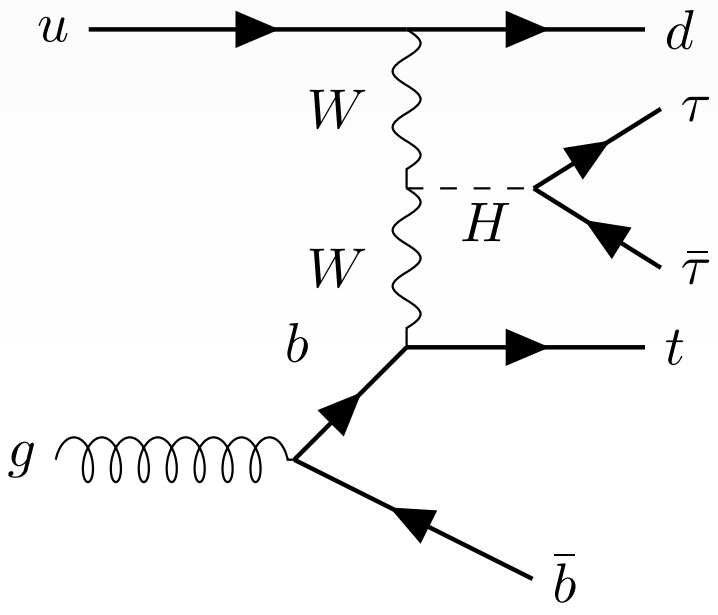
Hadronic Tau MVA

Christian Kirfel

24th November 2021

UNIVERSITÄT BONN

Selection dileptau



- n-jets: 2-6 (b-jets: **1**)
- b-jet WP: 70 DL1r
- nLeptons & nTaus:
  2e/μ **1**τ_{had}(1 OS light lepton)
- $E_{\text{T,miss}}$: no cut (to 800 GeV)

- jets:
  - $p_T > 25$ GeV
  - $|\eta| < 4.5$
  - EMPFlow
- electrons:
  - $p_T > 20$ GeV trigger matched 27 GeV
  - $|\eta| < 2.5$ not in 1.37 - 1.52
  - WP: Tight ;
    isolation: PLIVTight
- muons:
  - $p_T > 20$ GeV trigger matched 27 GeV
  - $|\eta| < 2.5$
  - WP: Tight ; isolation: PLIVTight
- taus:
  - $p_T > 20$ GeV trigger matched 27 GeV
  - $|\eta| < 2.5$ not in 1.37 - 1.52
  - WP: RNNMedium
  - ASG recommended OLR (τ_{had} remove jets)

Features

eta_jf	forward jet eta
pt_jf	forward jet transverse momentum
mass_jf	forward jet mass
phi_jf	forward jet phi
eta_b	b-jet eta
pt_b	b-jet transverse momentum
mass_b	b-jet mass
phi_b	b-jet phi
MMC_out_1	reconstructed Higgs mass
m_met	Missing energy
met_x	Missing energy x-component
met_y	Missing energy y-component
Reco_w_Tmass_1	Reconstructed Tmass of the W case 1
Reco_w_mass_1	Reconstructed mass of the W case 1

