# Search for a Standard Model Higgs in the mass range 200-600 GeV in the channel H→ZZ→l l̄qq with the ATLAS detector

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We describe the searches for a Standard Model (SM) Higgs boson in the channel H → ZZ → llqq (l = e,μ), in the range 200-600 GeV, using 4.71 fb−1 of pp collision data collected by the ATLAS experiment at $\sqrt{s}$ = 7 TeV taken in 2011. Events with two b-tagged jets, which have a better signal to background ratio, are treated as a separate channel. No significant excess of events above the estimated background is found and upper limits at 95% confidence level (CL) on the production cross section (relative to that expected from the Standard Model) of the Higgs boson with a mass in the range between 200 and 600 GeV are derived. The state of the art is the extension of the analysis for the first time, to the Low Mass range (120-200GeV).
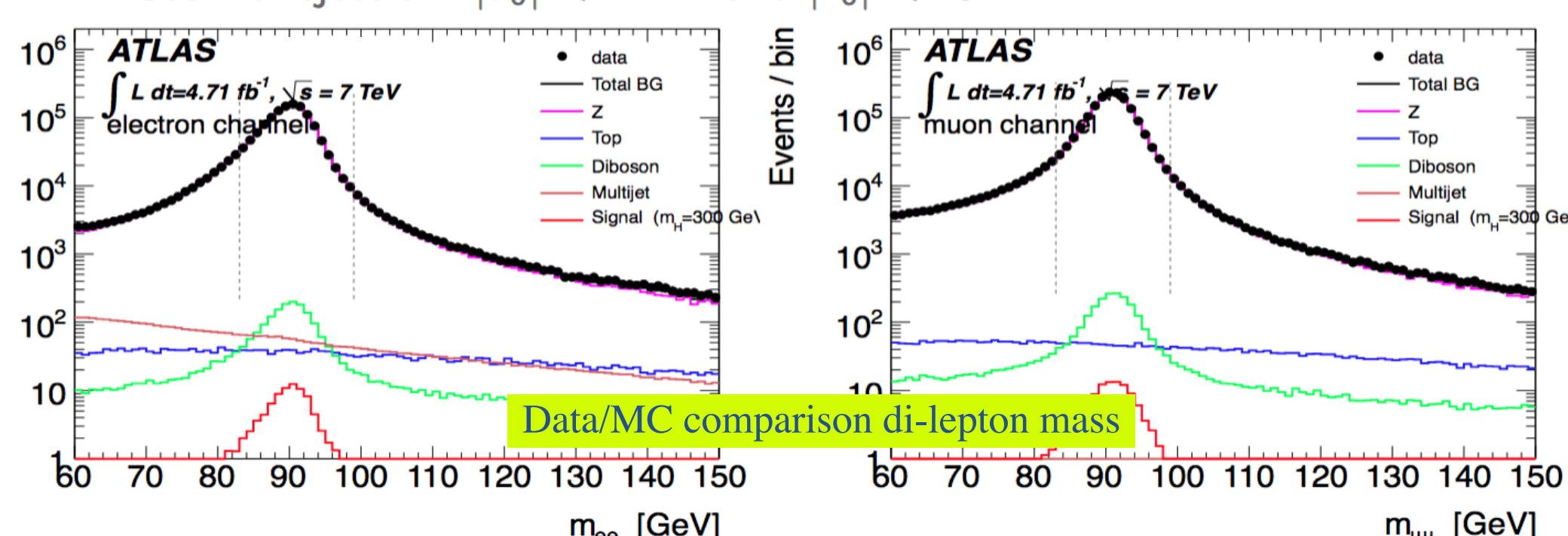
Data 2011

