Higgs Searches: A Status Report

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ATLAS EXPERIMENT

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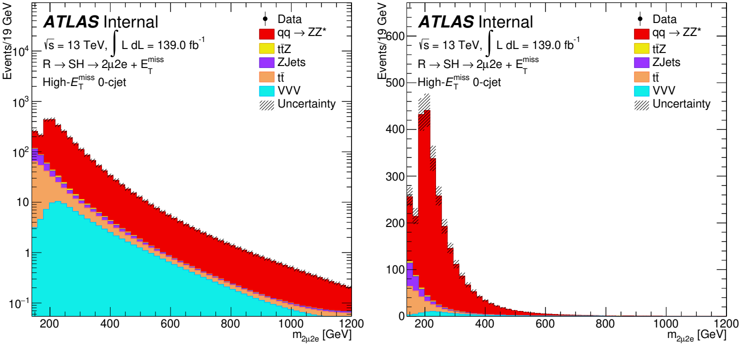
- The procedure for doing the statistics is defined by;

$$\mathcal{L}(x_1 \dots x_2 | \sigma_{ggRSH}) = \mathrm{Pois}(n | S + B) \times \left[\prod_{i=1}^{n} \frac{S \cdot f_S(x_i) + B \cdot f_B(x_i)}{S + B} \right]$$

$$S = \sigma_{ggRSH} \times \mathrm{BR}(H \to ZZ \to 4\ell) \cdot \mathrm{AC} \int L$$

Update on $R \to SH \to 4\ell + E_T^{miss}$ analysis

Statistics strategy



Thank you!

Signal samples have already been produced, JIRA, as follows:

- The mass of S is fixed to 160 GeV;
- The masses of R are 390 GeV, 450 GeV, 800 GeV and 1500 GeV:
  - $m_R = 390$ GeV: $m_H = 220$ GeV
  - $m_R = 450$ GeV: $m_H = 220$ GeV and 250 GeV
  - $m_R = 800$ GeV: $m_H = 220$ GeV, 300 GeV and 500 GeV
  - $m_R = 1500$ GeV:$m_H = 220$ GeV, 250 GeV and 1000 GeV
- Requested HIGG2D1 derivation with cache: 21.2.55 and p-tag: p3782. All jobs are finished see here; and
- The mini-tree production is done using HZZAnalRun2Code.

Background samples

- $qqZZ^*$, $ggZZ^*$, $t\bar{t}Z$, $Z + jets$, $t\bar{t}$ and VVV.

- Signal and background are mc16a, mc16d and mc16e combined;
- The signal cross section (xsection$\times$BR) is 1 fb^{-1} (set by hand);
- The significance is calculated using $S/\sqrt{S+B}$ and $S/\sqrt{B}$;
- S, and B are the signal and background event, respectively;
- Background events are normalised to cross section for the $m_{4\ell} > 200$ GeV;
- Scaling background events by 20.3% uncertainty. It's calculated as follow:

The background scaled by a number extracted as follows: For instance, for $m_H = 220$, and $m_R = 390$: events in $m_{4\ell}(210 - 230)$ GeV over the full range of $m_{4\ell}(> 200)$ GeV.

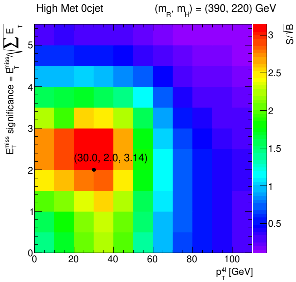
Additional slides

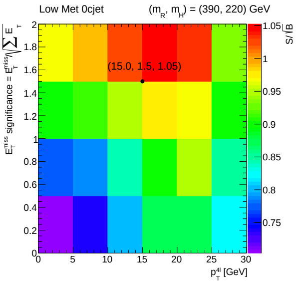
Event Selection	
QUADRUPLET SELECTION	- Require at least one quadruplet of leptons consisting of two pairs of same-flavour opposite-charge leptons fulfilling the following requirements: - p_{T} thresholds for three leading leptons in the quadruplet: 20, 15 and 10 GeV - At most 1 calo-tagged, stand-alone or silicon-associated muon per quadruplet - Leading di-lepton mass requirement: $50 < m_{12} < 106$ GeV - Sub-leading di-lepton mass requirement: $m_{\mathrm{threshold}} < m_{34} < 115$ 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 ($\Delta R = 0.30$): $\Sigma p_{\mathrm{T}}/p_{\mathrm{T}} < 0.15$ - Muon calorimeter isolation ($\Delta R = 0.20$): $\Sigma E_{\mathrm{T}}/p_{\mathrm{T}} < 0.30$ - Electron track isolation ($\Delta R = 0.20$) : $\Sigma E_{\mathrm{T}}/E_{\mathrm{T}} < 0.15$ - 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: - $\chi^2/\mathrm{ndof} < 5$ for 4μ and < 9 for others decay channels

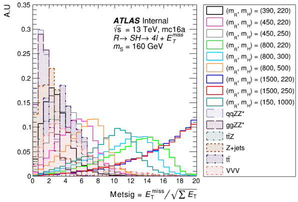
Update on $R \to SH \to 4\ell + E_T^{miss}$ analysis

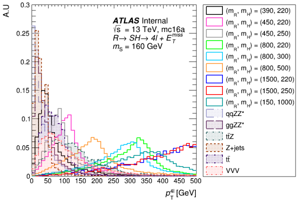
Signal optimisation

- ☐ Categorize event into 4 categories: Using $S/\sqrt{B}$ instead of $S/\sqrt{S+B}$ to avoid the cross-section dependency



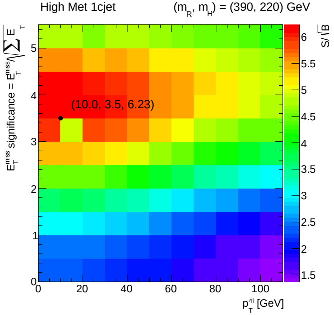


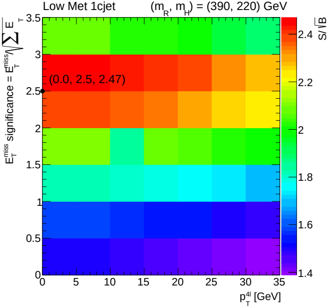


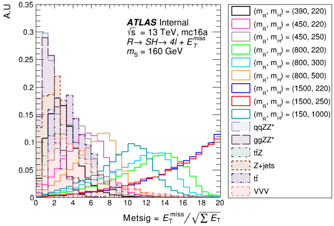


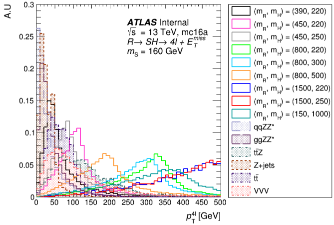
Update on $R \rightarrow SH \rightarrow 4\ell + E_{T}^{miss}$ analysis

Signal optimisation





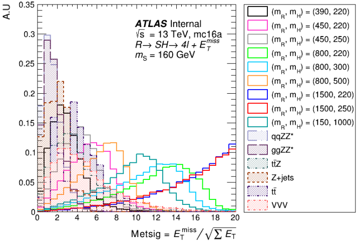




Remark

- We avoid the dependency of the cross-section by using $S/\sqrt{B}$. For the optimisation we used only $(m_R, m_H) = (390, 220)$ GeV mass point. So no need to use other mass points because the new categories cover the low and the high Met region.

- ☐ High met 0 central jet $\Rightarrow$ 30\2.0
- ☐ Low met 0 central jet $\Rightarrow$ 15\1.5
- ☐ High met 1 central jet $\Rightarrow$ 10\3.5
- ☐ Low met 1 central jet $\Rightarrow$ 0.0\2.5



See tables for the categories on backup slides.

Update on $R \to SH \to 4\ell + E_{\mathrm{T}}^{miss}$ analysis

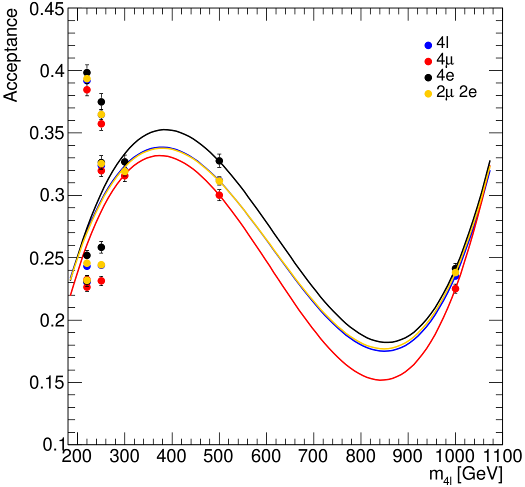
Signal acceptance

(m_R, m_H) GeV	4ℓ	4μ	$4e$	$2\mu 2e$
390, 220	23.01%	22.65%	23.11%	23.19%
450, 220	39.18%	38.46%	39.84%	39.34%
450, 250	36.46%	35.72%	37.50%	36.49%
800, 220	32.39%	31.97%	32.63%	32.53%
800, 300	31.97%	31.57%	32.67%	31.91%
800, 500	31.18%	30.01%	32.76%	31.15%
1500, 220	24.32%	23.24%	25.18%	24.56%
1500, 250	24.39%	23.14%	25.83%	24.44%
1500, 1000	23.53%	22.52%	24.13%	23.81%

Table: Signal efficiencies for the $4\ell + E_{\mathrm{T}}^{\mathrm{miss}}$ final states. The numbers recovered with simulated MC of mc16a, mc16d and mc16e for the High$-E_{\mathrm{T}}^{\mathrm{miss}}$ with zero central jet category. For the signal masses (m_R, m_H) of (390,220), (450,220), (450,250), (800, 220), (800, 300), (800, 500), (1500, 220), (1500, 220), and (1500, 1000) GeV. The efficiency is calculated by the ratio of the number of reconstructed events after all pre-selection requirements to the number of simulated events after the final selection the for inclusive lepton channel (4ℓ) and 4μ, $4e$, and $2\mu 2e$ channel

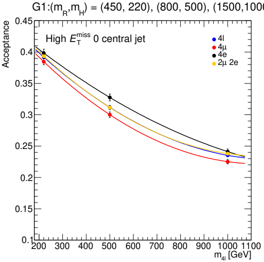
Update on $R \to SH \to 4\ell + E_T^{miss}$ analysis

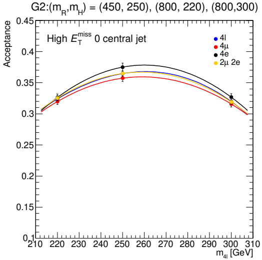
Signal acceptance

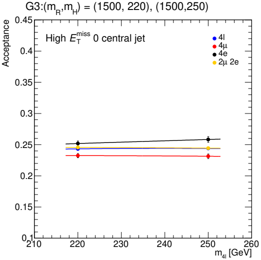


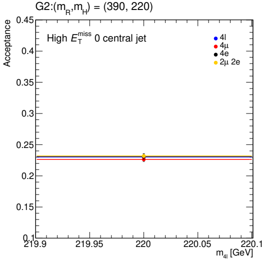
Update on $R \to SH \to 4\ell + E_T^{miss}$ analysis

Signal acceptance









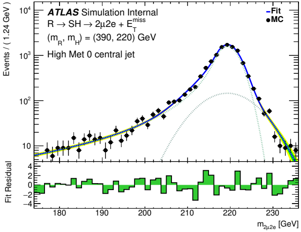
- The Crystal ball, CB, plus Gaussian, G, Pdf has the following form:

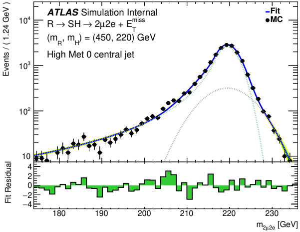
$$f(m_{4\ell}) = f_{\mathrm{CB}} \cdot \mathrm{CB}(m_{4\ell}; \mu, \sigma_{\mathrm{CB}}, \alpha_{\mathrm{CB}}, n_{\mathrm{CB}}) + (1 - f_{CB}) \cdot \mathrm{G}(m_{4\ell}; \mu, \sigma_G)$$

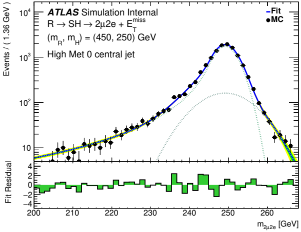
  - σ_{CB} and σ_G represent the invariant mass resolution;
  - μ is the mean value fixed to same parameter for both Pdf;
  - n_{CB} and α_{CB} model the shape and position of the non-Gaussian tail;
  - Where n_{CB} is the slop of the tail and α_{CB} measures how far from the peak the distribution become non-Gaussian;
  - f_{CB} is the relative normalisation of the Pdf.

