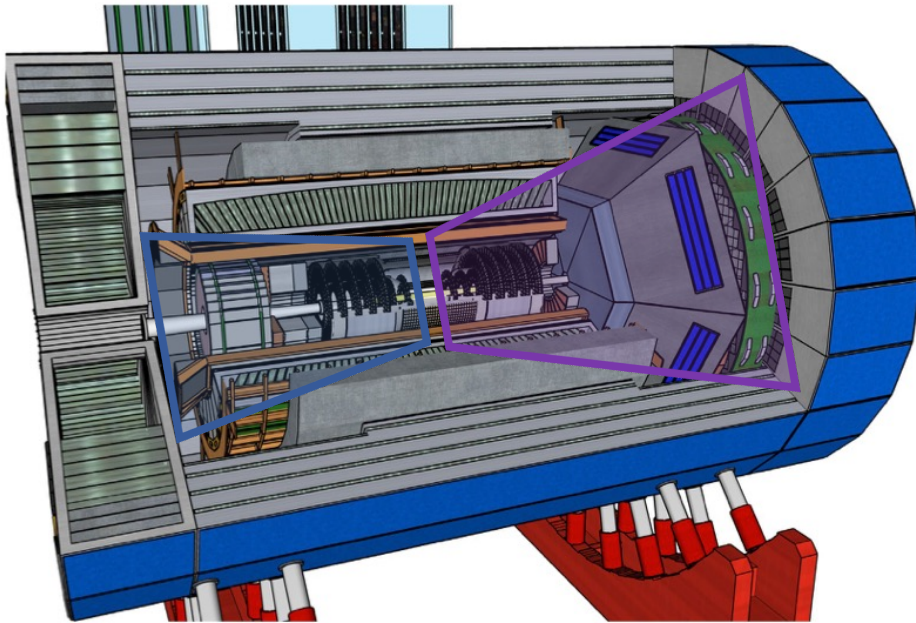


# ECCE Tracking detector progress report

Xuan Li (Los Alamos National Laboratory)  
on behalf of the ECCE Tracking Working Group

LA-UR-21-27260

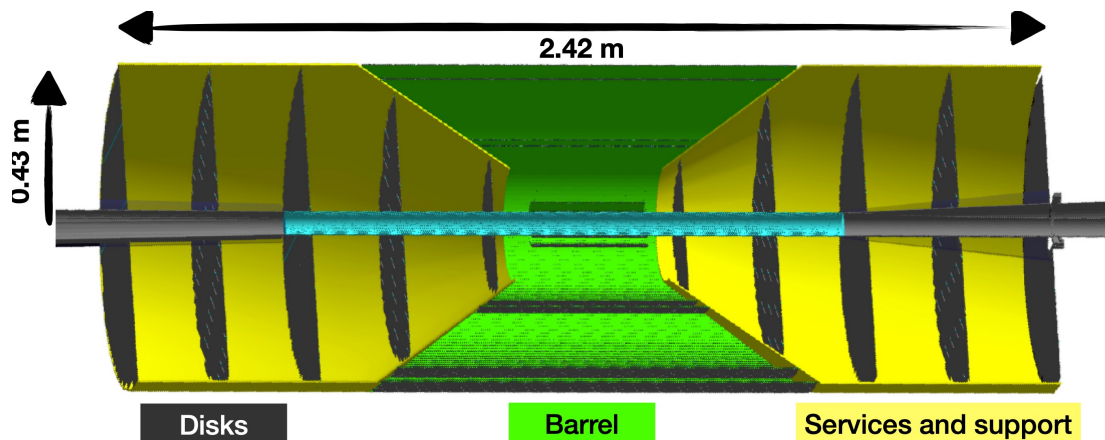
## ECCE detector layout



- Current technology candidates:
  - **Electron endcap:**
    - Monolithic Active Pixel Sensor (MAPS) based silicon planes.
    - $\mu$ Rwell/MPGD planes.
    - Low Gain Avalanche Diode (LGAD) based ToF (outer tracker).
  - **Central Barrel:**
    - Monolithic Active Pixel Sensor (MAPS) based silicon vertex/tracking layers.
    - $\mu$ Rwell/MPGD layers.
    - Low Gain Avalanche Diode (LGAD) based ToF (outer tracker)
  - **Hadron endcap:**
    - Monolithic Active Pixel Sensor (MAPS) based silicon planes.
    - $\mu$ Rwell/MPGD planes.
    - Low Gain Avalanche Diode (LGAD) based ToF (outer tracker).

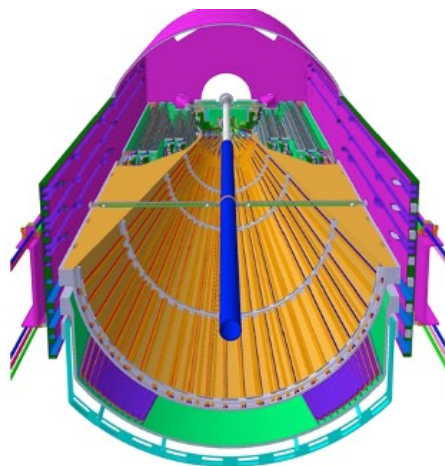
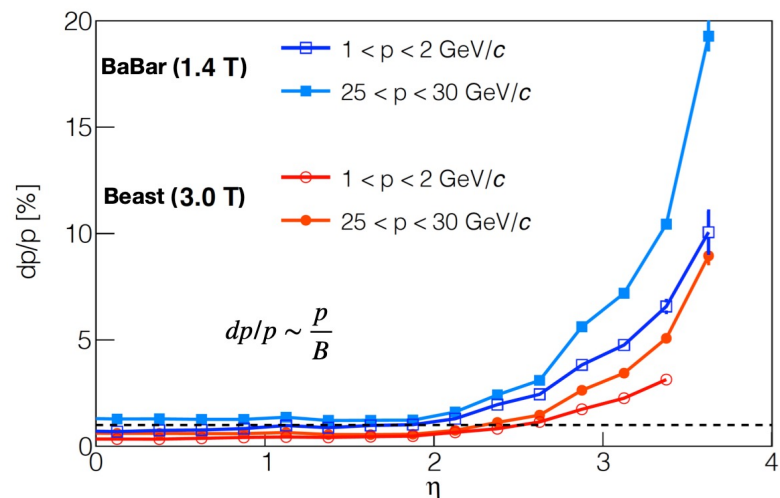
# All-Si Tracker

- All-Silicon Tracker design based on  $10\ \mu\text{m}$  pixel pitch MAPS (ITS-3 65 nm) technology.



