

# Development of a class for synchronized display pads for ratio type plots in the ROOT framework

CERN Summer Student Session

Paul Gessinger

Johannes Gutenberg University Mainz

Supervisors:

Olivier Couet

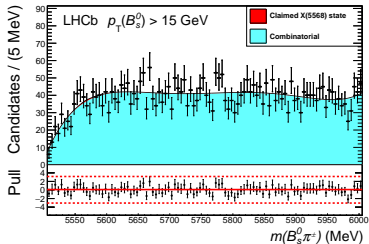
Lorenzo Moneta

09.08.2016

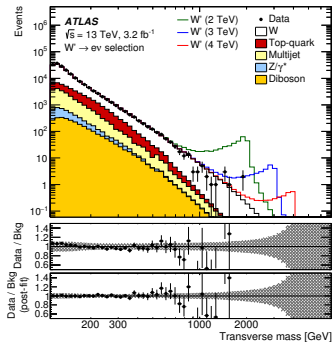
# The ROOT framework

- Scientific framework mainly written in C++
- Bridges to Python, R and others
- Widely used, especially in high energy physics
- Components for data management, plotting, analysis

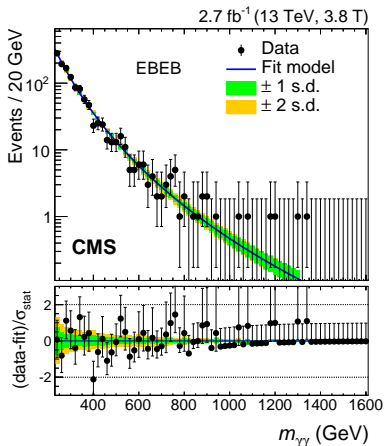
# Multiple linked pads



[2]



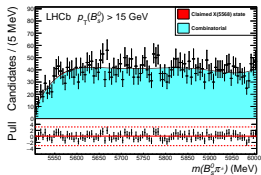
[1]



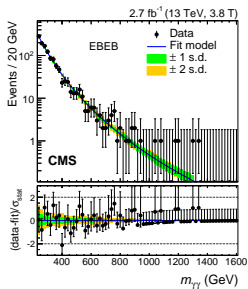
[3]

# Multiple linked pads

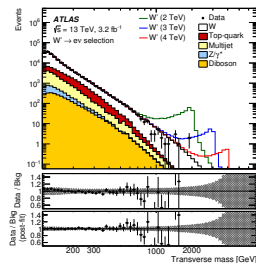
- Used in numerous contexts, but no standardized way to do it



[2]



[3]



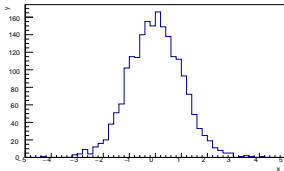
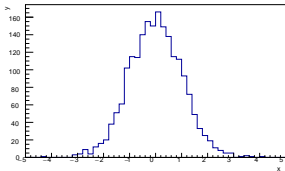
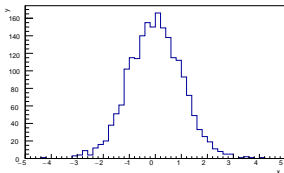
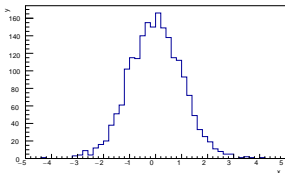
[1]

- Goal of project:

- ▶ Implement a class that links display pads together
- ▶ Consistent axes labels, ticks and marks
- ▶ Calculates lower plot, multiple different modes
- ▶ User interaction is possible, axes ranges, margins and options are synced
- ▶ Steerable through code with less repetition

