Studies of the MuGirl pattern recognition for the ATLAS upgrade

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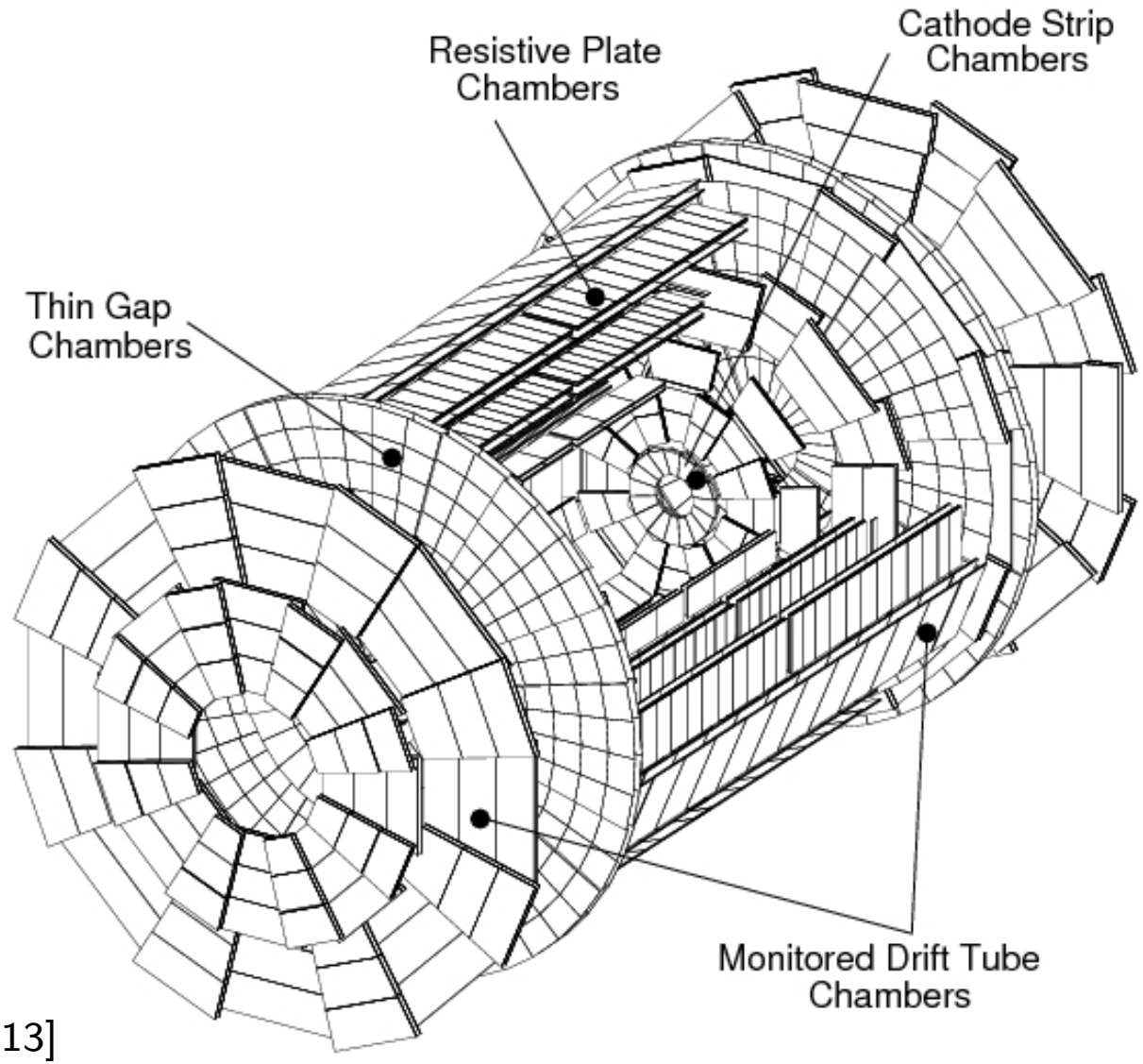
The ATLAS detector - The Muon spectrometer

Trigger chambers:
measure two coordinates η and ϕ

- RPC: barrel
- TGC: end-cap

Precision chambers:

- MDT: b and e-c measure only in η
- CSC: end-cap measure η precisely and ϕ coarsely



[Shlomit Tarem, LHC Detectors,2013]

