Institute of High Energy Physics
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ATLAS EXPERIMENT

Weekly Report

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2023/4/24

Introduction

- HHML non-res analysis:
  - CDS reply has been posted last Friday.
  - Plan to prepare the INT for review in this week.

2LSS

- Combined fit regions
  - QED (internal conversion)
  - Material conversion
  - HT_lep in em+mm for HF-mu
  - HT_lep in me+ee for HF-e
  - Drll01 in me+ee for HF-e
  - WZ control region in 3l
  - VVjj with mjj cut

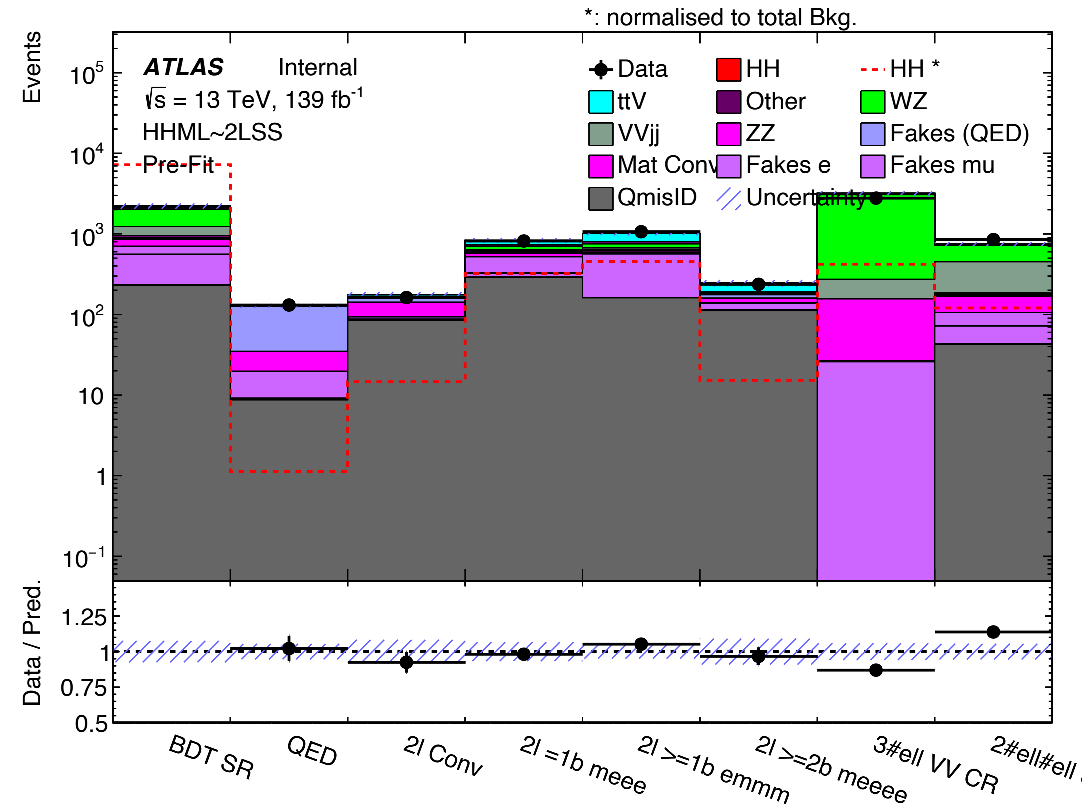
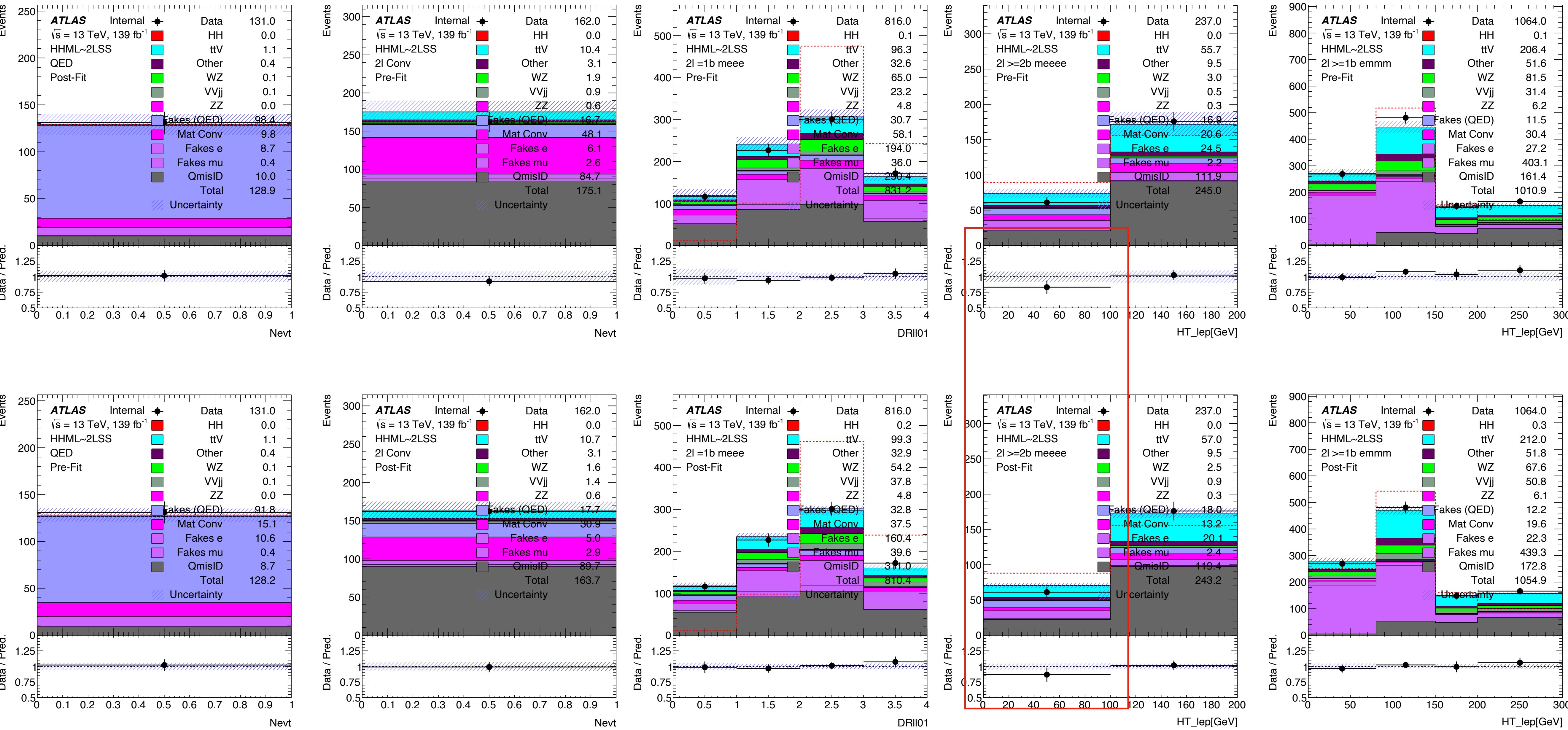


