Meirin Oan Evans, on behalf of everyone who's ever opened up LHC data
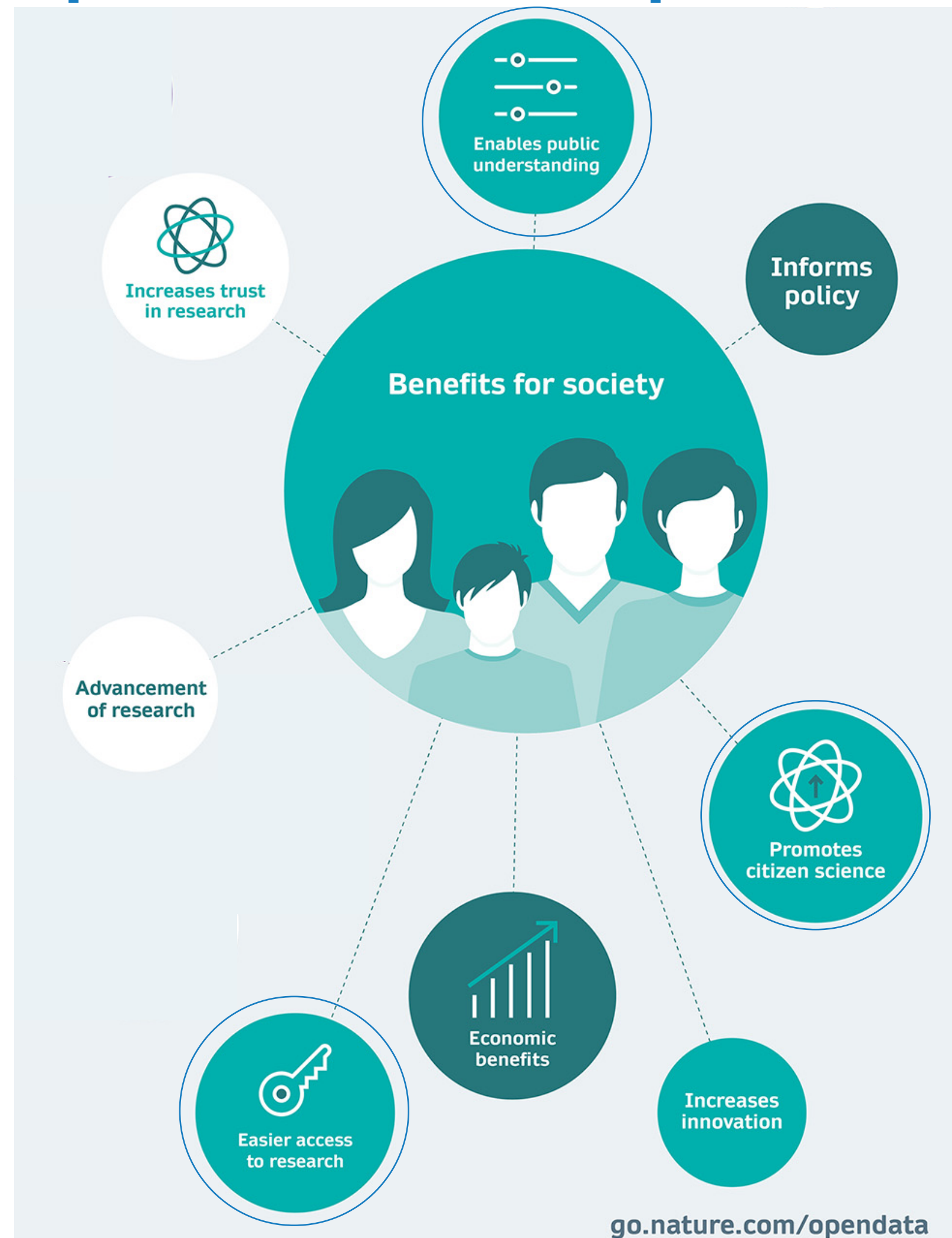
LHC Open Data for the world to see

Discussion points

1. The importance of Open Data

2. Educational motivations for LHC Open Data

3. Educational examples with LHC Open Data
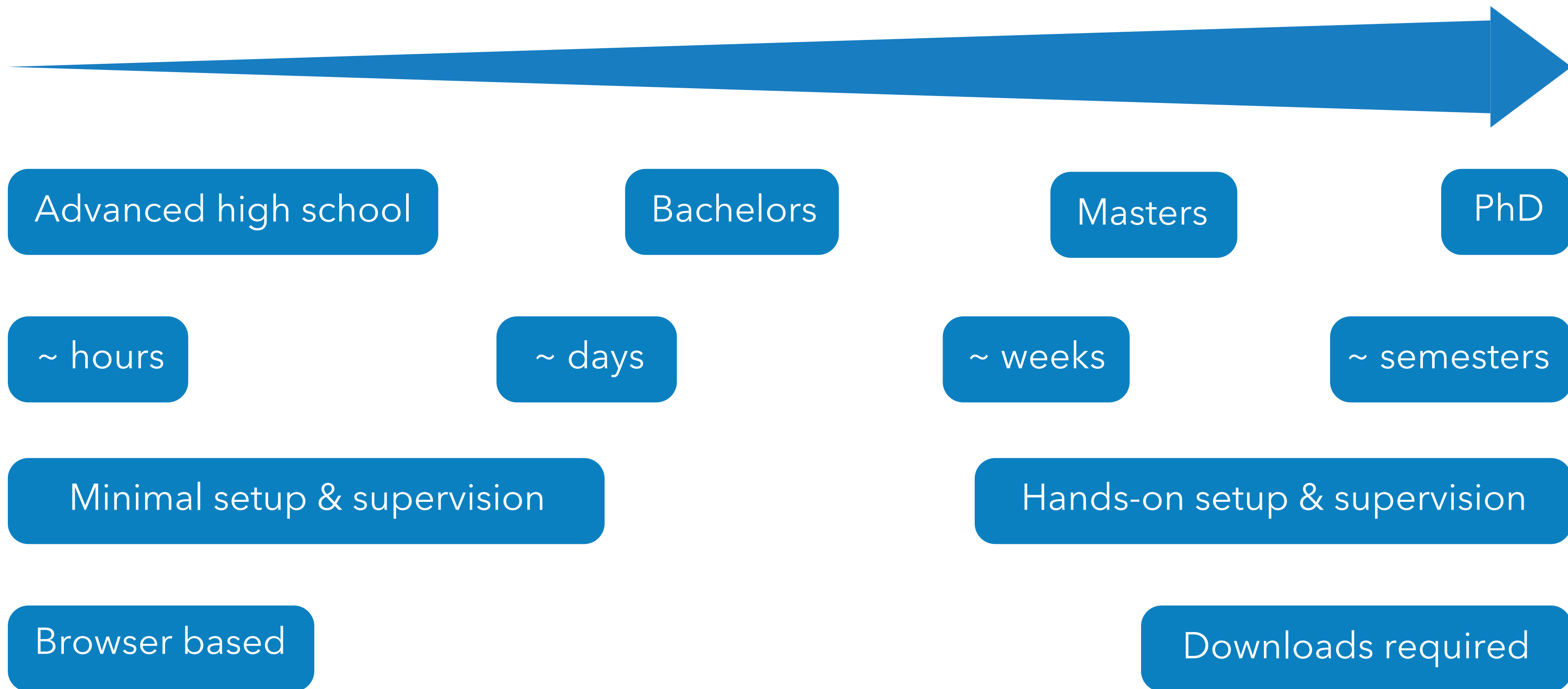
4. Future challenges

Open Data: a crucial part of science

- ▶ Enables public understanding
- ▶ Promotes citizen science
- ▶ Economic growth
- ▶ Easier access to research
- ▶ Increases trust in scientists

