SVT : Silicon Vertex Tracker

A New Detector for the Study of Strange Particle and Low p_T Physics at RHIC

SVT Collaboration

BNL, LBL, Ohio State U., U. of Texas, U. of Washington, Warsaw Polytechnica, IHEP Protvino,Wayne State U.

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1) Physics Goals of the SVT
2) Design Criteria
3) Proposed Design
4) Physics Capabilities of the SVT
5) Prototype Studies
6) Milestones

1) Physics Goals of the SVT

1) Complement and extend the Physics of the STAR Baseline detector

2) Strangeness Physics

- **Study of thermalization**
- **Strangeness Density**
- **QGP Formation**
- **Chiral Symmetry Restauration**
- **Detection of Strange and Multi–strange baryons and anti–baryons: Λ, Ξ^-, Ω^-, $\bar{\Lambda}$, $\bar{\Xi}^-$, $\bar{\Omega}^-$**
- **K^0_S Interferometry**

3) Soft Physics (Low p_T)

- **Low p_T enhancement and/or fluctuations**
- **Phase transition,**
- **Resonance Decays**
- **Bose–Einstein Condensation**
- **Disoriented Chiral Condensate (DCC)**

4) Charmed meson

- **Parton Scattering, pre–equilibrium stage Physics, QGP**
- **Chemical Equilibration**
- **Open charm production**

2) Design Criteria

Goals

– Extend STAR tracking to the lowest achievable momenta.
– Identify short lived particles decaying before they reach the TPC.

Requirements

– Minimize distance to primary vertex, maintain good radial coverage
– Minimize thickness/mass to minimize multiple scatterning and in detector particle production.
– Optimize position resolution to permit accurate tracking.
– Handle LARGE Multiplicity (occup: 3.5%).
– Minimize COST: minimize number of electronic channels.

3) Proposed Design

Choice of Technology : Silicon Drift Detectors (SDD)

– High Position Resolution (~ 20 microns)
– Accurate Charge Deposition Measurement (dE/dx)
– Can handle large multiplicities
– Anode segmentation and Drift time Readout minimize the number of electronic channels

Choice of Configuration:

– 216 SDDs mounted in a quasi–projective geometry on three concentric barrels positioned within the TPC around the colliding beams. (see schematic drawing)

Technical Summary:

– Based on 4 inch, high resistivity (~ 3KΩ/cm) n–type Si wafer as substrate.
– Field Shaping Electrodes constituted of p–type material implanted symmetrically on both wafer surfaces to from a regular strip pattern. (see schematic drawing)
– Prototype Cathode Pitch: 120 μm.
– High Voltage Gradient: up to 600 V/cm.
– Readout on Segmented Anodes with 250 μm pitch.
– FEE based on preamp–shaper (PASA) and switch–capacitor array (SCA) multiplexed into an ADC.

Technical SDD Summary

Wafer Diameter	4 in, 10.16 cm
SDD Length/Width	6 cm
Drift Length	3 cm
Wafer Thickness	300 μm
Average Drift time	3 μs
Time Samples	256
Sampling Rate	40 MHz
Anode Pitch	250 μm
Position Resolution	< 25 μm

SVT Configuration Summary

Projective Geometry
Full Azimuthal Coverage

Number of Concentric Layers	3
Radius of Barrels	
Inner Layer	5.97 cm
Middle	10.16 cm
Outer	14.91 cm
Length of active Area	42 cm
Number of Wafers	
Inner Layer	32 (8x4)
Middle	72 (12x6)
Outer	112 (16x7)
Average Total Thickness (incl. FEE)	3% X_0
Total Number of SDD	216
Number of Channels	103680

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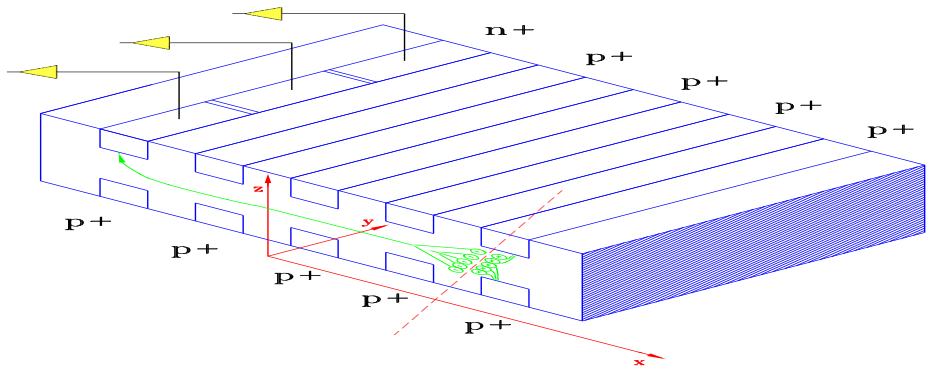

