Flavour tagging performance of the New CLIC Detector

CLICdp detector optimisation and validation meeting
01/08/2017

Outline

- **Flavour tagging strategy**
- CLICdet vs CLIC_SiD (double spirals)
- Impact of the γγ->hadrons background
- Jet clustering optimisation
- Summary

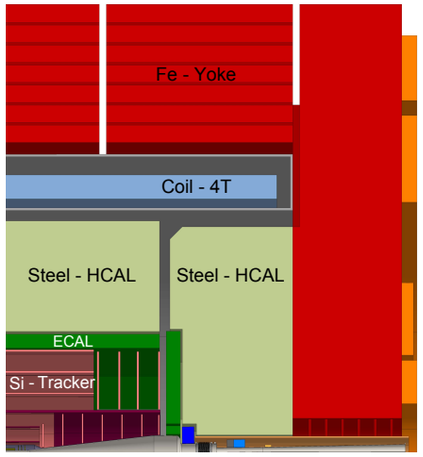
Flavour tagging

Flavour tagging depends on:

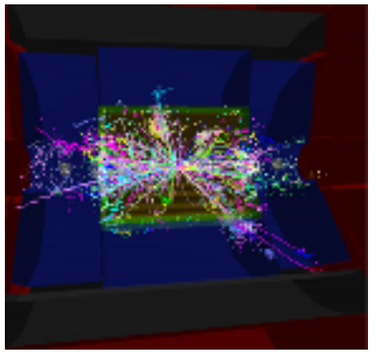
- **Impact parameters d0 and z0**
- **Tracking resolution**: track information used for vertex finding
- **Vertex resolution**: secondary vertices allow us to distinguish b-jets, c-jets and light flavour jets
- **Momentum resolution**: the momentum of the jet is used for the inspection of the jet constituents in terms of the jet direction
- **Jet clustering strategy**: specially when γγ->hadrons background is overlaid

Flavour tagging: Analysis chain

Detector Simulation

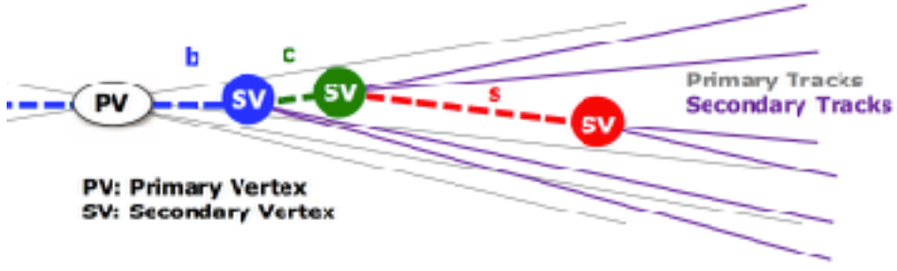


γγ->hadrons Overlay

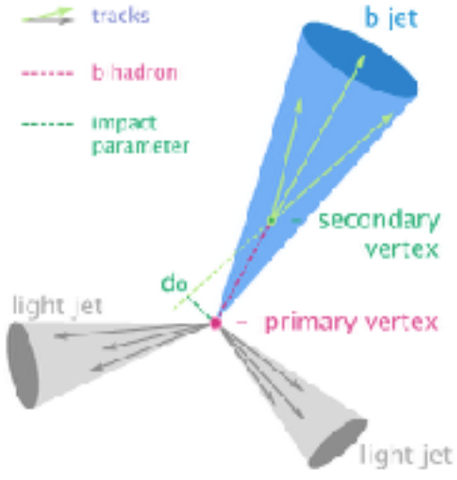


Reconstruction: Hits, Tracks, PandoraPFOs

Vertex reconstruction and jet clustering



Flavour tagging



Outline

- Flavour tagging strategy
- **CLICdet (CLIC_o3_v11) vs CLIC_SiD (double spirals)**
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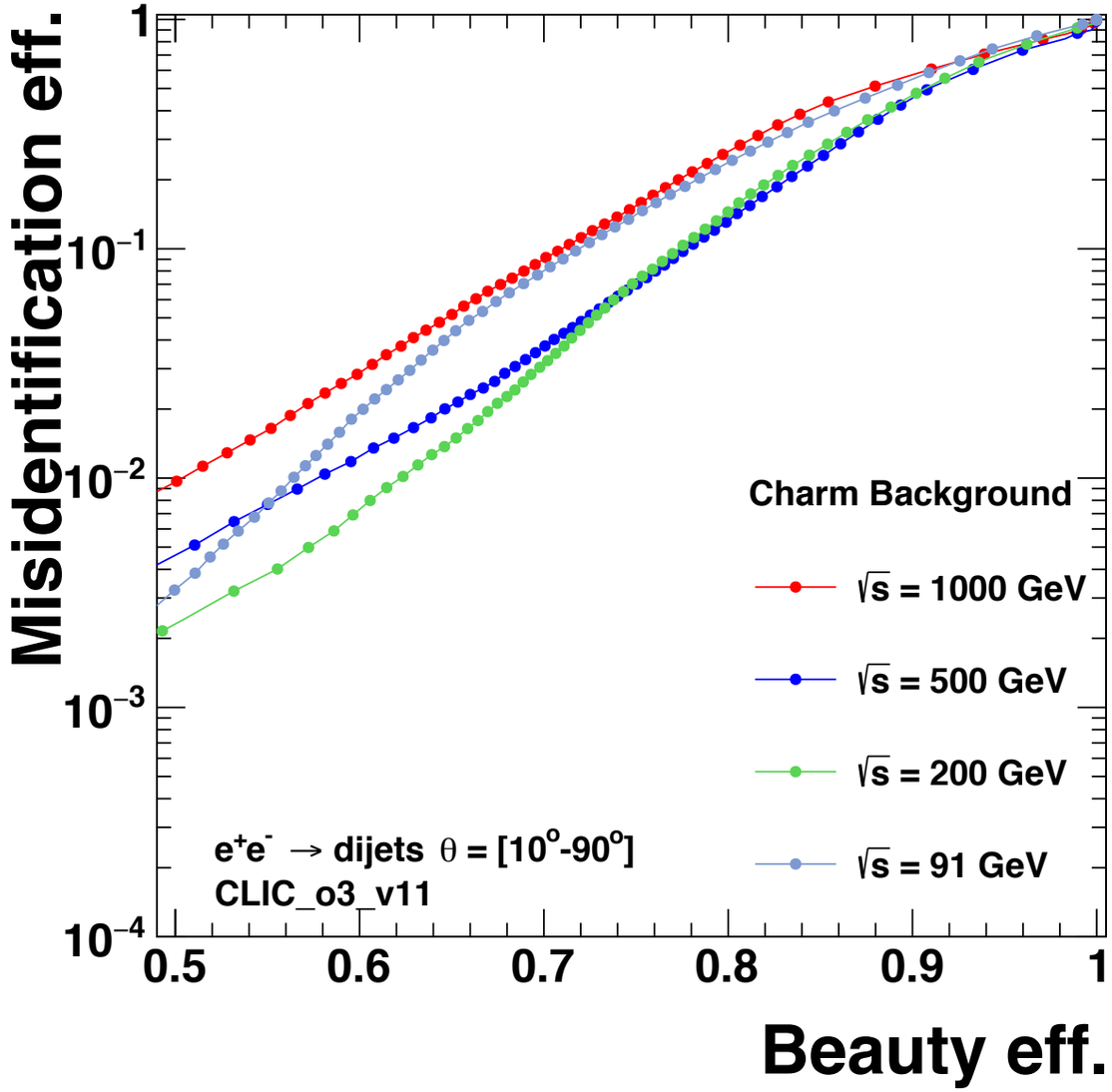
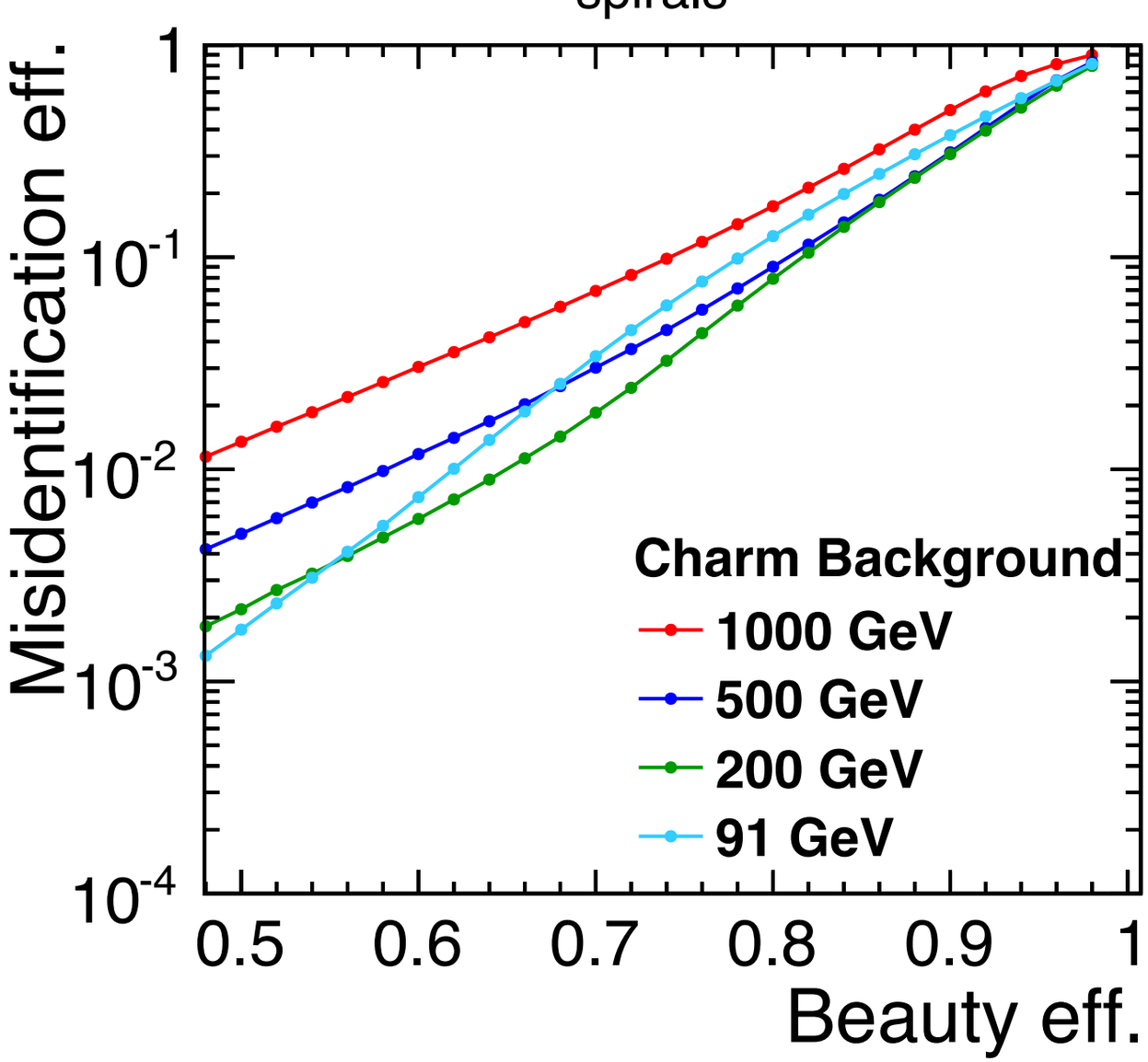
CLICdet vs CLIC_SiD: energy dependence

