

# Shower Profiles and Angular Resolution

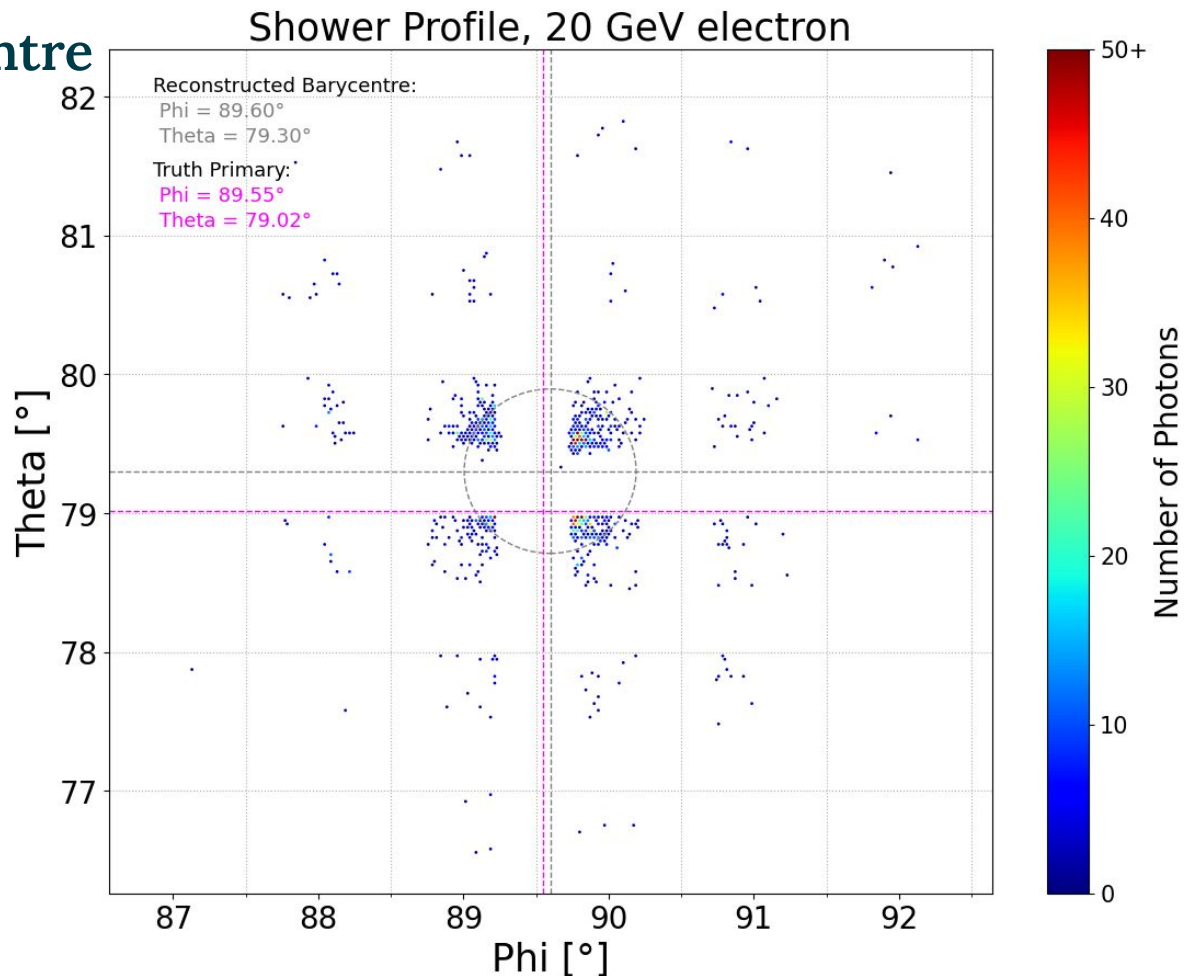
Andreas Loeschke Centeno



UNIVERSITY  
OF SUSSEX

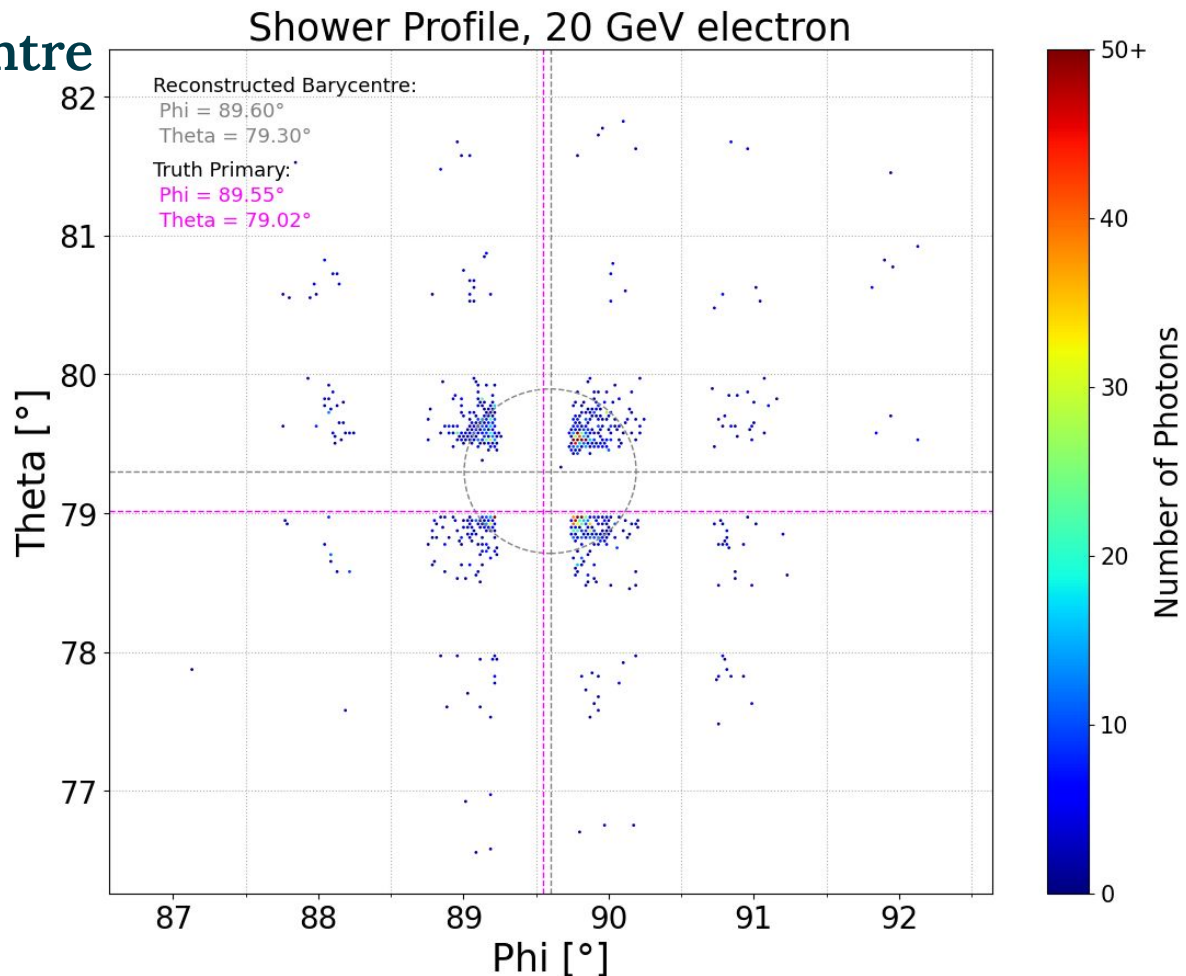
# Shower Profile and Barycentre

- Example for 20 GeV electron
  - No magn. field
  - $1^\circ \times 1^\circ$  towers (tower borders indicated by grid)
- Reconstructed fibre  $\phi$  and  $\theta$  based on the *back-side* readout
- Reconstructed barycentre based on energy in fibre ('combined' S and C) indicated with dashed line
- **True primary direction** also dashed lines

