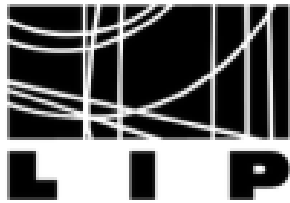


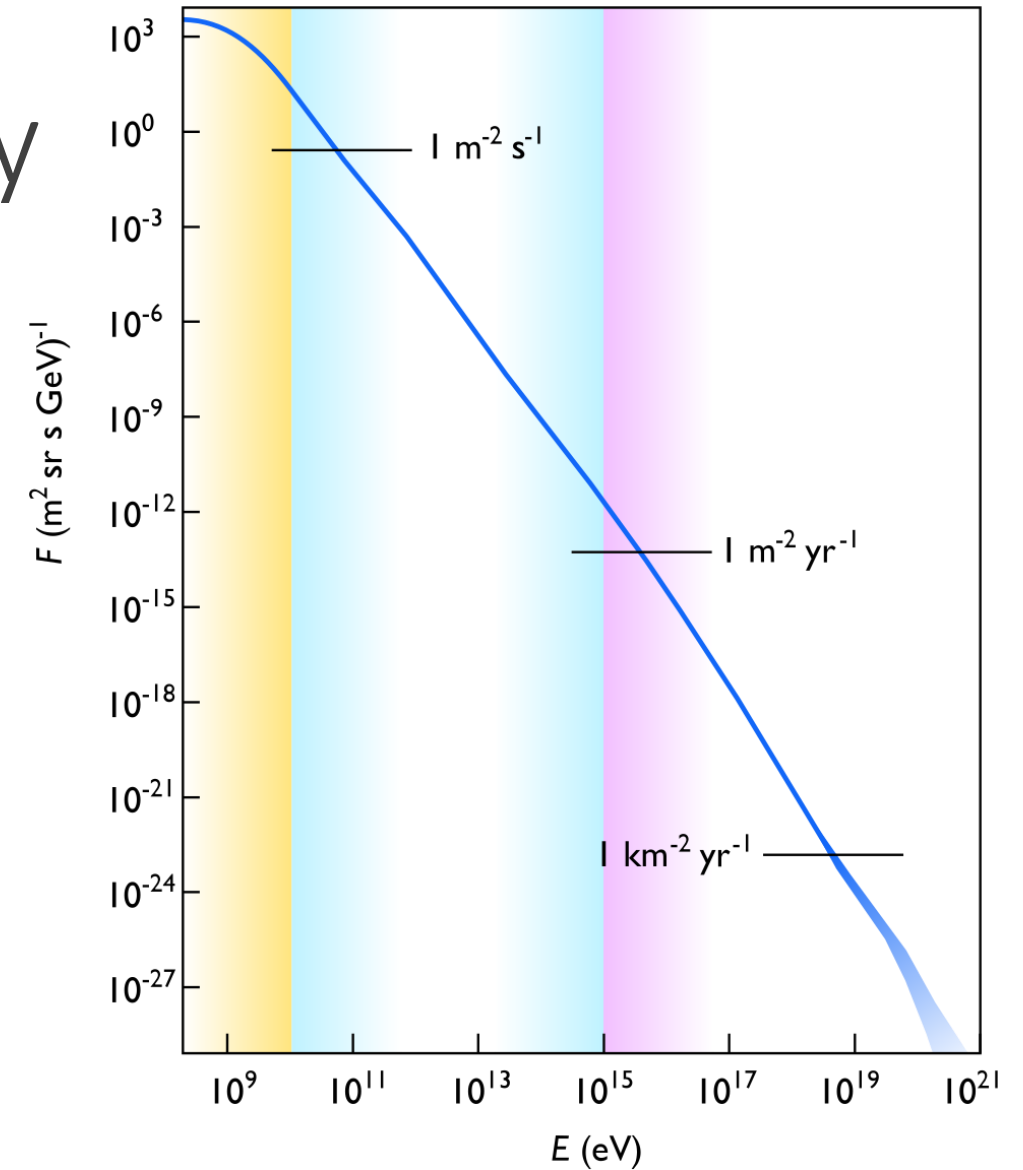
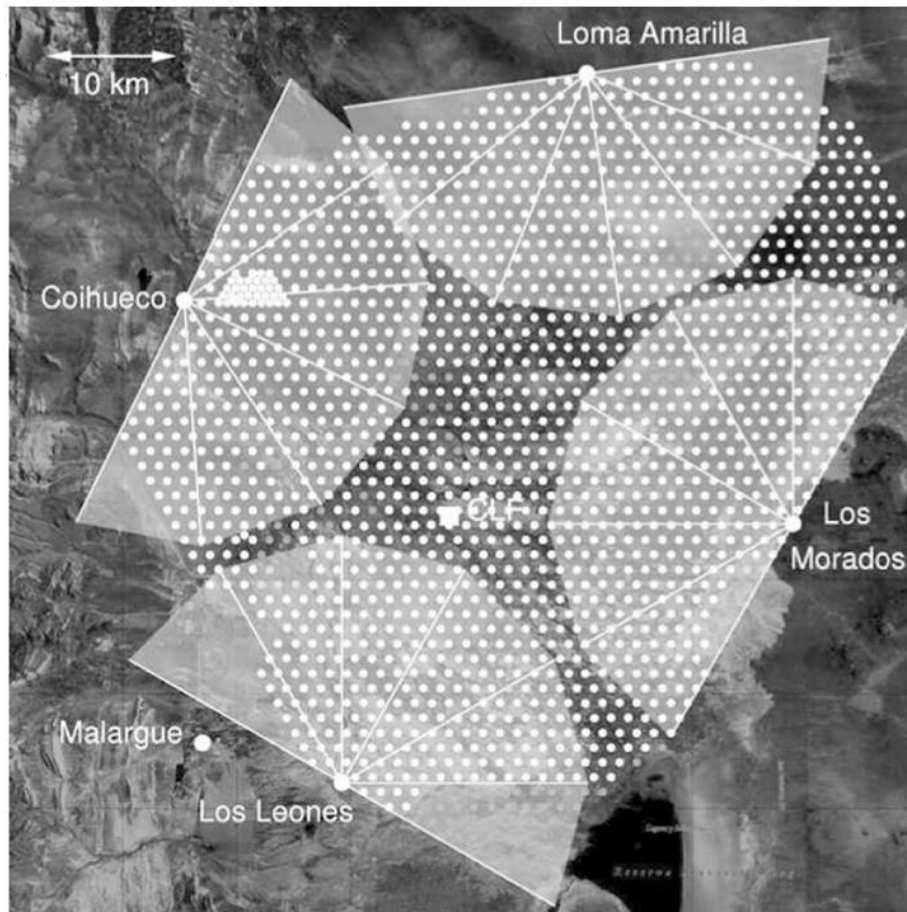
Simulation of an experimental setup for calibrations in Auger Phase II



