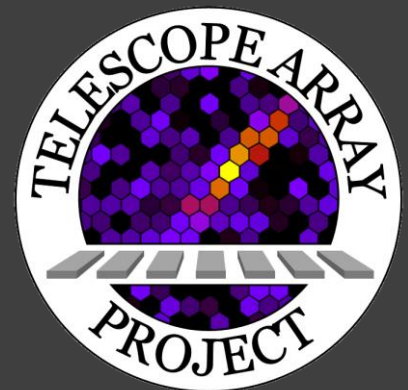




Status and Prospects of the TAx4 Experiment

Eiji Kido for the Telescope Array Collaboration

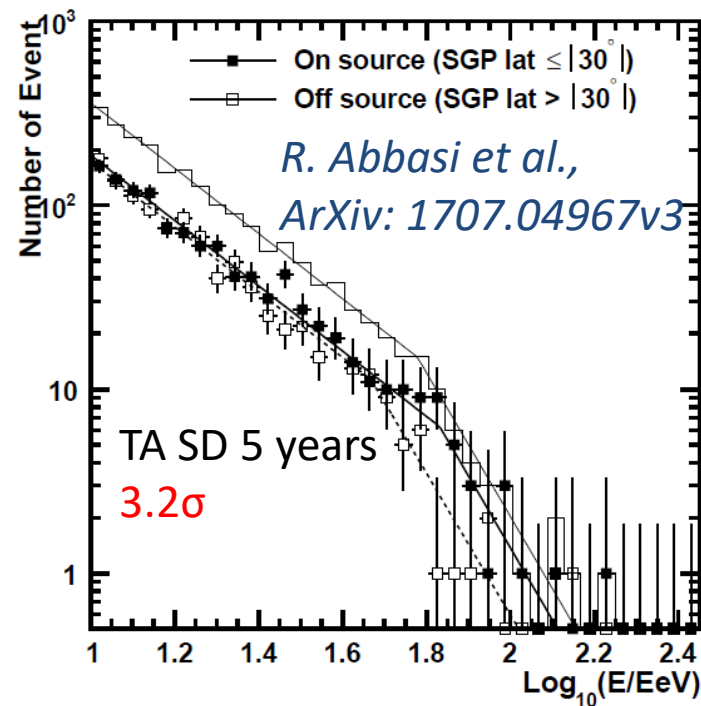
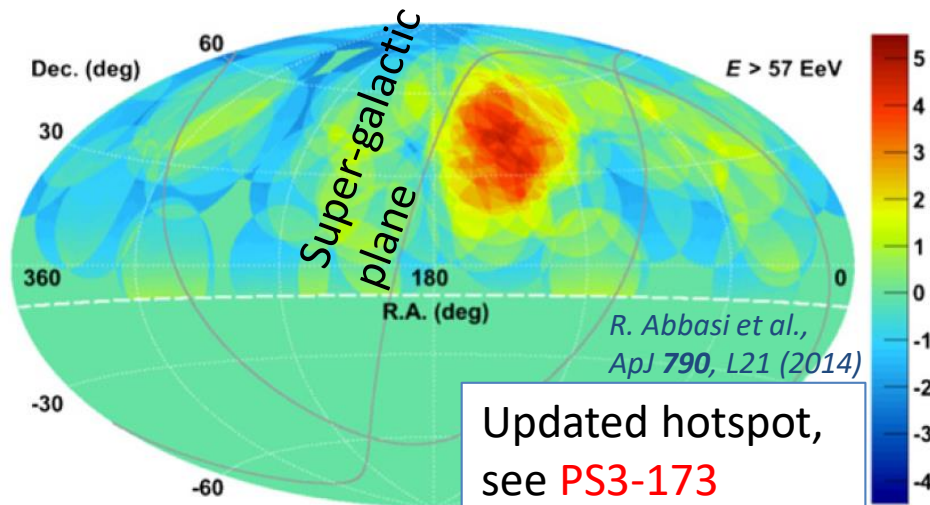
ICRR, University of Tokyo



Outline

- Motivation
- Construction of Surface Detectors (SDs)
- Construction of Fluorescence Detectors (FDs)
- Prospects
- Summary

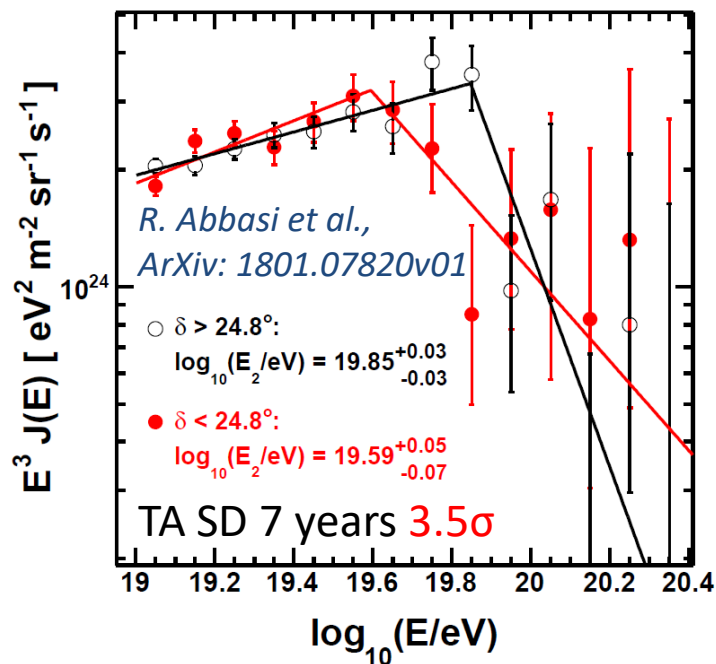
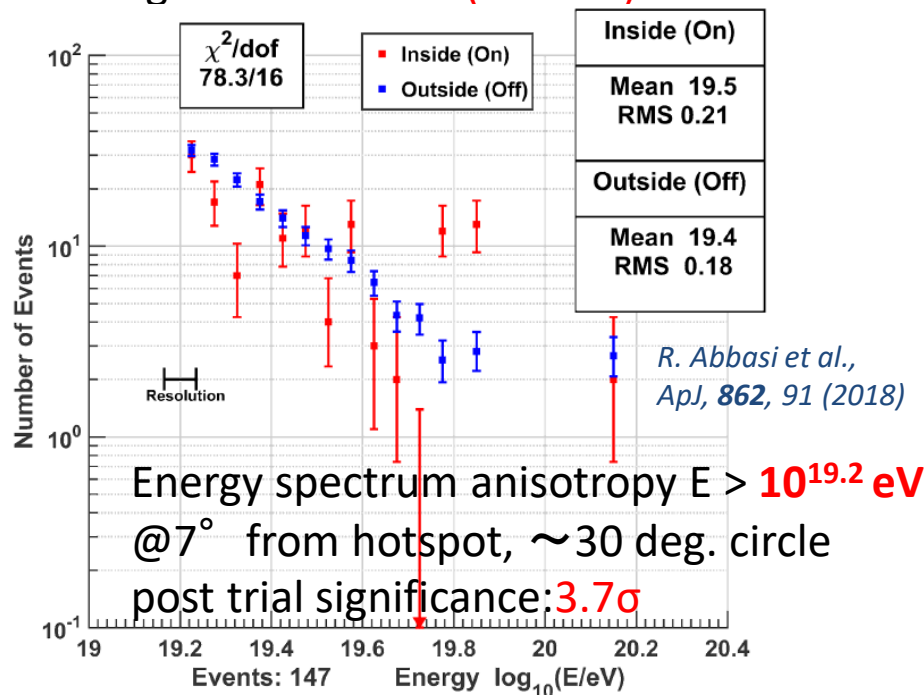
Significance map from isotropy



