Weekly Report

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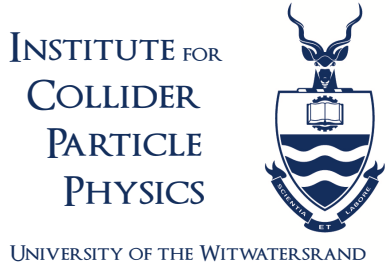
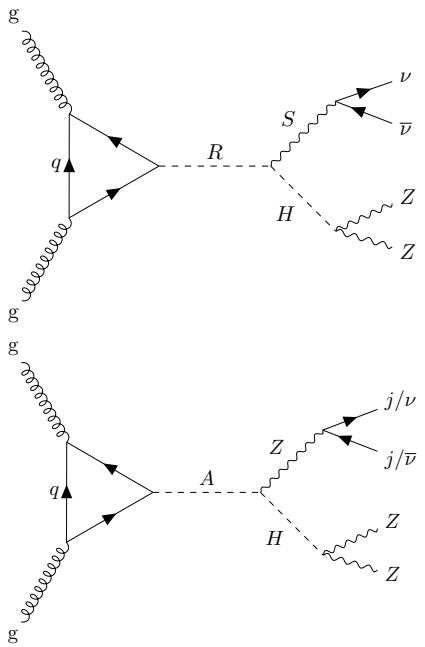
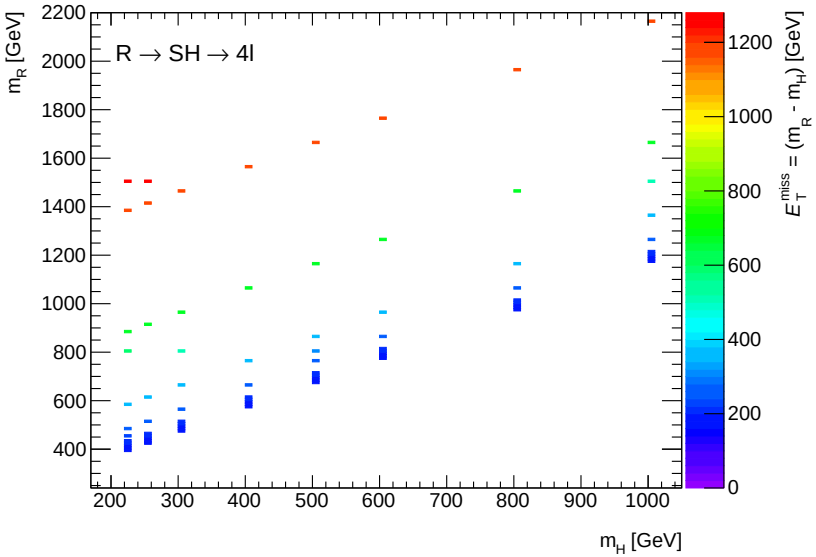
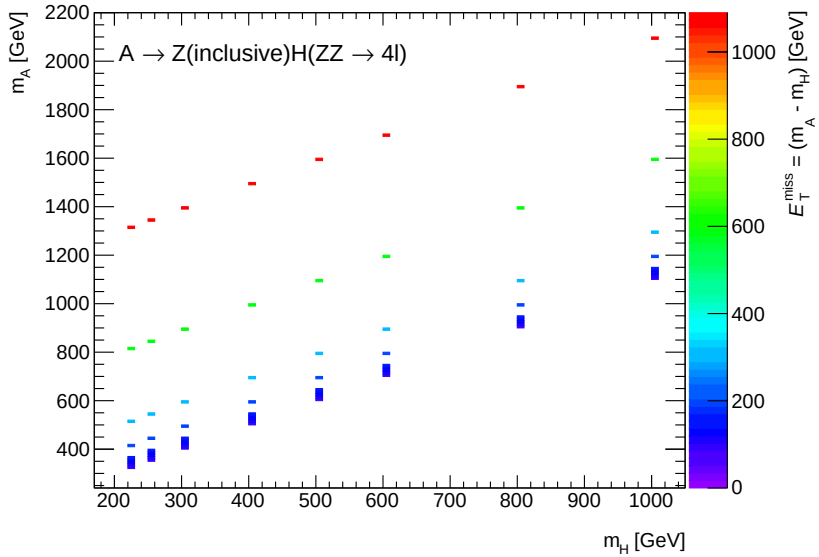


Introduction
Objective

- The 4ℓ+MET analysis searches for heavy resonances.
- Heavy bosons decay to 4ℓ in association with missing transverse energy.
- Interpret the data in terms of two models:
  - $R \to SH \to 4\ell + E_{\mathrm{T}}^{\mathrm{miss}}$ (RSH), JHEP 03 (2017) 094
  - $A \to Z(\mathit{inclusive})H(ZZ \to 4\ell)$ (AZH), Phys.Rev.Lett.113
- Targets Run-II dataset with luminosity of 139.0 fb^{-1}.
- Set upper limits on the 2D mass contour of A/R-H planes.



