Poster Rapporteur: Experiments

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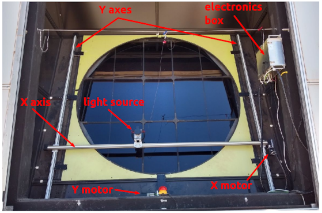
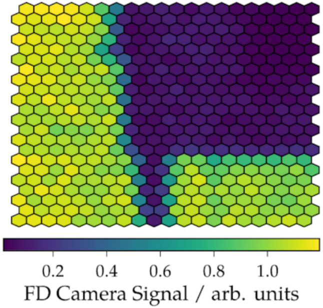
Outline

XY-Scanner for Auger FD calibration Martin Vacula [Pierre Auger collab.]

- Light source (UV LED in a 13.5 cm-diameter sphere) mounted on two vertical and one horizontal stages
- Moved all over the telescope aperture (1,700 positions with 6 cm spacing)
- Calibration constant for each PMT by integrating over all light source positions
- Typically $\mathcal{O}(1\%)$ change between measurements

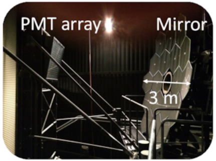




Oct-copter for TA FD calibration Takayuki Tomida [Telescope Array collab.]

- Light source (UV LED) on a drone flown 300 m from the Telescope Array FD equipped with a RTK-GPS (precision of 10 cm → 0.02°)
- (Size of TA FD pixels: 1°)
- Allows precise determinations of FD pointing direction, spot size, coma aberration

Fluorescence Detector (FD)



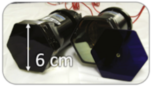
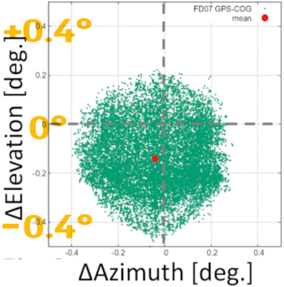
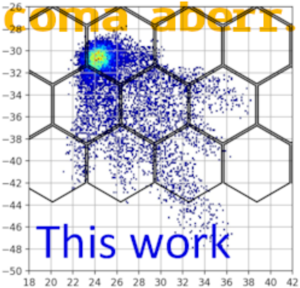


Photo multiplier tube (PMT)

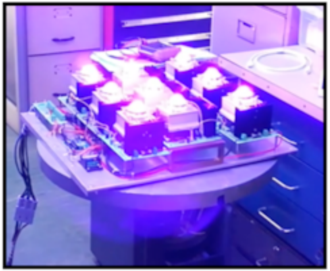


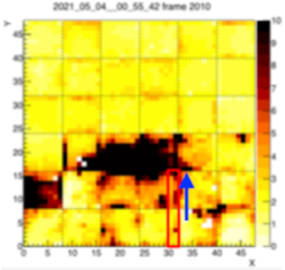


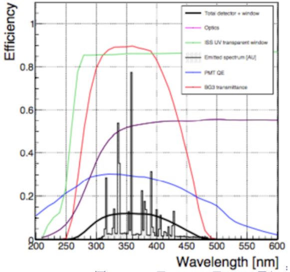
UV ground flasher for Mini-EUSO calibration

Hiroko Miyamoto [JEM-EUSO collab.]

- Mini-EUSO: ±22°-FoV telescope currently onboard the ISS facing nadir, with 2304 pixels, three timescales (2.5 μs, 320 μs, 40 ms)
- UV flasher (100 W UV LED) measured in Turin, then pointed up and detected by Mini-EUSO
- Efficiency determined, in good agreement with theoretical values (after correcting for atmospheric absorption)



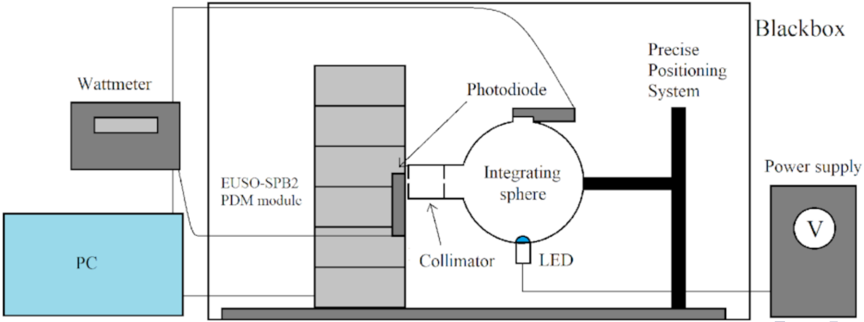




Calibration of EUSO-SPB2 photodetection modules

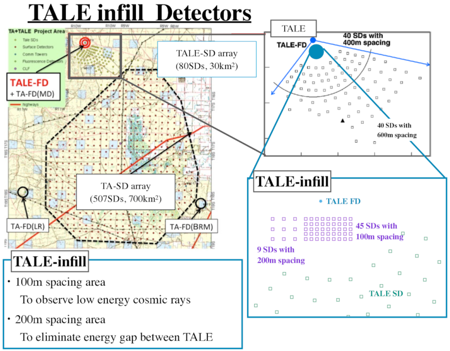
Daniil Trofimov [JEM-EUSO collab.]

