



中国科学院高能物理研究所  
Institute of High Energy Physics, Chinese Academy of Sciences

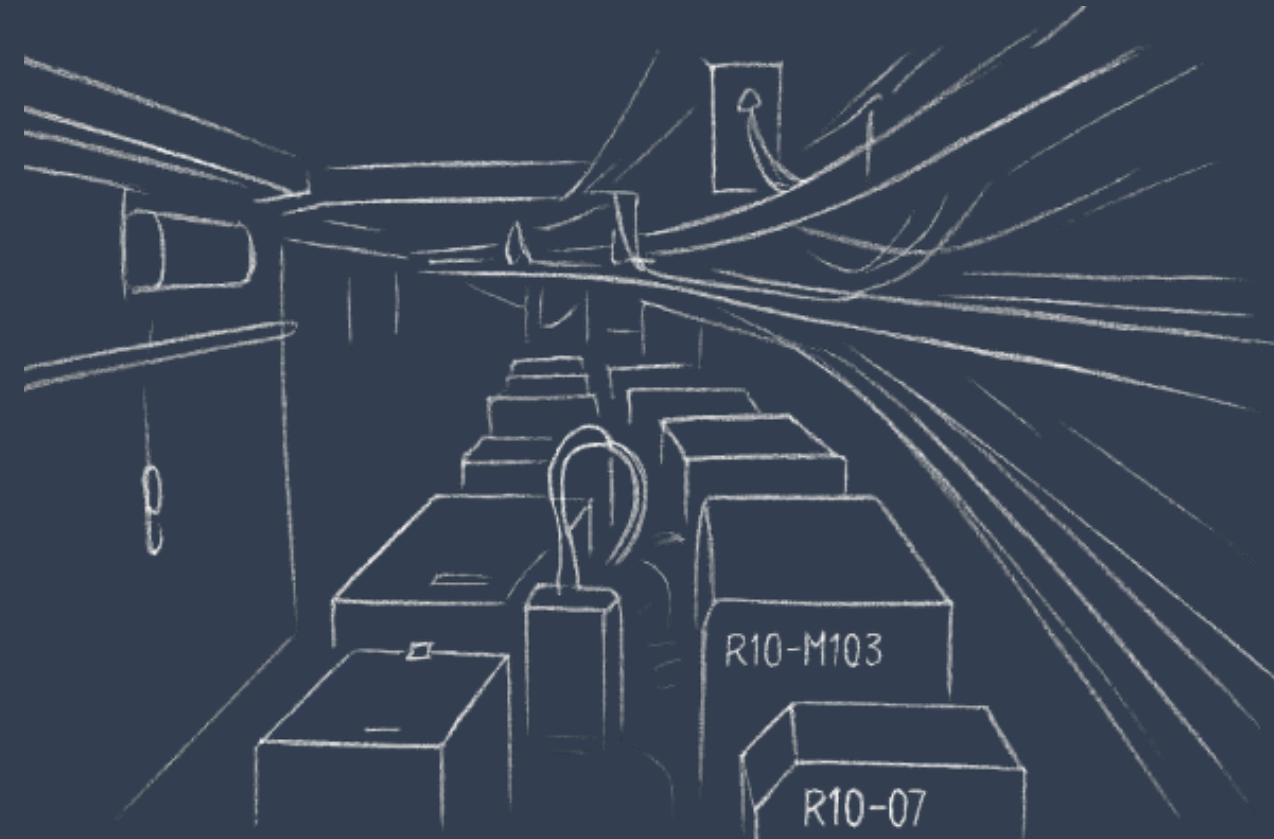


# IHEP SUSY Group Meeting

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**Institute of High Energy Physics  
Chinese Academy of Sciences**

*Aug 21, 2025*



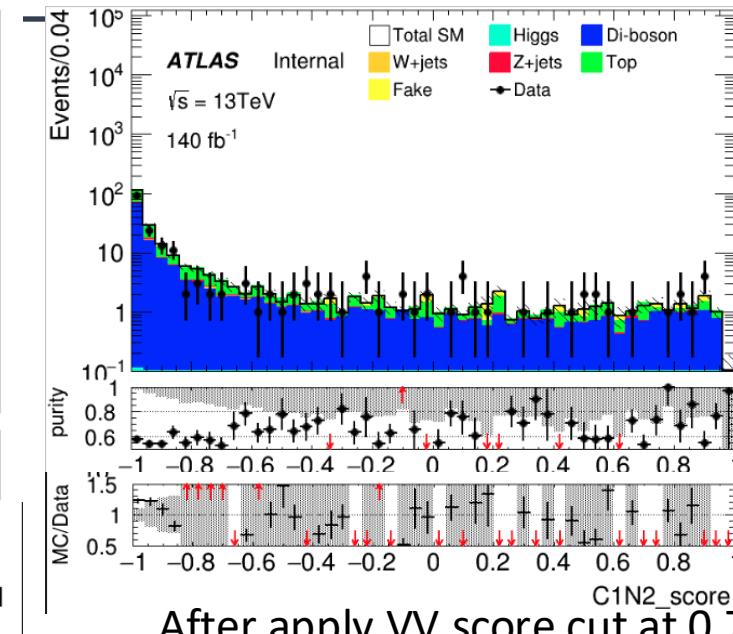
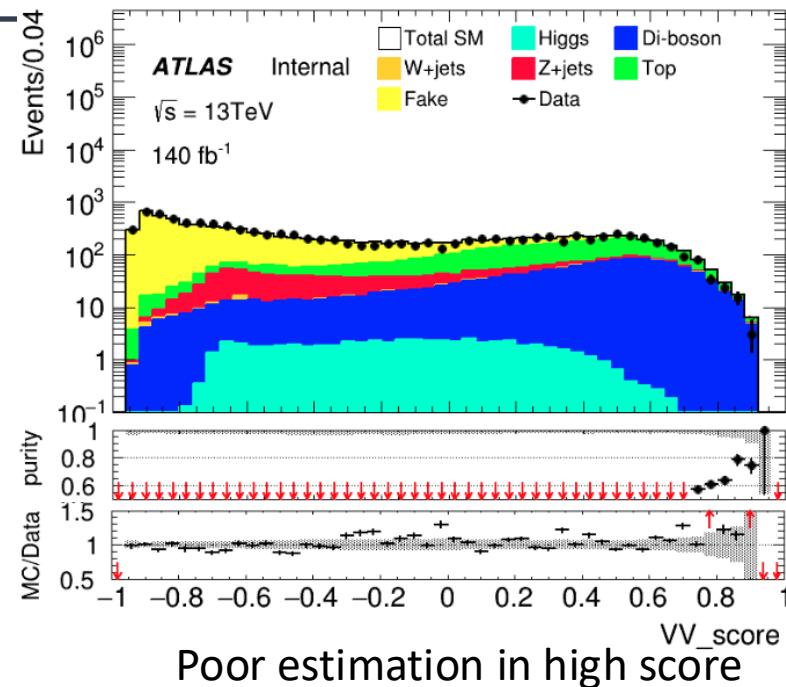


- Update VV CR/VR
- Split run2 and run3 then Update Bkg estimation(Done)
- Update support-note(Ongoing)

# VV CR/VR run2(LH)



Pre-selection + VV score > 0.7  
CR: C1N2 score < -0.6  
VR: -0.6 < C1N2 score < 0.9



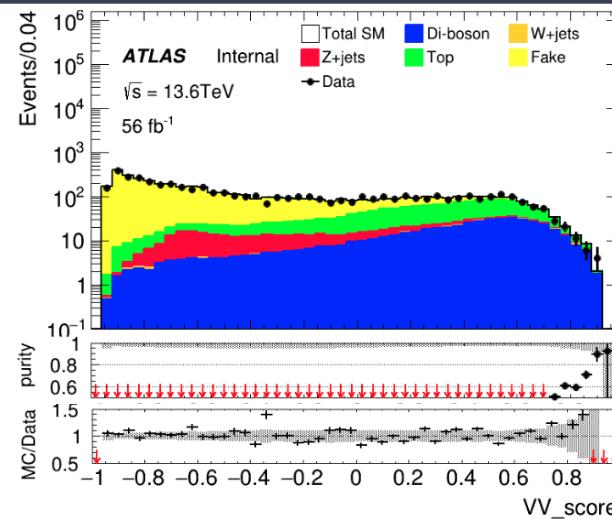
VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_04	107.653	1.78803	187.239	4.11777	151	0.574950	0.806456
C1N2_score	score_VR_04_19	31.3291	0.937328	48.6392	2.08185	44	0.644111	0.904620



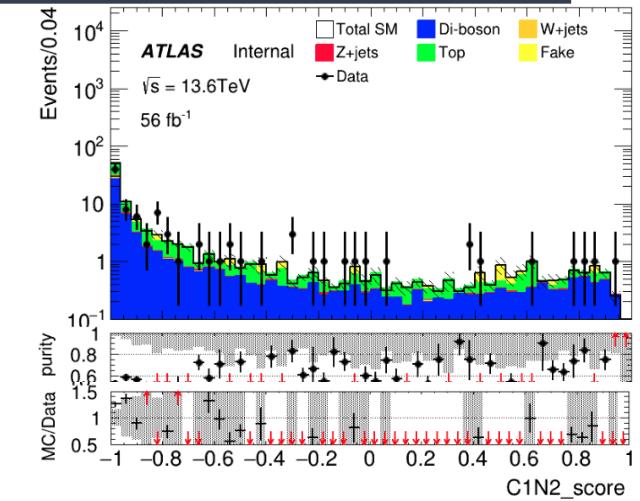
Pre-selection + VV score > 0.7

CR: C1N2 score < ?

VR: ? < C1N2 score < 0.9



Poor estimation in high score



After apply VV score cut at 0.7

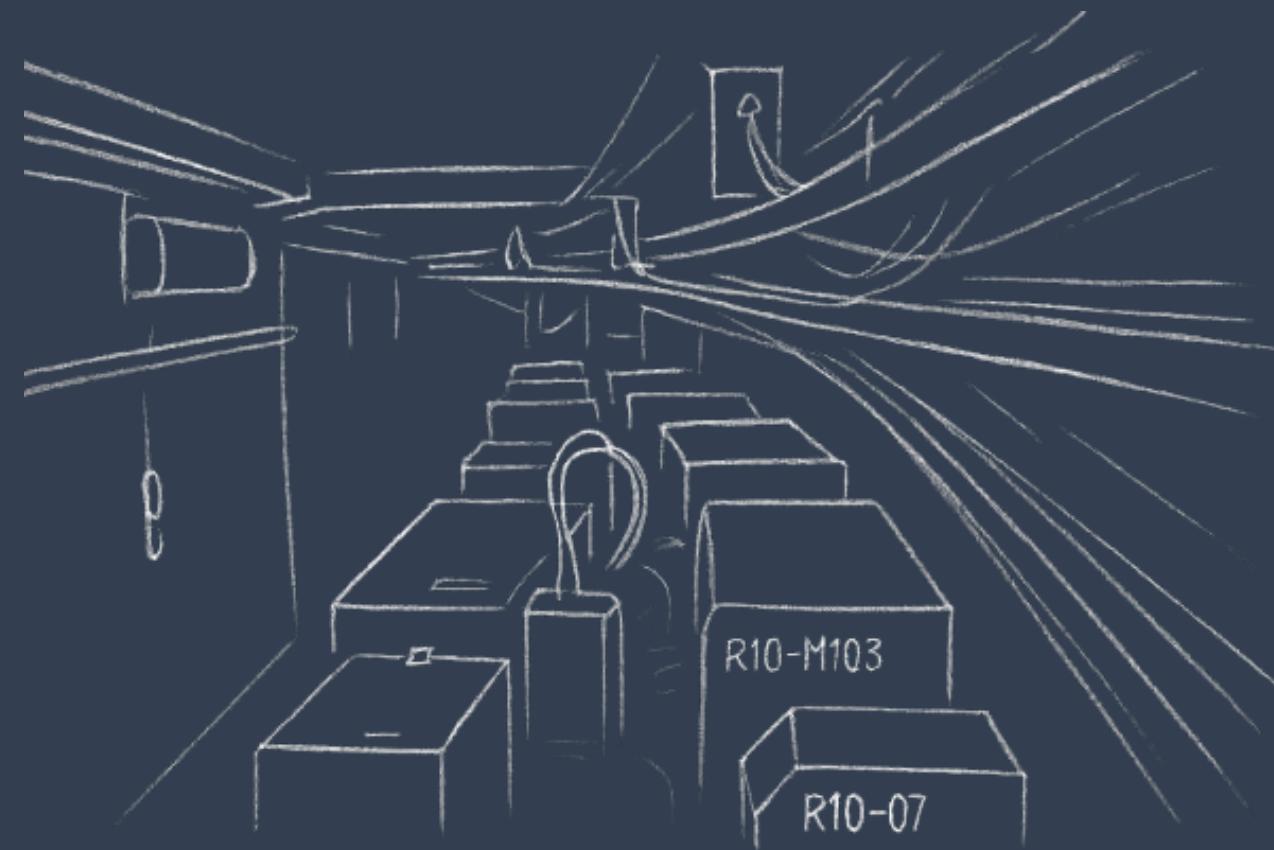
VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_04	43.5272	0.688996	81.1233	2.05634	70	0.536556	0.862884
C1N2_score	score_VR_04_19	12.6722	0.367379	21.7975	1.04771	21	0.581358	0.963412
C1N2_score	score_CR_00_05	44.7472	0.703827	83.2197	2.09493	73	0.537700	0.877197
C1N2_score	score_VR_05_19	11.4522	0.338099	19.7012	0.968247	18	0.581293	0.913651
C1N2_score	score_CR_00_06	46.0831	0.715315	85.7623	2.12737	75	0.537335	0.874510
C1N2_score	score_VR_06_19	10.1162	0.313063	17.1585	0.894731	16	0.589576	0.932483