Data: 4.71 fb-1   **MC's 2011**

MC 2011
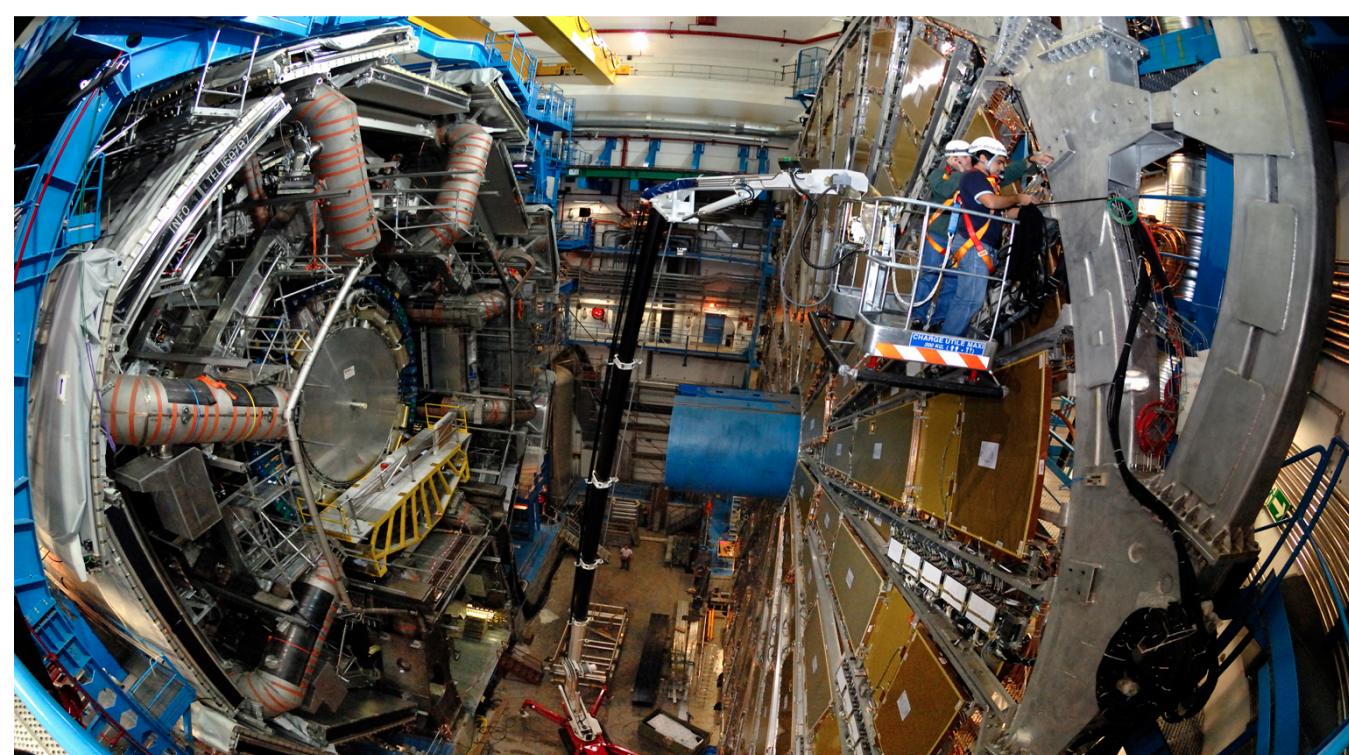
- **Data**
  - Using full 2011 data (B-M) → 4.71 fb−1 after WZ+jets GRL
- **Electrons**
  - Medium++ with author 1 or 3 and $p_T > 20$ GeV and $|\eta_{clus}| < 2.47$
  - Include crack regions
  - Track isolation: $\sum_{tracks}/p_T < 0.1$ within $\Delta R = 0.2$
  - Recommended smearing and efficiency corrections + systematics
- **Muons**
  - STACO combined/tagged with $p_T > 20$ GeV and $|\eta| < 2.5$
  - Recommended MCP cuts
  - Track isolation: $\sum_{tracks}/p_T < 0.1$ within $\Delta R = 0.2$
  - Cosmic rejection: $|d_0| < 1$ mm and $|z_0| < 10$ mm

Object Selection:
- Electrons
- Muons
- Jets
- MeT

- **Signal (MC11c)**
  - $H \rightarrow ZZ \rightarrow llqq$ taken from NLO POWHEG (gg + VBF)
    - p_T spectrum reweighted to HqT results
  - PYTHIA as cross-check and part of acceptance systematic on signal

IFAE 2012

- **Background (MC11c excpet SHERPA Z+HF)**
  - Z/W+jets: Combination of
    - ALPGEN to model Z+light jets (dominates untagged channel)
    - High stats SHERPA to model Z+heavy jets (dominates tagged)
  - Top: $t\bar{t}$ + single top from MC@NLO
  - Diboson: ZZ and WZ from HERWIG
  - QCD background: data-driven method

