

A background image showing a complex network of green and yellow particle tracks, resembling a bubble chamber or detector readout, with various loops and straight paths.

Weekly report

Abdualazem Fadol

March 23, 2020



INSTITUTE FOR
COLLIDER
PARTICLE
PHYSICS

UNIVERSITY OF THE WITWATERSRAND



DiHiggs multilepton analysis

Single-Higgs contribution

2

$\int L dt = 80.5 \text{ fb}^{-1}$	Non-Res	ZH	ggH	WH	VBF	ttH	Total background
4ℓ	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Total charge = 0	94.0%	99.9%	99.0%	64.7%	98.8%	87.1%	88.2%
Trigger Match	93.0%	99.6%	94.5%	64.7%	96.1%	85.4%	83.4%
Iso FixedCutLoose	73.2%	79.3%	74.5%	64.7%	74.9%	58.9%	42.0%
$m_{\ell\ell-}(\text{SFOS}) > 4 \text{ GeV}$	67.9%	75.1%	59.2%	33.9%	60.9%	56.1%	35.1%
0/1-SFOS	34.4%	29.7%	0.5%	33.9%	0.6%	35.1%	2.5%
b-veto	31.3%	25.6%	0.5%	33.9%	0.5%	4.5%	1.3%
$m_{b\ell} > 10 \text{ GeV}$	30.7%	25.6%	0.5%	33.9%	0.5%	4.5%	1.3%
$ m_{b\ell} - m_Z < 25 \text{ GeV}$	13.9%	25.6%	0.1%	33.9%	0.1%	1.9%	0.9%
$ m_{b\ell} - m_Z > 25 \text{ GeV}$	16.9%	0.0%	0.4%	0.0%	0.4%	2.6%	0.4%
$E_T^{\text{miss}} > 20 \text{ GeV}$	16.1%	0.0%	0.2%	0.0%	0.3%	2.4%	0.3%
$m_{\ell\ell-}(\text{SFOS}) > 4 \text{ GeV}$	67.9%	75.1%	59.2%	33.9%	60.9%	56.1%	35.1%
2-SFOS	33.4%	45.4%	58.7%	0.0%	60.4%	21.0%	32.7%
b-veto	28.9%	42.3%	55.9%	0.0%	54.2%	3.2%	30.2%
$m_{b\ell} > 10 \text{ GeV}$	28.4%	42.3%	53.4%	0.0%	51.7%	3.1%	28.0%
$ m_{b\ell} - m_Z > 30 \text{ GeV}$	25.9%	24.5%	53.3%	0.0%	51.6%	2.7%	6.8%
$E_T^{\text{miss}} > 50 \text{ GeV}$	17.6%	14.3%	2.5%	0.0%	4.2%	2.1%	0.6%
Acceptance $\times$ efficiency							
Total N. events	1868.4780	289600.00	19445000.0	250400.00	1723900.0	2027000.0	-
0/1-SFOS							
$ m_{b\ell} - m_Z < 25$	0.002372	0.000017	0.000000001	0.00000015	0.00000008	0.00000176	-
$E_T^{\text{miss}} > 20$	0.003224	0	0.00000004	0	0.00000096	0.00000274	-
2-SFOS							
$E_T^{\text{miss}} > 50 \text{ GeV}$	0.003943	0.000005	0.000055	0	0.00017343	0.00000195	-

DiHiggs multilepton analysis

Single-Higgs contribution

3

$\int Ldt = 80.5 \text{ fb}^{-1}$	Non-Res	ZH	ggH	WH	VBF	ttH	Total background
4ℓ	0.34 ± 0.02	24.87 ± 3.04	53.38 ± 0.24	1.49 ± 0.86	8.18 ± 0.04	19.11 ± 0.28	5748.33 ± 46.13
Total charge = 0	0.32 ± 0.02	24.84 ± 3.04	52.84 ± 0.24	0.96 ± 0.68	8.08 ± 0.04	16.65 ± 0.26	5067.17 ± 41.58
Trigger Match	0.32 ± 0.02	24.76 ± 3.03	50.42 ± 0.23	0.96 ± 0.68	7.86 ± 0.04	16.33 ± 0.26	4792.24 ± 39.91
Iso FixedCutLoose	0.25 ± 0.02	19.73 ± 2.69	39.76 ± 0.21	0.96 ± 0.68	6.13 ± 0.03	11.25 ± 0.22	2412.45 ± 12.67
$m_{\ell^+\ell^-} \text{ (SFOS)} > 4 \text{ GeV}$	0.23 ± 0.02	18.68 ± 2.62	31.60 ± 0.18	0.50 ± 0.50	4.98 ± 0.03	10.72 ± 0.21	2019.22 ± 12.17
0/1-SFOS	0.12 ± 0.00	7.38 ± 1.63	0.27 ± 0.02	0.50 ± 0.50	0.05 ± 0.00	6.71 ± 0.17	142.04 ± 6.49
b-veto	0.11 ± 0.00	6.36 ± 1.51	0.25 ± 0.02	0.50 ± 0.50	0.04 ± 0.00	0.86 ± 0.06	73.80 ± 5.04
$m_{b_h} > 10 \text{ GeV}$	0.11 ± 0.00	6.36 ± 1.51	0.25 ± 0.02	0.50 ± 0.50	0.04 ± 0.00	0.86 ± 0.06	72.89 ± 5.02
$ m_{b_b} - m_Z < 25 \text{ GeV}$	0.05 ± 0.00	6.36 ± 1.51	0.03 ± 0.01	0.50 ± 0.50	0.01 ± 0.00	0.37 ± 0.04	51.81 ± 3.54
$ m_{b_b} - m_Z > 25 \text{ GeV}$	0.06 ± 0.00	0.00 ± 0.00	0.21 ± 0.02	0.00 ± 0.00	0.03 ± 0.00	0.49 ± 0.04	21.09 ± 3.42
$E_T^{\text{miss}} > 20 \text{ GeV}$	0.06 ± 0.00	0.00 ± 0.00	0.13 ± 0.01	0.00 ± 0.00	0.03 ± 0.00	0.47 ± 0.04	19.02 ± 3.31
2-SFOS	0.11 ± 0.01	11.30 ± 2.05	31.33 ± 0.18	0.00 ± 0.00	4.93 ± 0.03	4.01 ± 0.13	1877.18 ± 9.32
b-veto	0.10 ± 0.01	10.51 ± 1.98	29.85 ± 0.18	0.00 ± 0.00	4.43 ± 0.03	0.61 ± 0.05	1735.06 ± 7.97
$m_{b_h} > 10 \text{ GeV}$	0.10 ± 0.01	10.51 ± 1.98	28.50 ± 0.17	0.00 ± 0.00	4.22 ± 0.03	0.59 ± 0.05	1610.46 ± 7.74
$ m_{b_h} - m_Z > 30 \text{ GeV}$	0.09 ± 0.01	6.09 ± 1.45	28.47 ± 0.17	0.00 ± 0.00	4.22 ± 0.03	0.52 ± 0.04	389.72 ± 4.87
$E_T^{\text{miss}} > 50 \text{ GeV}$	0.06 ± 0.01	3.56 ± 1.14	1.32 ± 0.04	0.00 ± 0.00	0.34 ± 0.01	0.40 ± 0.04	35.40 ± 2.95