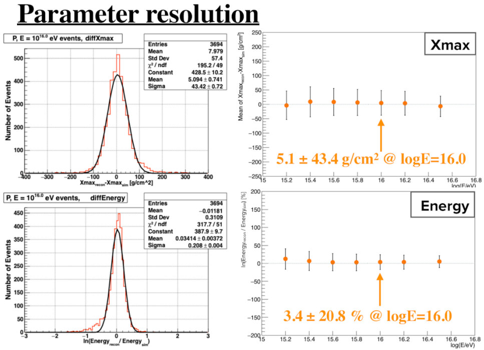
- EUSO-SPB2: balloon to be launched in 2023, with three PDMs (Mini-EUSO has one, JEM-EUSO will have tens)
- The PDMs have been calibrated both in full illumination mode and in single-pixel illumination mode.



TALE-infill energy and X_{max} Aoi Iwasaki [Telescope Array collab.]

- TALE-infill: Existing TALE FD, plus 100 m- and 200 m-spacing SD stations to be deployed in October–November 2022
- Will extend the TALE energy range down to PeV energies



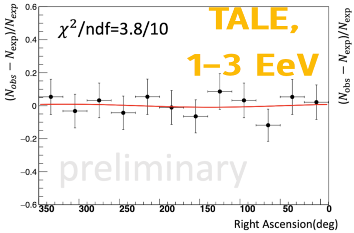


(optimized cuts might improve X_{max} resolution to $40\,\mathrm{g/cm^2}$)

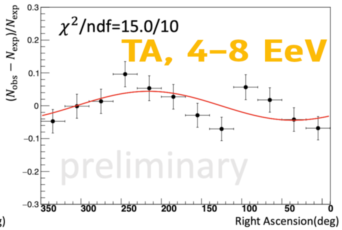
TALE and TA large-scale anisotropy

Toshihiro Fujii [Telescope Array collab.]

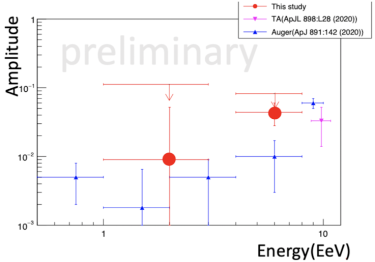
- No significant dipole observed yet either with TALE in $[1\,\mathrm{EeV}, 3\,\mathrm{EeV})$
  (2019 Oct 02–2021 Sep 28 → 1,122 events)
  or with TA in $[4\,\mathrm{EeV}, 8\,\mathrm{EeV})$
  (2008 May 11–2019 May 11 → 8,810 events)
- More statistic needed!

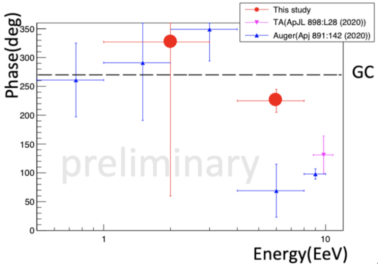


$(0.9 \pm 4.3)\%$, $(330 \pm 270)°$

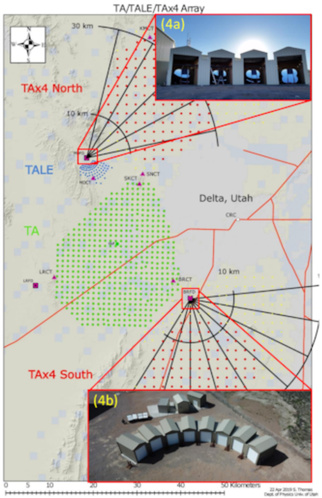


$(4.4 \pm 1.6)\%$, $(225 \pm 20)°$

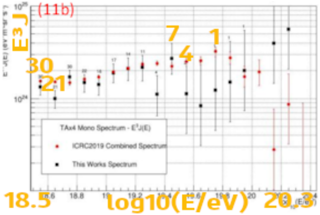


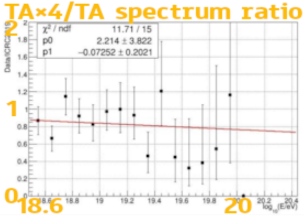


TA×4 monocular FD spectrum Mathew Potts [Telescope Array collab.]



