VBF $\mu\mu$ Channel Report

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MC and Data Samples

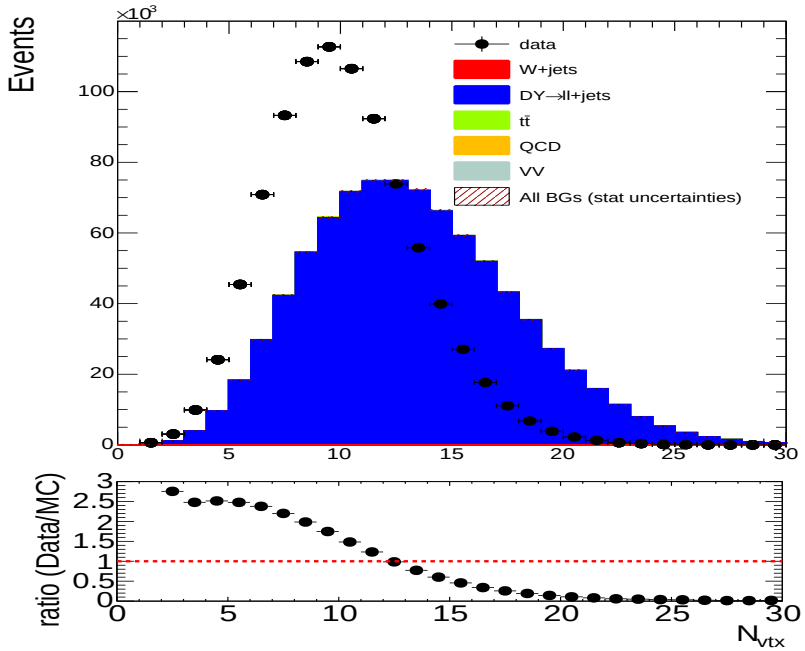
Sample	Cross section (pb)
QCD_Pt – 20toInf_MuEnrichedPt15_Asympt25ns	720648000
TTJets_madgraphMLM_Asympt25ns	831.76
ZZ_Asympt25ns	16.523
WW_Asympt25ns	115.0
WZ_Asympt25ns	47.30
WJetsToLNu_HT – 0to100_Asympt25ns	61526.7
WJetsToLNu_HT – 100to200_Asympt25ns	1632.54
WJetsToLNu_HT – 200to400_Asympt25ns	436.60
WJetsToLNu_HT – 400to600_Asympt25ns	59.37
WJetsToLNu_HT – 600toInf_Asympt25ns	22.78
DYJetsToLL_M – 50_HT – 0to100_Asympt25ns	6025.2
DYJetsToLL_M – 50_HT – 100to200_Asympt25ns	171.59
DYJetsToLL_M – 50_HT – 200to400_Asympt25ns	52.62
DYJetsToLL_M – 50_HT – 400to600_Asympt25ns	6.77
DYJetsToLL_M – 50_HT – 600toInf_Asympt25ns	2.72
DYJetsToLL_M – 5to50_Asympt25ns	71310.
SingleMuon_Run2015C_ReReco_25ns_MiniAODv2_December2015	
SingleMuon_Run2015D_PromptReco_v4_25ns$_M$iniAODv2_December2015	
SingleMuon_Run2015D_ReMiniAOD_25ns_MiniAODv2_December2015	
Total lumi	2110. pb

