

ATLAS OPEN DATA

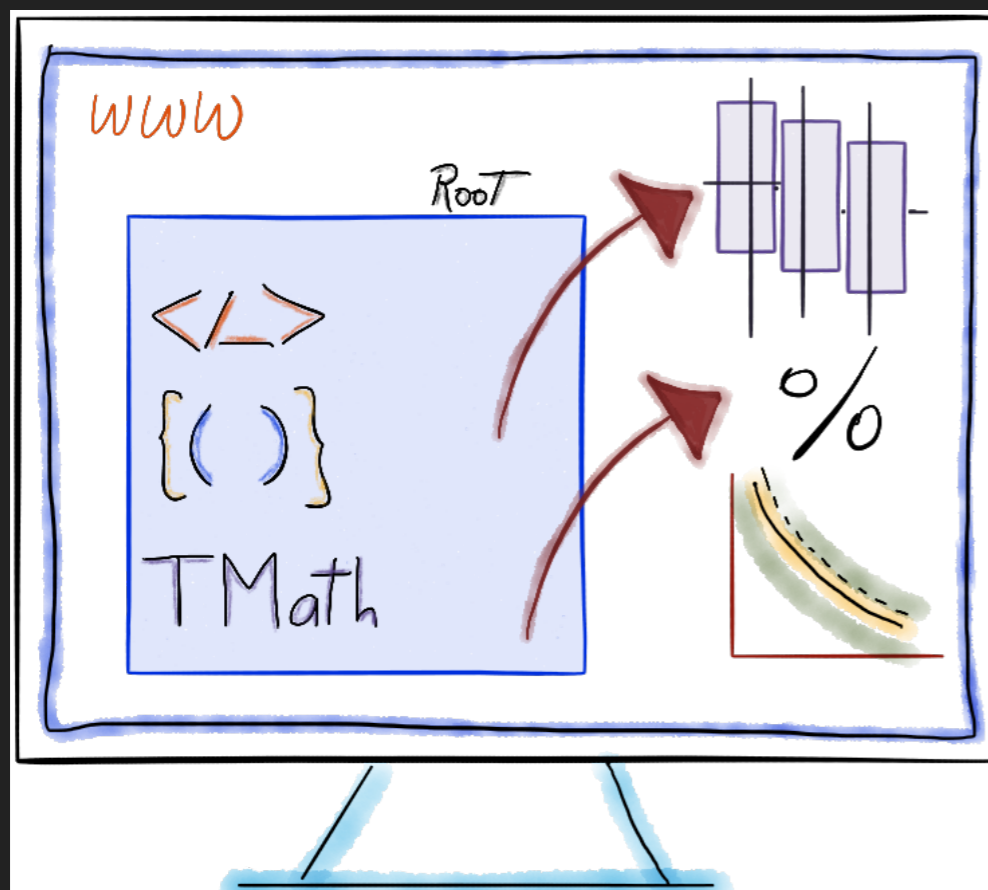
**MAKING YOUR OWN
PARTICLE PHYSICS
DISCOVERIES**

OUTLINE

OUTLINE

- ▶ What is ATLAS Open Data?
- ▶ How to make your own particle physics discoveries?
- ▶ What does it have to do with Maths Methods?
- ▶ Questions throughout!





WHO AM I?

WHO AM I?

ABOUT ME

- ▶ 1st year PhD student
- ▶ In ATLAS group
- ▶ Part of Experimental Particle Physics (EPP)
- ▶ New to Sussex



WHO AM I?