DiHiggs multilepton analysis

Single-Higgs contribution

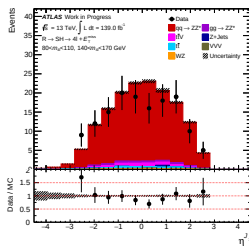
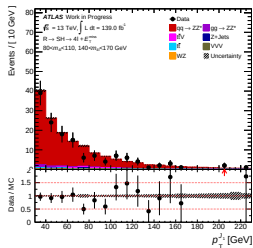
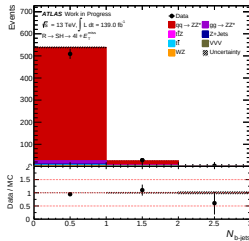
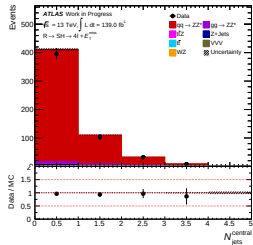
4

$\int L dt = 80.5 \text{ fb}^{-1}$	Non-Res	ZH	ggH	WH	VBF	ttH	Total background
4 ℓ	232.46 $\pm$ 10.97	71.57 $\pm$ 8.72	1586293.09 $\pm$ 7098.04	2.78 $\pm$ 1.61	169779.73 $\pm$ 836.11	9044.21 $\pm$ 132.02	8279386.59 $\pm$ 78191.36
Total charge = 0	218.47 $\pm$ 10.89	71.48 $\pm$ 8.72	1570320.81 $\pm$ 7062.00	1.92 $\pm$ 1.36	167782.34 $\pm$ 831.20	7873.74 $\pm$ 123.39	6669917.41 $\pm$ 69715.28
Trigger Match	216.14 $\pm$ 10.86	71.28 $\pm$ 8.72	1498348.70 $\pm$ 6898.05	1.92 $\pm$ 1.36	163159.43 $\pm$ 819.72	7724.85 $\pm$ 122.30	6195414.28 $\pm$ 67090.94
Iso FixedCutLoose	170.35 $\pm$ 10.61	57.21 $\pm$ 7.78	1181463.74 $\pm$ 6126.77	1.92 $\pm$ 1.36	127173.97 $\pm$ 723.68	5330.21 $\pm$ 101.85	715253.39 $\pm$ 14230.67
$m_{\ell\ell} - (\text{SFOS}) > 4 \text{ GeV}$	157.80 $\pm$ 10.55	54.04 $\pm$ 7.55	939104.73 $\pm$ 5461.17	1.01 $\pm$ 1.01	103395.75 $\pm$ 652.42	5081.65 $\pm$ 99.08	618092.46 $\pm$ 13810.34
0/1-SFOS	79.90 $\pm$ 3.15	21.91 $\pm$ 4.83	7960.46 $\pm$ 506.07	1.01 $\pm$ 1.01	948.16 $\pm$ 62.36	3184.85 $\pm$ 78.60	136729.05 $\pm$ 10254.92
b-veto	72.60 $\pm$ 2.89	18.93 $\pm$ 4.51	7482.94 $\pm$ 490.46	1.01 $\pm$ 1.01	855.64 $\pm$ 59.32	411.13 $\pm$ 27.82	84790.57 $\pm$ 7953.39
$m_{b\bar{b}} > 10 \text{ GeV}$	71.28 $\pm$ 2.86	18.93 $\pm$ 4.51	7303.24 $\pm$ 484.88	1.01 $\pm$ 1.01	827.65 $\pm$ 58.38	410.37 $\pm$ 27.77	82534.68 $\pm$ 7850.96
$ m_{b\bar{b}} - m_Z < 25 \text{ GeV}$	32.11 $\pm$ 1.95	18.93 $\pm$ 4.51	993.73 $\pm$ 182.24	1.01 $\pm$ 1.01	140.18 $\pm$ 24.71	178.04 $\pm$ 18.78	37366.89 $\pm$ 5113.53
$ m_{b\bar{b}} - m_Z > 25 \text{ GeV}$	39.17 $\pm$ 2.10	0.00 $\pm$ 0.00	6309.51 $\pm$ 449.32	0.00 $\pm$ 0.00	687.47 $\pm$ 52.89	232.33 $\pm$ 20.46	45167.79 $\pm$ 5937.85
$E_{\text{T}}^{\text{miss}} > 20 \text{ GeV}$	37.42 $\pm$ 2.05	0.00 $\pm$ 0.00	3835.30 $\pm$ 351.33	0.00 $\pm$ 0.00	549.65 $\pm$ 47.40	222.17 $\pm$ 20.15	43335.12 $\pm$ 5824.45
2-SFOS	77.91 $\pm$ 10.06	32.13 $\pm$ 5.81	931144.27 $\pm$ 5437.67	0.00 $\pm$ 0.00	102447.59 $\pm$ 649.44	1896.80 $\pm$ 60.32	481363.41 $\pm$ 8802.81
b-veto	67.43 $\pm$ 9.99	29.89 $\pm$ 5.59	887062.04 $\pm$ 5309.40	0.00 $\pm$ 0.00	92009.94 $\pm$ 615.84	283.14 $\pm$ 22.31	425587.95 $\pm$ 6800.28
$m_{b\bar{b}} > 10 \text{ GeV}$	66.23 $\pm$ 9.98	29.89 $\pm$ 5.59	846853.27 $\pm$ 5187.96	0.00 $\pm$ 0.00	87691.47 $\pm$ 601.21	274.15 $\pm$ 22.05	393495.73 $\pm$ 6488.95
$ m_{b\bar{b}} - m_Z > 30 \text{ GeV}$	60.34 $\pm$ 9.95	17.80 $\pm$ 4.23	846139.91 $\pm$ 5185.70	0.00 $\pm$ 0.00	87662.03 $\pm$ 601.11	242.27 $\pm$ 20.40	116070.34 $\pm$ 5556.21
$E_{\text{T}}^{\text{miss}} > 50 \text{ GeV}$	41.39 $\pm$ 9.83	10.35 $\pm$ 3.30	39279.38 $\pm$ 1117.88	0.00 $\pm$ 0.00	7118.38 $\pm$ 171.47	188.48 $\pm$ 18.29	27910.63 $\pm$ 4298.44