Rey Cruz-Torres (LBNL), Leo Greiner (LBNL), Yuxiang Zhao (IMP)

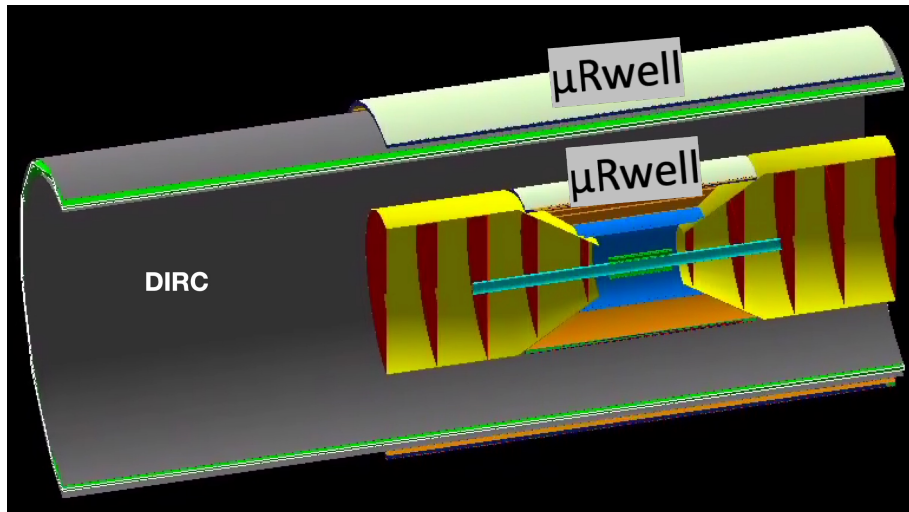
- Detector geometry implemented in Fun4All.
- Tracking performance evaluated. arXiv: 2102.08337
- Support structure and material budgets evaluated.



# Hybrid Si+Gas Alternative

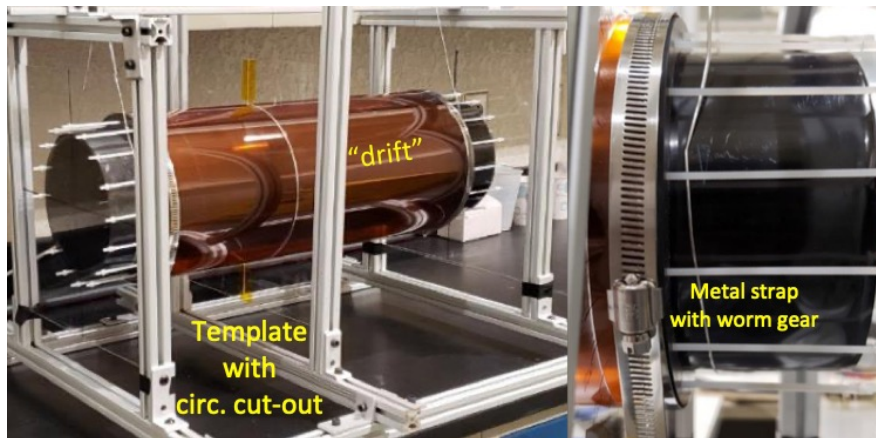


- Potential hybrid barrel detector consists of silicon and MPGD/ $\mu$ Rwell tracker.



Rey Cruz-Torres (LBNL), Nilanga Liyanage (UVA), Sourav Tarafdar (Vanderbilt Univ.)

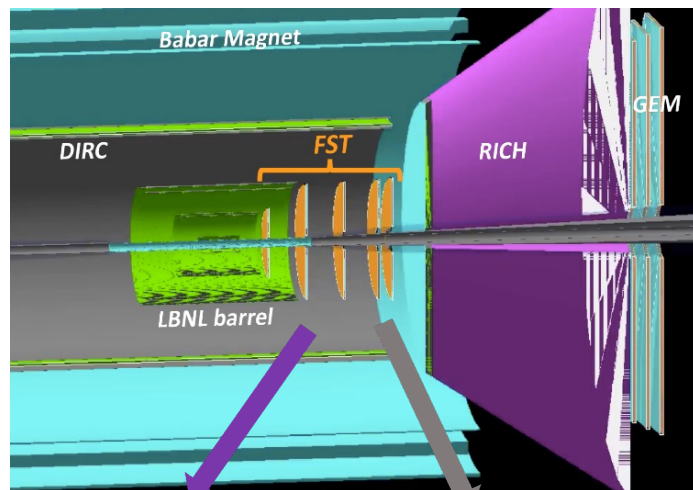
- Initial detector geometry based on the GEM implemented in Fun4All and corresponding tracking performance evaluated.
- Further updates based on  $\mu$ Rwell (MPGD) technology implemented.



# Forward Silicon Tracker

- Forward Silicon Tracker design based on  $20\ \mu\text{m}$  pixel pitch MAPS (ITS-3 like) technology and  $36.4\ \mu\text{m}$  pixel pitch DMAPS technology.

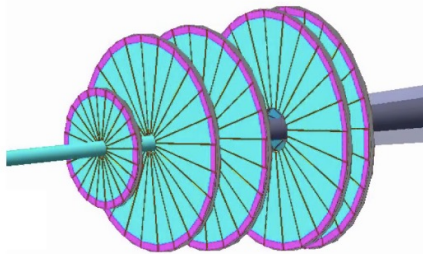
## LANL FST implemented in Fun4All



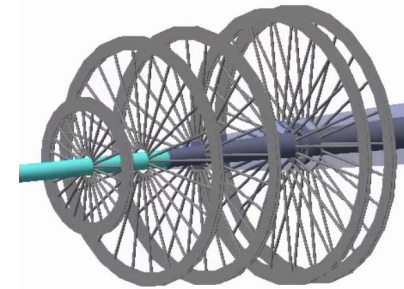
**Cheuk-Ping Wong (LANL), Xuan Li (LANL)**

- Detector geometry fully implemented in Fun4All.
- Initial tracking performance evaluated. arXiv: 2009.02888
- Recent updates with estimated support structure and cooling.

