Curriculum Vitae

Dr. Shin-Shan Yu

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Education and Position Held

Research Associate Since October 2005
Fermi National Accelerator Laboratory, Batavia, IL 60510

Ph.D. in Elementary Particle Physics May 2005
University of Pennsylvania, Philadelphia, PA 19104
Thesis Adviser: Prof. Nigel Lockyer
Thesis Title: *First Measurement of the Ratio of Branching Fractions* $\frac{\mathcal{B}(\Lambda_b \to \Lambda_c^+ \mu^- \overline{\nu}_\mu)}{\mathcal{B}(\Lambda_b \to \Lambda_c^+ \pi^-)}$ *at CDF II*
hep-ex/**0504059**

Bachelor of Science in Physics June 1997
National Taiwan University, Taipei, Taiwan

Research Synopsis

- Physics analysis
  - Searched for anomalous production of diphoton plus electron or muon
  - Measured the probability for an electron to fake a photon
  - Performed measurement of the Λ_b and B^0 semileptonic to hadronic relative branching fractions
  - Developed methods to estimate the backgrounds and to determine the Λ_b to B^0 production cross-section ratio
- Software experience
  - Simulating and studying a dual-readout calorimeter with Geant4 for the International Linear Collider
  - Familiar with the C^{++} programming, ROOT and Unix shell languages
  - Solely developed the dE/dx calibration and the particle identification software using dE/dx
  - Implemented a program to monitor the offline track quality
  - Learned to monitor the detector and trigger in the CDF control room
- Hardware for the drift chamber at CDF
  - Carrying sole responsibility for the calibration of readout electronics
  - Improved calibration software for debugging the readout chain
  - Optimized the test parameters and oversaw the construction of the readout chip test station
  - Wrote a C program to drive the chip test station, $\sim$ 6600 chips tested
  - Laid out a buffer board for providing current to the readout electronics ($\sim$ 60 daughter-boards per buffer board)
  - Shared substantial responsibility in the debugging and repairing of the readout electronics
  - Assisted with the commissioning of the drift chamber

Research Activity

Research Associate, Fermilab

I made a transition from the B to the Exotics physics group to increase my experience of high P_T physics analysis and prepare for LHC. I also joined an R&D calorimeter project for ILC or any future experiments.

Search for $\gamma\gamma + e, \mu$ In order to confirm or exclude the excess of $\gamma\gamma ee + \not{E}_T$ event at CDF I, a group of scientists (including I) from Carnegie Mellon University, Fermilab, Texas A&M University, and University of Chicago are working on a signature-based search for anomalous diphoton plus X production, using 10 times more data at CDF II. I am working with Dr. R. Culbertson on the search for diphoton plus electron or muon. The dominant backgrounds are fake photons from the bremsstrahlung or collinear FSR of electrons. We measure the fake rate with data enriched with Z^0 bosons and further apply them to the signal sample. The fake rate has been approved by the CDF collaboration and used by other photon analyses. We have completed our analysis using $\sim$684 pb^{-1} of data. The result was presented in several international conferences. We will finish an update using over 1 fb^{-1} of data within one month and start preparing for a publication.

Dual-readout calorimeter R&D Dr. A. Para from Fermilab and Prof. T. Zhao from University of Washington proposed a novel dual-readout sampling calorimeter, sandwiched with absorber, lead glass and scintillator, to improve the calorimeter energy resolution by measuring the EM fraction with the Cerenkov photons produced in the lead glass. I am working with Dr. A. Para and Dr. H. Wenzel from Fermilab on the Geant4 simulation so to understand the performance. Our simulation program allows us to change the detector material, geometric shape and granularity easily. We are starting from a simple detector with only one layer of lead glass and checking the correlation between the energy deposited in the lead glass and the number or energy of Cerenkov photons as a function of detector depth, incident particle energy and *etc.*

Ph.D, Collider Detector at Fermilab, University of Pennsylvania

The property of the b-hadrons is one of the primary interests at CDF. My thesis work involves a measurement of the relative decay rates of the Λ_b baryon.