ATLAS OPEN DATA TEAM @ SUSSEX



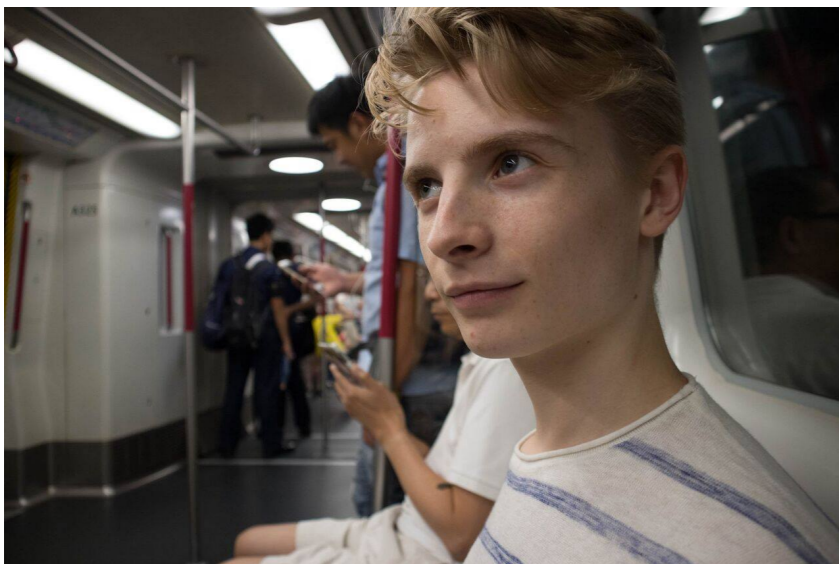
Kerim Suruliz
Post-doc



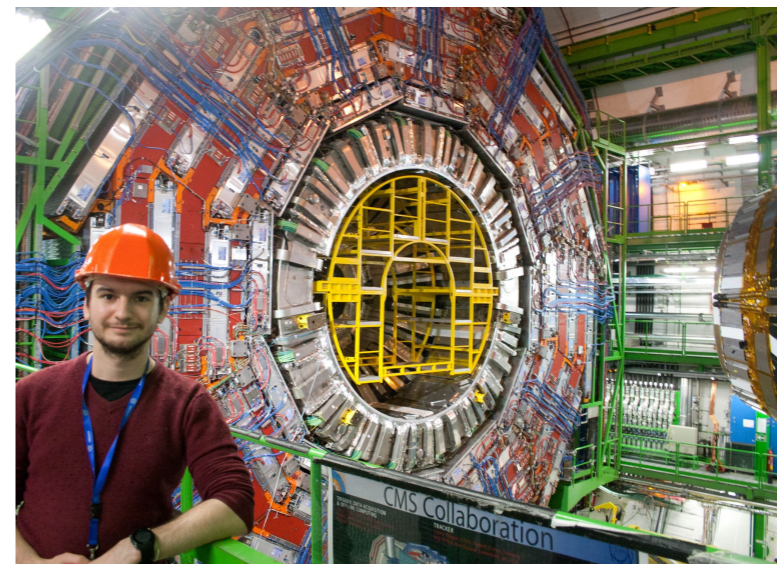
Kate Shaw
Lecturer



Lily Asquith
Lecturer

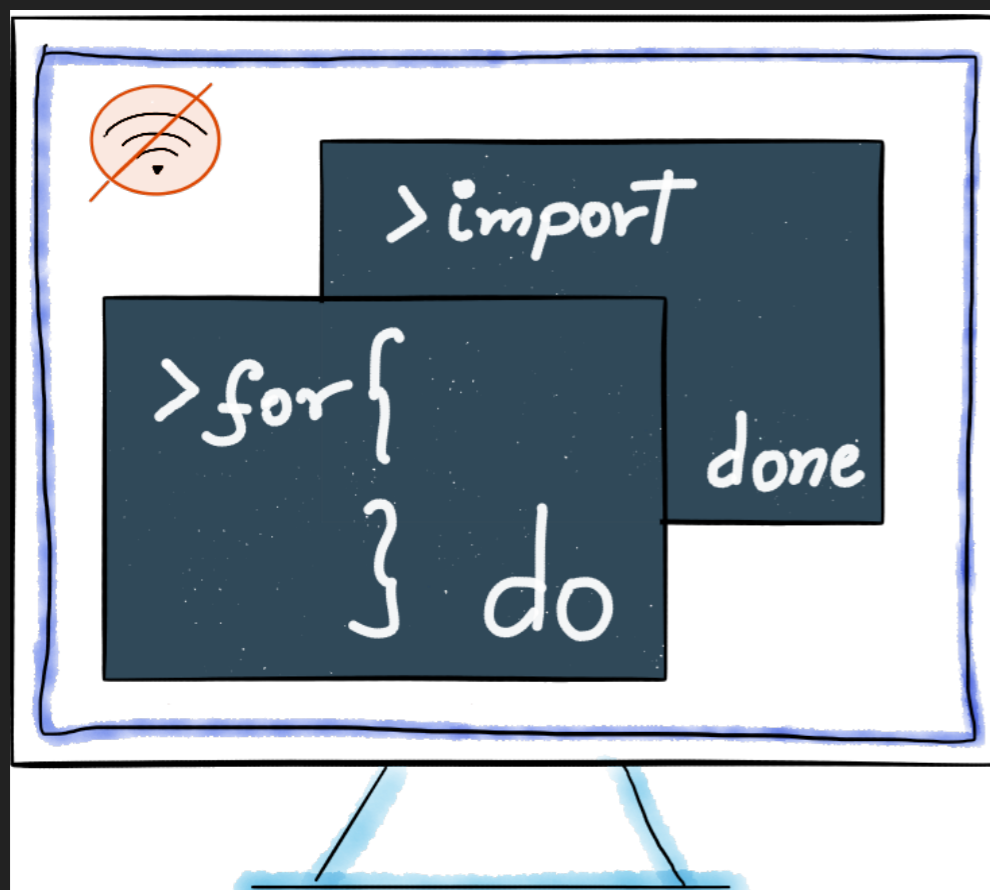


Josh McKeown
3rd Year student



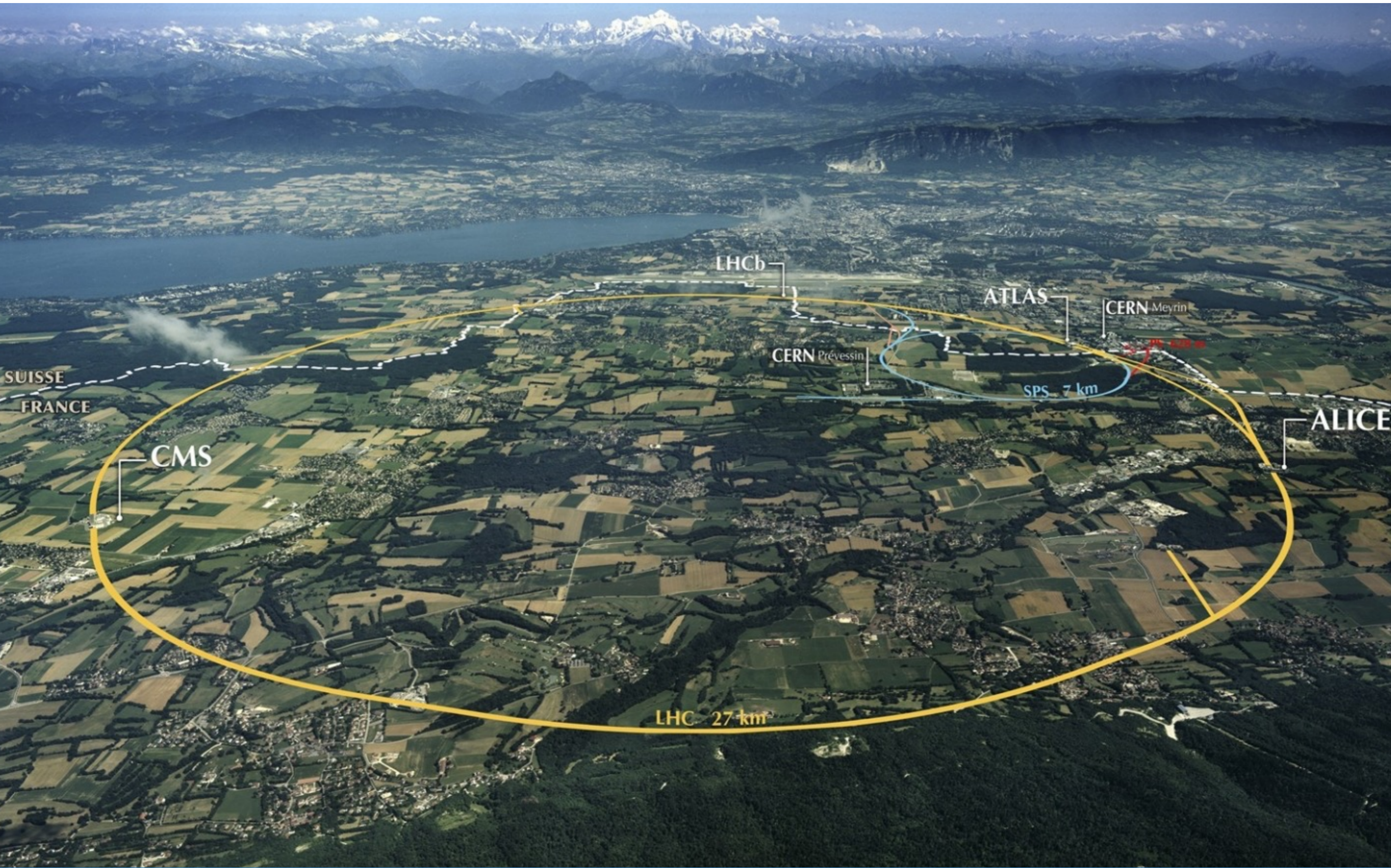
Tom Stevenson
Post-doc





**WHAT IS ATLAS
OPEN DATA?**

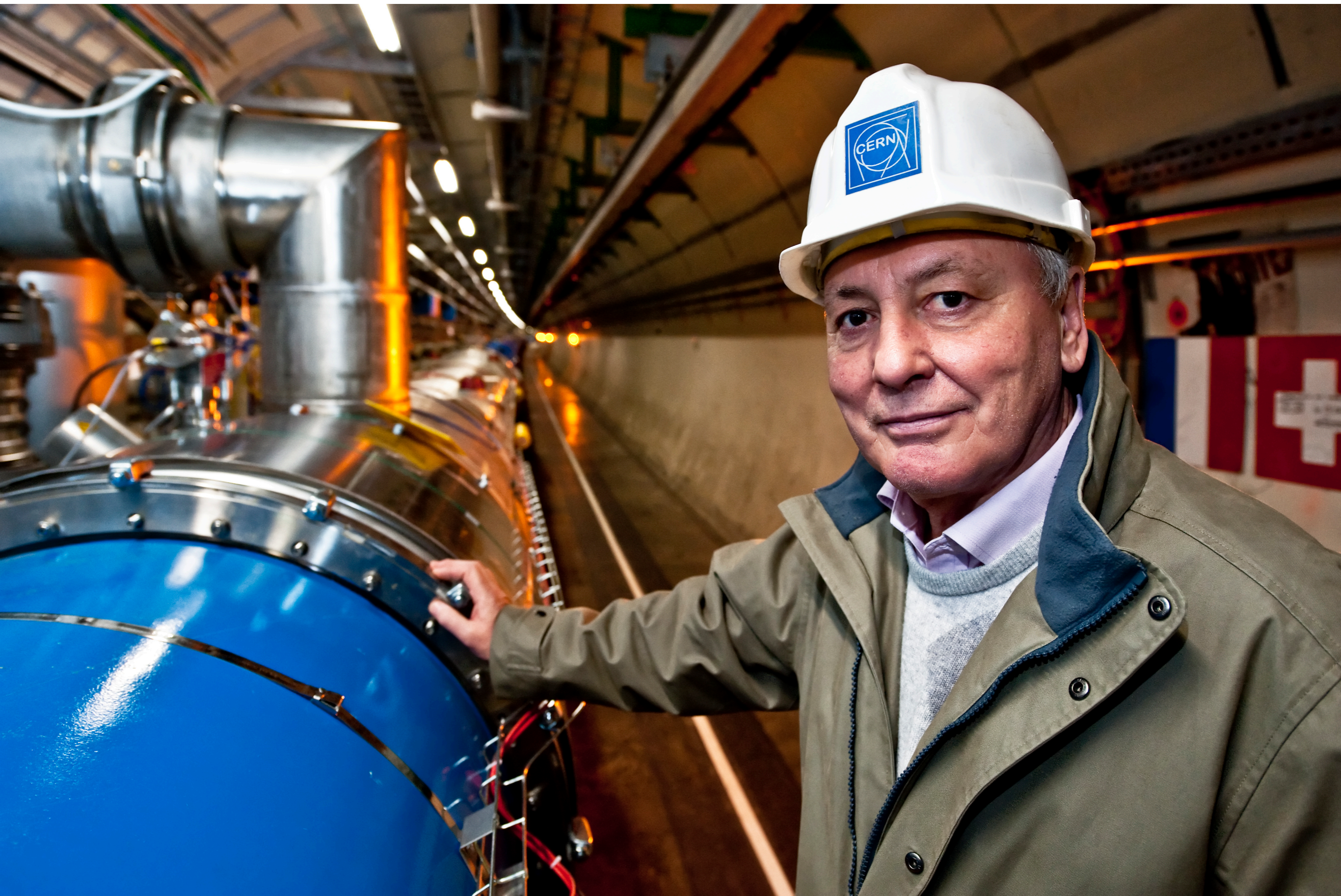
THE LARGE HADRON COLLIDER (LHC) @ CERN



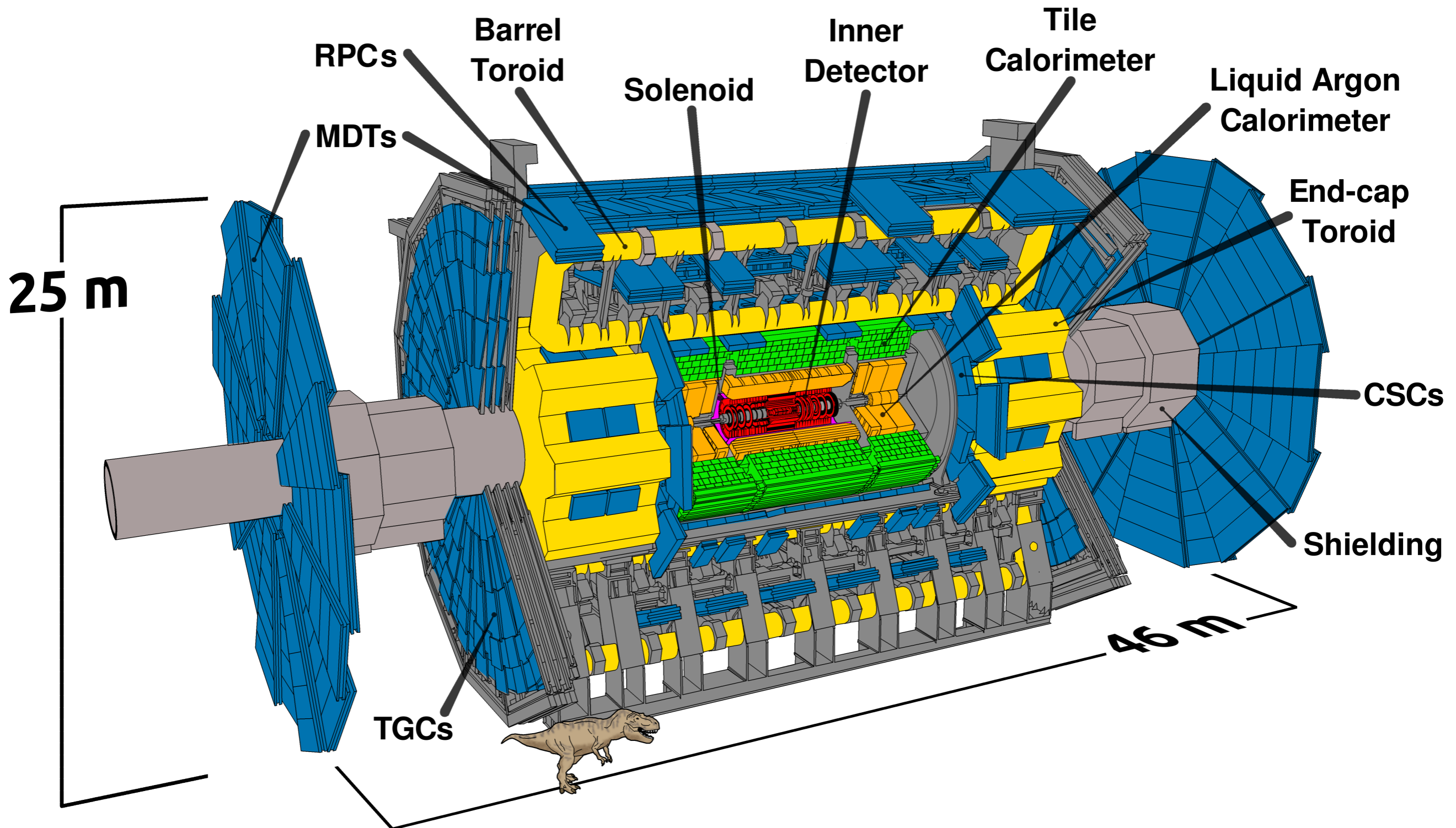
THE LARGE HADRON COLLIDER (LHC) @ CERN



LYN EVANS – LHC PROJECT LEADER



THE ATLAS DETECTOR



THE ATLAS DETECTOR



INTRO VIDEO

WHAT IS ATLAS OPEN DATA?

OPEN DATA

- ▶ Definition: Release data publicly
- ▶ For ATLAS:
 - ▶ visualise data
 - ▶ download & use data
 - ▶ open-source software for you to make your own discoveries

WHAT IS ATLAS OPEN DATA?

WHAT & WHO?

- ▶ Education, training, outreach
- ▶ Public data, educational tools
- ▶ Software, platforms, analysis examples
- ▶ Analyse ATLAS data, learn particle physics techniques
- ▶ Who? **YOU!** (University students)



WHAT IS ATLAS OPEN DATA?

AVAILABLE DATA

- ▶ Real data from 100 trillion proton–proton collisions
- ▶ Simulations of Standard Model & Beyond Standard Model processes



WHAT IS ATLAS OPEN DATA?

PARTICLES TO STUDY



up



charm



top



gluon



Higgs



down



strange



bottom



photon



dark matter



electron



muon



tau



Z



electron neutrino



muon neutrino



tau neutrino



W



WHAT IS ATLAS OPEN DATA?

(ANTI)PARTICLES TO STUDY



anti-up



anti-charm



anti-top



anti-down



anti-strange



anti-bottom



gluon



Higgs



photon



dark matter



positron



anti-muon



anti-tau



Z



anti-electron neutrino



anti-muon neutrino



anti-tau neutrino



W



WHAT IS ATLAS OPEN DATA?

WEBSITE

The screenshot shows the ATLAS Open Data website. At the top, there are navigation buttons: "take our 15 seconds survey!...", "...or do you have 60 seconds?!", "DOWNLOAD", and "COMMUNITY". The main navigation bar includes "Get Started" (Documentation, Histogram, Analyser, Analysis Browser), "Web Analysis" (Documentation, Analysis, ROOTbooks), and "Data & Tools" (Documentation, Datasets, Software, Virtual Machines). The ATLAS logo is on the left. A sidebar on the left contains social media icons for Facebook (263), Twitter, Email, LinkedIn, and Google+. The main content area features a large heading "Access Open Data from the ATLAS Experiment at CERN" and a paragraph: "The ATLAS data from 100 trillion proton collisions is now public! This marks the world's first open release of 8 TeV data, gathered from the Large Hadron Collider in 2012." Below this is a call to action: "ATLAS Open Data guides you through how to visualise the data, how to download and use the data, and even provides open-source software for you to make your own discoveries. Check the introductory video and get started now!". A large video player is on the right, showing the ATLAS logo and the text "open data ATLAS". A "Provide Feedback" button is on the right edge of the video player.

Note! [ATLAS Open Data](#) is primarily aimed at University students, postgraduate and external researchers. Please read more in [Target section](#)

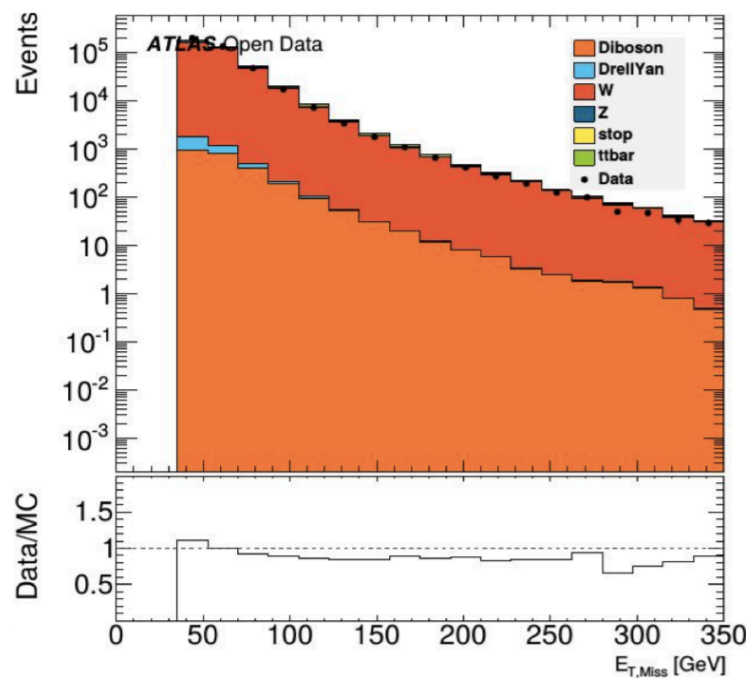
► opendata.atlas.cern



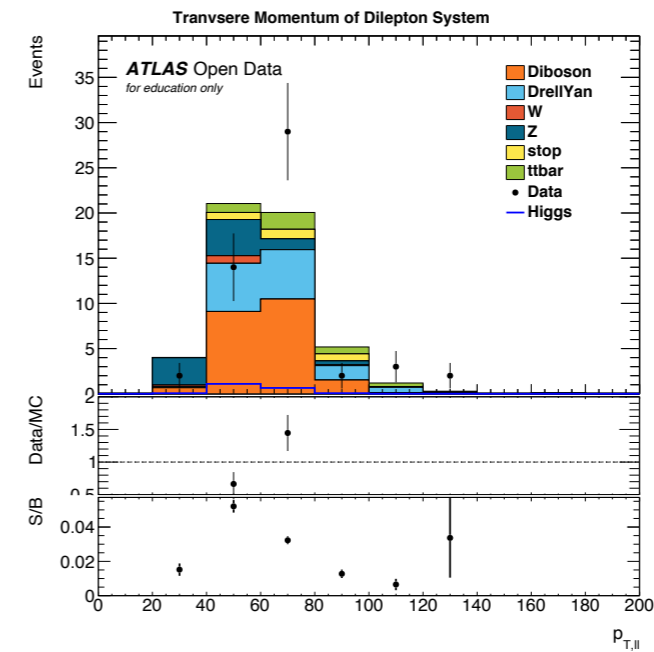
WHAT IS ATLAS OPEN DATA?

THESES

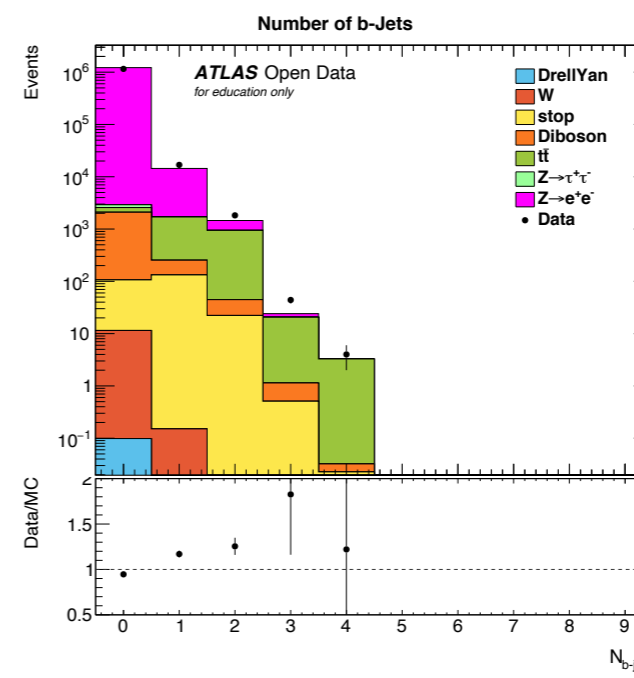
[Making ATLAS Data from CERN Accessible to the General Public: The Development and Evaluation of a Learning Resource in Experimental Particle Physics](#)



[Perspectives and Evaluation of Dark Matter production in association with a light quark, a heavy quark \(b-quark\) or an electroweak boson in particle colliders at a centre-of-mass energy of \$\(\sqrt{s}\)=8\$ TeV](#)



[Reconstruction of the invariant masses of bosons of the Standard Model using public data from ATLAS Open Data](#)

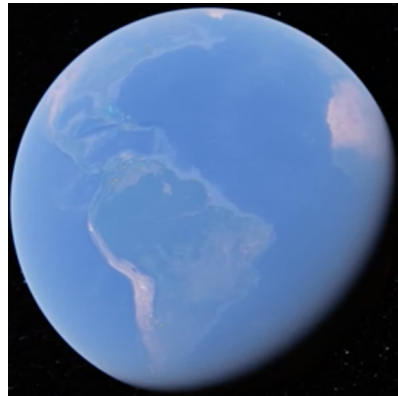


[Enabling Open Science with the ATLAS Open Data project at CERN](#)



WHAT IS ATLAS OPEN DATA?

