Study of the TKR response: clusters and ToT
A comparison of beam test data with MC predictions

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Motivations

- **Investigation of the causes of the discrepancies between data and MC predictions**
  - Data quality
    - noise
    - calibrations
    - beam
    - ?
  - MC simulation
    - physical processes
    - detector description
    - beam description
    - ?

Data samples

- **6 GeV/c protons:**
  - ❖ θ=0° x=561mm, y=13mm, z=0mm
    - ✓ run 1423 (old and new calibrations)
    - ✓ MC runs 156-181 (Bertini hadronic cascade model)
- **10 GeV/c protons:**
  - ❖ θ=0° x=561mm, y=13mm, z=0mm
    - ✓ run 1419 (only old calibrations available)
    - ✓ MC run 155
- **1 GeV/c electrons:**
  - ❖ θ=0° x=201mm y=40mm z=-47mm
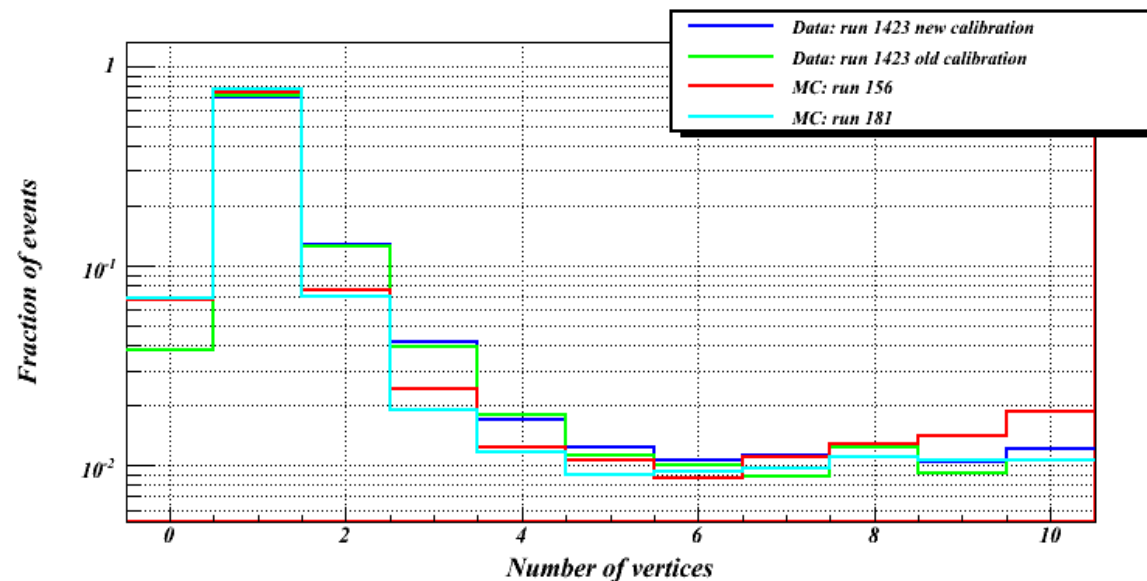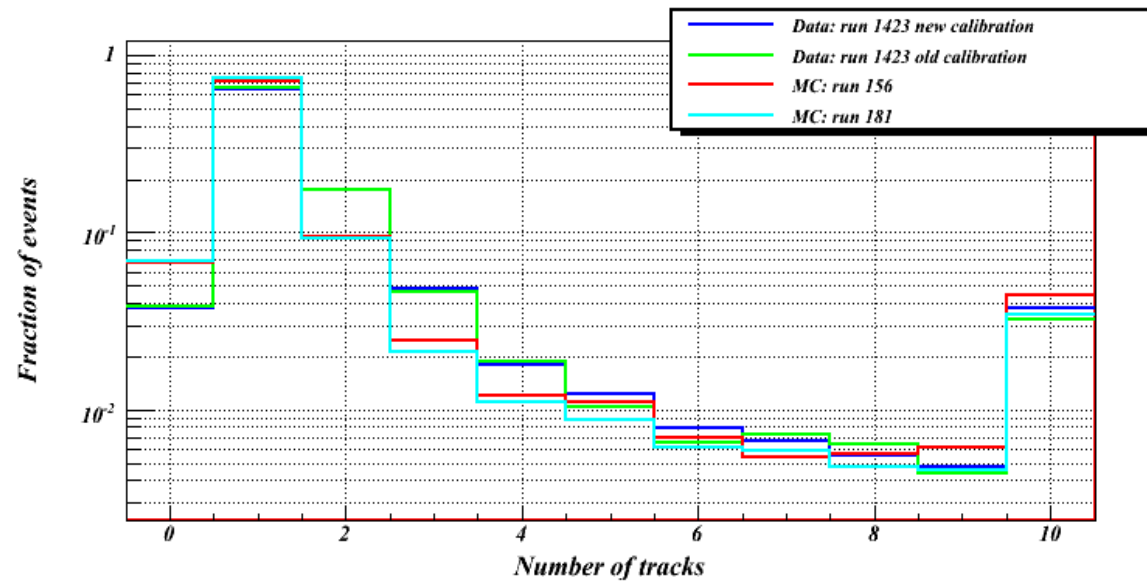   - ✓ run 1259 (new calibrations)
    - ✓ MC run 71

Data analysis

- **Data from MERIT and RECON n-tuples**
  - All events & single track events
  - Study of tracks and vertices
  - Study of clusters:
    - number of clusters
    - cluster sizes
    - distance of clusters from the shower axis (see Nicola Mazziotta's presentation)
  - Study of ToTs
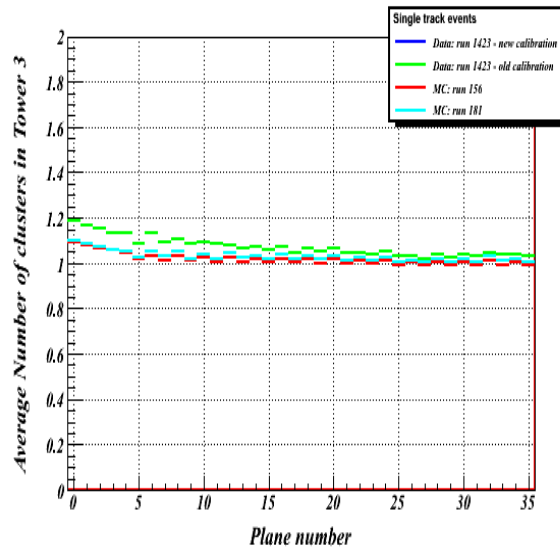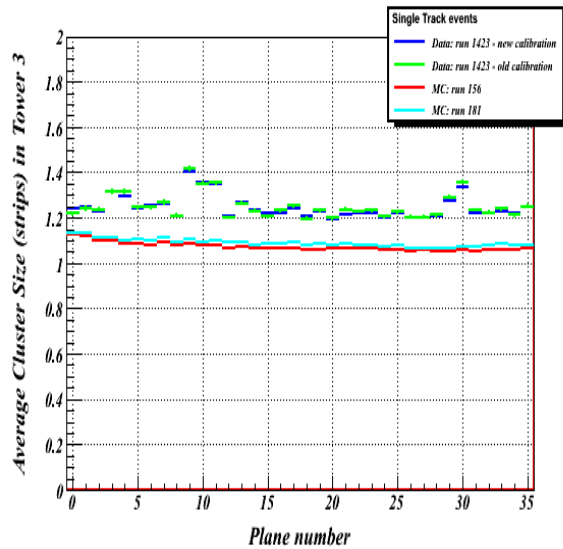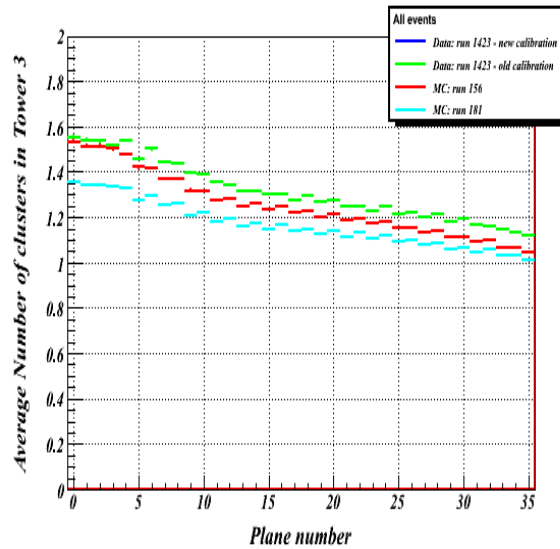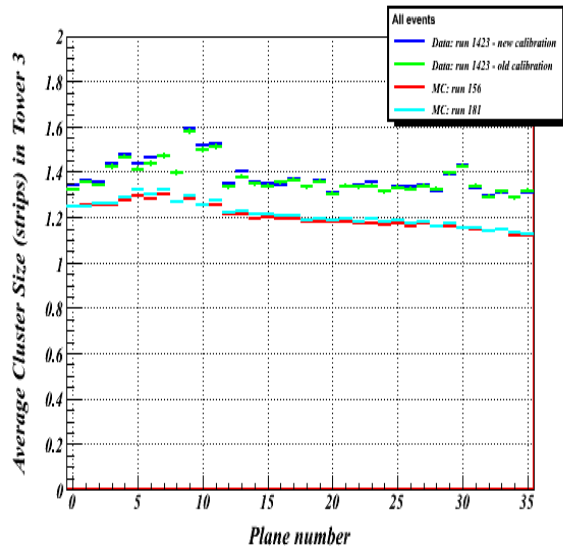   - ToT distributions in the SSD layers

