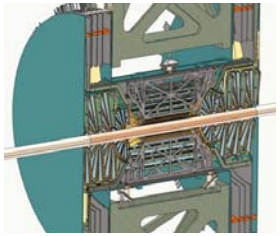
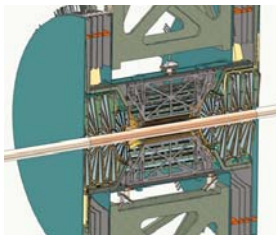


FVTX Project Overview

Melynda Brooks

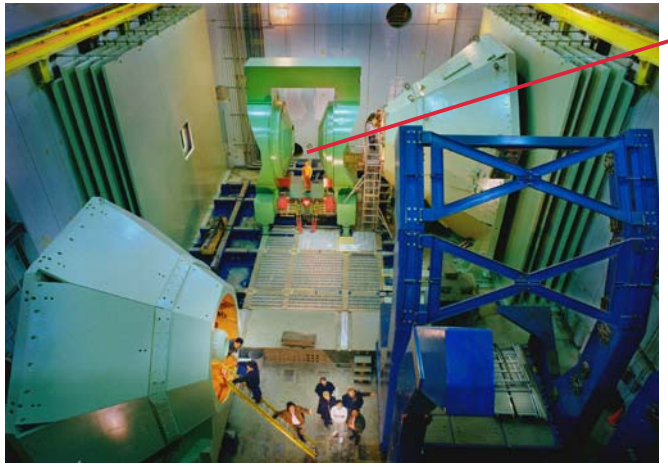
Los Alamos National Laboratory

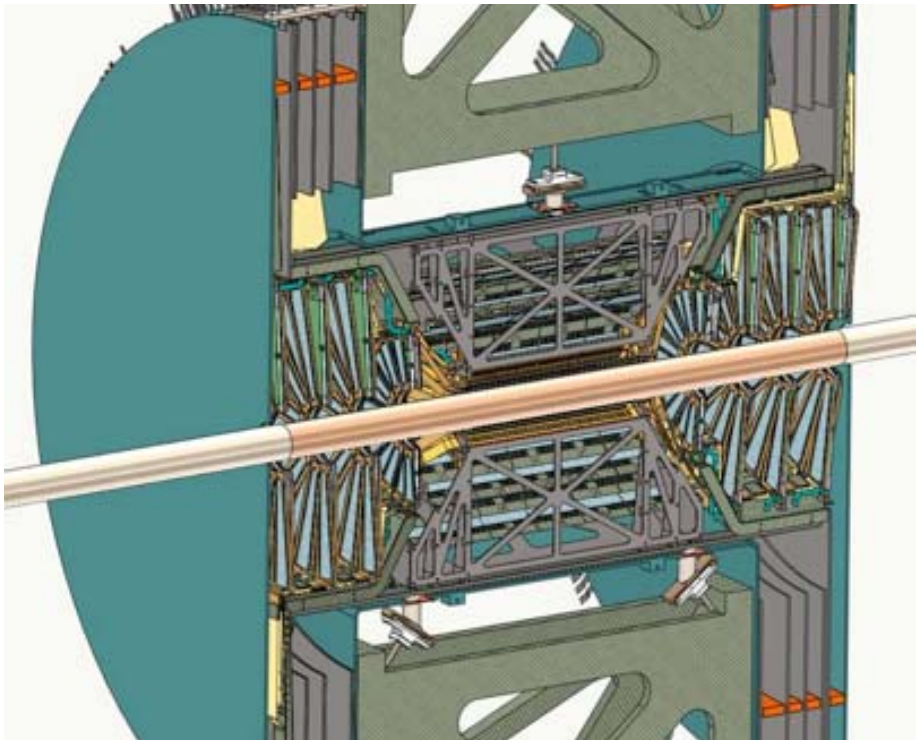
FVTX Project Manager

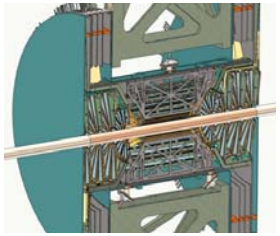


Talk Outline

- Project Overview
- Addressing past Review Questions
- Progress over First 1/2 Year of Construction
- FY09 Technical Plans
- Simulation/Software Plans
- Budget and Schedule Summary
- Day's agenda







Project Start Milestones

FVTX/NCC DOE Science Review July 9-10, 2007

- Additional work to demonstrate scientific feasibility
- Response document produced and submitted to DOE October 8, 2007

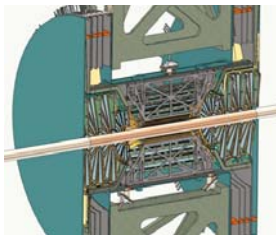
FVTX DOE Technical Review, November 2007

- Recommendations to be addressed at annual review (see later)
- Progress Report submitted to DOE September 2008

Construction Start

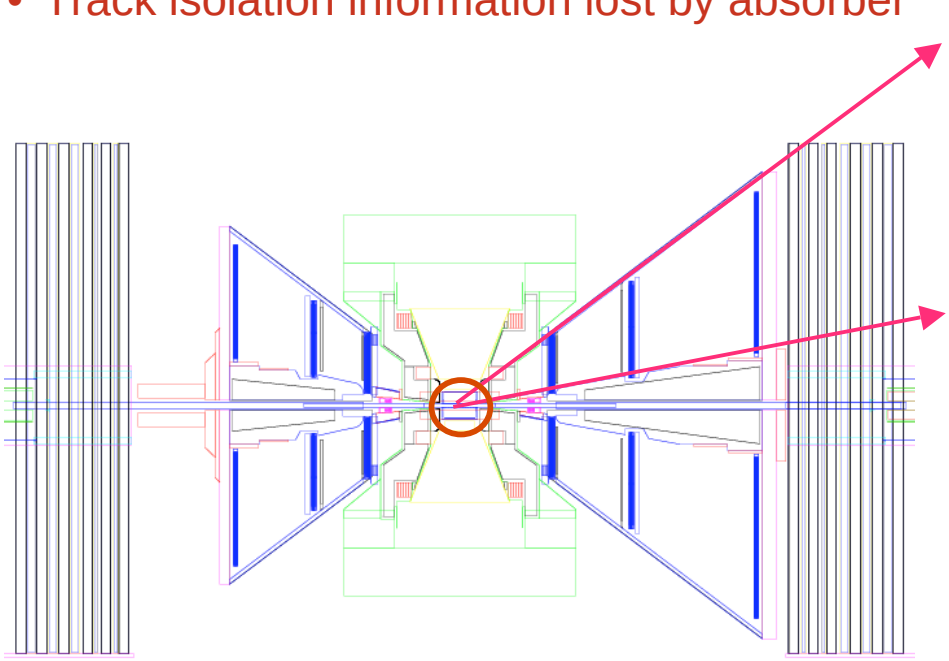
- Management Plan sign-off March 2008
- Construction Funds April 2008 - $500k in FY08