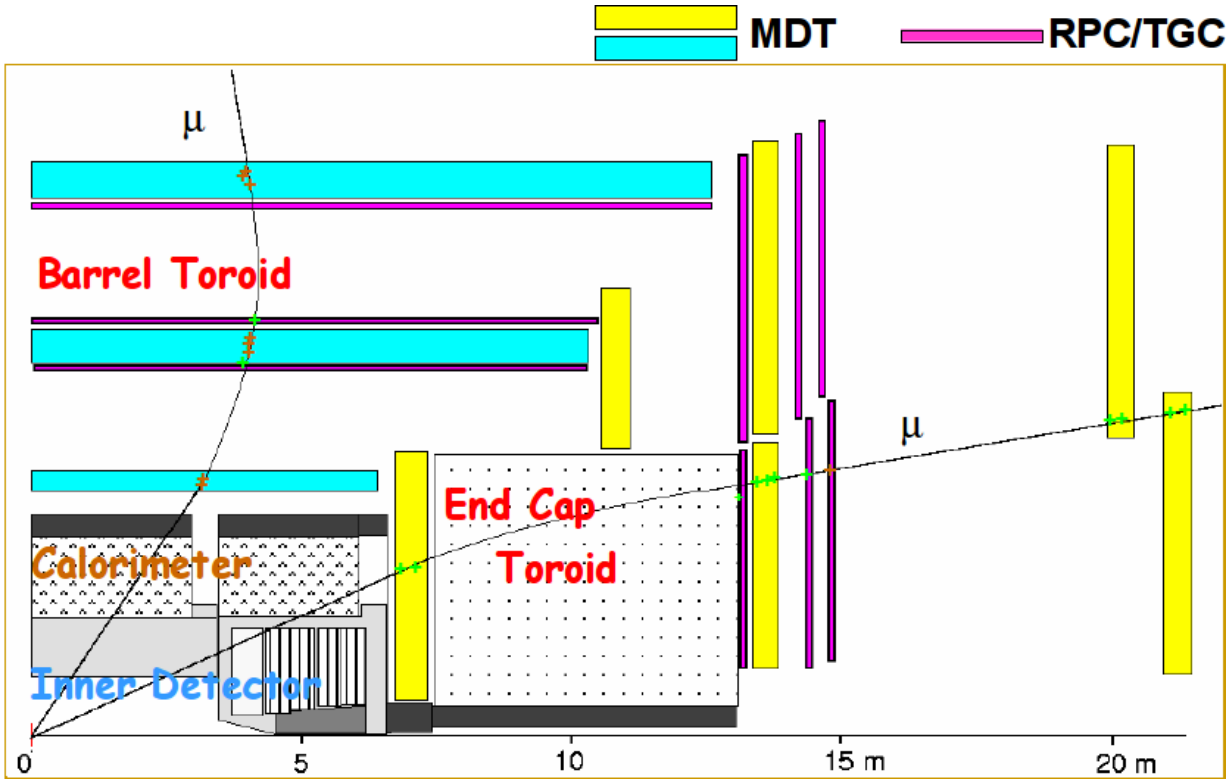
Muon Reconstruction

Muon detection system: Inner Detector (ID) + Muon Spectrometer (MS). Three measurement stations for each region of the MS: inner, middle and outer.

- **Standalone muons:** are reconstructed by finding tracks in the muon spectrometer and then extrapolating these to the beam line.
- **Combined muons:** are found by matching standalone muons to nearby inner detector tracks and then combining the measurements from the two systems.
- **Tagged muons:** are found by extrapolating inner detector tracks to the spectrometer detectors and searching for nearby hits.

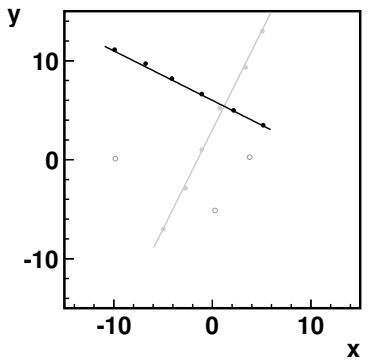
MuGirl

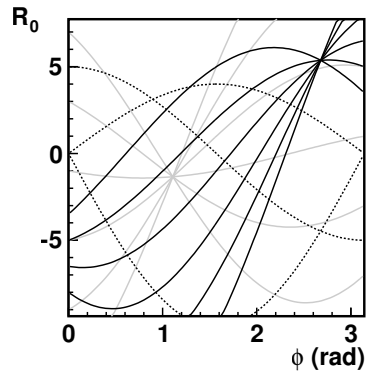
1. Initialize Muon candidate from ID track parameters
2. Extrapolate track to Muon Spectrometer chambers
3. Look for hits in a road around the track extrapolation
4. Make segments from hits
5. Improve extrapolation by using segment information
6. Collect hit & segment information to identify muon
7. Select "muon like" candidates
8. Fit a combined track using ID and MS hits from segments

