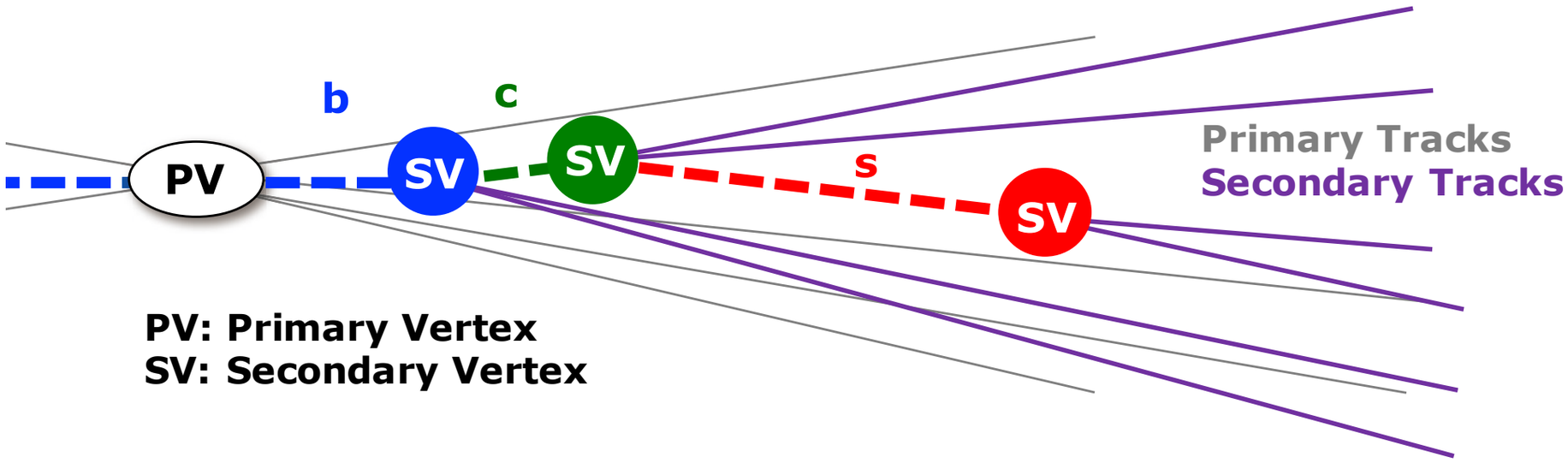
Primary and secondary vertices and flavour tagging performance of the New CLIC Detector

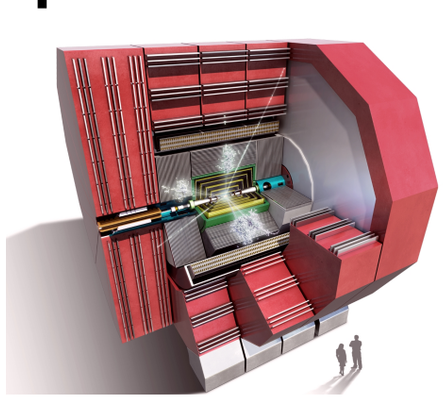
CLICdp detector optimisation and validation meeting
12/06/2017

Introduction

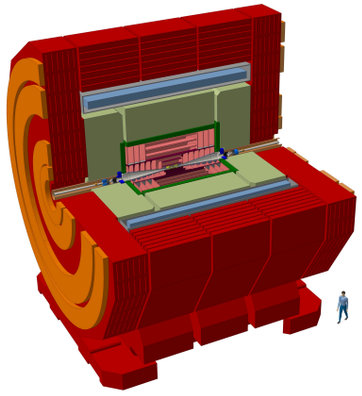
Study of the primary and secondary vertex resolution with the New CLIC detector



Comparison with CLIC CDR detector results from Estel



VS



Flavour tagging performance

Still preliminary results, work ongoing

Samples and framework

Samples ($\sqrt{s}$ = 350GeV) / No γγ→hadrons background

ee→ Zνν, Z→bb, ProdID = 2283

ee→ Zνν, Z→cc, ProdID = 2286

ee→ Zνν, Z→qq (q=uds), ProdID = 2289

Framework

ILCSoft-2017-05-30 and CLIC_o3_v11

Analysis chain

1. DDSIM (Detector simulation)
2. CLICReconstruction (Reconstruction of PFOs)
3. LCFIPlus (Vertex Finding and Flavour tagging)

Vertex reconstruction

Firstly run Valencia Jet algorithm to remove the most forward particles within the “beam jets”

Secondly, run the LCFIPlus Vertex Finder algorithm

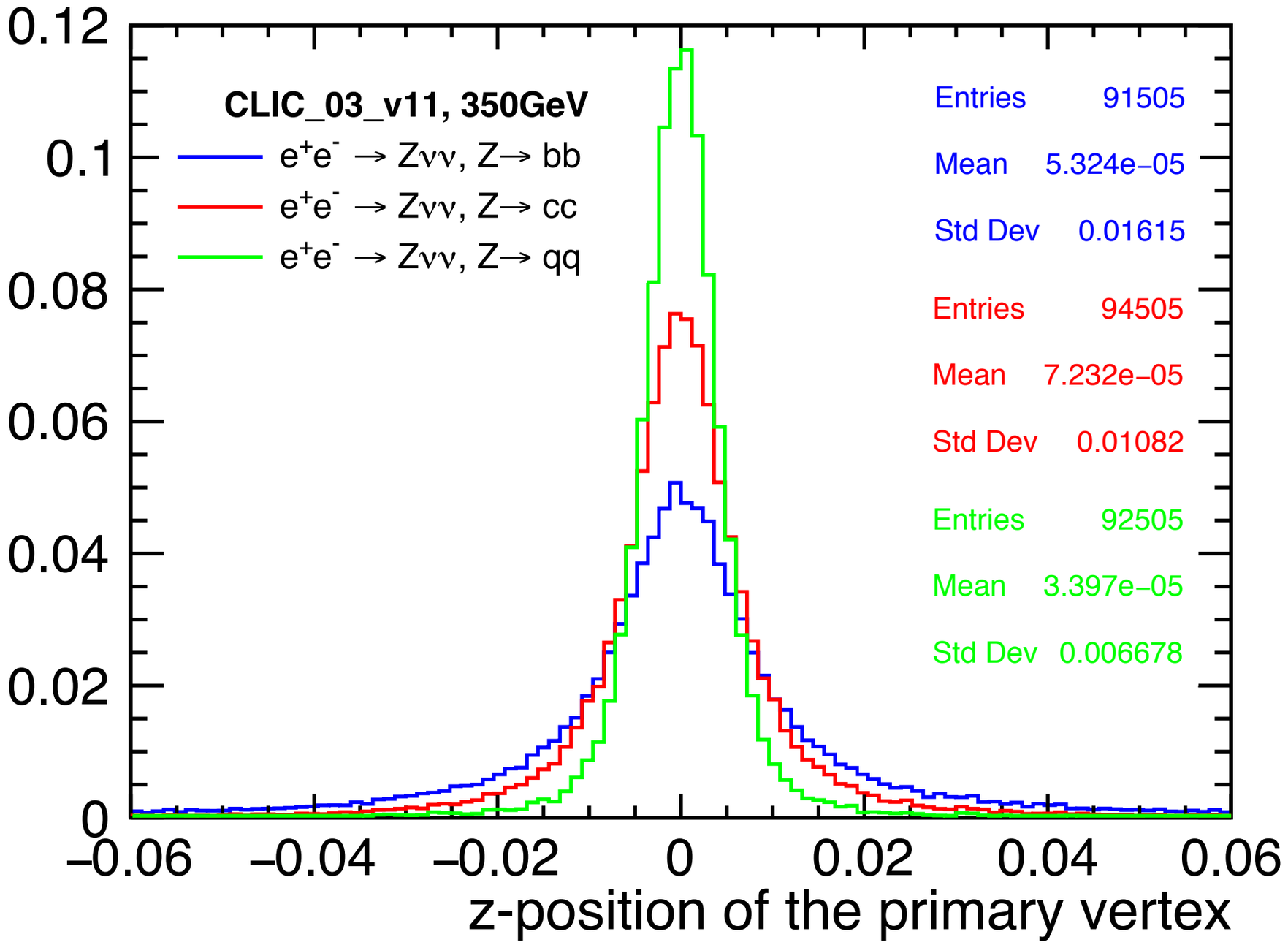
Primary vertex

- Start with all tracks
- Fit the tracks to a vertex
- Remove track which is most inconsistent with the vertex
- Repeat until all tracks are consistent with the vertex, i.e. chi2 contribution is smaller than some threshold value

