Calo seeding and GSF for forward tracks

Upgrade Inner Tracker && Egamma Group

Kaili Zhang

2019-01-21

Environments

- AtlasProduction,20.20.12.1
- Samples 50k each
  - r10846, Step 3, 25x100 digital clustering ATLAS-P2-ITK-17-00-01, $\mu = 0$;
  - mc15_14TeV.422029.ParticleGun_single_ele_Pt10.recon.RDO.e5286_s3348_s3347_r10846
  - mc15_14TeV.117050.PowhegPythia_P2011C_ttbar.recon.RDO.e2176_s3348_s3347_r10846
- Packages
  - Latest IDPVM;
  - InDetCaloClusterROISelector, InDetCaloClusterROIBuilder
- Interested Containers:
  - LArClusterEM Default setting, range from 0~2.47.
  - CaloTopoClusters Topology method, range from 0~4.8.

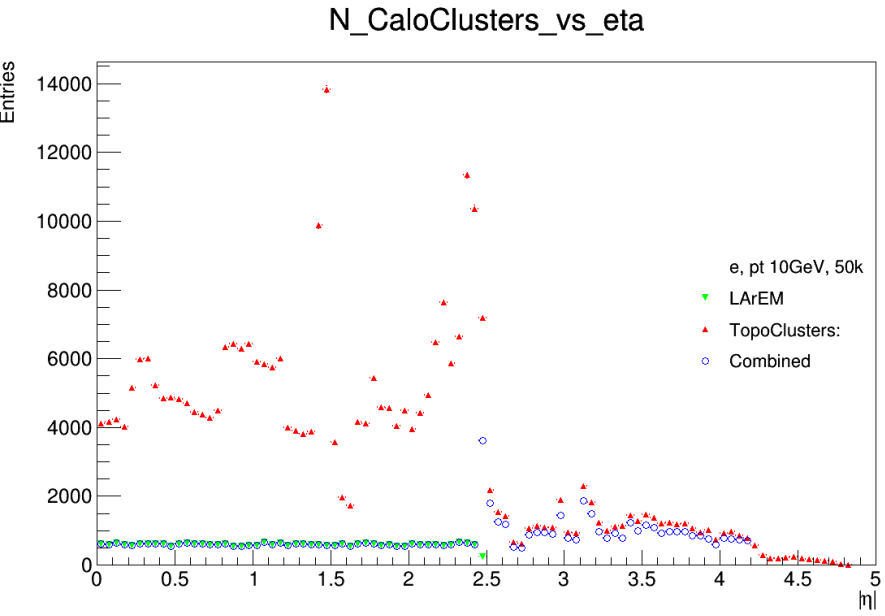
ROIs in the whole range

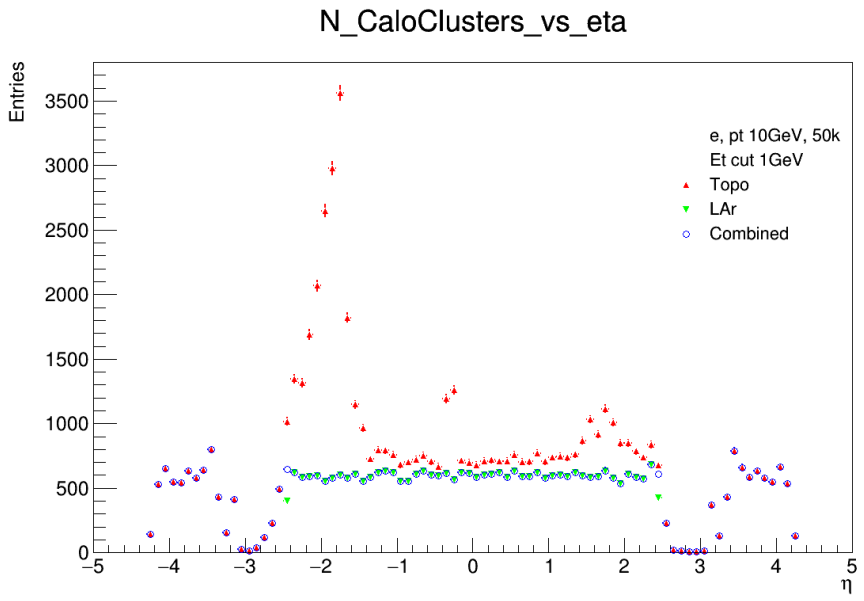
- 3 methods to use clusters are validated:
  1. LAr. default.
  2. Topo. topoclusters in the full range.
  3. Combined:
     - Use LAr with etaBE(2) first;
     - Use Topoclusters in forward, ranges $2.47 < \eta < 4.8$, with eta().
     - Ideally, it could keep the behavior in central region and use Topoclusters extending to forward.

Caloclusters Eta

$E_t > 1GeV, |\eta| \rightarrow \eta$:

The plot last week:





Asymmetry distribution for Topoclusters in central region.

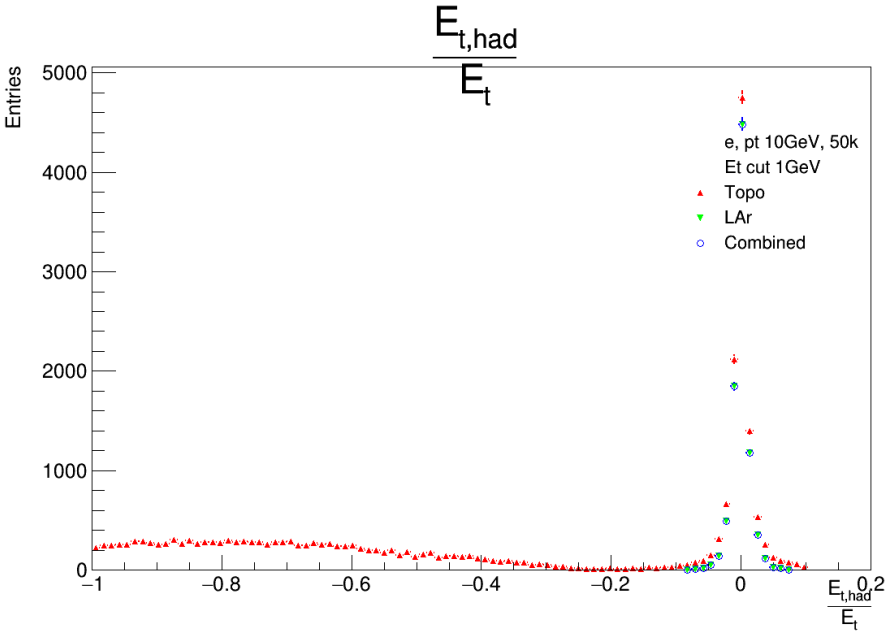
ROI selections: egamma Tools

- In ROIselector we have use several variables
  - Requires $E_t > 0$, $\frac{E_{237}}{E_{277}} > 0.65$, $\frac{E_{t,had}}{E_t} < 0.12$
  - Except η and E_t has good definitions in all ranges
    - also works good for Topoclusters
  - etaBE(2), e237, e277, ethad, ethad1
    - calculated by egammatools, mainly use calosamples in central region;
    - do not work for forward region
    - behaves different between Lar and TopoClueters.
  - Here the problem is ethad/ethad1 function in $-2.47 < \eta < -1$
    - Currently change to $|\frac{E_{t,had}}{E_t}| < 0.12$

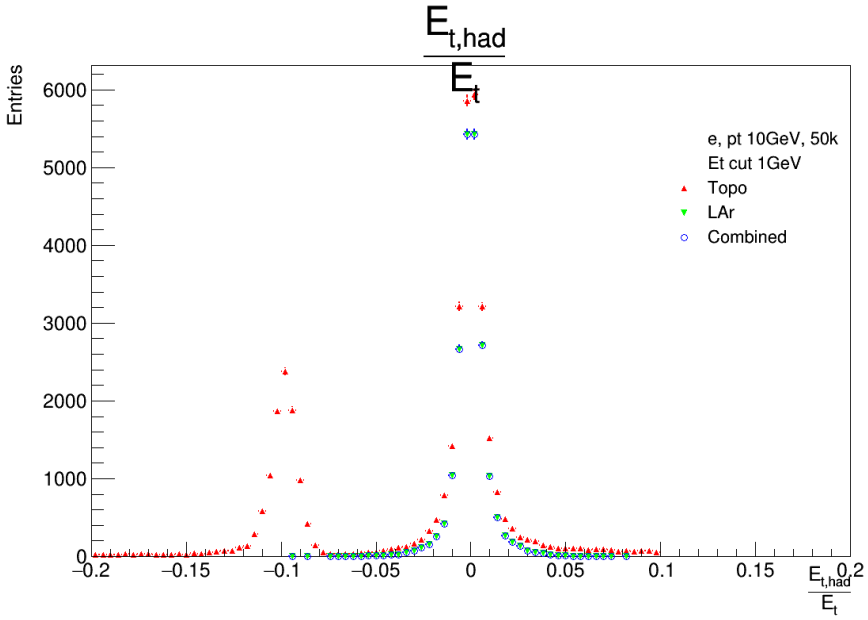
Maybe egamma experts have better suggestions?

