Si-based forward tracking calorimeter

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ITS upgrade, An example of MAPS

MAPS, something Korea can do very well...
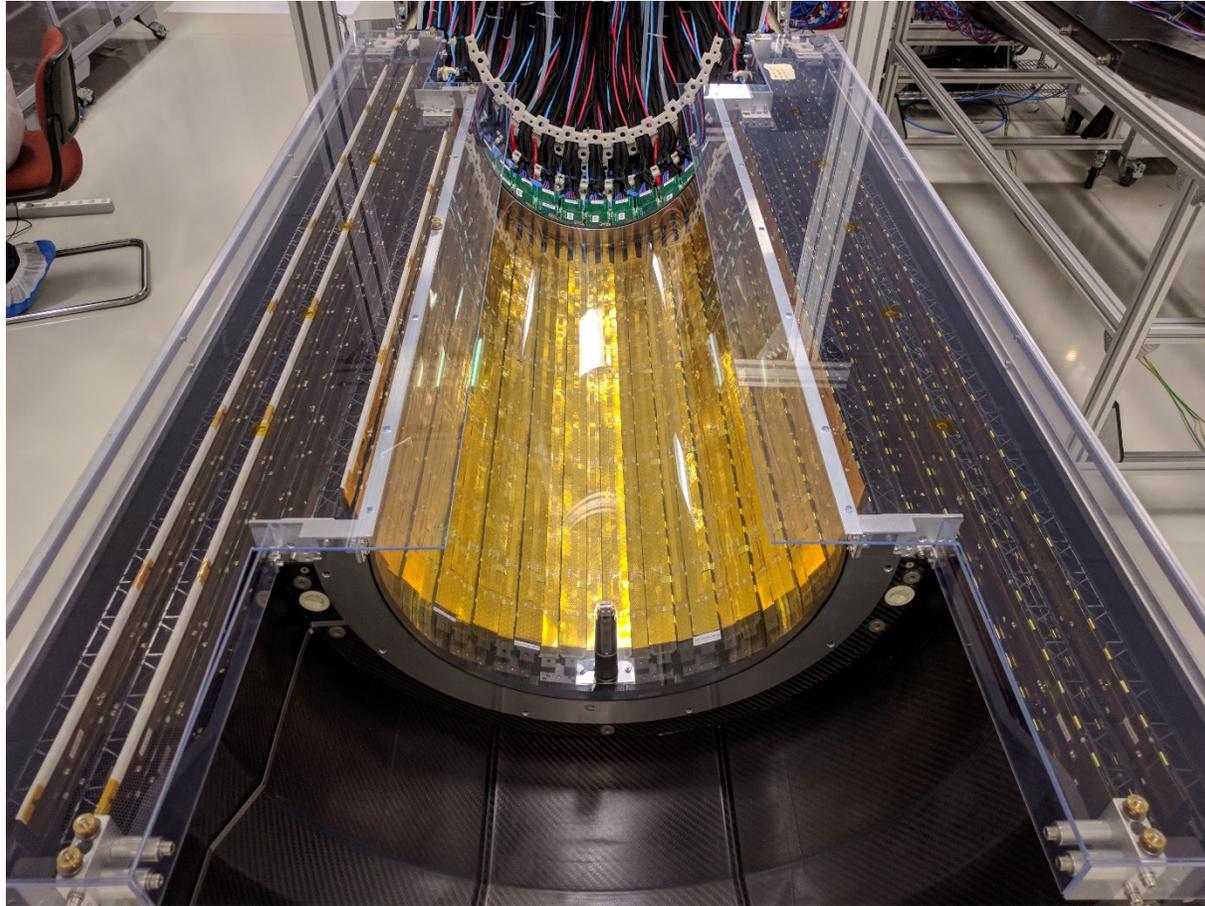
2021-2024

Key features

- Size of 1.5 (cm) x 3 (cm), 25(μ) x 25(μ) pixel, ~1(μs) shaping time

- Sensors thinned down to 50/100(μ) as a part of low material budget detector design (0.3% X_0 per layer for 3 inner layers, can we remove water cooling?)

- Sensors include front end and modest digital circuitry with 1 Gbps data link.

- PCIe based readout board based on commercial FPGA.

