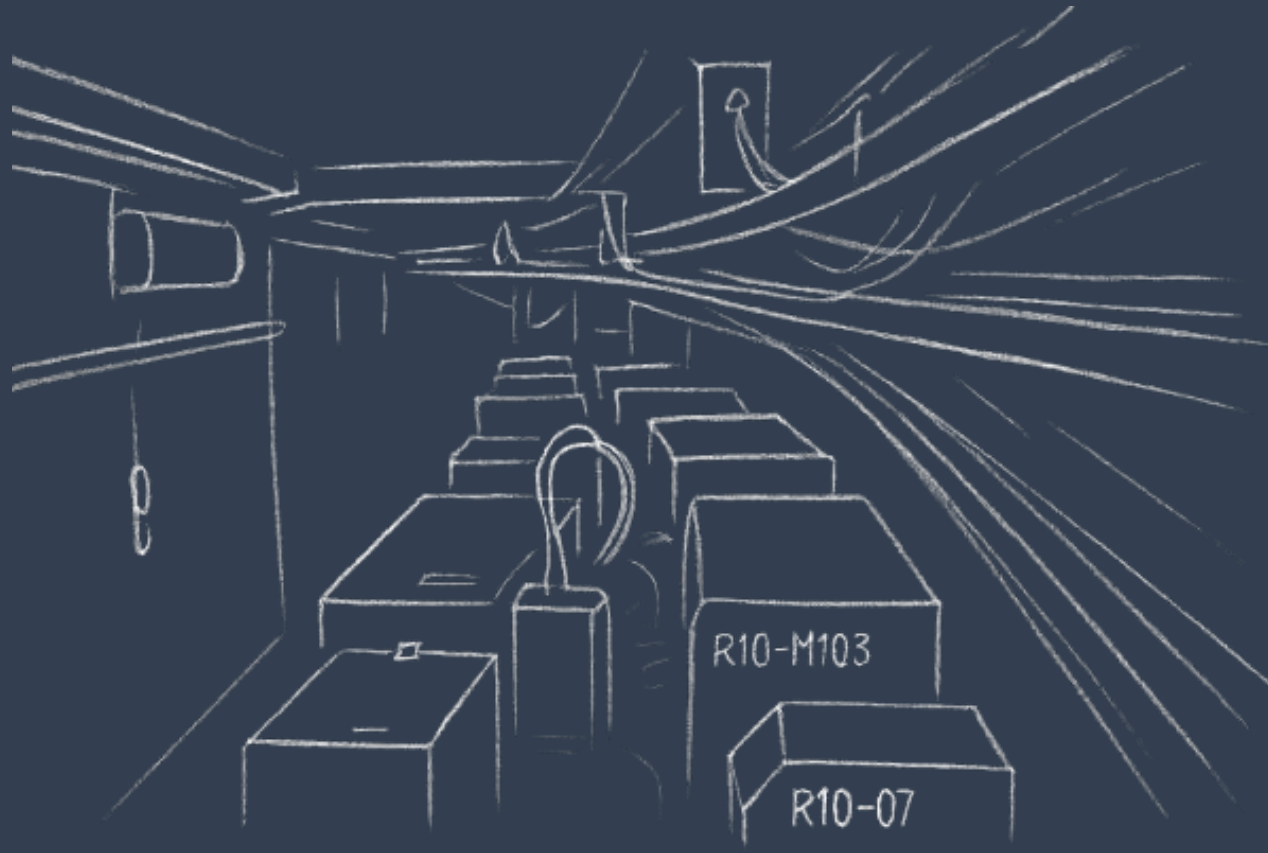
IHEP SUSY Group Meeting

Chengxin Liao

Institute of High Energy Physics
Chinese Academy of Sciences

Aug 20, 2025



C1N2 Status

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- Split run2 and run3 then Update Bkg estimation(Done)
- Update support-note(Ongoing)

  Note: lowerpad for MC modeling label have typo(bkg/MC, it should be bkg/Data)

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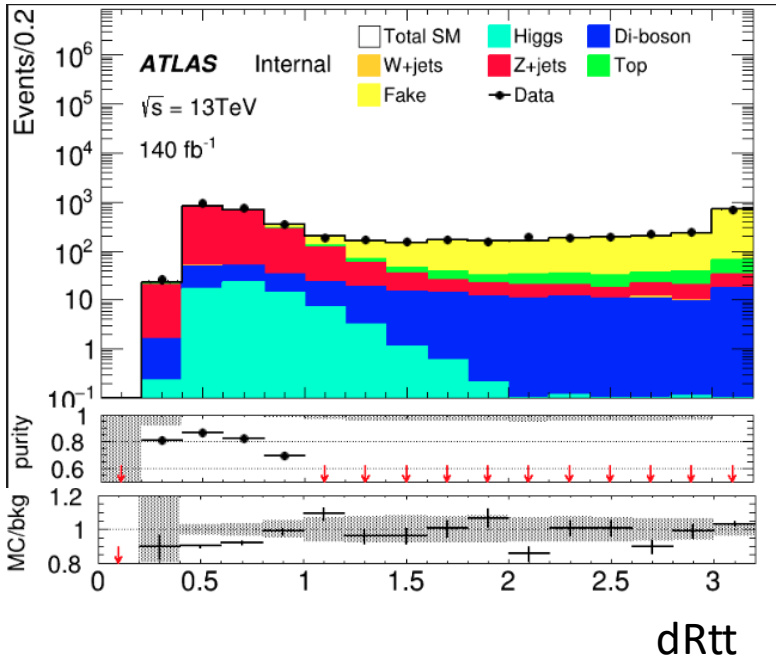
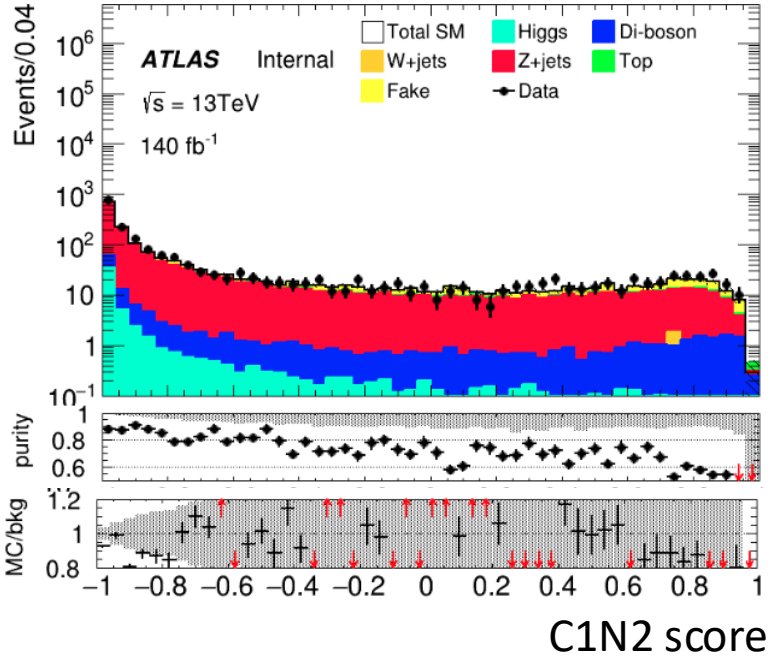
HH pre-selection(drop Mtt reco cut)
dRtt <= 1.0
CR: C1N2 score < -0.3
VR: -0.3 < C1N2 score < 0.9





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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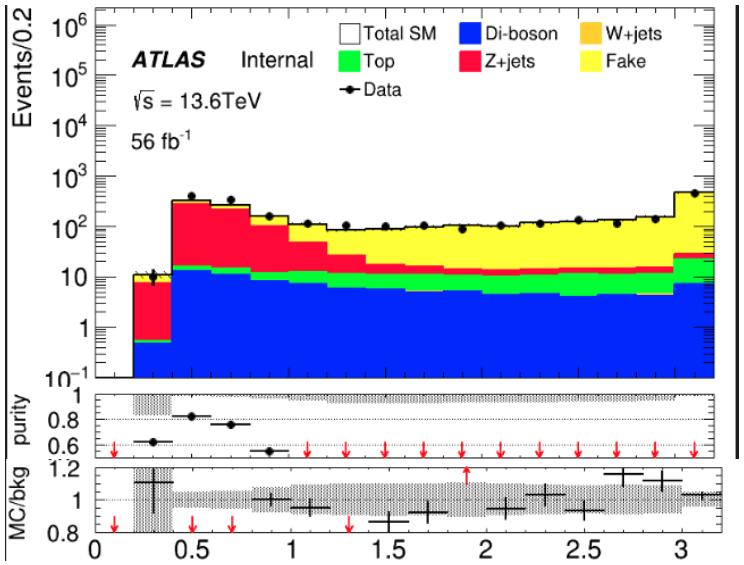
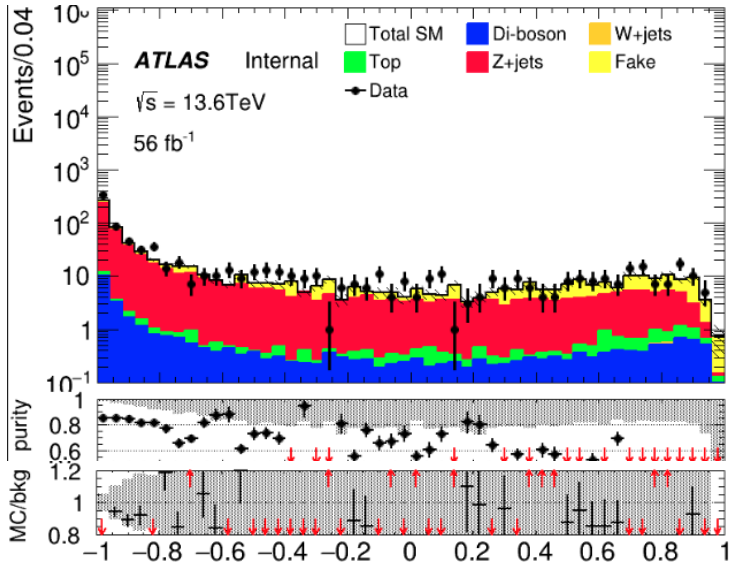
HH pre-selection(drop Mtt reco cut)
dRtt <= 1.0
CR: C1N2 score < -0.8
VR: -0.8 < C1N2 score < 0.9



dRtt



C1N2 score

VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_02	352.278	2.55332	413.587	5.52237	497	0.851764	1.201683
C1N2_score	score_VR_02_19	206.43	2.20244	330.794	9.10271	397	0.624045	1.200142

