



Forward Silicon Tracker for the EIC

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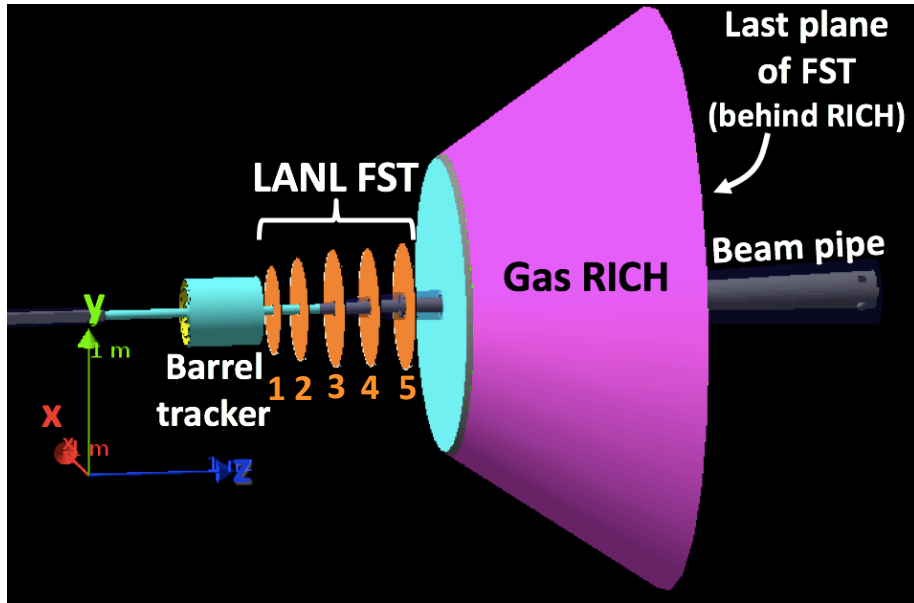
05-11-2021

Outline

- FST in the Yellow report
- Latest design of the forward silicon tracker
- Tracking performance of the FST with Babar Magnet
- Physics simulation with detector response
- Silicon sensor testing at LANL
- Summary and plan



FST in the Yellow Report



FST dimensions

Plane	Z (cm)	r_{in} (cm)	r_{out} (cm)	pixel Pitch (μm)	silicon thickness (μm)
1	35	4	25	20	ALICE 50
2	62.3	4.5	42	20	ITS3 50
3	90	5.2	43	20	type 50
4	115	6	44	36.4	100
5	125	6.5	45	36.4	MALTA 100
6	300	15	45	36.4	100

arXiv:2103.05419 (Chapter 11.2, p.460)

Silicon sensor options

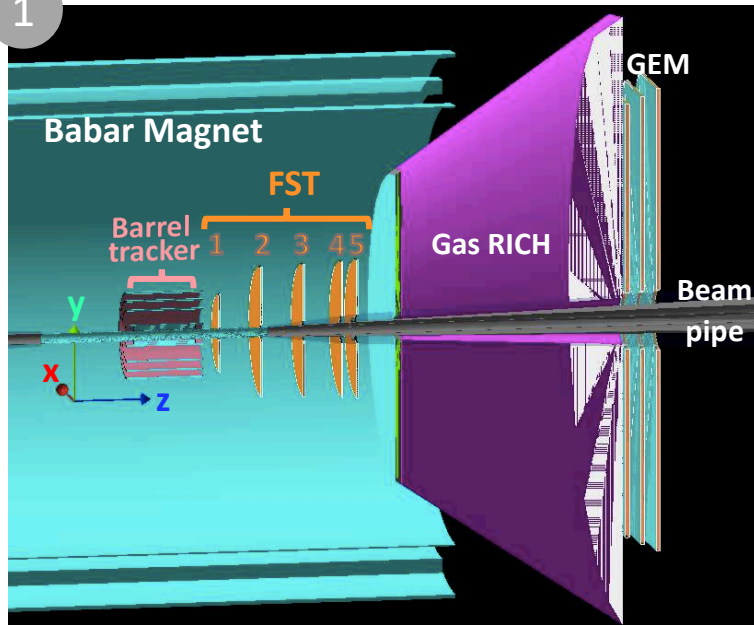
	Pixel pitch	Silicon thickness	Integration time
LGAD/AC-LGAD	100 μm m	<300 μm (<1% X_0)	300-500ps
MALTA	36.4μm m	100μm (<0.5% X_0)	5ns
ITS-3 type	20μm	50μm	100ns ?