MC Samples:
- Signal
- Backgrounds

Data/MC comparison di-lepton mass

- **Jets**
  - Anti-k_T 4 with $p_T > 25$ GeV and $|\eta| < 2.5$
    - Take kinematics directly from "AntiKt4TopoEMJets"
  - Remove negative energy jets
  - Remove events with jets pointing to the bad FEB region
  - Pile-up: reject jets with $|JVF| < 0.75$
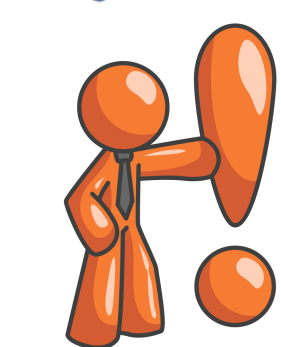 - Recommended JES uncertainty (inc pile-up, close-by jets, b JES)
- **b-tagging**
  - MV1 with $w > 0.60173$
  - $\approx 70\%$ efficiency with improved light jet rejection of ≈ 140
  - Applying preliminary correction derived by b-tagging
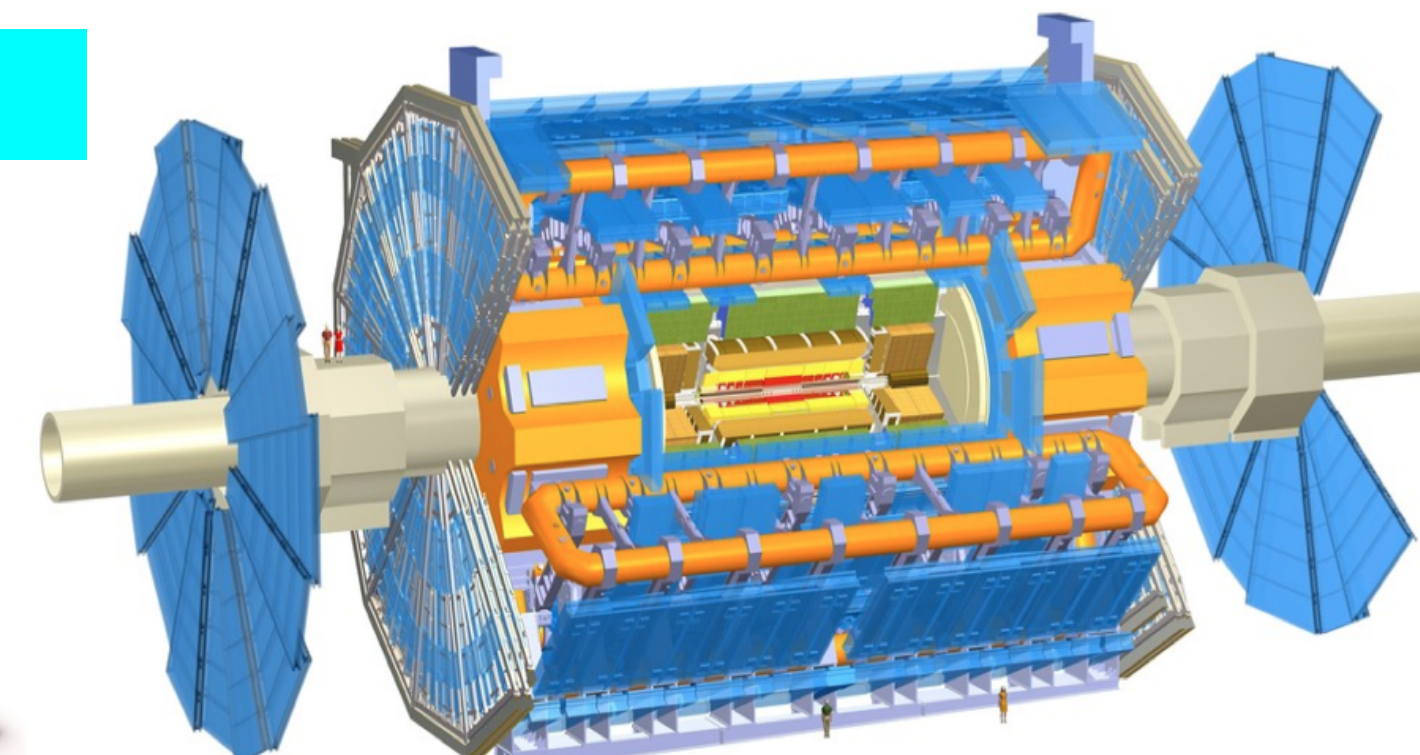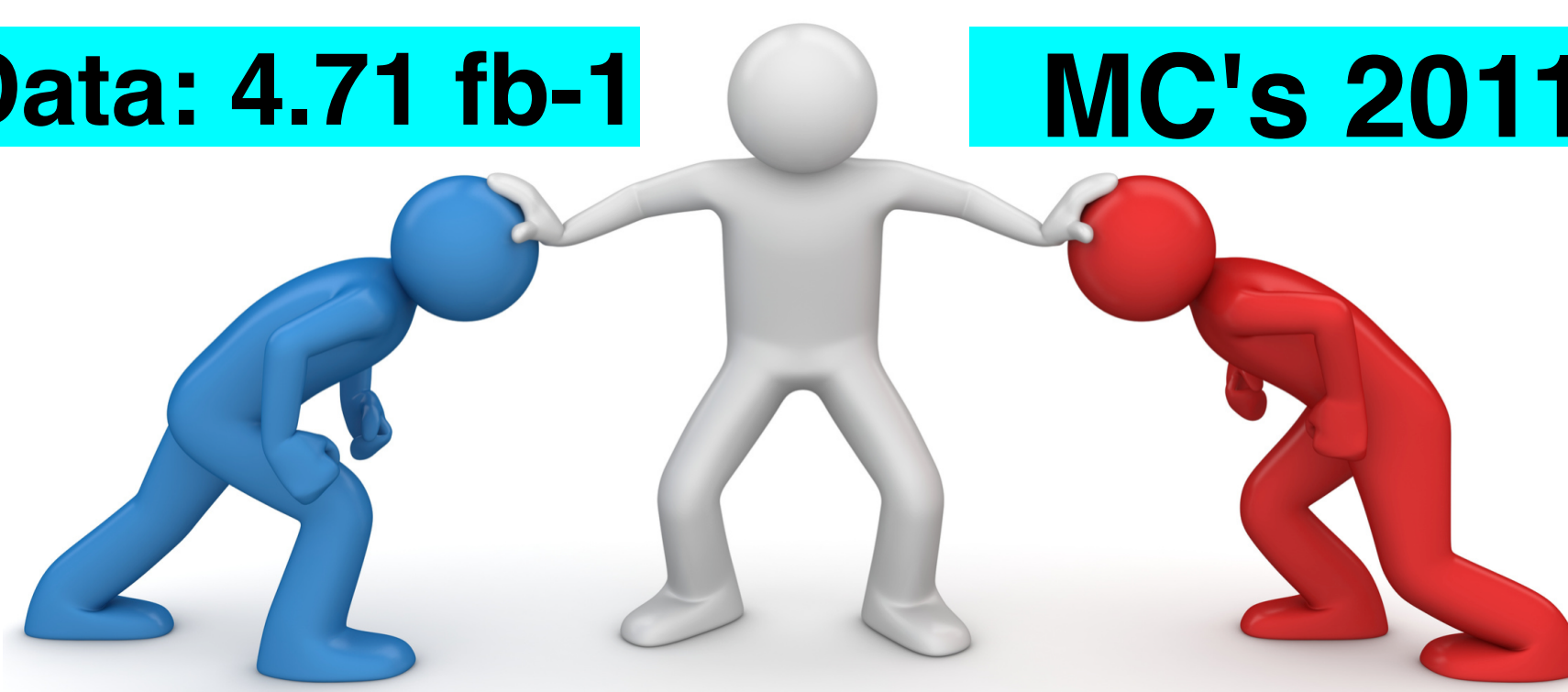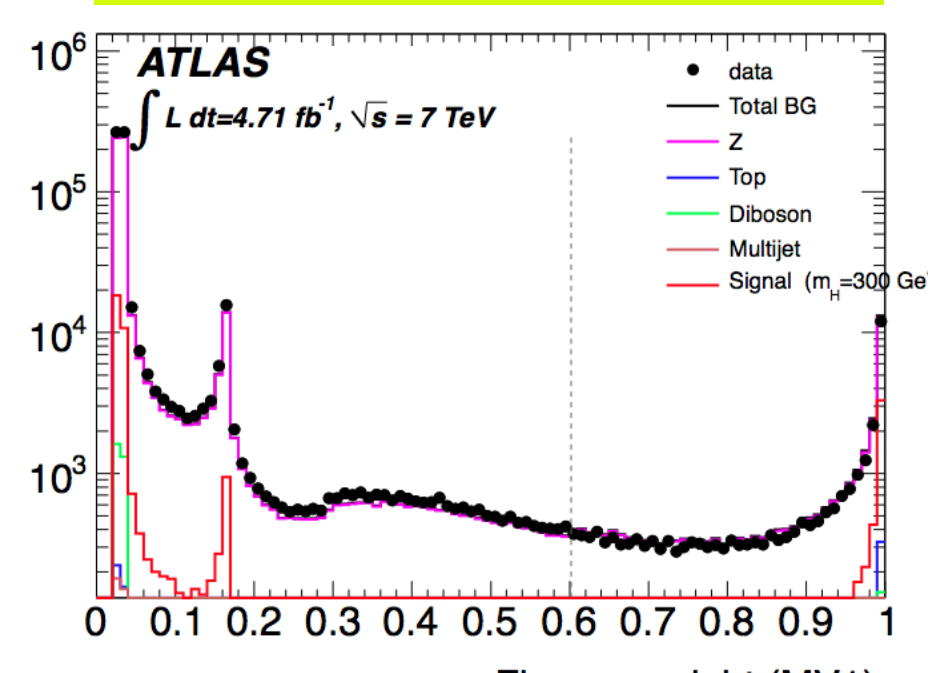- **MET**
  - MET_RefFinal out-of-the-box
- **Overlap Removal:** remove elecs within $\Delta R = 0.2$ of muons and then jets within $\Delta R = 0.4$ of elecs