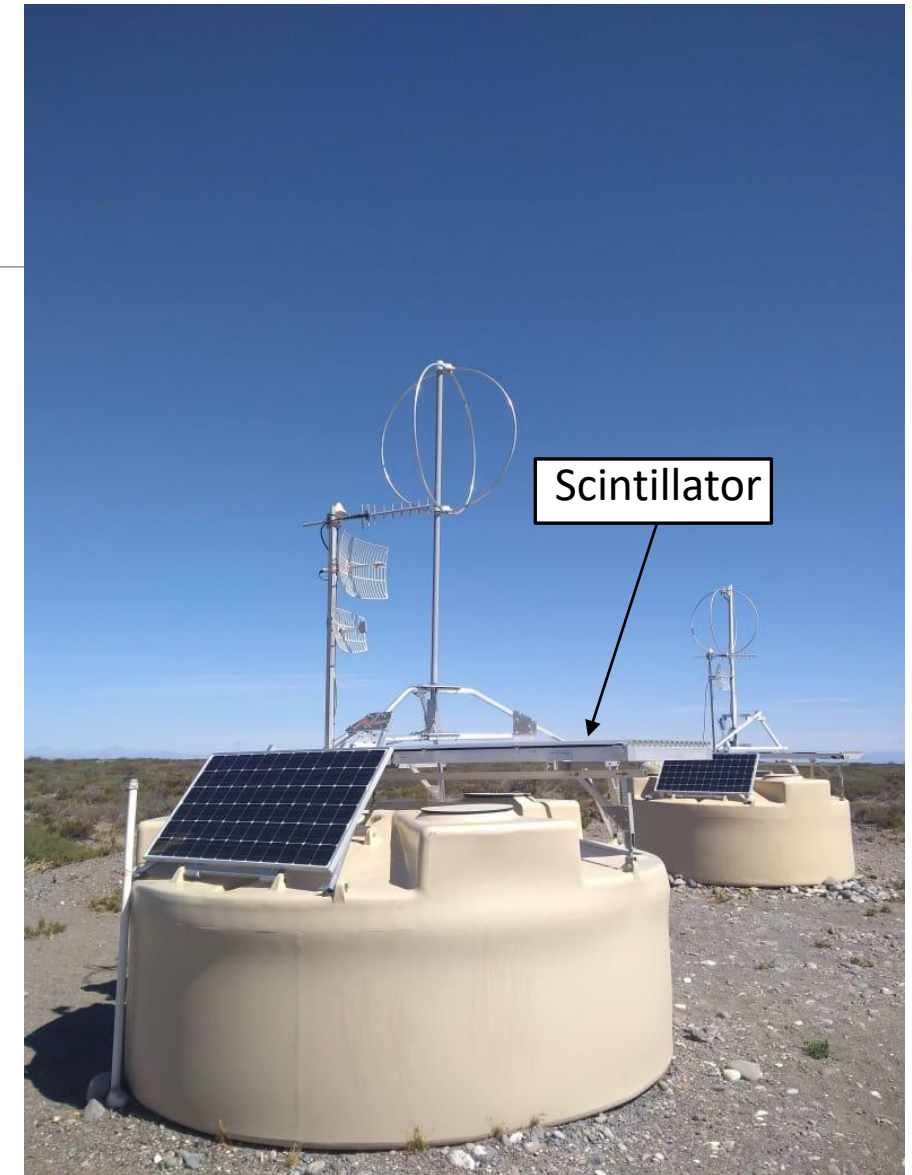
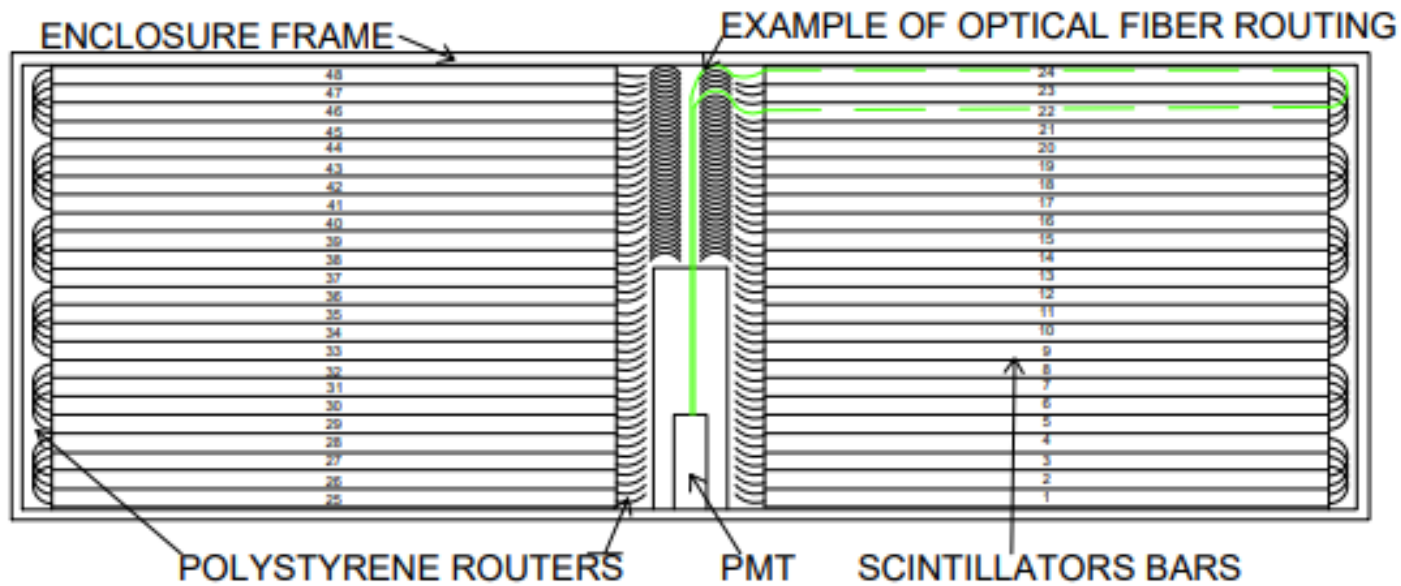
Luís Costa
supervisor:
. Raul Sarmento

