Transverse Profiles Analysis
- Update -

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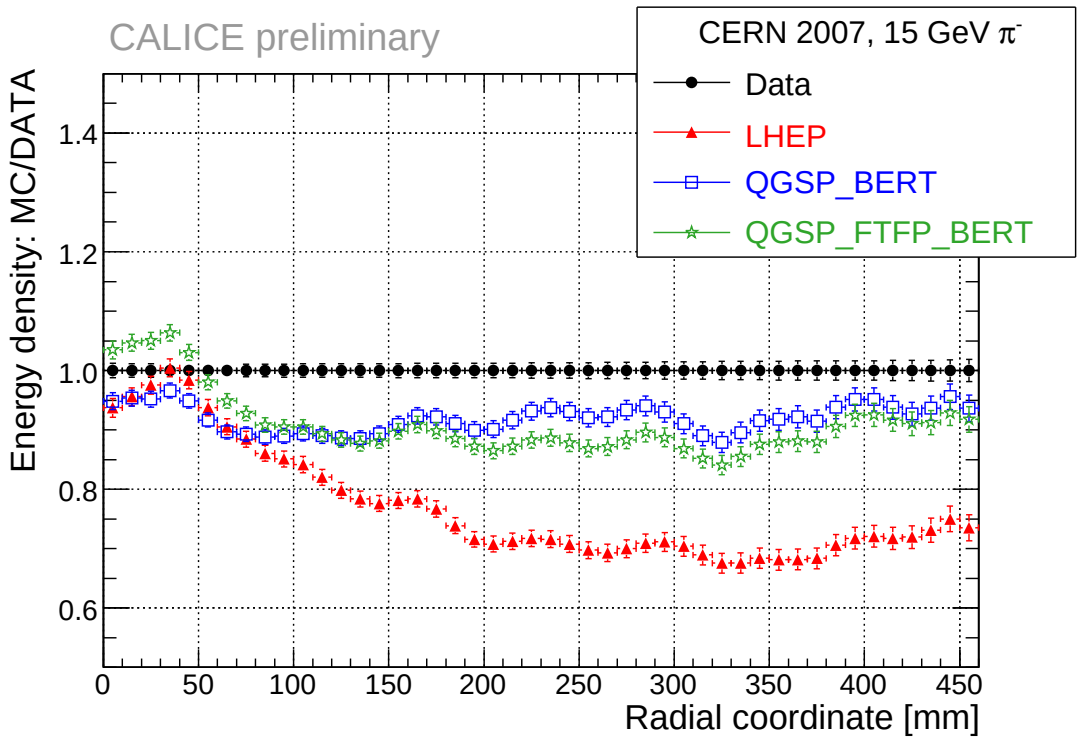
Overview

Reminder

- Profile done with respect to the track, i.e. axis of the shower:

$$\text{Radial coordinate} = \sqrt{(x_{HCAL} - x_{track})^2 + (y_{HCAL} - y_{track})^2}$$

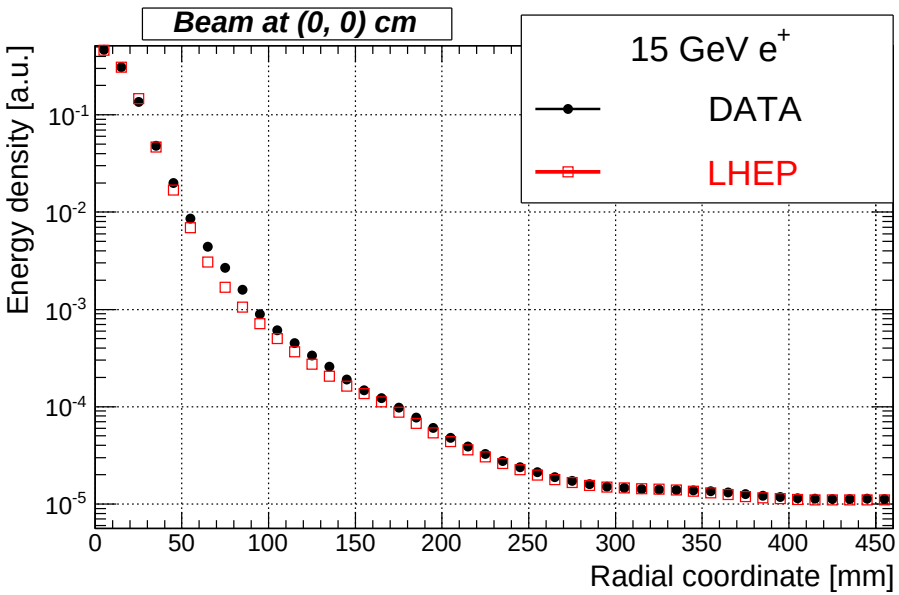
- Results of **transverse profiles in hadron showers** presented in CAN-011-e
- Non-flat behaviour of MC/data ratio not explained

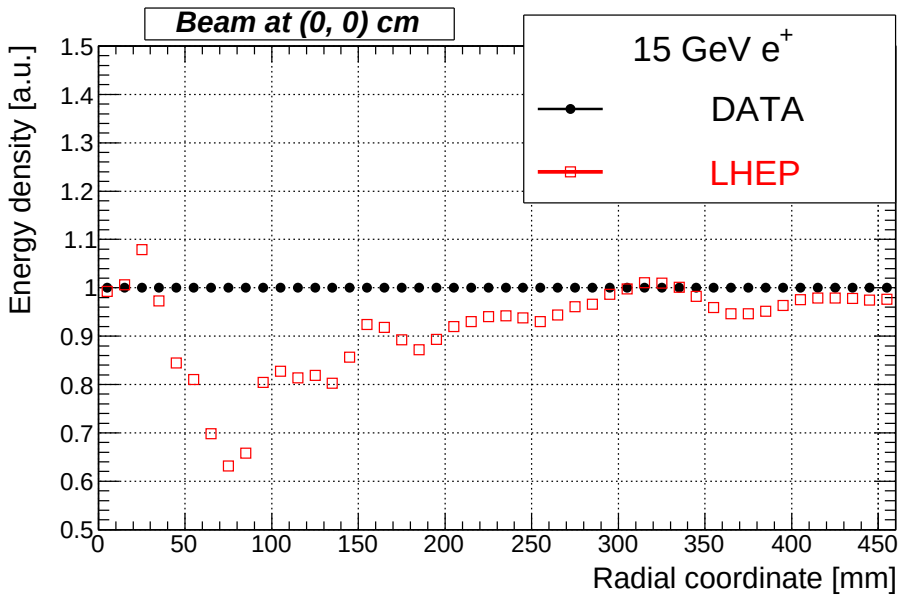


- In the following slides: concentrate on **electromagnetic showers** and check the situation there

