

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

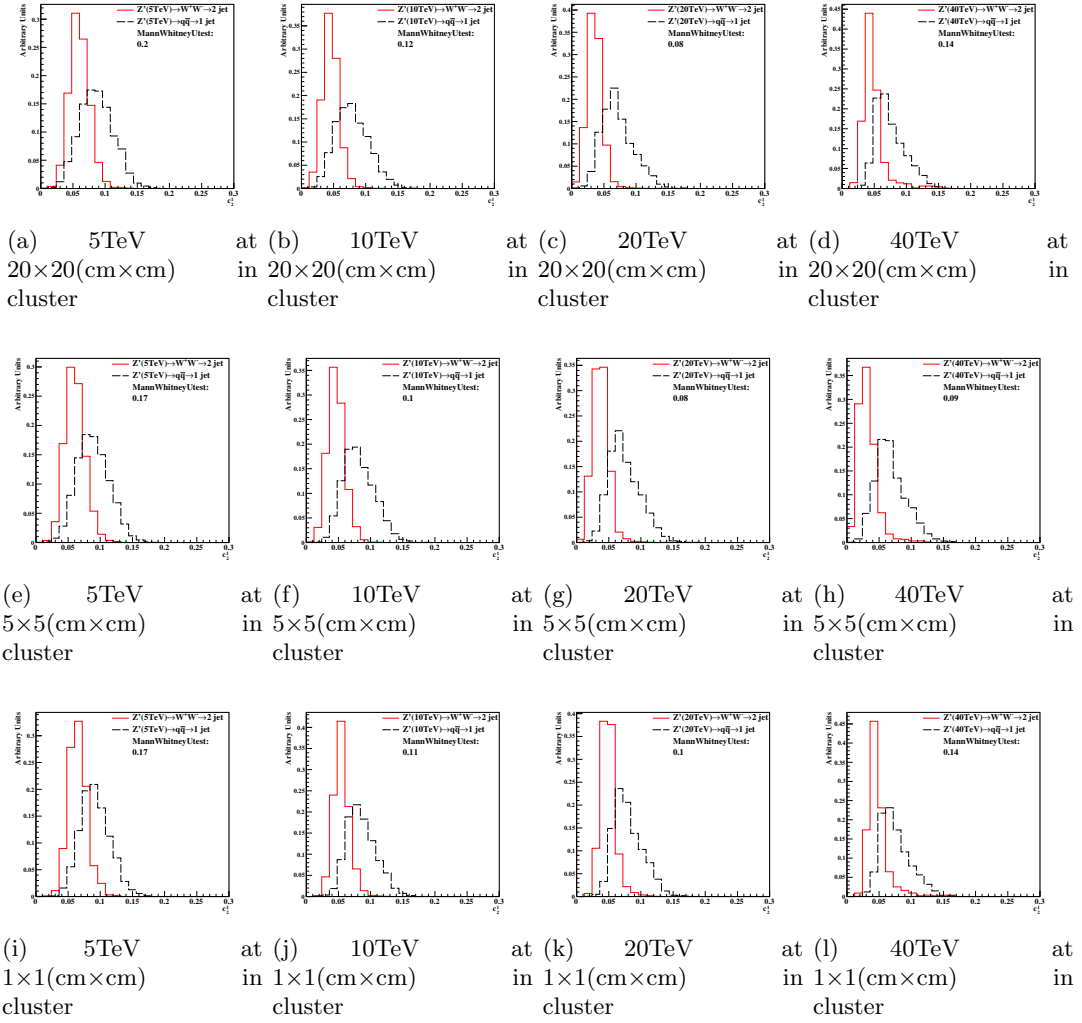
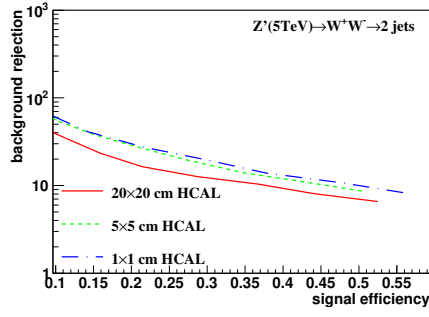
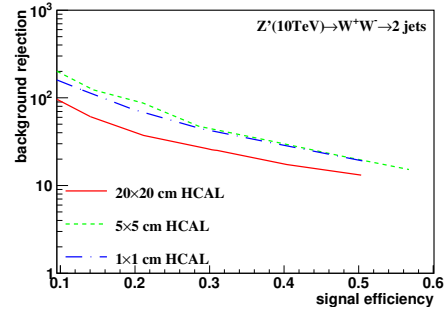