LIP-Minho
4/9/2026

Pierre Auger Observatory

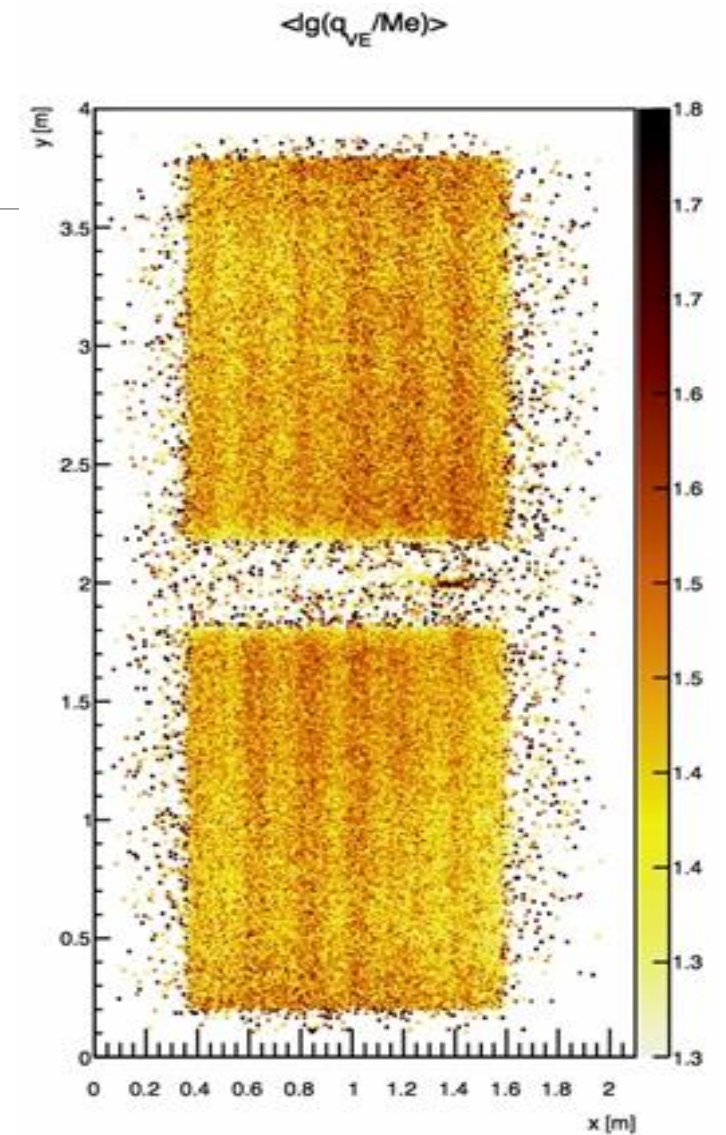
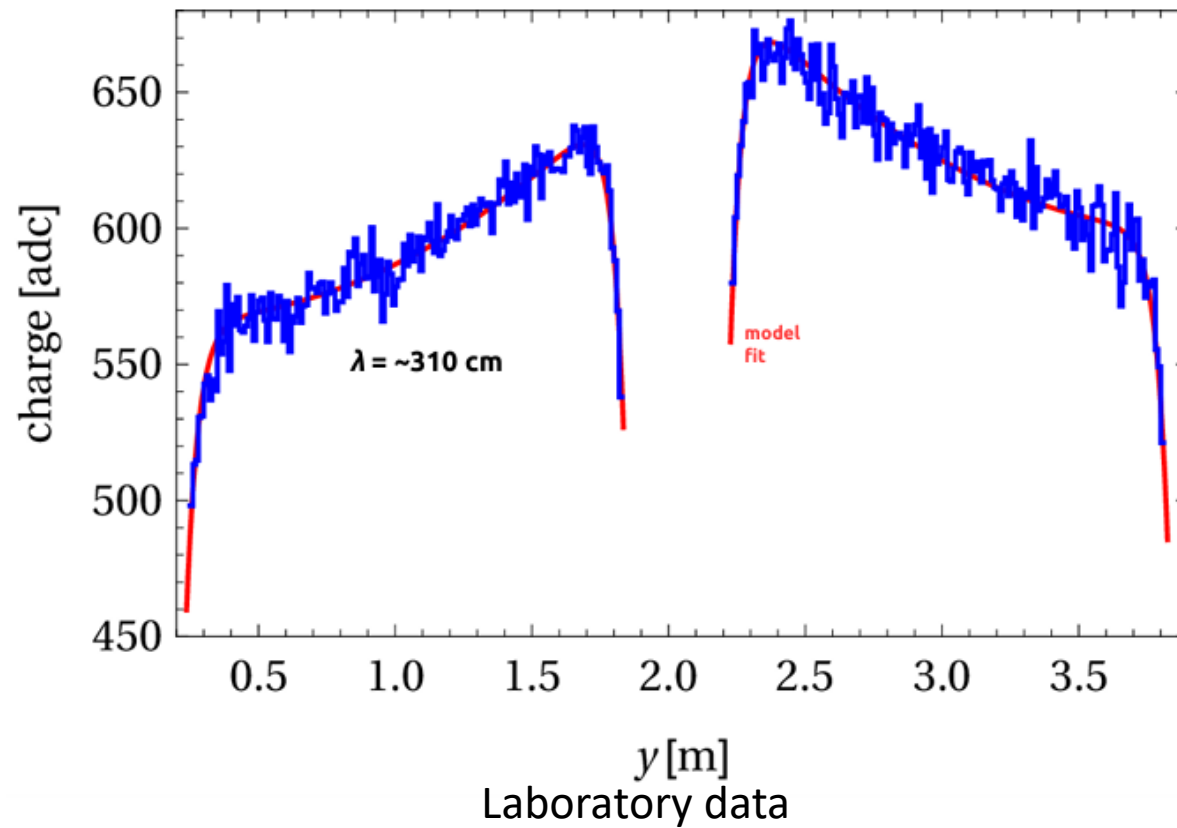