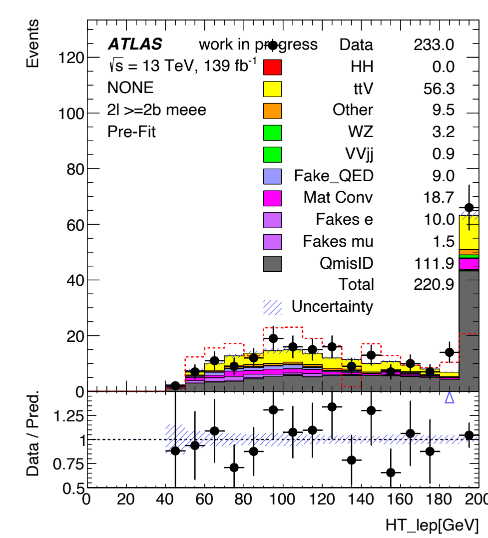
Table 5.6 Definition of control regions. Orthogonality requirements with respect to signal reigon are highlighted in blue.

Channel	Region	$N_{\text{lep}}^{\sum Q_i^\ell}$	$N_{\tau_{\text{had}}}^{\sum Q_i^\ell}$	N_{jet}	$N_{b-\text{jet}}$	BDT cut	$m_{\ell\ell\ell}$ [GeV]	$m_{\ell^+\ell^-}$ [GeV]	$m_{\ell^\pm\ell^\pm}$ [GeV]	E_T^{miss} [GeV]	m_{jj} [GeV]
2ℓSS	WZ CR	$3^{\pm1}$	0	≥ 2	0	$BDT_{All} < -0.4$ $BDT_{Vjets} > -0.8$	$\lvert m_{\ell\ell\ell} - m_Z \rvert > 10$	$\lvert m_{\ell\ell} - m_Z \rvert < 10$		> 30	
	$W^\pm W^\pm jj$ CR	$2^{\pm2}$	0	≥ 2	0	$BDT_{All} < -0.4$ $BDT_{Vjets} > -0.8$			$\lvert m_{\ell\ell} - m_Z \rvert > 10$		> 300
	QmisID	$e^\pm e^\pm$ $e^\pm e^\mp$	0	< 2	0			[78.5, 102.3]	[76.5, 101.3]		
	Conv CR	$2^{\pm2}$	0	≥ 2	≥ 1						
	QED CR	$2^{\pm2}$	0	≥ 2	≥ 1						
	HF-e CR	$\ell^\pm e^\pm$	0	2, 3	1 2						
	HF-μ CR	$\ell^\pm \mu^\pm$	0	2, 3	≥ 1						