- TA×4 North: 4 FD telescopes, completed in 2018
- TA×4 South: 8 FD telescopes, completed in 2019
- Resol.: $E \pm 20\%$, $\theta \pm 3°$, $\psi \pm 7°$, $X_{\max} \pm 86\,\mathrm{g/cm^2}$
- Good agreement with MC simulations and with main TA spectrum





- Will provide more statistics for future analyses

Requirements for future $X_{\max}$ anisotropies Ryosuke Saito

How much statistics will we need?

Hypotheses

- Background with constant $X_{\max}$ composition (Auger mix) over the full sky
- Excess (TA hotspot) due to one element
- Same energy spectrum shape (from TA measurements) in both

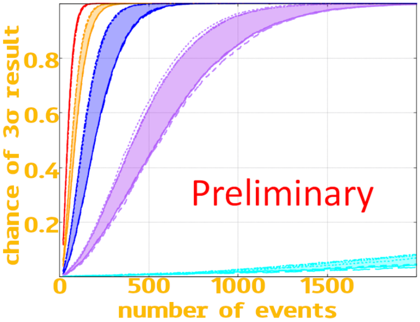
Procedure

- Simulate events according to the model above,
  until the $X_{\max}$ distributions inside and outside the hotspot
  differ with a 3σ statistical significance

Requirements for future X_{max} anisotropies Ryosuke Saito

Results

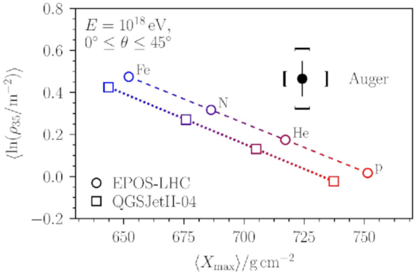
- Around **160**, **250**, **1 500**, **> 10 000** or **500** events needed if the hotspot is **protons**, **helium**, **nitrogen**, **silicon** or **iron**, respectively
- Relatively similar results between EPOS LHC and QGSJET II-04

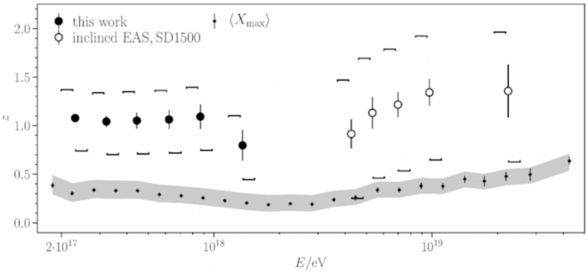


The Underground Muon Detector of Auger

Marina Scornavacche [Pierre Auger collab.]

- So far, $7 \times (2 \times 5\,\mathrm{m}^2 + 2 \times 10\,\mathrm{m}^2)$ scintillator modules buried 2.3 m deep to detect muons in showers (at low densities, individual muons can be counted)
- Result from engineering array: 38% (50%) more muons in real showers than in EPOS LHC (QGSJET II-04) simulations



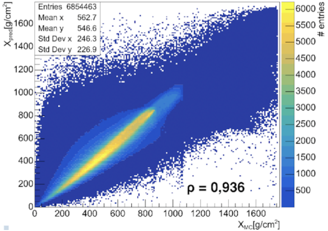


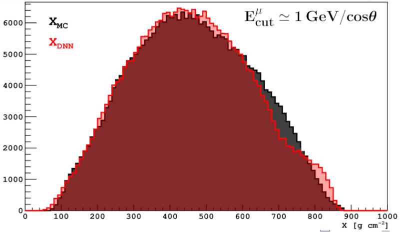
- Full array ($3 \times 10\,\mathrm{m}^2$ for each SD-750 station) to be completed by mid-2023

Muon production depth reconstructed via DNN

Eva dos Santos

- Muons are mostly produced within tens of metres of the shower axis, especially the most energetic ones.
- They incur geometric and kinematic delays ($\mathcal{O}(100\,\mathrm{ns})$)
- A deep neural network was trained to estimate the production distance of muons based on:
  - Zenith angle $\sec\theta$
  - Azimuth angle $\cos\zeta$
  - Core distance r
  - Arrival time t
  - Whether they reach the UMD (see previous slide)
- In MC, among muons reaching the UMD, bias $< 10\,\mathrm{g/cm^2}$, res. $\sim 80\,\mathrm{g/cm^2}$

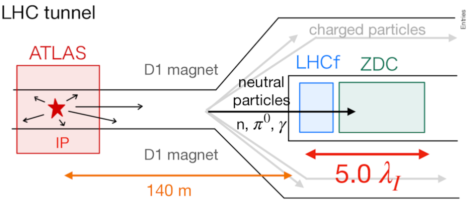


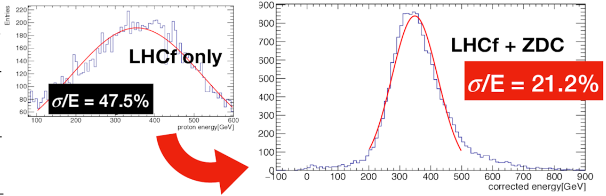


LHCf–ATLAS ZDC joint measurements

Moe Kondo [LHCf and ATLAS ZDC collabs.]