Ground-based Detectors



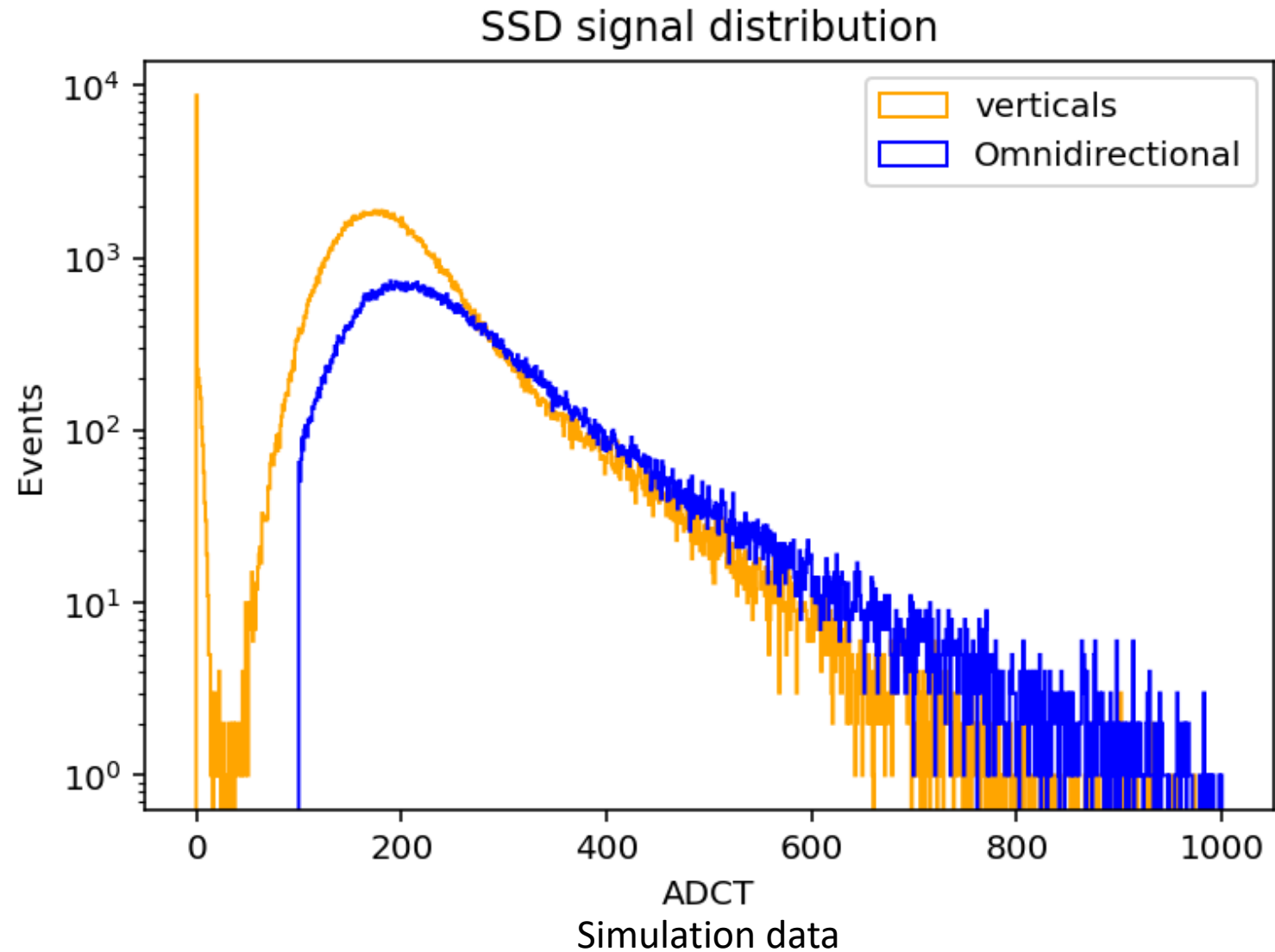
Scintillator

Attenuation