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4) Physics Capabilities of the SVT

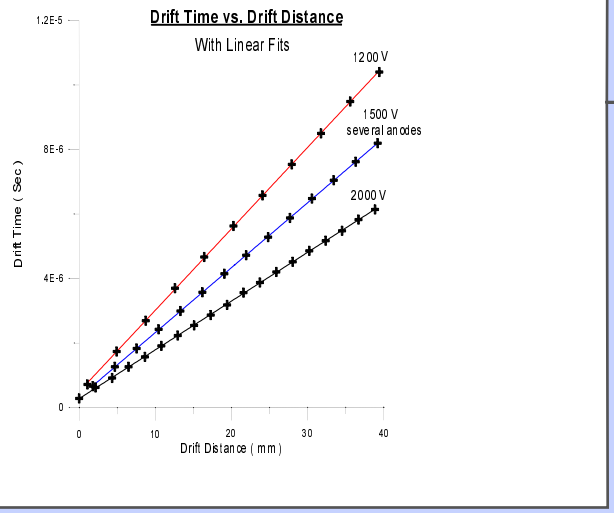
We present simulations of the performance of the SVT as a stand–alone detector and as used in conjunction with the STAR TPC for Physics Reconstruction.

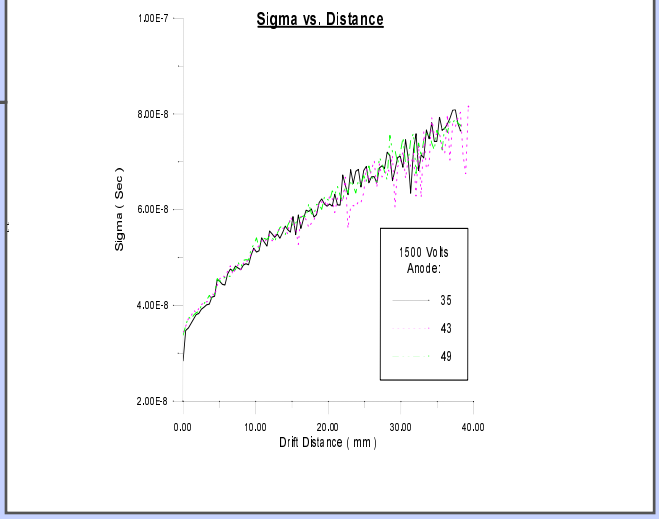
1) Momentum Resolution : $\Delta p/p$ ~ 10–15 % (stand–alone SVT)
2) Particle Identification – dE/dx
3) Primary/Secondary Track Reconstruction Efficiency
4) Invariant Mass Plot of Reconstructed K^0_S, Λ, and Ξ^-
5) HBT– K^0_S
6) Low p_T Enhancement/Fluctuations Studies