Reaching a broad audience

Advanced high school

Bachelors

Masters

PhD

~ hours

~ days

~ weeks

~ semesters

Minimal setup & supervision

Hands-on setup & supervision

Browser based

Downloads required

UNIVERSITY OF SUSSEX

opendata

The start of LHC Open Data: International Masterclasses and beyond

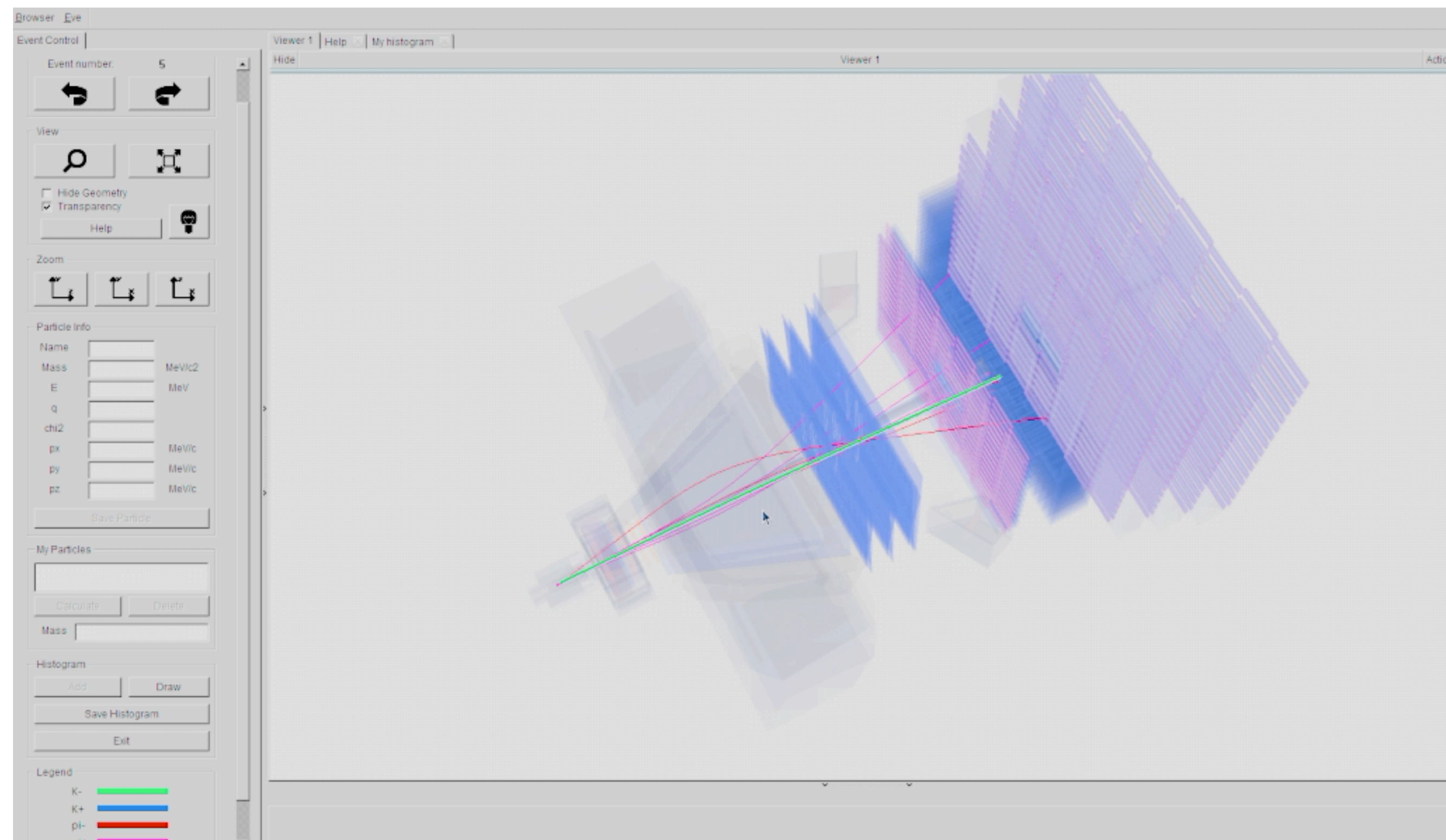▸ How can students go **beyond** in terms of time, difficulty, physics, data, research...?

CERN Open Data portal
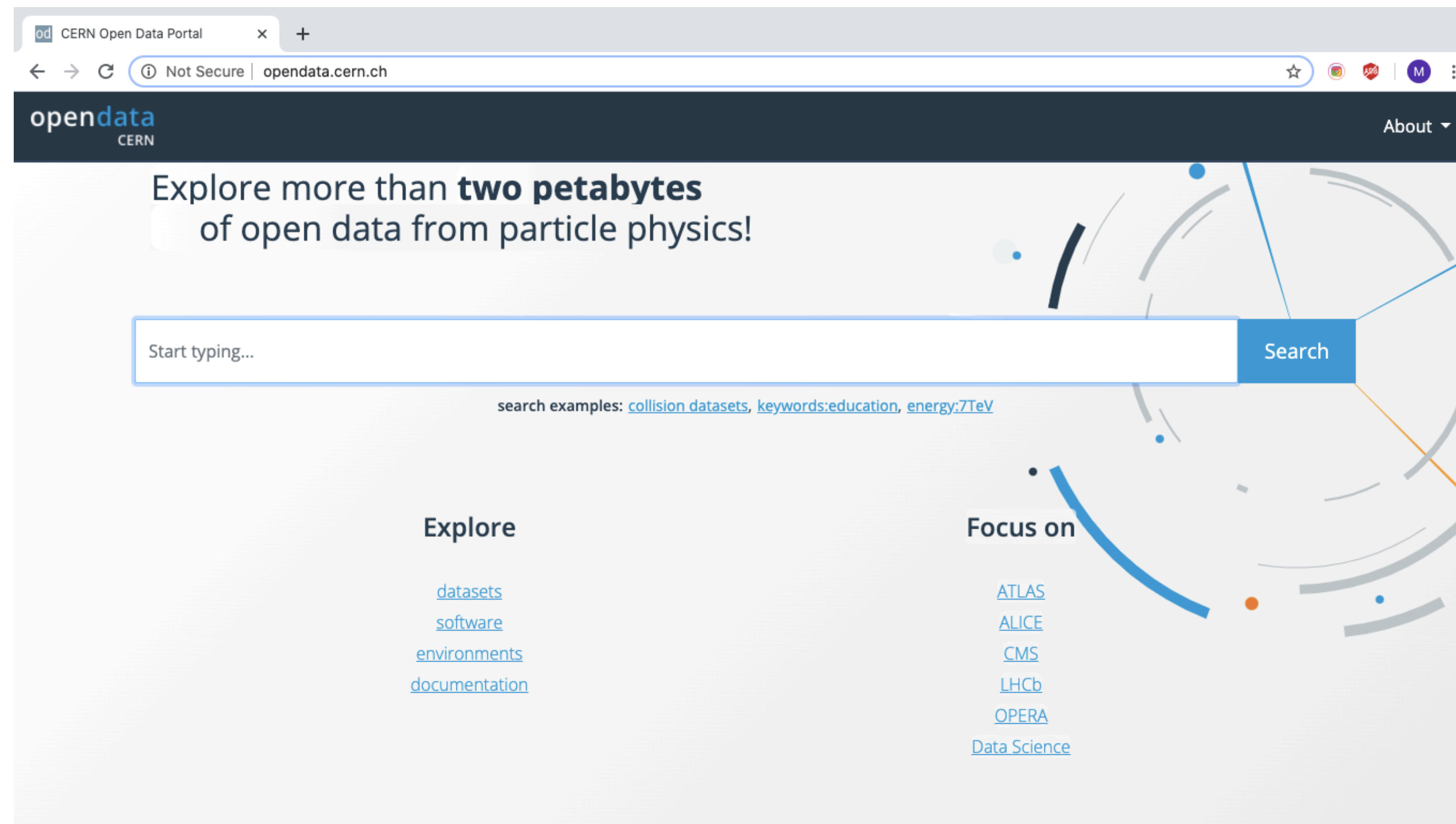
▸ **opendata.cern.ch** – the place to go to get started!

