$W' + b$

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Last report

- Last W'+b meeting: (Click here)
  - Studies using the tau signal sample (M=600).
    - Significance as a function of $m_T(\tau, p_T^{miss})$. Different top mass windows were used in the top reconstruction, but no appreciable change in significance was seen.

$$S = \frac{Signal}{\sqrt{Signal + Total\_Back}}$$

  - Jet+X talk on September 30Th (Click here).
    - **Hadronic channel:** Efficiency studies for the three years (2016, 2017 and 2018).
    - They were performed for the two main expected backgrounds. *tt* and W+Jets.
    - tt CR using the top tagger for all years.
    - First studies using the signal sample for 2017.
    - *Maybe, progress in the W+jets control region*.

- **Pending tasks**
  - Obtain a control region of W+jets. Today.
  - Weights for tt samples, using the variable ST in the tt control region. Today.

$t\bar{t}$ CR using the top tagger

	Criteria	Selection
Muon Veto	N_μ	= 0
	$\|\eta\|$	2.1
	$p_T(\mu)$	15 GeV
	Isolation	< 0.15
	Muon ID	Tight
Electron Veto	N_e	= 0
	$\|\eta\|$	2.4
	$p_T(e)$	10 GeV
	Isolation	< 0.15
	wp80iso	medium
Tau	$N(\tau_h)$	= 1
	$\|\eta(\tau_h)\|$	< 2.3
	$p_T(\tau_h)$	> 20 GeV
	TauID Algorithm	DeepTau
	DoDiscrAgainst	Jet = Tight
		AntiElectron = Tight
		AntiMuon = Tight
	ProngType	1or3
	ΔR	> 0.4
MET	p_T^{miss}	> 180 GeV
	MET filters/ corrections	Applied

Top tagger

b-jets	p_T	> 20 GeV
	$\|\eta(b)\|$	< 2.4
	pileup id	Tight
	DeepFlavor	Passing Tight wp (0.7476) (click here)
Light-jets	p_T	> 20 GeV
	$\|\eta(b)\|$	< 2.4
	pileup id	Tight
	DeepFlavor	Failing Loose wp (0.0532)
W-Jets	p_T	> 200 GeV
	$\|\eta(b)\|$	< 2.4
	particleNet_WvsQCD	Tight (click here)
Fat-Jets	p_T	> 300 GeV
	$\|\eta(b)\|$	< 2.4
	particleNet_TvsQCD	Tight (click here)
Trigger	MET	HLT_PFMETNoMu120_PFMHTNoMu120

- CR with τ + p_T^{miss} + b + Passing_top_tagger.
- In the top tagger, a top is valid if the mass of the reconstructed top is in the range [100-300]. More details can be found in the backup.
- 2017 luminosity and v9 UL samples were considered.
  - NanoAODv9 samples.
  - **MET dataset** was used: B, C, D, E. F.
- **Cutflow**:
  - GoodVertex.
  - met filters.
  - Trigger.
  - $p_T^{miss} > 180$ GeV.
  - $N(e) = 0$.
  - $N(\mu) = 0$.
  - $N(\tau) = 1$.
  - $N(b) = 1$.
  - Passing top tagger.
- Motivated by the work initiated by Alexis in the electronic channel, click here, I tried the idea of ST weights for the hadronic channel to see what impact it would have.

$$ST = \sum_i p_T(b) + \sum_i p_T(j) + p_T(\tau) + p_T^{miss}$$

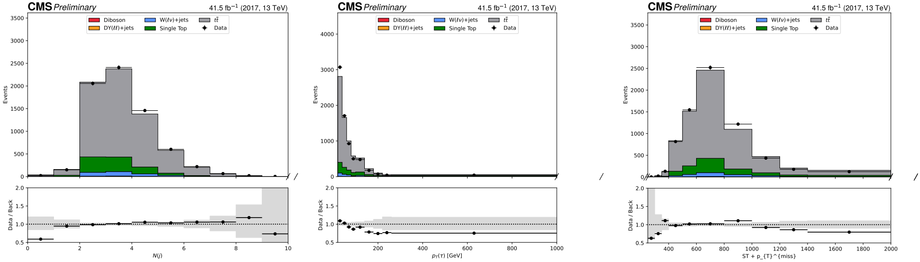
tt CR results

- Weights were calculated using:

