REINFORCE
REsearch INfrastructures FOR Citizens in Europe

The New Particle Search project on the Zooniverse platform

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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.

The demonstrator is part of the REINFORCE Citizen-Science EU (Dec ‘19-Nov ’22)

- To have citizens focus on visual inspection of events
- To train them to locate **displaced vertices** (HiggsHunters example)
- To train them to recognize characteristic signatures of electrons, muons, photons and converted photons **using the online HYPATIA event display**
- Finally, by combining the above: to let them make **possible discoveries of “new physics”**

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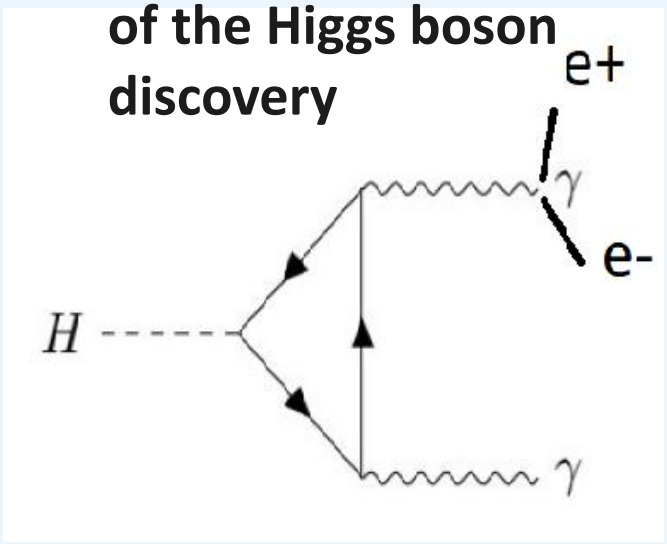
Reminder: The "discovery" path given to Citizen Scientists

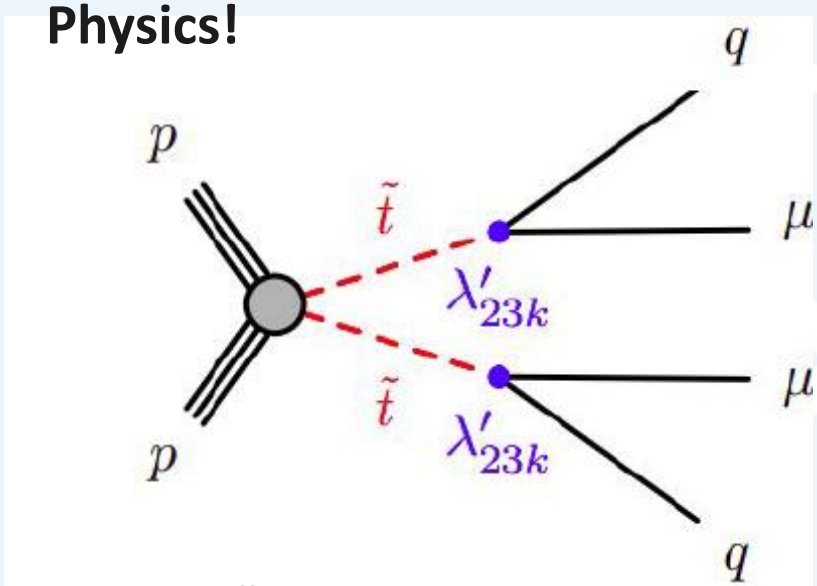
Citizen scientists **visually inspect** collision events in searches of **displaced vertices (DVs)**

to enhance their understanding of the Higgs boson discovery



Higgs→γγ with one converted photon

and identify signs of New Physics!

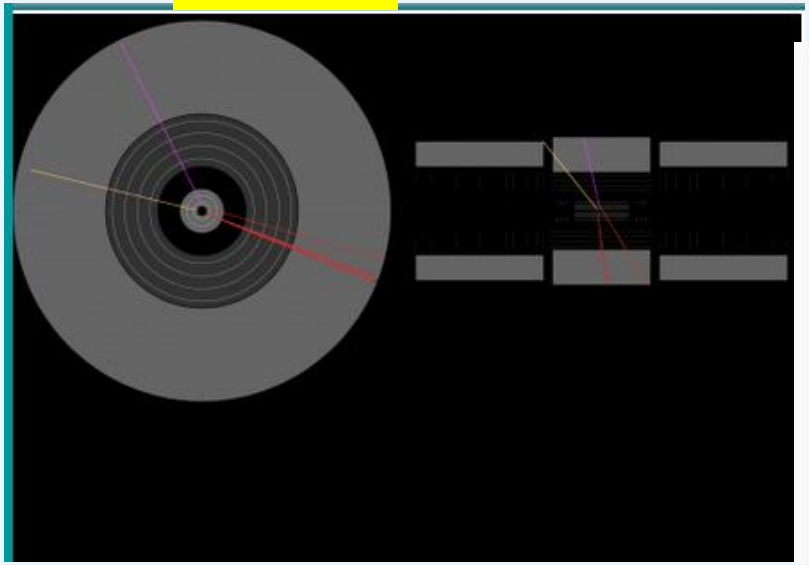


*Scenaria of **"New Physics"** with long-lived particles (ex RPV) **These could give answers to some open question***

