MVTX Summary

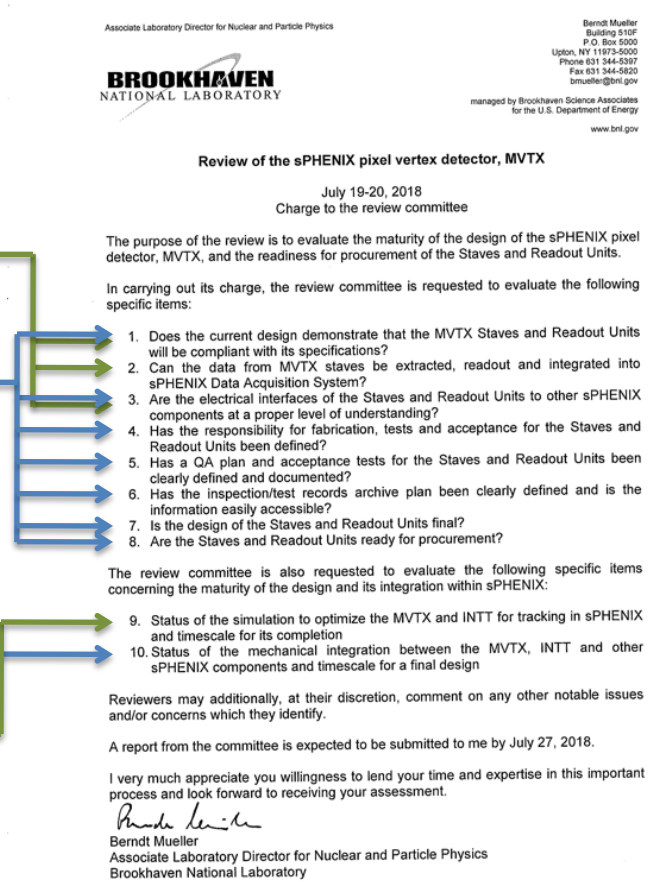
Ming Liu
Los Alamos National Laboratory

MVTX BNL Director's Review

July 19-20, 2018

Summary

- sPHENIX overview – Dave/Gunther
  - Compelling science
- MVTX overview –Ming
  - Status and highlights
- Readout integration – Alex/Sho
  - #1, 2, 3
- Staves – Leo/Grazyna
  - #1, 3, 4, 5, 6, 7, 8
- Readout Units – Jo
  - #1, 3, 4, 5, 6, 7, 8
- INTT overview – Rachid
  - Important for tracking
- Mechanical integration – Walt/Dan
  - #10
- Tracking simulation – Tony
  - #9
- Summary – Ming
  - **YES, we are ready, #1, 8**



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Review of the sPHENIX pixel vertex detector, MVTX

July 19-20, 2018
Charge to the review committee

The purpose of the review is to evaluate the maturity of the design of the sPHENIX pixel detector, MVTX, and the readiness for procurement of the Staves and Readout Units.

In carrying out its charge, the review committee is requested to evaluate the following specific items:

1. Does the current design demonstrate that the MVTX Staves and Readout Units will be compliant with its specifications?
2. Can the data from MVTX staves be extracted, readout and integrated into sPHENIX Data Acquisition System?
3. Are the electrical interfaces of the Staves and Readout Units to other sPHENIX components at a proper level of understanding?
4. Has the responsibility for fabrication, tests and acceptance for the Staves and Readout Units been defined?
5. Has a QA plan and acceptance tests for the Staves and Readout Units been clearly defined and documented?
6. Has the inspection/test records archive plan been clearly defined and is the information easily accessible?
7. Is the design of the Staves and Readout Units final?
8. Are the Staves and Readout Units ready for procurement?

The review committee is also requested to evaluate the following specific items concerning the maturity of the design and its integration within sPHENIX:

9. Status of the simulation to optimize the MVTX and INTT for tracking in sPHENIX and timescale for its completion
10. Status of the mechanical integration between the MVTX, INTT and other sPHENIX components and timescale for a final design

Reviewers may additionally, at their discretion, comment on any other notable issues and/or concerns which they identify.