Event Selection:
- Z -> ll
- H -> ZZ -> llqq

New and better b-tagging algorithm

- **Triggers:**
  - Standard single and dilepton triggers
  - Efficiency of 100% (95%) for electron/muon channel relative to offline
- **Z → ll selection**
  - Primary vertex with ≥ 3 tracks
  - Reject events with LAr noise bursts
  - Reject events in data with jets failing looser cleaning or in bad FEB region
  - Exactly 2 leptons with $83 < m_{ll} < 99$ GeV (opposite-charge for muons)
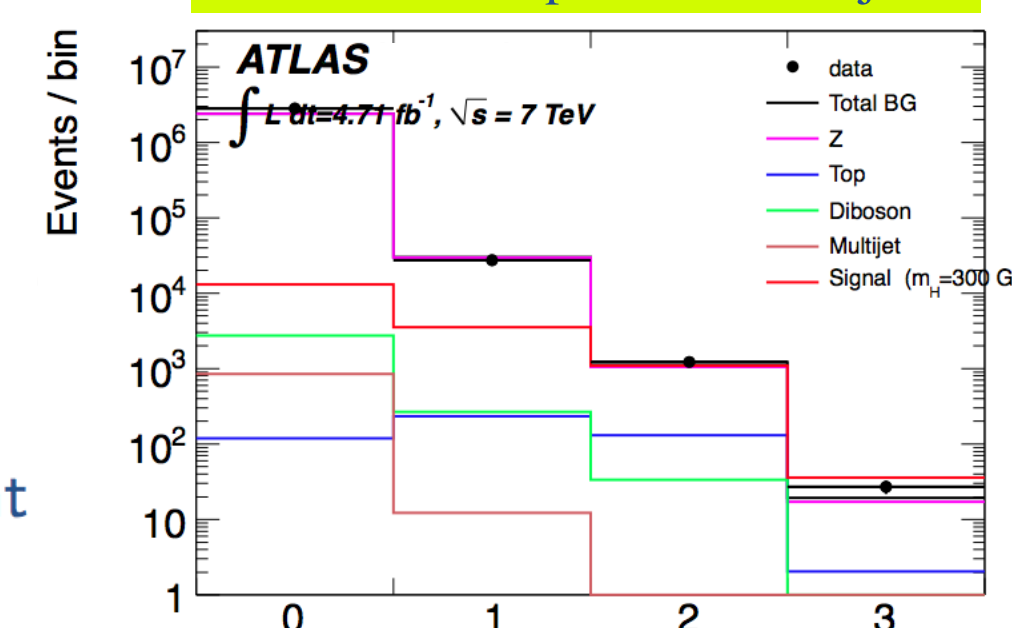- **H → ZZ → llqq selection**
  - $E_T^{miss} < 50$ GeV
  - At least 2 jets with $70 < M_{jj} < 105$ GeV and $\Delta R_{jj} > 0.7$
