W charge asymmetry studies at 13 TeV

2.11.2017

Electron selection requirements

- The electron track should have at most 1 hit missing in the crossed silicon layers before the first hit assigned to this track.
- The conversion fit probability with any of the other tracks should not be larger than $1e^{-6}$.
- Only a small amount of hadronic activity behind the electron ECAL deposit is allowed (H/E).

- The supercluster position and track direction, extrapolated to the vertex, should be matched ($\Delta\varphi_{In}$ and $\Delta\eta_{In}$).
- Small impact parameter in the transverse plane, $|d_{0,bs}|$, calculated with respect to the beam spot.
- Small longitudinal impact parameter, $|d_{z,pv}|$, calculated with respect to the beam spot.

Table 1: Electron selection requirements

Observable	Barrel	Endcap
Seed	Ecal-Driven	
E_T	> 25 GeV	
$\|\eta\|$	$< 2.5, \notin [1.4442, 1.566]$	
$\Delta\eta_{\text{In}}$ (B/E)	< 0.008925	< 0.007429
$\Delta\phi_{\text{In}}$ (B/E)	< 0.035973	< 0.067879
$\sigma_{i\eta i\eta}$ (B/E)	< 0.009996	< 0.030135
H/E (B/E)	< 0.050537	< 0.086782
$\|d_{0,bs}\|$	< 0.012235	< 0.036719
$\|d_{z,bs}\|$	< 0.042020	< 0.138142
$\|1/E - 1/p\|$ (B/E)	< 0.091942	< 0.100683
PFIso/p_T	< 0.107587	< 0.113254
Missing hits	≤ 1	
pass conversion veto		

Extra electron selection

- **For the $W \rightarrow e\nu$ selection, a veto on events with extra electrons is added. This additional electron is required to pass a looser selection.**

Table 2: Electron Veto selection requirements

Observable	Barrel	Endcap
Seed	Ecal-Driven	
E_T	> 10 GeV	
$\lvert\eta\rvert$	$< 2.5, \notin [1.4442, 1.566]$	
$\Delta\eta_{\mathrm{In}}$ (B/E)	< 0.013625	< 0.011932
$\Delta\phi_{\mathrm{In}}$ (B/E)	< 0.230374	< 0.255450
$\sigma_{i\eta i\eta}$ (B/E)	< 0.011586	< 0.031849
H/E (B/E)	< 0.181130	< 0.223870
$\lvert d_{0,bs}\rvert$	< 0.094095	< 0.342293
$\lvert d_{z,bs}\rvert$	< 0.713070	< 0.953461
$\lvert 1/E - 1/p\rvert$ (B/E)	< 0.295751	< 0.155501
PFIso/p_T	< 0.158721	< 0.177032
Missing hits	≤ 2	≤ 3
pass conversion veto		

Muon selection requirements

- Muons need to be reconstructed using the GlobalMuon algorithm.
- Muons have to pass the particle-flow muon ID.
- A quality requirement is applied to the global fit ($\chi^2 / n_{dof} < 10$).
- Muon segments should be present in at least two muon stations.
- At least one pixel hit is required.
- Minimum 5 tracker layers should have hits.
- At least one good muon hit should be included in the global muon track fit.
- Impact parameter in the transverse plane $|d_{0,pv}| < 0.02$ cm, calculated with respect to the primary vertex.
- Longitudinal impact parameter $|d_{z,pv}| < 0.5$ cm, calculated with respect to the primary vertex.

Table 3: Muon selection requirements

Observable	Value or Range
p_T	> 25 GeV
$\|\eta\|$	< 2.4
Id	GlobalMuon
Id	PFMuon
χ^2/ndof	< 10
# Valid Mu Hits	> 0
# Matched Stations	> 1
# Tracker Layers	> 5
# Valid pixel Hits	> 0
$\|d_{0,pv}\|$	< 0.2
$\|d_{z,pv}\|$	< 0.5
PFIso/p_T	< 0.12

Extra muon selection

- **In the muon case, for the W → μν selection, events with additional muons are vetoed. This veto-muon passes a looser selection.**

Table 4: Additional Muon Veto selection requirements

Observable	Value or Range
p_T	> 10 GeV
$\|\eta\|$	< 2.4
Id	GlobalMuon || TrackerMuon
Id	PFMuon
PFIso/p_T	< 0.20

Data sample and event selection

- **The dataset names for the data are listed in Table 5. All the runs are taken from the re-reco reconstruction dataset.**

Table 5: Collision dataset names.

/SingleMuon/Run2015C(D)-PromptReco-v1/
/SingleElectron/Run2015C(D)-PromptReco-v1/

- **The selection of W and Z boson events is based on single electron and muon triggers. The lowest p_T unprescaled triggers are used to select the events.**

Table 6: Summary of the trigger paths used in the W and Z boson measurements.

HLT Path	L1 Seed
HLT_Ele23_WpLoose_Gsf	*L1_SingleEG15* or *L1_SingleEG20*
HLT_Iso_Mu20	*L1_SingleMu16*

Efficiency

- **The total efficiency of the electrons can be factorized as follows for the electrons with the total efficiency defined with respect to a reconstructed supercluster passing the kinematic cuts**

$$\epsilon_{total} = \epsilon_{GSF+ID+ISO} \times \epsilon_{trigger},$$

- **For the muons, a similar factorization can be done**

$$\epsilon_{total} = \epsilon_{tracking+ID+ISO} \times \epsilon_{STA} \times \epsilon_{trigger},$$

Efficiency

- To correct for the differences in the kinematic spectrum between the Z tag-and-probe sample and the W candidates, the efficiencies will be measured in kinematic bins (η,p_T).

$$\epsilon_{W,data}(\eta, p_T) = \epsilon_{W,MC}(\eta, p_T)\frac{\epsilon_{T\&P,data}(\eta, p_T)}{\epsilon_{T\&P,MC}(\eta, p_T)}.$$

- In electron reconstruction, identification and isolation efficiency the exponential model for the background in the pass category and the *erfc* × Exp in the fail category.

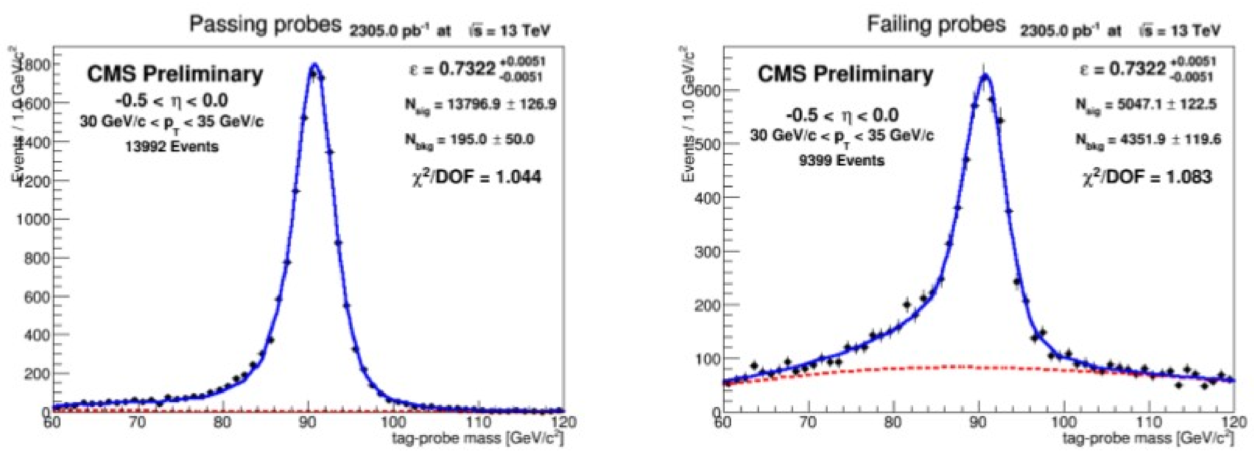
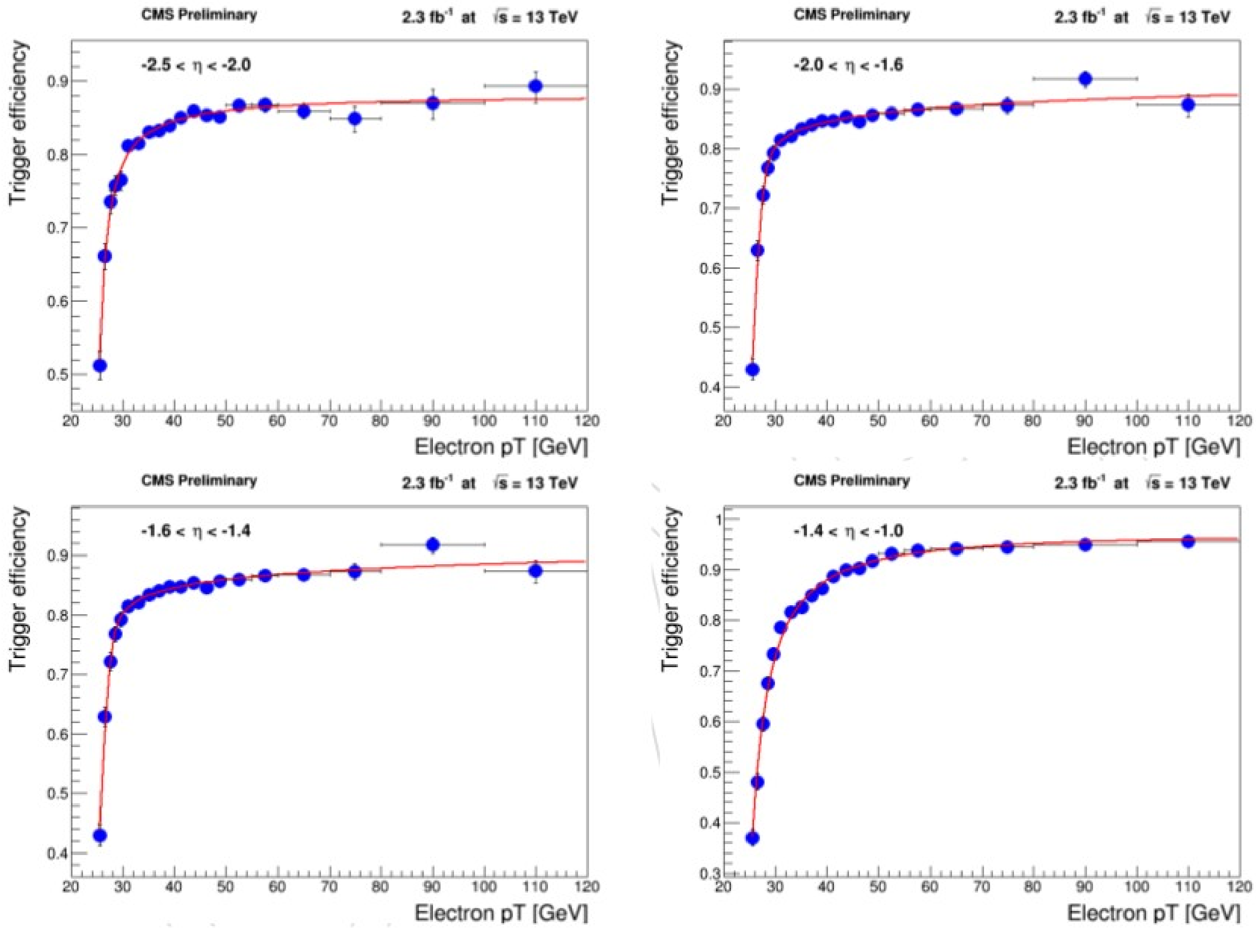


Figure 1: An example fit for $\epsilon_{GSF+ID+Iso}$.

Electron Trigger efficiency

- The efficiency of the trigger is measured with respect to a well identified electron, hence the probe is defined to be an ECAL-driven GSF-electron satisfying analysis selection cuts.



Muon tracking, identification and isolation efficiency

- The probe is defined to be a stand-alone muon. Backgrounds are accounted for in both the pass and fail samples using the exponential model.

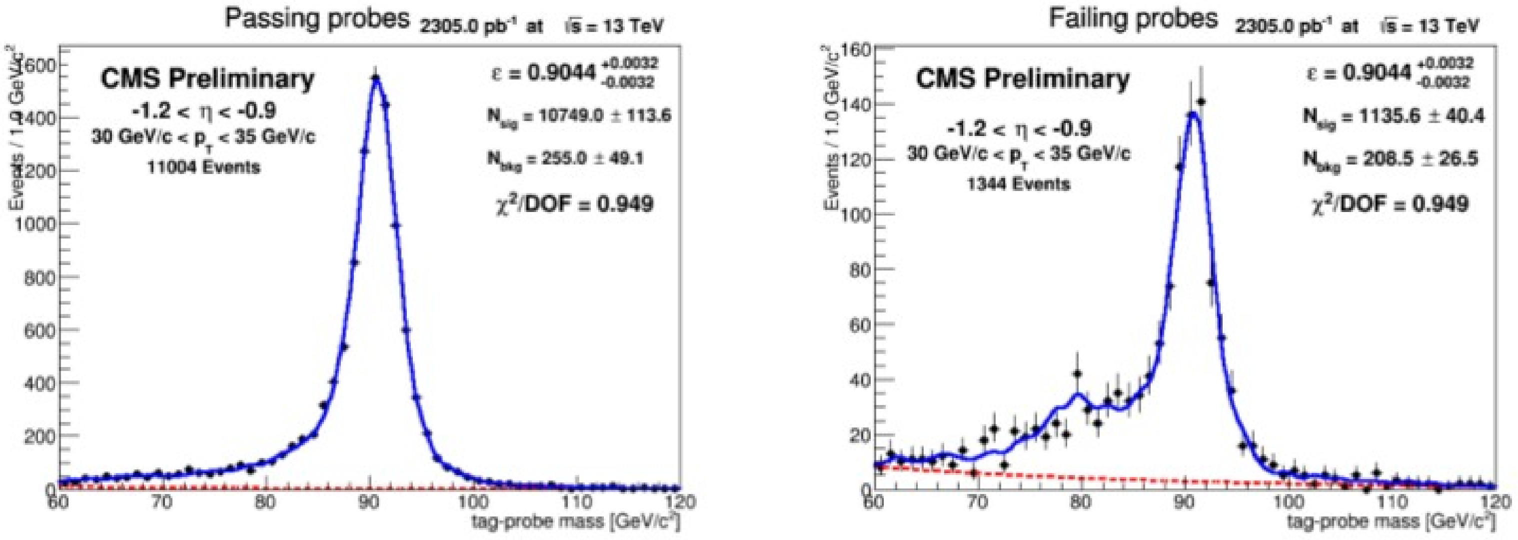
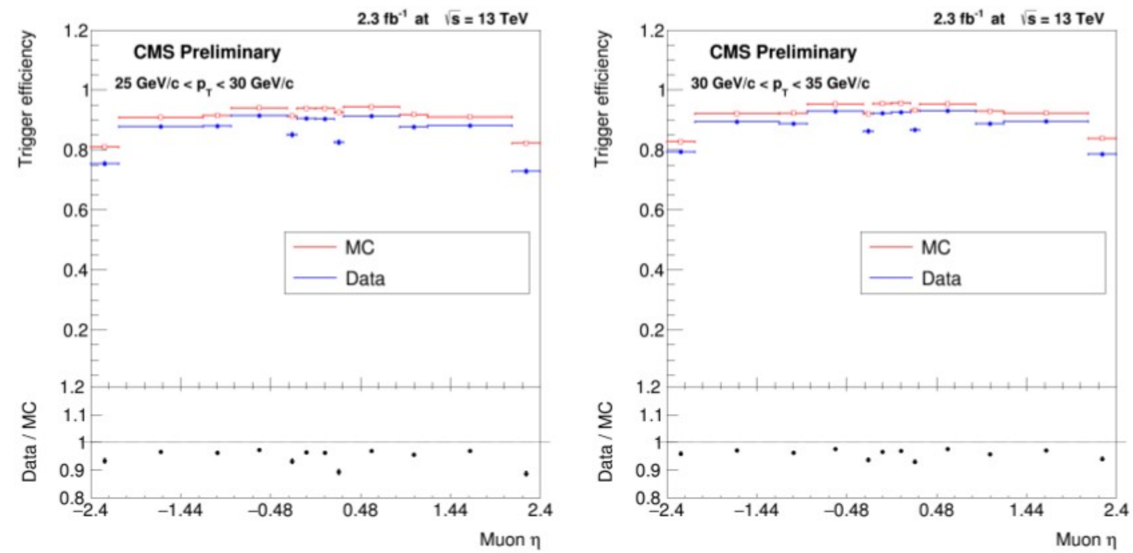


Figure 6: An example fit for $\epsilon_{tracking+ID+ISO}$.