Secondary vertex

- Create vertex “seeds” from track pairs
- Try to add more tracks to the vertex, accept if the vertex fit is good
- Repeat until there are no more tracks to add

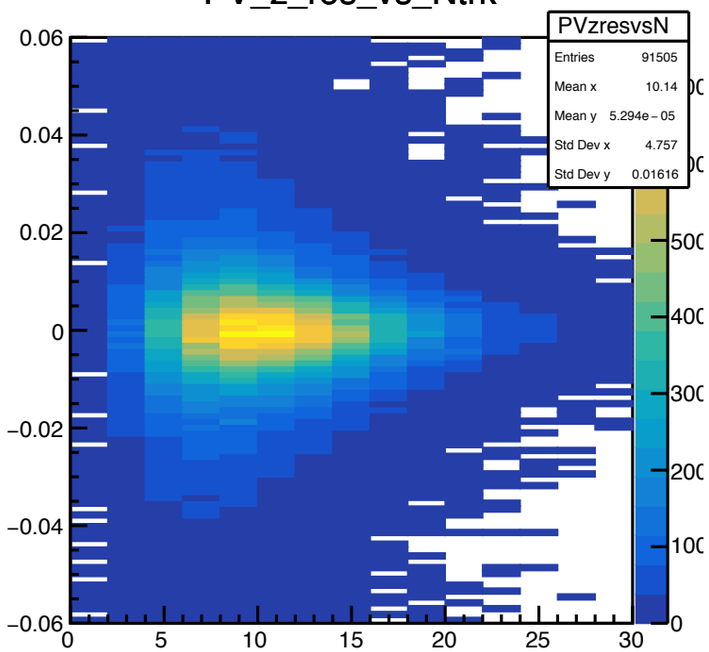
Primary vertex position

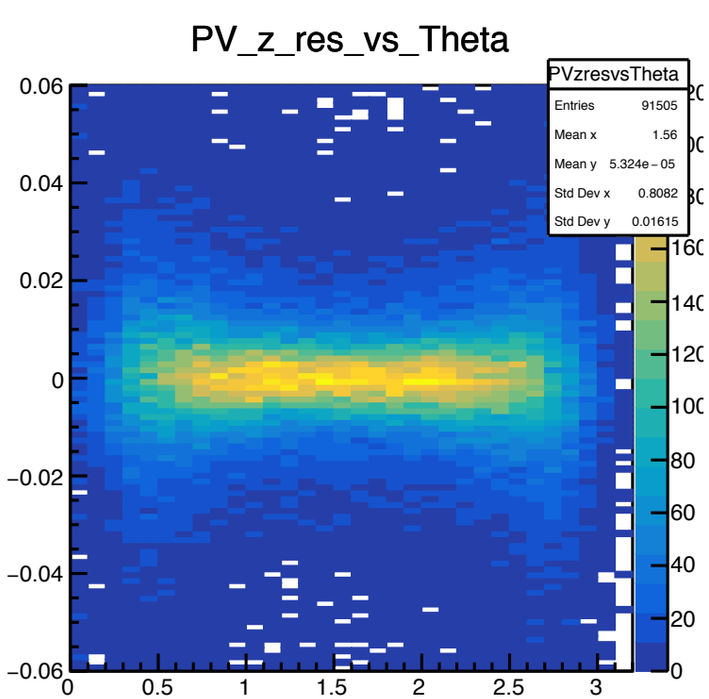


Z decays to bb/cc quarks give a slightly worse resolution than qq

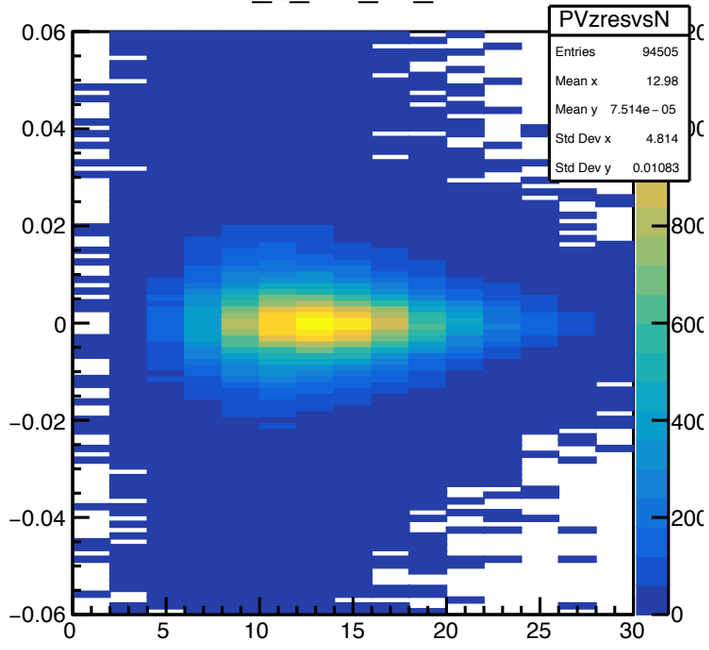
PV 2D Histograms resolution vs Ntracks

