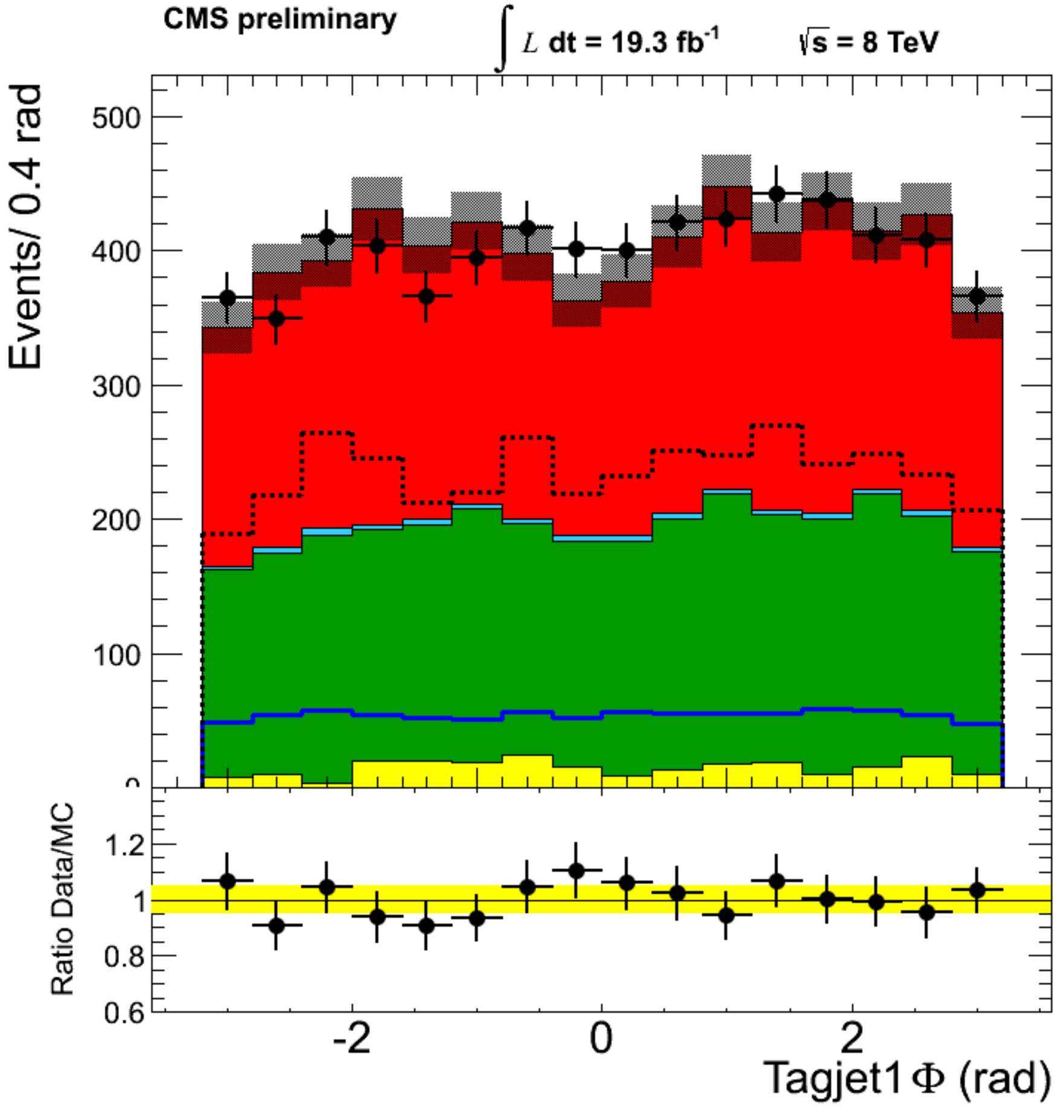
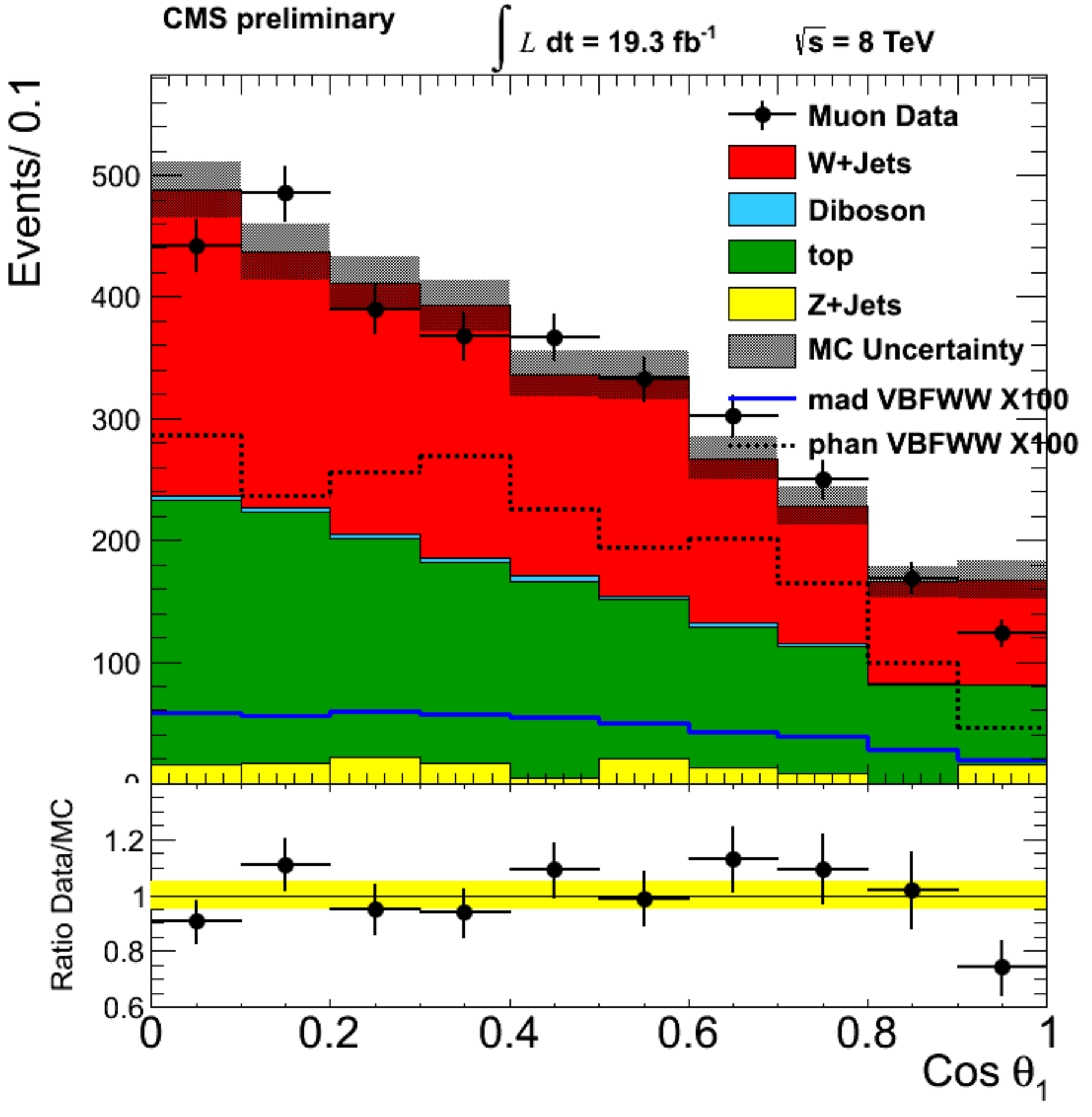
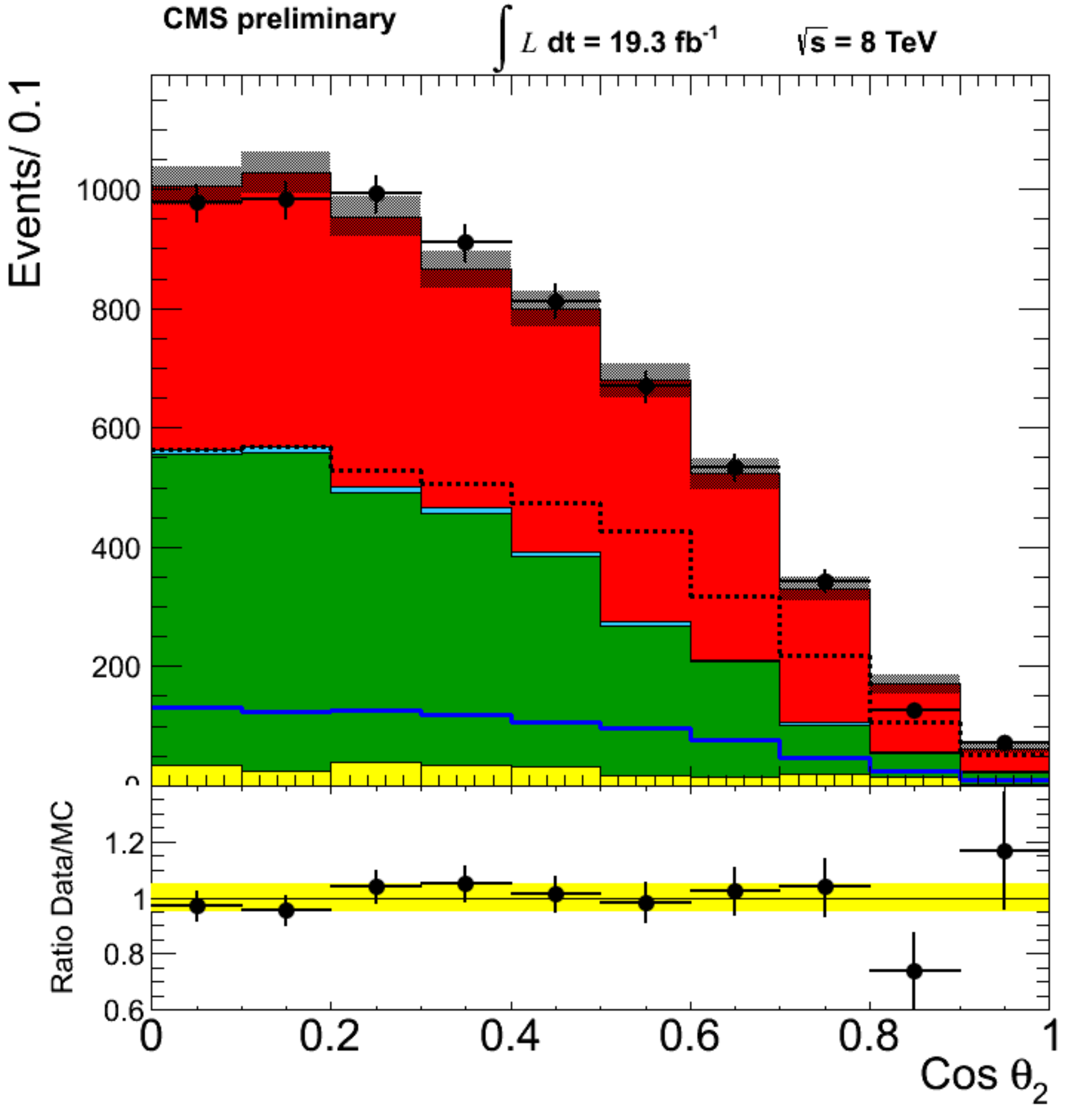
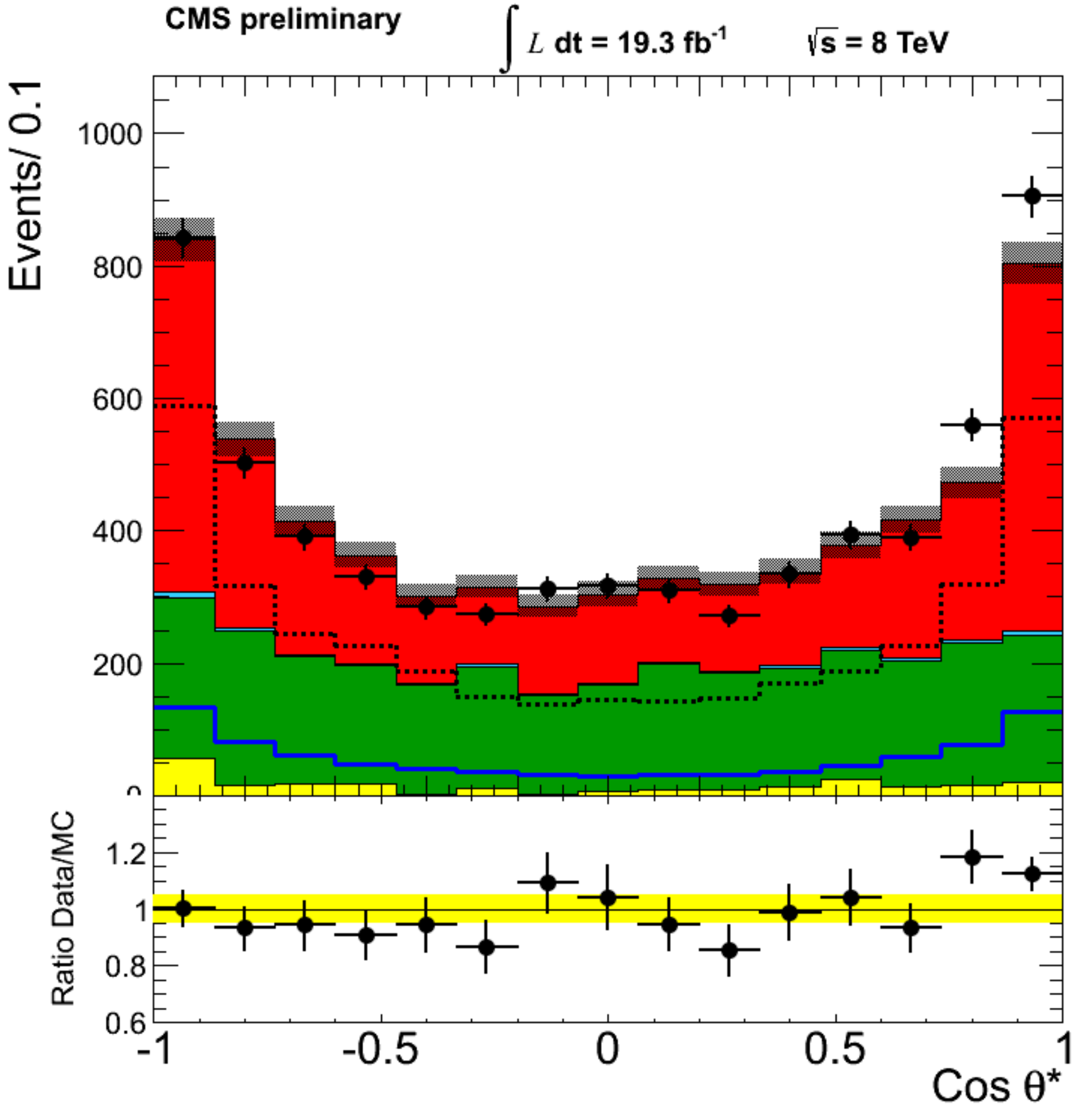
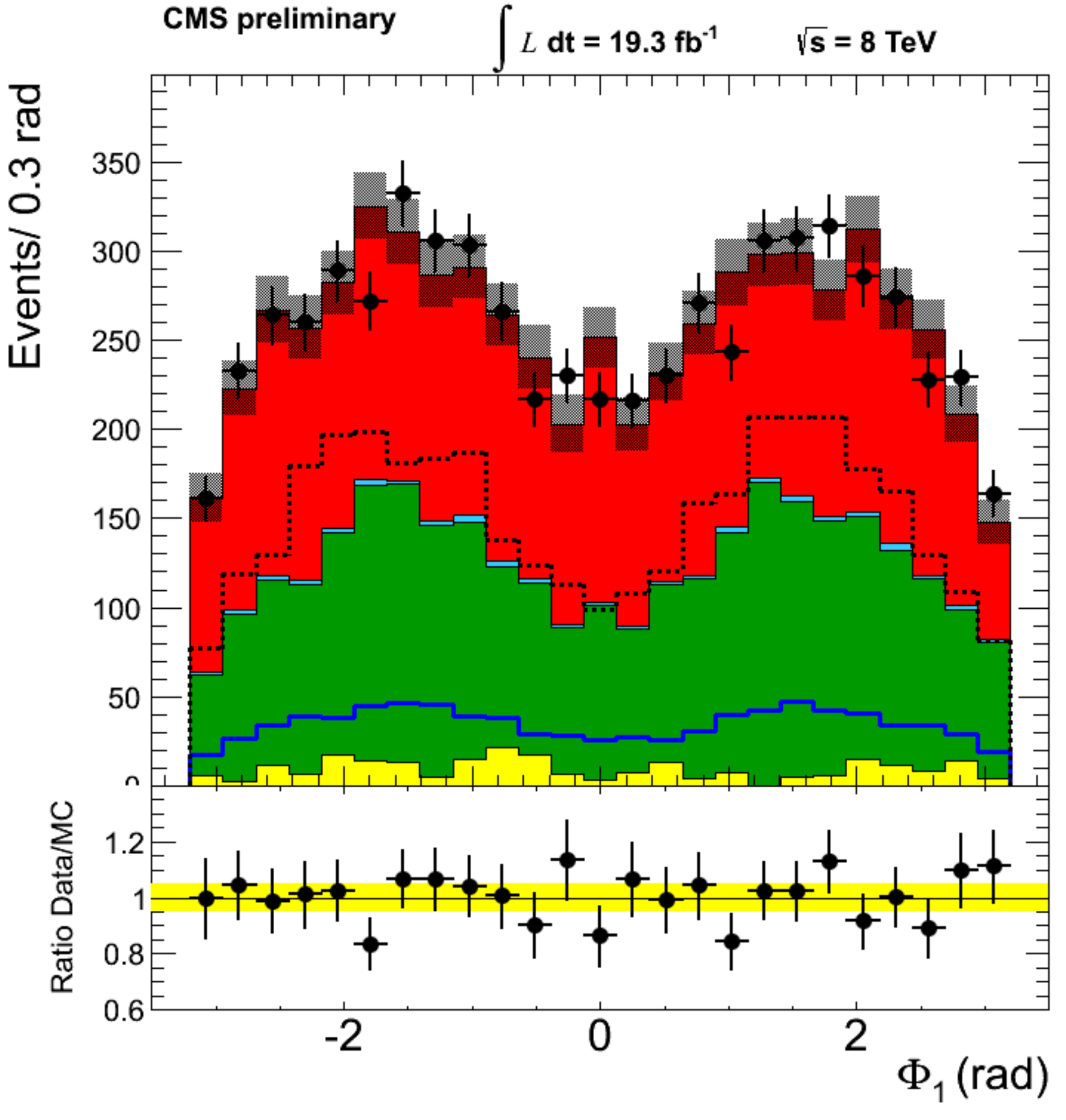
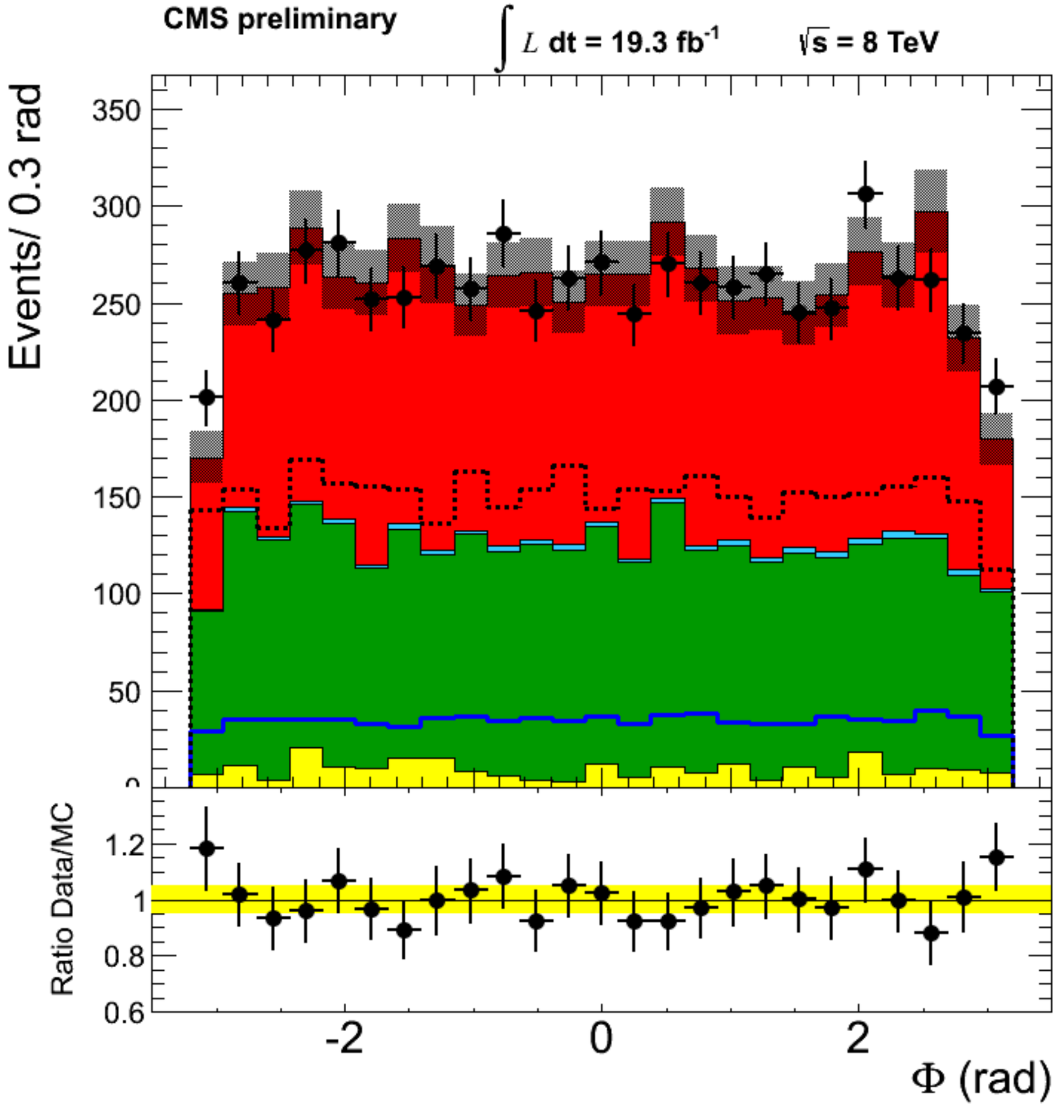

CMS preliminary
∫ L dt = 19.3 fb-1
√s = 8 TeV
Events/ 0.4 rad
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
-2
0
2
Tagjet1 Φ (rad)

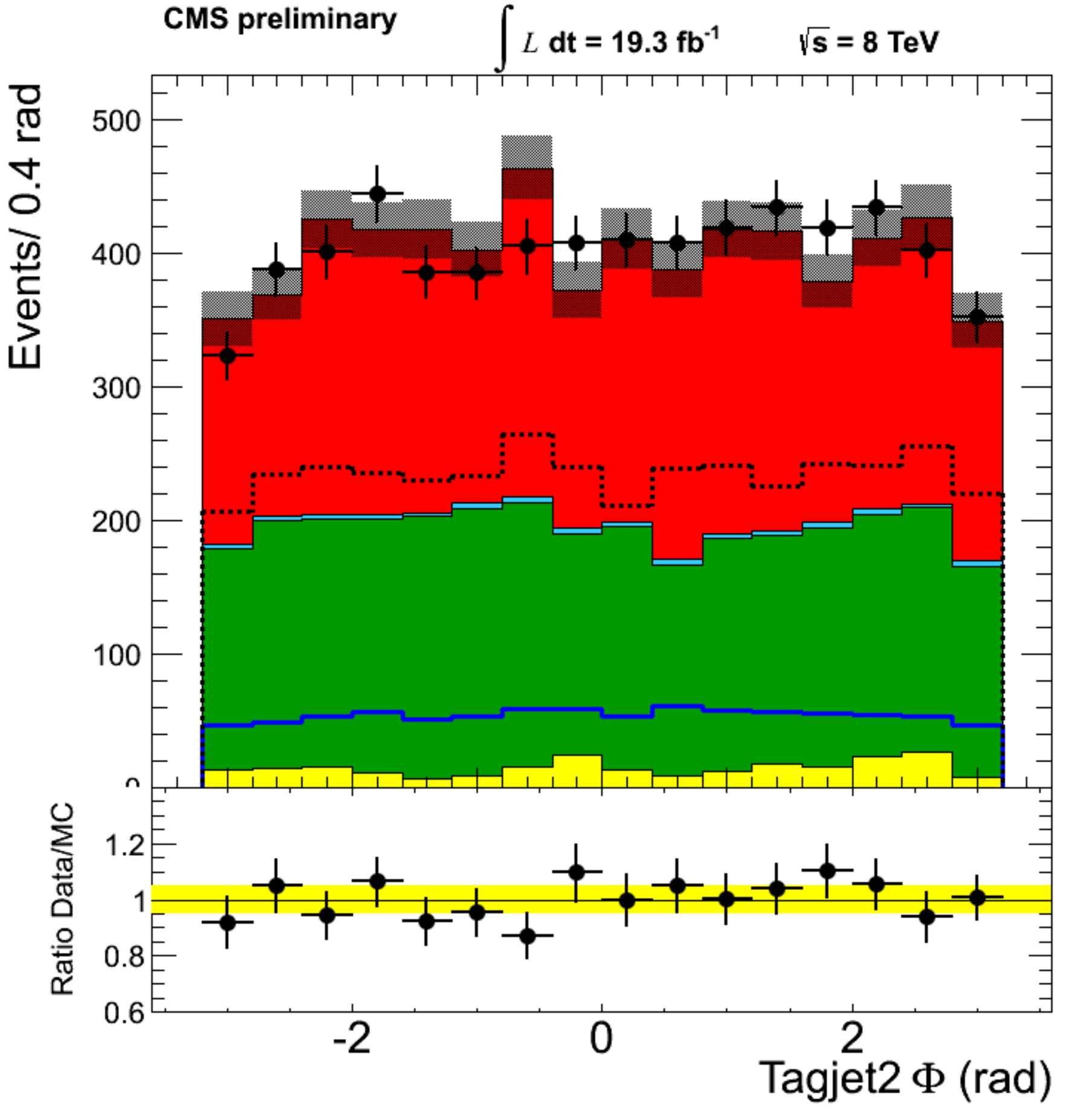

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Muon Data
W+Jets
Diboson
top
Z+Jets
MC Uncertainty
mad VBFWW X100
phan VBFWW X100
Events/ 0.1
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
0
0.2
0.4
0.6
0.8
1
Cos θ_1