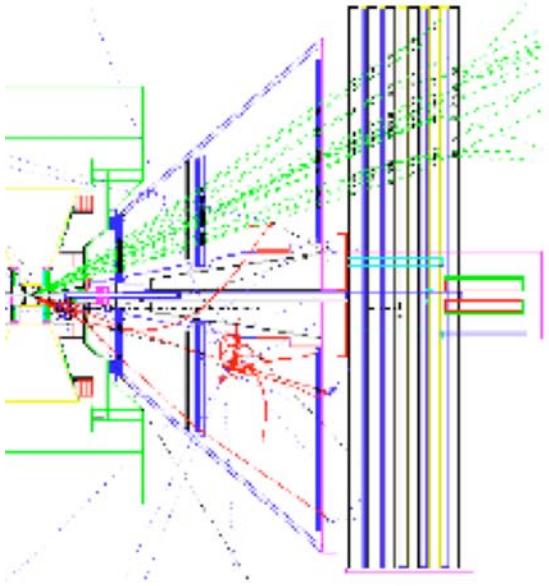
Annual Review - November 2008



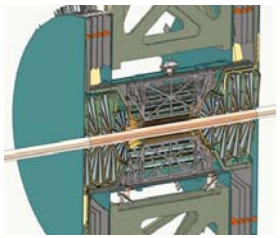
Why an FVTX Detector for Muons?

- Initial absorber to reduce hadrons that reach the active detectors
- Muon Tracking stations inside magnet to find tracks and measure momentum
- Muon Identifier for μ/π separation, Lvl-1 trigger
- ~1% "punch through", ~1% decay into muon before absorber, ~1%*15% decay after the absorber
- No way to discriminate $\pi/K \rightarrow \mu$, $D/B \rightarrow \mu$, π/K punch-through
- Mass resolution limited by absorber
- Track isolation information lost by absorber





Physics Programs Accessible With FVTX
Presented at 2007 Science Review



Single Muons:

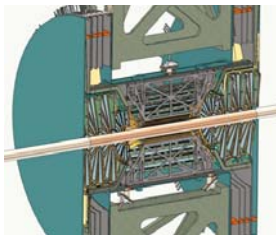
- Precision heavy flavor and hadron measurements at forward rapidity
- Separation of charm and beauty
- W background rejection improved

Dimuons:

- First direct bottom measurement via $B \rightarrow J/\psi$
- Separation of J/ψ from ψ' with improved resolution and S:B
- First Drell-Yan measurements from RHIC
- Direct measurement of c-cbar events via $\mu^+\mu^-$ becomes possible

Physics:

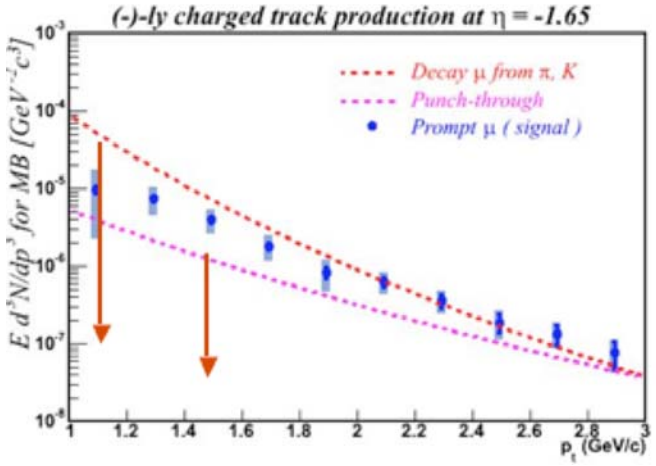
- Advance understanding of energy loss, by adding precise heavy flavor measurements of R_{AA} and flow.
- First detection of ψ' plus heavy quark allow detailed understanding of vector meson production and modification
- Separation/Understanding of Cold Nuclear Matter and QGP effects with rapidity coverage
- Precise gluon polarization and sea quark measurements over large x range, fundamental tests of Sivers functions possible

