ECCE TOF requirements and design

Wei Li

Rice University

EIC Detector 1 TOF-PID WG
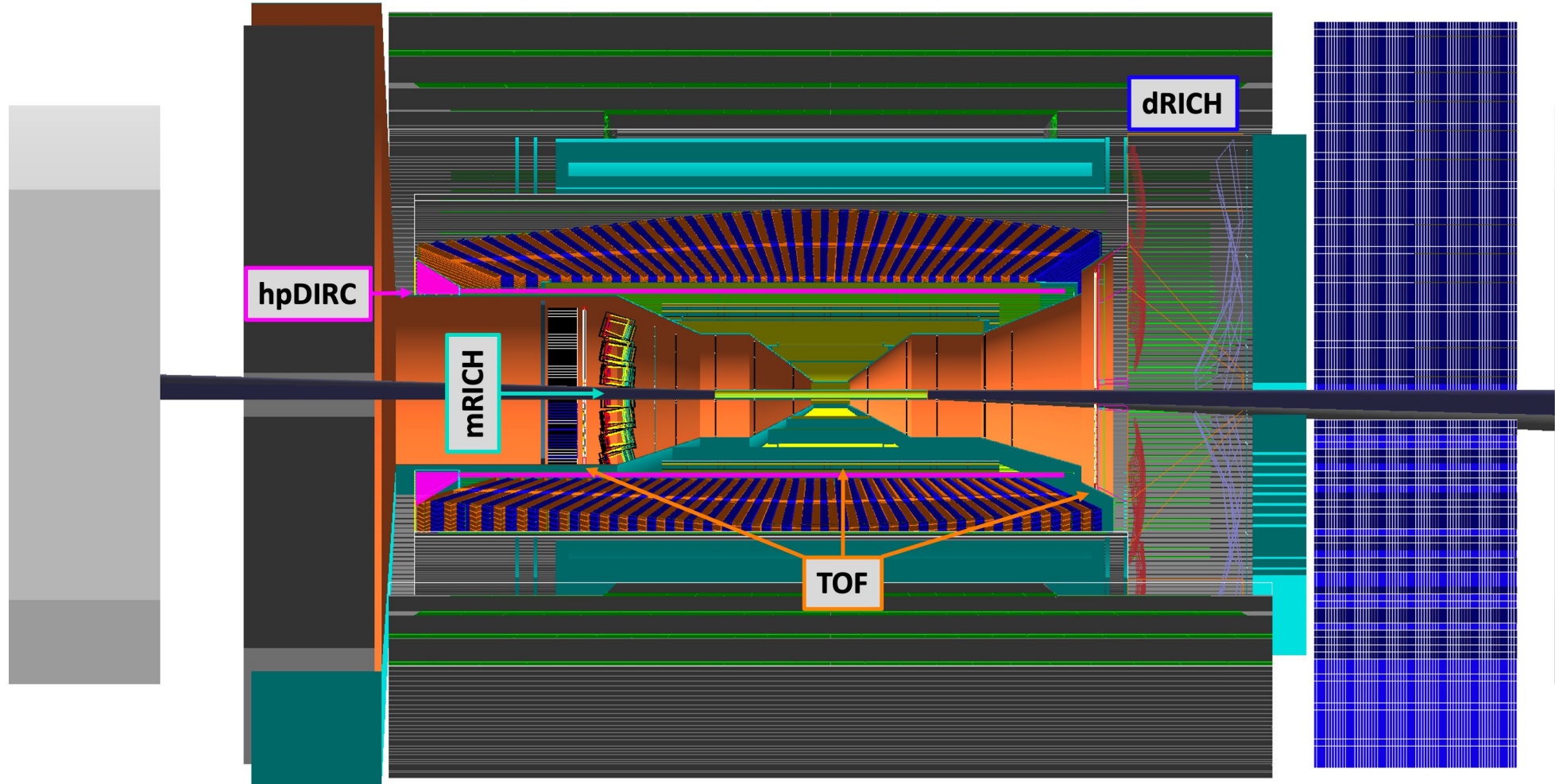April 25, 2022

ECCE TOF (tracking) Design

dRICH

hpDIRC

mRICH

TOF

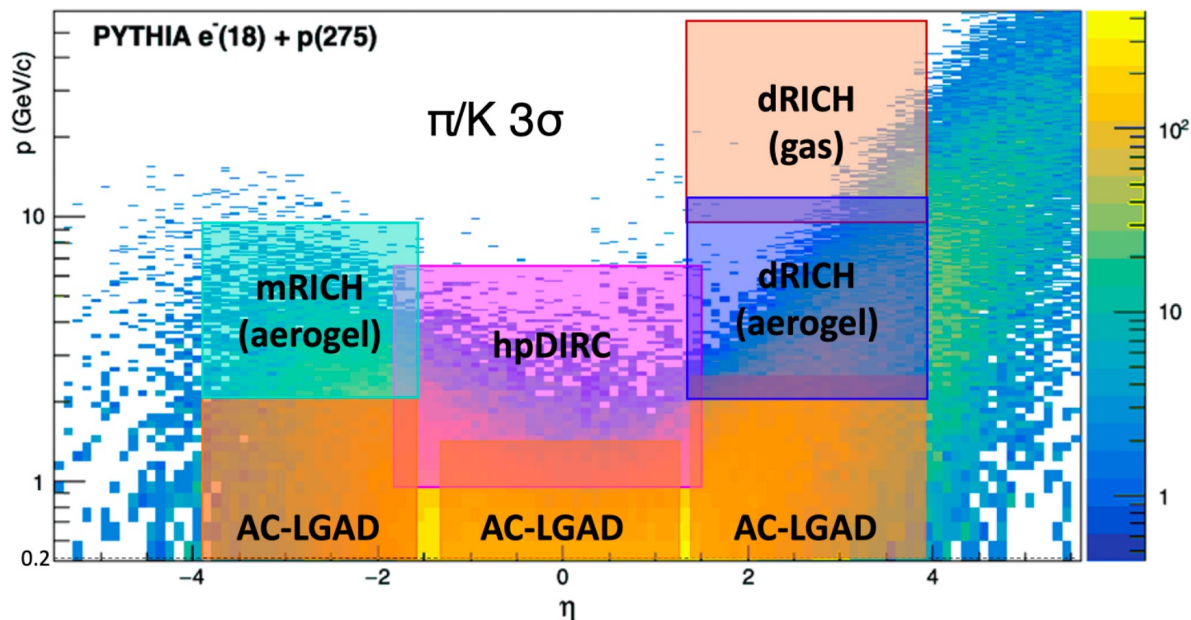https://www.ecce-eic.org/ecce-internal-notes

ECCE TOF (tracking) Design

General principles:

- a 4π TOP-PID coverage for (e/π/K/p) for low-to-intermediate p range that sufficiently overlaps with RICH-based PID systems to cover the full phase space for PID

- Provide a high spatial resolution point for tracking

- Forward ($1.5<\eta<3.5$): $0.15 <p < 2$ GeV
- Central ($|\eta|<1.4$): $0.15 < p_T < 1.5$ GeV
- Backward ($-3.7<\eta<-1.74$): $0.15 < p< 2.5$ GeV

- Explore novel technology (AC-LGADs, benefit the tracking) and leverage established designs (DC-LGADs for CMS/ATLAS) to minimize the cost and retain a fallback solution.

- Material budget does not impact the performance of other subsystems.

