$t\bar{t}Z'$ Meeting

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Conventions

l Leptons

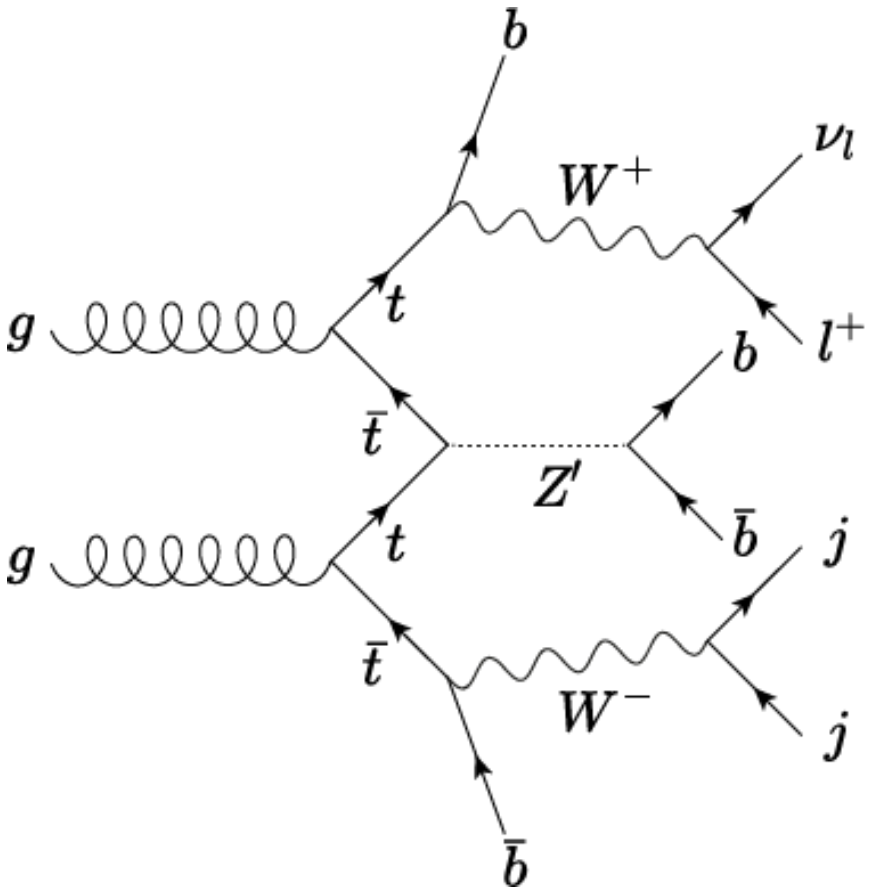
ν_l Neutrinos

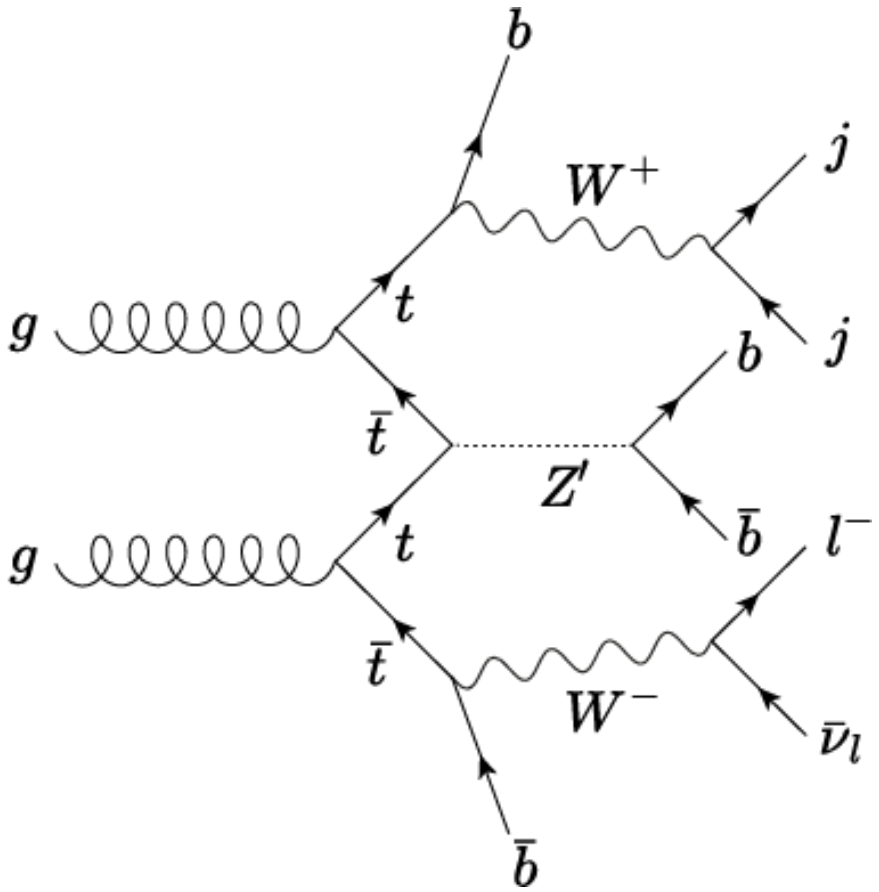
b_i b quarks $p_T(b_1) > p_T(b_2) > \cdots$