Muon Trigger efficiency

- The efficiency of the trigger is measured with respect to a well identified muon, so the probe is a muon satisfying the requirements.



	$-2.4 < \|\eta\| < -2.1$	$-2.1 < \|\eta\| < -1.2$	$-1.2 < \|\eta\| < -0.9$	$-0.9 < \|\eta\| < -0.3$	$-0.3 < \|\eta\| < -0.2$	$-0.2 < \|\eta\| < 0$
$25 < p_T < 30$	0.7548 ± 0.0061	0.8776 ± 0.0025	0.8795 ± 0.0041	0.9144 ± 0.0022	0.8508 ± 0.0070	0.9054 ± 0.0038
$30 < p_T < 35$	0.7939 ± 0.0048	0.8941 ± 0.0019	0.8886 ± 0.0031	0.9297 ± 0.0016	0.8630 ± 0.0052	0.9225 ± 0.0027
$35 < p_T < 40$	0.8094 ± 0.0041	0.9017 ± 0.0015	0.8982 ± 0.0024	0.9381 ± 0.0012	0.8792 ± 0.0043	0.9398 ± 0.0021
$40 < p_T < 45$	0.8308 ± 0.0037	0.9117 ± 0.0013	0.9047 ± 0.0020	0.9467 ± 0.0011	0.8924 ± 0.0038	0.9500 ± 0.0018
$45 < p_T < 55$	0.8344 ± 0.0038	0.9180 ± 0.0013	0.9046 ± 0.0021	0.9485 ± 0.0011	0.8839 ± 0.0042	0.9533 ± 0.0018
$55 < p_T < 1.3e+04$	0.8474 ± 0.0060	0.9213 ± 0.0020	0.8957 ± 0.0035	0.9509 ± 0.0017	0.8937 ± 0.0065	0.9575 ± 0.0029

	$0 < \|\eta\| < 0.2$	$0.2 < \|\eta\| < 0.3$	$0.3 < \|\eta\| < 0.9$	$0.9 < \|\eta\| < 1.2$	$1.2 < \|\eta\| < 2.1$	$2.1 < \|\eta\| < 2.4$
$25 < p_T < 30$	0.9035 ± 0.0038	0.8257 ± 0.0073	0.9139 ± 0.0022	0.8770 ± 0.0041	0.8812 ± 0.0024	0.7295 ± 0.0063
$30 < p_T < 35$	0.9258 ± 0.0027	0.8670 ± 0.0052	0.9307 ± 0.0016	0.8882 ± 0.0031	0.8961 ± 0.0019	0.7869 ± 0.0048
$35 < p_T < 40$	0.9380 ± 0.0021	0.8743 ± 0.0045	0.9434 ± 0.0012	0.8961 ± 0.0024	0.9074 ± 0.0015	0.8033 ± 0.0042
$40 < p_T < 45$	0.9430 ± 0.0019	0.8882 ± 0.0039	0.9468 ± 0.0011	0.9006 ± 0.0021	0.9163 ± 0.0012	0.8264 ± 0.0037
$45 < p_T < 55$	0.9512 ± 0.0019	0.8926 ± 0.0040	0.9533 ± 0.0011	0.9039 ± 0.0022	0.9221 ± 0.0012	0.8350 ± 0.0038
$55 < p_T < 1.3e+04$	0.9596 ± 0.0028	0.8887 ± 0.0066	0.9504 ± 0.0017	0.9012 ± 0.0035	0.9261 ± 0.0020	0.8416 ± 0.0060

Table 39: positive muon trigger efficiencies in data. The quoted uncertainties are statistical uncertainties only.

Number of mu$^+$ events

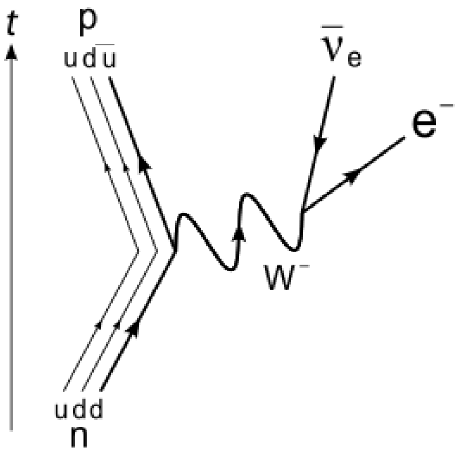
2[X2]	Signal Wmu+[Y2]	QCD Wmu+[Y2]	Other Wmu+[Y2]	AntiSignal Wmu+[Y2]	AntiQCD Wmu+[Y2]	AntiOther Wmu+[Y2]
1	774,109	80,161	52,875	2,151	112,559	752
2	726,176	82,157	38,986	1,915	100,935	720
3	805,010	82,804	62,718	1,995	111,345	737
4	803,904	82,913	62,632	2,023	103,723	732
5	729,282	81,036	65,984	1,894	89,074	674
6	765,867	75,574	67,283	1,742	84,503	610
7	799,938	87,355	114,172	1,654	82,785	533
8	826,707	101,421	90,622	1,668	75,819	522
9	923,551	100,676	124,443	1,574	75,088	481
10	971,813	107,856	84,488	1,406	62,732	364
11	1.01511e+06	87,168	97,152	1,598	49,027	381

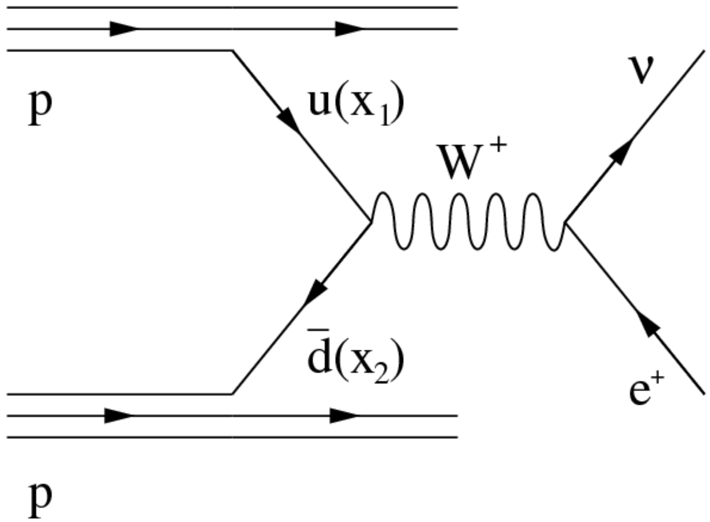
Number of mu$^-$ events

Eta bin[X1]	Signal Wmu-[Y1]	QCD Wmu-[Y1]	Other Wmu-[Y1]	AntiSignal Wmu-[Y1]	AntiQCD Wmu-[Y1]	AntiOther Wmu-[Y1]
1	659,418	76,637	48,366	1,723	110,732	768
2	612,102	67,676	49,626	1,584	100,754	689
3	674,086	89,983	47,940	1,638	110,020	744
4	657,173	98,848	44,189	1,680	103,599	761
5	600,924	71,865	61,849	1,392	89,398	614
6	589,402	93,119	56,380	1,463	83,107	625
7	633,312	102,531	67,772	1,208	82,895	544
8	626,782	112,098	62,234	1,080	75,582	445
9	657,458	114,862	106,228	1,137	74,073	464
10	660,861	128,627	69,552	973	62,214	411
11	662,881	103,676	96,289	1,098	49,234	417

W asymmetry

$W^{\pm}$ bosons in pp collisions primarily produced through $u\bar{d} \to W^+$ and $d\bar{u} \to W^-$.





W^+ bosons produced more often then W^- - that's called W asymmetry

$$\mathcal{A}(\eta) = \frac{\frac{d\sigma}{d\eta}(W^+ \to \mu^+\nu) - \frac{d\sigma}{d\eta}(W^- \to \mu^-\overline{\nu})}{\frac{d\sigma}{d\eta}(W^+ \to \mu^+\nu) + \frac{d\sigma}{d\eta}(W^- \to \mu^-\overline{\nu})}$$

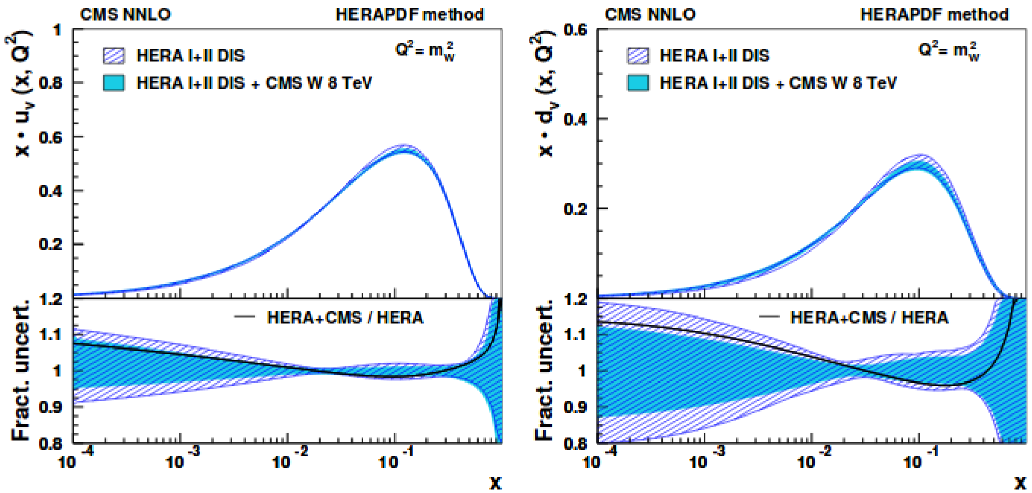
Previous studies

W asymmetry was studied by ATLAS, CMS and LHCb.
It allows to investigate:

- additional constraints on the ***d/u*** ratio and on the ***sea*** antiquark densities in the proton.
- to improve the PDF uncertainties for ***d*** and ***u*** quark flavors.

Previous CMS studies:

- 7 TeV: arXiv:1312.6283 , Phys. Rev. D 90 (2014) 032004
- 8 TeV: arXiv:1603.01803, Eur. Phys. J. C 76 (2016) 469



Significant improvement in $10^{-3} < x < 10^{-1}$

13 TeV

This study will be the first $W^{\pm}$ asymmetry study on 13TeV data sample collected with the CMS detector.

It is performed on measurement of inclusive $W^{\pm}$ and Z^0 boson production cross section in pp at 13 TeV 2015 data sample corresponding to integrated luminosity of $2.31 \pm 0.06\ fb^{-1}$ (SMP-16-013).

The measurements established around $W^{\pm}$ bosons decay channels into 1st or 2nd lepton generations. Significant contribution to the E_T^{miss} gives neutrinos.

The W boson signal and background yields are obtained from the E_T^{miss} distributions using a unbinned maximum-likelihood fit.

Event simulation, object and event selection

Simulation of the signal and background processes:

- MadGraph5 aMC@NLO - event samples for the $W^{\pm}$ and Z^{0} boson signal and top background.
- PYTHIA 8 with NNPDF3.0 - parton shower.
- PYTHIA 8 and POWHEG - diboson backgrounds.
- GEANT4 - detector response.

The events are collected when triggered by the presence of at least one electron/muon that passed kinematic cuts:

- $P_T > 25$ GeV
- $|\eta| < 2.5$ for electrons or $|\eta| < 2.4$ for muons

To distinguish the $W^{\pm}$ boson signal from QCD multijet, $W \to \tau\nu$, Drell–Yan, diboson and top-pair backgrounds E_T^{miss} is used.

Missing transverse energy and signal extraction

The E_T^{miss} model is fitted to the observed distribution as the sum of three contributions: the W boson signal, the QCD background and other backgrounds.

The QCD background is modeled by an analytic function using the data, while the signal and EW backgrounds are modeled with simulation-based fitting functions.

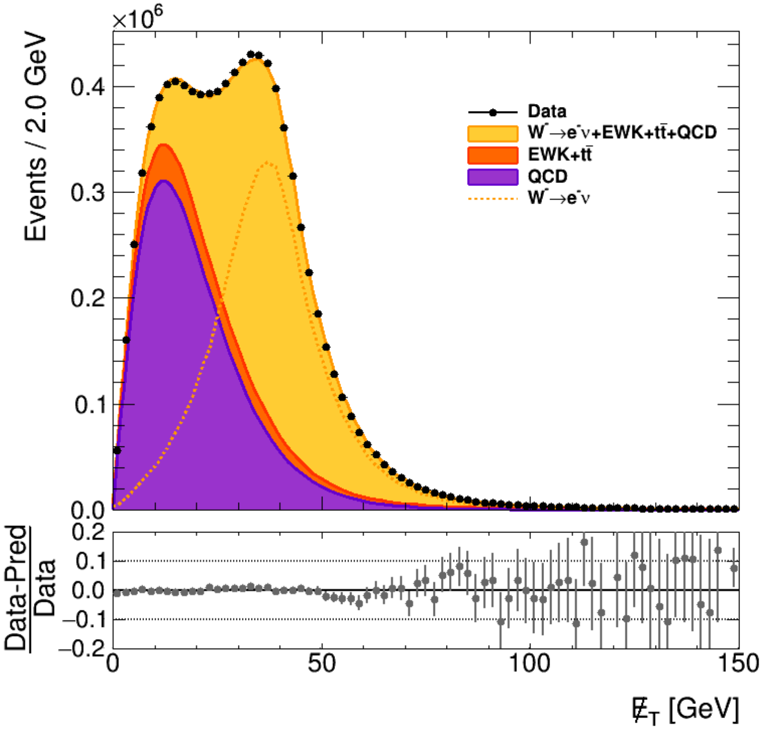
QCD background function: $f(x) = x*exp(-x^2 / ax^2+bx+c)$

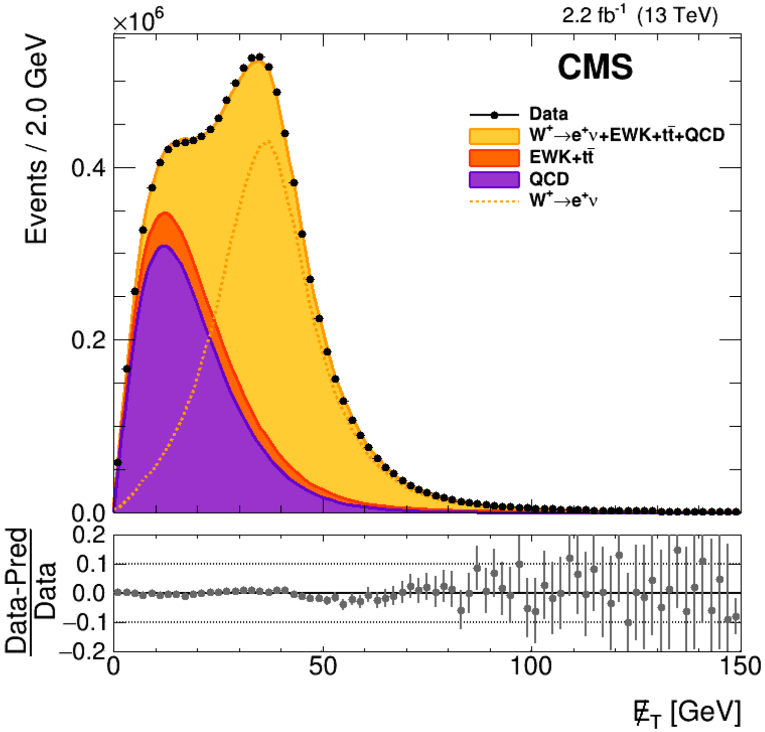
A simultaneous fit including QCD dominated control regions is also performed to improve the modeling of the QCD shape.