Transverse Profiles in EM Showers

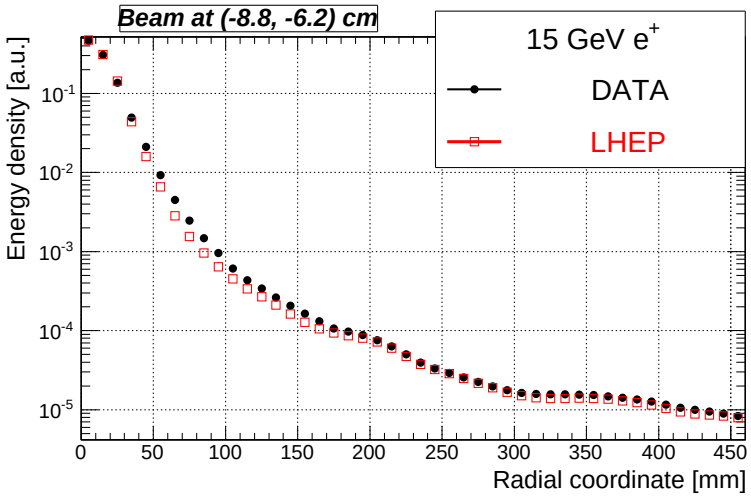
- Transverse profile ratio of MC/data for **positrons** also non-flat (but opposite direction compared to the pion case)
- Only LHEP shown, but QGSP_BERT similar

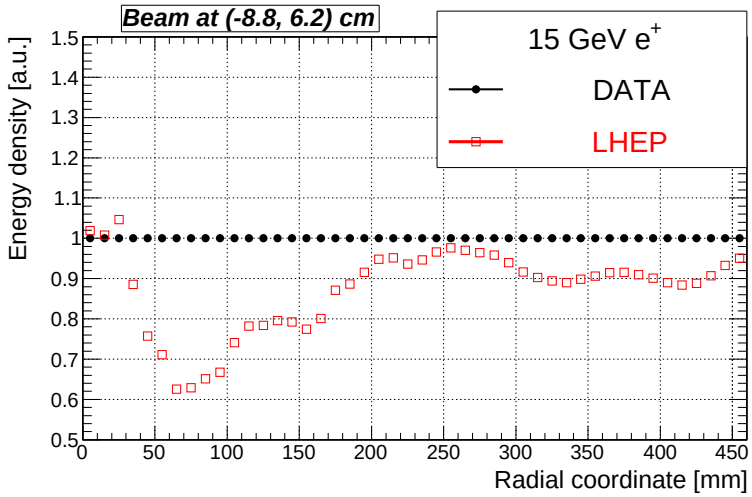


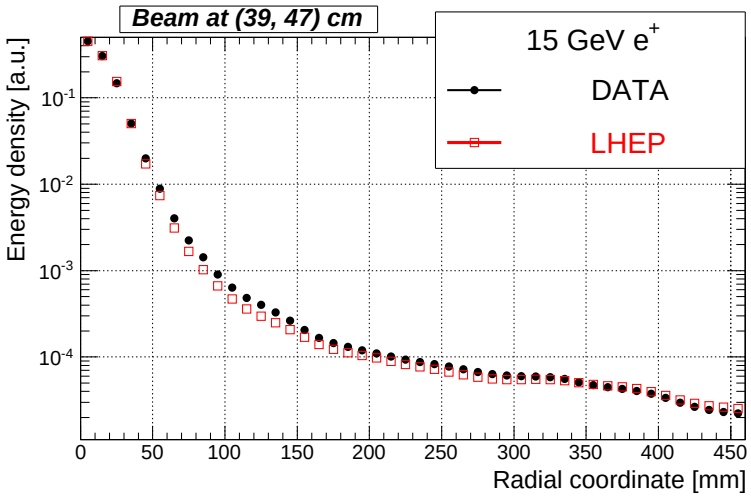


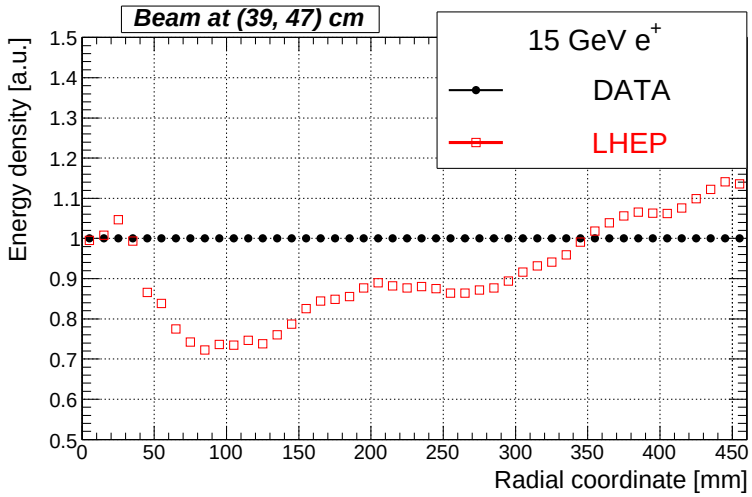
1) Detector Effects

- Check for possible detector effects by comparing runs with beam at (0, 0) with beams at another position