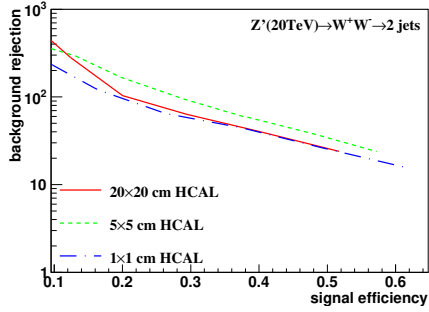
Figure 1: Distributions of Mann-Whitney value  $U$  in 5, 10, 20, 40 TeV energy collision for  $c_2^{(1)}$  in different detector sizes. Cell Size in  $20 \times 20$ ,  $5 \times 5$ , and  $1 \times 1 (\text{cm} \times \text{cm})$  are shown here.



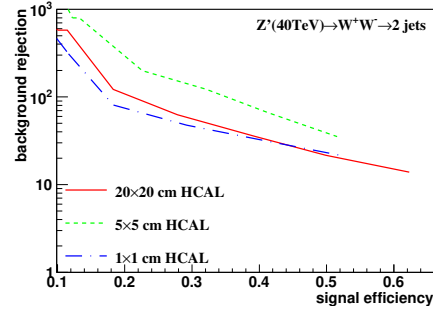
(a) 5 TeV using cluster method with New2 Method



(b) 10 TeV using cluster method with New2 Method



(c) 20 TeV using cluster method with New2 Method



(d) 40 TeV using cluster method with New2 Method

Figure 2: Signal efficiency versus background rejection rate using  $c_2^{(1)}$ . 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.

