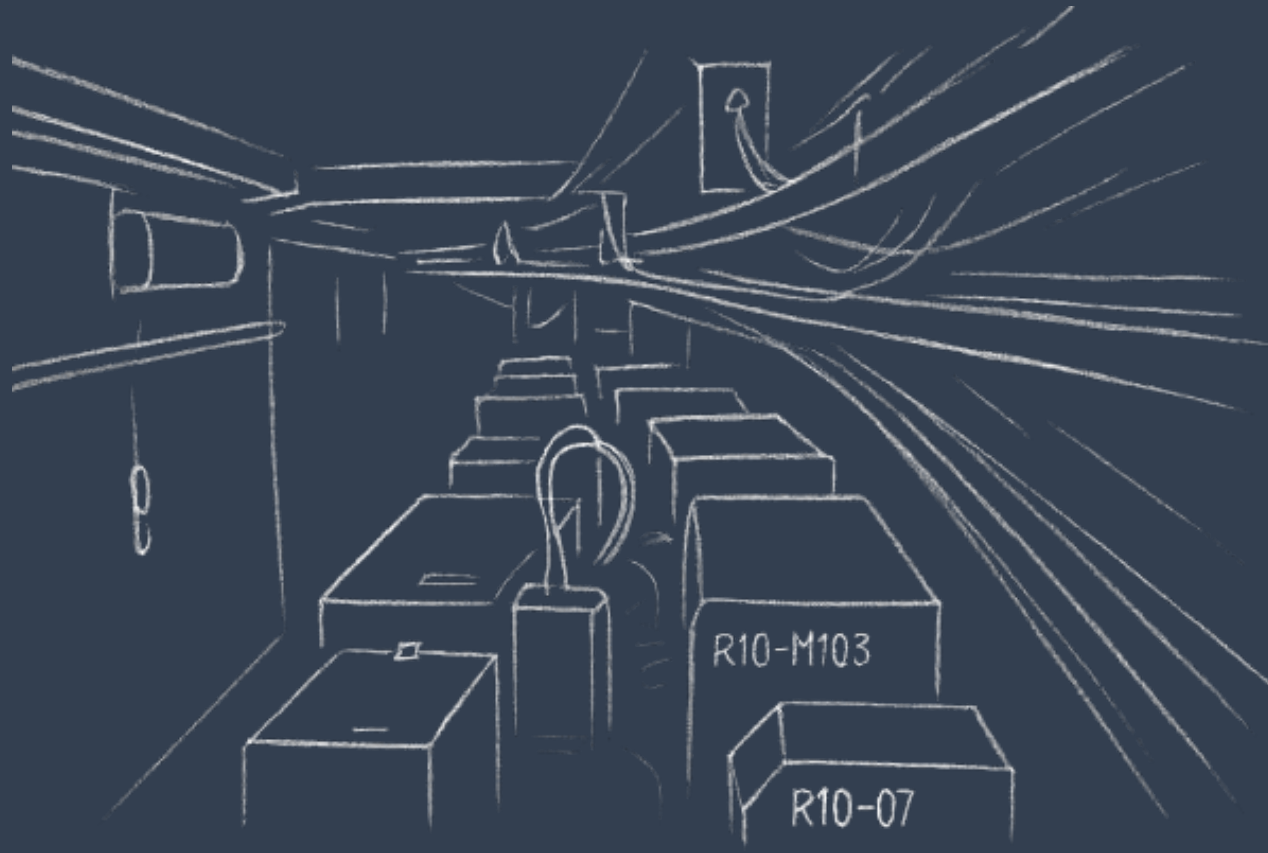
IHEP SUSY Group Meeting

Chengxin Liao

Institute of High Energy Physics
Chinese Academy of Sciences

Aug 21, 2025



C1N2 Status

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

VV CR/VR run2(LH)

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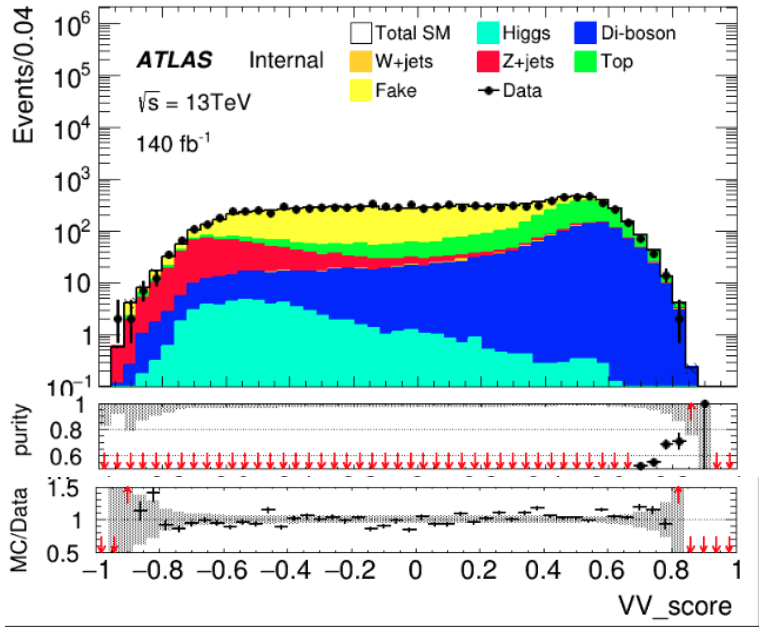
Pre-selection + VV score > 0.65
CR: C1N2 score < ?
VR: ? < C1N2 score < 0.9

VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_m10_m06	86.1018	1.58806	172.943	4.44425	164	0.497862	0.948288
C1N2_score	score_VR_m06_p09	38.6347	1.07737	70.9845	2.8566	67	0.544269	0.943868
C1N2_score	score_CR_m10_p05	89.2625	1.61621	178.077	4.50024	166	0.501258	0.932182
C1N2_score	score_VR_m05_p09	35.474	1.03466	65.851	2.76755	65	0.538701	0.987077
C1N2_score	score_CR_m10_m04	92.9376	1.65138	184.782	4.59459	172	0.502957	0.930826
C1N2_score	score_VR_m04_p09	31.7989	0.977541	59.1456	2.60791	59	0.537637	0.997538
C1N2_score	score_CR_m10_m03	95.0427	1.66788	189.159	4.64534	176	0.502448	0.930433
C1N2_score	score_VR_m03_p09	29.6938	0.949122	54.7686	2.51641	55	0.542168	1.004224
C1N2_score	score_CR_m10_m02	98.9511	1.71216	195.584	4.70688	180	0.505925	0.920319
C1N2_score	score_VR_m02_p09	25.7853	0.866682	48.3434	2.39933	51	0.533379	1.054953
C1N2_score	score_CR_m10_m01	100.895	1.72462	198.852	4.73559	186	0.507388	0.935370
C1N2_score	score_VR_m01_p09	23.8415	0.841626	45.0759	2.34216	45	0.528918	0.998316



VV CR/VR run3(LH)

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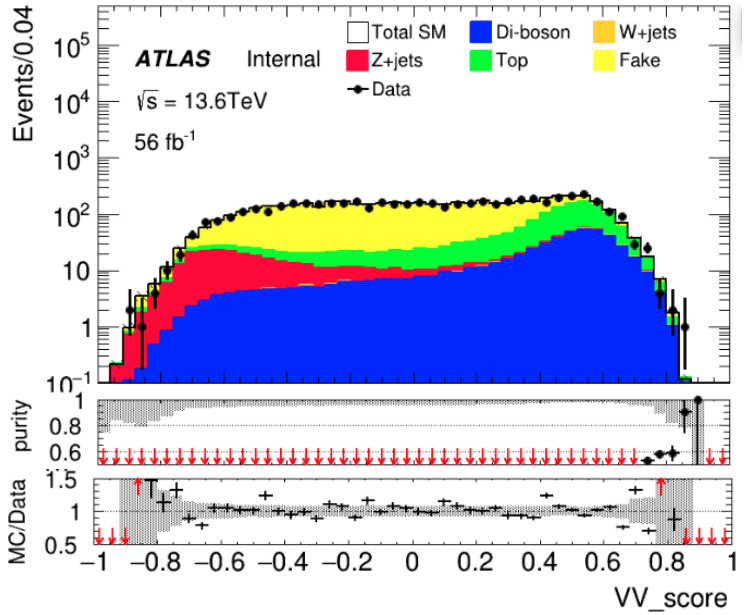
Pre-selection + VV score > 0.65
CR: C1N2 score < ?
VR: ? < C1N2 score < 0.9

VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_m10_m06	34.6856	0.610636	80.2768	2.52503	94	0.432075	1.170948
C1N2_score	score_VR_m06_p09	15.0295	0.385883	30.7263	1.37497	29	0.489142	0.943817
C1N2_score	score_CR_m10_p05	35.8817	0.616621	82.6529	2.55648	96	0.434125	1.161484
C1N2_score	score_VR_m05_p09	13.8334	0.376245	28.3503	1.31556	27	0.487948	0.952372
C1N2_score	score_CR_m10_m04	37.3044	0.629293	85.8823	2.60501	98	0.434366	1.141096
C1N2_score	score_VR_m04_p09	12.4108	0.354644	25.1208	1.21665	25	0.494045	0.995192
C1N2_score	score_CR_m10_m03	38.2738	0.634339	87.9404	2.62792	99	0.435224	1.125762
C1N2_score	score_VR_m03_p09	11.4413	0.345538	23.0627	1.16635	24	0.496098	1.040643
C1N2_score	score_CR_m10_m02	39.549	0.653242	91.0263	2.67124	106	0.434479	1.164499
C1N2_score	score_VR_m02_p09	10.1662	0.308313	19.9769	1.06337	17	0.508899	0.850985
C1N2_score	score_CR_m10_m01	40.2523	0.656717	92.3823	2.67684	108	0.435714	1.169056
C1N2_score	score_VR_m01_p09	9.4629	0.30084	18.6208	1.04922	15	0.508189	0.805549



