization of the Wigner Function**

Affiliation: Instituto de Fisica Teorica/UNESP

Co-authors/Collaboration: Qing-Hui Zhang

In the present study, we represent pions by Q-bosons and derive Bose-Einstein type of correlations among two identically charged of these particles, considering them as confined within finite volumes. Boundary effects on their spectrum are also analysed for a particular type of Q-boson[1]. The deformation Q could be viewed as an effective parameter by means of which the complexity of interacting systems could be reduced, although at the expense of deforming the commutation relations. In particular, it was shown that the deformation parameter could be linked to Q-deformed structures resulting from the composite nature of pseudo-scalar mesons. Thus, the Q-parameter could be related to the resolving power of "probing lenses": for increasing "magnification", the bosonic behavior of the Q-bosons could be blurred by the fermionic nature of their internal constituents, resulting in a decreasing value of Q. We show that our results are compatible with this interpretation. We illustrate the effects on the spectrum and on the two-Q-boson correlation function by means of two toy models, which extends our previous results on confined pions. We also derive a generalization of the Wigner function, with dependence on the deformation parameter Q. We show that this generalized expression is reduced to the original form for the Wigner function in the limit of no deformation, $Q \rightarrow 1$. [1] For details, see Q. H. Zhang and Sandra S. Padula, nucl-th/0211057.

HBT 8 **Tamas Csorgo, Bose-Einstein Correlations for Levy Distributions**

Affiliation: MTA KFKI RMKI

Co-authors/Collaboration: S. Hegyi and W. A. Zajc

The peak of the two-particle HBT correlation function is often believed to have a (multivariate) Gaussian form. We show that for the class of Levy stable distributions, characterized by the index of stability $0 < a \leq 2$, the peak has a streched Gaussian shape, $C_2 = 1 + \lambda \exp\left(-|\sum_{i,j} q_i R_{ij}^2 q_j|^{a/2}\right)$, and the Gaussian form corresponds to the special case of $a = 2$. We give examples of the HBT or Bose-Einstein correlation functions for univariate as well as multivariate stable distributions and related the index of stability to the anomalous dimension of QCD. Ref: T. Csorgo, S. Hegyi and W. A. Zajc, http://arXiv.org/abs/nucl-th/0310042.

HBT 9 **Selemon Bekele, Identical Meson Interferometry in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV in STAR**

Affiliation: Ohio State University

Co-authors/Collaboration: STAR

We present detailed studies of Bose-Einstein correlations with charged pions and neutral and charged kaons. HBT radius parameters are presented as a function of m_T, centrality, and azimuthal angle ϕ relative to the reaction plane. Different methods of accounting for the Coulomb interaction in charged-particle correlation functions are discussed. Dynamical flow effects are manifested in the m_T dependence of the HBT radii, which is similar for charged kaons and pions, consistent with expectations for emission from an expanding source; the K_s^0 HBT radius at $m_T \sim 1$ GeV, however, is unexpectedly large and violates this systematic. With the large pion statistics, we performed a unique study of HBT radii relative to the reaction plane, allowing the extraction of the size, shape, and orientation of the freeze-out source, for collisions of varying centrality. This information has been suggested [1] as a powerful probe of the evolution of the source and places tight constraints on theoretical approaches to modeling both source expansion and particle emission. The data allow an approximate mapping of the initial versus final (i.e. freeze-out) geometric anisotropy of the system, providing further insight on evolution timescales.
1) P.F. Kolb and U. Heinz, Nucl. Phys. A715, 653 (2003).

HBT 10 **Spencer R. Klein, Quantum Interference in ρ^0 Production in Ultra-Peripheral Heavy Ion Collisions**

Affiliation: LBNL

Co-authors/Collaboration: STAR

Quantum interference in ρ^0 production in ultra-peripheral heavy ion collisions
The STAR collaboration
Vector mesons are copiously produced in ultra-peripheral heavy ion collisions (UPCs). A photon from the electromagnetic field of one nucleus scatters coherently from the other nucleus, emerging as a vector meson. There are two indistinguishable possibilities: nucleus 1 emits a photon which scatters from nucleus 2, and vice versa. The amplitudes for these processes interfere even though the mesons decay before their wave functions can overlap. The interference is destructive since vector mesons are negative parity. We will present high-statistics STAR measurements of the p_T spectrum of ρ^0 produced in AuAu UPCs at a center-of-mass energy of 200 GeV per nucleon. The interference suppresses production of ρ^0 with $p_T <$ few $\hbar/\langle b\rangle \sim 20$ MeV/c, where $\langle b\rangle$ is the median impact parameter. We will discuss the interpretation of this interference in terms of wave function collapse. We will present measurements of exclusive ρ^0 and J/ψ production in dAu collisions, where the interference is expected to be absent, and consider future prospects for vector meson interferometry.

High p_T 1 **Paul Stankus, Pair Angular Correlations in a Two-Source "Jet/Flow" Model**

Affiliation: Oak Ridge National Lab

Co-authors/Collaboration:

The mathematical description of two-particle pair measurments is reviewed, in general and for the specific case of azimuthal angular correlations. The conditional multiplicity observable is also examined and compared to the correlation observable. A two-source "jet/flow" model is exhibited, which expressly allows for the possibility that a jet source could respect the collision reaction plane. The pair correlations expected within the model are calculated in detail and discussed.

High p_T 2 **Michael J. Tannenbaum, $x_T = 2p_T/\sqrt{s}$ Scaling in Au+Au Collisions for π^0 and Charged Hadrons in PHENIX**

Affiliation: Brookhaven National Laboratory

Co-authors/Collaboration: PHENIX

The single particle inclusive cross section for hard parton-parton scattering can be written as $Ed^3\sigma/d^3p = G(x_T)/\sqrt{s}^{n(x_T,\sqrt{s})}$ under the assumption of factorization of the reaction into scaling parton distribution and fragmentation functions together with a short-distance parton-parton hard scattering cross section. In LO QCD, $n = 4$, as in Rutherford scattering, but due to higher order effects, measured values of n in p-p collisions are in the range 5–8. x_T scaling of the invariant yields is applied to high p_T charged particle and π^0 production in Au+Au collisions at $\sqrt{s_{NN}} = 130$ and 200 GeV. The π^0 exhibit x_T scaling with $n \sim 6.3$ for both central and peripheral collisions, while charged hadrons x_T scale with $n \sim 6.3$ for peripheral and $n \sim 7.5$ for central Au+Au collisions, where the value for pp collisions in this x_T range is $n \sim 6.3$. This indicates that the dynamics in Au+Au interactions for high p_T particle production are the same as in p-p collisions: hard-scattering according to pQCD with scaling structure and fragmentation functions. The significant difference in n for charged hadrons in central and peripheral collisions is traced to the non-scaling behavior of proton production in Au+Au central collisions. Protons are enhanced compared to pions, relative to jet fragmentation, over the range $2 \leq p_T \leq 4.5$ GeV for both $\sqrt{s_{NN}}$ of 130 and 200 GeV—a clear violation of x_T scaling. This argues for production dynamics different from pQCD for protons in this p_T range.

High p_T 3 **Jiangyong Jia,** **High p_T Charged Pions in PHENIX**

Affiliation: Columbia University

Co-authors/Collaboration: PHENIX Collaboration

In addition to jet quenching, the detailed modification of energetic jets can also be studied through jet tomography [1], namely the jet angular correlation and high p_T azimuthal anisotropy (v_2). However, the study of jets in heavy ion collisions is complicated by several competing "soft" mechanisms such as hydrodynamics (with viscosity correction), coalescence or quark/diquark pickup etc. Angular correlation and azimuthal anisotropy of identified particle at p_T up to 10 GeV/c thus serve as an important handle to distinguish between the soft and the hard contribution. PHENIX can identify charged pions at $p_T > 4.8$ GeV/c using the Ring Imaging Cherenkov Detector. Charged pion yield can be extract from a statistical method developed in [2]. A clean sample of high p_T pions can be isolated by a energy cut in the Electromagnetic Calorimeter, which are then used to study the charged pion tagged angular correction and their azimuthal anisotropy.
The status of charge pion yield, v_2 and pion tagged angular correlation from $p+p$, $d+Au$ and $Au+Au$ collisions in the p_T from 6 to 10 GeV/c will be presented.
[1] X.N. Wang nucl-th/0305010 and references therein.
[2] PHENIX Collaboration nucl-ex/0308006.

High p_T 4 **Henner Buesching, Centrality Dependence of Neutral Pion Production in dAu Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: BNL

Co-authors/Collaboration: PHENIX

The suppression of high p_T neutral pions in central Au+Au collisions relative to the binary scaled p+p results has been one of the most significant observations at RHIC. The observed suppression may be interpreted as the effect of energy loss of the initially hard-scattered partons as they traverse the hot and dense matter produced in central Au+Au collisions. However, other theoretical studies interpret the suppression as an initial state effect, such as due to gluon saturation. In d+Au collisions, where no hot and dense matter is produced in the final state, the hard-scattered partons propagate and fragment in QCD vacuum. Initial state effects, however, are equally present in both d+A and A+A collisions, allowing the d+Au neutral pion results to provide a baseline measurement to separate initial and final state effects. We present the PHENIX results on the centrality dependence of the neutral pion production in d+Au collisions.

High p_T 5 **Nathan Grau, Jet Properties, $\langle \vec{j}_T \rangle$ and $\langle \vec{k}_T \rangle$ of High-p_T Protons, π^0 and Inclusive Hadrons in pp and dAu Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: Iowa State Univerisity

Co-authors/Collaboration: PHENIX

A major purpose of the RHIC program is to study QCD at high temperature and densities. The study of d-Au and p-p collisions yields understanding of initial state phenomena and provides a baseline for measurements in Au-Au collisions. Recent results from d-Au collisions at the PHENIX experiment at RHIC reveal an increase of high p_T particle production consistent with Cronin enhancement opposite to the suppression of high p_T particle production measured in Au-Au collisions. A complementary observable is di-jet acoplanarity measured via the initial parton transverse momentum, $\langle \vec{k}_T \rangle$. The mean jet fragmentation transverse momentum, $\langle \vec{j}_T \rangle$, and $\langle \vec{k}_T \rangle$ are measured from the near and far angle gaussian widths from the azimuthal correlation functions. We have measured high p_T baryons (p, $\bar{p}$), mesons (π^0), and inclusive charged hadrons and report on the extracted jet properties in both p-p and d-Au collisions at $\sqrt{s_{NN}} = 200$ GeV.

High p_T 6 **Stefan Bathe, Midrapidity Neutral Pion Production in Proton-Proton Collisions at $\sqrt{s} = 130$ GeV**

Affiliation: University of California at Riverside

Co-authors/Collaboration: PHENIX

The spin-averaged cross section of neutral pion production at mid-rapidity was measured in longitudinally polarized proton-proton collisions as part of the third year of the RHIC program. Neutral pion production in proton-proton collisions serves as an essential reference in understanding particle production in Au+Au and d+Au collisions. Furthermore, a comparison of the results to next-to-leading order pQCD calculations provides important insight in the theoretical understanding of the measurement of the double-spin, longitudinal asymmetry A_{LL}. First results on the cross section measurement will be presented. As compared to the measurement from the second RHIC physics run, it is intended to increase the precision and extend the transverse momentum range by combining the two results.

High p_T 7 **Paul Constantin, Jet Shape Measurements Via Two-Particle Azimuthal Correlations in pp and Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: Iowa State University

Co-authors/Collaboration: PHENIX

Recent results from p-p, d-Au and Au-Au collisions at RHIC demonstrate the existence of a strong suppression of high-$p_\perp$ hadrons in the final state of Au-Au collisions. Two-particle azimuthal correlations are a powerful method to further investigate the final-state processes taking place in high-$p_\perp$ particle production. We use two-particle correlations to extract the jet fragmentation mean transverse momentum, $j_\perp$, in p-p and Au-Au collisions. In addtion we can extract the parton transverse momentum, $k_\perp$, in p-p collisions as a measure of the initial state scattering of the initial partons.

High p_T 8 **Saskia Mioduszewski, η Production at High Transverse Momentum in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: Brookhaven National Laboratory

Co-authors/Collaboration: PHENIX

One of the most compelling results from RHIC is the suppression of high p_T hadrons in central Au+Au collisions. In the absence of any nuclear effects, the yields at high p_T are expected to scale with the number of binary nucleon-nucleon collisions. It has been observed, however, that the yields in central Au+Au collisions are significantly suppressed relative to the binary-scaled yields measured in pp collisions as well as those measured in peripheral Au+Au collisions. Furthermore, the suppression factor is dependent on the particle species in the p_T region between 2 and 4 GeV/c. Recently, much attention has been given to the flavor dependence of the suppression and understanding the source of the flavor dependence in this intermediate p_T range. We present measurements from the PHENIX detector of the eta yields as a function of centrality with emphasis on the suppression factor. Comparison to the suppression of other particle species will be made.

High p_T 9 **Anne Sickles, Jet-like Structure of Baryons and Mesons at $2.5 < p_T < 4$ GeV/c**

Affiliation: SUNY Stony Brook

Co-authors/Collaboration: PHENIX

A surprising excess of protons at intermediate p_T has been observed in Au+Au collisions at RHIC, for which the source is not known. In p+p collisions, particles at this p_T arise from jet fragmentation, however the observed baryon yield in AuAu is not compatible with the usual jet fragmentation function. We analyze angular correlations of identified leading particles at p_T of 2.5 - 4.0 GeV/c with lower momentum particles, and extract the absolute yield of jet partners per leading particle. The partner yields for leading mesons and baryons are compared to to determine the relative contribution from jet fragmentation and soft processes. Au+Au collisions are compared to p+p and d+Au.

High p_T 10 **Sean Leckey,** **Search for Jets at PHENIX**

Affiliation: SUNY Stony Brook

Co-authors/Collaboration: PHENIX Collaboration

Suppression of High p_T hadrons has been observed in Au+Au collisions and an absence of that suppression has been observed in d+Au collisions at $\sqrt{s}$=200 GeV. It has been predicted that a modification of jet properties and jet production mechanisms in Au+Au collisions plays a role in this suppresion. The identification and study of such jets can provide important insights on the medium produced at RHIC. We discuss the development and application of topologically inspired jet identification techniques used in p+p, d+Au and Au+Au at PHENIX. We present how jet fragmentation, dijet correlations and jet yields may be studied in this context. We report on the extracted jet properties in p+p, d+Au and Au+Au collisions.

High p_T 11 **Chunbin Yang,** **Fractional Energy Loss and Centrality Scaling**

Affiliation: Hua-Zhong Normal University, Wuhan, China

Co-authors/Collaboration: R.C. Hwa

The phenomenon of centrality scaling in the high-p_T spectra of pions produced at RHIC is examined in the framework of relating fractional energy loss to fractional centrality increase. A universal scaling behavior without explicit dependence on centrality is found in a variable *z*, which is proportional to $p_T N_{\rm part}^{\gamma}$. The exponent γ specifies the fractional proportionality relationship between energy loss and centrality

$$\frac{\delta p_T}{p_T} = \gamma \frac{\delta N_{\rm part}}{N_{\rm part}}.$$

γ can be directly determined from the data to be 0.077. It summarizes the nuclear suppression effect. In the recombination model the same value of γ is valid also for the fractional energy loss of the light quarks just before hadronization. The existence of the universal scaling behavior suggests that there is no essential difference in how the low- and high-p_T hadronization processes should be treated.

High p_T 12 **Michael Tokarev,** ***Z*-Scaling and High-p_T Particle Production in pp Collisions**

Affiliation: Joint Institute for Nuclear Research, Dubna, Russia

Co-authors/Collaboration: I.Zborovsky, Yu.Panebratsev, G.Skoro

Particle production with large transverse momenta is traditionally connected with local character of hadron interactions. Locality of the interaction is expressed in terms of the hadron constituents. Scaling features of high-p_T hadron spectra reflects self-similarity of constituent interactions. Therefore, search for scaling regularities in high energy collisions of hadrons and nuclei is of physical interest.
One of the methods to study the properties of particle structure, constituent interactions and particle formation is *z*-scaling. *Z*-scaling is new feature of high-p_T particle production observed in hadron-hadron and hadron-nucleus collisions. It reflects symmetry properties of particle structure, interaction of their constituents and mechanism of particle formation such as the self-similarity and fractality. The properties of particle production in pp collisions are basis for analysis of *pA* and *AA* experimental data and verification of theory. Therefore, study of the *z*-scaling in elementary hadron-hadron collisions is useful for comparison and understanding of mechanism of the particle formation in the nuclear environment.
Results of new analysis of particle high-p_T spectra obtained at RHIC and Tevatron are presented in the *z*-variable and compared with other data. Violation of the *z*-scaling is suggested to be used in searching for new physical phenomena in high energy collisions of hadrons and nuclei.

High p_T 13 **Kai Gallmeister, Suppression of High Transverse Momentum Particles at RHIC by (Pre-)Hadronic FSI**

Affiliation: Institut fuer Theoretische Physik, Universitaet Giessen, Germany

Co-authors/Collaboration: W. Cassing, C. Greiner

We investigate transverse hadron spectra from proton+proton, deuteron+Au and Au+Au collisions at $\sqrt{s} = 200$ GeV within the Hadron–String–Dynamics (HSD) approach which is based on quark, diquark, string and hadronic degrees of freedom, combined with Pythia calculations for high $p_\perp$ spectra. The comparison to experimental data from RHIC shows that pre–hadronic effects of the leading hadrons can be responsible for both the hardening of the spectra for low transverse momenta as well as the suppression of high $p_\perp$ hadrons. The interactions of formed, non–leading hadrons are found to be more or less negligible for $p_\perp \geq 8$ GeV/c and cannot be responsible for the large suppression seen experimentally, but have some importance for lower $p_\perp$ values. These findings are in nice agreement with the hadron attenuation observed in virtual photon induced reactions on nuclei at HERMES.

High p_T 14 **Alexander M. Snigirev,** **Azimuthal Correlators as Tool of QGP Study**

Affiliation: SINP, MSU

Co-authors/Collaboration: I.P. Lokhtin, L.I. Sarycheva

We investigate the possibility for the appearance of azimuthal anisotropy of jet spectra due to rescattering and energy loss of hard partons in a dense quark-gluon matter formed in the region of the initial nuclear overlap in collisions characterized by a nonzero value of the impact parameter. Methods used in current experiments for measurement of coefficients of particle flow anisotropy without reconstruction of the nuclear reaction plane are generalized for calculation (measurement) of a coefficient of jet elliptic anisotropy. We illustrate the reliability of this technique, based on considering the second and higher order correlators between the azimuthal position of jet axis and the angles of particles (not incorporated in the jet), in a real physical situation under LHC conditions.

High p_T 15 **Enke Wang, Photon Radiation and Dilepton Production Induced by Rescattering in a Strongly Interacting Medium**

Affiliation: Institute of Particle Physics, Huazhong Normal Uni.

Co-authors/Collaboration:

Using the opacity expansion technique we investigate the photon radiation and dilepton production induced by multiple rescattering when energetic parton jet passing through the strong interacting medium. The real photon radiation and dilepton invariant-mass spectrums are presented. It is shown that the energy loss of parton jet arising from the Abelian LPM effect for photon radiation has different target thickness dependence compared with that from non-Abelian LPM effect for gluon radiation.

