

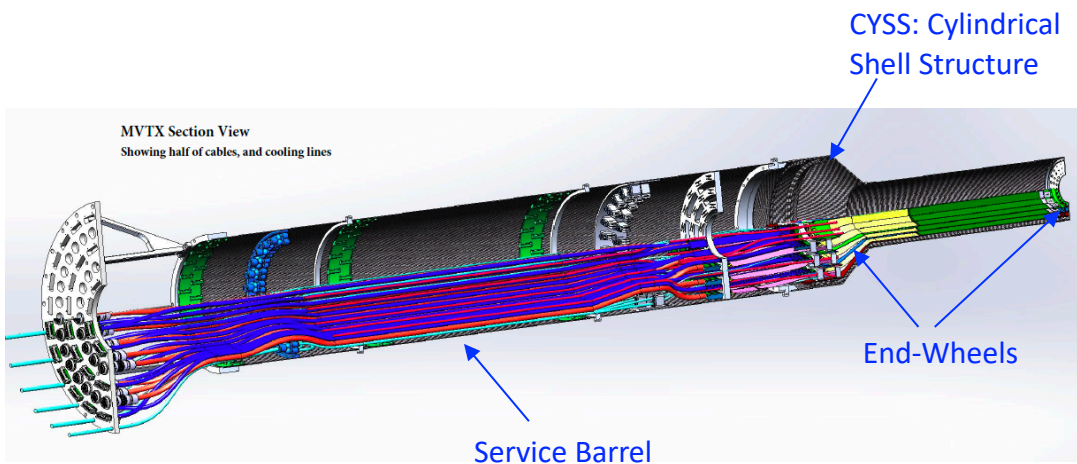
MVTX Final Design Review: Overview

Ming Liu (LANL)

Camelia Mironov (MIT) and Grazyna Odyniec (LBNL)

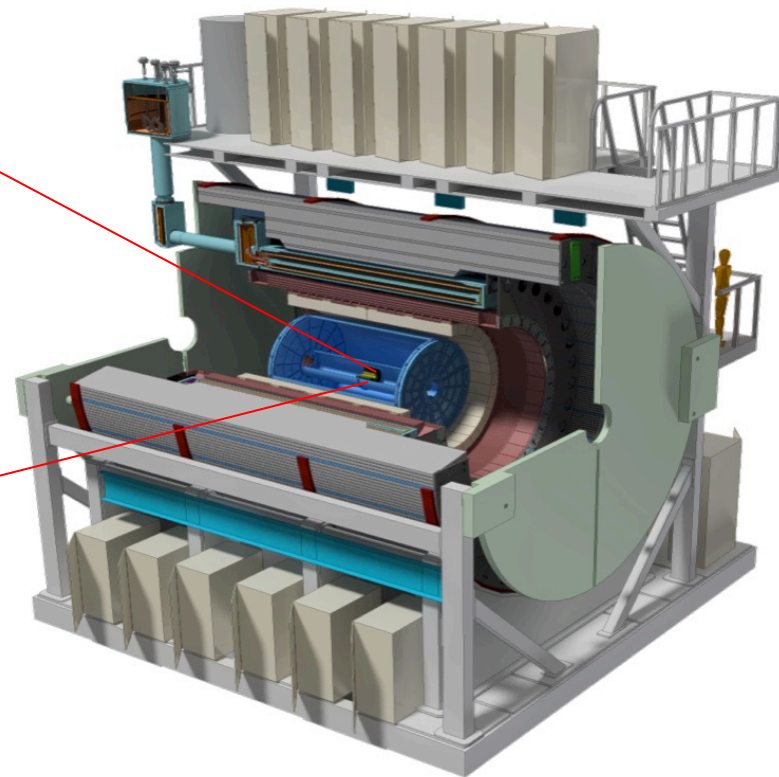
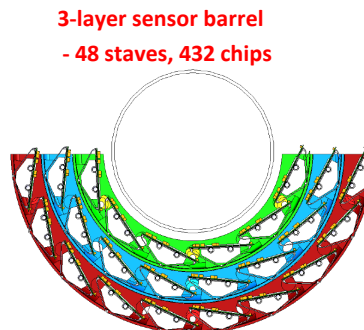
January 29th, 2020 @BNL

