Status Report on TKR Beam Test analysis

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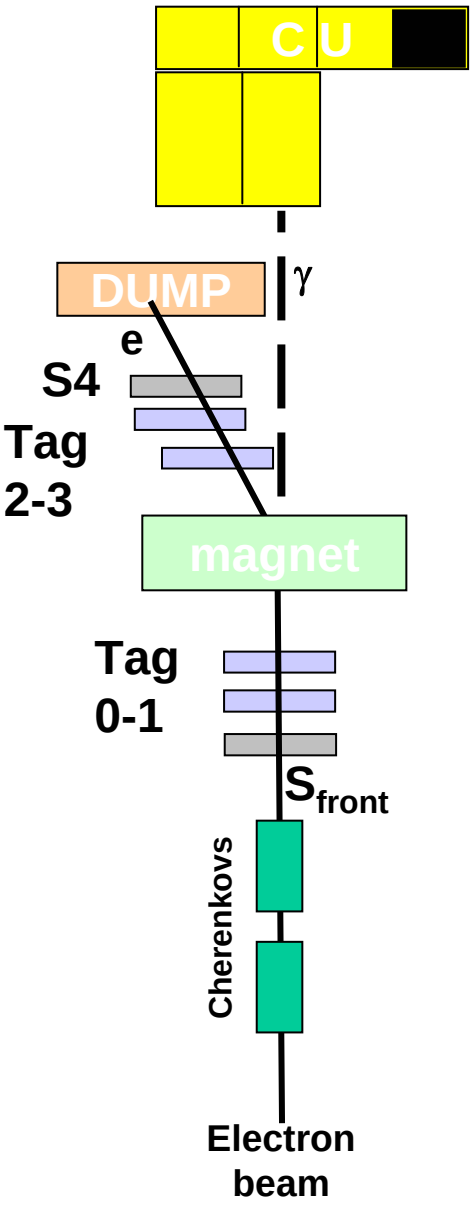
On behalf of
Beam Test Working Group

Outline

- Angular dispersion with photon runs (PSF)
- TKR Trigger efficiency from electron runs
- TKR Cluster and Hit studies

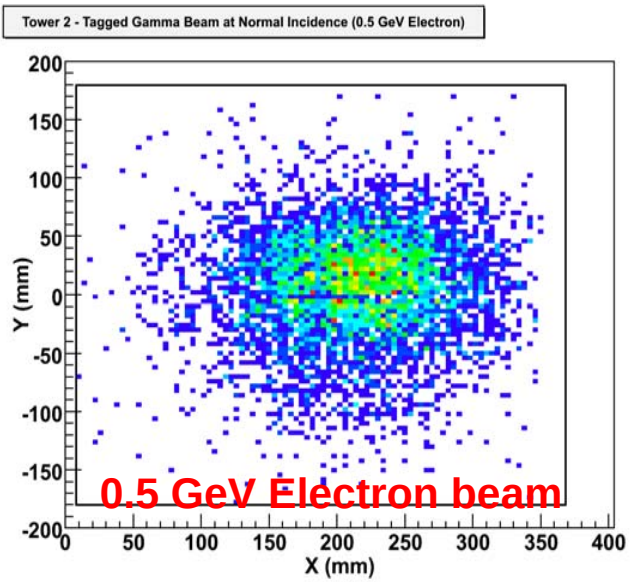
Photon configuration set-up

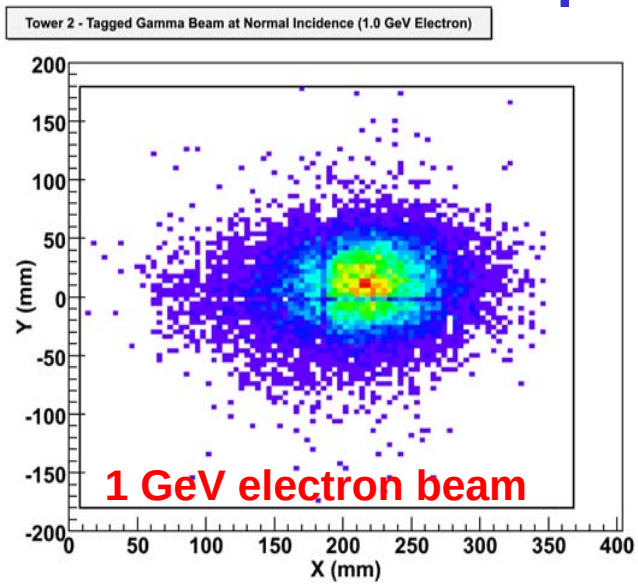


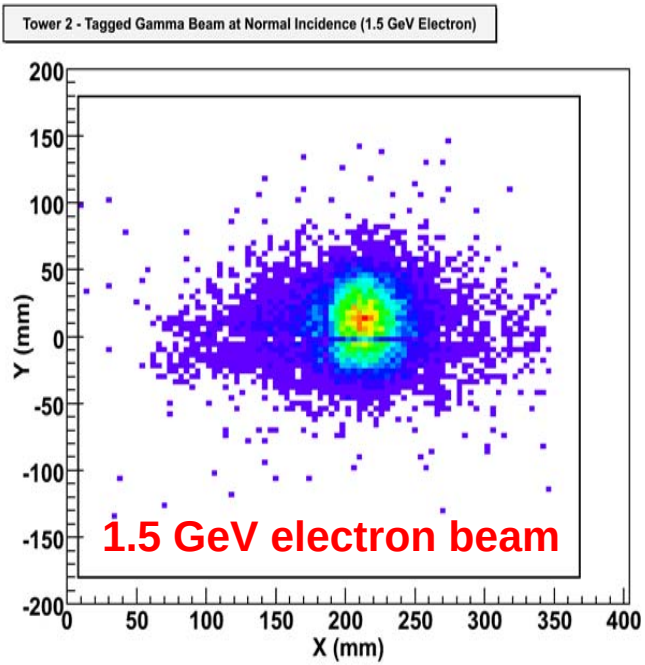
The gamma ray beam at the CERN PS T9 line was produced by bremsstrahlung between electrons and the upstream materials. A magnet has been used to well separate electrons from photons. Finally a beam dump has been used to stop electrons.

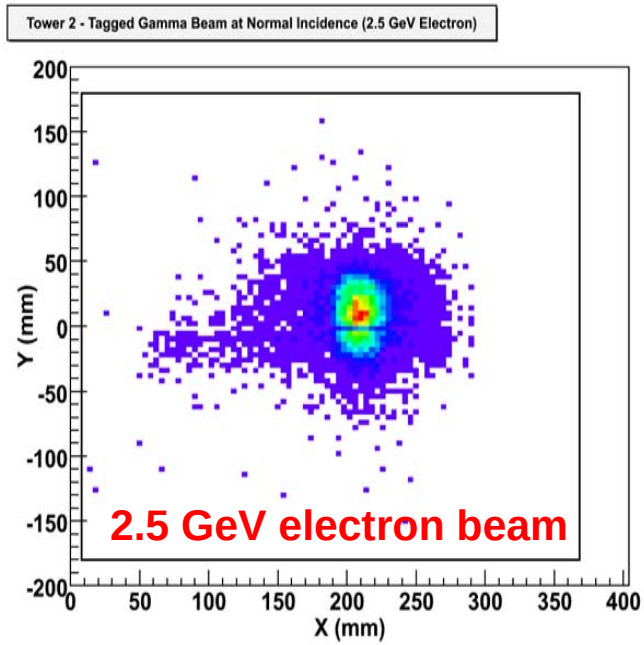
- **Tagged photon beam**
  - An external tracker (4 x-y view silicon strip detector) was used to track electrons upstream and downstream the magnet, read-out by means of an external DAQ
  - Trigger on S4&S_{front} & Cherenkovs
  - External DAQ was synchronized with the CU one, then the data have been merged with the CU one
  - Different electron beam energy in the range 0.5-2.5 GeV and magnetic field intensity have been used to provide a gamma spectrum to the CU below 2 GeV
- **Not tagged photon beam**
  - Trigger on S_{front} & Cherenkov
  - Full bremsstrahlung spectrum from 2.5GeV/c electron beam

Photon beam spot









- Data points are gamma vertex positions
- Beam dispersion and electron-gamma angle have to be taken into account in analysis and MC
- Beam dispersion from electron data
  - 0.5 GeV: 14 mrad
  - 1.0 GeV: 9 mrad
  - 1.5 GeV: 7 mrad
  - 2.5 GeV: 4 mrad

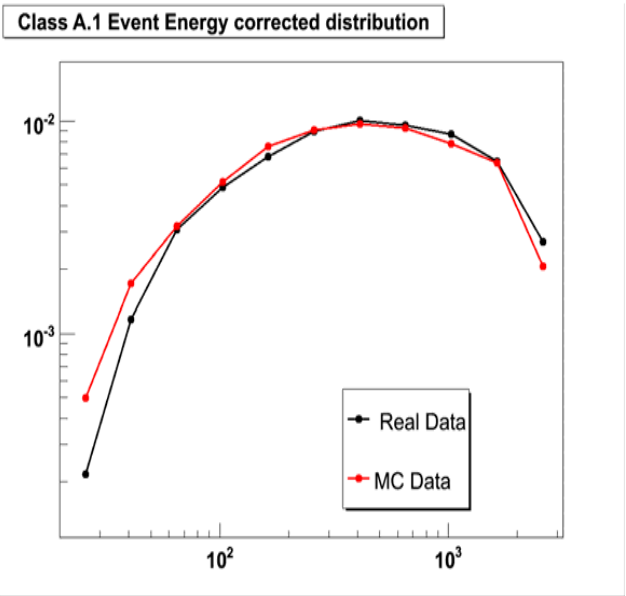
Photon Event classification

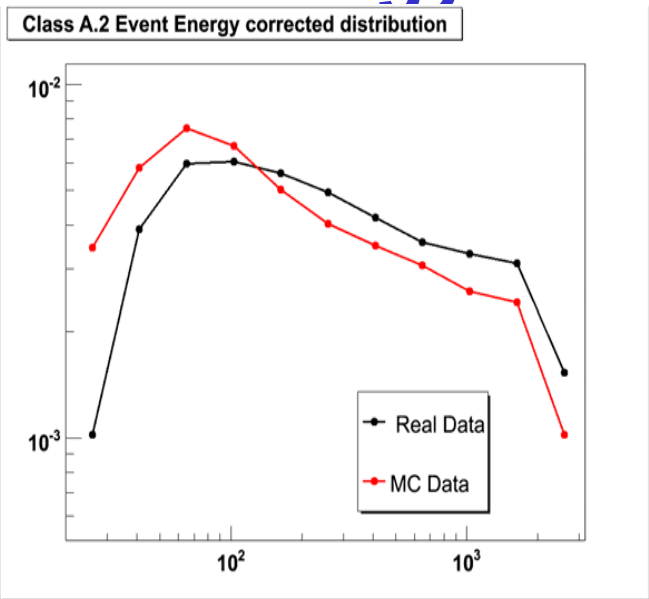
Score

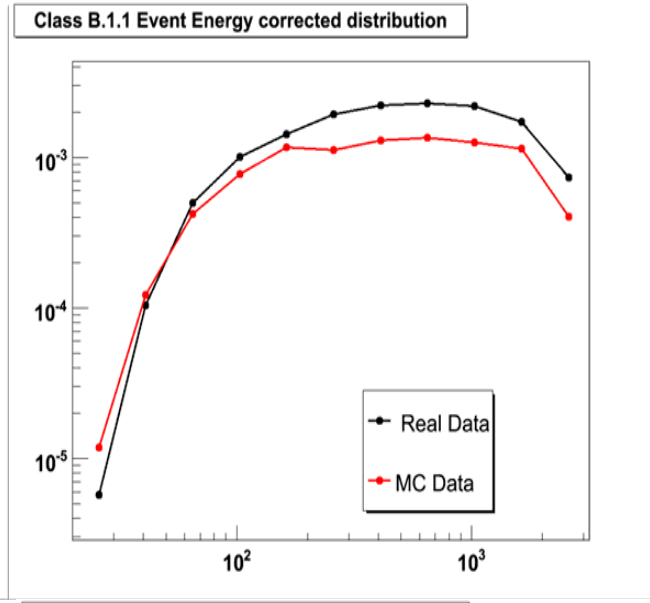
- **Class A: events with 1 vertex**
  - **Class A.1: events with 2 tracks:**
    - Tkr1LastLayer == 0 && Tkr2LastLayer == 0 && Tkr1FirstLayer > 1 && Tkr2FirstLayer > 1
      - **Class A.1.1: CalCsIRLn > 6**
        - » **Class A.1.1.1: First two top TKR plane as Veto**
  - **Class A.2: events with 1 track:**
    - Tkr1LastLayer == 0 && Tkr1FirstLayer > 1
      - **Class A.2.1: CalCsIRLn > 6**
        - » **Class A.2.1.1: First two top TKR plane as Veto**
- **Class B: events with 2 Vertices**
  - Class B.1.1: Number of tracks associated with the first vertex (Vtx1NumTkrs)==2 && Tkr1LastLayer == 0 && Tkr2LastLayer == 0 && Tkr1FirstLayer > 1 && Tkr2FirstLayer > 1 && CalCsIRLn > 6
- **Class C: events with 3 o more Vertices**
  - Class C.1.1: Number of tracks associated with the first vertex (Vtx1NumTkrs)==2 && Tkr1LastLayer == 0 && Tkr2LastLayer == 0 && Tkr1FirstLayer > 1 && Tkr2FirstLayer > 1 && CalCsIRLn > 6

