The REINFORCE citizen-science project and the search for new long-lived particles at the LHC

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REsearch INfrastructures
FOR Citizens in Europe
https://www.reinforceeu.eu

Science with and for Society (SWAFS)
H2020-SwafS-2018-2020

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This project has received funding from the European Union’s Horizon 2020 research and innovation programme under ‘grant agreement No 872859.
**REINFORCE**: intends to establish a community of citizens actively engaged in public-funded frontier research.

Assess the benefit to science

Assess the benefit to society

**PLUS:**
Explore the potential of frontier citizen science for inclusion and diversity.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under `grant agreement No 872859.
Citizens will become scientists of CERN, the largest particle-physics lab in the world.

to discover New Physics with the Large Hadron Collider (LHC), the most powerful collider ever built.
Exploit ATLAS Data/MC to provide:
- an exciting and educating experience to citizen-scientists
- quantitative assessments on potential contribution.

Possible subject for visual analysis: Displaced Vertices (DVs)

SM $H \rightarrow \gamma\gamma$ with a converted photon.  

SUSY scenarios with long-lived particles.
Exploit ATLAS Data/MC to provide:

- an exciting and educating experience to citizen-scientists
- quantitative assessments on potential contribution.

- **Stage 1**
  Visual detection of Displaced Vertices (DV)
  - SIMULATED DATA -

- **Stage 2**
  Particle Identification
  - SIMULATED DATA -

- **Stage 3**
  Discovery
  - REAL DATA -

- **Stages 1 & 2**: will provide the main results (citizens’ efficiency Vs our custom algorithm).
- **Stage 3**: gives citizens the opportunity to apply what learned on a sample of real data.
A generous 10 fb$^{-1}$ of Open Data is offered by the collaboration for exposure to the public.

Addition approval (required multiple meetings) has been given to our project to expose:
- Open Data but from special processing chains (large radius tracking),
- additional information to that already made public.
Zooniverse

CITIZEN-FRIENDLY ENVIRONMENT & PUBLICITY BOOST

with over 2M registered volunteers.
HYPATIA

VISUAL DATA-ANALYSIS FRAMEWORK

successfully used for many years in IPPOG Masterclasses & other outreach actions.
The project on ZOONIVERSE
THE PROJECT ON ZOONIVERSE

Homepage with links providing lots of information about:
• physics (related to the project);
• the ATLAS experiment;
• the group.
The Project on Zooniverse

Each button loads the respective stage.
Citizen scientists are invited to identify any displaced vertex in the displayed event using their mouse pointer.

In this stage we use SUSY MC samples (stop $\rightarrow$ DV + $\mu$).

The track selection mimics the one used by ATLAS to reconstruct DVs (plus additional criteria for visualization).

Tracks from the primary vertex have been removed.

Stationary image of the ATLAS inner detector (transverse & longitudinal view).

Tracks are colored to allow association between the two views.
STAGE 1 – Displaced Vertex Identification

Citizen scientists are invited to identify any displaced vertex in the displayed event using their mouse pointer.

Brief tutorial.

Link to a detailed HELP section:
- video instructions
- examples
- training cases
Citizen scientists are invited to identify any displaced vertex in the displayed event using their mouse pointer.
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- Citizens’ data will be collected by Zooniverse and provided to us for analysis/evaluation.
- Citizens’ performance will be compared to an automatic algorithm that we are developing.
HYPATIA takes over from Zooniverse:

This Stage of the Demonstrator uses an external web event display called "HYPATIA" to identify different kinds of particles.

Click here for detailed instructions

Link to load HYPATIA

Tutorial and Help page are provided

Click here to open HYPATIA

NEED SOME HELP WITH THIS TASK?

Done & Talk

Done
In this stage we use SM MC samples $(H \to \gamma\gamma, H \to ZZ^* \to 4l)$.

- Selection of electrons / photons / converted photons from the respective cluster in the EM calorimeter.
- Selection of muons from their track.
- Substantial adjustment of the official HYPATIA to provide more realistic cases.
- Simplified menu (suitable for particle identification)
STAGE 2 – Particle Identification

Selections are stored by HYPATIA

- Citizens’ data will be collected by HYPATIA for analysis/evaluation.
- Citizens’ performance will be compared to a machine-learning algorithm that we are developing.
STAGE 3 – Study of Higgs bosons

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Tutorial and Help page are provided
Citizens’ data will be collected by HYPATIA for analysis/evaluation.
High rated events can be discussed on the project’s discussion board.
STAGE 3B – Discovery of Long-Lived Particles

- Citizens’ data will be collected by HYPATIA for analysis/evaluation.
- High rated events can be discussed on the project’s discussion board.

Using real ATLAS data (RPVLL stream). Citizens will search for muon-jet DVs:
- mark the lepton associated with the DV,
- rate the event (low → high interest).

Selection of a muon associated with a DV.

Star rating system to classify events according to interest level.

Information (Etmiss, MDV, RDV) to assist event rating.
After tens of meetings (collaboration / advisory board / EU review board / ATLAS)

➔ The platform is finalized and will deploy in the next months.
➔ Citizen data will be collected for about a year.
➔ Analysis of citizens’ data will follow.

Additional Information and News on the project website:
https://www.reinforceeu.eu