MVTX Detector – “Adapted” from ALICE ITS Design



MVTX parameters: L = 271 mm

R (mm)	min	mid	max
Layer 0	24.61	25.23	27.93
Layer 1	31.98	33.35	36.25
Layer 2	39.93	41.48	44.26



Scope of the MVTX Project – WBS 3.02

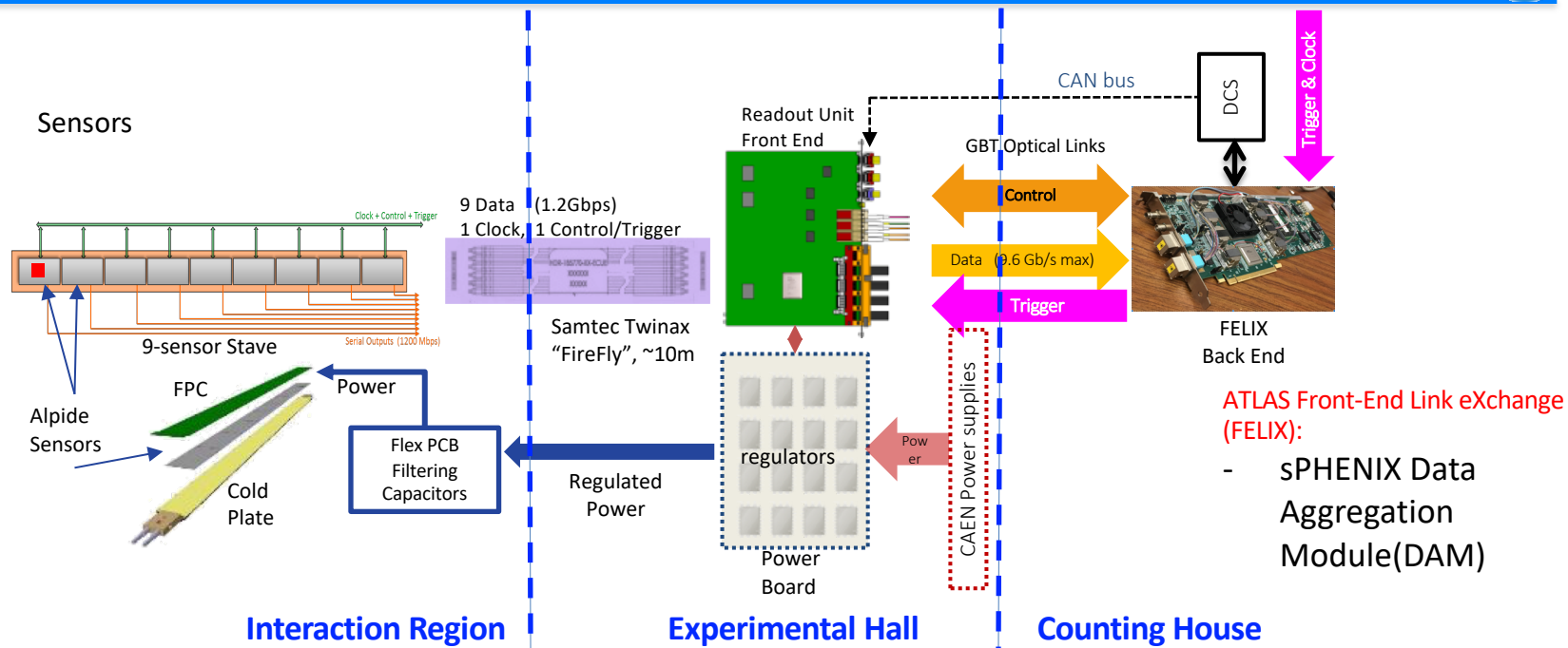


- Mechanical system (3.02.03, 3.02.04)
 - **MVTX detector mechanical structures**
 - Design & simulations
 - End Wheels
 - Cylindrical support structure
 - Service barrels
 - **Mechanical system integration**
 - Service barrel support & interface to sPHENIX
 - Installation tooling etc.
 - Adopt ALICE cooling parameters
 - Detector safety
 - **Detector assembly**
 - Stave QA & detector assembly @LBNL
- Electronics (3.02.02)
 - **Readout Integration**
