FastJet hands-on session

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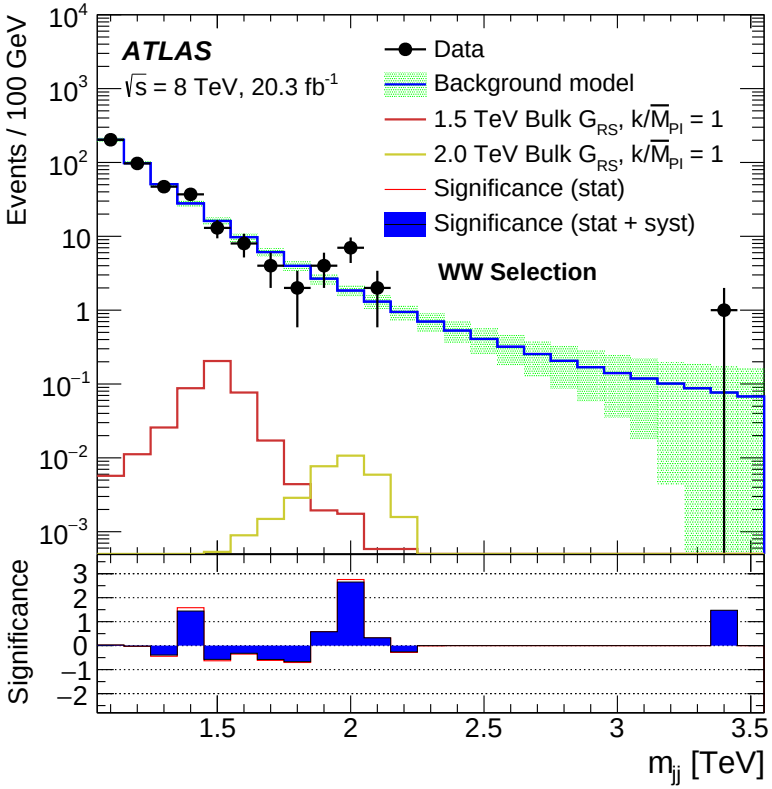
Motivation: ATLAS di-boson search



[arXiv:1506.00962]

- excess observed for a dijet invariant mass around 2 TeV in the WW channel ($X \to WW \to$ jets)
- $m_X \approx 2TeV \Rightarrow$ boosted W jets
- This was with 8 TeV data (20 fb^{-1}). Gone with more stat in 13 TeV data

Idea here: roughly reproduce that analysis

Files

On the USB stick, you'll find

- A bunch or README and instruction files
- Event files:
  - `Zp2WW-2TeV-nev1e3.PU14.gz`: an example signal file $Z' \to WW$, Ws decay hadronically, $M_{Z'} = 2$ TeV
  - `dijets-ptmingen400-nev1e4.PU14.gz`: background events (high-p_t dijets)
  - `dijets-ptmingen400-nev1e5.PU14.gz`: extended background sample
  - `mixed.PU14.gz`: mixed (unknown) signal+background sample (100k events)
- analysis codes in `C++` and `python`, and `GNUPlot` files

I will assume everyting is in a `fastjet-tutorial` directory

Basic workflow

Note: also described in the README files

1. Install `FastJet` (from within the `fastjet-tutorial` dir) following `http://fastjet.fr/quickstart.html`
2. go to the analysis directory (here `C++`) and run

```
make
./VV-search dijets-ptmingen400-nev1e4.PU14.gz dijets-init.hist 10000
./VV-search Zp2WW-2TeVnev1e3.PU14.gz signal-init.hist 1000
gnuplot plot-init.gp
evince plot.pdf
```

For the `python version, just run VV-search.py without make`

Comments/questions:

- The plot should show a smooth background and a large signal
- both pages are the same for now
- If you run the mixed sample, do you see the signal?

  (you should edit the .gp file)

The analysis

Look at `VV-search.cc`, or `VV-search.py` to see what it does (mostly basic jets and cuts)

Try improving things (look for "`HERE YOU CAN PLACE...`"):

- Impose a cut $|y_1 - y_2| < 1.2$ between the rapidities of the jets
  Can you figure out why this is effective at large dijet mass?
- Impose a cut on the individual jet masses (between 70 and 100 GeV)
- you might (optionally) want to add new histogrms to look at the $|y_1 - y_2|$ and jet mass distributions.
- Do you see the signal in the mixed sample now?

The analysis (cont'd)

Now try using the mass-drop tagger introduced in the lecture to further improve things/

- First define a mass-drop tagger

```
double mucut = 1.0;
double ycut = 0.2;
MassDropTagger mdt(mucut, ycut);
```

- For each jet (or a vector of jets), apply it via

```
PseudoJet mmdt_jet = mdt(jet)
```

- use these transformed jets to impose the mass cuts and reconstruct the dijet mass
- Do you see the signal in the mixed sample now?

Answer

$$m_X = \qquad \text{TeV}$$