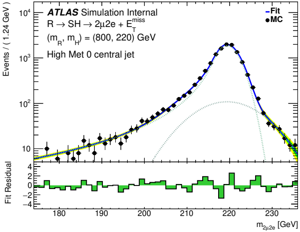
Update on $R \to SH \to 4\ell + E_T^{miss}$ analysis

High Met 0 central jet for $2\mu 2e$ channel





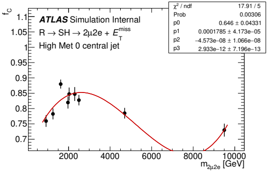


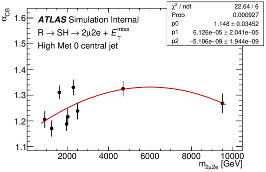


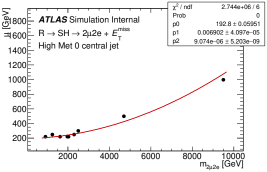
- ☐ The samples have more high p_T events will have different resolution of the mass.

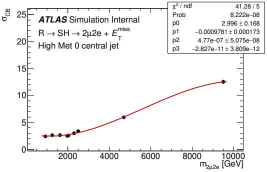
Update on $R \to SH \to 4\ell + E_T^{miss}$ analysis

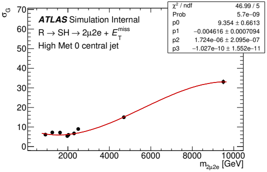
Interpolation of μ, $f_C B$, σ_G, σ_{CB} and α_{CB} parameters





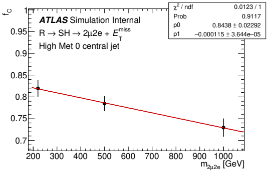


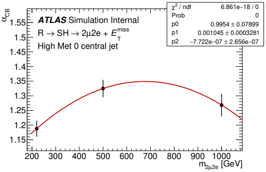


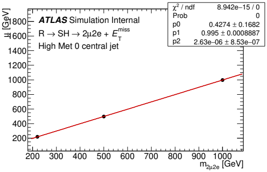


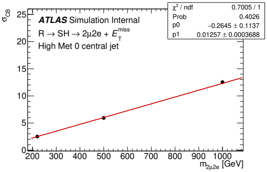
Update on $R \to SH \to 4\ell + E_T^{miss}$ analysis

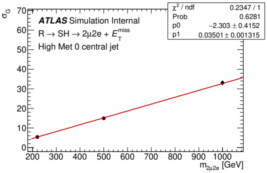
Interpolation of μ, $f_C B$, σ_G, σ_{CB} and α_{CB} parameters











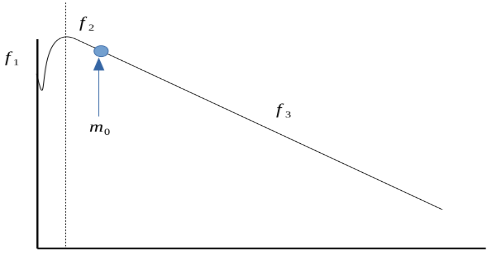
Update on $R \to SH \to 4\ell + E_T^{miss}$ analysis

Background parametrisation

$$f^{ggZZ/qqZZ}(m_{4\ell}) = (f_1(m_{4\ell}) + f_2(m_{4\ell})) \times H(m_0 - m_{4\ell}) \times C_0 + f_3^{ggZZ/qqZZ}(m_{4\ell}) \times H(m_{4\ell} - m_0),$$

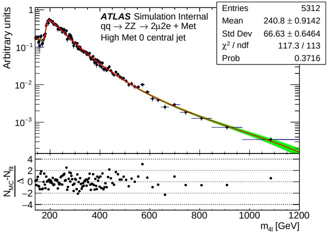
where:

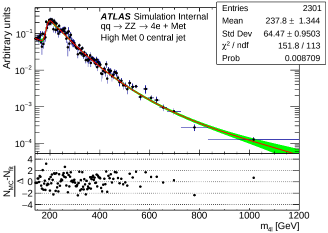
$$\begin{aligned}
f_1(m_{4\ell}) &= \exp(a_1 + a_2 \cdot m_{4\ell} + a_3 \cdot m_{4\ell}^2), \\
f_2(m_{4\ell}) &= \left\{\frac{1}{2} + \frac{1}{2}\,\mathrm{erf}\left(\frac{m_{4\ell} - b_1}{b_2}\right)\right\} \times \frac{1}{1 + \exp\left(\frac{m_{4\ell}-b_1}{b_3}\right)}, \\
f_3^{qqZZ/ggZZ}(m_{4\ell}) &= \exp\left(c_1 + c_2 \cdot m_{4\ell} + c_3 \cdot m_{4\ell}^2 + c_4 \cdot m_{4\ell}^3 + c_5 \cdot m_{4\ell}^4 + c_6 \cdot m_{4\ell}^5\right), \\
C_0 &= \frac{f_3(m_0)}{f_1(m_0) + f_2(m_0)}.
\end{aligned}$$

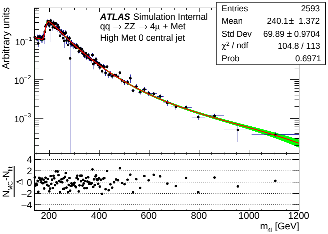


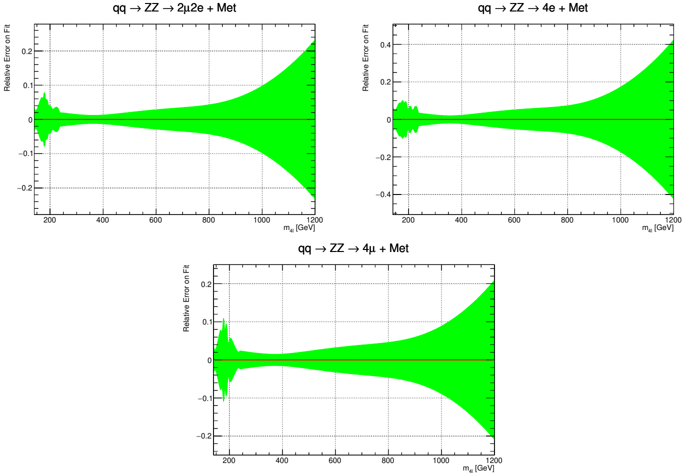
Update on $R \to SH \to 4\ell + E_T^{miss}$ analysis

Background parametrisation





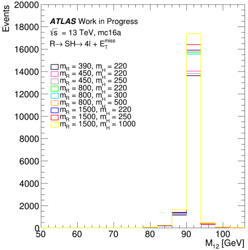


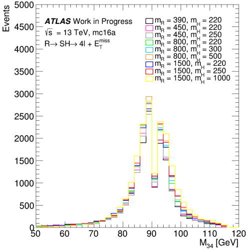


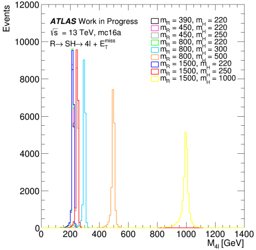
qq → ZZ → 2μ2e + Met
Relative Error on Fit
m_{4l} [GeV]
qq → ZZ → 4e + Met
Relative Error on Fit
m_{4l} [GeV]
qq → ZZ → 4μ + Met
Relative Error on Fit
m_{4l} [GeV]

Additional slides

Kinematic distributions for the signal

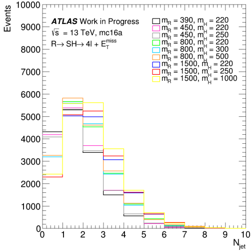


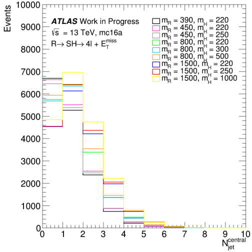


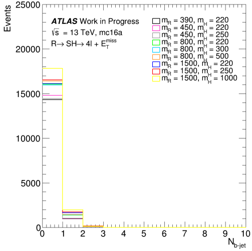


Additional slides

Kinematic distributions for the signal

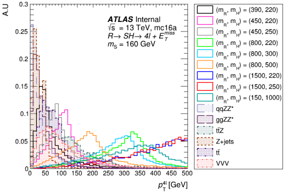


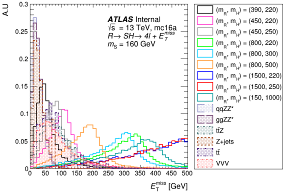


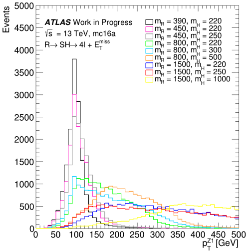


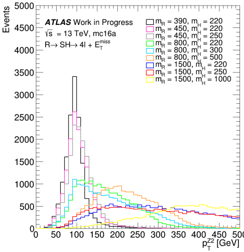
Additional slides

Kinematic distributions for the signal









Additional slides

Kinematic distributions for signal & background

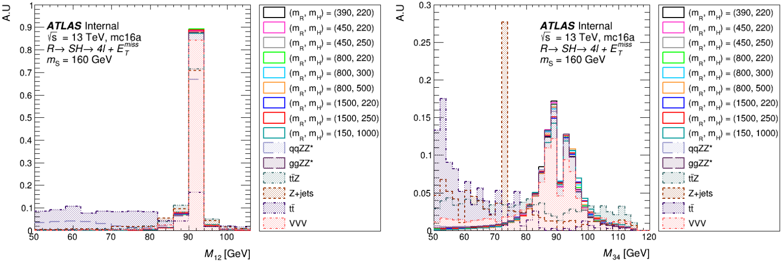


Figure: The invariant mass of the first (left) and the second (right) lepton pairs.

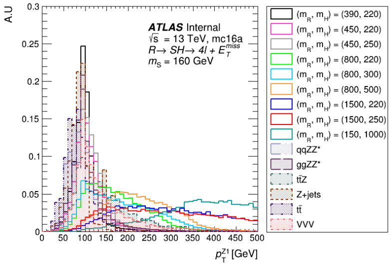
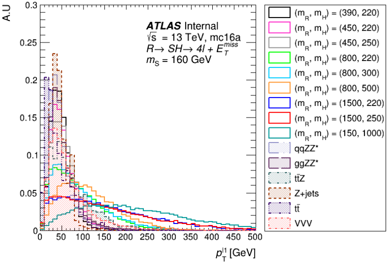
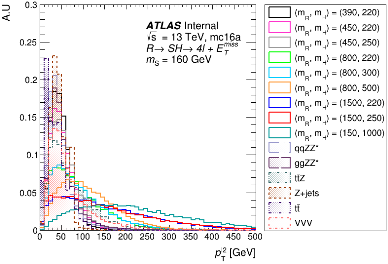


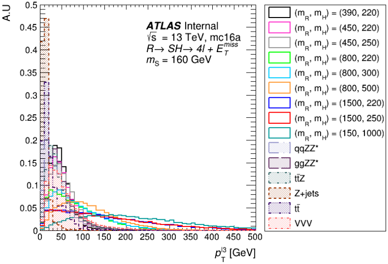
Figure: The invariant mass of the first (left) and the second (right) lepton pairs.