HH channel: Top bkg estimation(run2)

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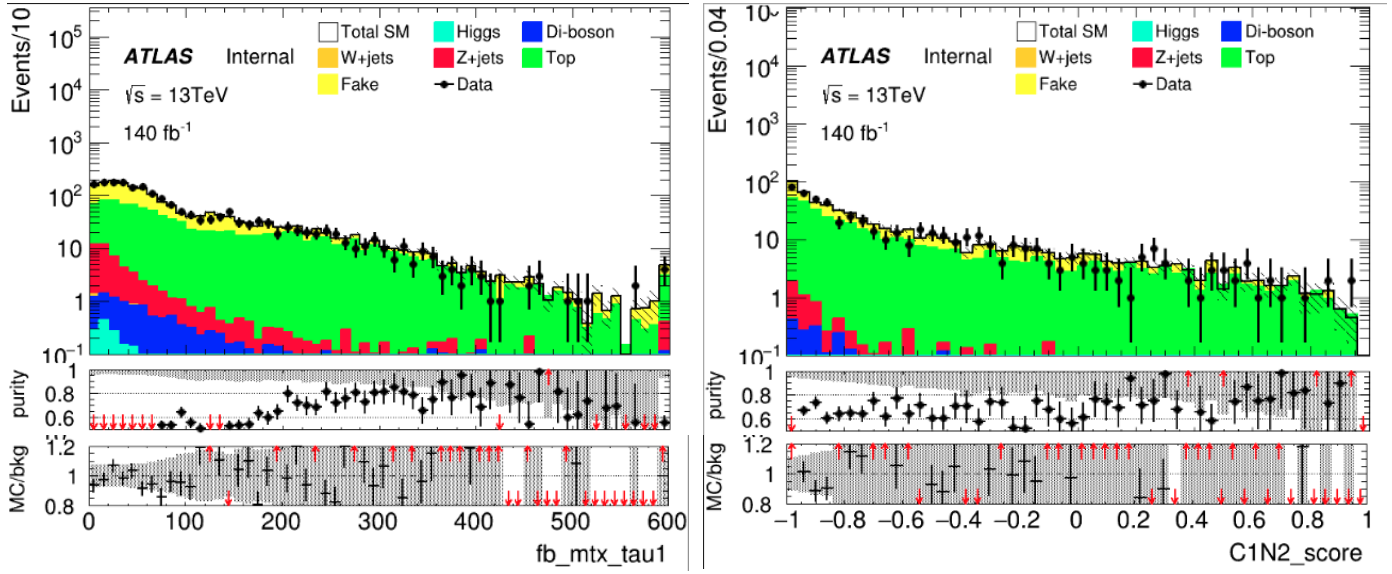
HH pre-selection(remove bVeto and add bJets > 0)

$M_T(tau1, MET) > 120$

Orthogonal with SR



CR: C1N2 score < -0.3

VR: -0.3 < C1N2 score < 1.0

VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_07	204.575	5.44436	334.659	9.69996	304	0.611294	0.908387
C1N2_score	score_VR_07_20	166.327	4.93114	237.871	7.68435	216	0.699235	0.908057

HH channel: Top bkg estimation(run2)

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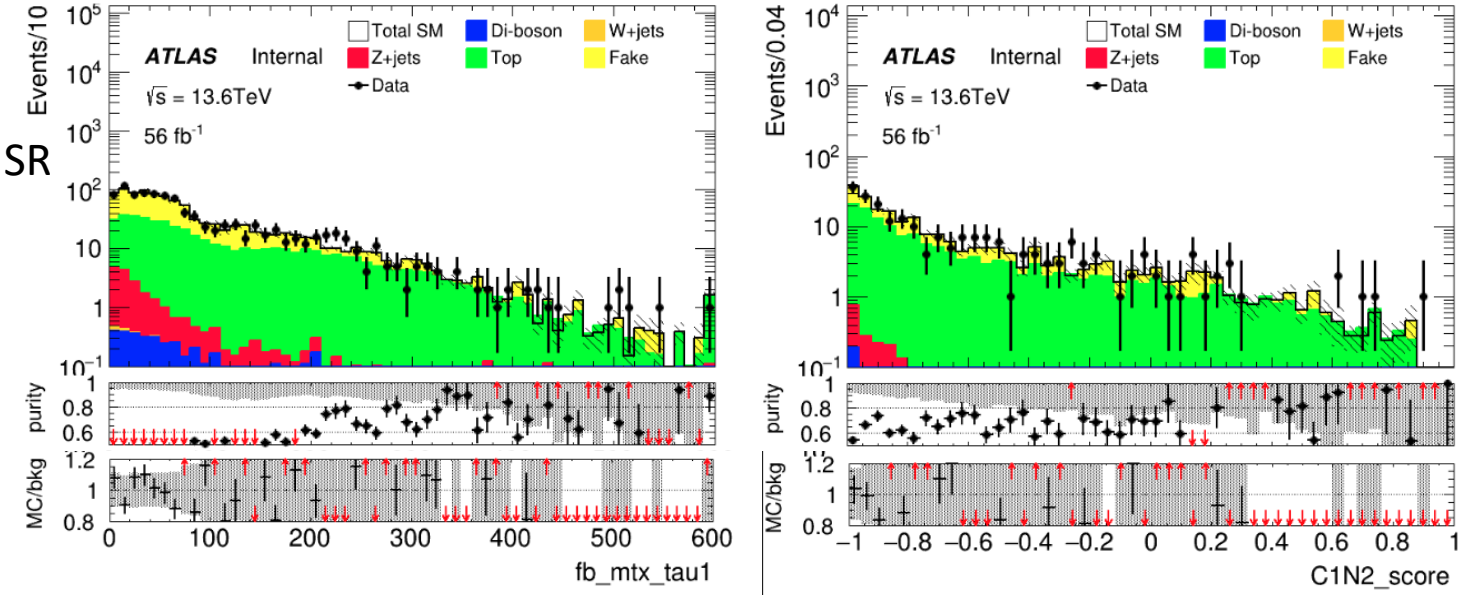
HH pre-selection(remove bVeto and add bJets > 0)

$M_T(tau1, MET) > 150$

Orthogonal with SR



CR: C1N2 score < -0.2

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)

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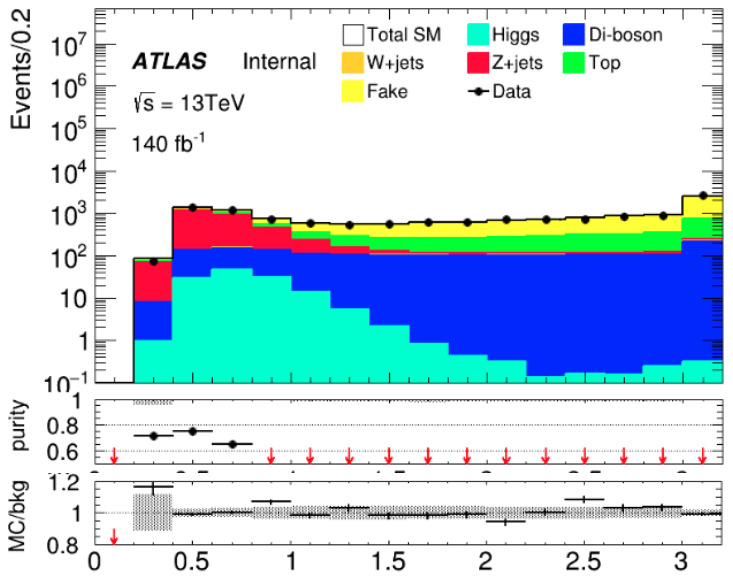
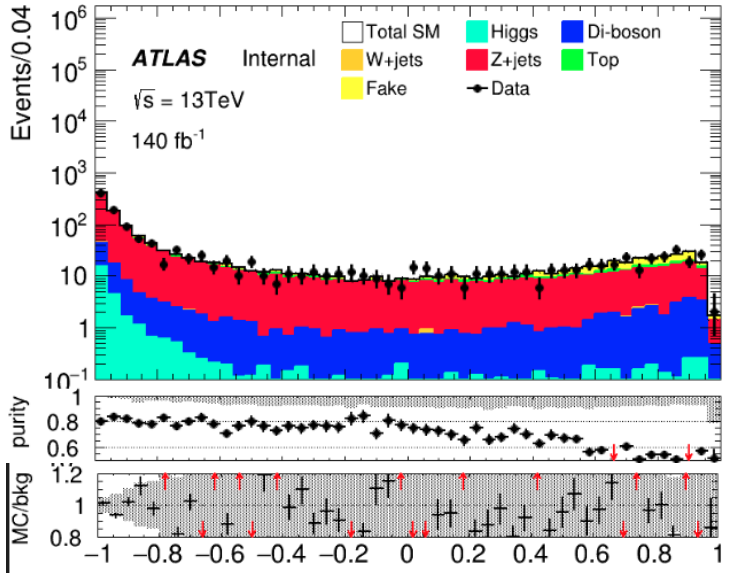
HH pre-selection(drop Mtt reco cut)
dRtt <= 0.6

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	608.46	3.54483	749.339	6.77819	747	0.811996	0.996879
C1N2_score	score_VR_02_19	445.198	3.13754	637.244	7.72386	642	0.698630	1.007463

LH channel: Z bkg estimation(run3)

