



Z + μ studies with fake muons from light jets

Updated results with 3.32 fb^{-1}

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MAX-PLANCK-GESELLSCHAFT



Samples and Event Selection

■ Data (p2425):

Period D - J

Integrated Luminosity of 3.32 fb^{-1}

GRL: All_Good/data15_13TeV.periodAllYear_DetStatus-v73-pro19-08_DQDefects-00-01-02_PHYS_StandardGRL_All_Good_25ns.xml

■ Luminosity calculation and pileup reweighting:

ilumicalc_histograms_None_276262-284484.root

■ MC (mc15a - p2425):

Z+jets: (Sherpa, 361372-361419)

WZ: (Powheg/Pythia8, 361601)

ZZ: (Powheg/Pythia8, 361603, 343213)

ttbar: (Powheg/Pythia, 410000)

Signal: (Powheg/Pythia8, 341471)



■ Event Selection:

- Same Event Selection as for 2fb^{-1}
- New recommendations for electrons and muons!
- AnalysisBase 2.3.35
- Updated cross sections from:

<https://twiki.cern.ch/twiki/bin/view/AtlasProtected/CentralMC15ProductionList>

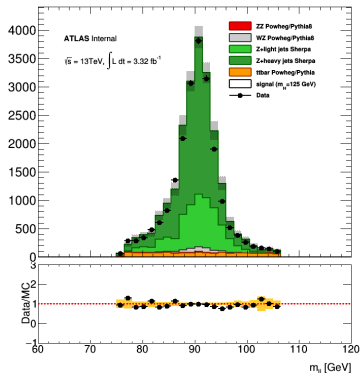
■ Enrichment with Z+light jet events:

by means of the cut on the momentum balance, $\frac{p_T^{\text{ID}} - p_T^{\text{MS}}}{p_T^{\text{ID}}}$

Z+ μ candidates before the cut on the p_T -balance

Number of expected and observed events:

Data	20951.00	
Total MC	22275.63	± 721.13
Z+light jets	5880.70	± 329.55
Z+heavy jets	14457.15	± 349.02
Top Quark	1378.30	± 29.01
WZ	472.18	± 3.47
ZZ	85.42	± 0.88
Signal	1.87	± 0.05



Reasonable agreement between data and simulation

Additional muons before the cut on p_T -balance

	All muons		$ d_0\text{sig} < 3.0$		track+topo		All cuts	
Data	20701.00		13230.00		3730.00		2622.00	
Total MC	22236.70	± 709.70	14077.31	± 606.93	3310.47	± 228.16	2209.80	± 193.55
Z+light jets	5683.45	± 321.81	5129.45	± 311.04	408.69	± 84.23	349.31	± 81.74
Z+heavy jets	14447.43	± 349.02	7788.29	± 269.22	2260.93	± 130.56	1285.65	± 100.79
Top Quark	1374.41	± 28.97	515.96	± 17.69	85.48	± 7.18	48.72	± 5.35
WZ	472.18	± 3.47	454.58	± 3.40	450.10	± 3.39	435.38	± 3.33
ZZ	85.34	± 0.88	78.21	± 0.84	78.01	± 0.84	72.00	± 0.80
Signal	1.87	± 0.05	1.76	± 0.05	1.69	± 0.04	1.61	± 0.04

- Z + light jet contribution: **25.76 %**

- Cut Efficiencies: $\text{Efficiency (MC/Data)} = \frac{(\text{total (MC/Data)} - \text{WZ} - \text{ZZ})_{\text{afterCut}}}{(\text{total (MC/Data)} - \text{WZ} - \text{ZZ})_{\text{beforeCut}}}$