Dissertation I have completed my thesis, “First measurement of the ratio of branching fractions $\mathcal{B}(\Lambda_b \to \Lambda_c^+ \mu^- \overline{\nu}_\mu)$ to $\mathcal{B}(\Lambda_b \to \Lambda_c^+ \pi^-)$.” Now I am preparing for the publication of this measurement with the co-authors: Dr. R.J. Tesarek and Dr. D. Litvintsev from Fermilab, Dr. J. Heinrich and Prof. N. Lockyer from UPenn. The Λ_b decays are interesting for two reasons: first, Fermilab Tevatron is currently the only collider that produces a large sample of Λ_b. Second, the theoretical treatment of Λ_b is simpler than that of the b-mesons. This stimulates us to study Λ_b through various measurements, such as the branching fractions. The advantage of measuring a ratio of branching fractions is that the systematic uncertainties from the trigger and reconstruction efficiencies cancel. In addition to the Λ_b mode, we also performed similar measurements in the B^0 system: ratio of $\mathcal{B}(\overline{B}^0 \to D^{*+} \mu^- \overline{\nu}_\mu)$ to $\mathcal{B}(\overline{B}^0 \to D^{*+} \pi^-)$ and ratio of $\mathcal{B}(\overline{B}^0 \to D^{+} \mu^- \overline{\nu}_\mu)$ to $\mathcal{B}(\overline{B}^0 \to D^{+} \pi^-)$, which served as the control sample for the cross-check of our analysis methods.

The University of Pennsylvania plays a leading role in the design, production and commissioning of the readout electronics for the drift chamber, Central Outer Tracker (COT), at CDF. I have worked on the COT front-end readout electronics: Penn-built Amplifier-Shaper-Discriminator-Charge measurement (ASDQ) and the Time to Digital Converter (TDC). The signal picked up by the COT wires is sent to the ASDQ, and then to the TDC for further processing. In the presence of the magnetic field, signal from the COT determines the charged particle momentum. Therefore, the performance of the readout electronics is crucial to every physics analysis at CDF. I have also worked on the software for the COT. I wrote a C^{++} program to monitor the quality of tracks reconstructed with the COT information. The track quality determines whether one particular period of data should be discarded or not. I developed and performed early calibration of the dE/dx measured in the COT, which utilized the function of charge measurement within the ASDQ. The dE/dx allows statistical separations of K, π, p and e with momentum below 15 GeV/c. It is an important tool for identifying the flavors and daughter particles of b-hadrons, and has been applied in the search for exotic massive particles.

Calibration of dE/dx I developed the algorithm to calibrate dE/dx for the particle identification. I used the conversion electron sample to check and remove the dE/dx dependence on the detector geometry, high voltage, pressure, *etc.* Protons, muons, and pions from the Λ, J/ψ and K_s decays were collected to obtain the dependence of the calibrated dE/dx on the particle velocity. Further improvements and corrections were performed later by the dE/dx group led by Prof. S. Giagu.

Track monitor With the guidance of Prof. F Wuerthwein, Prof. L. Demortier and Dr. K Burkett, I implemented a C^{++} program to monitor the offline COT track quality. The program has been integrated into the CDF data quality management project and determines the COT condition for each run.

Control room shifts During the CDF commissioning and early run II period, I was trained to take data, monitor the detector and the trigger in the CDF control room. This was especially a challenging period, as the detector and trigger were both immature. We played a key role in helping the experts to locate the problems.

Hardware My hardware work at UPenn had been supervised by Dr. W. Bokhari, staff physicists M. Newcomer and R. Van Berg. In order to examine about 6600 ASDQ chips and select those of good quality, an automatic test station was needed. I optimized the parameters for the circuit of the test station and oversaw the construction. Then, I wrote a C program to drive the test station. In order to keep the ASDQ control voltages constant, I laid out a buffer board to provide current to the ASDQ daughter-boards (about 60 daughter-boards per buffer board). From the September of 1999, I was involved in the COT detector commissioning and helped testing the wire tension, gas leak, *etc.* Then, I shared responsibilities with the Penn Research Associates in the installation of the ASDQ daughter-boards, debugging and repairing of the readout electronics. In the summer of 2000, I worked on the TDC with the University of Michigan HEP group. Many TDC vias broke easily due to their small diameters. This problem caused poor connection between different layers in the TDC. I learned how to assemble the TDC and locate the broken vias by performing series of tests.

Undergraduate, National Taiwan University

I was a summer student of the HEP group at the National Taiwan University, supervised by Prof. Y.H. Chang, Dr. K. Ueno and Prof. W.S. Hou. I built a mini multiwire projection drift chamber and the readout electronics board. The drift chamber was an aluminum box of dimension 40 cm$\times$30 cm$\times$20 cm. Four boards with progressively increasing high voltages were stacked on one another, on top of a wire plane. At the bottom was a ground plane composed of a grid of aluminum pads for the charge measurement. This first contact with the drift chamber and electronics became a foundation of my later research at CDF.

