LGADs at ORNL

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ORNL

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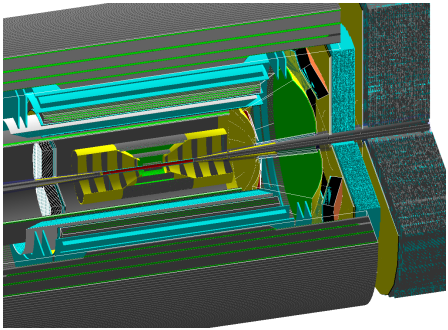
Timing Tracking Layers (TTL) in Fun4All

- **ETTL**:
  - timing layers in electron endcap region with 500μm pitch size in front of EEMC, 95% hit efficiency
  - current default: 2 disks at Z = -155.5 cm & Z = -158.5 cm, $-3.7 < \eta < -1.6$
- **CTTL**:
  - timing layers in the barrel region with 500μm pitch size 1 layer each in front of CEMC and CHCAL-IN, 95% hit efficiency
  - current default: 2 barrels at R = 92 cm ($|\eta| < 1.34$) and R = 114.7 cm ($|\eta| < 1.11$)
- **FTTL**:
  - timing layer in hadron endcap region 500 μm pitch, 95% hit efficiency
  - current default:
    2 disks before FEMC Z = 287 cm & Z = 289 cm
    1 disk beore FHCAL Z = 340 cm

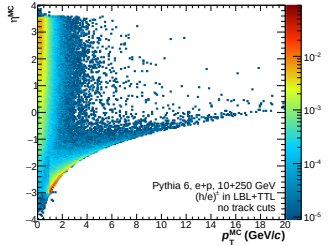


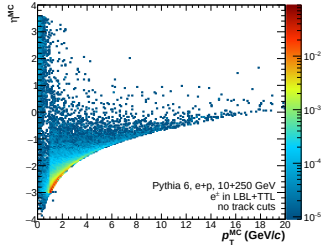
- TTL design can be complemented with any of the current trackers (FST, GEM, TPC, LBL) or PID detectors (only EGEM last disk in conflict with ETTL) PR-370 & PR-15
- Multiple other options for FTTL implemented, i.e 2 disk version, coarser granularity, only disks in front of FEMC ... PR-15, PR-17

Overview studies for eRD29

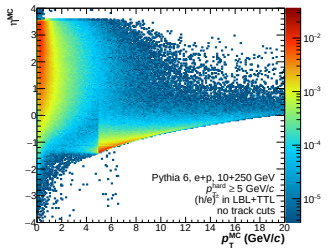
1. Time resolution with "optimal" setup in eta slices
2. Impact of timing layers on tracking performance using optimal LBL or LANL inner tracker in eta slice
   - Pitch size 1.3mm (ETL default)
   - Pitch size 0.5 mm (assumed default for TTL)
   - Pitch size 0.5 mm AC-LGADs (30 microns resol)
3. Study impact of timing layer between E and H-Cal (tracking perf & timing resol) + efficiency? Study done again as function of eta. Use LBL tracker as default
   - Default (done in 1) & 2))
   - Only 1 layer before and after ECal (only fwd. changes)
   - 1 layer before ECAL none after

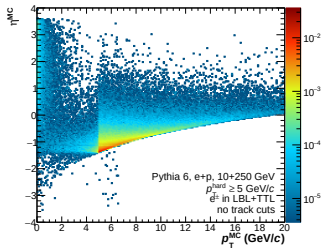
EIC generator setup





MB e-p (100K events)





e-p (250K events),
$p_{T,\,hard} \geq 5$GeV/c

- General setup in fun4all for e+p collisions with 10 and 250 GeV beam energy respectively
- Requiring $p_{T,\,hard} \geq 5$ reduces η region for electrons significantly enhances hadron prod in central barrel and fwd region
- Use $p_{T,\,hard} \geq 5$ production to study PID in central barrel and fwd
- PID studies in backward region need MB productions
- Should we do single pion productions flat in eta and p_T (0-50 GeV/c) for tracking studies?

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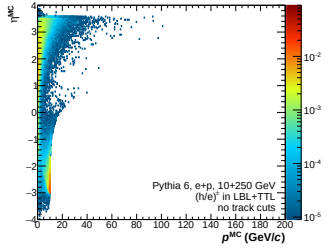

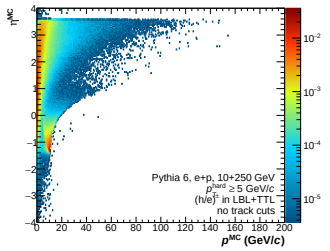

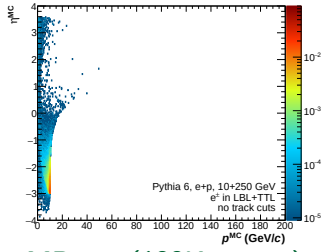

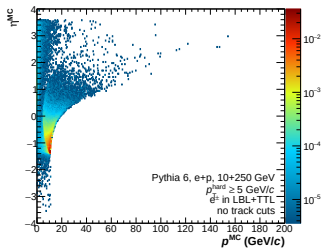

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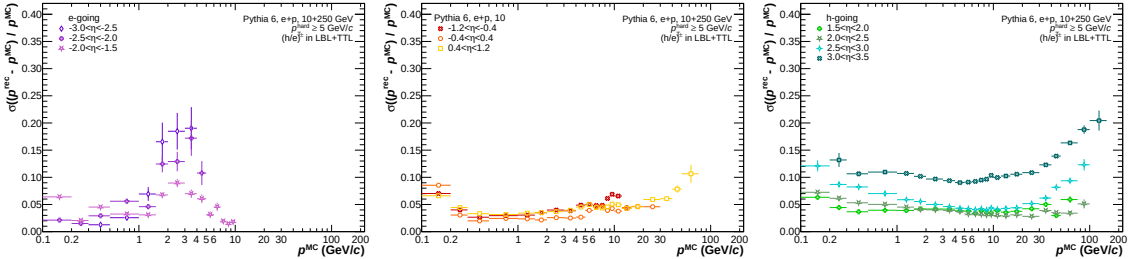