6 GeV/c protons

Tracks & vertices

- *More events without tracks in the MC!*

- *More events with multiple tracks in data*

- *ToT calibrations are not relevant for tracking*

- *No significant differences between the two MC models*
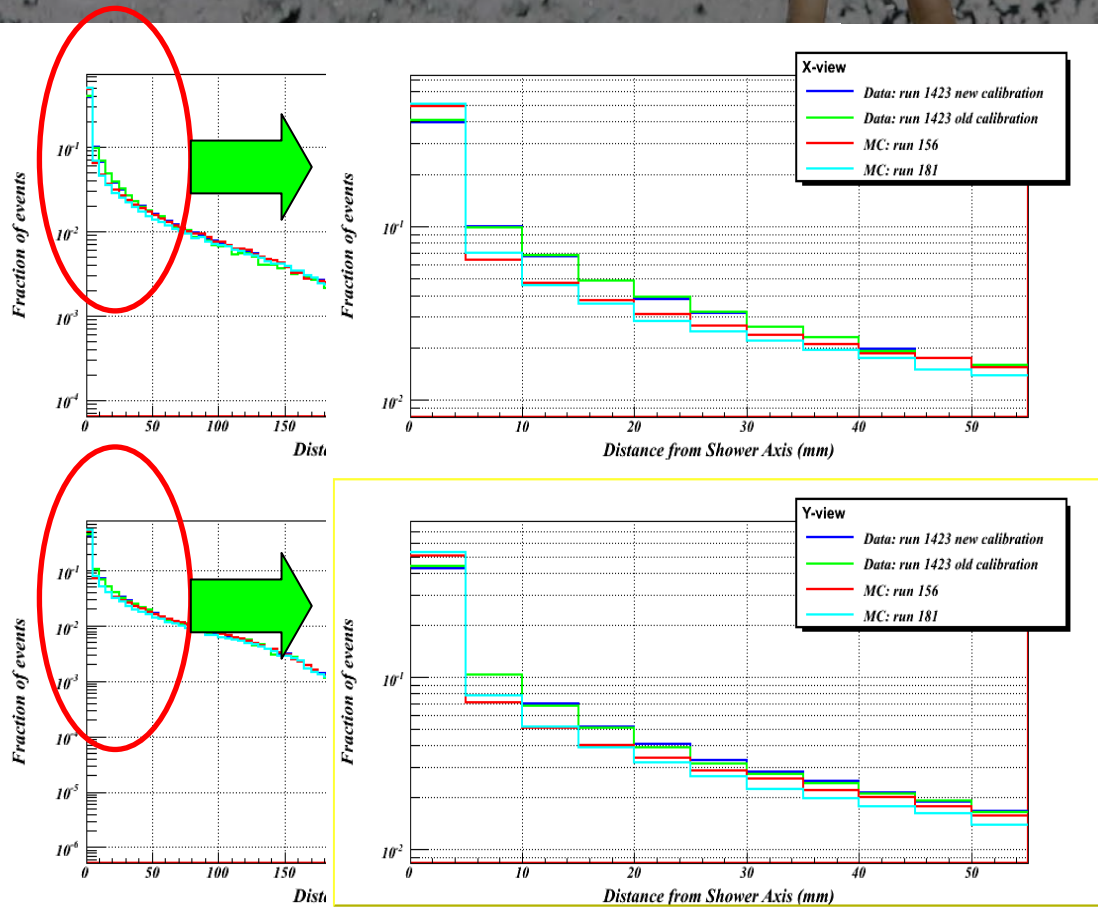
Number and size of clusters

Data:

- cluster sizes and number of clusters do not depend on ToT calibrations

- fluctuations in cluster sizes through the tower

MC:

- less clusters

- smaller cluster sizes

- less clusters in the Bertini MC when no cuts are imposed on the number of tracks

Cluster positions with respect to the shower axis

- Exponential tail of the cluster distance distribution → *negligible number of noisy strips*

- In MC there is a larger fraction of clusters closer to the shower axis

- *No relevant changes with the Bertini hadronic cascade models*

X-view
- Data: run 1423 new calibration
- Data: run 1423 old calibration
- MC: run 156
- MC: run 181

Y-view
- Data: run 1423 new calibration
- Data: run 1423 old calibration
- MC: run 156
- MC: run 181

Maximum cluster distance with respect to the shower axis

X-view
- Data: run 1423 new calibration
- Data: run 1423 old calibration
- MC: run 156
- MC: run 181