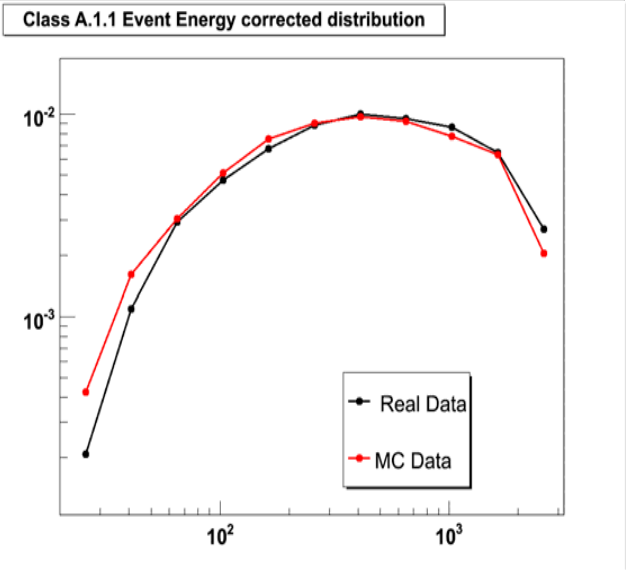
Score

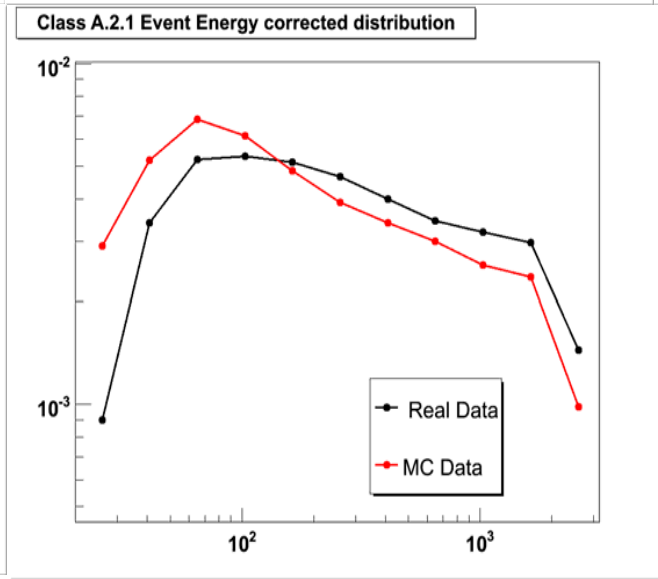
Event class energy distribution

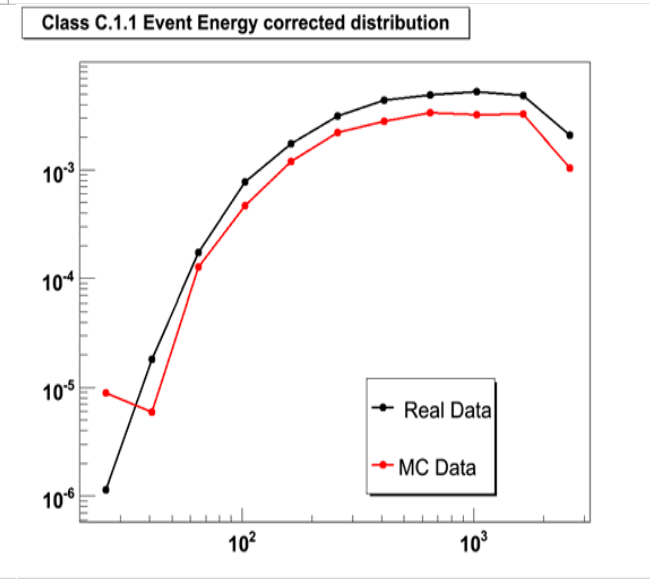












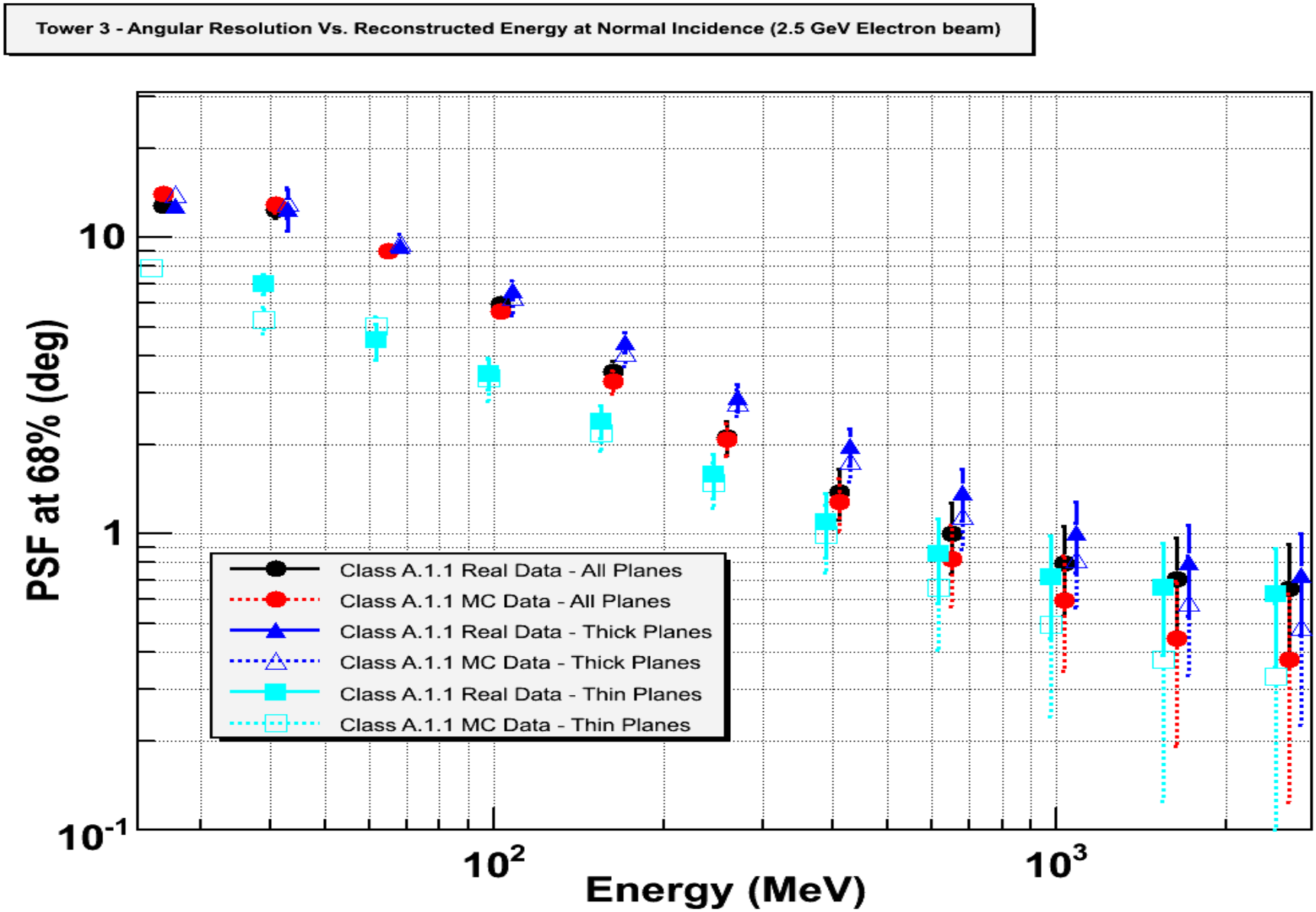
Angular dispersion evaluation

- Non tagged mode:
  - The gamma angle has been calculated with the respect to the nominal beam direction
  - 5 energy bins per decade starting from 20 MeV have been defined
  - For each bin energy, the angular dispersion distribution is filled in a histogram with 0.1° bin width
  - **all gamma runs (both full brems. and tagged) have been used with 2.5 GeV electron beam**
- Tagged mode:
  - The gamma angle has been evaluated with the respect to the incoming beam direction measured from the tagger
  - …..

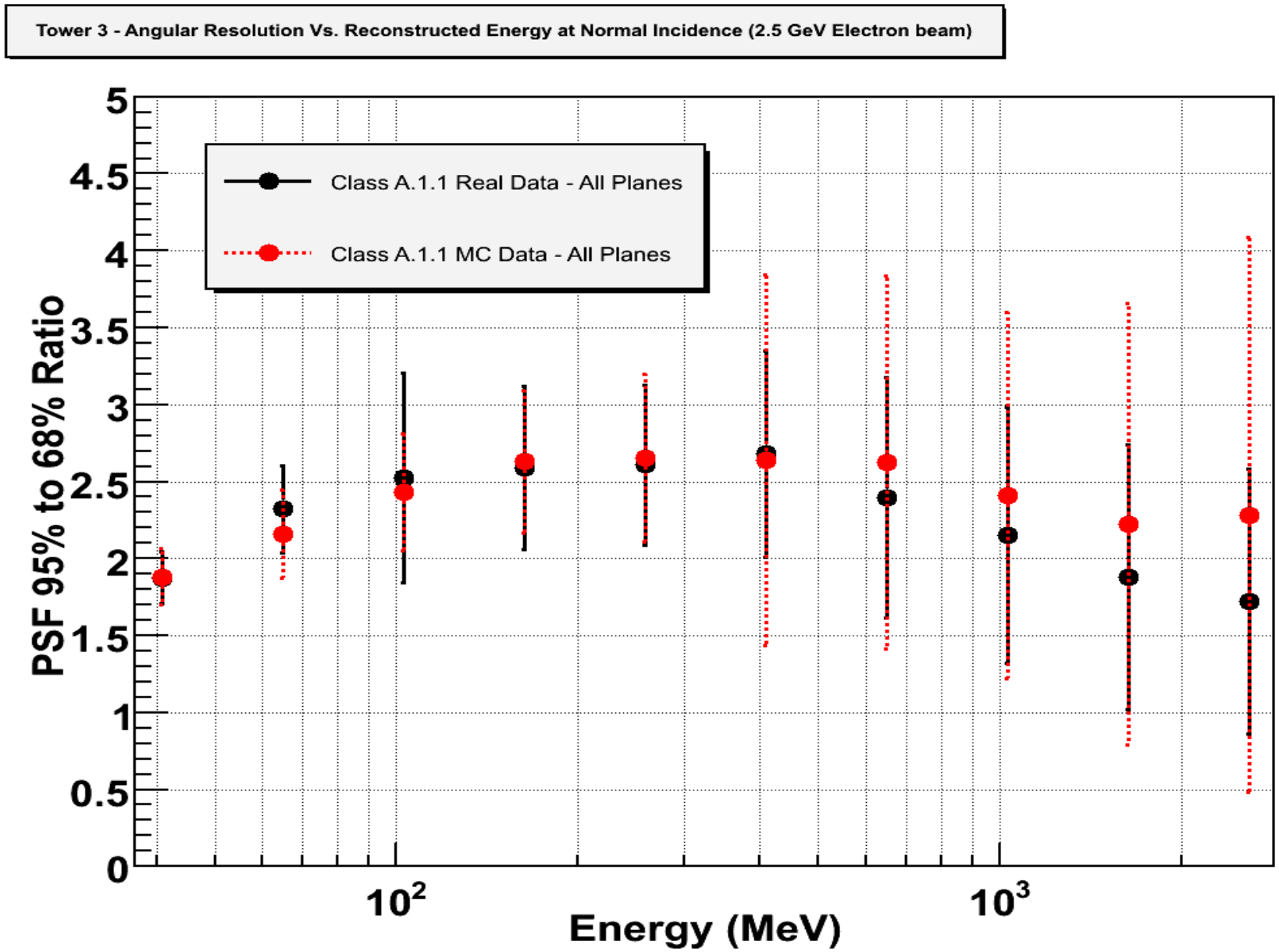
Uncertainties to the PSF in non tagged run mode

- Beam divergence: 4 mrad at 2.5 GeV/c electron beam, $\delta\theta_f \sim 0.229°$
- Uncertainty of the CU position with respect to the beam: $\delta\theta_f \sim 0.1°$ **(TBR)**
- Gamma production angle by bremsstrahlung with respect to the electron: few mrad, $\delta\theta_f \sim 0.1°$
  - The quoted value comes from the cross section used in Geant code
- Statistical and systematic errors have been added in quadrature

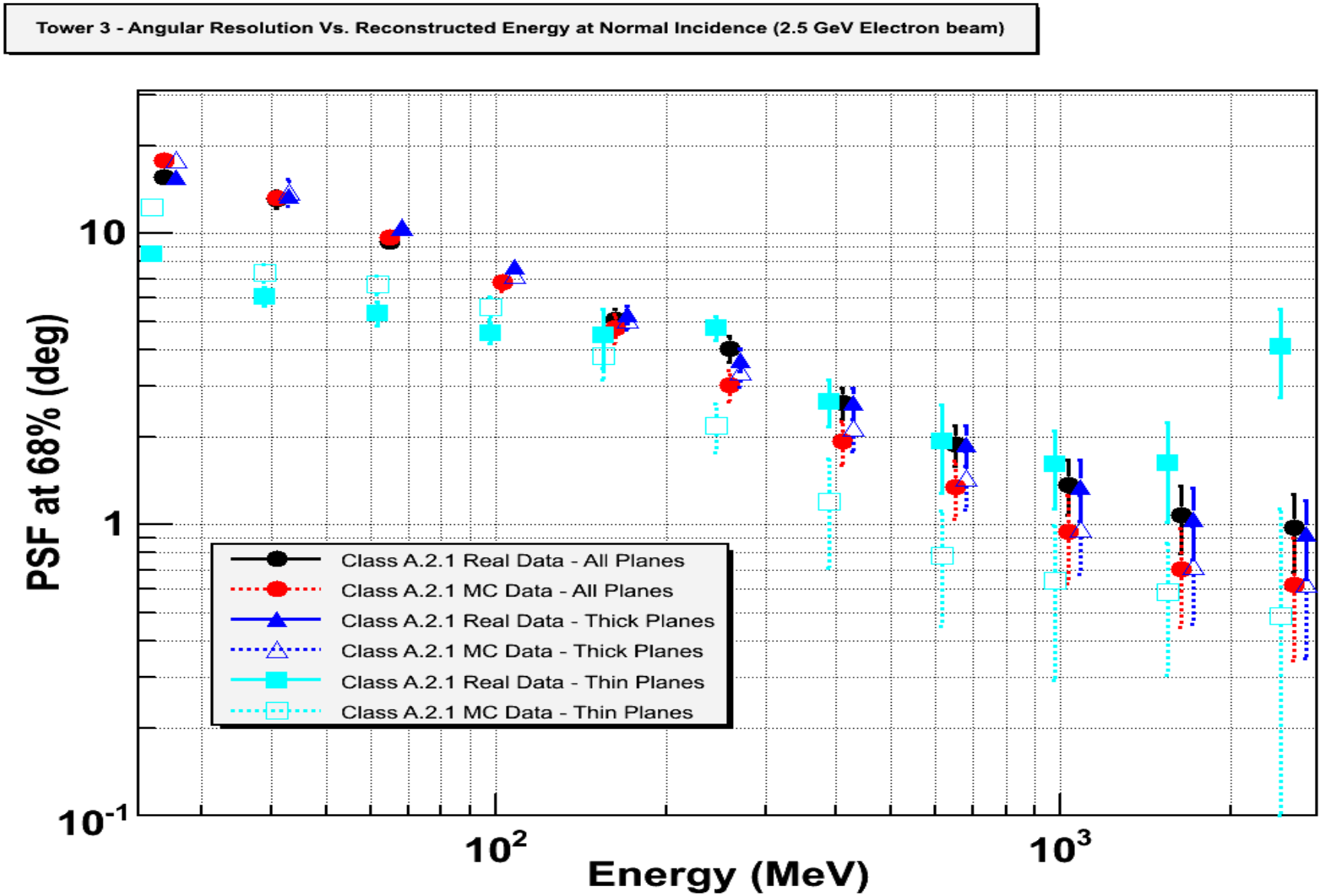
PSF at 68% - Class A.1.1 - Tower 3 at 0 Deg