no track cuts

- p_T resolution strongly η dependent
- p_T resolution particle species dependent
- worse tracking performance for $1.0 < |\eta| < 1.2$ and for $|\eta| > 2.5$ compared to other η regions
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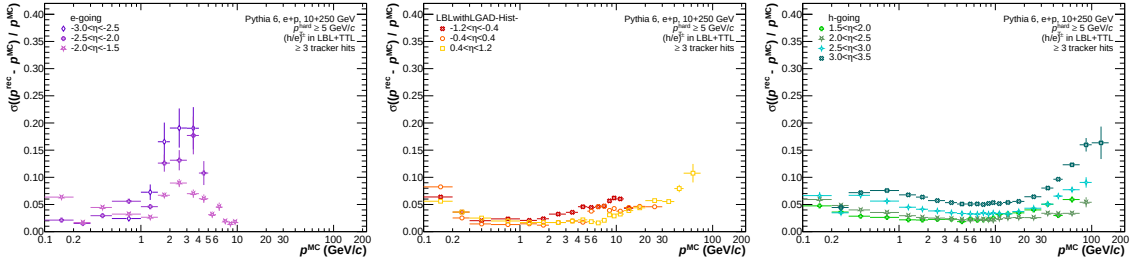

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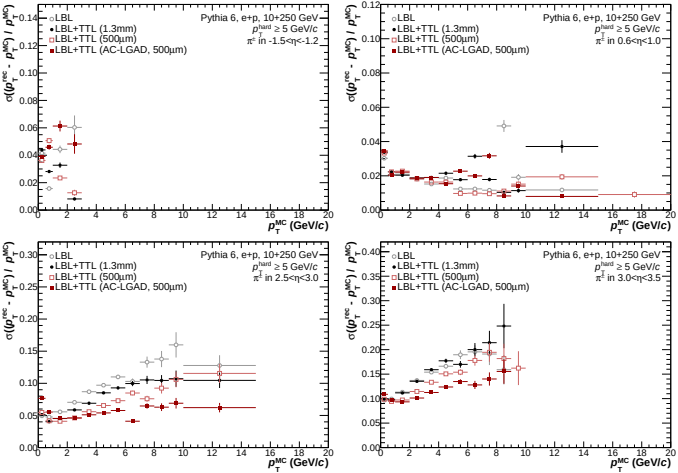

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- Expected improvement in forward region
- Electron going region not conclusive (very little entries & just at outer edge between EEMC and CEMC region)
- Central barrel region mild/ negligible improvement
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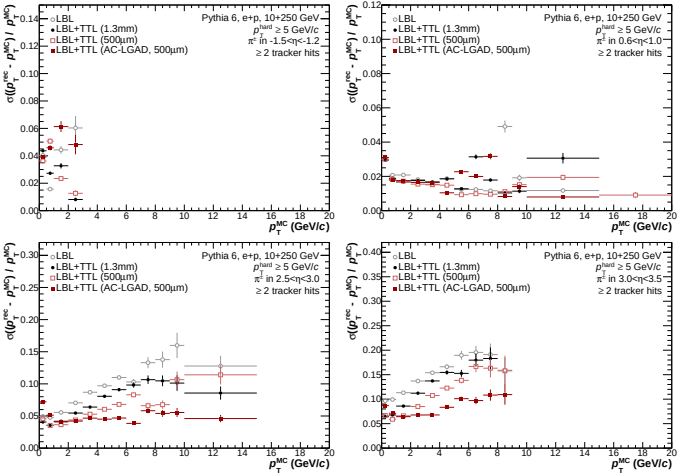

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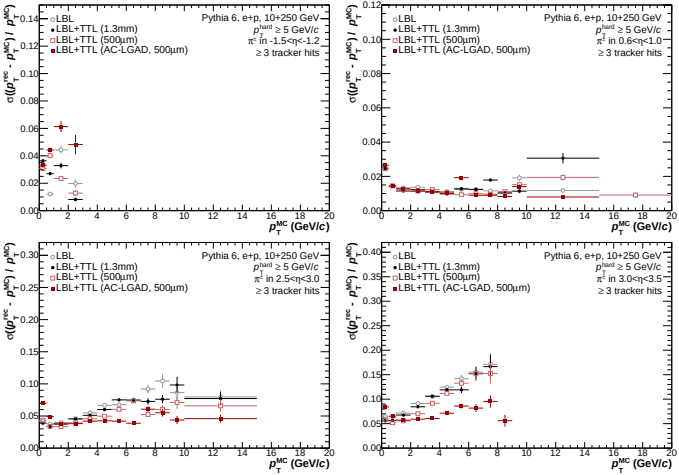

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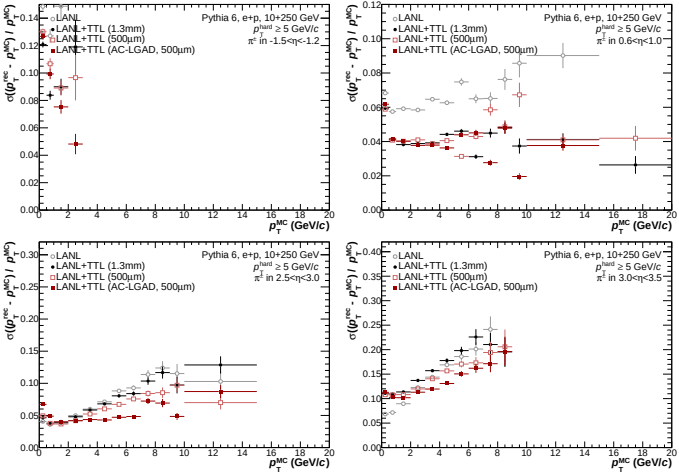