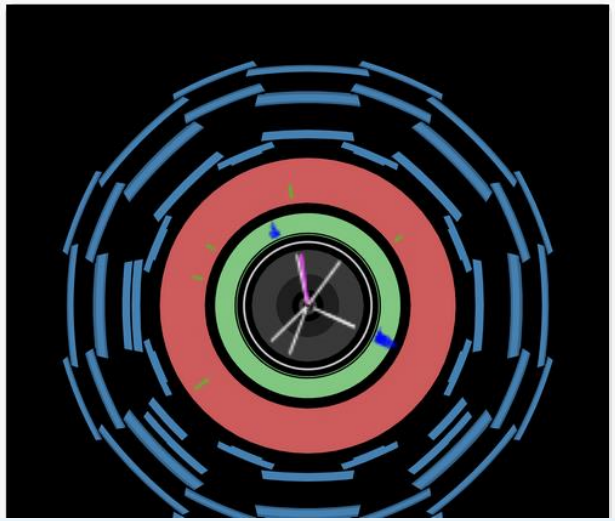
The citizen's work path is split in three stages

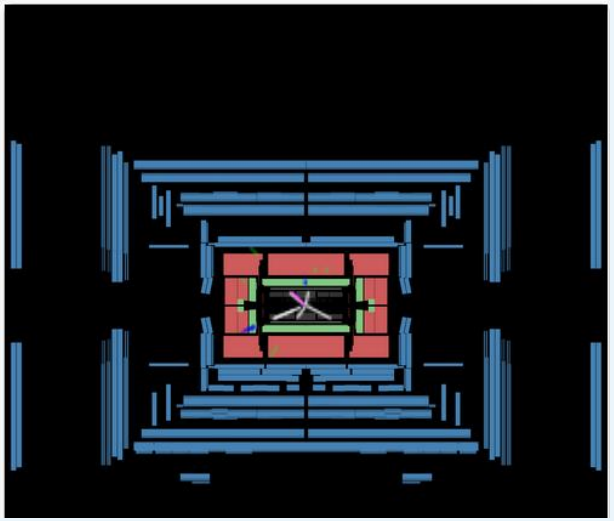
- A dedicated **data-selection/data-filtering procedure** was performed in order to transform ATLAS data into a format suitable for this WP, and facilitate the visual analysis.
- **Special permission** had to be given by ATLAS for the use of the relevant DV data
- We developed all the **visualization tools** needed.
  In addition to studying stationary images, citizens **interact with HYPATIA event display** (had to develop several versions dedicated to each Stage).
- **Automated algorithms** are being developed to get quantitative results on the citizens' performance on the simulated datasets.

Stage 1



Stage 2 and 3 INTERACTIVE





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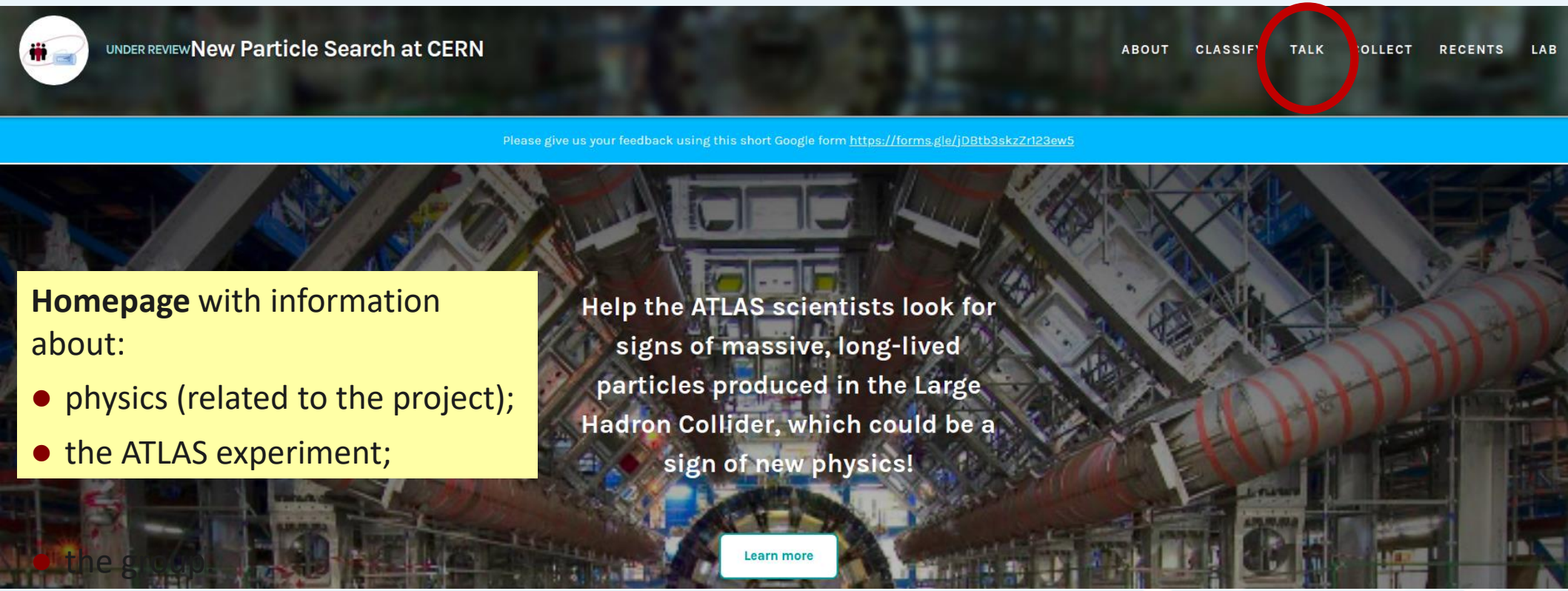
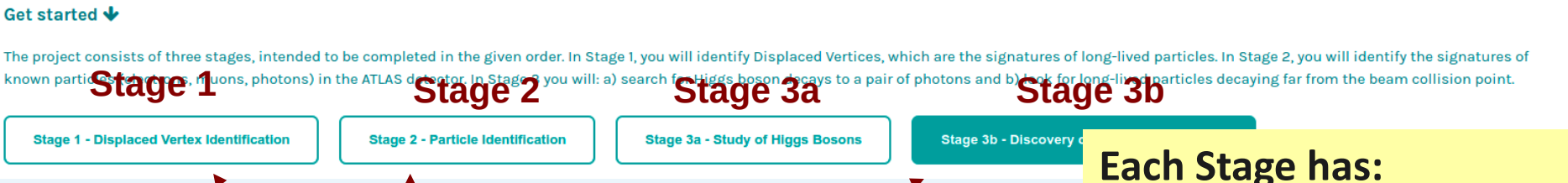
BIG NEWS: The Project on ZOONIVERSE

