

## MUON MULTIPLICITIES AND SINGLE MUON RATES MEASURED USING THE UNDERGROUND COSMIC-RAY EXPERIMENT EMMA

P. Kuusiniemi<sup>1</sup>, T. Enqvist<sup>1</sup>, L. Bezrukov<sup>2</sup>, H. Fynbo<sup>3</sup>, L. Inzhechik<sup>4</sup>, J. Joutsenvaara<sup>1</sup>, K. Loo<sup>5</sup>, B. Lubsandorzhev<sup>2</sup>, V. Petkov<sup>2</sup>, M. Słupecki<sup>5</sup>, W. H. Trzaska<sup>5</sup> and A. Virkajärvi<sup>1,5</sup>

<sup>1</sup> Oulu Southern Institute and Department of Physics, University of Oulu, Finland

<sup>2</sup> Institute of Nuclear Research, Russian Academy of Sciences, Moscow, Russia

<sup>3</sup> Department of Physics and Astronomy, Aarhus University, Denmark

<sup>4</sup> Moscow Institute of Physics and Technology, Moscow, Russia

<sup>5</sup> Department of Physics, University of Jyväskylä, Finland

email: pasi.kuusiniemi@oulu.fi

CORSIKA [1] air-shower simulations indicate that the muon lateral density distributions with muon energies of 50 GeV and above are sensitive to the energy and mass of the primary cosmic rays. Furthermore, energy vs. mass distributions are nearly model independent at the knee region (primary energies of  $\sim 1 - 10$  PeV).

EMMA (Experiment with Multi-Muon Array) [2, 3] operates 75 metres below ground (210 m.w.e. or  $\sim 50$  GeV muon cutoff energy) in the shallow section of the Pyhäsalmi mine, Finland. The array dedicated to the composition analysis of cosmic rays at the knee region. It is designed for muon-multiplicity measurements event by event. These data are used to extract the lateral density distribution and the arrival angles for each air shower.

EMMA consists of eleven detector stations,  $\sim 15$  m<sup>2</sup> each. Three central tracking stations are used for high muon multiplicities (indicating the primary energy) and arrival angles while eight sampling stations are for the tails of lateral distributions (indicating the primary mass). The three tracking stations and six sampling stations are already operating and recording data. The first results of measured muon multiplicities and single muon rates will be presented.

[1] D. Heck *et al.* 1998 Report FZKA 6019

[2] P. Kuusiniemi *et al.* 2011 *Astrophys. Space Sci. Trans.* **7** 93.

[3] P. Kuusiniemi *et al.* *Journal of Physics: Conference Series*, TAUP2015 Proceedings, to be published