

The XY Scanner

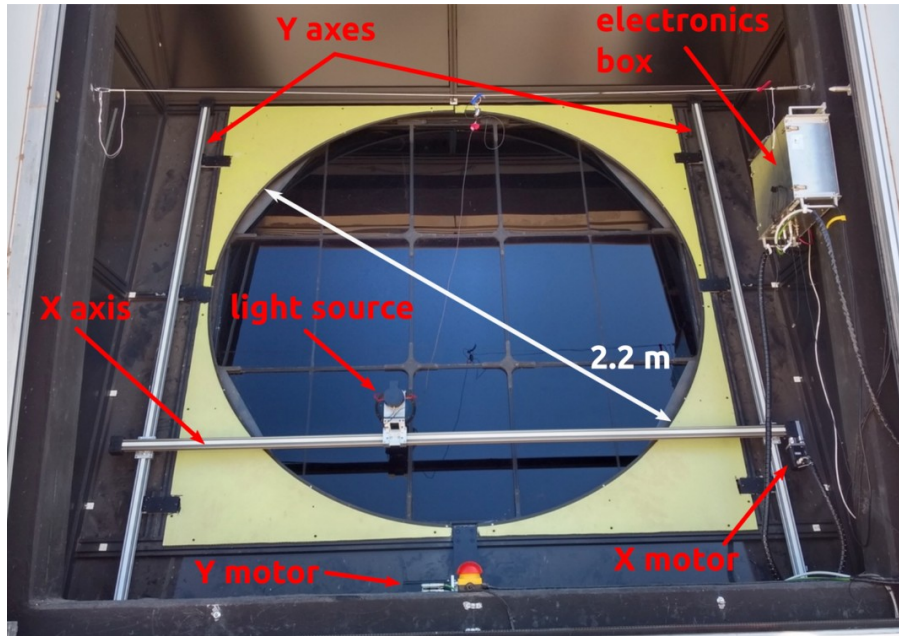
PIERRE
AUGER
OBSERVATORY

A Versatile Method of the Absolute End-to-End Calibration of Fluorescence Detectors

Christoph M. Schäfer for the Pierre Auger Collaboration



The XY-Scanner Stage

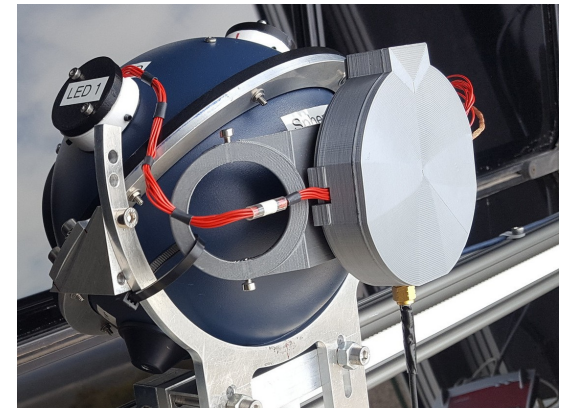


XY Scanner System

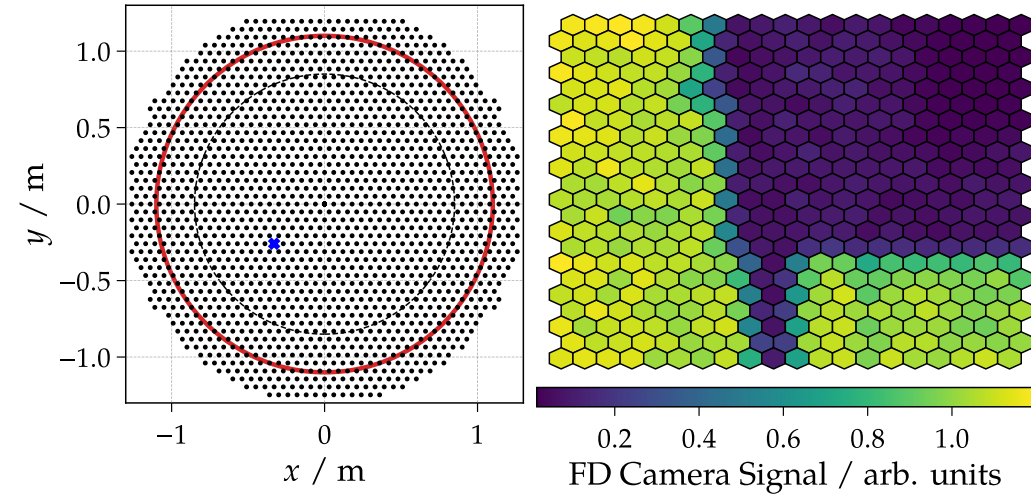
- Compact light source is moved by the XY-scanner system across aperture opening
- Motorized positioning system
 - Two vertical linear stages permanently fixed at telescope
 - one horizontal linear stage
 - Sub-millimeter relative precision
 - Auto-correction of missed steps

