STATUS OF UNDERGROUND COSMIC-RAY EXPERIMENT EMMA

J. Joutsenvaara[a], L. Bezrukov[b], T. Enqvist[a], H. Fynbo[c], L. Inzhechik[d], P. Kuusiniemi[a], K. Loo[e], B. Lubsandorzhiev[b], V. Petkov[b], M. Slupecki[e], W.H. Trzaska[e], and A. Virkajärvi[a]

[a]Kerttu Saalasti Institute, University of Oulu, Finland
[b]Russian Academy of Sciences, Institute of Nuclear Research, Moscow, Russia
[c]Department of Physics and Astronomy, Aarhus University, Denmark
[d]Moscow Institute of Physics and Technology, Moscow, Russia
[e]Department of Physics, University of Jyväskylä, Finland
email: jari.joutsenvaara@oulu.fi

Air-shower simulations indicate (for example, CORSIKA [1]) that muon lateral density distributions with muon energies greater than ∼50 GeV are sensitive to the energy and mass of the primary cosmic rays. Furthermore, at the *knee* region (primary energies between 1–10 PeV), the distributions are nearly model independent. The knee, i.e., clear change in the energy spectrum at 3 PeV, was found already in 1950's but the reason it exists is still not completely understood.

EMMA (Experiment with Multi-Muon Array) [2, 3] is operating at the depth of 75 m (equivalent to 210 mwe or 50 GeV muon cutoff energy) in the shallow section of the Pyhäsalmi mine, Finland. It provides an alternative way to study the knee region and the main motivation of the EMMA experiment is to analyze the composition of cosmic rays around the knee region. The array is designed to measure in event-by-event mode the muon multiplicity and its lateral distribution and the arrival direction of an air shower.

The array consists of eleven detector stations (three *tracking stations* and eight *sampling stations*) of 15 m^2 each and three types of detectors. The three central tracking stations have been taking data continuously over two years allowing preliminary analysis for the composition. However, the full operation of the sampling stations is also needed in order to yield final and the most accurate composition data.

In the present work, the status of the EMMA experiment is presented including the first results of measured muon multiplicities and single muon rates with the tracking stations.

[1] D. Heck *et al.*, Report FZKA 6019 (1998).
[2] P. Kuusiniemi *et al.*, Astrophys. Space Sci. Trans. 7 (2011) 93.
[3] P. Kuusiniemi *et al.*, Journal of Physics: Conference Series 718 (2016) 052021.