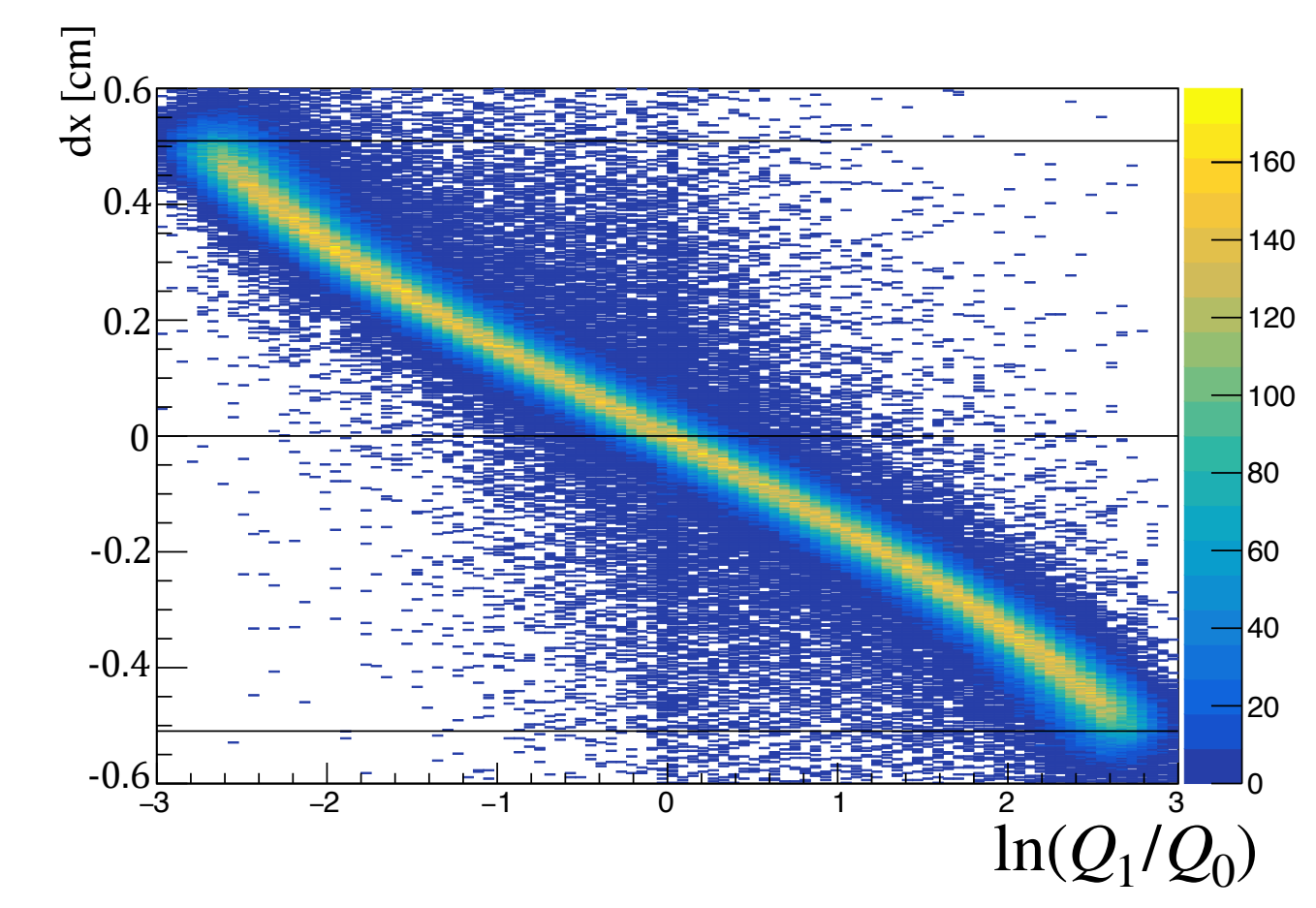
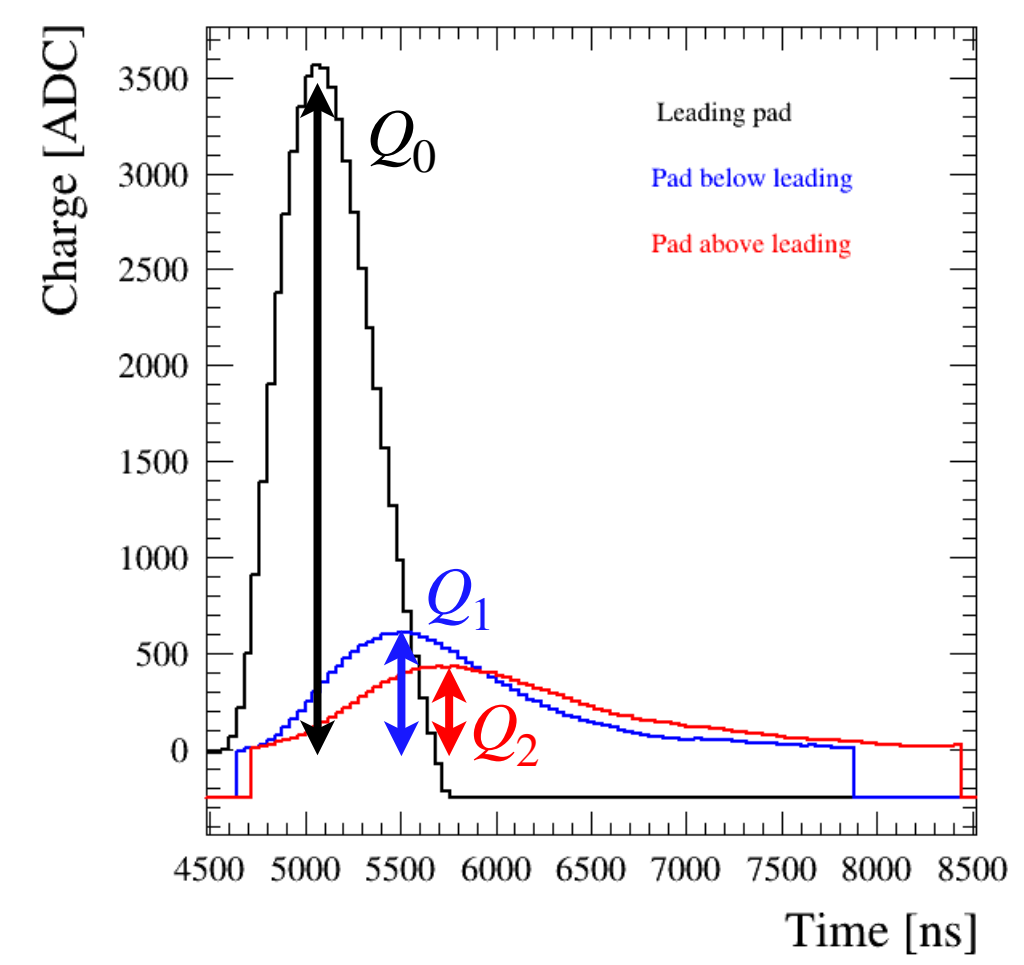