VIDEOS



[People using & creating ATLAS Open Data & Tools](#)



[ATLAS Open Data website Community](#)



[ATLAS OpenData demo apps](#)



[Getting the Virtual Machine set and run](#)

```
Simple pyROOT notebook example
In [1]: import ROOT
Welcome to JupyROOT 6.08/04
In [2]: bgs= ROOT.TFile.Open("http://opendata.atlas.cern/release/samples/MC/mc_105985.WW.root")
sig = ROOT.TFile.Open("http://opendata.atlas.cern/release/samples/MC/mc_161005.ggh125_WW2lep.root")
In [3]: c = ROOT.TCanvas("testCanvas","a first way to plot a variable",800,600)
In [4]: t_bgs = bgs.Get("mini")
t_sig = sig.Get("mini")
In [5]: h_bgs = ROOT.TH1F("variable_bgs","Example plot: Number of Leptons",4,0,4)
h2_bgs = ROOT.TH1F("variable2_bgs","Example plot: Number of Jets",10,0,10)
h_sig = ROOT.TH1F("variable_sig","Example plot: Number of Leptons",4,0,4)
h2_sig = ROOT.TH1F("variable2_sig","Example plot: Number of Jets",10,0,10)
In [6]: for event in t_bgs:
h_bgs.Fill(t_bgs.lep_n)
h2_bgs.Fill(t_bgs.jet_n)
for event in t_sig:
```

[Intro to notebooks + Open Data](#)

An introductory notebook to HEP analysis in Python

In this notebook you can find an easy set of commands that show some basic computing techniques commonly used in High Energy Physics (HEP) analyzes. It also shows how to create a histogram, fill it and draw it. Moreover it is an introduction to ROOT too. The final output is a plot with the number of leptons. Check the description of the variables inside the dataset at the end of this notebook

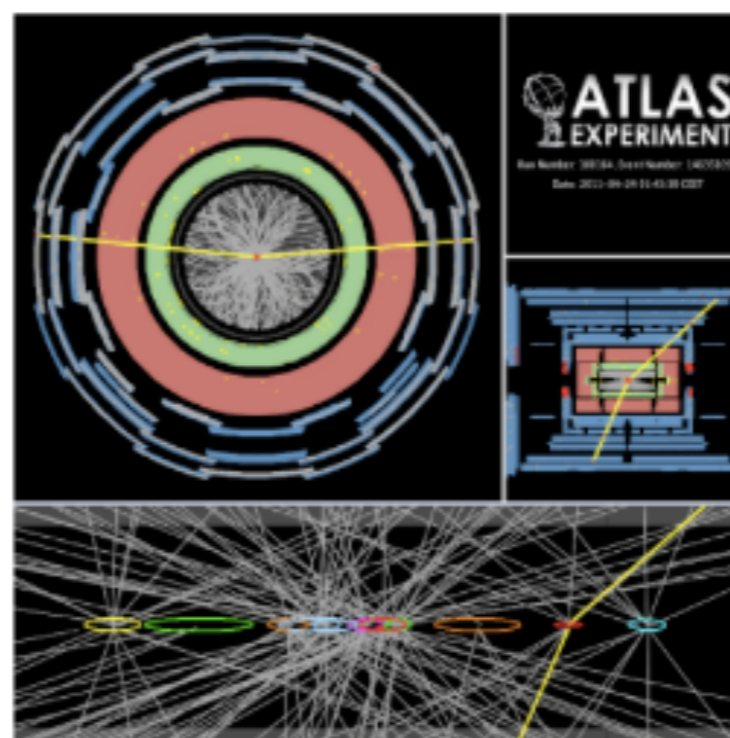
All done with less that 15 lines of code!

An introduction to the ATLAS public datasets

[ATLAS Open Data: Raw Jupyter notebook creation](#)



ATLAS events

[Get Started](#)[The Higgs Boson](#)[ATLAS events](#)[Analyses](#)[Data and Simulated Data](#)[Histogram Analyser](#)[Histogram Analyser 2](#)[Separate Signals](#)[Find the Higgs](#)[Analysis browser](#)[ROOTbrowser datasets](#)[ROOTbrowser Variable Names](#)[ROOTbrowser final plots](#)[Glossary](#)[Particle Physics Masterclasses](#)[Published with GitBook](#)

Beams of [protons](#) are accelerated around the [Large Hadron Collider \(LHC\)](#) and are brought to collision at the centre of the [ATLAS](#) detector. The collisions produce debris in the form of new particles which fly out in all directions. Over a billion particle interactions take place in the ATLAS detector every second.

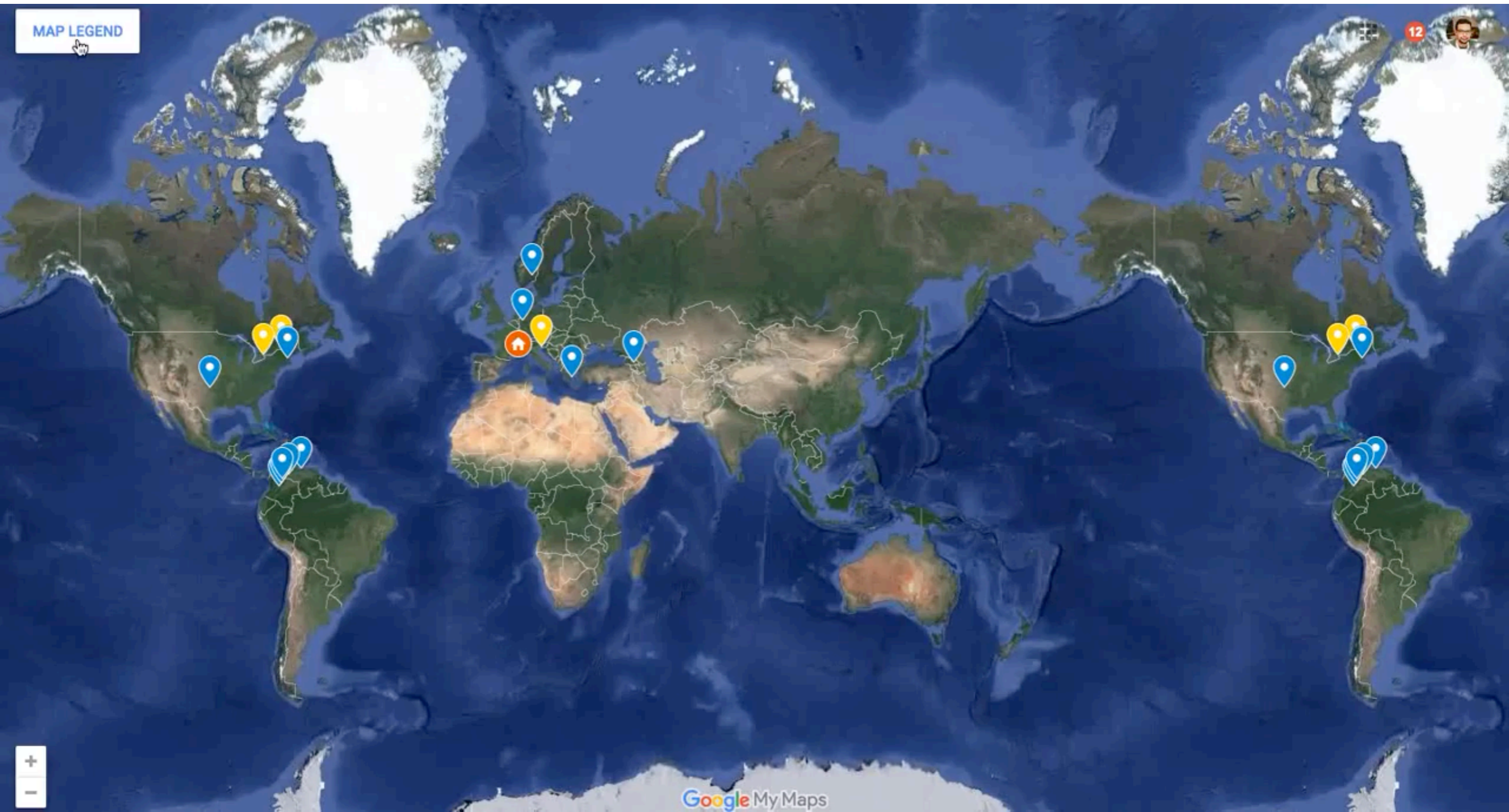
The protons within the two beams are grouped in bunches which are squeezed down in size to increase the chances of a collision. In the released data, the bunches crossed every 50 ns. There were about 30 collisions on average per **bunch-crossing**.

An [event](#) is the data resulting from a particular bunch-crossing.

Pile-up is defined as the average number of particle interactions per bunch-crossing. It is directly correlated with the instantaneous luminosity.

[Luminosity](#) is one of the most important parameters of the LHC. The higher the luminosity, the more data the experiments can gather to allow them to observe rare processes. However, increasing luminosity increases pile-up. This presents a challenge for physics analyses as it makes successfully identify collisions of interest harder.

ATLAS OPEN DATA AND FRIENDS AROUND THE WORLD



WORLDWIDE USE

California



Montréal



ZPATH



Lund



Dortmund



Göttingen



Michigan



HYPATIA



MANCHESTER
1824

Switzerland
Users: 297 The University of Manchester



Maastricht



Dresden



Creative

Commons



CEVALE2VE

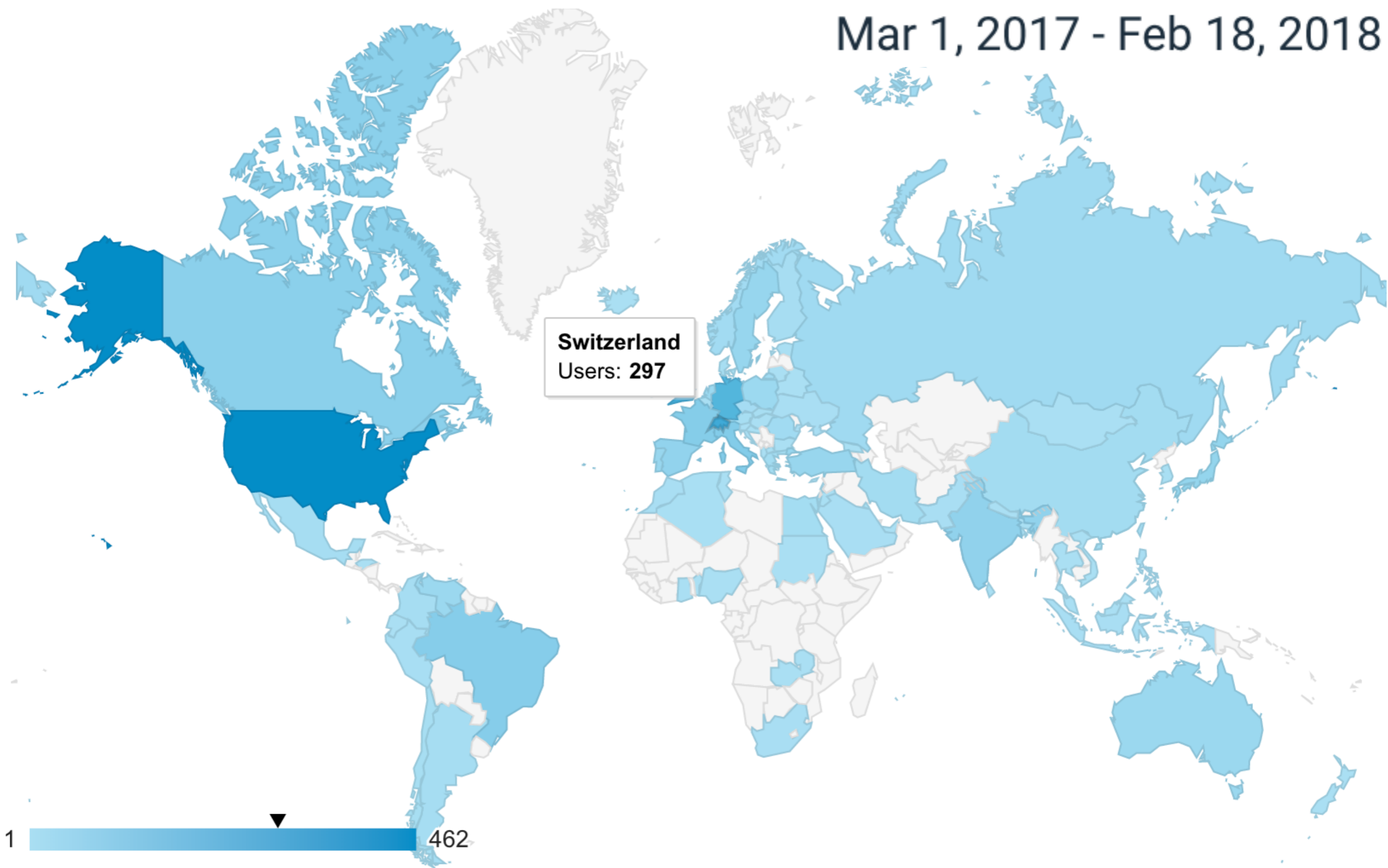






Valencia



WORLDWIDE USE

Mar 1, 2017 - Feb 18, 2018



Country ?	Users ?	Sessions ?	Pages / Session ?
	2,534 % of Total: 100.00% (2,534)	6,035 % of Total: 100.00% (6,035)	3.24 Avg for View: 3.24 (0.00%)
1.  United States	462 (17.61%)	957 (15.86%)	3.20
2.  Switzerland	297 (11.32%)	771 (12.78%)	3.32
3.  United Kingdom	286 (10.90%)	548 (9.08%)	3.93
4.  Germany	238 (9.07%)	625 (10.36%)	3.45
5.  Italy	110 (4.19%)	289 (4.79%)	3.76
6.  France	101 (3.85%)	126 (2.09%)	3.32
7.  Brazil	100 (3.81%)	276 (4.57%)	3.58
8.  Canada	88 (3.35%)	271 (4.49%)	2.87
9.  India	72 (2.74%)	129 (2.14%)	3.71
10.  Spain	68 (2.59%)	150 (2.49%)	3.12

WHAT IS ATLAS OPEN DATA?

WORLDWIDE USE

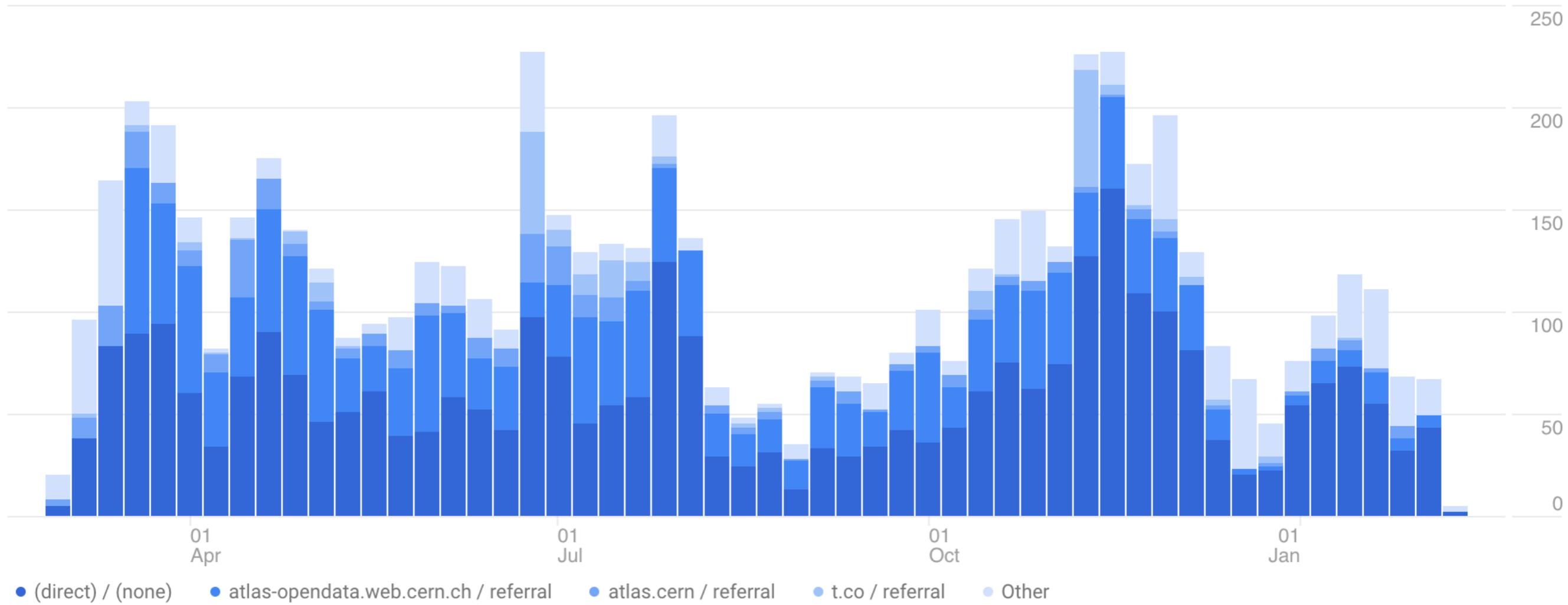
How do you acquire users?