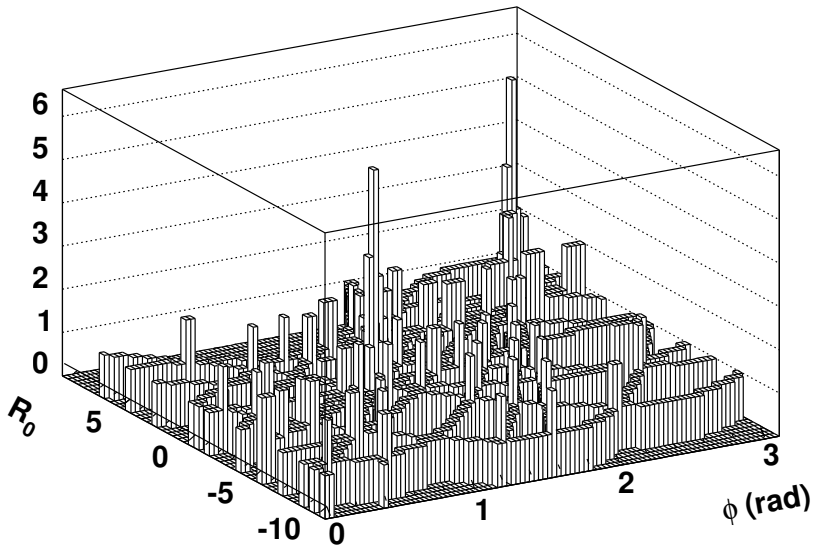


Hough Transform

- Transforms points in the x, y space into lines in R_0, ϕ
- Straight lines in the x, y plane are points in the Hough space
  - The lines of all hits from a given line cross in one point in the Hough space
  - When combined with a histogramming technique the problem reduces to finding the bins with the highest value in the histogram