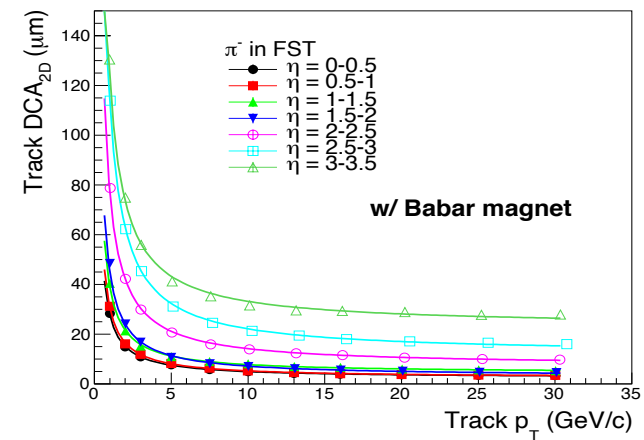
Silicon wedge and readout



Support and cooling



DCA<sub>2D</sub> resolution VS p<sub>T</sub>

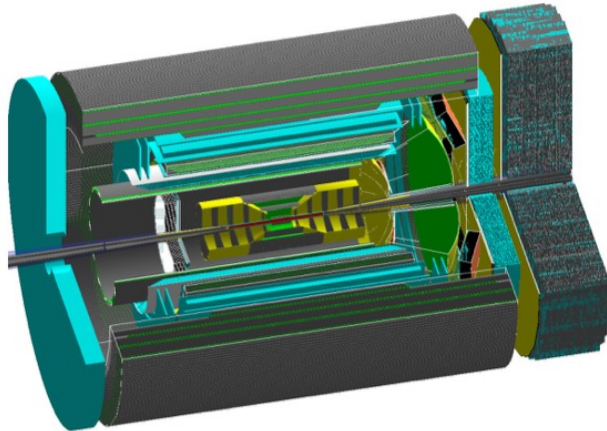


# LGAD based ToF (Outer Tracker)

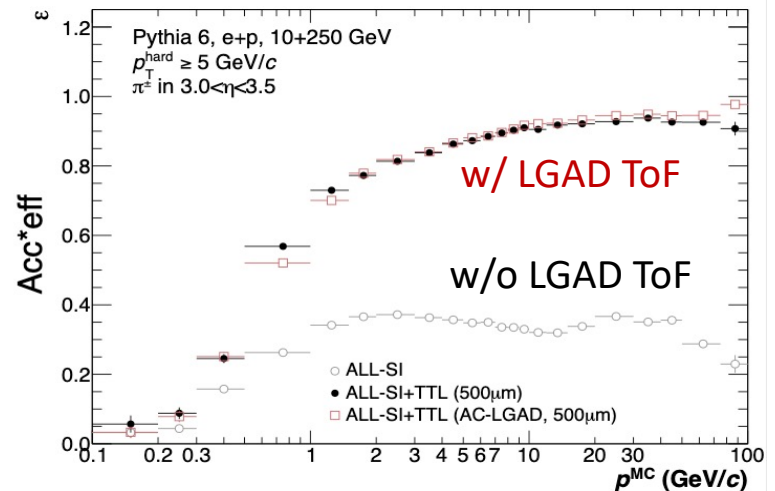
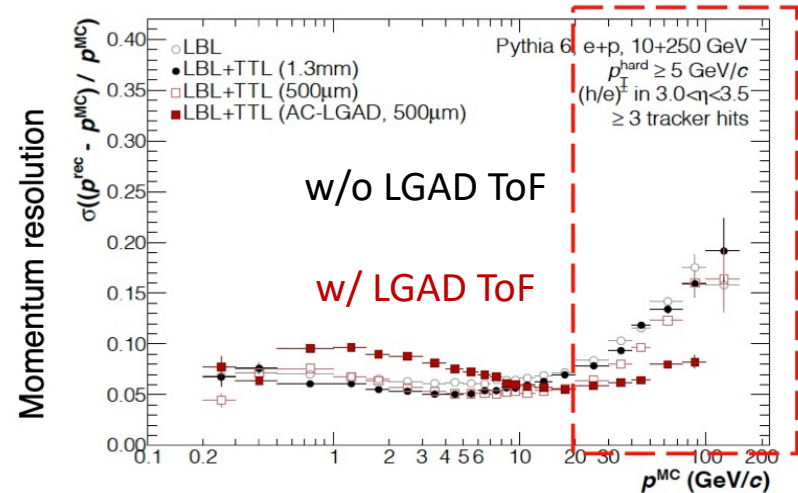
- The LGAD based ToF has been implemented within the barrel, hadron and electron endcap regions in Fun4All.

See Xiaochun's talk about the ECCE PID

- For example, including the LGAD ToF in the hadron endcap region can improve the tracking performance and coverage of the All-Si tracker in the forward region.



