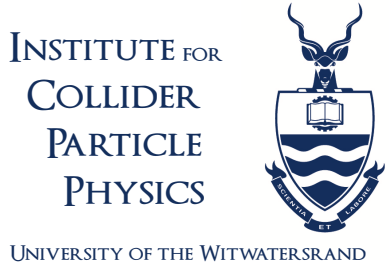
4ℓ+MET: Analysis update

Abdualazem Fadol

October 26, 2020



Signal samples

- DAOD request is submitted here , the requested p-tag is p4222.
- The samples are almost finish, but it complains about some, you can see in the link above.
- It sounds like the old ones that we requested here , but 4 samples are stack there.
- We can now start working on the new minitrees with the MET bug fix.

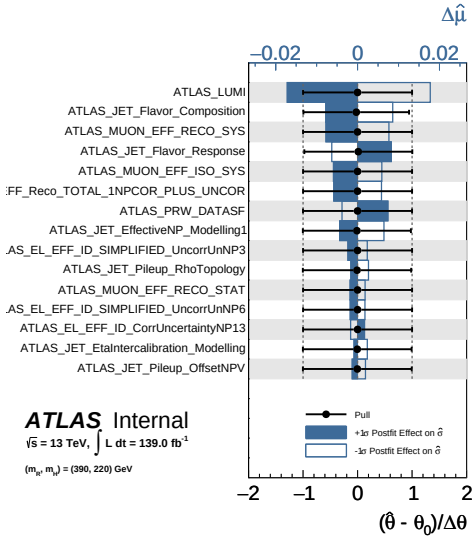
Upper limits on the cross-section

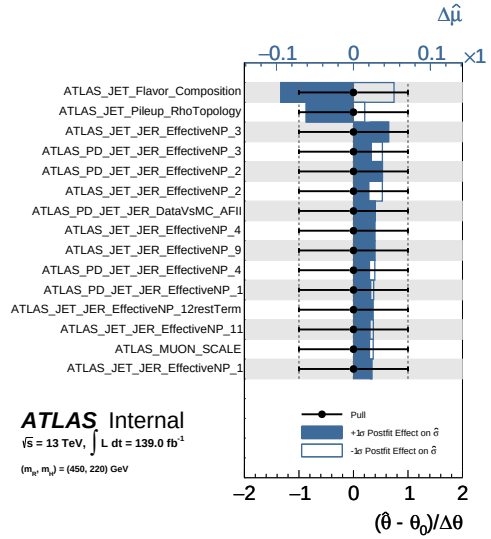
mass point = m_R, m_H [GeV]	-2σ	-1σ	Median	$+1\sigma$	$+2\sigma$
390, 220	0.064	0.085	0.119	0.177	0.246
450, 220	0.037	0.049	0.069	0.103	0.144
450, 250	0.033	0.045	0.062	0.089	0.127
800, 220	0.028	0.038	0.052	0.079	0.112
800, 300	0.020	0.027	0.037	0.054	0.079
800, 500	0.012	0.017	0.023	0.034	0.051
1500, 220	0.026	0.034	0.048	0.072	0.103
1500, 250	0.021	0.029	0.040	0.059	0.087

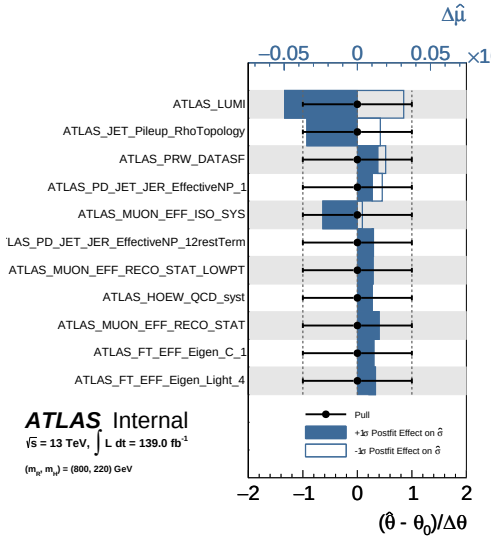
mass point = m_R, m_H [GeV]	-2σ	-1σ	Median	$+1\sigma$	$+2\sigma$
390, 220	0.068	0.0916	0.127	0.190	0.263
450, 220	0.037	0.049	0.069	0.103	0.145
450, 250	0.033	0.045	0.062	0.089	0.129
800, 220	0.028	0.038	0.052	0.079	0.113
800, 300	0.020	0.027	0.037	0.054	0.079
800, 500	0.012	0.017	0.023	0.034	0.052
1500, 220	0.028	0.038	0.053	0.080	0.114
1500, 250	0.022	0.029	0.040	0.060	0.088

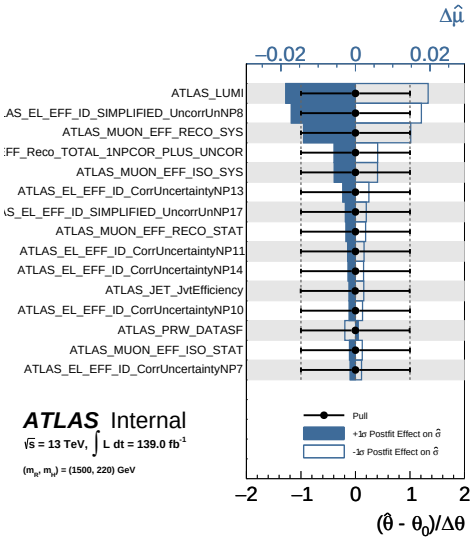
- Upper limit after adding the experimental uncertainty for the signal.
- We also considered 1.7% global uncertainty on the luminosity.

NP ranking study









Summary

- I'm generating the rest of the systematic for the remaining samples, and soon I'll have them.
- I showed the upper limit for some of the signal samples that we have their systematic.
- We also have all the signal parameters for the RSH model except the 4 samples that are still running.

Working on now . . .

- Signal fit for the AZH model.
- Trying to move to the new background model.

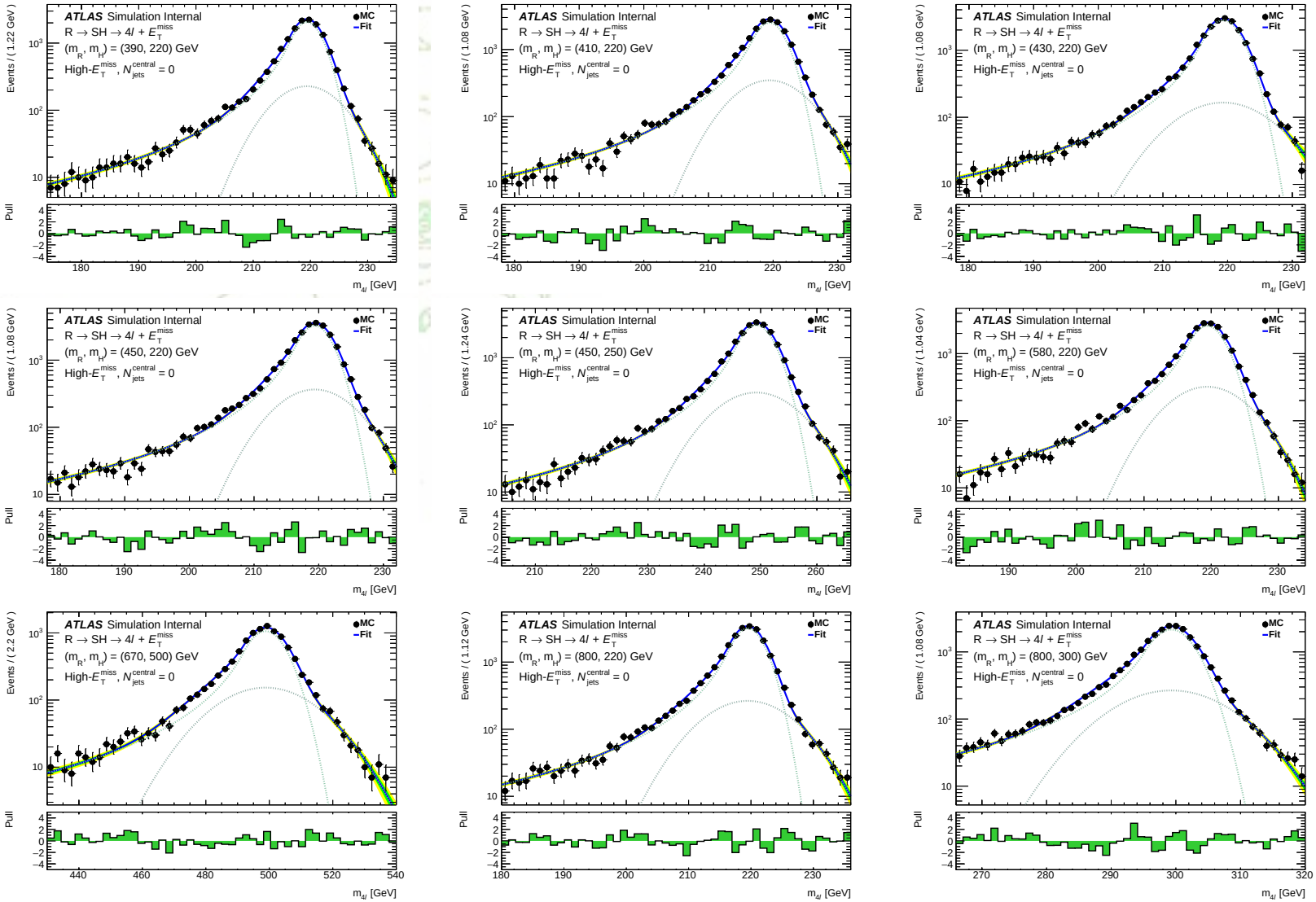
Thank you!

Additional slides
Event selection

Event Selection	
QUADRUPLET SELECTION	- Require at least one quadruplet of leptons consisting of two pairs of same-flavour opposite-charge leptons fulfilling the following requirements: - p_{T} thresholds for three leading leptons in the quadruplet: 20, 15 and 10 GeV - Maximum one calo-tagged or stand-alone muon or silicon-associated forward per quadruplet - Leading di-lepton mass requirement: $50 < m_{12} < 106$ GeV - Sub-leading di-lepton mass requirement: $m_{\mathrm{threshold}} < m_{34} < 115$ GeV - $\Delta R(\ell, \ell') > 0.10$ for all leptons in the quadruplet - Remove quadruplet if alternative same-flavour opposite-charge di-lepton gives $m_{\ell\ell} < 5$ GeV - Keep all quadruplets passing the above selection
ISOLATION	- Contribution from the other leptons of the quadruplet is subtracted - FixedCutPFlowLoose WP for all leptons
IMPACT PARAMETER SIGNIFICANCE	- Apply impact parameter significance cut to all leptons of the quadruplet - For electrons: $d_0/\sigma_{d_0} < 5$ - For muons: $d_0/\sigma_{d_0} < 3$
BEST QUADRUPLET	- If more than one quadruplet has been selected, choose the quadruplet with highest Higgs decay ME according to channel: 4μ, $2e2\mu$, $2\mu2e$ and $4e$
VERTEX SELECTION	- Require a common vertex for the leptons: - $\chi^2/\mathrm{ndof} < 5$ for 4μ and < 9 for others decay channels