$$weight = \frac{Data - Non\_tt}{tt}$$

Bin Range	Data	tt	SingleTop	DYJetsToLL	WJetsToLNu	VV	TotalBack	Data/TotalBack	Data - Non_tt	Weight
[250,300]	3	3.72 ± 0.39	1.1 ± 0.66	0.0 ± 0.0	0.01 ± 0.01	0.0 ± 0.0	4.83 ± 0.76	0.62 ± 0.36	1.89 ± 0.85	0.508 ± 0.235
[300,350]	23	25.29 ± 0.93	4.57 ± 1.48	0.36 ± 0.23	0.59 ± 0.41	0.0 ± 0.0	30.81 ± 1.81	0.75 ± 0.16	17.48 ± 2.03	0.691 ± 0.084
[350,400]	132	102.08 ± 1.89	14.39 ± 2.15	0.2 ± 0.07	3.72 ± 1.13	0.0 ± 0.0	120.2 ± 3.07	1.1 ± 0.1	113.88 ± 3.61	1.116 ± 0.041
[400,500]	816	711.99 ± 5.01	102.78 ± 6.25	1.69 ± 0.47	28.32 ± 3.24	0.75 ± 0.31	845.53 ± 8.66	0.97 ± 0.03	682.46 ± 10.0	0.959 ± 0.069
[500,600]	1546	1275.44 ± 6.76	198.33 ± 8.72	4.75 ± 0.78	53.15 ± 4.17	1.13 ± 0.38	1532.8 ± 11.83	1.01 ± 0.03	1288.64 ± 13.63	1.010 ± 0.012
[600,800]	2520	2056.88 ± 8.67	329.88 ± 11.21	8.71 ± 0.86	89.8 ± 5.41	2.51 ± 0.66	2487.58 ± 15.21	1.01 ± 0.02	2089.3 ± 17.51	1.016 ± 0.010
[800,1000]	1218	927.34 ± 5.84	128.44 ± 7.12	5.18 ± 0.44	48.92 ± 3.6	1.79 ± 0.55	1111.67 ± 9.91	1.1 ± 0.03	1033.67 ± 11.5	1.115 ± 0.014
[1000,1200]	435	378.37 ± 3.74	67.0 ± 5.11	3.3 ± 0.25	27.04 ± 1.81	0.54 ± 0.32	476.26 ± 6.6	0.91 ± 0.04	337.11 ± 7.59	0.891 ± 0.022
[1200,1400]	177	161.18 ± 2.45	32.96 ± 3.68	1.55 ± 0.12	11.5 ± 0.86	0.34 ± 0.24	207.48 ± 4.51	0.85 ± 0.06	130.7 ± 5.13	0.811 ± 0.034
[1400,2000]	123	116.6 ± 2.1	29.67 ± 3.38	1.25 ± 0.09	8.58 ± 0.51	0.0 ± 0.0	156.11 ± 4.01	0.79 ± 0.07	83.49 ± 4.53	0.716 ± 0.041
Sum	6993	5758.89 ± 14.46	908.92 ± 18.7	26.76 ± 1.38	271.63 ± 8.71	7.06 ± 1.07	6973.27 ± 25.25	1.0 ± 0.01	5778.62 ± 29.1	1.003 ± 0.006

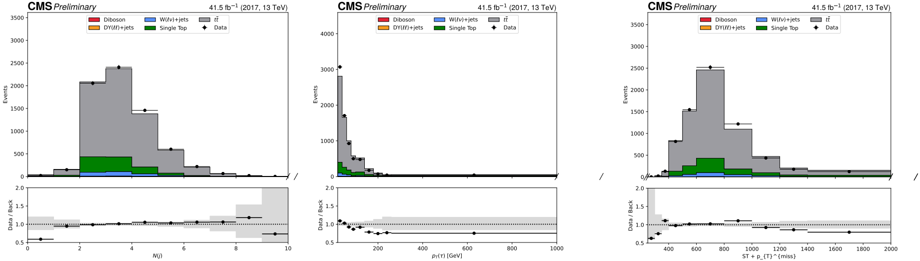
- I required in the tt CR: $p_T^{miss} \geq 180$ GeV; $p_T(\tau) \geq 20$ GeV; $p_T(j) \geq 20$ GeV; $p_T(b) \geq 20$ GeV. So I would expect that $S_T > 240$ GeV (**Result in accordance with the plots and table**).