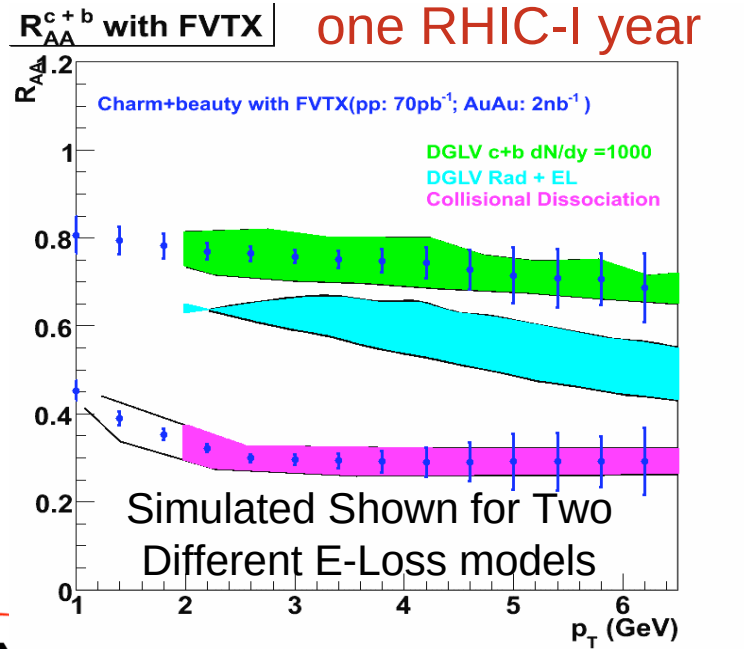


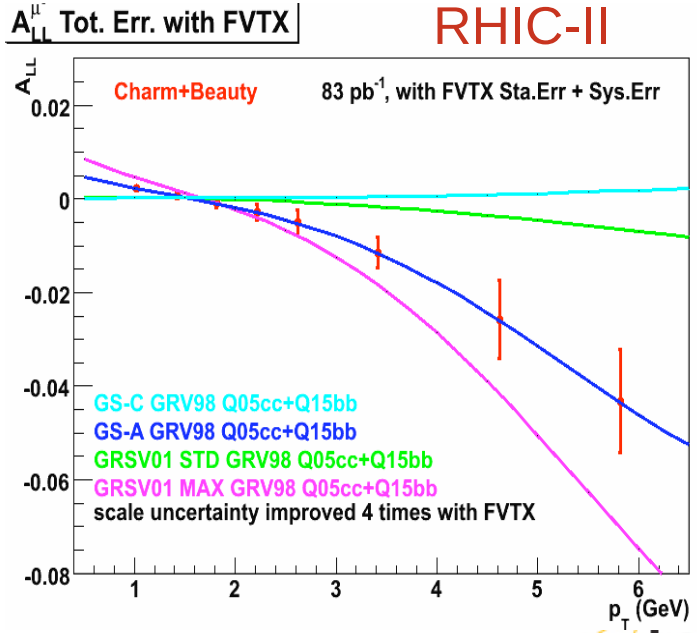
Reminder of Simulated Performance

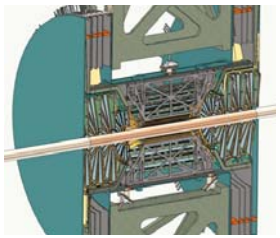
Improved S:B in heavy flavor via single muons allows precision heavy flavor R_{AA}, A_{LL} measurements

(Zhengyun will give software details)