A report from the committee is expected to be submitted to me by July 27, 2018.

I very much appreciate you willingness to lend your time and expertise in this important process and look forward to receiving your assessment.

Berndt Mueller
Associate Laboratory Director for Nuclear and Particle Physics
Brookhaven National Laboratory

#1: Does the current design demonstrate that the MVTX staves and readout units will be compliant with their specifications?

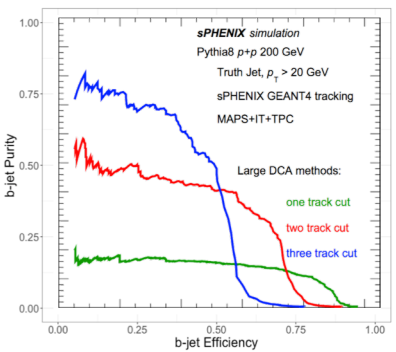
- Yes!
  - Acceptance
  - Readout speed
  - Spatial resolution
  - Hit efficiency
  - Noise and occupancy
  - Radiation tolerance

Presentations from all

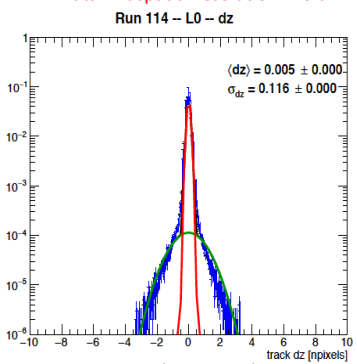
Item	Requirement
Acceptance	Vertex $\|z\|$ <10 cm, $\|\eta\| < 1$, full azimuthal coverage
Readout speed	Matching the sPHENIX DAQ 15 kHz event trigger rate
DCA resolution	$< 50\ \mu$m for charged pions at p_T =1 GeV/c
Tracking efficiency	$> 80\%$ efficiency for charged pions at p_T =1 GeV/c in the 10% most central Au+Au collisions

Table 1: Summary for the vertex detector requirements

Simulation: Excellent b-jet tagging

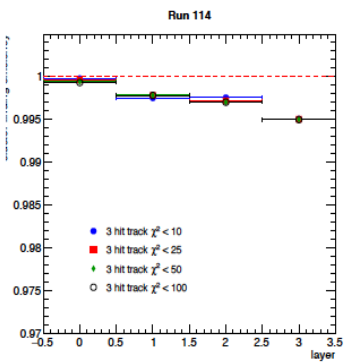


Data: Hit spatial resolution: < 5 um

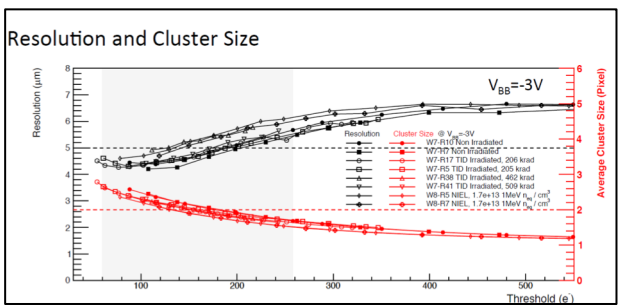


Pixel size (~28um)