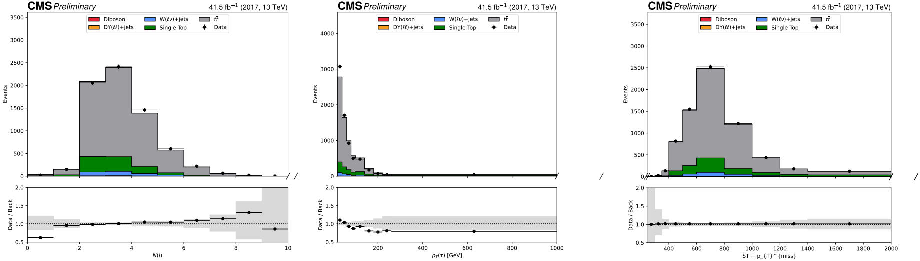
- Plots obtained from the control region.

tt CR results

- Comparison of the results when applying the weigths presented in the previous slide.
- **Without ST weights**



- **With ST weights:** Weights were applied only to the tt samples. No major impact is seen apart from the ST plot.



W+Jets CR

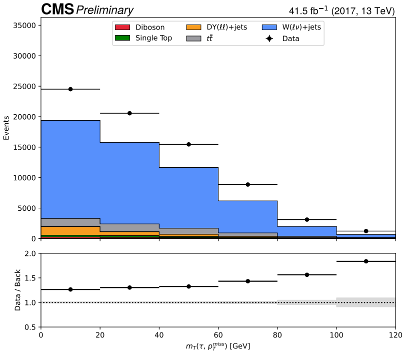
	Criteria	Selection
Muon Veto	N_μ	$= 0$
	$\|\eta\|$	< 2.1
	$p_T(\mu)$	≥ 20 GeV
	Isolation	< 0.15
	Muon ID	Tight
Electron Veto	N_e	$= 0$
	$\|\eta\|$	< 2.1
	$p_T(e)$	≥ 10 GeV
	Isolation	< 0.15
	wp90iso	
Tau	$N(\tau_h)$	$= 1$
	$\|\eta(\tau_h)\|$	< 2.3
	$p_T(\tau_h)$	≥ 20 GeV
	TauID Algorithm	DeepTau
	DoDiscrAgainst	Jet = Tight
		AntiElectron = Tight
		AntiMuon = Tight
	ProngType	1or3
	ΔR	> 0.4
MET	p_T^{miss}	> 180 GeV
	MET filters/ corrections	Applied
b-jets	$N(b)$	$= 0$
	p_T	≥ 20 GeV
	$\|\eta(b)\|$	< 2.4
	pileup id	Tight
	DeepFlavor	Passing Medium wp (0.3040) (click here)
Tau-Met	$m_T(\tau, p_T^{miss})$	≤ 120 GeV
Trigger	MET	HLT_PFMETNoMu120_PFMHTNoMu120

- CR with $\tau + p_T^{miss}$.
- 2017 luminosity and v9 UL samples were considered.
  - NanoAODv9 samples.
  - **MET dataset** was used: B, C, D, E. F.
- **Cutflow**:
  - GoodVertex.
  - met filters.
  - Trigger.
  - $p_T^{miss} > 180$ GeV.
  - $N(b) = 0$.
  - $N(e) = 0$.
  - $N(\mu) = 0$.
  - $N(\tau) = 1$.
  - $m_T(\tau, p_T^{miss}) \leq 120$ GeV.
- The ISR weights, for W+Jets and DY+Jets, calculated by Sebastian were used. **Thank you Sebastian!** (click here).

W+Jets CR

- Table and plot show the results obtained by applying the events selection criteria.
  - *Bin-to-bin information corresponds to the transverse mass*: $m_T(\tau, p_T^{miss})$.