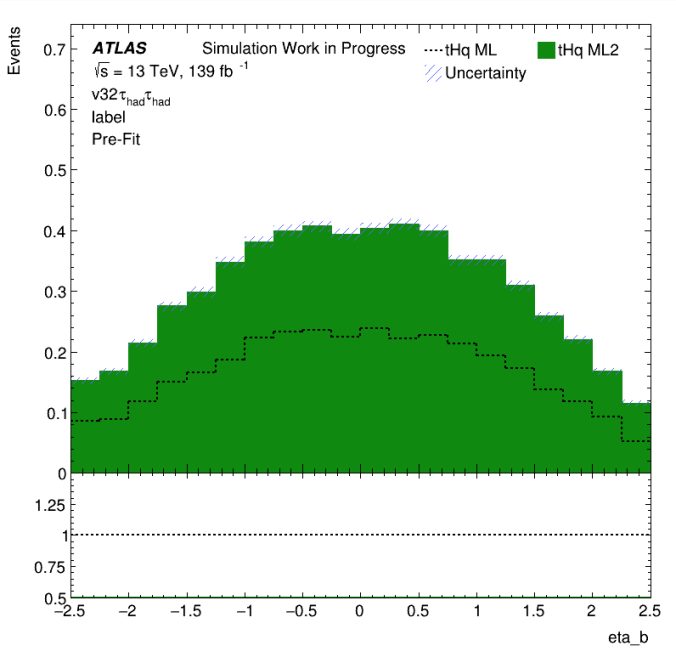
deltaRTau	Delta R of the hadronic taus
deltaPhiTau	Delta phi of the hadronic taus
HvisPt	pt of LorentzV sum of hadronic taus
HvisEta	eta of LorentzV sum of hadronic taus
TvisMass	mass of reconstructed top
TvisPt	pt of visible top
TvisEta	eta of visible top
fs_had_tau_1_pt	Hadronic tau pt
fs_had_tau_1_eta	Hadronic tau eta
fs_had_tau_1_m	Hadronic tau m
lep_Top_pt	Light lepton pt
lep_Top_eta	Light lepton eta

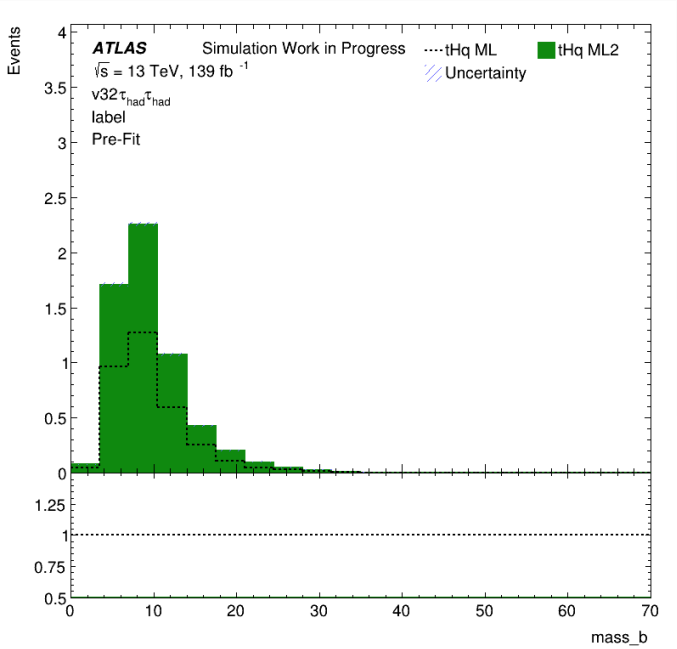
- Experimented with many setups.
- Ranking is planned for documentation but no improvement is expected