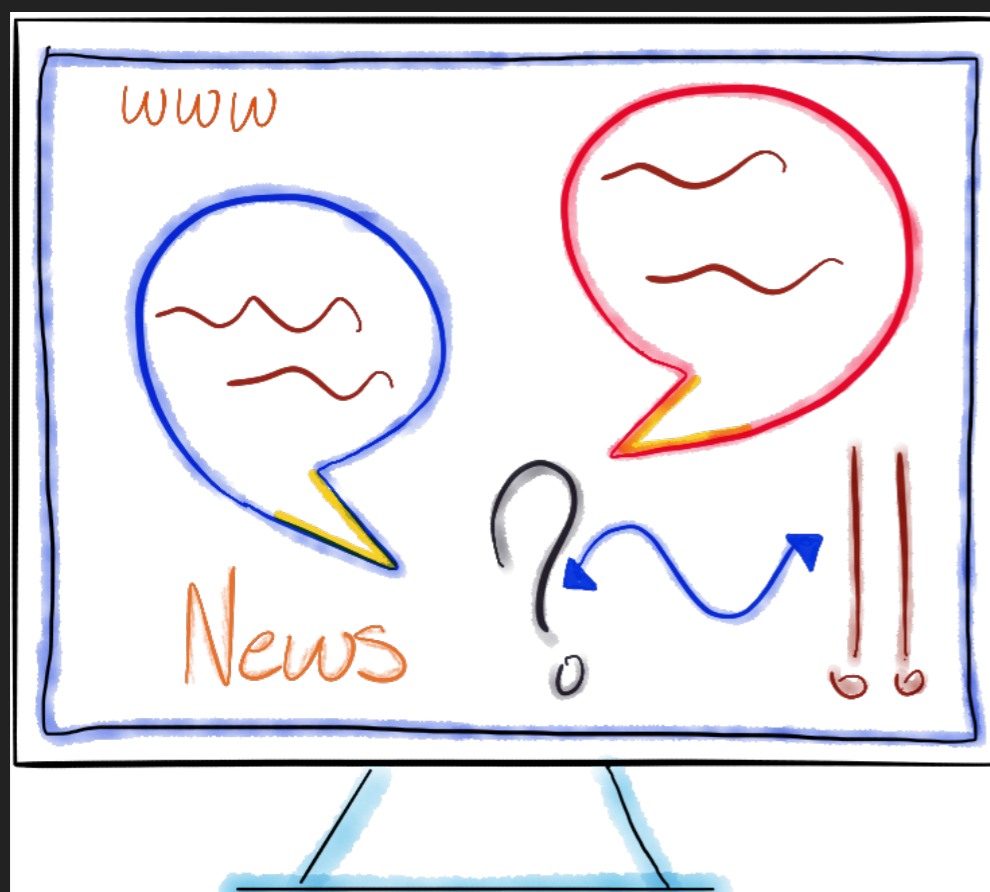
Mar 1, 2017 - Feb 18, 2018

Traffic Channel

Source / Medium

Referrals

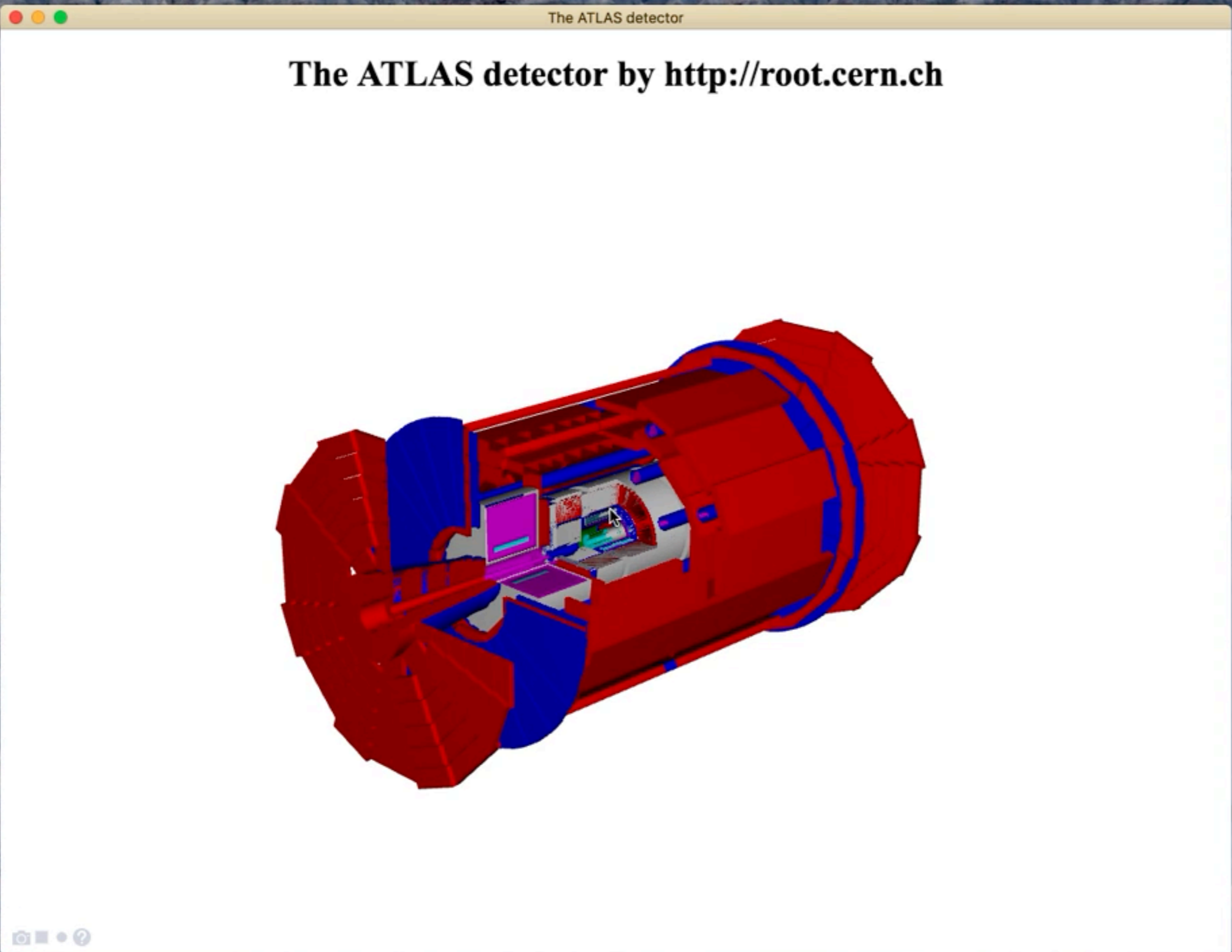




**HOW TO MAKE YOUR
OWN PARTICLE PHYSICS
DISCOVERIES?**

GET STARTED

ATLAS DETECTOR VISUALISATION



LIVE EVENT DISPLAYS

The screenshot shows a web browser window at `opendata.atlas.cern`. The navigation bar includes links for **Documentation**, **Histograms Analyser**, **Analysis Browser**, and **Live Events**. The main content area features a large circular detector layout on the left, a smaller schematic on the top right, and a detailed event information panel on the bottom right. The event information includes the ATLAS logo, Run Number: 367384, Event Number: 248463568, Date: 2018-12-02 17:05:13 CET, and a description: "Snapshot of an ion collision directly from the ATLAS experiment".


opendata.atlas.cern

Documentation Histograms Analyser Analysis Browser Live Events

Live ATLAS events The ATLAS experiment Collaboration site Help

f
t
e
in

Questions? Feedback!

 **ATLAS**
EXPERIMENT

Run Number: 367384, Event Number: 248463568

Date: 2018-12-02 17:05:13 CET

Snapshot of an ion collision
directly from the ATLAS experiment

HOW TO MAKE YOUR OWN PARTICLE PHYSICS DISCOVERIES?

HISTOGRAM ANALYSER



Get Started

Documentation, [Histogram
Analyser](#), Analysis Browser

Web Analysis

Documentation, Analysis
ROOTbooks

Data & Tools

Documentation, Datasets,
Software, Virtual Machines

Get Started - Histograms Analyser

Physicists use cuts to select events of interest. Cuts are made that preferentially remove the unwanted processes (background) but leave the desired process (signal). It is useful to have a good understanding of the physics processes involved when applying cuts. **The 4 processes displayed in Histogram Analyser are $H \rightarrow WW$, WW , $t\bar{t}$ and Z .** Each process is represented by a different colour. **Make cuts using your cursor.**

Do you want to know more? Check the [Documentation](#)

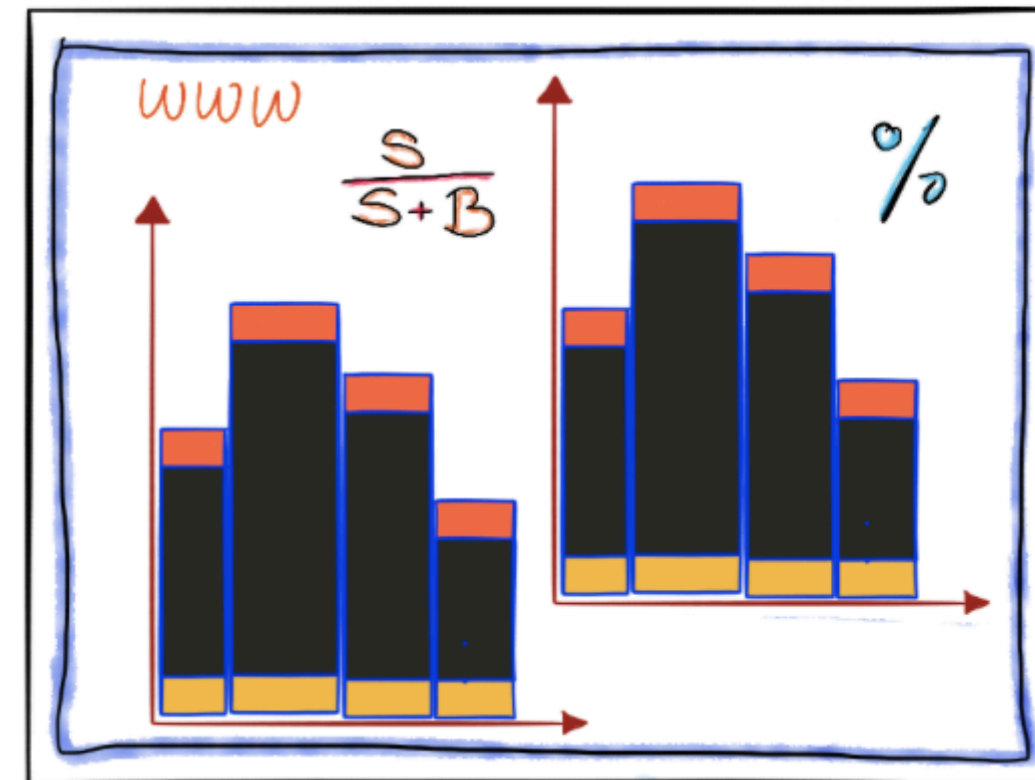


FIGURE OUT THE STEPS TO DISCOVER THE HIGGS

Histogram Analyser: a web based tool for fast, cut-based analysis of data



HOW TO MAKE YOUR OWN PARTICLE PHYSICS DISCOVERIES?

ANALYSIS BROWSER



Get Started

Documentation, Histogram
Analyser, [Analysis Browser](#)

Web Analysis

Documentation, Analysis
ROOTbooks

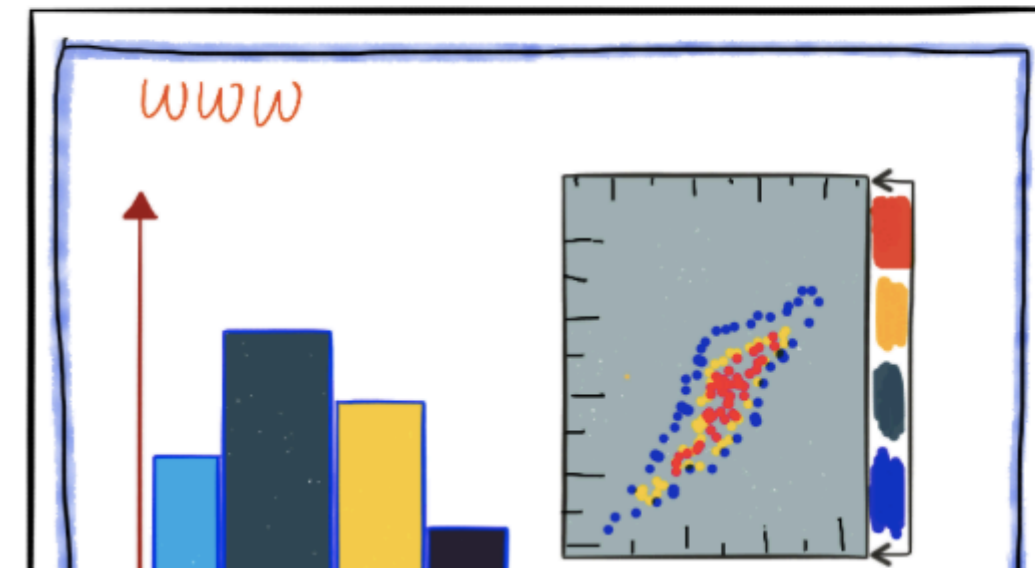
Data & Tools

Documentation, Datasets,
Software, Virtual Machines

Get Started - Analysis Browser

Look into the plots! A web based **tool for displaying and analysing data and Monte-Carlo** simulated data. Select a dataset using the drop-down menu (*second text box*) or a complete physics analysis tab: It is like **a live scientific paper!** click into the plot, zoom into the data-points, set a logarithmic scale and more.