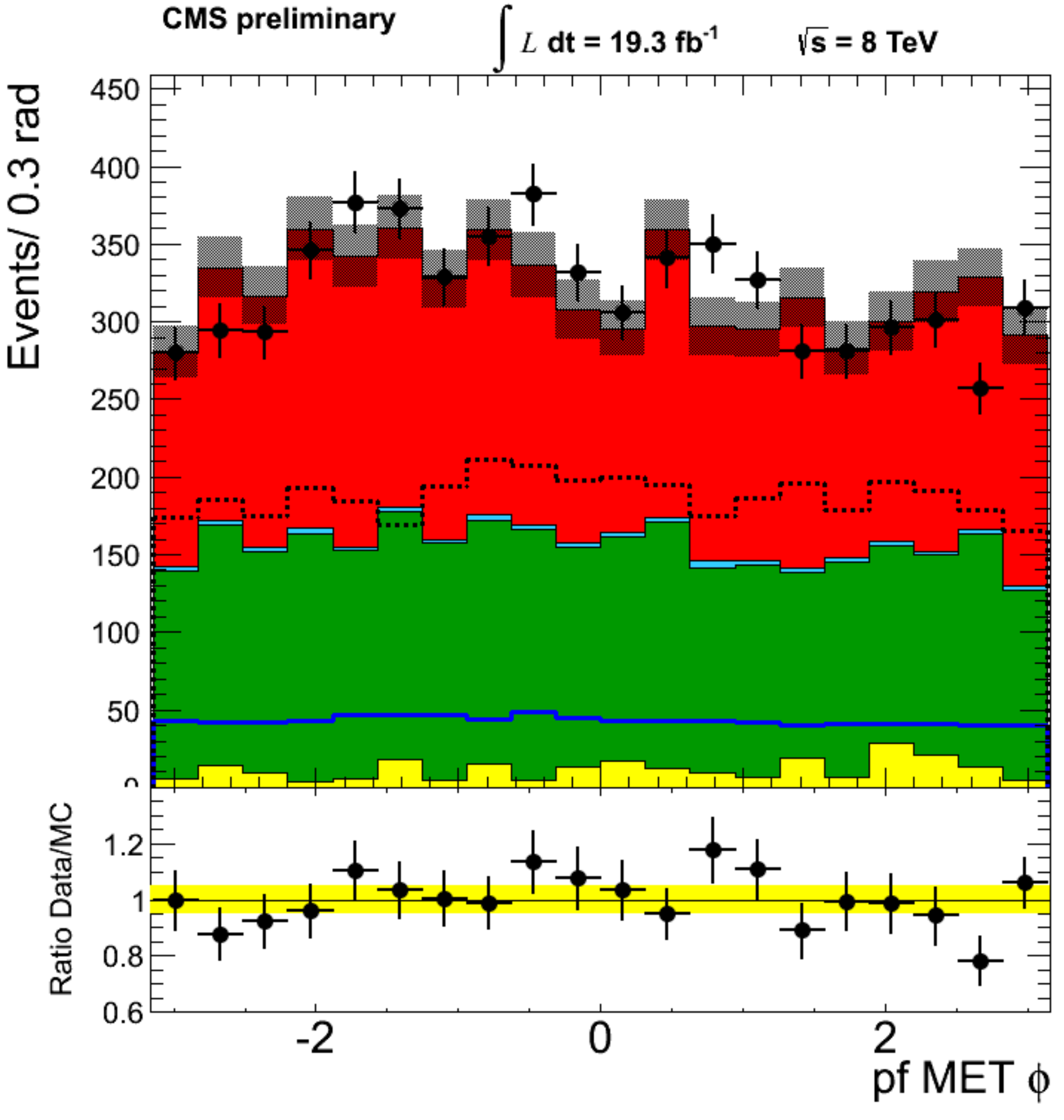

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.1
1000
800
600
400
200
Ratio Data/MC
1.2
1
0.8
0.6
0
0.2
0.4
0.6
0.8
1
Cos θ_2

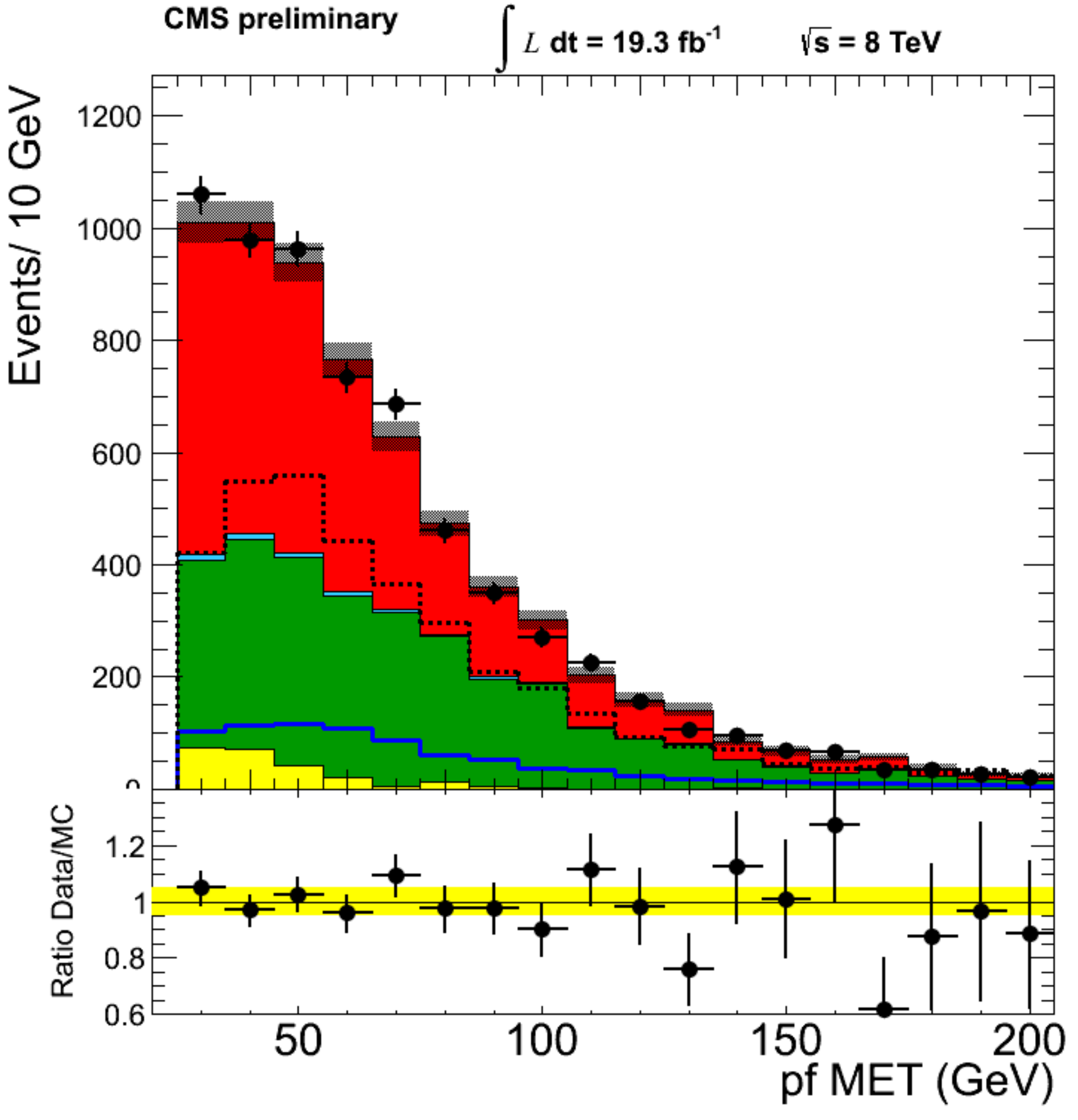

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Events/ 0.1
1000
800
600
400
200
Ratio Data/MC
1.2
1
0.8
0.6
-1
-0.5
0
0.5
1
Cos θ*

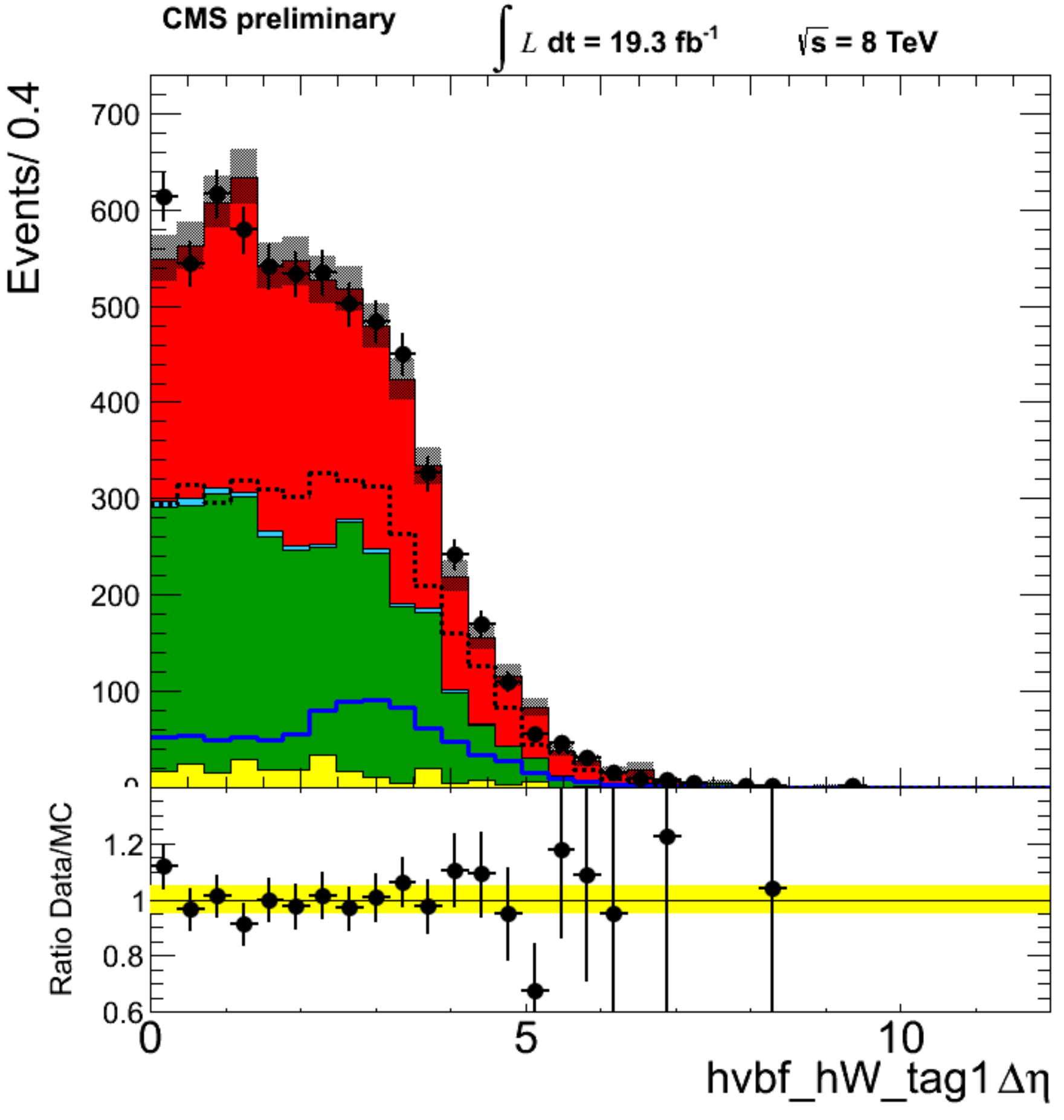

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.3 rad
350
300
250
200
150
100
50
Ratio Data/MC
1.2
1
0.8
0.6
-2
0
2
Φ_1 (rad)

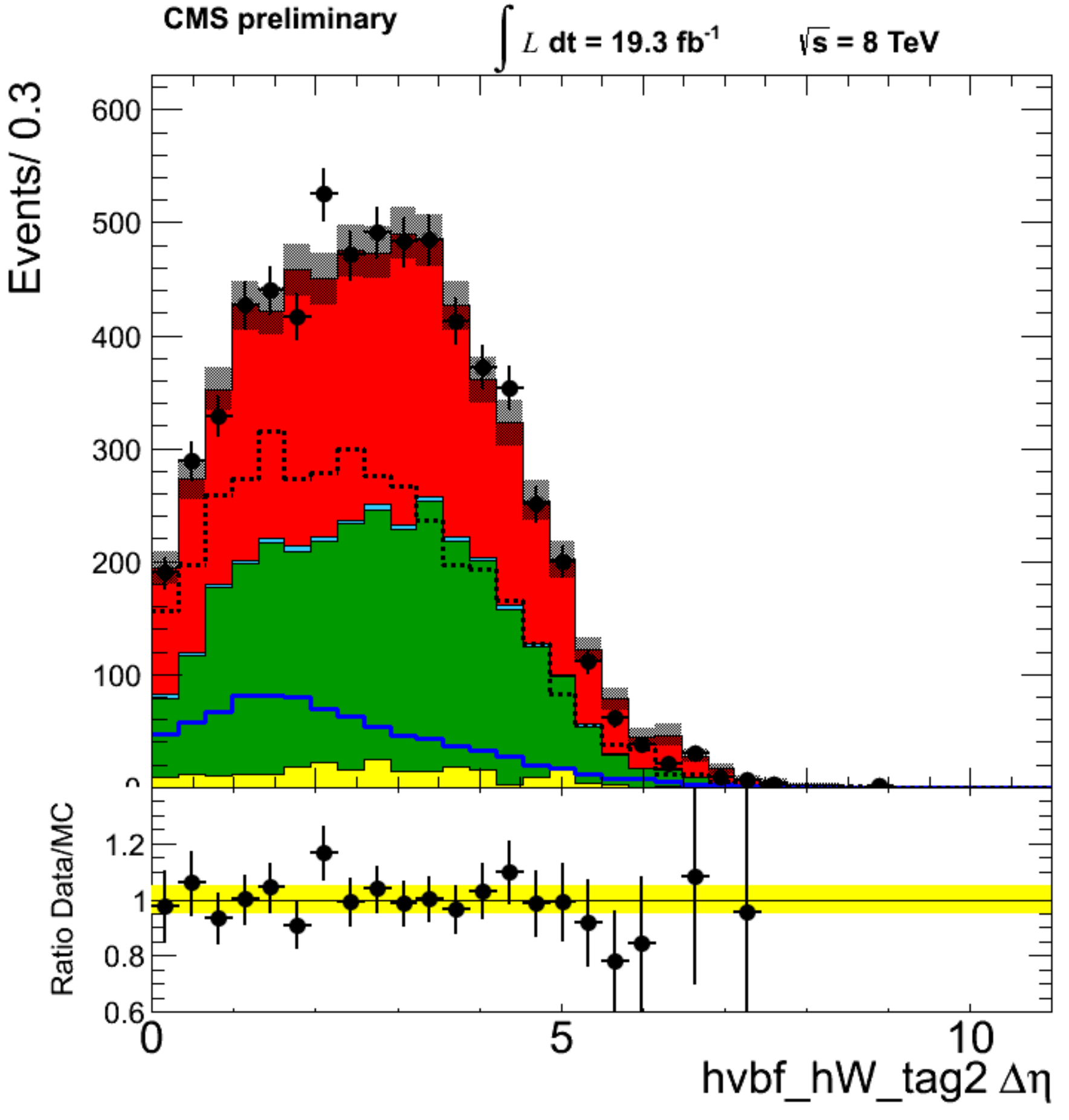

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.3 rad
350
300
250
200
150
100
50
Ratio Data/MC
1.2
1
0.8
0.6
-2
0
2
Φ (rad)

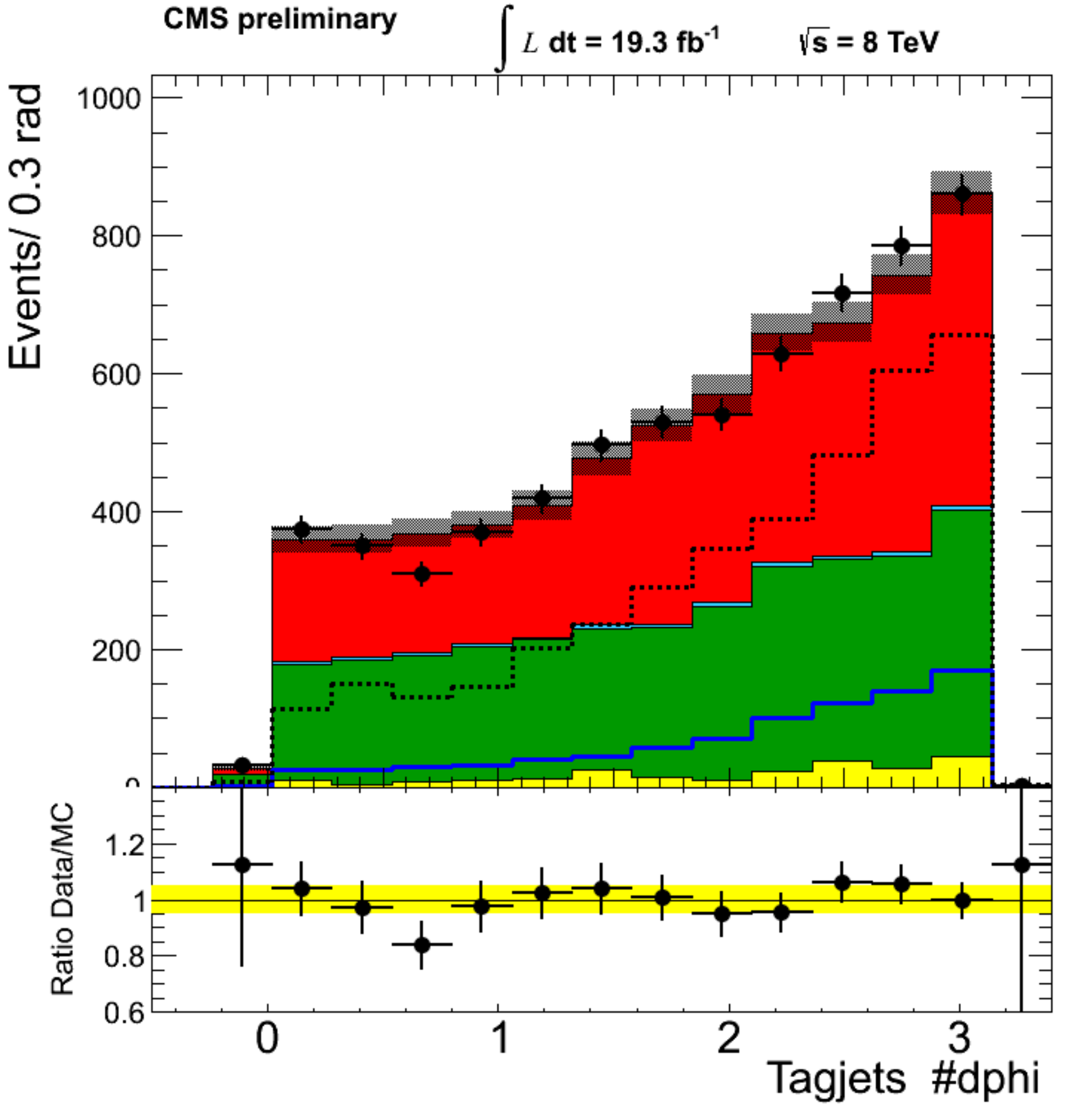

CMS preliminary
∫ L dt = 19.3 fb-1
√s = 8 TeV
Events/ 0.4 rad
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
-2
0
2
Tagjet2 Φ (rad)

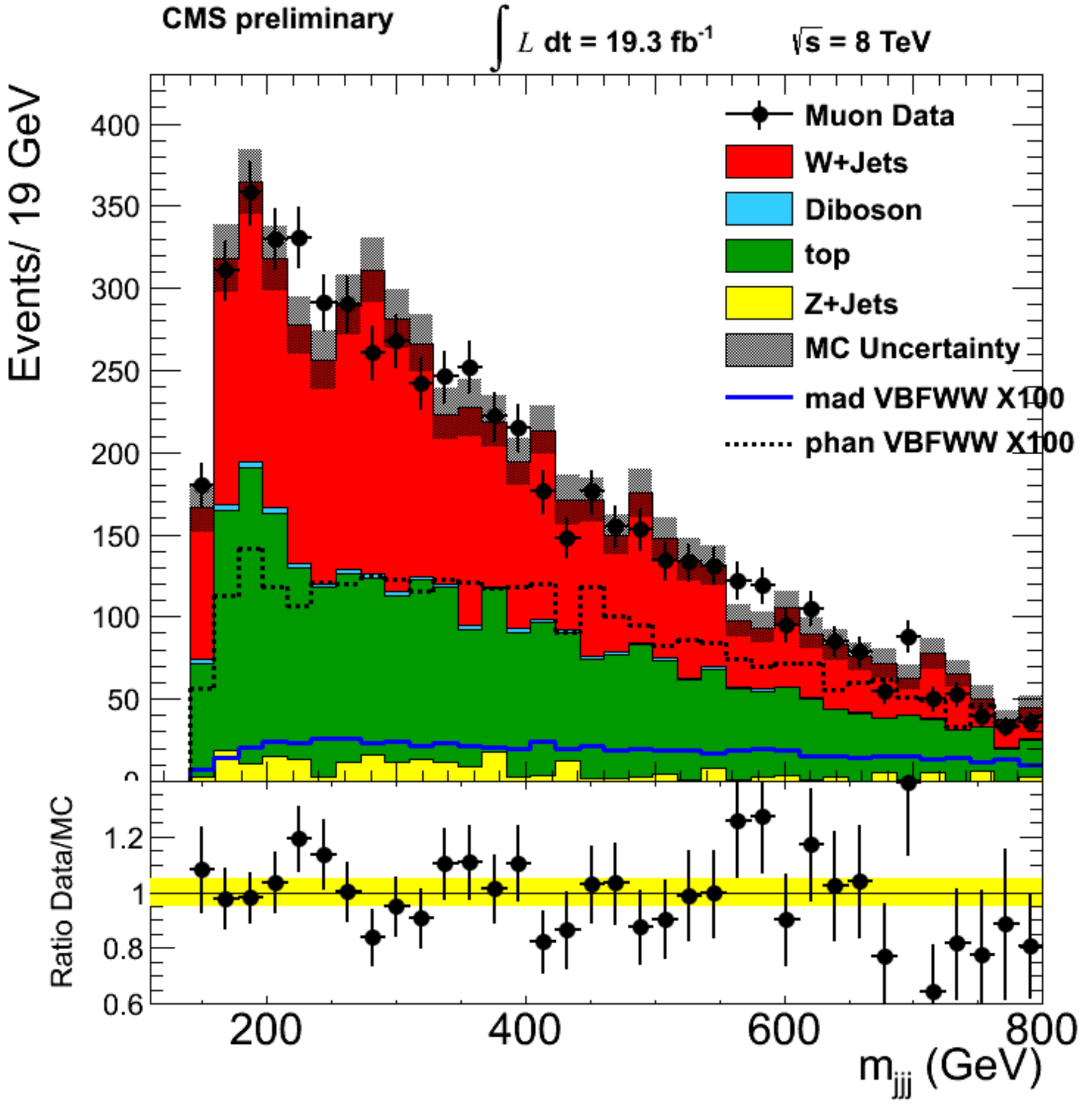

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.3 rad
450
400
350
300
250
200
150
100
50
Ratio Data/MC
1.2
1
0.8
0.6
-2
0
2
pf MET ϕ

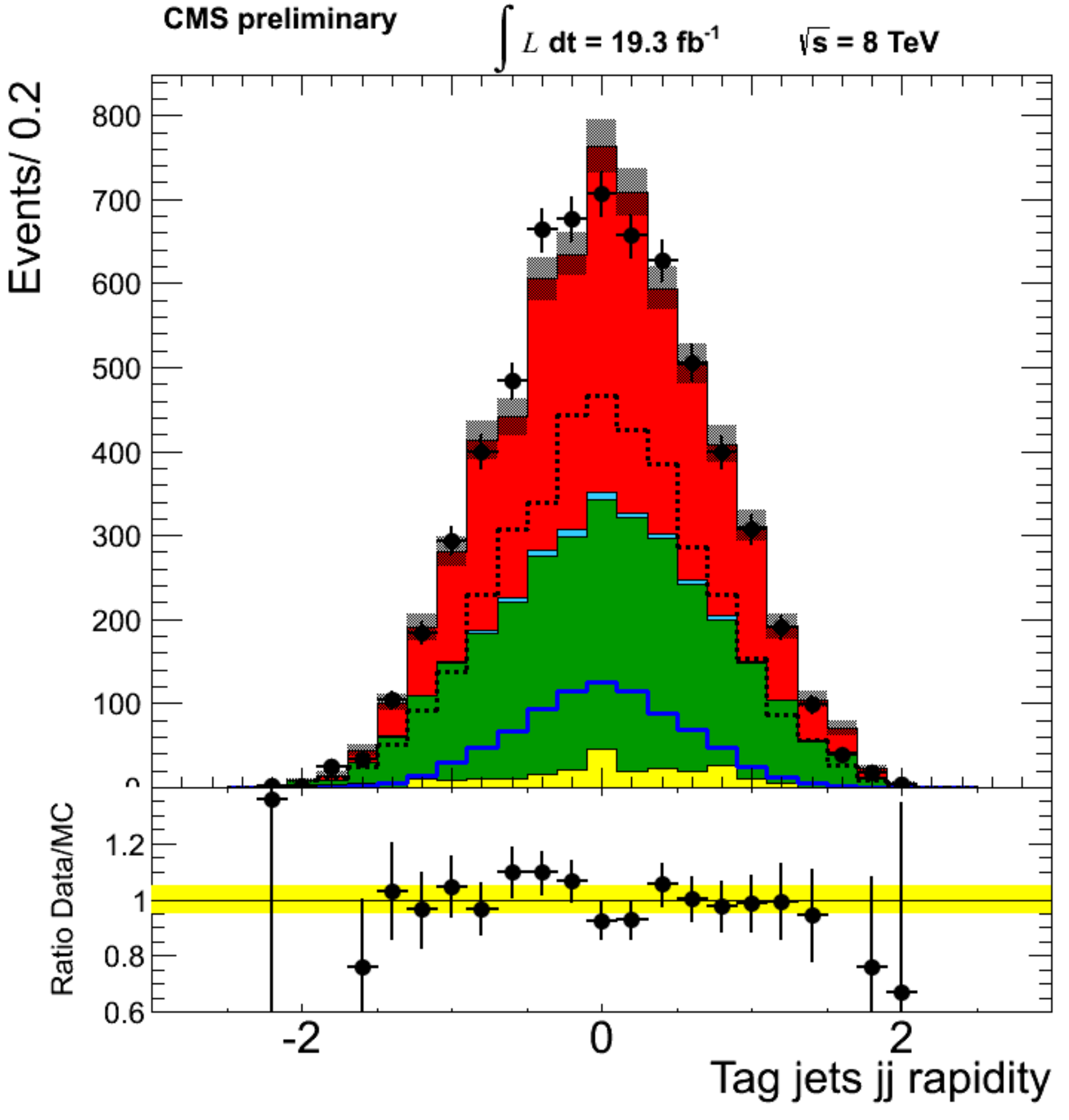

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 10 GeV
1200
1000
800
600
400
200
Ratio Data/MC
1.2
1
0.8
0.6
50
100
150
200
pf MET (GeV)

