Weekly Report

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July 6, 2020

HHML 2LSS update

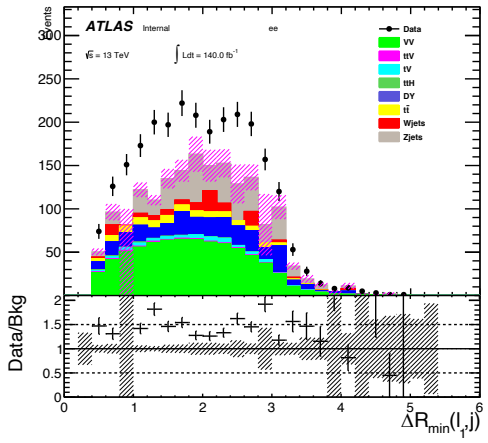
- Background estimation
- Working point Refer to ttH multilepton run2 study
- Rework of fakes measurements

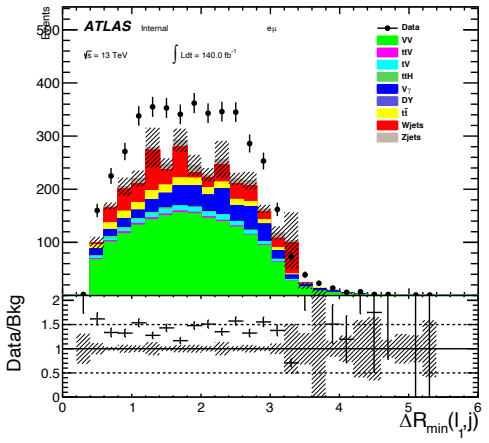
Major backgrounds

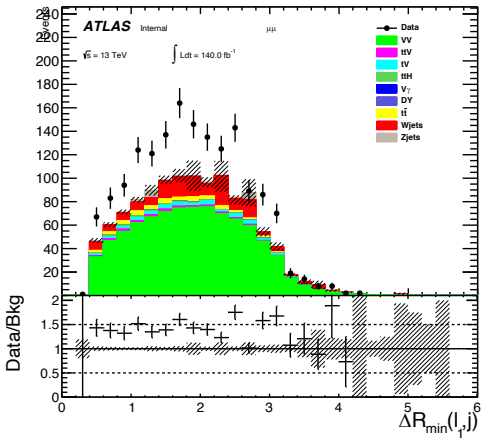
- Prompt backgrounds :
  - Dominant background source, two charged leptons escaping
  - Diboson, triboson, tV, ttV, XH
  - Using Simulated MC

- Not-prompt/fake background
  - Final state object reconstructed as a prompt lepton is either a non-prompt lepton or a fake lepton
  - Dominant sources:W+jets,ttbar
  - Data driven estimation
- Charge misidentification background
  - Due to erroneous track curvature measurement (esp. for high pT tracks)
  - wrongly reconstructed electron in $e^{\pm} \rightarrow e^{\pm}\gamma \rightarrow e^{\pm}e^{+}e^{-}$
  - Dominant souces: Z+jets, ttbar
  - Data driven estimation