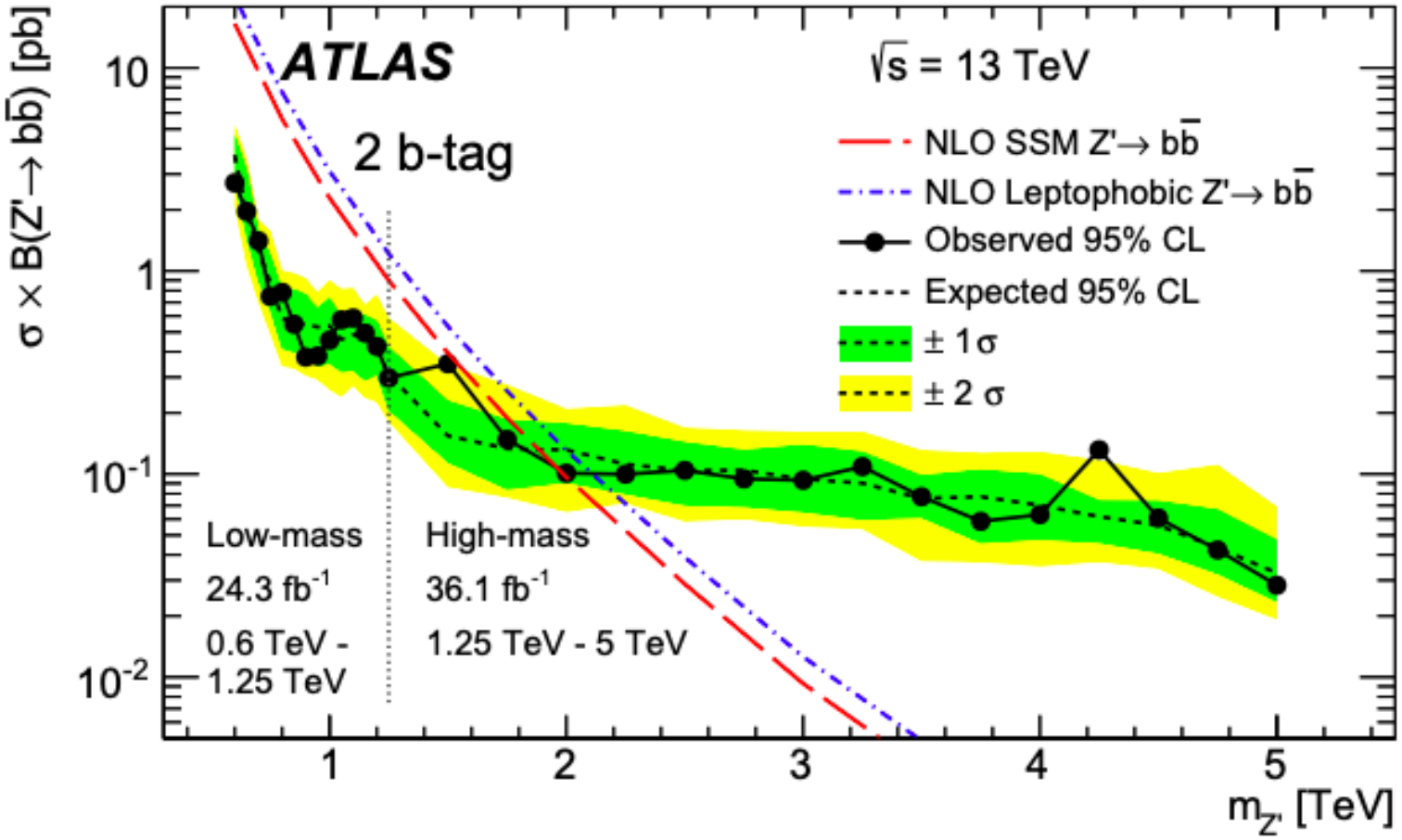
j_i Jets $p_T(j_1) > p_T(j_2)$

$TL(p)$ Momentum TLorenzVector of particle p

Analysis of $Z' \rightarrow b\bar{b}$ in Semi-Leptonic Channel



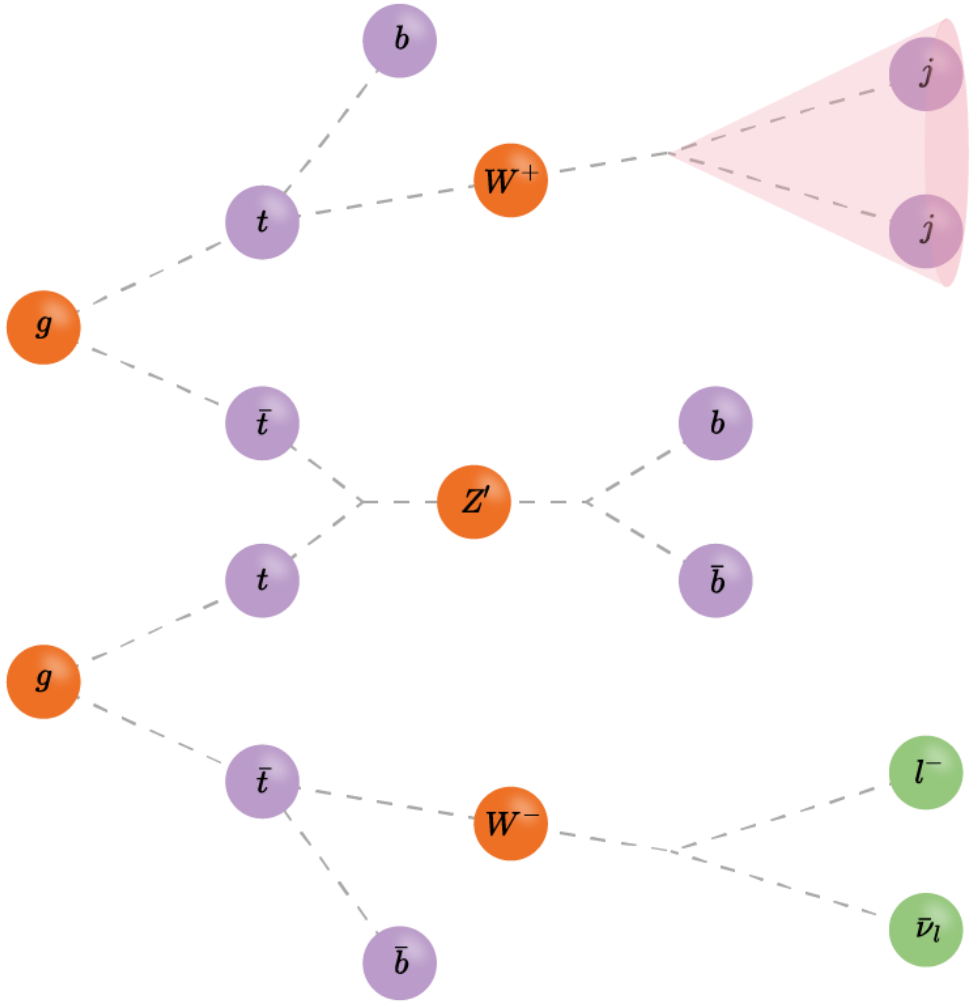




Plot of $\sigma \times B(Z' \to b\bar{b})$ vs $M_{Z'}$, where red dashed and blue dotted-dashed lines denote Next-to-Leading-Order(NLO) Sequential Standard Model and Leptophobic model predictions. Taken from [1].

Top Reconstruction Algorithm

Create Dijet Pairs

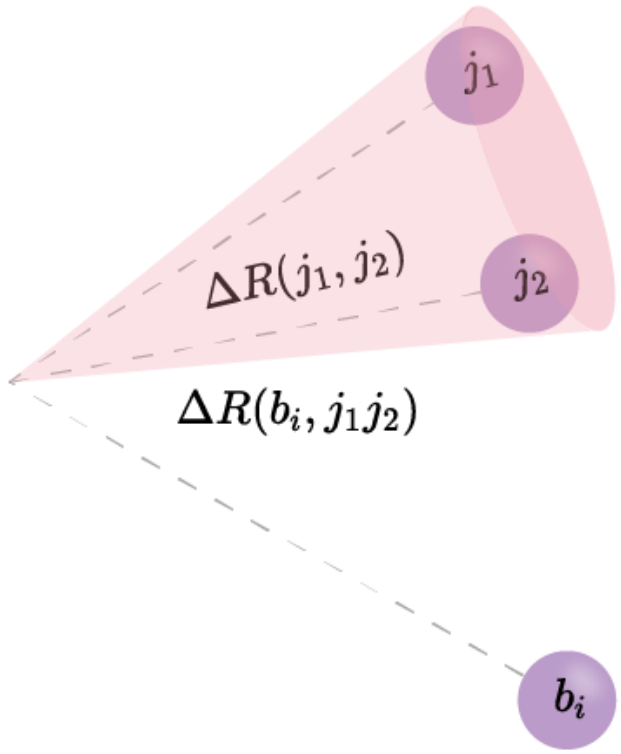


Dijet pair $j_1 j_2$

We create

$$TL(j_1 j_2) = TL(j_1) + TL(j_2)$$

Calculate $\Delta R(b_i, j_1 j_2)$



We keep $\Delta R(b_s, j_1 j_2)$ for the b-quark $b_i = b_s$ such that:

$$\Delta R(b_s, j_1 j_2) = \min_{\forall i}\{\Delta R(b_i, j_1 j_2)\}$$

We create TLorentzVectors for the Used b-quark b_s (Ub) and for the other b-quarks (Nb):

$$TL(Ub) = TL(b_s)$$

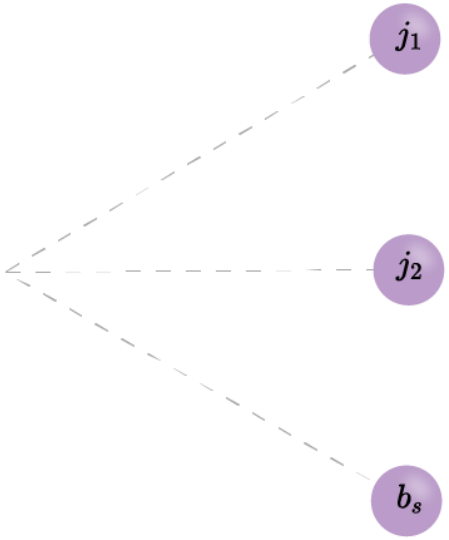
$$TL(Nb) = \sum_{i \neq s} TL(b_i)$$

We create a TLorentzVector $TL(b_\alpha b_\beta)$, where $\alpha, \beta \neq s$ (b_α, b_β belongs to Nb) such that b_α and b_β are determined by:

$$p_T(b_\alpha) - p_T(b_\beta) = \min_{\forall i,j \neq s}\{|p_T(b_i) - p_T(b_j)|\}:$$

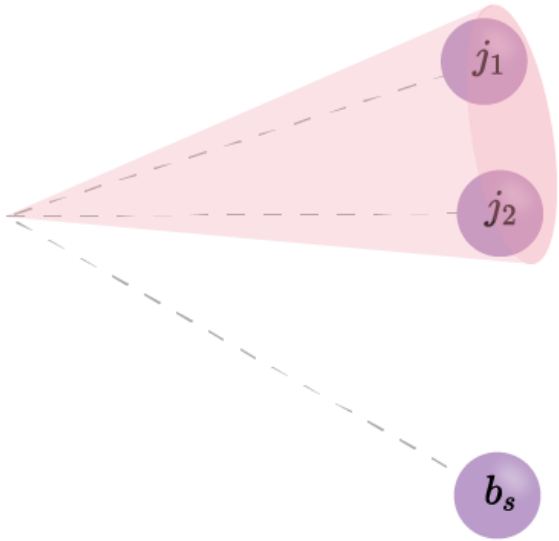
$$TL(b_\alpha b_\beta) = TL(b_\alpha) + TL(b_\beta)$$

Classification of events



$\Delta R(j_1, j_2) > 0.8$:

Not Merged = True
Partially Merged = False
Fully Merged = False

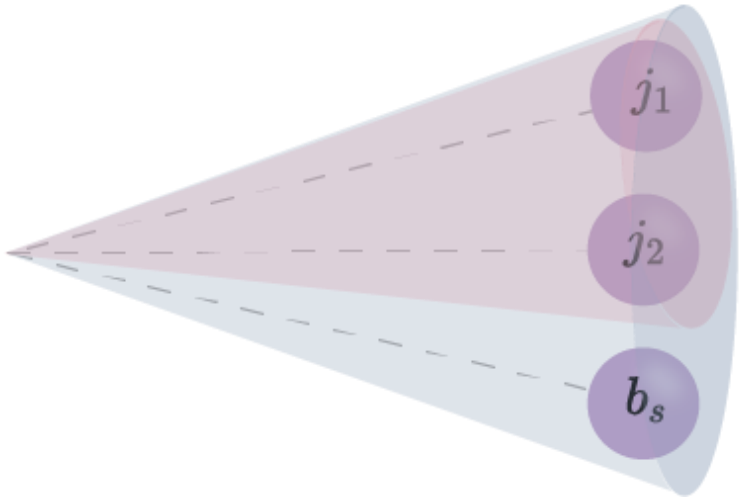


$\Delta R(j_1, j_2) < 0.8$ and $\Delta R(b_s, j_1 j_2) > 1.0$:

Not Merged = False
Partially Merged = True
Fully Merged = False

Keep Reconstructed W (RW) and Reconstructed t (Rt) TLorentzVectors

$TL(RW) \doteq TL(j_1 j_2)$
$TL(Rt) = TL(b_s) + TL(j_1 j_2)$



$\Delta R(j_1, j_2) < 0.8$ and $\Delta R(b_s, j_1 j_2) < 1.0$:

