Search for WWW Production with 8 TeV Data and Doubly Charged Higgs with 13 TeV Data from ATLAS

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Introduction

$\sqrt{s} = 8$ TeV, $\int L = 20.3\ fb^{-1}$

Goals:

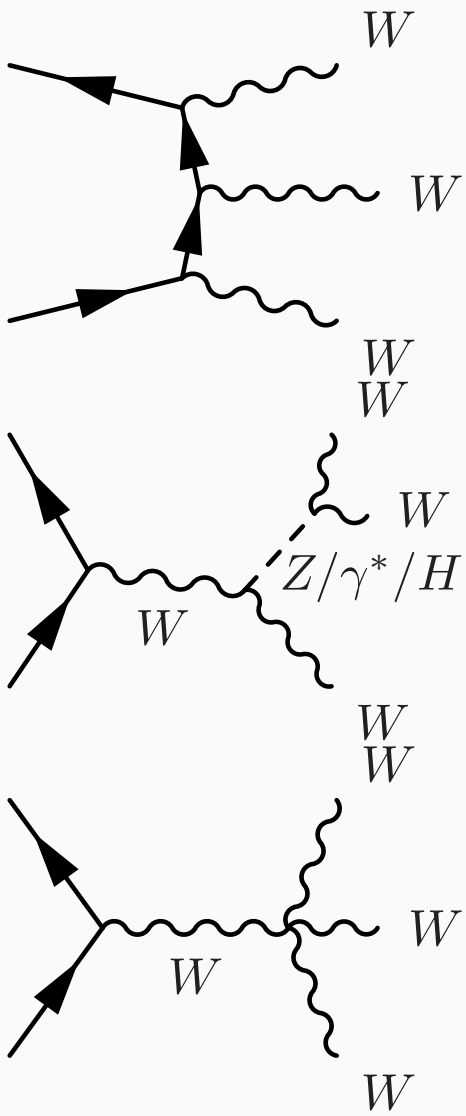
- Search for triboson $W^{\pm}W^{\pm}W^{\mp}$ production.
- Sensitive to new physics via aQGC.

Signal:

- $W^{\pm}W^{\pm}W^{\mp} \rightarrow l^{\pm}\nu l^{\pm}\nu l^{\mp}\nu$.
- $W^{\pm}W^{\pm}W^{\mp} \rightarrow l^{\pm}\nu l^{\pm}\nu jj$ (l = e,μ).

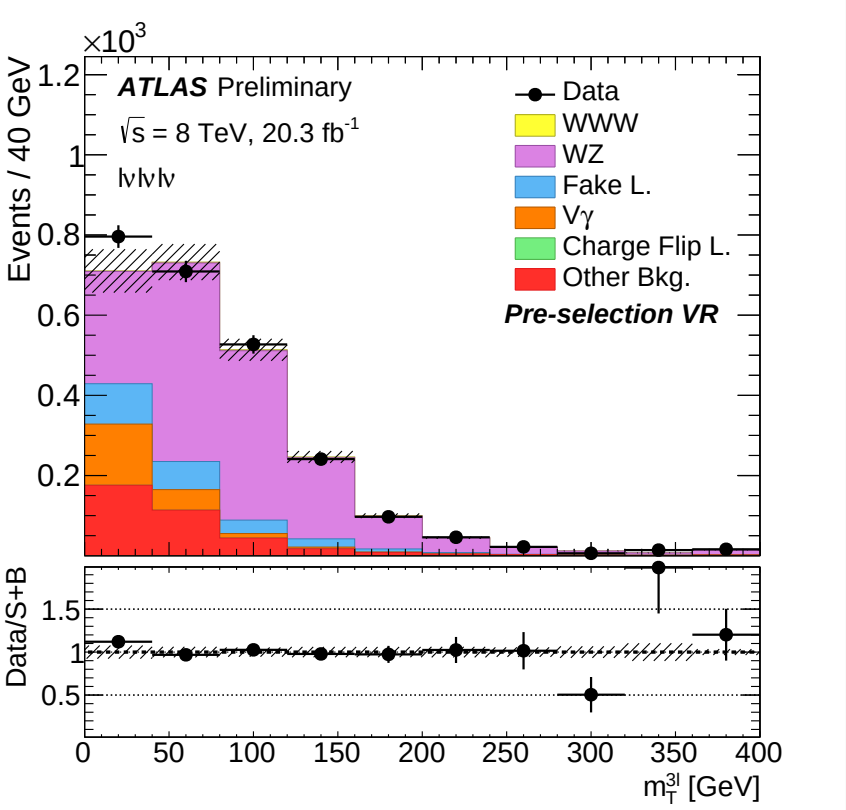
Backgrounds:

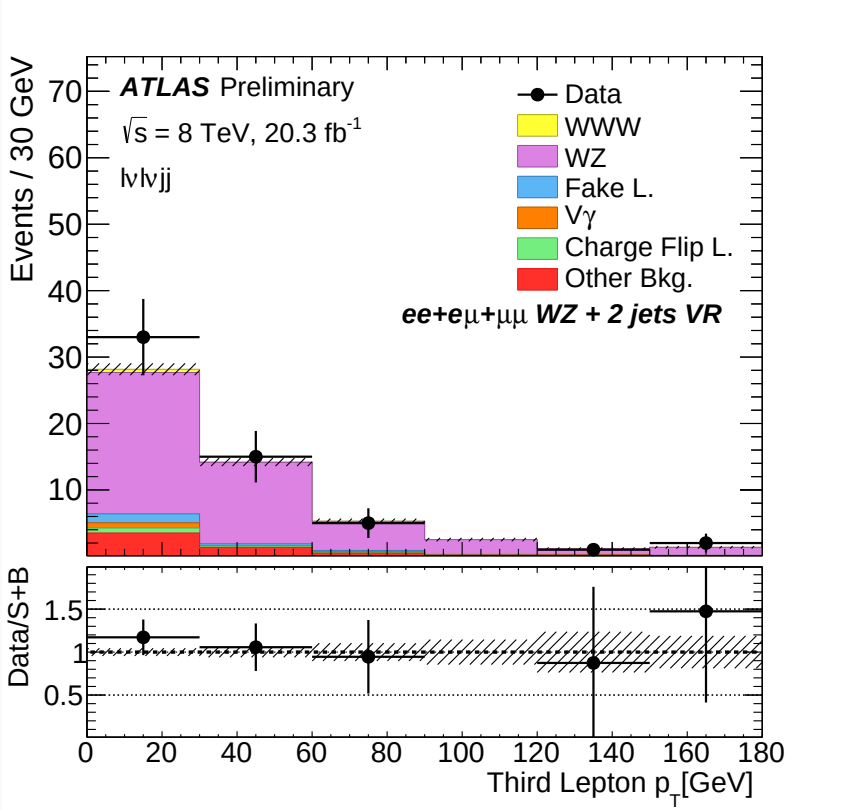
- WZ/γ^*, Wγ+jets or Zγ+jets (MC).
- Lepton's charge mis-ID (Data-driven).
- Fake leptons originated from jets or hadronic decays(Data driven).
- Contribute to lepton's charge mis-ID and statistical interpretation.