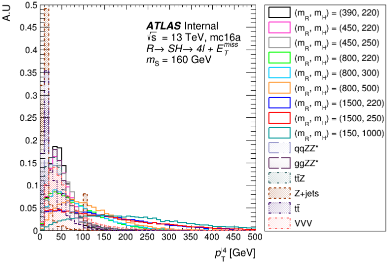
Additional slides

Kinematic distributions









Additional slides

High Met 0 central jet

	$(m_R, m_H) = (390, 220)$	$qqZZ^*$	$ggZZ^*$	$t\bar{t}Z$	$Z + jets$	$t\bar{t}$	VVV	$s/\sqrt{b}$
4ℓ	64.51±0.24	2510.45±5.75	349.64±0.71	8.94±0.05	3.87±0.84	3.55±0.23	19.08±0.11	2.661
B-veto	60.07±0.23	2394.48±5.70	334.96±0.69	1.72±0.02	3.63±0.84	2.27±0.16	17.79±0.11	2.540
$N_{jet}^{central} = 0$	28.02±0.16	1607.35±5.06	211.64±0.55	0.42±0.01	2.10±0.15	0.99±0.10	9.30±0.07	1.453
$p_T^{4\ell} > 0.00$ & Metsig > 0.00	28.02±0.00	1607.35±0.00	211.64±0.00	0.42±0.00	2.10±0.00	0.99±0.00	9.30±0.00	1.453
$p_T^{4\ell} > 0.00$ & Metsig > 0.50	27.47±0.00	1236.12±0.00	180.35±0.00	0.41±0.00	1.98±0.00	0.94±0.00	9.16±0.00	1.613
$p_T^{4\ell} > 0.00$ & Metsig > 1.00	25.61±0.00	685.37±0.00	117.69±0.00	0.40±0.00	1.62±0.00	0.90±0.00	8.77±0.00	1.991
$p_T^{4\ell} > 0.00$ & Metsig > 1.50	22.60±0.00	346.29±0.00	66.12±0.00	0.38±0.00	1.27±0.00	0.79±0.00	8.19±0.00	2.439
$p_T^{4\ell} > 0.00$ & Metsig > 2.00	18.26±0.00	172.22±0.00	34.04±0.00	0.35±0.00	0.79±0.00	0.68±0.00	7.50±0.00	2.761
$p_T^{4\ell} > 0.00$ & Metsig > 2.50	12.83±0.00	83.44±0.00	16.71±0.00	0.33±0.00	0.53±0.00	0.60±0.00	6.77±0.00	2.736
$p_T^{4\ell} > 0.00$ & Metsig > 3.00	7.52±0.00	39.01±0.00	8.01±0.00	0.29±0.00	0.30±0.00	0.55±0.00	6.02±0.00	2.267
$p_T^{4\ell} > 0.00$ & Metsig > 3.50	3.71±0.00	18.93±0.00	3.77±0.00	0.26±0.00	0.17±0.00	0.46±0.00	5.32±0.00	1.533
$p_T^{4\ell} > 0.00$ & Metsig > 4.00	1.74±0.00	9.25±0.00	1.79±0.00	0.22±0.00	0.08±0.00	0.38±0.00	4.66±0.00	0.954
$p_T^{4\ell} > 0.00$ & Metsig > 4.50	0.81±0.00	4.19±0.00	0.79±0.00	0.18±0.00	0.06±0.00	0.26±0.00	4.02±0.00	0.583
$p_T^{4\ell} > 0.00$ & Metsig > 5.00	0.39±0.00	2.29±0.00	0.38±0.00	0.16±0.00	0.05±0.00	0.22±0.00	3.47±0.00	0.336
$p_T^{4\ell} > 10.00$ & Metsig > 0.00	27.17±0.00	1063.48±0.00	180.22±0.00	0.42±0.00	1.82±0.00	0.95±0.00	9.15±0.00	1.702
$p_T^{4\ell} > 10.00$ & Metsig > 0.50	26.74±0.01	913.21±1.03	159.88±0.12	0.41±0.00	1.76±0.02	0.93±0.02	9.04±0.00	1.802
$p_T^{4\ell} > 10.00$ & Metsig > 1.00	25.12±0.02	567.10±1.44	109.46±0.18	0.40±0.00	1.49±0.04	0.89±0.02	8.69±0.01	2.125
$p_T^{4\ell} > 10.00$ & Metsig > 1.50	22.26±0.02	291.10±1.55	62.42±0.20	0.38±0.00	1.20±0.05	0.78±0.02	8.14±0.01	2.590
$p_T^{4\ell} > 10.00$ & Metsig > 2.00	18.03±0.02	142.89±1.60	32.18±0.21	0.35±0.00	0.77±0.05	0.67±0.02	7.47±0.01	2.947
$p_T^{4\ell} > 10.00$ & Metsig > 2.50	12.67±0.02	68.91±1.62	15.83±0.21	0.32±0.00	0.52±0.05	0.59±0.02	6.75±0.01	2.918
$p_T^{4\ell} > 10.00$ & Metsig > 3.00	7.43±0.03	31.91±1.64	7.58±0.21	0.29±0.00	0.29±0.05	0.54±0.02	6.00±0.01	2.414
$p_T^{4\ell} > 10.00$ & Metsig > 3.50	3.65±0.03	15.05±1.64	3.53±0.21	0.26±0.00	0.17±0.05	0.45±0.02	5.31±0.01	1.627
$p_T^{4\ell} > 10.00$ & Metsig > 4.00	1.71±0.03	7.19±1.64	1.66±0.21	0.22±0.00	0.08±0.05	0.37±0.02	4.65±0.01	1.008
$p_T^{4\ell} > 10.00$ & Metsig > 4.50	0.79±0.03	3.09±1.65	0.73±0.21	0.18±0.00	0.06±0.05	0.25±0.02	4.02±0.01	0.611
$p_T^{4\ell} > 10.00$ & Metsig > 5.00	0.38±0.03	1.84±1.65	0.35±0.21	0.16±0.00	0.05±0.05	0.21±0.02	3.47±0.01	0.345
$p_T^{4\ell} > 20.00$ & Metsig > 0.00	24.47±0.00	571.61±0.00	118.61±0.00	0.40±0.00	1.25±0.00	0.93±0.00	8.72±0.00	2.051
$p_T^{4\ell} > 20.00$ & Metsig > 0.50	24.17±0.02	510.65±1.31	107.98±0.17	0.40±0.00	1.22±0.03	0.91±0.03	8.64±0.01	2.138
$p_T^{4\ell} > 20.00$ & Metsig > 1.00	23.06±0.03	368.70±3.95	81.82±0.29	0.39±0.00	1.08±0.06	0.87±0.03	8.39±0.01	2.383
$p_T^{4\ell} > 20.00$ & Metsig > 1.50	20.91±0.04	217.03±4.13	51.37±0.33	0.37±0.00	0.96±0.07	0.77±0.03	7.97±0.01	2.781
$p_T^{4\ell} > 20.00$ & Metsig > 2.00	17.13±0.05	110.51±4.19	27.50±0.35	0.34±0.00	0.68±0.08	0.66±0.03	7.38±0.02	3.136
$p_T^{4\ell} > 20.00$ & Metsig > 2.50	12.10±0.05	53.17±4.22	13.63±0.36	0.32±0.00	0.45±0.09	0.59±0.03	6.69±0.02	3.103
$p_T^{4\ell} > 20.00$ & Metsig > 3.00	7.05±0.05	24.27±4.23	6.54±0.36	0.28±0.00	0.27±0.10	0.54±0.03	5.98±0.02	2.544
$p_T^{4\ell} > 20.00$ & Metsig > 3.50	3.41±0.05	11.15±4.24	3.03±0.36	0.25±0.00	0.17±0.10	0.45±0.03	5.30±0.02	1.678
$p_T^{4\ell} > 20.00$ & Metsig > 4.00	1.59±0.06	5.22±4.24	1.41±0.37	0.21±0.00	0.07±0.10	0.37±0.03	4.65±0.02	1.019
$p_T^{4\ell} > 20.00$ & Metsig > 4.50	0.73±0.06	2.19±4.24	0.62±0.37	0.18±0.00	0.05±0.10	0.25±0.03	4.01±0.02	0.598
$p_T^{4\ell} > 20.00$ & Metsig > 5.00	0.36±0.06	1.40±4.24	0.29±0.37	0.15±0.00	0.04±0.10	0.21±0.03	3.47±0.02	0.336
$p_T^{4\ell} > 30.00$ & Metsig > 0.00	19.78±0.00	312.75±0.00	70.36±0.00	0.39±0.00	0.85±0.00	0.80±0.00	8.07±0.00	2.214
$p_T^{4\ell} > 30.00$ & Metsig > 0.50	19.56±0.02	280.94±1.50	64.29±0.19	0.38±0.00	0.84±0.03	0.78±0.03	8.00±0.01	2.304
$p_T^{4\ell} > 30.00$ & Metsig > 1.00	18.79±0.04	211.83±4.16	50.32±0.32	0.37±0.00	0.77±0.06	0.77±0.03	7.82±0.01	2.529
$p_T^{4\ell} > 30.00$ & Metsig > 1.50	17.41±0.05	140.82±4.48	34.97±0.40	0.36±0.00	0.69±0.08	0.69±0.03	7.54±0.02	2.840
$p_T^{4\ell} > 30.00$ & Metsig > 2.00	14.87±0.07	80.74±4.61	20.88±0.43	0.33±0.00	0.55±0.10	0.63±0.04	7.13±0.02	3.143
$p_T^{4\ell} > 30.00$ & Metsig > 2.50	10.87±0.07	41.23±4.66	10.95±0.44	0.31±0.00	0.39±0.10	0.55±0.04	6.57±0.02	3.114
$p_T^{4\ell} > 30.00$ & Metsig > 3.00	6.35±0.08	19.35±4.69	5.36±0.45	0.28±0.00	0.24±0.11	0.51±0.04	5.91±0.03	2.507
$p_T^{4\ell} > 30.00$ & Metsig > 3.50	3.06±0.08	9.12±4.70	2.49±0.45	0.24±0.00	0.13±0.11	0.44±0.04	5.26±0.03	1.614
$p_T^{4\ell} > 30.00$ & Metsig > 4.00	1.41±0.08	4.58±4.70	1.15±0.45	0.21±0.00	0.07±0.11	0.36±0.04	4.63±0.03	0.942
$p_T^{4\ell} > 30.00$ & Metsig > 4.50	0.65±0.08	2.17±4.71	0.50±0.45	0.18±0.00	0.04±0.11	0.24±0.04	4.01±0.03	0.538
$p_T^{4\ell} > 30.00$ & Metsig > 5.00	0.32±0.09	1.10±4.74	0.22±0.45	0.15±0.00	0.03±0.11	0.21±0.04	3.46±0.03	0.312
$p_T^{4\ell} > 40.00$ & Metsig > 0.00	13.20±0.00	167.47±0.00	40.51±0.00	0.37±0.00	0.49±0.00	0.67±0.00	7.29±0.00	1.989
$p_T^{4\ell} > 40.00$ & Metsig > 0.50	13.04±0.02	150.71±1.61	37.07±0.20	0.36±0.00	0.47±0.03	0.67±0.03	7.24±0.01	2.065
$p_T^{4\ell} > 40.00$ & Metsig > 1.00	12.49±0.04	114.34±4.25	29.04±0.34	0.35±0.00	0.44±0.06	0.65±0.03	7.09±0.01	2.249
$p_T^{4\ell} > 40.00$ & Metsig > 1.50	11.61±0.06	78.22±4.60	20.74±0.42	0.34±0.00	0.39±0.08	0.58±0.03	6.89±0.02	2.490
$p_T^{4\ell} > 40.00$ & Metsig > 2.00	10.18±0.08	49.60±4.77	13.39±0.46	0.31±0.00	0.32±0.10	0.56±0.04	6.63±0.03	2.686
$p_T^{4\ell} > 40.00$ & Metsig > 2.50	8.04±0.09	28.94±4.84	7.88±0.48	0.29±0.00	0.26±0.11	0.49±0.05	6.30±0.03	2.684
$p_T^{4\ell} > 40.00$ & Metsig > 3.00	5.10±0.11	14.89±4.88	4.14±0.49	0.27±0.00	0.17±0.12	0.46±0.05	5.79±0.03	2.232
$p_T^{4\ell} > 40.00$ & Metsig > 3.50	2.55±0.11	7.20±4.90	1.97±0.49	0.24±0.00	0.11±0.13	0.44±0.06	5.20±0.03	1.452
$p_T^{4\ell} > 40.00$ & Metsig > 4.00	1.18±0.11	3.55±4.90	0.93±0.49	0.20±0.00	0.04±0.13	0.36±0.06	4.60±0.03	0.845
$p_T^{4\ell} > 40.00$ & Metsig > 4.50	0.55±0.11	1.75±4.90	0.40±0.50	0.17±0.00	0.02±0.13	0.24±0.06	3.99±0.03	0.472
$p_T^{4\ell} > 40.00$ & Metsig > 5.00	0.27±0.11	0.89±4.94	0.18±0.50	0.15±0.00	0.02±0.13	0.21±0.06	3.45±0.03	0.275
$p_T^{4\ell} > 50.00$ & Metsig > 0.00	7.20±0.00	93.28±0.00	23.52±0.00	0.34±0.00	0.29±0.00	0.58±0.00	6.55±0.00	1.431
$p_T^{4\ell} > 50.00$ & Metsig > 0.50	7.09±0.02	83.38±1.64	21.41±0.20	0.33±0.00	0.28±0.03	0.58±0.03	6.50±0.01	1.485
$p_T^{4\ell} > 50.00$ & Metsig > 1.00	6.72±0.04	63.17±4.28	16.71±0.35	0.32±0.00	0.26±0.06	0.58±0.03	6.38±0.01	1.596
$p_T^{4\ell} > 50.00$ & Metsig > 1.50	6.16±0.06	43.20±4.64	12.00±0.44	0.31±0.00	0.23±0.09	0.50±0.03	6.23±0.02	1.729
$p_T^{4\ell} > 50.00$ & Metsig > 2.00	5.31±0.08	27.89±4.82	7.92±0.48	0.29±0.00	0.19±0.11	0.48±0.05	6.04±0.03	1.800
$p_T^{4\ell} > 50.00$ & Metsig > 2.50	4.27±0.10	17.28±4.90	4.93±0.50	0.27±0.00	0.17±0.12	0.46±0.06	5.83±0.03	1.760
$p_T^{4\ell} > 50.00$ & Metsig > 3.00	3.05±0.12	9.99±4.95	2.85±0.51	0.25±0.00	0.13±0.13	0.44±0.06	5.50±0.04	1.545
$p_T^{4\ell} > 50.00$ & Metsig > 3.50	1.82±0.13	5.36±4.96	1.49±0.52	0.22±0.00	0.09±0.13	0.42±0.07	5.06±0.04	1.135
$p_T^{4\ell} > 50.00$ & Metsig > 4.00	0.91±0.13	2.72±4.97	0.74±0.52	0.19±0.00	0.04±0.13	0.34±0.07	4.53±0.04	0.687
$p_T^{4\ell} > 50.00$ & Metsig > 4.50	0.43±0.14	1.39±4.97	0.33±0.52	0.17±0.00	0.02±0.13	0.24±0.07	3.96±0.04	0.389
$p_T^{4\ell} > 50.00$ & Metsig > 5.00	0.21±0.14	0.73±5.00	0.14±0.52	0.14±0.00	0.02±0.14	0.20±0.07	3.44±0.04	0.221
$p_T^{4\ell} > 60.00$ & Metsig > 0.00	3.81±0.00	56.14±0.00	14.19±0.00	0.31±0.00	0.17±0.00	0.47±0.00	5.75±0.00	0.963
$p_T^{4\ell} > 60.00$ & Metsig > 0.50	3.73±0.02	49.33±1.65	12.79±0.21	0.30±0.00	0.16±0.03	0.47±0.03	5.70±0.01	1.000
$p_T^{4\ell} > 60.00$ & Metsig > 1.00	3.46±0.04	36.45±4.29	9.82±0.36	0.30±0.00	0.14±0.07	0.47±0.03	5.61±0.02	1.057
$p_T^{4\ell} > 60.00$ & Metsig > 1.50	3.09±0.06	24.45±4.66	7.01±0.44	0.28±0.00	0.13±0.09	0.41±0.04	5.48±0.02	1.117
$p_T^{4\ell} > 60.00$ & Metsig > 2.00	2.59±0.09	15.88±4.84	4.62±0.49	0.27±0.00	0.12±0.11	0.39±0.05	5.35±0.03	1.115
$p_T^{4\ell} > 60.00$ & Metsig > 2.50	2.05±0.11	10.04±4.92	2.89±0.51	0.25±0.00	0.11±0.12	0.38±0.06	5.21±0.03	1.045
$p_T^{4\ell} > 60.00$ & Metsig > 3.00	1.49±0.13	6.08±4.97	1.72±0.52	0.23±0.00	0.09±0.13	0.37±0.06	5.01±0.04	0.898
$p_T^{4\ell} > 60.00$ & Metsig > 3.50	1.01±0.14	3.61±4.99	1.02±0.53	0.21±0.00	0.05±0.14	0.35±0.07	4.74±0.04	0.712
$p_T^{4\ell} > 60.00$ & Metsig > 4.00	0.58±0.14	2.05±4.99	0.55±0.53	0.18±0.00	0.03±0.14	0.30±0.07	4.36±0.04	0.474
$p_T^{4\ell} > 60.00$ & Metsig > 4.50	0.31±0.15	1.14±5.00	0.25±0.53	0.16±0.00	0.02±0.14	0.21±0.07	3.89±0.04	0.289
$p_T^{4\ell} > 60.00$ & Metsig > 5.00	0.17±0.15	0.64±5.03	0.11±0.53	0.14±0.00	0.02±0.14	0.18±0.07	3.40±0.04	0.174

