The XY Scanner – A Versatile Method of the Absolute End-to-End Calibration of Fluorescence Detectors

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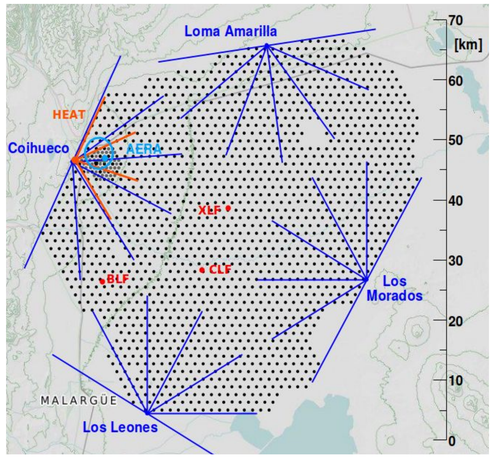
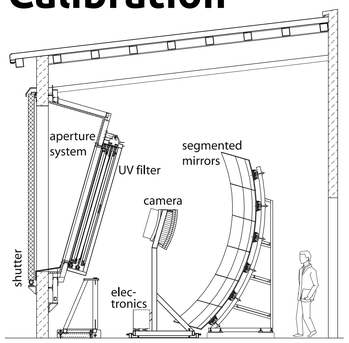
PIERRE AUGER OBSERVATORY

The Pierre Auger Observatory



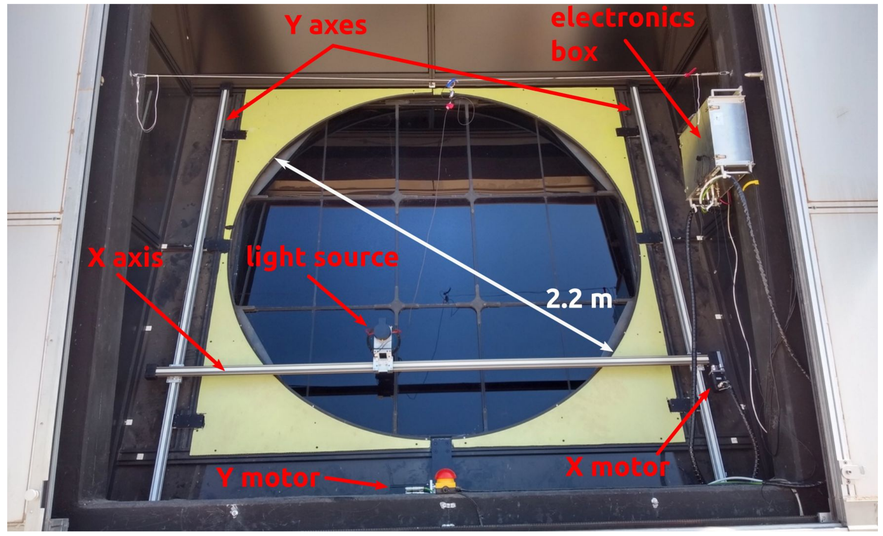
- 1660 surface detector stations
- 27 fluorescence detectors (FD) at 4 sites

Fluorescence Telescopes & Calibration



- Large aperture fluorescence telescopes
- 440 pixel PMT-camera
- Nightly relative calibration
- Current absolute calibration method (*drum*)
  - Illumination of the full aperture with uniform large-diameter light source
  - Calibration of the large source difficult
  - Large team required
  - Correction for back-reflections at the filter

The XY Scanner Stage

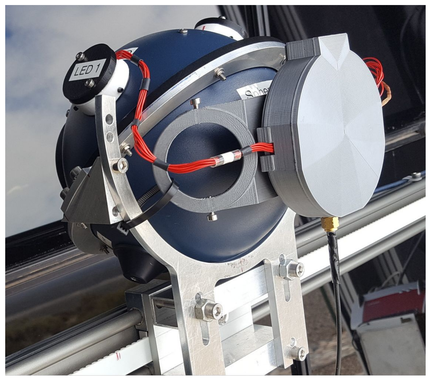


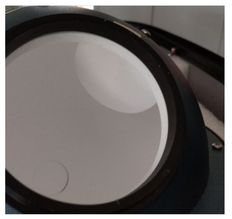
XY Scanner System:

- compact light source moved across aperture opening
- Motorized positioning system
  - Two vertical, one horizontal linear stages
  - Sub-millimeter relative precision
  - Auto-correction of missed steps

Calibration Light Source:

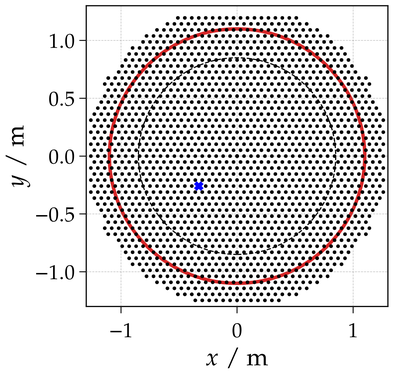
- Portable light source
- General purpose integrating sphere
  - 13.5 cm diameter
  - 5.04 cm exit port
  - Modified to match closer to Lambertian emitter
- Temperature stabilized LED
  - λ = 365 nm, 5 µs long pulses
- Photodiode monitors pulse-to-pulse stability
- Intensity calibrated in the laboratory at 3.5% level

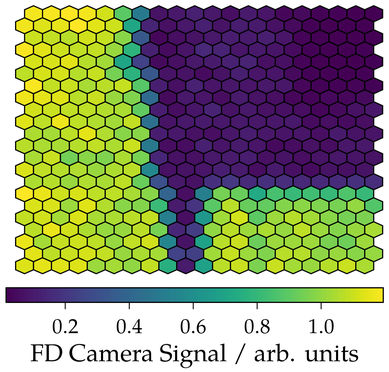




Novel Calibration Method

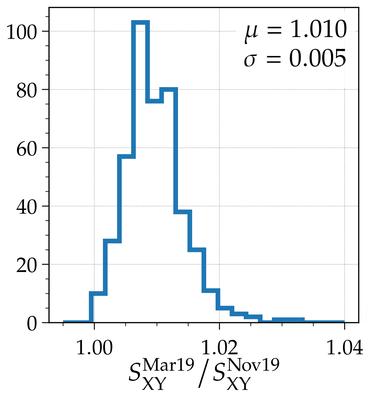
- Light source is moved to uniformly distributed positions across the FD aperture window
- Flashing frequency limited to 1 Hz by FD electronics
- Triangular grid with 6 cm spacing → ~1700 points
  - Tradeoff between measuring time and aperture coverage
- Readout of the FD camera for a given position shown below

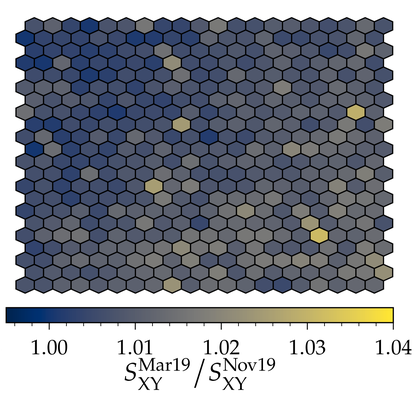




Reproducibility of the Method:

- PMT signal ratios between measurements performed in March and November 2019
  - Identical settings and setup
  - On average ~1% change in the PMT signals
  - Reproducibility at 1% level





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