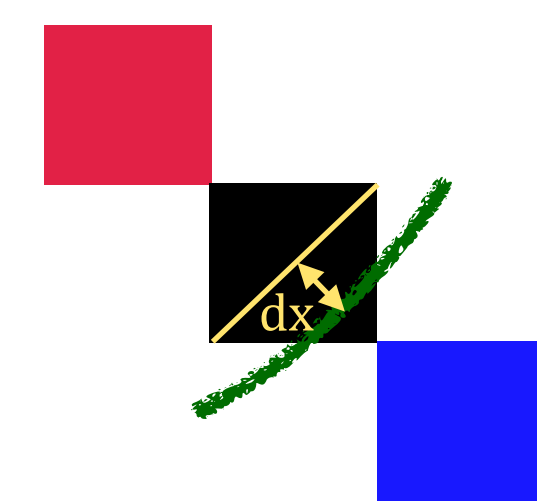
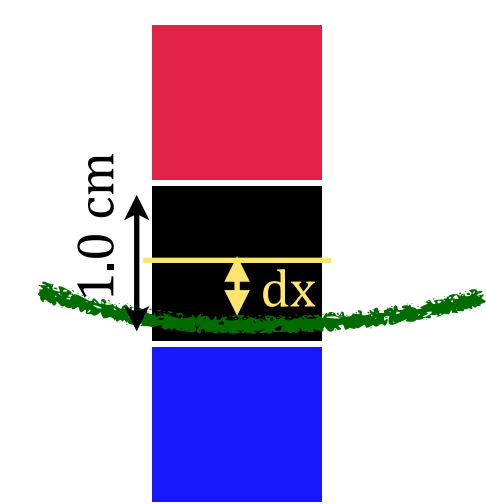