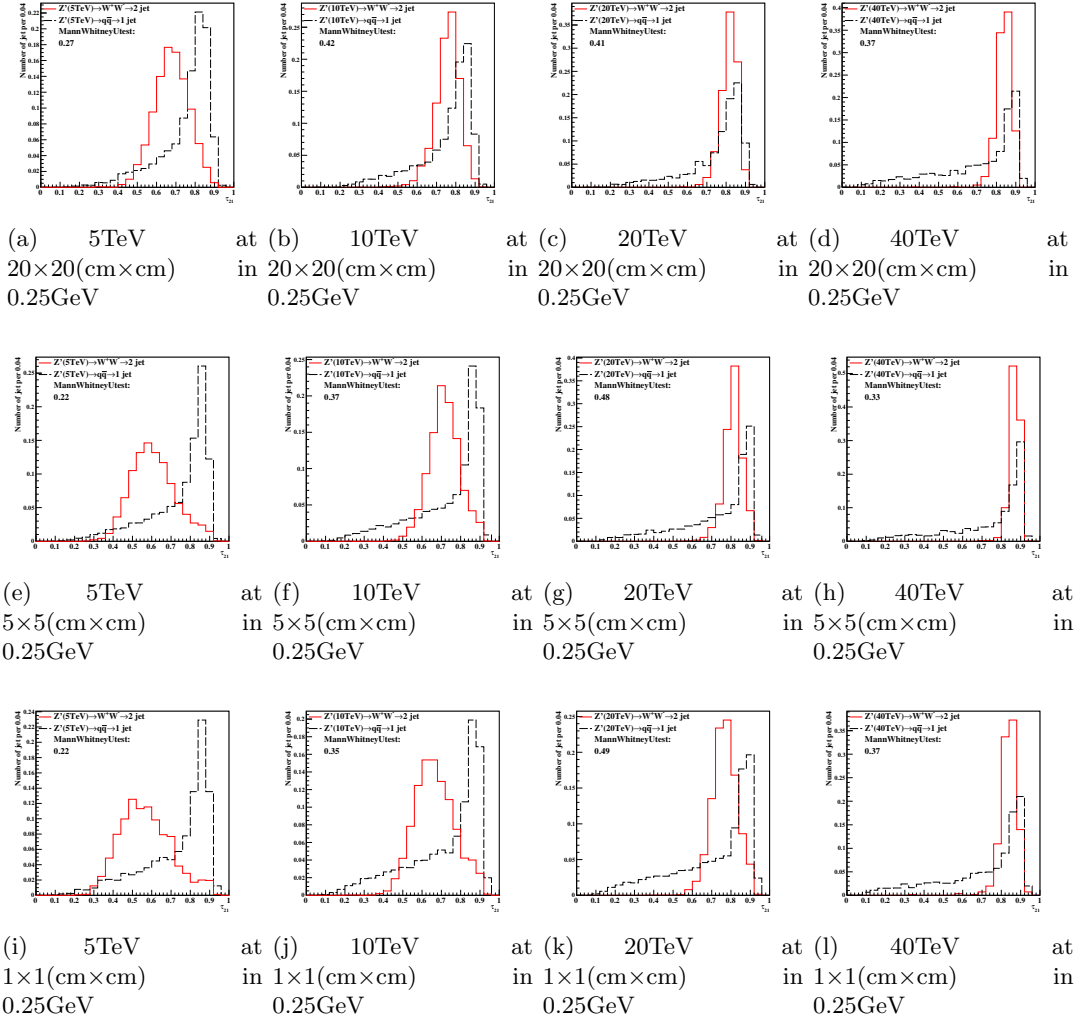
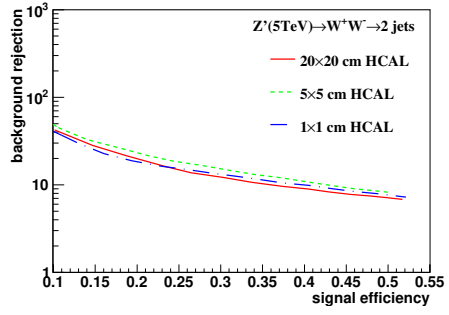
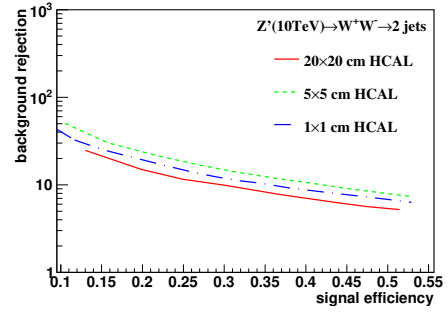


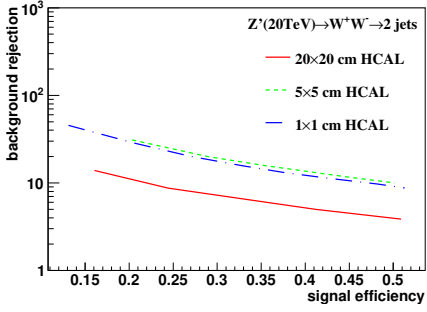
Figure 3: Distributions of Mann-Whitney value U in 5, 10, 20, 40TeV energy collision for  $\tau_{21}$  in different detector sizes. Cell Size in 20×20, 5×5, and 1×1(cm×cm) are shown here.



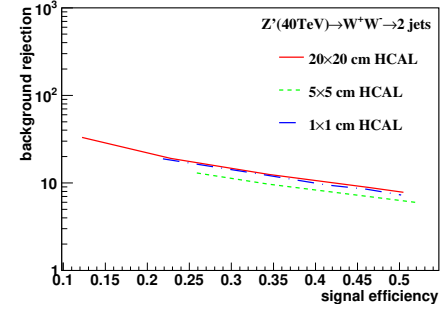
(a) 5 TeV rawhit cut at 0.25GeV compare with New2 Method



(b) 10 TeV rawhit cut at 0.25GeV compare with New2 Method



(c) 20 TeV rawhit cut at 0.25GeV compare with New2 Method



(d) 40 TeV rawhit cut at 0.25GeV compare with New2 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.

