Observation of cosmic ray modulation and possible detection of the solar flares with GRAPES III muon telescopes at Ooty.

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ABSTRACT

We have observed the variation of muons (>1GeV) intensity for one year at Ooty (latitude 11.4 longitude 76.7) with the large muon detectors of GRAPES III (total area of 560 m^2). These detectors were constructed primarily to observe the muons in the Air Shower. Since our recording system store the muon counting rate each one second, we can get the variation of cosmic rays for very short time interval, 1 sec onward. Since the total counting rate of muons is so high, about 5.3 x 10^4/sec, even rapid change can be analyzed with reasonable statistics. We present the variation of muons in solar flare event with 5 min. interval and for one month with one hour interval.

Recently we introduced the angle measurement system for individual muons to one of the unit ($36m^2$). We are planning to extend it for all the units.

INTRODUCTION

So far quite a few attempt have been made to understand the cause of sidereal time variation of cosmic rays.(D.L.Hll et. al.) But the origin of the sidereal diurnal variation are not understood yet. So we planned to have a muon telescope with huge effective area and narrow angle resolution to observe this sidereal variation with great accuracy. Since our telescope is located near equator (latitude 11.4 degree), it has an advantage of looking northern and southern hemisphere with same detector.

Using same detector we are hoping to detect the short time variation in Solar flare event at ground level. Those rapid change would give the clue to understand the mechanisms of particle acceleration in their earlier stage.

DETECTORS AND EXPERIMENTAL CONDITIONS

The details of the muon telescope is to be found in Proceedings of last ICRC (N.Ito et. al.).

Our muon telescope consisted of four layers of proportional counters seperated with concrete

of 15 cm thick each. Total thickness of detector is 550g/cm^2, so the minimum energy of penetrating muon is about 1 GeV. We are recording the total counts of 4-layer penetrating muons in each second. All the observed data presented here does not have any angular information.

Though the daily temperature variation outside detector is around 15 degrees, it is within one degree at detector. The atmospheric pressure changes very much periodically with 12 hours cycle. Fig.1 shows a typical example of the variation of muon intensity and 12 hours variation