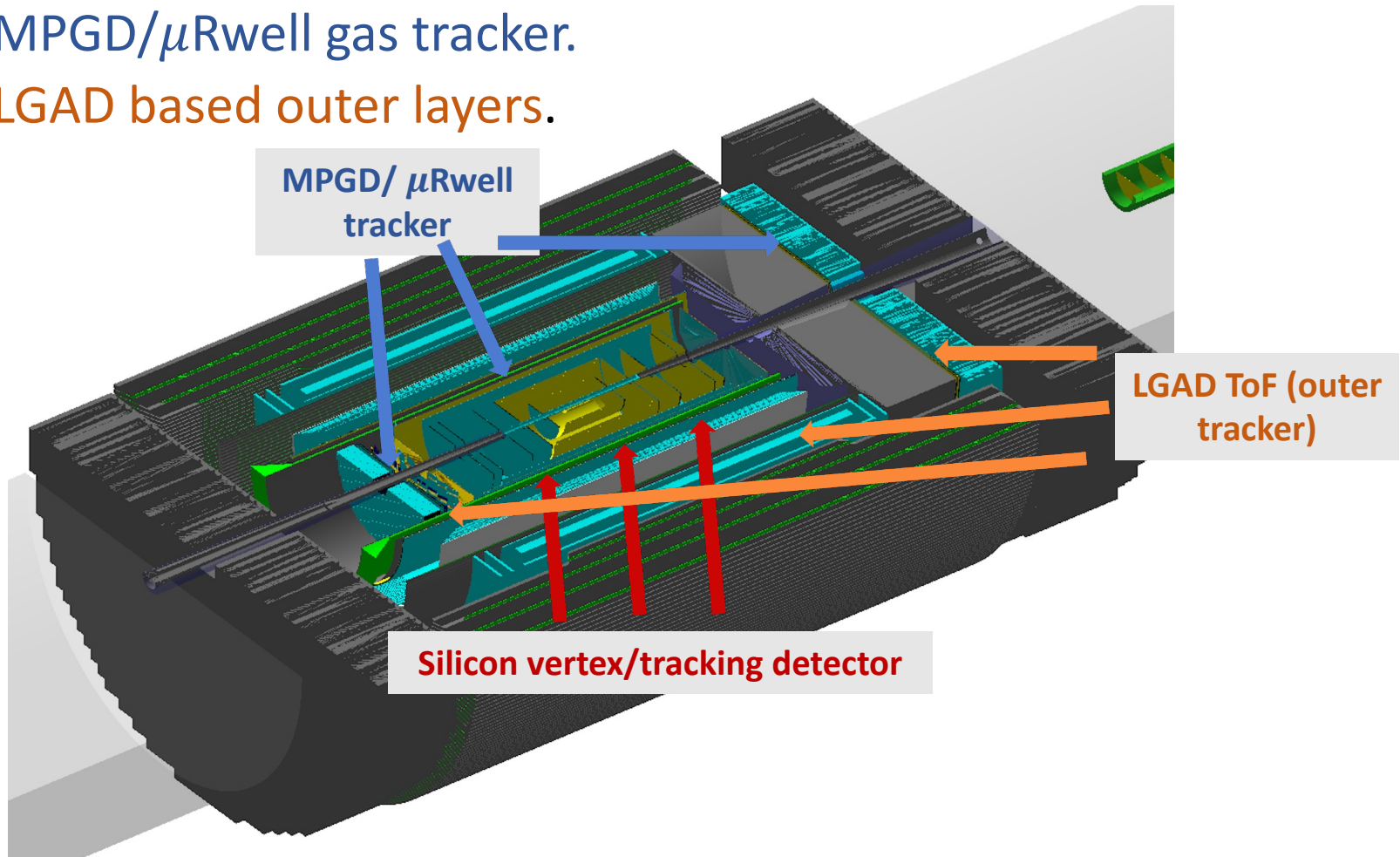
## Wei Li (Rice Univ.) Friederike Bock (ORNL)



# Integrated ECCE Detector implemented in Fun4All



- July concept ECCE tracking detector consists of
  - MAPS based silicon vertex/tracking layers/planes.
  - MPGD/ $\mu$ Rwell gas tracker.
  - LGAD based outer layers.