 - RU QA & assembly @UT-A
 - Backend: ATLAS FELIX
 - FELIX boards @LANL/BNL
 - Frontend RU services: daughter cards, transition boards, cables etc.
 - **Ancillary systems - “adopt” ALICE ITS system**
 - Power, slow control & monitoring etc.

BNL provides Staves & RUs, w/o cost to MVTX project:

- 84 ALICE/ITS-IB (modified) staves from CERN;
48+spares(2-inner layers+10%)
- 60 ALICE/ITS-RU from CERN
48+spares(12, 25%)

All Sensors and Readout Electronics Tested



84 staves in production at CERN
complete in 2020

60 RUs produced;
PUs ready for production

8 FELIX to be produced
with TPC in 2020

ATLAS Front-End Link eXchange
(FELIX):

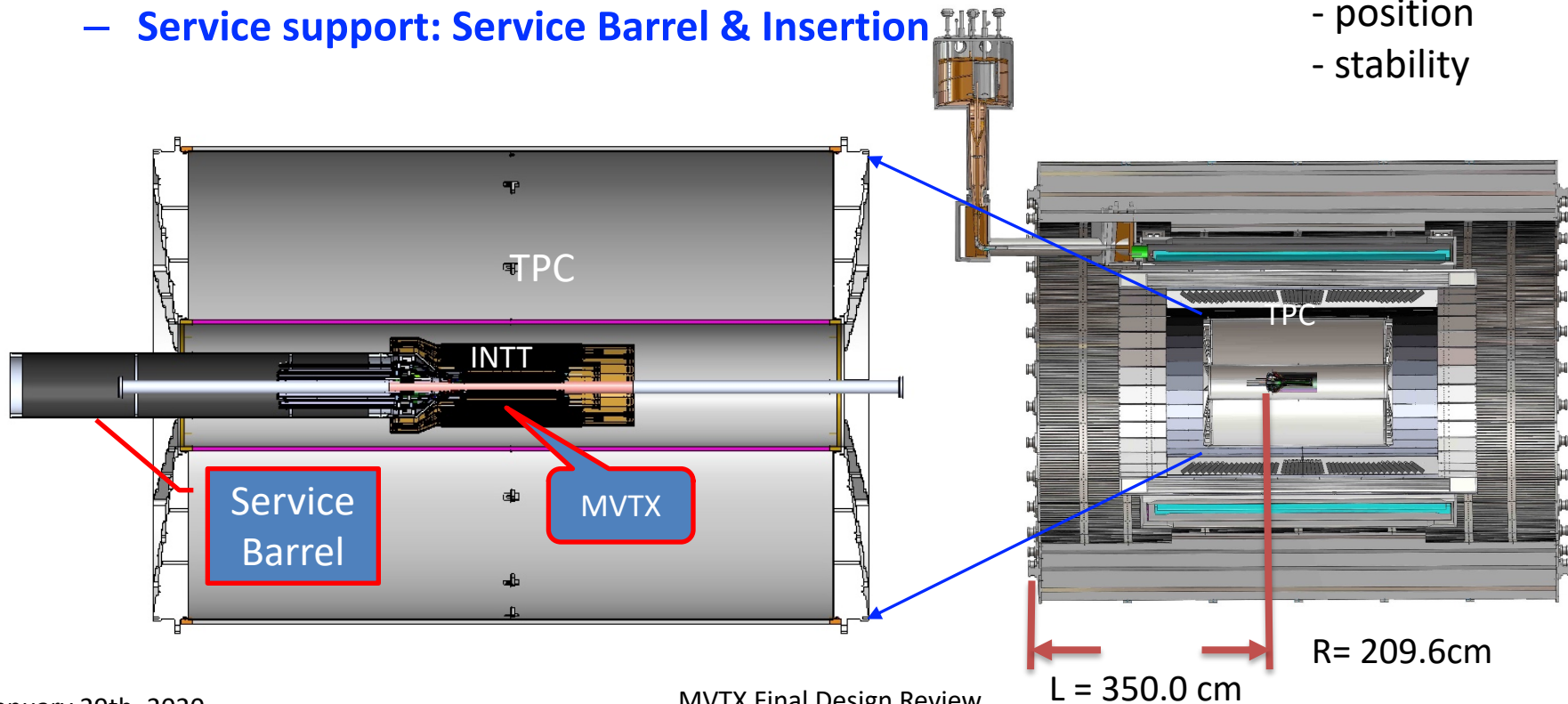
- sPHENIX Data Aggregation Module(DAM)