    - ΔR cut removes region not well modelled by background MC
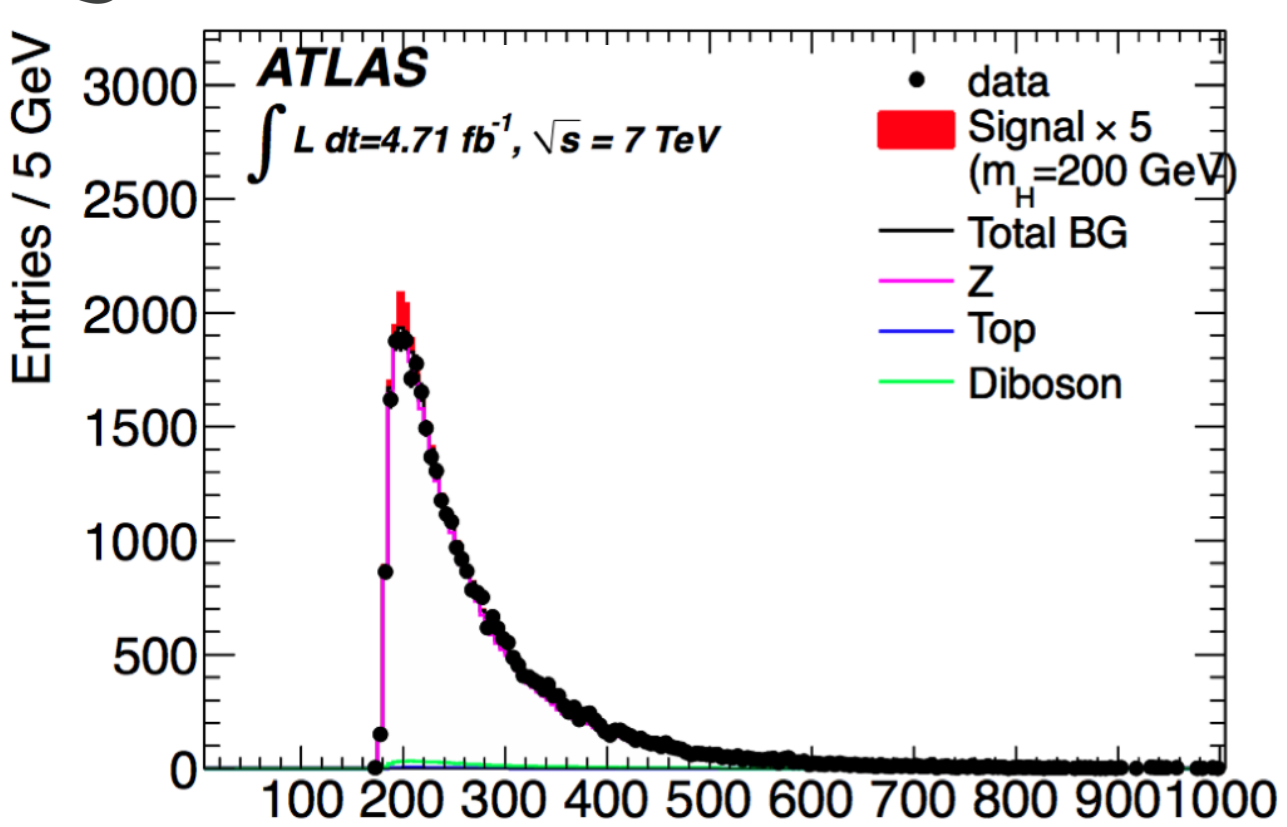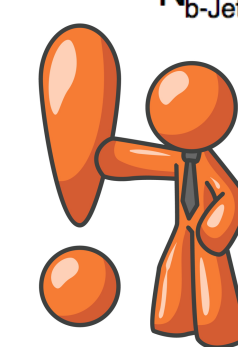- **High M_H selection for $M_H \geq 300$ GeV**
  - $P_T^{jet} > 45$ GeV
  - $\Delta\phi_{ll} < 90°$ and $\Delta\phi_{jj} < 90°$
- **Split events (for low and high m_H selection) into 2 samples:**
  - "tagged": 2 b-tagged jets
  - "untagged": < 2 b-tagged jets
- **Reject events with more than 2 b-tags to reduce top background**
- **For tagged samples always take two b-tagged jets**
  - In this case, scale jet energy so m_{jj} peaks at m_Z
- **For untagged sample take all combinations of up to 3 leading jets that fulfill M_{jj} and high m_H cuts.**