https://www.zooniverse.org/projects/reinforce/new-particle-search-at-cern



Homepage with information about:

- physics (related to the project);
- the ATLAS experiment;
- the group

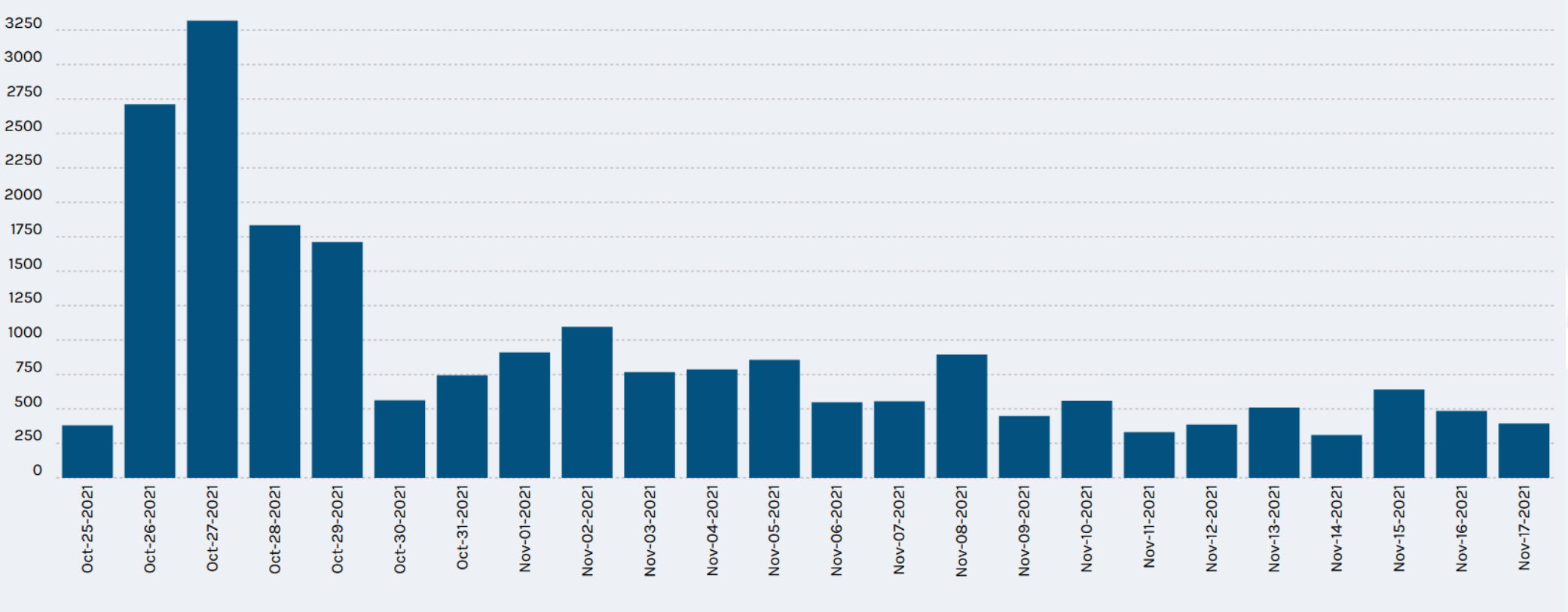


Each button loads the respective stage.