Event Selection Criteria

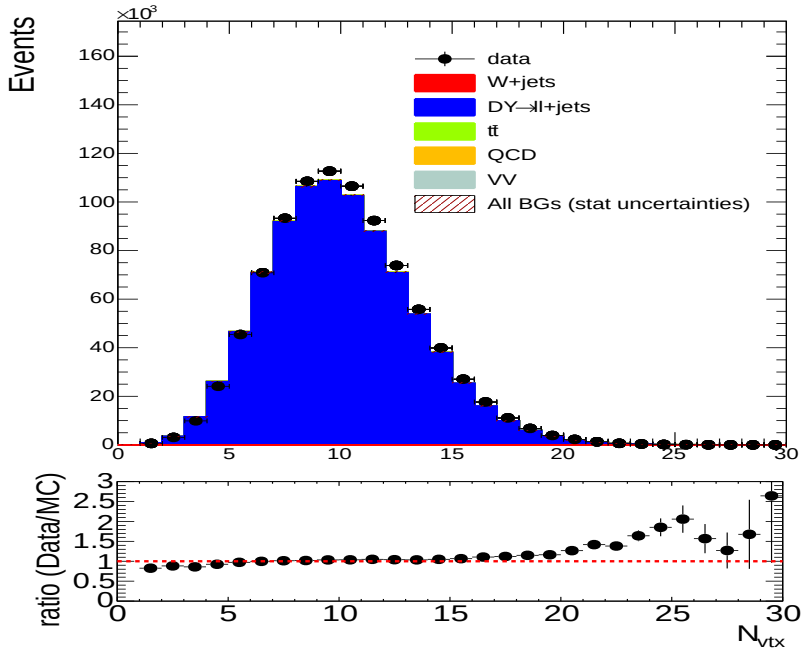
Background	Events
Central Selections	
Trigger	HLT_IsoMu24_eta2p1_v, HLT_IsoMu18_v
$\mu\ p_T^{lead}$	$>$ 20 GeV
$\mu\ \lvert\eta^{lead}\rvert$	$>$ 2.1
$\mu\ p_T^{sub-lead}$	$>$ 10 GeV
$\mu\ \lvert\eta^{sub-lead}\rvert$	$>$ 2.1
μ^{lead} & $\mu^{sub-lead}$	Tight ID
$p_T^{lead}(jet)$	$>$ 50 GeV
$\lvert\eta^{lead}\rvert(jet)$	$>$ 5.
$p_T^{sub-lead}(jet)$	$>$ 50 GeV
$\lvert\eta^{sub-lead}\rvert(jet)$	$>$ 5.
N_{b-jets}	0
E_T^{miss}	$>$ 75 GeV
Overlaps removal	Yes
VBF Selections	
$\eta_{j1} \cdot \eta_{j2}$	$<$ 0
$\lvert\Delta\eta(j_1, j_2)\rvert$	$>$ 4.2
$m_{j1,j2}$	$>$ 250 GeV