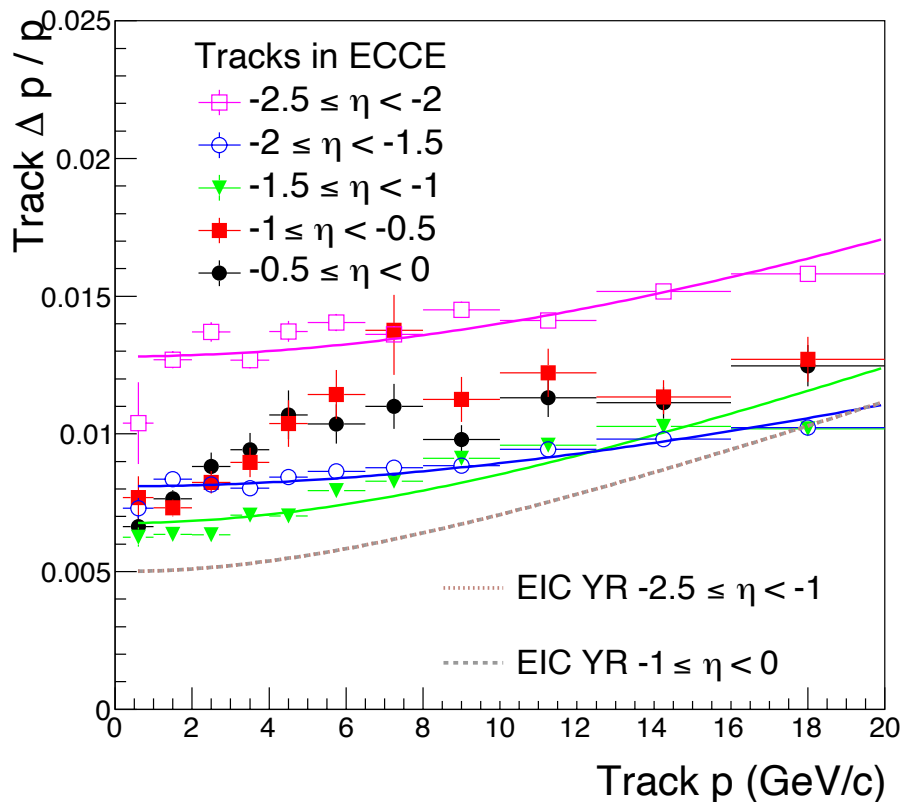


# ECCE Detector Tracking Performance: Momentum resolution

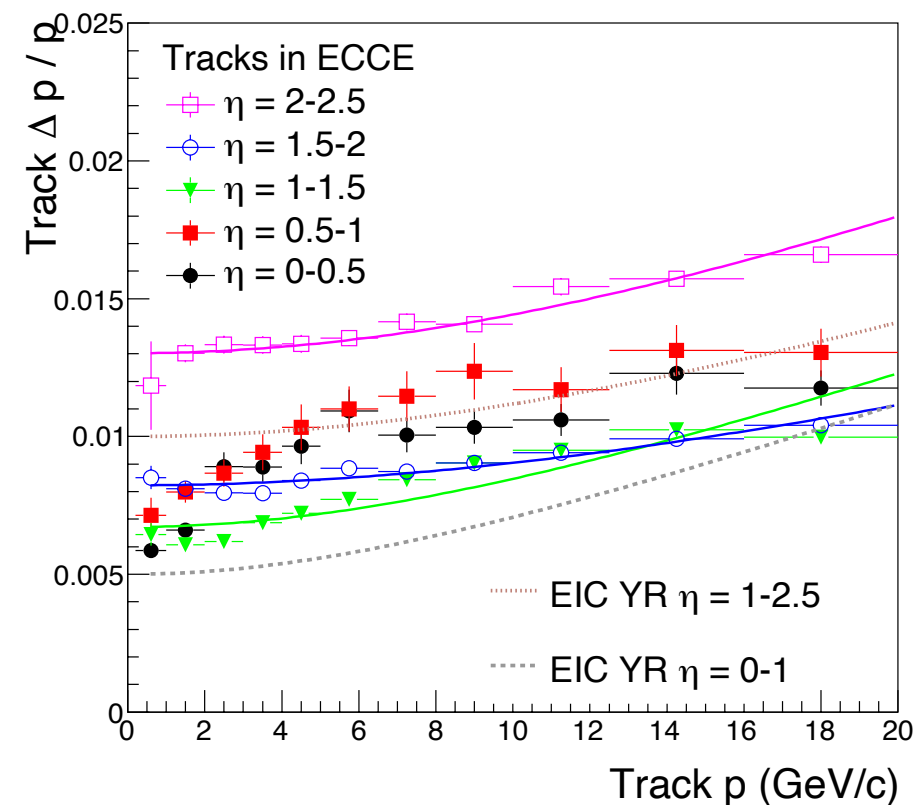


- The tracking momentum resolution of the current ECCE design is not far from the EIC Yellow Report requirements.