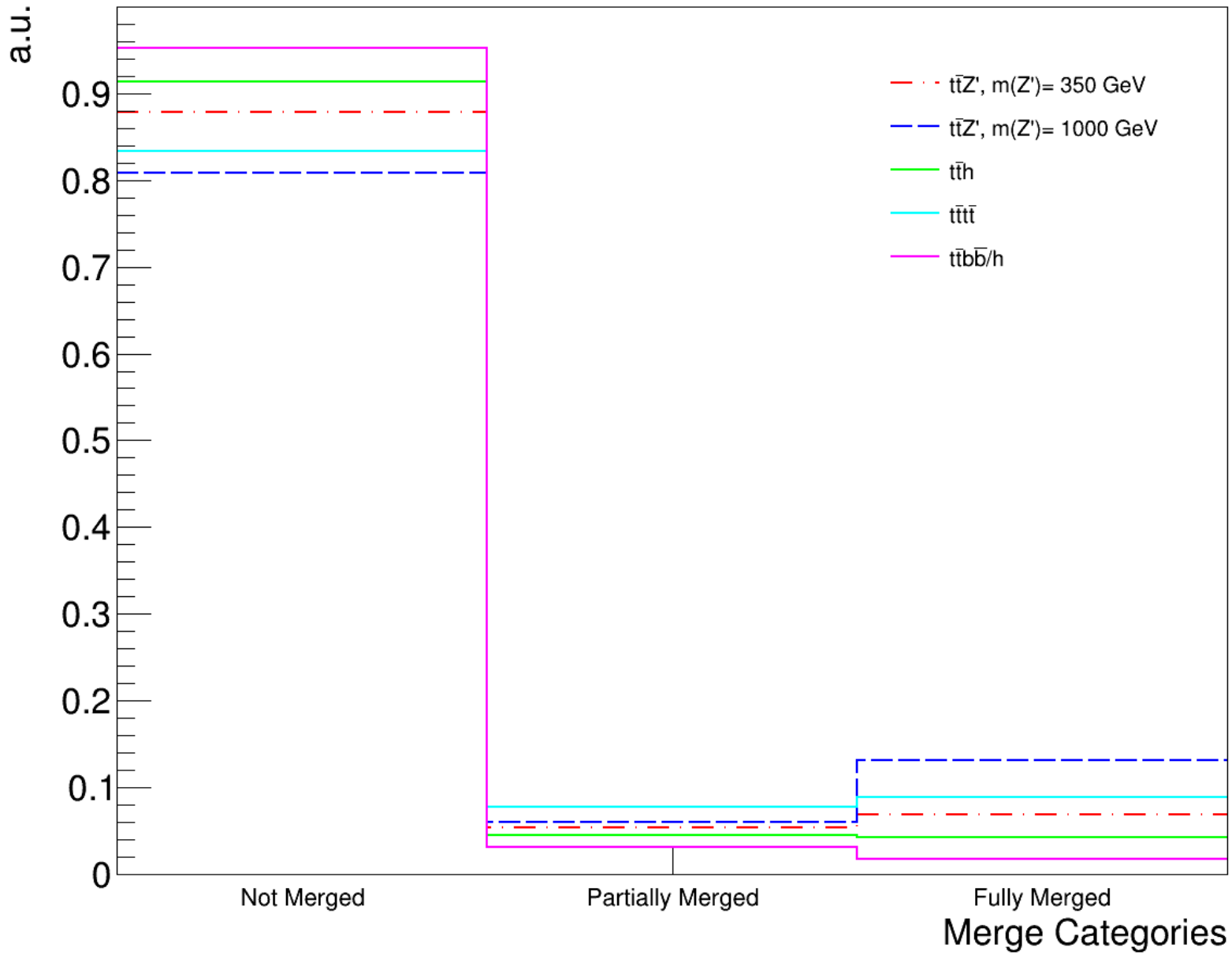
Not Merged = False
Partially Merged = False
Fully Merged = True

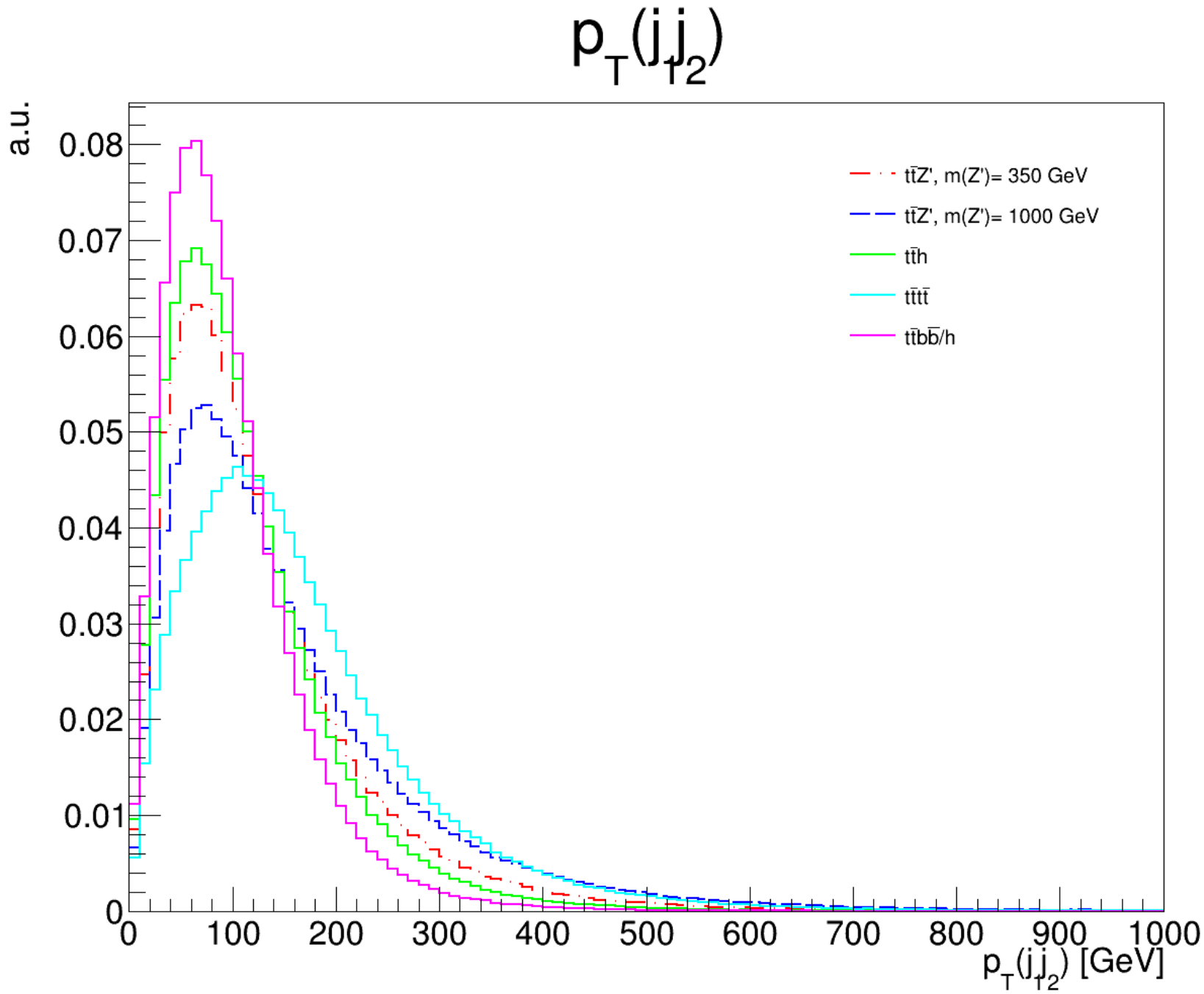
Keep Reconstructed t (Rt) TLorentzVector :

