

The Telescope Array

- Status and prospects -

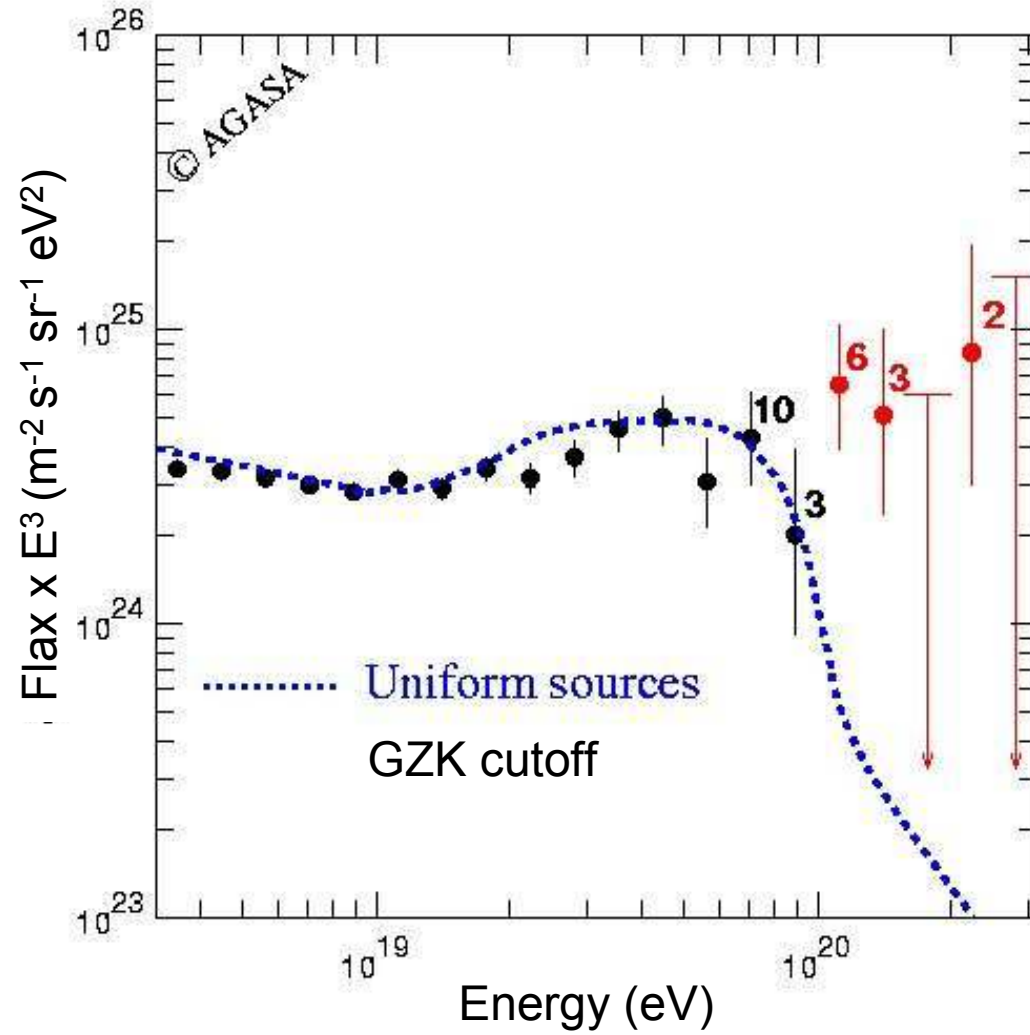
Hisao Tokuno

ICRR, Tokyo U.

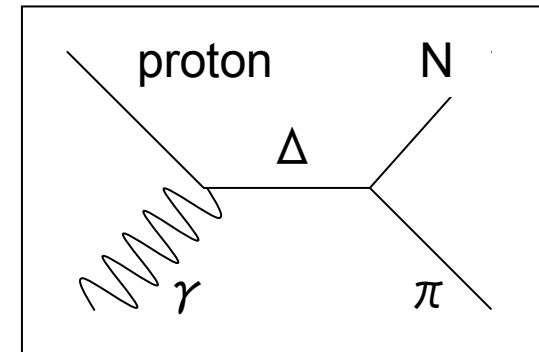
The Telescope array collaboration

2007/Sep/14

UHECR spectrum

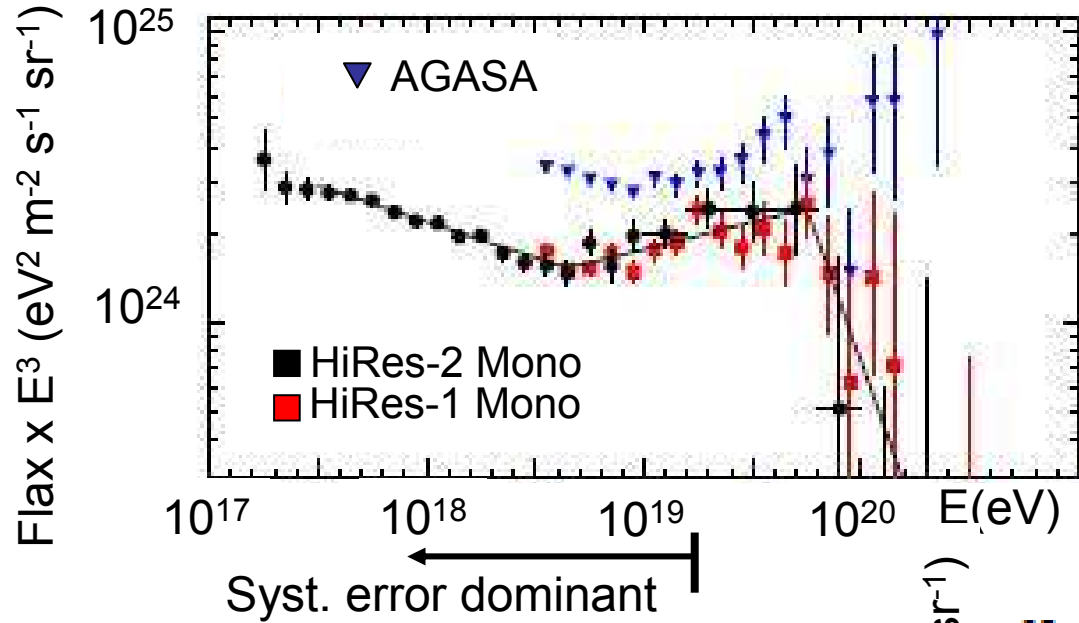


UHECRs ($>3\text{-}5 \times 10^{19} \text{ eV}$)
 encounter CMB
 \rightarrow GZK cutoff



AGASA results
 (Syst. Err +/-20%)

UHECR spectrum

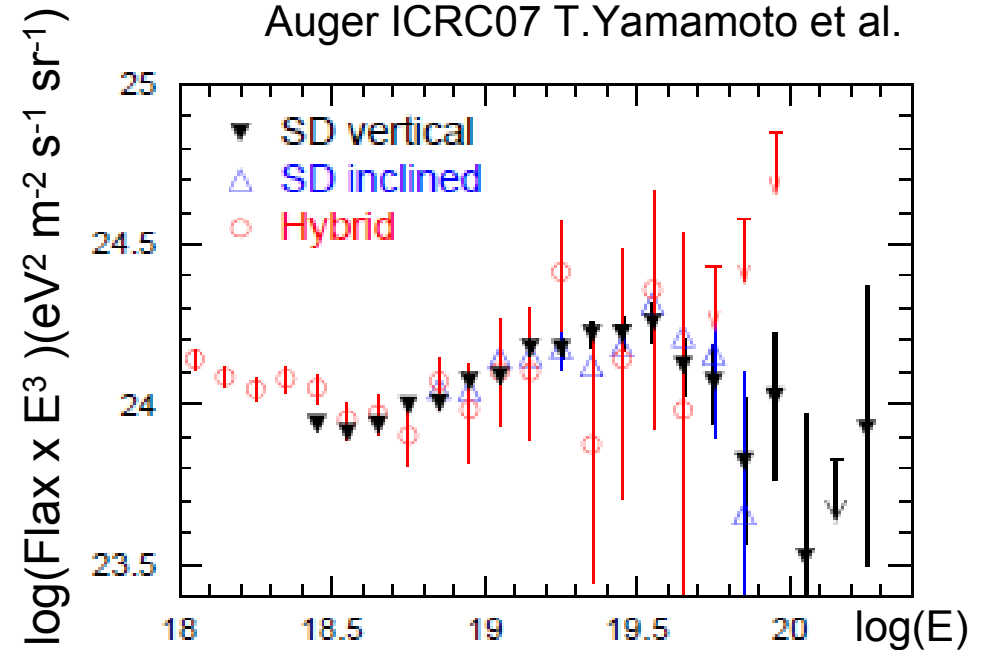


Obs. Energy spectrum is different from each other

Energy Spectrum cutoff or not?

Estimated Systematic Error +/- 20~30% for each experimental results

Auger ICRC07 T.Yamamoto et al.



UHECR spectrum

Difference of Observed Energy spectrum

Not only poor statistics,
Systematic differences between each experiment can be seen

Why?

possibilities

- Difference of detection method
 - Difference of detection components with MC dependence
(Electro magnetic components, Mu, air fluorescence)
 - Unstable UHECR source
 - Difference of UHECR Source distribution
(Auger: South hemisphere, Others: North hemisphere)
- etc ...