Ethad_ratio

- $-2.47 < \eta < -1$
- Topocluster has lots of <-0.2 entry;



- Other region:
- small peak at -0.1*, unknown;



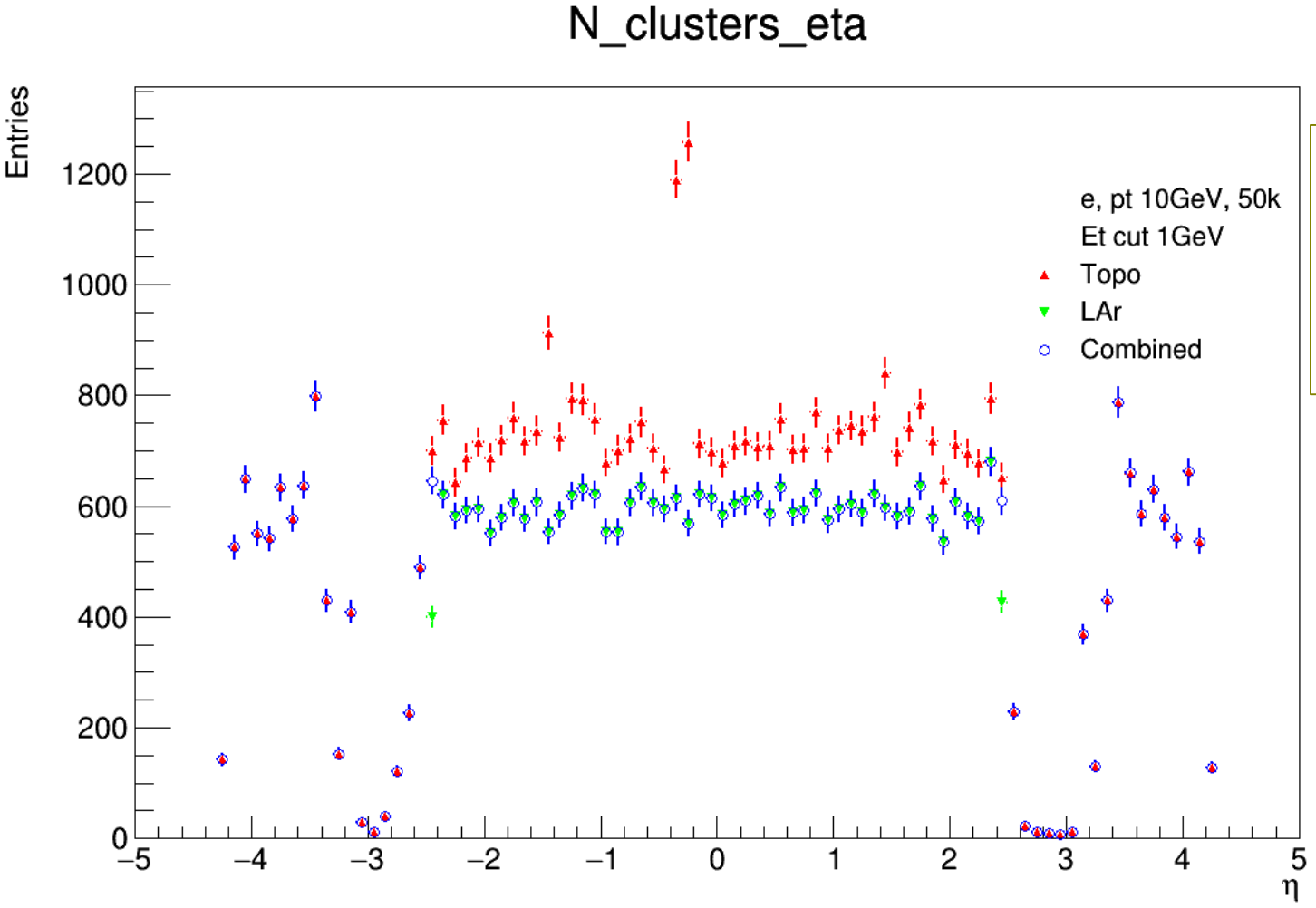
Brief transverse energy in the first sampling of the hadronic calorimeters behind the cluster

ethad: CaloSampling::HEC0 + CaloSampling::TileBar0 + CaloSampling::TileExt0 for $0.8 < |\eta| < 1.37$

ethad1: CaloSampling::HEC0 + CaloSampling::TileBar0 + CaloSampling::TileExt0 - CaloSampling::TileGap3, for $|\eta| < 0.8,\ 1.37 < |\eta| < 2.47$;

No proper variable for $|\eta| > 2.47$;

Caloclusters Eta with $|\frac{E_{t,had}}{E_t}| < 0.12$

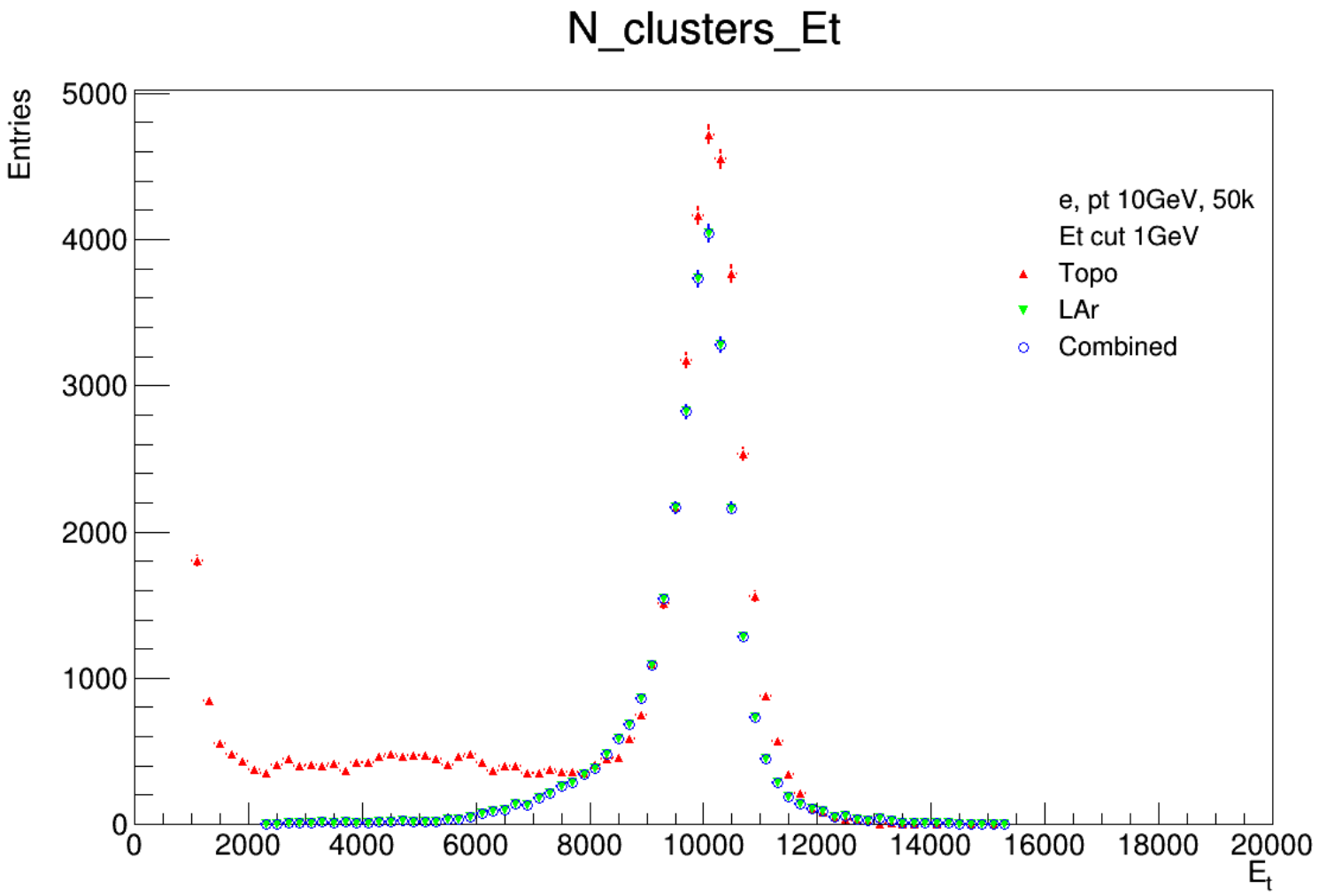


50k electrons
29487 LAr clusters
13716 Forward;
36847 topoclusters in central region

- Currently, the combined container is LAr in central region, Topoclusters in forward.
- The peak in -0.6~-0.6 for TopoClusters disappears when enlarge Et cut to 1.5GeV.