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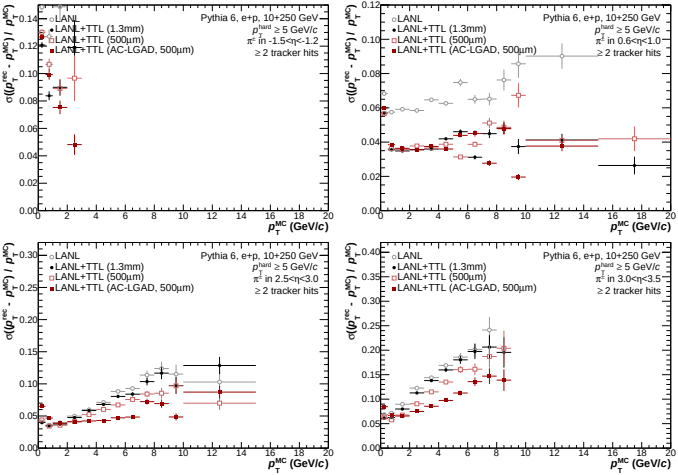

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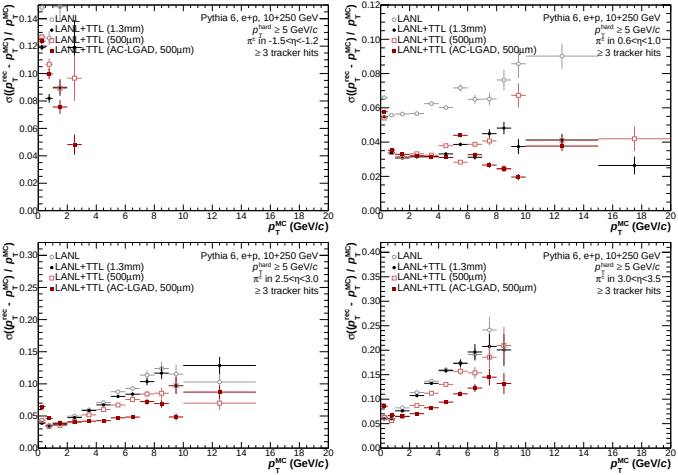

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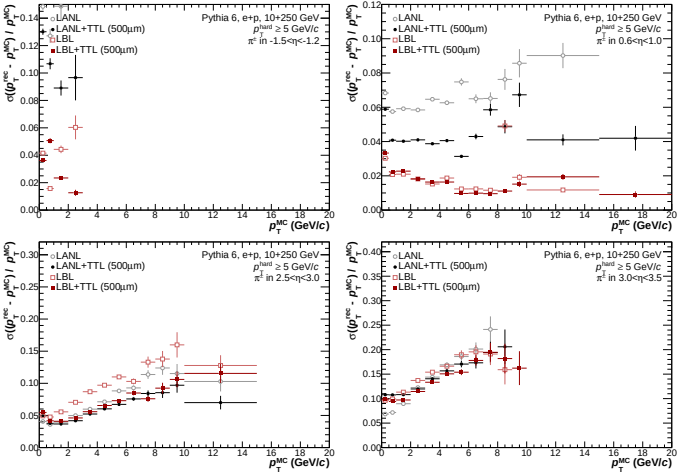

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→ Inclusion of TTL significantly improvement for LANL, little for LBL tracker

- LBL worse in forward region

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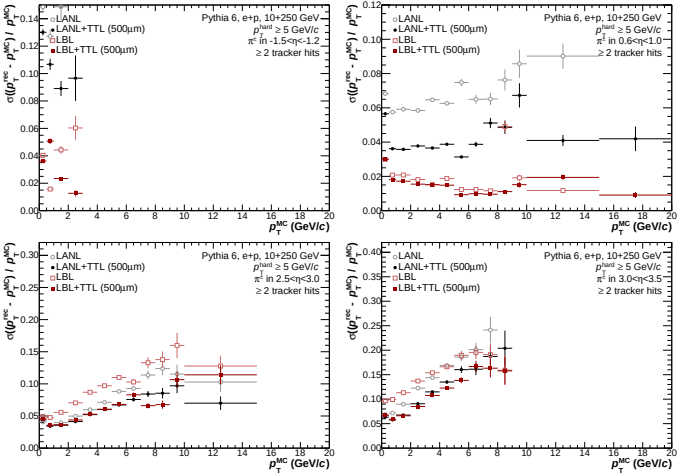

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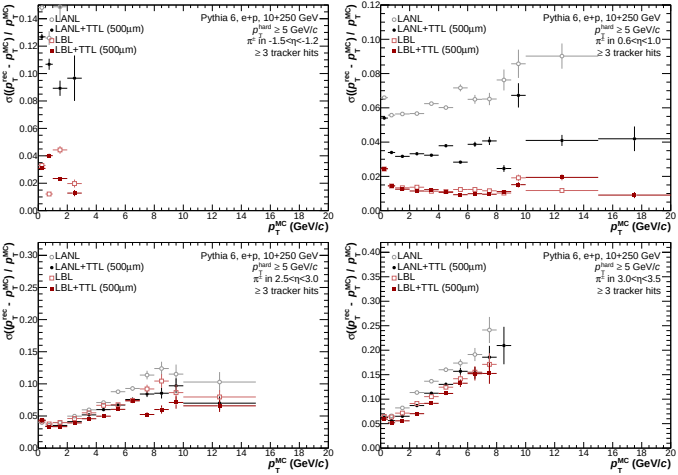