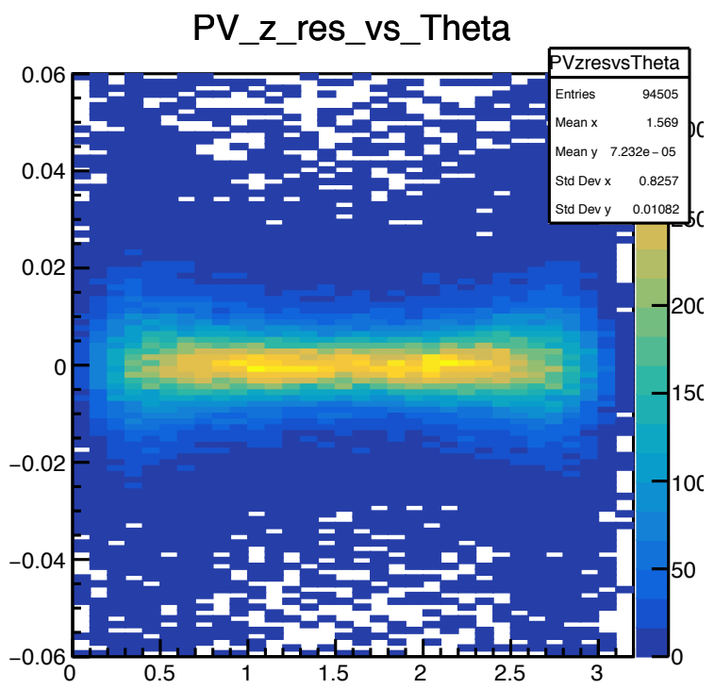
bb



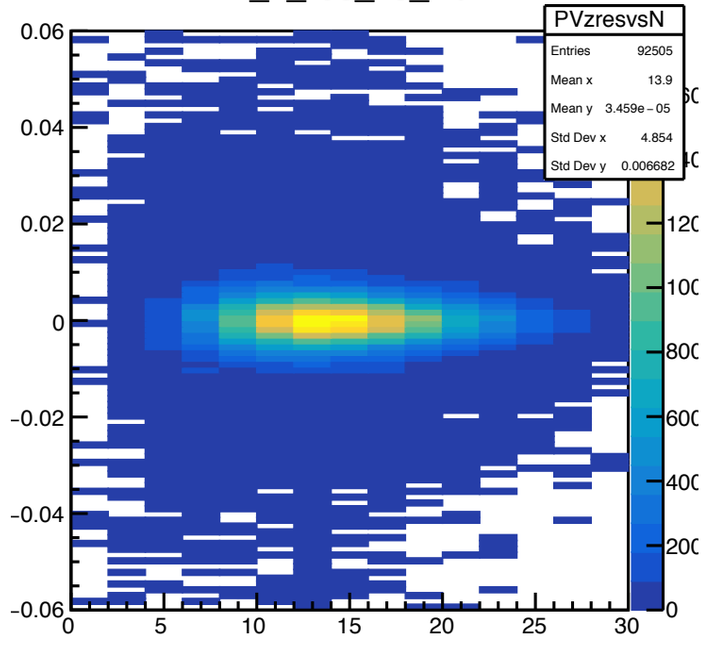


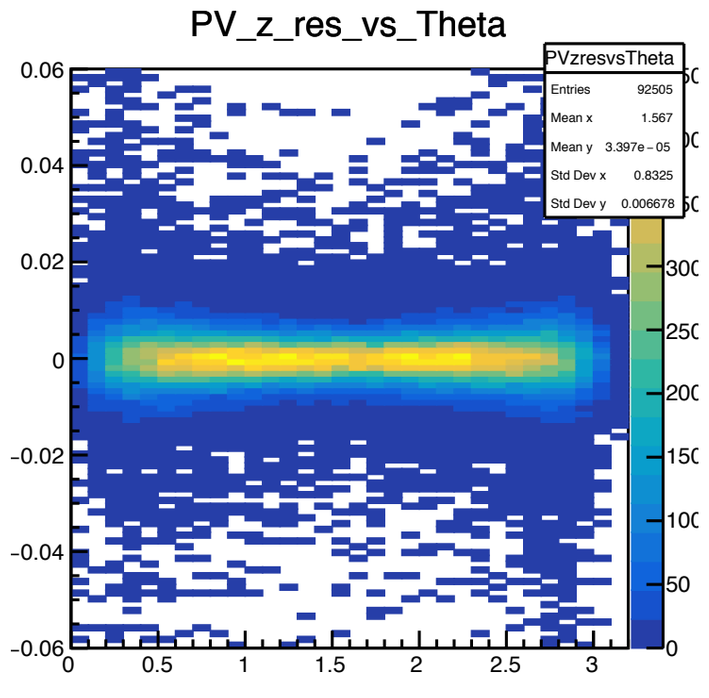
cc



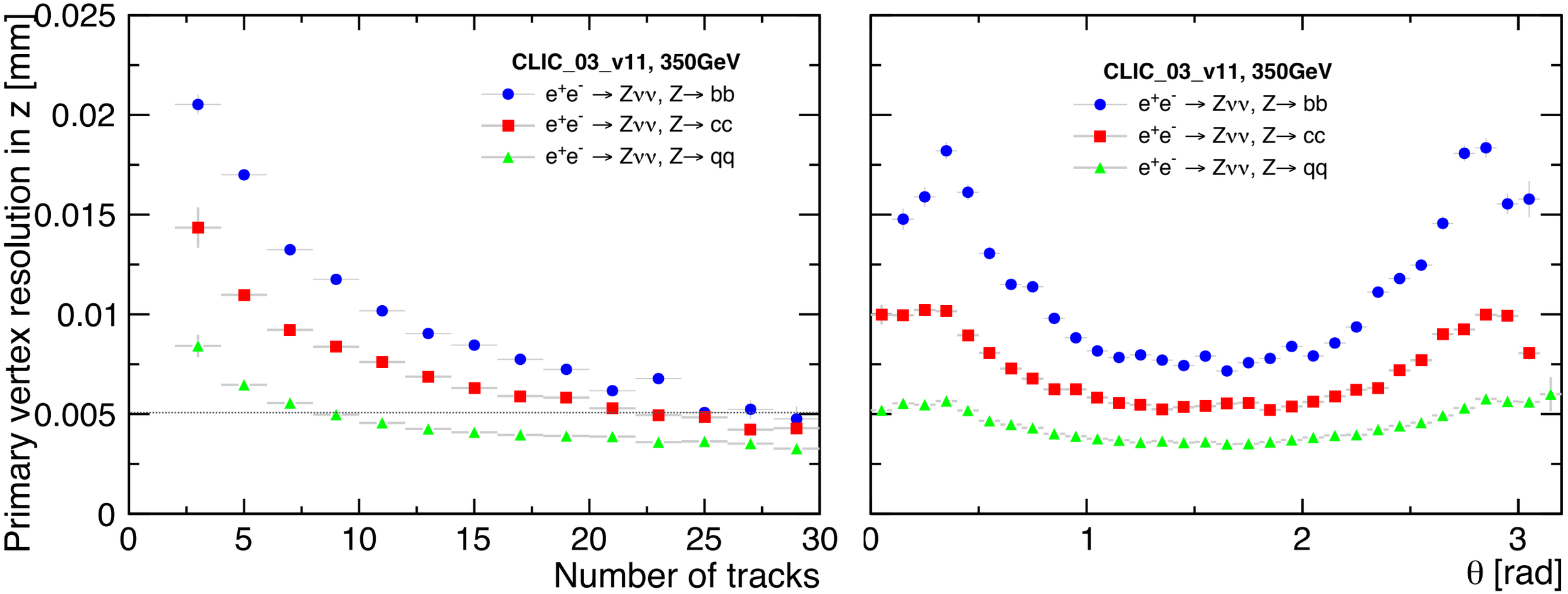


qq





Primary vertex resolution

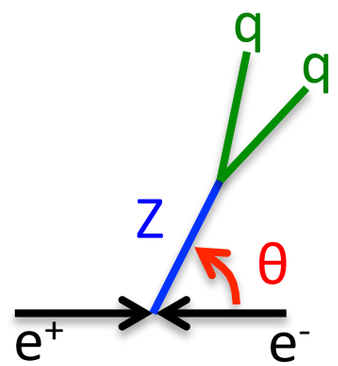


Resolution of the PV versus the number of tracks and the angle theta

Significant difference between samples

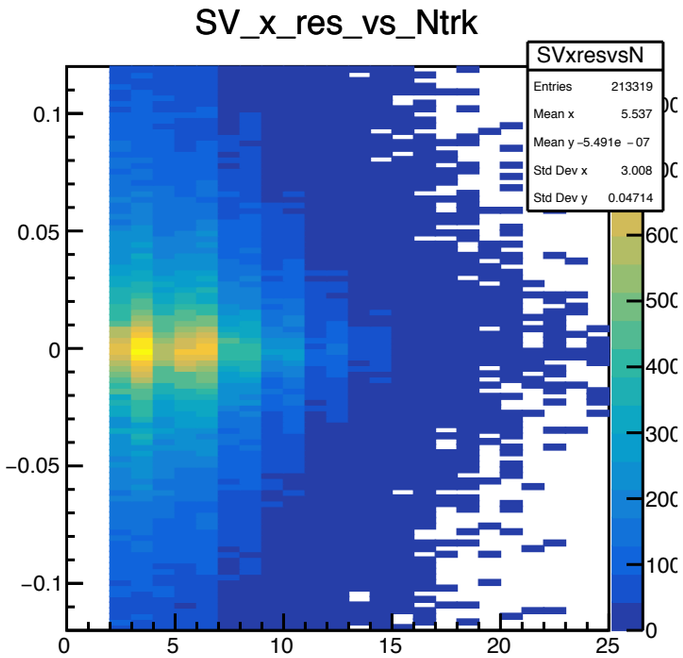
Resolutions between 3-5 μm for +25 tracks in all samples