The Telescope Array tackling the problems

High accuracy

Hybrid (combination different detection method)

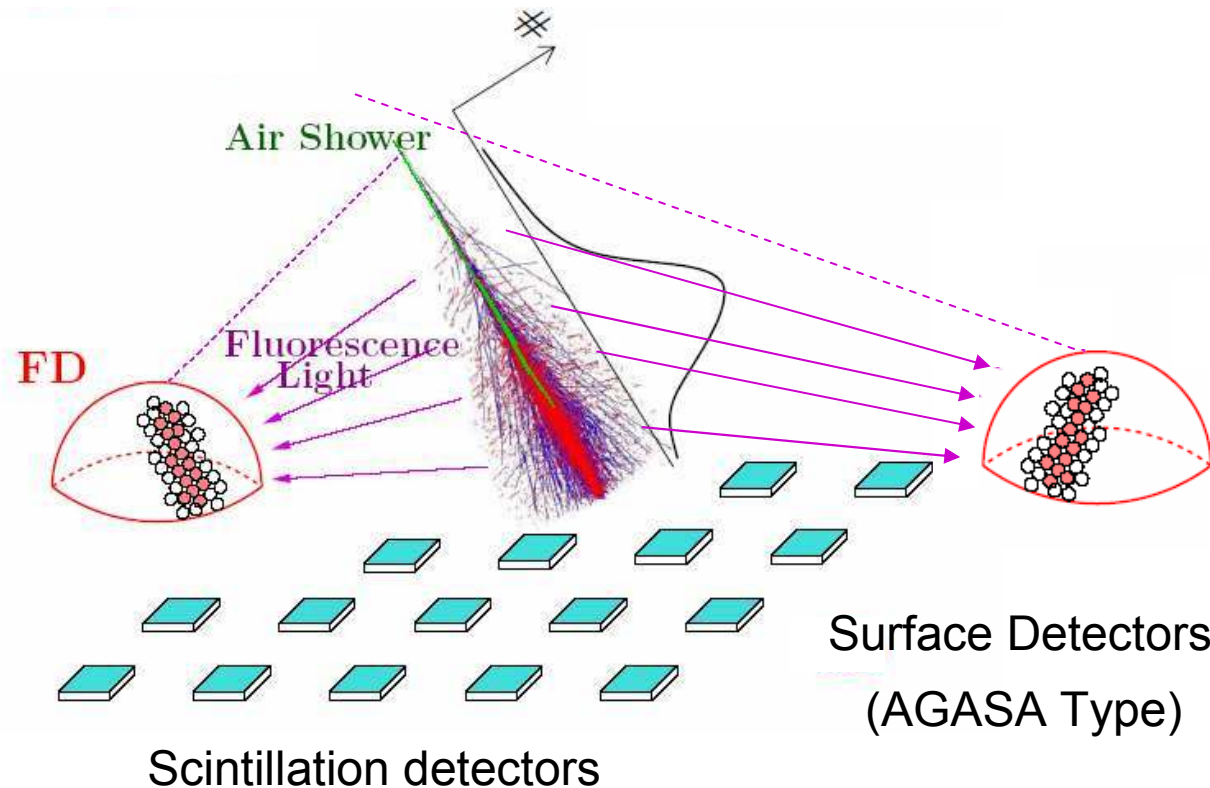
➤ **Surface Detectors** (AGASA type)

➤ **Fluorescence Detectors** (HiRes type)

High statistics

Aperture $\sim 10 \times$ AGASA

Fluorescence
Detectors
(HiRes Type)



Surface Detectors
(AGASA Type)

Scintillation detectors

FD part

in Utah, US

3rd station

Middle Drum



2nd station

Long Ridge



Black Rock Mesa



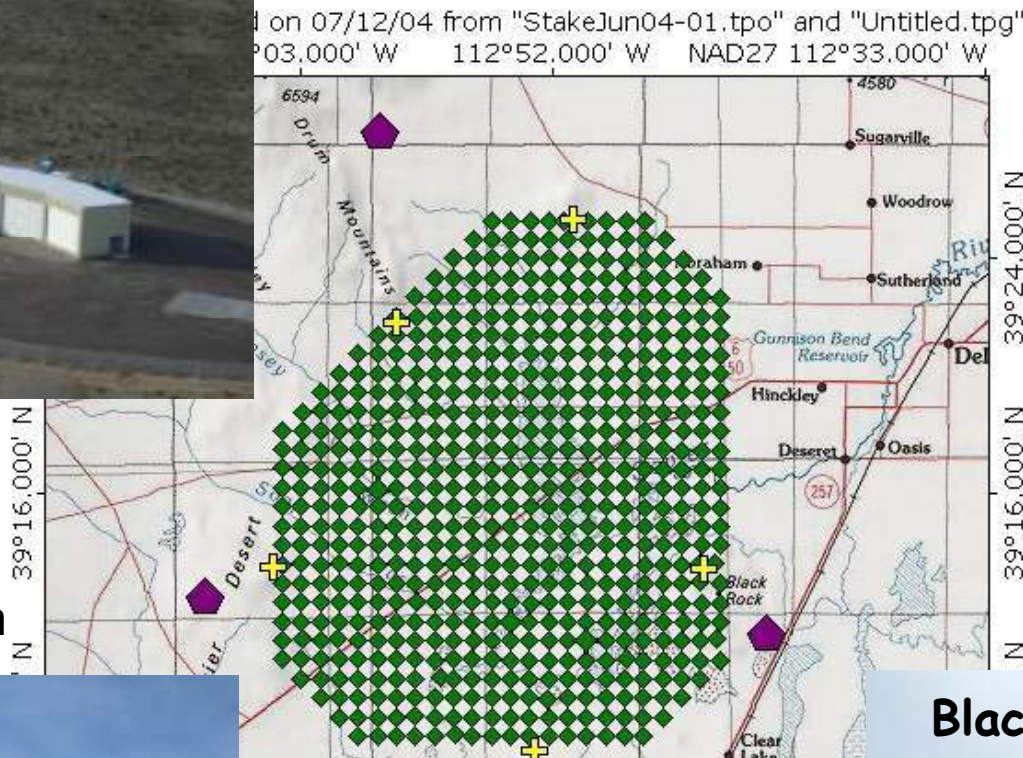
1st, 2nd station

Elevation: 3~33°
Azimuth: 108°
Camera: 12

3rd station

Hires-I

1st station



1st, 2nd station of FD

Newly telescopes
12 telescopes/station

camera
60 mm Hex.,
256 PMTs

1021mm
893mm

FOV: 3° – 18° x 18°

17.7° – 33° x 18°

Diameter: 3.3 m

Mirrors

PMT: HAMAMATSU R9508

Bleeder circuit with pre-amplifier

1st station: completed

2nd station: 6 cameras completed, 6 cameras waiting for HVPS installation.

3rd station of FD

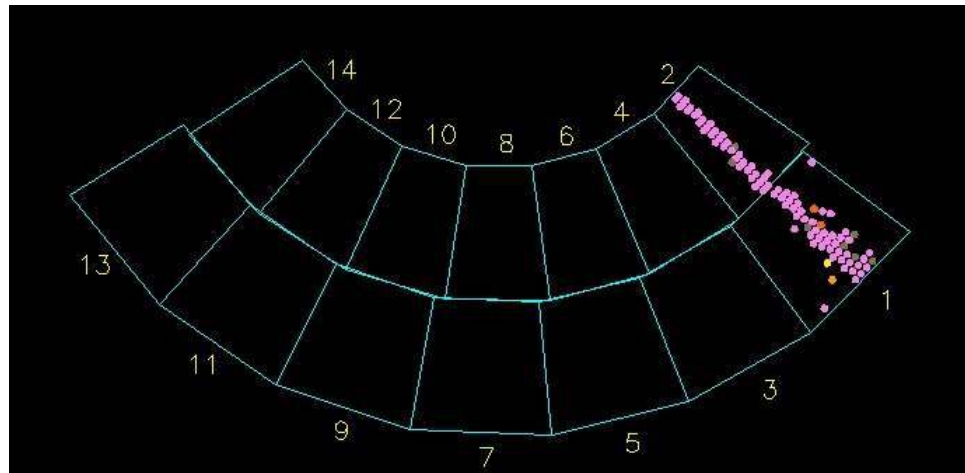
Hires-I has been moved.

Now calibration and test operation is running.

3rd station Middle Drum



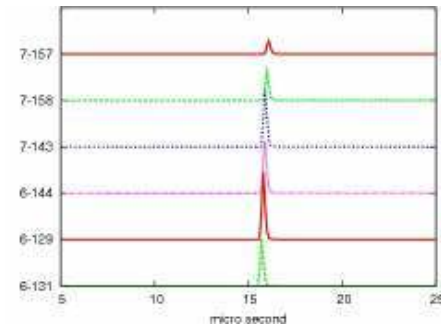
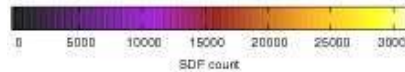
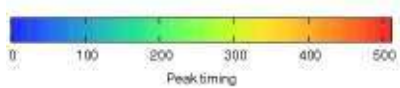
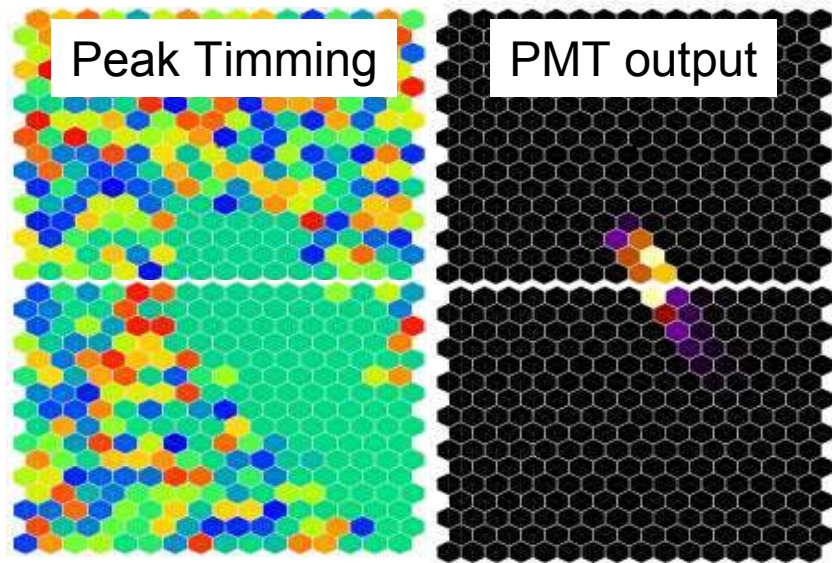
14 Mirrors/cameras
PMT FOV $\sim 1^\circ$
Mirror 5.2m^2



FD Stereo event example

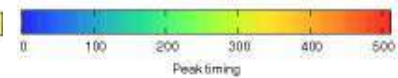
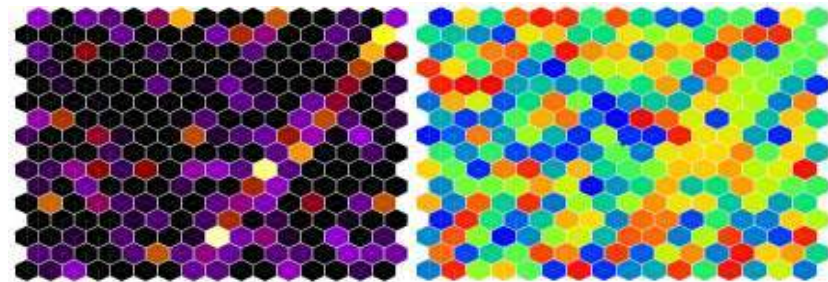
Stereo operation have been started June2007