Data/MC comparison of # b-jets

No evidence for a signal is observed

Results

Observed limit excludes $360 \leq m_H \leq 420$ GeV at 95% CL
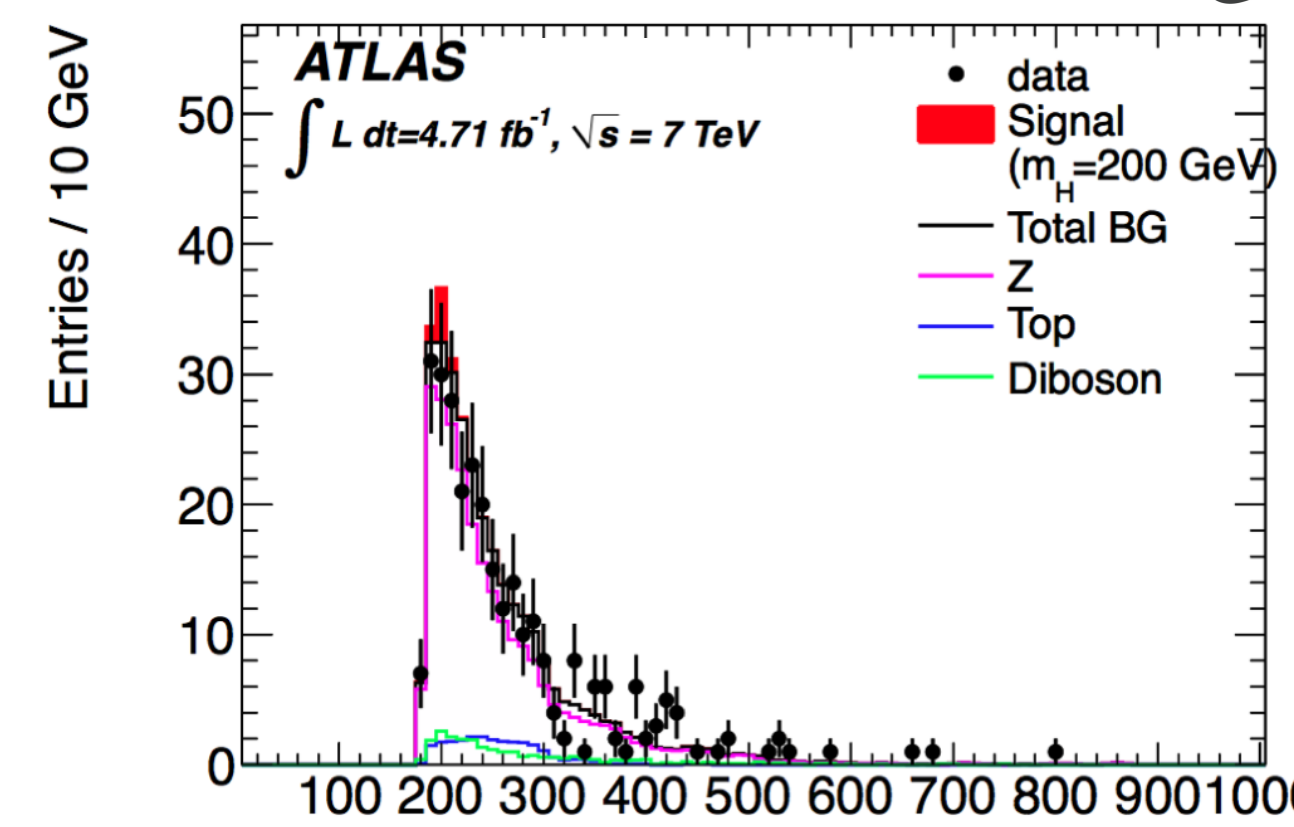
