ANALYZING TIME-DELAY HISTOGRAMS FROM 2019-2020 CHANGVAN LATITUDE SURVEY

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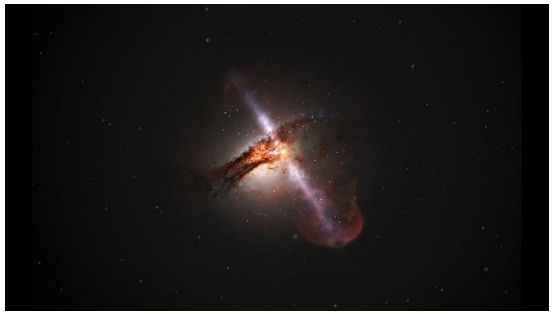
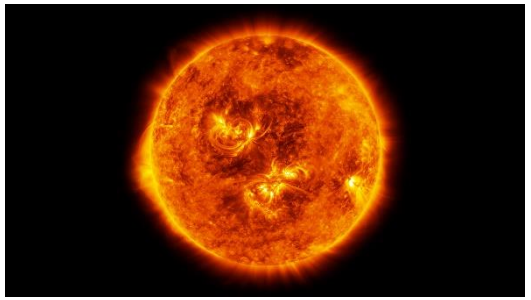
PURPOSE OF THIS PROJECT

we pursue techniques to determine the spectrum index of Galactic Cosmic Rays (GCRs) using a data from a Changvan detector, avoiding the systematic uncertainties of cross-station comparisons.