CLICdet



CLIC_SiD (ds)



ee -> dijets (bb, cc, qq)

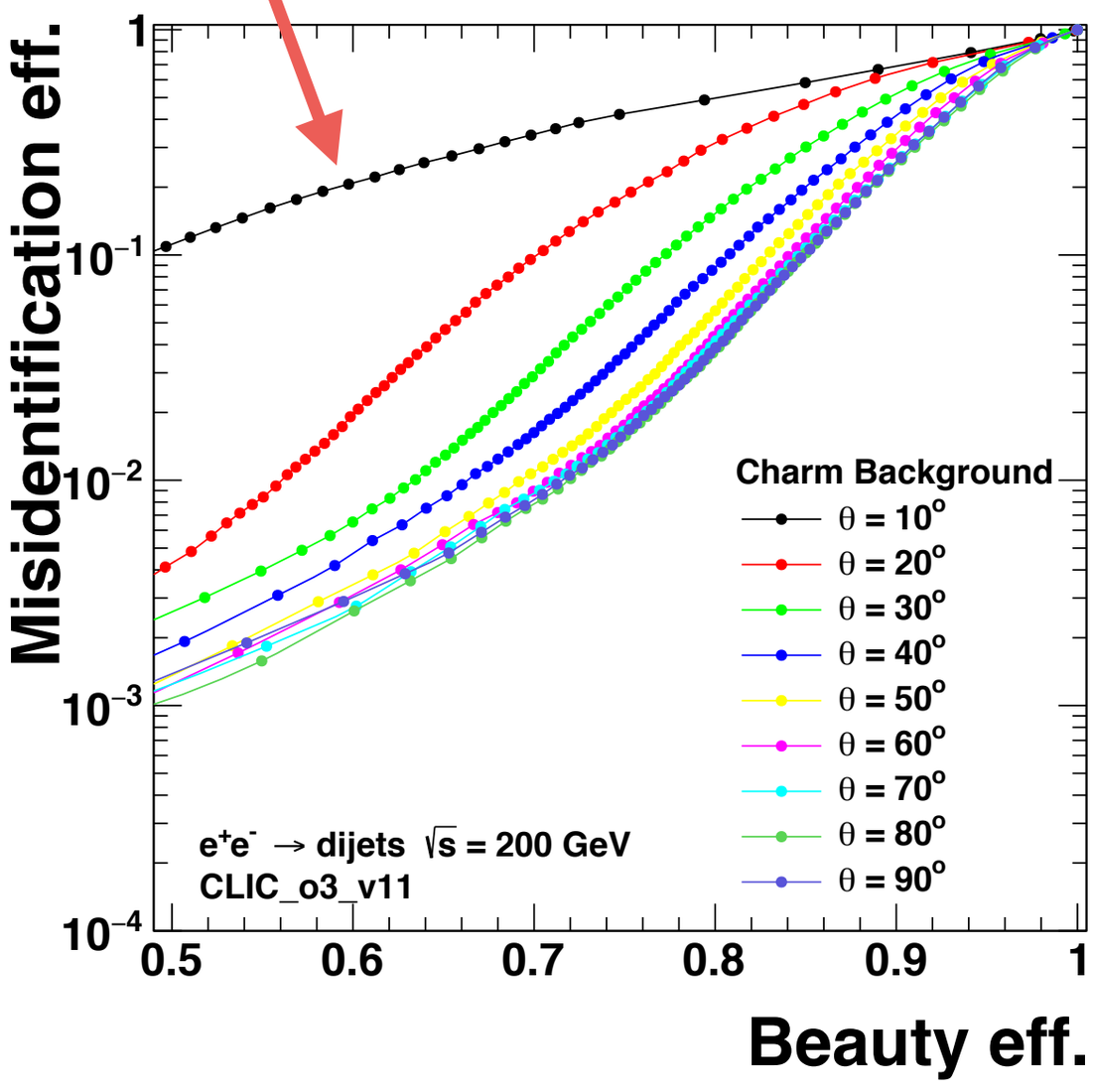
NO γγ -> had. Overlaid

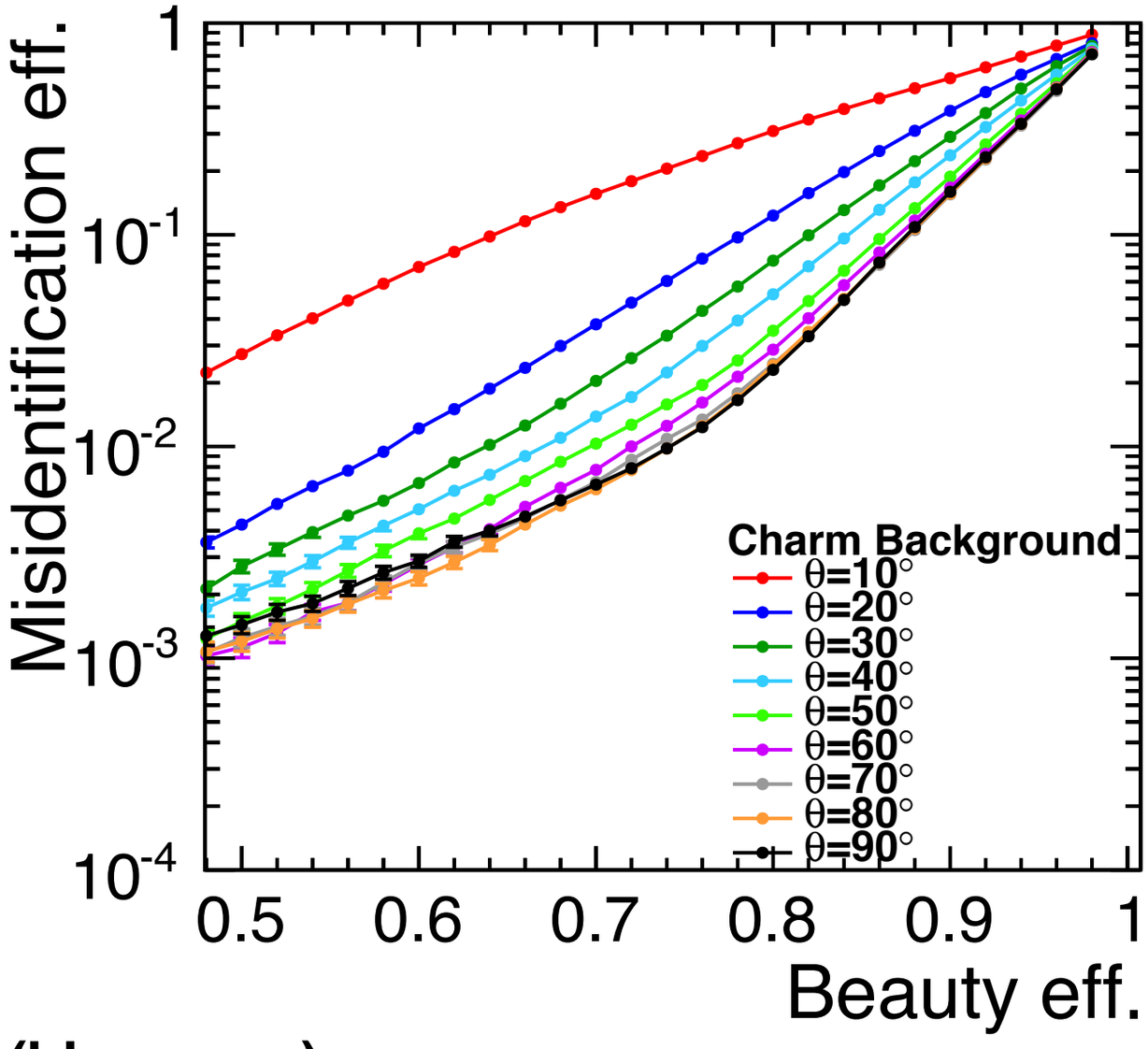
CLICdet vs CLIC_SiD: angle dependence

CLICdet

CLIC_SiD (ds)