- Reasonable size and cost (e.g., comparable to CMS/ATLAS TOF system).
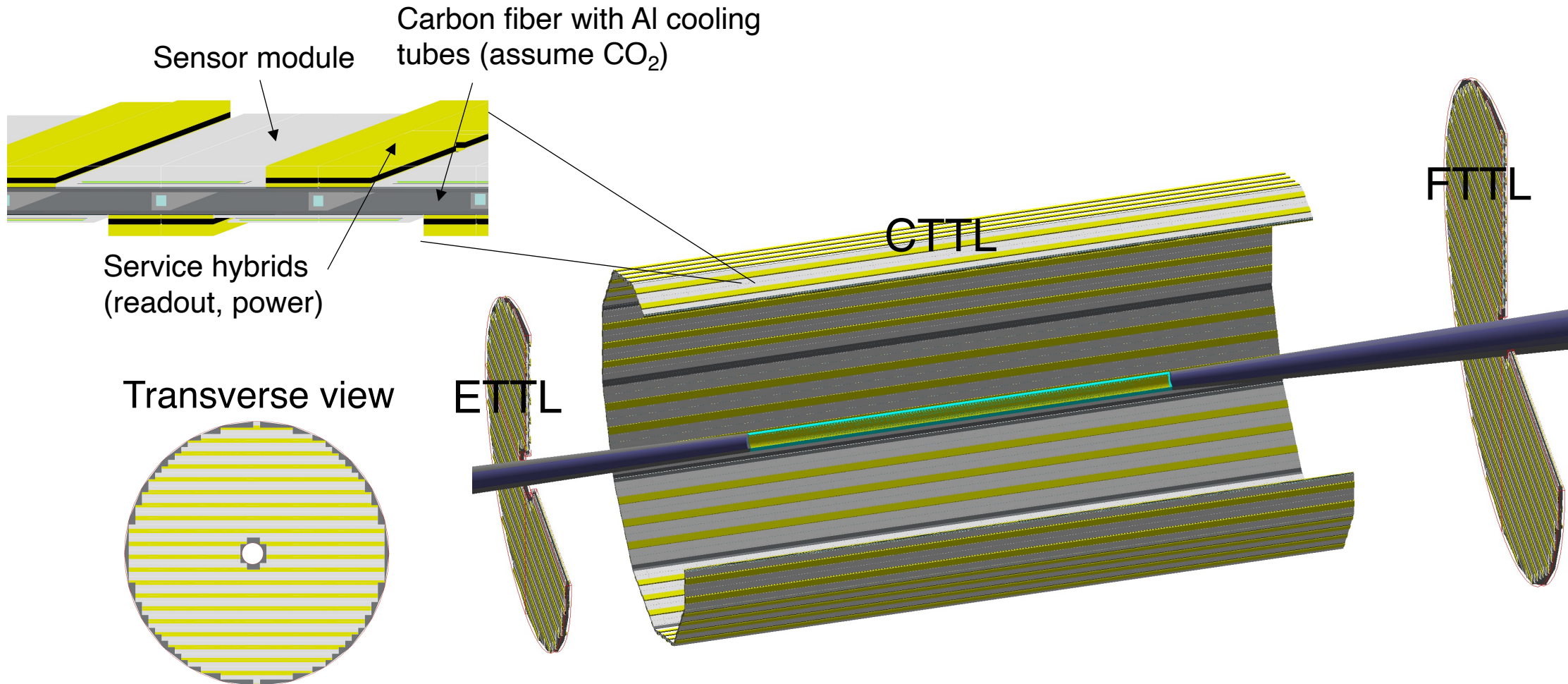
3

ECCE TOF (tracking) Design

Key specifications:

- σ_t = 25 ps per hit
- 0.5x3 mm^2 pixel: σ_x = 30μm per hit
- Material: ~ 6% total
- Total area: ~ 15 m^2 (comparable to CMS ETL)
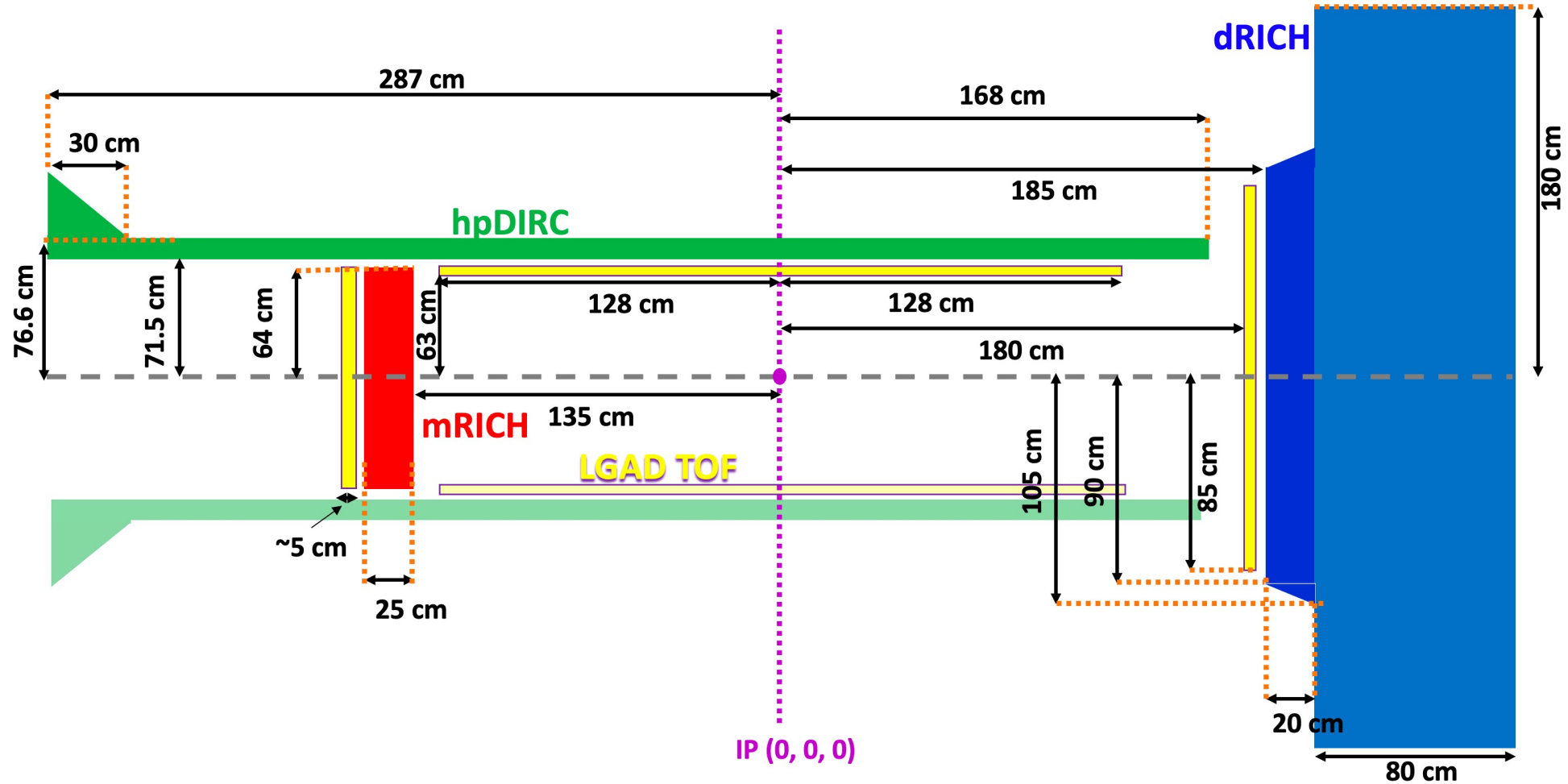- Number of readout channels: 8-9 millions (comparable to CMS ETL)
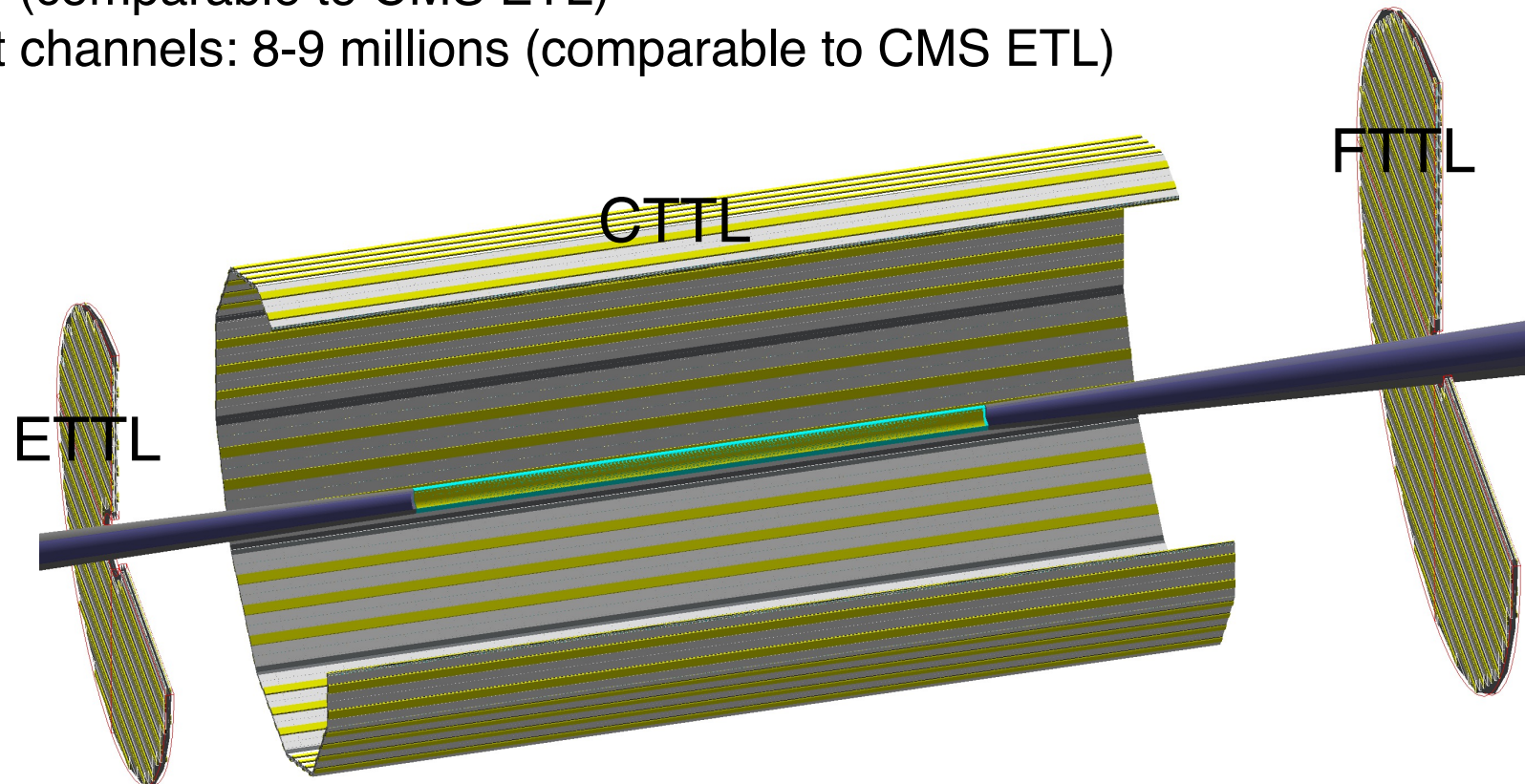
ECCE TOF (tracking) Design

