H→ZZ→4L MEASUREMENTS AND CUT FLOW ANALYSIS

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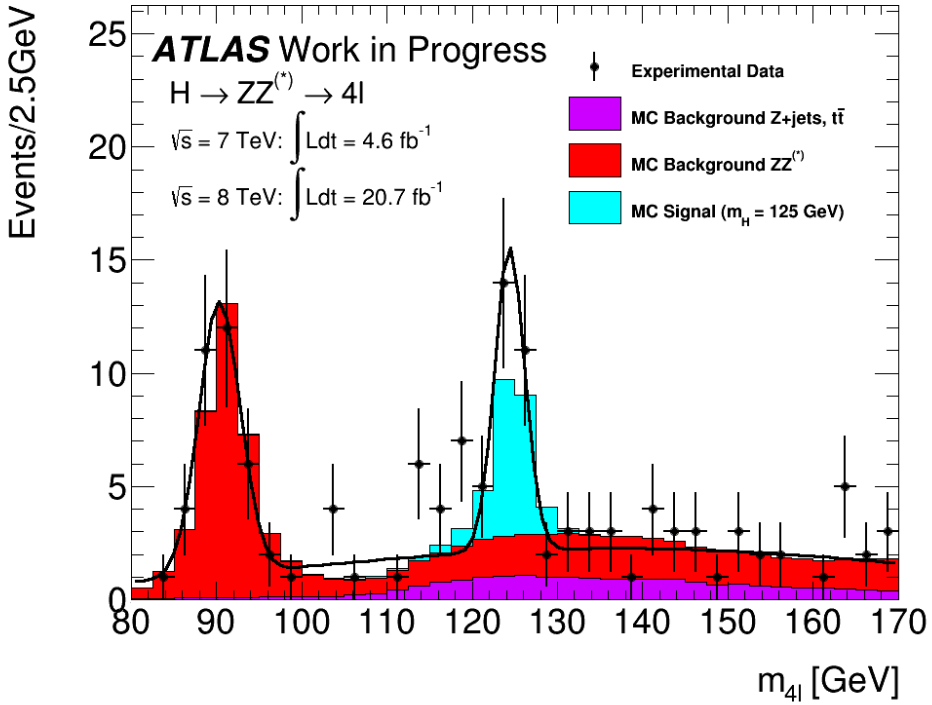
Higgs Mass Analysis

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Experimental Data Fit Results
Higgs Amplitude:   13.5
Higgs Mass:   124.4
Higgs #sigma:   1.8
Z Amplitude:   12.0
Z Mass:   90.3
Z #sigma:   2.4

Simulation Data Fit Results
Higgs Amplitude:   7.9
Higgs Mass:   124.6
Higgs #sigma:   2.5
Z Amplitude:   11.2
Z Mass:   91.0
Z #sigma:   2.9