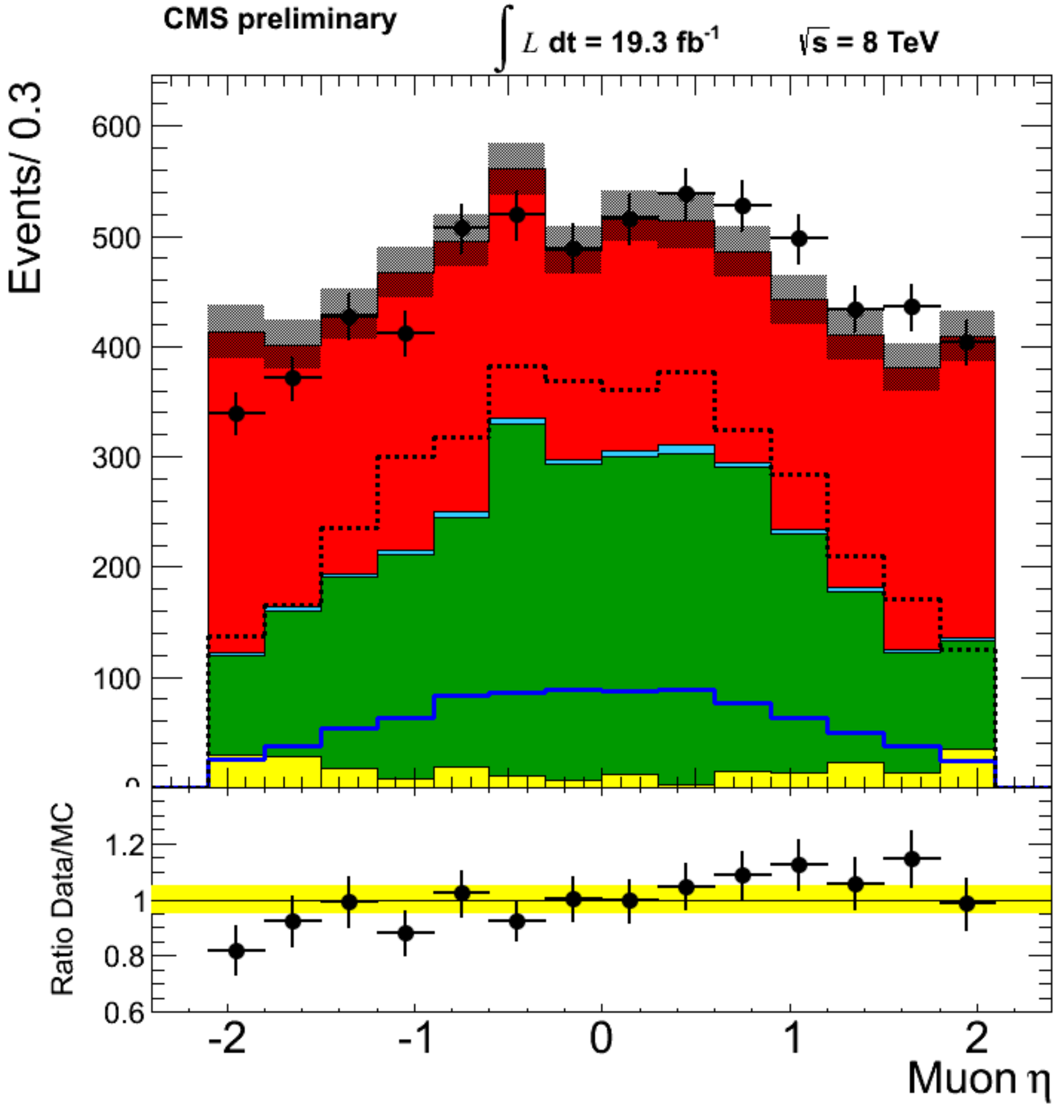

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.4
700
600
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
0
5
10
hvbf_hW_tag1 Δη

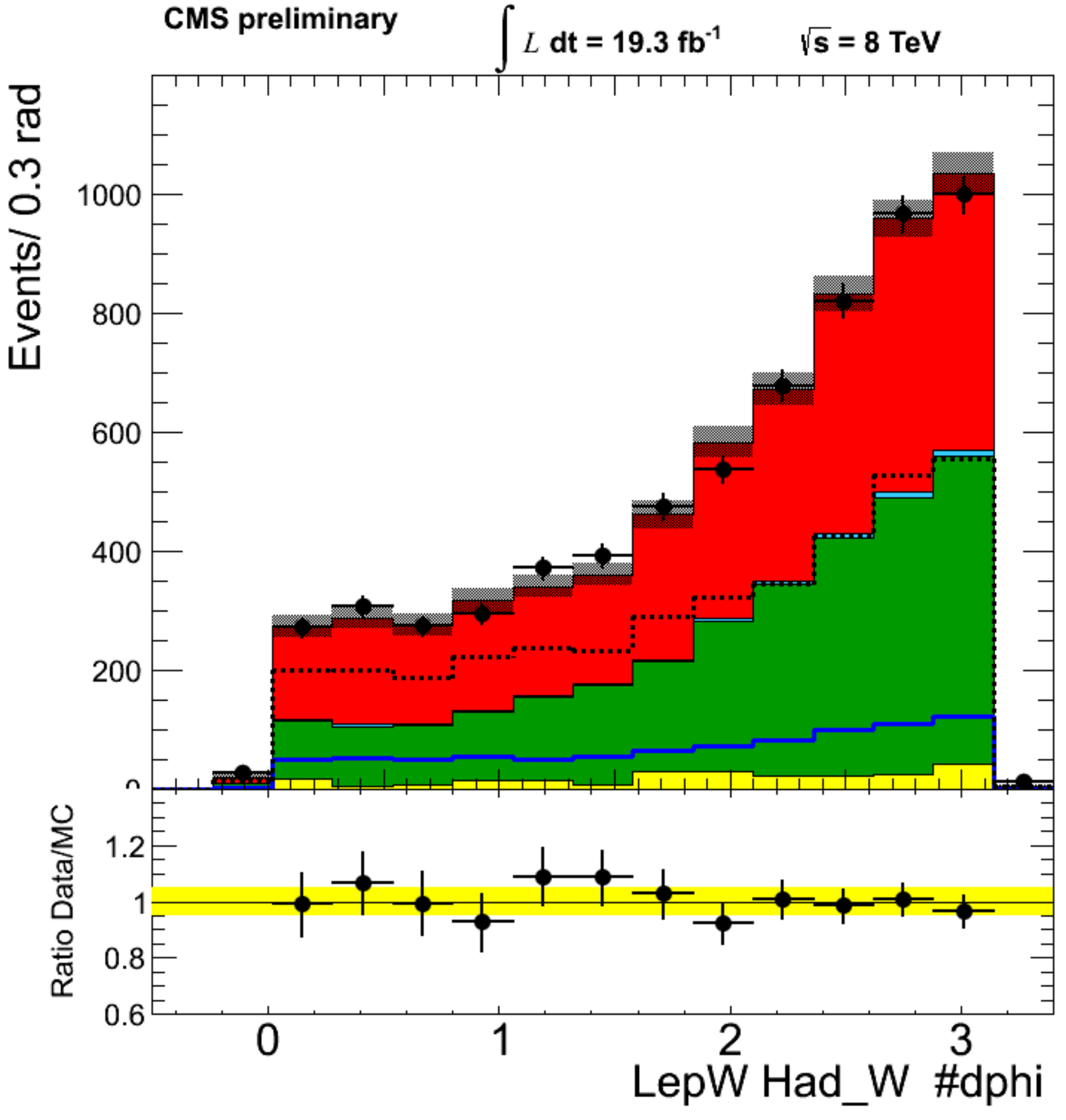

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Events/ 0.3
600
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
0
5
10
hvbf_hW_tag2 Δη

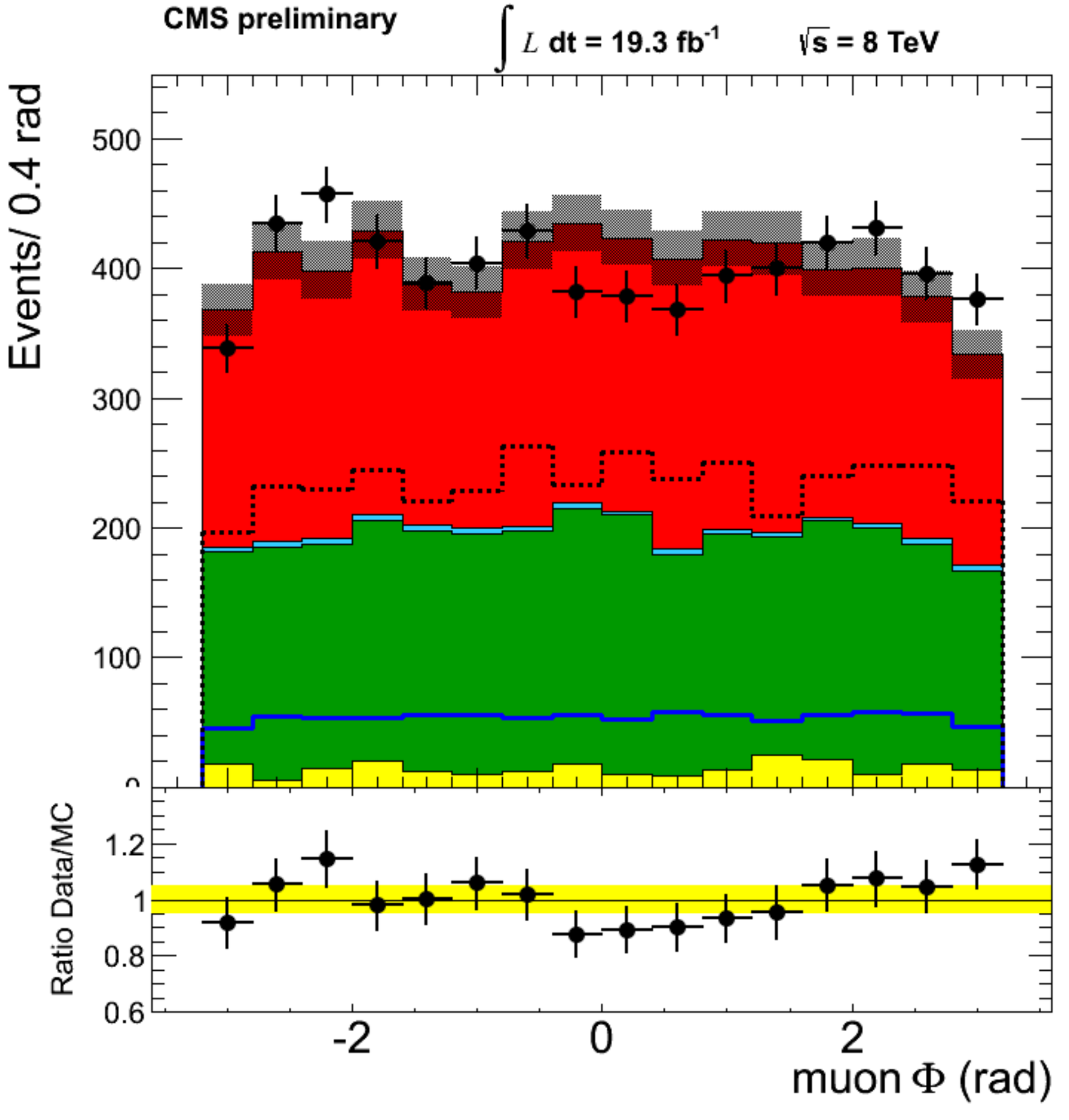

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.3 rad
1000
800
600
400
200
Ratio Data/MC
1.2
1
0.8
0.6
0
1
2
3
Tagjets #dphi

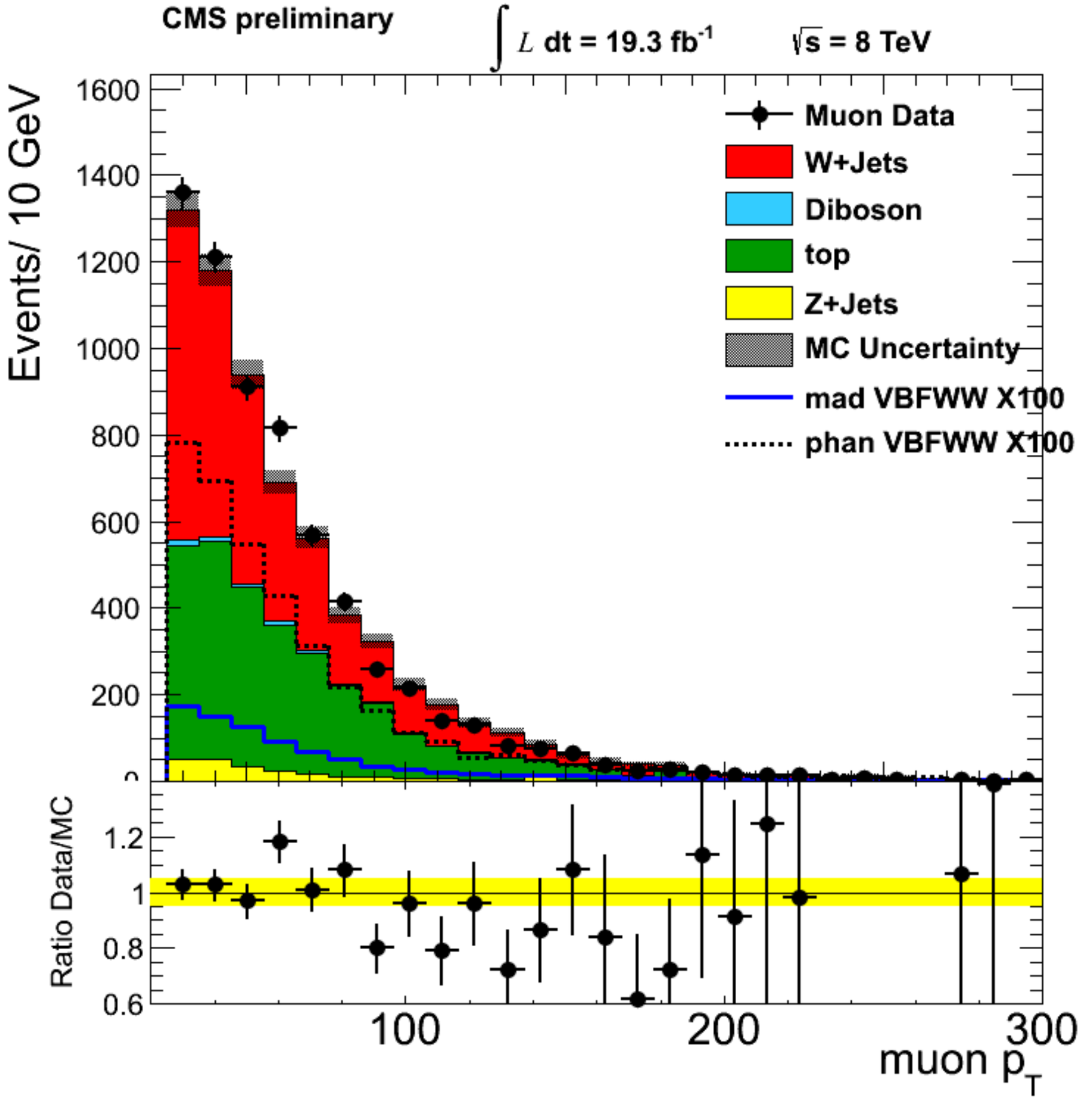

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Muon Data
W+Jets
Diboson
top
Z+Jets
MC Uncertainty
mad VBFWW X100
phan VBFWW X100
Events/ 19 GeV
Ratio Data/MC
m_{jjj} (GeV)

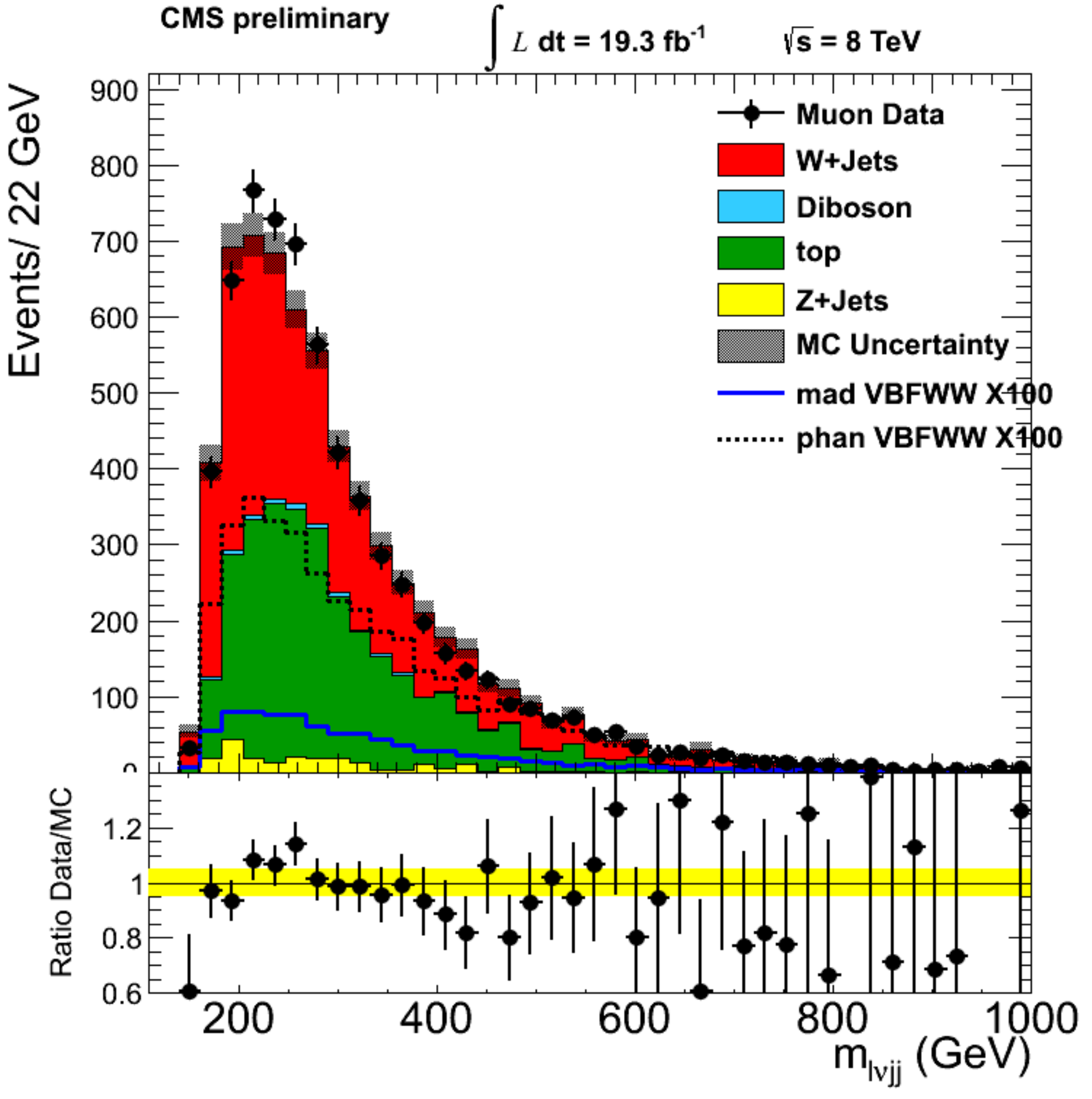

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.2
800
700
600
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
-2
0
2
Tag jets jj rapidity

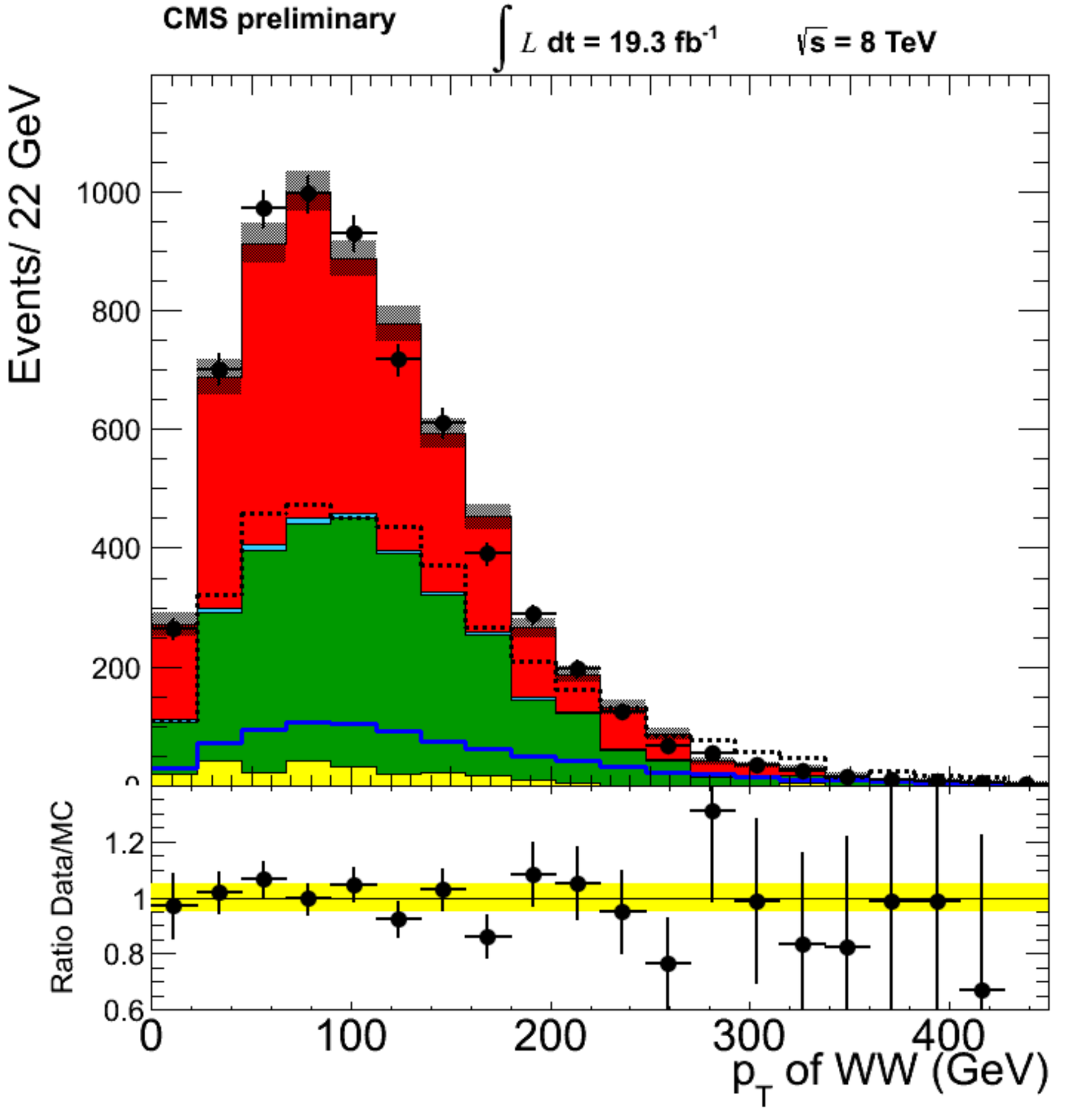

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Events/ 0.3
600
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
-2
-1
0
1
2
Muon η

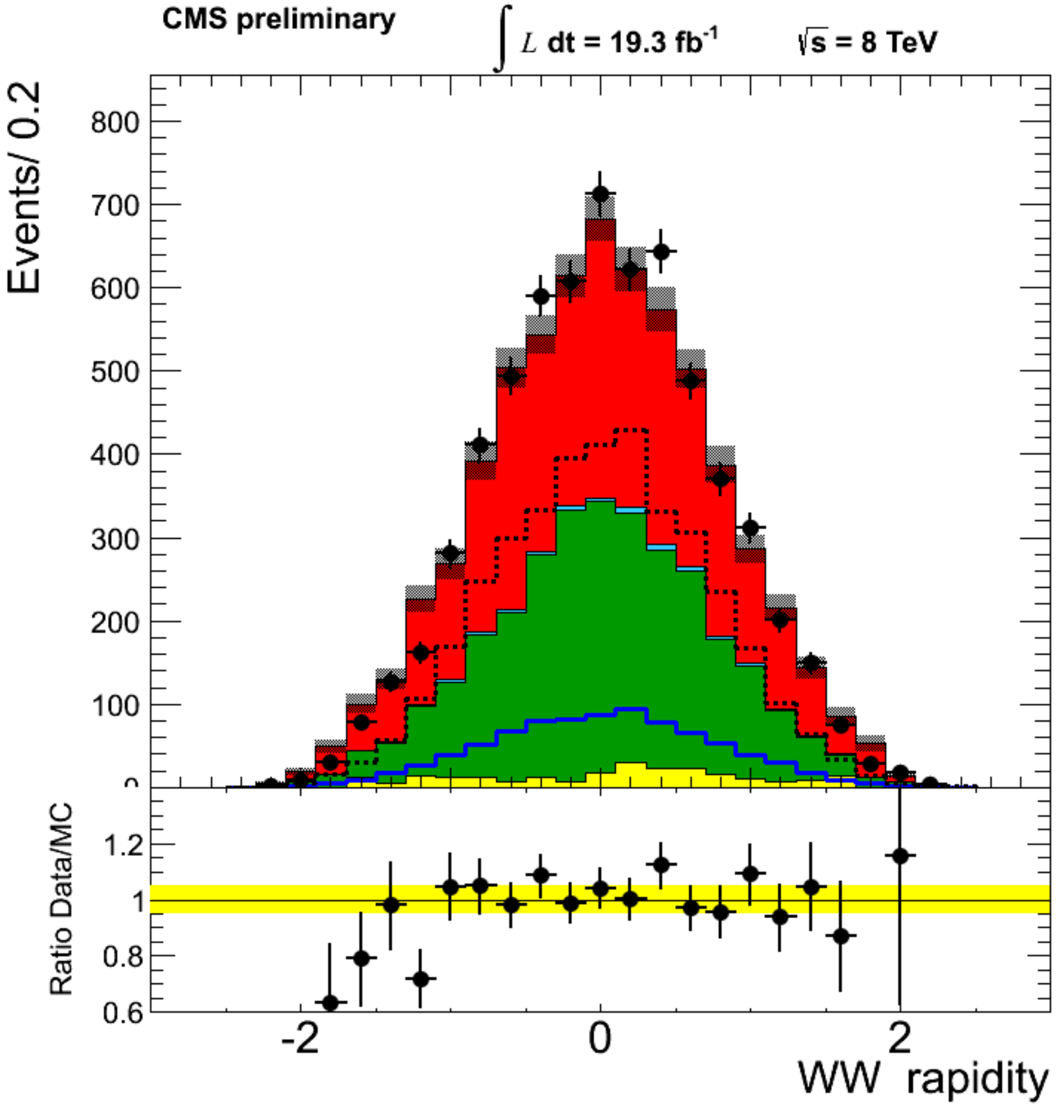

CMS preliminary
∫ L dt = 19.3 fb-1
√s = 8 TeV
Events/ 0.3 rad
1000
800
600
400
200
Ratio Data/MC
1.2
1
0.8
0.6
0
1
2
3
LepW Had_W #dphi