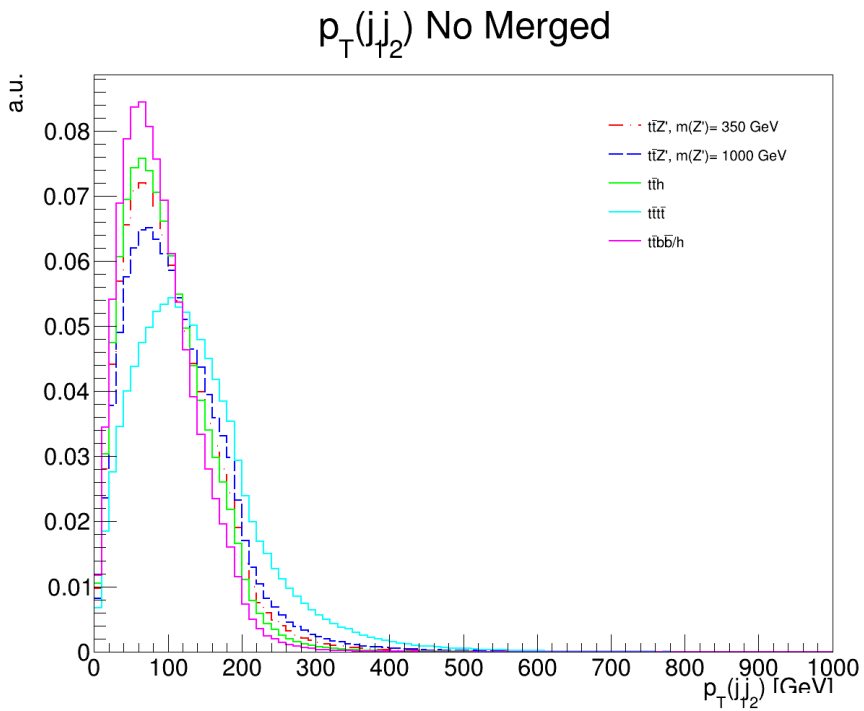
$TL(Rt) = TL(b_s) + TL(j_1 j_2)$

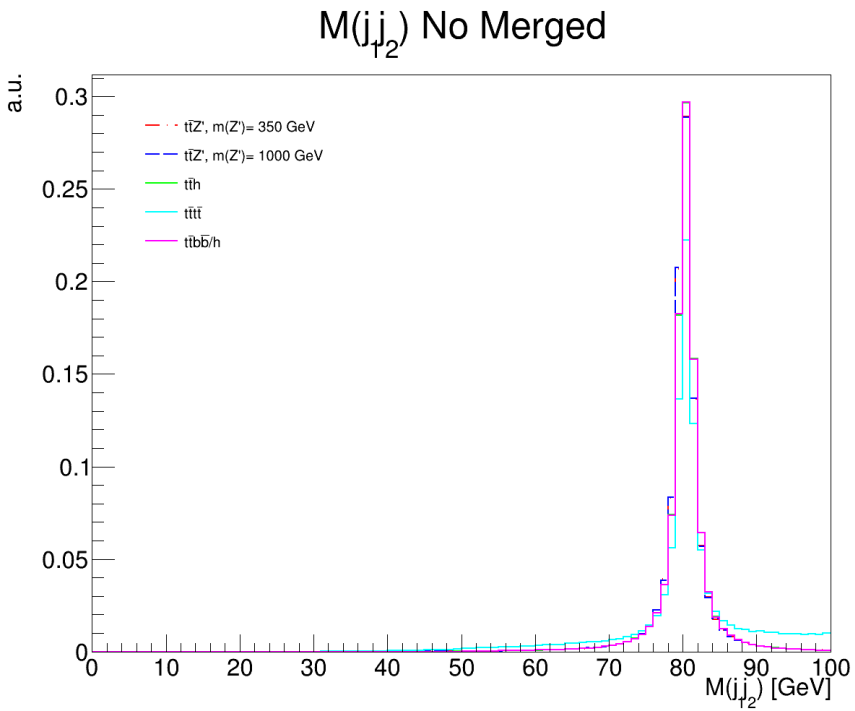
Results

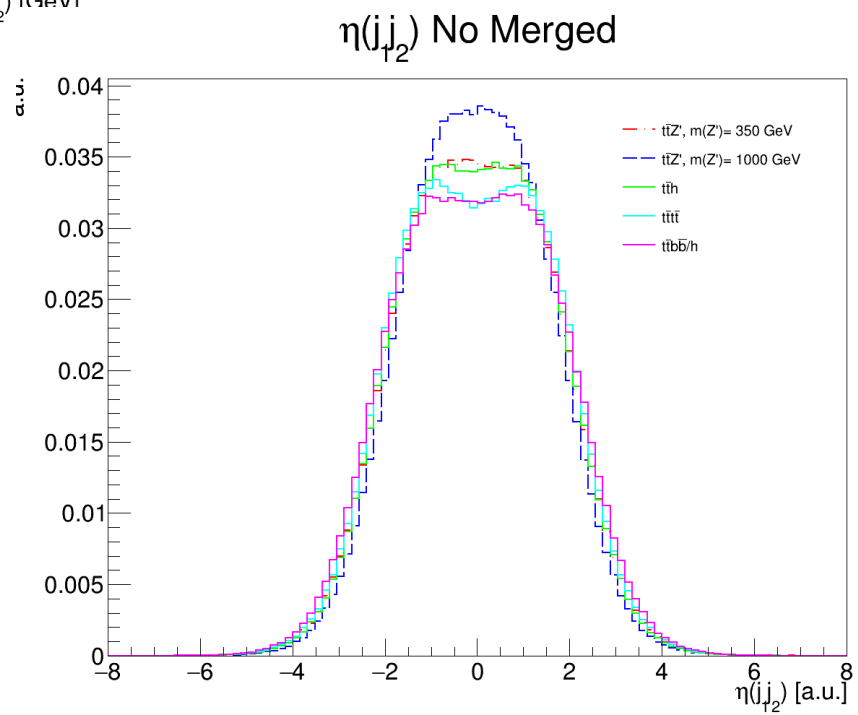
Merge Categories

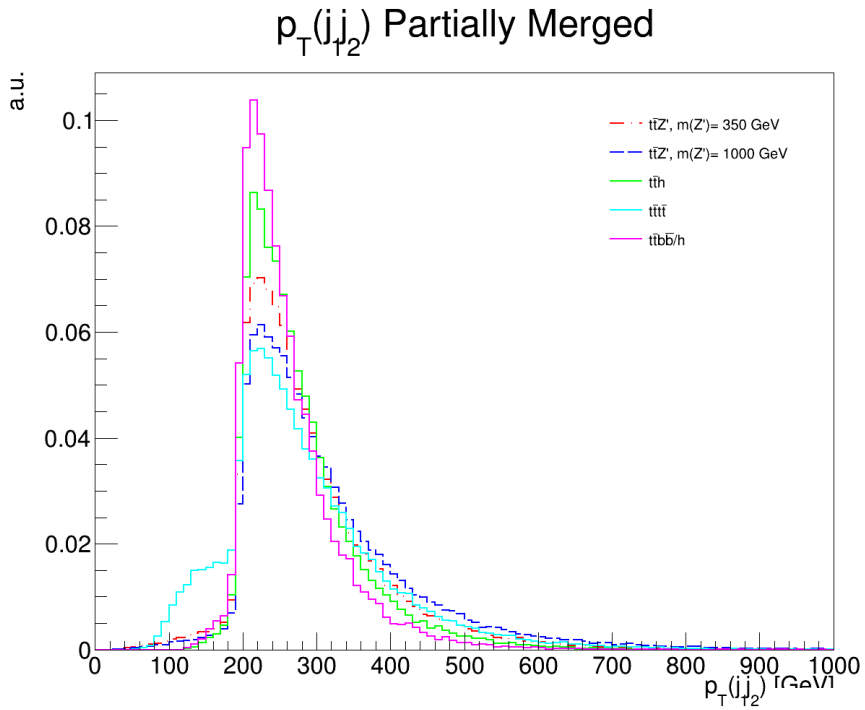


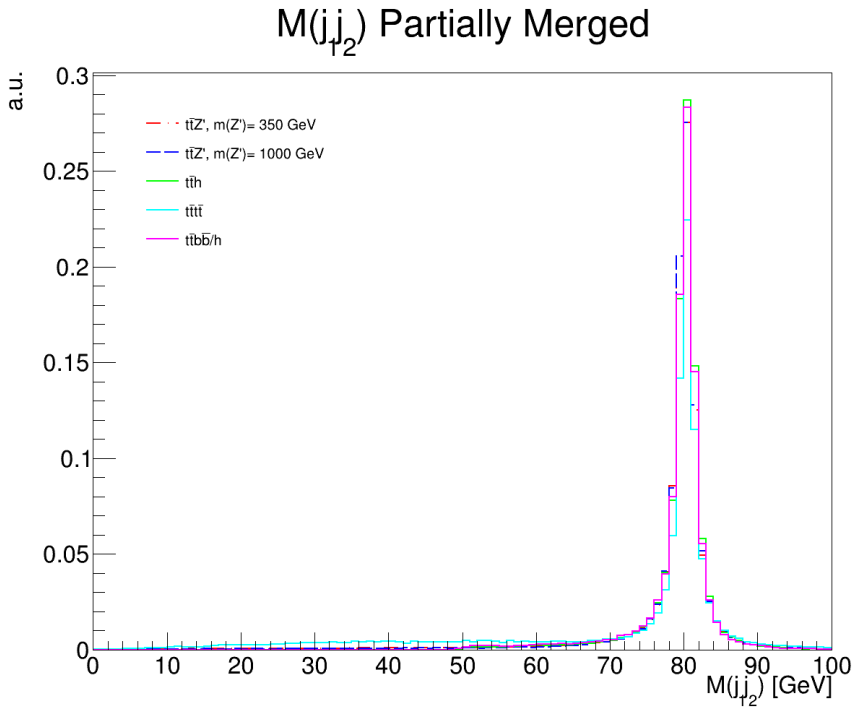

$p_T(jj_{t2})$
a.u.
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
100
200
300
400
500
600
700
800
900
1000
$p_T(jj_{t2})$ [GeV]
$t\bar{t}Z'$, m(Z')= 350 GeV
$t\bar{t}Z'$, m(Z')= 1000 GeV
$t\bar{t}h$
$t\bar{t}t\bar{t}$
$t\bar{t}b\bar{b}/h$

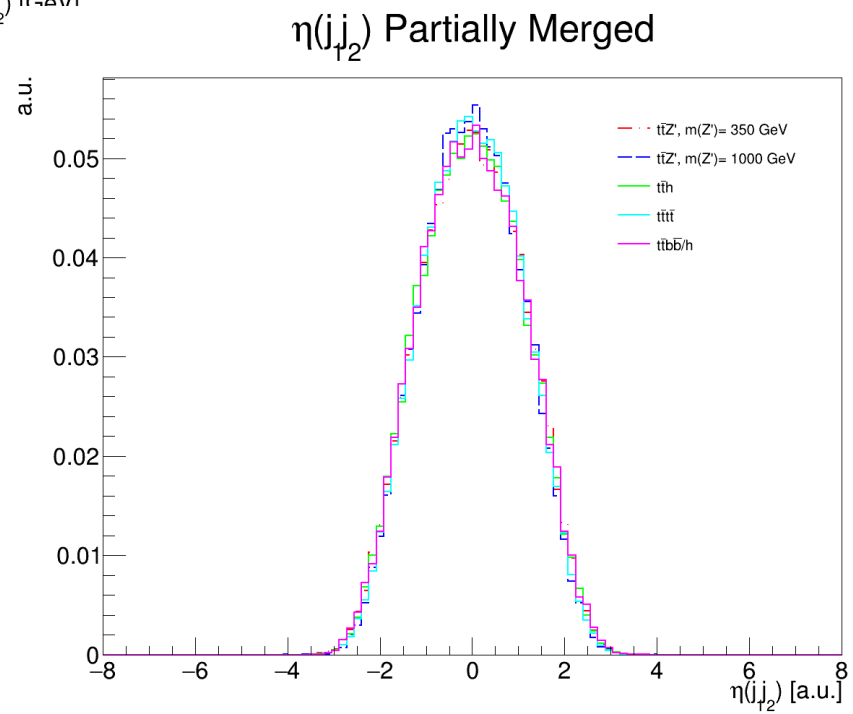

$p_T(j_{r2})$ No Merged
a.u.
$t\bar{t}Z'$, m(Z')= 350 GeV
$t\bar{t}Z'$, m(Z')= 1000 GeV
$t\bar{t}h$
$t\bar{t}t\bar{t}$
$t\bar{t}b\bar{b}/h$
$p_T(j_{r2})$ [GeV]


$M(j_{r2})$ No Merged
a.u.
$t\bar{t}Z'$, m(Z')= 350 GeV
$t\bar{t}Z'$, m(Z')= 1000 GeV
$t\bar{t}h$
$t\bar{t}t\bar{t}$
$t\bar{t}b\bar{b}/h$
$M(j_{r2})$ [GeV]