- Kinematic distribution in Njets>=2 region

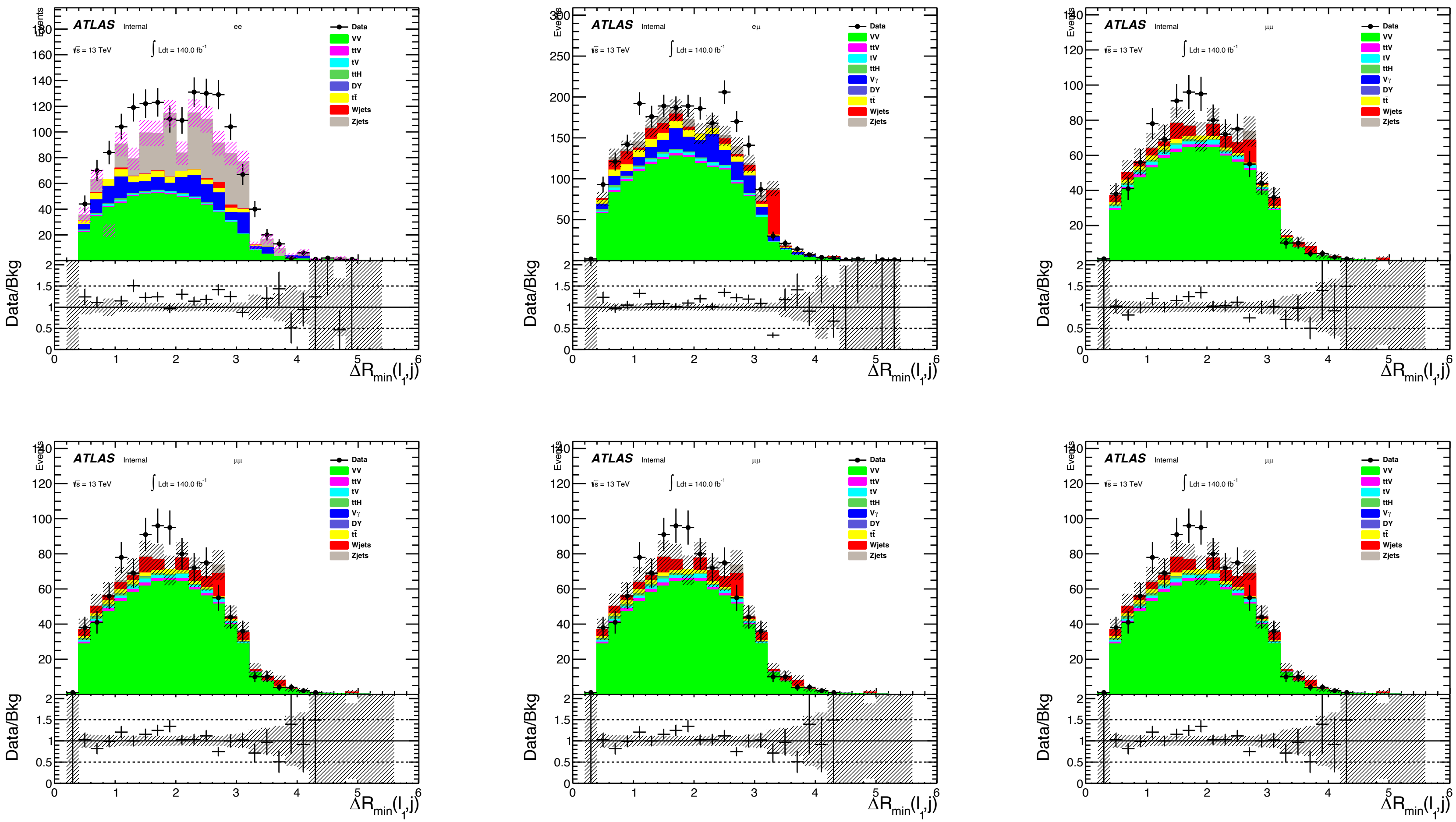




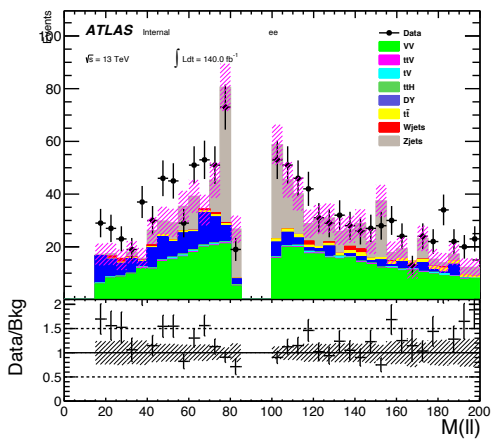


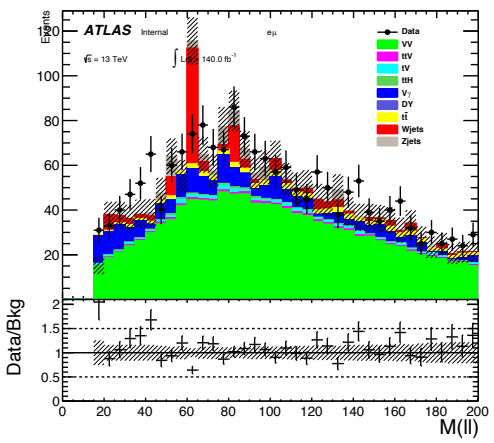
- Large discrepancy without PLV

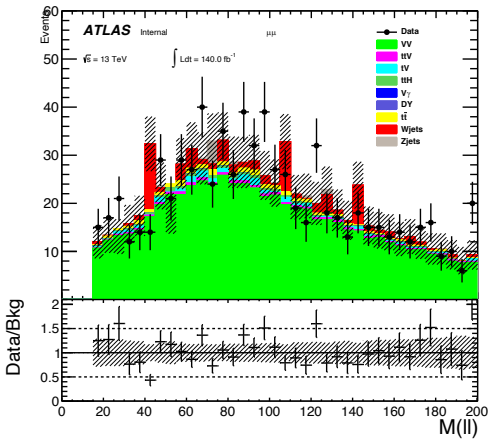
MC simulation and Data comparision

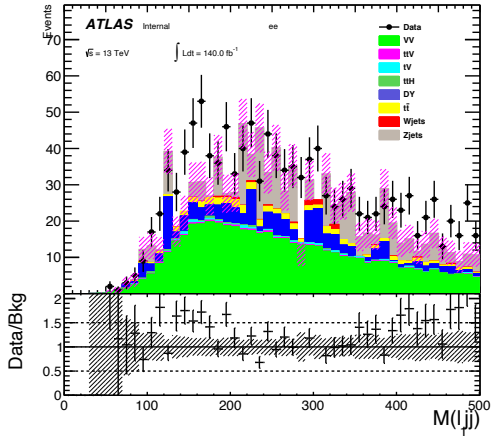


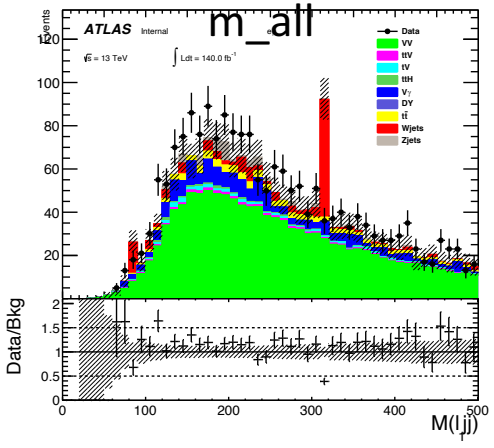
- Better comparision with ttHML W.P