D⁰ lifetime in LHCb
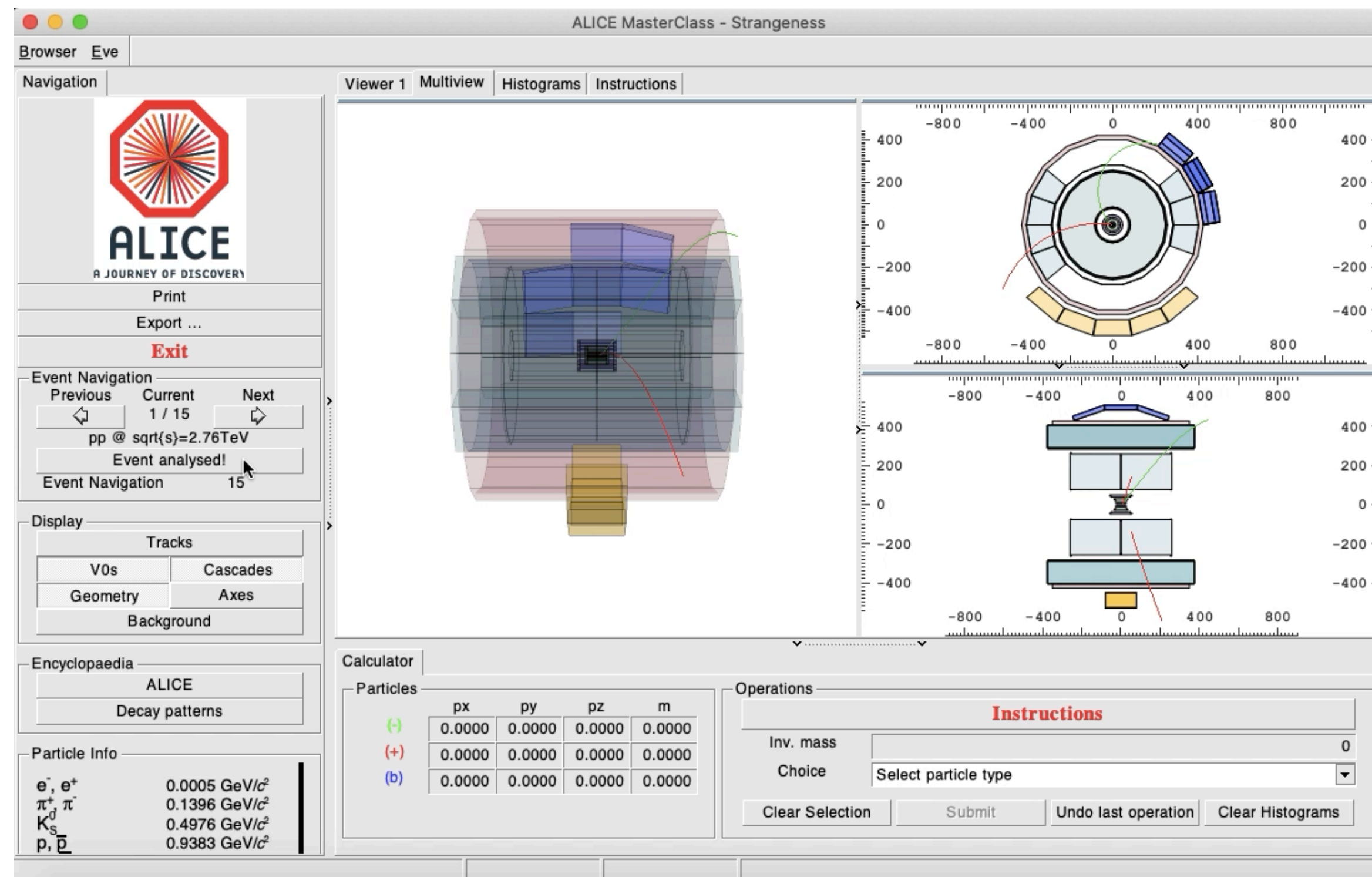

▶ Analyse event displays

▶ Fit to D0 lifetime

▶ VM image

▶ Help on getting started with LHCb Open Data

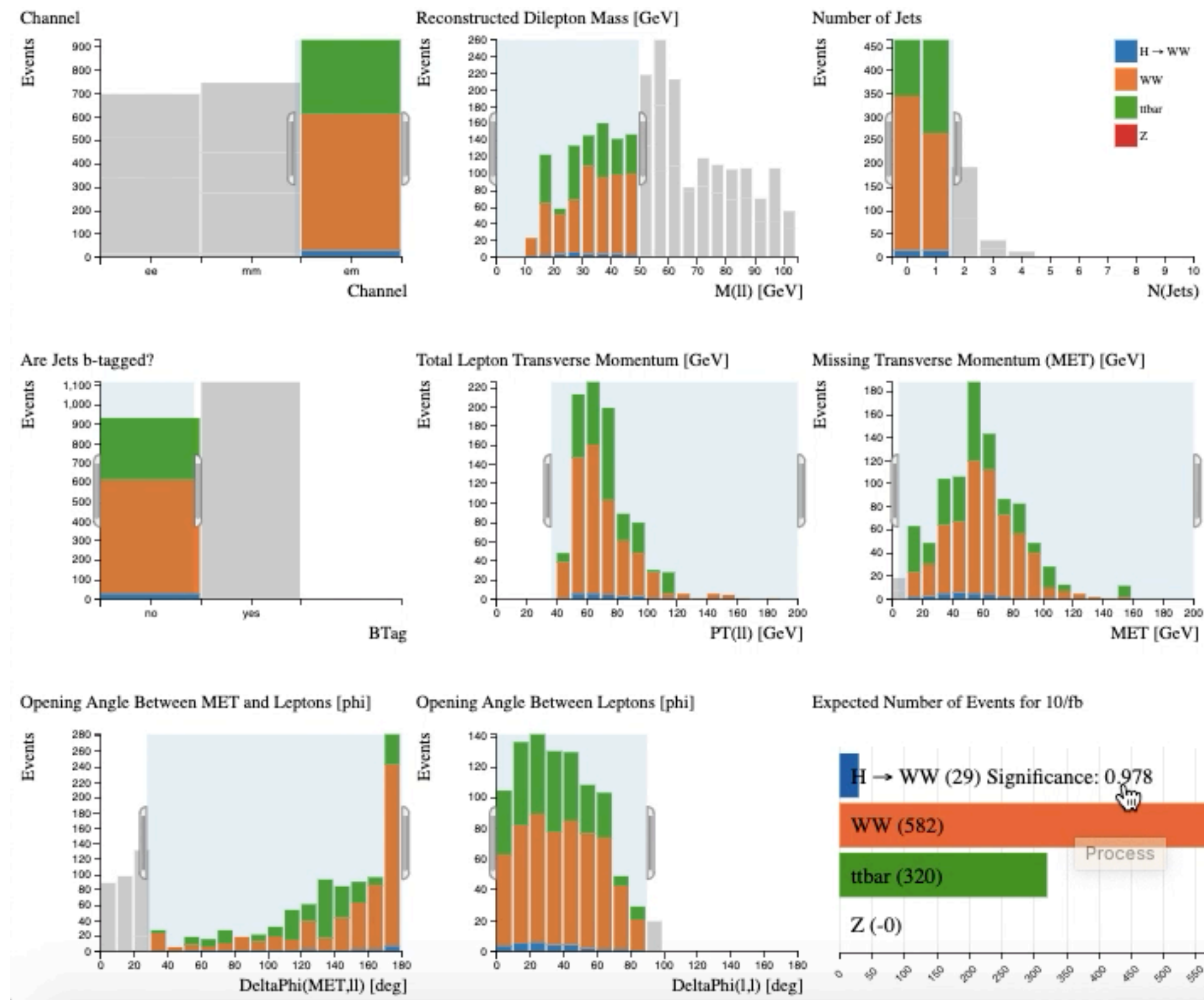▶ lhcb-public.web.cern.ch/en/LHCb-outreach

Looking for strange particles in ALICE

- Aimed at **high school**

- Could be used as exercise for **UG**

- Software + data packaged together

- Can be **used as tool by teachers** (support from physicists even better!)