- Using both ALICE ITS-3 like and MALTA sensors will yield good spatial and timing resolutions
- There's also an integrated setup with a 3-plane GEM tracker which replace the plane 6 of FST
- Tracking performance with both Babar and BeAST magnets are included in the yellow report

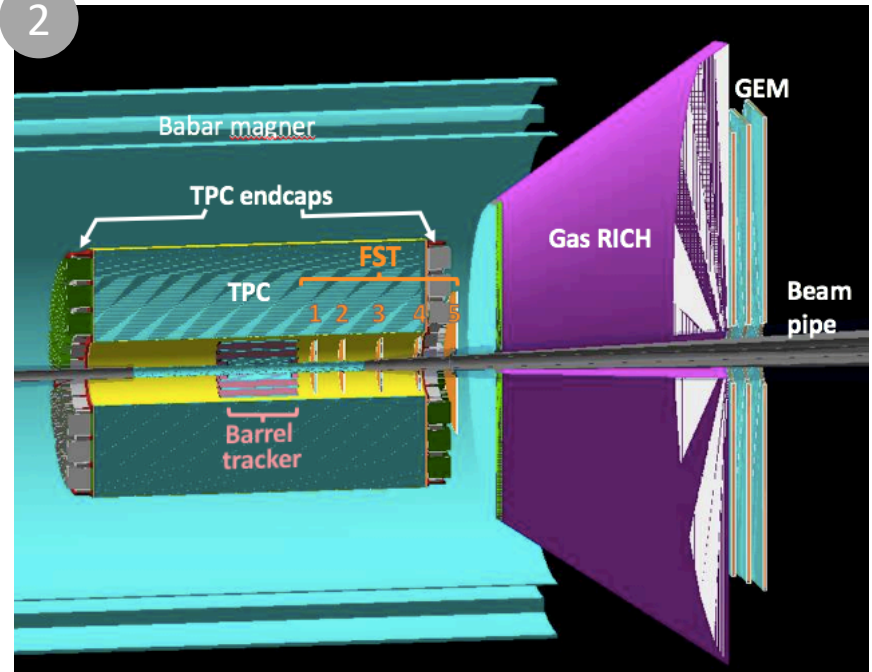


Latest Designs of FST with the Babar Magnet

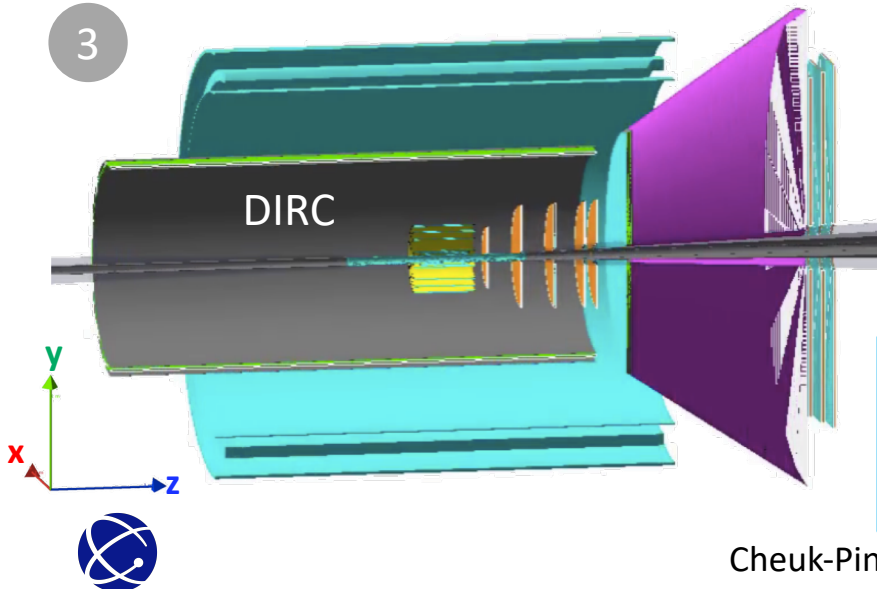
1



2



3

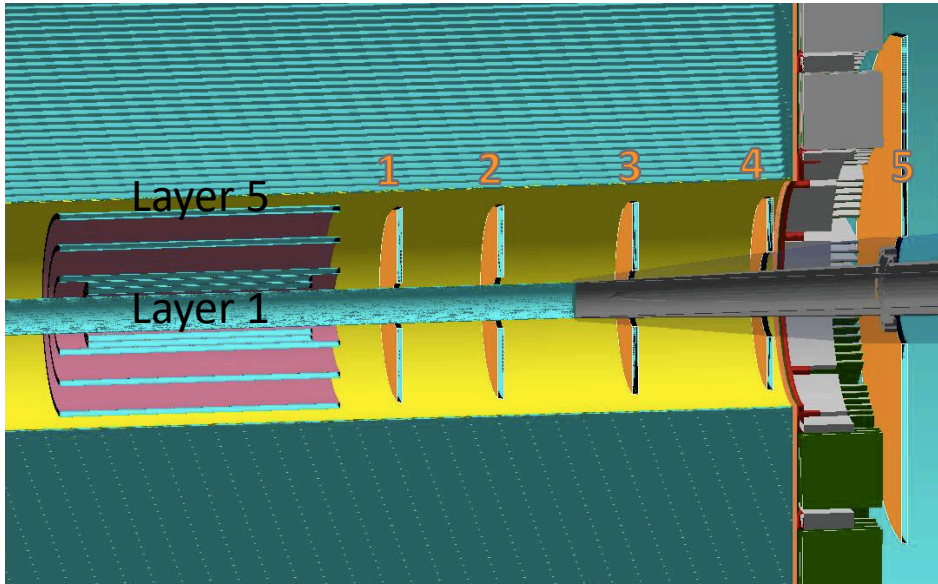


1. 5-plane FST + barrel tracker + gas RICH + GEM
2. Modified 5-plane FST+ modified barrel tracker + TPC + gas RICH + GEM
(see performance in the next slides)
3. FST inside the DIRC