- Nominal samples are used

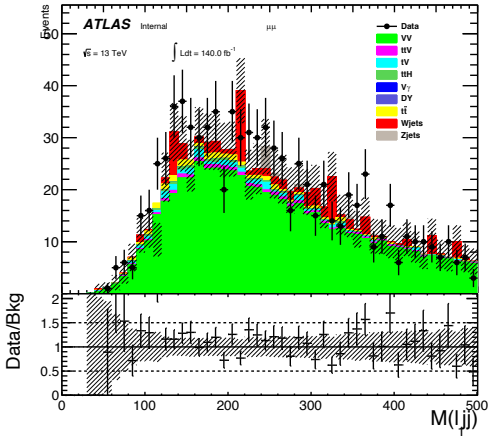

ATLAS Internal
ee
√s = 13 TeV
∫ Ldt = 140.0 fb⁻¹
Data
VV
ttV
tV
ttH
DY
tt̄
Wjets
Zjets
Events
Data/Bkg
M(ll)


ATLAS Internal
eμ
√s = 13 TeV
Data
VV
ttV
tV
ttH
Vγ
DY
tt̄
Wjets
Zjets
Events
Data/Bkg
M(ll)


ATLAS Internal
μμ
√s = 13 TeV
Data
VV
ttV
tV
ttH
Vγ
DY
tt̄
Wjets
Zjets
Events
Data/Bkg
M(ll)