- alice-masterclass.web.cern.ch

ATLAS' Histogram Analyser

▸ A web-based tool for **fast**, cut-based analysis of data

▸ **Visualise** data using online histograms

▸ Search for the Higgs with **only your mouse!**

▸ ATLAS Open Data website

CMS Open Data education
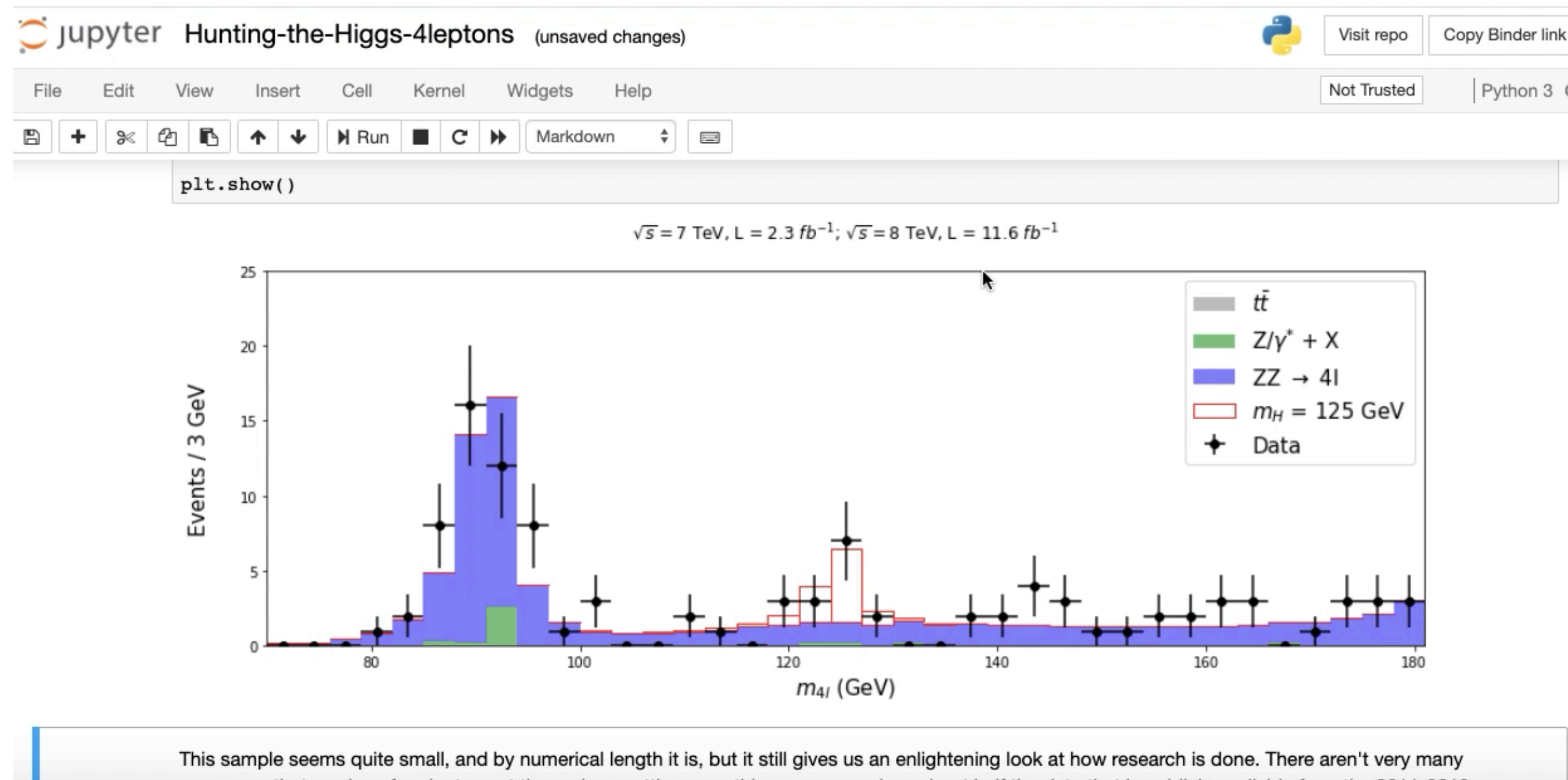
▸ **Open-source exercises in** 🇫🇮🇬🇧🇪🇸🇩🇪🇬🇷
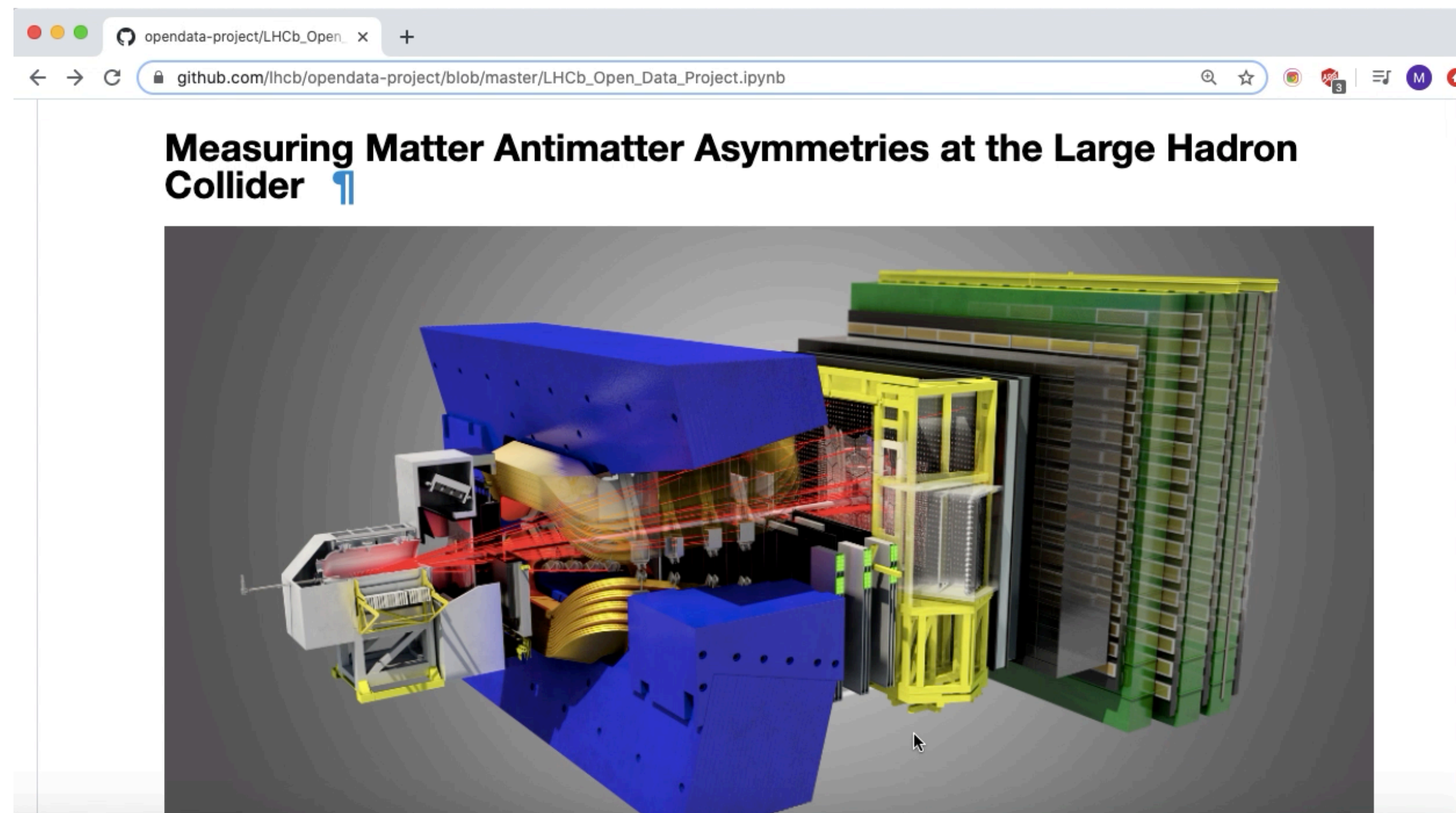
▸ **Simplified data** formats

▸ See **Higgs peak** build within minutes of opening a webpage!