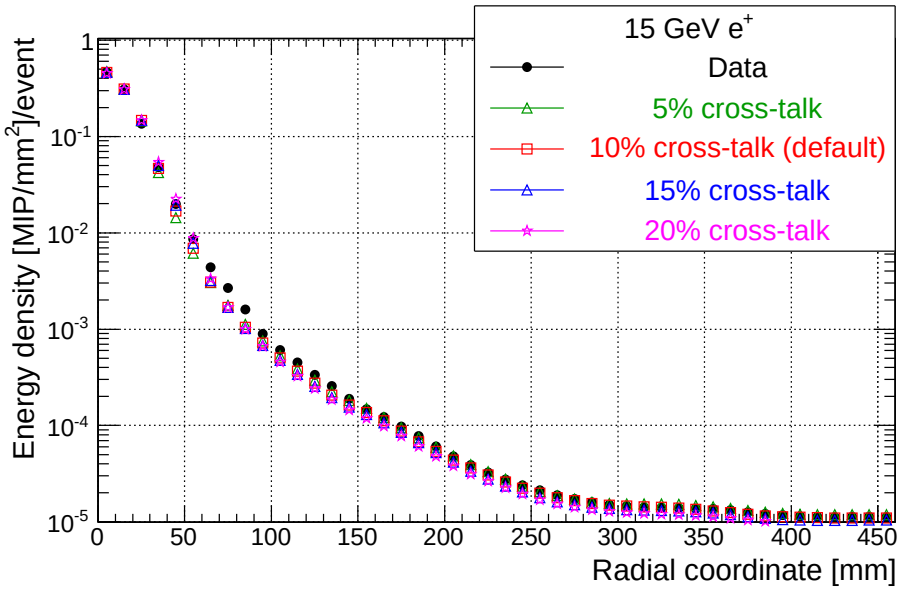


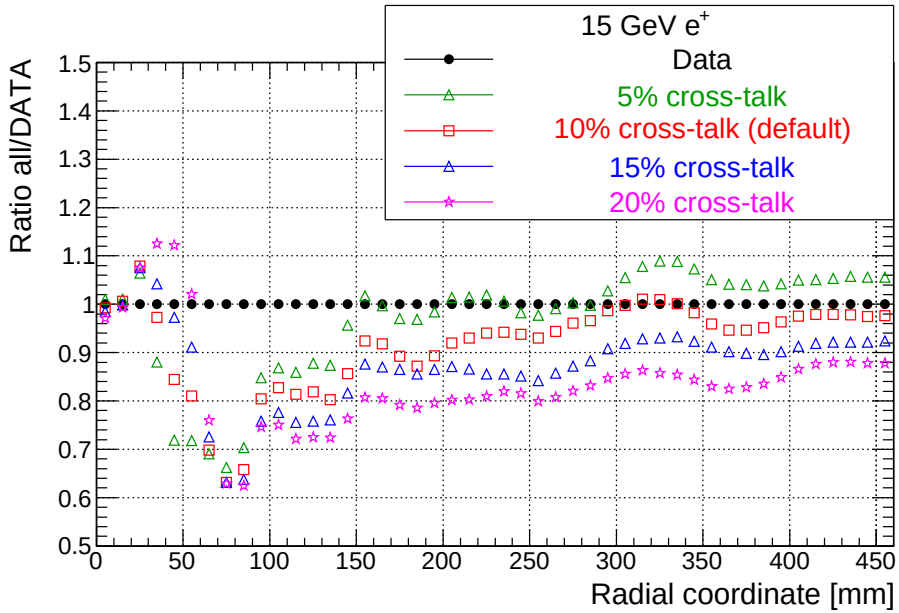




2) Effect of Cross-talk

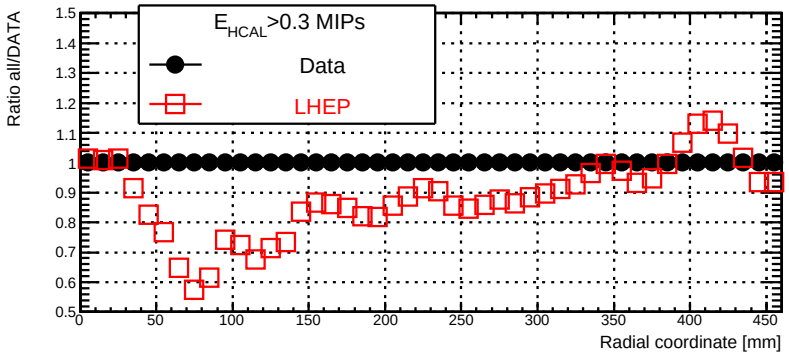
- Light cross-talk between the AHCAL tiles introduced in digitisation
- Default: 10 % cross-talk, i.e. 2.5% of the energy of one tile goes into each of the 4 neighbouring tiles

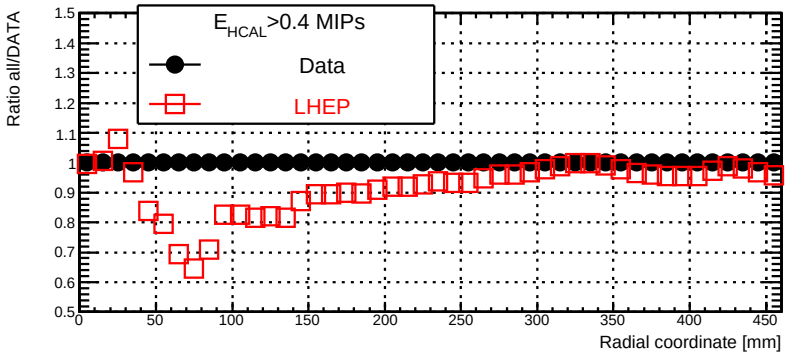


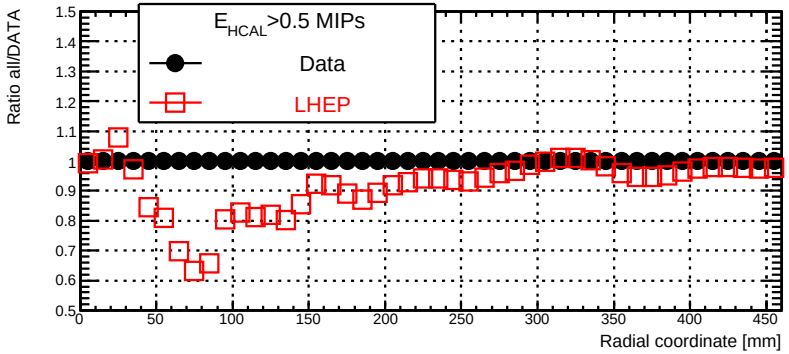


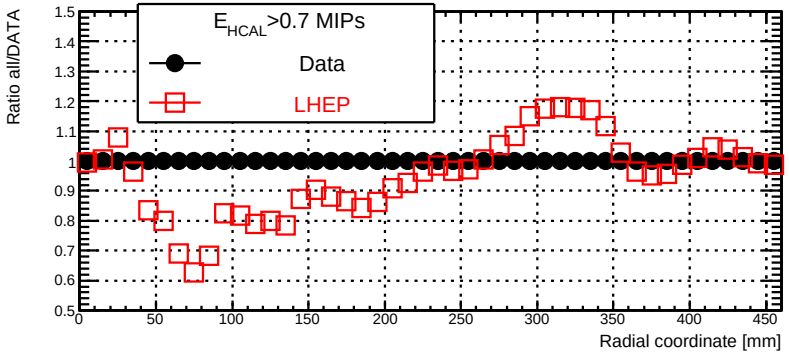
- Cross-talk value has minimal impact on the drop seen between 5 and 10 cm

