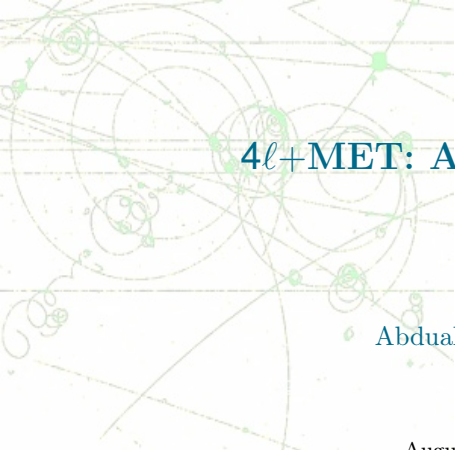


A complex visualization of particle tracks and interaction points, likely from a particle detector, showing various colored lines and dots representing different particles and their paths.

4ℓ +MET: Analysis update

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August 10, 2020



INSTITUTE FOR
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PARTICLE
PHYSICS

UNIVERSITY OF THE WITWATERSRAND



□ EMPFlow bug fix checks

- $qqZZ$ sample with 364252 DSID and p4191 (official sample)

□ The impact of the object-based E_T^{miss} significance

- Dropping $qqZZ$ (EW) background

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- Dropping $qqZZ$ (EW) background

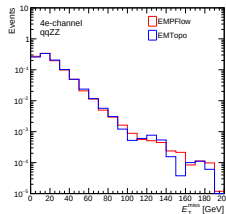
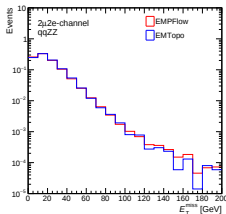
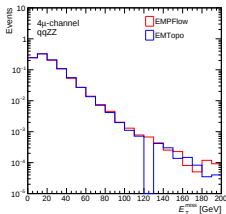
□ Signal parametrisation

- Improvement on the signal fit to the model
- Checking the effect of different categories on the initial values

EMPFlow bug fix checks

$qqZZ$ sample with 364252 DSID and p4191 (official sample)

3

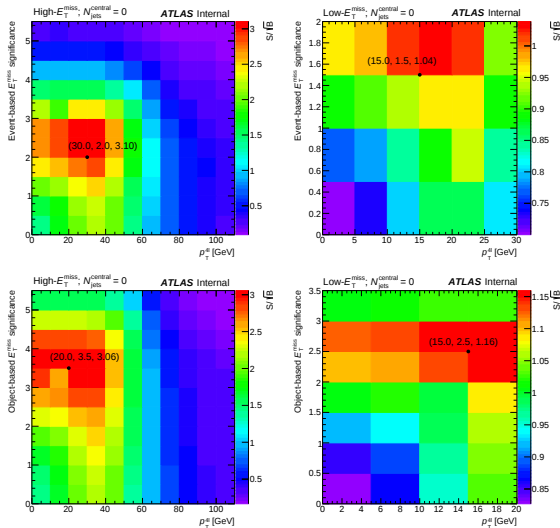


- ☐ E_T^{miss} distributions of $qqZZ$ sample for 4μ , $4e$ and $2\mu 2e$ channels.
- ☐ The read histogram is the EMPFlow with bug fix swithtered on;
- ☐ Comparing it with the EMTopo with 21.2.91 release (red).
- ☐ The EMPFlow looks much better than the one for the $ggZZ$.