COSMIC RAYS

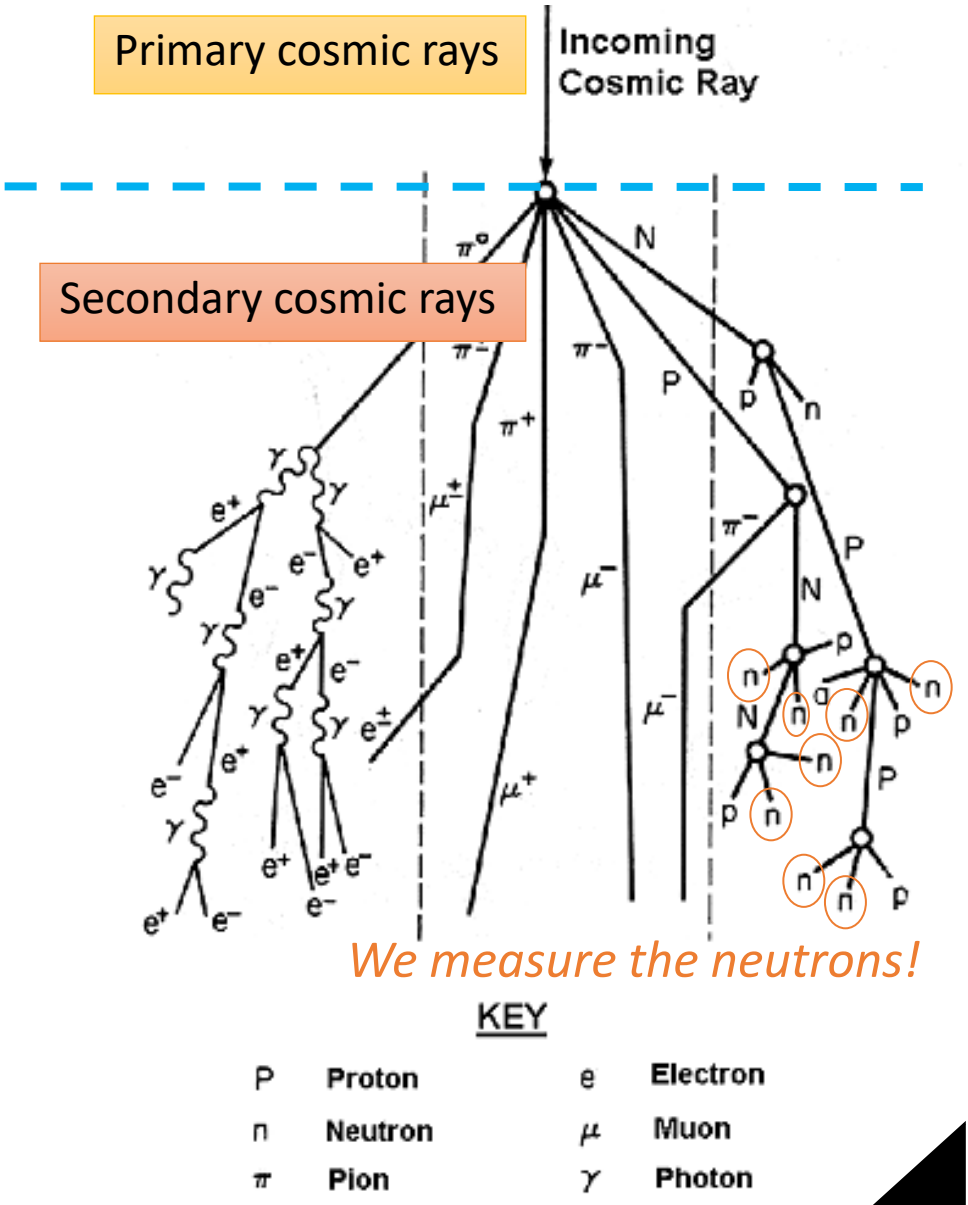




Earth's Atmosphere

Primary cosmic rays

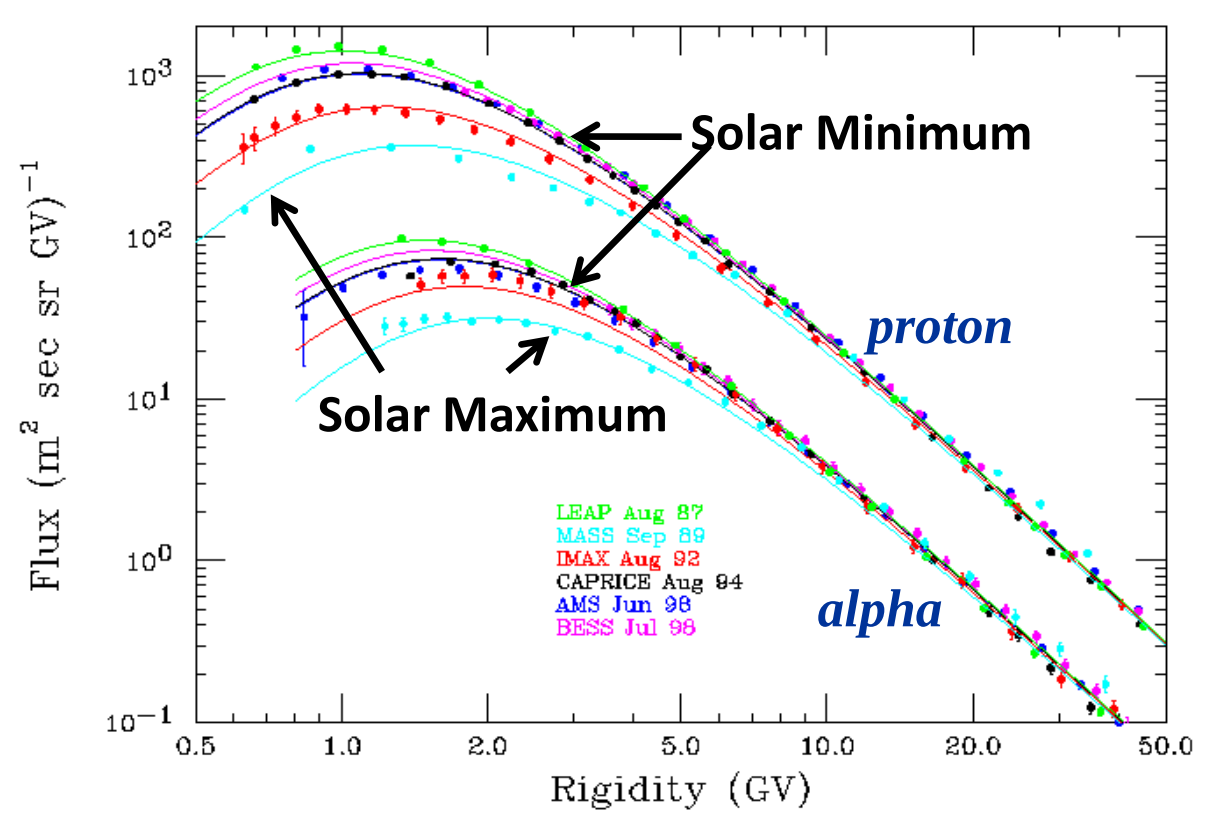
Secondary cosmic rays



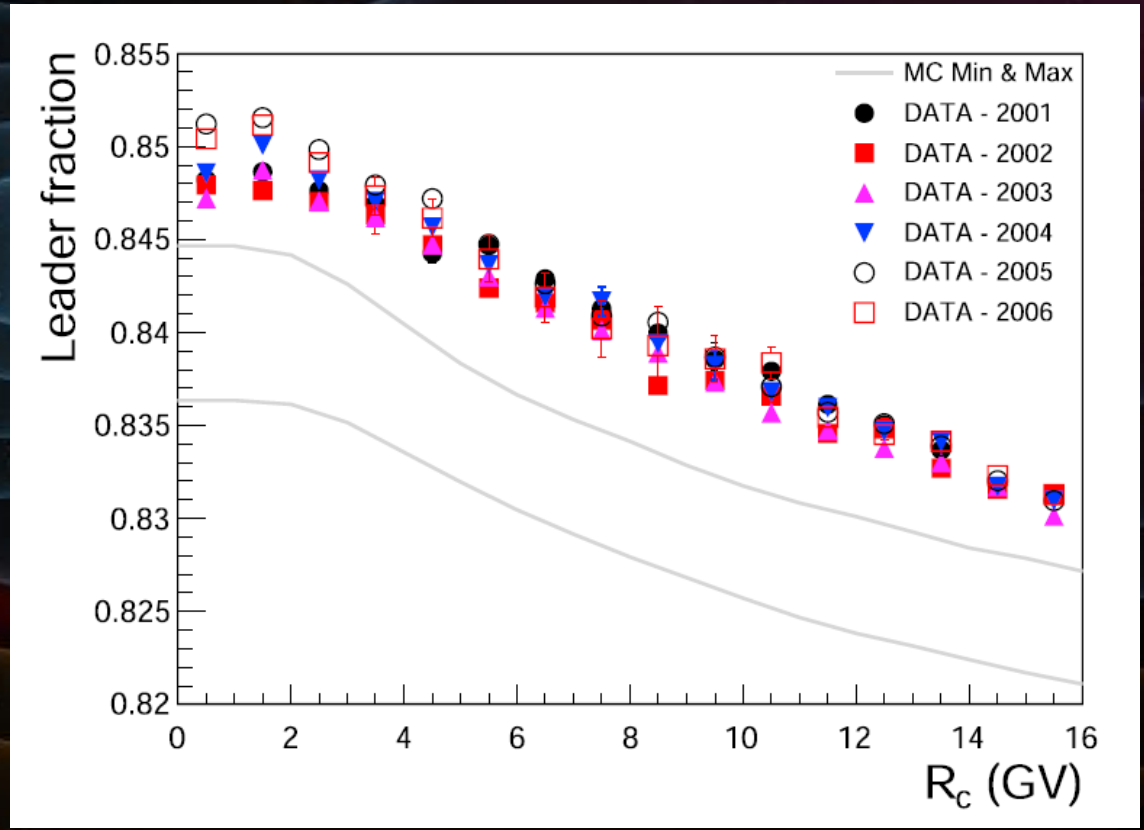
We measure the neutrons!