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# Backup





## HH run2 sample with cut

fb_mcChannelNumber	Weight_mc	phys name	category	yield_frac
700602	2.885653969057861	Sh_2212_llvv_os	VV	0.48318873163089454
410470	1.5330489853387628	PhPy8EG_A14_ttbar_hdamp258p75_nonallhad	MainTop	0.25670160133431214
700794	0.5676474979389354	Sh_2214_Ztautau_maxHTpTV2_CVetoBVeto	Zjets	0.09504981452509885
700601	0.37867702141803133	Sh_2212_lllv	VV	0.06340762670739847
700793	0.2708884099133192	Sh_2214_Ztautau_maxHTpTV2_CFilterBVeto	Zjets	0.04535894760876716
701010	0.17150281277467447	Sh_2214_llvjj_os	VV	0.0287173124235618
700792	0.07537775892048387	Sh_2214_Ztautau_maxHTpTV2_BFilter	Zjets	0.012621639363731226

## HH run2 sample without cut

fb_mcChannelNumber	Weight_mc	phys name	category	yield_frac
700794	353.2419426784479	Sh_2214_Ztautau_maxHTpTV2_CVetoBVeto	Zjets	0.4016554218471695
410470	151.49799207592255	PhPy8EG_A14_ttbar_hdamp258p75_nonallhad	MainTop	0.1722615085141372
700602	122.96639717867026	Sh_2212_llvv_os	VV	0.13981952357448293
700793	110.51649983780405	Sh_2214_Ztautau_maxHTpTV2_CFilterBVeto	Zjets	0.1256633089118557
700601	26.267928490961992	Sh_2212_lllv	VV	0.029868072344661413
700792	16.054967150516173	Sh_2214_Ztautau_maxHTpTV2_BFilter	Zjets	0.018255376342590997
345123	14.79703666224564	PowhegPy8EG_NNLOPS_nnlo_30_ggH125_tautauh30h20	ggH	0.016825040530570382
700360	14.233284640319363	Sh_2211_Ztt2jets_Min_N_TChannel	Zjets	0.01618402362734801
601355	13.8387177917744	PhPy8EG_tW_dyn_DR_incl_top	MainTop	0.015735379525807957
346193	13.106504964951732	PowhegPy8EG_NNPDF30_AZNLOCTEQ6L1_VBFH125_tautauh30h20	VBFH	0.014902813467515494
701010	10.391354104222618	Sh_2214_llvjj_os	VV	0.011815538337966176
601352	10.284217561641821	PhPy8EG_tW_dyn_DR_incl_antitop	MainTop	0.011693718225441463



## HH run3 sample with cut

fb_mcChannelNumber	Weight_mc	phys name	category	yield_frac
701050	1.0367553001216316	Sh_llvv_os	VV	0.476437370405141
601230	0.5901986142305764	PhPy8EG_A14_ttbar_hdamp258p75_dil	top	0.2712237649016935
700794	0.21516089414363362	Sh_2214_Ztautau_maxHTpTV2_CVetoBVeto	Vjets	0.09887645677604465
701045	0.13387573013427248	Sh_lllv	VV	0.06152213624445232
701010	0.09910325854217991	Sh_2214_llvjj_os	VV	0.045542565244544794
700793	0.0414772349583026	Sh_2214_Ztautau_maxHTpTV2_CFilterBVeto	Vjets	0.019060722190560774

## HH run3 sample without cut

fb_mcChannelNumber	Weight_mc	phys name	category	yield_frac
700794	137.66637730306843	Sh_2214_Ztautau_maxHTpTV2_CVetoBVeto	Vjets	0.4032047108919486
601230	66.98791941833271	PhPy8EG_A14_ttbar_hdamp258p75_dil	top	0.19619783139103472
701050	50.985344976531	Sh_llvv_os	VV	0.149328628265794
700793	46.07238443559022	Sh_2214_Ztautau_maxHTpTV2_CFilterBVeto	Vjets	0.13493928445257938
701045	11.137533868229442	Sh_lllv	VV	0.03262020989702215
700792	6.874238251246562	Sh_2214_Ztautau_maxHTpTV2_BFilter	Vjets	0.020133639752823406
601352	5.447627062297788	PhPy8EG_tW_dyn_DR_incl_antitop	top	0.015955303958245272
601355	4.1352331211522575	PhPy8EG_tW_dyn_DR_incl_top	top	0.012111493799349385
701010	3.9545153850238437	Sh_2214_llvjj_os	VV	0.011582197946751391



## LH run2 sample with cut

fb_mcChannelNumber	Weight_mc	phys name	category	yield_frac
700602	9.565934298682981	Sh_2212_llvv_os	VV	0.4673955032335123
410470	3.613521768307098	PhPy8EG_A14_ttbar_hdamp258p75_nonallhad	MainTop	0.17655816699218577
700794	2.122082271504951	Sh_2214_Ztautau_maxHTpTV2_CVetoBVeto	Zjets	0.10368581679779336
700601	1.0378891374254793	Sh_2212_lllv	VV	0.05071169219240468
601352	0.840677124384215	PhPy8EG_tW_dyn_DR_incl_antitop	MainTop	0.041075831731622894
701010	0.7267328908008782	Sh_2214_llvvjj_os	VV	0.03550846938798095
700793	0.5967881904458583	Sh_2214_Ztautau_maxHTpTV2_CFilterBVeto	Zjets	0.029159317625217486
601355	0.4179926412747281	PhPy8EG_tW_dyn_DR_incl_top	MainTop	0.020423293200268415

## LH run2 sample without cut

fb_mcChannelNumber	Weight_mc	phys name	category	yield_frac
410470	1960.9807526771415	PhPy8EG_A14_ttbar_hdamp258p75_nonallhad	MainTop	0.4457310358807448
700602	1131.4409853911725	Sh_2212_llvv_os	VV	0.25717659990687813
700794	476.55284228481344	Sh_2214_Ztautau_maxHTpTV2_CVetoBVeto	Zjets	0.10832048797701549
700793	154.392221725202	Sh_2214_Ztautau_maxHTpTV2_CFilterBVeto	Zjets	0.03509336072144208
601355	135.5552841459881	PhPy8EG_tW_dyn_DR_incl_top	MainTop	0.030811723745382325
601352	131.4687138526521	PhPy8EG_tW_dyn_DR_incl_antitop	MainTop	0.029882846086812034
700601	124.62964070492023	Sh_2212_lllv	VV	0.028328324373918613
701010	83.6741165389491	Sh_2214_llvvjj_os	VV	0.019019131416968288



## LH run3 sample with cut

fb_mcChannelNumber	Weight_mc	phys name	category	yield_frac
701050	3.8102031602430295	Sh_llvv_os	VV	0.48967390188658305
601230	1.5512733377547712	PhPy8EG_A14_ttbar_hdamp258p75_dil	top	0.19936419037103278
700794	0.8517227919163614	Sh_2214_Ztautau_maxHTpTV2_CVetoBVeto	Vjets	0.10946041596816503
701045	0.4146970916913137	Sh_lllv	VV	0.05329541088736888
701010	0.3221119062114607	Sh_2214_llvjj_os	VV	0.04139668866072496
601355	0.23029303360806969	PhPy8EG_tW_dyn_DR_incl_top	top	0.02959645026827616
700793	0.17641155040451234	Sh_2214_Ztautau_maxHTpTV2_CFilterBVeto	Vjets	0.022671791658198423
700785	0.11284882316068273	Sh_2214_Wtaunu_maxHTpTV2_CVetoBVeto	Vjets	0.014502933632776651

## LH run3 sample without cut

fb_mcChannelNumber	Weight_mc	phys name	category	yield_frac
601230	849.5075049542239	PhPy8EG_A14_ttbar_hdamp258p75_dil	top	0.4793142608927102
701050	440.5554150412966	Sh_llvv_os	VV	0.2485728400412177
700794	169.17790738694697	Sh_2214_Ztautau_maxHTpTV2_CVetoBVeto	Vjets	0.09545458182022701
601352	61.71761355609071	PhPy8EG_tW_dyn_DR_incl_antitop	top	0.034822685088925234
601355	61.33945419989877	PhPy8EG_tW_dyn_DR_incl_top	top	0.03460931773047844
700793	55.594173784217624	Sh_2214_Ztautau_maxHTpTV2_CFilterBVeto	Vjets	0.03136768087617901
701045	49.00452005069978	Sh_lllv	VV	0.027649626603085578
701010	34.07158628436075	Sh_2214_llvjj_os	VV	0.019224076423210147

# Pre-Selection



## HH Pre-selection

$\geq 2$  medium taus

0 base lepton

$\text{MET} \geq 200$ ; pass MET trigger

$1 \leq n\text{Jet}$

Opposite-sign hadronic-hadronic tau pair

bveto

jet  $\text{pt} > 100$  GeV

$\text{M}_{\text{tt}}\text{\_reco} \leq 40$  GeV ||  $\text{M}_{\text{tt}}\text{\_reco} \geq 130$  GeV

## LH Pre-selection

$\geq 1$  medium taus

1 base lepton, 1 signal lepton

$\text{MET} \geq 200$ ; pass MET trigger

$1 \leq n\text{Jet}$

Opposite-sign lepton-hadronic tau pair

bveto

jet  $\text{pt} > 100$  GeV

$\text{M}_{\text{tt}}\text{\_reco} \leq 40$  GeV ||  $\text{M}_{\text{tt}}\text{\_reco} \geq 130$  GeV

# HH channel: Z bkg estimation(run2)

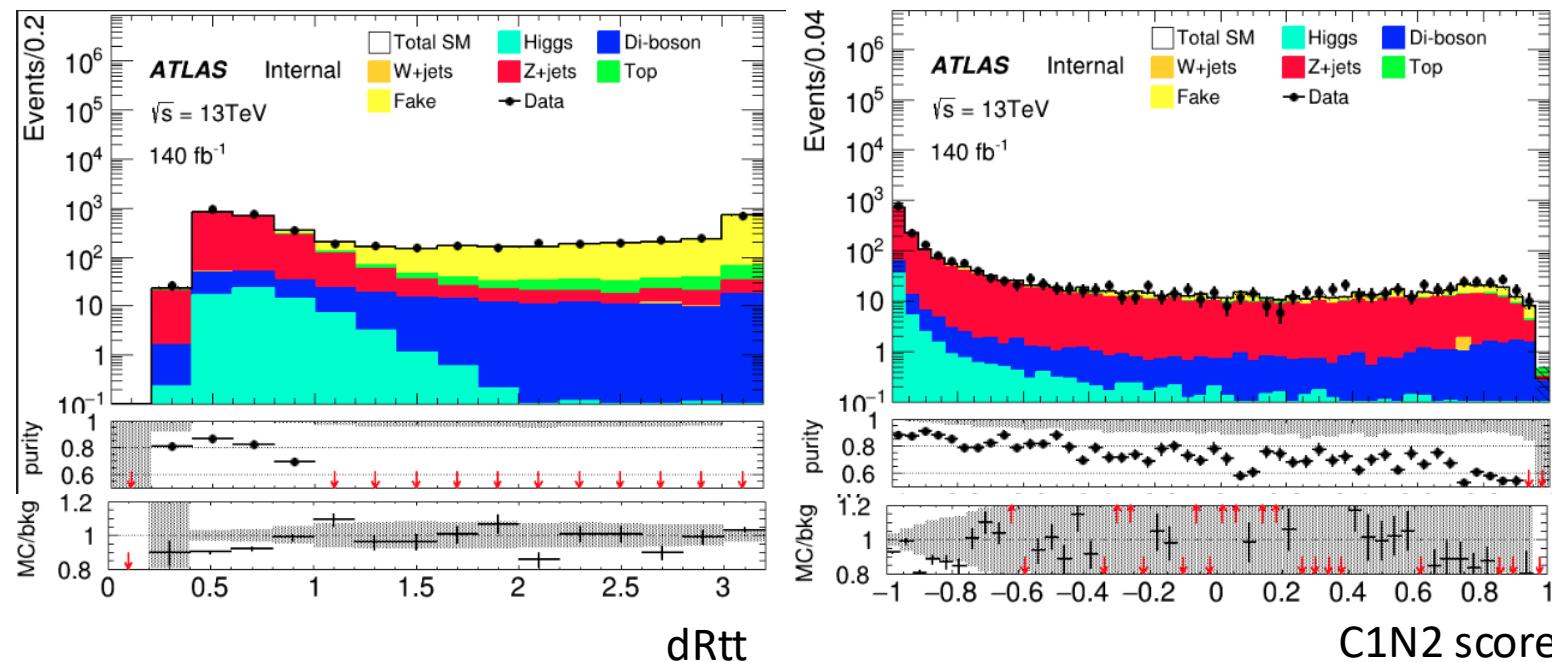


HH pre-selection(drop Mtt reco cut)

dRtt  $\leq 1.0$

CR: C1N2 score  $< -0.3$

VR:  $-0.3 < \text{C1N2 score} < 0.9$



VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_07	1258.12	5.53658	1452.39	10.0763	1568	0.866244	1.079603
C1N2_score	score_VR_07_19	289.617	3.01433	427.092	8.69179	464	0.678113	1.086416