$R \rightarrow SH \rightarrow 4\ell + E_T^{\text{miss}}$

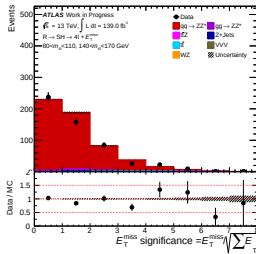
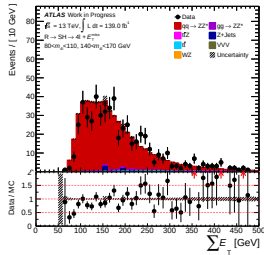
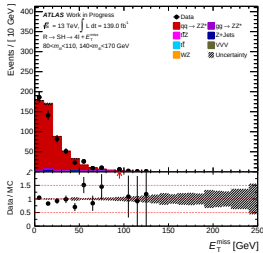
Fixing the control plots

5



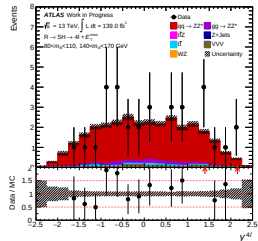
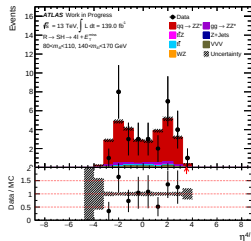
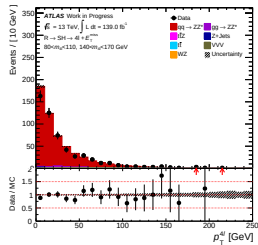
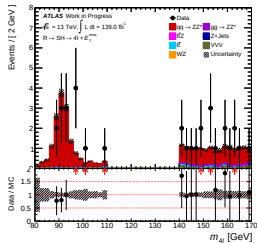
$R \rightarrow SH \rightarrow 4\ell + E_T^{\text{miss}}$

Fixing the control plots



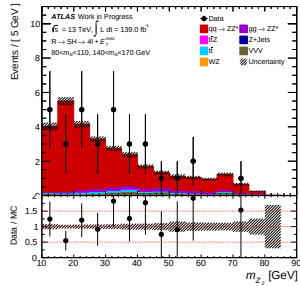
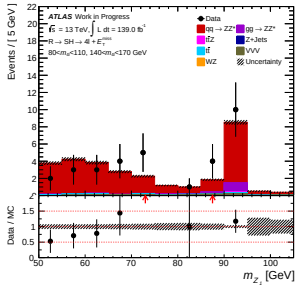
$R \rightarrow SH \rightarrow 4\ell + E_T^{\text{miss}}$

Fixing the control plots

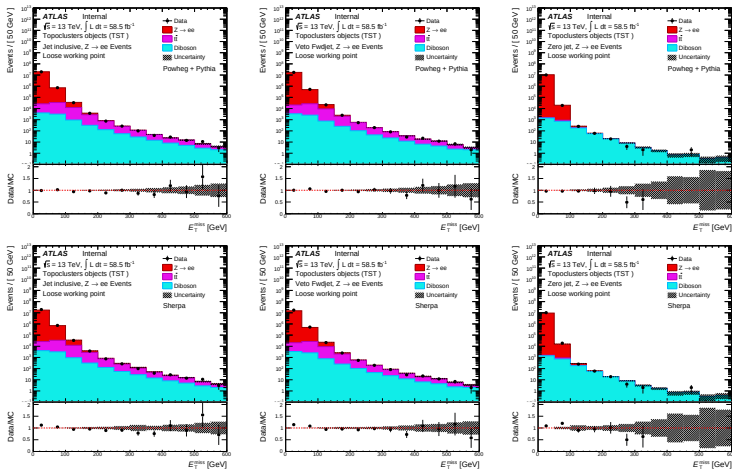


$R \rightarrow SH \rightarrow 4\ell + E_T^{\text{miss}}$

Fixing the control plots

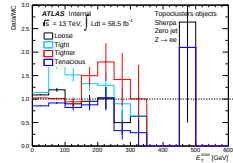
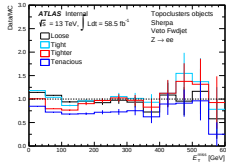
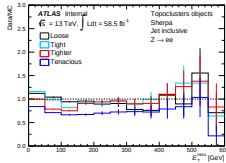
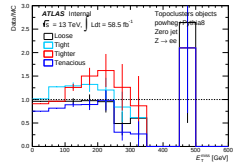
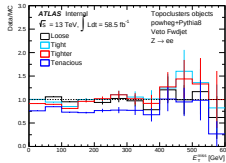
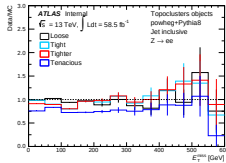