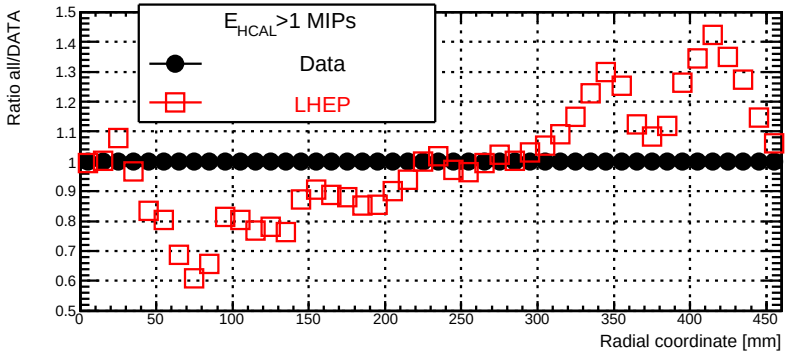
3) Effect of the MIP Cut Value





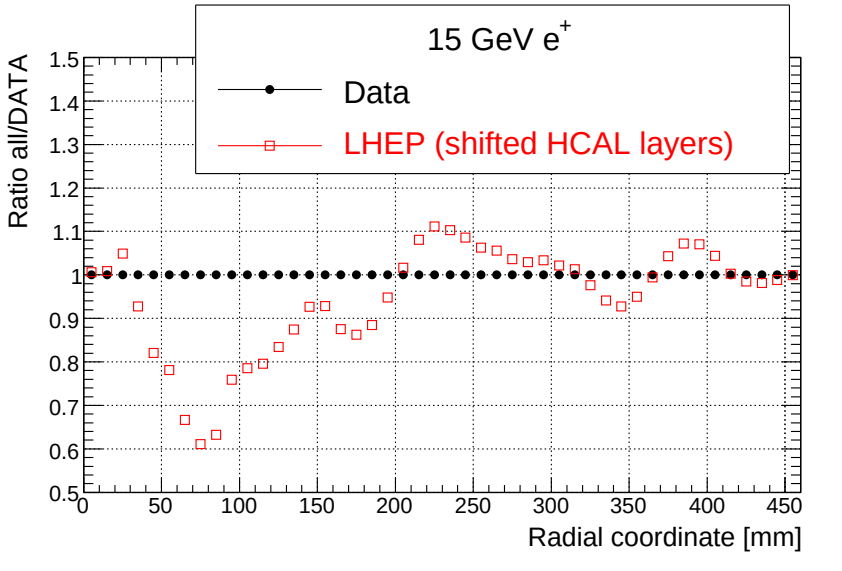






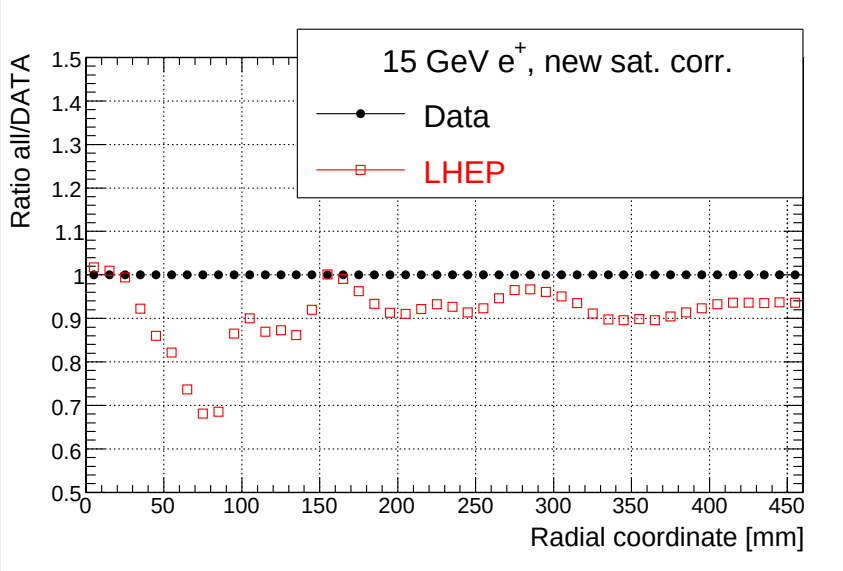
4) Shifted HCAL layers:

- Experiment: HCAL layers not perfectly aligned (spread of around 5 mm)
- $\Rightarrow$ Shift HCAL layers in Mokka, randomly, with a spread of 6 mm



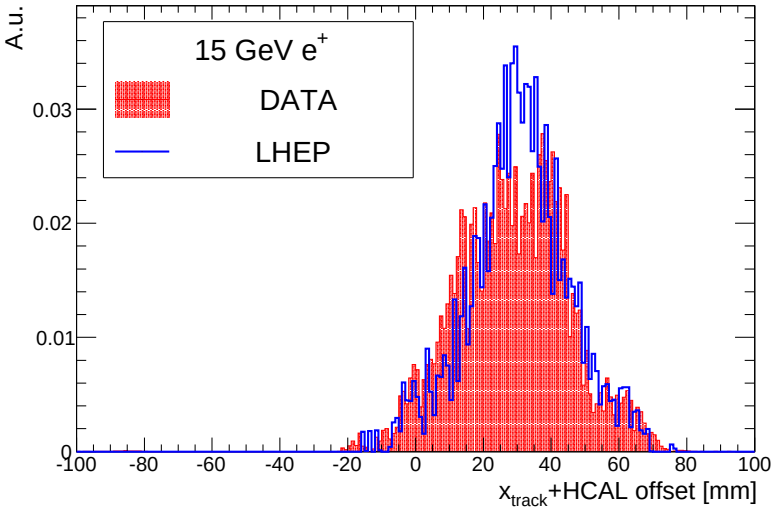
5) Saturation Correction:

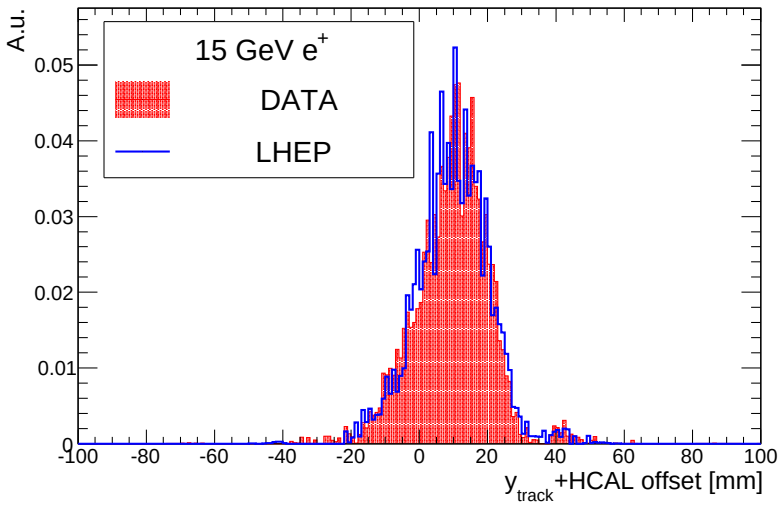
- New treatment of saturation correction (double exponential fit of saturation curve)