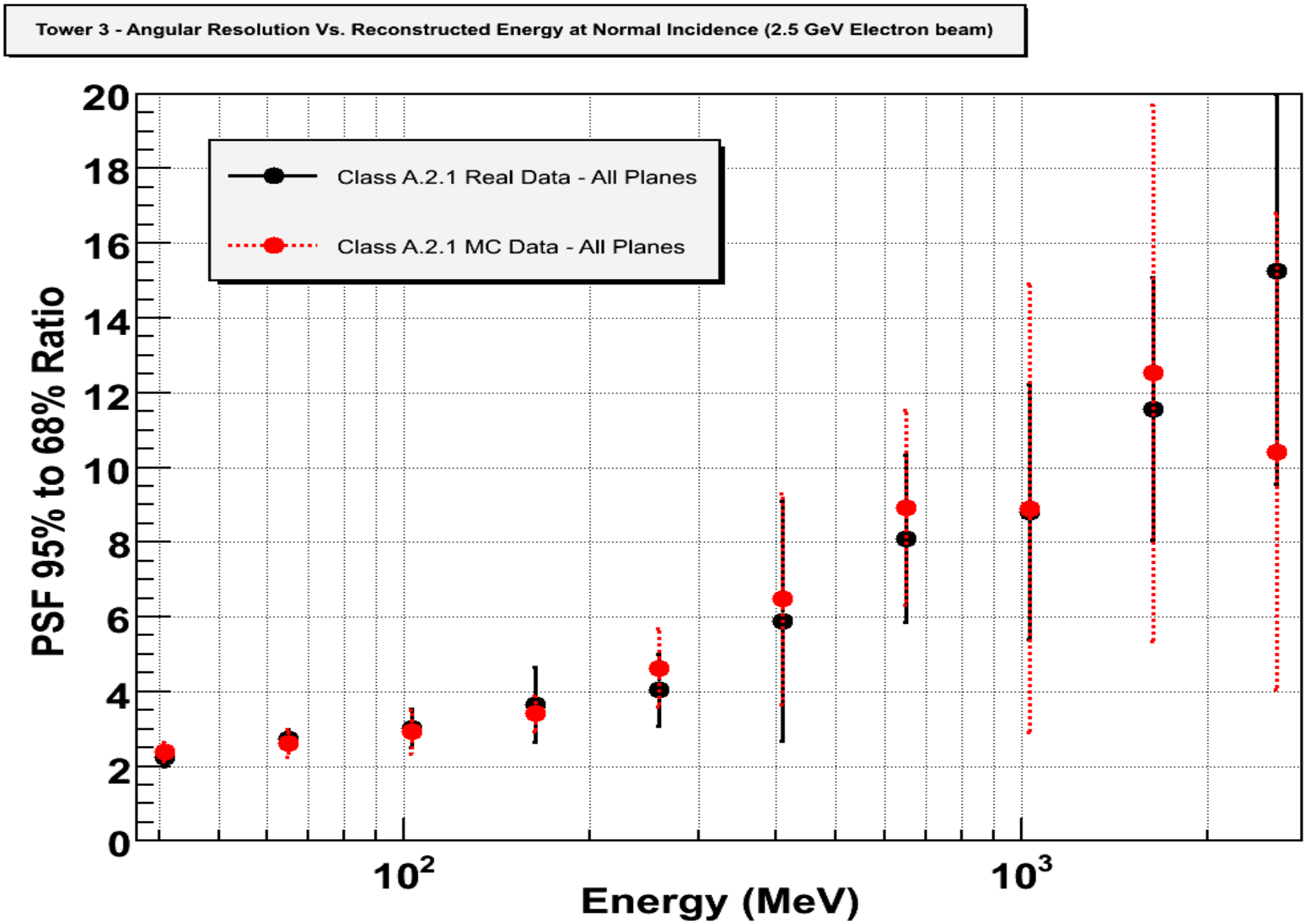
PSF 95% to 68% ratio – Class A.1.1 at 0 Deg



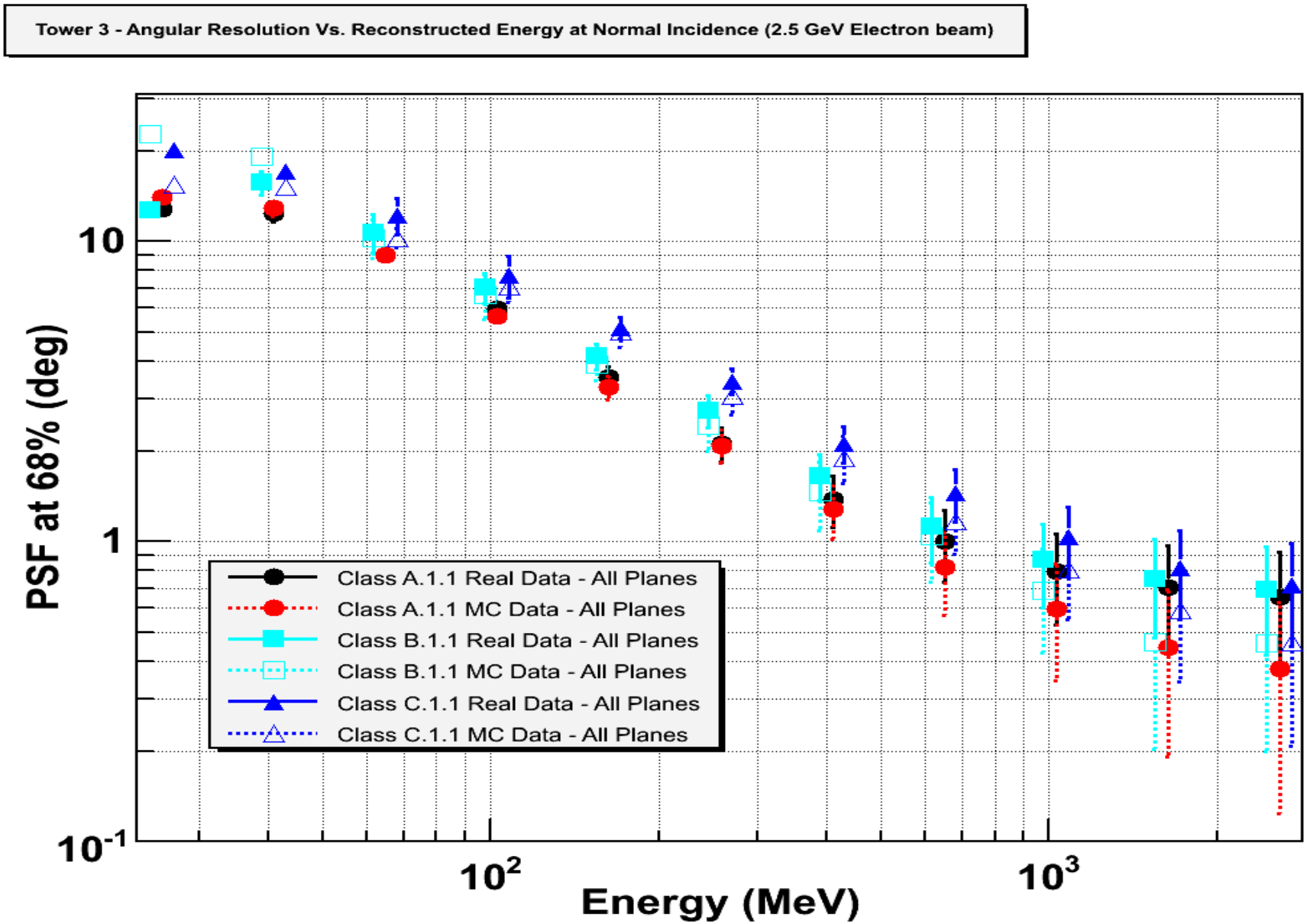
PSF at 68% - Class A.2.1 - Tower 3 at 0 Deg



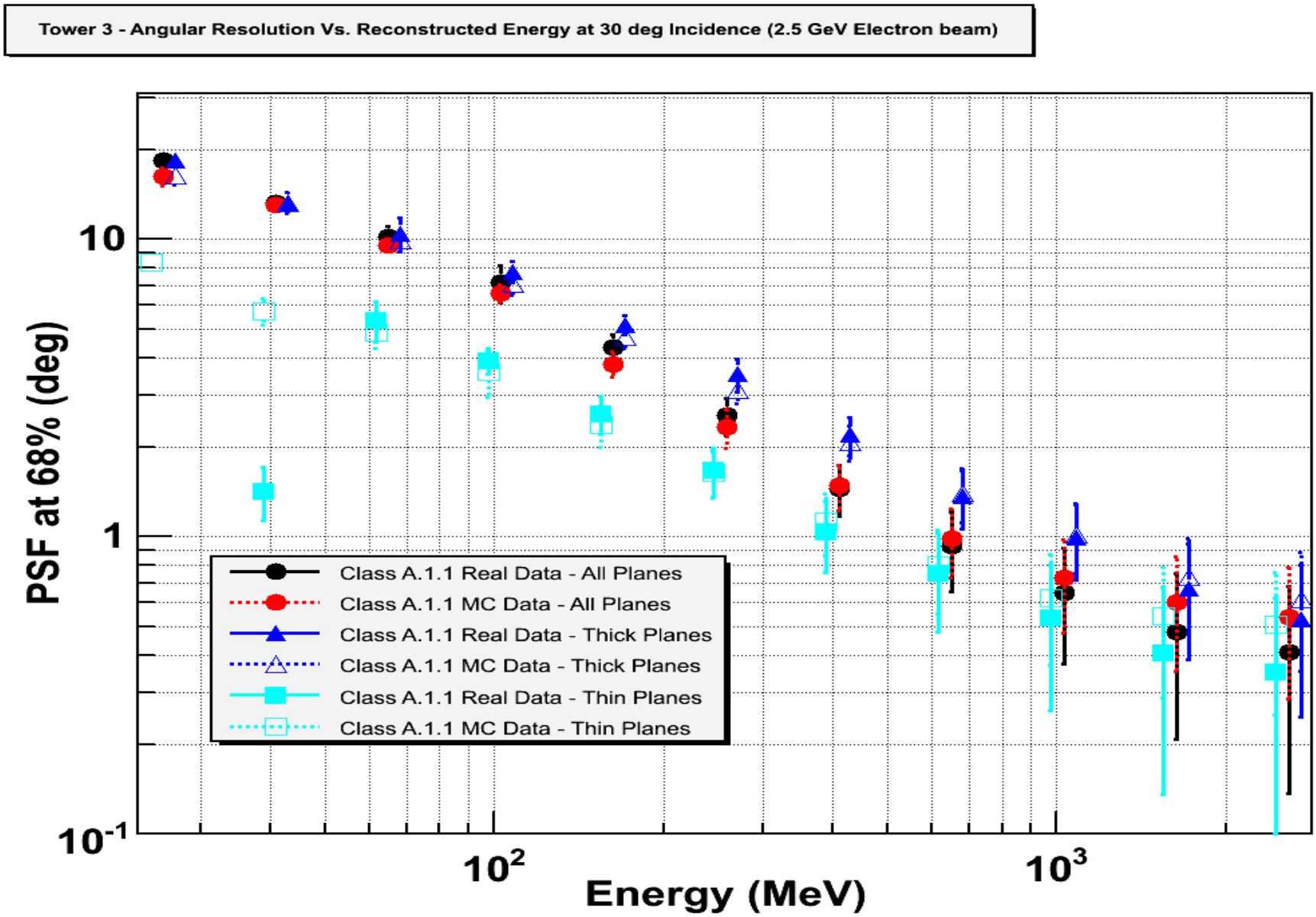
PSF 95% to 68% ratio – Class A.2.1 at 0 Deg



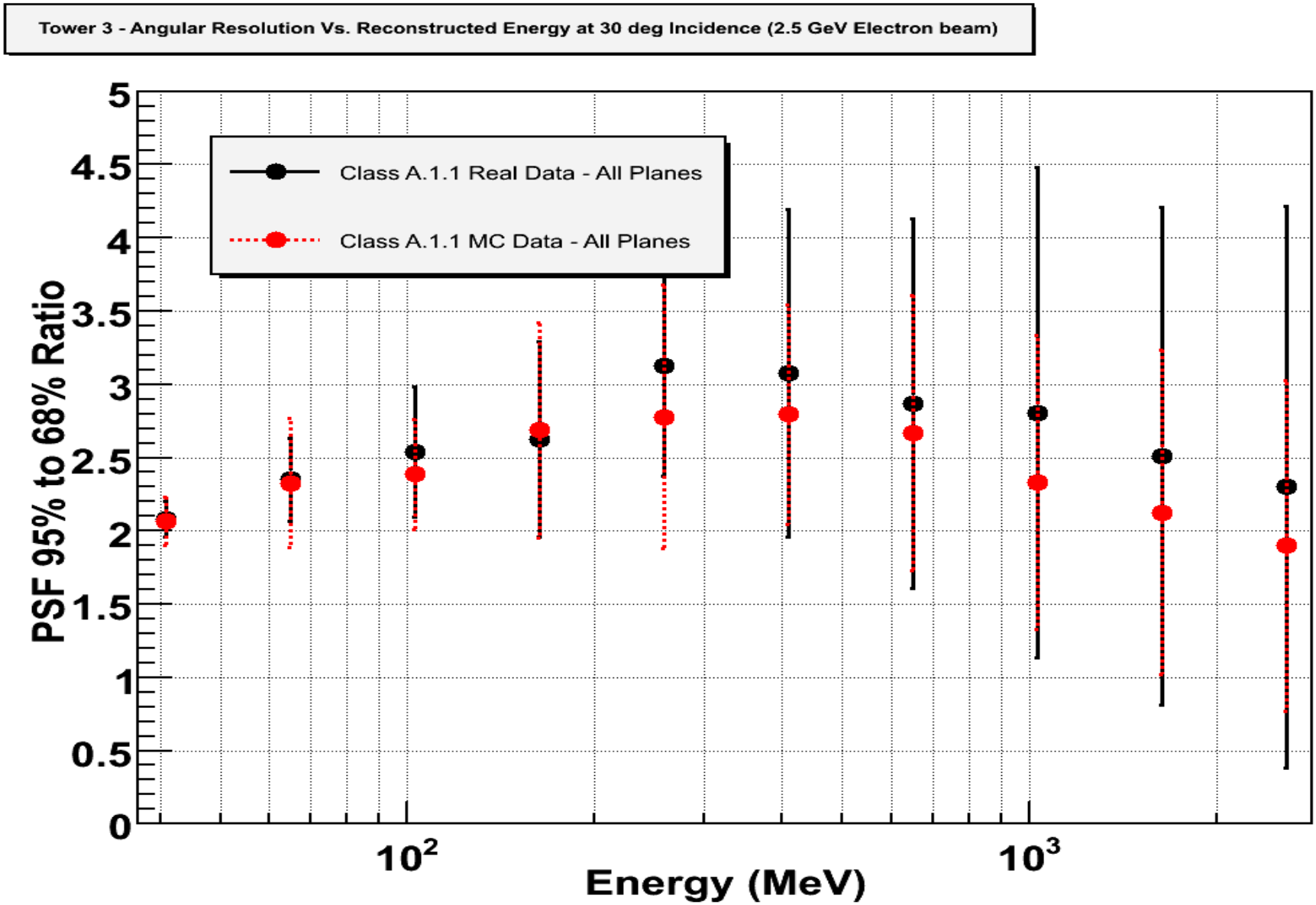
PSF at 68% - Class A, B and C - TWR 3 at 0 Deg