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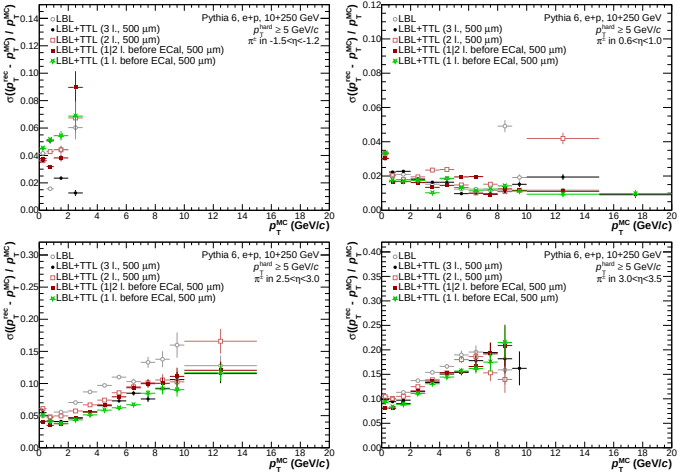

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- Conclusions not trivial to draw as tracking performance changes drastically for no track cuts
- If more than 2 layers for TTL possible tracks based on timing layers only with very poor momentum resolution (as so close together & far from prim vtx) but they can be found
- Need study of realistic efficiency in parallel
- 2 layers in front of ECal fwd most likely not needed as too close together only helps in junction with 3rd layer after ECal

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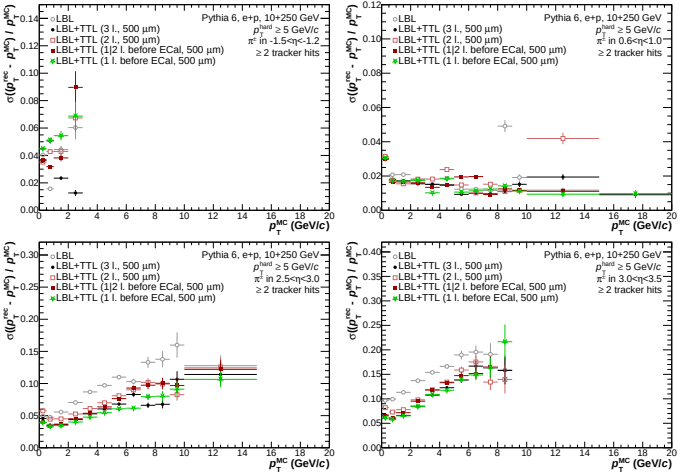

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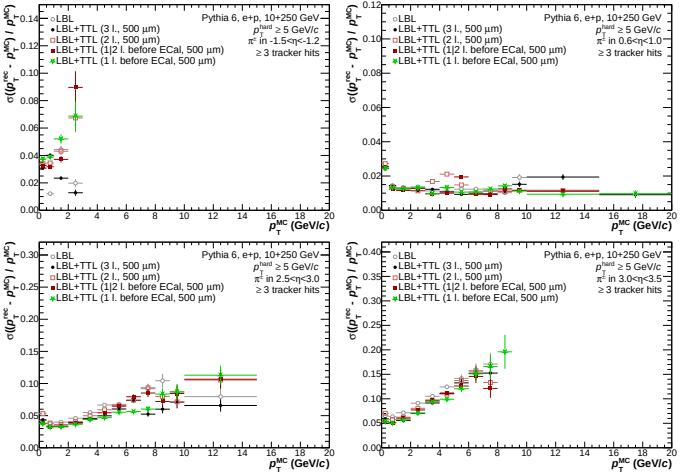

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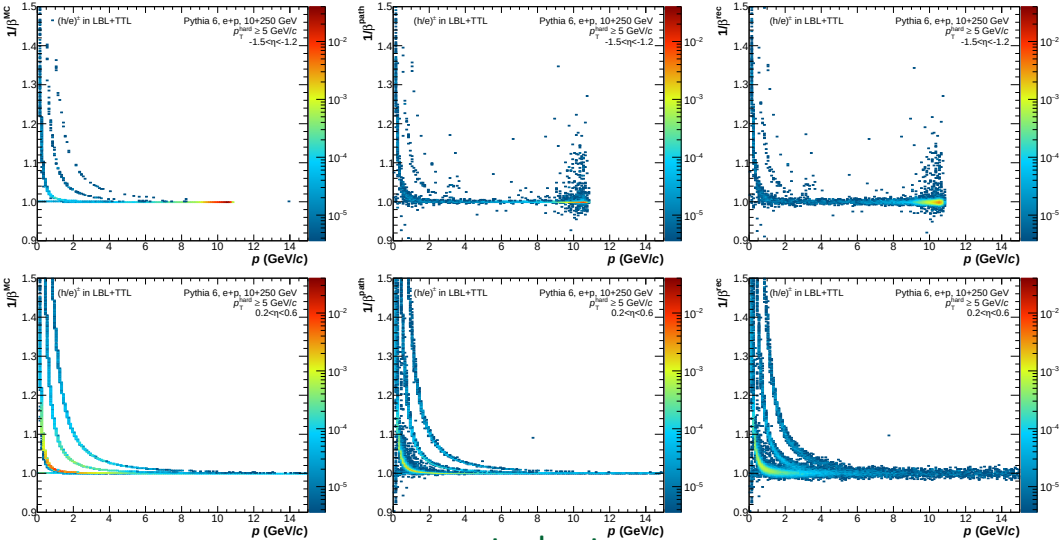
PID discrimination studies, e-going and central



