Density Imaging of an Active Hydrothermal System With Atmospheric Muons

Master 2 Research Internship at Laboratory of Physics of Clermont (LPC)
Supervisors: Cristina Cârloganu
Co-supervisors / team participants: Franck Martin, Francois Montanet (LPSC)
Contact: carlogan@in2p3.fr (04 73 40 72 92)

DIRE (Data integration from multiprobe sensor networks to assess risk scenario's at volcanic hydrothermal ecosystems) is an interdisciplinary project that will use Vulcano (Eolian Islands, Italy) as a testbench for assessing risk scenario's at volcanic hydrothermal systems from surface (temperature, gas, deformations) and in depth (muographic imaging) monitoring of the volcano, using deep learning algorithms. The project was funded by ANR in 2020 for a four-years duration and brings together particle physicists from LPC Clermont, data scientists from LIMOS/Clermont, volcanologists from LMV Clermont, INGV-Catania and Palermo and risk experts from Geneva University.

The LPC group oversees the muographic imaging within DIRE. Muography is a novel imaging technique using the attenuation of the atmospheric muon flux propagating through a volcano to infer its inner (density) structure. For the first time, a dynamic imaging will be attempted to monitor real-time changes in the structure induced by meteoric water movements within the structure.

The infrastructure of a first muon telescope is already on site. The telescope should be finalized by summer 2023 by the deployment of the muon detectors, the Glass Resistive Plate Chambers (GRPCs). Before deployment, the GRPCs (already built at LPC) will be qualified in the laboratory using a cosmic ray testbench. The M2 candidate will be involved in this qualification work, learning how to operate detectors and to analyse the data to characterize the detector performance.

The trainee will also work on optimizing the muon reconstruction algorithms using feedback from testbench qualification of the detectors. The algorithms will be tested both on Monte Carlo simulations and muographic data taken with a previous telescope on puy de Dôme.

A good understanding of particle physics and detector physics, previous knowledge of ROOT and C++, expertise in data analysis are required. Good communication and team-work skills are necessary.

A successful internship can be continued with a PhD.