# HH channel: Z bkg estimation(run3)

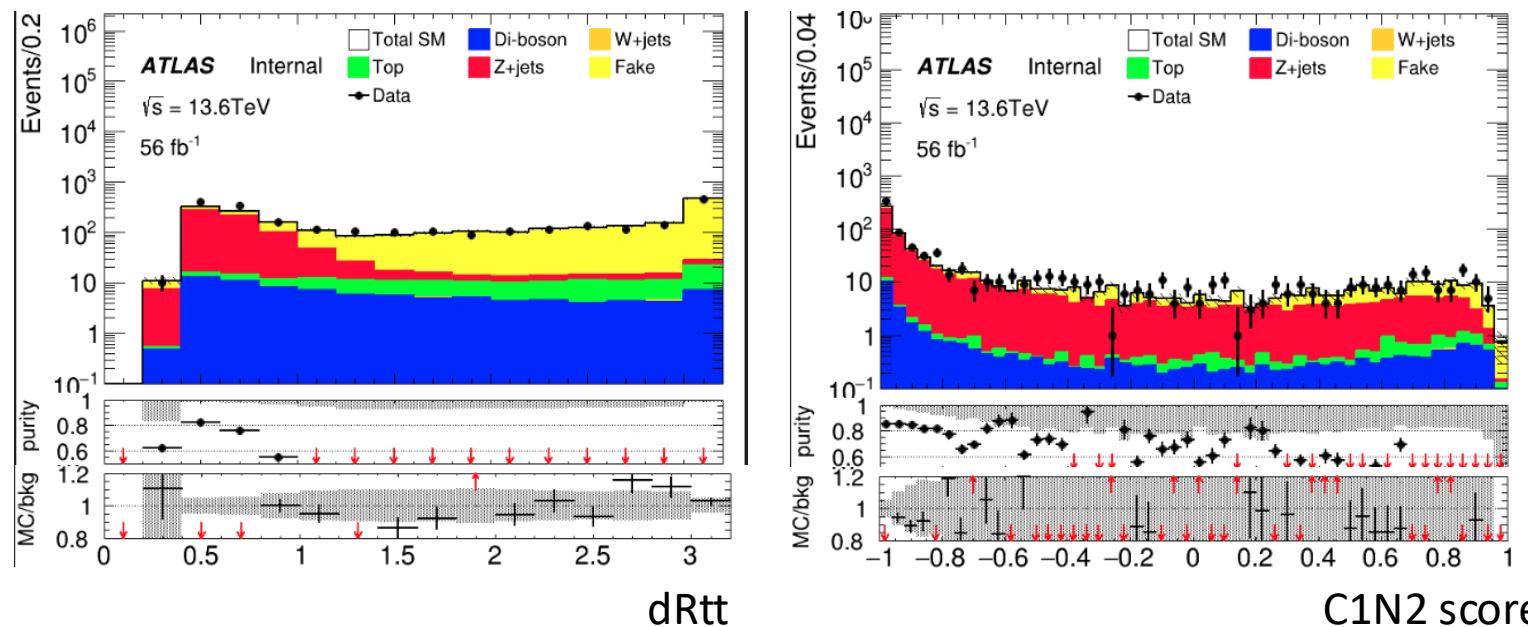


HH pre-selection(drop Mtt reco cut)

dRtt  $\leq 1.0$

CR: C1N2 score  $< -0.3$

VR:  $-0.3 < \text{C1N2 score} < 0.9$



VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_07	454.913	2.97726	551.72	7.70054	670	0.824537	1.214385
C1N2_score	score_VR_07_19	103.795	1.58308	192.661	7.35239	224	0.538746	1.162664

# HH channel: Top bkg estimation(run2)



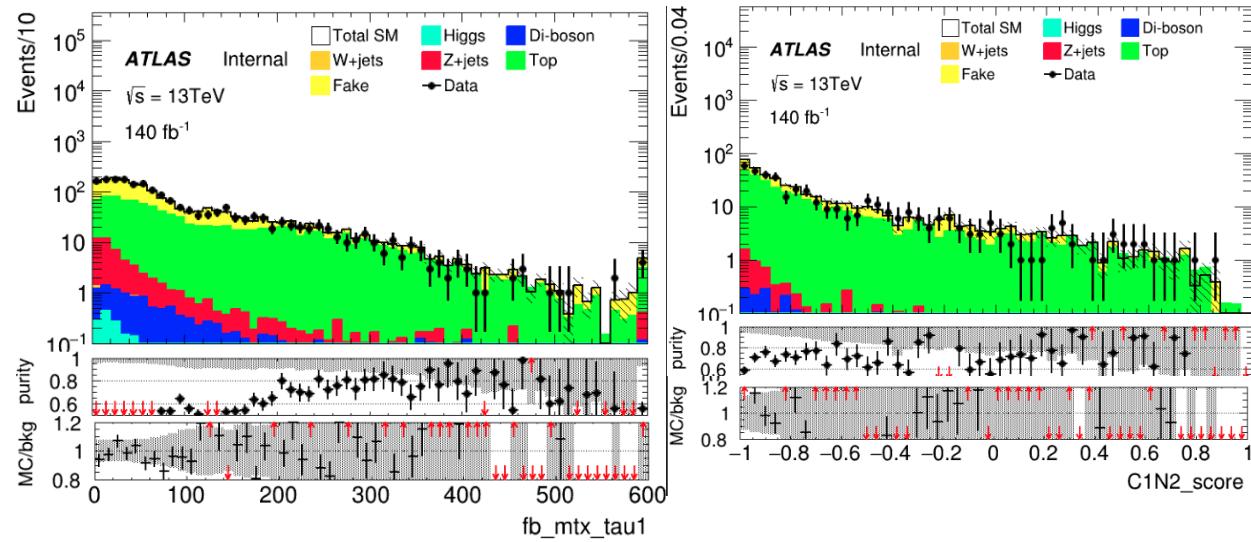
HH pre-selection(remove bVeto and add bJets > 0)

$M_T(\tau_1, MET) > 150$

Orthogonal with SR

CR: C1N2 score < -0.8

VR: -0.2 < C1N2 score < 1.0



Wrong label, should be 00\_02

Region

VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_08	134.158	4.39877	200.997	7.00963	180	0.667462	0.895537
C1N2_score	score_CR_08_20	175.879	5.0719	242.003	7.54143	217	0.726763	0.896682

# HH channel: Top bkg estimation(run2)



VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_02	134.158	4.39877	200.997	7.00963	180	0.667462	0.895537
C1N2_score	score_CR_02_20	175.879	5.0719	242.003	7.54143	217	0.726763	0.896682
C1N2_score	score_CR_00_03	182.392	5.13863	266.54	7.98746	236	0.684295	0.885421
C1N2_score	score_CR_03_20	127.645	4.32063	176.46	6.49681	161	0.723363	0.912387
C1N2_score	score_CR_00_04	211.448	5.54146	305.469	8.55257	266	0.692209	0.870793
C1N2_score	score_CR_04_20	98.5884	3.79021	137.531	5.73251	131	0.716843	0.952509
C1N2_score	score_CR_00_05	225.917	5.73238	325.908	8.82062	279	0.693194	0.856070
C1N2_score	score_CR_05_20	84.1191	3.49475	117.092	5.31081	118	0.718402	1.007755

# HH channel: Top bkg estimation(run3)



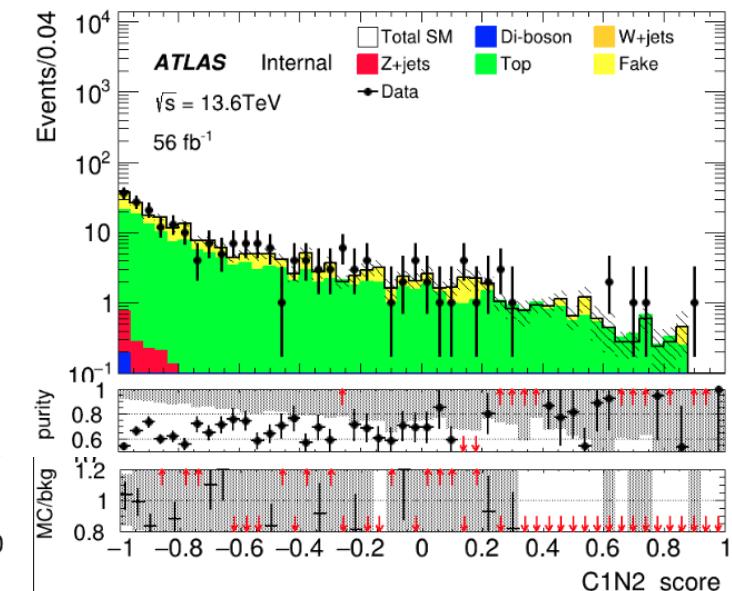
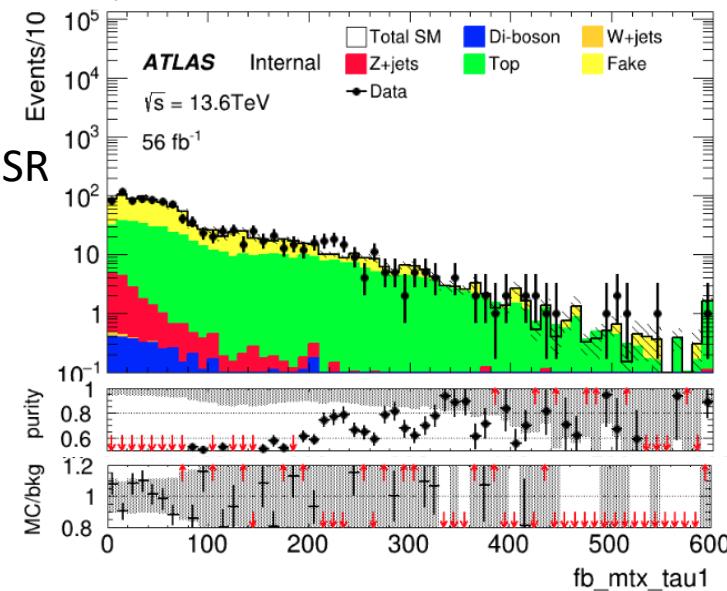
HH pre-selection(remove bVeto and add bJets > 0)

$M_T(\tau_1, MET) > 150$

Orthogonal with SR

CR: C1N2 score < -0.8

VR: -0.2 < C1N2 score < 1.0



VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_08	60.8912	1.58861	97.9923	4.67955	96	0.621388	0.979669
C1N2_score	score_VR_08_20	83.8068	1.94	123.476	4.53532	121	0.678728	0.979946