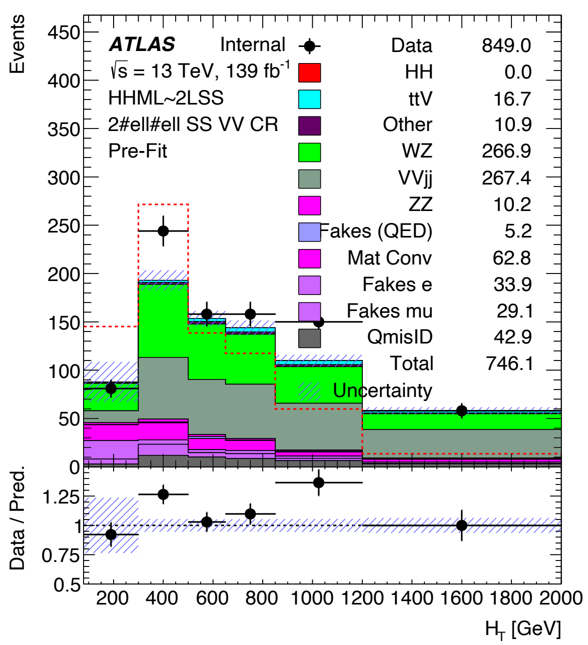
Template fit control region plots

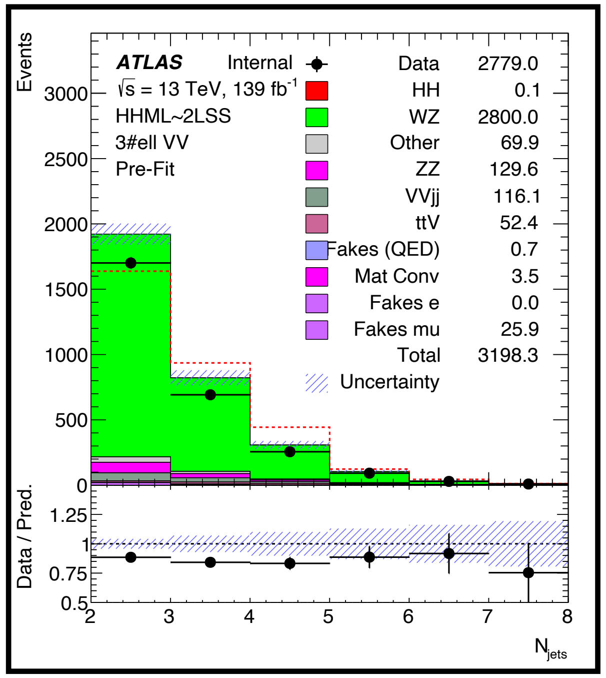


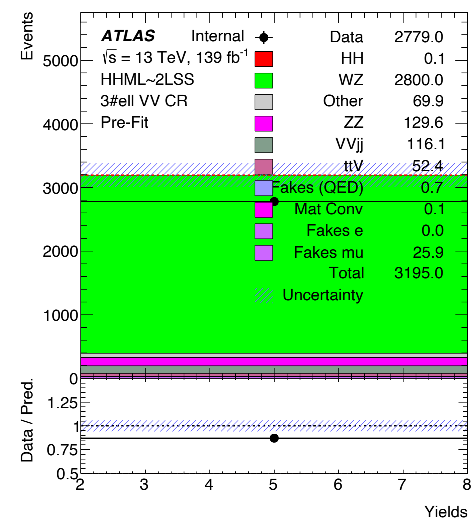
Could be tuned with better binning

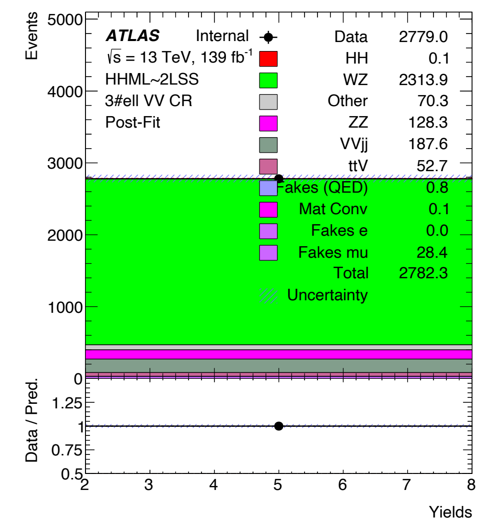


- Additional two regions for WZ and WZjj:
  - One binned fit for WZ (Njets distribution just for visualization)
  - We don’t observe Njets dependent shape. While 3l channel is different => Hard to have a 2l & 3l combined fit