The FST design is not finalized. We are open to work with other subsystem groups in the integrated detector setup



Barrel and FST Setup Inside the TPC

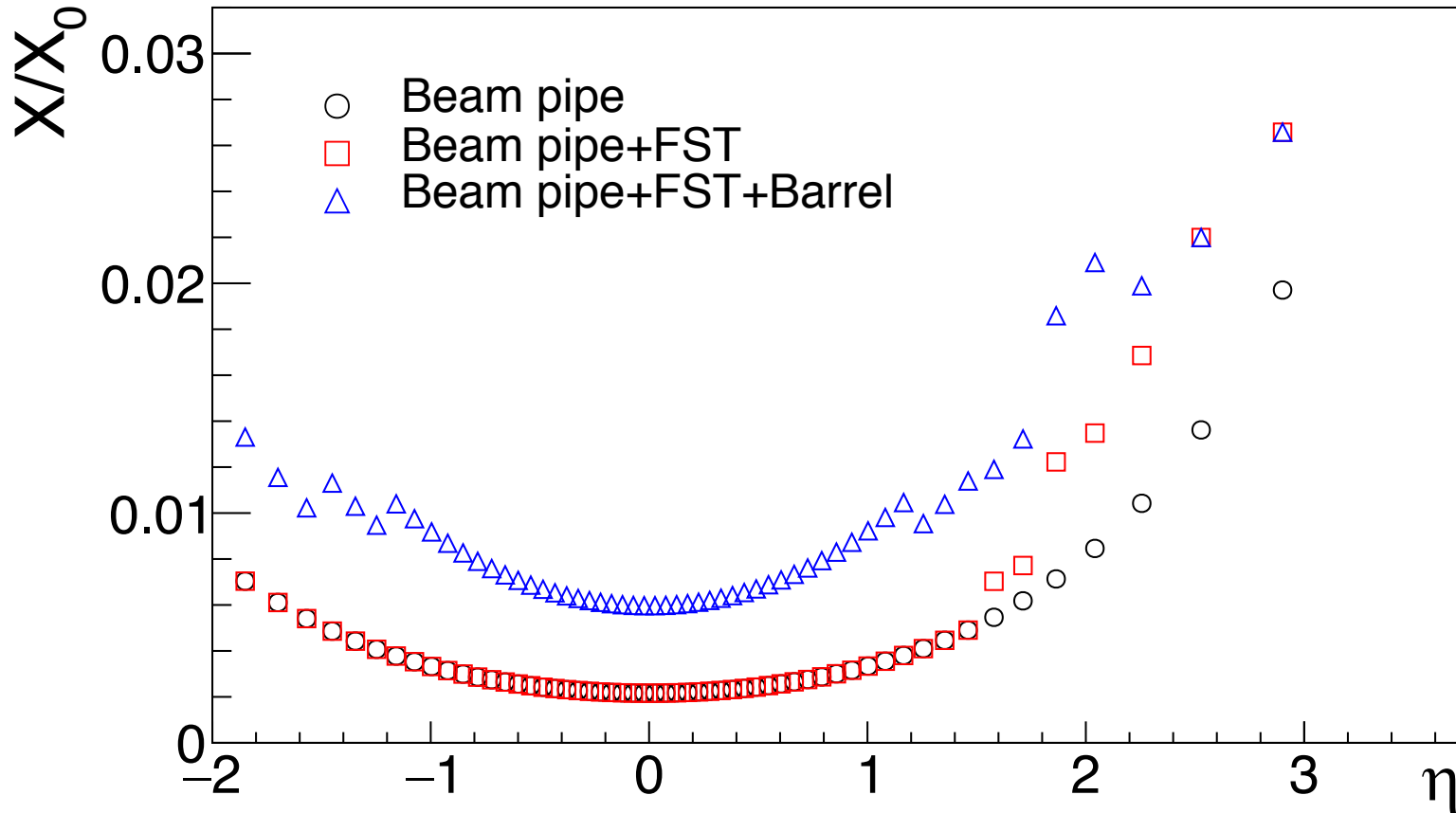


Barrel Layer	Half length (cm)	r (cm)	Pixel pitch (um)	Silicon thickness (um)
1	20	3.64	20	50
2	20	4.81	20	50
3	25	5.98	20	50
4	25	11.5	36.4	100
5	25	17	36.4	100

FST Plane	z (cm)	r _{in} (cm)	r _{out} (cm)	Pixel pitch (um)	Silicon thickness (um)
1	35	4	17	20	50
2	53	4.5	17	20	50
3	77	5	17	20	50
4	101	7.5	17	36.4	100
5	125	9.5	43	36.4	100