b-tagging performance almost an order of magnitude worse at 10°



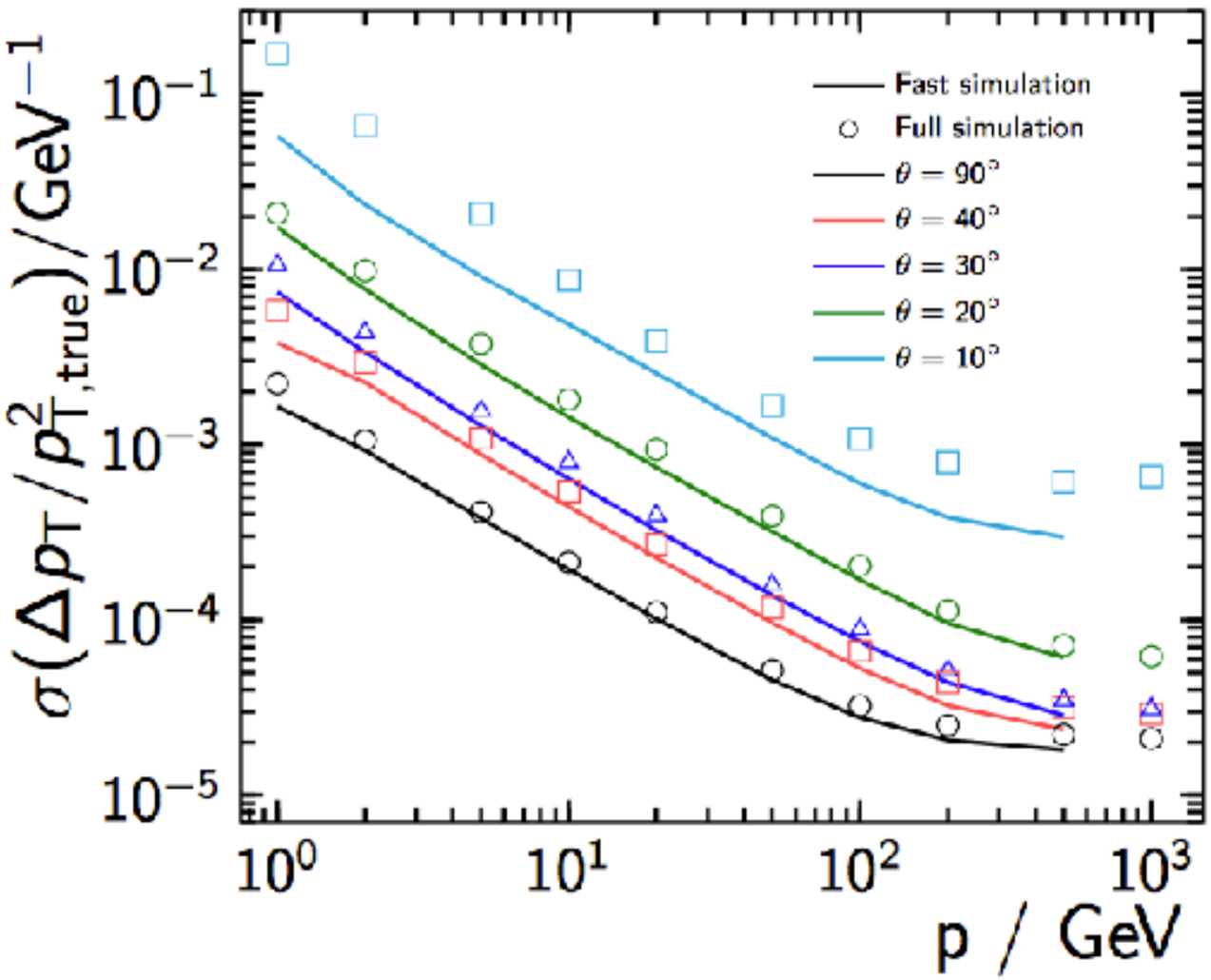


ee -> dijets (bb, cc, qq)

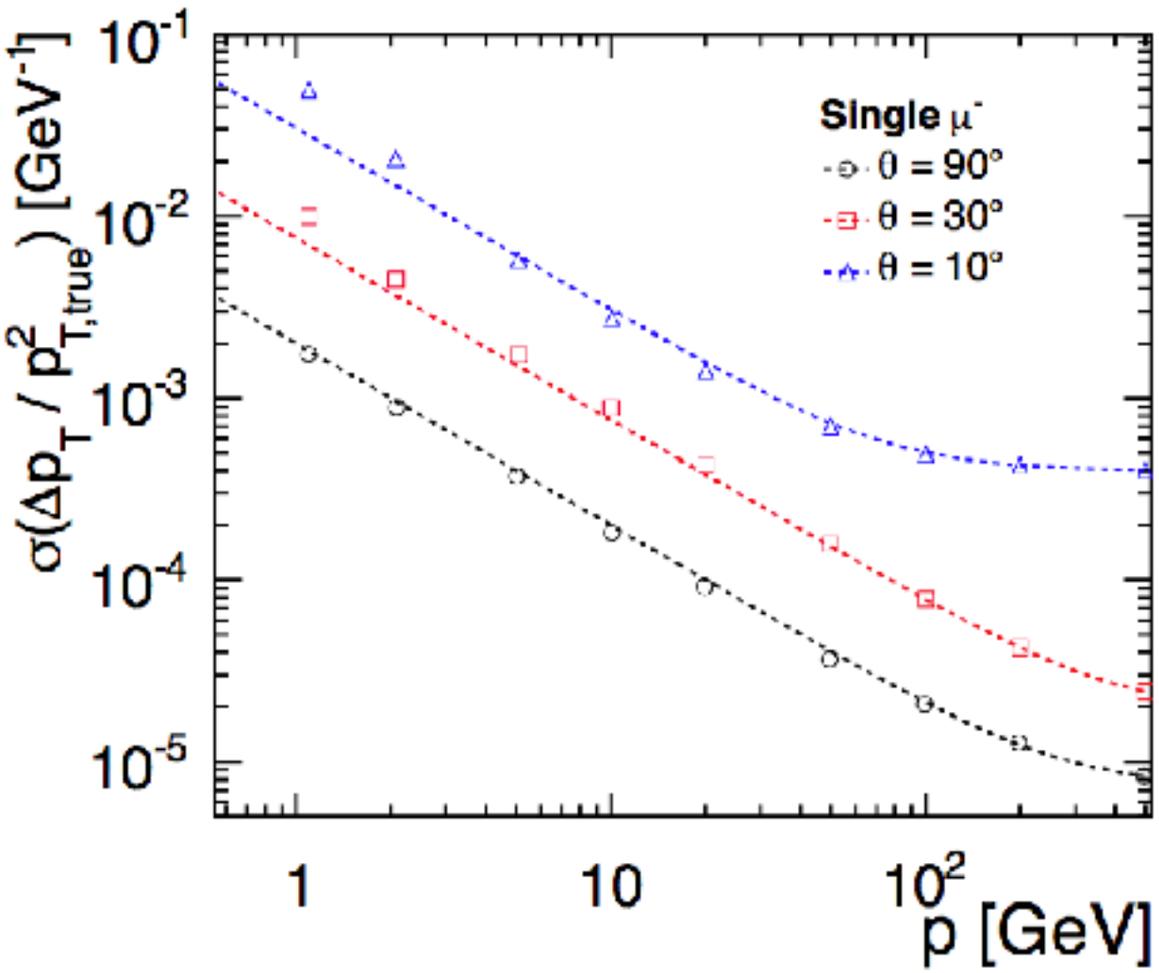
NO γγ -> had. Overlaid

p_T resolution

CLICdet



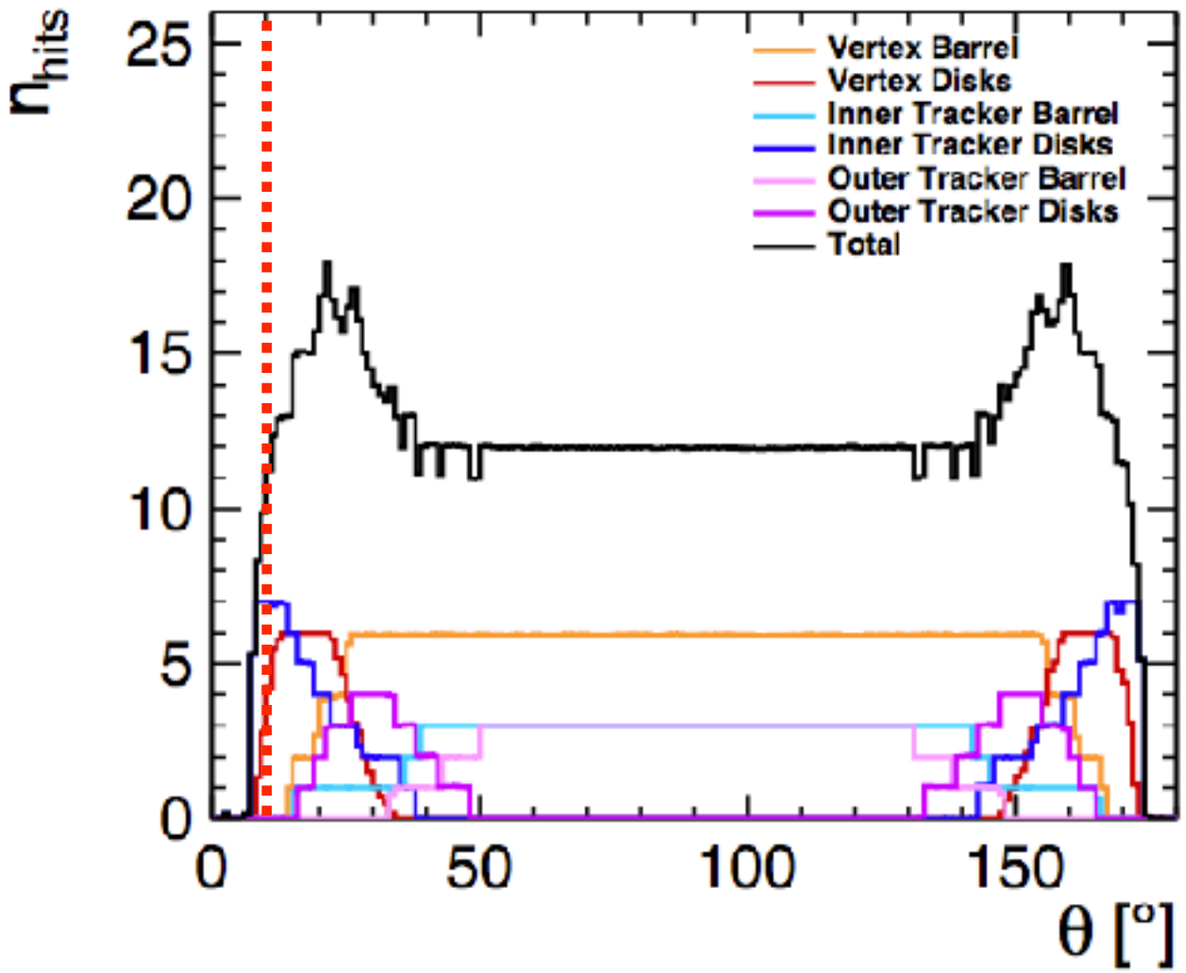
CLIC_SiD (ds)