Number of Primary Vertices

No PU Weights

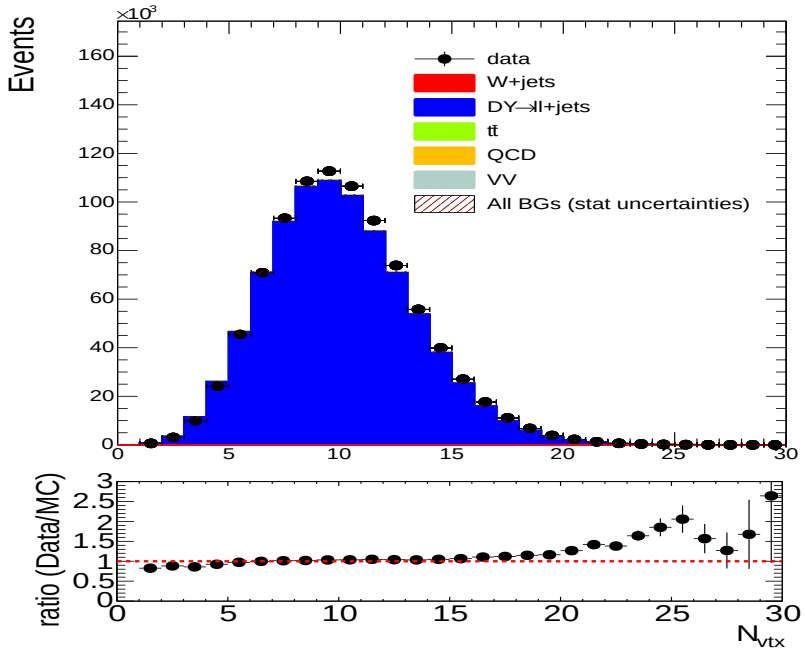


With PU Weights

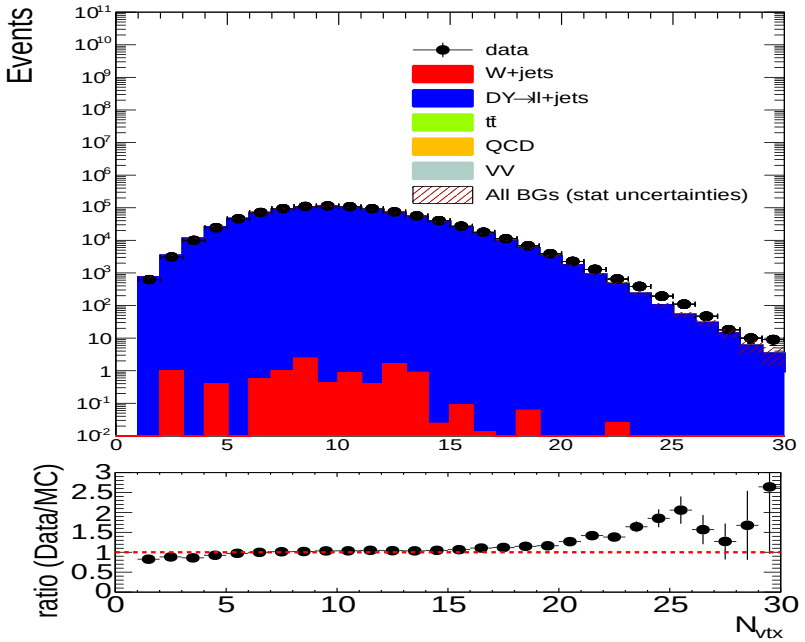


Number of Primary Vertices

With PU Weights - Linear

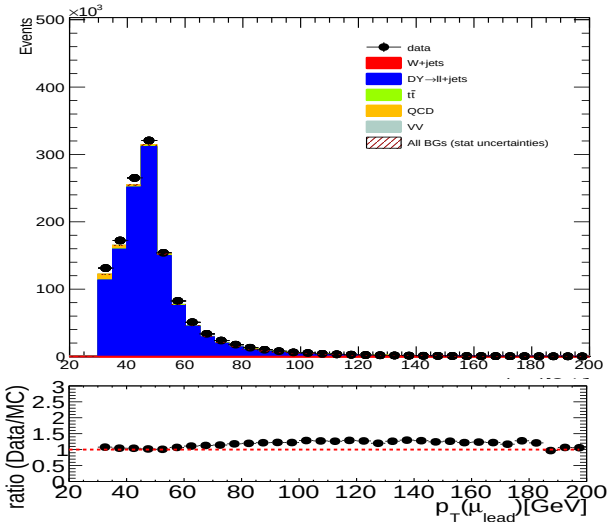


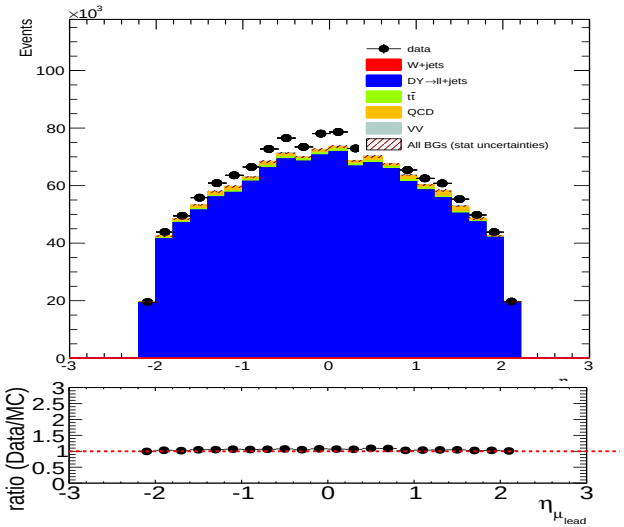
With PU Weights - log



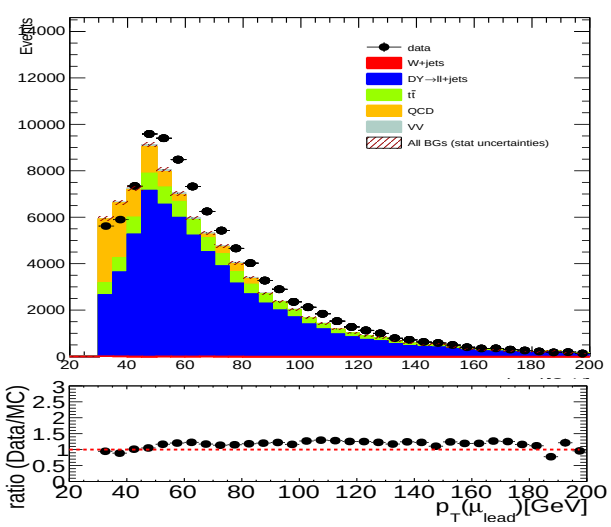
Kinematic Distributions - Muon1

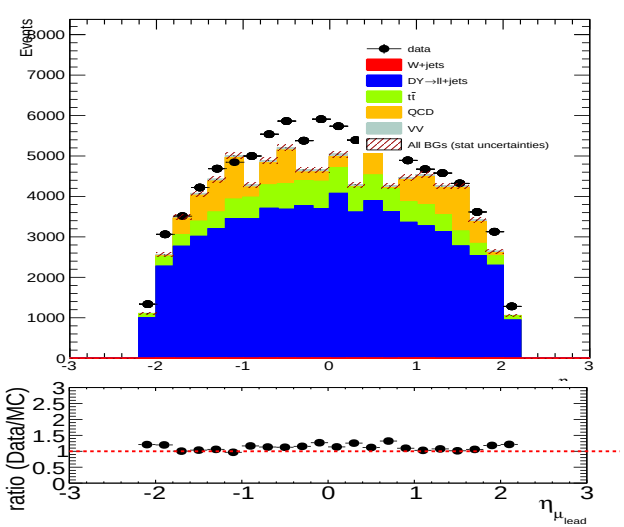
RecoMuon2Nmax