Caloclusters Et cut:1GeV

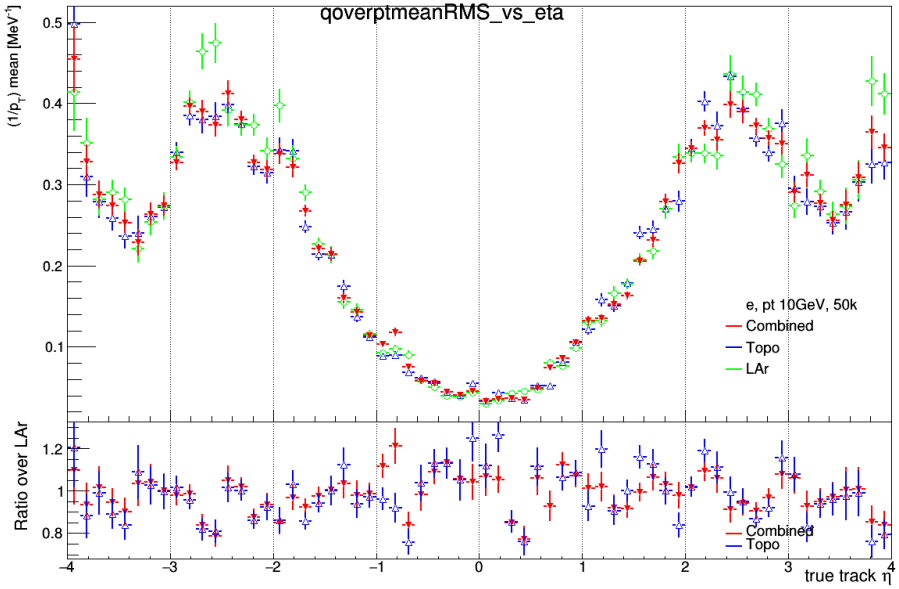
Et cut can may shift from 1GeV to 5GeV somehow;

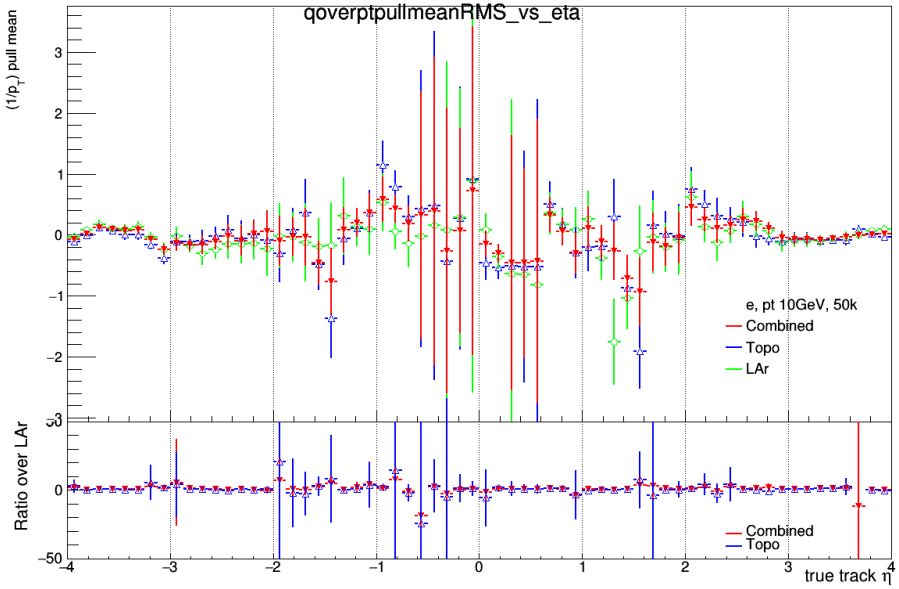


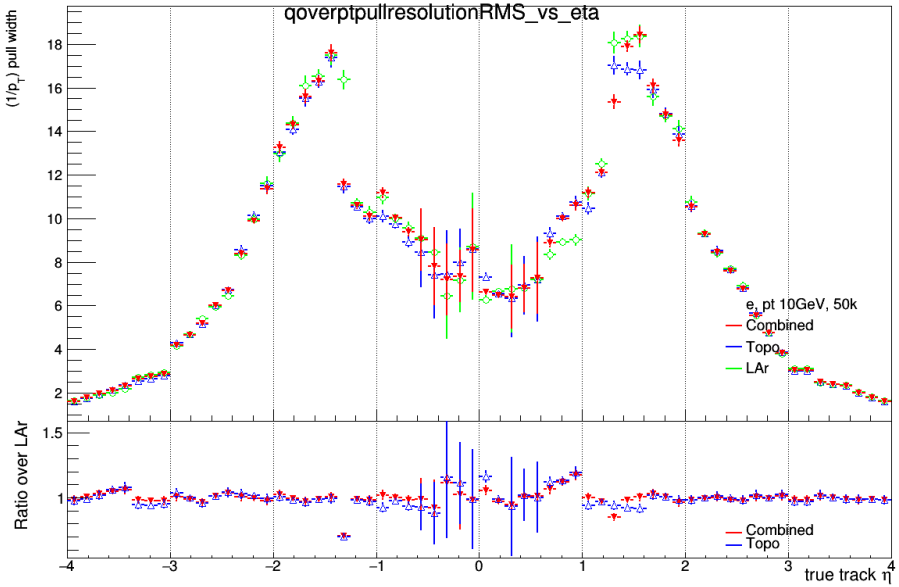
ROI selections

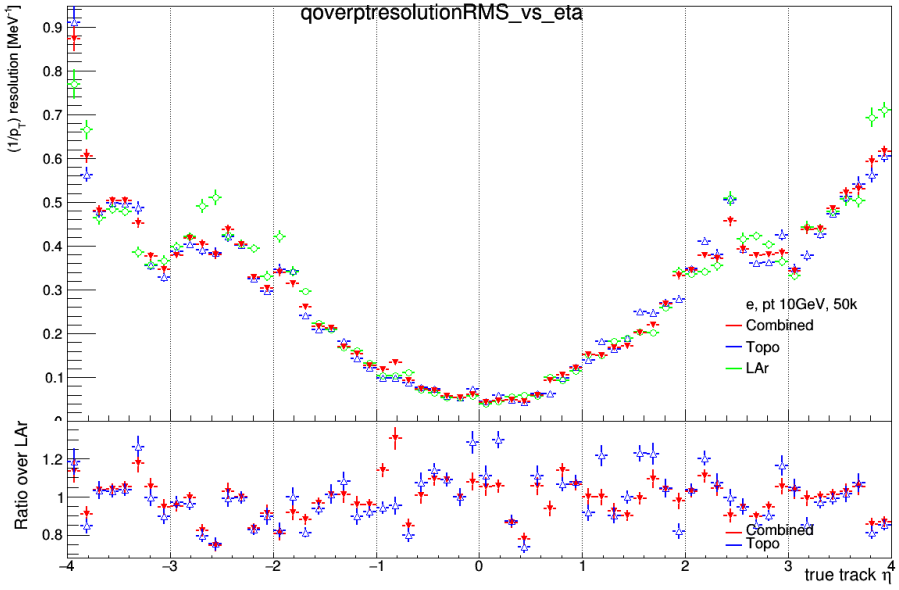
- Ideally we want only one candidate ROI for single electron sample
  - can be done when we optimize the selection more carefully
- Egamma tools are not designed for Topoclusters now
  - May need to validate the performance, or change the code;
  - Central region: since we continue to use LAr in the, not hurry?
  - Forward region: need to new method to validate the ROIs.
- While current 3 methods show no significant deviations In IDPVM distributions
  - How goodness of one ROI still unknown;
  - major task…… would dig further.

