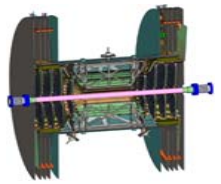
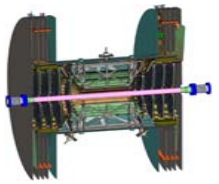


FVTX Software and Simulation

Zhengyun You

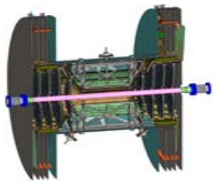
Los Alamos National Laboratory

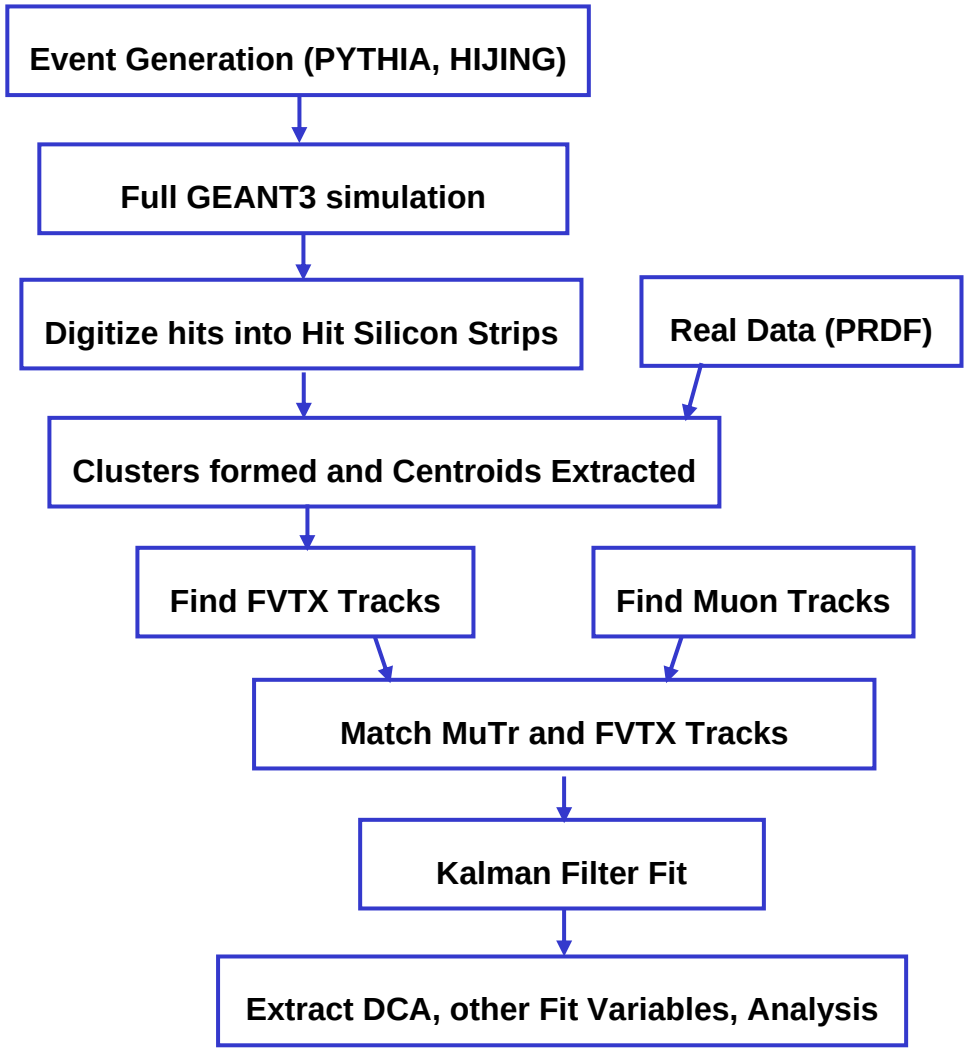
Outline



- Software updates
  - Simulation
  - Geometry
  - Hit response & reconstruction
  - Tracking
- Ongoing and future work
- Software organization

Software Overview





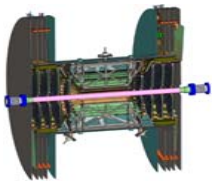
Current status:

- ✓ All materials have been updated to current design in simulation
- ✓ Full geometry updated in simulation and offline code
- ✓ New hit response and cluster fitting
- ✓ Track reconstruction algorithm updated

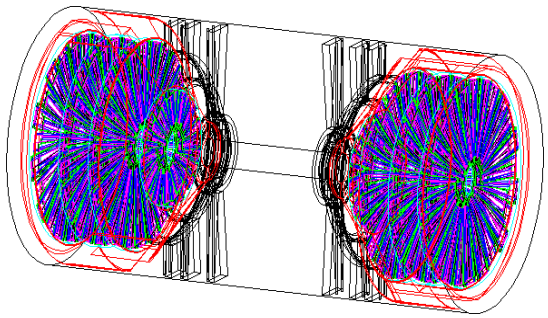
To be developed :

- Phenix Raw Data File **(PRDF)** generation
- Alignment and Calibration software
- Online Monitoring
- Database Interface

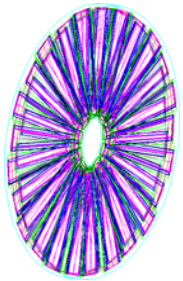
Simulation



Materials fully described in GEANT3

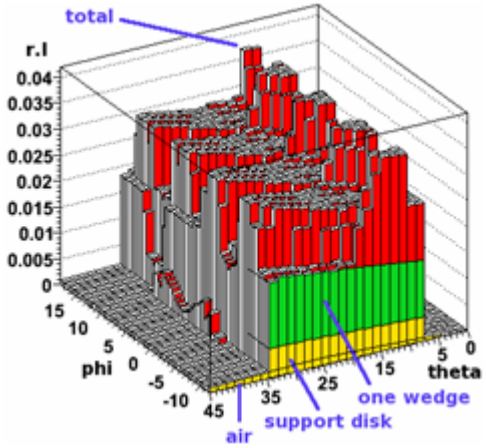


FVTX overall

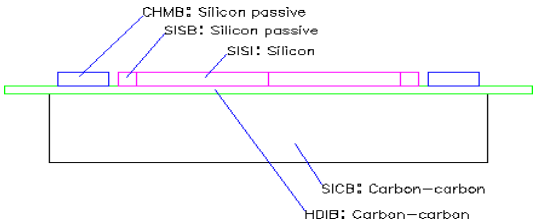


Station

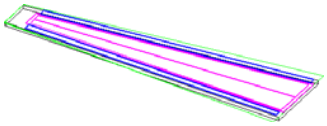
Radiation length



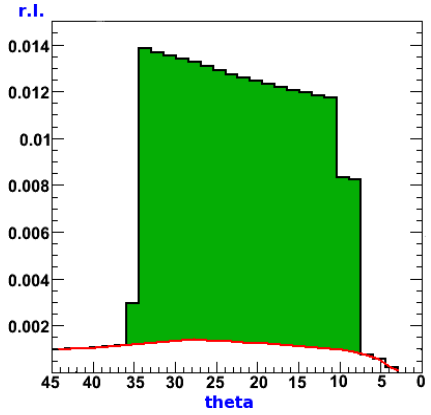
Radiation length on one Station (North St2)