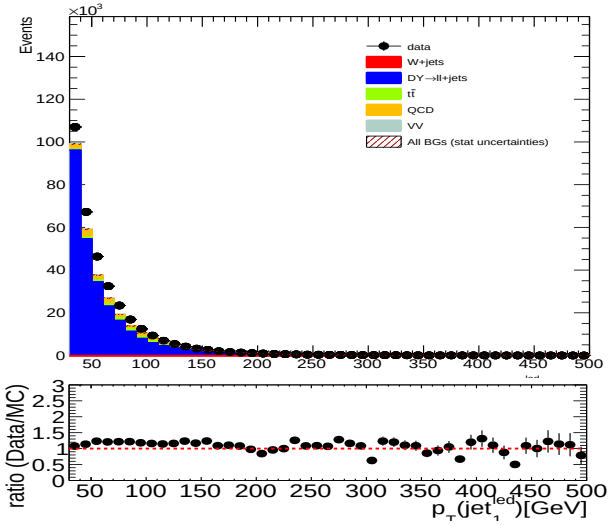
RecoSecondLeadingJetNmin

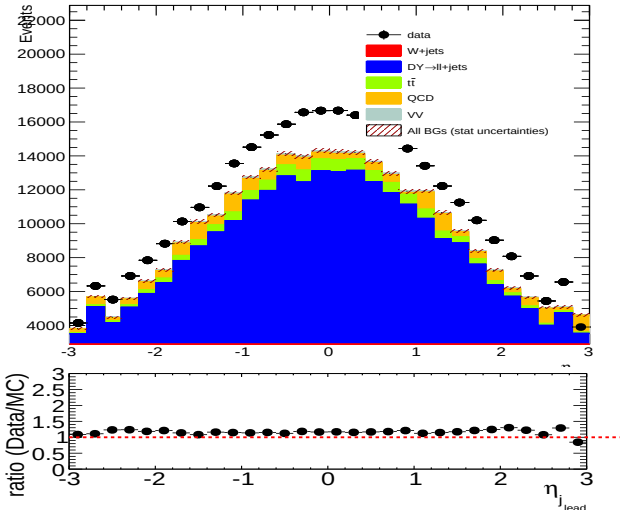




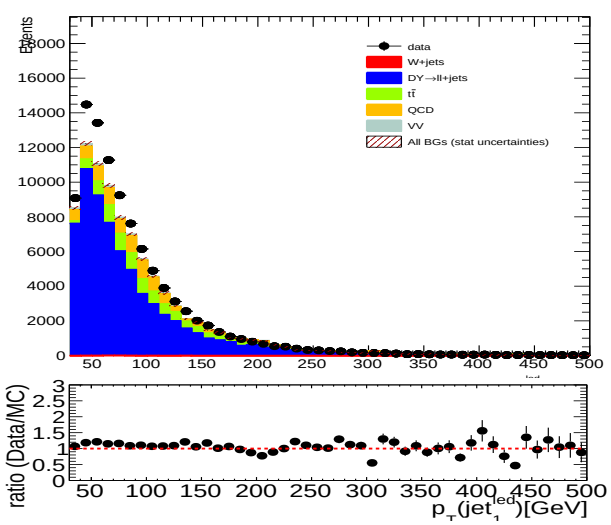
Kinematic Distributions - Jet1 CR1

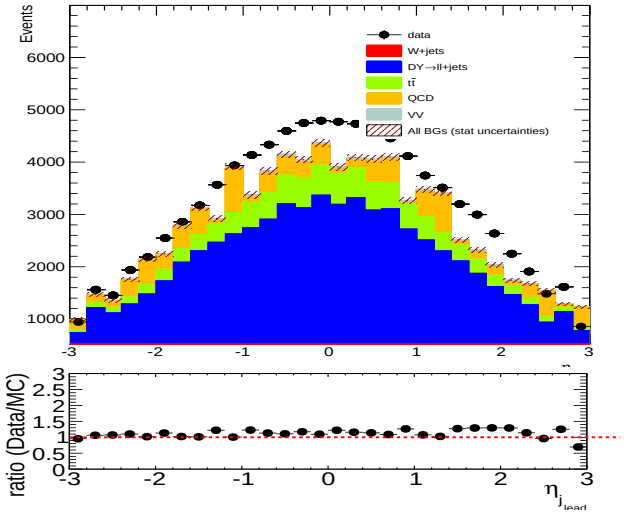
RecoMuon2Nmax





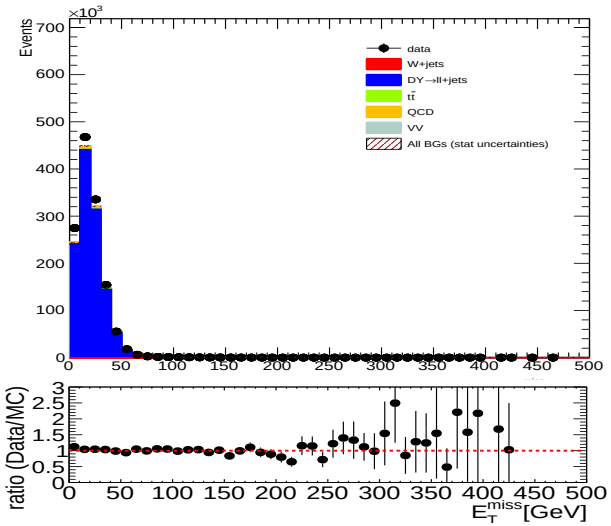
RecoSecondLeadingJetNmin



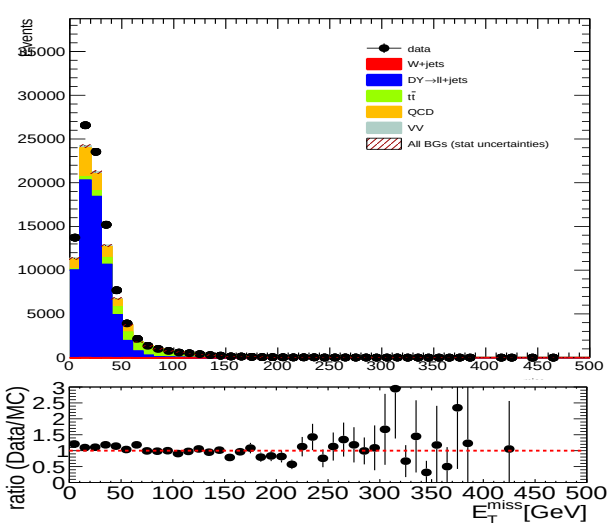


Kinematic Distributions - Jet1 CR1

RecoMuon2Nmax



