sPHENIX MVTX Introduction

(Monolithic-Active-Pixel-Sensor (MAPS) based VerTex detector)

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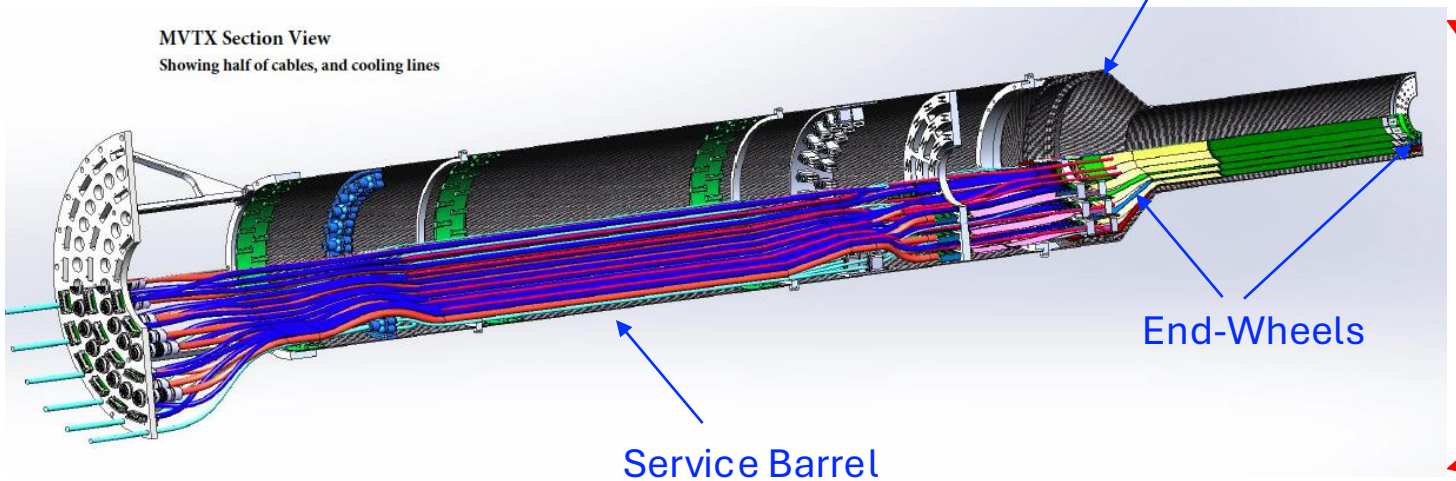
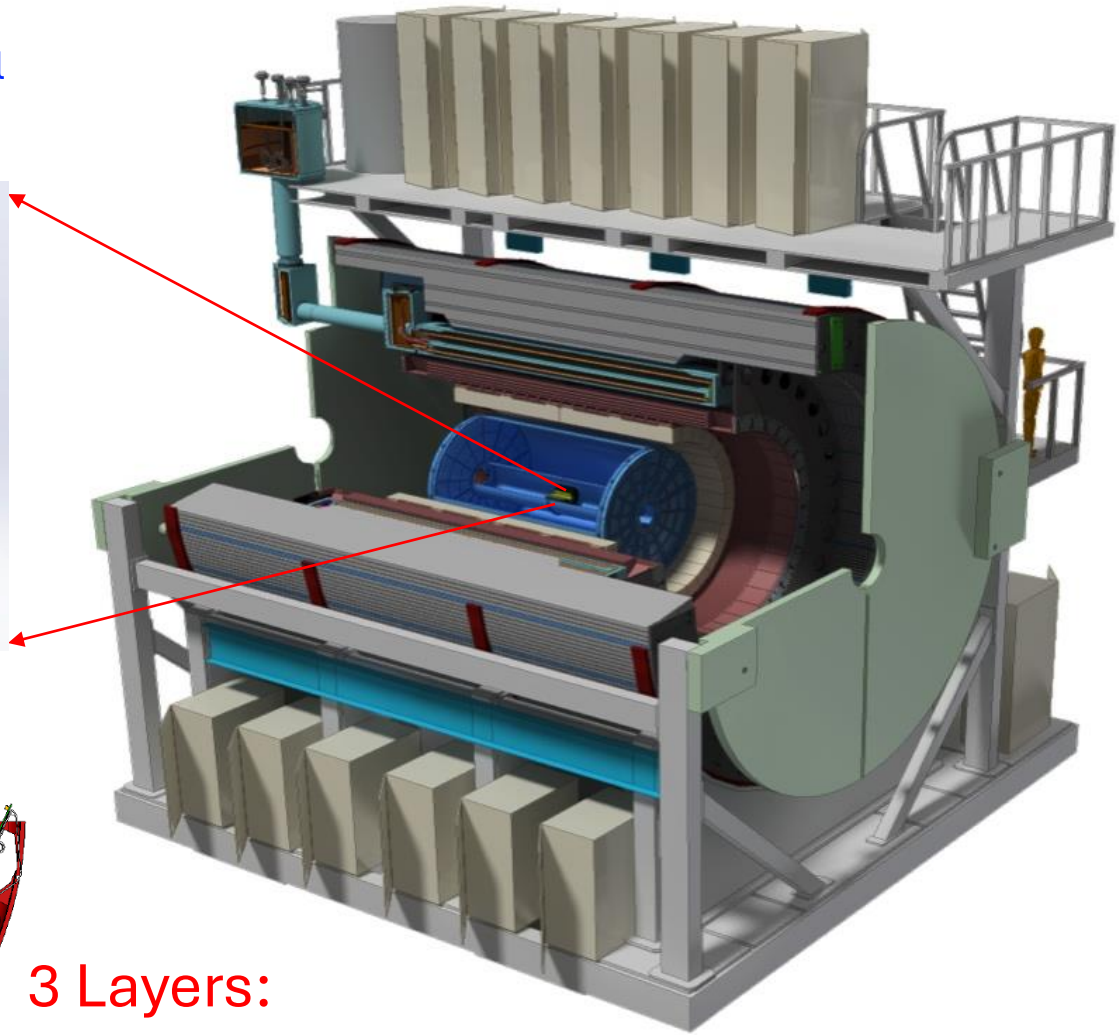
MVTX Detector in sPHENIX