Additional slides

Low Met 0 central jet

	$(m_R, m_H) = (390, 220)$	$qqZZ^*$	$ggZZ^*$	$t\bar{t}Z$	$Z+jets$	$t\bar{t}$	VVV	$s/\sqrt{b}$
4ℓ	64.51±0.24	2510.45±5.75	349.64±0.71	8.94±0.05	3.87±0.84	3.55±0.23	19.08±0.11	2.661
B-veto	60.07±0.23	2394.48±5.70	334.96±0.69	1.72±0.02	3.63±0.84	2.27±0.16	17.79±0.11	2.540
$N_{\mathrm{jet}}^{\mathrm{central}} = 0$	28.02±0.16	1607.35±5.06	211.64±0.55	0.42±0.01	2.10±0.15	0.99±0.10	9.30±0.07	1.453
$p_T^{4\ell} > 0.00$ & Metsig > 0.00	13.15±0.00	1526.61±0.00	190.77±0.00	0.09±0.00	1.55±0.00	0.36±0.00	2.17±0.00	0.703
$p_T^{4\ell} > 0.00$ & Metsig > 0.50	12.60±0.00	1155.38±0.00	159.47±0.00	0.08±0.00	1.43±0.00	0.31±0.00	2.03±0.00	0.770
$p_T^{4\ell} > 0.00$ & Metsig > 1.00	10.74±0.00	604.62±0.00	96.81±0.00	0.07±0.00	1.07±0.00	0.27±0.00	1.64±0.00	0.898
$p_T^{4\ell} > 0.00$ & Metsig > 1.50	7.73±0.00	265.55±0.00	45.24±0.00	0.05±0.00	0.73±0.00	0.16±0.00	1.06±0.00	0.970
$p_T^{4\ell} > 10.00$ & Metsig > 0.00	12.30±0.00	982.74±0.00	159.35±0.00	0.08±0.00	1.27±0.00	0.32±0.00	2.03±0.00	0.807
$p_T^{4\ell} > 10.00$ & Metsig > 0.50	11.88±0.01	832.47±1.03	139.00±0.12	0.08±0.00	1.21±0.02	0.30±0.02	1.91±0.00	0.844
$p_T^{4\ell} > 10.00$ & Metsig > 1.00	10.25±0.02	486.36±1.44	88.59±0.18	0.07±0.00	0.94±0.04	0.26±0.02	1.56±0.01	0.946
$p_T^{4\ell} > 10.00$ & Metsig > 1.50	7.39±0.02	210.36±1.55	41.54±0.20	0.05±0.00	0.65±0.05	0.15±0.02	1.01±0.01	1.030
$p_T^{4\ell} > 15.00$ & Metsig > 0.00	11.22±0.00	689.13±0.00	128.27±0.00	0.08±0.00	0.96±0.00	0.31±0.00	1.83±0.00	0.869
$p_T^{4\ell} > 15.00$ & Metsig > 0.50	10.86±0.01	600.82±1.18	113.76±0.15	0.07±0.00	0.91±0.03	0.30±0.03	1.74±0.01	0.900
$p_T^{4\ell} > 15.00$ & Metsig > 1.00	9.49±0.02	386.30±1.79	76.84±0.25	0.06±0.00	0.73±0.05	0.26±0.03	1.45±0.01	0.976
$p_T^{4\ell} > 15.00$ & Metsig > 1.50	6.89±0.03	172.44±1.98	36.85±0.28	0.04±0.00	0.53±0.06	0.15±0.03	0.95±0.01	1.052
$p_T^{4\ell} > 20.00$ & Metsig > 0.00	9.60±0.00	490.87±0.00	97.73±0.00	0.07±0.00	0.70±0.00	0.30±0.00	1.59±0.00	0.877
$p_T^{4\ell} > 20.00$ & Metsig > 0.50	9.31±0.02	429.91±1.31	87.10±0.17	0.07±0.00	0.67±0.03	0.28±0.03	1.51±0.01	0.906
$p_T^{4\ell} > 20.00$ & Metsig > 1.00	8.19±0.03	287.96±3.95	60.95±0.29	0.06±0.00	0.53±0.06	0.24±0.03	1.26±0.01	0.970
$p_T^{4\ell} > 20.00$ & Metsig > 1.50	6.04±0.04	136.29±4.13	30.49±0.33	0.04±0.00	0.41±0.07	0.14±0.03	0.84±0.01	1.033
$p_T^{4\ell} > 25.00$ & Metsig > 0.00	7.54±0.00	345.05±0.00	70.89±0.00	0.07±0.00	0.53±0.00	0.25±0.00	1.29±0.00	0.818
$p_T^{4\ell} > 25.00$ & Metsig > 0.50	7.29±0.02	300.51±1.44	62.89±0.18	0.06±0.00	0.51±0.03	0.23±0.03	1.21±0.01	0.846
$p_T^{4\ell} > 25.00$ & Metsig > 1.00	6.37±0.03	202.95±4.09	44.15±0.31	0.05±0.00	0.38±0.06	0.22±0.03	1.00±0.01	0.896
$p_T^{4\ell} > 25.00$ & Metsig > 1.50	4.64±0.05	98.43±4.36	22.49±0.37	0.03±0.00	0.28±0.08	0.13±0.03	0.66±0.02	0.932
$p_T^{4\ell} > 5.00$ & Metsig > 0.00	12.94±0.00	1333.50±0.00	182.83±0.00	0.09±0.00	1.45±0.00	0.36±0.00	2.14±0.00	0.737
$p_T^{4\ell} > 5.00$ & Metsig > 0.50	12.42±0.01	1058.18±0.68	154.94±0.07	0.08±0.00	1.34±0.01	0.31±0.00	2.00±0.00	0.791
$p_T^{4\ell} > 5.00$ & Metsig > 1.00	10.61±0.01	568.66±0.88	95.02±0.09	0.07±0.00	1.01±0.02	0.27±0.00	1.62±0.00	0.912
$p_T^{4\ell} > 5.00$ & Metsig > 1.50	7.64±0.01	247.18±0.93	44.36±0.10	0.05±0.00	0.69±0.02	0.16±0.00	1.05±0.00	0.990