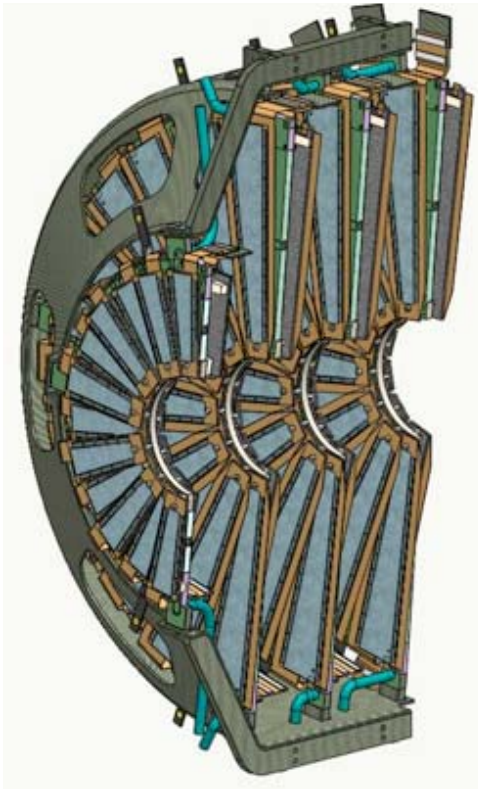


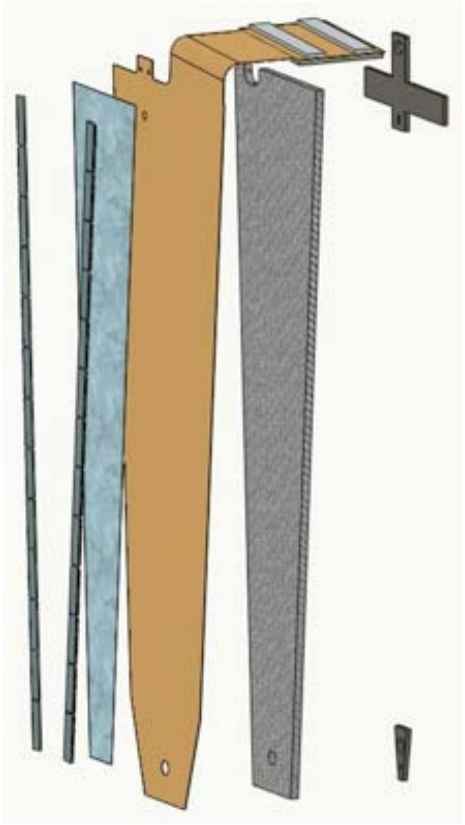


FVTX Geometrical Design

Four tracking stations with full azimuthal coverage

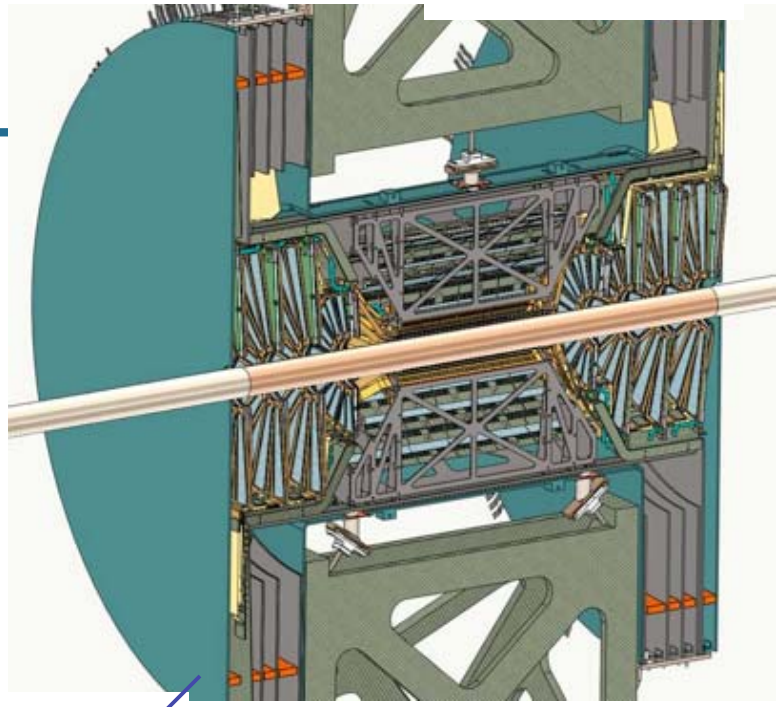
- 75 μm pitch strips in radial direction, 3.75° staggered phi strips
- Radiation length < 2.4%/wedge to minimize multiple scattering
- Outer Support and Cooling outside active area
- Kapton cable plant primarily outside active area

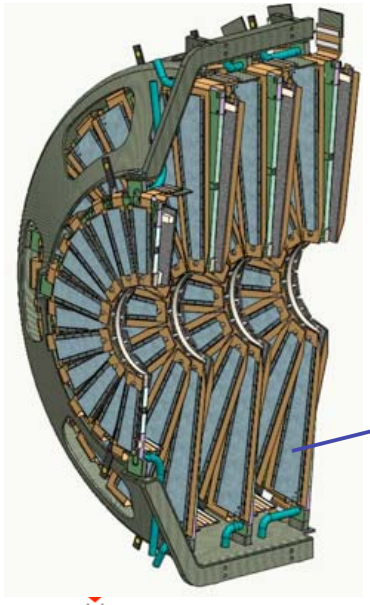


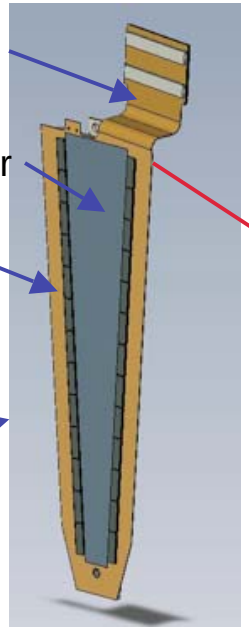


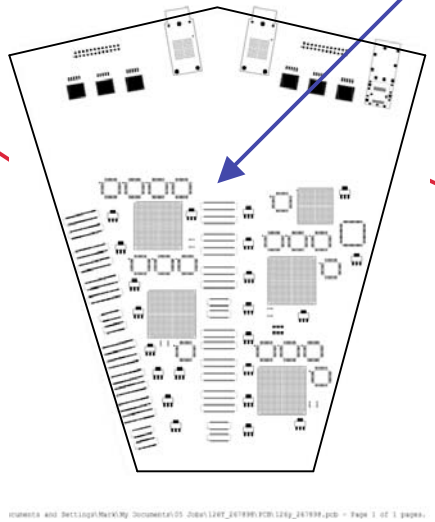
FVTX Electrical Design

- p on n ministrip sensor, 75 μm x 3.75º →
- Data push FPHX readout chip →
- High density interconnect cable →
- ROC (big wheel area in IR) →
- FEM (VME crate in CH) →
- PHENIX DCMs



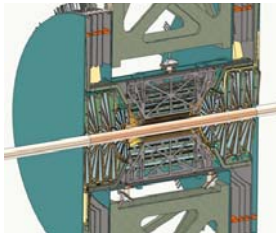






FEM, Counting House

Performance Requirements

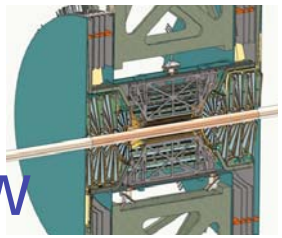


Silicon Sensors - good efficiency and resolution, low noise, minimize radiation length

DAQ - keep up with expected data rates, ability to participate in Lvl-1

Integration into PHENIX - seamless integration into PHENIX data-taking

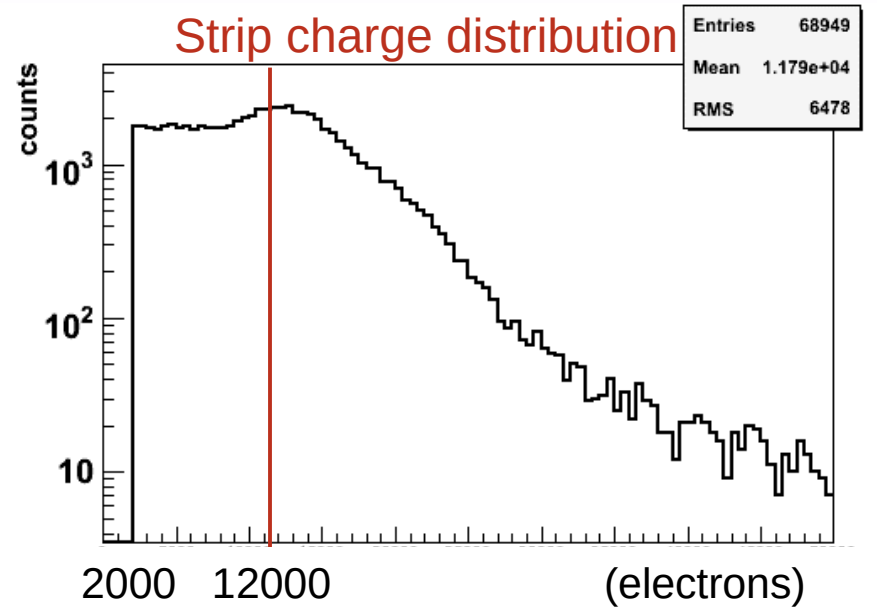
	Minimum Acceptable	Expected Performance
Mini strips active	>90%	>95%
hit efficiency	>95%	99%
Radiation length per wedge	< 2.4 %	1.5%
Detector hit resolution	< 25 μm	~15 μm
Noise hits/chip	<1%	<<1% (thresh:noise=5)
LVL1 latency	4 μs	
LVL1 Multi-Event buffer depth	4 events	
Read-out time	< 40 μs	
Read-out rate	> 10 kHz	