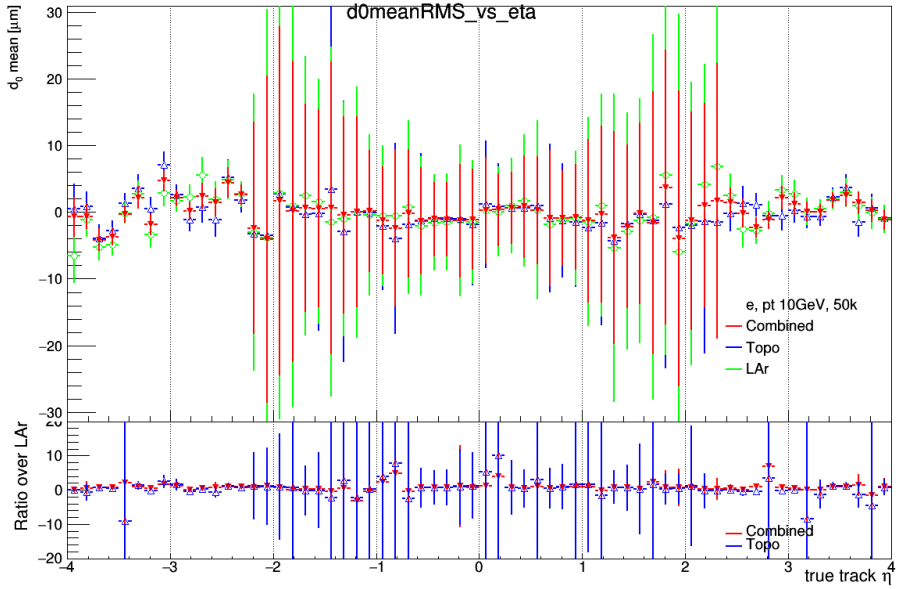
IDPVM

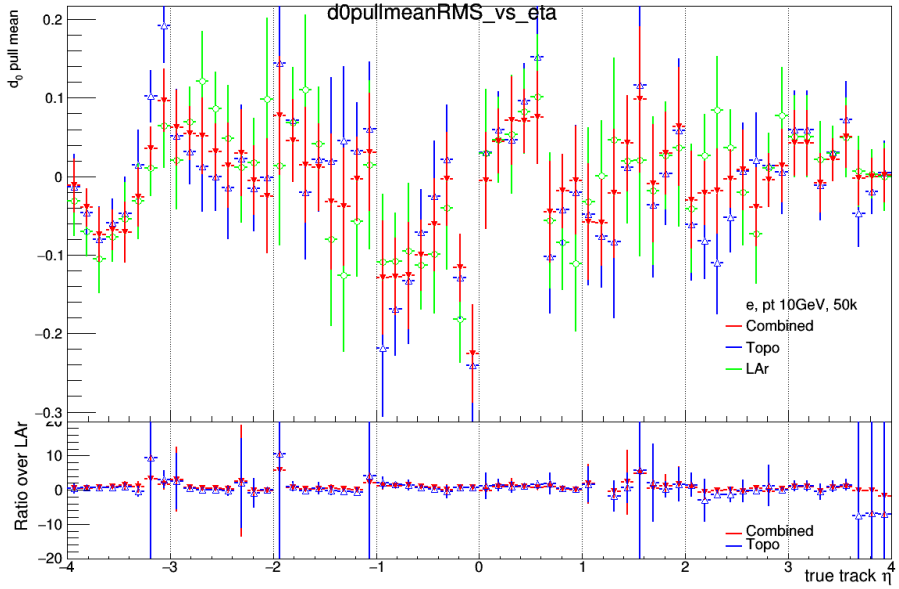

qoverptmeanRMS_vs_eta
(1/p_T) mean [MeV^-1]
e, pt 10GeV, 50k
Combined
Topo
LAr
Ratio over LAr
Combined
Topo
true track η

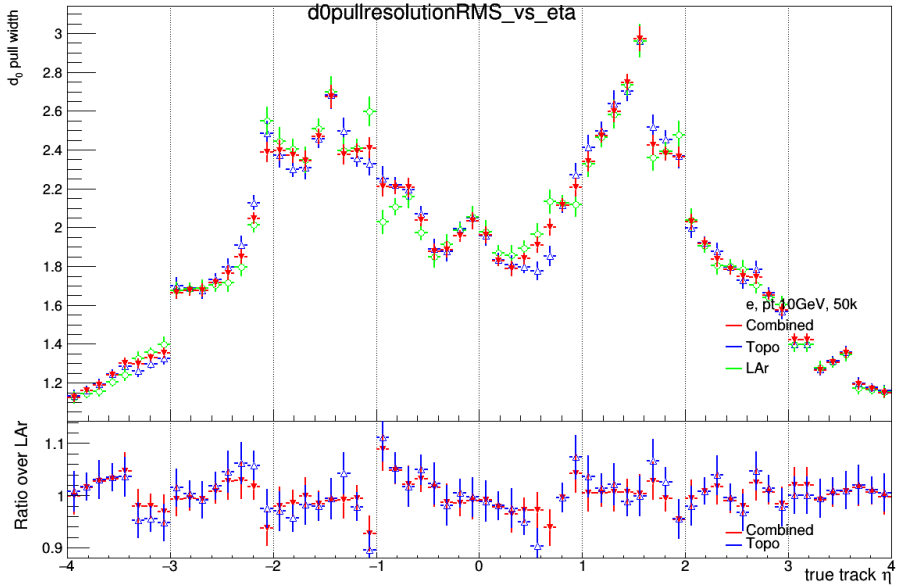

qoverptpullmeanRMS_vs_eta
(1/p_T) pull mean
e, pt 10GeV, 50k
Combined
Topo
LAr
Ratio over LAr
Combined
Topo
true track η

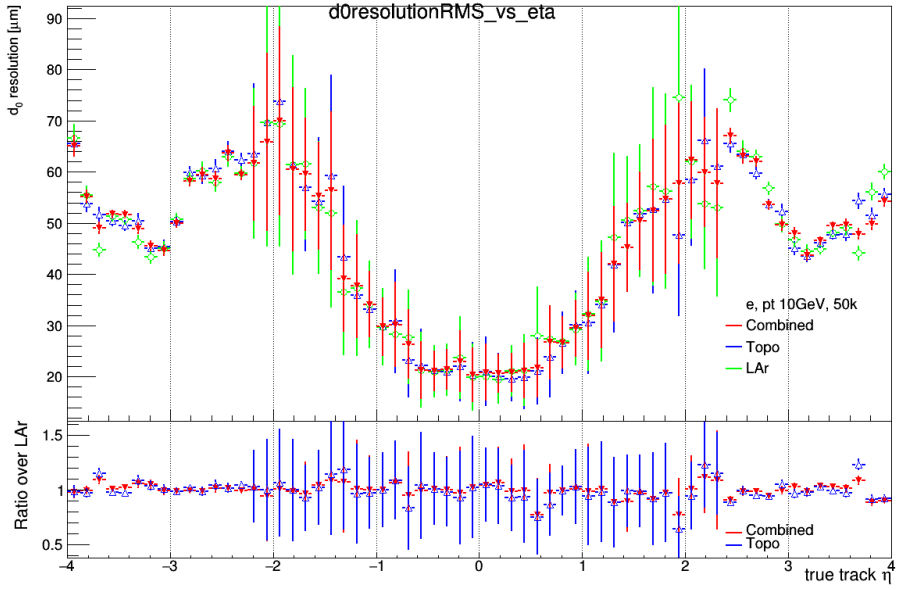

qoverptpullresolutionRMS_vs_eta
(1/p_T) pull width
e, pt 10GeV, 50k
Combined
Topo
LAr
Ratio over LAr
Combined
Topo
true track η

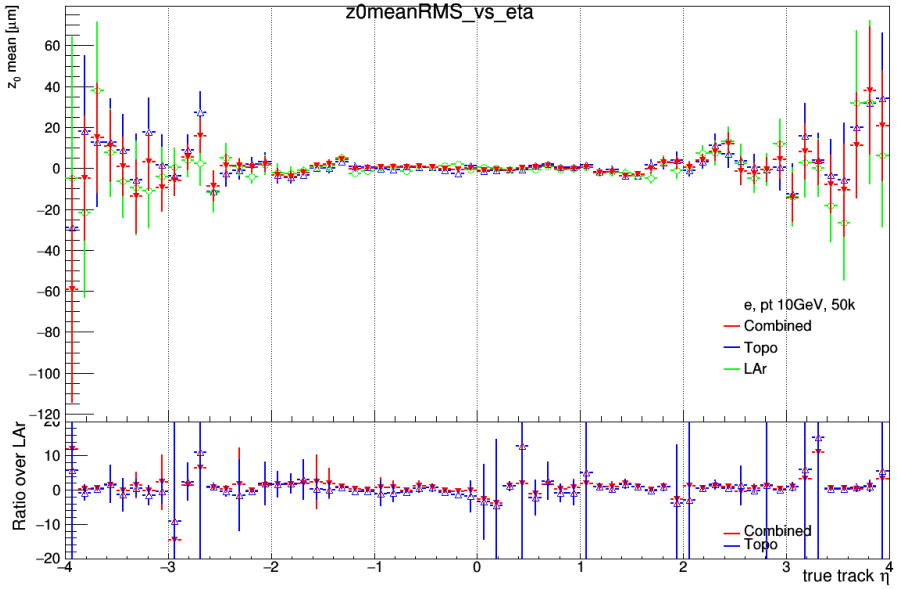

qoverptresolutionRMS_vs_eta
(1/p_T) resolution [MeV^-1]
e, pt 10GeV, 50k
Combined
Topo
LAr
Ratio over LAr
Combined
Topo
true track η