CYSS: Cylindrical Shell Structure

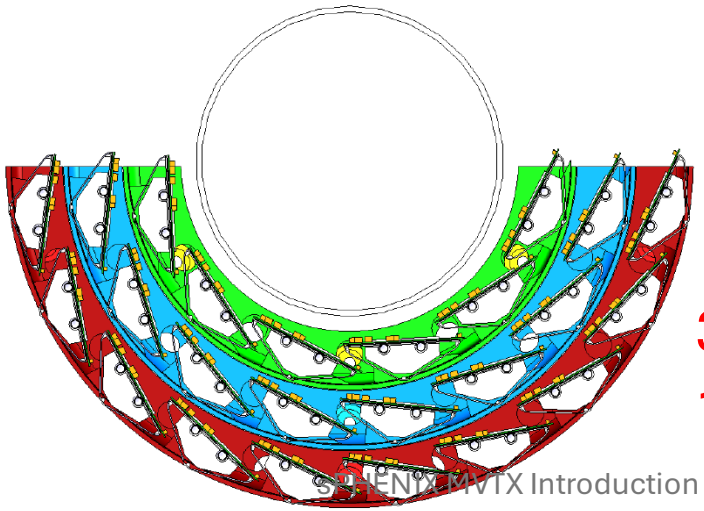
End-Wheels

Service Barrel



MVTX parameters: L = 271 mm

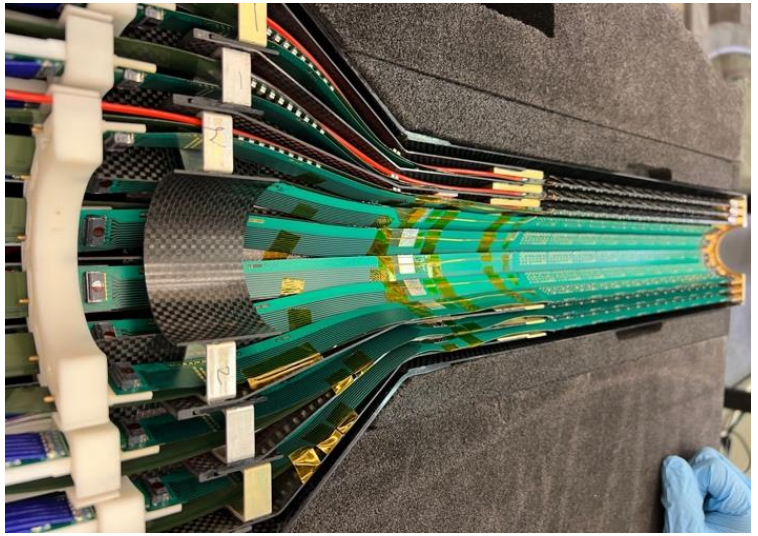
	R_min (mm)
Layer 0	24.61
Layer 1	31.98
Layer 2	39.93