Control regions are obtained by inverting the isolation requirement on the lepton candidates.

Missing E_T for the whole eta region in e^-,e^+ channels

Results represents signal extraction in signal region. The dotted orange lines shows the distribution of the W boson signal, violet corresponds to QCD while the red is EWK+$t\bar{t}$.





Data is in a good agreement with the fit

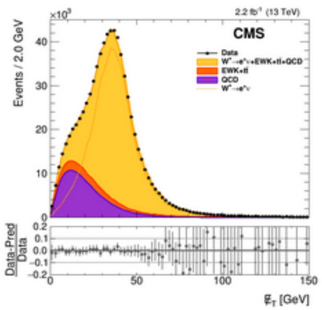
Pseudorapidity binned fit

The results of the fit represented for all pseudorapidity regions:

1 - [0.0 - 0.2]
2 - [0.2 - 0.4]
3 - [0.4 - 0.6]
4 - [0.6 - 0.8]
5 - [0.8 - 1.0]
6 - [1.0 - 1.2]
7 - [1.2 - 1.4]
8 - [1.4 - 1.6]
9 - [1.6 - 1.85]
10 - [1.85- 2.1]
11 - [2.1 - 2.5] (for muons: 11 - [2.1 - 2.4])

Eta binned results for e⁺ - signal region

wenu_fitmetp_eta_1.png



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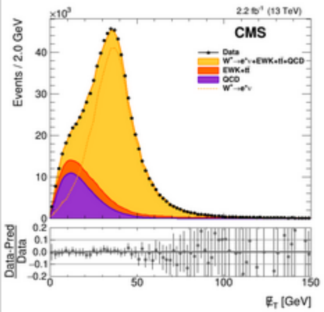
wenu_fitmetp_eta_2.png



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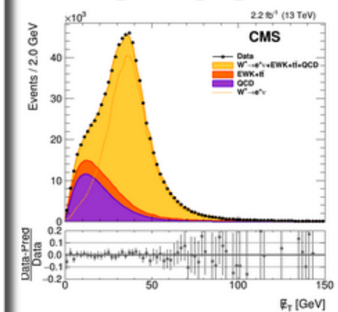
wenu_fitmetp_eta_3.png



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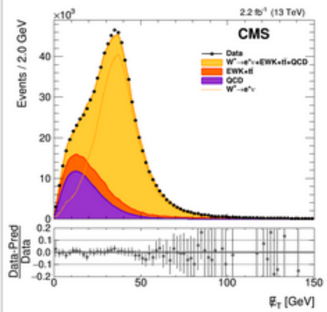
wenu_fitmetp_eta_4.png



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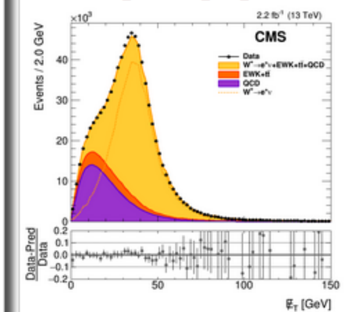
wenu_fitmetp_eta_5.png



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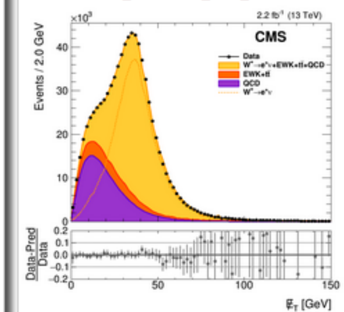
wenu_fitmetp_eta_6.png



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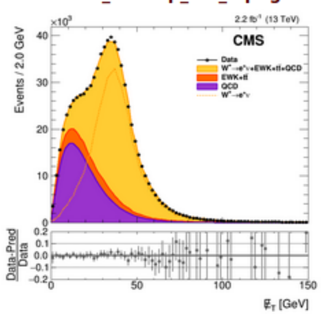
wenu_fitmetp_eta_7.png



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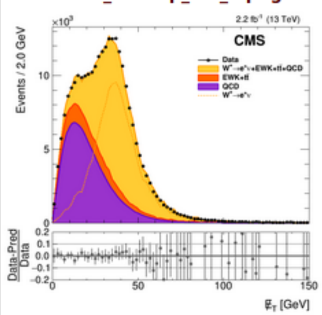

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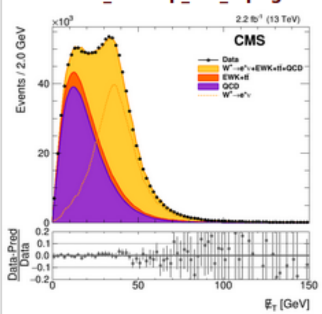

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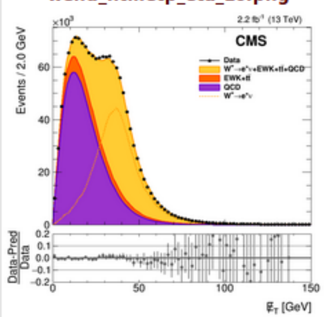

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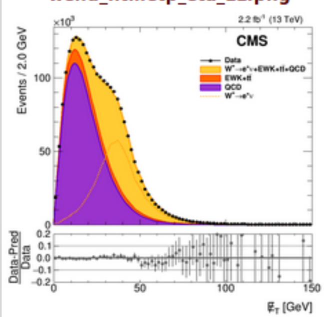

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- QCD background rises with increase of eta bins
- Data is in a good agreement with the fit

Eta binned results for e⁻ - signal region

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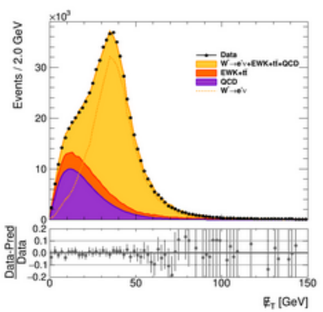

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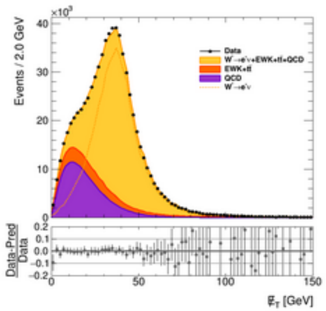

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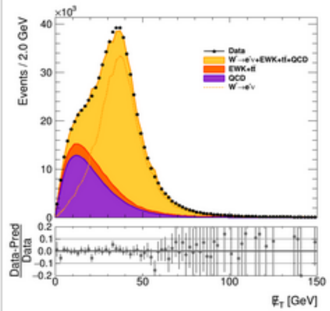
wenu_fitmetm_eta_3.png



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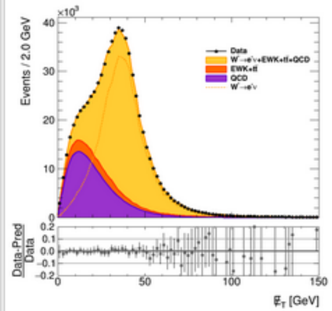

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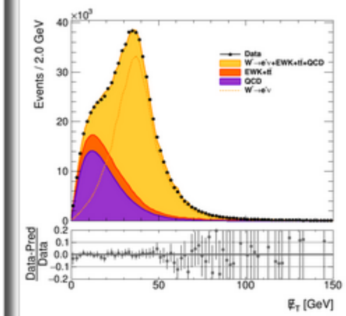

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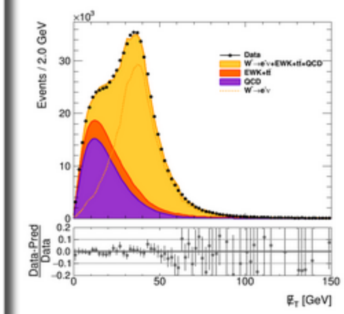

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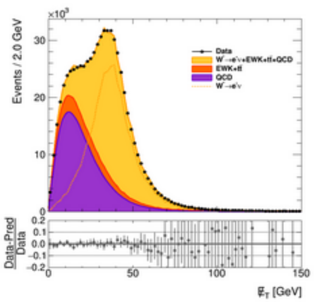

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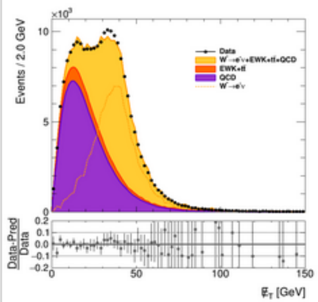

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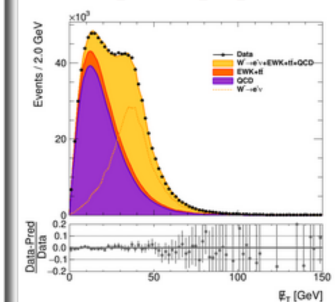

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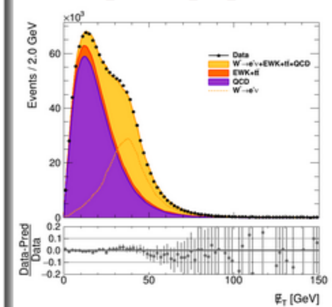

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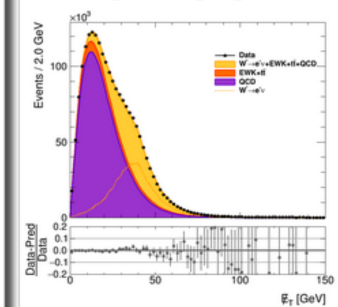

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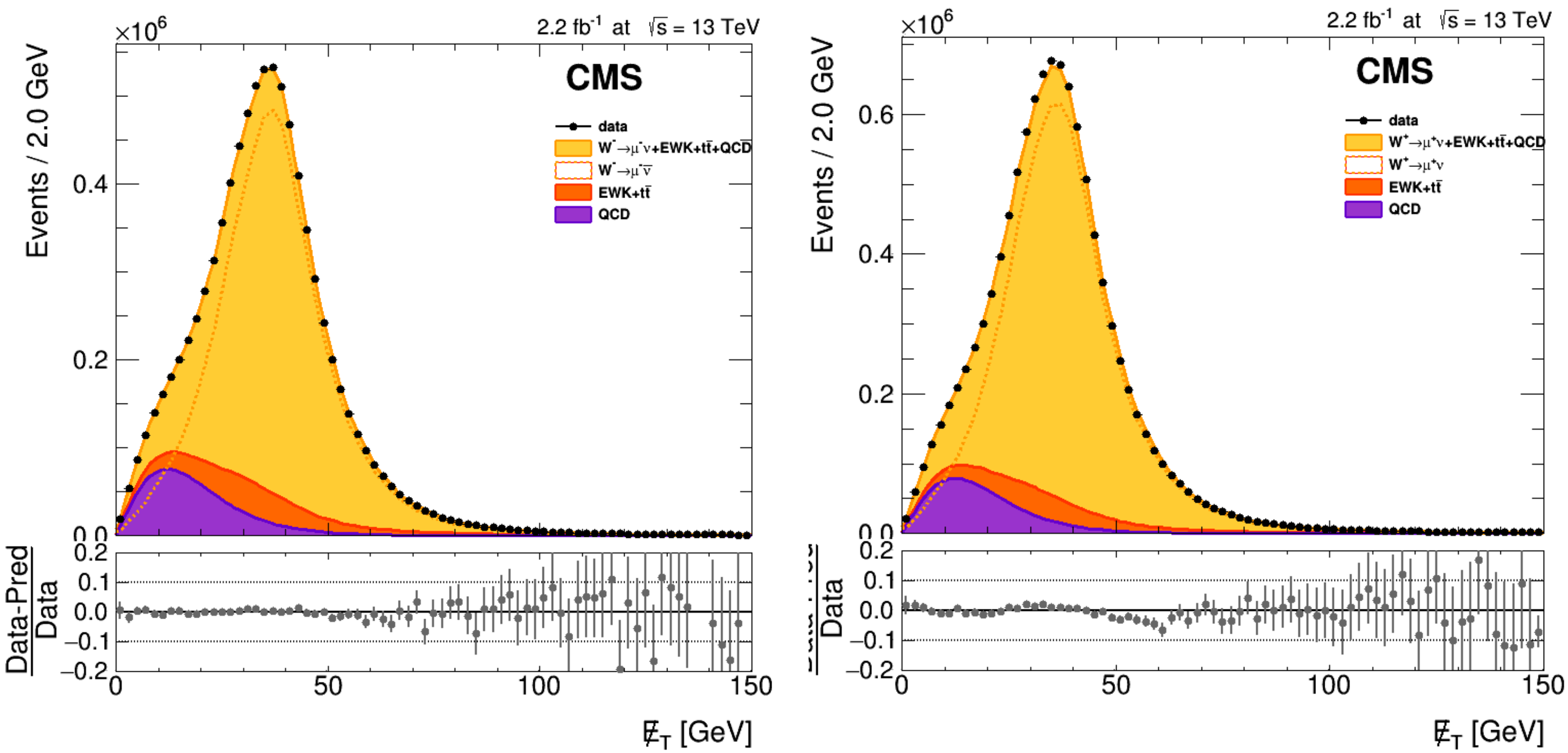
- Data is in a good agreement with the fit

