Some results of test beams 2017 / 2018: resolution impact

A. Principe

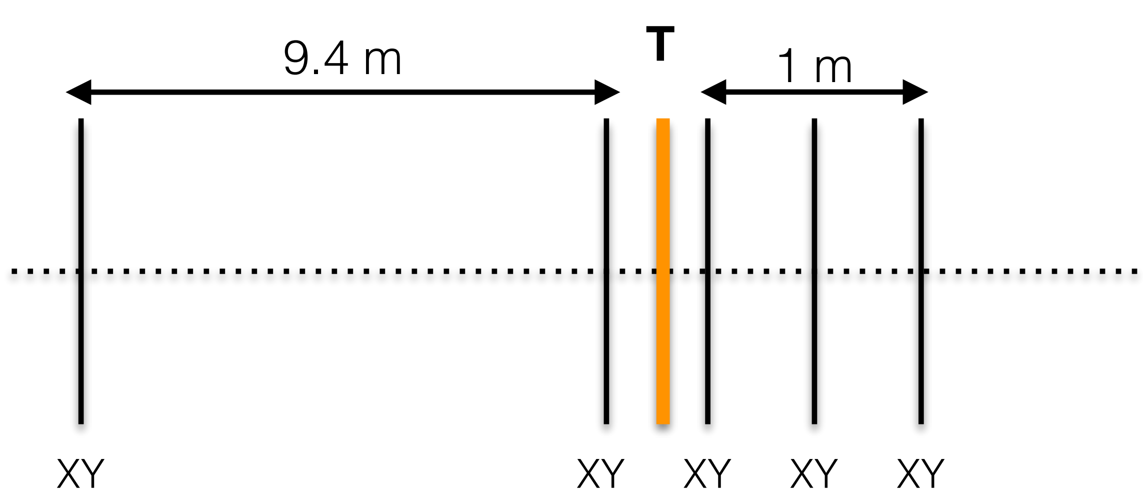
meeting 24/07/2018

Test beam 2017 (finished)

- At CERN (H8) with UA9 telescope: dedicated to multiple scattering (MS) measurement.
- e- / e+ 12, 20 GeV on 2, 4, 8, 20 mm graphite and without target.
- muons 160 GeV on 8 mm and without target.
- pions 80, 180 GeV without target for alignment.

Apparatus

- 5 trackers stations with single-sided silicon strips, 2 upstream + 3 downstream, without uv planes.
- **UA9 sensor thickness: 320 μm.**
- **size: 3.8 x 3.8 cm^2**
- **pitch: 60 μm with intermediate strip**
- **point resolution ~ 7 μm.**

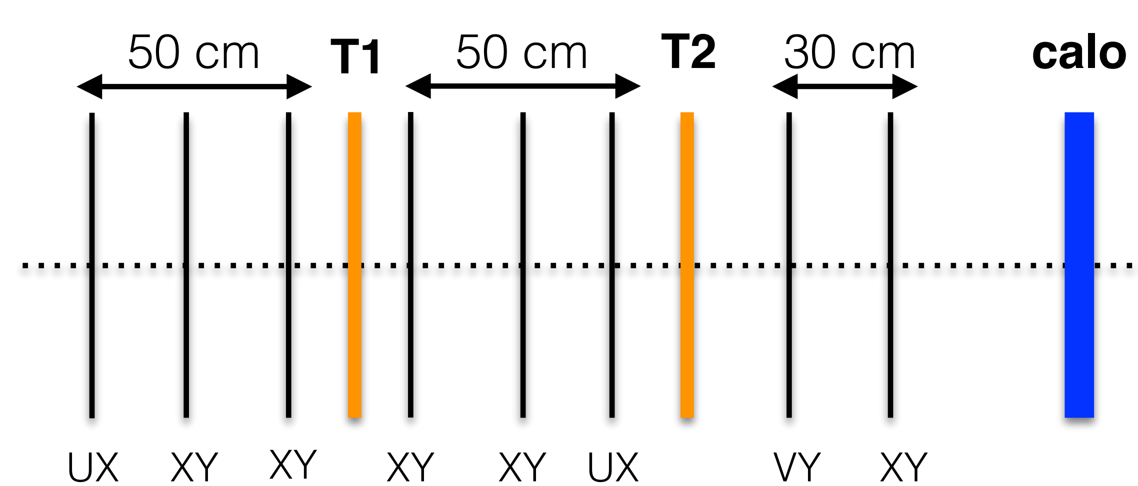


Test beam 2018 (in progress)

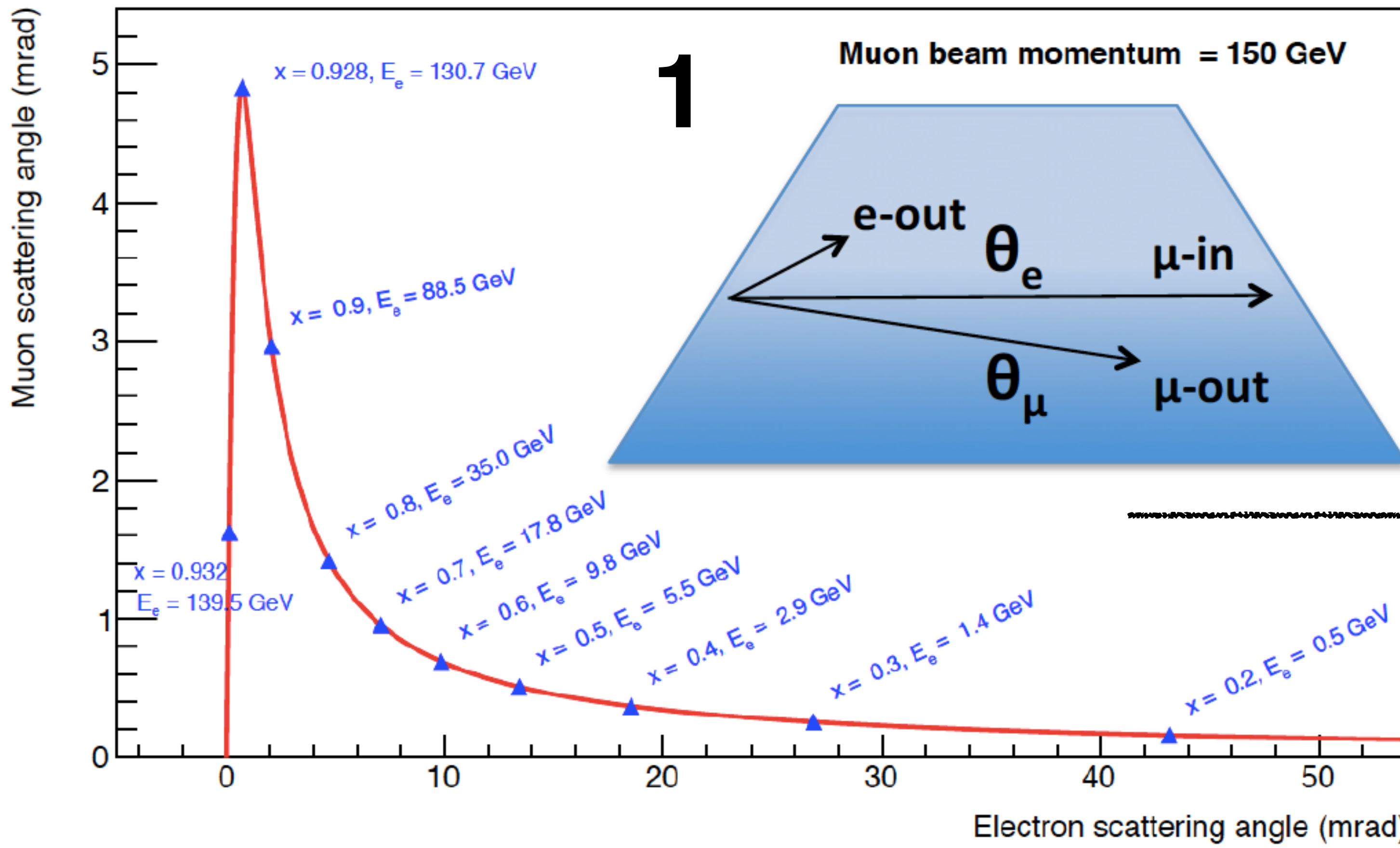
- At CERN (behind COMPASS) with AGILE setup: dedicated to muon-electron scattering, to test two modules + final calorimeter measures.
- ~190 GeV muons (3 beam setup, depending on COMPASS requests) on two modules with 8 mm graphite targets.