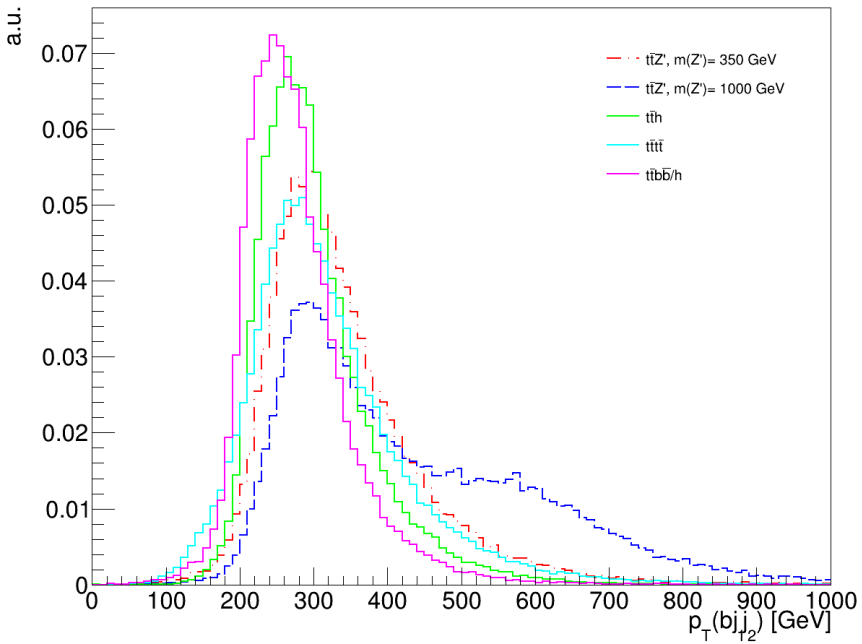

$\eta(j_{r2})$ No Merged
a.u.
$t\bar{t}Z'$, m(Z')= 350 GeV
$t\bar{t}Z'$, m(Z')= 1000 GeV
$t\bar{t}h$
$t\bar{t}t\bar{t}$
$t\bar{t}b\bar{b}/h$
$\eta(j_{r2})$ [a.u.]


$p_T(j_{t_2})$ Partially Merged
a.u.
$t\bar{t}Z'$, m(Z')= 350 GeV
$t\bar{t}Z'$, m(Z')= 1000 GeV
$t\bar{t}h$
$t\bar{t}t\bar{t}$
$t\bar{t}b\bar{b}/h$
$p_T(j_{t_2})$ [GeV]

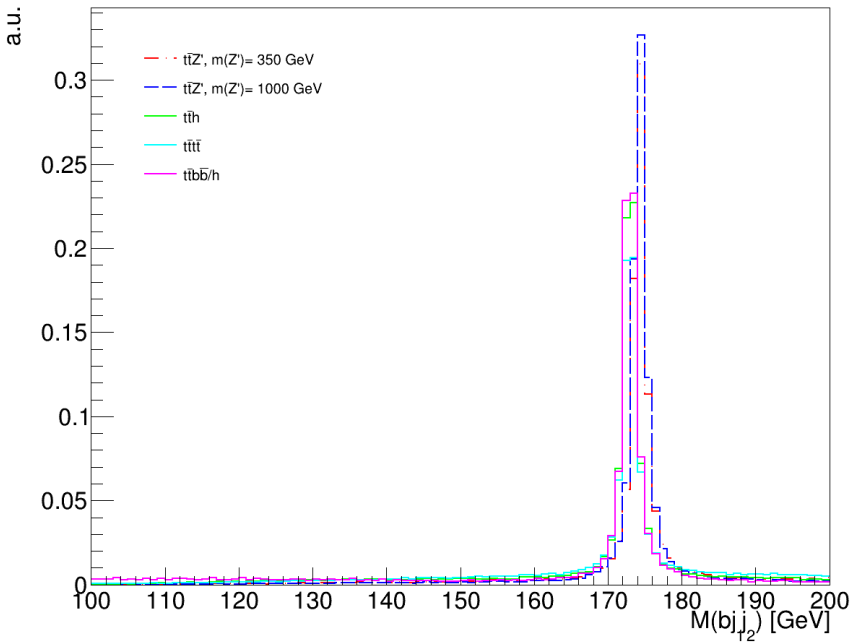

$M(j_{t_2})$ Partially Merged
a.u.
$t\bar{t}Z'$, m(Z')= 350 GeV
$t\bar{t}Z'$, m(Z')= 1000 GeV
$t\bar{t}h$
$t\bar{t}t\bar{t}$
$t\bar{t}b\bar{b}/h$
$M(j_{t_2})$ [GeV]


$\eta(j_{t_2})$ Partially Merged
a.u.
$t\bar{t}Z'$, m(Z')= 350 GeV
$t\bar{t}Z'$, m(Z')= 1000 GeV
$t\bar{t}h$
$t\bar{t}t\bar{t}$
$t\bar{t}b\bar{b}/h$
$\eta(j_{t_2})$ [a.u.]