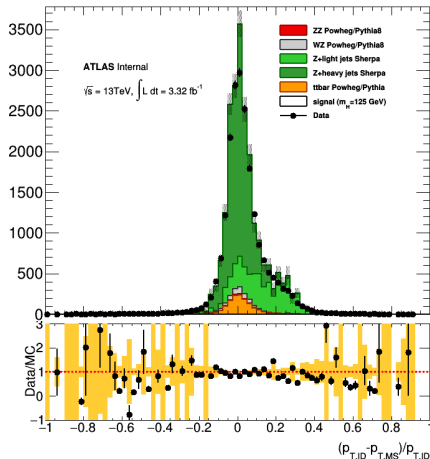
	$d_0\text{sig}$		track+topo		all cuts	
Cut eff. MC	(62.47	± 3.47) %	(12.82	± 1.77) %	(7.84	± 1.24) %
Cut eff. Data	(63.03	± 0.73) %	(15.90	± 0.32) %	(10.50	± 0.26) %

- Cut Efficiencies for 2 fb^{-1} : Jet + light jet contribution 25.74 %

	$d_0\text{sig}$		track+topo		all cuts	
Cut eff. MC	(63.05	± 3.56) %	(13.03	± 1.40) %	(8.07	± 1.07) %
Cut eff. Data	(62.45	± 0.94) %	(16.12	± 0.40) %	(10.65	± 0.34) %

Muon momentum balance

- Applying cut on p_T -balance in order to increase the Z+light contribution:
$$\frac{p_T^{\text{ID}} - p_T^{\text{MS}}}{p_T^{\text{ID}}} > 0.24$$
- Cut value chosen such to give the highest ratio between Z+light jet and other backgrounds

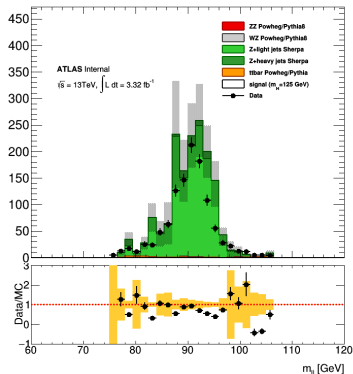


Reasonable agreement between data and simulation

Z+ μ candidates after the cut on the p_T -balance>0.24

Number of expected and observed events:

Data	1121.00	
Total MC	1537.67	± 206.23
Z+light jets	1436.76	± 173.45
Z+heavy jets	69.02	± 28.33
Top Quark	25.83	± 4.00
WZ	5.27	± 0.36
ZZ	0.78	± 0.09
Signal	0.00	± 0.00



Good agreement between data and simulation, rather low statistics

Additional muons after the cut on p_T -balance > 0.24

	All muons		$ d_0 \text{sig} < 3.0$		track+topo		All cuts	
Data	1121.00		1000.00		133.00		113.00	
Total MC	1537.67	± 206.23	1400.44	± 195.59	52.71	± 52.74	49.36	± 50.52
Z+light jets	1436.76	± 173.45	1348.54	± 170.27	32.61	± 41.45	32.53	± 41.45
Z+heavy jets	69.02	± 28.33	30.99	± 21.91	14.54	± 10.50	11.41	± 8.01
Top Quark	25.83	± 4.00	15.09	± 2.97	0.47	± 0.38	0.47	± 0.38
WZ	5.27	± 0.36	5.08	± 0.36	4.47	± 0.33	4.37	± 0.33
ZZ	0.78	± 0.09	0.73	± 0.08	0.61	± 0.08	0.57	± 0.08
Signal	0.00	± 0.00	0.00	± 0.00	0.00	± 0.00	0.00	± 0.00

- Z + light jet contribution: 93.44 %
- Cut Efficiencies:

	d0sig		track+topo		all cuts	
Cut eff. MC	(91.06	± 17.70) %	(3.11	± 3.45) %	(2.90	± 3.28) %
Cut eff. Data	(89.17	± 3.90) %	(11.47	± 1.04) %	(9.69	± 0.95) %