High p_T 16 **Claus Jorgensen,** **High p_T Hadron Yields in Au+Au and dAu Collisions**

Affiliation: Niels Bohr Institute

Co-authors/Collaboration: BRAHMS

A strong suppression of the high p_T yields in Au+Au collisions at RHIC compared to the expectations from scaled yields in elementary collisions has been observed during the first two years of running [1,2]. This may be interpreted as due to energy loss of partons induced by a dense parton medium. The suppression has also been observed to $\eta = 2.2$ [2] suggesting that the suppressing medium is extended in the longitudinal direction. In contrast, high p_T yields in d+Au collisions show an enhancement, verifying that the suppression observed in the Au+Au collisions is due to final state effects [2,3].
The BRAHMS spectrometers have the unique ability to measure hadrons over a broad range of rapidity and transverse momenta. This allows us to study the rapidity dependence of the high p_T yields. During the 2002 Au+Au run and the 2003 d+Au run BRAHMS collected large samples of high p_T data at midrapidity and at forward rapidities.
In this talk we present transverse momentum spectra of unidentified hadrons from Au+Au and d+Au collisions at different pseudo-rapidities and centralities. The spectra are compared to spectra from scaled elementary collisions and model predictions.
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High p_T 17 **Gustavo Conesa,** **Photon-Tagged Jets to Study Jet Quenching**

Affiliation: IFIC

Co-authors/Collaboration: Yuri Kharlov, Yves Schutz, Hugues Delagrange

Prompt photons accompanied by a jet produced in the opposite direction at high p_T can be studied as a probe of the dense medium formed in heavy-ion collisions. The ALICE experiment at LHC will allow to detect and identify prompt photons by the detector PHOS, while hadrons from jets will be detected by TPC and, optionally, EMCAL.
Photons produced at the earlier stage of the nuclei collisions, preserve almost all their energy after traversing through the dense nucleus medium. Hence, the attenuation of the jet energy can be measured via comparison of the prompt photon and jet kinematics. The methods to identify direct photons and photon-jet events are discussed. Applying a jet-quenching model, we study the modification of the photon-tagged jet fragmentation-function by the nuclear medium.

High p_T 18 **Tetsufumi Hirano, Back-to-Back Correlations of High p_T Hadrons From Dynamical Model Calculations**

Affiliation: RIKEN BNL Research Center

Co-authors/Collaboration: Yasushi Nara

We investigate the azimuthal correlation function for high p_T charged hadrons in Au+Au collisions at $\sqrt{s_{NN}}$=200 GeV by using a dynamical model in which hydrodynamics is combined with explicitly traversing jets. The STAR Collaboration observed the disappearance of away-side peak in the correlation functions only in central collisions. In addition to the jet quenching phenomena already observed at RHIC, the correlation measurement may provide a novel opportunity to study the bulk QCD matter produced in relativistic heavy ion collisions. In order to interpret the disappearance of the away-side peaks, we study the effects of (a) parton energy loss in a hot medium, (b) intrinsic k_T of partons in a nucleus and (c) $p_\perp$ broadening of jets. Parton energy loss is found to be a dominant effect on the reduction of the away-side peaks in the correlation function. We also discuss the centrality dependence of the correlation functions within our approach.

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High p_T 19

Tetsufumi Hirano, Interplay Between Soft and Hard Hadronic Components: Spectra From Low to High p_T and From Midrapidity to Forward Rapidity

Affiliation: RIKEN BNL Research Center

Co-authors/Collaboration: Yasushi Nara

We investigate the transverse dynamics in Au+Au collisions at $\sqrt{s_{NN}}$=200 GeV by emphasis upon the interplay between soft and hard hadronic components. From hydrodynamics combined with traversing minijets which go through jet quenching in the hot medium, we calculate interactions of hard jets with the soft hydrodynamic components. Hydrodynamic radial flow and jet quenching are found to be the keys to understand the differences among the hadron spectra for pions, kaons, and protons. Radial flow pushes thermalized particles toward high p_T region, while jet quenching shifts pQCD components to low p_T region. As a result, there is an interplay effect between these soft and hard hadronic components in the intermediate p_T region ($p_T \sim$ 2-4 GeV/c). This leads to the natural interpretation for $N_p/N_\pi \sim 1$, $R_{AA} > 1$ for protons, and $v_2^p > v_2^\pi$ observed at RHIC. In addition to the above results near midrapidity, we also study the jet quenching in forward rapidity region. Recently, the BRAHMS Collaboration observed that the ratio of nuclear modification factors at η =2.2 and 0 becomes less than unity in high p_T region. We will give a possible explanation for this "peculiar" data.

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[2] T.Hirano and Y.Nara, "Pseudorapidity dependence of parton energy loss in relativistic heavy ion collisions", nucl-th/0307087.

High p_T 20 **Andreas Morsch, Jet Physics with Charged Particles in Pb+Pb Collisions at the LHC with the ALICE Detector**

Affiliation: CERN

Co-authors/Collaboration: ALICE

ALICE in its present design has only limited capabilities to measure the jet energy. However, it is likely that the most interesting observables which can reveal the presence and nature of interactions of final state partons with deconfinded partonic matter and the associated radiation of additional gluons are mainly related to the structure of the jets, i.e. the phase space distribution of particles close to the jet-axis. Examples are the longitudinal and transverse momenta relative to the jet axis.
The capabilities of ALICE to measure these distributions using charged particles for low jet energies, down to 5 GeV, will be demonstrated. The sensitivity for different quenching scenarios will be discussed.

High p_T 21 **Christof Roland, Study of Jets in Heavy Ion Collisions with the CMS detector at LHC**

Affiliation: MIT

Co-authors/Collaboration: CMS Collaboration

Large transverse momentum jets provide unique tools to study QCD and dense matter in high-energy heavy-ion collisions [1,2]. Recent results on the suppression of high transverse momentum particles in Au+Au collisions at $\sqrt{S_{NN}} = 200$ GeV indicate a pronounced energy loss of leading partons in the dense and strongly interacting matter formed in these collisions [3-6]. Extension of the Heavy Ion research program to LHC energies of $\sqrt{S_{NN}} = 5.5$ TeV will, for the first time, allow the study of these effects directly through the copiously produced, highly energetic jets. The CMS Heavy Ion group [7] has performed extensive studies on the possibility of measuring jet properties in Heavy Ion Collisions. The CMS detector combines large acceptance calorimetry augmented with a high precision silicon tracker.We show that the CMS detector will serve as an effective tool to reconstruct jets in both the calorimeters and tracker and to study medium induced modification of jet properties in heavy ion collisions.

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[7] CMS Collaboration www.cern.ch/cms and www.rice.edu/∼yepes/cmshi.

High p_T 22 **Ivan Vitev, Jet Tomography of Heavy Ion Reactions and the QGP Paradigm at RHIC**

Affiliation: Iowa State University

Co-authors/Collaboration: Azfar Adil, Miklos Gyulassy, Jianwei Qiu

The discovery of jet quenching at RHIC and the evidence for its final state partonic origin from the recent $d+Au$ control measurement provide a powerful new tool - jet tomography - to probe the initial conditions and evolution of the quark gluon plasma produced in energetic $Au+Au$ reactions. The single inclusive high $p_T \geq 5$ GeV hadron suppression pattern, its centrality and rapidity dependence and the broadening and disappearance of the back-to-back jet correlations map out the beam energy and impact parameter dependence of the initial conditions achieved in such collisions. The inferred initial energy density $\varepsilon \sim 20$ GeV/fm^3 in central $Au+Au$ reactions, more than 100 times cold nuclear matter density, is in remarkable agreement with the hydrodynamic initial conditions required to fit the observed bulk collective elliptic flow. The corresponding gluon rapidity density $dN^g/dy \sim 1000$ is comparable to the measured hadron multiplicity and estimates based on gluon saturation models. The consistency of these different lines of evidence strongly supports the QGP paradigm at RHIC.

High p_T 23 **David Hardtke and Thomas Humanic, Can Hadronic Rescattering Explain the "Jet Quenching" at RHIC?**

Affiliation: UC Berkeley/LBNL and Ohio State

Co-authors/Collaboration:

Experimental data from RHIC indicate modifications of high pt particle production in nucleus-nucleus collisions. In particular, there is a suppression of high pt particle production compared to the binary collision expectation ($R_{AA} < 1$), a large azimuthal asymmetry of high pt particle production with respect to the reaction plane, and an absence of back-to-back high pt hadron pairs. These observations can naturally explained in terms of parton energy loss in a dense gluonic medium. Here we test an alternative hypothesis, that the partons fragment into hadrons inside the dense nuclear medium and these hadronic jet remnants interact with a dense hadronic gas.
The calculations were made by embedding simulated jets into a hadronic rescattering model that is able to describe many hadronic observables at low transverse momentum. We find notable discrepancies between these hadronic rescattering calculations and the experimental data, particularly a massive degradation of the two-particle jet-like correlation signature. This degradation is not seen in the experimental data. From this we conclude that the RHIC high pt data are most likely explained via partonic interactions before fragmentation.

High p_T 24 **Stefan Kretzer,** **Fragmentation Functions**

Affiliation: BNL

Co-authors/Collaboration:

Fragmentation functions are introduced as one of the ingredients to calculate - within perturbative QCD - the production of hadrons in hard collisions. Conceptual similarities and differences to parton distribution functions are discussed and, where required, differences between the naive parton model and the more sophisticated perturbative QCD approach are pointed out. Our present knowledge of fragmentation functions is summarized through an overview/comparison of previous and ongoing global analysis efforts and a discussion of the data sets that go into it. Applications to / implications for RHIC phenomenology are presented/discussed.

High p_T 25 **Ying Guo, Angular Distributions of High p_T Dihadron Correlations at RHIC: Dependence on $\Delta\eta$, Reaction Plane and Leading Particle Species**

Affiliation: Wayne State University

Co-authors/Collaboration: STAR

Recent measurements of high pt charged hadron production at RHIC indicate substantial final-state interaction of hard-scattered partons with the medium created in Au+Au collisions. The measurements of the jet-like correlations based on the two-particle distributions in the relative azimuthal angle and pseudorapidity for high pt hadrons are directly related to the medium modification of jet fragmentation functions. We present the systematic measurements of two-particle correlations for different systems and collision centralities. The near-side jet cone properties are studied via delta eta correlations of the high pt hadrons. The jet-like azimuthal angular correlations are measured for leading strange particles with different transverse momentum thresholds. Azimuthal anisotropy of the back-to-back suppression is studied with respect to the reaction plane orientation.

High p_T 26 **David d'Enterria, Jet quenching at $\sqrt{s_{NN}} \approx 20$ GeV? High p_T *AA* Data at the CERN-SPS**

Affiliation: Nevis Labs. Columbia University

Co-authors/Collaboration:

Hadron production at high transverse momentum (p_T) in central Au+Au reactions at BNL-RHIC collider energies ($\sqrt{s_{NN}}$ = 200 GeV) shows significant deviations compared to p+p, d+Au, and Au+Au peripheral collisions at the same $\sqrt{s_{NN}}$, as well as to nucleus-nucleus data at lower center-of-mass energies. One of the main observations is the suppressed production of high p_T hadrons compared to the expectations of scaling with the number of nucleon-nucleon collisions ("N_{coll} scaling"). Such a result is consistent with final-state "jet quenching" effects in a dense QCD medium. At CERN-SPS energies ($\sqrt{s_{NN}} \approx 20$ GeV), though several "smoking gun" signals of QGP formation were observed, high p_T particle production was seen not to be suppressed but it enhanced in agreement with observations of initial-state multiple scattering in p+A collisions ("Cronin enhancement"). In this contribution, I will reexamine the whole set of available high p_T data from the SPS experiments: π^0 from Pb+Pb at $\sqrt{s_{NN}}$ = 17.4 GeV (WA98), $\pi^{\pm}$ from Pb+Au at $\sqrt{s_{NN}}$ = 17.4 GeV (CERES/NA45), and π^0 from S+Au at $\sqrt{s_{NN}}$ = 20 GeV (WA80), and compare them to p+p baseline results from the literature, at around the same $\sqrt{s_{NN}}$, that had not been taken into account so far. The resulting nuclear modification factors (R_{AA}) indicate that the amount of "Cronin enhancement", if any, is much less significant than considered hitherto and that, within the errors, high p_T production at SPS is actually consistent with "N_{coll} scaling". Such a result is more compatible with the actual empirical observation that the "N_{coll}-scaled" ratio of central to peripheral collisions (R_{cp}) at SPS is below or around unity (an indication that some amount of suppression may be actually already present at these energies), and reinforces the interest of concurrently measuring high p_T Au+Au and p+p data around $\sqrt{s_{NN}} \approx 20$ GeV at RHIC.

High p_T 27 **Heli Honkanen,** **High-p_T Hadron Spectra with Parton Energy Loss Through Multiple Soft Scattering**

Affiliation: University of Jyvaskyla, Department of Physics

Co-authors/Collaboration: K.J. Eskola, C.A. Salgado, U.A. Wiedemann

We study the high-p_T suppression of hadron spectra in nucleus-nucleus collisions in terms of parton energy loss in dense partonic medium. In a pQCD analysis [1], incorporating factorized leading-order partonic cross sections, (nuclear) parton distributions and fragmentation functions but no intrinsic transverse momenta, we found a satisfactory agreement with the high-p_T $p\,\bar{p}(p)$ data at collider energies and peripheral Au+Au data at RHIC by introducing a cms-energy dependent *K*-factor. We now incorporate the medium-dependent quenching weights for multiple soft scattering [2] into the pQCD analysis [1] and determine the values of the corresponding transport coefficients from the RHIC data. Comparison with the data is shown and predictions for the LHC are discussed.

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[2] C.A. Salgado and U.A. Wiedemann, Phys.Rev.D **68** (2003) 014008.

High p_T 28 **Axel Drees and Jiangyong Jia, Medium-Induced Jet Absorption at RHIC**

Affiliation: State University of NewYork at Stony Brook

Co-authors/Collaboration:

Data from Au-Au collisions at RHIC have revealed rich information on high p_T particle production in a range where it is thought to origin from jet fragmentation. Over most of the impact parameter range particle yields and their characteristic back-to-back correlations are suppressed compare to extrapolations from p-p, while simultaneously large anisotropy with respect to the reaction plane are observed. The absence of these phenomena in d-Au collisions suggests that in Au-Au collisions a dense and opaque medium is produced and that the data may be consistent with parton energy loss.
We present a simple model of jet absorption in opaque matter which incorporates a realistic nuclear geometry. The results are compared to the experimental data and predictions are made for the system size and beam energy dependence. The model describes quantitatively the observed suppression of the high p_T hadron yield and of the back-to-back angular correlations as well as the dependence on the collision centrality. These results are rather insensitive to the details of the absorption pattern and the energy density profile used, which indicates that both the suppression of the yield and of the back-to-back correlations depend mostly on volume and average energy density of the opaque medium. In contrast, we find that the anisotropy is very sensitive to the absorption pattern and energy density profile. However, for any realistic nuclear geometry the azimuthal anisotropy is significantly lower than observed in the data. We conclude that in order to account for the anisotropy, different mechanisms must supplement the jet absorption.

High p_T 29 **Fred Cooper, J/ψ Production in pp collisions at RHIC at $\sqrt{s} = 200$ and 500 GeV**

Affiliation: National Science Foundation

Co-authors/Collaboration: Gouranga Nayak and Ming X. Liu

Understanding J/ψ production mechanism at high energy hadronic collisions, such as at Tevatron, is an important issue at the moment. From this point of view understanding J/ψ production mechanism in pp collisions at RHIC is very important for both heavy ion and spin program. Using perturbative QCD (pQCD) and non relativistic QCD (NRQCD), we compute the p_T dependent J/ψ production cross section within the PHENIX detector acceptance at RHIC, at center of mass energy 200 and 500 GeV in pp collisions. We consider both parton fusion and parton fragmentation processes within color singlet and octet models in our calculation. Our results are compared with the recent PHENIX data at RHIC at center of mass energy equals to 200 GeV in pp collision. The data rule out the color singlet model and favor color octet model.
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High p_T 30 **Jorge Casalderrey-Solana, Jet Fragmentation Due to Quark/Diquark Pick-up**

Affiliation: Stony Brook

Co-authors/Collaboration: E.Shuryak

We developed a model aimed at explaining jet quenching, large azimuthal asymmetry and baryon/meson ratio at large transverse momenta $p_t = 2 - 10, GeV$ observed at RHIC. Its main point is matter-induced modification of the fragmentation process. Specifically, we assume that a QCD string can be cut before its natural breaking, picking up quarks and/or diquarks. We model the early quark/diquark production via QCD sphalerons. The resulting short strings decay according to Lund model area law, often via 2 or 3-body decays, with a harder fragmentation function than that for long strings. This enhances baryon/meson ratio and also increases v2.

High p_T 31 **Gabor Papp, What Can We Learn From the Rapidity Dependence of High p_T Meson Production?**

Affiliation: Eötvös University, Budapest

Co-authors/Collaboration: G. Fai, P. Levai

Recent RHIC experiments made a systematic study of heavy ion reactions ranging from $p-p$ through $d+Au$ to $Au+Au$ collisions. The data at high transverse momenta helps to distinguish between initial and final state interactions in meson production. In this talk we argue, that a systematic study in the rapidity measures sensitively the nuclear shadowing effect at high Bjorken x and the endpoint of the spectra, accessible at high ($y \sim 2-3$) rapidity provides information on the transverse momentum broadening in the initial phase. Using perturbative QCD calculation we show how different shadowing and transverse momentum broadening scenarios affect the nuclear modification factor R_{dAu} at high rapidity.

High p_T 32

Subhasis Chattopadhyay, Correlations Between Photons and Charged Particles at Large Transverse Momenta in pp and dAu collisions at $\sqrt{s_{NN}} = 200$ GeV

Affiliation: Variable Energy Cyclotron Centre, Koltaka, India

Co-authors/Collaboration: STAR

We present angular correlations of high transverse momentum (high p_T) photons measured in the STAR Electromagnetic Calorimeter (EMC) with high p_T charged tracks measured in the STAR Time Projection Chamber for p+p and d+Au collisions at $\sqrt{s_{NN}}$ =200 GeV. STAR EMC has the capability of triggering events with high p_T photons, thereby enabling us to study the correlation with trigger photons having much larger p_T compared to charged particles.
Particles produced in jets have characteristic correlation structure in pseudorapidity and azimuthal angle. Modifications of fragmentation function for partons passing through a dense medium are expected to be reflected in various characteristic parameters of jets. Measurement of these parameters in dAu and pp collisions disentangle the initial state effects (eg. gluon saturation, Cronin effect) from the final state effect (jet quenching) expected to be observed in AA collisions. Extensive studies have been made on azimuthal correlations of charged particles at large transverse momenta (2GeV/c $< p_T <$ 6 GeV/c) at RHIC energy. We report here the study of azimuthal correlations using photons as triggered particles having p_T up to 8 GeV/c. Details of the correlation functions for both near angle and far angle correlations (width, height) and their variation in dAu collsions compared to pp collisions will be discussed.

High p_T 33 **Vladislav Pantuev, Charged Hadron Production at Large Transverse Momentum in Au+Au and dAu Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: State University of New York at Stony Brook

Co-authors/Collaboration: PHENIX

The supperession of hadron yields with high transverse momentum in central Au+Au collisions compared to peripheral and nucleon-nucleon collisions at RHIC energies is well established observation. To understand is this a final state effect indused by the hot, dense medium formed in heavy ion collisions or an initial state effect due to the modification of parton distributions inside nuclei, a ”control” experiments at RHIC with deutron-gold collisions have beed performed.
We will present the resent PHENIX results on charged hadron spectra measured at mid-rapidity at high transverse momenta in d+Au collisions at $\sqrt{s} = 200$ GeV. The experimental data on hadron yields normalized to the number of nucleon-nucleon collisions do not show suppression, instead, there is a small enhancement in the yield of high momentum particles. It means that initial state effects are not responsible for the observed suppression in central Au+Au collisions.
The modification of the hadron spectra shape in d+Au collisons with centrality and number of binary collisions, data for pAu and nAu in addition to dAu colliosions will be presented.
Comparision to the previous PHENIX data in Au+Au will be shown as well.

High p_T 34 **Wolf G. Holzmann,** **Angular Correlation Measurements in pp, dAu and Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: Nuclear Chemistry Group SUNY Stony Brook

Co-authors/Collaboration: PHENIX

Azimuthal angular correlations provide a powerful probe for the reaction dynamics in Au+Au collisions at RHIC. An extensive array of such correlation measurements have been performed for charged hadrons and identified particles in p+p, d+Au and Au+Au collisions with the PHENIX detector at ($\sqrt{s_{NN}}$ =130 and 200 *GeV*). Systematic comparisons of these measurements provide important insights on a) the relative influences of (di-)jet and harmonic contributions to the correlation functions, b) possible modifications to jet properties due to initial- and final-state effects and c) the properties of the hot and dense matter that the jets traverse. New results will be shown and discussed with special emphasis on what can be learned about the QCD medium from these measurements.