E_T^{miss} distribution $Z \rightarrow ee$ (Topoclusters, Loose)



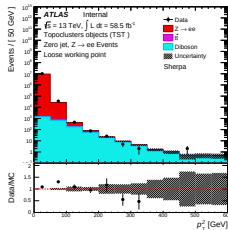
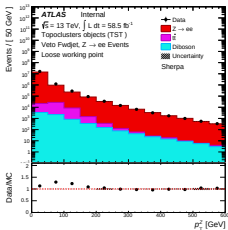
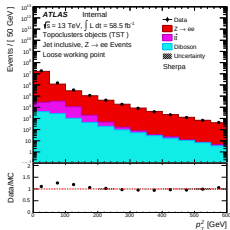
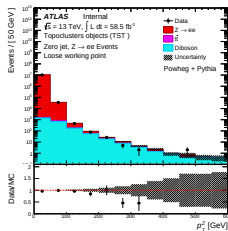
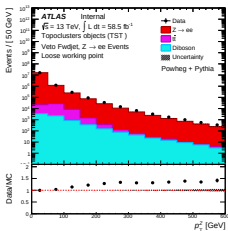
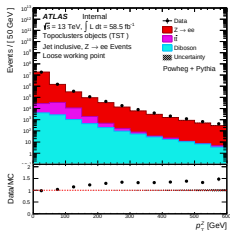
E_T^{miss} distribution

$Z \rightarrow ee$ (Topoclusters)



p_T^Z distribution

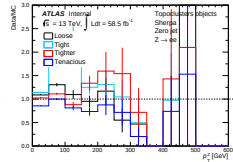
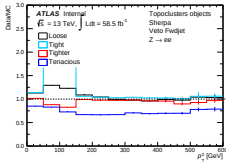
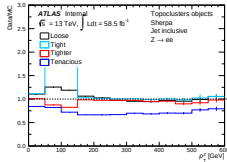
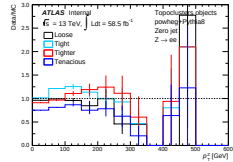
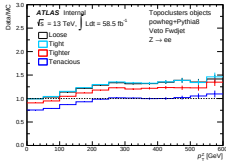
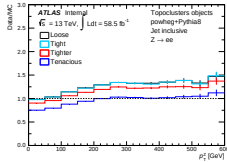
$Z \rightarrow ee$ (Topoclusters, Loose)



p_T^Z distribution

$Z \rightarrow ee$ (Topoclusters)

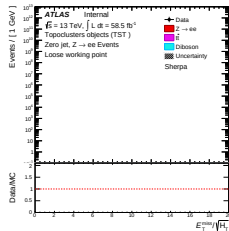
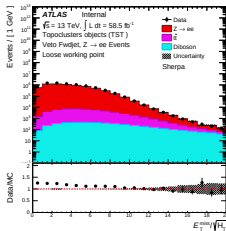
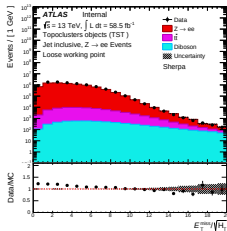
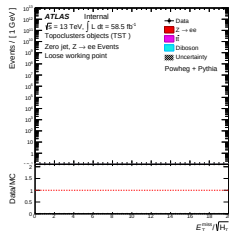
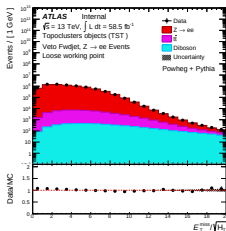
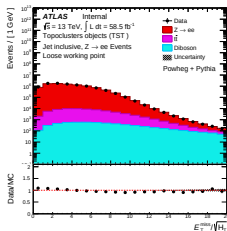
12



$E_T^{\text{miss}} / \sqrt{H_T}$ distribution

$Z \rightarrow ee$ (Topoclusters, Loose)

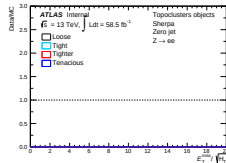
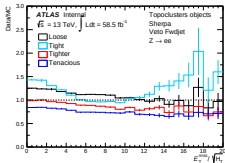
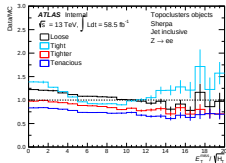
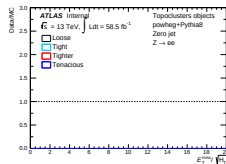
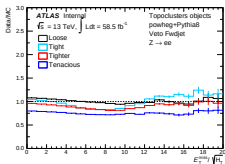
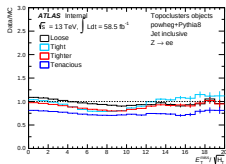
13



$E_T^{\text{miss}} / \sqrt{H_T}$ distribution

$Z \rightarrow ee$ (Topoclusters)

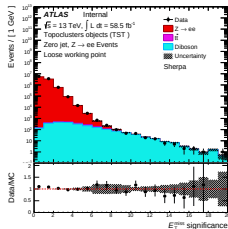
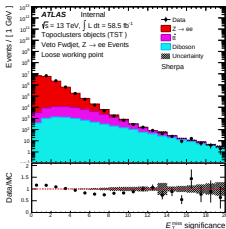
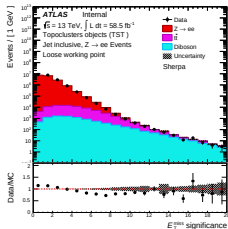
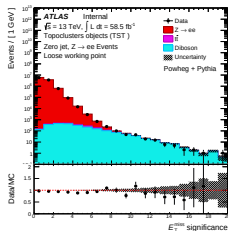
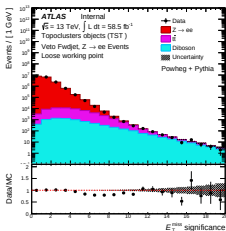
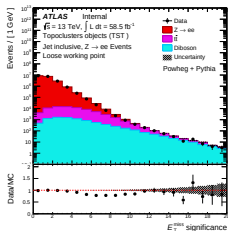
14