ATLAS Internal
ee
√s = 13 TeV
Data
VV
ttV
tV
ttH
DY
tt̄
Wjets
Zjets
Events
Data/Bkg
M(lljj)


m_all
ATLAS Internal
√s = 13 TeV
Data
VV
ttV
tV
ttH
Vγ
DY
tt̄
Wjets
Zjets
Events
Data/Bkg
M(lljj)


ATLAS Internal
μμ
√s = 13 TeV
Data
VV
ttV
tV
ttH
Vγ
DY
tt̄
Wjets
Zjets
Events
Data/Bkg
M(lljj)

Fake leptons estimation

- Events containing at least one fake lepton are estimated with the data-driven fake-factor method.
- Idea
  - select a control sample of events enriched, use an extrapolation factor to relate these events to the background in the signal region
- Fake source
  - Electron: charged hadrons, photon conversions, or semi-leptonic heavy-flavor decays
  - Muon: almost all come from either semi- leptonic heavy-flavor decays or meson decays in flight

Fake leptons estimation

- Definition $\theta_\ell = \frac{N_{\ell\ell}}{N_{\ell\not\ell}}$
  - numerator :full particle selection in the signal region
  - denominator : suppress real lepton and enhance misID jets

	Tight electron	Anti-tight electron
ID	TightLH	Fail TightLH
Isolation	isolationFCTight, PLV<-0.7	isolationFCTight, PLV<-0.7
QmisID	QIDBDT>0.3	QIDBDT>0.3

	Tight muon	Anti-tight moun
ID	Tight	-
Isolation	isolationPFlowTight, PLV<-0.5	Fail isolationPFlowTight, PLV<-0.5

- Fake CR :Njet== 1

Fake leptons estimation

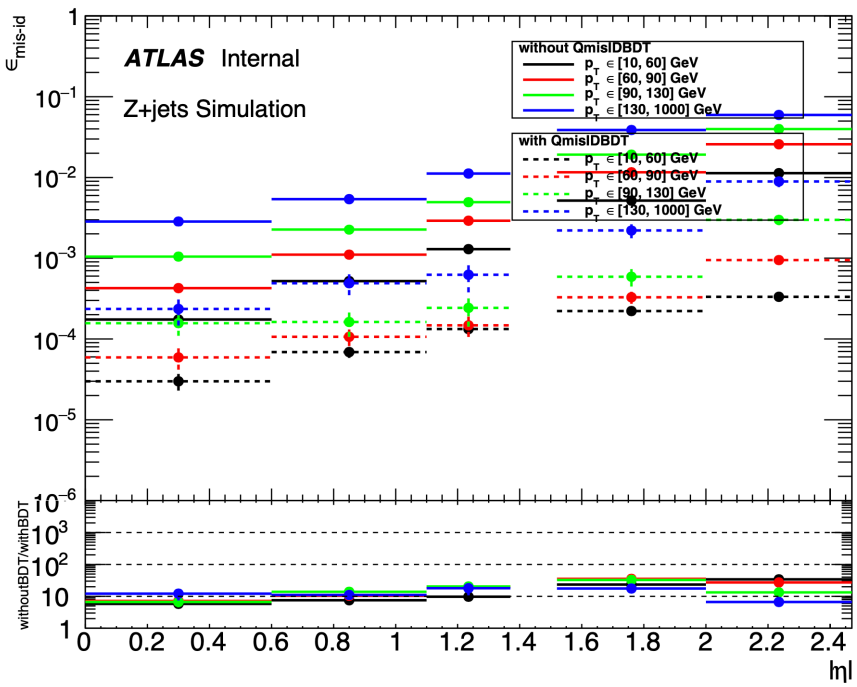
- Fact factor derivation

$$\theta_e(1 \le N_{\text{jet}} \le 2) = \frac{N_{ee}^{\text{data}} - N_{ee}^{\text{promptSS}} - N_{ee}^{V\gamma} - N_{ee}^{\text{QmisID}}}{N_{e\not{e}}^{\text{data}} - N_{e\not{e}}^{\text{promptSS}} - N_{e\not{e}}^{V\gamma} - N_{e\not{e}}^{\text{QmisID MC}}} \quad \theta_\mu(1 \le N_{\text{jet}} \le 2) = \frac{N_{\mu\mu}^{\text{data}} - N_{\mu\mu}^{\text{promptSS}} - N_{\mu\mu}^{V\gamma}}{N_{\mu\not{\mu}}^{\text{data}} - N_{\mu\not{\mu}}^{\text{promptSS}} - N_{\mu\not{\mu}}^{V\gamma}}$$