Wedge projection view

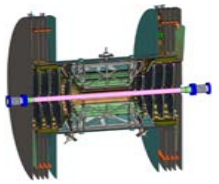


Wedge

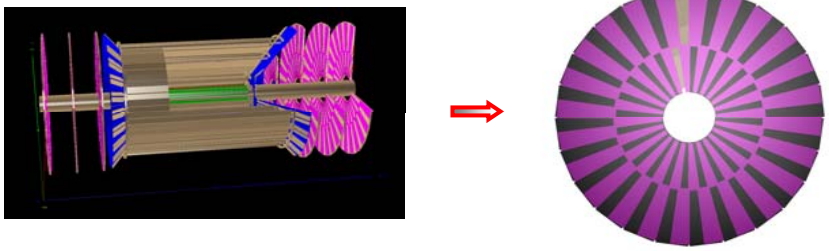


Radiation length of one Wedge (North St2, Wedge 1)

Geometry in Offline

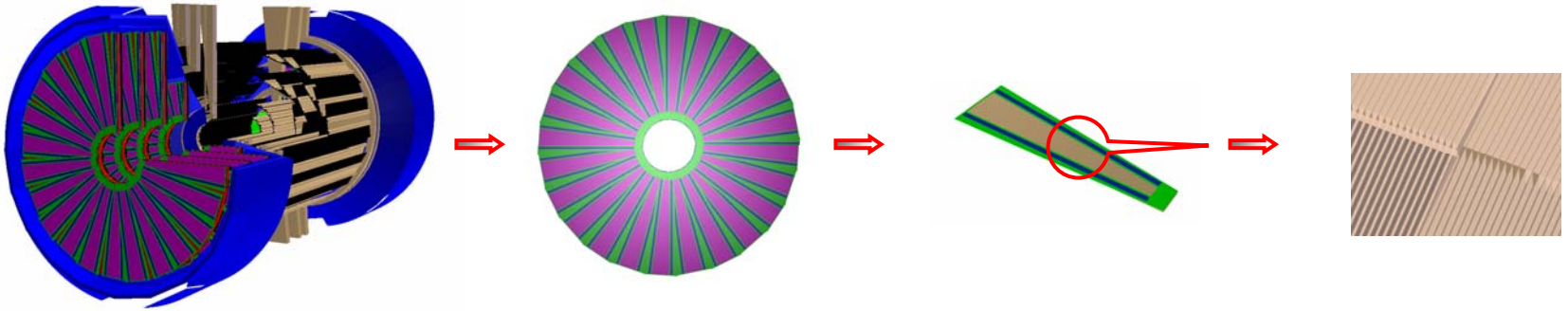


Old design



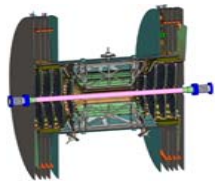
- Offline geometry is fully converted from detector description in GEANT3 to ROOT for consistency, with alignment correction allowed
- Two versions of design allowed for performance comparison
- Strips added for full description

New design (displayed in ROOT)

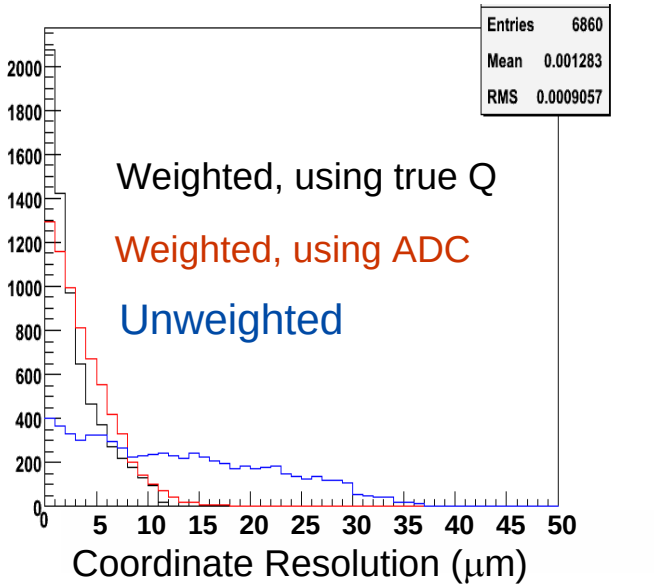


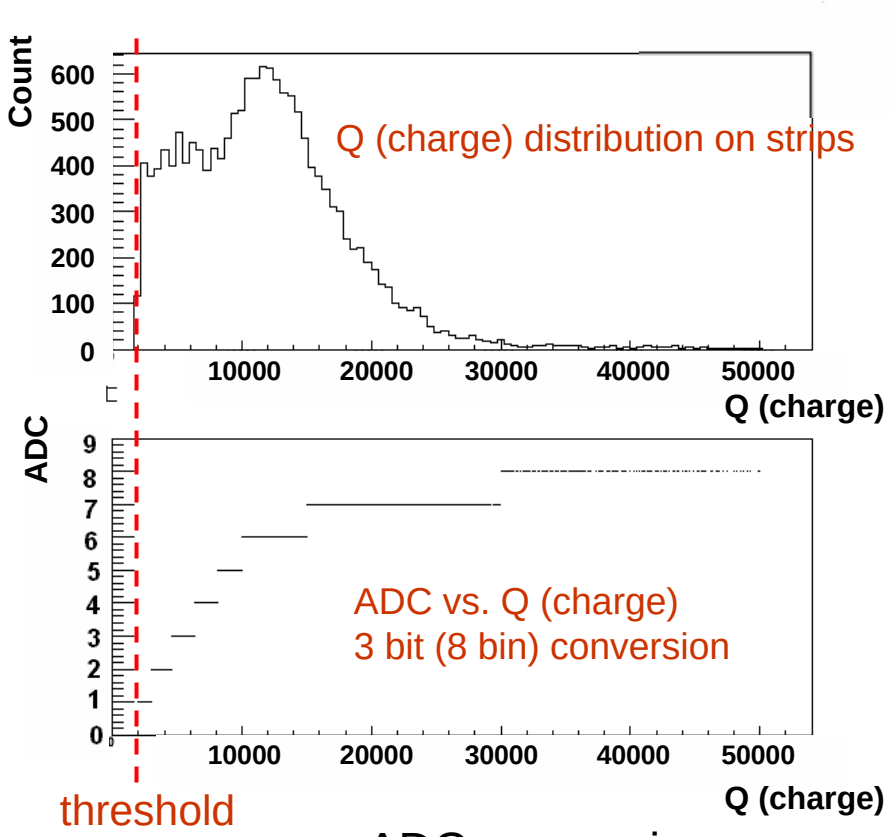
FVTX Station Wedge Strips

Hit response & reconstruction



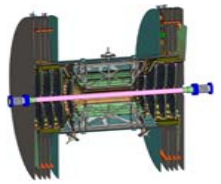
- ✓ ADC conversion (3 bit)
- ✓ Noise level added
  - ✓ Noises added to charge
  - ✓ Random noise hits added
- ✓ Cluster finding & Fitting