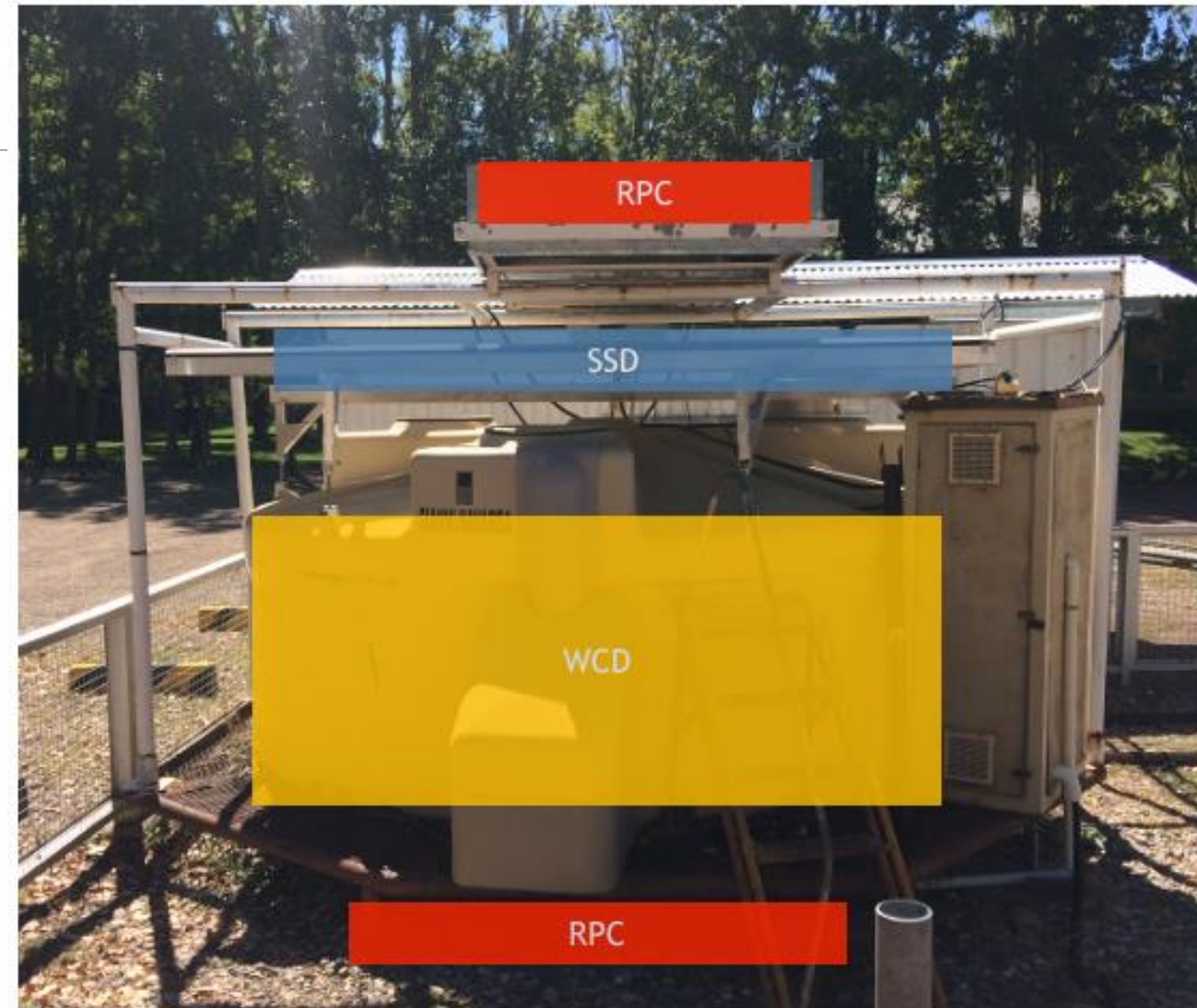
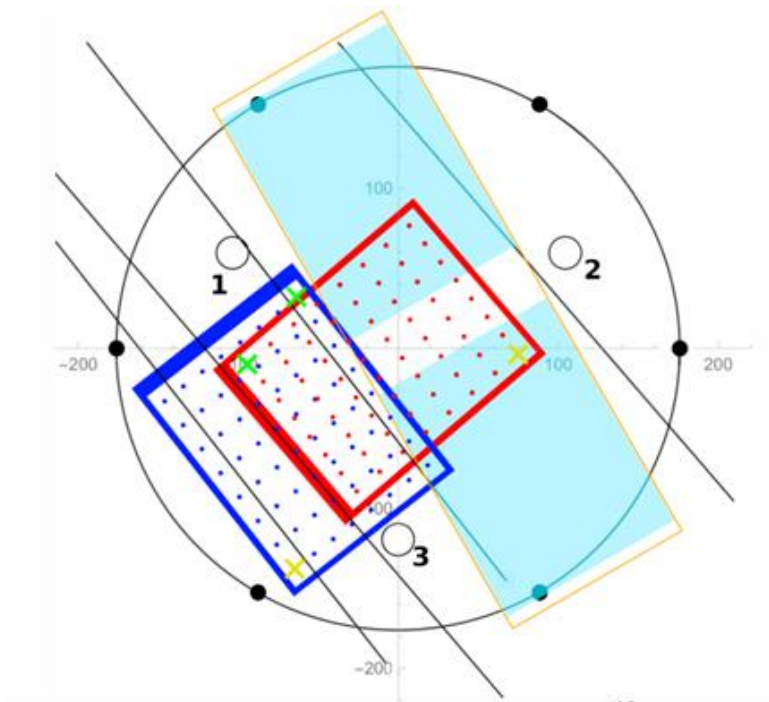
Calibration