The design is largely a copy of CMS ETL module, electronics, service design (minimize the risk!) but adopts lighter support/cooling to minimize material budget

Sensor module

Carbon fiber with Al cooling tubes (assume CO_2)

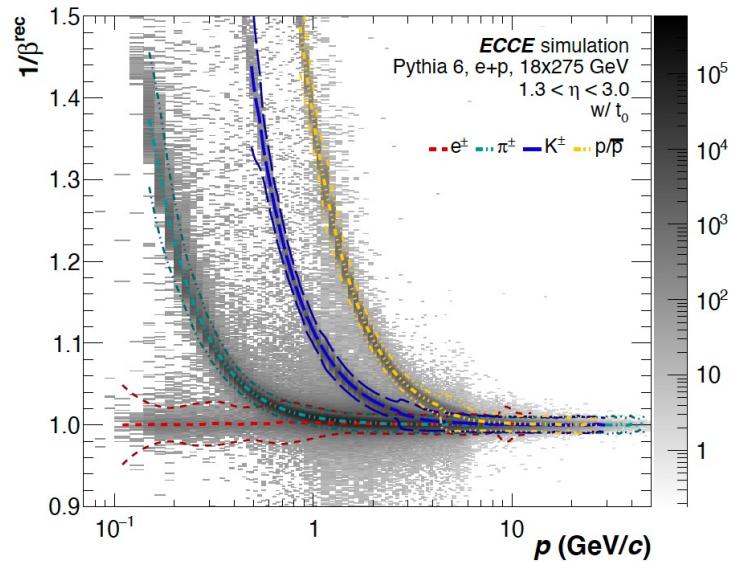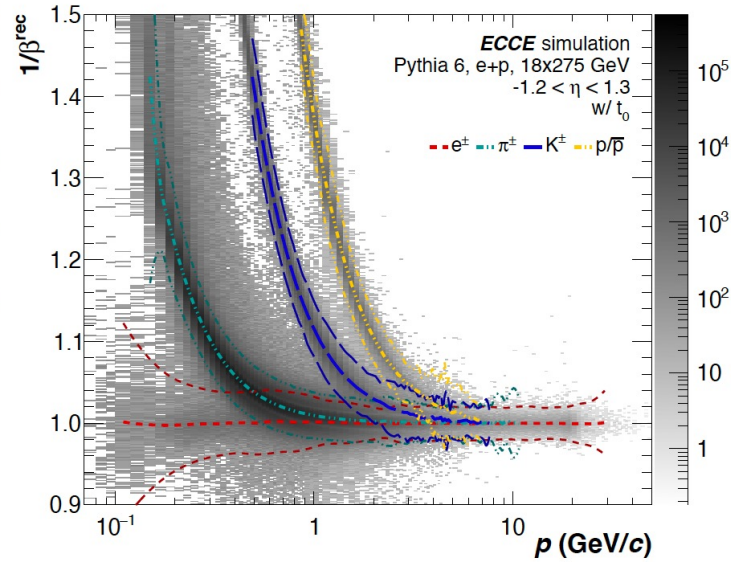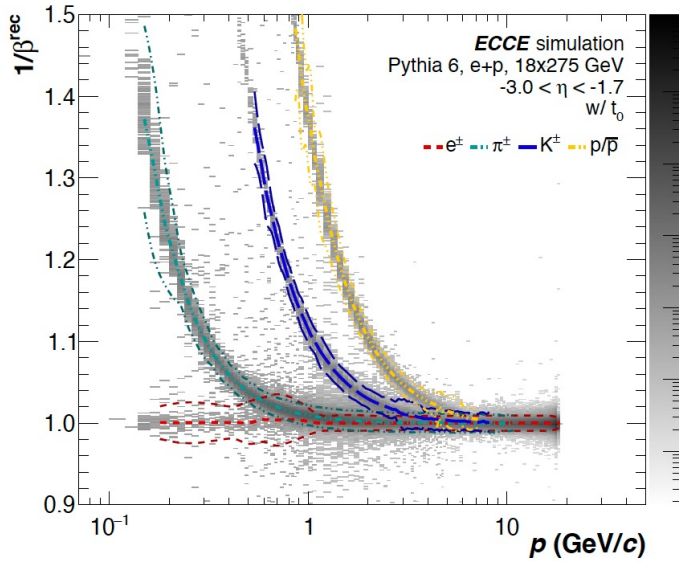Service hybrids (readout, power)