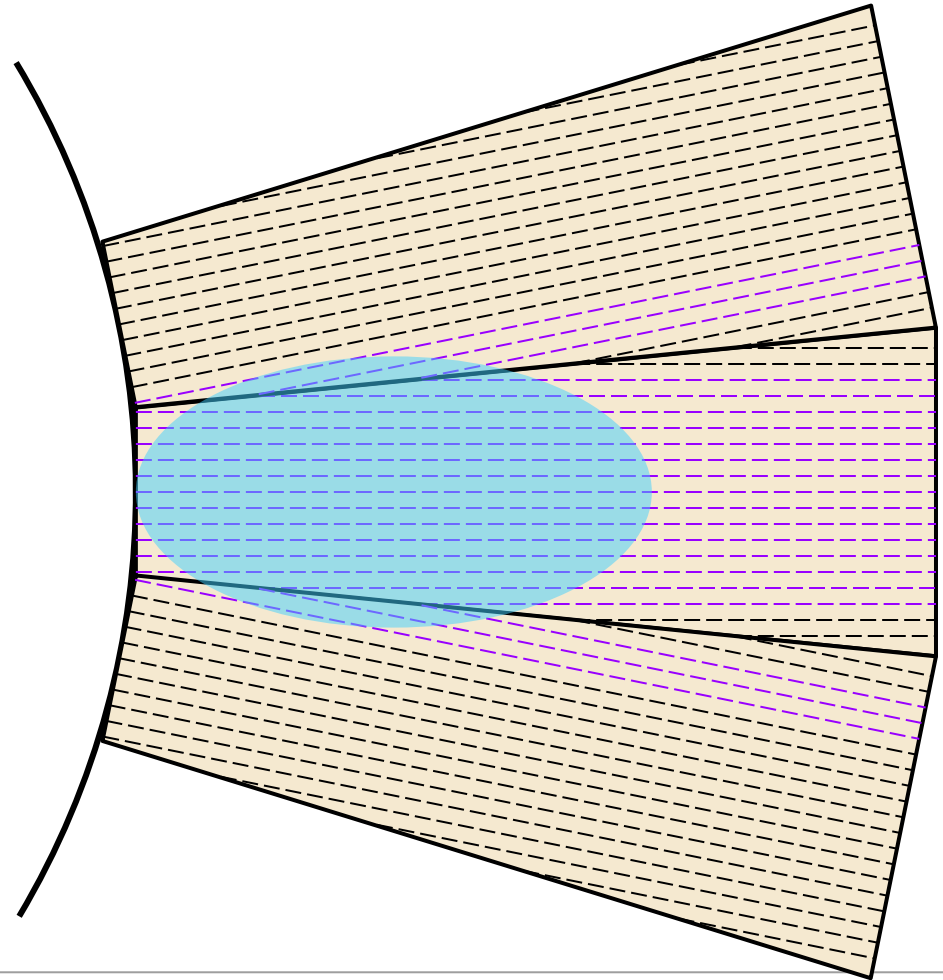


# Shower Profile and Barycentre

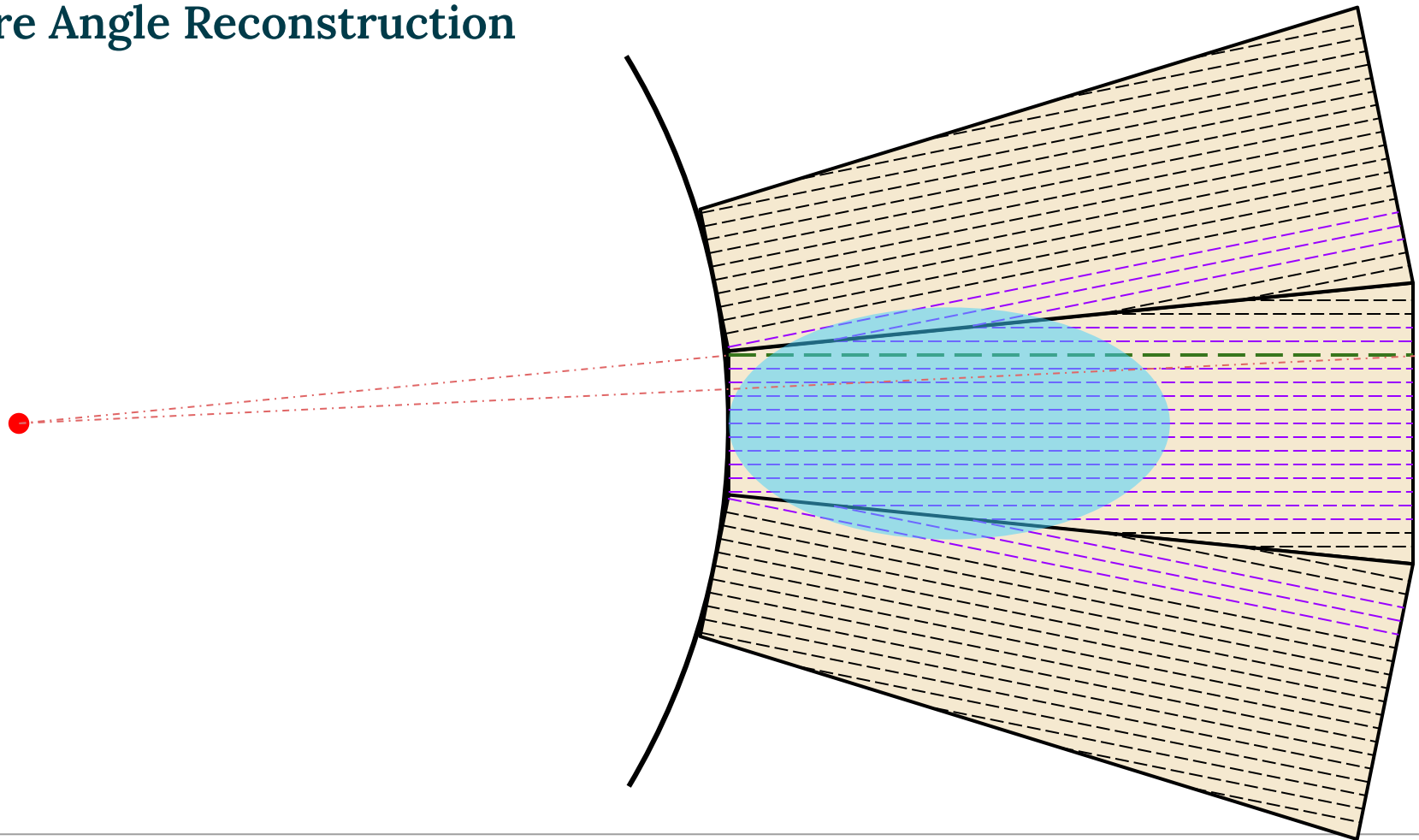
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- **True primary direction** also dashed lines
- Shower develops in front of tower: gaps between fibres