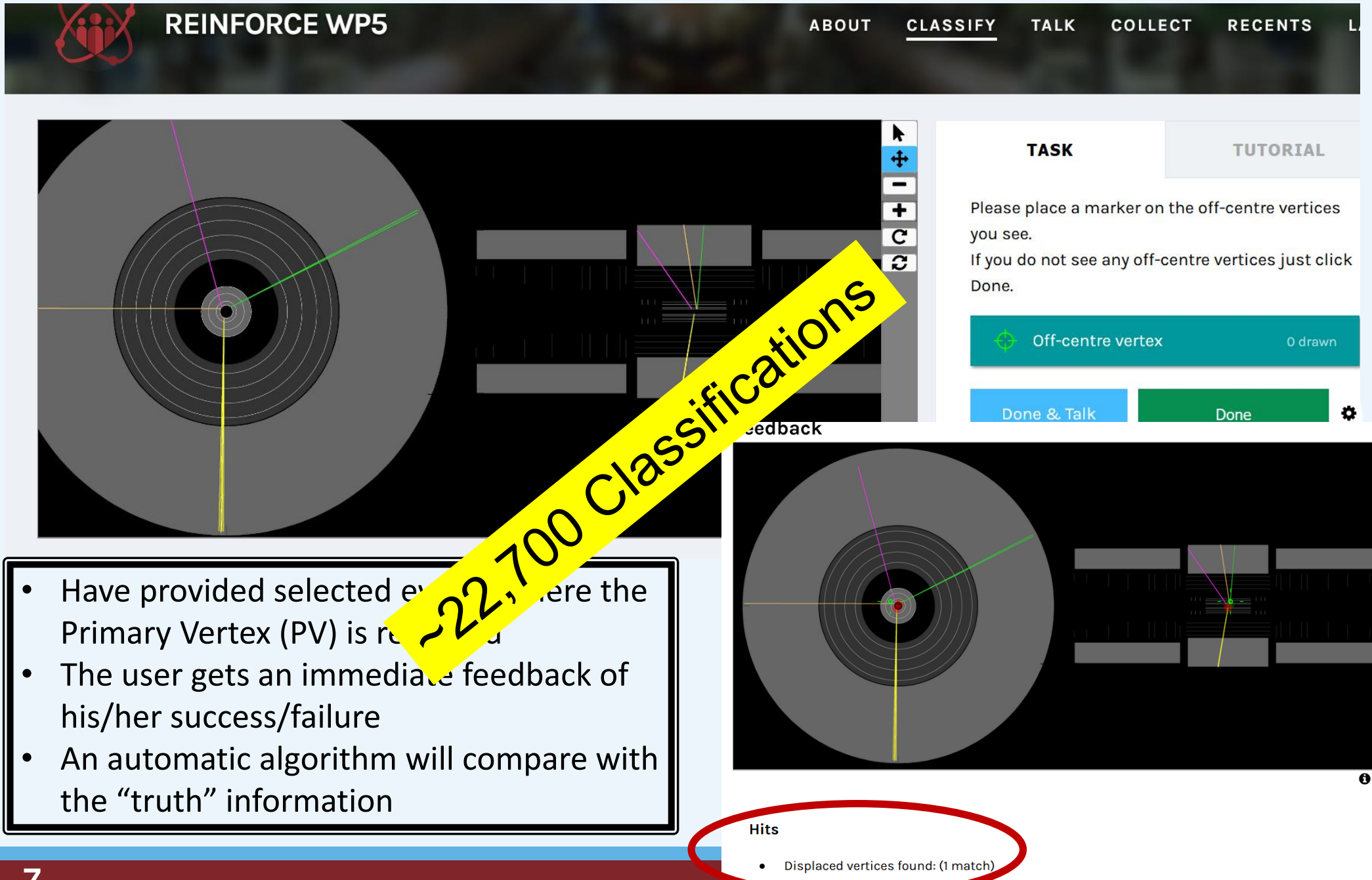
Each Stage has:

- Tutorial
- Help page/Instructions (including a short video)