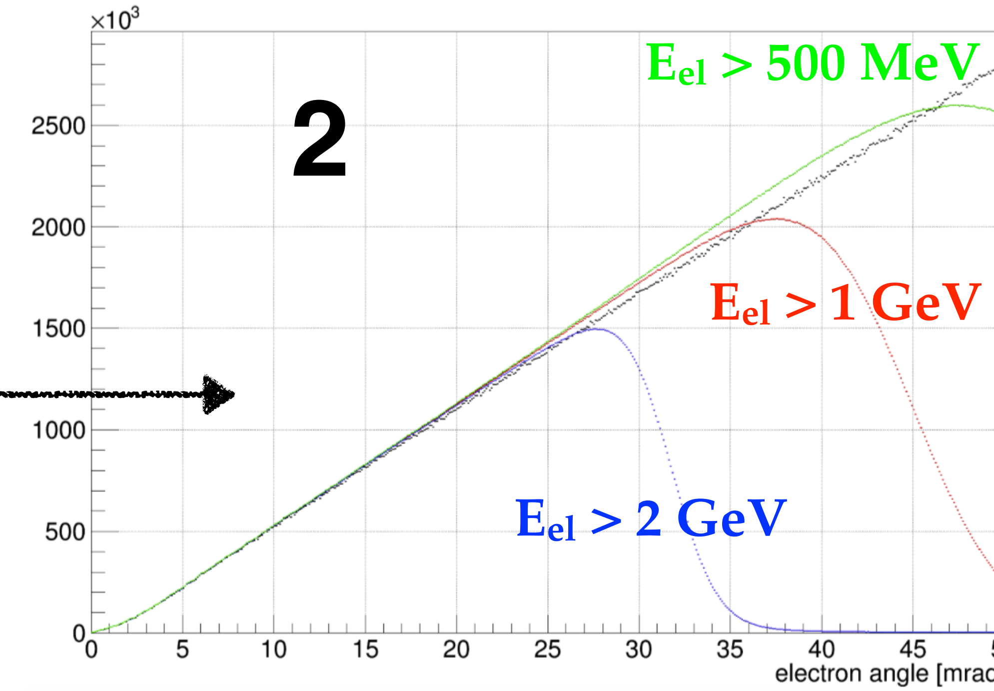
Apparatus

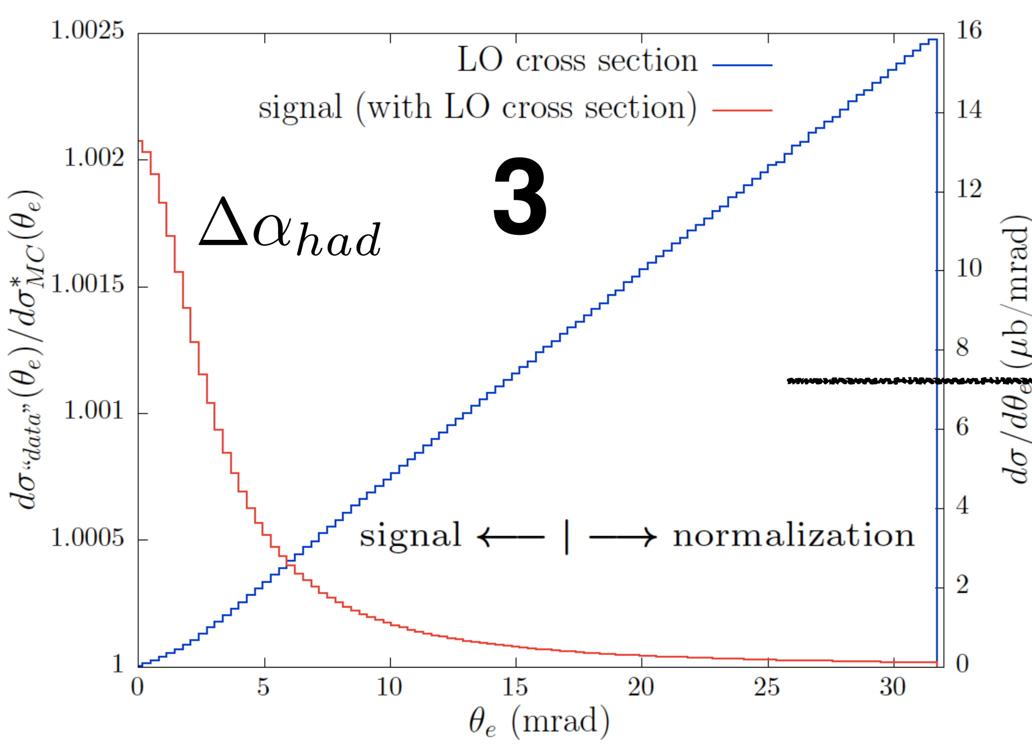
- 2(+1) trackers stations, T1, 3 stations on first module, T2, 2 stations on second module + calorimeter. Three uv planes for disanbiguity.
- **AGILE sensor thickness: 410 μm.**
- **size: 9.3 x 9.3 cm^2**
- **pitch: 242 μm with intermediate strip**
- **point resolution ~ 34 μm.**



MUonE experiment in one shot!







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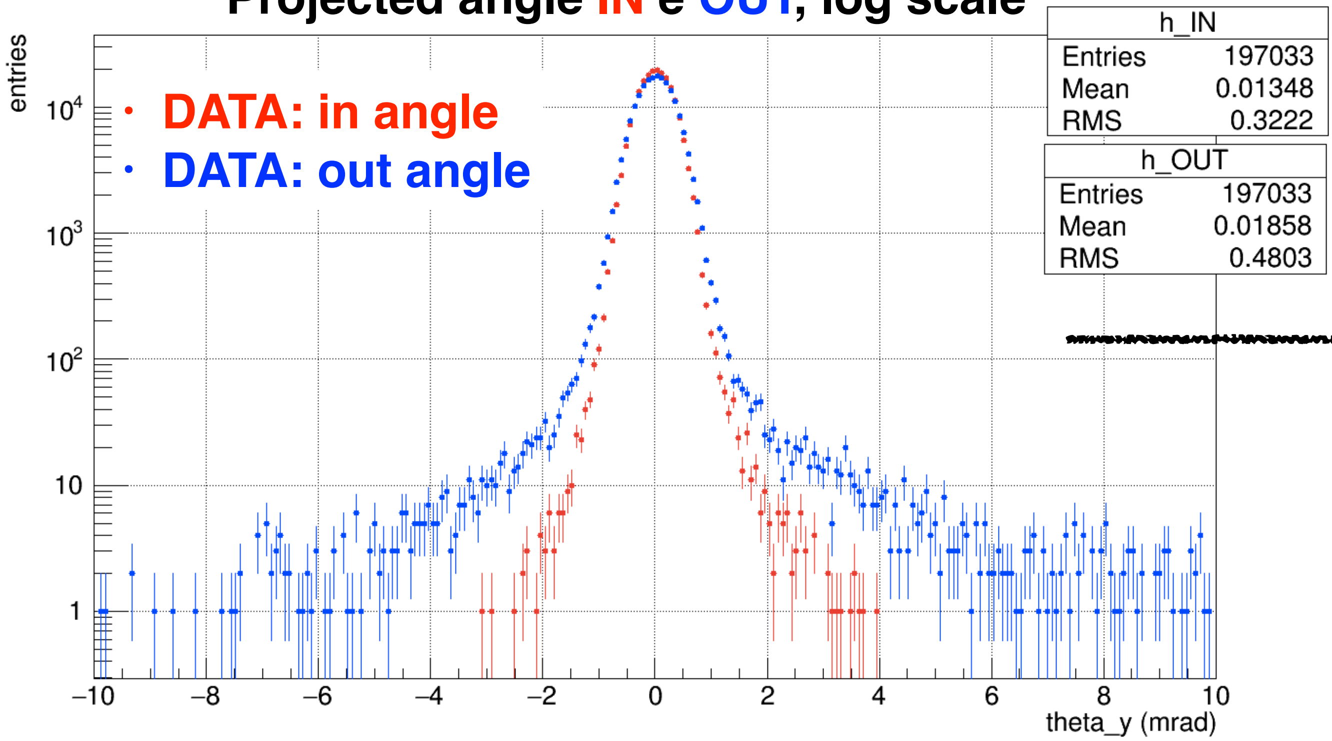
$$a_\mu^{\rm HLO} = \frac{\alpha}{\pi}\int_0^1 dx\,(1-x)\,\Delta\alpha_{\rm had}[t(x)]$$

