Measurement of the Cosmic Ray Spectrum with the SD433

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DDAp/DDEIT-HIRSAP Meeting 2022
Nov 10th 2022

Outline of my Ph.D.

Measurement of the cosmic ray spectrum with the 433-metre surface detector of the Pierre Auger Observatory.

Conicet Ph.D. grant from April 2020 until March 2025.

Member of DDAp since February 2022.

Shifts: SD (July 2020), UMD (Nov 2021), FD (Aug - Sept 2022).

Previous work: SD1500 Efficiency

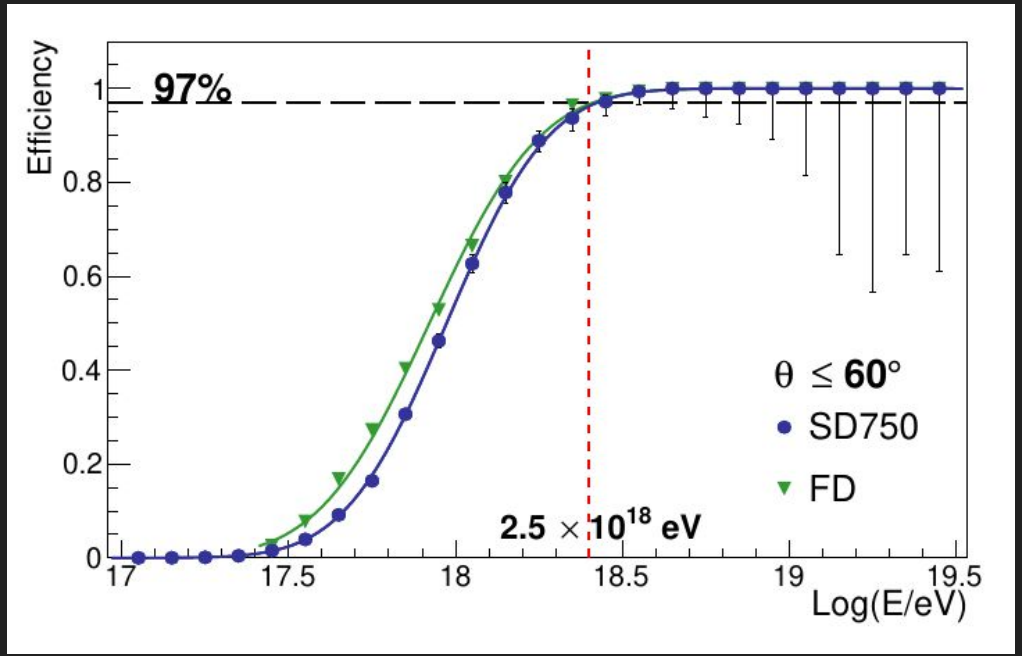
Measurement of the SD1500 efficiency using the SD750 event set.

Data driven measurement with low systematics.

Study of the dependency of the efficiency with zenith angle.

Analysis using both old triggers only and including new triggers.

$$\varepsilon(E,\theta) = \frac{1}{2}\left[1 + \mathrm{erf}\left(\frac{\log_{10}(E_{750}/\mathrm{eV}) - a(\theta)}{b(\theta)}\right)\right]$$