# Fibre Angle Reconstruction

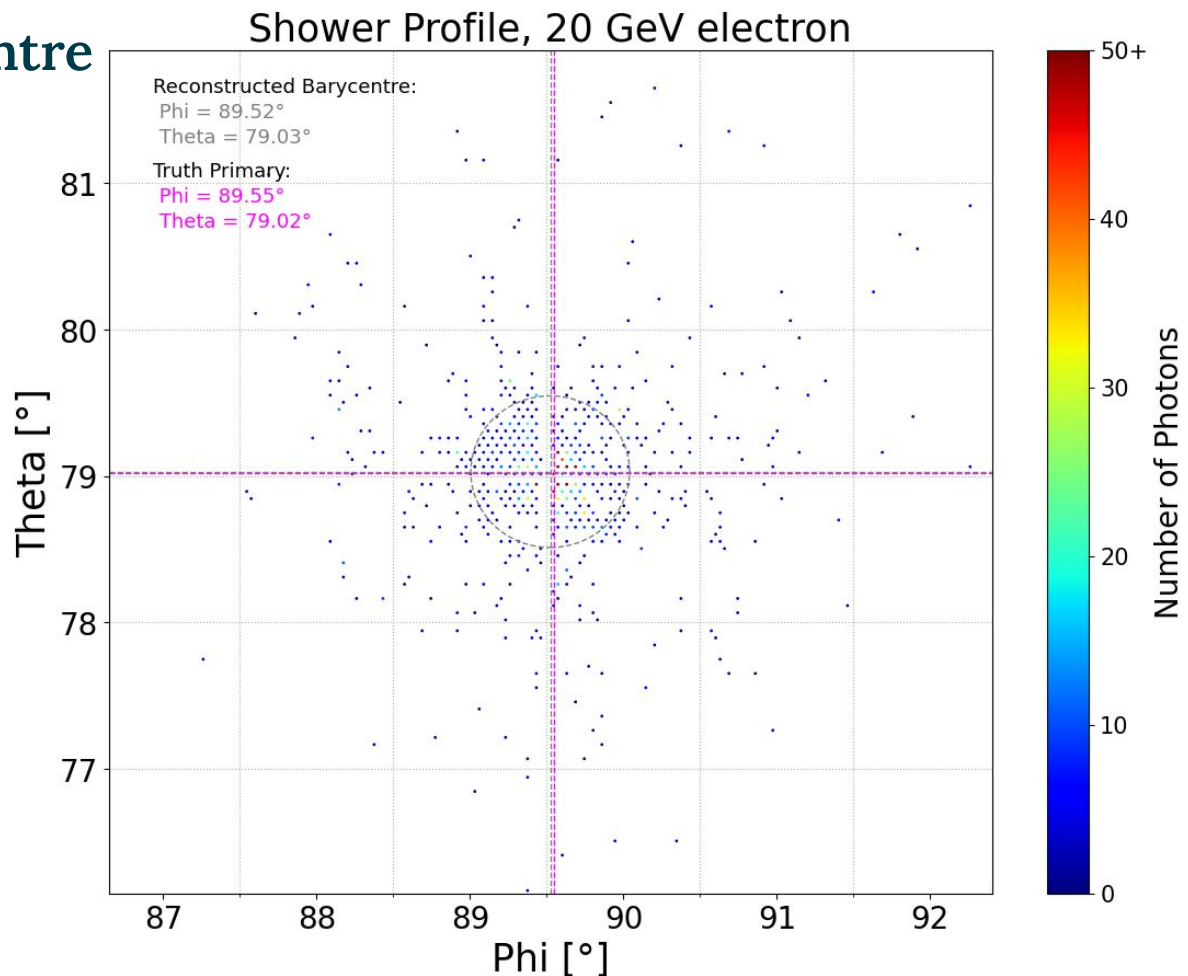


# Fibre Angle Reconstruction

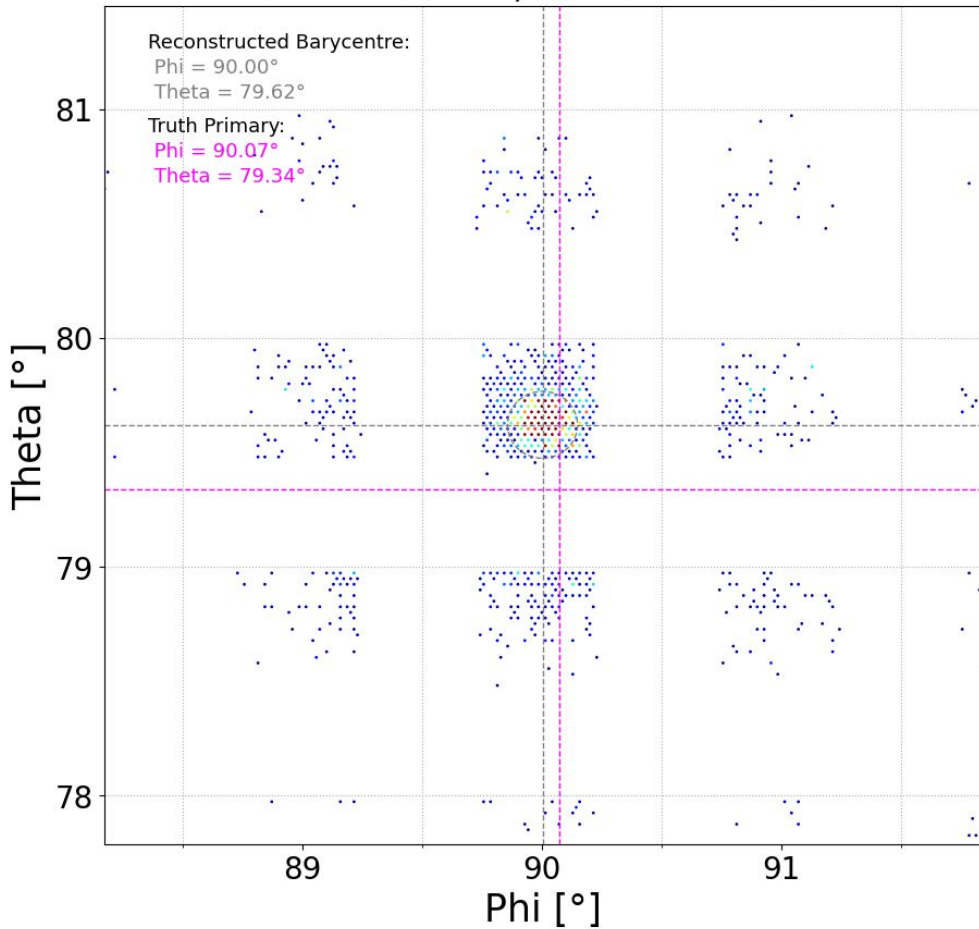


# Shower Profile and Barycentre

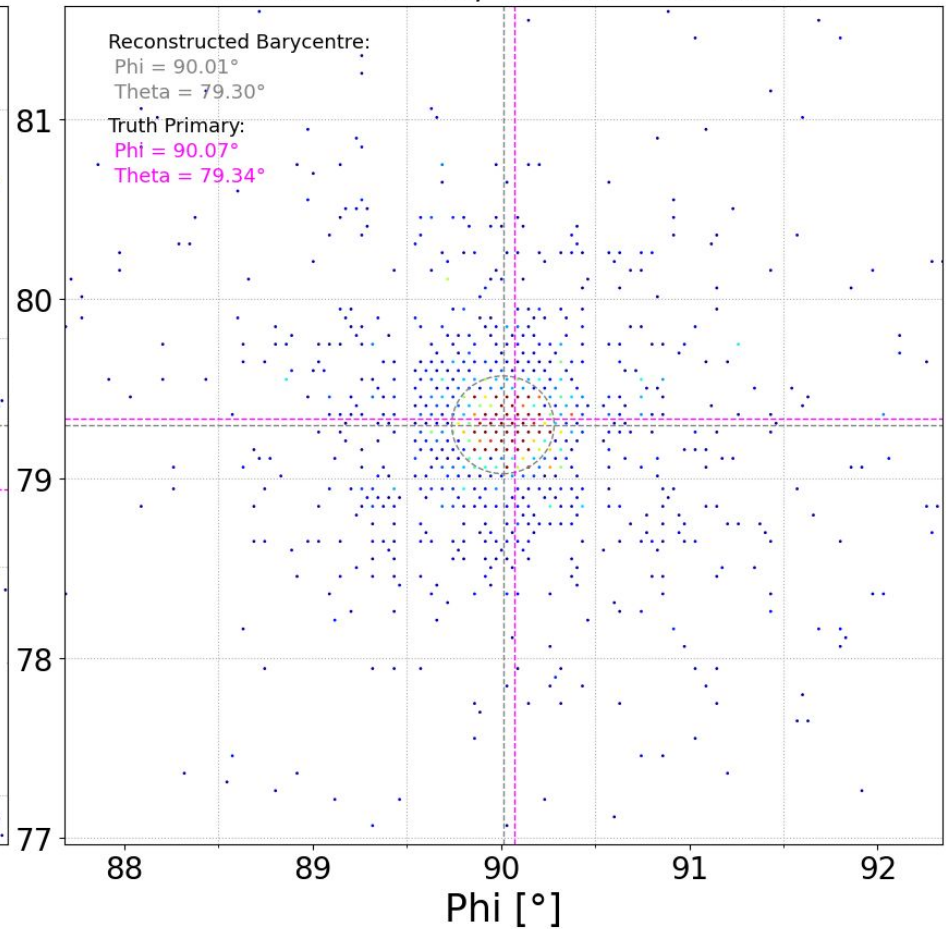
- *Front-side* reconstruction
  - Ignoring any fibres not on the front face
- Far better agreement with truth direction
- Similar for other examples