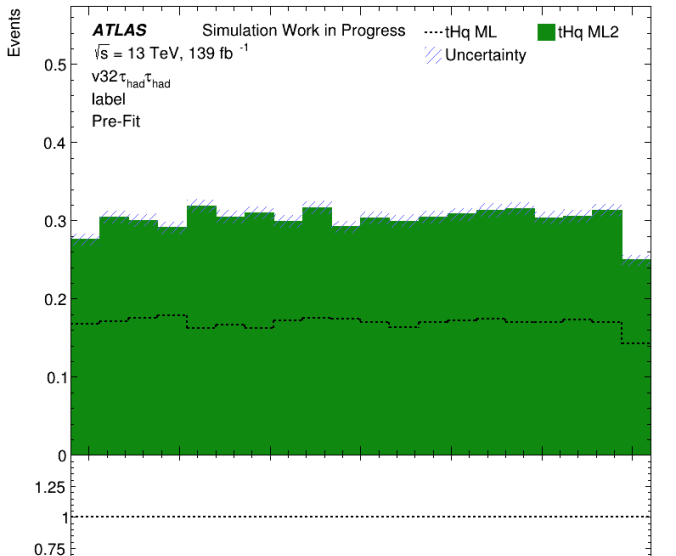
Lephad Hyperparameters

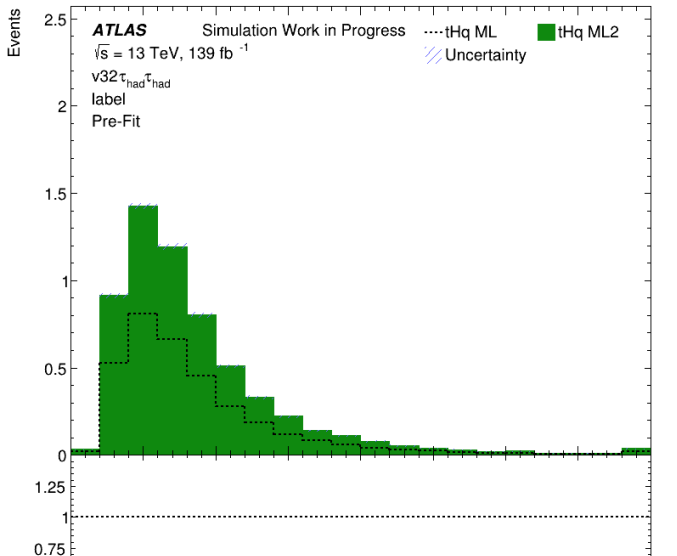
Hyperparameter	Setting
Nodes	120
Layers	6
Dropout	0.65
Batchnormalisation	On
Activation	elu
Output activation	sigmoid
Batch size	1000
Optimisation	Adam
Weight Initialisation	Lecun Normalisation