Do you want to know more? Check the [Documentation](#)



LEARN USING AN INTERACTIVE PHYSICS PAPER

opendata.atlas.cern/index.php

take our 15 seconds survey!... ...or do you have 60 seconds?! DOWNLOAD COMMUNITY

open data ATLAS

Get Started
Documentation, Histogram Analyser, Analysis Browser

Web Analysis
Documentation, Online ROOTbooks

Data & Tools
Documentation, Datasets, Software, Virtual Machines

Access Open Data from the ATLAS Experiment at CERN

The [ATLAS](#) data from 100 trillion proton collisions is now public! This marks the world's first open release of 8 TeV data, gathered from the [Large Hadron Collider](#) in 2012.

ATLAS Open Data guides you through how to visualise the data, how to download and use the data, and even provides open-source software for you to make your own discoveries. **Check the introductory video and get started now!**

open data ATLAS

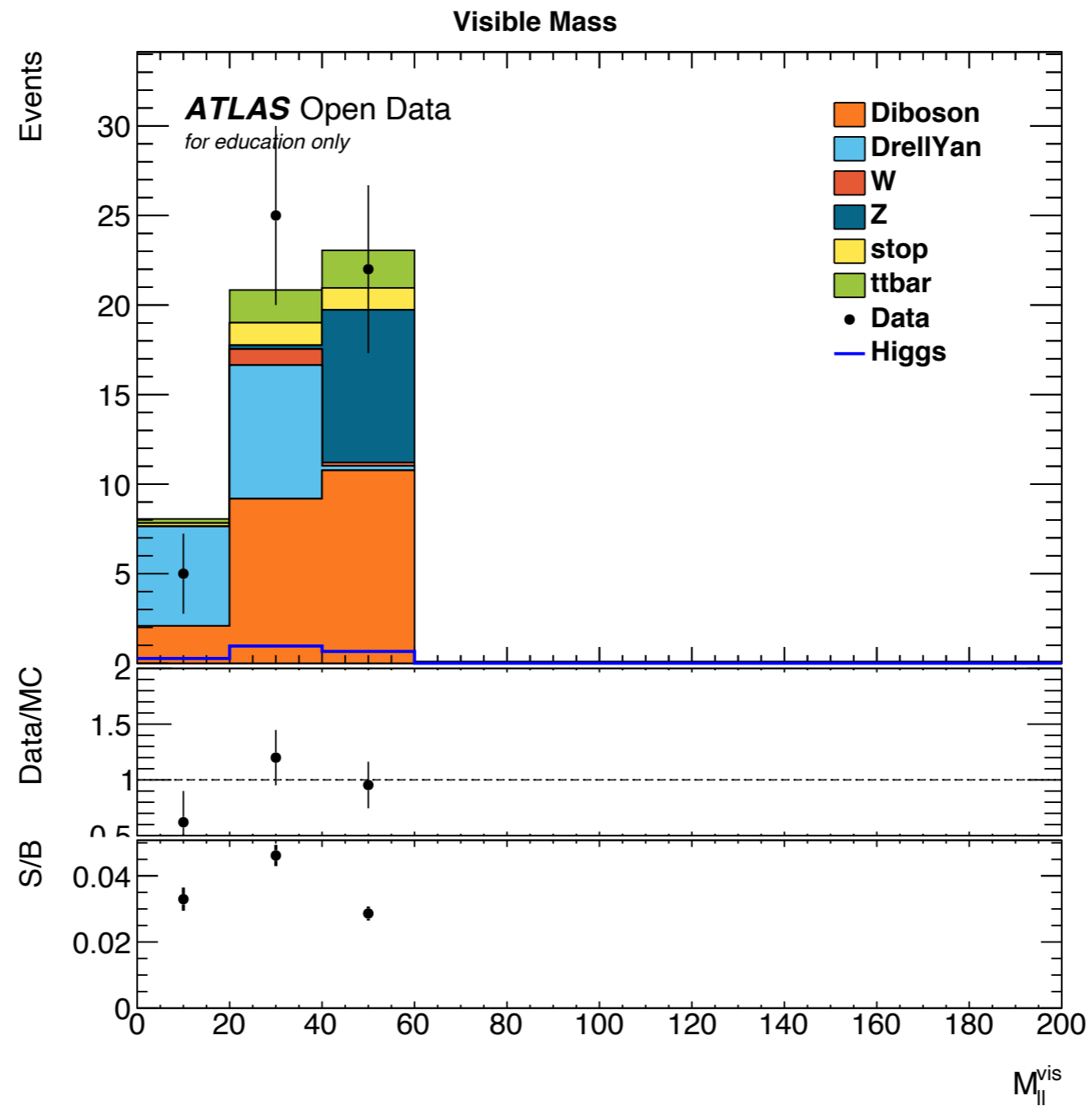
Note! [ATLAS Open Data](#) is primarily aimed at University students, postgraduate and external researchers. Please read more in [Target section](#)

www

In the **Get Started**

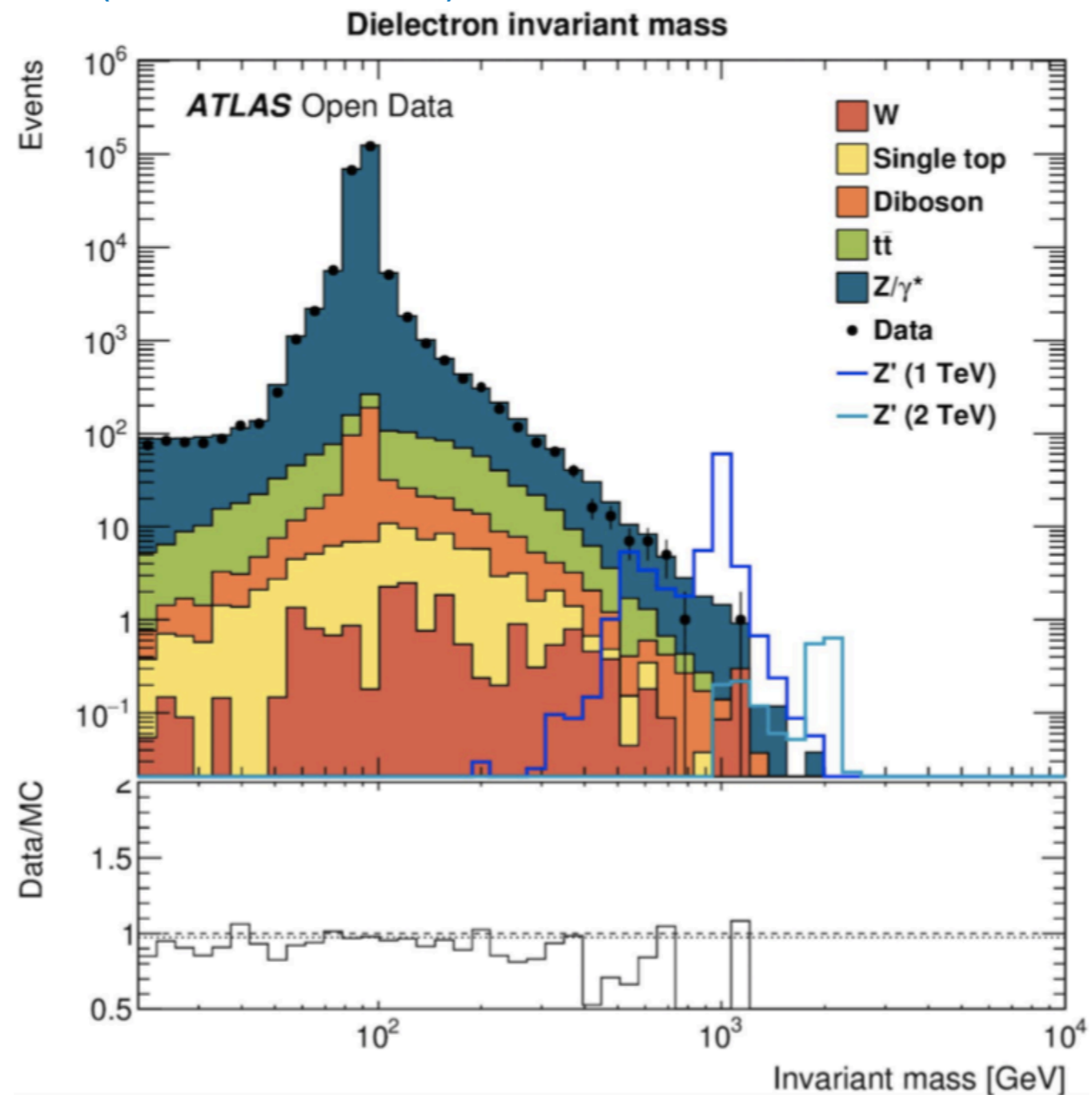
HOW TO MAKE YOUR OWN PARTICLE PHYSICS DISCOVERIES?

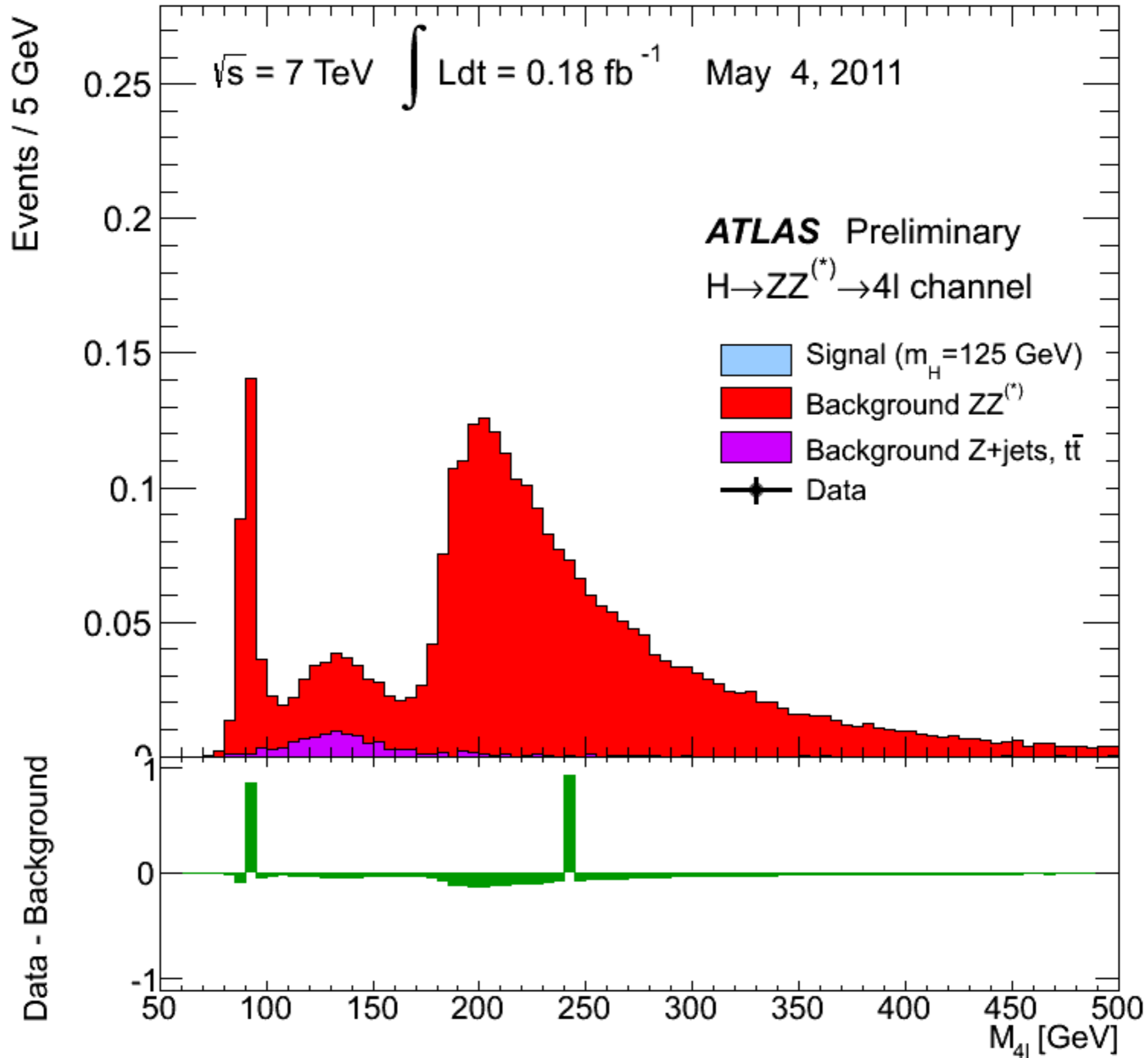
H → WW ANALYSIS



HOW TO MAKE YOUR OWN PARTICLE PHYSICS DISCOVERIES?

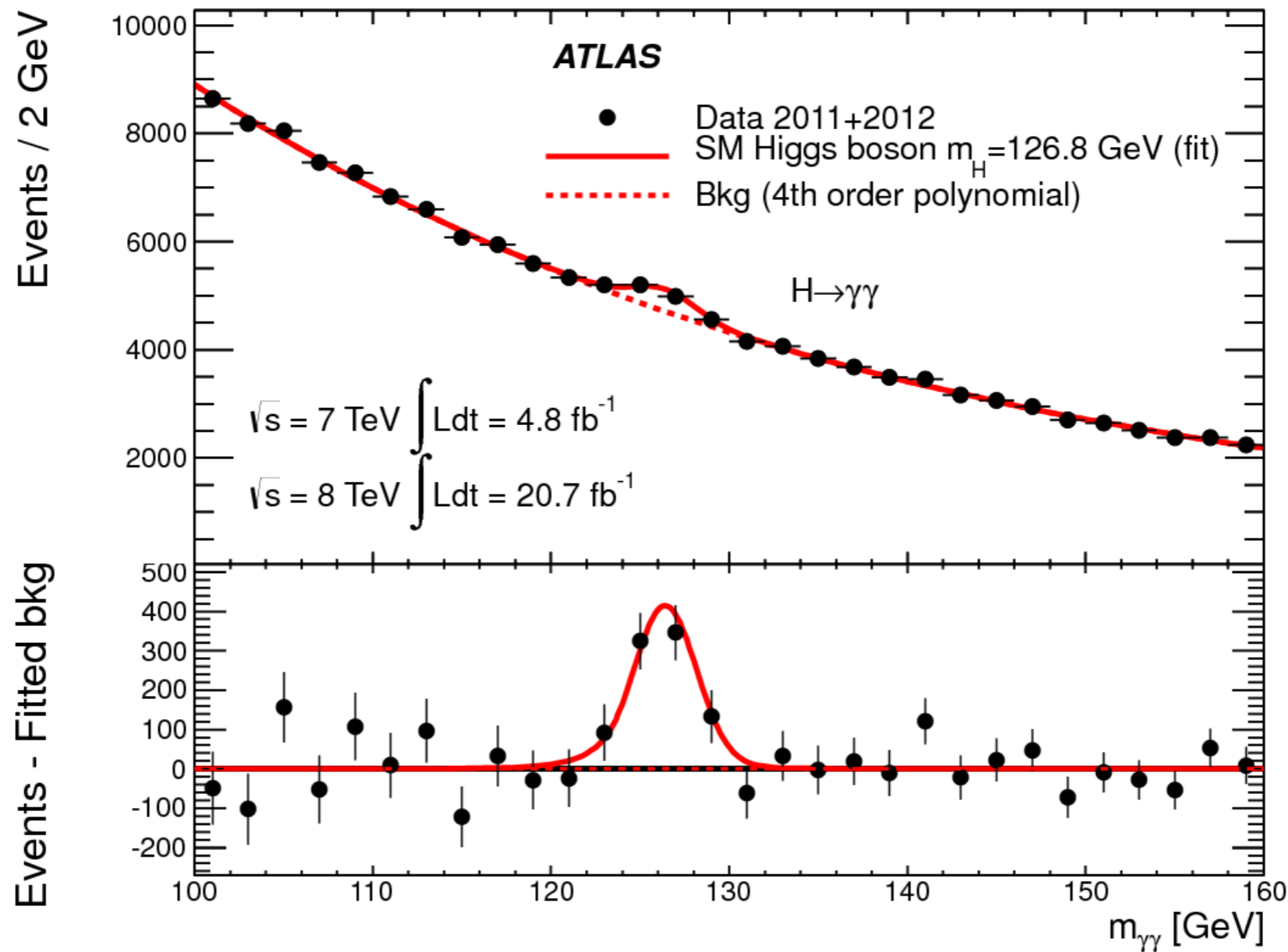
Z' ANALYSIS (DARK MATTER)