MVTX Mechanical System & Integration

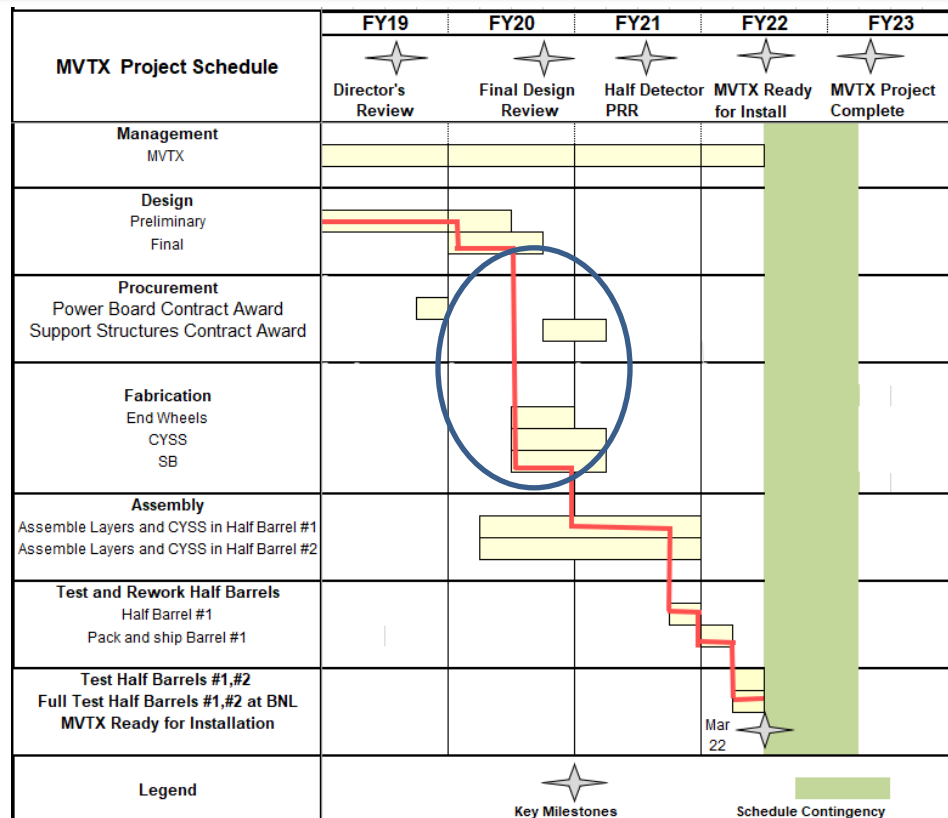
- MVTX system preliminary design, with two parts:

- **Detector sensor support: CYSS & End Wheels**
- **Service support: Service Barrel & Insertion**

- low mass
- position
- stability



MVTX Project Schedule



From MVTX PMP

Near term critical activities:

- Carbon structure test production
- Qualify vendor(s)
- Full production starts in Fall 2020
- Power Units production

From BNL:

- 60 Readout Units produced;
- 84 sensor staves in production, finish in 2020

Figure 2: Baseline critical path and early completion schedule of the MVTX project

MVTX Status and Plan

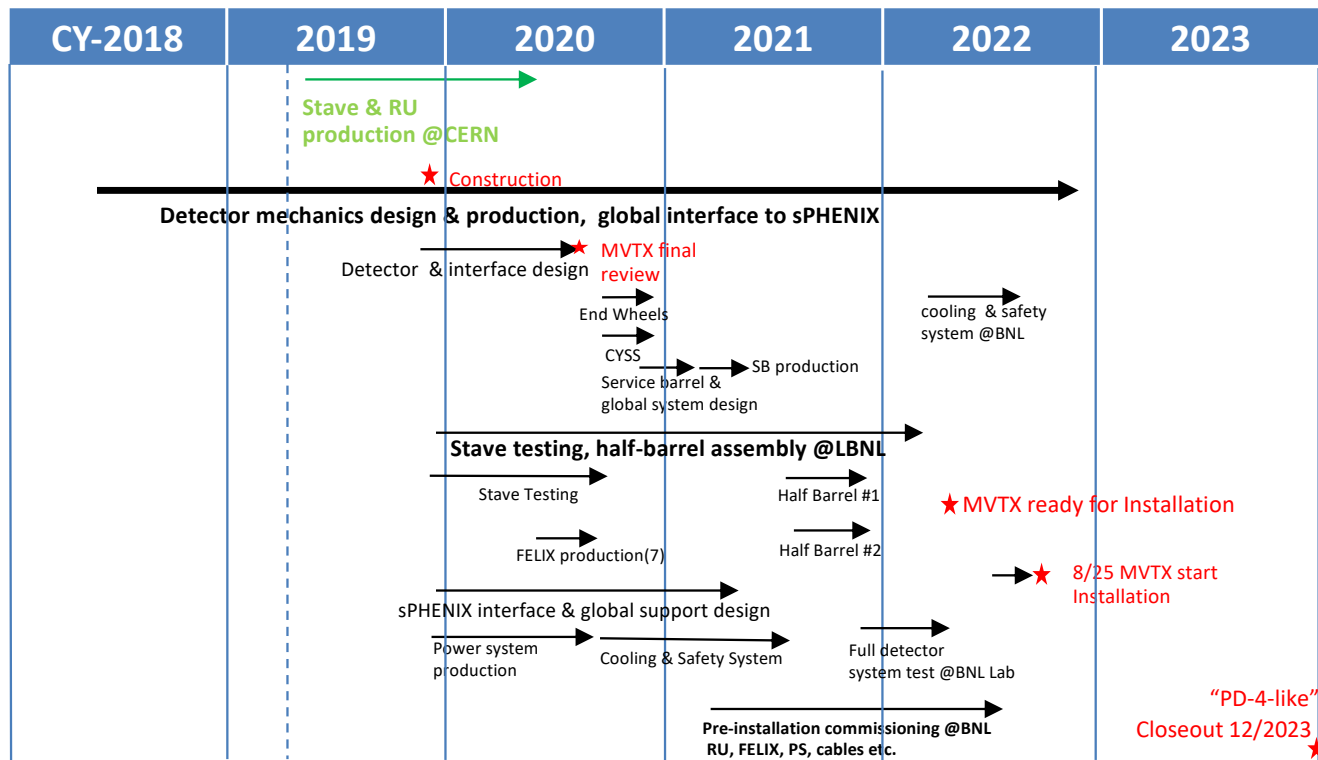


- MVTX detector mechanical support & integration
 - **Sensor support, CYSS & End Wheels** Jason, Jim, Joe, Walt's talks
 - **Services Barrel and global integration**
 - **Our plan:**
 - Test production -> vendor selection -> full production -> build MVTX
- MVTX sensor & readout system
 - Power Units and Cooling plates Jo, Yuan's talks
 - **Ready for production now**
 - 8 Backend FELIX to be produced in 2020
 - sPHENIX production, TPC + MVTX