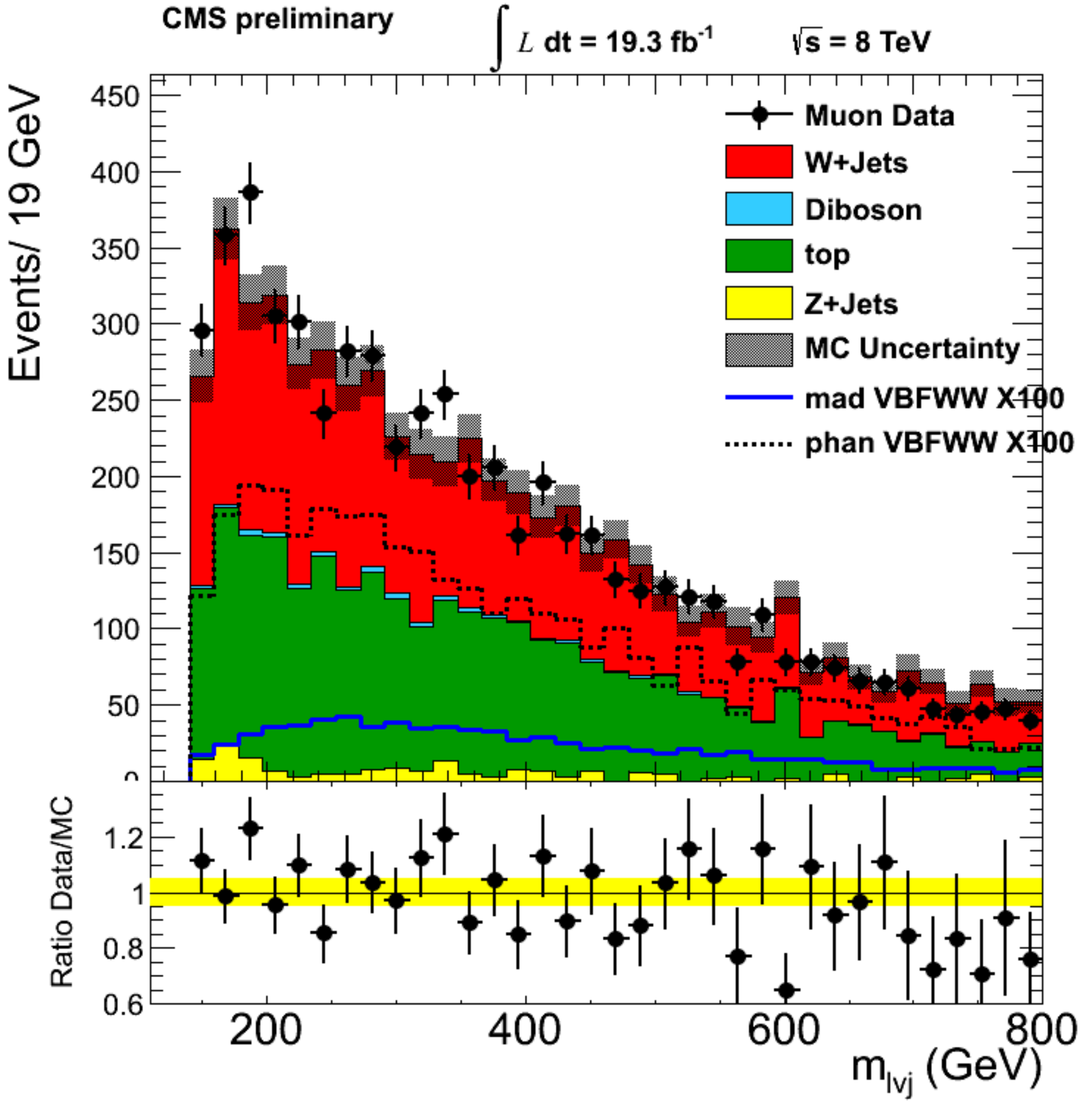

CMS preliminary
∫ L dt = 19.3 fb-1
√s = 8 TeV
Events/ 0.4 rad
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
-2
0
2
muon Φ (rad)

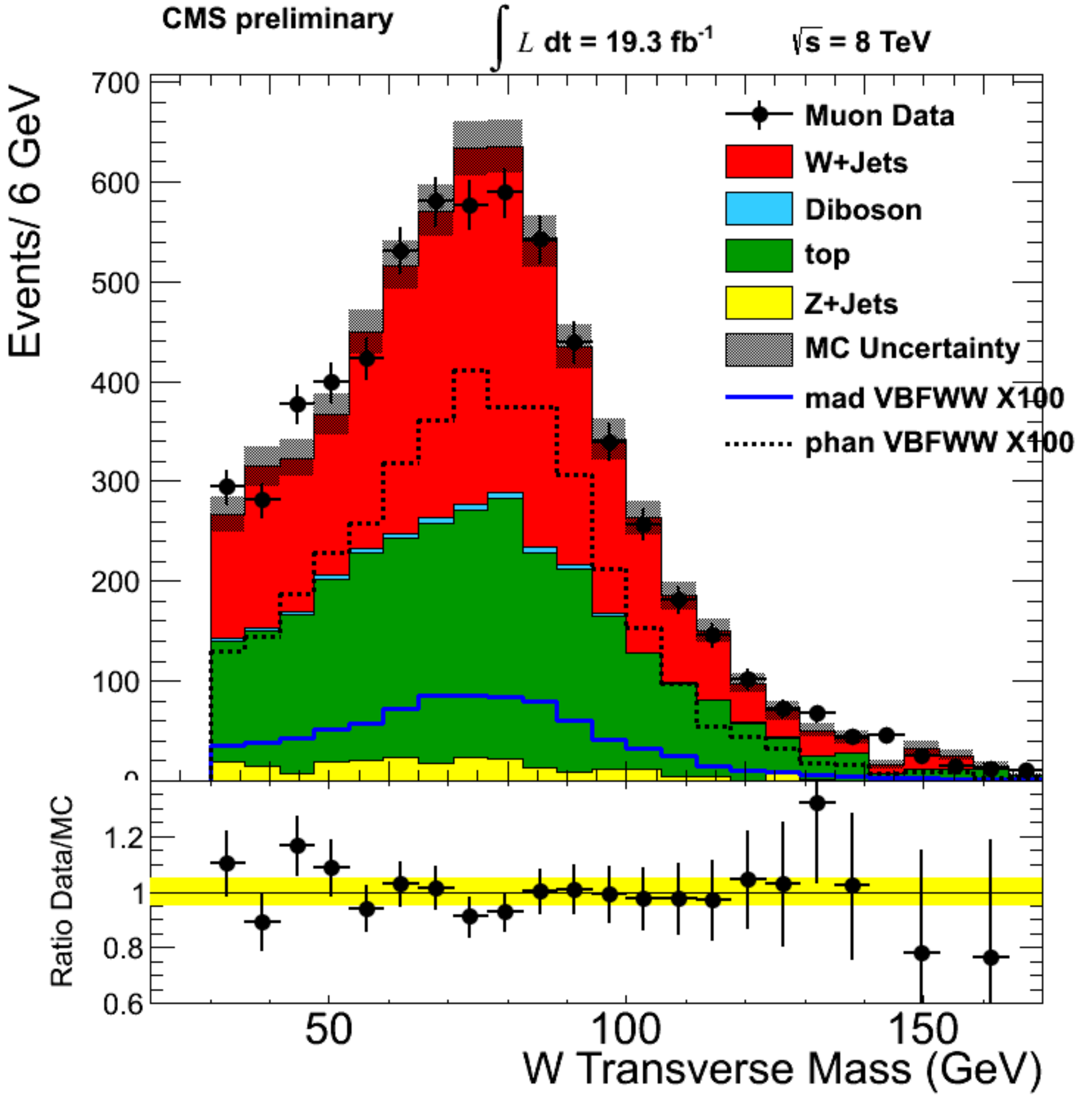

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Events/ 10 GeV
Muon Data
W+Jets
Diboson
top
Z+Jets
MC Uncertainty
mad VBFWW X100
phan VBFWW X100
Ratio Data/MC
muon p_T

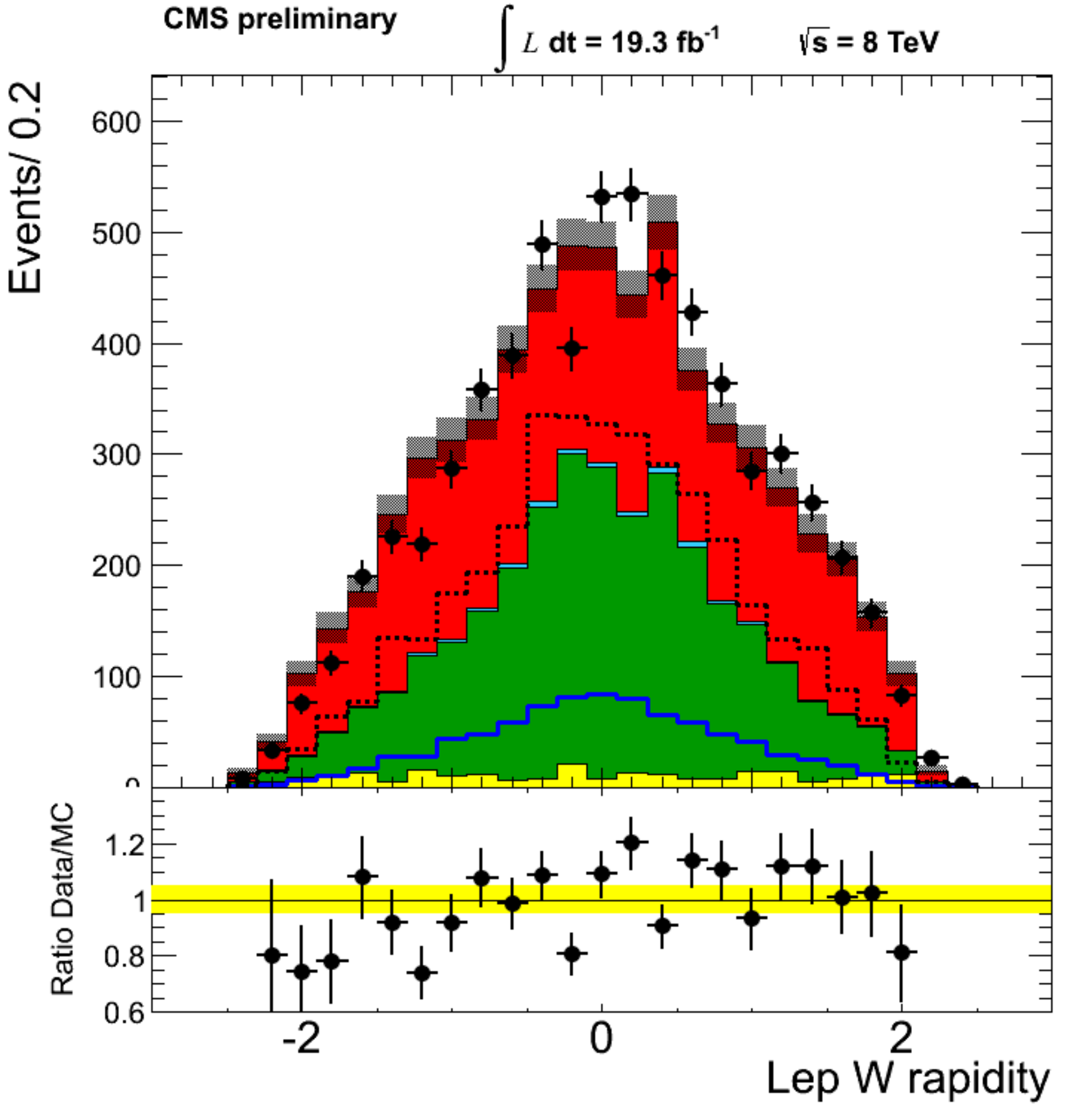

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Muon Data
W+Jets
Diboson
top
Z+Jets
MC Uncertainty
mad VBFWW X100
phan VBFWW X100
Events/ 22 GeV
Ratio Data/MC
m_{lvjj} (GeV)

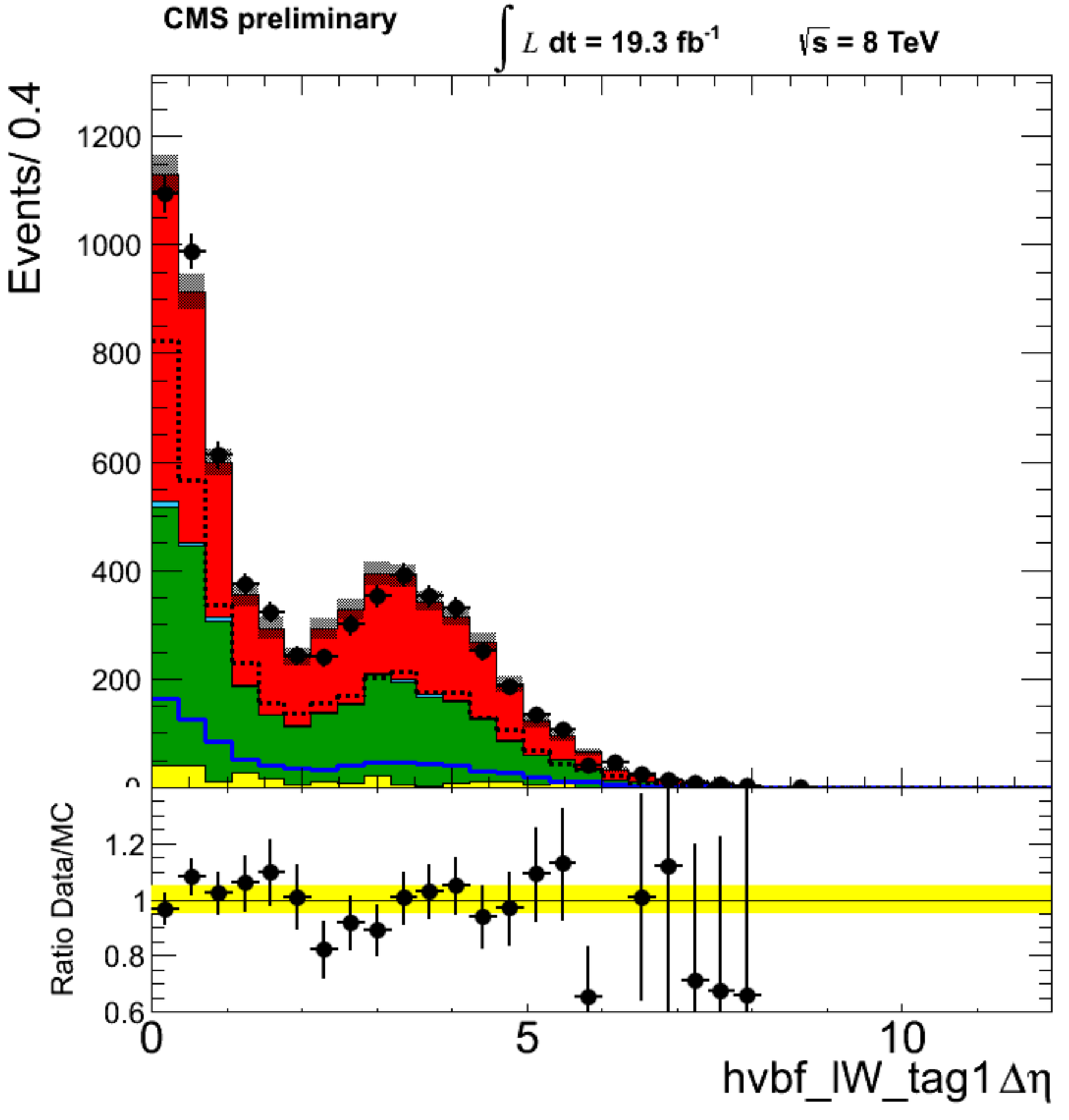

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 22 GeV
1000
800
600
400
200
Ratio Data/MC
1.2
1
0.8
0.6
0
100
200
300
400
p_T of WW (GeV)

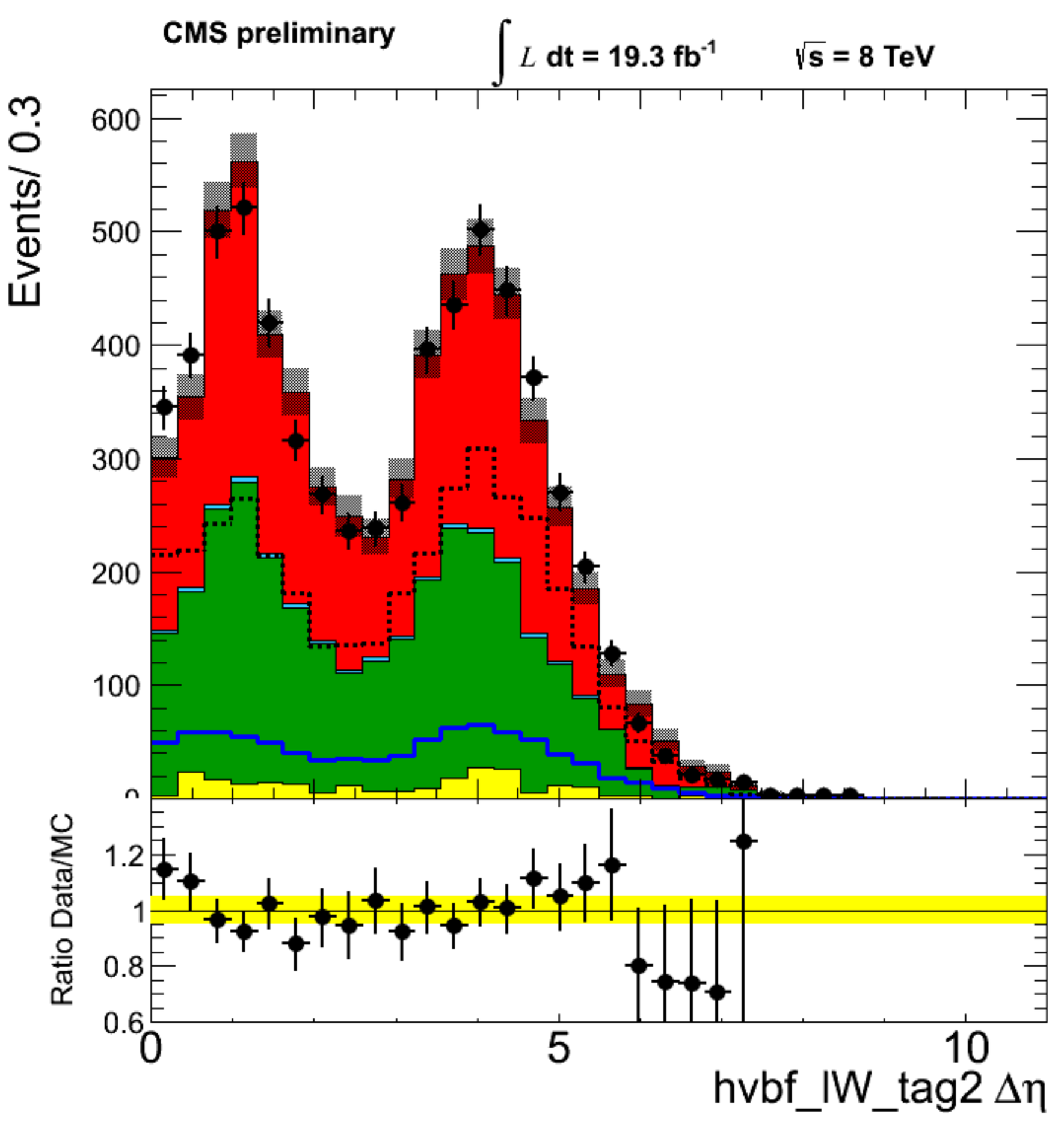

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Events/ 0.2
800
700
600
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
-2
0
2
WW rapidity

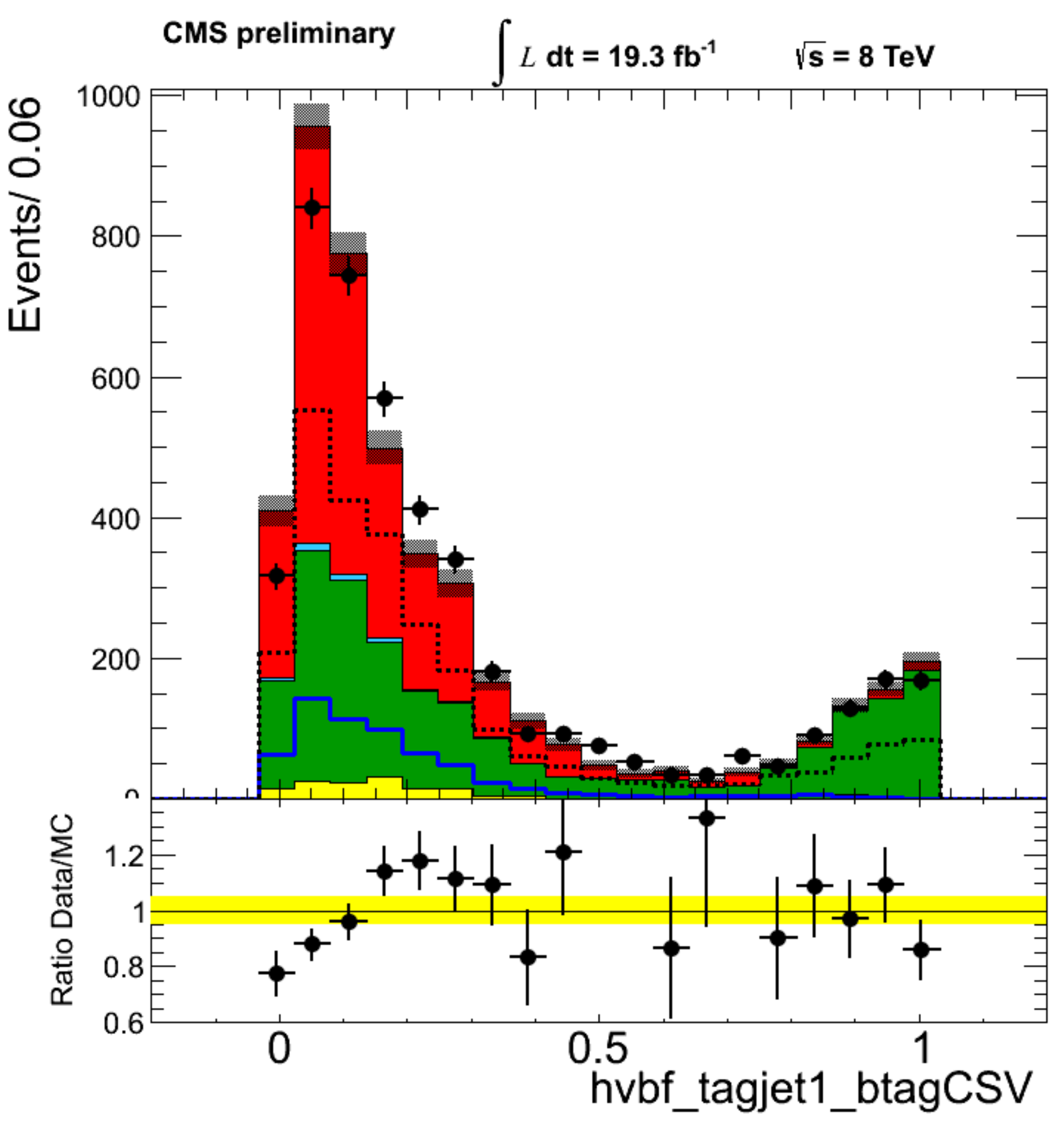

CMS preliminary
$\int L\ dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Muon Data
W+Jets
Diboson
top
Z+Jets
MC Uncertainty
mad VBFWW X100
phan VBFWW X100
Events/ 19 GeV
Ratio Data/MC
m_{lvj} (GeV)

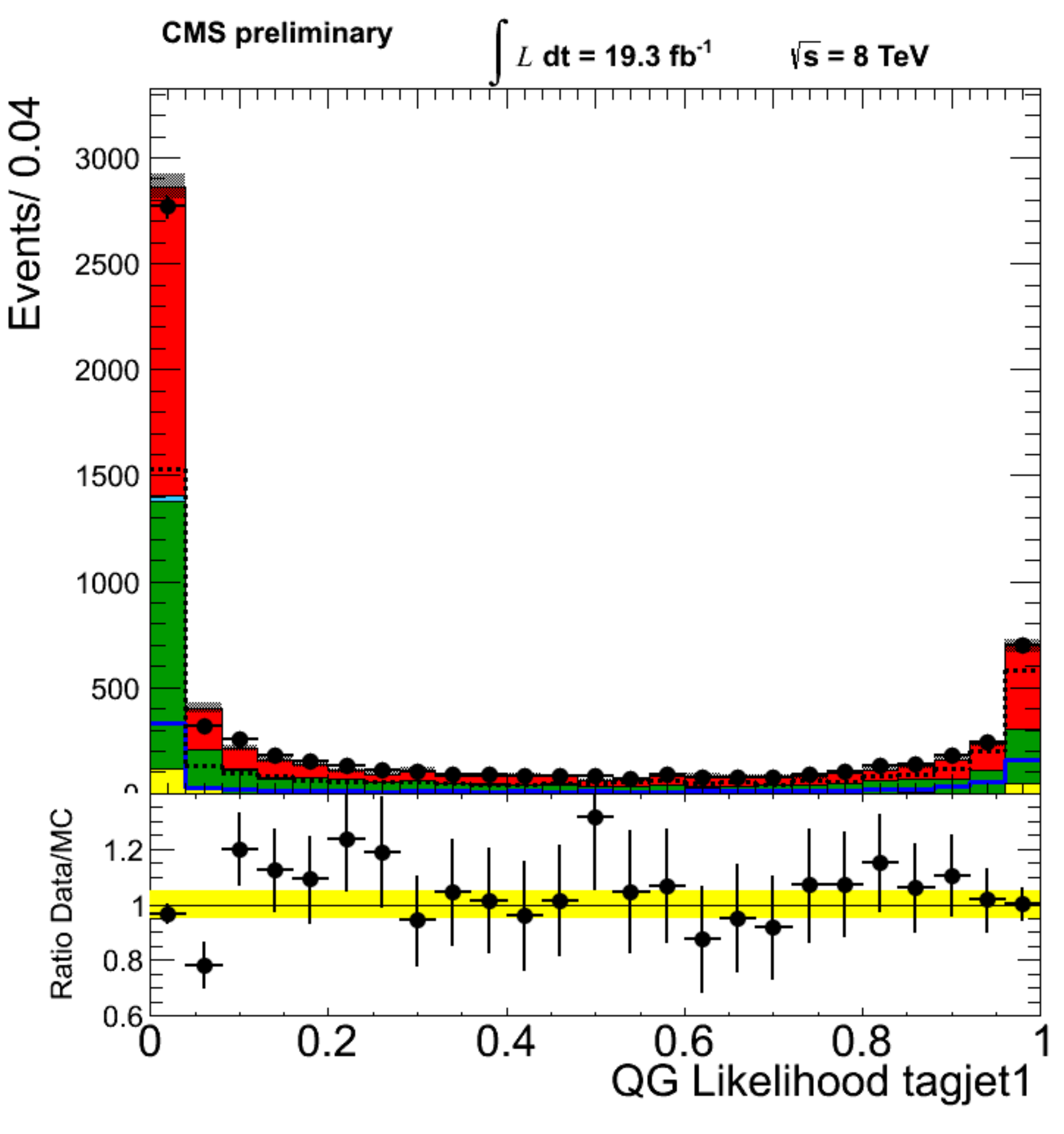

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Muon Data
W+Jets
Diboson
top
Z+Jets
MC Uncertainty
mad VBFWW X100
phan VBFWW X100
Events/ 6 GeV
Ratio Data/MC
W Transverse Mass (GeV)