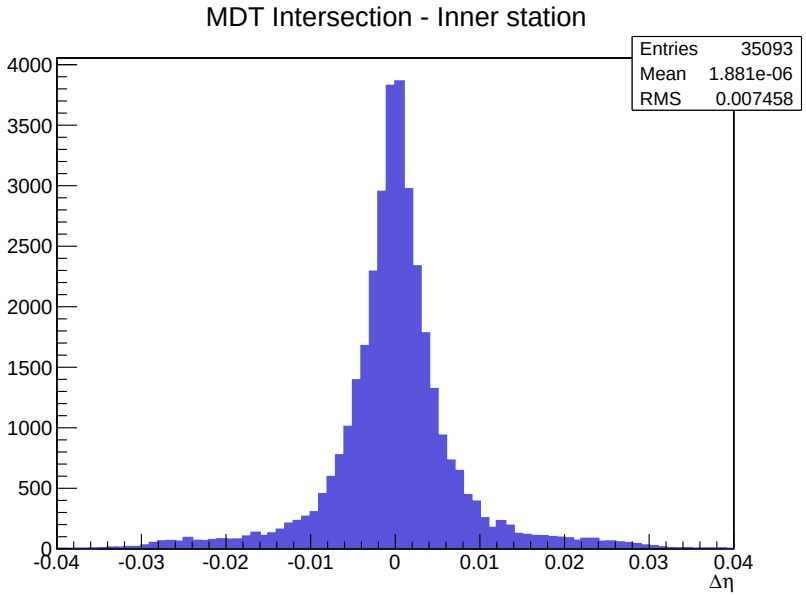


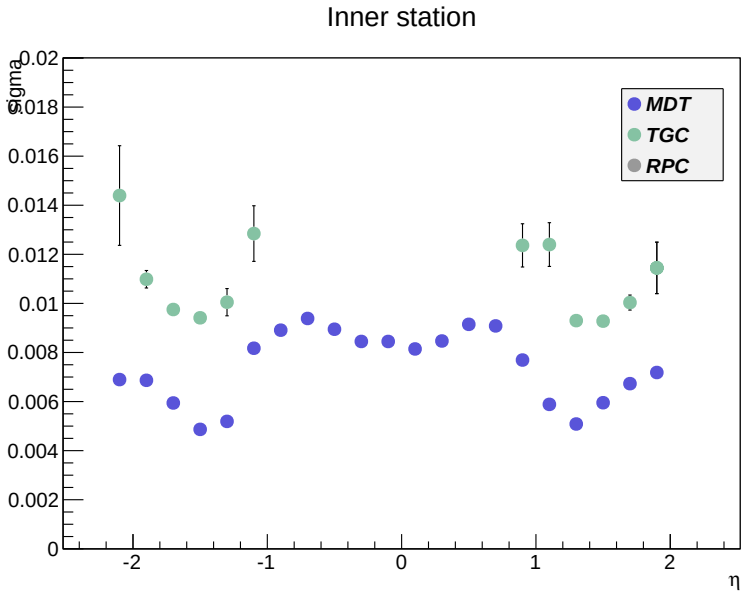
Advantages of the method

- very good background rejection properties
- complexity almost linear with number of hits

[N. Van Eldik, Muon reconstruction in ATLAS]