Transverse view

CTTL

FTTL

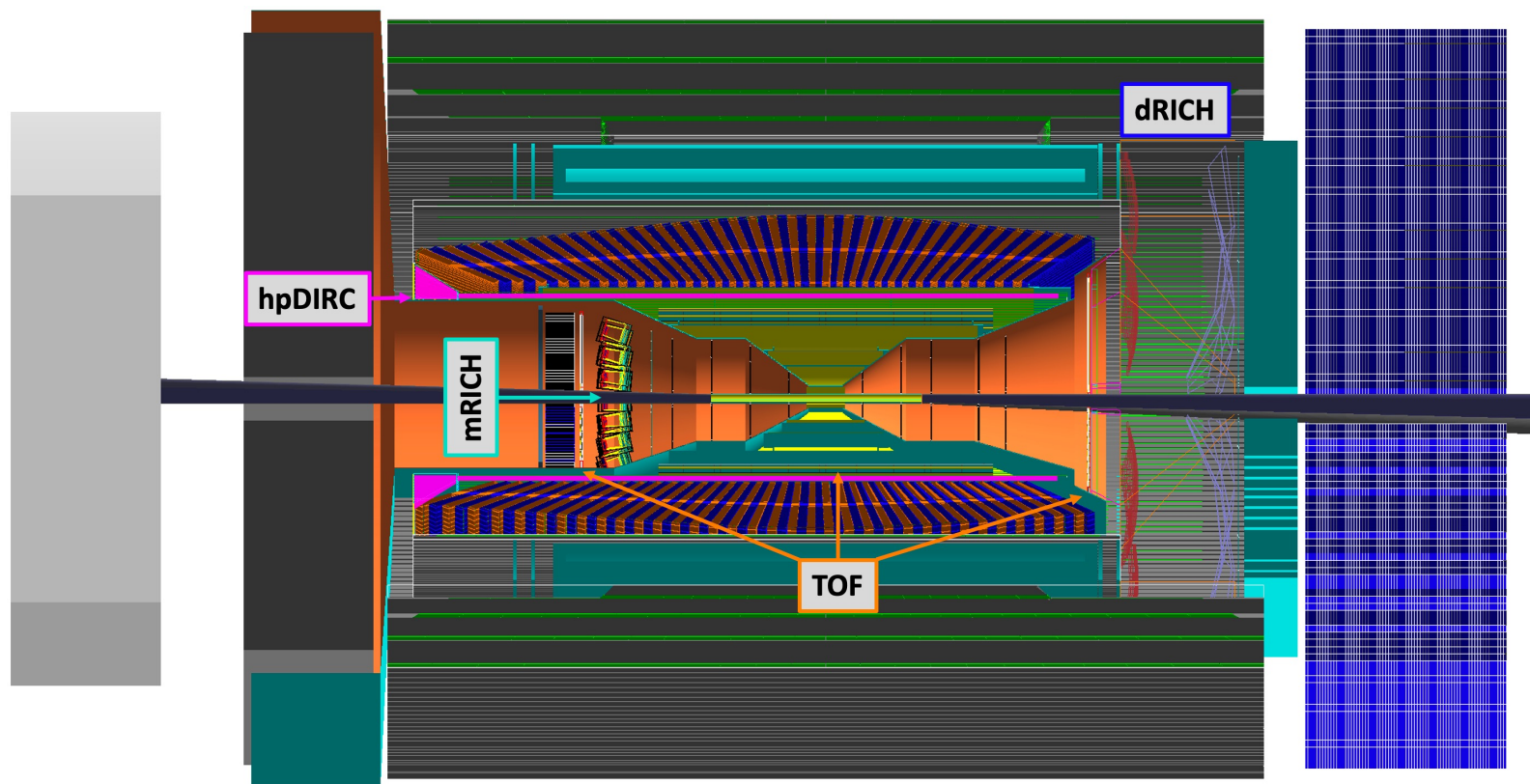ETTL

ECCE TOF (tracking) Design

Schematics of dimensions and locations

ECCE TOF (tracking) Performance

t$_0$ included

Possible Fallback options

Use DC-LGADs instead of AC-LGADs and insert an additional layer of μRwell
- Mature design is available from CMS ETL
- Lose 10-15% acceptance because of intra-pad dead zone (unless using TI)
- More space needed (LGADs + μRWell), (slightly) increased cost

Final words …

We invite all of you to join and contribute to build the TOF at EIC Detector 1 (it is taking >15 groups to build CMS ETL)

We encourage everyone to review the ECCE design, raise your concerns so that we can have well-defined tasks to investigate, optimize the design and make changes that are necessary, based on the physics performance requirements.