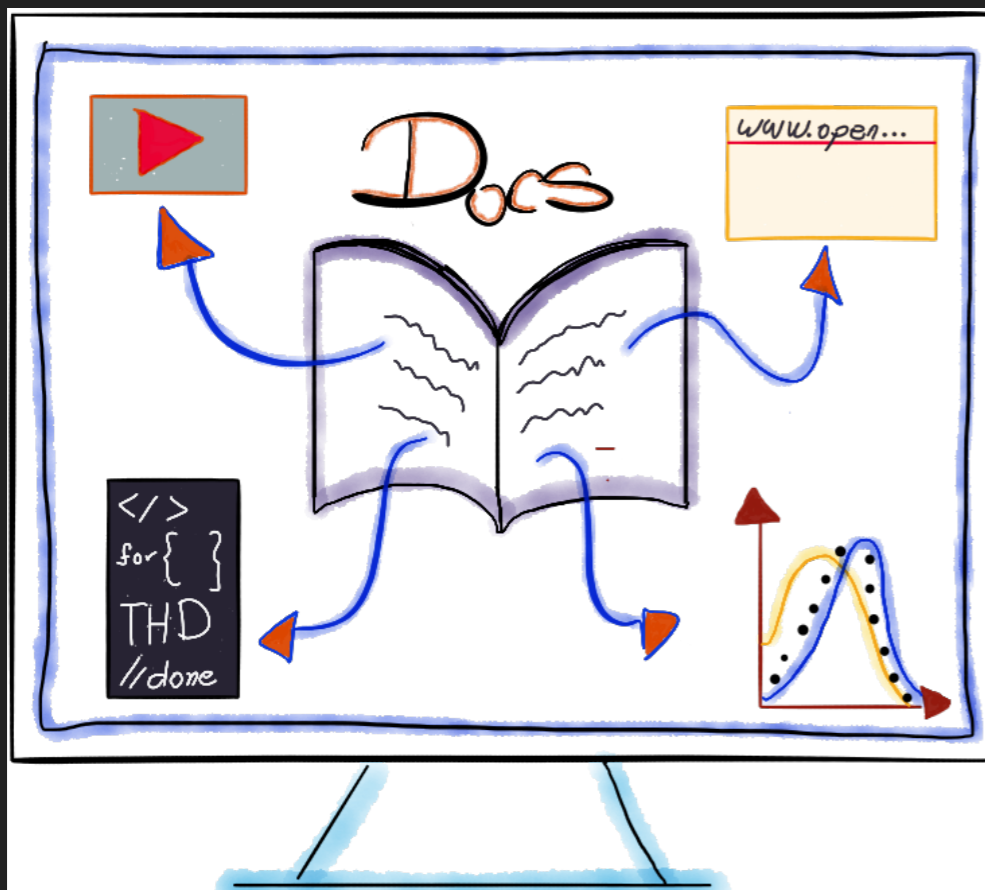




HOW TO MAKE YOUR OWN PARTICLE PHYSICS DISCOVERIES?

HIGGS BOSON DISCOVERY PLOT





**WHAT DOES THIS HAVE
TO DO WITH MATHS
METHODS?**

WHAT DOES THIS HAVE TO DO WITH MATHS METHODS?

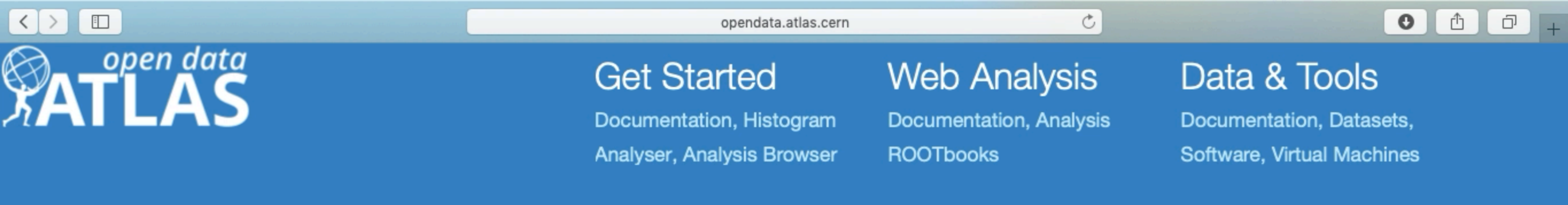
PROGRAMMING

- ▶ All user analysis scripts in Python
- ▶ Jupyter notebooks for interactive code writing



WEB ANALYSIS

WEB ANALYSIS ROOTBOOKS



ATLAS ROOTbooks Gallery

ready to test our examples? click over any of the #'s to know more

The image shows a screenshot of a ROOT C++ notebook interface. At the top, there is a Feynman diagram of a Z boson decaying into two charm quarks (c and c-bar). Below the diagram, there is an "Introduction" section with text: "Let's take a current ATLAS Open Data sample and create a histogram:". This is followed by a code cell with the command `!jzroot on`. Another code cell contains include statements for `<iostream>`, `<string>`, `<stdio.h>`, and `<time.h>`. A text block explains a function to print the execution time. The final code cell starts with `!sleep -d` and includes a URL for a StackOverflow question. The notebook interface includes a menu bar (File, Edit, View, Insert, Cell, Kernel, Help) and a toolbar with various icons.

#3 Title for ROOTbook

Description of the notebook: The ATLAS data from 100 trillion proton collisions is now public! This marks the world's first open release of 8 TeV data, gathered from the Large Hadron Collider in 2012.

Interact with this ROOTbook using one of the methods below!

- Visualise it using [our nbviewer area](#), and download it
- Run it on your computer! [Get one of our VMs](#)
- Work on it directly in your [CERN SWAN account](#)

WHAT DOES THIS HAVE TO DO WITH MATHS METHODS?

INTRO TO HIGH ENERGY PHYSICS ANALYSIS



JUPYTER

FAQ



An introductory notebook to HEP analysis in Python

In this notebook you can find an easy set of commands that show some basic computing techniques commonly used in High Energy Physics (HEP) analyzes.

It also shows how to create an histogram, fill it and draw it. Moreover it is an introduction to [ROOT](#) too. The final output is a plot with the number of leptons.

Check the [description of the variables inside the dataset](#) at the end of this notebook

All done with less that 15 lines of code!

An introduction to the ATLAS public datasets

WHAT DOES THIS HAVE TO DO WITH MATHS METHODS?

ONTO MORE DIFFICULT ANALYSES...

 jupyter
nbviewer

JUPYTER

FAQ



notebooks / november_2017_v1.0



A more difficult notebook in python

In this notebook you can find a more difficult program that shows further high energy physics (HEP) analysis techniques.

The following analysis is searching for events where Z bosons decay to two leptons of same flavour and opposite charge (to be seen for example in the Feynman diagram).



WHAT DOES THIS HAVE TO DO WITH MATHS METHODS?

USING PYTHON FOR PARTICLE PHYSICS

Simple pyROOT notebook example

```
In [1]: import ROOT
```

```
Welcome to JupyROOT 6.08/04
```

```
In [2]: bgs= ROOT.TFile.Open("http://opendata.atlas.cern/release/samples/MC/mc_105985.WW.root")
sig = ROOT.TFile.Open("http://opendata.atlas.cern/release/samples/MC/mc_161005.ggH125_WW2lep.root")
```

```
In [3]: c = ROOT.TCanvas("testCanvas","a first way to plot a variable",800,600)
```

```
In [4]: t_bgs = bgs.Get("mini")
t_sig = sig.Get("mini")
```

```
In [5]: h_bgs = ROOT.TH1F("variable_bgs","Example plot: Number of Leptons",4,0,4)
h2_bgs = ROOT.TH1F("variable2_bgs","Example plot: Number of Jets",10,0,10)

h_sig = ROOT.TH1F("variable_sig","Example plot: Number of Leptons",4,0,4)
h2_sig = ROOT.TH1F("variable2_sig","Example plot: Number of Jets",10,0,10)
```

```
In [6]: for event in t_bgs:
        h_bgs.Fill(t_bgs.lep_n)
        h2_bgs.Fill(t_bgs.jet_n)
for event in t_sig:
```

WHAT DOES THIS HAVE TO DO WITH MATHS METHODS?

USING PYTHON WITH SPECIAL RELATIVITY

Simple pyROOT notebook example using TLorentz Vectors

```
In [1]: import ROOT
```

```
Welcome to JupyROOT 6.08/04
```

```
In [2]: ## f = ROOT.TFile.Open("mc_105986.ZZ.root")  
## f = ROOT.TFile.Open("mc_147770.Zee.root")  
f = ROOT.TFile.Open("http://opendata.atlas.cern/release/samples/MC/mc_147770.Zee.root")
```

```
In [3]: c = ROOT.TCanvas("testCanvas", "a first way to plot a variable", 800, 600)
```

```
In [4]: t = f.Get("mini")
```

```
In [5]: h = ROOT.TH1F("variable", "Example plot: Number of Leptons", 4, 0, 4)
```

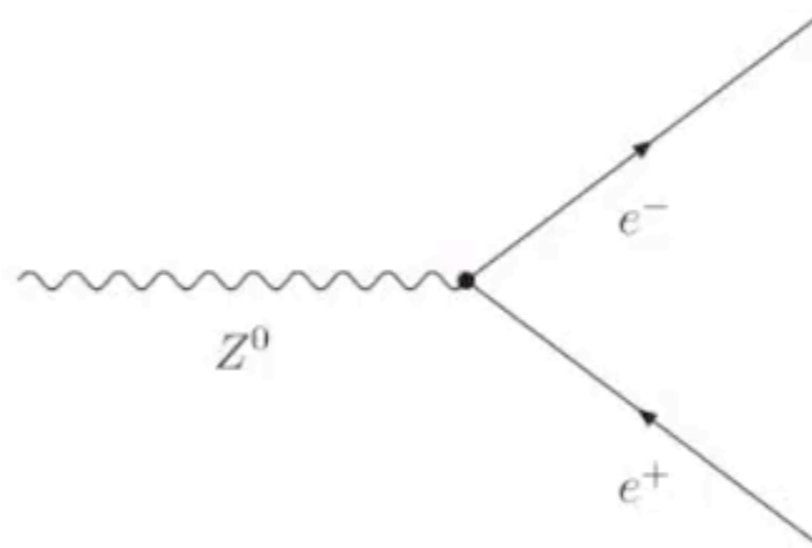
```
In [ ]: h_M11 = ROOT.TH1F("h_M11", "Invariant mass of the two Leptons", 50, 0, 200)
```

```
In [ ]: for event in t:  
    """This is the cut #1: request at least 2 leptons"""  
    if t.lep_n > 1:  
        """Let's define one TLorentz vector for each, e.i. two vectors!"""  
        leadingLep = ROOT.TLorentzVector(t.lep_pt[0], t.lep_eta[0], t.lep_phi[0], t.lep_E[0])  
        secondLep = ROOT.TLorentzVector(t.lep_pt[1], t.lep_eta[1], t.lep_phi[1], t.lep_E[1])
```

WHAT DOES THE CODE DO?



Example of the reconstruction of the invariant Mass of the Z boson in C++



Introduction Let's take a current ATLAS Open Data sample and create a histogram:

```
In [1]: %jsroot on
```

We need to include some standard C++ and ROOT libraries

DATA & TOOLS

WHAT DOES THIS HAVE TO DO WITH MATHS METHODS?

DATA & TOOLS



Get Started

Documentation, Histogram
Analyser, Analysis Browser

Web Analysis

Documentation, Analysis
ROOTbooks

Data & Tools

Documentation, Datasets,
Software, Virtual Machines

Data & Tools

Now that you have learned to visualise data and use code for analysis, you are ready to take an in-depth look at ATLAS data. **Start your analysis now!** In this section, you can download the full datasets, install a virtual machine and learn how to execute analysis software.

Explore:

- **Documentation:** a step-by-step guide to downloading datasets, software and virtual machines
- **Datasets:** download the ATLAS datasets
- **Software:** download and run analysis software
- **Virtual Machines:** download and prepare a virtual machine to run on your computer



WHAT DOES THIS HAVE TO DO WITH MATHS METHODS?

DATA & TOOLS FRAMEWORK

The screenshot shows the GitHub interface for the repository 'atlas-outreach-data-tools / atlas-outreach-data-tools-framework'. The repository is described as 'Python software framework for the ATLAS OpenData project'. It has 4 commits, 1 branch, 2 releases, and 1 contributor. The latest commit is by 'artfísica' to clean, dated 6 Feb. The repository contains several folders and files, all of which were last updated 3 years ago. The folders are Analysis, Configurations, Input, Output, and Plotting. The files are PlotResults.py, README.md, and RunScript.py. The README.md file has a description: 'Adding missing s in documentation to run Plotting code'.

atlas-outreach-data-tools / atlas-outreach-data-tools-framework

Python software framework for the ATLAS OpenData project

4 commits 1 branch 2 releases 1 contributor

Branch: master New pull request Create new file Upload files Find File Clone or download

artfísica to clean Latest commit 099fb10 on 6 Feb

Analysis	First version for ATLAS collaboration review before 2016 release	3 years ago
Configurations	First version for ATLAS collaboration review before 2016 release	3 years ago
Input	First version for ATLAS collaboration review before 2016 release	3 years ago
Output	First version for ATLAS collaboration review before 2016 release	3 years ago
Plotting	First version for ATLAS collaboration review before 2016 release	3 years ago
PlotResults.py	First version for ATLAS collaboration review before 2016 release	3 years ago
README.md	Adding missing s in documentation to run Plotting code	3 years ago
RunScript.py	First version for ATLAS collaboration review before 2016 release	3 years ago

README.md

WHAT DOES THIS HAVE TO DO WITH MATHS METHODS?

