

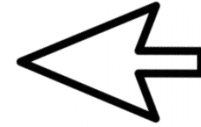


Reproducing the Higgs to 2 photons ATLAS Open Data analysis

Leonid Serkin

INFN Gruppo Collegato di Udine and ICTP Trieste

Run online the Hyy C++ framework (code.viewer)



or direct link:

https://nbviewer.jupyter.org/github/atlas-outreach-data-tools/notebooks-collection-opendata/blob/master/13-TeV-examples/python/ATLAS_OpenData_13-TeV_python_full_HyyAnalysis_5min.ipynb

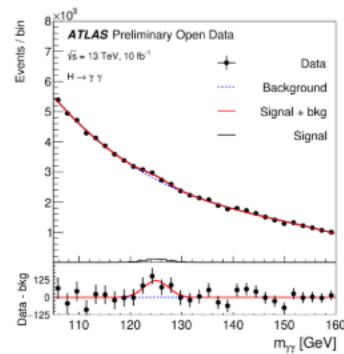
Run online the Hyy C++ framework ([code](#), [viewer](#))



Get running the full Hyy analysis using the 13 TeV dataset in 5 minutes!

Introduction The analysis is based on the 13 TeV Open Data. The ATLAS note [ATL-OREACH-PUB-2020-001](#) can be used as a guide on the content, properties, capabilities and limitations of the released datasets.

In the following, in about 5 minutes we are going to re-produce the H- $\gamma\gamma$ analysis plots from the note.



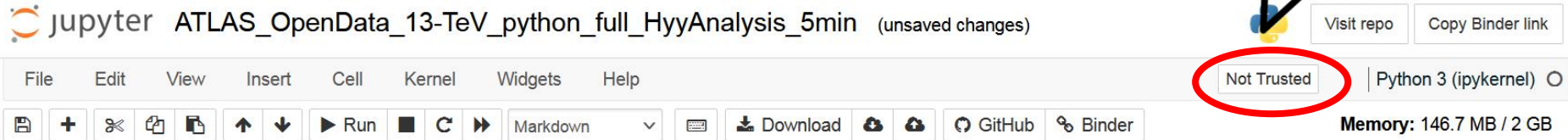
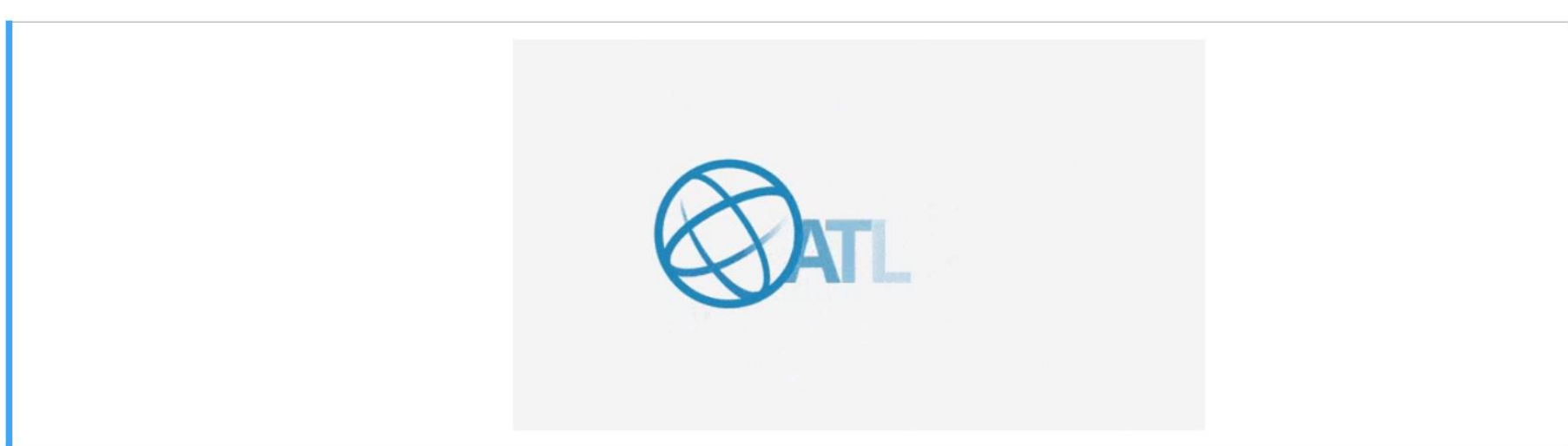
Run online the Hyy analysis on Binder