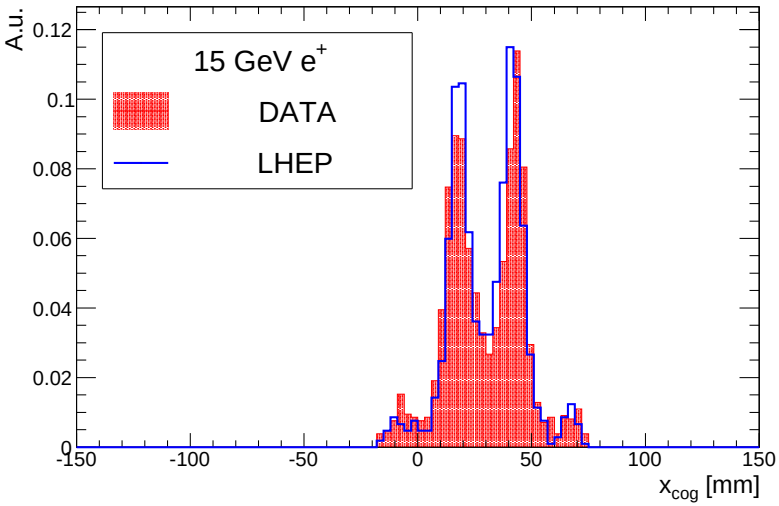


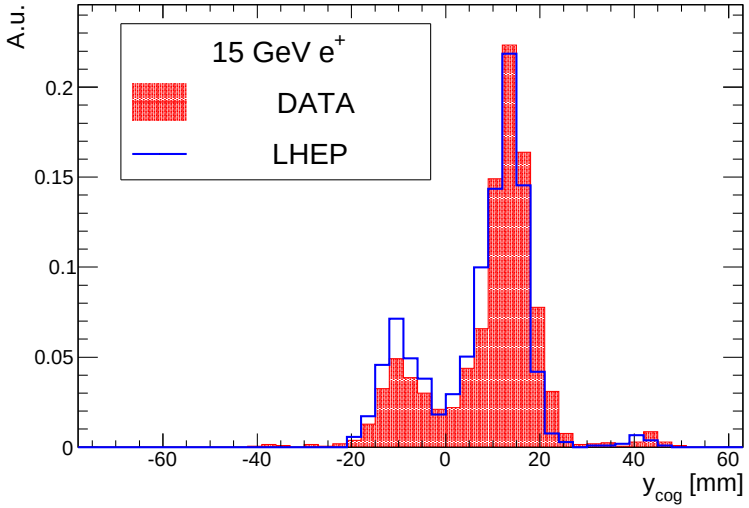
6) Shape of the Beam Profile

- Beam profile in Monte Carlo biased using information from experimental data (based on the GEANT4 **global particle source**)



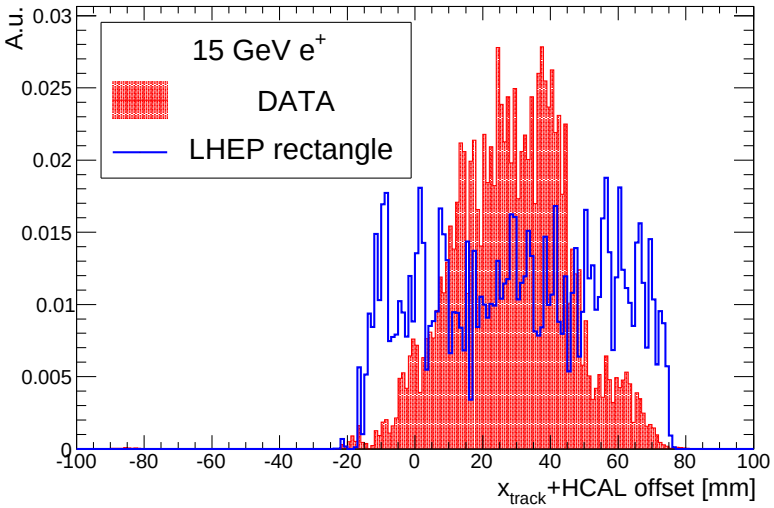


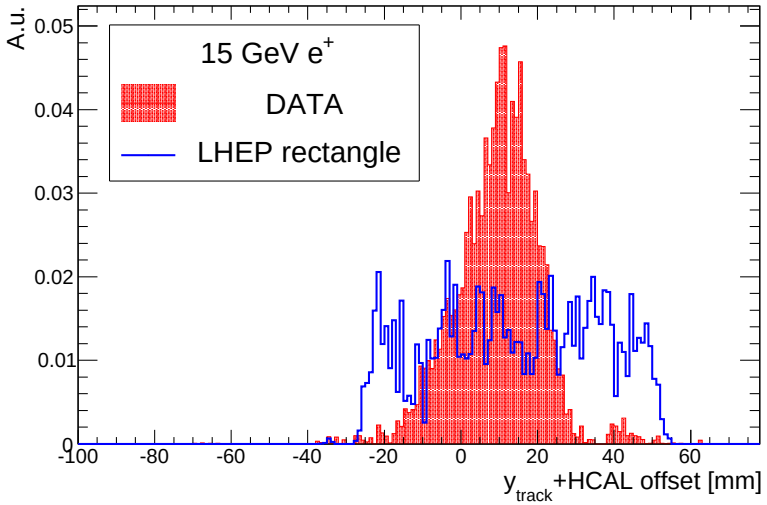


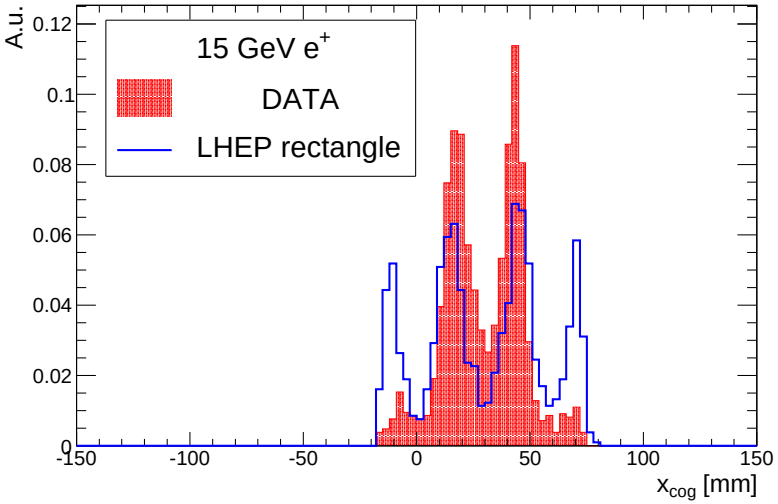


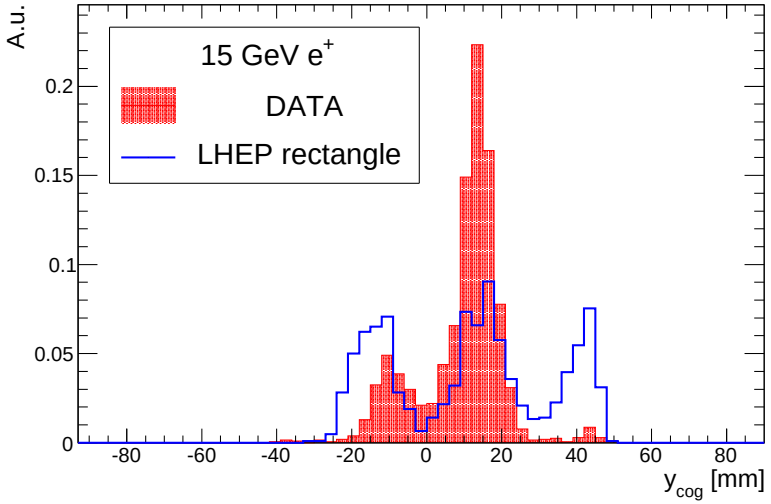
6) Shape of the Beam Profile - continued

