



Department of Physics, Shandong University

compressed EWK study(ISRC1N2)

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Introduction

event selection

Selection

- lep-had
channel: $n\text{Taus} \geq 1; n\text{Leps} \geq 1$
- had-had
channel: $n\text{Taus} \geq 2; n\text{Leps} = 0$
- $\text{MET} \geq 200$; pass MET trigger
- $1 \leq n\text{BaseJet} \leq 8$
- b-veto
- OS

Both data and bkg are sourced from run2(1516, 17, 18).

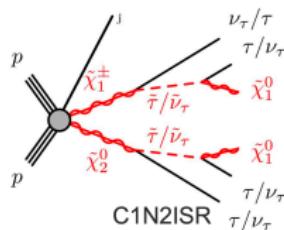


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MC modeling

HH cutflow comparsion

jiarong's cutflow

Cut name	baseline	signal tau cut	signal lep cut	pass MET trigger	MET>200
Wjets	36910790.2 +/- 22959.74	227485.23 +/- 1770.31	73392.93 +/- 955.13	37276.94 +/- 471.71	4171.35 +/- 75.96
TopPair	7534021.4 +/- 1055.09	46602.11 +/- 85.24	29154.71 +/- 68.3	25781.67 +/- 63.35	3493.17 +/- 23.03
SingleTop	988110.24 +/- 342.8	5067.94 +/- 25.6	3222.52 +/- 20.5	2828.31 +/- 19.29	462.65 +/- 8.04
OtherTop	43746.18 +/- 352.34	630.78 +/- 22.85	273.86 +/- 1.89	239.66 +/- 1.8	55.96 +/- 0.9
Zttjets	5779690.55 +/- 9204.86	70018.94 +/- 785.84	42543.37 +/- 548.16	23154.34 +/- 161.89	2358.25 +/- 29.33
Zlljets	221114969.3 +/- 28905.76	36458.71 +/- 324.32	4319.3 +/- 120.41	395.08 +/- 4.87	61.84 +/- 1.07
VV	1310870.13 +/- 2148.26	7533.16 +/- 24.19	3139.54 +/- 13.46	2621.95 +/- 11.2	579.74 +/- 4.12
Higgs	29153.2 +/- 18.17	867.06 +/- 2.66	529.49 +/- 1.91	402.02 +/- 1.49	62.7 +/- 0.6
dijet	2739992885.1 +/- 382761122.33	27609529.58 +/- 26367725.95	27605283.03 +/- 26367725.82	27535064.53 +/- 26367714.5	186.17 +/- 47.22
bkg	3013704236.3 +/- 382761124.23	28004193.52 +/- 26367726.02	27761858.74 +/- 26367725.84	27627764.5 +/- 26367714.5	11431.82 +/- 97.34
bkg wo dijet	273711351.21 +/- 38123.38	394663.94 +/- 1966.15	156575.71 +/- 1110.19	92699.97 +/- 503.25	11245.65 +/- 85.12
data	292613535.0 +/- 17105.95	586282.0 +/- 765.69	407240.0 +/- 638.15	182101.0 +/- 426.73	11210.0 +/- 105.88

chengxin's cutflow

Cut name	baseline	signal tau cut	signal lep cut	pass MET trigger	MET>150
Wjets	36910790.2 +/- 22959.74	227485.23 +/- 1770.31	73392.93 +/- 955.13	37276.94 +/- 471.71	11976.76 +/- 189.99
TopPair	7534021.4 +/- 1055.09	46602.11 +/- 85.24	29154.71 +/- 68.3	25781.67 +/- 63.35	9935.89 +/- 38.89
SingleTop	988110.24 +/- 342.8	5067.94 +/- 25.6	3222.52 +/- 20.5	2828.31 +/- 19.29	1158.14 +/- 12.52
OtherTop	43746.18 +/- 352.34	630.78 +/- 22.85	273.86 +/- 1.89	239.66 +/- 1.8	121.07 +/- 1.3
Zttjets	5779690.55 +/- 9204.86	70018.94 +/- 785.84	42543.37 +/- 548.16	23154.34 +/- 161.89	7118.17 +/- 52.53
Zlljets	221114969.3 +/- 28905.76	36458.71 +/- 324.32	4319.3 +/- 120.41	395.08 +/- 4.87	158.51 +/- 2.03
VV	1310870.13 +/- 2148.26	7533.16 +/- 24.19	3139.54 +/- 13.46	2621.95 +/- 11.2	1236.43 +/- 6.55
Higgs	29153.2 +/- 18.17	867.06 +/- 2.66	529.49 +/- 1.91	402.02 +/- 1.49	165.1 +/- 0.96
dijet	2739992885.1 +/- 382761122.33	27609529.58 +/- 26367725.95	27605283.03 +/- 26367725.82	27535064.53 +/- 26367714.5	885.99 +/- 206.95
bkg	3013704236.3 +/- 382761124.23	28004193.52 +/- 26367726.02	27761858.74 +/- 26367725.84	27627764.5 +/- 26367714.5	32756.06 +/- 288.8
bkg wo dijet	273711351.21 +/- 38123.38	394663.94 +/- 1966.15	156575.71 +/- 1110.19	92699.97 +/- 503.25	31870.07 +/- 201.43
data	292613535.0 +/- 17105.95	586282.0 +/- 765.69	407240.0 +/- 638.15	182101.0 +/- 426.73	31921.0 +/- 178.66

C1N2ISR:MC modeling

LH cutflow comparsion

jiarong's cutflow

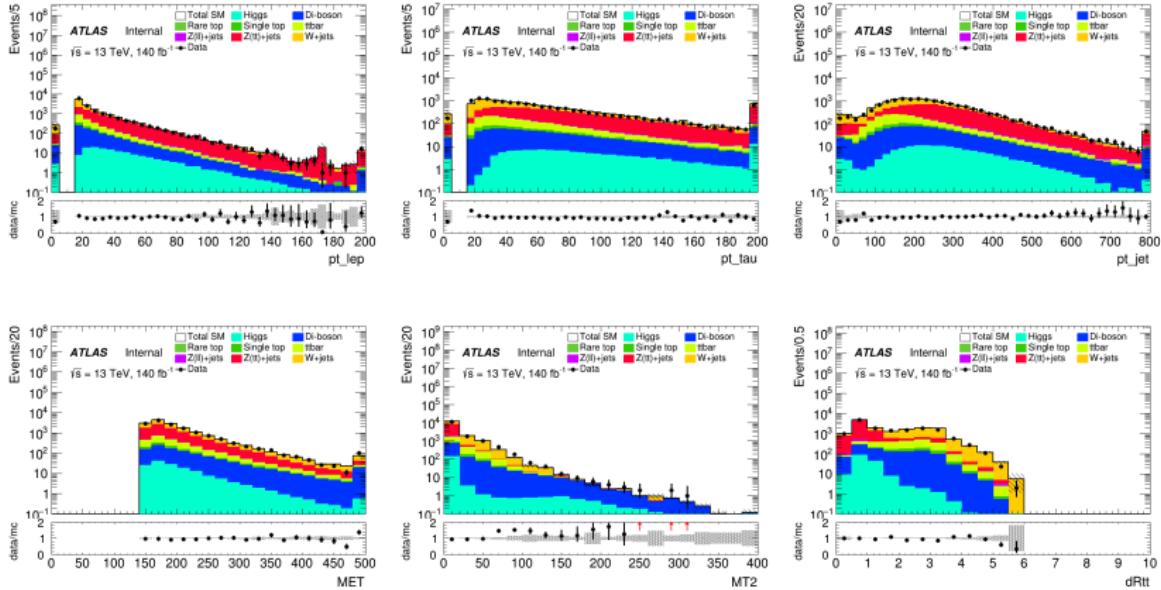
Cut name	baseline	signal tau cut	signal lep cut	pass MET trigger	MET>200
Wjets	36910790.2 + 22959.74	20163118.47 + 17726.83	19181417.03 + 17321.41	400339.22 + 855.46	19908.53 + 106.14
TopPair	7534021.4 + 1055.09	1512883.18 + 476.74	1274946.24 + 434.67	325111.94 + 220.23	28971.03 + 65.77
SingleTop	988110.24 + 342.8	201833.19 + 155.94	175293.87 + 144.99	34093.54 + 66.93	3313.02 + 21.4
OtherTop	43746.18 + 352.34	8482.23 + 152.45	5767.05 + 135.27	2399.01 + 91.23	432.14 + 20.72
Zttjets	5779690.55 + 9204.86	3220731.18 + 6973.12	2637387.66 + 6459.62	70581.09 + 341.53	4334.14 + 38.75
Zlljets	221114969.3 + 28905.76	4055309.63 + 4072.66	2076241.52 + 3279.04	17007.84 + 72.78	265.32 + 3.81
VV	1310870.13 + 2148.26	221902.39 + 765.78	183041.15 + 176.22	24420.22 + 37.63	3753.33 + 9.85
Higgs	29153.2 + 18.17	23663.9 + 17.51	18105.11 + 15.51	1913.19 + 4.55	180.64 + 1.41
dijet	273992885.1 + 382761122.33	207700675.42 + 54043947.9	93288309.52 + 32863616.64	17425.83 + 4207.3	118.82 + 35.7
bkg	3013704236.3 + 382761124.23	237108599.59 + 54043951.42	118840509.16 + 32863622.01	893291.88 + 4314.85	61276.96 + 139.17
bkg wo dijet	273711351.21 + 38123.38	29407924.17 + 19501.62	25552199.64 + 18782.16	875866.05 + 957.33	61158.13 + 134.51
data	292613535.0 + 17105.95	31554940.0 + 5617.38	24770923.0 + 4977.04	739914.0 + 860.18	54826.0 + 234.15