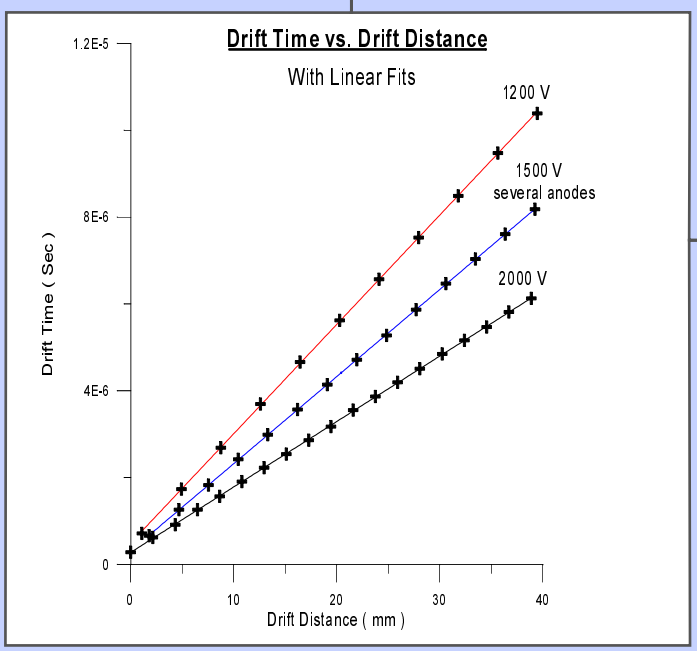
5) Prototype Studies

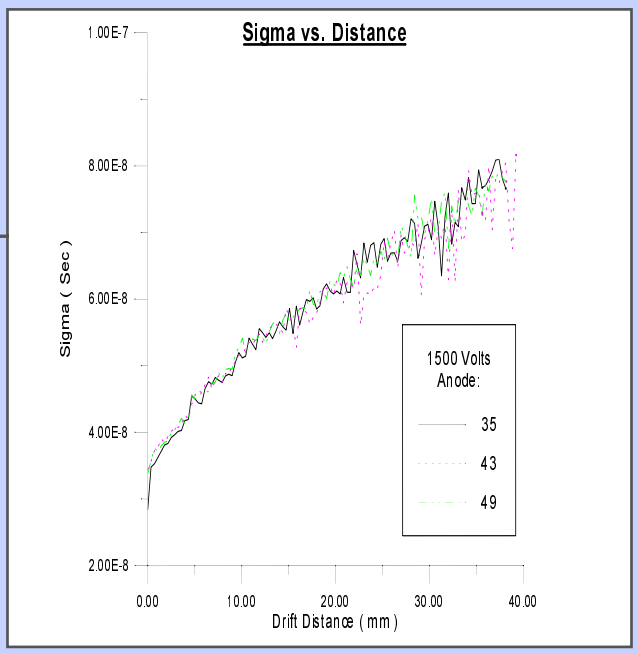
1) Drift Time vs Drift Distance
2) Pulse Width (sigma) as a function of Drift Distance
3) Position Accuracy measurement in the drift direction
4) Position Accuracy measurement in the lateral direction
5) Lateral Spread of the Charge Distribution vs Drift Distance
6) Charge Collected vs Drift Distance
7) Drift Time vs Drift Distance measured for many anodes
8) Photograph of the test beam setup at the AGS