Our involvement
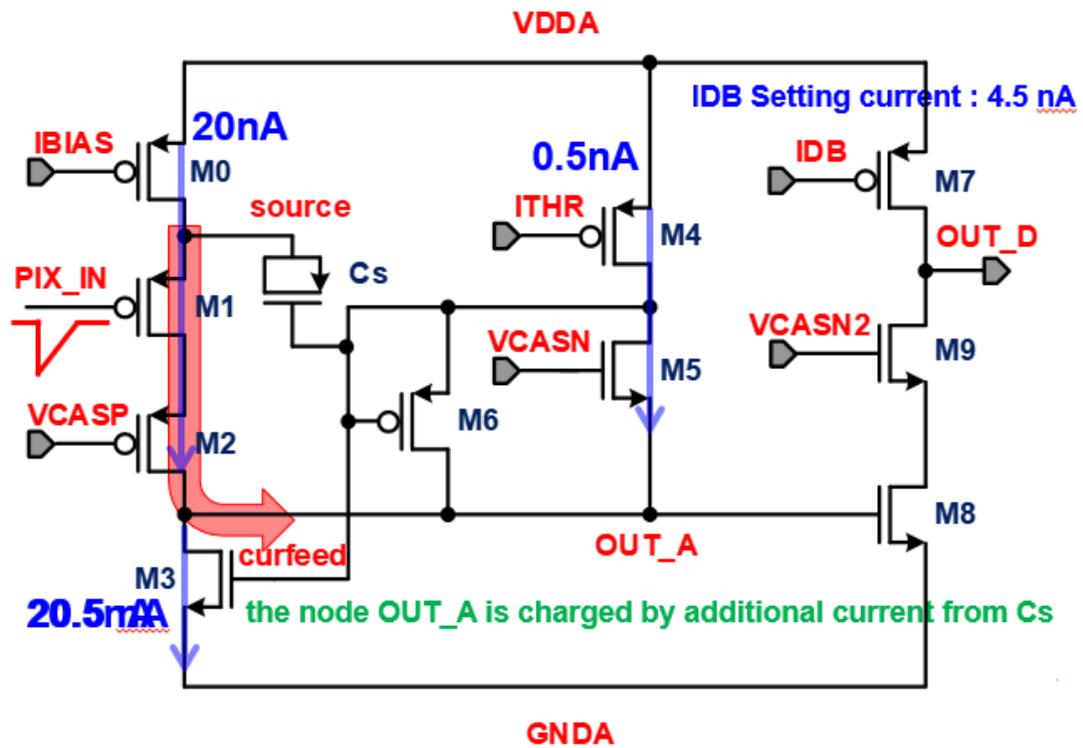
Design
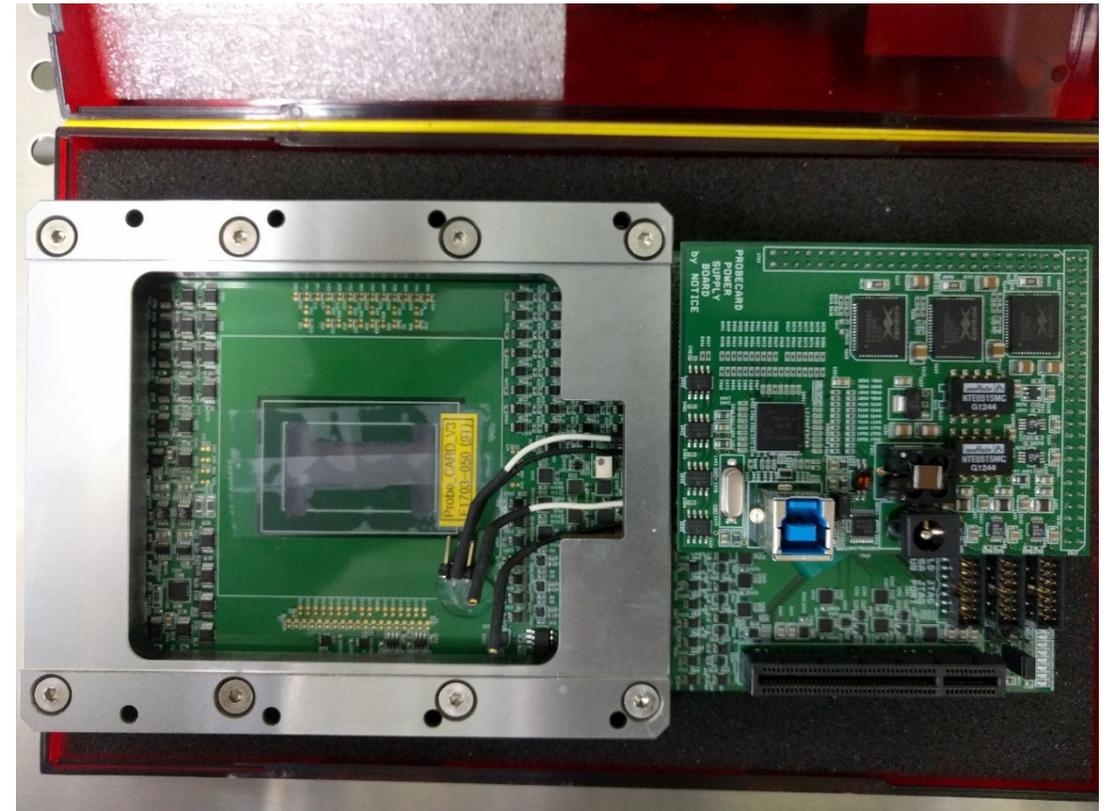
Test board