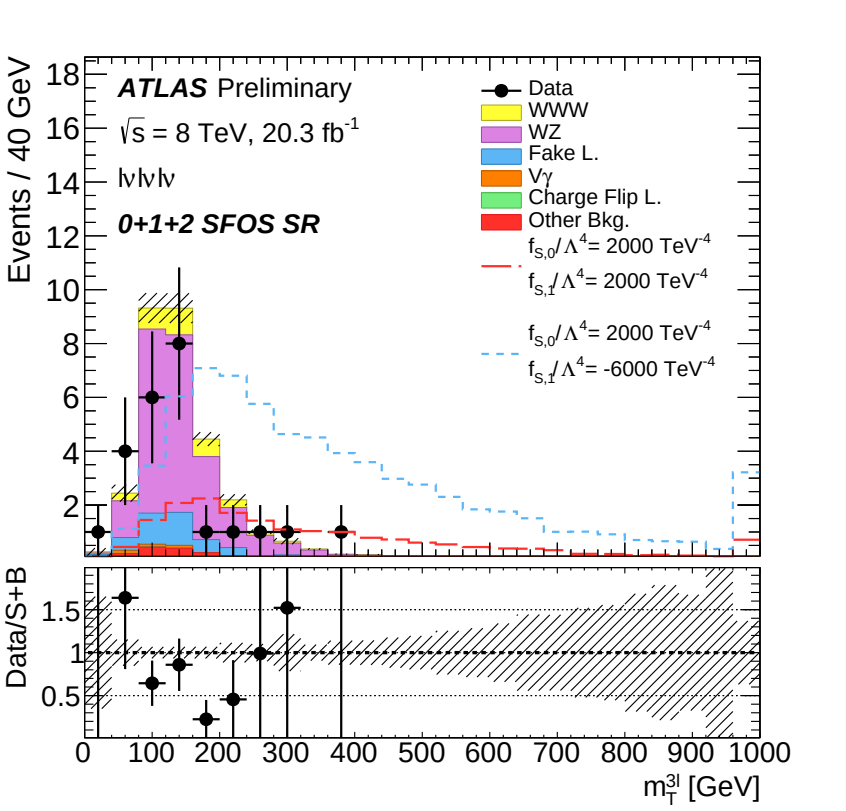
Validation Region

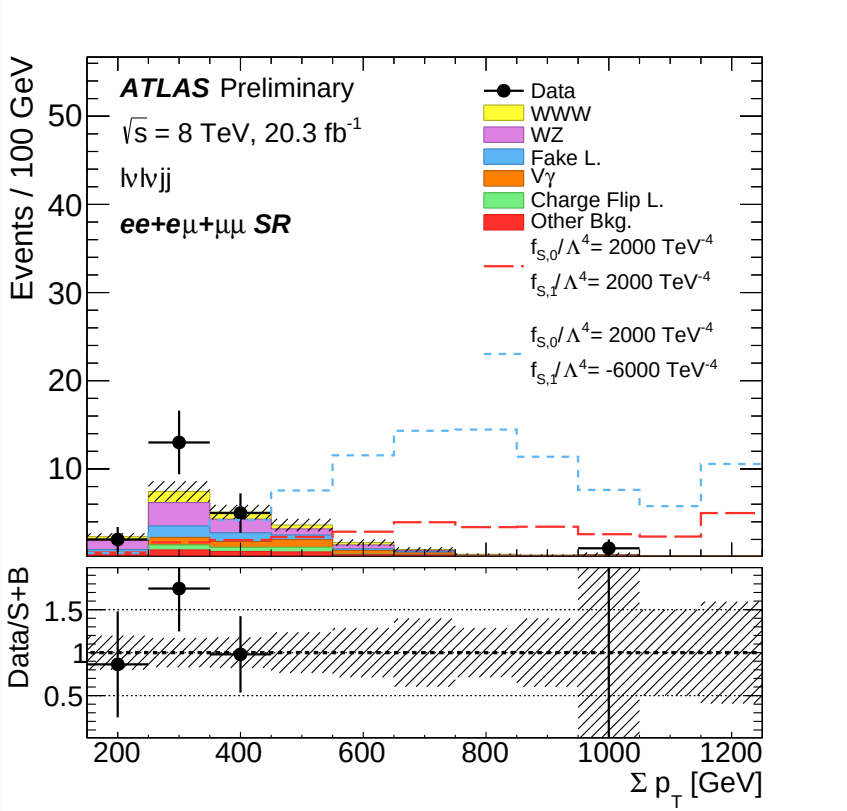
- Distributions in validation region for $l\nu l\nu l\nu$ and $l\nu l\nu jj$ channels.
- m_T^{3l} for $l\nu l\nu l\nu$ channel(Left).
- Third lepton pT for $l\nu l\nu jj$ channel(Right).





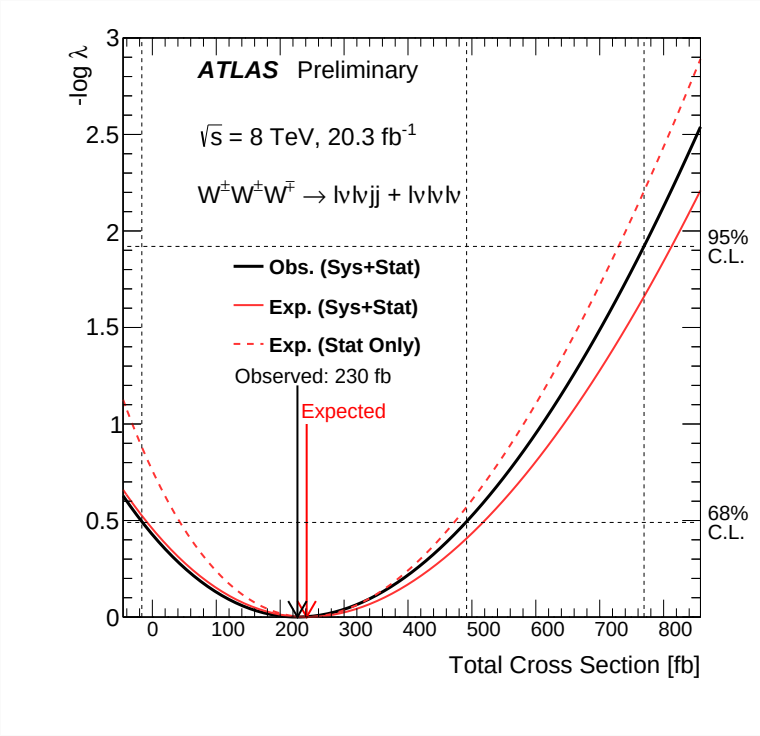
Signal Region

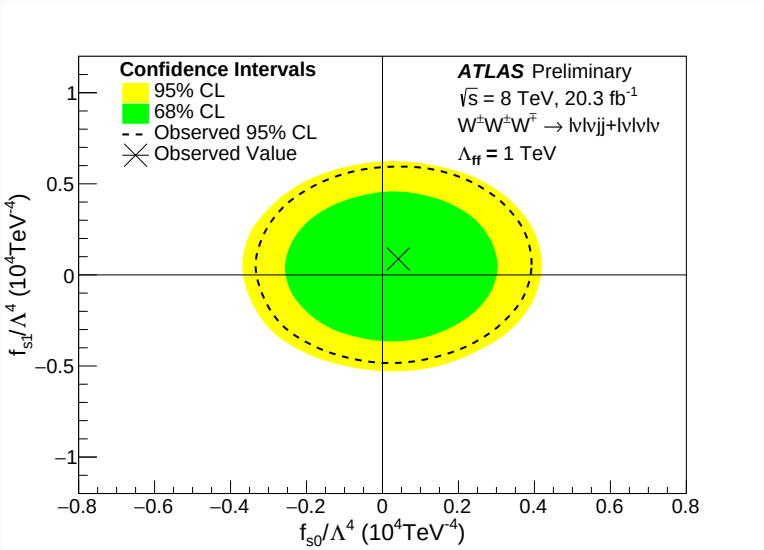




Cross Section and aQGCs

- No significant deviation from SM observed.
  - Total and fiducial cross-sections extracted, only ∼1 sigma significance.
- aQGCs limits with 95%CL set.