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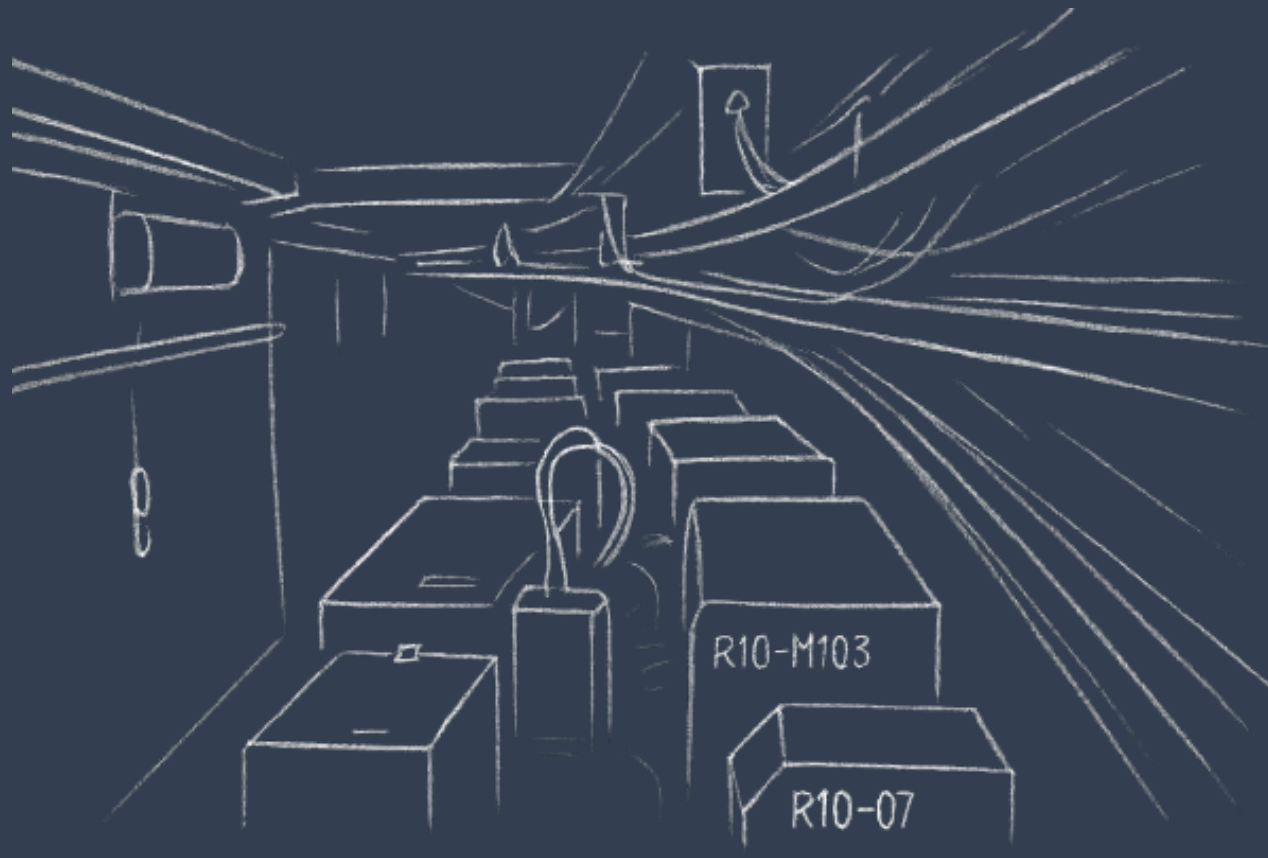
ATLAS EXPERIMENT

Backup



SR bkg info

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_llvvjj_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_llvvjj_os	VV	0.011815538337966176
601352	10.284217561641821	PhPy8EG_tW_dyn_DR_incl_antitop	MainTop	0.011693718225441463

SR bkg info

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_llvvjj_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_llvvjj_os	VV	0.011582197946751391

SR bkg info

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

SR bkg info

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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_llvvjj_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_llvvjj_os	VV	0.019224076423210147

Pre-Selection

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HH Pre-selection	LH Pre-selection
>= 2 medium taus	>= 1 medium taus
0 base lepton	1 base lepton, 1 signal lepton
MET ≥ 200; pass MET trigger	MET ≥ 200; pass MET trigger
1≤nJet	1≤nJet
Opposite-sign hadronic-hadronic tau pair	Opposite-sign lepton-hadronic tau pair
bveto	bveto
jet pt>100 GeV	jet pt>100 GeV
Mtt_reco <= 40 GeV || Mtt_reco >= 130GeV	Mtt_reco <= 40 GeV || Mtt_reco >= 130GeV

HH channel: Z bkg estimation(run2)

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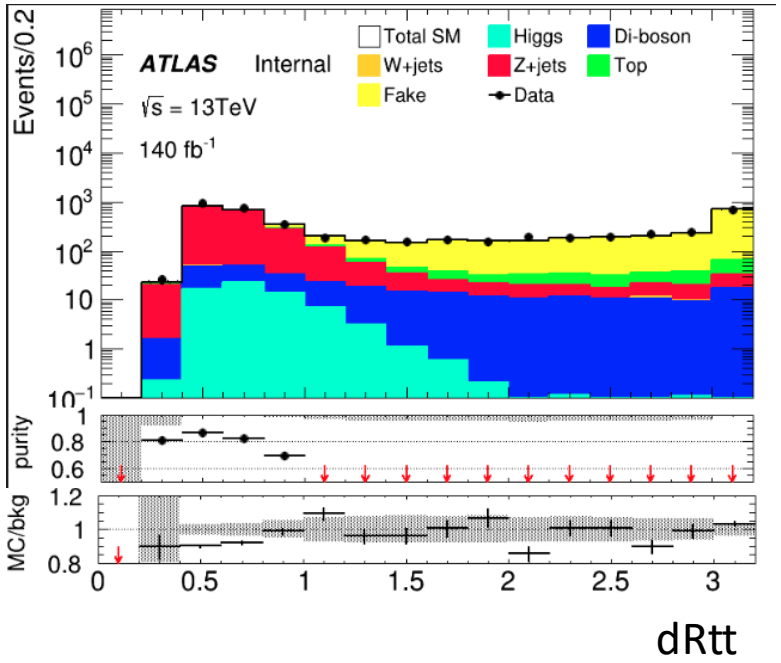
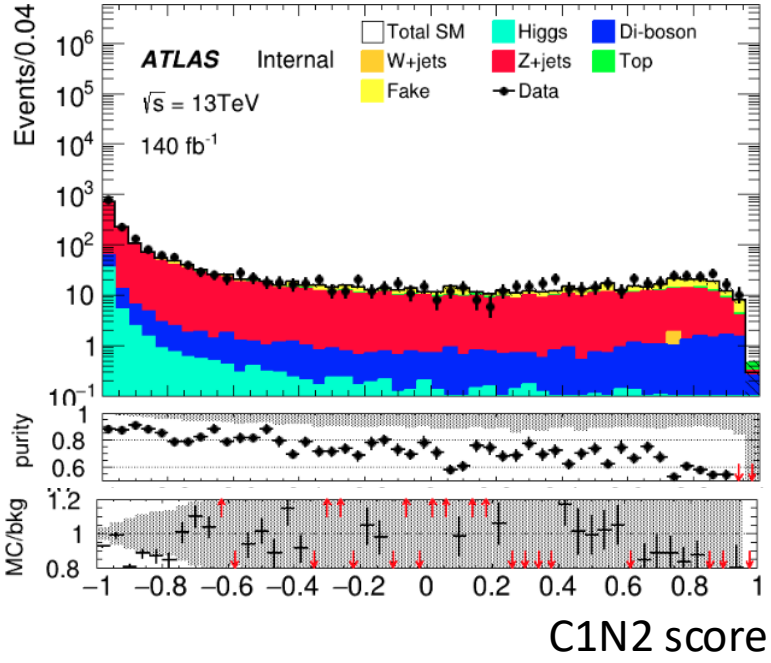
HH pre-selection(drop Mtt reco cut)
dRtt <= 1.0
CR: C1N2 score < -0.3
VR: -0.3 < C1N2 score < 0.9





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)

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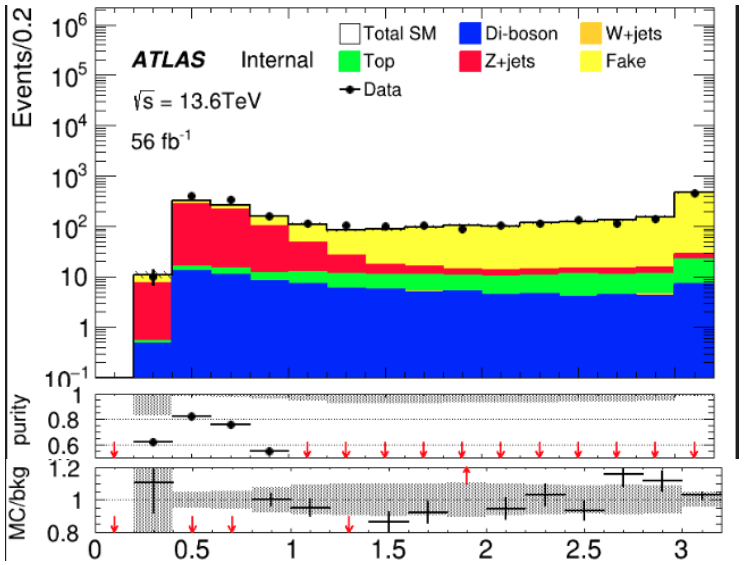
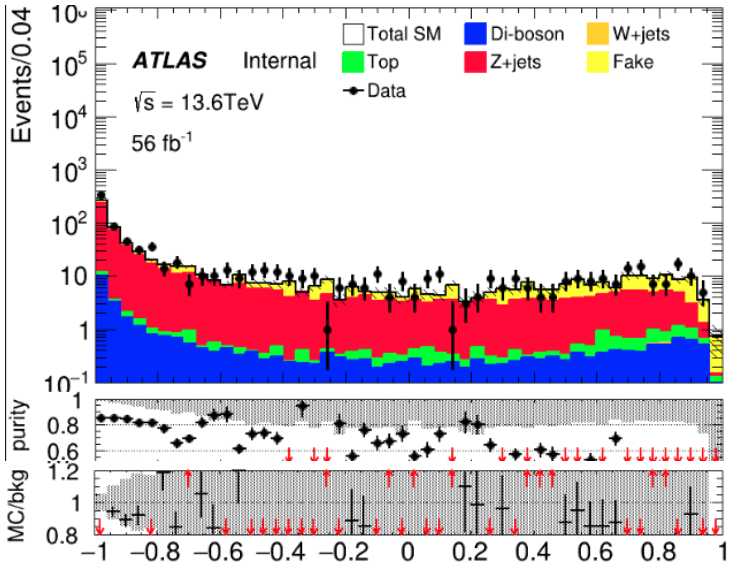
HH pre-selection(drop Mtt reco cut)
dRtt <= 1.0
CR: C1N2 score < -0.3
VR: -0.3 < C1N2 score < 0.9



dRtt



C1N2 score

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)

