Preliminary results of:

**Comparative study of S1000 and S1500**

to determine the energy of extensive air showers measured by the Surface Detector at the Pierre Auger Observatory

Ariel Bridgeman, David Schmidt, Frederic Sarazin

*Colorado School of Mines*
Events with no saturated tanks are best constrained at 1000 m from the core. By design, S1000 is least sensitive to different parameterizations of the LDF.

Events with one or more saturated tanks are not necessarily best constrained at 1000 m from the core when considering different LDF parameterizations (ropt increases to ~1500 m).
MALDERA & NAVARRA 2008
Analyzed S1600 as an energy estimator in the context of:
(a) Avoided constant intensity cut method
(b) Reduced uncertainty in energy reconstructions for events with one or more saturated tanks.

SCHMIDT, MAYOTTE, & SARAZIN
- $E_{SD}$ deviates significantly using NKG and Power Law reconstructions LDFs.
- Poor bracketing of the LDF at 1000 m from the core results in most significant deviations. This occurs more frequently at lower zenith angles.

Implications
- Larger uncertainty in energy.
- Biasing of energy calibration by saturated events.
- Possible bias in energy spectrum, etc.
**Study Parameters**

**LDFs:** NKG  
**DATA SET:** 2004 – 2012  
**OFFLINE VERSION:** 2.9.1  
**PHYSICAL TRIGGER:** 6T5

- Separate CIC(θ) derived for NKG S1000 and S1500
- Separate Energy Calibrations performed for NKG S1000 and S1500
CIC Derivation

Obtained CIC derivation program from Alexander Schulz at KIT.
Energy Calibration

$S_{1000}$

Events (after cuts): 2164
$A = 0.185 \pm 0.003$
$B = 1.025 \pm 0.004$

$S_{1500}$

Events (after cuts): 2337
$A = 0.187 \pm 0.002$
$B = 1.014 \pm 0.004$

ICRC 2013

Events (after cuts): 1475
$A = 0.190 \pm 0.005$
$B = 1.025 \pm 0.007$

Obtained energy calibration derivation program from Alexander Schulz at KIT.
Energy Comparison

The diagram shows a scatter plot with the energy of two different events, $E_{1500}$ (EeV) versus $E_{1000}$ (EeV). The data points are distributed along a diagonal line, indicating a strong correlation between the two energies.
Percent Difference in Energy

The graph shows the percent difference in energy ($E_{1000}/E_{1500} - E_{\text{Ave}}$) as a function of $E_{\text{Ave}}$ in EeV. The data points are scattered across the graph, indicating varying degrees of percent difference for different energy levels. The x-axis represents $E_{\text{Ave}}$ in EeV, while the y-axis represents the percent difference.
If an event has one or more saturated tanks, S1000 may not be properly bracketed. S1500 may be more stable than S1000 for high energy reconstructions due to bracketing of LDF. However, S1500 has a higher uncertainty in signal and associated reconstructed energy than S1000.

**Trade-off between stability and uncertainty**

**REFINEMENT OF STUDY**
- Investigate bracketing cases
- Develop:
  1. Region where S1000 and S1500 perform well
  2. Region where S1000 performs best
  3. Region where S1500 performs best
Backup Slides
Energy Difference
2D Energy Difference Histogram
2D Percent Energy Difference Histogram