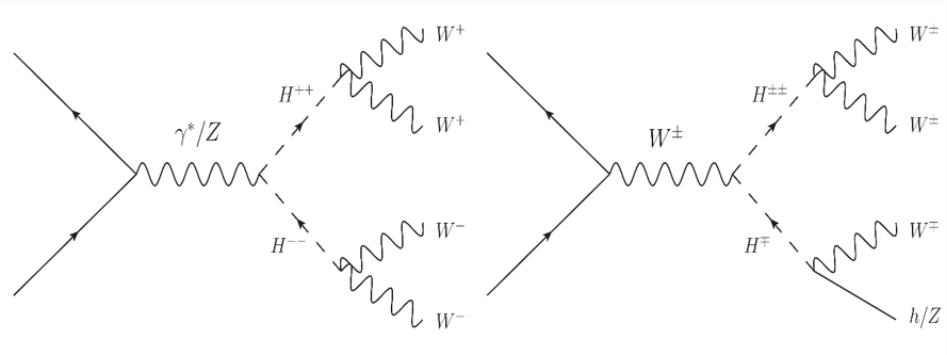


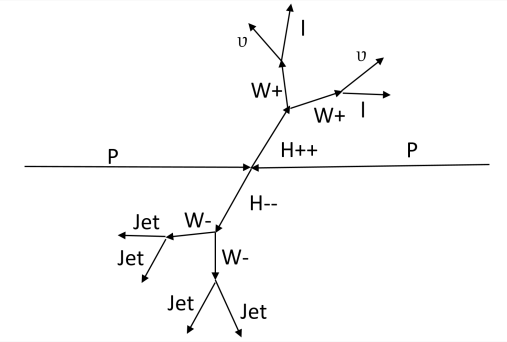


Doubly Charged Higgs

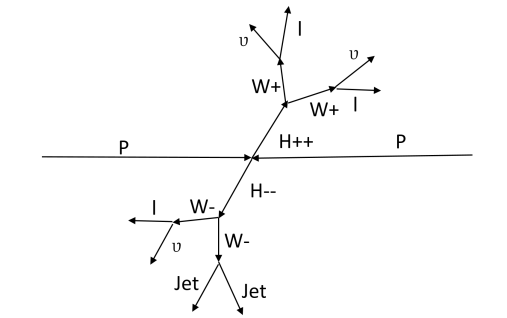
Outline

- Pair and associated production modes.





- Analysis only pair production for now.
  - Mass points 200, 300, 400, 500, 600, 700 GeV considered.
  - $M_{H^{\pm\pm}} = 200$ GeV as benchmark.



- Background estimation done.
- Statistical interpretation done.
- Based on 20.7, i.e. full ICHEP datasets.
- Working on 2LSS channel.

Backgrounds

- Figure. 1 shows comparison between mc and data at event pre-selection stage.
- Main backgrounds are VJets, Vgamma, Top and VV.
  - VJets,Vgamma, Top and WW are estimated with data-driven techniques.
  - VV(WZ, ZZ, ssWW) is estimated with MC.