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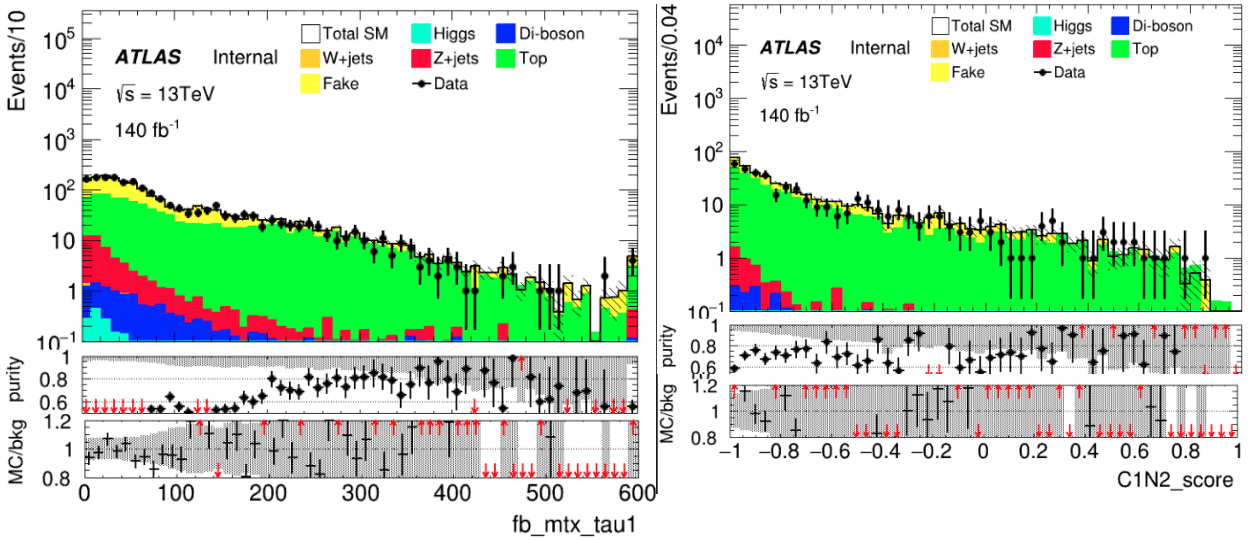
HH pre-selection(remove bVeto and add bJets > 0)

$M_T(tau1, MET) > 150$

Orthogonal with SR



CR: C1N2 score < -0.8

VR: -0.8 < C1N2 score < 1.0

Wrong label, should be 00_02

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)

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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

-0.8

-0.7

-0.6

-0.5

HH channel: Top bkg estimation(run3)

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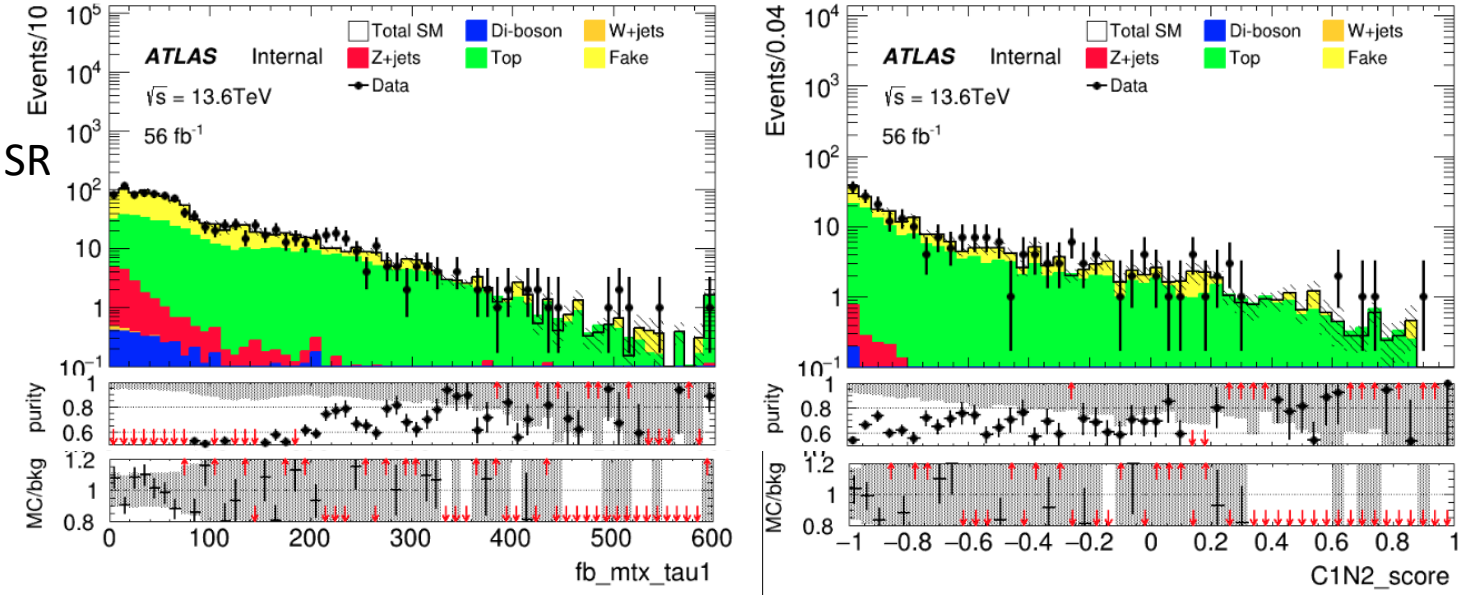
HH pre-selection(remove bVeto and add bJets > 0)

$M_T(tau1, MET) > 150$

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	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)

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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)

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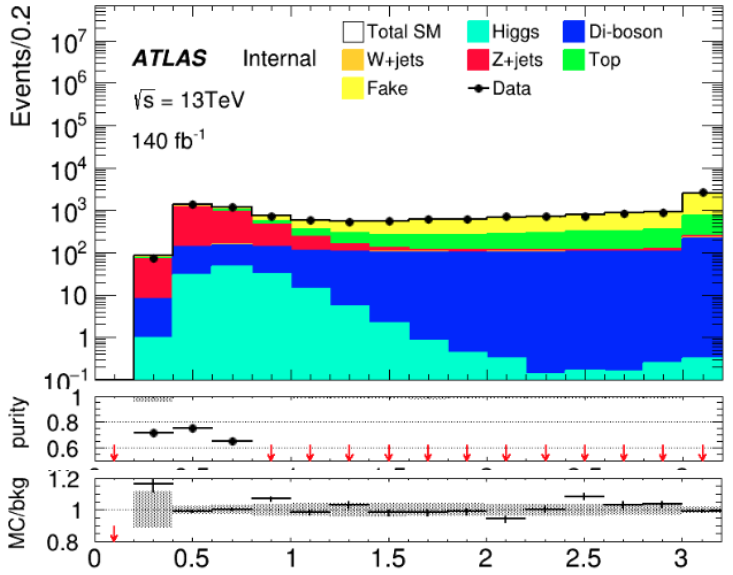
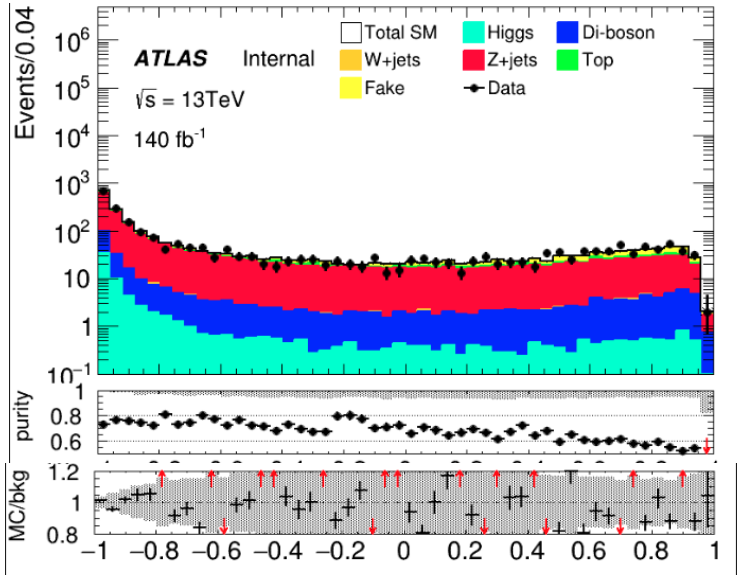
HH pre-selection(drop Mtt reco cut)
dRtt <= 0.8

CR: C1N2 score < -0.8
VR: -0.8 < C1N2 score < 0.9



dRtt



C1N2 score

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)

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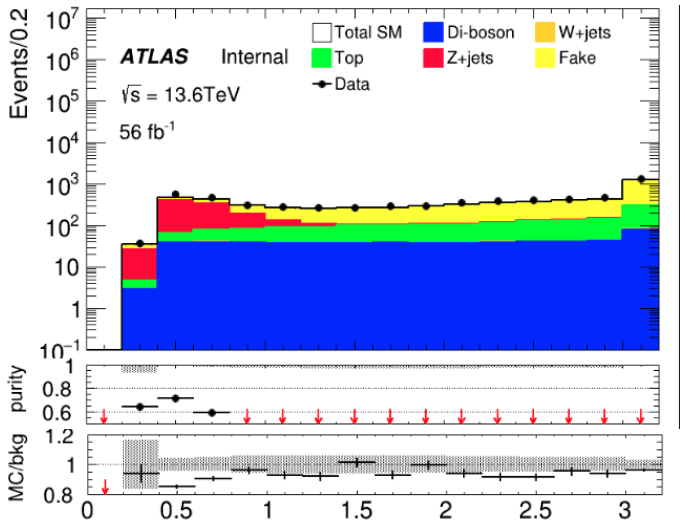
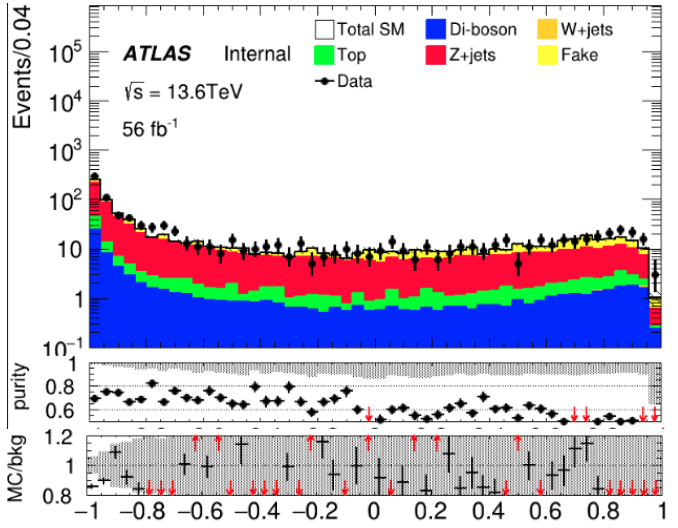
HH pre-selection(drop Mtt reco cut)
dRtt <= 0.8

CR: C1N2 score < -0.8
VR: -0.8 < C1N2 score < 0.9



dRtt



C1N2 score

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)