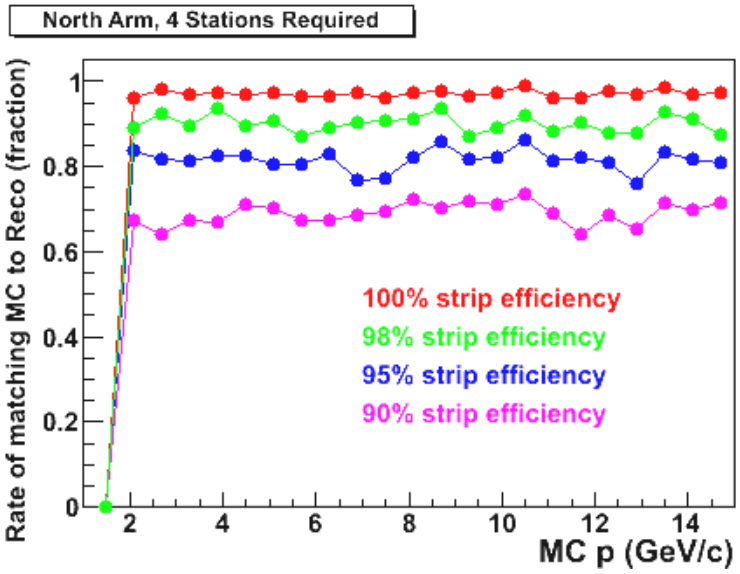
ADC conversion

Tracking

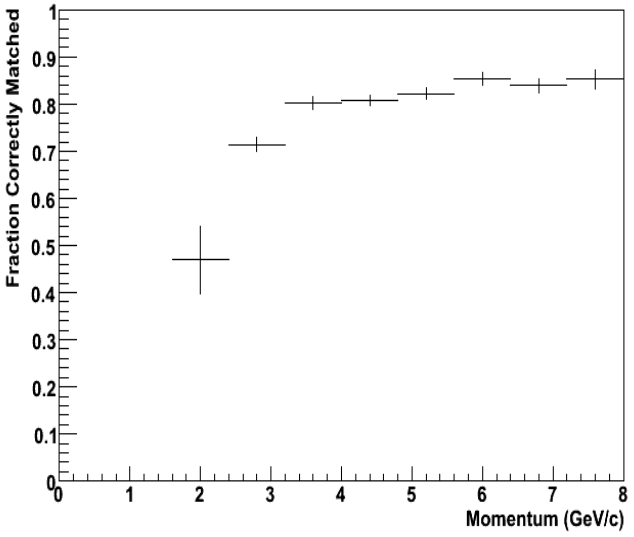


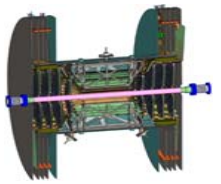
- ✓ New track finding algorithm (Columbia)
- ✓ In Au+Au events (highest occupancy environment, but reasonably modest, 3% occupancy)
- ✓ Good FVTX track finding efficiency
- ✓ Good efficiency for matching Muon (MUID+MUTR) tracks and FVTX tracks
- ✓ Expect further tuning to improve performance even further

FVTX Track Finding Efficiency
(In Au+Au events)



MUTR-FVTX Track Matching Efficiency
(Prompt muons in Au+Au events)

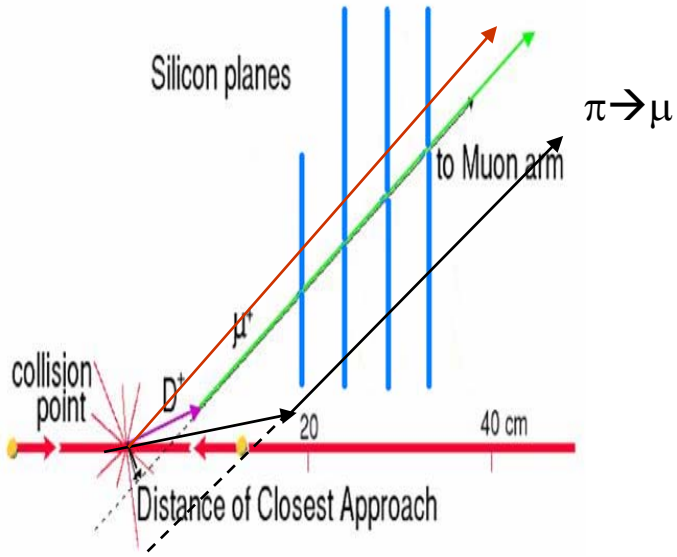




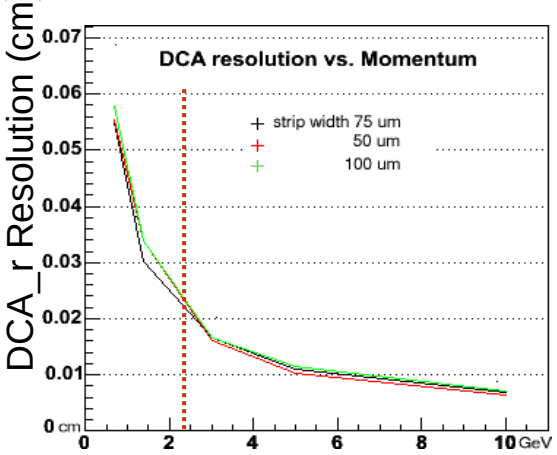
DCA (Distance of Closest Approach)

- Use Kalman Filter to fit and project to z_vertex
- Get DCA components in r (good) and phi (less good)
- ~100 μm resolution in DCA_r
- Multiple-scattering dominated resolution
- Sufficient resolution to separate prompt, heavy quark, and light meson decays

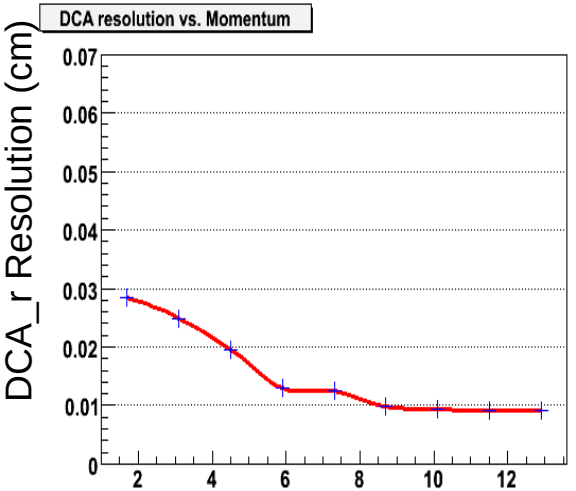
prompt



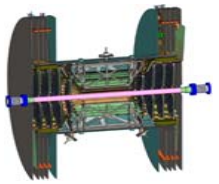
DCA_r (old design and simulation in review 2007)