Full launch 26/10
Almost 42,000 classifications
~850 volunteers



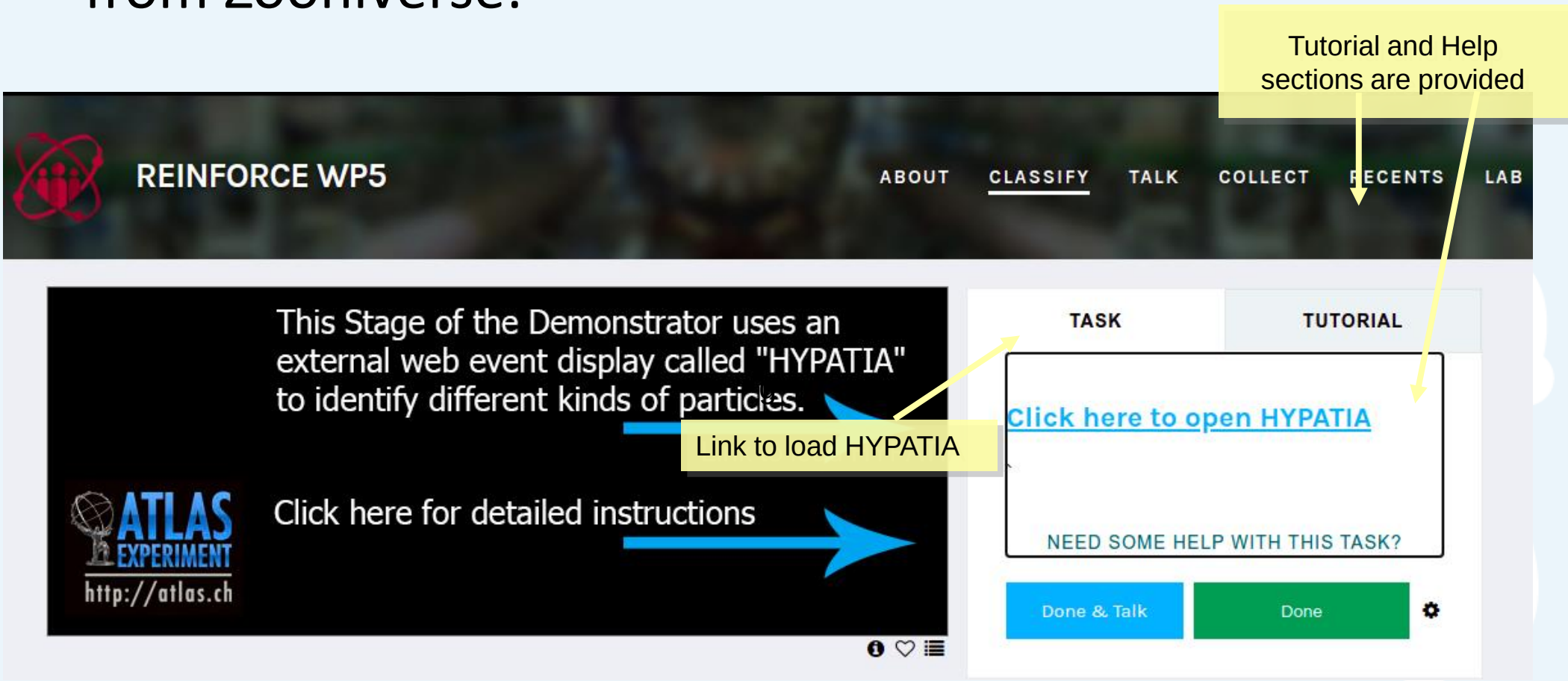
Stage 1 (on Zooniverse –simulated data)
DV identification



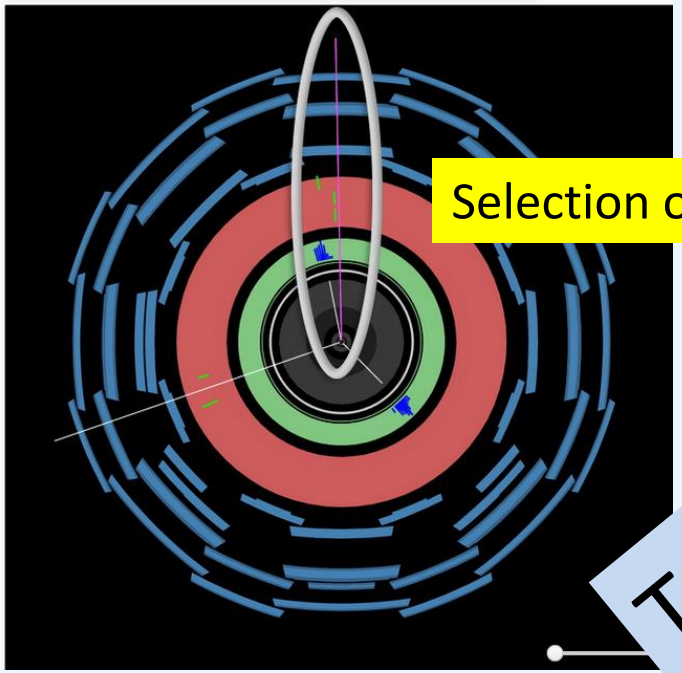
- Have provided selected e… …ere the Primary Vertex (PV) is re… …d
- The user gets an immedia… feedback of his/her success/failure
- An automatic algorithm will compare with the “truth” information

STAGE 2 – Particle Identification (e,μ,γ,conv. γ)

HYPATIA takes over from Zooniverse:



STAGE 2: PARTICLE IDENTIFICATION-simulated data (e,μ,γ,γ*)