Flavor 1 **Alexandre Lebedev,** **Measurement of $\chi_c \to J/\psi + \gamma$ in dAu Collisions at RHIC/PHENIX**

Affiliation: Iowa State University

Co-authors/Collaboration: PHENIX Collaboration

Charmonium production is considered as a powerful probe of the hot matter created in high energy nuclear collisions. The comparison of heavy (χ_c) and light (J/ψ) charmonium production can provide valuable information about the properties of this hot and dense matter. In addition, a significant fraction of J/ψ is produced not directly, but via decays of heavier $c\bar{c}$ states, in particular χ_c. Measuring the χ_c yield can improve our understanding of the J/ψ suppression observed in high energy nuclear collisions.
The PHENIX Experiment at RHIC has the unique ability to measure both J/ψ and χ_c (via $J/\psi + \gamma$ decay). The ongoing $\chi_c \to J/\psi + \gamma$ analysis in dAu collisions at $\sqrt{s_{NN}}$ = 200 GeV will be described.

Flavor 2

David Silvermyr, First Observation of the ψ' at RHIC - Techniques for Fitting Dimuon Spectra in dAu Collisions at $\sqrt{s_{NN}} = 200$ GeV

Affiliation: Oak Ridge National Laboratory

Co-authors/Collaboration: PHENIX Collaboration

Particles carrying charm or bottom quarks are sensitive probes to study the early stage of high energy heavy ion collisions. d-Au collisions were studied for the first time at RHIC in 2003. These collisions are of considerable interest to establish a reliable baseline for cold nuclear matter to be used in comparisons with Au-Au results and distinguish possible anomalous effects, such as J/ψ suppression (or enhancement) for the hot and dense matter.
PHENIX has excellent coverage for muon detection in the rapidity range $1.2 < |\eta| < 2.4$. During the 2003 RHIC run, PHENIX collected an integrated luminosity of about 2.7 nb^{-1} of d+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. This is the first RHIC run with sufficient luminosity to possibly allow simultaneous determination of not only the J/ψ but also e.g. the ψ' yield. Techniques used to fit the dimuon spectra, taking into account line-shapes for the expected contributing physics signals, will be presented and discussed.

Flavor 3 **Kenneth Read,** **Estimating and Removing Background Components in Measuring Inclusive Single Muon Production in pp Collisions at RHIC**

Affiliation: Physics Division, Oak Ridge National Laboratory* and the University of Tennessee

Co-authors/Collaboration: For the PHENIX Collaboration

In p+p collisions at RHIC, measuring single muon production can be used to study semileptonic decays of heavy quarks and the W boson. PHENIX has excellent coverage for muon detection in the rapidity range $1.2 < |\eta| < 2.4$. At low p_T, most of the muons within the PHENIX acceptance are due to decays of hadrons (π, K, etc.). At high p_T, heavy quark decays become more important. In order to measure heavy quark decays, one must understand and remove the contribution to the inclusive muon spectrum due to decays of hadrons. We present the results of a simulation study concerning the influence of pion and kaon production on such measurements. During the 2003 RHIC run, PHENIX collected an integrated luminosity of 0.35 pb^{-1} of p+p collisions at $\sqrt{s} = 200$ GeV. We compare the data to our expectations from simulations.
*Oak Ridge National Laboratory is managed by UT-Battelle, LLC, for the U.S. Department of Energy under contract DE-AC05-00OR22725.

Flavor 4 **Kyoichiro Ozawa,** **Measurements of $J/\psi \to e^+e^-$ in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: CNS, University of Tokyo

Co-authors/Collaboration: PHENIX

Measurements of the J/ψ yield in heavy ion collisions are expected as one of the most promising probes of deconfined matter, since theoretical models predict that the J/ψ yield will be suppressed due to the Debye screening effect in a Quark Gluon Plasma.
In this context, many theoretical efforts have been made recently to investigate the behavior of J/ψ at RHIC energy. Among these activities, one interesting prediction is the enhancement of the J/ψ yield which is based on the recombination of $c\bar{c}$ pairs. In addition, coalescence models should be tested by the J/ψ measurements. Testing these models is going to require good measurements of the centrality and p_T dependence of J/ψ production, as well as the overall yield.
The PHENIX experiment measured the J/ψ yield in Au-Au collisions at $\sqrt{s_{NN}} = 200$ GeV using electron decays. We will present the final results of the electron decay mode analysis for the RHIC 2000/2001 run. In addition, a comparison with model prediction will be shown.
Also, an estimate of the J/ψ yield in the upcoming RHIC 2003/2004 run is made based on the expected luminosity.

Flavor 5 **Youngil Kwon, Measurement of Heavy Flavor Production in Proton Collisions at RHIC by the Detection of Inclusive Muons**

Affiliation: Yonsei Univ.

Co-authors/Collaboration: for the PHENIX Collaboration

PHENIX has collected an integrated luminosity of 0.35 pb^{-1} of p + p collisions at $\sqrt{s} = 200$ GeV. PHENIX can detect muons produced in these collisions in the pseudorapidity range $1.2 < |\eta| < 2.4$ with 2π azimuthal angle coverage. A significant fraction of these detected muons result from the semileptonic decays of heavy-flavored hadrons. We describe procedures to separate muons originating from the semileptonic decays of heavy-flavored hadrons from the detected inclusive muon distribution. The deduced production cross section can be compared with the prediction from pQCD. Charge asymmetry in the production of muons from heavy flavored hadrons will be discussed.

Flavor 6 **Andrew M. Glenn,** **Single Muon Production in $\sqrt{s_{NN}} = 200$ GeV Au+Au Collisions at the PHENIX Experiment**

Affiliation: University of Tennessee

Co-authors/Collaboration: PHENIX

In 2001, the PHENIX experiment at BNL's Relativistic Heavy Ion Collider (RHIC) collected data for $Au+Au$ collisions at $\sqrt{s_{NN}} = 200GeV$. The addition of the south muon spectrometer, which covers $-2.2 < \eta < -1.2$, prior to this run provided the experiment's first muon detection capability. Single muons provide the ability to investigate charm production via semi-leptonic decays of D mesons, and extraction of the open charm cross-section provides essential information for the study of all aspects of charm production in heavy ion collisions. In particular, open charm production is sensitive to the initial state gluon density and will provide input to the models of charmonium suppression and enhancement, especially when coupled with analogous information from $p+p$ and $d+Au$ collisions. The current status of single muon studies for RHIC Run II $Au+Au$ data will be shown. Issues related to muon identification, tracking in the complete muon arm, and separation of contributions to single muons, with emphasis on the unique challenges and opportunities in $Au+Au$, will be presented.

Flavor 7 **Jane M. Burward-Hoy,** **Centrality Dependence of $J/\psi \to \mu^+\mu^-$ in High-Energy dAu Collisions**

Affiliation: Los Alamos National Laboratory

Co-authors/Collaboration: PHENIX Collaboration

Parton densities within a single proton change when bound within a nucleus (shadowing). Experimentally, d+Au collisions (cold nuclear matter) may quantify the amount of shadowing and other nuclear effects that are expected and serve as an essential baseline measurement for heavier colliding systems such as Au+Au (hot, dense nuclear matter). As the J/ψ is primarily produced by gluon fusion early in the collision, it probes the gluon density distribution initially present. The PHENIX Experiment at the Relativistic Heavy Ion Collider (RHIC) has measured the production of J/ψ particles in d+Au collisions at center-of-mass energies of 200 GeV per nucleon with its two muon spectrometer arms positioned at forward and backward rapidities.
In 2003, approximately 2000 J/ψ are expected from the d+Au data set (and several hundred in p+p) allowing for measures of its rapidity, momentum, and angular distributions. In particular, the ratio of the rapidity distributions of J/ψ produced in d+Au and p+p collisions is measured as a function of the d+Au impact parameter (centrality dependence of the collision). These data will ultimately help us understand nuclear effects at this center-of-mass energy (including shadowing) in cold nuclear matter. The current status of this centrality measurement will be presented.

Flavor 8 Xiaorong Wang, J/ψ Polarization Study for dAu Collisions at RHIC

Affiliation: New Mexico State University

Co-authors/Collaboration: PHENIX collaboration

The polarization of quarkonium is typically measured via the angular distribution of its decay leptons. This measurement provides a unique and detailed test of the quarkonium production mechanism at RHIC energies for different colliding systems. The PHENIX experiment at RHIC has the unique ability to measure heavy flavor production through both $\mu^+\mu^-$ and e^+e^- decay channels. This study focuses on the results from the $\mu^+\mu^-$ channel. The current status of extracting the J/ψ polarization from PHENIX Run3 $d+Au$ data, bin-by-bin background subtraction, and acceptance correction will be presented.

Flavor 9 **Xinhua Li, Single Electrons from Semi-leptonic Charm Meson Decays in pp Collisions at 200 GeV**

Affiliation: UC Riverside

Co-authors/Collaboration: for PHENIX Collaboration

The suppression of quarkonium production is predicted as one of the characteristics of a potential phase transition of nuclear matter from confined to deconfined quarks and gluons. The measurement of open charm production in pp collisions provides an important baseline for charmonium measurements in dAu as well as AuAu collisions. There various competing nuclear effects such as shadowing, heavy quark energy loss, color screening, and charm recombination need to be disentangled.
The PHENIX experiment has collected data from pp collisions at 200 GeV in the 2001/2002 run at RHIC. Particles carrying open charm can be studied by the contributions from their semileptonic decays, e.g. $D \rightarrow eKu$, to single electron spectra. Photonic sources, mostly from π^0 Dalitz decays and photon conversions, can be subtracted by photon and electron coincidence. Following this approach, we will present the current status of the analysis.

Flavor 10 **DongJo Kim,** **J/ψ Production in pp Collisions at $\sqrt{s_{NN}} = 200$ GeV with the PHENIX Experiment at RHIC**

Affiliation: Yonsei University

Co-authors/Collaboration: for the PHENIX collaboration

Measurements of J/ψ mesons in proton-proton collisions at RHIC provide useful information on both the perturbative and non-perturbative aspects of QCD, and also play an important role as reference data for understanding both heavy ion physics and spin physics at RHIC. The results of total and differential cross sections for J/ψ production and mean transverse momentum of J/ψs, which have been measured with the PHENIX experiment in p+p collisions at $\sqrt{s_{NN}}$ = 200 GeV in Run 2001-2003,will be presented. Those results are compared with other experimental results as well as theoretical models.

Flavor 11 **Sergey Butsyk, Heavy Flavor Production in pp and dAu collisions at $\sqrt{s_{NN}} = 200$ GeV at RHIC**

Affiliation: SUNY at Stony Brook

Co-authors/Collaboration: PHENIX collaboration

Heavy flavor particles carying charm or beauty quarks play an important role in understanding the physics of heavy ion collisions. The measurement of charm and bottom in p+p and d+Au collisions provides a baseline for J/ψ production in heavy ion collisions. Results from d+Au collisions are sensitive to the initial gluon density inside nuclei as well as they reflect cold nuclear matter effects on heavy quarks.
The unique electron identification capabilities of the PHENIX detector at RHIC allow to measure semi-leptonic decays of heavy flavor. Using p+p and d+Au data collected in the 2001/2003 runs at $\sqrt{s_{NN}}$ = 200 GeV single electron inclusive p_T distributions have been studied. The contribution from heavy flavor decays can be extracted by two methods which are completely independent from each other.
The “Converter” method uses a special data set where the photonic component of the inclusive electron spectrum is enhanced by adding a photon converter to the standard experimental setup. Combining the measurement with and without the converter being installed allows to extract the non-photonic contribution from the electron spectrum.
In the “Cocktail” method the contributions from Dalitz decays, other light hadron decays, and photon conversions are calculated and subtracted from the inclusive electron spectrum.
The current status of the heavy flavor measurement will be presented.

Flavor 12 **Gobinda C. Mishra,** **Study of J/ψ Polarization in pp Collisions at $\sqrt{s_{NN}} = 200$ GeV with the PHENIX Experiment at RHIC**

Affiliation: Georgia State University

Co-authors/Collaboration: PHENIX Collaboration

The lepton pair production in hadron hadron collisions provides a basic testing ground for our understanding of QCD. Particularly, the angular distribution of lepton pairs from the decay of heavy quarkonia gives a measure of their state of polarization, which is sensitive to their production mechanism. The PHENIX experiment at RHIC provides the opportunity to measure this angular distribution in an unexplored energy regime. This measurement also provides a baseline reference for similar measurements from d+Au and Au+Au collisions at the same energy. The PHENIX experiment has collected data from p+p collisions at $\sqrt{s_{NN}} = 200$ GeV in year 2002-2003. The analysis is based on the J/ψ to $\mu^+\mu^-$ decay channel. The current analysis status will be presented.

Flavor 13 **Chun Zhang, Nuclear Modification Effects on J/ψ production in $\sqrt{s_{NN}} =$ 200 GeV dAu Collisions at RHIC**

Affiliation: Columbia University

Co-authors/Collaboration: PHENIX

J/ψ suppression is one of the important signatures of quark gluon plasma formation in high energy heavy nuclei reaction. In order to obtain an affirmative observation of J/ψ suppression, it is important to understand nuclear modification effects on J/ψ production. In 2003, the Relativistic Heavy Ion Collider (RHIC) has collided deuteron-gold and proton-proton beams at $\sqrt{s_{NN}} = 200$ GeV for this purpose. The PHENIX detector, one of the four detectors at RHIC, has the ability to measure J/ψ via its two muon arms which are designed to measure quarkonia production in a wide x_f and transverse momentum range. The data taken by PHENIX will provide valuable information needed to understand the nuclear modification effects on J/ψ production. We will present the current status of PHENIX measurement of J/ψ production in different x_f and p_T bins.

Flavor 14 **Sotiria Batsouli,** **Study of Electron-Hadron Azimuthal Correlations**

Affiliation: Columbia University

Co-authors/Collaboration: PHENIX

PHENIX data on single electron production in central and minimum bias $Au+Au$ collisions at $\sqrt{s_{NN}} = 130GeV$ indicate an excess of electrons over known light hadronic sources that has been attributed to open charm. The electron data from open charm decay are consistent with two different scenarios. One is the creation of a medium completely transparent to heavy quarks which then fragment into D/B mesons outside the system. The other is the creation of a highly opaque medium with the heavy quarks rescattering and hadronizing in the system.
If the excess electrons do indeed come from open charm then one would expect a near side azimuthal correlation between electrons and hadrons from the semileptonic decays of the D mesons. In addition, if the medium is transparent to heavy quarks (i.e., there is no significant energy loss in the medium) then a clear back-to-back correlation between the electrons and the hadrons of the charm jets is expected.However if the medium is highly opaque then such a back-to-back correlation should not exist
A method for studying electron-hadron azimuthal correlations will be presented

Flavor 15 **Takashi Hachiya,** **Single Electrons From Semi-leptonic Decays of Heavy Flavor in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: Hiroshima University

Co-authors/Collaboration: the PHENIX collaboration

Heavy flavored particles are one of the important probes to study hot and dense matter created in high energy heavy ion collisions. The measurement of single electrons at high transverse momentum (p_T) is a useful way to study heavy flavor production, mainly charm quarks, which is sensitive to the initial stage of the collisions. During the 2001/2002 run period, the PHENIX experiment recorded 30M minimum bias $Au+Au$ collisions at $\sqrt{s_{NN}} = 200GeV$. The inclusive electron spectrum can be decomposed into contributions from non-photonic sources which are charm and beauty decays, and from photonic sources which mainly are Dalitz decays of neutral pions and photon conversions in material. The current status of the analysis will be shown.

Flavor 16 **Soichiro Kametani, $J/\psi \to e^+e^-$ Yield in dAu Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: Center for Nuclear Study, Graduate School of Science, University of Tokyo

Co-authors/Collaboration: PHENIX Collaboration

During the 2003 d+Au run at RHIC, the PHENIX experiment recorded data corresponding to 2.74 nb^{-1} of integrated luminosity. These data are being used to study the production of J/ψ in cold nuclear matter.
In d+Au collisions, $c\overline{c}$ pairs are produced through hard processes whose probability is proportional to the number of nucleon-nucleon collisions. The $c\overline{c}$ pairs interact with the surrounding nuclear medium after they are formed. Additionally, nuclear shadowing, the depletion of parton density in the low it x region in a nucleus compared to that in a nucleon, may reduce the yield of $c\overline{c}$ pairs. These nuclear effects must be studied carefully in order to understand the modification of the J/ψ yield in normal nuclear matter, as a baseline for understanding J/ψ yields from Relativistic Heavy Ion Collisions, where suppression or enhancement has been predicted due to the formation of the Quark Gluon Plasma.
These studies may also help towards understanding the time evolution of $c\overline{c}$ pairs into J/ψ.
The measurement of centrality, which is correlated with the impact parameter, is important in this analysis, and careful studies have been made of it.
The current status of the analysis of J/ψ data from the e^+e^- channel in d+Au collisions will be presented.

Flavor 17 **Amruta Mishra,** **Mass Modification of D Mesons in Hot Hadronic Matter**

Affiliation: Institute for Theoretical Physics, University of Frankfurt, Germany

Co-authors/Collaboration: E. Bratkovskaya, J. Schaffner-Bielich, S. Schramm, H. Stoecker

We evaluate the in-medium D and $\bar{D}$-meson masses in hot hadronic matter induced by interactions with the light hadron sector described in a chiral SU(3) model. The effective Lagrangian approach is generalized to SU(4) to include charmed mesons. We find that the D-mass drops substantially at finite temperatures and densities, which open the channels of the decay of the charmonium states (ψ', χ_c, J/ψ) to $D\bar{D}$ pairs in the thermal medium. The effects of vacuum polarisations from the baryon sector on the medium modification of the D-meson mass relative to those obtained in the mean field approximation are investigated. The results of the present work are compared to calculations based on the QCD sum-rule approach, the quark-meson coupling model, chiral perturbation theory, as well as to studies of quarkonium dissociation using heavy quark potential from lattice QCD.

Flavor 18 **Andrea Dainese,** **Study of Charm Quenching in ALICE**

Affiliation: University and INFN, Padova (Italy)

Co-authors/Collaboration: ALICE

ALICE will study nucleus–nucleus collisions at the LHC in order to investigate the properties of QCD matter at extreme energy densities.
Hard partons and heavy quarks, abundantly produced at LHC energies in initial hard scattering processes, are sensitive probes of the medium formed in the collision as they may lose energy by gluon bremsstrahlung while propagating through the medium itself. The result is a medium-dependent quenching of leading hadrons and jets.
Charm mesons are expected to be less quenched than hadrons containing only light quarks since (a) they are originated by c quarks while other hadrons come mainly from the fragmentation of gluons, which lose more energy than quarks because of their larger colour charge, and (b) gluon radiation off heavy quarks should be suppressed by the dead cone effect (Dokshitzer and Kharzeev, 2002).
Using the quenching weights (Salgado and Wiedemann, 2003) with a dead cone correction, we obtain a *D*/pion ratio significantly enhanced in central Pb–Pb with respect to pp collisions. The study of this effect at the LHC will provide an important test for the coherence of the current understanding of energy loss in hot quark-gluon matter.
We show that the exclusive reconstruction of $D^0 \to K^-\pi^+$ decays with ALICE allows to measure the nuclear modification factor of *D* mesons and of the *D*/pion ratio up to $p_t \simeq 15$ GeV$/c$ and, thus, to investigate the quenching of charm quarks.