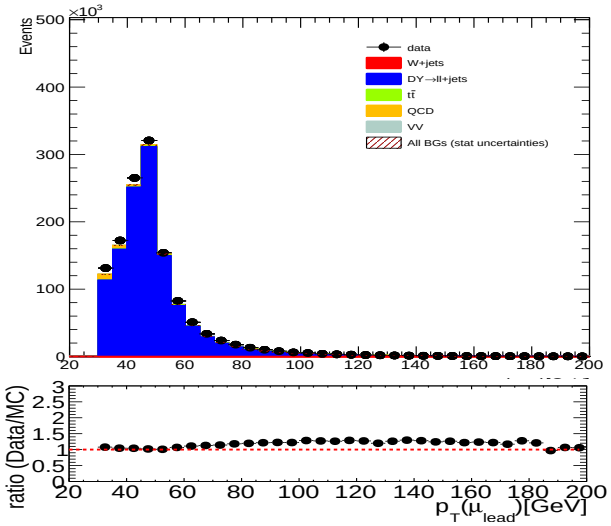
RecoSecondLeadingJetNmin

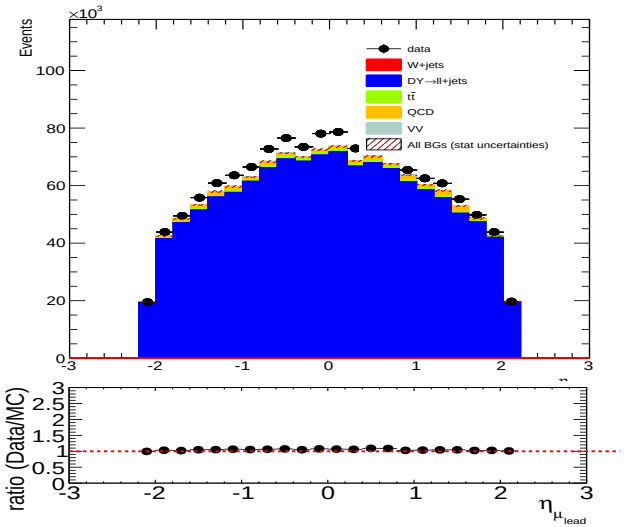


- Total number of data events after the FirstLeadingJetNmin cut: 24687
- Total number of BG events after the FirstLeadingJetNmin cut: 21806.7
- BG over MC ratio: 0.88. There is a 12% more data than MC BGs. Perhaps missing BGs?
- Will create CRs for DY and ttbar to see if there are scale factors that might account for the difference.