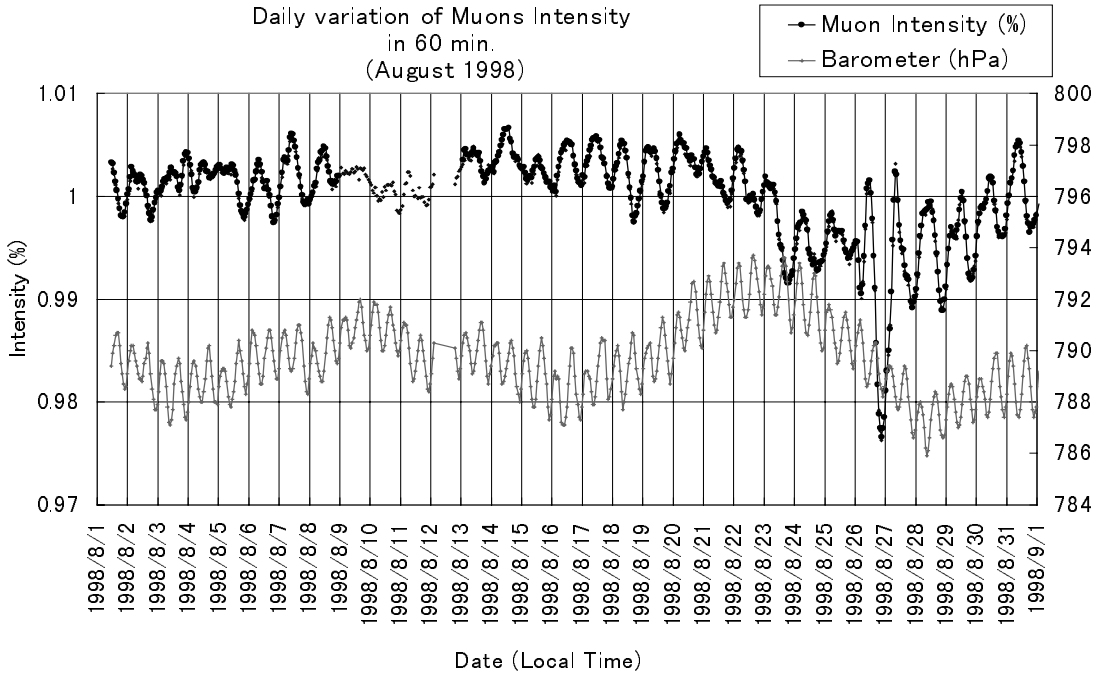

Figure 1: Daily variation of muon intensity (60 min.)

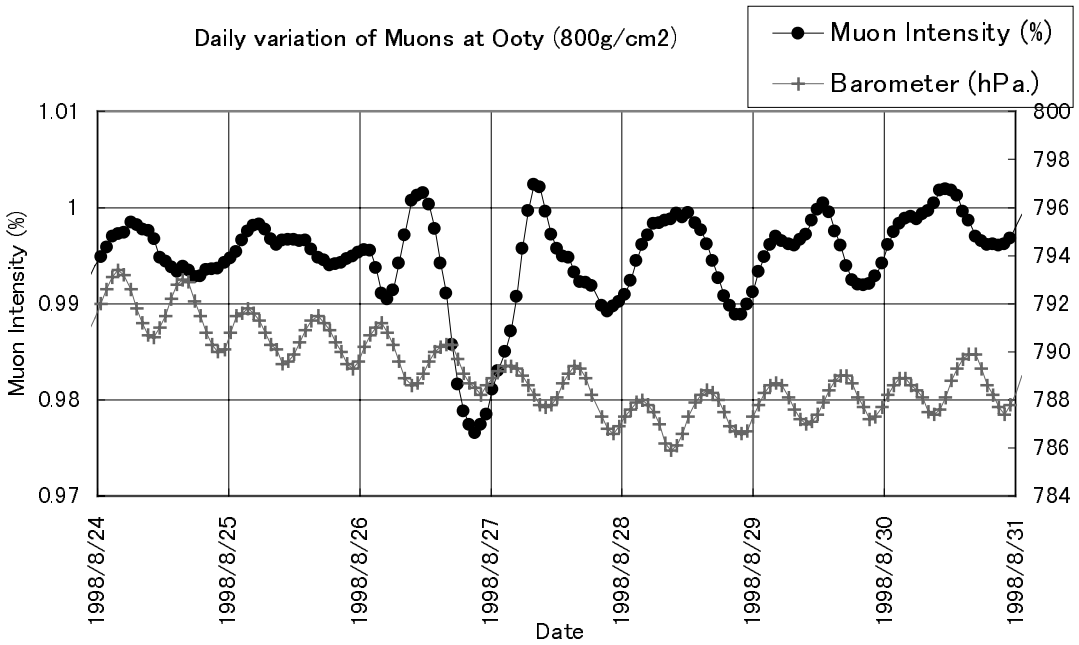

Figure 2: example of Forbush event

of atmospheric pressure for a month.

ANALYSIS OF SOLAR FLARE EVENT

Nagoya's STE Lab group observed the low energy neutron associated with the Solar flare. If the high energy neutrons are to be produced during the Solar flare event, our present detector might be able to see increase at that incidence. We selected the solar flare event greater than M 5 class which occurred at around 10:00 to 14:00 local time. Observation period is between March 1988 and January 1999. Some of the typical example is shown in fig.3 and 4. Counting rate is summed up for 5 minutes.

We have examined each raw data (one second interval) whether there is any misbehavior due to hard and soft ware problems and then summed up for all the units together. We tried to find out the optimum time interval to see the change in intensity. For this purpose 1 min. , 3 min and 5 min interval were checked, but none of the data set showed significant increase or change in counting rate during those solar flare time.