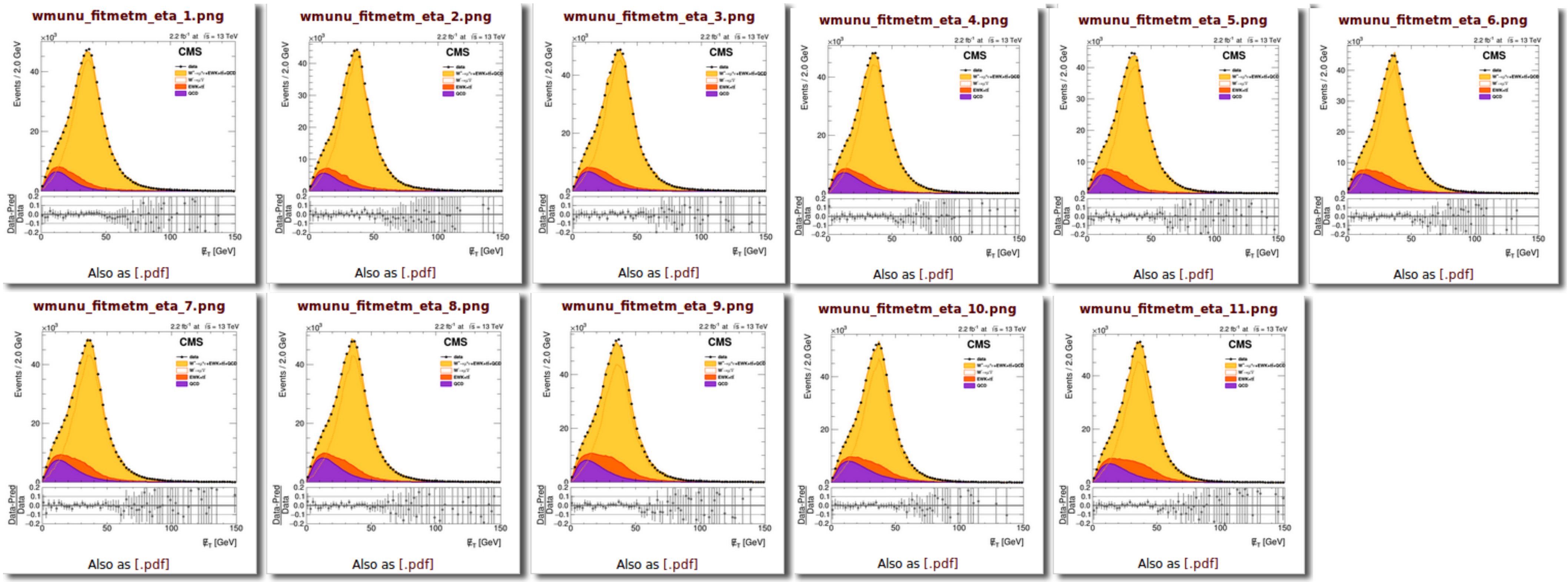
Missing E_T for the whole eta region in μ^-, μ^+ channels

Results represents signal extraction in signal region. The dotted orange lines shows the distribution of the W boson signal, violet corresponds to QCD while red is EWK+$t\bar{t}$.



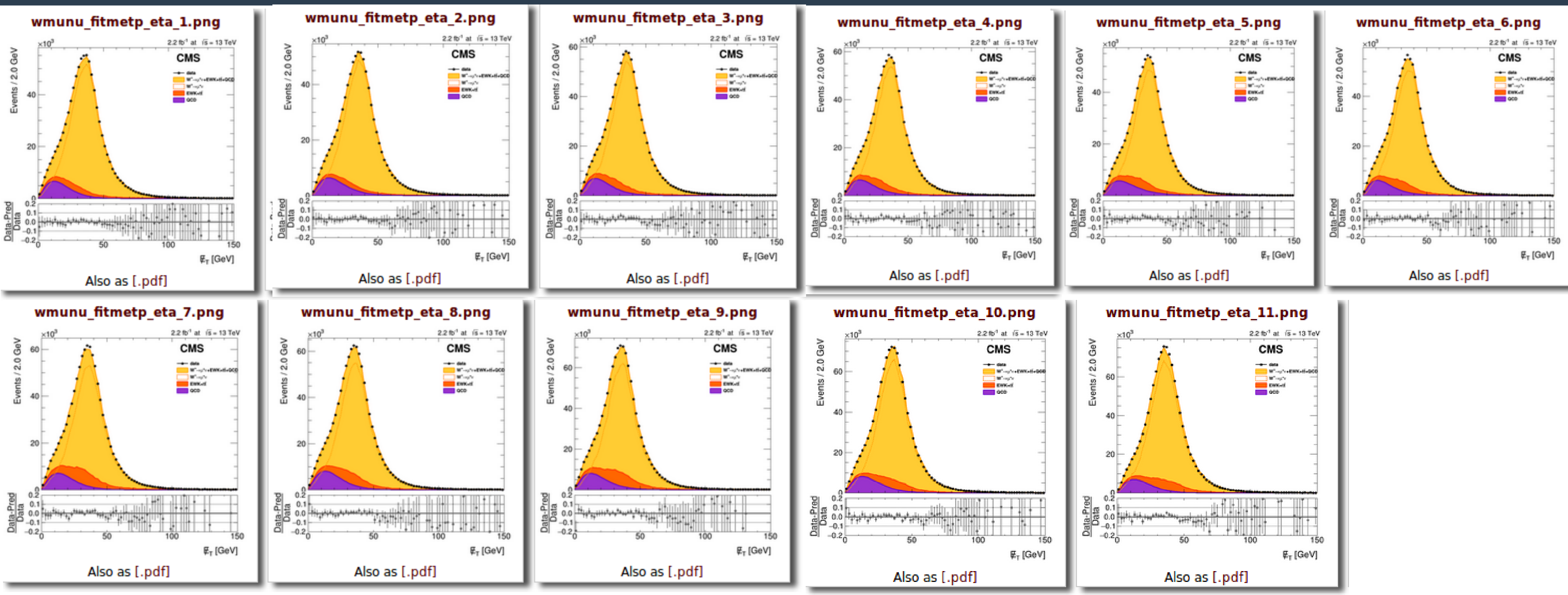
Data is in a good agreement with the fit

Eta binned results for μ⁻ - signal region



- QCD background much smaller
- Data is in a good agreement with the fit

Eta binned results for μ⁺ - signal region



- Data is in a good agreement with the fit

Control region of QCD background

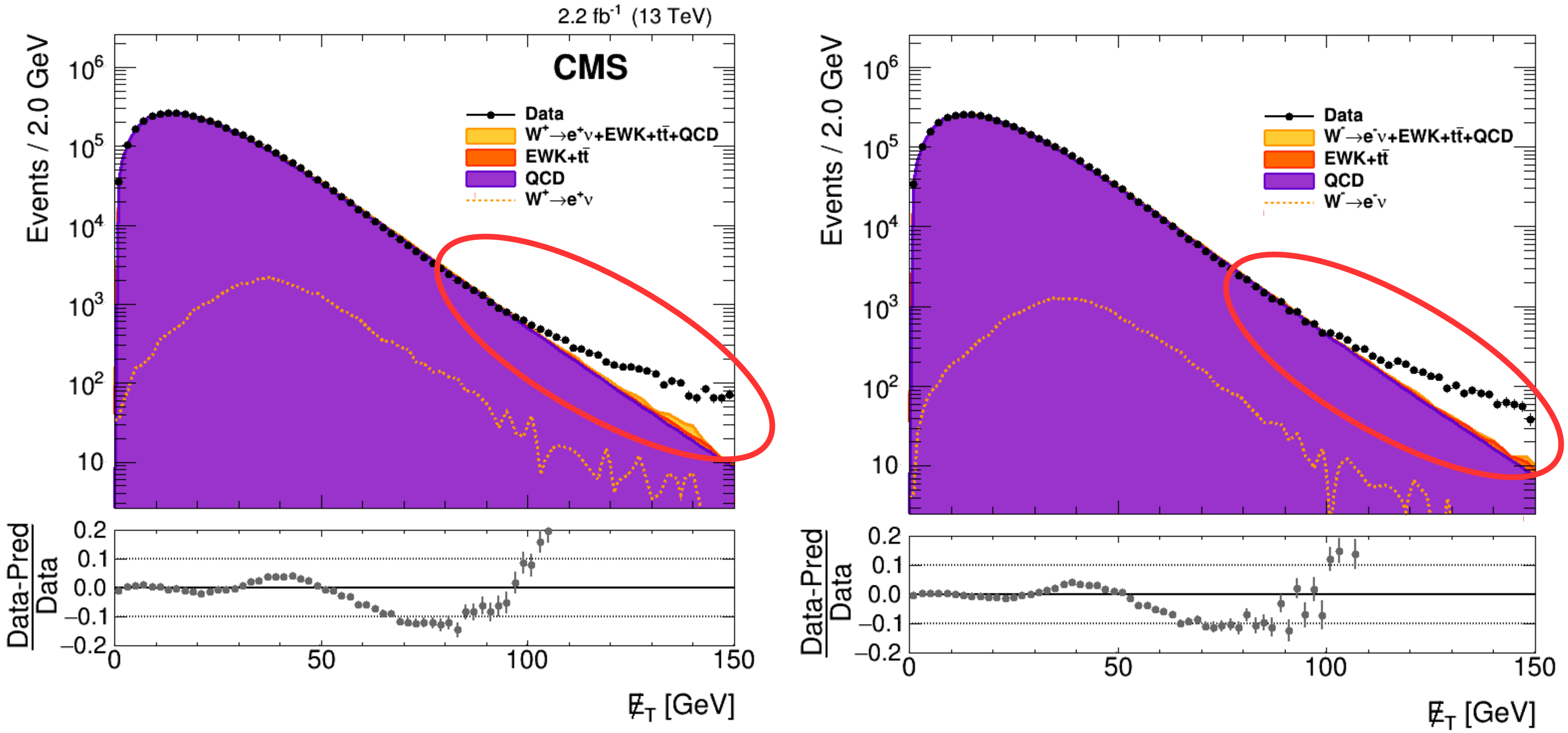
QCD background modeled by analytical function:

$$f(x) = x*\exp(\{-x^2\} / \{ax^2+bx+c\})$$

$a = 4.0 \in [-10.0, 10.0]$
$b = 6.0 \in [0.0, 20.0]$
$c = 2.9 \in [0.3, 6.0]$
$x \in [0.0, 2.0, 150.0]$

Control region for e^- & e^+

Results represents estimation of a QCD background using control region. The dotted orange lines shows the distribution of the W boson signal, violet corresponds to QCD and red is EWK+$t\bar{t}$.



Problem with QCD estimation at high E_t^{miss}

Eta binned results for e^- & e^+ - control region

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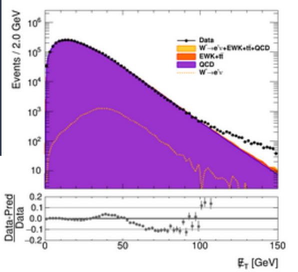

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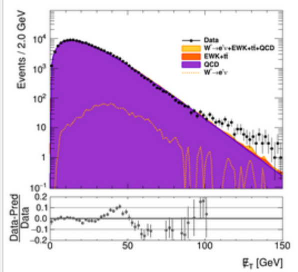

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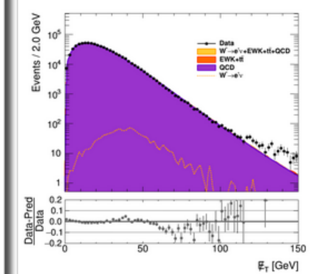

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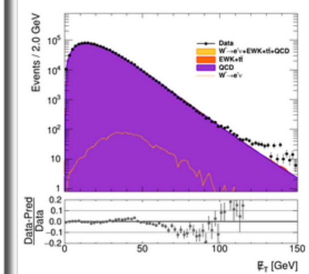

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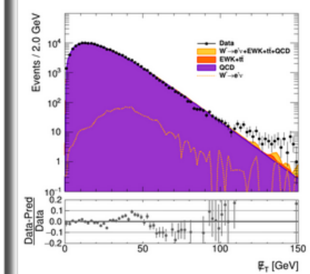

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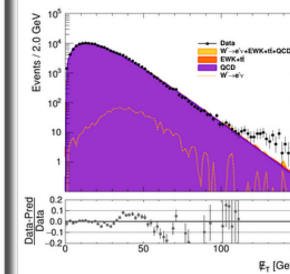

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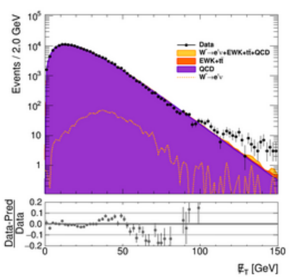

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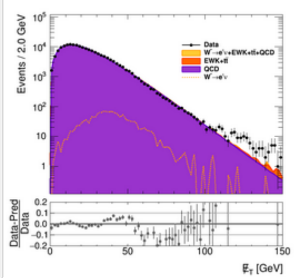

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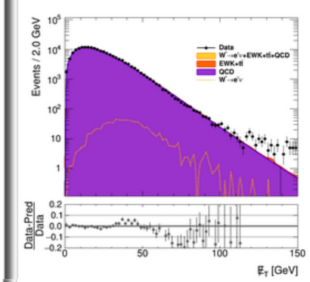

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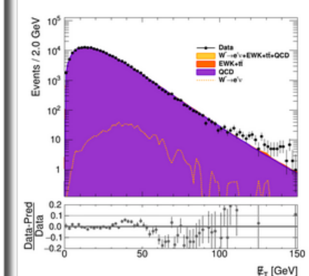

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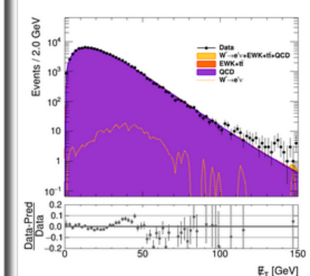

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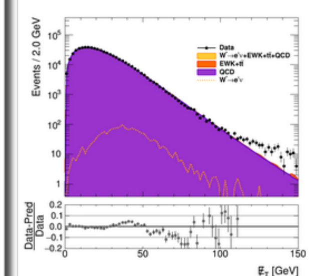

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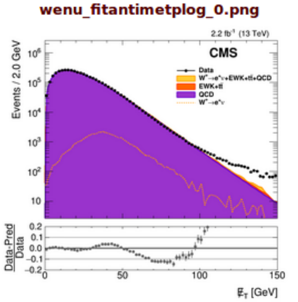

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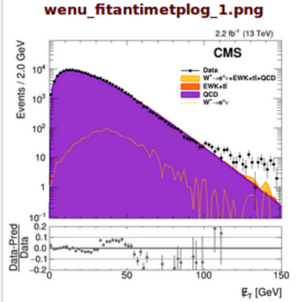

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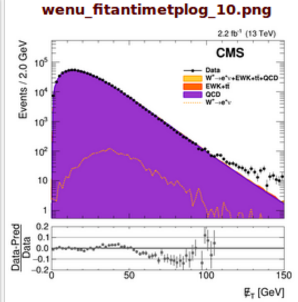

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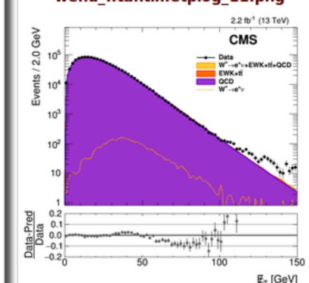

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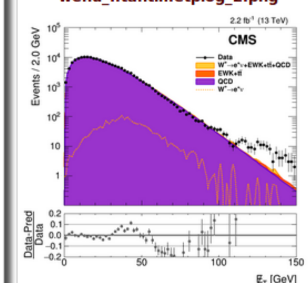