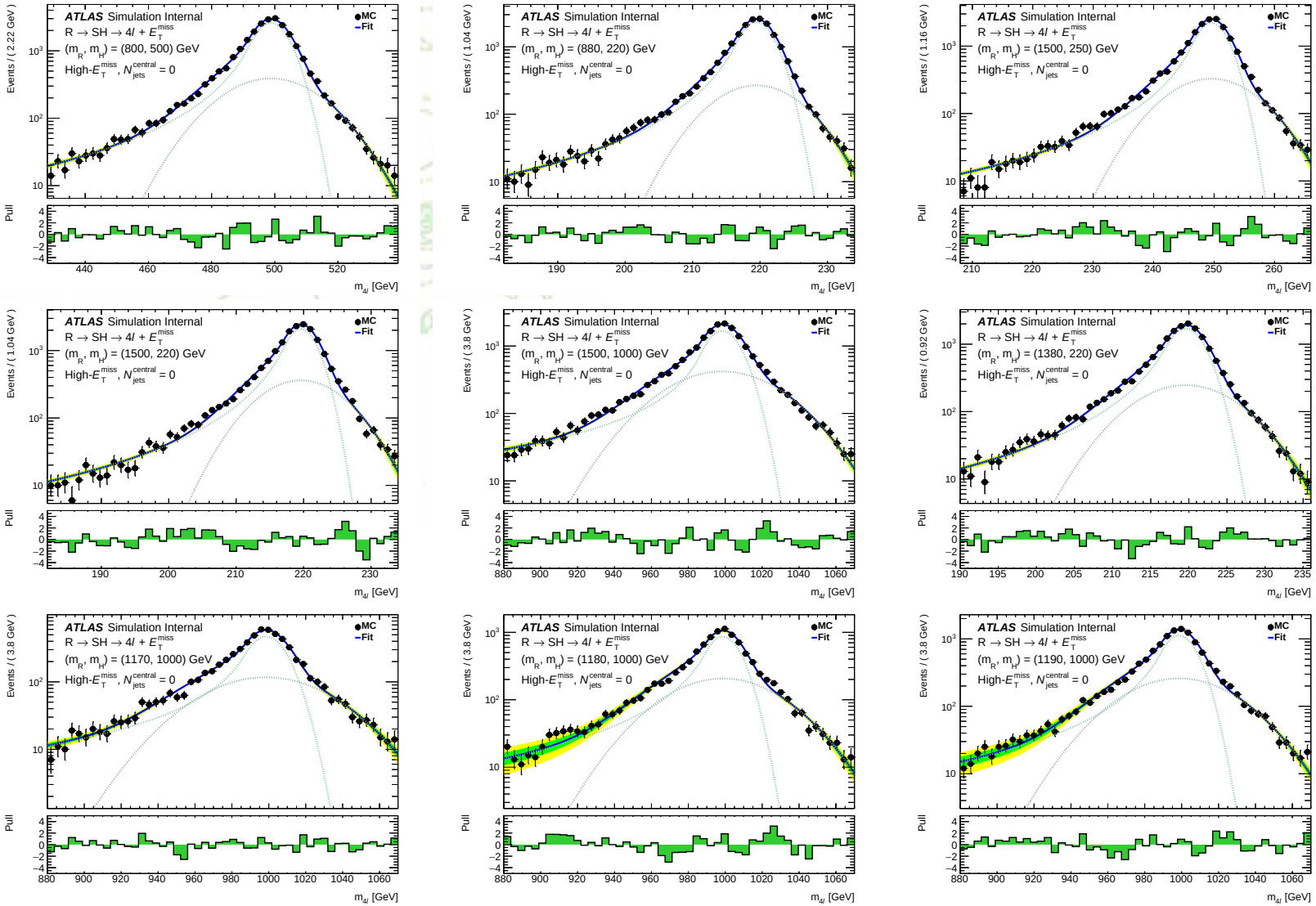
Signal parametrisation for RSH model

High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$



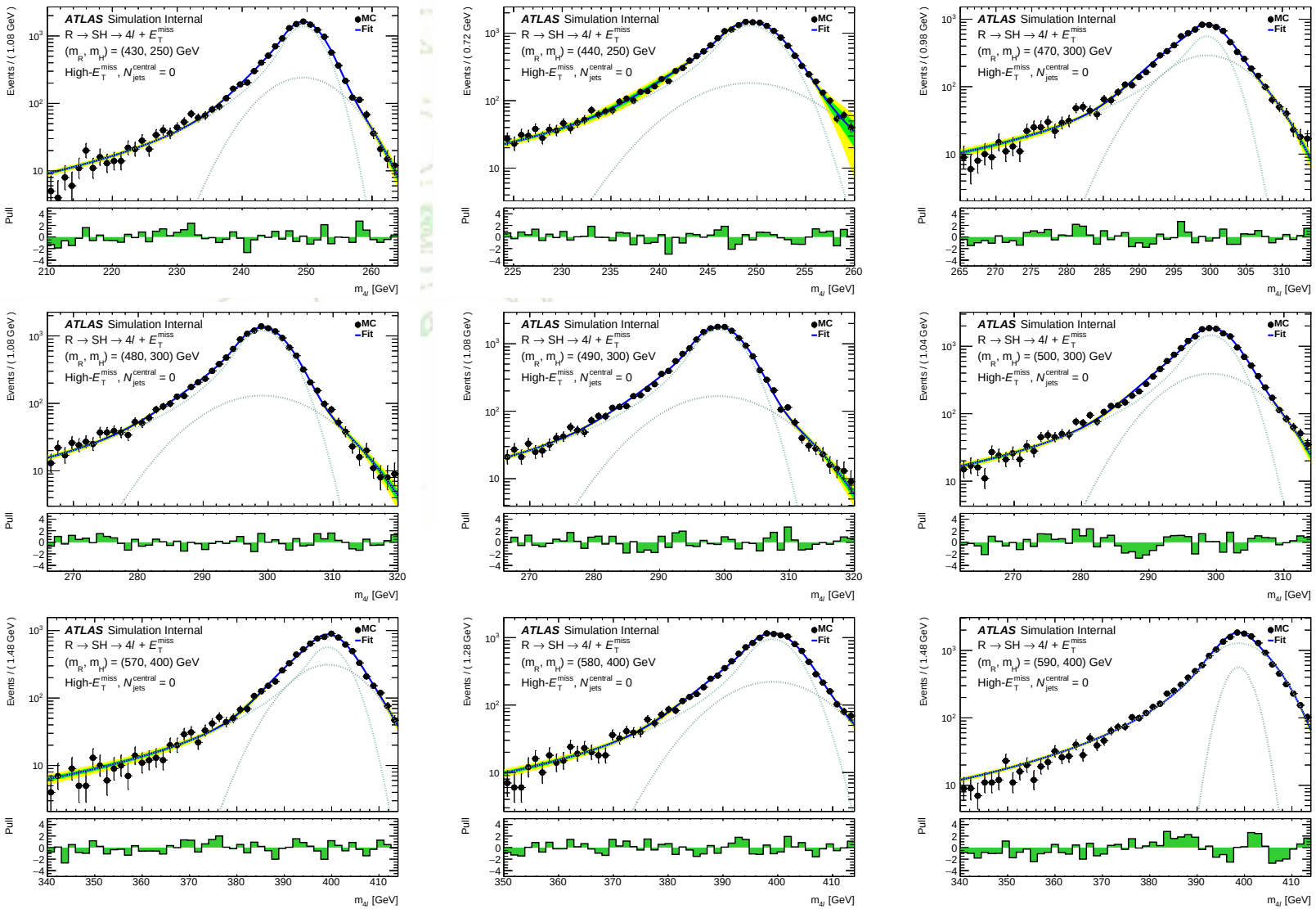
Signal parametrisation for RSH model

High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$



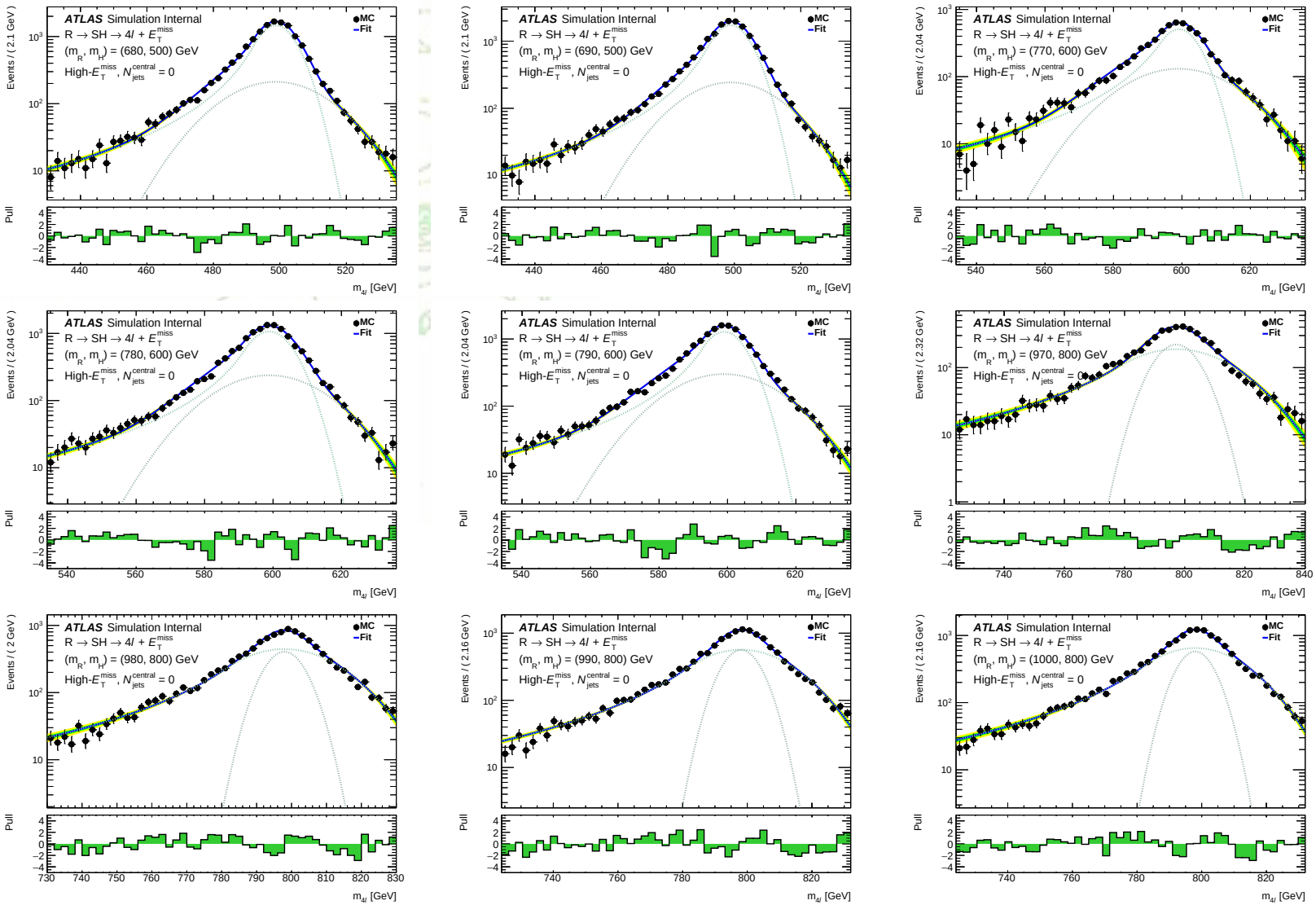
Signal parametrisation for RSH model

High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$



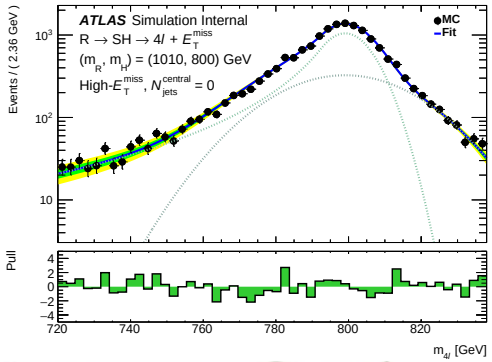
Signal parametrisation for RSH model

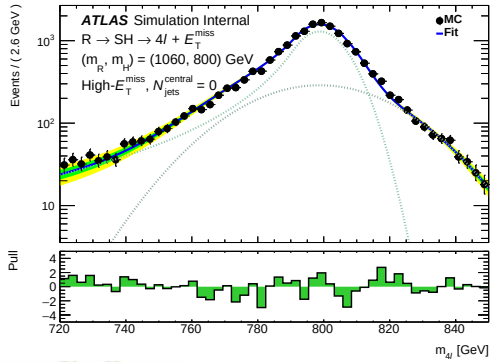
High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$

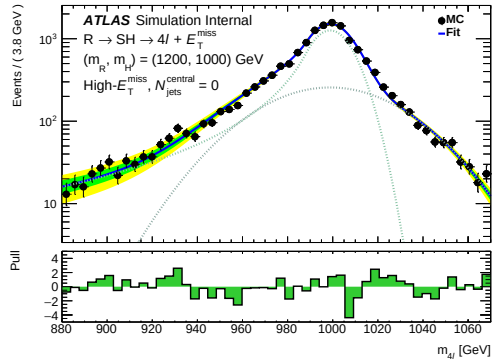


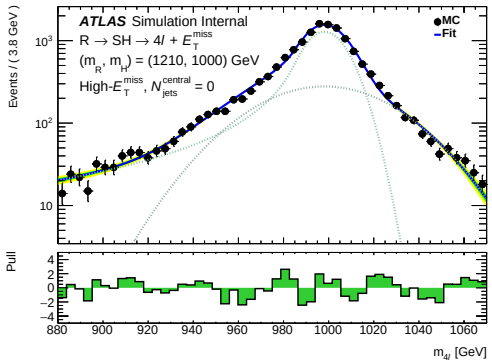
Signal parametrisation for RSH model

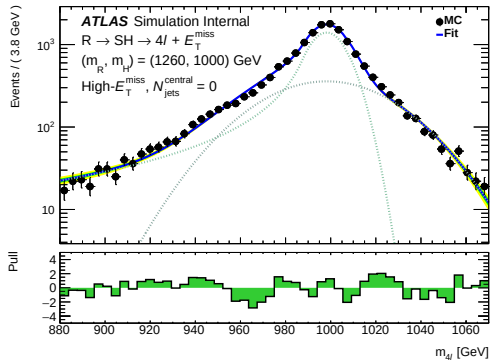
High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$

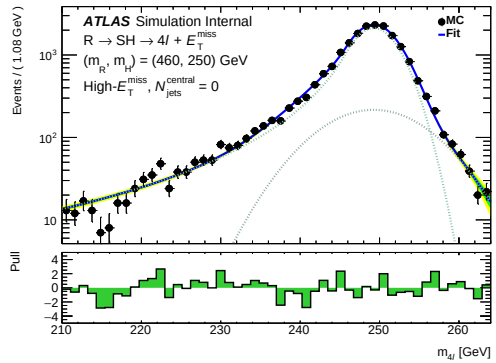


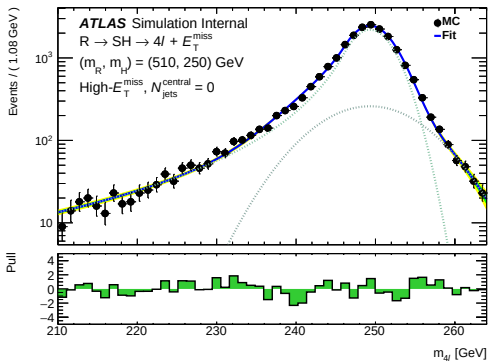


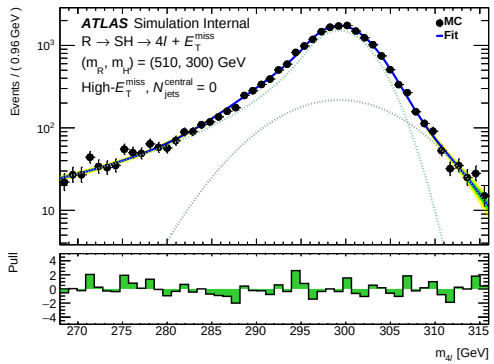


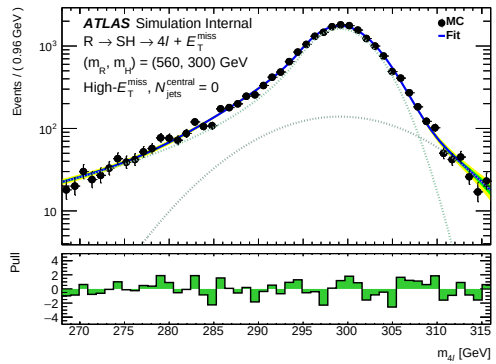






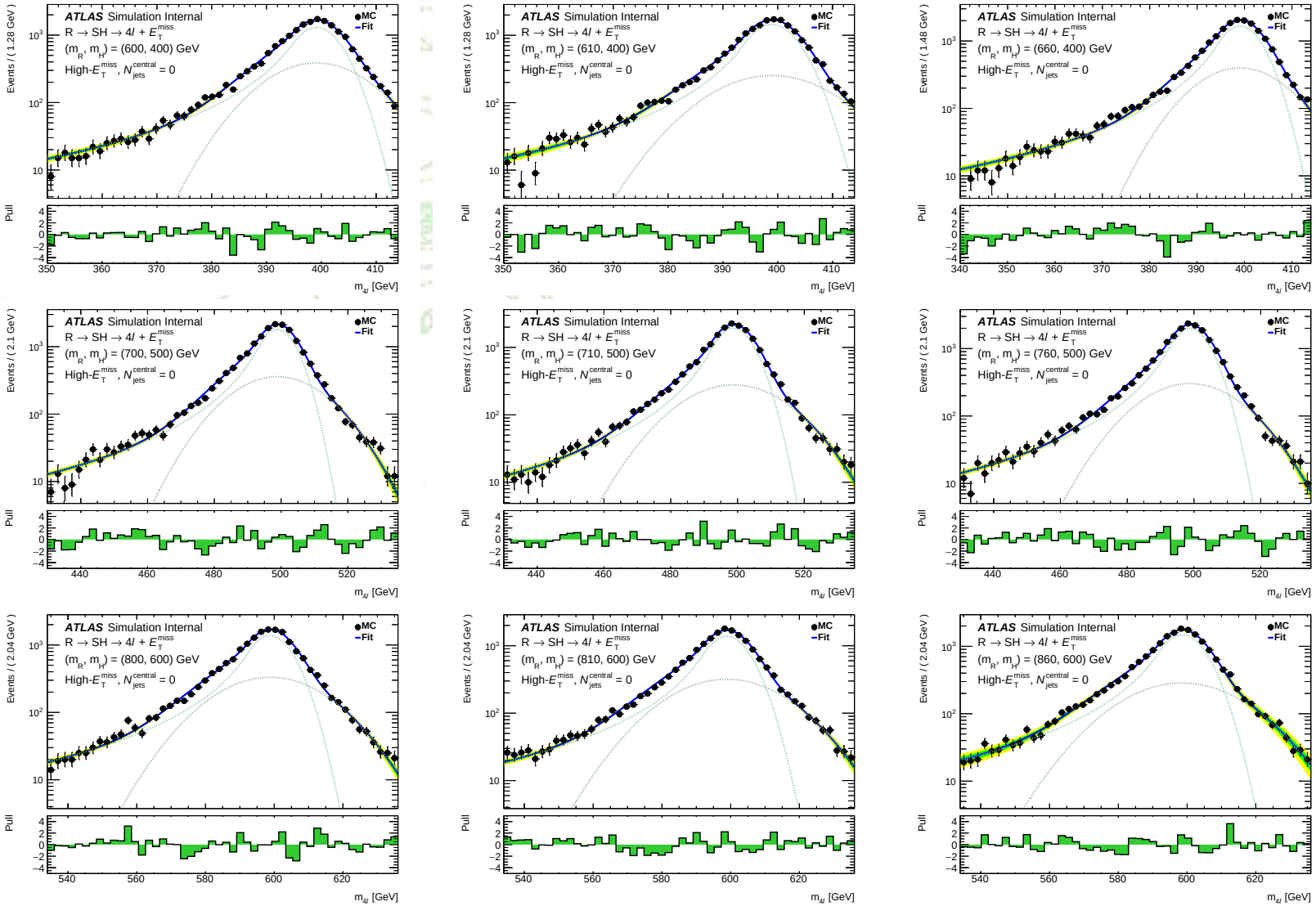






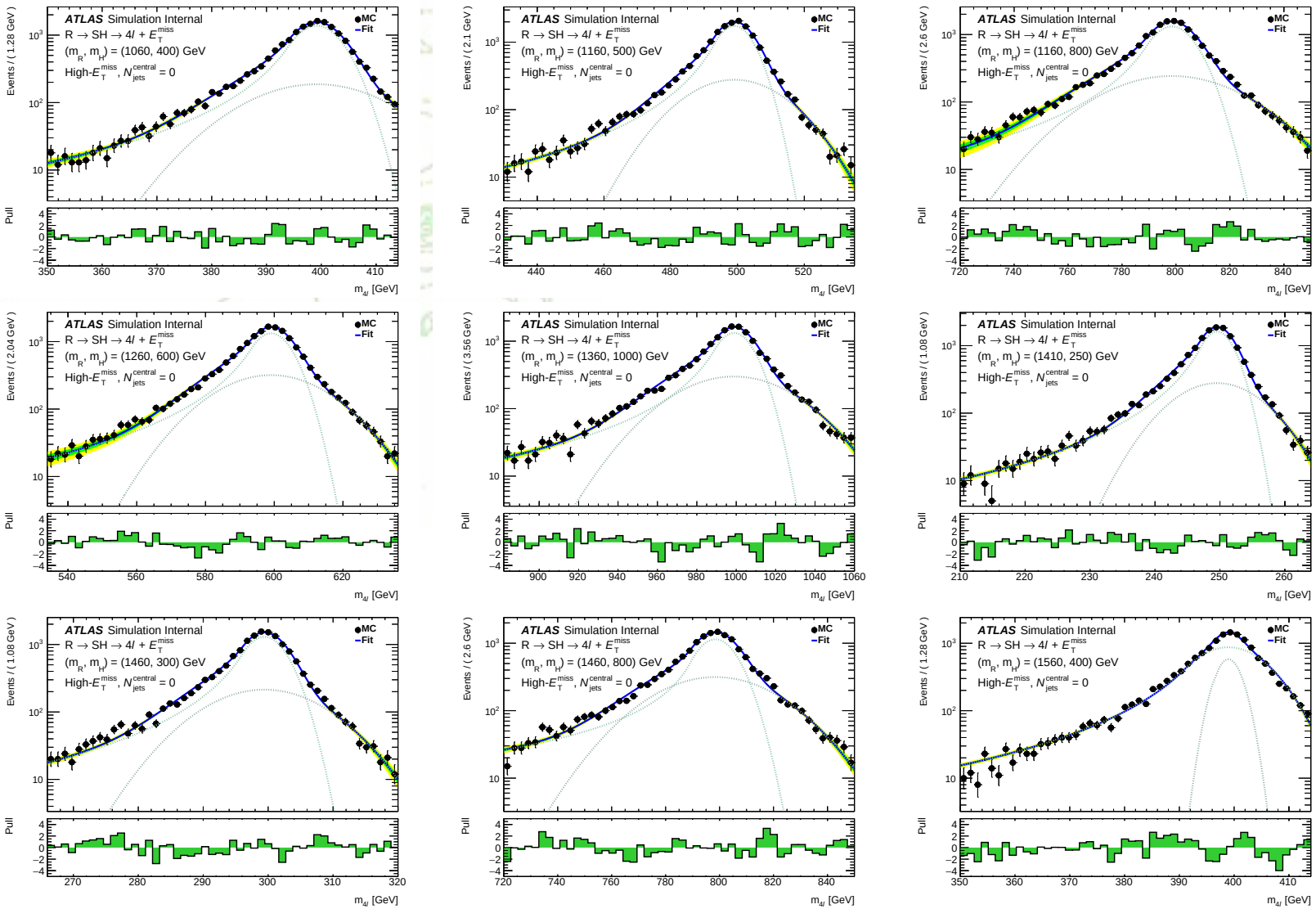
Signal parametrisation for RSH model

High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$



Signal parametrisation for RSH model

High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$



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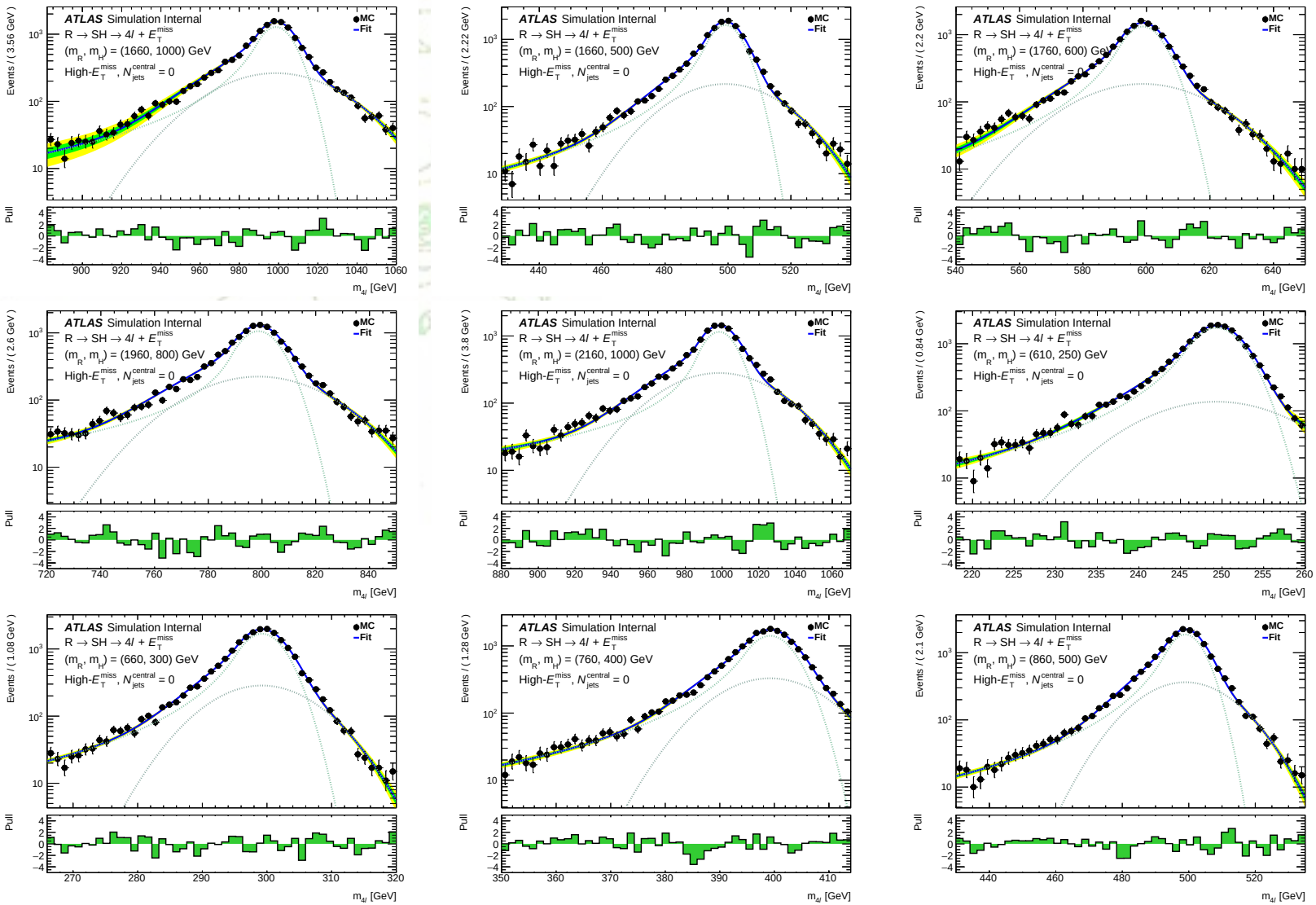
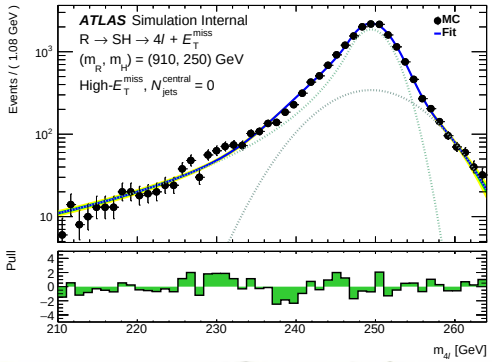
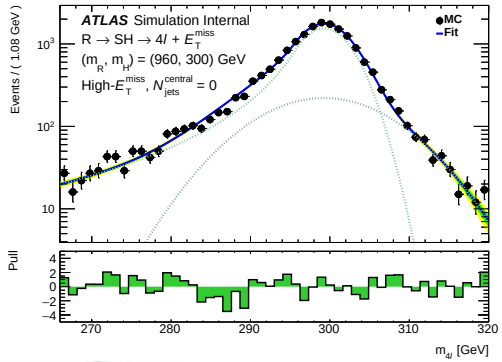
High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$

