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[Abstract]

Imaging via detection of cosmic muon induced secondary particles

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Abstract: Cosmic-ray muography has been used for the inspection of geological and industrial structures (e.g. fuel in nuclear reactors). However, the muon imaging of small structures with low atomic number and density was not yet solved appropriately. Completely new imaging method by cosmic-ray muons, based on the detection of secondary produced radiation in object material has been demonstrated by our research group. Taking advantage of the production rate of secondaries in the target materials, detected in coincidence with muons by plastic scintillator detectors, together with muon tracker, the first cosmic-ray muon images of bone and soft tissue

were created. These pictures represent the first radiographies of structures of organic origin ever recorded by cosmic rays. The research using Monte-Carlo (MC) simulations, done by Geant4 software, includes simulations of the interactions of cosmic-ray muons with different detectors and different target materials in order to optimize the experimental setups and further investigate the processes leading to image creation.

In this work, we will present two experimental setups in Novi Sad (MUCA) and Budapest (COMIS), used for muography of different test materials and the obtained images via those setups. MUCA- Muon Camera setup consists of 4 plastic scintillation detectors (50cm × 50cm × 5cm) and muon tracker (5 CCC boards 25cm x 25cm) placed above the object imaged. COMIS (Cosmic Muon Induced Secondaries) experimental setup is comprised of muon tracker (5 CCC boards 50cm x 50cm, with 2mm resolution) placed below the object imaged, 4 plastic scintillation detectors (50cm × 50cm × 5cm) positioned around the object and 4 plastic scintillation detectors (25cm × 25cm × 5cm) under the target volume. The aim of this research is to provide imaging and composition study of various objects, emphasizing low atomic number and density materials, using only natural omnipresent cosmic radiation.

Keywords: cosmic muon imaging; muon secondaries detection; low atomic number materials; Geant4 simulations; coincidence event detection