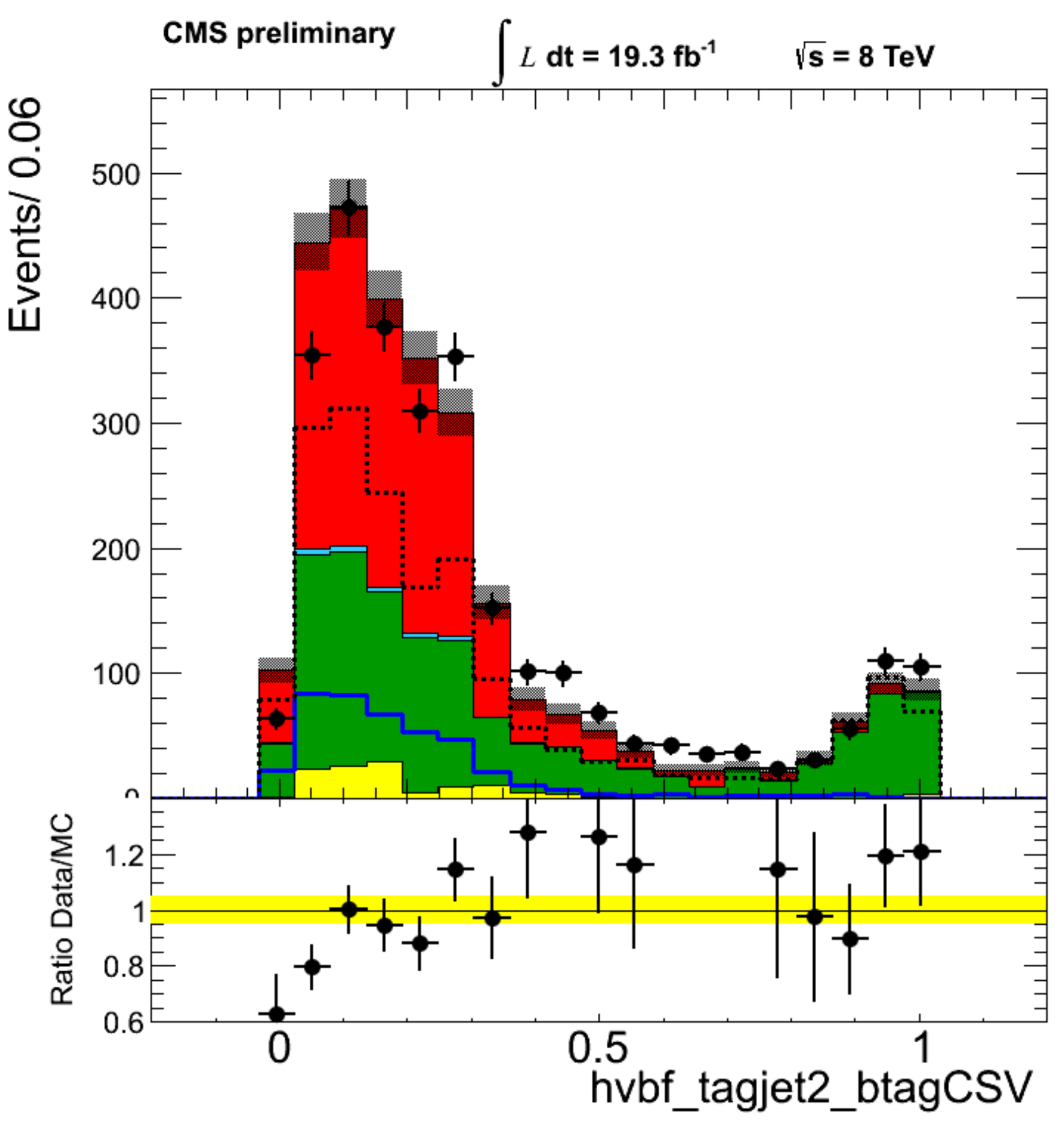

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.2
600
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
-2
0
2
Lep W rapidity

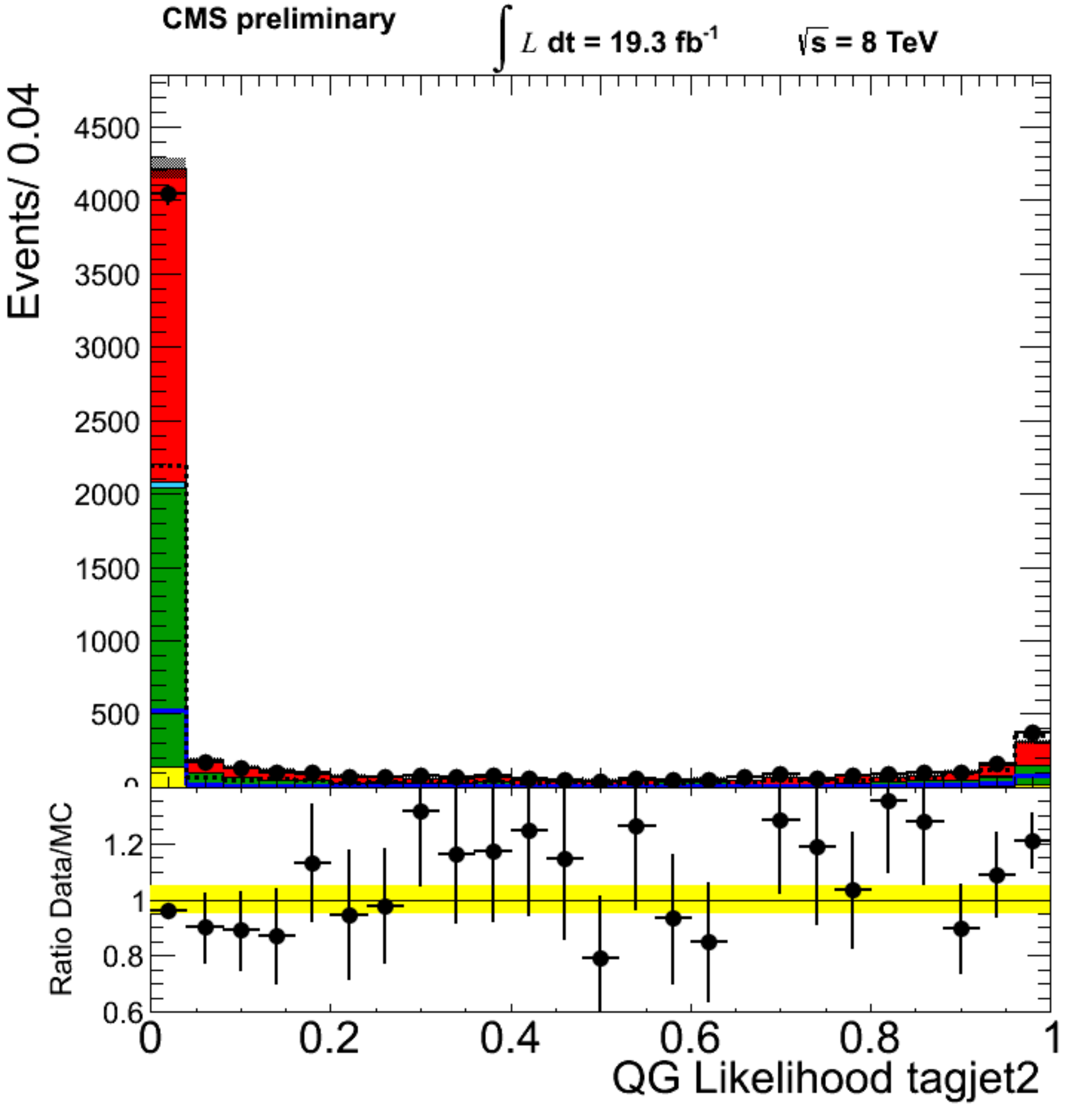

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.4
1200
1000
800
600
400
200
Ratio Data/MC
1.2
1
0.8
0.6
0
5
10
hvbf_lW_tag1 Δη

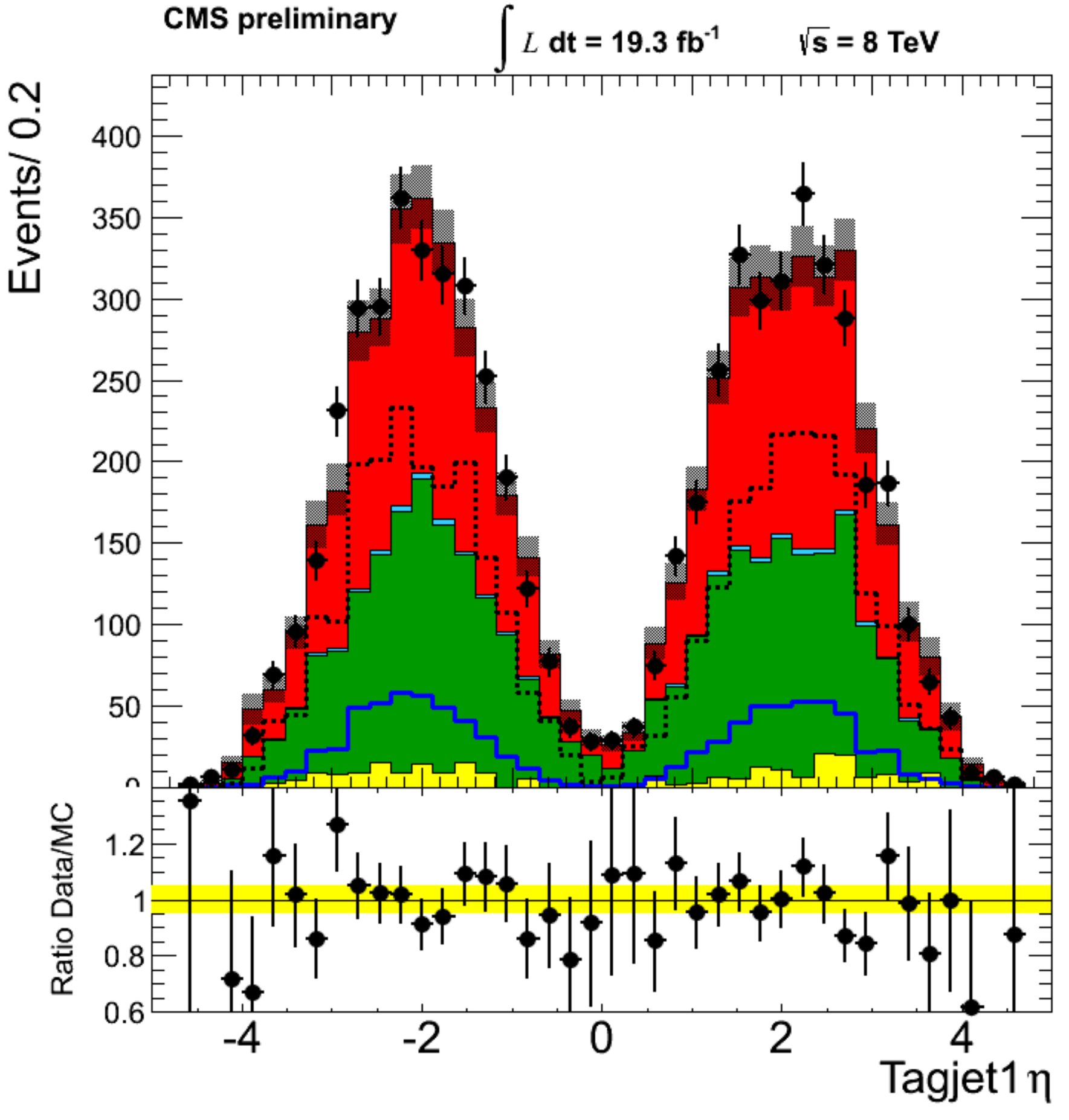

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.3
600
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
0
5
10
hvbf_lW_tag2 Δη

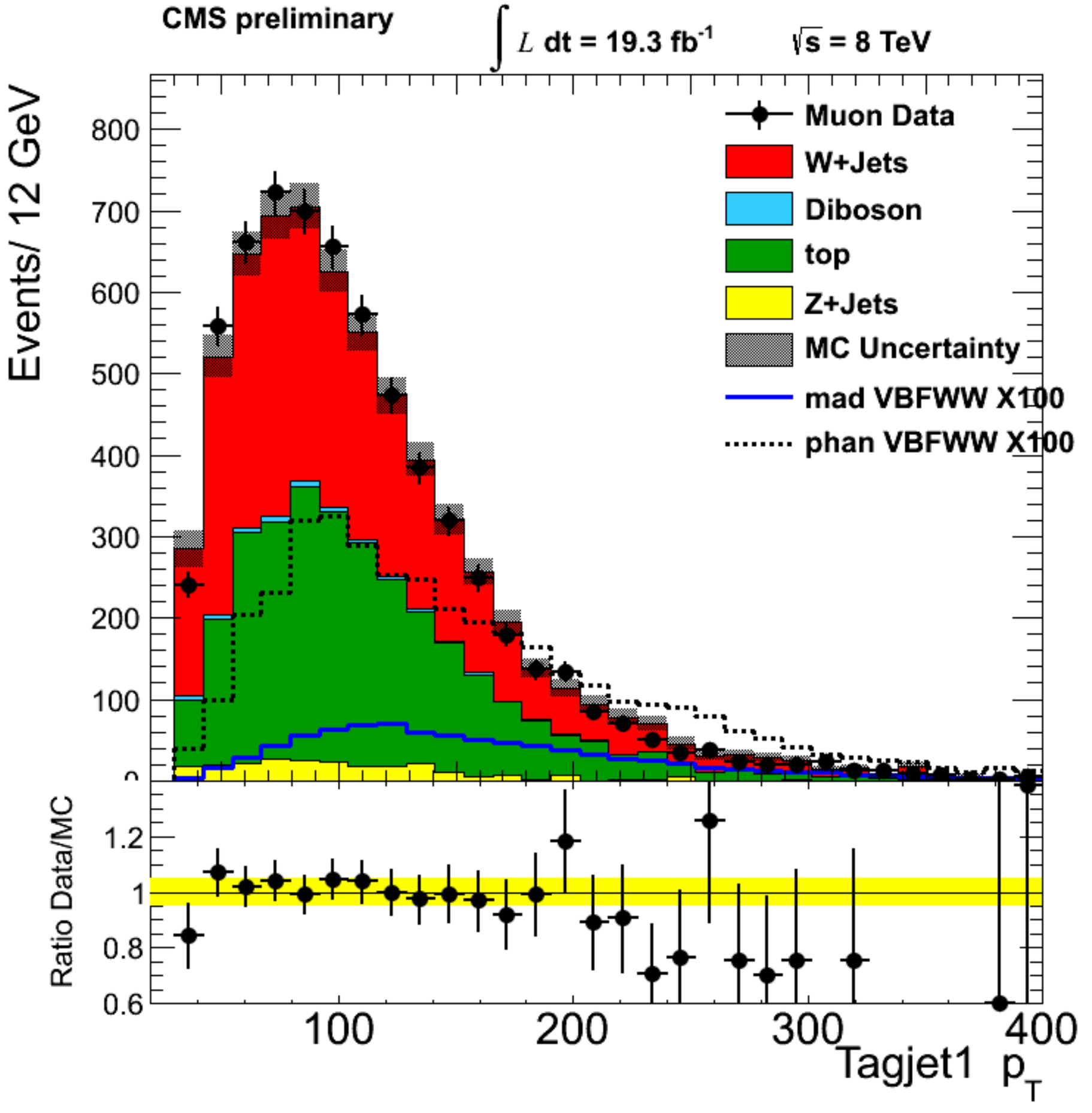

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.06
1000
800
600
400
200
Ratio Data/MC
1.2
1
0.8
0.6
0
0.5
1
hvbf_tagjet1_btagCSV

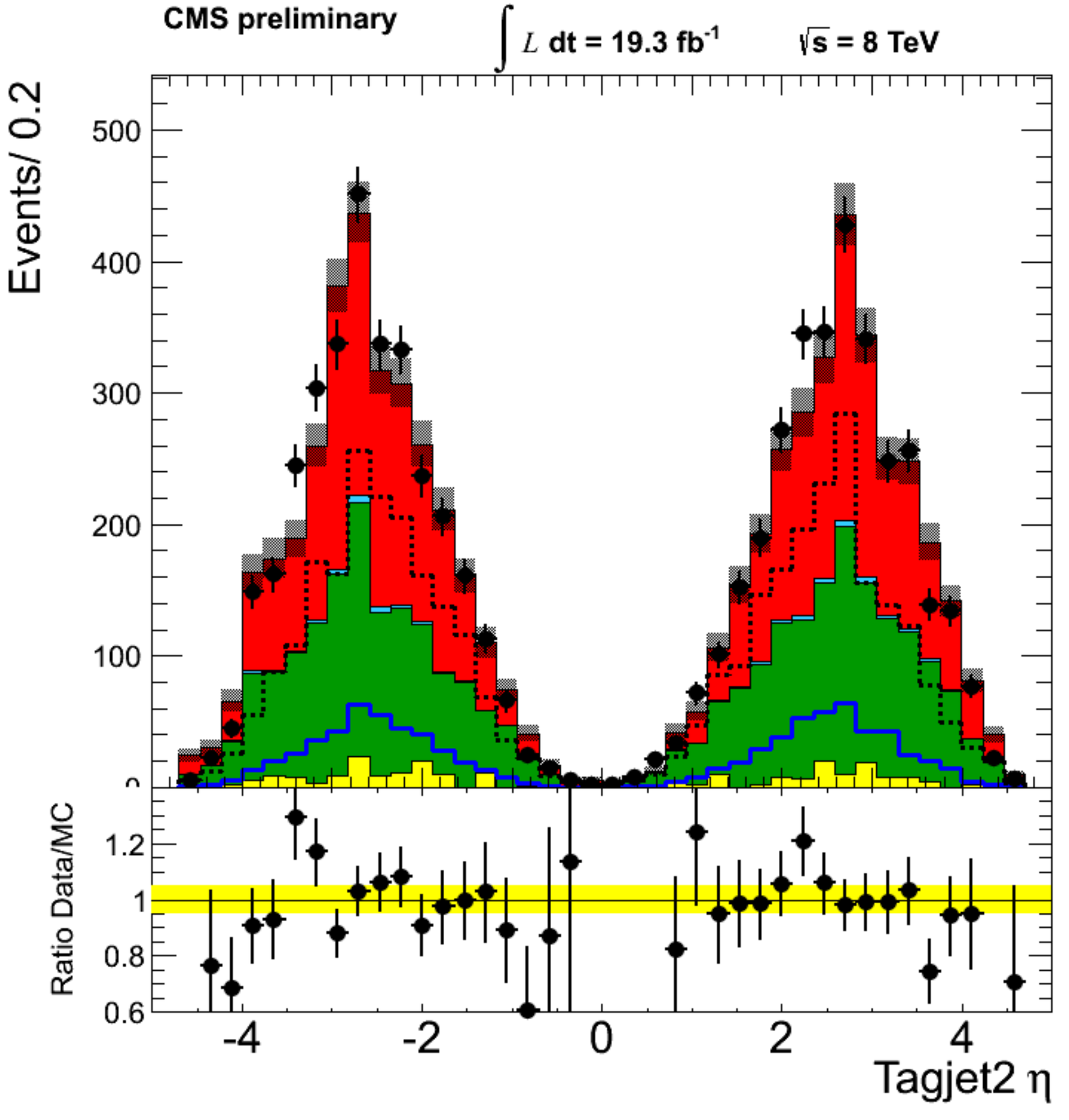

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Events/ 0.04
3000
2500
2000
1500
1000
500
Ratio Data/MC
1.2
1
0.8
0.6
0
0.2
0.4
0.6
0.8
1
QG Likelihood tagjet1

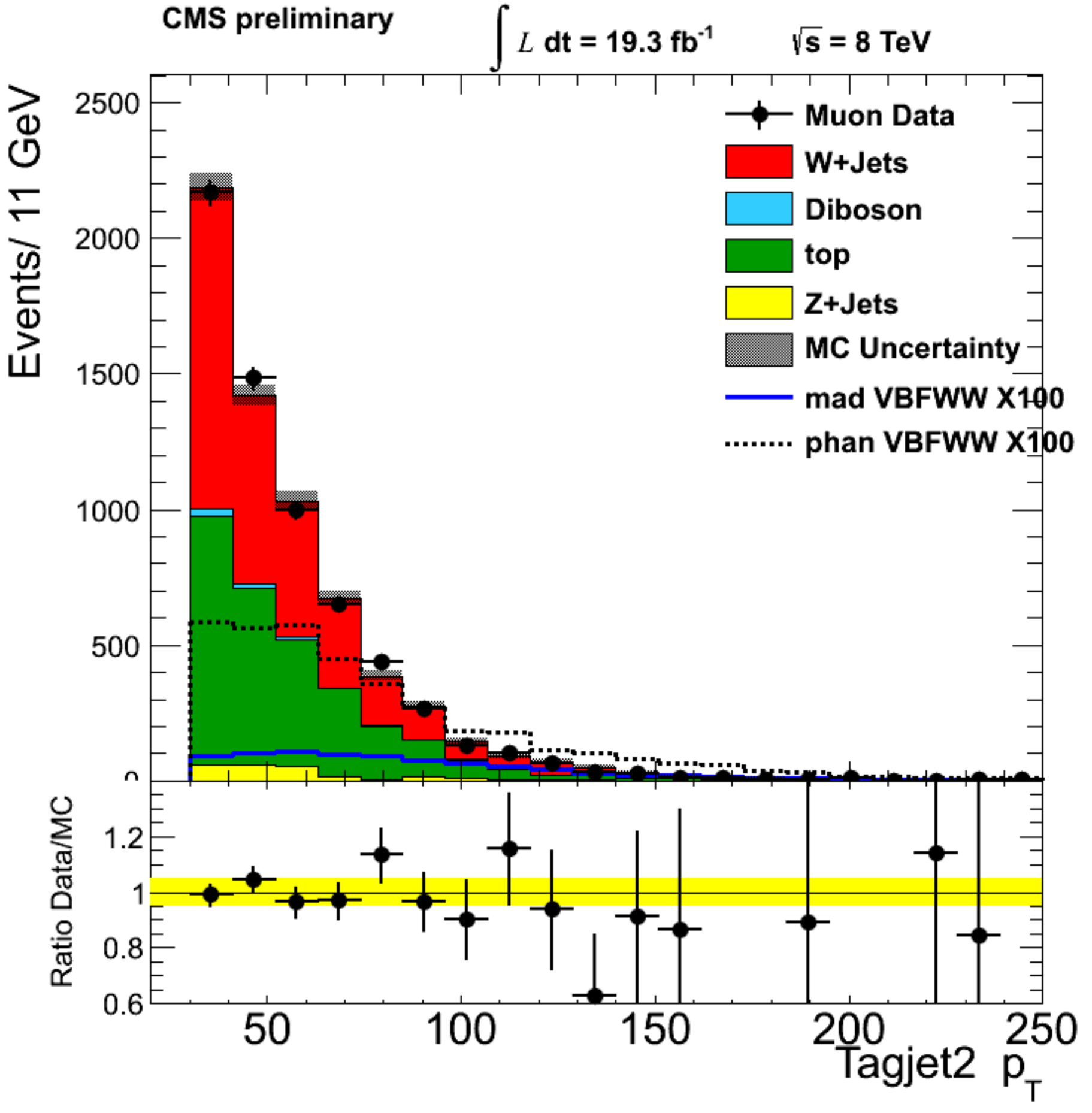

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.06
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
0
0.5
1
hvbf_tagjet2_btagCSV

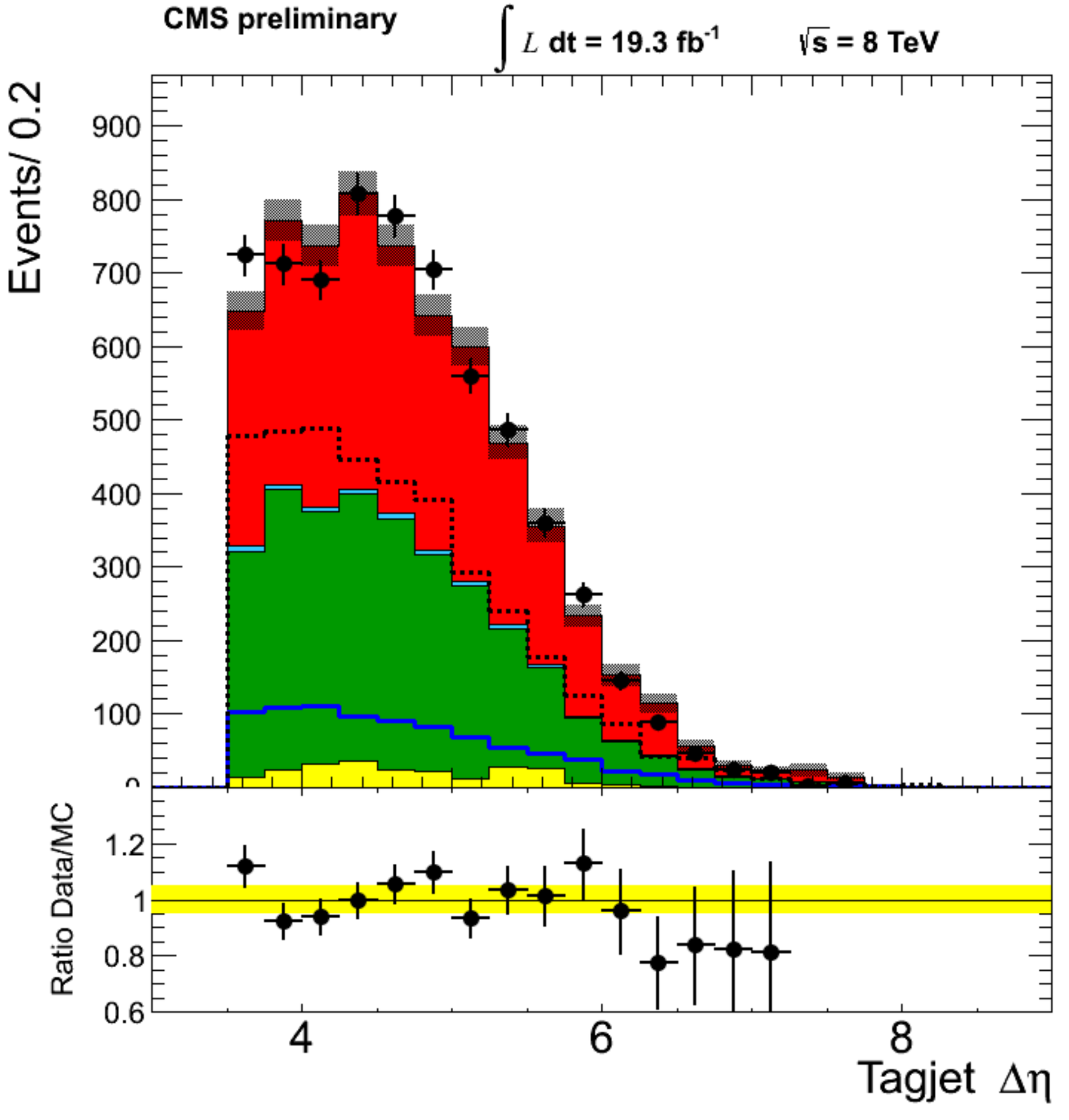

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Events/ 0.04
4500
4000
3500
3000
2500
2000
1500
1000
500
Ratio Data/MC
1.2
1
0.8
0.6
0
0.2
0.4
0.6
0.8
1
QG Likelihood tagjet2

