

1. Studies of signal and background separation using Mann-Whitney U test and some new methods

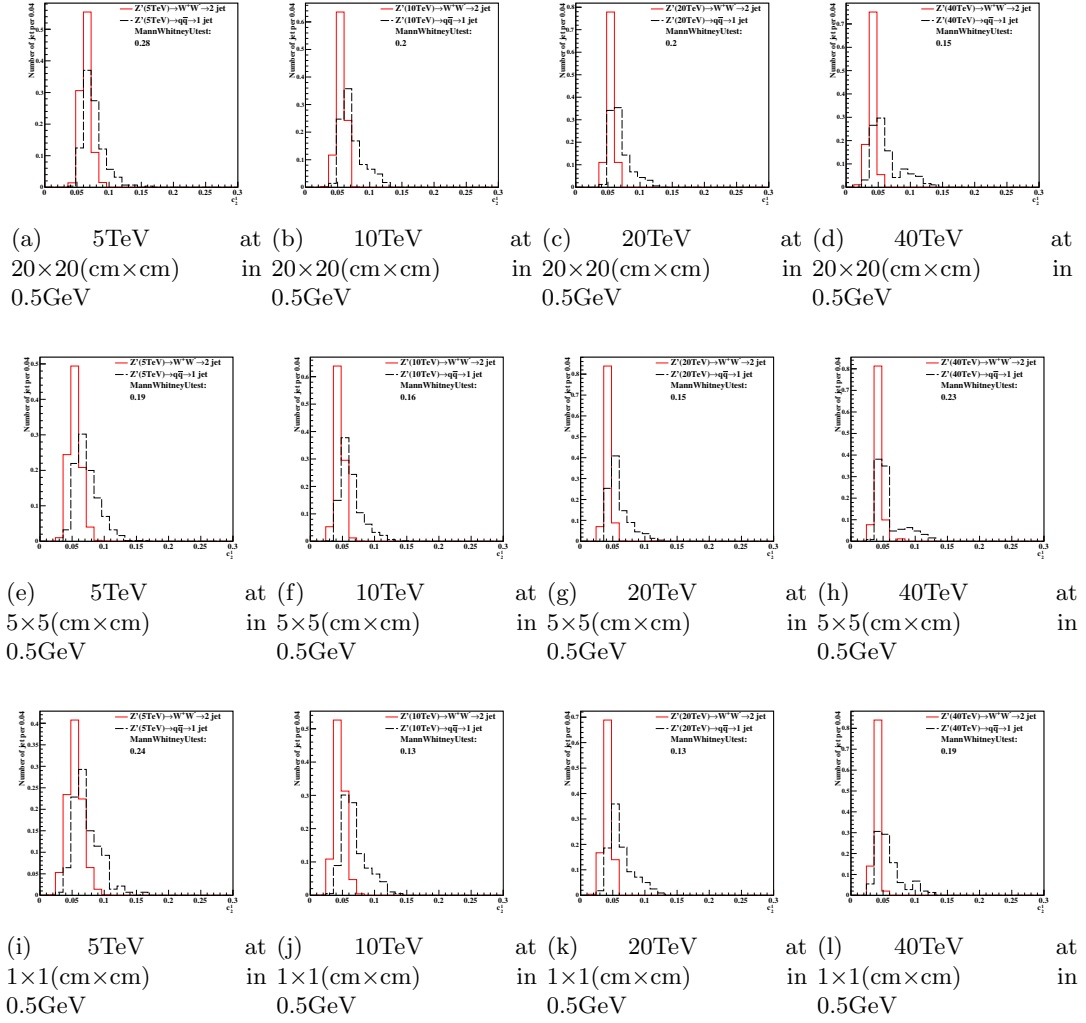
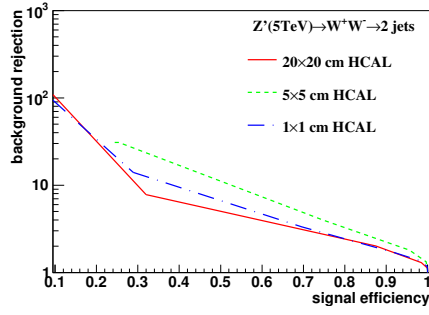
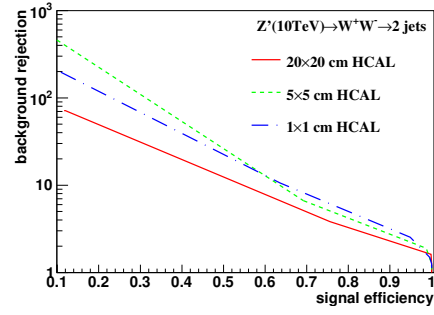