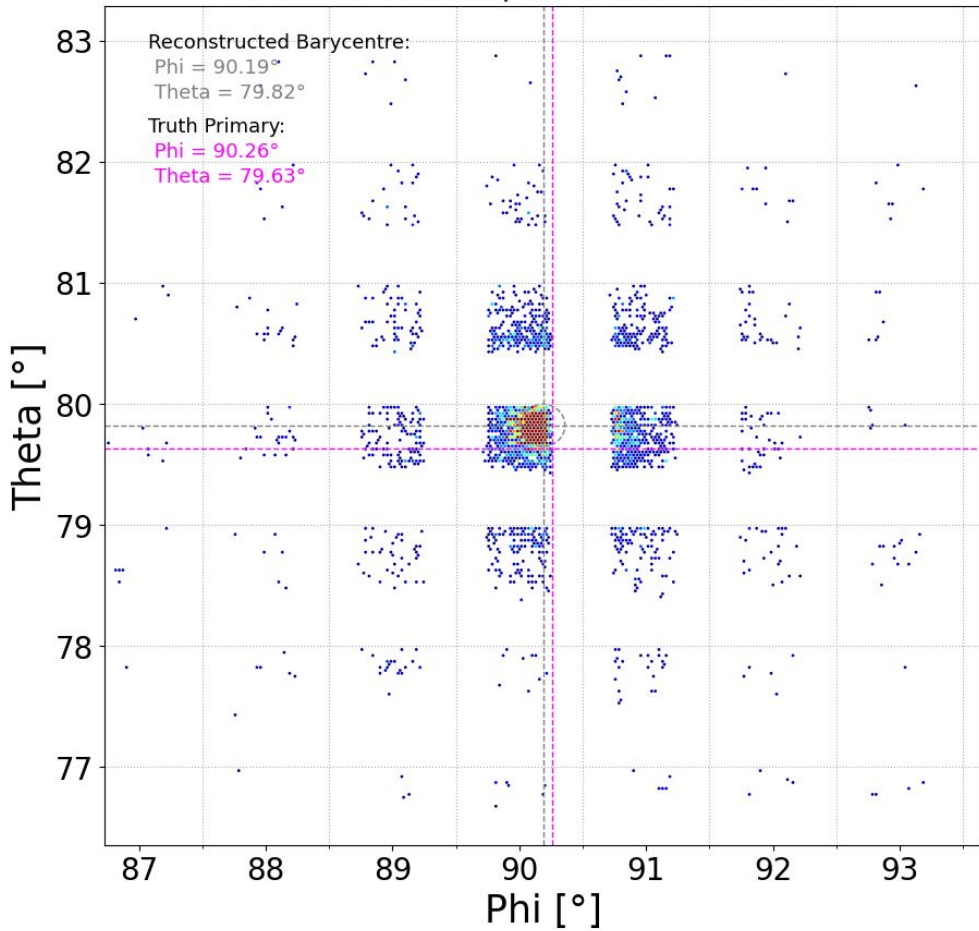
### Shower Profile, 40 GeV electron



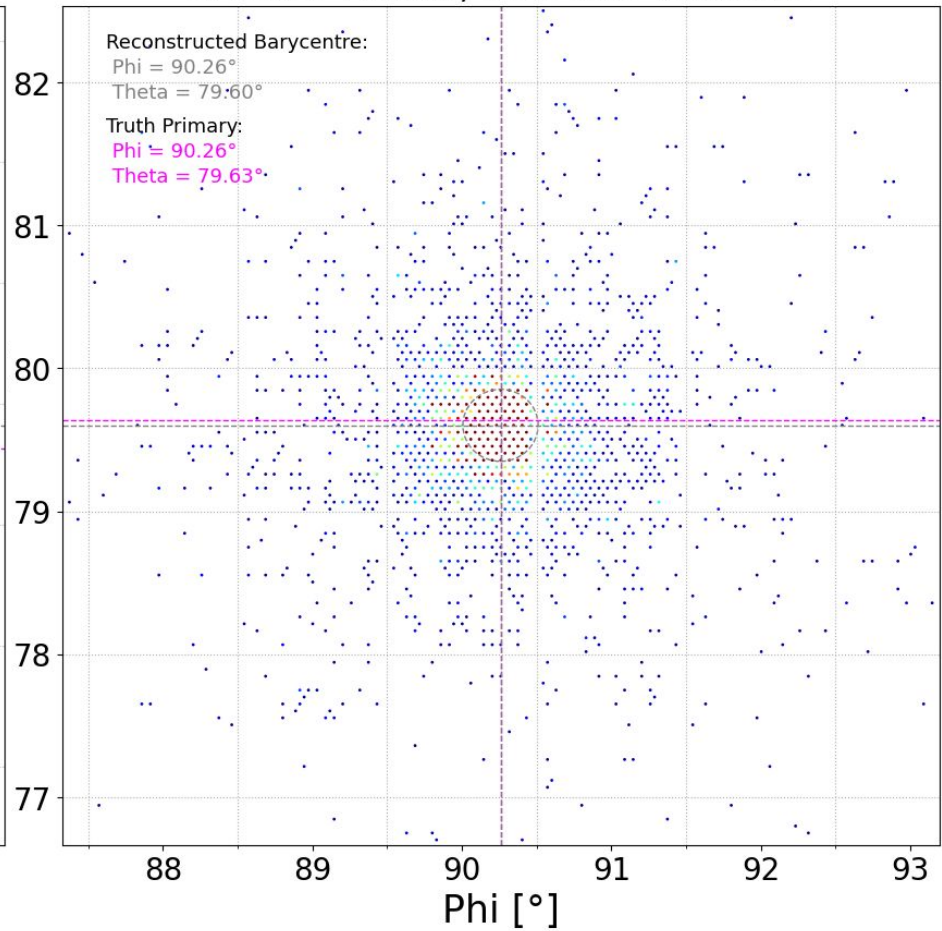
### Shower Profile, 40 GeV electron



### Shower Profile, 120 GeV electron



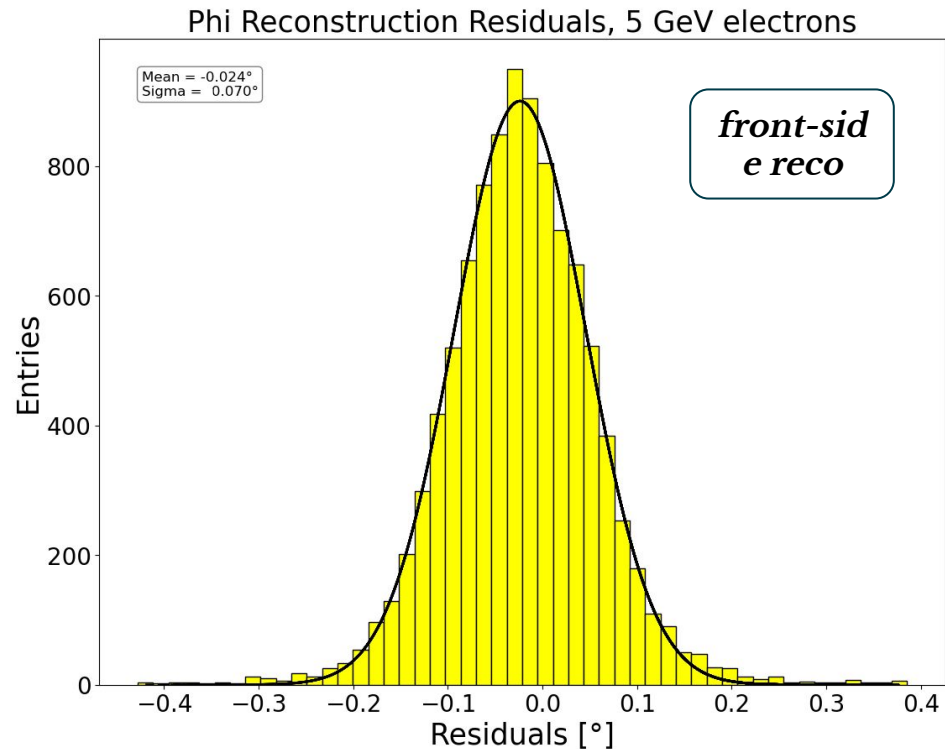
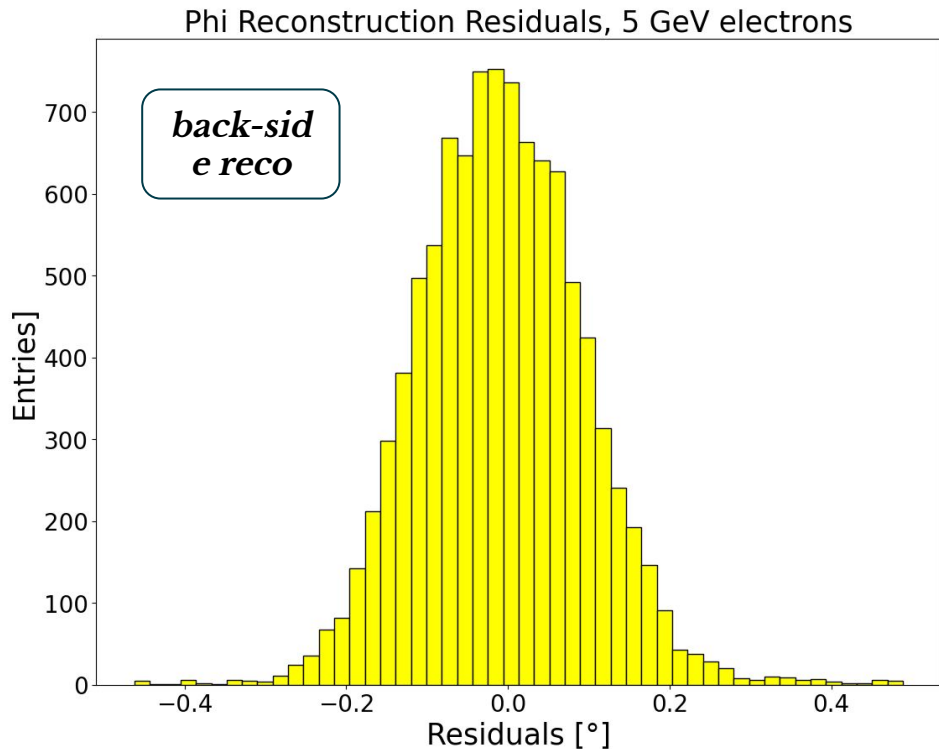
### Shower Profile, 120 GeV electron





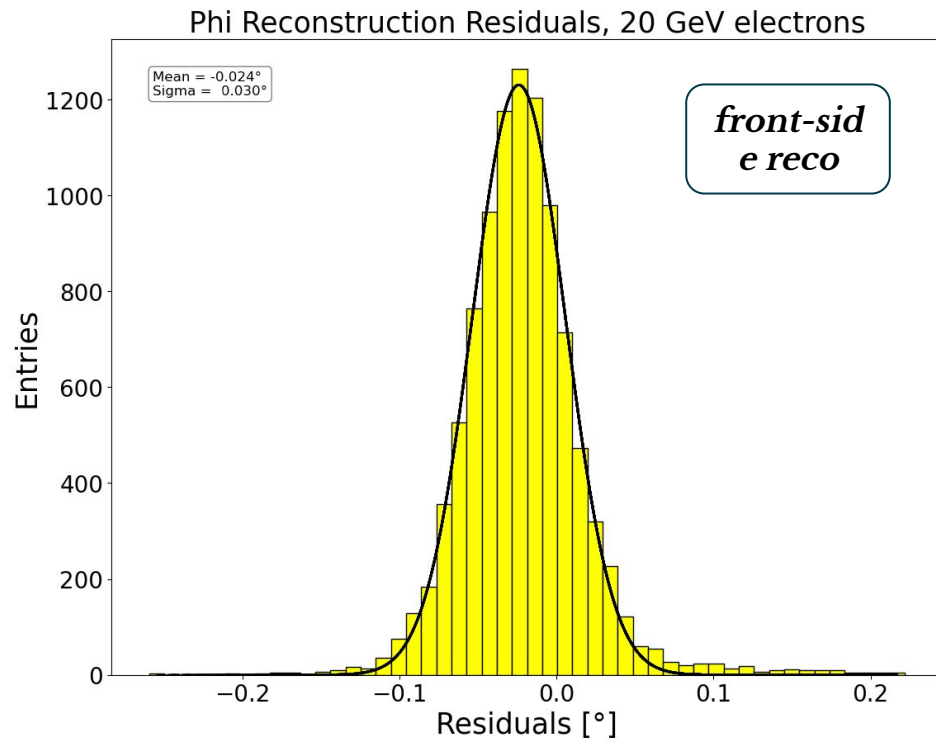
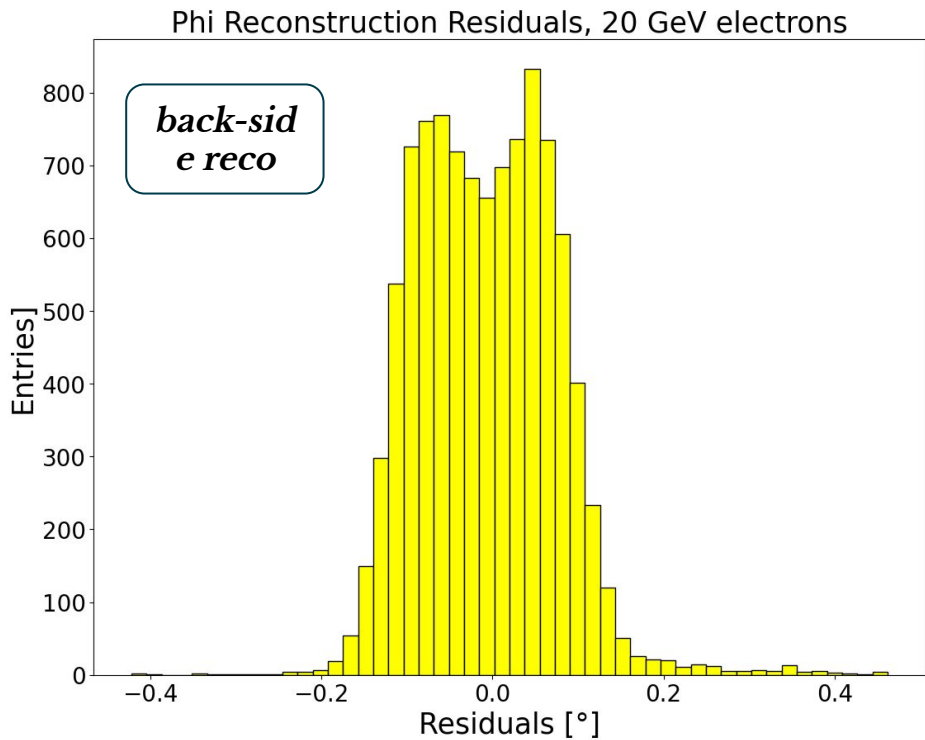
# Residuals and Angular Resolution: $\varphi$ , 5GeV