pT resolution up to a factor 4 better in CLIC_SiD for low momenta particles

n_{hits} vertex+tracker

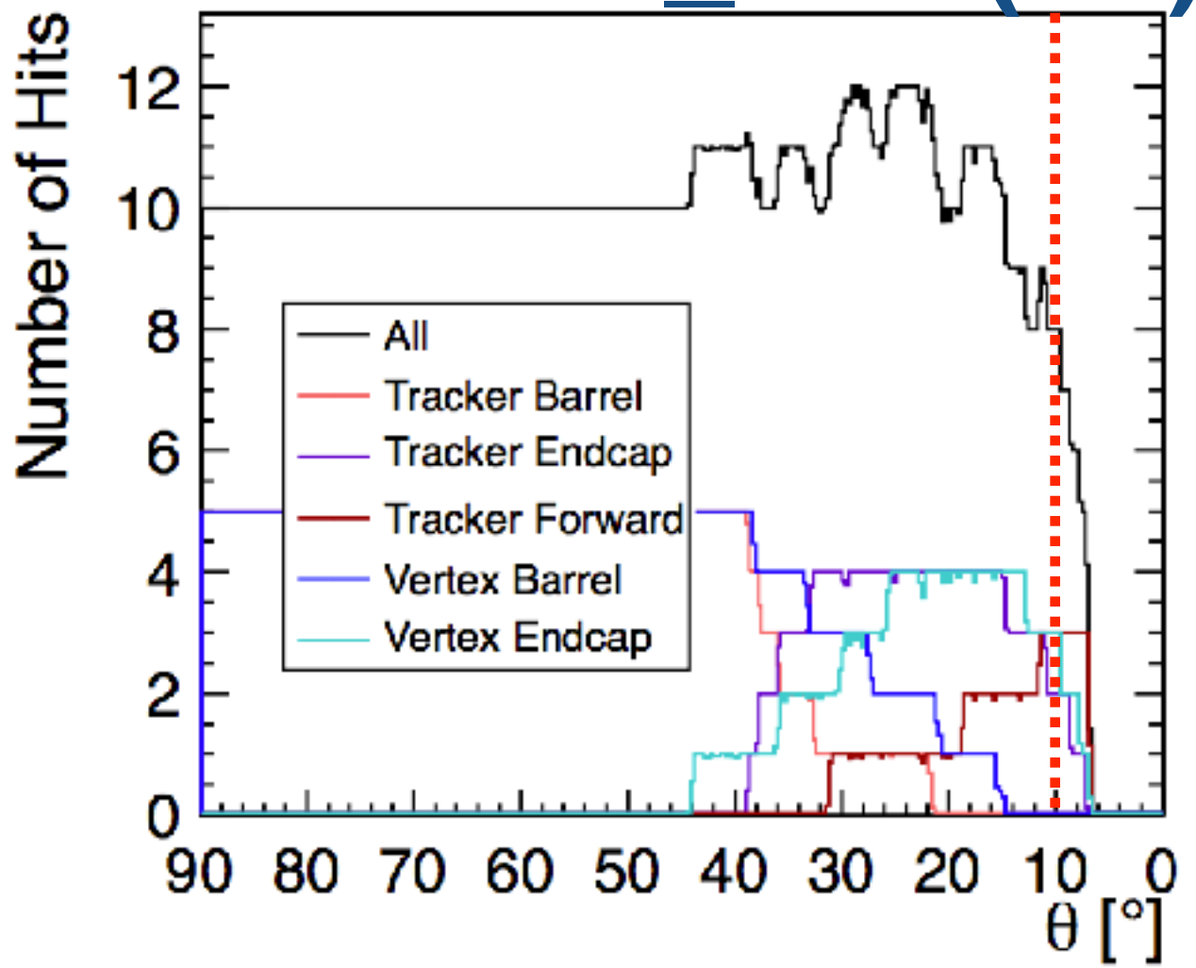
CLICdet



n_{hits} for 10°

Vertex Disks: 4
Inner Tracker Disks: 7
Total: 11

CLIC_SiD (ds)