5) Prototype Studies

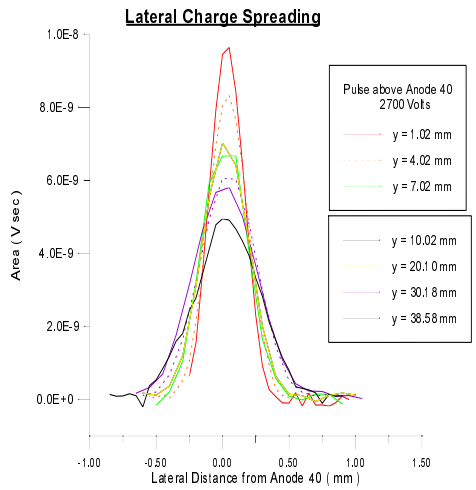


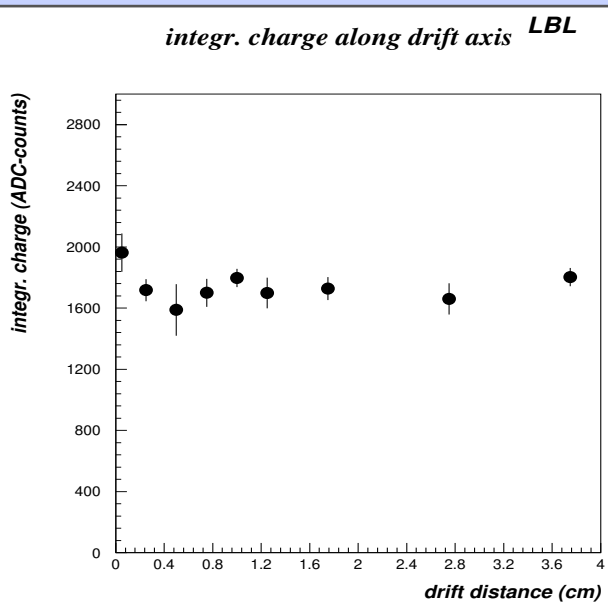


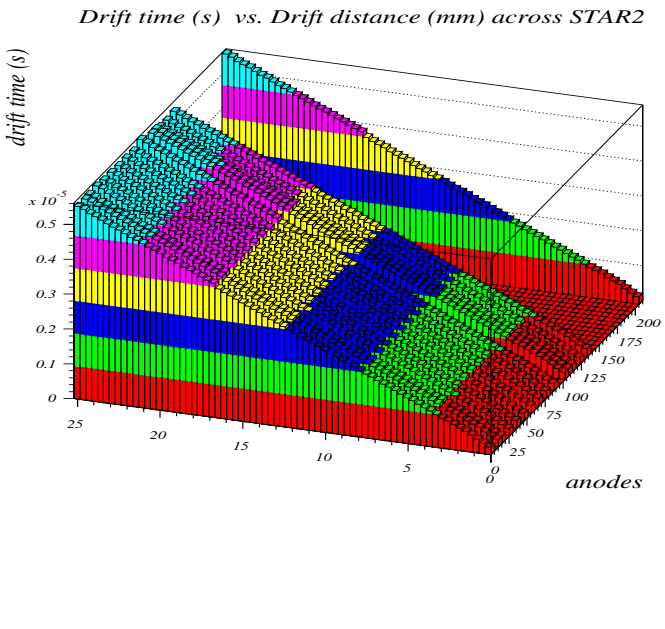




5) Prototype Studies – cont'd





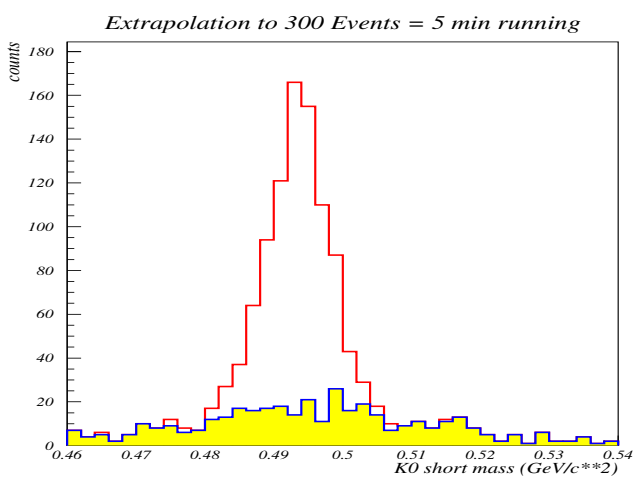


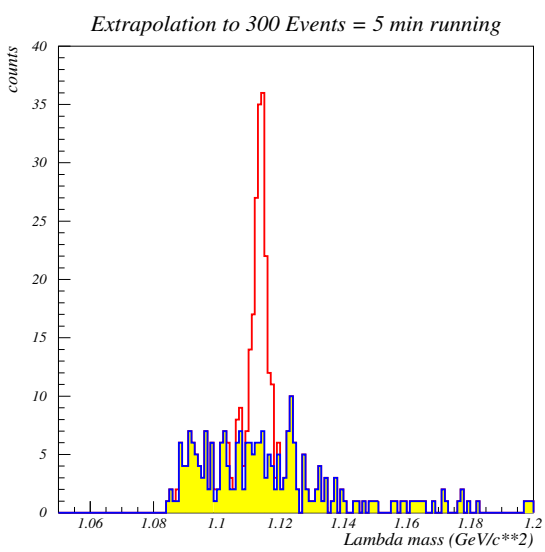
Test Beam Results:

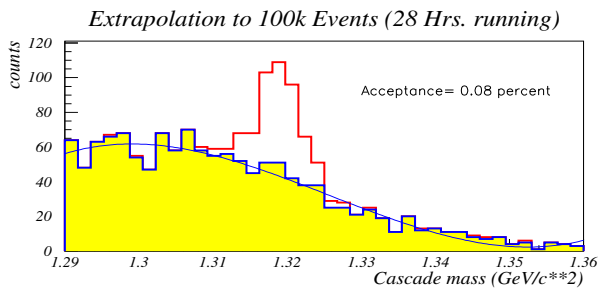
Proton/Pions 500 Mev/c – 2 GeV/c @AGS

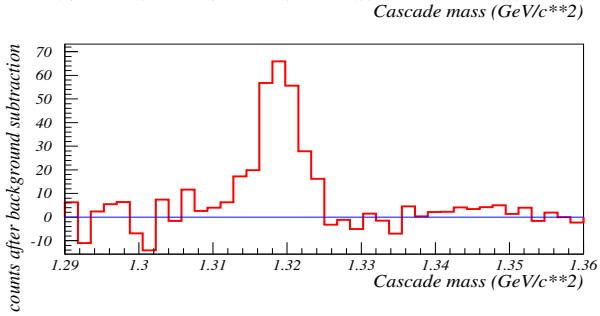
In good agreement with bench test results shown here.