Bin Range [GeV]	Data	tt	SingleTop	DYJetsToLL	WJetsToLNu	VV	TotalBack	Data/TotalBack
[0,20]	24512	954.78 ± 6.29	284.96 ± 11.07	1417.33 ± 21.07	16067.55 ± 75.24	268.23 ± 6.99	18992.84 ± 79.47	1.29 ± 0.01
[20,40]	20563	902.85 ± 6.08	277.22 ± 10.84	643.2 ± 8.12	13368.32 ± 68.37	212.78 ± 6.21	15404.36 ± 70.24	1.33 ± 0.01
[40,60]	15453	701.99 ± 5.33	205.72 ± 9.45	352.11 ± 6.03	9955.14 ± 60.28	156.39 ± 5.26	11371.35 ± 61.77	1.36 ± 0.01
[60,80]	8867	397.94 ± 4.4	101.98 ± 6.55	176.94 ± 4.43	5254.36 ± 44.05	94.06 ± 4.12	6025.28 ± 45.12	1.47 ± 0.02
[80,100]	3115	163.15 ± 2.53	37.07 ± 3.9	77.42 ± 3.1	1613.36 ± 26.05	34.27 ± 2.5	1925.27 ± 26.76	1.62 ± 0.03
[100,120]	1228	81.97 ± 1.77	16.38 ± 2.76	23.53 ± 2.47	495.13 ± 18.74	17.05 ± 1.74	634.51 ± 18.94	1.94 ± 0.06
Sum	73738	3202.68 ± 11.42	923.78 ± 19.88	2690.53 ± 24.12	46753.86 ± 130.11	782.78 ± 11.89	54353.61 ± 134.82	1.36 ± 0.0

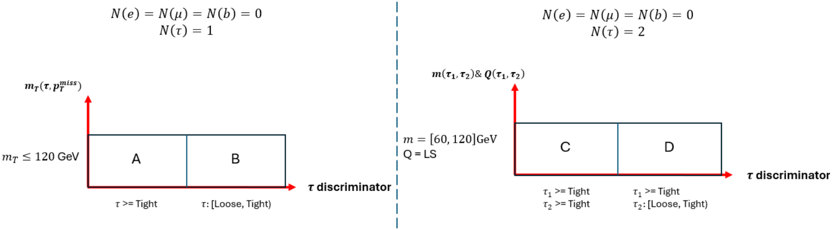


- Summary of results:

Process (2017)	Events
W+Jets	46753.9 ± 130.1 (85.9 %)
$t\bar{t}$	3202.7 ± 11.4 (5.9 %)
Drell-Yan	2690.5 ± 24.1 (4.9 %)
SingleTop	923.8 ± 19.9 (1.8 %)
Diboson	782.8 ± 11.9 (1.4 %)
Total Back	54353.6 ± 134.8 (100 %)
Data	73738
W+Jets Purity	85.9%
W+Jets Scale Factor	1.41 ± 0.04

- Main background is W+Jets, as expected (85.9 %).
- SF deviates 41 % from unity
  - Since *Data* > *MC*, it was suspected that the difference was due to a possible contribution from QCD. Methodology A,B,C,D was proposed to estimate this contribution.

W+Jets CR



$$N^A_{QCD} = (N^B_{Data} - N^B_{MC})TF^{CD}_{\left(\frac{Tight}{[Loose,Tight)}\right)}$$

Transfer factor can be calculated using CD

$$TF^{CD} = \frac{(N^C_{Data} - N^C_{MC})}{(N^D_{Data} - N^D_{MC})}$$

- More details about the event selection criteria are on the following slide.
- CR A is our W+Jets control region.
- CR B will give us an estimate of QCD, while regions C and D will allow us to determine the scale factor needed to move the estimation to CR A.