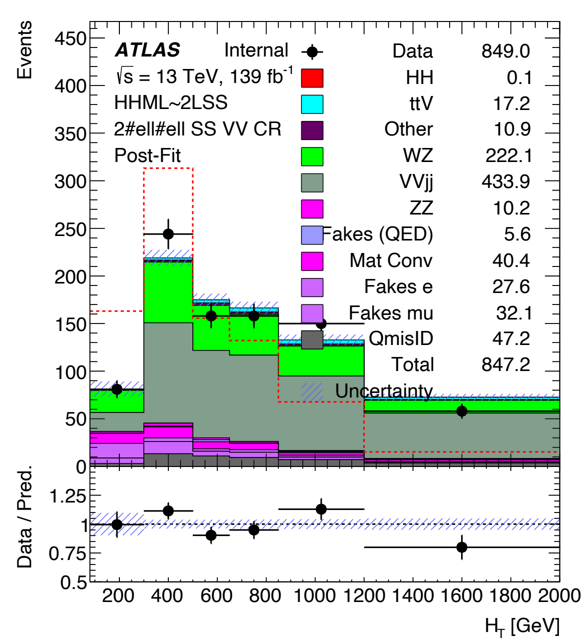


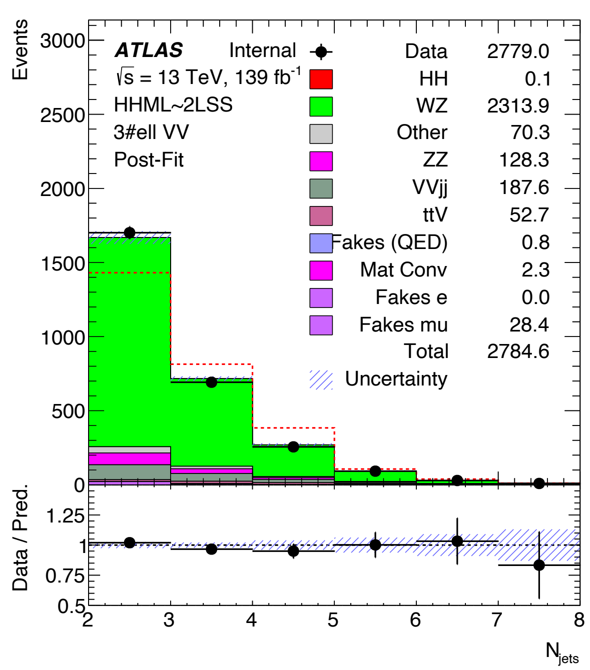


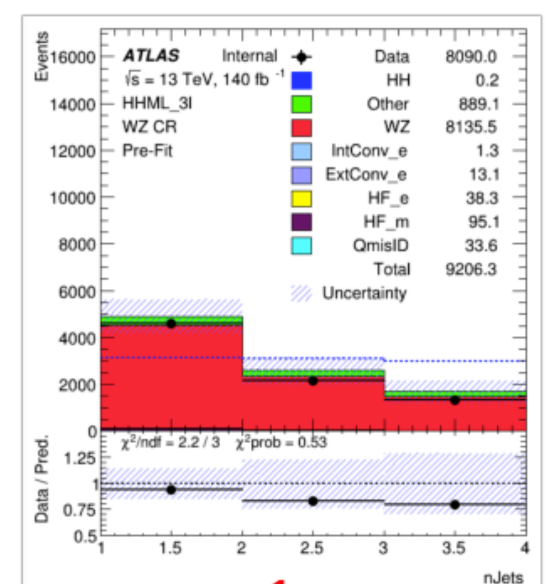




Actual fit region







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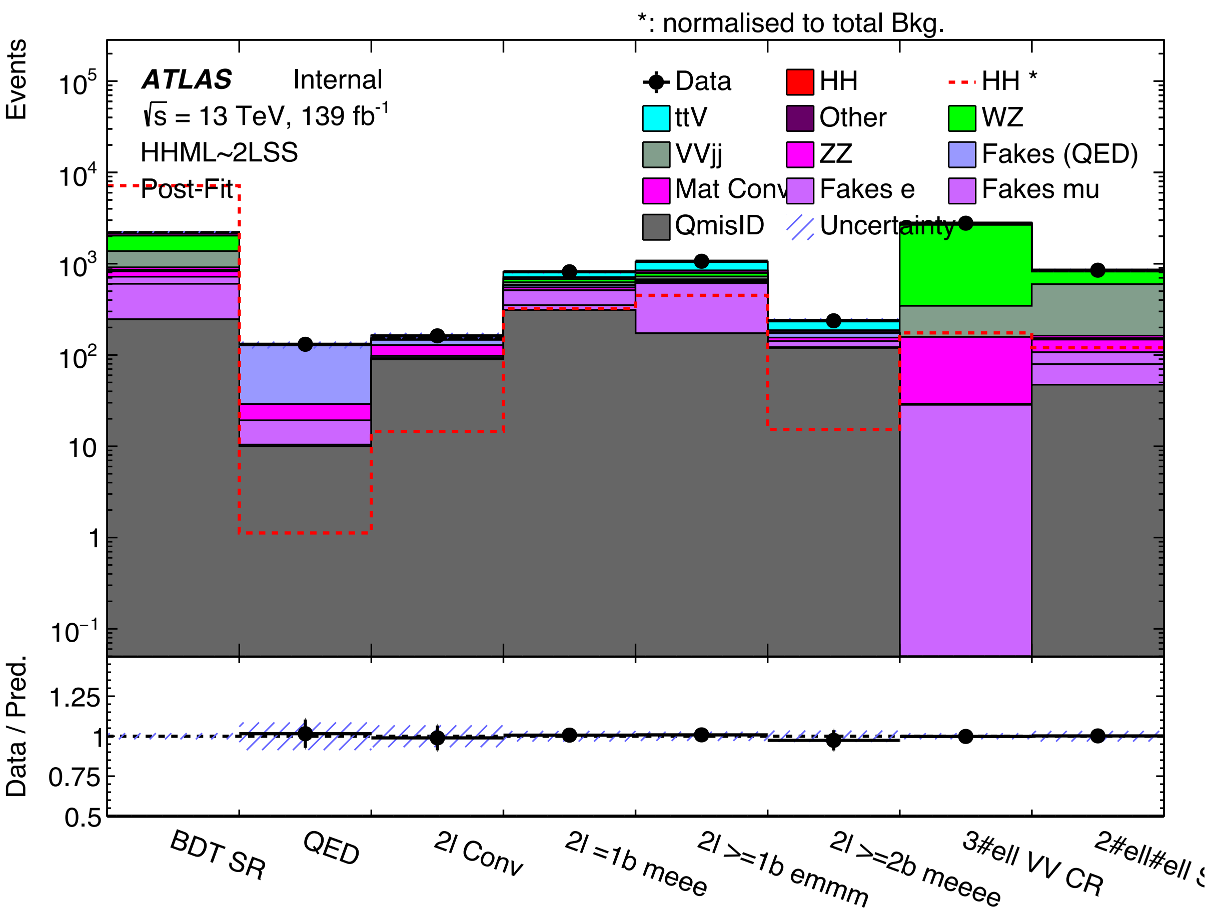
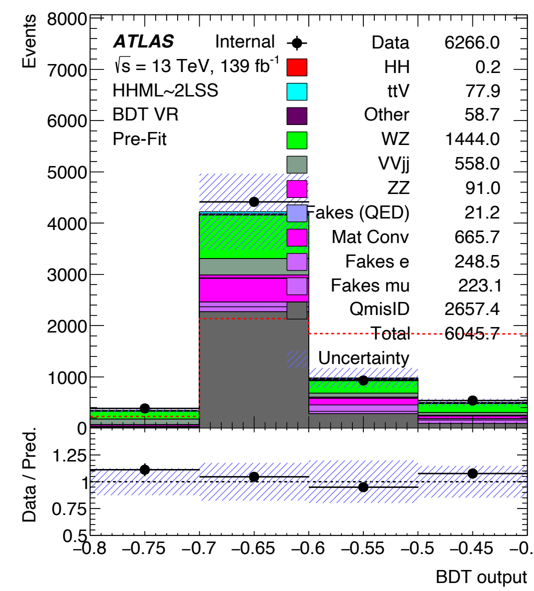
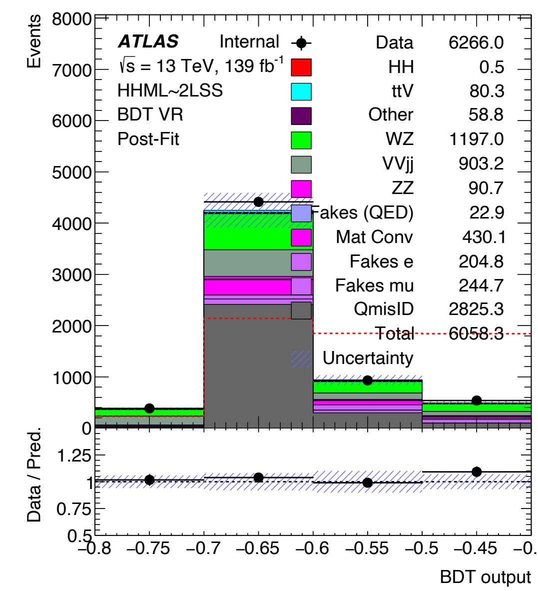