4) Invariant Mass of Reconstructed K^0_s, Λ, and Ξ^-

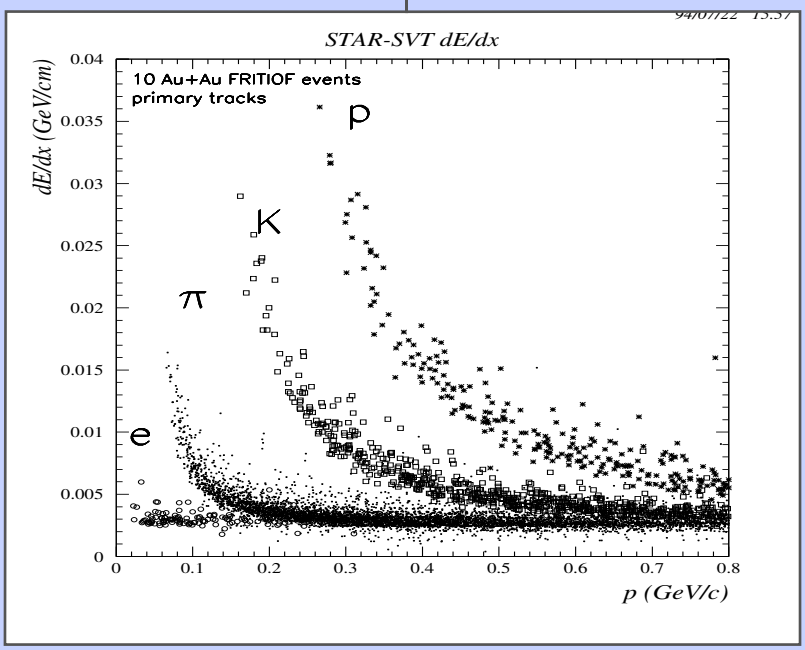




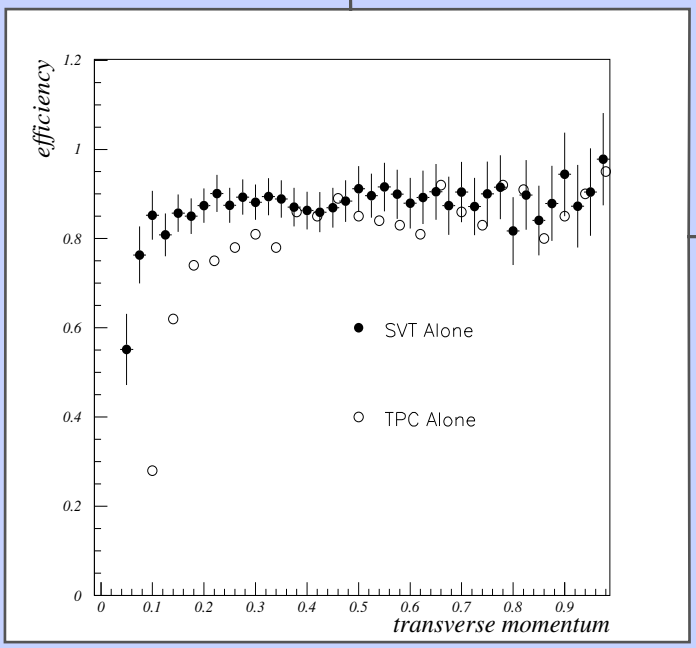


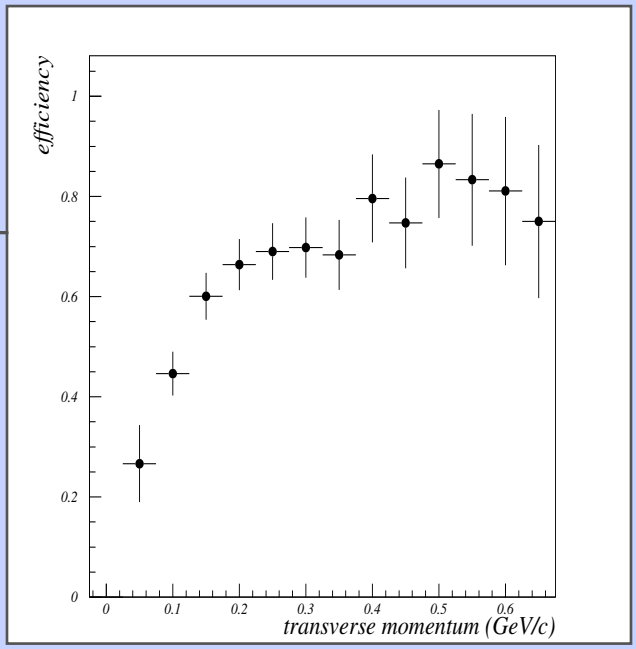