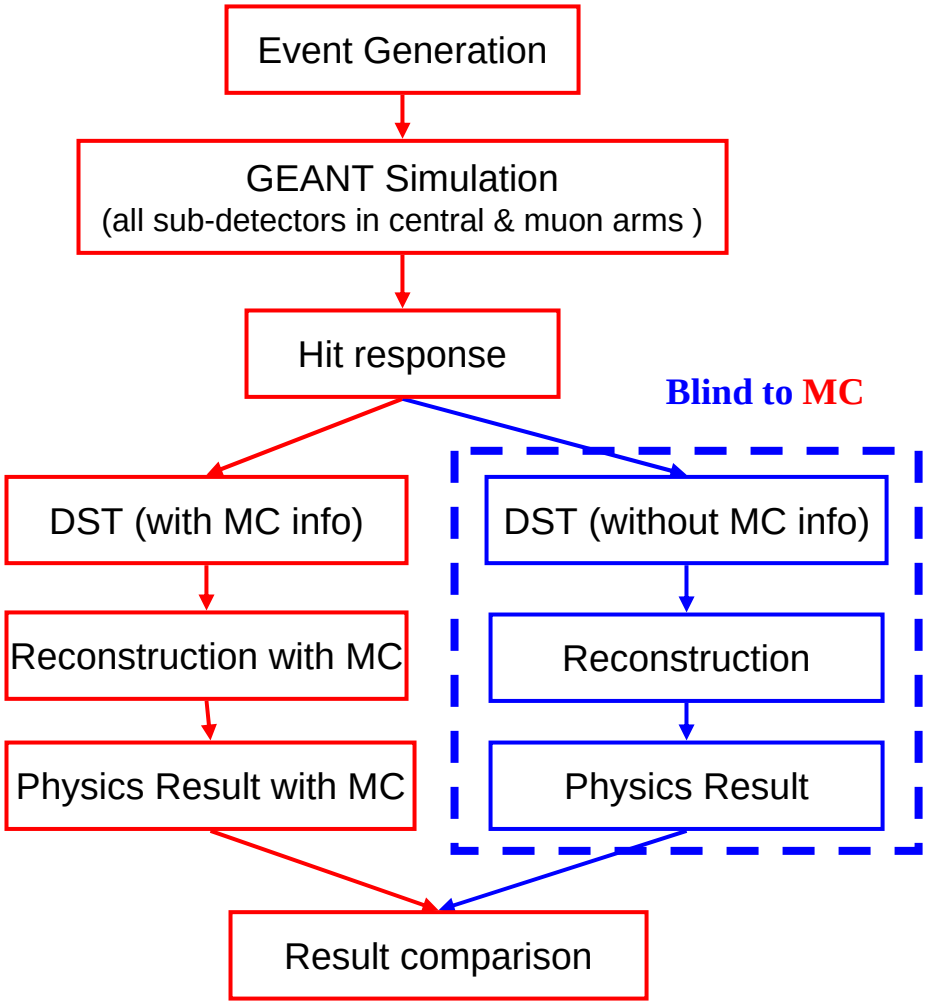
DCA_r (with updated geometry and software)



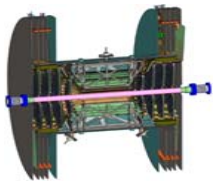
Blind analysis



- The purpose of blind analysis is to test the performance of VTX/FVTX software, and to show that they are ready for real data analysis
- Events are generated and simulated with VTX + FVTX + other PHENIX sub-detectors
- Analyzers only get DST files and are blind to MC information. Analysis results will be compared with MC information. If possible problems exist, they will be found and be fixed until two sides match.



Roadmap



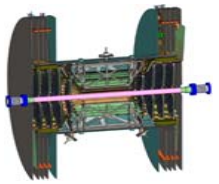
5/08 — 11/08 — 4/09

- Geometry revalidation
- Check Cluster&Track finding
- Test events generation
- Test events analysis
- Large scale events generation
- MC Info
- Loop
- Events analysis
- Result comparison
- Fix possible problems

Blind analysis

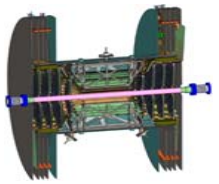
- Alignment tool
- Database
- Online Monitoring

Manpower in Blind Analysis

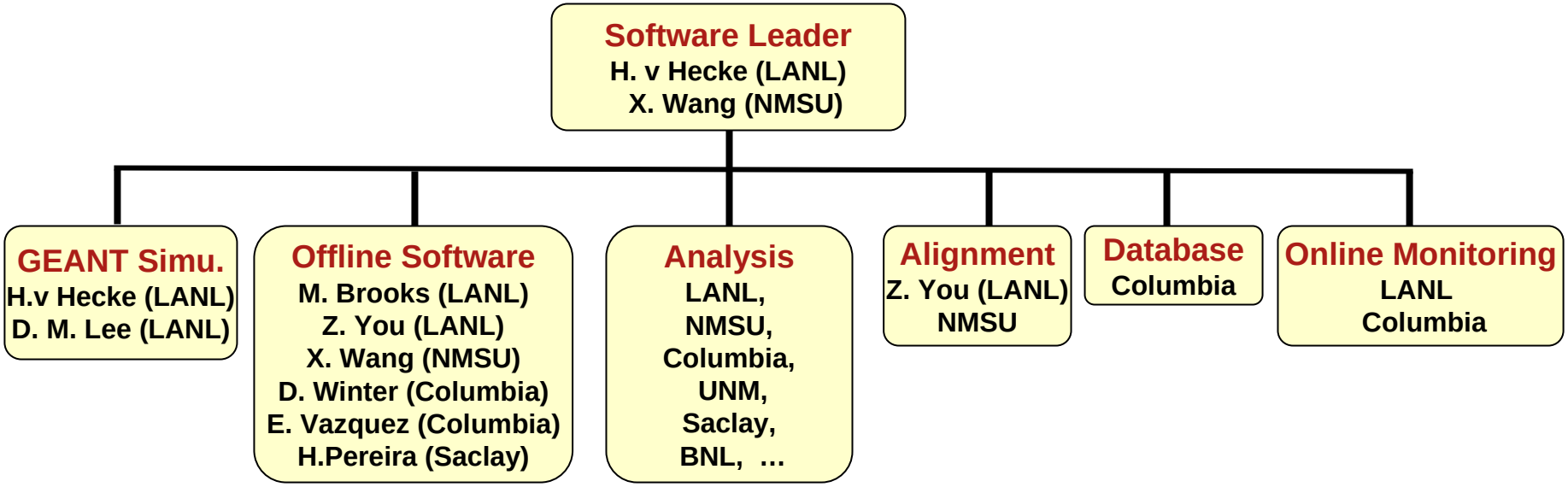


Coordinator	Anthony Denis Frawley (FSU)
Geometry revalidation	Alexandre Lebedev (IASU), Hubert van Hecke (LANL), Zhengyun You (LANL)
Barrel vertex finding	Alan Dion (IASU), Dave Winter (Columbia)
Forward vertex finding	Melynda Brooks (LANL), Hugo Pereira (Saclay), Dave Winter (Columbia)
Background generation	Axel Dress (SUNYSB), Benjamin Bannier (SUNYSB)
Event generation	Alexandre Lebedev (IASU), Axel Dress (SUNYSB), Benjamin Bannier (SUNYSB)
Event analysis	LANL, Columbia, NMSU, …