- Default: beam profile in Monte Carlo just a simple **rectangle**



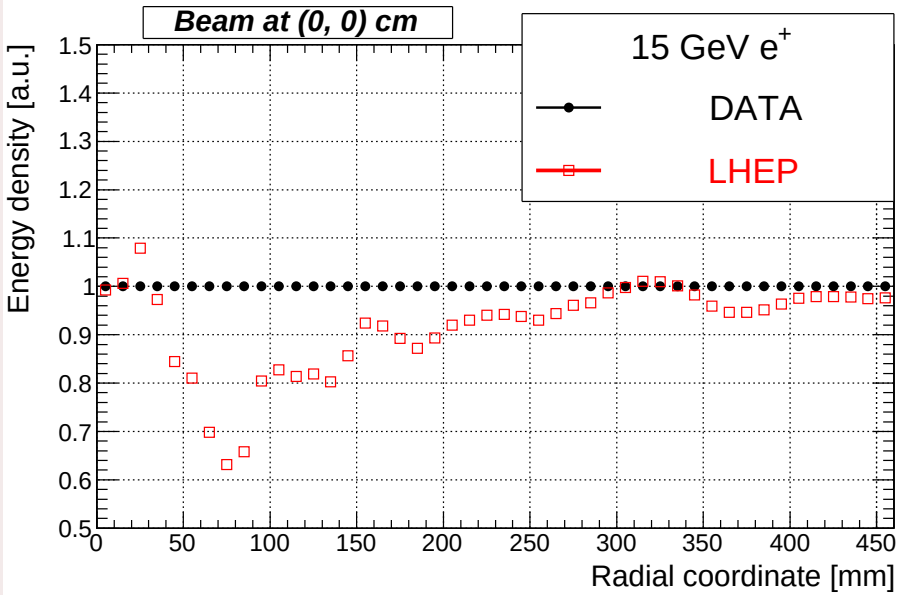




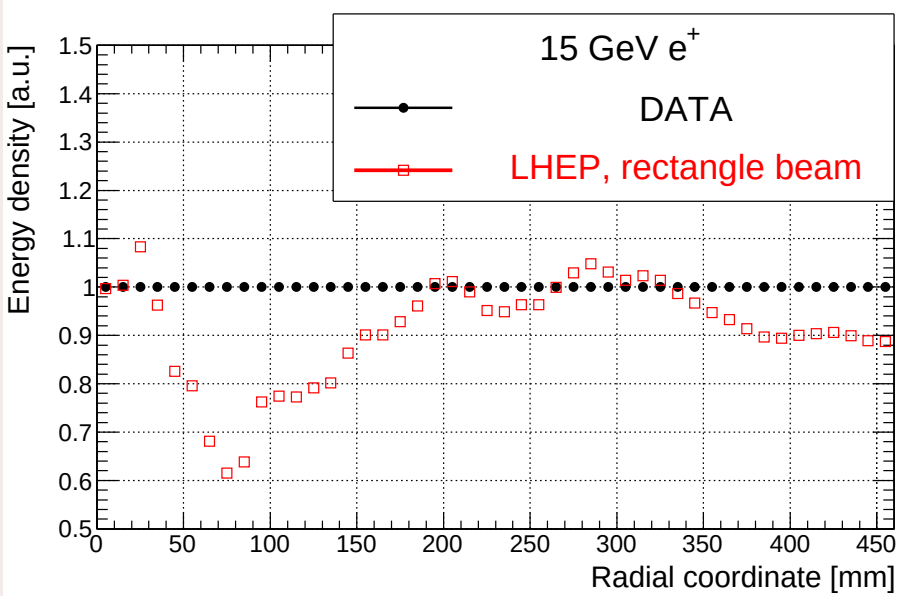


6) Shape of the Beam Profile - continued

Beam profi le from data



Beam profi le just rectangle

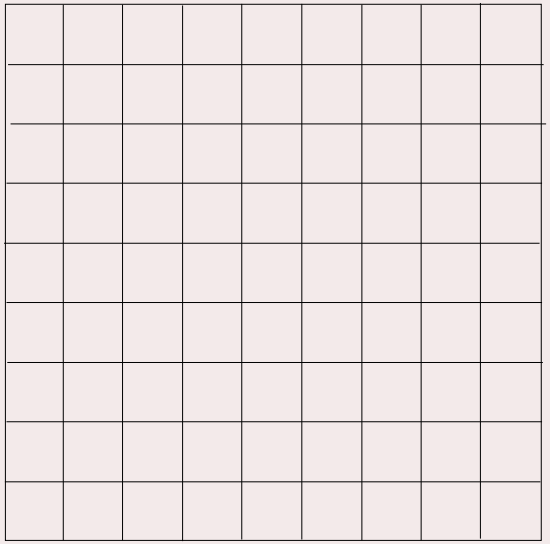


- Shape of the beam profile has little impact on the drop seen between 5 and 10 cm

7) Effect of the Mokka Implementation

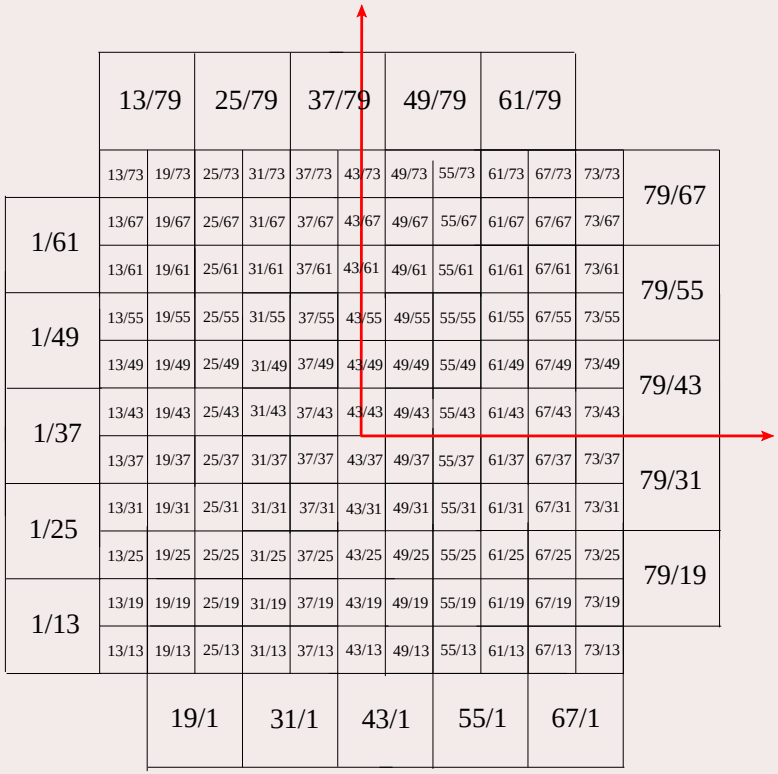
Default Mokka:

- 900 virtual cells, $1 \times 1\ \mathrm{cm}^2$ each
- Grouped in larger cells during digitisation

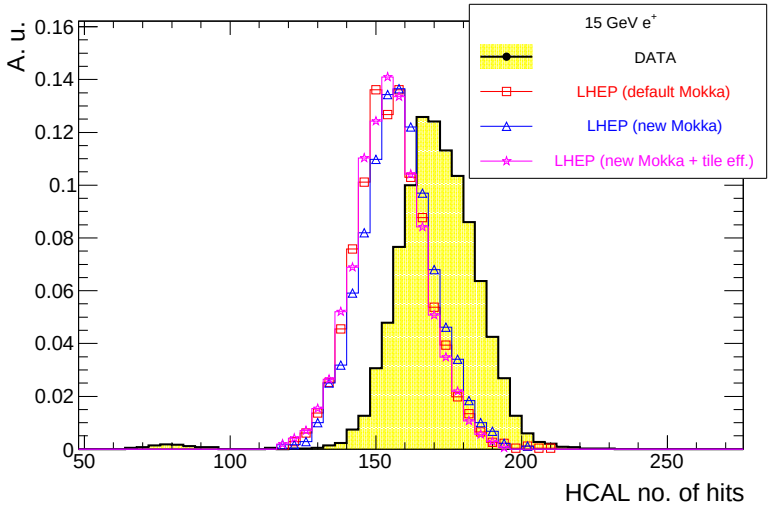


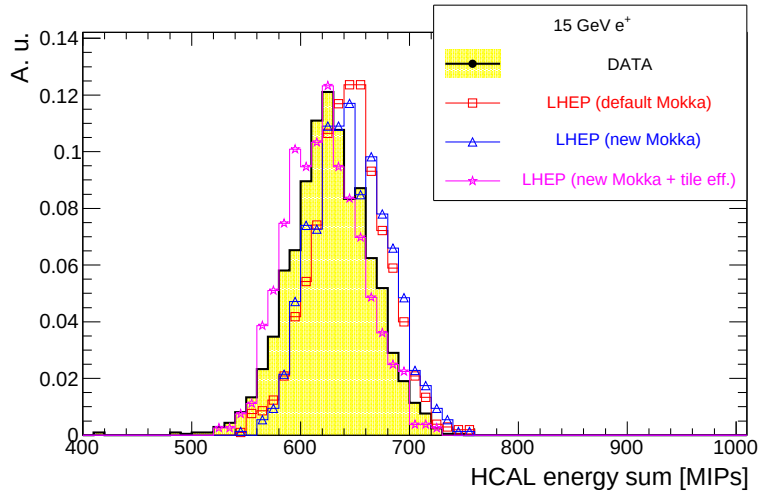
Private Mokka:

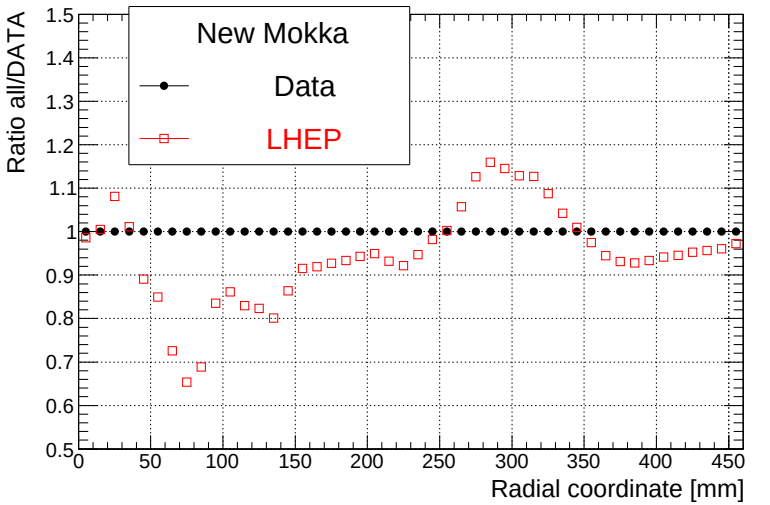
- Separate volumes for each $3 \times 3\ \mathrm{cm}^2$, $6 \times 6\ \mathrm{cm}^2$ and $12 \times 12\ \mathrm{cm}^2$ cells
- *New Mokka + tile efficiency:* simulated tile inefficiency (i.e. hits close to the margin of the tiles deposit only approx 80% of their energy)

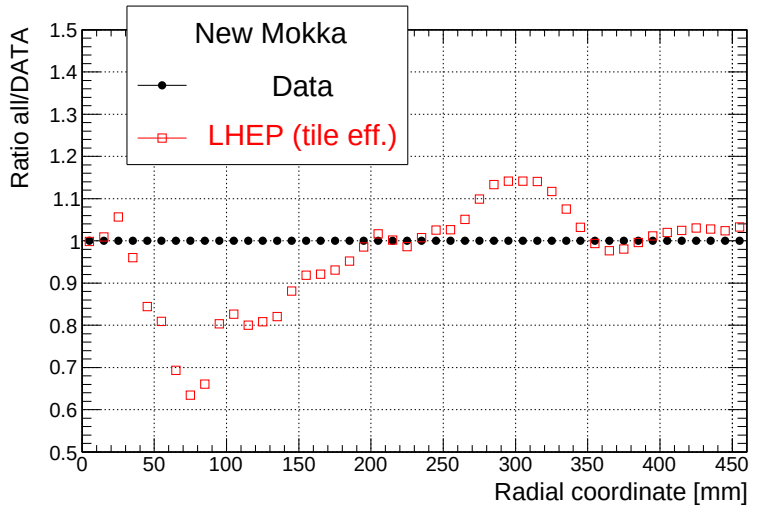


7) Effect of the Mokka Implementation - continued







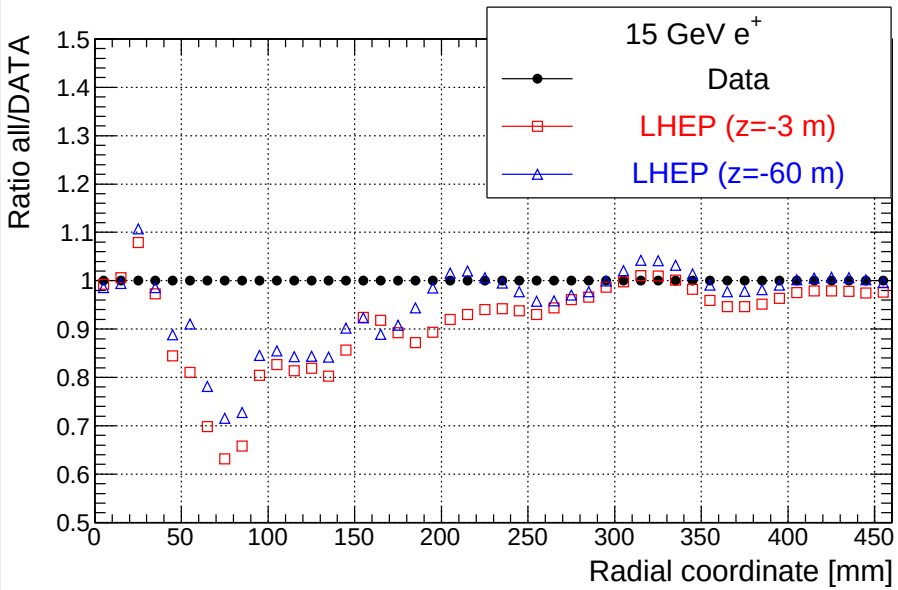


- Drop between 5 and 10 cm present also for the new Mokka implementation...