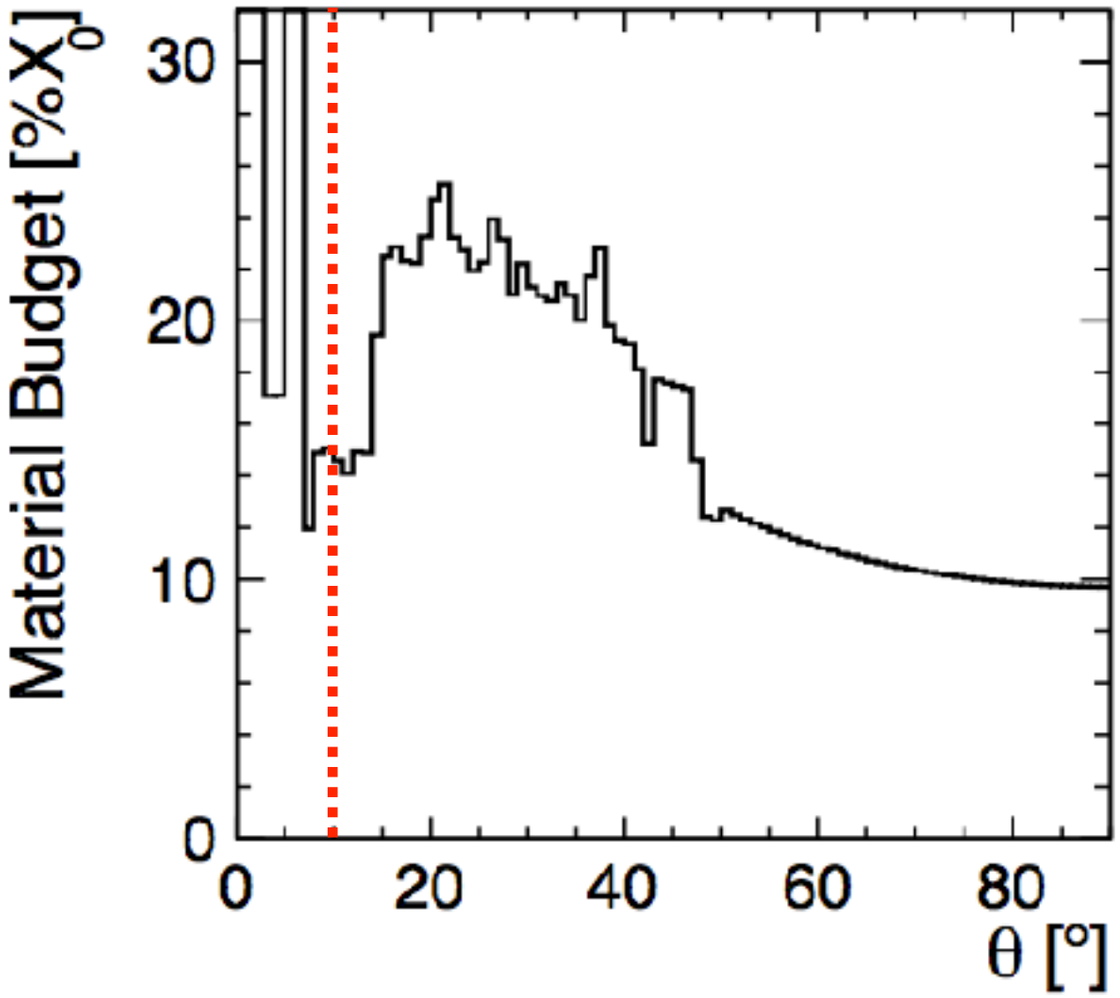


n_{hits} for 10°

Tracker endcap: 2
Vertex endcap: 3
Tracker Forward: 3
Total: 8

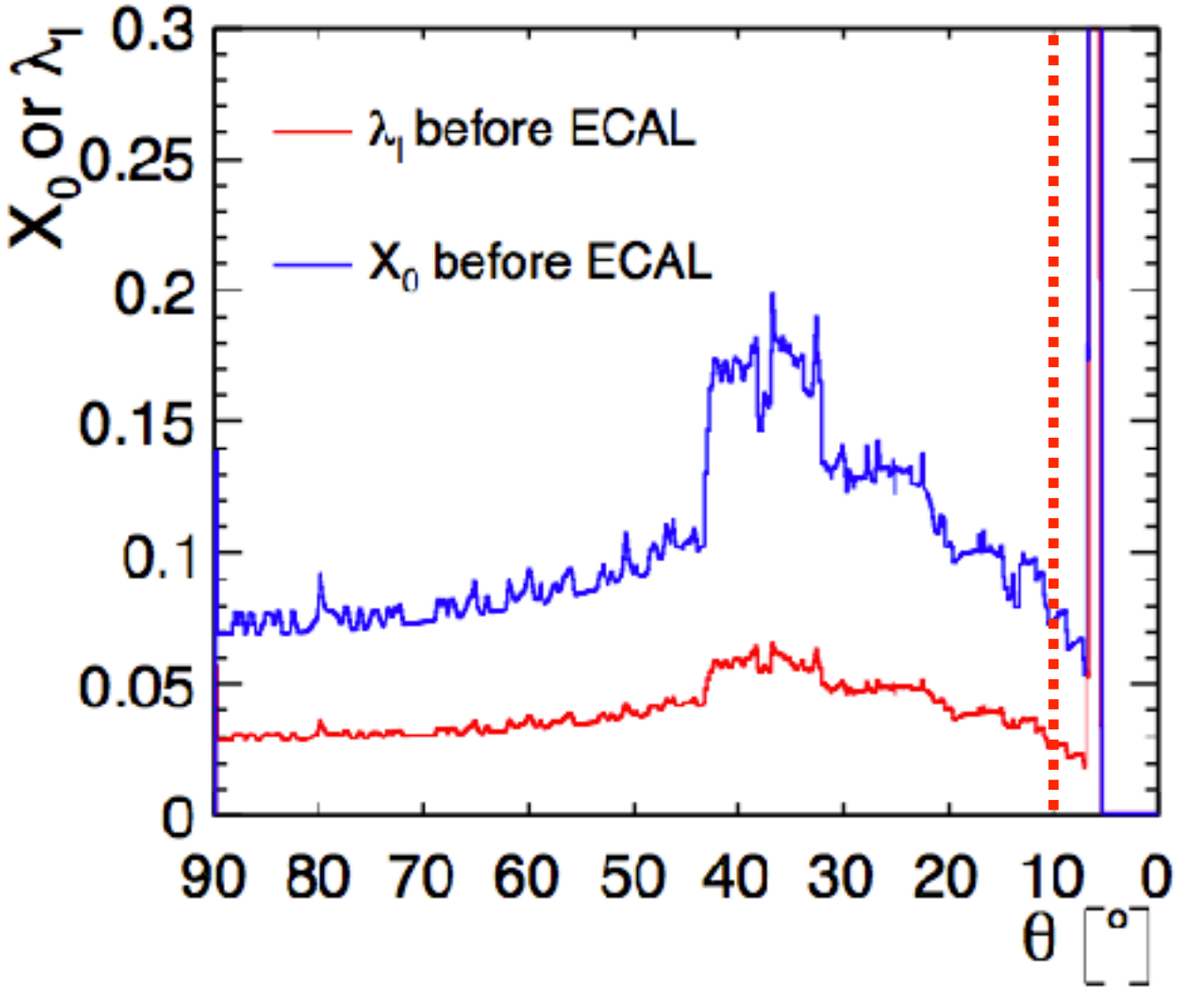
Material Budget

CLICdet



$X_0(10^o)$ = 15%

CLIC_SiD (ds)



$X_0(10^o)$ = 0,075

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- **Impact of the γγ->hadrons background**
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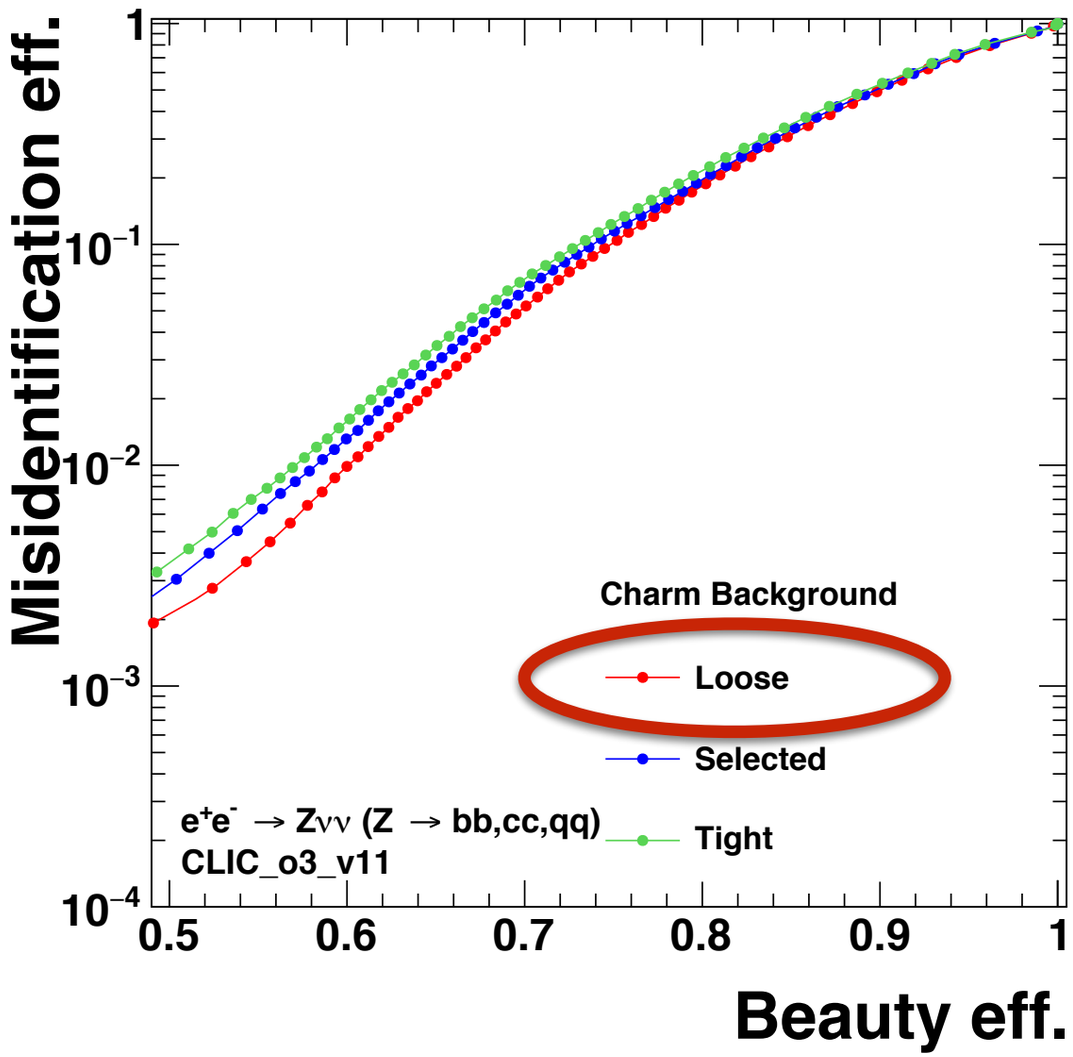
Impact of the γγ->hadrons background

- Use CLIC timing cuts (Loose, Selected, Tight)

- Robust jet reconstruction algorithm required to reduce the impact of γγ->hadrons background (Valencia or kt)