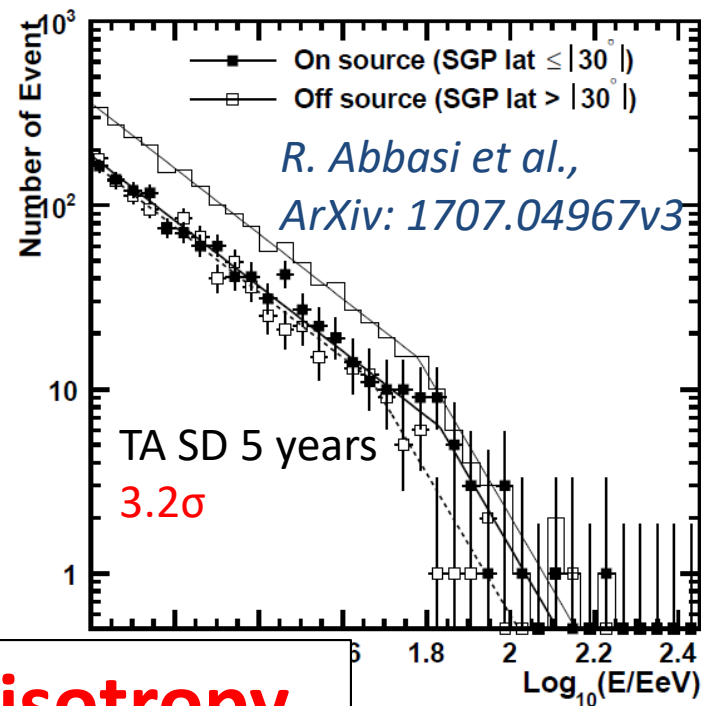
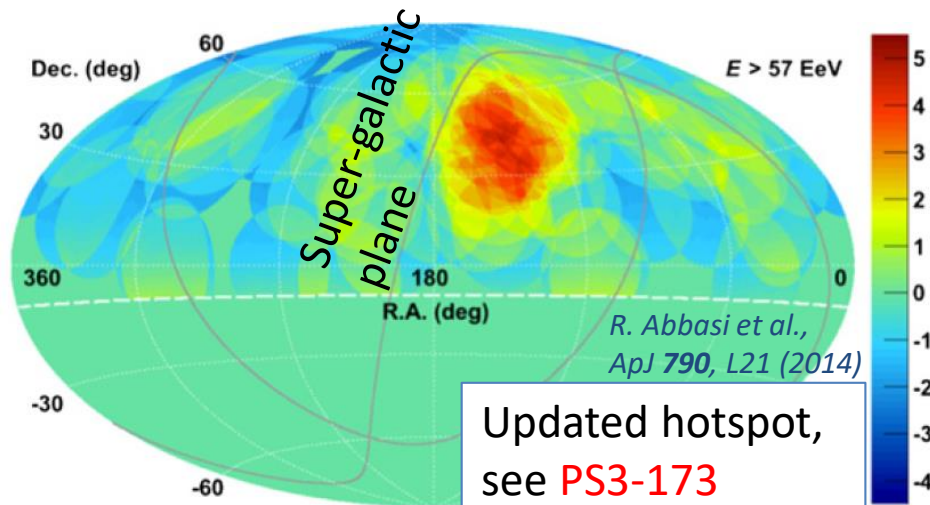
TA SD 5 years $E > 57 \text{ EeV}$ 72 events

20 deg. from each events are counted.

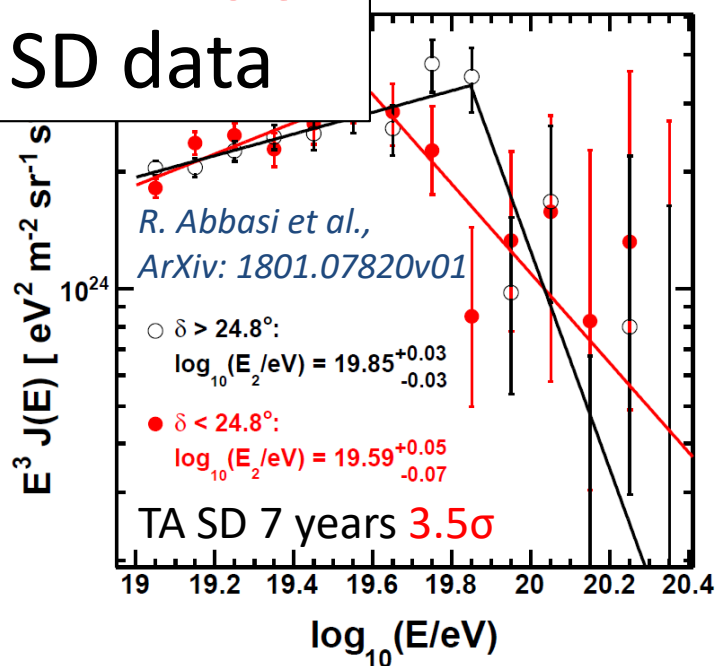
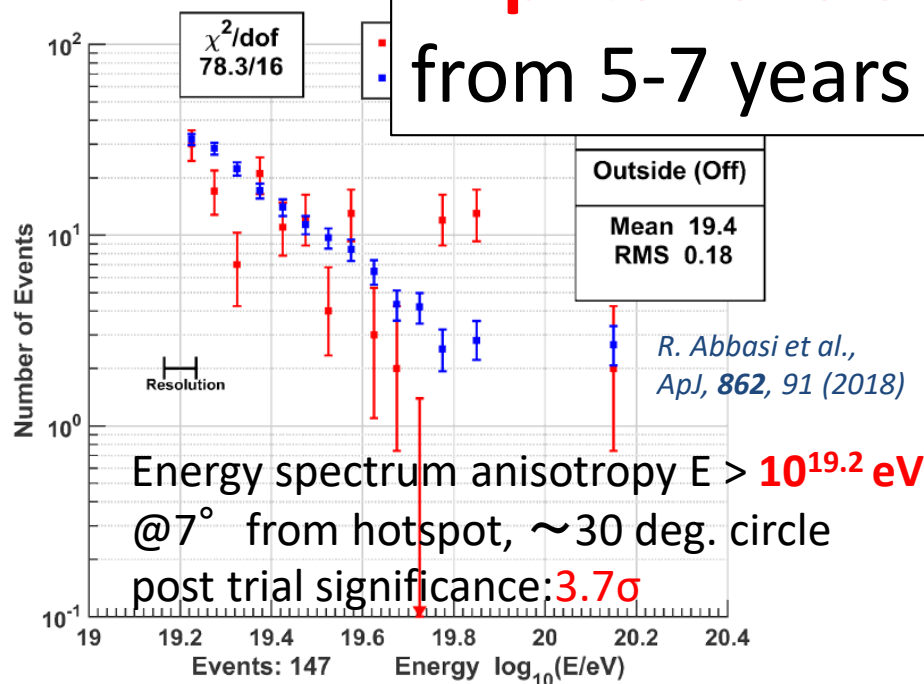
Global significance: **3.4 σ (0.037%)**