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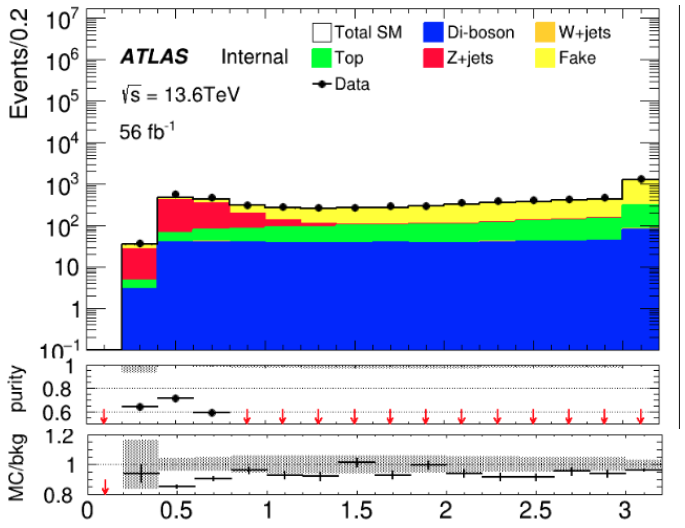
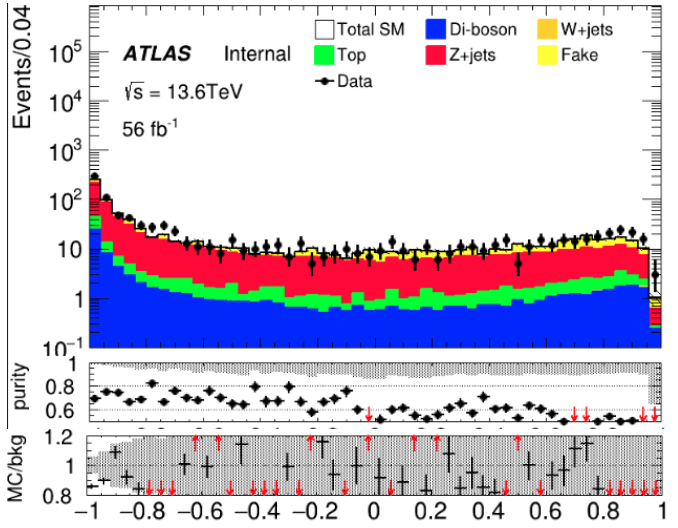
HH pre-selection(drop Mtt reco cut)
dRtt <= 0.8

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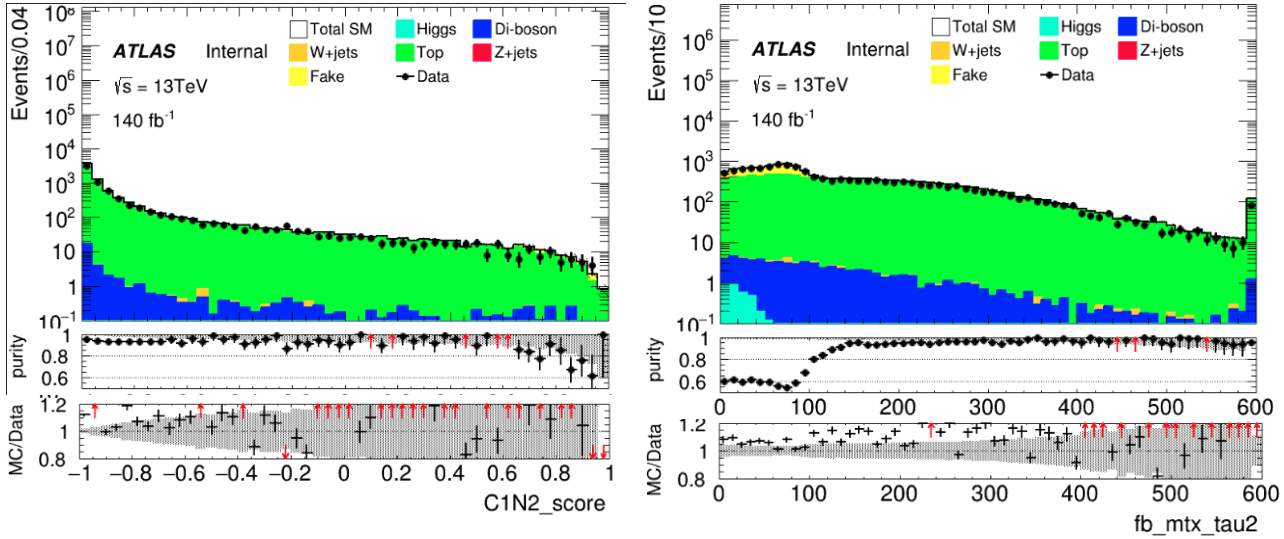
HH pre-selection(remove bVeto and add bJets > 0)

$M_T(tau2, MET) > 110$

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(run2)

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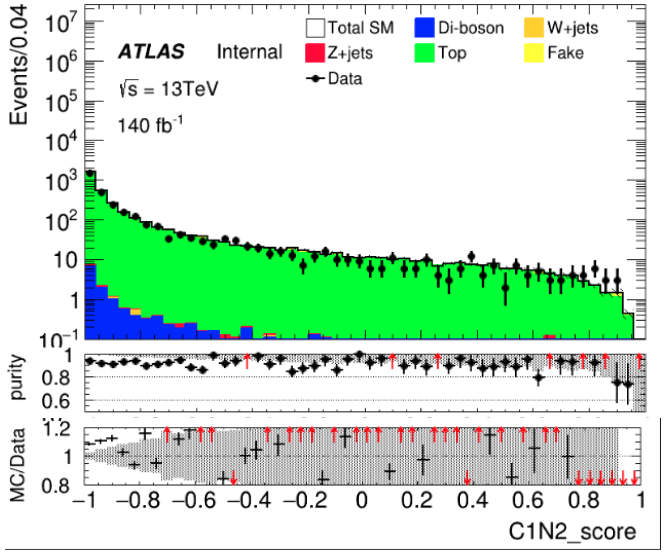
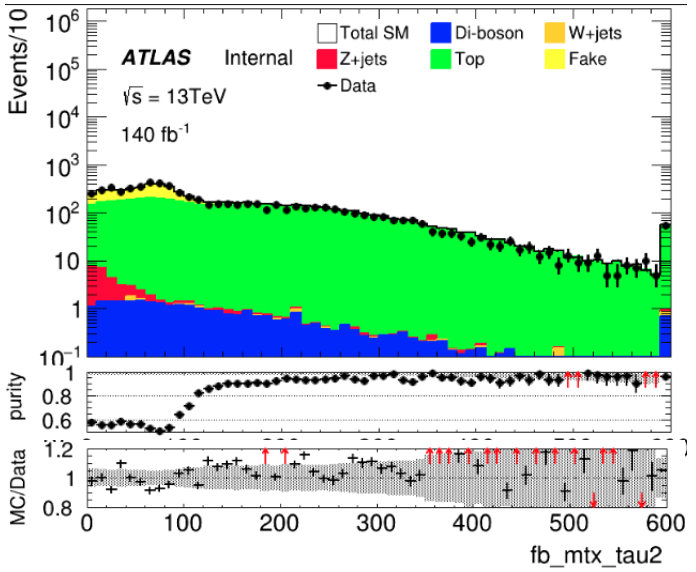
HH pre-selection(remove bVeto and add bJets > 0)

$M_T(tau2, MET) > 110$

Orthogonal with SR





CR: C1N2 score < -0.5

VR: -0.5 < C1N2 score < 1.0

VarName	RegionName	RegionYields	RegionError	MCYields	MCError	Data	Purity	DataMC
C1N2_score	score_CR_00_05	2949.61	11.2502	3193.76	16.6039	2927	0.923554	0.916475
C1N2_score	score_CR_05_20	399.104	4.21815	430.817	6.07637	397	0.926387	0.921504

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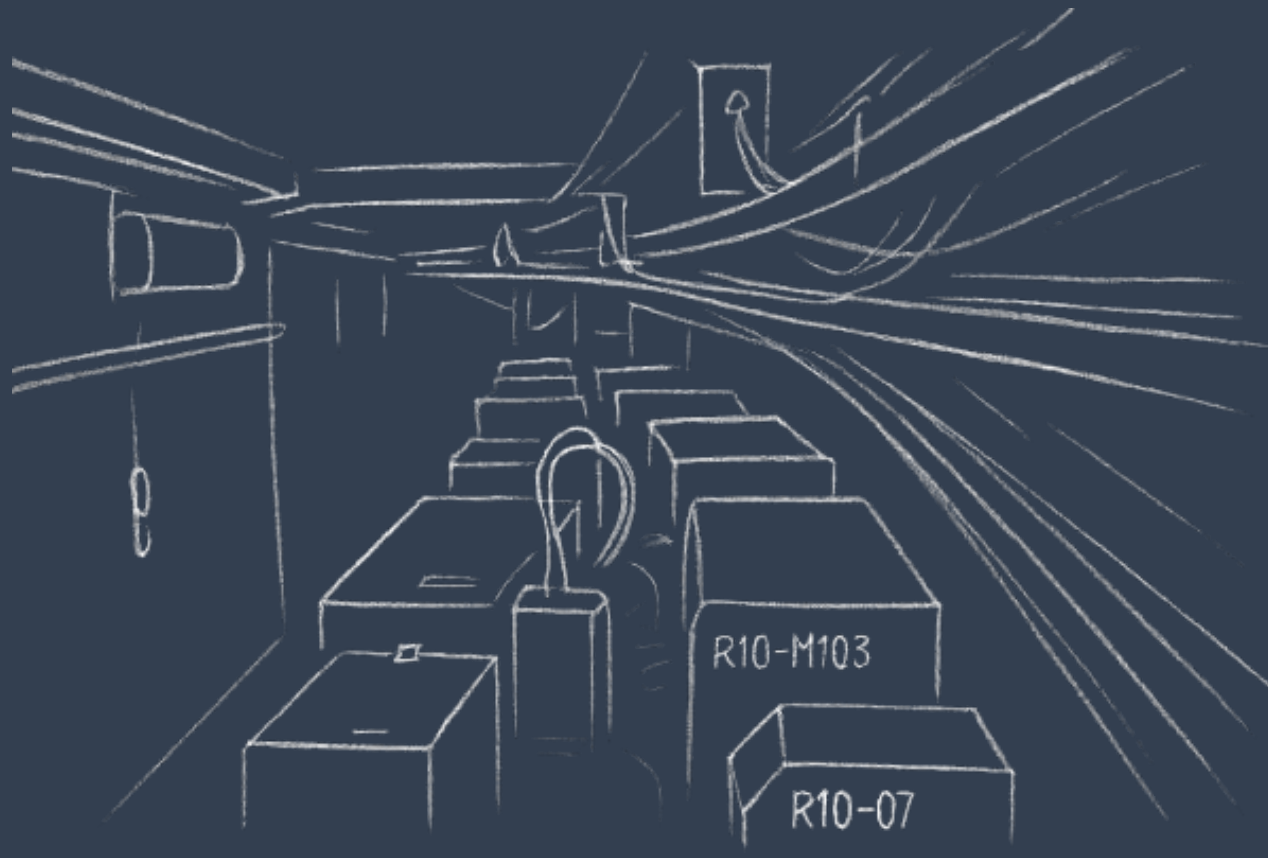
ATLAS EXPERIMENT