Production test equipment & test
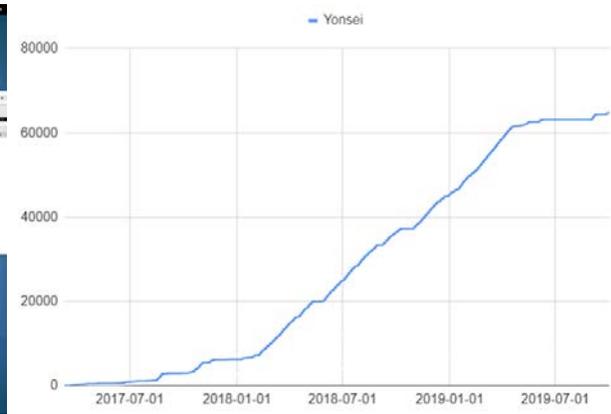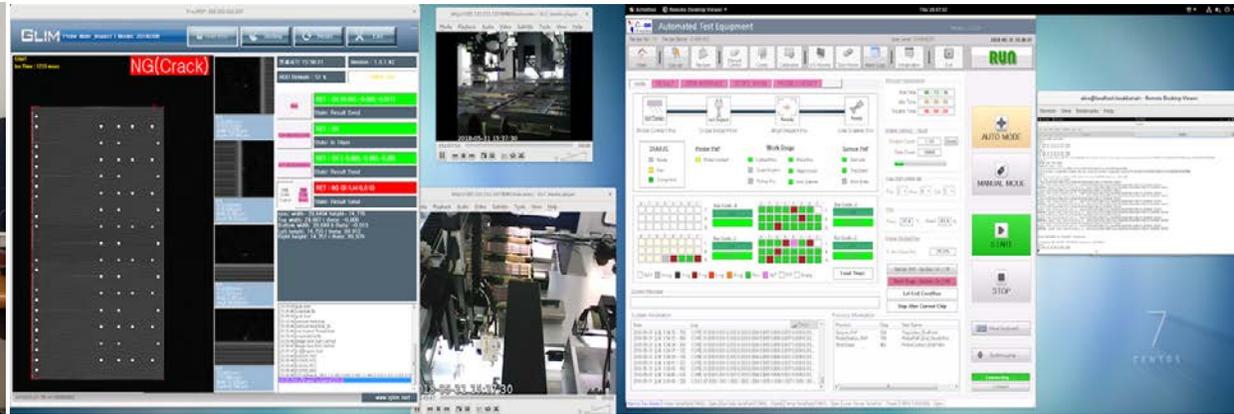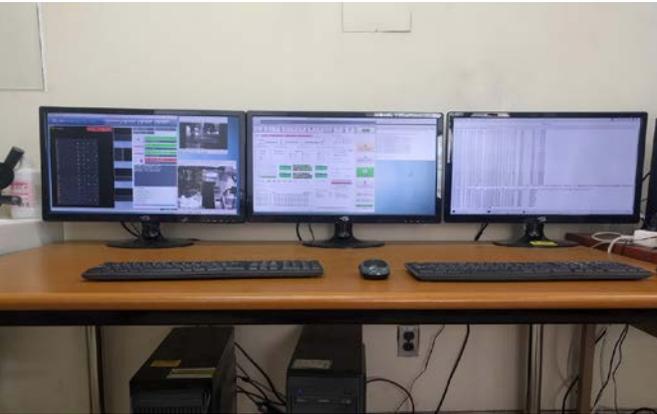