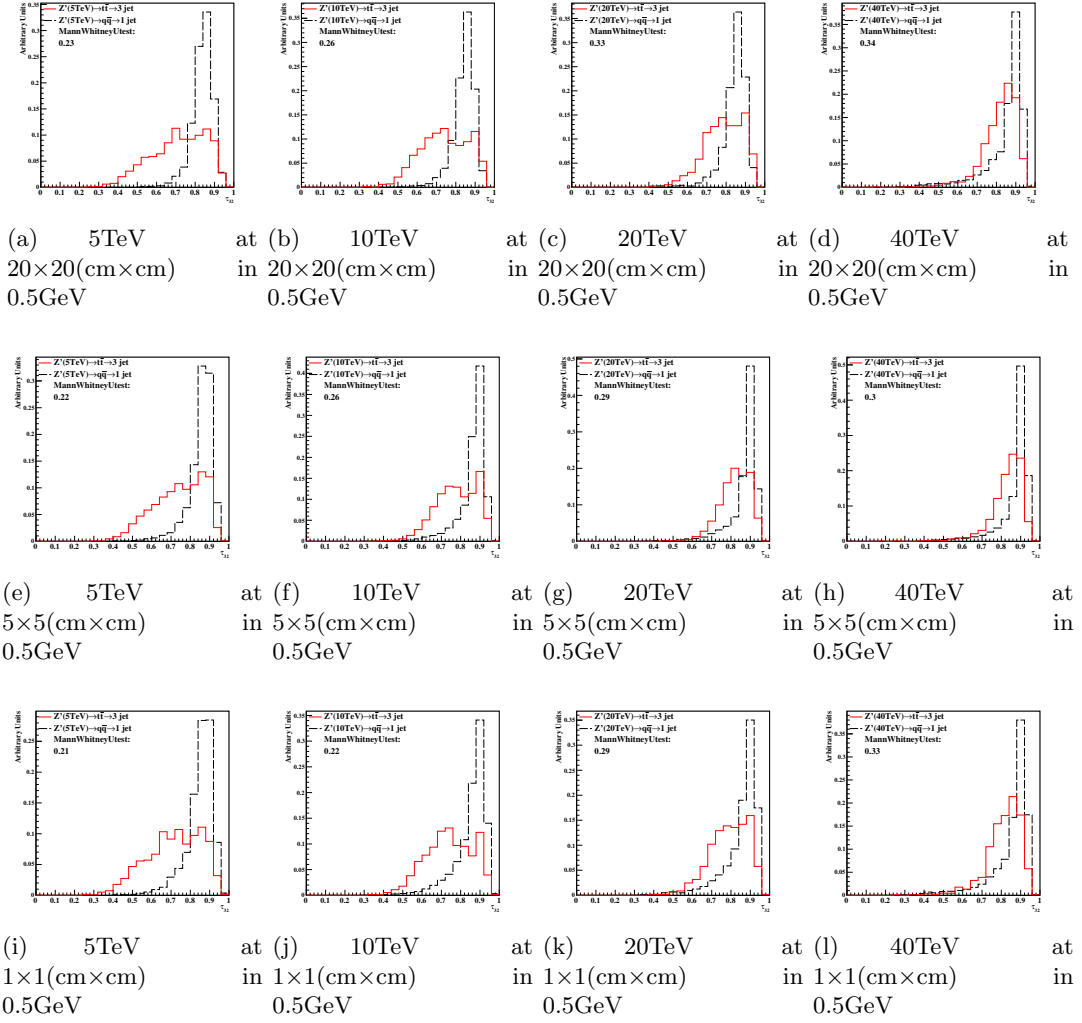
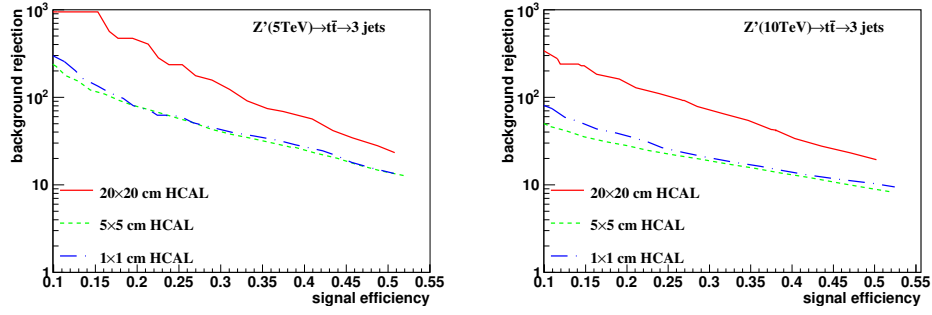
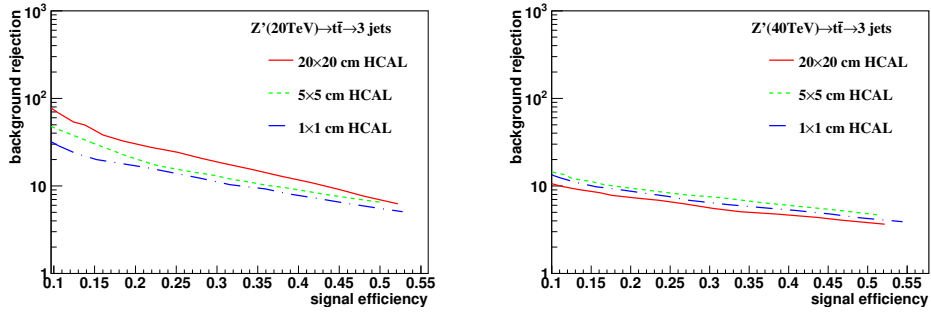