- Residuals = Reconstructed - Truth



# Residuals and Angular Resolution: $\varphi$ , 20GeV

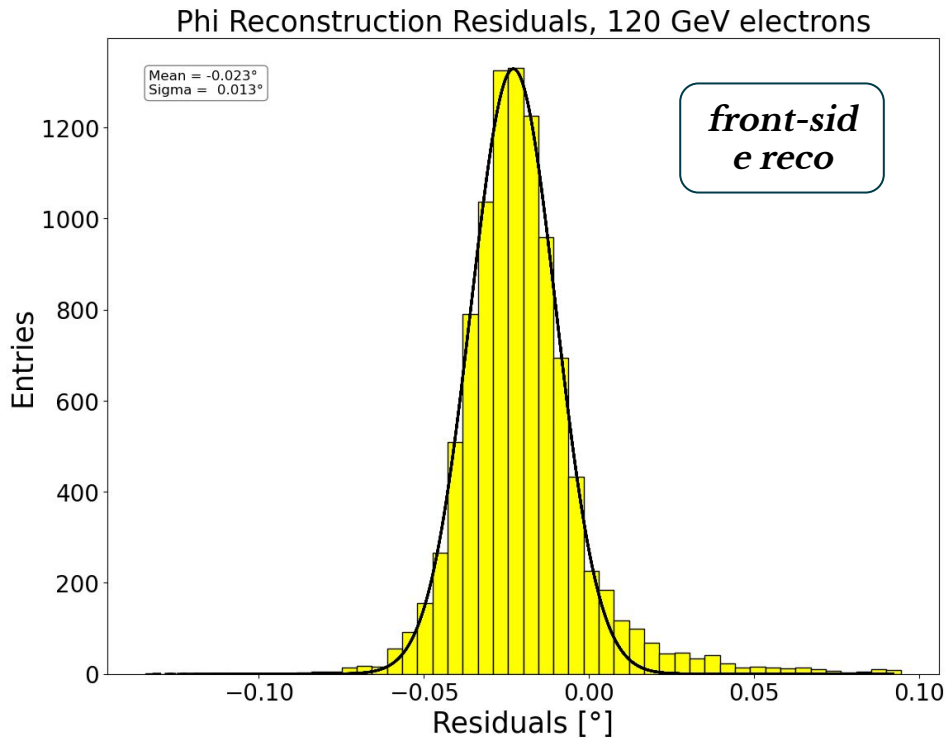
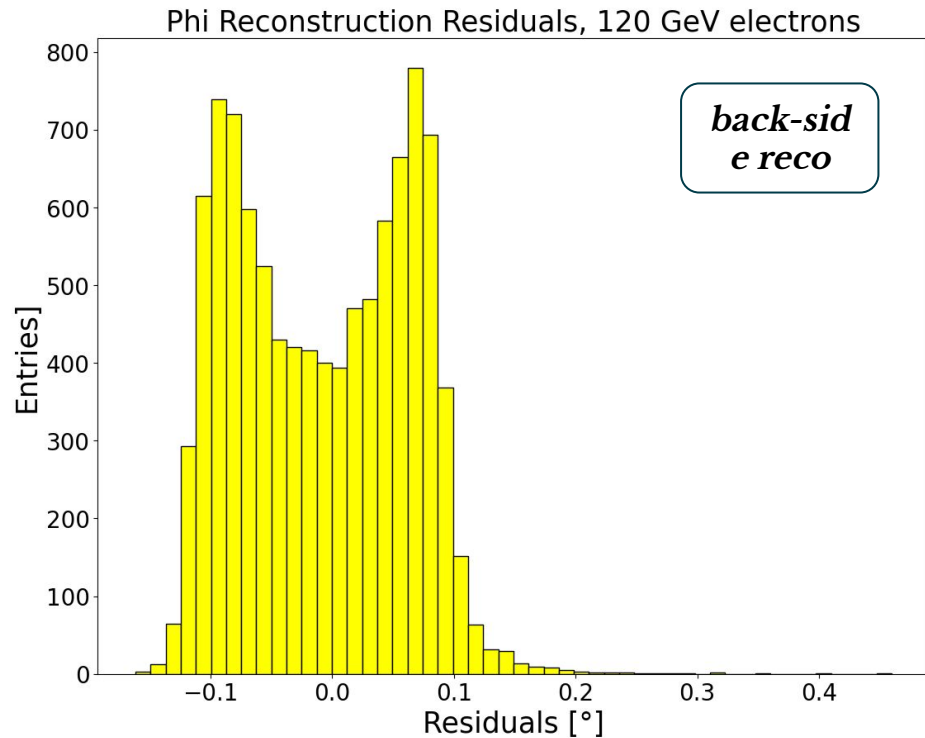
- Double peak structure evolving in back-side reco



# Residuals and Angular Resolution: $\varphi$ , 120GeV

- Suspicion: pulling of barycentre from neighbouring towers (farther away in back-side reco due to gaps)

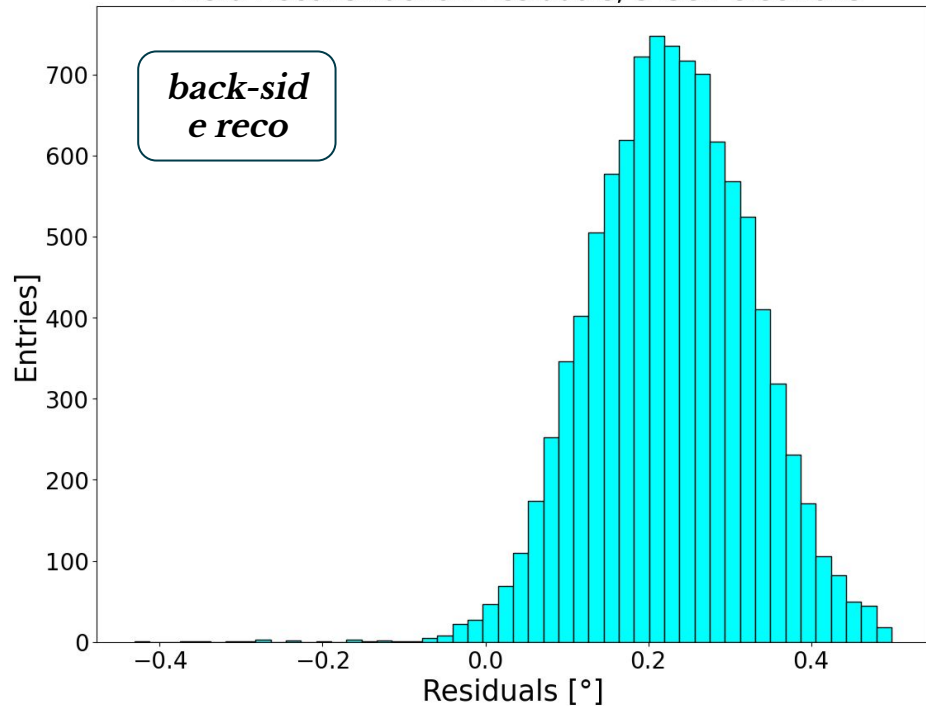
- Constant negative bias despite symmetry?
- Non-symmetrical tail ?