Run online the Hyy C++ framework ([code](#), [viewer](#))

jupyter ATLAS_OpenData_13-TeV_python_full_HyyAnalysis_5min (unsaved changes)

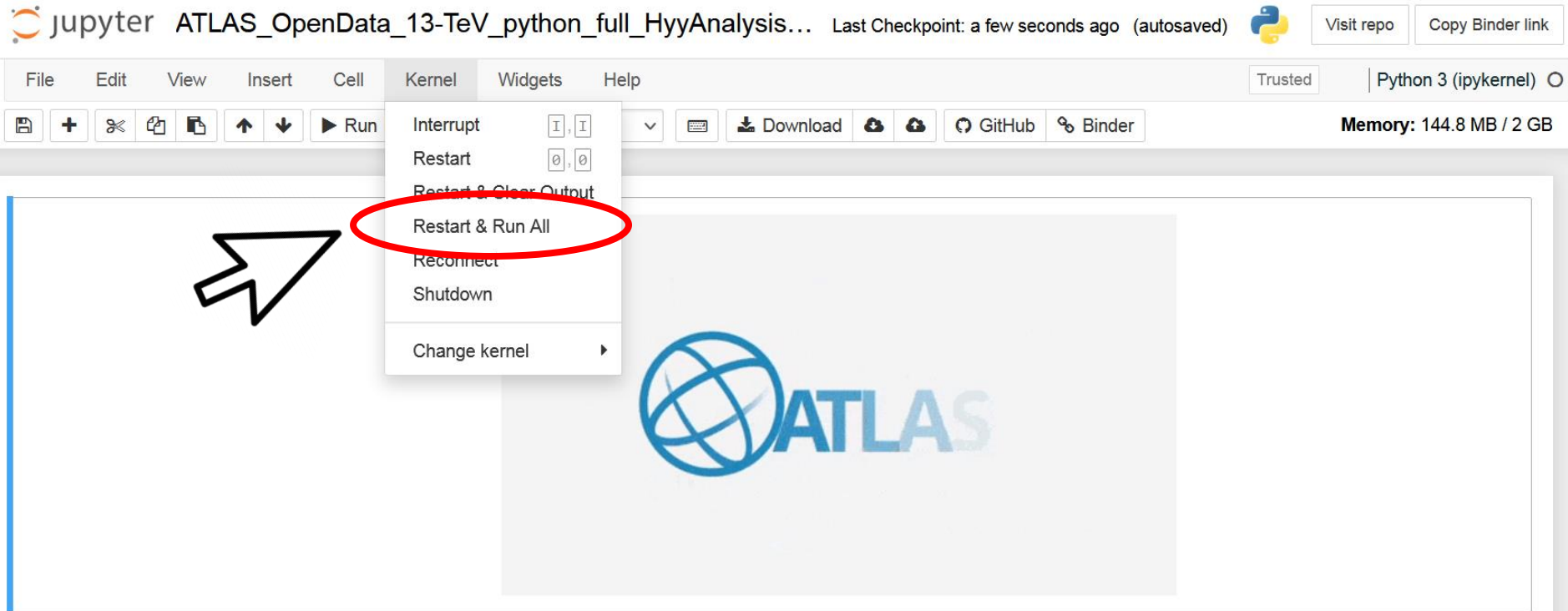
File Edit View Insert Cell Kernel Widgets Help

Not Trusted Python 3 (ipykernel) Memory: 146.7 MB / 2 GB

A screenshot of a JupyterLab interface. At the top, it says 'jupyter ATLAS_OpenData_13-TeV_python_full_HyyAnalysis_5min (unsaved changes)'. Below that is a menu bar with 'File', 'Edit', 'View', 'Insert', 'Cell', 'Kernel', 'Widgets', and 'Help'. A toolbar contains icons for file operations, a 'Run' button, a 'Markdown' dropdown, and 'Download', 'GitHub', and 'Binder' buttons. On the right, there are buttons for 'Visit repo' and 'Copy Binder link'. A 'Not Trusted' warning is circled in red, with a mouse cursor pointing to it. The memory usage is shown as 'Memory: 146.7 MB / 2 GB'.

Get running the full Hyy analysis using the 13 TeV dataset in 5 minutes!