▸ github.com/cms-opendata-education

Matter–antimatter differences

Measuring Matter Antimatter Asymmetries at the Large Hadron Collider ¶

▸ github.com/lhcb/opendata-project

▸ Analyse B-meson decays

▸ Jupyter notebook provides **guided analysis** of LHCb data
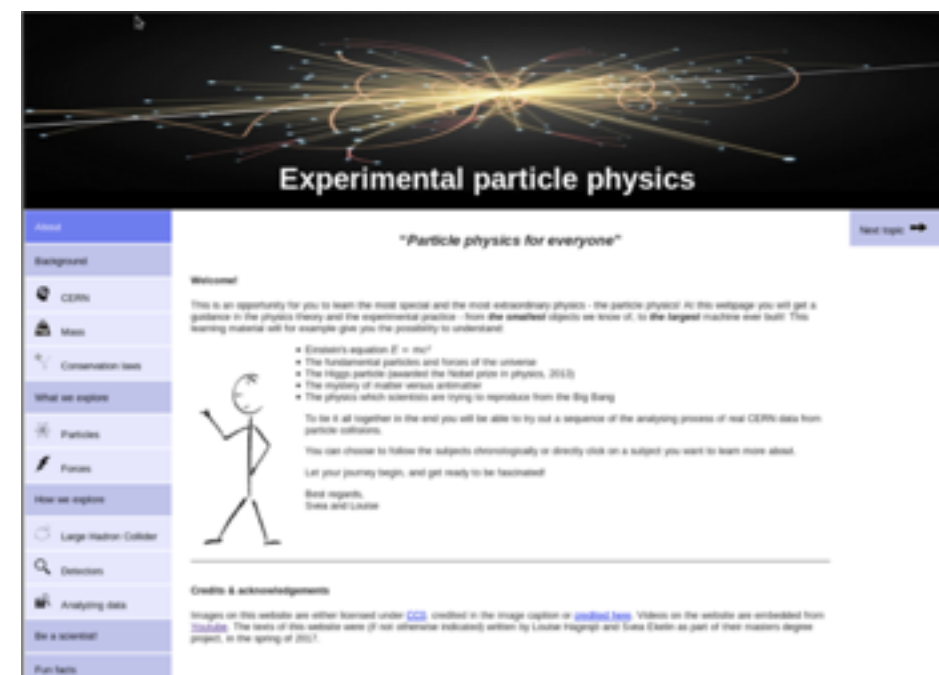
▸ Could be used in 3rd year lab

Higgs-to-four-lepton analysis example
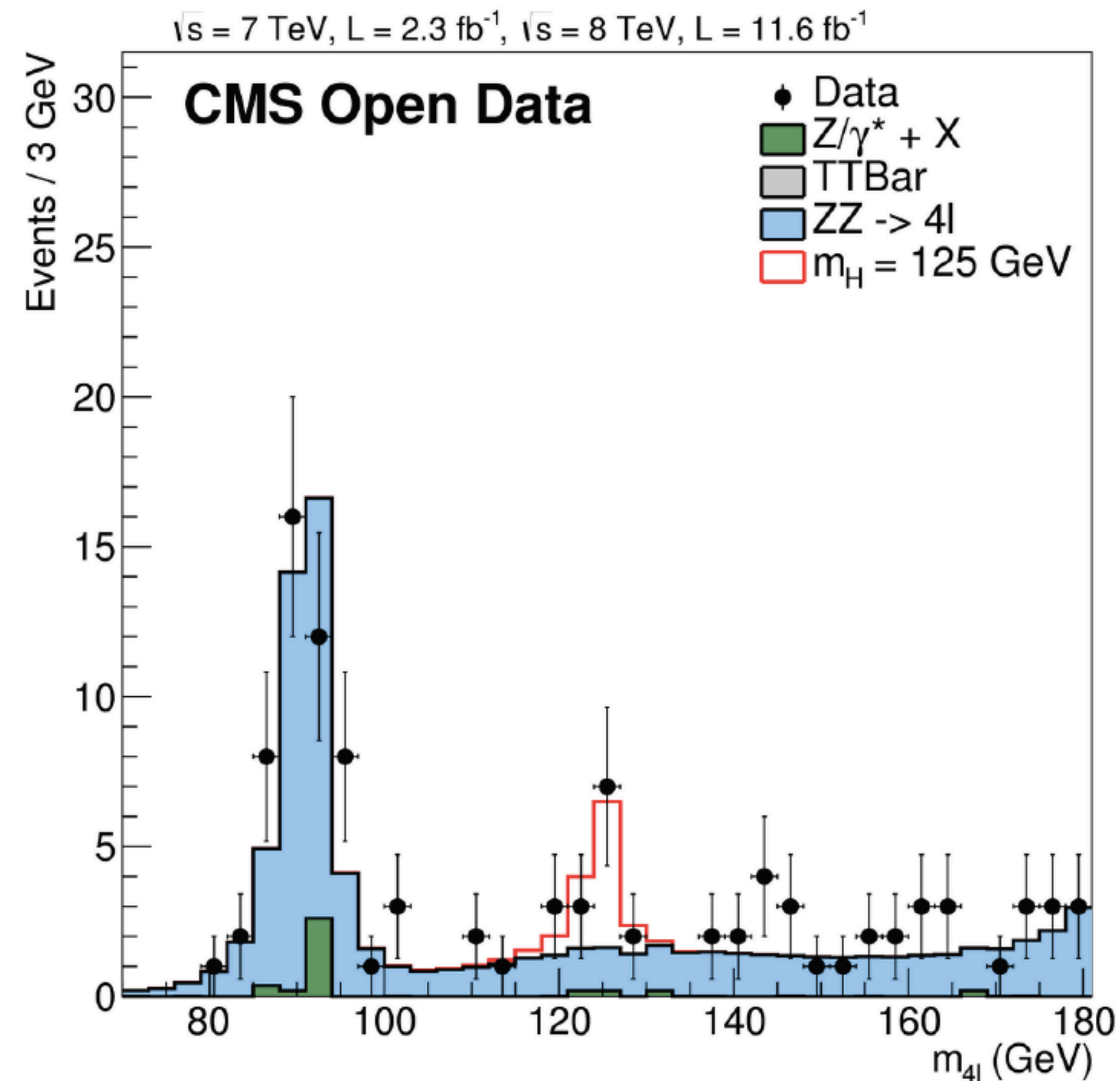
- ▸ Use up to **half of Run 1 data**
- ▸ A well-documented analysis example accessible and available at **different levels of complexity**
- ▸ Very **complete overview** of analysis procedure
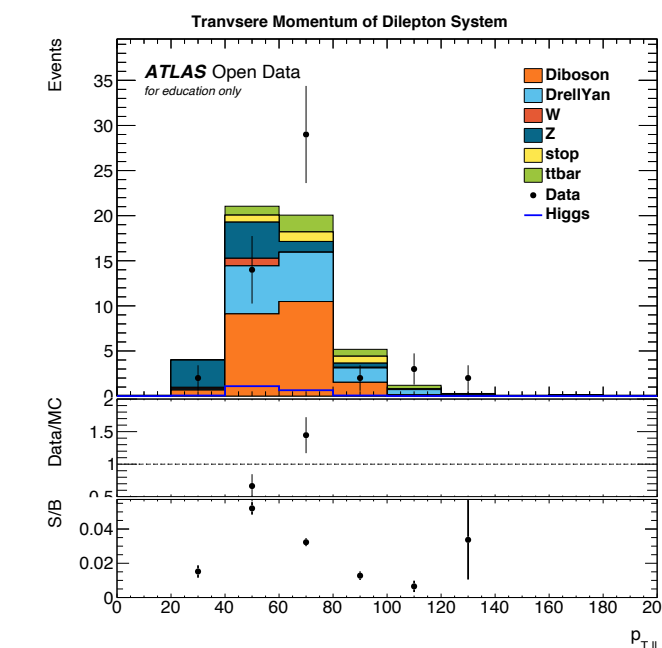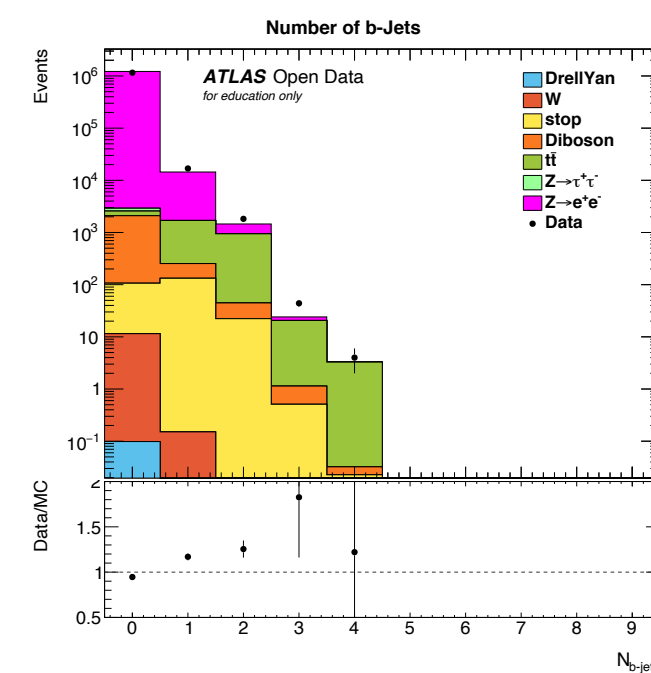- ▸ Higgs "discovery"!
- ▸ Documentation