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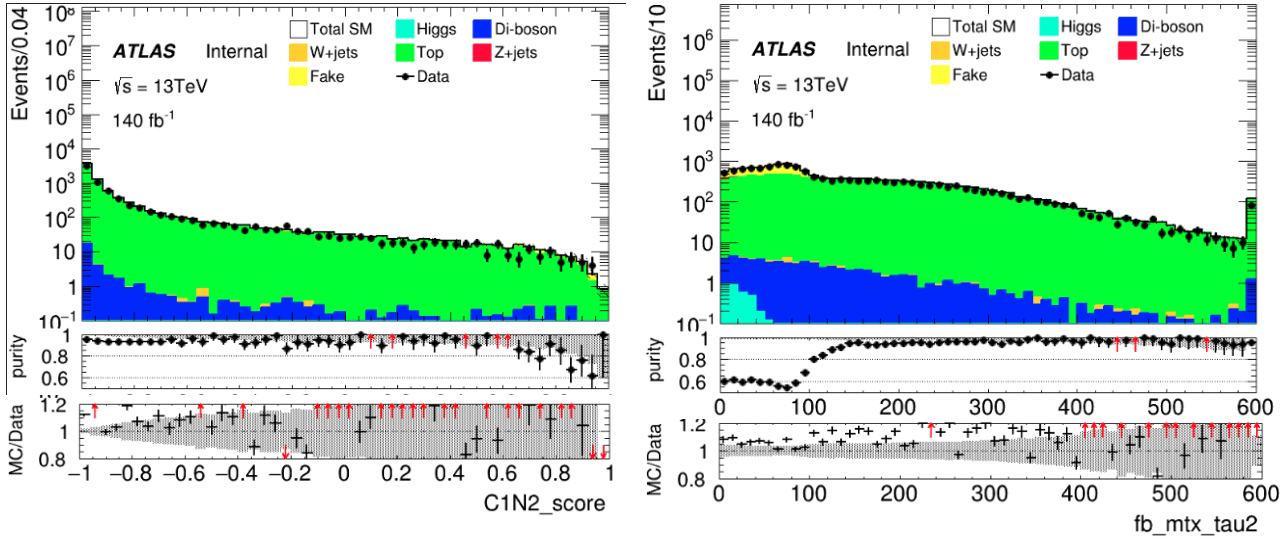
HH pre-selection(remove bVeto and add bJets > 0)

$M_T(tau2, MET) > 110$

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)

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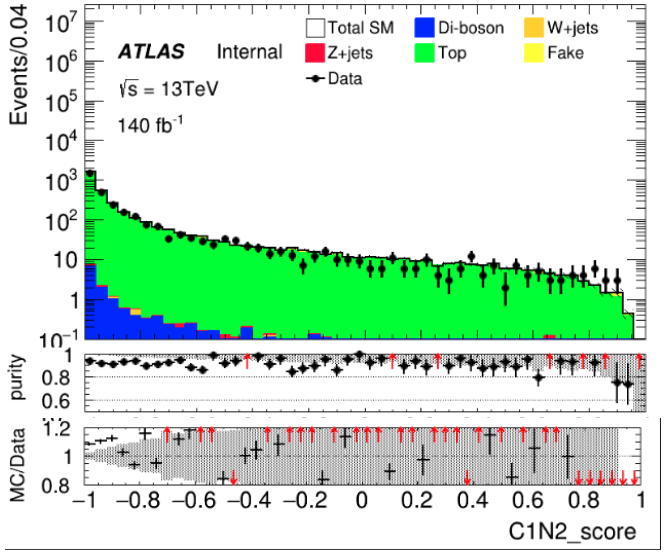
HH pre-selection(remove bVeto and add bJets > 0)

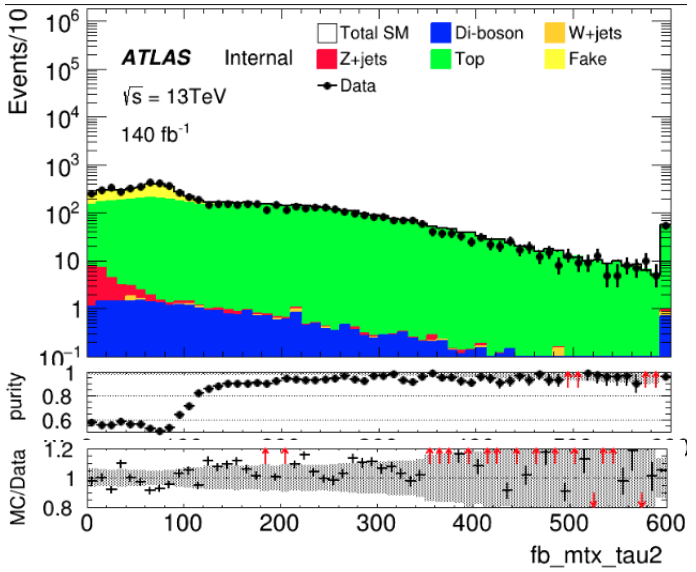
$M_T(tau2, MET) > 110$

Orthogonal with SR

CR: C1N2 score < -0.8

VR: -0.8 < C1N2 score < 1.0

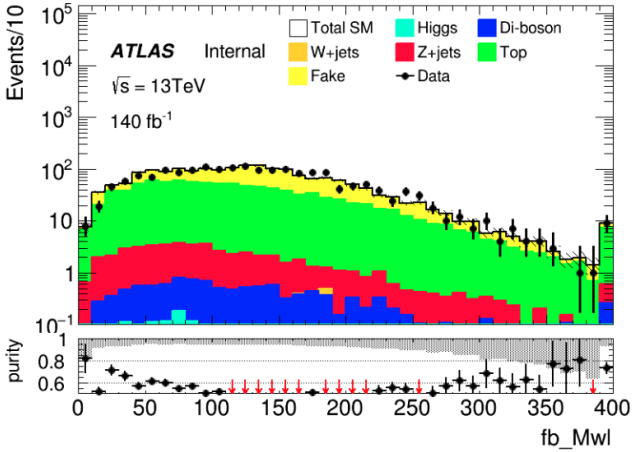




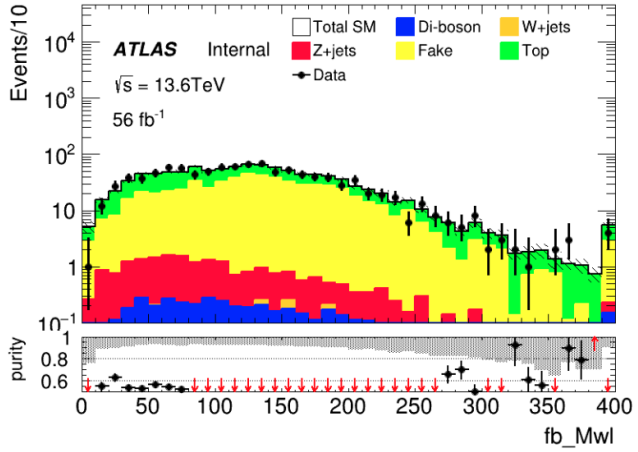
VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_08	2482.03	10.2931	2683.31	15.1554	2460	0.924986	0.916777
C1N2_score	score_VR_08_20	866.683	6.19781	941.263	9.10633	864	0.920767	0.917916

Distribution Check

HH TCR run2

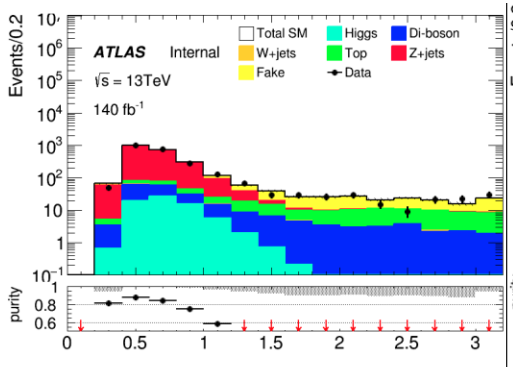


HH TCR run3

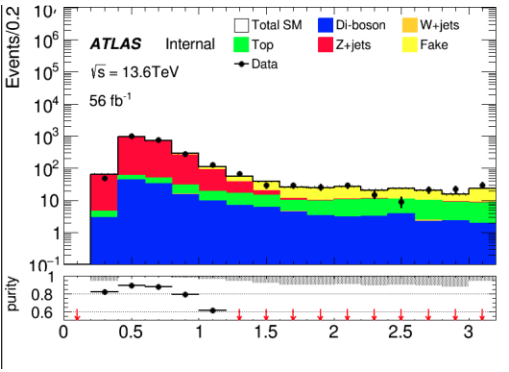


LH Channel
Change Mtt_reco to [10,130]