Awards

- Scholarship of National Gifted Students in Physics (1993-1997)
- Skipped the last year of high school study and entered National Taiwan University by exemplary performance on the Joint College Entrance Exam

Selected Publications

[1] S.S. Yu, A. Pronko, R.Culbertson, "The Probability of an Electron Faking an Isolated Prompt Photon in CEM", CDF/PHYS/EXOTIC/PUBLIC/**8220** (2006)

[2] R. Culbertson, S.S. Yu *et al.*, "Search for Anomalous Diphoton Plus X Production", CDF/ANAL/EXOTIC/PUBLIC/**8129**(2006)

[3] S.S. Yu, R.J. Tesarek, D. Litvintsev, J. Heinrich, N.S. Lockyer, "First Measurement of the Ratio of Branching Fractions $\mathcal{B}(\Lambda_b \to \Lambda_c^+ \mu^- \overline{\nu}_\mu)$ to $\mathcal{B}(\Lambda_b \to \Lambda_c^+ \pi^-)$ at CDF II," work in progress, to be submitted to Phys. Rev. D

[4] S.S. Yu, R.J. Tesarek, D. Litvintsev, J. Heinrich, N.S. Lockyer, "First Measurement of the Ratio of Branching Fractions $\mathcal{B}(\Lambda_b \to \Lambda_c^+ \mu^- \overline{\nu}_\mu)$ to $\mathcal{B}(\Lambda_b \to \Lambda_c^+ \pi^-)$ at CDF II," CDF/PUB/BOTTOM/PUBLIC/**7635**(2005)

[5] S. S. Yu, "First Measurement of the Ratio of Branching Fractions $\mathcal{B}(\Lambda_b \to \Lambda_c^+ \mu^- \overline{\nu}_\mu)$ to $\mathcal{B}(\Lambda_b \to \Lambda_c^+ \pi^-)$ at CDF II," arXiv:hep-ex/0504059.

[6] T. Affolder *et al.* [CDF Collaboration], "CDF Central Outer Tracker," Nucl. Instrum. Meth. A **526**, 249 (2004).

CDF Internal Notes

[1] D. Litvintsev, S.S. Yu, R.J. Tesarek [Fermilab], "Measurement of the Λ_b pT spectrum in the TTT data using fully reconstructed decay to $\Lambda_c \pi$", CDF/PHYS/BOTTOM/CDFR/**8156** (2006)

[2] S.S. Yu, R. Tesarek *et al.* [Fermilab], "User Guide of the Lambdab Pt Spectrum", CDF/ANAL/BOTTOM/CDFR/**8111** (2006)

[3] S.S. Yu, R. Culbertson *et al.* [Fermilab], "Search for gamma gamma + e or mu in the 683.7 pb-1 of Data", CDF/ANAL/EXOTIC/CDFR/**8064** (2006)

[4] S.S. Yu, R.J. Tesarek, D. Litvintsev, J. Heinrich, N.S. Lockyer [University of Pennsylvania, Fermilab], "Ratio of $\mathcal{B}(\Lambda_b \to \Lambda_c^+ \mu^- \overline{\nu}_\mu)$ to $\mathcal{B}(\Lambda_b \to \Lambda_c^+ \pi^-)$ in the two track trigger," CDF/PHYS/BOTTOM/CDFR/**7559** (2005)

[5] S.S. Yu, R.J. Tesarek, D. Litvintsev, J. Heinrich, N.S. Lockyer [University of Pennsylvania, Fermilab], "Correction of Λ_b to B^0 Production Cross-Section Ratio," CDF/PHYS/BOTTOM/CDFR/**7558** (2005)

[6] D. Litvintsev, S.S. Yu, R.J. Tesarek [Fermilab, University of Pennsylvania], "Observation of Λ_c^* and Σ_c in semileptonic Λ_b decays," CDF/PHYS/BOTTOM/CDFR/**7546** (2005)

[7] R.J. Tesarek, D. Litvintsev, S.S. Yu [Fermilab, University of Pennsylvania], "Λ_b semileptonic backgrounds," CDF/ANAL/BOTTOM/CDFR/**7545** (2005)

[8] S.S. Yu, R.J. Tesarek, D. Litvintsev, J. Heinrich, N.S. Lockyer [University of Pennsylvania, Fermilab], "Description of the Datasets for the Ratio of Semileptonic to Hadronic Partial Decay Width," CDF/PHYS/BOTTOM/CDFR/**6979** (2003)