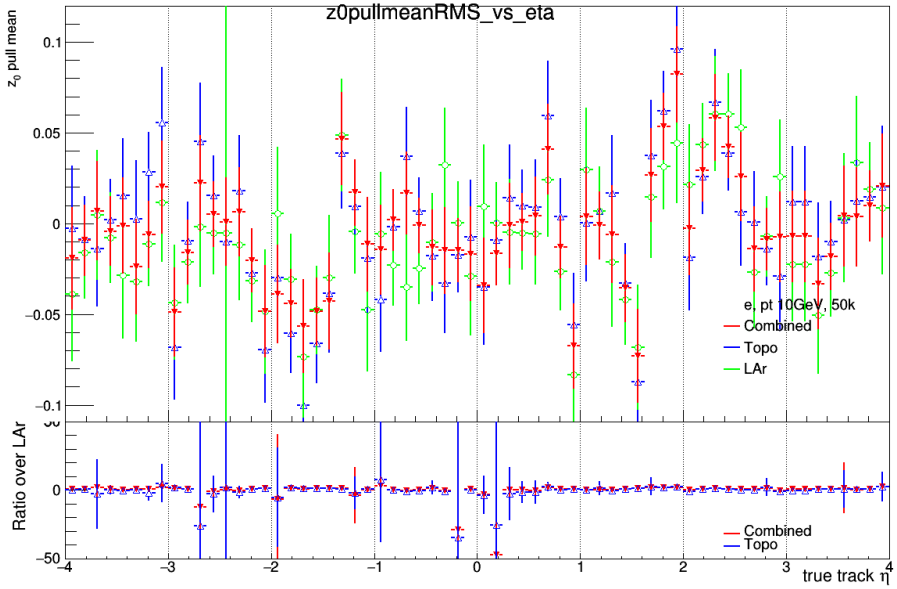

d0meanRMS_vs_eta
d0 mean [μm]
e, pt 10GeV, 50k
Combined
Topo
LAr
Ratio over LAr
Combined
Topo
true track η

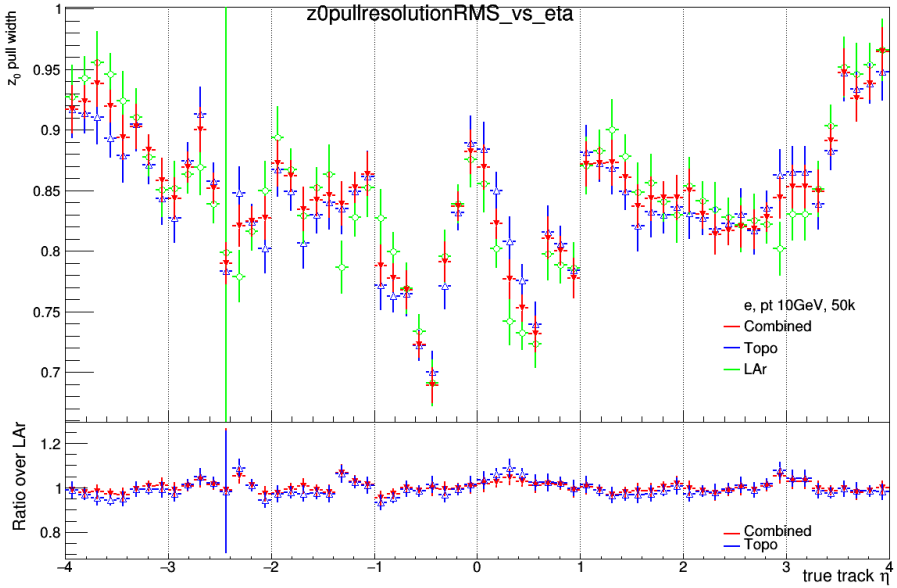

d0pullmeanRMS_vs_eta
d0 pull mean
e, pt 10GeV, 50k
Combined
Topo
LAr
Ratio over LAr
Combined
Topo
true track η

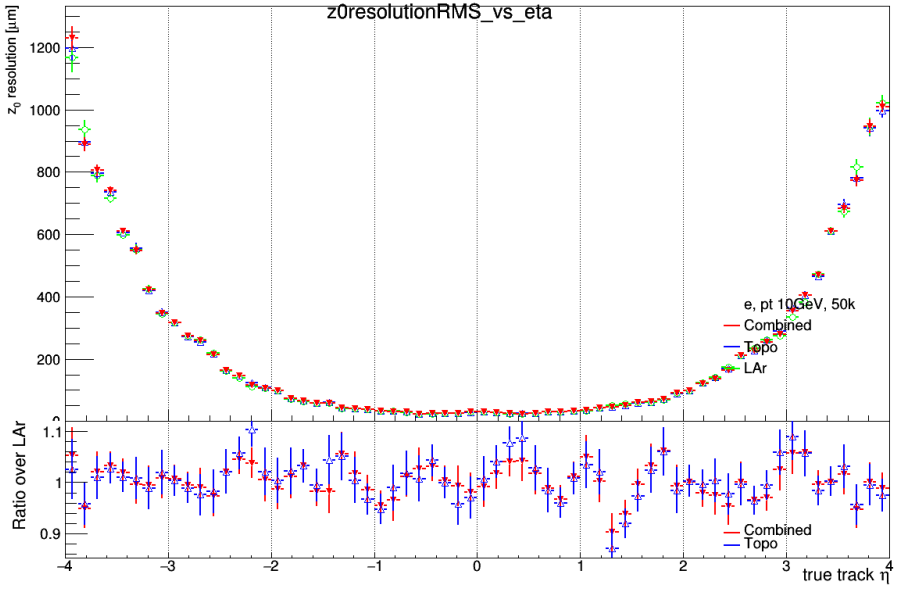

d0pullresolutionRMS_vs_eta
d0 pull width
e, pt 10GeV, 50k
Combined
Topo
LAr
Ratio over LAr
Combined
Topo
true track η

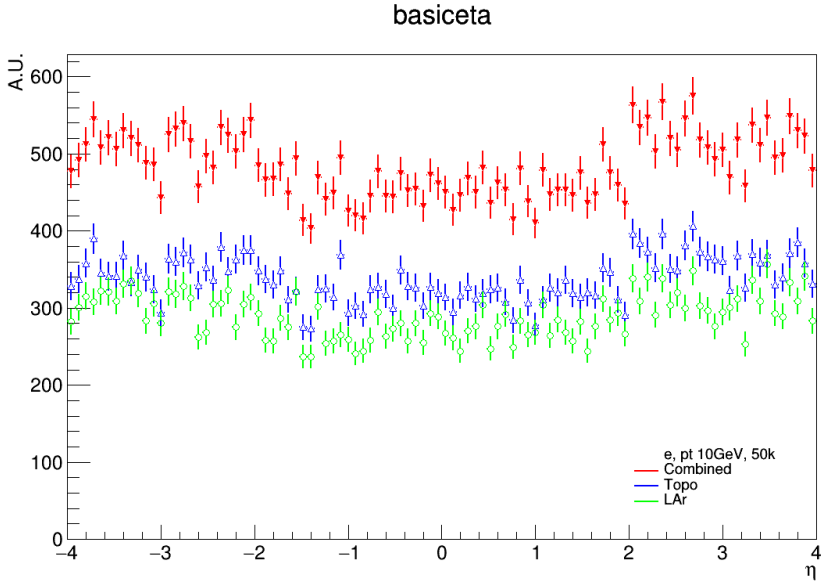

d0resolutionRMS_vs_eta
d0 resolution [μm]
e, pt 10GeV, 50k
Combined
Topo
LAr
Ratio over LAr
Combined
Topo
true track η