chengxin's cutflow

Cut name	baseline	signal tau cut	signal lep cut	pass MET trigger	MET>150
Wjets	36910790.2 + 22959.74	20163118.47 + 17726.83	1919770.26 + 17326.57	400852.5 + 856.02	62216.76 + 217.23
TopPair	7534021.4 + 1055.09	1512883.18 + 476.74	1326081.89 + 443.18	337671.69 + 224.38	86832.83 + 113.71
SingleTop	988110.24 + 342.8	201833.19 + 155.94	179968.97 + 147.21	35029.51 + 67.91	8832.05 + 34.5
OtherTop	43746.18 + 352.34	8482.23 + 152.45	7283.24 + 145.4	2953.46 + 93.85	1071.41 + 42.68
Zttjets	5779690.55 + 9204.86	3220731.18 + 6973.12	2654322.19 + 6473.64	71148.75 + 341.96	13209.66 + 104.45
Zlljets	221114969.3 + 28905.76	4055309.63 + 4072.66	3950413.09 + 4028.51	42308.0 + 100.53	950.23 + 9.06
VV	1310870.13 + 2148.26	221902.39 + 765.78	205260.58 + 764.09	28031.04 + 743.99	9250.07 + 743.18
Higgs	29153.2 + 18.17	23663.9 + 17.51	18410.11 + 15.57	1960.62 + 4.59	472.24 + 2.27
dijet	273992885.1 + 382761122.33	207700675.42 + 54043947.9	93294284.35 + 32863616.87	17429.11 + 4207.3	466.79 + 118.86
bkg	3013704236.3 + 382761124.23	237108599.59 + 54043951.42	120833726.69 + 32863622.33	937384.67 + 4379.33	18330.05 + 800.35
bkg wo dijet	273711351.21 + 38123.38	29407924.17 + 19501.62	27539442.34 + 18951.78	919955.57 + 1215.37	182835.25 + 791.48
data	292613535.0 + 17105.95	31554940.0 + 5617.38	26508997.0 + 5148.69	776874.0 + 881.4	164202.0 + 405.22

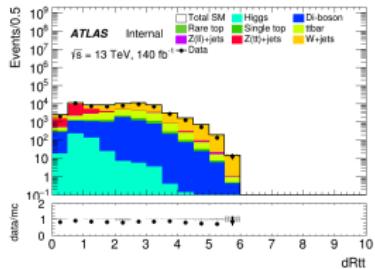
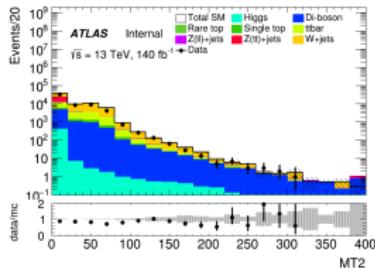
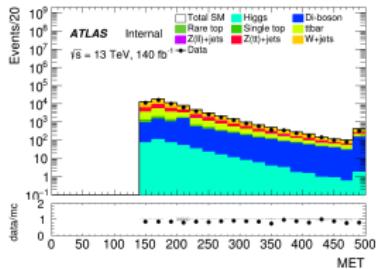
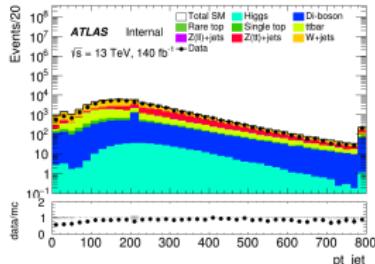
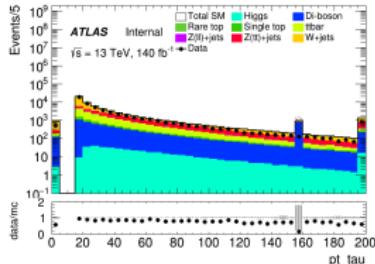
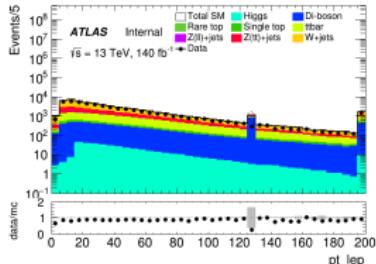
MC modeling

HH MC modeling check



MC modeling

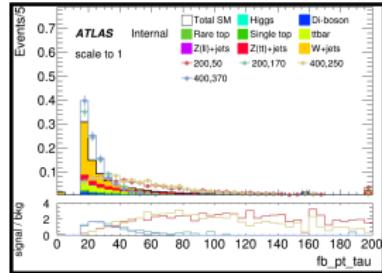
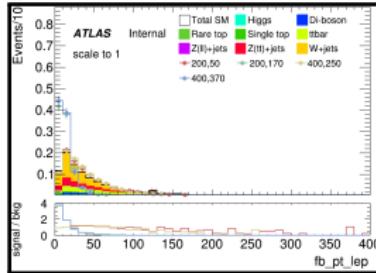
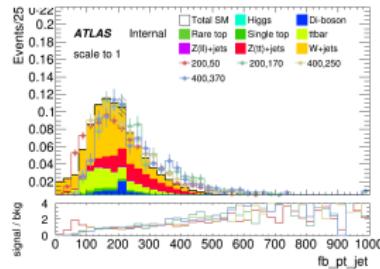
LH MC modeling check



kinematic distribution

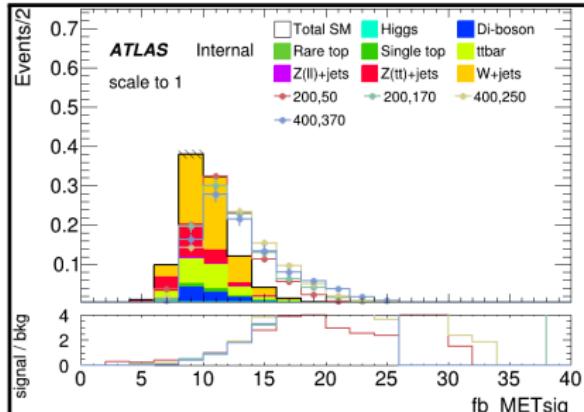
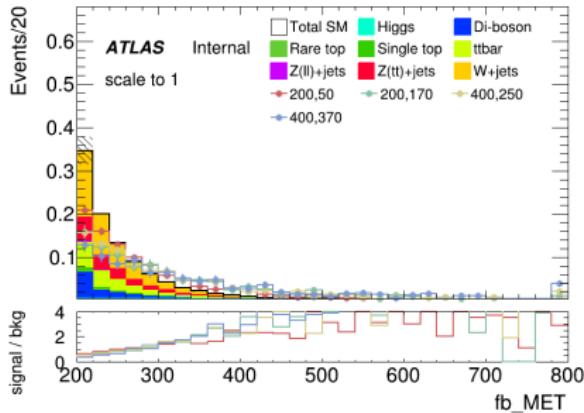
LH: p_T

For sig/bkg, both bkg and signal distribution are normalized to 1. Kinematic variables with better separation power are marked with black box.