Analysis of beam data taken with the HA-TPCs and iterative logQ parameterization

The logQ method

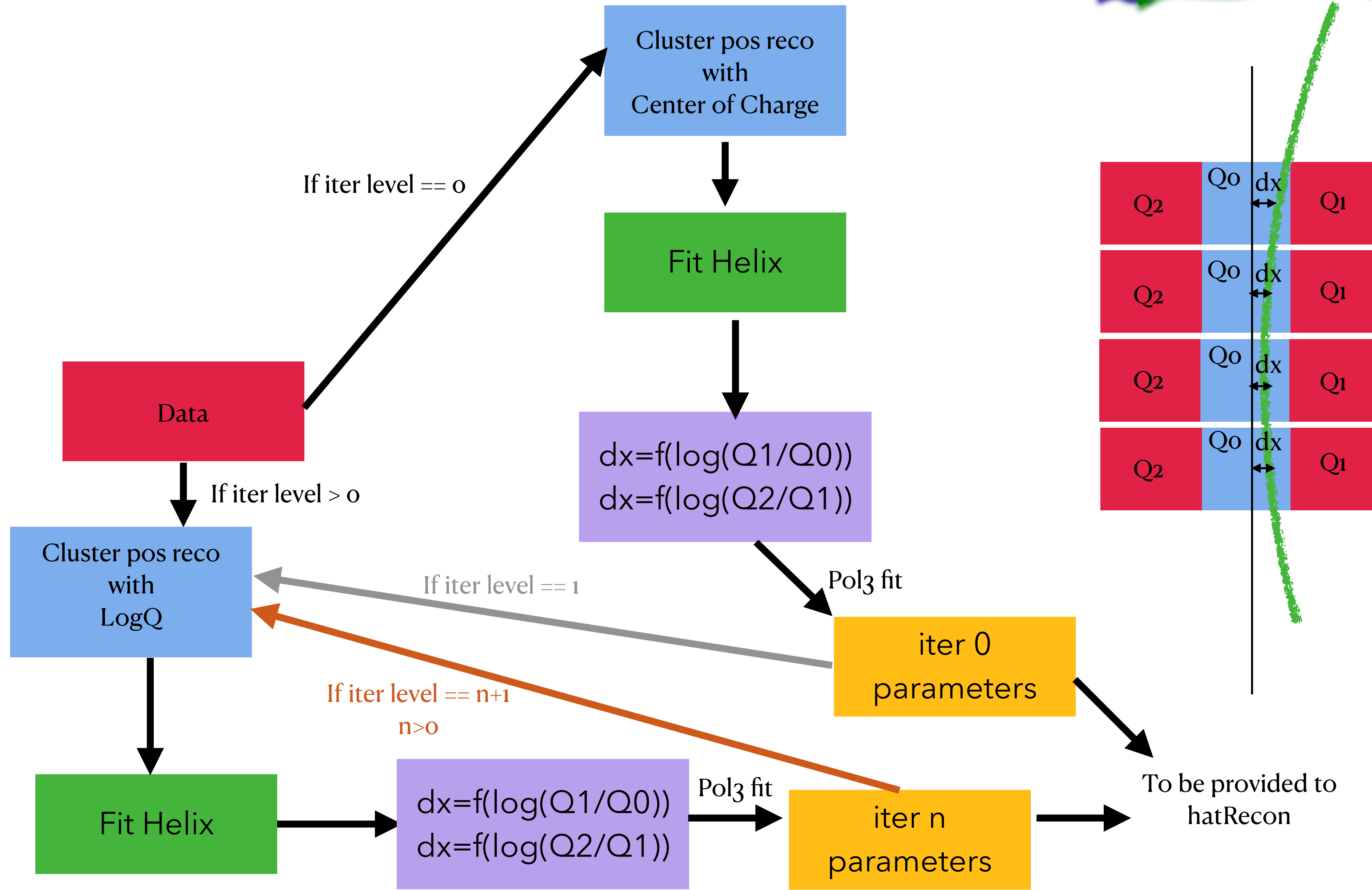
- Method for reconstructing the track position within a pad using the ln of the amplitude ratio of waveforms from pads within the same cluster (see formulas at the bottom right).
- The α_{ij} and β_{ij} parameters depend on the angle of the track and the drift distance of the ionization electrons
- The α_{ij} and β_{ij} parameters were first obtained using the DESY 2021 test beam data, before that I developed an app to iteratively tune them on cosmics and beam data taken by the HA-TPCs at J-PARC



$$dx = \alpha_{10} \ln^3 \left(\frac{Q_1}{Q_0} \right) + \beta_{10} \ln \left(\frac{Q_1}{Q_0} \right) \quad dx = \alpha_{21} \ln^3 \left(\frac{Q_2}{Q_1} \right) + \beta_{21} \ln \left(\frac{Q_2}{Q_1} \right)$$

