



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

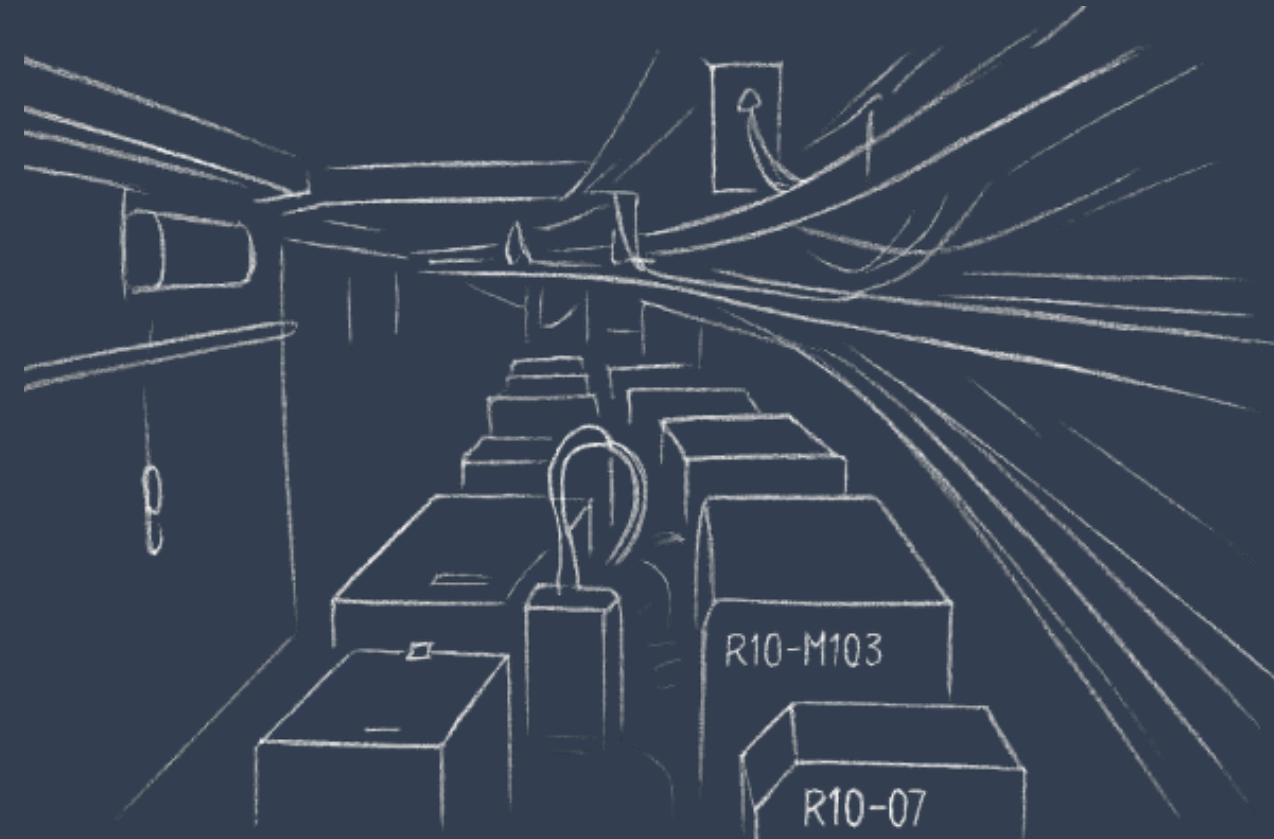


IHEP SUSY Group Meeting

Chengxin Liao

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

Aug 21, 2025





- Provide SR bkg info(Done)
- Split run2 and run3 then Update Bkg estimation(Done)
- Update support-note(Ongoing)



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

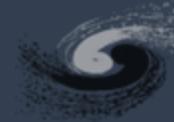


LH run3 sample with cut

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

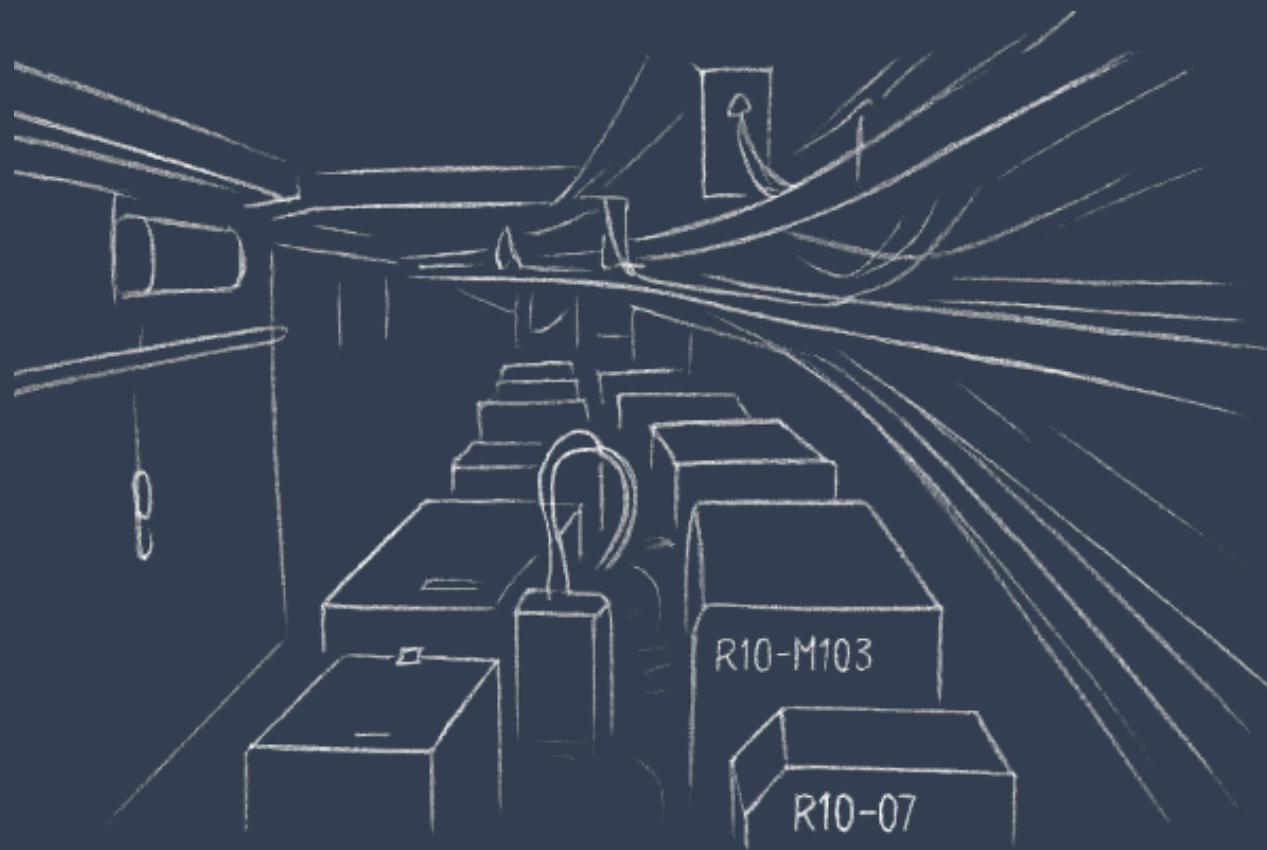
fb_mcChannelNumber	Weight_mc	phys name	category	yield_frac
601230	849.5075049542239	PhPy8EG_A14_ttbar_hdamp258p75_dil	top	0.4793142608927102
701050	440.5554150412966	Sh_llvv_os	VV	0.2485728400412177
700794	169.17790738694697	Sh_2214_Ztautau_maxHTpTV2_CVetoBVeto	Vjets	0.09545458182022701
601352	61.71761355609071	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



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

ATLAS
EXPERIMENT

Backup



Pre-Selection



HH Pre-selection

≥ 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

≥ 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)

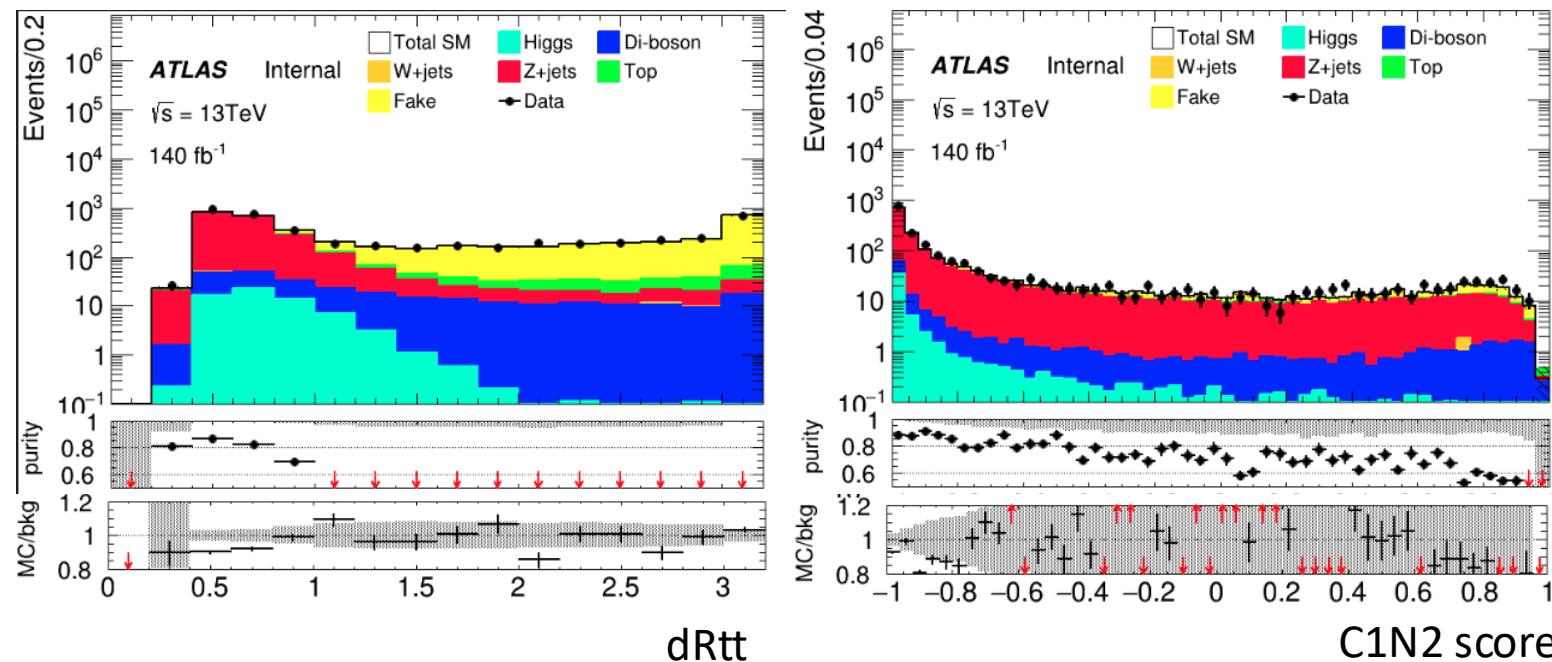


HH pre-selection(drop Mtt reco cut)

dRtt ≤ 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)