Bachelors/Masters theses

Making ATLAS Data from CERN Accessible to the General Public (2017)
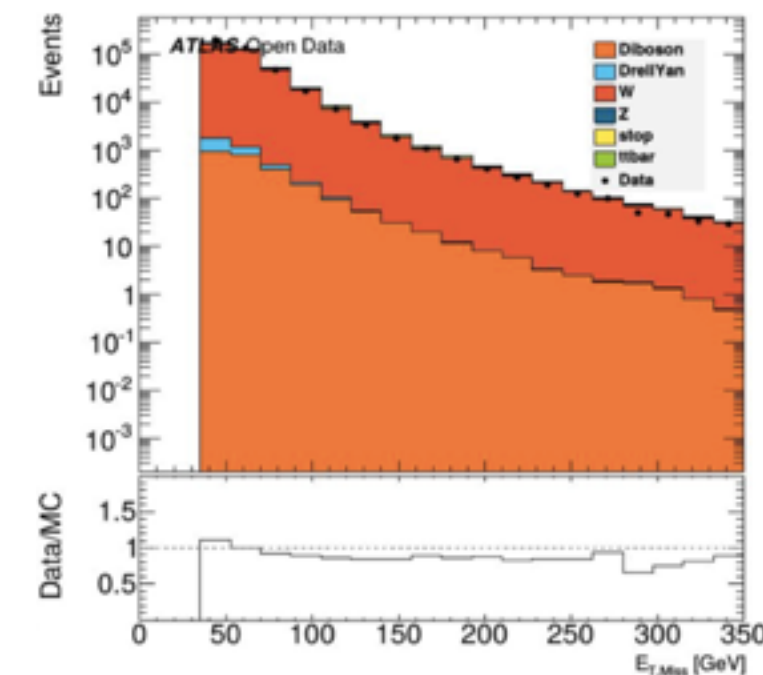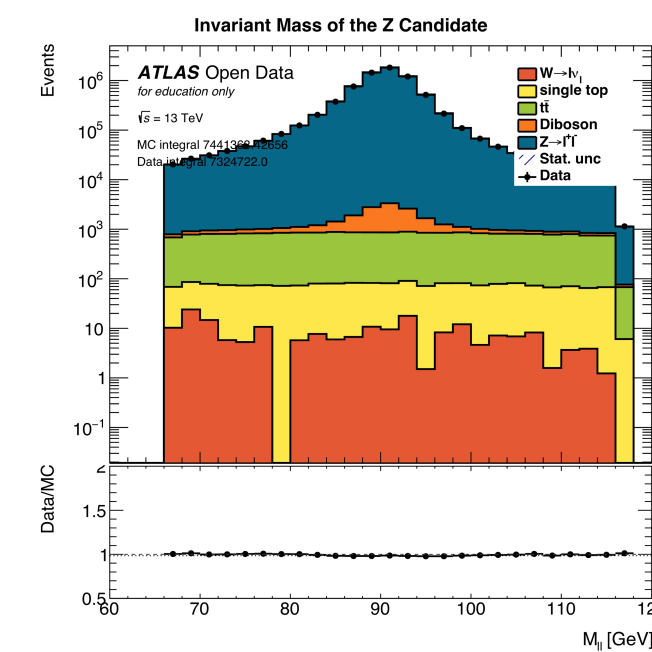

Perspectives and Evaluation of Dark Matter production (2017)

Reconstruction of the invariant masses of bosons (2017)

Enabling Open Science with the ATLAS Open Data project (2018)

A Contribution to ATLAS Open Data (2019)

Open Data to train teachers

▸ Key is to **respect teacher constraints** (time, skills, tools)

▸ Ensure **skills acquired** in working with particle physics data are applicable to other topics

▸ Photo from an [Open Data tutorial for CERN's International Teacher Programme](#)

Thoughts for the future

▸ How to ensure our tools and resources are **accessible** without guidance from physicists?

▸ How to incorporate our tools and resources into more university (and pre-university!) courses?

▸ Can we spread our tools and resources into **wider use**? e.g. on platforms that teach data science, Kaggle...

▸ How can we **teach more than just physics** – computing, data science, machine learning...?

Take home messages

▸ Open Data are a **crucial** part of science

  • especially science education & outreach

▸ LHC Open Data are for a **range of students**

  • from advanced high school to PhD

▸ opendata.cern.ch to get started

▸ We have many **challenges to address** going forward

▸ Where can you use Open Data in **your teaching**?

Thanks!
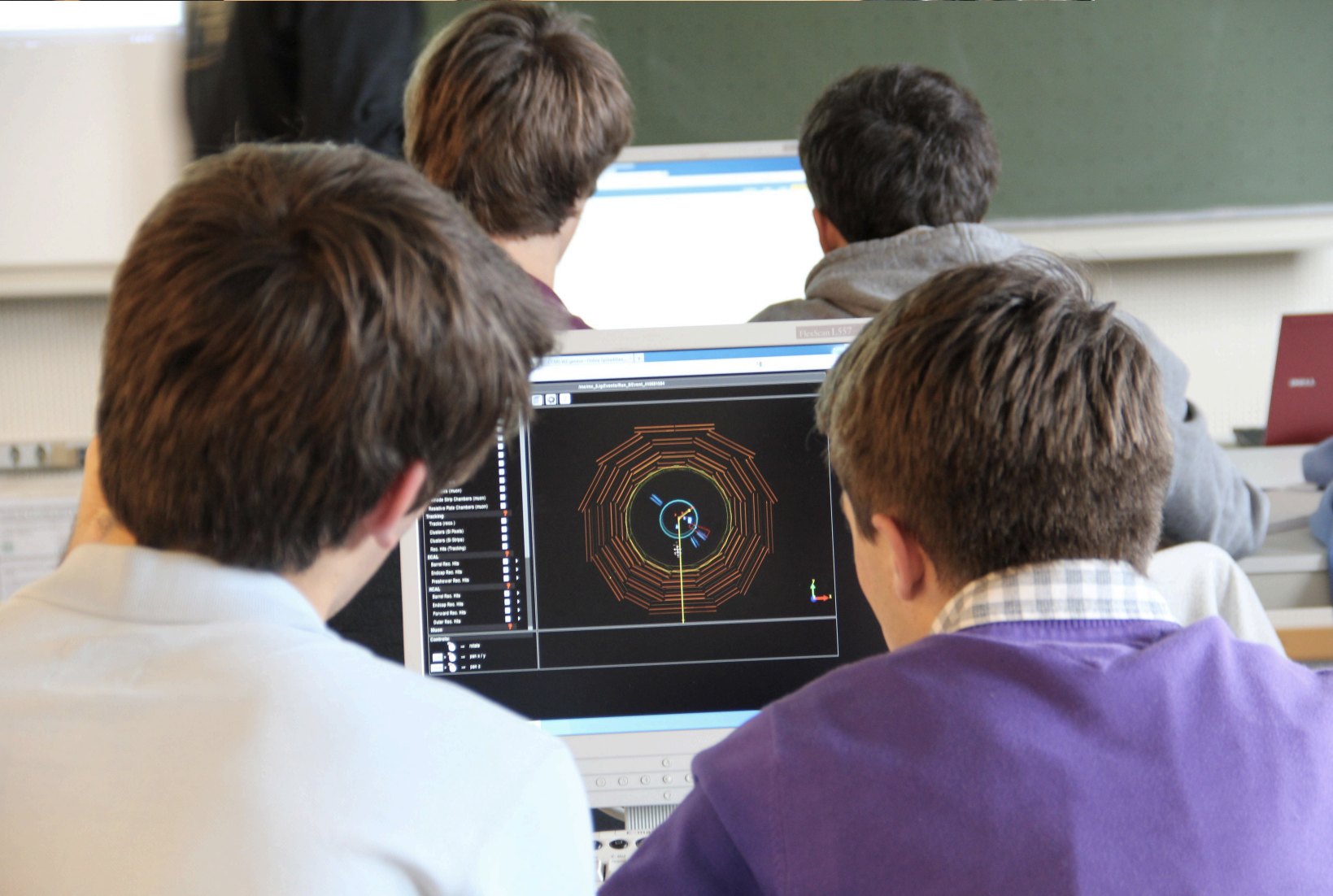
*to everybody making LHC data open

**to everybody exploring LHC Open Data

Backup

Want to chat?