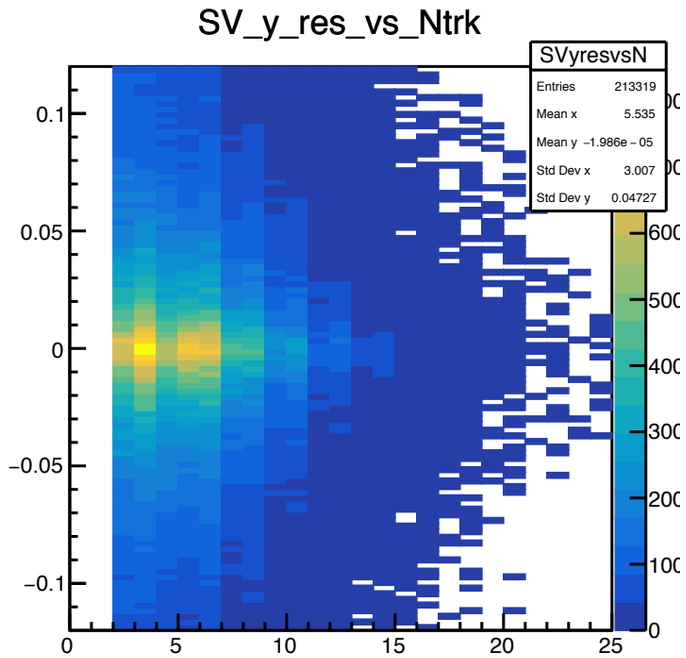
Resolution has a strong dependence on theta as expected