# HH channel: Top bkg estimation(run3)



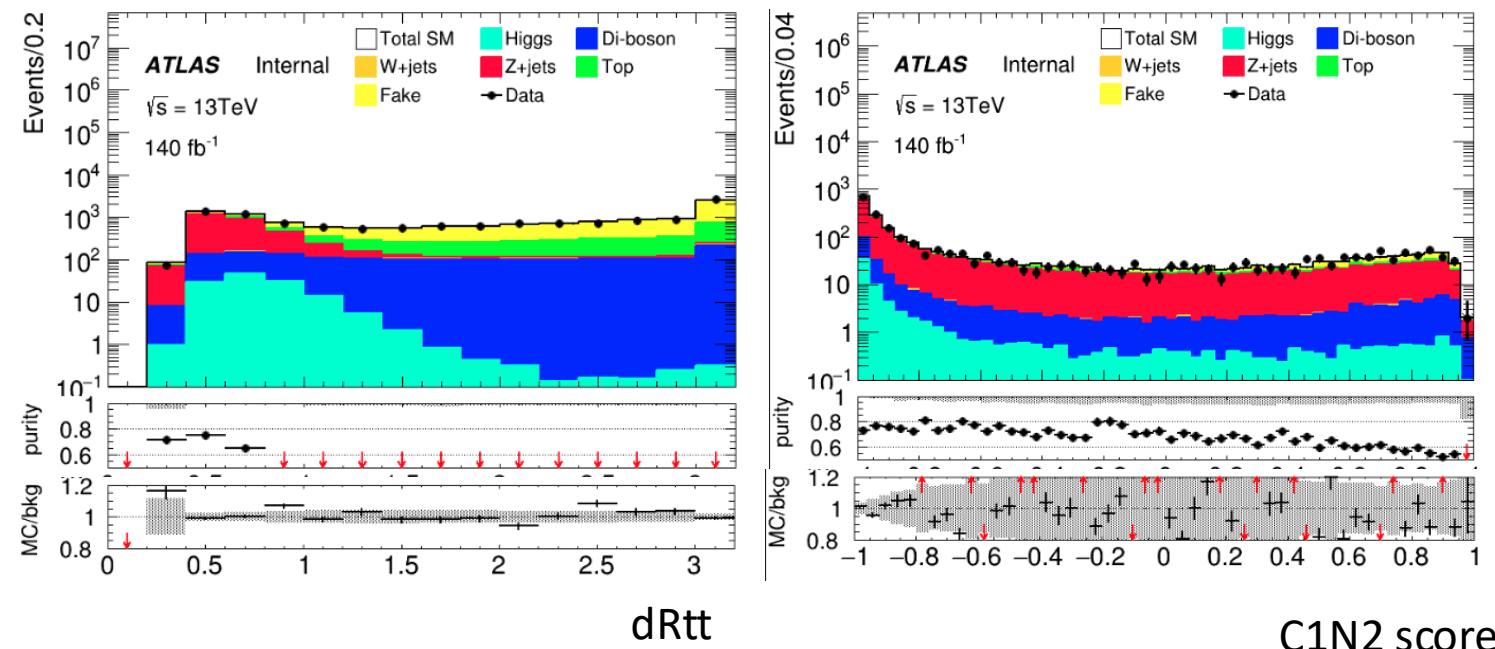
VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_02	60.8912	1.58861	97.9923	4.67955	96	0.621388	0.979669
C1N2_score	score_CR_02_20	83.8068	1.94	123.476	4.53532	121	0.678728	0.979946
C1N2_score	score_CR_00_03	81.1283	1.84636	130.623	5.27091	123	0.621086	0.941638
C1N2_score	score_CR_03_20	63.5697	1.69653	90.8451	3.83208	94	0.699759	1.034729
C1N2_score	score_CR_00_04	93.7584	1.97827	148.723	5.5115	142	0.630422	0.954794
C1N2_score	score_CR_04_20	50.9396	1.54069	72.7453	3.47717	75	0.700246	1.030995
C1N2_score	score_CR_00_05	100.353	2.03864	158.602	5.67384	156	0.632732	0.983592
C1N2_score	score_CR_05_20	44.3453	1.45987	62.8661	3.20545	61	0.705393	0.970316

# LH channel: Z bkg estimation(run2)



HH pre-selection(drop Mtt reco cut)  
 $dR_{tt} \leq 0.8$

CR: C1N2 score < -0.8  
VR:  $-0.8 < C1N2 \text{ score} < 0.9$



VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_02	917.1	4.57526	1233.19	9.34801	1231	0.743684	0.998228
C1N2_score	score_VR_02_19	884.617	4.80366	1294.8	11.3944	1299	0.683209	1.003246

# LH channel: Z bkg estimation(run3)

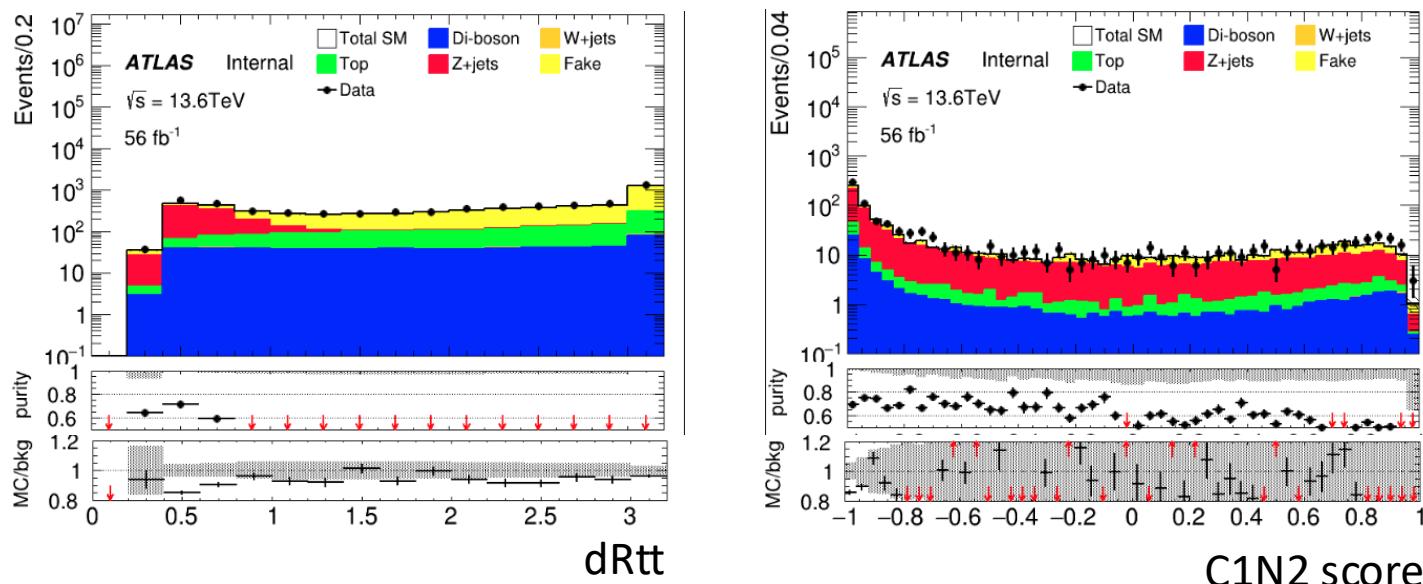


HH pre-selection(drop Mtt reco cut)

$dR_{tt} \leq 0.8$

CR: C1N2 score < -0.8

VR:  $-0.8 < C1N2 \text{ score} < 0.9$



VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_02	311.31	2.34649	438.072	5.52401	490	0.710638	1.118539
C1N2_score	score_CR_02_20	299.47	2.47646	483.885	7.39987	547	0.618888	1.130435

# LH channel: Top bkg estimation(run2)



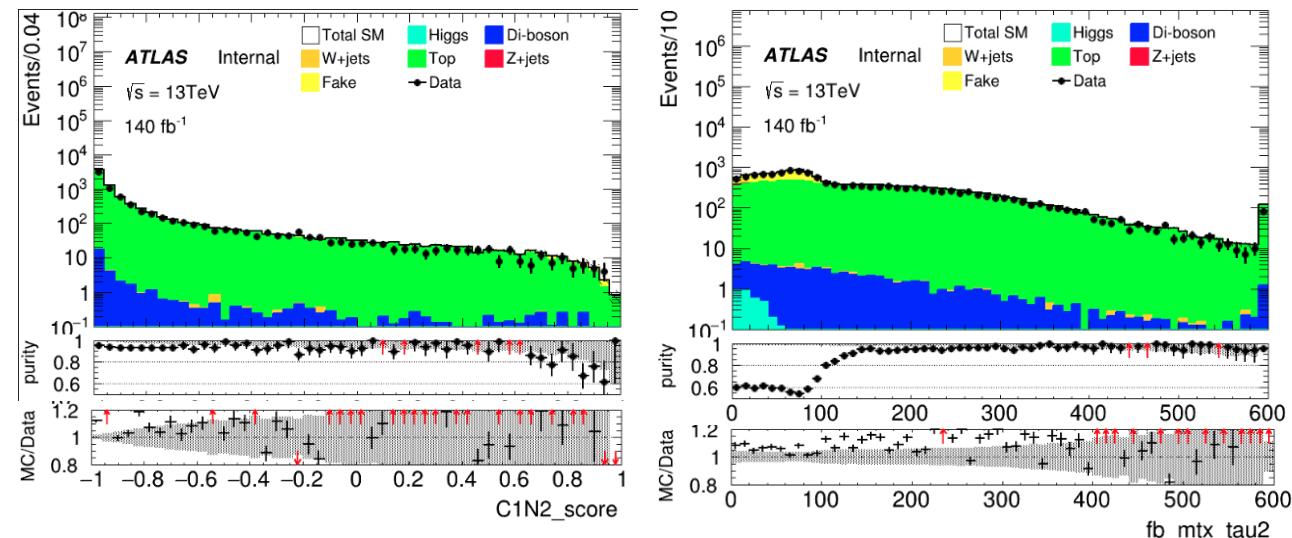
HH pre-selection(remove bVeto and add bJets > 0)

$M_T(\tau_2, MET) > 110$

Orthogonal with SR

CR: C1N2 score < -0.8

VR: -0.8 < C1N2 score < 1.0



VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_08	5402.87	27.8401	5679.73	31.9386	5071	0.951255	0.892824
C1N2_score	score_VR_08_20	1884.23	16.4037	1996.78	18.928	1776	0.943633	0.889432

# LH channel: Top bkg estimation(run3)



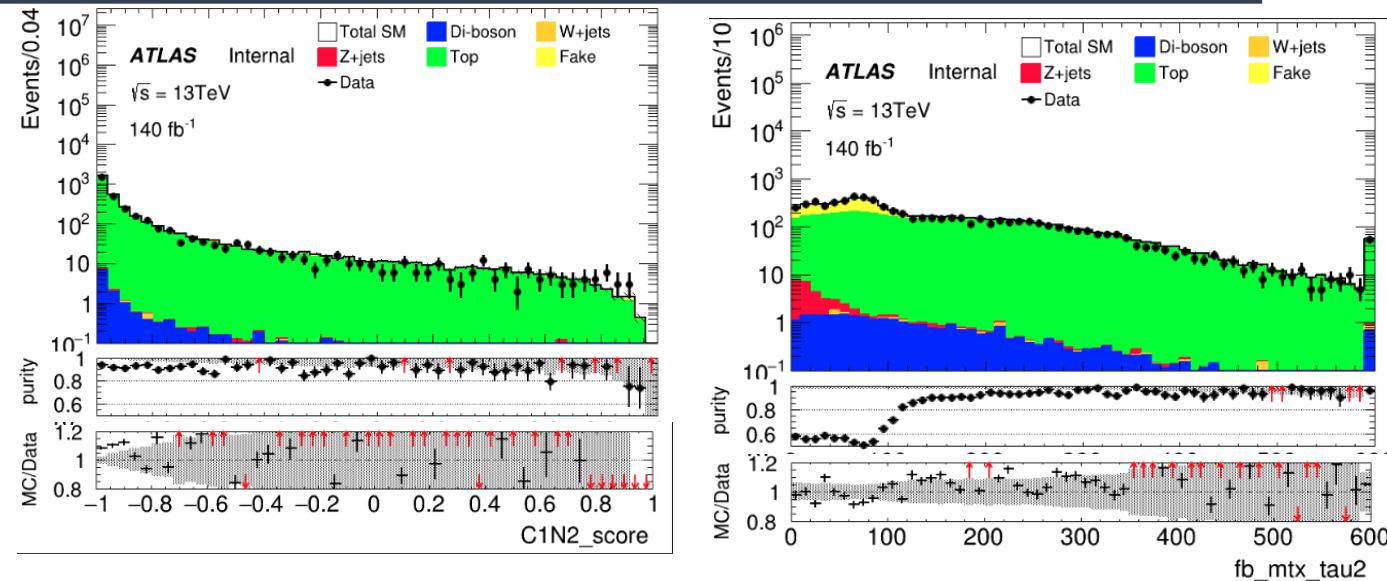
HH pre-selection(remove bVeto and add bJets > 0)