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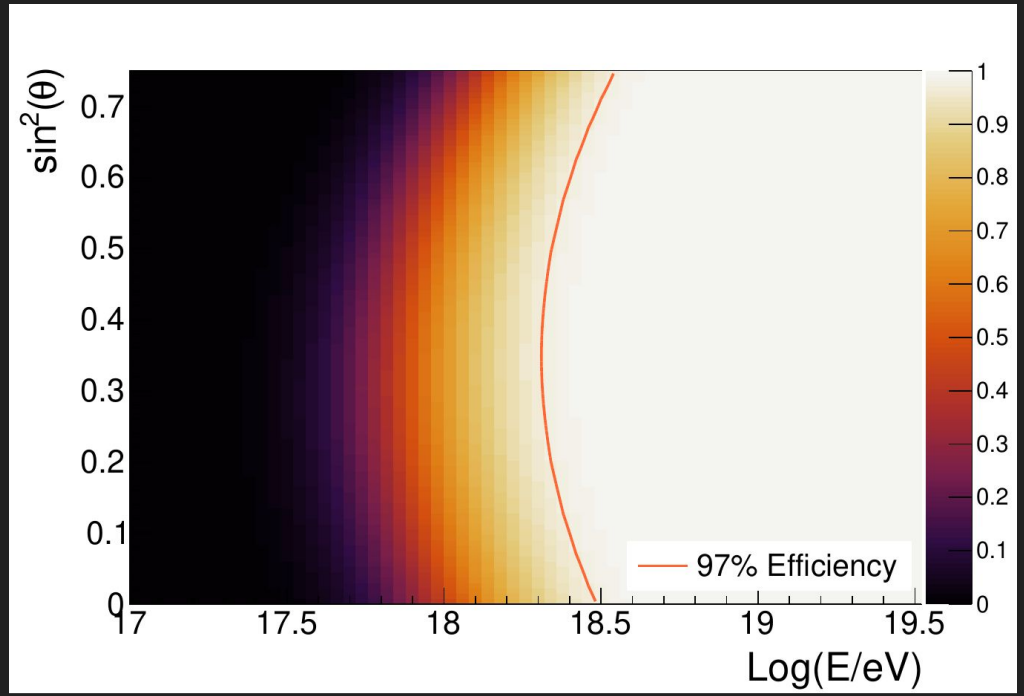


Previous work: SD1500 Efficiency

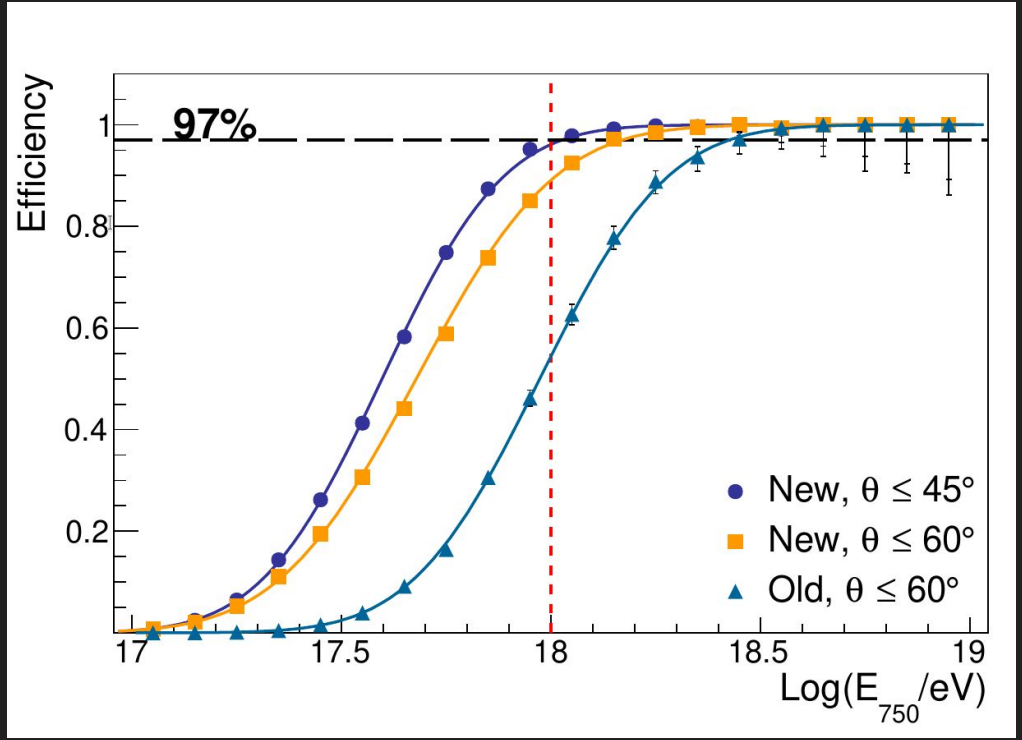
Full efficiency threshold at 2.5 10^{18} eV in accordance to measurement with hybrid events.