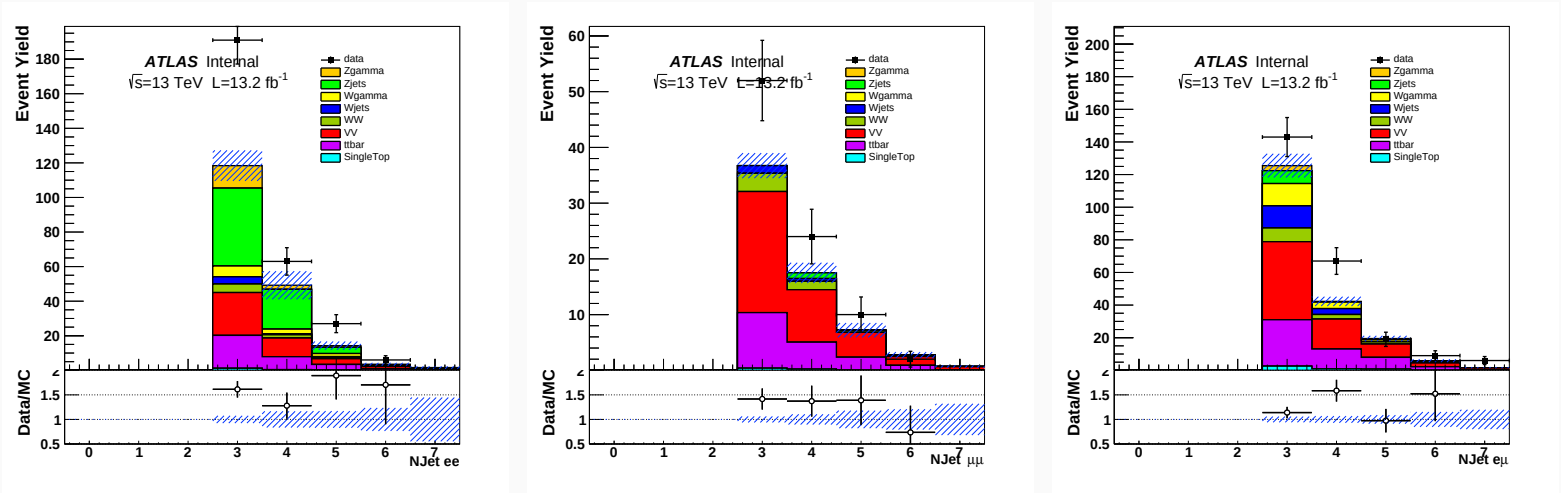


Figure 1: Jet multiplicity of ee, $\mu\mu$ and eμ channels from left to right at event pre-selection stage, signal rescaled.

QMisID

- For 2LSS channel, events from like ZJets can enter signal region due to charge flip.
- Electron charge mis-ID rate measured with likelihood method to estimate such background.
- Truth Match method based on MC as cross check.

$$\ln \mathcal{L}(\varepsilon | N_{tot}, N_{ss}) = \sum_{i,j} \ln \left[N^{i,j}_{tot}(\varepsilon_i + \varepsilon_j) \right] N^{i,j}_{SS} - N^{i,j}_{tot}(\varepsilon_i + \varepsilon_j) \qquad (1)$$

- $|\eta|$ bins: [0, 0.6], [0.6, 1.1] , [1.1, 1.37], [1.52, 1.7], [1.7, 2.3], [2.3, 2.47]
- Pt[GeV] bins: [20, 60], [60, 90], [90, 130], [130, 1000]

Region to Measure Rates

- Regions used to measure QMisID rates shown in Figure. 2

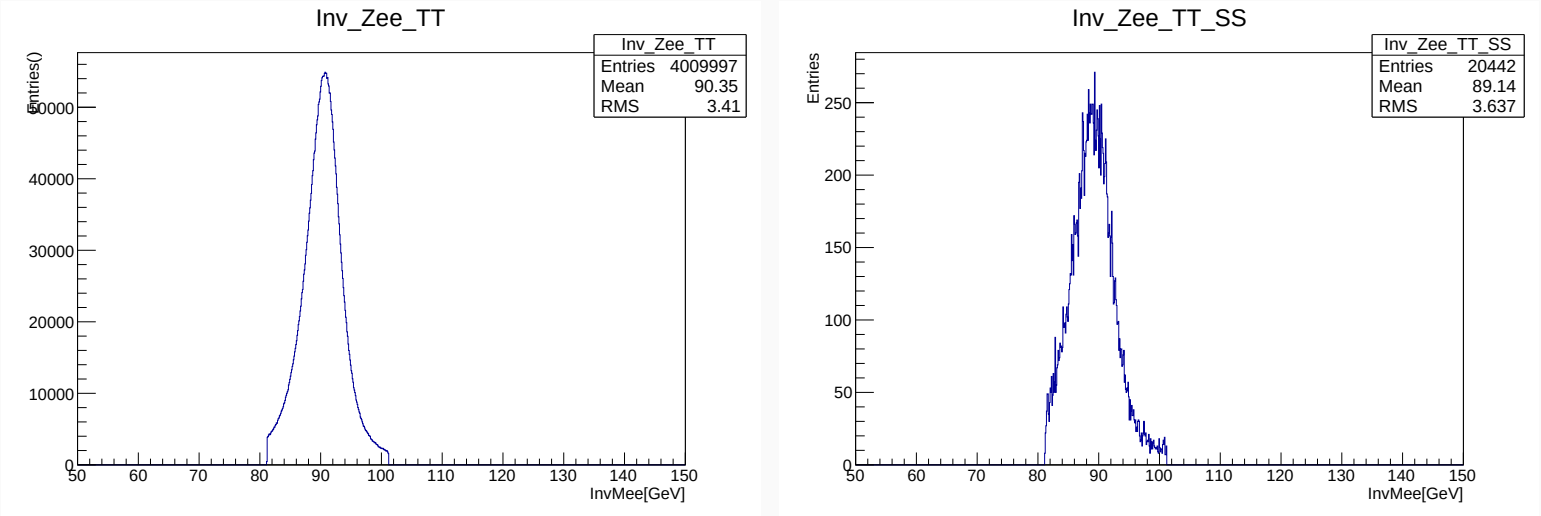


Figure 2: Invariant mass of two electrons for total events and events with same sign electrons

Closure Test for Likelihood Method

- Electron's charge mis-ID rates measured with likelihood and truth match method are compared in Figure. 3
- Excellent agreement observed.