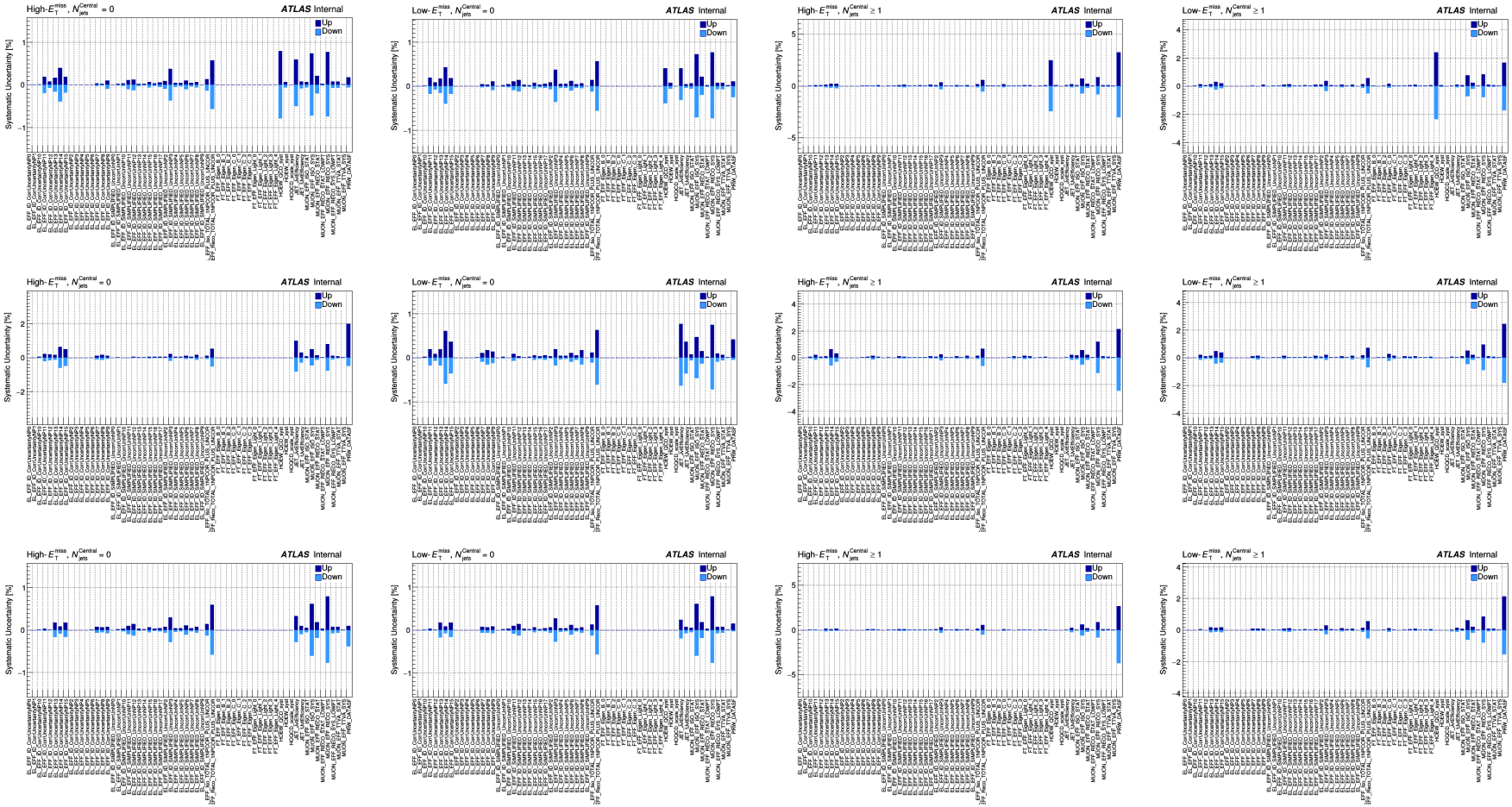




- The analysis benefits from the ability to control the quantity of the missing transverse energy by varying the masses of *R*, *A*, and *H*.
- The search focuses on the high mass region of the *H* bosons, $m_{4\ell} > 200$ GeV.