When including new triggers we get full efficiency at 10^{18} eV ($\theta<45°$).

Parametrization of the efficiency with zenith angle and energy.

Preview of extension of the spectrum to energies below the full efficiency threshold.

GAP Note 066-2021.



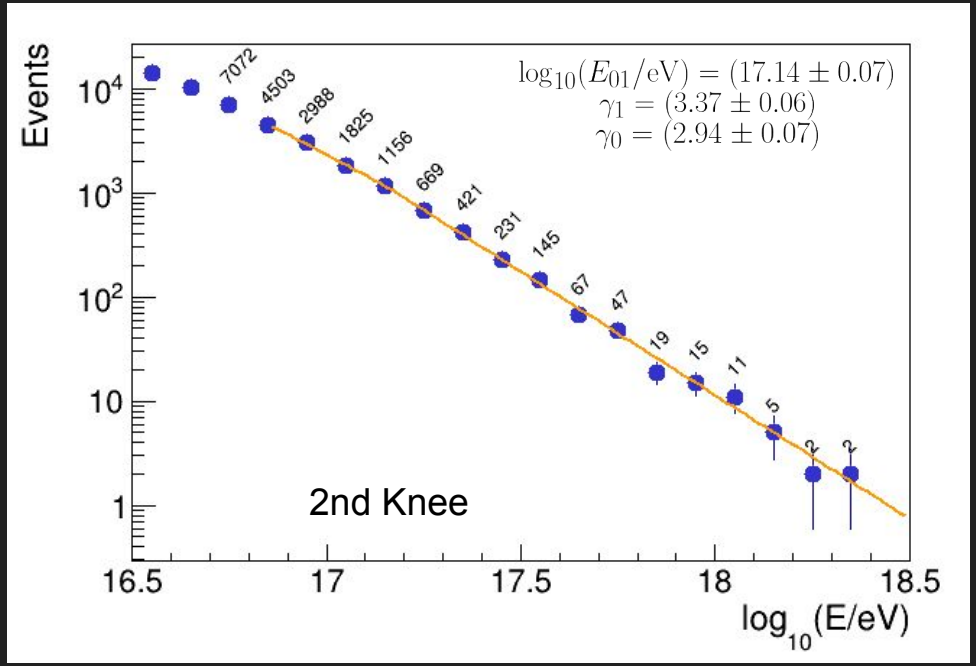
Current work: SD433 Spectrum

Likelihood fit of the SD433 histogram.

Broken power law with soft transitions.

2nd Knee energy and spectral indexes before and after are free parameters.

$$J(E) = J_0 \left(\frac{E}{10^{17}\,\mathrm{eV}} \right)^{-\gamma_0} \left[1 + \left(\frac{E}{E_{01}} \right)^{\frac{1}{\omega_{01}}} \right]^{\frac{\gamma_0 - \gamma_1}{\omega_{01}}}$$