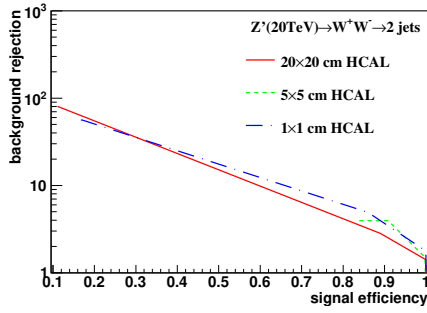
Figure 1: Distributions of Mann-Whitney value U in 5, 10, 20, 40TeV energy collision for c2b1 in different detector sizes. Cell Size in 20×20, 5×5, and 1×1(cm×cm) are shown here.



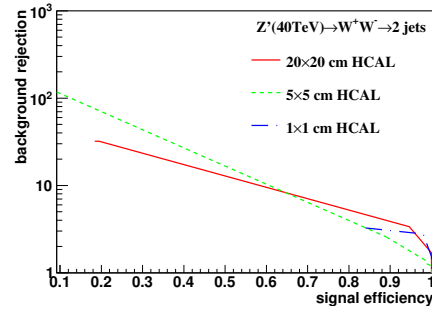
(a) 5 TeV using Rawhit 0.5GeV cut method with New2 after cut Method



(b) 10 TeV using Rawhit 0.5GeV cut method with New2 after cut Method



(c) 20 TeV using Rawhit 0.5GeV cut method with New2 after cut Method



(d) 40 TeV using Rawhit 0.5GeV cut method with New2 after cut Method

Figure 2: Signal efficiency versus background rejection rate using c2b1. The energies of collision at (a)5, (b)10, (c)20, (d)40TeV are shown here. In each picture, the three ROC curves correspond to different detector sizes.