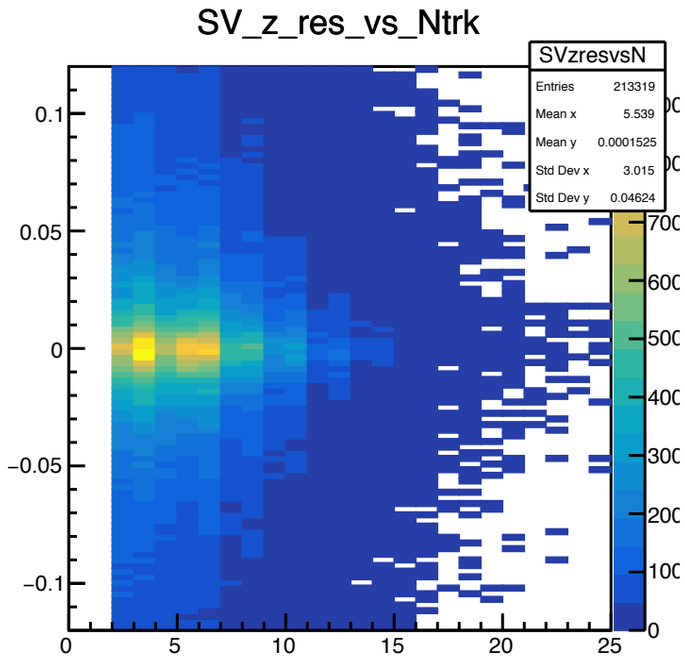


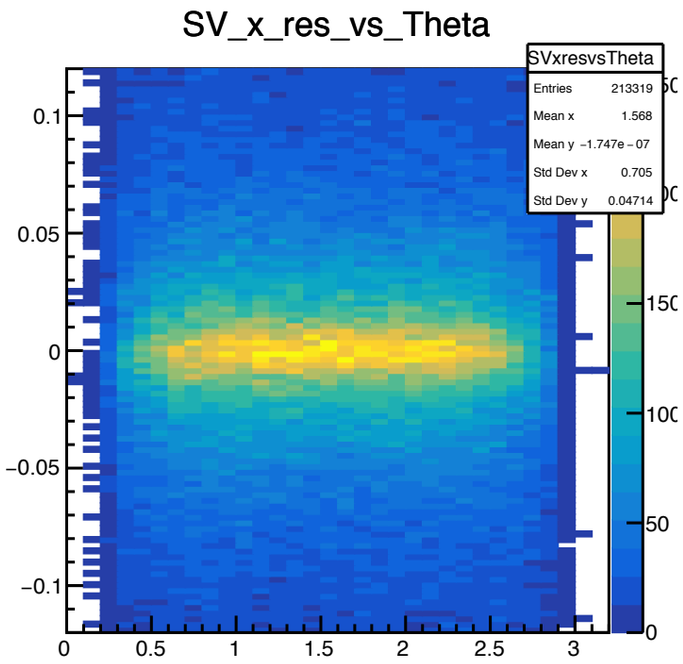
SV 2D Histograms resolution vs Ntracks

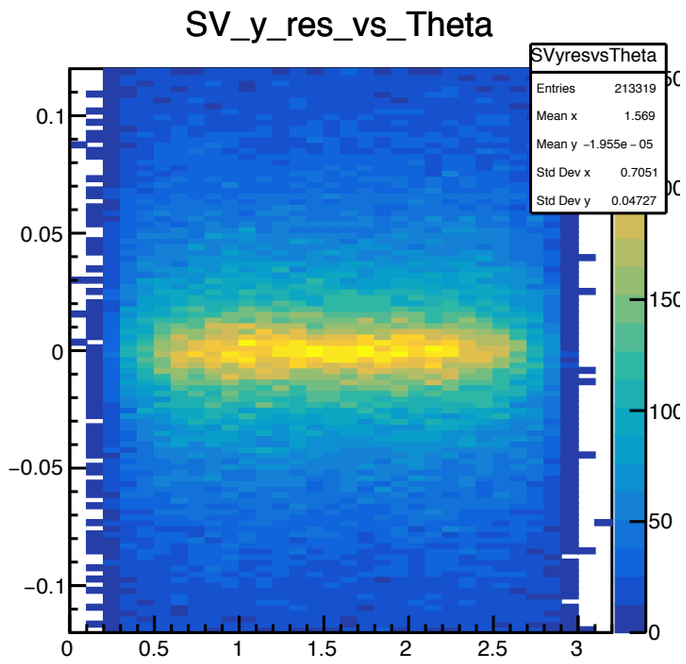
ee→ Zvv, Z→bb

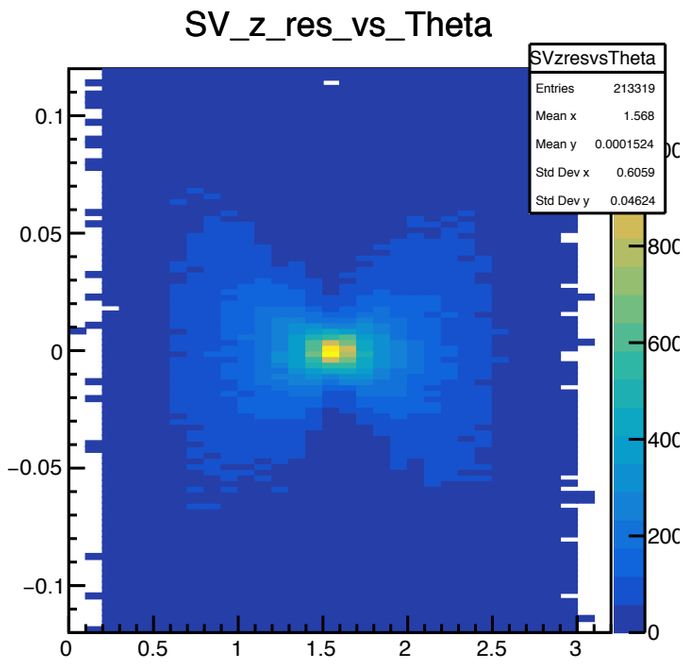




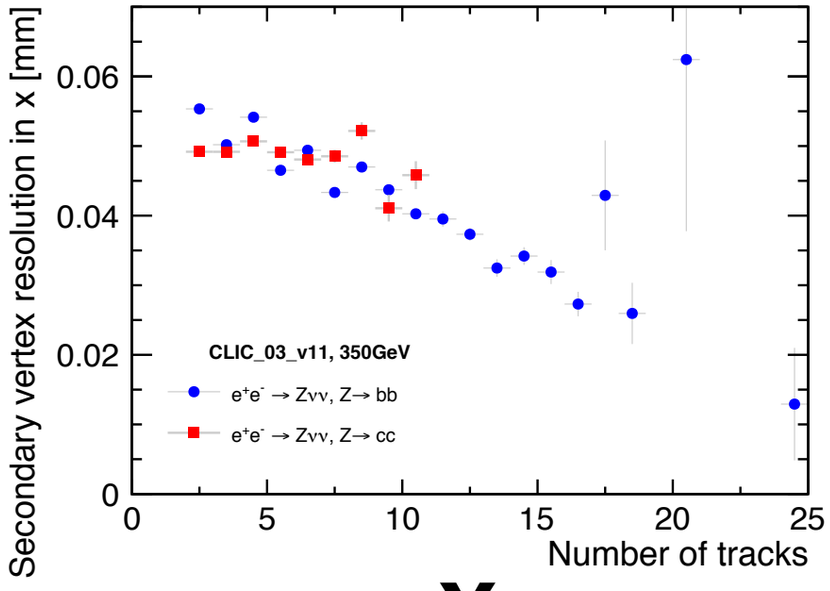




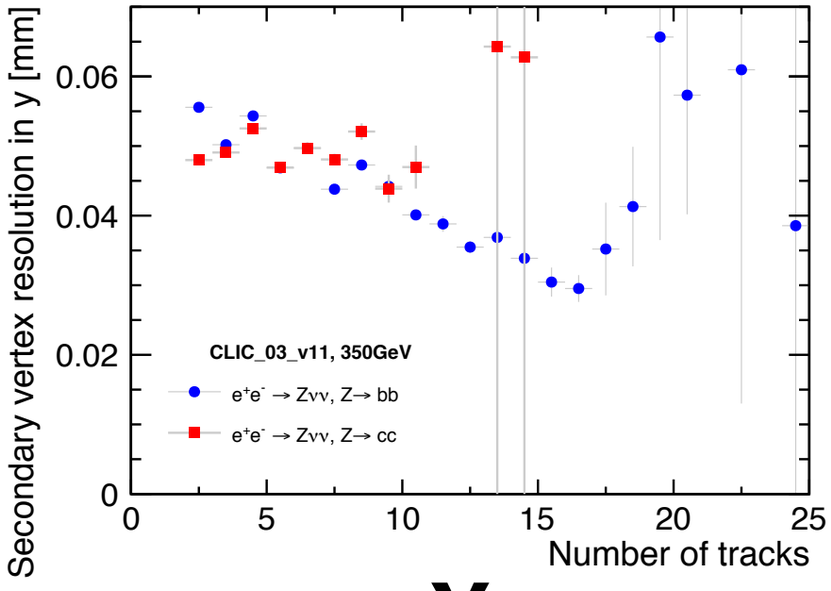




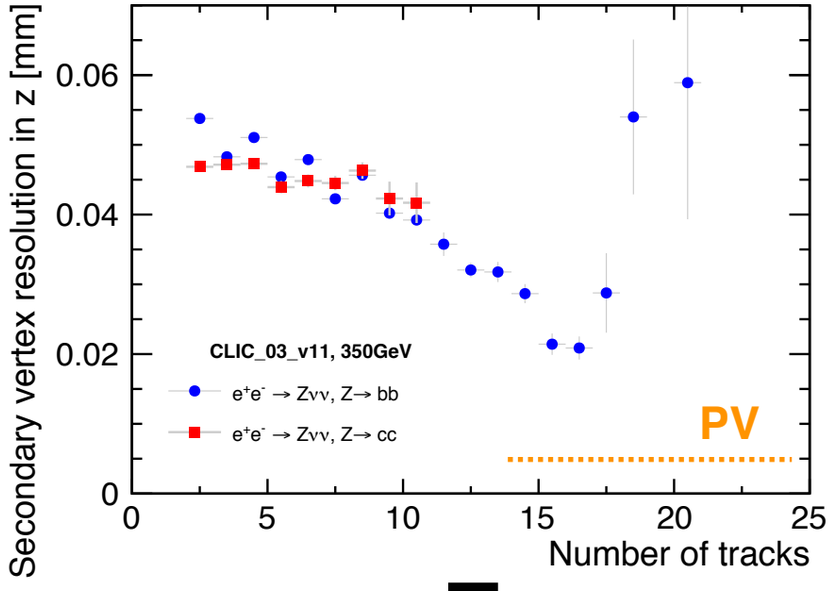
Secondary vertex resolution



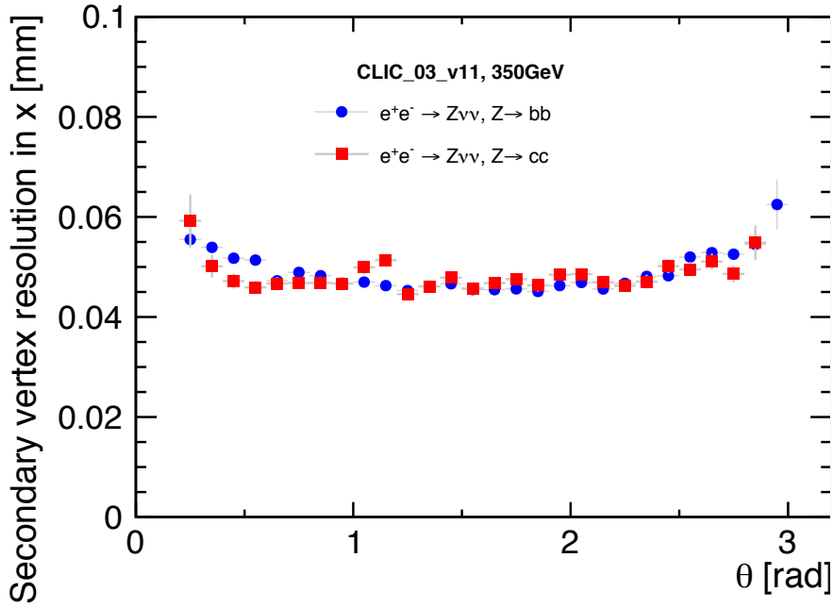
X

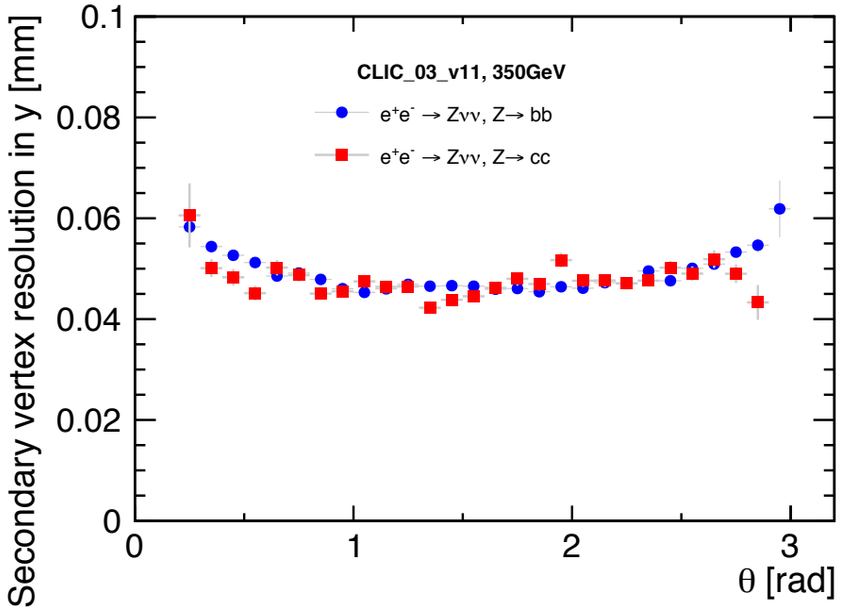