Object-based E_T^{miss} significance

High- E_T^{miss} and $N_{\text{jets}}^{\text{central}} = 0$ category

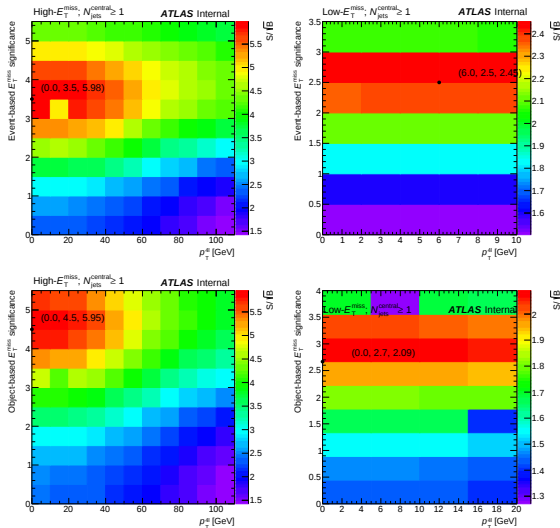
4



Object-based E_T^{miss} significance

High- E_T^{miss} and $N_{\text{jets}}^{\text{central}} \geq 1$ category

5

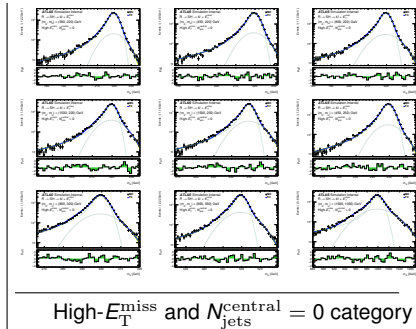


Signal parametrisation

High- E_T^{miss} and $N_{\text{jets}}^{\text{central}} = 0$ category

6

Mass point = (m_R, m_H) [GeV]	χ^2/ndof
390, 220	0.96
450, 220	1.54
800, 220	1.25
1500, 220	1.91
450, 250	1.40
1500, 250	1.72
800, 300	1.63
800, 500	1.54
1500, 1000	1.71



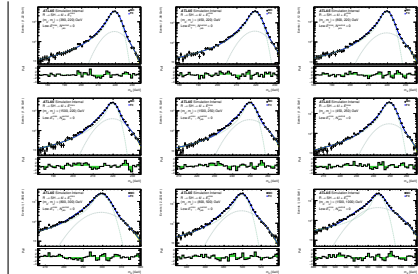
- More improvement could be done for some of the high χ^2 values.

Signal parametrisation

Low- E_T^{miss} and $N_{\text{jets}}^{\text{central}} = 0$ category

7

Mass point = (m_R, m_H) [GeV]	χ^2/ndof
390, 220	1.28
450, 220	1.57
800, 220	1.25
1500, 220	1.90
450, 250	1.42
1500, 250	1.72
800, 300	1.65
800, 500	1.59
1500, 1000	1.80



Low- E_T^{miss} and $N_{\text{jets}}^{\text{central}} = 0$ category

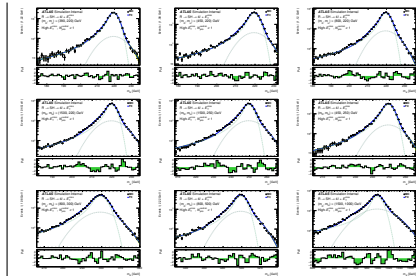
- With the same initial parameters we see small change on χ^2 values.

Signal parametrisation

High- E_T^{miss} and $N_{\text{jets}}^{\text{central}} \geq 1$ category

8

Mass point = (m_R, m_H) [GeV]	χ^2/ndof
390, 220	1.32
450, 220	1.99
800, 220	2.25
1500, 220	2.48
450, 250	1.43
1500, 250	3.51
800, 300	2.22
800, 500	2.91
1500, 1000	5.08



High- E_T^{miss} and $N_{\text{jets}}^{\text{central}} \geq 1$ category

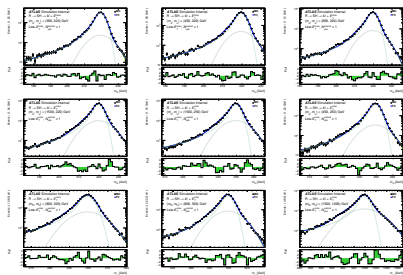
- There are the same parameters used for the first category, but it seems that they don't work for all the mass points.

Signal parametrisation

Low- E_T^{miss} and $N_{\text{jets}}^{\text{central}} \geq 1$ category

9

Mass point = (m_R, m_H) [GeV]	χ^2/ndof
390, 220	1.43
450, 220	1.98
800, 220	2.28
1500, 220	2.47
450, 250	1.92
1500, 250	3.49
800, 300	2.20
800, 500	3.02
1500, 1000	5.28



Low- E_T^{miss} and $N_{\text{jets}}^{\text{central}} \geq 1$ category

□ The same thing happens here as well.

- ☐ The EMPFlow bug fix works well with $qqZZ$ sample (the official).
- ☐ We might need to produce private samples such as $ggZZ$ and $t\bar{t}$.
- ☐ After removing the $qqZZ$ (EW) still the object-based E_T^{miss} significance is still no good.
- ☐ The signal fit looks good and more improvement could be done.
- ☐ The initial parameters do not work well for both categories.



Thank you!



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: $m_{\text{threshold}} < m_{34} < 115$ 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: $4\mu, 2e2\mu, 2\mu2e$ and $4e$
VERTEX SELECTION	- Require a common vertex for the leptons: - $\chi^2/\text{ndof} < 5$ for 4μ and < 9 for others decay channels