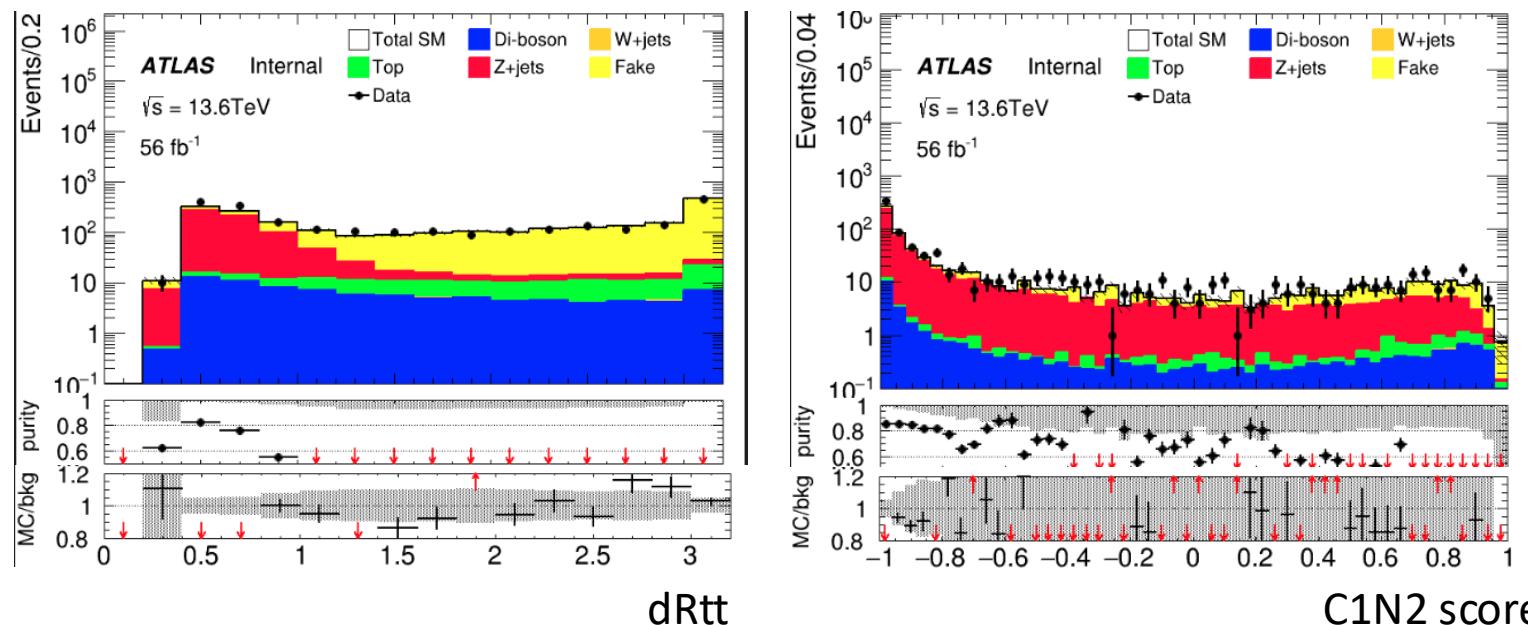


HH pre-selection(drop Mtt reco cut)

dRtt ≤ 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)



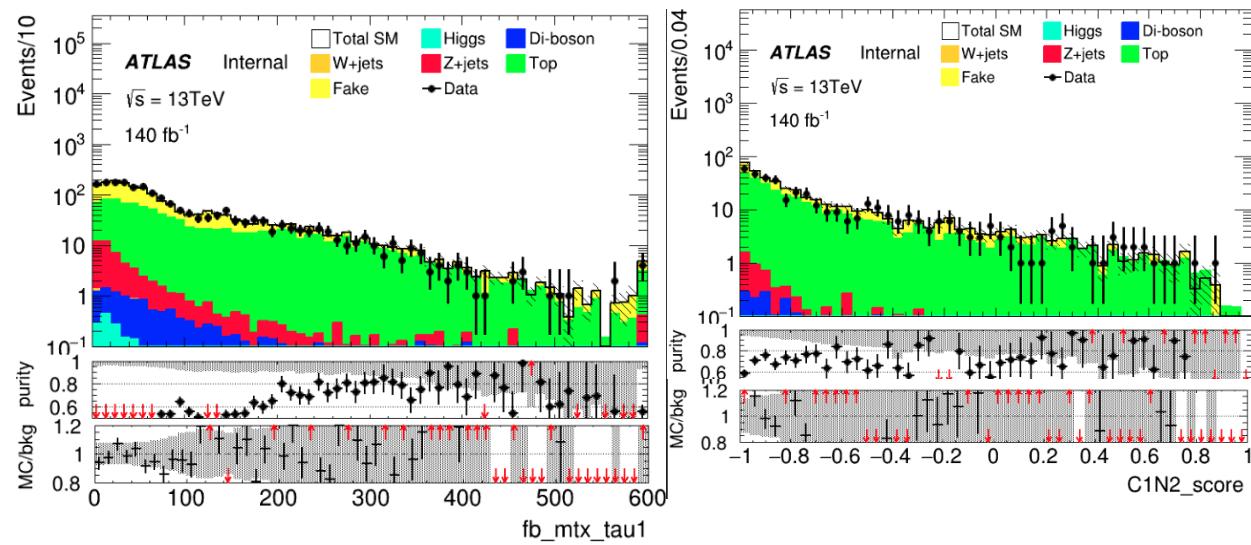
HH pre-selection(remove bVeto and add bJets > 0)

$M_T(\tau_1, MET) > 150$

Orthogonal with SR

CR: C1N2 score < -0.2

VR: -0.2 < C1N2 score < 1.0



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(run3)



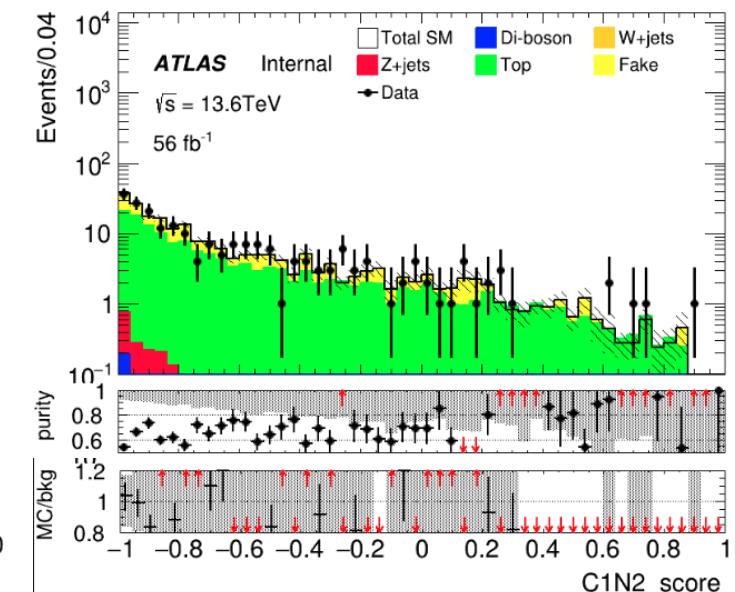
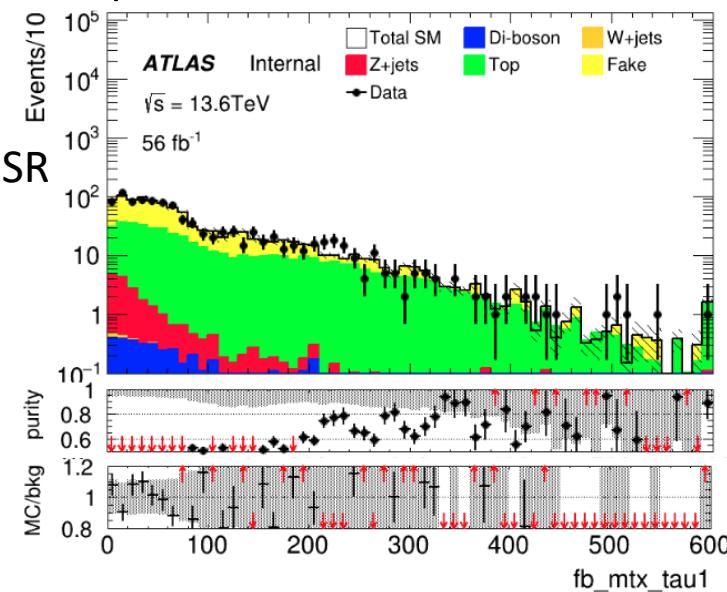
HH pre-selection(remove bVeto and add $b\text{Jets} > 0$)