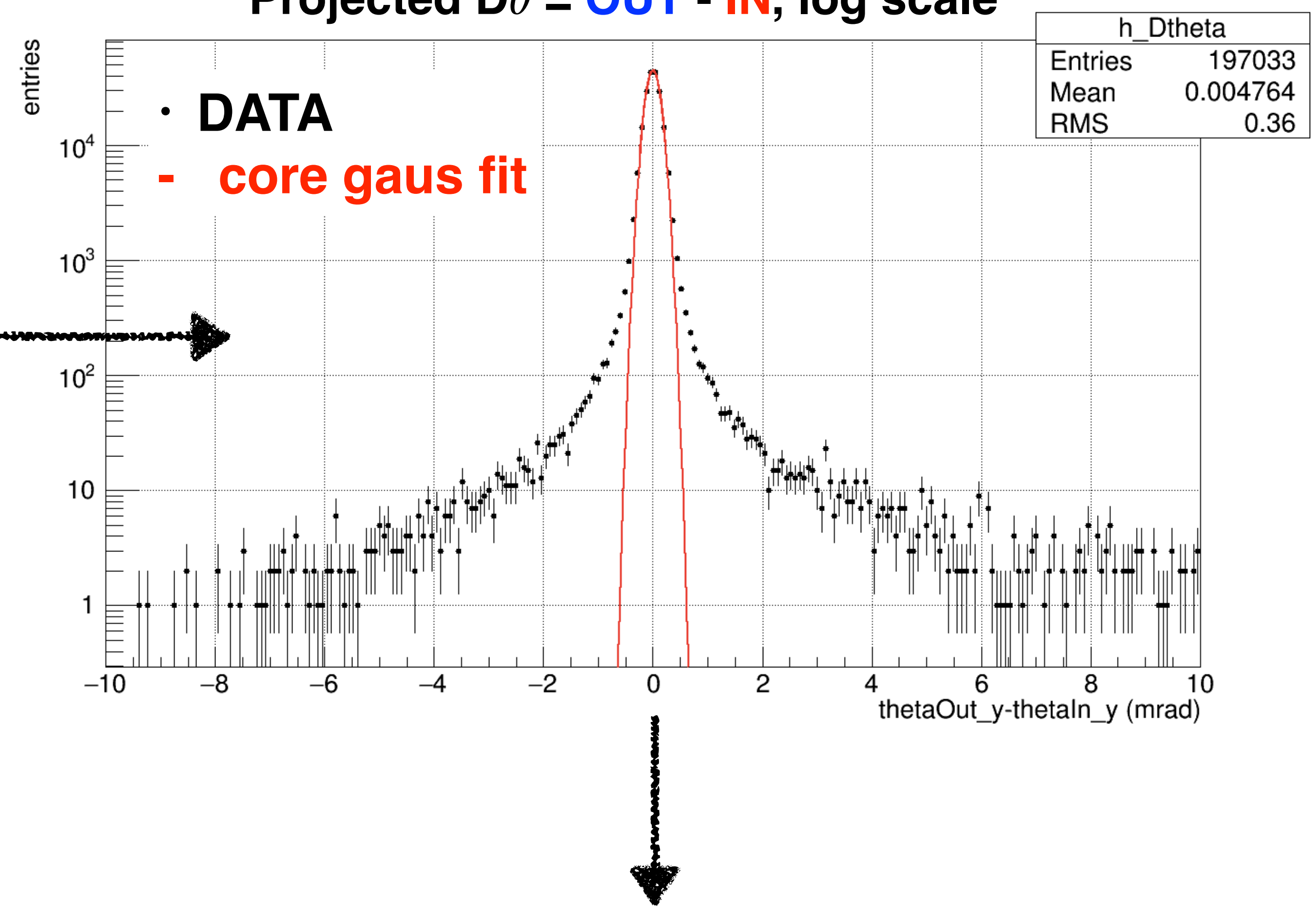
$$t(x) = \frac{x^2 m_\mu^2}{x-1} < 0$$

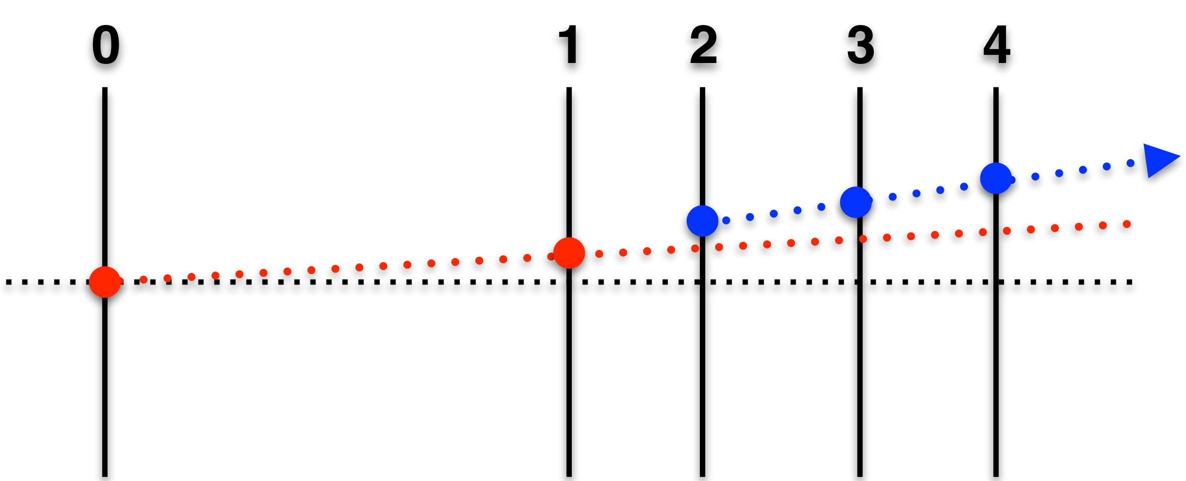
Angular resolution: 12 GeV e⁻ without target, TB2017