Annual Review Requests from Tech. Review

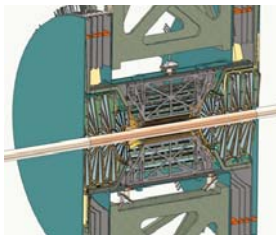
"Prior to the next annual review, perform a detailed study of the trade-offs between noise hit levels, ADC signal thresholds, raw data bandwidth bottlenecks, Level-1 latency and memory requirements, tracking efficiency, and physics performance. Derive a set of "final" functional requirements that the FVTX system needs to satisfy within a reasonable period of time after project completion in order to achieve the physics goals and meet the recommendations expressed in the FVTX Science Review report."

- **Nominal noise = 400 electrons**
- **Nominal threshold = 2000 electrons**
- **Noise rate expected << 0.1% specified < 1%**



Studied resolution and efficiency versus:

- Threshold levels (can we increase thresholds if noise higher than expected?)
- Threshold:noise ratio (can we tolerate more noise hits in the system?)

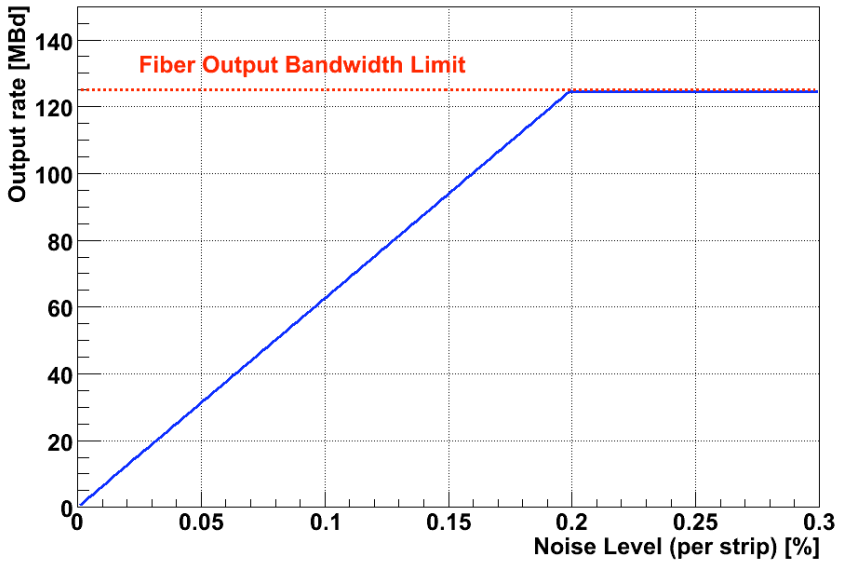


DAQ Bandwidth and Thresholds

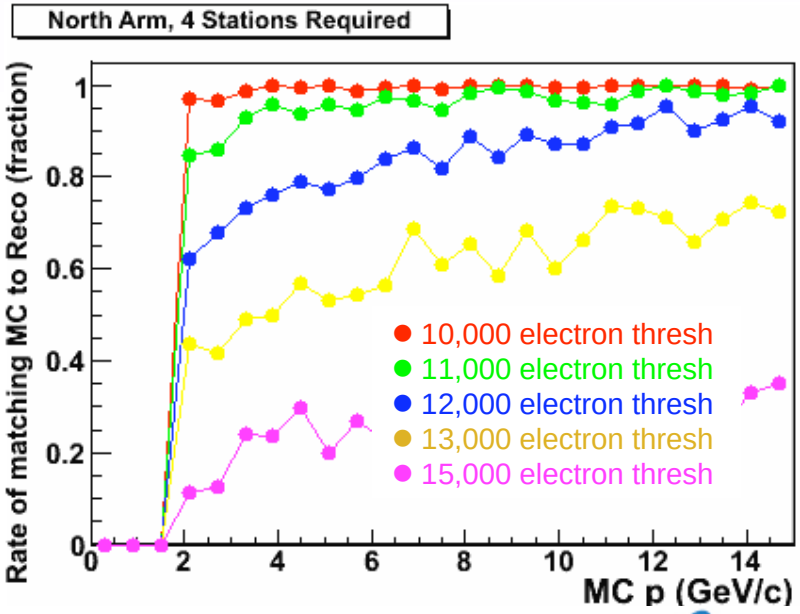
Bandwidth limitations alone → Noise hits should be <0.1% of detector to not saturate DAQ bandwidth (some options to increase this number with more fibers)

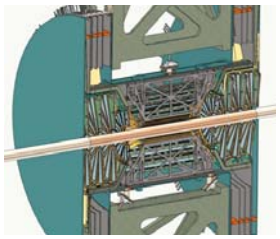
Thresholds can be ~5x nominal and still maintain good efficiency (Nominal threshold = 2000 electrons)