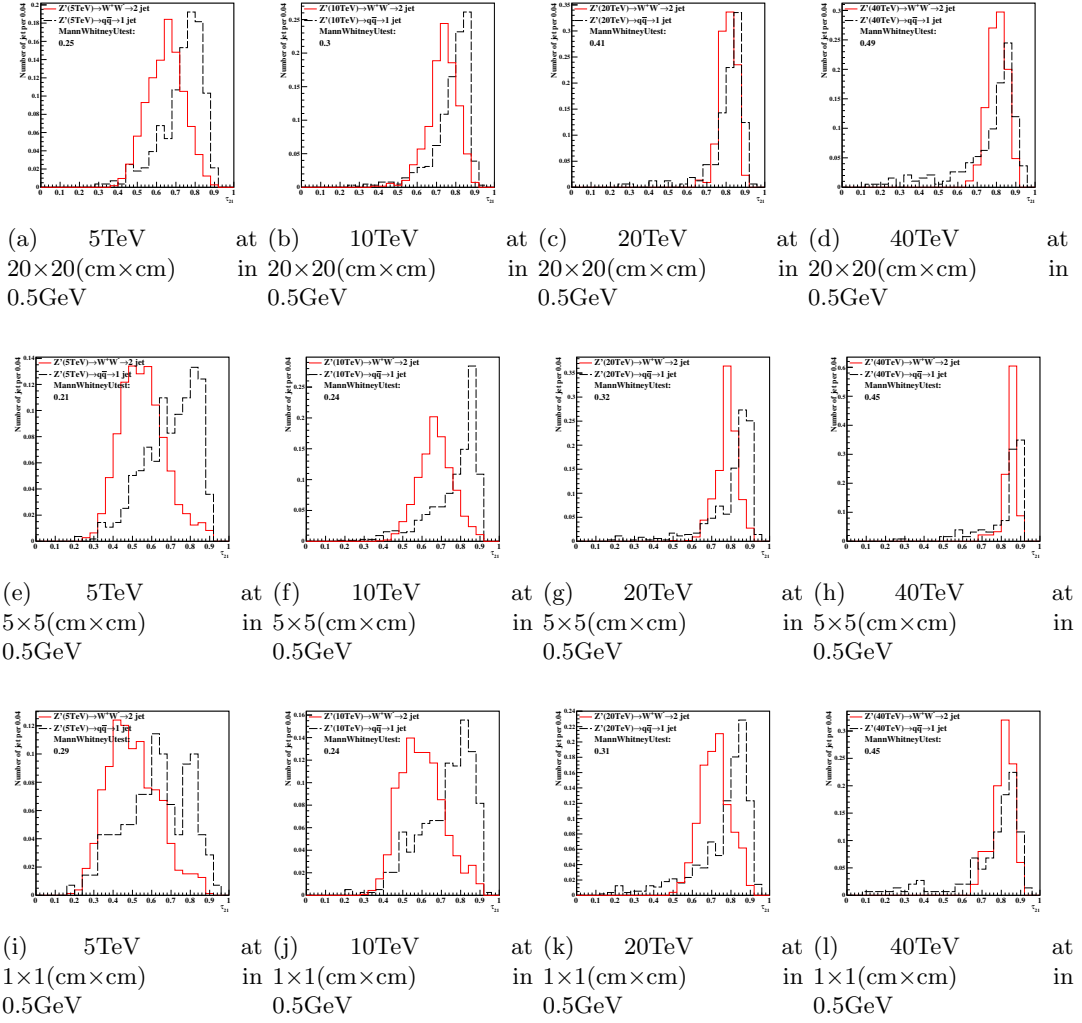
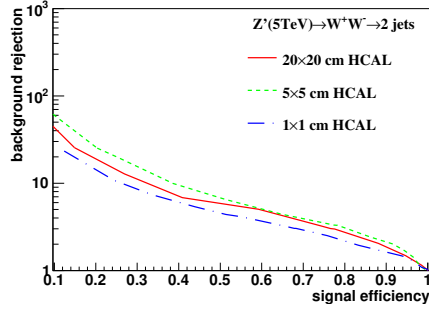
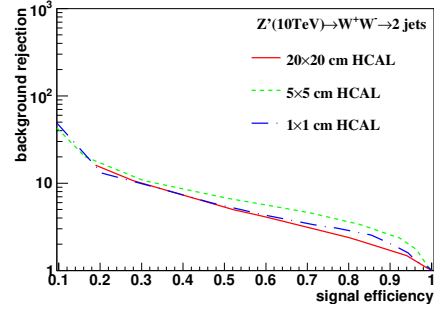


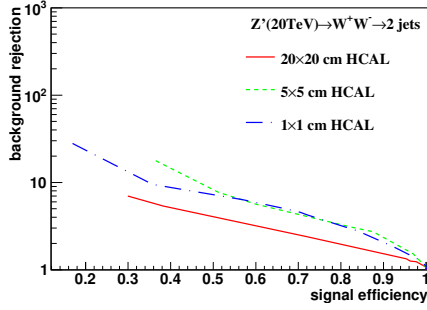
Figure 3: Distributions of Mann-Whitney value U in 5, 10, 20, 40TeV energy collision for  $\tau_{21}$  in different detector sizes. Cell Size in 20 $\times$ 20, 5 $\times$ 5, and 1 $\times$ 1(cm $\times$ cm) are shown here.



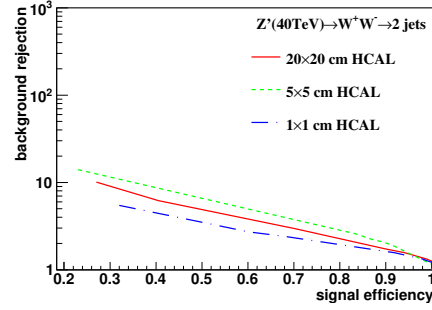
(a) 5 TeV using Rawhit 0.5GeV cut method with New2 after cut Method



(b) 10 TeV using Rawhit 0.5GeV cut method with New2 after cut Method



(c) 20 TeV using Rawhit 0.5GeV cut method with New2 after cut Method



(d) 40 TeV using Rawhit 0.5GeV cut method with New2 after cut Method

Figure 4: Signal efficiency versus background rejection rate using  $\tau_{21}$ . The energies of collision at (a)5, (b)10, (c)20, (d)40TeV are shown here. In each picture, the three ROC curves correspond to different detector sizes.