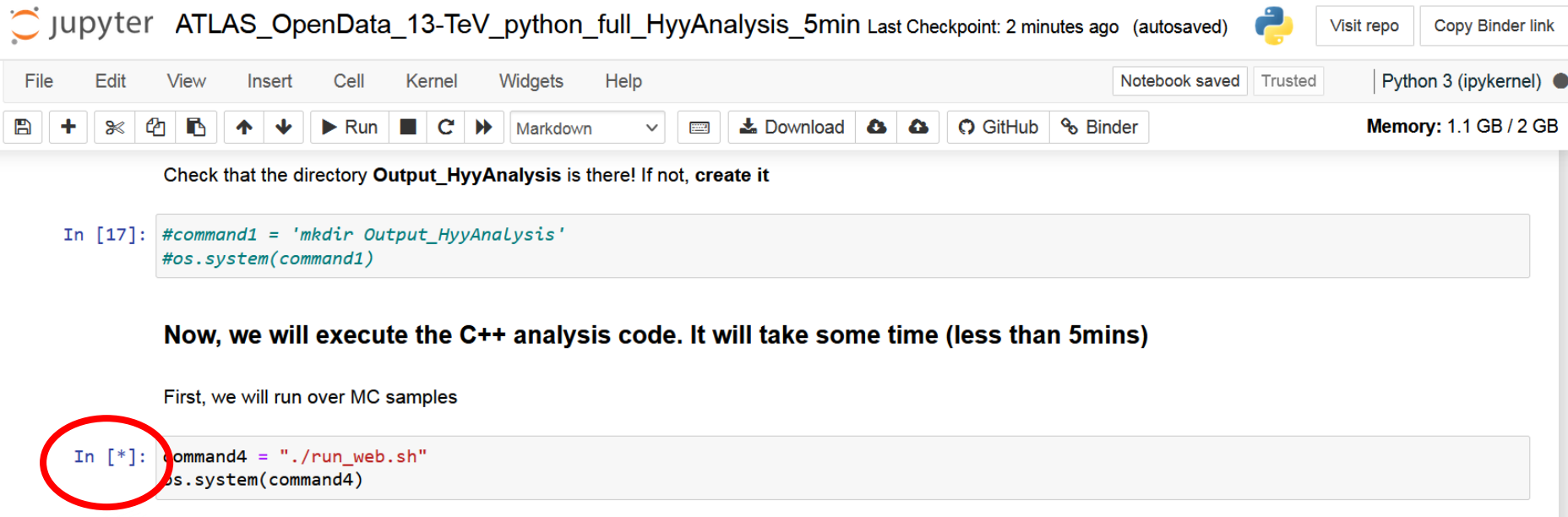
Run online the Hyy C++ framework ([code](#), [viewer](#))



The screenshot shows a JupyterLab interface for a Binder environment. The top bar displays the Jupyter logo, the repository name "ATLAS_OpenData_13-TeV_python_full_HyyAnalysis...", and the last checkpoint time "Last Checkpoint: a few seconds ago (autosaved)". There are buttons for "Visit repo" and "Copy Binder link". The main interface includes a menu bar with "File", "Edit", "View", "Insert", "Cell", "Kernel", "Widgets", and "Help". Below the menu bar is a toolbar with icons for "Run", "Download", "GitHub", and "Binder". The "Kernel" menu is open, showing options: "Interrupt", "Restart", "Restart & Clear Output", "Restart & Run All" (circled in red), "Reconnect", "Shutdown", and "Change kernel". A mouse cursor points to the "Restart & Run All" option. The main content area displays the ATLAS logo.

Get running the full Hyy analysis using the 13 TeV dataset in 5 minutes!

Run online the Hyy C++ framework ([code](#), [viewer](#))



jupyter ATLAS_OpenData_13-TeV_python_full_HyyAnalysis_5min Last Checkpoint: 2 minutes ago (autosaved) Visit repo Copy Binder link

File Edit View Insert Cell Kernel Widgets Help Notebook saved Trusted Python 3 (ipykernel) Memory: 1.1 GB / 2 GB

Check that the directory **Output_HyyAnalysis** is there! If not, **create it**

```
In [17]: #command1 = 'mkdir Output_HyyAnalysis'
#os.system(command1)
```

Now, we will execute the C++ analysis code. It will take some time (less than 5mins)

First, we will run over MC samples

```
In [*]: command4 = "./run_web.sh"
os.system(command4)
```