Y-view
- Data: run 1423 new calibration
- Data: run 1423 old calibration
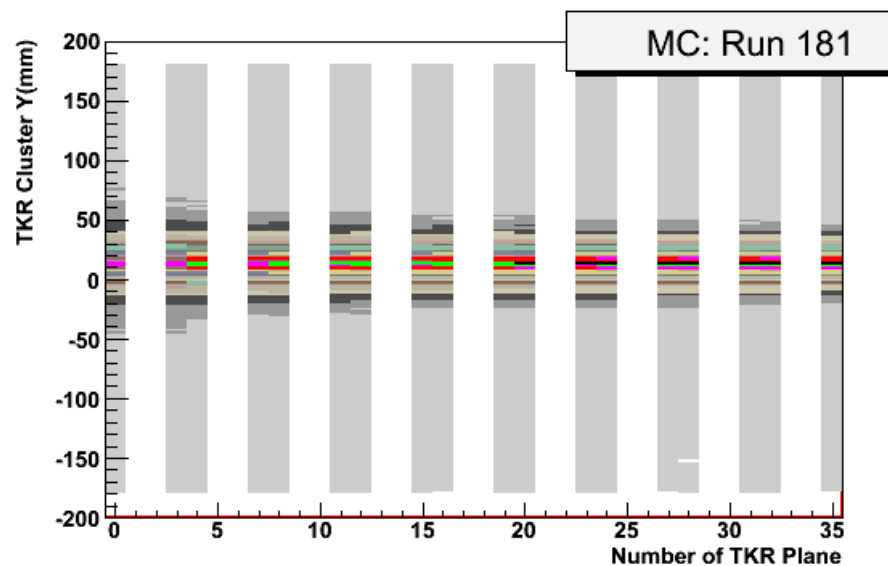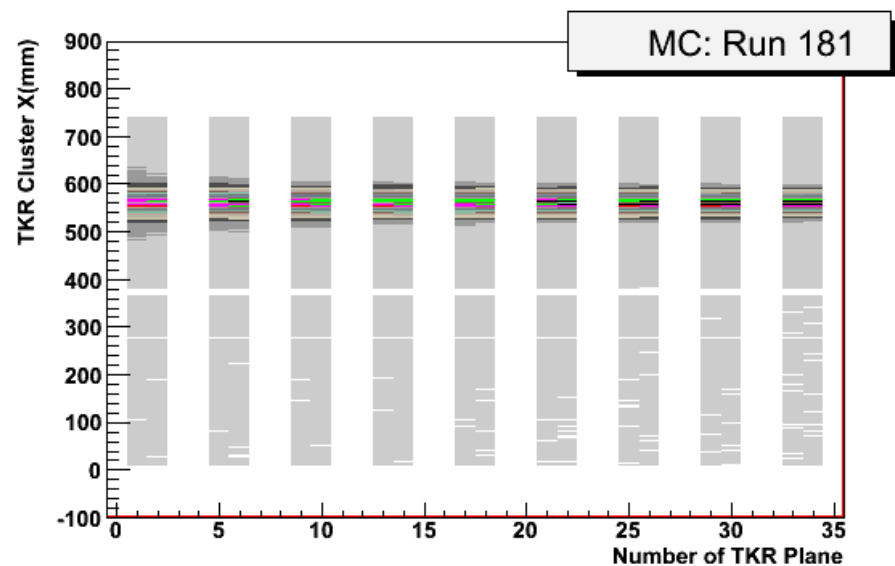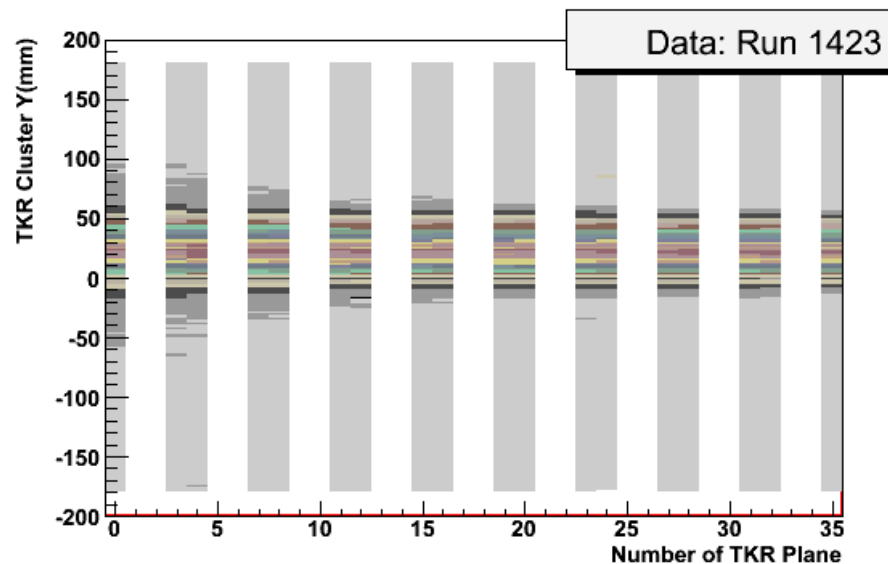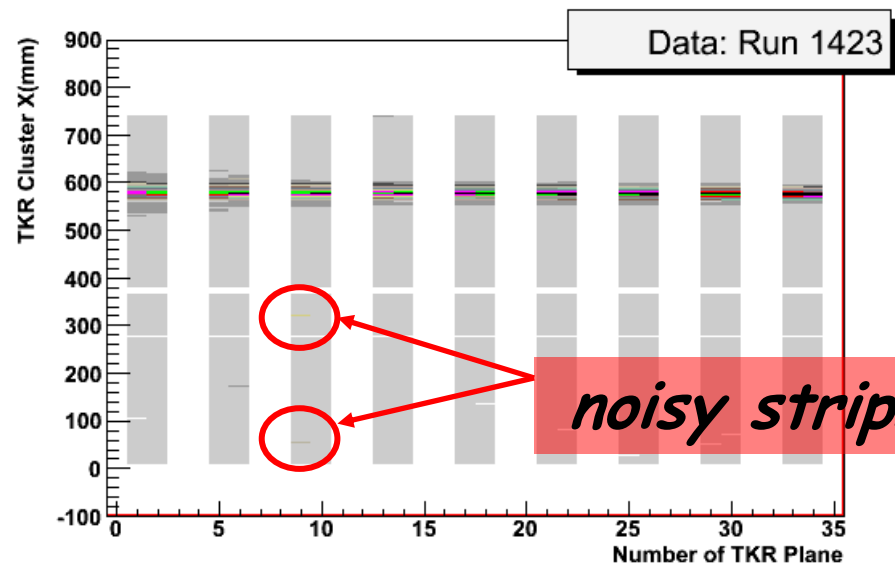- MC: run 156
- MC: run 181