Bandwidth Limitations



Single Tracks Embedded in Au+Au





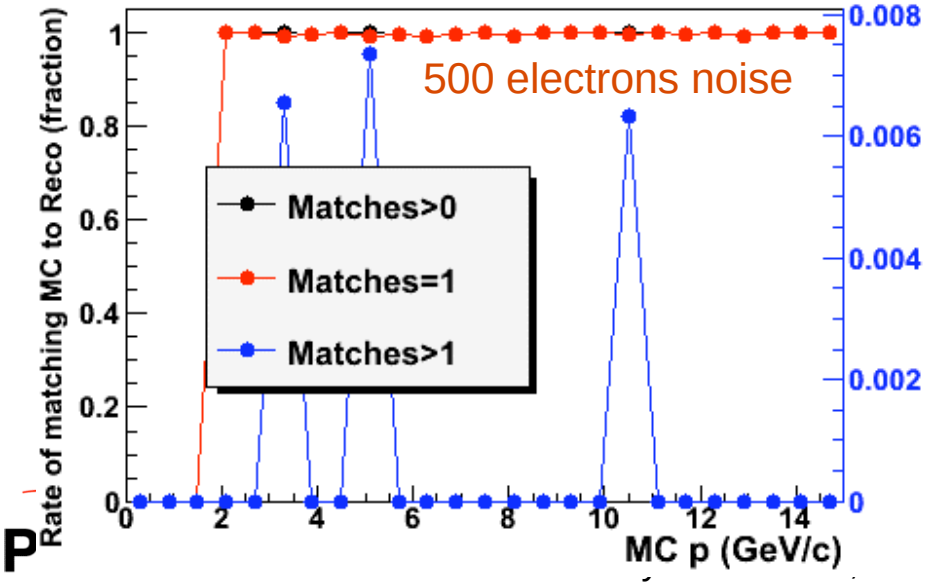
Vary Threshold:Noise

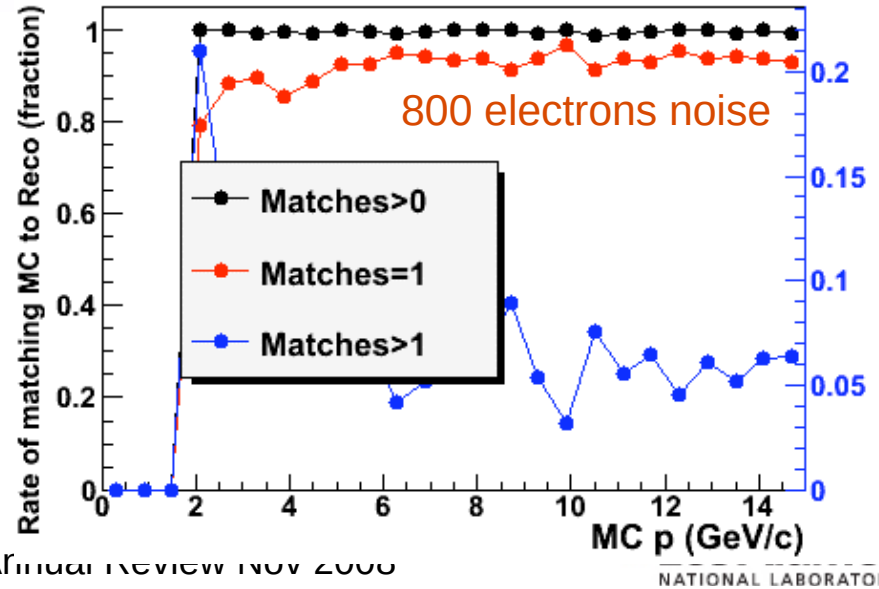
- Nominal threshold:noise of 5:1 gives good efficiency and few ghost tracks, 4:1 ratio still looks good
- Significant number of ghost tracks show up at 2.5:1 level

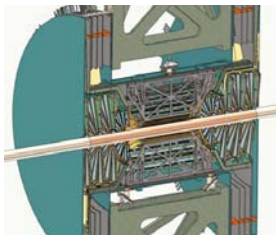
Conclusion - we could tolerate decrease in threshold:noise to 4:1 but not more

This is consistent with not wanting to have too much bandwidth taken up by noise hits too.

Thresholds should be adjusted higher to compensate for noise, rather than allowing threshold:noise to decrease much







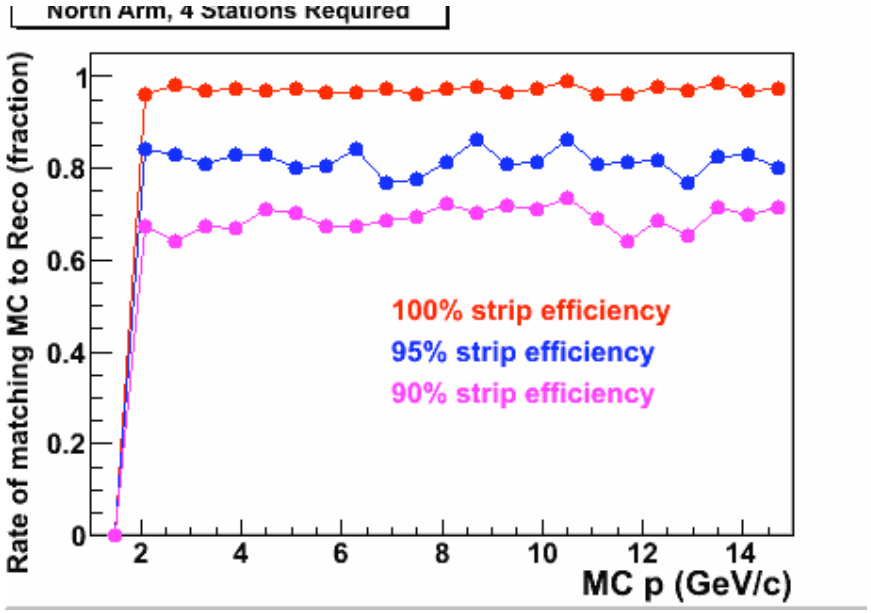
Track Efficiency vs. Detector Efficiency

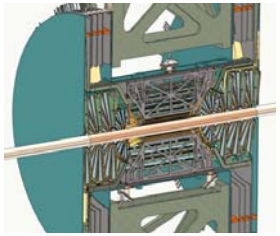
Worst-case scenario - require 4 hits reconstructed

Tracking Efficiency = $\frac{\text{reconstructed tracks with 4 hits}}{\text{tracks that hit 4 stations}}$

~80% of tracks reconstructed with detector efficiency >= 95%

Conclusion - specification of >95% detector efficiency is o.k. to maintain most of our physics signal statistics, and we expect better efficiency if we allow 3-hit tracks.