Negative weight handling

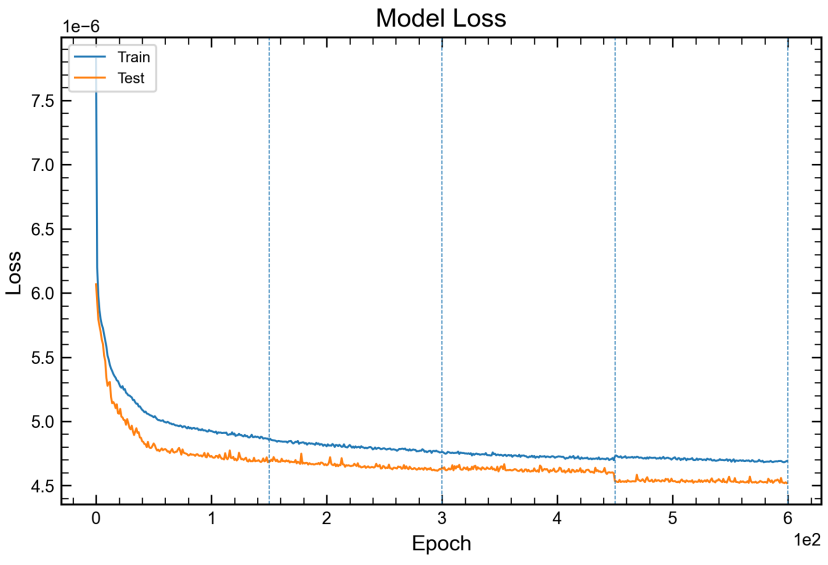


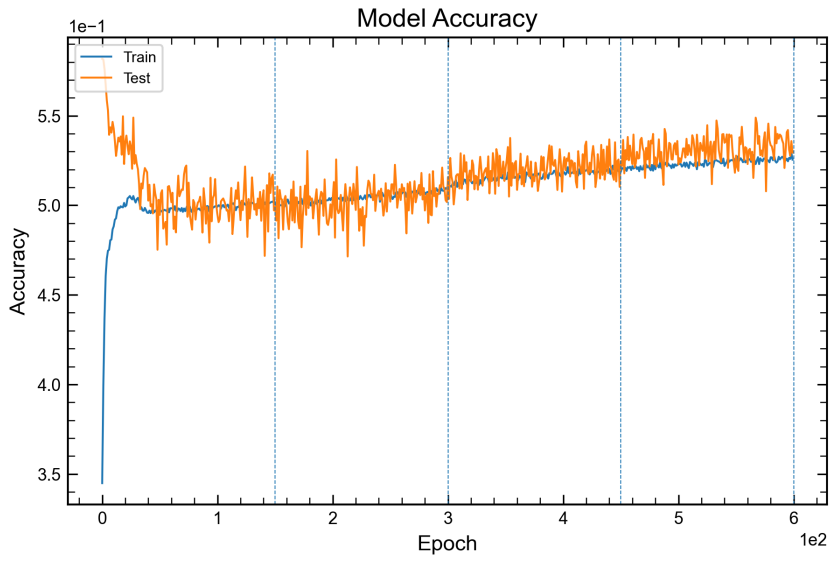




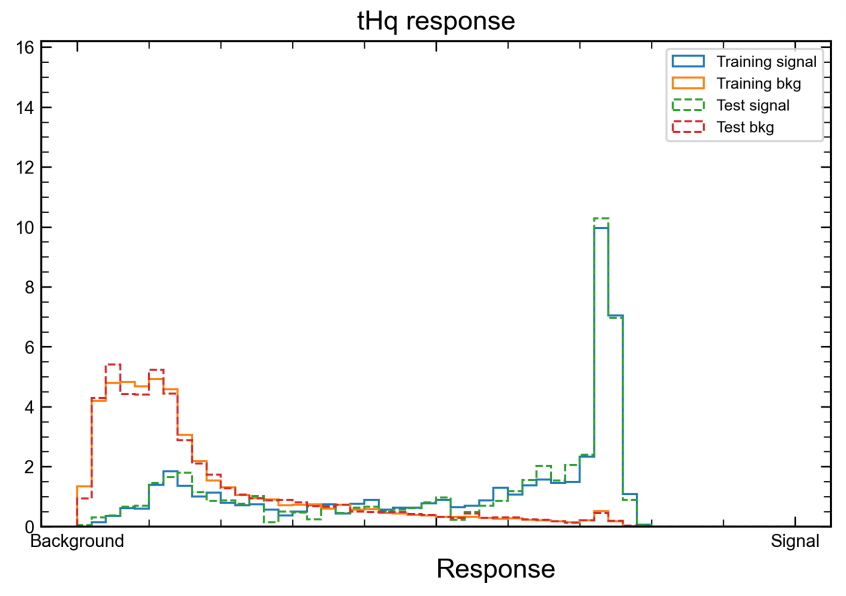


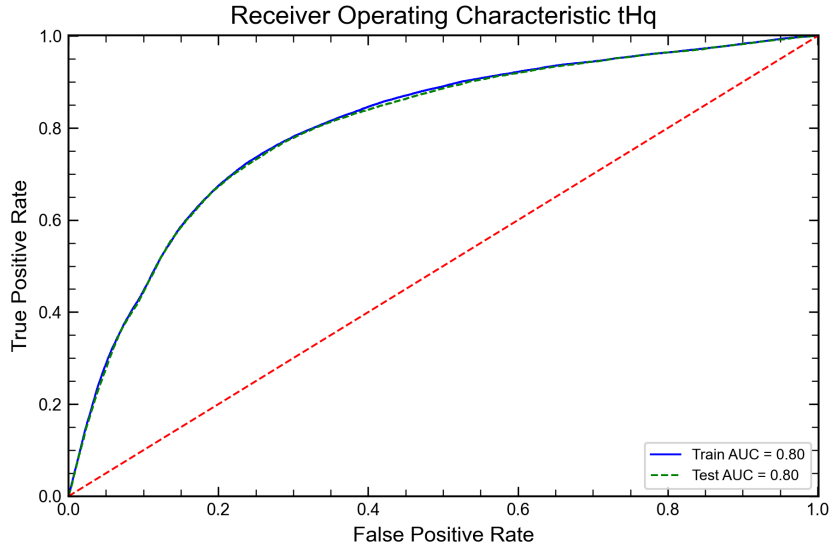
Monitoring lephad



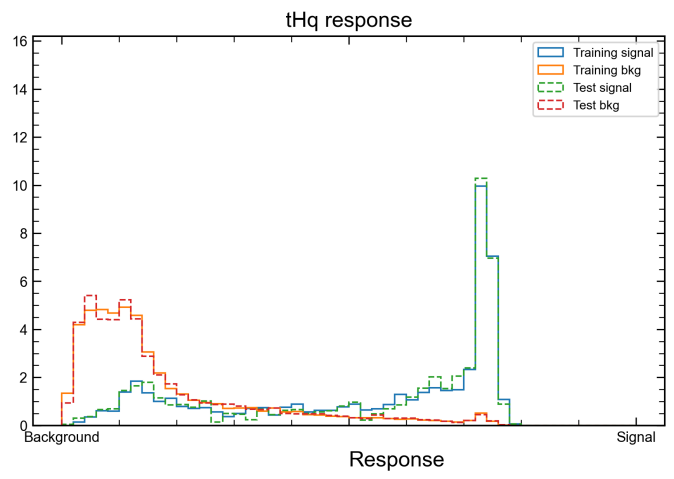


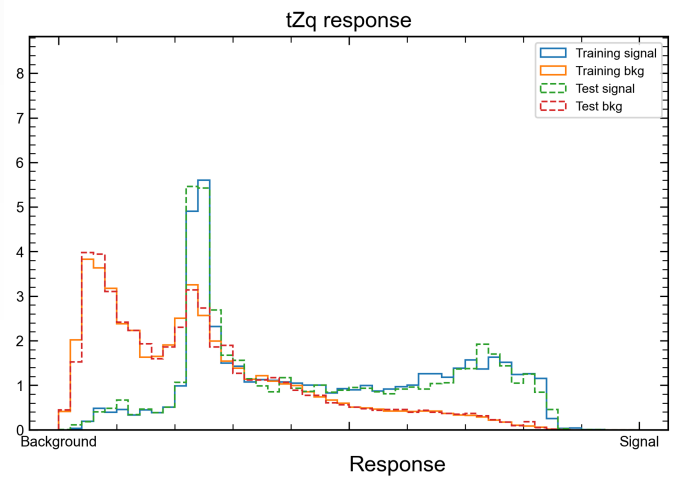
