ECCE LGADs TTL discussion

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ECCE Tracking WG meeting
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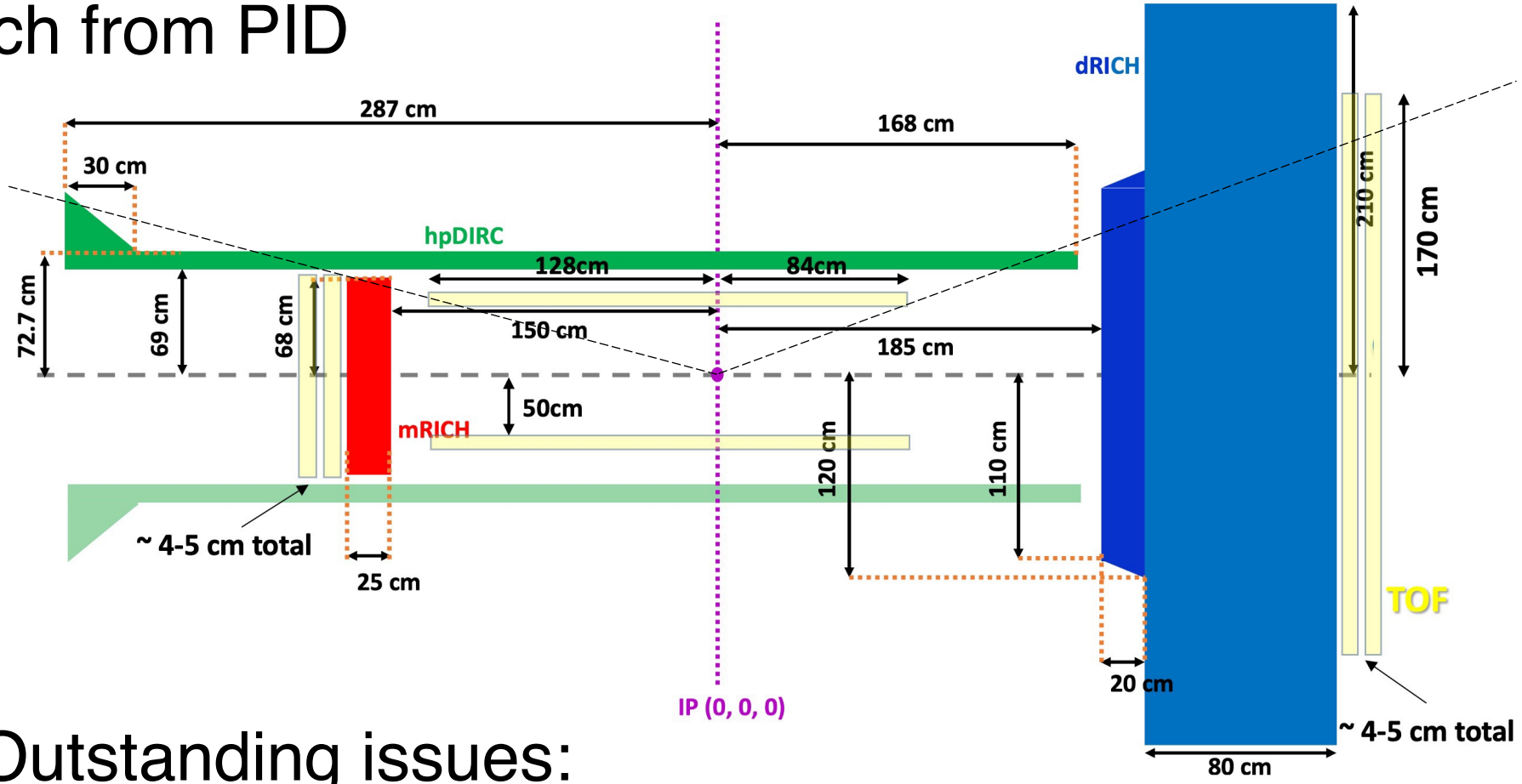
LGADs TTL in ECCE

Sketch from PID



Outstanding issues:

- Location of barrel layer: inside or outside DIRC?
- Total area and # of channels: cooling, cost concerns
- Material budgets (currently a placeholder)