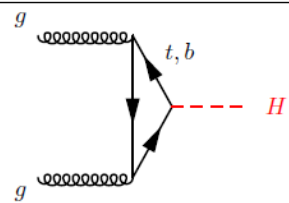
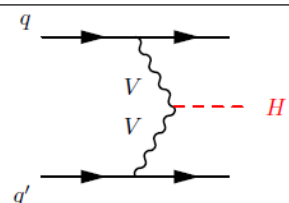
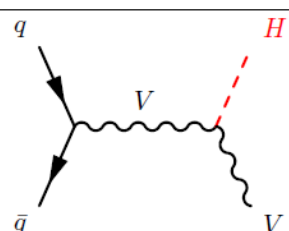
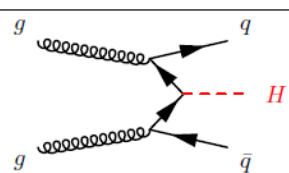
[*] means it is running this particular command

Takes 15-20 mins to run in Binder

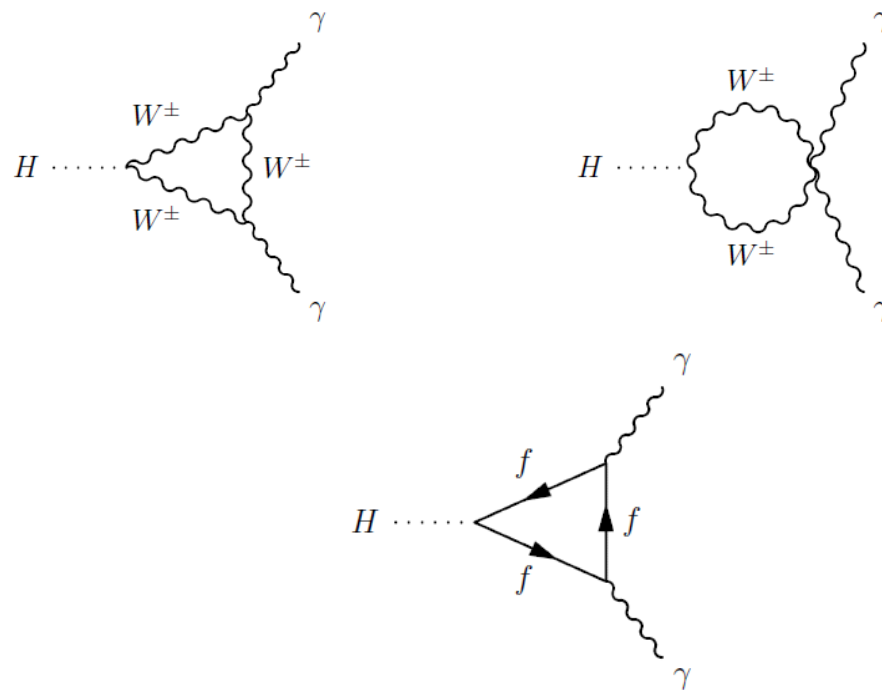
inputs are taken directly from
<http://opendata.cern.ch/eos/>

- SM Higgs boson decaying into 2 photons:

Production

Production mode	LO diagram
ggF production	
VBF production	
VH production	
q-q-bar H production	

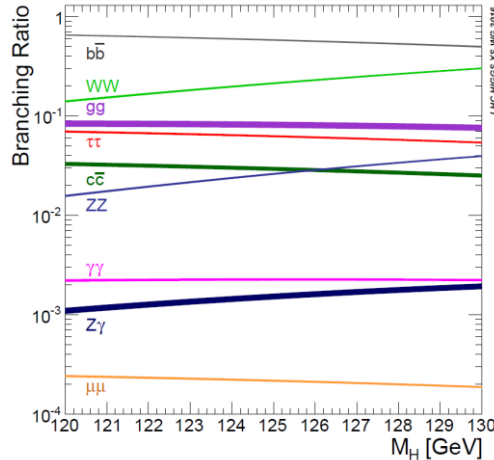
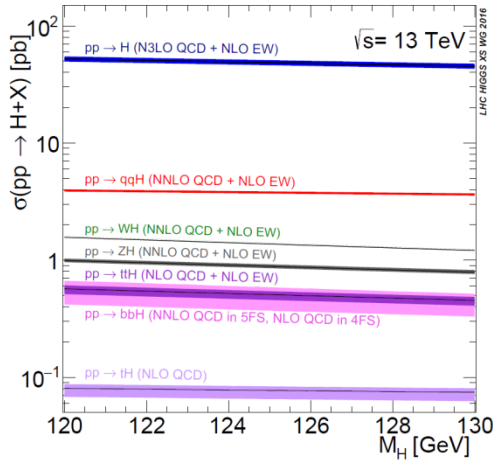
Decay