$M_T(\tau_2, MET) > 110$

Orthogonal with SR

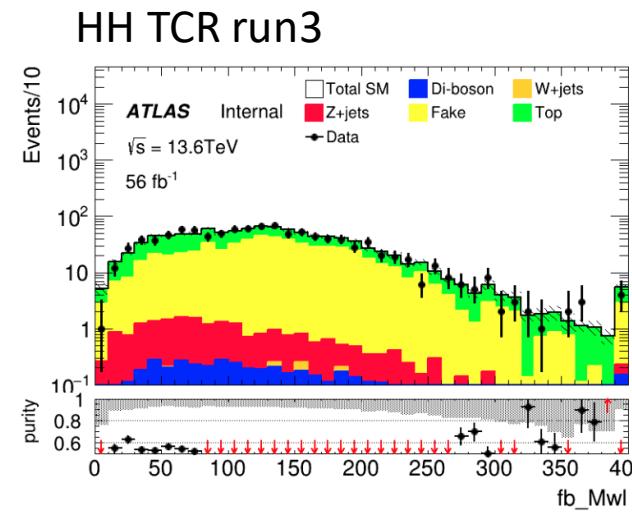
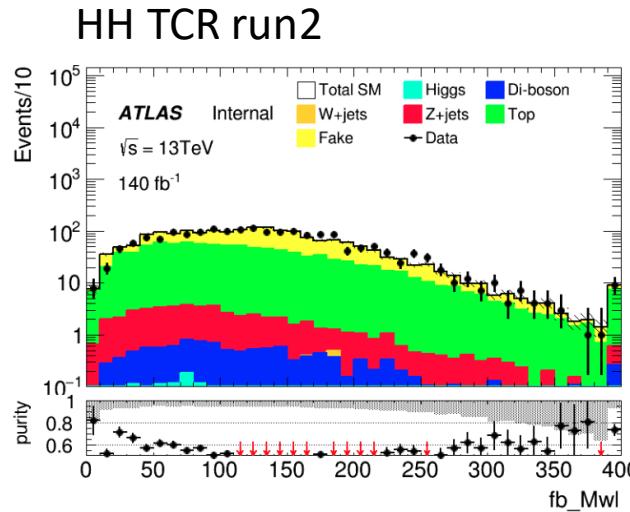
CR: C1N2 score < -0.8

VR: -0.8 < C1N2 score < 1.0

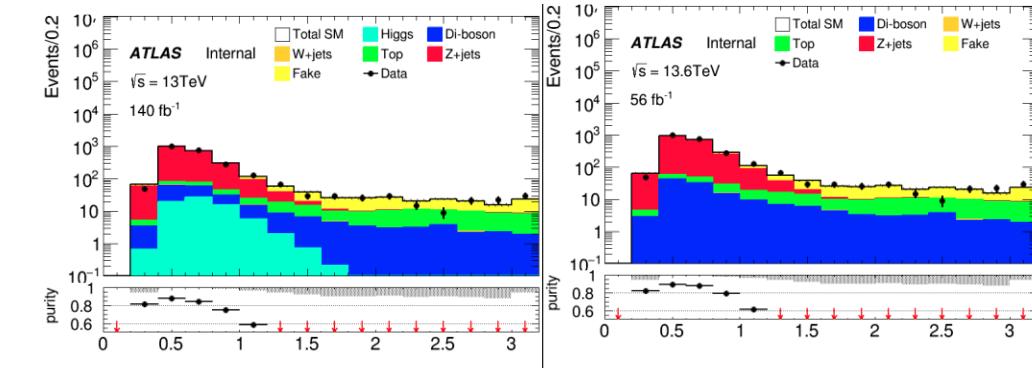


VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_08	2482.03	10.2931	2683.31	15.1554	2460	0.924986	0.916777
C1N2_score	score_VR_08_20	866.683	6.19781	941.263	9.10633	864	0.920767	0.917916

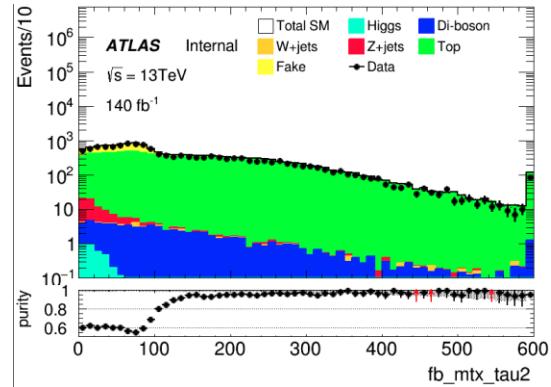
# Distribution Check



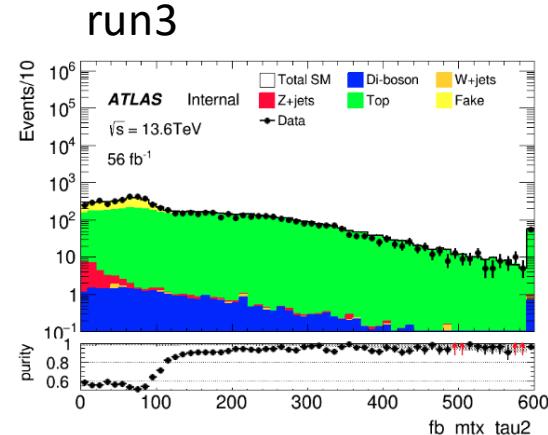
**LH Channel**  
**Change Mtt\_reco to [10,130]**  
**run2**



**LH channel**  
**run2**



**$M_{inv}(\tau_2, MET)$**

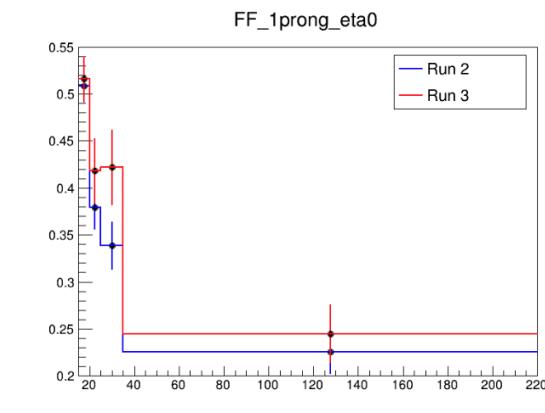


# Cross-Check FF



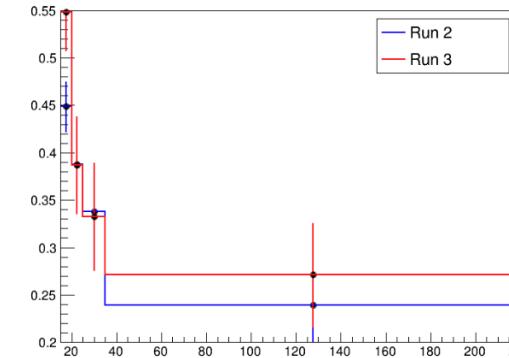
My result

$$0 < |\eta| < 1$$

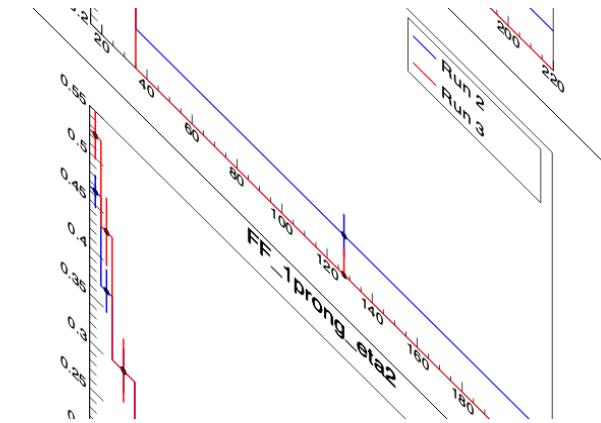


$$1 < |\eta| < 1.37$$

FF\_1prong\_eta1

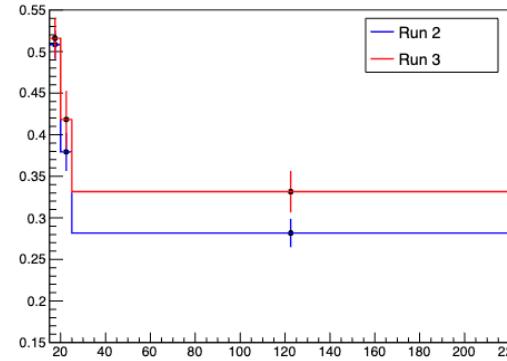


$$1.52 < |\eta| < 2.5$$

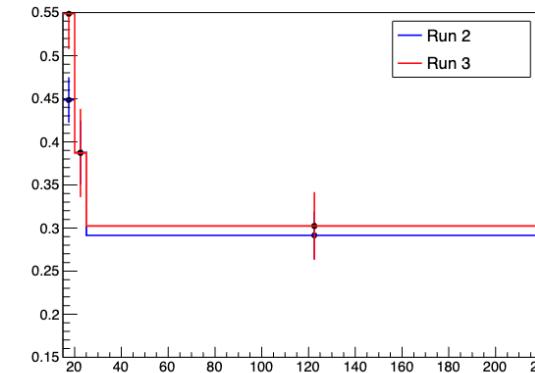


Wenyi's result

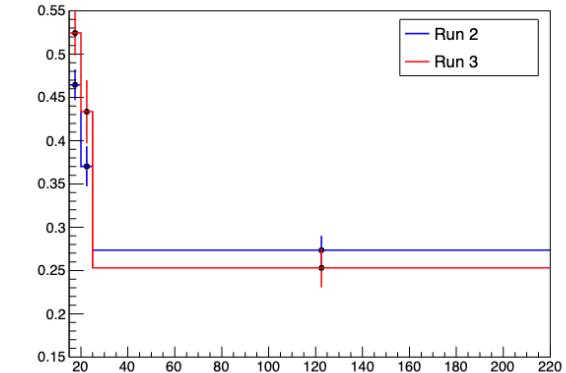
FF\_1prong\_eta0



FF\_1prong\_eta1



FF\_1prong\_eta2



Same value for first two bins and different in last bin for different rebin strategy

I check FF with same rebin method in case, it turns out we are the same

# Fake Factor for Run2 and Run3



Selection:

nBaseTau == 1

nBaseLep >= 1, SigLep >= 1

MET trigger, MET >= 200

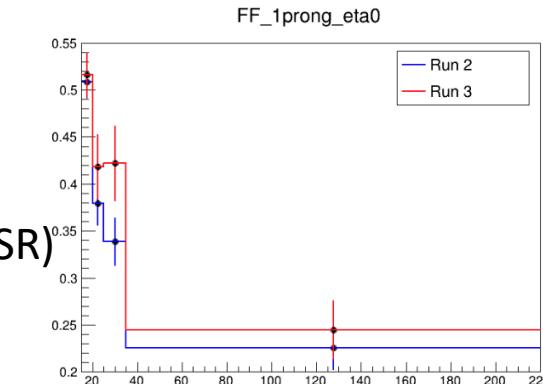
Same-Signal(Orthogonal with SR)