Figure 5: Distributions of Mann-Whitney value U in 5, 10, 20, 40 TeV energy collision for  $\tau_{32}$  in different detector sizes. Cell Size in 20x20, 5x5, and 1x1(cm x cm) are shown here.

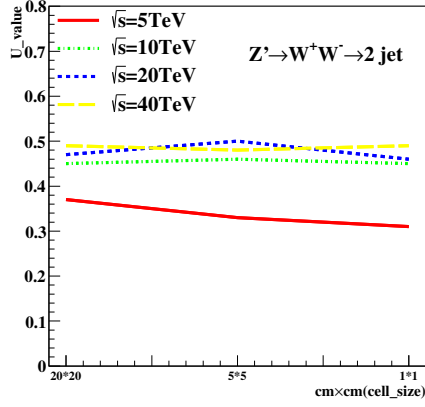


(a) 5 TeV rawhit cut at 0.5GeV compare with New2 Method (b) 10 TeV rawhit cut at 0.5GeV compare with New2 Method

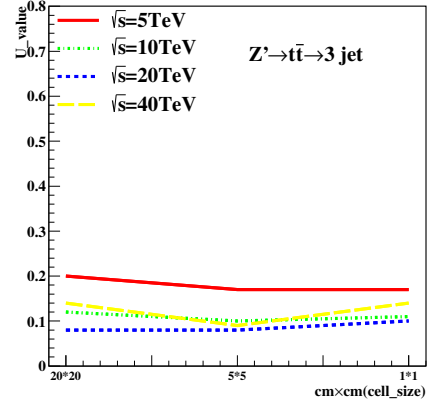


(c) 20 TeV rawhit cut at 0.5GeV compare with New2 Method (d) 40 TeV rawhit cut at 0.5GeV compare with New2 Method

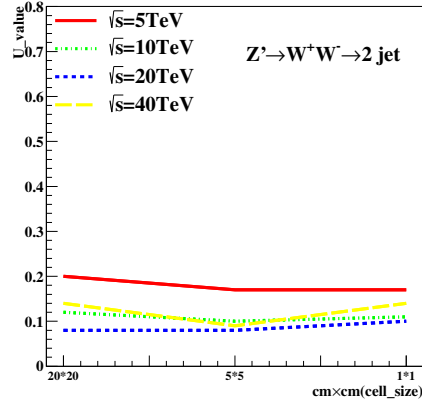
Figure 6: Signal efficiency versus background rejection rate using  $\tau_{32}$ . The energies of collision at (a)5, (b)10, (c)20, (d)40TeV are shown here. In each picture, the three ROC curves correspond to different detector sizes.