3 Layers:
12/16/20 staves

sPHENIX MVTX Detectors

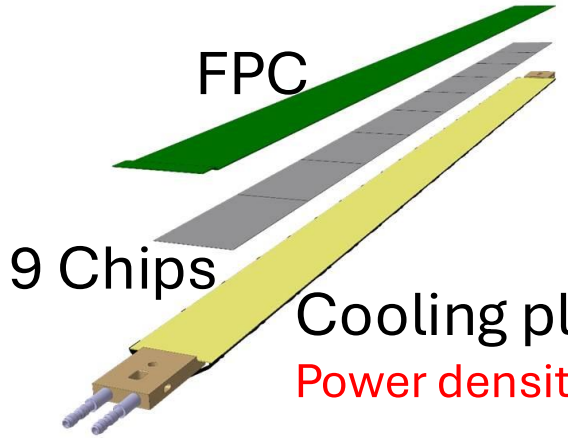
- **Construction completed in 2022**
  - ➢ 84 staves available, 48 used in MVTX, rest as spares
- **Installed in sPHENIX IR in 2023**
  - ➢ Short commission run in 2023, Au+Au collisions
- **Long 1-year 2024 p+p run**
  - ➢ Triger-less full streaming readout
- **Long 1-year 2025 Au+Au run**
  - ➢ in progress, triggered readout mode
- Available in 2026 for other experiments
  - ➢ Full detectors, readout and control



Monolithic-Active-Pixel-Sensors (MAPS)

A State of the Art Pixel Tracker

- Advantages of ALICE MAPS/ALPIDE:
  - Very fine pitch (27x29 μm), 5um tracking resolution
  - High efficiency (>99%) and low noise (<10^{-6})
  - Time resolution, ~5 μs
  - Ultra-thin/low mass, 50μm (~0.3% X_0)
  - On-pixel digitization, low power dissipation
  - Full streaming readout (trigger less) and trigger mode
  - Rad hard, >2.7MRad