Backup slides

Schedules & Milestones (July 2019)

- Technically driven schedule
 - Day-1 physics
 - CERN production
 - Fund available as needed
- Funding delay
 - R&D
 - Production
 - Preparation
- Low schedule contingency
- Early R&D by LANL LDRD



MVTX High Level Cost

WBS	Level 2 WBS Description	Burdened AY\$ labor	Burdened AY\$ M&S	Burdened AY\$ Total
3.02.01	MVTX Project Management	\$498.8k	\$46.8k	\$544.6k
3.02.02	MVTX Electronics	\$211.2k	\$358.4k	\$569.6k
3.02.03	MVTX Mechanics and Detector Assembly	\$1241.6k	\$667.0k	\$1908.6k
3.02.04	MVTX Integration and Installation	\$456.8k	\$416.5k	\$873.3k
	Total	\$2187.8k	\$1500.6k	\$3688.5k

MVTX Carbon Structure Cost(July 2019)

	WBS	Cost (K)	Contingency	Basis
End Wheels	03.02.02 Line 143	\$311	40% 60%	Previous experience
Cylindrical Structure	03.02.03.01 Line 158	\$201	40%	Previous experience
Service Barrel	03.02.03.02 Line 169	\$266	40%	Previous experience

Changed to 60%,
following review
recommendations

MVTX Milestones and Key Tasks



Table 5 Milestones and Key Tasks:

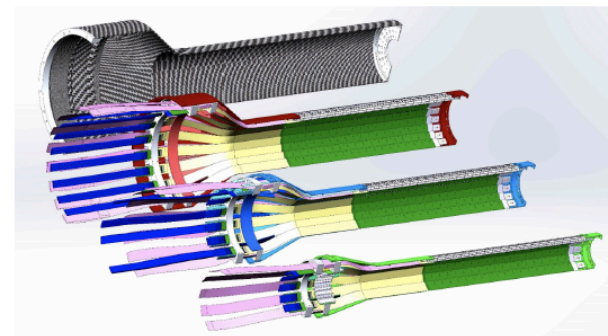
Milestone	Date
Project Start	December 2019
Preliminary Design of the MVTX Detector	March 2020
Power Board Production Contract Award	April 2020
End Wheel, CYSS and SB Design Complete	June 2020
Start Test and Rework Staves – Batch 1	July 2020
Insertion Mock-up Ready	August 2020
MVTX Final Design Review	September 2020
Samtec Readout Cable Contract Award	November 2020
Complete End-Wheels Fabrication	January 2021
Complete CYSS Fabrication	February 2021
Complete SB Fabrication	March 2021
Support Structure Production Start	April 2021
Test Installation of Staves onto End-Wheels	May 2021
Half-Detector Assembly Review	July 2021
Perform Half-Detector Metrology on Layers	September 2021
Assemble Layers and CYSS into Half-Barrel #1	October 2021
Assemble Layers and CYSS into Half-Barrel #2	November 2021
Test and Rework Half-Barrel #1	December 2021
1 st Half Barrels Assembled	February 2022
2 nd Half Barrels Assembled	March 2022
Test Half Barrels at BNL	April 2022
MVTX ready for Installation	June 2022
Approve Project Complete	May 2023

MVTX PMP

Project Management Plan

Yes.