$E_T^{\text{miss}} / \sqrt{\sum E_T}$ distribution

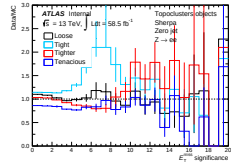
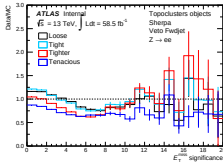
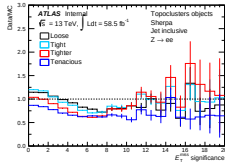
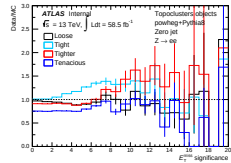
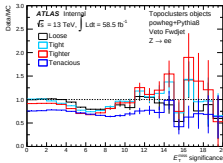
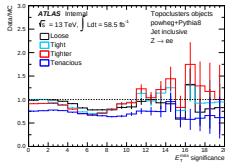
$Z \rightarrow ee$ (Topoclusters, Loose)

15



$E_T^{\text{miss}} / \sqrt{\sum E_T}$ distribution

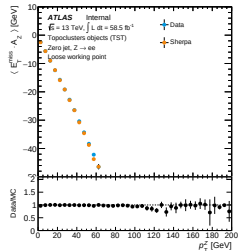
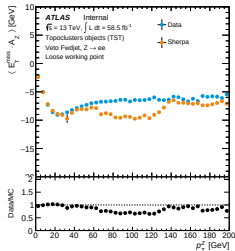
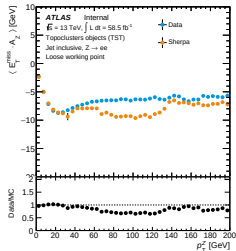
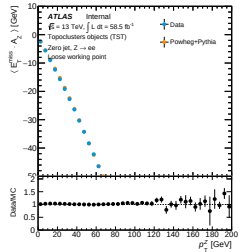
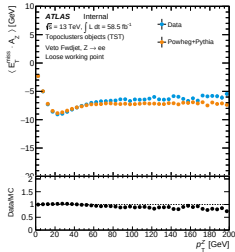
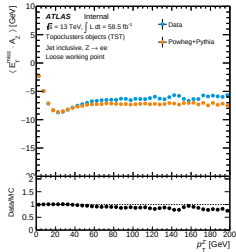
$Z \rightarrow ee$ (Topoclusters)



The E_T^{miss} scale

$Z \rightarrow ee$ (Topoclusters)

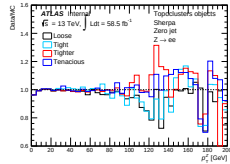
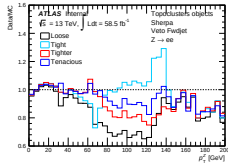
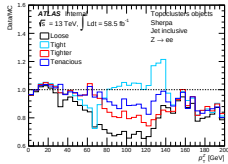
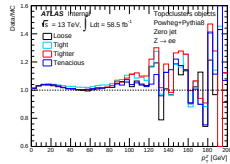
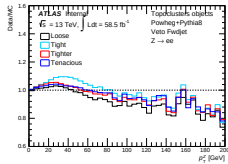
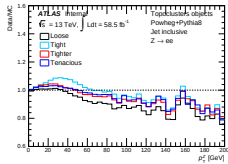
17



The E_T^{miss} scale

$Z \rightarrow ee$ (Topoclusters)

18





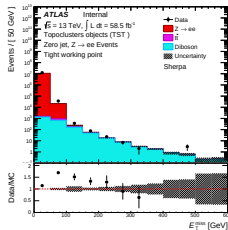
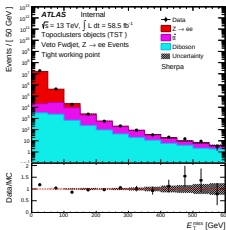
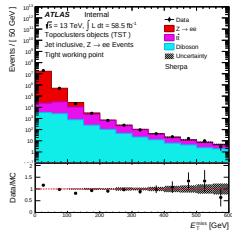
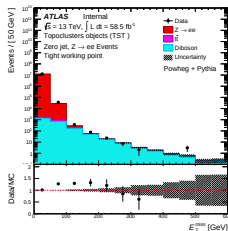
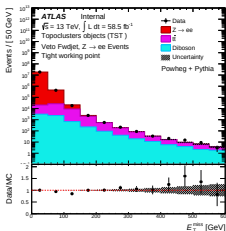
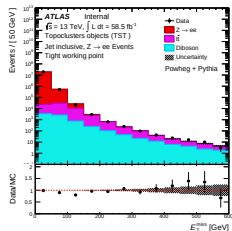
Thank you!



Additional slides

E_T^{miss} distribution, $Z \rightarrow ee$ (Topoclusters, Tight)

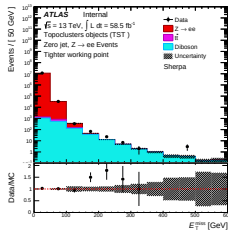
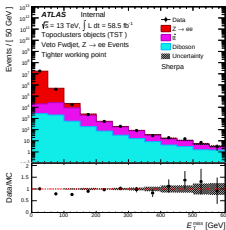
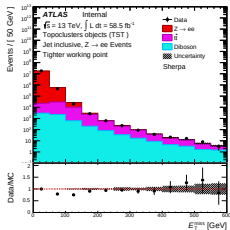
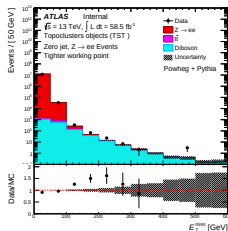
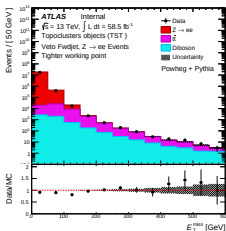
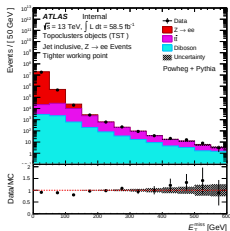
20