- Cut Efficiencies for 2 fb^{-1} : Jet + light jet contribution 93.36 %

	d0sig		track+topo		all cuts	
Cut eff. MC	(93.61	± 19.74) %	(4.00	± 4.13) %	(3.92	± 3.95) %
Cut eff. Data	(89.15	± 4.99) %	(12.52	± 1.38) %	(10.33	± 1.26) %



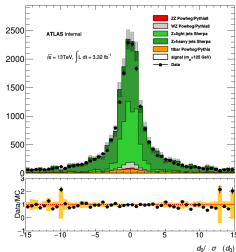
Summary & Plans

- Cut efficiencies are similar to those with 2 fb^{-1}
- Update with mc15b

BACKUP

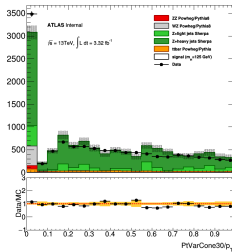
Additional muons before the cut on p_T -balance:

Impact parameter
significance:



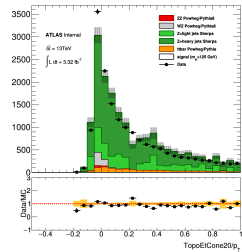
Good agreement
between MC and Data

Track isolation:



MC underestimated at
low isolation values

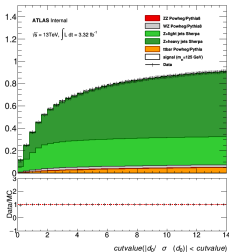
Calorimeter isolation:



MC underestimated
around isolation = 0

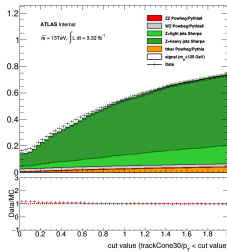
Cut efficiencies before the cut on p_T -balance:

Impact parameter
significance:



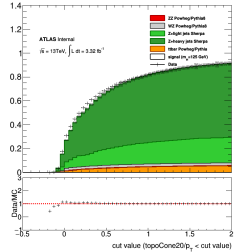
Good agreement
between MC and Data

Track isolation:



MC underestimated at
low isolation values

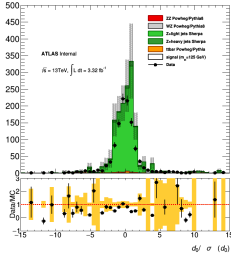
Calorimeter isolation:



MC underestimated
around isolation = 0

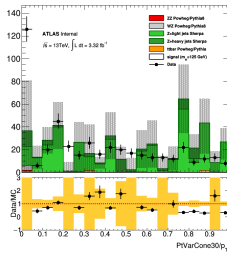
Additional muons after the cut on p_T -balance:

Impact parameter
significance:



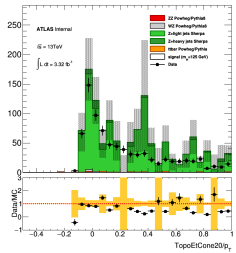
Good agreement
between MC and Data

Track isolation:



MC underestimated at
low isolation values

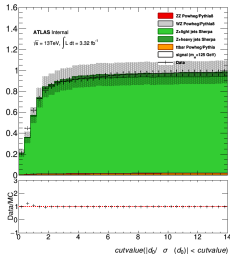
Calorimeter isolation:



Reasonable agreement
between MC and Data

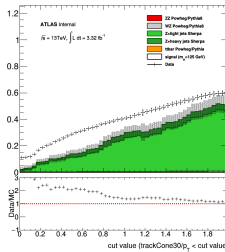
Cut efficiencies after the cut on p_T -balance:

Impact parameter
significance:



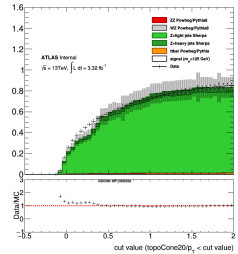
Good agreement
between MC and Data

Track isolation:



MC underestimated the
data

Calorimeter isolation:



MC underestimated
around isolation = 0