Projected angle IN e OUT, log scale



Projected Dθ = OUT - IN, log scale



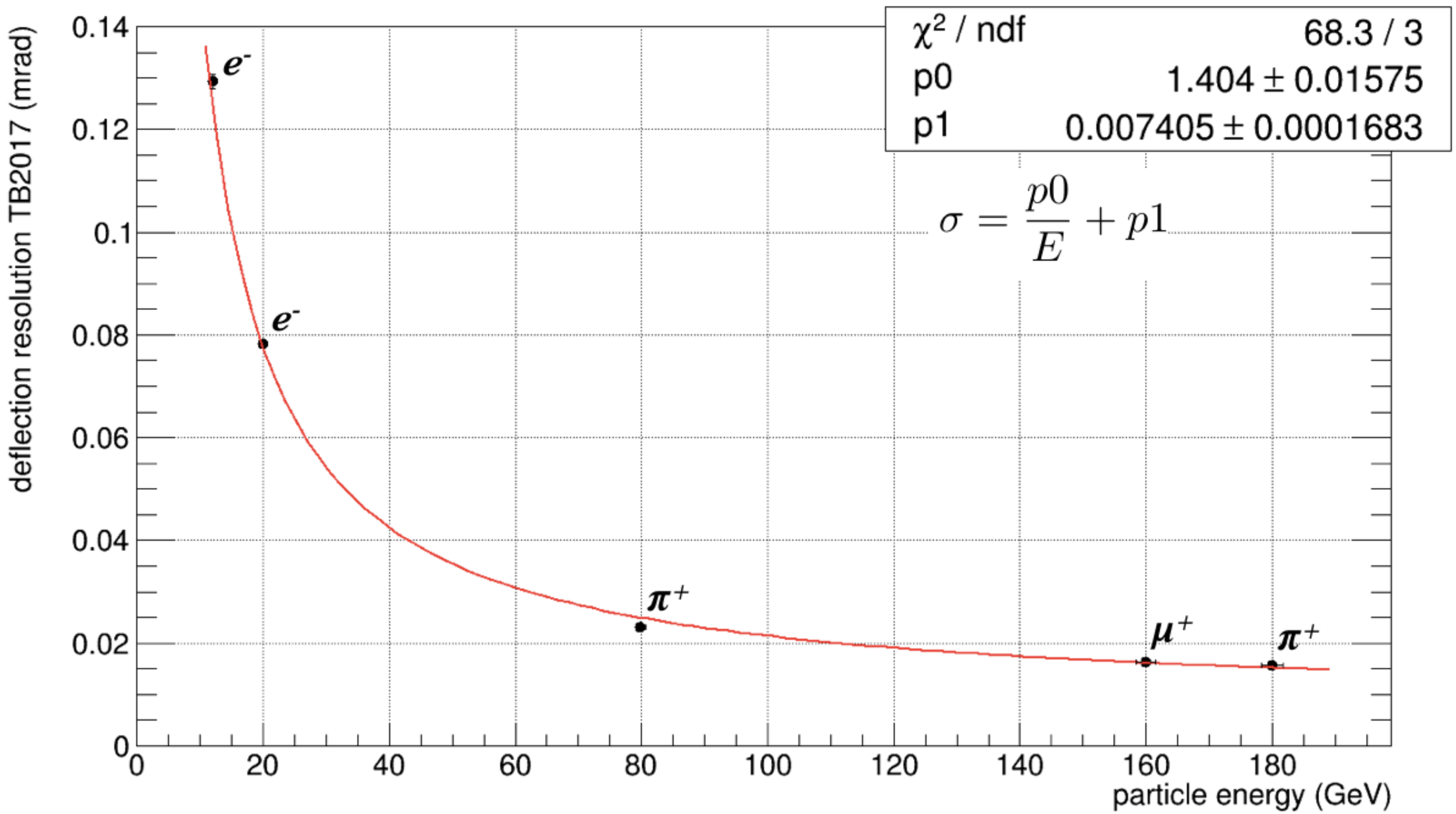


- Gaussian core contains ~ 90% of single events.
- From fit results of the core:

  σ ~ 0.13 mrad (at 12 GeV)

- These angle distributions are due to silicon MSC, intrinsic resolution and to a (little) energy loss in each tracker station.
- Distribution of angle difference (run <u>without</u> target) represents our method resolution on **Dθ.**

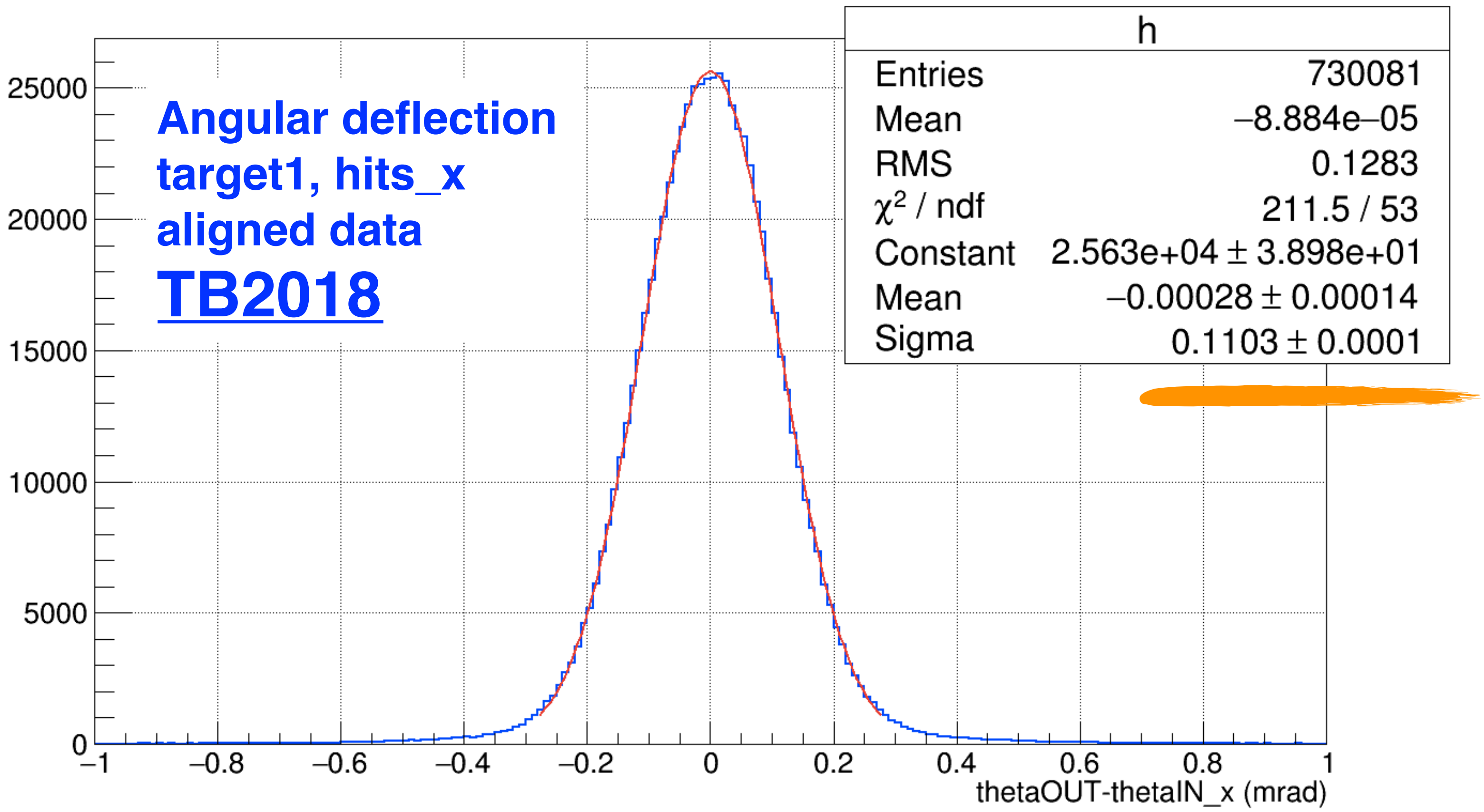
Angular resolution from TB2017 DATA



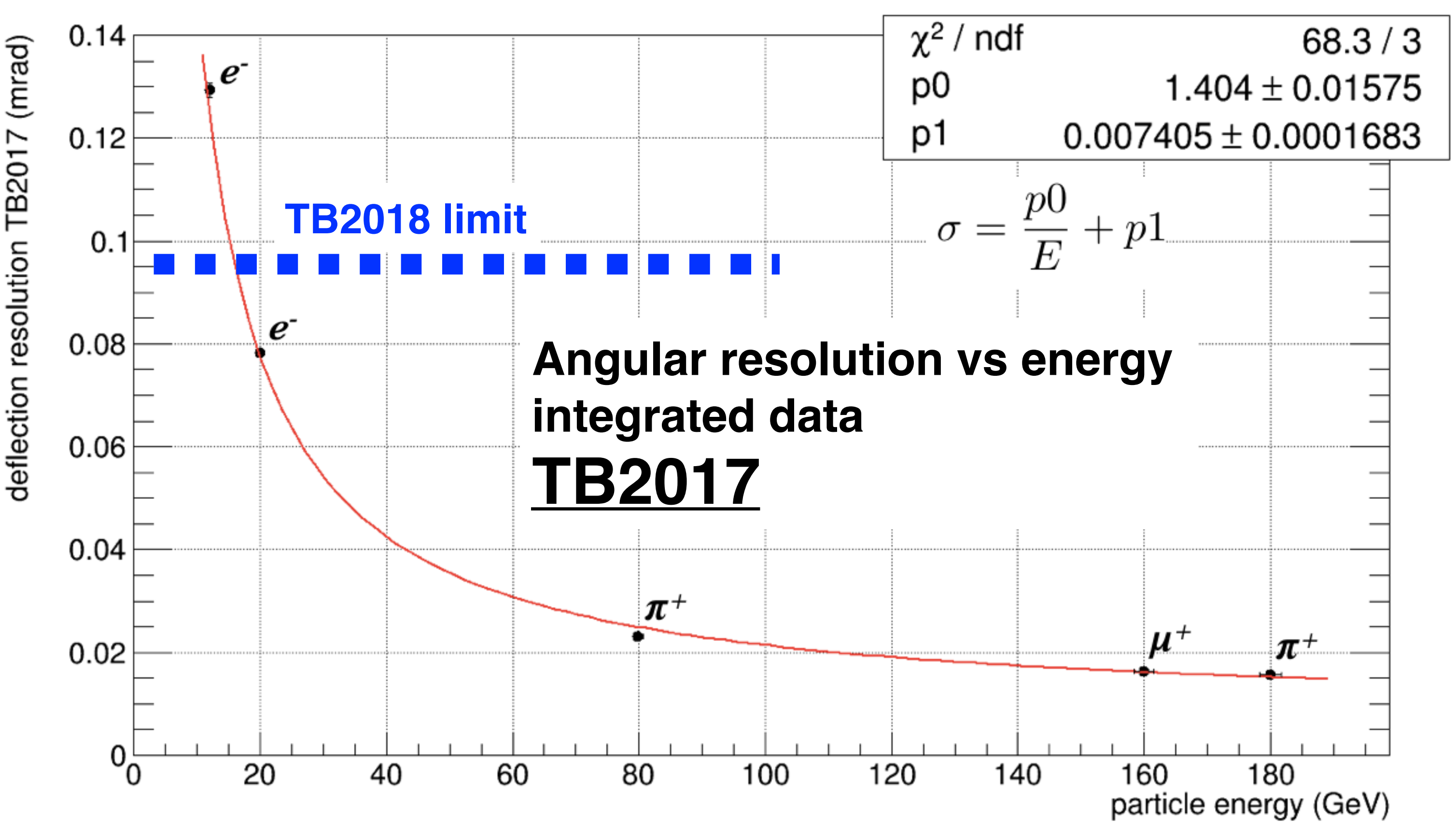
- "Apparatus angular resolution": convolution of multiple scattering and intrinsic trackers resolution.