Significance map from isotropy



Implications of anisotropy from 5-7 years TA SD data



Arrangement of Detectors

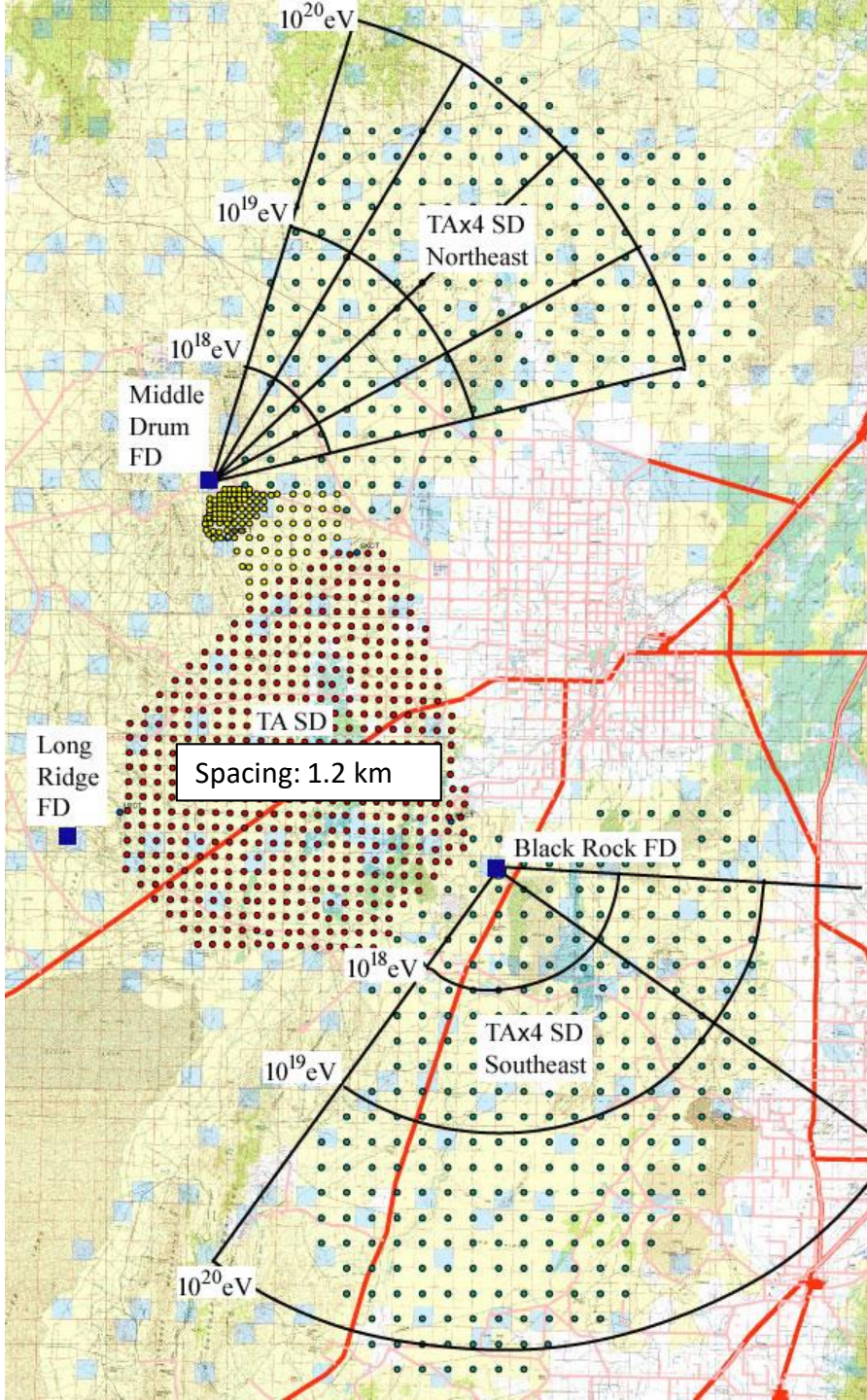
To study more about the highest energies and examine the implications obtained by TA