- Again we learn that in data we find more clusters far from the shower axis

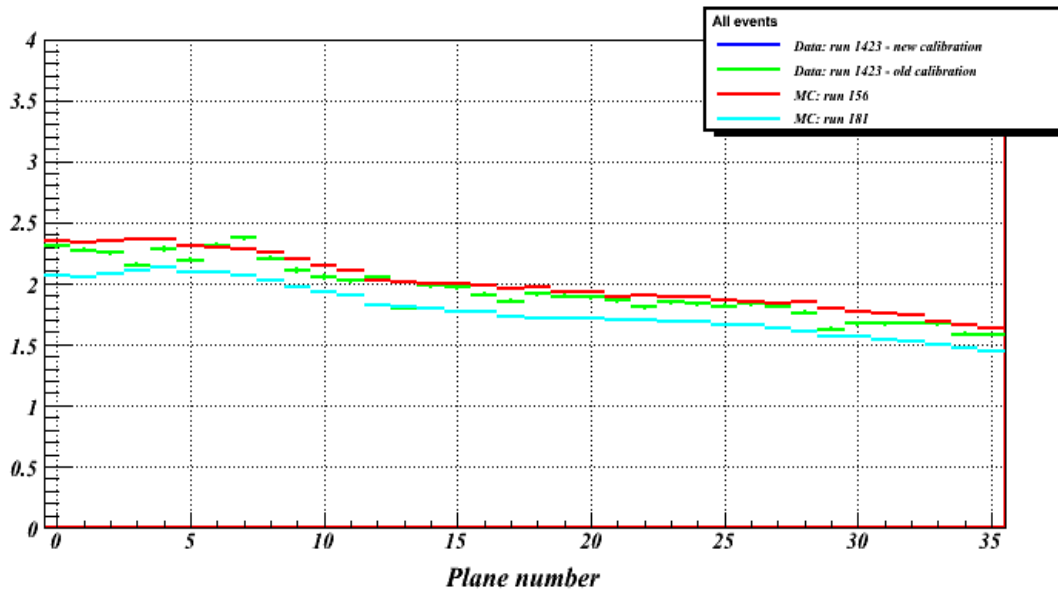**Where do these two peaks come from?**
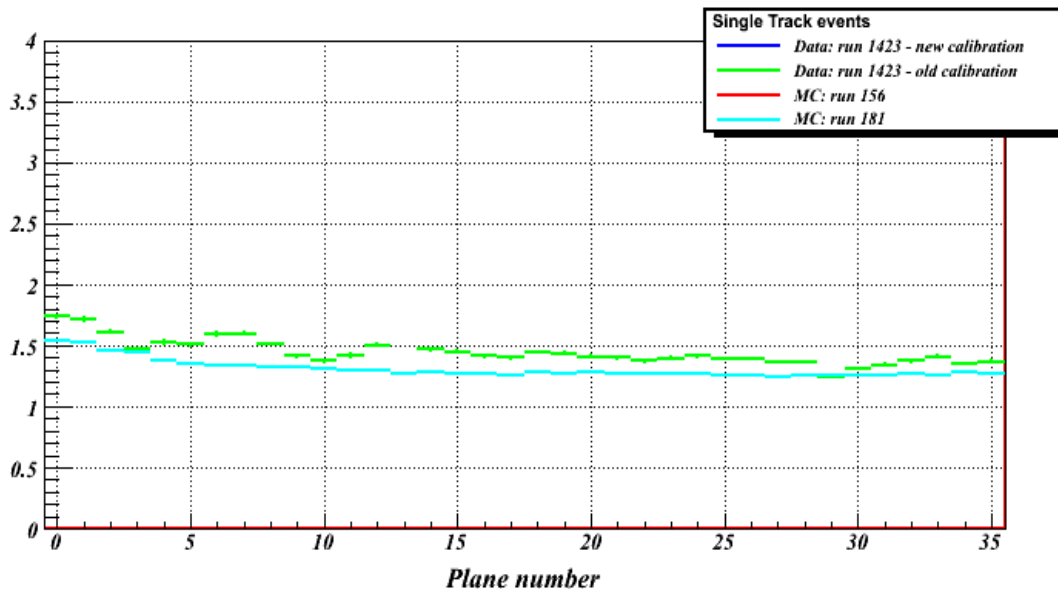
Just noisy strips in TWR 2!