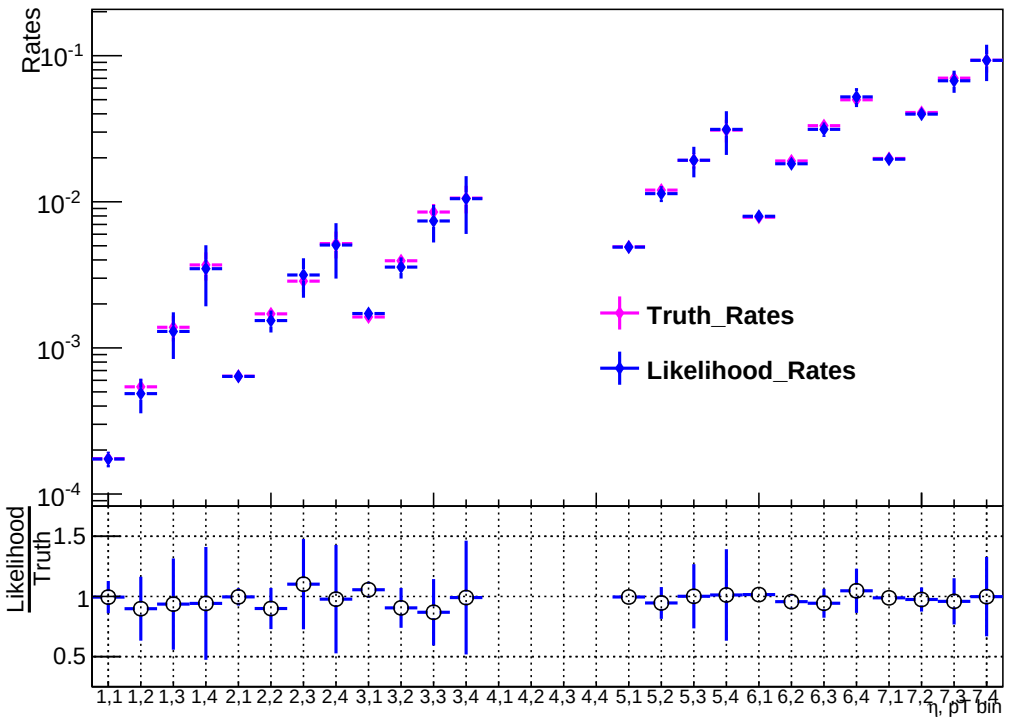


Figure 3: Closure test for likelihood method.

Fake Background

- Background due to fake leptons originating from heavy flavor decays and mis-reconstructed leptons originating from hadrons in jets.
- Fake factor method is used to estimate such background.
- Background contributions due to fake leptons are determined with Control Regions selected by requiring one "good" and one "bad" lepton.

Background Estimation

- Fake from VJets/DY/Vgamma/Top estimated with fake factors measured before.
- ChargeFlip from ZJets/DY/Zgamma/Top estimated with electron's charge mis-ID rates.
- Other backgrounds estimated with MC.
- Estimation at pre-selection level shown in Tabel. 1 and Figure. 4.
- Systematic and statistic uncertainties included.

	Fake	QMisId	Prompt	Total	Data
ee	155±15	147±2.3	51±3	353±15	292
$\mu\mu$	53.8±5.8		43.4±2.3	97±6.2	88
$e\mu$	206±13	21.9±0.9	95.6±3.3	324±14	265