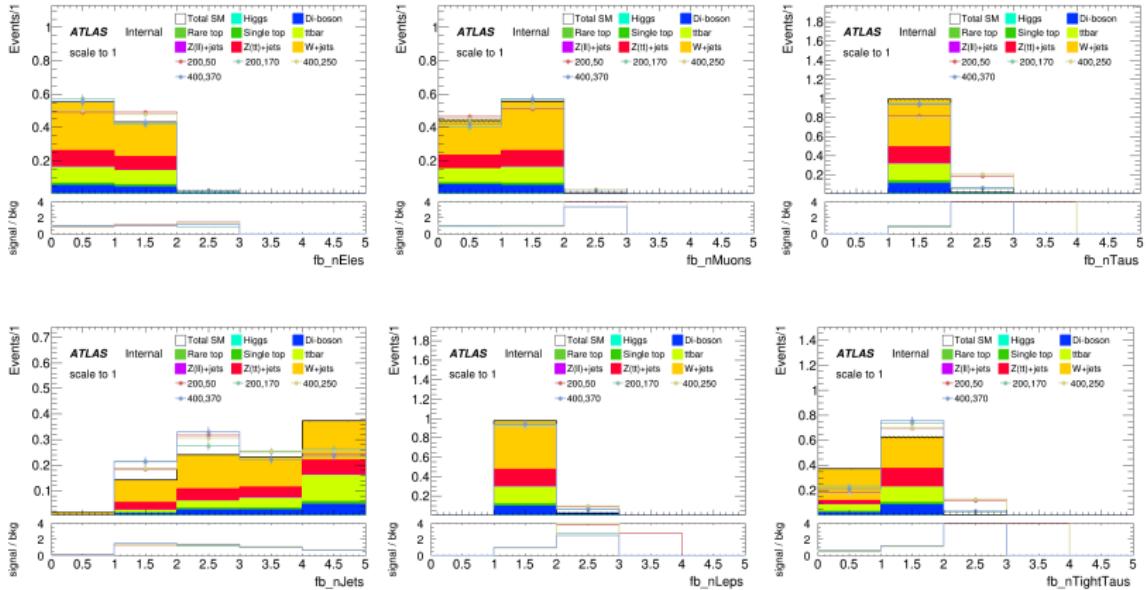
notice: t_1 is leading tau, t_2 is leading lep, j is leading jet, x is MET.

kinematic distribution LH:MET



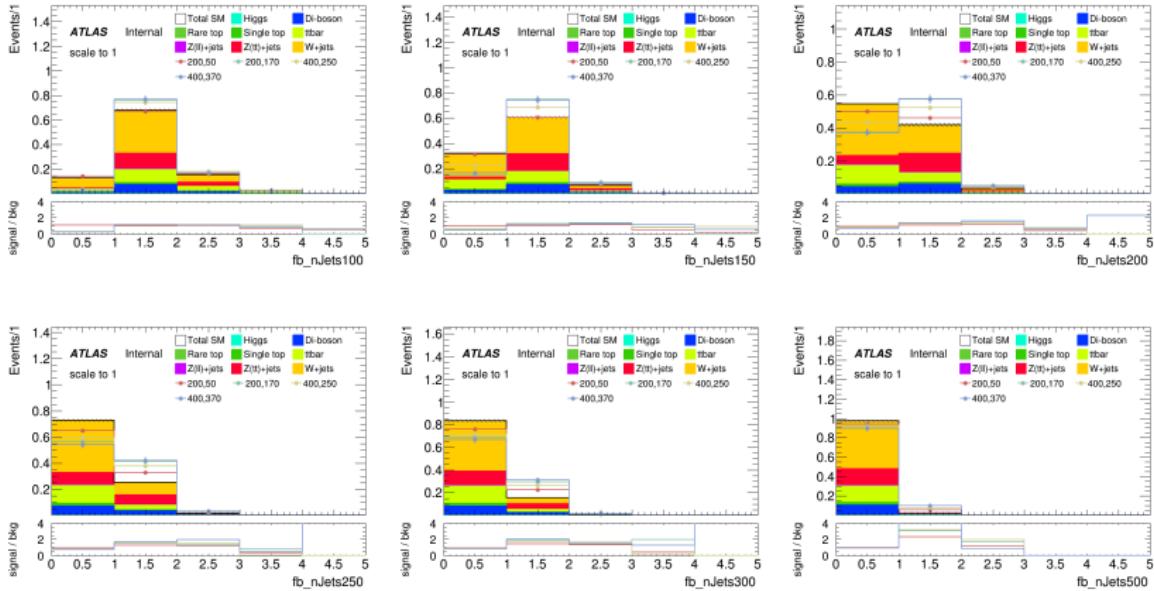
kinematic distribution

LH:num of obj



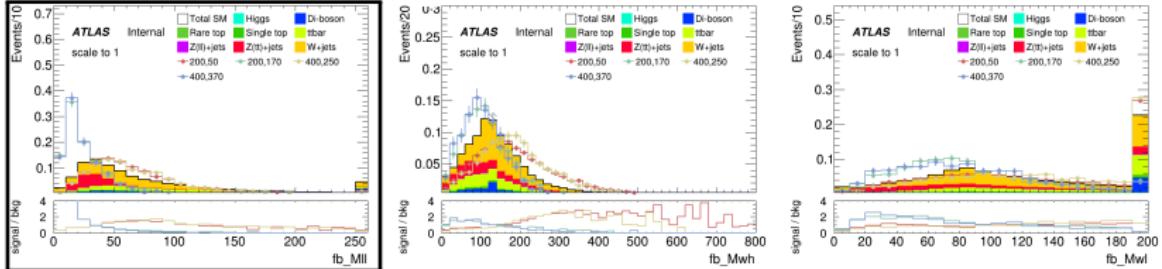
kinematic distribution

LH:num of obj



kinematic distribution

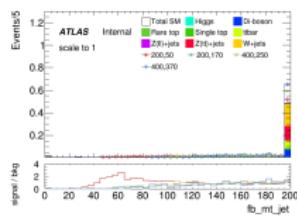
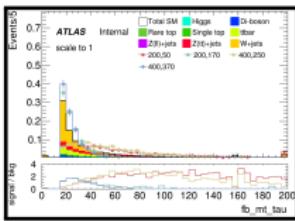
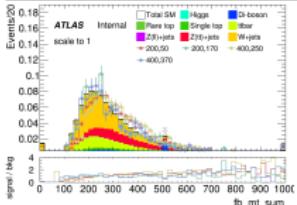
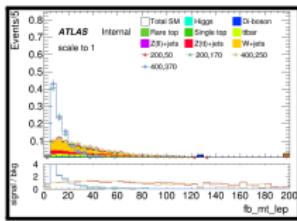
LH: m_{inv}



notice: M_{ll} is the invariant between tau1 and tau2, M_{wh} is the invariant between tau1 and MET, M_{wl} is the invariant between tau2 and MET