$\Delta p / p$  VS  $p$  in  $-2.5 \leq \eta < 0$



$\Delta p / p$  VS  $p$  in  $0 \leq \eta < 2.5$



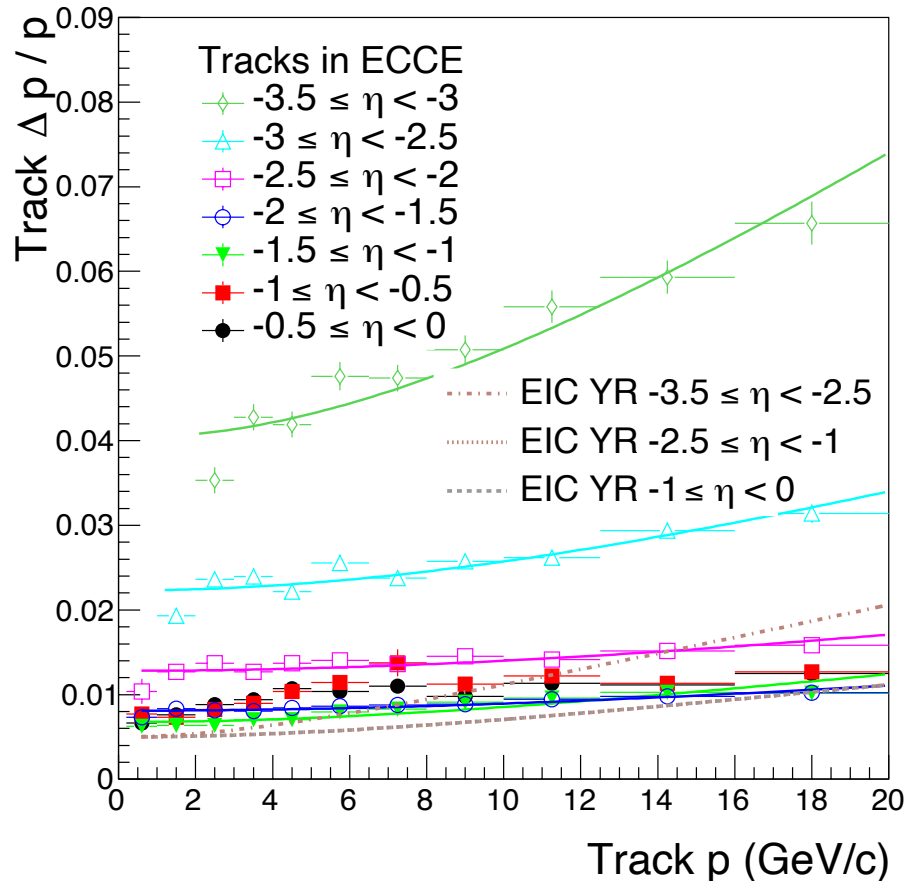


# ECCE Detector Tracking Performance: Momentum resolution

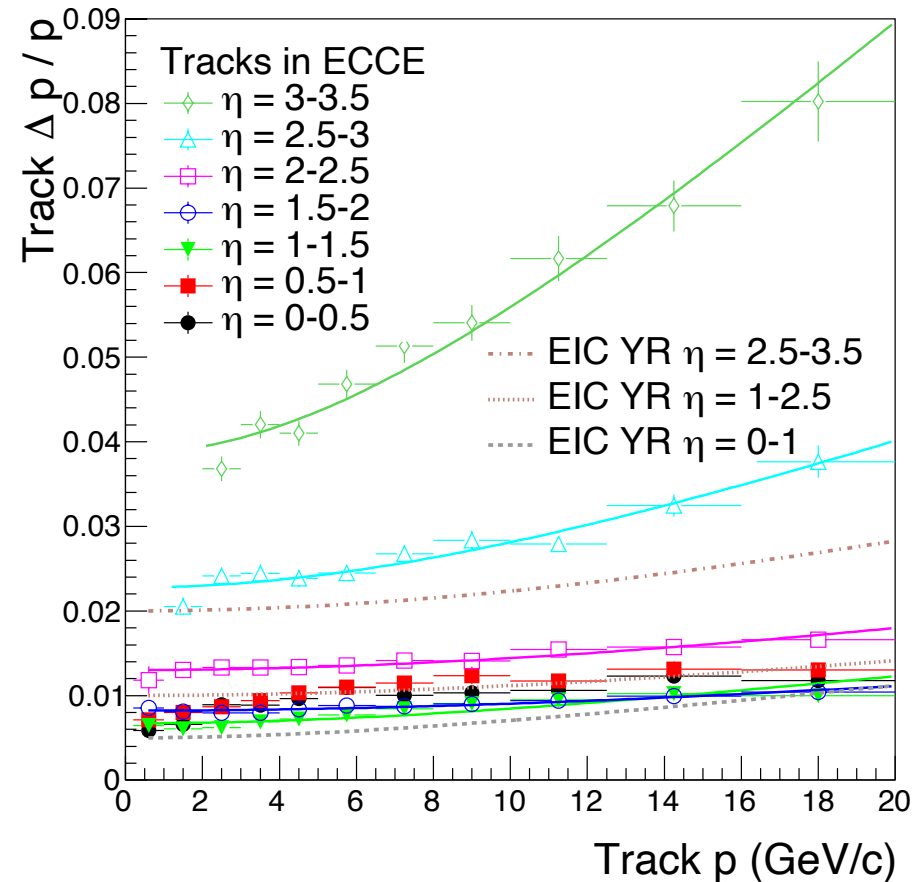


- The tracking momentum resolution of the current ECCE design is not far from the EIC Yellow Report requirements.

$\Delta p / p$  VS  $p$  in  $-3.5 \leq \eta < 0$



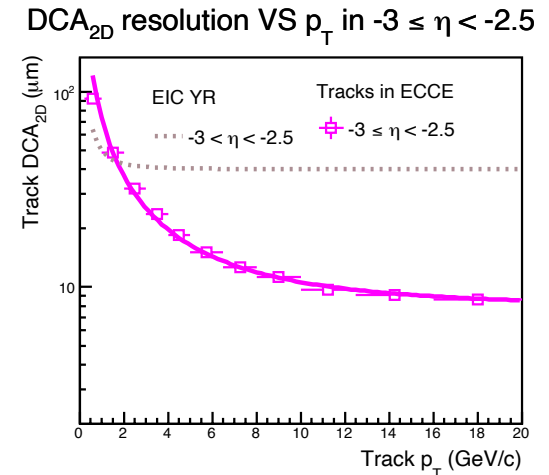
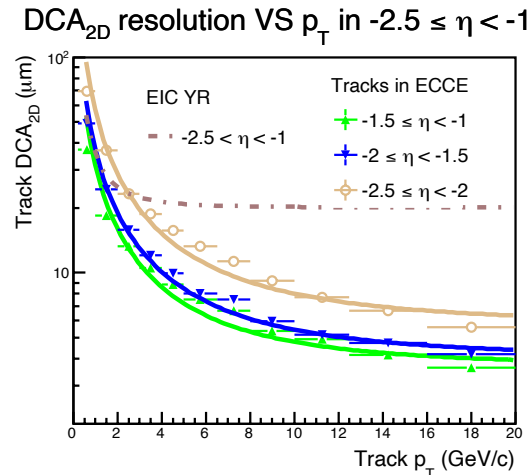
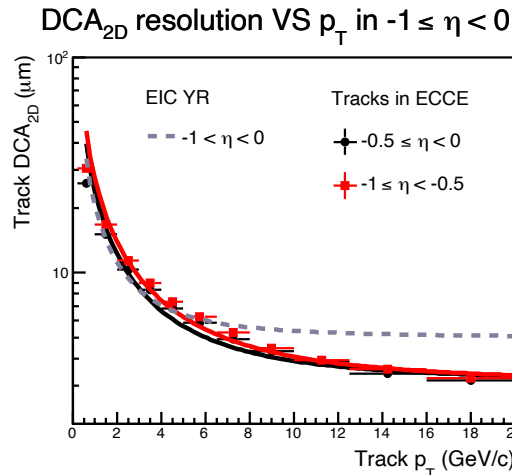
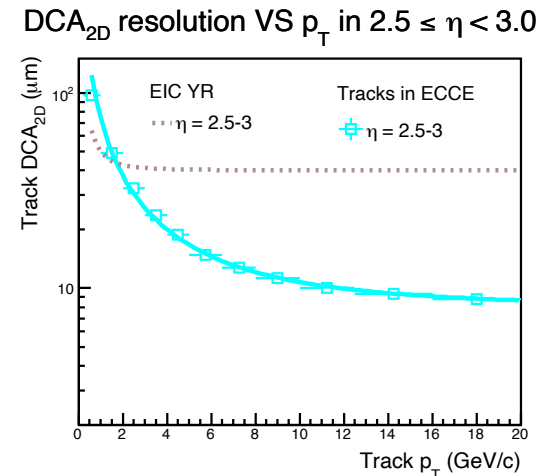
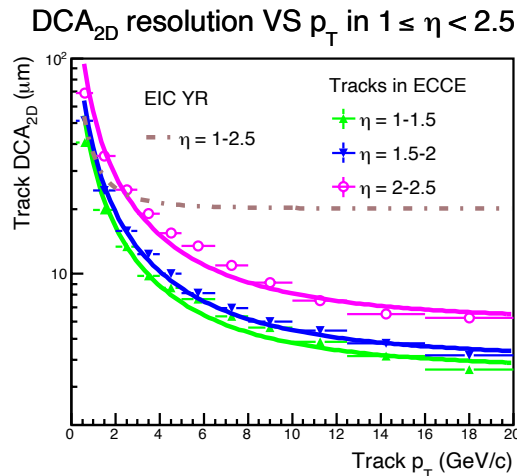
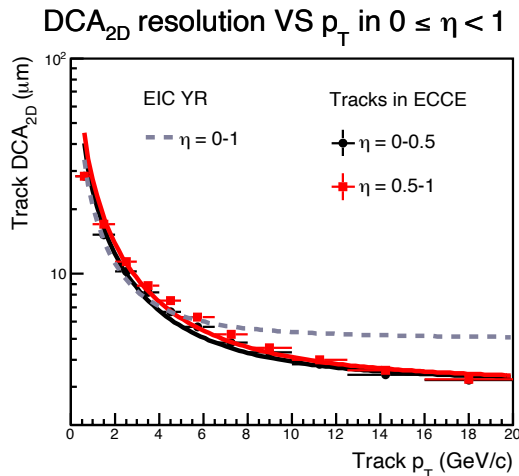
$\Delta p / p$  VS  $p$  in  $0 \leq \eta < 3.5$



# ECCE Detector Tracking Performance: DCA<sub>2D</sub> resolution



- The tracking DCA<sub>2D</sub> resolution of the current ECCE design meets the EIC Yellow Report requirements.