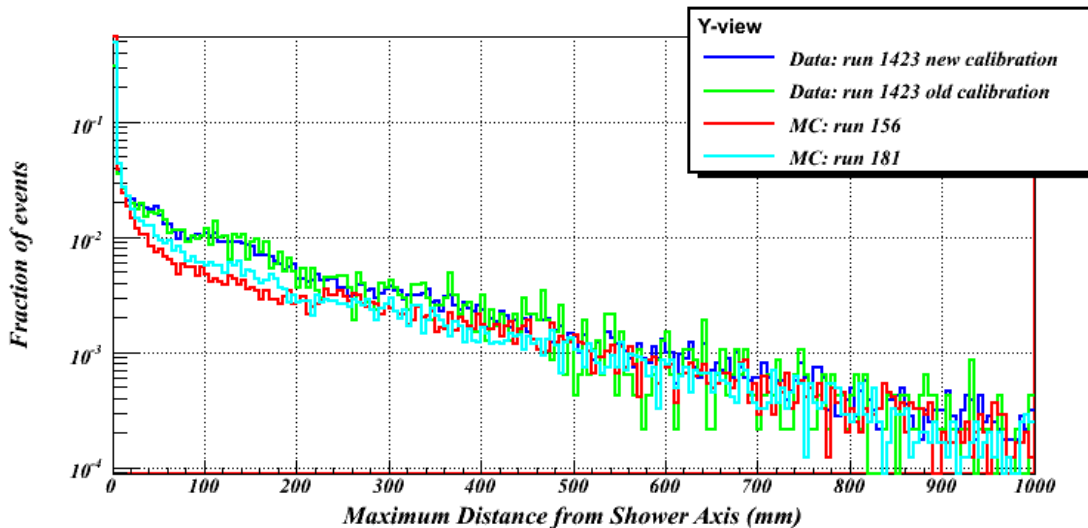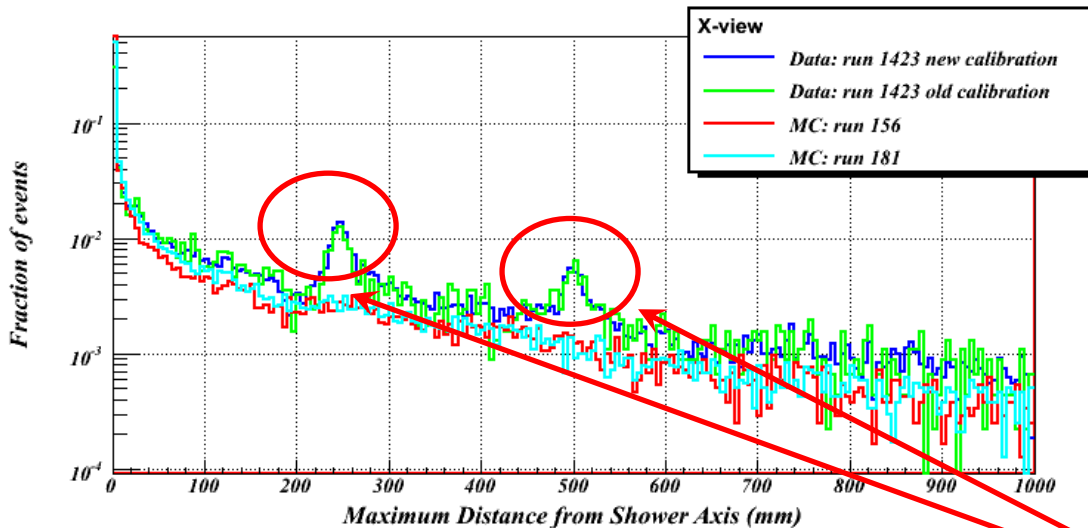
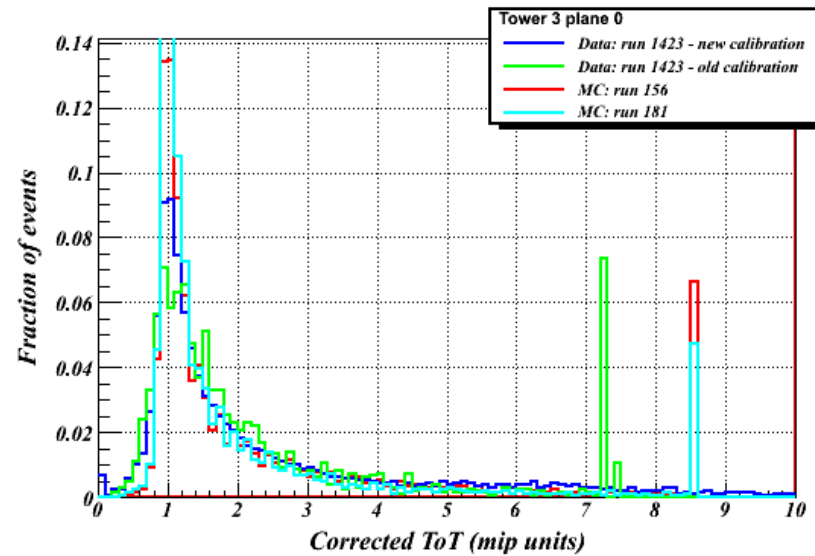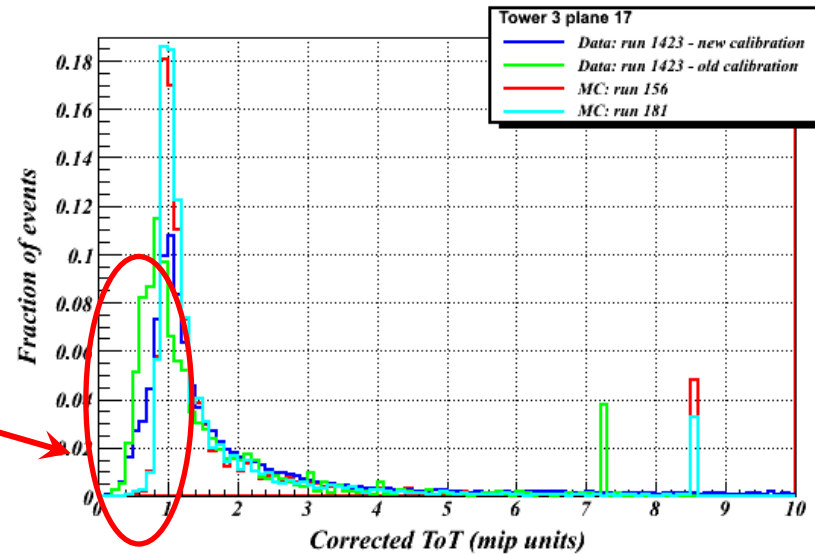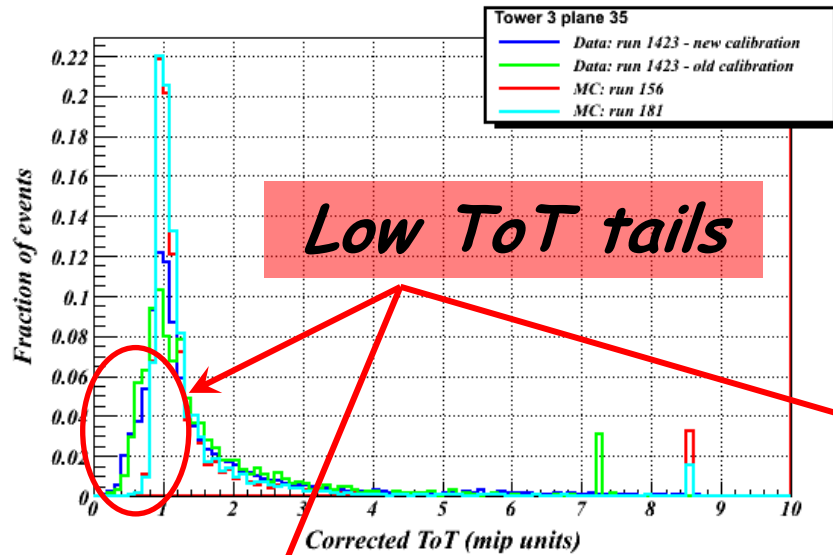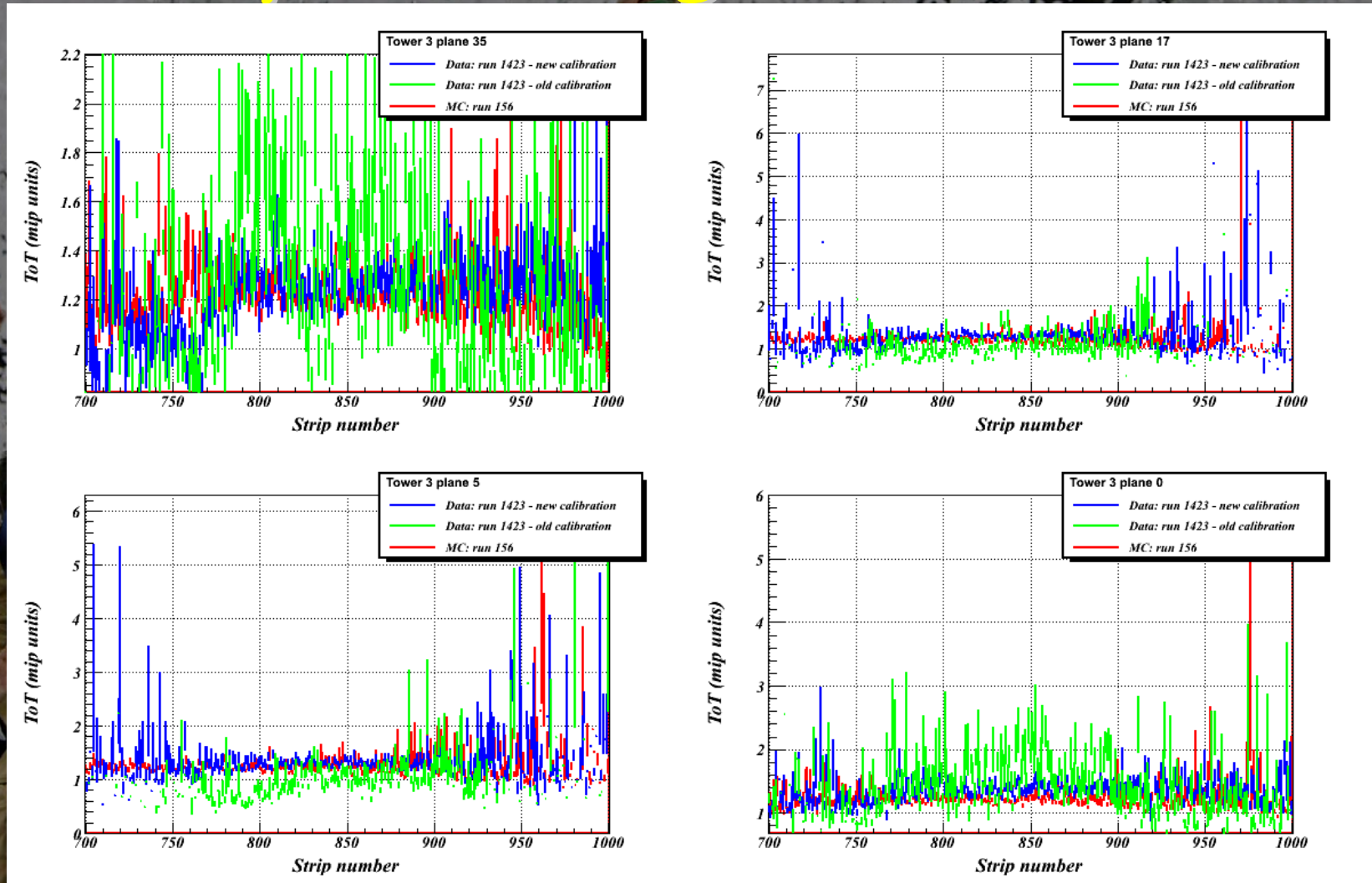# A look at the cluster display