ANALYSIS.PY

```
54 # retrieving objects
55 eventinfo = self.Store.getEventInfo()
56 weight = eventinfo.scalefactor()*eventinfo.eventWeight() if not self.getIsData() else 1
57 self.countEvent("no cut", weight)
58
59 # apply standard event based selection
60 if not AH.StandardEventCuts(eventinfo): return False
61 self.countEvent("EventCuts", weight)
62
63 # Lepton Requirements
64 GoodLeptons = AH.selectAndSortContainer(self.Store.getLeptons(), AH.isGoodLepton, lambda p: p.pt())
65 if not (len(GoodLeptons) == 2): return False
66 self.countEvent("2 high pt Leptons", weight)
67
68 leadLepton = GoodLeptons[0]
69 trailLepton = GoodLeptons[1]
70
71 # test Z candidate
72 if not (leadLepton.charge() * trailLepton.charge() < 0): return False
73 if not (abs(leadLepton.pdgId()) == abs(trailLepton.pdgId())): return False
74 if not (abs((leadLepton.tlv() + trailLepton.tlv()).M() - Constants.Z_Mass) < 20): return False
```

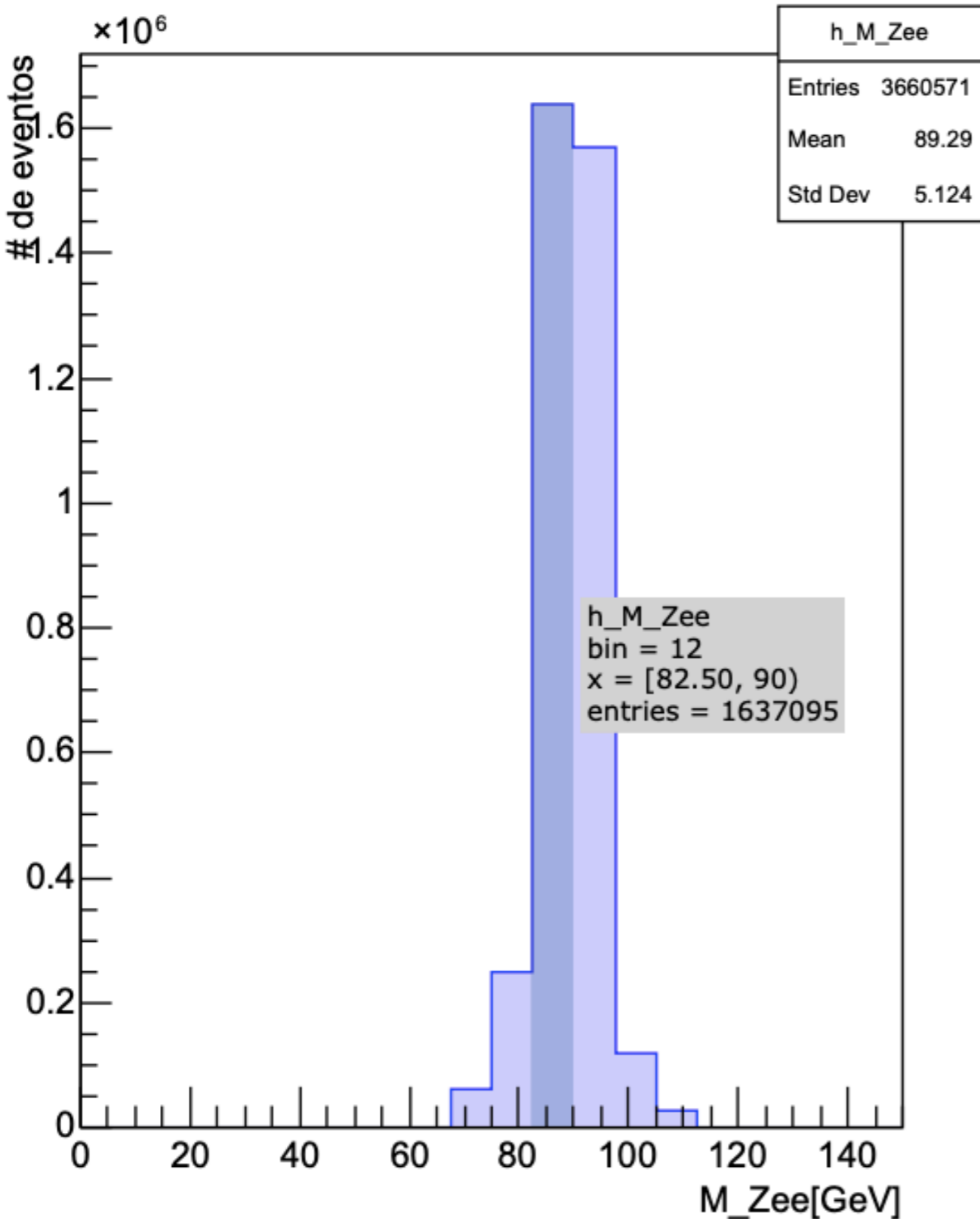
RESEARCH PLACEMENTS (RP)

- ▶ New Research Placement on ATLAS Open Data starting this year!
- ▶ “The ATLAS experiment provides Open Data, allowing students to access real proton-proton collision data collected by ATLAS, along with tools, software, documentation all accessible on the ATLAS Open Data website <http://opendata.atlas.cern> and CERN Open Data Portal <http://opendata.cern.ch>”...

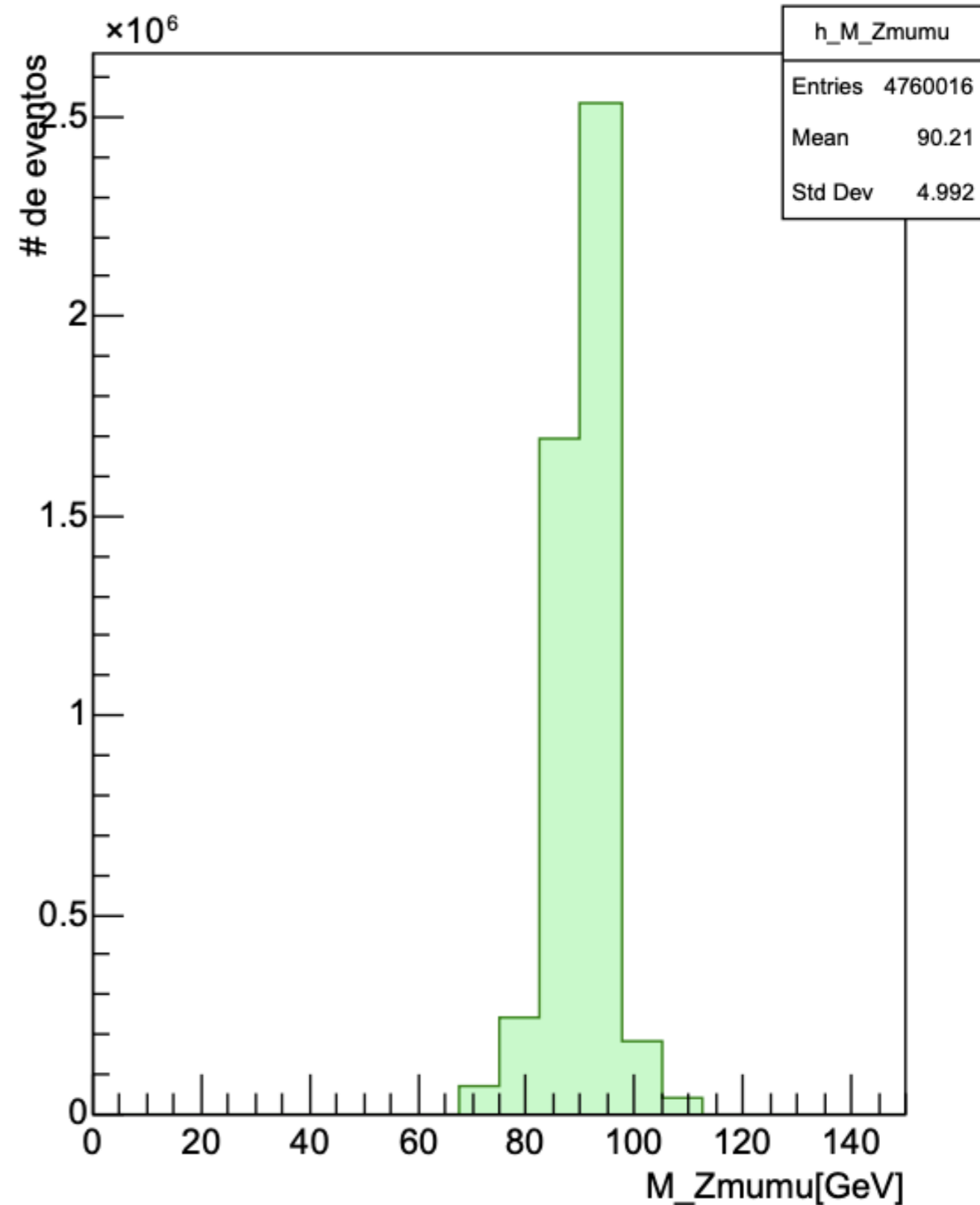


3RD YEAR PARTICLE PHYSICS COURSE @ SUSSEX

Invariant Mass of the Z (Zee)

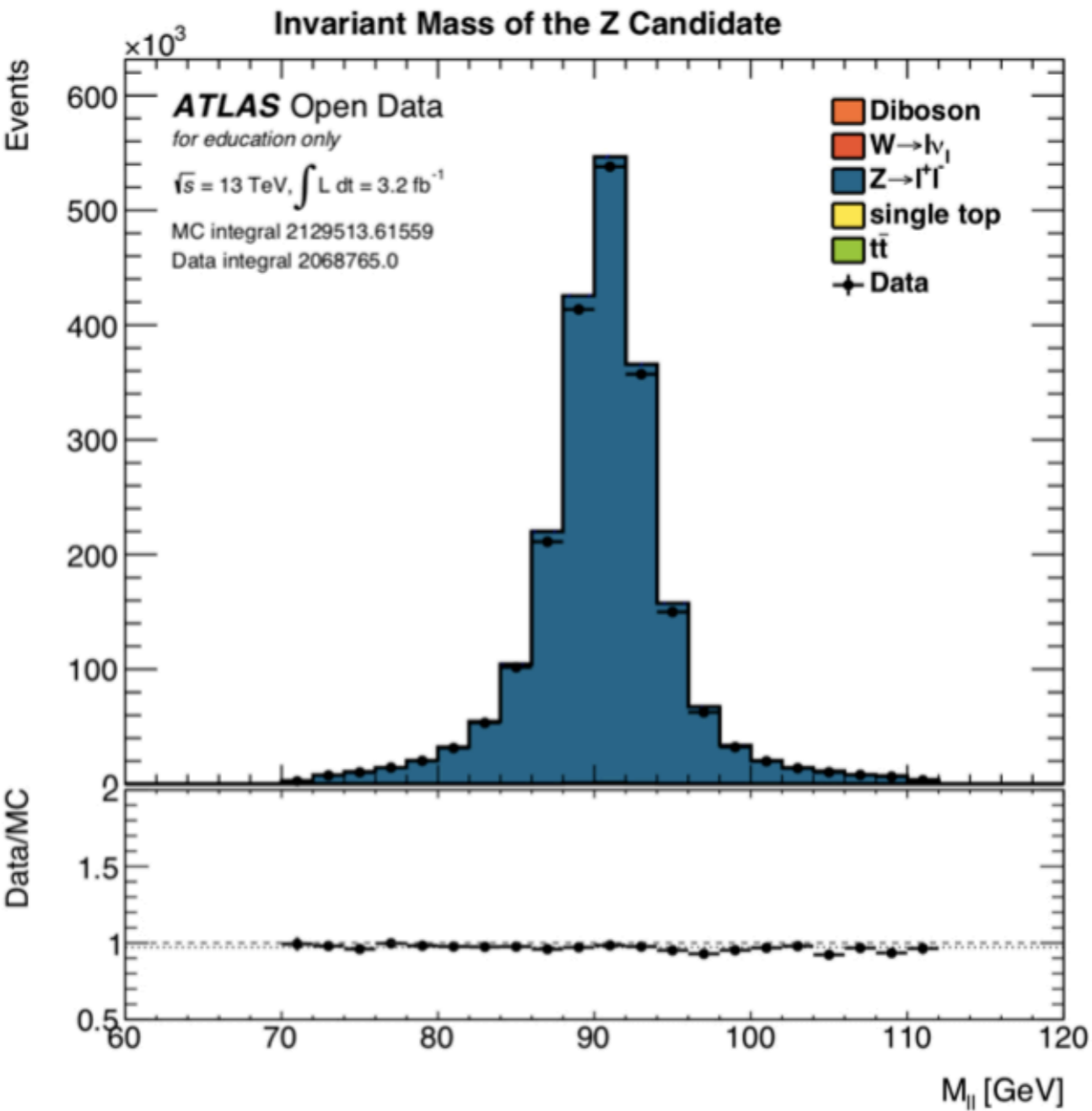


Invariant Mass of the Z (Zmumu)

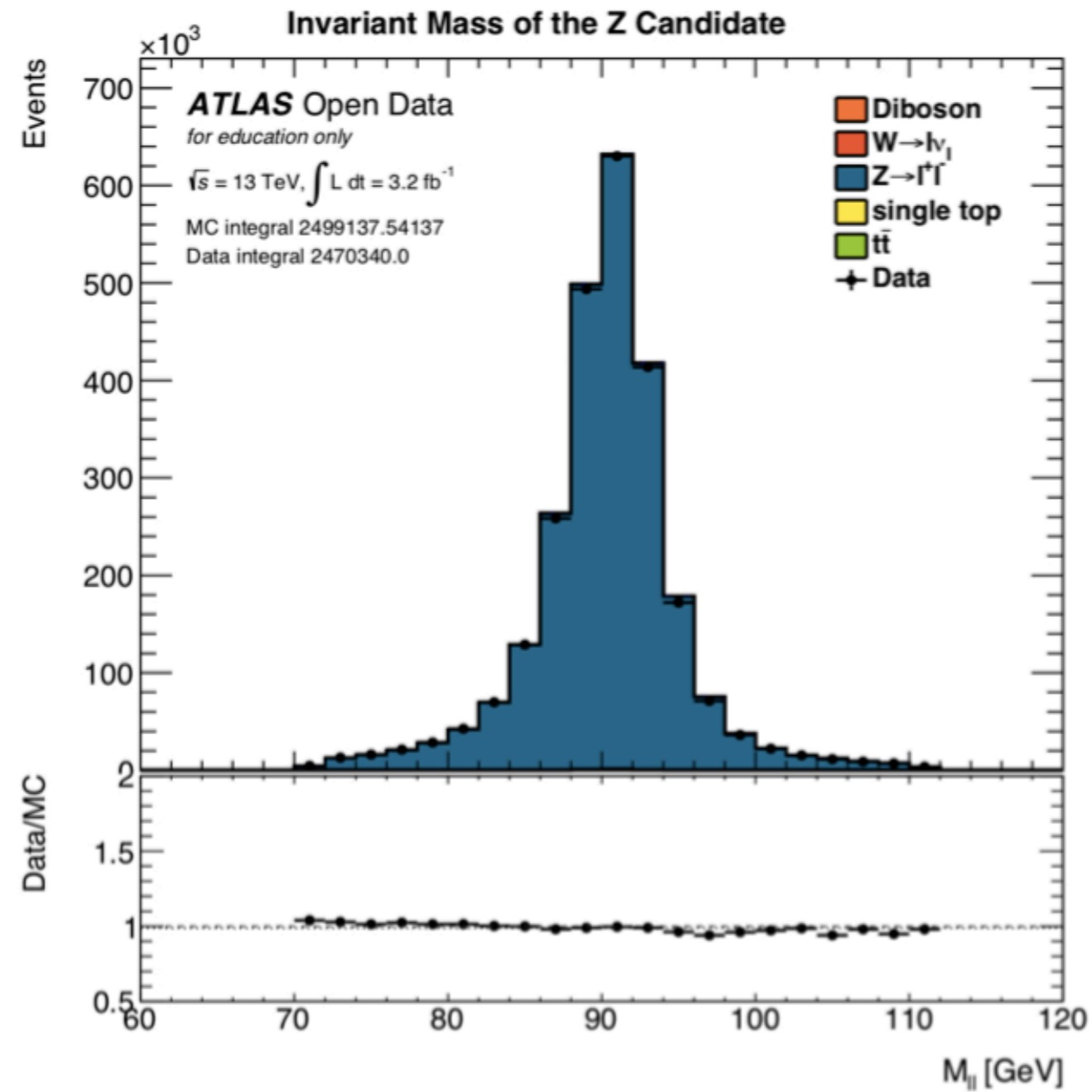


WHAT DOES THIS HAVE TO DO WITH MATHS METHODS?