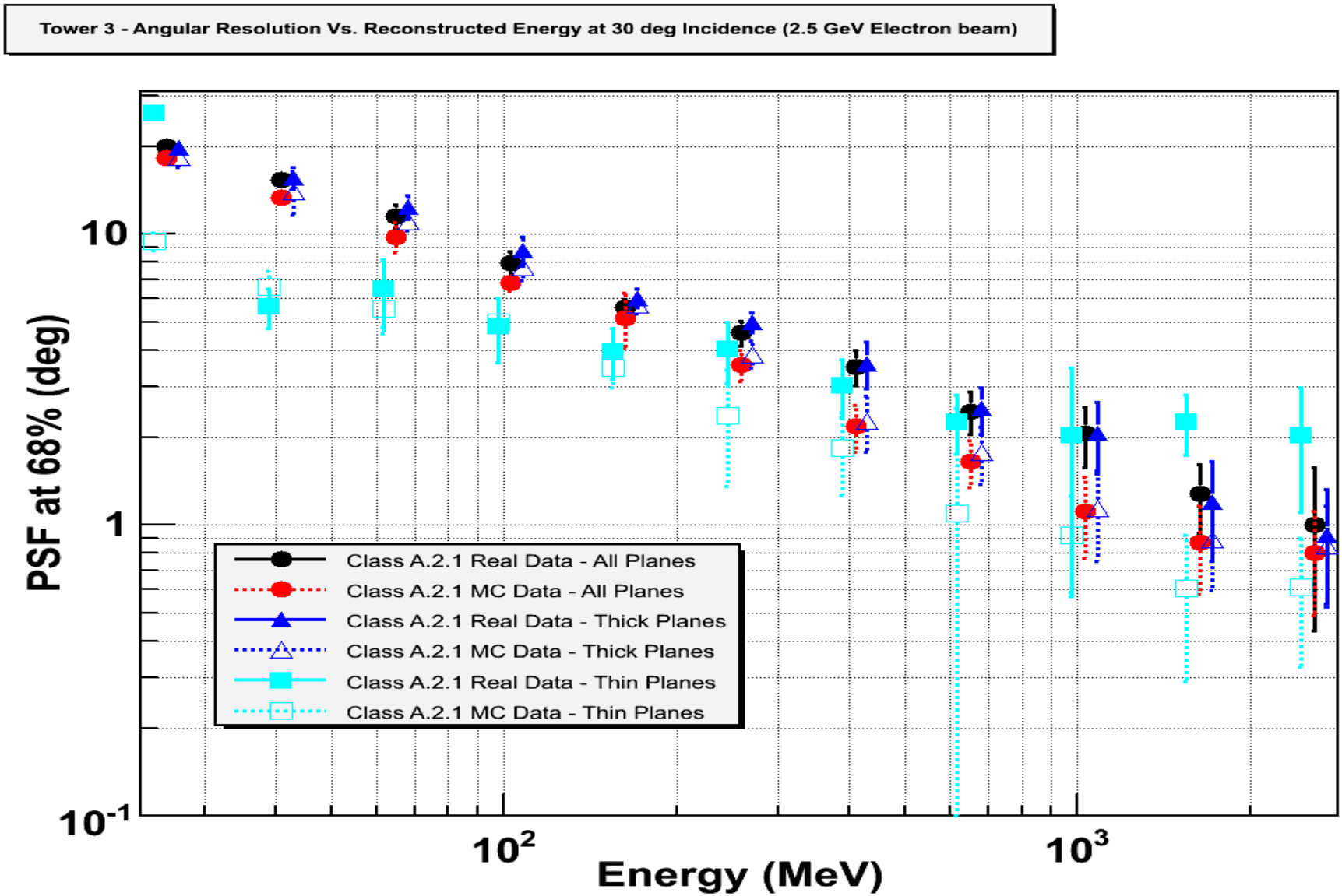
PSF at 68% - Class A.1.1 - 30 Deg



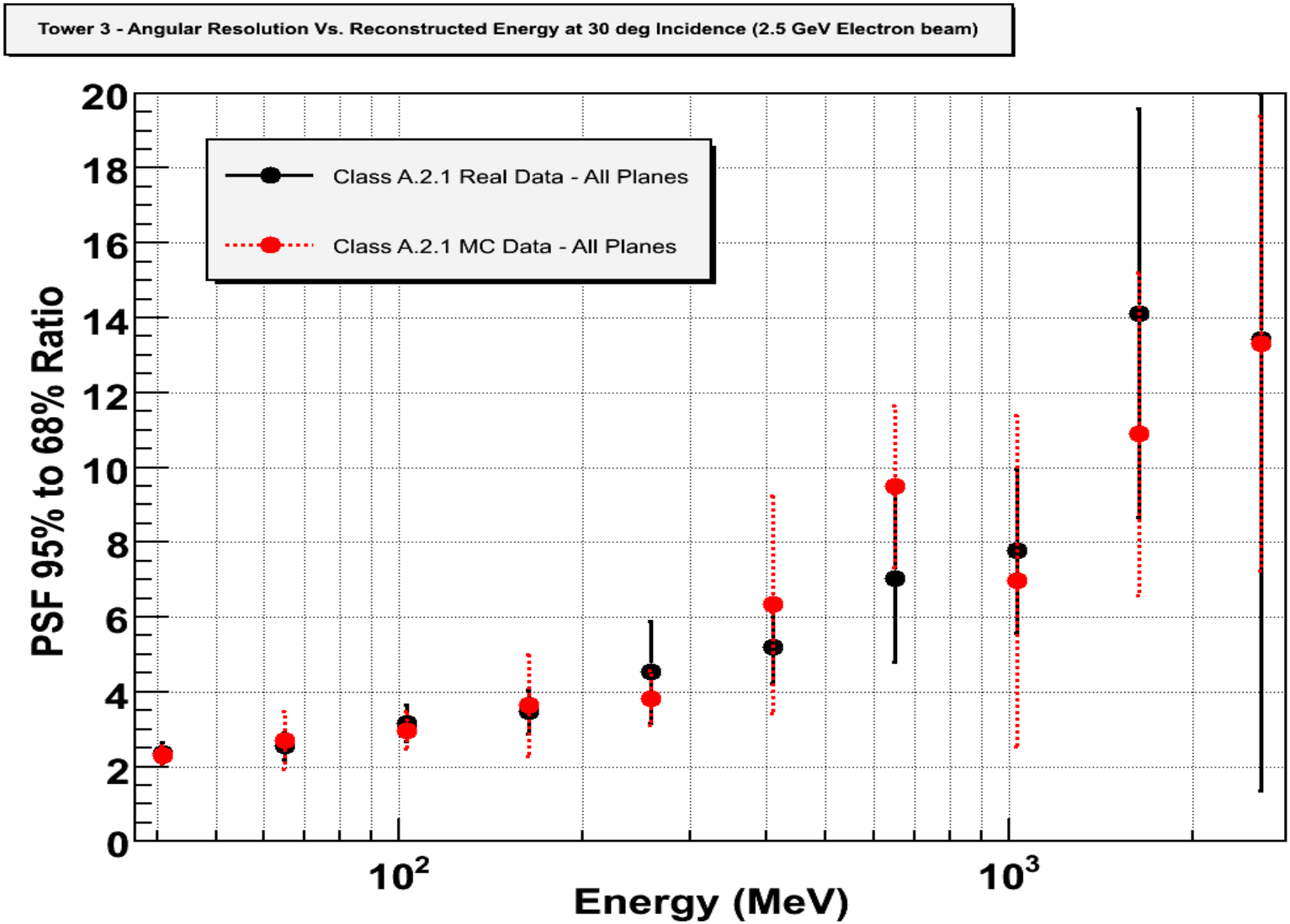
PSF 95% to 68% ratio – Class A.1.1 at 30 Deg



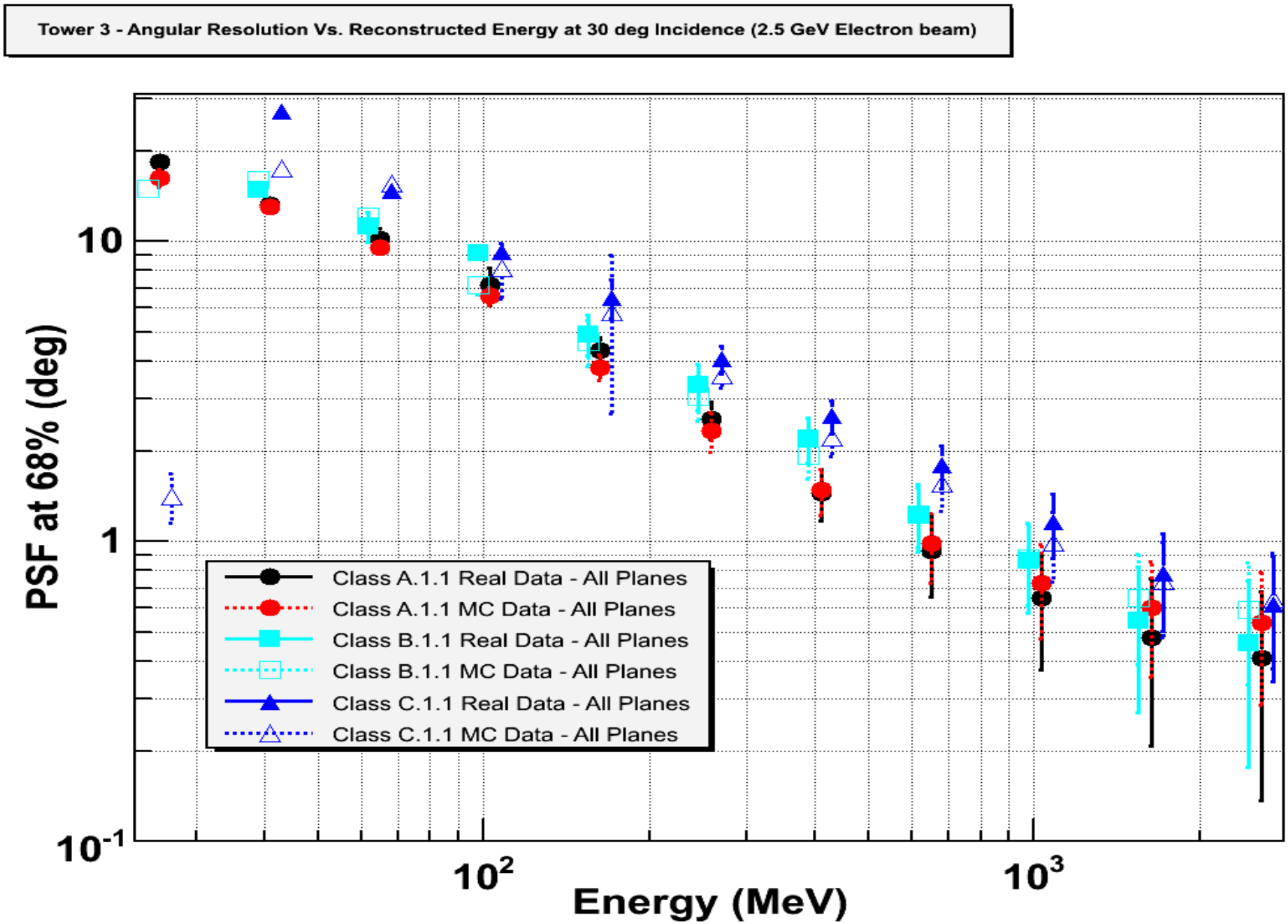
PSF at 68% - Class A.2.1 - 30 Deg



PSF 95% to 68% ratio – Class A.2.1 at 30 Deg

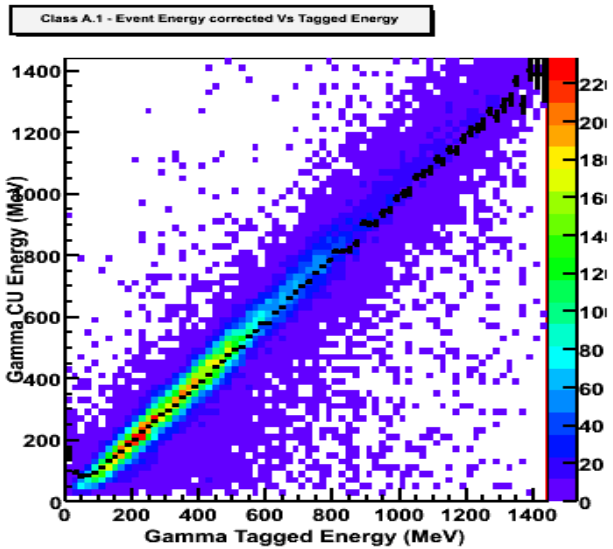


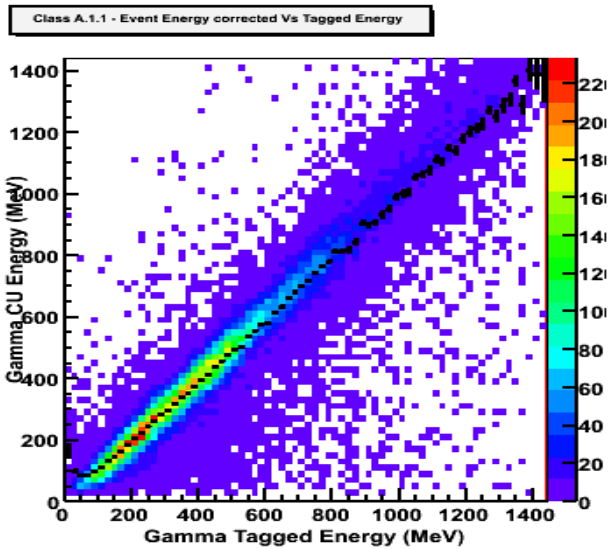
PSF at 68% - Class A, B and C - at 30 Deg

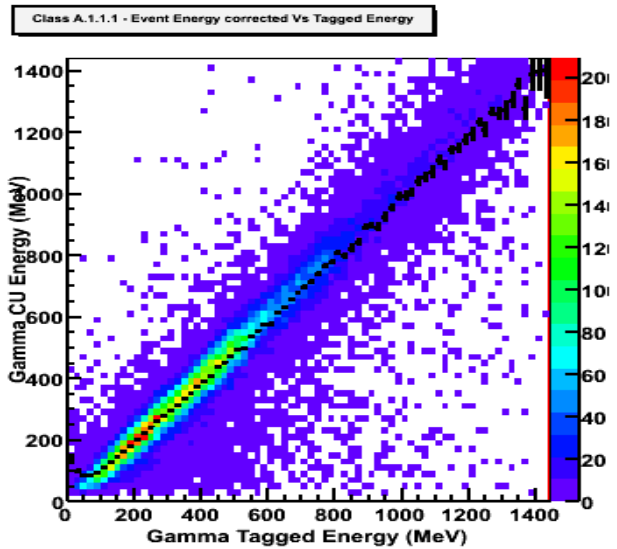


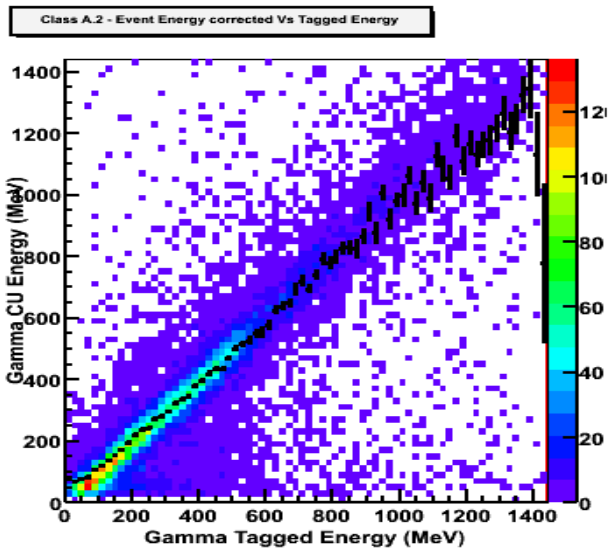
Energy calibration: CAL + TKR

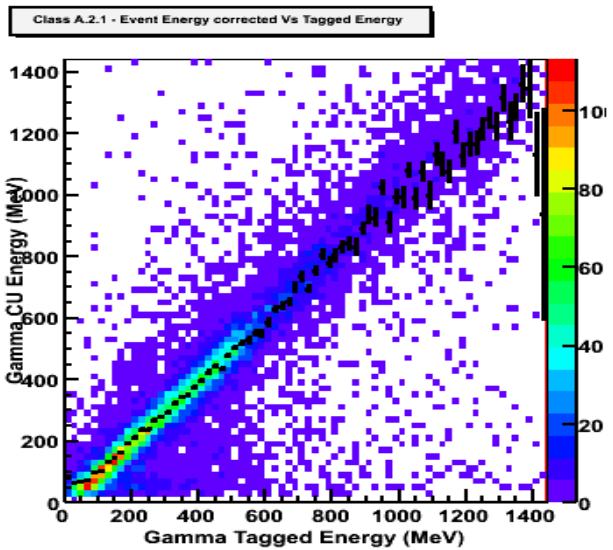
The tagger provide a direct energy calibration of the CU