$$\theta_{MS} \propto \frac{13.6}{E}\sqrt{\frac{d}{X_0}} \oplus \theta_i = \frac{\delta x_i \sqrt{2}}{L} \longrightarrow \Delta\theta = \sqrt{\theta_{MS}^2 + \theta_i^2}$$

Intrinsic resolution TB2018: AGILE sensors + apparatus

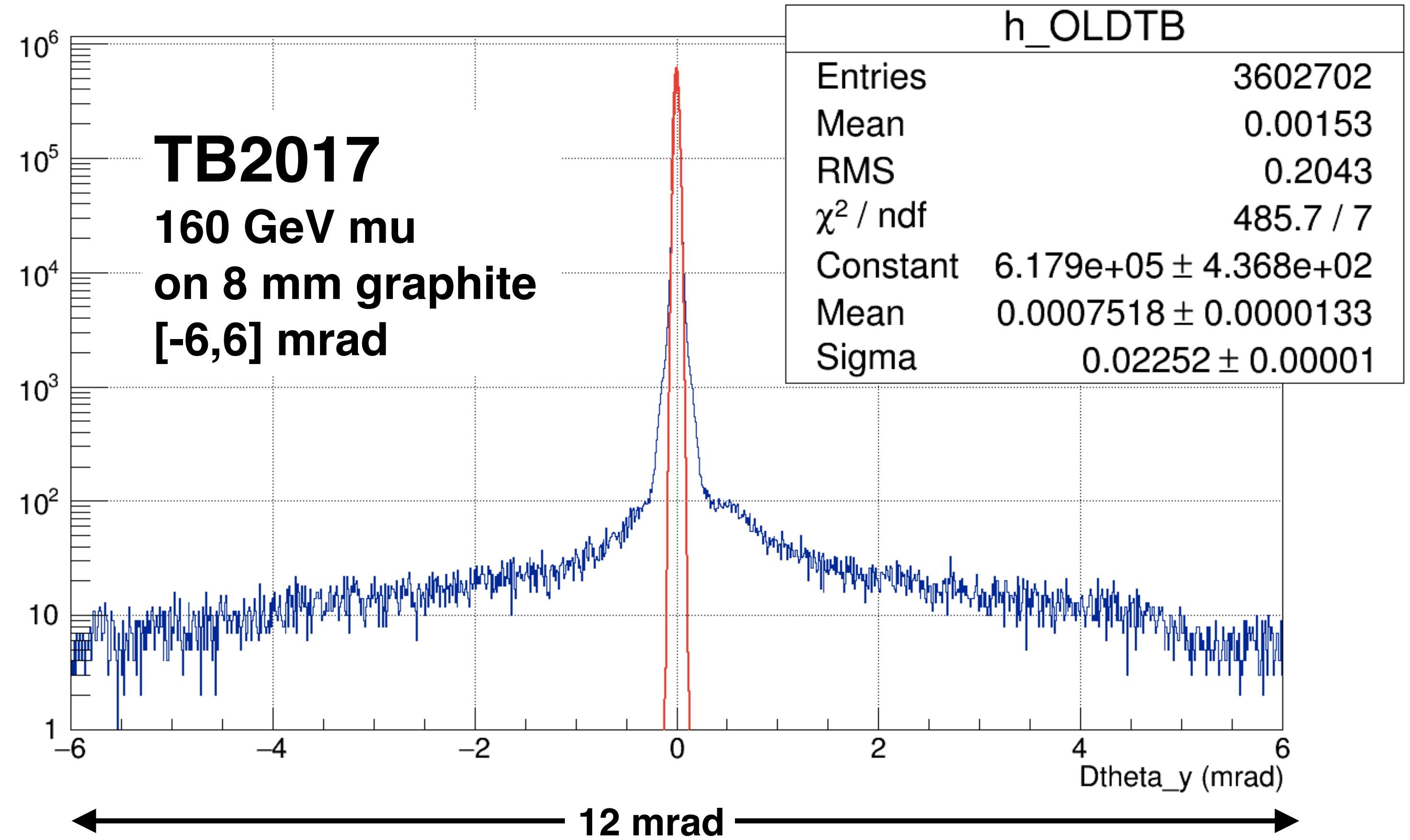


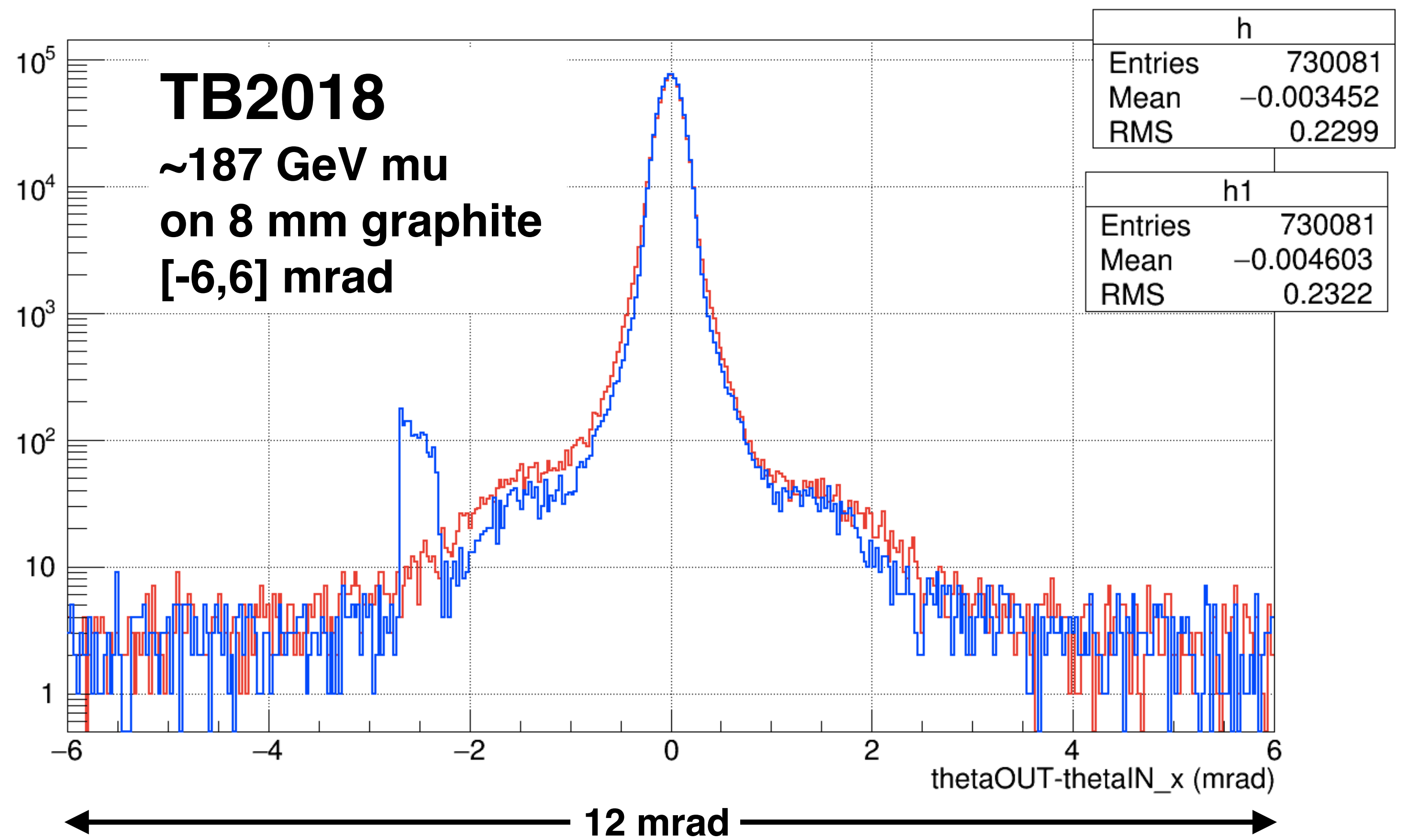
- For **~ 187 GeV** muon (sigma Highland MS):
  - 8 mm graphite **~ 0.012 mrad**
  - 4-5 Si layer of 410 um **~ 0.009 mrad**
  - sum in quadrature **~ 0.015 mrad** (not so different from pion data TB2017).
- Why sigma is now > 0.10 mrad? Because the intrinsic resolution of apparatus 2018 (pitch 242 um with floating strip, medium downstream arm ~ 50 cm) is:
  - 35 um * sqrt(2) / 50 cm **~ 0.10 mrad**



- With our previous dedicated apparatus to multiple scattering measure, we were able to see MSC of pions and muons over 150 GeV.
- Now, the second setup (**without target2**) should be able to achieve ~0.040-0.045 mrad of point resolution: we might see this difference on analysis of both data sets.

