

# Initial results of a direct comparison between the Surface Detectors of the Pierre Auger Observatory and the Telescope Array



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## Introduction

The Pierre Auger Observatory (Auger) and the Telescope Array (TA) aim at unraveling the origin and nature of Ultra-High Energy Cosmic Rays (UHECR). At present, there appear to be differences between Auger and TA results, e.g. the energy at which the flux suppression occurs and the composition of the UHECR. From a detection standpoint, the Auger and TA surface detectors (SD) are not equally sensitive to the air shower components.

In order to make direct comparisons between the SD detection techniques used by Auger and TA, a two-phase joint research program is followed. In the first phase, two Auger SD stations were deployed at the TA Central Laser Facility (CLF) to compare station-level responses. The second phase will be to co-locate six Auger SD stations with TA stations in the field to compare event-level responses. This poster concentrates on the results obtained with the first Auger SD station ("Auger North" design) deployed in Oct. 2014.

## Experiment

The Auger North SD station is a water Cherenkov tank with one PMT. It is a cost-effective version of the Auger South SD station. The TA SD station has two layers of plastic scintillator with two PMTs. The stations are placed on a square grid with 1.2 km spacing in 700 km<sup>2</sup> area.

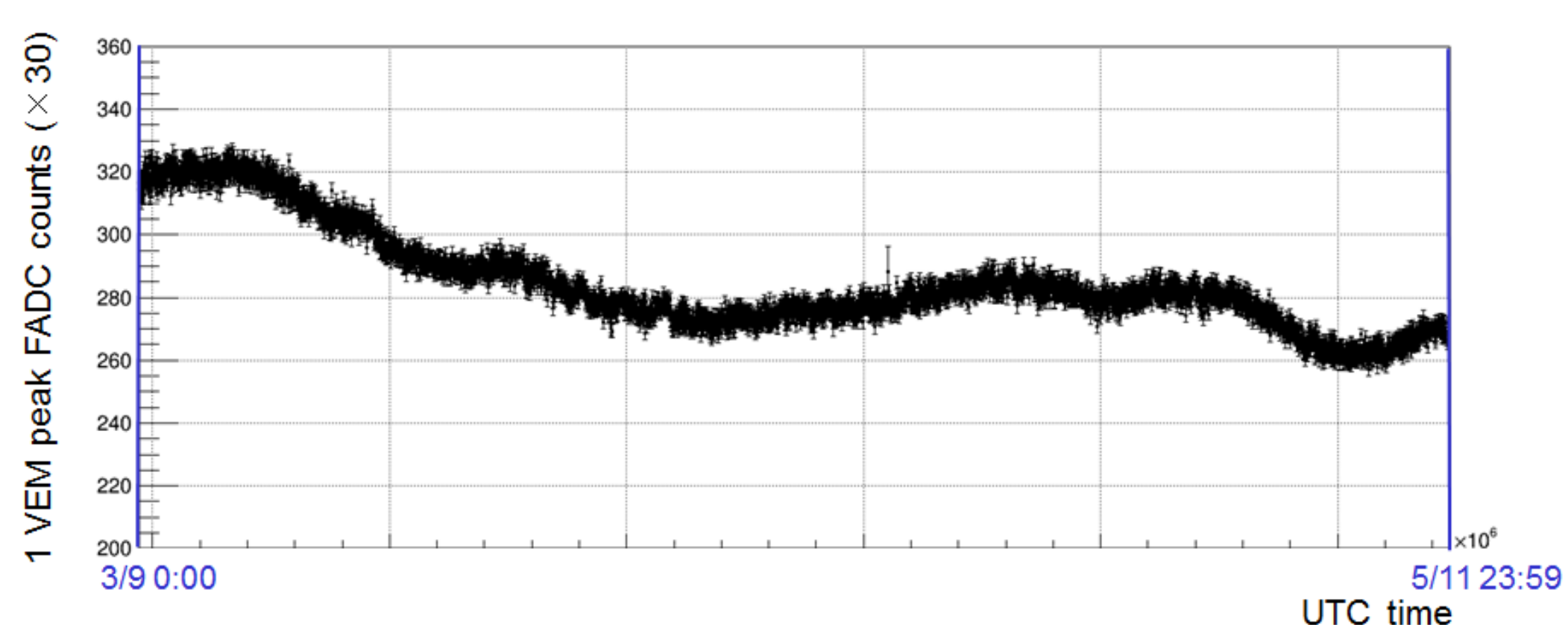
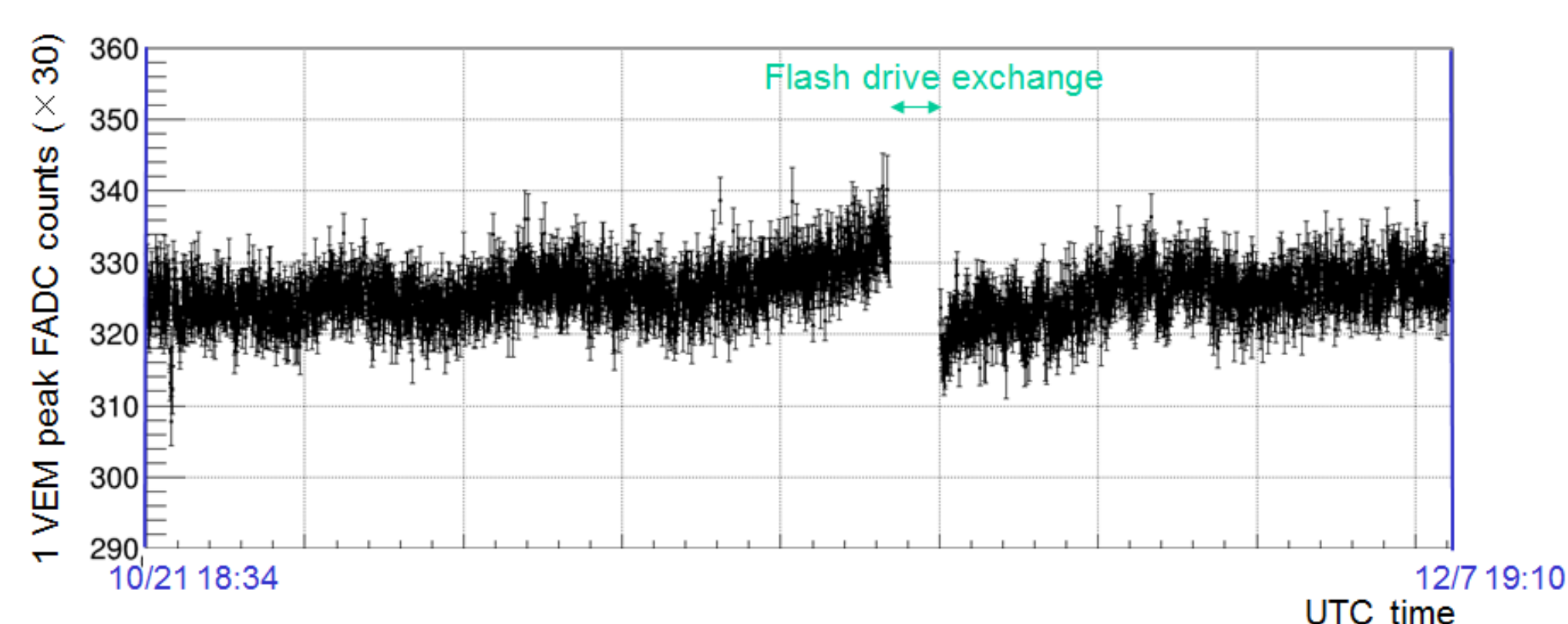
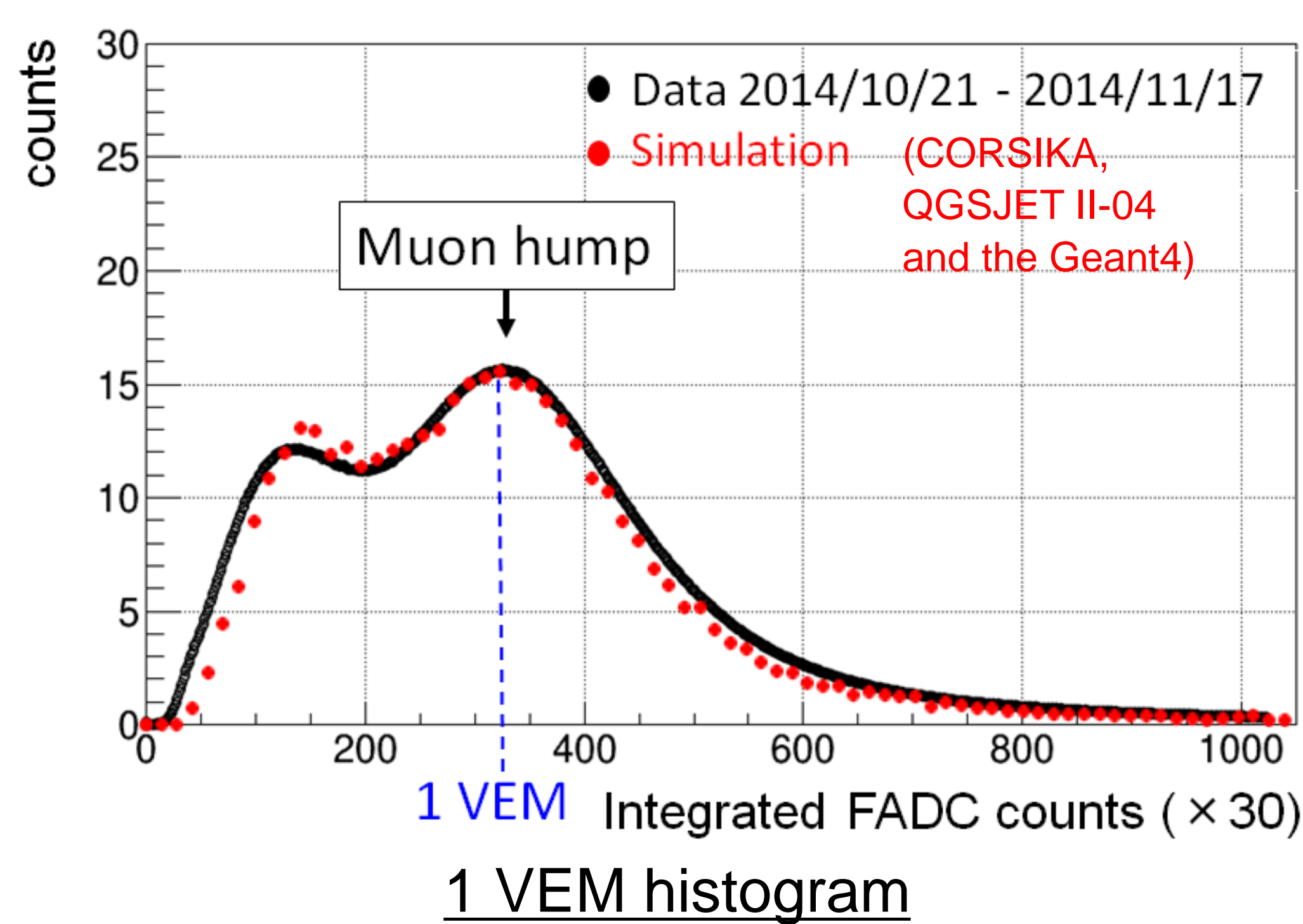