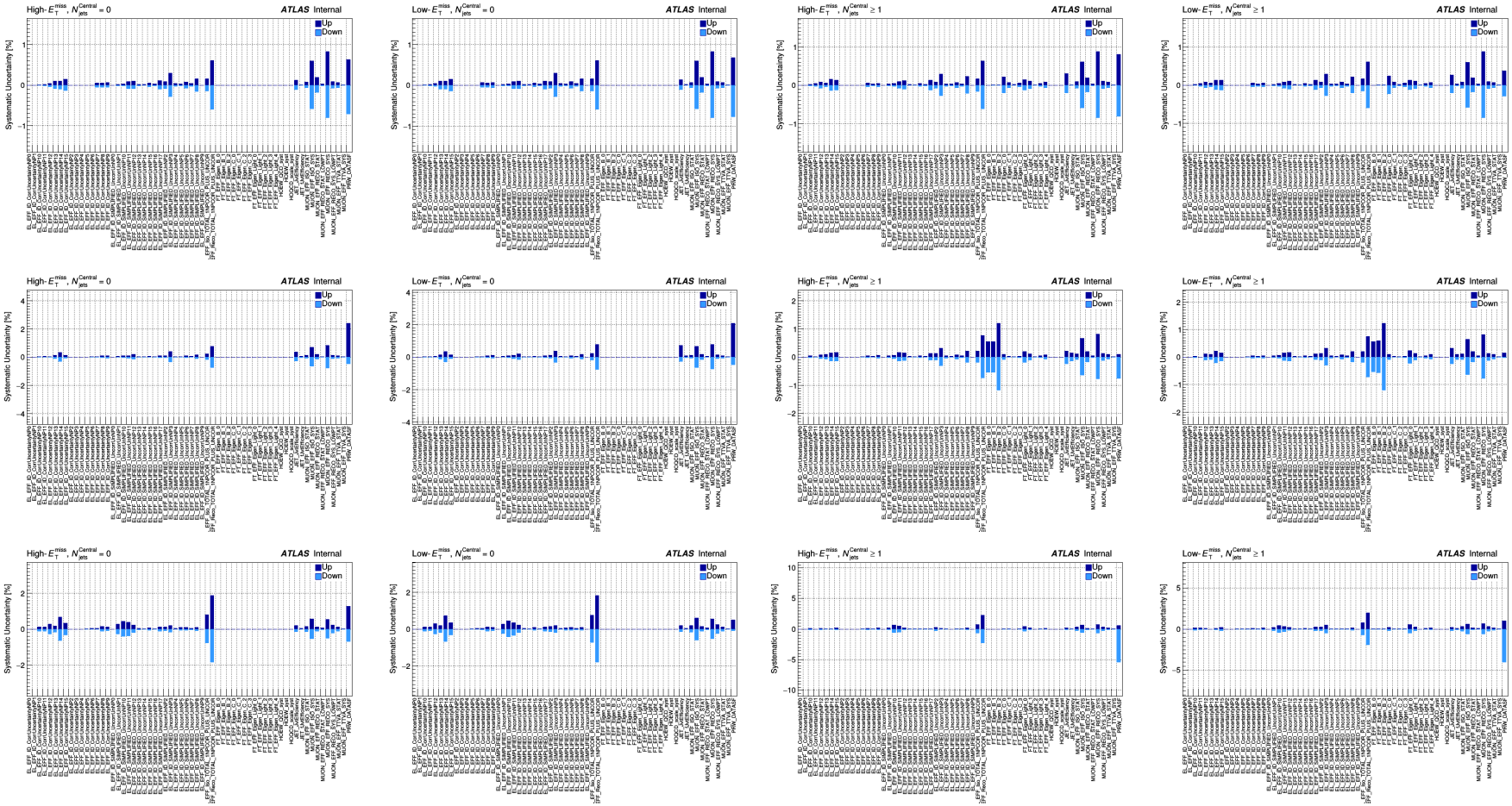
Experimental systematic uncertainties

Normalisation systematic uncertainty: *qqZZ*, *qqZZ*(*EW*) and *ggZZ*

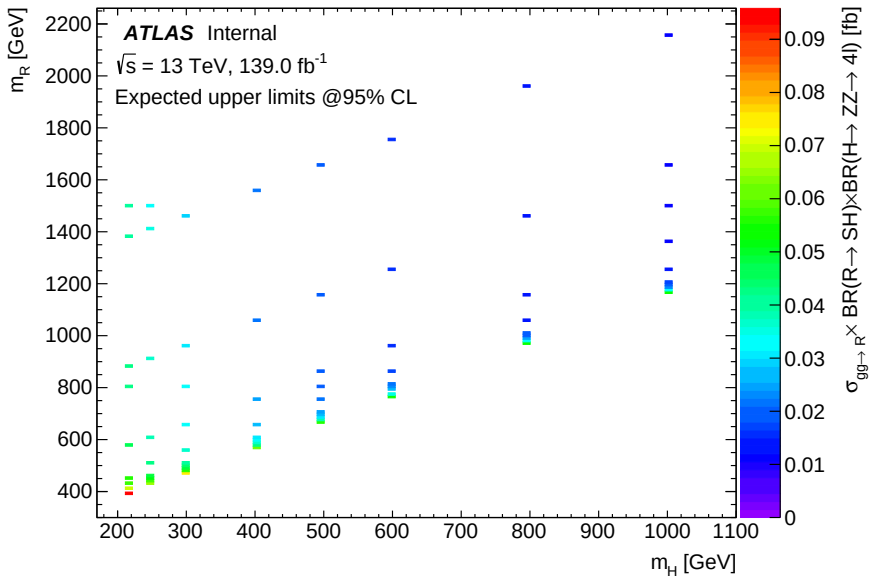


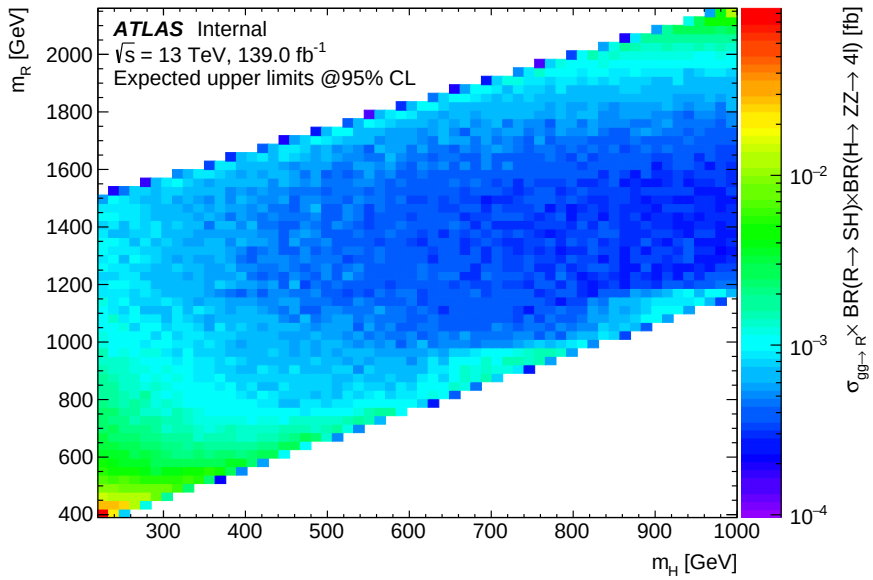
Experimental systematic uncertainties

Normalisation systematic uncertainty: *VVV*, $t\bar{t}V$ and *WZ*



Expected upper limits: $gg \rightarrow R$





- The expected upper limits at 95% CL on $\sigma_{gg\rightarrow R} \times BR(R \rightarrow SH) \times BR(H \rightarrow ZZ \rightarrow 4\ell)$
- No systematic uncertainty considered here, only systemic on the luminosity.
- However, there's a problem with the interpolation (right) in which we're investigating.

Summary

- The experimental systematic uncertainties for the $qqZZ$, $ggZZ$, $qqZZ$(EW), $t\bar{t}V$, VVV and WZ backgrounds are shown.
- These were only normalisation systematic uncertainties, we still need to look at the shapes.
- Shown a preliminary upper limits on the 2D counter of $m_R - m_H$ plane for the RSH model.

On going . . .

- Finalising the systematic samples for the signals and backgrounds, but we have space problem.
- Signal parametrisation for the AZH model, and calculating the AZH cross sections.
- Producing new minitree for the EMPFlow with bug fix switched on.

- Reported the progress of $4\ell + E_{\mathrm{T}}^{\mathrm{miss}}$ analysis on the HBSM meetings last Thursday.

Thank you!

Additional slides
Pre-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 - At most 1 calo-tagged, stand-alone or silicon-associated muon per quadruplet - Leading di-lepton mass requirement: $50 < m_{12} < 106$ GeV - Sub-leading di-lepton mass requirement: $m_{\text{threshold}} < m_{34} < 115$ GeV - $\Delta R(\ell, \ell') > 0.10$ for all lepton pairs 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 Needs updating	- Contribution from the other leptons of the quadruplet is subtracted - Muon track isolation ($\Delta R = 0.30$): $\Sigma p_T / p_T < 0.15$ - Muon calorimeter isolation ($\Delta R = 0.20$): $\Sigma E_T / p_T < 0.30$ - Electron track isolation ($\Delta R = 0.20$) : $\Sigma E_T / E_T < 0.15$ - Electron calorimeter isolation ($\Delta R = 0.20$) : $\Sigma E_T / E_T < 0.20$
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: - $\chi^2/\text{ndof} < 5$ for 4μ and < 9 for others decay channels

Additional slides
Systematic uncertainty

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	