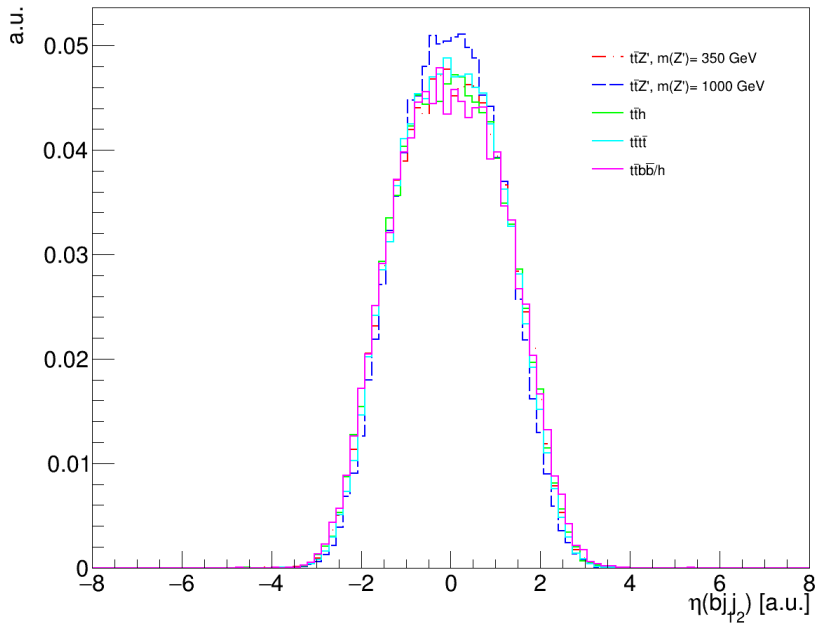
$p_T(bjj_{t2})$ Partially Merged



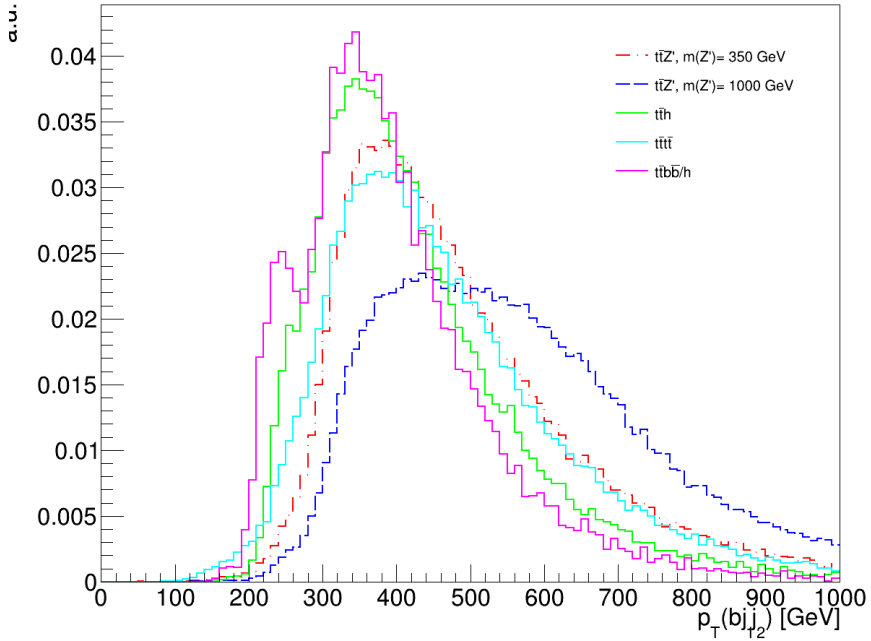
$M(bjj_{t2})$ Partially Merged



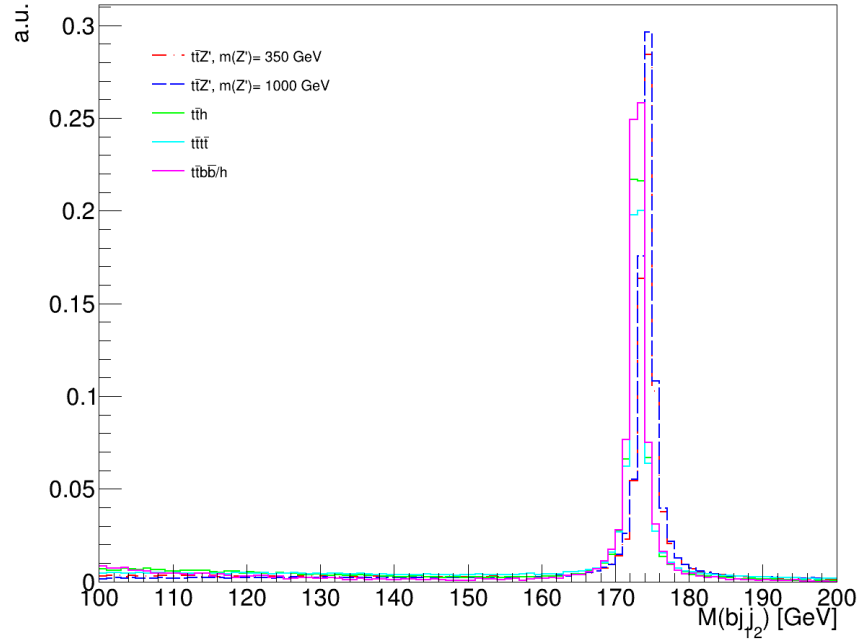
$\eta(bjj_{t2})$ Partially Merged



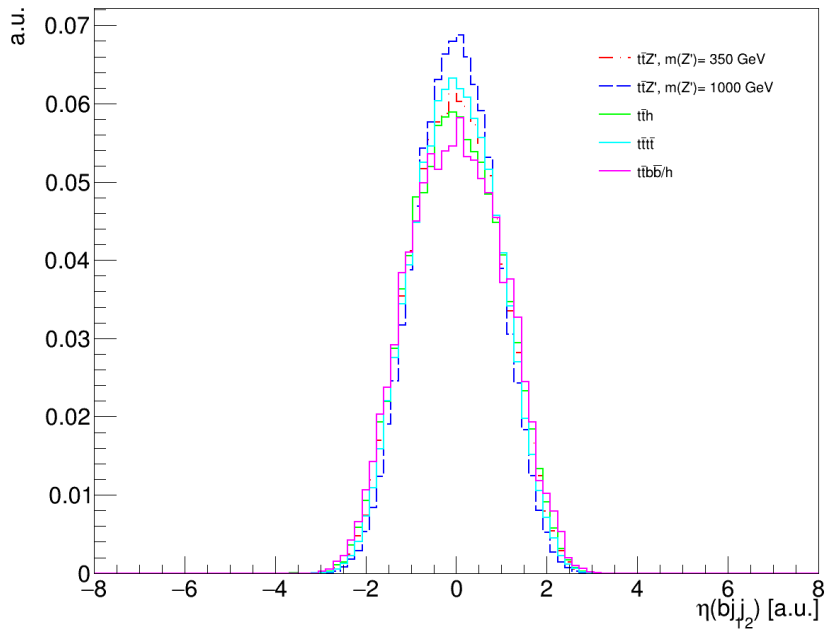
$p_T(bjj_{\tau 2})$ Fully Merged

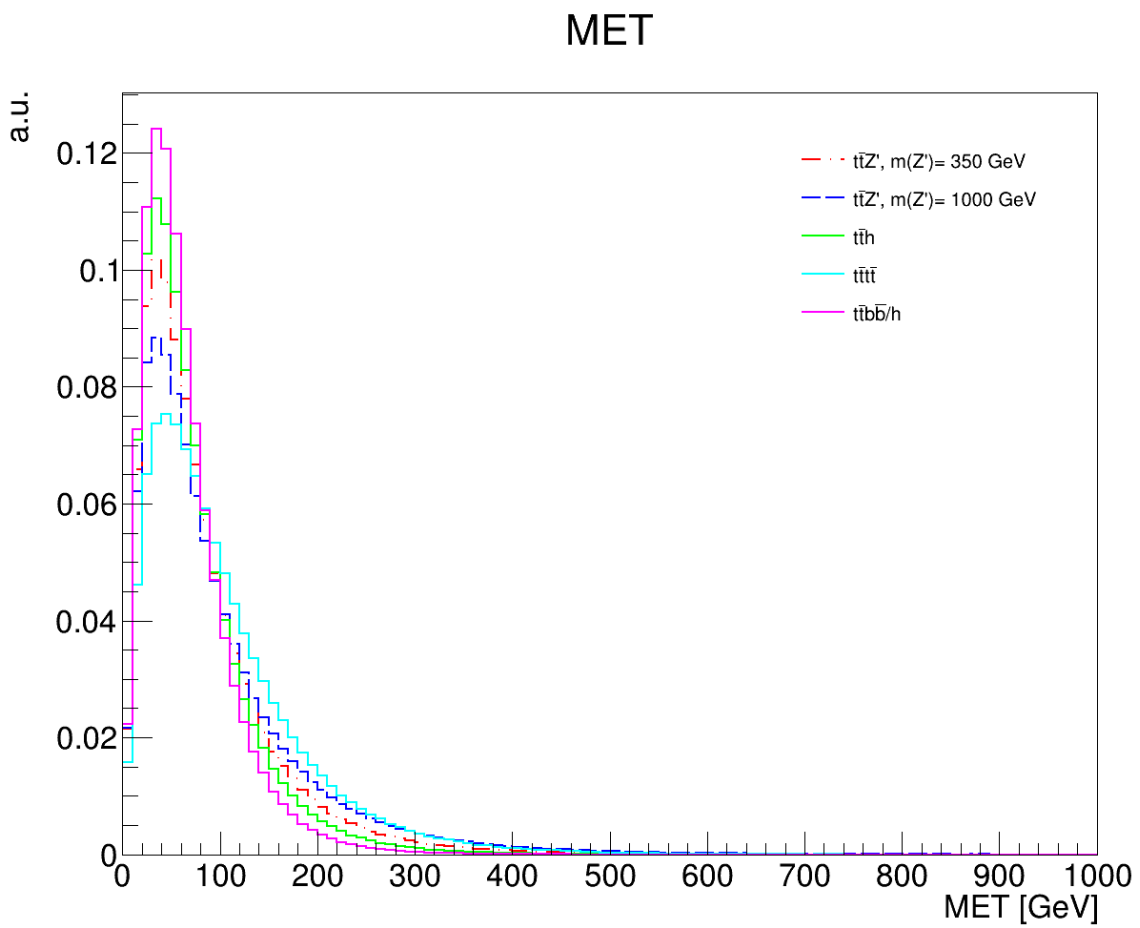


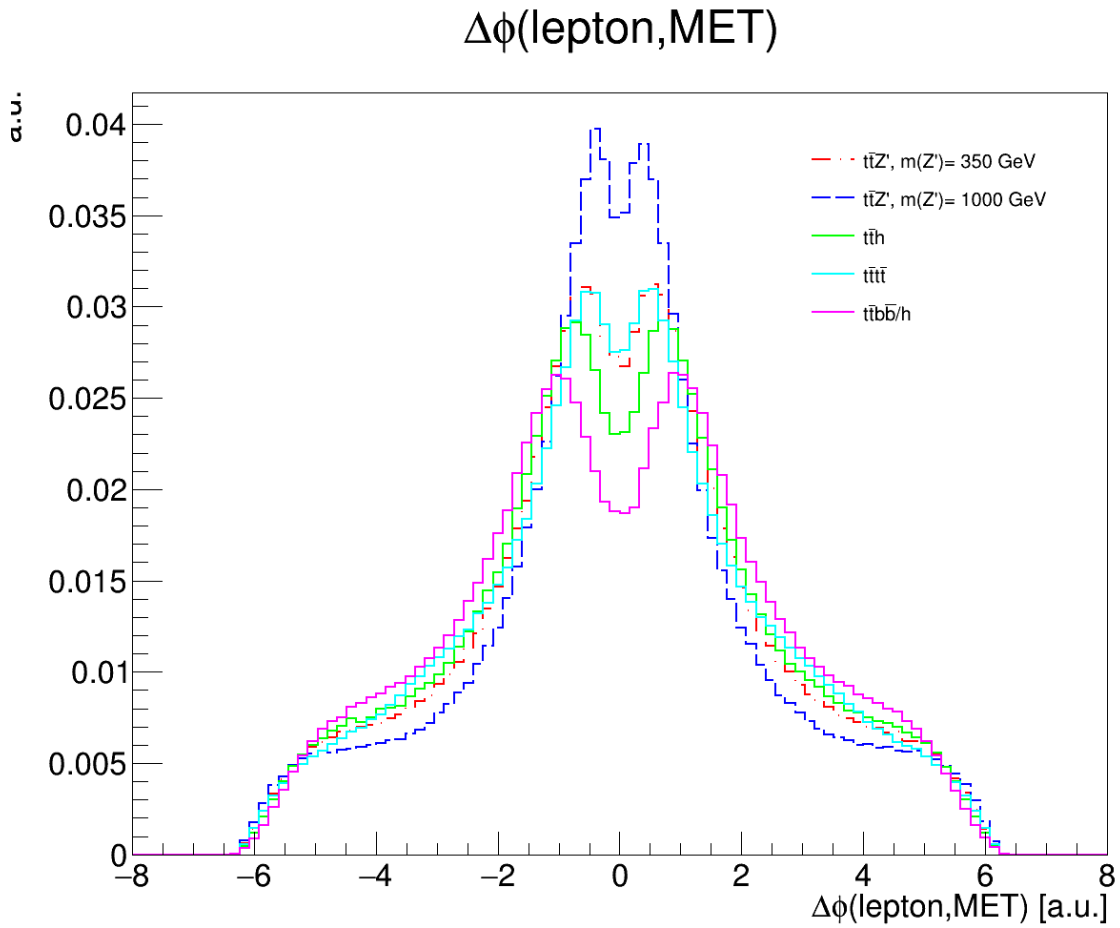
$M(bjj_{\tau 2})$ Fully Merged

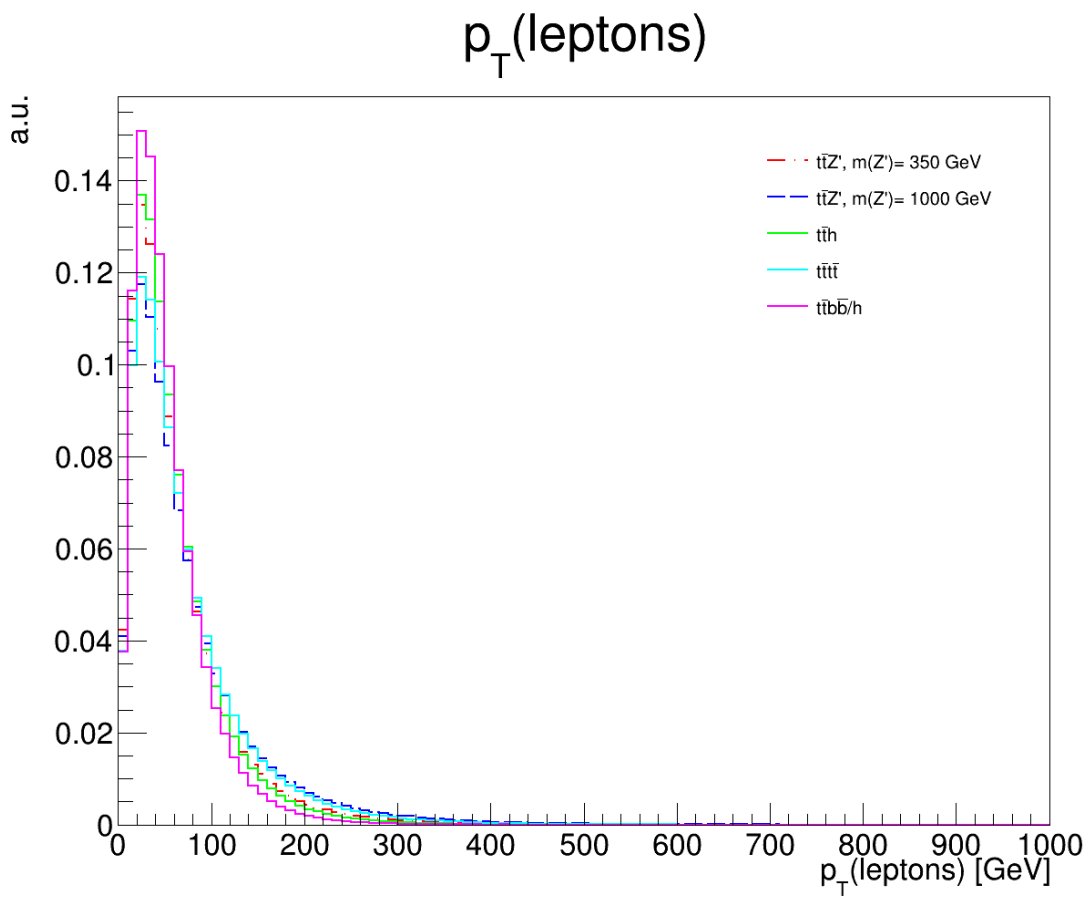


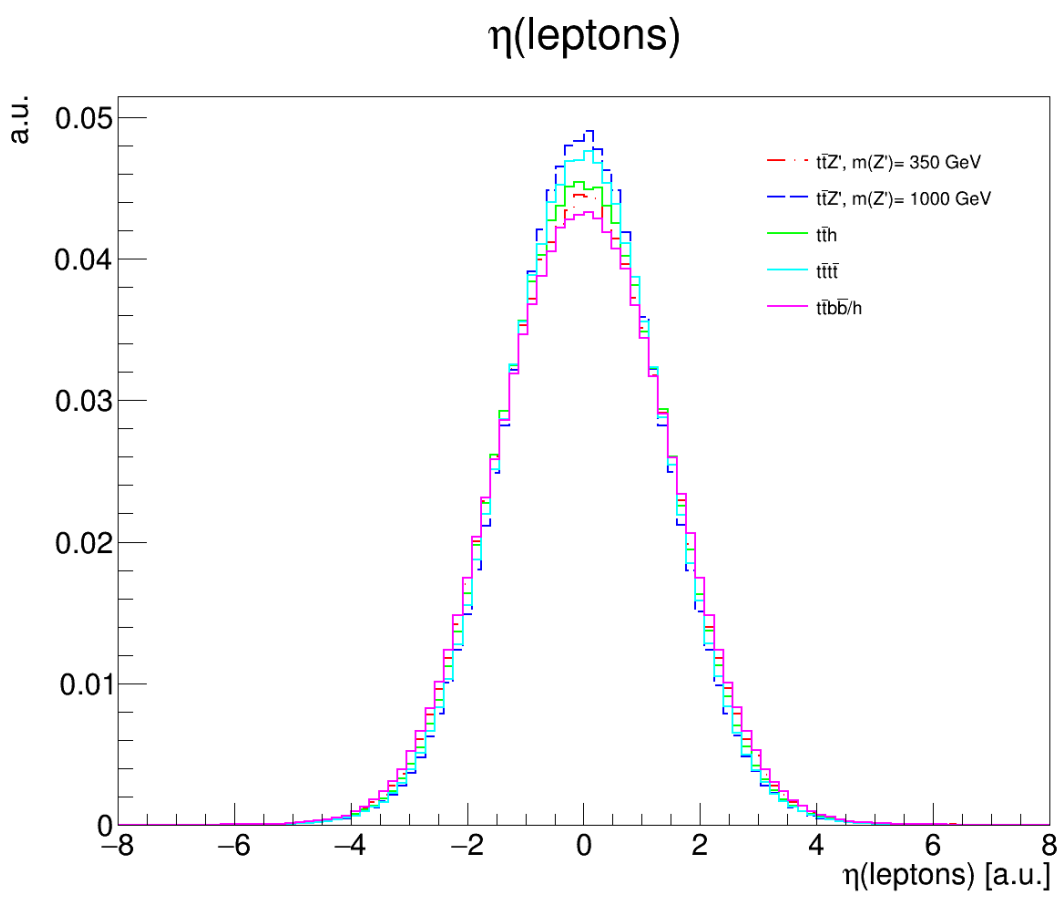
$\eta(bjj_{\tau 2})$ Fully Merged



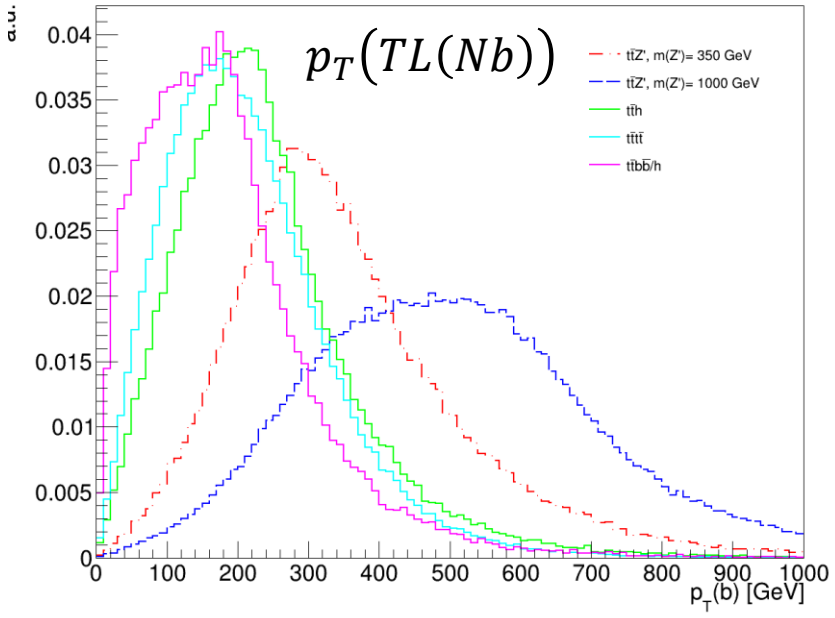

MET
a.u.
0.12
0.1
0.08
0.06
0.04
0.02
0
0
100
200
300
400
500
600
700
800
900