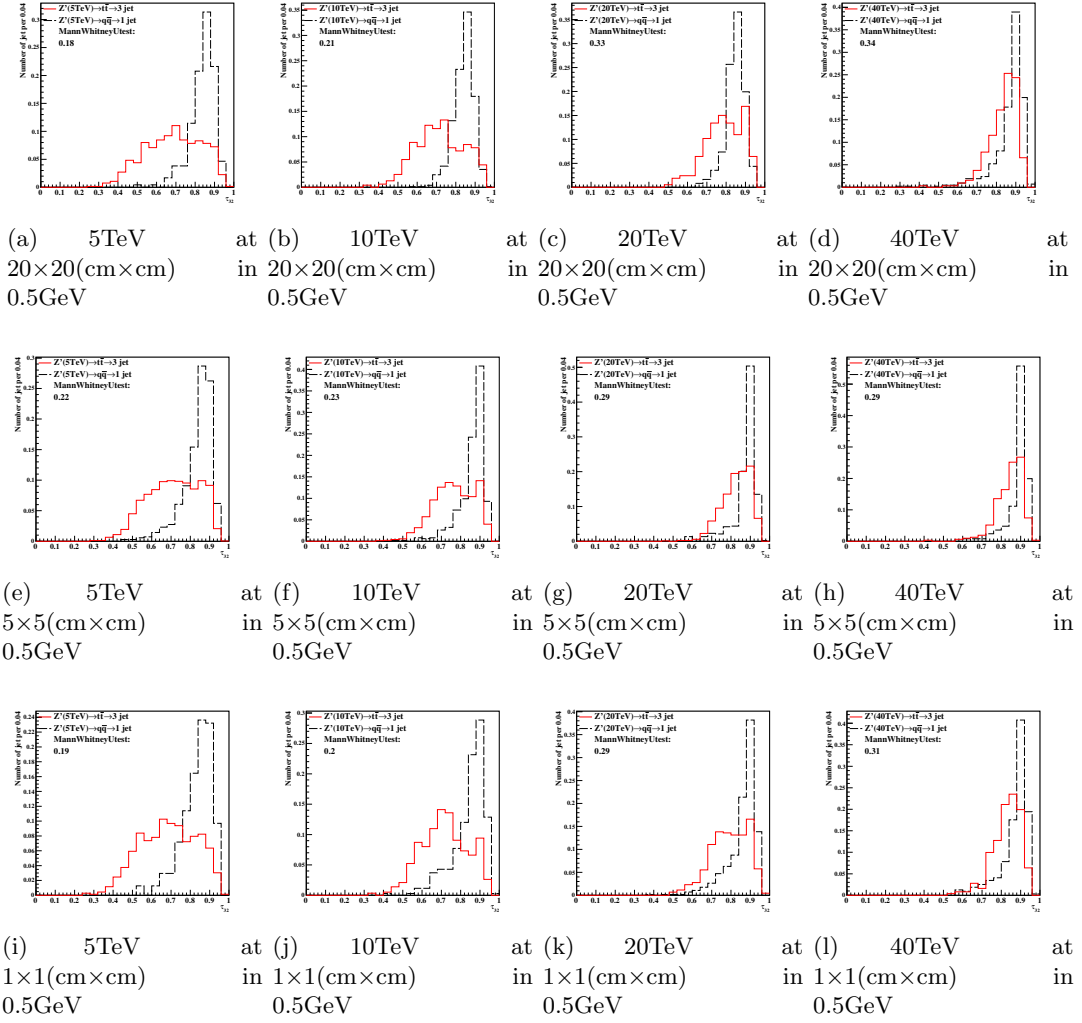
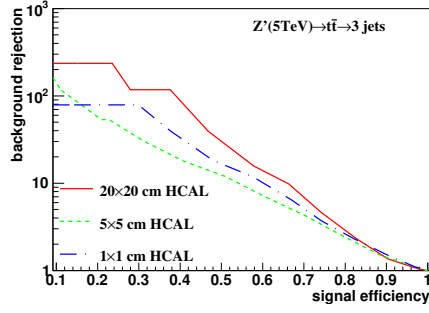
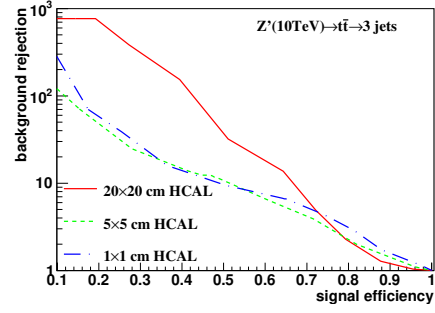


