



# C++ framework to analyse 13 TeV ATLAS Open Data

## • C++ Analysis Framework

- ✓ It is a collection of C++ macros and scripts that work under ROOT with 12 analysis examples in a broad set of physics, objects and final states
- ✓ It contains a single folder per analysis examples and each folder contains only 4 C++ files and a BASH script
- ✓ It has a single folder for the Plotting area where all the analysis are included for producing the final plots
- ✓ It is accessible in the CERN and ATLAS Open Data websites, supports serial and parallel execution (PROOF) and works in the VM, MyBinder and SWAN platforms.

|            |                   |
|------------|-------------------|
| Analysis   | HWWAnalysis       |
|            | HZZAnalysis       |
| Plotting   | HyyAnalysis       |
|            | SUSYAnalysis      |
| README.md  | SingleTopAnalysis |
| welcome.sh | TTbarAnalysis     |

|                       |
|-----------------------|
| WBosonAnalysis        |
| WZDiBosonAnalysis     |
| ZBosonAnalysis        |
| ZPrimeBoostedAnalysis |
| ZTauTauAnalysis       |
| ZZDiBosonAnalysis     |

```

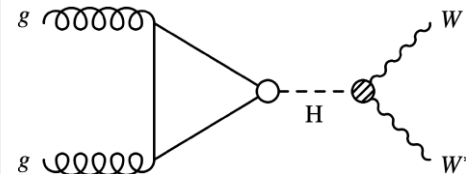
for(unsigned int i=0; i<photon_n; i++)
{
  // photons are tight
  if( photon_isTightID->at(i) )
  {
    // photons with 25 GeV and excluding the transition region between the barrel and endcap calorimeters
    if( photon_pt->at(i) >25000. && TMath::Abs(photon_eta->at(i))<2.37 && ( TMath::Abs(photon_eta->at(i)) < 1.37
    {
      goodphoton_n = goodphoton_n + 1;
      goodphoton_index[photon_index] = i;
      photon_index++;
    }
  }
}

```

Based on:

**Measurements of gluon–gluon fusion and vector-boson fusion Higgs boson production cross-sections in the  $H \rightarrow WW^* \rightarrow e\nu\mu\nu$  decay channel in  $pp$  collisions at  $\sqrt{s} = 13$  TeV with the ATLAS detector**

The ATLAS Collaboration

[Phys. Lett. B 789 \(2019\) 508](#)

Simplified selection:

- Single-electron or single-muon trigger satisfied;
- Exactly two isolated, different-flavour opposite-sign leptons (electrons or muons) with  $p_T > 22$  and 15 GeV, respectively;
- Missing transverse momentum  $E_T^{\text{miss}}$  larger than 30 GeV;
- Exactly zero or at most one jet with  $p_T > 30$  GeV, and exactly zero  $b$ -tagged jets (MV2c10 @ 85% WP) with  $p_T > 20$  GeV;
- Azimuthal angle between  $E_T^{\text{miss}}$  and the dilepton system  $\Delta\phi(\ell\ell, E_T^{\text{miss}}) > \pi/2$ ;
- Transverse momentum of the dilepton system  $p_T^{\ell\ell} > 30$  GeV;
- The invariant mass of the two leptons  $m_{\ell\ell}$  must satisfy:  $10 \text{ GeV} < m_{\ell\ell} < 55 \text{ GeV}$ ;
- Azimuthal angle between the two leptons  $\Delta\phi(\ell, \ell) < 1.8$ .

HWW  
Analysis

## How to run the analysis:



## HWW Analysis

1.)

Analysis

Plotting

README.md

welcome.sh

3.)

HWWAnalysis.C

HWWAnalysis.h

HWWAnalysisHistograms.h

main\_HWWAnalysis.C

run.sh

2.)

HWWAnalysis

HZZAnalysis

HyyAnalysis

SUSYAnalysis

SingleTopAnalysis

TTbarAnalysis

WBosonAnalysis

WZDiBosonAnalysis

ZBosonAnalysis

ZPrimeBoostedAnalysis

ZTauTauAnalysis

ZZDiBosonAnalysis

4.)

```
-bash-4.2$ ./run.sh
Which option should I run?
Options are:
0 = run all data and MC one after another
11,12,13,14 = run data only (can be run in parallel)
2,3,4,5,6 = run MC samples only (can be run in parallel)
2
Option is 2
Should I use PROOF? (will make things faster)
Options are:
0 = NO
1 = YES
0
PROOF option is 0
starting ROOT
Warning in <TClass::Init>: no dictionary for class ROOT::TIOFeatures is available
Info in <TUnixSystem::ACLiC>: creating shared library Analysis/HWWAnalysis/./HWWAnalysis_C.so
Starting analysis with process option: ZqqZll
Analysed a total of: 50000 events out of 1403146 in this sample
Analysed a total of: 100000 events out of 1403146 in this sample
Analysed a total of: 150000 events out of 1403146 in this sample
Analysed a total of: 200000 events out of 1403146 in this sample
```

How to plot  
the results:



HWW  
Analysis

1.) Analysis

Plotting

README.md

welcome.sh

3.)

```
-bash-4.2$ ./plotme.sh
WELCOME!! Which analysis you want to plot?
Input your option now (and click <ENTER>):
0 = WBosonAnalysis
1 = ZBosonAnalysis
2 = TTbarAnalysis
3 = SingleTopAnalysis
4 = WZDiBosonAnalysis
5 = ZZDiBosonAnalysis
6 = HbbAnalysis
7 = HZZAnalysis
8 = ZTauTauAnalysis
9 = HyyAnalysis
10 = SUSYAnalysis
11 = ZPrimeBoostedAnalysis
11
Now, choose the location of the ZPrimeBoostedAnalysis output!
If the location corresponds to ../Analysis/ZPrimeBoostedAnalysis/Output_ZPrimeBoostedAnalysis: type 0
If you have a custom location path: type 1
0
Info in <TUnixSystem::ACliC>: creating shared library Plotting/./Plotting_cxx.so
Analysis option found, proceeding...
Reading list of histograms from: list_histos/HistoList_ZPrimeBoostedAnalysis.txt

Analysis: ZPrimeBoostedAnalysis, reading input from: inputfiles/Files_ZPrime.txt

Reading files from: ../Analysis/ZPrimeBoostedAnalysis/Output_ZPrimeBoostedAnalysis

====processing ZPrimeBoostedAnalysis====

Plotting histogram: hist_etmiss
Info in <TCanvas::Print>: png file histograms/hist_etmiss.png has been created
Info in <TCanvas::Print>: pdf file histograms/hist_etmiss.pdf has been created
```

2.)

inputfiles

list\_histos

Makefile

Plotting.cxx

Plotting.h

clean.sh

plotme.sh

<http://opendata.atlas.cern/release/2020/documentation/frameworks/cpp.html>