- Measurements of γ, π^0, n emitted in the very forward region by pp collisions by the LHC-forward and ATLAS Zero Degree Calorimeter experiments in order to investigate hadronic interaction models and the muon excess in air showers
- Much better resolution than LHCf alone

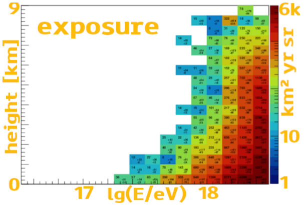


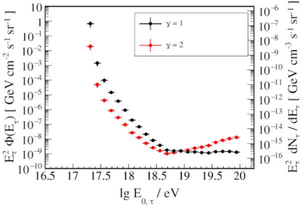


Search for upgoing events in Auger

Vladimir Novotný [Pierre Auger collab.]

- ANITA detected events looking like upward-going ν_τ-initiated air showers, at angles that should not be possible according to the Standard Model.
- Auger FD data were searched for similar showers.
- After filtering misreconstructed downgoing showers and calibration laser shots out, one event survived (compatible with the expected background).
- This fact and the exposure (computed via MC) were used to set limits to upgoing τ leptons.





Payload for Ultrahigh Energy Observations (PUEO)

Austin Cummings

- Radio detection of cosmic ray- and neutrino-induced showers (successor experiment of ANITA)
- Comprises a main instrument and a low-frequency instrument
- Goals:
  - Detection of (or limits on) EeV neutrinos
  - Search for ANITA-like upgoing events
  - Studies of ice properties
- `PUEOSim` MC code developed for PUEO
- ν`SpaceSim` for future detectors in space

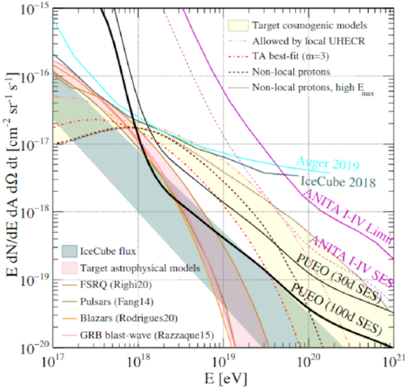
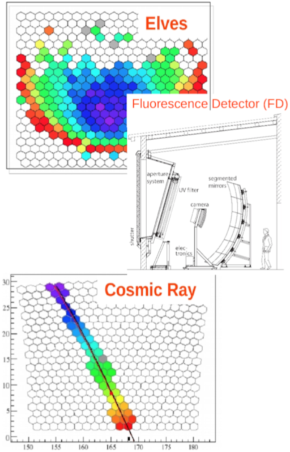


Figure: Expected sensitivity

ELVES and terrestial gamma-ray flashes at Auger

Roberta Colalillo [Pierre Auger collab.]

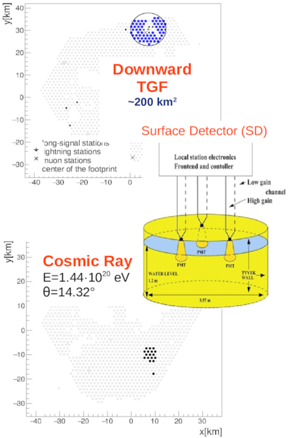
- Lightning is one of the most energetic phenomena on Earth. It can trigger **ELVES** and TGFs.
- ELVES are transient luminous events at the base of the ionosphere ($\sim 10^2$ km high).
- They are visible from 250–1000 km away in Auger FD data as expanding rings.
- Based on their time structure, they can be classified as single-peaked or double-peaked.
- There may be several different mechanisms producing the latter. New triggers for HEAT have been devised to study them.



ELVES and terrestial gamma-ray flashes at Auger

Roberta Colalillo [Pierre Auger collab.]

- Lightning is one of the most energetic phenomena on Earth. It can trigger ELVES and **TGFs**.
- TGFs are millisecond pulses of gamma rays produced by relativistic runaway electron avalanches in thunderstorm clouds.
- They are visible in Auger SD data as rings.
- The hole in the middle is because the signal there is too long for Auger cosmic-ray triggers.
- A new trigger has been devised to study them and fill the hole.



Thanks for your attention!