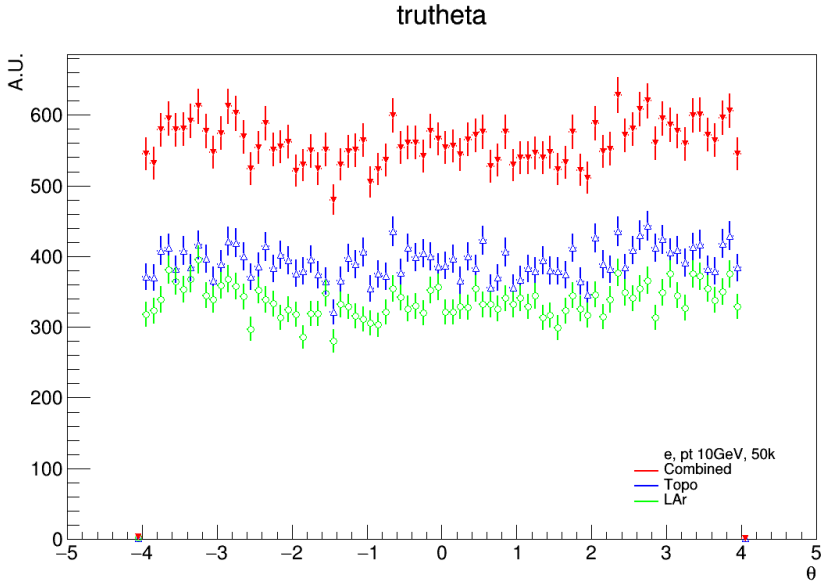

z0meanRMS_vs_eta
z_0 mean [μm]
e, pt 10GeV, 50k
Combined
Topo
LAr
Ratio over LAr
Combined
Topo
true track η

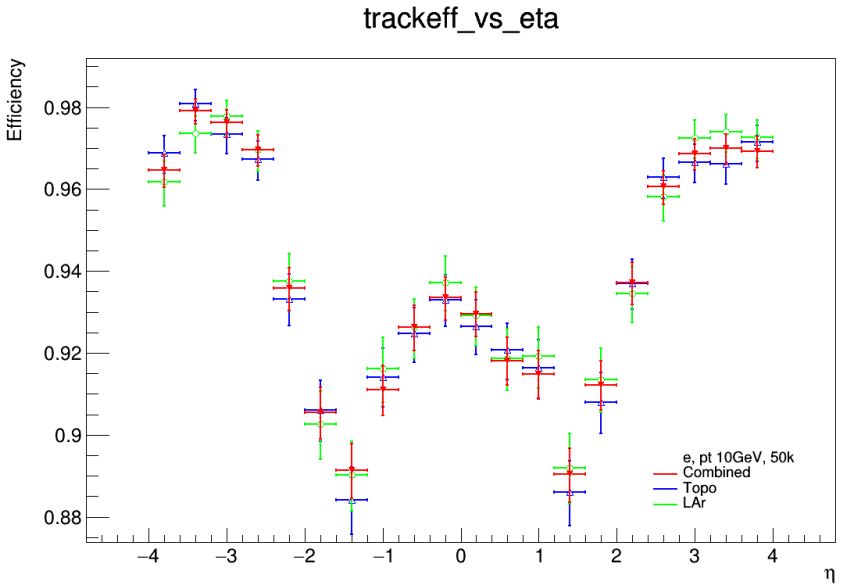

z0pullmeanRMS_vs_eta
z_0 pull mean
e, pt 10GeV, 50k
Combined
Topo
LAr
Ratio over LAr
Combined
Topo
true track η


z0pullresolutionRMS_vs_eta
z_0 pull width
e, pt 10GeV, 50k
Combined
Topo
LAr
Ratio over LAr
Combined
Topo
true track η


z0resolutionRMS_vs_eta
z_0 resolution [μm]
e, pt 10GeV, 50k
Combined
Topo
LAr
Ratio over LAr
Combined
Topo
true track η


basiceta
A.U.
600
500
400
300
200
100
0
−4
−3
−2
−1
0
1
2
3
4
η
e, pt 10GeV, 50k
Combined
Topo
LAr


trutheta
A.U.
600
500
400
300
200
100
0
−5
−4
−3
−2
−1
0
1
2
3
4
5
θ
e, pt 10GeV, 50k
Combined
Topo
LAr

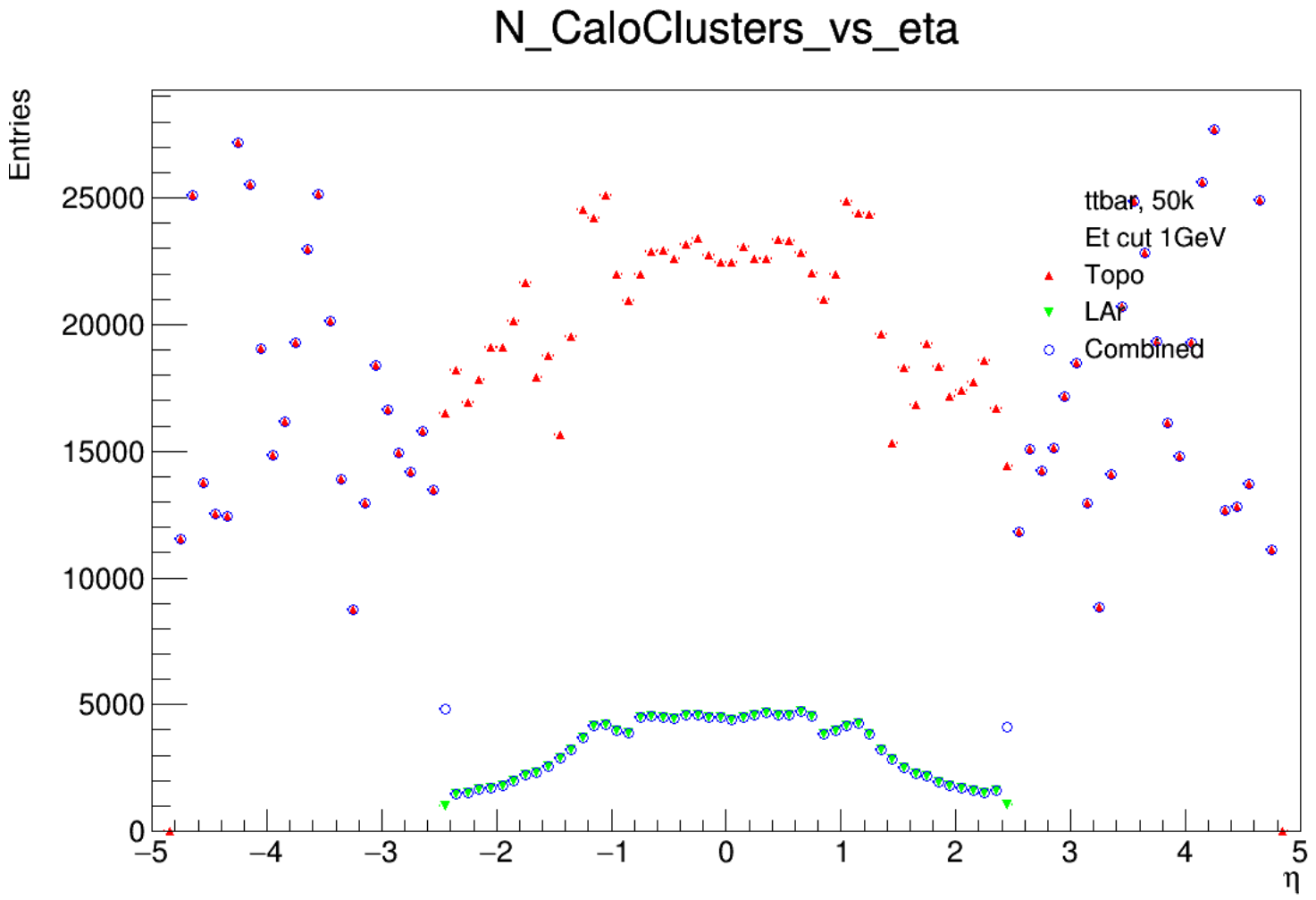

trackeff_vs_eta
Efficiency
0.98
0.96
0.94
0.92
0.9
0.88
−4
−3
−2
−1
0
1
2
3
4
η
e, pt 10GeV, 50k
Combined
Topo
LAr