Data: Hit efficiency > 99.5%



Data: Impacts of radiation

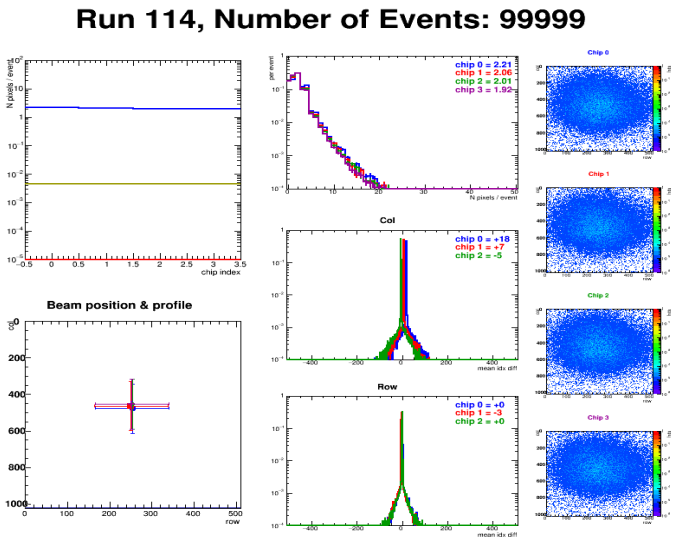


#2: Can the data from MVTX staves be extracted, readout and integrated into sPHENIX DAQ?

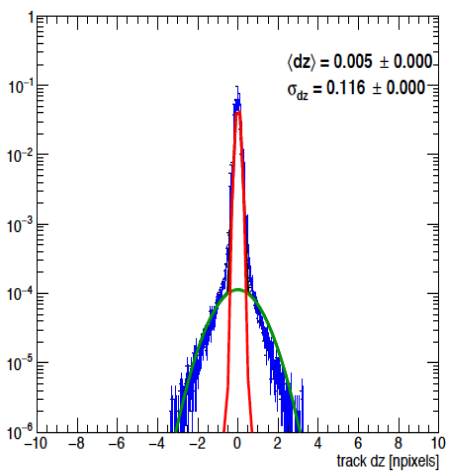
Sho, Alex, Jo

- Yes!
  - Test beam online monitoring and data analysis have been carried out in the sPHENIX online and offline framework

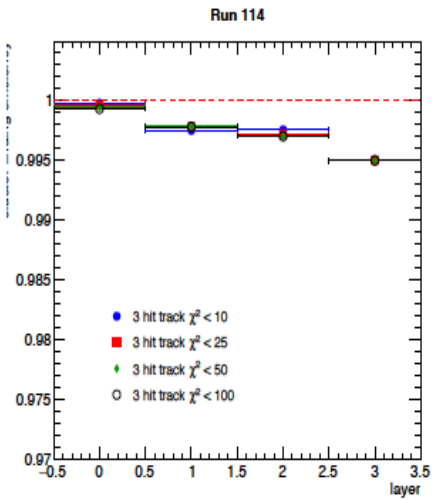
Online display:



Hit Spatial Resolution: < 5 um



Hit Efficiency > 99.5%

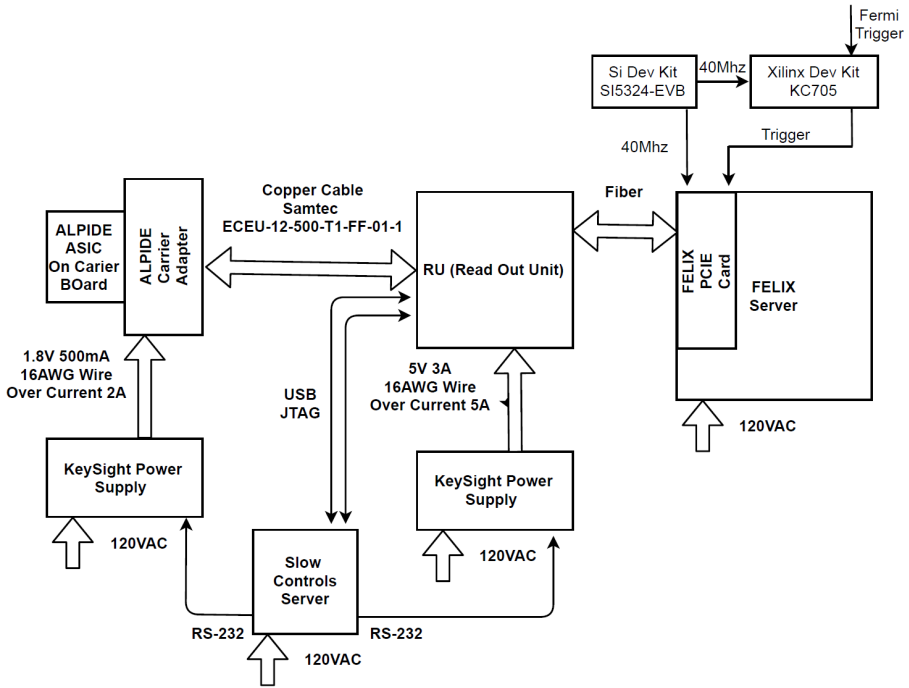


Pixel size (~28um)

#3: Are the electrical interfaces of the Staves and Readout Units to other sPHENIX components at a proper level of understanding?

Sho, Alex, Jo

- Yes!
  - We have exercised the full readout chain and controls at Fermilab test beam

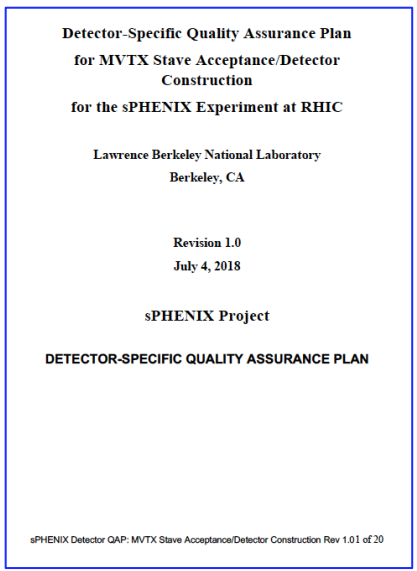


#4, Has the responsibility for fabrication, tests and acceptance for the Staves and Readout Units been defined?

Leo & Jo

- Yes!
  - ALICE/CERN will produce staves and RU for sPHENIX.
  - sPHENIX/MVTX group will perform the acceptance test and QA in US.

L3: Grazyna Odyniec/LBNL



Detector-Specific Quality Assurance Plan

for MVTX Stave Acceptance/Detector Construction

for the sPHENIX Experiment at RHIC

Lawrence Berkeley National Laboratory
Berkeley, CA

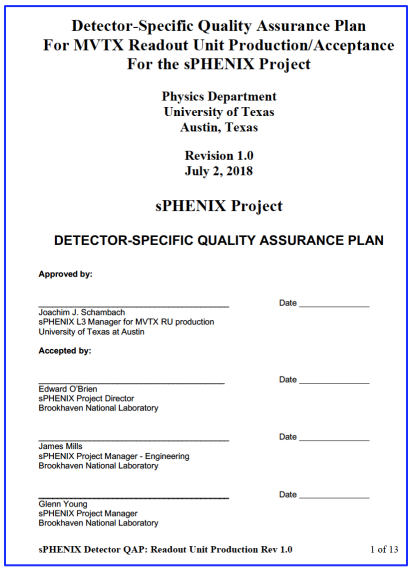
Revision 1.0
July 4, 2018

sPHENIX Project

DETECTOR-SPECIFIC QUALITY ASSURANCE PLAN

sPHENIX Detector QAP: MVTX Stave Acceptance/Detector Construction Rev 1.01 of 20

L3: Joachim J. Schambach/UT-Austin



Detector-Specific Quality Assurance Plan
For MVTX Readout Unit Production/Acceptance
For the sPHENIX Project

Physics Department
University of Texas
Austin, Texas

Revision 1.0
July 2, 2018

sPHENIX Project

DETECTOR-SPECIFIC QUALITY ASSURANCE PLAN

Approved by:

Joachim J. Schambach
sPHENIX L3 Manager for MVTX RU production
University of Texas at Austin
Date

Accepted by:

Edward O'Brien
sPHENIX Project Director
Brookhaven National Laboratory
Date

James Mills
sPHENIX Project Manager - Engineering
Brookhaven National Laboratory
Date