Area and # of channels

- FTTL (2 layers): 14 m^2
- ETTL (2 layers): 2.3 m^2
- CTTL: 6.3 m^2 (r=0.5 m) vs. 16.1 m^2 (r=0.8m, currently in ECCE)

Total: 22.6 m^2 or 32.4 m^2

Main cost driver will be FTTL and/or CTTL if at r=0.8m

Will tracking benefit significantly from CTTL at r=0.8m?
If not, preferably closer to mainly play the role of TOF
for pi/K/p below 0.5 GeV and electron for t_0

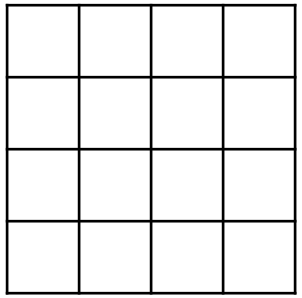
Area and # of channels

Currently assume ~30 μm position resolution achieved by 500-600 μm pitch (demonstrated by laser and beam test)

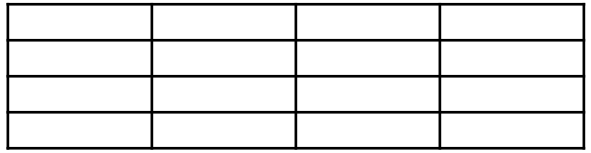
With square pixels, # of channels: 63M or 90M!
– not realistic in terms of cost and cooling

Possible solution: rectangular pixel 0.65x2.6 mm^2

CMS: 1.3x1.3 mm^2



0.65x2.6 mm^2



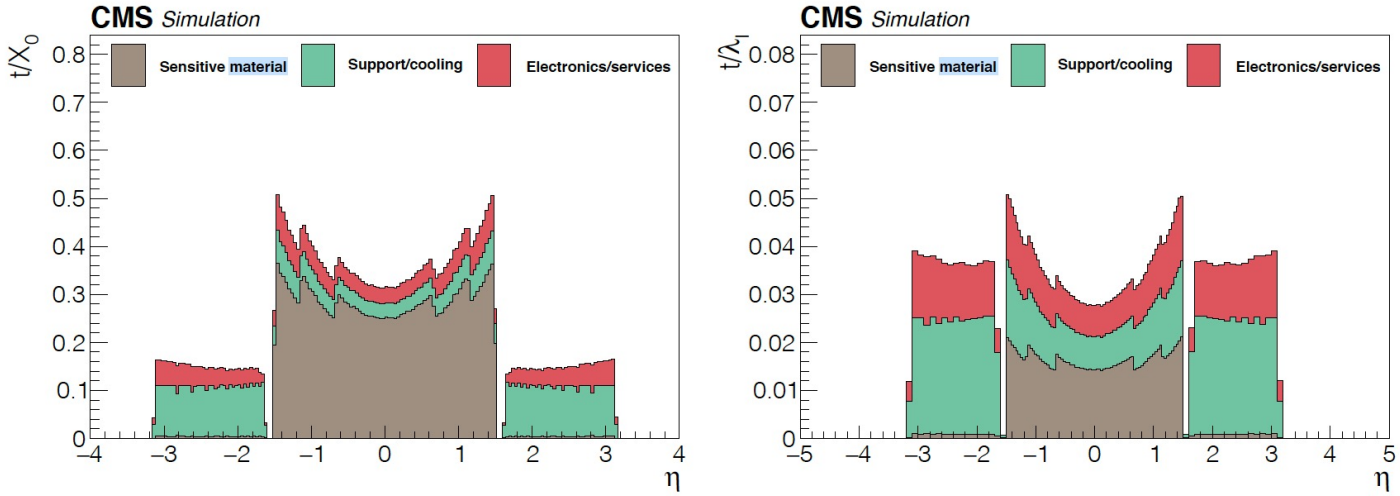
will produce such sensors at BNL to test