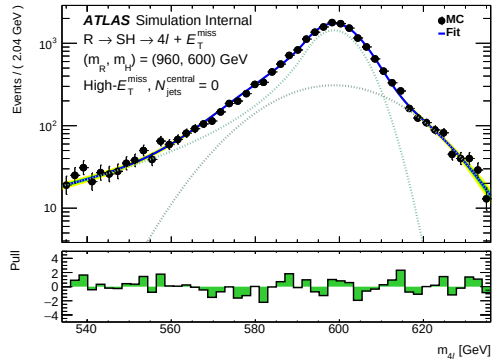


Signal parametrisation for RSH model

High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$:Summary of χ^2/ndof values for all signal mass points







Mass point = (m_X, m_H) [GeV]	χ^2/ndof
390, 220	0.98
450, 220	1.58
800, 220	1.29
1500, 220	1.90
450, 250	1.35
1500, 250	1.73
800, 300	1.48
800, 500	1.57
1500, 1000	1.75
410, 220	1.33
430, 220	1.37
580, 220	1.71
880, 220	1.15
1380, 220	1.40
670, 500	1.06
610, 250	1.51
660, 300	1.58
1170, 1000	0.85
-	-

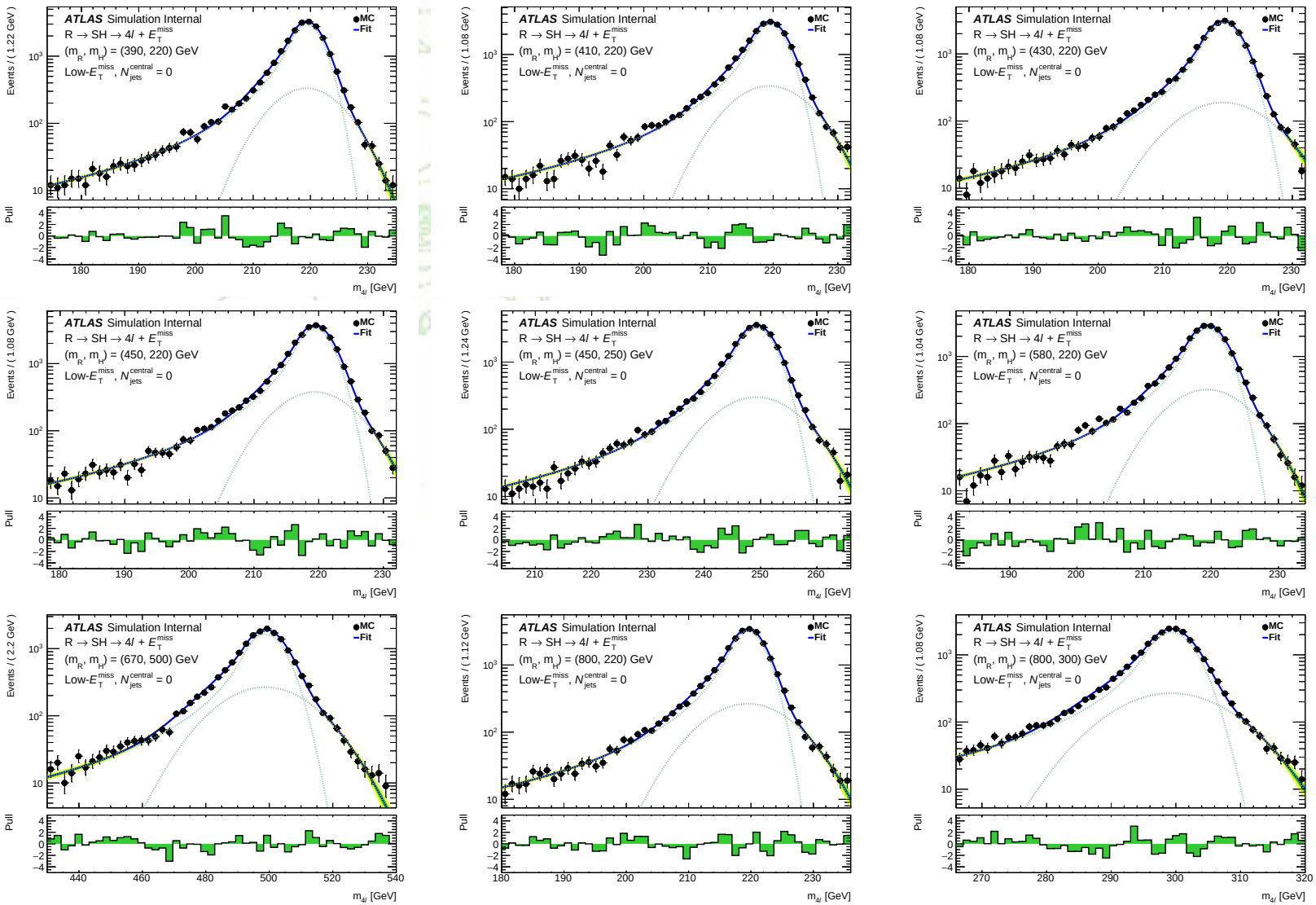
Mass point = (m_X, m_H) [GeV]	χ^2/ndof
470, 300	1.21
570, 400	1.08
770, 600	1.14
970, 800	1.43
430, 250	1.28
480, 300	0.80
580, 400	0.99
680, 500	1.12
780, 600	1.75
980, 800	1.77
1180, 1000	1.82
440, 250	1.10
490, 300	1.21
590, 400	2.26
690, 500	1.29
790, 600	1.76
990, 800	1.98
1190, 1000	1.44
500, 300	1.72

Mass point = (m_X, m_H) [GeV]	χ^2/ndof
600, 400	1.34
700, 500	1.86
800, 600	1.69
1000, 800	1.75
1200, 1000	2.00
460, 250	1.85
510, 300	1.09
610, 400	2.04
710, 500	1.48
810, 600	1.31
1010, 800	1.42
1210, 1000	1.86
510, 250	1.10
560, 300	1.49
660, 400	1.56
760, 500	1.85
860, 600	1.33
1060, 800	1.58
1260, 1000	1.72

Mass point = (m_X, m_H) [GeV]	χ^2/ndof
760, 400	1.46
860, 500	1.40
960, 600	1.13
1160, 800	1.78
1360, 1000	2.18
910, 250	1.43
960, 300	1.95
1060, 400	1.32
1160, 500	1.73
1260, 600	0.98
1460, 800	1.88
1660, 1000	1.56
1410, 250	1.54
1460, 300	1.60
1560, 400	2.64
1660, 500	2.00
1760, 600	1.78
1960, 800	1.98
2160, 1000	1.88