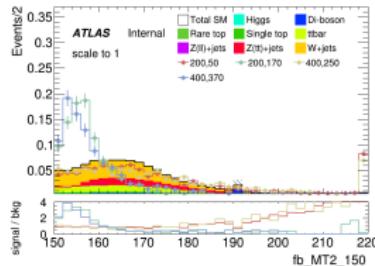
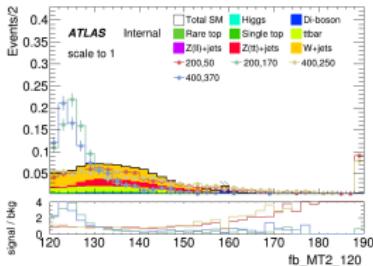
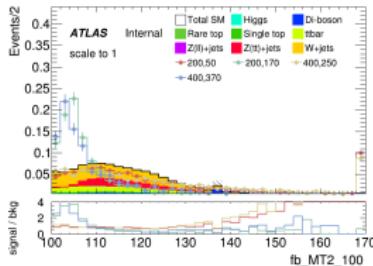
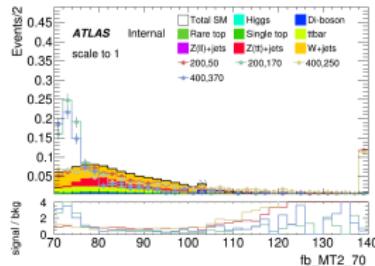
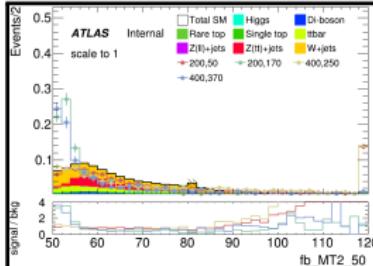
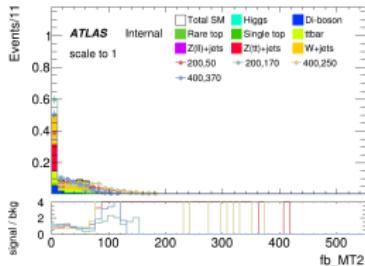
kinematic distribution

LH:transverse mass

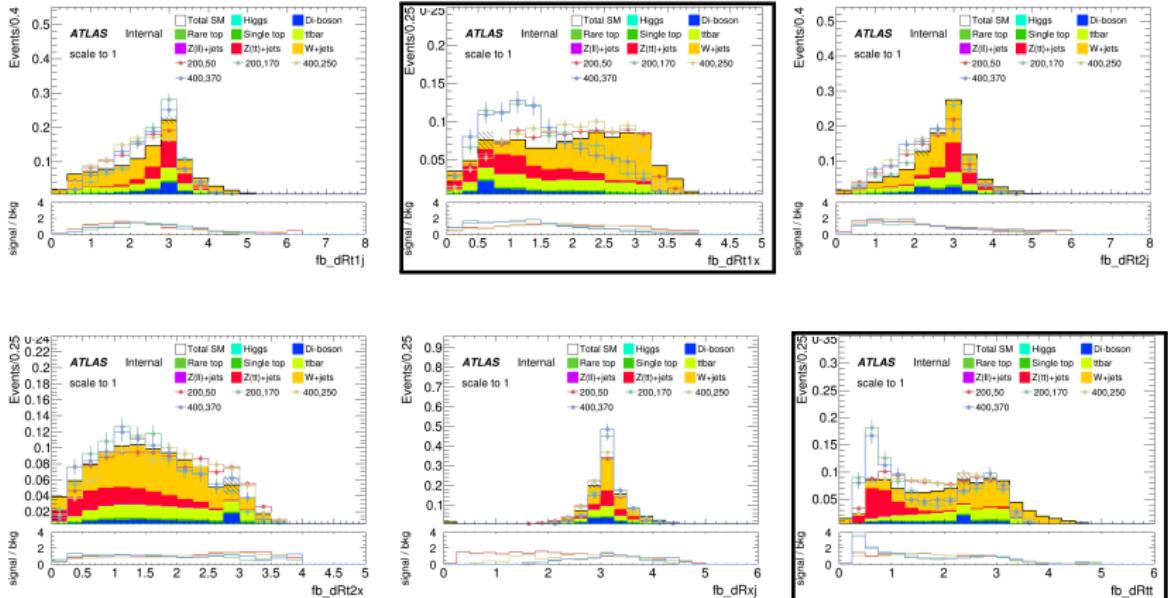


kinematic distribution

LH:MT2



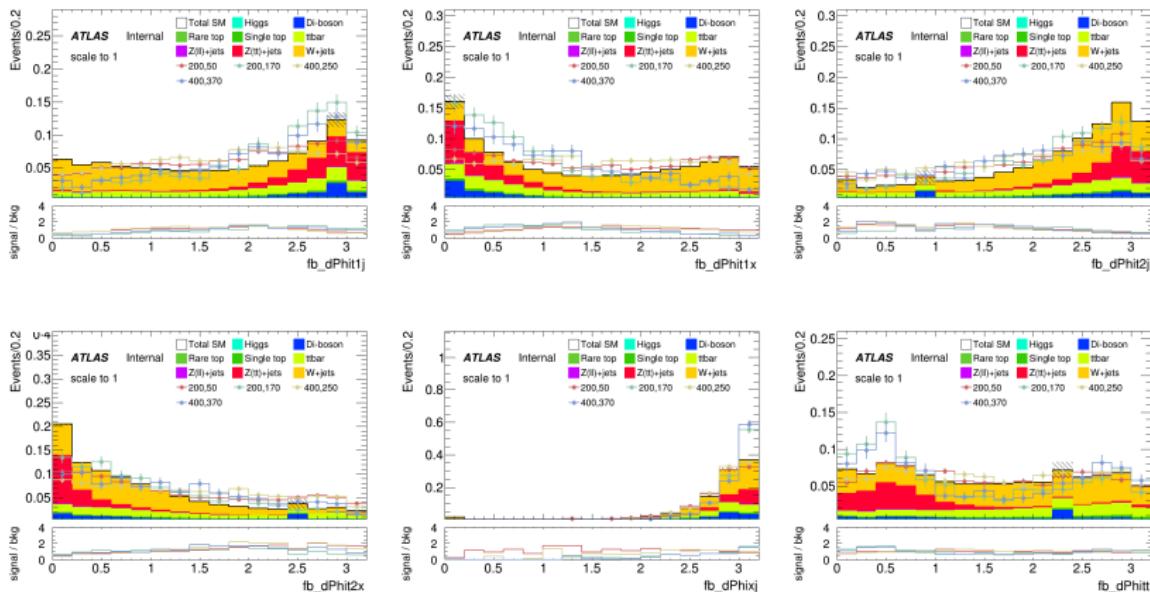
kinematic distribution LH: ΔR



notice: t1 is leading tau, t2 is leading lep, j is leading jet, x is MET.

kinematic distribution

LH: $\Delta\phi$



notice: t1 is leading tau, t2 is leading lep, j is leading jet, x is MET.

Cut and Count

Here are my Cut choose and event apply

```
cuts=[  
    ["fb_pt_lep", {30,40,50}, '<'],  
    ["fb_pt_tau", {35,40,45,50,55}, '<'],  
    ["fb_METsig", {15,20,25,30}, '>'],  
    #["fb_Mll", {10,20,30,40,50}, '>'],  
    ["fb_mt_lep", {5,10,15,20,25}, '>'],  
    ["fb_mt_tau", {15,20,25,30}, '>'],  
    ["fb_MT2_50", {72,74,76,78,80}, '>'],  
    ["fb_dRt1x", {0.25,0.5,0.75,1.00}, '<'],  
]
```

```
Start the CutCount for sample CIN2ISR_200p0_170p0_run2 with 551 events and 6000 cut steps  
Start the CutCount for sample Higgs_run2 with 51398 events and 6000 cut steps  
Start the CutCount for sample dijet_run2 with 291 events and 6000 cut steps  
Start the CutCount for sample VV_run2 with 265085 events and 6000 cut steps  
Start the CutCount for sample Zlljets_run2 with 10048 events and 6000 cut steps  
Start the CutCount for sample Zttjets_run2 with 763468 events and 6000 cut steps  
Start the CutCount for sample OtherTop_run2 with 6481 events and 6000 cut steps  
Start the CutCount for sample TopPair_run2 with 9121 events and 6000 cut steps  
Start the CutCount for sample Wjets_run2 with 35159 events and 6000 cut steps  
Start the CutCount for sample SingleTop_run2 with 2091 events and 6000 cut steps
```

Cut and Count

Currently, I have only applied a relatively rough cut, resulting in a very low Zn value.