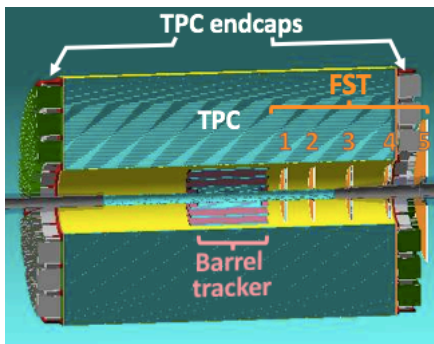
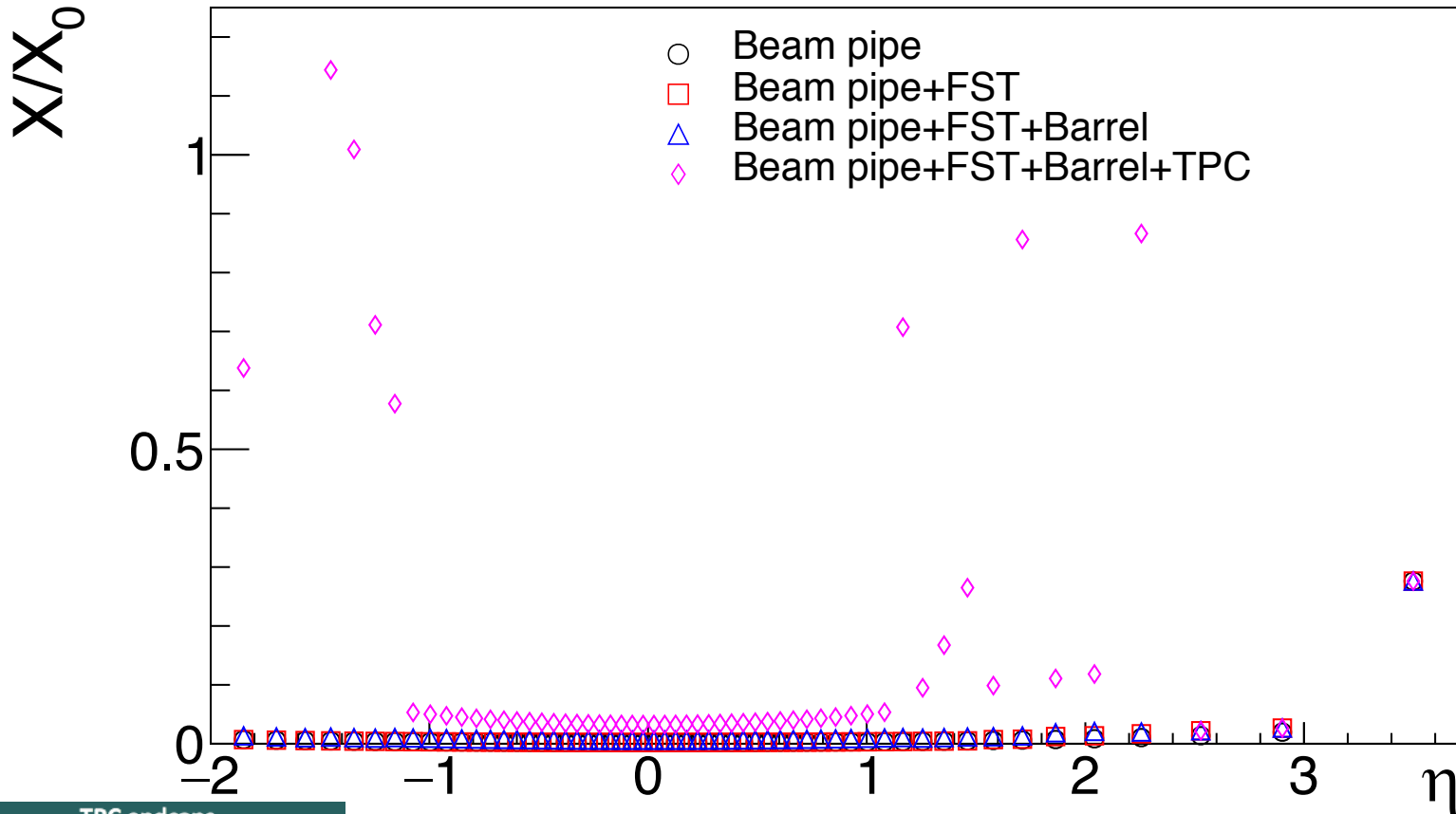
Material Budget of FST and Barrel



- Material budget of FST alone <1%
- Material budget of beam pipe + FST + barrel tracker <3%