Additional slides

E_T^{miss} distribution, $Z \rightarrow ee$ (Topoclusters, Tighter)

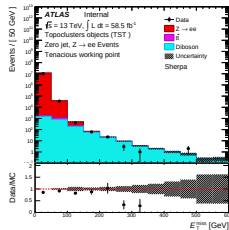
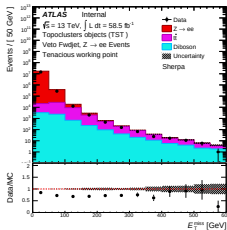
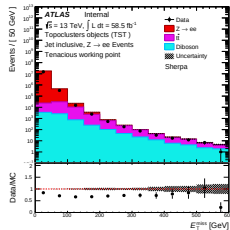
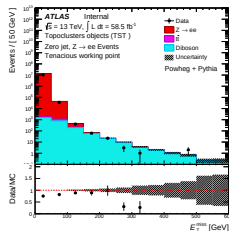
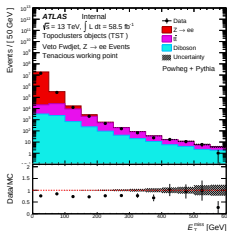
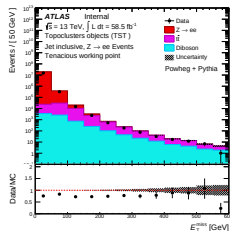
21



Additional slides

E_T^{miss} distribution, $Z \rightarrow ee$ (Topoclusters, Tenacious)

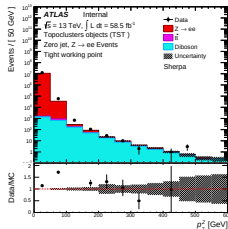
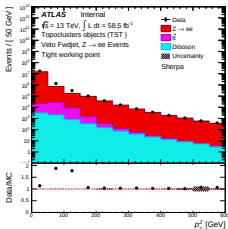
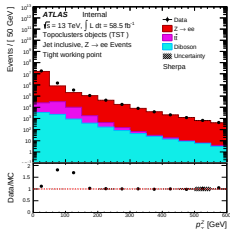
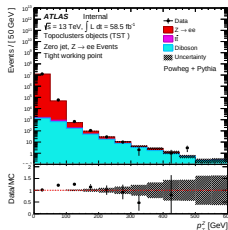
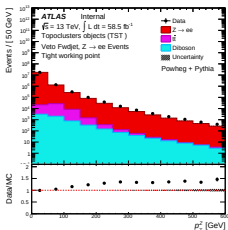
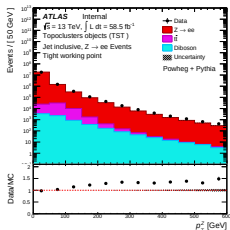
22



Additional slides

p_T^Z distribution, $Z \rightarrow ee$ (Topoclusters, Tight)

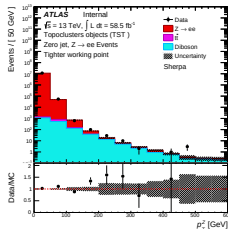
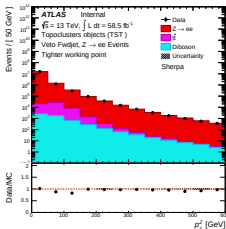
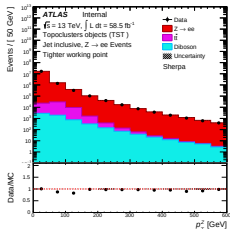
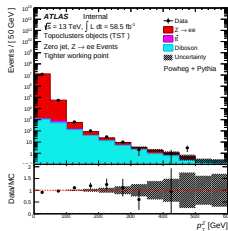
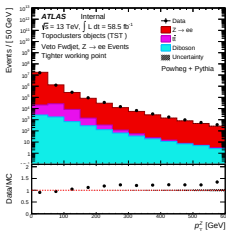
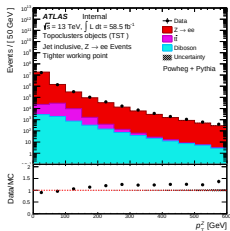
23



Additional slides

p_T^Z distribution, $Z \rightarrow ee$ (Topoclusters, Tighter)

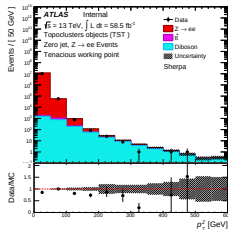
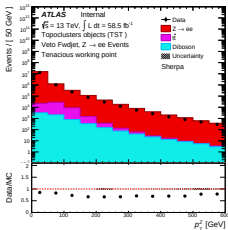
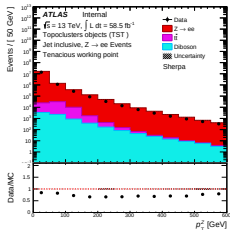
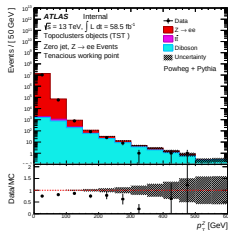
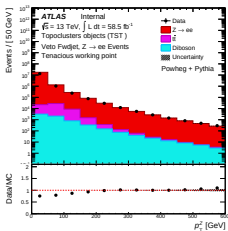
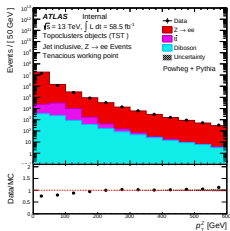
24



Additional slides

p_T^Z distribution, $Z \rightarrow ee$ (Topoclusters, Tenacious)