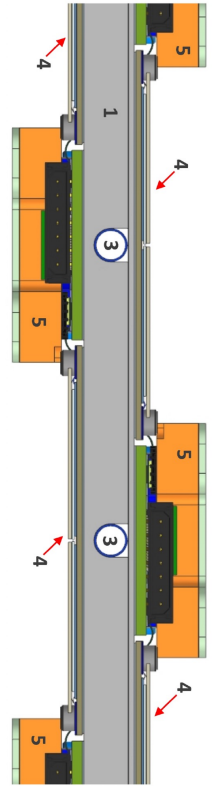
Same channel density as CMS

CTTL: better precision in phi
FTTL/ETTL: two layers in “cross”

# of channels: 13M or 19M!
(vs. 8.6M in CMS)

Material budgets





~15%X_0 for two layers at CMS, mainly Al support

6mm Al to support ~1 ton (detector 280kg + moderator 600kg)

TTL material budget in ECCE (currently a placeholder):

- Implement 6mm Al in FTTL/ETTL (may be possible to reduce)
- Reduce to 0.6mm carbon in CTTL? (inner tracker type support)

See Nicolas's talk for detailed implementation of TTL structure

Rough estimate of cost

CMS ETL costs ~ $10M for ~15 m^2, ~ $2M fixed cost not scaling with area: e.g., masks for ASICs, LGADs sensors, etc.

TTL estimates in ECCE:

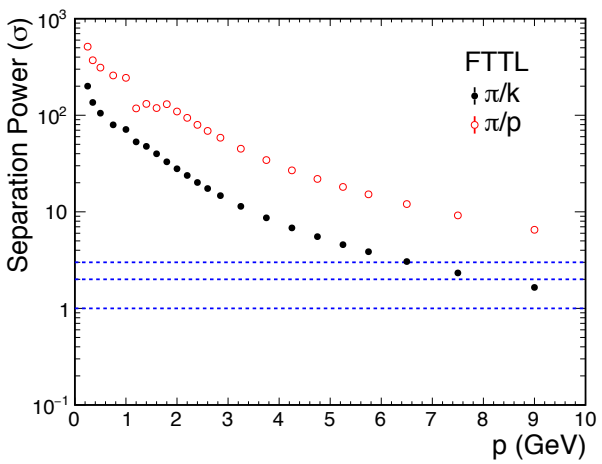
- 22.6 m^2: $14M = $7.4M (FTTL) + $1.2M (ETTL) + $3.4M (CTTL) + $2M
- 32.4 m^2: $19.2M = $7.4M (FTTL) + $1.2M (ETTL) + $8.6M (CTTL) + $2M

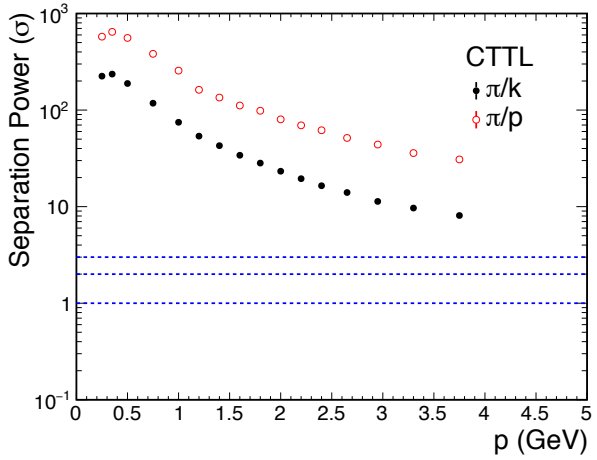
Backups

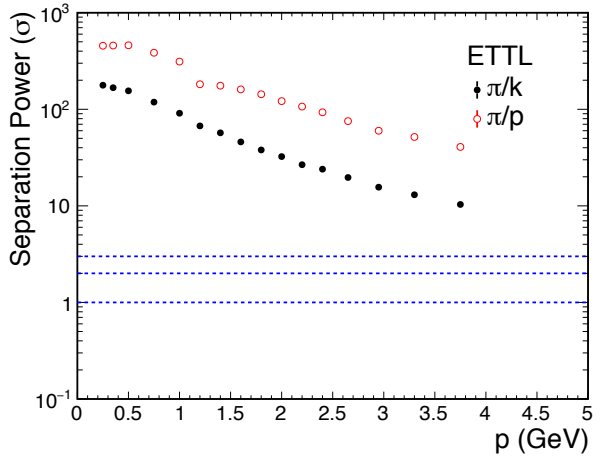
PID performance

Forward (1<η<3.5): Central (|η|<1): Backward (-3.5<η<-1):