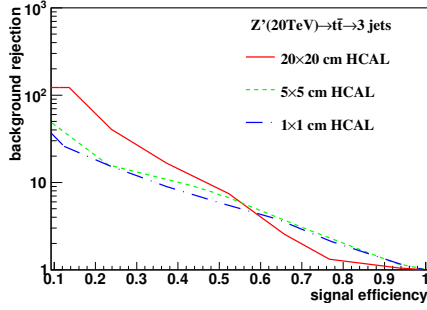
Figure 5: Distributions of Mann-Whitney value U in 5, 10, 20, 40TeV energy collision for  $\tau_{32}$  in different detector sizes. Cell Size in 20×20, 5×5, and 1×1(cm×cm) are shown here.



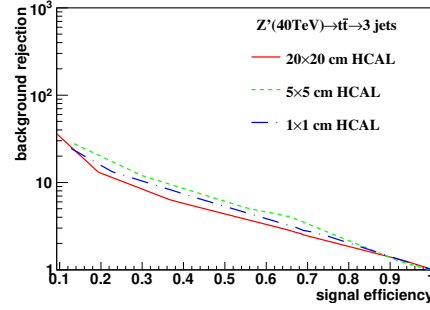
(a) 5 TeV using Rawhit 0.5GeV cut method with New2 after cut Method



(b) 10 TeV using Rawhit 0.5GeV cut method with New2 after cut Method

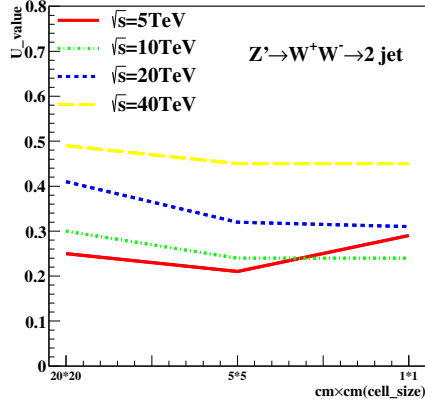


(c) 20 TeV using Rawhit 0.5GeV cut method with New2 after cut Method

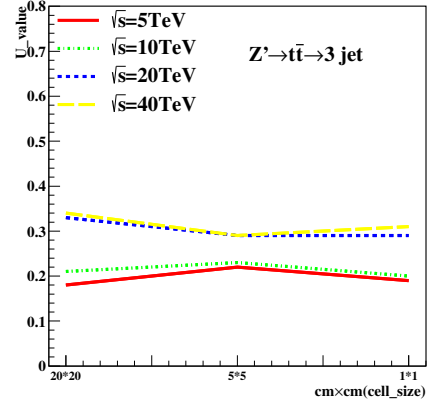


(d) 40 TeV using Rawhit 0.5GeV cut method with New2 after cut Method

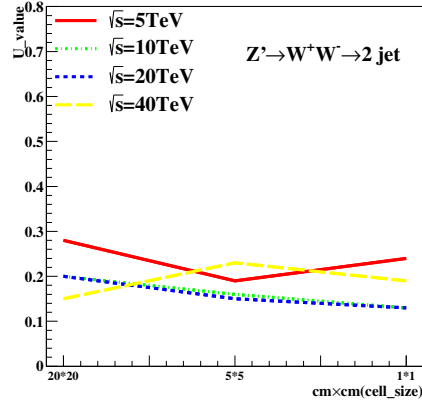
Figure 6: Signal efficiency versus background rejection rate using  $\tau_{32}$ . The energies of collision at (a)5, (b)10, (c)20, (d)40TeV are shown here. In each picture, the three ROC curves correspond to different detector sizes.



(a)  $\tau_{21}$  rawhit cut at 0.5 GeV



(b)  $\tau_{32}$  rawhit cut at 0.5 GeV



(c)  $c_2^{(1)}$  rawhit cut at 0.5 GeV

Figure 7: The Mann-Whitney U values for  $\tau_{21}, \tau_{32}$  and  $c_2^{(1)}$  reconstructed from calorimeter hit at 0.5 GeV cut at different collision energies correspond to different detector sizes in rawhit cut at 0.5 GeV. The energies of collision at 5, 10, 20, 40, 20, 40 TeV are shown in each figure.