Flavor 19 **Rachid Guernane, Physics Performance of the ALICE Forward Muon Spectrometer**

Affiliation: INFN, Torino

Co-authors/Collaboration: ALICE Collaboration

Heavy flavor systems produced in hadronic reactions provide a valuable laboratory for the study of strong interactions. Due to their relatively large mass, heavy quark production should indeed be reliably calculable in the perturbative approach. Moreover, charm and beauty quarks once produced in a heavy ion collision have to propagate through the surrounding quark-gluon matter. So measuring heavy quark states allows to probe the properties of the dense medium.
The ALICE Dimuon Forward Spectrometer has been designed to measure the complete spectrum of heavy quark vector mesons as well as correlated muons from open charm and beauty via their muonic decays in pp, p-A and A-A collisions. LHC center of mass energies will offer significantly larger heavy flavor cross sections than those accessible today. Consequently, quarkonia signals will be sitting on top of a complex combinatorial background mostly originating from muonic decay of open charm and beauty particles. Nevertheless, once disentangled, this background will be used to measure the total heavy flavor cross sections.
In this talk, we will review the expected performance of the ALICE Dimuon Forward Spectrometer for heavy flavor detection based on preliminary analysis strategies including background subtraction techniques.

Flavor 20 **Mauro Villa, Open and Hidden Beauty Production in** 920 **GeV Proton-Nucleus Collisions**

Affiliation: INFN, Bologna

Co-authors/Collaboration: HERA-B

HERA-B is a fixed target experiment at the 920 GeV HERA proton beam at DESY which uses a variety nuclear targets. A dilepton trigger can select events containing leptonic J/ψ decays. During the last data taking period Nov. 02 - Feb.03, 150 million dilepton triggers and 200 million minimum bias triggers were recorded.
About 300,000 leptonic J/ψ decays ($\sim 170,000 J/\psi \to \mu^+\mu^-$ and $\sim 130,000 J/\psi \to e^+e^-$) were counted in the dilepton trigger sample. These events allow a substantially improved determination of the $b\bar{b}$ cross section over our previously published result of $\sigma_{b\bar{b}} = 32^{+14}_{-12}(\text{stat})^{+6}_{-7}(\text{syst})$ nb/nucleon, which was based on a small sample acquired in the summer 2000.
First results of the 2002/2003 data are presented, including a preliminary measurement of the $b\bar{b}$ cross section in proton-nucleus collisions and a preliminary measurement of the Υ production cross section.

Flavor 21 **Wolfgang Gradl, Charmonium production in 920 GeV Proton-Nucleus Collisions**

Affiliation: Heidelberg University

Co-authors/Collaboration: HERA-B

HERA-B is a fixed target experiment at the 920 GeV HERA proton beam at DESY. Thin wires of various materials are inserted into the proton beam halo and give rise to proton-nucleus collisions. A dilepton trigger can select events containing leptonic J/ψ decays. During the last data taking period Nov. 02 - Feb. 03, 150 million dilepton triggers and 200 million minimum bias triggers were recorded. About 300,000 leptonic J/ψ decays ($\sim 170,000 J/\psi \to \mu^+\mu^-$ and $\sim 130,000 J/\psi \to e^+e^-$) were counted in the dilepton trigger sample.
These events allow a measurement of the shape of the differential cross sections for inclusive J/ψ production at $\sqrt{s} = 41.6$ GeV in a kinematic range of $-0.3 < x_F < 0.15$ and $0. < p_t < 4.5$ GeV/c. The measurement is performed on both the e^+e^- and the $\mu^+\mu^-$ decay mode of the J/ψ. The shape of the differential cross section can be parameterized in terms of $\langle p_t \rangle$ and c where $d\sigma/dp_t^2 \sim (1+(p_t/p_0)^2)^{-6}$ and $d\sigma/dx_F \sim (1-|x_F|)^c$. The parameters $\langle p_t \rangle$ and c are reported and compared to other measurements and theoretical predictions.
The angular distribution for the leptonic decays is generally parameterized as $d\sigma/d\cos\theta \sim (1+\lambda\cos^2\theta)$. A measurement of the polarization parameter λ and its dependence on x_F and p_t is also presented.

Flavor 22 **Marco Bruschi, HERA-g, A New Experiment for Studying Centrally Produced Events in pN Interactions at $\sqrt{s} = 41.6$ GeV**

Affiliation: University of Bologna, Italy

Co-authors/Collaboration: HERA-B

A new experiment, called HERA-g, for study of centrally produced events on pN interactions at $\sqrt{s} = 41.6$ GeV using the existing HERA-B detector at DESY will be described. The experiment will be based on an efficient rapidity gap trigger the will allow to select events useful to study different classes of production mechanism like double pomeron exchange (glueball studies), pomeron-reggeon exchange (hybrid studies) and pomeron-odderon. The multi-level HERA-B trigger scheme will allow to collect, also in short time (few hundred hours), unprecedented statistics in many channels relevant for glueball and exotics searches. The high beam energy will allow the access to high invariant mass regions (up to 3.5 GeV) , with significant statistics. The experiment has unique characteristics also to investigate pN interaction mechanisms, due to the capability to work with targets having different Z. In this respect we have already some evidence, although with limited statistics, of possible nuclear effects related to the target material in double pomeron exchange interactions. In fact, we observed an asimmetry in the Feynman x distributions for centrally produced $\pi^+\pi^-$ final states that could be correlated to collective nuclear effects. Other topics that could be addressed by the HERA-g experiment concern the hadronic properties changes when the hadrons are embedded in nuclei.

Flavor 23 **Marc Bedjidian,** **Quarkonia and Z^0 Production in Heavy Ion Collisions with CMS**

Affiliation: Institut de Physique Nucleaire de Lyon, France

Co-authors/Collaboration: CMS

The observation of anomalous J/ψ suppression at the CERN-SPS has focussed attention on quarkonia production as an important signature of quark-gluon plasma formation. Nuclear collisions with $\sqrt{s_{NN}} \geq 5.5$ TeV at the LHC will allow CMS to extend the study of the J/ψ suppression pattern to higher energies. Furthermore, studies of the Υ family may provide a cleaner picture of the suppression mechanism. In addition, the very high energy allows CMS to use the Z^0 as a probe of heavy ion collisions for the first time. We report the capabilities of the CMS detector to study quarkonia and Z^0 production through the dimuon decay channel. The CMS muon acceptance is broad in the central region, $|\eta| \leq 2.4$, and, thanks to the powerful tracking system and 4T magnetic field, the dimuon mass resolution is ≈ 50 MeV at the Υ mass. Results of the simulations are shown assuming two sets of charged hadron multiplicities, $dN_{\rm ch}/d\eta = 5000$ and 2500, in central Pb+Pb collisions. The most recent estimates of the quarkonia and heavy flavour cross sections are used in the simulations. Dimuon mass spectra, signal/background ratios, and the expected statistics are presented for the J/ψ and Υ family and the Z^0 resonance.

Flavor 24 **Joakim Nystrand,** **Photoproduction of Heavy Vector Mesons in Proton-Proton and Pb+Pb Collisions at the LHC**

Affiliation: University of Bergen, Norway

Co-authors/Collaboration: Spencer R. Klein, Lawrence Berkeley National Laboratory

Mid-rapidity photoproduction of heavy vector mesons at the LHC is a sensitive probe of the gluon distribution in protons and nuclei down to $x = 2 \cdot 10^{-4}$. These interactions may occur for large impact parameters, where the probability of having a hadronic interaction in the same event is negligible. The cross section for exclusive production of lighter vector mesons at heavy-ion colliders has been found to be large [1], and the experimental feasibiltity of studying exclusive ρ^0-production in Au+Au collisions at the Relativistic Heavy-Ion Collider has recently been demonstrated by the STAR collaboration [2]. Here, calculations of exclusive vector meson production in proton-proton collisions will be presented for the first time and the calculations for heavy-ion interactions will be extended to include the Upsilon.
Although the cross sections for photoproduction of vector mesons are considerably smaller than for hadron production, the very different overall structure of the photon induced events may be used to identify them experimentally. The photonuclear events will in general have a much lower multiplicity than hadronic events, and there will be a rapidity gap, void of particles, between the produced meson and the proton or nucleus that emitted the photon. Experimental techniques for identifying the photon-induced events will be discussed.
[1] S.R. Klein and J. Nystrand, Phys. Rev. C 60 (1999) 014903.
[2] C. Adler et al. [STAR Collaboration], Phys. Rev. Lett. 89 (2002) 272302.

Flavor 25 **Kevin Haglin, Review of Meson Exchange Models for J/ψ Breakup Dynamics**

Affiliation: Saint Cloud State University

Co-authors/Collaboration: Charles Gale and Alex Bourque (McGill)

We review recent meson exchange calculations for hadronic breakup reactions of J/ψ. The common starting point is a four-flavor chiral Lagrangian, but models differ from this point in terms of 1) a presence or absence of anomalous parity terms, i.e. Wess-Zumino interactions, 2) the ways in which overall model calibration is accomplished, 3) the ways and the extent to which appropriate symmetries are respected, and 4) the manner in which hadron structure is implemented into vertex form factors. While models have converged significantly over the past few years, there remain subtle features of the models which can be used as guidance going forward. For instance, Ward identities, Adler's thereom and covariance for the vertex form factor structures are expected to constrain theoretical error bars further. Having convergence of meson exchange calculations with quark model predictions and QCD sum rule estimates will go a long way toward allowing definitive interpretation regarding J/ψ suppression at RHIC.

Flavor 26 **Alexandre A.P. Suaide,** **Inclusive Electron Distributions at High p_T in dAu and pp Collisions at RHIC**

Affiliation: University of Sao Paulo

Co-authors/Collaboration: STAR

The single electron spectrum over a sufficiently broad p_T range provides a measurement of charm and beauty production at RHIC energies. In heavy ion collisions, these heavy quark production rates are expected to be an important diagnostic of the possible quark gluon plasma (QGP) formed in the initial moments of the collision. In particular, comparative measurements in pp, dAu and AuAu will provide important sensitivity to the initial state gluon densities in these systems. In AuAu collisions, medium effects such as heavy quark energy loss can be studied through a comparison of the p_T distributions in beauty and charm production with those observed for inclusive hadrons. Finally, measuring open charm and beauty production at RHIC provides essential reference data for studies of color screening via quarkonium suppression. We present preliminary measurements of inclusive electron and positron spectra in d+Au and p+p collisions at $\sqrt{s_{NN}} = 200$ GeV for $1.5 < p_T < 8.0$ GeV/c. These measurements, which are among the first in an extended program of high pT heavy quark studies in STAR, were carried out using the STAR Time Projection Chamber (TPC) and the Barrel Electromagnetic calorimeter (BEMC). The combination of the STAR TPC and BEMC is capable of electron identification in pp, pA and heavy-ion collisions with high efficiency and purity. Overall hadron rejection factors in the range of $2 \cdot 10^5$ have been achieved in d+Au data.In this work we describe the measurement technique used to discriminate electrons from hadrons and compare the results for single electron spectra with theoretical calculations.

Flavor 27 **Ming Xiong Liu, Open Charm Production in pp and dAu Collisions Measured by the PHENIX Experiment**

Affiliation: Los Alamos National Lab

Co-authors/Collaboration: PHENIX collaboration

We report on the open charm measurements by the PHENIX experiment in p-p and dAu collisions. PHENIX has collected 2.74 nb^{-1} d-Au and 0.35 pb^{-1} p-p collisions during RHIC run-3. This provides an opportunity to study open charm production in p-p and d-Au collisions at centre of mass energy $\sqrt{s_{NN}}$ = 200 GeV. At RHIC energy, open charm production is sensitive to the gluon distribution in nuclei as well as to other nuclear medium effects. It also provides a baseline reference to the charmonium production which has been proposed as a probe for Quark-Gluon-Plasma in heavy ion collisions.
PHENIX detectors measure electrons and muons in the rapidity range $|\eta| < 0.35$ and $1.2 < |\eta| < 2.4$, respectively, thus enabling us to study open charm production in both central and forward rapidity. The current status of the open charm measurements with leptons will be presented.

Flavor 28 **Sidi Benzahra,** **Dissociation of Quarkonium in Quark Gluon Plasma**

Affiliation: North Dakota State University

Co-authors/Collaboration: Benjamin Bayman

In this work we calculate the dissociation of heavy mesons such as the upsilon due to absorption of a thermal gluon in a quark gluon plasma. We also calculate the dissociation of heavy mesons due to the effect of color charge screening. The lifetime of quarkonium moving with velocity v through a quark gluon plasma at temperature T is computed. An explicit configuration-space potential is found for the screened interaction between the quarks constituting the meson. This potential is non-spherical, but axially symmetric about the direction of v. We solve the Schrodinger equation for the relative motion of the quarks in this potential, and use the bound-state wavefunction as the initial state for the dissociation of the meson. The meson lifetime is thus determined as a function of v and T, and conclusions are drawn concerning the possibility of detection of the meson in a high-energy heavy-nucleus collision.

Flavor 29 **Maria B. Gay Ducati,** **Bottomonium Production in Hadron Colliders**

Affiliation: Instituto de Fisica, Univ. Fed. do Rio Grande do Sul, Brazil

Co-authors/Collaboration: C. Brenner Mariotto and G. Ingelman

Production of bottomonium in hadronic colisions is studied in the framework of the soft colour approach. We show our results p_t distribution for Υ production, comparing predictions from the color evaporation, soft color interaction and generalized area law models, with the Tevatron data. Predictions to the LHC are also presented.

Electro 1 **Marcia M. de Moura, Direct Photon Production From Transverse Energy Measurements in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV**

Affiliation: University of So Paulo

Co-authors/Collaboration: STAR

Direct photon measurements are a very interesting tool to probe the matter formed in relativistic heavy ion collisions. Due to their large mean free path relative to the size of the fireball, they may exhibit sensitivity to the initial state of matter formed in the collision. In some theoretical models the direct photon yield reflects the initial temperature of the system.
We present results on the estimation of the p_T integrated direct photon production for AuAu collisions at RHIC full energy $\sqrt{s_{NN}} = 200$ GeV. In the present analysis, we used the data taken with STAR Electromagnetic Calorimeter covering $0 < \eta < 1.0$ and $\Delta\phi = 60^\circ$. We obtained the electromagnetic fraction of the transverse energy event by event, which results mainly from hadronic decays. The largest contribution to the electromagnetic transverse energy originates in π^0 and η decay photons. By subtracting the contribution of such sources we obtain an upper limit on the photon production component due to direct thermal radiation. The measurements are made as a function of centrality of the collision.

Electro 2 **Abhijit Majumder,** **The Dilepton Signature of Broken Charge Conjugation and Rotational Invariance in a QGP**

Affiliation: LBNL

Co-authors/Collaboration: A. Bourque, C. Gale

The observational consequences of certain broken symmetries in a thermalised quark gluon plasma have been elucidated. The signature under study will be the spectrum of dileptons radiating from the plasma. The channel under investigation is the two-gluon-photon vertex. This is a pure medium effect: the channel being non-vanishing only in plasmas with explicit broken charge conjugation invariance. The rates are also sensitive to rotational invariance through the constraints imposed by Yang's theorem. Yang's theorem is understood in the medium via the destructive interference between various multiple scattering diagrams obtained by the spectator interpretation. This serves as a very important application of the spectator interpretation where a physical description of the mechanism of symmetry breaking is obtained. This is not afforded by the diagrams of the imaginary time formalism. This symmetry is broken at lowest order by the preferred frame of the plasma, and at higher orders by the effective masses of the gluons. Rates from both these approaches are discussed and presented in comparison with the Born term. It is demonstrated that in some regions of parameter space the rate from this process dominates over the Born term.

Electro 3 **Satoshi Yokkaichi, Vector Meson Measurements at the J-PARC 50 GeV PS**

Affiliation: RIKEN

Co-authors/Collaboration: K. Ozawa (CNS,University of Tokyo) and S. Sawada (KEK)

We have proposed an experiment at J-PARC to measure the modification of vector mesons due to the chiral symmetry restoration in dense matter. Detail design and feasibility of this experiment are presented.
High intensity ($10^9 - 10^{10}$/pulse) primary proton beam from the 50-GeV PS will be used to produce vector mesons in target nuclei. Electron-positron pairs from vector meson decays will be measured with a wide acceptance spectrometer that mainly covers slowly moving mesons, which have a larger probability to decay inside nuclei. With the next generation spectrometer using GEM foils for electron ID and tracking, it is possible to collect about $5000 - 50000$ of ϕ mesons. It means $10 - 100$ times as large statistics as collected by the KEK-PS E325 experiment, which already reported the modification of ρ/ω mesons in nuclear matter (PRL 86 (2001) 5019, PANIC02 and CIPANP03), but not yet about ϕ mesons. The spectrometer also have a capability for heavy-ion induced reactions discussed in J-PARC phase-II or after.

Electro 4 **Yuji Tsuchimoto, Measurement of low Mass Vector Mesons by e^+e^- Pairs in $\sqrt{s_{NN}} = 200$ GeV dAu Collisions at PHENIX**

Affiliation: Hiroshima University, 1-3-1 Kagamiyama, Higashi-Hiroshima

Co-authors/Collaboration: PHENIX Collaboration

Recently evidence for in-medium modification of vector mesons was reported [1]. The modification is predicted as a consequence of a partial restoration of the chiral symmetry in hot and/or dense matter. As such it is expected in the hot matter created by heavy ion collisions at RHIC. The measurement of vector mesons in cold nuclear matter is important not only for comparison with Au+Au but also for improving our understanding of in-medium modification. The PHENIX detector can detect electrons and hadrons within the same acceptance of mid rapidity. ω and ϕ mesons have both hadronic and leptonic decay modes and, in particular, the branching ratio of the ϕ may be sensitive to in-medium modifications. We studied the invariant mass spectra of e^+e^- pairs in $\sqrt{s_{NN}} = 200$ GeV d+Au collision at PHENIX. The current status of the ω and ϕ analysis will be shown.

[1] K. Ozawa et al., Phys. Rev. Lett. 86, 5019 (2001).

Electro 5 **Takao Sakaguchi, Searching for Non-hadronic Sources of Photons in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV at RHIC-PHENIX**

Affiliation: CNS, University of Tokyo

Co-authors/Collaboration: PHENIX Collaboration

Recent results on the high p_T hadron spectra measured by PHENIX detector at RHIC in d-Au and Au-Au collisions at $\sqrt{s_{NN}}$=200,GeV suggested that the hot-dense matter has been produced at RHIC, though it is not clarified if the matter is in thermally equilibrium.
Photons have long been considered an excellent probe of each stage of the collision dynamics because photons have a long mean free path compared to the size of the nuclear volume involved in the collisions, and will not be intracted strongly once produced. Moreover, the photons will give us the information on the thermodynamics of the state.
There have been prediction that the photons from QGP phase can be observed around the p_T region of 2-3,GeV/c on top of the huge background γ's from known hadronic sources such as π^0 or η. The contribution of such photons are estimated 10-20,% of those from backgrounds, and can be observed after carefully subtracting the backgrounds.
In this presentation, the latest result on the non-hadronics sources of photons in Au+Au collisions at $\sqrt{s_{NN}}$=200,GeV will be shown, and discussed what we learned.

Electro 6 **Klaus Reygers, Direct Photon Search in $\sqrt{s_{NN}} = 200$ GeV pp Collisions with the Statistical Background Subtraction Method**

Affiliation: University of Münster

Co-authors/Collaboration: PHENIX Collaboration

High p_T neutral pions are substantially suppressed in central Au+Au collisions relative to a p+p reference spectrum scaled by the number of inelastic nucleon-nucleon collisions. Energy loss of fast partons in the created medium of high color charge density provides an explanation for this observation. By contrast, high p_T direct photon production in Au+Au is not expected to be suppressed relative to a p+p reference in this jet quenching scenario. In order to study the scaling behavior of high p_T direct photons from p+p to Au+Au the measurement of the p+p reference spectrum is of great importance. Moreover, the measurement of direct photons in p+p reveals information about the gluon structure function of the proton. We present results based on a statistical subtraction of background photons from decays of neutral pions and other mesons.