Backup



Distribution Check

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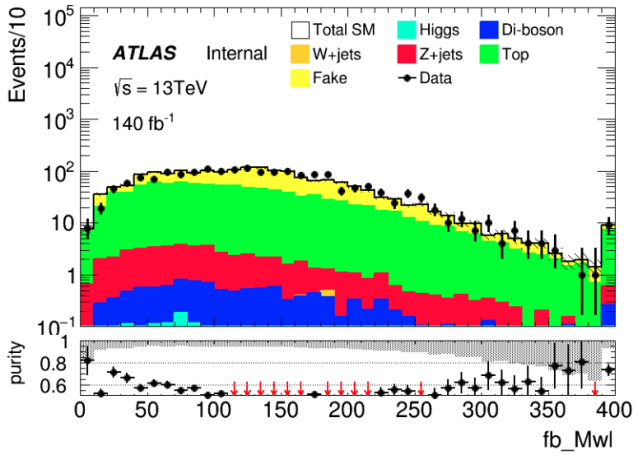
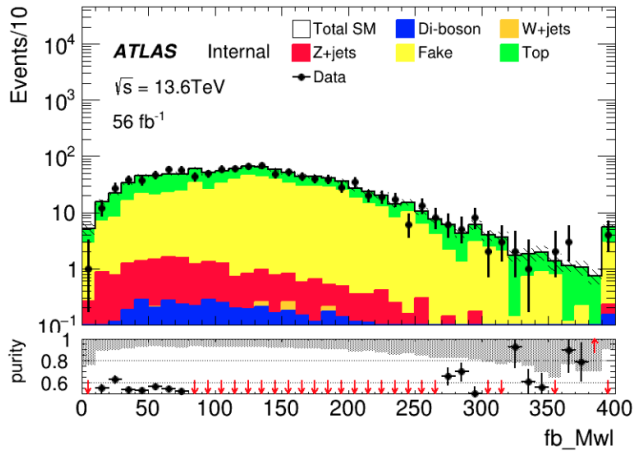
HH TCR run2

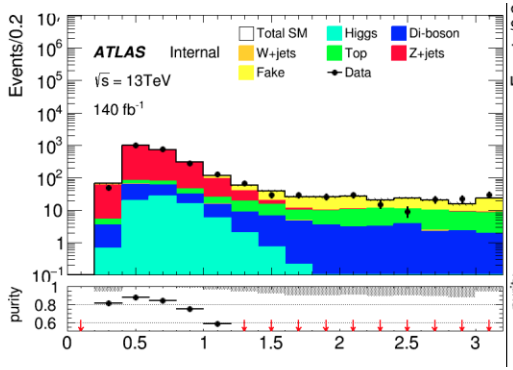


HH TCR run3

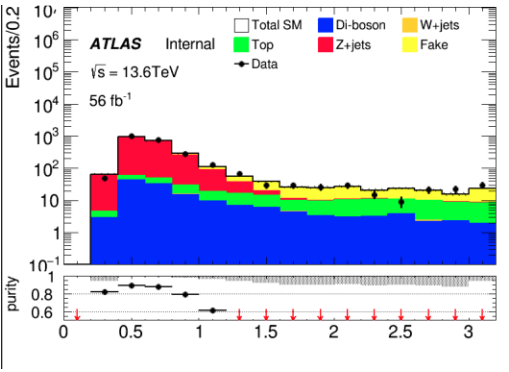


LH Channel
Change Mtt_reco to [10,130]

run2



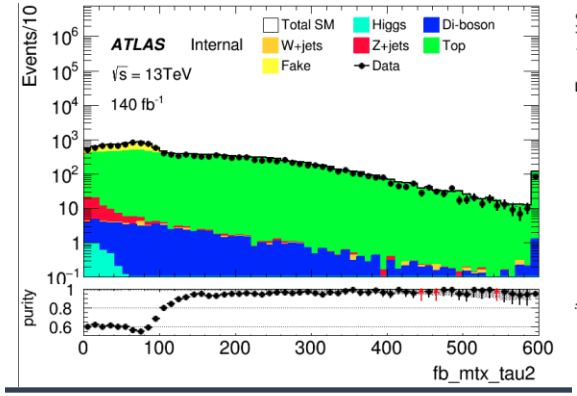
run3



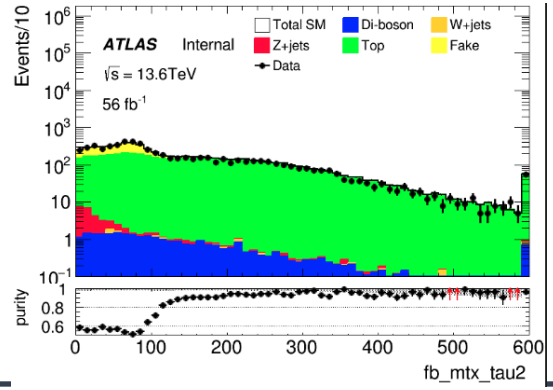
LH channel

$M_{inv}(tau2, MET)$

run2



run3



Cross-Check FF

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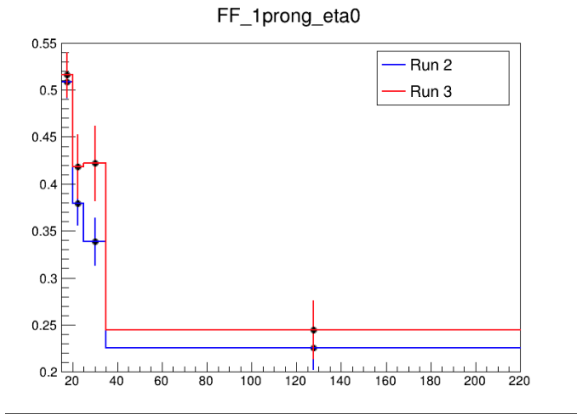
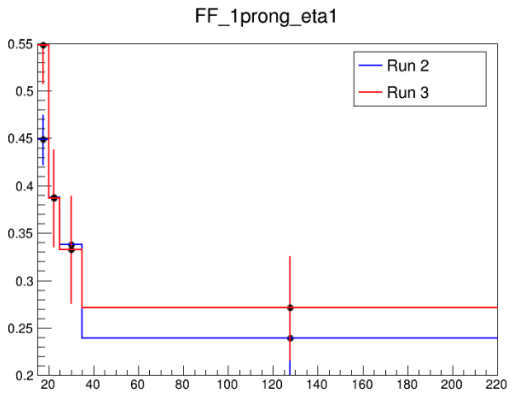
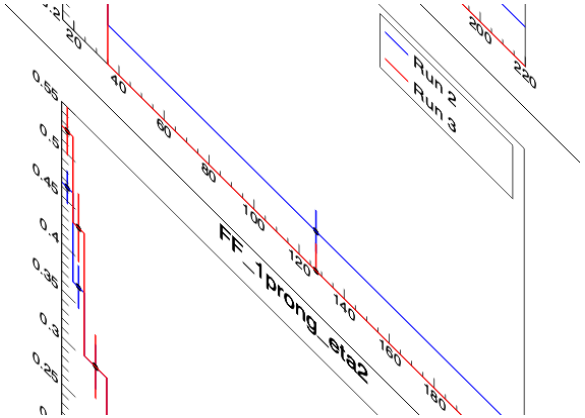
$0 < |\eta| < 1$ | $1 < |\eta| < 1.37$ | $1.52 < |\eta| < 2.5$