W+Jets CR

	Criteria	Selection CR A	Selection CR B	Selection CR C	Selection CR D
Muon Veto	N_μ	$= 0$	$= 0$	$= 0$	$= 0$
	$\|\eta\|$	< 2.1	< 2.1	< 2.1	< 2.1
	$p_T(\mu)$	≥ 20 GeV	≥ 20 GeV	≥ 20 GeV	≥ 20 GeV
	Isolation	< 0.15	< 0.15	< 0.15	< 0.15
	Muon ID	Tight	Tight	Tight	Tight
Electron Veto	N_e	$= 0$	$= 0$	$= 0$	$= 0$
	$\|\eta\|$	< 2.1	< 2.1	< 2.1	< 2.1
	$p_T(e)$	≥ 10 GeV	≥ 10 GeV	≥ 10 GeV	≥ 10 GeV
	Isolation	< 0.15	< 0.15	< 0.15	< 0.15
	wp90iso	wp90iso	wp90iso	wp90iso	wp90iso
Tau	$N(\tau_h)$	$= 1$	$= 1$	$= 2$	$= 2$
	$\|\eta(\tau_h)\|$	< 2.3	< 2.3	< 2.3	< 2.3
	$p_T(\tau_h)$	≥ 20 GeV	≥ 20 GeV	≥ 20 GeV	≥ 20 GeV
	TauID Algorithm	DeepTau	DeepTau	DeepTau	DeepTau
	DoDiscrAgainst	Jet = Tight	Jet = [Loose, Tight)	Jet = Tight	Jet = [Loose, Tight)
		AntiElectron = Tight	AntiElectron = Tight	AntiElectron = Tight	AntiElectron = Tight
		AntiMuon = Tight	AntiMuon = Tight	AntiMuon = Tight	AntiMuon = Tight
	ProngType	1or3	1or3	1or3	1or3
	ΔR	> 0.4	> 0.4	> 0.4	> 0.4
MET	p_T^{miss}	> 180 GeV	> 180 GeV	> 30 GeV	> 30 GeV
	MET filters/ corrections	Applied	Applied	Applied	Applied
b-jets	$N(b)$	$= 0$	$= 0$	$= 0$	$= 0$
	p_T	≥ 20 GeV	≥ 20 GeV	≥ 20 GeV	≥ 20 GeV
	$\|\eta(b)\|$	< 2.4	< 2.4	< 2.4	< 2.4
	pileup id	Tight	Tight	Tight	Tight
	DeepFlavor	Medium wp (0.3040)	Medium wp (0.3040)	Medium wp (0.3040)	Medium wp (0.3040) (click here)
Transverse mass	$m_T(\tau, p_T^{miss})$	≤ 120 GeV	≤ 120 GeV	...	...
Ditau	$m(\tau_1, \tau_2)$	...	...	$[60 - 120]$ GeV	$[60 - 120]$ GeV
	$Q(\tau_1)Q(\tau_2)$	...	...	LS	LS
Trigger	MET	HLT_PFMETNoMu120_PFMHTNoMu120	HLT_PFMETNoMu120_PFMHTNoMu120	DiTau triggers	DiTau triggers

- **DiTau triggers**: Recommendation for 2017 Data MC (click here).
  - DoubleTightChargedIsoPFTau35_Trk1_TightID_eta2p1_Reg,
  - DoubleMediumChargedIsoPFTau40_Trk1_TightID_eta2p1_Reg,
  - DoubleTightChargedIsoPFTau40_Trk1_eta2p1_Reg
- Rows highlighted in red indicate changes between control regions.
  - ... means that the criterion does not apply.
  - $[Loose, Tight)$ means passing Loose, but failing tight.

W+Jets CR

Process (2017)	CR A	CR B	CR C	CR D
W+Jets	46753.9 ± 130.1 (85.9 %)	111953.5 ± 156.5 (84.6 %)	1.13 ± 1.22 (27.7 %)	1.74 ± 1.27 (37.4 %)
$t\bar{t}$	3202.7 ± 11.4 (5.9 %)	1098.1 ± 9.5 (7.8 %)	0.41 ± 0.18 (10.2 %)	0.86 ± 0.32 (18.6 %)
Drell-Yan	2690.5 ± 24.1 (4.9 %)	575.7 ± 16.8 (4.1 %)	2.33 ± 1.07 (57.2 %)	2.03 ± 0.99 (43.7 %)
SingleTop	923.8 ± 19.9 (1.8 %)	297.9 ± 19.0 (2.1 %)	0.0 ± 0.0 (0.0 %)	0.02 ± 0.02 (0.4 %)
Diboson	782.8 ± 11.9 (1.4 %)	205.9 ± 9.8 (1.5 %)	0.20 ± 0.20 (4.9 %)	0.0 ± 0.0 (0.0 %)
Total Back	54353.6 ± 134.8 (100 %)	14131.2 ± 159.1 (100 %)	4.08 ± 1.65 (100 %)	4.66 ± 1.64 (100 %)
Data	73738	28605	11	34
Data - MC	···	14473.8	6.92	29.34

$$TF = 6.92/29.34 = 0.24$$

- **QCD estimation:** 0.24 × 14473.8 = 3473.7 events.
  - QCD would be the second most important background in CR A.
- Total Back (CR A) = 54353.6 + 3473.7 = 57827.3.