500 new SDs with 2.08 km spacing

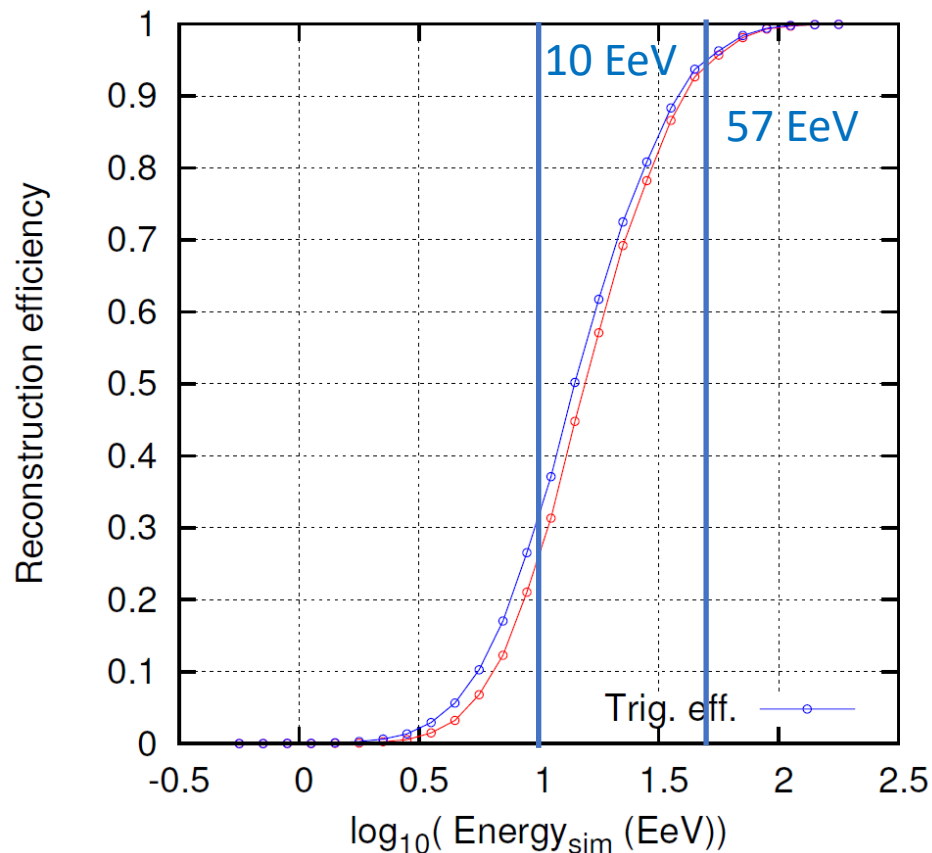
and TA SDs cover

4 × TA SD detection area ($\sim 3000 \text{ km}^2$)

2 new Fluorescence Detector (FD) stations
(4+8 HiRes Telescopes)



Expectation of the Performance of New SD Array



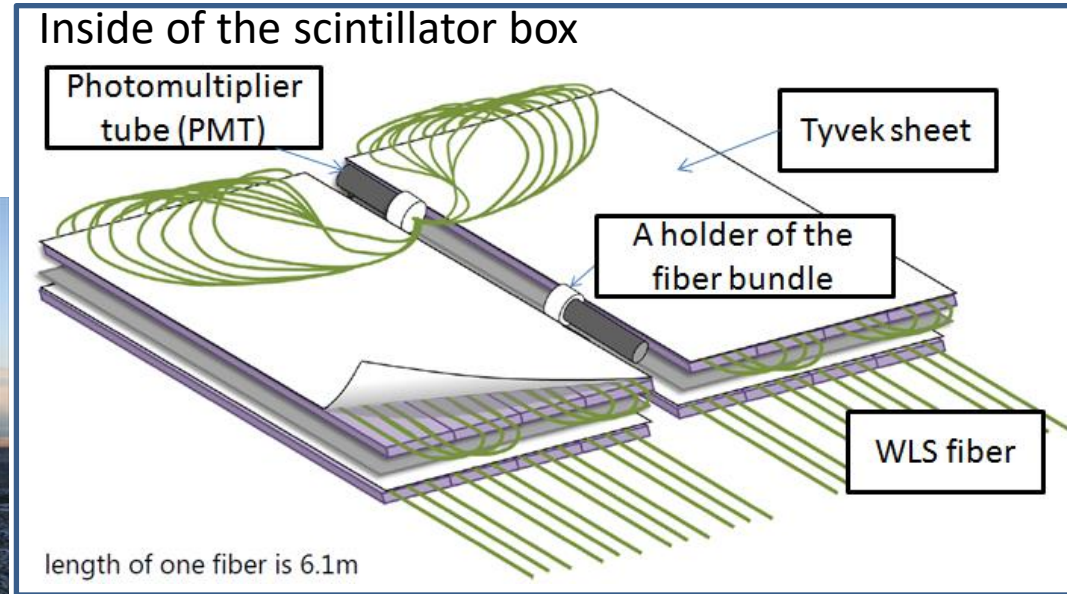
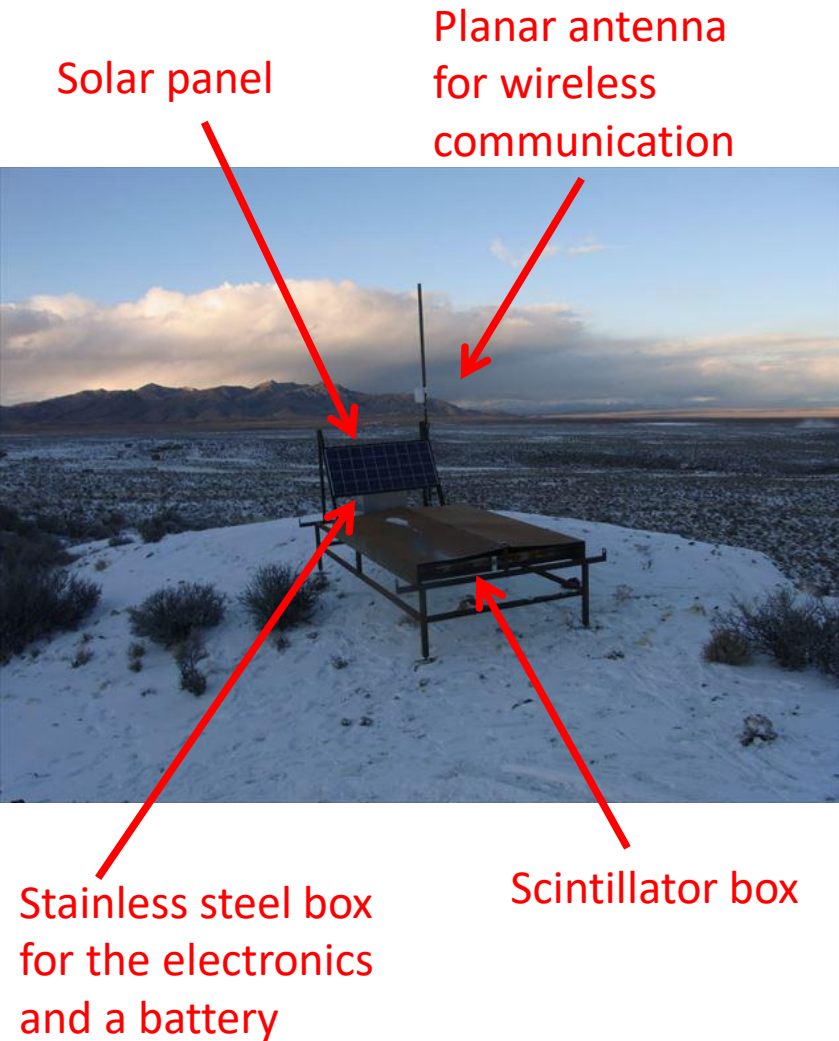
SD array: square grid with 2.08 km spacing