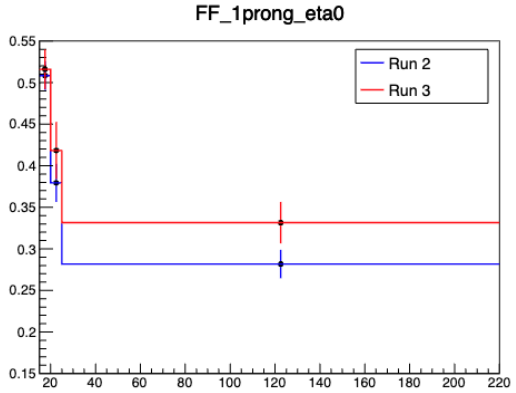
My result

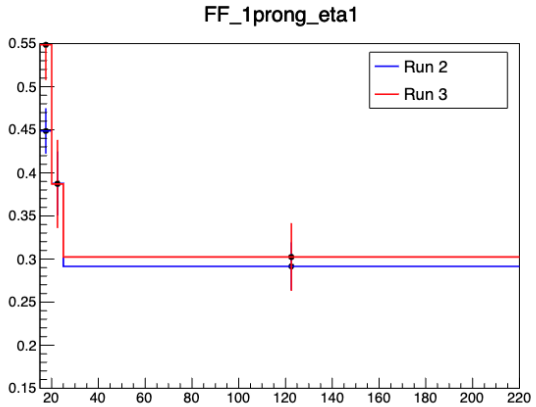


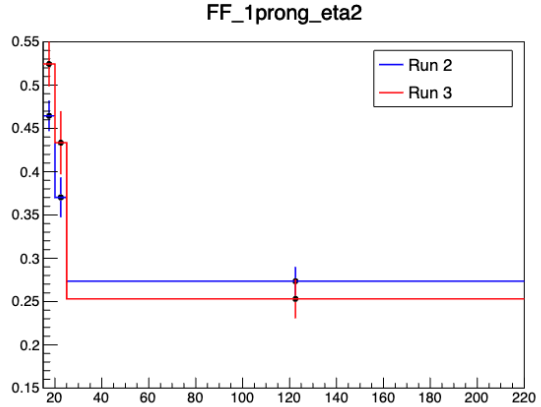




Wenyi's result







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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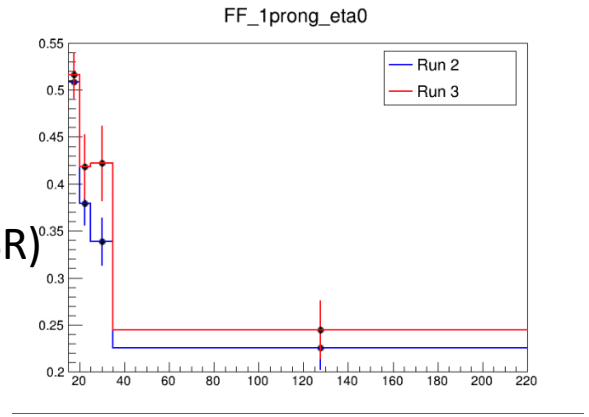
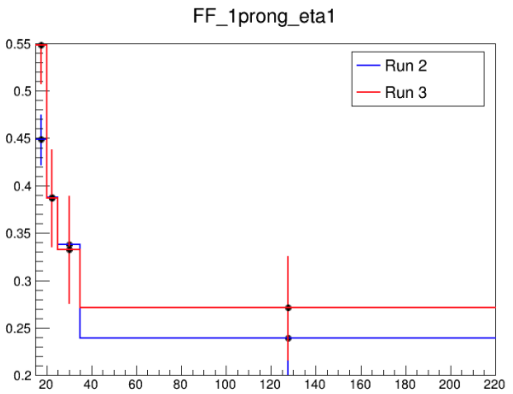
Selection:

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

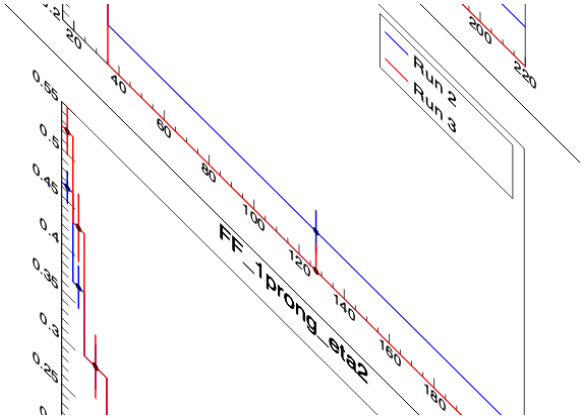
$0 < |\eta| < 1$



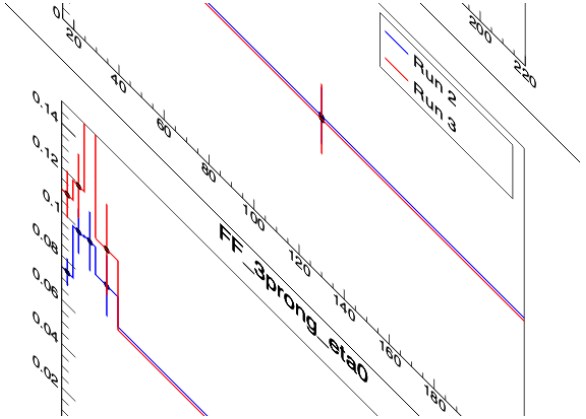
$1 < |\eta| < 1.37$

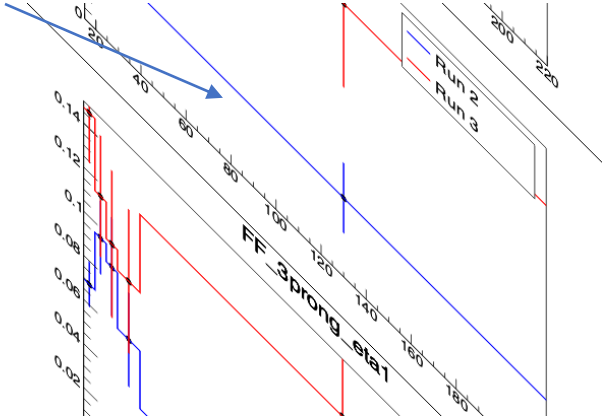


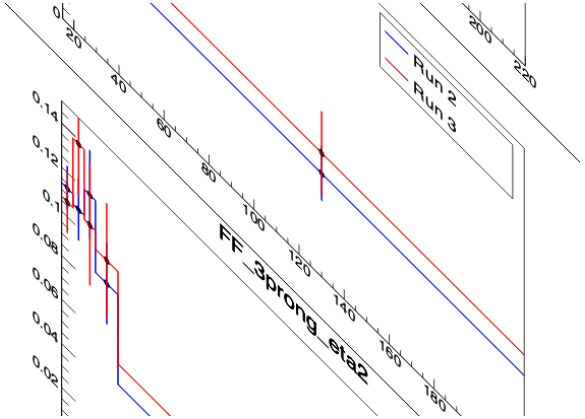
$1.52 < |\eta| < 2.5$



A small bump show in the last bin







MC modeling in Pre-Selection(HH)

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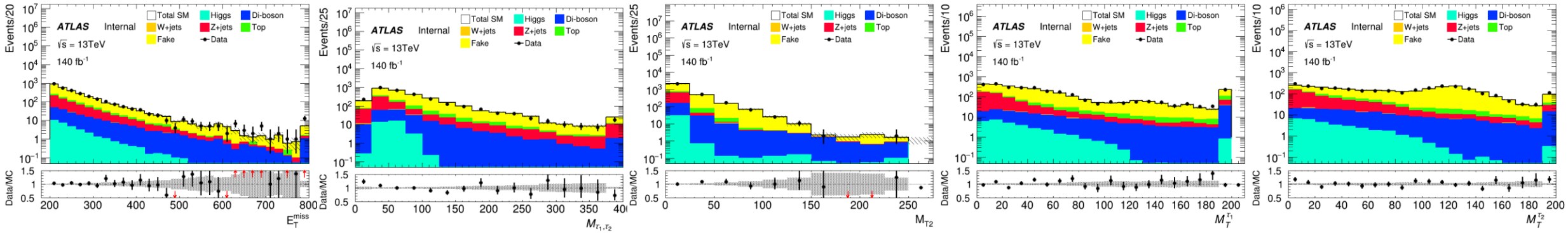
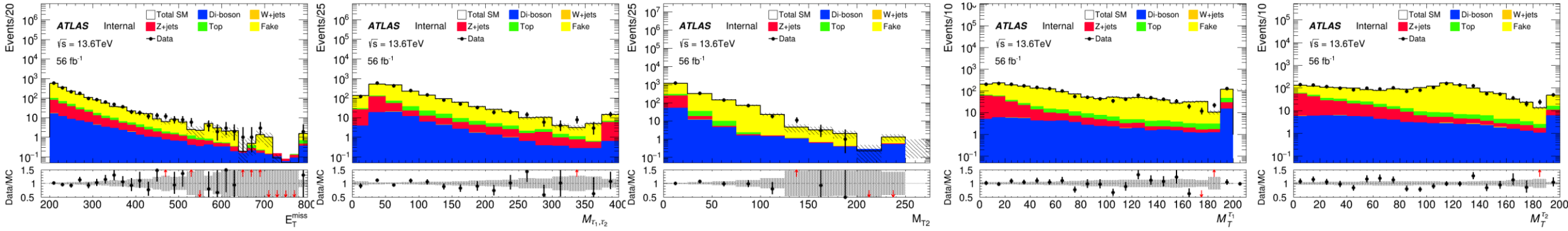
run2



run3



MC modeling in Pre-Selection(HH)

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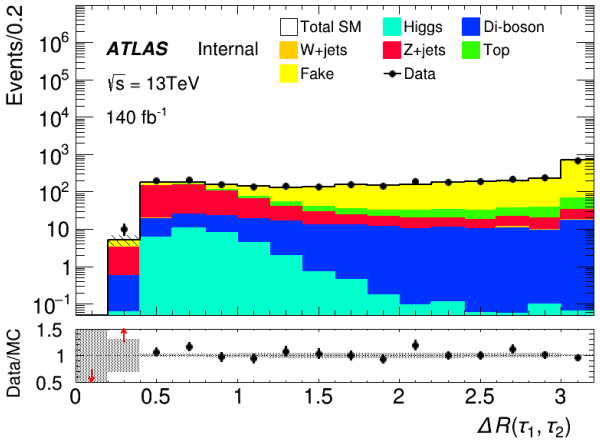
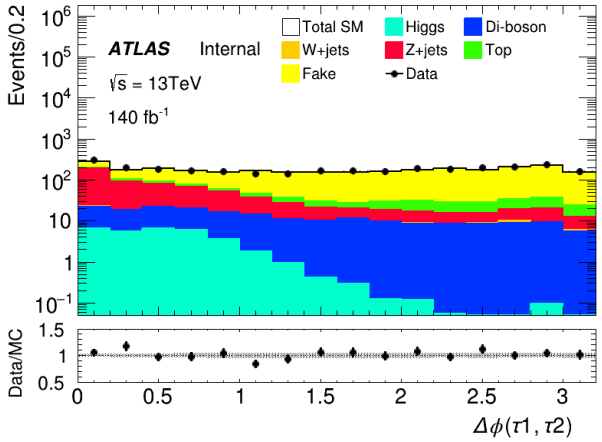
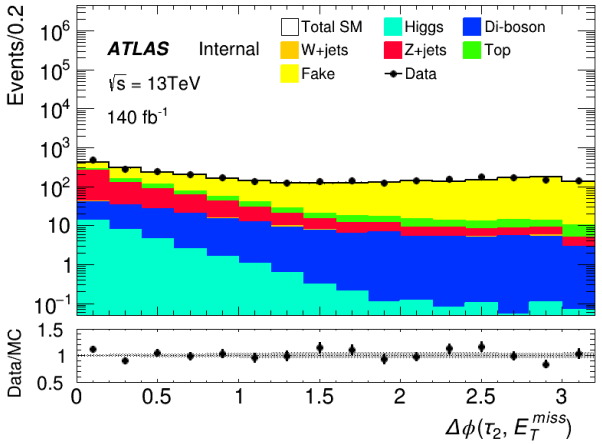
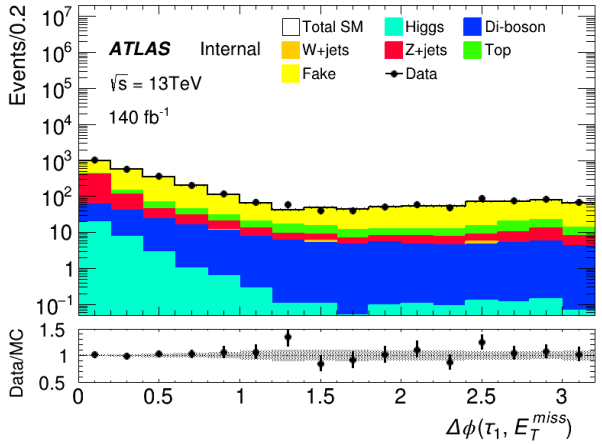
run2