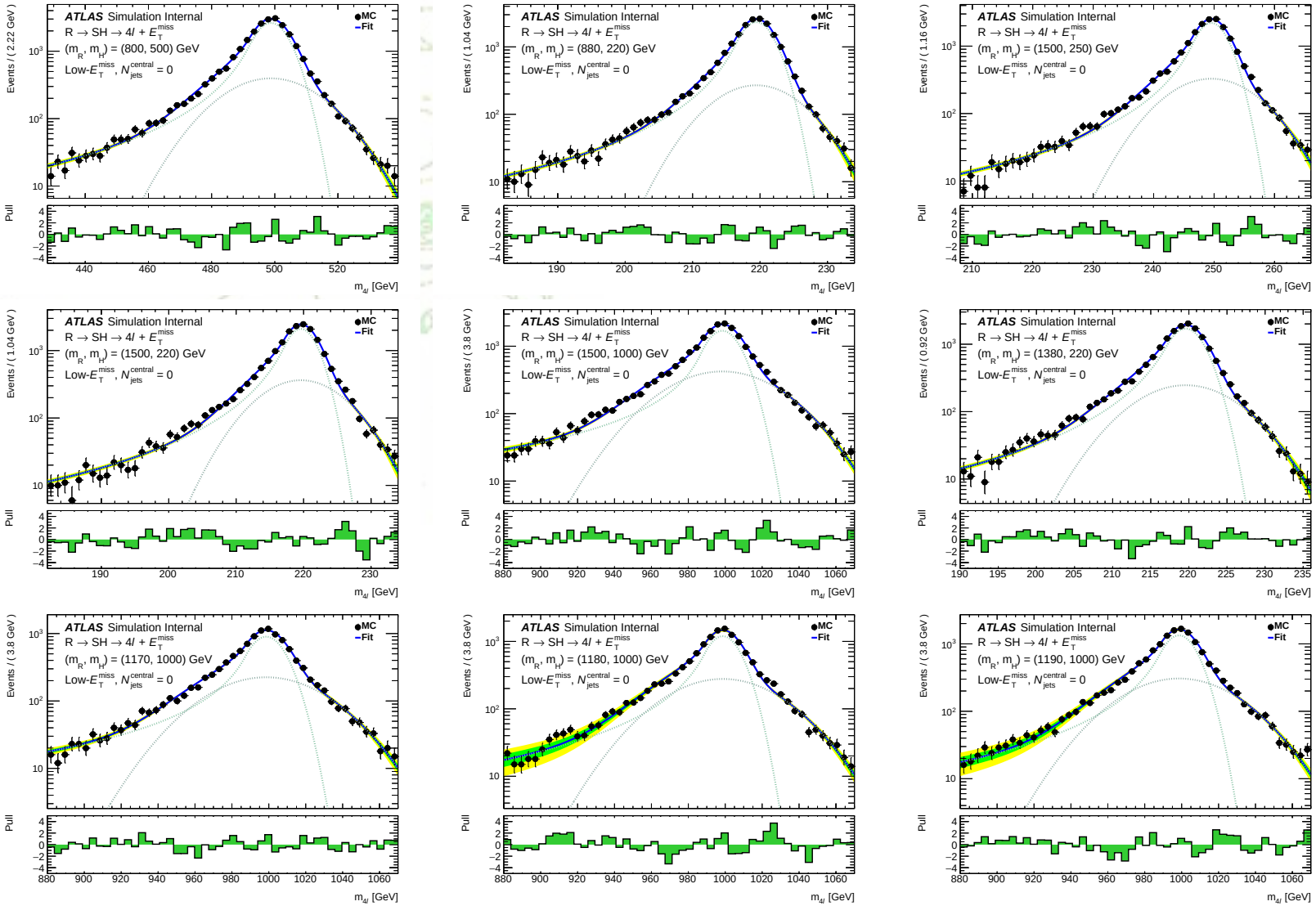
Signal parametrisation for RSH model

Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$



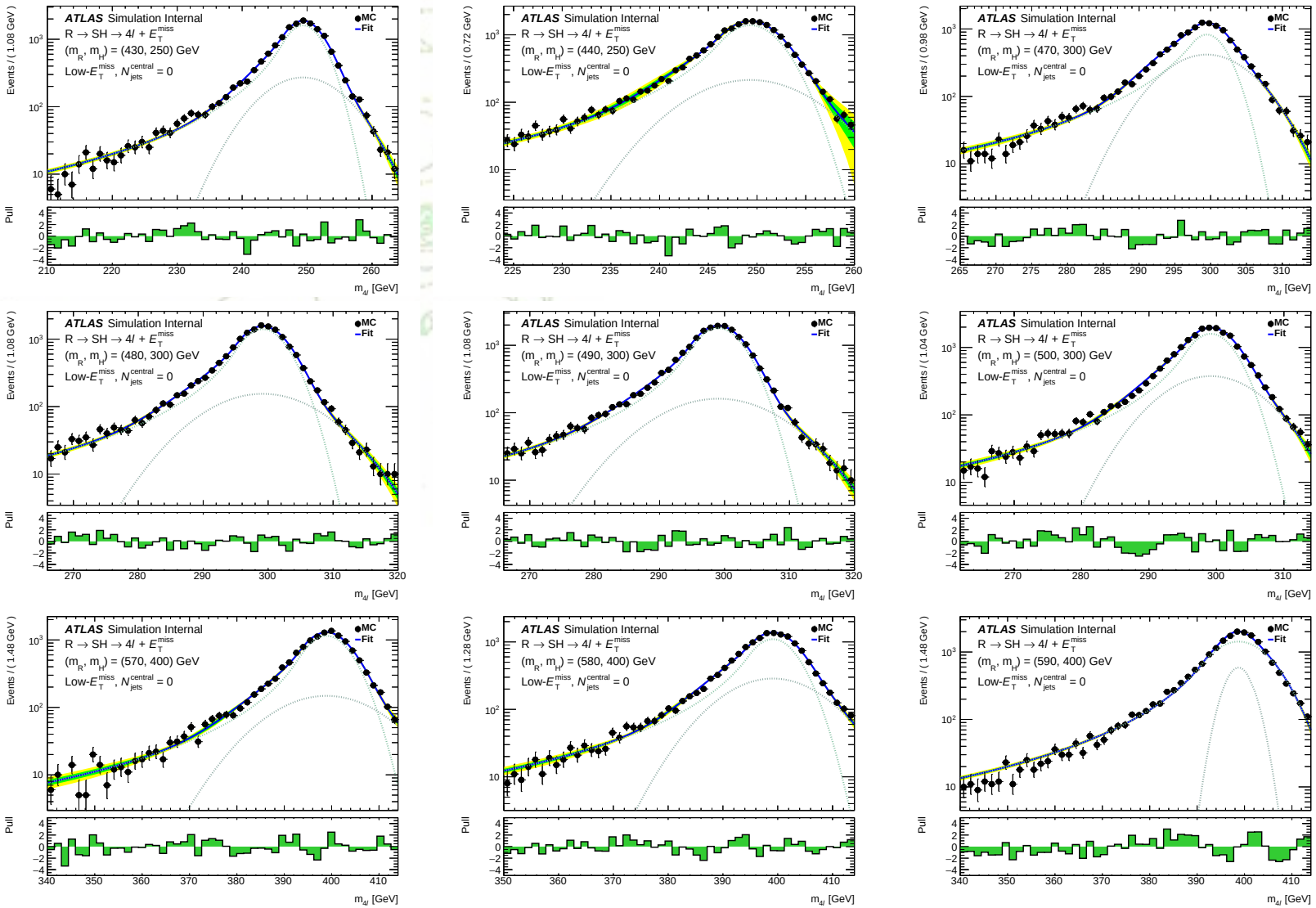
Signal parametrisation for RSH model

Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$



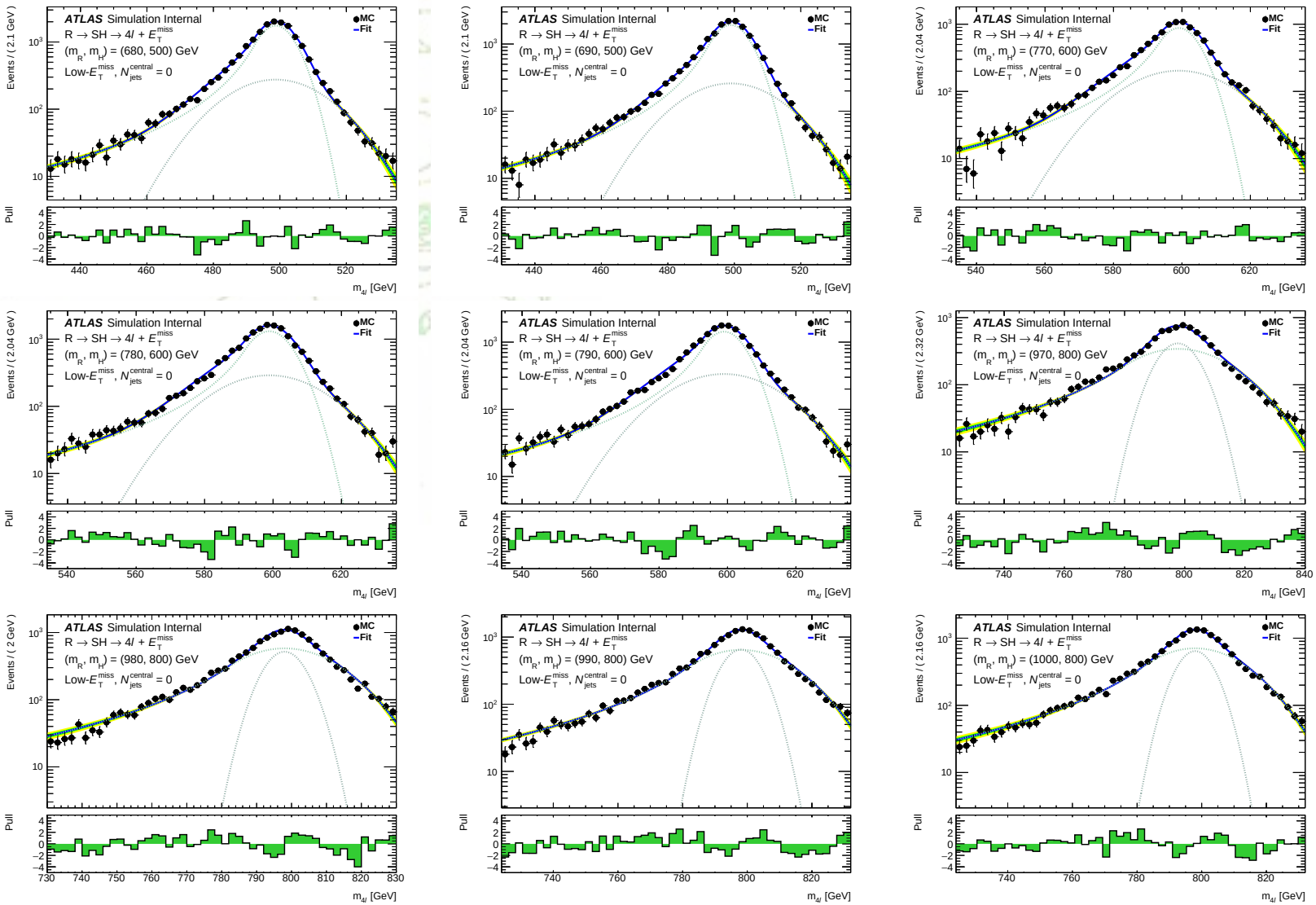
Signal parametrisation for RSH model

Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$



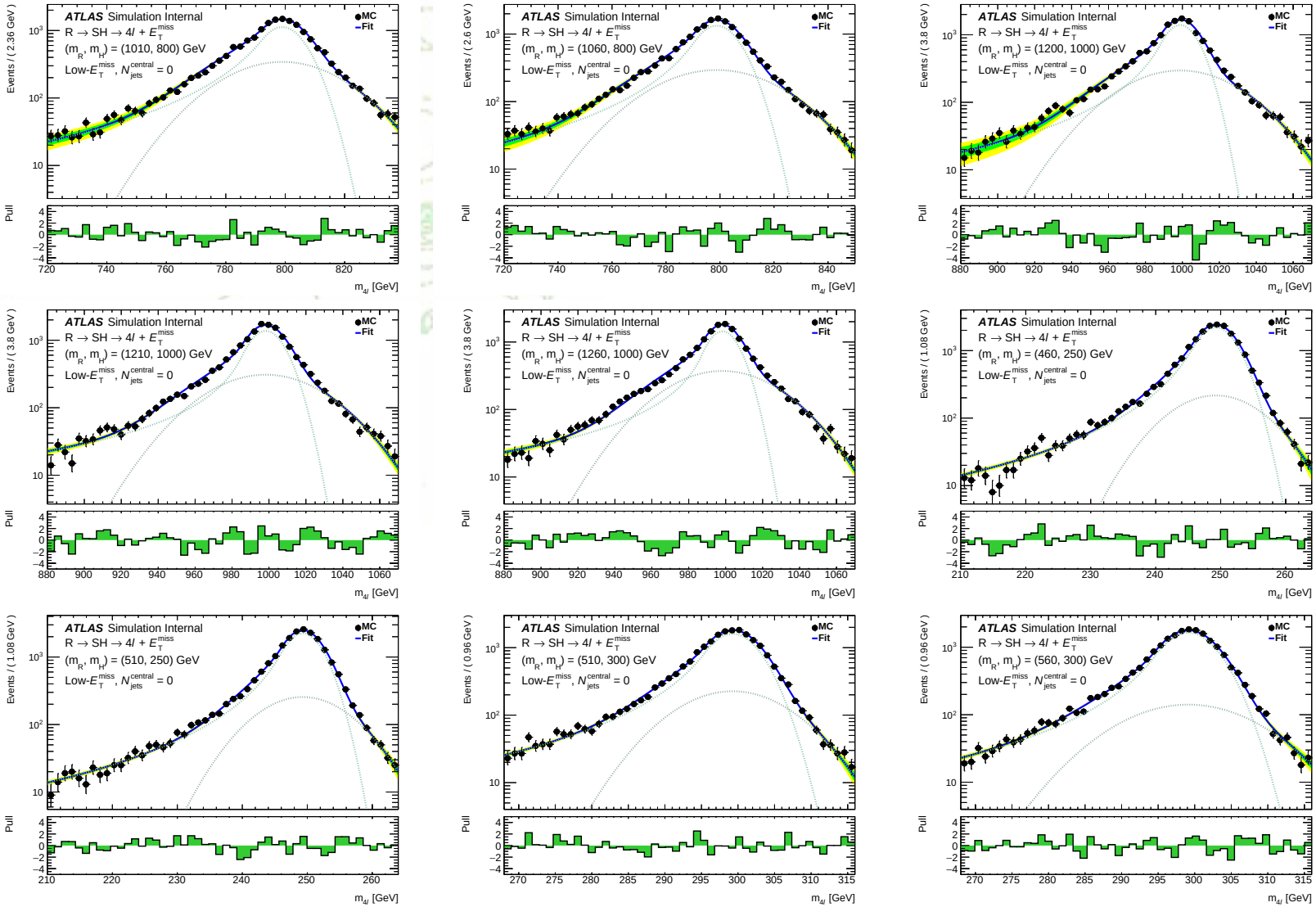
Signal parametrisation for RSH model

Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$



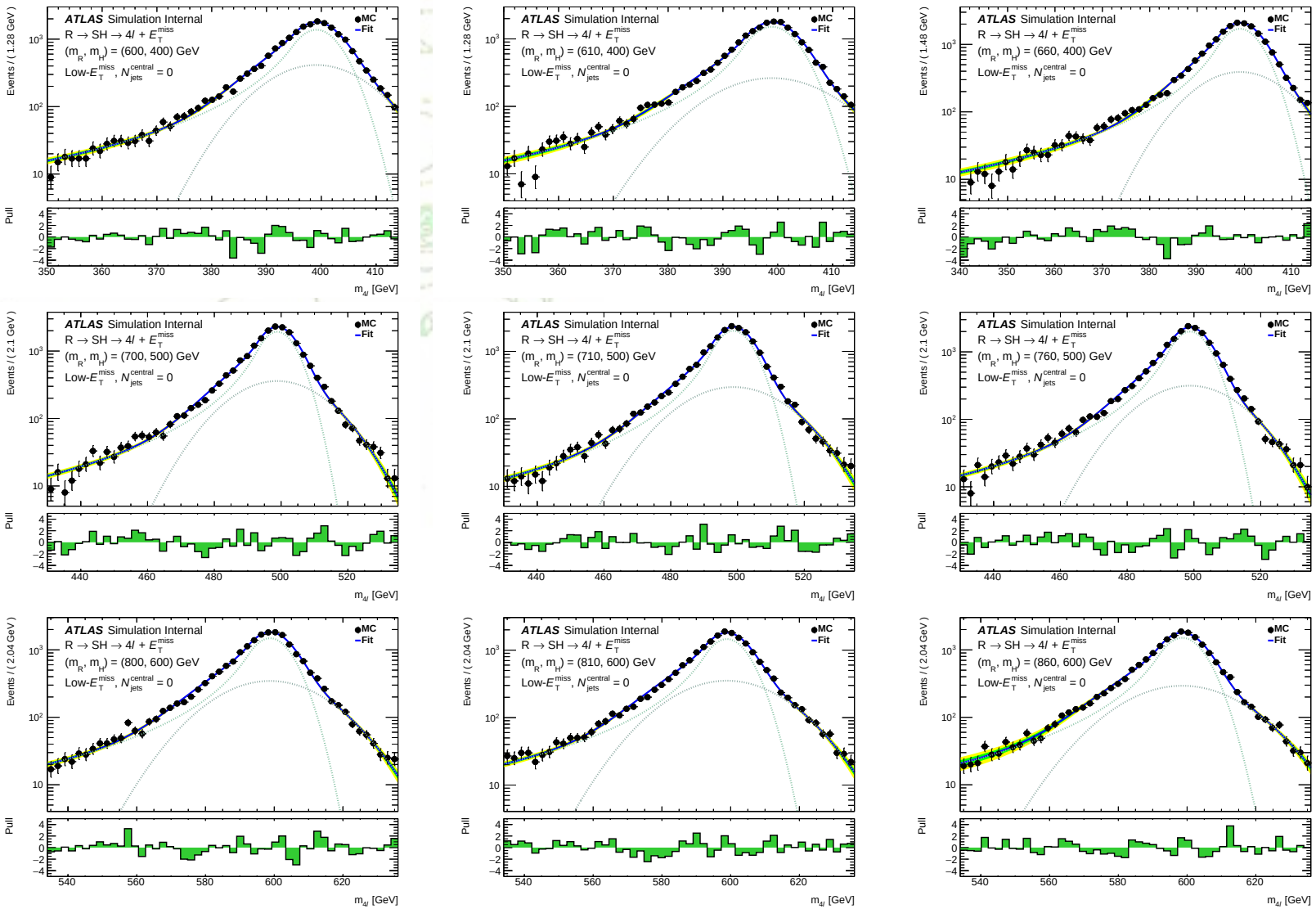
Signal parametrisation for RSH model

Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$



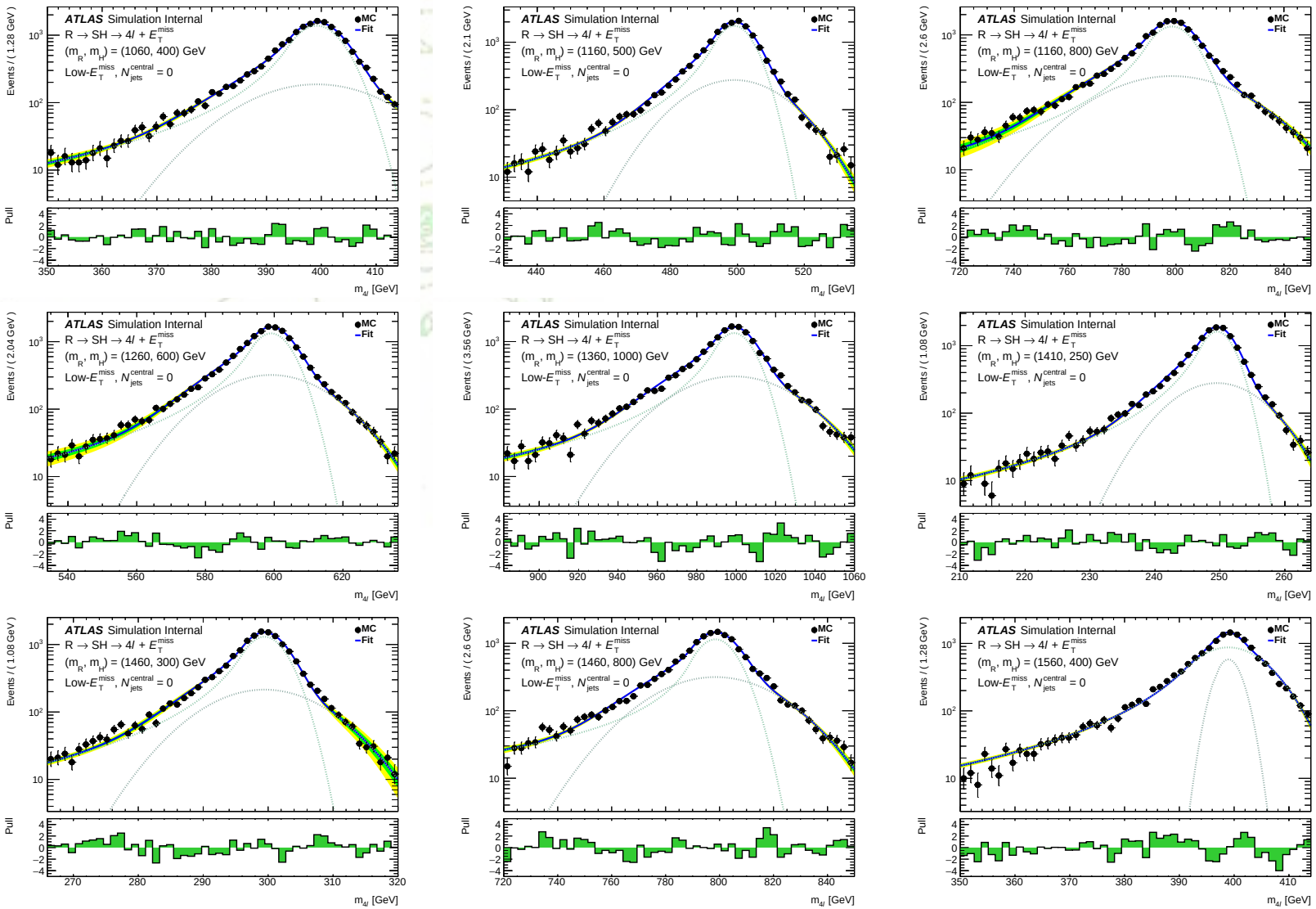
Signal parametrisation for RSH model

Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$



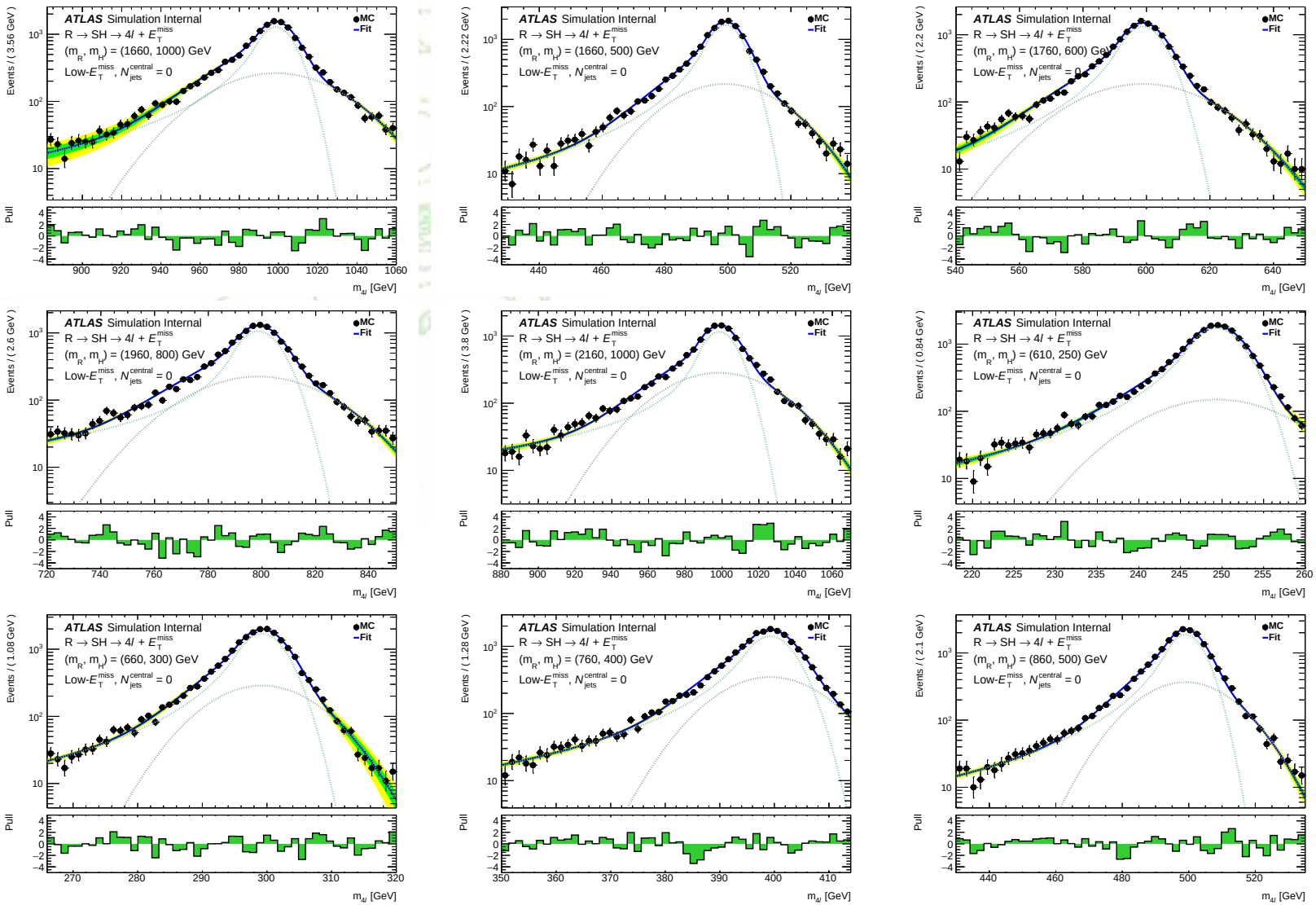
Signal parametrisation for RSH model

Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$



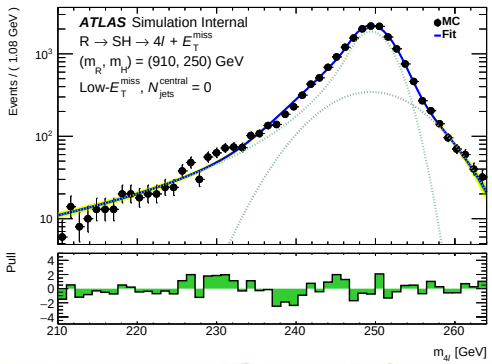
Signal parametrisation for RSH model

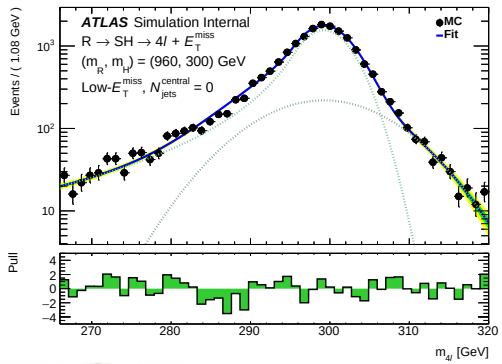
Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$

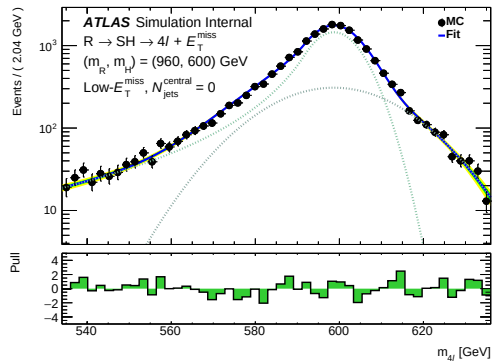


Signal parametrisation for RSH model

Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}}$: Summary of χ^2/ndof values for all signal mass points







Mass point = (m_X, m_H) [GeV]	χ^2/ndof
390, 220	1.23
450, 220	1.63
800, 220	1.30
1500, 220	1.89
450, 250	1.40
1500, 250	1.72
800, 300	1.50
800, 500	1.60
1500, 1000	1.83
410, 220	1.57
430, 220	1.36
580, 220	1.73
880, 220	1.15
1380, 220	1.41
670, 500	1.18
610, 250	1.51
660, 300	1.58
1170, 1000	1.05
-	-