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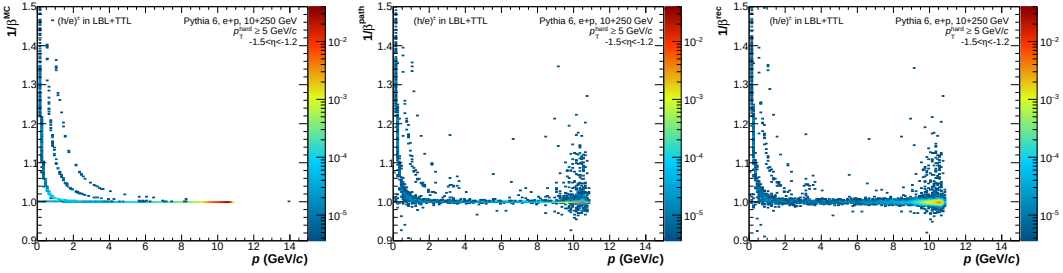

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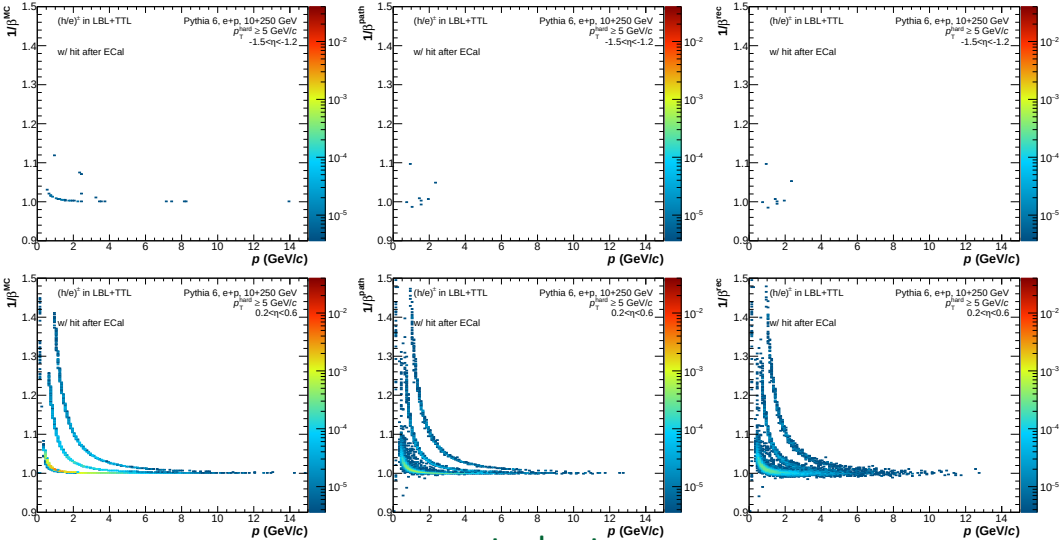

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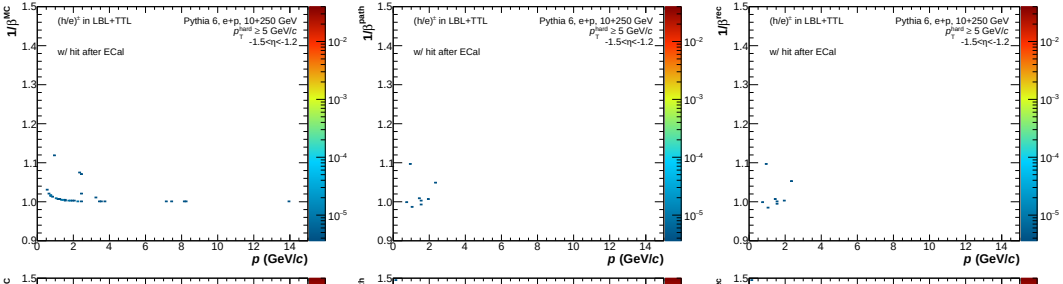

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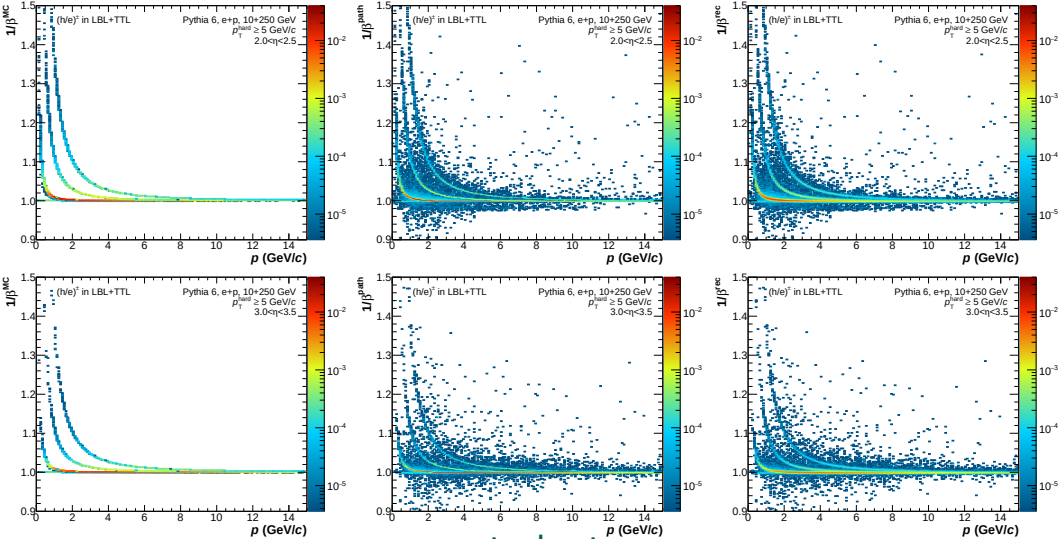