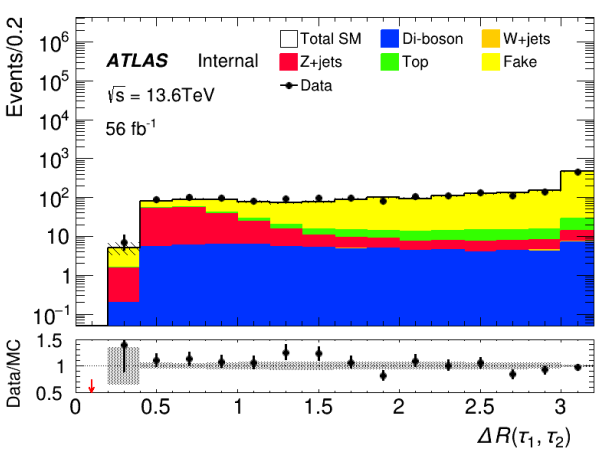


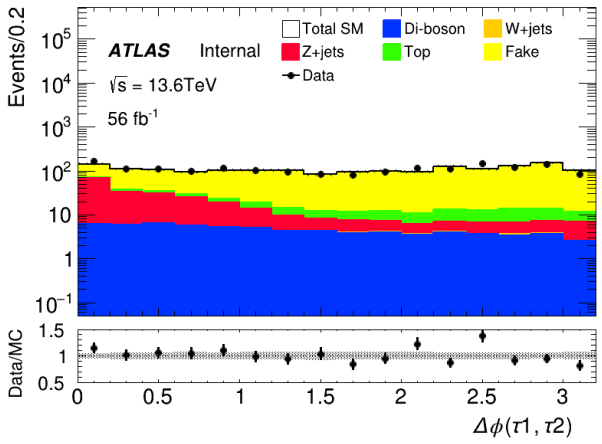


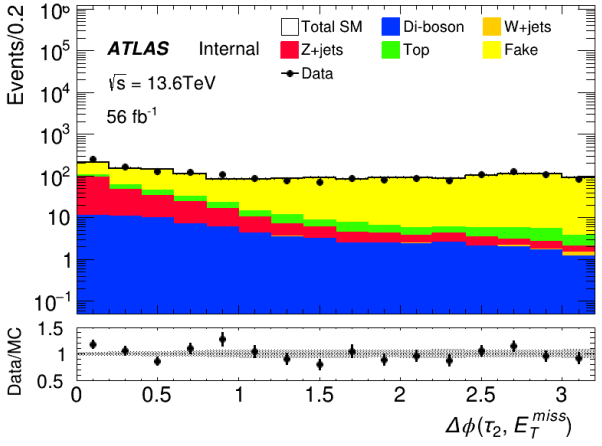


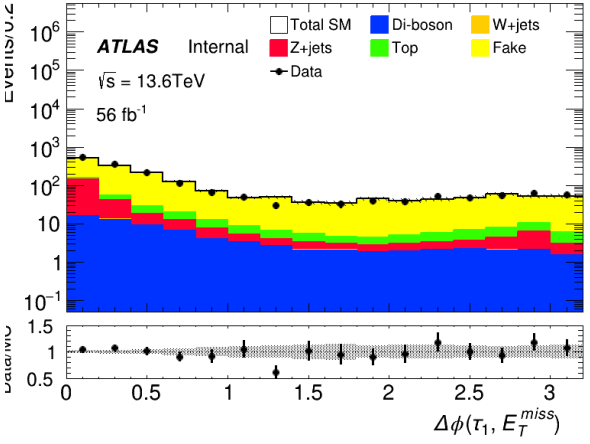


run3









MC modeling in Pre-Selection(HH)

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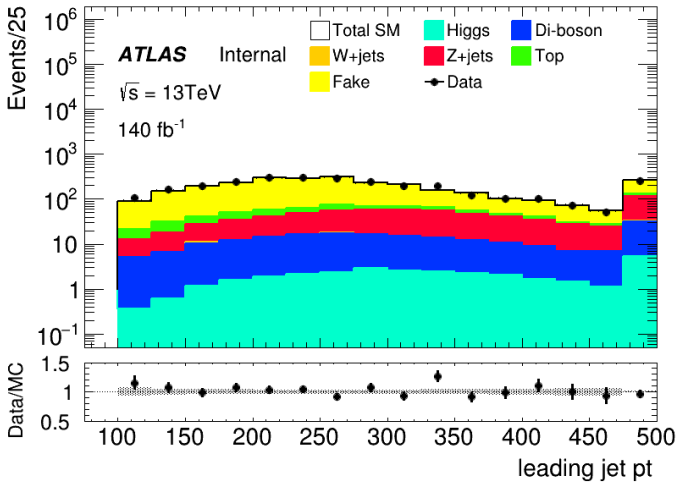
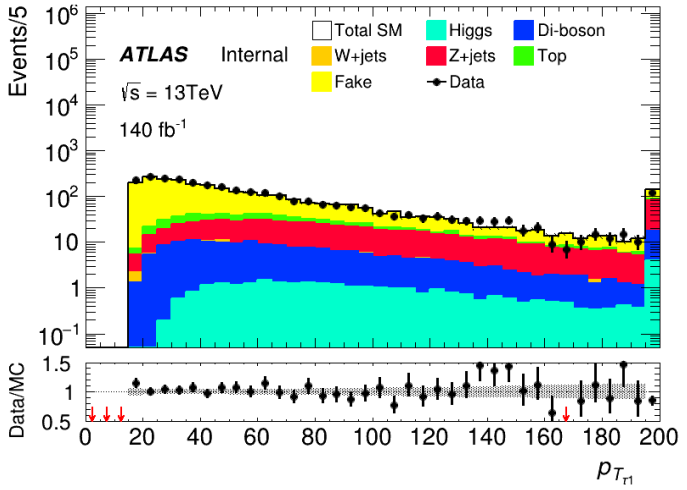
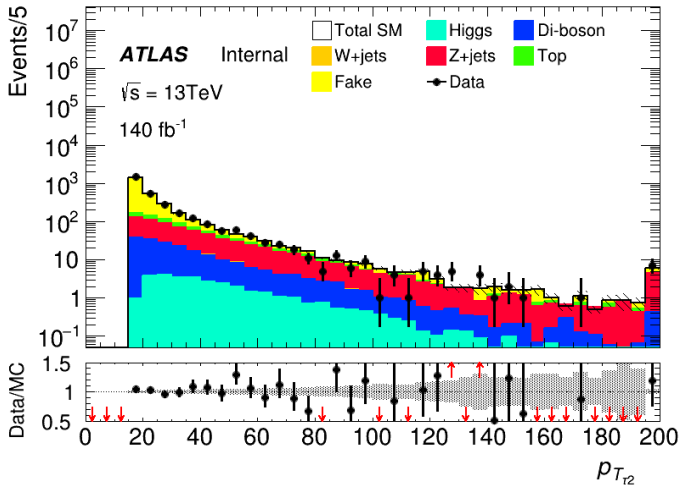
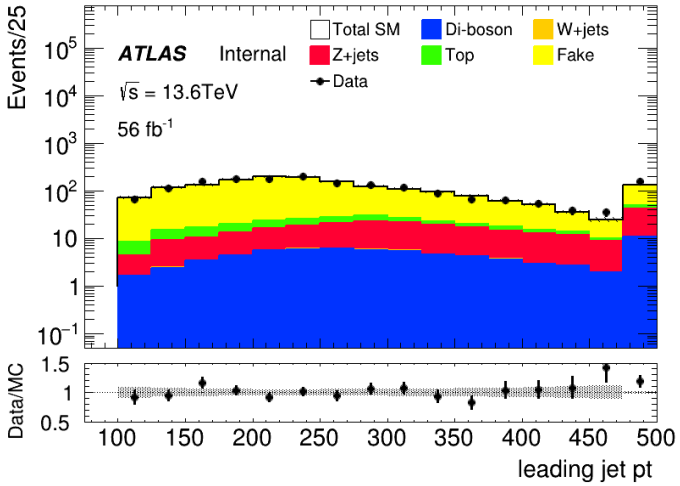
run2