GALACTIC COSMIC RAY FLUX

Distribution of cosmic-ray flux as a function of particle energy.

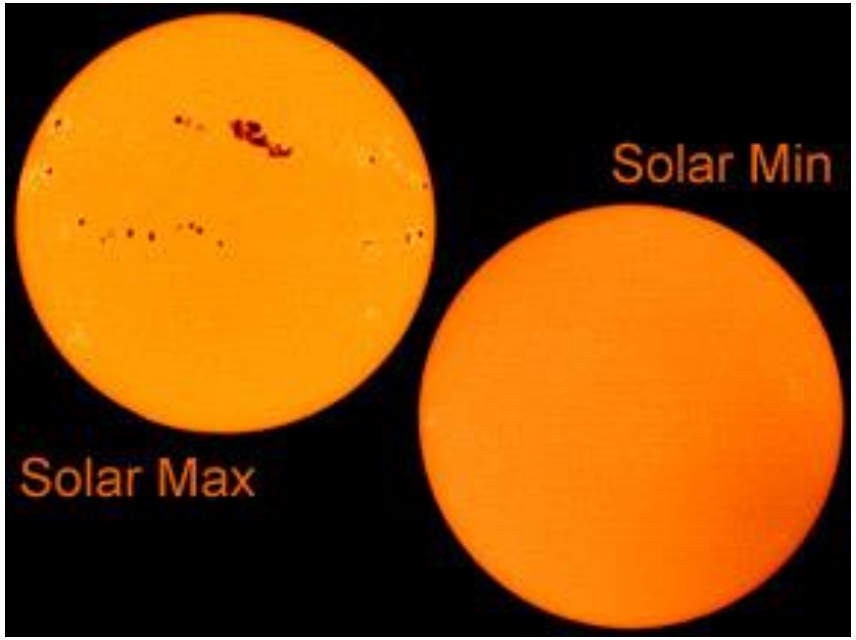


Dependence of the leader fraction L measured by the mobile neutron monitor on the apparent cutoff rigidity R_c for the six surveys.