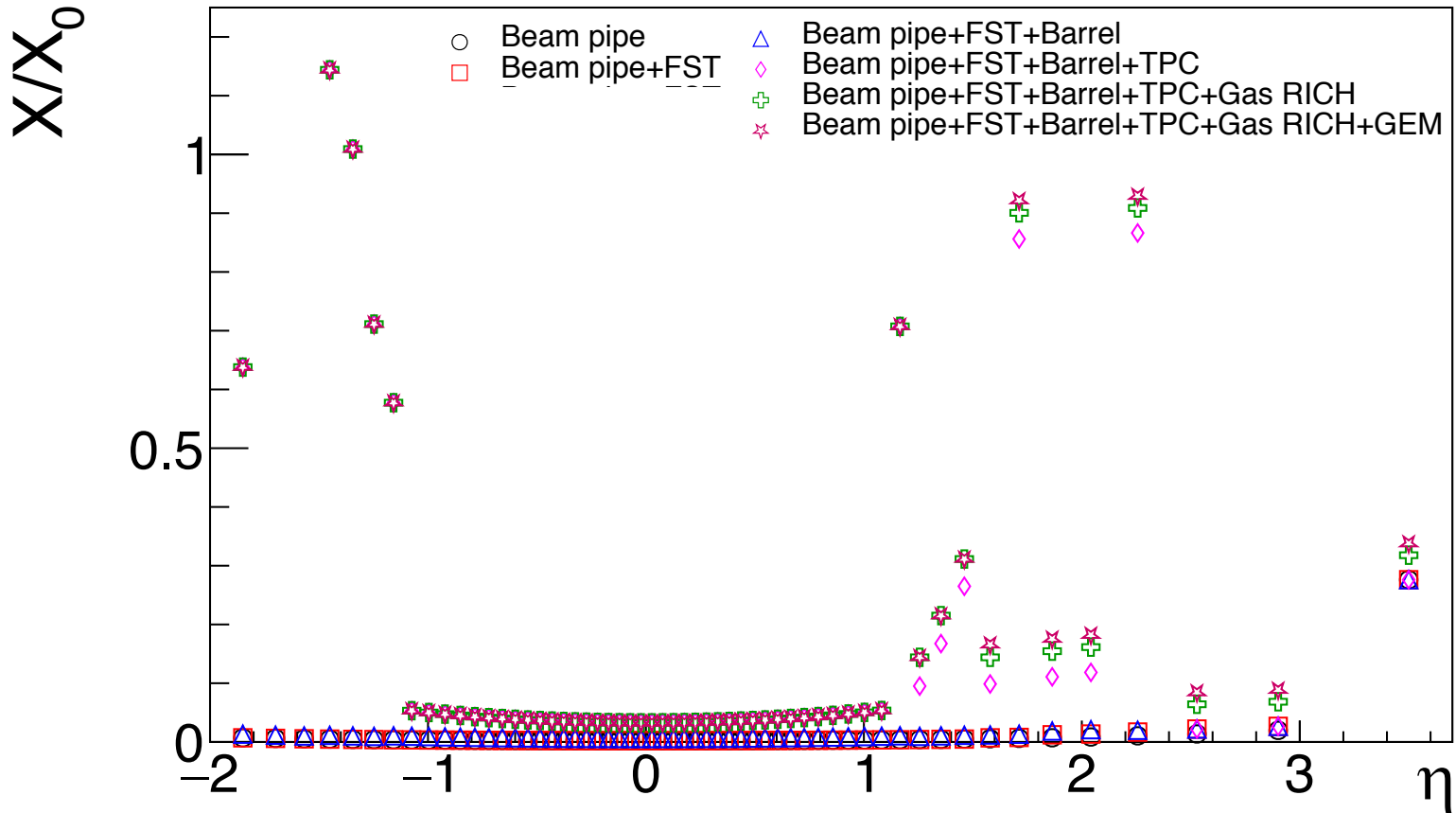


Material Budget with Additional TPC



- Central region ($-1 < \eta < 1$): smaller than 10%
- Spike at backward and forward region due to TPC endcap