	Type	Area	Sampling rate	Detection particle
TA SD	Scintillator	3 m <sup>2</sup>	50 MHz	Mostly electromagnetic
Auger SD	Water Cherenkov	10 m <sup>2</sup>	40 MHz (South) 100 MHz (North)	$\mu$ • electromagnetic (different response)

## Analysis and results

### Calibration

A small dataset of atmospheric muons is collected to derive the Vertical Equivalent Muon (VEM) calibration from the single muon energy loss spectrum. The overall shape of the spectrum can be well described by the simulation. The VEM calibration appears to be relatively stable with small day/night (temperature-related) variation.

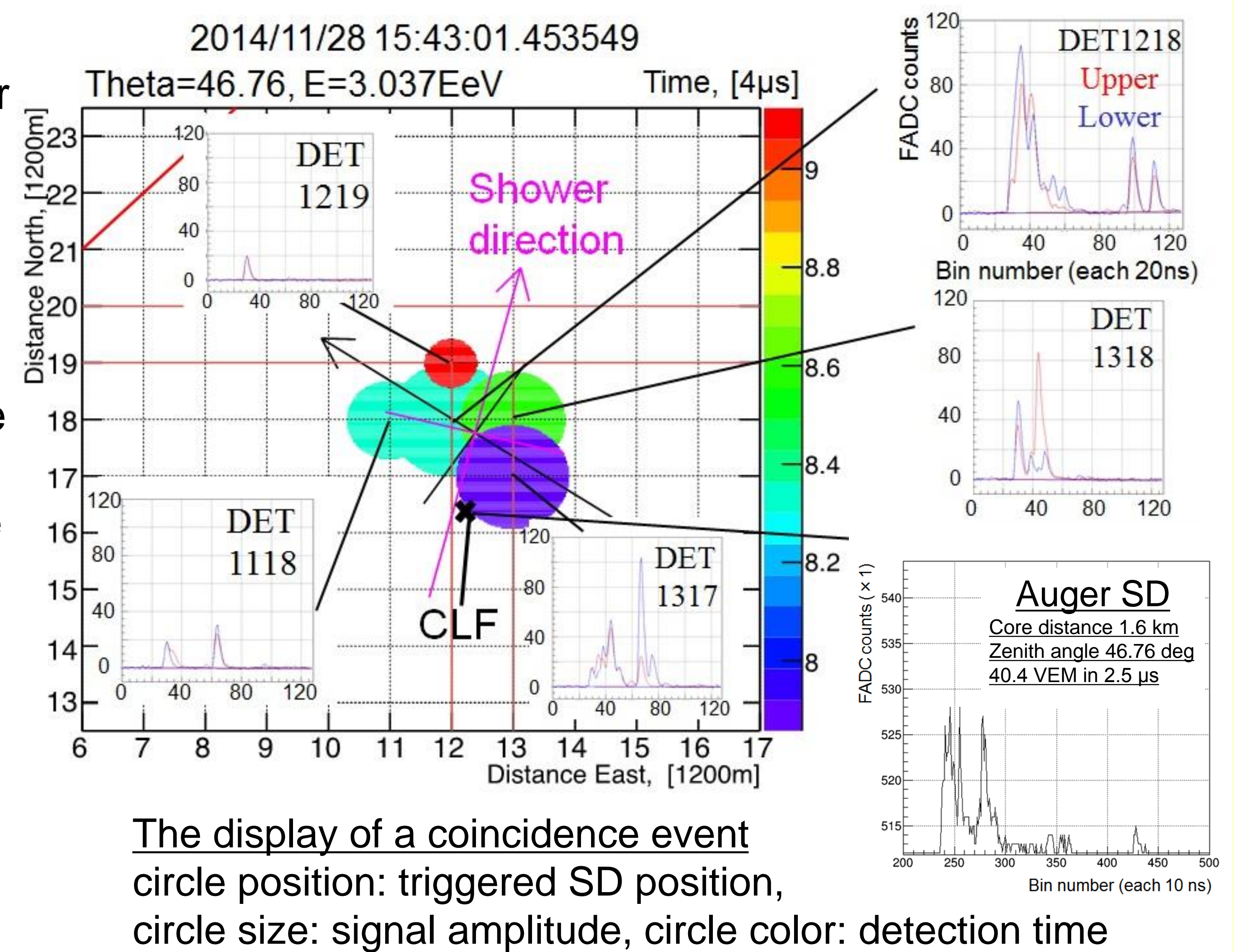


Time variation of the peak position of 1 VEM histogram

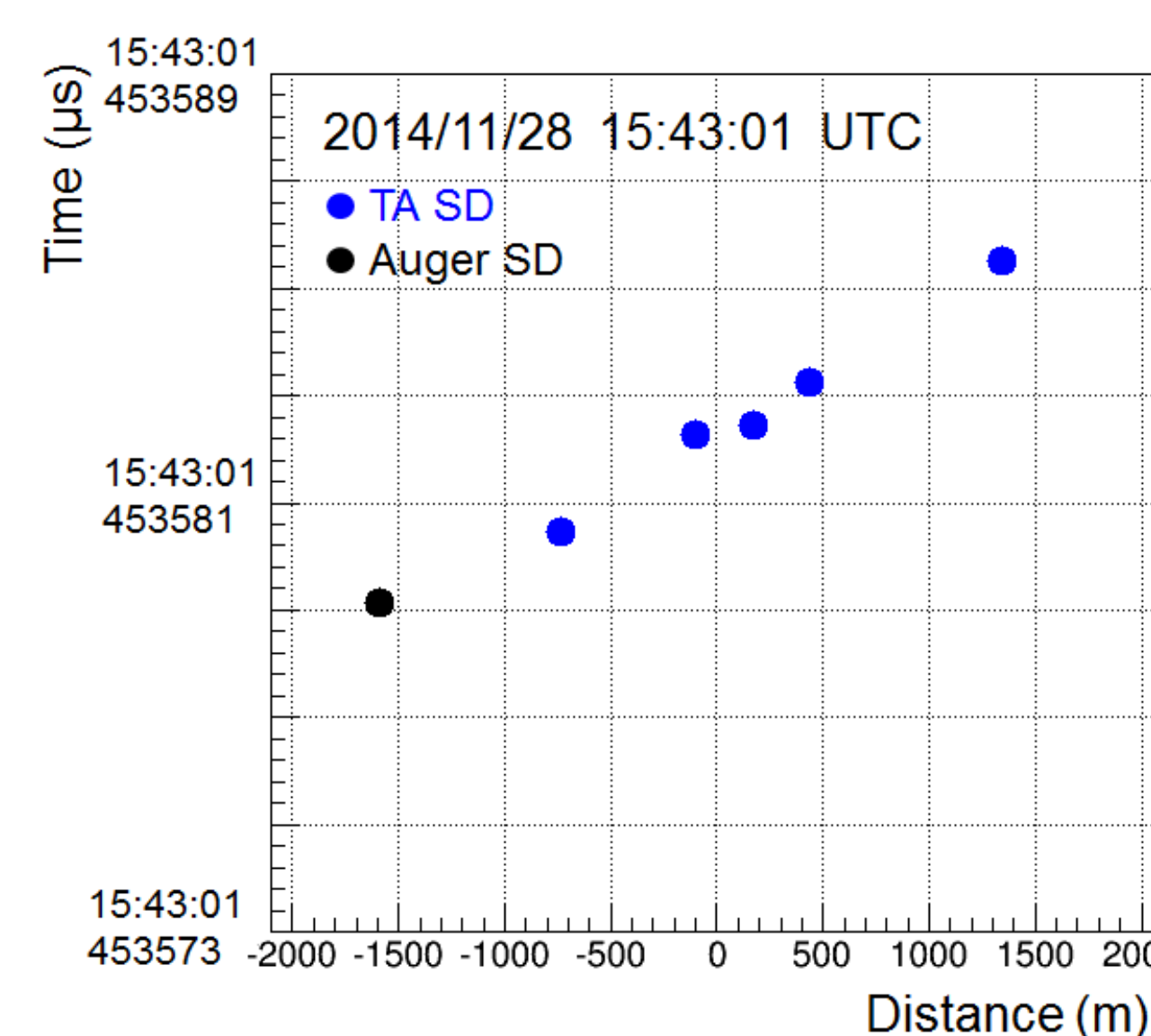
### Coincidence event between Auger SD and TA SD

The data are recorded on the drive of the Auger SD station at a rate of about 20 Hz. To identify UHECR shower events, the trigger timestamps are checked against the TA SD event trigger time within a  $\pm 32 \mu\text{s}$  window. Air showers are reconstructed with the TA SD array. The dataset periods are 3.5 months; Oct. 21 – Nov. 17, 2014, Nov. 19 – Dec. 7, 2014 and Mar. 9 – May 11, 2015.

Once the timestamp matching process is completed, 37 Auger North SD events are obtained in coincidence with TA SD events. Among them, 24 events have core positions within 5 km of the Auger North SD.



The display of a coincidence event  
circle position: triggered SD position,  
circle size: signal amplitude, circle color: detection time



The distribution of the station trigger time as function of the shower core distance along the shower axis projected onto the ground

The Auger SD appears as the earliest trigger time among the SDs. The feature is consistent with the geometry in the above figure.

## Summary & prospects

A joint Auger-TA experimental research program studying the differences in SD responses is ongoing. The Auger-TA coincidences have been observed by matching the Auger SD station timestamps to the TA shower trigger in post processing.

In Jun. 2015, a second Auger (South) station was deployed in the field, and both Auger SD stations were connected to a single board computer inside the CLF. This enables the direct collection of higher-level local and global triggers in the near future.