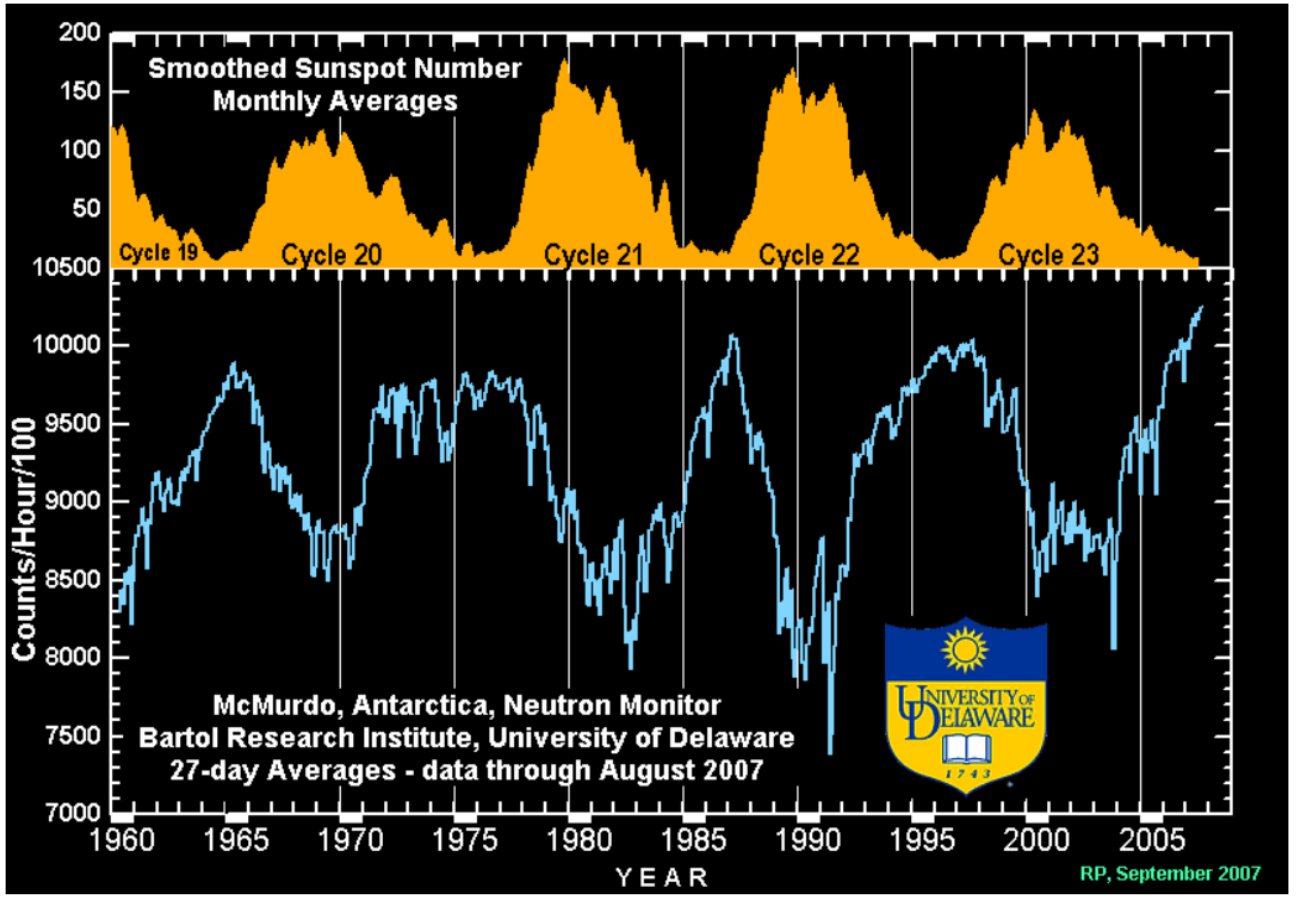


Mangeard et al., 2016b

SOLAR MODULATION



Picture from:
https://www.windows2universe.org/sun/activity/sunspot_cycle.html



CHANGVAN LATITUDE SURVEY

The tracking of the Xuelong icebreaker from Shanghai to Antarctica in 2019

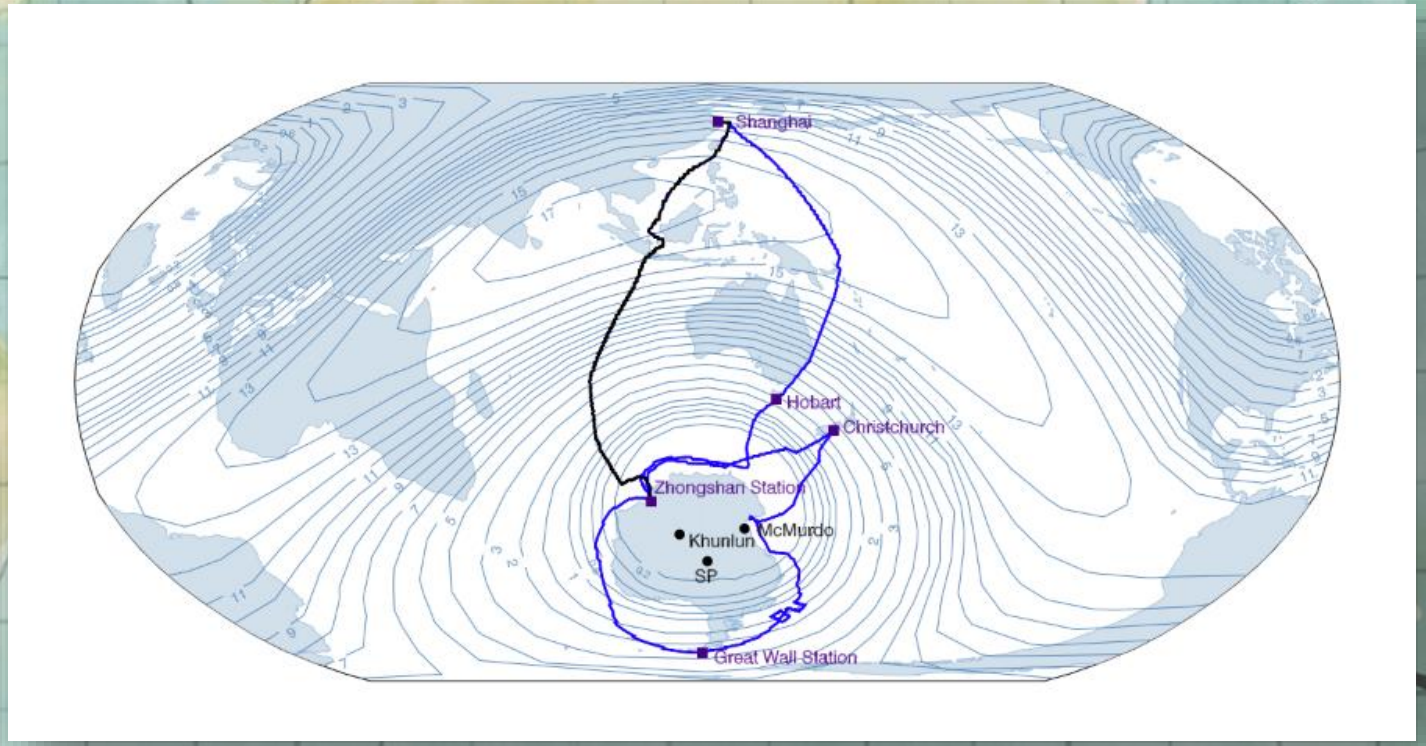


Figure from : Miss Sidarat Khamphakdee

CHANGVAN NEUTRON DETECTOR

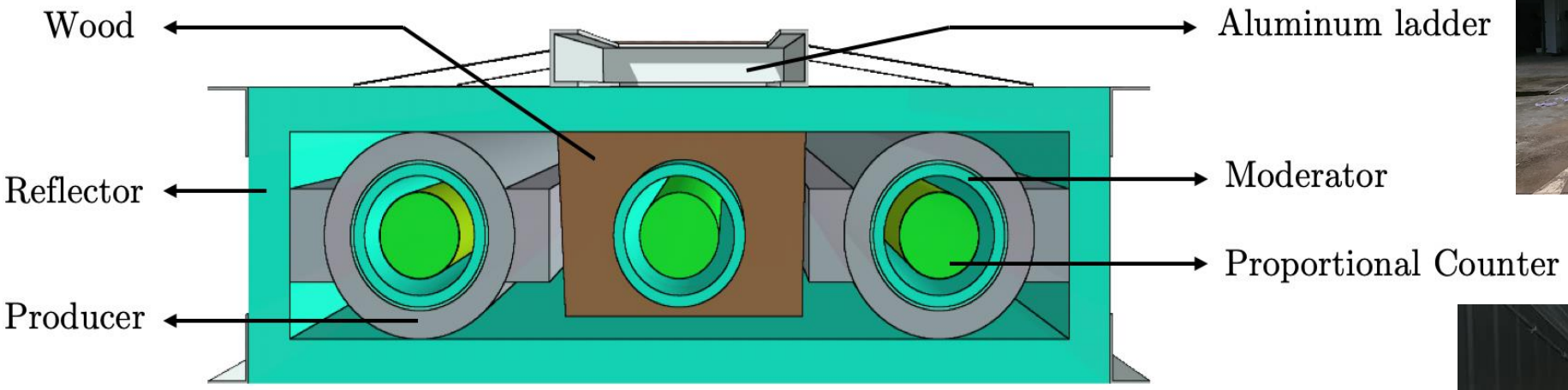
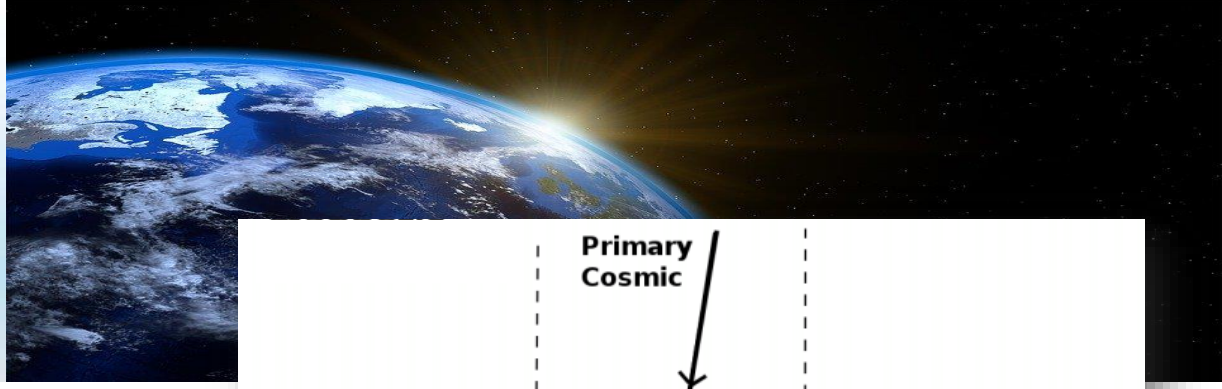