Backups

ECCE TOF (tracking) Performance

Impact on forward tracking by LGADs layers
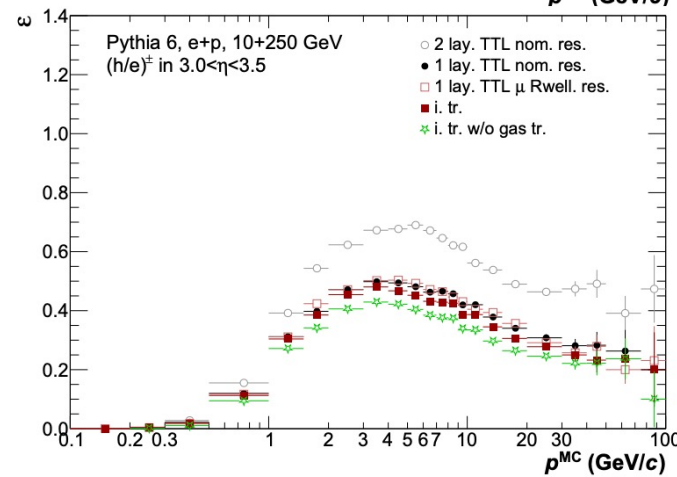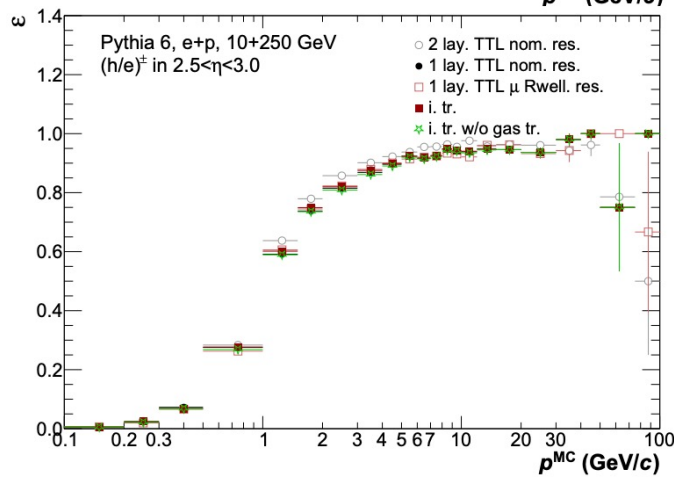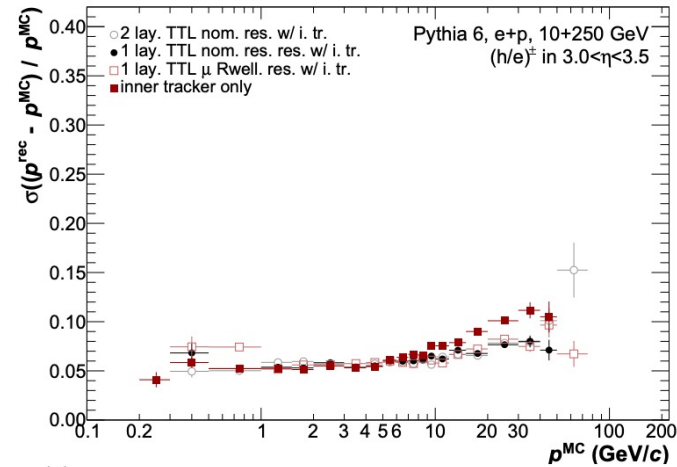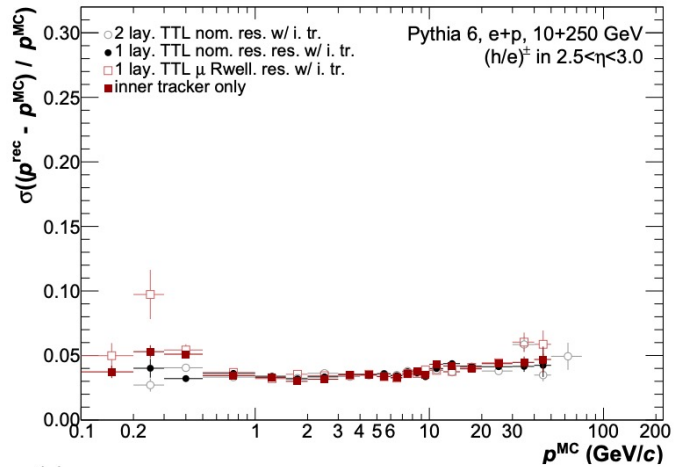
Improved momentum resolution at high p

Improved efficiency at very forward region

F. Bock