	Zn	Signal	totalBkg	fb_pt_lep	fb_pt_tau	fb_mt_lep	fb_mt_tau	fb_MT2_50	fb_dRt1x
416	0.185455	0.272799 +- 0.194202	1.54562 +- 0.615221(99)	30	45	5	30	78	1.0
526	0.185455	0.272799 +- 0.194202	1.54562 +- 0.615221(99)	30	45	15	30	78	1.0
471	0.185455	0.272799 +- 0.194202	1.54562 +- 0.615221(99)	30	45	10	30	78	1.0
113	0.148740	0.120514 +- 0.120514	0.481763 +- 0.327677(14)	30	35	15	30	80	1.0
75	0.148740	0.120514 +- 0.120514	0.481763 +- 0.327677(14)	30	35	10	30	80	1.0
37	0.148740	0.120514 +- 0.120514	0.481763 +- 0.327677(14)	30	35	5	30	80	1.0
1249	0.143790	0.120514 +- 0.120514	0.525909 +- 0.329366(18)	40	35	15	30	80	1.0
1211	0.143790	0.120514 +- 0.120514	0.525909 +- 0.329366(18)	40	35	10	30	80	1.0
1173	0.143790	0.120514 +- 0.120514	0.525909 +- 0.329366(18)	40	35	5	30	80	1.0
2398	0.143790	0.120514 +- 0.120514	0.525909 +- 0.329366(18)	50	35	15	30	80	1.0
2322	0.143790	0.120514 +- 0.120514	0.525909 +- 0.329366(18)	50	35	5	30	80	1.0
2360	0.143790	0.120514 +- 0.120514	0.525909 +- 0.329366(18)	50	35	10	30	80	1.0
255	0.138874	0.120514 +- 0.120514	0.572274 +- 0.33373(30)	30	40	10	30	80	1.0
220	0.138874	0.120514 +- 0.120514	0.572274 +- 0.33373(30)	30	40	5	30	80	1.0
290	0.138874	0.120514 +- 0.120514	0.572274 +- 0.33373(30)	30	40	15	30	80	1.0
666	0.138843	0.272799 +- 0.194202	2.75998 +- 0.802415(135)	30	50	5	30	78	1.0
721	0.138843	0.272799 +- 0.194202	2.75998 +- 0.802415(135)	30	50	10	30	78	1.0
776	0.138843	0.272799 +- 0.194202	2.75998 +- 0.802415(135)	30	50	15	30	78	1.0
35	0.137035	0.120514 +- 0.120514	0.436429 +- 0.494688(26)	30	35	5	30	78	1.0

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TODO

1. Improve Cut count and optimization
2. start ML

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4.5 kinematic Variable

The definition of rapidity is $y = \frac{1}{2} \ln \frac{E+p_z}{E-p_z}$. η is pseudo-rapidity, $\eta = -\ln(\tan(\frac{\theta}{2}))$. It's easy to detect, and when speed close to light-speed, pseudo-rapidity nearly equal rapidity which can simplify detect of rapidity.

ϕ is azimuthal angle of cylindrical coordinates

R is angular distance, $R = \sqrt{\Delta\phi^2 + \Delta\eta^2}$, R usually use to judge which particle belong to the same jet.

METsig is Missing Transverse Energy Significance,

$METsig = \frac{MET}{\sigma_{MET}}$, σ_{MET} is the uncertainty of MET.

Mll is the invariant between two taus,

$$Mll = \sqrt{(E_1 + E_2)^2 - (\vec{p}_1 + \vec{p}_2)^2}$$

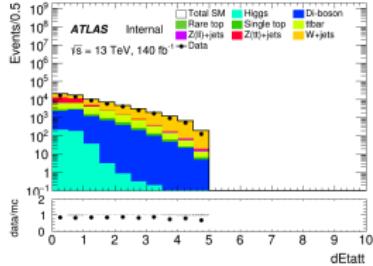
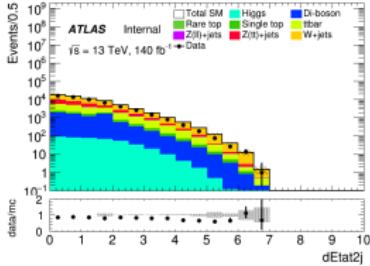
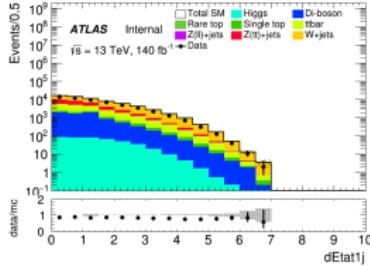
MC modeling

Normal Variable

variable : $\left\{ \begin{array}{l} \Delta\eta : dEtat1j, dEtat2j, dEtatt \\ \text{between tau1(tau2) and jet(tau2)} \\ \Delta\phi : dPhi(t1j, t1x, t2j, t2x, xj, tt) \\ \Delta R : dR(t1j, t1x, t2j, t2x, xj, tt), R = \sqrt{\Delta\eta^2 + \Delta\phi^2} \\ \eta : \eta(jet, lep, tau) \\ p_t : p_t(jet, lep, tau) \\ num : (\text{Jet}, \text{Ele}, \text{Muon}, \text{Tau}, \text{Lep}, \text{Tight Tau}) \\ \text{transverse mass, stranverse mass:} \\ MET : Met, MetSig \\ \text{invariant mass} \end{array} \right.$

C1N2ISR:MC modeling

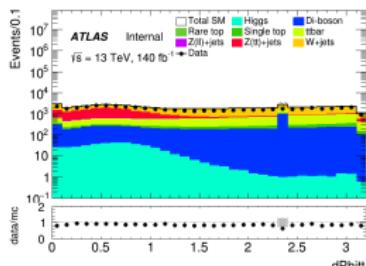
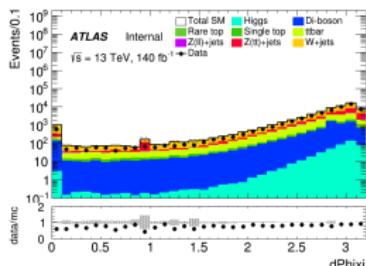
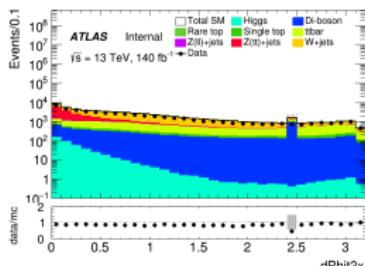
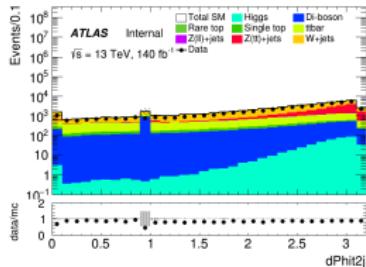
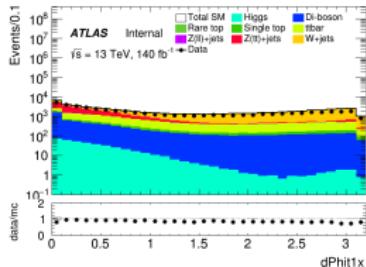
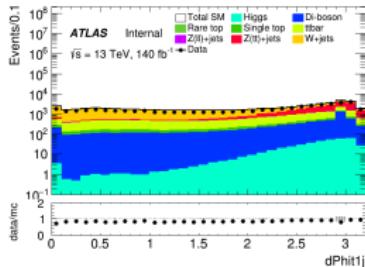
LH: $\Delta\eta$



notice: t_1 is leading tau, t_2 is leading lep, j is leading jet, x is MET.