Trigger condition: adjacent 3 SDs within 14 μsec

$E > 57 \text{ EeV}$:

- Reconstruction efficiency $> 95\%$
- Angular resolution: 2.2°
- Energy resolution: $\sim 25\%$

Design of SDs



- **2 layers 3 m² 1.2 cm thick plastic scintillators**
→ Calibration of signals using single muons
- DAQ with 2.4 GHz wireless communication

PMT and arrangement of WLF fibers was changed from TA SD for the cost reduction

Single peak: **21 p.e.** in average

Non-uniformity: **< 15 %**

Pulse linearity: **50 mA** (**~2 x TA SDs**)

Deployment of Assembled SDs

<https://www.flickr.com/photos/142880279@N06/albums/72157689940402503>

Helicopter for the
transportation of SDs



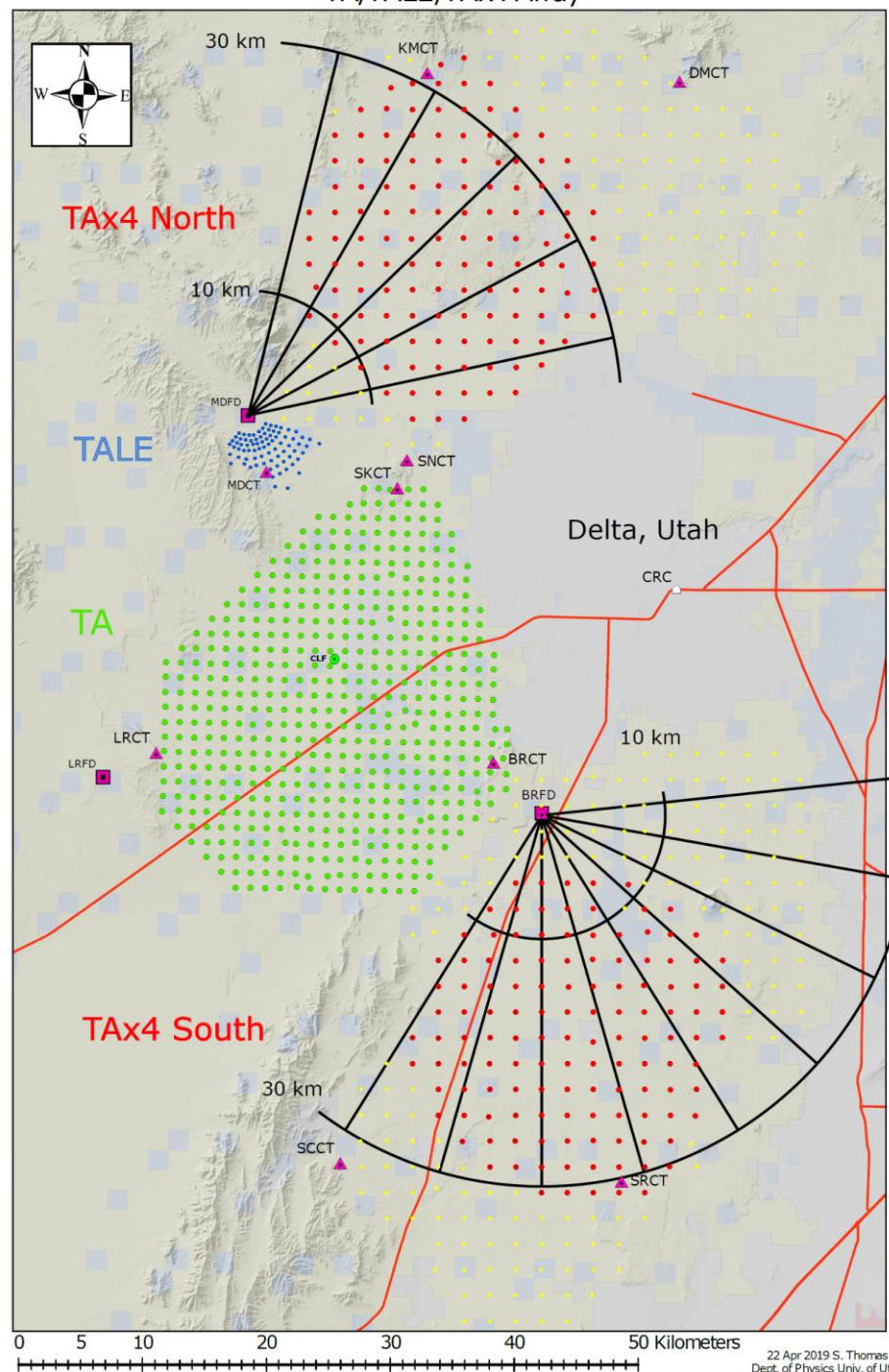
Deployment of SDs, Team on the Ground



13 Feb. 2019: deployment of SDs was allowed.

19 Feb. – 12 Mar. 2019:

More than half of TAx4 SDs were deployed.



Deployed SDs and Communication Towers

- 257 SDs were deployed
- 6 communication towers were constructed.
- SD array is divided into 6 sub-arrays for each communication towers.
- Locations of SDs were decided to optimize hybrid events above 10 EeV and consider practical conditions of wireless communications

