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## Cosmic Muon Images: a muon tomography citizen science project

**Theodore Avgitas** and Jacques Marteau

Lyon 1, IP2I, France (avgitas@ipnl.in2p3.fr)

Muon tomography has witnessed significant growth during the last decade with volcanology being the main driving force behind this great success. Many sites around the world are currently studied and many new ideas concerning R&D, potential new targets and data analysis techniques are brought to light. Nevertheless, the potential for further developments is hindered by the lack of manpower to explore this changing landscape. Citizen science is the active involvement of the public in scientific research with the goal to further the domain's knowledge. Citizen science projects has been developed during the last decade around experiments that produce high volume of data like ATLAS at CERN with the Higgs Hunters project and LIGO gravitational wave detector with Gravity Spy. This kind of projects has proved to build strong connections with a community of people that have an inner will for participation in scientific endeavors and muon tomography reaches fast that point where such a community could be proved valuable.

Cosmic Muon Images is a muon tomography citizen science framework developed within the REsearch Infrastructures FOR Citizens in Europe (REINFORCE[1]) project (EU-funded, GA-822859). REINFORCE brings together four major scientific domains in order to engage citizen scientists in the process of scientific discovery. Muon tomography, Gravitational Waves, Neutrino Astronomy and High Energy Physics provide the ground for discussion and active involvement of people from all over the world with critical scientific issues like detection techniques, signal vs background rejection, environmental impact on measurement and many more. The goal of reaching the broadest possible audience would be disrupted if the data used by these projects were not accessible easily by as many people as possible. SonoUno[2] is a user centered software developed within REINFORCE that allows people with different sensory styles to explore scientific data, both visually and through sonorization.

Zooniverse[3] website hosts various citizen science projects, and a very active community has grown around it over many years. Cosmic Muon Images utilizes the website's tools to develop workflows while at the same time communicate the science behind muon tomography so that people do their work more efficiently and consciously. Muon telescope data are visualized with 3D and 1D plots with the goal being the identification of patterns through a series of lines and points on these plots. This pattern identification results will be used to train Machine Learning (ML) algorithms to discriminate between signal and background events. Afterward we will evaluate the performance (speed, accuracy) of these ML algorithms in comparison to more traditional track reconstruction and event selection algorithms that are already in use. Furthermore, the classification of a dataset that people have cataloged by eye can prove to be extremely valuable so

much for simulation development and background identification.

Muon Tomography provides a vast landscape of applications for citizen scientists to explore and projects that facilitate active participation can have mutual benefits for scientists and citizens alike, this is a first step towards this direction.

[1] <https://www.reinforceeu.eu/>

[2] <http://sion.frm.utn.edu.ar/sonoUno/>

[3] <https://www.zooniverse.org/>