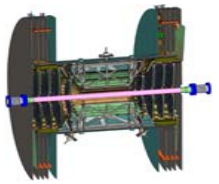
Future Work & Manpower



- Blind analysis
- Alignment tool
- Online monitoring
- Database interface

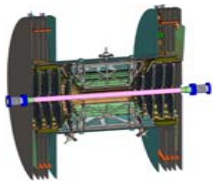


Summary

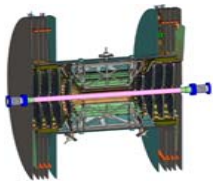


- Much progress in software updates in this year
  - All materials described in GEANT3
  - Full geometry updated in offline code
  - New hits response and cluster finding
  - New track finding algorithm

- Blind analysis and other work is going well



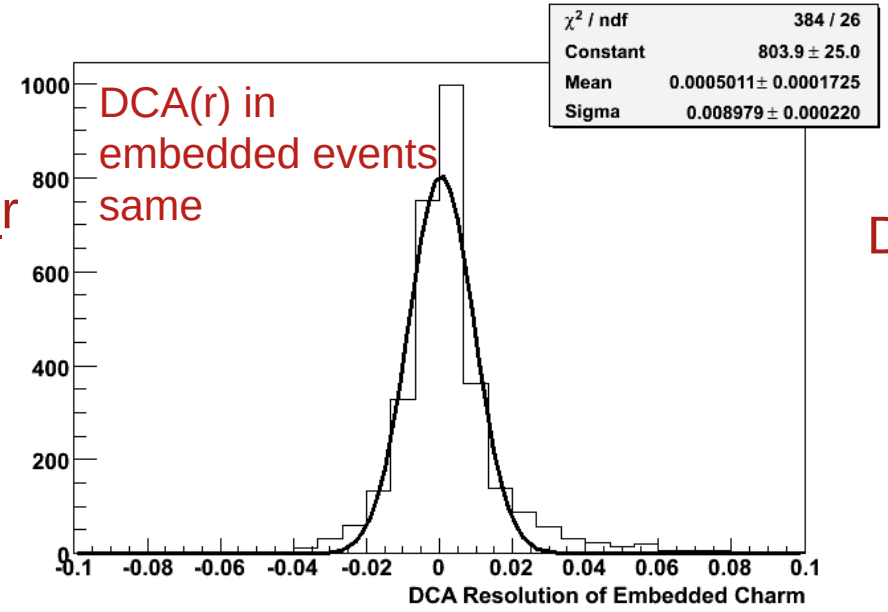
Backup Slides



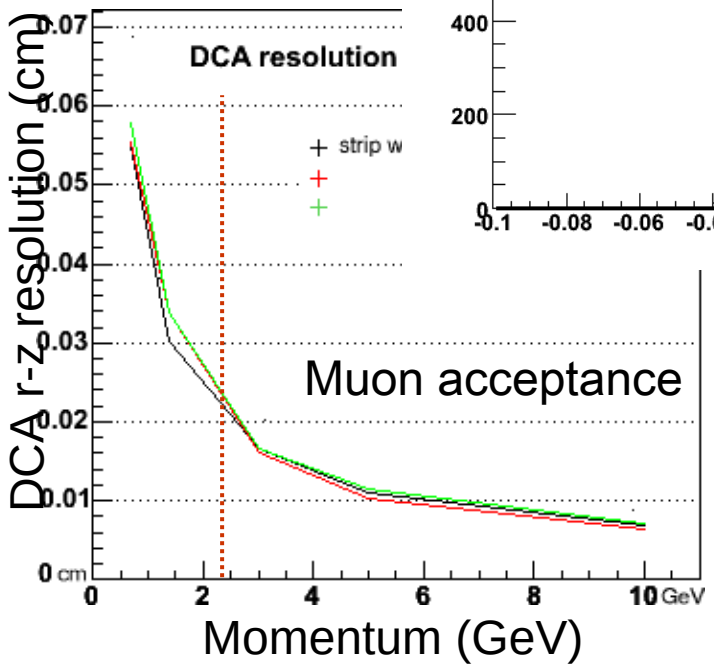
FVTX Performance – DCA (In Review 2007)