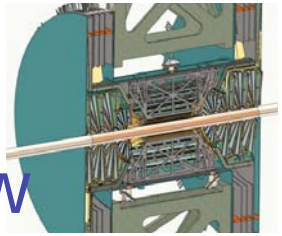




Physics Performance Requirements

- Noise levels can be higher than nominal, but need to maintain approximately nominal threshold:noise ratio.

	Minimum Acceptable	Expected Performance
Mini strips active	>90%	>95%
hit efficiency	>95%	99%
Radiation length per wedge	< 2.4 %	1.5%
Detector hit resolution	< 25 μm	~15 μm
Noise hits/chip	<1% → **<2000 e noise, thresh:noise >= 4**	400 e noise, thresh:noise = 5
LVL1 latency	4 μs	
LVL1 Multi-Event buffer depth	4 events	
Read-out time	< 40 μs	
Read-out rate	> 10 kHz	



Annual Review Requests from Tech. Review

"Documents for technical specifications, testing plans, and procedures should be finalized, approved, and adopted prior to procurement"

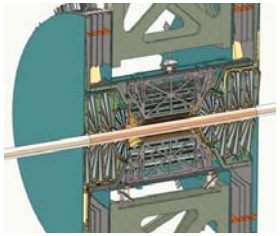
- Documents for sensor, FPHX, HDI, ROC, FEM produced. Some already in the process of being implemented

"A detailed grounding & shielding plan should be developed and reviewed prior to the annual review"

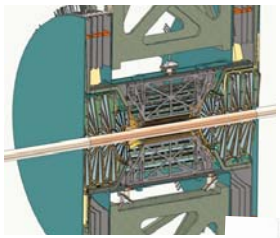
- Grounding & shielding plan produced: collaboration with LANL, Eric Mannel (electronic integration engineer), FPHX designers (FNAL), HDI designers
- Reviewed along with electronics components at August 2008 PHENIX review. Presentation in Electronics Section

"Identify a systems integration manager"

- Project managers provide overall integration, Walt Sondheim mechanical integration, Eric Mannel electrical integration, Robert Pak integration to BNL infrastructure



Project Progress

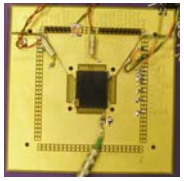


FY08 Progress - Technical

Wedge Components

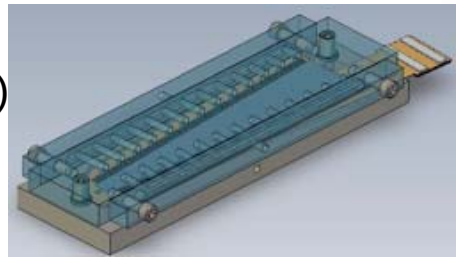
- Prototype sensors procured and delivery expected Oct. 30
- 1st round FPHX chip delivered in August and testing in progress
- HDI layout completed, prototype not in hand yet

FPHX



Detector Assembly

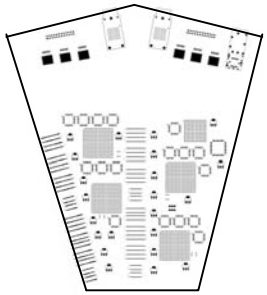
- Wedge assembly prep at FNAL Silicon Fabrication Facility (SiDet)
- Wedge assembly fixtures designed and out for procurement
- Steve Pate working on assembly areas at BNL



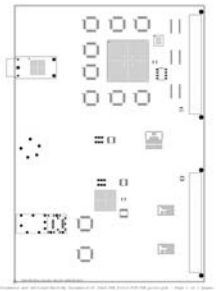
DAQ

- ROC prototype in process of being manufactured
- FEM prototype still needs to go into layout

ROC

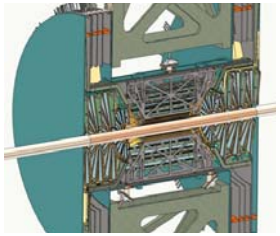


FEM



Mechanics

- Cage, backplane and disk designs completed 1st round



FY08 Progress - Simulations

Software Updates:

- Updated geometry to reflect latest designs (sensors, backplane, VTX material)
- Updated code to import simulation geometry into offline geometry
- Study of physics performance versus detector performance
- Updated cluster fitting to use ADC information
- Continued development of Track Finding software

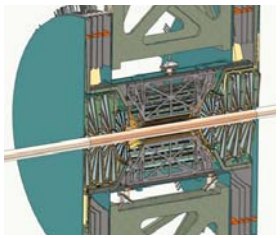
Working toward Blind Analysis to perform full physics analysis on large data set produced by independent group:

- Established blind analysis steps needed
- Fully checked newest geometry through reconstruction
- Converted Nov. 07 analysis codes to work Blind Analysis DSTs
- Event generation beginning now

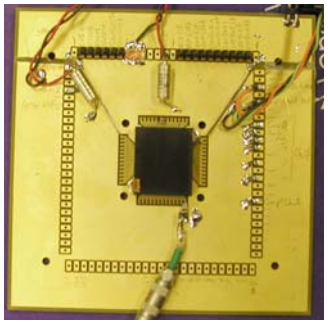
All simulation reconstruction will work on real data

Other future activities:

- Database interface will be handled by Columbia
- Alignment Software - NMSU/LANL

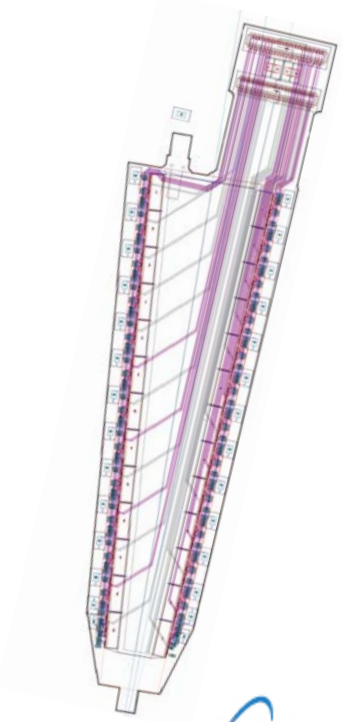


Issues/Concerns



Wedge Components

- Some sensor prototype delayed, but doesn't affect critical path
- HDI prototype now on critical path
- Working with FNAL to ensure FPHX designers available for 2nd round prototype work