$M_T(\tau_1, \text{MET}) > 150$

Orthogonal with SR

CR: C1N2 score < -0.2

VR: -0.2 < C1N2 score < 1.0



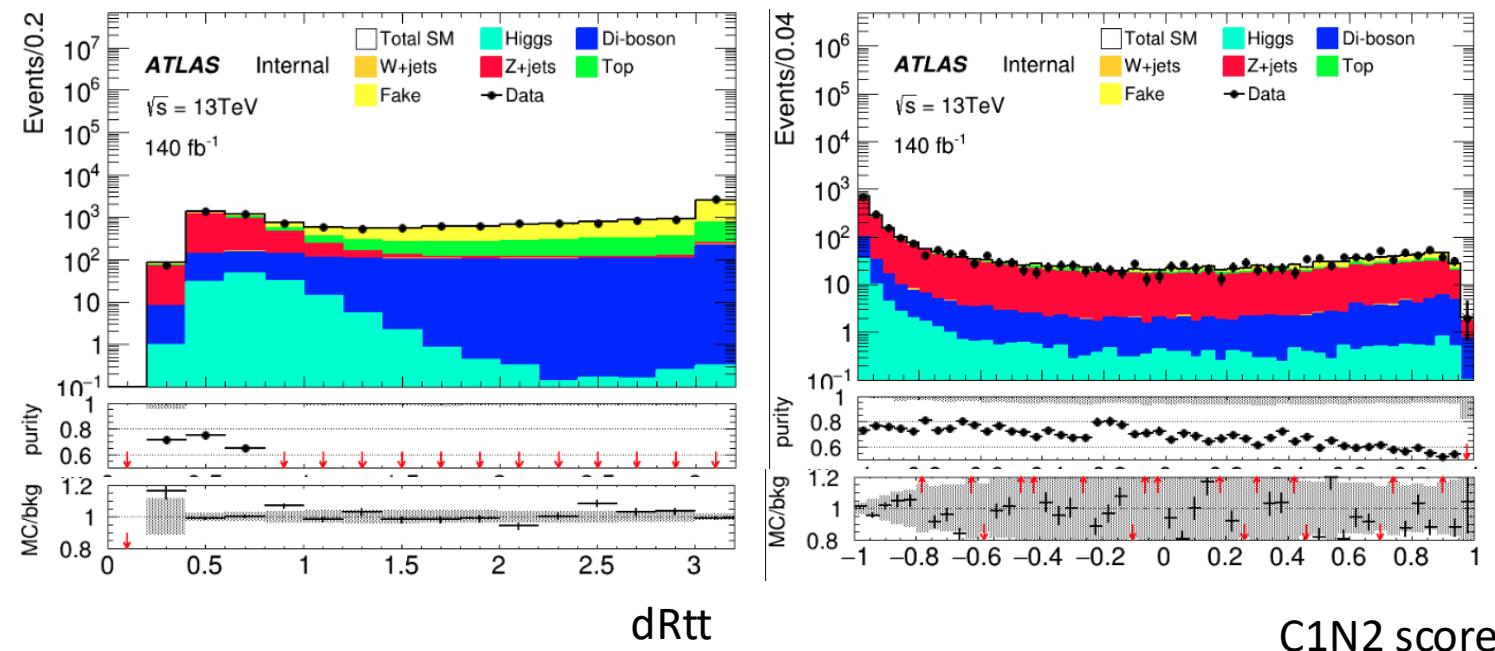
VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_08	60.8912	1.58861	97.9923	4.67955	96	0.621388	0.979669
C1N2_score	score_VR_08_20	83.8068	1.94	123.476	4.53532	121	0.678728	0.979946

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)

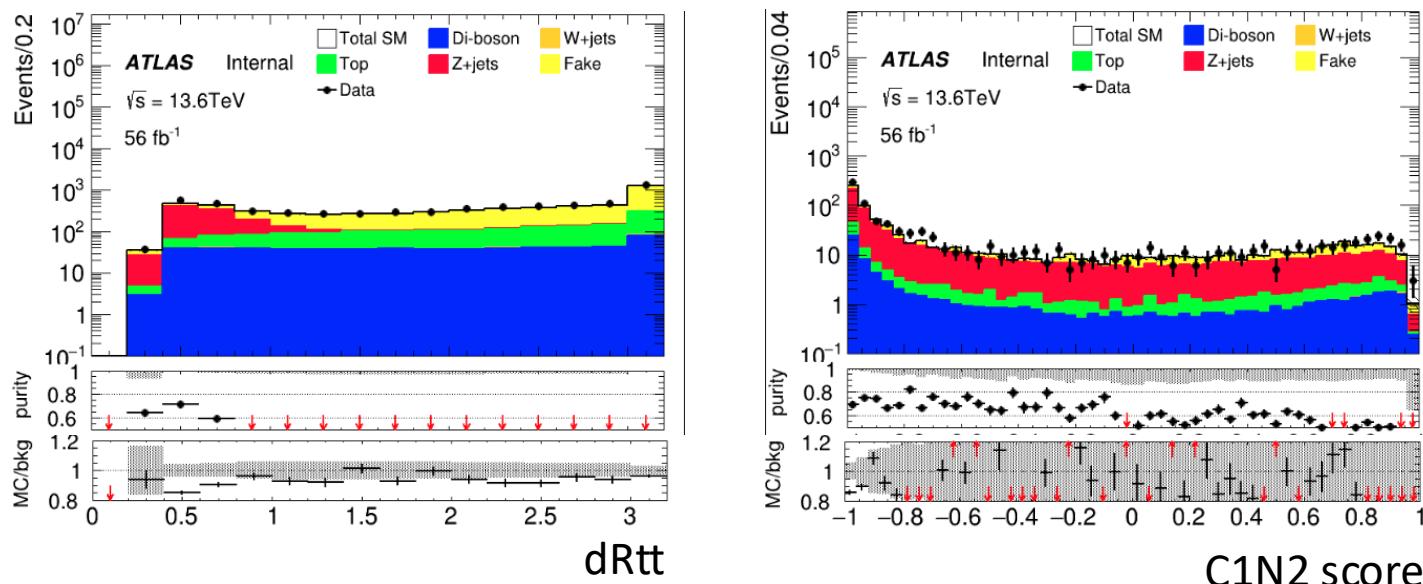


HH pre-selection(drop Mtt reco cut)

$dR_{tt} \leq 0.8$

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)



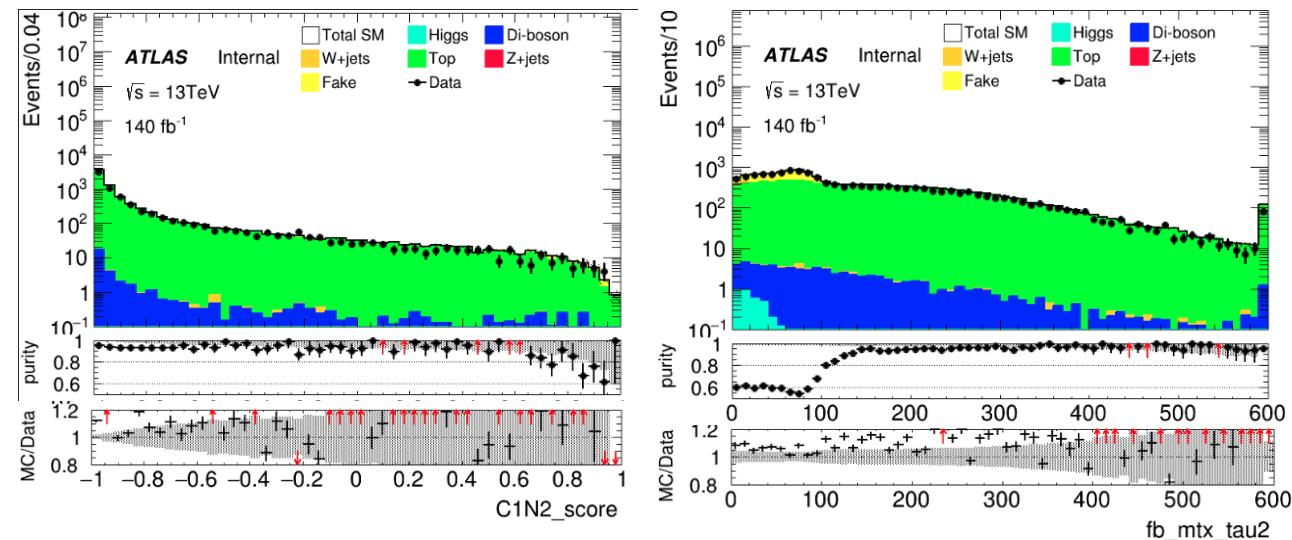
HH pre-selection(remove bVeto and add bJets > 0)

$M_T(\tau_2, MET) > 110$

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)



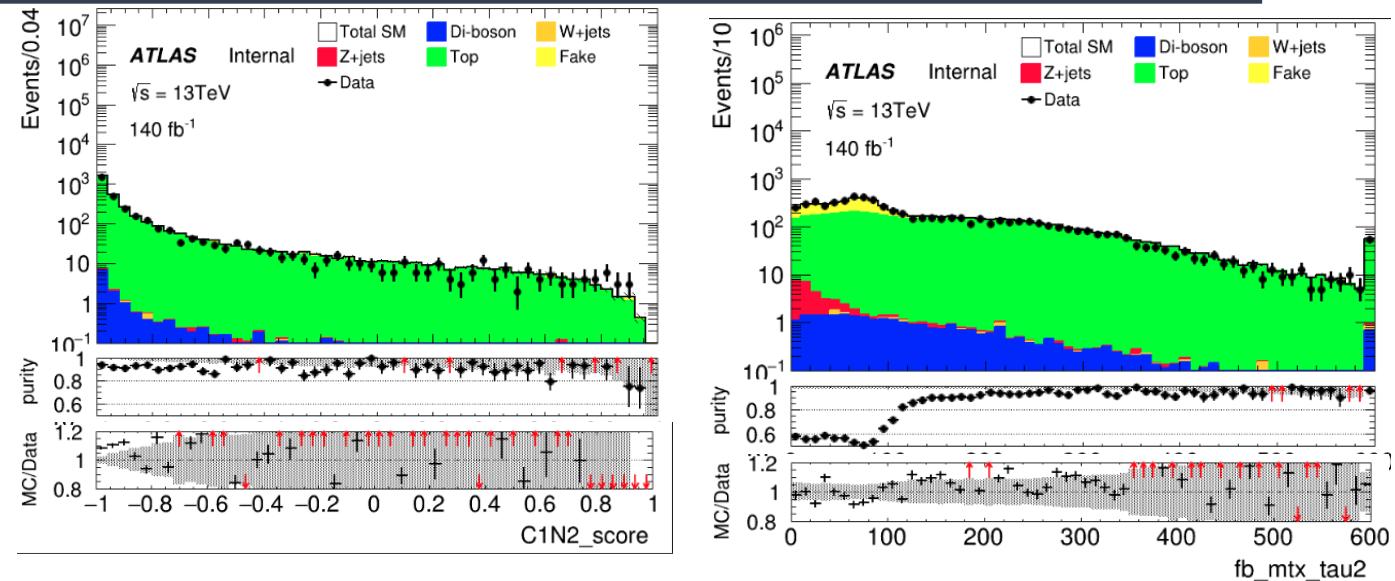
HH pre-selection(remove bVeto and add bJets > 0)