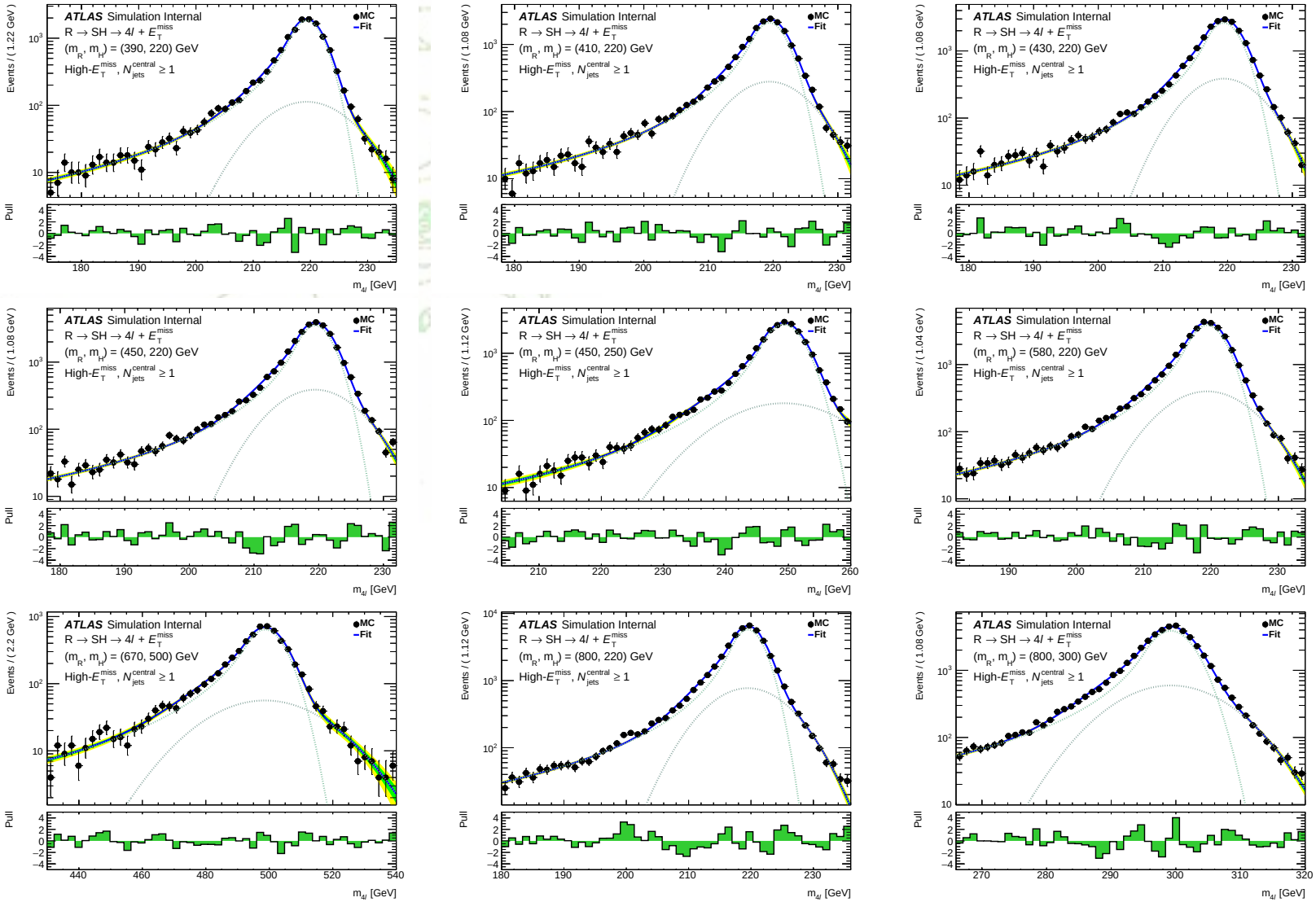
Mass point = (m_X, m_H) [GeV]	χ^2/ndof
470, 300	1.42
570, 400	1.69
770, 600	1.35
970, 800	2.14
430, 250	1.49
480, 300	0.97
580, 400	1.13
680, 500	1.31
780, 600	1.75
980, 800	2.26
1180, 1000	2.05
440, 250	1.32
490, 300	1.05
590, 400	2.44
690, 500	1.44
790, 600	1.87
990, 800	2.12
1190, 1000	1.76
500, 300	1.86

Mass point = (m_X, m_H) [GeV]	χ^2/ndof
600, 400	1.33
700, 500	1.88
800, 600	1.59
1000, 800	1.85
1200, 1000	2.26
460, 250	1.85
510, 300	1.09
610, 400	2.03
710, 500	1.53
810, 600	1.37
1010, 800	1.45
1210, 1000	2.25
510, 250	1.15
560, 300	1.45
660, 400	1.59
760, 500	1.86
860, 600	1.36
1060, 800	1.66
1260, 1000	1.82

Mass point = (m_X, m_H) [GeV]	χ^2/ndof
760, 400	1.44
860, 500	1.47
960, 600	1.14
1160, 800	1.78
1360, 1000	2.28
910, 250	1.45
960, 300	1.95
1060, 400	1.30
1160, 500	1.76
1260, 600	0.96
1460, 800	1.93
1660, 1000	1.53
1410, 250	1.50
1460, 300	1.59
1560, 400	2.63
1660, 500	1.98
1760, 600	1.79
1960, 800	1.99
2160, 1000	1.89