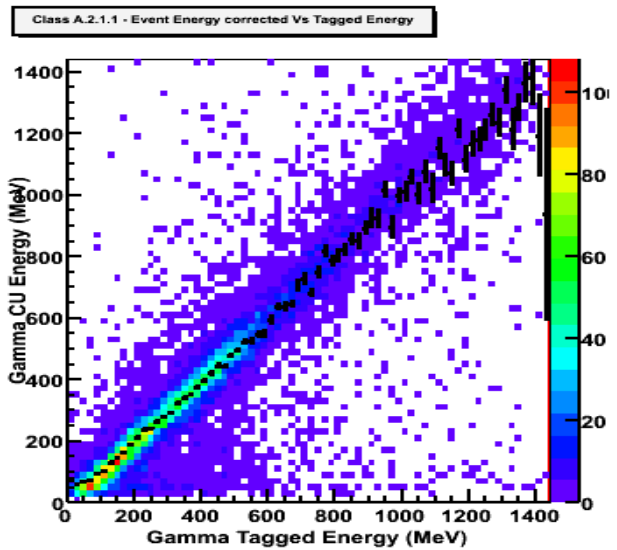




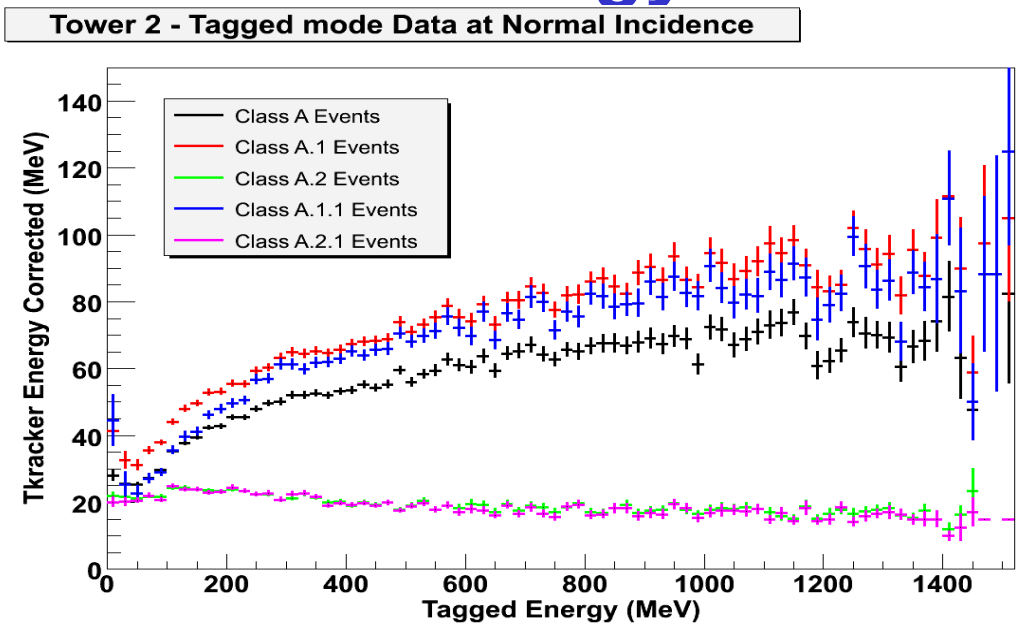


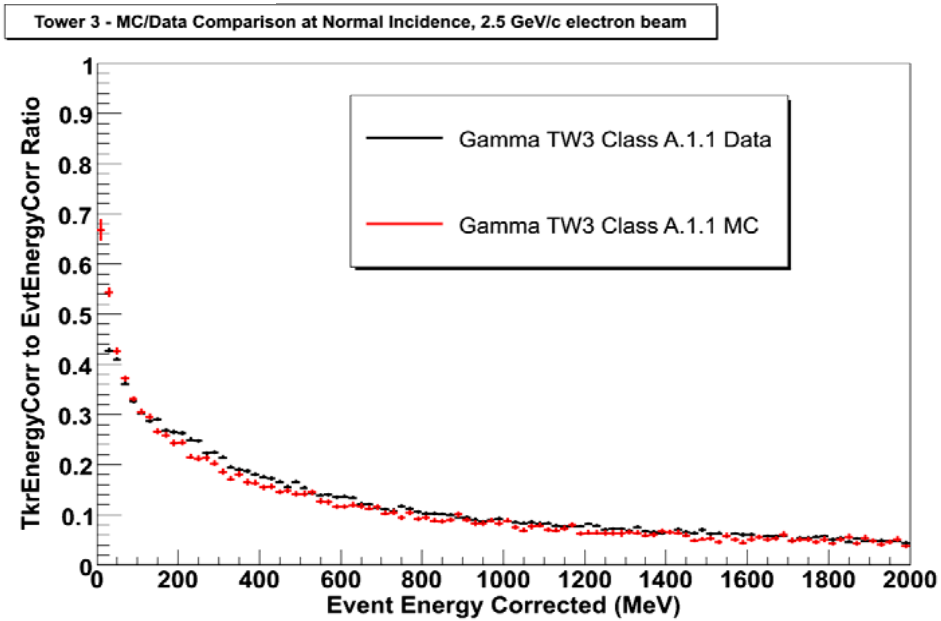




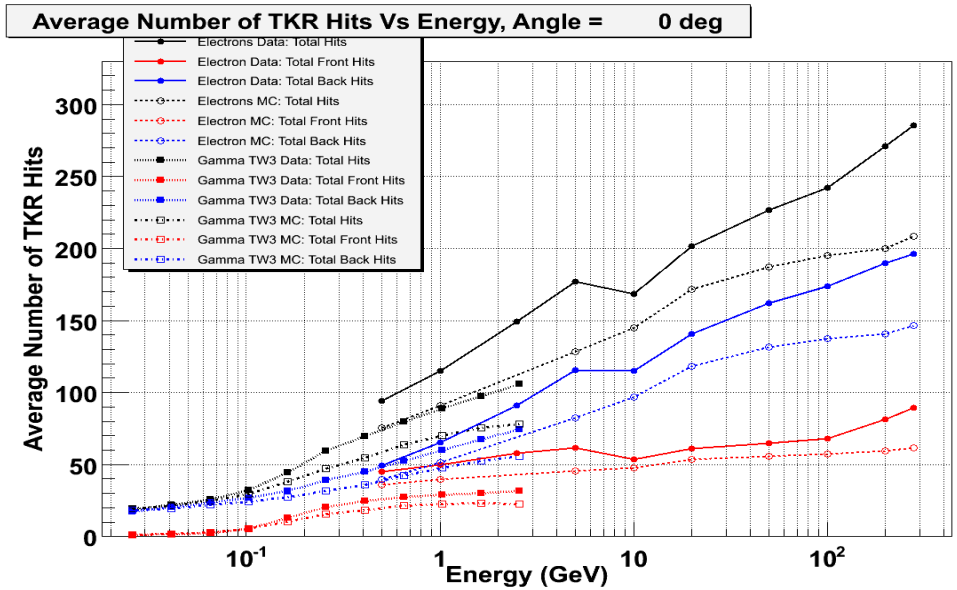


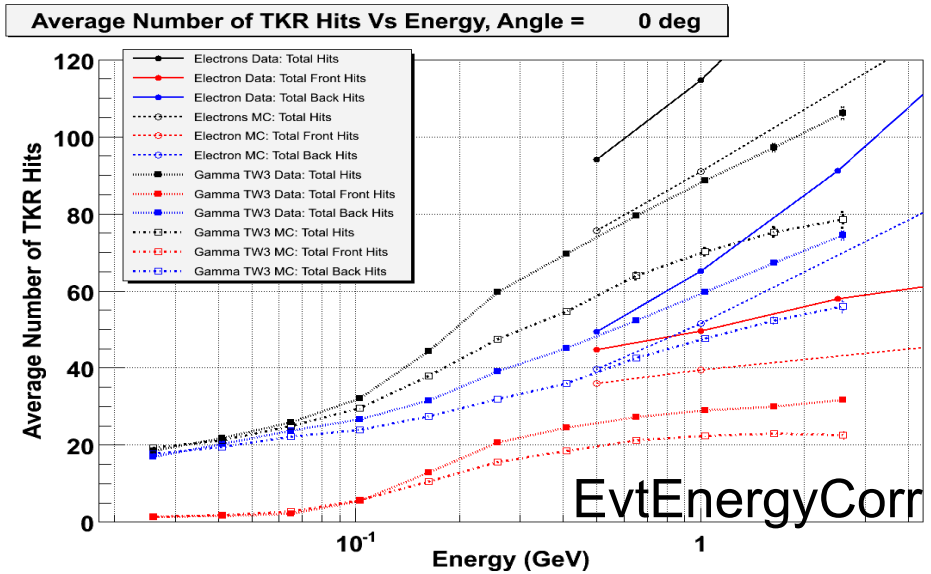
Energy calibration: Tracker

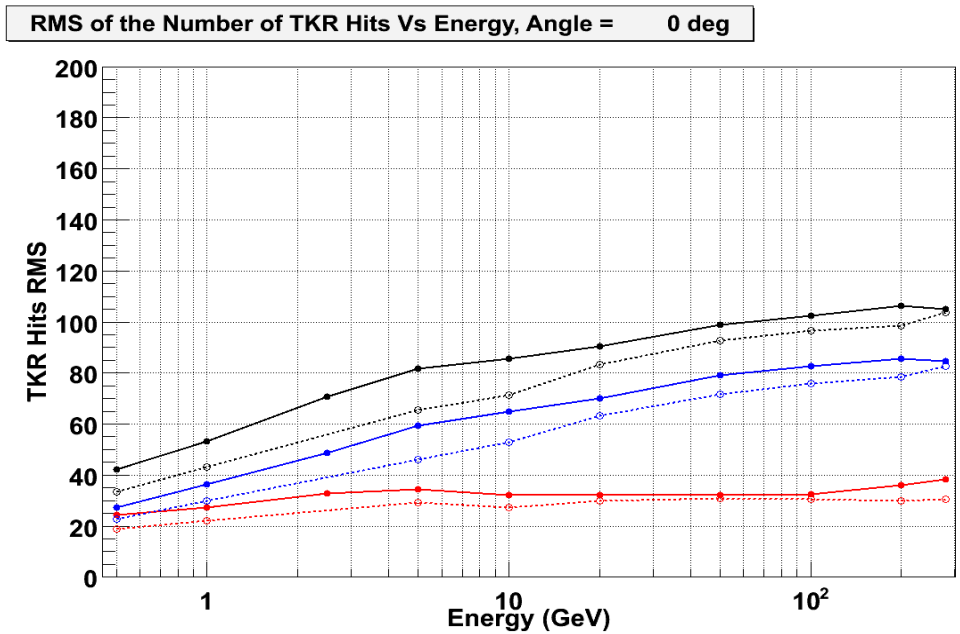


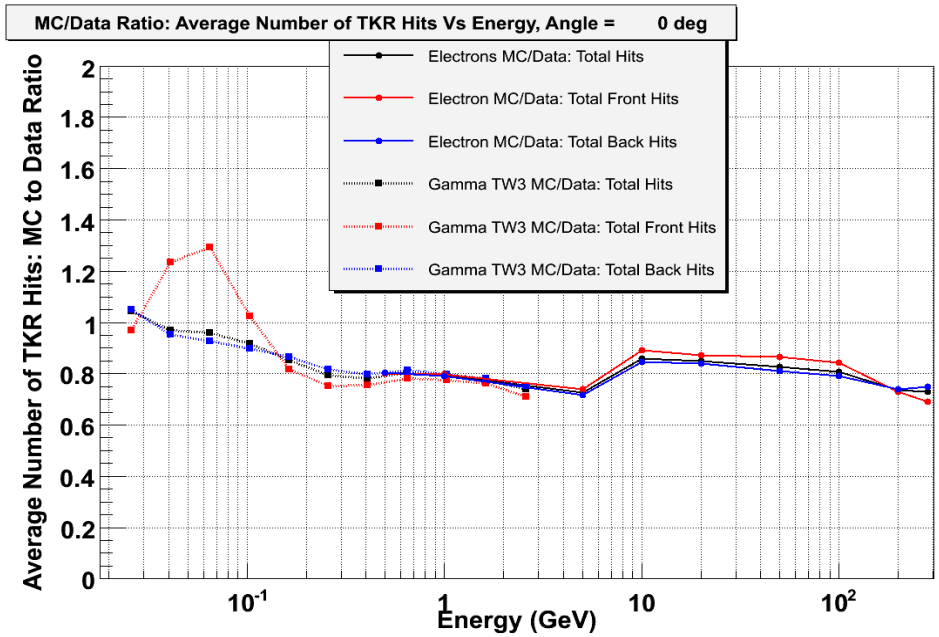


Hits summary at 0 deg

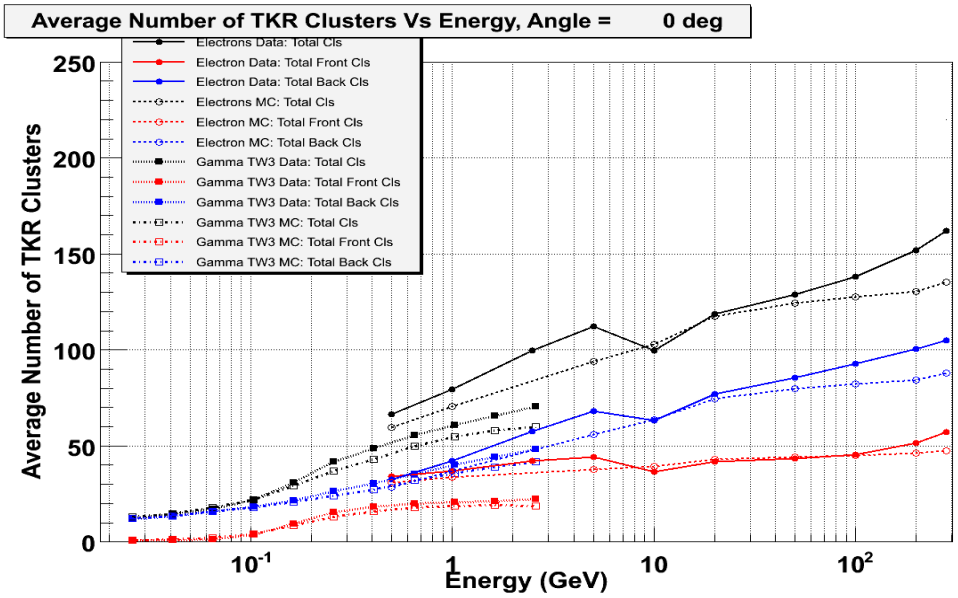


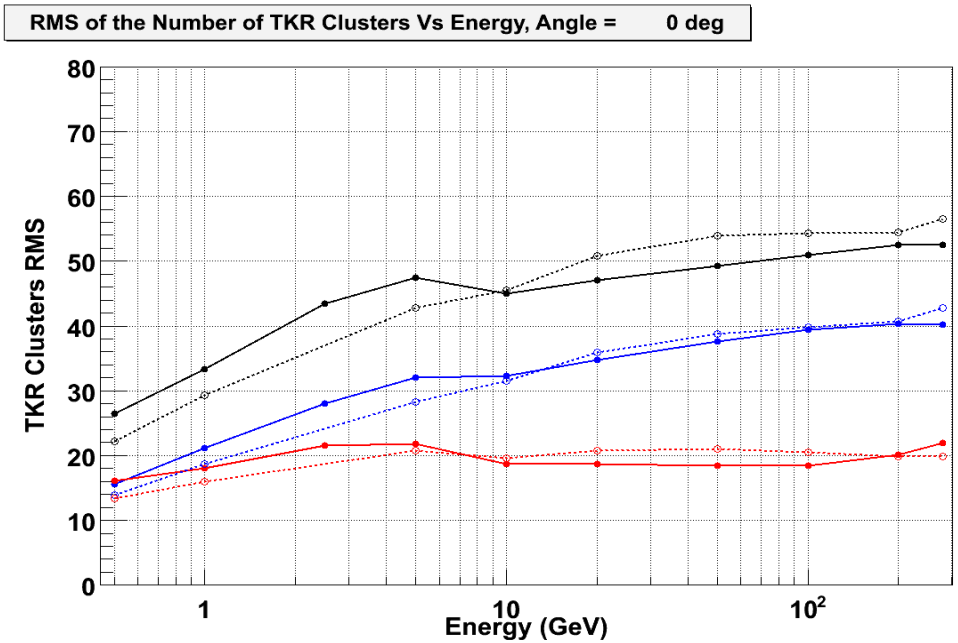


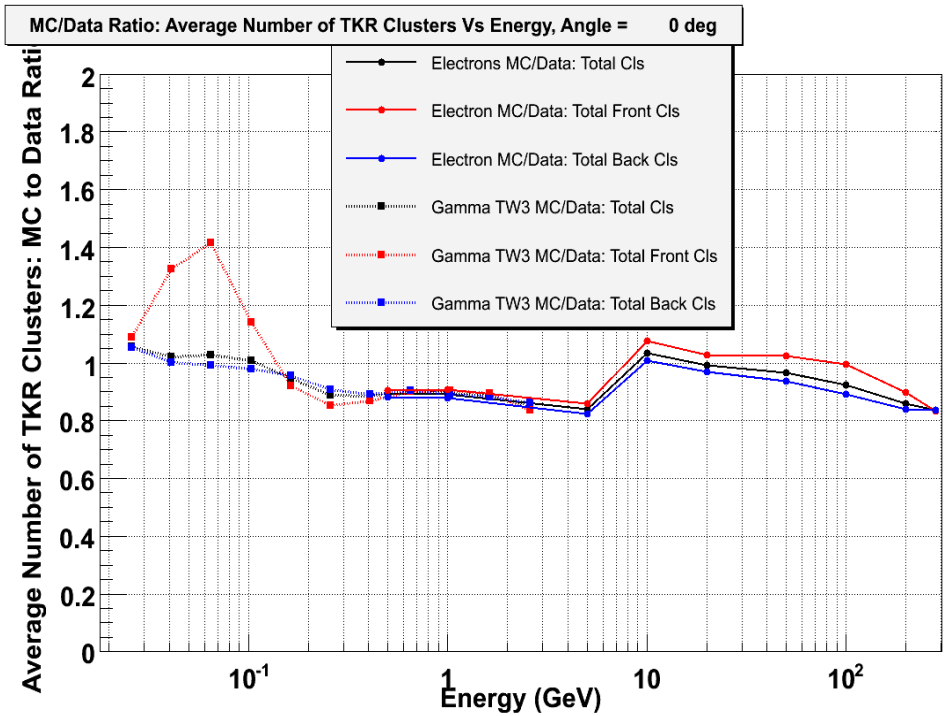




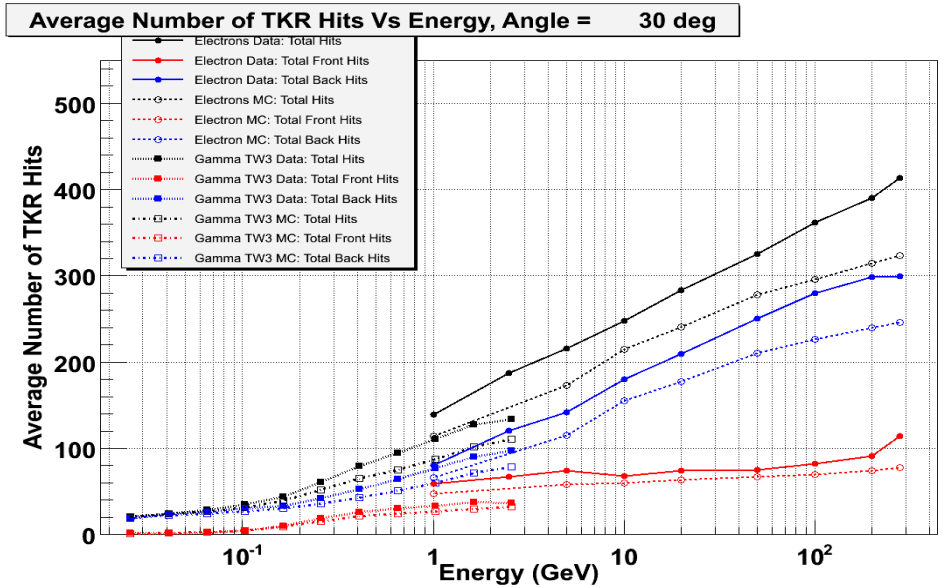
Clusters summary at 0 deg

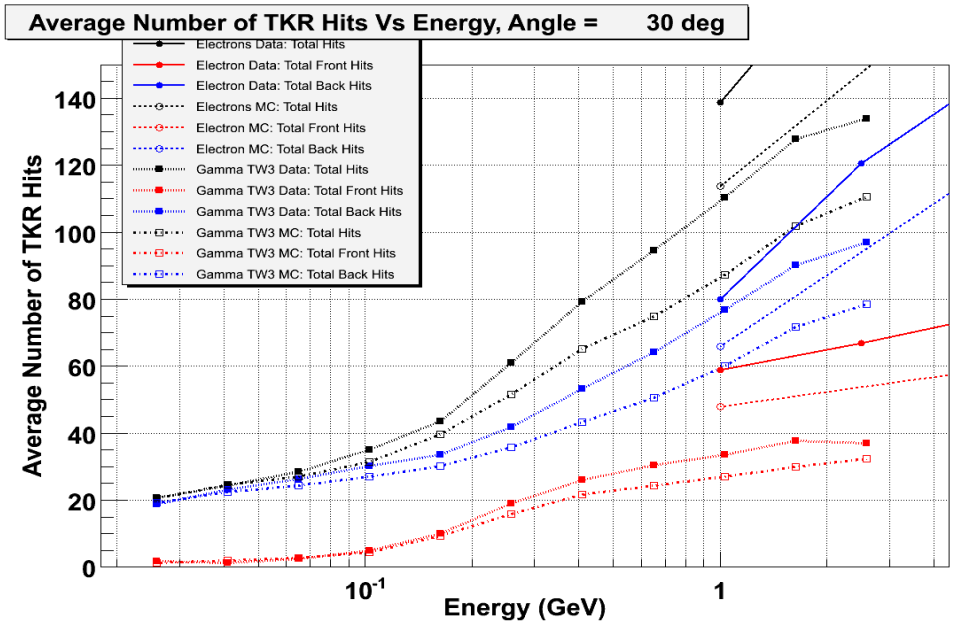


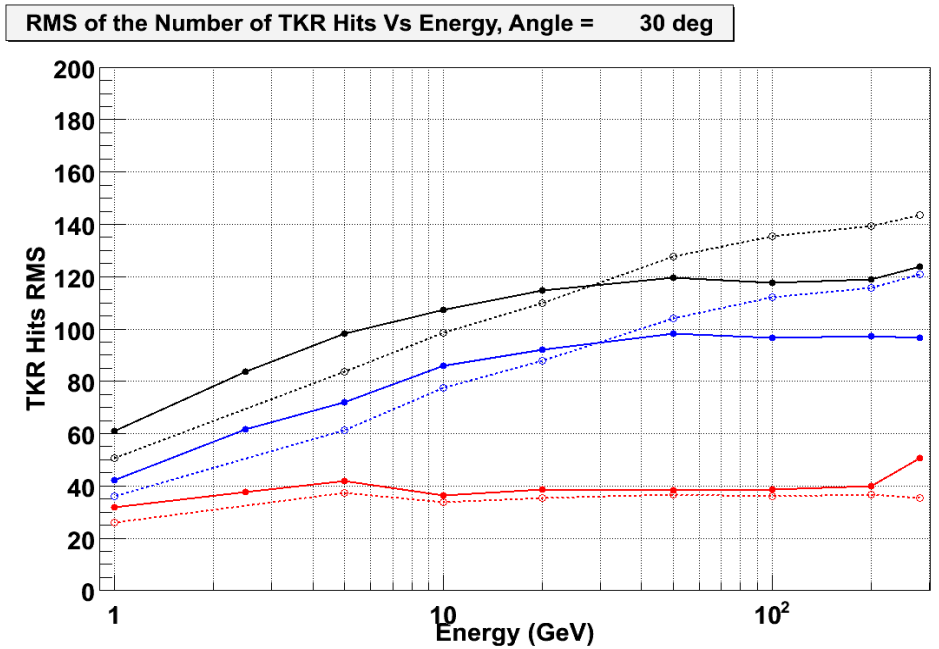


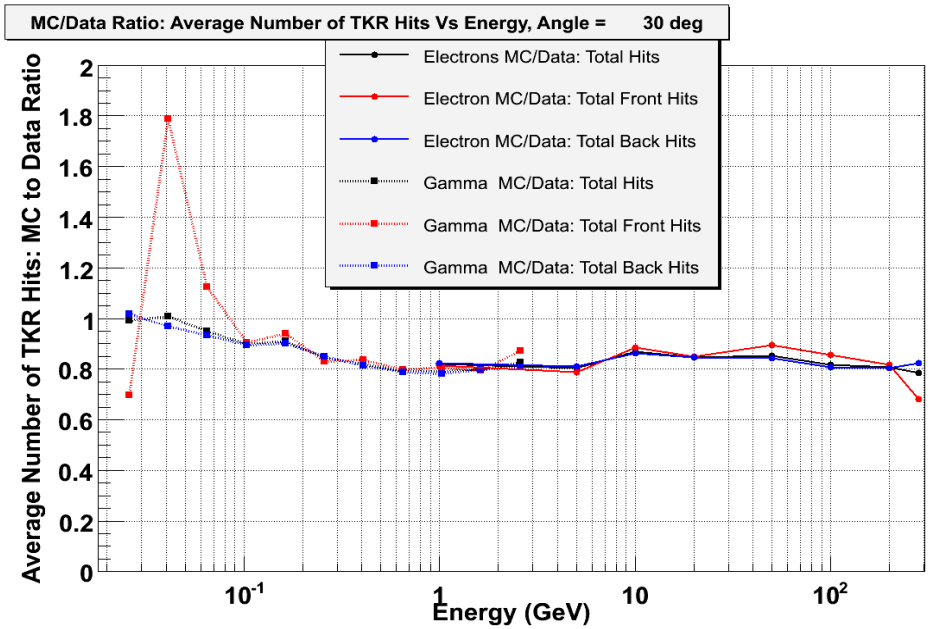


Hits summary at 30 deg

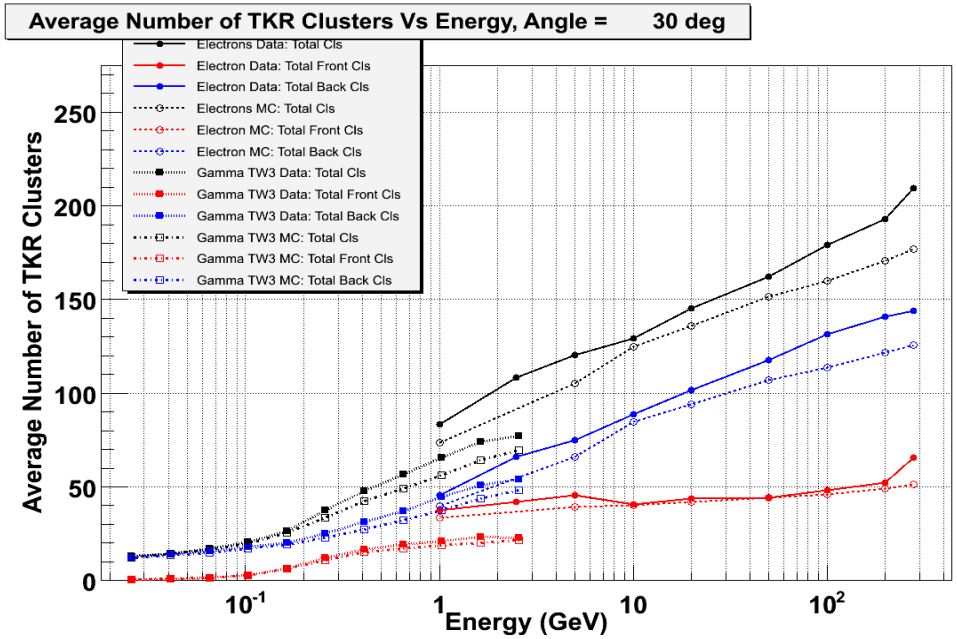