Iterative parameterization of logQ

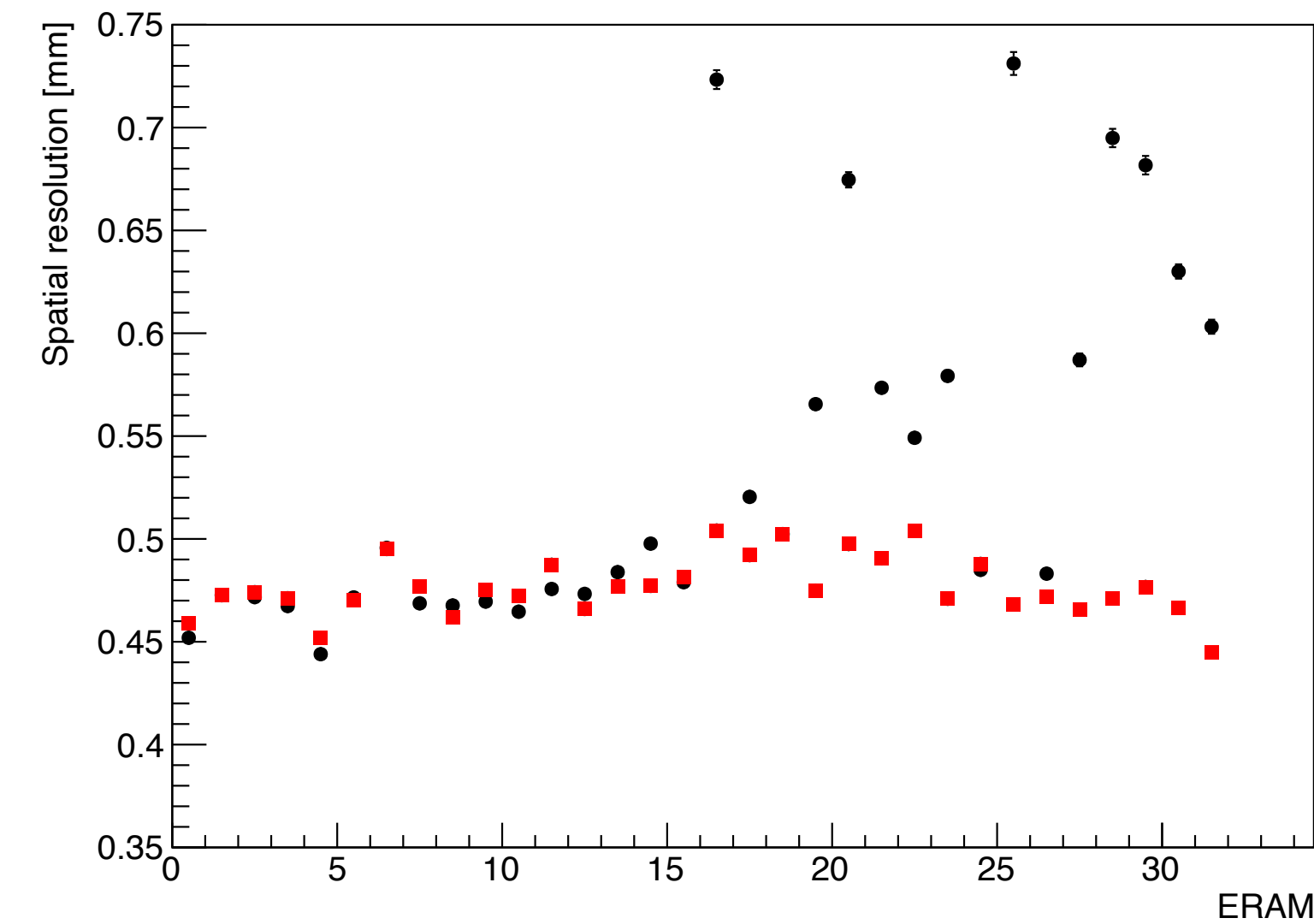
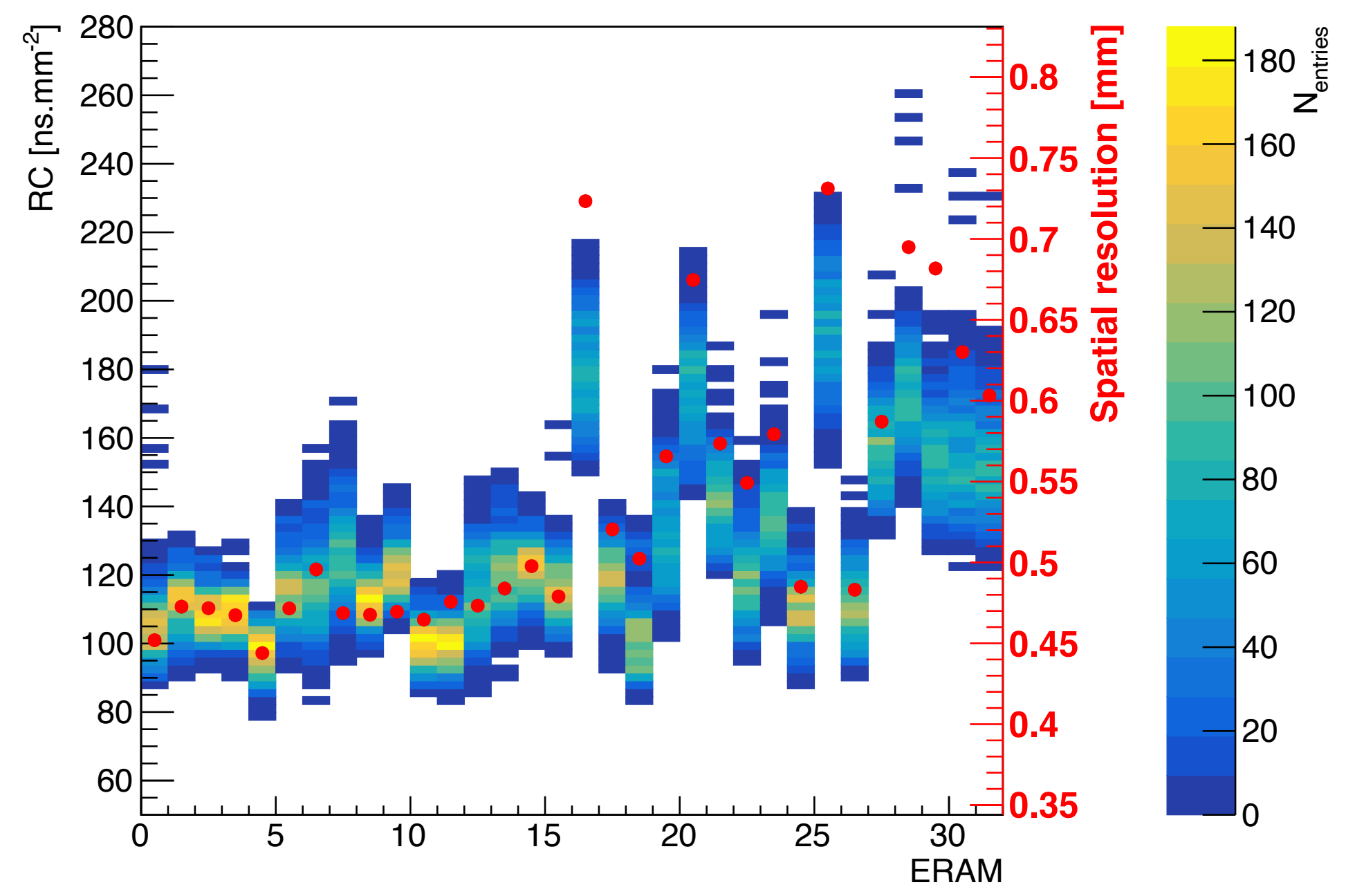
- Iteration 0 is performed using the charge barycenter in each cluster (a less precise method but without parameterization bias).
- Subsequent iterations use the parameters obtained from the previous iteration.