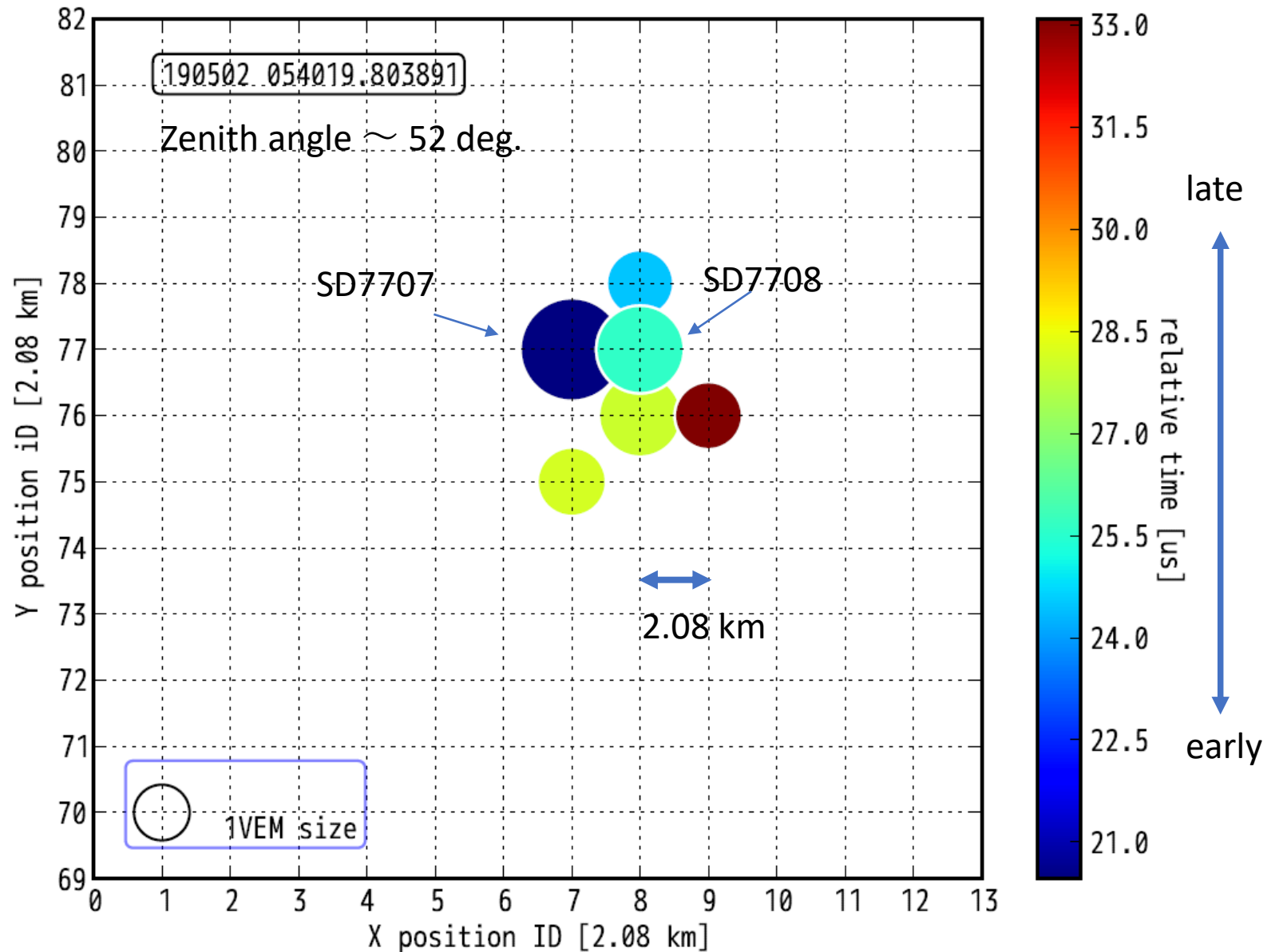
Detailed set up of communication towers, see [PS1-204](#) poster presentation by T. Nonaka

Tuning Antennas



- March and June 2019
- Antennas of each SD were aligned to each communication tower.
- **Test run of DAQ of each sub-array was started** from the end of Apr when the sub-array is ready.
- **Cosmic ray events** are being collected. (next slide)

Cosmic Ray Event



upper
lower

SD7609

SD7507

SD7608

SD7708

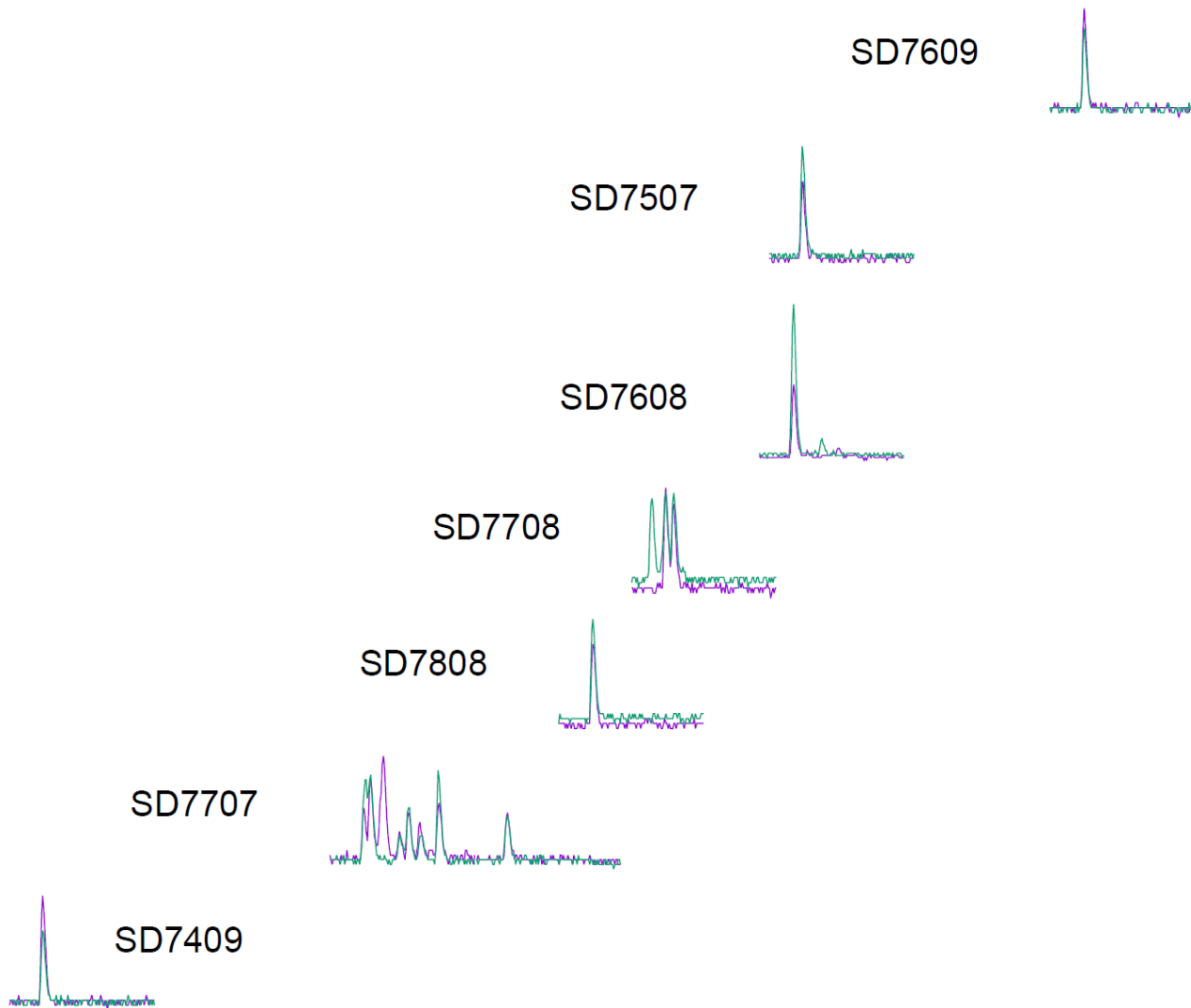
SD7808

SD7707

SD7409

-15 -10 -5 0 5 10 15

micro second



Construction of North FD Station



16th Feb. 2018

First light was observed.