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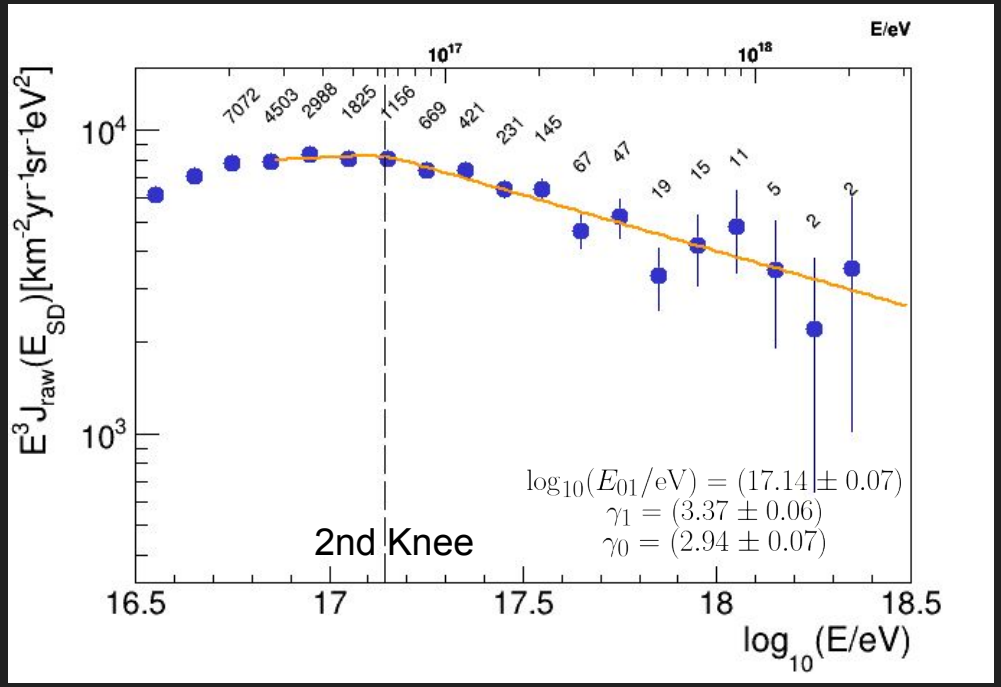


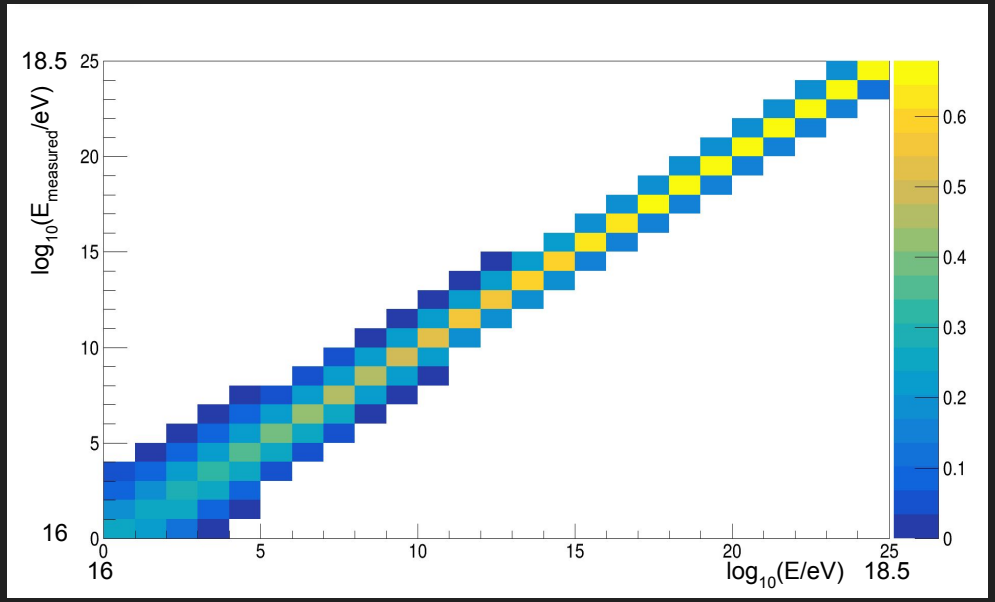
Current work: Spectrum Unfolding

Currently working in the Spectrum unfolding.

Determination of the Migration Matrix:

$$R_{ij} = \frac{\int_i dE \int_j r(E|\varepsilon,\sigma(\varepsilon))\mathrm{eff}(\varepsilon)J(\varepsilon)d\varepsilon}{\int_j J(\varepsilon)d\varepsilon}$$

Iterative approach in the spectrum fit since R depends on our spectrum model.



Next Steps

SD433 Spectrum Update talk in Auger Collaboration Meeting (Nov 2022)

Finish Spectrum Unfolding (Mar 2023)

First stay in Karlsruhe (Apr 2023)

ICRC SD433 Spectrum Presentation (Jul 2023)