- Leptons in equation:
  - identified with truth-reco object matching to remove the overlap with the fakes
  - PromptSS :diboson, VVV, tV, ttV ,XH
  - Denominator in θ_e: use ttbar,Zjets,Wjets to provide one real lepton(by truth matching) and one fake lepton

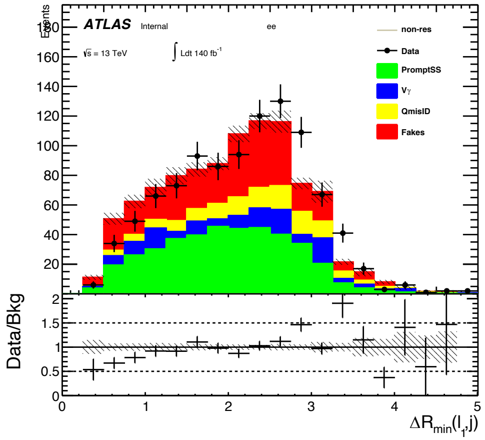
- Overall ff from 140-1fb
  - $\theta_e = 0.3244 \pm 0.0331, \theta_\mu = 0.1971 \pm 0.0200$

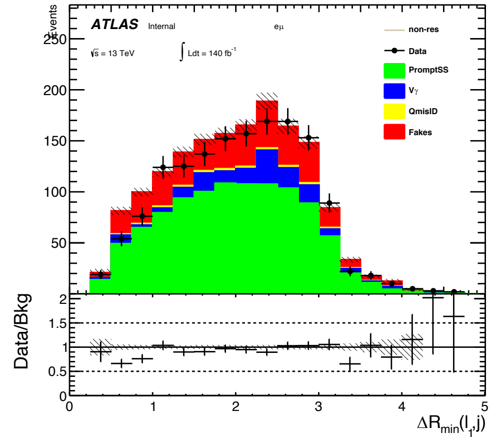
- Charge misidentification background

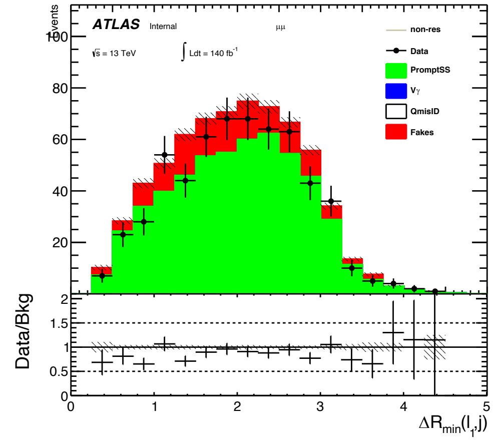


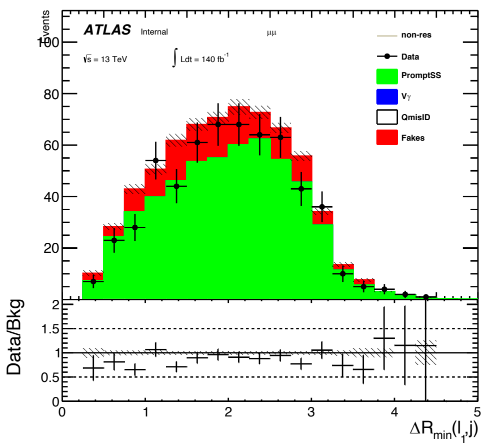
- The QMisID rates are derived from the 80-1fb data and validate with Z->ee process