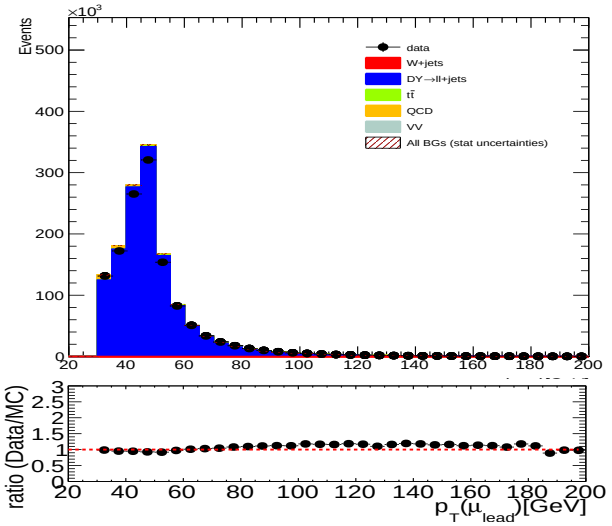
Kinematic Distributions - SF on DY: 1.1

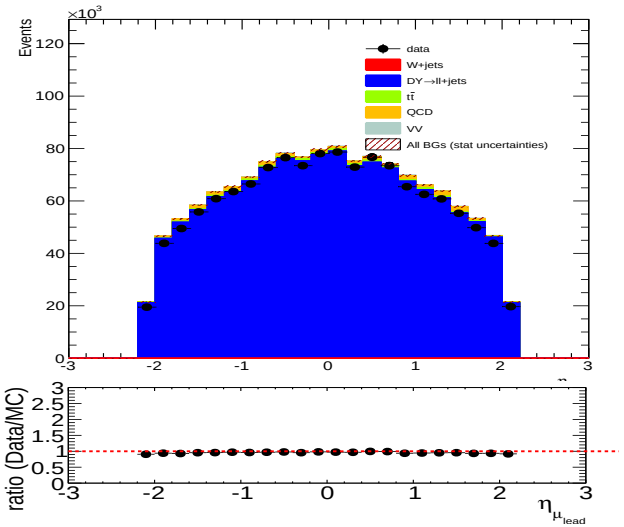
RecoMuon2Nmax





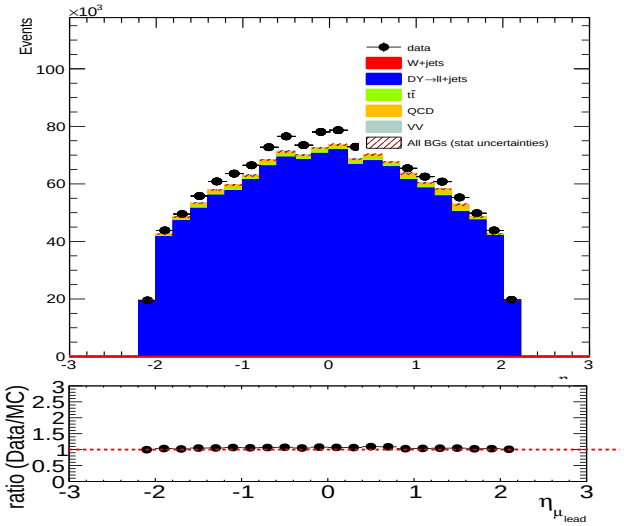
RecoSecondLeadingJetNmin

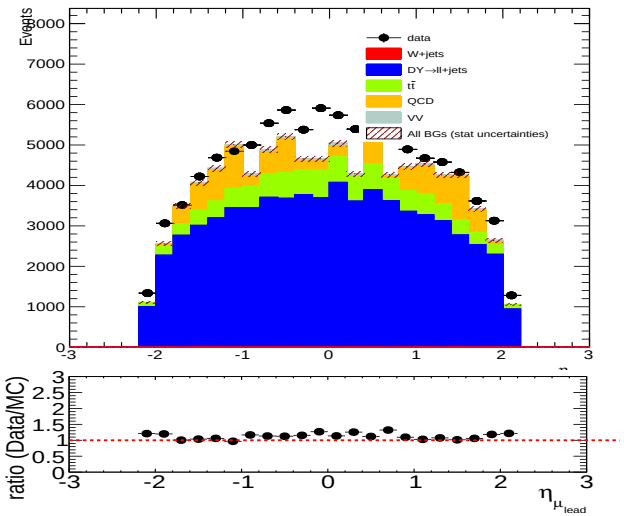




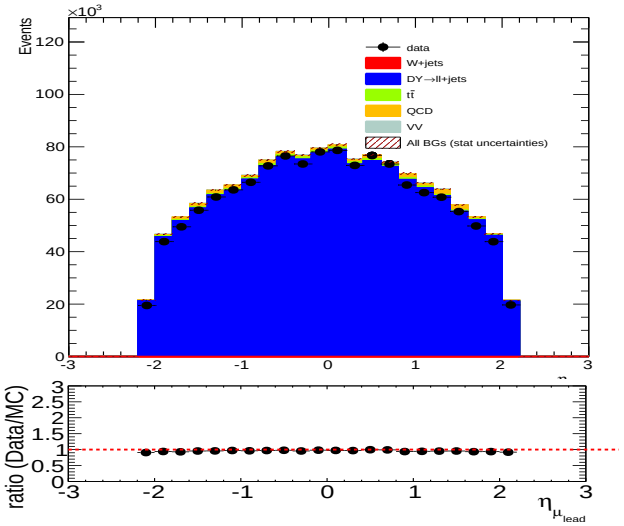
Kinematic Distributions - SF on DY: 1.1

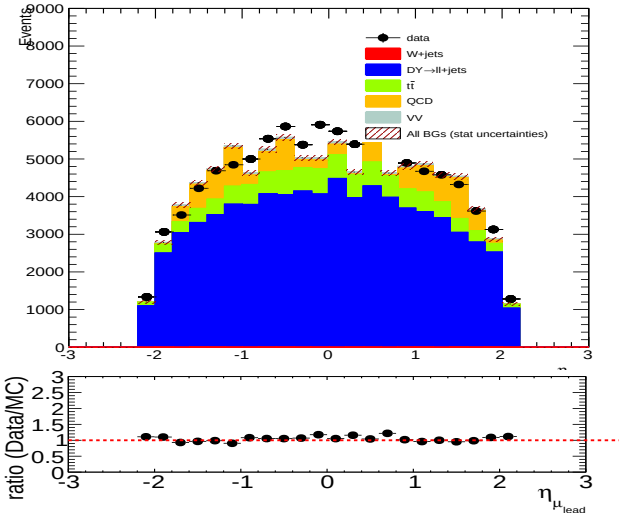
RecoMuon2Nmax





RecoSecondLeadingJetNmin





Cut Name	$DYTOLL_{10to50}$	$DY \rightarrow \ell\ell_{HT-0To100}$	$DY \rightarrow \ell\ell_{HT-100To200}$
Trigger	0.141 ± 0.001	19.3 ± 0.013	24.7 ± 0.03
Muon1Nmin	96.8 ± 0.15	98 ± 0.011	98.7 ± 0.01
Muon1Nmax	100 ± 0.01	$100 \pm 7.1e-5$	100 ± 0.0002
Muon2Nmin	26 ± 0.39	54.9 ± 0.04	53.3 ± 0.06
Muon2Nmax	100 ± 0.03	100 ± 0.0001	100 ± 0.0003
FirstLeadingJetNmin	2.61 ± 0.29	0.379 ± 0.007	14.9 ± 0.06
SecondLeadingJetNmin	29.1 ± 4.9	11.6 ± 0.5	27.6 ± 0.20
SusyCombiNmin	$0 \pm 1.08e-05$	$0 \pm 1.17e-5$	0.0139 ± 0.01
DiMuonCombiNmin	-	-	100 ± 31.8
DiJetCombiNmin	-	-	100 ± 31.8
Events	0 ± 24.03	0 ± 2.11	0.27 ± 0.19