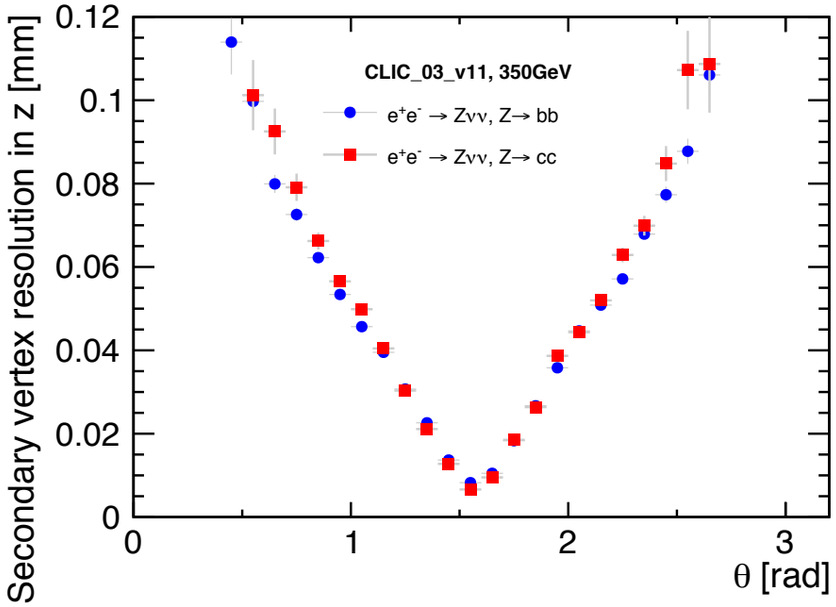
Y



Z

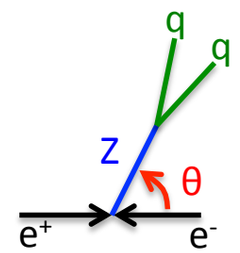






Resolution of the SV 4-5 times worse than PV resolution

20-25 μm for +15 tracks



Flavour tagging

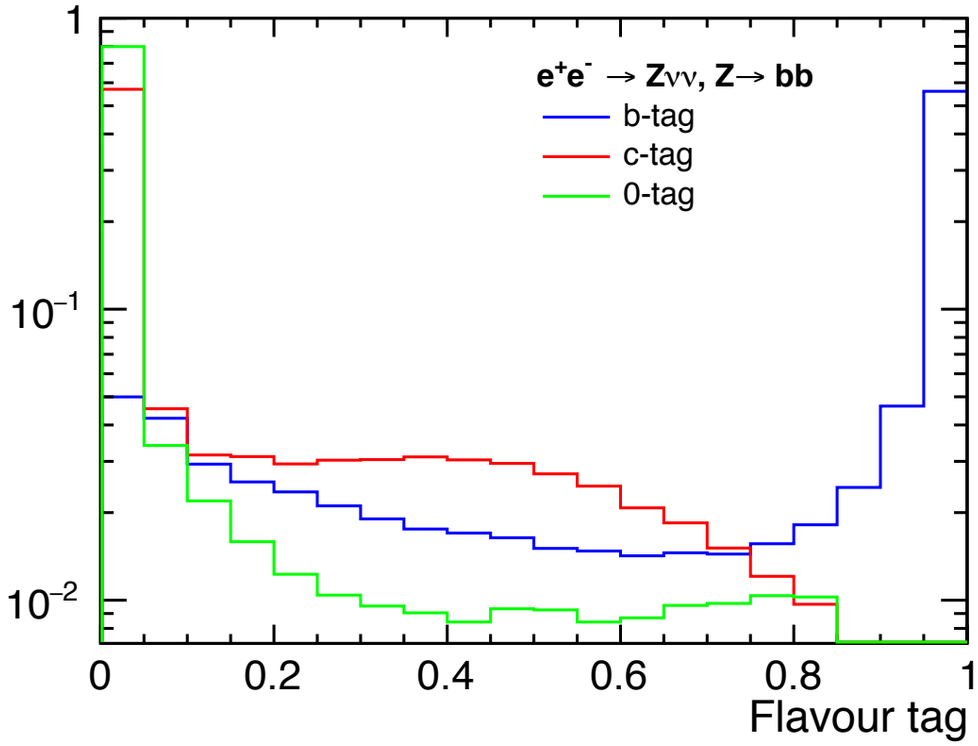
LCFIPlus package

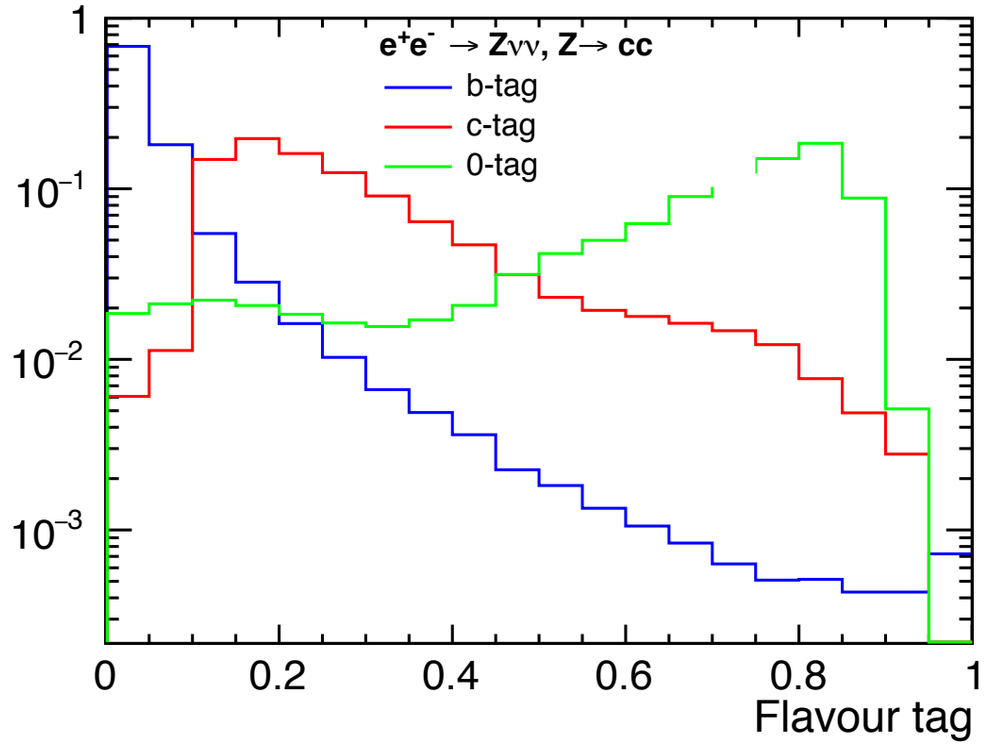
- Multivariate analysis (BDT)
- Separated by number of vertices
- Vertex position/mass/tracks
- Impact parameters of tracks
- ~ 20 variables