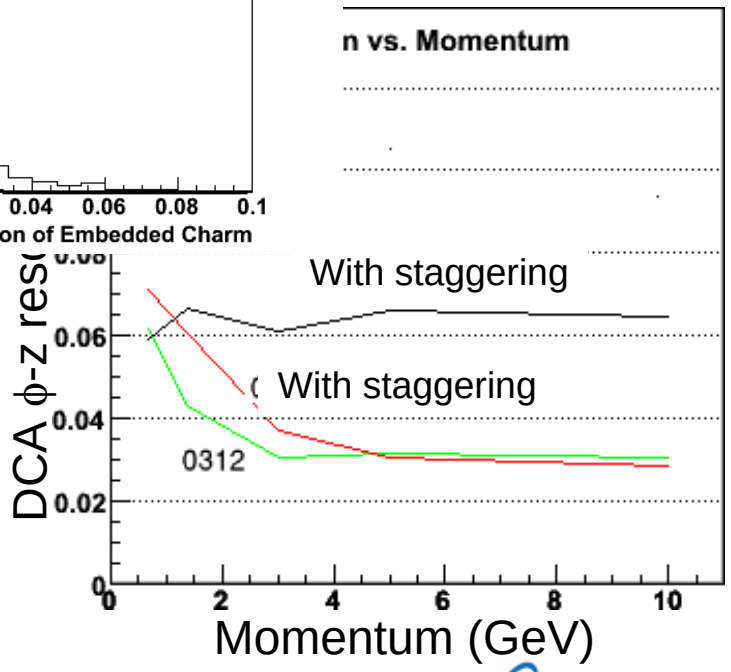
DCA_r

DCA(r) in embedded events same

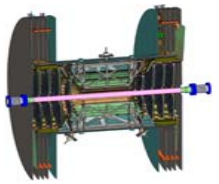


DCA_phi

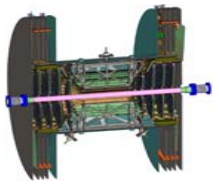




Physics analysis

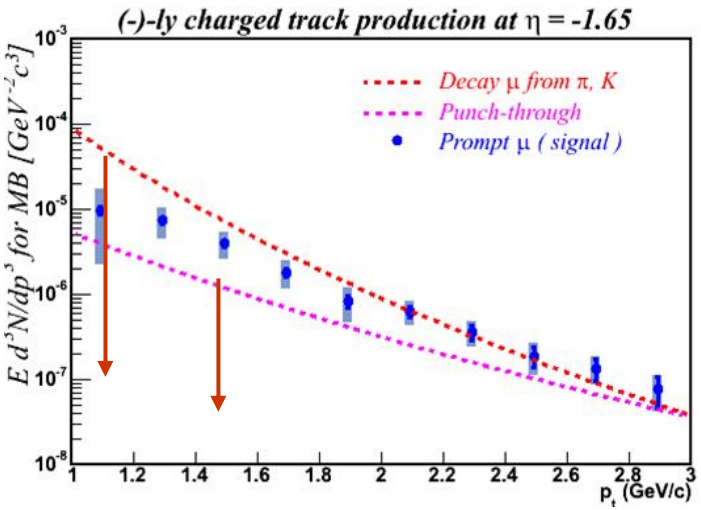


- **Single Muons**
  - Precise heavy flavor and hadron measurements at forward rapidity
  - Separation of charm and beauty
  - W background rejection improved
- **Dimuons**
  - First direct bottom measurement via $B \rightarrow J/\psi$
  - Separation of J/ψ from ψ' with improved in resolution and S:B
  - First Drell-Yan measurements from RHIC
  - Direct measurement of c-cbar events via $\mu^+\mu^-$ becomes possible
- **Physics**
  - Advance understanding of energy loss, by adding precise heavy flavor measurements of R_{AA} and flow.
  - First detection of ψ' plus heavy quark allow detailed understanding of vector meson production and modification
  - Separation/Understanding of Cold Nuclear Matter and QGP effects with rapidity coverage
  - Precise gluon polarization and sea quark measurements over large x range, fundamental tests of Sivers functions possible

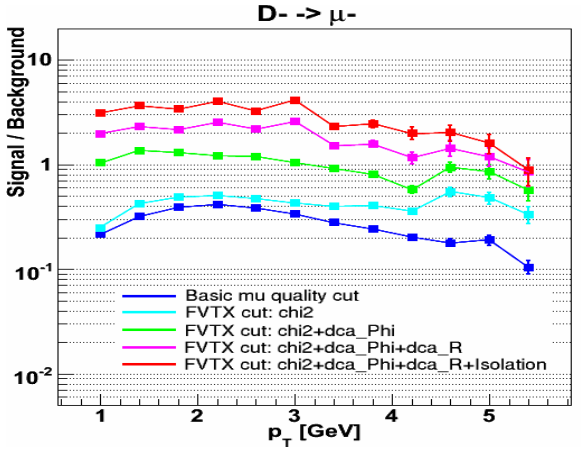


Heavy flavor measurement

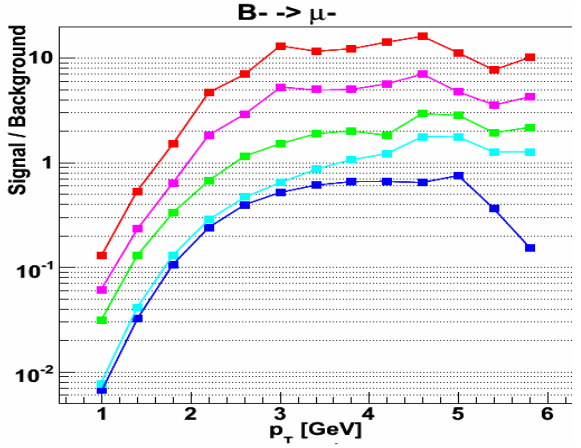
Signal & Background extracted from PHENIX run2 measurements



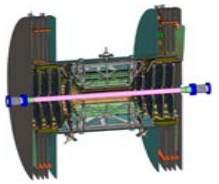
Full simulation and reconstruction with FVTX



S/B enhancement for D -> μ



S/B enhancement for B -> μ

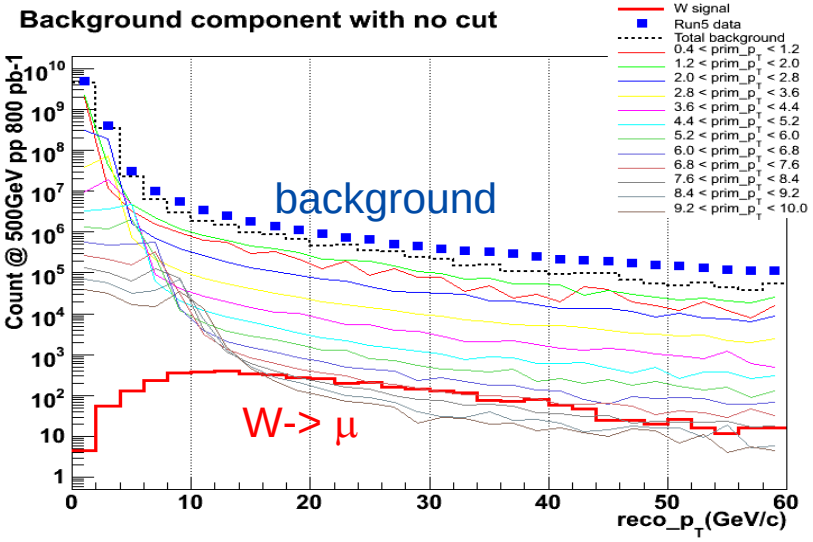


W background rejection

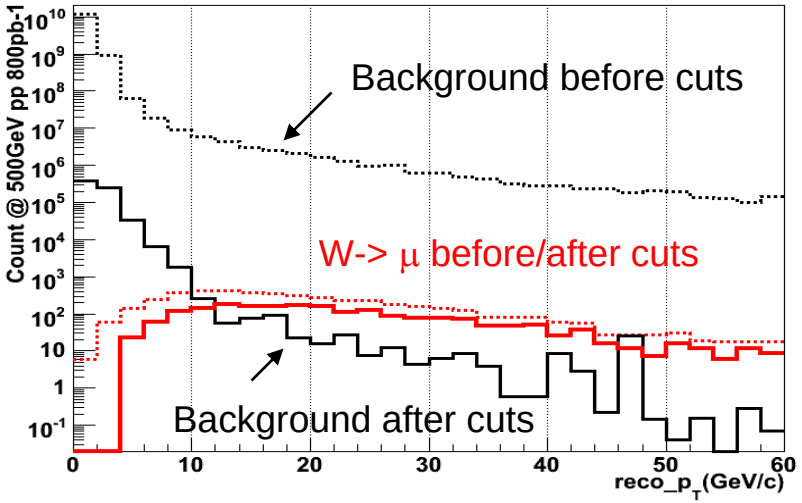
Single muon spectrum contributions from:

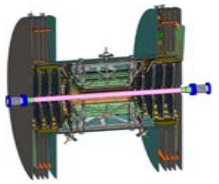
- W-->μX
- Hadron punch-throughs & decays
- Mis-reconstructed hadrons
- Tight MuTr cuts plus FVTX cuts improve signal:background by ~10^5