Electro 7 **Gabor David, Disentangling Contributions to the Direct Photon Spectrum From Different Physics Processes in 200 GeV Heavy Ion Collisions**

Affiliation: Brookhaven National Laboratory

Co-authors/Collaboration: PHENIX

Direct photons - defined as those not originating from decays of final state hadrons - are produced during the entire time history of relativistic heavy ion collisions by different physics mechanisms, each in turn dominating production in a particular pT range and having a characteristic shape. Therefore, at least in principle, contributions from the different processes (like hard scattering, Bremsstrahlung, QGP radiation, direct photons from the hot hadron gas) can be unfolded when starting at very high pT where pQCD is assumed to dominate. Although this unfolding process cannot be purely experimental - still it gives constraints to the types and actual parameters of models describing lower pT contributions.
Methods of such unfolding will be presented, the stability of the results as a function of errors on the direct photon spectrum will be studied, finally using the direct photon spectra from PHENIX in 200 GeV pp and AuAu collisions a first attempt to unfold the contributions from various physics processes will be made.

Electro 8 **Takuma Horaguchi, Measurement of the Direct Photon Cross Section in Proton-Proton Collisions at $\sqrt{s} = 200$ GeV with PHENIX**

Affiliation: Department of Physics, Tokyo Institute of Technology, Tokyo, 152-8551, Japan

Co-authors/Collaboration: PHENIX Collaboration

Polarized proton-proton collisions at the Relativistic Heavy Ion Collider (RHIC) will give information on the spin structure of the nucleon. As a baseline for a polarized gluon distribution measurement using direct photons from quark-gluon compton scattering, the direct photon cross section provides us the unpolarized gluon density distribution, and is a testing ground for the precision of perturbative QCD in this regime. In PHENIX, we have collected data with an integrated luminosity of $0.15 pb^{-1}$ for transversely polarized proton-proton collisions with 15% average polarization in the run of 2001-2002 and $0.35 pb^{-1}$ for longitudinally polarized data in the run 2003 at $\sqrt{s} = 200 GeV$ with 30% average polarization. In this analysis, we will present the current status of direct photon measurement.

Electro 9 **Xiaofei Zhang,** **Probing Small-x Gluons by Low Mass Drell-Yan Pairs at RHIC and LHC**

Affiliation: Kent State University

Co-authors/Collaboration: George Fai (Kent State), Jianwei Qiu (Iowa State)

We calculate the transverse momentum distribution of low-mass Drell-Yan pairs in QCD perturbation theory with all-order resummation. We demonstrate that the transverse momentum distribution of low-mass Drell-Yan pairs is an advantageous source of constraints on the gluon distribution and its nuclear dependence. With the reduction in background, we argue that the measurement of low mass Drell-Yan pairs in the forward region is a good and clean probe of small-x gluons at RHIC/LHC.

Theory 1 **Takashi Ikeda,** **Quark Number Susceptibility at the Critical End Point**

Affiliation: RIKEN BNL Research Center

Co-authors/Collaboration: Yoshitaka Hatta

The quark number susceptibility in the T-μ plane, and its critical exponents at the tricritical point (TCP) and the critical end point (CEP) are investigated. We pointed out the possibility that the hidden TCP affects the physics near CEP.

Theory 2 **Deog Ki Hong,** **High Density Effective Theory of Quark Matter**

Affiliation: Pusan National University, Korea

Co-authors/Collaboration:

We discuss the formal aspects of the high density effective theory (HDET) of QCD, relevant to the low energy physics of dense quark matter. Then, we discuss the recent development in dense QCD from color superconductivity to the meson condensation, in terms of HDET. By solvong Schwinger-Dyson gap equations in the next-to-leading order, we find the precise form of gap, the critical temperature. Finally, as applications of HDET, we calculate the axial anomaly in dense QCD and propose a solution to the sign problem of QCD at finite density.

Theory 3 **Konstantin Petrov,** **Static Quark-Antiquark Pair Potentials and Heavy Flavour Physics at Finite Temperature from Lattice QCD**

Affiliation: Brookhaven Natl. Lab

Co-authors/Collaboration: Peter Petreczky

We present calculation of singlet and octet (as well as color averaged) potentials (free and internal eneries) of quark-anti-quark pair in strongly interacting medium below and above deconfinement transition using lattice QCD. We consider the case of 3 and 2+1 flavor QCD with various quark masses (we use configurations with Asqtad-improved dynamical fermions generated by MILC). The relevance of these calculations for the problem of in-medium mass shift of D and B-mesons in the confined phase as well as quarkonium suppression in the deconfined phase is also discussed(cf. S.Digal, P.Petreczky, H.Satz, Phys.Lett. B514 (2001) 57; Phys. Rev. D64 (2001) 094015).

Theory 4 **Tamas S. Biro,** **pQCD Parton Spectra Folded to Gibb's Distribution**

Affiliation: KFKI Res.Inst.Part.Nucl.Phys. Budapest

Co-authors/Collaboration: Berndt Muller

We point out that exponential shape of transverse spectra can be obtained as the Fourier transform of the limiting distribution of randomly positioned partons with power law spectra given by pQCD, which actually realize Tsallis distributions. Gibb's law is recovered at the Tsallis parameter q=1, a value typical for RHIC starts at q=0.87.

Theory 5 **Ivan Vitev,** **Resummed QCD Power Corrections to Nuclear Shadowing**

Affiliation: Iowa State University

Co-authors/Collaboration: Jianwei Qiu

We calculate and resum a perturbative expansion of nuclear enhanced power corrections in the quantity $(\xi^2/Q^2)(A^{1/3}-1)$ to the structure functions measured in deeply inelastic scattering of leptons on a nuclear target. Our results for the Bjorken x-, Q^2- and A-dependence of nuclear shadowing in $F_2^A(x,Q^2)$ and the nuclear modifications to $F_L^A(x,Q^2)$, calculated in terms of the QCD factorization approach, are consistent with existing data for $\xi^2 = 0.09-0.12$ GeV^2. We also discuss the impact of our results on the extraction of nuclear parton distribution functions. Less shadowing and correspondingly less antishadowing than currently anticipated may provide important constraints on the interpretation of the $d+A$ and $Au+Au$ data from RHIC. Further theoretical investigation of nuclear enhanced high twist corrections for different observables and future measurements at HERA, RHIC, EIC and LHC are expected to play a critical role in disentangling the process dependent and process independent parts of the strong interaction dynamics at small x.

Theory 6 **Volodymyr Magas,** **Freeze-Out and Deconfinement of Hadronic Matter**

Affiliation: University of Valencia

Co-authors/Collaboration: H. Satz

Conditions for the confinement phase transition and for the freeze-out will be discussed in a simple model of percolating hadrons. The interacting hadronic matter implies the existence of a large-scale connected cluster of a uniform nature, the size of such clusters as function of hadron density is specified by percolation theory. In such a system on a purely geometrical basis there are two critical densities, based on which we can formulate the freeze-out and deconfinement conditions in terms of the percolation of hadronic clusters or vacuum correspondingly. The resulting freeze-out condition as function of temperature and baryochemical potential interpolates between resonance gas behaviour at low baryon density and repulsive nucleonic matter at low temperature. The results of our analysis are in a good agreement with data and lattice QCD calculations.
V. Magas, H. Satz, ”Conditions for confinement and freeze-out”, hep-ph/0308155, submitted to Eur. Phys. J. C.

Theory 7 **David E. Miller,** **Quantum Entropy for Quark States**

Affiliation: Penn State U./ U. Bielefeld

Co-authors/Collaboration: Abdel-Nasser Tawfik

We discuss the presence of quantum entropy arising directly from the $SU(3)_c$ color symmetry in the quark singlet ground state of the hadrons. This entropy is calculated from the quantum density matrix ρ for the colored quark states which is defined by the prescription of von Neumann so that the entropy is $-Tr\ \rho \ln \rho$. Thus in the singlet state for both mesons and baryons the value is just $\ln 3$. The quantum entropy can be directly related to the correlations in the ground state. We investigate the temperature dependence of this entropy in some particular models. We look at its relationship to the equation of state in the bag model for quarks and gluons at low temperatures and small chemical potentials.

Theory 8 **Bernd R. Schlei, Simulations of Relativistic Heavy-Ion Collisions: Hydrodynamics at Work!**

Affiliation: Los Alamos National Laboratory

Co-authors/Collaboration:

Relativistic fluid dynamical models are widely used to describe heavy-ion collisions. Their advantage is that one can vary flexibly the Equation of State (EoS) of the matter and test its consequences on the reaction dynamics and the outcome. This makes fluid dynamical models a very powerful tool to study possible phase transitions in heavy-ion collisions such as the liquid-gas or the Quark-Gluon Plasma (QGP) phase transition. In this talk, I shall provide an overview over a variety of relativistic hydrodynamic models, some of which are widely used for the interpretation of experimental data, their particular assumptions, and implementations. The initial and final, freeze-out stages of the reaction are outside the domain of applicability of the fluid dynamical model. Fluid dynamics is not valid when the fluid becomes diffuse. When it is believed that the transition from a fluid to particles occurs (Freeze-Out), a popular approach for the calculation of single and double inclusive momentum distributions of hadrons is represented by the integration of source or emission functions. The source functions are expressed in the case of relativistic hydrodynamic models in terms of hydrodynamic fields across a freeze-out hyper-surface (FOHS). Until very recently, no numerical method on how to construct a FOHS from 3+1 dimensional data was known. With the advent of the novel STEVE (Space-Time-Enclosing Volume Extraction) algorithm it is no longer necessary to discuss hadronic multi- particle production in reduced dimensions. I am going to explain this novel algorithm in great detail as well.

Theory 9 **Javier L. Albacete, Energy Dependence of the Cronin Effect from Small x Evolution**

Affiliation: Theory Division, CERN

Co-authors/Collaboration: N. Armesto, A. Kovner, C. A. Salgado and U. A. Wiedemann

In the last years it has been suggested that the non-linear evolution of dense partonic systems at high energies or small x may be relevant for the dynamics of p–A and A–B collisions at collider energies. Here we discuss to what extent the description of Cronin enhancement in the framework of this non-linear evolution is consistent with the observations in d–Au and Au–Au collisions at the Relativistic Heavy Ion Collider. By solving the Balitsky-Kovchegov (BK) evolution equation numerically for several initial conditions encoding Cronin enhancement, we find that the properly normalized nuclear gluon distribution is suppressed at all transverse momenta relative to that of a single nucleon. Calculating the resulting spectrum of produced gluons in p–A and A–A collisions, we establish that the nonlinear QCD evolution is unable to generate a Cronin type enhancement, and that it quickly erases any such enhancement which may be present at lower energies.

Theory 10 **Johannes Ranft, RHIC Data and the Multichain Monte Carlo DPMJET-III**

Affiliation: Physics Dept. Siegen University,Siegen,Germany

Co-authors/Collaboration: F.Bopp, R.Engel, S.Roesler

Using data from RHIC we are able to systematically adjust and improve the two-component Dual Parton Model (DPM) event generator DPMJET-III. Three examples: Introducing the long postulated percolation and fusion of chains the model describes multiplicities and pseudorapidity distributions in nucleus-nucleus collisions at all centralities. Guided by the d-Au data from RHIC the model is reformulated so that collision scaling in h-A and d-A collisions is obtained. Implementing anomalous baryon stopping helps to get a better description of baryon distributions.

Theory 11 **Georg Wolschin,** **Diffusion and Local Deconfinement at RHIC Energies**

Affiliation: Heidelberg University

Co-authors/Collaboration:

In relativistic systems at RHIC energies, new deconfinement signatures emerge and indicate an increasingly clear separation between soft hadronic processes, and hard partonic interactions in a locally deconfined subsystem. Here the emphasis is on longitudinal variables, namely, net-baryon rapidity distributions. As described in a Relativistic Diffusion Model, they change from bell-shaped at the lower to double-humped at the higher SPS-energy, but do not reach local statistical equilibrium. At $\sqrt{s_{NN}}$ = 200 GeV in the Au-Au system, however, they are shown to consist of three components. In addition to the nonequilibrium contributions, a third fraction close to midrapidity containing $Z_{eq} \simeq 22$ protons reaches local statistical equilibrium in a discontinuous transition. It may be associated with a deconfinement of the participant partons and thus, serve as a signature for Quark-Gluon Matter formation.

[1] G. Wolschin, Phys. Lett. B 569, 67 (2003), and preprint (2003).

Theory 12 **Mikkel B. Johnson,** **Energy Loss and Momentum Broadening of Fast Partons in the Nuclear Medium**

Affiliation: Los Alamos National Laboratory

Co-authors/Collaboration:

The color dipole approach has been applied in the target rest frame to address the issues of transverse momentum broadening and energy loss of a fast quark propagating in the nuclear medium. New calculations for the transverse momentum distribution will be presented, and the results will be compared to the E866 Drell-Yan data. The theory will be shown to compare favorably to the data, and these results will be shown to suggest that the momentum broadening of a quark is about twice the generally accepted size.

Theory 13 **Sabine Hossenfelder,** **Signatures of Large Extra Dimensions**

Affiliation: ITP Frankfurt

Co-authors/Collaboration:

Recent models with extra dimensions provide a solution to the hierarchy problem by modifying the topology of space time. Motivated by string theory, in these models the Planck scale is lowered to values that will soon be accessible at the LHC. Therefore, it may be possible in the near future to test general properties of space time and get a first look at quantum gravity. Within the model, observables can be computed that allow to predict interesting new effects, such as graviton and black hole production.

Theory 14 **Chihiro Sasaki,** **Pion Velocity Near the Chiral Phase Transition**

Affiliation: Nagoya University

Co-authors/Collaboration: M.Harada, Y.Kim, M.Rho

Our starting point is the premise that the effectice field theory (EFT) is to be defined from QCD at a suitable matching scale. Using the hidden local symmetry as an EFT, it is shown that the chiral symmetry restoration is realized as the vector manifestaion (VM), in which the massless vector meson becomes the chiral partner of pion at the critical point. I show that the pion velocity is related to an existence of a new fixed point near the chiral phase transition point, and estimate the value of the pion velocity, which is close to the speed of light. The new fixed point concerning the pion velocity is originated in the VM. The value of the pion velocity near the critical point is determined through the matching between the current correlator in HLS and that obtaind from the operator product expansion.

Theory 15 **Eugenio Megias,** **The Effective Action of QCD at High Temperature**

Affiliation: Universidad de Granada

Co-authors/Collaboration: E. Ruiz Arriola, L.L. Salcedo

Using a new technique to compute the heat kernel expansion at finite temperature, we obtain the one-loop effective action of QCD at high temperature with massless quarks. The result is given within a covariant derivative expansion including operators of mass dimension six and in the $\overline{\rm MS}$ scheme. The calculation is carried out within the covariant background field method. The result is fully gauge invariant and the thermal Wilson line plays an essential role. Our result is obtained considering general background fields which may be non-stationary. We consider a general SU(N) gauge group and we particularize the results for the SU(2) and SU(3) groups. We study the breaking of the center symmetry of the gauge group when fermions are included. The corresponding dimensionally reduced effective action is also obtained, yielding operators of the effective field theory up to dimension six. We reproduce existing results by S.Chapman (PRD50,5308(1994)), but including fermions. We observe that the higher orders operators are rather sensitive to the number of quark flavors. This conclusion has also been obtained by J.Wirstam (PRD65,014020(2001)), however we disagree with his calculation in details. Our results can be applied to studies in lattice in the region of temperatures above 2.5 times that of phase transition. This work is a continuation of another published in Physics Letters B 563 (2003) 173-178.

Theory 16 **Masayasu Harada,** **Vector Manifestation in Hot and/or Dense Matter**

Affiliation: Nagoya University

Co-authors/Collaboration: Youngman Kim, Mannque Rho, Chihiro Sasaki

Recently, the vector manifestation (VM) is proposed as a novel manifestation of the Wigner realization of chiral symmetry in which the symmetry is restored at the chiral restoration point by the massless degenerate pion and the rho meson as the chiral partner. I summarize the main features of the VM, compared with the conventional manifestation a la the linear sigma model, and show how the VM is formulated in hot and dense QCD using the effective field theory based on the hidden local symmetry.

Theory 17

Rainer J. Fries, Electromagnetic Signals From Jets Traveling Through a Hot Medium

Affiliation: University of Minnesota

Co-authors/Collaboration:

Fast partons passing through a hot quark gluon plasma interact with the medium. Induced gluon radiation occurs and leads to the famous phenomenon of energy loss. Much more rare is induced photon radiation by interactions with the medium. This will not contribute considerably to the energy loss of the parton, but this photon source is still quite bright in comparison with other photon production mechanims. We will discuss this effect and present some results.

Theory 18 **Felix Zantow, A New Look at Heavy Quark Potentials at Finite Temperature and First Consequences for the Quarkonium Spectra**

Affiliation: Bielefeld University, Department of Physics

Co-authors/Collaboration: S. Digal, O. Kaczmarek, F. Karsch, P. Petreczky and H. Satz

One of the basic approaches in the discussion of thermal properties of heavy quark bound states is based on the analysis of the non-relativistic Schroedinger-Eq. using potentials calculated in, or motivated through, lattice calculations. So far, however, lattice calculations at finite temperatures provided the color averaged free energies rather than the color singlet energies which could define the finite temperature potential. Of even greater importance than the free energy for the analysis of the confinement forces is the potential energy at finite temperature, however, its calculation at finite temperature is still missing. Moreover, the role of any entropy in the free energy has been ignored so far in potential models using free energies.
We present here first lattice results from SU(3) (quenched QCD) for the quark antiquark potential energy at finite temperature which we extract from the free energies by applying thermal relations. In fact, the potential energies show a surprisingly different behavior from the behavior of the free energies as the entropy turns out to be quite important in the free energy. We use these new potentials as an input in potential models to analyze the temperature dependence of the quarkonium spectra.

Theory 19 **Yoshiki Watanabe, Novel Pattern of Chiral Symmetry Breaking at Finite Temperature and Density**

Affiliation: University of Tokyo

Co-authors/Collaboration: Tetsuo Hatsuda, Kenji Fukushima

To describe the chiral phase transition at finite temperature and density, the chiral condensate $\langle\bar{\Psi}\Psi\rangle$ has been used as the order parameter. This characterizes the complete breaking of axial part of chiral symmetry. We have recently studied another pattern of chiral symmetry breaking which leaves the discrete subgroup of chiral symmetry unbroken. We show that this symmetry breaking pattern inevitably requires higher dimensional composite operator as an order parameter. After making general analysis of this novel form of symmetry breaking on the basis of the Ginzburg-Landau effective lagrangian, we demonstrate the idea in the three dimensional O(2) ϕ^6 theory by introducing two order parameters $\langle\phi_1\rangle$ and $\langle\phi_1^2-\phi_2^2\rangle$. Possible connection of this study with the well-known example of the 4-quark order parameter in the CFL phase of color superconductivity will be also discussed.

Theory 20 **Cornelius C. Noack,** **Causality Problems with the Parton Cascade Approach to Ultarelativistic Heavy Ion Reactions**

Affiliation: Univ. Bremen

Co-authors/Collaboration:

Parton cascade models (VNI, pcpc, ZPC etc.) have been surprisingly successful in describing heavy-ion reactions at RHIC energies — surprising because in spite of their QCD bells and whistles, they essentially embody emphclassical many-particle dynamics. The procedure to determine the sequence of the binary parton interactions, however – an essential aspect of all such models – is by necessity an artificial and ad-hoc feature of these codes. This has been recognized early on as a serious drawback of non-covariant cascade models.
We show explicitly that, while in pcpc the interaction sequence is determined covariantly and thus is independent of the coordinate system in which the code is run, this alone does not solve the basic causality problem raised by such classical models.
While this aspect of the cascade approach is of fundamental concern, it does not necessarily invalidate parton cascade models for practical purposes, and we discuss in detail the practical, relevance of this causality problem in some of the existing codes.