(camera 28: Xe Flasher)

Stable operation was started from
8th June 2018.



Construction of South FD Station

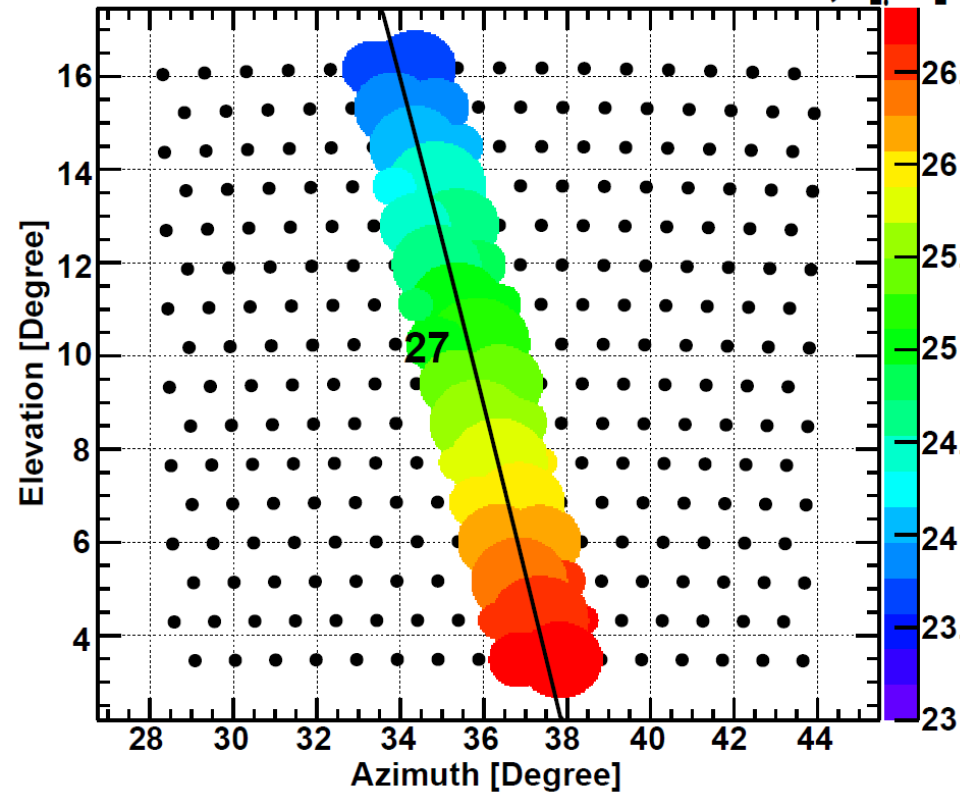


- Construction is ongoing.
- Mirrors were installed. The directions of mirrors were aligned.
- FADC electronics racks were installed.
- PMT cluster, other electronics will be installed.

Cosmic Ray Event

TA4XMDFD: 180616 074411.875382

Time, [μ s]