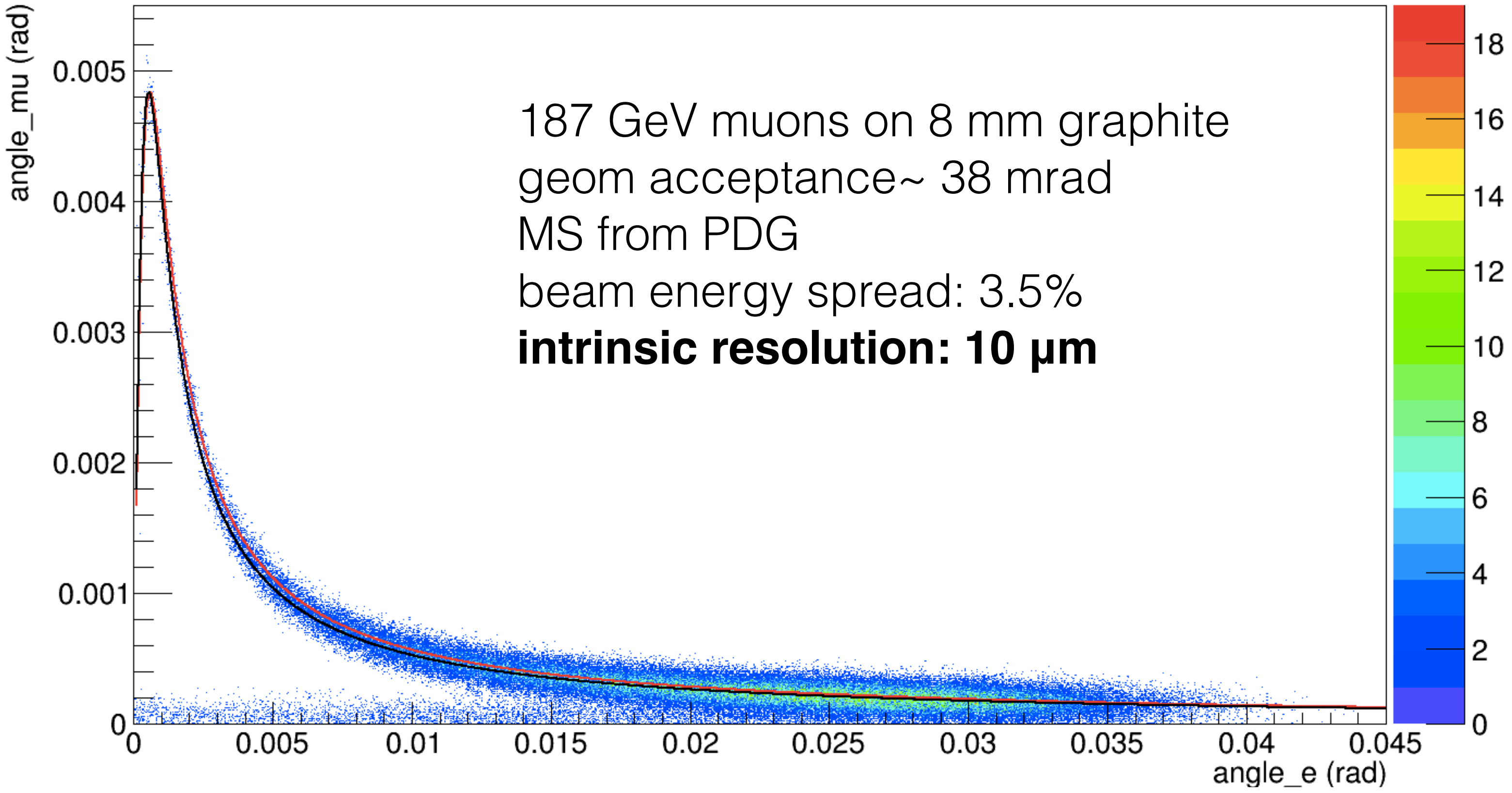
Angular deflection: TB2018 vs TB2017

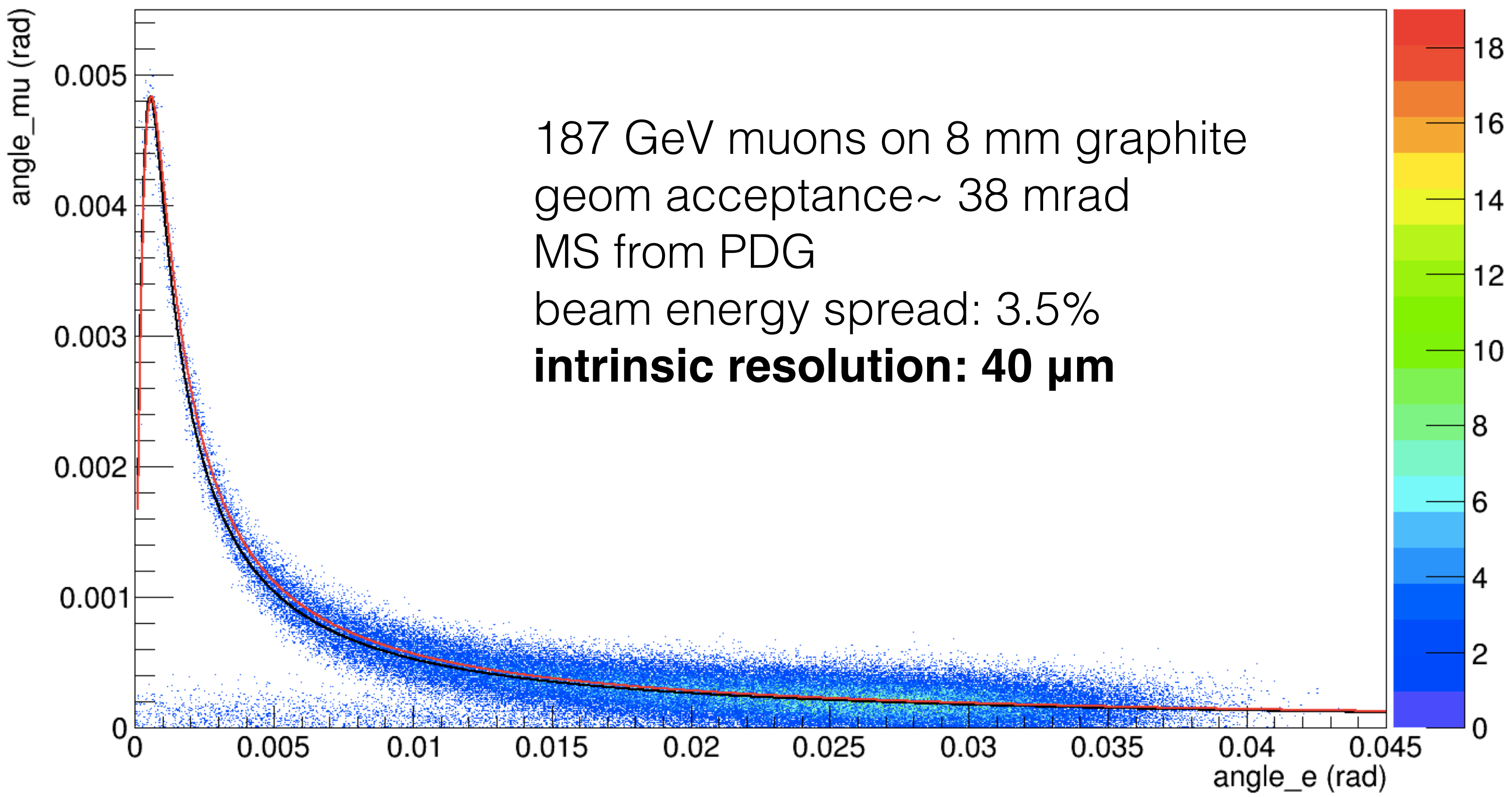




- Although greater energy, angular distribution of the 2018 muons looks like wider, due to the worst intrinsic angular resolution.