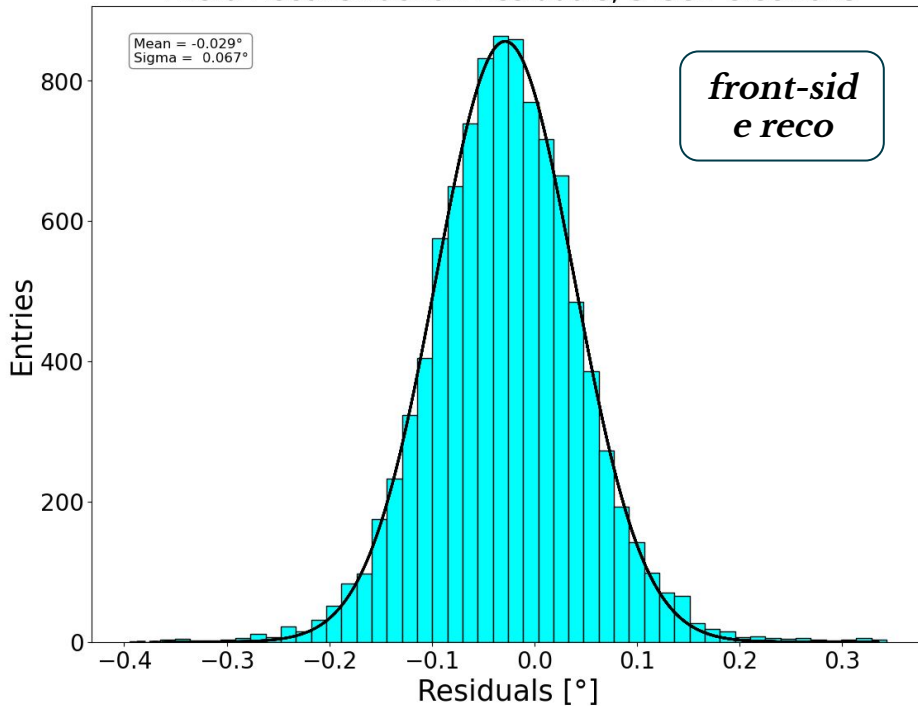
# Residuals and Angular Resolution: $\theta$ , 5GeV

- Overestimating  $\theta$  for back-side reconstruction
- Slightly underestimating for front-side (shower develops a few  $X_0$  in)

Theta Reconstruction Residuals, 5 GeV electrons

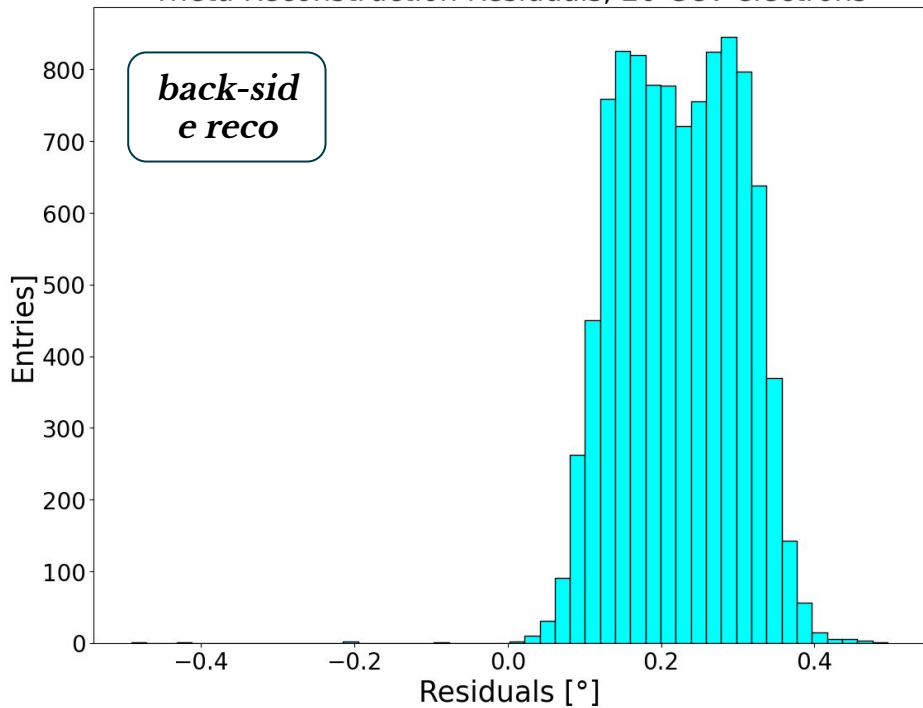


Theta Reconstruction Residuals, 5 GeV electrons

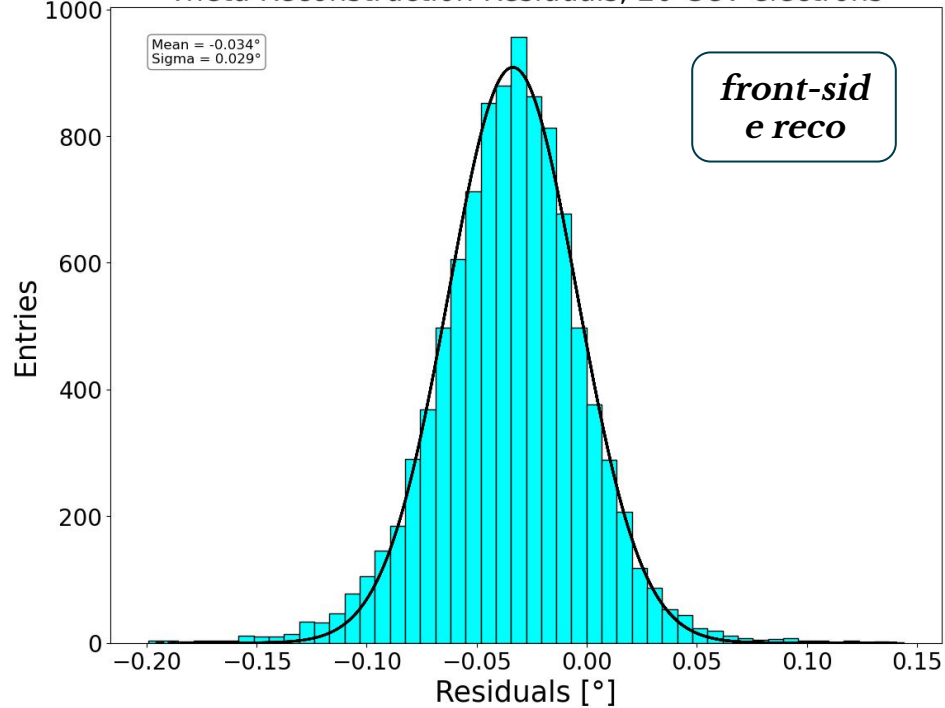


# Residuals and Angular Resolution: $\theta$ , 20GeV

Theta Reconstruction Residuals, 20 GeV electrons



Theta Reconstruction Residuals, 20 GeV electrons

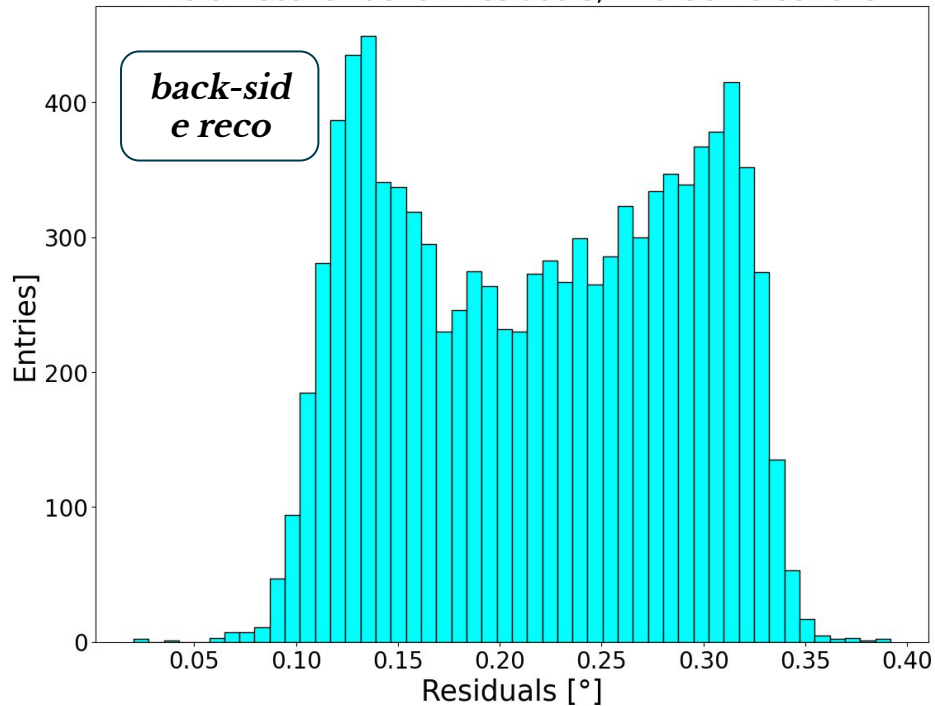


# Residuals and Angular Resolution: $\theta$ , 120GeV

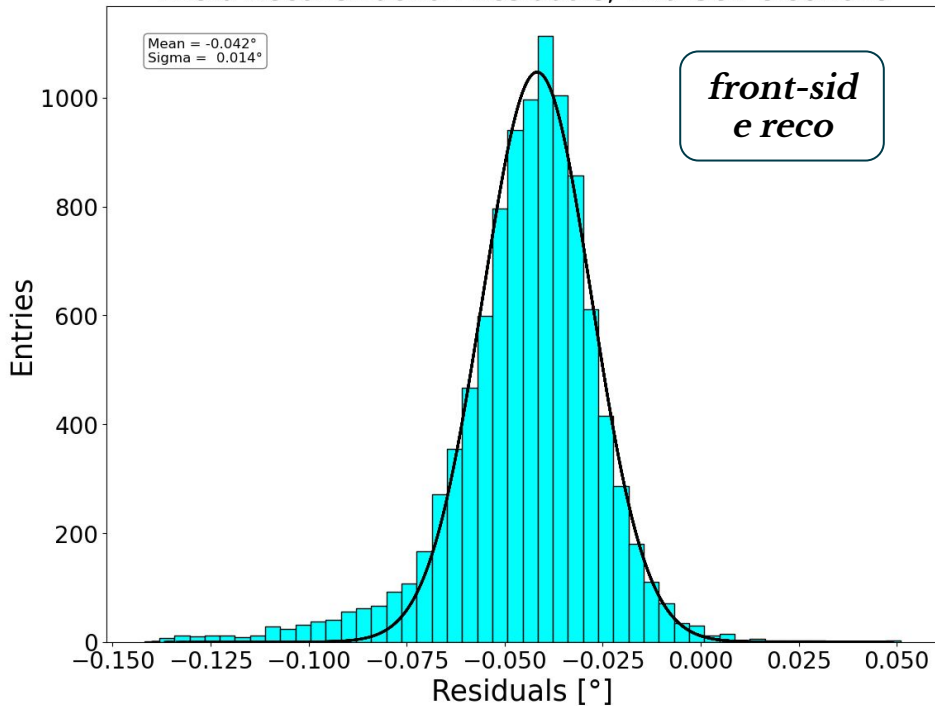
- Also double peak structure, pull from neighbouring towers with constant bias of  $0.2^\circ$

- Negative tail ...