Next steps

Image taken from depositphotos.com (click here)

- Continue studies with W+Jets CR.
- Manuel's talk:
  - Efficiency studies (2016; 2017; 2018) in w+jets and tt CRs.
  - *tt* CR using the top tagger (2016; 2017; 2018).
    - $\tau + p_T^{miss} > 180 + top\_tagger$
  - Validation CR using the top tagger (2016; 2017; 2018).

Backup

mtop [120-230]

	SignalTau_600GeV	tt	SingleTop	DYJetsToLL	WJetsToLNu	VV	TotalBack	Signal/TotalBack	Significancia
[0.0,20.0]	28.24±5.37	1550.04±7.91	518.5±17.02	57.91±2.28	436.4±11.24	10.35±1.3	2573.21±22.03	0.01±32.93	0.55
[20.0,40.0]	46.25±6.93	1471.58±7.69	507.66±17.59	28.49±1.44	363.3±10.53	8.77±1.17	2379.81±21.97	0.02±58.3	0.94
[40.0,60.0]	30.92±5.9	1124.94±6.71	409.95±15.7	15.27±1.05	248.86±8.55	6.42±1.01	1805.43::19.16	0.02±51.38	0.72
[60.0,80.0]	32.1±5.63	637.57±5.05	225.87±12.19	7.6±0.7	122.43±5.85	3.41±0.71	996.88±14.47	0.03±96.59	1.0
[80.0,100.0]	31.36±5.59	281.34±3.33	85.4±6.8	4.59±0.72	36.78±3.18	0.86±0.36	408.98±8.25	0.08±230.0	1.49
[100.0,150.0]	171.24±13.23	352.17±3.62	67.38±6.1	2.94±0.57	29.2±3.33	1.08±0.41	452.78±7.86	0.38±1134.59	6.85
[150.0,200.0]	281.57±16.81	260.59±3.08	33.07±3.97	1.35±0.47	9.44±2.01	1.11±0.41	305.55±5.45	0.92±2764.59	11.62
[200.0,250.0]	397.66±20.04	158.78±2.43	19.44±3.01	0.82±0.28	4.79±1.21	0.19±0.19	184.02±4.07	2.16±6482.79	16.49
[250.0,300.0]	477.5±22.0	101.8±1.96	10.51±2.28	0.17±0.06	4.69±1.41	0.28±0.2	117.45±3.32	4.07±12196.2	19.58
[300.0,400.0]	1553.65±40.73	82.79±1.78	10.62±2.4	0.28±0.08	4.83±1.69	0.34±0.24	98.87±3.44	15.71±47144.06	38.22
[400.0,500.0]	1465.06±39.69	27.07±1.05	6.66±1.71	0.91±0.47	5.55±1.73	0.75±0.38	40.93±2.72	35.79±107372.75	37.75
[500.0,600.0]	610.51±25.67	9.4±0.64	4.43±1.84	0.53±0.44	2.12±1.11	0.21±0.21	16.69±2.29	36.57±109722.77	24.38
[600.0,800.0]	132.53±11.84	3.58±0.38	2.21±1.11	0.1±0.03	1.34±0.6	0.0±0.0	7.24±1.32	18.32±54950.65	11.21
[800.0,1000.0]	16.44±4.12	0.58±0.15	3.24±1.32	0.02±0.01	0.0±0.0	0.0±0.0	3.84±1.33	4.28±12838.27	3.65

Frame Title

	events	error	percentage
SingleTop	2.886555	1.782345	8.9
VV	1.852357	1.018356	5.7
WJetsToLNu	15.846733	5.644075	49.0
tt	7.693809	0.774161	23.8
DYJetsToLL	4.07205	1.495055	12.6
Data	44.0	6.63325	NaN
Total bkg	32.35	6.24	NaN
Data/bkg	1.36	0.33	NaN
SF_WJetsToLNu	1.735	0.92	NaN

Figure: CR C: MET trigger, but MET > 30 GeV

	events	error	percentage
DYJetsToLL	7.507568	1.922211	7.2
WJetsToLNu	67.94473	11.569587	64.7
SingleTop	4.111629	2.238737	3.9
tt	23.328843	1.402538	22.2
VV	2.062947	0.830116	2.0
Data	148.0	12.165525	NaN
Total bkg	104.96	12.05	NaN
Data/bkg	1.41	0.2	NaN
SF_WJetsToLNu	1.633	0.41	NaN