History of logQ iterative parameterization



- Iterative parameterization for vertical tracks (horizontal clusters)
 - ▶ Using cosmics data taken by Bottom HAT in December 2023 (3 ranges and then 10 ranges of drift), no improvement when separating between ERAMs
 - ▶ When analyzing cosmics data taken by both HATs in May 2024, it was observed that spatial resolution in Top HAT was worse, especially for ERAMs with a RC value far from Bottom HAT mean RC value
 - ▶ Iterative parameterization done for 10 ranges of drift distance and separated between the 32 ERAMs using cosmics data taken by both HATs in May 2024
- Iterative parameterization for horizontal tracks (vertical clusters)
 - ▶ Iterative parameterization done for 10 ranges of drift distance and separated between the 32 ERAMs using beam data taken by both HATs in June 2024
- Iterative parameterization for diagonal tracks (diagonal clusters) **NEW**
 - ▶ Iterative parameterization done for 10 ranges of drift distance and separated between the 32 ERAMs using beam data taken by both HATs in June 2024



Analysis performed



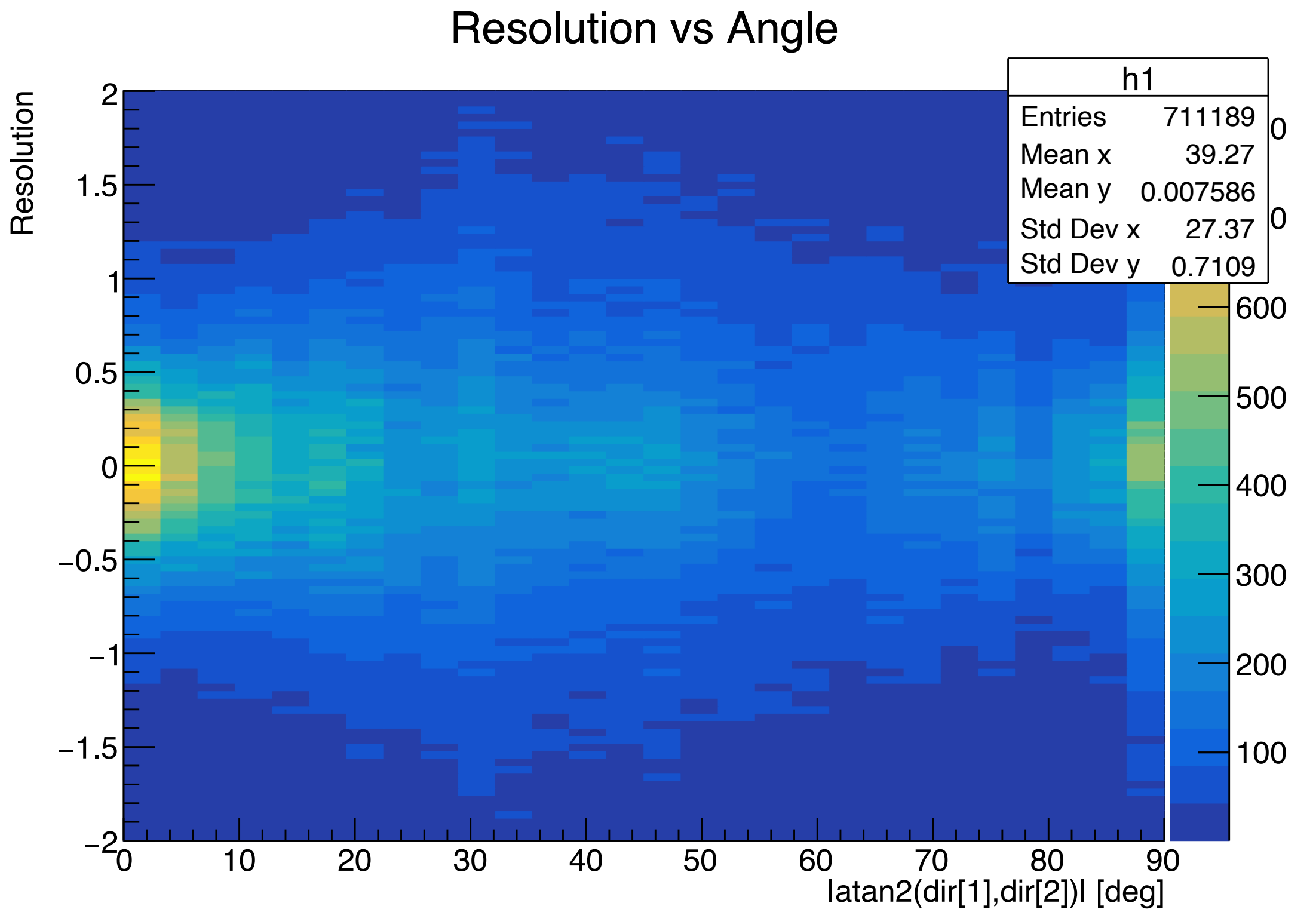
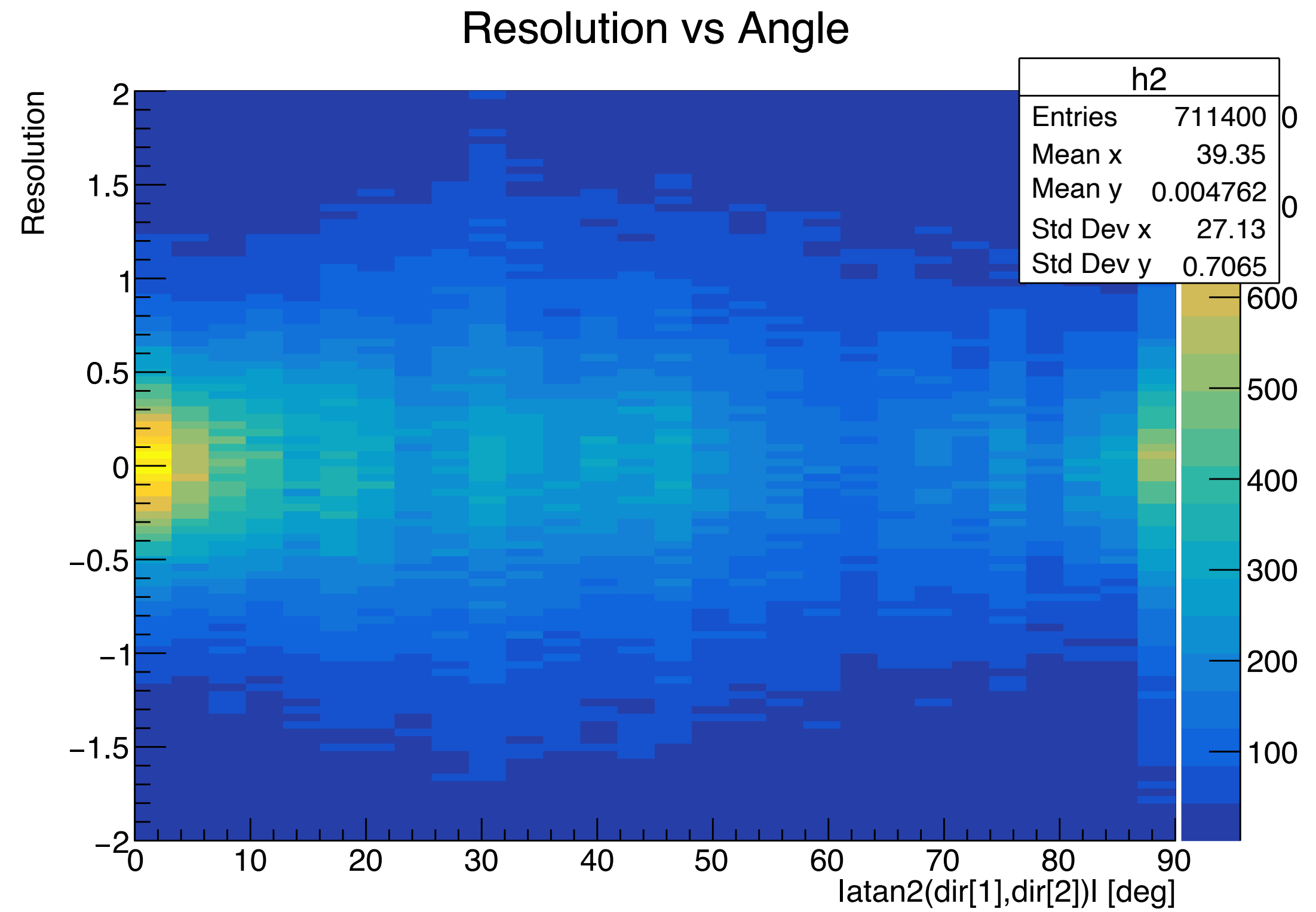
- CCIN2P3 was in maintenance, so it was not possible to run on a large statistics
- I was able to analyze files nd280_00016922_0000.daq.mid.gz and nd280_00016922_0001.daq.mid.gz
- These are beam data taken with HAT in global DAQ in June 2024 and they contain 37554 reconstructed tracks in the HATs in total
- Ran hatRecon with and without using iterative logQ parameterization
- Very basic comparison of spatial resolution vs track angle in the 2 configurations.