Figure 1: The simulation of neutron monitor detector of Changvan by FLUKA simulation program.
Ref. Miss Kanokkarn Fongsamut

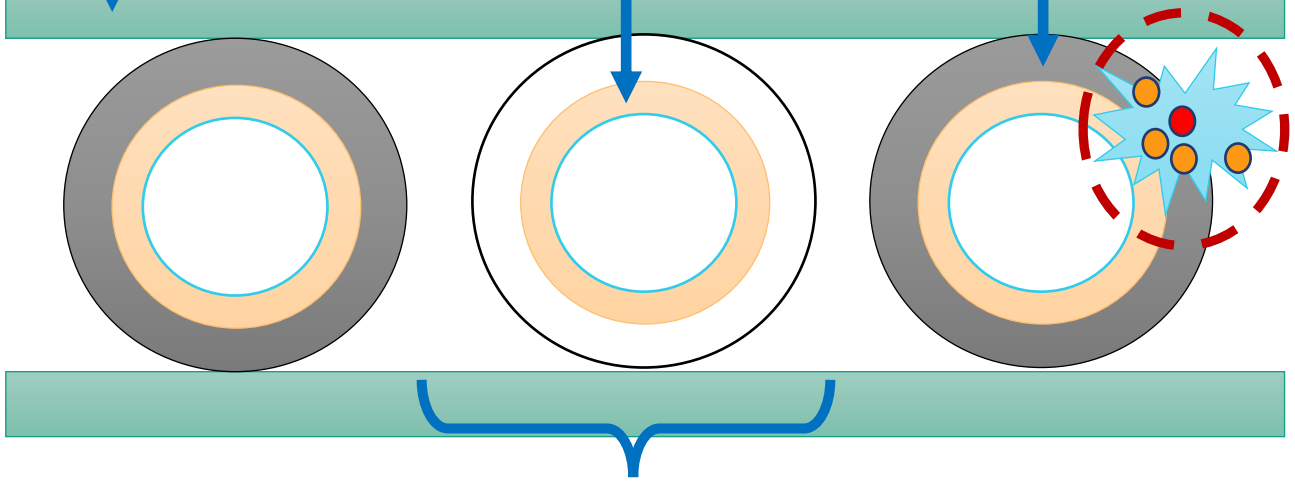
NEUTRON DETECTOR



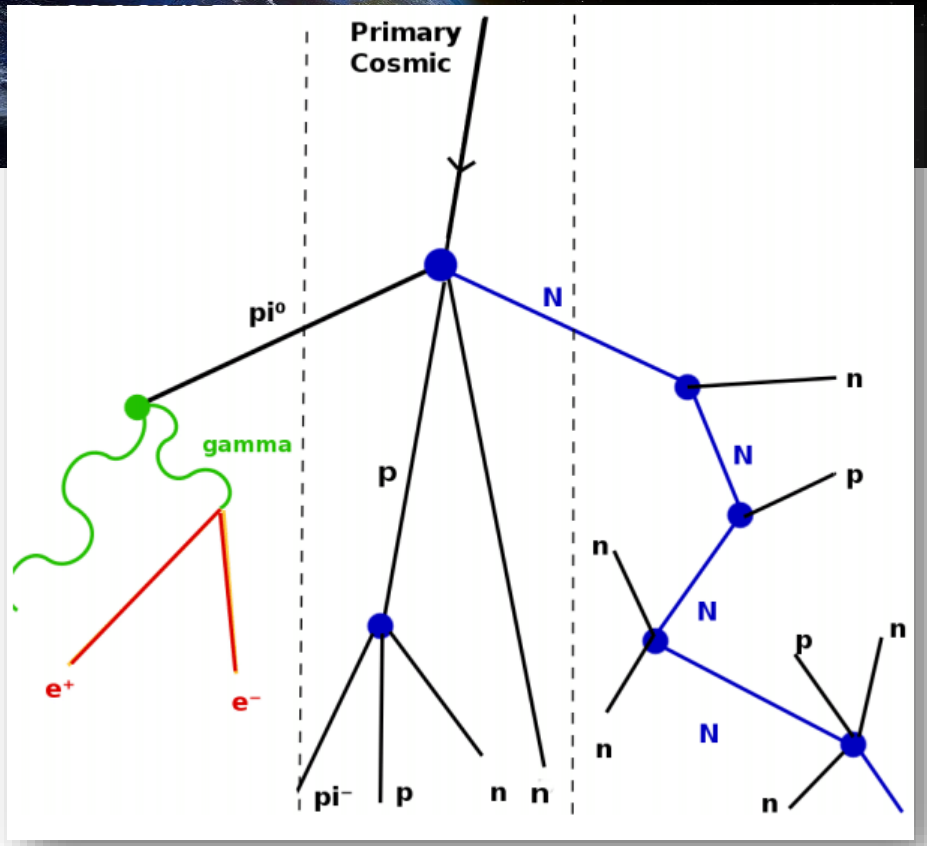
Polyethylene reflector

Neutron detector ($^{10}BF_3$ prop. counter)