A look at the ToTs

- **New calibrations do not change the average ToTs**

- **MC ToTs are lower than data**

- Differences between MC 156 and MC 181 when all events are considered

- Same behaviour when single track events are considered

ToT distributions

Low ToT tails
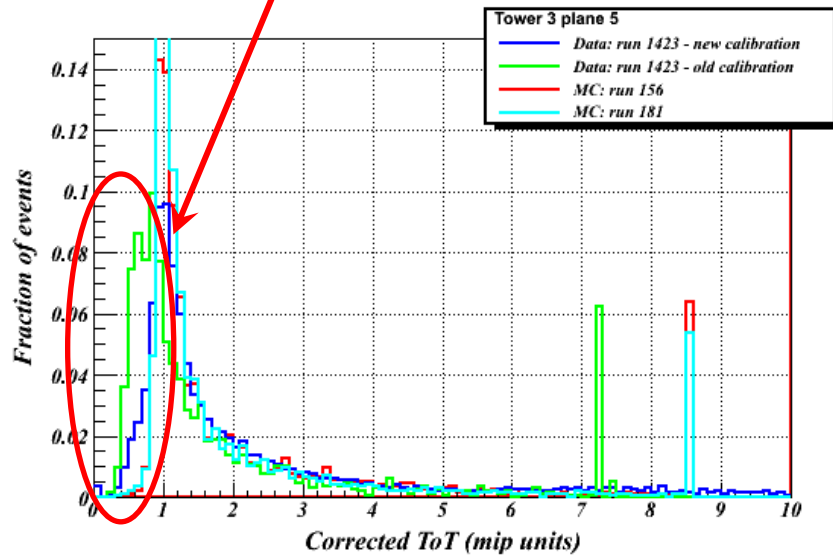
ToT maps for single cluster events

Tower 3 plane 35
Data: run 1423 - new calibration
Data: run 1423 - old calibration
MC: run 156

Tower 3 plane 17
Data: run 1423 - new calibration
Data: run 1423 - old calibration
MC: run 156

Tower 3 plane 5
Data: run 1423 - new calibration
Data: run 1423 - old calibration
MC: run 156

Tower 3 plane 0
Data: run 1423 - new calibration
Data: run 1423 - old calibration
MC: run 156

Equalization among strips has been improved, but there is still some work to be done...

ToT vs threshold

PSpice simulation

y = -10.11x + 12.61
$R^2 = 1.00$

ToT(microseconds) vs Threshold (MIP units)
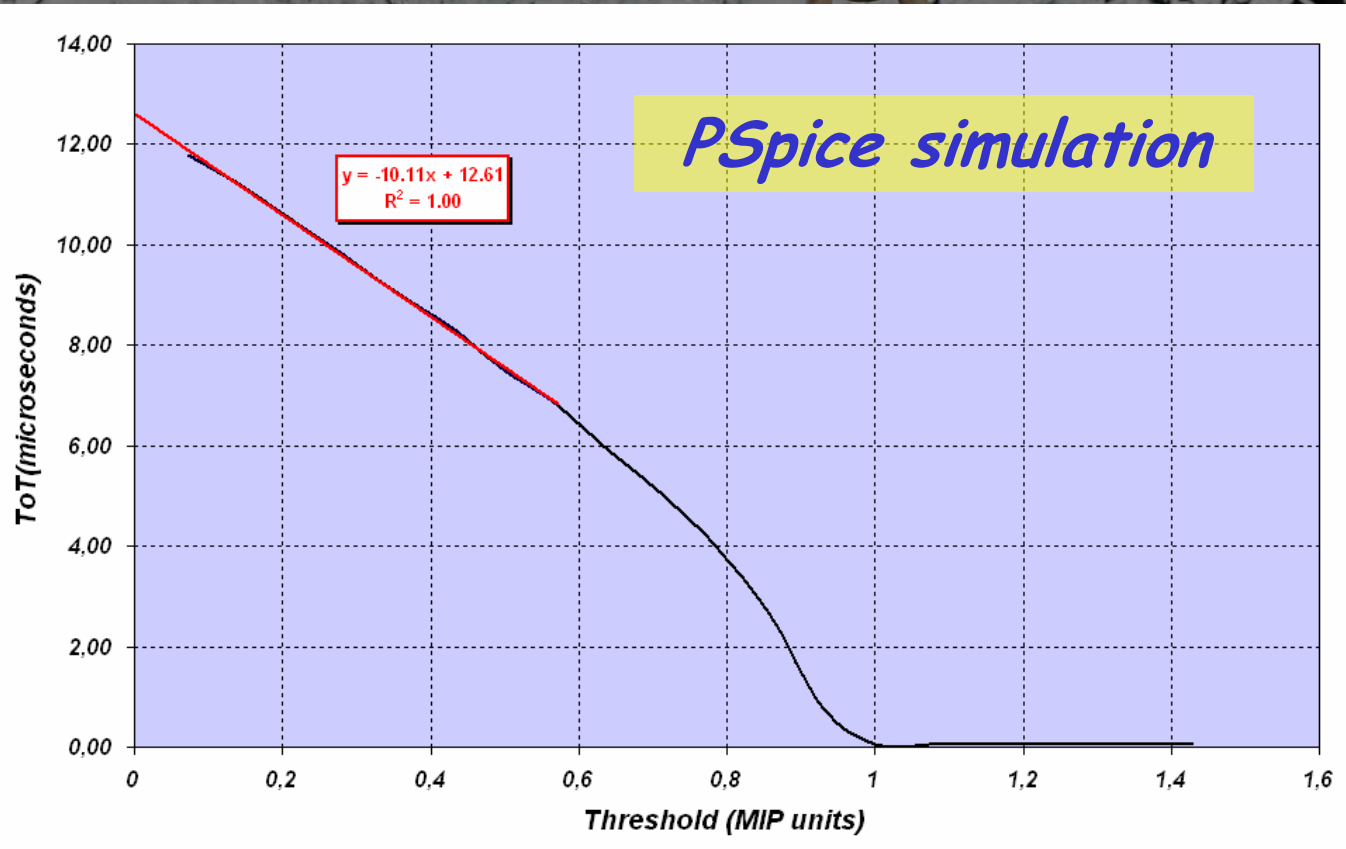
- *ToT depends linearly on threshold in a wide range*
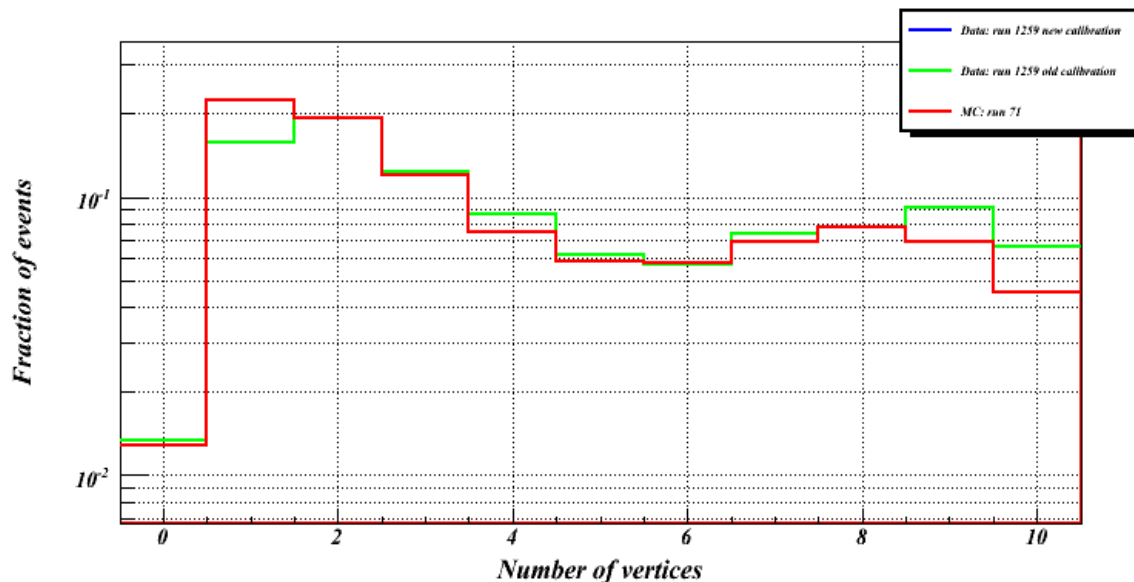- *Fluctuations on the threshold can cause fluctuations of the same order on the ToT*