- SM Higgs boson decaying into 2 photons:

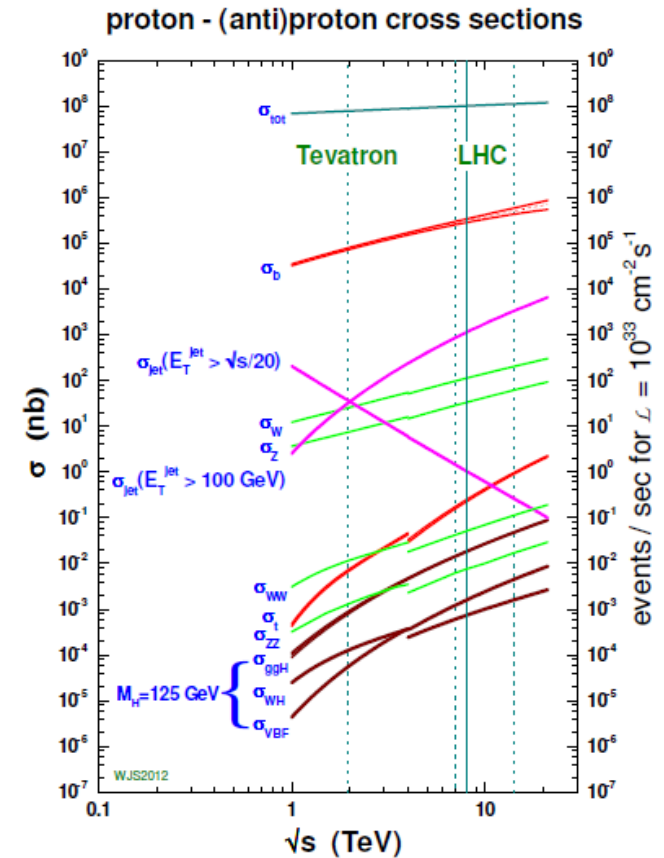
Cross-section and branching

LHC Higgs Working Group



$$BR(H \rightarrow \gamma\gamma)|_{m_H=125.09\text{GeV}} \approx 0.227\%$$

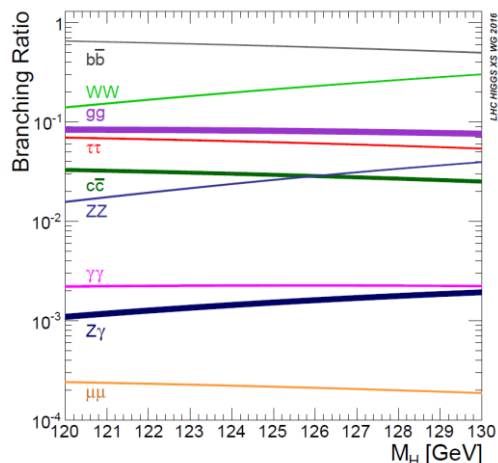
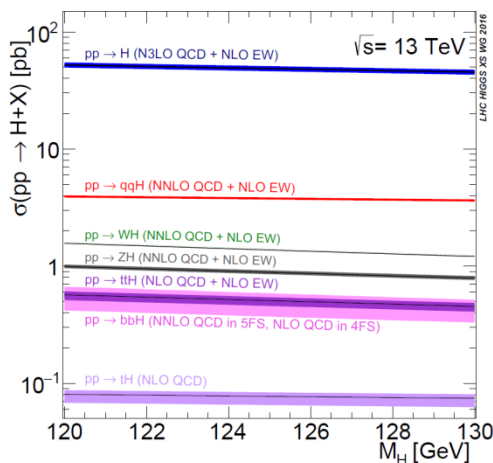
Background



- SM Higgs boson decaying into 2 photons:

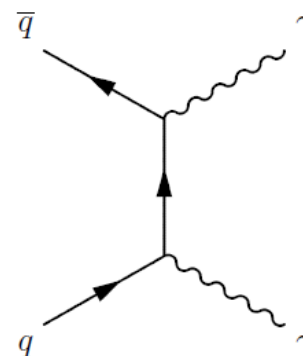
Cross-section and branching

[LHC Higgs Working Group](#)

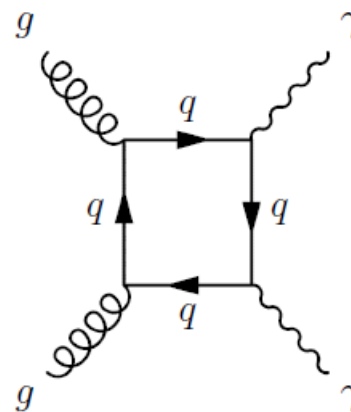


$$BR(H \rightarrow \gamma\gamma)|_{m_H=125.09\text{GeV}} \approx 0.227\%$$

Background



Born process



Box or quark loop process

- 13 TeV ATLAS Open Data $H \rightarrow \gamma\gamma$ analysis



Based on:

[PRD 98 \(2018\) 052005](#)

11th January 2019

Measurements of Higgs boson properties in the diphoton decay channel with 36 fb^{-1} of pp collision data at $\sqrt{s} = 13 \text{ TeV}$ with the ATLAS detector

The ATLAS Collaboration

Simplified selection:

- 2 photons with $p_T > 35, 25 \text{ GeV}$
- $E_T / m(\gamma\gamma) > 0.35(0.25)$
- $105 \text{ GeV} < m(\gamma\gamma) < 160 \text{ GeV}$

Background:

Estimated from data, without the use of MC simulation, by fitting the diphoton invariant-mass distribution in a range (105 -- 160 GeV) with a third-order polynomial function with free shape and normalisation parameters

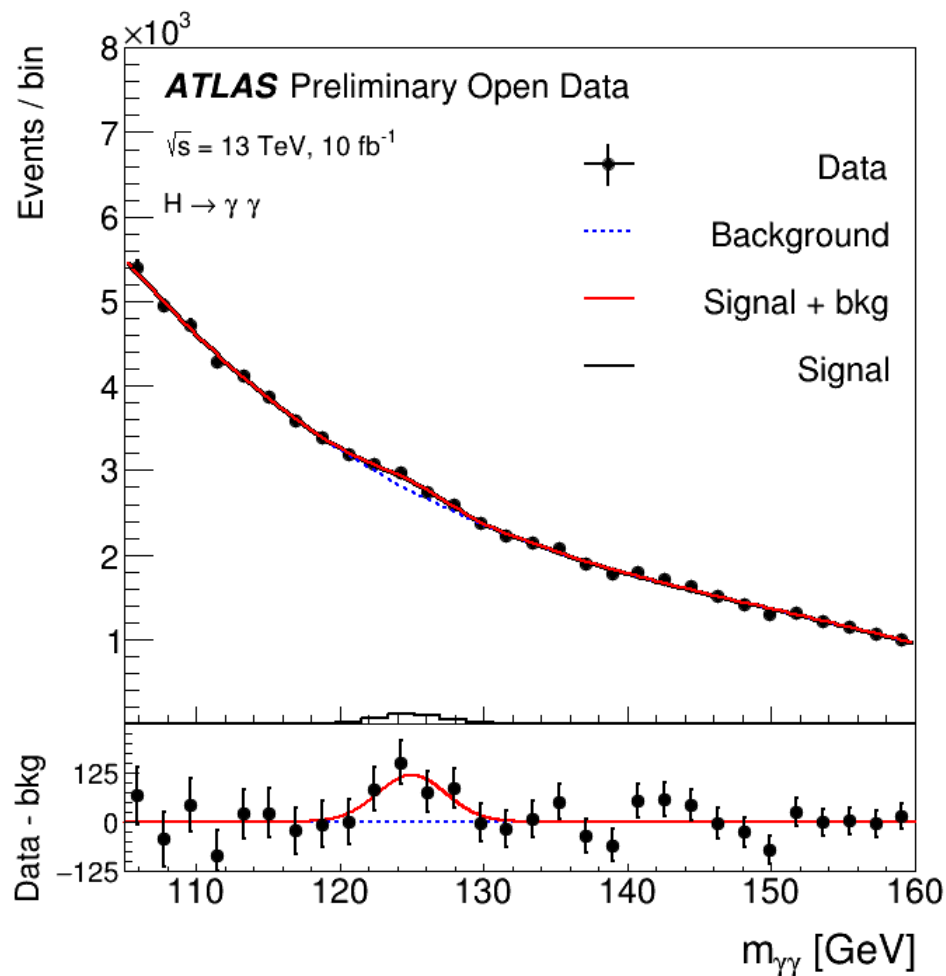
Signal:

Signal MC simulations of the five main Higgs-boson production mechanisms (ggF, VBF, WH, ZH, ttH) are used to model the shape of the invariant mass of the signal, modelled as a Gaussian function

- 13 TeV ATLAS Open Data $H \rightarrow \gamma\gamma$ analysis



Figure to be produced:



- 13 TeV ATLAS Open Data $H \rightarrow \gamma\gamma$ analysis

[documentation](#)

or direct link

<http://opendata.atlas.cern/release/2020/documentation/physics/YY.html>

A set of multiple notebooks using 13 TeV ATLAS Open Data

[github](#)

or

direct link:

<https://github.com/atlas-outreach-data-tools/notebooks-collection-opendata>

☰ README.md

ATLAS Open Data

notebooks-collection-opendata

A set of multiple notebooks using 8 TeV and 13 TeV ATLAS Open Data datasets

To execute in MyBinder: 

Note: before starting running the code in the jupyter notebooks, click on the up right button "not trusted" in order to get "trusted" displayed. This should lead the JavaScript to be executed, that is useful to visualise interactive histograms. If that doesn't work, simply go to the top of the notebook, find the cell that contains the line of code `%jsroot` and comment out that.

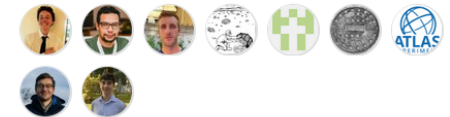
For more, please go to: <http://opendata.atlas.cern>

@2021

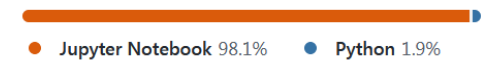
Packages

No packages published

Contributors 9



Languages



The image shows a screenshot of a Binder notebook interface. The left sidebar displays a file explorer with the following files:

Name	Last Modified
ATLAS_OpenData_13-TeV_analysis_example-cpp_Hyy_channel.ipynb	2 minutes ago
ATLAS_OpenData_13-TeV_simple_cpp_example_histogram.ipynb	5 months ago

The main area shows a notebook titled "ATLAS_OpenData_13-TeV_ar" with a histogram plot titled "Diphoton inva". The y-axis is labeled "Events / bin" and ranges from 0 to 200,000. The histogram shows a distribution of events per bin, with a peak around 200,000 events per bin.

1. Setup ROOT, some gcc version and git

2. Clone the repository:

```
git clone https://github.com/atlas-outreach-data-tools/atlas-outreach-cpp-framework-13tev.git
```

3. cd atlas-outreach-cpp-framework-13tev

4. execute the welcome script with option 1:

```
./welcome.sh
```

5. go to the analysis directory

```
cd Analysis/HyyAnalysis
```

6. execute the analysis script with options 0 and then 0 (no PROOF):

```
./run.sh
```

7. go to the Plotting directory:

```
cd ../../Plotting/
```

8. execute the plotting script with options 9 and 0:

```
./plotme.sh
```

9. Take a look at the plots in histograms/

For those working on CERN Ixplus

Try to setup root 6.08 with gcc6.2:

```
lsetup "root 6.08.06-x86_64-slc6-gcc62-opt"  
lsetup git
```

open **main_HyyAnalysis.C**

find the line and uncomment the path

```
/* Local path example */
```

```
TString path = "/eos/project/a/atlas-outreach/projects/open-  
data/OpenDataTuples/renamedLargeRJets/GamGam/";
```

then comment the online path

```
/* The URL to the CERN Open Data portal repository */
```

```
TString path = "http://opendata.cern.ch/eos/opendata/atlas/OutreachDatasets/2020-01-22/GamGam/";
```

by doing this, you will be reading the files from atlas eos

For those working on Trieste farm “farmts”

open **main_HyyAnalysis.C**

use a new local path

```
TString path = " /eos/infnts/atlas/public/OpenDataTuples/GamGam/";
```

by doing this, you will be reading the files from the infnts eos