Long Ridge (2nd station)



frame head (sec) =
50.0017877

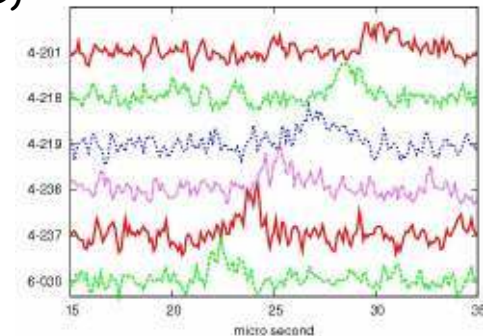
Black Rock Mesa (1st station)



June 14, 2007, 09:49(UTC)

frame head =
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Trigger rate ~1Hz

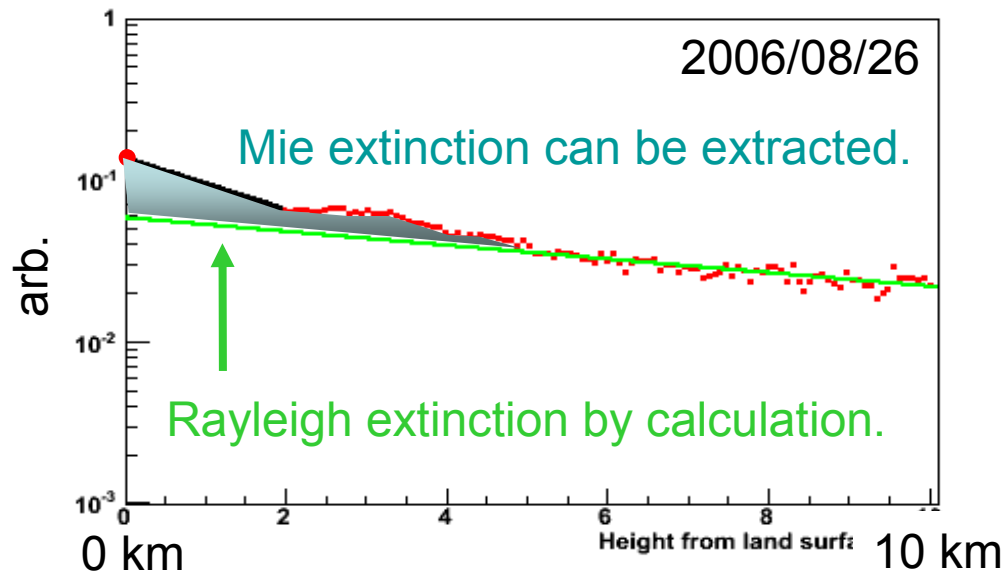


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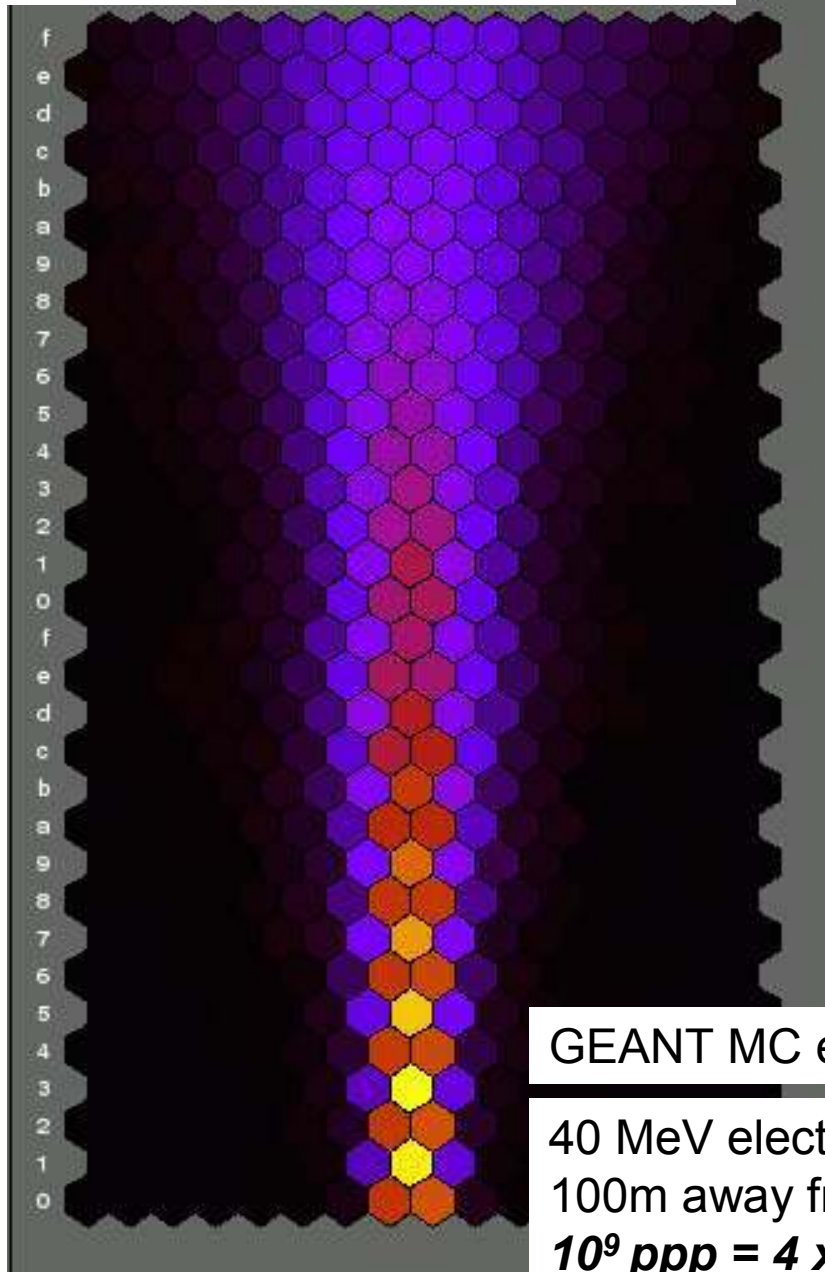
Atmospheric Transparency monitoring

Fluorescence light are attenuated by Rayleigh & Mie scattering

Extinction Coefficient is measured by Backscatt. Lidar @ BRM



End to End calibration FD



GEANT MC event

40 MeV electrons
100m away from telescope
 $10^9 \text{ ppp} = 4 \times 10^{16} \text{ eV}$

Absolute Energy Calibration on site
by 40 MeV electron linac beam



Now being assembled
at KEK B-factory.