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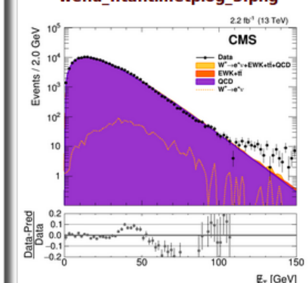

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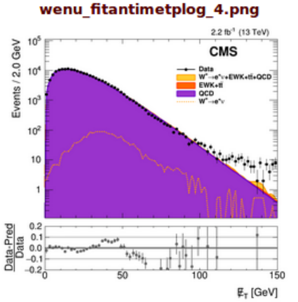

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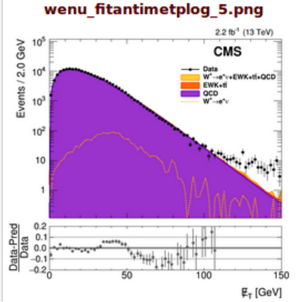

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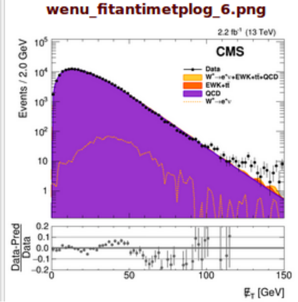

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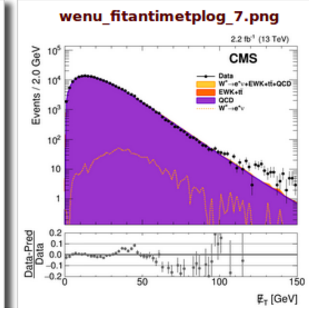

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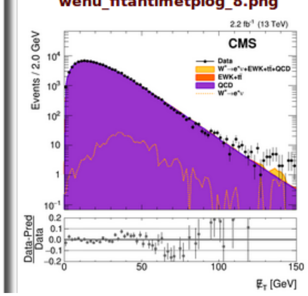

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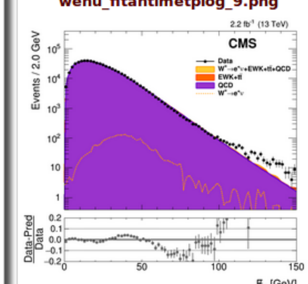
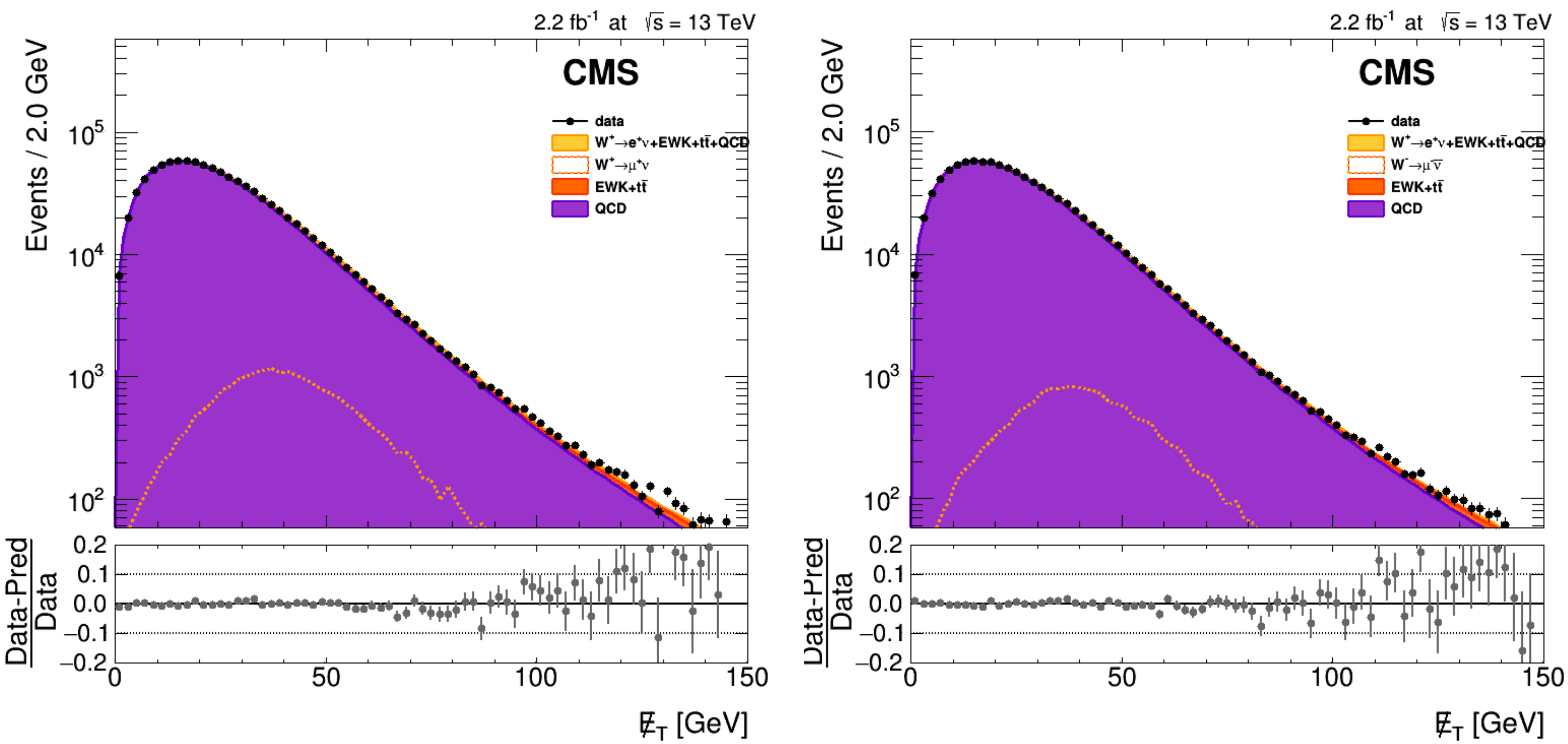


Control region for μ⁻ & μ+

Results represents estimation of a QCD background using control region. The dotted orange lines shows the distribution of the W boson signal, violet corresponds to QCD and red is EWK+$t\bar{t}$.



Some small effects with QCD estimation at high E_t^{miss} for μ channel

Eta binned results for μ⁻ & μ⁺ - control region

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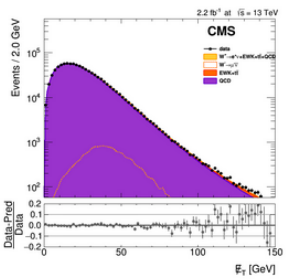

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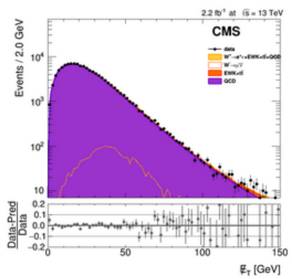

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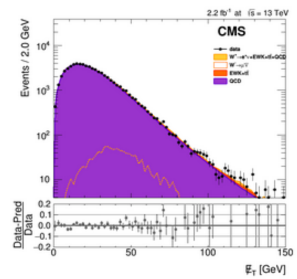

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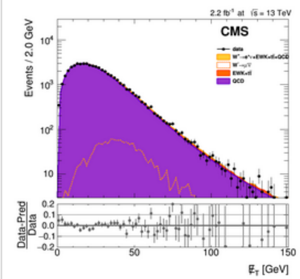

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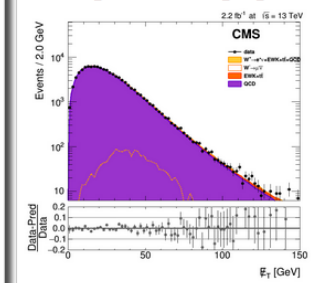

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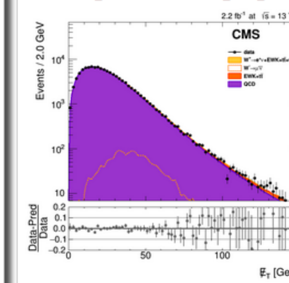

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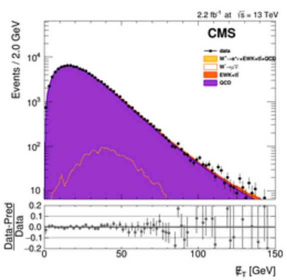

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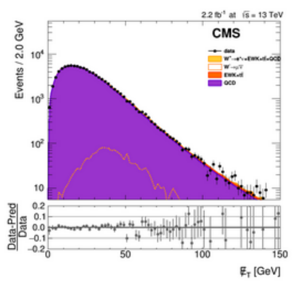

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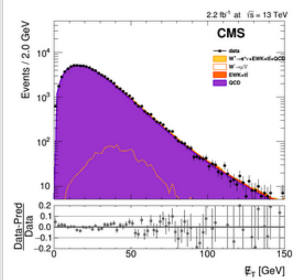

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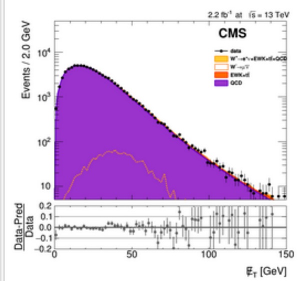

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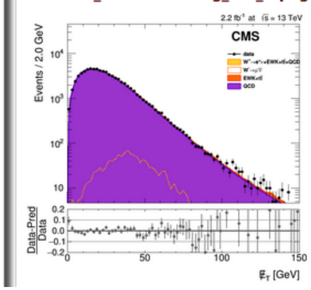

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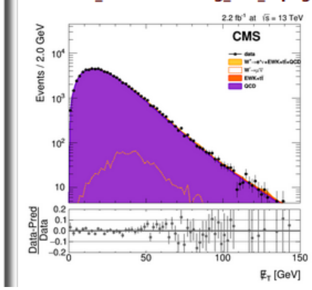

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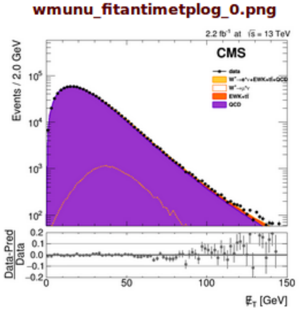

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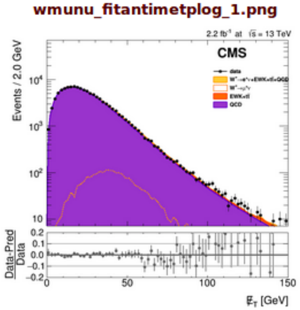

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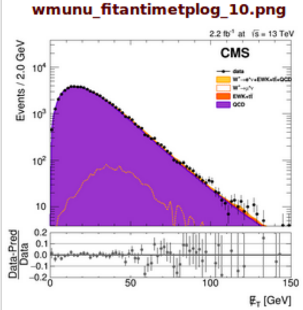

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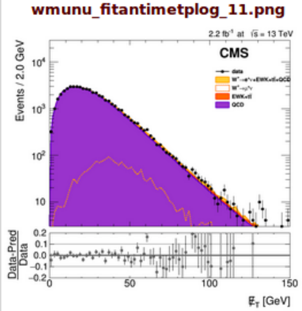

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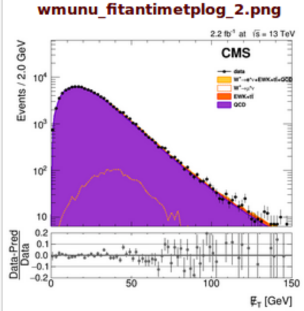

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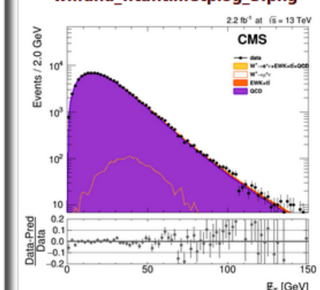

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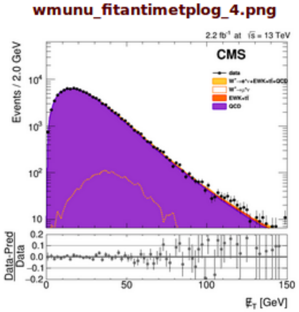

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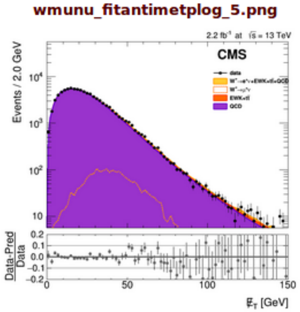

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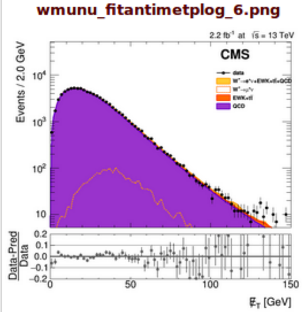

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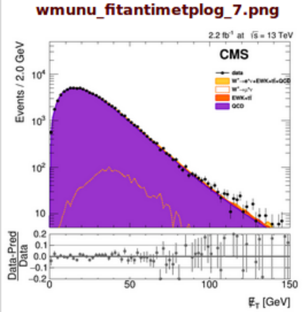

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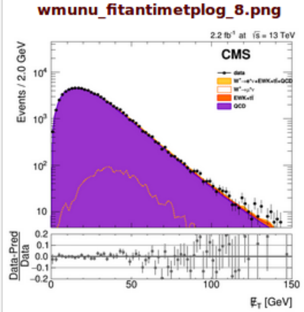

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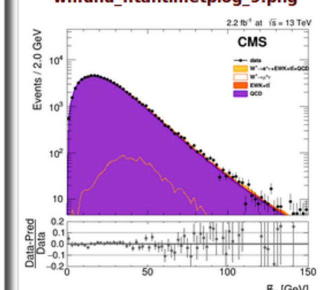


Intermediate results

- An important conclusion is a good agreement of the signal with theoretical assumptions, especially for muon channel.
- Same results for different eta region.
- Fitting issues in control region for electron channel revealed.

Next steps*

Muon channel:
- eta binned summary table.
- treatment of systematic uncertainties.

Electron channel:
- investigate possible fitting issues.
- try to propose more effective fit.

* - more ideas to come.

Back up

Object and event selection

For this analysis, the events are collected when triggered by the presence of at least one electron/muon with large transverse energy and η cut:

- $P_T > 25$ GeV
- $|\eta| < 2.5$ for electrons or $|\eta| < 2.4$ for muons

Electron candidates are identified using the simple cut-based approach using information of the cluster shape, hadronic activity, and track quality. Particle candidates are identified using a particle-flow algorithm.

Muons are reconstructed from seed tracks in the muon detector combined with silicon strip and pixel information using a global fit. Muon candidates are identified using the simple cut-based approach using information of the track and global fit quality.

Lepton efficiencies

The lepton efficiencies are estimated in data and simulation using tag-and-probe, a technique exploiting the pure Z signal to get an unbiased sample of high-p_T leptons similar to those created in W decay.