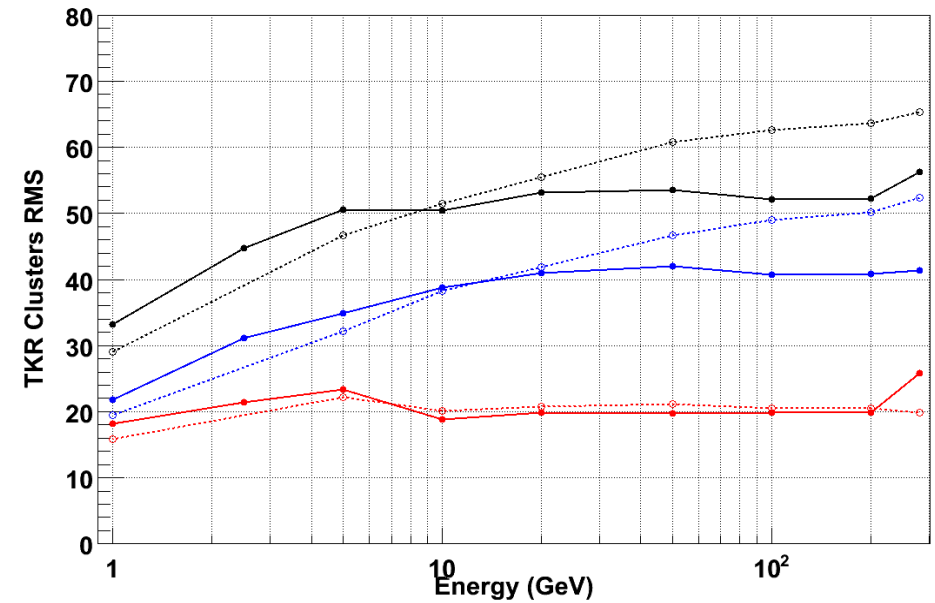


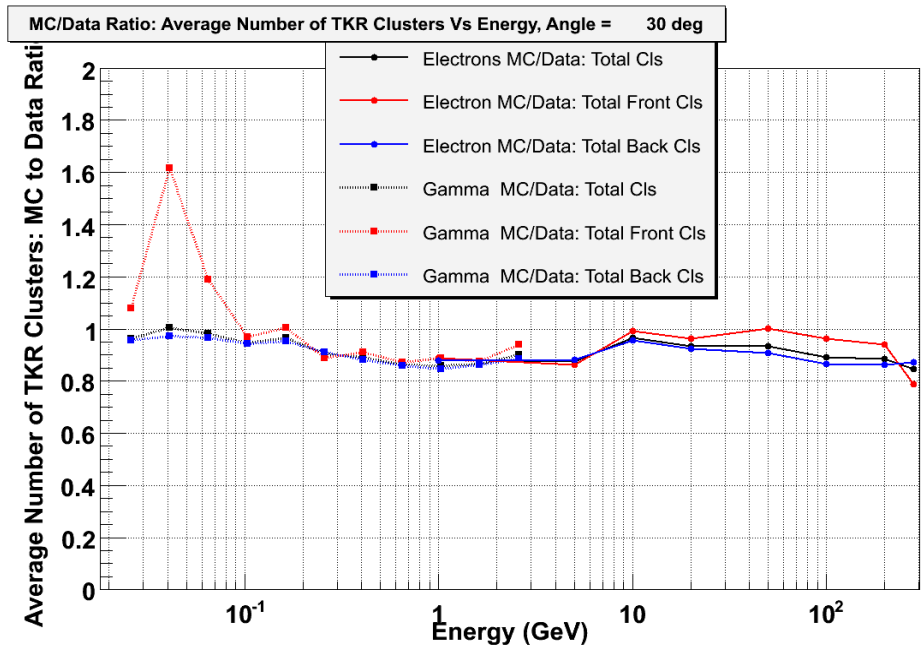




Clusters summary at 30 deg

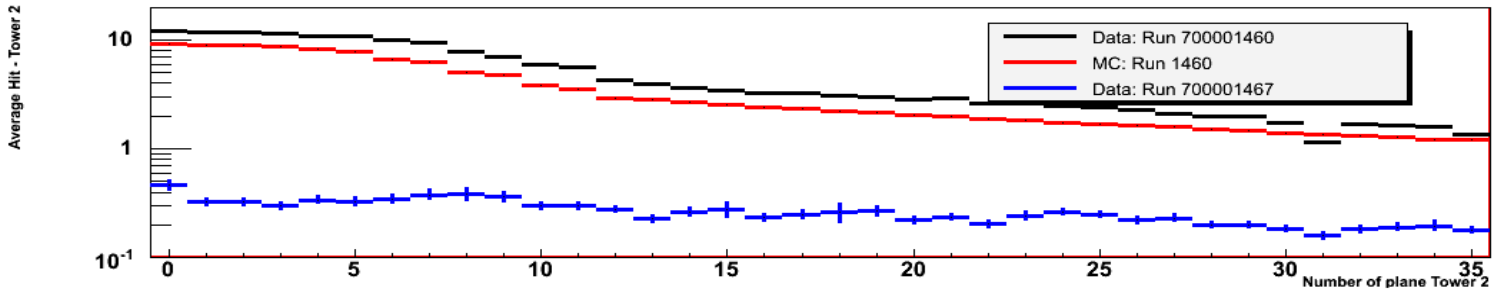


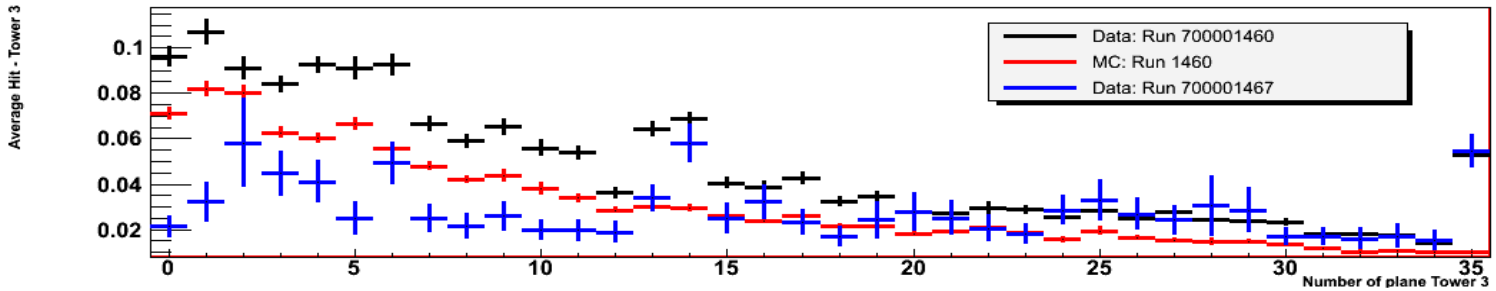


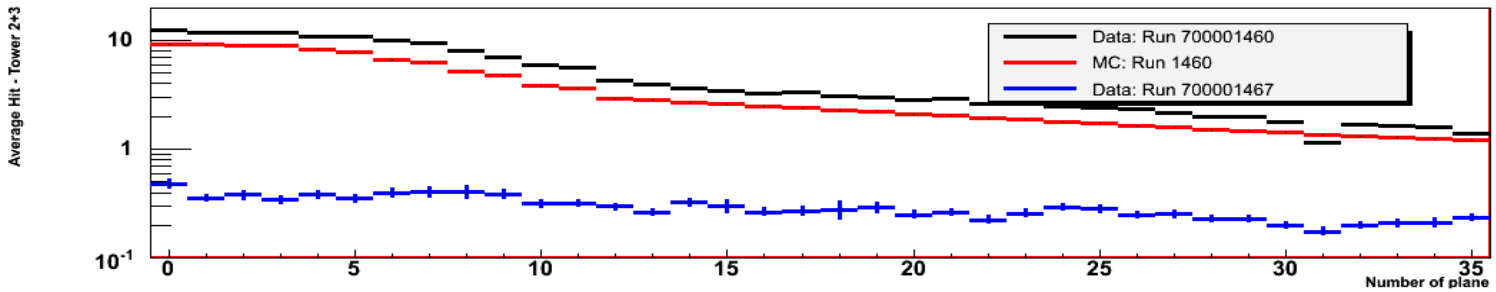


Noisy Strip studies

- The noisy strip contribution to the hit profile could be studied from run with uncorrelated trigger
- The Run 1467 (5 GeV electrons with random trigger) has been compared the Run 1460 (5 GeV electron)



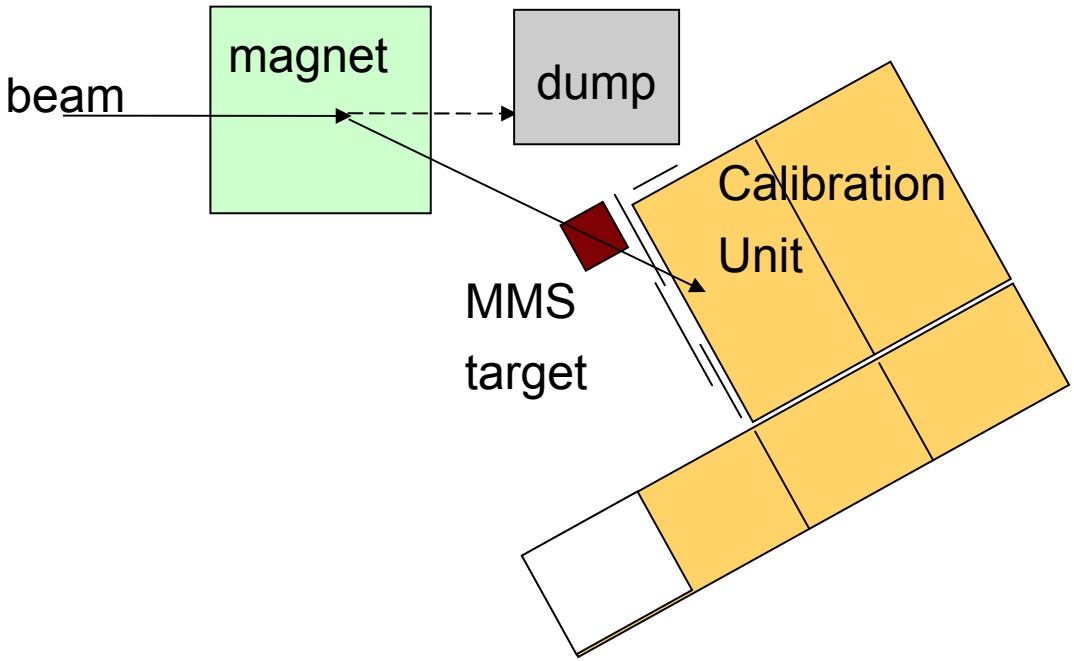




Beam on Tower 2

Halo beam studies

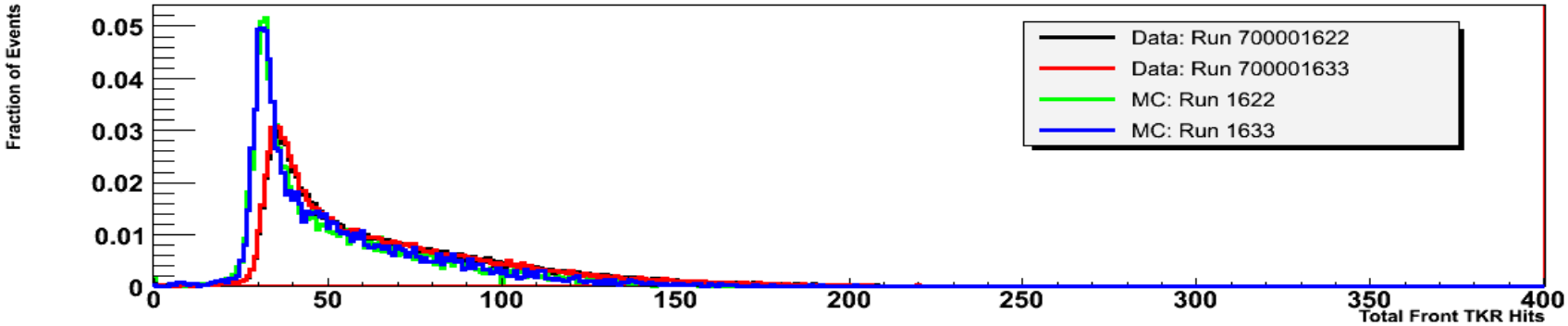
"Clean" low energy e± T9-PS test beam set-up to study the background

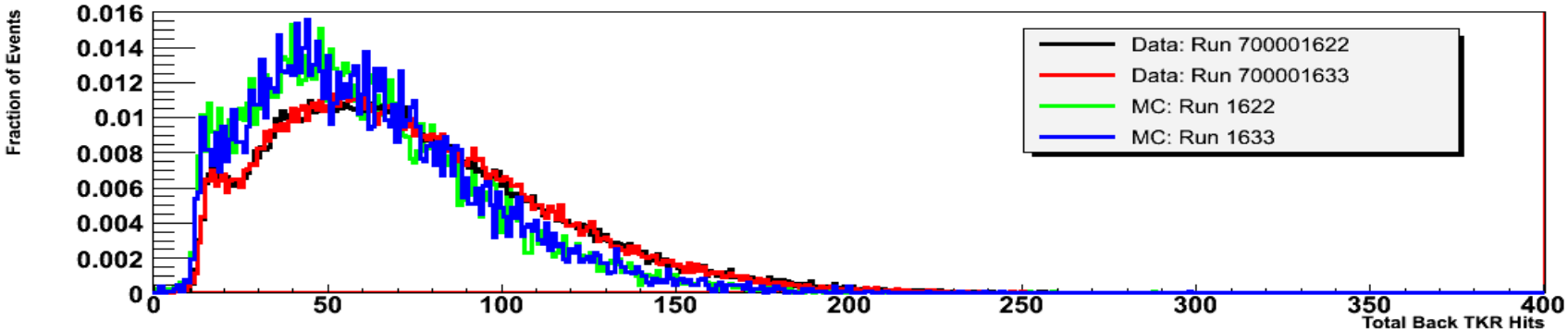


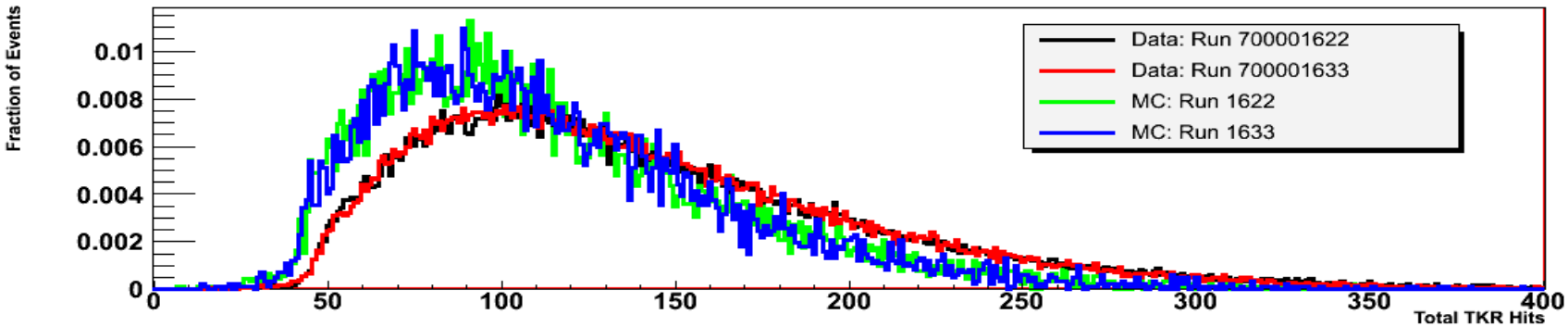
Positrons setup:

- **Magnet ON and extended dump to stop bremsstrahlung γ from e+**
- **Shoot 1M e^+ (1 GeV/c) through 4 layers MMS placed in front of ACD side top tile**
- **Also shoot 1M e^- for comparison and background subtraction**

1 GeV e± -35 deg hits distributions







Transverse cluster distribution

- The distances of the clusters in each view have been studied with respect to:
  - The first track (best track)
  - Shower axis
- Relevant distributions:
  - Cluster distance, D_i, weighted with its size, S_i,
  - The average cluster distances, $<D>$, in each event

$$< D >= \sum_{Clusters} D_i \times S_i \Big/ \sum_{Clusters} S_i$$

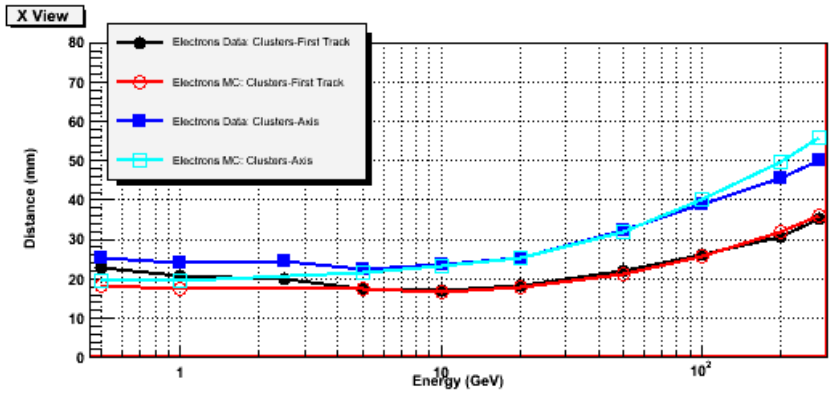
  - The maximum cluster distance, $MaxD_i$, weighted with its size, S_i, ***in*** each event