1000
MET [GeV]
tt̄Z', m(Z')= 350 GeV
tt̄Z', m(Z')= 1000 GeV
tt̄h
tt̄tt̄
tt̄bb̄/h


Δϕ(lepton,MET)
a.u.
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
−8
−6
−4
−2
0
2
4
6
8
Δϕ(lepton,MET) [a.u.]
tt̄Z', m(Z')= 350 GeV
tt̄Z', m(Z')= 1000 GeV
tt̄h
tt̄tt̄
tt̄bb̄/h

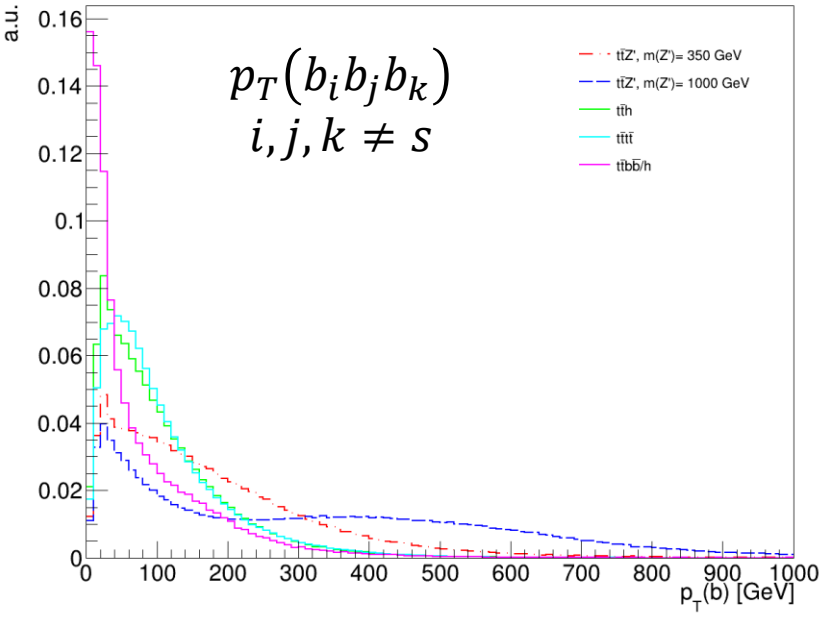

p_T(leptons)
a.u.
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
100
200
300
400
500
600
700
800
900
1000
p_T(leptons) [GeV]
tt̄Z', m(Z')= 350 GeV
tt̄Z', m(Z')= 1000 GeV
tt̄h
tt̄tt̄
tt̄bb̄/h


η(leptons)
a.u.
0.05
0.04
0.03
0.02
0.01
0
−8
−6
−4
−2
0
2
4
6
8
η(leptons) [a.u.]
tt̄Z', m(Z')= 350 GeV
tt̄Z', m(Z')= 1000 GeV
tt̄h
tt̄tt̄
tt̄bb̄/h