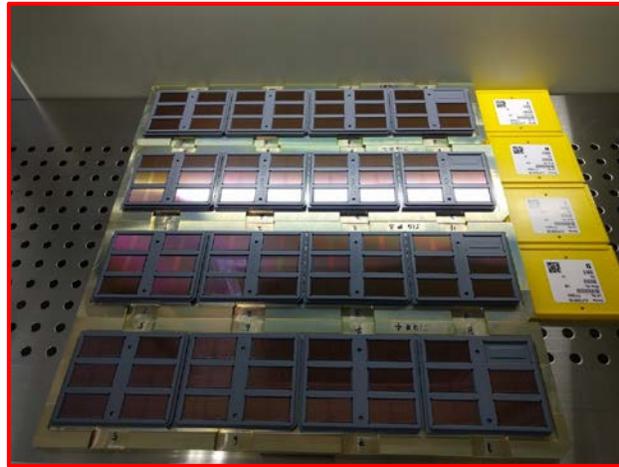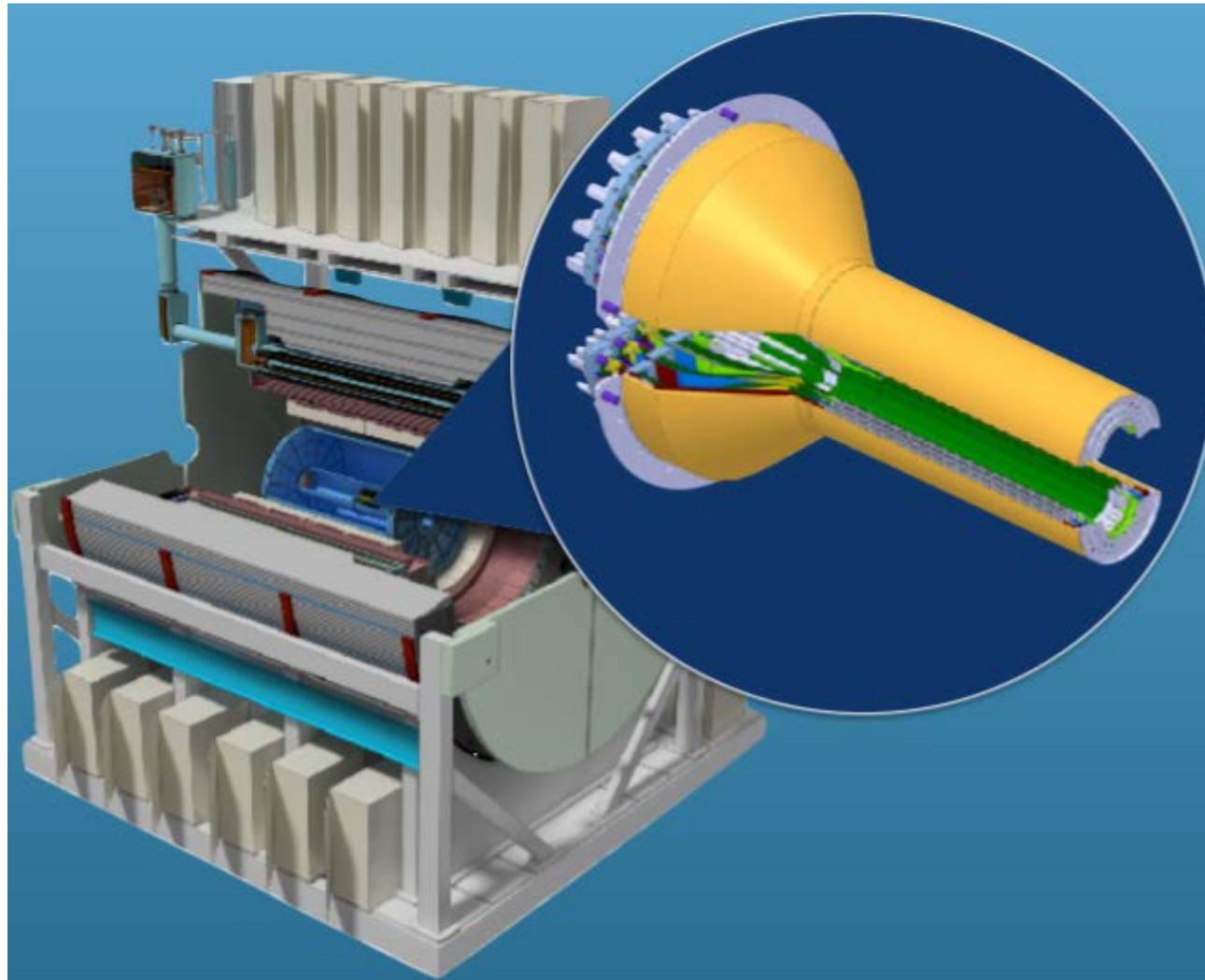
A Monolithic Active Pixel Sensor
Detector for the sPHENIX
Experiment