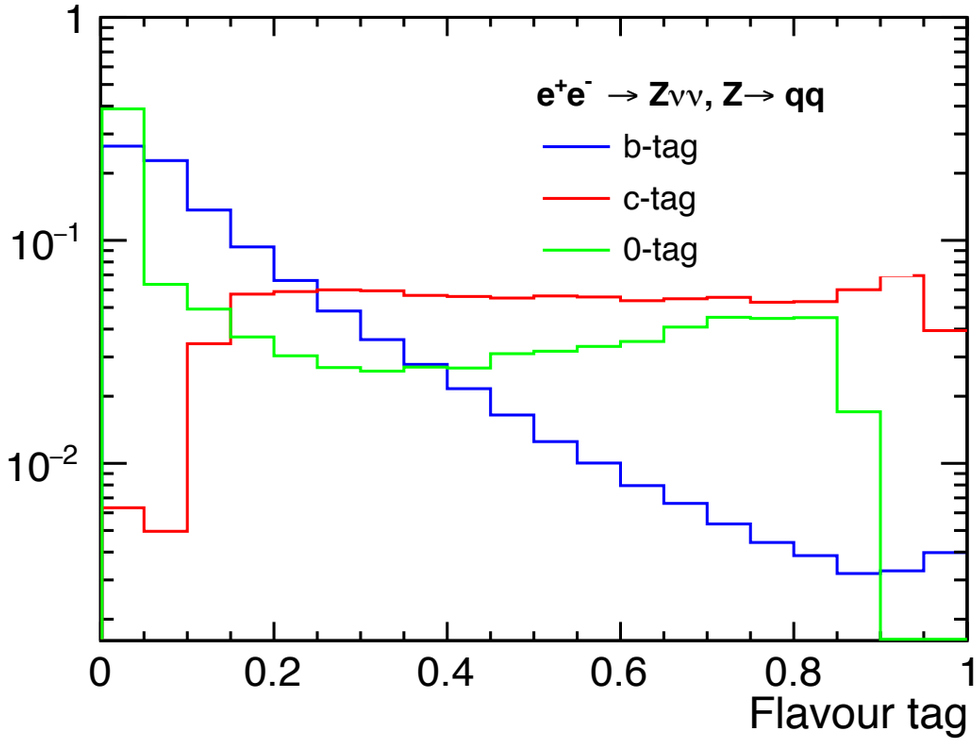
Training flavour tagging

- To fully take advantage of the shape of the distributions, while taking into account the correlations among the variables
- Following numbers are obtained from the training of the CLIC_ILD_CDR detector at 350 GeV
- Training with the New CLIC detector ongoing

Flavour tagging (PRELIMINARY)



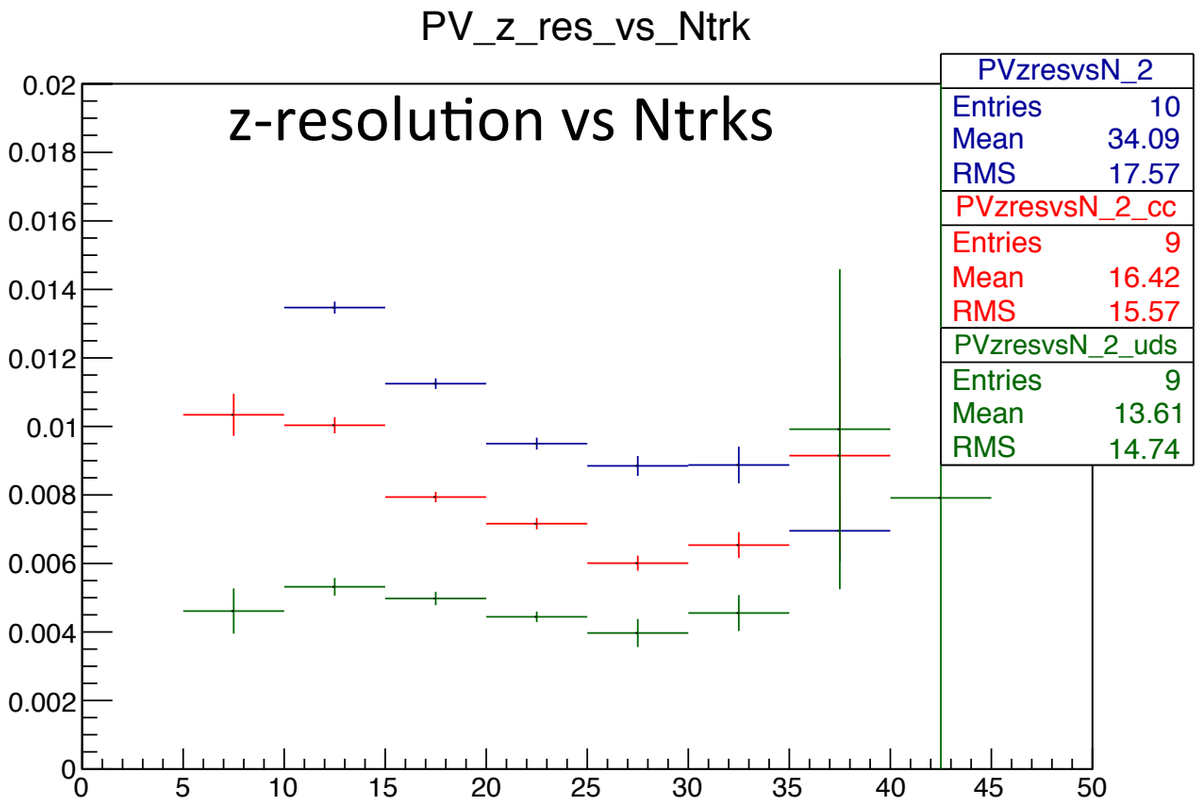




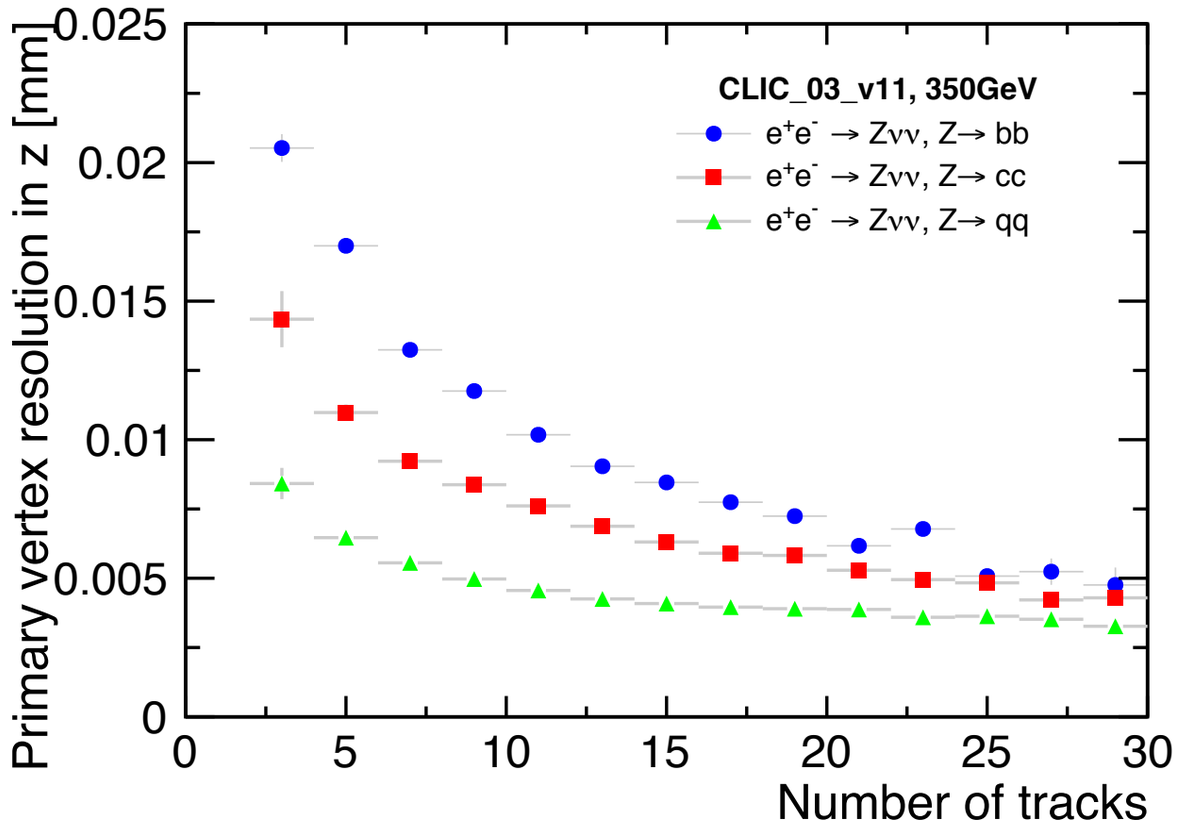
Mean-tag	Z->bb	Z->cc	Z->qq
b-tag	0,745	0,167	0,060
c-tag	0,175	0,548	0,292
0-tag	0,080	0,285	0,644