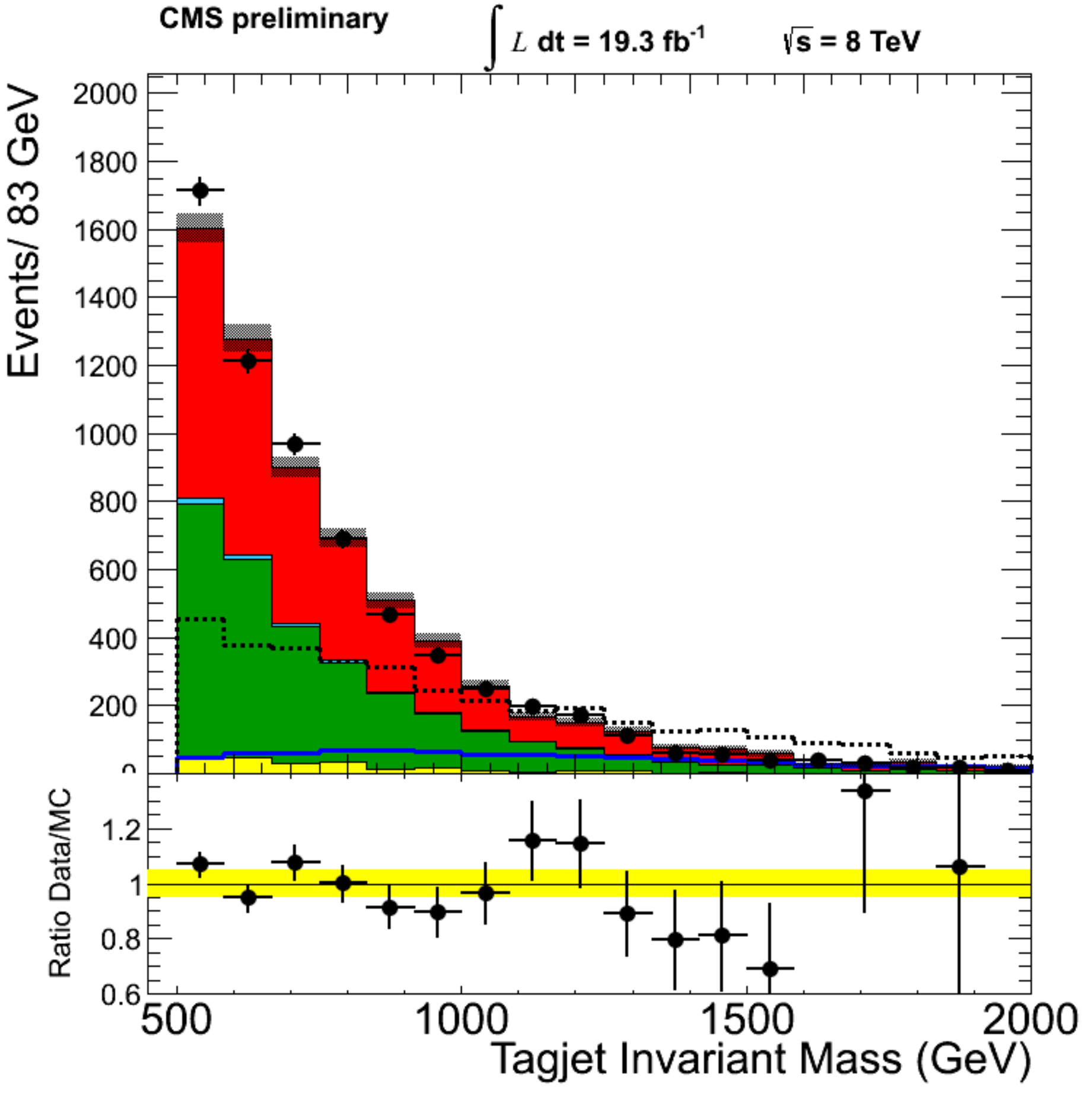

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.2
400
350
300
250
200
150
100
50
Ratio Data/MC
1.2
1
0.8
0.6
-4
-2
0
2
4
Tagjet1 η

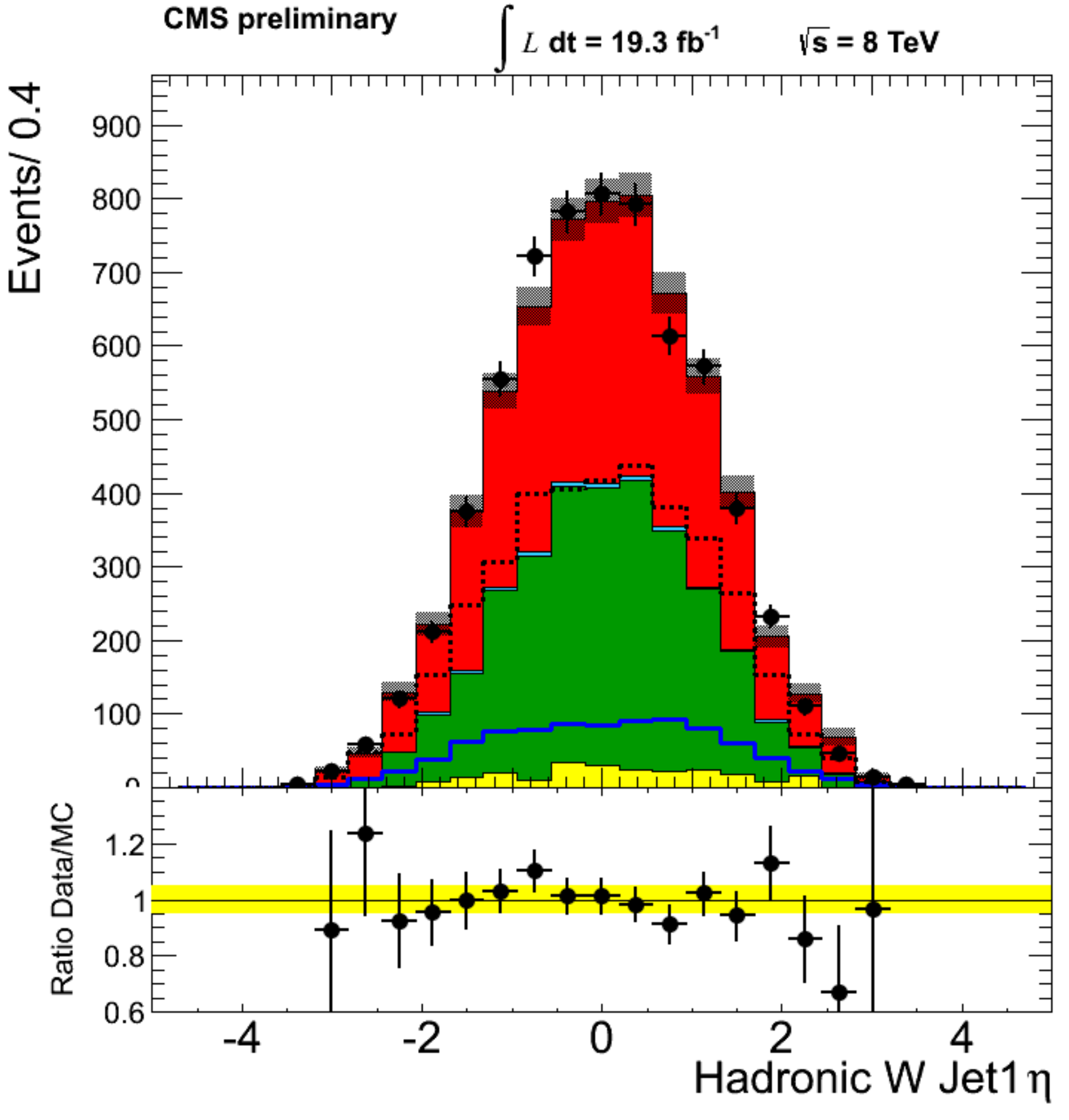

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Muon Data
W+Jets
Diboson
top
Z+Jets
MC Uncertainty
mad VBFWW X100
phan VBFWW X100
Events/ 12 GeV
800
700
600
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
100
200
300
400
Tagjet1 p_T

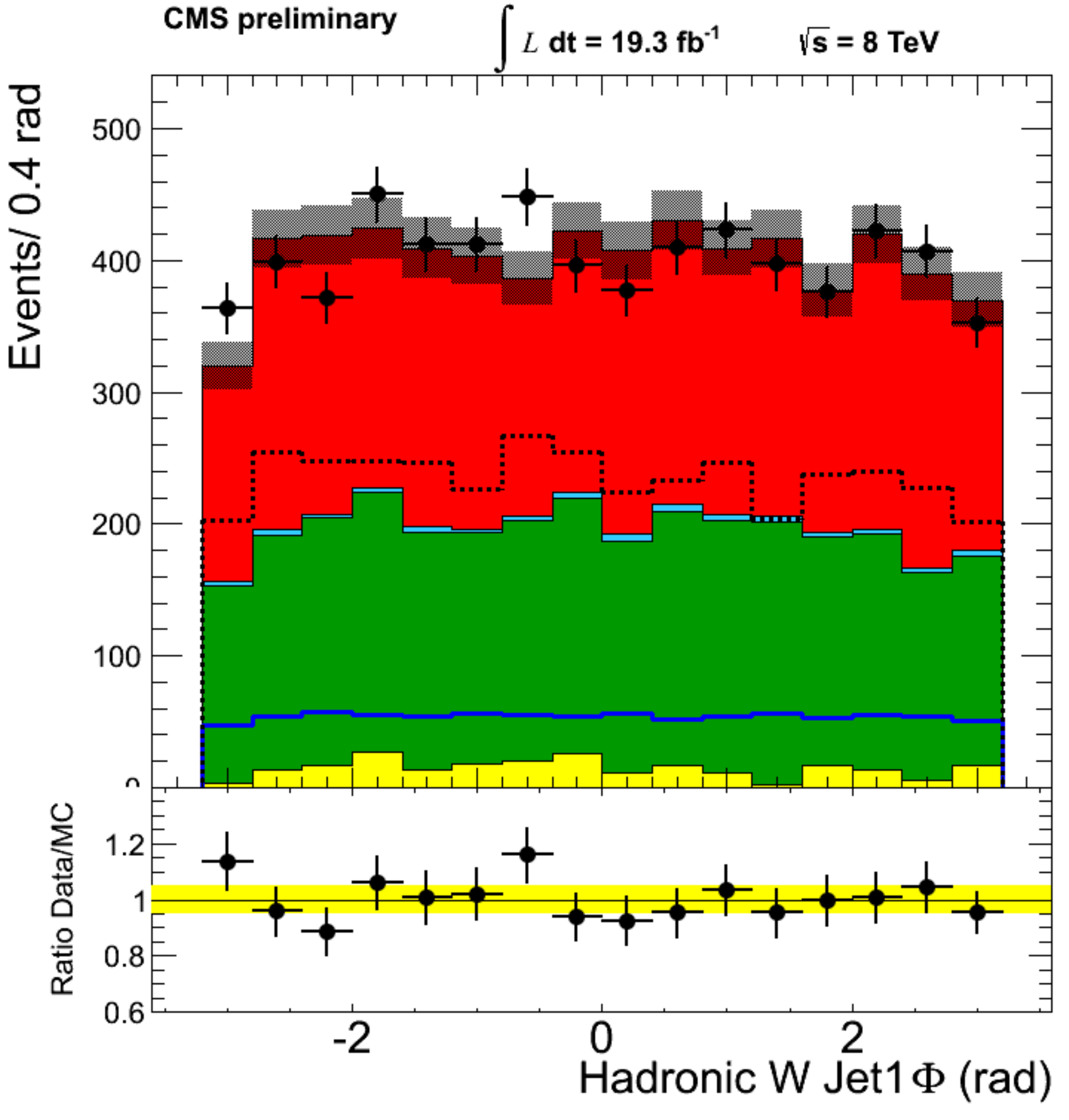

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.2
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
-4
-2
0
2
4
Tagjet2 η

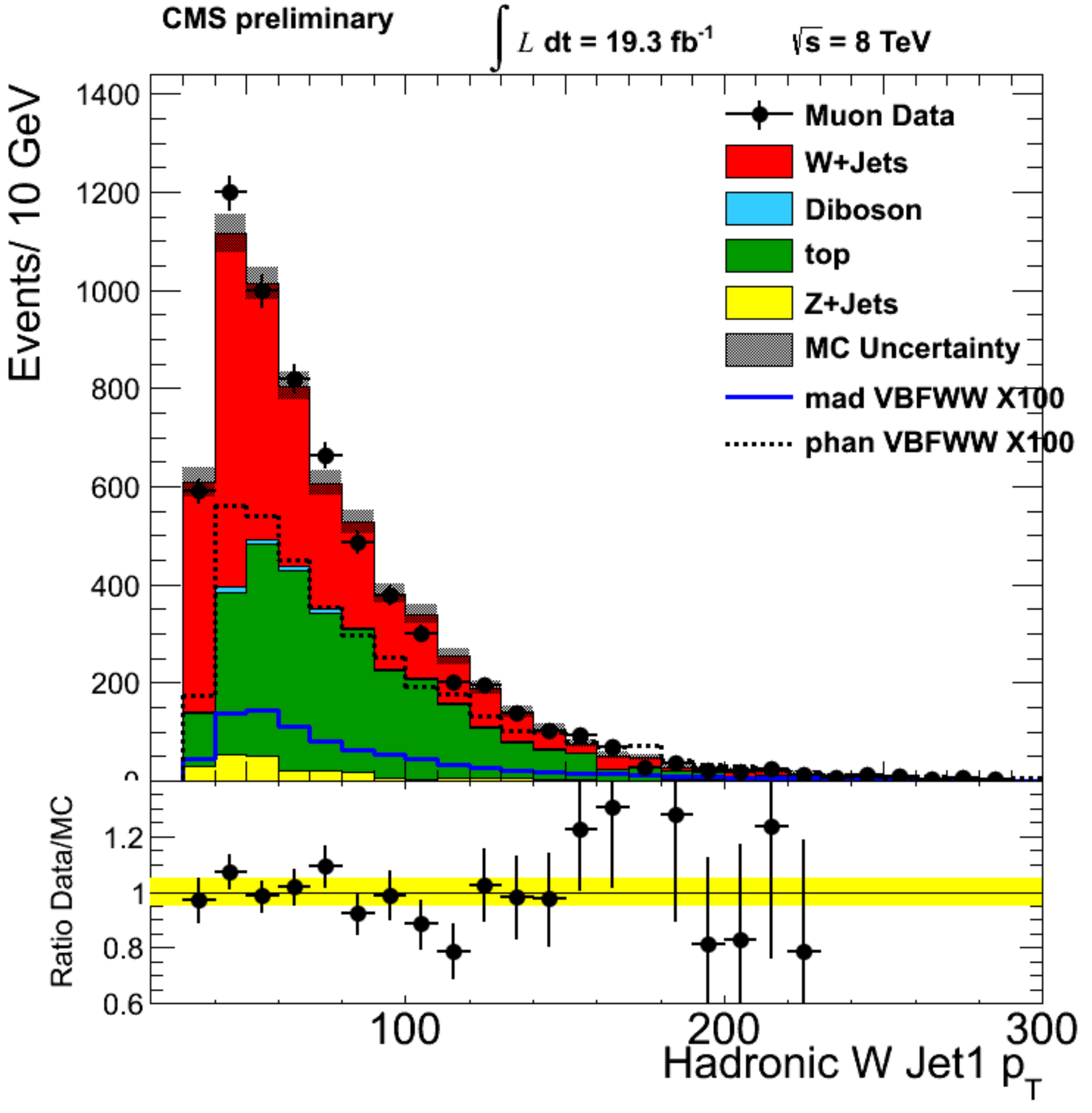

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Muon Data
W+Jets
Diboson
top
Z+Jets
MC Uncertainty
mad VBFWW X100
phan VBFWW X100
Events/ 11 GeV
2500
2000
1500
1000
500
Ratio Data/MC
1.2
1
0.8
0.6
50
100
150
200
250
Tagjet2 p_T

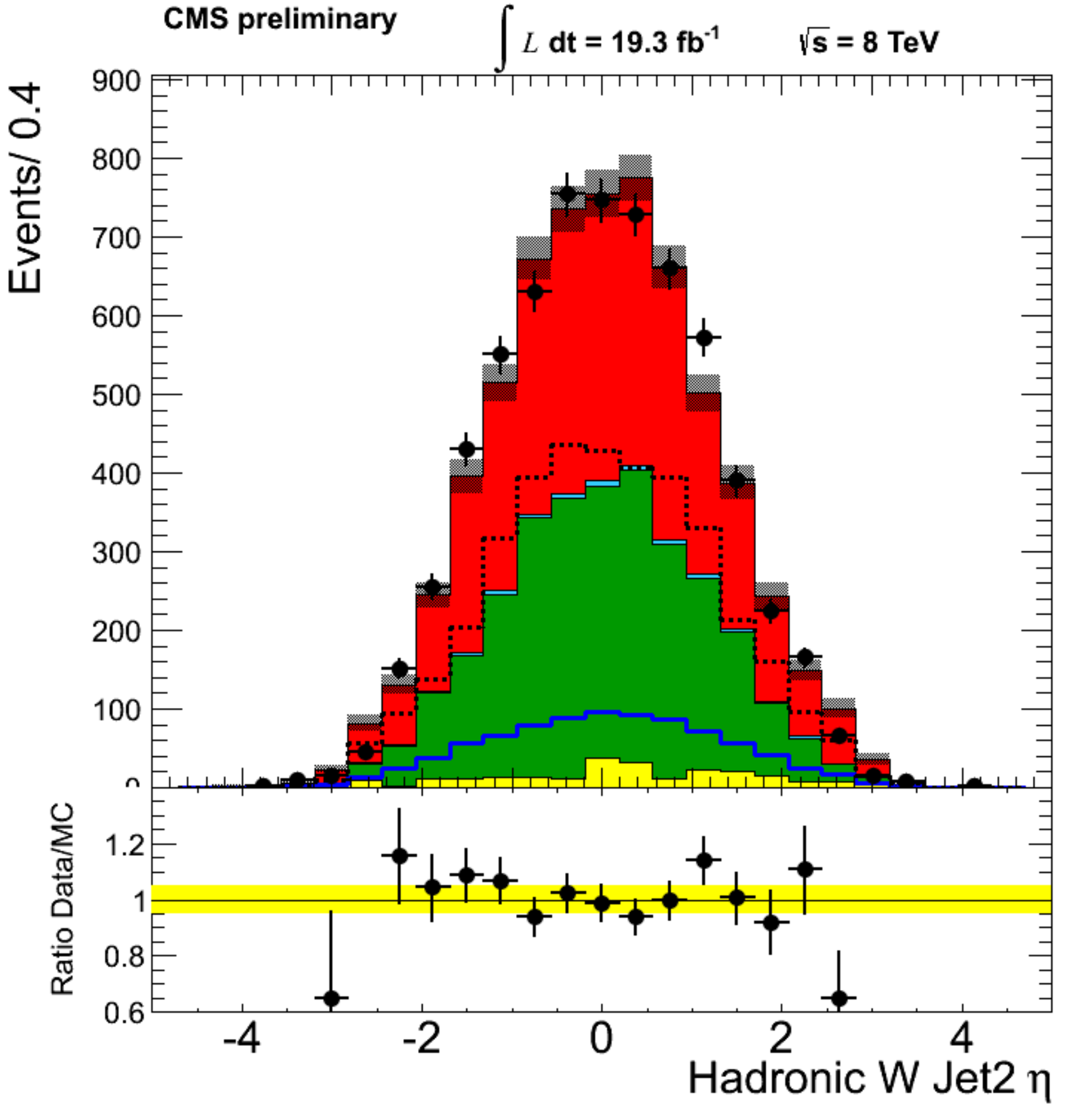

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.2
900
800
700
600
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
4
6
8
Tagjet Δη

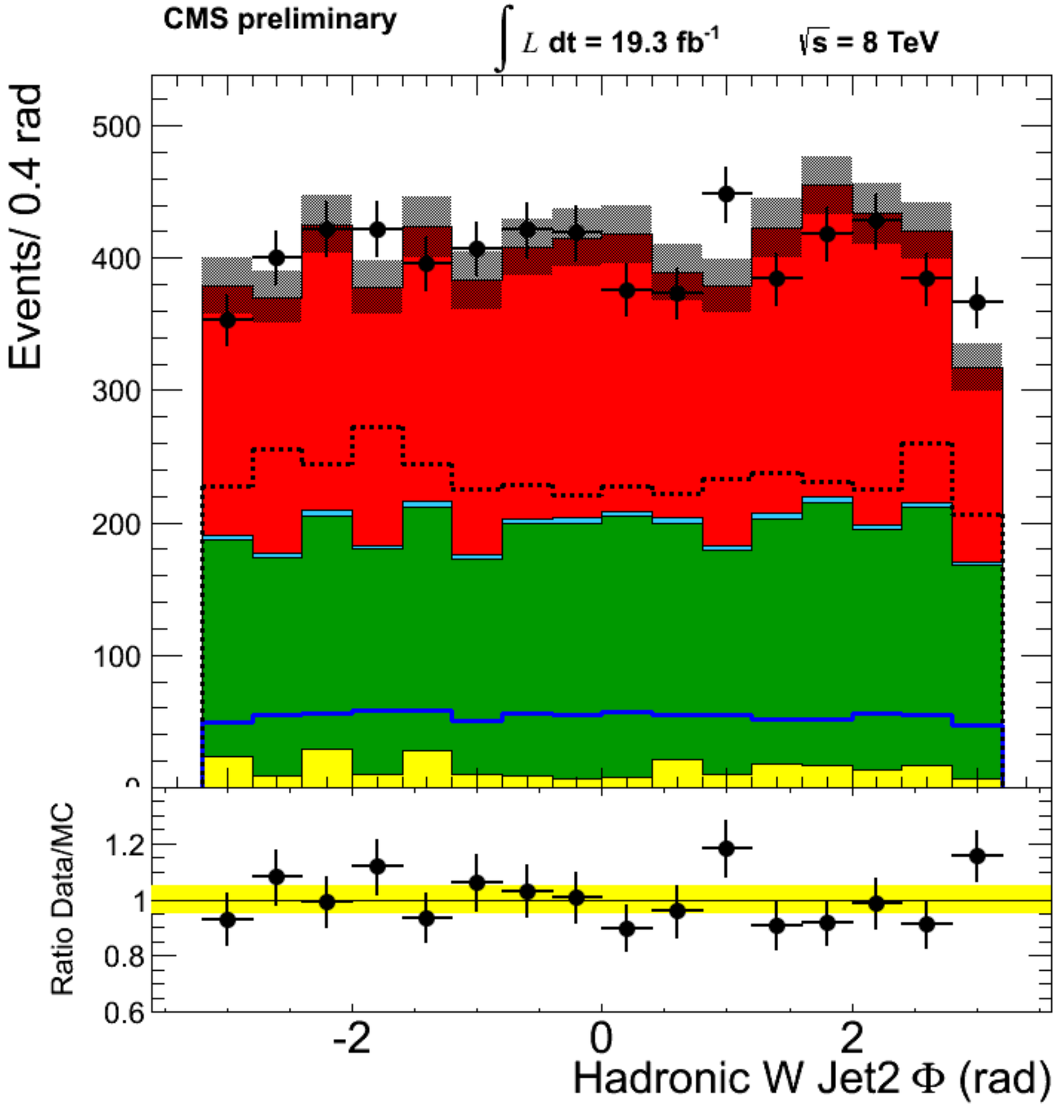

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 83 GeV
2000
1800
1600
1400
1200
1000
800
600
400
200
Ratio Data/MC
1.2
1
0.8
0.6
500
1000
1500
2000
Tagjet Invariant Mass (GeV)

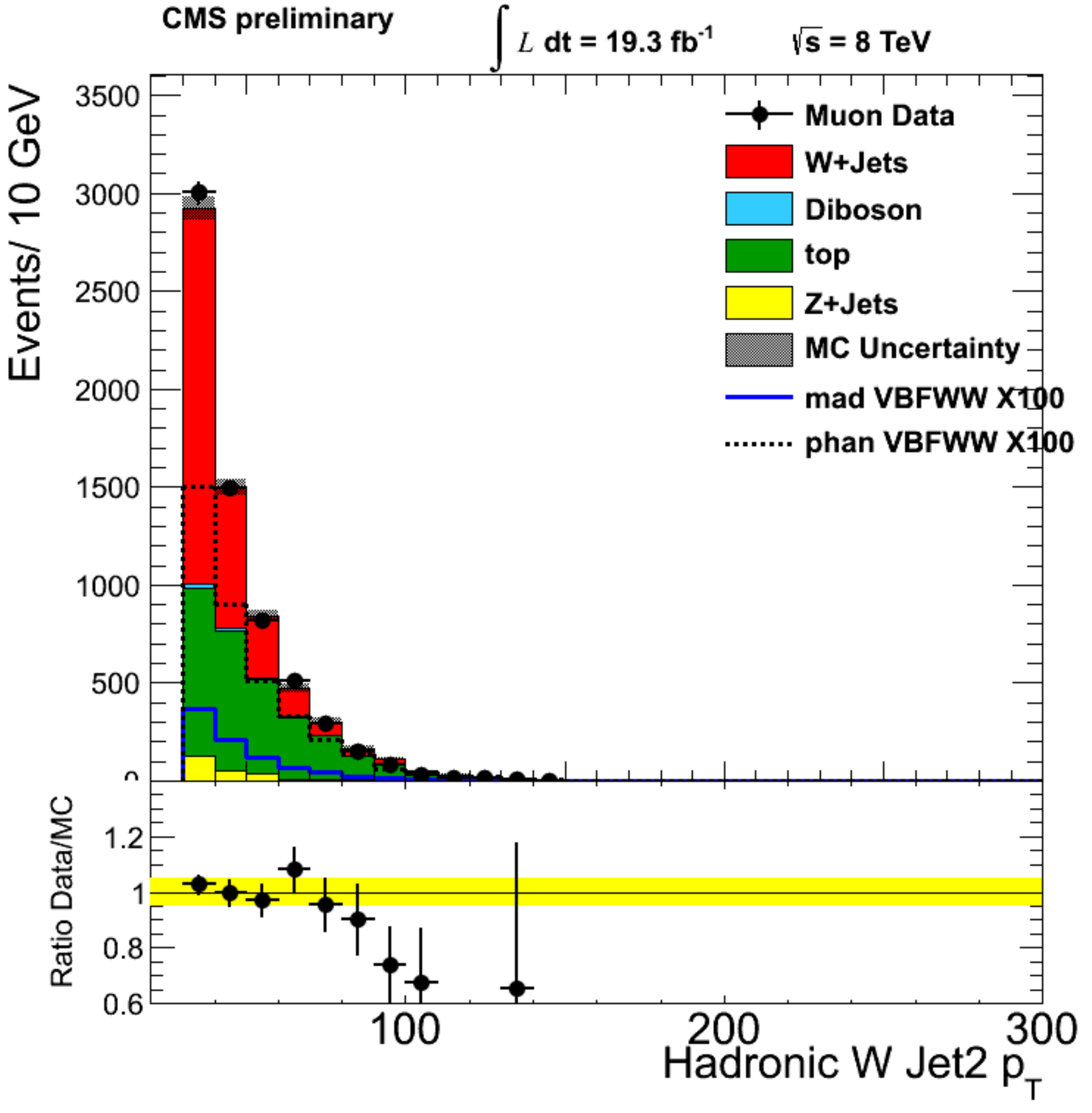

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.4
900
800
700
600
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
-4
-2
0
2
4
Hadronic W Jet1 η