SD part



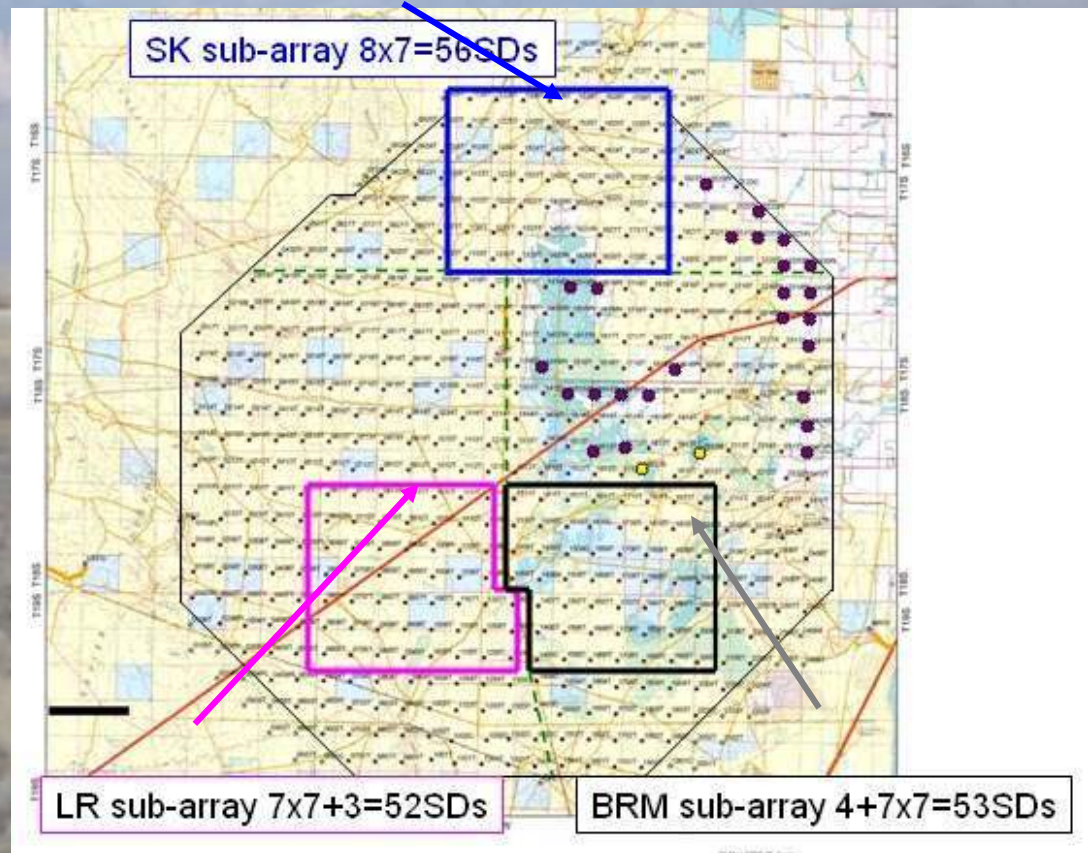
SD part

512 SDs (485 SDs installed Feb 2007)
The rest of 27 SDs will be installed this autumn.

Wireless LAN antenna

Solar Panel

3m², 2 layer Plastic scintillator

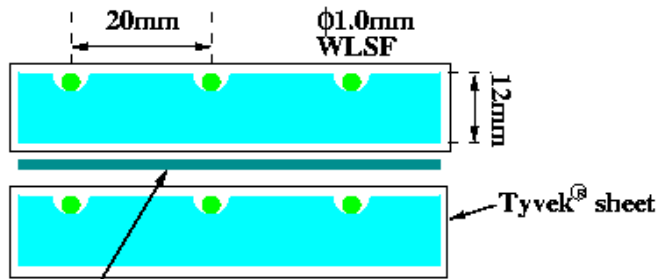
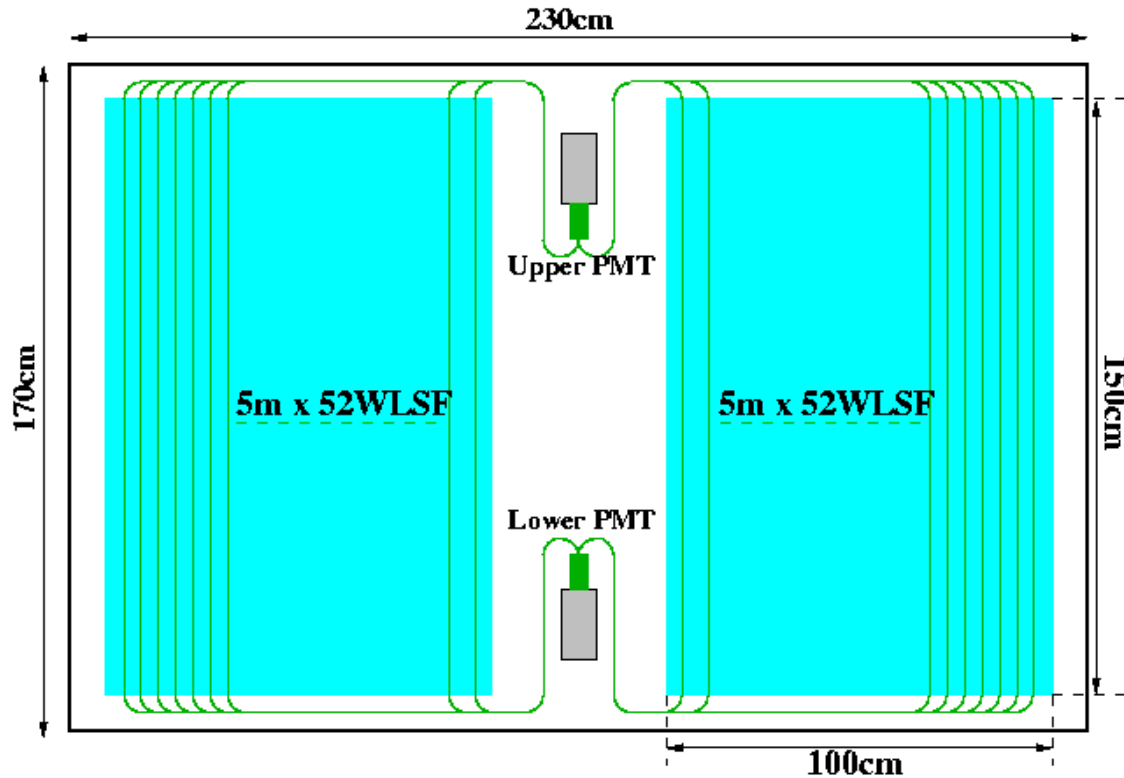


Three sub-arrays (~7x7 SDs for each)
are prepared for the observation and detailed check.

1.2km spacing, trigger efficiency ~100% >10¹⁹eV

SD

schematic view of SD



Upper & Lower layer are divided in antic

Upper & Lower Layer are separated optically.

Scintillator

Area: 3m²

Thickness: 1.2cm

Layers: Upper/lower

PMT

Electrontubes 9124SA

2 PMTs (Upper, Lower)

Wave Length shifting Fiber

1mm diameter

2cm interval

2 layer

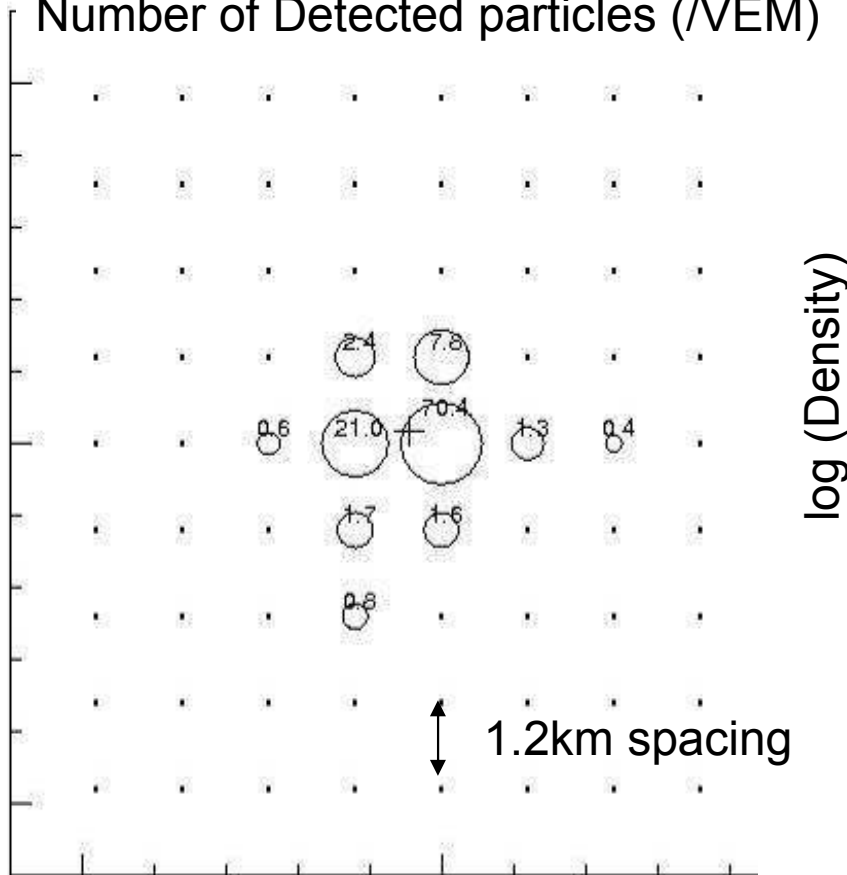
- Trigger & Calibration

- Extension of Dynamic Range

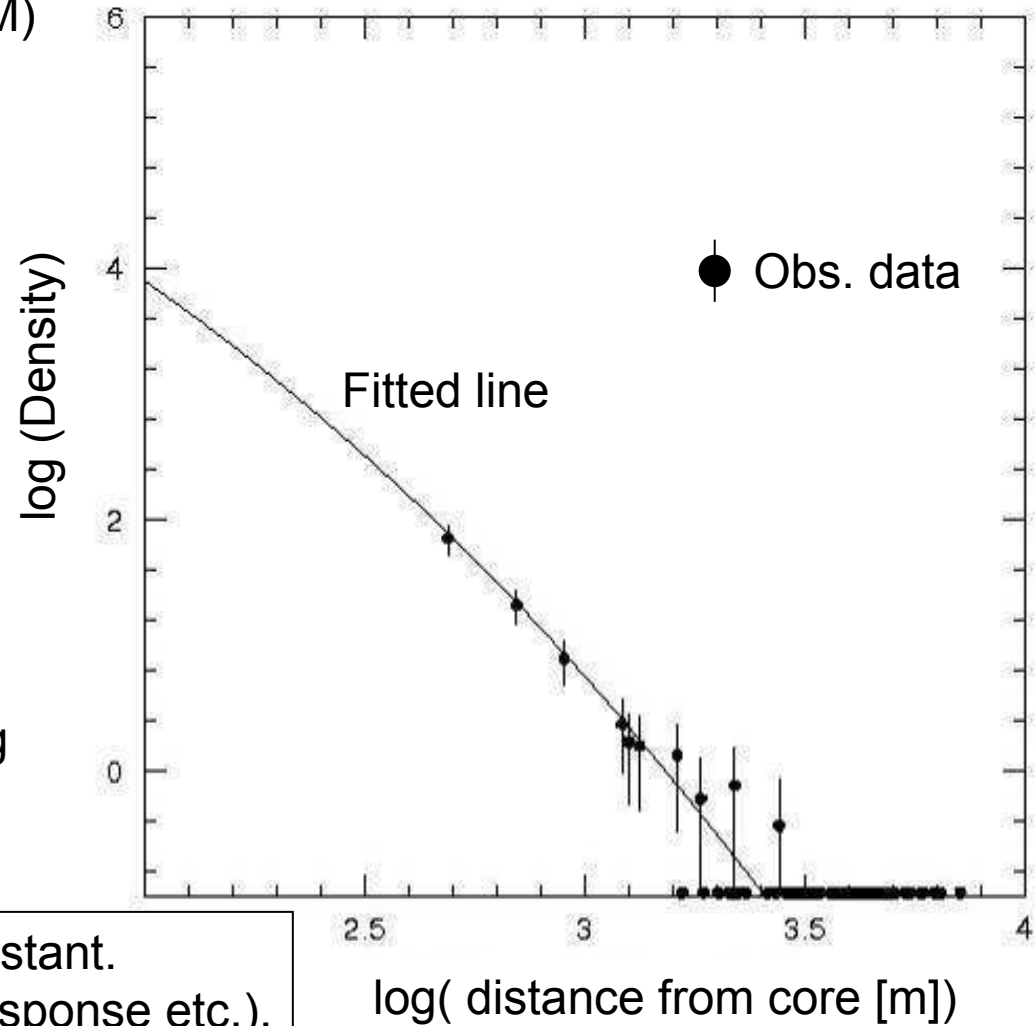
SD: Event example

TID391, 07/07/04 07:55:17

Number of Detected particles (/VEM)



Lateral density distribution



Now we are checking calibration constant.
pre-analysis (trigger rate, detector response etc.).

TA (Phase-I) prospect

➤ UHECR Energy spectrum

- To confirm UHECR Energy spectrum on the North hemisphere (to understand the difference of spectrum between AGASA and HiRes)
- To compare the energy and aperture estimation power of FD-Mono, HiRes-I, FD-stereo, SD, and Hybrid.

SD AGASA type (plastic scintillators measure Elemag. components mainly)

FD Hires type (Elemag. components) 3rd FD Hires-I

FD End to End calibration (electron beam)

➤ Anisotropy

- To confirm the Anisotropy of UHECR on the North hemisphere.

