Optimization of the Cut-Based analysis in the H to WW* channel of the Gluon-Gluon Fusion

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The Standard Model

- Fundamental units of the Universe
- Three of the four fundamental forces
- All but first generations decay to lighter particles
- Fundamental particles can decay using "virtual" interaction particles.

Large Hadron Collider (LHC)

- Synchrotron

- 8.36 T (more than 100000 times stronger than earth)

- About 27 km long

- Discovered the Higgs Boson in 2012
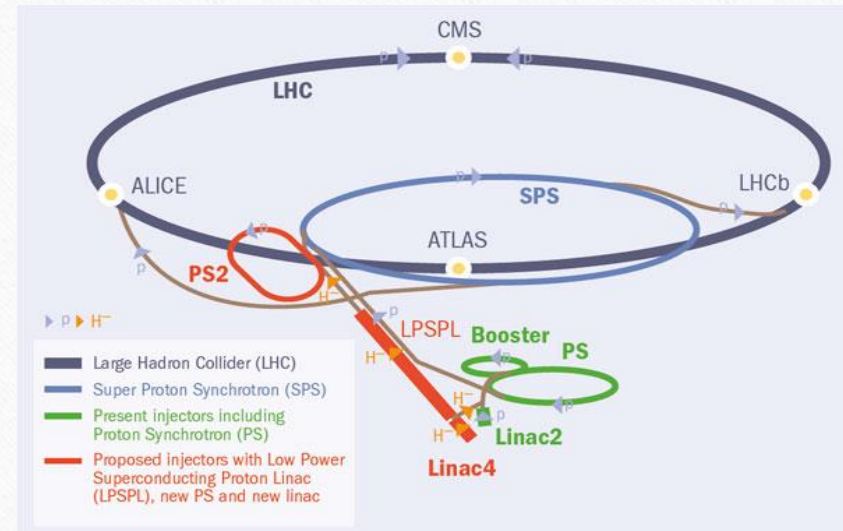
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ATLAS Detector

- One of the two detectors used to discover the Higgs Boson

- Inner detector – measures charged particle trajectories and momenta

- Calorimeters – measure the energy of specific particles (photon/electron-positron pairs or hadron showers)

- Muon chambers – measure momenta and trajectories of muons
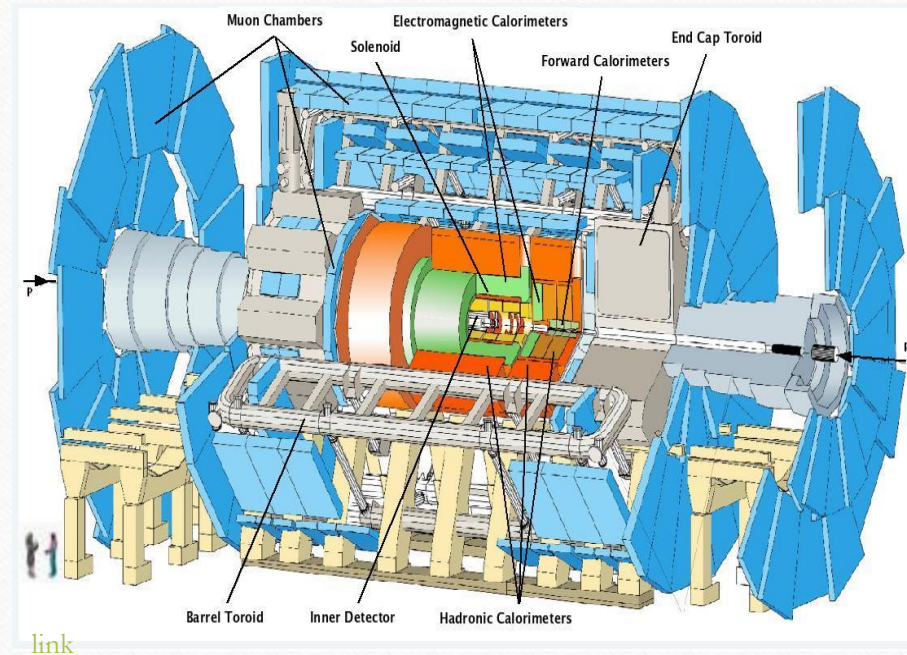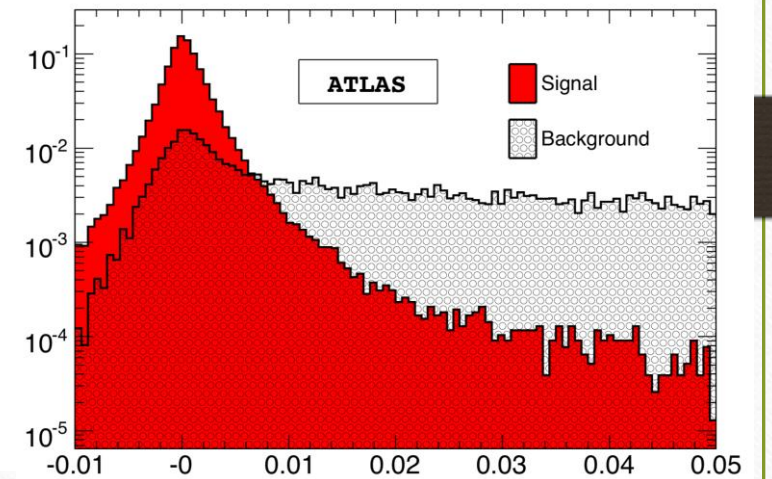