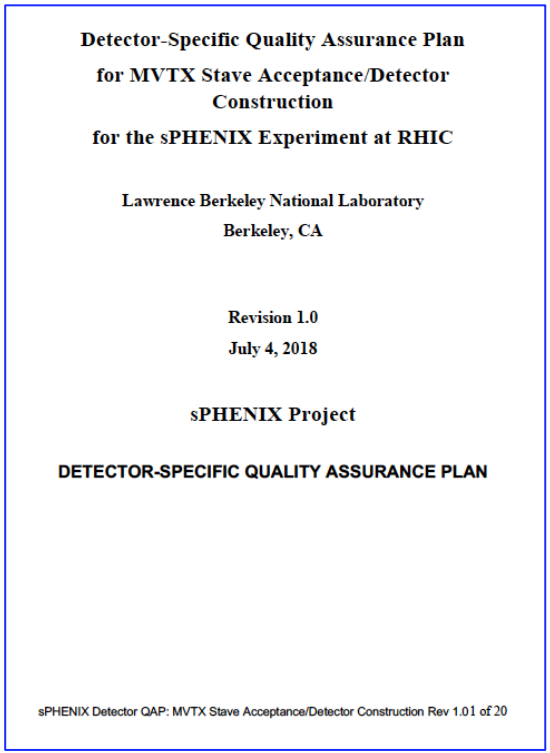
Glenn Young
sPHENIX Project Manager
Brookhaven National Laboratory
Date

sPHENIX Detector QAP: Readout Unit Production Rev 1.0 1 of 13

#5, Has a QA plan and acceptance tests for the Staves and Readout Units been defined?

- Yes!
  - Both stave and RU QAP documents are available.

Leo & Jo



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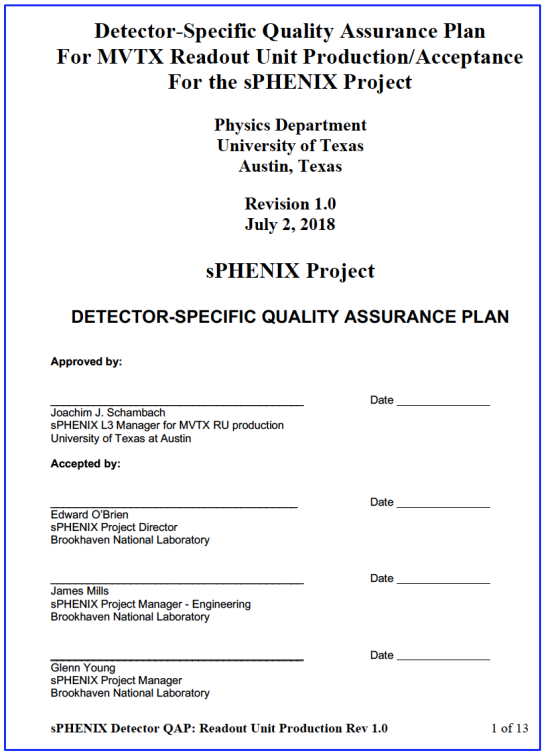

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Austin, Texas

Revision 1.0
July 2, 2018

sPHENIX Project

DETECTOR-SPECIFIC QUALITY ASSURANCE PLAN

Approved by:

_____ Date _____
Joachim J. Schambach
sPHENIX L3 Manager for MVTX RU production
University of Texas at Austin

Accepted by:

_____ Date _____
Edward O'Brien
sPHENIX Project Director
Brookhaven National Laboratory

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James Mills
sPHENIX Project Manager - Engineering
Brookhaven National Laboratory

_____ Date _____
Glenn Young
sPHENIX Project Manager
Brookhaven National Laboratory

sPHENIX Detector QAP: Readout Unit Production Rev 1.0 1 of 13

#6, Has the inspection/test records archive plan been defined and is the information easily accessible?