AGASA: cluster (doublet, triplet)

HiRes: BL Lac correlation

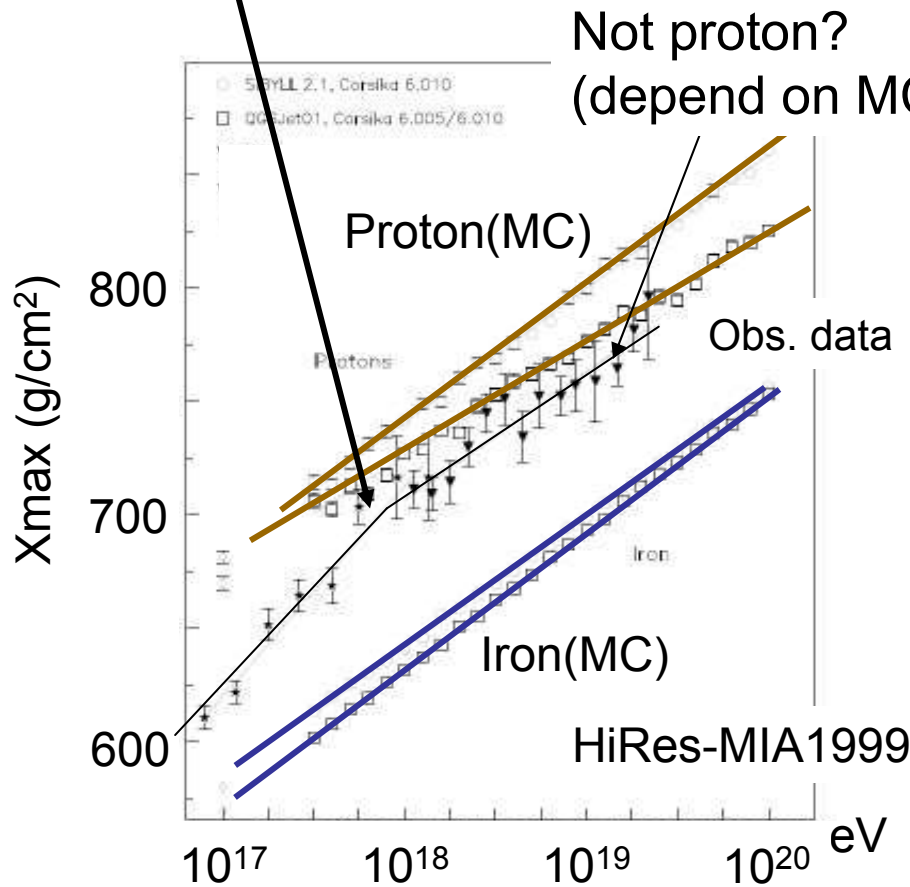
➤ Composition

Composition at the low energy region

Galactic/Extragalactic Transition appear?
Highest Energy of Galactic CR?

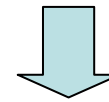
FD + Low energy Extension (TALE)

- Target energy range: $10^{17} \sim 10^{19}$ eV
- Infill SD array
- tower FD (for higher altitude)



Composition study is depend on MC strongly

The difference between MC model is comparable to statistical error.



MC calibration is needed.

LHCf experiment (see next talk)

(Energy estimation power will be progress also)

Conclusion

FD

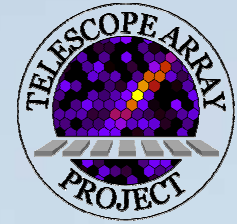
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To confirm UHECR Energy spectrum and anisotropy
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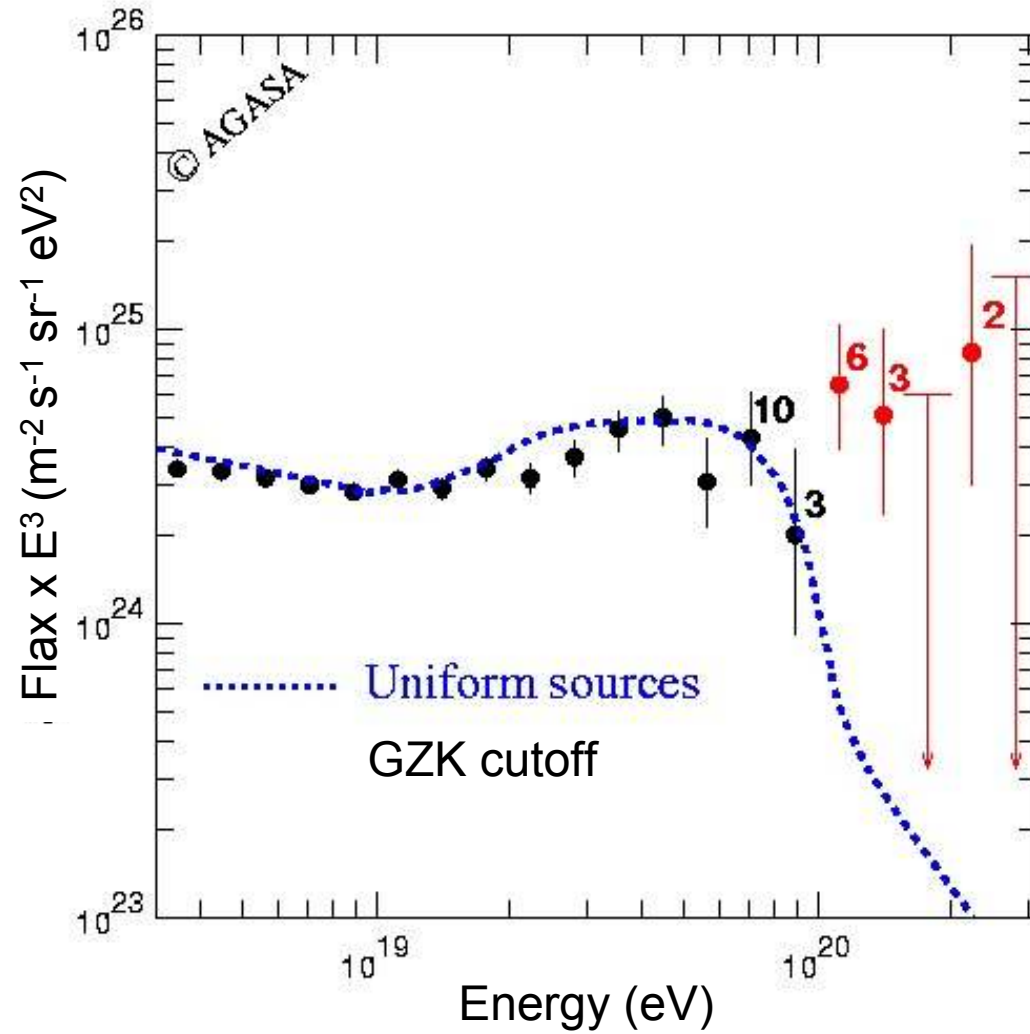
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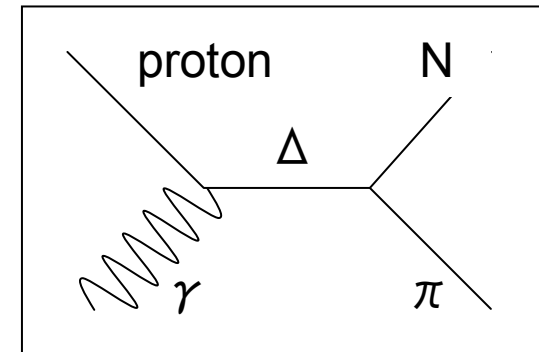
The Telescope array collaboration

2007/Sep/14

UHECR spectrum

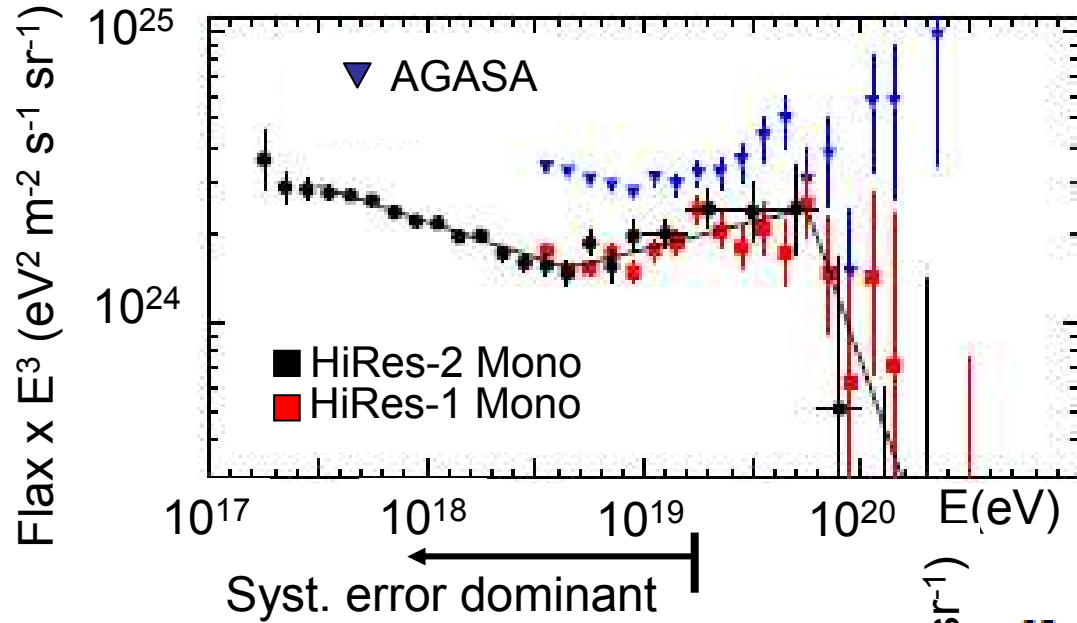


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AGASA results
 (Syst. Err $\pm 20\%$)

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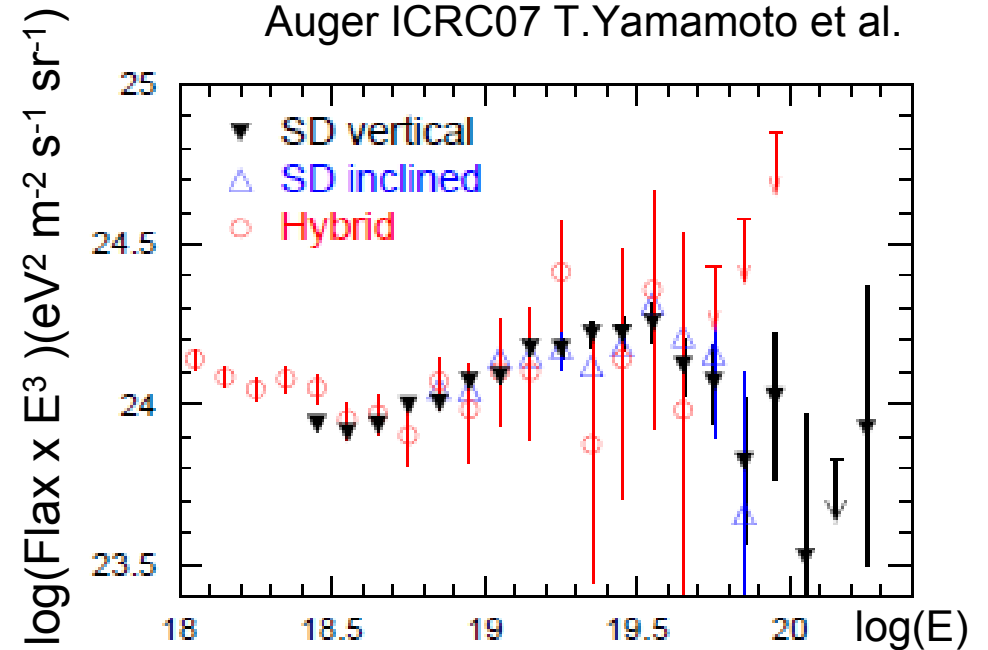