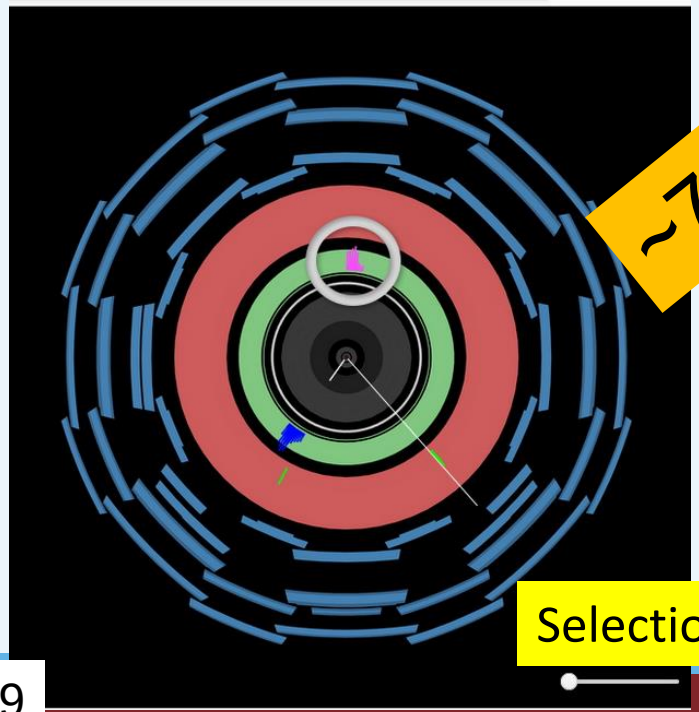


Selection of a muon

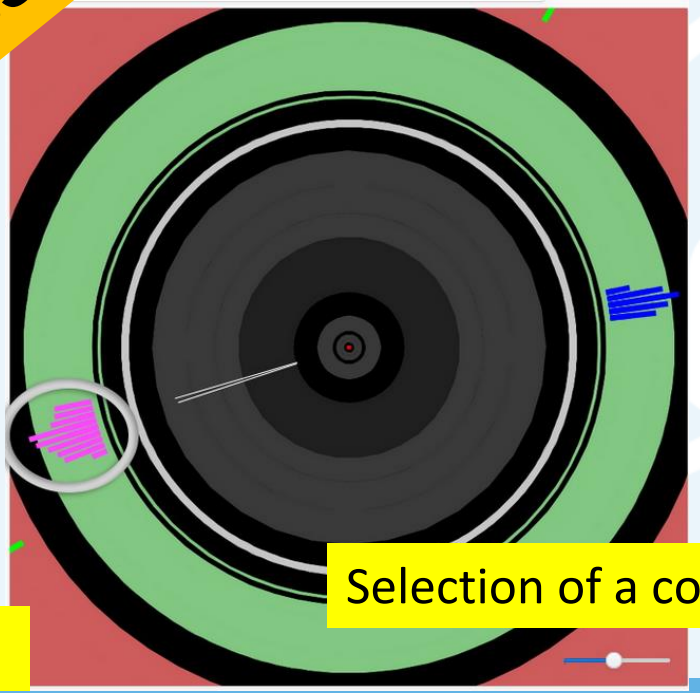
Selection of an electron

Tutorial

~7900 Classifications



Selection of a photon

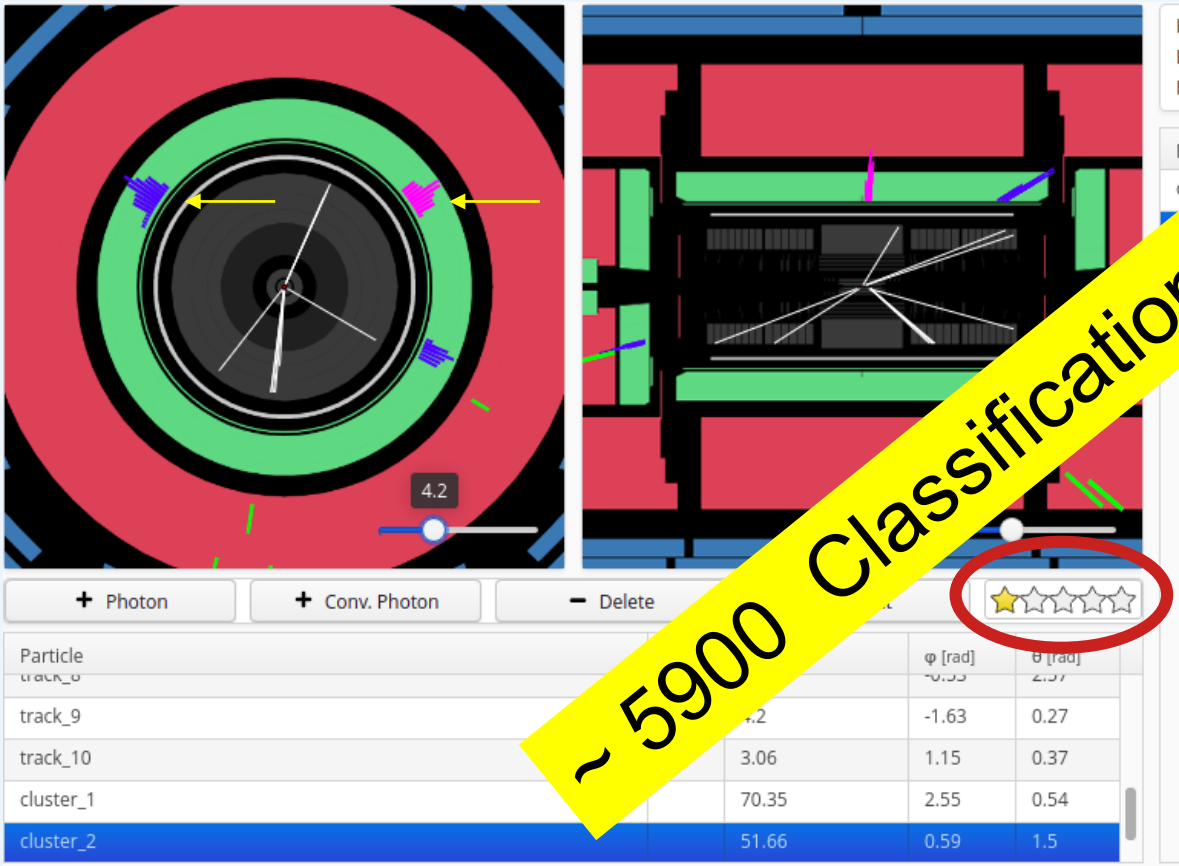


Selection of a converted photon

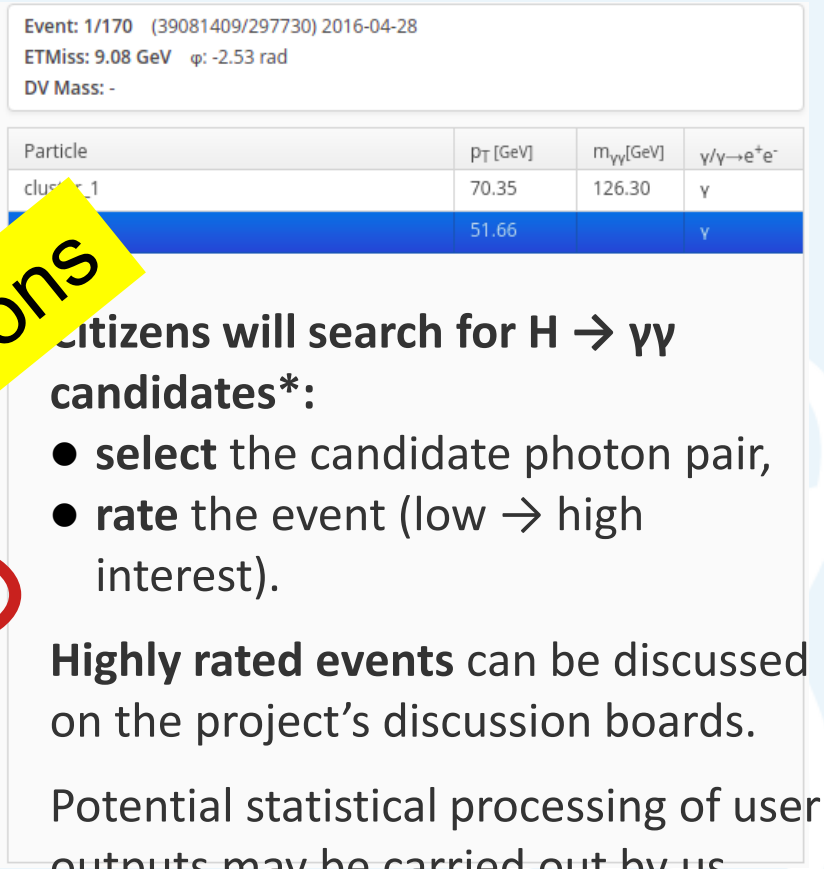
STAGE 3(a,b):REAL DATA

Stage 3a - H→γγ STUDY (using HYPATIA)

Event Handling



~ 5900 Classifications



Citizens will search for H → γγ candidates*:

- **select** the candidate photon pair,
- **rate** the event (low → high interest).

Highly rated events can be discussed on the project's discussion boards.

Potential statistical processing of user outputs may be carried out by us alone.

*All ATLAS open data pre-selection cuts have been applied to the sample

Stage 3b - Neutral long-lived particle-hunting

- Citizens are advised to look at M_{DV}, R_{DV}, p_T and d_0 of the event and rate it accordingly with stars
- Every time they select a muon: the M_T of muon p_T and the E^T_{miss} is calculated ($m_{\mu\nu}$)

WP on inclusion and diversity (the data will be sonified)

The Back Page

Where I work
Wanda Diaz Merced

I am standing in front of Virgo — a gravitational-wave observatory near Pisa, Italy, where I work as a computer scientist and astrophysicist — facing one of its 3-kilometre-long arms, in which a laser bounces between two mirrors in an internal pipe. The arms sense tiny changes in space-time (a model that fuses the three dimensions of space and the one dimension of time into a four-dimensional entity) when gravitational waves arrive from the distant Universe.