σ_t = 0 ps

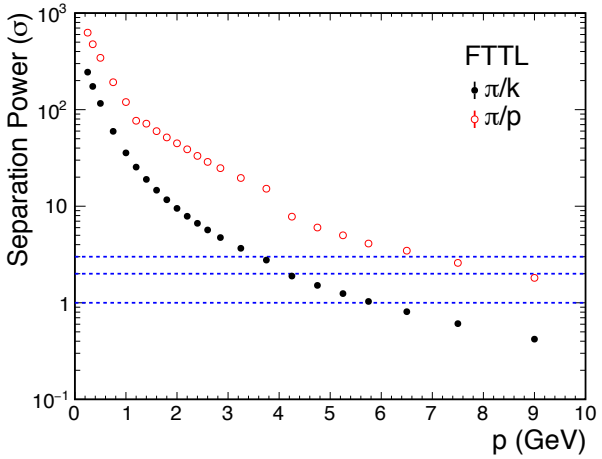


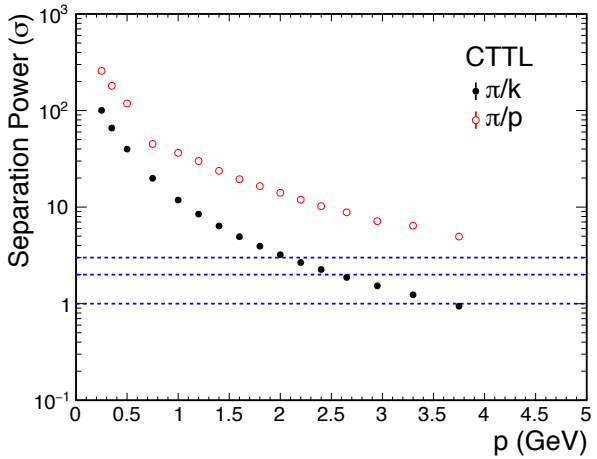


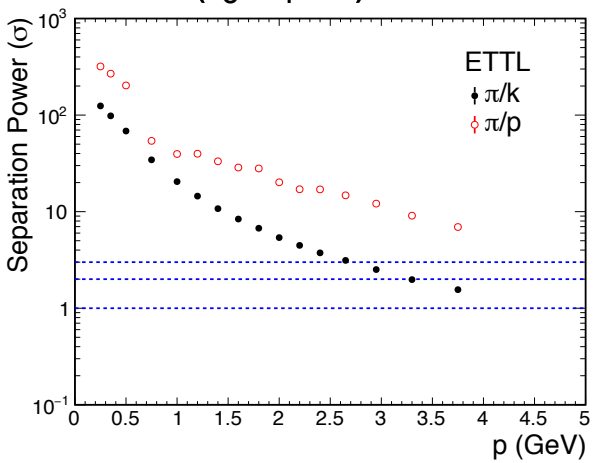


all uncertainties (t_0, t_f, L) included

σ_t = 20 ps





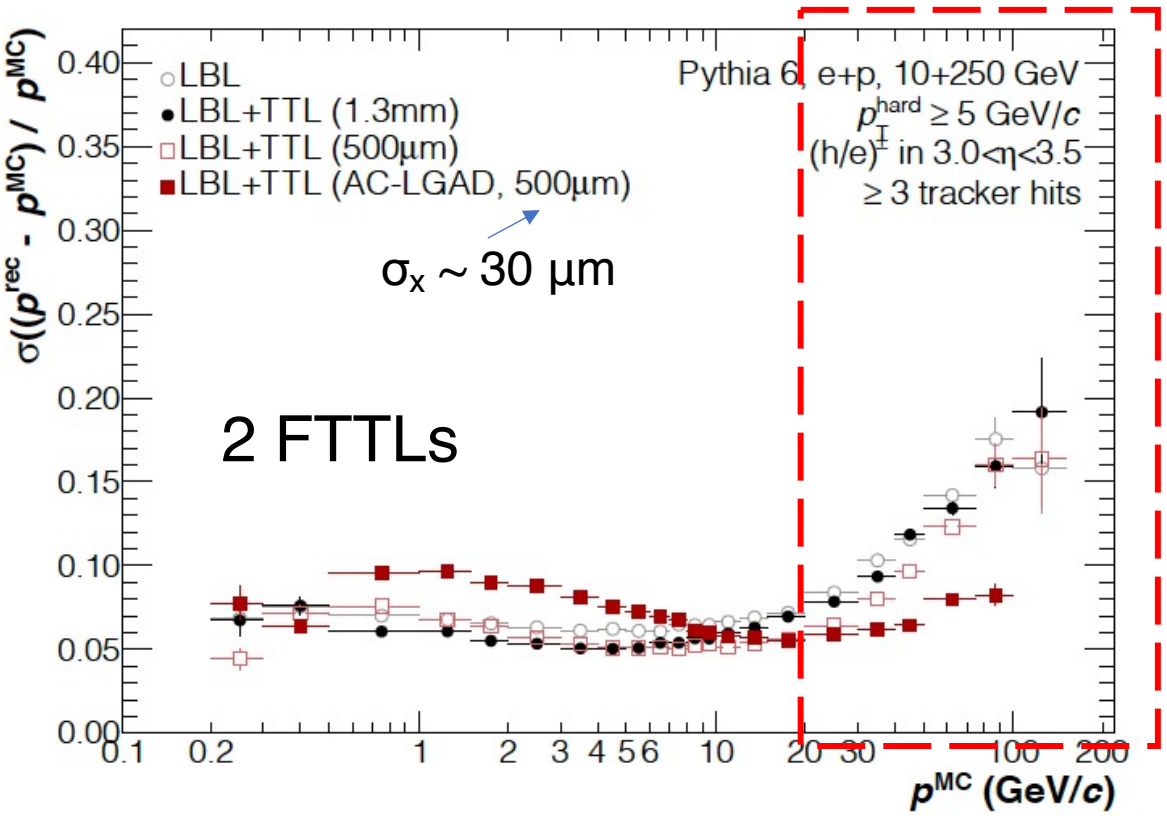


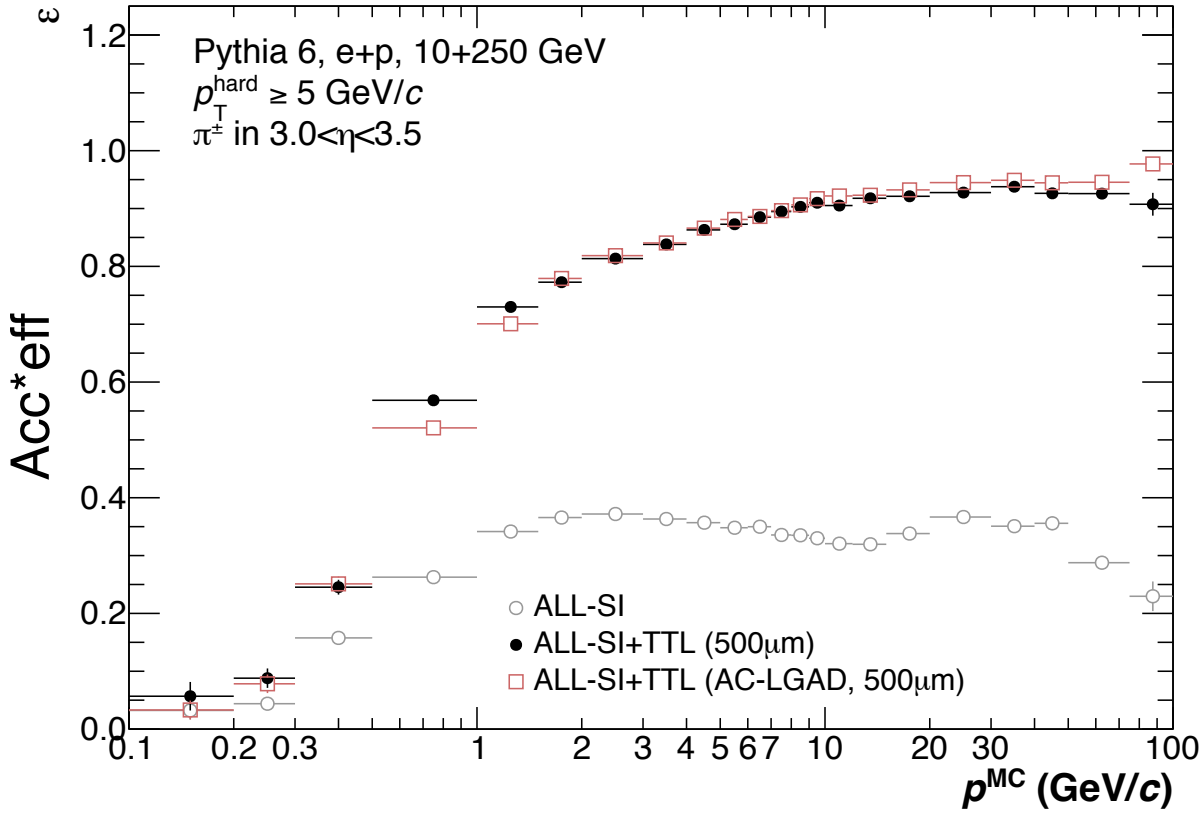
0.2-4 GeV 0.2-2.5 GeV 0.2-3 GeV