Experimental Higgs Mass: 124.4 ± 0.4 GeV
Simulation Higgs Mass: 124.6 ± 0.5 GeV
Signal Strength: 1.7 ± 0.8
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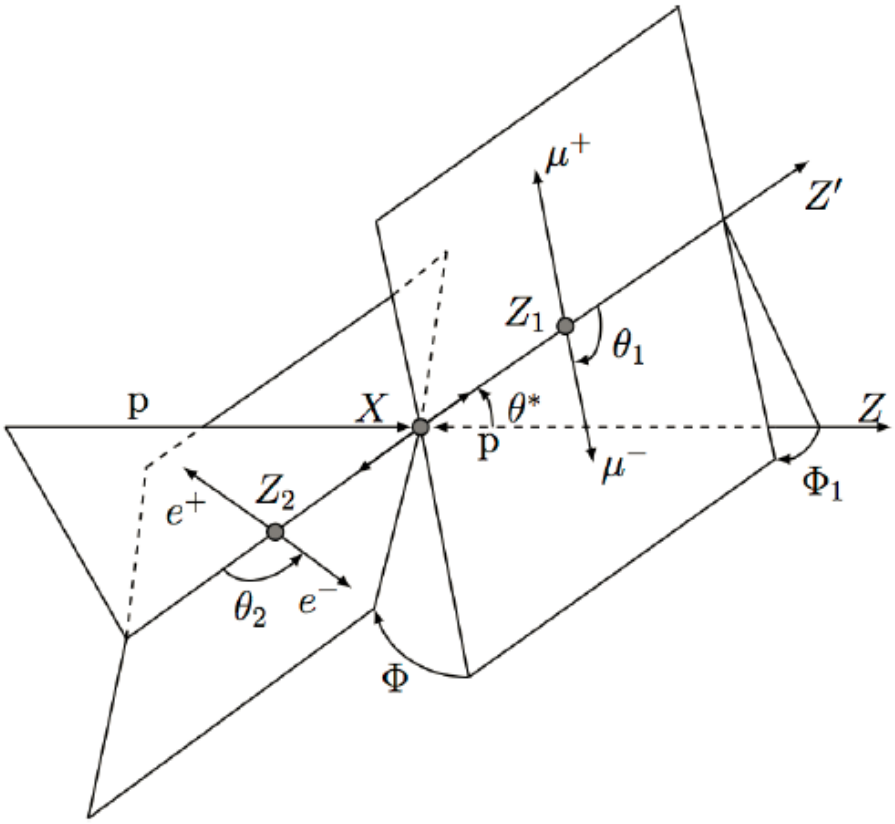
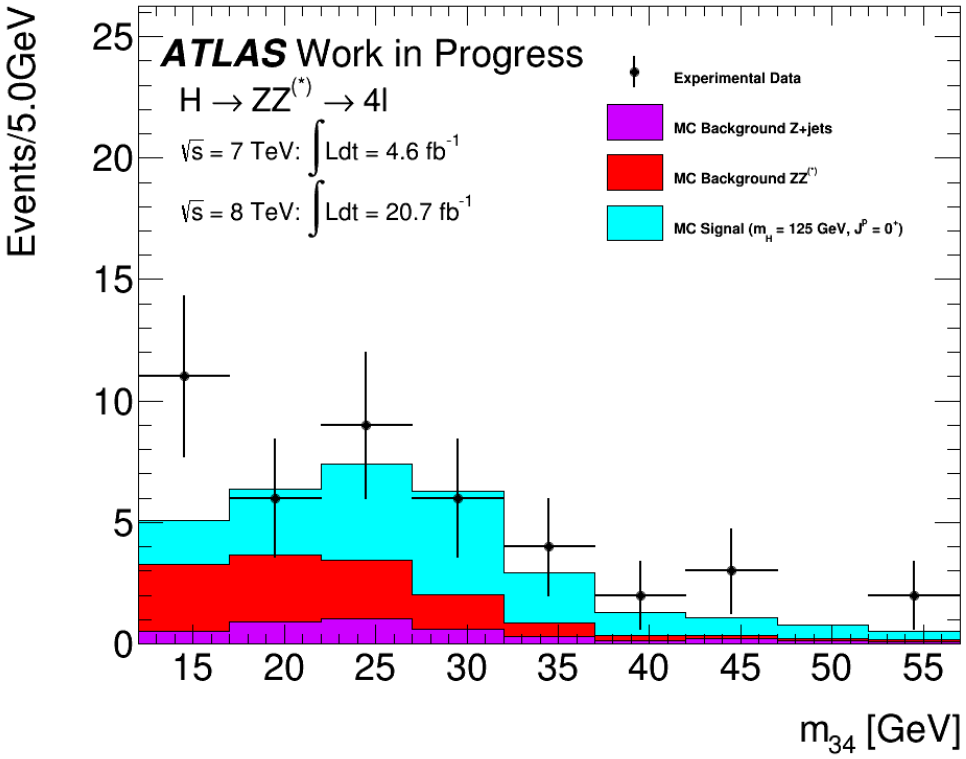
- Found using ROOT's Gaussian fit to both Z and Higgs Signals
- Current accepted mass (found using likelihood fits to simulation data): $124.3\ ^{+0.6}_{-0.5}\ (\text{stat})^{+0.5}_{-0.3}\ (\text{sys})$
- Altering normalization, signal shape, and uncertainty in the MC data (and optimizing) would allow for more precise mass measurement
- Altering normalization in MC data would allow for more precise signal strength measurement