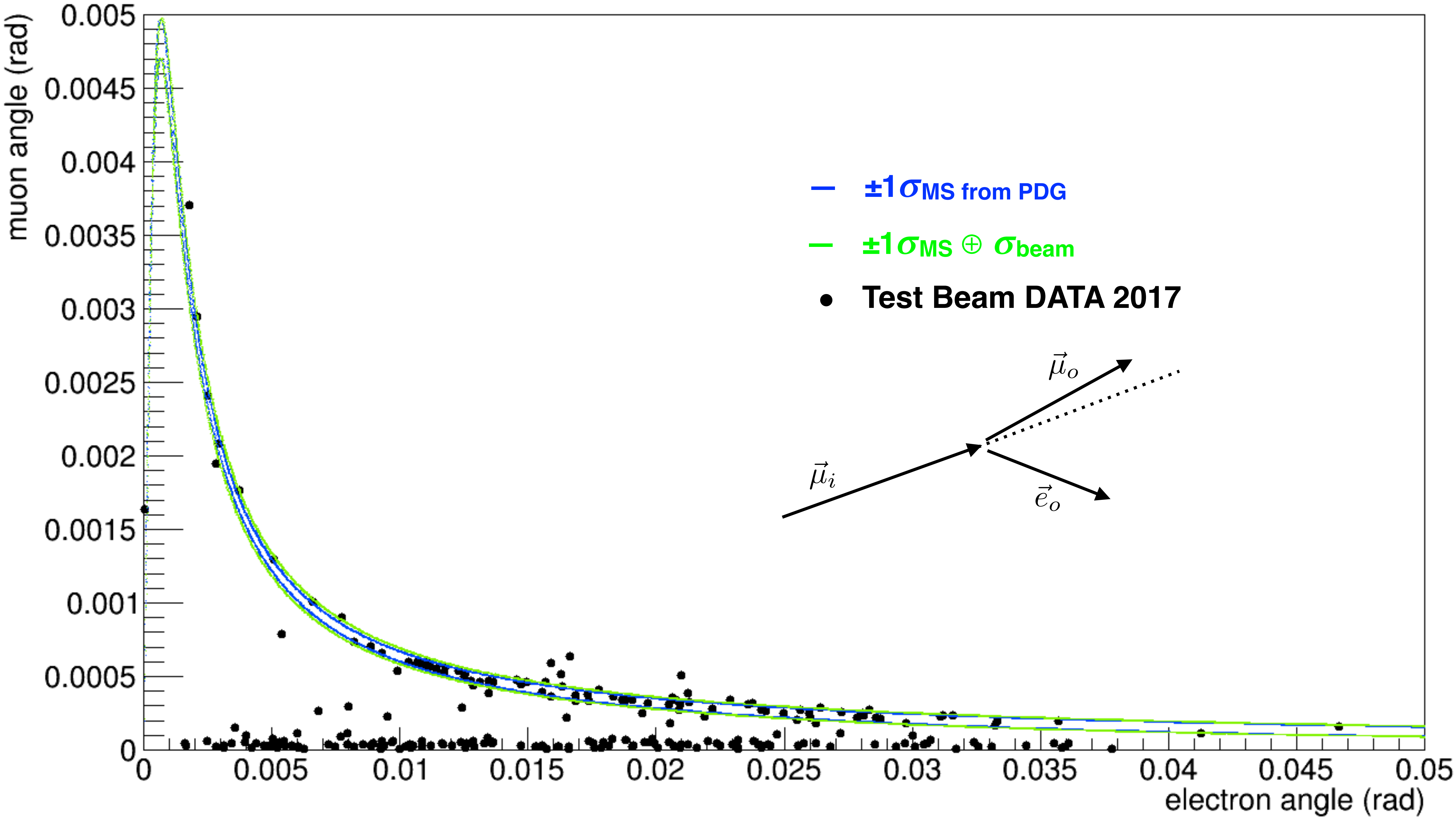
Monte Carlo comparison: 10 μm vs 40 μm





- Toy-MC: only elastic events, no background.
- Comparison between 10 μm / 40 μm of point resolution of trackers.

Correlation plot mu-e, test beam 2017



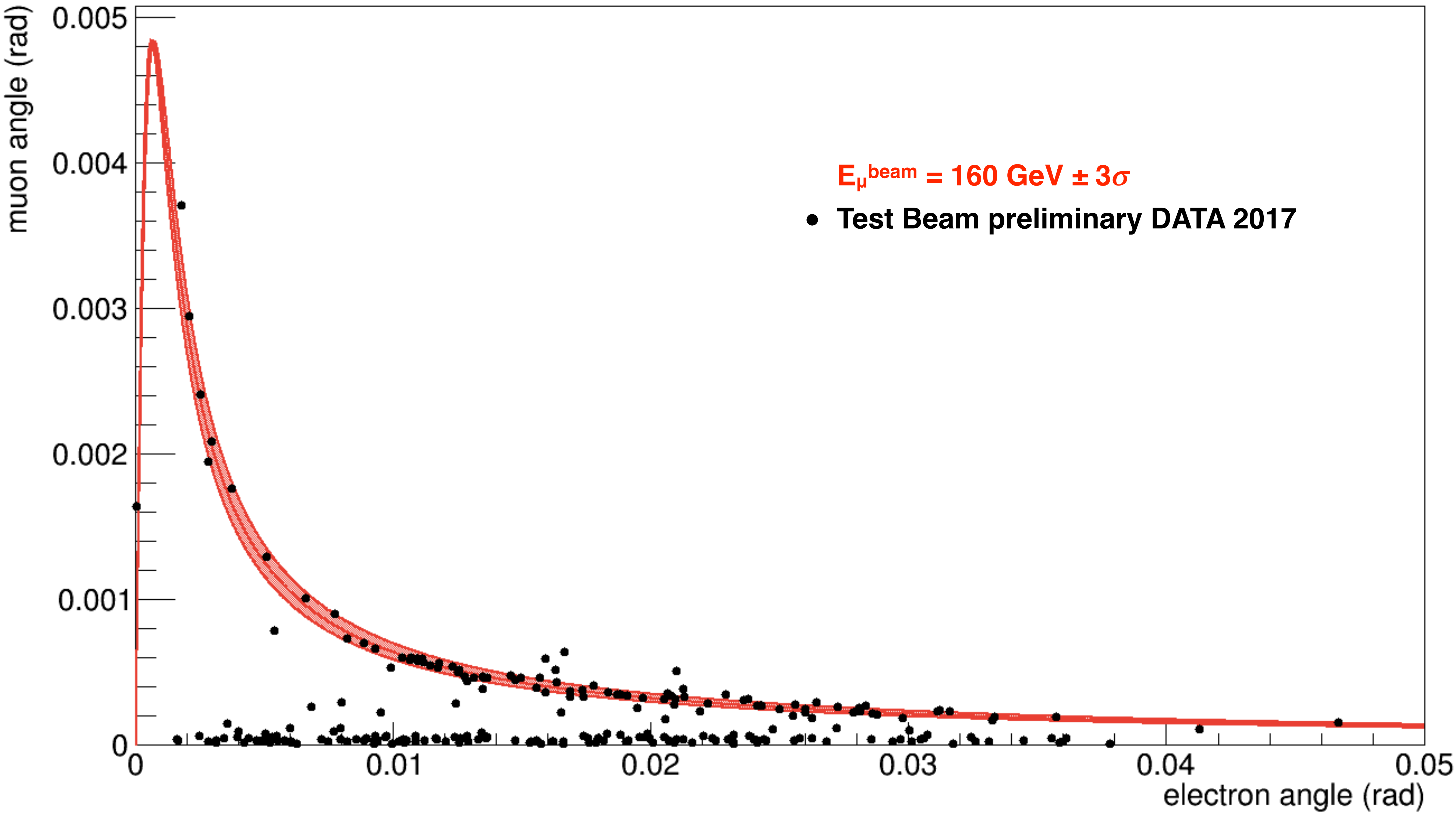
- Although this setup was dedicated to other measures, the signal seems relevant.
- Test beam 2018 is under analysis: analyzed statistics is still too low, but the effect of the worst intrinsic resolution on the points dispersion is already clear.