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Signal vs. Background

- Signal – measurements of the specific process being looked for

- Background – measurements of phenomena that resemble the signal
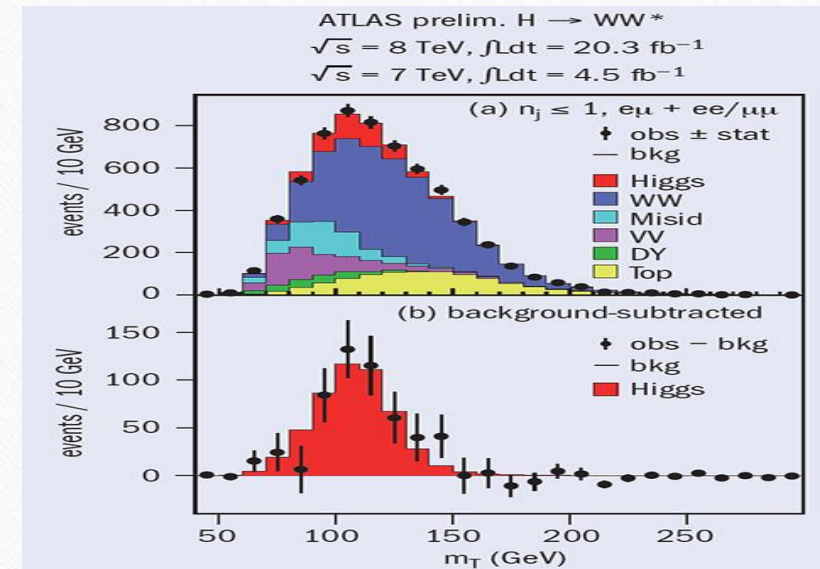
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Signal vs. Background
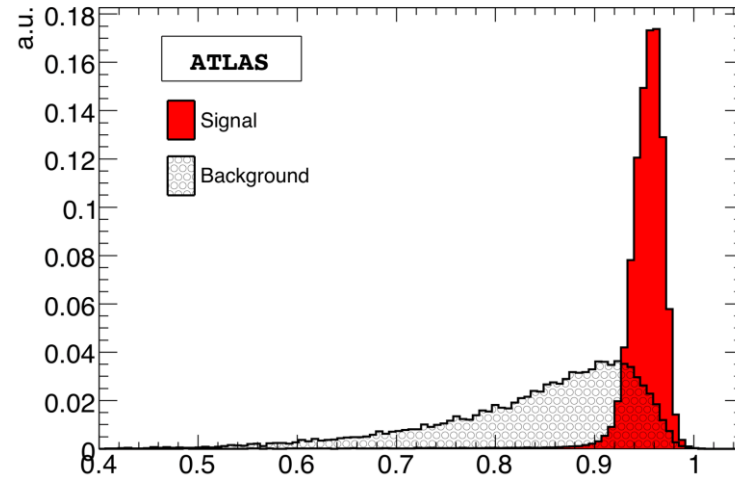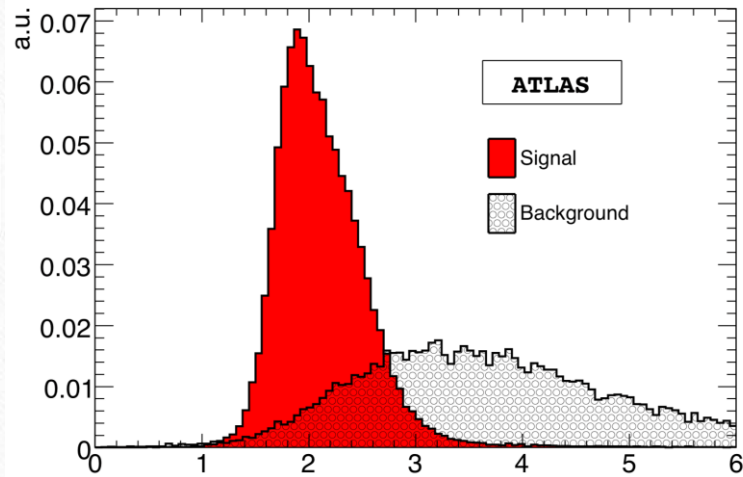
Cut based analysis