Additional slides

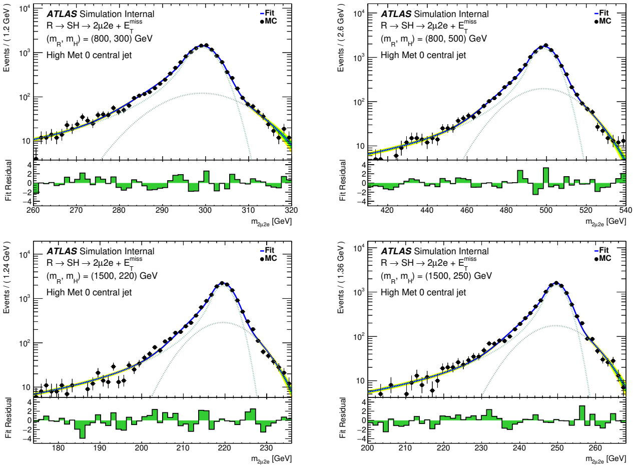
High Met 1 central jet

	$(m_R, m_H) = (390, 220)$	$qqZZ^*$	$ggZZ^*$	$t\bar{t}Z$	$Z + jets$	$t\bar{t}$	VVV	$s/\sqrt{b}$
4ℓ	64.51±0.24	2510.45±5.75	349.64±0.71	8.94±0.05	3.87±0.84	3.55±0.23	19.08±0.11	2.661
B-veto	60.07±0.23	2394.48±5.70	334.96±0.69	1.72±0.02	3.63±0.84	2.27±0.16	17.79±0.11	2.540
$N_{jet}^{central} \geq 1$	32.05±0.17	787.13±2.63	123.31±0.42	1.30±0.02	1.53±0.83	1.27±0.13	8.49±0.08	2.341
$p_T^{4\ell} > 0.00$ GeV & Metsig > 0.00	32.05±0.17	787.13±2.63	123.31±0.42	1.30±0.02	1.53±0.83	1.27±0.13	8.49±0.08	2.341
$p_T^{4\ell} > 0.00$ GeV & Metsig > 0.50	31.46±0.17	657.01±2.45	106.88±0.39	1.28±0.02	1.49±0.83	1.27±0.13	8.32±0.08	2.506
$p_T^{4\ell} > 0.00$ GeV & Metsig > 1.00	29.70±0.16	409.28±1.53	72.34±0.32	1.23±0.02	1.43±0.83	1.21±0.12	7.89±0.08	2.968
$p_T^{4\ell} > 0.00$ GeV & Metsig > 1.50	26.92±0.16	217.56±1.12	41.32±0.25	1.15±0.02	1.29±0.82	1.15±0.12	7.29±0.08	3.638
$p_T^{4\ell} > 0.00$ GeV & Metsig > 2.00	23.40±0.15	104.71±0.82	21.23±0.18	1.04±0.02	0.25±0.05	1.04±0.12	6.55±0.07	4.473
$p_T^{4\ell} > 0.00$ GeV & Metsig > 2.50	19.58±0.13	48.63±0.61	10.13±0.12	0.93±0.02	0.18±0.04	0.95±0.11	5.79±0.07	5.324
$p_T^{4\ell} > 0.00$ GeV & Metsig > 3.00	15.63±0.12	22.57±0.33	4.78±0.08	0.81±0.01	0.09±0.03	0.86±0.11	5.06±0.06	5.932
$p_T^{4\ell} > 0.00$ GeV & Metsig > 3.50	11.99±0.10	10.40±0.23	2.21±0.06	0.69±0.01	0.05±0.03	0.67±0.09	4.40±0.06	6.198
$p_T^{4\ell} > 0.00$ GeV & Metsig > 4.00	8.99±0.09	4.83±0.15	0.98±0.04	0.58±0.01	0.03±0.02	0.55±0.08	3.78±0.05	6.079
$p_T^{4\ell} > 0.00$ GeV & Metsig > 4.50	6.61±0.08	2.36±0.10	0.45±0.03	0.49±0.01	0.01±0.02	0.43±0.07	3.25±0.05	5.553
$p_T^{4\ell} > 0.00$ GeV & Metsig > 5.00	4.74±0.07	1.14±0.07	0.18±0.02	0.40±0.01	-0.01±0.01	0.39±0.07	2.77±0.05	4.769
$p_T^{4\ell} > 10.00$ GeV & Metsig > 0.00	31.54±0.17	768.05±2.61	121.50±0.42	1.29±0.02	1.51±0.83	1.26±0.13	8.42±0.08	2.331
$p_T^{4\ell} > 10.00$ GeV & Metsig > 0.50	30.95±0.17	639.68±2.43	105.22±0.39	1.27±0.02	1.48±0.83	1.26±0.13	8.26±0.08	2.496
$p_T^{4\ell} > 10.00$ GeV & Metsig > 1.00	29.20±0.16	395.34±1.51	71.01±0.32	1.22±0.02	1.42±0.83	1.20±0.12	7.83±0.08	2.965
$p_T^{4\ell} > 10.00$ GeV & Metsig > 1.50	26.44±0.16	207.68±1.10	40.38±0.24	1.14±0.02	1.29±0.82	1.14±0.12	7.24±0.07	3.647
$p_T^{4\ell} > 10.00$ GeV & Metsig > 2.00	22.97±0.14	99.05±0.80	20.70±0.17	1.04±0.02	0.25±0.05	1.03±0.12	6.50±0.07	4.496
$p_T^{4\ell} > 10.00$ GeV & Metsig > 2.50	19.23±0.13	46.06±0.60	9.89±0.12	0.92±0.02	0.18±0.04	0.94±0.11	5.75±0.07	5.345
$p_T^{4\ell} > 10.00$ GeV & Metsig > 3.00	15.35±0.12	21.45±0.32	4.67±0.08	0.81±0.01	0.09±0.03	0.86±0.11	5.03±0.06	5.940
$p_T^{4\ell} > 10.00$ GeV & Metsig > 3.50	11.80±0.10	9.81±0.22	2.15±0.06	0.69±0.01	0.05±0.03	0.66±0.09	4.37±0.06	6.221
$p_T^{4\ell} > 10.00$ GeV & Metsig > 4.00	8.88±0.09	4.54±0.15	0.95±0.04	0.58±0.01	0.03±0.02	0.54±0.08	3.76±0.05	6.107
$p_T^{4\ell} > 10.00$ GeV & Metsig > 4.50	6.56±0.08	2.24±0.10	0.44±0.03	0.48±0.01	0.01±0.02	0.43±0.07	3.24±0.05	5.563
$p_T^{4\ell} > 10.00$ GeV & Metsig > 5.00	4.72±0.06	1.06±0.06	0.18±0.02	0.40±0.01	-0.01±0.01	0.39±0.07	2.76±0.05	4.789
$p_T^{4\ell} > 20.00$ GeV & Metsig > 0.00	30.03±0.17	727.67±2.20	115.32±0.41	1.27±0.02	1.49±0.83	1.24±0.13	8.24±0.08	2.279
$p_T^{4\ell} > 20.00$ GeV & Metsig > 0.50	29.45±0.16	602.83±1.99	99.52±0.38	1.25±0.02	1.45±0.83	1.24±0.13	8.08±0.08	2.446
$p_T^{4\ell} > 20.00$ GeV & Metsig > 1.00	27.75±0.16	368.32±1.43	66.64±0.31	1.20±0.02	1.39±0.83	1.18±0.12	7.67±0.08	2.915
$p_T^{4\ell} > 20.00$ GeV & Metsig > 1.50	25.08±0.15	190.63±1.02	37.62±0.23	1.12±0.02	1.27±0.82	1.12±0.12	7.09±0.07	3.601
$p_T^{4\ell} > 20.00$ GeV & Metsig > 2.00	21.75±0.14	89.86±0.76	19.19±0.17	1.02±0.02	0.23±0.05	1.02±0.12	6.39±0.07	4.449
$p_T^{4\ell} > 20.00$ GeV & Metsig > 2.50	18.20±0.13	41.70±0.58	9.15±0.12	0.91±0.02	0.15±0.04	0.93±0.11	5.65±0.07	5.282
$p_T^{4\ell} > 20.00$ GeV & Metsig > 3.00	14.59±0.11	19.25±0.30	4.33±0.08	0.79±0.01	0.08±0.03	0.85±0.11	4.95±0.06	5.885
$p_T^{4\ell} > 20.00$ GeV & Metsig > 3.50	11.28±0.10	8.85±0.21	1.99±0.05	0.67±0.01	0.05±0.03	0.66±0.09	4.32±0.06	6.154
$p_T^{4\ell} > 20.00$ GeV & Metsig > 4.00	8.56±0.09	4.09±0.14	0.88±0.04	0.57±0.01	0.03±0.02	0.54±0.08	3.72±0.05	6.062
$p_T^{4\ell} > 20.00$ GeV & Metsig > 4.50	6.40±0.08	2.02±0.09	0.41±0.02	0.47±0.01	0.01±0.02	0.43±0.07	3.21±0.05	5.549
$p_T^{4\ell} > 20.00$ GeV & Metsig > 5.00	4.64±0.06	0.95±0.06	0.16±0.01	0.39±0.01	-0.01±0.01	0.39±0.07	2.74±0.05	4.788
$p_T^{4\ell} > 30.00$ GeV & Metsig > 0.00	27.84±0.16	669.92±2.06	104.23±0.39	1.23±0.02	1.44±0.83	1.18±0.12	7.97±0.08	2.204
$p_T^{4\ell} > 30.00$ GeV & Metsig > 0.50	27.29±0.16	552.48±1.85	89.67±0.36	1.21±0.02	1.41±0.83	1.18±0.12	7.82±0.08	2.369
$p_T^{4\ell} > 30.00$ GeV & Metsig > 1.00	25.66±0.15	335.10±1.31	59.69±0.29	1.16±0.02	1.36±0.83	1.12±0.12	7.42±0.07	2.827
$p_T^{4\ell} > 30.00$ GeV & Metsig > 1.50	23.14±0.15	172.38±0.93	33.51±0.22	1.08±0.02	1.24±0.82	1.06±0.12	6.87±0.07	3.493
$p_T^{4\ell} > 30.00$ GeV & Metsig > 2.00	20.02±0.13	80.88±0.69	17.03±0.16	0.99±0.02	0.21±0.05	0.97±0.11	6.20±0.07	4.310
$p_T^{4\ell} > 30.00$ GeV & Metsig > 2.50	16.73±0.12	37.05±0.54	8.04±0.11	0.88±0.02	0.14±0.04	0.89±0.11	5.50±0.07	5.126
$p_T^{4\ell} > 30.00$ GeV & Metsig > 3.00	13.43±0.11	16.77±0.26	3.79±0.07	0.77±0.01	0.07±0.03	0.81±0.10	4.82±0.06	5.736
$p_T^{4\ell} > 30.00$ GeV & Metsig > 3.50	10.47±0.10	7.70±0.18	1.74±0.05	0.66±0.01	0.04±0.02	0.61±0.09	4.22±0.06	6.010
$p_T^{4\ell} > 30.00$ GeV & Metsig > 4.00	8.08±0.09	3.56±0.12	0.77±0.03	0.56±0.01	0.02±0.02	0.53±0.08	3.65±0.05	5.951
$p_T^{4\ell} > 30.00$ GeV & Metsig > 4.50	6.13±0.07	1.77±0.08	0.36±0.02	0.46±0.01	-0.00±0.01	0.42±0.07	3.16±0.05	5.476
$p_T^{4\ell} > 30.00$ GeV & Metsig > 5.00	4.52±0.06	0.79±0.05	0.14±0.01	0.38±0.01	-0.01±0.01	0.39±0.07	2.70±0.05	4.784
$p_T^{4\ell} > 40.00$ GeV & Metsig > 0.00	25.03±0.15	591.10±1.71	90.10±0.36	1.17±0.02	1.34±0.82	1.16±0.12	7.60±0.07	2.111
$p_T^{4\ell} > 40.00$ GeV & Metsig > 0.50	24.54±0.15	488.41±1.53	77.71±0.33	1.15±0.02	1.32±0.82	1.16±0.12	7.46±0.07	2.267
$p_T^{4\ell} > 40.00$ GeV & Metsig > 1.00	23.06±0.14	296.51±1.17	51.80±0.27	1.11±0.02	1.28±0.82	1.10±0.12	7.08±0.07	2.702
$p_T^{4\ell} > 40.00$ GeV & Metsig > 1.50	20.77±0.14	151.47±0.84	29.01±0.21	1.03±0.02	1.17±0.82	1.05±0.12	6.56±0.07	3.342
$p_T^{4\ell} > 40.00$ GeV & Metsig > 2.00	17.93±0.13	70.10±0.63	14.65±0.15	0.94±0.02	0.19±0.04	0.96±0.11	5.94±0.07	4.131
$p_T^{4\ell} > 40.00$ GeV & Metsig > 2.50	15.04±0.12	31.61±0.50	6.90±0.10	0.84±0.02	0.13±0.03	0.88±0.11	5.28±0.06	4.941
$p_T^{4\ell} > 40.00$ GeV & Metsig > 3.00	12.17±0.10	14.29±0.23	3.22±0.07	0.74±0.01	0.08±0.03	0.79±0.10	4.64±0.06	5.542
$p_T^{4\ell} > 40.00$ GeV & Metsig > 3.50	9.61±0.09	6.49±0.16	1.47±0.05	0.63±0.01	0.05±0.02	0.61±0.09	4.08±0.06	5.840
$p_T^{4\ell} > 40.00$ GeV & Metsig > 4.00	7.53±0.08	2.96±0.10	0.65±0.03	0.53±0.01	0.03±0.01	0.52±0.08	3.54±0.05	5.824
$p_T^{4\ell} > 40.00$ GeV & Metsig > 4.50	5.83±0.07	1.53±0.07	0.30±0.02	0.45±0.01	0.01±0.01	0.42±0.07	3.08±0.05	5.376
$p_T^{4\ell} > 40.00$ GeV & Metsig > 5.00	4.37±0.06	0.69±0.04	0.12±0.01	0.37±0.01	0.00±0.00	0.39±0.07	2.65±0.05	4.720
$p_T^{4\ell} > 50.00$ GeV & Metsig > 0.00	22.01±0.14	507.48±1.49	74.79±0.33	1.11±0.02	0.42±0.06	1.02±0.12	7.22±0.07	2.008
$p_T^{4\ell} > 50.00$ GeV & Metsig > 0.50	21.57±0.14	421.04±1.33	64.74±0.31	1.10±0.02	0.39±0.06	1.02±0.12	7.08±0.07	2.151
$p_T^{4\ell} > 50.00$ GeV & Metsig > 1.00	20.25±0.14	256.89±1.04	43.40±0.25	1.05±0.02	0.35±0.06	0.97±0.11	6.74±0.07	2.556
$p_T^{4\ell} > 50.00$ GeV & Metsig > 1.50	18.23±0.13	130.96±0.76	24.23±0.19	0.99±0.02	0.26±0.05	0.92±0.11	6.26±0.07	3.164
$p_T^{4\ell} > 50.00$ GeV & Metsig > 2.00	15.78±0.12	60.20±0.58	12.23±0.13	0.90±0.02	0.18±0.04	0.84±0.11	5.68±0.07	3.914
$p_T^{4\ell} > 50.00$ GeV & Metsig > 2.50	13.29±0.11	26.95±0.47	5.79±0.09	0.81±0.01	0.12±0.03	0.77±0.10	5.07±0.06	4.691
$p_T^{4\ell} > 50.00$ GeV & Metsig > 3.00	10.83±0.10	12.23±0.20	2.70±0.06	0.70±0.01	0.08±0.03	0.70±0.10	4.47±0.06	5.260
$p_T^{4\ell} > 50.00$ GeV & Metsig > 3.50	8.69±0.09	5.56±0.14	1.24±0.04	0.60±0.01	0.05±0.02	0.53±0.08	3.93±0.06	5.591
$p_T^{4\ell} > 50.00$ GeV & Metsig > 4.00	6.94±0.08	2.62±0.09	0.53±0.03	0.51±0.01	0.03±0.01	0.44±0.07	3.43±0.05	5.599
$p_T^{4\ell} > 50.00$ GeV & Metsig > 4.50	5.45±0.07	1.36±0.06	0.24±0.02	0.43±0.01	0.01±0.01	0.36±0.07	2.99±0.05	5.211
$p_T^{4\ell} > 50.00$ GeV & Metsig > 5.00	4.17±0.06	0.60±0.04	0.10±0.01	0.36±0.01	0.00±0.00	0.33±0.06	2.58±0.04	4.650
$p_T^{4\ell} > 60.00$ GeV & Metsig > 0.00	18.99±0.13	431.79±1.28	60.82±0.30	1.04±0.02	0.30±0.05	0.89±0.11	6.79±0.07	1.882
$p_T^{4\ell} > 60.00$ GeV & Metsig > 0.50	18.62±0.13	358.85±1.13	52.82±0.28	1.03±0.02	0.29±0.05	0.89±0.11	6.67±0.07	2.016
$p_T^{4\ell} > 60.00$ GeV & Metsig > 1.00	17.51±0.13	219.69±0.87	35.56±0.23	0.99±0.02	0.25±0.05	0.84±0.11	6.35±0.07	2.393
$p_T^{4\ell} > 60.00$ GeV & Metsig > 1.50	15.81±0.12	112.76±0.60	19.94±0.17	0.93±0.02	0.17±0.04	0.81±0.11	5.91±0.07	2.959
$p_T^{4\ell} > 60.00$ GeV & Metsig > 2.00	13.76±0.11	51.85±0.41	10.05±0.12	0.85±0.02	0.12±0.03	0.73±0.10	5.38±0.06	3.678
$p_T^{4\ell} > 60.00$ GeV & Metsig > 2.50	11.70±0.10	23.52±0.28	4.75±0.08	0.76±0.01	0.07±0.03	0.66±0.10	4.82±0.06	4.417
$p_T^{4\ell} > 60.00$ GeV & Metsig > 3.00	9.68±0.09	10.50±0.18	2.25±0.06	0.67±0.01	0.04±0.02	0.59±0.09	4.26±0.06	5.022
$p_T^{4\ell} > 60.00$ GeV & Metsig > 3.50	7.91±0.08	4.80±0.12	1.02±0.04	0.57±0.01	0.02±0.01	0.43±0.07	3.75±0.05	5.395
$p_T^{4\ell} > 60.00$ GeV & Metsig > 4.00	6.42±0.08	2.27±0.08	0.44±0.03	0.49±0.01	0.01±0.01	0.36±0.07	3.28±0.05	5.443
$p_T^{4\ell} > 60.00$ GeV & Metsig > 4.50	5.14±0.07	1.15±0.05	0.19±0.02	0.41±0.01	0.01±0.01	0.33±0.06	2.88±0.05	5.113
$p_T^{4\ell} > 60.00$ GeV & Metsig > 5.00	4.00±0.06	0.51±0.03	0.07±0.01	0.34±0.01	0.00±0.00	0.31±0.06	2.50±0.04	4.599