bVeto

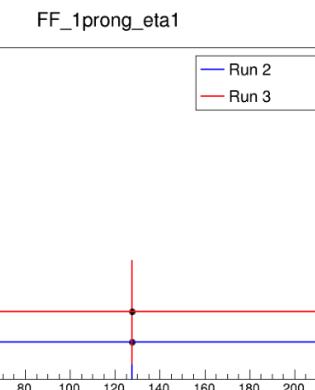
ID: nMediumTau == 1

antiID: nMediumTau < 1

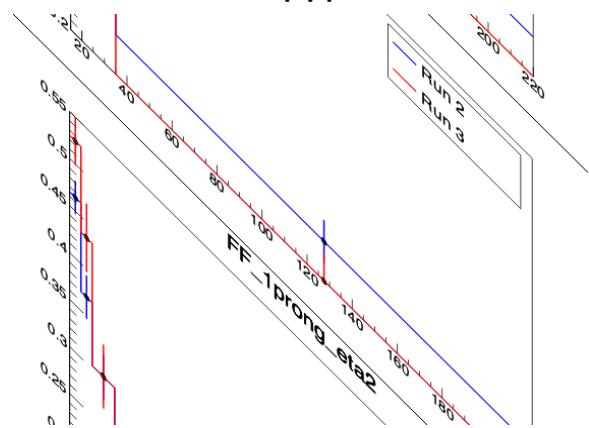
$0 < |\eta| < 1$



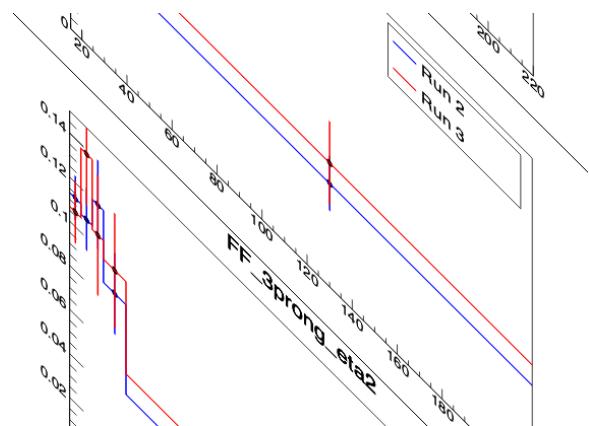
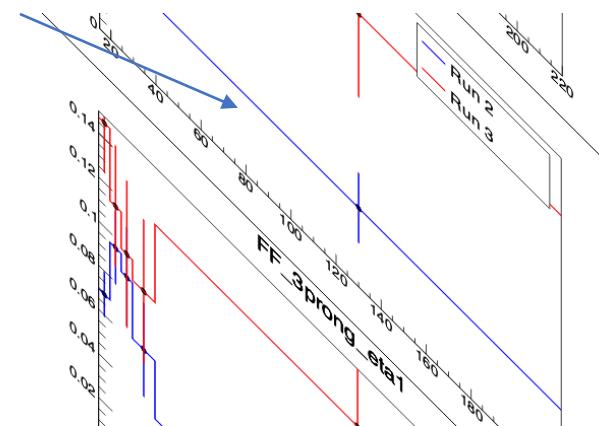
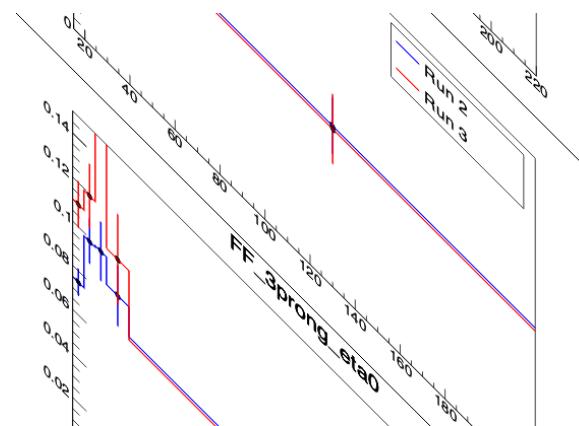
$1 < |\eta| < 1.37$



$1.52 < |\eta| < 2.5$



A small bump show in the last bin

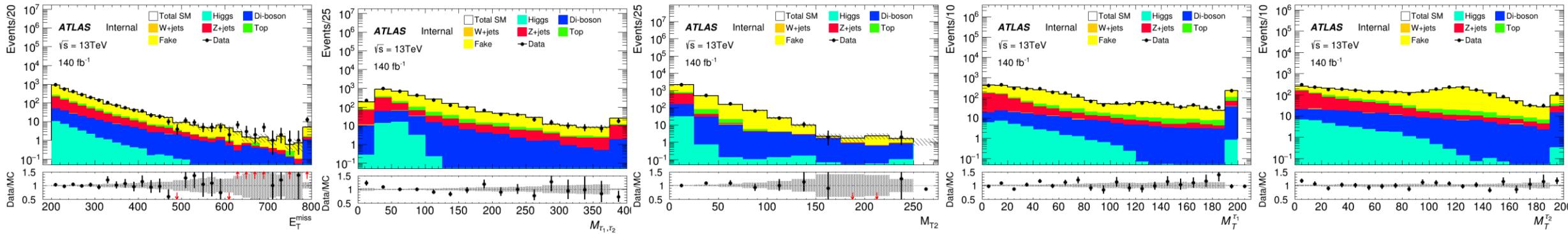


# MC modeling in Pre-Selection(HH)

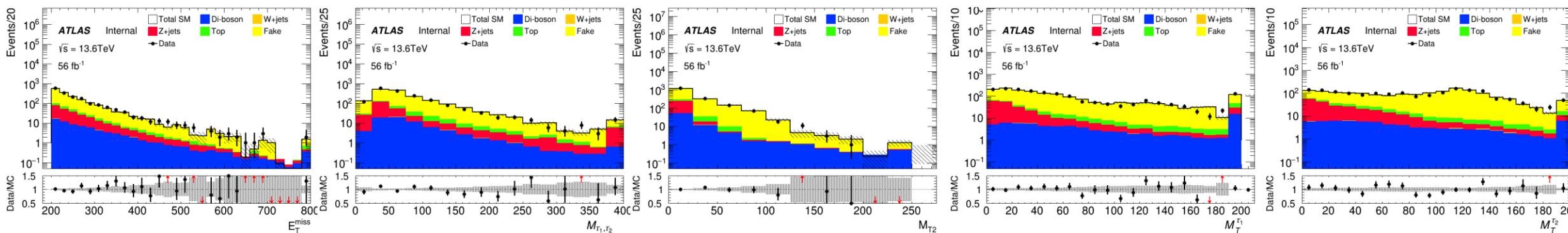


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run2



run3

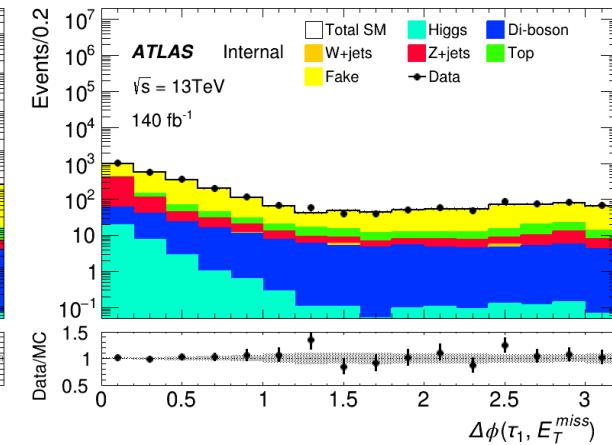
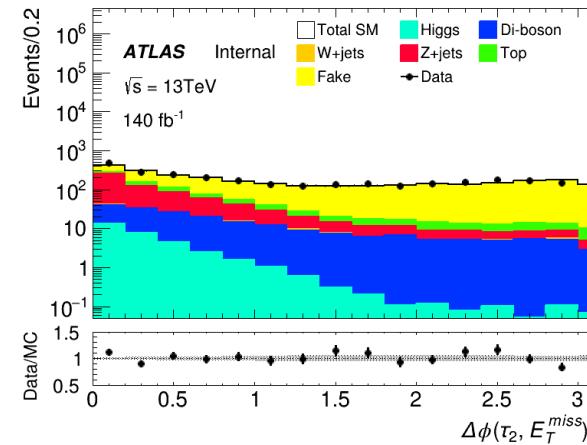
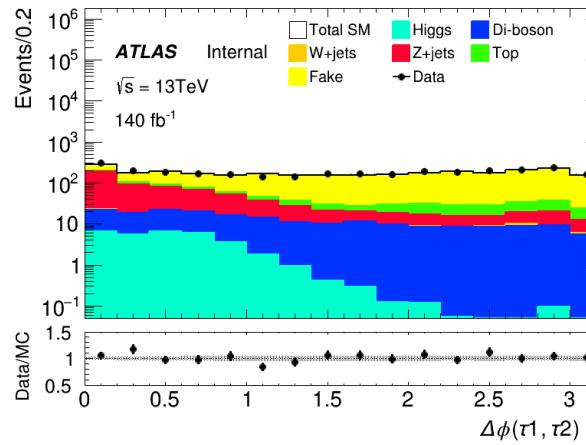
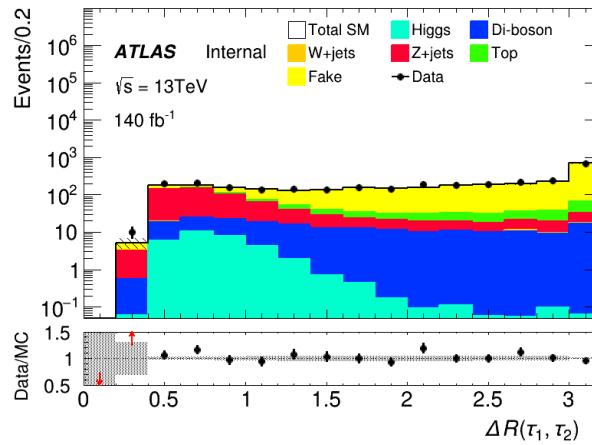


# MC modeling in Pre-Selection(HH)

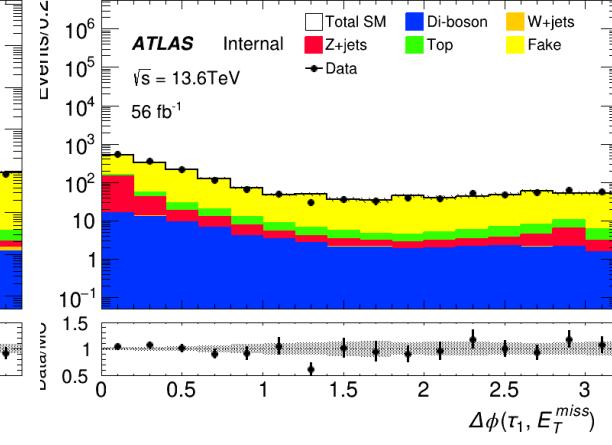
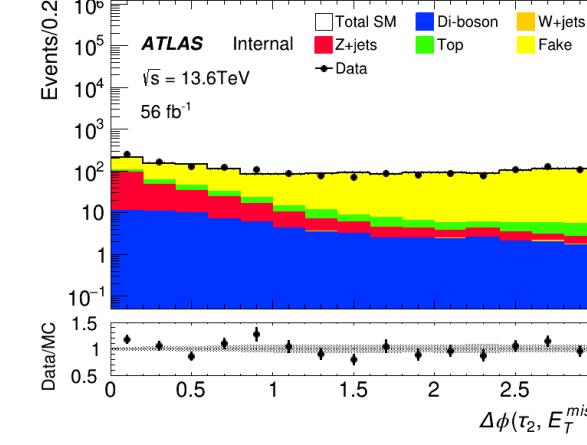
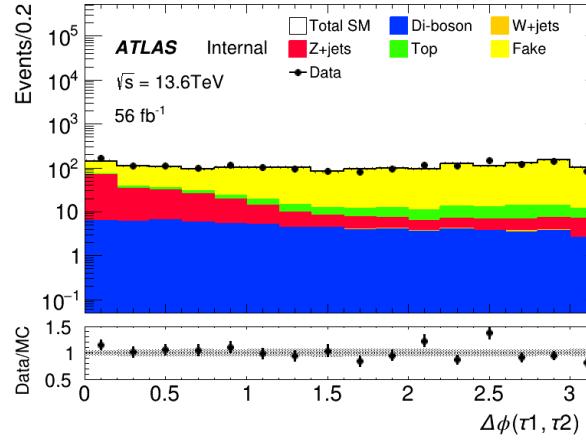
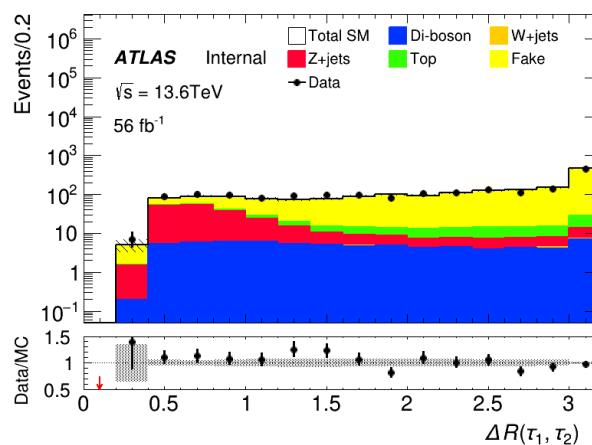


