

Status Report

(2022.9 - 2022.12)

Xiaonan Hou Supervisor: Hongbo Liao

2023/1/5

Outline



1 Analysis of ttZ'

- Signal validation
- Top reconstruction

2 Analysis of 4top

- Cross check
- Check and download missing samples

3 Hardware work

- HGCal
- Others

4 Plans for next steps

Analysis of ttZ'



1. Signal validation

σ [fb] 10

10²

10

10-2

10 10

10 10 give a talk on <u>B2G Resonances</u>(14 October 2022)

θ=1/2π

3500 Mass [GeV]



Z' coupling to higher-generation

fermions

signal sample validation

2 Universidad de los Andes

3. Institute of High Energy Physic

Iniversidad de los Andes

Ion, Francesco Romeo¹, Andres Florez², Hongbo Liac

Use the **Top-philic-Zprime_V1** UFO from authors of paper UFO model

Private signal production using <u>Sihyun's event production framework</u> originally d eveloped under EXO

This plot shows the xSec before decaying the top The xSec values are the same in the UFO model considered

We have shown $\theta = 0$, ct = 1, mass = 1/3TeV for the ttZ' process in the talk Plots are shown using generator level information

Z' pt, eta phi and mass Top, W, b, j, lep multiplicity Top kinematic distributions DeltaEta,Phi,R Top distributions DeltaEta,Phi,R Top decay distributions All jet pT, eta, phi distributions

Detailed slides

Results are as expected!

VANDERBILT



2023/1/5

4

Analysis of ttZ'



Move to reco level:

b-tagger: btagDeepFlavB selections: muon = 1, electron = 0, tau = 0fatjets = 0 (W jets = 0, Top jets = 0) >= 7 jets $>= 1T \ 1M \ 1L \ (>= 3 \ b \ jets)$

gen-matching before top reconstruction





Finally, can reconstruct at least 3 tops (2 hadronic + 1 leptonic)

02

Analysis of 4top

1. Help to do a cross check with Huiling

independent code: just followed the AN of Huiling's the same object selections, luminosity and cross section event weight = genWeight * prefiringWeight no JER and no TES

fix the bugs: Float_t -> Double_t conversion (very important influence!)

Last time we have small difference, now we reach the same result

cuts: HLT -> baseline1 (jets number >=6) -> baseline2 (6th jet pt > 40GeV) -> baseline3 (Jets HT > 500GeV) -> SR

process	initial	HLT	baseline1	baseline2	baseline3	1tau0l_muon	1tau0l_lep	1tau0l_tau	1tau0l_jet	1tau0l_bjet
tttt	4544000.0	4232869.0	161.09	126.12	121.55	88.79	68.01	5.22	3.96	3.6
tt	295335000.0	32492447.0	1242279.01	633200.9	506452.12	477097.56	453378.95	7956.74	2751.5	1756.88
qcd	106411630.0	10145831.0	36744077.09	14950851.12	11941997.12	11935304.22	11924172.49	23497.41	5695.33	689.54
ttX	40314514.0	16959947.0	22326.63	12054.15	10565.29	9629.81	8894.53	226.73	87.05	61.11
VV	24556000.0	79220.0	194.01	94.12	83.24	81.54	80.03	0.72	0.15	0.03
singleTop	9012000.0	632353.0	41962.64	21162.79	17893.85	17089.63	16433.42	244.55	68.07	38.72
totalbg	475629144.0	60309798.0	38050839.38	15617363.08	12476991.62	12439202.75	12402959.42	31926.15	8602.09	2546.28
totalMC	480173144.0	64542667.0	38051000.47	15617489.2	12477113.17	12439291.55	12403027.44	31931.38	8606.05	2549.88

Huiling's result

2016postVFP 1tau0l

										-	
Selection	$\operatorname{Ini}\operatorname{evt}$	Metfilter	Trigger	baseline1	baseline2	baseline3	0 T muon	0 T ele	1 TTau	$\operatorname{Jet}_{\mathcal{S}} >= 8$	M BJets $>= 2$
tttt	191.84	191.47	176.32	161.09	126.12	121.55	88.79	68.01	5.22	3.96	3.60
\mathbf{qcd}	4640125424798.96	4639130661667.41	75217620.42	36744077.09	14950851.12	11941997.12	11935304.22	11924172.49	23497.41	5695.33	689.54
tt	13617979.85	13606464.23	1618169.03	1242279.00	633200.89	506452.18	477097.61	453379.00	7956.74	2751.50	1756.88
ttX	105490.81	105266.78	31546.31	22326.63	12054.15	10565.29	9629.81	8894.53	226.73	87.05	61.11
single top	1182805.11	1181777.74	60858.45	41962.64	21162.79	17893.85	17089.63	16433.42	244.55	68.07	38.72
VV	161554.01	161449.74	510.24	194.01	94.12	83.24	81.54	80.03	0.72	0.15	0.03
totalbkg	4640140492628.74	4639145716625.90	76928704.45	38050839.37	15617363.07	12476991.67	12439202.81	12402959.48	31926.15	8602.09	2546.28
$\operatorname{totalMC}$	4640140492820.59	4639145716817.36	76928880.77	38051000.46	15617489.19	12477113.22	12439291.60	12403027.49	31931.38	8606.05	2549.88
VV totalbkg totalMC	$\frac{161554.01}{4640140492628.74}$ $\frac{4640140492820.59}{640140492820.59}$	$\frac{161449.74}{4639145716625.90}\\4639145716817.36$	$\begin{array}{r} 510.24 \\ \hline 76928704.45 \\ \hline 76928880.77 \end{array}$	$\frac{194.01}{38050839.37}\\38051000.46$	$\begin{array}{r} 94.12 \\ 15617363.07 \\ 15617489.19 \end{array}$	$\frac{83.24}{12476991.67}$ 12477113.22	$\frac{81.54}{12439202.81}$ 12439291.60	$\frac{80.03}{12402959.48}$ 12403027.49	$\begin{array}{r} 0.72 \\ \hline 31926.15 \\ \hline 31931.38 \end{array}$	$\frac{0.15}{8602.09}$ 8606.05	$ \begin{array}{r} 0.03 \\ 2546.28 \\ 2549.88 \\ \end{array} $