	$(m_R, m_H) = (390, 220)$	$qqZZ^*$	$ggZZ^*$	$t\bar{t}Z$	$Z+jets$	$t\bar{t}$	VVV	$s/\sqrt{b}$
4ℓ	64.51±0.24	2510.45±5.75	349.64±0.71	8.94±0.05	3.87±0.84	3.55±0.23	19.08±0.11	2.661
B-veto	60.07±0.23	2394.48±5.70	334.96±0.69	1.72±0.02	3.63±0.84	2.27±0.16	17.79±0.11	2.540
$N_{jet}^{central} \geq 1$	32.05±0.17	787.13±2.63	123.31±0.42	1.30±0.02	1.53±0.83	1.27±0.13	8.49±0.08	2.341
$p_T^{4\ell} > 0.00$ GeV & Metsig > 0.00	20.25±0.14	777.32±2.62	121.16±0.42	0.61±0.01	1.47±0.83	0.61±0.09	4.12±0.05	1.494
$p_T^{4\ell} > 0.00$ GeV & Metsig > 0.50	19.66±0.13	647.21±2.44	104.73±0.39	0.59±0.01	1.44±0.83	0.61±0.09	3.96±0.05	1.584
$p_T^{4\ell} > 0.00$ GeV & Metsig > 1.00	17.90±0.13	399.48±1.52	70.19±0.32	0.54±0.01	1.37±0.83	0.54±0.08	3.52±0.05	1.822
$p_T^{4\ell} > 0.00$ GeV & Metsig > 1.50	15.12±0.12	207.75±1.10	39.17±0.24	0.46±0.01	1.24±0.82	0.49±0.08	2.92±0.05	2.114
$p_T^{4\ell} > 0.00$ GeV & Metsig > 2.00	11.60±0.10	94.91±0.79	19.08±0.17	0.36±0.01	0.20±0.04	0.37±0.07	2.18±0.04	2.379
$p_T^{4\ell} > 0.00$ GeV & Metsig > 2.50	7.78±0.08	38.83±0.57	7.99±0.11	0.24±0.01	0.12±0.03	0.28±0.06	1.42±0.03	2.469
$p_T^{4\ell} > 0.00$ GeV & Metsig > 3.00	3.83±0.06	12.77±0.25	2.64±0.06	0.13±0.01	0.04±0.02	0.20±0.06	0.69±0.02	2.093
$p_T^{4\ell} > 5.00$ GeV & Metsig > 0.00	20.12±0.14	771.50±2.61	120.76±0.42	0.61±0.01	1.47±0.83	0.61±0.09	4.10±0.05	1.490
$p_T^{4\ell} > 5.00$ GeV & Metsig > 0.50	19.54±0.13	641.99±2.43	104.36±0.39	0.59±0.01	1.43±0.83	0.61±0.09	3.94±0.05	1.580
$p_T^{4\ell} > 5.00$ GeV & Metsig > 1.00	17.78±0.13	395.31±1.51	69.90±0.32	0.54±0.01	1.37±0.83	0.54±0.08	3.51±0.05	1.818
$p_T^{4\ell} > 5.00$ GeV & Metsig > 1.50	15.01±0.12	204.76±1.09	38.96±0.24	0.46±0.01	1.23±0.82	0.49±0.08	2.91±0.05	2.112
$p_T^{4\ell} > 5.00$ GeV & Metsig > 2.00	11.50±0.10	93.23±0.79	18.94±0.17	0.36±0.01	0.19±0.04	0.37±0.07	2.17±0.04	2.377
$p_T^{4\ell} > 5.00$ GeV & Metsig > 2.50	7.70±0.08	38.05±0.57	7.92±0.11	0.24±0.01	0.12±0.03	0.28±0.06	1.41±0.03	2.464
$p_T^{4\ell} > 5.00$ GeV & Metsig > 3.00	3.76±0.06	12.47±0.25	2.60±0.06	0.12±0.01	0.04±0.02	0.20±0.06	0.68±0.02	2.081
$p_T^{4\ell} > 10.00$ GeV & Metsig > 0.00	19.74±0.13	758.25±2.60	119.35±0.41	0.60±0.01	1.46±0.83	0.60±0.09	4.05±0.05	1.473
$p_T^{4\ell} > 10.00$ GeV & Metsig > 0.50	19.15±0.13	629.87±2.42	103.07±0.39	0.59±0.01	1.42±0.83	0.60±0.09	3.89±0.05	1.563
$p_T^{4\ell} > 10.00$ GeV & Metsig > 1.00	17.40±0.13	385.54±1.49	68.86±0.32	0.53±0.01	1.36±0.83	0.54±0.08	3.46±0.05	1.800
$p_T^{4\ell} > 10.00$ GeV & Metsig > 1.50	14.64±0.12	197.87±1.07	38.24±0.24	0.45±0.01	1.23±0.82	0.48±0.08	2.87±0.05	2.092
$p_T^{4\ell} > 10.00$ GeV & Metsig > 2.00	11.17±0.10	89.24±0.77	18.55±0.16	0.35±0.01	0.19±0.04	0.37±0.07	2.13±0.04	2.354
$p_T^{4\ell} > 10.00$ GeV & Metsig > 2.50	7.43±0.08	36.26±0.56	7.75±0.11	0.24±0.01	0.12±0.03	0.28±0.06	1.38±0.03	2.430
$p_T^{4\ell} > 10.00$ GeV & Metsig > 3.00	3.55±0.06	11.65±0.24	2.52±0.06	0.12±0.01	0.04±0.02	0.19±0.06	0.66±0.02	2.023
$p_T^{4\ell} > 15.00$ GeV & Metsig > 0.00	19.32±0.13	740.77±2.58	116.98±0.41	0.60±0.01	1.45±0.83	0.59±0.09	4.01±0.05	1.458
$p_T^{4\ell} > 15.00$ GeV & Metsig > 0.50	18.73±0.13	613.95±2.40	100.89±0.38	0.58±0.01	1.41±0.83	0.59±0.09	3.85±0.05	1.548
$p_T^{4\ell} > 15.00$ GeV & Metsig > 1.00	17.01±0.13	373.09±1.46	67.16±0.31	0.53±0.01	1.35±0.83	0.53±0.08	3.42±0.05	1.787
$p_T^{4\ell} > 15.00$ GeV & Metsig > 1.50	14.28±0.11	189.70±1.04	37.14±0.23	0.45±0.01	1.23±0.82	0.47±0.08	2.83±0.05	2.081
$p_T^{4\ell} > 15.00$ GeV & Metsig > 2.00	10.87±0.10	84.88±0.76	17.98±0.16	0.35±0.01	0.18±0.04	0.37±0.07	2.11±0.04	2.345
$p_T^{4\ell} > 15.00$ GeV & Metsig > 2.50	7.21±0.08	34.46±0.55	7.49±0.10	0.24±0.01	0.11±0.03	0.28±0.06	1.36±0.03	2.413
$p_T^{4\ell} > 15.00$ GeV & Metsig > 3.00	3.45±0.06	10.96±0.23	2.45±0.06	0.12±0.01	0.04±0.02	0.19±0.06	0.65±0.02	2.015
$p_T^{4\ell} > 20.00$ GeV & Metsig > 0.00	18.75±0.13	718.82±2.19	113.33±0.40	0.59±0.01	1.43±0.83	0.58±0.09	3.93±0.05	1.437
$p_T^{4\ell} > 20.00$ GeV & Metsig > 0.50	18.18±0.13	593.98±1.98	97.53±0.37	0.58±0.01	1.39±0.83	0.58±0.09	3.77±0.05	1.527
$p_T^{4\ell} > 20.00$ GeV & Metsig > 1.00	16.47±0.12	359.47±1.42	64.65±0.31	0.52±0.01	1.33±0.83	0.52±0.08	3.35±0.05	1.763
$p_T^{4\ell} > 20.00$ GeV & Metsig > 1.50	13.80±0.11	181.78±1.00	35.63±0.23	0.45±0.01	1.21±0.82	0.46±0.08	2.77±0.05	2.054
$p_T^{4\ell} > 20.00$ GeV & Metsig > 2.00	10.47±0.10	81.00±0.73	17.20±0.16	0.35±0.01	0.17±0.04	0.37±0.07	2.07±0.04	2.310
$p_T^{4\ell} > 20.00$ GeV & Metsig > 2.50	6.92±0.08	32.84±0.54	7.16±0.10	0.24±0.01	0.10±0.03	0.28±0.06	1.34±0.03	2.373
$p_T^{4\ell} > 20.00$ GeV & Metsig > 3.00	3.31±0.06	10.40±0.22	2.34±0.06	0.12±0.01	0.03±0.02	0.19±0.06	0.63±0.02	1.981
$p_T^{4\ell} > 25.00$ GeV & Metsig > 0.00	18.08±0.13	693.64±2.13	108.53±0.39	0.58±0.01	1.42±0.83	0.58±0.09	3.85±0.05	1.411
$p_T^{4\ell} > 25.00$ GeV & Metsig > 0.50	17.51±0.13	571.60±1.92	93.22±0.37	0.57±0.01	1.39±0.83	0.58±0.09	3.69±0.05	1.501
$p_T^{4\ell} > 25.00$ GeV & Metsig > 1.00	15.84±0.12	344.28±1.36	61.60±0.30	0.52±0.01	1.32±0.83	0.51±0.08	3.28±0.05	1.733
$p_T^{4\ell} > 25.00$ GeV & Metsig > 1.50	13.24±0.11	173.81±0.96	33.86±0.22	0.44±0.01	1.20±0.82	0.45±0.08	2.71±0.05	2.017
$p_T^{4\ell} > 25.00$ GeV & Metsig > 2.00	10.01±0.10	77.39±0.70	16.32±0.15	0.34±0.01	0.17±0.04	0.37±0.07	2.02±0.04	2.261
$p_T^{4\ell} > 25.00$ GeV & Metsig > 2.50	6.59±0.08	31.16±0.52	6.76±0.10	0.23±0.01	0.10±0.03	0.28±0.06	1.31±0.03	2.319
$p_T^{4\ell} > 25.00$ GeV & Metsig > 3.00	3.13±0.05	9.72±0.20	2.21±0.06	0.12±0.01	0.03±0.02	0.19±0.06	0.62±0.02	1.938
$p_T^{4\ell} > 30.00$ GeV & Metsig > 0.00	17.36±0.13	662.22±2.06	102.50±0.38	0.57±0.01	1.40±0.83	0.56±0.09	3.76±0.05	1.388
$p_T^{4\ell} > 30.00$ GeV & Metsig > 0.50	16.81±0.12	544.79±1.85	87.93±0.36	0.55±0.01	1.38±0.83	0.56±0.09	3.60±0.05	1.477
$p_T^{4\ell} > 30.00$ GeV & Metsig > 1.00	15.19±0.12	327.41±1.30	57.95±0.29	0.50±0.01	1.32±0.83	0.50±0.08	3.20±0.05	1.705
$p_T^{4\ell} > 30.00$ GeV & Metsig > 1.50	12.66±0.11	164.68±0.91	31.77±0.21	0.43±0.01	1.20±0.82	0.45±0.08	2.65±0.04	1.982
$p_T^{4\ell} > 30.00$ GeV & Metsig > 2.00	9.54±0.09	73.18±0.66	15.29±0.15	0.33±0.01	0.17±0.04	0.36±0.07	1.98±0.04	2.216
$p_T^{4\ell} > 30.00$ GeV & Metsig > 2.50	6.26±0.08	29.35±0.50	6.30±0.10	0.22±0.01	0.10±0.03	0.28±0.06	1.28±0.03	2.268
$p_T^{4\ell} > 30.00$ GeV & Metsig > 3.00	2.96±0.05	9.07±0.19	2.05±0.05	0.11±0.01	0.03±0.02	0.19±0.06	0.61±0.02	1.891