LS3 upgrade, Evolution in MAPS

We will make key contributions in the new upgrade.

Advanced technology
  180 (nm) CIS process
    →
  63 (nm) CMOS process

15 (μm) x 15(μm) pixel
Shaping time for front end : 10 (ns) – 1(μs)
Stitching & large sensor area

Advanced digital IP's?

2026-2029

Future

eRHIC Kinematics

RHIC proton/nucleus beam energies, 200/100A GeV

$$y_p = 6.1$$

$$y_A = 5.4$$

Phase-I, lepton beam energies 5 - 10 GeV: $y_e = 9.9 - 10.6$

Phase-II, lepton beam energies 10 - 30 GeV: $y_e = 10.6 - 11.7$

$$y_{beam,e+p} \approx 10.8 + \underline{5.8}$$

Gain from collider operation

Virtual photon kinematics
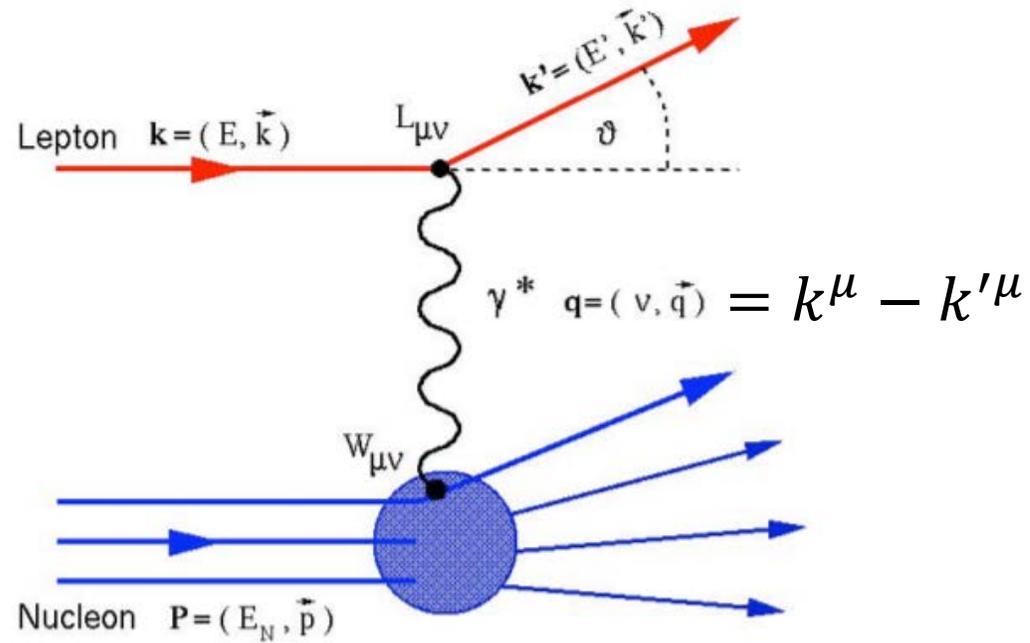
$$Q^2 = -q^\mu q_\mu = -(k^\mu - k'^\mu) \cdot \left(k_\mu - k'_\mu\right) = 2k^\mu \cdot k'_\mu = 4kk' \sin^2 \frac{\theta}{2}$$

eRHIC detector design

IR-Design

Combined function magnet

Quad 2

Quad 3

Dipole

θ=9.82 mrad

ZDC

0.32 m

Ion beam
θ=10 mrad

neutrons
θ=4 mrad

Electron quadrupoles

0.85m

1.53m 0.81 m

1.512 m

0.993 m

1.95 m

5.475 m

θ=10 mrad

1.9 cm (p₀/2.5)

4.50 m

IP
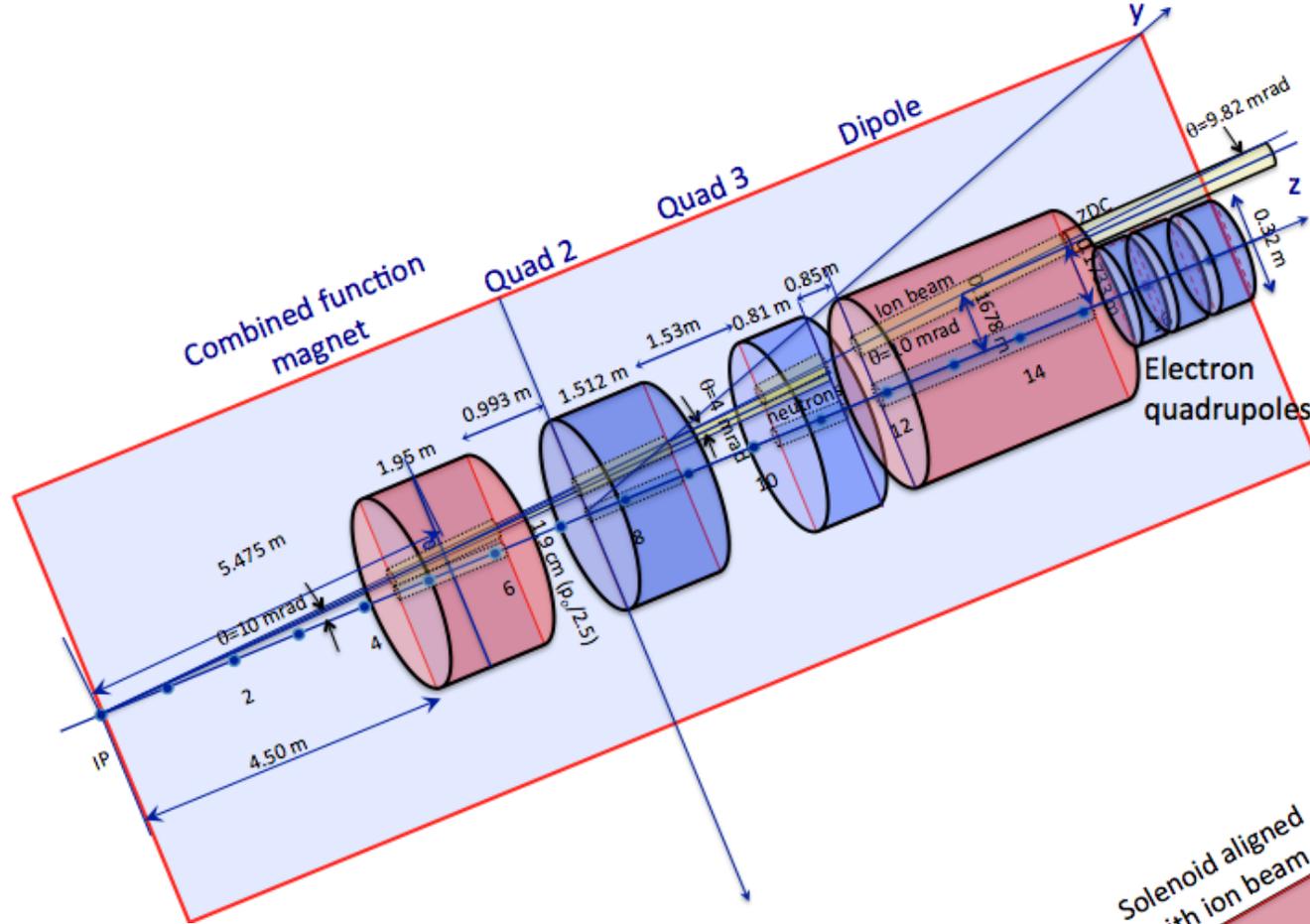
All optimized for dedicated detector
Have +/-4.5m for main-detector
→ roman pots / ZDC
→ low Q2-tagger