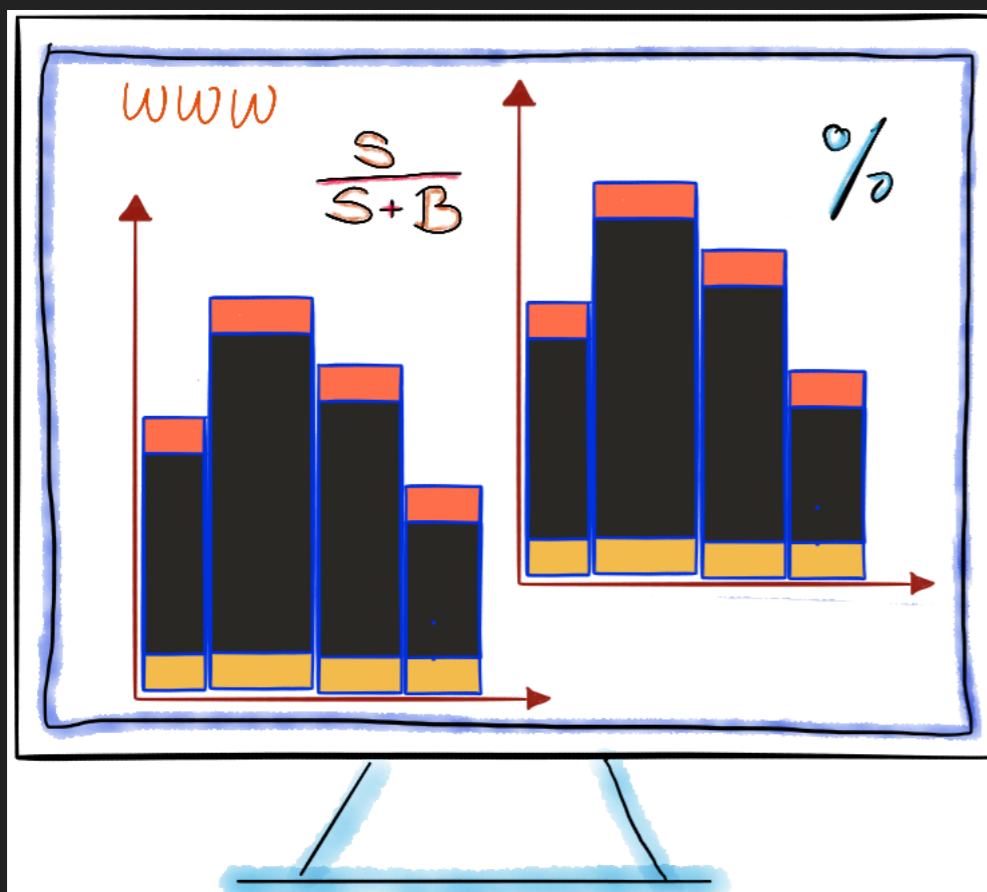
FINAL YEAR PROJECTS



$p_T > 30 \text{ GeV}$



$p_T > 25 \text{ GeV}$



**WHAT TO TAKE
HOME?**

WHAT TO TAKE HOME?

SUMMARY

- ▶ There's lots **YOU** can do with ATLAS Open Data already
- ▶ ATLAS Open Data is aimed at students just like you
- ▶ Head to opendata.atlas.cern to get started
- ▶ There'll be lots more you can do as you keep learning

WHAT TO TAKE HOME?

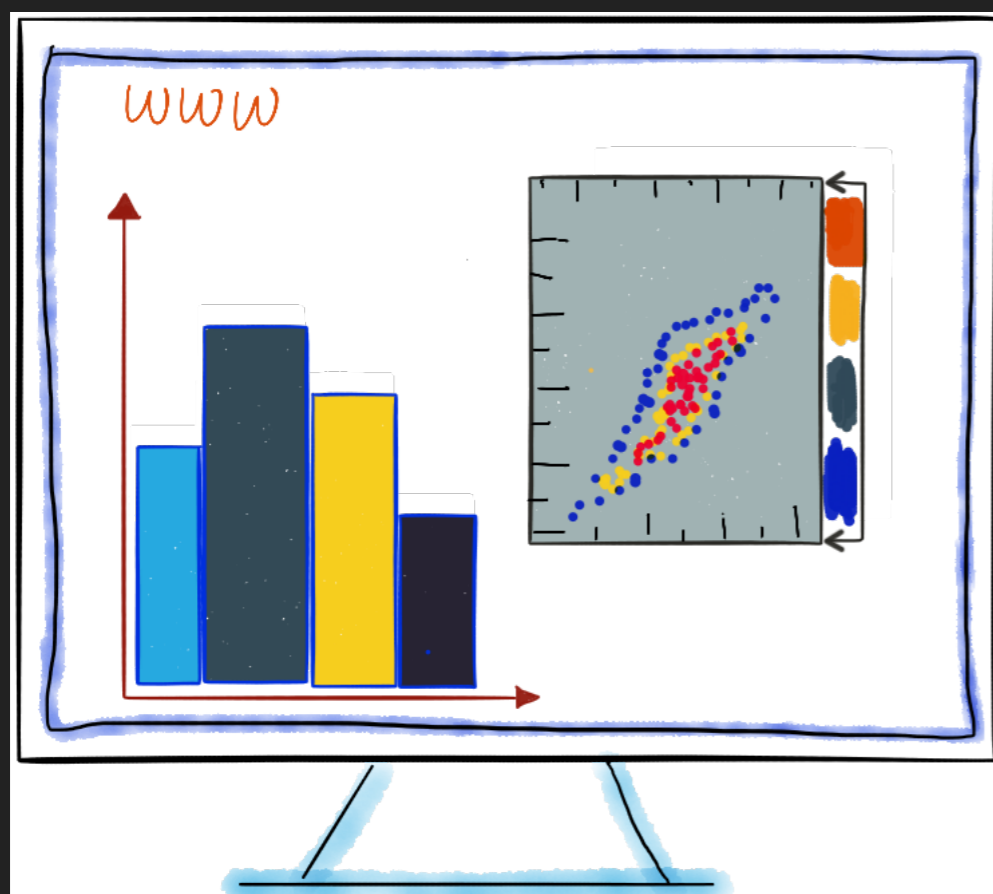
THANKS!

- ▶ meirin.oan.evans@cern.ch
- ▶ me338@sussex.ac.uk
- ▶ Any questions?



opendata.atlas.cern





BACKUP

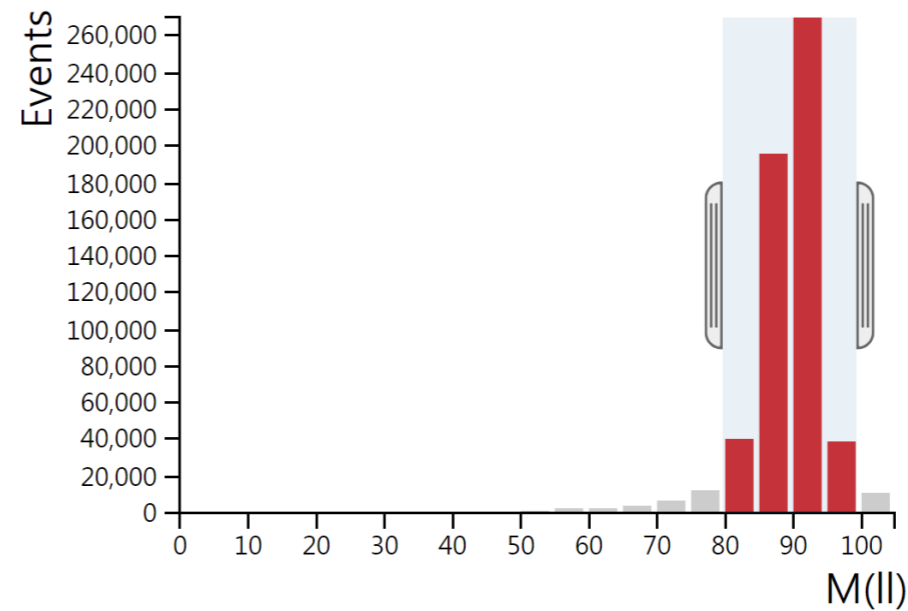
WHAT IS ATLAS OPEN DATA?

ARTICLES



[ATLAS' Higgs ML Challenge data open to public](#)

Reconstructed Dilepton Mass [GeV]



[Explore LHC Data on new ATLAS educational platform](#)



[Dortmund students work with ATLAS data](#)



[Boosting high-energy physics education around the world with ATLAS Open Data](#)



WHAT IS ATLAS OPEN DATA?

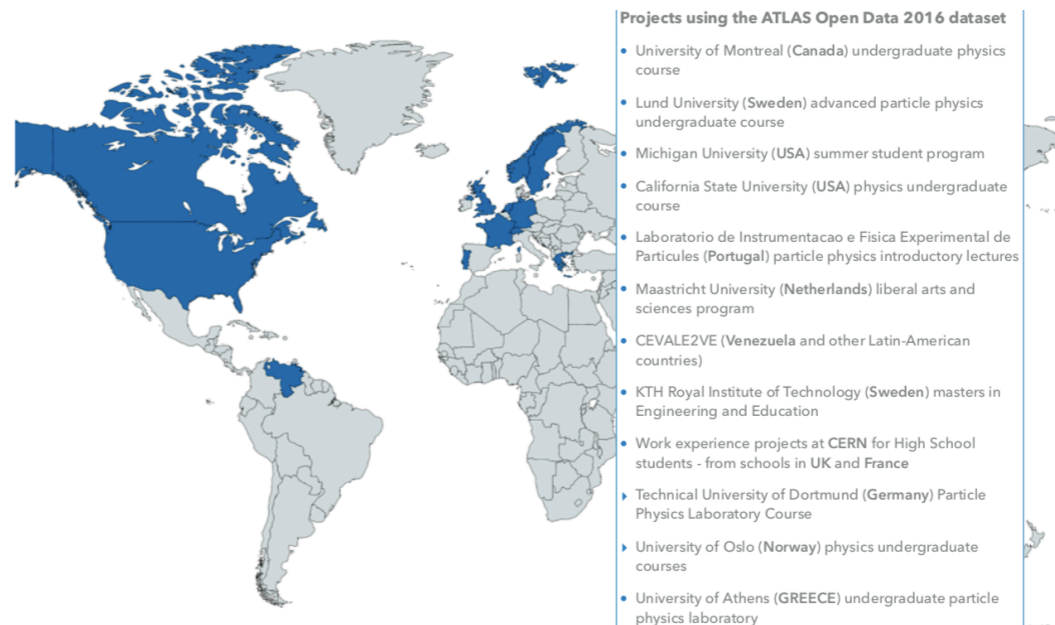
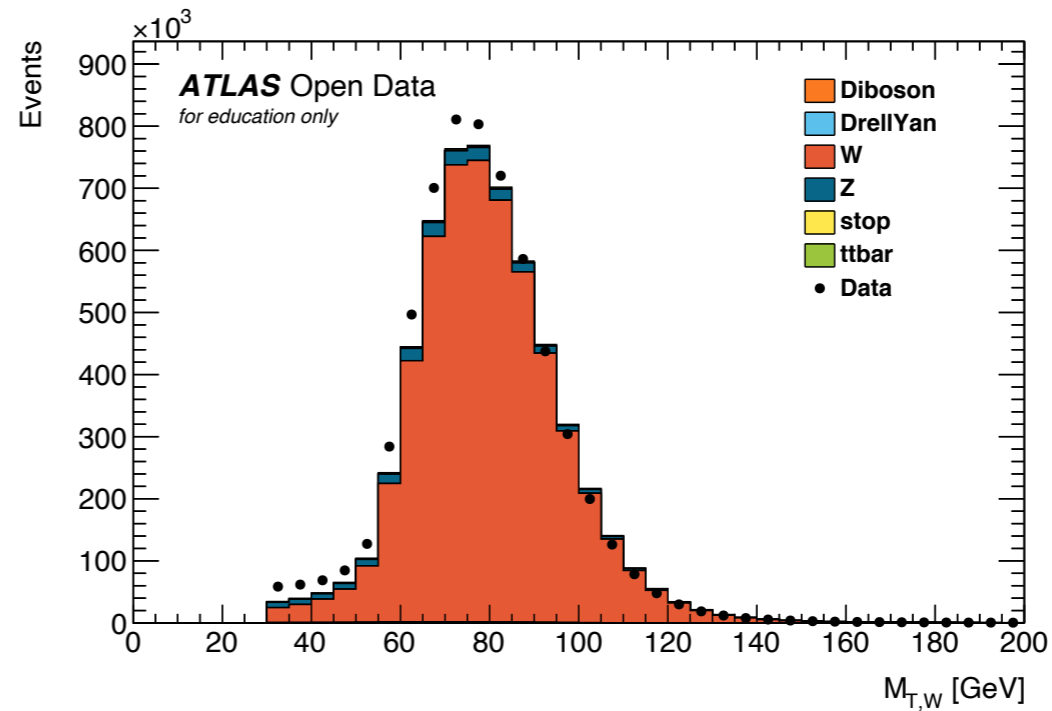
REVIEWS

[Review of ATLAS Open Data Dataset](#)

written after dataset release

[Review of ATLAS Open Data 8 TeV datasets, tools & activities](#)

written after user feedback



WORLDWIDE USE

Final year projects
Sussex
US
UNIVERSITY OF SUSSEX

Lab course
Dortmund
tu

Lab course
Göttingen
GA
1737

Switzerland
Users: 297
Lab course
Manchester
MANCHESTER
1824
The University of Manchester

Lab course
Dresden
TU

Web-based
interactive
learning tool
Georgia



WHAT DOES THIS HAVE TO DO WITH MATHS METHODS?

VIRTUAL MACHINE

WHAT DOES THIS HAVE TO DO WITH MATHS METHODS?

MACHINE LEARNING

- ▶ We're in constant contact & communication with other groups looking at public data
- ▶ Like ATLAS Machine Learning