Pb producer



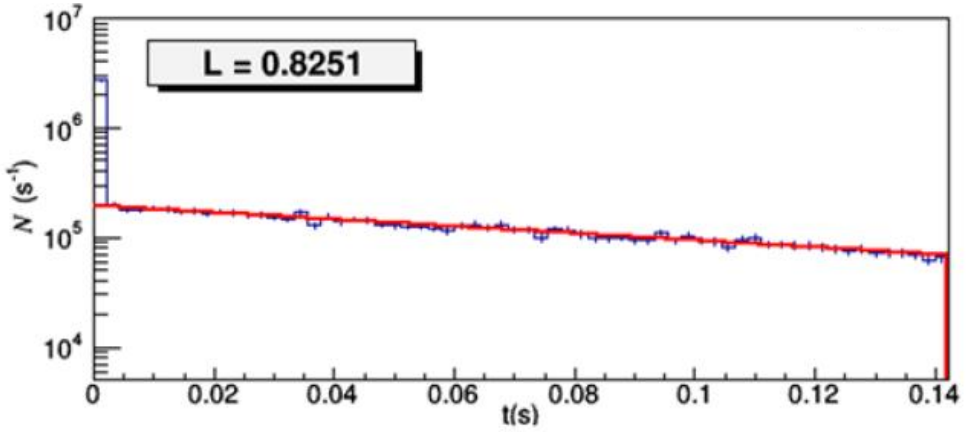
Bare Neutron monitor

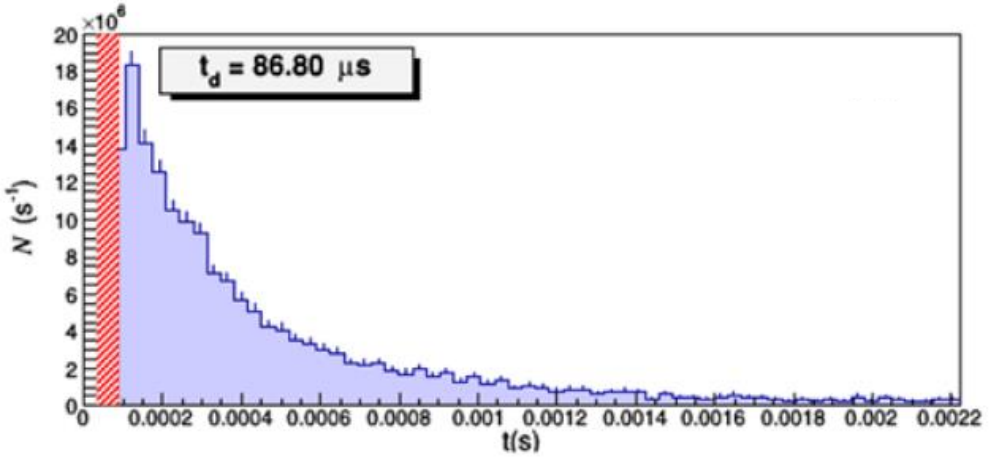


The secondary particles are produced in the atmosphere through cosmic ray.

TIME-DELAY HISTOGRAMS

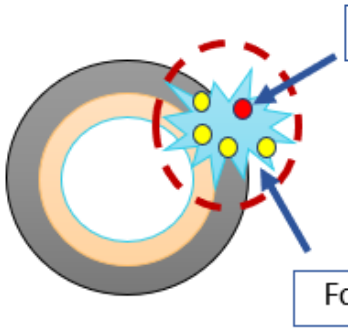
- The time delay refers to the time interval between successive neutron detections in one counter.
- (left) Long time delays show the exponential distribution typical of unrelated events.
- (right) The short time histogram, which is actually a zoom in the long time histogram, shows the nonexponential excess at short time delays that can be attributed to the time delays between neutrons produced in the same secondary particle interaction in the lead. The electronic dead time is typically td ~ 86.80 μs.





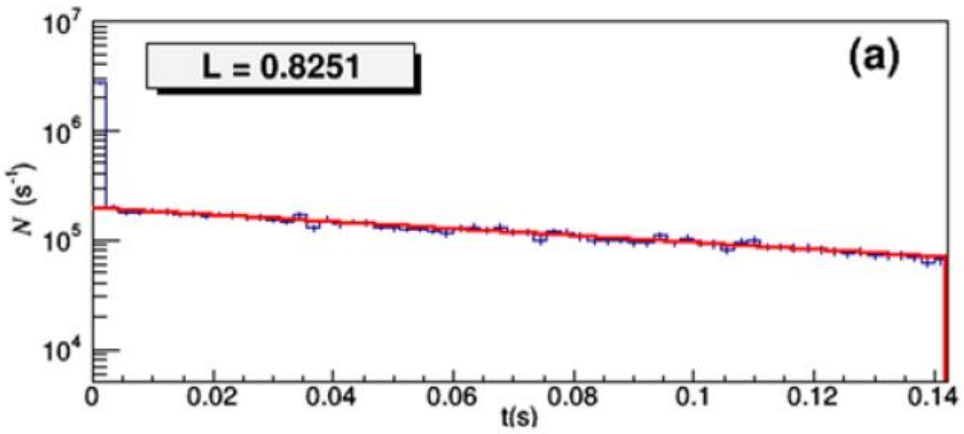
LEADER FRACTION

The leader fraction (L), defined as neutron counts that do not follow a previous neutron count in the same counter from the same atmospheric secondary particle



$$\text{Leader Fraction} = \frac{\text{First count (Leader)}}{\text{All pulse (Leader + Followers)}}$$

We fitted to the function $N(t) = Ae^{-\alpha t}$, shown in red, from 5 ms to the next to last time bin *(*excluding the overflow time bin*)*.