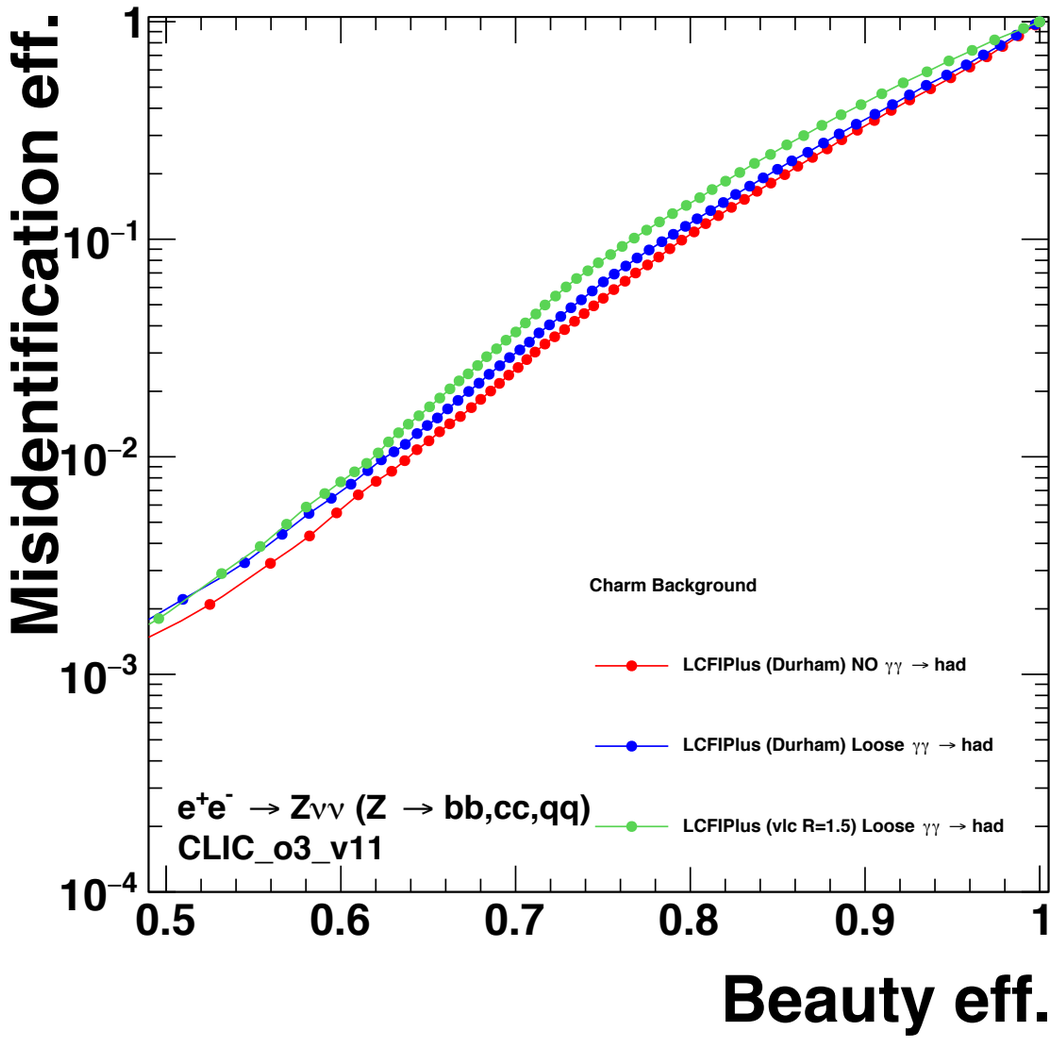


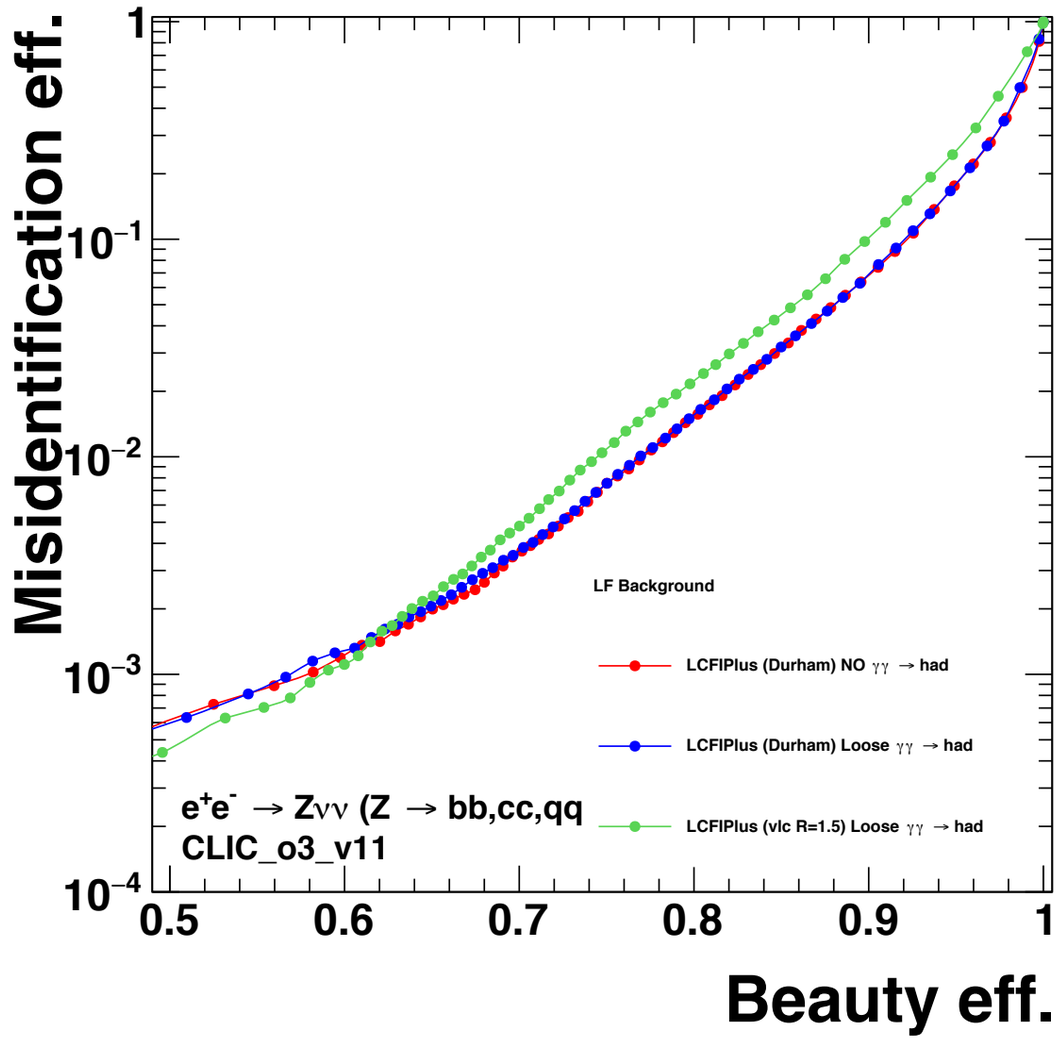
As expected loose timing cuts
Are the best option at low energies

Impact of the γγ->hadrons background

ee -> Znunu (Z -> bb, cc, qq) 350 GeV

0.0464 γγ -> had. / BX





Durham no dramatically affected by γγ -> had. with loose timing cuts.
Valencia R=1.5 doesn't help too much -> larger R?

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Jet Clustering optimisation

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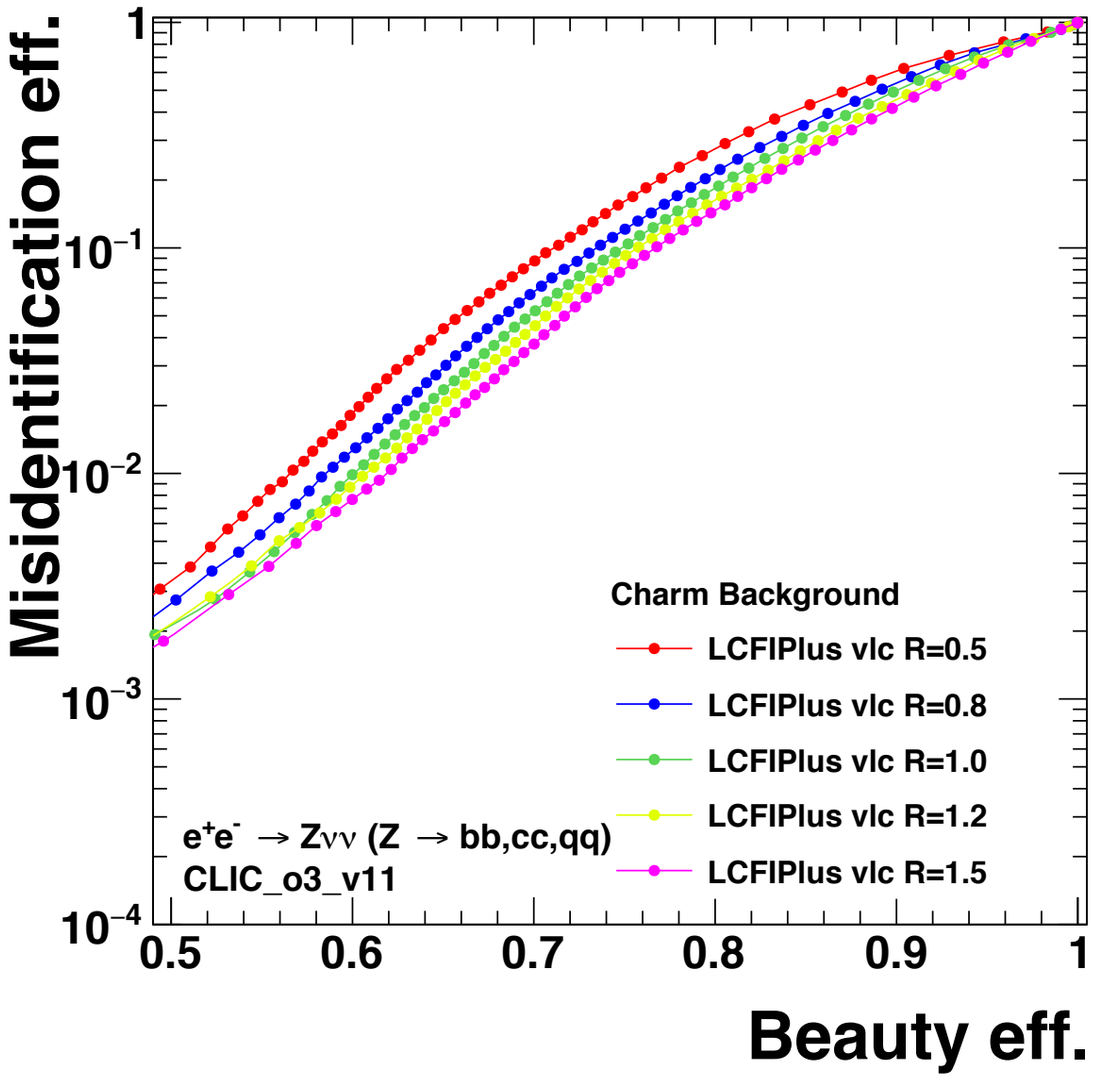
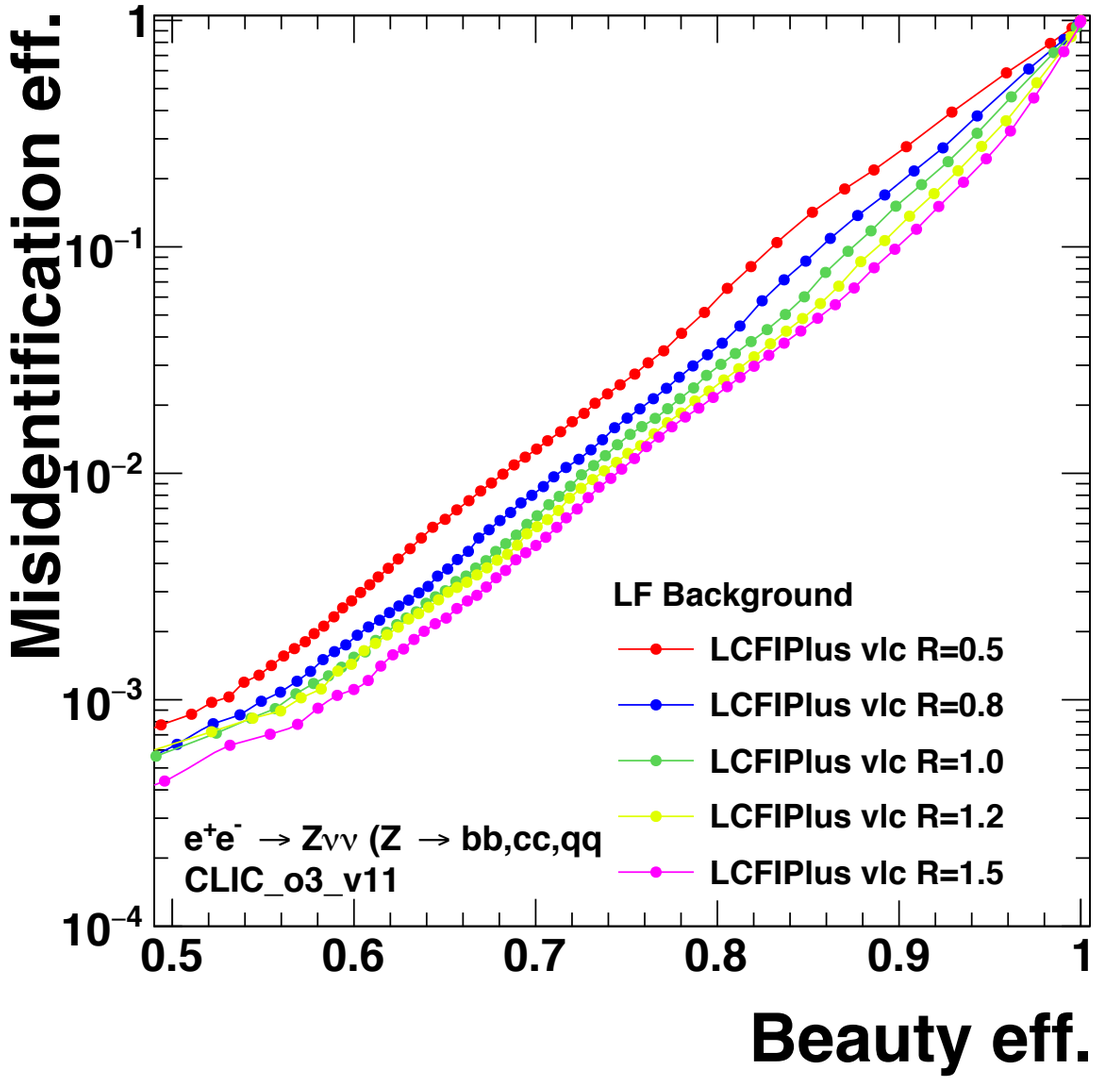
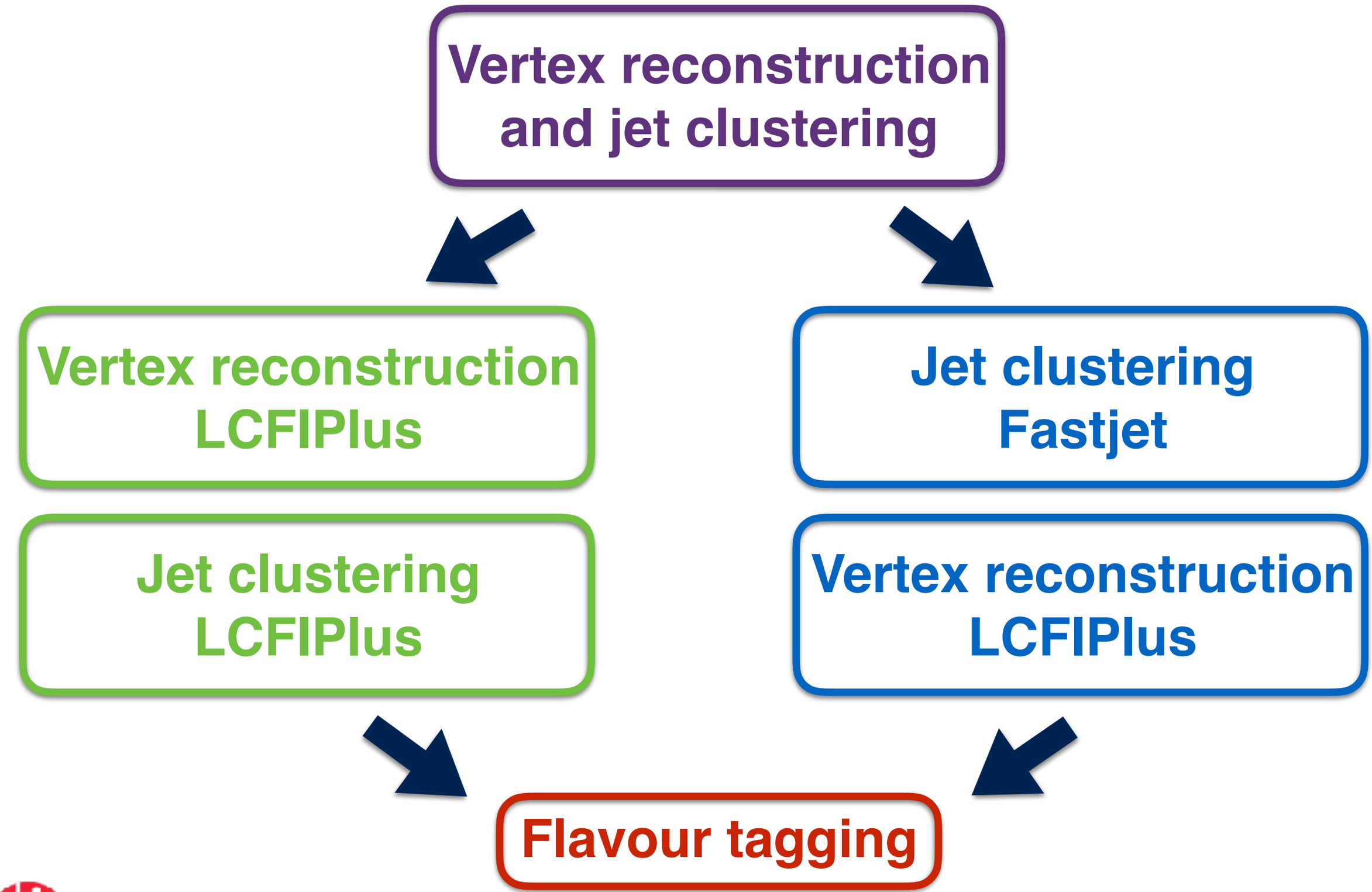