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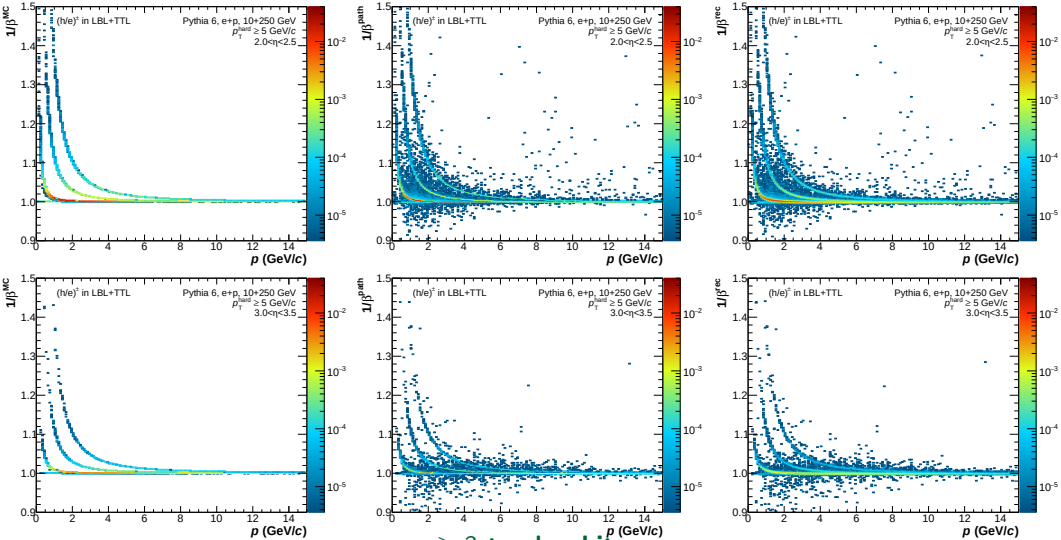

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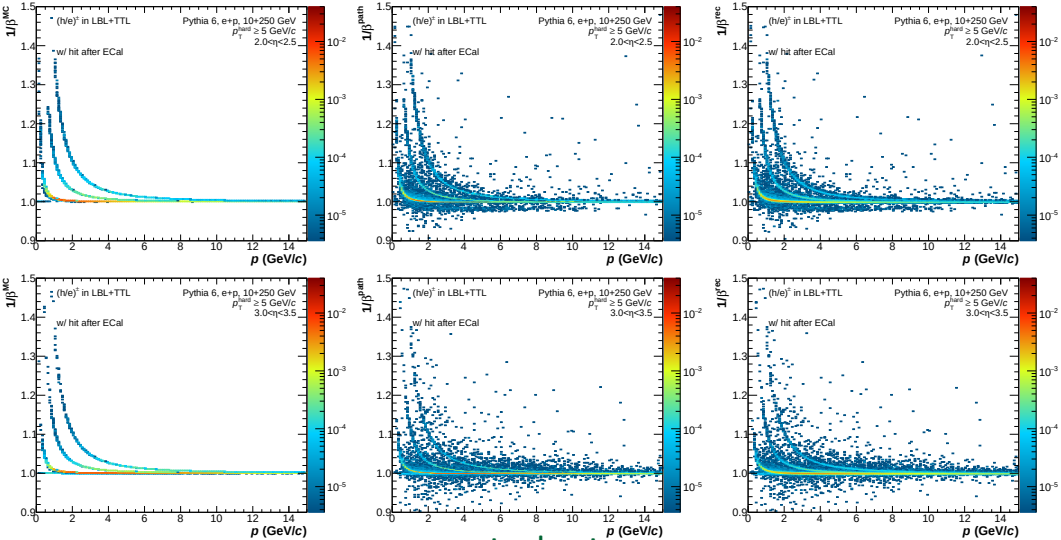

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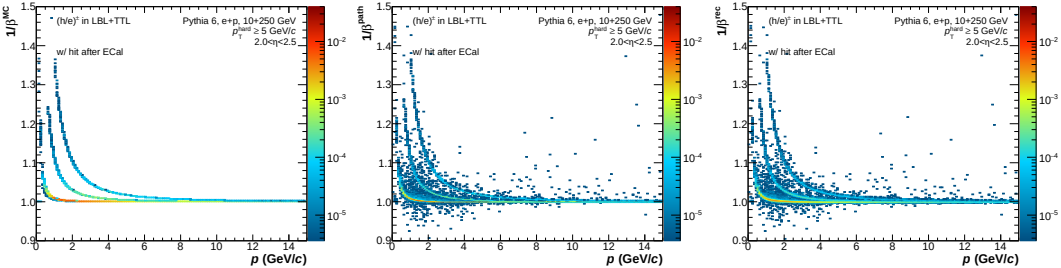

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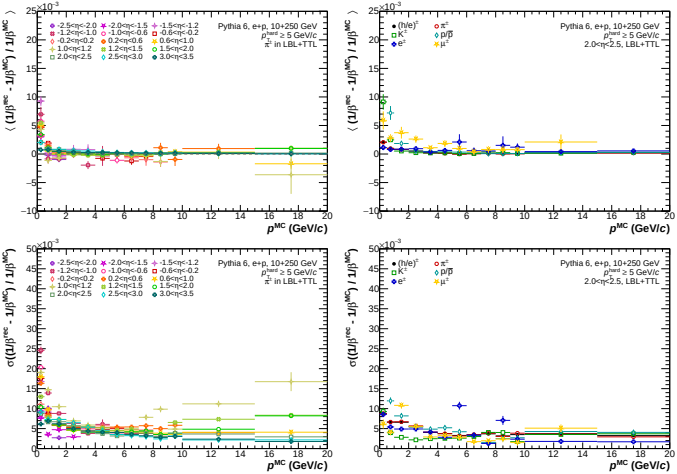