# Structure of a plot in ROOT

- Hierarchy of pads
- Easy to divide into sub pads of equal size

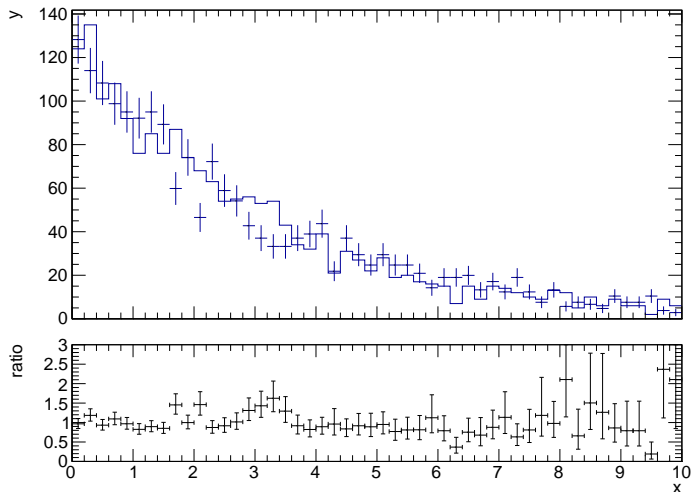


- Every pad is independent (ranges, zoom, properties)
- Not always desirable

# Introducing TRatioPlot

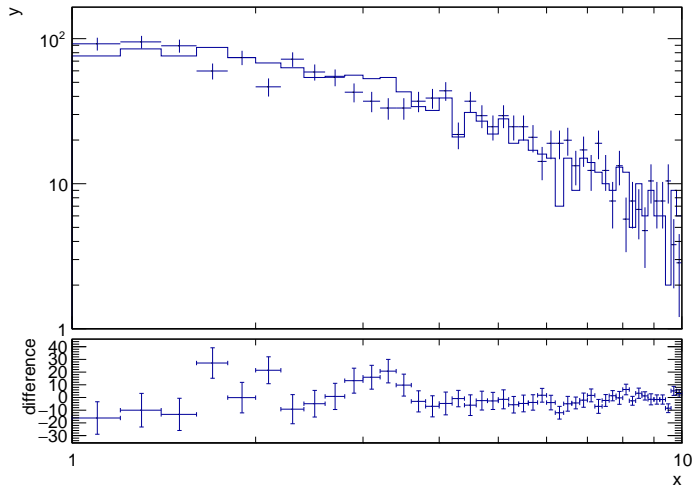
# Introducing TRatioPlot

Ratio of two histograms



# Introducing TRatioPlot

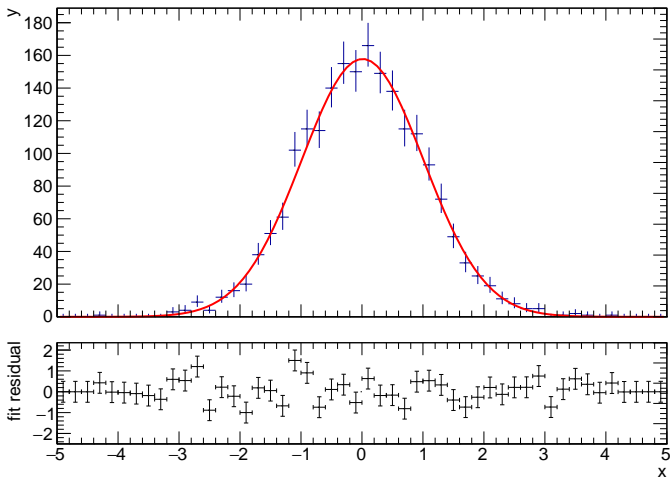
Difference between two histograms





# Introducing TRatioPlot

Residual of histogram and a fit



# Benefits

- Visual:
  - ▶ Uniform size units for labels, tickmarks, titles
  - ▶ Single shared x axis
  - ▶ Direct access to both pads for further drawing
- Automatic construction of ratio, difference with error calculated by TEfficiency, symmetric and asymmetric
- Automatic construction of fit residual with error calculation using poisson error, normal approximation
- Configurable with options
- Works well within regular sub pad structure

# Work in progress

- Basic implementation working
- Refinement in progress
- Documentation is pending
- Additional features:
  - ▶ Automatic drawing of gridlines at 0, 1 depending on plot type
  - ▶ Automatic drawing of confidence bands for fit residual based on fit parameter uncertainties
- Possible improvements:
  - ▶ Generalization to more than two pads

- [1] Morad Aaboud et al. "Search for new resonances in events with one lepton and missing transverse momentum in  $pp$  collisions at  $\sqrt{s} = 13$  TeV with the ATLAS detector". In: (2016). arXiv: 1606.03977 [hep-ex].
- [2] Roel Aaij et al. "Search for structure in the  $B_s^0 \pi^\pm$  invariant mass spectrum". In: (2016). arXiv: 1608.00435 [hep-ex].
- [3] Vardan Khachatryan et al. "Search for resonant production of high-mass photon pairs in proton-proton collisions at  $\sqrt{s} = 8$  and 13 TeV". In: *Phys. Rev. Lett.* 117.5 (2016), p. 051802. DOI: 10.1103/PhysRevLett.117.051802. arXiv: 1606.04093 [hep-ex].