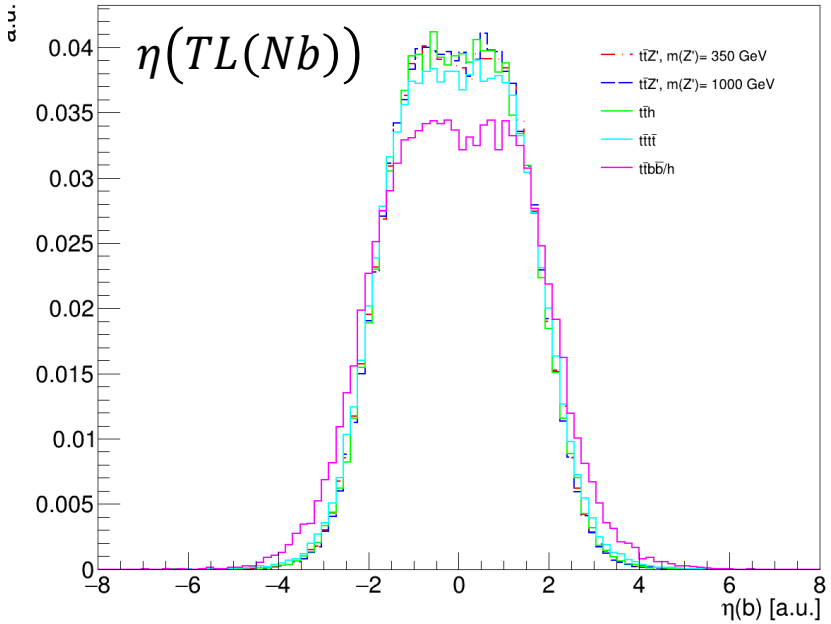
p$_T$(b)- b-quarks Not Used as one TLorentzVector



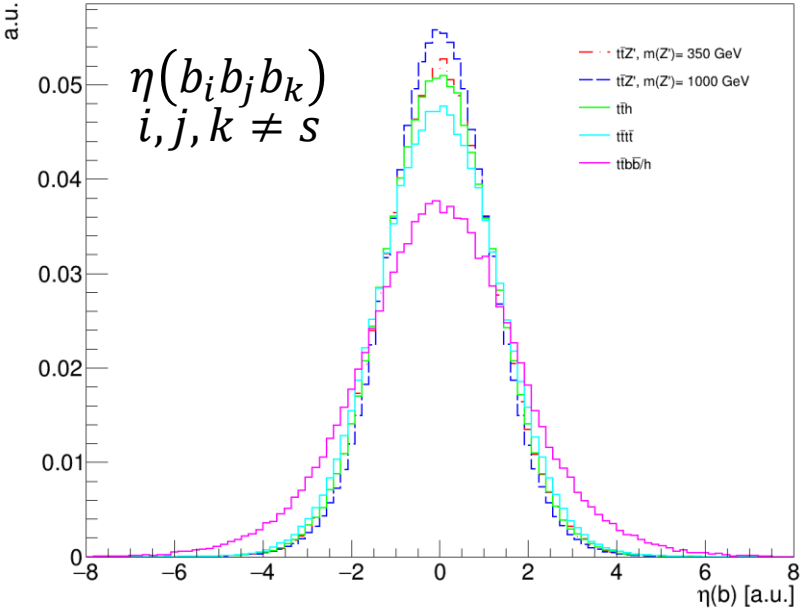
p$_T$(b)- b-quarks Not Used as individual entities

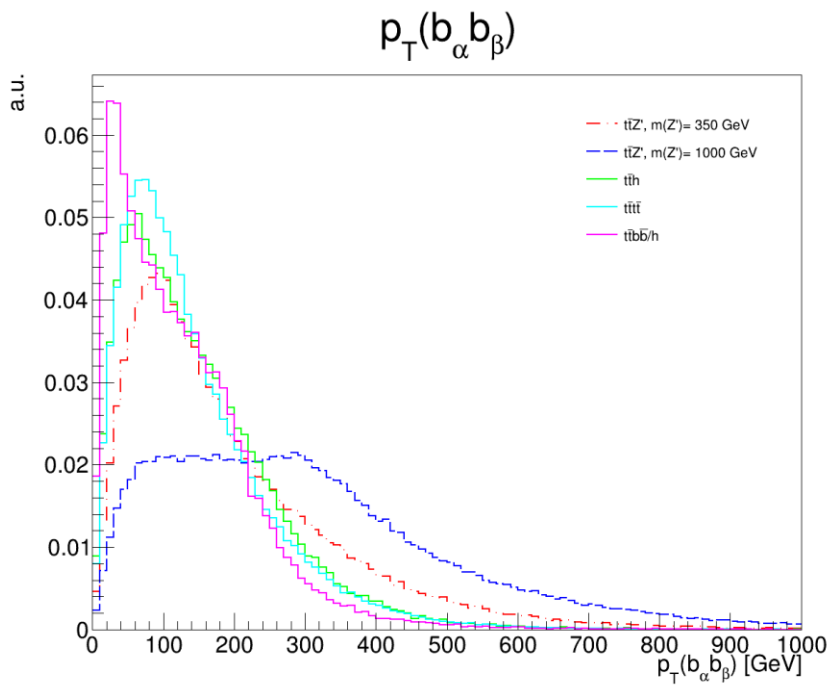


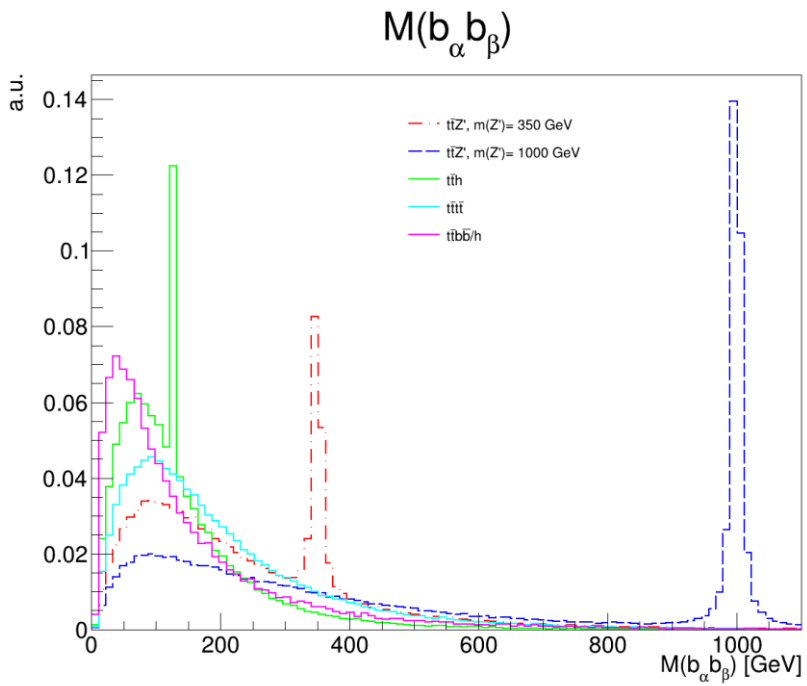
η(b)- b-quarks Not Used as one TLorentzVector

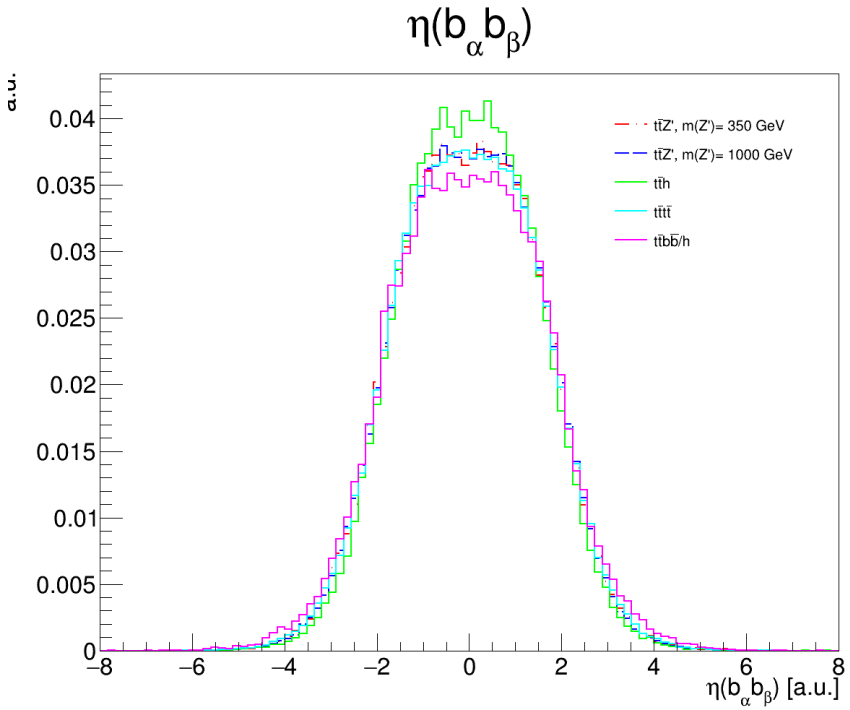


η(b)- b-quarks Not Used as individual entities




$p_T(b_\alpha b_\beta)$
a.u.
$t\bar{t}Z'$, m(Z')= 350 GeV
$t\bar{t}Z'$, m(Z')= 1000 GeV
$t\bar{t}h$
$t\bar{t}t\bar{t}$
$t\bar{t}b\bar{b}/h$
$p_T(b_\alpha b_\beta)$ [GeV]


$M(b_\alpha b_\beta)$
a.u.
$t\bar{t}Z'$, m(Z')= 350 GeV
$t\bar{t}Z'$, m(Z')= 1000 GeV
$t\bar{t}h$
$t\bar{t}t\bar{t}$
$t\bar{t}b\bar{b}/h$
$M(b_\alpha b_\beta)$ [GeV]


$\eta(b_\alpha b_\beta)$
a.u.
$t\bar{t}Z'$, m(Z')= 350 GeV
$t\bar{t}Z'$, m(Z')= 1000 GeV
$t\bar{t}h$
$t\bar{t}t\bar{t}$
$t\bar{t}b\bar{b}/h$
$\eta(b_\alpha b_\beta)$ [a.u.]

References:

[1] M. Aaboud, G. Aad, B. Abbott, O. Abdinov, B. Abeloos, D. Abhayasinghe, S. Abidi,O. AbouZeid, N. Abraham, H. Abramowicz, and et al., “Search for resonances in the massdistribution of jet pairs with one or two jets identified as b-jets in proton-proton collisions at √s= 13 tev with the atlas detector,”Physical Review D, 2018