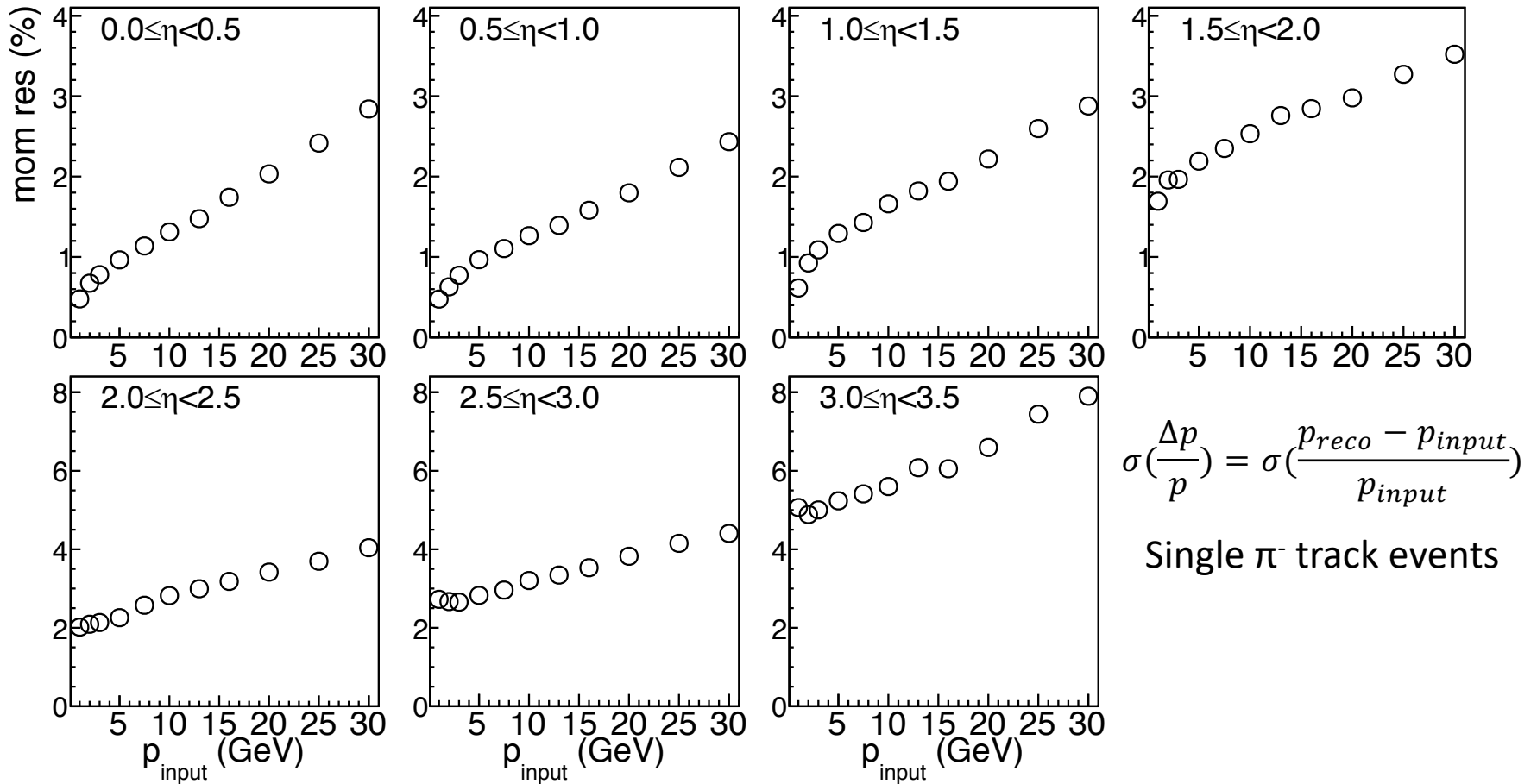
Material Budget of the Integrated Setup



TPC endcap is the major contributor to the detector material budget in the forward and backward region ($|\eta| > 1$)



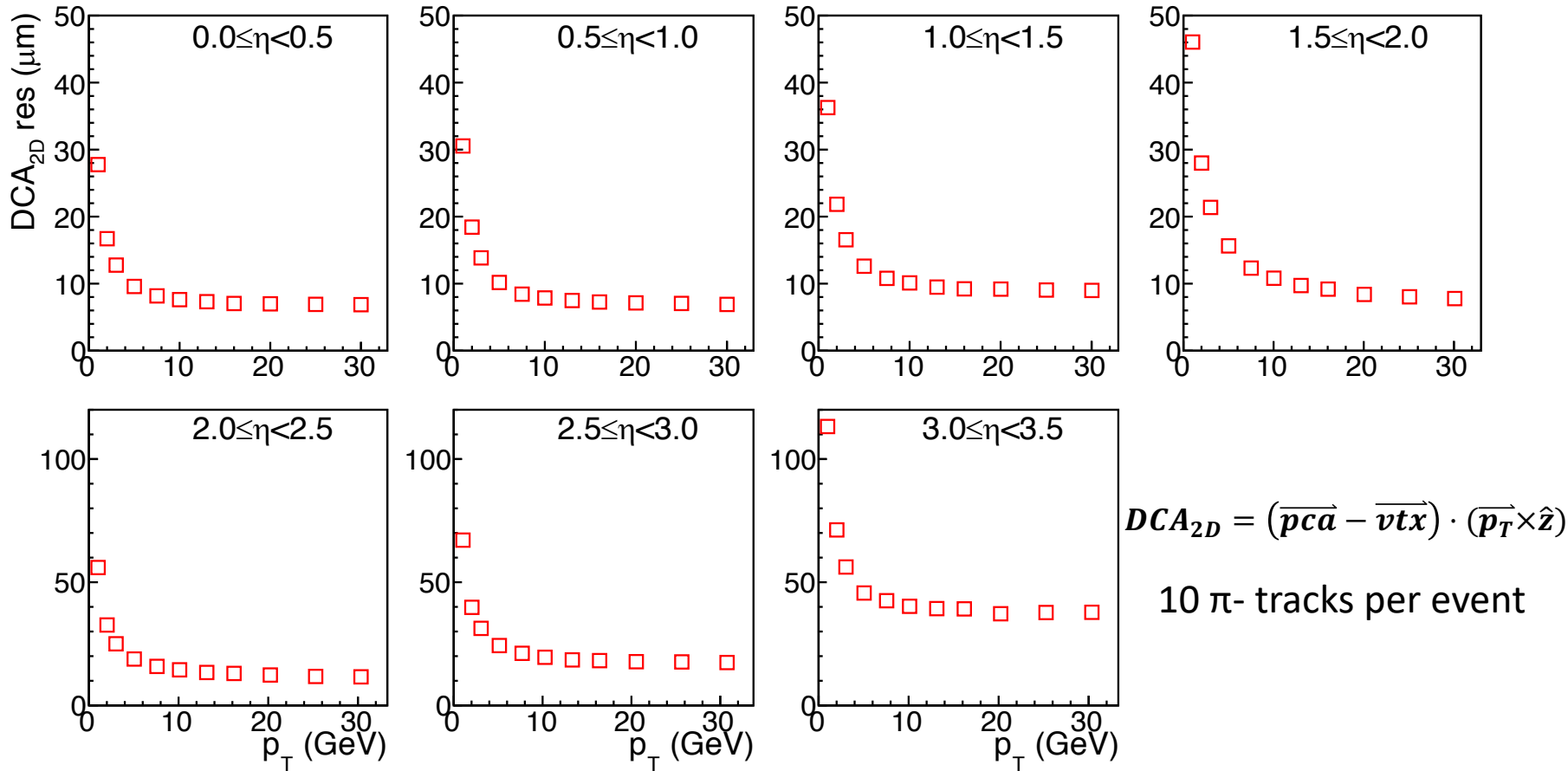
Momentum Resolution of the Tracking System (Babar Magnet Peaks at 1.4T)