$$S = \frac{Q_{omnidirectional}}{Q_{verticals}}$$

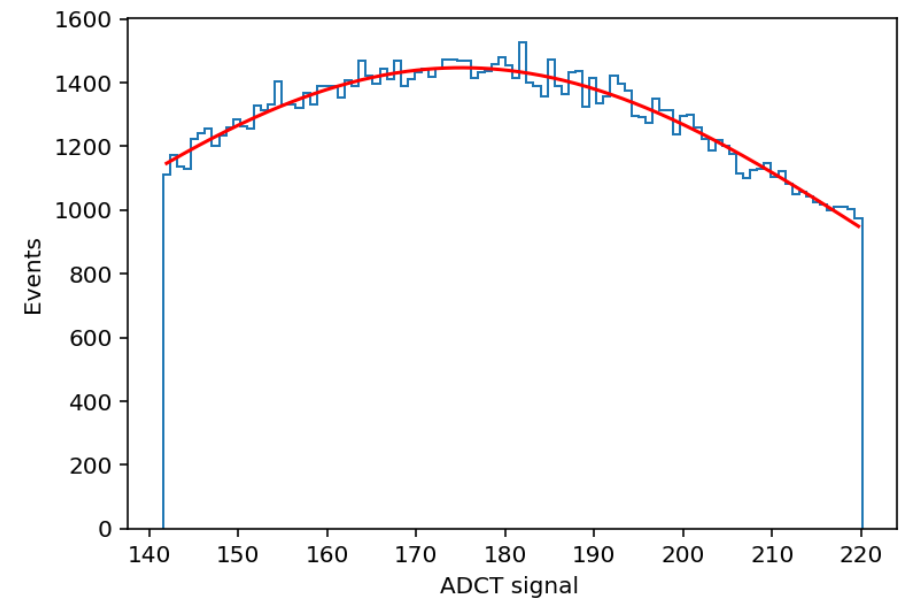
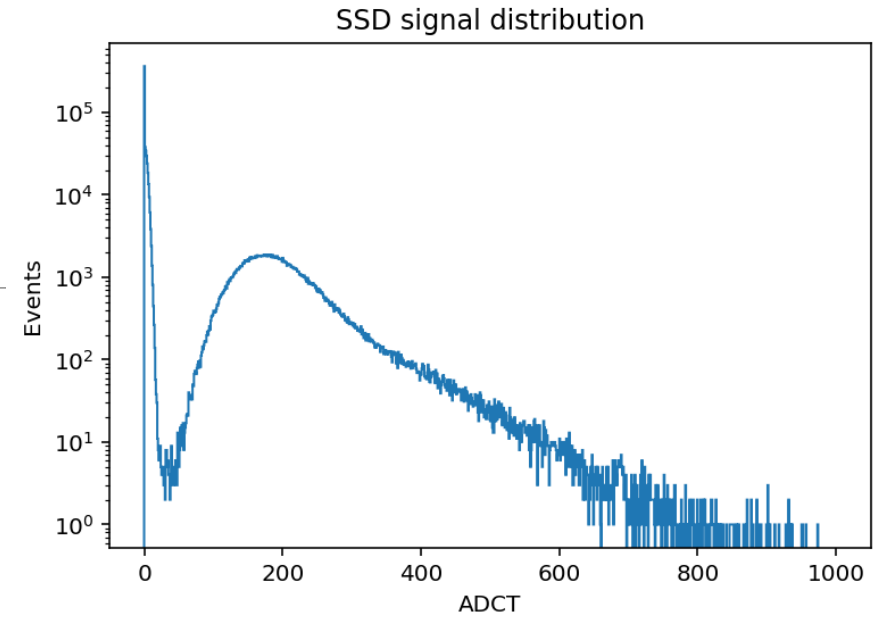
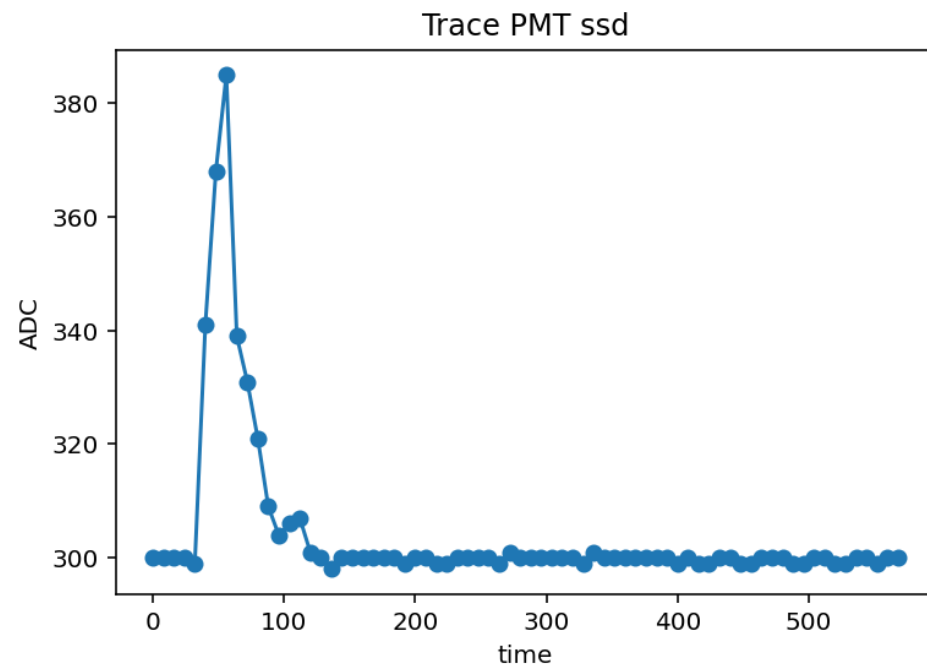