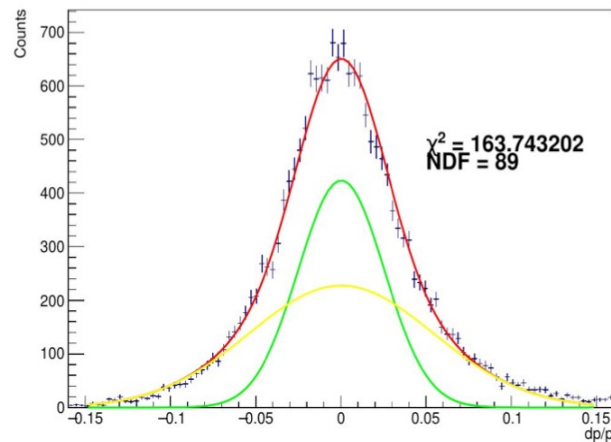
# Ongoing tracking performance studies (I)



- With the new simulation production for the integrated ECCE detector, various tracking performance studies are underway.

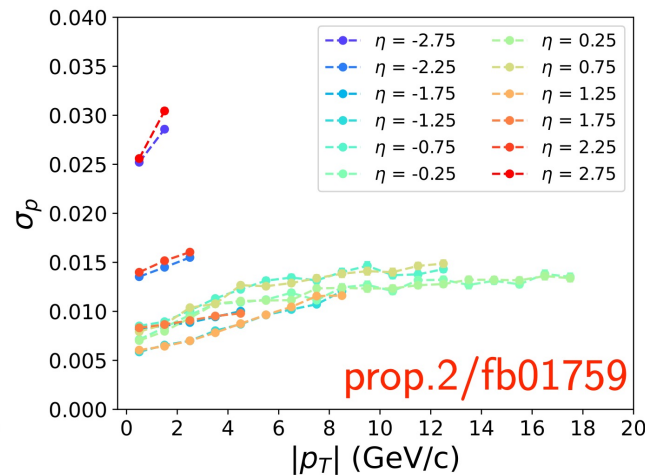
## Karthik Suresh (Regina)

$2.5 < |\eta| < 3.5, 2.0 < p < 4.0 \text{ GeV}/c$



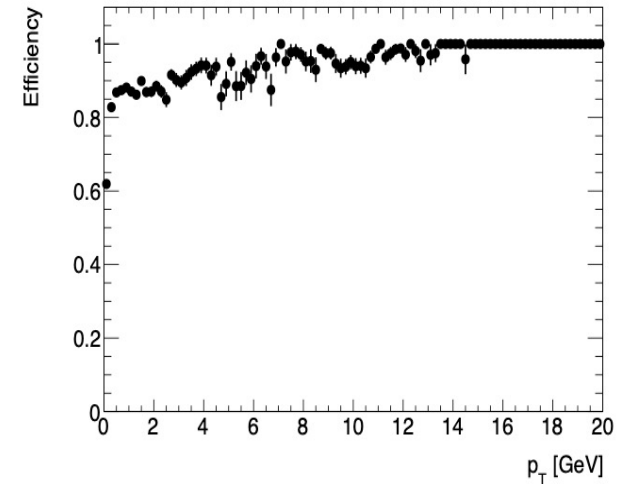
Improved tracking momentum resolution fit.

## Tyler Kutz (MIT & GWU)



$p_T$  dependent tracking momentum resolution.

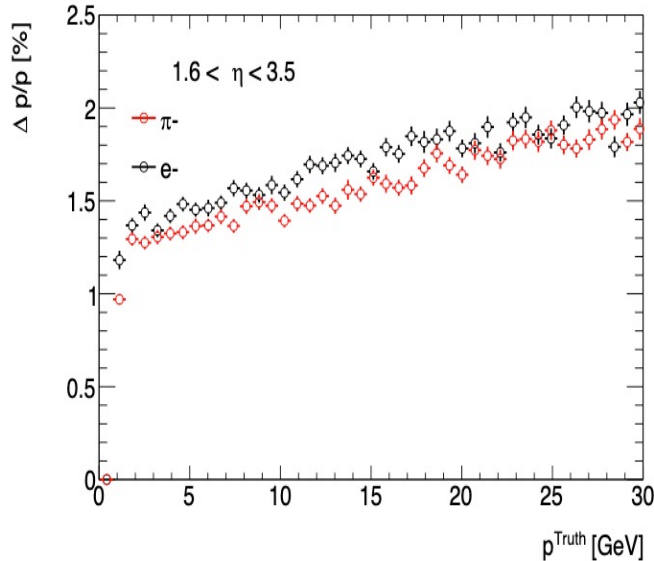
## Sebastian Tapia (ISU)



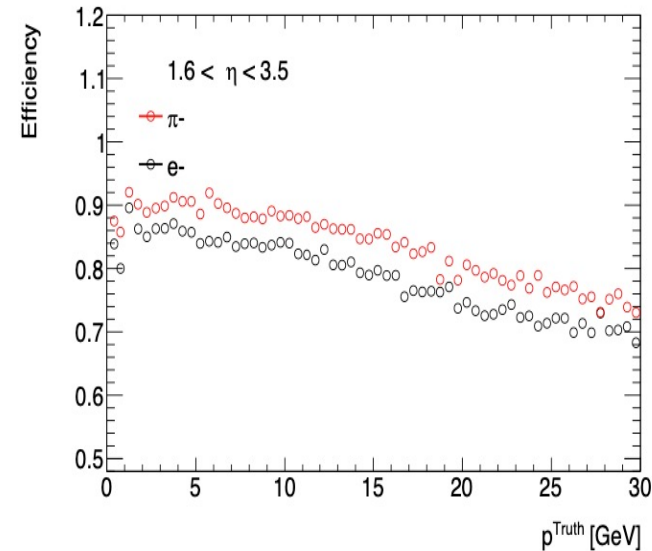
$p_T$  dependent tracking efficiency.