Some events in the Universe, such as massive stars exploding, produce gravitational waves — undulating space-time that propagates in all directions — and radiation that ordinary telescopes and X-ray telescopes can detect. Those emissions carry information about the origins of the events that produced them or about gravity itself.

I'm from Puerto Rico, and lost my sight in my twenties from degenerative diabetic retinopathy. So I use sound, as I'm doing here, to explore measurements of gravitational waves. I earned a PhD in computer science at the University of Glasgow, UK, so that I could develop software tools to analyse astronomical data by converting it into sound. By 'listening' to the mathematics, I want to identify the possible X-ray counterparts to gravitational waves detected by Virgo.

Gravitational-wave data from colliding black holes is called a 'chirp': it sounds like a bird when it's converted into sound.

Virgo, now closed for upgrades, will reopen after June 2022. Meanwhile, I'm working with colleagues on Research Infrastructures For Citizens in Europe. We'll develop software that anyone, regardless of where they live or of any disabilities, can use to make multisensorial data and contribute to research.

To get a sense of Virgo's size, I've walked to the end of one of its arms and back. I like to sing while walking to focus on my destination. But when the detector restarts, it is so sensitive that it might pick up my voice. So the people in the control room sometimes tell me I cannot walk and sing.

Wanda Diaz Merced is a computer scientist and astrophysicist with Virgo near Pisa, Italy.
Interview by Davide Castelvecchi.

Photographed for *Nature* by Enrico Sacchetti.