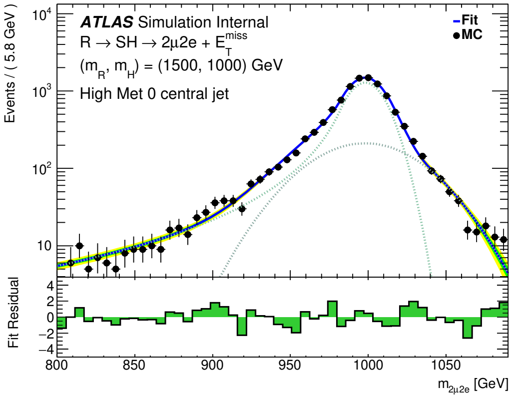
Signal parametrisation

High Met 0 central jet for $2\mu 2e$ channel



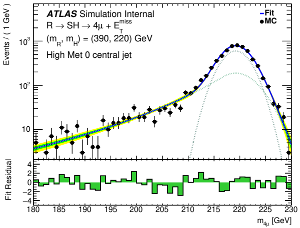
Signal parametrisation

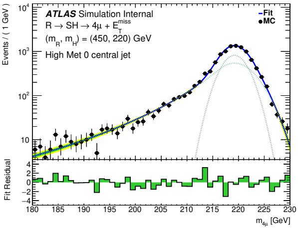
High Met 0 central jet for $2\mu 2e$ channel

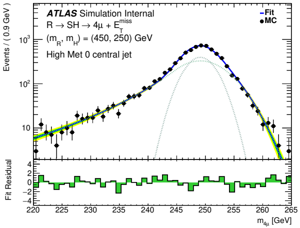


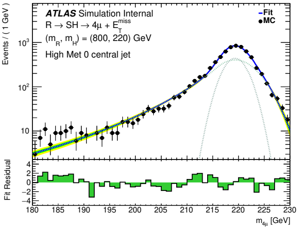
Signal parametrisation

High Met 0 central jet for 4μ channel



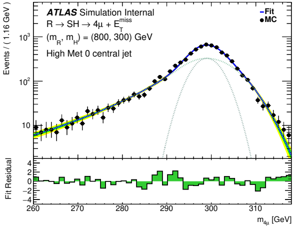


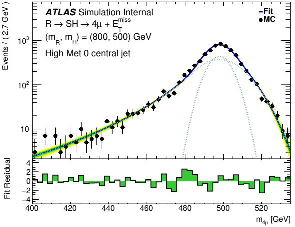


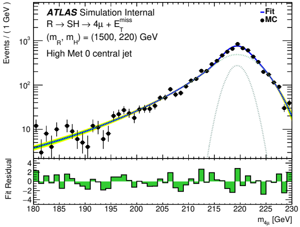


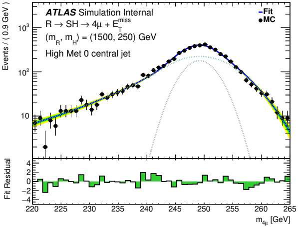
Signal parametrisation

High Met 0 central jet for 4μ channel



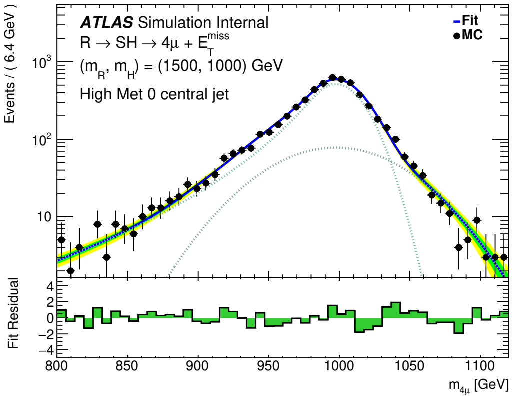




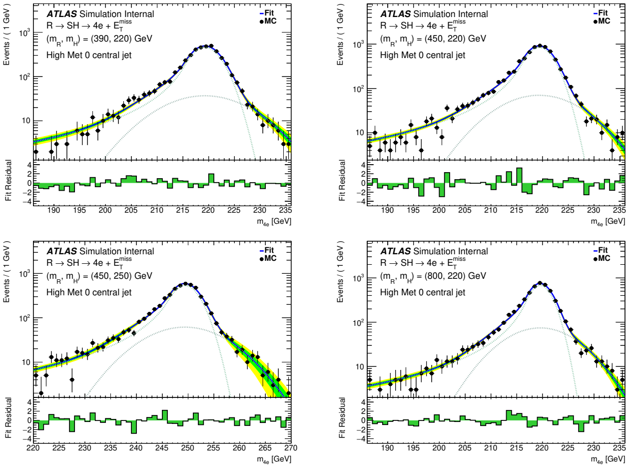


Signal parametrisation

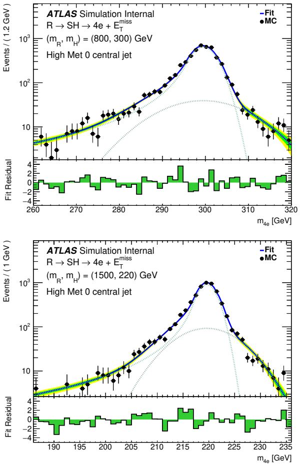
High Met 0 central jet for 4μ channel



Signal parametrisation
High Met 0 central jet for 4e channel

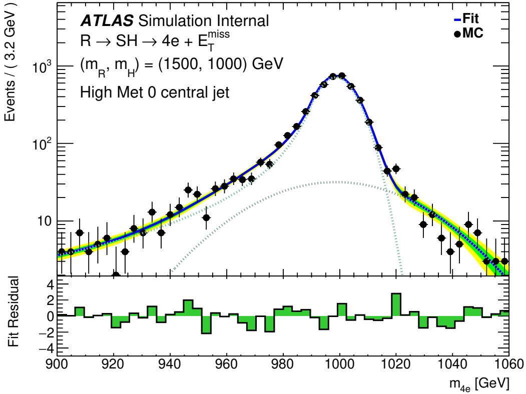


Signal parametrisation
High Met 0 central jet for 4e channel



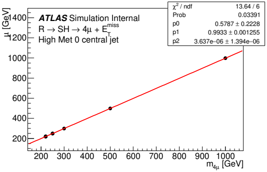
Signal parametrisation

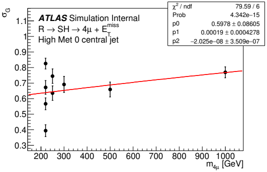
High Met 0 central jet for 4e channel

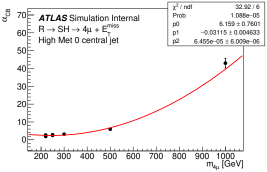


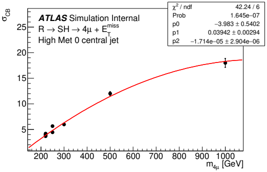
Interpolation of μ, f_C, σ_G, σ_C and α_C parameters

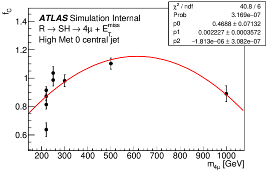
4μ-channel





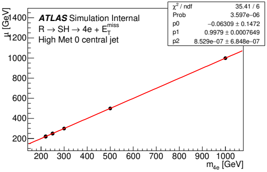


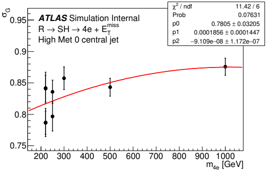


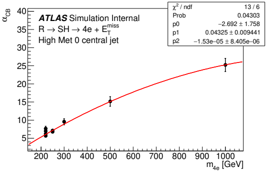


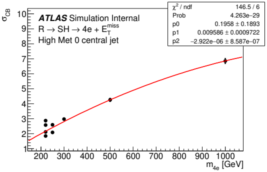
Interpolation of μ, f_C, σ_G, σ_C and α_C parameters

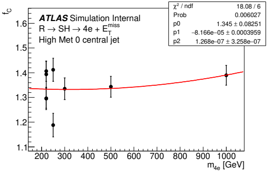
4e-channel





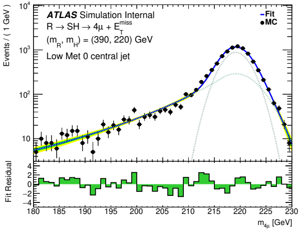


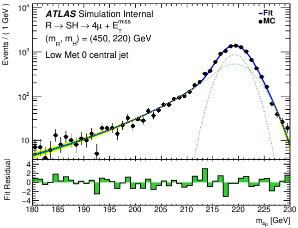


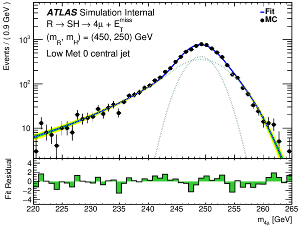


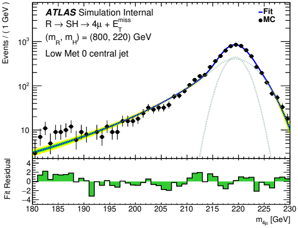
Signal parametrisation

Low Met 0 central jet for 4μ channel



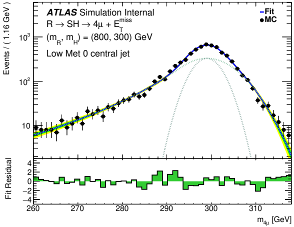


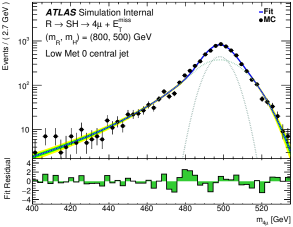


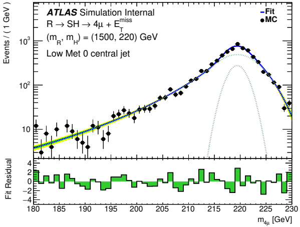


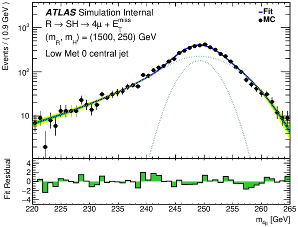
Signal parametrisation

Low Met 0 central jet for 4μ channel



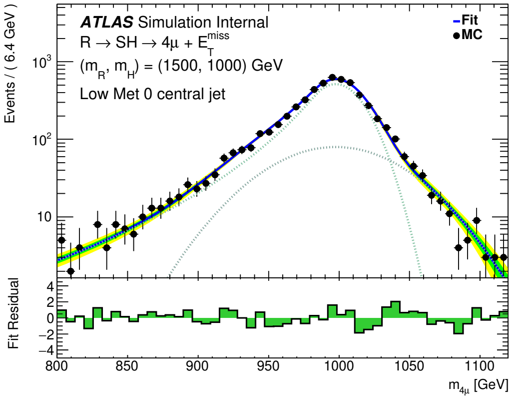




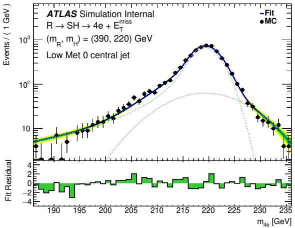


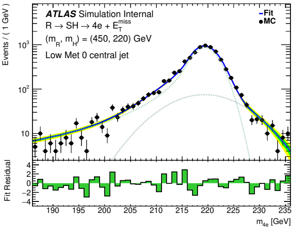
Signal parametrisation

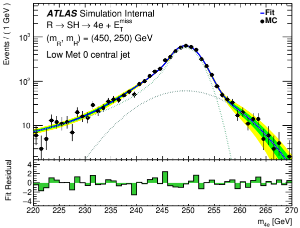
Low Met 0 central jet for 4μ channel

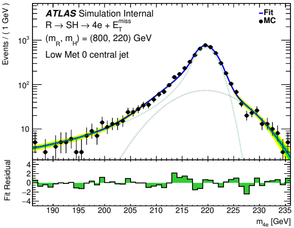


Signal parametrisation
Low Met 0 central jet for 4e channel



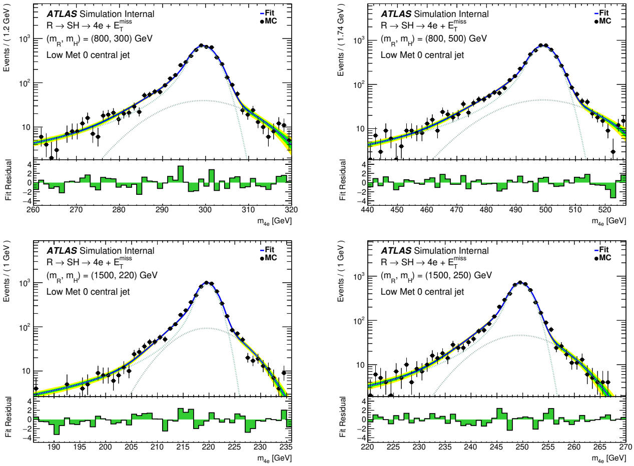






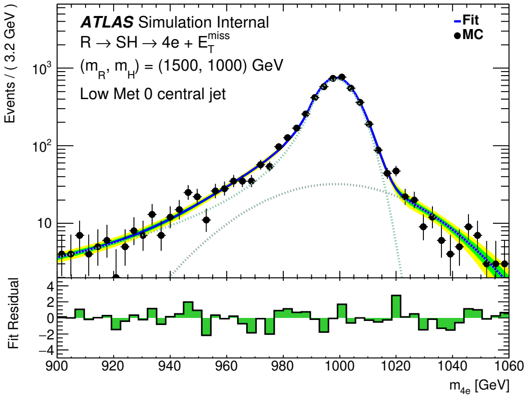
Signal parametrisation

Low Met 0 central jet for 4e channel



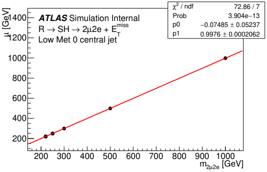
Signal parametrisation

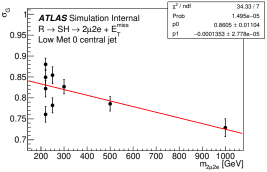
Low Met 0 central jet for 4*e* channel

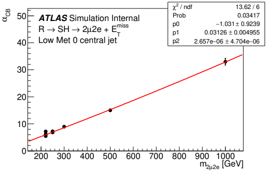


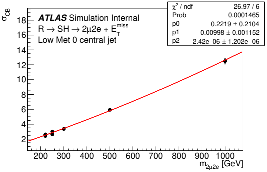
Interpolation of μ, f_C, σ_G, σ_C and α_C parameters