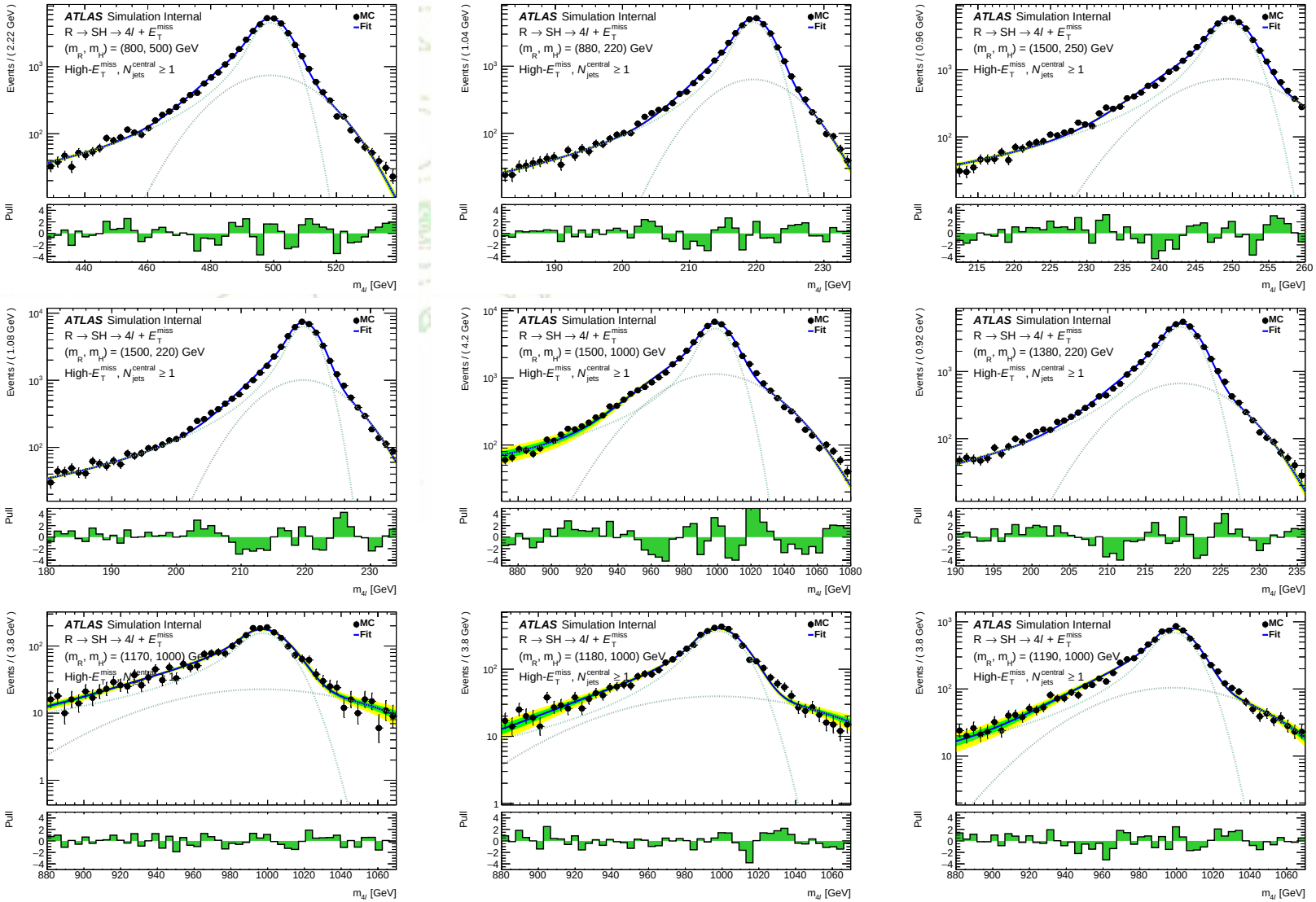
Signal parametrisation for RSH model

High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$



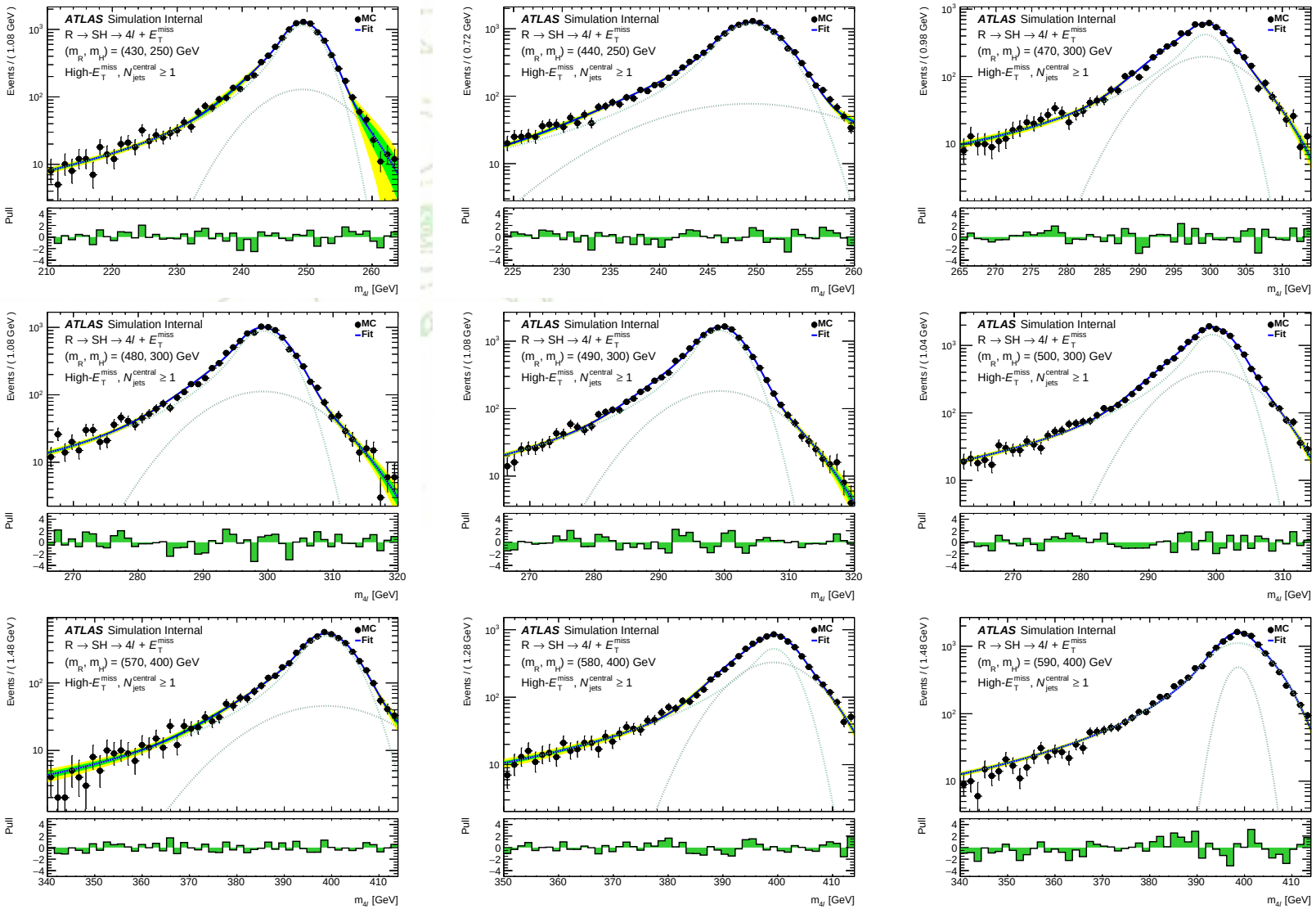
Signal parametrisation for RSH model

High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$



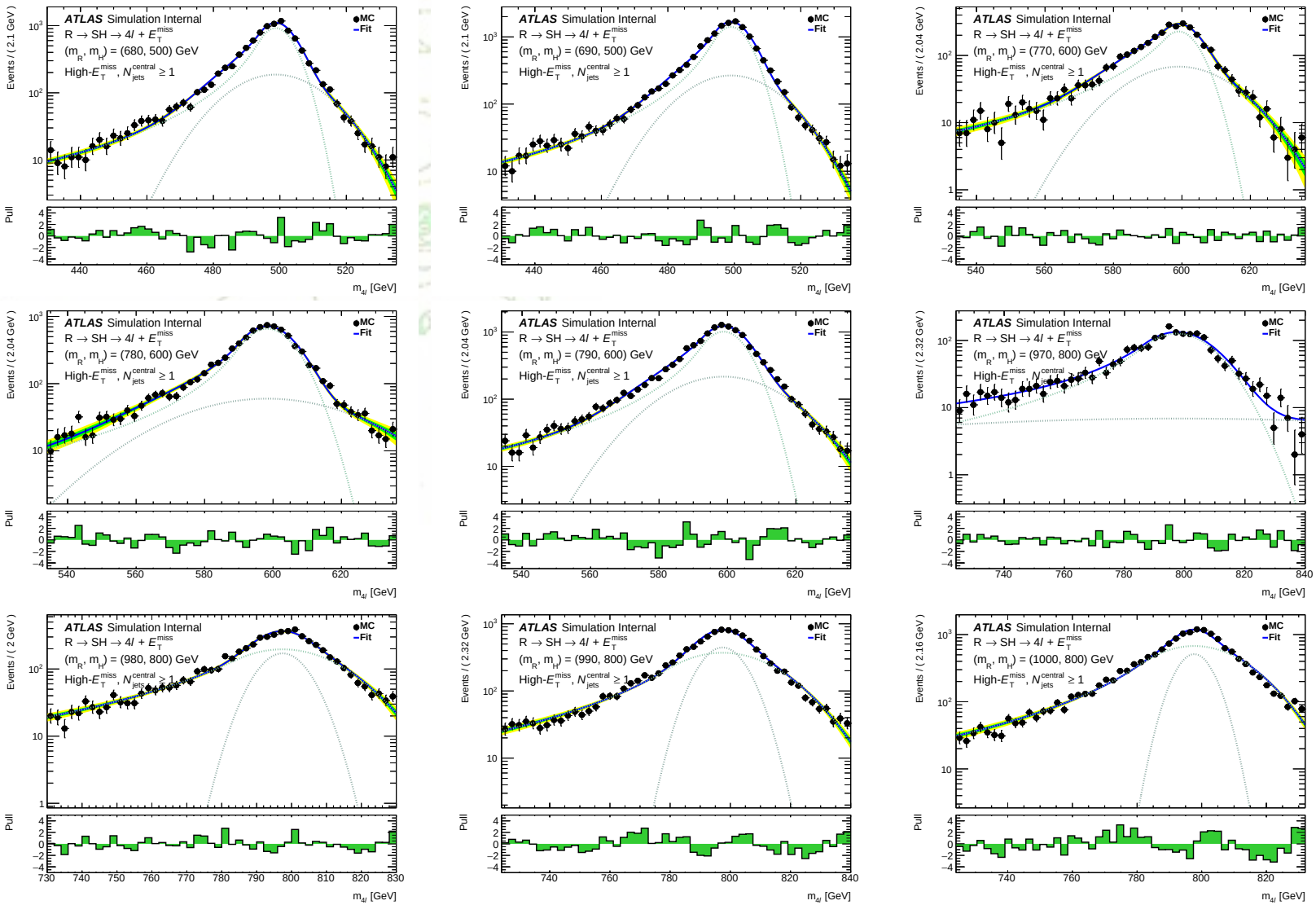
Signal parametrisation for RSH model

High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$



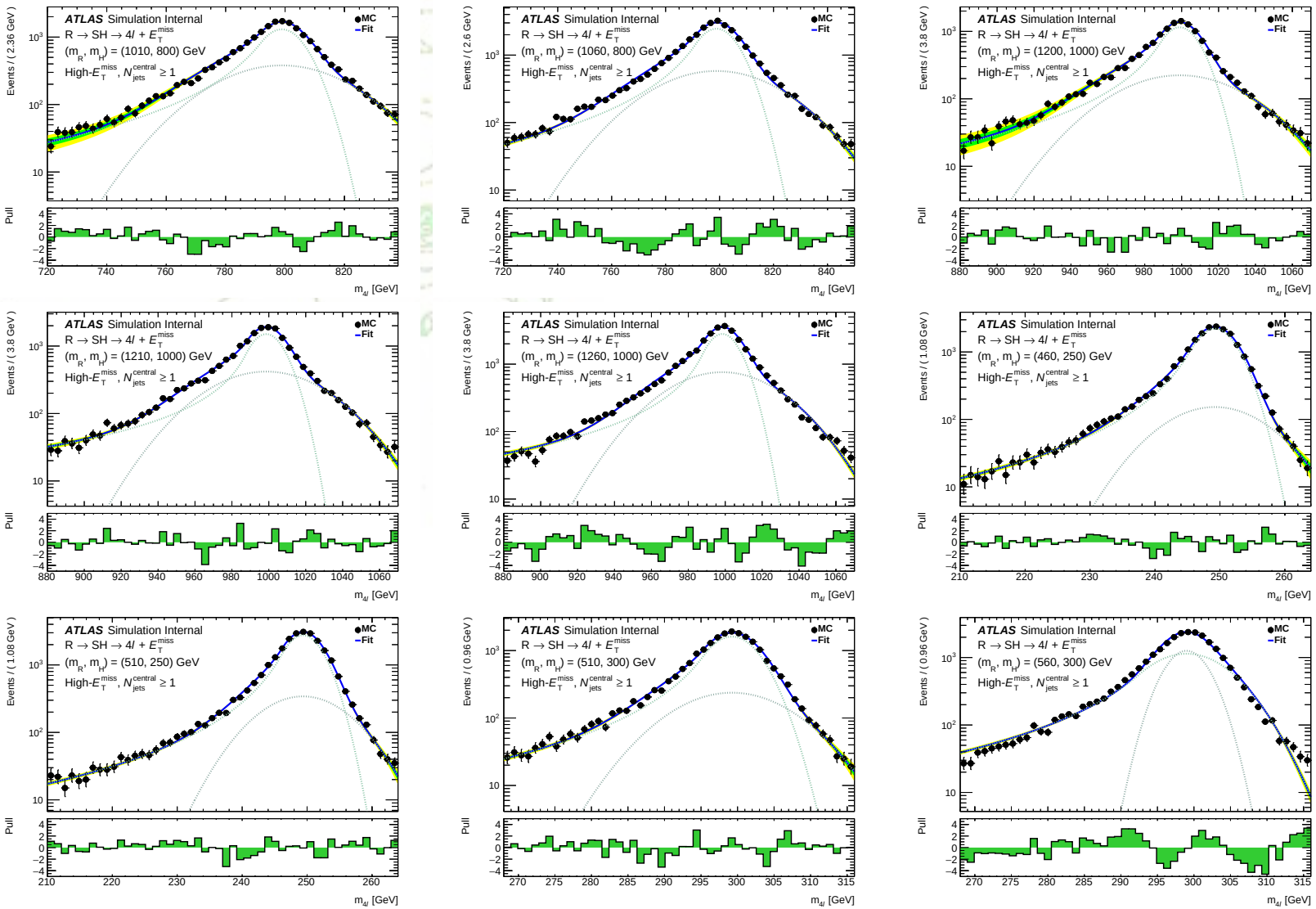
Signal parametrisation for RSH model

High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$



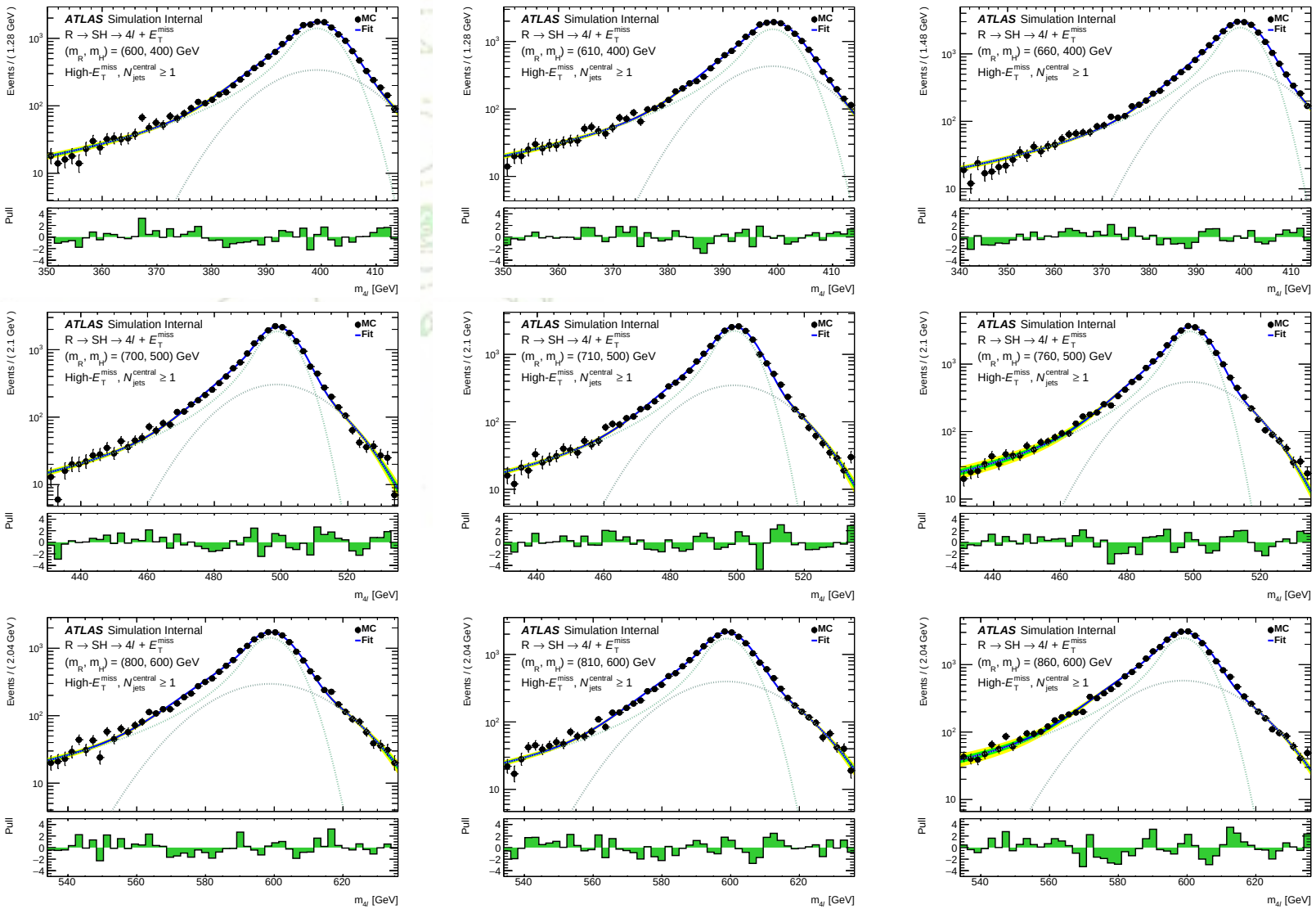
Signal parametrisation for RSH model

High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$



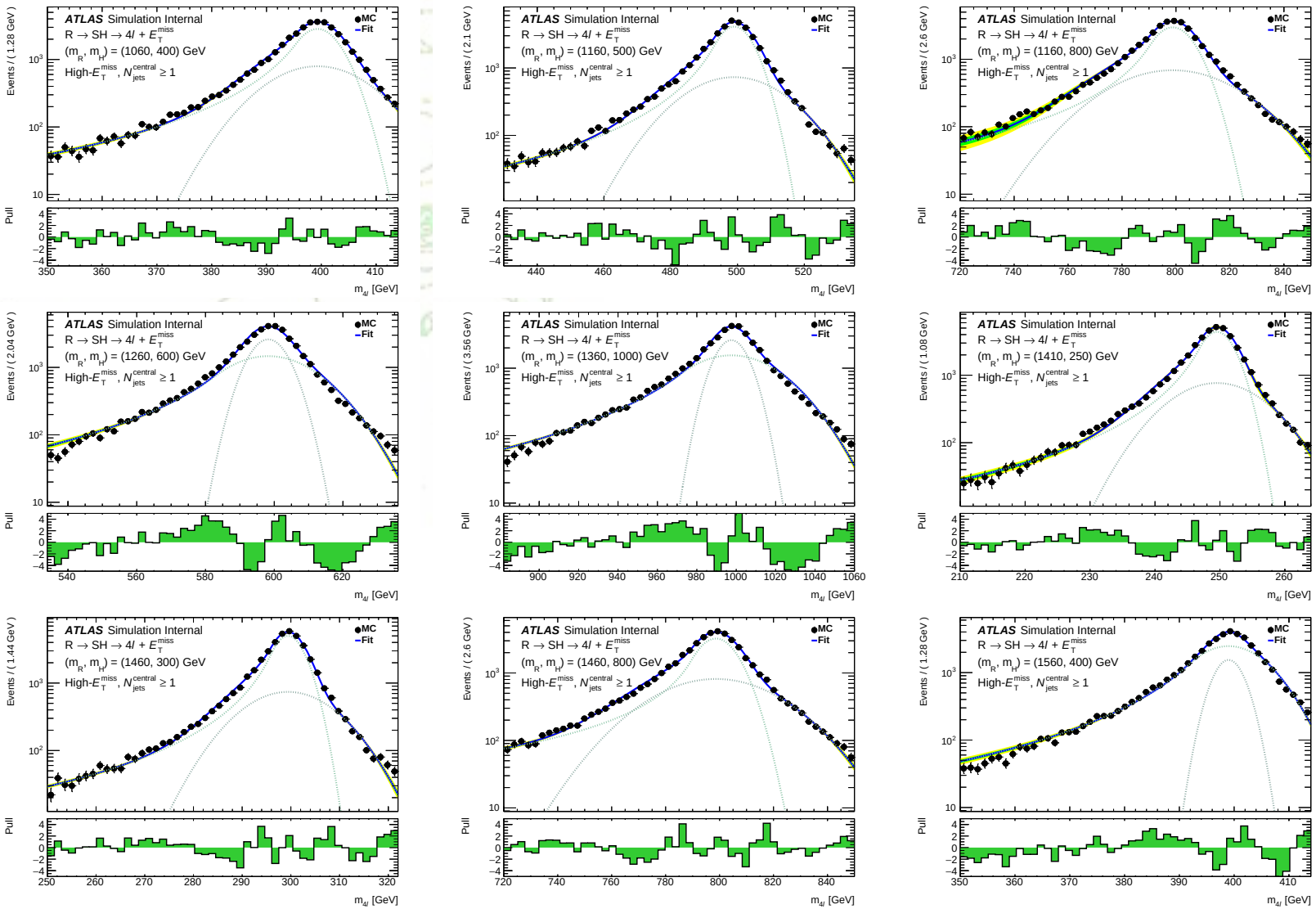
Signal parametrisation for RSH model

High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$



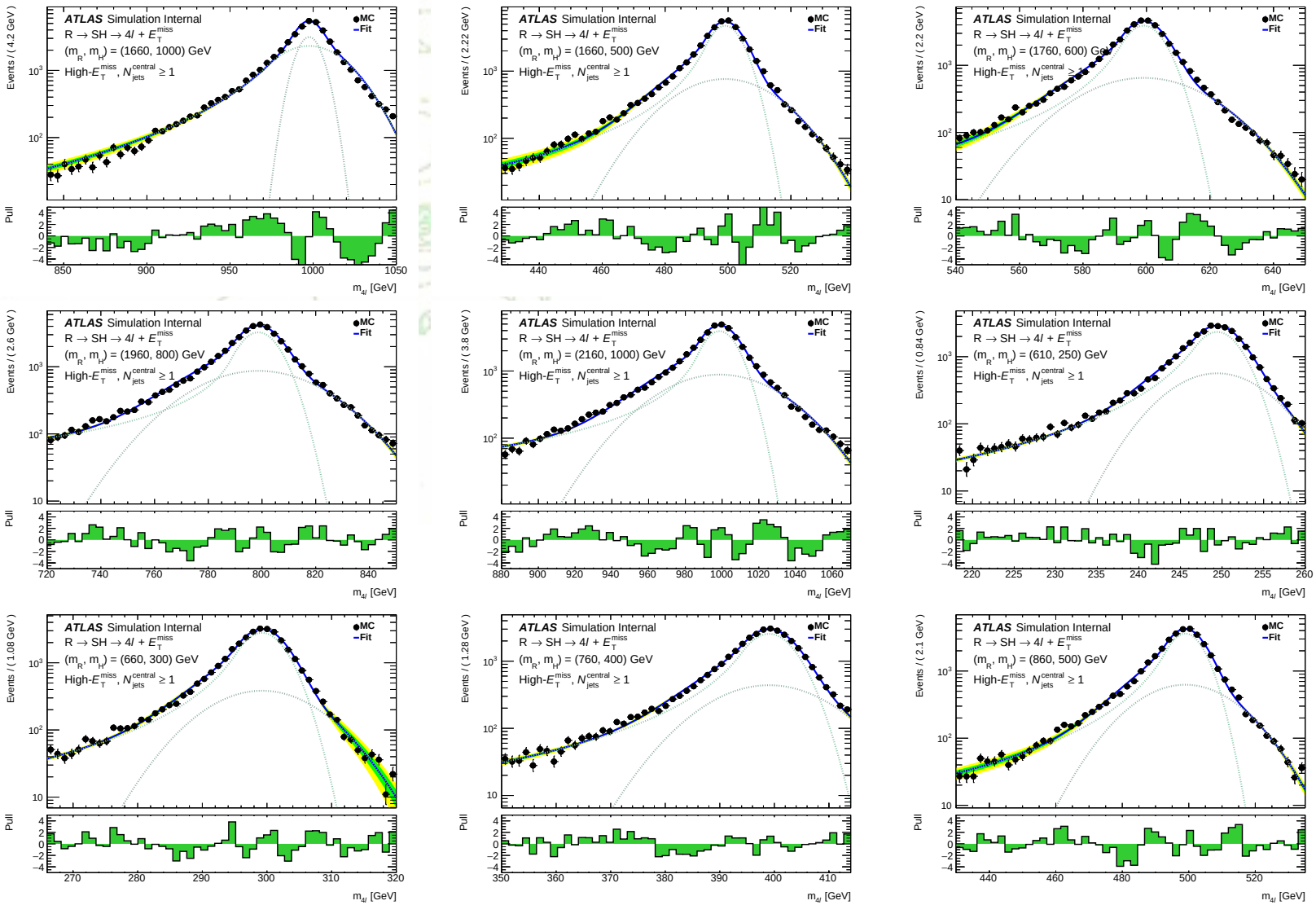
Signal parametrisation for RSH model

High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$



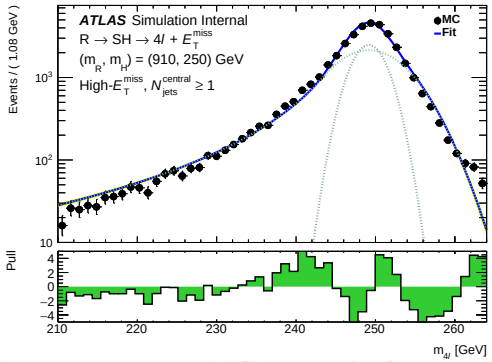
Signal parametrisation for RSH model

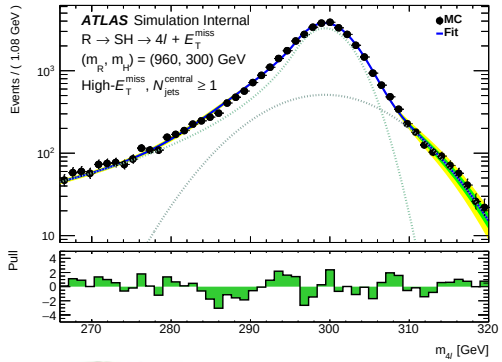
High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$

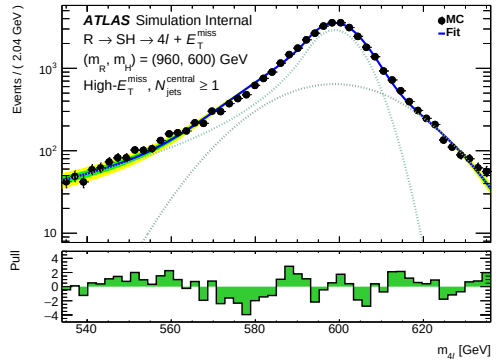


Signal parametrisation for RSH model

High-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$:Summary of χ^2/ndof values for all signal mass points







Mass point = (m_X, m_H) [GeV]	χ^2/ndof
390, 220	1.26
450, 220	1.92
800, 220	2.13
1500, 220	2.64
450, 250	1.41
1500, 250	3.23
800, 300	2.09
800, 500	2.65
1500, 1000	5.79
410, 220	1.51
430, 220	1.28
580, 220	1.40
880, 220	1.87
1380, 220	3.27
670, 500	0.90
610, 250	2.15
660, 300	2.73
1170, 1000	0.91
-	-

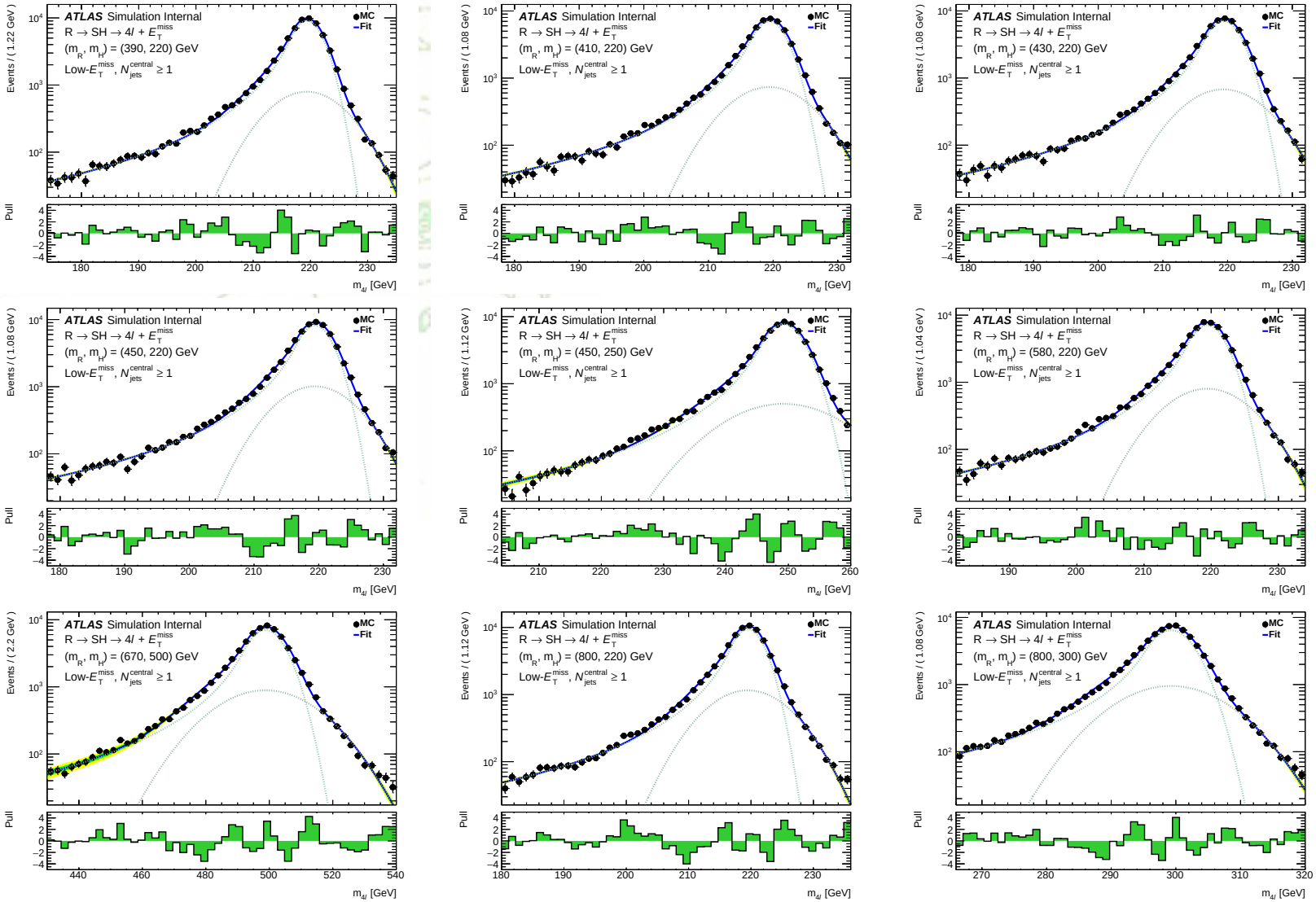
Mass point = (m_X, m_H) [GeV]	χ^2/ndof
470, 300	1.31
570, 400	0.54
770, 600	0.83
970, 800	1.14
430, 250	1.06
480, 300	1.79
580, 400	0.76
680, 500	1.60
780, 600	1.29
980, 800	1.10
1180, 1000	1.45
440, 250	1.01
490, 300	1.17
590, 400	2.13
690, 500	1.32
790, 600	1.79
990, 800	1.84
1190, 1000	1.62
500, 300	1.20

Mass point = (m_X, m_H) [GeV]	χ^2/ndof
600, 400	1.29
700, 500	1.82
800, 600	1.59
1000, 800	3.01
1200, 1000	1.62
460, 250	1.15
510, 300	1.84
610, 400	1.14
710, 500	2.10
810, 600	1.81
1010, 800	1.62
1210, 1000	1.68
510, 250	1.30
560, 300	4.74
660, 400	1.12
760, 500	1.95
860, 600	2.83
1060, 800	3.02
1260, 1000	3.63