Table 1: Background estimation at event pre-selection stage

Background Estimation

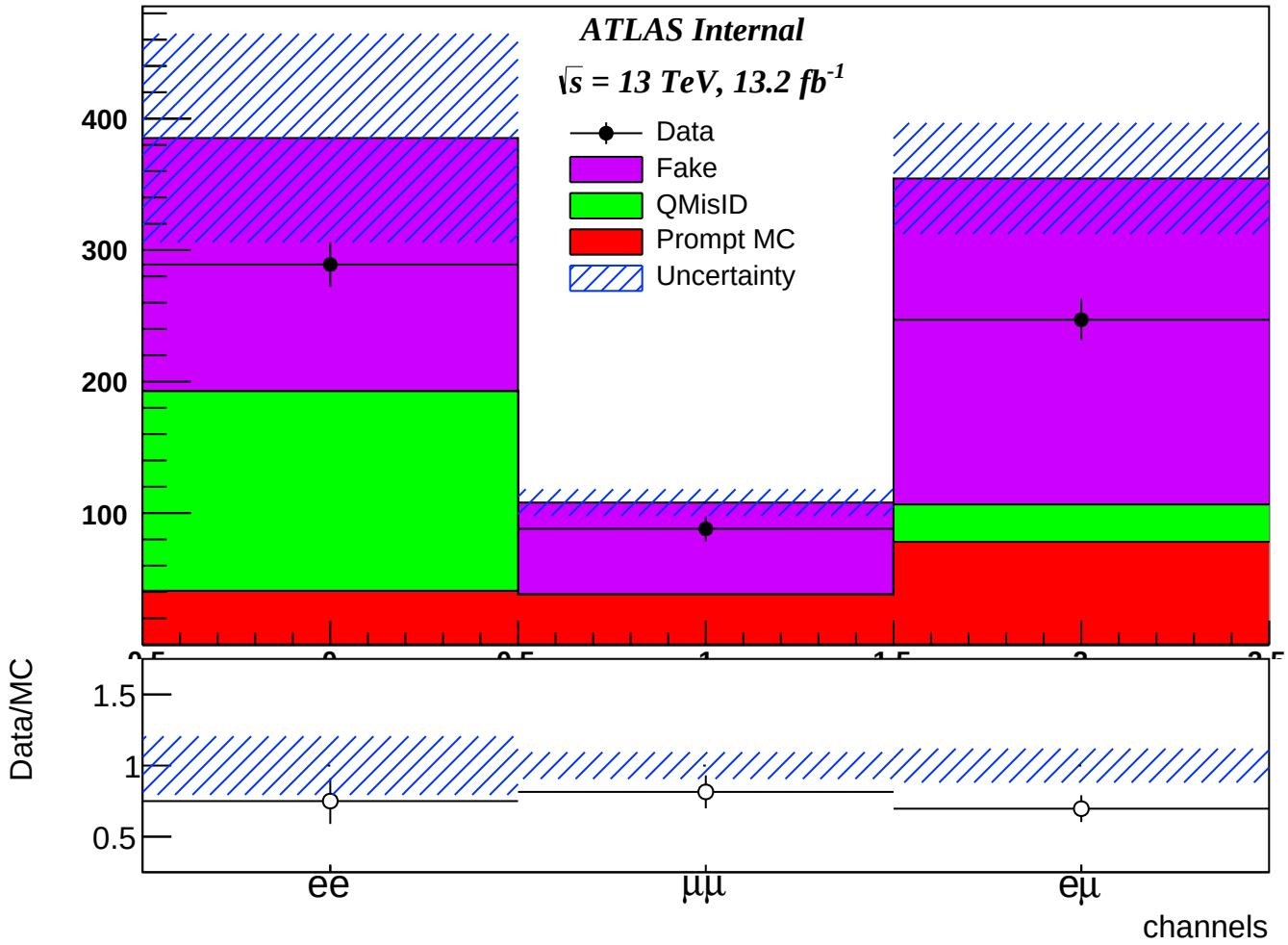


Figure 4: Background estimation at event pre-selection stage.

MET Distribution at Pre-Selection Stage

- Fake and QMisID estimated with data-driven techniques.
- Comparison between background estimation and data at event pre-selection stage is shown in Figure. 5.