Residuals vs track angle



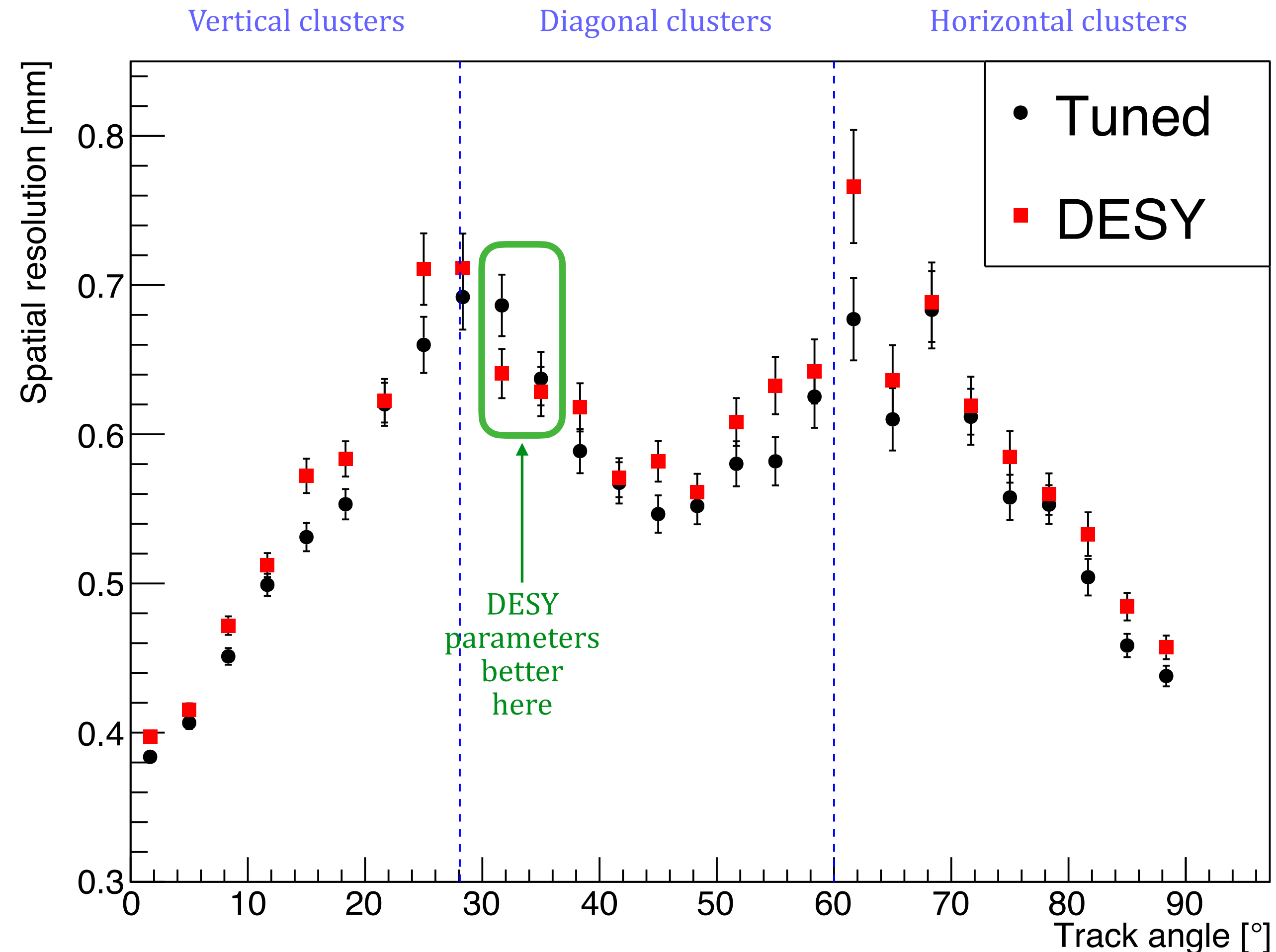
- Using DESY 2021 parameters

- Using tuned parameters



Spatial resolution vs track angle

- Took the sigma value of the gaus fit performed on the residuals distribution for each bin in angle
- Iteratively obtained logQ parameters give better spatial resolution everywhere except between 30 and 35°
- But should reproduce it with more statistics to confirm this apparent behavior



Summary



- Should do this study with more statistics, separated between the different ERAMs and different regions of drift, different columns and rows of pads in a given ERAM... → SOON
- Should compare data and MC → SOON
- Now that I have the app to tune the parameters for diagonal clusters, I can try it on cosmic data instead of beam data in order to see if the parameterization is improved → SOON
- In general using the iterative logQ parameters improve the results ✓
- But as I mentioned the statistics I have is low, so should do that with more stats and more different configurations → SOON