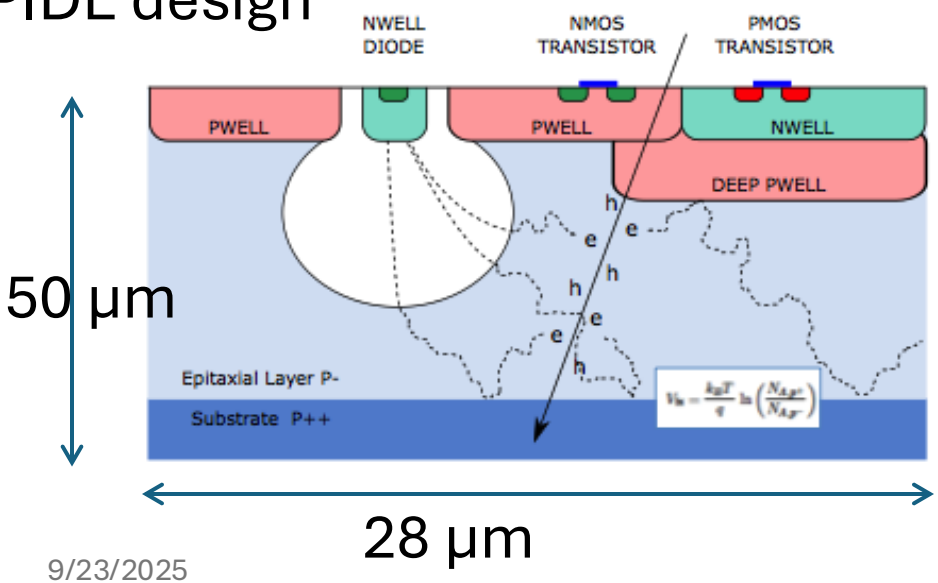


Chip:
1.5 x3 cm^2

Power density < 40 mW/cm^2

A 9-chip MAPS stave, (1.5 x 3)x9cm^2

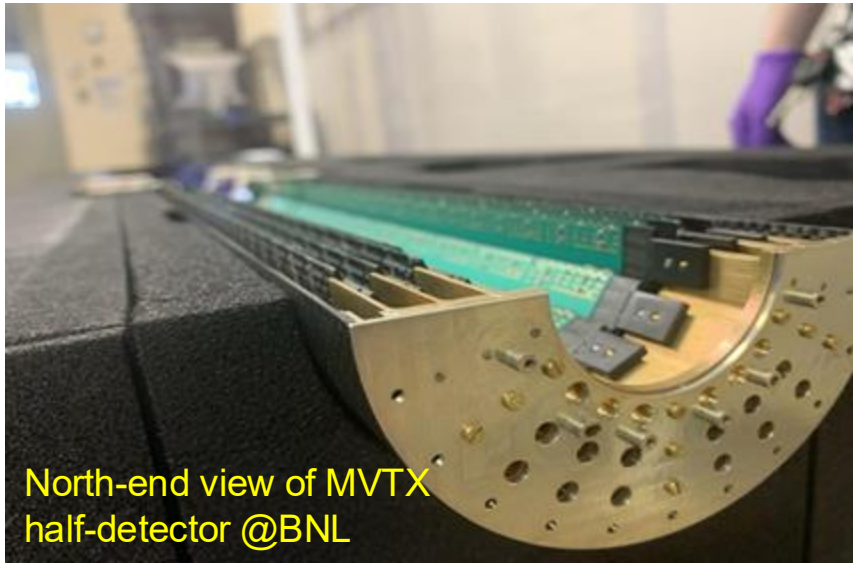
ALPIDE design



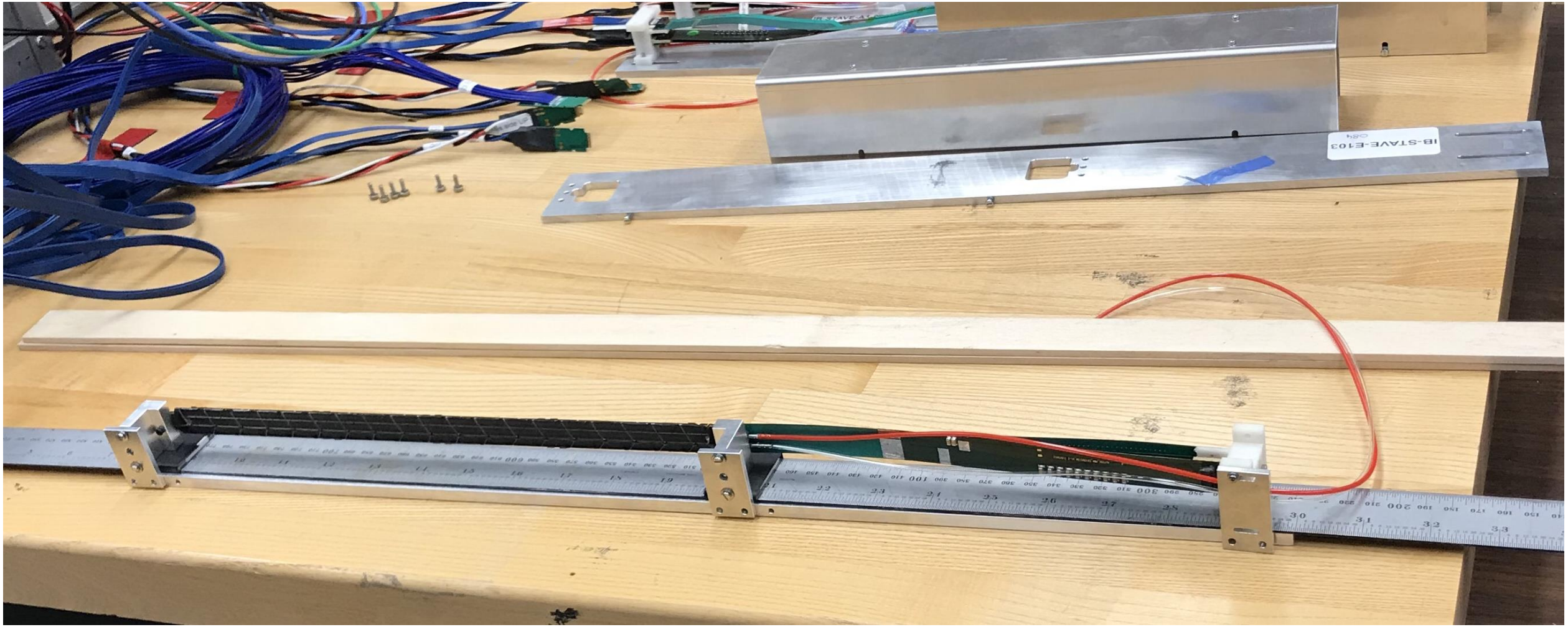
Tower Jazz 0.18 μm CMOS

- feature size 180 nm
- metal layers 6
- gate oxide 3nm

substrate: $N_A \sim 10^{18}$
epitaxial layer: $N_A \sim 10^{13}$
deep p-well: $N_A \sim 10^{16}$