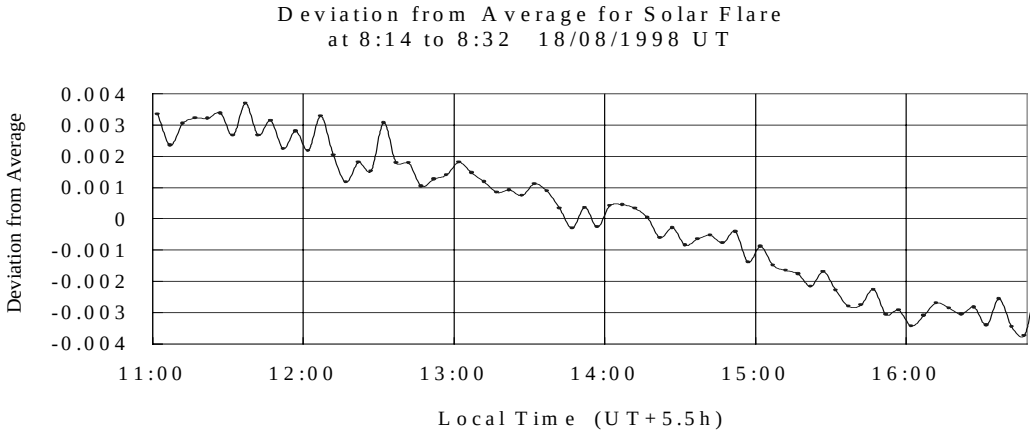

Figure 3: Muon intensity during the Solar flare on 18/08/1998

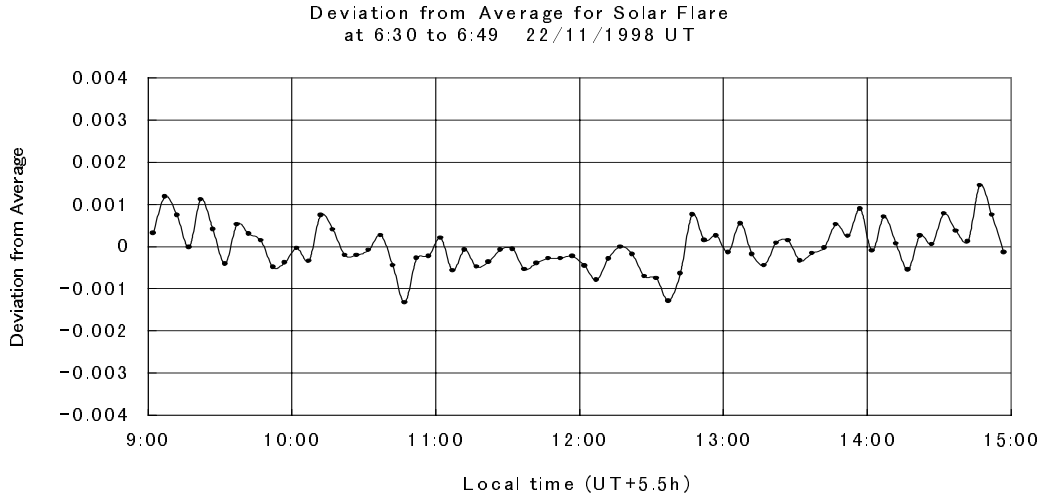

Figure 4: Muon intensity during the Solar flare on 22/11/1998

DISCUSSIONS AND CONCLUSIONS

We could not find any significant increase of muons associated with solar flare. As I mentioned earlier, present data is just total counting rate of penetrating muons, so the sensitivity of our detectors would be limited.

As a next step of the experiment, we introduced the angle measurement system for individual muons. The accuracy of this angle measurement is around 15 degrees. This is due to the limitation of size of proportional counters and their vertical separation. Minimum time resolution of observation is one second. Installing this systems into one of the unit we started the observation from March 1999 and we are going to install this recording systems into another 10 units within this fiscal year. With this arrangement we are expecting to detect much detailed sidereal variation in a short observation time and the rapid change of high energy neutron intensity in Solar flare event, if any.

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