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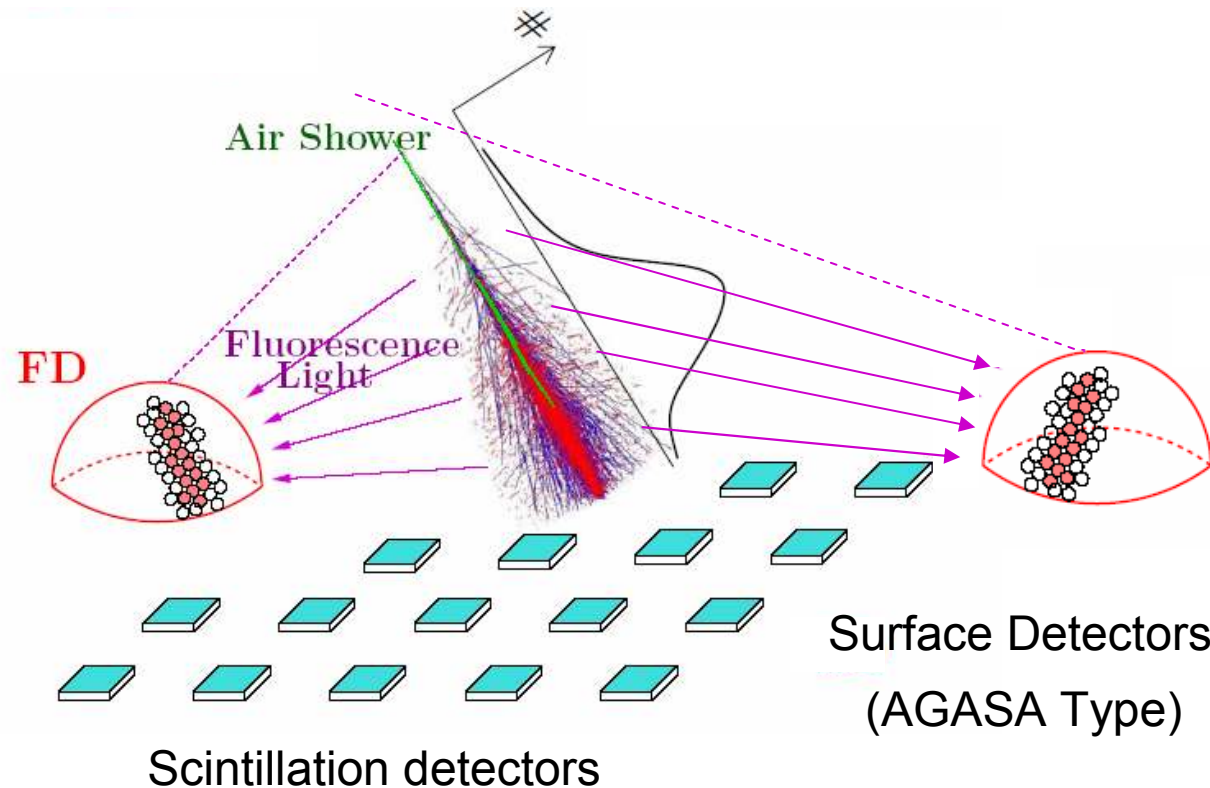
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Fluorescence
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Surface Detectors
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Scintillation detectors

FD part

in Utah, US

3rd station

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2nd station

Long Ridge



Black Rock Mesa



~30km

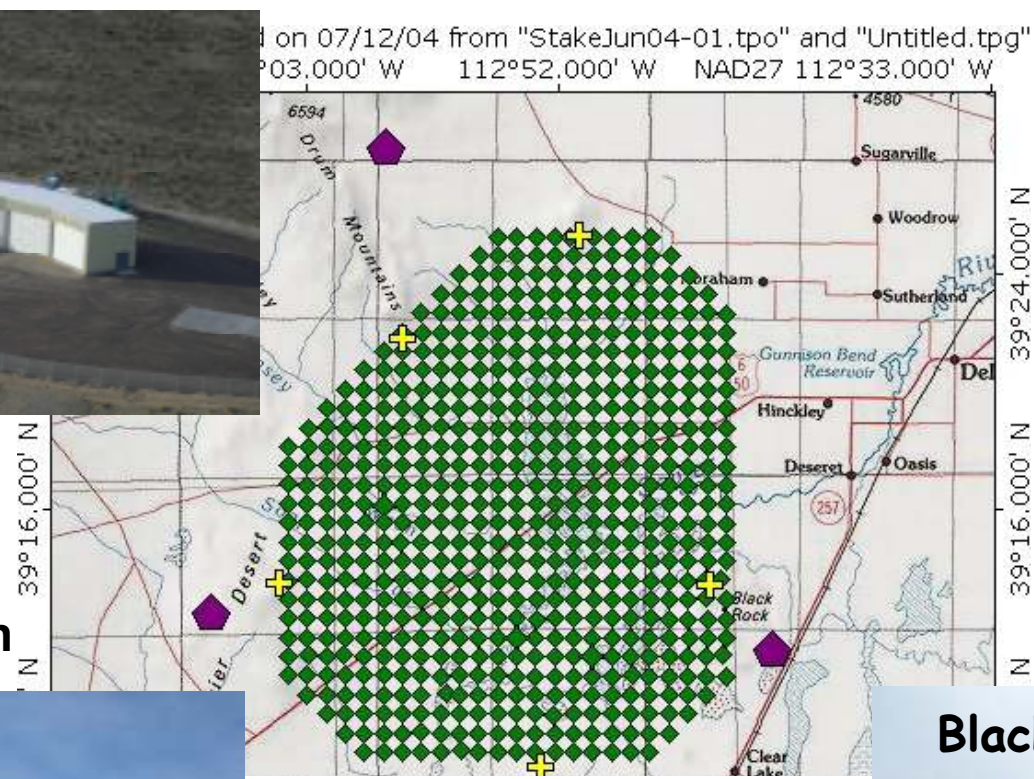
1st, 2nd station

Elevation: 3~33°
Azimuth: 108°
Camera: 12

3rd station

Hires-I

1st station



on 07/12/04 from "StakeJun04-01.tpo" and "Untitled.tpg"
03,000' W 112°52,000' W NAD27 112°33,000' W

39°16,000' N

39°24,000' N
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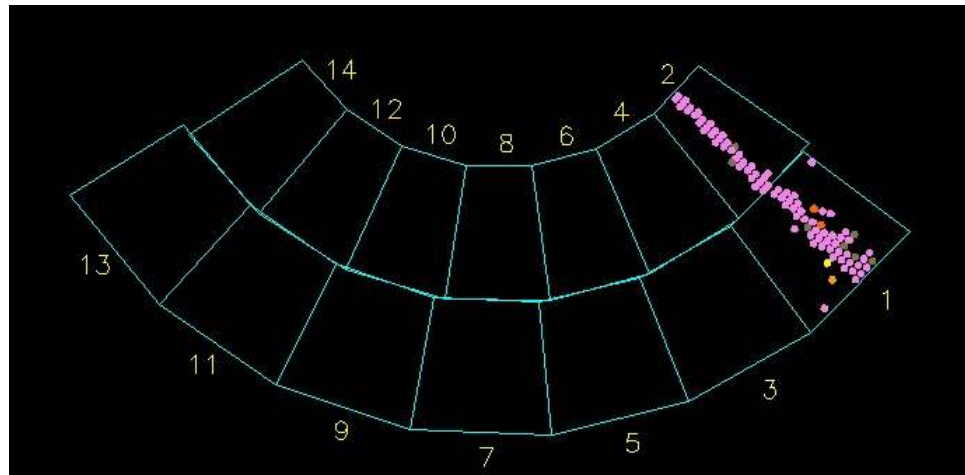
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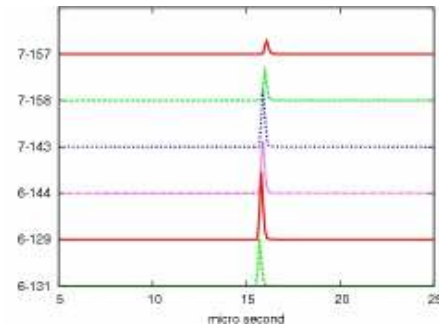
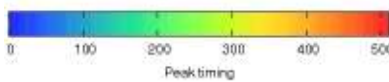
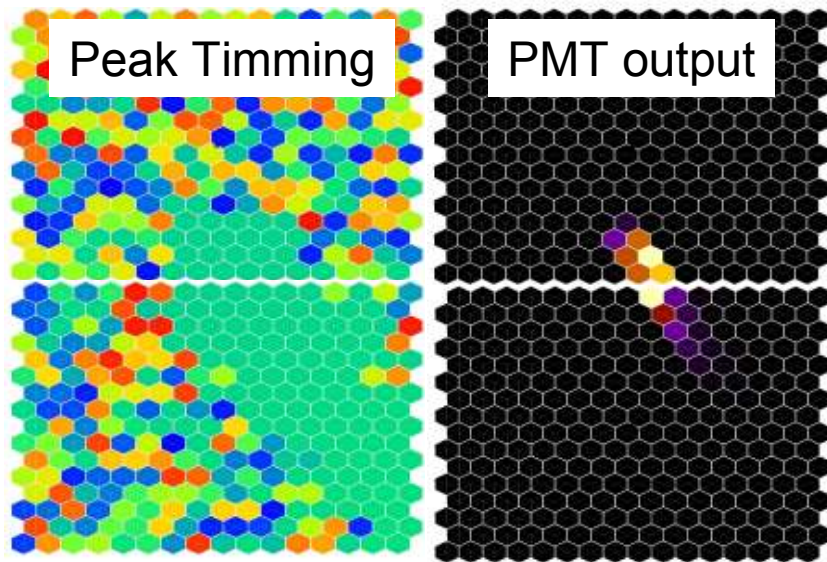
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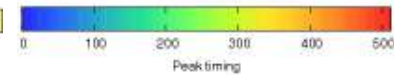
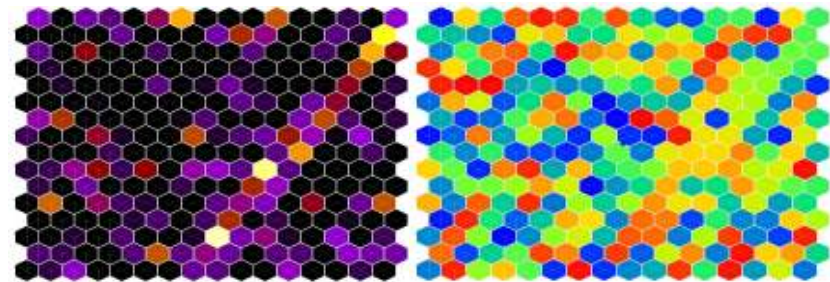
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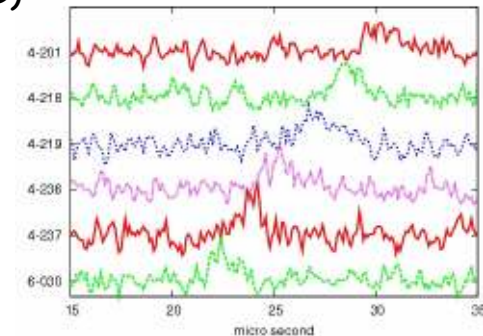
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June 14, 2007, 09:49(UTC)