- With the new simulation production for the integrated ECCE detector, various tracking performance studies are underway.

Sourav Tarafdar (Vanderbilt Univ.)

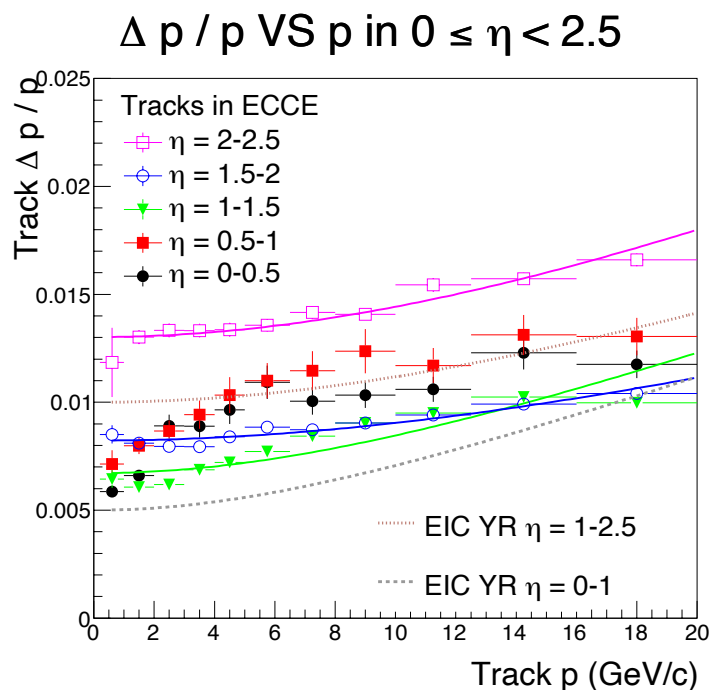


$p$  dependent tracking momentum resolution in the forward region .

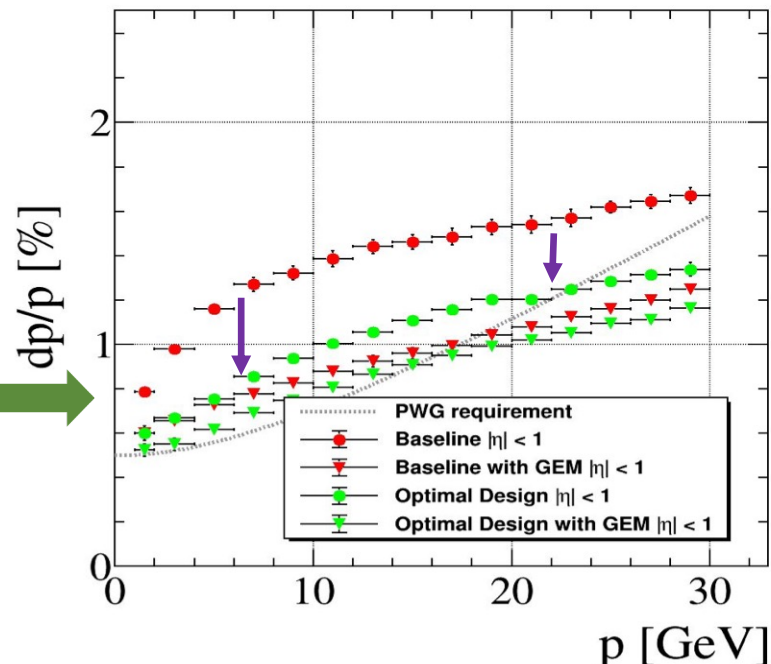


$p$  dependent tracking efficiency in the forward region.

- With the new simulation production for the integrated ECCE detector, various tracking performance studies are underway.



Cristiano Fanelli (MIT), Karthik Suresh (Regina)



- More results will come.

Barrel Si tracker + GEM optimization with AI.

- We have collected various tracking technology/design inputs from various institutions/consortia.
- The July concept ECCE integrated tracking detector has been implemented in simulation.
- Tracking performance of the integrated ECCE tracking detector is promising.
- More detailed studies are underway.
- We welcome new contributions/collaborators!

- **MattMost link:**

<https://chat.sdcc.bnl.gov/ecce/channels/ecce-tracking>

- **ECCE Tracking WIKI page:**

[https://wiki.bnl.gov/eicug/index.php/ECCE\\_Detector#ECCE\\_Tracking](https://wiki.bnl.gov/eicug/index.php/ECCE_Detector#ECCE_Tracking)

- **ECCE indico page:**

<https://indico.bnl.gov/category/345/>

- Please sign up for [ecce-eic-public-l](#) and [ecce-eic-det-l](#) to receive future meeting announcements and share your thoughts!





- We focus on the tracking detector options and associated studies such as simulation, design, integration etc. using the existing Babar magnet at IP6 (IP8).

## ECCE Tracking Working Group Meeting

Tuesday 4 May 2021, 13:00 → 14:00 US/Mountain



**Description** EIC ECCE tracking discussions.

The phone bridge:

<https://bnl.zoomgov.com/j/1618724619?pwd=MIFFejBUenlrZVhxZlFrMEUwaVFUdz09>

### 13:00 → 13:15 Introduction from the covener

**Speakers:** Prof. Nilanga Liyanage (UVA) , Dr Xuan Li (Los Alamos National Laboratory)

 EIC\_ECCE\_tracking...

### 13:15 → 14:00 Open discussions

- 1, technology interests.
- 2, simulation status and tasks.
- 3, integration with the other detector subsystems.
- 4, volunteers who will lead a specific task.
- 5, the other topics (e.g. physics related studies).

 EIC\_ECCE\_tracking...

- **Meeting organization:** we meet on a weekly basis but switch the meeting date and time to allow colleagues from different time zones to dial in. The upcoming meetings are arranged the following:

- 3PM US ET on Tuesdays.
- 10:30AM US ET on Fridays.

- Please see progresses and recent studies in the indico: <https://indico.bnl.gov/category/345/>