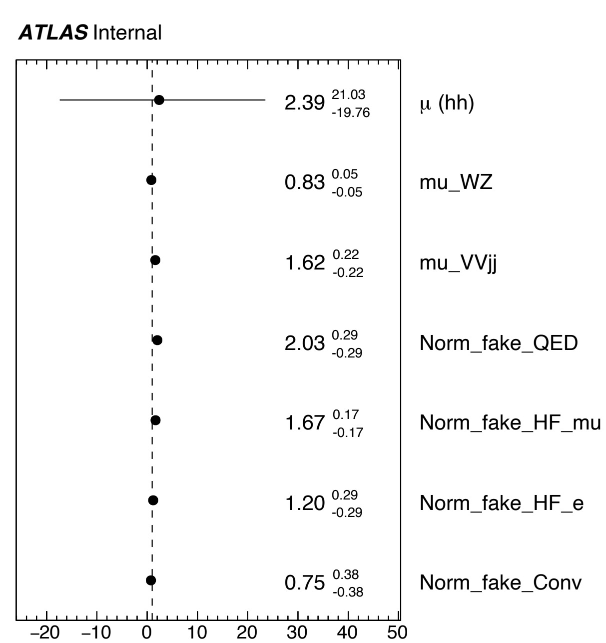
Fit validation

- The fit is preformed in CR + SR, using hybrid datasets. Sideband data in CR and Asimov data in SR.
- Uncertainty included: Full detector systematic + main theory uncertainty with flat numbers in cross section.
- Good agreement with VV alone fit.