Theory 21 **Tuomas Lappi, Particle Production in the Classical Field Model for Heavy Ion Collisions**

Affiliation: University of Helsinki and Helsinki Institute of Physics

Co-authors/Collaboration: F. Gelis and K. Kajantie

We report on numerical computations of gluon multiplicity and transverse energy in central relativistical heavy ion collisions within the classical field model of McLerran and Venugopalan. After an error in earlier calculations has been corrected the model yields results that are in better agreement with experimental results and theoretical expectations.
We also report on ongoing work to study chemical equilibration by nonperturbatively computing the quark-antiquark production from the classical color fields in the same framework.

Theory 22 **Yu-Gang Ma, Δ Scaling and Multiplicity Information Entropy in Relativistic Nucleus-Nucleus Collisions**

Affiliation: Shanghai Institute of Nuclear Research, Chinese Academy of Sciences

Co-authors/Collaboration:

The Δ-scaling method has been applied to relativistic p+p, C+C and Pb+Pb collision data which were simulated using a high energy Monte Carlo package, LUCIAE 3.0. The Δ-scaling is found to be valid for some physical variables, such as total multiplicity of charged particles, strange particle multiplicity and number of binary nucleon-nucleon collisions from these simulated nucleus-nucleus collisions over an extended energy ranging from Elab = 20 to 200 A GeV. In addition we derived information entropy from the multiplicity distribution as a function of beam energy for these collisions.

Theory 23 **Taeko Matsuura, Ginzburg-Landau Approach to the Phase Transtions of Color Superconductivity at Finite Temperature**

Affiliation: University of Tokyo

Co-authors/Collaboration: G. Baym (Univ. Illinois), T. Hatsuda (Univ. of Tokyo), K. Iida (RIKEN) and M. Tachibana (RIKEN)

The finite temperature phase transition of the three-flavor color superconductor will be presented by using the Ginzburg-Landau (GL) theory. This is based on a work in collabollation with G. Baym (Univ. Illinois), T. Hatsuda (Univ. of Tokyo), K. Iida (RIKEN) and M. Tachibana (RIKEN). We will discuss two topics: (i) the effect of thermal fluctuations of gluons and diquarks on super-to-normal phase transition in color superconductivity, and (ii) the effect of the strange quark mass and the instantons on the phase diagram of color superconductivity.
As for (i), we have shown that the system is the Type I superconductor at high baryon densities, and the gluonic fluctuation (which dominates over the diquark fluctuation) has a significant effect on the GL free energy. This leads to a rather strong first order transition in contrast to the very weak first order transition in metallic Type I superconductors. We find that the strength of the first order transition decreases as the baryon density increases. Also the critical temperature of the first order transition turns out to be smaller than that without the gluonic fluctuations. Explicit formulae for the critical temperature, the discontinuity of the order parameter at the critical point and the latent heat are derived in the weak coupling. Reliability of the one-loop approximation is discussed by making comparison with the size of the Ginzburg critical region.
As for (ii), we have shown that the instanton and strange-quark mass introduce a wide variety of the phase diagram for color superconductivity. They produce the splitting of single phase transition, normal-super(2SC) and super(2SC)-super(”modified”CFL), whose order are both second order in mean field approximation. The qualitative estimation shows 2SC ranges wider as the density decreases and ”modified” CFL becomes ”purer” when the temperature is lowered.

Theory 24 **Genis Musulmanbekov,** **On The Quark Structure Of Nuclei**

Affiliation: Joint Institute for Nuclear Research

Co-authors/Collaboration:

How are the nucleon properties modified inside nuclei and do quarks manifest themselves explicitly in ground state nuclei? These questions are the topics of the talk, where we show that the nuclear modification of nucleon properties is a result of correlations of quarks of bound nucleons.The structure of nuclei is analysed in the framework of Strongly Correlated Quark Model (SCQM), elaborated by the author for description of hadron structure. The model is identical to breather-soliton solution of sine–Gordon equation. It demonstrates interplay between current and constituent (nonrelativistic) quark states inside hadrons as chiral symmetry breaking with constituent mass generation.
It is shown, as well, that quarks of bound nucleons inside nuclei are arranged in such a way that nuclei possess crystal-like structure. It turns out that our approach is identical to face–centered–cubic lattice model of nuclear structure proposed by N. Cook and V. Dallacasa about twenty years ago. This arrangement with nucleons occupying the lattice sites brings together shell, liguid–drop and cluster characteristics, as found in conventional models, within a single theoretical framework. According to this picture small quark configurations occurring inside free nucleon are suppressed inside nuclei. That is constituent quark configurations are predominantly realized inside nuclei. This effect results in modification of nucleon structure functions inside nuclei which is at the bottom of such nuclear phenomena, as old EMC – effect, color transparency breaking, jet and J/ψ suppression and enhancement of multiparticle production in nucleus – nucleus collisions at high energies and others.

Theory 25 **Motoi Tachibana, Effects of Strange Quark Mass and Instanton on Color Superconductivity in the Ginzburg-Landau Approach**

Affiliation: RIKEN

Co-authors/Collaboration: Tetsuo Hatsuda, Kei Iida and Taeko Matsuura

The finite temperature phase transition of the three-flavor color superconductor will be presented by using the Ginzburg-Landau (GL) theory. This is based on a work in collabollation with T. Hatsuda (Univ. of Tokyo), K. Iida (RIKEN) and T. Matsuura (Univ. of Tokyo).
We will specifically discuss the effect of the strange quark mass and instantons on the phase diagram of color superconductivity.
We have shown that the instanton and strange-quark mass introduce a wide variety of the phase diagram for color superconductivity. The strange quark mass plays a role of raising the energy of pairings involving the strange quark. On the other hand, the exisitence of instantons lowers the energy of ud pairing. Consequently, both effects produce the splitting of single phase transition, normal-super(2SC) and super(2SC)-super(”modified”CFL), whose orders are both second order in the mean field approximation. The qualitative estimation shows 2SC ranges wider as the density decreases and ”modified” CFL gets ”purer” when the temperature is lowered. In addition, we will discuss the effect of gauge field (gluon) fluctuations in one-loop approximation, which leads to the first order phase transition.

Theory 26 **Hirotsugu Fujii, Hydrodynamic and Sigma Modes Near the Critical End Point**

Affiliation: University of Tokyo, Komaba

Co-authors/Collaboration: OHTANI, Munehisa

We discuss the transition between the hadronic phase and the plasma phase at finite temperature/density. It is argued that the soft mode at the QCD critical end point is different from the sigma meson mode. That is, the softening of the hydrodynamic mode is responsible for the divergence of the susceptibilities at CEP, whereas the sigma meson softening is essential at the chiral critical point in the massless two-flavor case. Our explicit calculations are performed within the Ginzburg-Landau approach as well as the Nambu-Jona-Lasinio model, and we study the spectral contributions to the scalar, baryon number susceptibilities and specific heat. The result implies that the sigma-to-two-pion decay does not directly see the CEP and that the slowing out of equilibrium is more relevant and important here because the hydrodynamic mode is slower than the non-conserved sigma mode.
ref. H.Fujii, Phys.Rev.D67, 094018(2003). H.Fujii and M.Ohtani, to be submitted.

Theory 27 **Robert D. Pisarski,** **Approximate Z(3) Symmetry in QCD**

Affiliation: BNL & NBI

Co-authors/Collaboration: A. Dumitru, Y. Hatta, J. Lenaghan, and K. Orginos

QCD may exhibit an approximate global Z(3) symmetry, which in the pure gauge theory is exact. Such an approximate symmetry can be tested by measuring renormalized Polyakov loops on the lattice. A new systematic proceedure for computing renormalized loops on the lattice was developed, and tested in numerical simulations in the pure gauge theory. The results suggest a matrix-valued mean field theory for Polyakov loops. A possible extension of the matrix model to QCD is also presented.

Theory 28 **Shinji Ejiri, Numerical Study of the Equation of State for Two Flavor QCD at Non-Zero Chemical Potential**

Affiliation: University of Bielefeld

Co-authors/Collaboration: C.R. Allton, M. Doering, S.J. Hands, O. Kaczmarek, F. Karsch, E. Laermann and C. Schmidt

It is important to study QCD at high temperature and high density by numerical simulations of lattice QCD. In particular, studies of the equation of state (EoS) can provide basic input for the analysis of the experimental signatures for QGP formation, e.g. the EoS will control the properties of any hydrodynamic expansion. We extend studies of the EoS to non-zero baryon number density. The simulation at non-zero baryon density had been known to be difficult until recently, however the study based on a Taylor expansion with respect to chemical potential μ_q is found to be an efficient technique to investigate the low density regime, interesting for heavy-ion collisions. If we calculate the Taylor expansion coefficients at $\mu_q = 0$, the technical difficulty at non-zero μ_q is resolved and a quantitative study becomes possible within the error by truncation of higher order terms.
We discuss the equation of state for 2 flavor QCD at non-zero temperature and density. Derivatives of $\ln Z$ with respect to μ_q are calculated up to sixth order. From this Taylor series, the pressure, quark number density and associated susceptibilities are estimated as functions of temperature and μ_q. We also discuss the radius of the convergence of the expansion to confirm the reliability of our calculation.

Theory 29 **Masakiyo Kitazawa, Precursor of Color superconductivity: Pseudogap Phenomenon and Experimental Observables**

Affiliation: Kyoto University

Co-authors/Collaboration: T. Koide, T. Kunihiro, Y. Nemoto

It was shown in our previous works that the pair field of the color superconductivity (CSC) can have large fluctuations even well above critical temperature T_c at relatively low density region. One may thus expect that precursory phenomena of CSC appear as possible anomalous behavior of various observables in the normal phase above T_c reflecting the large fluctuation.
(1) In high temperature superconductivity (HTSC), there exists a depression in the quark density of state at the vicinity of the Fermi energy above T_c, which is known as a pseudogap phenomenon. We shall show such a phenomenon occur also in CSC owing to the large fluctuation of the order parameter in the normal phase; the density of state of the high density quark matter shows a clear pseudogap even well above T_c of CSC. We shall also discus the nature of hot and dense quak matter on the basis of the similarity and differences between HTSC and CSC.
(2)In the metal superconductivity, an anomalous enhancement of electric conductivity (paraconductivity) is observed above T_c. The origin of the paraconductivity is the collective fluctuation of the pair field: Near T_c, the collective mode couples with photons through, for example, the Aslamasov-Larkin term. Since the pair field of CSC can also couple with photons, similar paraconductivity is anticipated around T_c in CSC. We indicate that the color-super paraconductivity leads to an anomalous dilepton production in the heavy ion collision.

Theory 30 **Masakiyo Kitazawa,** **Non-equilibrium Critical Dynamics in Hot Quark Matter**

Affiliation: Kyoto University

Co-authors/Collaboration: T. Kunihiro,Y. Nemoto

In describing the critical dynamics near second order (or weak first order) phase transitions, it is known essential to incorporate the dissipation of the order parameter and other macroscopic variables as well as nonlinear fluctuations of the order parameter. It is also the case in describing the evolution of the hadronic or partonic matter produced by the heavy-ion collisions at RHIC or LHC, where the fire balls created by the collisions may undergo the QCD phase transitions.
In this talk, we shall report on a derivation of the macroscopic non-equilibrium critical dynamics of the chiral and color superconducting phase transitions based on Nambu-Jona-Lasinio model as a microscopic theory of QCD. We shall show that the slow and long-wave length dynamics of the order parameter obey simple equations characterized by a few parameters which are determined by the microscopic theory.
In the case of the color superconductivity, our result shows that the dynamics of the pair field is not given by a simple time-dependent Ginzburg-Landau equation, which is suitable for overdumped modes, but given by an equation for a damped but oscillating mode. We shall also clarify the underlying mechanism realizing such a dissipation and differences. The dissipations obtained will be transcribed in terms of viscosities of macroscopic variables, which have relevance to hydrodynamical simulations of the fire balls.

Theory 31 **Masashi Kaneta, Centrality Dependence of Chemical Freezeout in Au+Au Collisions at RHIC**

Affiliation: RIKEN-BNL Research Center

Co-authors/Collaboration: Nu Xu (LBNL)

We will report centrality dependence of chemical freeze-out temperature (T_{ch}),light quark chemical potential (μ_q), strange quark chemical potential (μ_s), and strangeness saturation factor (γ_s) in Au+Au collisions at $\sqrt{s_{NN}}$ = 130 GeV. A systemactic study for combination of ratios for chemical freeze-out fit is studied and we found small dependences for the combination. The results show γ_s increasing with centrality but the other parameters have less sensitivity to the centralities. Additionaly, we compare fit results from central Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV with 130 GeV results.

Theory 32 **Carsten Greiner, Kinetic and Chemical Equilibration in a Parton Cascade Including Inelastic Collisions**

Affiliation: Institut für Theoretische Physik, Universität Frankfurt, Germany

Co-authors/Collaboration: Zhe Xu

We present a new 3+1 dim. Monte Carlo algorithm solving the kinetic Boltzmann equation for partons including the inelastic $gg \leftrightarrow ggg$ pQCD multiplication processes. The back reaction channel is treated for the first time fully consistently within this scheme. An extended stochastic method is used to solve the collision integral. Assuming multiple production of minijets in Au+Au collisions as initial space-time input, we study the kinetic and chemical equilibration at RHIC energy. It is demonstrated that thermalization is driven mainly by the inelastic processes on a timescale of less than 1 fm/c. We also discuss the consequence on parton thermalization when a color glass condensate is considered as the very initial state of partonic matter. Again, we find a fast thermalization within the various local rapidity cells of the partonic phase.

Theory 33 **Vasile Topor Pop, Baryon Junction Transport Observable via HIJING/B$\overline{\text{B}}$ v2.0**

Affiliation: McGill University, Montreal, Canada

Co-authors/Collaboration: M. Gyulassy, J. Barrette, C. Gale, X. N. Wang, Nu Xu

Large The anomalous production of moderate p_T baryons and anti baryons at RHIC provides information about baryon number transport and production mechanisms in high energy nuclear collisions. String fragmentation based Monte Carlo event generators like HIJING v1.37 fail to describe those data. One intriguing possibility suggested by Kharzeev and implemented in HIJING/B$\overline{\text{B}}$ v1.10 by Vance it et al. was that baryon junctions may play an important role in baryon dynamics. The net valence baryon number rapidity distributions are consistent with present data, and the proton transverse spectra can be understood better due to the small Regge slope of the juction. However, B$\overline{\text{B}}$ v1.10 fails to blue shift the antibaryon spectrum even though a novel element in that is baryon junction loops which should boost both baryon and antibaryons. We constructed a new modified version of HIJING/B$\overline{\text{B}}$ (v2.0) to more faithfully simulate the expected physics of p_T junction loop. Introducing this corrected junction loop algorithm leads to a significant improvement in comparison with recent PHENIX, STAR and BRAHMS data. In particular, this new version described well the rapidity distribution of the net-p ($p-\overline{p}$), as well as the transverse momentum. Futhermore, the "anomalous" baryon-mesons composition at intermediate p_T observed in particle ratios $\overline{p}/p$, p/π^+, $\overline{p}/\pi$ is now well reproduced.

Theory 34 **Laszlo P. Csernai,** **Multi-Module Models for Heavy Ion Reactions**

Affiliation: University of Bergen

Co-authors/Collaboration:

We search for flow signals of phase transition in ultra-relativistic heavy ion collisions. Earlier fluid dynamical calculations with QGP show a softening of the directed flow while with hadronic matter this effect is absent. On the other hand we indicated that a third flow component shows up in the reaction plane as enhanced emission which is orthogonal to the directed flow. This is not shadowed by the deflected projectile and target and shows up at measurable rapidities, $y_{cm} = 1 - 2$. To study the formation of this effect initial stages of relativistic heavy ion collisions are studied. An effective string rope model is presented for heavy ion collisions at RHIC energies. Our model takes into account baryon recoil for both target and projectile, arising from the acceleration of partons in an effective field. The typical field strength (string tension) for RHIC energies is about 5-12 GeV/fm, what allows us to talk about ”string ropes”. The results show that a QGP forms a tilted disk, such that the direction of the largest pressure gradient stays in the reaction plane, but deviates from both the beam and the usual transverse flow directions. The produced initial state can be used as an initial condition for further hydrodynamical calculations. Such initial conditions lead to the creation of third flow component.

Theory 35 **Peter Levai, Hadron Production in the Intermediate Transverse Momentum Window at RHIC Energies**

Affiliation: RMKI, Research Inst. Particle and Nuclear Physics

Co-authors/Collaboration:

In the transverse momentum window $2 < p_T < 6$ GeV hadron production is not fully understand, neither in proton-proton collisions, nor in heavy ion collisions at RHIC energies. Although pion spectra can be reproduced in a perturbative QCD frame including stronger or weaker jet energy loss, but proton and antiproton productions was found far beyond the theoretical estimates. Quark coalescence and parton recombination can reproduce the measured anomalous baryon (antibaryon) to meson ratios and many one-particle distributions in heavy ion collisions, but jet-jet correlation data remain unsupported. I discuss the consequences of other microscopical hadron production mechanisms and display a possible solution for the above problem, which include both a pQCD frame and the basic idea of parton coalescence.

Theory 36 **Joerg Ruppert, On the Self Consistent Description of Strongly Interacting Matter**

Affiliation: Univ. Frankfurt

Co-authors/Collaboration:

We investigate the properties of hot strongly interacting matter using self-consistent resummation schemes. We studied the physics of scalar and pseudoscalar mesons at finite temperature considering the influence of different chiral symmetry breaking patterns and different quark flavors in the framework of linear sigma models in the Hartree approximation. Independenly from these investigations, we studied the properties of the rho-vector-meson at high temperature considering it's interaction with the pions in a self-consistent one-loop resummation. We have considered finite width effects only and have shown that the rho-meson spectral function gets contributions even below the two-pion threshold. This is different from perturbative calculations. Physically this leads to a significant modification of the expected dilepton production rate especially in the low-mass region.

Theory 37 **Sven Soff** *et al.*, **Excitation functions of the strangeness dynamics**

Affiliation: Frankfurt University

Co-authors/Collaboration: E. Bratkovskaya, M. Bleicher, M. Reiter, H. Stoecker, M. vanLeeuwen, S. Bass, and W. Cassing

We address by means of transport theory the latest status of the HBT-puzzle at RHIC. The differences of various models are pointed out with respect to their predictions, assumptions and space-time evolution characteristics. Moreover, it is demonstrated what complementary information can be obtained from the study of non-identical two-particle correlations at low relative momenta. In addition, we also show the impact of strong color field properties on the particle production mechanisms, in particular, on the phi-meson production. The associated intrinsic transverse momenta largely determine the relative contributions from different production mechanisms to the finally observed spectra. Finally, we investigate excitation functions on strangeness observables (kink, horn, step) and test them concerning their anomaly.

Theory 38 **Xiaofei Zhang,** **Charged Hadron/Pion Ratios at RHIC**

Affiliation: Kent State University

Co-authors/Collaboration: George Fai

It will be of great interest to see if the anomalous enhancement of the high-p_T proton/pion and charged-hadron/pion ratios reported earlier will be further substantiated in the Fall 2004 RHIC data. Coalescence models provide one avenue to attempt to explain some features of the enhancement. Alternatively, we suggest that the non-universality of transverse-momentum broadening, implied by the higher-twist structure of pQCD calculations may in part be responsible for the effect.
The early Fermilab and CERN ISR data, associated with the discovery of the Cronin enhancement, already show the non-universality of the enhancement for different particle species. After some time, interest in the experimental and theoretical study of this issue was recently renewed by RHIC data on Au+Au and d+Au. It is also important to realize the necessity of reliably calculating the Cronin enhancement in order to judge the magnitude of jet quenching. We explore the consequences of different Cronin enhancement coefficients in the widths of the transverse-momentum distributions of different secondaries. We find that the main features of the transverse-momentum and impact-parameter dependence of hadron/pion ratios at 200 GeV can be obtained in a simplistic model, if the non-universality is incorporated. The difference of the nuclear modification factors for hadrons and pions, recently measured in d+Au collisions, is also displayed by the model at sufficiently high p_T. Enhancement of the charged-hadron/pion ratio in d+Au compared to proton-proton collisions is a direct prediction of the model, which could be tested in the near future.