Simulated W signal and background from Run5



Background reduced by ~10^5
Most of signals kept

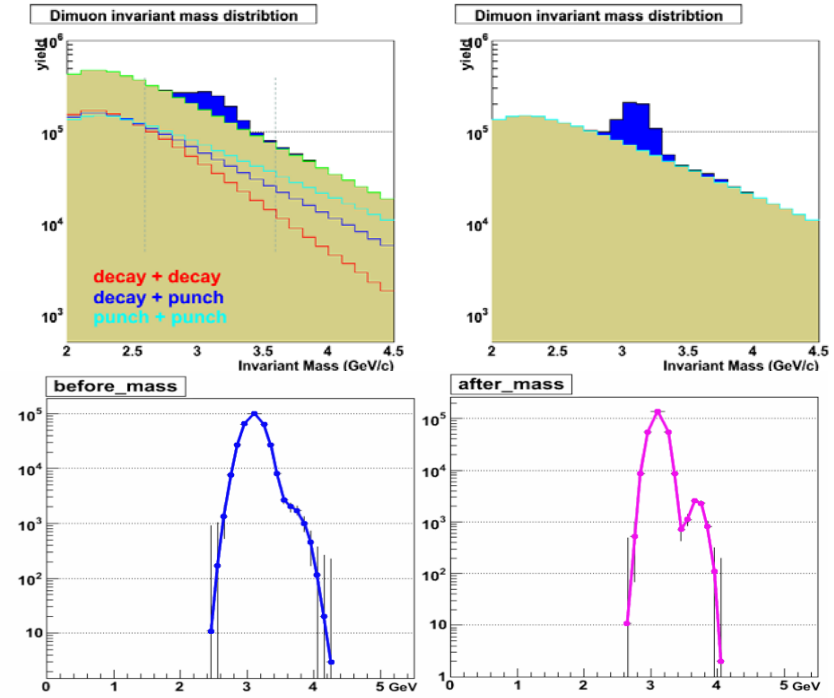




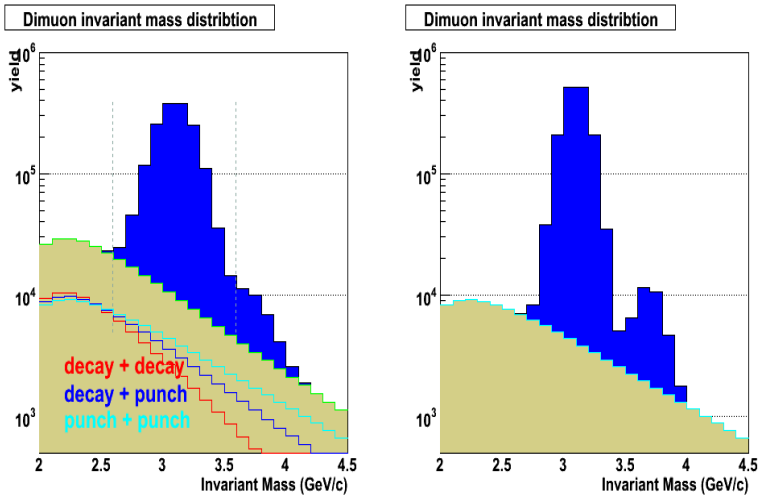
Dimuon spectra improvement

- Mass Resolution and Background Rejection Improvement
- ψ' added to vector meson measurements, J/ψ improved for given run, precision open heavy flavor added (recombination)
- QGP and CNM vector meson production understood

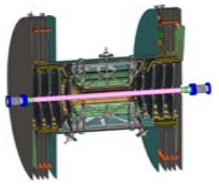
Au+Au



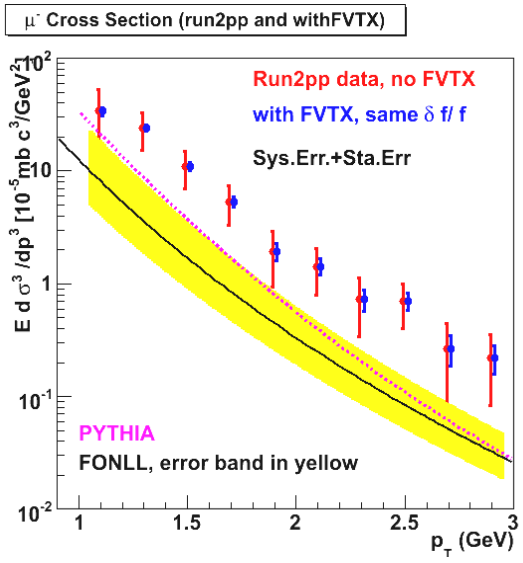
p+p

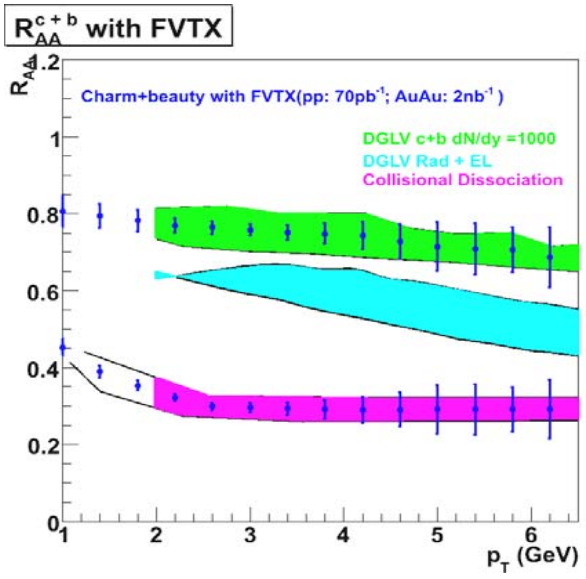


Heavy Ion R_{AA} with FVTX



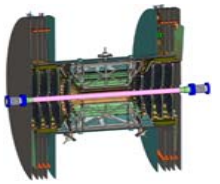
- Mechanisms for heavy/light quark suppression poorly understood
- Clear distinction among models
  - Radiative energy loss (W.Horowitz & S.Wicks et al.)
  - Radiative and collisional energy loss (M. Djordjevic et al.)
  - Dissociative energy loss (I. Vitev et al.)