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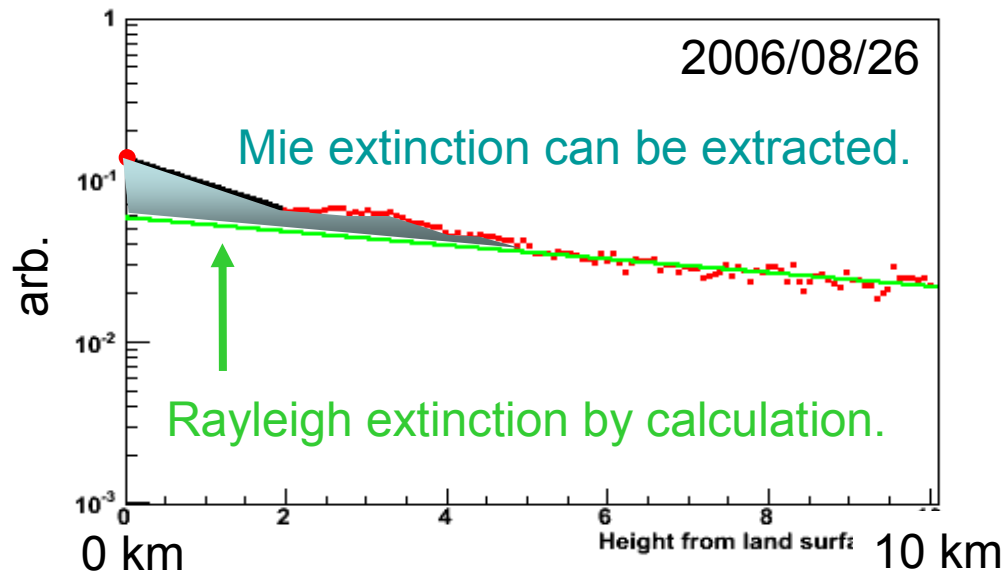


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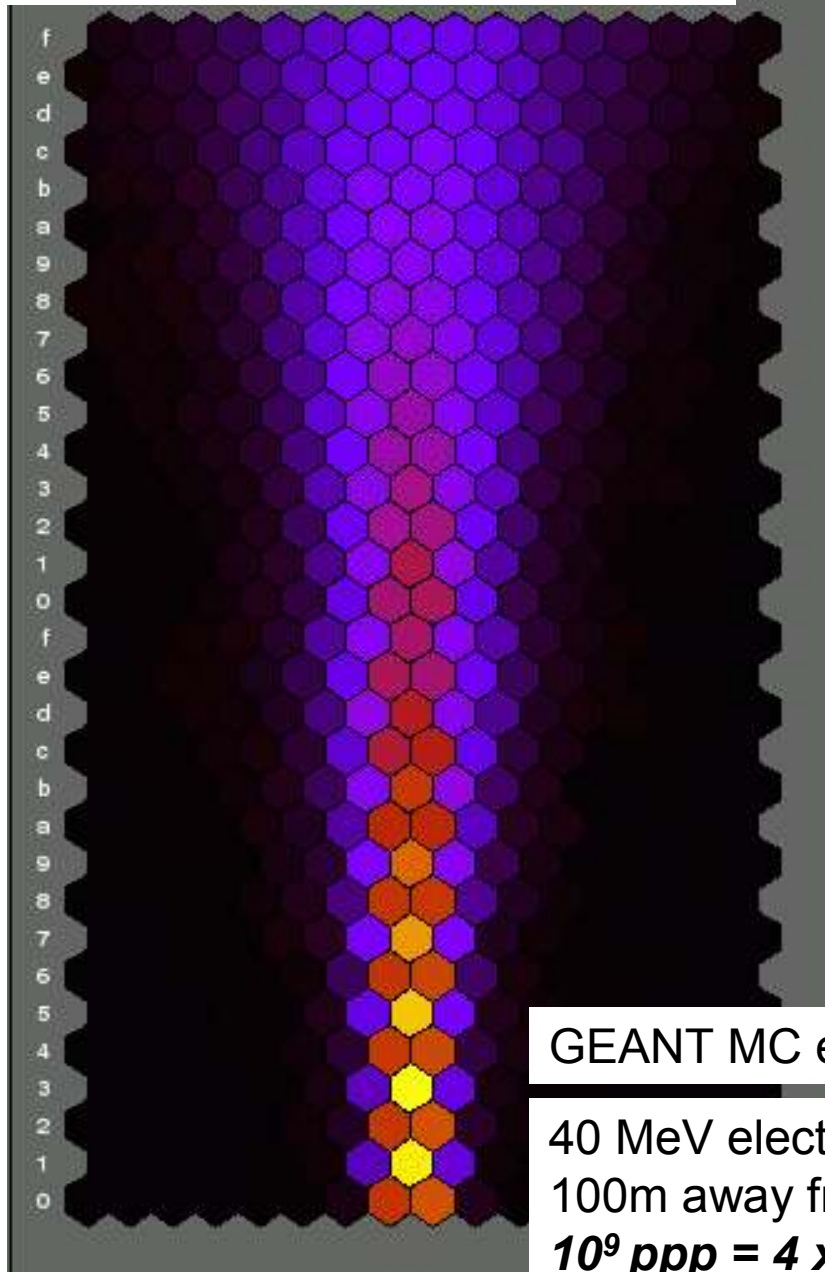
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End to End calibration FD



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SD part



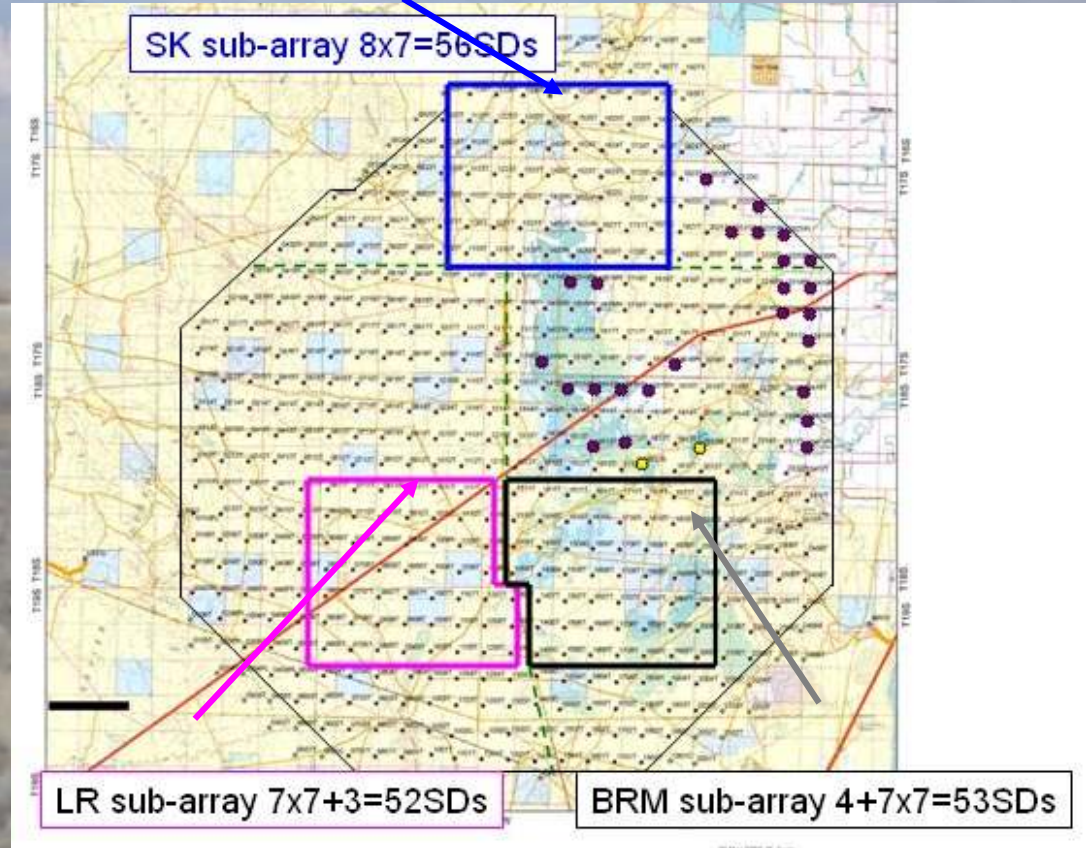
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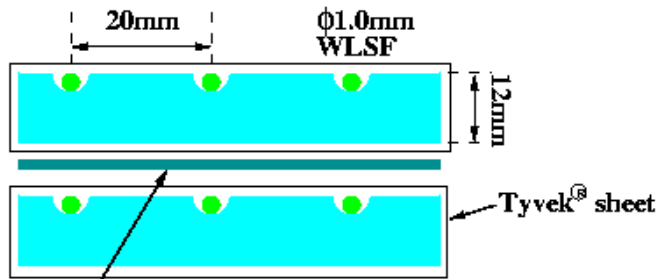
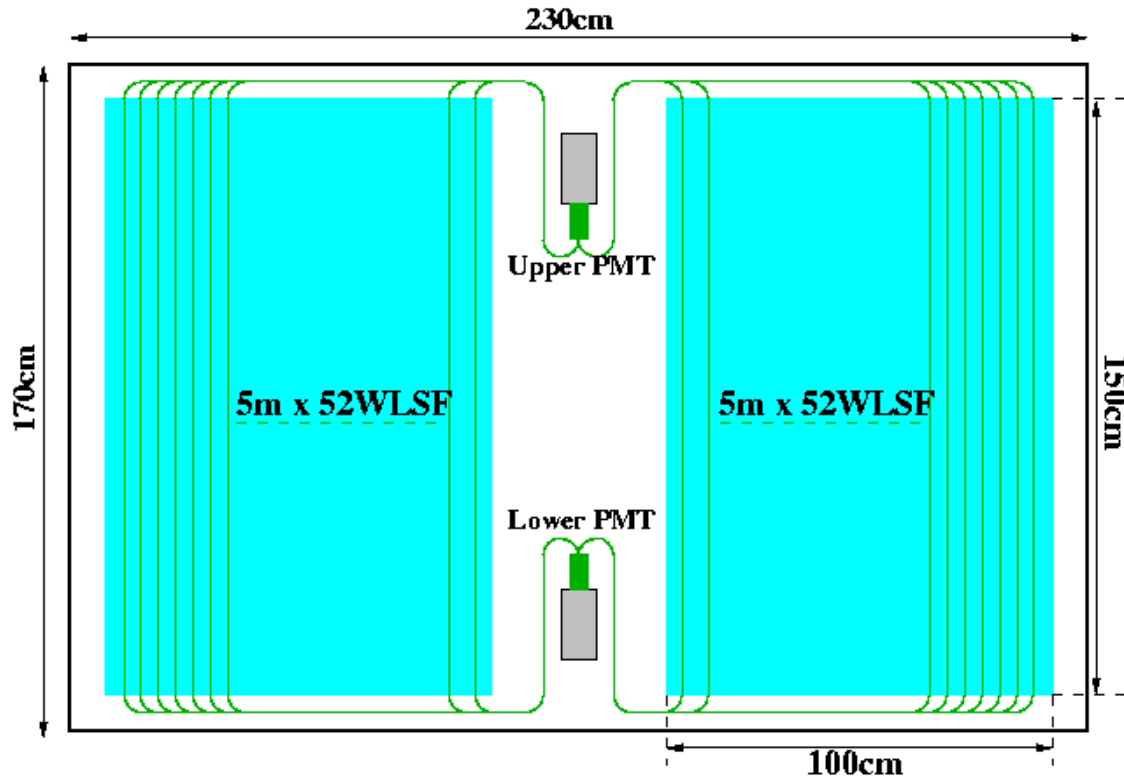