Primary vertex resolution comparison

CLIC_ILD_CDR
ee→ Zvv, 1.4 TeV



New CLIC detector
ee→ Zvv, 350 GeV

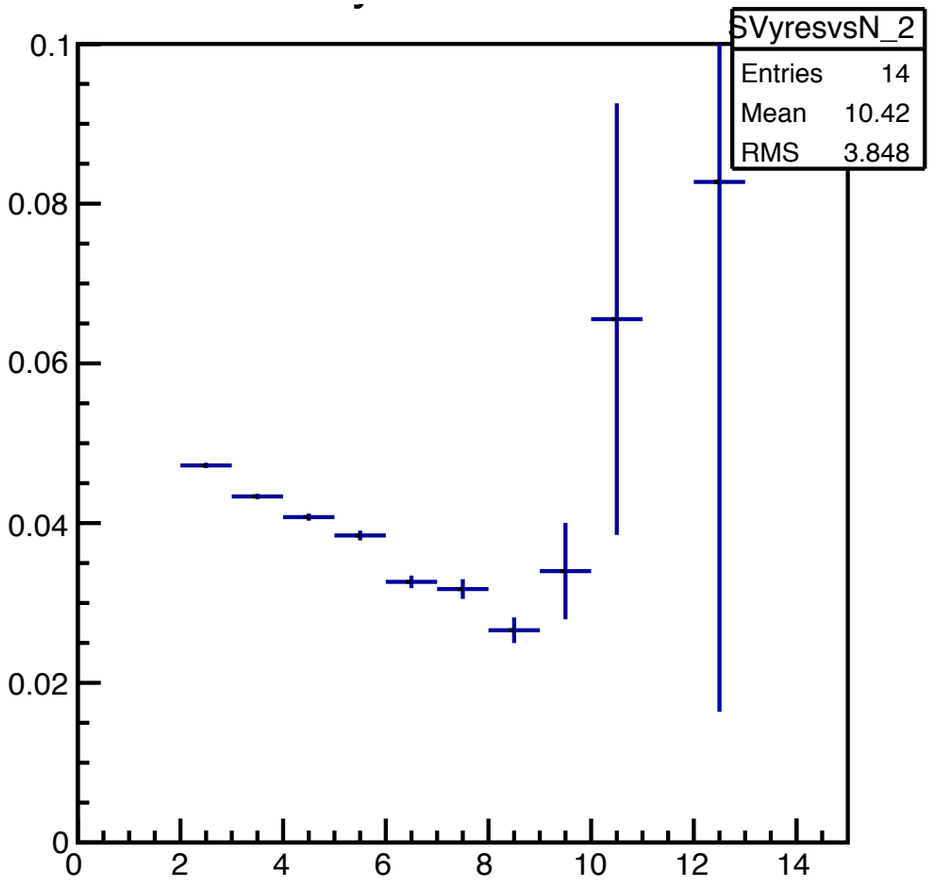


Resolution of the PV is pretty similar for qq events (~3-4 μm)

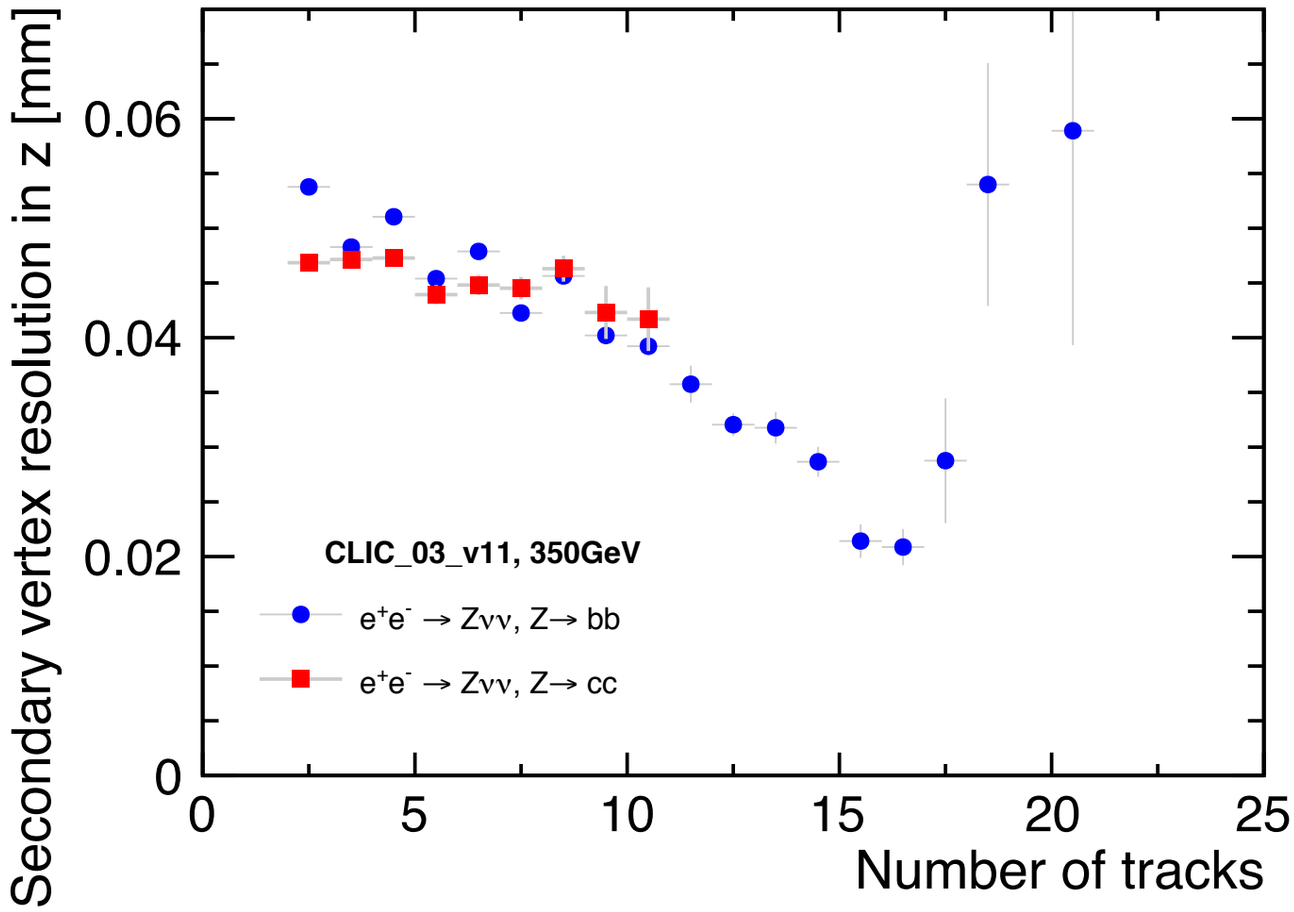
Slightly better resolution with the New CLIC detector for bb and cc events (< 10 μm)

Secondary vertex resolution comparison

CLIC_ILD_CDR
ee→ Zvv, 1.4 TeV



New CLIC detector
ee→ Zvv, 350 GeV



Resolution of the SV behaves similar, ~20 μm in the best case

A factor 2 better better with the new CLIC detector around 15 tracks

Summary

PV and SV resolutions

The new detector performs the vertex reconstruction as expected

Similar and consistent results between CDR detectors and the new detector

Flavour tagging

Still in a very preliminary stage

Next steps

Train the flavour tagging with the new detector model

Overlay $\gamma\gamma \rightarrow$hadrons background

Future work: test flavour tagging performance at high energy CLIC stages