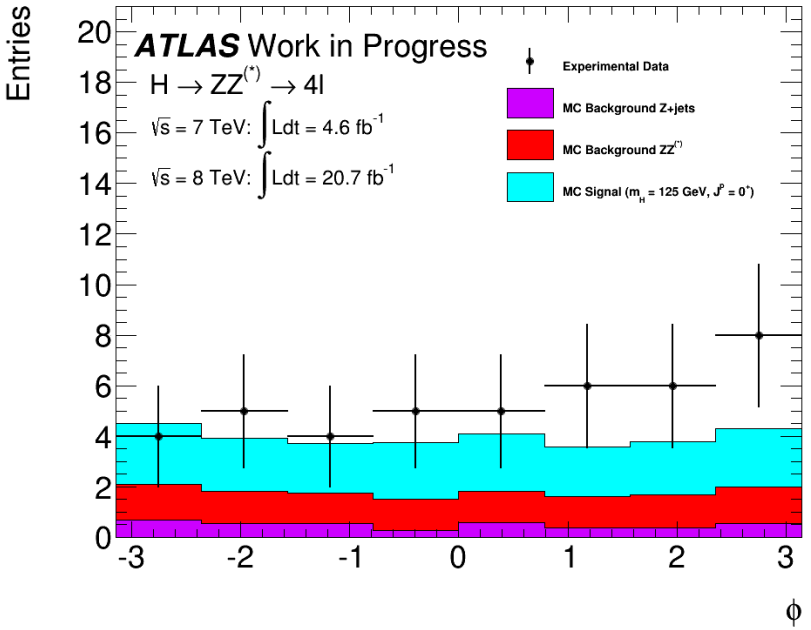
Higgs Spin Analysis

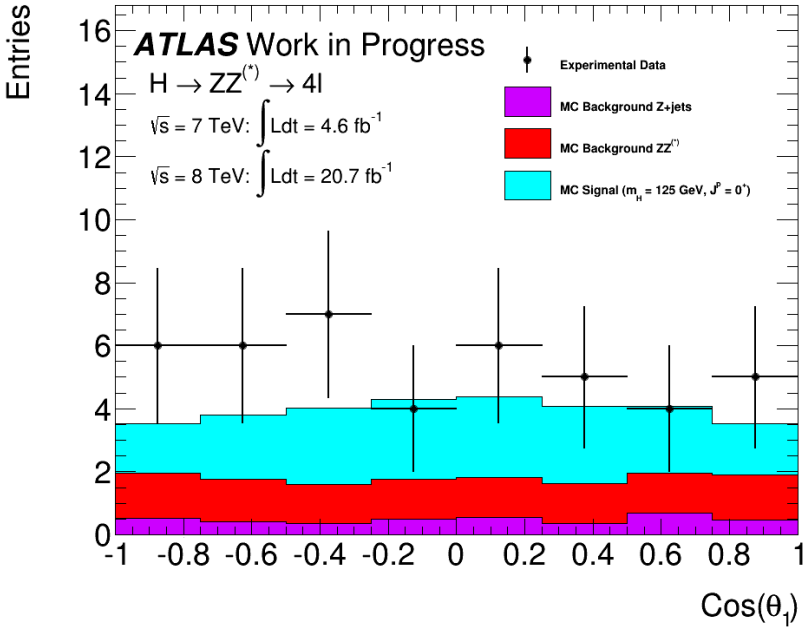
- Decay angles depend on spin/parity of Higgs
- Comparison tests between MC and Experimental Data
- Important information:
  - Φ – angle between planes for each lepton pair
  - $\cos(\theta_1)$ - angle between heavier pair of leptons
  - m_{34} mass of lighter Z boson



Higgs Spin Analysis







- Graphs comparing the experimental and MC data for spin 0^+
- Similar plots for spin $0^-, 1^+, 1^-, 2^+, 2^-$

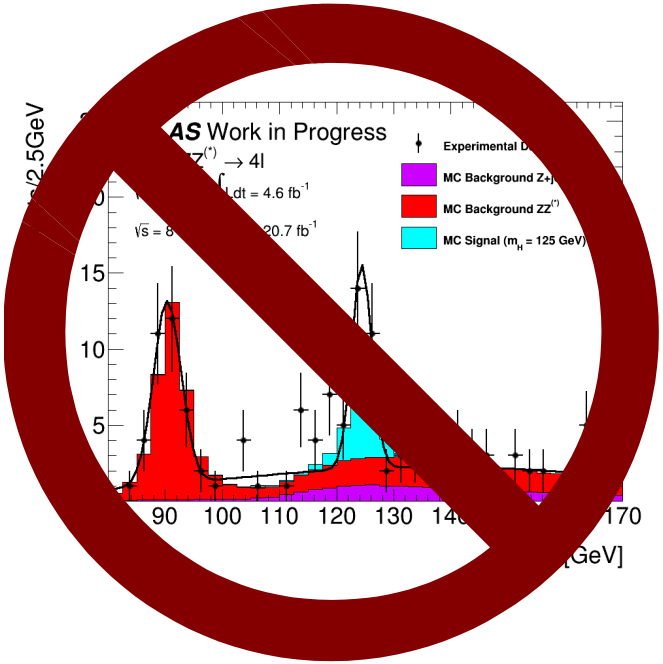
Higgs Spin Analysis Results

Spin/Parity	0p	0m	1p	1m	2p	2m
Kolmogorov Test						
Cos(Theta)	1.0	1.0	1.0	1.0	1.0	1.0
Phi	0.996	0.996	0.997	0.998	0.999	0.998
M34	0.996	0.975	0.947	0.953	0.976	1.0
Combined	0.997	0.99	0.981	0.984	0.991	0.999
Chi^2 Test						
Cos(Theta)	0.997	0.996	0.997	0.998	0.997	0.997
Phi	0.995	0.99	0.996	0.996	0.996	0.995
M34	0.931	0.928	0.549	0.773	0.904	0.961
Combined	0.974	0.971	0.847	0.922	0.966	0.984