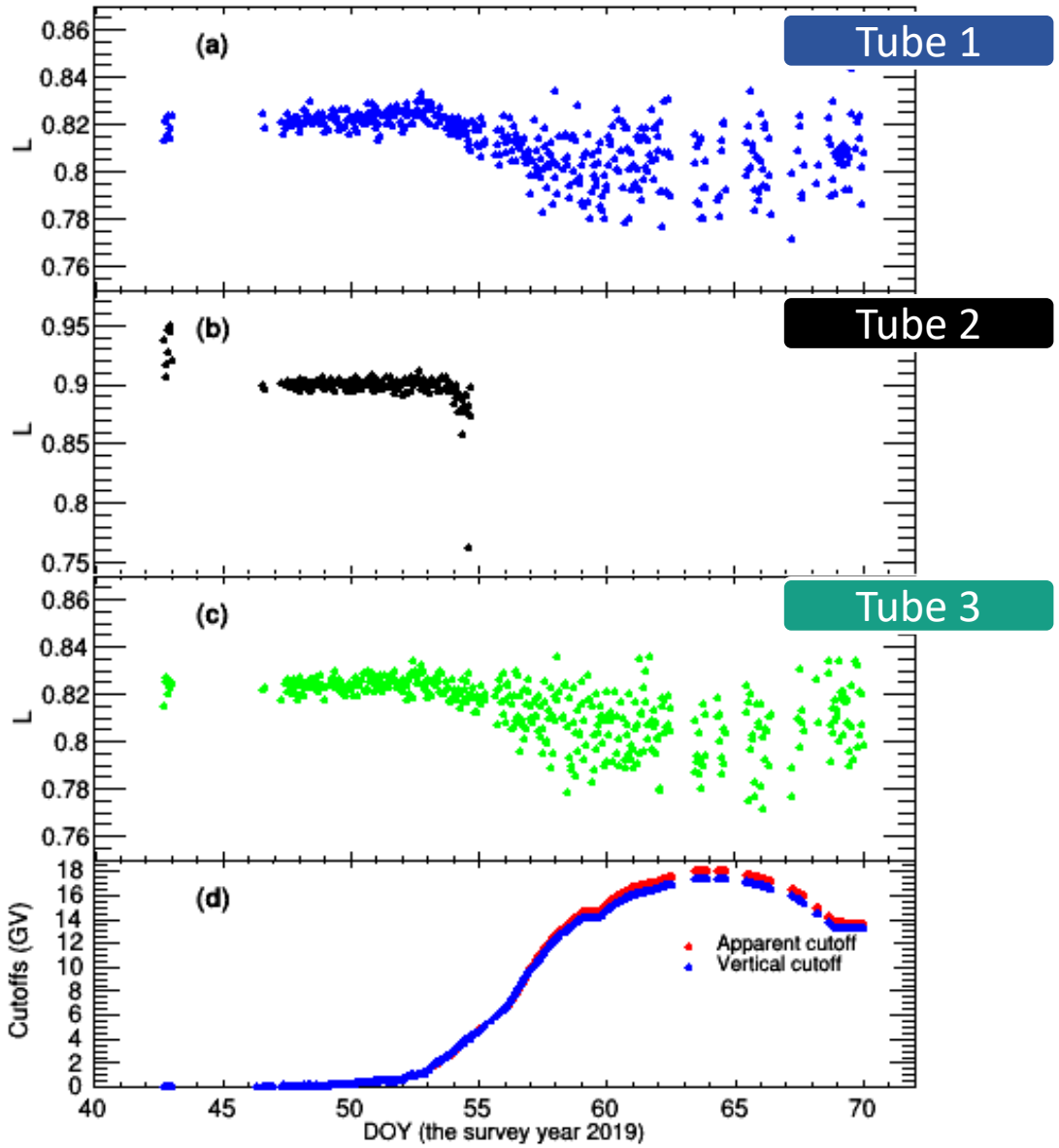
$$L = \frac{\int_{t_d}^{\infty} A_0 e^{-\alpha t} \cdot dt}{\int_{t_d}^{t_o} N_t \cdot dt + \int_{t_o}^{\infty} A_0 e^{-\alpha t} \cdot dt}$$