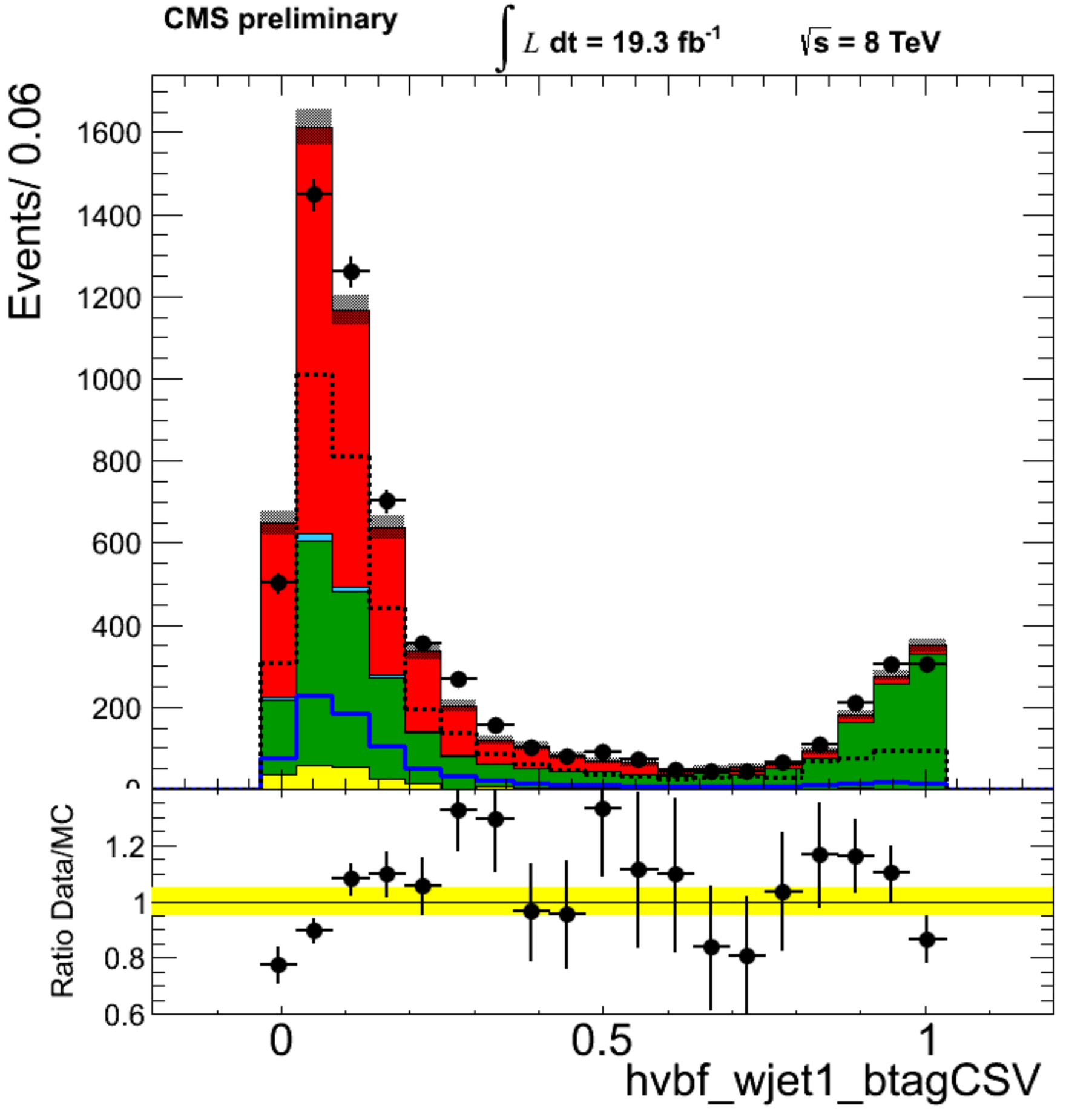

CMS preliminary
$\int L\ dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Events/ 0.4 rad
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
-2
0
2
Hadronic W Jet1 Φ (rad)

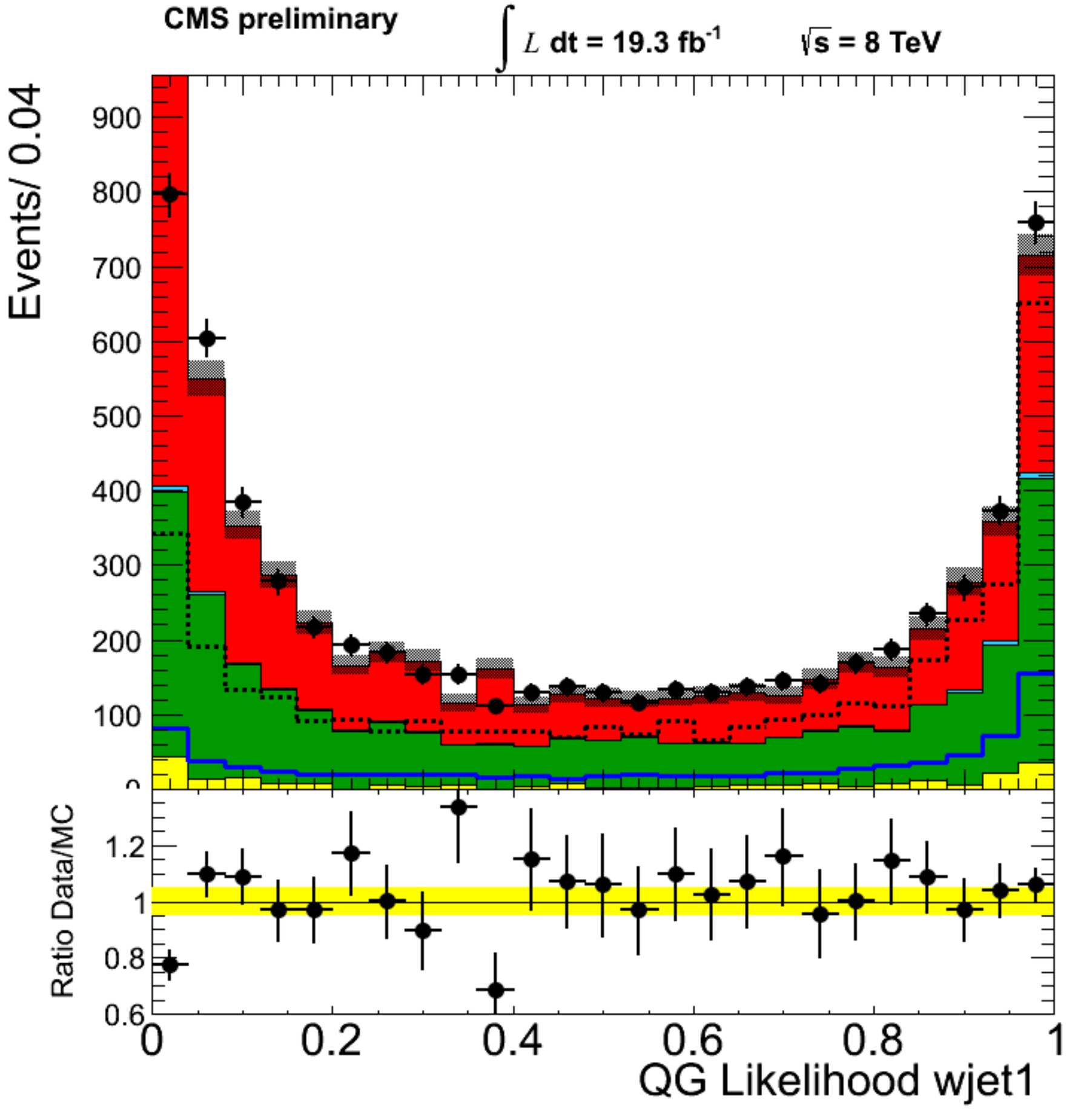

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Muon Data
W+Jets
Diboson
top
Z+Jets
MC Uncertainty
mad VBFWW X100
phan VBFWW X100
Events/ 10 GeV
1400
1200
1000
800
600
400
200
Ratio Data/MC
1.2
1
0.8
0.6
100
200
300
Hadronic W Jet1 p_T

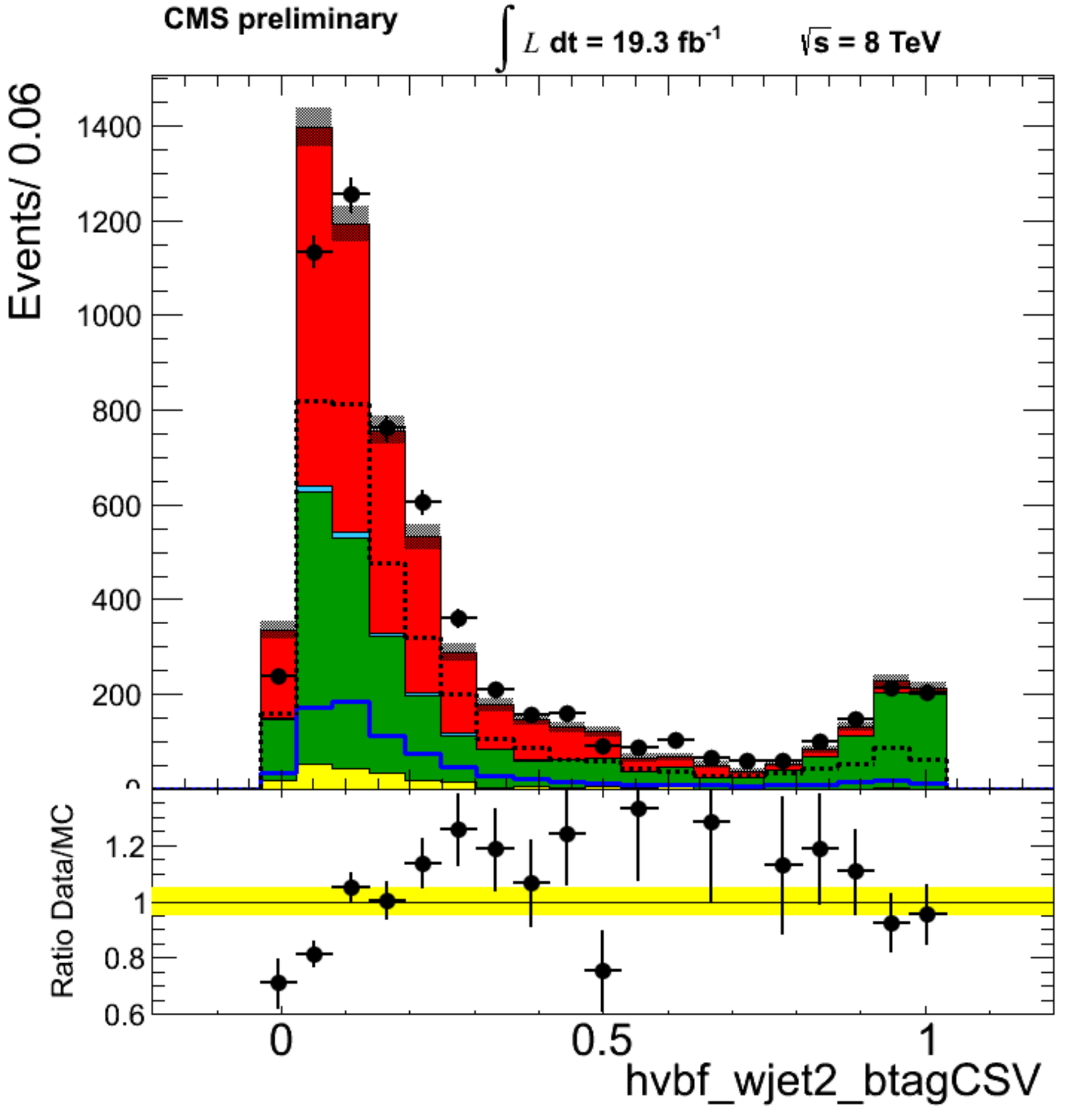

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.4
900
800
700
600
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
-4
-2
0
2
4
Hadronic W Jet2 η

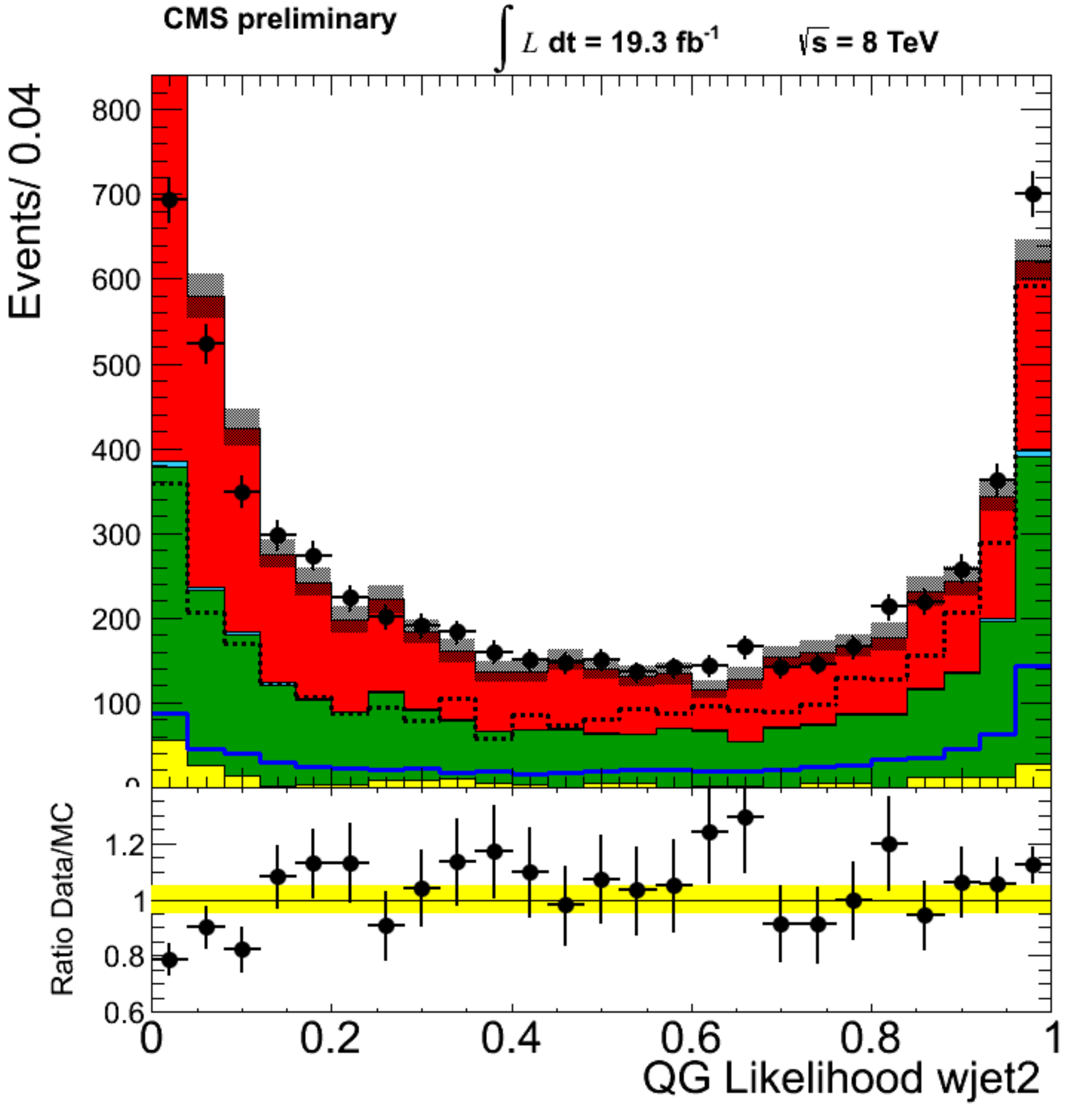

CMS preliminary
∫ L dt = 19.3 fb-1
√s = 8 TeV
Events/ 0.4 rad
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
-2
0
2
Hadronic W Jet2 Φ (rad)

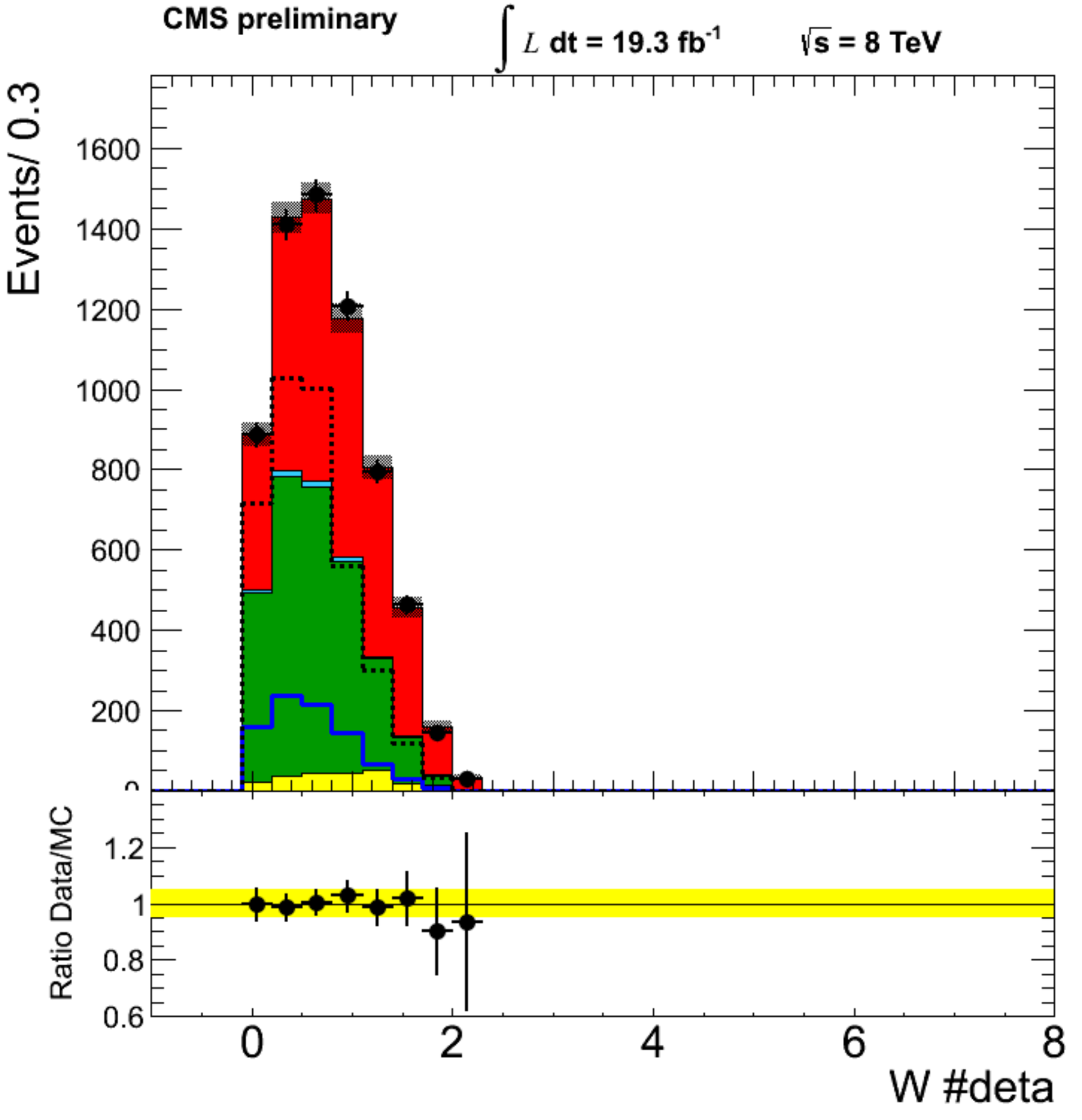

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Muon Data
W+Jets
Diboson
top
Z+Jets
MC Uncertainty
mad VBFWW X100
phan VBFWW X100
Events/ 10 GeV
3500
3000
2500
2000
1500
1000
500
Ratio Data/MC
1.2
1
0.8
0.6
100
200
300
Hadronic W Jet2 p_T

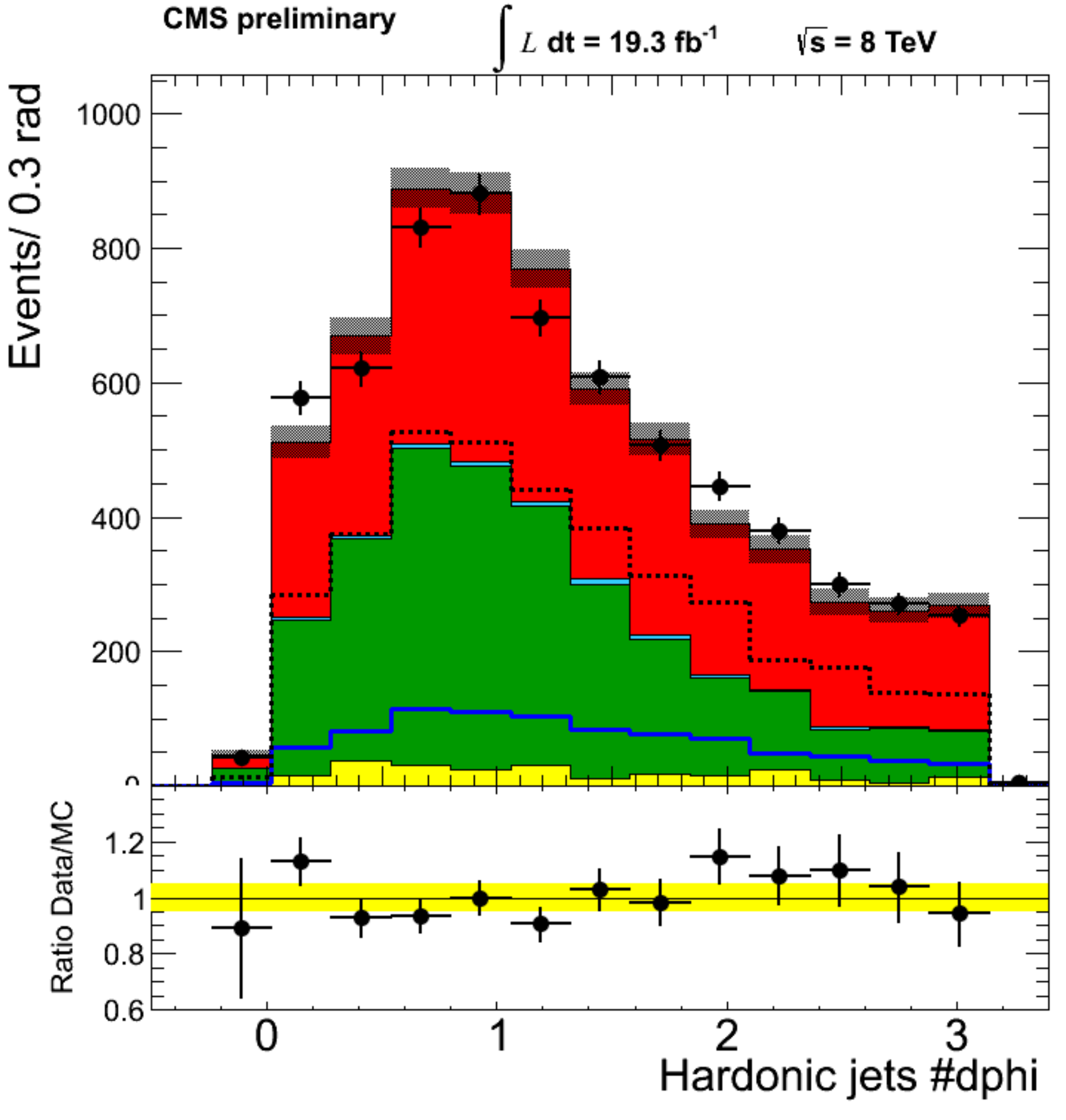

CMS preliminary
∫ L dt = 19.3 fb-1
√s = 8 TeV
Events/ 0.06
1600
1400
1200
1000
800
600
400
200
Ratio Data/MC
1.2
1
0.8
0.6
0
0.5
1
hvbf_wjet1_btagCSV

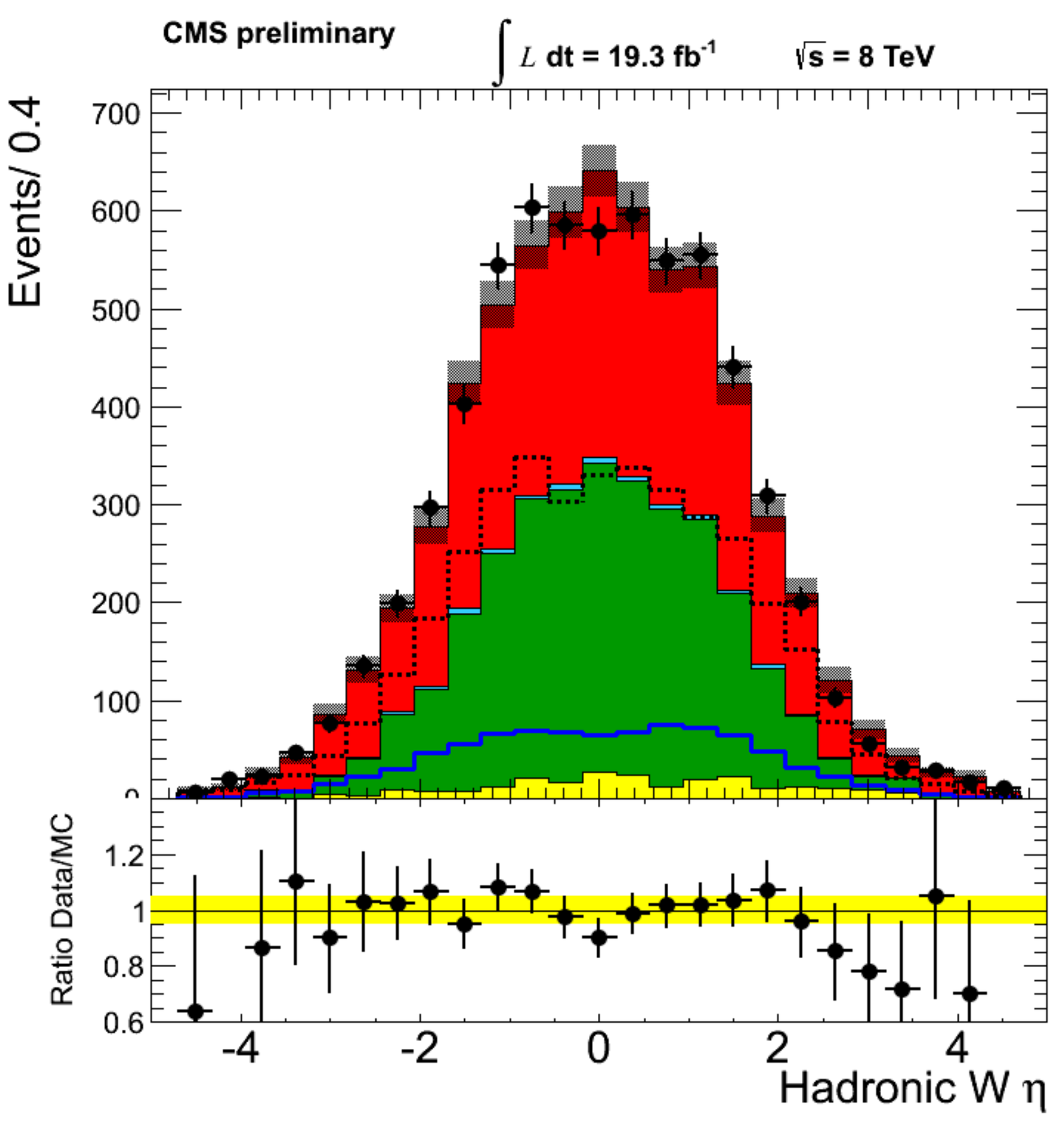

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.04
900
800
700
600
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
0
0.2
0.4
0.6
0.8
1
QG Likelihood wjet1

