

Research Report

ICRR Inter-University Research Program 2021

Research Subject: A joint observation of near earth space through ~100 GeV cosmic rays using the Akeno and the GRAPES-3 muon telescope

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Summary of Research Result: A large area (560 m²) muon telescope based on proportional counters of dimension 6m x 6m x 0.1m each, has been operating in Ooty, India since 2000 as a part of the GRAPES-3 air shower array with the joint efforts of the Indian and Japanese scientists. The muon telescope records about 4 billion muons every day, providing an unprecedented high sensitivity in the measurements of the Galactic cosmic ray modulation, caused by the dynamically changing solar activities. A similar configuration muon telescope is being operated at the Akeno observatory, Japan, but with an area of about 15% of the GRAPES-3 muon telescope. The two muon telescopes have an overlapping field of view of 20% and can provide complementary observations on the space weather. Visits to Japan by Indian researchers or vice versa was not possible in the fiscal year 2021 due to the continued covid pandemic and carry over of the approved budget to fiscal year 2022 was requested. However, regular analysis meetings and discussions were conducted in virtual mode involving researchers from the Indian and Japan side. An investigation on the solar diurnal anisotropy in the cosmic ray flux using 21 years of data (2001-2021) recorded by the GRAPES-3 muon telescope was carried out. Dependence of solar diurnal anisotropy amplitude on the interplanetary magnetic field was studied and a strong correlation has been observed. The results are under finalization. The diurnal anisotropy is observed by the ground based detectors as a time variation with a period of 24 hour. However, using the high statistics GRAPES-3 data, a spatial map of the diurnal anisotropy could be produced, demonstrating that the diurnal anisotropy is an anisotropy effect in the heliosphere.

The upgrade of the GRAPES-3 muon telescope at Ooty is under progress which will double the total area for muon observation. It is expected to be completed within a year's time. The expansion would enhance the GRAPES-3 capability for solar modulation studies as well as cosmic ray composition and gamma ray studies. The data acquisition system (DAQ) of the Akeno muon telescope is very old causing breaks in the data recording, hence it needs to be upgraded. Development efforts for new and efficient electronics and DAQ for the GRAPES-3 new muon telescope were undertaken in the last few years and successfully achieved. As a part of the proposal, the Ooty group is helping out in the upgrade of the DAQ system of the Akeno muon telescope from the outdated PCI interface to TCP/IP interface which would enable uninterrupted observation of muon data. The fabrication of the required system is under progress and will be delivered to the concerned Japanese researchers for installing in the Akeno muon telescope.

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