run2



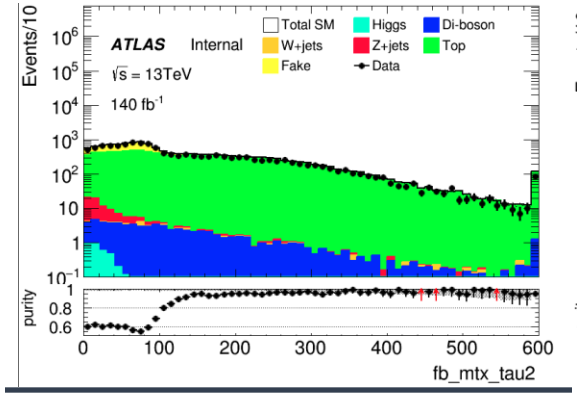
run3



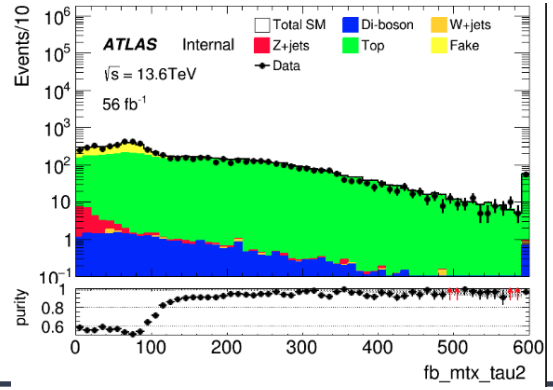
LH channel

$M_{inv}(tau2, MET)$

run2



run3



Cross-Check FF

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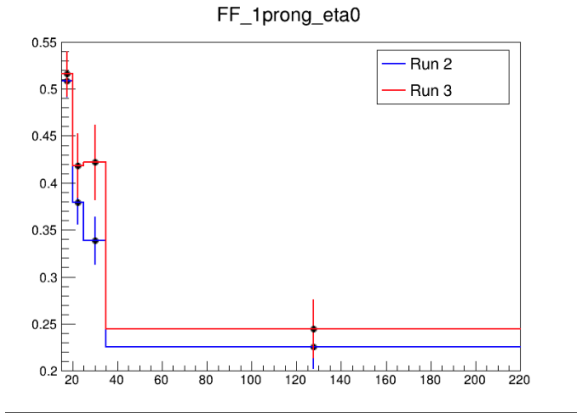
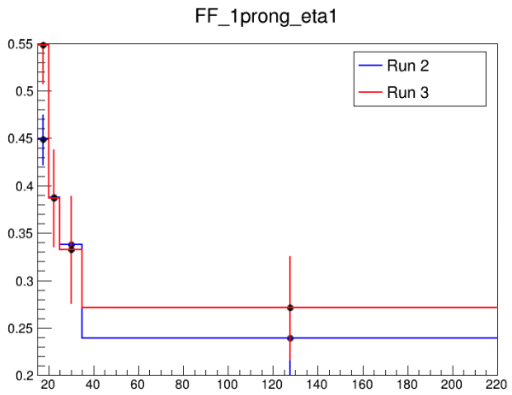
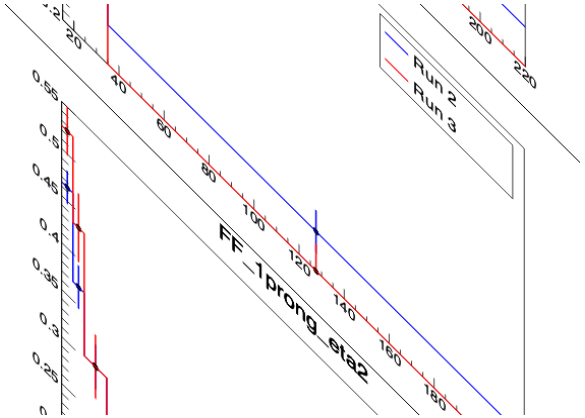
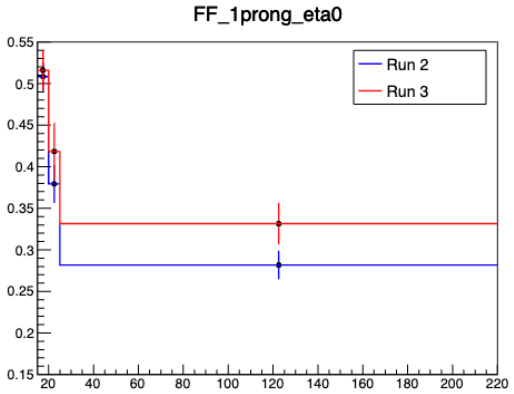
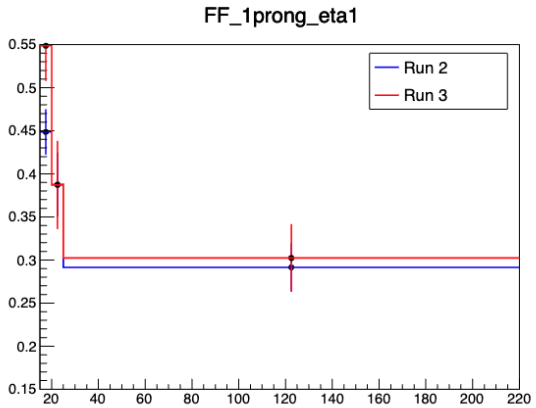
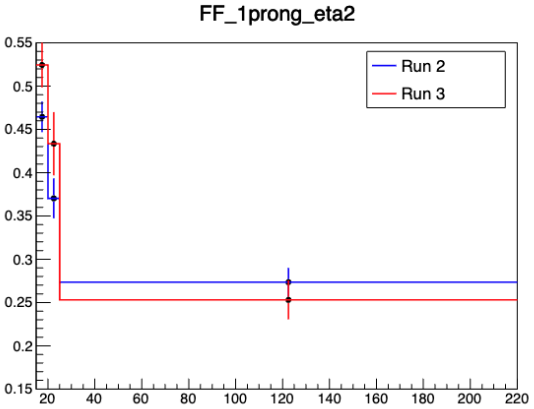
	$0 < \|\eta\| < 1$	$1 < \|\eta\| < 1.37$	$1.52 < \|\eta\| < 2.5$
My result			
Wenyi's result			

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

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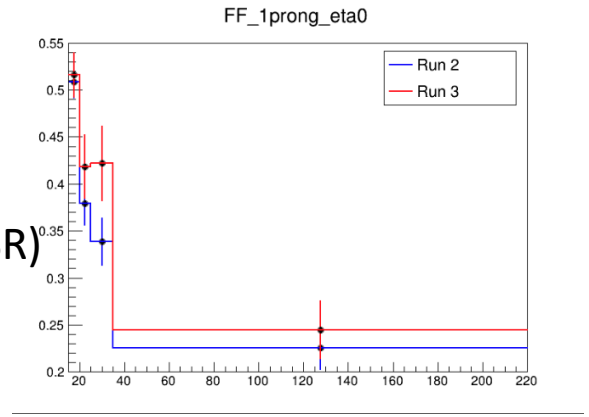
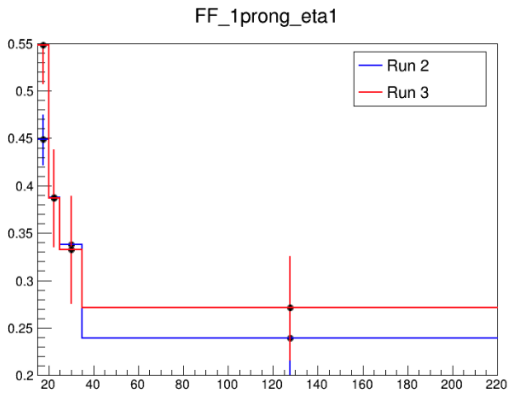
Selection:

nBaseTau == 1
nBaseLep >= 1, SigLep >= 1
MET trigger, MET >= 200
Same-Signal(Orthogonal with SR)
bVeto
ID: nMediumTau == 1
antiID: nMediumTau < 1

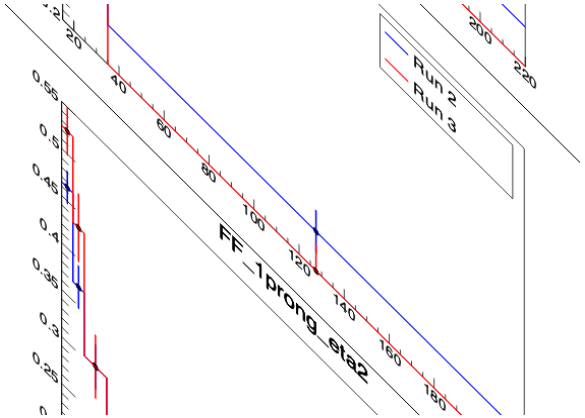
$0 < |\eta| < 1$



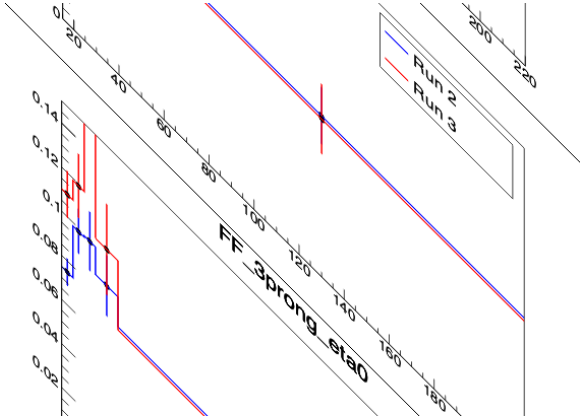
$1 < |\eta| < 1.37$

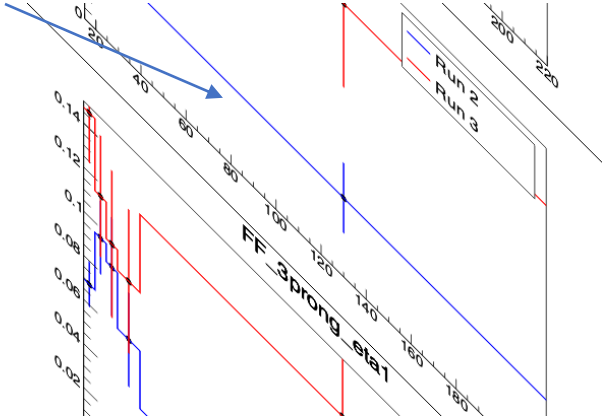


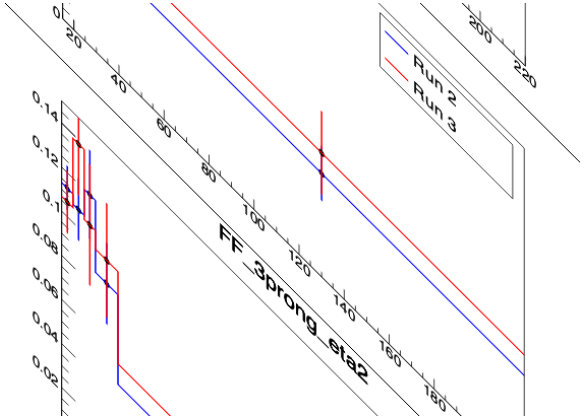
$1.52 < |\eta| < 2.5$



A small bump show in the last bin







MC modeling in Pre-Selection(HH)

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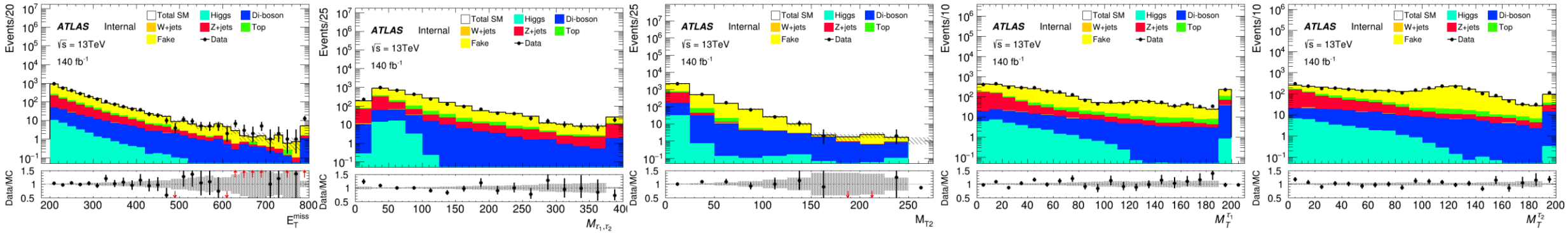
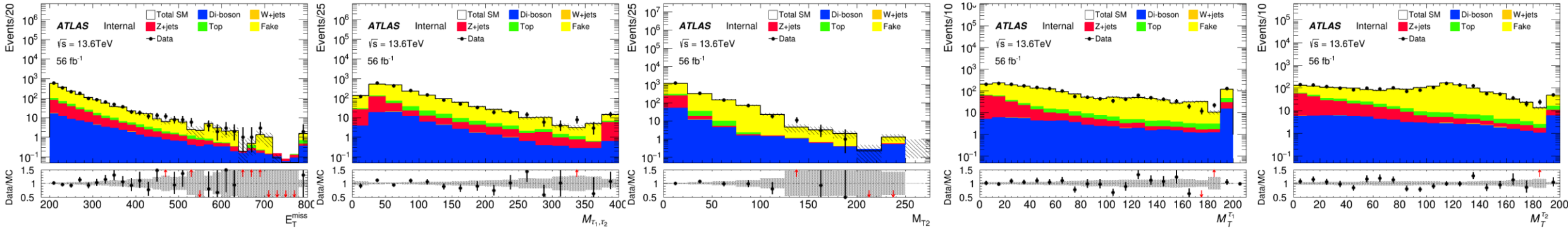
run2



run3



MC modeling in Pre-Selection(HH)