Solenoid aligned with ion beam

Combined function magnet

Quad 2

Quad 3

Dipole

θ=10.03 mrad

ZDC

Electron quadrupoles

Ion beam

0.85m

1.53m 0.81 m

1.512 m

0.993 m

1.95 m

5.475 m

θ=10 mrad

4.50 m

IP

E.C. Aschenauer
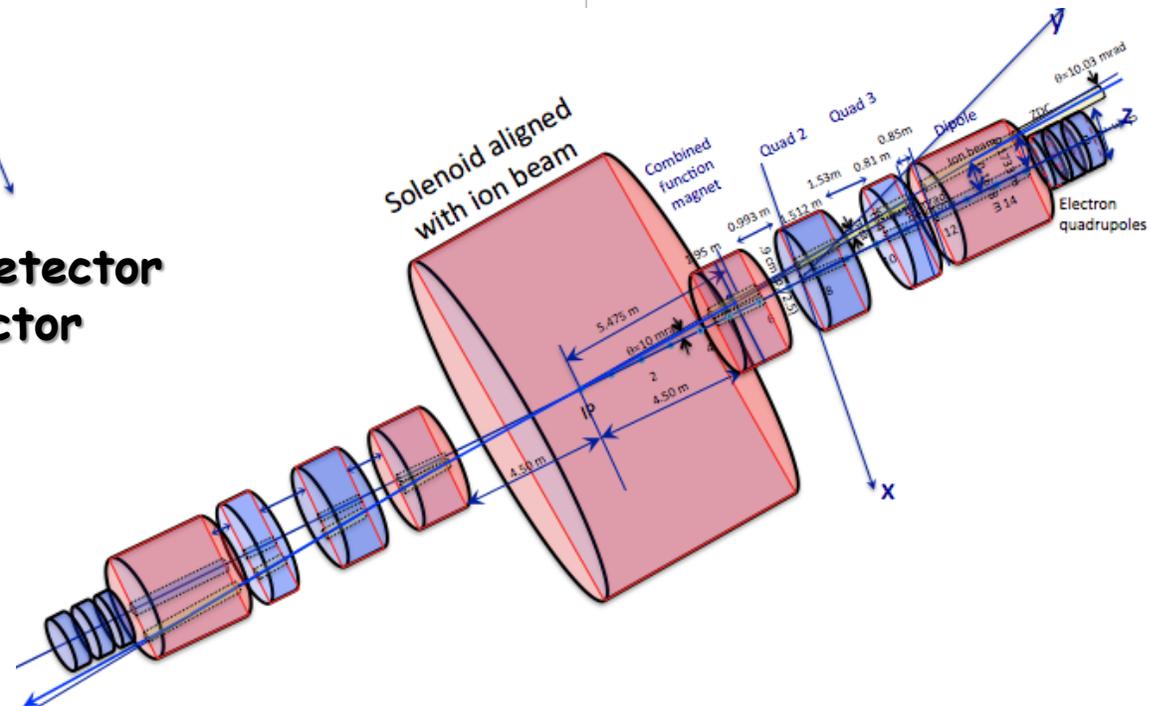
MAPS