▸ Join my Zoom room after this session!

▸ meirin.oan.evans@cern.ch

▸ @meirinoanevans

▸ @meirinoanevans

▸ meirin-oan-evans

▸ Or just look for me at CERN

 • (this is what I look like) →

Despina

Kate

Arturo

alice-masterclass-dev@cern.ch

atlas.outreach.data.tools@cern.ch

Contact us

Kati

Edgar

Concezio
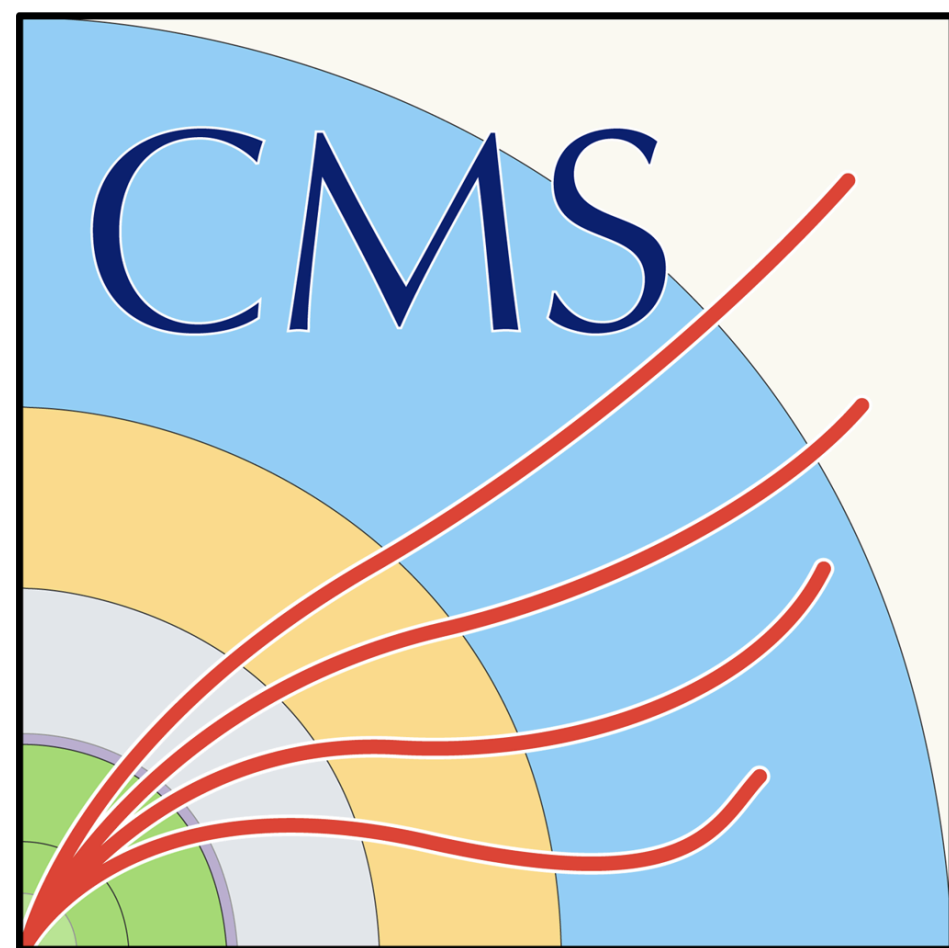
Sebastian

opendata-support@cern.ch
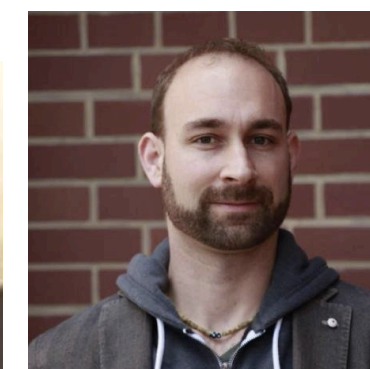
*plus everybody in the respective teams

Open Data workshop for theorists
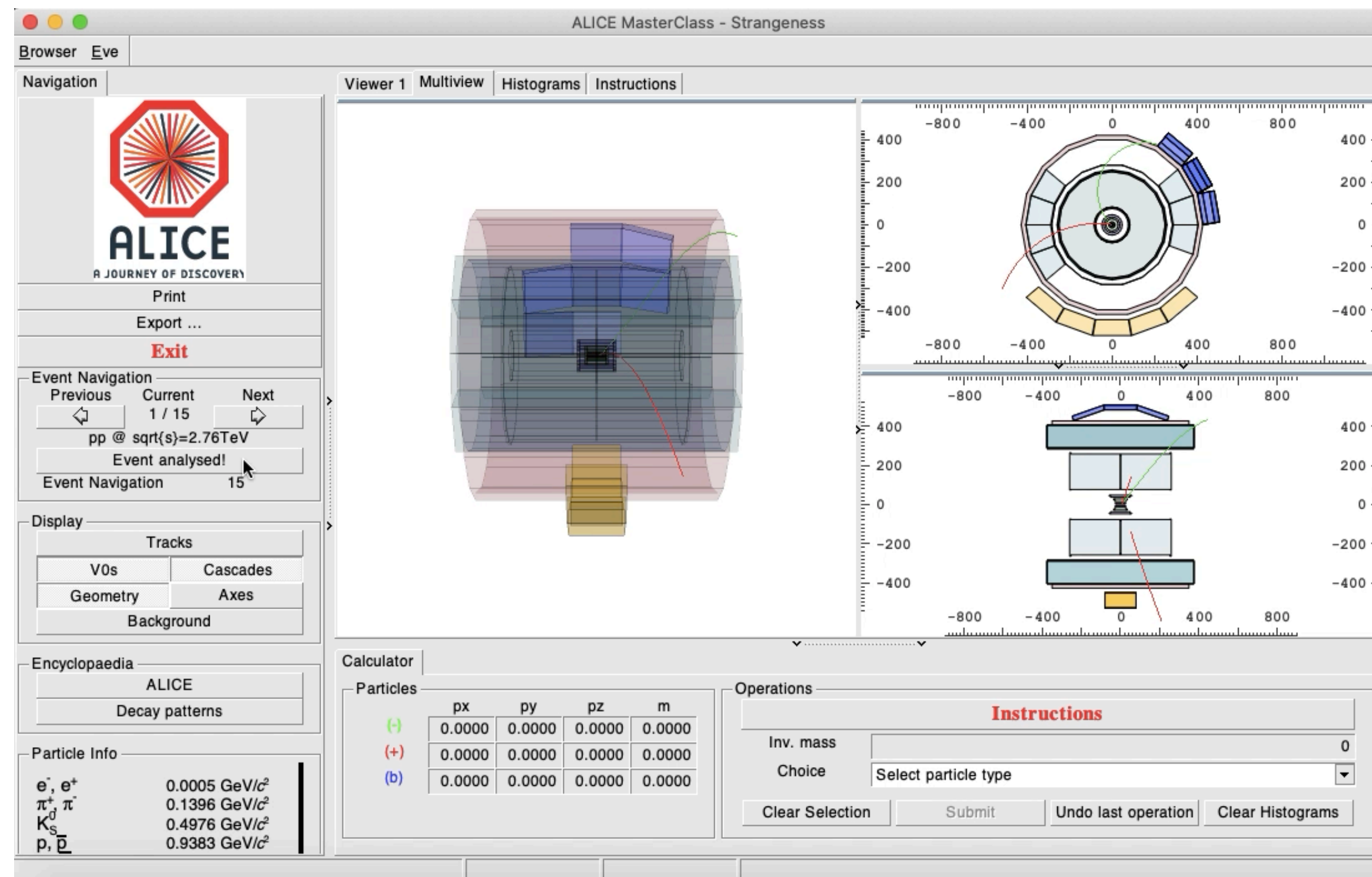
D⁰ lifetime in LHCb

- Analyse event displays

- Fit to D0 lifetime

- Virtual Machine image (being replaced by web app)