Simulation

- Omnidirectional
- Verticals
- Experience



Simulation



Charge Calibration Simulation

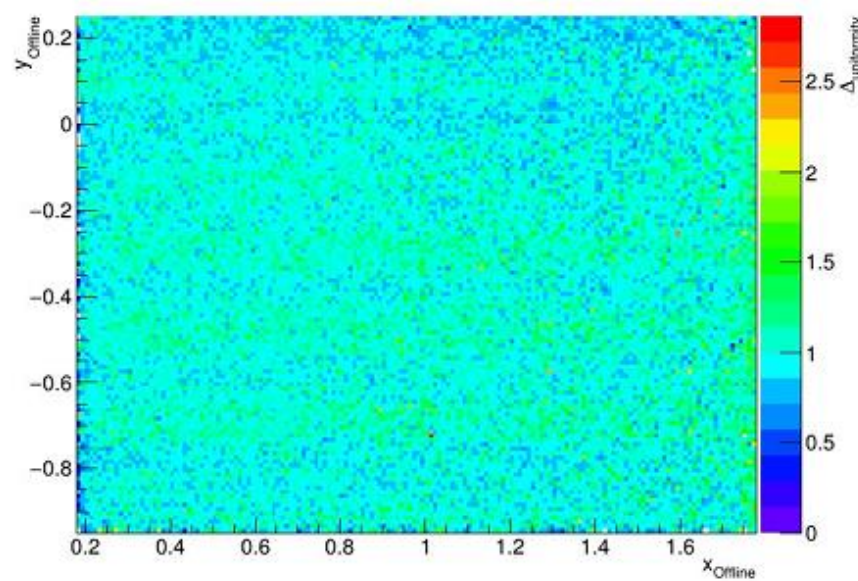
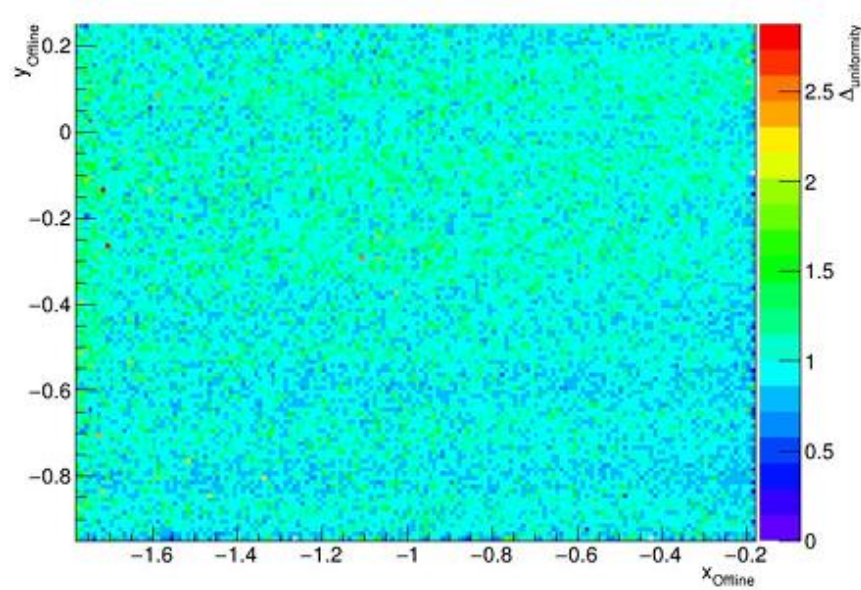
$$\frac{Q_{omni}}{Q_{verticals}} = \frac{202,2 \pm 0,8}{175,1 \pm 0,4} = 1,15 \pm 0,01$$

$$\frac{Q_{omni}}{Q_{disk}} = \frac{202,2 \pm 0,8}{179,5 \pm 3,5} = 1,13 \pm 0,02$$