VST(Barrel micro-vertex tracking detector)
FST/Backward vertex tracker (FST/BST)
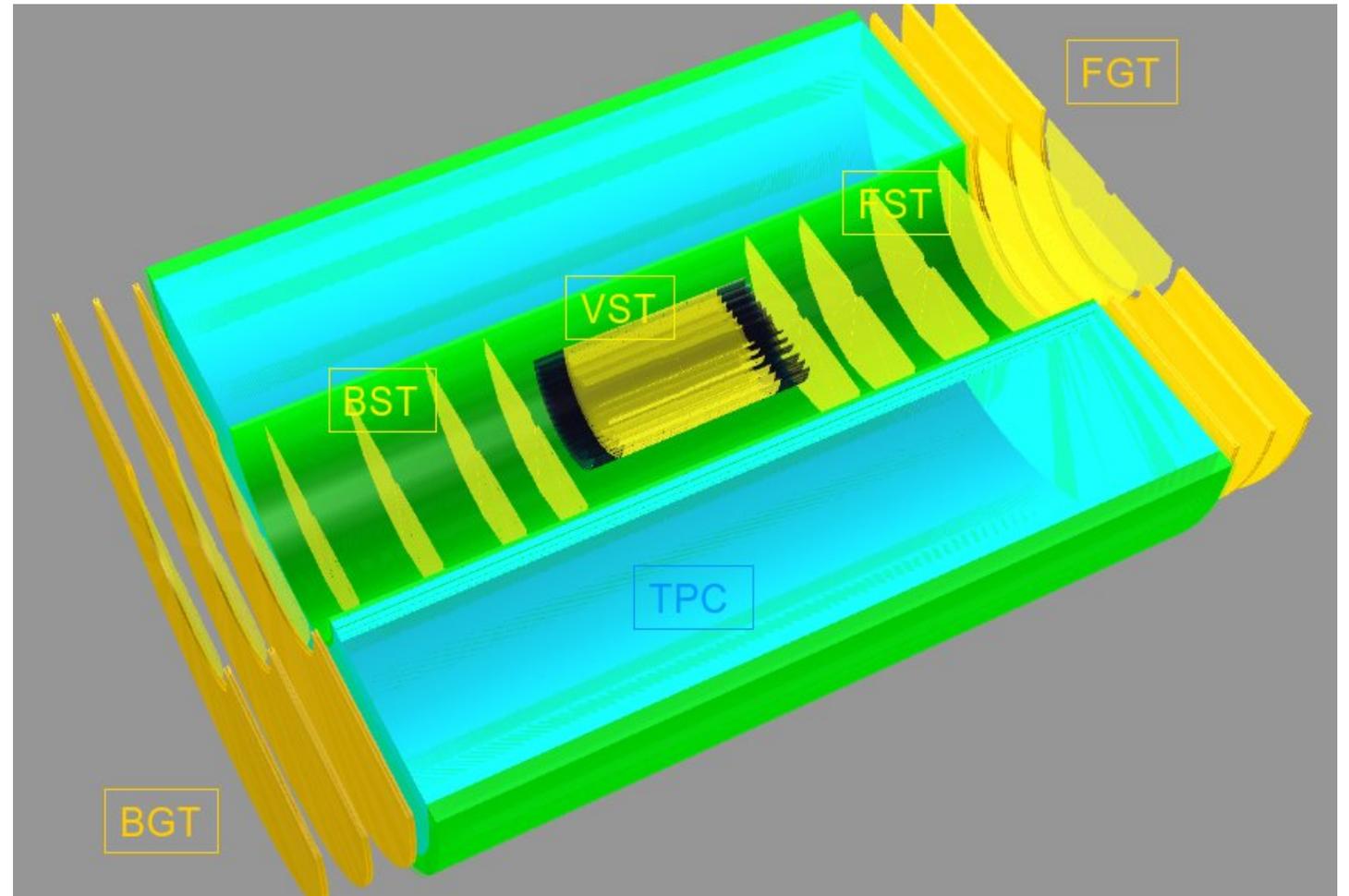
https://wiki.bnl.gov/eic/index.php/ERHIC_Dedicated_Detector_Design

sPHENIX
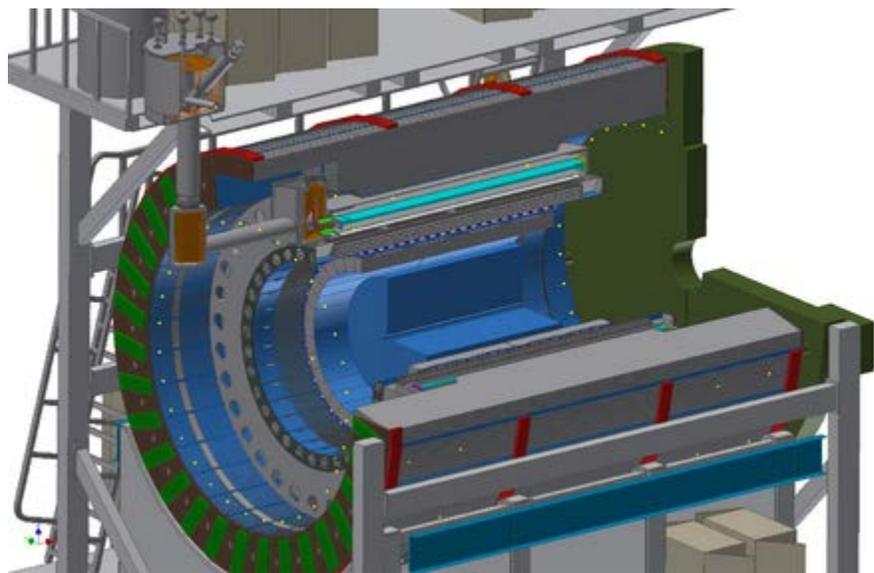
- MVTX
- INTT
- TPC
- EMCal
- HCal