2) Particle Identification

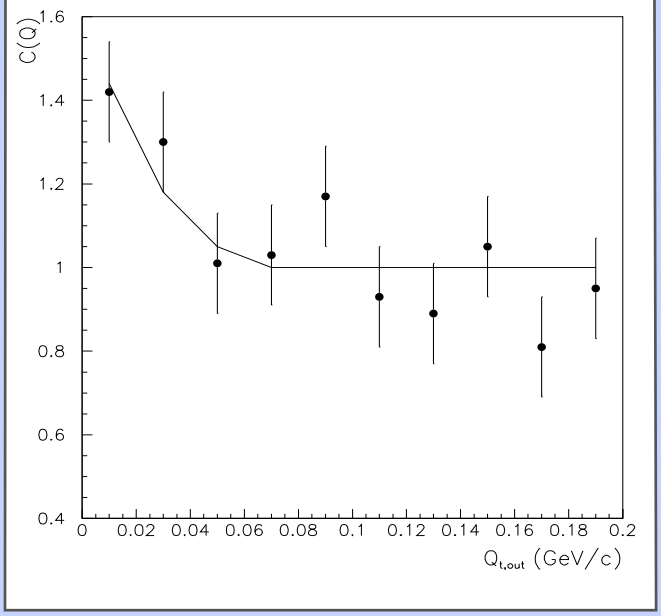


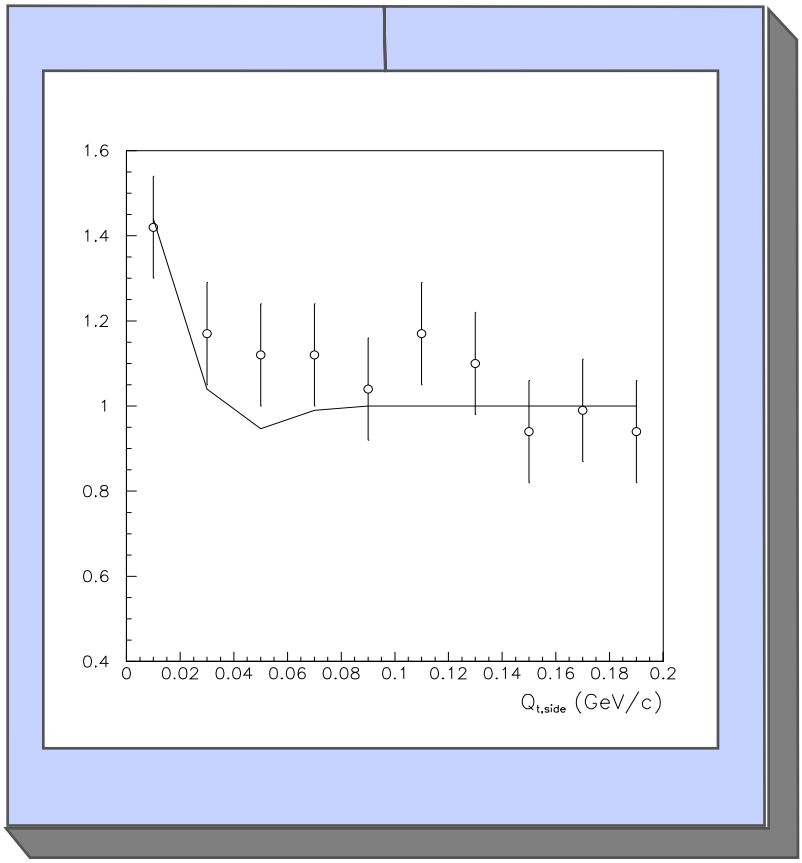
3) Primary/Secondary Track Reconstruction Efficiency