Conclusions

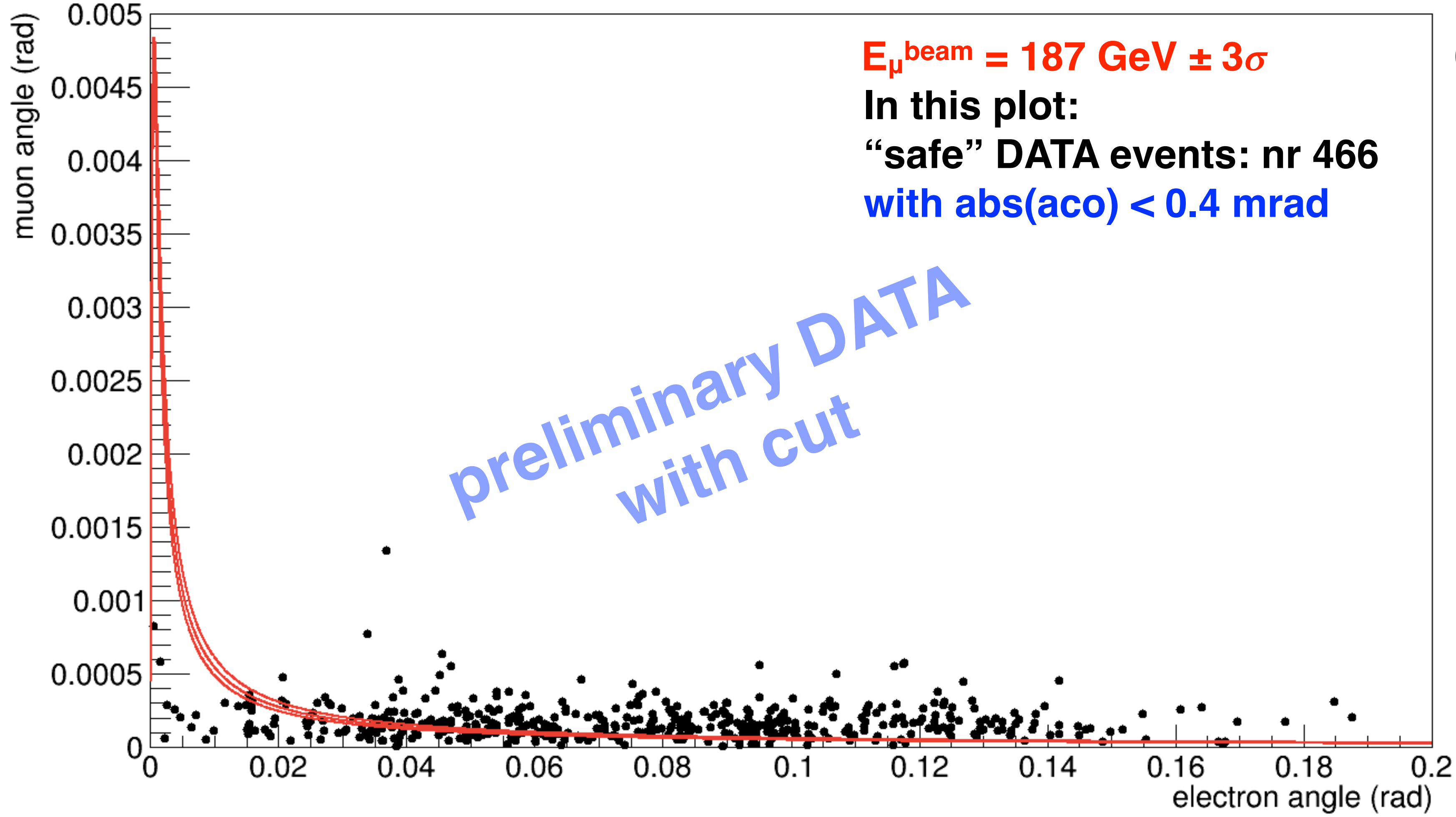
- The apparatus resolution will clearly play a fundamental role in this experiment: I have shown you very briefly what the impact of different resolutions is.
- The sensors thickness are not so different for our two test beams: Geant4 simulations of complete apparatus are ongoing to answer the question of what it is the best choice for MUonE.
- We are analyzing new data: alignment, tracking, pattern reco… so first results with higher statistics will come soon!

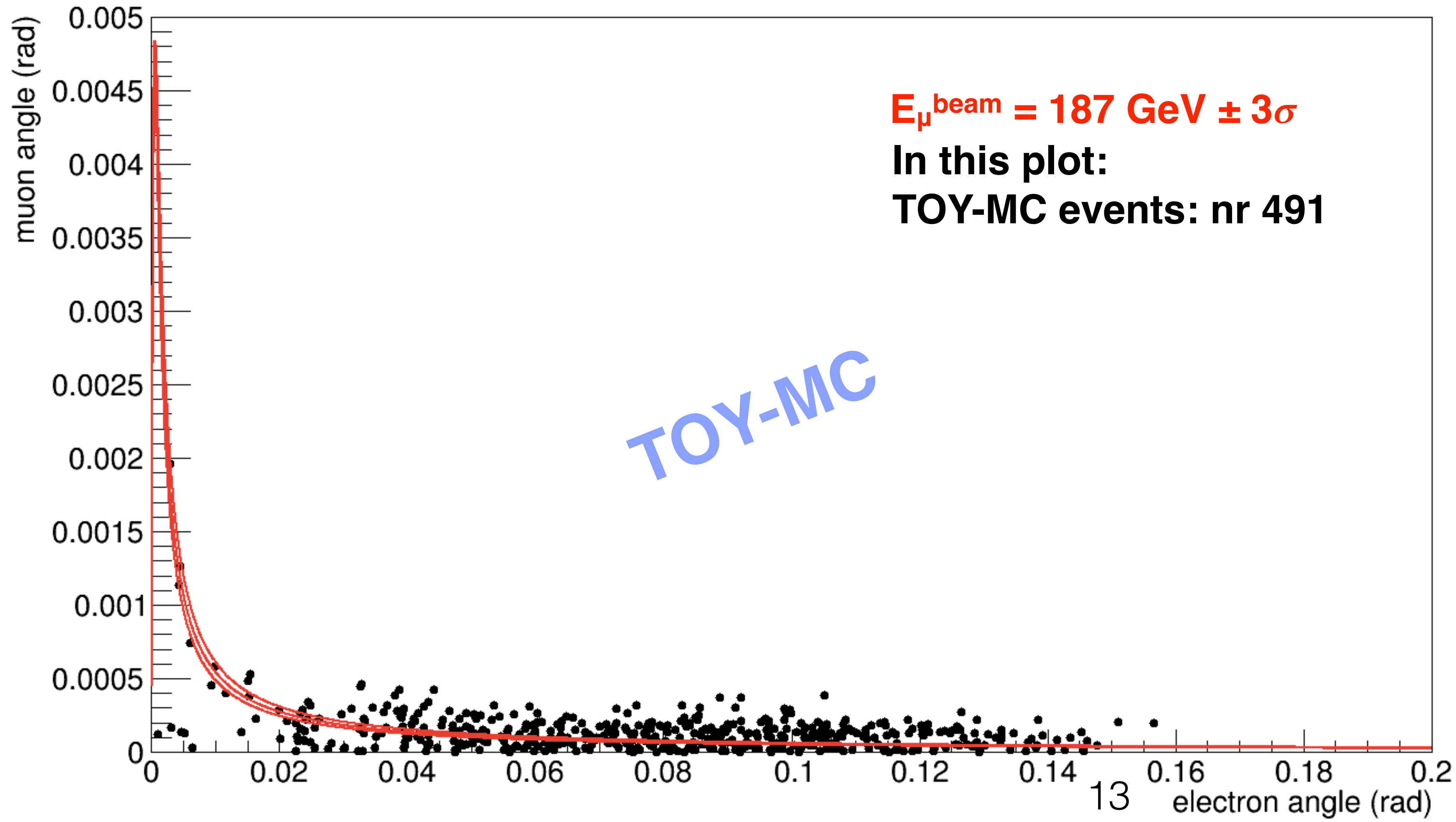
Backup slides

Effect of beam spread



Comparison new data / MC first analysed run TB2018





- Too low analysed statistics to make some comments, but a simple simulation shows a similar qualitative behavior.
- In particular geometrical acceptance is about 150 mrad.

Comparison new data MC first analysed run TB2018