$M_T(\tau_2, MET) > 110$

Orthogonal with SR

CR: C1N2 score < -0.8

VR: -0.8 < C1N2 score < 1.0

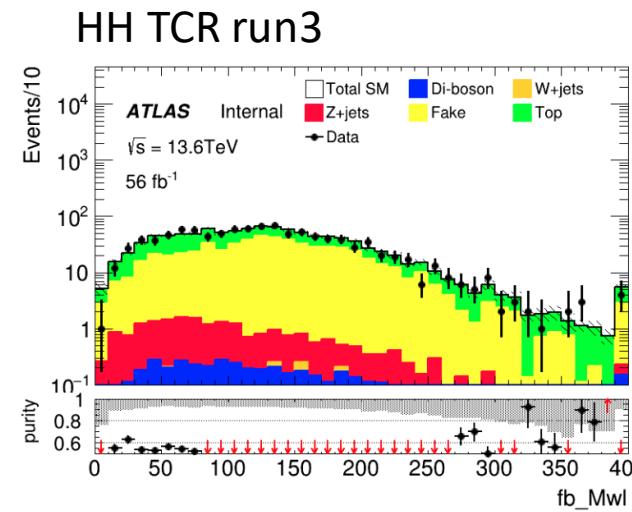
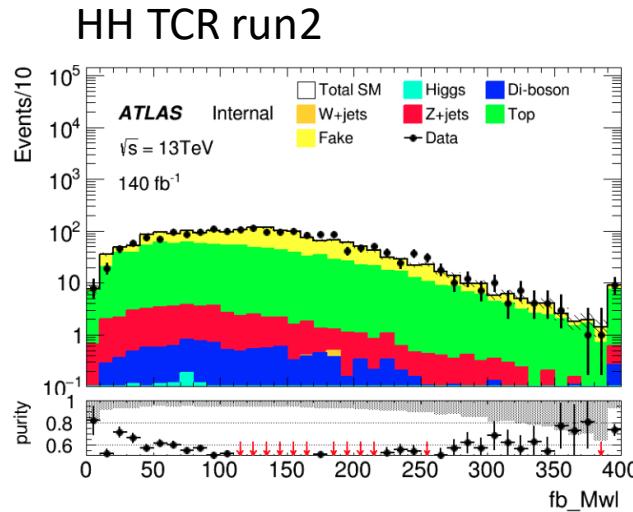


VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_08	2482.03	10.2931	2683.31	15.1554	2460	0.924986	0.916777
C1N2_score	score_VR_08_20	866.683	6.19781	941.263	9.10633	864	0.920767	0.917916

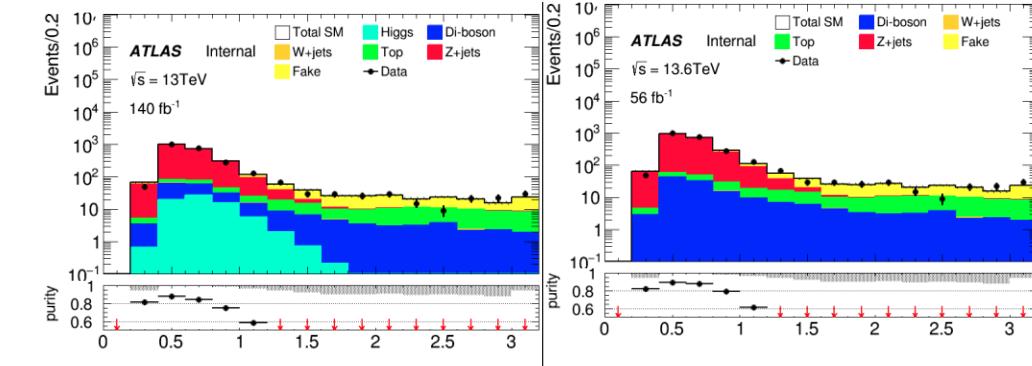
Distribution Check



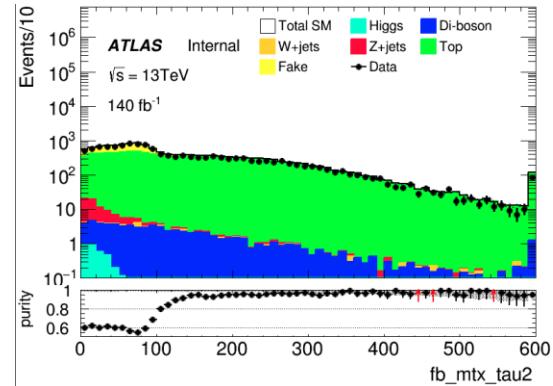
Institute of High Energy Physics
Chinese Academy of Sciences



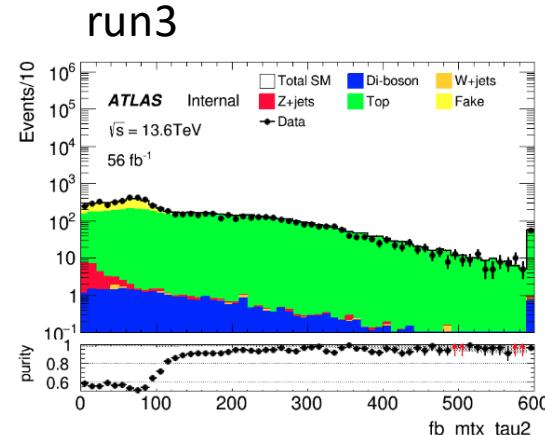
LH Channel
Change Mtt_reco to [10,130]
run2



LH channel
run2



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

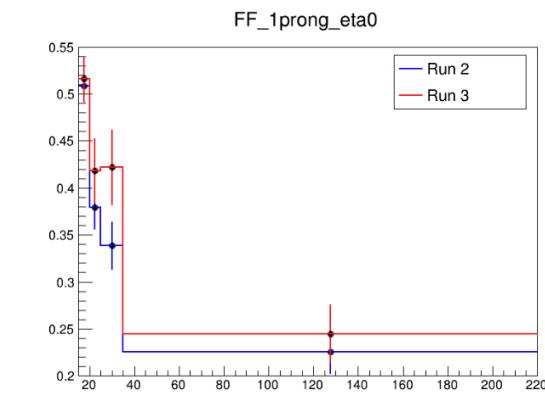


Cross-Check FF



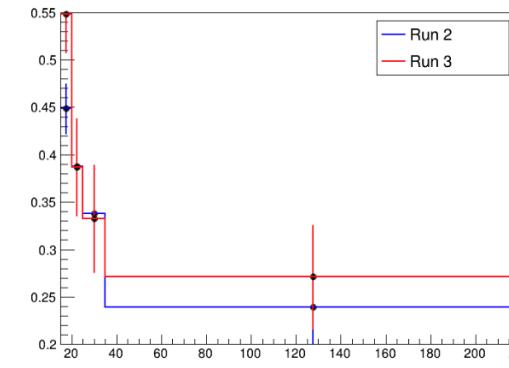
My result

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

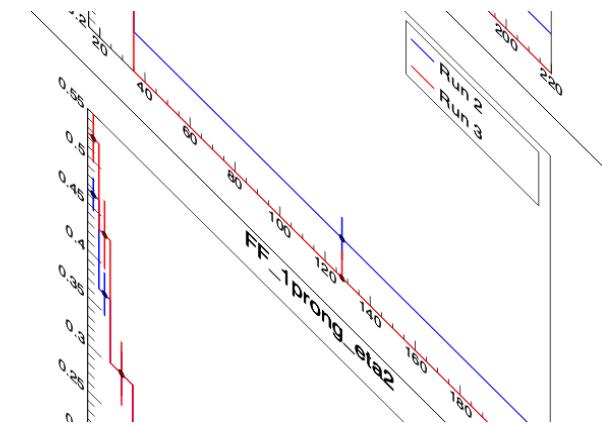


$$1 < |\eta| < 1.37$$

FF_1prong_eta1

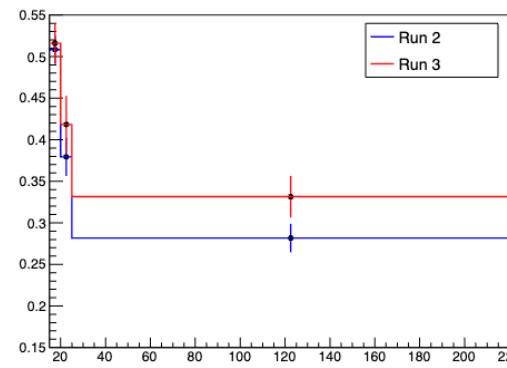


$$1.52 < |\eta| < 2.5$$

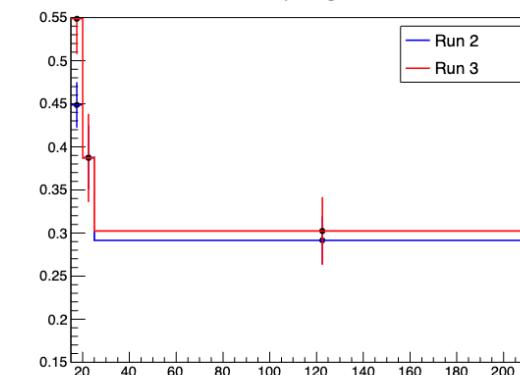


Wenyi's result

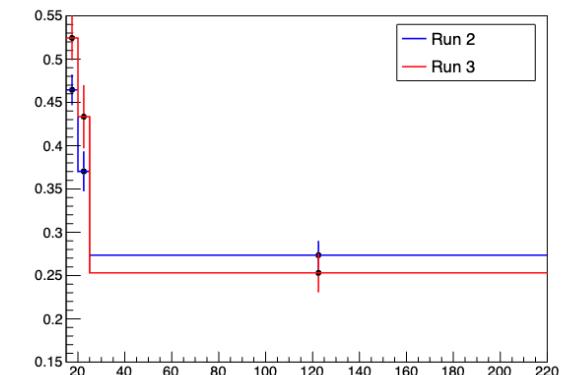
FF_1prong_eta0



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

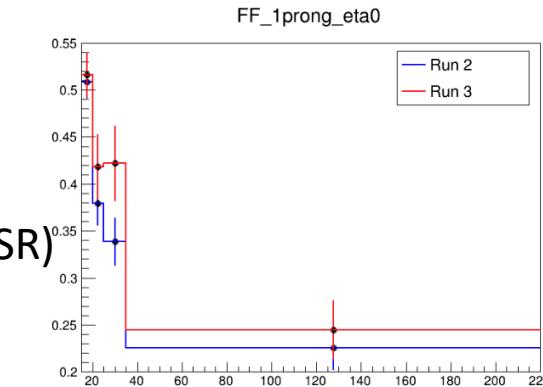
Same-Signal(Orthogonal with SR)