MVTX Staves @LANL Lab



Possible Other Applications

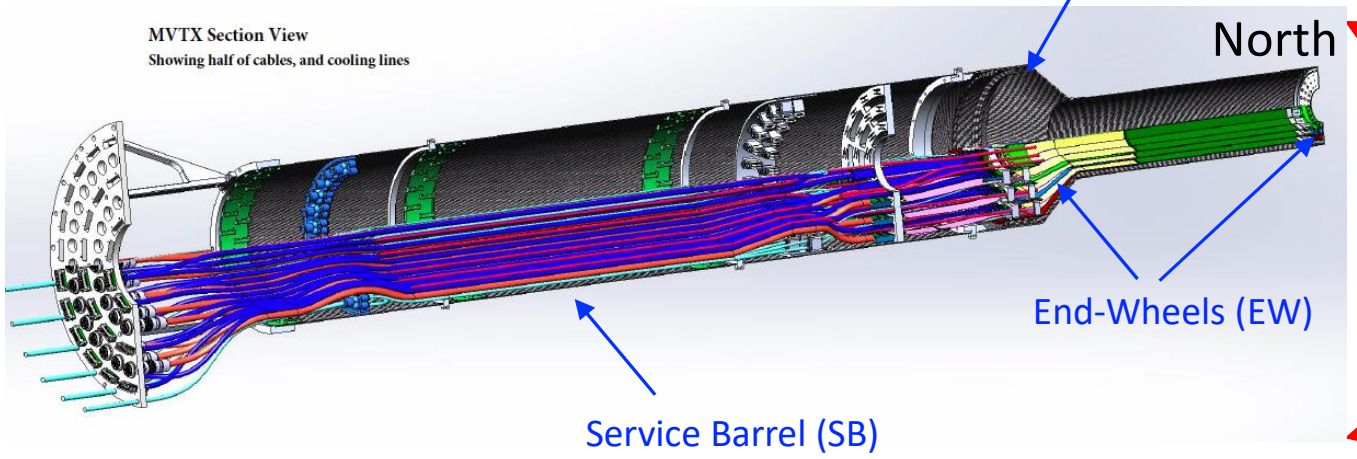
- JLab
- CERN collider
- CERN fixed target
- FNAL
- SLAC?
- New configurations possible