C1N2ISR:MC modeling

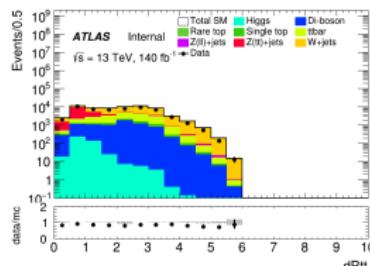
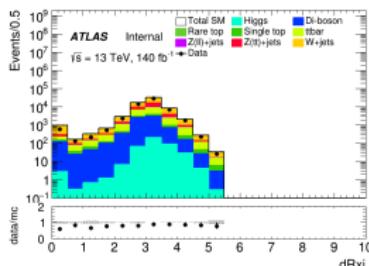
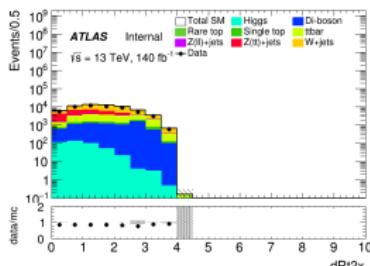
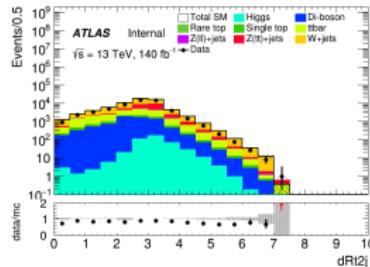
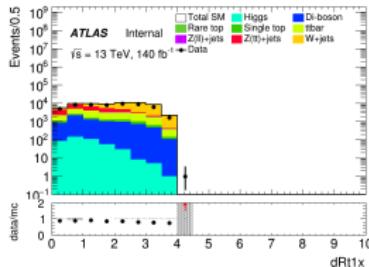
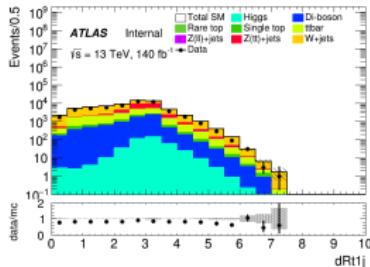
LH: $\Delta\phi$



notice: t1 is leading tau, t2 is leading lep, j is leading jet, x is MET.

C1N2ISR:MC modeling

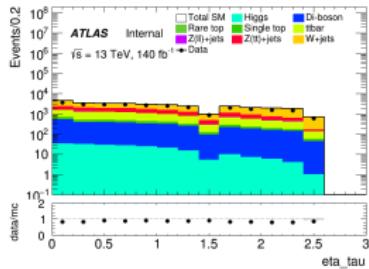
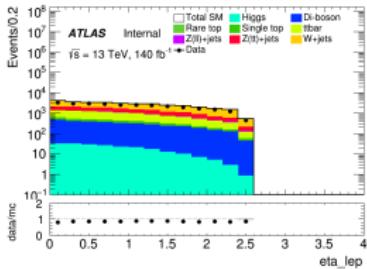
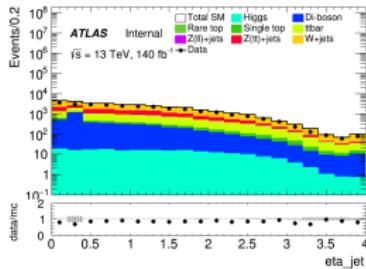
LH: ΔR



notice: t1 is leading tau, t2 is leading lep, j is leading jet, x is MET.

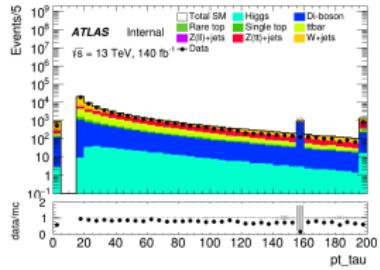
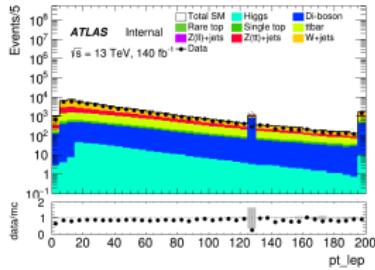
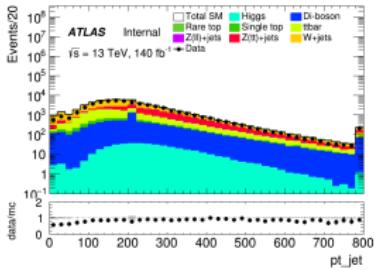
C1N2ISR:MC modeling

LH: η



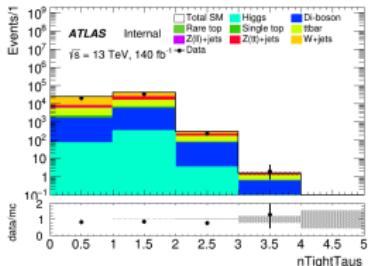
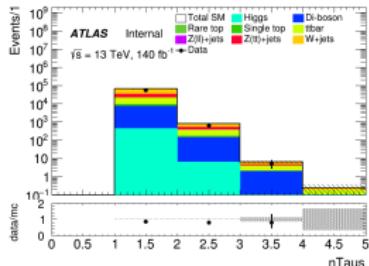
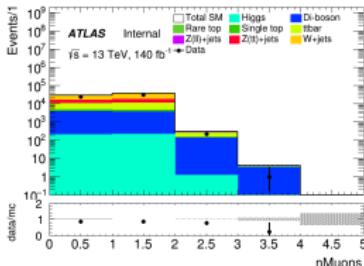
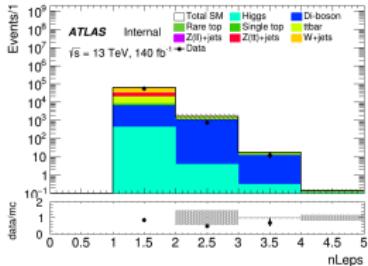
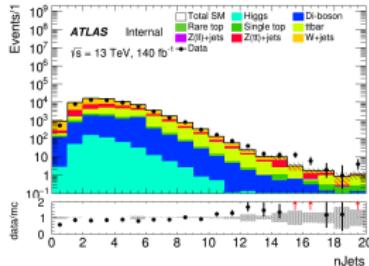
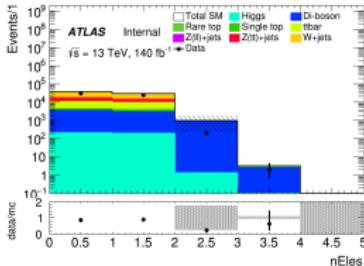
C1N2ISR:MC modeling

LH: p_t



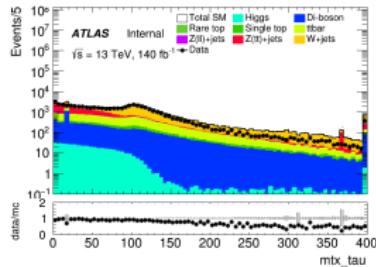
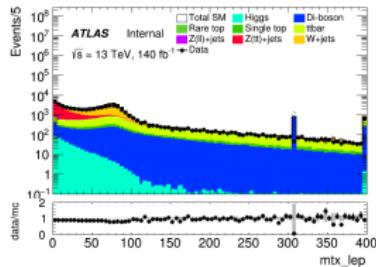
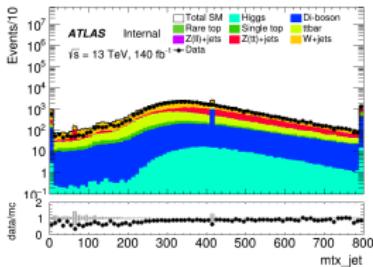
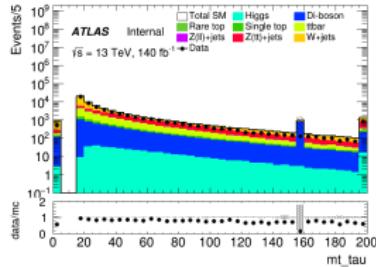
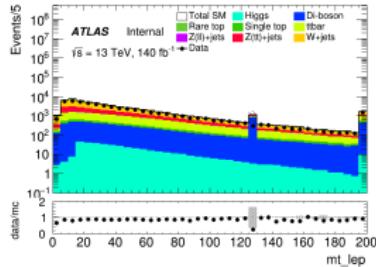
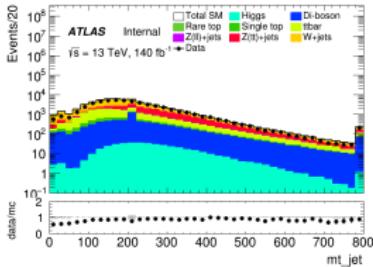
C1N2ISR:MC modeling