Figure: CR D: MET trigger, but MET > 30 GeV

Top tagger validation CR region

	Criteria	Selection
Muon	N_μ	= 1
	$\|\eta\|$	2.1
	$p_T(\mu)$	28 GeV
	Isolation	< 0.15
	Muon ID	Tight
Electron Veto	N_e	= 0
	$\|\eta\|$	2.4
	$p_T(e)$	10 GeV
	Isolation	< 0.15
	wp80iso	medium
Tau	$N(\tau_h)$	= 1
	$\|\eta(\tau_h)\|$	< 2.3
	$p_T(\tau_h)$	> 20 GeV
	TauID Algorithm	DeepTau
	DoDiscrAgainst	Jet = Tight
		AntiElectron = Tight
		AntiMuon = Tight
	ProngType	1or3
	ΔR	> 0.4
MET	p_T^{miss}	> 60 GeV
	MET filters/ corrections	Applied
	Top tagger	
b-jets	p_T	> 20 GeV
	$\|\eta(b)\|$	< 2.4
	pileup id	Tight
	DeepFlavor	Passing Medium wp click here
Light-jets	p_T	> 20 GeV
	$\|\eta(b)\|$	< 2.4
	pileup id	Tight
	DeepFlavor	Failing Loose wp (0.0532)
W-Jets	p_T	> 200 GeV
	$\|\eta(b)\|$	< 2.4
	particleNet_WvsQCD	Tight
Fat-Jets	p_T	> 300 GeV
	$\|\eta(b)\|$	< 2.4
	particleNet_TvsQCD	Tight
Trigger	Muon	HLT_IsoMu27

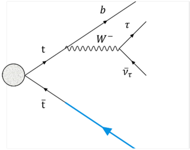
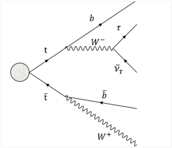
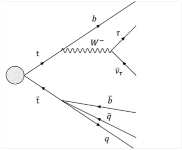
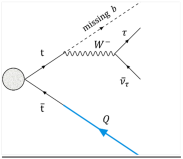
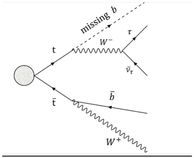
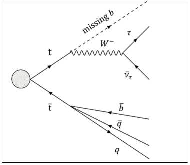
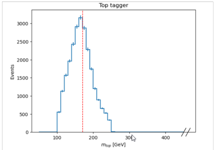
- CR with $\mu + p_T^{miss}$ + TOP (13 cases).
- 2017 luminosity and v9 UL samples were considered, NanoAODv9. **SingleMuon dataset** was used: B, C, D, E. F
- Cross cleanings of 0.4 and 0.8, $\Delta R > 0.4$ and $\Delta R > 0.8$, were applied.
- Light-jets fail the Loose wp to be differentiated from b-jets.
- The particleNet algorithm allows the identification of Tops and Ws candidates. (click here).

Mistagging Rate	WP for Top	WP for W	WP for W (MD)
5%	-	0.71	-
2.5%	-	-	0.58
1%	0.58	0.94	0.81
0.5%	0.80	0.98	0.89
0.1%	0.97	-	-

  - ParticleNet_W_Nominal and ParticleNet_Top_Nominal. (click here) were implemented.
- JEC/JER puppi was applied for the ak8 jets "FatJets" (click here), so MET was also recalculated (click here).
- The top tagger was implemented following the proposal given by Francesco, thank you very much! (click here).
  - $p_T^{miss} > 60$ GeV was considered. (click here).

Top tagger scenarios

We consider scenarios from one jet to N jets in the top tagger.

1 jet	2 jets	3 jets	4jets
	Unresolve 	*Partially resolve* 	*Resolve* 
Unresolve 	*Partially resolve* 	*Resolve* 	 Logic Or applied to the 6 cases considered a TTToSemiLeptonic sample.

- Dashed lines represent a particle that was not detected.
- Any of the cases shown in the table would trigger the top tagger, so the final top tagger will be the OR between all the orthogonal scenarios.
    - **Resolve:** 2 light jets + 1b reconstruct a top.