bVeto

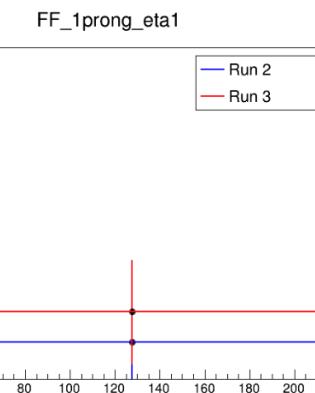
ID: nMediumTau == 1

antiID: nMediumTau < 1

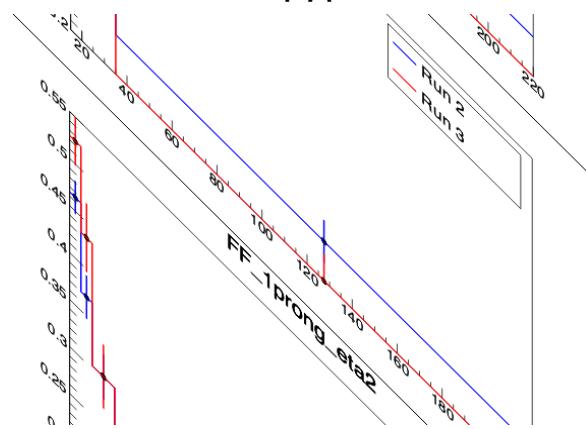
$0 < |\eta| < 1$



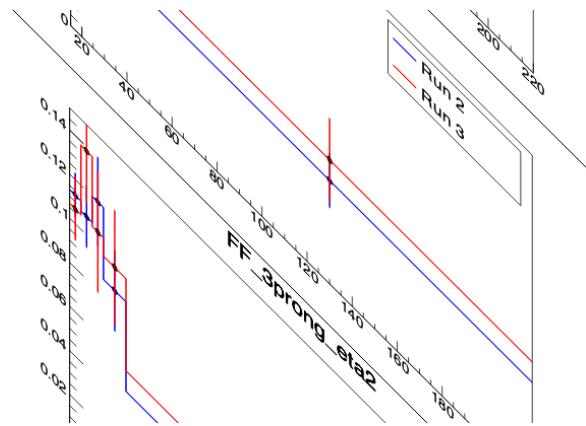
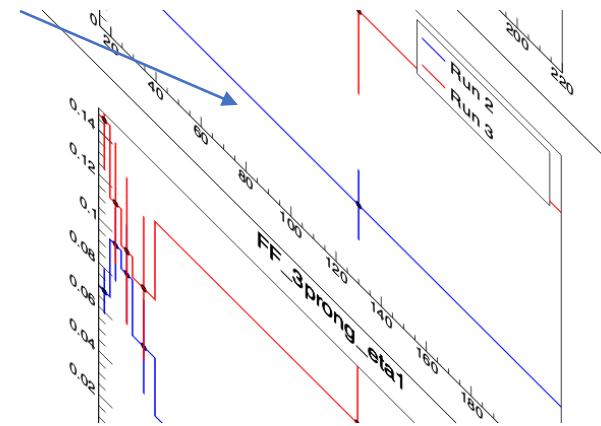
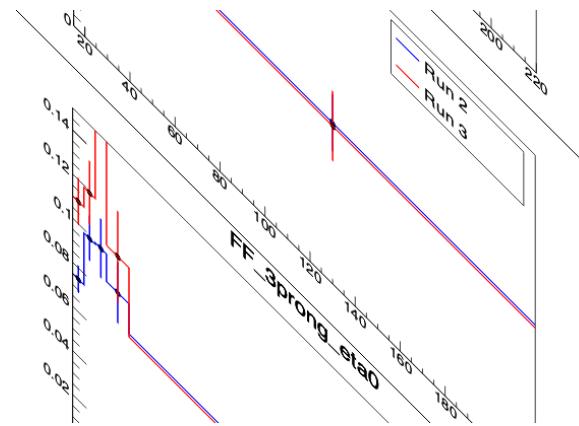
$1 < |\eta| < 1.37$



$1.52 < |\eta| < 2.5$



A small bump show in the last bin

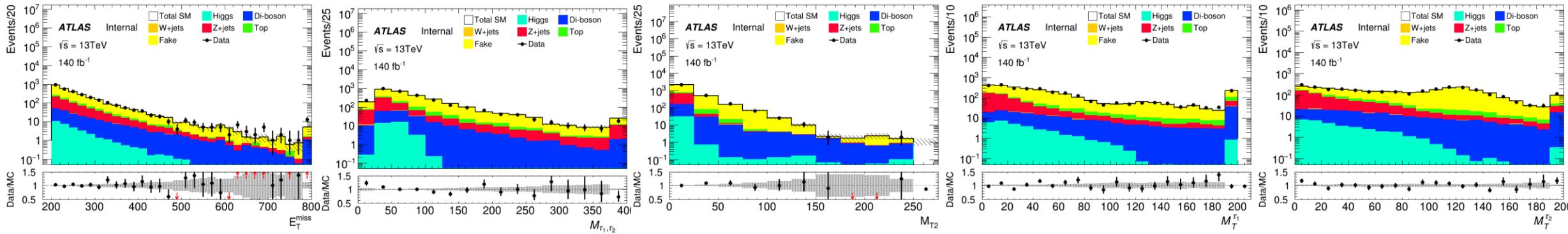


MC modeling in Pre-Selection(HH)

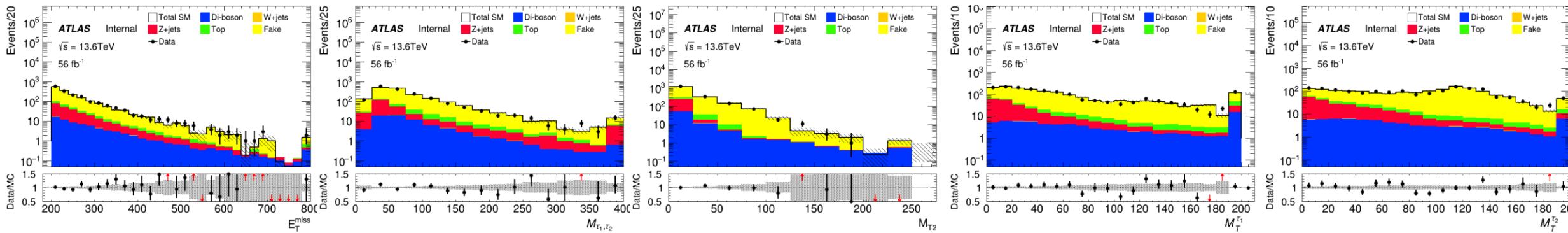


Institute of High Energy Physics
Chinese Academy of Sciences

run2



run3

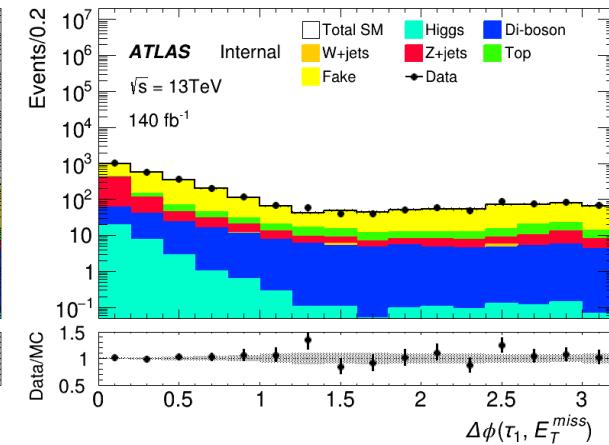
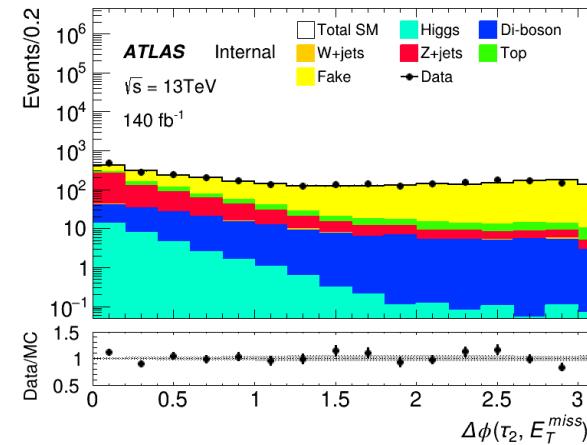
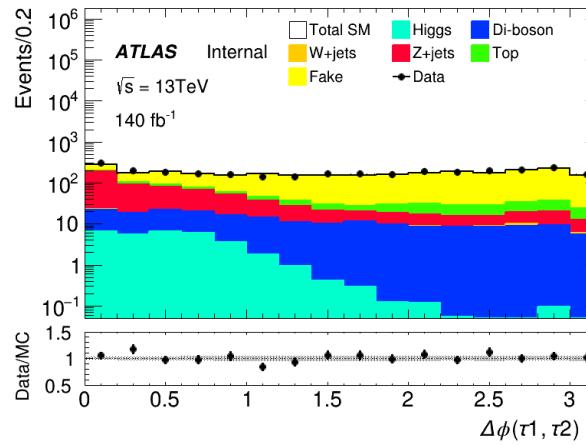
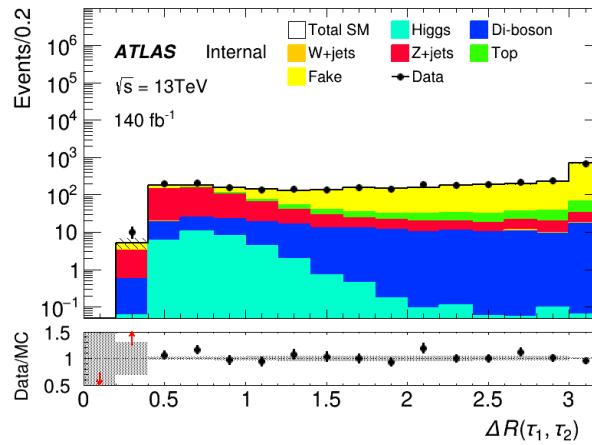