Portable Light Source

- General purpose integrating sphere (\varnothing 13.5 cm)
 - Temperature stabilized LED, $\lambda = 365$ nm
- Internal photo-diode monitors pulse-to-pulse stability
- Intensity calibrated in the laboratory at 3.5% level



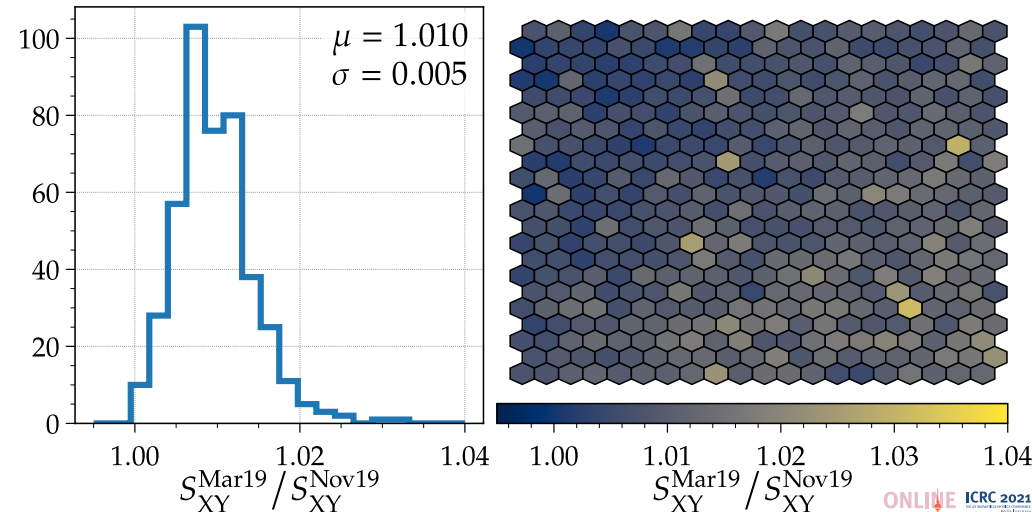
Novel Calibration Method



- Light source is moved to uniformly distributed positions across the telescope aperture window
- Triangular grid with 6 cm spacing
→ ~1700 points

Reproducibility of the Method

- Measurements performed in March 2019 and November 2019 with identical settings and setup
- On average ~1% change in PMT signals



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

Christoph M. Schäfer^a for the Pierre Auger Collaboration^b

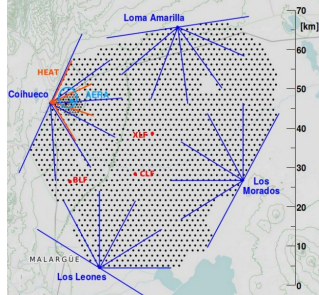
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PoS(ICRC2021)220

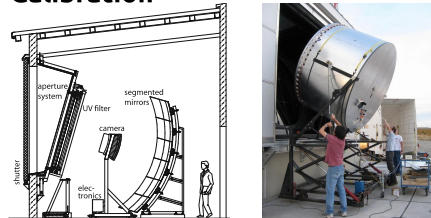


The Pierre Auger Observatory



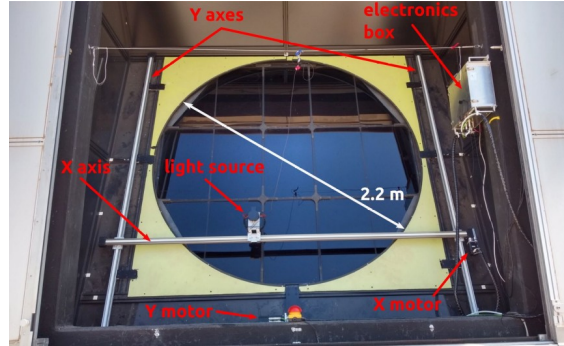
- 1660 surface detector stations
- 27 fluorescence detectors (FD) at 4 sites

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

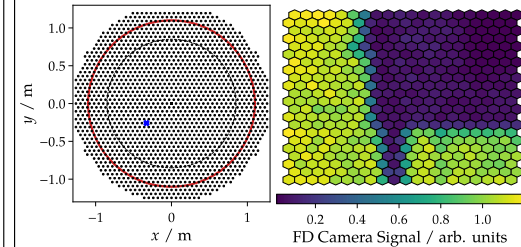
Calibration Light Source:

- 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
- $\lambda = 365 \text{ nm}$, $5 \mu\text{s}$ 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 $\rightarrow \sim 1700$ 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 $\sim 1\%$ change in the PMT signals
- Reproducibility at 1% level