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- $1/\beta$ resolution strongly η dependent
- $1/\beta$ resolution mildly species dependent
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- mean is not centered at 0 for low momentum $\rightarrow$ resolution overestimated

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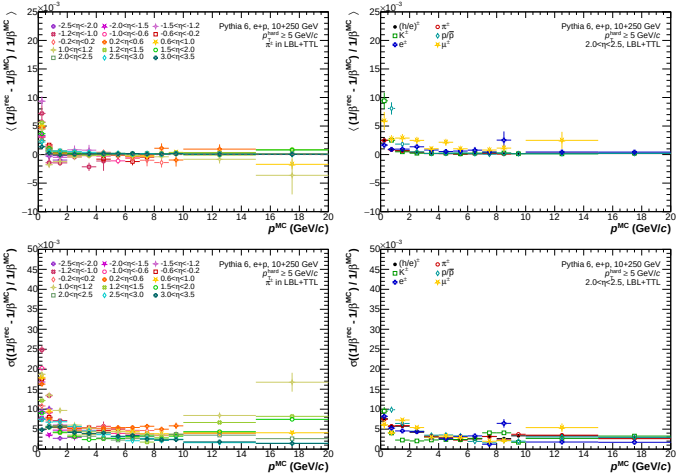

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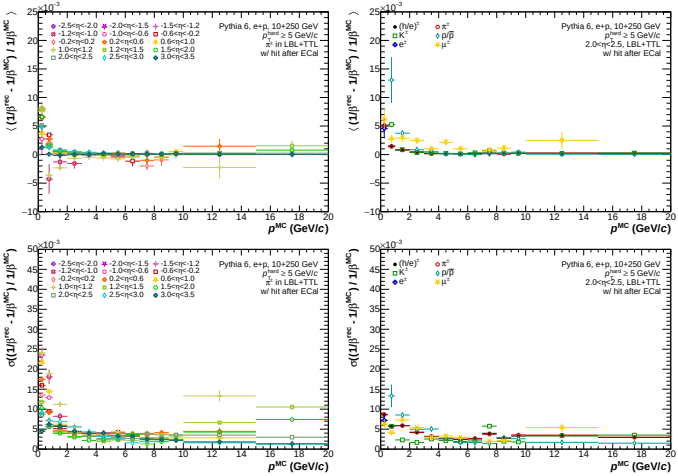

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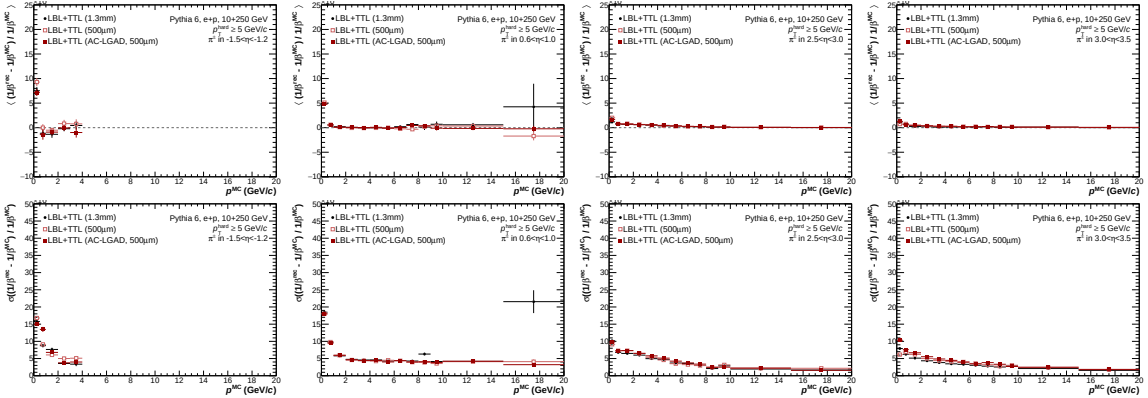

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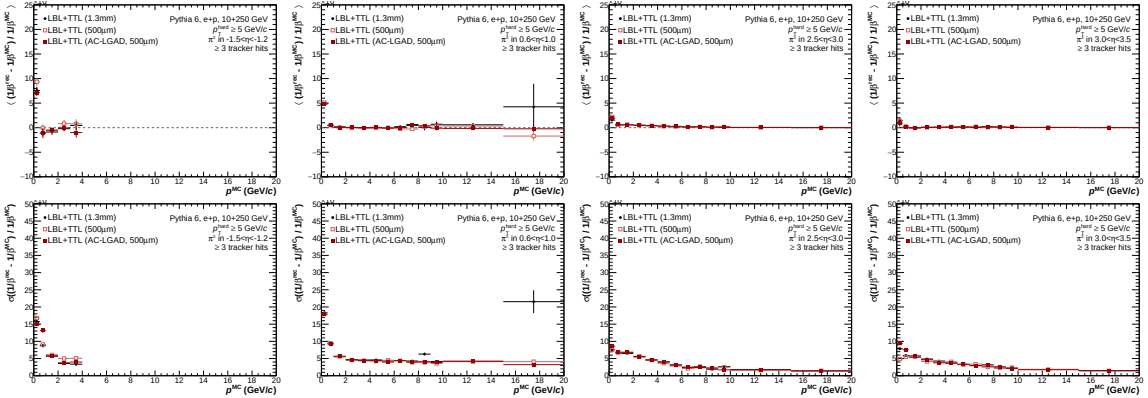