Nature article about Wanda Diaz Merced working in Virgo

Nature | Vol 597 | 2 September 2021

CONCLUSIONS

THE LAUNCH WAS DONE 3 WEEKS AGO

➔Citizen data will be collected for about a year (**Already has ~20,500 classifications)**

➔Analysis of citizens' data will follow.

➔**The other three REINFORCE platforms are ready as well and under review**

For additional information:

- Project Website: https://www.reinforceeu.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under `grant agreement No 872859.

Thank you

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PARTNERS

COORDINATOR

EGO European Gravitational Observatory

CONICET

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Communicating ICT to markets

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Back-up

REINFORCE & ATLAS

3-Stage Work Package

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

Stage - 2
Particle Identification
- SIMULATED DATA -

REAL DATA "DISCOVERY"STAGES

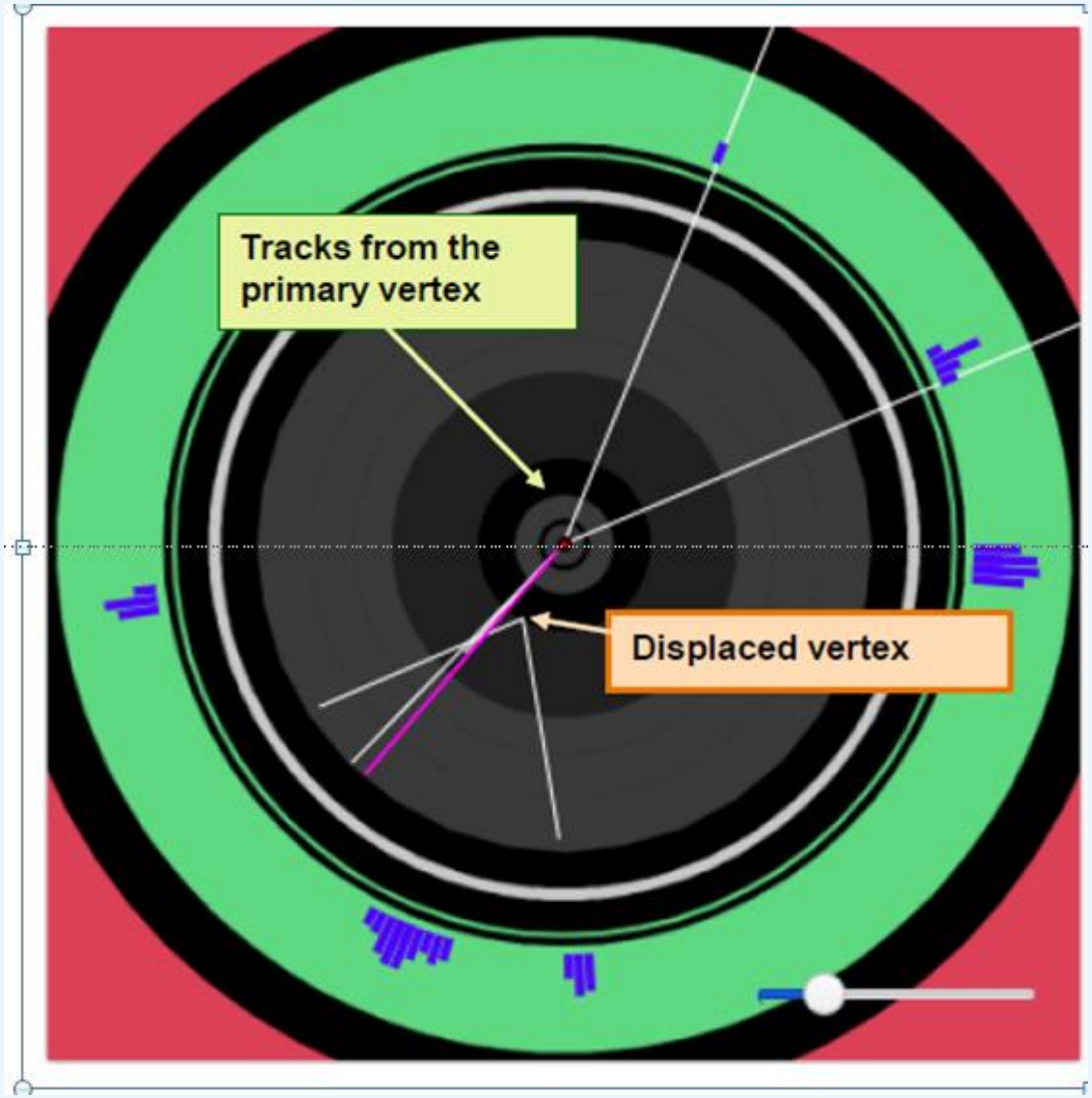
Stage – 3a
Higgs→γγ STUDY

Stage – 3b
LLP Hunting/Discovery

Reminder:

- **Stages 1 & 2:** will provide the main results (citizens' efficiency vs our custom algorithms).
- **Stage 3:** gives citizens the opportunity to apply what learned on samples of **real data.**

Stage 3b - Neutral long-lived particle-hunting (using HYPATIA)



Citizens will search for muon-jet DV*s:

- **mark the muon** associated with the DV,
- **rate** the event (low → high interest).

Highly rated events can be discussed on the project's discussion boards.

Potential statistical processing of user outputs may be carried out by us alone.

*preselection of events where distance between PV and DV is >5cm has been applied