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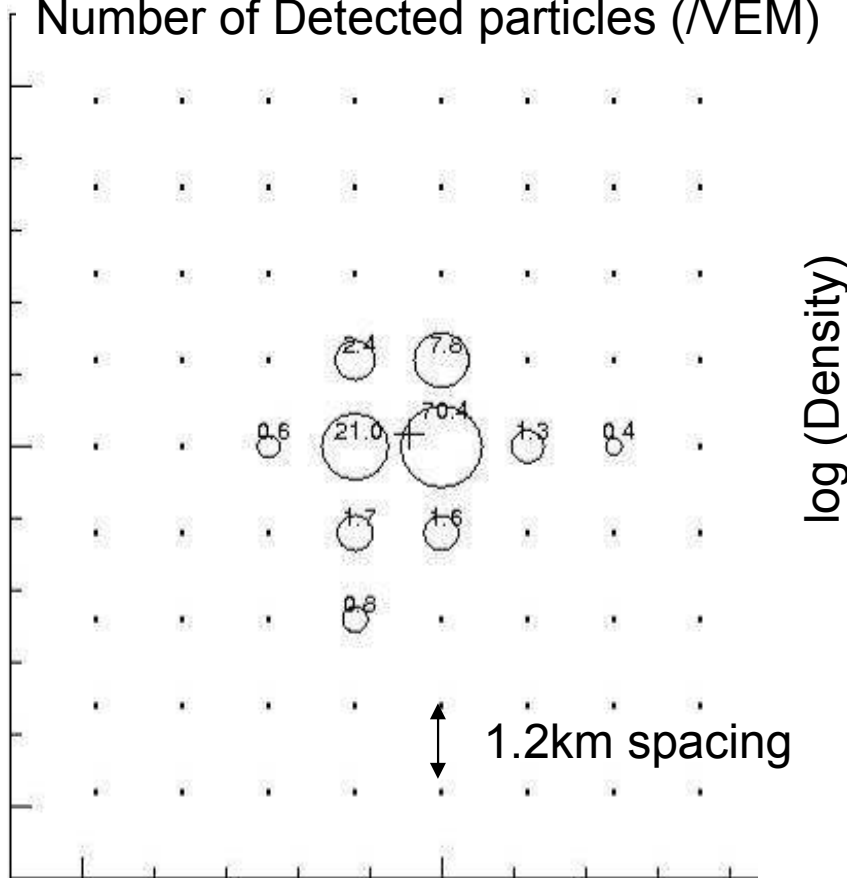
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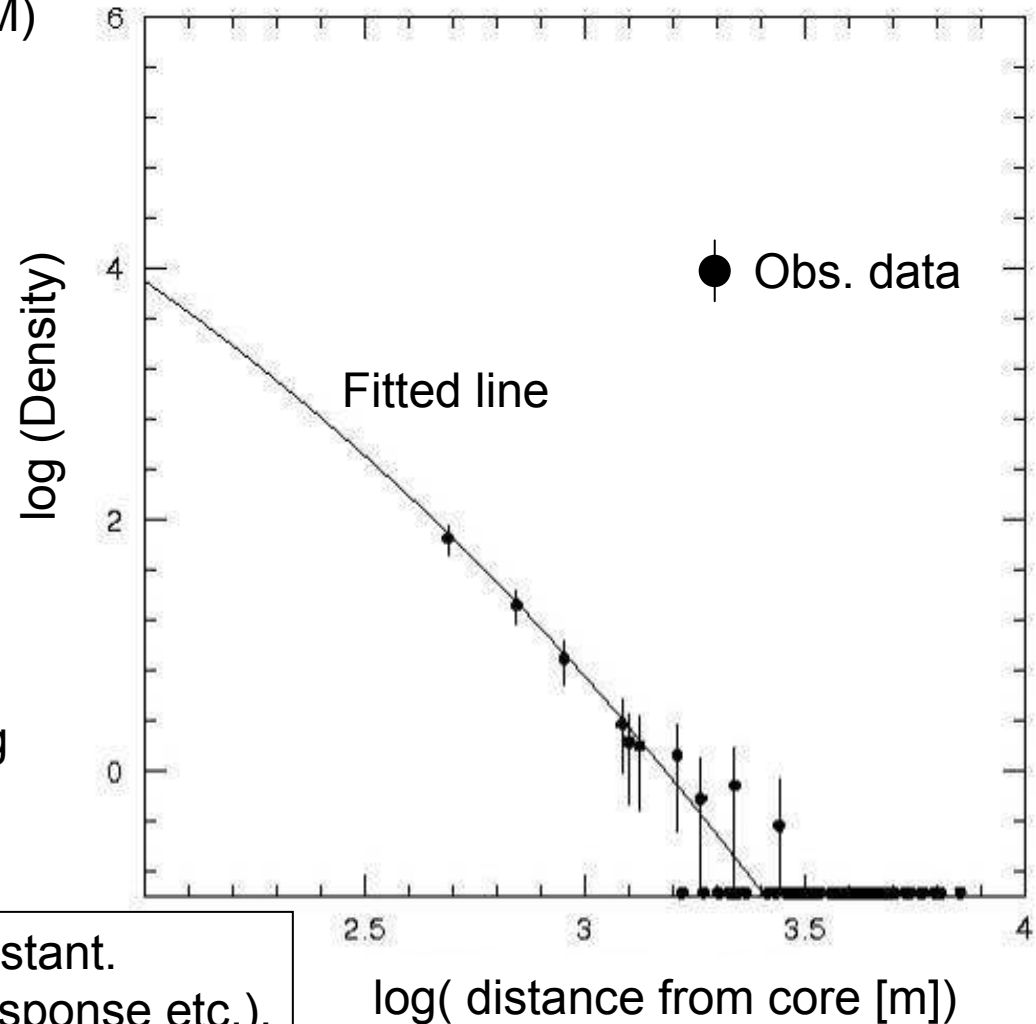
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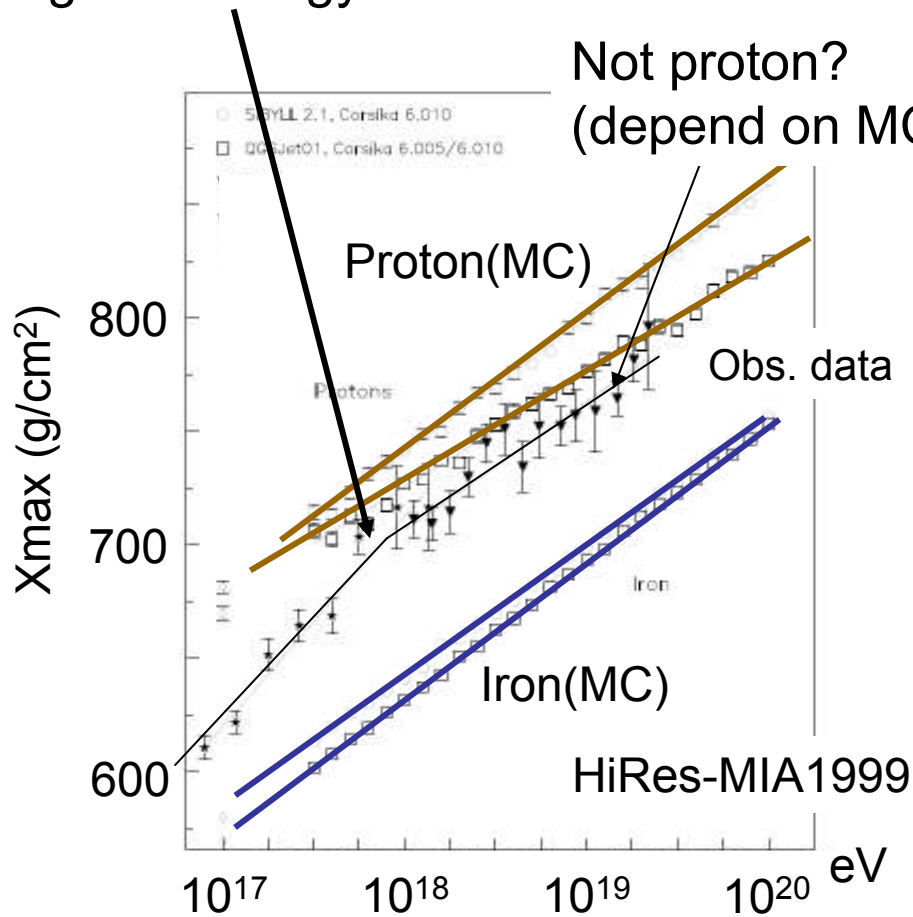
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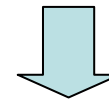
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