For electron candidates:

$$e_{total} = e_{GSF+ID+ISO} \times e_{trigger} ,$$

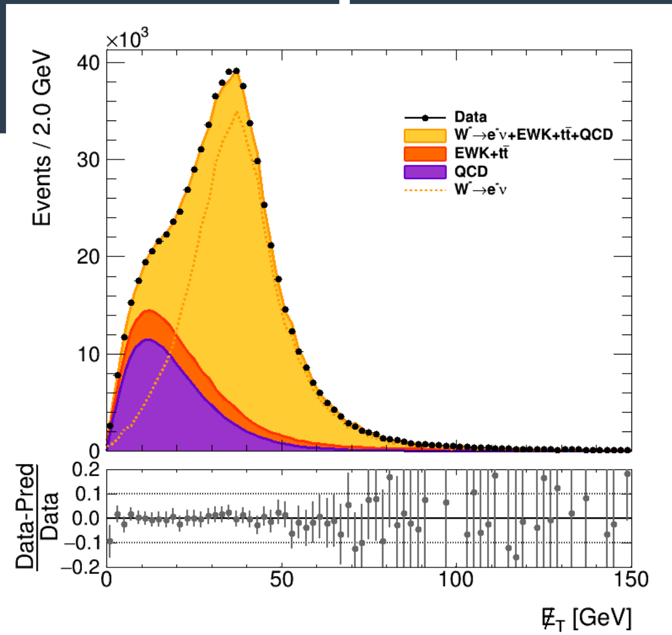
where $e_{GSF + ID + ISO}$ is the efficiency to create an electron candidate passing identification and isolation criteria starting from a supercluster and $e_{trigger}$ is the efficiency for a fully identified and isolated electron candidate to pass the trigger (HLT and Level-1) requirements.

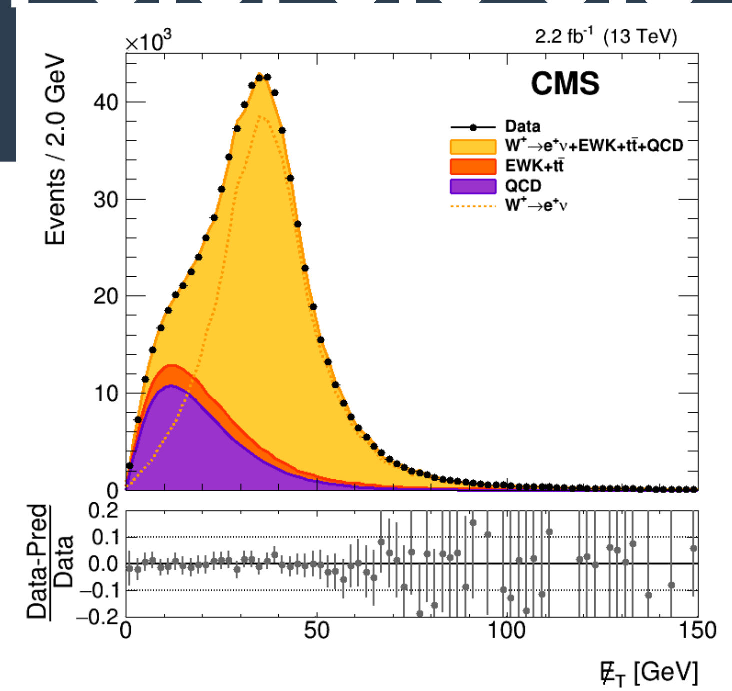
For the muon candidates, a similar factorization is performed

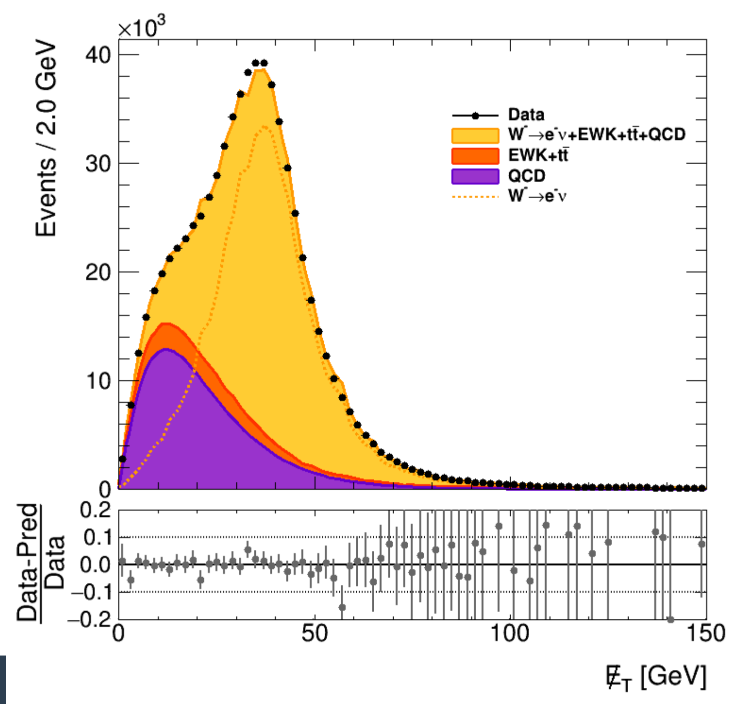
$$e_{total} = e_{tracking+ID+ISO} \times e_{STA} \times e_{trigger} ,$$

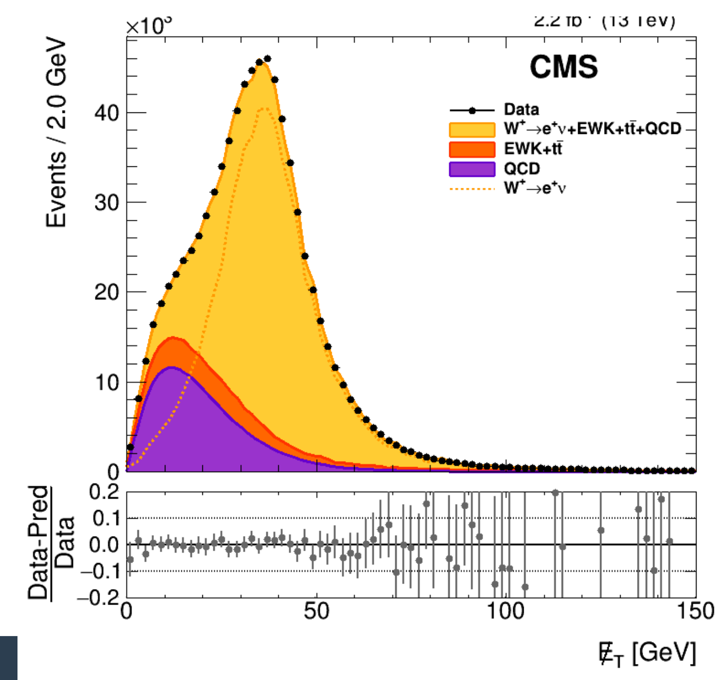
where $e_{tracking+ID+ISO}$ is the efficiency for a track in the muon detector to be matched to a global muon that passes the identification and isolation criteria, e_{STA} is the efficiency for a isolated tracker track from a muon to be matched to a global muon, and $e_{trigger}$ is the efficiency for a fully identified and isolated muon to pass the trigger (HLT and Level-1) requirements.

