Study on the cosmic ray intensity variation using scintillation counters for air shower observation

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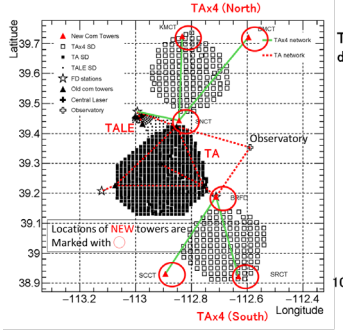
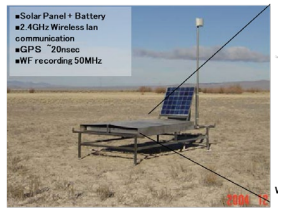
Telescope Array Detectors

Total detector area for atmospheric muon : 1500 m^{2+}



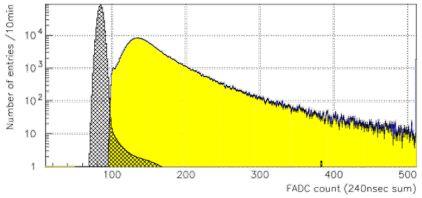
Three observations of different energies

- TA
  - $10^{18} eV \sim 10^{20} eV$
- TALE
  - $10^{16} eV \sim 10^{18.5} eV$
- TAx4
  - $10^{19.7} eV \sim 10^{20} eV$



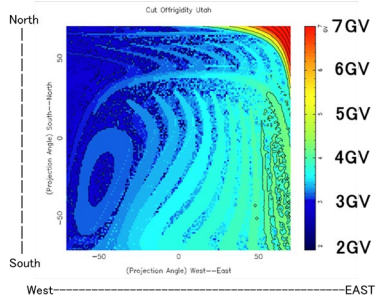
TASD:
- Large area surface → collect scintillation light with WLS fiber
- Thin schinchlator →Low threashold. (~30MeV)
- Sensitive to EM / Mu

SD monitoring data



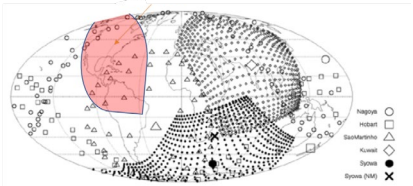
- ✓ **Charge distribution of atmospheric particles are collected every 10 min from all detector unit.**
- ✓ **Trigger rate is recorded 1min resolution.**
- ✓ $Count\ rate \sim 750\ Hz$ / SD
- ✓ **We use this for cosmic ray intensity monitor.**

Geographical condition



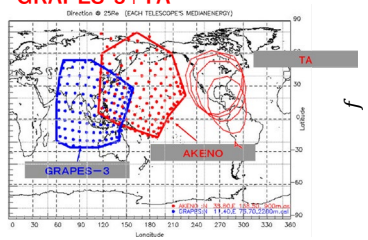
The cut off rigidity at the experimental site were calculated for various arriving direction of primary cosmic ray at top of atmosphere. The calculation were done with "backtracking method" assuming IGRF geomagnetic field model(2000). Approximate observing direction after considering geomagnetic field is displayed together with Field of View of other observations such as GMDN and GRAPES-3

GMDN+TA



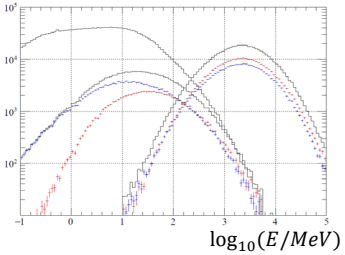
Space weather study using cosmic ray observations at Syowa Station in Antarctic
K. Munakata , C. Kato , A. Kadokura2 and R Kataoka

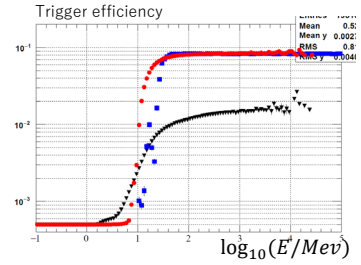
GRAPES-3+TA



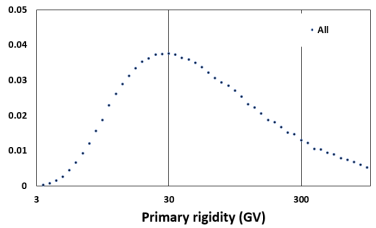
Detector response

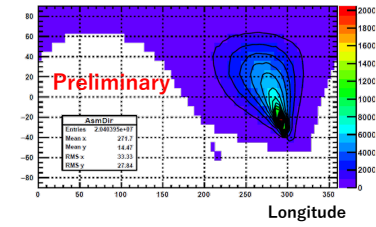
Using the CORSIKA air shower simulation code, primary cosmic rays are injected from the top of the atmosphere in the range of 2.5 GV- 1000 GV (zenith angle < 75^o) to produce atmospheric particles at the observed height of TA.