MC modeling in Pre-Selection(HH)

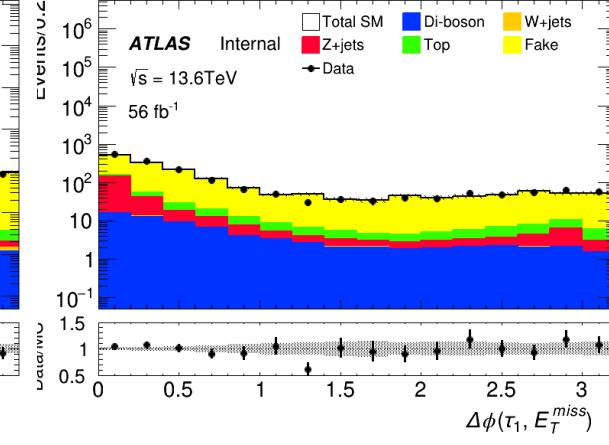
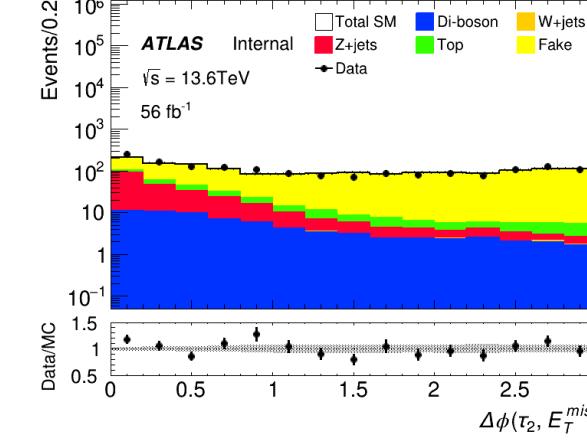
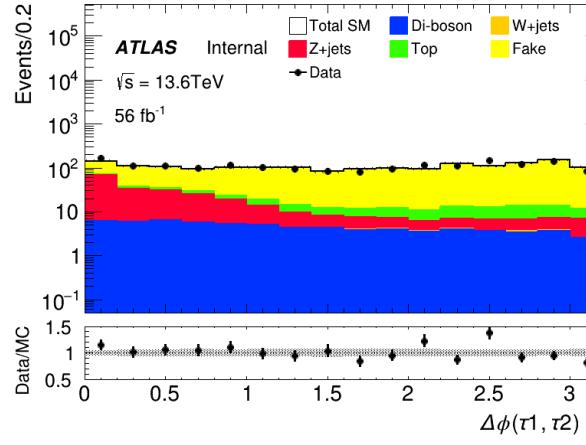
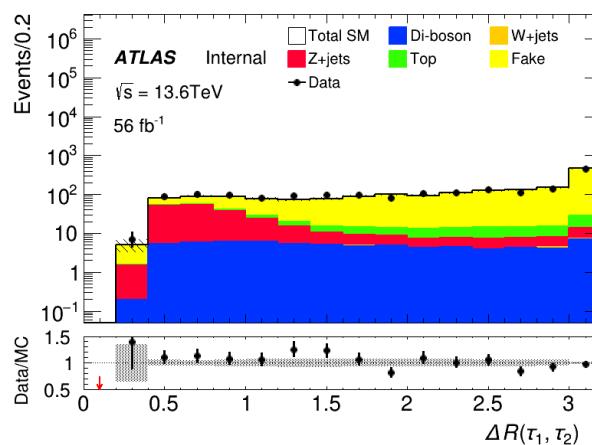


Institute of High Energy Physics
Chinese Academy of Sciences

run2



run3

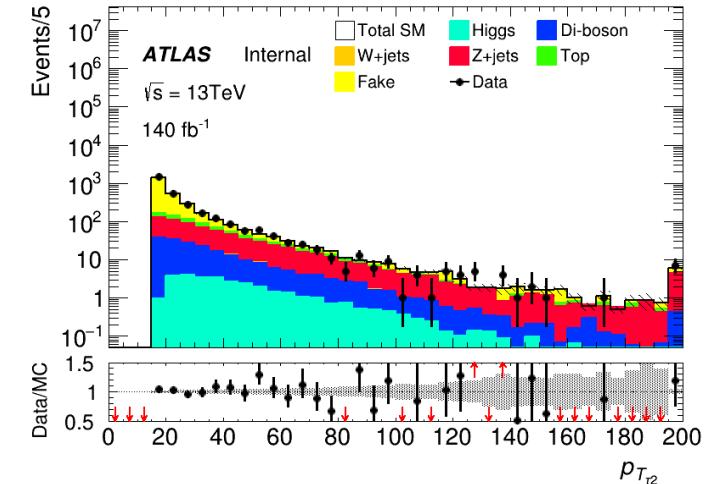
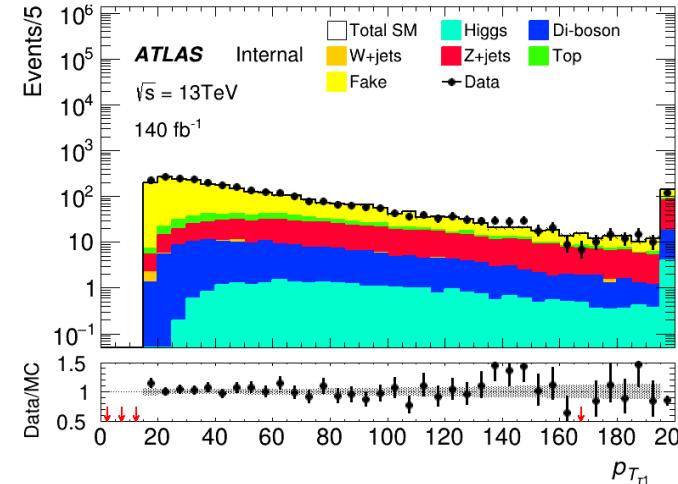
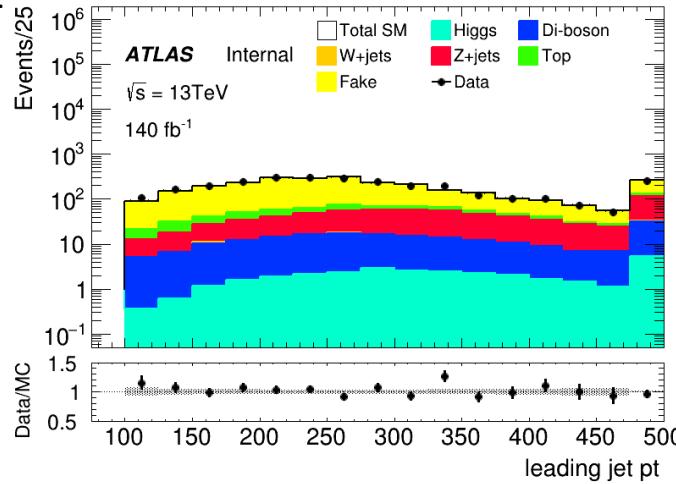


MC modeling in Pre-Selection(HH)

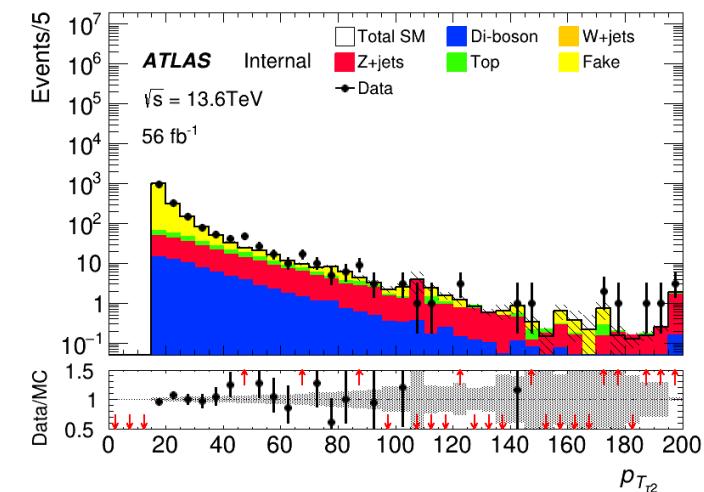
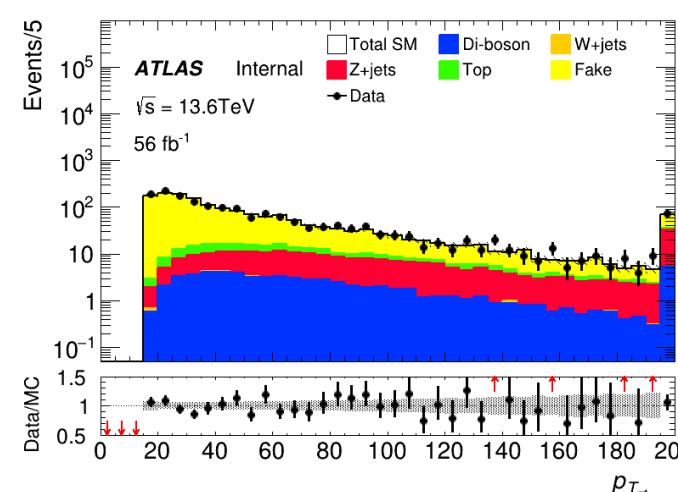
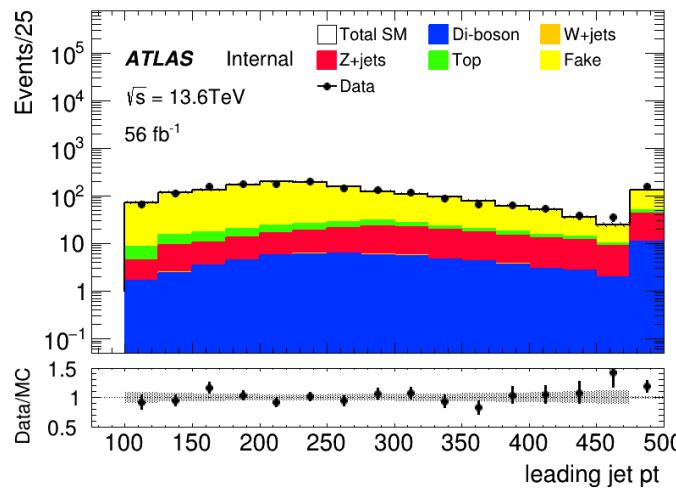


