Muon Tomography applied in the Lousal Mine (Portugal)

Pedro Teixeira¹, Lorenzo Cazon², Bento Caldeira¹, Alberto Blanco², José Borges¹, Sofia Adringa², Pedro Assis², Bernardo Tomé², Ricardo Luz², José Nogueira², Luís Lopes², Mourad Bezzeghoud¹, Miguel Ferreira², Pedro Nogueira¹, Catarina Espírito Santo², Daniel Galaviz², Fernando Barão², and Mário Pimenta²,³

¹University of Évora, Institute of Earth Sciences, Physics, Portugal (pmmt@uevora.pt)
²Laboratory of Instrumentation and Experimental Particle Physics, Particle Physics, Portugal.
³Instituto Superior Técnico, Physics, Portugal

Muon Tomography is an imaging technique that uses muons, a natural background radiation, as a means of observing the earth's subsurface. Muons are elementary particles like electrons but with a much greater mass that gives them a high penetrative power across matter. With suitable detectors it is possible to create muographs (muon radiographs) to obtain the column density distribution of the surveyed region. This project is a collaboration between University of Évora and the Laboratory of Instrumentation and Experimental Particle Physics (LIP). Both are Portuguese institutions that intend to apply the muon tomography in the geophysics field. The chosen location was the Lousal Mine, an abandoned and well mapped mine in Portugal with all the support infrastructures necessary that make it an ideal location to test the muon telescope developed by us. The detection will take place inside a mine gallery about 18 m below the surface. The telescope will do a geological reconnaissance of the ground above the gallery with the intention of mapping structures and ore masses already known and of improving the existing information with new data. This will serve to test the performance and sensitivity of the muon telescope, made of particle detectors called RPCs. A working prototype was put in place to gather preliminary information and establish the requirements of the equipment. After that, a muon telescope equipped with four RPC detectors, with an area of 1 m² each, was assembled and has been collecting muons inside the Lousal Mine for the last few months. The tomographic aspect of the work is born from placing the telescope in different locations inside the mine and by orienting it to observe in different directions. Simulations of the muons detection have been made using GEANT4 software. The simulations allow to study the expected result of muographs produced by the muon flux passing through a simulated ground with different characteristics. The aim of this work is to combine the muography information with gravimetry data, from a gravimetric survey that will be carried on site, through a joint inversion of both data sets in order to obtain 3D density profiles of the observed region. Other geophysical methods are being applied above the mine to survey the surface, using photogrammetry, and the ground, using GPR and seismic refraction. These methods give knowledge about the arrangement of the ground, can be compared with previous acquired information and will help to perfect the 3D density profiles.