Theory 39 **Xiang-Qian Luo,** **Lattice QCD at Finite Density**

Affiliation: Zhongshan University

Co-authors/Collaboration:

At sufficiently high density, QCD is expected to undergo phase transition from quark confinement to new form of matter. Lattice gauge theory is in principle the most reliable tool for studying such a phase transition. However, the Lagrangian Monte Carlo simulation doesn't work at large chemical potential. To solve the problem, we develop a Hamiltonian approach to lattice QCD at finite chemical potential. We discuss the chiral phase transition and diquark condensation at strong coupling.

Other 1 **Ajay Sharma, The Generalised Mass-Energy Equation $E = mc^2$: Its Mathematical Justification and Application in General Physics and Cosmology**

Affiliation: Community Science Centre

Co-authors/Collaboration:

Einstein derived (in Sep 1905 paper), an equation between light energy (L) emitted and decrease in mass (m) of body i.e. (which is speculative origin of E = c2m) completely disregarding many other possibilities from the derivation. It theorizes when light energy (L) is emanated from luminous body, then mass of body decreases. In blatant way the other possibility (Gm = V 0.0001523L/cv +L/c2) from the same mathematical derivation under logical conditions, contradicts the law of conservation of matter and energy but these are unnoticed yet. For example, it is equally feasible (as feasible as Diracs prediction of positron) from the same mathematical derivation that the mass of source must also INCREASE or remain the SAME when it emits light energy. It clearly implies that mass of body inherently increases when energy is emitted or energy is emitted from body without change in mass. Then Einstein speculated general Mass Energy Equivalence E = c2M from it without mathematical proof. All these aspects are logically discussed here thus Einsteins unfinished task has been completed here. Further an alternate equation i.e. E = Ac2 M, has been purposely derived, in entirely different and flawless ways taking in account the existing theoretical concepts and experimental results. The new equation implies that energy emitted on annihilation of mass (or vice versa) can be equal, less and more than predicted by Einsteins equation. It successfully explains the energy emitted (1045J) in Gamma Ray Bursts (intense and short) with high value of A i.e. 2.57e1018 . The energy emitted by Quasars (15.56e1041J) in extremely small region can be explained with value of A as 4e1016.

Astro 1 **Bruno Alessandro,** **Cosmic Ray Studies with the ALICE Detector**

Affiliation: I.N.F.N. Torino (Italy)

Co-authors/Collaboration: G. De Cataldo, A. Fernandez Tellez, E. Gamez Flores, F. Riggi, M. Sitta

The underground location of the ALICE experiment, with about 30 m of overburden rock, is well suited for the detection of atmospheric muons, with energy above the threshold of $E_{th} = 15$ GeV imposed by the site. These secondary muons come from primary cosmic ray interactions with the nuclei of the atmosphere. Based on simulation results we propose some cosmic ray measurements with ALICE alone, such as : the single muon energy spectrum in the energy range 30 GeV - 1 TeV, the ratio of negative to positive muons and multi-muon event rates. The existence of an air-shower apparatus, located above ALICE on the roof of surface building, opens also the possibility of studying correlated events between ALICE and the surface apparatus. In these events the measurement of some observables related to the air showers allows for the analysis of the cosmic ray composition in the energy range around the knee ($10^6 - 10^7$ GeV) where the primary flux slopes sharply. We describe then the ALICE cosmic ray trigger consisting of an array of plastic scintillators of 40 m^2 of surface placed on the top sides of the central ALICE magnet. The effects of the environment, such as the rock above the experiment and the system of shafts, are described in details in the simulation programs. Finally the performance of the TPC for the detection of single muon events is investigated, and also preliminary performances on multi-muons events are presented.

Astro 2 **Prashanth Jaikumar, Surface Photon Emission as a Signature of a Bare Strange Quark Star**

Affiliation: McGill University

Co-authors/Collaboration: Charles Gale, Dany Page and Madappa Prakash

Quark stars with a surface containing quarks and electrons cannot be easily distinguished from normal neutron stars on the basis of their gross physical properties such as masses and radii alone. However, the luminosity and spectral characteristics of photons emitted from their respective surfaces can be significantly different [1,2]. A bare quark star, in addition to emitting thermal photons at super-Eddington luminosities for extended periods of time, can also emit non-thermal photons from the Bremsstrahlung process $e^- e^- \rightarrow e^- e^- \gamma$ occurring in the electrosphere. vskip 0.2cm We compute the bremsstrahlung photon emissivity and show that for surface temperatures $T < 10^{10}$K, this non-thermal emission is comparable to the photon emissivity from $e^+ e^-$ annihilation occurring via the Schwinger mechanism in the presence of strong electric fields at the surface of the quark star. The average energy of the photons emitted from the bremsstrahlung process is larger than that from the pair annihilation process. As a result, the bare quark star produces a distinctive photon spectrum and temperature evolution, whose predicted characteristics, if observed, constitute an almost unmistakable detection of a strange quark star and serve to shed light on color superconductivity at stellar densities.

[1] D. Page and V. V. Usov, Phys. Rev. Lett. **89**, 131101 (2002).
[2] A.G. Aksenov, M. Milgrom and V.V. Usov, Mon. Not. Roy. Astron. Soc. **343**, L69 (2003).

Astro 3 **Brian Connolly,** **Measurement of the Inelastic p-Air Cross Section Using HiRes Stereo Data**

Affiliation: Columbia University

Co-authors/Collaboration:

We present a measurement of the inelastic p-air cross section at $\sqrt{S} > 44$ TeV with the High Resolution Fly's Eye (HiRes) stereo detector. HiRes measures the attenuation length of the primary cosmic ray indirectly from the distribution of the slant depth at which the number of shower particles reaches a maximum. In order to calculate the attenuation length from the slant depth, we determine the rate at which the energy of the primary particle dissipates using air shower simulations. The measurement of the attenuation length then allows one to calculate the inelastic cross-section for air, and, ultimately, the total proton-proton cross-section. We test the consistency of the models of the first interaction (e.g., QGSJET) with the HiRes data.

Instr. 1 **Bjorn S. Nilsen,** **ALICE Inner Tracking System Alignment Monitoring System**

Affiliation: The Ohio State University

Co-authors/Collaboration: ALICE

The ALICE Inner Tracking system, ITS, is a high precision, high multiplicity, tracking detector made up of 6 layers of 3 different types of silicon detectors, innermost pixels, middle drift, and outer double sided micro-strips. To get the optimal performance from such a system, the position of each silicon detector needs to be known to be better than that detector's position resolution, which can be as good as 20 microns. This will be done by a system of surveys and alignment measurements using tracking. These sorts of measurements can only be done during limited times and are rather time consuming. Consequently, a system to monitor the relative position of a number of key points on the ITS has been developed, ITS Alignment Monitoring System, ITSAMS. This system must be very sensitive (sensitive to motions of a Si detector of less than 20 microns), reliable (last the 10 or more years of ALICE operations), compact (fit within the a space of less than 5 cm tall), and introduce a minimal amount of material within the ITS tracking volume. Such a system has been developed at Ohio State University using off-the shelf USB video cameras, spherical mirrors, and laser beams introduced via a single mode fiber. Operational principles, measured resolutions, and design specifications will be described.

Instr. 2 **Toru Sugitate** *et al.*, **Photon Detector with PbWO4 Crystals and APD Readout**

Affiliation: Hiroshima University

Co-authors/Collaboration: ALICE/PHOS Collaboration

A high-segmentation high-resolution photon detector is under development aiming at high-quality photon measurement in relativistic heavy-ion collisions. The first prototype of the detector module for ALICE experiment at CERN LHC, with 256 channels of PbWO4 crystals and APD readout, has been constructed and tested with high-energy electron beams at CERN PS and SPS. Results of its performance evaluation will be presented, along with basic properties of its components such as the APD and the pre-amplifier system.

Instr. 3 **Fuminori Sakuma,** **Spectrometer for Measurements of Vector Mesons in Nuclear Matter at KEK-PS E325**

Affiliation: Department of Physics, Faculty of Science, Kyoto University

Co-authors/Collaboration: J.Chiba, H.Enyo, H.Funahashi, H.Hamagaki, M.Ieiri, M.Ishino, H.Kanda, M.Kitaguchi, S.Mihara, T.Miyashita, T.Murakami, R.Muto, M.Naruki, M.Nomachi, K.Ozawa, O.Sasaki, H.D.Sato, M.Sekimoto, T.Tabaru, K.H.Tanaka, S.Yamada, S.Yokkaichi, Y.Yoshimura

We report on the spectrometer constructed to measure the invariant massspectra of ρ, ω and ϕ mesons through their e^+e^- or K^+K^- decays in 12GeV p+A interactions. The spectrometer was built at the primary beam line in KEK Proton- Synchrotron. Using this spectrometer the experiment E325 has been observed a signature of in-medium modification of the ρ and/or ω mesons at normal nuclear-matter density for the first time. The spectrometer have two electron arms and two kaon arms, which share a dipole magnet and tracking devices. Tracking is performed with three types of drift chambers. The electron identification was performed with two stages of electron identification counters, gas Cerenkov counters and lead-glass EM calorimeters. The kaon identification was performed with aerogel Cerenkov counters and TOF-systems. The mass resolution for $\omega \rightarrow e^+e^-$ is about 10 MeV/c^2. Details of the spectrometer configuration and the performances are described at the poster session.

Instr. 4 **Fukutaro Kajihara, Electron Trigger Performance in the PHENIX Run3 Experiment**

Affiliation: Center for Nuclear Study, Graduate School of Science, University of Tokyo

Co-authors/Collaboration: Y.Akiba, S.Bathe, K.N.Barish, F.Bauer, M.Grosse Perdekamp, H.Hamagaki, M.Inuzuka, S.Kametani, K.Okada, K.Ozawa, T.Sakaguchi, H.Torii and X.Wei for the PHENIX Collaboration

Measurements of J/ψ and low mass lepton pairs play an important role in the experimental studies with high energy heavy ion collisions. The PHENIX experiment at the Relativistic Heavy Ion Collider (RHIC) in the Brookhaven National Laboratory (BNL) has the capability to measure lepton pairs, which is unique among the experiments at RHIC.
RHIC is a high luminosity machine providing very high data rates; i.e. 1.8 Gbytes/s in proton-proton (p-p) and 1.1 Gbytes/s in deuteron-Gold (d-Au) collisions. Those rates exceed bandwidth (30 - 60 Mbyte/s) of the PHENIX data acquisition system. A hardware trigger system is needed to reduce the event rate and to accumulate rare events efficiently, e.g. electrons from J/ψ or ψ'. In the PHENIX detectors, the Ring-Imaging CHerenkov counter (RICH) and the Electro-Magnetic Calorimeter (EMCal) are the main components for the electron identification. The electron trigger in the PHENIX is realized with the EMCal-RICH Trigger (ERT) system which is composed of EMCal, RICH, and logical trigger circuits which require geometrical hit coincidences between the two detectors.
We will present the performance of the ERT system and detection efficiency of J/ψ in p-p and d-Au collisions at $\sqrt{s_{NN}}$ = 200 GeV, taken in 2003.

Instr. 5 **Vasily Dzhordzhadze,** **Shielding the PHENIX Muon Identifier from Beam-Related Backgrounds**

Affiliation: University of Tennessee, Knoxville, TN 37996

Co-authors/Collaboration: PHENIX

The Phenix Muon Identifier is sensitive to beam-related backgrounds coming from the RHIC Tunnel. The background conditions during the 2003 RHIC run were so severe, that it was occasionally necessary to switch off the system at the beginnings of spills, thus losing some of the highest intensities available. Beam related backgrounds lead to false hypothesis triggers and cause increased current draw by the Iarroci tubes in the system, which results in lowered efficiency and could ultimately lead to premature aging of the tubes. We present the results of a study of the beam-related background performed using the beam tracing program MARS. The fluxes and their composition at the tunnel side of the muon identifier are presented. Shielding strategies will be explored. Preparations are underway to install shielding in the tunnel for the upcoming 2004 RHIC run.

Instr. 6 **IhnJea Choi,** **Performance of the PHENIX MVD Readout System**

Affiliation: Yonsei University, South Korea

Co-authors/Collaboration: PHENIX

The readout system for the Multiplicity-Vertex Detector (MVD) in the PHENIX experiment at RHIC is composed of Multi-Chip Modules (MCMs), Data Collection Interface Modules (DCIMs), and Data Collection Modules (DCMs). In addition, Timing and Control Interface Modules (TCIMs) distribute clock signals to the MCMs and DCIMs. The silicon sensors are attached to the MCMs – in some cases by cables and in some cases directly connected. The Voltage Differential Signaling (LVDS) method is used between the MCMs and the DCIMs. From the DCIMs to the DCMs, a Glink Optical Fiber connection is used. The technical problems which prevented the MVD from being readout reliably in the early runs at RHIC will be discussed, as will the solutions to those problems.

Instr. 7 **Nora De Marco,** **Perfomance of the Neutron Zero Degree Calorimeter for the ALICE Experiment**

Affiliation: INFN - Torino, Italy

Co-authors/Collaboration: ALICE

The performance of the neutron (ZN) Zero Degree Calorimeter for the ALICE experiment, which will measure the energy of the spectator neutrons in the heavy ion collisions, are presented. The ZN is a spaghetti calorimeter, that exploit the Cherenkov light produced by the shower particles in silica optical fibers embedded in a W-alloy absorber. The calorimeter was tested at the CERN SPS using pion and positron beams of different momentum ranging from 50 to 150 GeV/c. The main features of the detector are presented: the linearity and energy resolution as a function of energy and the uniformity of the response as a function of the beam impact point on the front face of the calorimeter. The experimental results are compared to Monte Carlo simulations.

Instr. 8 Anders Vestbø, The ALICE High Level Trigger

Affiliation: University of Bergen

Co-authors/Collaboration: V. Lindenstruth, C. Loizides, D. Rohrich, B. Skaali, T. Steinbeck, R. Stock, H. Tilsner, K. Ullaland, T. Vik

The ALICE experiment at LHC will implement a High Level Trigger System, where the information from all major detectors are combined, including the TPC, TRD, DIMUON, ITS etc. The largest computing challenge is imposed by the TPC, requiring realtime pattern recognition. The main task is to reconstruct the tracks in the TPC, and in a final stage combine the tracking information from all detectors. Based on the physics observables selective readout is done by generation of a software trigger (High Level Trigger), capable of selecting interesting (sub)events from the input data stream. Depending on the physic program various prosessing options are currently being developed, including region of interest processing, rejecting events based on software trigger and data compression schemes. Examples of such triggers are verification of candidates for high-pt dielectron heavy-quarkonium decays, momentum filter to enhance the open-charm signal, high-pt jets selection etc.
Technically the HLT system entails a very large scale processing farm with about 1000 active processors. The input data stream is designed for 25 GB/sec. The system nodes will be interfaced to the front-end electronics via optical fibers connecting to their internal PCI-bus using a custom PCI card. These boards provide a co-processor functionality for the first steps of the pattern recognition.
The talk will give an overview of the HLT project including the online tracking in the TPC and the foreseen functionality and performance. The expected trigger selectivity will be discussed for one specific physics observable.

Instr. 9 **Craig Woody,** **A Fast, Compact TPC with GEM Readout for Tracking and Electron Identification in PHENIX**

Affiliation: Brookhaven National Lab

Co-authors/Collaboration: for the PHENIX Collaboration

A fast, compact TPC with enhanced electron identification capabilities is being developed to address future tracking needs in PHENIX for both relativistic heavy ion and high luminosity polarized proton collisions at RHIC. The detector consists of a TPC inner tracker that employs a short drift region and a fast drift gas to achieve high readout speeds, along with a proximity focused CsI photocathode Cherenkov detector for electron identification. Both the TPC and the Cherenkov imager utilize GEM detectors as readout devices. The overall detector design will be described, along with experience obtained with prototype GEM detectors. Results will be given from measurements made with a TPC drift cell with fast drift gases which could potentially serve as both the drift gas for the TPC and the radiator gas for the Cherenkov, as well as a common operating gas for the GEM detectors. A study of new commercially manufactured GEM foils will also be presented.

Instr. 10 **Constantin Loizides, High Level Trigger Identification of High Energy Jets in ALICE**

Affiliation: IKF, University of Frankfurt

Co-authors/Collaboration: ALICE Collaboration

One interesting observable at ALICE will be the measurement of the inclusive jet cross section at 100 to 200 GeV transversal jet energy and its fragmentation function; both to be compared to pp. The window of about 100 to 200 GeV transversal jet energy is compatible with the expected p_t resolution of the inner tracking complex (ITS+TPC+TRD) and the energy of the leading parton, but requires an HLT online processing of TPC data at a rate of 200 Hz central PbPb in order to collect sufficient statistics. The online trigger algorithm running on the HLT system is based on charged tracking and jet recognition using a cone jet finder algorithm, which might be improved by the additional online evaluation of the EM calorimeter towers. The dependence of the efficiency versus the selectivity of the trigger has been studied by simulations of pp and PbPb interactions using PYTHIA and HIJING events. For a chosen parameter set of the trigger algorithm the triggered events are the relevant sample of events to be further analyzed by offline. Their resulting jet E_t distribution and the corresponding fragmentation functions might be sensitive to different jet attenuation scenarios.

Instr. 11 **Dmitry Arkhipkin, Performance of the STAR Barrel Electromagnetic Calorimeter**

Affiliation: Wayne State University and JINR Dubna

Co-authors/Collaboration: STAR Collaboration

The STAR Barrel electromagnetic calorimeter was installed at the 50% level in the 2003 d + Au and p + p RHIC run at $\sqrt{s_{NN}} = 200$ GeV. The acceptance of the calorimeter was $0 < \eta < 1$ with full azimuthal coverage, $\Delta\phi = 360^o$. For these runs, the instrumented detector consisted of 2400 Pb/Scintillator sampling calorimeter towers each spanning $(\Delta\eta, \Delta\phi) = (0.05, 0.05)$ and two layers of gaseous shower maximum detector (SMD) located at a depth of 5 radiation lengths within the sampling layers. Strip readout of the SMD with 18,000 channels in the η and ϕ directions provided the location and spatial distribution of showers with high resolution. Several million minimum bias and high tower triggered events have been analyzed using TPC tracking and dE/dx identification to create samples of electron and hadron candidates that have been used to study the calorimeter performance. In particular, in the present report, we focus on a comparison of the measured and simulated characteristics of electromagnetic and hadronic showers in the SMD and calorimeter towers with particular emphasis on the contribution of the SMD to electron-hadron discrimination, photon and reconstruction.

Instr. 12 **Mikhail Ippolitov, Performance of the 256 Channel Prototype of the ALICE Photon Spectrometer PHOS**

Affiliation: RRC "Kurchatov Institute"

Co-authors/Collaboration: ALICE/PHOS

Lead-tungstate crystals PbWO4 (PWO) are considered as a promising material for electromagnetic calorimetry. Currently, PWO have been chosen to construct electromagnetic calorimeters of ALICE and CMS experiments at CERN and BteV experiments at FNAL. The ALICE Photon spectrometer PHOS is dedicated for search for electromagnetic signals from Quark-Gluon Plasma. PHOS is optimized for measurements of photons and neutral pion and eta mesons in wide energy range (0.5-100 GeV). In this paper we will present main characteristics of 256-channel prototype of the ALICE/PHOS detector, stacked to form a 16x16 array. Prototype was assembled from 22x22x180 mm^3 PWO crystals, delivered by North Crystals Company, Russia. Each crystal was read out by 5x5 mm^2 sensitive area Hamamatsu APD. The whole assembly was placed inside a thermo-insulated container and cooled down to 25oC. The long temperature stability during experiments was better than 0.1 oC. The prototype was tested with pion and electron secondary beams at the CERN PS and SPS accelerators. A set of thin scintillator beam counters and Cherenkov detector were used to define particles type in the beam. Energy resolution and linearity were measured with electrons in momentum range 0.6- 150 GeV/c. Prototype demonstrated excellent linearity. Energy resolution of the prototype is ranging from 4% at 1 GeV to 1% at 150 GeV. Timing resolution of the prototype was measured in energy range 0-6 GeV, and is better than 1.2 ns for energies above 1 GeV. Two-photon invariant mass distributions were measured with negative-pion beams colliding with 10% of nuclear interaction length thick carbon target in energy range 6-100 GeV. Peaks, corresponding to two-photon decays of π^0 and η mesons were observed. It has been found that invariant-mass resolution is around 8 MeV and 20 MeV for π^0 and η mesons respectively.