Others

- 4W Combination
- multi-lepton kickoff
- ……

ttbar clusters

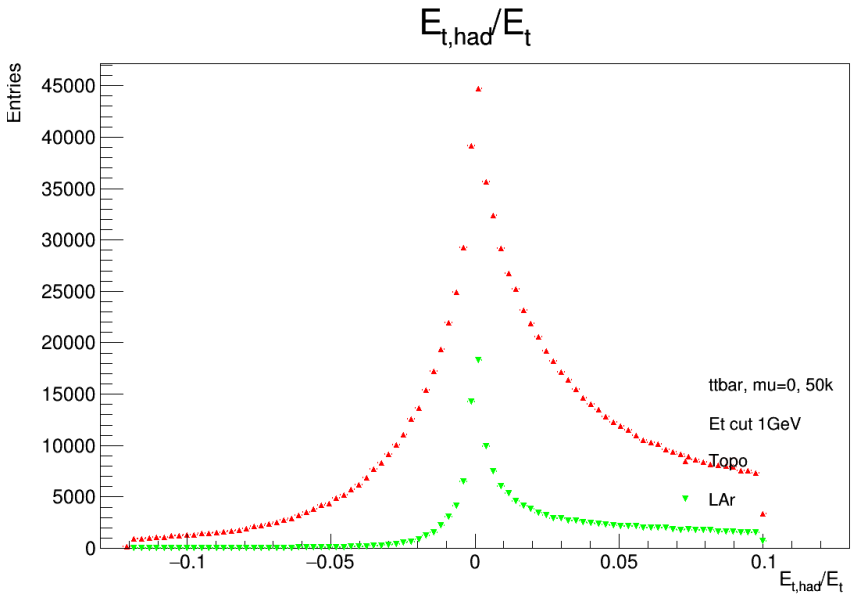
Eta



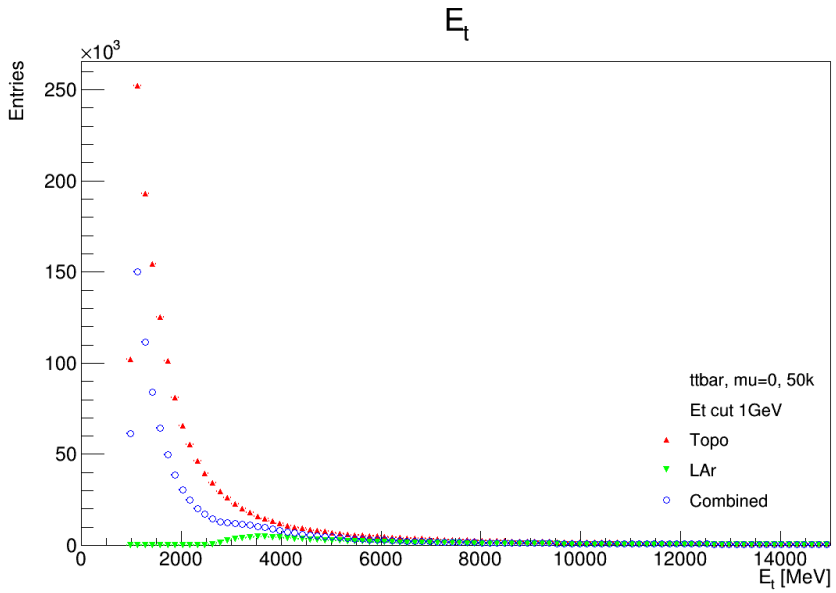
50k ttbar;

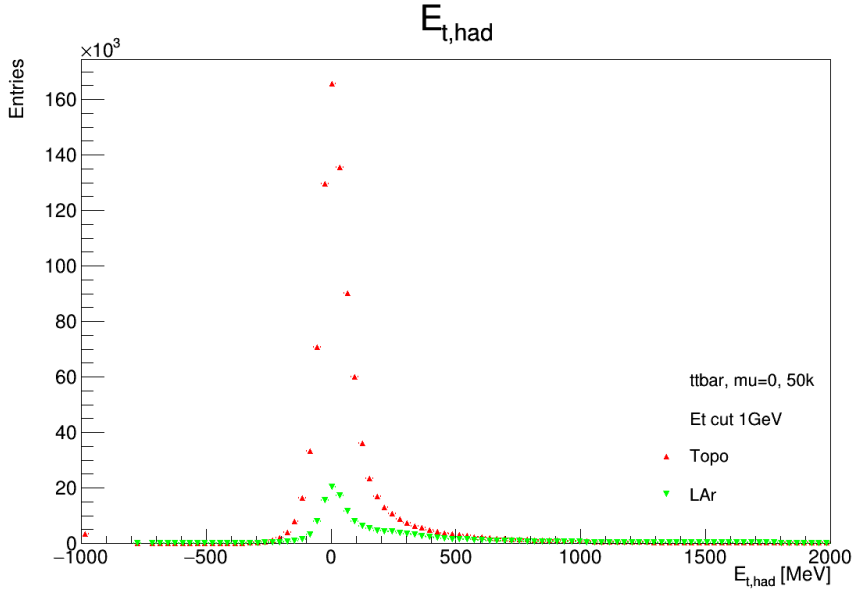
LAr: 161k; Forawrd: 796k; Central TopoClusters: 914k; ~5.7 times than the LAr;

Et

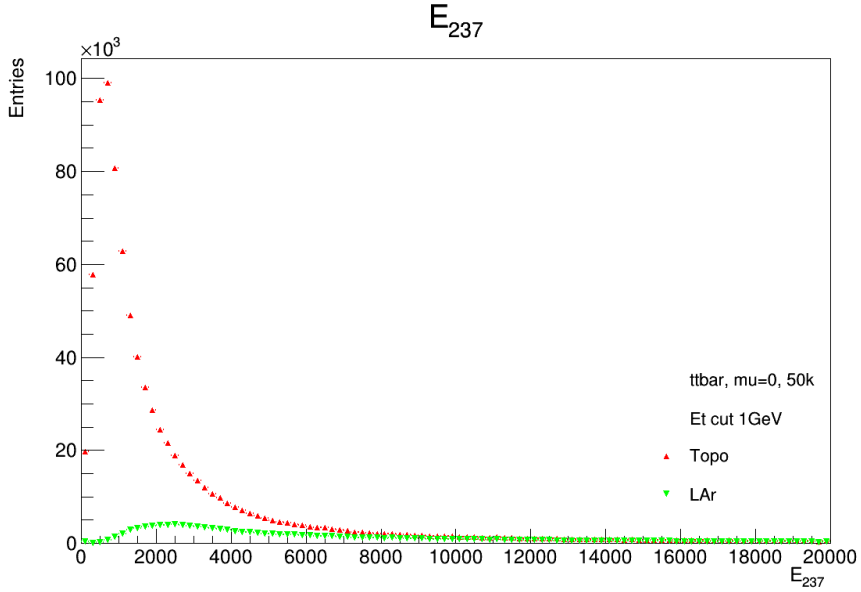


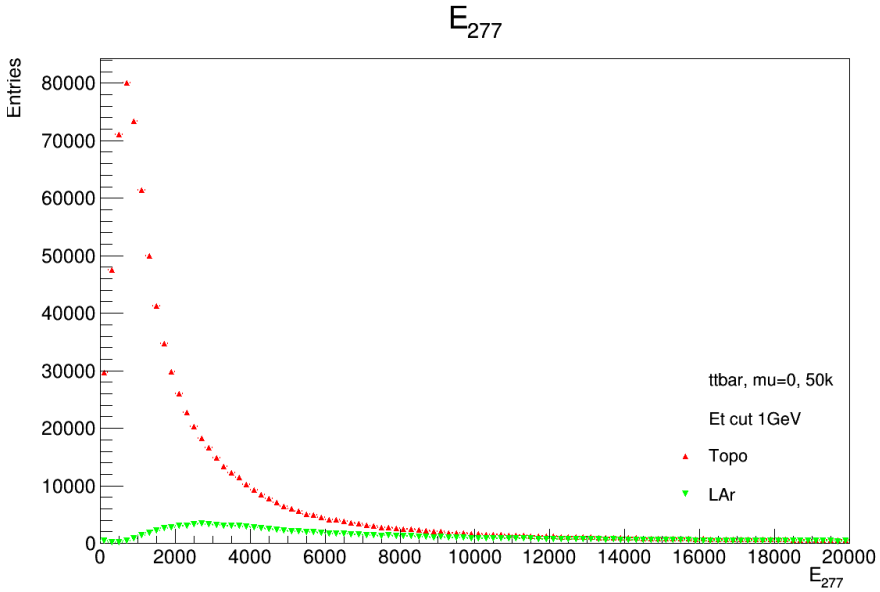
- $|\frac{E_{t,had}}{E_t}| < 0.12$ works;
- We can raise the Et cut to decrease the candidate ROIs