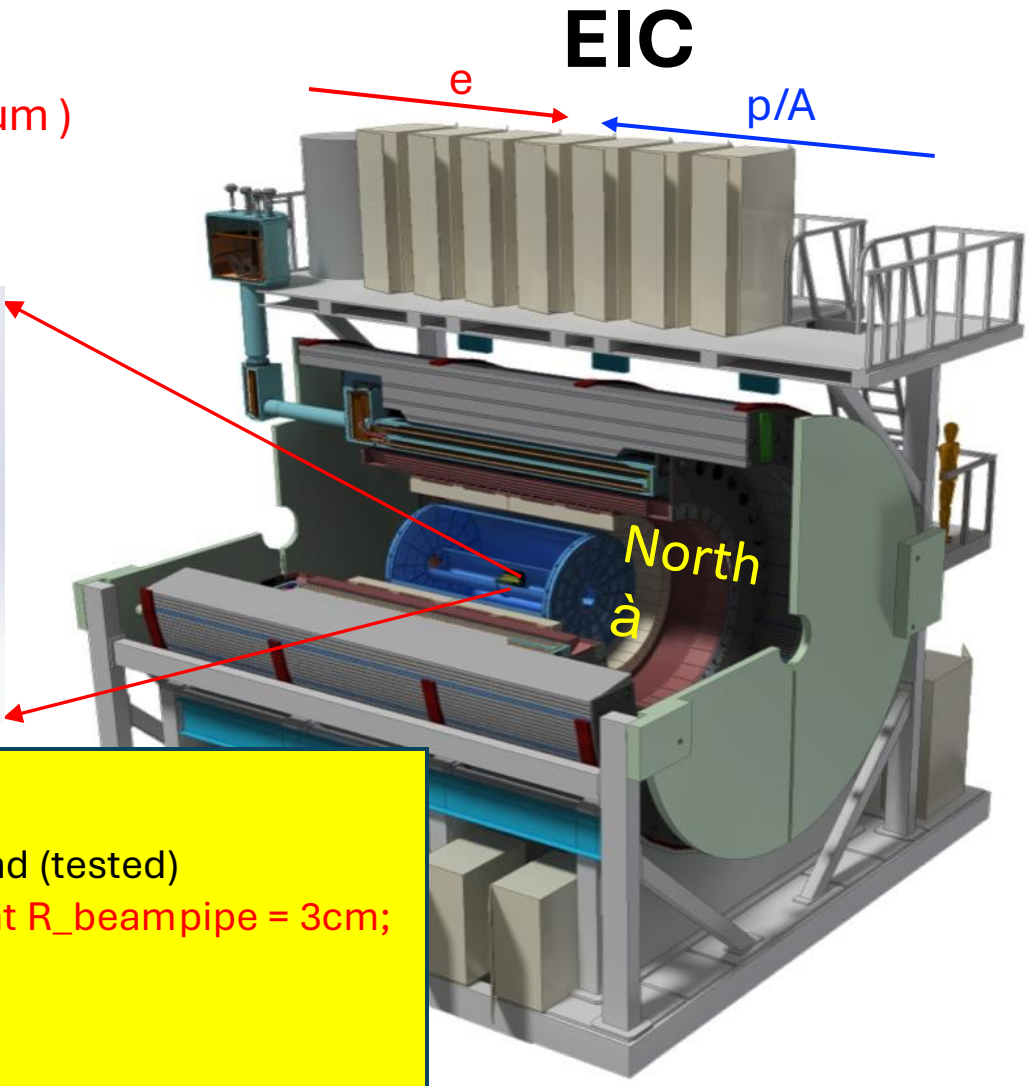
Reconfigure MVTX for EIC ?

- if we can't afford a new vertex detector (ITS-3, HV-MAPS like)

MVTX sensors (ITS-2):

- 27um x 29 um, (spatial resolution ~<5.0um, <20/sqrt(12)= 5.8um)
- Event timing resolution ~5uS
- Excellent candidate for EIC HF/Jlab…





MVTX staves should still be in excellent condition for EIC day-1 physics,

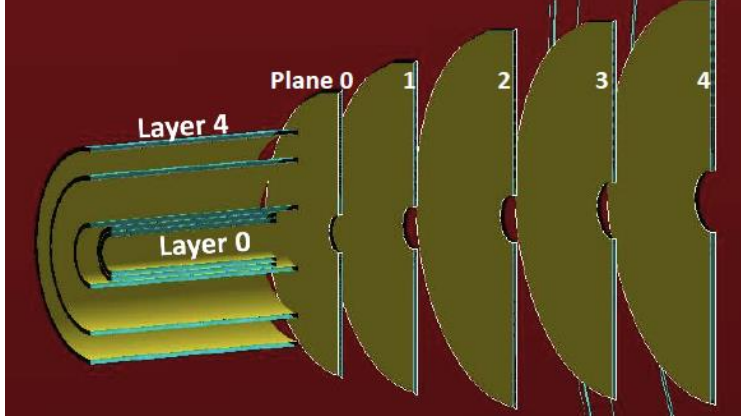
- Expected radiation dosage after 5 years of run: ~O(10) kRad << 2.7 MRad (tested)
- MVTX could provide excellent coverage for the central barrel, |eta|~<1.5 at R_beampipe = 3cm;
  - *requires other fast detector(s) for fast beam-crossing timing (spin)*
  - reconfigured to fit the new (larger) beam pipe (R ~3cm)

- Small event pile-up from EIC collisions:

  0.7MHz x 5 uS = 3.5 events "per readout/trigger", other backgrounds dominant?

EIC Central Barrel: “MVTX-Like” Design with Extended Power FPC

Barrel + Disks



Central hadrons
|eta|<1.55

Forward hadrons;
1 < |eta| < 3.5 (3.0)

Central electrons
|eta| < 1.55

607.94
108.35
81.96
A
271.20*
*Length for the nine sensors on stave assembly
276.60
A

~11cm extension

Eta ~2.1

Forward electrons
1 < |eta| < 3.5

EMCal – best for E measurement?