At 350 GeV, bigger radius (R >=1.5) performs better.
Lower values of R are too tight

Jet clustering strategies



Jet clustering strategies

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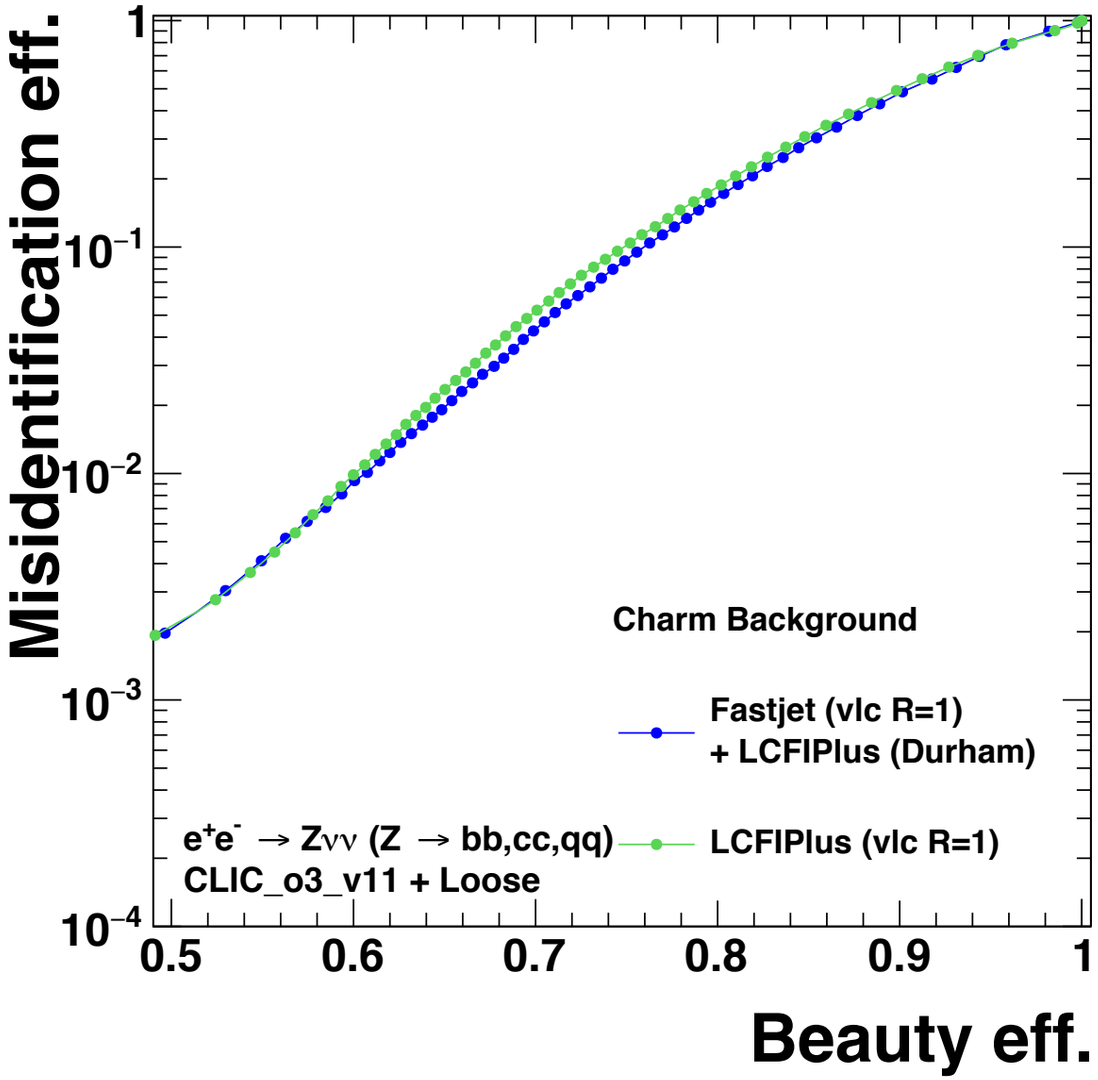
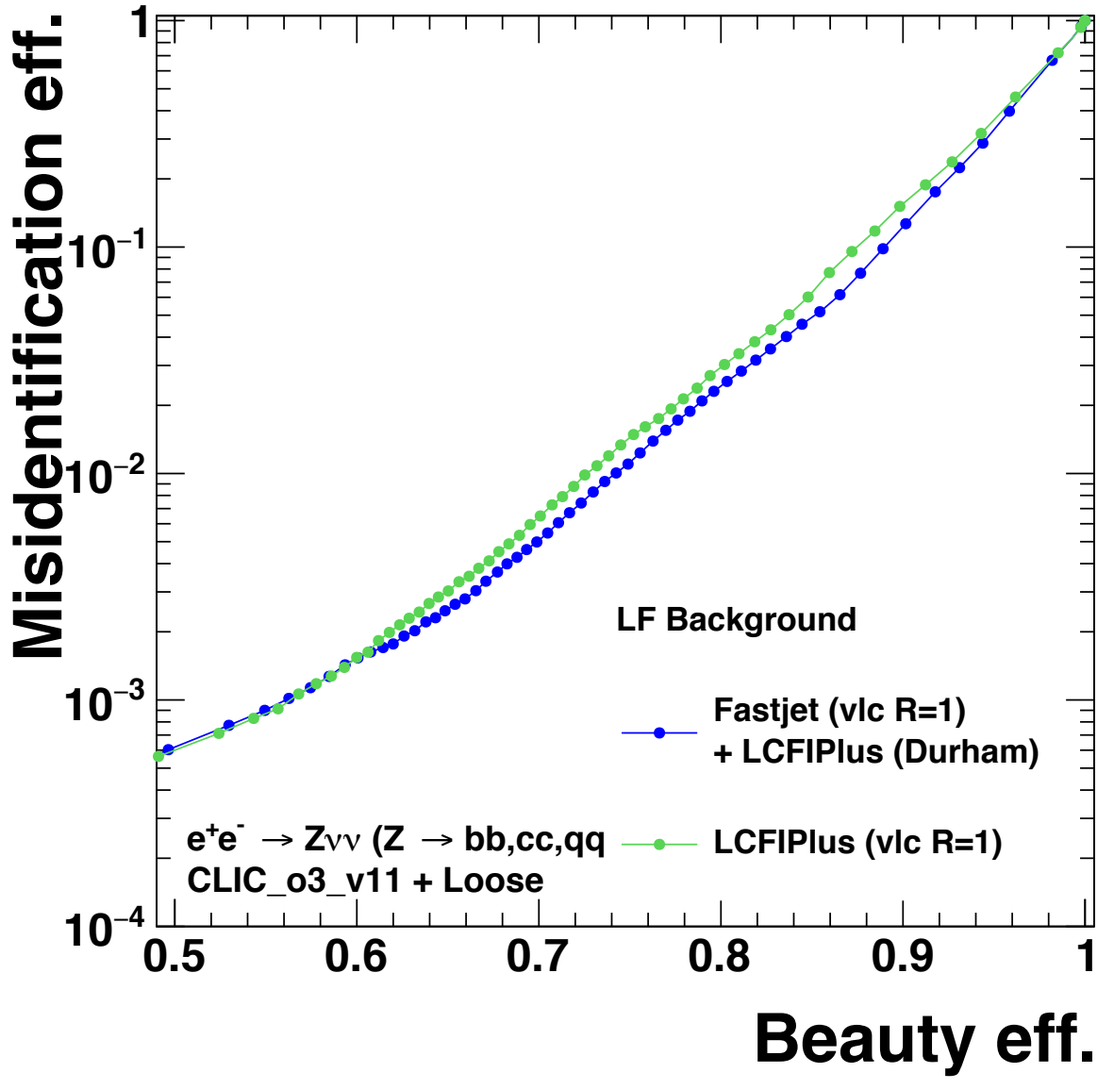