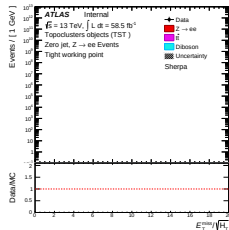
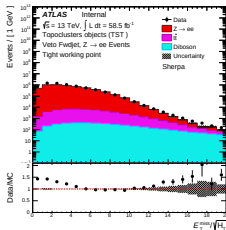
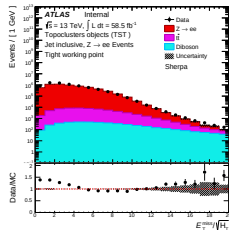
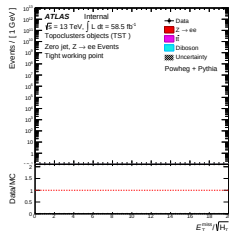
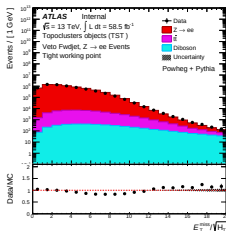
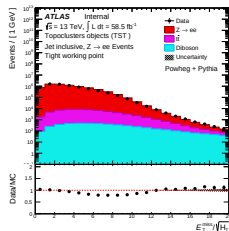
25



Additional slides

$E_T^{\text{miss}}/\sqrt{H_T}$ distribution, $Z \rightarrow ee$ (Topoclusters, Tight)

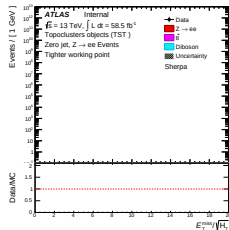
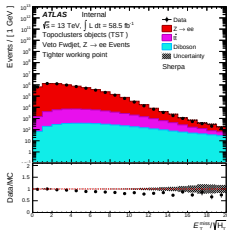
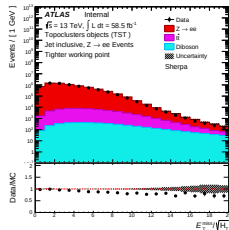
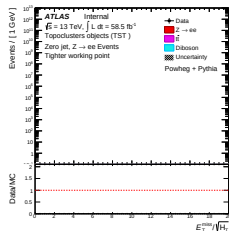
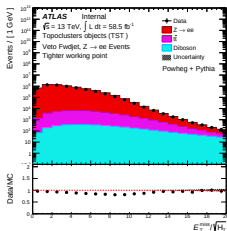
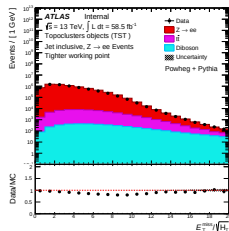
26



Additional slides

$E_T^{\text{miss}}/\sqrt{H_T}$ distribution, $Z \rightarrow ee$ (Topoclusters, Tighter)

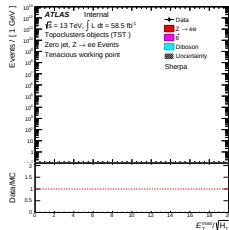
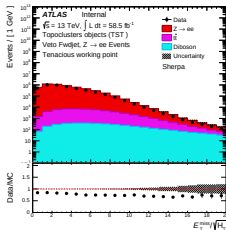
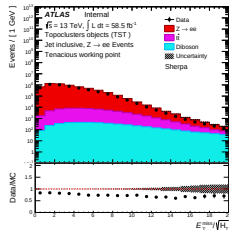
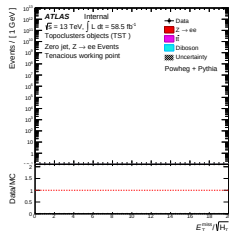
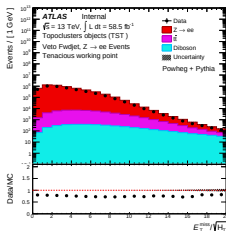
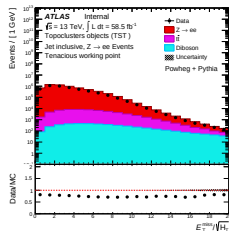
27



Additional slides

$E_T^{\text{miss}}/\sqrt{H_T}$ distribution, $Z \rightarrow ee$ (Topoclusters, Tenacious)

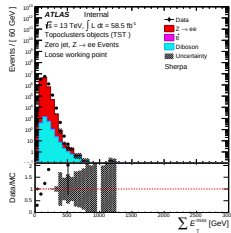
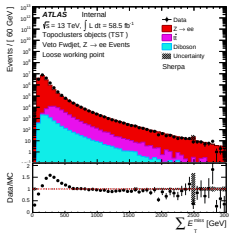
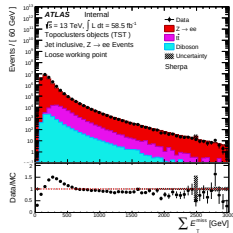
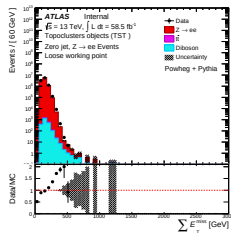
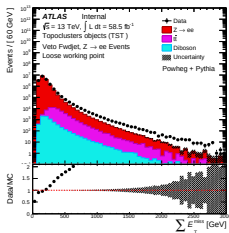
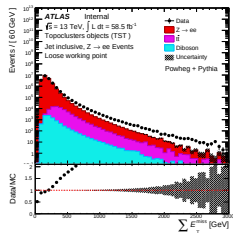
28



Additional slides

ΣE_T distribution, $Z \rightarrow ee$ (Topoclusters, Loose)

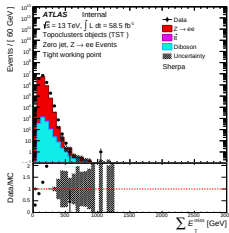
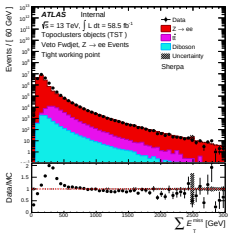
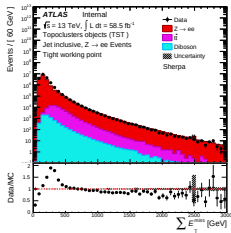
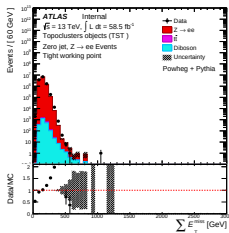
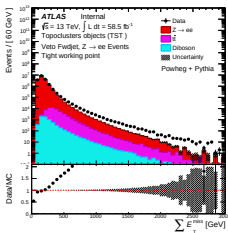
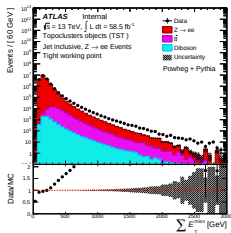
29