Generic concept study

200 tungsten-sensor sandwich layers, total 30X$_0$, B=1T

[MC Hit] LAYER:IX
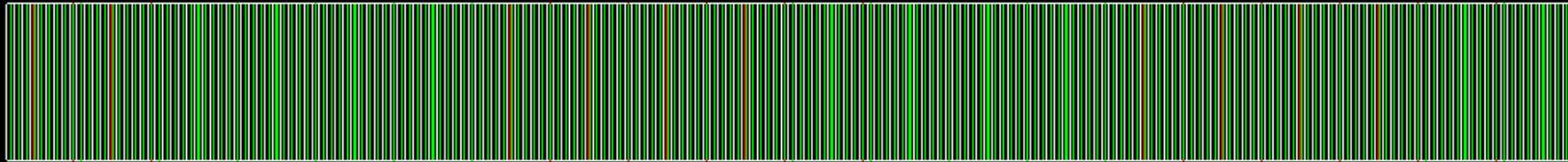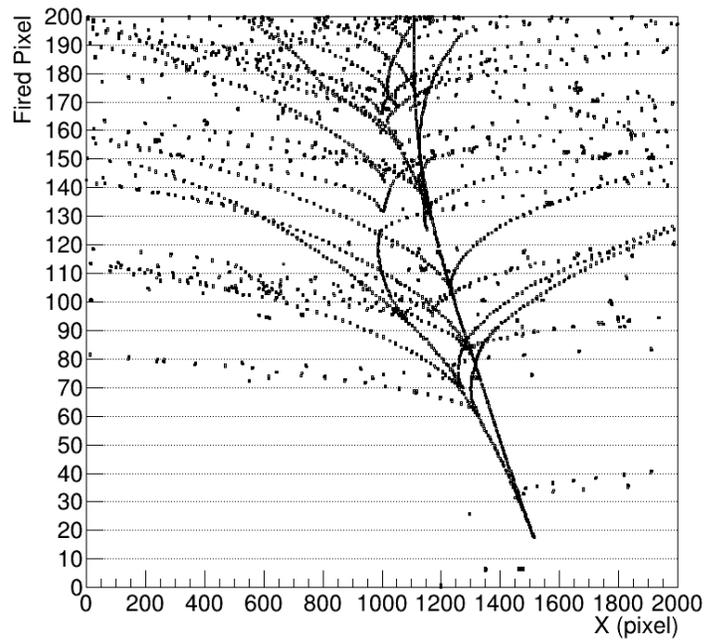
[MC Hit , E > 8MeV] LAYER:IX

Geant4 MC Hit
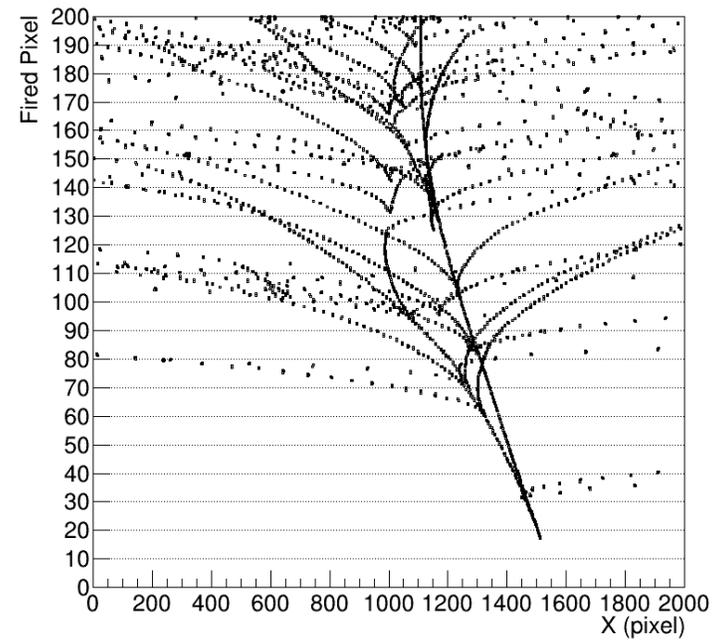
[Track Reconstruction] LAYER:IX

[Track Reconstruction γ → e⁺ + e⁻] LAYER:IX

Reconstruction

e^- : +

e^+ : ×