Missing E_T for eta 0.4-0.6, 0.6-0.8

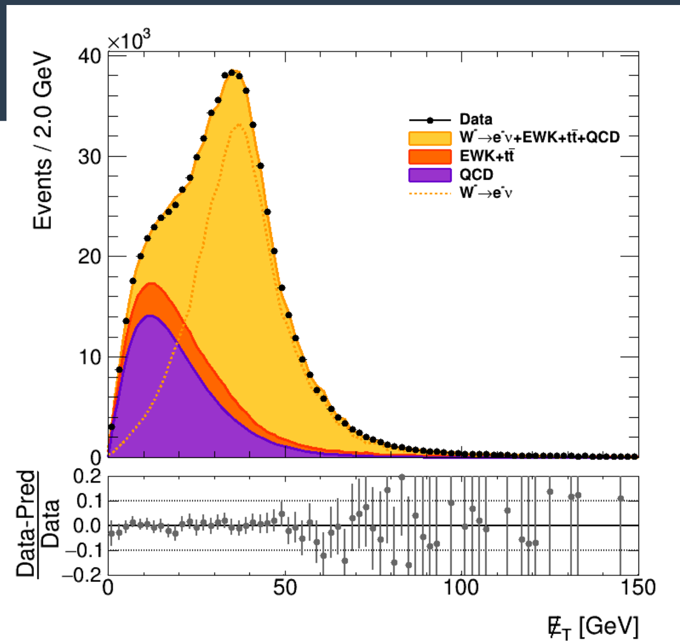


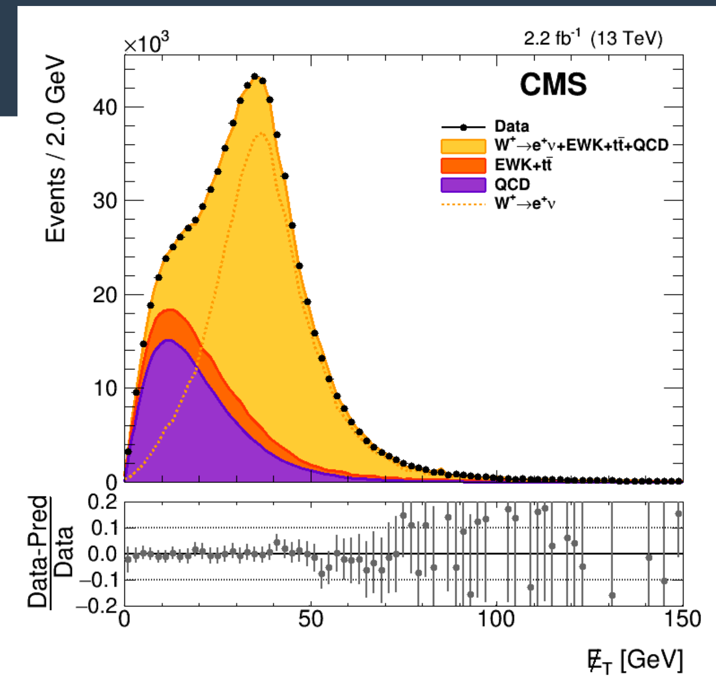


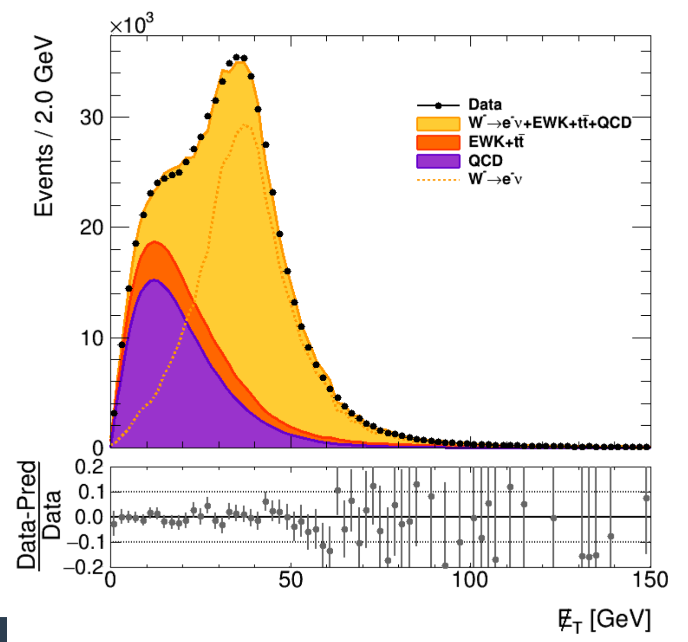


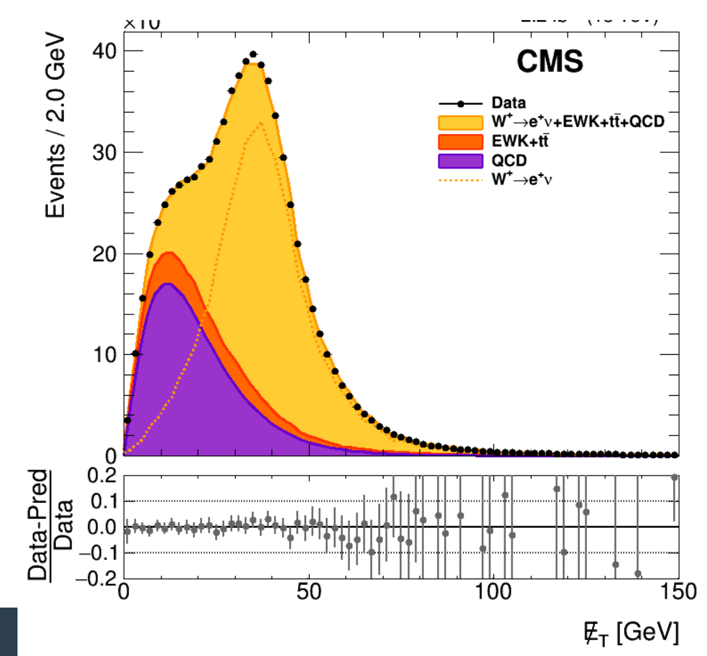


Missing E_T for eta 0.8-1.0 1.0-1.2

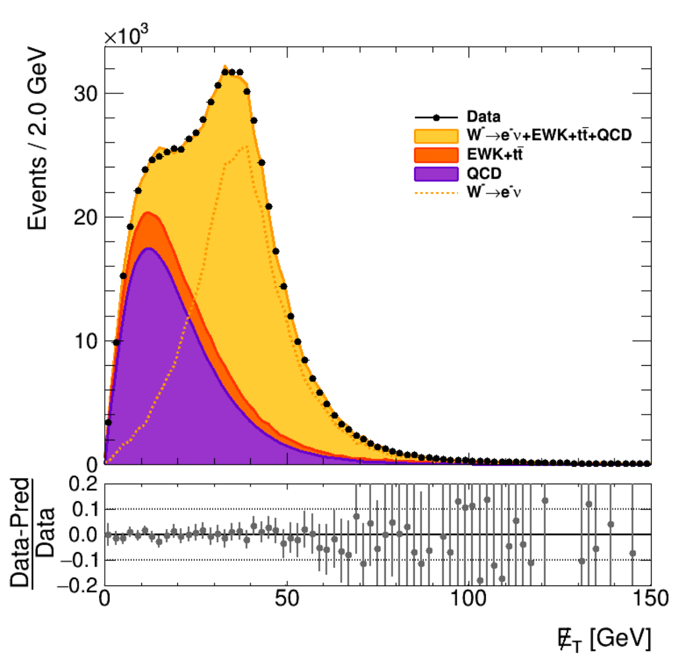


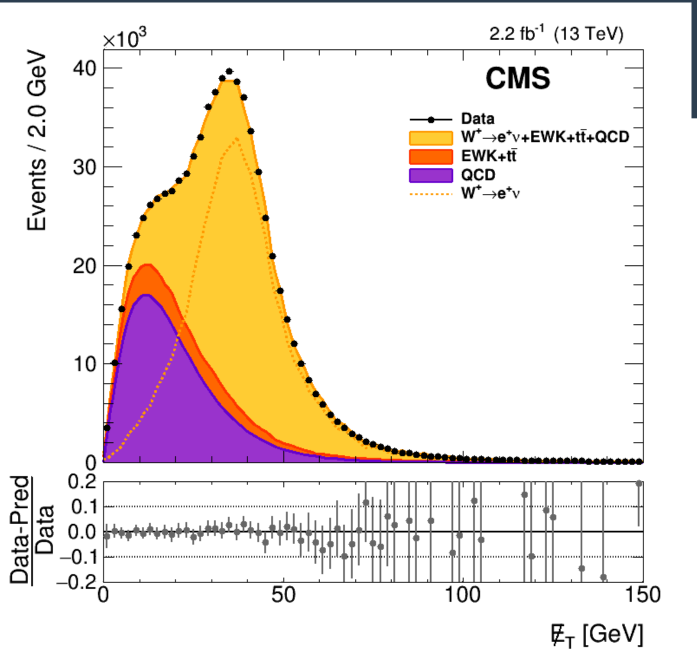


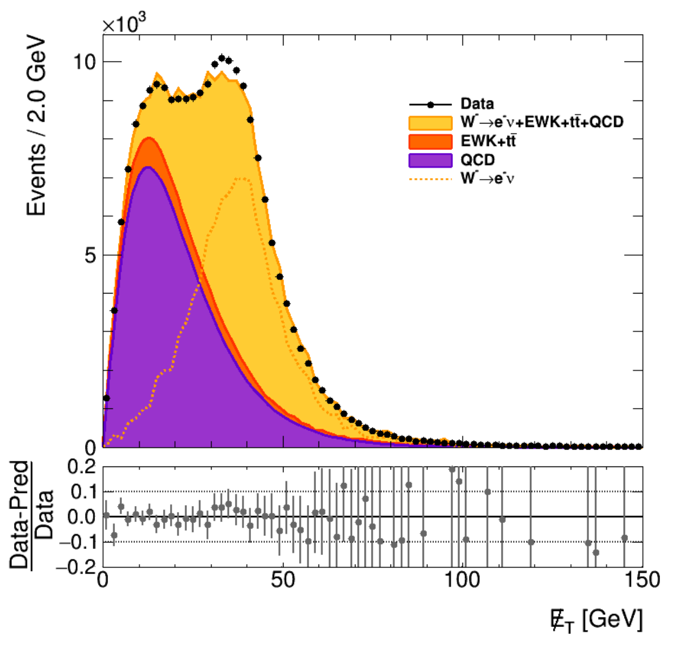


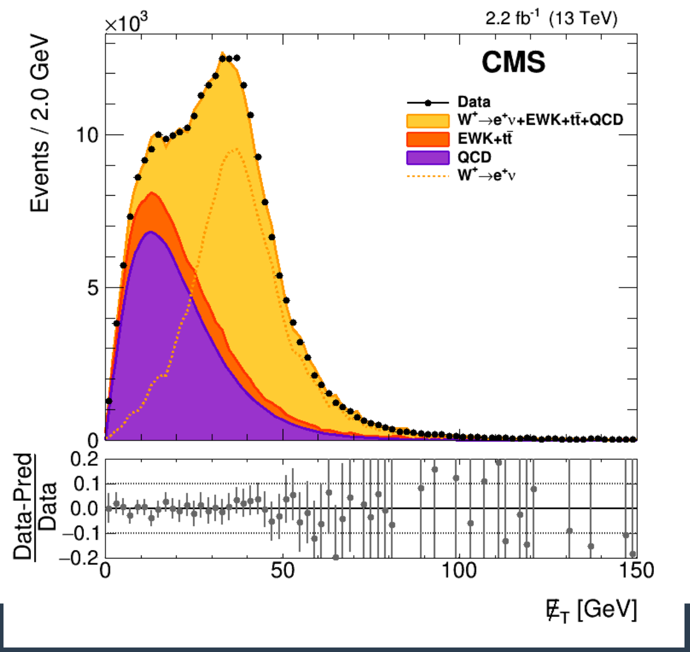


Missing E_T for eta 1.2-1.4 1.4-1.6

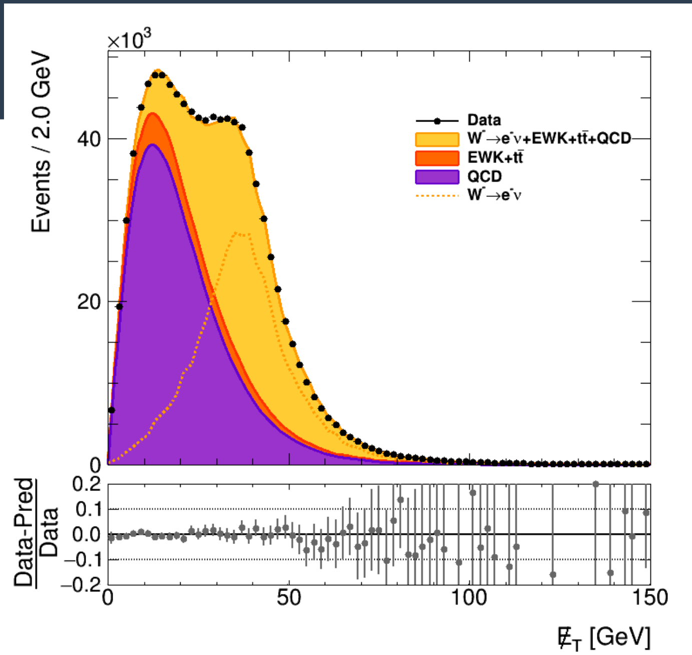


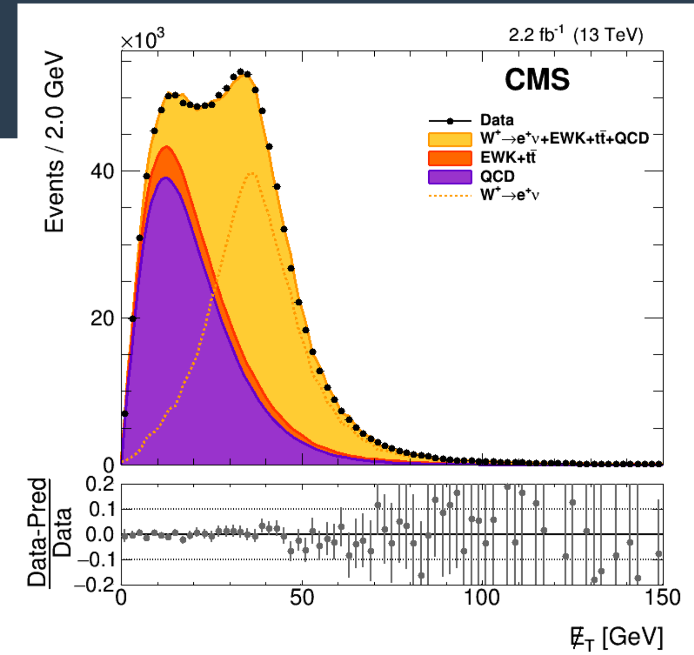


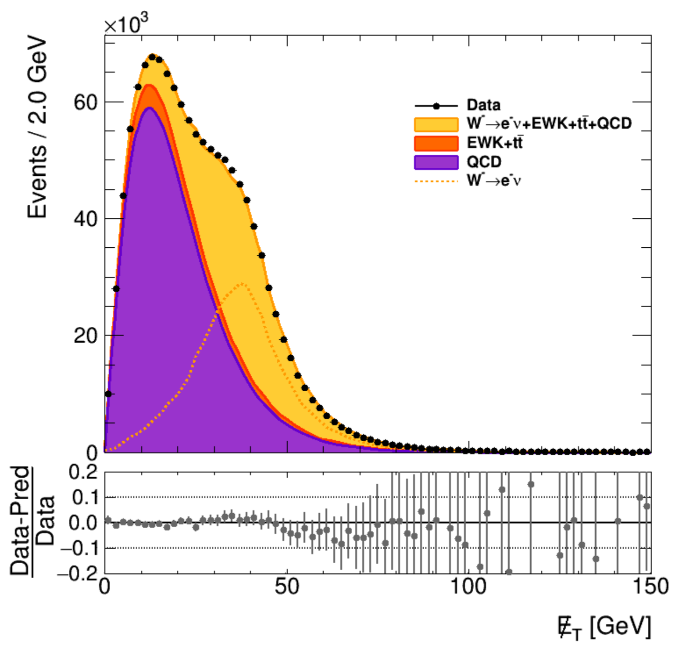


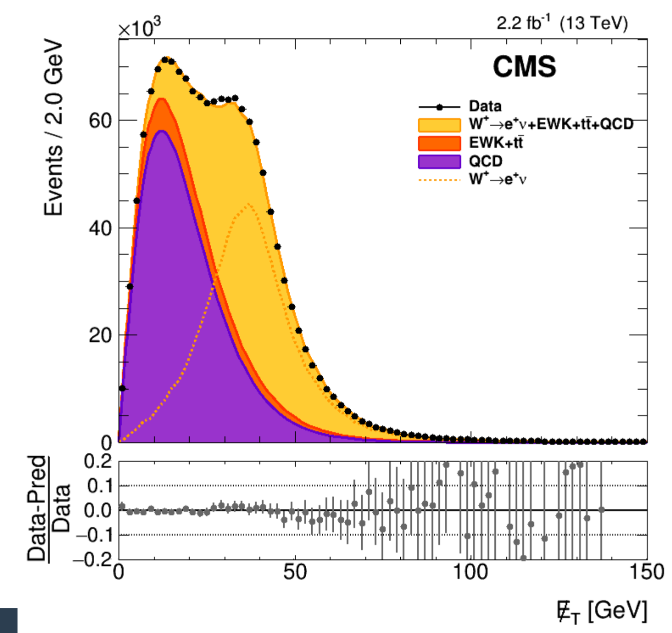


Missing E_T for eta 1.6-1.9 1.9-2.1

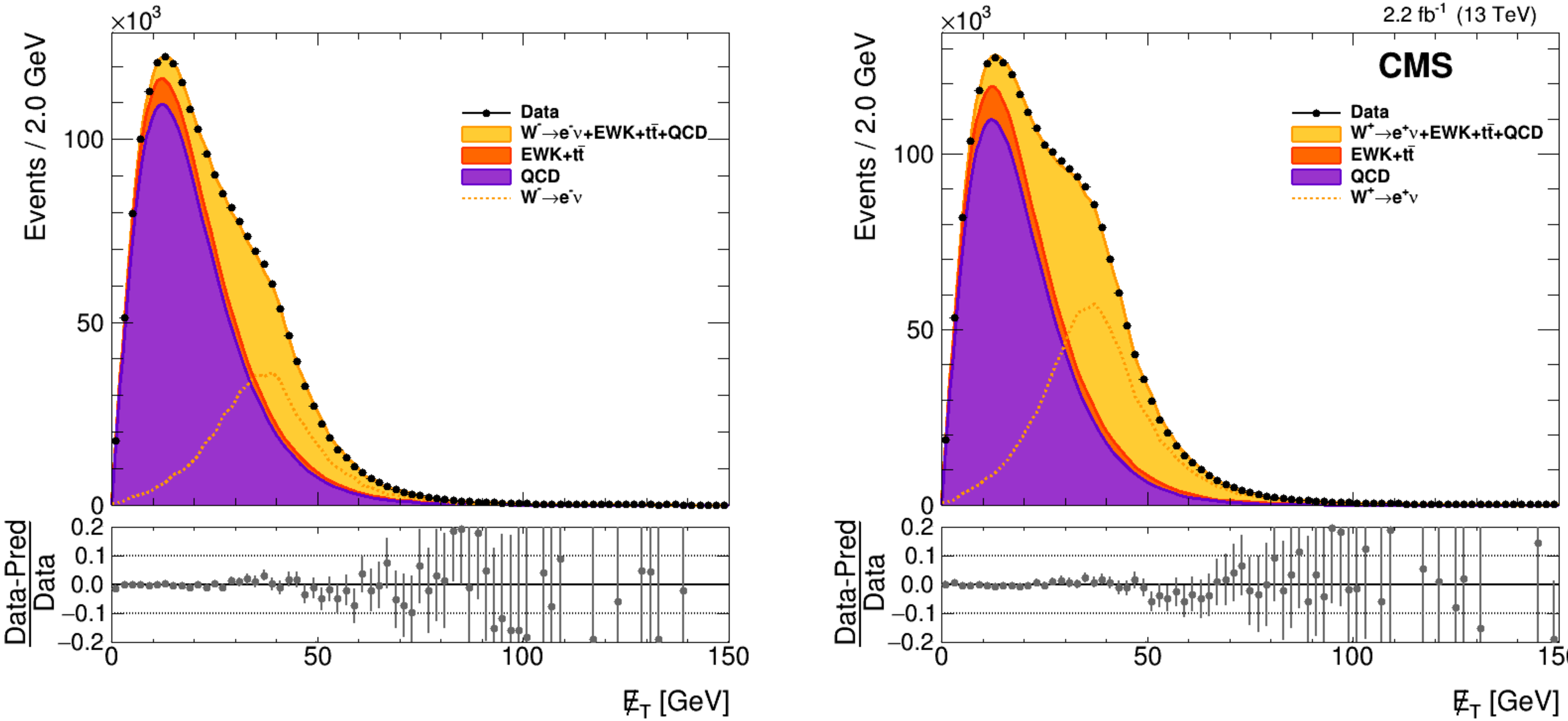






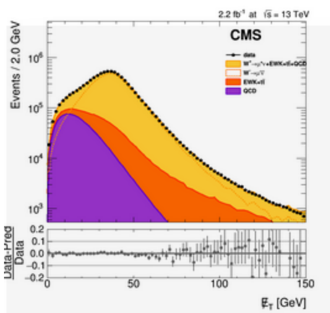


Missing E_T for eta 2.1-2.5



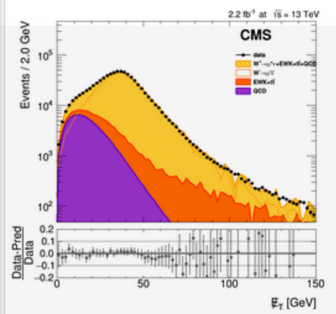
Eta binned results in log scale for μ⁻ - signal region

Wmunu_fitmetmlog_eta_0.png



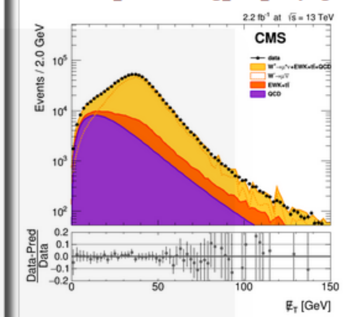
Also as [.pdf]

Wmunu_fitmetmlog_eta_1.png



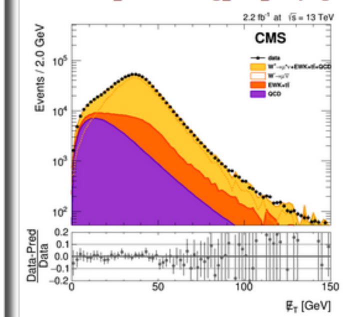
Also as [.pdf]

Wmunu_fitmetmlog_eta_10.png



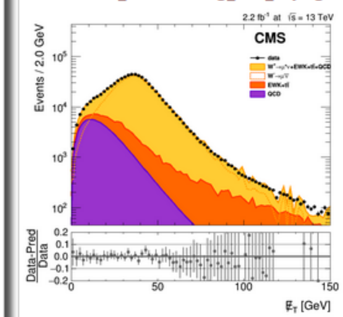
Also as [.pdf]

Wmunu_fitmetmlog_eta_11.png



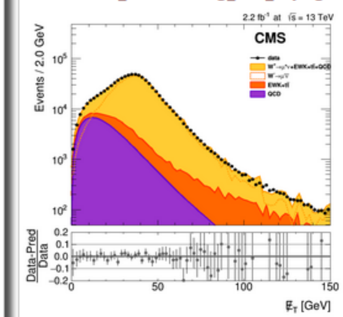
Also as [.pdf]