Results lephad

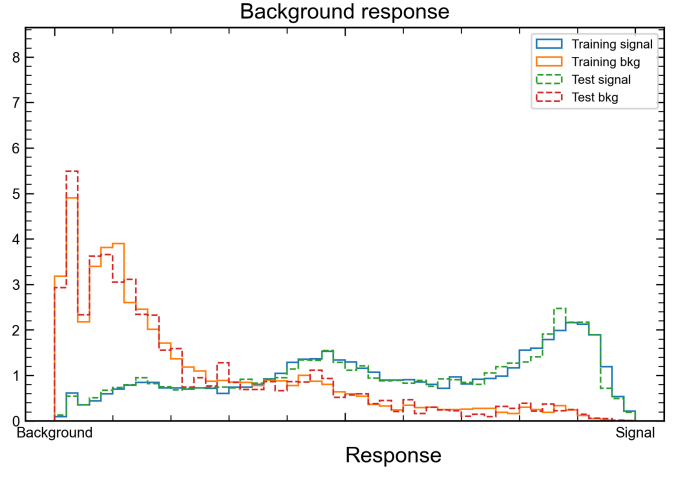


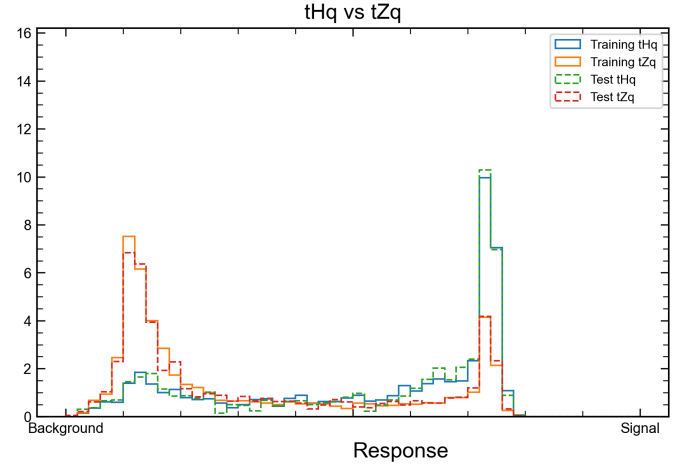


Responses


tHq response
Training signal
Training bkg
Test signal
Test bkg
Background
Signal
Response


tZq response
Training signal
Training bkg
Test signal
Test bkg
Background
Signal
Response