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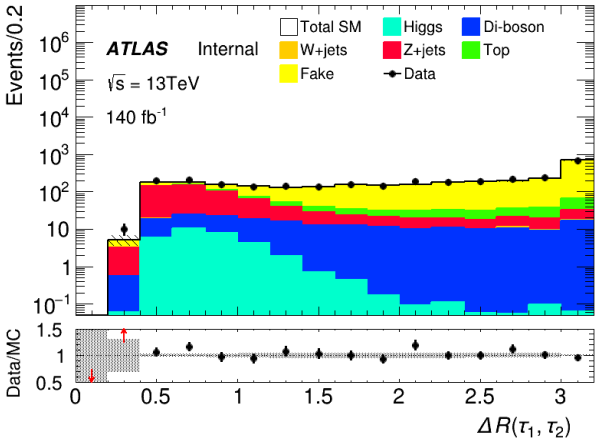
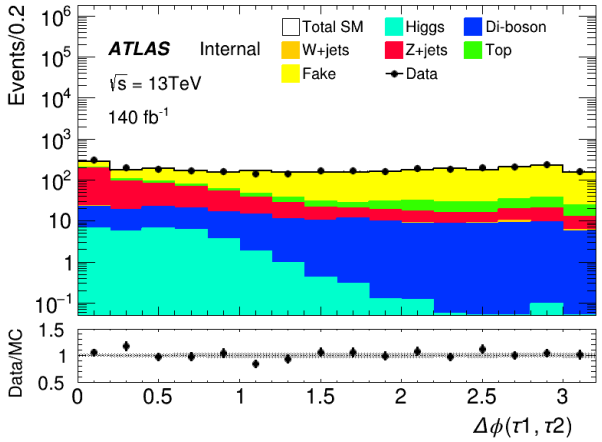
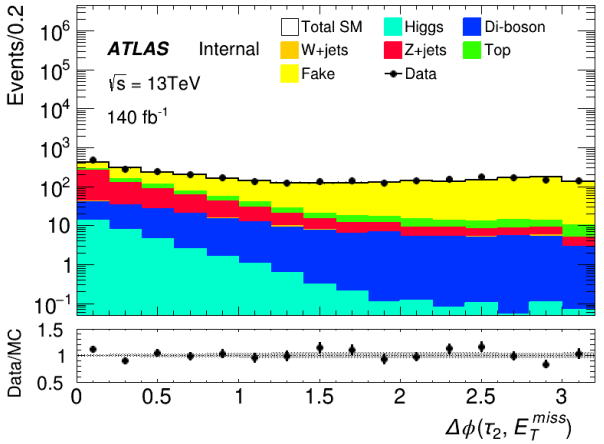
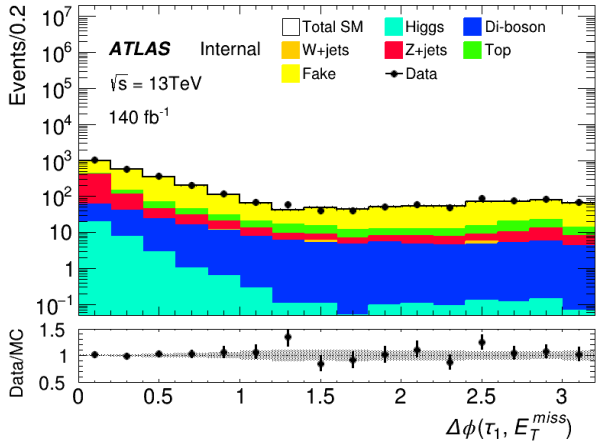
run2

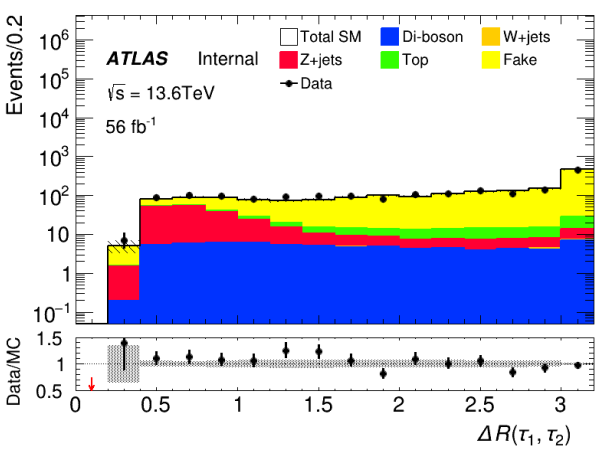


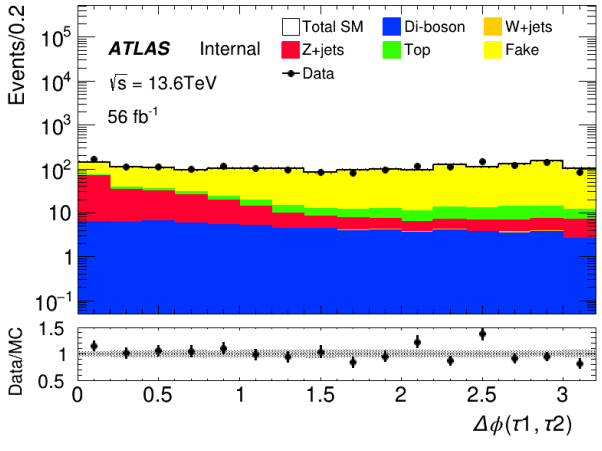


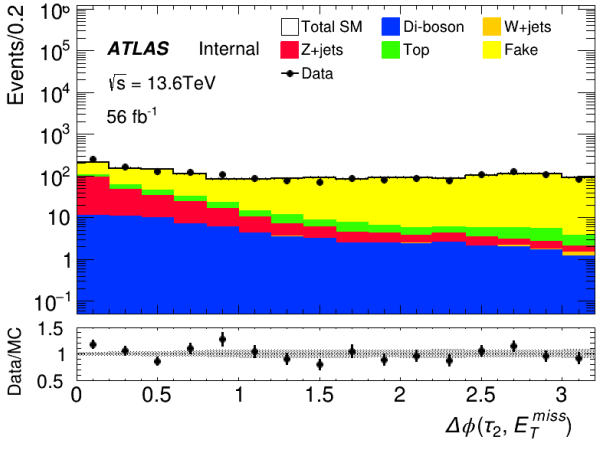


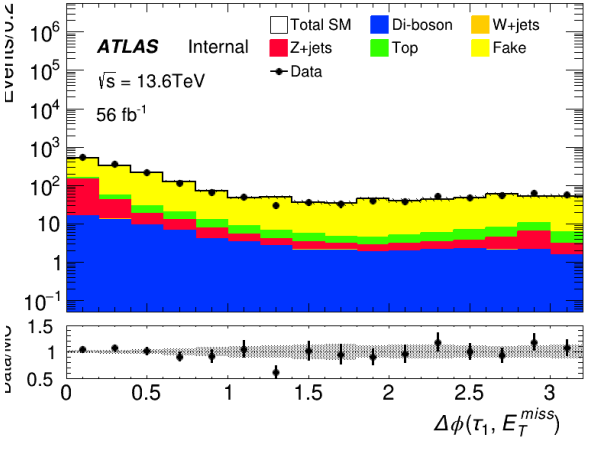


run3









MC modeling in Pre-Selection(HH)

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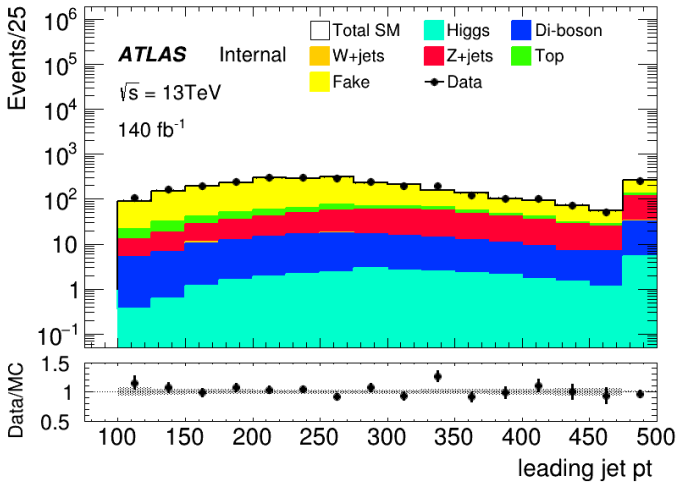
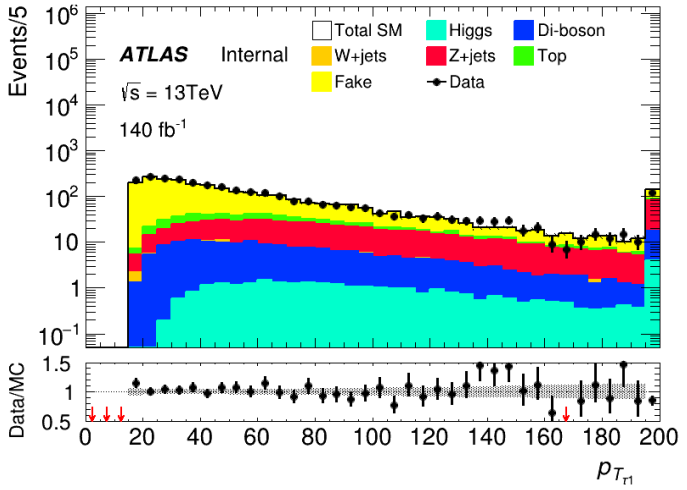
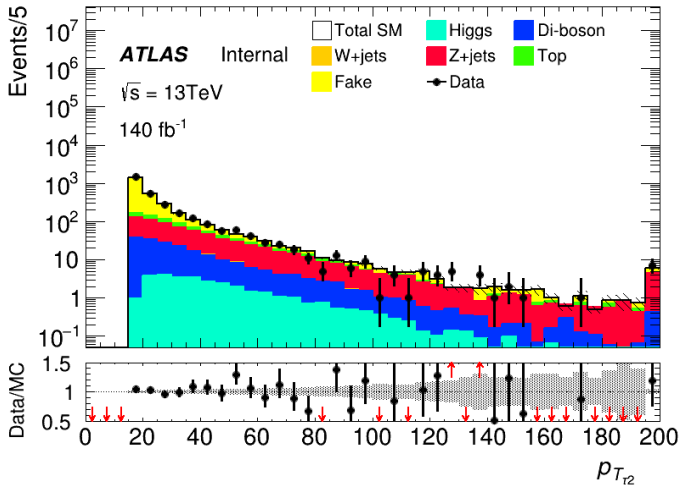
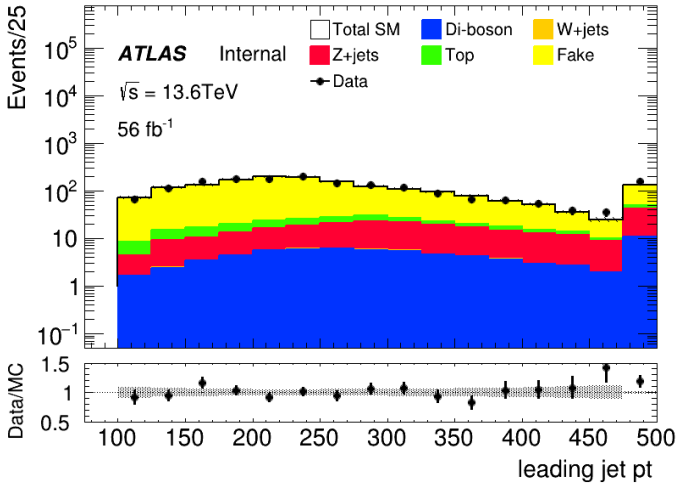
run2