- Yes!

Leo & Jo

Follow the same QA procedures being used for ALICE ITS/IB production at CERN

- Use ALICE DB for initial sPHENIX production
- Move to sPHENIX DB later when available

Parameter	Gold	Silver	Bronze	Not working/ No back bias	
Iddd clocked	500 to 850 mA	otherwise	-	--	➔ Power Test
Idda clocked	120 to 250 mA	otherwise	--	--	
Ibb @ 3V	Up to 10 mA	otherwise	--	--	
Max. bias voltage	4V	--	--	Otherwise	
FIFO errors	0	--	--	Otherwise	➔ FIFO Test
FIFO exceptions	0	--	--	Otherwise	
Timeouts	0	-	-	Otherwise	➔ Digital Scan
Corrupt events	0	-	-	Otherwise	
Bad pixels per chip	< 50	< 2100	< 5243	Otherwise	
Pixels without threshold per chip	< 5243	< 26214	< 52429	Otherwise	➔ Threshold Scan
Dead pixels per chip	< 50	< 2100	< 5243	Otherwise	
Average HIC noise	< 10 e	Otherwise	--	--	
Deviation of chip threshold	< 20%	< 30%	Otherwise	--	
Threshold RMS	< 30 e	--	Otherwise	--	
Threshold RMS / Threshold mean	< 0.3	--	< 0.5	Otherwise	

An example from ALICE ITS stave electrical QA characterization

#7: Is the design of the Stave and Readout Units final?

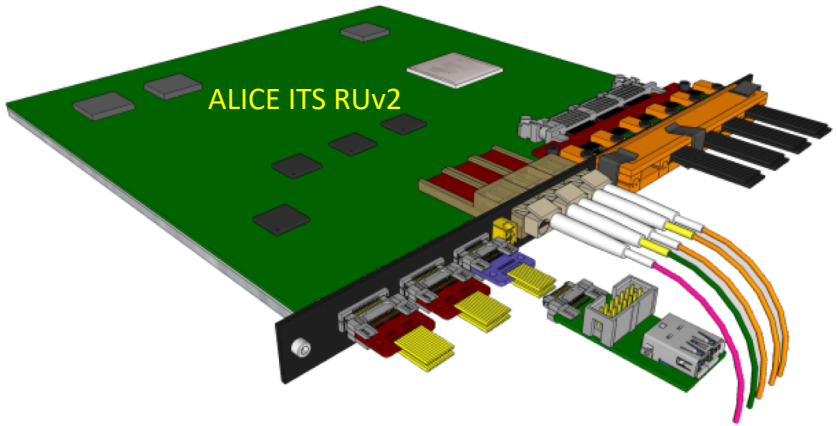
Leo & Jo

Stave: Yes!

- Minor modification of power extension cable for FPC, MVTX 35cm cables (ALICE, 15cm)
- ALICE ITS/IB staves production in progress

RU: Yes!

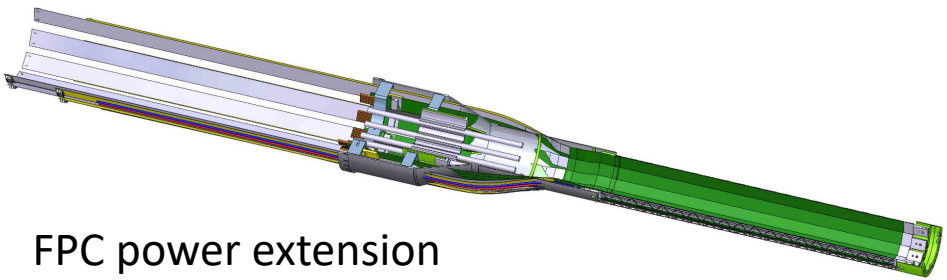
- Pre-production boards (v2.0) being tested at CERN
- ALICE ITS RU production follows after the test.



#8, Are the staves and readout units ready for procurement?

