

## The REINFORCE EU citizen science project

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The REINFORCE EU (Research Infrastructures FOR Citizens in Europe) was a three-year long SwafS project which engaged citizens in active collaboration with the scientists working in large research infrastructures across Europe. The overall aim was to bridge the gap between them and reinforce society's science capital. The citizen scientists had at their disposal data from four different "discovery demonstrators" hosted on the online Zooniverse platform.

The demonstrators asked for the citizen contribution to front-end research such as: gravitational wave astronomy, deep sea neutrino telescopes, particle search at CERN and cosmic rays. The task of the citizens was to help the scientists to optimize the detectors and/or the reconstruction algorithms. A separate dedicated working package was devoted to exploring the potential of frontier citizen science for inclusion and diversity. The emphasis was given to sonification for inclusion of visually impaired citizens, senior citizen science courses and artistic interventions.

The focus of the talk will be on the demonstrator titled "Search for new particles at CERN", where citizen-scientists visually inspected events collected by the ATLAS detector at LHC and searched for signatures of new particles. To make this possible, the demonstrator adopted a three-stage architecture. The first two stages used simulated data to train citizens, but also to allow for a quantitative assessment of their performance and a comparison with machine learning algorithms. The third stage used real data, providing two research paths: (a) study of Higgs boson decays to two photons, one of which could be converted to an electron-positron pair by interaction with detector material, and (b) search for yet undiscovered long-lived particles, predicted by certain theories Beyond-the-Standard-Model. The second stage events were sonified by CONICET.

The results of 360,000 classifications showed that citizen scientists can carry out complicated tasks responsibly, with a performance comparable to that of a purpose-built machine-based algorithm and can identify interesting patterns or errors in the reconstruction, in individual events. Moreover, the demonstrator showed that the statistical combination of user responses (user consensus) appears to be quite a powerful tool that can be further considered and exploited in fundamental scientific research.

The demonstrator approach to applying citizen science to high energy physics proved that users could contribute to the field, but also identify areas where further study is necessary.

**Presenter:** KOURKOUHELIS, Christine (National and Kapodistrian University of Athens)

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