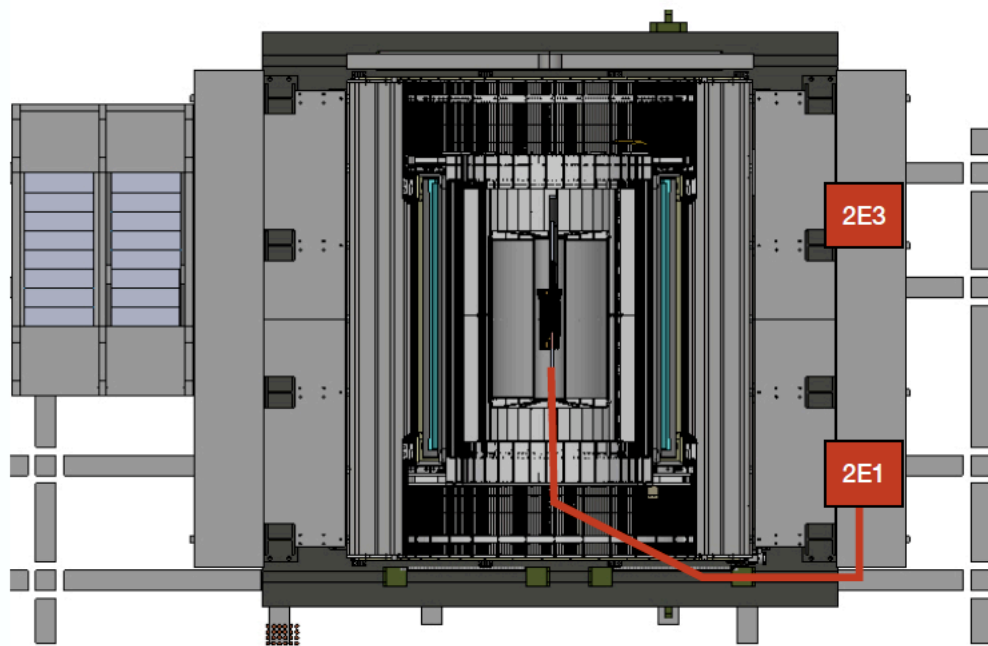
- Draft PMP document completed
 - **Project baseline**
 - Physics
 - Functional requirements/KPP
 - Technical scope
 - Cost breakdown
 - Schedule
 - Funding profile
 - Planned BNL funding
 - Baseline change control
 - **Management structure**
 - Organization and team
 - Management responsibilities
 - Participating institutions
 - **Project management and oversight**
 - Risk management
 - Project reporting
 - Engineering and technology readiness
 - Quality assurance and configuration/document management
 - Operation readiness plan
 - ESSH plans and fabrication
 - Project closeout
- Project fully integrated into sPHENIX P6
 - **Costs, schedules and risk register**



**Management Plan
for
A Monolithic-Active-Pixel-Sensor-based Vertex Detector
(MVTX) Upgrade for the sPHENIX Experiment
at the
Brookhaven National Laboratory
July 22, 2019**

Deliver MVTX on schedule/budget for day-1 physics!

Long Custom MVTX Readout Cables Tested



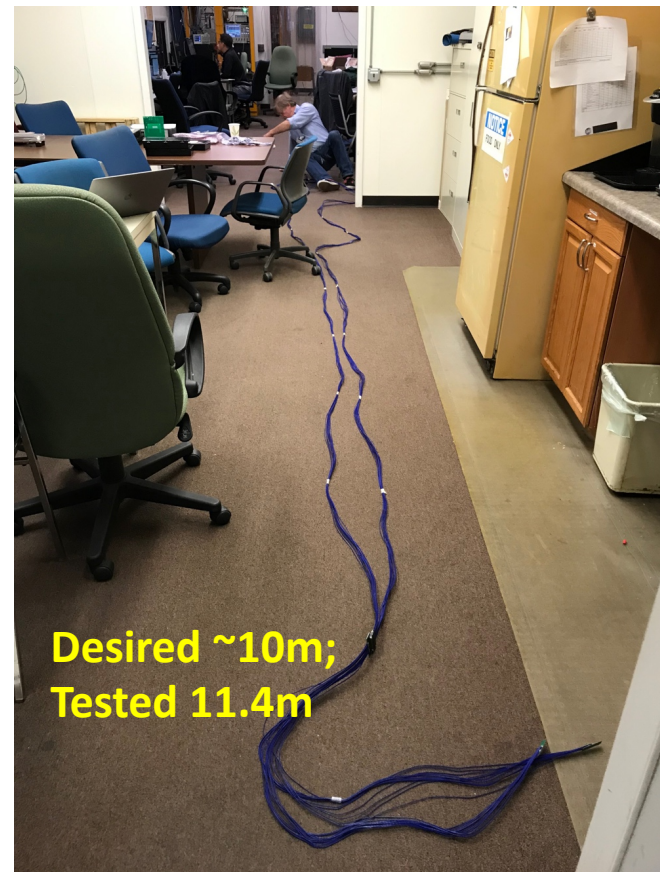
BNL has approved “non-halogen free” cables for sPHENIX