[9] R.J. Tesarek, S.S. Yu [Fermilab, University of Pennsylvania], "A Study of Backgrounds to the Decay $\overline{B}^0 \to D^+ \mu^- \overline{\nu}_\mu$," CDF/PHYS/BOTTOM/CDFR/**6599** (2003)

[10] S.S. Yu, R.J. Tesarek, N.S. Lockyer [University of Pennsylvania, Fermilab], "Measurement of Ratios of $\mathcal{B}(\overline{B}^0 \to D^{*+} \mu^- \overline{\nu}_\mu)$ to $\mathcal{B}(\overline{B}^0 \to D^{*+} \pi^-)$," CDF/DOC/BOTTOM/CDFR/**6595** (2003)

[11] S.S. Yu, J. Heinrich, N.S. Lockyer *et al.* [University of Pennsylvania], "COT dE/dx Measurement and Corrections," CDF/DOC/BOTTOM/PUBLIC/**6361** (2003)

Conferences and Workshops

- Talks and Posters
  - "Search for Higgs at CDF"
    SUSY06, Irvine, CA 92660, June 2006
  - "Measurement of the Λ_b Relative Branching Fractions at CDF II"
    Lawrence Livermore High Energy Physics Seminar, Livermore, CA 94551, August 2005
  - "Measurement of the Λ_b Relative Branching Fractions at CDF II"
    SLAC Experimental High Energy Physics Seminar, Menlo Park, CA. 94025, August 2005
  - "Measurement of the Λ_b Relative Branching Fractions at CDF II"
    Yale University High Energy Physics Seminar, New Haven, CT 06511, July 2005
  - "Measurement of the Λ_b Relative Branching Fractions at CDF II"
    Fermi National Laboratory High Energy Physics Seminar, Batavia, IL 60510, June 2005
  - "Measurement of the Λ_b Relative Branching Fractions at CDF II"
    Brookhaven National Laboratory High Energy Physics Seminar, Upton, NY 11973 , June 2005
  - "Measurement of the Λ_b Relative Branching Fractions at CDF II"
    Johns Hopkins University High Energy Physics Seminar, Baltimore, MD 21218, June 2005
  - "Measurement of the Λ_b Relative Branching Fractions at CDF II"
    Chicago Flavor Seminar, Batavia, IL 60510, June 2005
  - "Λ_b Physics at CDF"
    Frontiers In Contemporary Physics - III, Nashville, TN, May 2005
  - "Measurement of Λ_b Branching Ratios in Modes Containing a Λ_c"
    Lepton/Photon, Batavia, IL, August 2003
  - "Particle ID with dE/dx Measurement from CDF Central Outer Tracker"
    Annual APS Meeting, Albuquerque, NM, April 2002
  - "COT Electronics Summary"
    CDF Week, Batavia, IL, May 2000
  - "ASDQ Performance"
    CDF COT Workshop, Philadelphia, PA, April 1998
- Analysis results presented (by other CDF collaborators)
  - "Search for Physics Beyond the Standard Model at the Tevatron"
    SUSY06, Irvine, CA 92660, June 2006
  - "Recent Tevatron Results"
    Linear Collider Workshop, Bangalore, India, March 2006
  - "Non SUSY Searches at the Tevatron"
    XX Rencontres de Physique de La Valle d'Aoste, La Thuile, Italy, March 2006
  - "First Measurement of $\mathrm{BR}(\Lambda_b \to \Lambda_c^+ \mu^- \overline{\nu}_\mu)/\mathrm{BR}(\Lambda_b \to \Lambda_c^+ \pi^-)$ at CDF"
    International Europhysics Conference on High Energy Physics, Lisbon, Portugal, July 2005
  - "Branching ratios from B_s^0 and Λ_b"
    Flavor Physics and CP Violation Workshop, Paris, France, June 2003
- Attended
  - Mini-Workshop of Fermilab Advanced Analysis Methods Group, Batavia, IL, June 2002
  - Flavor Physics and CP Violation Workshop, Philadelphia, PA, May 2002
  - HEP Mini-Symposium, Philadelphia, PA, April 2001
  - B Physics and CP Violation Workshop IV, Ise-Shima, Japan, February 2001
  - HEP Mini-Symposium, Philadelphia, PA, April 2000
  - CP Violation Workshop, Philadelphia, PA, May 1999
  - APS Centennial Meeting, Atlanta, GA, March 1999

References

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