- $\eta < 1$: momentum resolution $< 3\%$
- $1 < \eta < 2$: momentum resolution $< 4\%$
- $\eta > 2$: momentum resolution $< 8\%$



DCA_{2D} Resolution of the Tracking System (Babar Magnet Peaks at 1.4T)



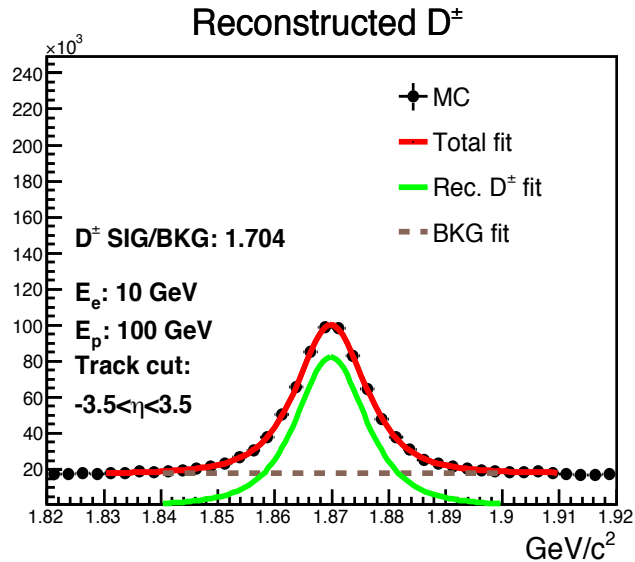
- $\eta < 1$: DCA_{2D} resolution < 32 μm
- $1 < \eta < 2.5$: DCA_{2D} resolution < 60 μm
- $\eta > 2.5$: DCA_{2D} resolution < 120 μm



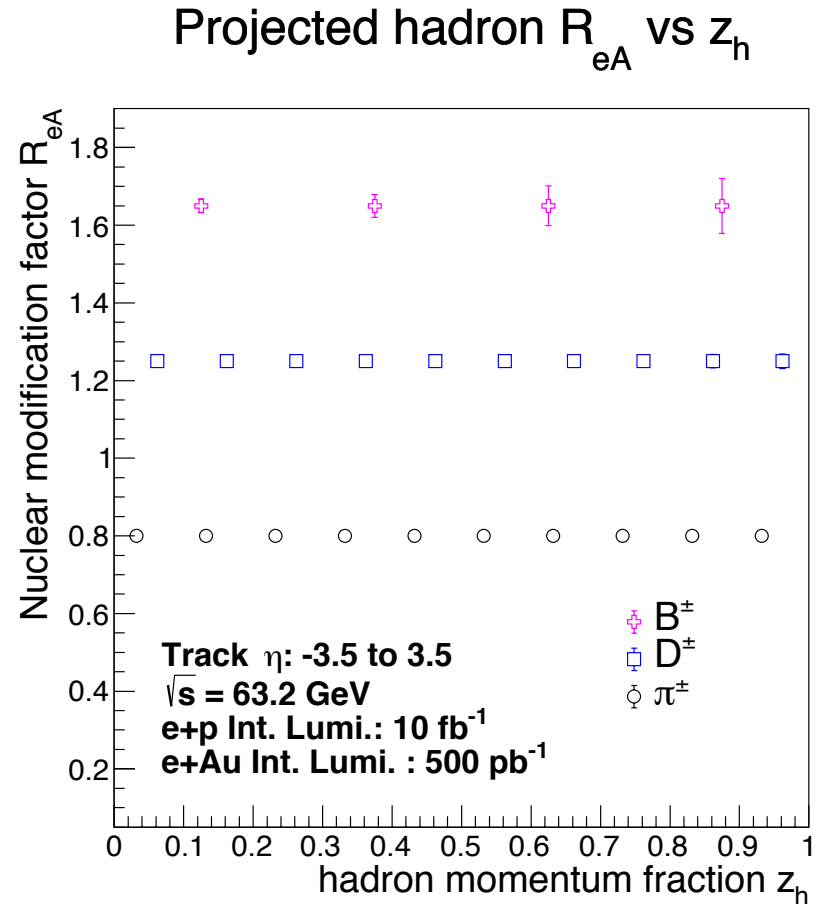
Physics Simulation with Detector Response

The full analysis framework includes the event generation (PYTHIA), detector response in GEANT4 simulation, beam remnant & QCD background, and hadron reconstruction algorithm