MET Trigger Efficiency Studies in W+Jets CR (τ_h channel)

	Criteria	Selection
Muon	$p_T(\mu)$	> 30 GeV
	$\|\eta(\mu)\|$	< 2.1
	ID	Tight
	Reference trigger	*HLT_IsoMu27*
Electron Veto	$p_T(\mu)$	> 10 GeV
	$\|\eta(\mu)\|$	< 2.1
	Cut Base ID	Medium
	Isolation	< 0.15
Tau	$p_T(\tau_h)$	> 20
	$\|\eta(\tau_h)\|$	< 2.1
	$\|dz\|$	< 0.2
	TauID algorithm	DeepTau
	DoDiscrAgainst	Jet = Tight
		Electron = Tight
		Muon = Tight
	PronType	1or3
	ΔR	> 0.4
MET	p_T^{miss}	> 50 GeV
Jet	$p_T(j)$	> 30 GeV
	$\|\eta(j)\|$	< 2.4
	Id	Tight
Leading Jet	$p_T(j_l)$	> 50 GeV
	$\|\eta(j_l)\|$	< 3.0
	Id	Tight
b-jets	$p_T(b)$	> 30 GeV
	$\|\eta(b)\|$	< 2.4
	DeepFlavour: Loose	2016_Pre: 0.0508; 2016_Post: 0.0480
		2017:0.0532; 2018:0.0490
	ΔR	> 0.4
Trigger under study	MET Trigger	HLT_PFMETNoMu120_PFMHTNoMu120

- We have obtained a *W+Jets* CR using SingleMuon dataset to measure the MET trigger performance.
- Table shows the event selection criteria to obtain the CR ($\geq$ 1jet + p_T^{miss}+$\geq$ 1mu).
- We use MET corrections.
- **CutFlow**:
  - GoodVertex.
  - Reference trigger.
  - $N(\mu) \geq 1$.
  - $N(e) = 0$.
  - $N(\tau) = 0$.
  - $p_T^{miss} \geq 50$ GeV.
  - $N(j) \geq 1$.
  - $N(b) = 0$.
  - Trigger under study.

Trigger efficiency formula:

$$\varepsilon = \frac{Cuts\ \&\ Reference\_trigger\ \&\ Trigger\_under\_study}{Cuts\ \&\ Reference\_trigger} = \frac{Trigger\_under\_study(cut)}{N(b){=}0(Cut)}$$

Numerator is a subset of the denominator events.

Top tagger scenarios

- The following table shows the cases according to the number of objects. As can be seen, we have no overlapping cases.

Case	Name	N(top-jet) $N(Q)$	N(w-jets) $N(W)$	N(b-jets) $N(b)$	N(light-jets) $N(q)$
Case 1	1 jet; unresolved case	1	0	0	0
Case 2	2 jets; unresolved case	1	0	1	0
Case 3	2 jets; partially resolve case	0	1	1	0
Case 4	3 jets; partially resolve case	0	1	2	0
Case 5	3 jets; resolve case	0	0	1	2
Case 6	4 jets; resolve case	0	0	2	2
Case 7	N jets; resolve case	⋯	⋯	2	> 2
Case 8	N bjets; resolve case	⋯	⋯	> 2	2
Case 9	1 jet; unresolve case (general)	1	0	0	> 0
Case 10	2 jets; unresolve case (general)	1	0	1	> 0
Case 11	2 jets; partially resolve (general)	0	1	1	> 0
Case 12	3 jets; partially resolve case (general)	0	1	2	> 0
Case 13	3 jets; resolve case (general)	0	0	1	> 2

- **All cases are orthogonal to each other**.
  - The following cases are complementary to each other: **(1,9)**; **(2,10)**; **(3,11)**; **(4,12)**; **(5;13)**; **(6,7,8)**.
  - ⋯ means that no conditions were specified.
  - For instance, the case with 4jets:
    - $\mathrm{N(q)} = 2$ and $\mathrm{N(b)} = 2$ are required.
    - $40\mathrm{GeV} \leq m(q1, q2) \leq 200\mathrm{GeV}$. Passing jets allows us to define the W $(W = q1 + q2)$.
    - We identify the b-jet with the lowest momentum (b2), and higher momentum (b1).
    - $100\mathrm{GeV} \leq m(W, b2) \leq 300\mathrm{GeV}$. Objects passing the condition will reconstruct tops $(\mathrm{t} = \mathrm{W} + \mathrm{b2})$, but if the event does not pass, the process is repeated with b1 $(100\mathrm{GeV} \leq m(W, b1) \leq 300\mathrm{GeV})$.