Institute of High Energy Physics
Chinese Academy of Sciences

run2



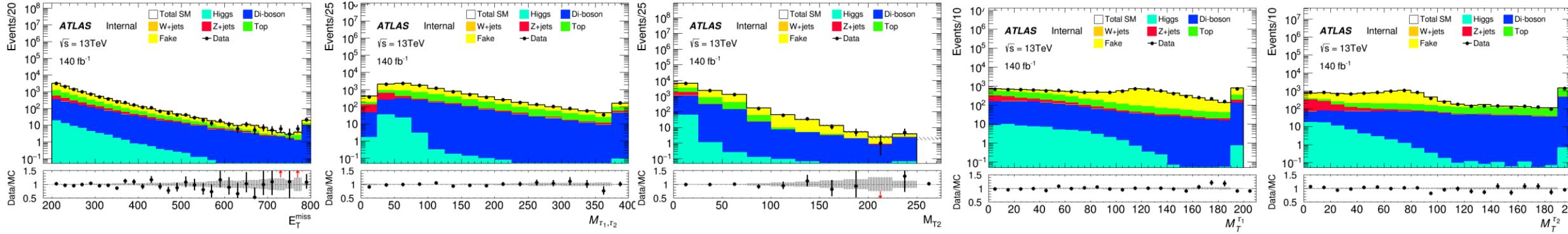
run3



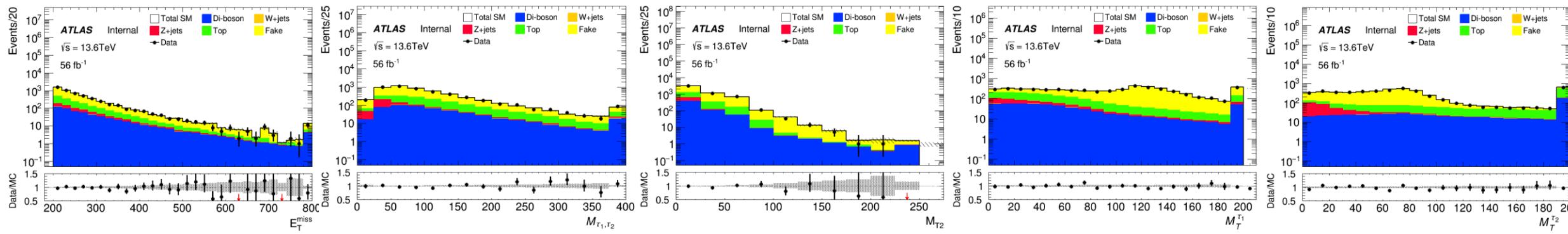
MC modeling in Pre-Selection(LH)



run2



run3

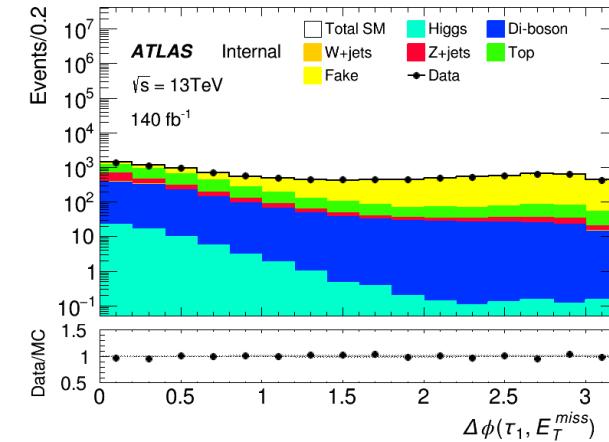
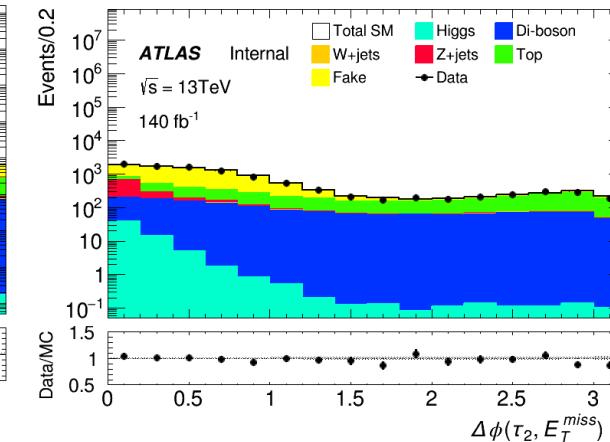
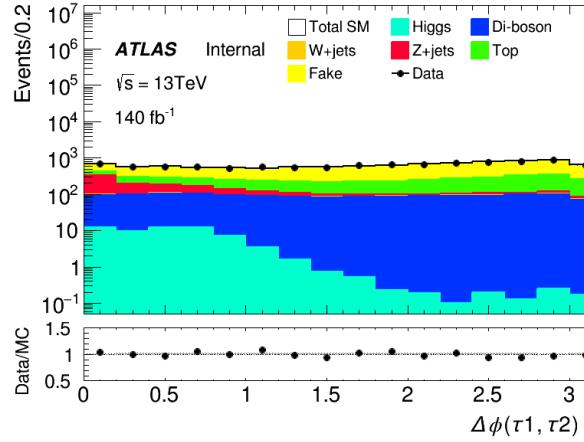
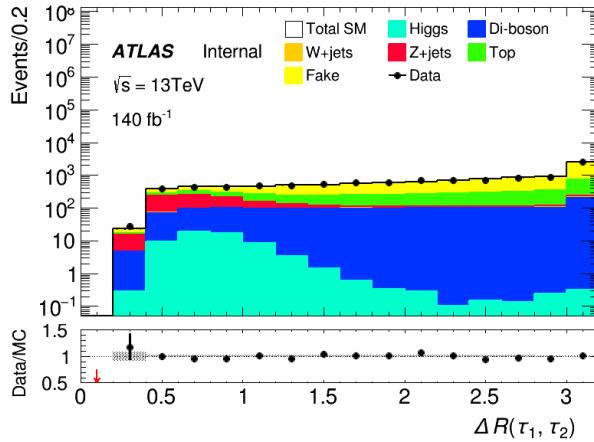


MC modeling in Pre-Selection(LH)

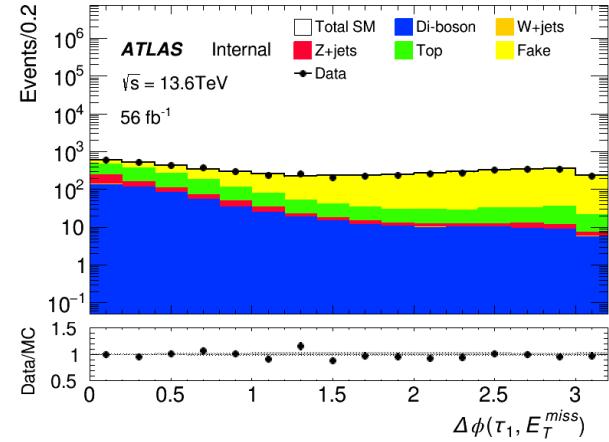
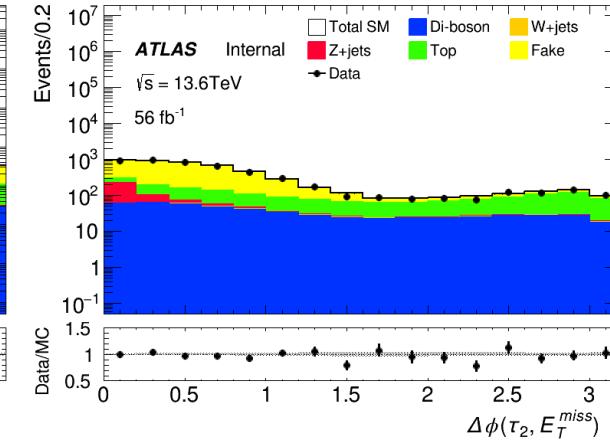
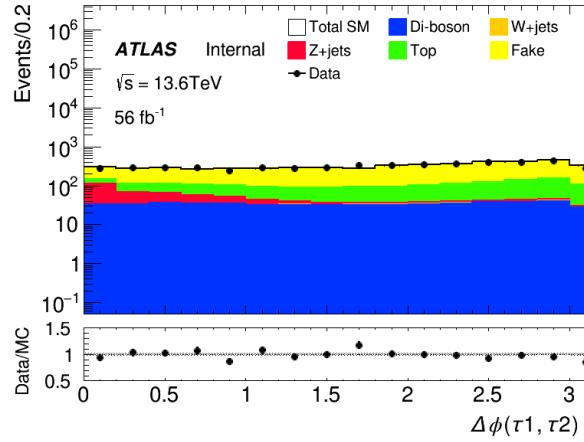
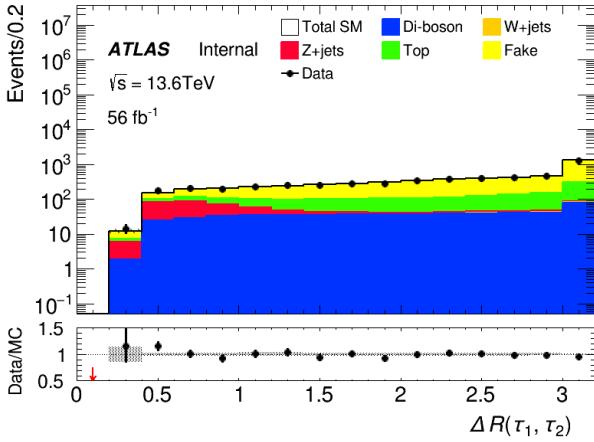