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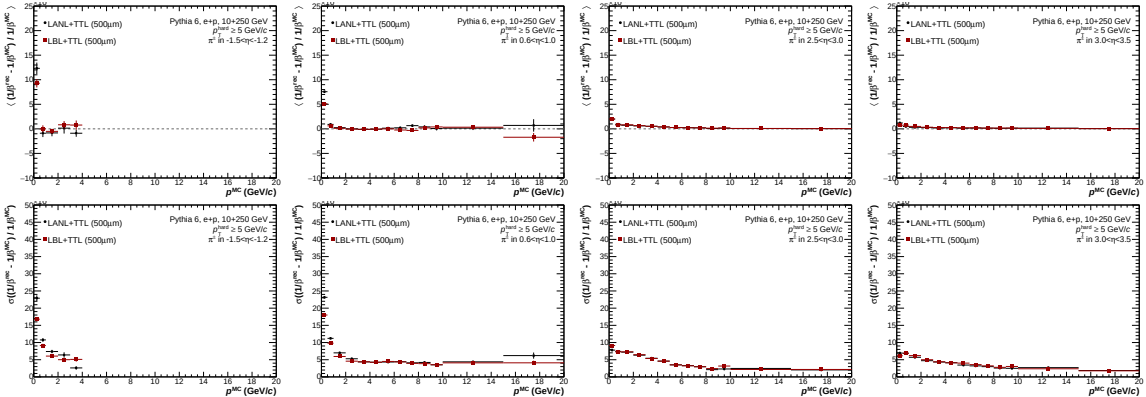

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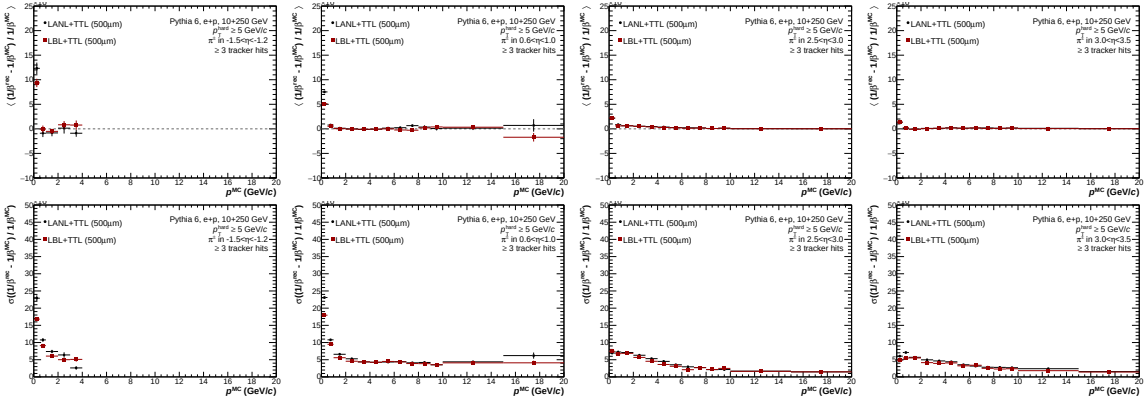

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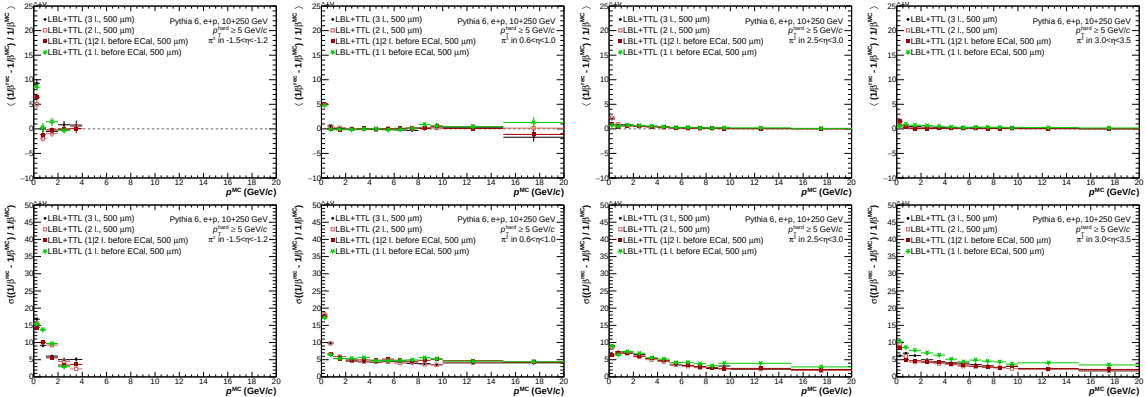

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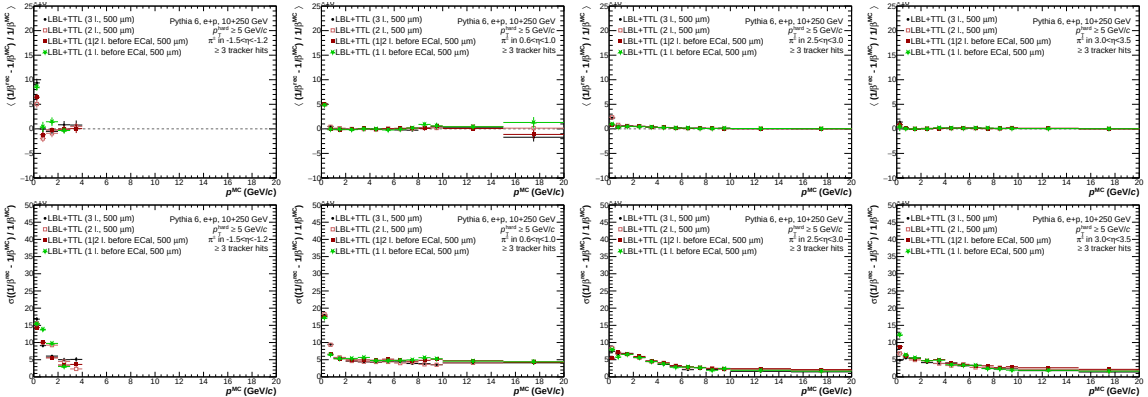

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