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run2



run3

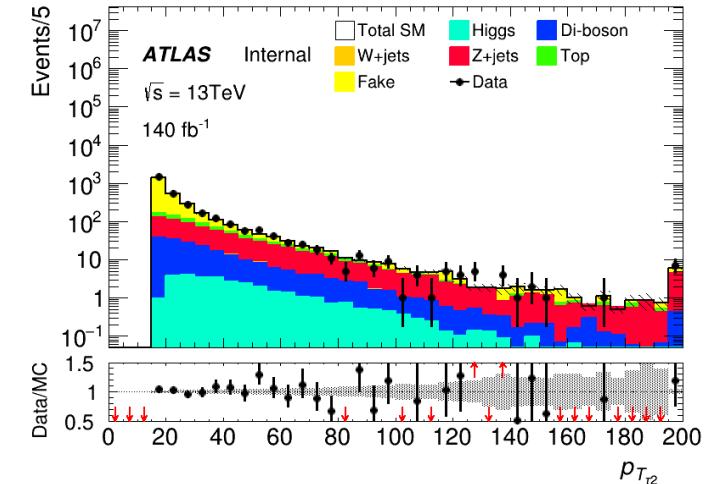
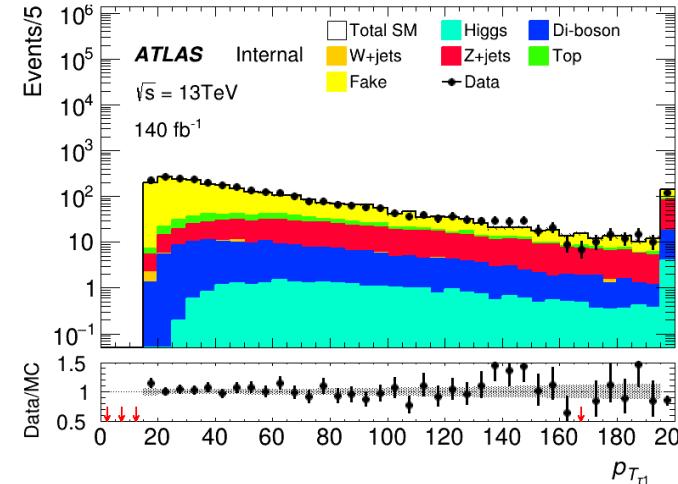
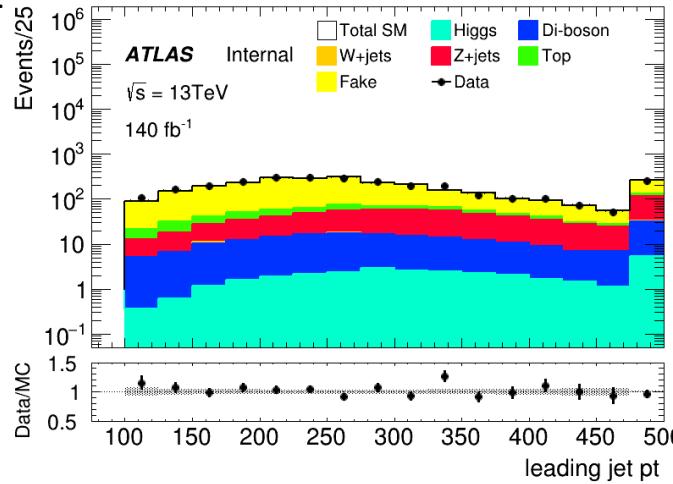


# MC modeling in Pre-Selection(HH)

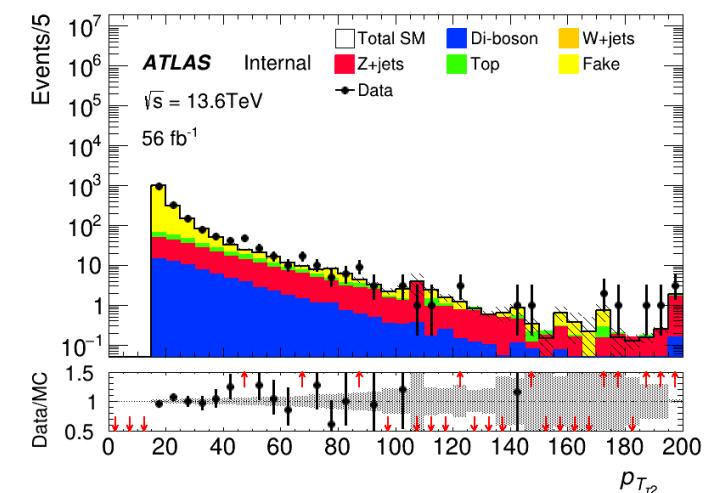
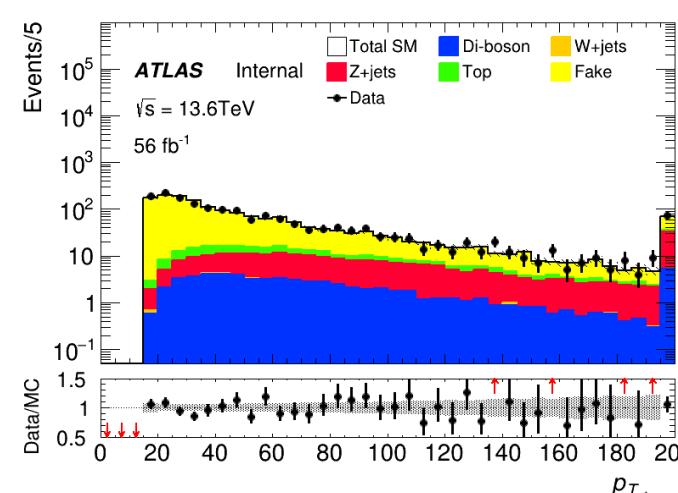
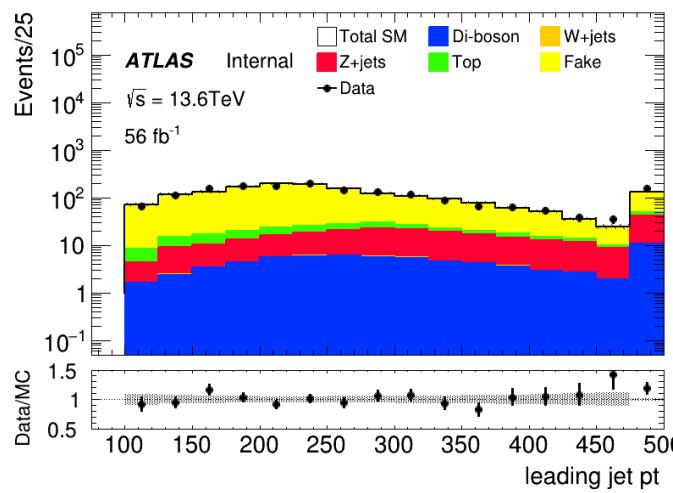


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run2



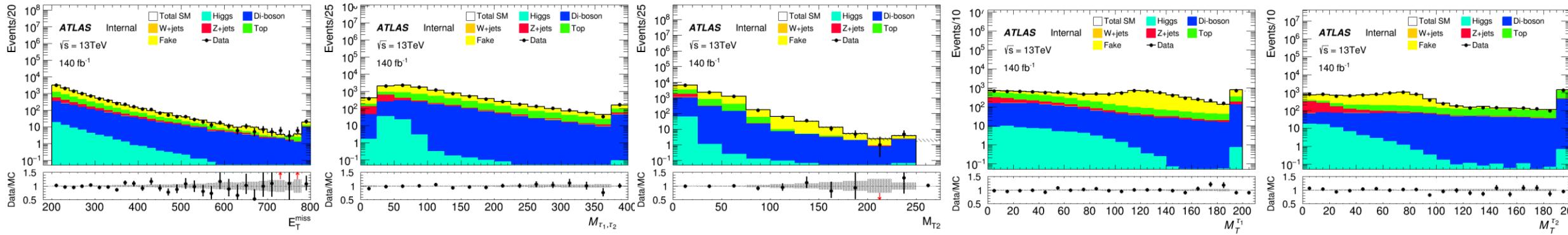
run3



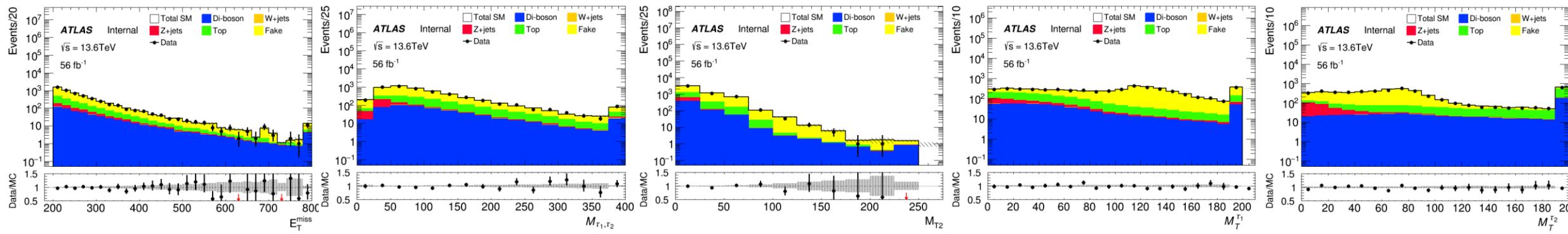
# MC modeling in Pre-Selection(LH)



run2



run3

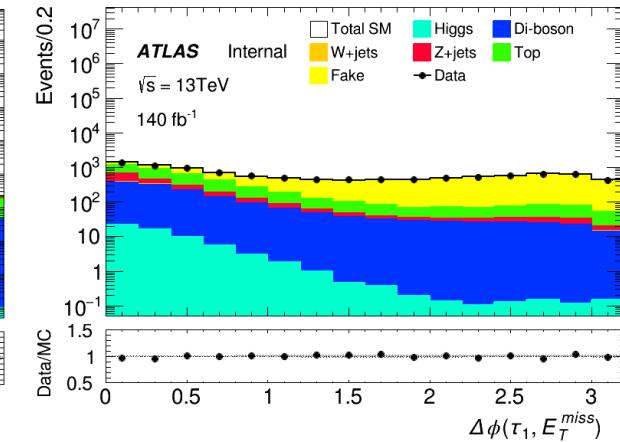
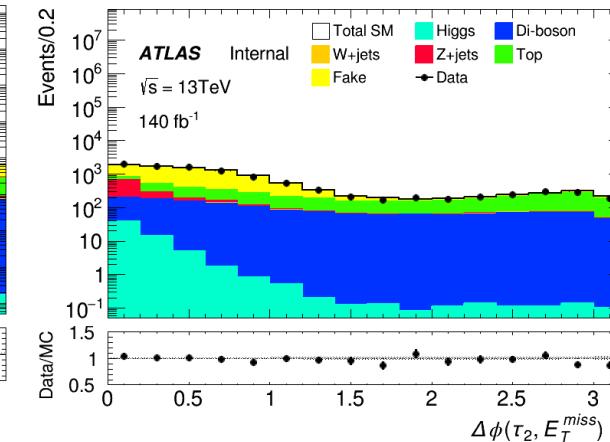
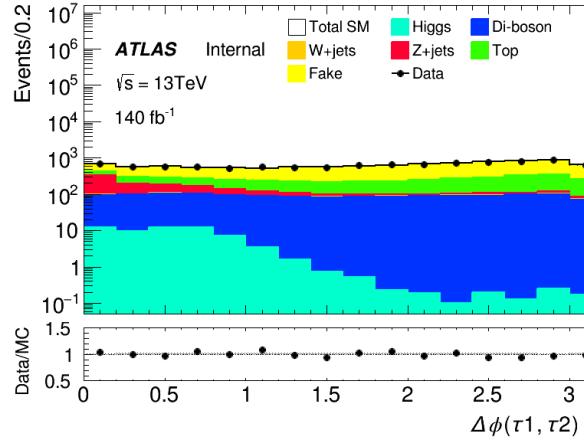
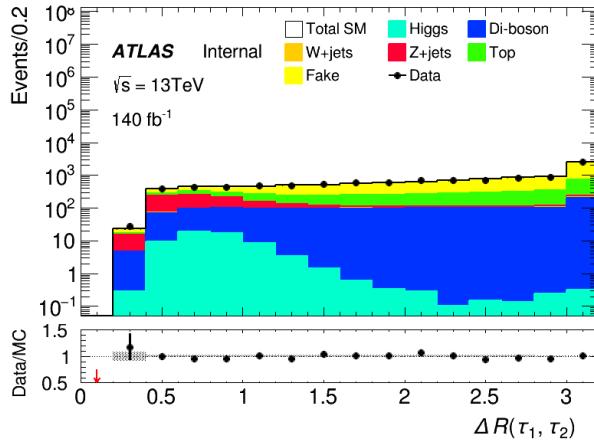