02

Analysis of 4top

Event yield in each subchannel 2016postVFP:

process	1tau0l	1tau1l	1tau2l	2tau0l	2tau1
tttt	93880.00	49349.00	7178.00	3176.00	942.00
tt	38326.00	4585.00	57.00	348.00	10.00
qcd	138.00	0.00	0.00	2.00	0.00
ttX	59972.00	13575.00	1374.00	2444.00	379.00
VV	5.00	0.00	0.00	0.00	0.00
singleTop	760.00	344.00	52.00	140.00	7.00
totalbg	99201.00	18504.00	1483.00	2934.00	396.00
totalMC	193081.00	67853.00	8661.00	6110.00	1338.00

Huiling's result

process	1tau0l	1tau1l	1tau2l	2tau0l	2tau1l
tttt	3.60	1.83	0.25	0.13	0.04
tt	1756.88	166.32	2.01	14.11	0.36
qcd	689.54	0.00	0.00	8.08	0.00
ttX	61.11	11.46	0.96	1.78	0.25
VV	0.03	0.00	0.00	0.00	0.00
singleTop	38.72	4.97	0.24	0.26	0.01
totalbg	2546.28	182.76	3.22	24.23	0.61
totalMC	2549.88	184.59	3.46	24.35	0.65



Xiaonan's result

process	1tau0l	1tau1l	1tau2l	2tau0l	2tau1l
tttt	3.60	1.83	0.25	0.13	0.04
tt	1756.88	166.32	2.01	14.11	0.36
qcd	689.54	0.00	0.00	8.08	0.00
ttX	61.11	11.46	0.96	1.78	0.25
VV	0.03	0.00	0.00	0.00	0.00
single top	38.72	4.97	0.24	0.26	0.01
totalbkg	2524.28	182.76	3.22	24.23	0.61
totalMC	2549.88	184.59	3.46	24.35	0.65

Reach the same result for all conditions

2. Help to check some samples

- check out whether all the samples are complete and right
- check the year and the recommendation for the data

^{2023/1/5} download the missing samples

Hardware work

1. HGCal bonding

03

9





front side result meet our requirements performance as good as previous

backside: only import the program (lack of the proper base)



2. Do some other works at CERN

Plans for next steps



Plans:

Analysis of ttz'

- Try to solve the problem in signal and finish the top reconstruction part
- Discuss the analysis strategy
- Give a talk on B2G-Resonances in January

Analysis of 4top:

- Help to do some other things if need Hardware working:
- Do some other works at CERN



Thanks

01 Analysis of ttZ' Cross section study $\mathcal{L}_{int} = \bar{t}\gamma_{\mu}(c_LP_L + c_RP_R)tV_1^{\mu} = c_t\bar{t}\gamma_{\mu}(\cos\theta P_L + \sin\theta P_R)tV_1^{\mu}$ $P_{R/L} = (1 \pm \gamma_5)/2$ is projection operators $c_t = \sqrt{(c_L)^2 + (c_R)^2}$ is coupling of vector singlet with top quarks $tan\theta = c_R/c_L$ tangent of the chirality angle tan = 0, tangent = 0,



Analysis of ttZ'



There are two ways to produce a top-philic resonance at the LHC: at one loop and at tree level



In our analysis, we focus on the production of the tree level

So we will have these different cases for Z' coupling to tops

	0 top (hadronic decay)	1 top	2 top	3 top	4top
0 lep				tjZ' or tWZ'	ttZ'
1 lep			tjZ' or tWZ'	ttZ' or tWZ'	
2 lep		tjZ' or tWZ'	ttZ' or tWZ'		
3 lep	tjZ' or tWZ'	ttZ' or tWZ'			
4 lep	ttZ' or tWZ'				

We aim to consider hadronic top and at least 1,2 muons, to intercept scenario explaining B-physics anomalies

2023/1/5



tjz' branch ratio of events going to leptons: (The results are as expected!)

	expected	observerd 1TeV	observerd 2TeV	observerd 3TeV
0 leptons	31.72%	31.07%	30.77%	30.76%
1 leptons	43.12%	43.97%	44.28%	44.35%
2 leptons	21.56%	21.53%	21.48%	21.43%
3 leptons	3.60%	3.44%	3.47%	3.46%

ttz' branch ratio of events going to leptons:

	expected	observed 0.5TeV	observerd 1.5TeV	observerd 3TeV
0 leptons	20.15%	31.85%	31.85%	31.75%
1 leptons	39.70%	42.27%	42.47%	42.13%
2 leptons	29.33%	20.85%	20.62%	20.95%
3 leptons	9.63%	4.67%	4.68%	4.76%
4 leptons	1.19%	0.36%	0.38%	0.40%

Finding the reasons: we have accidentally defined all the decay channel except the tau in the proc card

now is working on this