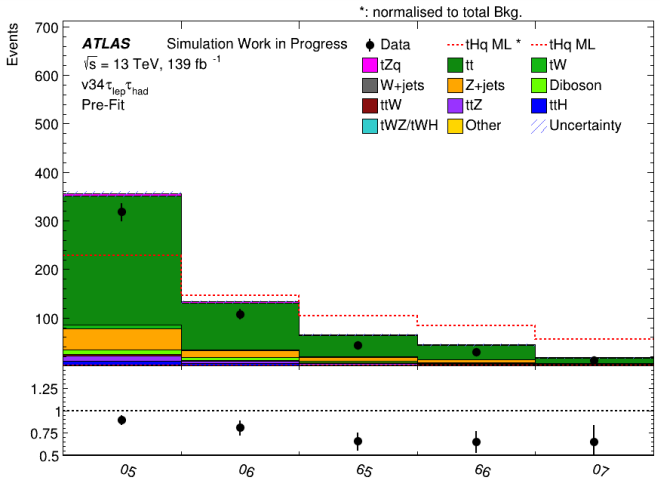

Background response
Training signal
Training bkg
Test signal
Test bkg
Background
Signal
Response

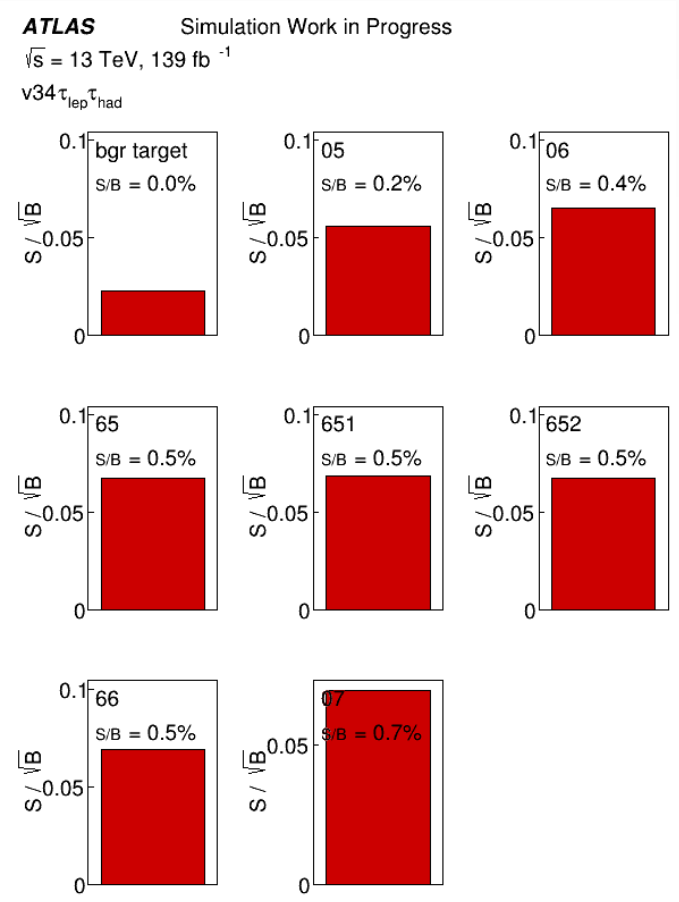

tHq vs tZq
Training tHq
Training tZq
Test tHq
Test tZq
Background
Signal
Response