Instr. 13 **Madan M. Aggarwal** *et al.*, **The STAR Photon Multiplicity Detector**

Affiliation: Panjab Univ, Chandigarh

Co-authors/Collaboration: Z. Ahammed, S.K. Badyal, S. Bhardwaj

The Photon Multiplicity Detector (PMD) in the STAR experiment at RHIC is designed to measure the multiplicity and spatial (eta-phi) distribution of photons on an event-by-event basis. It will address physics issues relating to event-by-event fluctuations, flow and formation of disoriented chiral condensates (DCC). The PMD is a preshower detector of high granularity having full azimuthal coverage in the pseudorapidity region of 2.4 to 3.7. The PMD consists of two planes of gas detectors, separated by three radiation length converter plate. The veto detector in front of the converter is used to reject charged particles. The gas detectors are based on a honeycomb cell proportional chamber design with wire readout, where the area of each cell is $1cm^2$. The operating gas is selected to be a mixture of Ar(70%) and CO_2 (30%). For charged particles the signal is almost always confined to one cell whereas photon showers affect larger number of cells. The full detector consists of 85,000 such cells, arranged in 24 supermodules. The front-end electronics is based on the use of 16-channel gassiplex chips which provide analog multiplexed signals and readout using custom built ADC boards (C-RAMS). Major part of the installation and commissioning of the PMD is complete. The engineering performance of the detector has been tested during Run3 p-p run. The detector is expected to take data in the RHIC Run4. Details of the detector, along with the results from testbeam runs and data from the first weeks of Au+Au beam will be presented and discussed.

Instr. 14 Børge S. Nielsen, Forward Detectors in ALICE

Affiliation: Niels Bohr Institute

Co-authors/Collaboration: ALICE collaboration

The Forward Detectors in ALICE are designed for charged particle multiplicity measurements in the forward regions of pseudo-rapidity, and to provide online timing and vertex determination at trigger level 0.
The Forward Multiplicity Detector (FMD) is a ring counter system of single layers of single sided silicon strip detectors. Combined with the pixel system of the Inner Tracking System (ITS), the FMD will measure charged particle multiplicities for all collision types in the range $-3.4 < \eta < 5.1$. Overlaps between the various rings and with the ITS assures redundancy and checks of analysis procedures. Due to the high charged particle density in central Pb–Pb collisions, pulse height analysis will be important for counting multiple hits on single channels. Nevertheless, the segmentation is kept high enough to use counting statistics for multiplicity determination. The FMD will allow for the study of multiplicity fluctuations on an event by event basis and for flow analysis in the considered pseudo-rapidity range.
The timing and trigger detectors, T0 and V0, are each placed on both sides of the interaction region. The T0 detectors consist of quartz radiator Cherenkovs with photomultiplier readout. Online timing resolution of 50 psec allows to determine the interaction vertex by time difference with a precision of 2 cm. The signal is used as start time for the Time Of Flight detectors and for the deadtime free LVL0 trigger. A similar vertex and timing signal, with poorer resolution but in a larger solid angle is given by two arrays of scintillator tiles with wavelength shifting fibre readout that comprise the V0 detectors. The tile segmentation is such as to provide an online measure of charged particle multiplicity sufficient for the ALICE centrality trigger.

Instr. 15 **Ivan Kotov,** **Silicon Drift Detectors From STAR to ALICE**

Affiliation: The Ohio State University

Co-authors/Collaboration: ALICE collaboration

Silicond Drift Detectors (SDD) technology was successfully used for STAR Silicon Vertex Tracker and is being further developed for ALICE ITS Silicon Drift Detectors layers. The key features of SDD technology attractive for high energy heavy ion experiments are unambiguous two-dimensional coordinate measurements and low noise. The physics, principle of operation and factors effecting the performance of SDDs are briefly reviewed. The recent experimental results and current status of ALICE SDDs are presented.

Instr. 16 **Mark Horner,** **Design, Response and Physics of the ALICE EMCal**

Affiliation: University of Cape Town/LBNL

Co-authors/Collaboration: ALICE-USA Collaboration

The ALICE-USA collaboration has proposed the addition of a large area electromagnetic calorimeter to the ALICE experiment at the LHC. This will allow the extension of the hard physics capabilities of ALICE, specifically in the areas of high-pt jets and expected jet-quenching effects. We have undertaken detailed simulations of detector response and research and development studies to optimise the design of the detector. An overview of the broad physics program of the ALICE EMCal, its proposed design and the expected detector response will be presented.

Instr. 17 Michael Murray, Forward Physics at the LHC with CMS

Affiliation: University of Kansas

Co-authors/Collaboration: CMS

The CMS experimental area at the LHC will contain a unique suite of forward detectors. The detectors are the forward hadronic calorimeter, which will be operational for all CMS running, and the CASTOR, TOTEM and Zero Degree Calorimeters [1-3], which will be used for AA, pA and low luminosity pp running. CMS will include almost hermetic calorimetry and multiplicity measurements from $\eta = 0 - 7$, the widest rapidity acceptance at the LHC. For pp and pA collisions, we can measure parton distribution functions in regions of Feynman x at least an order of magnitude below current data and at perturbative values of Q^2. In pA running, CMS will measure the complete energy and particle flow for interactions that approach the GKZ [4] limit of cosmic rays. These data will provide a direct calibration of the air shower experiments and a clearer view of ultra high energy cosmic rays. The very wide rapidity coverage will allow us to compare the propagation of forward jets to transverse jets, [5]. Finally, in nucleus nucleus collisions the forward detectors will allow us to explore regions where gluon saturation should be very strong and also understand the longitudinal dynamics of the system.

[1] The Totem Experiment totem.web.cern.ch/Totem/welcome.html
[2] The Castor Detector angelis.home.cern.ch/angelis/castor/Welcome.html
[3] See for example the US CMS Heavy Ion Proposal yepes.rice.edu/cms/
[4] K. Greisen, Phys. Rev. Lett. **16** 748 (1966); G. T. Zatsepin and V. A. Kuzmin, Sov. Phys. JETP Lett. **4**, 78 (1966).
[5] R. C. Hwa, C.B. Yang Phys.Rev. **C68** (2003) 024907.

Instr. 18 **Sebastian White, A Shower Maximum Detector for Forward Neutron Measurements in PHENIX**

Affiliation: Brookhaven National Lab

Co-authors/Collaboration:

A position sensitive scintillator strip detector was installed at a depth of 2 Interaction lengths in the PHENIX Zero Degree Calorimeters during Run III. The scintillators strip/wavelength shifter fiber arrays provide a two-dimensional measurement of the spectator neutron pt distribution. They are also used to measure a net pt of neutrons- either due to correlation with the reaction plane in Ion collisions or to beam polarization during the pp run. They have also been used to measure beam displacements in RHIC and correlated with measurements using accelerator instrumentation. Performance of this system will be discussed and illustrated with data from Run III.

Instr. 19 Conor Henderson, A High p_T Spectrometer Trigger for PHOBOS

Affiliation: Massachusetts Institute of Technology

Co-authors/Collaboration: PHOBOS Collaboration

The PHOBOS experiment at RHIC commissioned a new Spectrometer trigger system for selecting events containing high transverse-momentum particles. This trigger was designed for use in the low-multiplicity environment of d+Au and p+p collisions.
Two new scintillator arrays were installed, and the existing Time-of-Flight walls were incorporated into the trigger system. Hit positions in these detectors, in combination with the event vertex, were used to select nearly straight-line track trajectories corresponding to high-momentum particles. The online decision was made using a programmable electronic logic module.
The goal of the Spectrometer trigger was to enhance the yield of high-p_T (> 2 GeV/c) tracks in the PHOBOS Time-of-Flight walls per recorded event; the result was an increase by a factor of 15 over a minimum-bias trigger. We will discuss the design and implementation of the Spectrometer trigger, and review its performance in the 2003 physics run.

Instr. 20 **Corey Reed,** **Forward Proton Calorimetry at PHOBOS**

Affiliation: MIT

Co-authors/Collaboration: PHOBOS

The PHOBOS experiment commissioned two hadronic calorimeters for the deuteron-gold run at RHIC. The calorimeters are composed of lead-scintillator modules originally constructed for the E864(AGS) experiment. Each module contains an array of longitudinal scintillating fibers arranged at regular intervals to provide uniform shower sampling over the entire detector. These detectors are used to complement and extend the experiment's ability to measure the collision centrality. Protons having beam or near-beam velocity (i.e. fragmentation and struck protons) are bent into the calorimeters by RHIC accelerator magnets. The detector on the deuteron exit side of the collision makes it possible to select neutron-gold interactions in which the proton suffered only minor changes in its momentum. The installation and performance of these detectors will be discussed, and results using the detectors will be reviewed.

Instr. 21 **P. Tlustý, Particle Identification in the HADES Spectrometer and Particle Production in C+C at** 2 *A***GeV**

Affiliation: Nuclear Physics Institute, 250 68 e, Czech Republic

Co-authors/Collaboration: HADES collaboration

The HADES spectrometer installed at GSI Darmstadt is devoted to study production of di-electron pairs from proton- and pion-induced reactions and nucleus-nucleus collisions. Extraction of rare lepton pairs in high hadron multiplicity events requires efficient particle identification (PID). In HADES electrons are identified by a RICH as well as a Pre-Shower and a TimeOfFlight (TOF) detector. For all charged particles momentum is measured by a tracking system combined with a toroidal superconducting magnet, and the TOF detector provides velocity and energy loss. The particle identification method has been implemented, allowing efficient identification of particles, using full experimental information from all subdetectors. The basis of the method is test of hypothesis, that the reconstructed track can be identified as certain particle specie. Several measured variables associated to each identified track from various subdetectors are used to provide a set of probabilities in individual PID algorithms, which are then merged assuming their statistical independence. For the resulted PID probability calculation the Bayes method taking into account the prior abundance of individual particle types, as well as the known detector response, is implemented. The performance of the method - in terms of efficiency and purity - is then evaluated in detailed simulations. To demonstrate the method performance, single particle spectra of charged hadrons and electrons from C+C at 2 A GeV will be presented and compared with results of corresponding simulations. In order to verify the method the proton and pion yields and transverse mass and rapidity distributions will be compared with existing data.

Instr. 22 **Per Thomas Hille, The Photon Spectrometer in ALICE: Readout Electronics, Trigger and Physics Capabilities**

Affiliation: University of Oslo

Co-authors/Collaboration: ALICE PHOS collaboration

The Photon Spectrometer in ALICE is an electromagnetic calorimeter of high granularity consisting of 17920 lead-tungstate crystals, coupled to Avalanche Photo Diodes (APD). Due to the small Moliere radius of the crystals the detector is able to cope with the expected high multiplicity in central Pb-Pb collisions. The performance requirements are i) energy dynamic range up to 100 GeV, ii) L0 and L1 trigger capabilities, and iii) TOF discrimination of anti-neutrons. This allows studying direct photon production in the low energy region as well as the measurement of high pT neutral pion spectra and jets.
The APDs are read out by a low noise preamplifier coupled to a matching shaping amplifier. The amplifier supplies two energy channels with low and high gain factors and shaping time 1?s, plus fast (100ns) analog sums of 2x2 crystals for the trigger. Both the energy and trigger signals are digitized by the ALTRO readout chip developed for the ALICE TPC. The digitized trigger signals are processed by FPGA firmware providing one L0 and several L1 trigger outputs. The energy channel signals are oversampled at 20 MHz so that by fitting the signal shape a timing resolution of about 2ns can be extracted. A readout controller unit (TPC RCU) collects the data from the energy ALTROs and interfaces the system to the ALICE DAQ, Trigger and DCS systems. The bias voltages of the APDs are individually controlled to equalize the gain factors.
Beam test results taken with the first prototype will be presented.

Instr. 23 **Masahide Inuzuka,** **Gas Electron Multiplier Produced with the Plasma Etching Method**

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Co-authors/Collaboration: H.Hamagaki, K.Ozawa, T.Sakaguchi, T.Tamagawa, F.Kajihara, T.Isobe, T.Gunji, N.Kurihara, S.Oda, Y.Yamaguchi, S.Sawada, S.Yokkaichi

It is expected that detectors consisting of Gas Electron Multiplier (GEM) will play an important role in the experiments with high energy and heavy ion collisions: in particular, the applications to Time Projection Chamber (TPC) and Hadron Blind Detector (HBD). The GEMs with front-end readout of TPC can reduce positive ion feedback sufficiently. The HBD, in which the top layer of GEM is coated with CsI photocathode, will gain the electron identification capability and background rejection power.
We have produced GEM using the plasma etching method in Japan. The new GEM has a cylindrical shape. Amplification factor was measured as a function of the applied voltage and the gain characteristics are very similar to those of the GEMs made at CERN. With KEK testbeams, the response to MIPs were also investigated by varying the electric field in the drift region. We will present the results of these measurements together with prospects of application to TPC and HBD.

Instr. 24 **Andrew Rose,** **STAR Integrated Tracker**

Affiliation: Wayne State University

Co-authors/Collaboration: STAR Collaboration

We present the design and performance analysis of a new integrated track reconstruction code developed for the STAR experiment at RHIC. The existing code, which consists of components written in FORTRAN, C, and C++, will be retired. The new code provides for the integration of the TPC baseline detector, the SVT, SSD inner tracker detectors, and future upgrades under a single framework. It is written entirely in C++ using a strong object-oriented model. Key features are a built-in KALMAN filter for track finding and fitting in a single pass, a simple geometry model for representation of detector components, a flexible track representation model, and a powerful object factory and memory management model. Critical issues emphasized in the implementation and performance analysis of the tracker are code robustness, optimization of track reconstruction quality, minimization of reconstruction time and memory footprint. The new tracker will be deployed for the analysis of STAR run 4 data.

Instr. 25 Markus Oldenburg, Development of a Vertex Detector for STAR

Affiliation: Lawrence Berkeley National Laboratory

Co-authors/Collaboration: F. Bieser, Y. Chen, R. Gareus, S. Kleinfelder, I. Kotov, H. Matis, D. Reichhold, F. Retiere, H.-G. Ritter, K. Schweda, H. Wieman, E. Yamamoto

There is tremendous interest in ultra-relativistic heavy-ion physics to measure heavy flavor particles. Heavy flavor provides a direct link with the early phases of nucleus-nucleus interactions and may be sensitive to the dynamics of the evolving fireball produced in these interactions. While the current configuration of the STAR detector will remain relevant well into this decade, the vertex detector project addresses the need for a very high-precision, low-mass detector to measure heavy flavor. The vertex detector project takes advantage of the relatively new CMOS-based sensor technology and pushes the limits of present technologies in its structural design.
We will discuss various silicon pixel designs as well as mechanical concepts that have been considered to date. The impact of the project's physics goals and technological limitations on the evolution of the detector will be discussed.

Instr. 26 **Xiaochun He,** **Event Tagging and Filtering: the PHENIX Level-2 Trigger**

Affiliation: Georgia State University

Co-authors/Collaboration: PHENIX

The PHENIX Level-2 is a software-based trigger which runs in the scope of the PHENIX Event Builder of the PHENIX data acquisition system. The first online implementation of the PHENIX Level-2 was for the second RHIC run in 2001/2002 and its results was published in NIM A409 560-592 (2003). The Level-2 trigger provides the capability for the PHENIX experiment to do event tagging and filtering online based on potential physics interests. The Level-2 trigger algorithms are developed and tested in a offline framework before being integrated into the Event Builder. The infrastructure of the Level-2 trigger which includes its offline development framework, online configuration and monitoring will be presented in this talk.

Instr. 27 **Masahiro Konno, Development and Construction of PHENIX Aerogel Cherenkov Detector**

Affiliation: Univ. of Tsukuba

Co-authors/Collaboration: The PHENIX Collaboration

The remarkable feature of the PHENIX detector is capability of particle identification (PID). The present TOF & RICH configurations leave some gaps in the PID. By the addition of an aerogel threshold Cherenkov detector with a refractive index of 1.011, those gaps would be bridged. Hadron particle identification can be achieved seamlessly up to pt of 8 GeV/c.
Intense research and development aimed to design, construct and install in the PHENIX detector have been dedicated. The detector, segmented into 160 cells, will be installed in the W1 sector of PHENIX. Each cell has aerogel volume $(22(z) \times 11(\phi) \times 12(r)\,\mathrm{cm}^3)$, followed by an integration cube viewed by two 3" PMTs. The beam test done at KEK shows that positional uniformity with this configuration is the best of all configurations studied. To eliminate dead space, every other cells along z-direction are flipped in the radial direction. With this configuration, all the sensitive aerogel volumes are kept in one plane, which contributes to the uniform detector response. Construction is underway to install in the PHENIX detector for the upcoming run.

Instr. 28 **Dong Xin, The Performance of a Prototype MRPC Time-of-Flight Detector for the STAR Experiment**

Affiliation: Rice University

Co-authors/Collaboration: STAR TOF Group

A prototype, 168-channel multi-gap resistive plate chamber (MRPC) time-of-flight system for the STAR experiment at RHIC was completed in February 2002. The prototype system was tested for 10 weeks at the AGS at BNL and installed in the STAR detector for the 2002-2003 physics run. The MRPC detectors were operated on a number of different gas mixtures and high voltages at the AGS and at STAR. The results for detection efficiency, time resolution, streamer probability, and noise rates are presented. We present plans for the deployment of a large-area TOF system in STAR using this technology.

Instr. 29 Itzhak Tserruya, A Hadron Blind Detector for PHENIX

Affiliation: Weizmann Institute

Co-authors/Collaboration: PHENIX Collaboration

A Hadron Blind Detector (HBD) is being developed as upgrade of the PHENIX detector for the measurement of low-mass e+e- pairs in Au-Au collisions at RHIC. The proposed scheme consists of a Cherenkov detector, operated with pure CF_4 both as radiator and detector gas in a special windowless proximity focus geometry, with a reflective CsI photocathode, and a triple GEM detector element with pad readout. The combination of a windowless detector with CsI photocathode and CF_4 results in a very large bandwidth (from 6 to 11.5 eV) and a very high figure of merit $N_0 = 940/cm$. With these unprecedented numbers, one expects approximately 40 photo-electrons in a 50 cm long radiator, thus ensuring the necessary high levels of single electron efficiency and double hit recognition. The detector is designed to operate at a relatively moderate gain of a few times 10^3. A comprehensive R&D program aiming at demonstrating the validity and feasibility of the proposed concept is almost complete. We will present results of extensive studies using UV lamp, Fe^55 x-ray source, Am^241 alpha source and cosmic rays. These include measurements of the gain curve of a triple GEM structure, photoelectron detection efficiency, ion back-flow, discharge probability, aging of the CsI photocathode and of the GEM foils in CF_4. Using cosmic rays we demonstrate that the required hadron rejection factor of about 200 is attainable and we confirm the expected yield of 40 detected photoelectrons per electron.

Instr. 30 **Mohamed Khalil Boudjemline,** **Simulation of Cathode Pad Chamber (CPC) Response**

Affiliation: Subatech (Nantes)

Co-authors/Collaboration:

My work consists to realise a code of simulation of the Cathode Pad Chamber response used in the tracking system of dimuon spectrometer of ALICE experiment. An existing code (Aliroot) is based on energy loss of particles in gas. Its disadvantage is that it does not take into account the angle effect of tracks. Our aim is to reproduce this effect on the spatial resolution along wires. Calculations are compared with experimental results obtained with a beam of 7GeV/c Pions.