16th Topical Seminar on Innovative Particle and Radiation Detectors

ArchéMuons: Near Surface Muography studies for targets of Archaeological interest.

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Abstract

ArchéMuons project is a collaboration of the **Institute of Physics of the 2 Infinities of Lyon** (IP2I Lyon), the **Laboratory of Geology of Lyon** (LGL) and the **Archéorient Laboratory** under the auspices of the **Gallo-Roman Museum** in Vienne, France. The three teams will perform geophysics surveys and muography measurements at the archaeological site of the Palais de Miroir [1]. A muon detector will be placed inside a gallery of the partially excavated foundations of the site to study the overburden structure with electric resistivity and seismometry surveys as a reference. The results of the different methods will then be compared to evaluate the benefits from their synergies. The inspiration behind this approach is based on the successful precedent of the La Soufriere volcano [2] where a distributed network of muon detectors operates in conjunction with various local geophysics surveys to provide accurate 3D images of the internal density distribution of the Dome.
ArchéMuons kickstarted in November 2022 with the electric resistivity survey and muon data acquisition with a small portable scintillator detector placed inside the site foundations. This preliminary dataset showed an environment rich in background particles a finding confirmed by simulation and attributed to the muon electromagnetic interactions with the surrounding materials. In June 2023 a seismometry survey will take place using a Distributed Acoustic Sensing (DAS) technic with optical fibers as deformation sensors. In the same time, a muon telescope will be installed underground, to perform muography and assess the overburden. The long data acquisition duration provides the opportunity to use different types of scintillators, detector geometries and a hybrid tracker/Čerenkov detector combination to evaluate their performance with experimental data and to develop further their respective simulation.
We will provide an overview of the science case, the archaeological interest and present the current status of the project from the muography perspective. We will discuss the simulation predictions, the comparison with the detector characterization data, the prospect of studying the water retention of the overburden and its interplay with the atmospheric conditions [3]. We will close with an outlook on future directions of the project based on the current findings.

[1] B. Tauzin et al., I-DUST 2022
[2] Rosas-Carbajal, M., Jourde, K., Marteau, J., Deroussi, S., Komorowski, J.-C., and Gibert, D. (2017), Three-dimensional density structure of La Soufrière de Guadeloupe lava dome from simultaneous muon radiographies and gravity data, *Geophys. Res. Lett.*, 44, 6743– 6751, doi:10.1002/2017GL074285
[3] Jourde, K., Gibert, D., Marteau, J. *et al.* Monitoring temporal opacity fluctuations of large structures with muon radiography: a calibration experiment using a water tower. *Sci Rep* **6**, 23054 (2016). https://doi.org/10.1038/srep23054