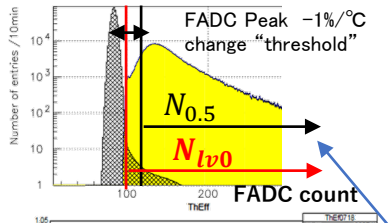
From the GEANT-4 simulation, the triggering efficiency of atmospheric particles in each direction of incidence to the detector is known as a function of energy.

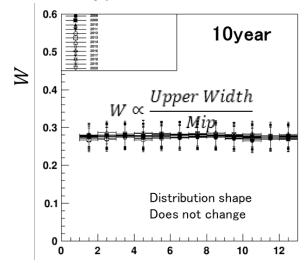


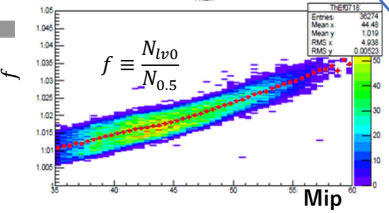


Response function : The relative contribution to the count rate is obtained as a function of direction and energy. Here cutoff rigidity also being considered. Median rigidity is 42GV as atypical value.

Local temperature effect







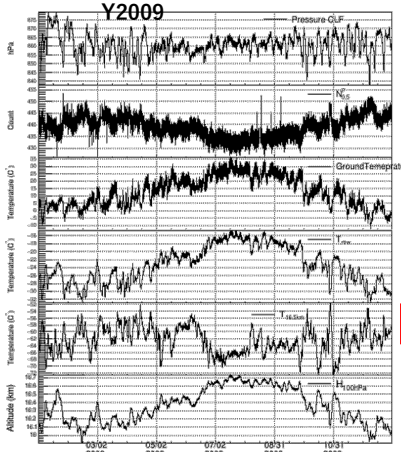
$N_{0.5}$ is free from local temperature effect. For short time resolution ~ 1min, the f factor can be used.

Atmospheric effect

Flux of low energy muon, it is dominated by low energy decayed $\pi^{\pm}$, will decrease as atmosphere heated by decay of muon due to longer time of flight. @Muon stations at airshower detectors.

Pressure effect and Atmosperic temperature effect.

Pressure effect was estimated ted using the correration between $N_{0.5}$ and largest pressure variation in one month in the 12 year observation . The used pressure is the one measured at center of the TA array. Pressure coeff: -0.282 ± 0.003 [$\%/hPa$]
For Temeprature effect we used **GDAS** model.



Left plot shows following data
- 1st Pressure at CLF
- 2nd $N_{0.5}^{PC}$ Pressure corrected Muon count
- 3rd GroundTemperature
- 4th Mass Weighted Temperature
- 5th $T_{16.5}$ Temperature at altitude 16.5 km
- 6th Altitude (km) of 100hPa of atm pressure.

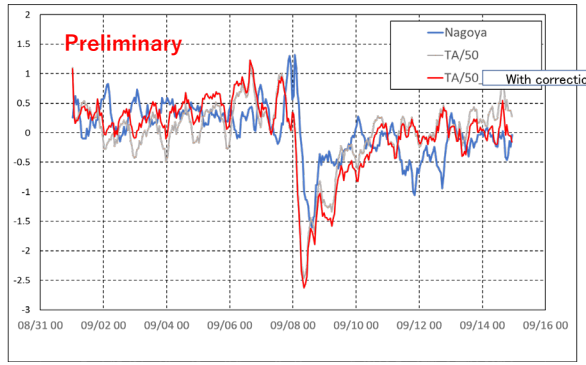
Table: Summary of atm temperature coefficient

Method	Slope	Error
H100hPa	$-3.992\ \%/km$	$\pm 0.01\ \%/km$
Tmw	$-0.186\ \%/K$	$\pm 0.005\ \%/K$
Tgrd	$-0.076\ \%/K$	$\pm 0.002\ \%/K$
T16.5km	$+0.142\ \%/K$	$\pm 0.001\ \%/K$

For definition of T_{mw} please refer de Mendonca et.al Apj 830_88 2016

Application to the real data

The Forbush decrease observed during the period 01/09/2017 - 14/09/2017 is displayed with the corrected data. We corrected atmospheric temperature effect and pressure effect with value as mentioned above.



Blue: Nagoya Muon telescope
Gray: TASD w/o Atm correction
Red: TASD w Atm correction (T_{mw})

Summary:

We calculated charactaristics of our observation such as response function and correction of local temperature effect. Also we considered atmospheric temperature effect and obtained data comparable with other observations.