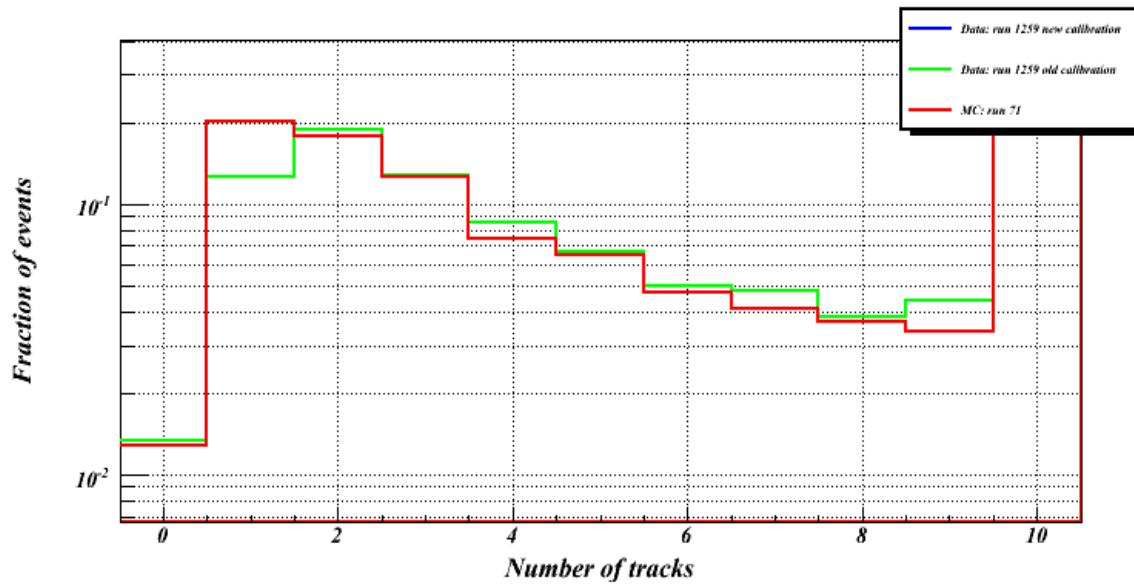1 GeV/c electrons
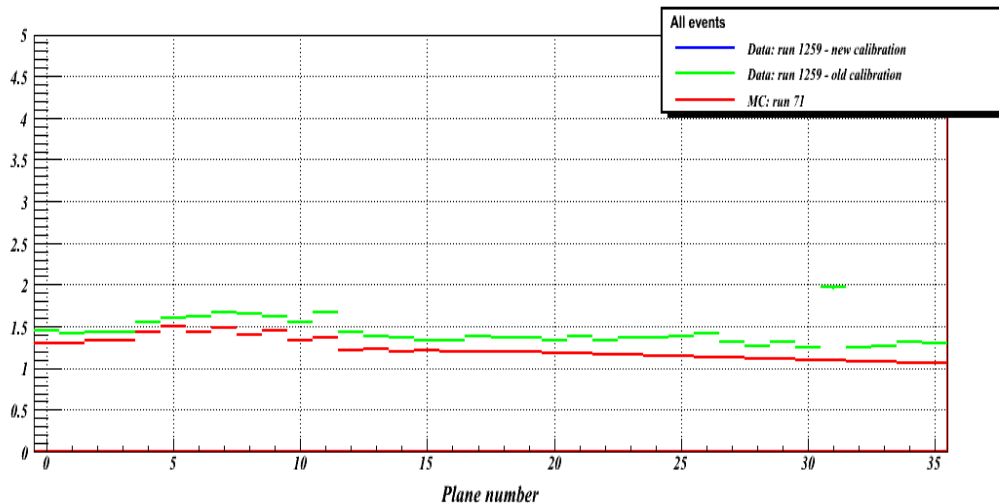
Tracks & Vertices

- *Same fraction of events without tracks in data and MC*

- *Still more events with multiple tracks in data*

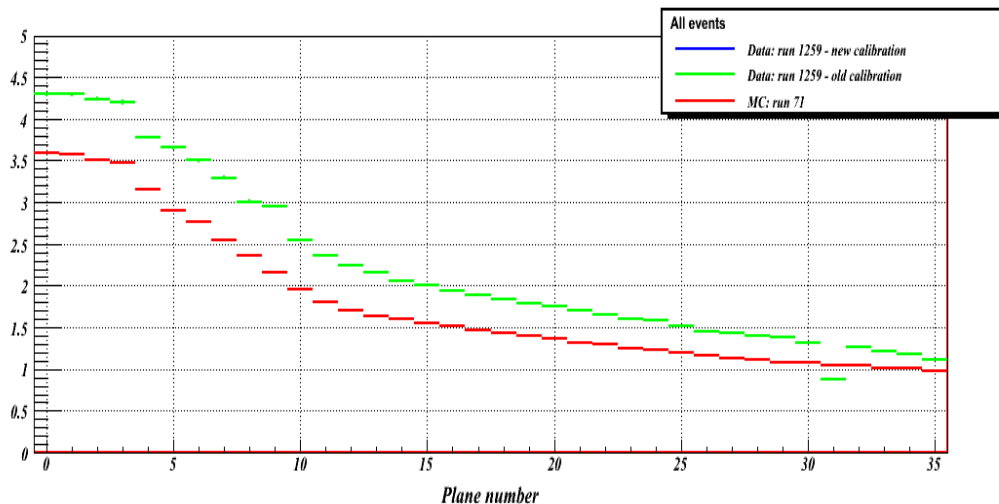- *ToT calibrations are not relevant for tracking*

Number and size of Clusters

Data:

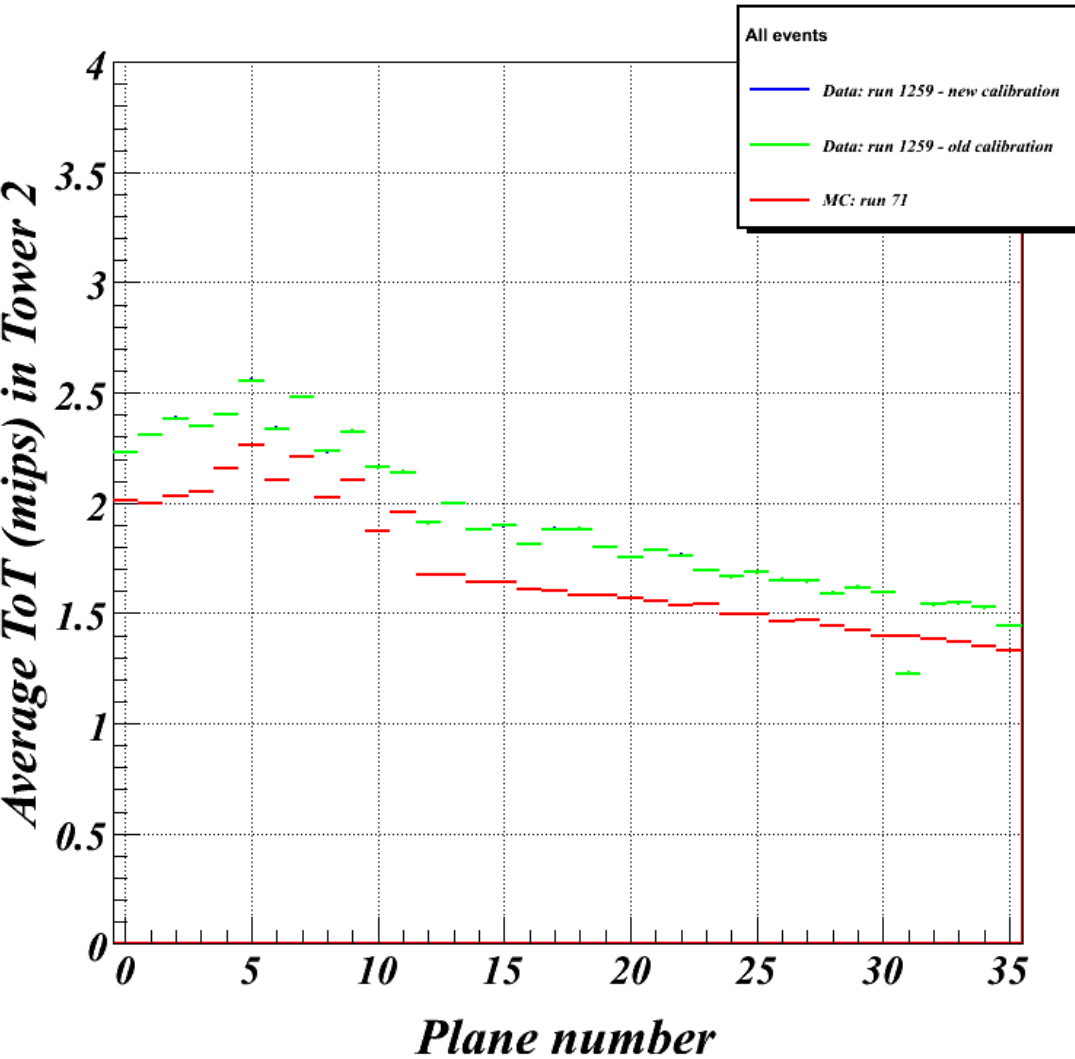- cluster sizes and number of clusters do not depend on ToT calibrations

- known problems in layer 31

MC:
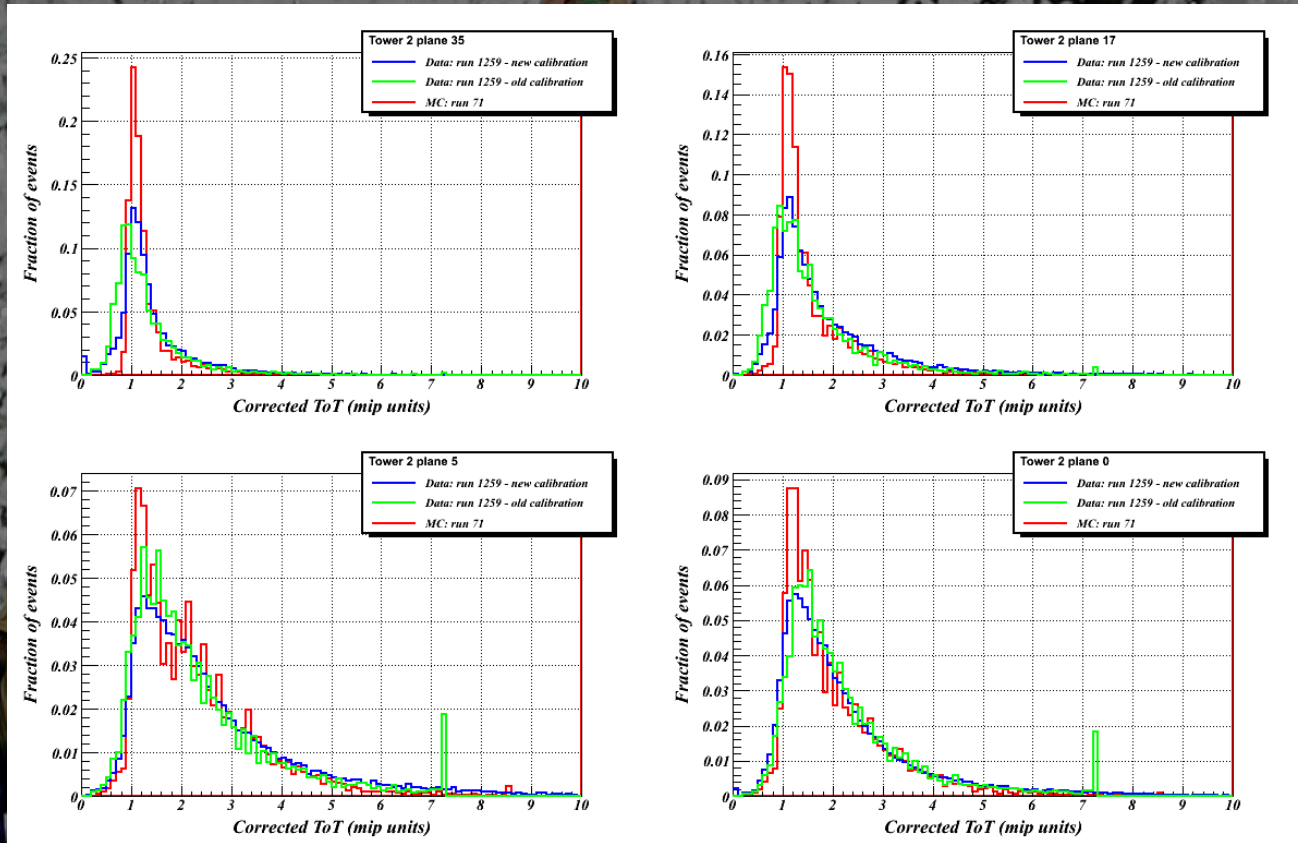
- less clusters

- smaller cluster sizes

ToTs per plane

- Also for electrons, new calibrations do not change the average ToTs

- MC ToTs are lower than data

ToT distributions

Also for electrons, new calibrations allow to improve the shape of ToT distributions

The low ToT tail is still present in the upper planes

The behaviour of lower planes is better reproduced by the MC

Conclusions

- **Cluster distributions:**
  - MC underestimates the number of clusters, the cluster size and the cluster distances with respect to the shower axis
    - Are MC hadronic showers narrower with respect to real ones?
    - Do we have events with two particles travelling together?
- **ToT distributions:**
  - New calibrations have improved the shape of the ToT distributions
    - The equalization among strips has been also improved
  - MC distributions are narrower with respect to real ones
    - do we have to improve the MC description of charge sharing?
    - do we have to take threshold fluctuations into account?
    - are noisy strips included in MC simulations?