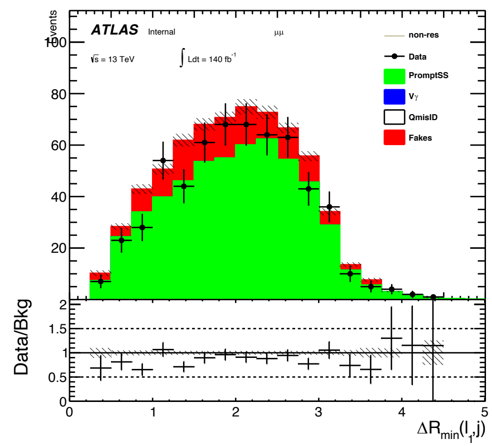
Data/MC at preselection level

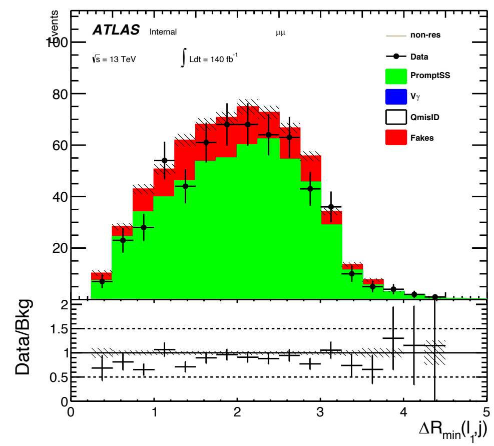




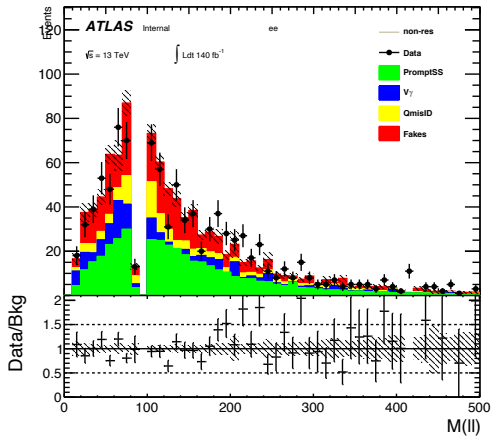


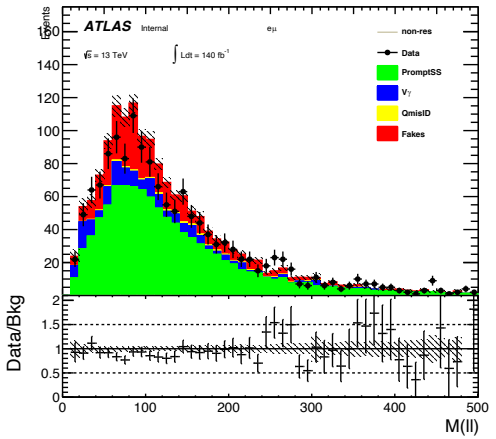


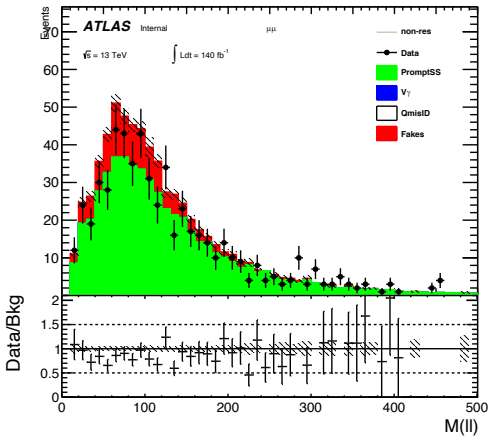


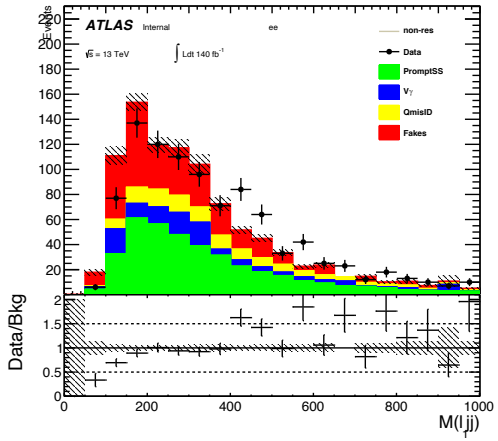


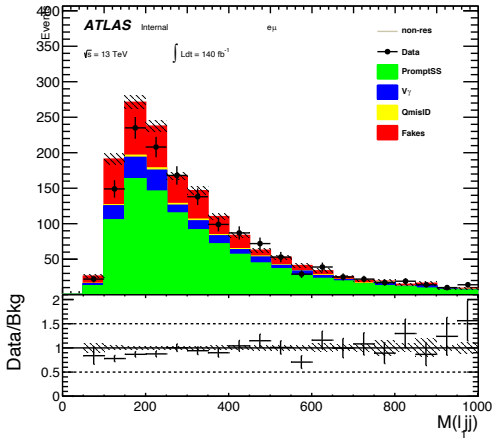
Data/MC at preselection level

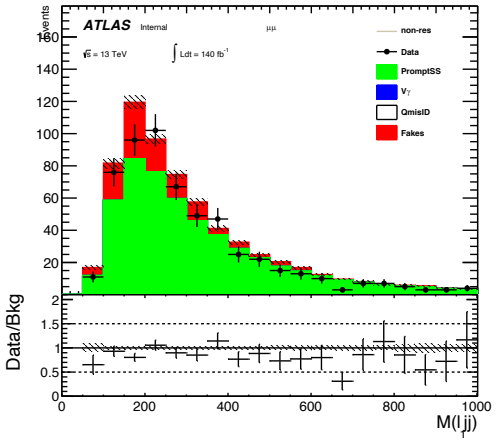












Summary

- Fakes are suppressed considerably by PLV in $\ell^{\pm}\ell^{\pm}$ channel
- Fake factor method has performs stable results for this analysis
- Pt/η dependent fake rates may help with fake description

Combined fit with all the data sets

mH	mS	Chi2 from CMS_hZZ	Chi2 from ATLAS_hyy	Chi2 from CMS_hyy	Chi2 from ATLAS_hZZ
262	136	9.281	18.538	15.126	17.11
262	138	9.27	18.737	15.128	17.21
262	140	9.291	18.962	15.017	17.289
262	142	9.313	19.082	14.921	17.339
262	144	9.329	19.145	14.869	17.357
264	136	9.305	18.186	15.485	16.985
264	138	9.298	18.428	15.089	17.165