Cut Name	$DY \rightarrow \ell\ell_{HT-200To400}$	$DY \rightarrow \ell\ell_{HT-400To600}$	$DY \rightarrow \ell\ell_{HT-600ToInf}$
Trigger	25.9 ± 0.04	27.3 ± 0.04	28.3 ± 0.04
Muon1Nmin	98.4 ± 0.03	97.9 ± 0.03	96.8 ± 0.03
Muon1Nmax	100 ± 0.001	100 ± 0.0004	100 ± 0.0004
Muon2Nmin	53 ± 0.101	52.6 ± 0.09	51.9 ± 0.10
Muon2Nmax	100 ± 0.001	100 ± 0.001	100 ± 0.01
FirstLeadingJetNmin	13.7 ± 0.09	5.26 ± 0.06	2.5 ± 0.04
SecondLeadingJetNmin	69.1 ± 0.35	90.5 ± 0.33	94.6 ± 0.38
SusyCombiNmin	0.057 ± 0.02	0.849 ± 0.11	5.26 ± 0.39
DiMuonCombiNmin	100 ± 13.4	100 ± 1.87	97.7 ± 1.13
DiJetCombiNmin	85.7 ± 13.2	35 ± 6.16	11.1 ± 2.4
Events	0.68 ± 0.28	0.28 ± 0.06	0.11 ± 0.03

CutName	$t\bar{t}$	$QCD^{MuEnri}_{Pt-20toInf}$	WW_{inclus}	ZZ_{inclus}	WZ_{inclus}
Trigger	13.3 ± 0.01	1.01 ± 0.003	10.2 ± 0.031	7.74 ± 0.03	5.26 ± 0.02
Muon1Nmin	95.4 ± 0.02	60.5 ± 0.13	97.1 ± 0.053	97.7 ± 0.06	98.4 ± 0.05
Muon1Nmax	$100 \pm 8.11e-5$	100 ± 0.001	100 ± 0.001	100 ± 0.002	100 ± 0.002
Muon2Nmin	6.08 ± 0.02	1.29 ± 0.04	5.05 ± 0.07	20.8 ± 0.15	55.5 ± 0.22
FirstLeadingJetNmin	18.1 ± 0.13	8.96 ± 0.89	1.73 ± 0.19	8.15 ± 0.22	8.61 ± 0.167
SecLeadingJetNmin	49.1 ± 0.40	37.6 ± 5.02	31.8 ± 5.0	31.7 ± 1.32	29.4 ± 0.92
SusyCombiNmin	0.614 ± 0.09	2.86 ± 2.82	0 ± 0.0001	0.255 ± 0.25	0.14 ± 0.14
DiMuonCombiNmin	97.9 ± 2.1	$0 \pm 7.64e-6$	-	100 ± 43.7	100 ± 43.7
DiJetCombiNmin	78.3 ± 6.08	-	-	100 ± 43.7	0 ± 0.0001
Events	5.57 ± 0.93	0 ± 72.40	0 ± 0.37	0.12 ± 0.10	0 ± 0.05

Cut Name	$wjets_{j0}$	$wjets_{j1}$	$wjets_{j2}$	$wjets_{j3}$	$wjets_{j4}$
TriggerNmin	12.3 ± 0.004	15.5 ± 0.011	16.5 ± 0.016	17.7 ± 0.03	18.7 ± 0.04
Muon1Nmin	96.1 ± 0.007	97.4 ± 0.013	96.8 ± 0.019	95.8 ± 0.04	94.5 ± 0.05
Muon2Nmin	0.00524 ± 0.0002	0.0194 ± 0.0011	0.023 ± 0.002	0.0295 ± 0.003	0.0297 ± 0.004
FirstLeadingJetNmin	0.234 ± 0.23	8.5 ± 1.63	18.8 ± 2.83	4.65 ± 2.27	3.7 ± 2.57
SecoLeadingJetNmin	$0 \pm 1.4e-6$	28 ± 8.98	66.7 ± 7.86	100 ± 20.5	$0 \pm 9.7e-5$
SusyCombiNmin	-	$0 \pm 9.97e-6$	$0 \pm 1.9e-5$	$0 \pm 5.8e-5$	-
DiMuonCombiNmin	-	-	-	-	-
DiJetCombiNmin	-	-	-	-	-
Events	0 ± 2.69	0 ± 0.51	0 ± 0.27	0 ± 0.11	0 ± 0.07

Final MC Number of Events

- No charge requirement is been applied to the muons.
- Nevertheless, all the events that survived are OS.
- As in the 8 TeV analysis, the dominant BGs are $t\bar{t}$ and DY.

Background	Events
$t\bar{t}$	5.57 ± 0.93
$DY \rightarrow \mu\mu$	1.34 ± 24.12
QCD	$0. \pm 72.40$
W+jets	0 ± 2.75
VV	$0. \pm 0.39$

Summary

- Correct PU weights have been implemented.
- It seems there is a SF of 1.1 on the DY BG. We need to obtain the CR and measure the exact SF.
- Need the signal samples to study the muonID and start the optimization of the cuts.