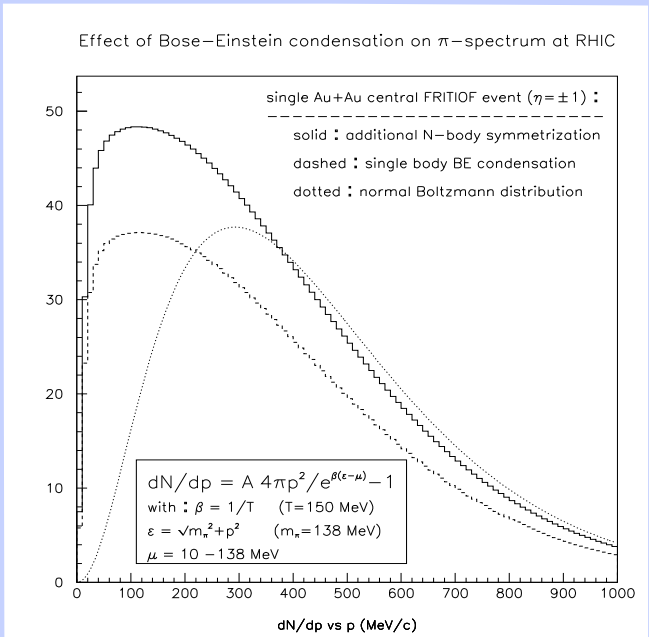


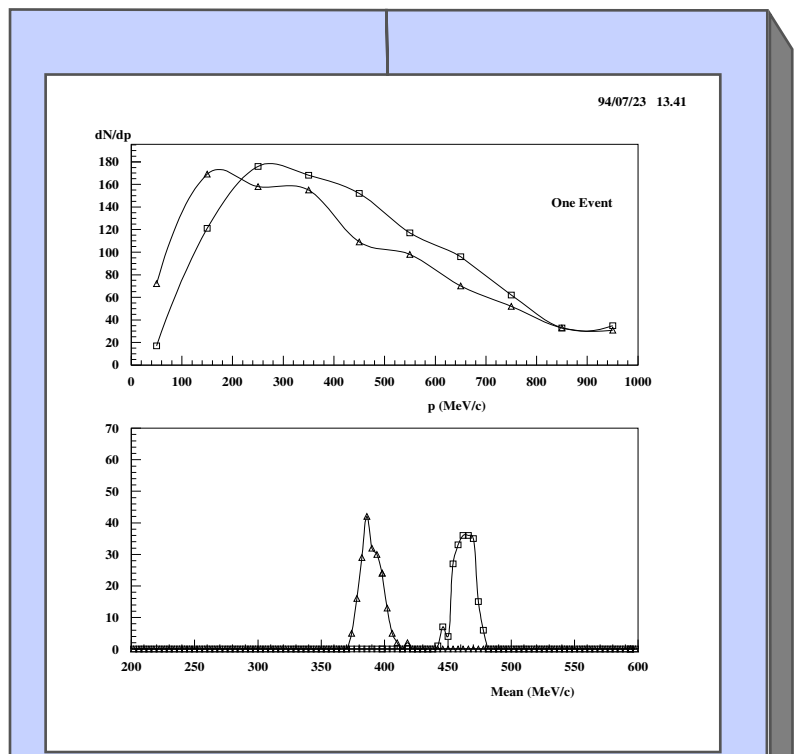
5) HBT – K^0_s





6) Low p_T Physics





6) Milestones

Completion of hybrid layout	December 94
SVT–CDR	December 94
Wafer layout decision	April 95
Completion of Hybrid Prototype	May 95
Final MEE Design	June 95
Final PDR	October 95
Final Ladder Prototype	October 95
Final FDR	May 96
End of Chip Production	March 97
Readout Board Assembly	March 97
Support Structure Machined	March 97
Assembly Start	July 97
Assembly Stop	July 98
First Assmebly Test	October 98
Transport to BNL – Installation	November 98
Final Assembly Test	February 99
RHIC Turn On	March 99