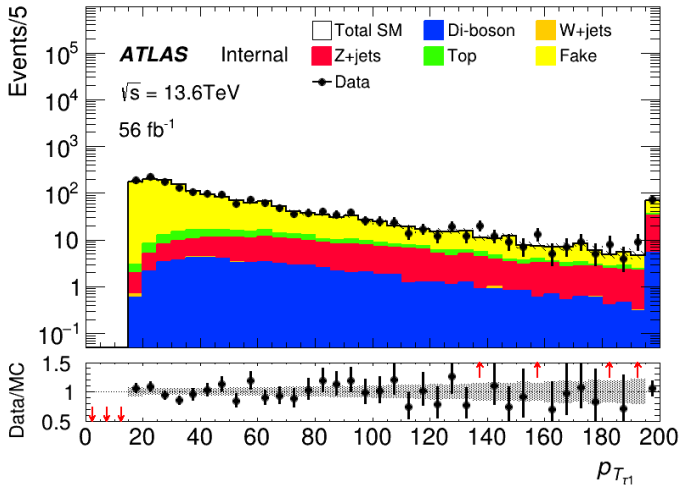


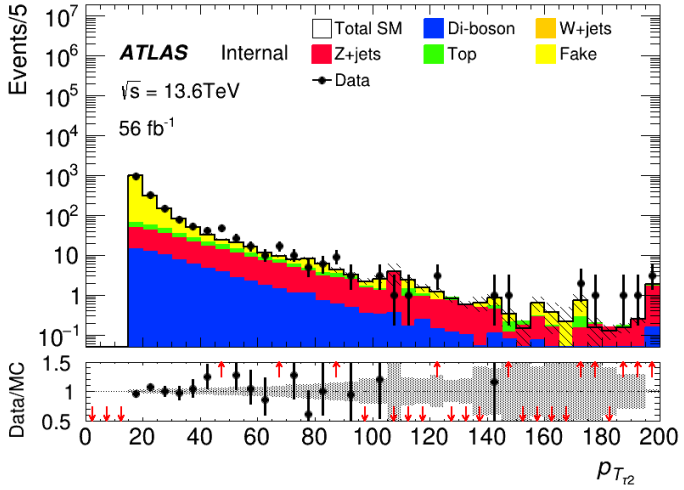




run3







MC modeling in Pre-Selection(LH)

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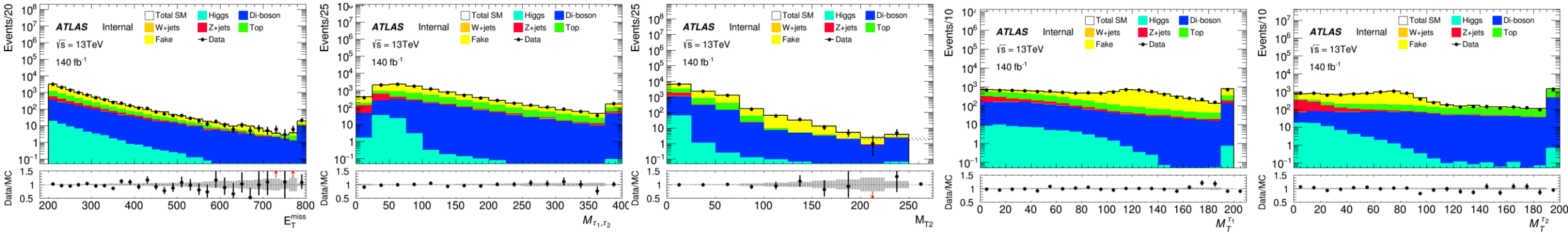
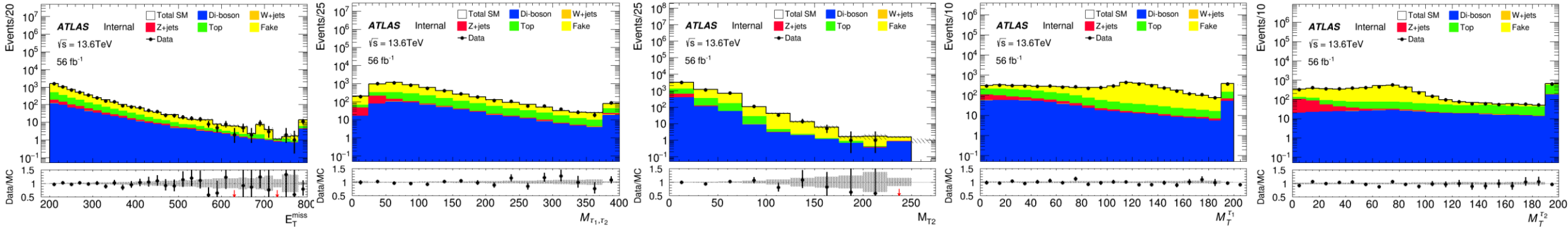
run2



run3



MC modeling in Pre-Selection(LH)

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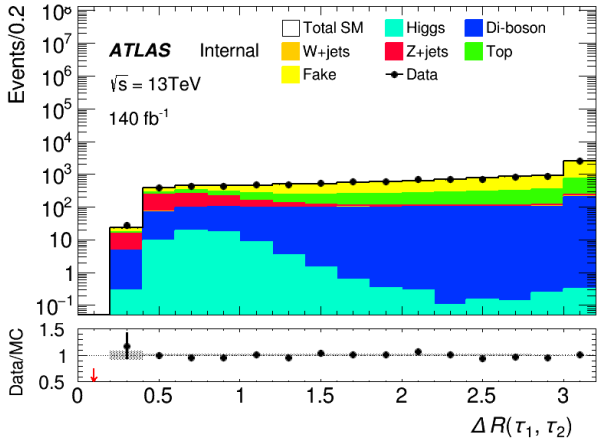
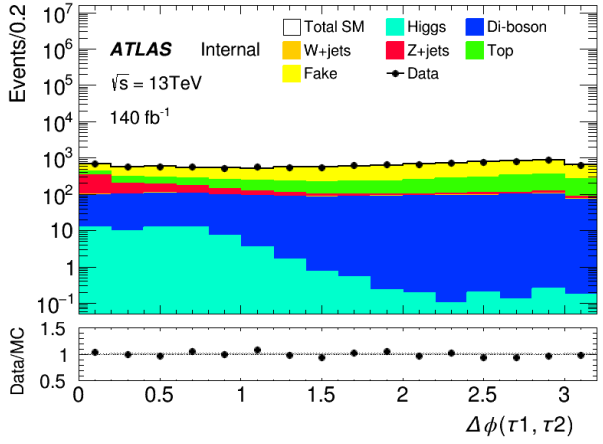
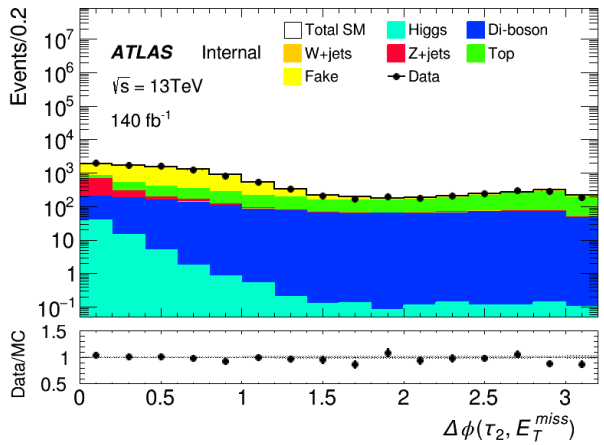
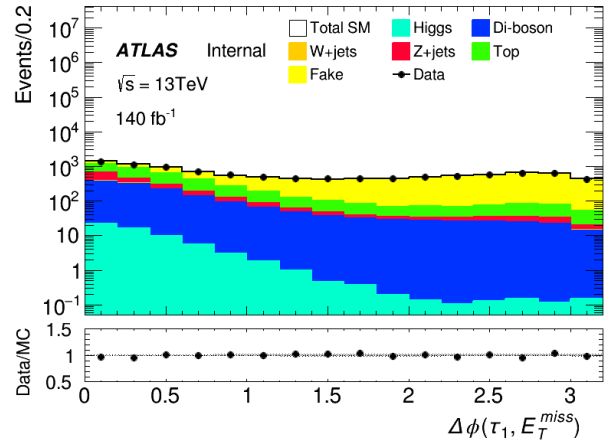
run2