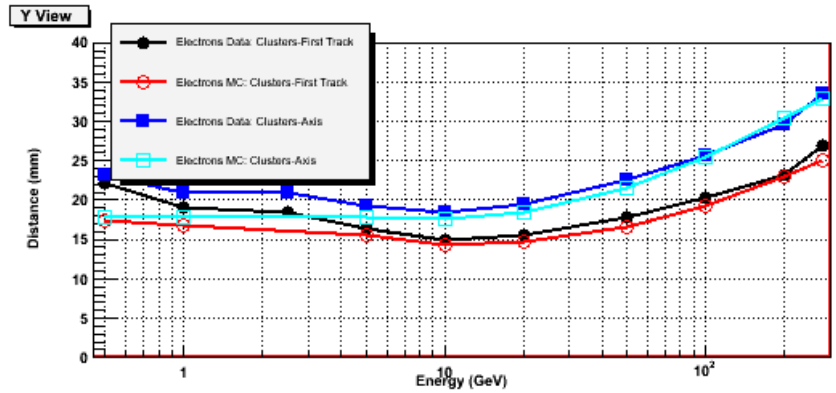
Shower axis definition

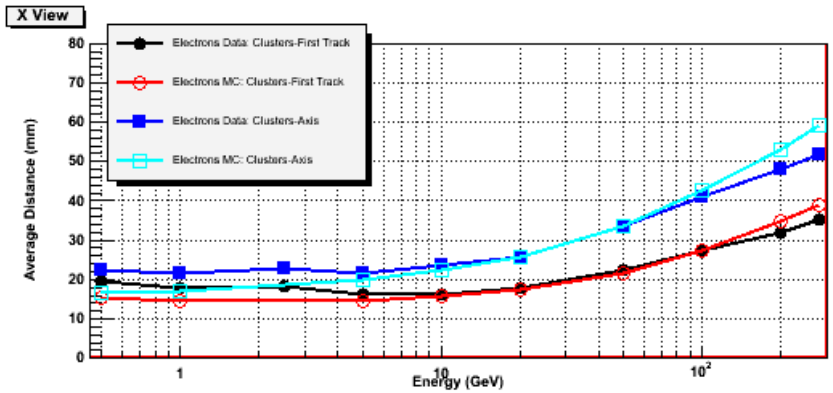
- In each view, the top Z fired plane have been identified, Z_{top}
- The top position in the X (Y) view, X_{top} (Y_{top}), is evaluated as average of the X (Y) cluster positions in the top plane in that view
- In each view, the shower axis slope is evaluated as: (in the X view)

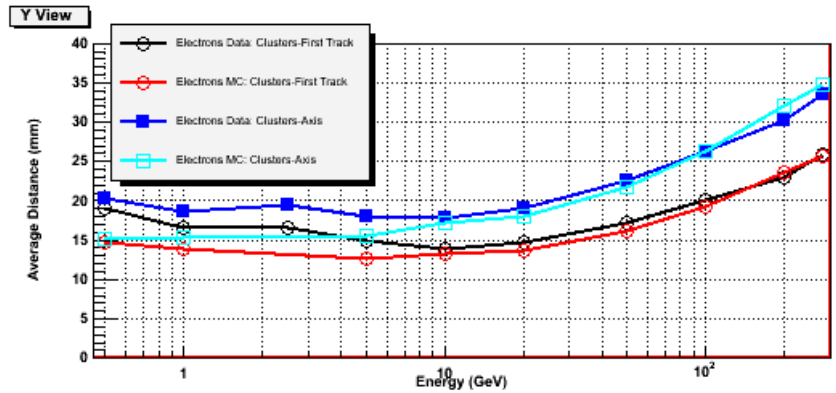
$$Slope = \sum_{Clusters} \left(X_i - X_{top}\right) / \left(Z_i - Z_{top}\right) \times S_i \Big/ \sum_{Clusters} S_i$$

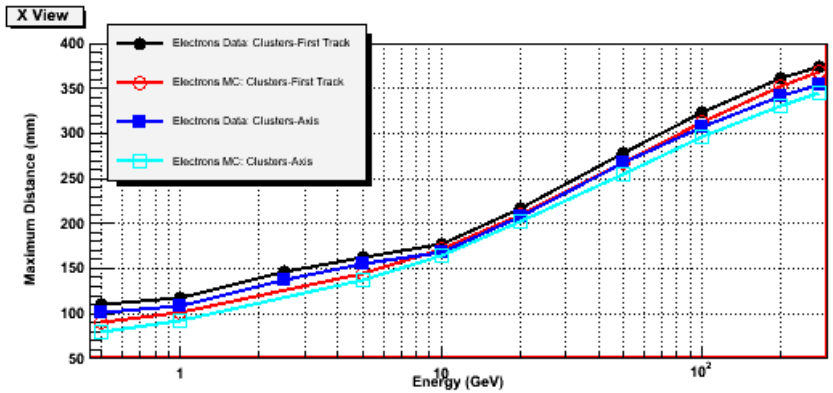
Distances summary at 0 deg

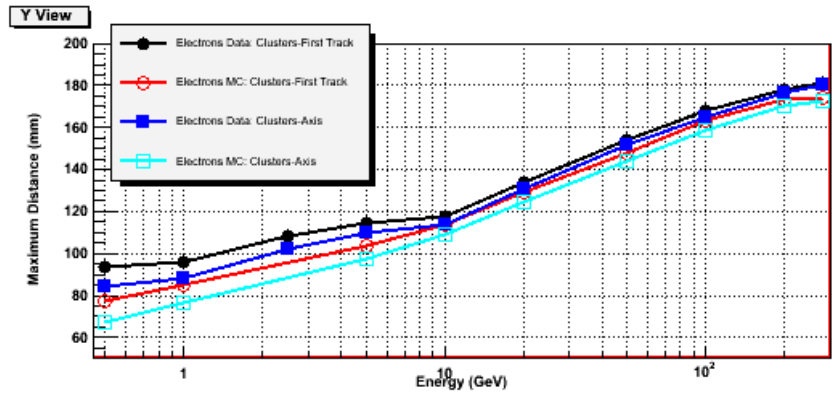




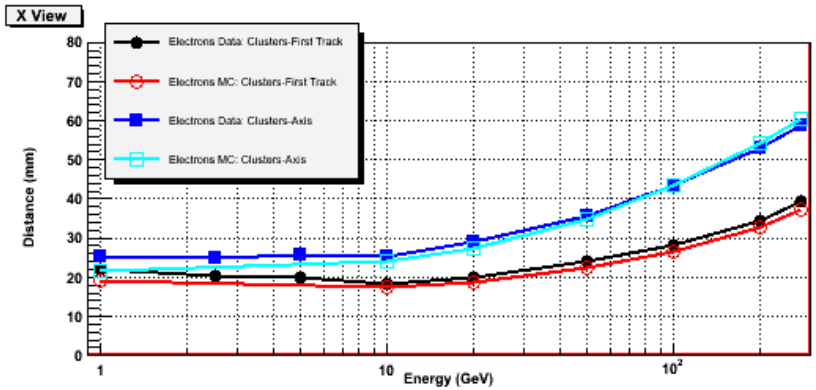


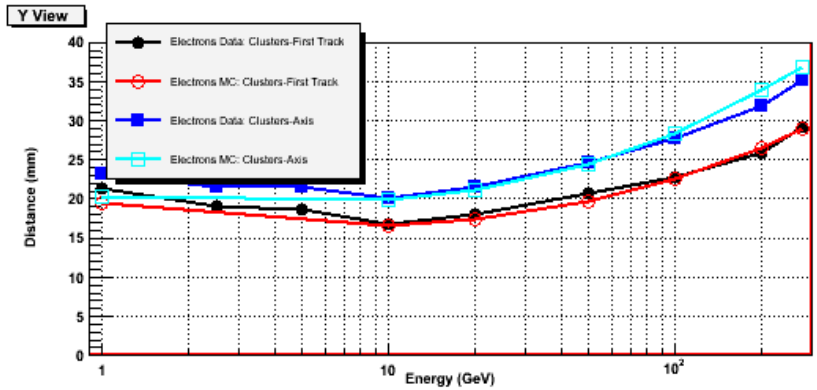


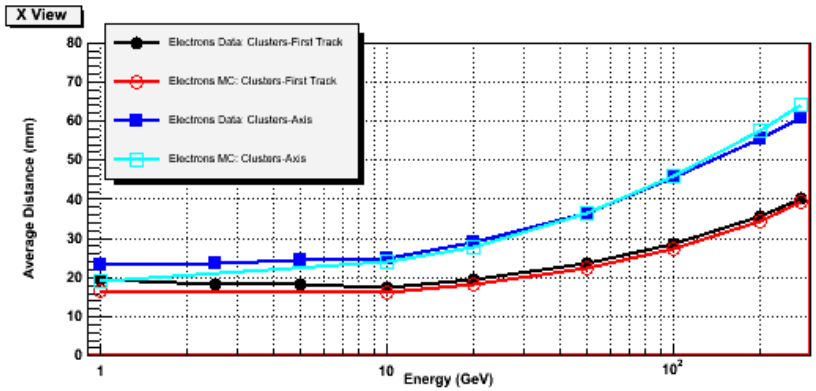


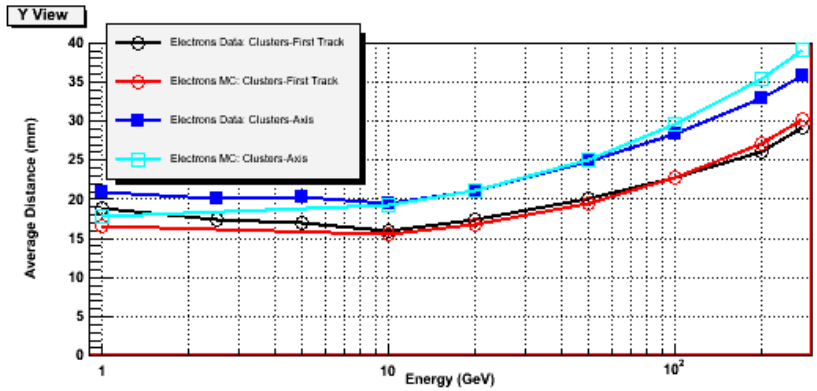


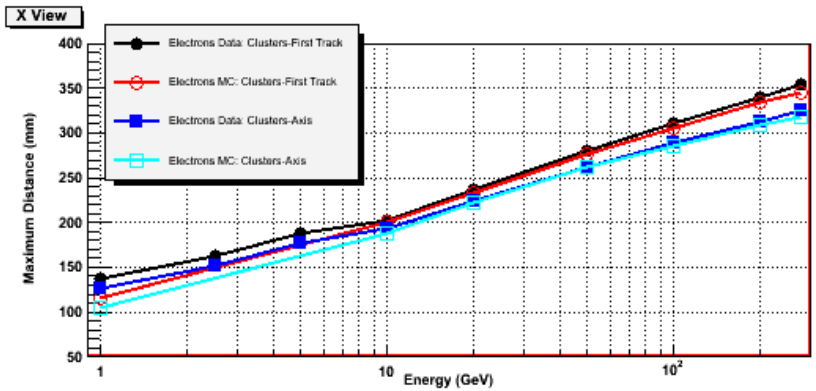
Distances summary at 30 deg

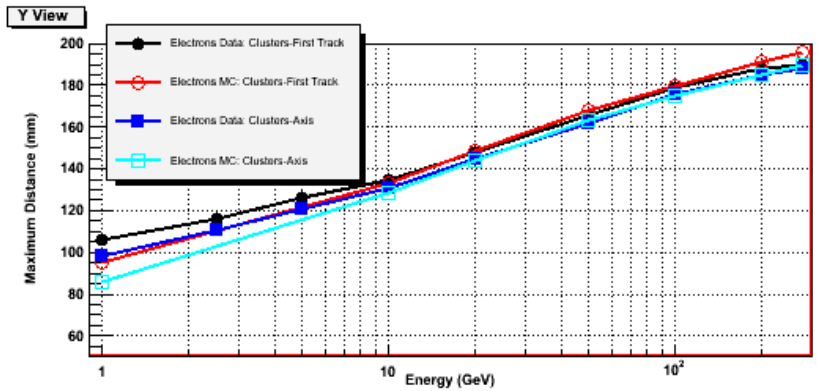




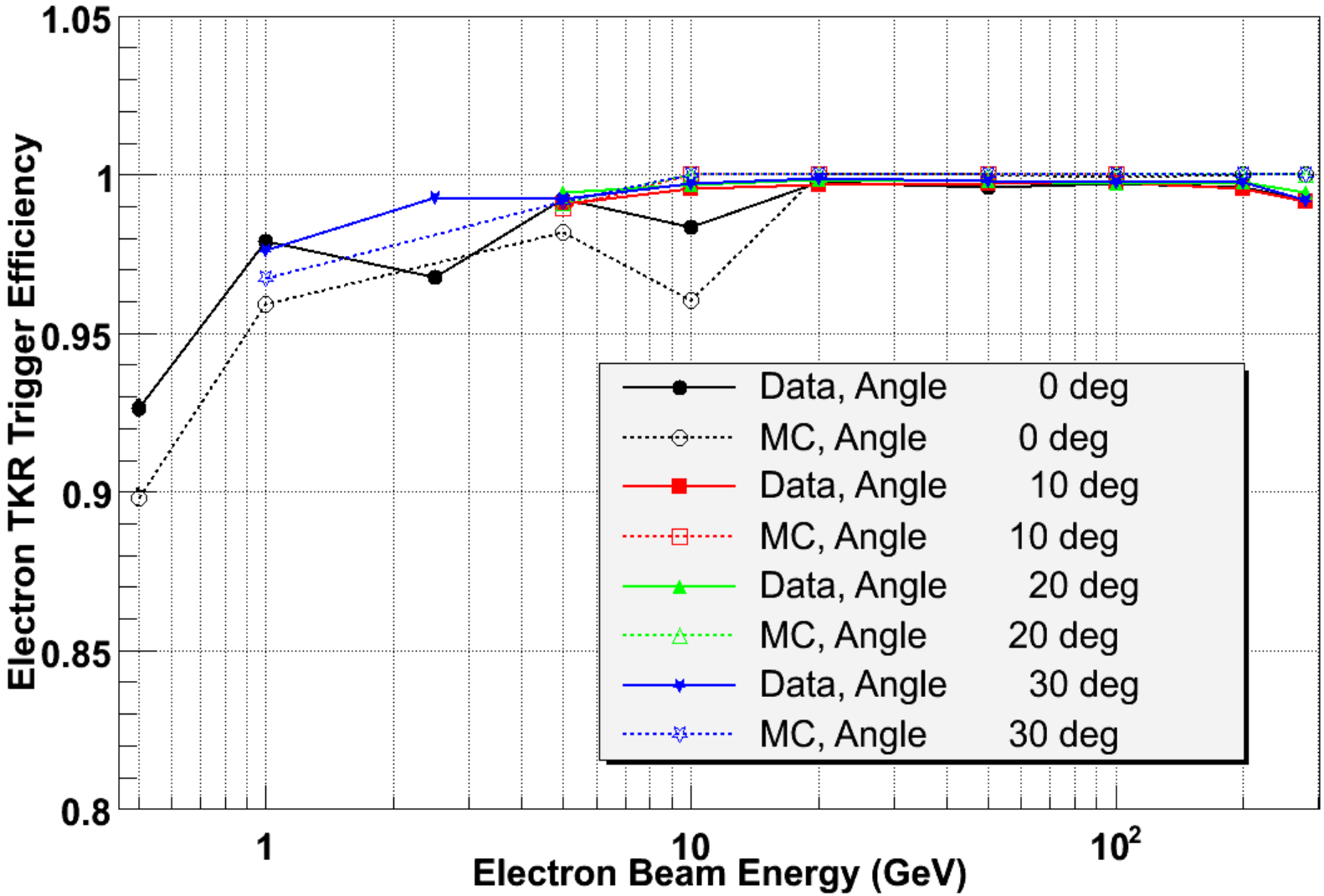








TKR Trigger Efficiency



Conclusions

- MC/Data Comparison:
  - PSF ≈ 1, data and MC are within the error bars
  - Hits ≈ 0.8 – 0.9
  - Clusters ≈ 0.9 - 1.0
  - Trigger ≈ 1
- The halo beam and the noisy strips (run with random trigger) do not support an hit excess in the real data
  - There is a hit deficit in the MC