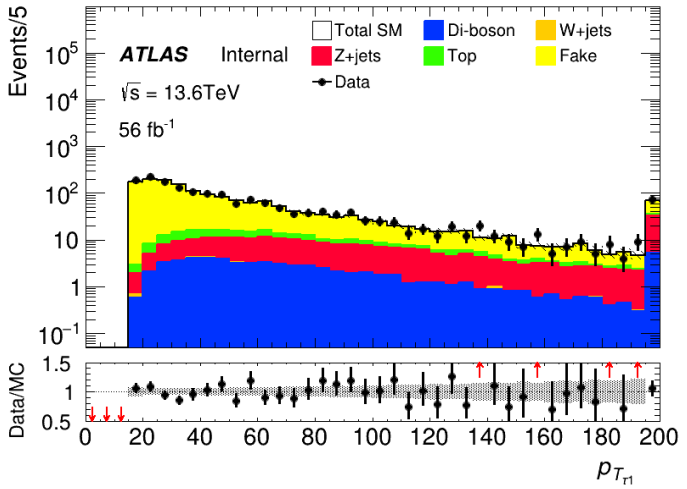


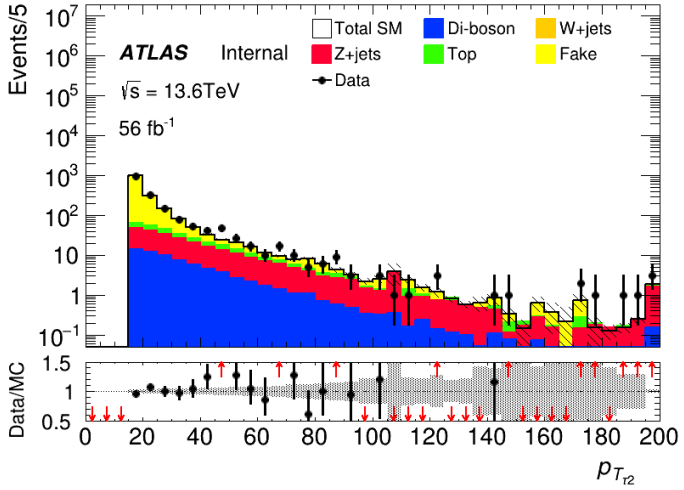




run3







MC modeling in Pre-Selection(LH)

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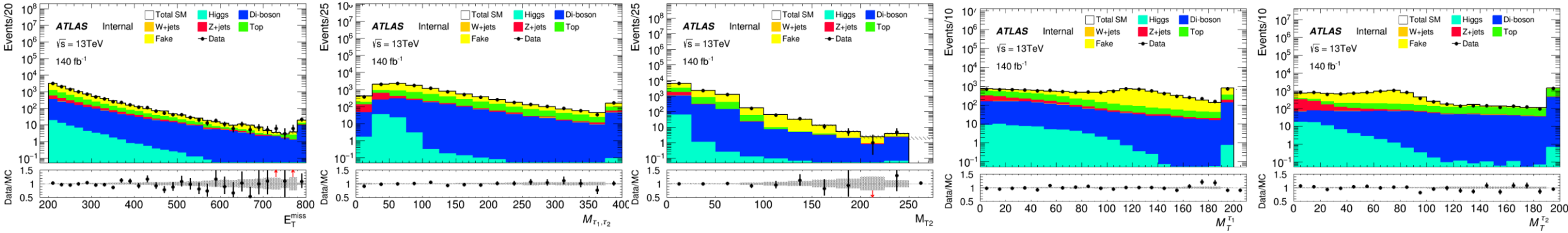
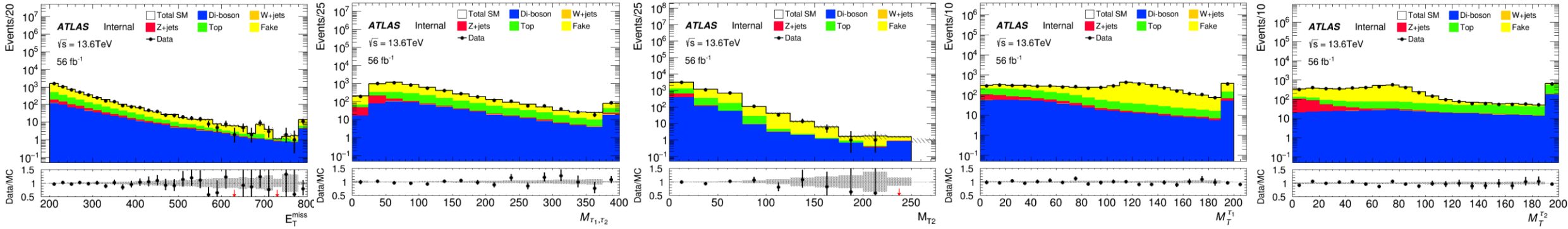
run2



run3



MC modeling in Pre-Selection(LH)

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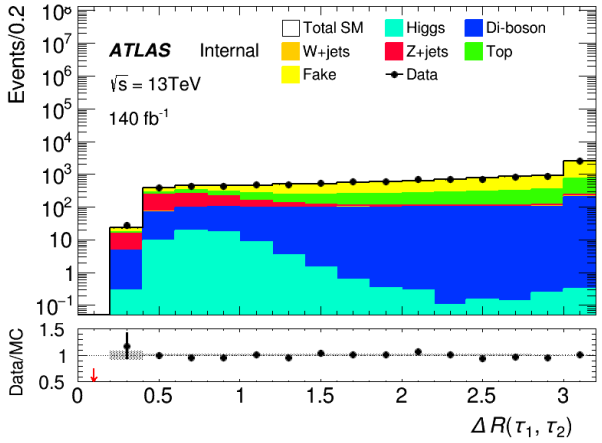
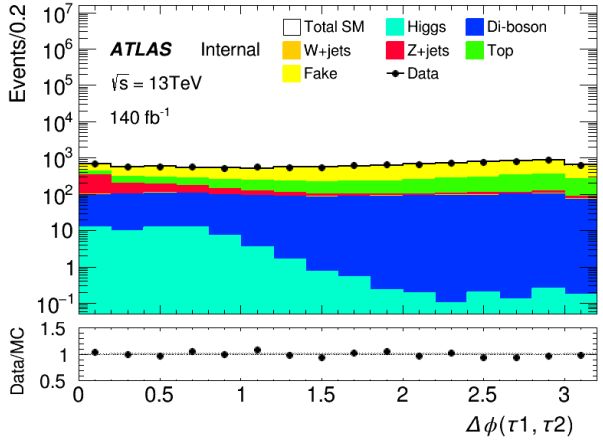
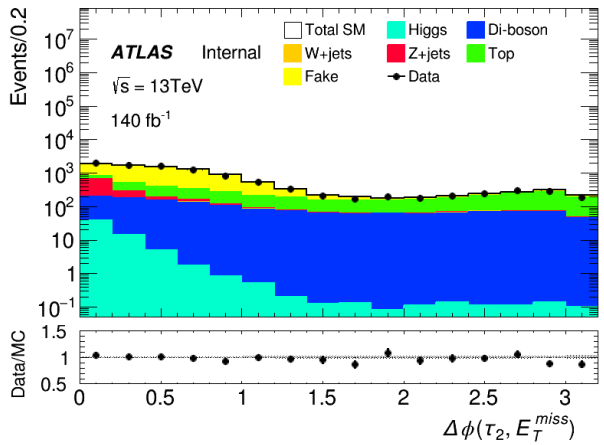
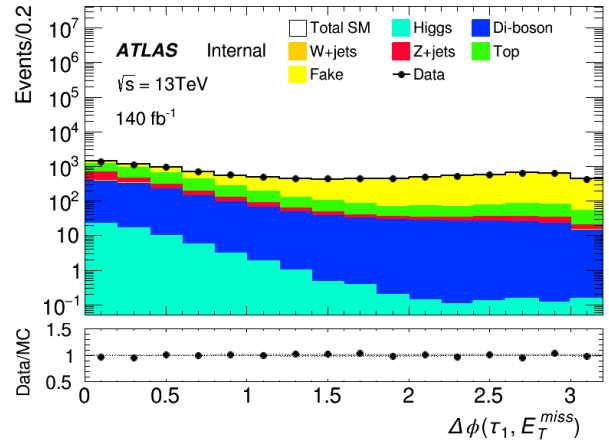
run2

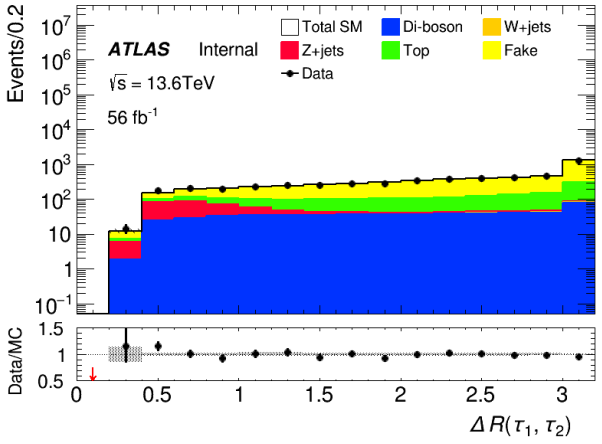


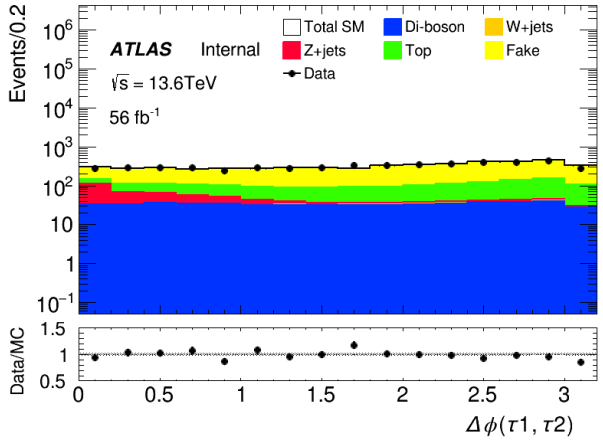


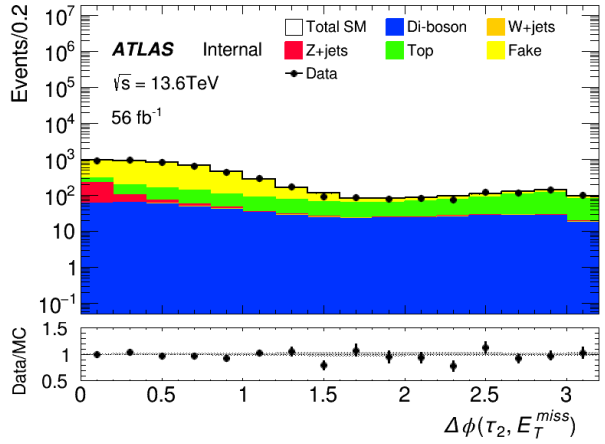


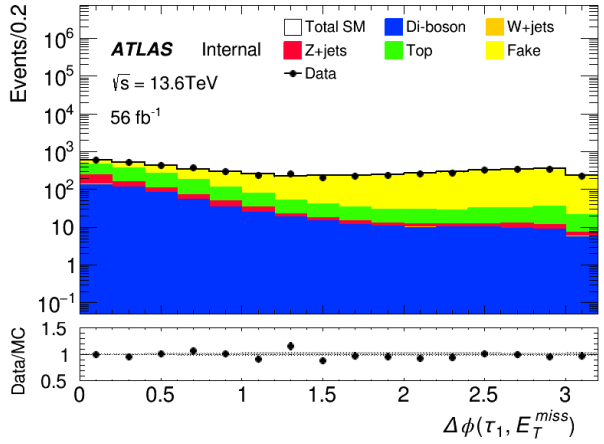


run3









MC modeling in Pre-Selection(LH)