Charge Calibration Simulation

$$\frac{Q_{omni}}{Q_{verticals}} = \frac{198,2 \pm 0,6}{163,5 \pm 0,4} = 1,21 \pm 0,01$$

$$\frac{Q_{omni}}{Q_{disk}} = \frac{198,2 \pm 0,6}{183 \pm 4,4} = 1,08 \pm 0,03$$



Scintillator non-uniformity maps

Charge Calibration Simulation

Without Map

$$\frac{Q_{omni}}{Q_{verticals}} = \frac{202,2 \pm 0,8}{175,1 \pm 0,4} = 1,15 \pm 0,01$$

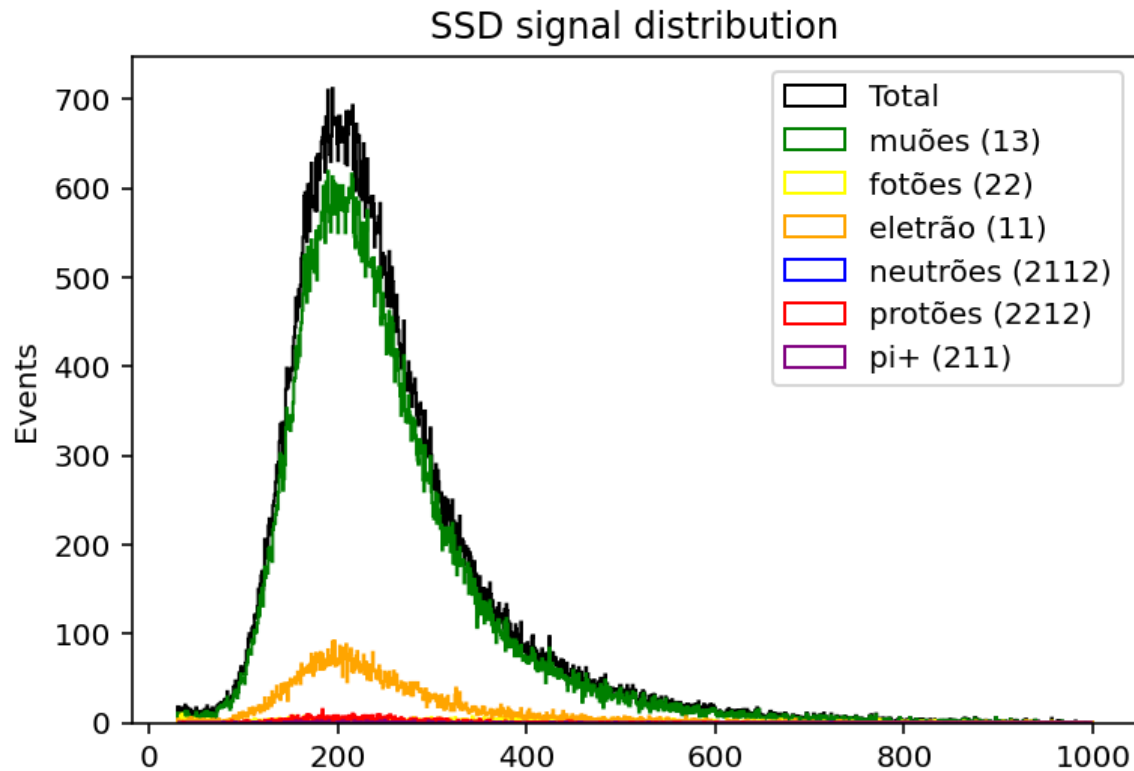
$$\frac{Q_{omni}}{Q_{disk}} = \frac{202,2 \pm 0,8}{179,5 \pm 3,5} = 1,13 \pm 0,02$$

With Map

$$\frac{Q_{omni}}{Q_{verticals}} = \frac{198,2 \pm 0,6}{163,5 \pm 0,4} = 1,21 \pm 0,01$$

$$\frac{Q_{omni}}{Q_{disk}} = \frac{198,2 \pm 0,6}{183 \pm 4,4} = 1,08 \pm 0,03$$

Conclusion



- In the scintillator, there is a small contribution from the e^- , unlike in the tank.
- Without the map, there is no effect between de constants with verticals and disk.
- With the map, there is effect between de constants with verticals and disk.
- The constante of Charge Cabrilation don't agree with the datas, but amplitude yes

Bibliography

- Powerpoint interno: Estágios de Verão do LIP 2026 de Raul Sarmento
- https://en.wikipedia.org/wiki/Cosmic_ray#/media/File:Cosmic_ray_flux_versus_particle_energy.svg
- <https://visitantes.auger.org.ar/index.php/radio-deteccion/>
- <https://arxiv.org/pdf/2507.07762>

Amplitude Calibration Simulation-anexo

Without Map

$$\frac{A_{omni}}{A_{verticals}} = \frac{58,9 \pm 0,2}{50,6 \pm 0,2} = 1,16$$

$$\frac{A_{omni}}{A_{disk}} = \frac{58,9 \pm 0,2}{50,7 \pm 0,8} = 1,16$$