Mass point = (m_X, m_H) [GeV]	χ^2/ndof
760, 400	1.70
860, 500	3.07
960, 600	2.63
1160, 800	3.76
1360, 1000	8.05
910, 250	7.68
960, 300	1.67
1060, 400	2.08
1160, 500	3.69
1260, 600	8.69
1460, 800	2.50
1660, 1000	7.62
1410, 250	2.78
1460, 300	2.92
1560, 400	4.57
1660, 500	4.47
1760, 600	4.28
1960, 800	2.50
2160, 1000	3.95

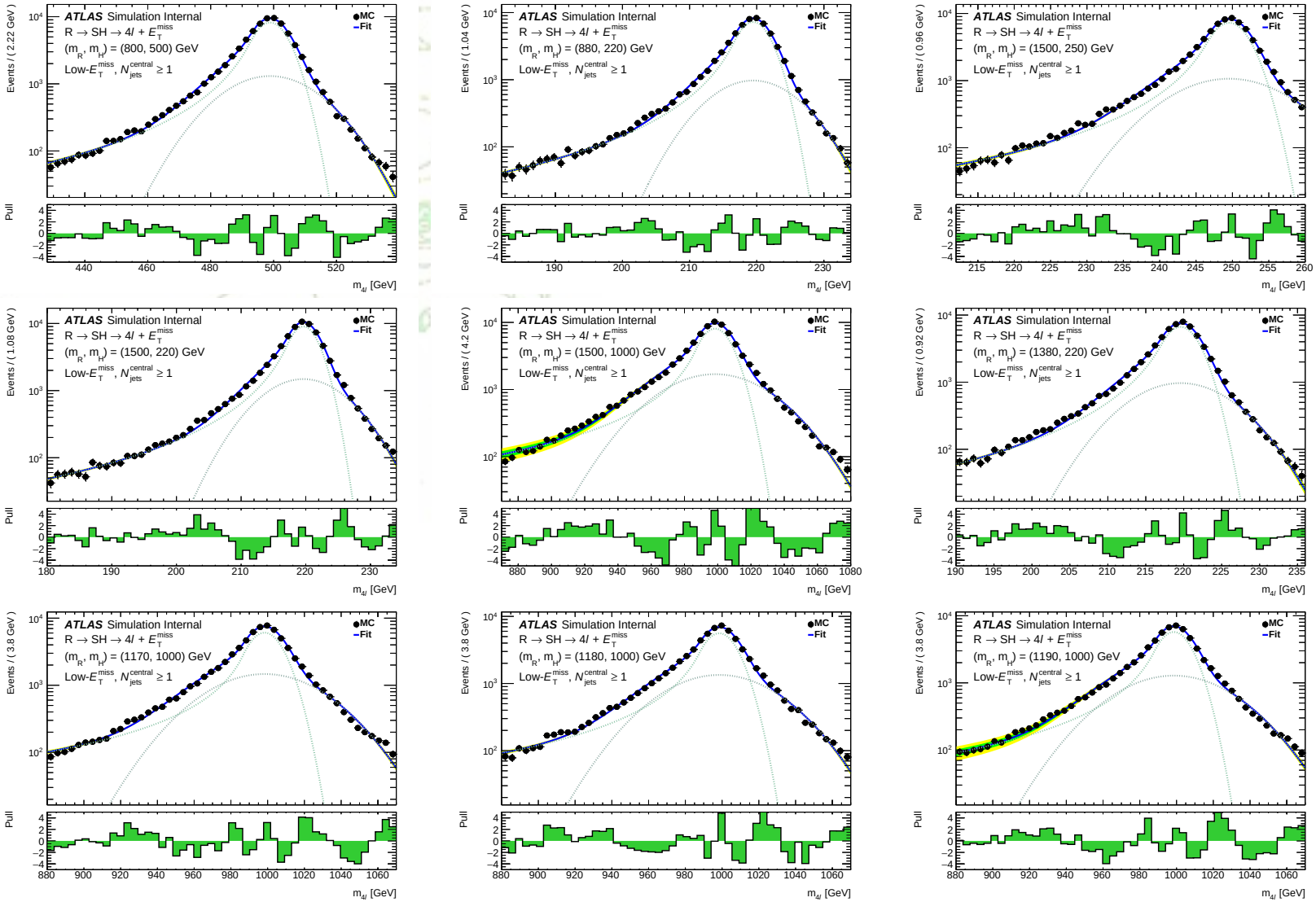
Signal parametrisation for RSH model

Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$



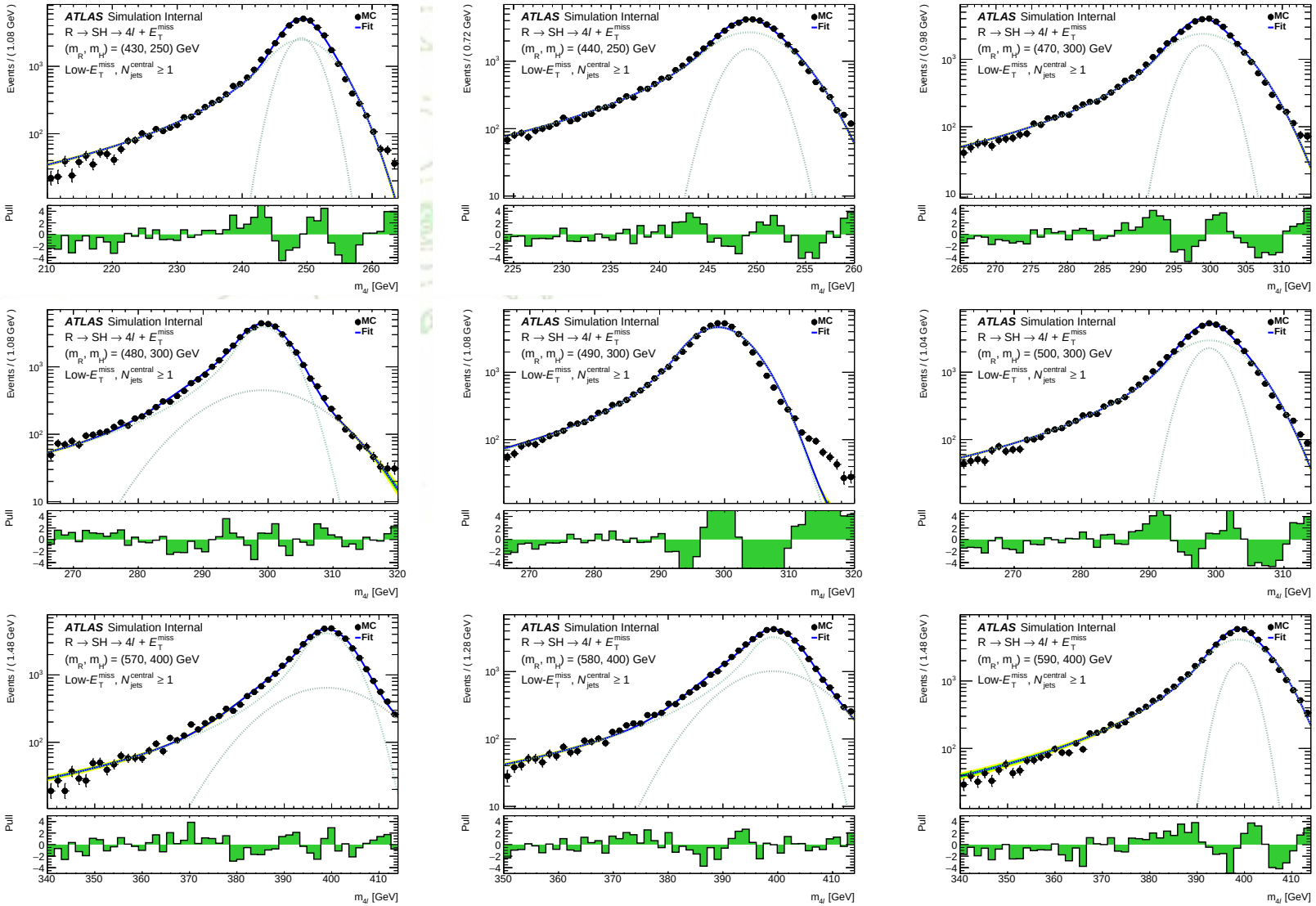
Signal parametrisation for RSH model

Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$



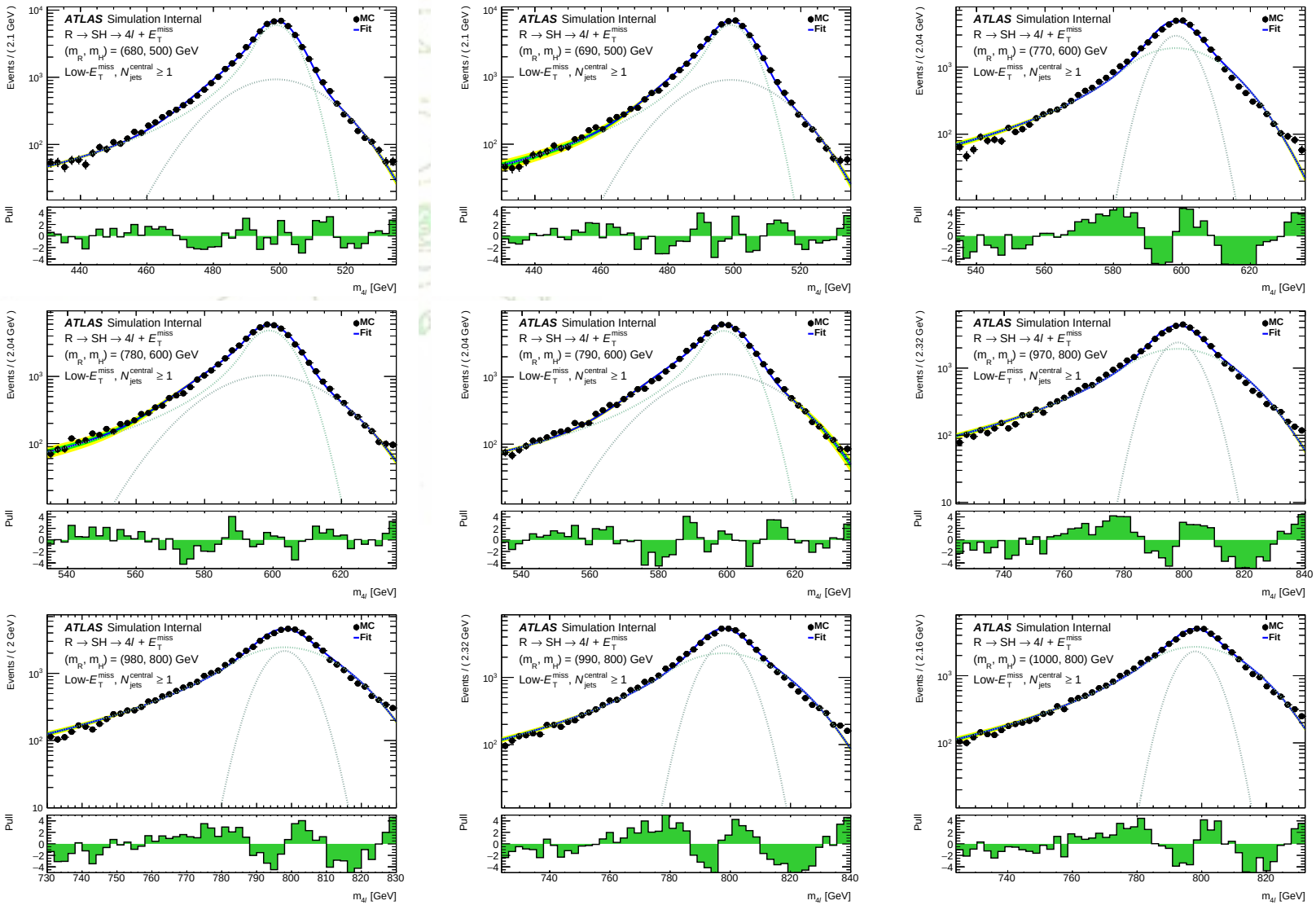
Signal parametrisation for RSH model

Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$



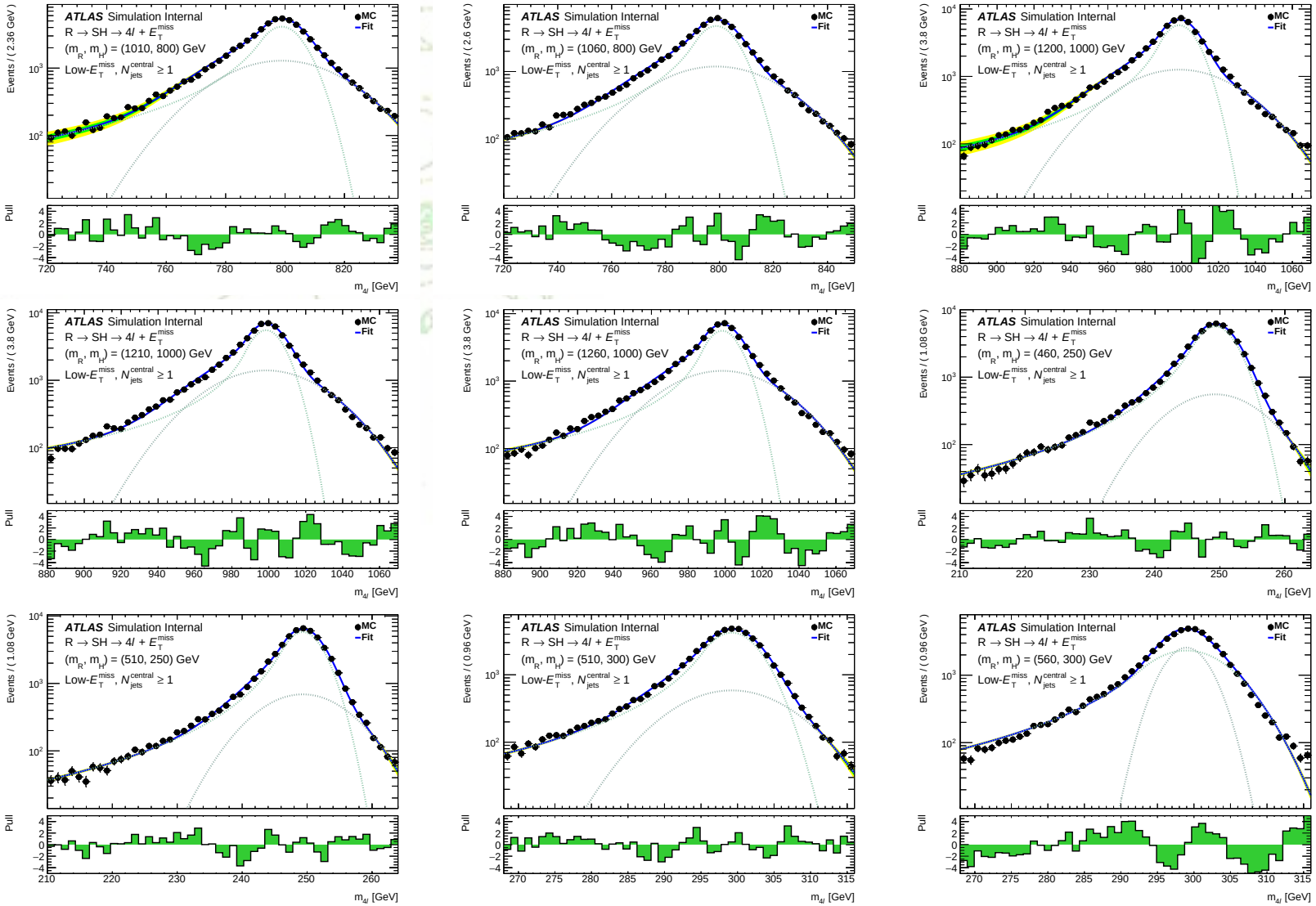
Signal parametrisation for RSH model

Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$



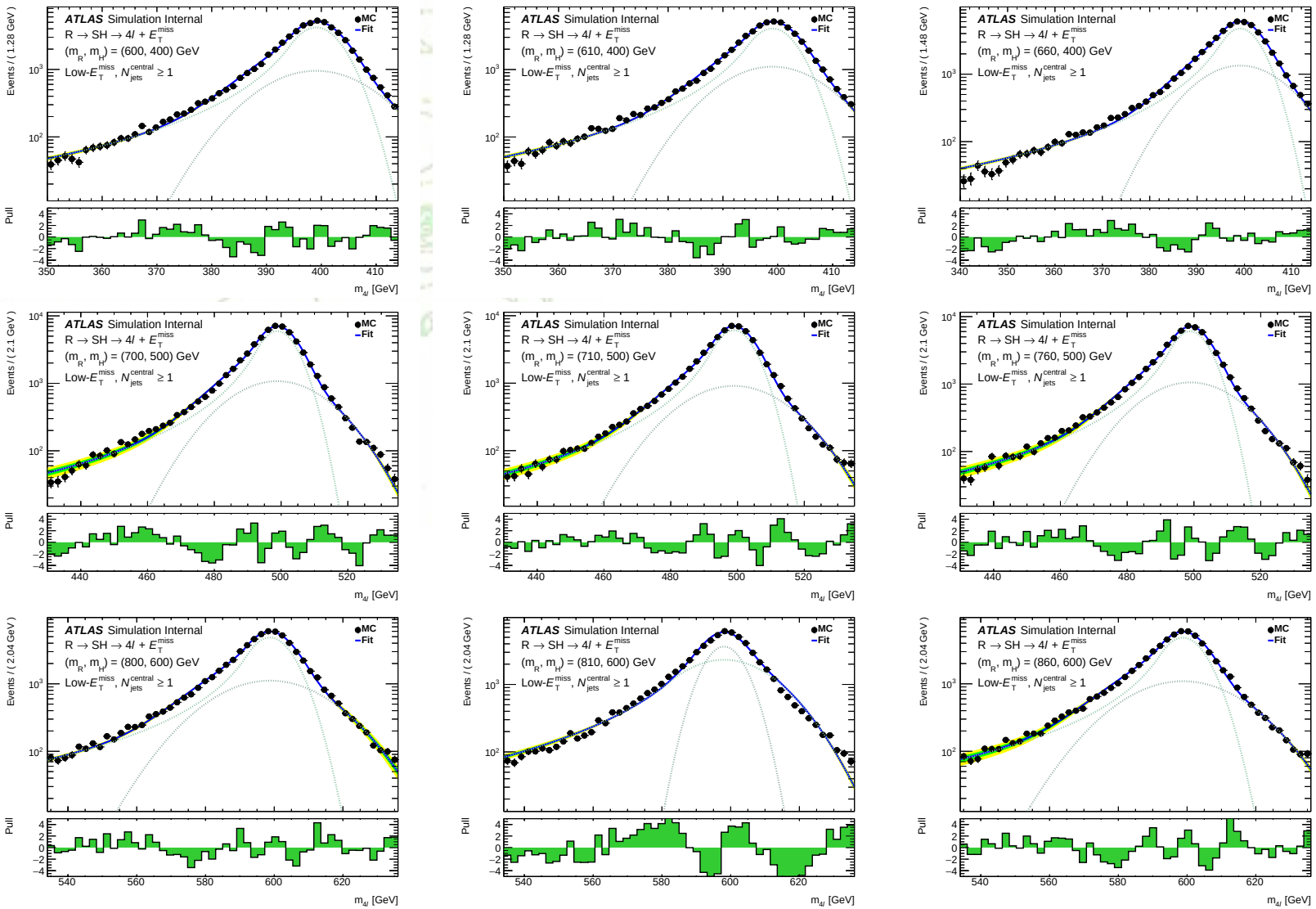
Signal parametrisation for RSH model

Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$



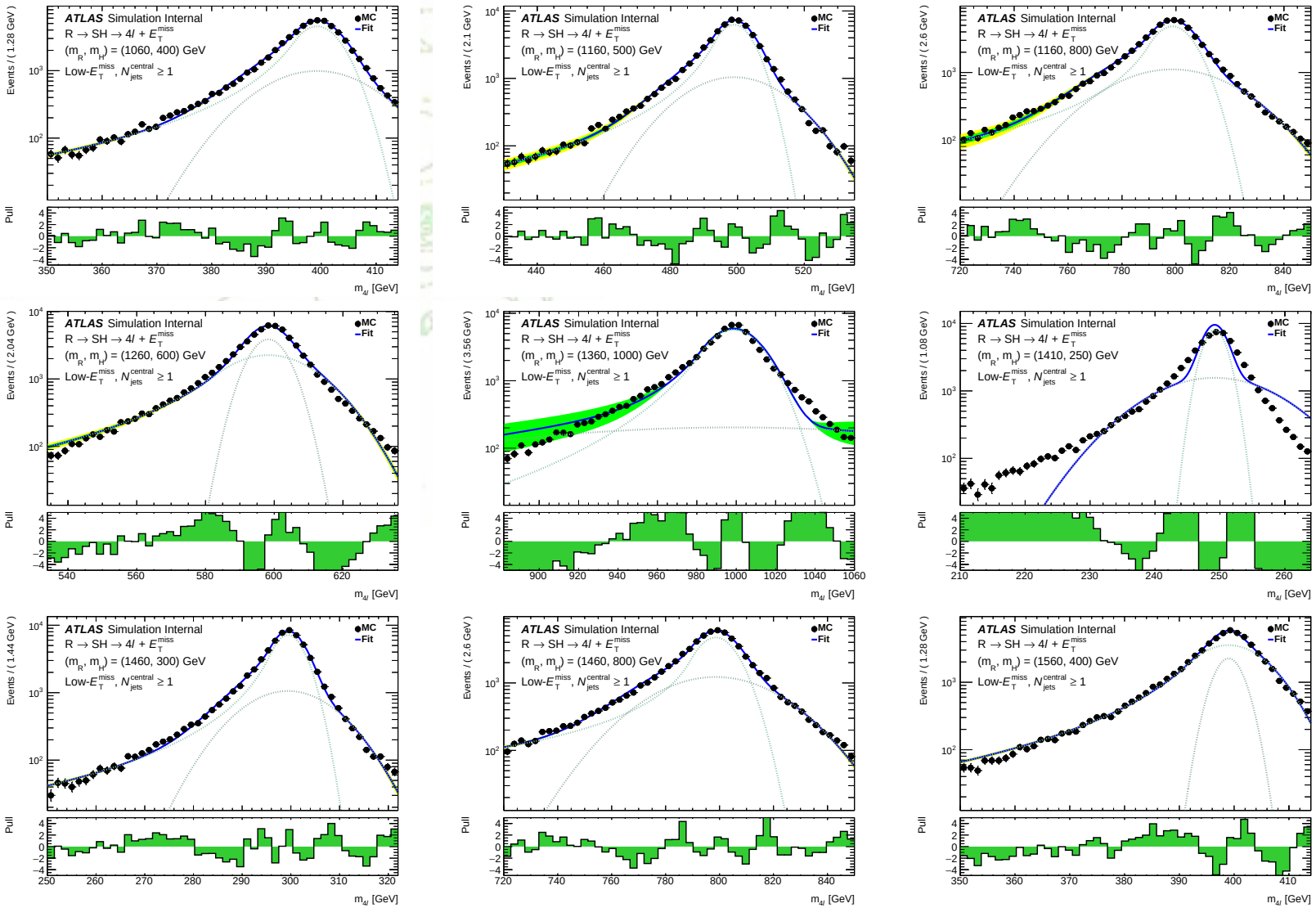
Signal parametrisation for RSH model

Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$



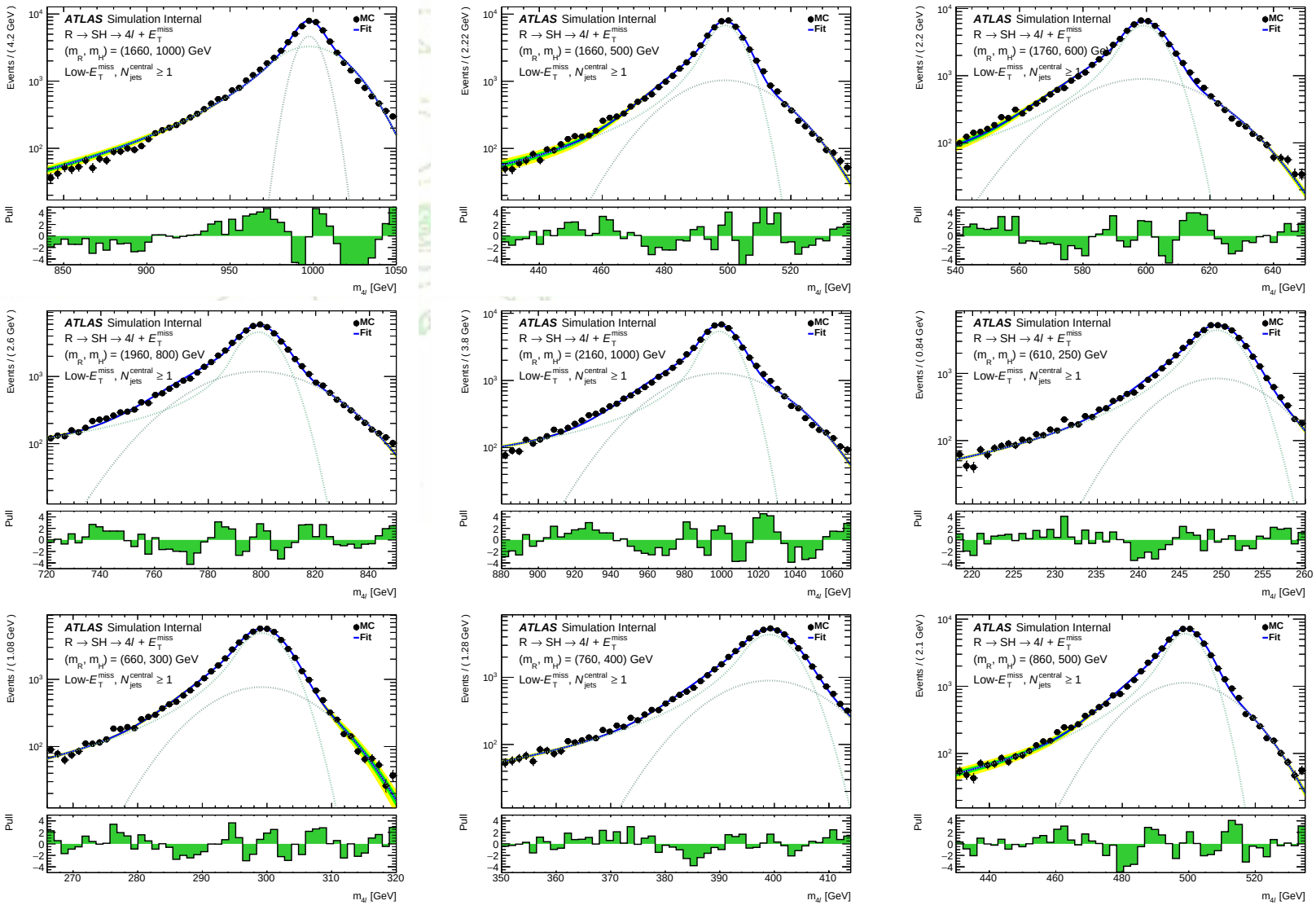
Signal parametrisation for RSH model

Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$



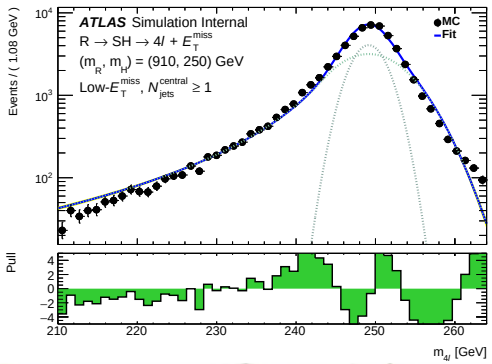
Signal parametrisation for RSH model

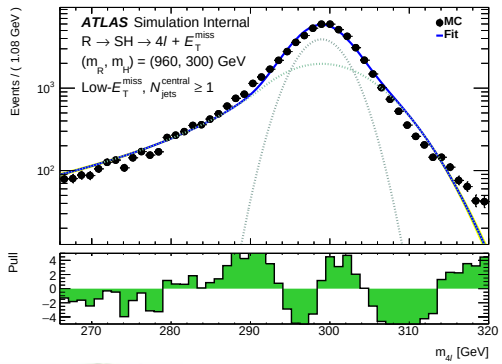
Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$

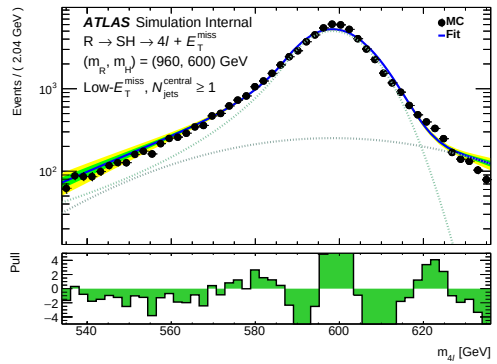


Signal parametrisation for RSH model

Low-$E_{\mathrm{T}}^{\mathrm{miss}}$, $N_{\mathrm{jets}}^{\mathrm{Central}} \geq 1$: Summary of χ^2/ndof values for all signal mass points







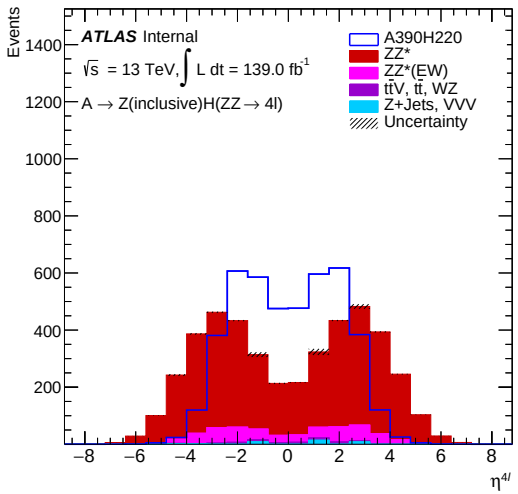
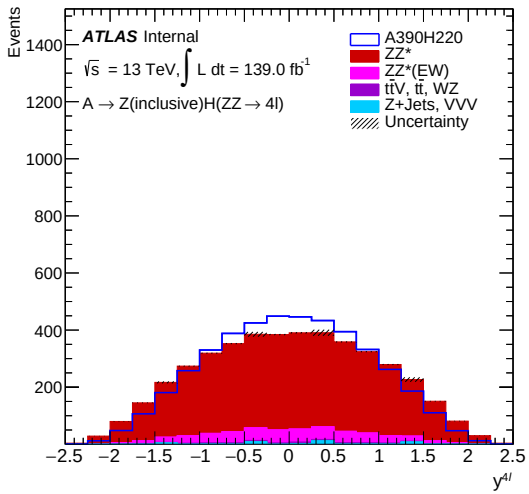
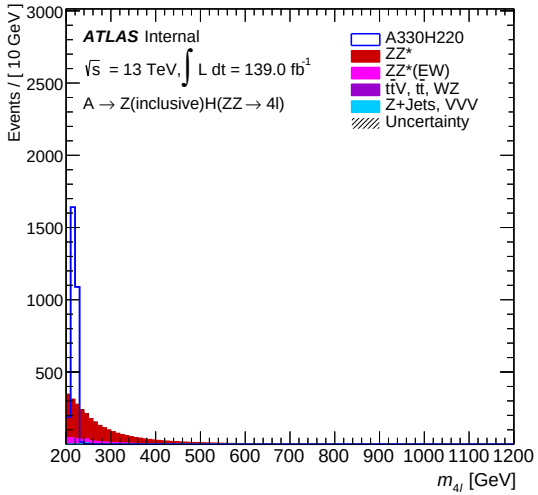
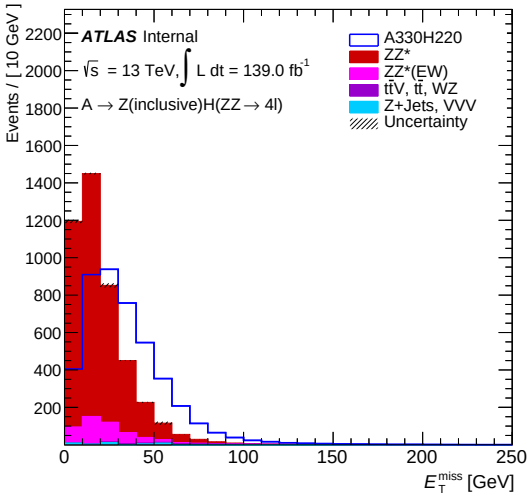
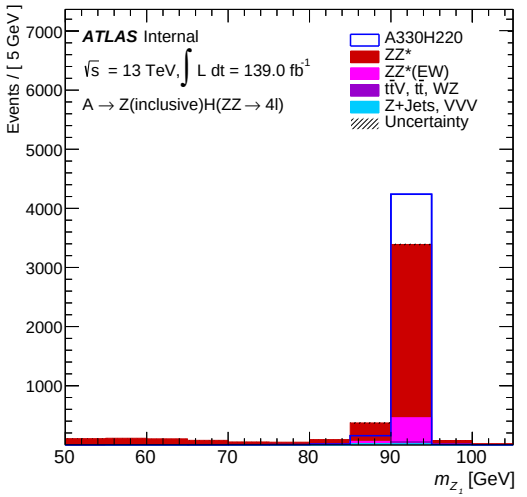
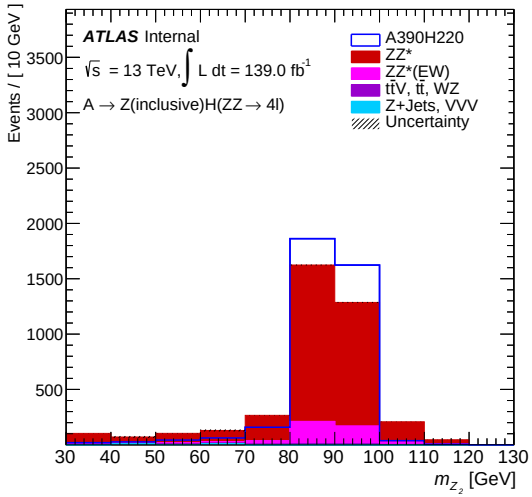
Mass point = (m_X, m_H) [GeV]	χ^2/ndof
390, 220	2.72
450, 220	2.89
800, 220	3.13
1500, 220	3.81
450, 250	3.50
1500, 250	4.11
800, 300	2.93
800, 500	3.95
1500, 1000	7.87
410, 220	2.47
430, 220	1.67
580, 220	2.27
880, 220	2.43
1380, 220	3.86
670, 500	3.37
610, 250	2.86
660, 300	3.45
1170, 1000	4.62
-	-

Mass point = (m_X, m_H) [GeV]	χ^2/ndof