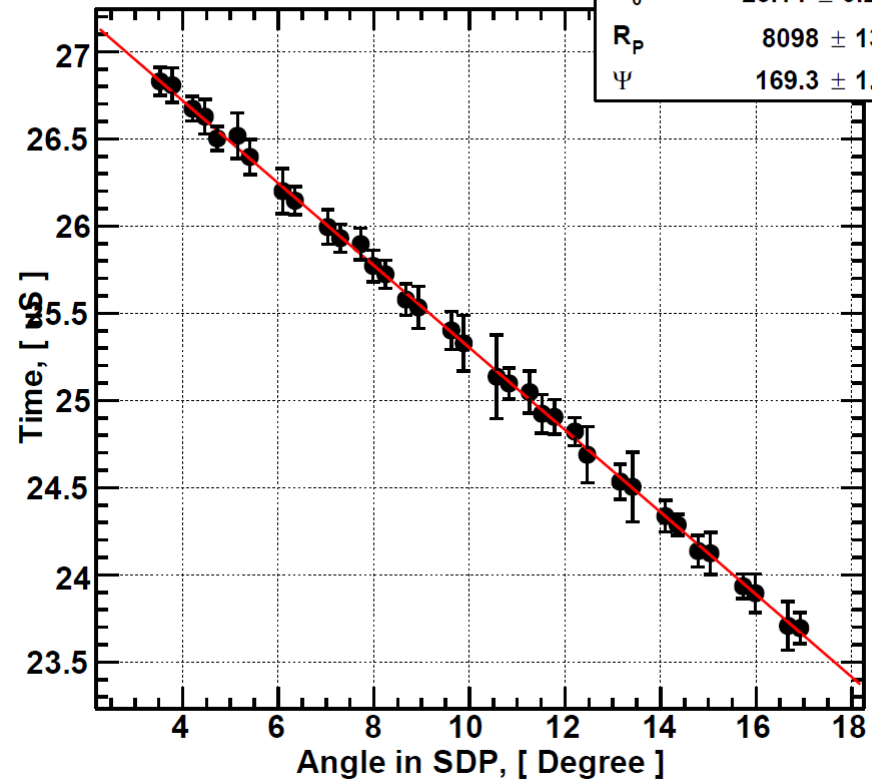
Time vs Angle, TA4XMDFD-Mono

df 2.59 / 32

25.14 ± 0.2488

R_p 8098 ± 130.5

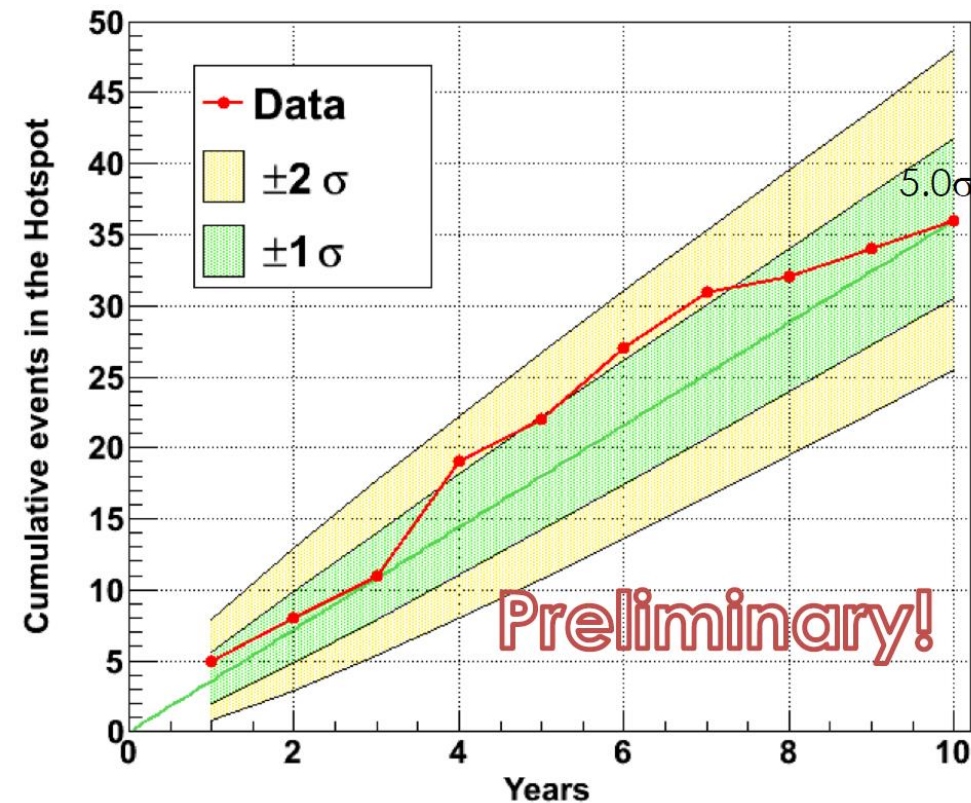
Ψ 169.3 ± 1.054



- Data analysis is ongoing.
- MC simulations will be generated, and quality cuts will be studied.

Expectation of Hotspot

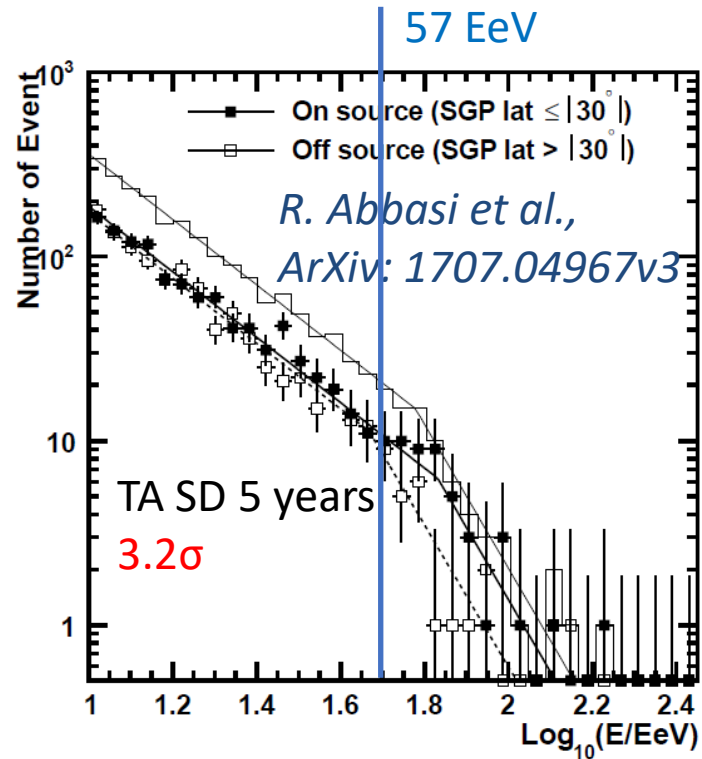
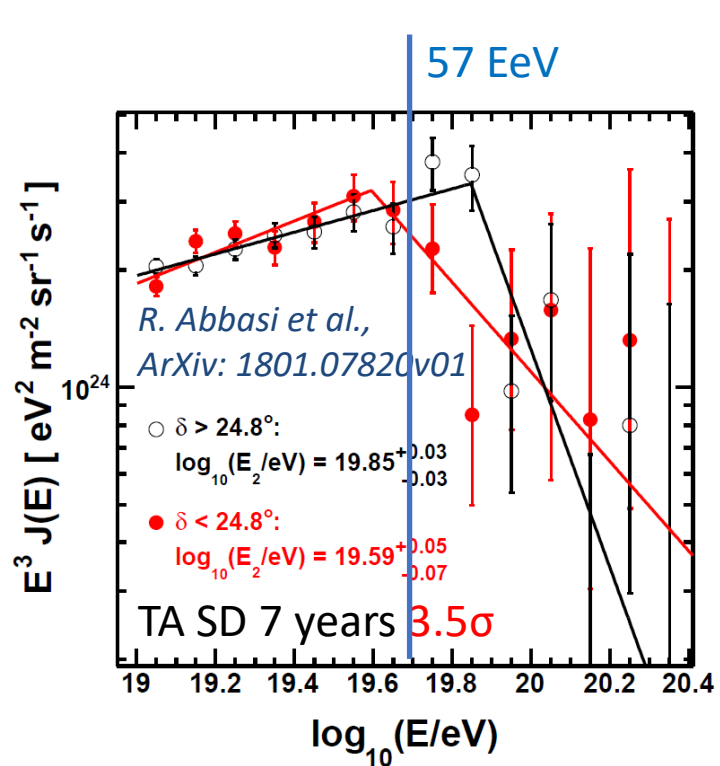
Hotspot position	Search radius	ON	α^* OFF (OFF)	ON/OFF ratio (α)	σ
RA:144.3° Dec: 40.3°	25°	36	12.6 (121)	0.10435	5.0



Independent ~ 40 events with $E > 57$ EeV are expected at the hotspot from ~ 2.5 years of full operation of TAx4 SD

For detail, see
PS3-173 by K. Kawata

Expectation of Spectrum Anisotropy



- 7 years TA SD equivalent energy spectrum with $E > 57$ EeV will be obtained from ~ 2 years of full operation of TAx4 SD.
- Xmax at the highest energies will be also measured.
- $\sim 3 \times$ TA SDFD hybrid equivalent data will be obtained by the full TAx4.

Summary

- Implications on anisotropy were obtained by the TA experiment.
- Arrangement of TAx4 detectors:
 - **500 new** SDs with **2.08 km** spacing + TA SDs
→ Coverage of **4 ×** TA SDs $\sim 3000 \text{ km}^2$
 - **2 new** Fluorescence Detector (FD) stations (4+8 HiRes Telescopes)
- **More than half of TAx4 SDs** were deployed.
- **North TAx4 FD** was constructed.
- **Data acquisition was started.**
SD: from **Apr. 2019**, FD: from **Jun. 2018**
- Cosmic ray events are being collected.
- Prospects
 - Hotspot and spectrum anisotropy with $E > 57 \text{ EeV}$ will be studied with \sim **4 ×** TA SD equivalent statistics if the full operation is started.
 - X_{max} : \sim **3 ×** TA SDFD equivalent events will be expected at the highest energies if the full operation is started.

Backup