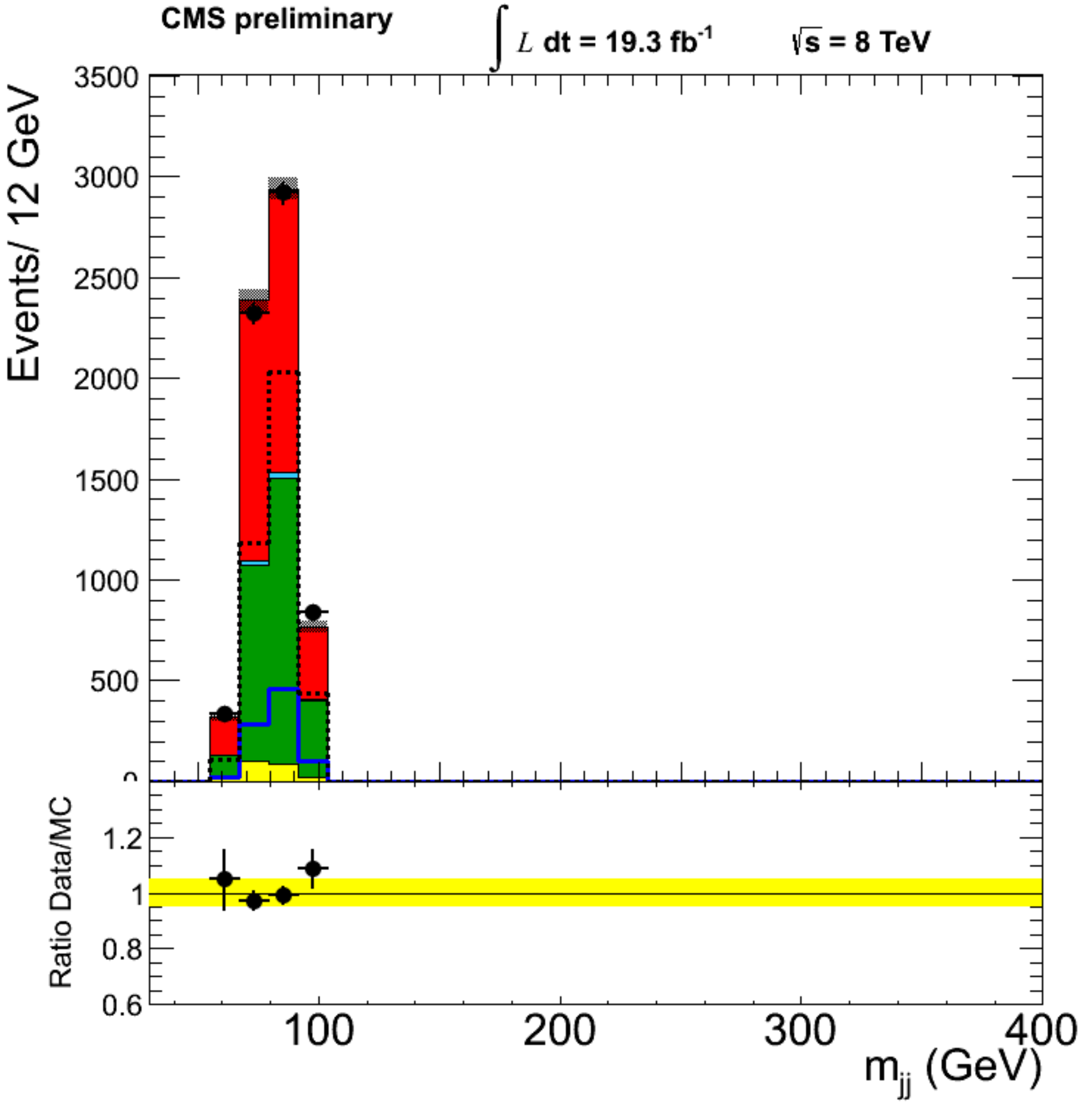

CMS preliminary
∫ L dt = 19.3 fb-1
√s = 8 TeV
Events/ 0.06
1400
1200
1000
800
600
400
200
Ratio Data/MC
1.2
1
0.8
0.6
0
0.5
1
hvbf_wjet2_btagCSV

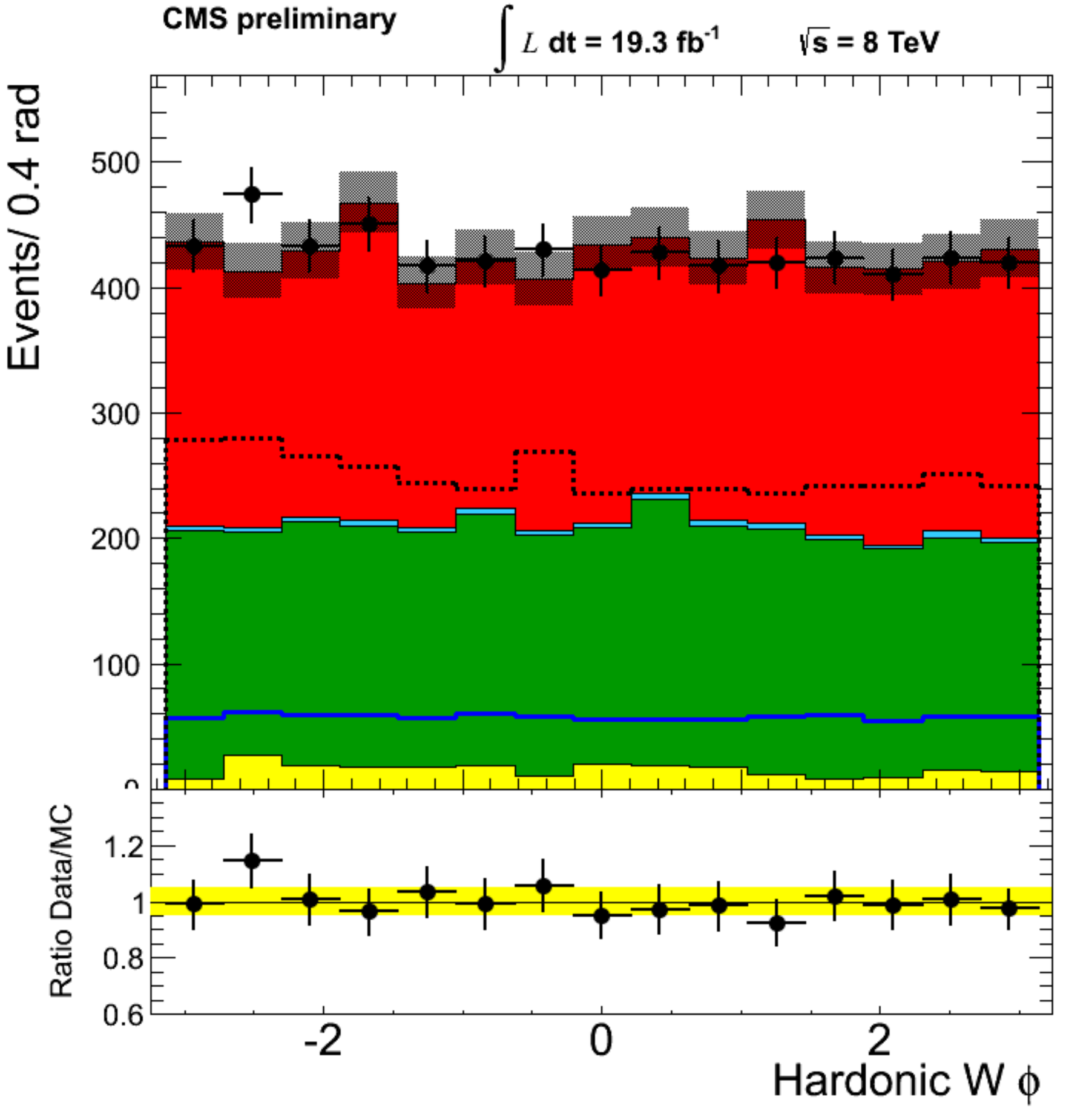

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.04
800
700
600
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
0
0.2
0.4
0.6
0.8
1
QG Likelihood wjet2

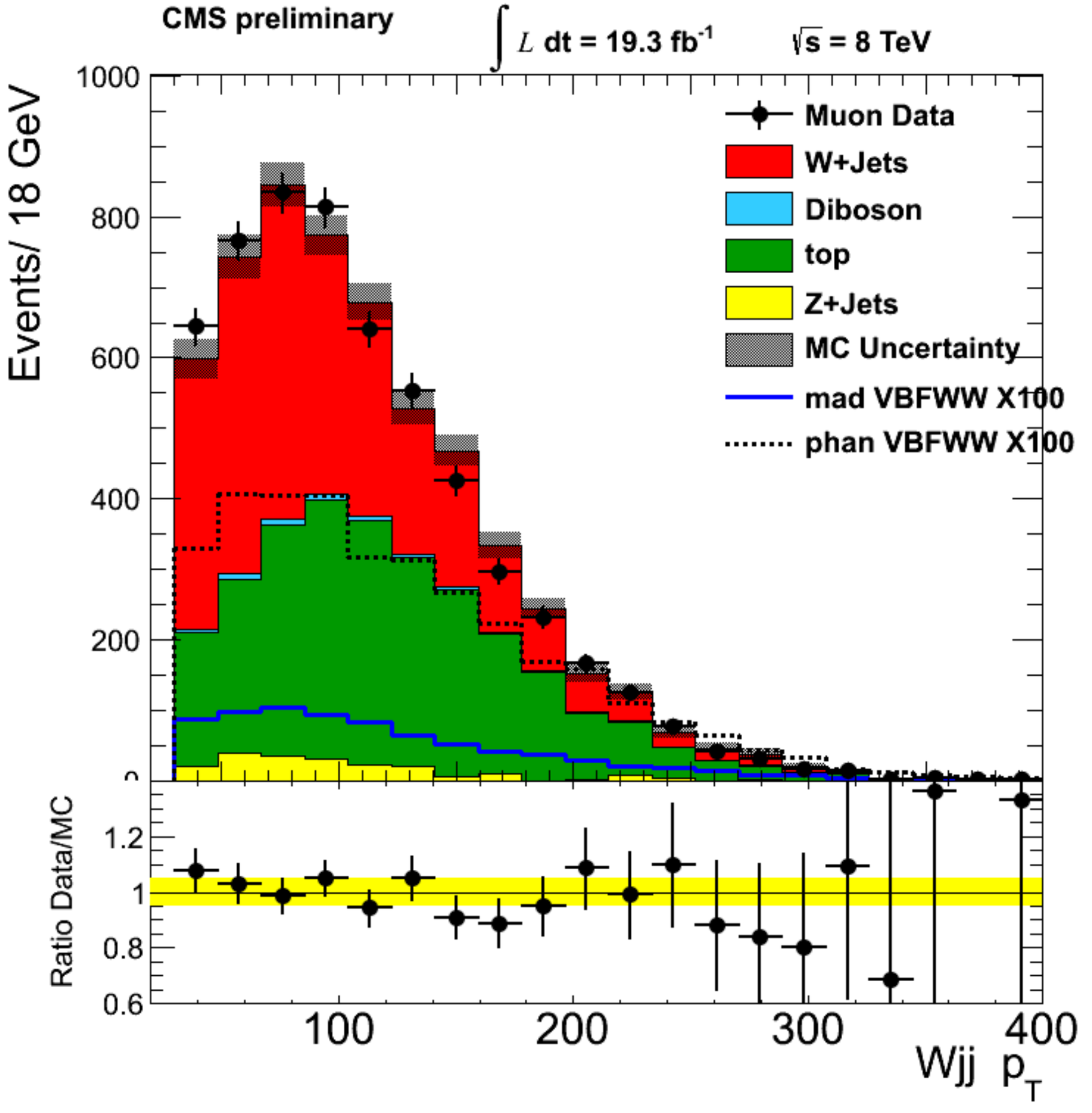

CMS preliminary
∫ L dt = 19.3 fb-1
√s = 8 TeV
Events/ 0.3
1600
1400
1200
1000
800
600
400
200
Ratio Data/MC
1.2
1
0.8
0.6
0
2
4
6
8
W #deta

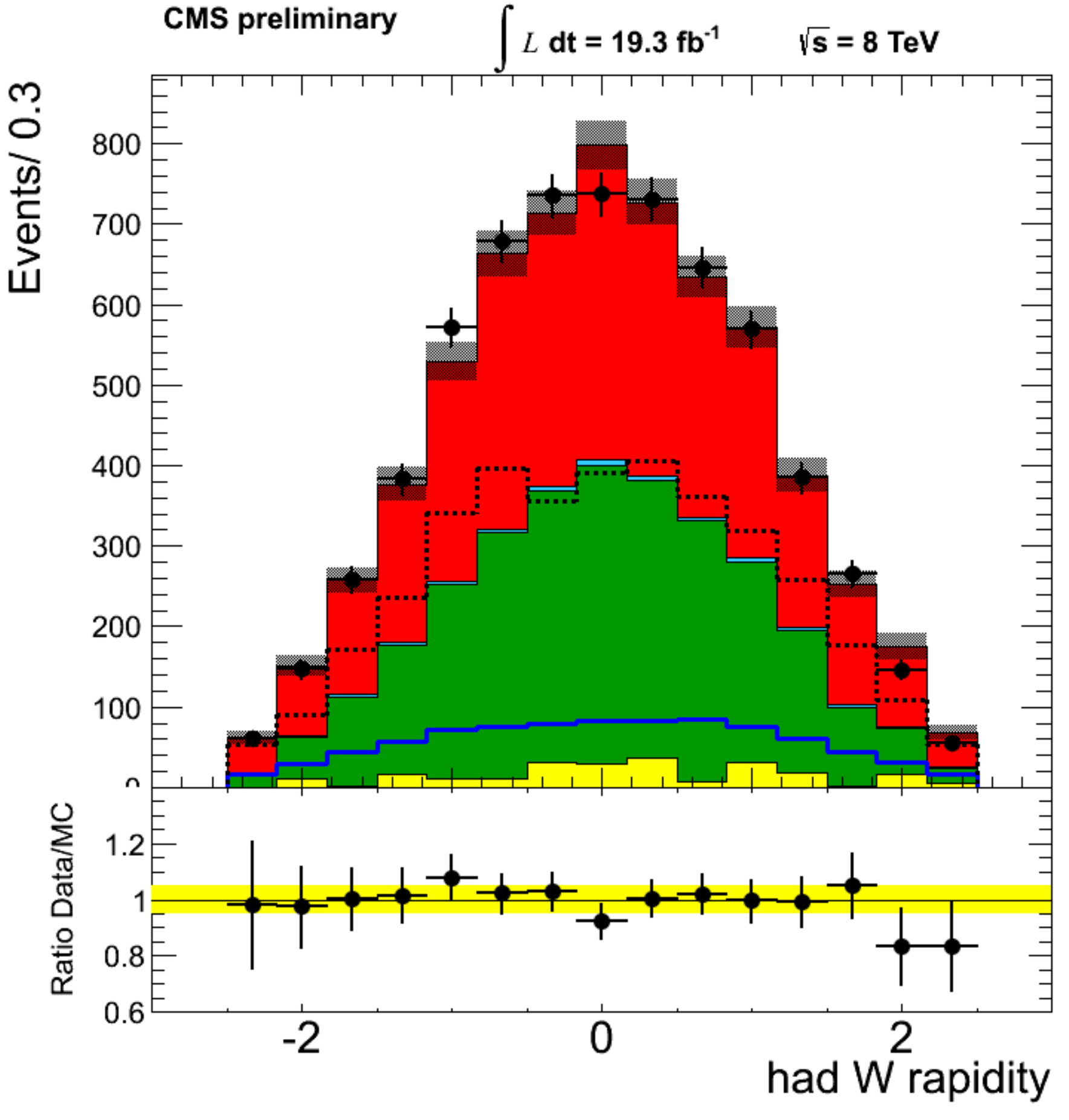

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.3 rad
1000
800
600
400
200
Ratio Data/MC
1.2
1
0.8
0.6
0
1
2
3
Hardonic jets #dphi

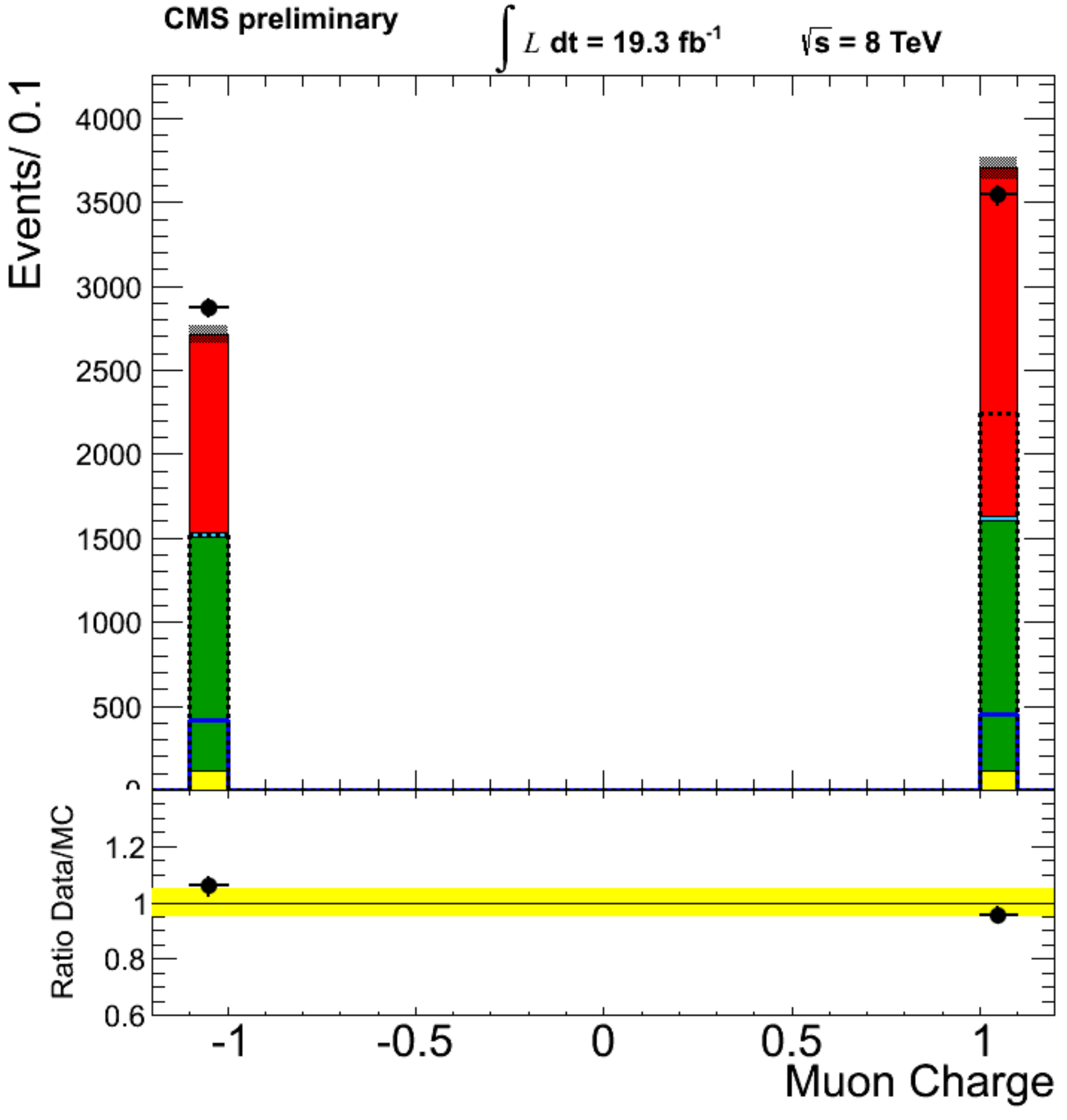

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.4
700
600
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
-4
-2
0
2
4
Hadronic W η

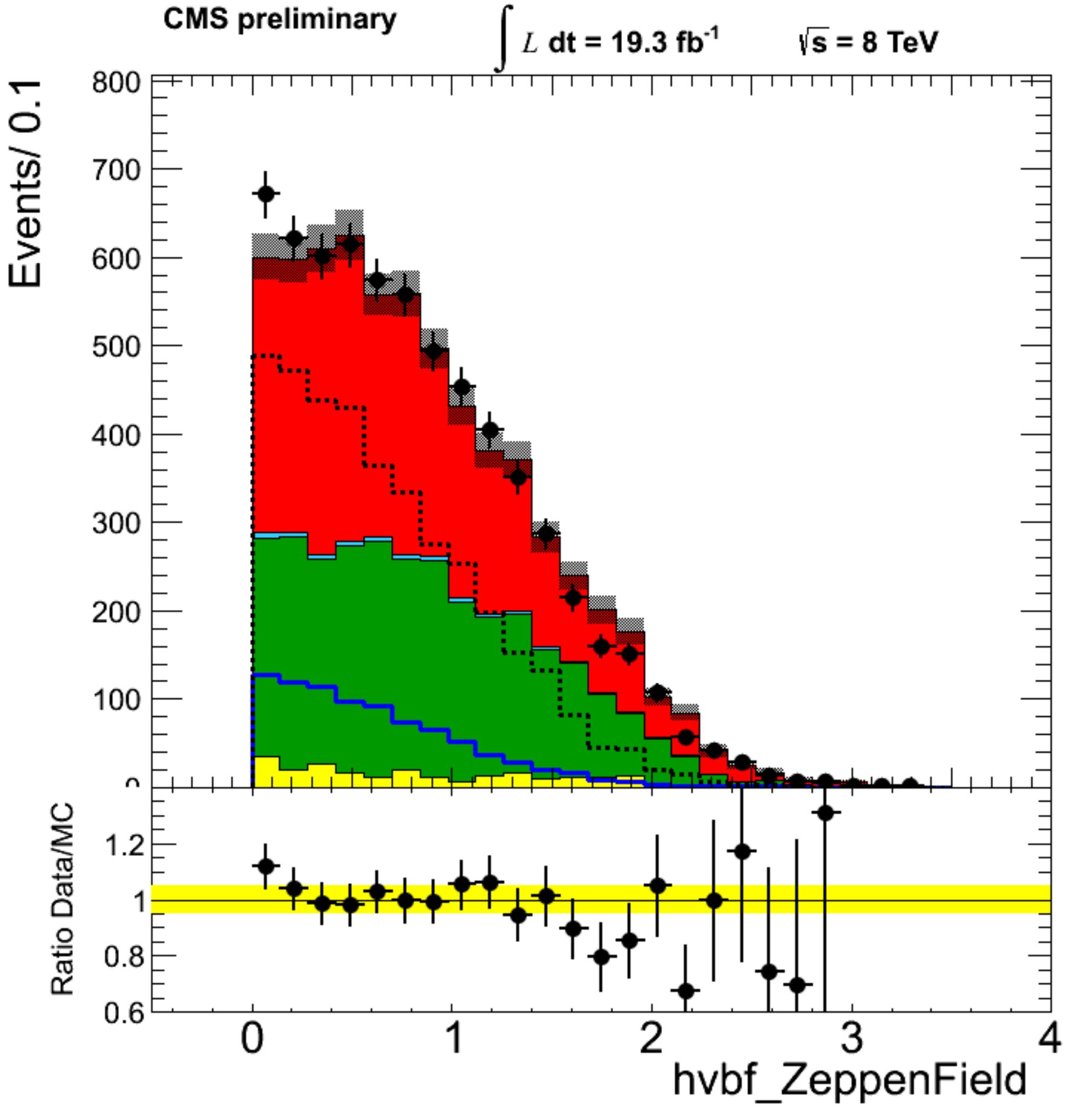

CMS preliminary
∫ L dt = 19.3 fb-1
√s = 8 TeV
Events/ 12 GeV
3500
3000
2500
2000
1500
1000
500
Ratio Data/MC
1.2
1
0.8
0.6
100
200
300
400
mjj (GeV)

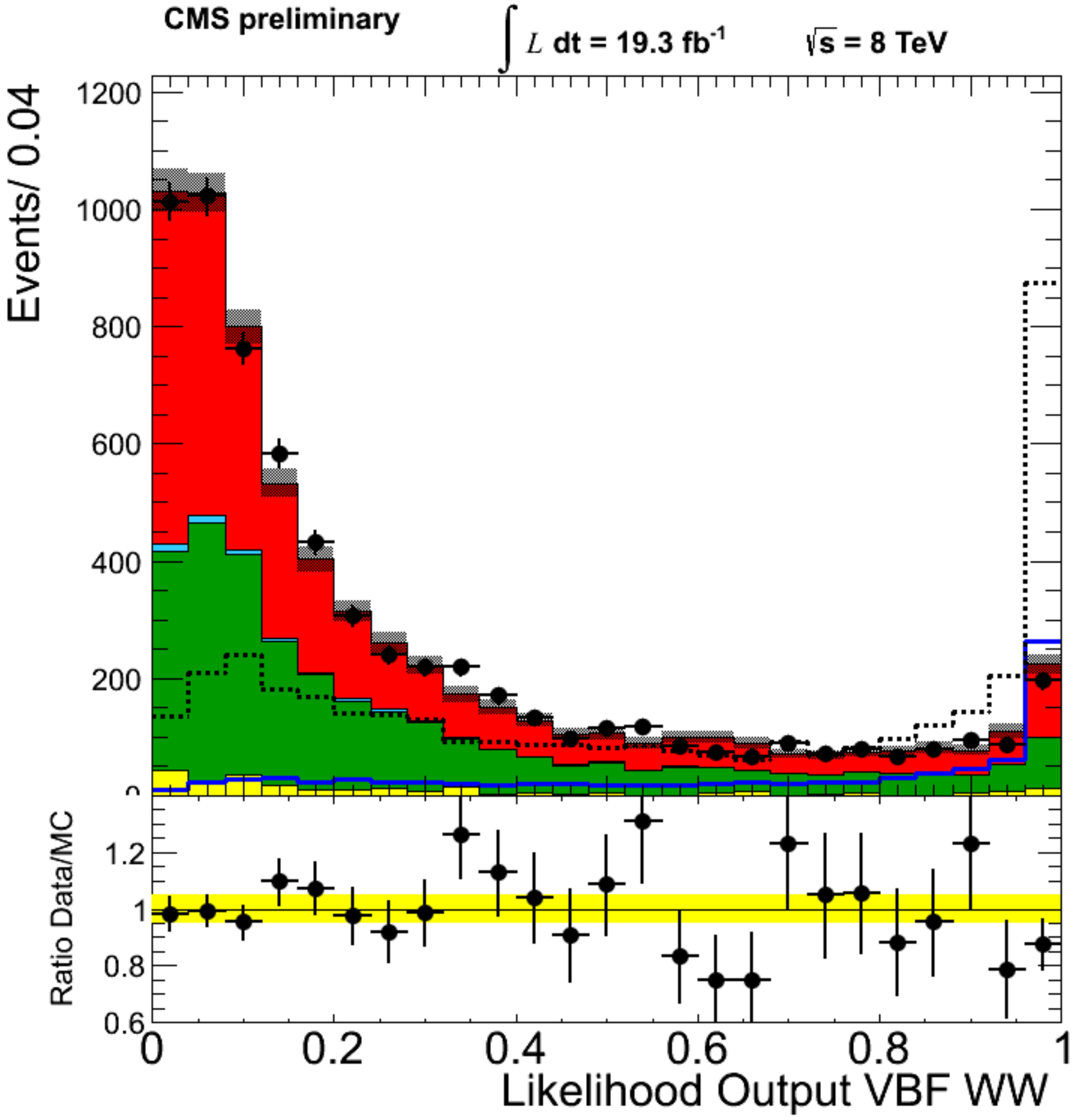

CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.4 rad
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
-2
0
2
Hardonic W ϕ


CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Muon Data
W+Jets
Diboson
top
Z+Jets
MC Uncertainty
mad VBFWW X100
phan VBFWW X100
Events/ 18 GeV
1000
800
600
400
200
Ratio Data/MC
1.2
1
0.8
0.6
100
200
300
400
Wjj p_T


CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8$ TeV
Events/ 0.3
800
700
600
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
-2
0
2
had W rapidity


CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.1
4000
3500
3000
2500
2000
1500
1000
500
Ratio Data/MC
1.2
1
0.8
0.6
-1
-0.5
0
0.5
1
Muon Charge


CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.1
800
700
600
500
400
300
200
100
Ratio Data/MC
1.2
1
0.8
0.6
0
1
2
3
4
hvbf_ZeppenField


CMS preliminary
$\int L\,dt = 19.3\ fb^{-1}$
$\sqrt{s} = 8\ TeV$
Events/ 0.04
1200
1000
800
600
400
200
Ratio Data/MC
1.2
1
0.8
0.6
0
0.2
0.4
0.6
0.8
1
Likelihood Output VBF WW