Additional slides

ΣE_T distribution, $Z \rightarrow ee$ (Topoclusters, Tight)

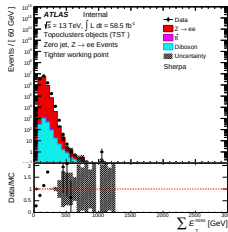
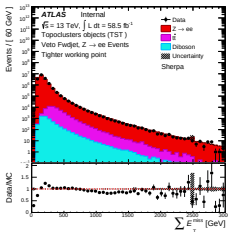
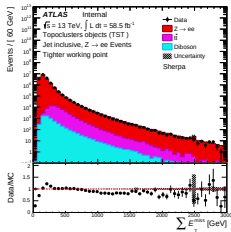
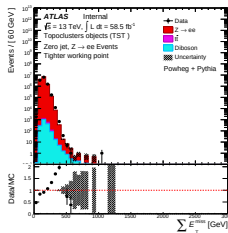
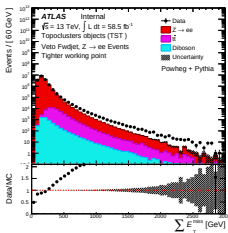
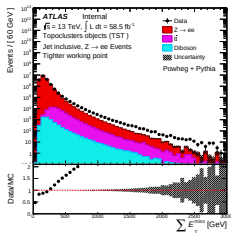
30



Additional slides

ΣE_T distribution, $Z \rightarrow ee$ (Topoclusters, Tigher)

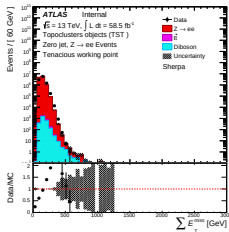
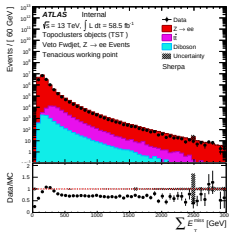
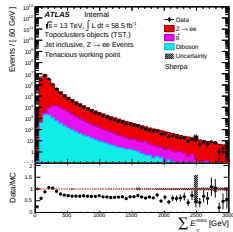
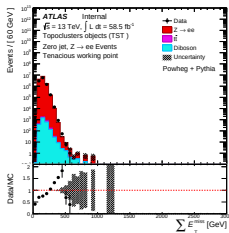
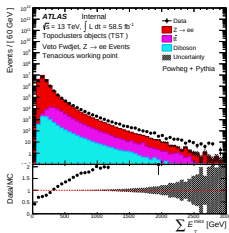
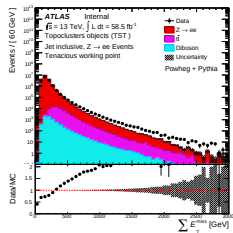
31



Additional slides

ΣE_T distribution, $Z \rightarrow ee$ (Topoclusters, Tenacious)

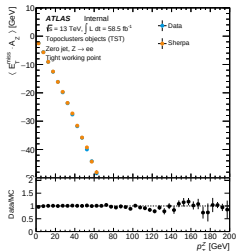
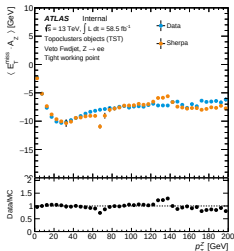
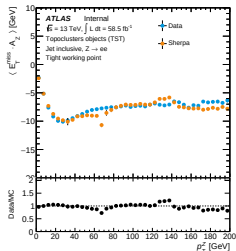
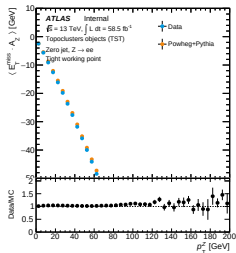
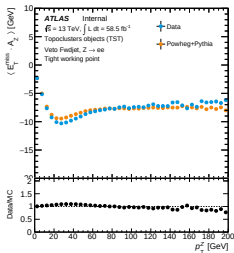
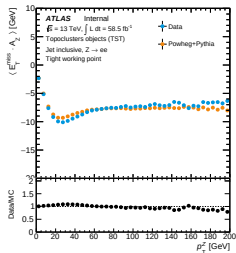
32



Additional slides

The E_T^{miss} scale, $Z \rightarrow ee$ (Topoclusters, Tight)

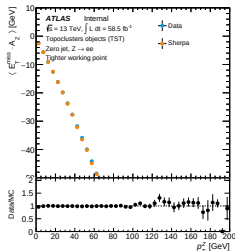
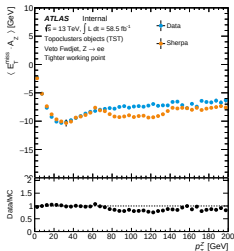
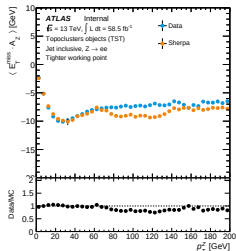
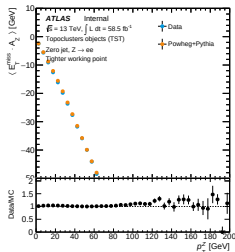
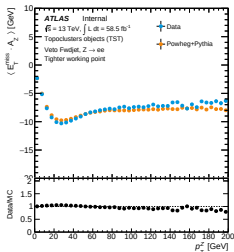
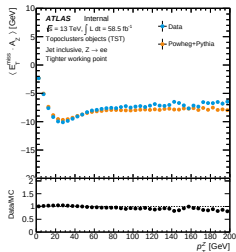
33



Additional slides

The E_T^{miss} scale, $Z \rightarrow ee$ (Topoclusters, Tighter)

34



Additional slides

The E_T^{miss} scale, $Z \rightarrow ee$ (Topoclusters, Tenacious)

35