470, 300	5.20
570, 400	2.52
770, 600	11.89
970, 800	8.10
430, 250	6.72
480, 300	2.49
580, 400	2.21
680, 500	2.82
780, 600	2.93
980, 800	6.51
1180, 1000	4.85
440, 250	3.90
490, 300	27.01
590, 400	5.04
690, 500	3.55
790, 600	4.21
990, 800	8.57
1190, 1000	4.76
500, 300	7.37

Mass point = (m_X, m_H) [GeV]	χ^2/ndof
600, 400	2.62
700, 500	4.11
800, 600	2.96
1000, 800	6.69
1200, 1000	6.21
460, 250	2.24
510, 300	2.08
610, 400	2.29
710, 500	3.17
810, 600	13.04
1010, 800	2.73
1210, 1000	4.85
510, 250	2.17
560, 300	7.89
660, 400	2.16
760, 500	3.63
860, 600	4.04
1060, 800	3.94
1260, 1000	5.59

Mass point = (m_X, m_H) [GeV]	χ^2/ndof
760, 400	2.11
860, 500	4.04
960, 600	18.24
1160, 800	4.39
1360, 1000	42.13
910, 250	13.08
960, 300	14.94
1060, 400	2.79
1160, 500	4.50
1260, 600	12.18
1460, 800	3.46
1660, 1000	10.40
1410, 250	180.50
1460, 300	3.83
1560, 400	6.35
1660, 500	5.38
1760, 600	5.24
1960, 800	3.60
2160, 1000	5.56

Additional slides
Nuisance parameters

Normalisation	Shape
Electrons	
	EG_RESOLUTION_ALL
EL_EFF_ID_CorrUncertaintyNP[0-15]	EG_SCALE_ALLCORR
EL_EFF_ID_SIMPLIFIED_UncorrUncertaintyNP[0-17]	EG_SCALE_E4SCINTILLATOR
EL_EFF_Iso_TOTAL_1NPCOR_PLUS_UNCOR	EG_SCALE_LARCALIB_EXTRA2015PRE
EL_EFF_Reco_TOTAL_1NPCOR_PLUS_UNCOR	EG_SCALE_LARTEMPERATURE_EXTRA2015PRE
	EG_SCALE_LARTEMPERATURE_EXTRA2016PRE
Muons	
MUON_EFF_ISO_STAT	
MUON_EFF_ISO_SYS	MUON_ID
MUON_EFF_RECO_STAT	MUON_MS
MUON_EFF_RECO_STAT_LOWPT	MUON_SAGITTA_RESBIAS
MUON_EFF_RECO_SYS	MUON_SAGITTA_RHO
MUON_EFF_RECO_SYS_LOWPT	MUON_SCALE
MUON_EFF_TTVA_STAT	
MUON_EFF_TTVA_SYS	
Jets	
	JET_BJES_Response
	JET_EffectiveNP_[1-7]
	JET_EffectiveNP_8restTerm
	JET_EtaIntercalibration_Modelling
	JET_EtaIntercalibration_NonClosure_highE
	JET_EtaIntercalibration_NonClosure_negEta
	JET_EtaIntercalibration_NonClosure_posEta
	JET_EtaIntercalibration_TotalStat
	JET_Flavor_Composition
	JET_Flavor_Response
	JET_JER_DataVsMC
	JET_JER_EffectiveNP_[1-6]
	JET_JER_EffectiveNP_7restTerm
	JET_Pileup_OffsetMu
	JET_Pileup_OffsetNPV
	JET_Pileup_PtTerm
	JET_Pileup_RhoTopology
	JET_PunchThrough_MC16
	JET_SingleParticle_HighPt
Missing transverse energy	
	MET_SoftTrk_ResoPara
	MET_SoftTrk_ResoPerp
	MET_SoftTrk_Scale
Other	
HOEW_QCD_syst	
HOEW_syst	
HOQCD_scale_syst	
PRW_DATASF	

Additional slides
AZH kinematic distributions