264	140	9.204	18.741	15.13	17.217
264	142	9.285	18.944	15.019	17.294
264	144	9.321	19.071	14.923	17.333
266	136	9.258	18.43	15.36	17.08
266	138	9.324	18.119	15.524	16.971
266	140	9.281	18.478	15.154	17.11
266	142	9.265	18.741	15.13	17.199
266	144	9.289	18.971	15.002	17.302
268	136	9.261	18.524	15.31	17.157
268	138	9.264	18.411	15.369	17.071
268	140	9.334	17.997	15.584	16.97
268	142	9.279	18.515	15.137	17.111
268	144	9.263	18.738	15.139	17.189
270	136	9.271	18.689	15.198	17.246
270	138	9.262	18.526	15.309	17.156
270	140	9.256	18.418	15.369	17.069
270	142	9.319	17.986	15.606	16.963
270	144	9.287	18.442	15.168	17.11
272	136	9.283	18.855	15.084	17.32
272	138	9.279	18.699	15.187	17.26
272	140	9.26	18.524	15.306	17.164
272	142	9.247	18.417	15.373	17.068
272	144	9.313	18.074	15.551	16.982
274	136	9.316	19.027	14.951	17.381
274	138	9.29	18.853	15.079	17.329
274	140	9.259	18.661	15.218	17.253
274	142	9.252	18.529	15.316	17.153
274	144	9.256	18.41	15.375	17.067
Bin number		13	26	13	19