sPHENIX MVTX: 7.9+m

Cable-A: 1.4 m

Cable-B: 6.5+ m

Power cable: 4.7+ m



**Desired ~10m;
Tested 11.4m**

Electronics Tested @Fermilab

5/20-25, 6/17-22, 2019

- 4 staves
- 2 RUv1.1
- 1 PU
- 1 FELIX Server + RCDAQ
- sPHENIX GTM
- 11.4m Custom SamTec Cable
- Negative pressured cooling for staves

- 1 fully functioning 9-chip stave;
- 3 staves with a few broken sensors

120GeV p-beam
10kHz (30kHz)
Beam intensity:
30k ~ 120k ppp

4-stave telescope



SamTec: 11.4m
(2.6m+8.8m)

RU-2: 1 stave

RU-1: 3 staves

5m SamTec

Beam Trigger

GTM

Timing & Trigger

FELIX

Data & Control

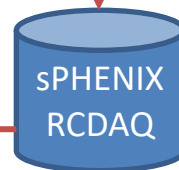
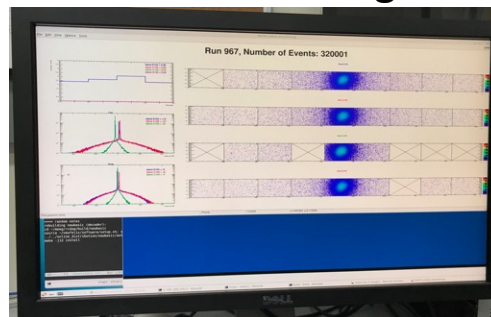


A full system with final sensor/readout* hardware:

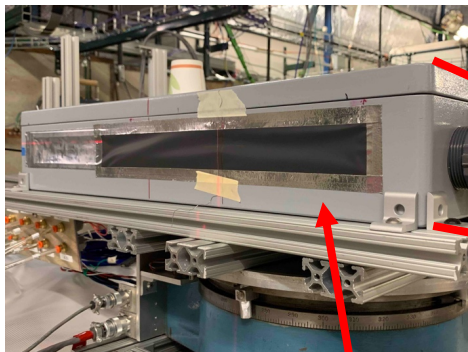
- Multi-Stave + Multi-RU -> FELIX readout demonstrated
- sPHENIX GTM integrated
- Long readout SamTec cable certified
- Cooling system demonstrated

* RUv1.1 identical to the final RUv2 electrically

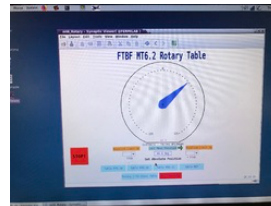
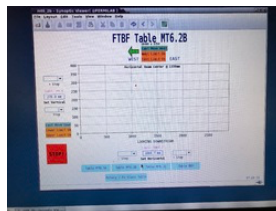
Online Monitoring



2019 MVTX Test Beam Setup @Fermilab



Stave housing sits on a motion table which can be moved in (x, y) plane perpendicular to the nominal beam direction. It can also be rotated (+40, -40) degrees (see photo on right). Operation was done at counting house.



Detector Misalignment & Hit Spatial Resolution Study SPHENIX

Typically staves offset by,

Horizontally: $20 \times 30 \mu\text{m} = 600 \mu\text{m}$

Vertically: $5 \times 30 \mu\text{m} = 150 \mu\text{m}$

Hit spatial resolution: (w/o clustering)

Peak_sigma_core = 0.55 (pixel size) = $15 \mu\text{m}$

Chip spatial resolution = $15/\sqrt{2} = 11 \mu\text{m}$

(same as 2018 TB results)