- Help on getting started with LHCb Open Data

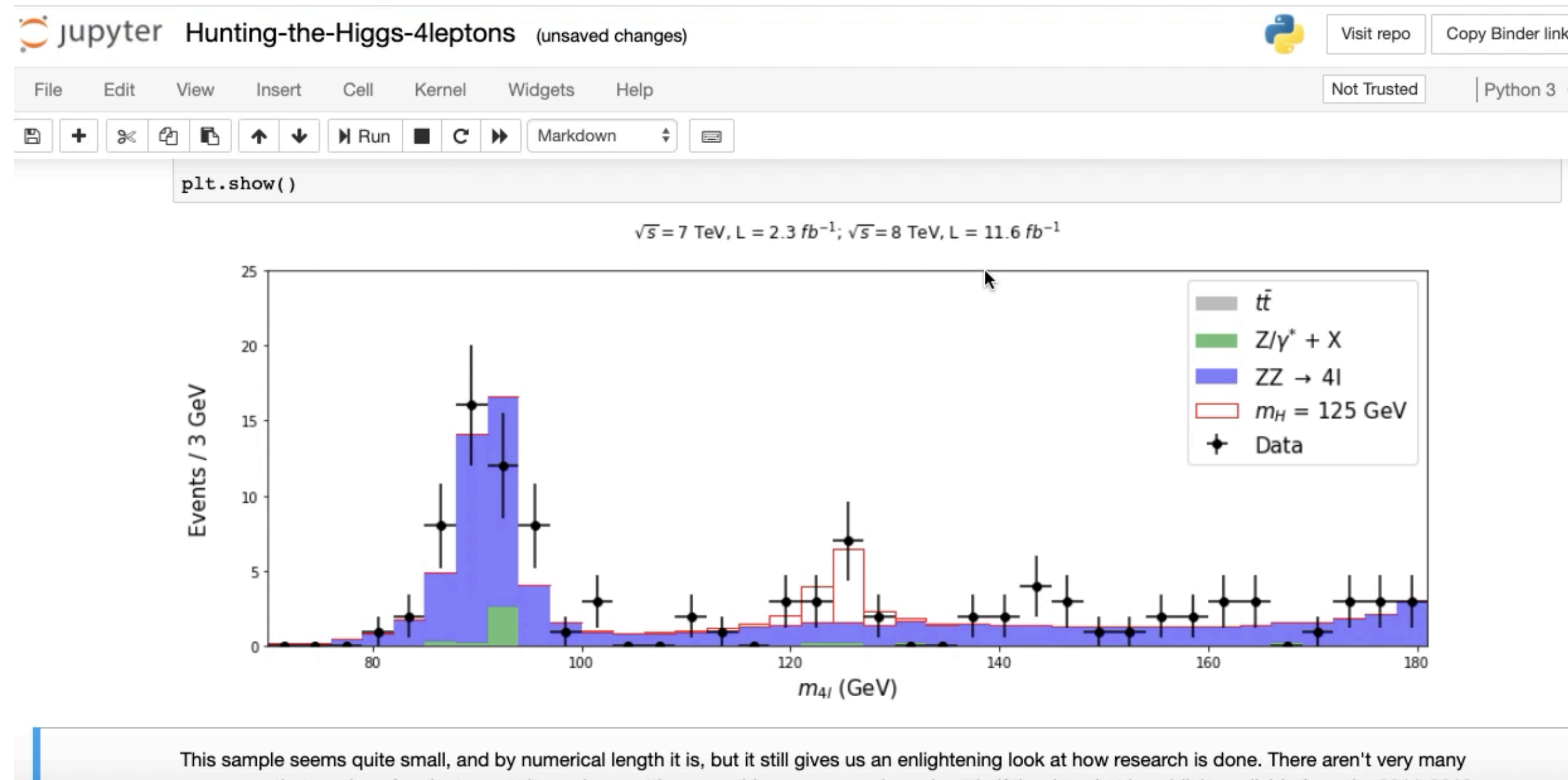- lhcb-public.web.cern.ch/en/LHCb-outreach

Looking for strange particles in ALICE

▸ Aimed at **high school**

▸ Could be used as exercise for **UG**

▸ Software + data packaged together

▸ VM and executable version

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▸ alice-masterclass.web.cern.ch

CMS Open Data education
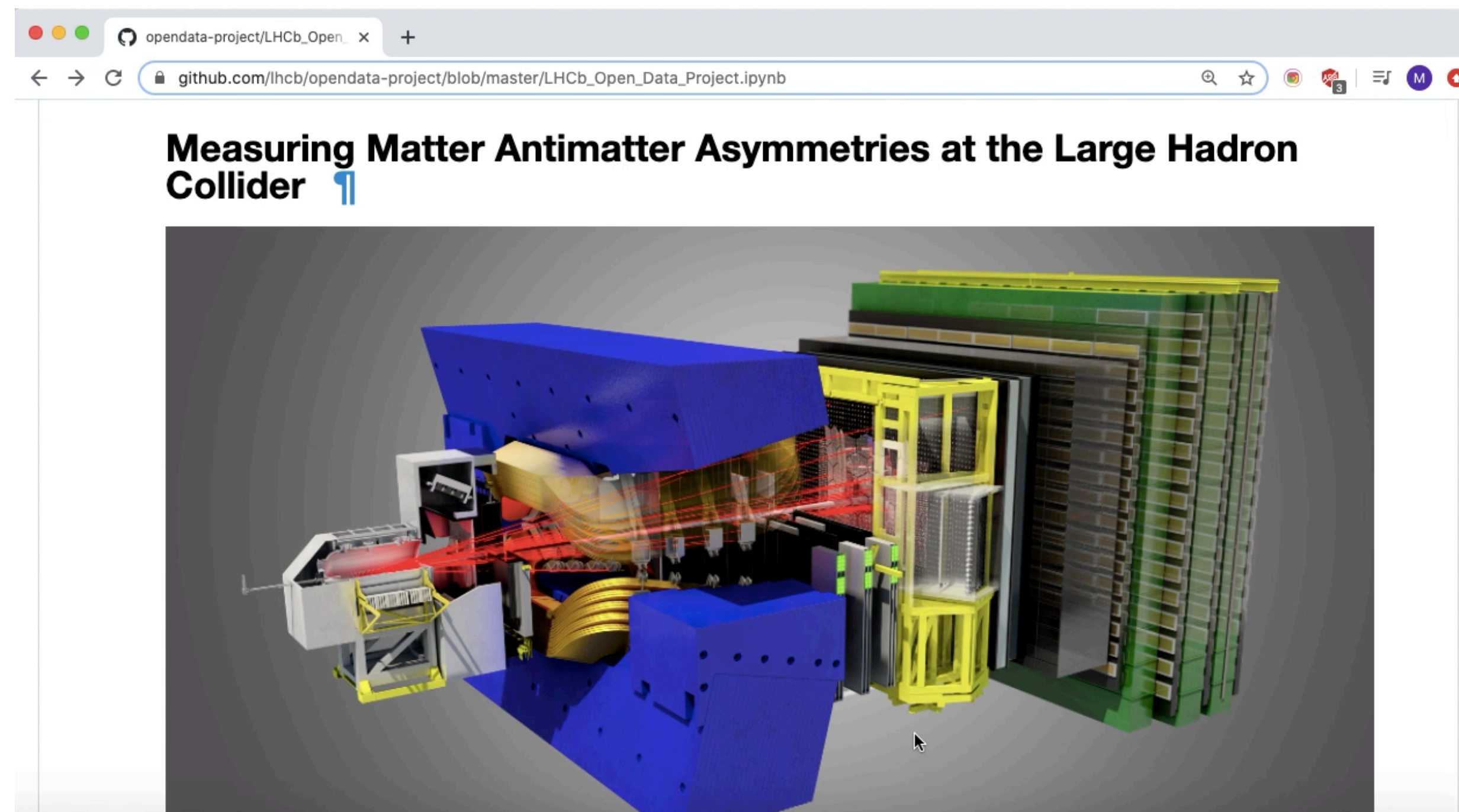

▸ **Open-source exercises in many languages** 🇫🇮🇬🇧🇪🇸🇩🇪🇬🇷

▸ **Simplified data formats in Jupyter notebooks + Binder/Colab**

▸ See a **Higgs peak** build within a minute of opening a webpage!

▸ github.com/cms-opendata-education

Matter–antimatter differences

▸ **github.com/lhcb/opendata-project**

▸ Analyse B-meson decays to 3 charged hadrons

▸ ~9 million 7 TeV **data events** (1GB)

▸ Jupyter **notebook** provides **guided analysis** of LHCb data

▸ Could be used in a 3rd year lab course, for example