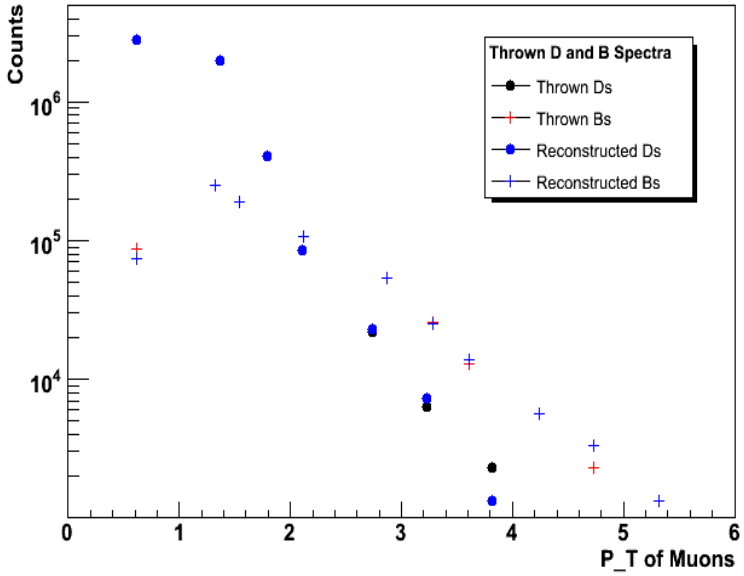


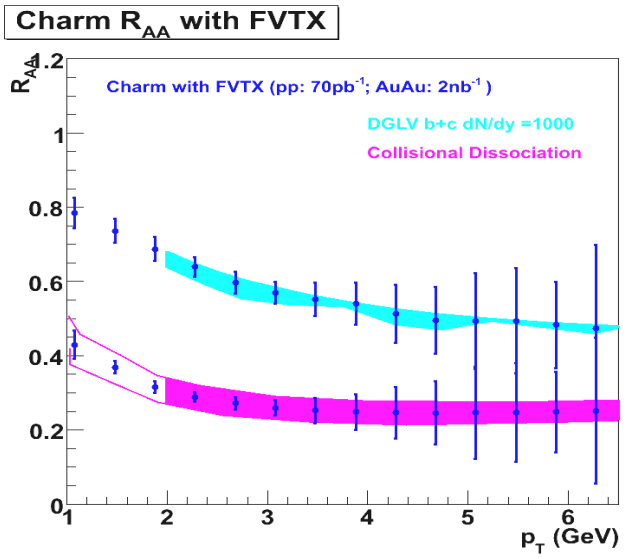
FVTX provides discrimination power even without c/b separation

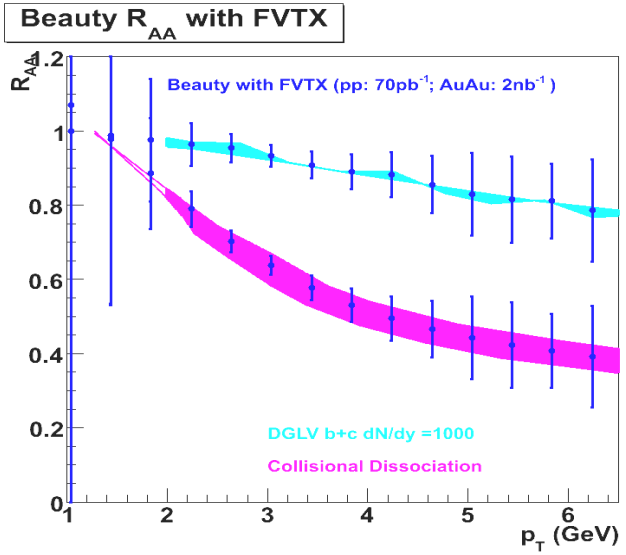
Heavy Ion R_{AA} for charm/beauty Separated



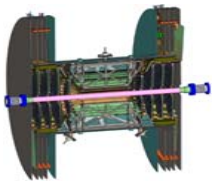
Statistical separation of charm and beauty with DCA cuts

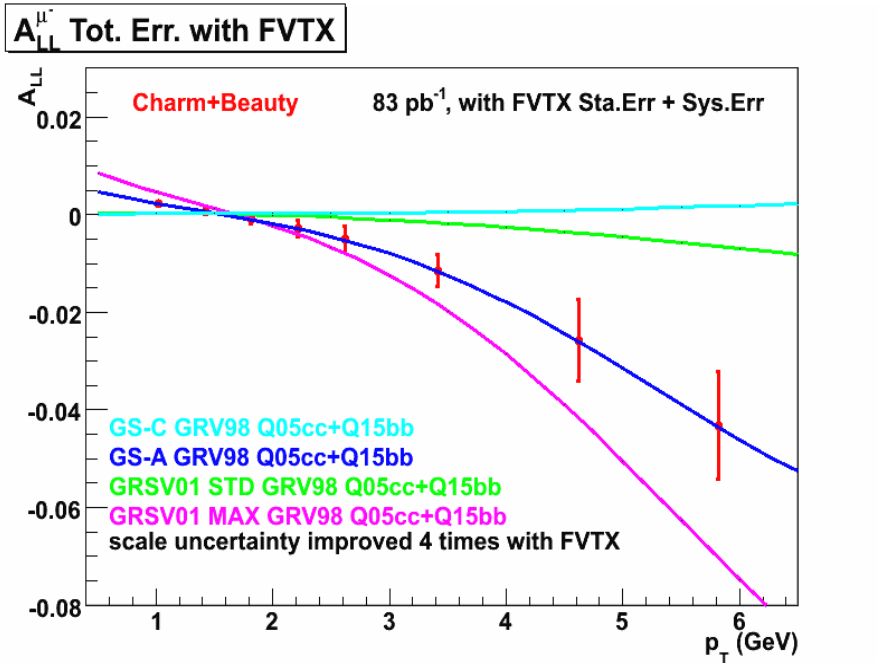


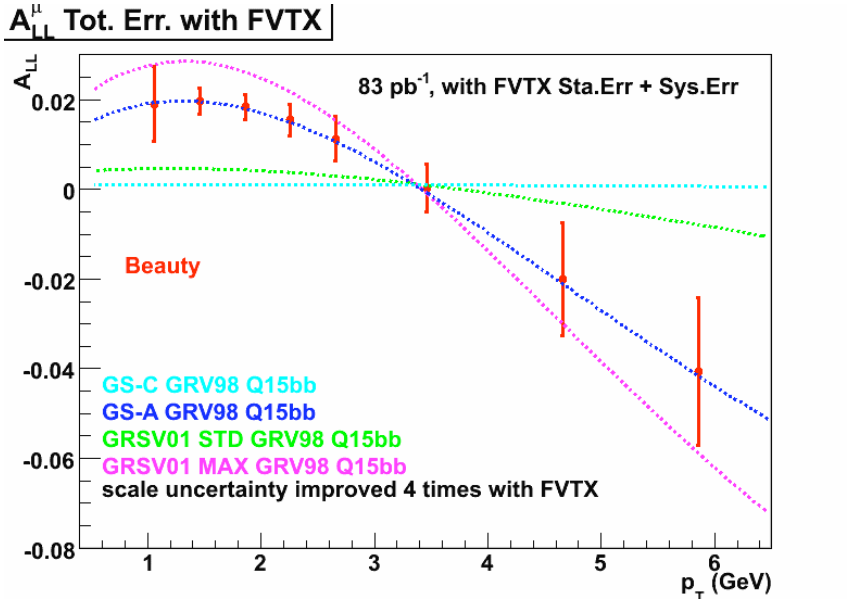




Double Spin Asymmetry A_{LL} from pp







Measurements of open charm and beauty add decisive information to the quest determining the source of the nucleon spin!