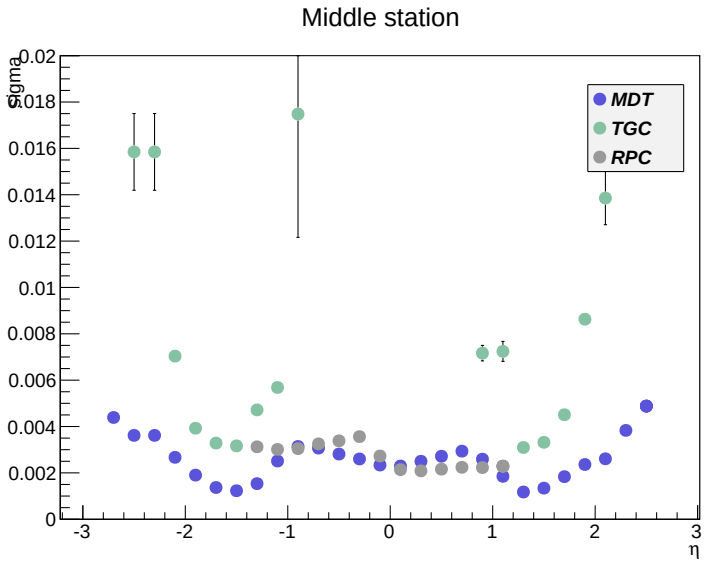
$\Delta\eta$ as a function of η



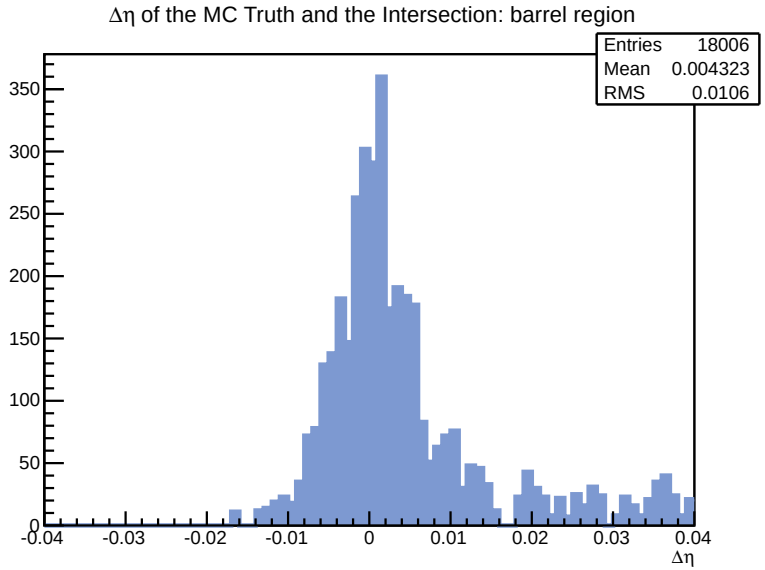


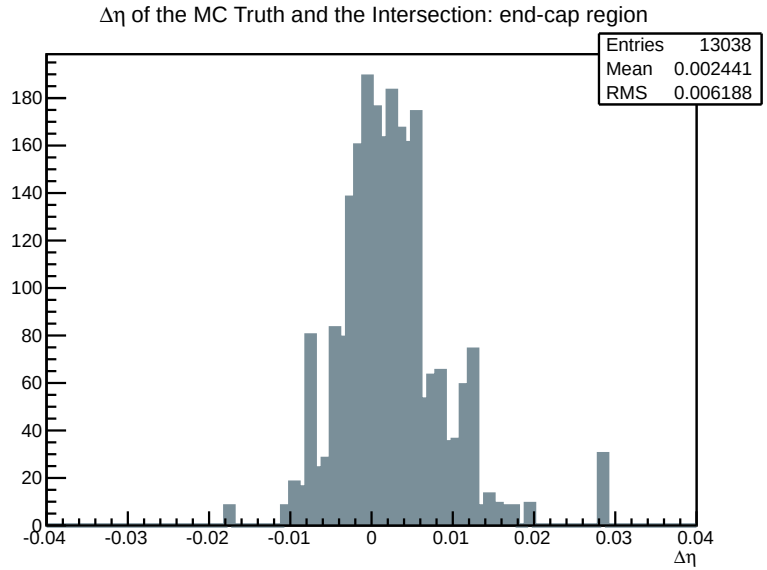
$\Delta\eta =$ distance between the extrapolated track and the hit.

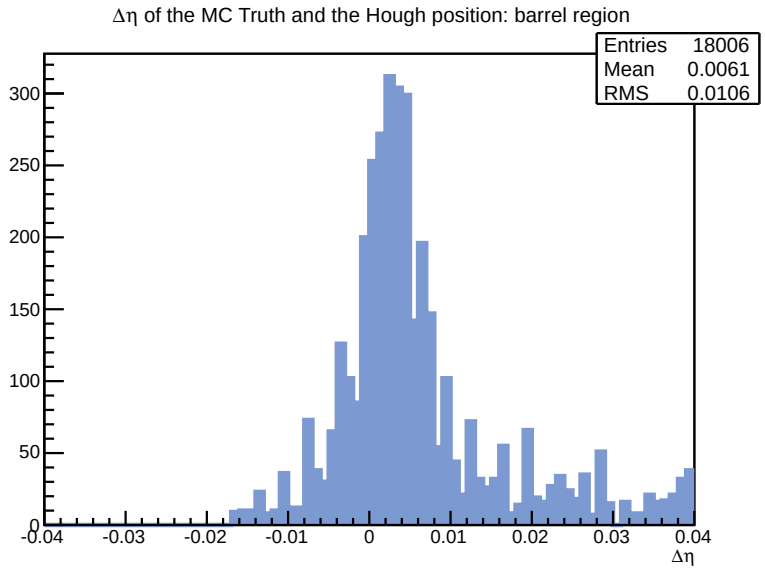
We cut in η and we calculate the sigma of the hit for each $\Delta\eta$.