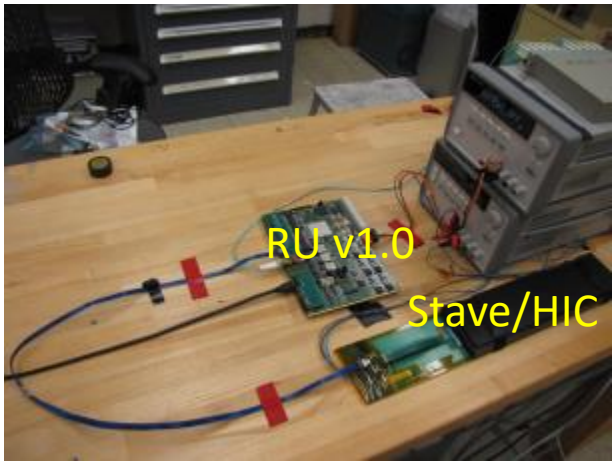
Leo, Jo, Walt

- Staves: Yes!
  - High-speed line, no change
  - Longer (15cm ->35cm) power extension cables, Prototype power extension cables produced at LANL for testing.
- RU: Yes!
  - Once the final v2 pre-production boards pass the test, full production will proceed
  - RU v1 meets readout integration requirements



FPC power extension for MVTX

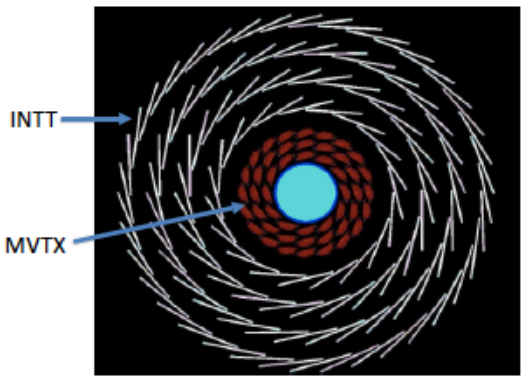
Sensor barrel

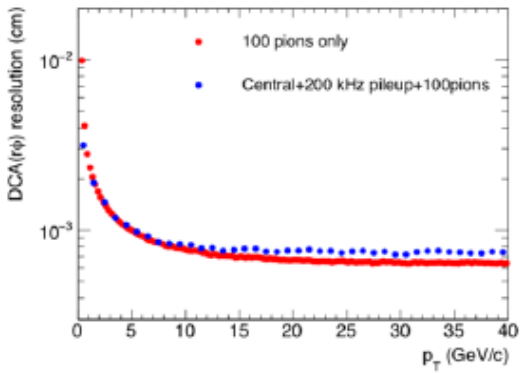


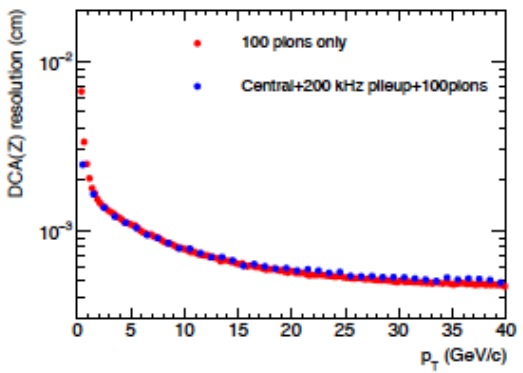
#9, Status of the simulation to optimize the MVTX and INTT for tacking in sPHENIX and timescale for its completion

Tony, Dave & Gunther

- All essential sPHENIX simulation tools are available to verify tracking performance with various layers of INTT configurations
- A simulation task force formed, with charge and targeted due date







#10, Status of the mechanical integration between the MVTX, INTT and other sPHENIX components and timescale for a final design

Walt & Dan

- sPHENIX Office of System Integration coordinates integration effort
- Significant progress on the integration in the past few months - the integration issues of inner tracking system appear manageable
- Detailed 3-D models being developed, a physical mock-up to confirm the final design