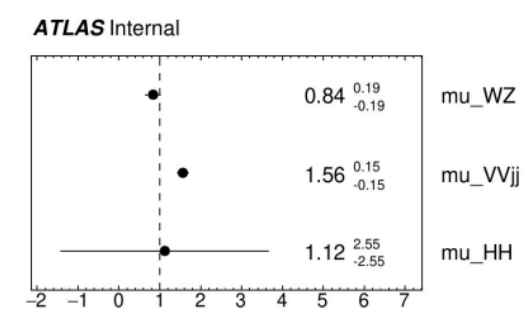








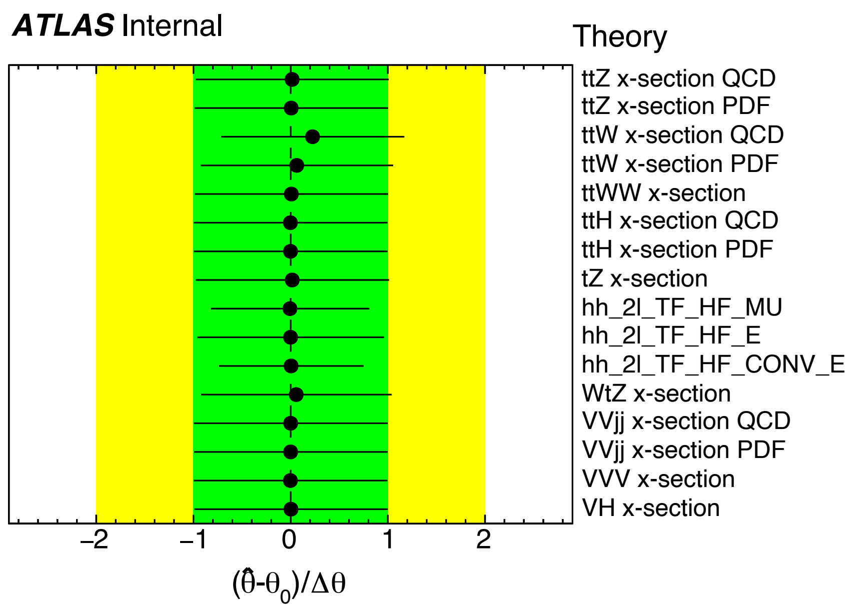
Combined

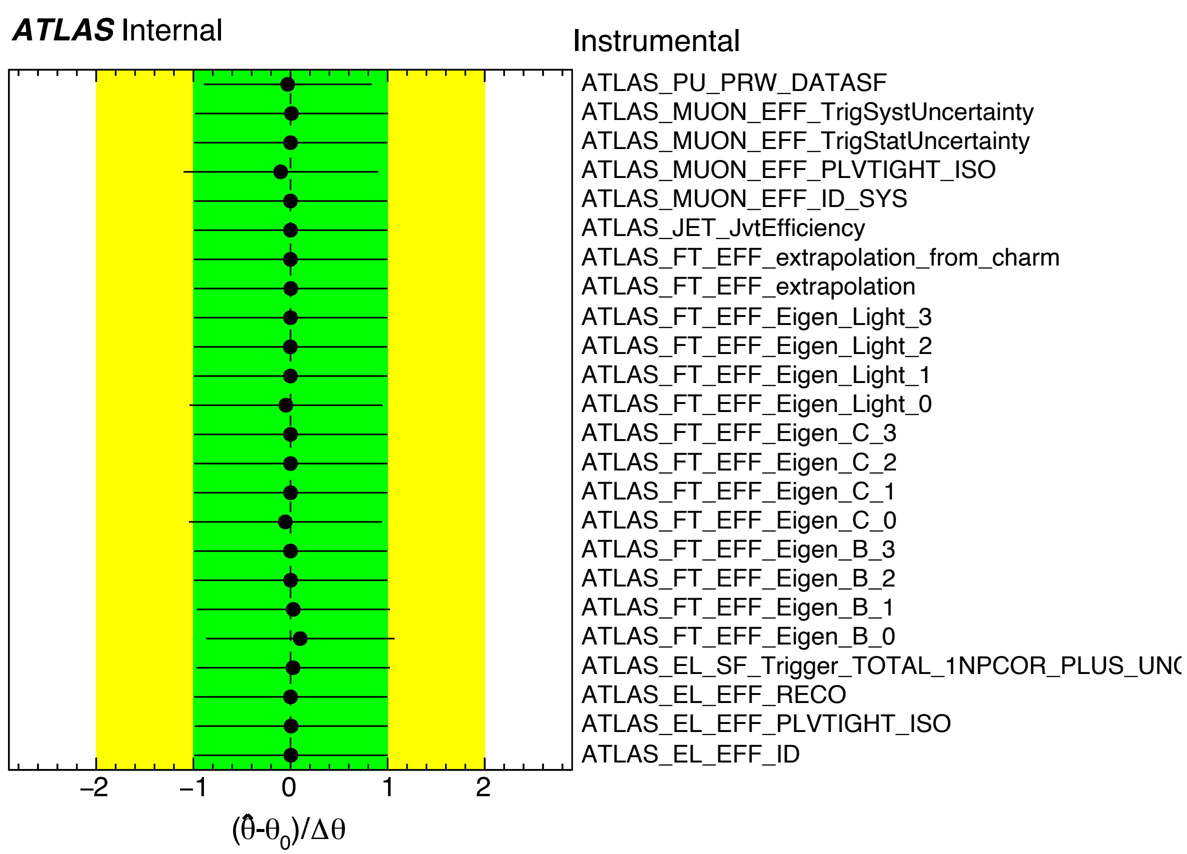


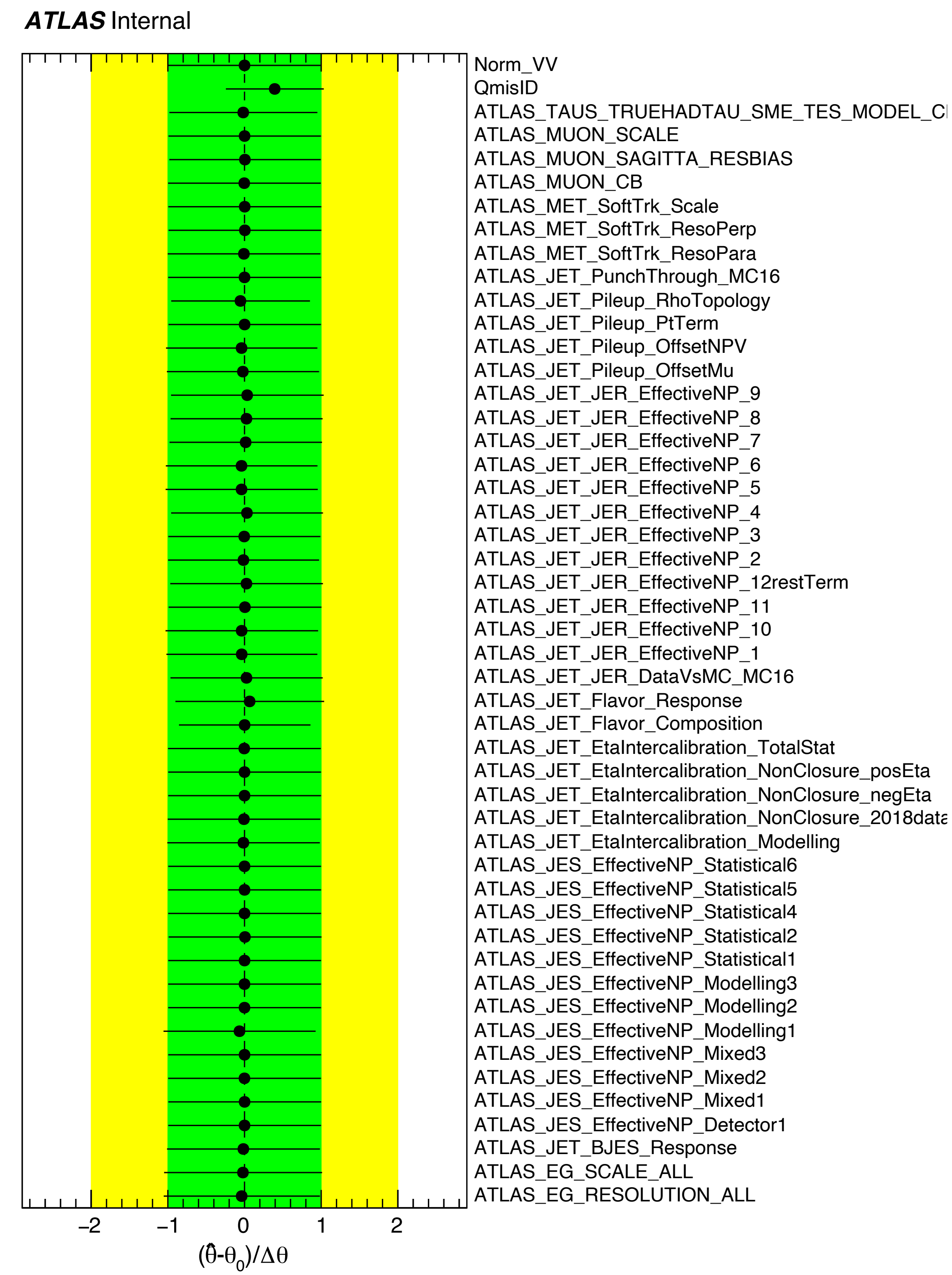
VV alone, from Angela

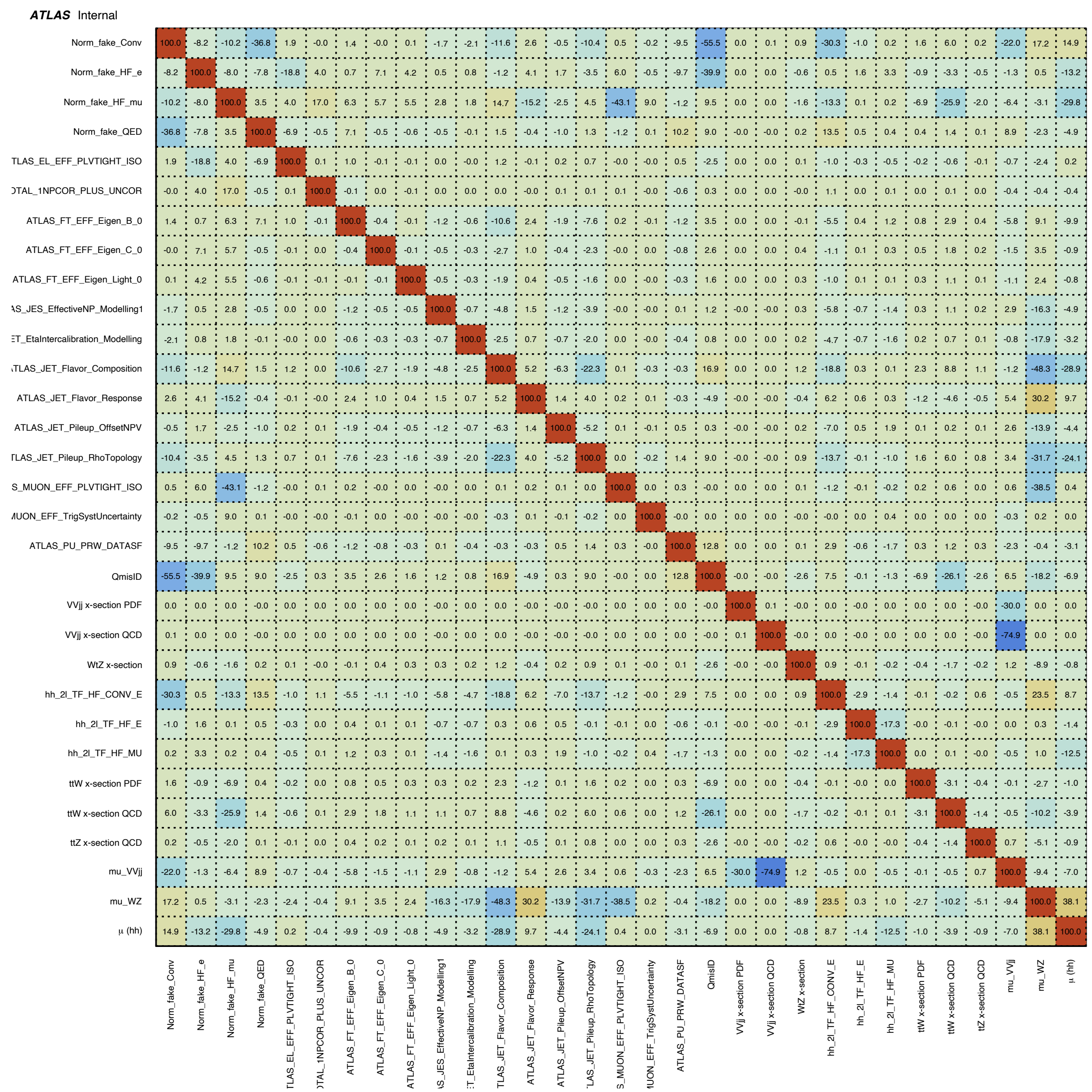
Pull plots

- Constraint in QmisID is due to its contribution to CRs.









- Large correlations between QmisID and mu-fake, mu-hf-e, could due to large statistics and overconservative uncertainty
    - Try to decorrelate it between two regions to see which region is responsible.