Flavour-tagging performance quite similar on both strategies

Summary

- Flavour tagging performance in the new CLIC detector degraded at 10° due to poorer momentum resolution, material budget and less efficient vertex reconstruction

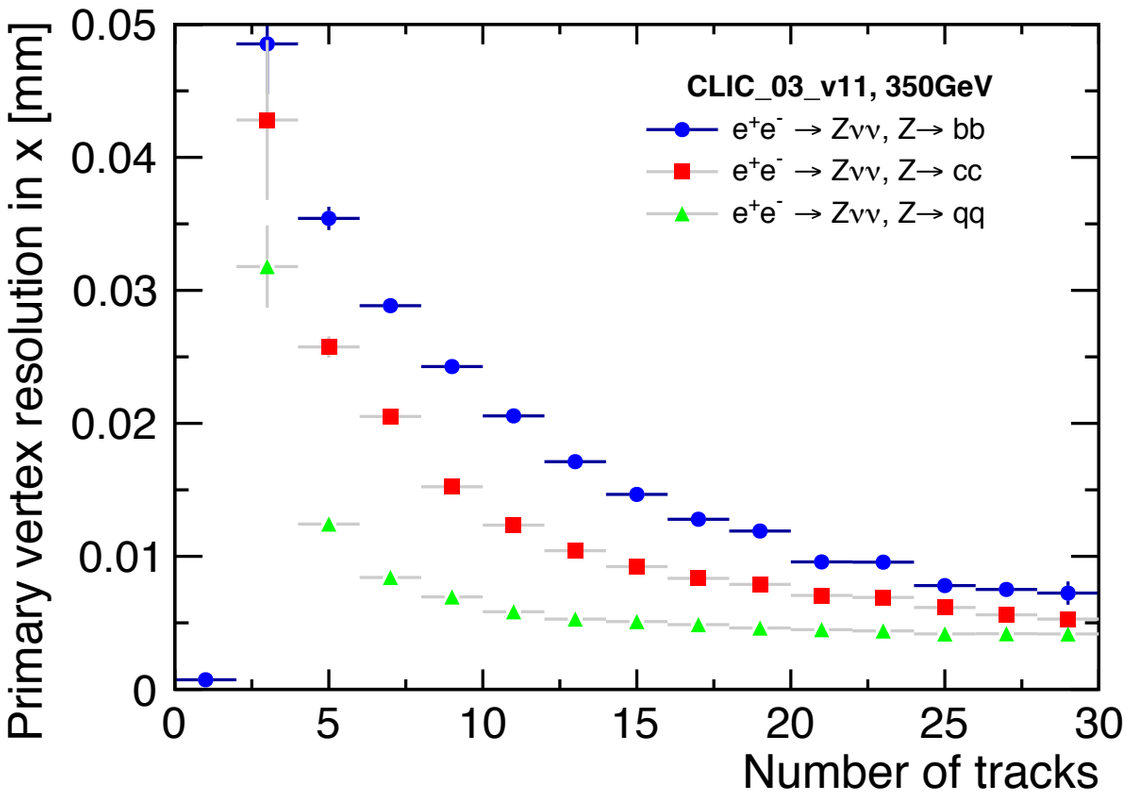
- The impact of the γγ->hadrons on the flavour tagging performance seems to be negligible when Loose Timing cuts are used even for durham jet clustering.

- Jet clustering strategies studied perform similarly, being slightly better the FastJet + LCFIPlus strategy.

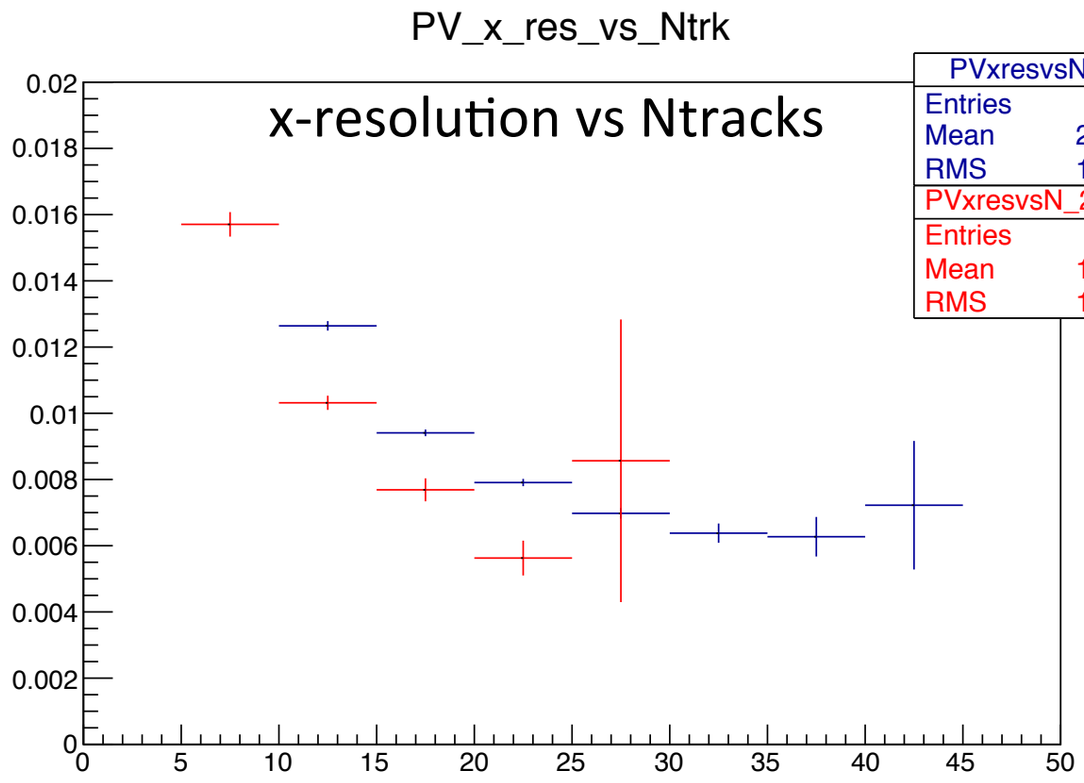
- Future work:
  - Try R values in Valencia algorithm bigger than 1.5
  - Test flavour tagging performance at TeV scale, bigger impact γγ->hadrons expected

PV resolution

CLICdet



CLIC_SiD (ds)



Twice better PV resolution for low number of tracks in CLIC_SiD

Tracker (XZ-view)