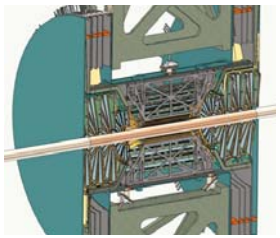


Assembly

- No issues to date

DAQ

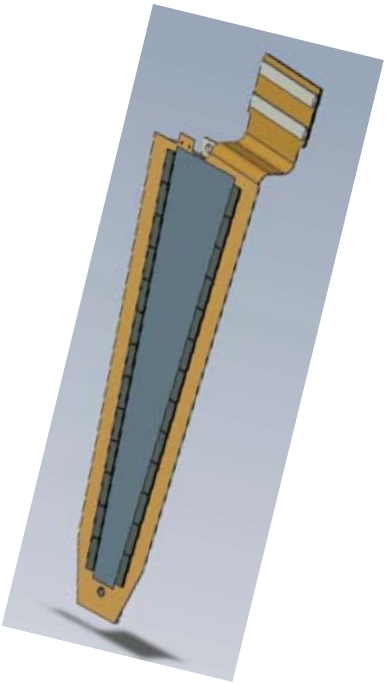
- ROC/FEM delayed, but don't affect critical path



FY09 Plans

Wedge Components and Assembly

- Test prototype sensors and use in prototype wedge assembly (system) tests
- HDI prototype procured and used in prototype wedge assembly tests
- Wedge assembly plan tested out with prototype components and fixtures
- 2nd round FPHX design (currently don't expect major changes from 1st round)
- Continued work to set up SiDet and BNL assembly areas
- Make decision on level of SiDet involvement in wedge assembly



DAQ

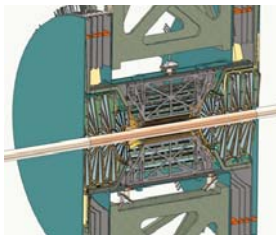
- Test ROC prototype and move to second round prototyping
- Complete and test FEM prototype.

Mechanics

- Procure prototype cage

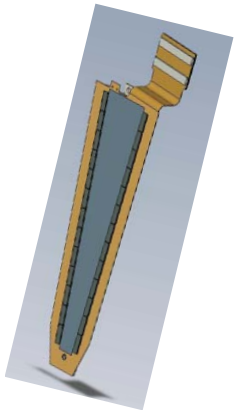
Production Procurements

- Procure production sensors
- Procure production HDIs
- Procure production backplanes and disk

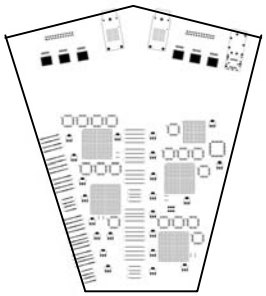


Project Reviews

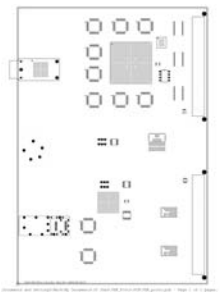
Feb-April 2008	FPHX Design Reviews before prototype submission
August 2008	Overall Electronics Design Review
August 2008	Informal Mechanics Review of Components
Feb 2009	Wedge System test complete - HDI Prototype Review
Feb 2009	Sensor Review before Production
Feb 2009	ROC (+ FEM?) Prototype Review
July 2009	HDI Final Design Review (?)
July 2009	ROC + FEM Final Review
Dec 2009	FPHX Final Review
March 2009	Final Design Review of Mechanical Structures

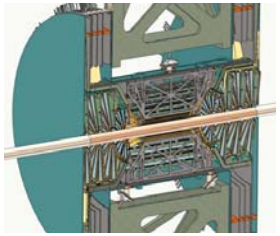


ROC



FEM





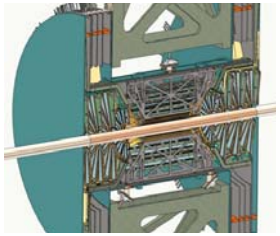
Budget and Schedule Summary

Total Cost Updates ($4.88 baseline), in AY dollars

- Sensor quotes from Hamamatsu - prototype more, production less -->$32k savings
- FPHX - FNAL did not include all overhead in estimates, plus prototyping took longer --> $174k increase, but may need fewer prototypes
- Backplane quote from LBL --> $84k less than baseline project estimate

Current Schedule Expectations - Installed in FY11

- FPHX (critical path) suffered 1.5 month delay in 1st round prototype
- However, tests of chip look very promising - may not need three rounds of prototypes
- HDI prototyping suffered several delays. Now prototype is part of critical path. Production HDIs are not on critical path.
- ROC/FEM prototyping delayed due to lack of funding, but should not effect critical path



Day's Agenda

9:45 – 10:30	Cost & Schedule – Dave Lee
break	
10:45 – 11:15	Simulations - Zhengyun
11:15 – 11:45	WBS 1.4.1, 1.4.2, Sensors/FPHX Readout Chip – Jon Kapustinsky
11:45 – 12:05	WBS 1.4.3 HDI – Doug Fields
lunch	
1:00 – 1:30	WBS 1.5.2, 1.5.3 DAQ Overview – Sergey Butsyk
1:30 – 2:00	WBS 1.5.2, 1.5.3 DAQ Implementation –Mark Prokop
2:00 – 2:20	WBS 1.4, 1.7 Wedge Assembly – Dave Winter
break	
2:30 – 2:50	WBS 1.7 Detector Assembly – Steve Pate
2:50 – 3:10	WBS 1.6 Mechanics -- Walt Sondheim
3:10 – 3:30	WBS 1.8.1 Mechanical Integration -- Robert Pak
3:30 – 3:50	WBS 1.8.2 Electrical Integration – Eric Mannel