LH: num



C1N2ISR:MC modeling

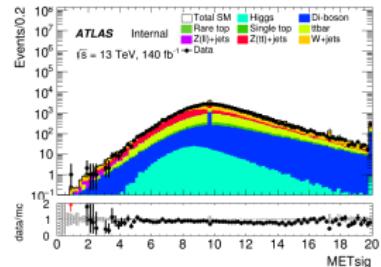
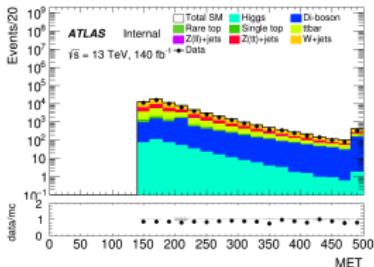
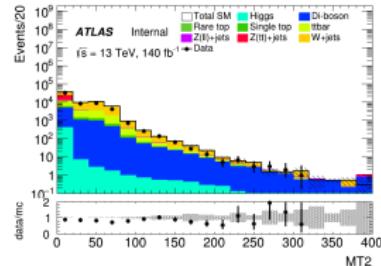
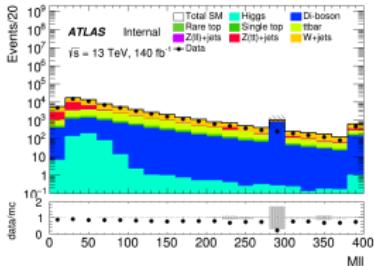
LH: transverse mass



notice: mtx is the projection of MT in METvec.

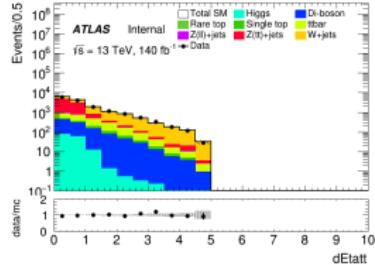
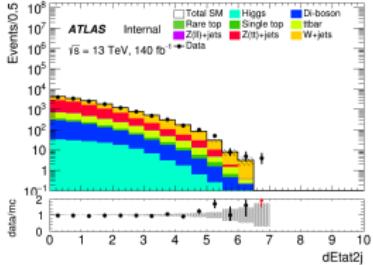
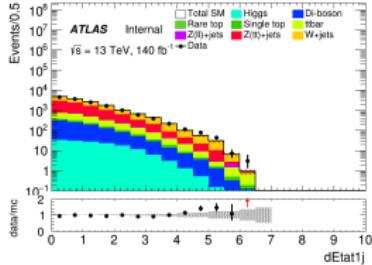
C1N2ISR:MC modeling

LH: stranverse mass, invariant mass, MET



C1N2ISR:MC modeling

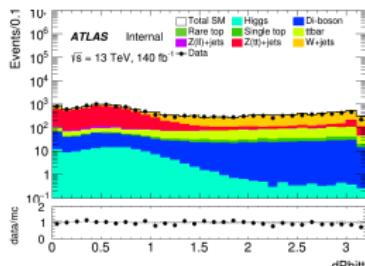
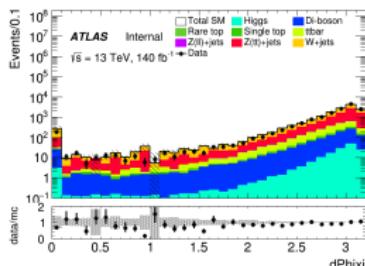
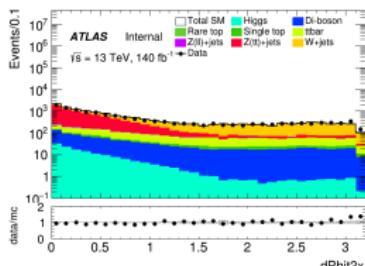
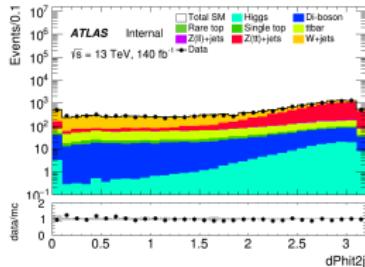
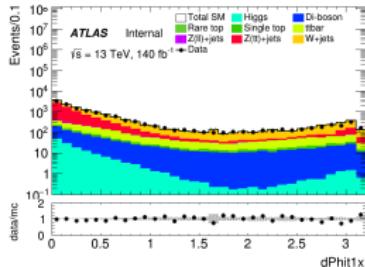
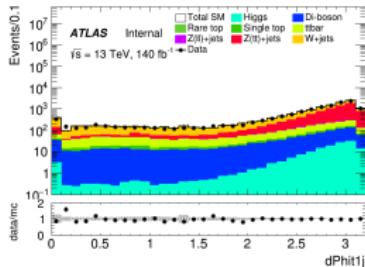
HH: $\Delta\eta$



notice: t_1 is leading tau, t_2 is next leading tau, j is leading jet, x is MET.

C1N2ISR:MC modeling

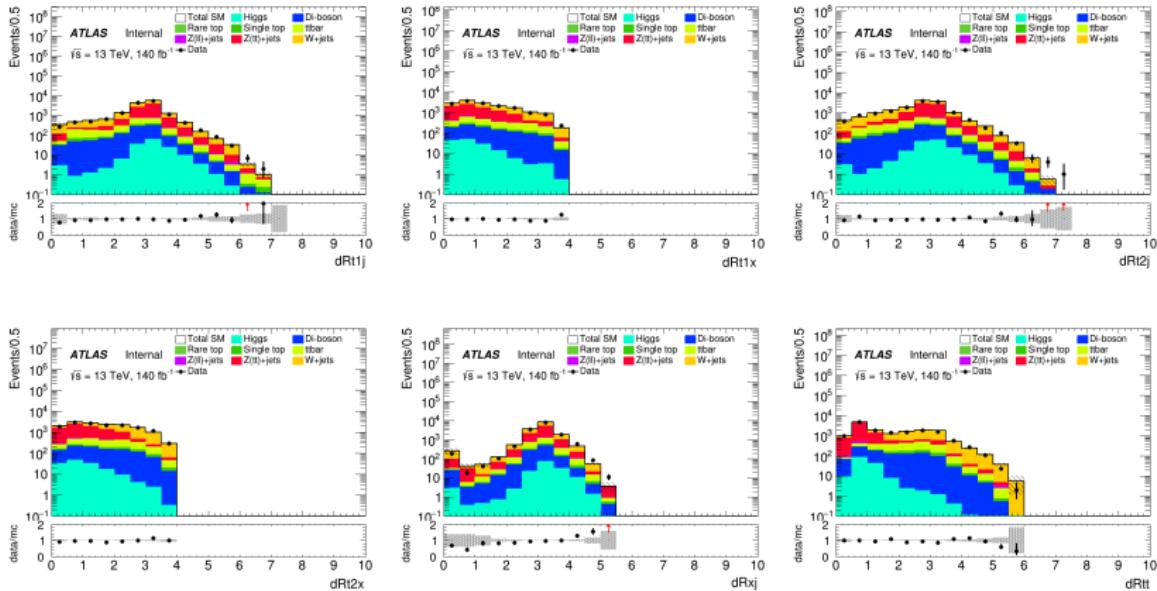
HH: $\Delta\phi$



notice: t1 is leading tau, t2 is next leading tau, j is leading jet, x is MET.

C1N2ISR:MC modeling

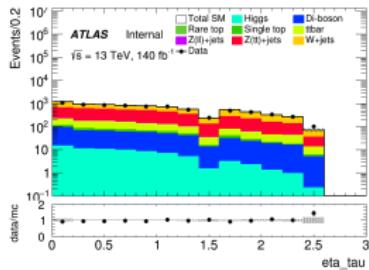
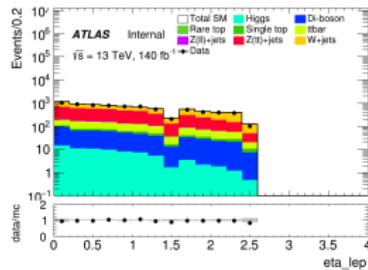
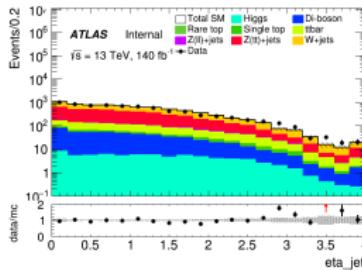
HH: ΔR



notice: t_1 is leading tau, t_2 is next leading tau, j is leading jet, x is MET.