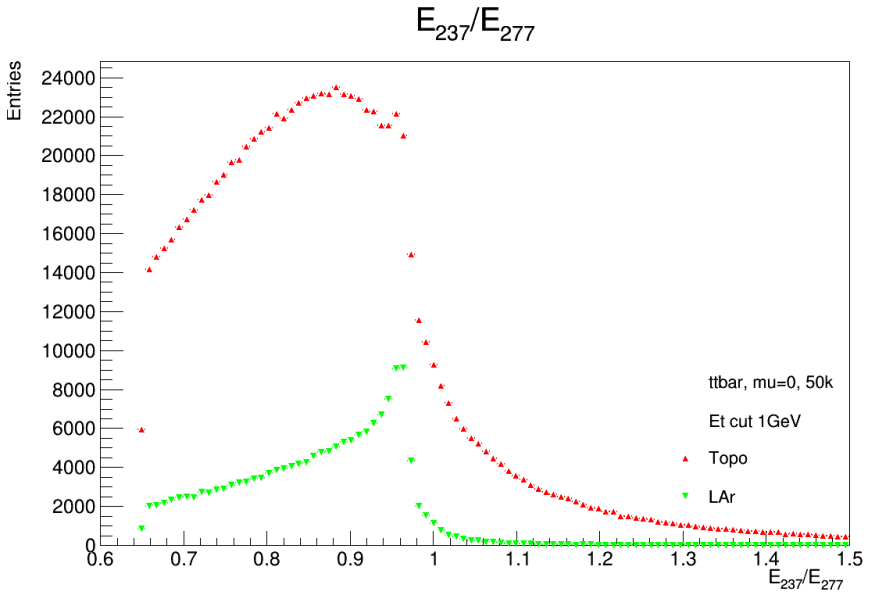




E237, E277

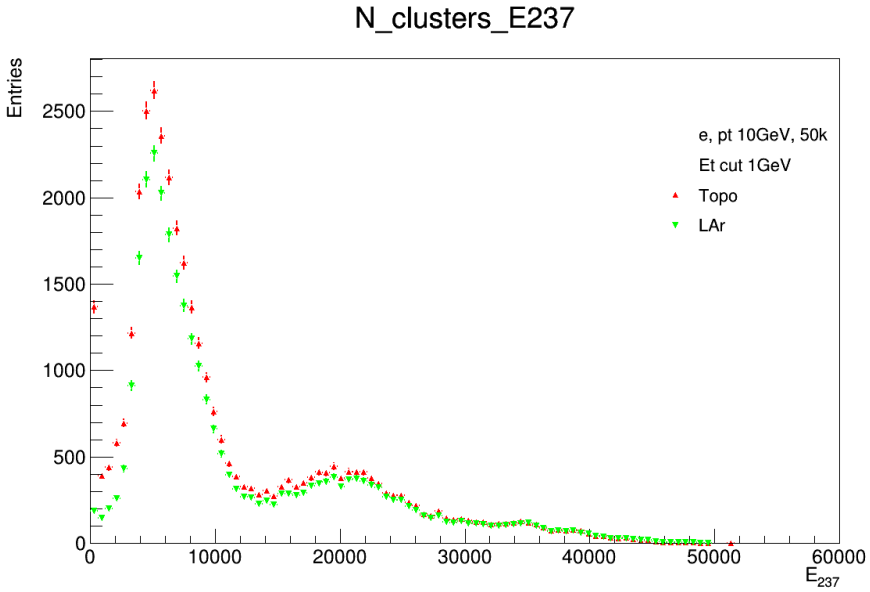

E_{237}
×10³
Entries
100
80
60
40
20
0
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
E_{237}
ttbar, mu=0, 50k
Et cut 1GeV
Topo
LAr

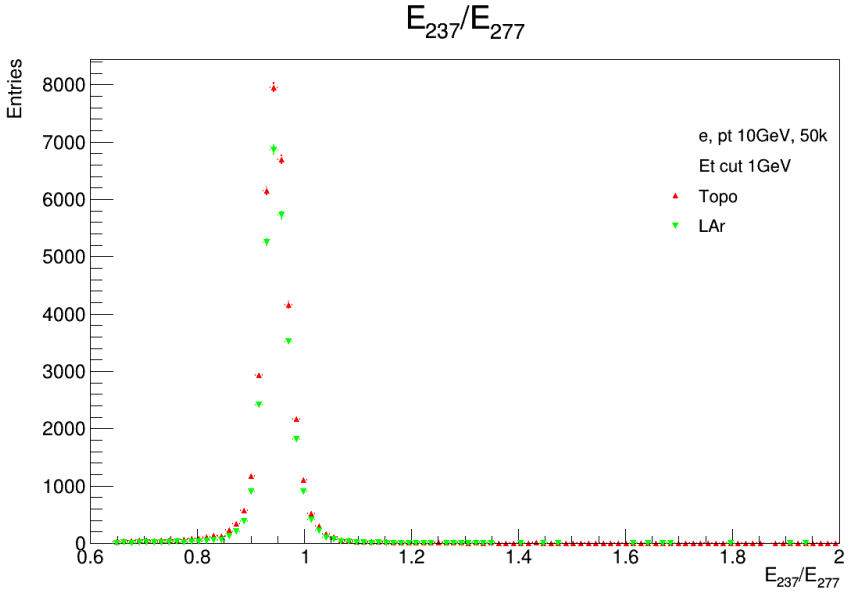

E_{277}
Entries
80000
70000
60000
50000
40000
30000
20000
10000
0
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
E_{277}
ttbar, mu=0, 50k
Et cut 1GeV
Topo
LAr

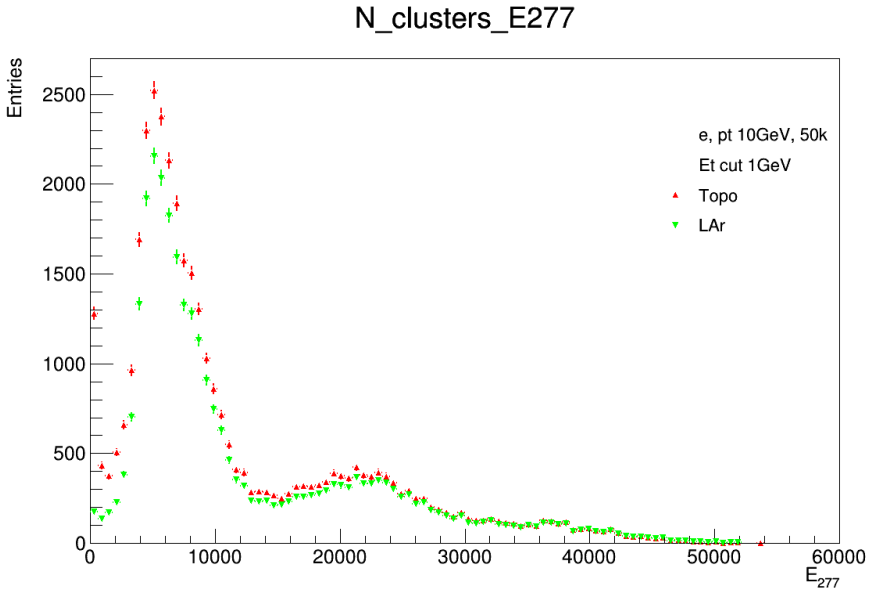

E_{237}/E_{277}
Entries
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
E_{237}/E_{277}
ttbar, mu=0, 50k
Et cut 1GeV
Topo
LAr

backups

Caloclusters $\frac{E_{237}}{E_{277}} > 0.65$

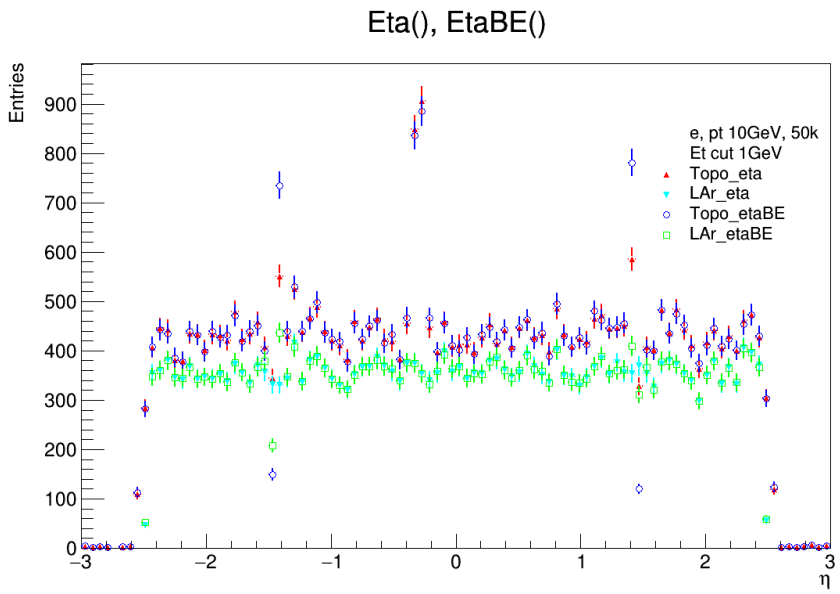






- e237: brief uncalibrated energy (sum of cells) of the middle sampling in a rectangle of size 3x7
- e277: brief uncalibrated energy (sum of cells) of the middle sampling in a rectangle of size 7x7

EtaBE(2) or Eta()?



- EtaBE(2) only works for -2.5 and 2.5;
- $1.37 < |\eta| < 1.51$ behaves different:
- Seems eta() has less fluctuations?