or for the discrete histogram,

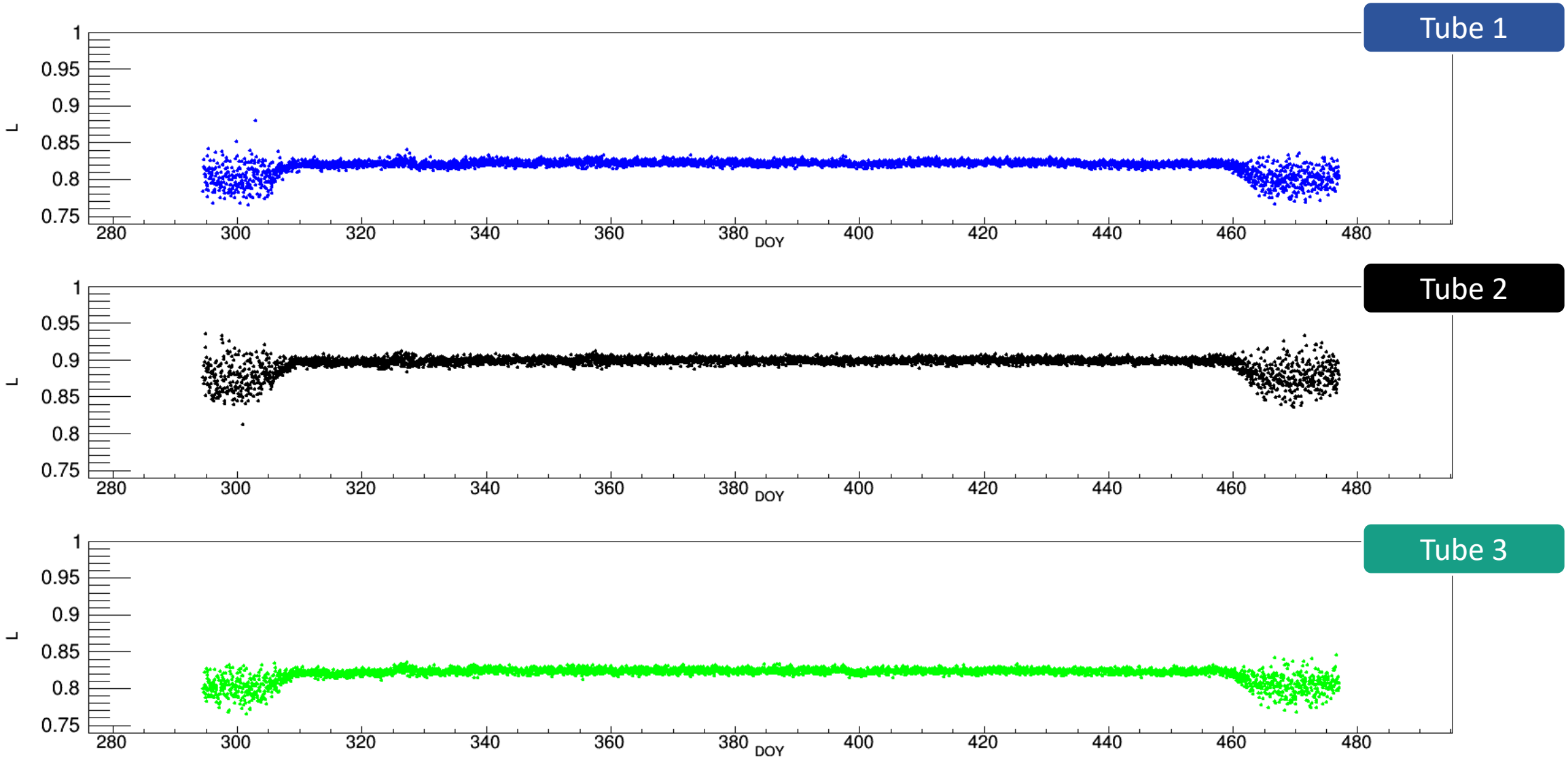
$$L = \frac{\frac{A_0}{\alpha} e^{-\alpha t_d}}{\sum_{t=t_d}^{t_o} N_t + \frac{A_0}{\alpha} e^{-\alpha t_o}},$$

The results from Changvan Latitude Survey

Leader fraction of the survey year 2019 (CHINARE35)

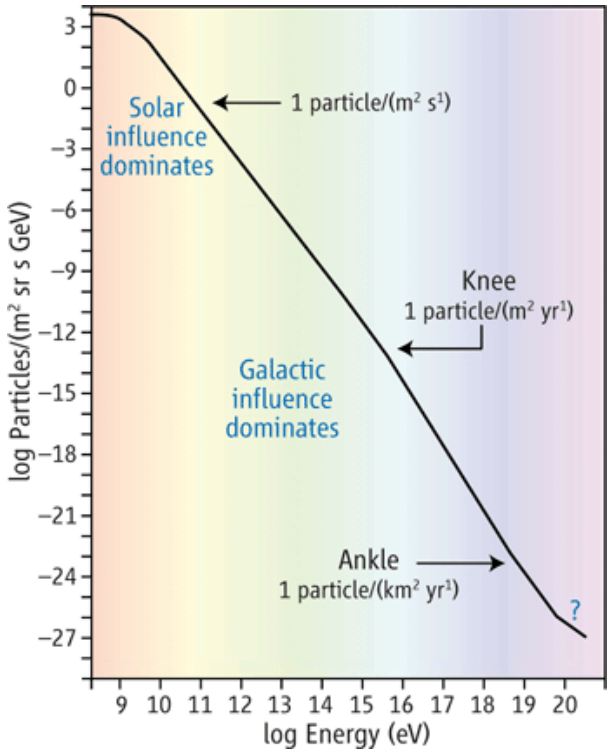


Leader fraction of the survey year 2019-2020 (CHINARE36)

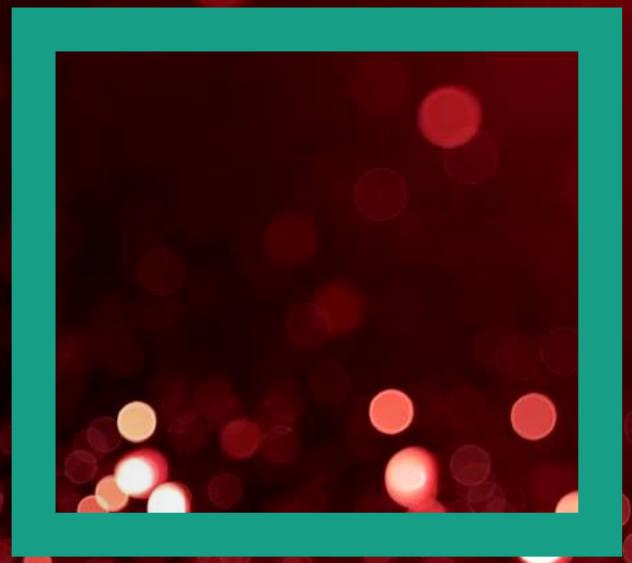


NEXT STEP

Analyzed the data from cross-tubes time delay histograms of Changvan neutron monitor to find the **leader fraction of cross tubes to** get closer to indicate the cosmic ray spectral index



Cosmic-ray spectrum. Distribution of cosmic-ray flux as a function of particle energy.

Ref. M. Amenomori et al.

THANK YOU FOR YOUR ATTENTION