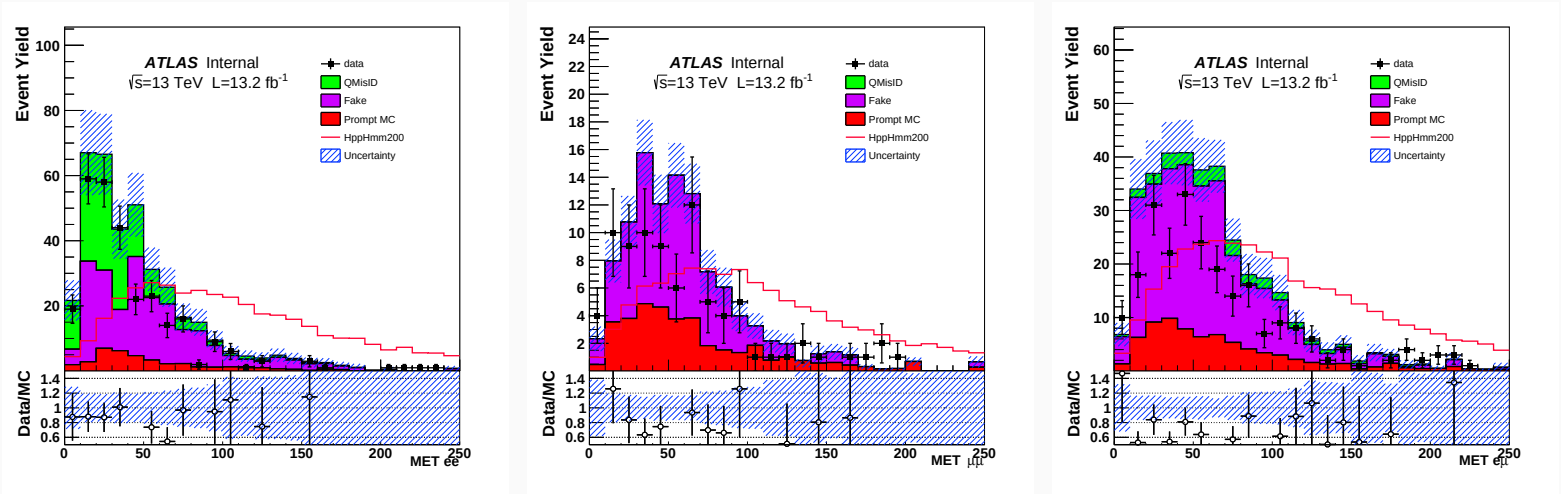
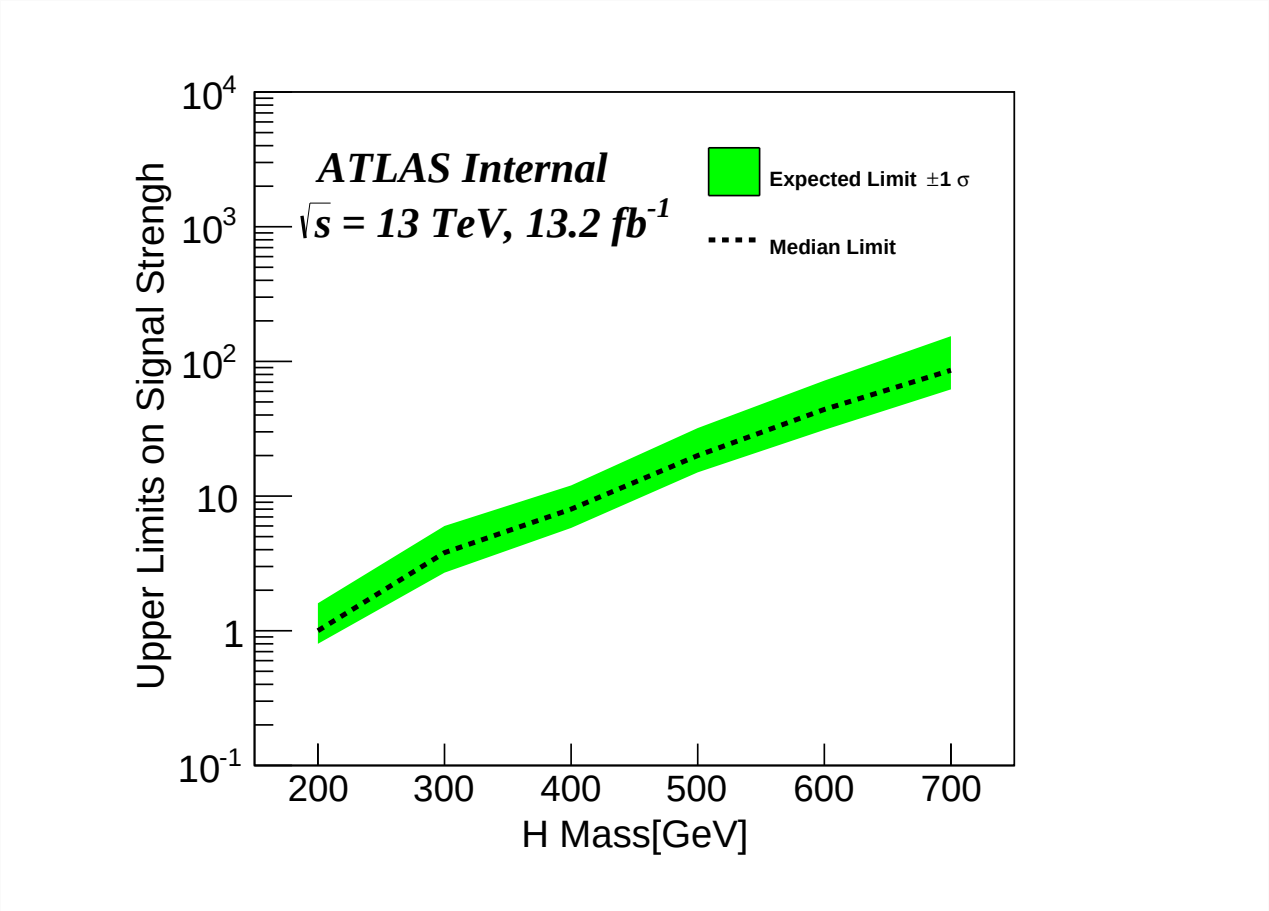


Figure 5: MET at event pre-selection stage, from left to right are ee, $\mu\mu$ and eμ channels

Results

- Limits are calculated with TtHFitter based on likelihood ratio test.
- The parameter of interest (POI) is the signal strength.
- The systematic uncertainties are treated as nuisance parameters.



Summary

- Paper for WWW analysis is now under 3^{rd} circulation in ATLAS.
- 2LSS channel of doubly charged Higgs analysis:
  - QMisID and fake estimation done(Including systematics).
  - MVA optimization for different mass points done.
  - Statistical intepretation done.
  - MC systematic to be included soon.
  - Already have one EB meeting, plan to unblind soon.