C1N2ISR:MC modeling

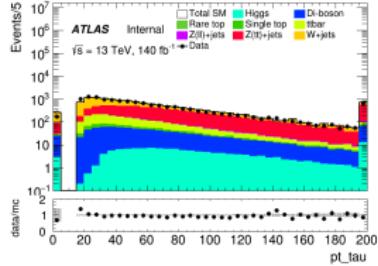
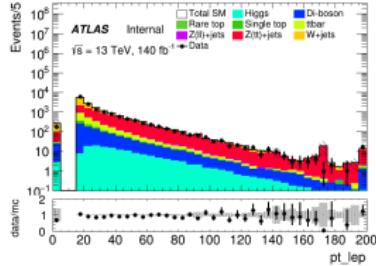
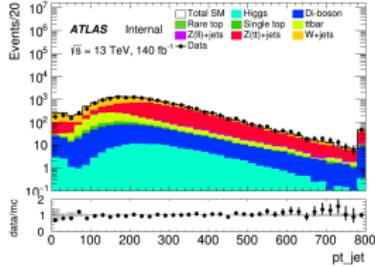
HH: η



notice: jet is leading jet, lep is next leading tau, tau is leading tau.

C1N2ISR:MC modeling

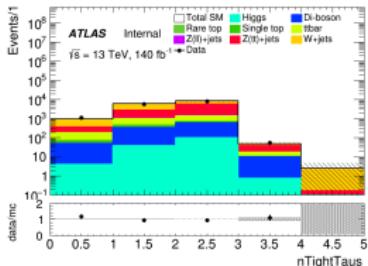
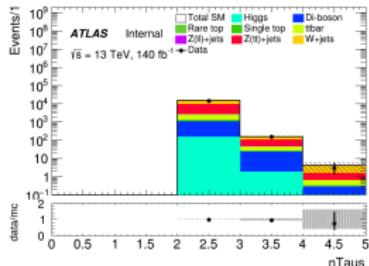
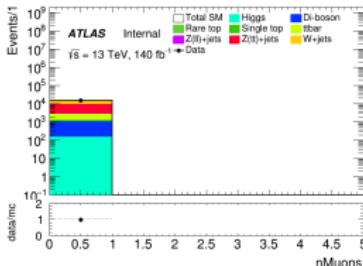
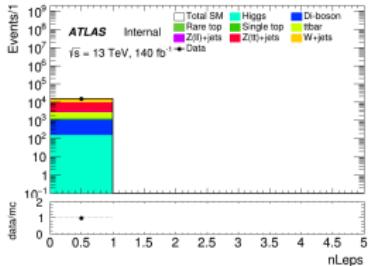
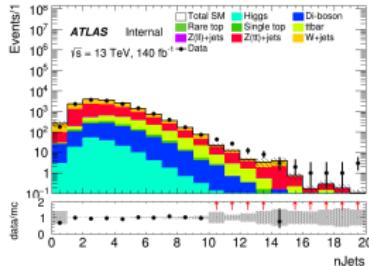
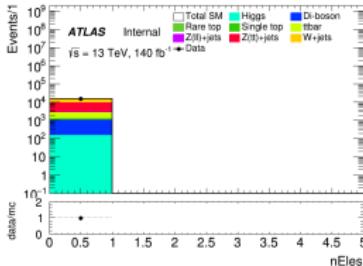
HH: p_t



notice: jet is leading jet, lep is next leading tau, tau is leading tau.

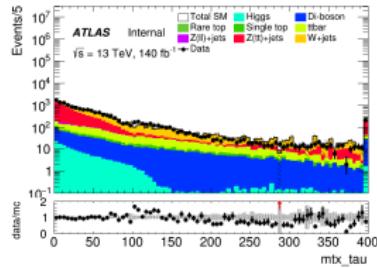
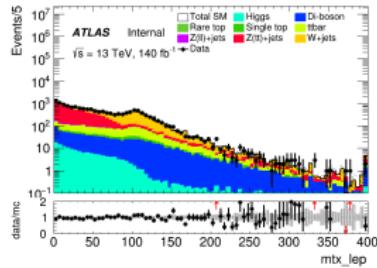
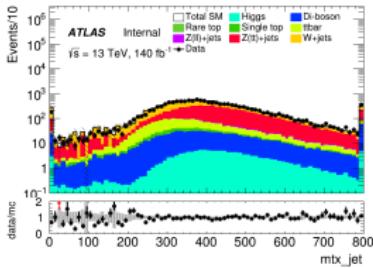
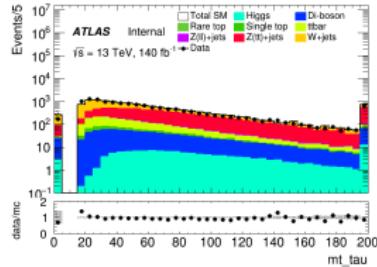
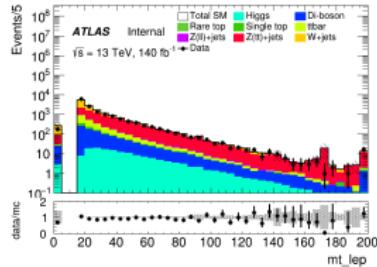
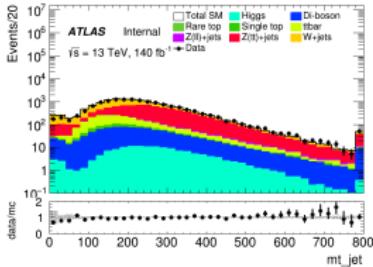
C1N2ISR:MC modeling

HH: num



C1N2ISR:MC modeling

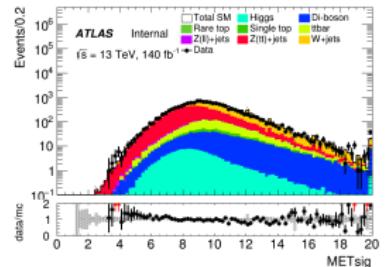
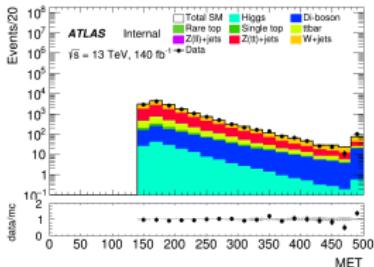
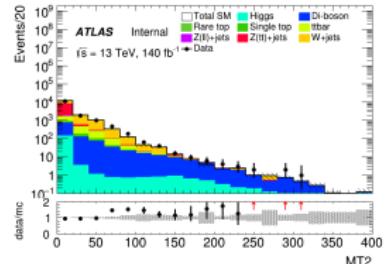
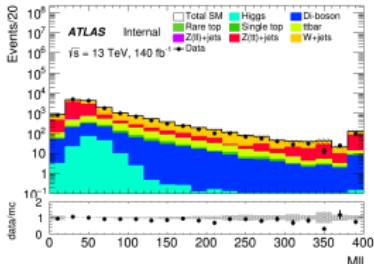
HH: transverse mass



notice: mt_x is the projection of MT in METvec.

C1N2ISR:MC modeling

HH: stranverse mass, invariant mass, MET



kinematic distributions

Variable choose

variable : $\left\{ \begin{array}{l} p_T : jet, lep, tau \\ MET \\ \text{num of obj} : base(jet, lep, e, \mu, \tau), \text{pass cut}(jet, lep, e, \mu, \tau, T\tau) \\ m_{inv}(tau1 - tau2, t1 - MET, t2 - MET) \\ m_T : lep, jet, \tau, sum \\ MT2 \\ \Delta R : R_{t1-t2}, R_{t1-E_{miss}}, R_{t2-E_{miss}}, R_{t1-jet}, R_{E_{miss}-jet} \\ \Delta \phi : \phi_{t1-t2}, \phi_{t1-E_{miss}}, \phi_{t2-E_{miss}}, \phi_{t1-jet}, \phi_{E_{miss}-jet} \end{array} \right.$