Institute of High Energy Physics
Chinese Academy of Sciences

run2



run3

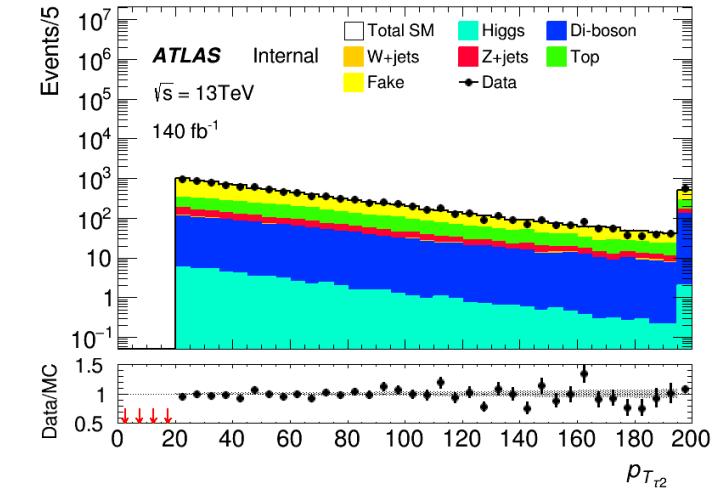
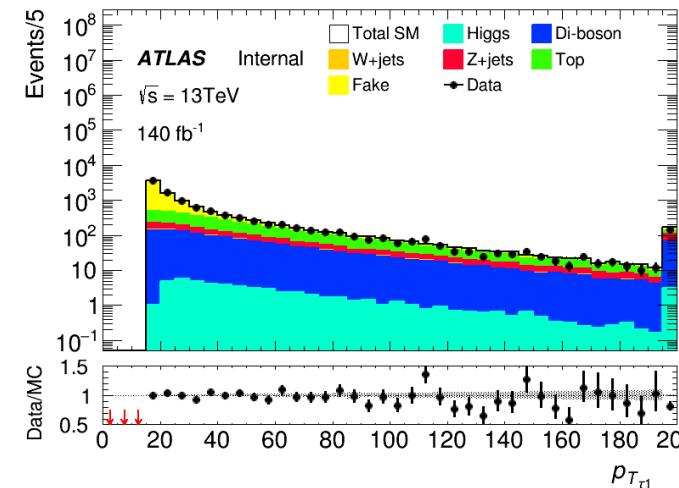
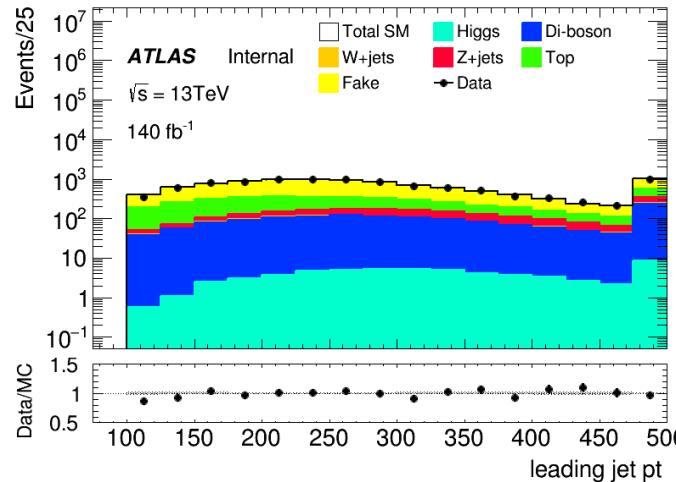


MC modeling in Pre-Selection(LH)

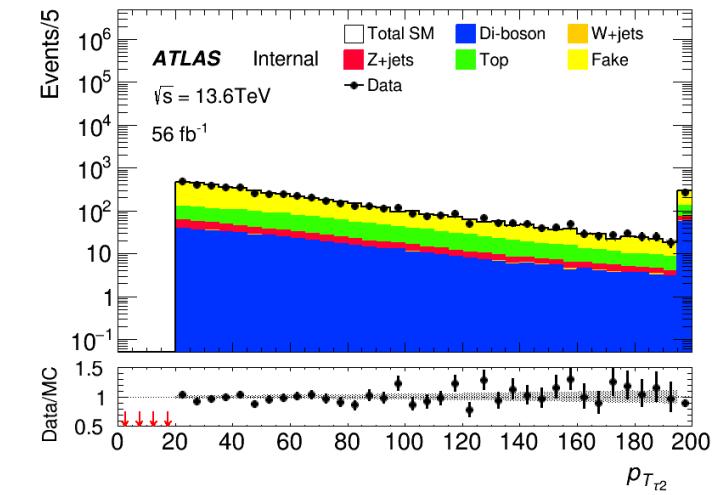
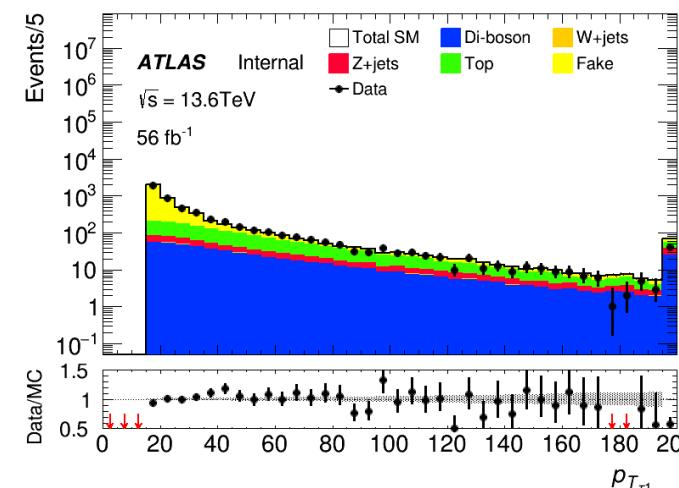
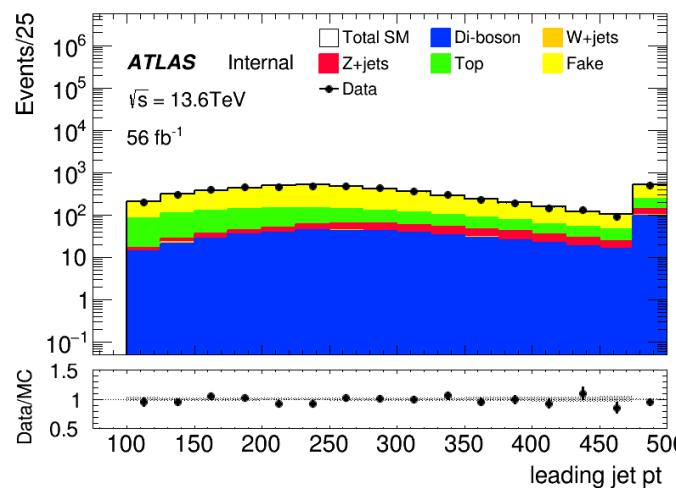


Institute of High Energy Physics
Chinese Academy of Sciences

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)`

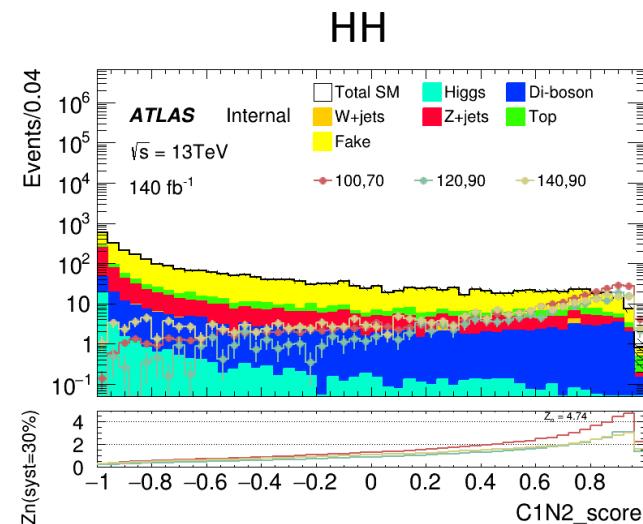
Split strategy: Separate entries by using mod 5, for Fake bkg, if separate follow sequence, all weighted entry will split into first fold

BDT distribution for LH and HH

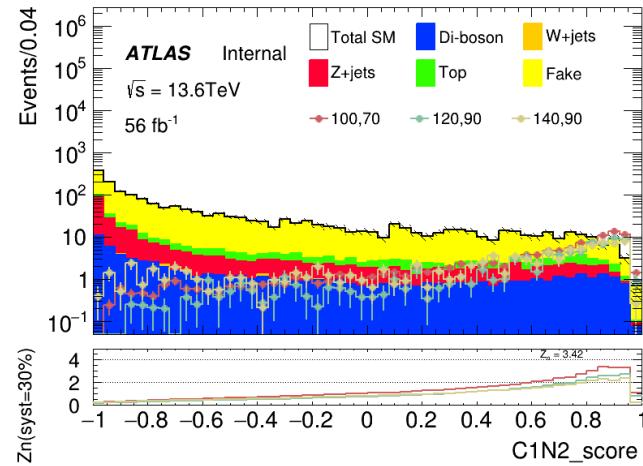


Institute of High Energy Physics
Chinese Academy of Sciences

run2



run3



LH