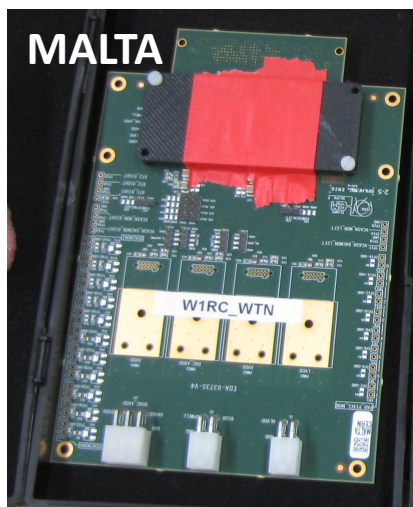
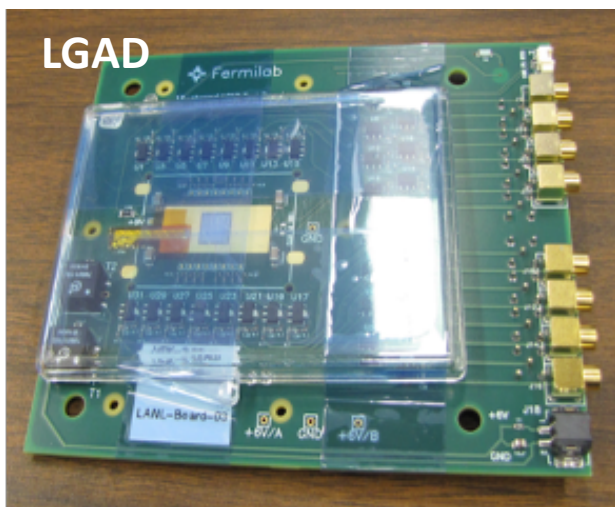
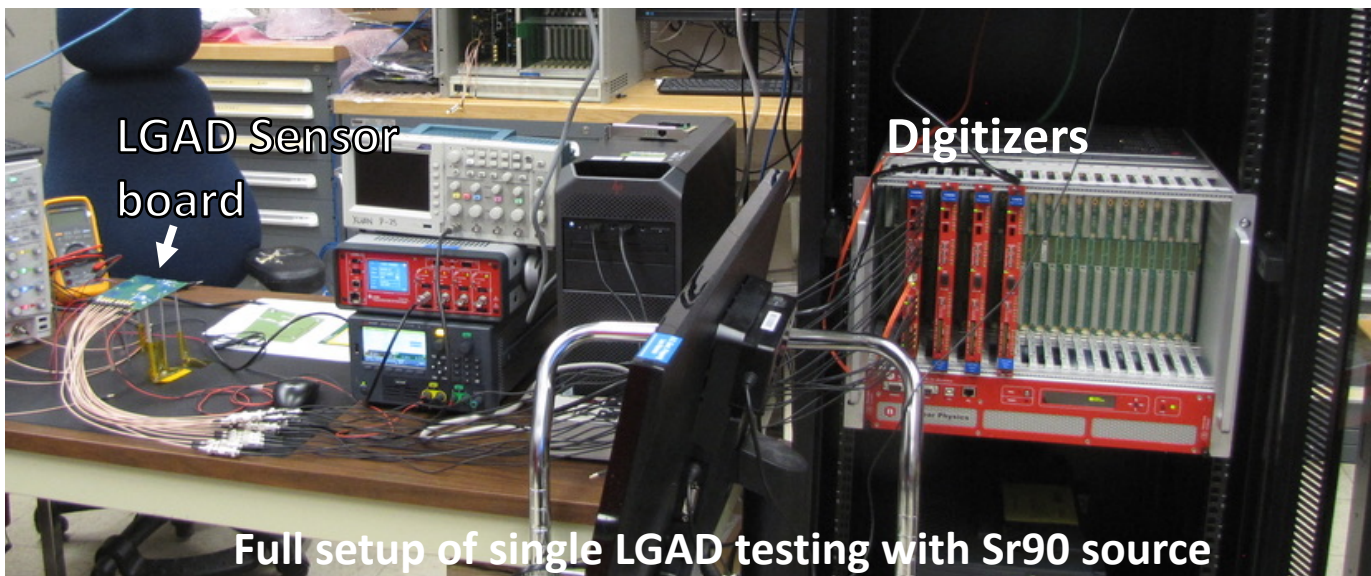
arXiv: 2009.02888, EPJ Web of Conferences 235, 04002 (2020)



- 10 x 100 GeV e-p collisions
- $\int L dt = 10 \text{ fb}^{-1} = 1\text{-year EIC operation}$
- 20-35 μm primary vertex resolution depends on the track multiplicity
- Const. 95% $K/\pi/p$ separation
- $-2 < \eta < 3.5$
- DCA cut on tracks



Sensor Testing at LANL



- Testing LGAD and MALTA sensors (existing sensor technologies)
- Preparing for beam test at LANL LANCE facility



Summary and Plan

EIC FST technical notes - arXiv:2009.02888v1

- Update on FST detector simulation study since the yellow report:
Tracking performance of integrated setup with the Babar magnet
- Tracking performance from simulation is imported to physics simulation for physics projections
- LGAD and MALTA are being tested at LANL

Plan

- Implement a detail FST design in Fun4All software including service parts and supporting structures
- We are happy to work with other subsystem groups on the integrated detector design