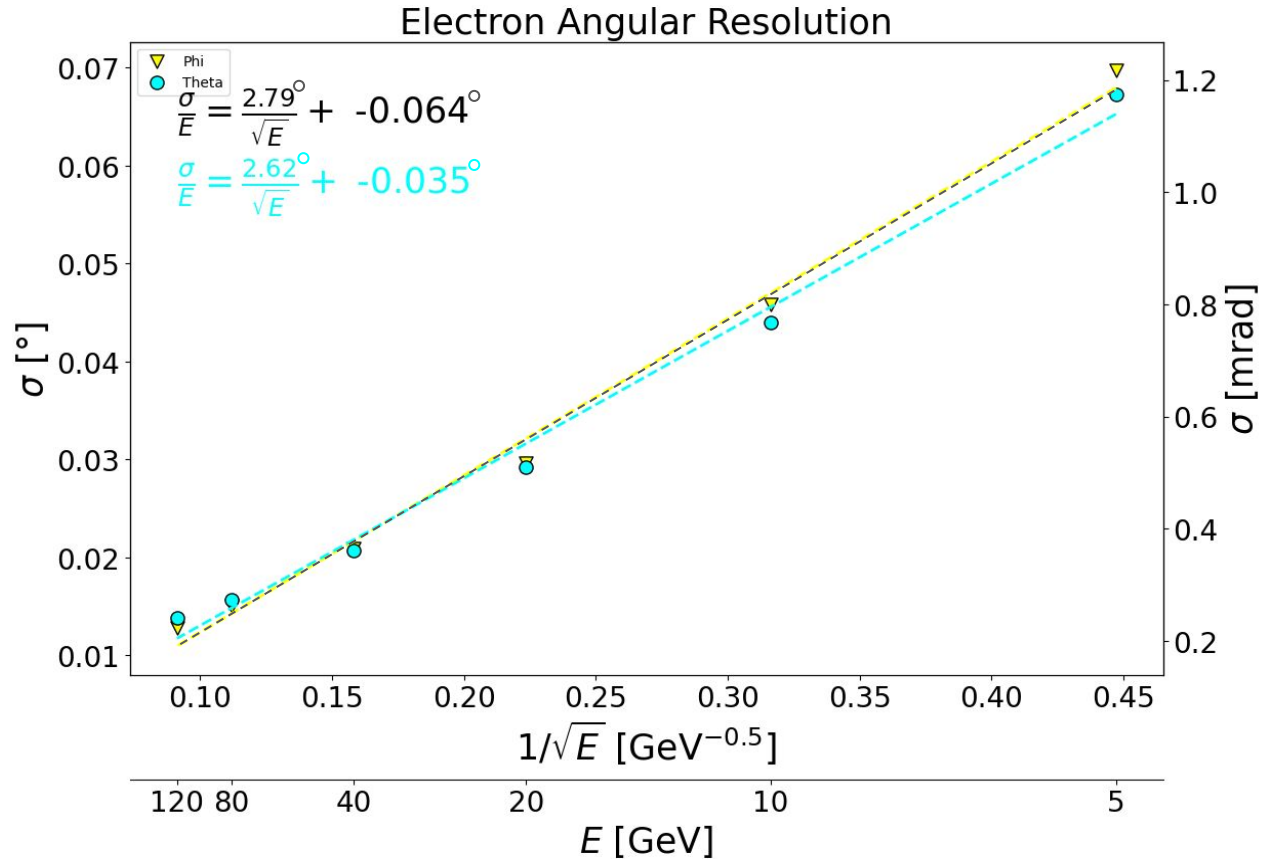
Theta Reconstruction Residuals, 120 GeV electrons