- Cut-based analysis – The usage of "cut off" criterion is used to distinguish the background from the signal, but you can lose some signal in the process.

- Note: this is one of the many different used analyses used to realize signal

Cut off criteria for Gluon – Gluon Fusion

Category	$N_{\text{jet},(p_T>30 \text{ GeV})}=0$ ggF	$N_{\text{jet},(p_T>30 \text{ GeV})}=1$ ggF	$N_{\text{jet},(p_T>30 \text{ GeV})}\geq 2$ VBF
Preselection	Two isolated, different-flavour leptons ($\ell=e,\mu$) with opposite charge $p_T^{\text{lead}} > 22$ GeV, $p_T^{\text{sublead}} > 15$ GeV $m_{\ell\ell} > 10$ GeV $p_T^{\text{miss}} > 20$ GeV		
Background rejection	$\Delta\phi(\ell\ell, E_T^{\text{miss}}) > \pi/2$ $p_T^{\ell\ell} > 30$ GeV	$N_{b\text{-jet},(p_T>20 \text{ GeV})}=0$ $\max\left(m_T^{\ell}\right) > 50$ GeV $m_{\tau\tau} < m_Z - 25$ GeV	
$H \rightarrow WW^* \rightarrow e\nu\mu\nu$ topology	$m_{\ell\ell} < 55$ GeV $\Delta\phi_{\ell\ell} < 1.8$		central jet veto outside lepton veto
Discriminant variable BDT input variables	m_T		BDT $m_{jj}, \Delta y_{jj}, m_{\ell\ell}, \Delta\phi_{\ell\ell}, m_T, \sum_\ell C_\ell, \sum_{\ell,j} m_{\ell j}, p_T^{\text{tot}}$

What my research this summer is?

- Perform a cut-based analysis on the Gluon - Gluon fusion mode of the H to WW* decay channel.

- Compare to previous cut-off criteria

- Check for optimization

Gluon - Gluon fusion