Untagged Channel
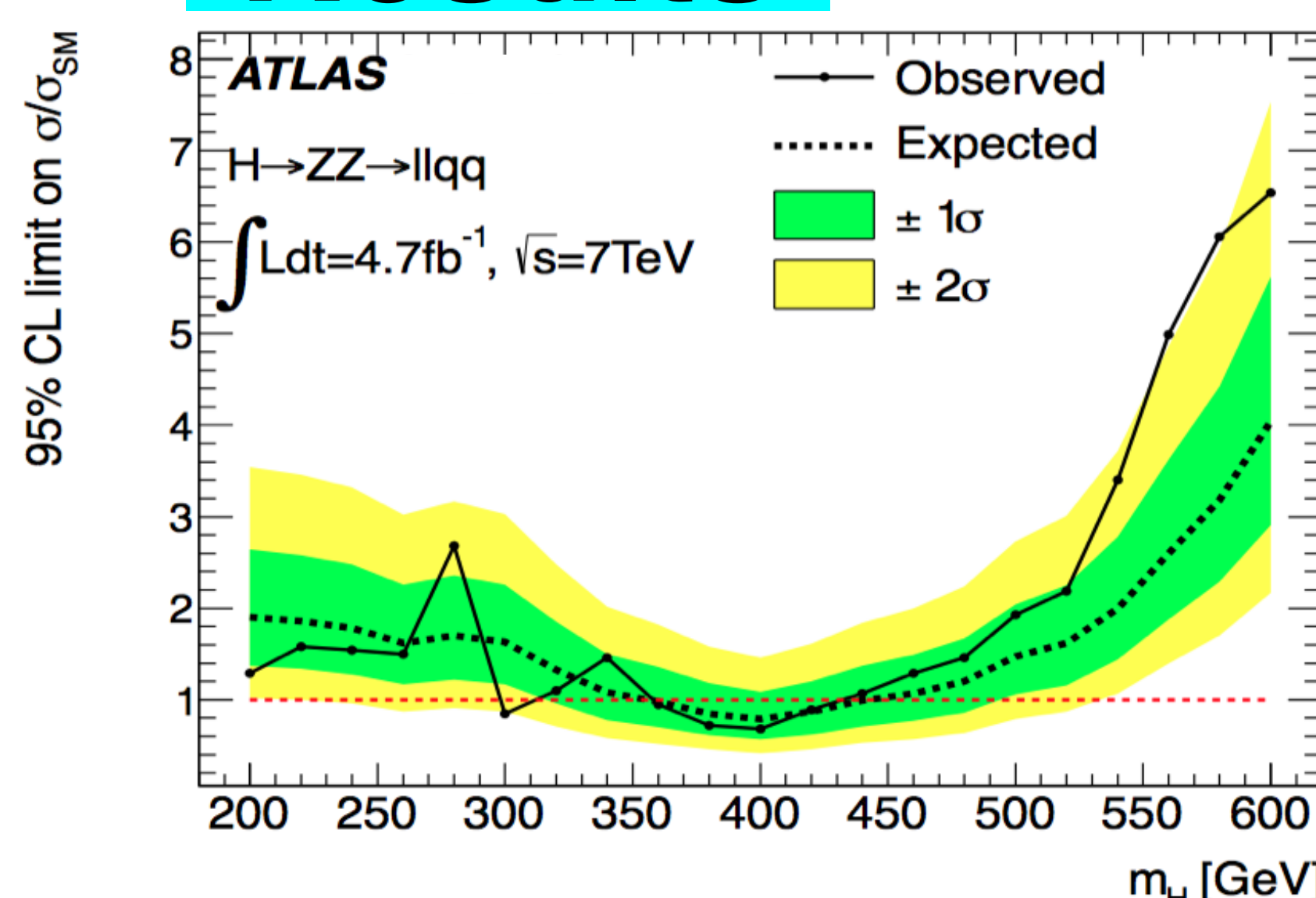
Tagged Channel

Invariant mass of the llqq system: 200-400-600 GeV signal

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