

Density Imaging of Volcanoes using Atmospheric Muons

Master 2 Research Internship at Laboratory of Physics of Clermont (LPC)

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Muography is a novel imaging technique based on the attenuation of the atmospheric muon flux. It is particularly well suited to the study of large structures as volcanoes, pyramids, etc. The (2D) integrated density maps are inferred from the measurement of the muon flux transmitted through the targets through an inverse treatment. The tomographic reconstruction is non trivial since ill-posed because of the limited number of radiographic images that can be taken. As a consequence, the 3D information is recovered using a joint inversion of muographic and gravimetric data. Indeed, the gravimetric data are themselves governed by the density distribution in the target.

The muon telescopes of the current generation are plain trackers. They do not measure the energy of the impinging particles and do not allow for a robust particle identification. The precise description of the detector response requires combining in situ measurements and detailed Monte Carlo simulations. The trainee will be in charge of the detector simulation using Geant 4 and will study the calibration of the muon telescope using previously made measurements on Puy de Dôme volcano. A particular focus of the study will be on quantifying the systematic uncertainties affecting this calibration.

The trainee will work in the muography team at LPC, team with an internationally recognised expertise in this research field. He/she will participate to the data taking campaigns on Puy de Dôme and Vesuvius volcanoes planned for Spring 2018. The LPC team collaborates with particle physicists, geophysicists and volcanologists from France, Italy and Portugal. The trainee will therefore have the opportunity to work in an interdisciplinary and international work environment.

Standard knowledge in particle physics and programming are required. C/C++ knowledge is preferred; notions of python are an advantage. Good mastership of Geant4, the standard simulation toolkit in Particle Physics will be acquired during the internship.

The internship offers a rare opportunity to closely work with a running detector and at to get involved with high level simulation and analysis tools.

The internship can be continued with a PhD.