Yields

	bgr target	05	06	65	651	652	66	07
tHq ML	2.09 ± 0.04	1.309 ± 0.033	1.130 ± 0.031	0.981 ± 0.029	0.959 ± 0.028	0.976 ± 0.028	0.903 ± 0.027	0.725 ± 0.024
tZq	42.4 ± 0.5	11.08 ± 0.32	8.87 ± 0.30	7.39 ± 0.29	7.26 ± 0.29	7.29 ± 0.29	6.58 ± 0.28	4.71 ± 0.27
tt	4712 ± 15	365 ± 4	182.6 ± 3.4	116.9 ± 2.9	106.2 ± 2.8	116.5 ± 2.9	93.6 ± 2.7	58.0 ± 2.4
tW	227 ± 6	11.9 ± 1.7	5.5 ± 1.4	4.7 ± 1.4	3.9 ± 1.4	4.7 ± 1.4	4.0 ± 1.4	2.6 ± 1.3
W+jets	5.1 ± 1.2	3.4 ± 1.1	3.3 ± 3.1	3.3 ± 3.1	3.0 ± 3.1	3.3 ± 3.1	2.1 ± 0.9	1.9 ± 3.1
Z+jets	2850 ± 70	54 ± 6	21 ± 4	13.1 ± 3.5	12.4 ± 3.2	13.0 ± 3.5	8.7 ± 3.0	5.3 ± 2.0
Diboson	150.8 ± 2.0	19.9 ± 0.6	14.6 ± 0.5	11.6 ± 0.5	11.1 ± 0.5	11.5 ± 0.5	9.6 ± 0.4	6.2 ± 0.4
ttW	55.8 ± 0.7	20.9 ± 0.5	17.9 ± 0.5	15.2 ± 0.4	14.5 ± 0.4	15.1 ± 0.4	13.4 ± 0.4	8.7 ± 0.4
ttZ	119.8 ± 1.0	27.5 ± 0.5	21.6 ± 0.5	17.2 ± 0.5	16.3 ± 0.4	17.1 ± 0.4	14.6 ± 0.4	9.3 ± 0.4
ttH	53.32 ± 0.23	23.80 ± 0.19	19.42 ± 0.18	15.88 ± 0.17	15.23 ± 0.16	15.76 ± 0.17	13.75 ± 0.16	9.00 ± 0.14
tWZ/tWH	21.91 ± 0.13	5.87 ± 0.08	4.58 ± 0.07	3.74 ± 0.07	3.54 ± 0.07	3.72 ± 0.07	3.24 ± 0.06	2.15 ± 0.05
Other	10.7 ± 1.8	2.0 ± 0.4	1.8 ± 0.4	1.6 ± 0.4	1.6 ± 0.4	1.5 ± 0.4	1.4 ± 0.4	1.1 ± 0.4
Total background	8250 ± 70	545 ± 8	302 ± 5	211 ± 4	195 ± 4	209 ± 4	171 ± 4	109.0 ± 2.8
Data	7604	513	282	195	181	194	161	95

S over B


*: normalised to total Bkg.
ATLAS Simulation Work in Progress
√s = 13 TeV, 139 fb -1
v34τlepτhad
Pre-Fit
Data
tZq
W+jets
ttW
tWZ/tWH
tHq ML *
tt
Z+jets
ttZ
Other
tHq ML
tW
Diboson
ttH
Uncertainty
Events
05
06
65
66
07


ATLAS Simulation Work in Progress
√s = 13 TeV, 139 fb -1
v34τlepτhad
bgr target
S/B = 0.0%
05
S/B = 0.2%
06
S/B = 0.4%
65
S/B = 0.5%
651
S/B = 0.5%
652
S/B = 0.5%
66
S/B = 0.5%
07
S/B = 0.7%
S/√B

Summary

- Every tool necessary to fit with the NN output is in place and tested
- The model shows good stability and tests for negative weights setups hold
- Additionally, feature behaviour with respect wo weight sign was investigated
- Test fits created for lephad (and hadhad)
- Variable ranking planned, only needed for documentation
- Improved performance expected from combining categorical likelihhods, simple 2D cut not enough.