# MC modeling in Pre-Selection(LH)

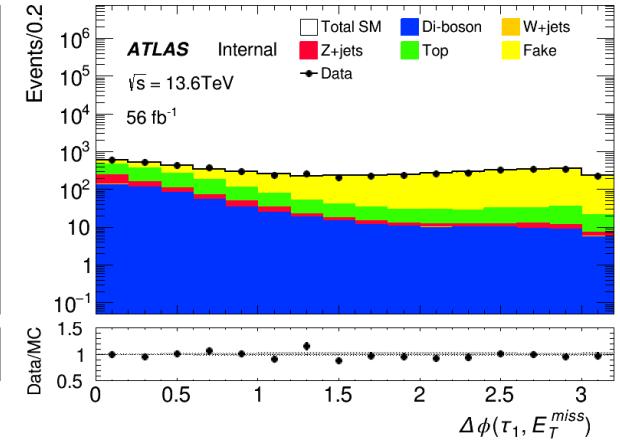
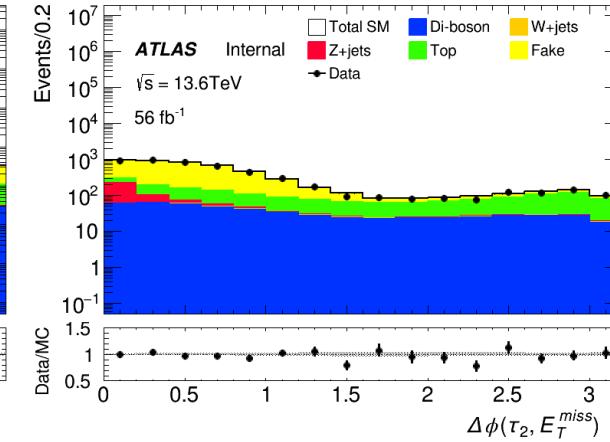
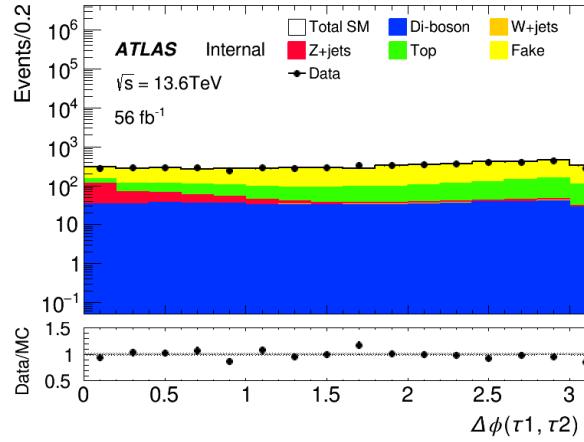
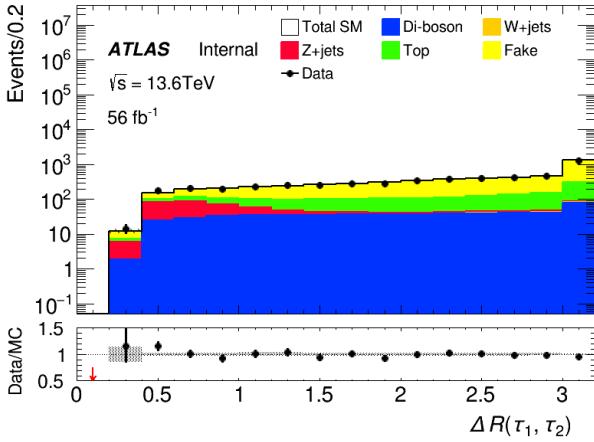


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run2



run3

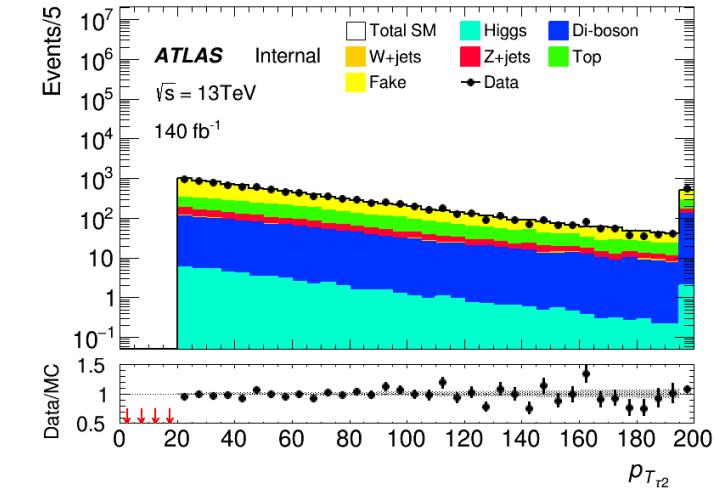
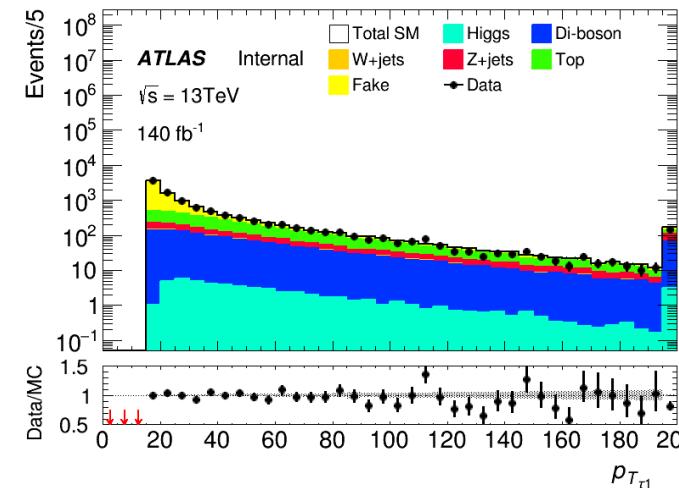
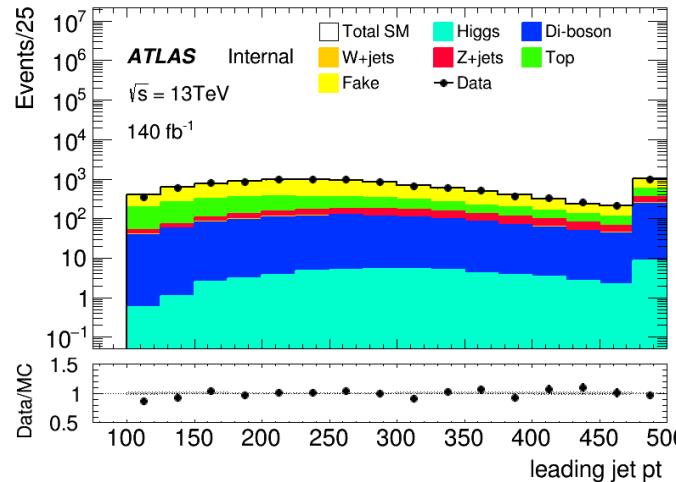


# MC modeling in Pre-Selection(LH)

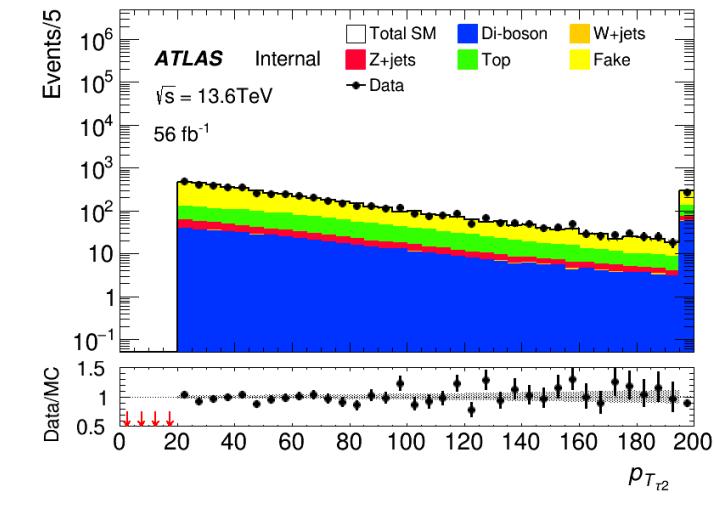
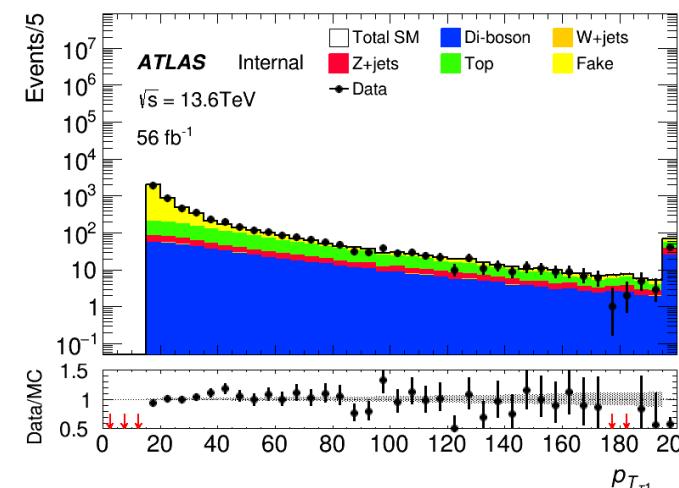
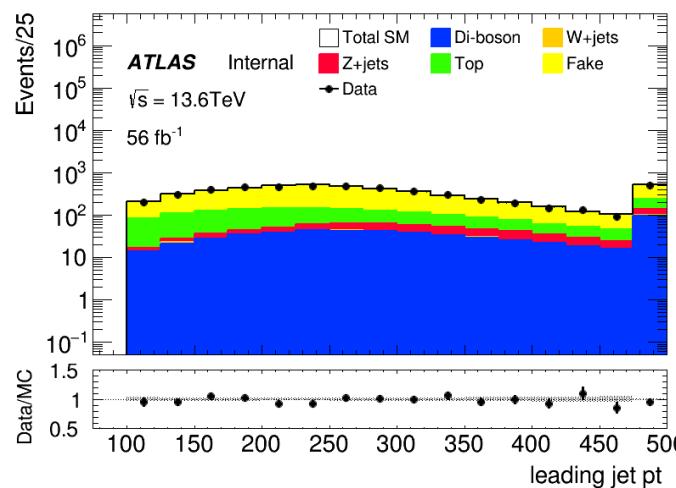


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run2



run3





Input sample:

bkg: run2 bkg sample passed pre-selection(HH/LH)

sig: 100\_70, 120\_90, 140\_90(only run2)

Hyperparameters:

HH: Ntrees = 300, MaxDepth = 6, MinNodeSize = 1%, Learning rate = 0.05

LH: Ntrees = 200, MaxDepth = 6, MinNodeSize = 1%, Learning rate = 0.05

Weight choose: `abs(physics weight)`

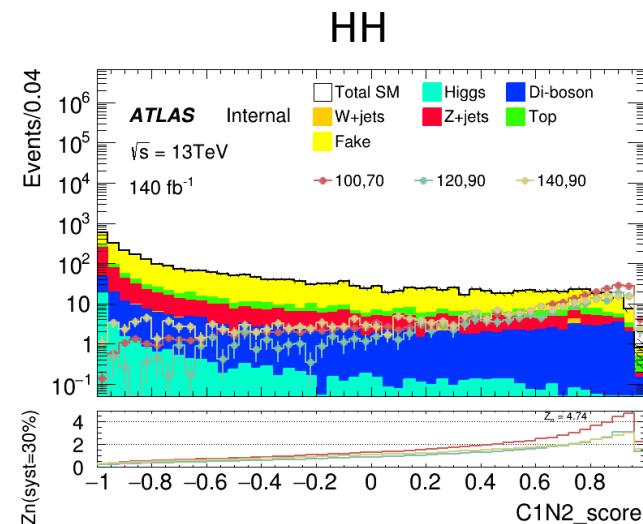
Split strategy: Separate entries by using mod 5, for Fake bkg, if separate follow sequence, all weighted entry will split into first fold

# BDT distribution for LH and HH

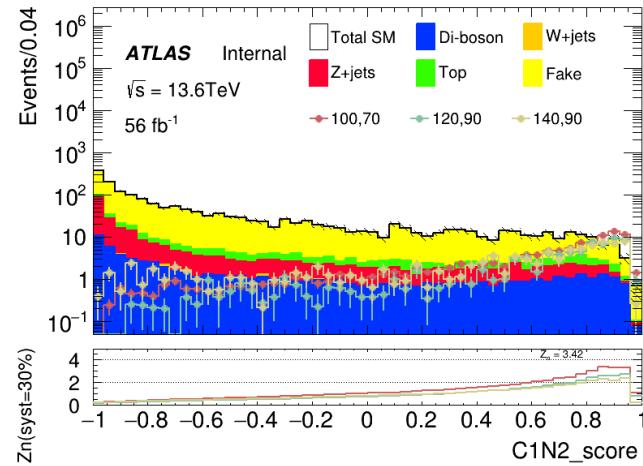


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run2



run3



### LH