Forward tracking with LGADs

Tracking w/o vs. w/ LGADs layers

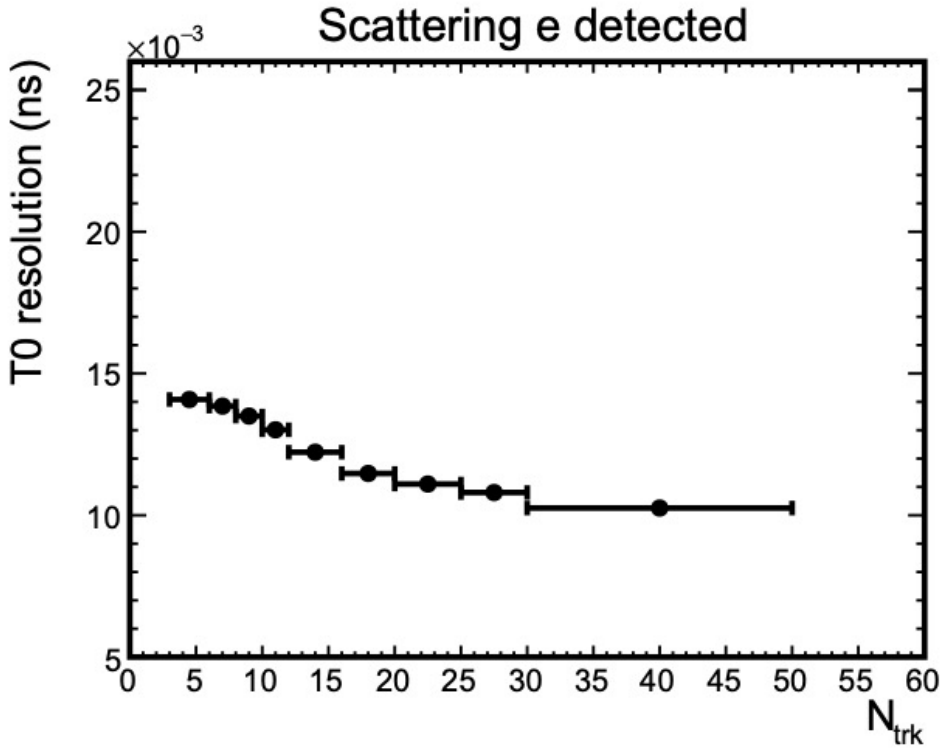
Momentum resolution





LGADs layers will serve as both TOF and outer tracker (behind RICH) to improve *p* resolution by up to 50% at 100 GeV/c and efficiency at forward y

PID performance



Iterative procedure to determine T_0:

- Assume scattered e is detected by TOF
- Start with pion assuming for all other particles to fit T_0
- Update mass assumption for outliers in next iterations

Details described in https://wiki.bnl.gov/conferences/images/0/01/ERD29_progress_report_March2021.pdf
(still optimizing)