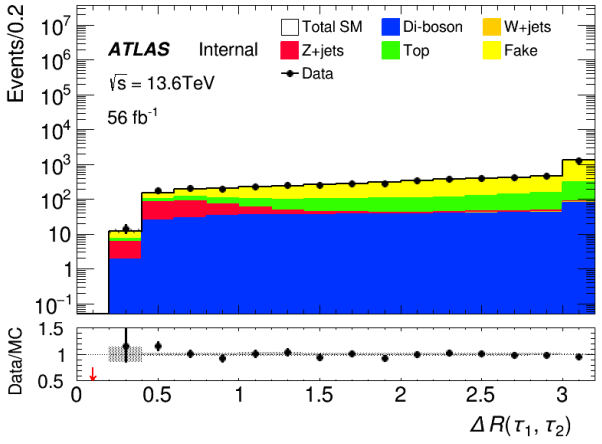


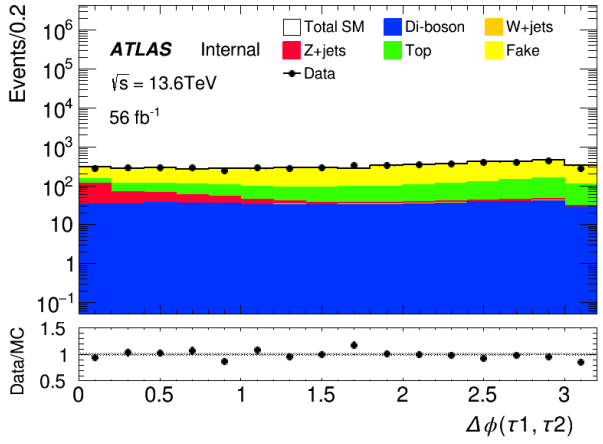


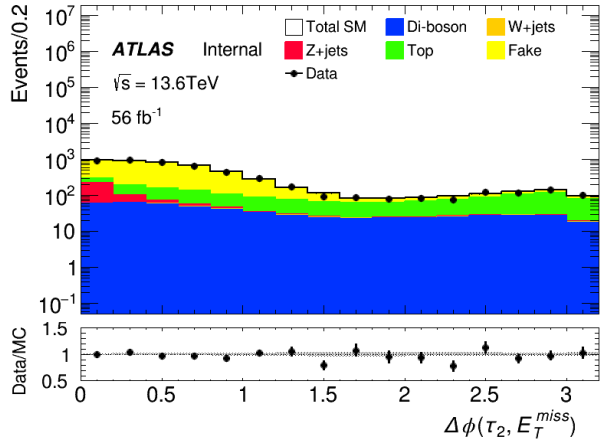


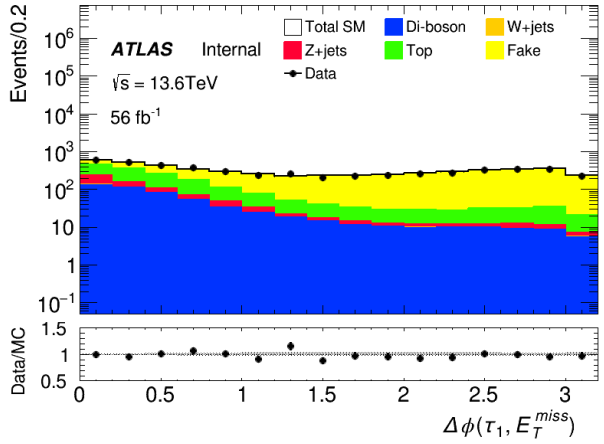


run3









MC modeling in Pre-Selection(LH)

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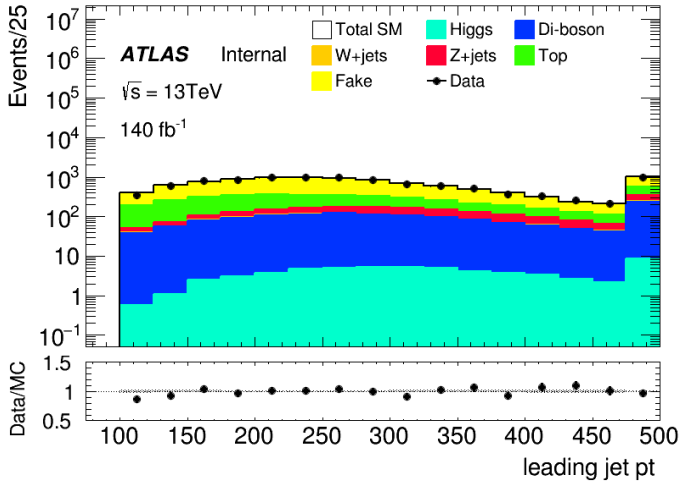
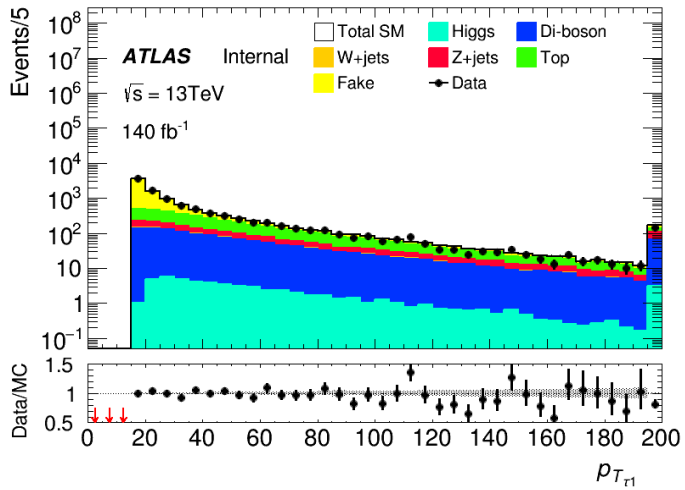
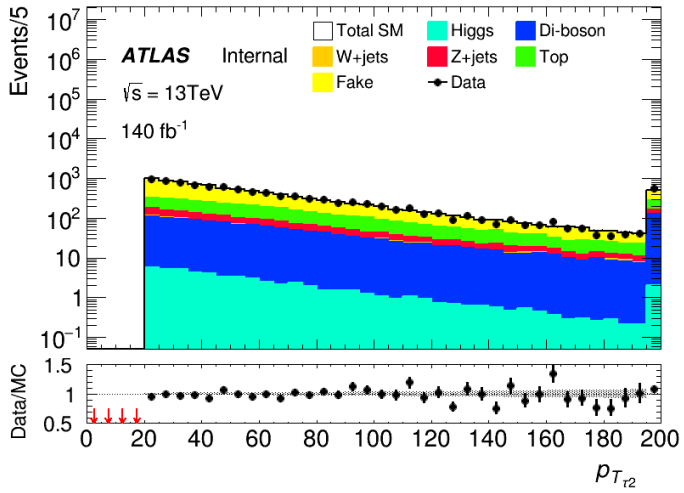
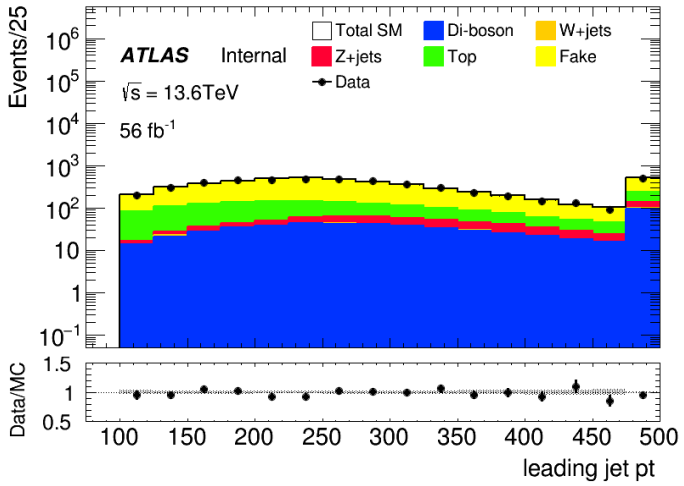
run2

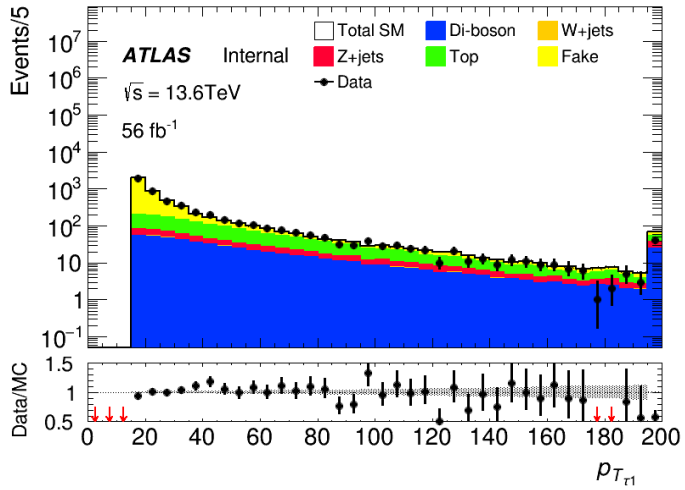


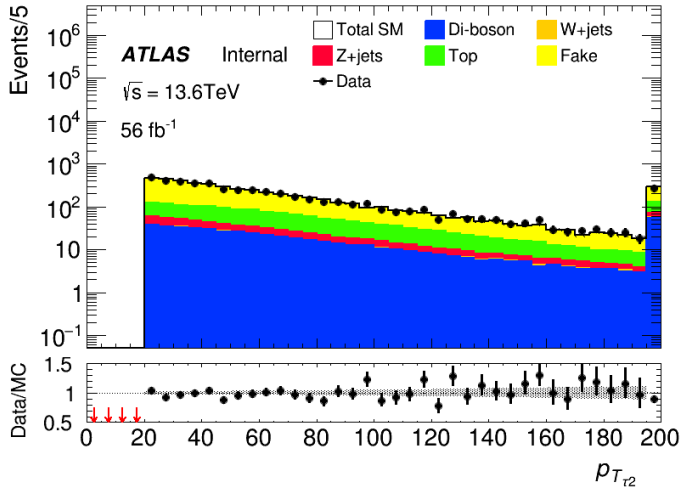




run3







C1N2 SR(HH and LH)

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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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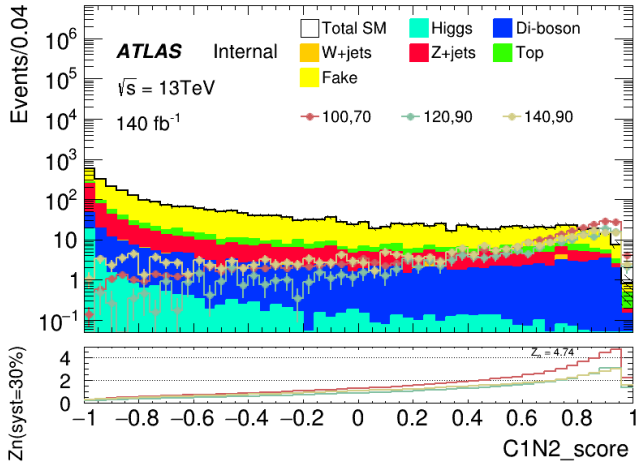
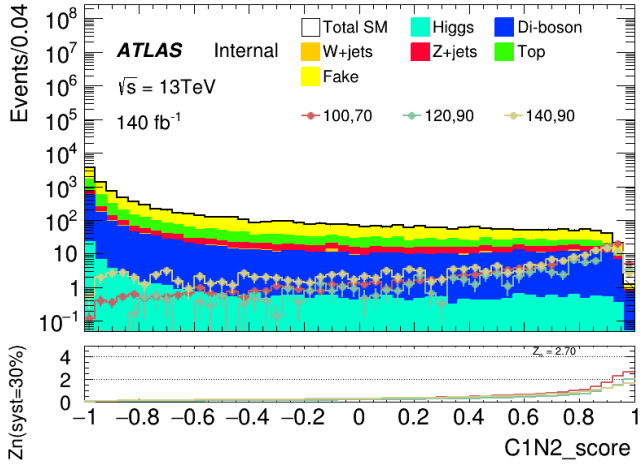
HH

LH

run2





run3