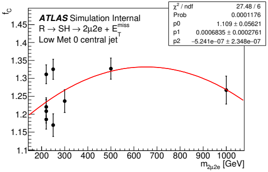
$2\mu 2e$-channel





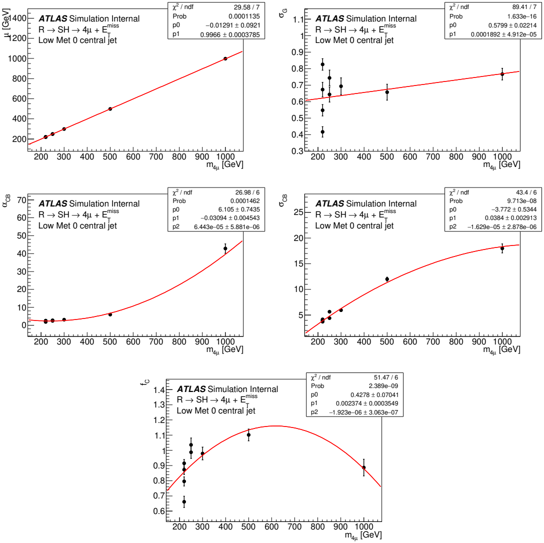




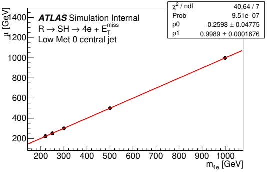


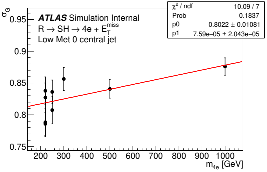
Interpolation of μ, f_C, σ_G, σ_C and α_C parameters

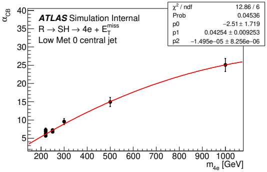
4μ-channel

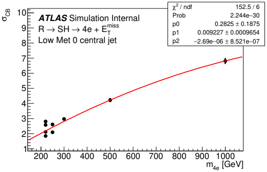


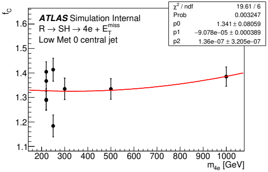
Interpolation of μ, f_C, σ_G, σ_C and α_C parameters
4e-channel



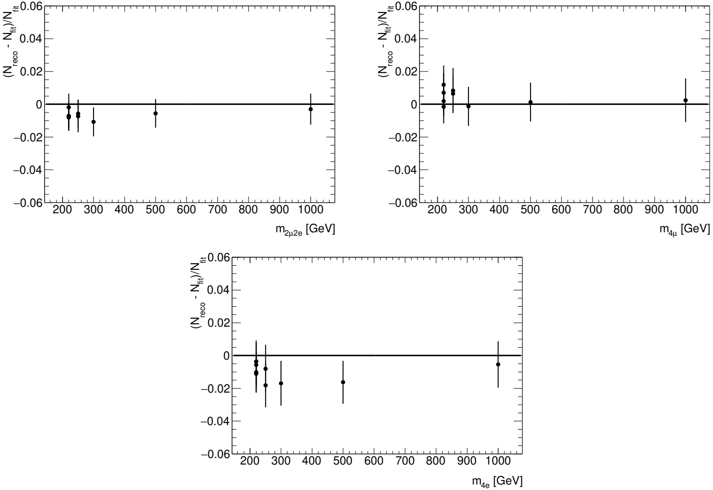






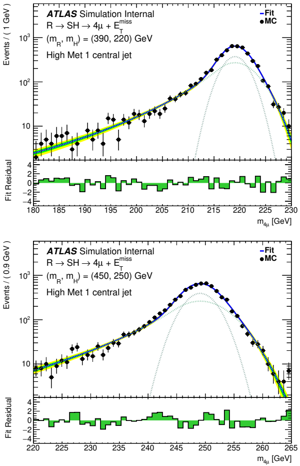


Study the bias induced by the signal extraction
Low Met 0 central jet for all the channels



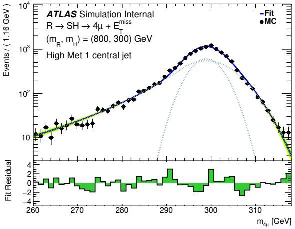
Signal parametrisation

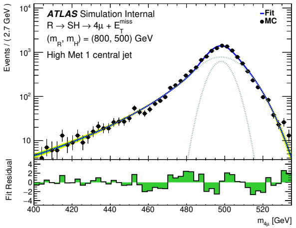
High Met 1 central jet for 4μ channel

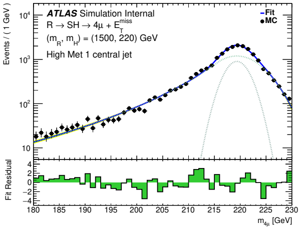


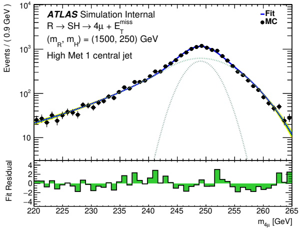
Signal parametrisation

High Met 1 central jet for 4μ channel



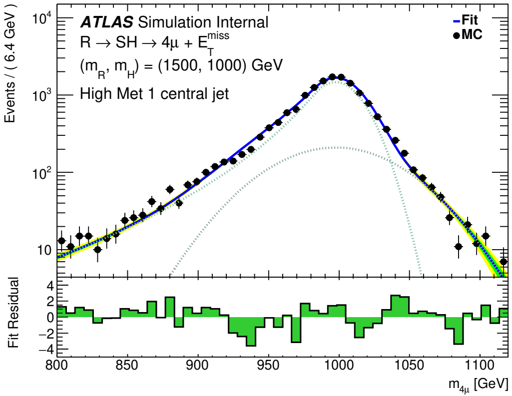






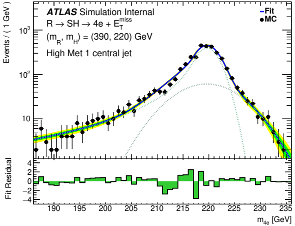
Signal parametrisation

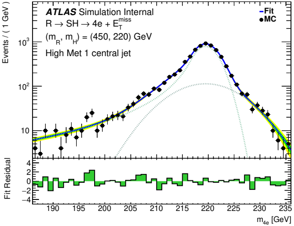
High Met 1 central jet for 4μ channel

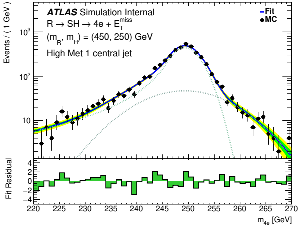


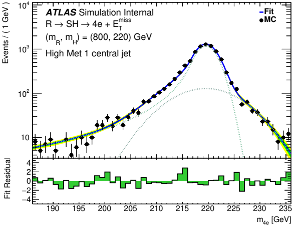
Signal parametrisation

High Met 1 central jet for 4e channel



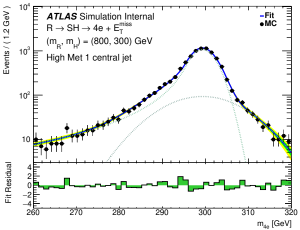


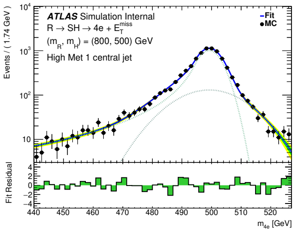


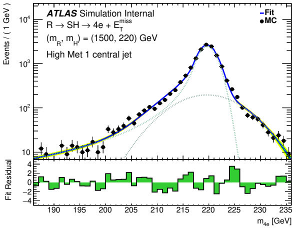


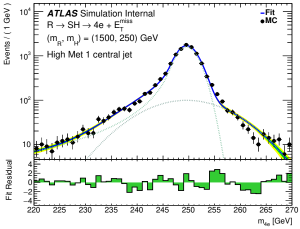
Signal parametrisation

High Met 1 central jet for 4e channel



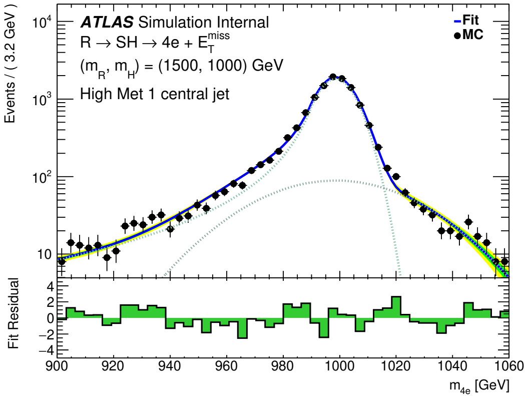






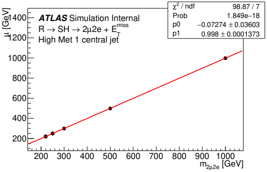
Signal parametrisation

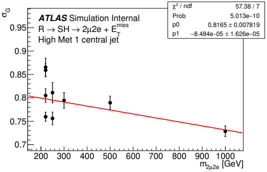
High Met 1 central jet for 4*e* channel

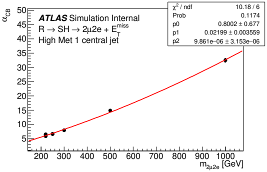


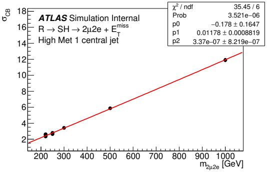
Interpolation of μ, f_C, σ_G, σ_C and α_C parameters

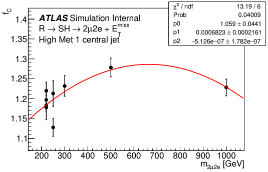
$2\mu 2e$-channel





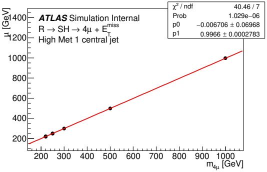


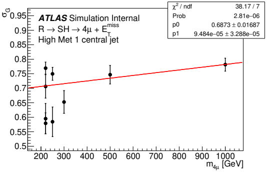


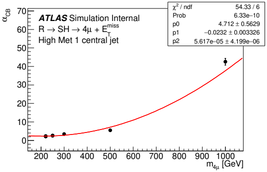


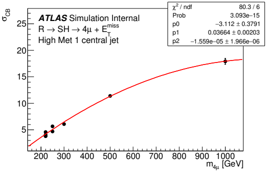
Interpolation of μ, f_C, σ_G, σ_C and α_C parameters

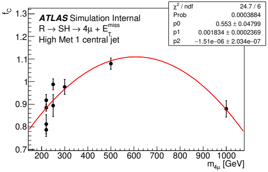
4μ-channel



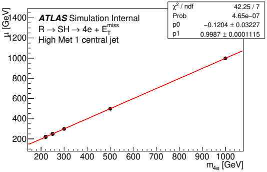


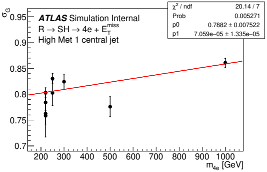


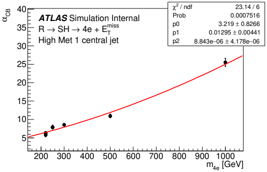


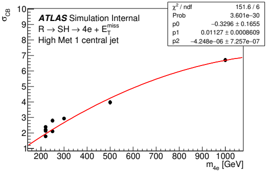


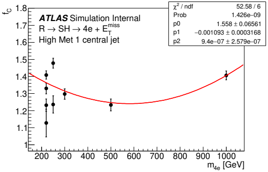
Interpolation of μ, f_C, σ_G, σ_C and α_C parameters
4e-channel











Study the bias induced by the signal extraction

High Met 1 central jet for all the channels