GWitchHunters

A citizen science project for the improvement of gravitational wave detectors

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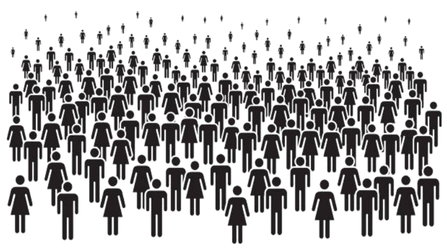
Gravitational-wave detectors are very sophisticated instruments devoted to the formidable task of measuring space-time deformations as small as a thousandth the size of the atomic nucleus, such as those produced by astrophysical phenomena like the coalescence of compact binary systems. GWitchHunters is a new citizen science initiative developed within the REINFORCE project (funded under the H2020 "Science With And For Society" program), aimed at promoting the study of the noise of gravitational-wave detectors and the improvement of their sensitivity. To achieve this goal, gravitational-wave data is presented to the citizens in the form of images and sounds, on which citizens are asked to perform quick-look analysis, such as identifying relations and patterns among them. This constitutes an important input to the detector characterization activity carried out by the researchers. To make the work done by the participants even more enjoyable, we have made use of the Zooniverse web platform and mobile app, where citizens can get entertained while learning and actively contributing to real science. We will report on the status of the project as well as on its impact on the study and characterization of noise in the Advanced Virgo detector.

Together for Gravitational Wave Research

- Promote Science
- Develop communication means enjoyable by the vastest audience



- Make citizens active contributors
- Develop knowledge and new techniques

Citizen Science and Machine Learning

- Detector characterization is crucial to assess data quality
- Transient noise events limit the sensitivity to the astrophysical signals and must be identified and removed
- Machine learning is a promising tool to classify and characterize these transient, namely *glitches*
- Citizen Science can contribute to GW science; successful experience of the Gravity Spy project.

REINFORCE
REsearch INfrastructures FOR Citizens in Europe

A Research & Innovation Project, supported by the EU H2020 SWAFS "Science with and for Society" work program, aiming at creating a series of cutting-edge **citizen science** demonstrators on Frontier Physics research, including GWs and fundamental particles, and with the goal of engaging >100,000 citizens.
Check out the other REINFORCE partners at ICHEP!!

The Project

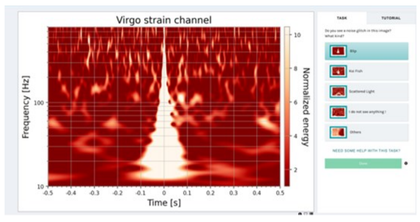
GWitchHunters is a REINFORCE project focused on citizen science to improve sensitivity of GW detectors

- Hosted on Zooniverse, the popular citizen science platform
- Data from Virgo O3
- Focused on glitch analysis and classification
- Different levels of increasing difficulty
- Playground Level with self-assessment and feedback
- Multilanguage support
- Data presented as spectrograms of GW main channel (hrec) + auxiliary channels
- Designed to complement and extend the Gravity Spy project
- Launched in Nov 2021, after ~1 year development

The Tasks

Different tasks are offered to citizens, including glitch identification and classification

Levels of increasing difficulty, including Playground and Mobile Levels

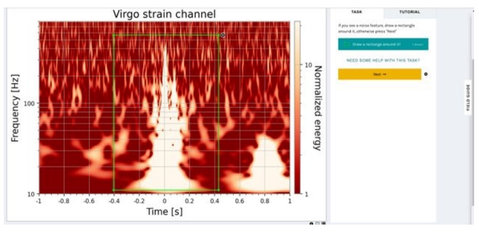


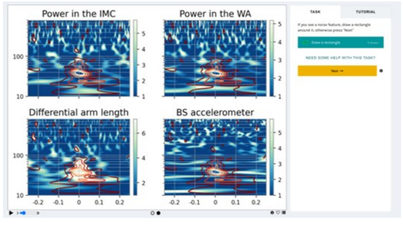
Classification

- Data as spectrograms
- Choose among known classes
- Search and propose new glitch classes

Identification

- Draw rectangles around glitches
- More glitches in images
- Linked with classification



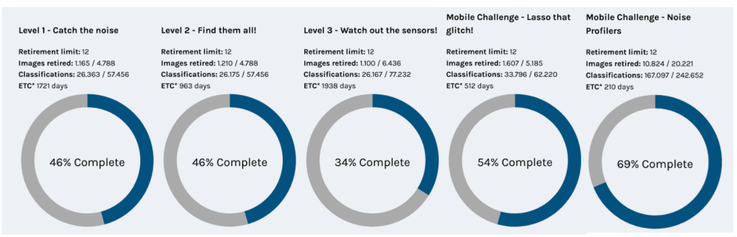


Auxiliary Channels

- 8 aux channels from local sensors
- Compare morphology with the main channel, the Virgo strain signal
- Search for glitch origin

First Results

Data produced by the GWitchHunters platform serve as input for Machine Learning tools



- Officially launched on Nov 2021
- First Dataset completed (O3a data)
- Added a new dataset (+2000 glitches from O3b)
- >2700 registered users
- 25% total completion
- Winter and Easter Challenges to boost engaging

- Dedicated Machine Learning tools to analyze data
- Spectrograms as 2D input for Convolutional Neural Networks
- Test on simulations, work in progress on data
- Output send to Virgo Glitch Database to be used in detector characterization work
- Fully automatic pipeline aiming at O4 (Dec 2022)

CNN 2D Confusion matrix for simulated data (Razzano&Cuoco 2018)

References

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