    - Try to decorrelate QmisID into three terms: Closure, statistical, Z-peak window ? Then constraint could be reduced.
- Largest correlation: muVVjj and VVjj x-section PDF, which is understandable.

Backup

Selection cut	2ℓSS	3ℓ	3ℓ $W^{\pm}Z$ CR for 2ℓSS
Trigger	SL OR DL	SL OR DL	SL OR DL
TrigMatch	Tight e or μ	✓	✓
N_ℓ	==2	==3	==3 (2ℓ SS +1 type Loose)
Total charge	+ 1	±1	±1
Lepton selection	T	ℓ_1: L, $\ell_{2,3}$: T	ℓ_0: L, $\ell_{1,2}$: T
low di-lepton mass veto	$m(\ell^\pm\ell^\pm) > 12$ GeV	$m(\ell^+\ell^-) > 12$ GeV	$m(\ell_i\ell_j) > 12$ GeV ($i, j \in \{0, 1, 2\}$)
p_T^ℓ	> 20 GeV	ℓ_1 :> 10 GeV, $\ell_{2,3}$:> 15 GeV	ℓ_0 :> 10 GeV, $\ell_{1,2}$:> 20 GeV
τ-veto	✓	✓	✓
b-veto	✓	✓	✓
N_{jets}	≥ 2	≥ 2	≥ 2
Z-veto	-	$\lvert m_{SFOS} - 91.2\rvert > 10$ GeV	-
$Z - \gamma$-veto	-	$\lvert m_{lll} - 91.2\rvert > 10$ GeV	$\lvert m_{lll} - 91.2\rvert > 10$ GeV
$\ell\ell$-pair	-	-	≥ 1 OSSF pair
Z+jets selection	-	-	$\lvert m_{SFOS} - 91.2\rvert < 10$ GeV
E_T^{miss}	-	-	> 30 GeV

Table 17: 3ℓ $W^{\pm}Z$ CR for the 2ℓSS analysis, compared to the 3ℓ and 2ℓSS pre-selection.