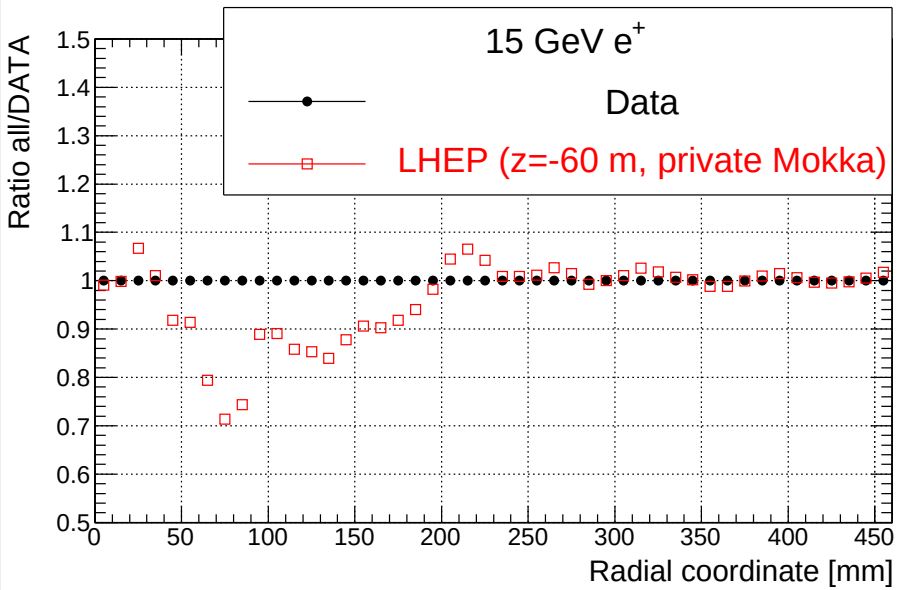
8) Gun Position in Monte Carlo

- My default: particle gun positioned at $z = -3$ m, i.e. in front of the most upstream drift chamber (good beam profile)
- David's suggestion: use $z = -60$ m, maybe effect from soft neutrons

Default Mokka:



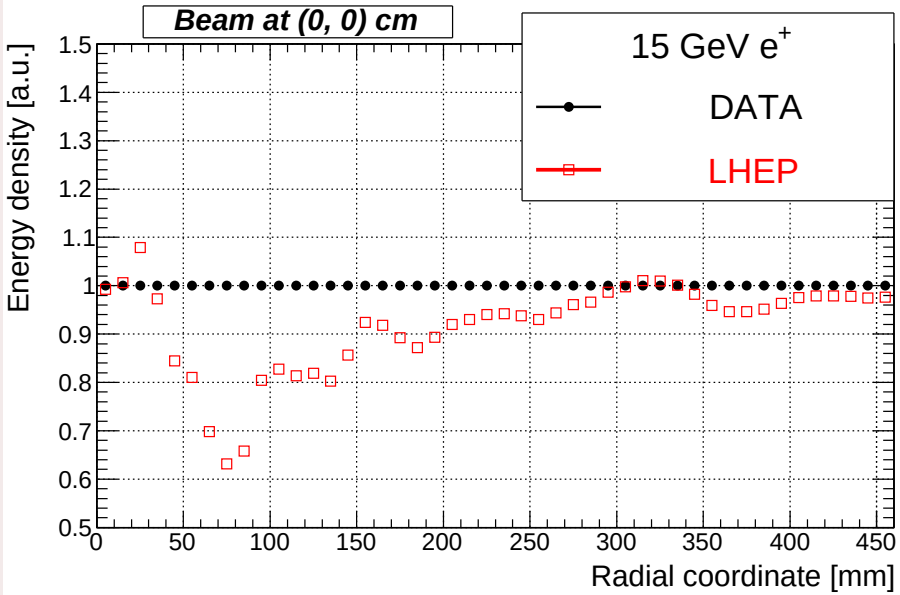
Private Mokka version:



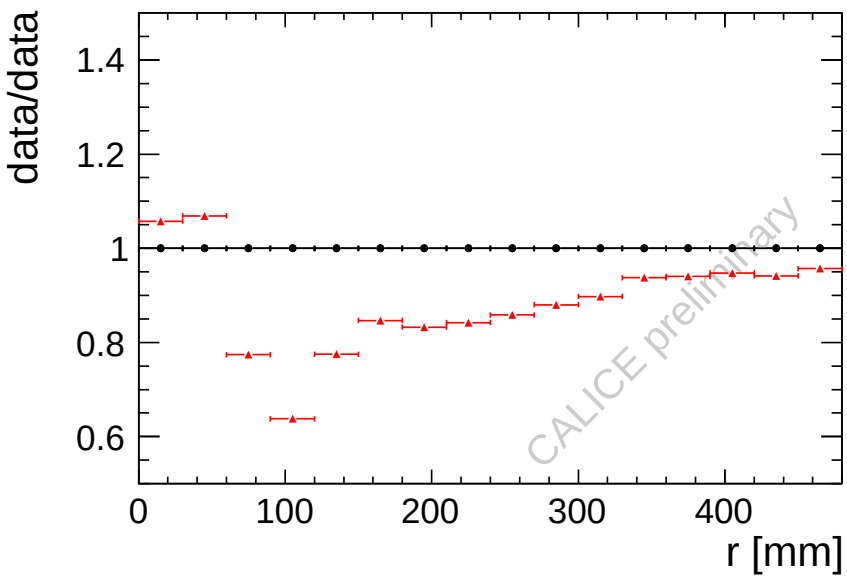
- Soft electrons soften the effect by about 10%, but not the final solution yet

9) Software Used to Calculate the Transverse Energy Density

Angela:



Beni:



- The software does not cause the drop
- Mistake/feature most probably in the files itself (digitisation, calibration?)

Conclusions

- Transverse profiles with e^+ in AHCAL
- Different studies done to identify source of non-flat behaviour of MC/data ratio:
  - detector effects (due to active tile)
  - cross-talk effect
  - MIP cut
  - alignment of AHCAL layers (thanks to Niels)
  - treatment of saturation correction (many thanks to Niels)
  - shape of the beam profi le
  - Mokka implementation
  - gun position
  - software used to measure transverse energy density (thanks to Beni)
- Unfortunately no solution yet
- Any ideas/suggestions/critics are wellcome