Wmunu_fitmetmlog_eta_2.png



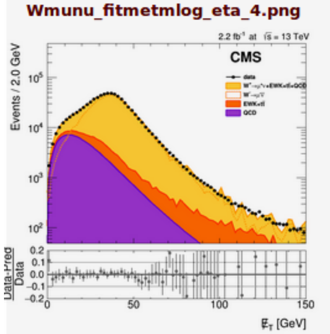
Also as [.pdf]

Wmunu_fitmetmlog_eta_3.png

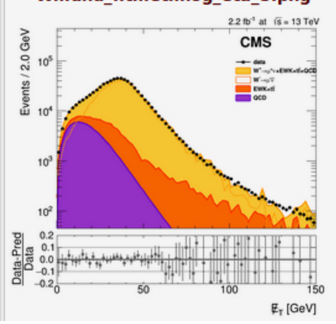


Also as [.pdf]

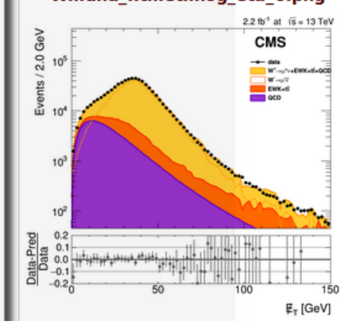
Wmunu_fitmetmlog_eta_4.png



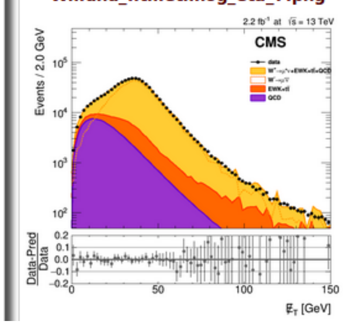
Wmunu_fitmetmlog_eta_5.png



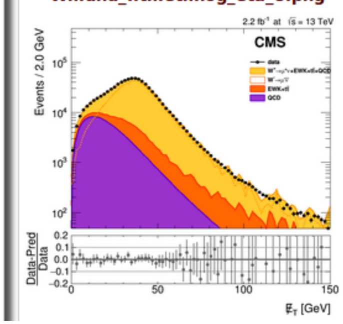
Wmunu_fitmetmlog_eta_6.png



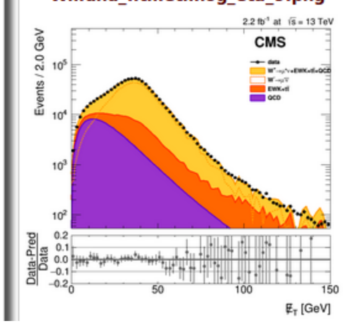
Wmunu_fitmetmlog_eta_7.png



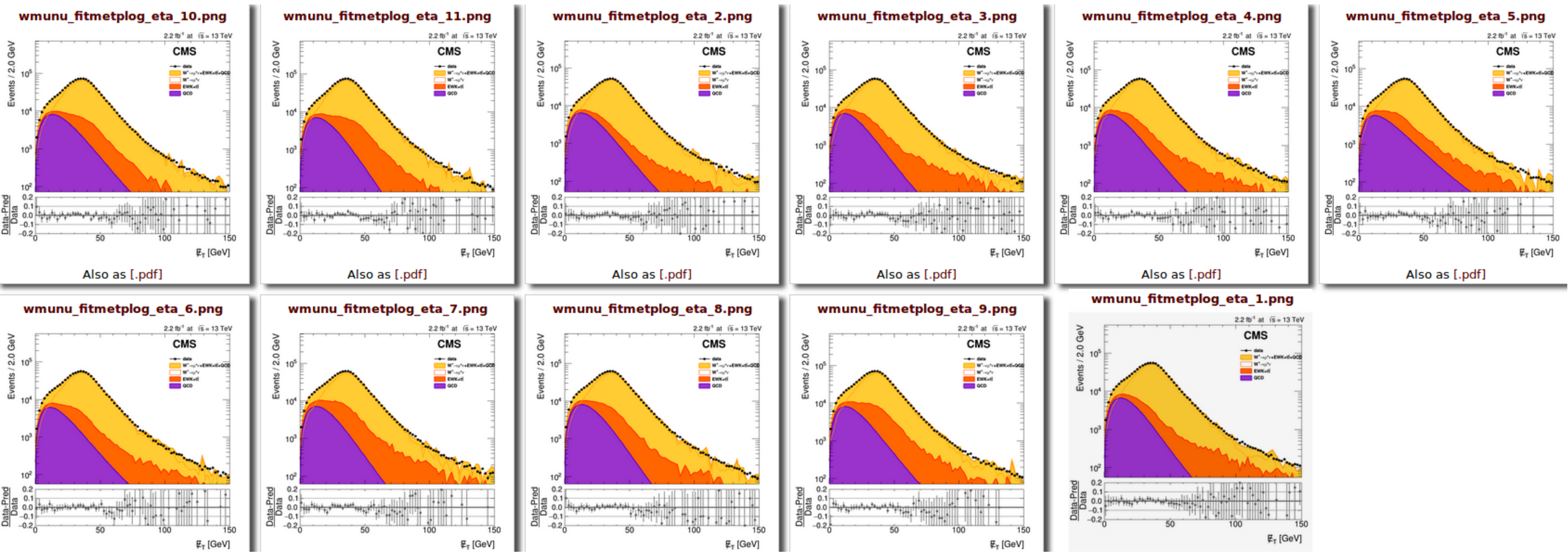
Wmunu_fitmetmlog_eta_8.png



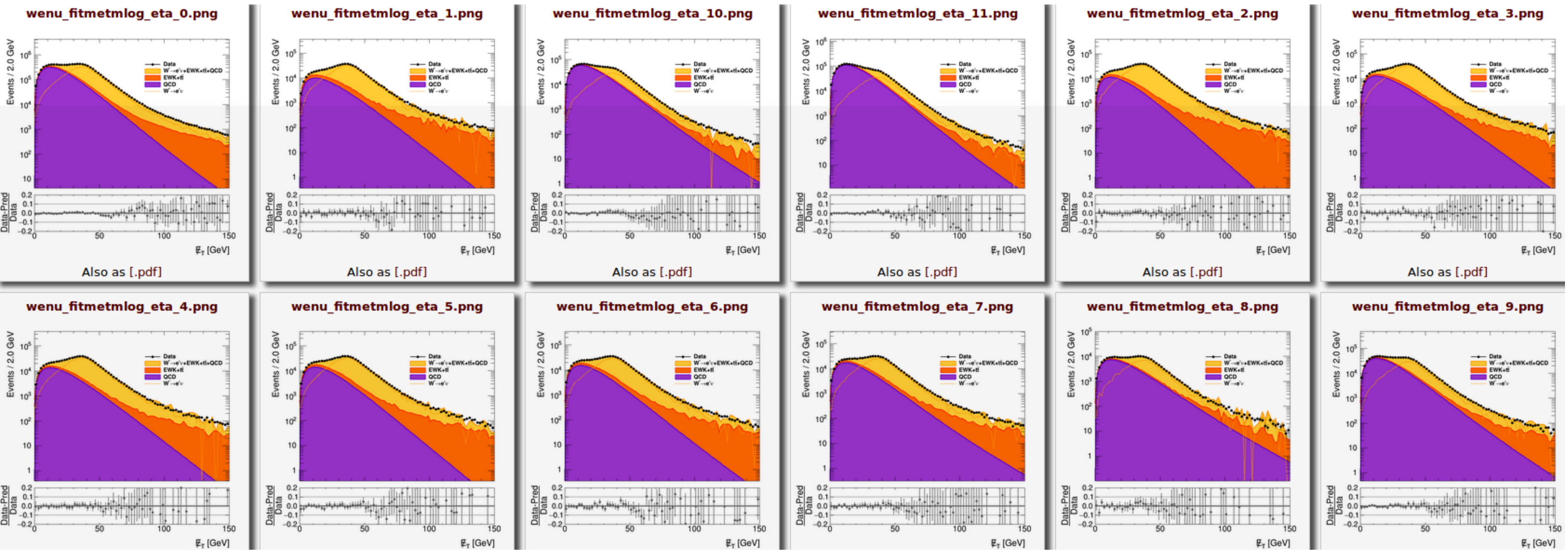
Wmunu_fitmetmlog_eta_9.png



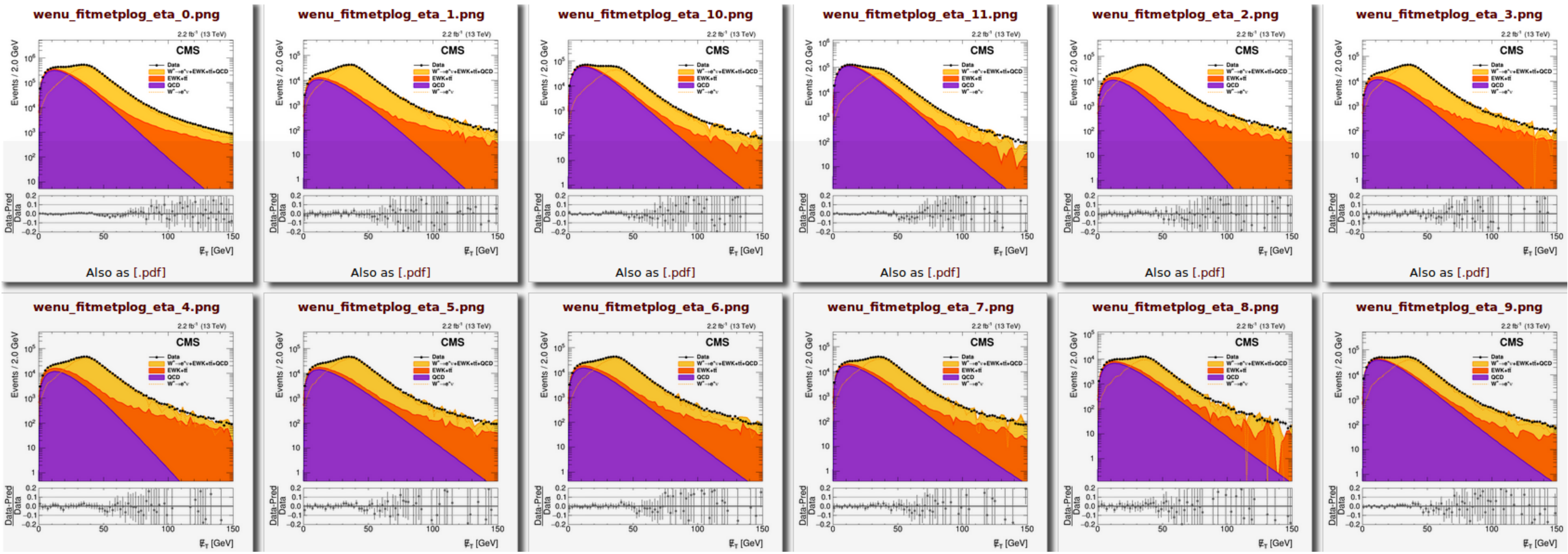
Eta binned results in log scale for μ^+ - signal region



Eta binned results in log scale for e^- - signal region



Eta binned results in log scale for e^{-} - signal region



Fit table for bin 1.2-1.4

```
 *** Yields *** (1.2,1.4) :
Selected: 704761
  Signal: 435573.4003 +/- 2210.683183
     QCD: 201324.4345 +/- 2896.693949
   Other: 67852.89905 +/- 2056.653743
AntiSelected: 177600
  Signal: 780.6002841 +/- 98.07050961
     QCD: 176673.0977 +/- 437.1072762
   Other: 136.4313625 +/- 17.14051803


  RooFitResult: minimized FCN value: -6489281.266, estimated distance to minimum: 4.019910745e-06
                covariance matrix quality: Full, accurate covariance matrix
                Status : MIGRAD=4 HESSE=0 MINOS=6

    Constant Parameter    Value
  --------------------  ------------
                 dewkm    1.7478e-01

    Floating Parameter  InitialValue    FinalValue (+HiError,-LoError)    GblCorr.
  --------------------  ------------  ----------------------------------  --------
               a1_qcdm    4.0000e+00    1.1259e+00 (+1.60e-01,-1.59e-01)  <none>
              a2_aqcdm    6.0000e+00    8.6016e+00 (+1.69e-01,-1.70e-01)  <none>
               a2_qcdm    6.0000e+00    7.5408e+00 (+2.33e-01,--0.00e+00)  <none>
              a3_aqcdm    2.9000e+00    1.5736e+00 (+5.22e-02,-5.17e-02)  <none>
               a3_qcdm    2.9000e+00    1.3676e+00 (+5.04e-02,-5.29e-02)  <none>
                 cewkm    1.2670e-01    1.5578e-01 (+4.87e-03,-4.83e-03)  <none>
             nAntiQCDm    1.6872e+05    1.7667e+05 (+4.38e+02,-4.36e+02)  <none>
             nAntiSigm    6.6119e+02    7.8060e+02 (+9.23e+01,-9.71e+01)  <none>
                 nQCDm    1.4095e+05    2.0132e+05 (+3.14e+03,-3.09e+03)  <none>
                 nSigm    5.6381e+05    4.3557e+05 (+2.42e+03,-2.39e+03)  <none>



  Correlation Matrix
 --------------------
   1.0000  -0.9563  -0.5214   0.8219  -0.3955  -0.1879   0.0004  -0.0013   0.0665   0.0794
  -0.9563   1.0000   0.4986  -0.9333   0.3783   0.1797  -0.0129   0.0453  -0.0636  -0.0759
  -0.5214   0.4986   1.0000  -0.4286   0.8499  -0.0374  -0.0002   0.0007   0.6463  -0.7016
   0.8219  -0.9333  -0.4286   1.0000  -0.3251  -0.1544   0.0024  -0.0084   0.0546   0.0652
  -0.3955   0.3783   0.8499  -0.3251   1.0000  -0.0688  -0.0001   0.0005   0.4093  -0.4072
  -0.1879   0.1797  -0.0374  -0.1544  -0.0688   1.0000  -0.0001   0.0002  -0.5404  -0.2108
   0.0004  -0.0129  -0.0002   0.0024  -0.0001  -0.0001   1.0000  -0.2665   0.0000   0.0000
  -0.0013   0.0453   0.0007  -0.0084   0.0005   0.0002  -0.2665   1.0000  -0.0001  -0.0001
   0.0665  -0.0636   0.6463   0.0546   0.4093  -0.5404   0.0000  -0.0001   1.0000  -0.6612
   0.0794  -0.0759  -0.7016   0.0652  -0.4072  -0.2108   0.0000  -0.0001  -0.6612   1.0000

  Chi2 Test
 -----------
      prob = 1
   chi2/ndf = 0.3968

  KS Test
 ---------
   prob = 0.8188
   prob = 0.592 with 1000 pseudo-experiments

fitresWem_bin_6.txt (END)
```

Input ntuple files

Enums for isolated e^+ , e^- (signal region):

- **eData**
- **eWenu (MC)**
- **eEWK (τ channel and DY)**
- **eQCD**
- **eBKG (diboson and $t\bar{t}$)**

Enums for non isolated e^+,e^- (control region):

- **eAntiData**
- **eAntiWenu**
- **eAntiEWK**
- **eAntiQCD**