Theta Reconstruction Residuals, 120 GeV electrons

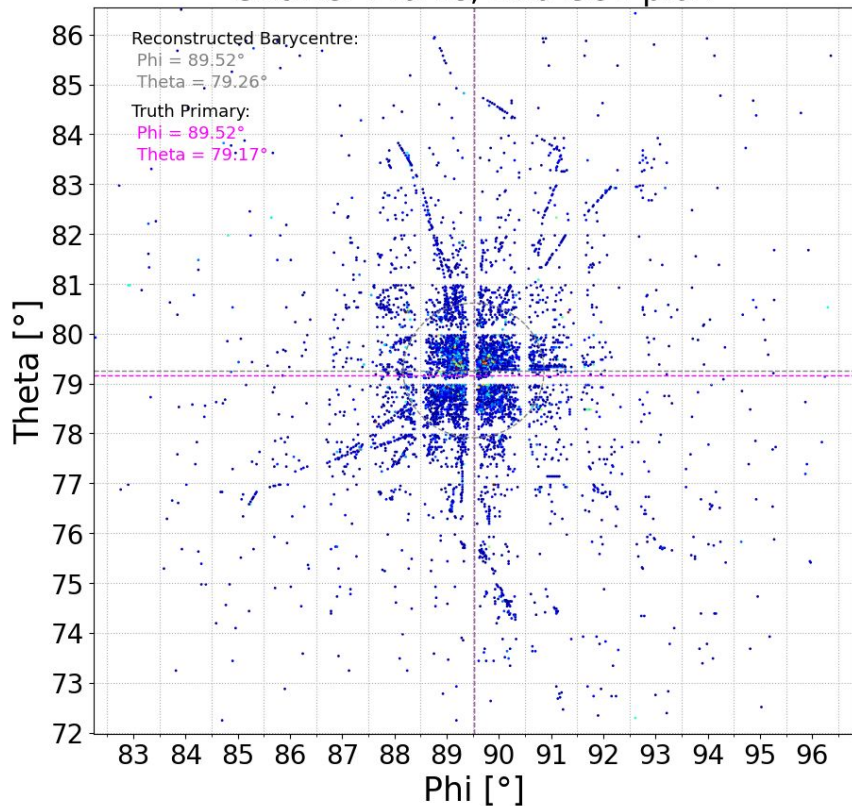


# Angular Resolution Fit (electrons):

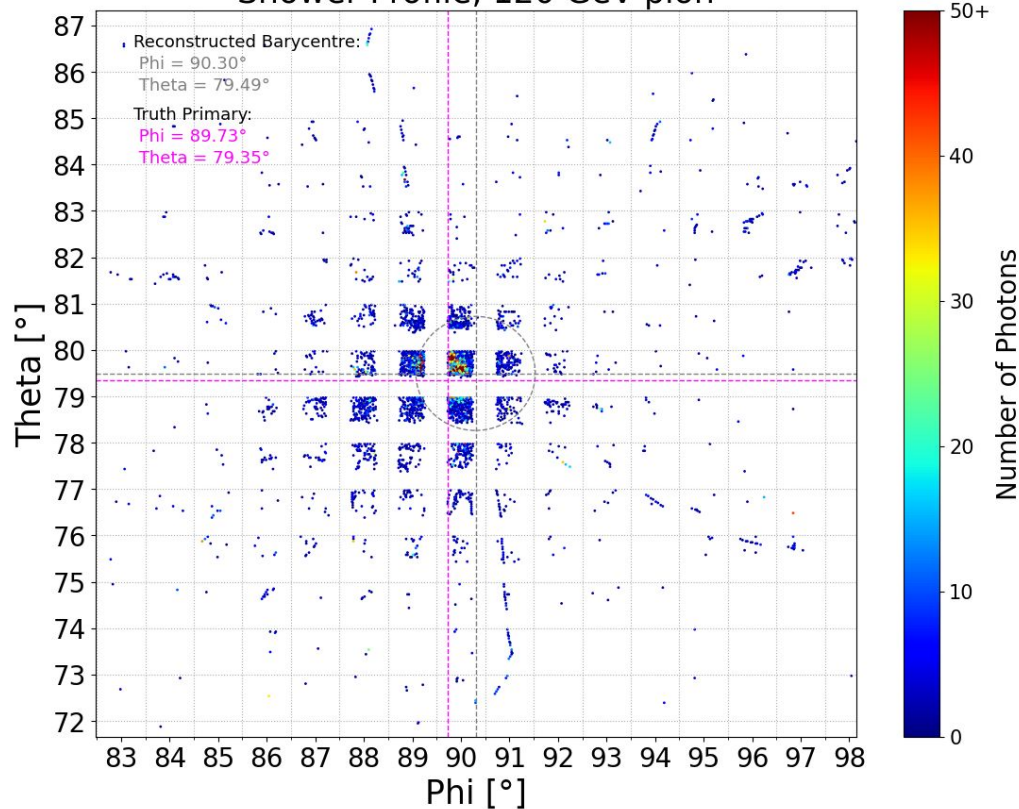


# Pion Events and Angular Resolution

Shower Profile, 120 GeV pion



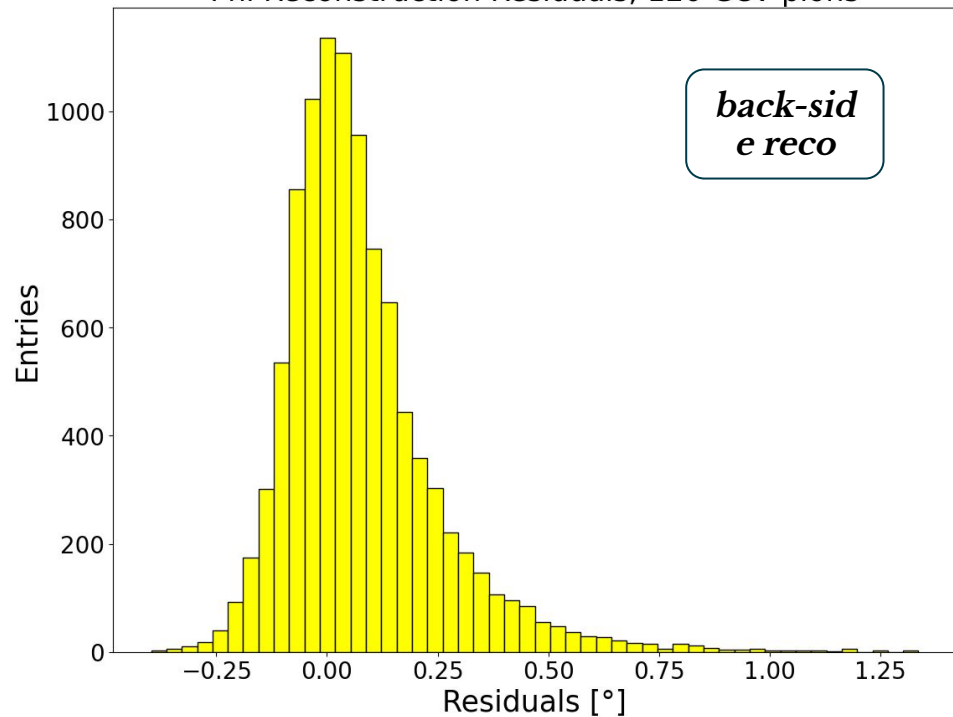
Shower Profile, 120 GeV pion



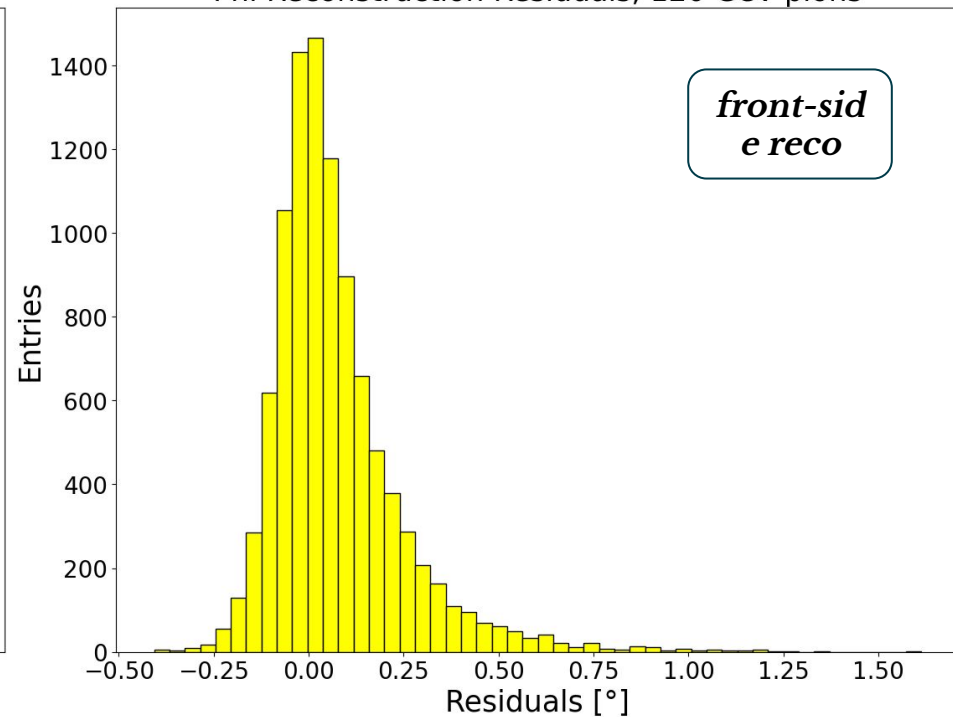


# Pion Events and Angular Resolution: $\phi$ , 120GeV

Phi Reconstruction Residuals, 120 GeV pions

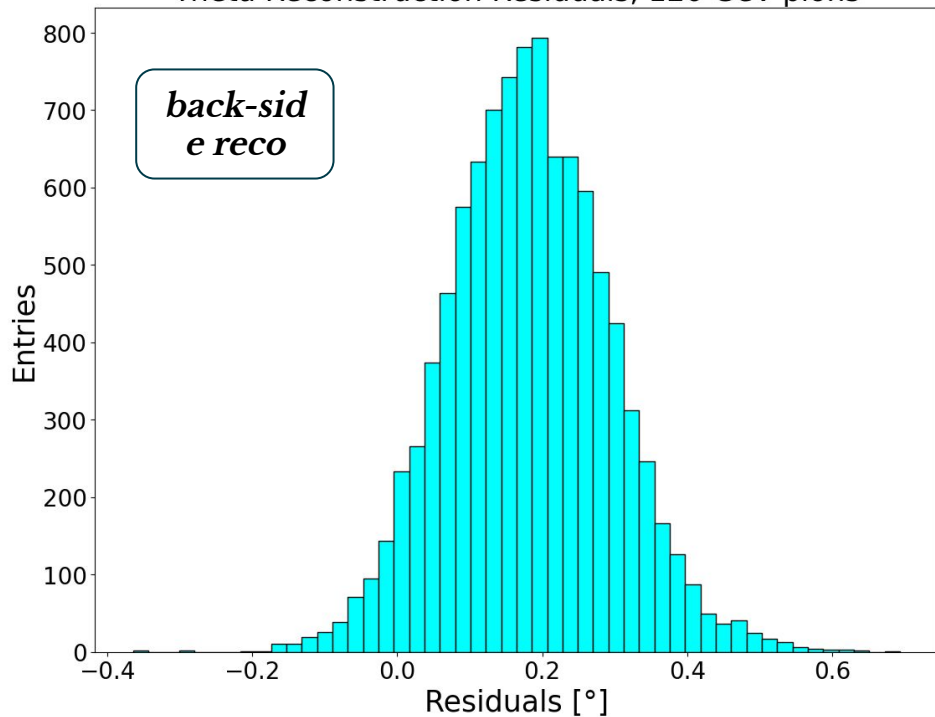


Phi Reconstruction Residuals, 120 GeV pions

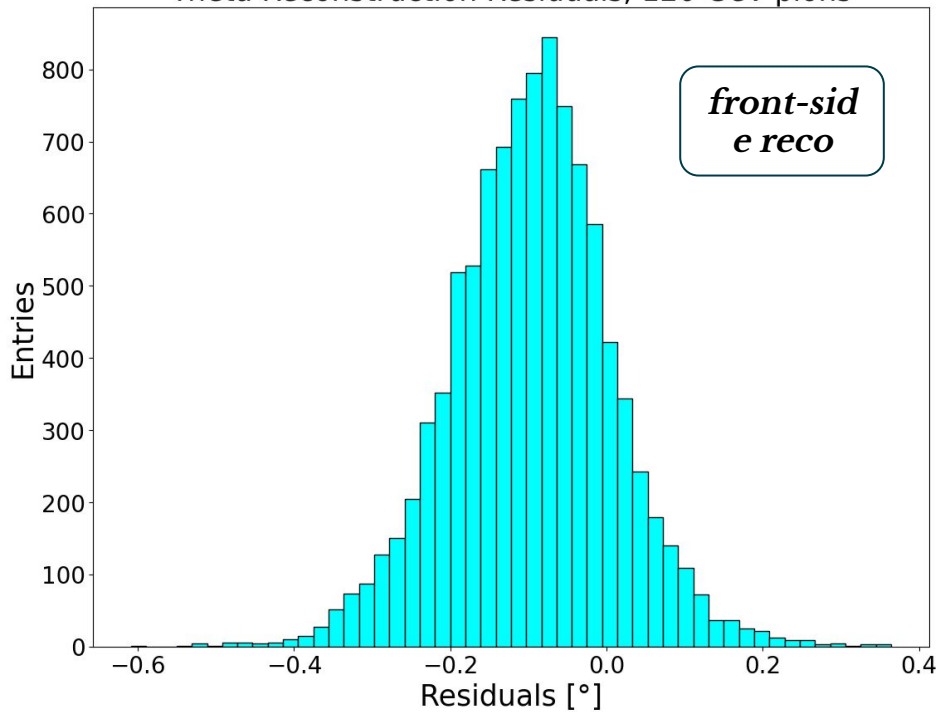


# Pion Events and Angular Resolution: $\theta$ , 120GeV

Theta Reconstruction Residuals, 120 GeV pions



Theta Reconstruction Residuals, 120 GeV pions



# Conclusion

- Angular resolution in 'combined' channel consistently below 0.07 degree (1.22 millirad)
- Some effects to be understood:
  - Constant negative bias in phi: 1 mm effect from tube placement
  - Asymmetric tail towards positive residuals in phi: ???
  - Negative residual tail in theta
- Next steps:
  - Also pion resolution