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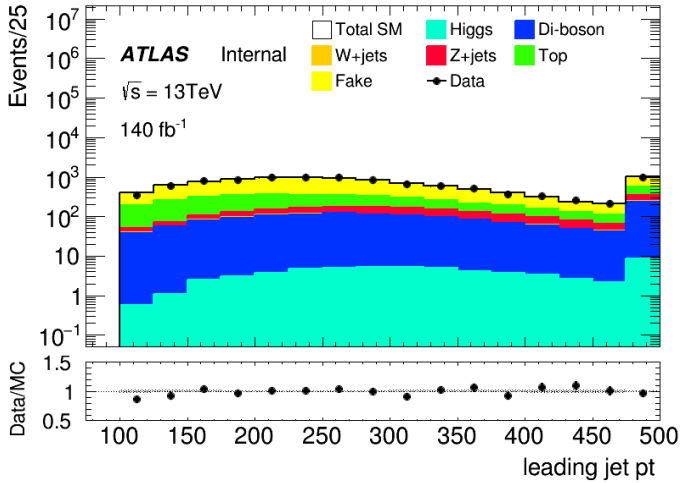
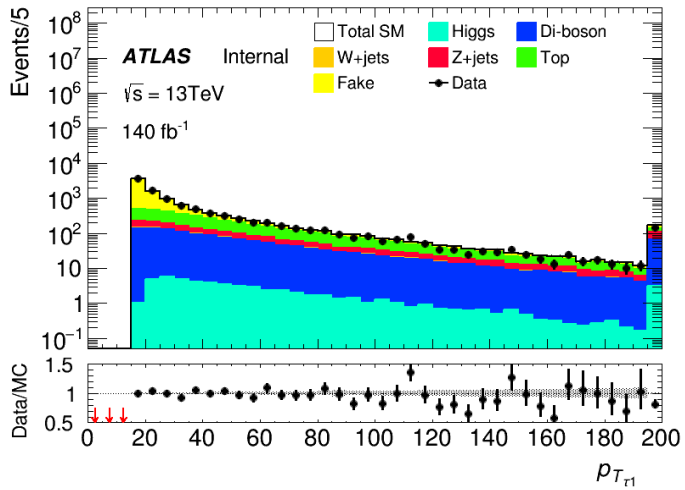
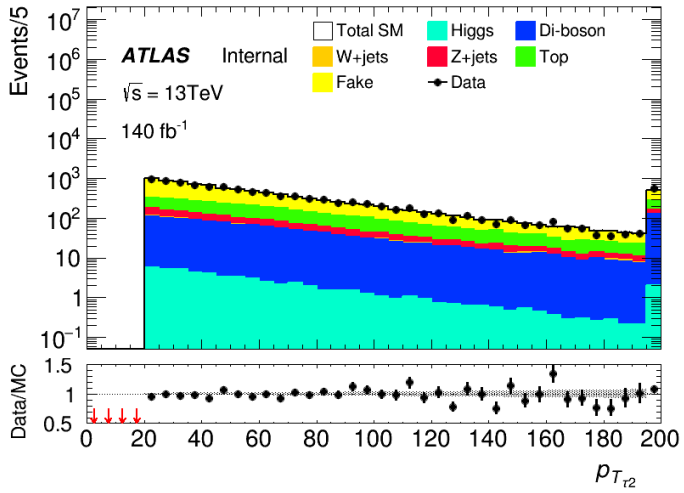
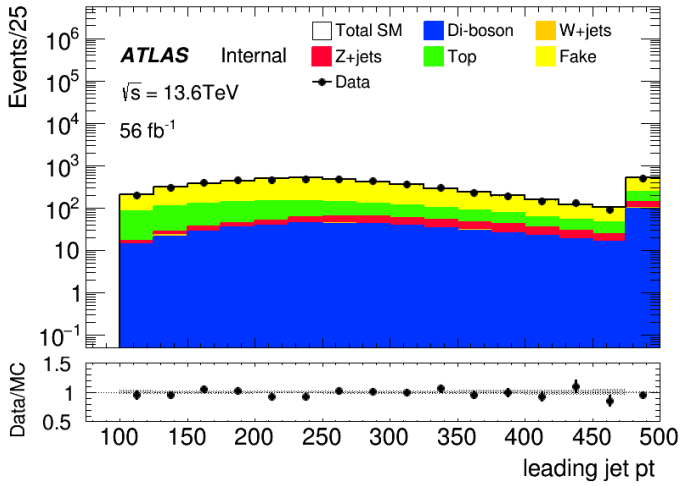
run2

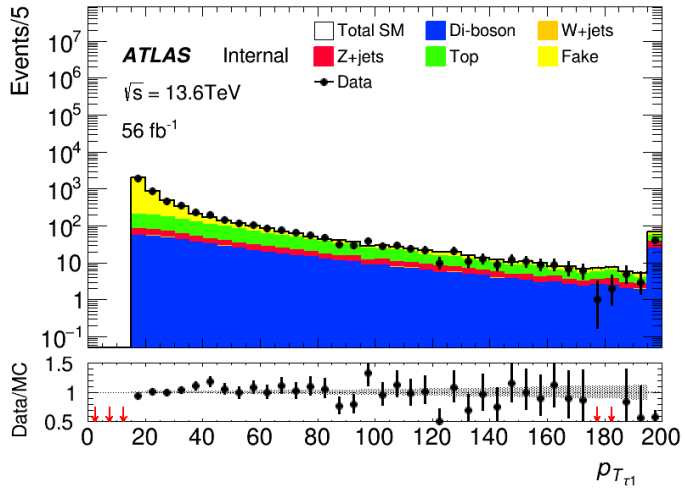


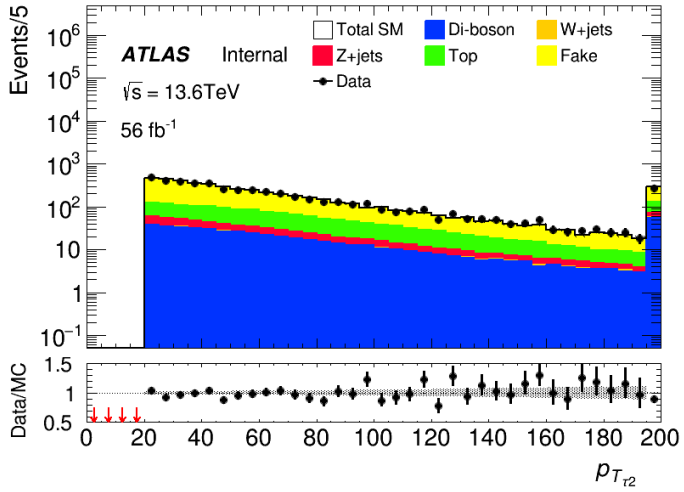




run3







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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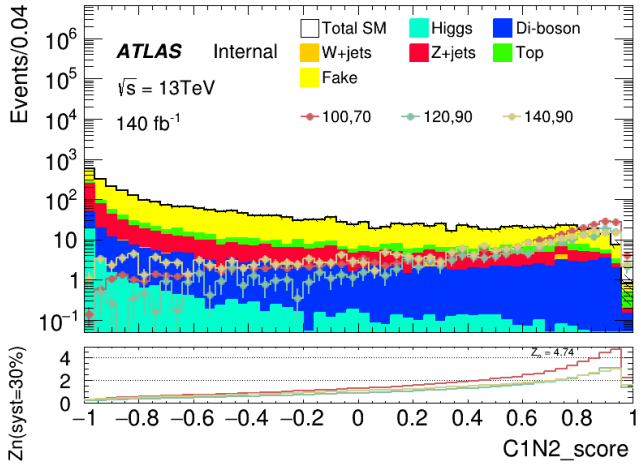
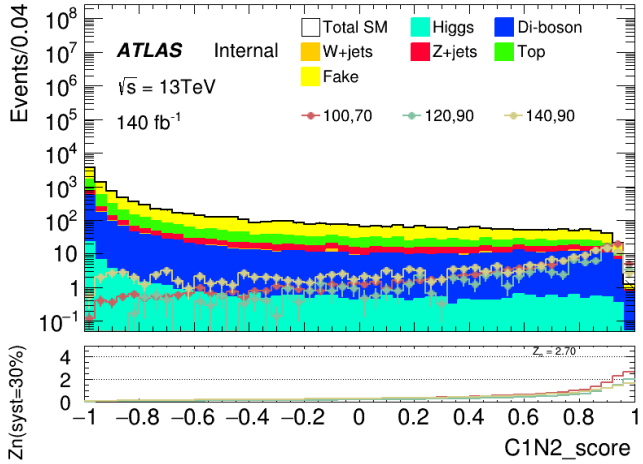
HH

LH

run2





run3