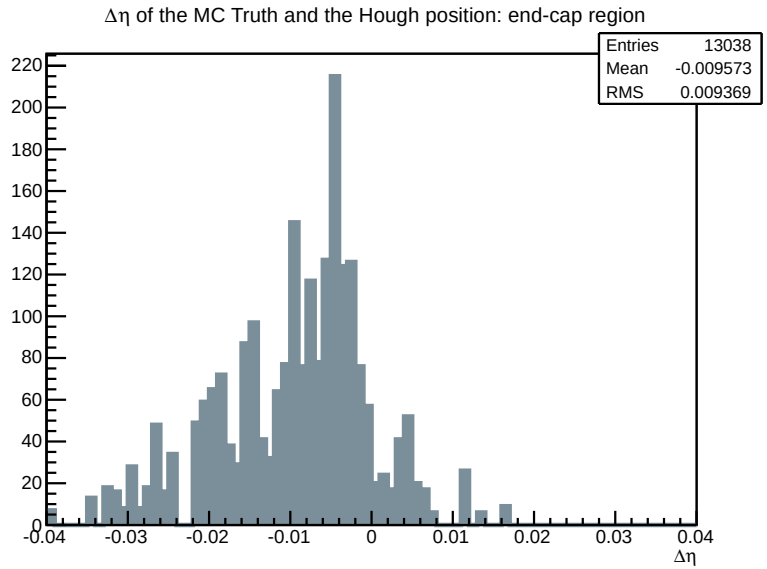


Matching of the Intersection and the Hough Maxima with the MC truth

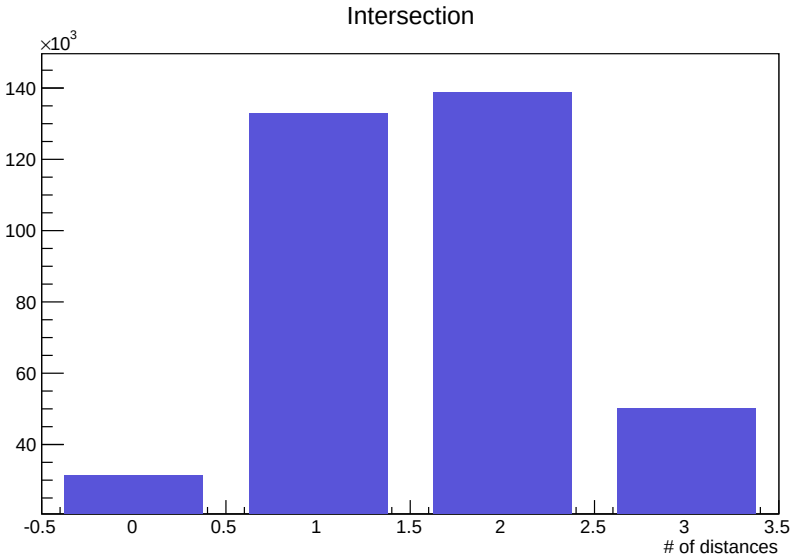


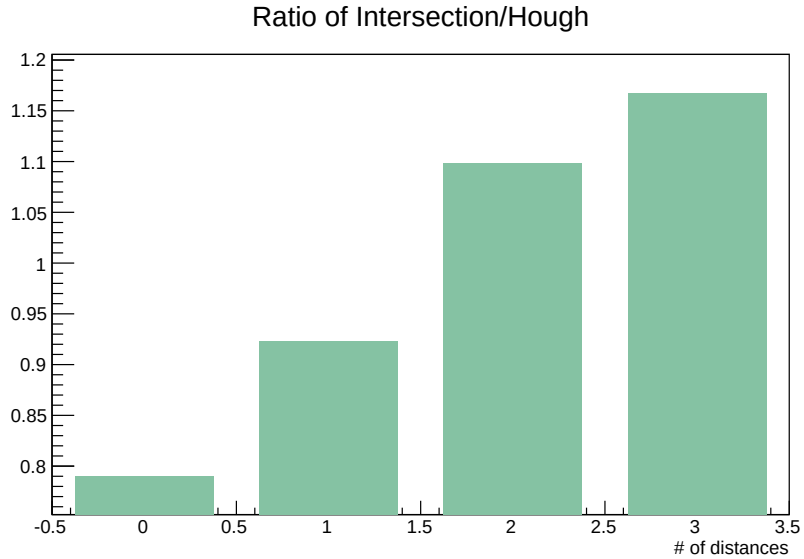


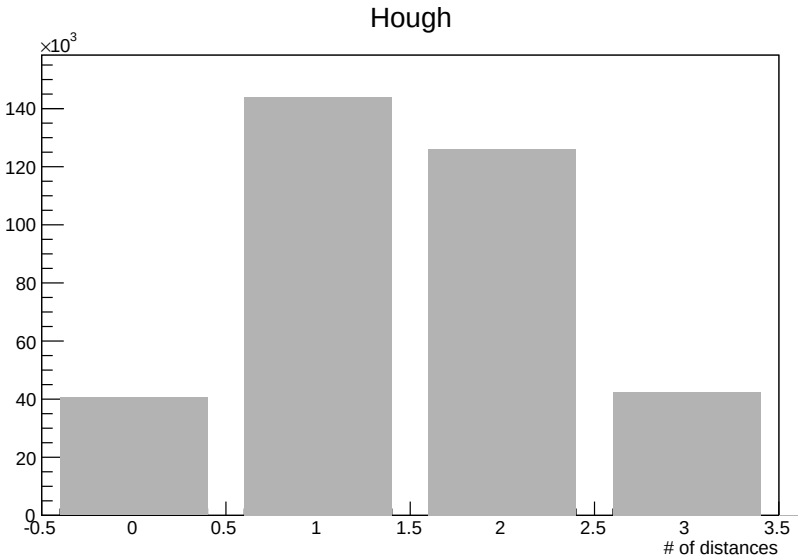




Number of hit cluster found







Distribution of the number of stations where we found a hit cluster for the Intersection method and Hough Maxima method per candidate.

Conclusions

- Roads for MuGirl pattern recognition studied.
  - Road for the extrapolation intersection.
- Checked the performance of the Hough Transform.
  - Road size.
  - The position of maxima (match with the MC truth).
  - Number of Hough maxima with respect to the number of intersections.
- The preliminary studies show that the Hough transform is a bit inefficient with respect of the extrapolation method in finding cluster of the hit. To be crosschecked with the efficiency to have a segment fit out of the selected hits.