- Two comparison tests: Kolmogorov-Smirnov and χ^2
- Spin 1 is disfavored (Higgs decays to two photons)
- Theoretical prediction: spin 0^+
- My results: spin 0^+ and 2^- are favored

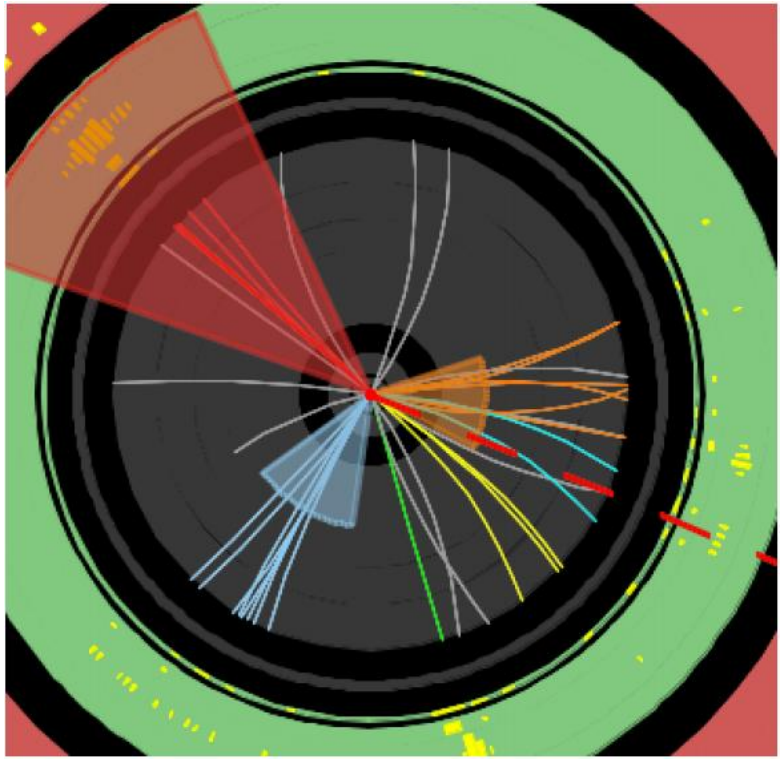
ATLAS Unblinding

- February 25: ATLAS unblinded update to H→4l experimental data
- Asked for Gaussian fits (earlier methods) to get quick visual data representation with approximate results
- Unfortunately, this data is still confidential, so I can't show any plots…



Seminar on Atlantis

- Hands-on seminar about new Java application (recommended by Dr. Teuscher)
- Visualizes raw event data from ATLAS detectors and allows user manipulation:
  - Selecting particle paths/hits
  - Summarizing resultant information about groups of particles
  - Different 3D views from all directions
- Little relation to current projects, but helped me understand how data from detectors is collected and stored



Cut-Flow Analysis

- In order to pare down the data taken by the ATLAS detector and the simulations, large cuts must be made to remove background and irrelevant data
- Some simple cuts:
  - Requirement of 2 pairs of same flavor opposite sign leptons
  - Electron $p_T > 6\ GeV,\ |\eta| < 2.47$
  - Muon $p_T > 6\ GeV,\ |\eta| < 2.7$
  - $50\ GeV < m_{12} < 106\ GeV,\ \ m_{threshold} < m_{34} < 115\ GeV$
- More complex alterations include isolation cuts, impact parameter significance, FSR corrections, smearing, data-driven normalization, etc…

Current Work with Cut-Flow Analysis

- Help of Fabien Tarrade and Haider Abidi
- Learning the ROOT programming necessary to make the aforementioned cuts
- Outputting relevant information to verify group's results and fixing bugs that might be causing discrepancies
- Future work includes rewriting the entire code
  - Refactoring/modularizing it to make it easier to understand and simpler to modify/debug (current files >7000 lines)
  - Change of initial data type from ROOT file to C++ objects
  - Adding additional cuts to more accurately pare down 2011/12 data and to prepare for 2015 (higher luminosity) data


Gillette