(a)  $\tau_{21}$  in cluster



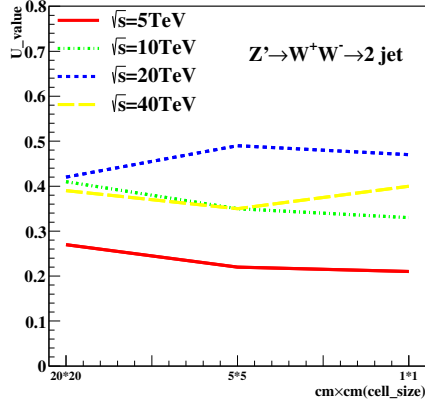
(b)  $\tau_{32}$  in cluster



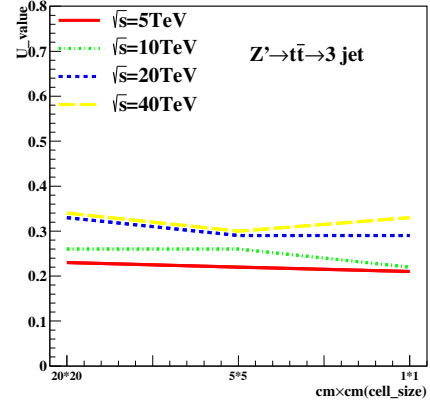
(c)  $c_2^{(1)}$  in cluster

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

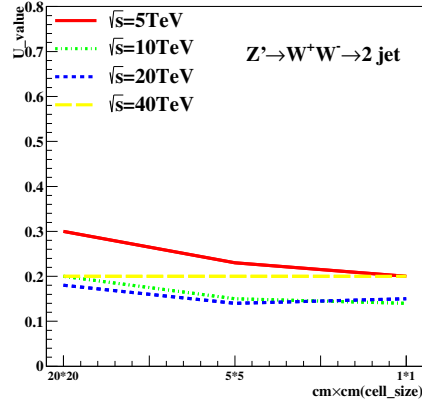




(a)  $\tau_{21}$  rawhit cut at 0.5GeV

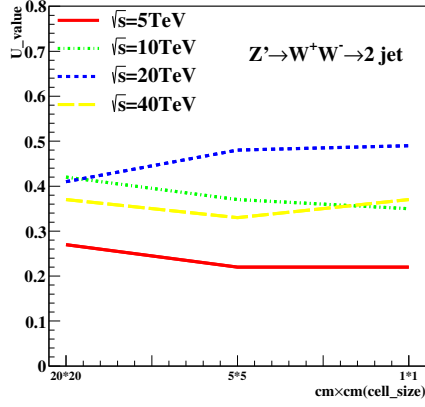


(b)  $\tau_{32}$  rawhit cut at 0.5GeV

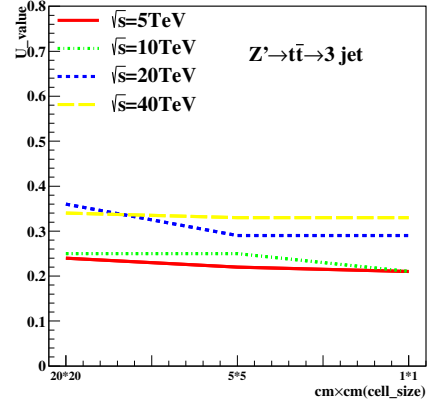


(c)  $c_2^{(1)}$  rawhit cut at 0.5GeV

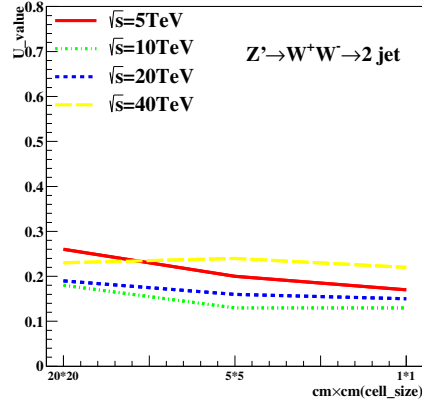
Figure 8: The Mann-Whitney U values for  $\tau_{21}, \tau_{32}$  and  $c_2^{(1)}$  reconstructed from calorimeter hit at 0.5GeV cut at different collision energies correspond to different detector sizes in rawhit cut at 0.5GeV. The energies of collision at 5, 10, 20, 40, 20, 40TeV are shown in each figure.



(a)  $\tau_{21}$  rawhit cut at 0.25GeV



(b)  $\tau_{32}$  rawhit cut at 0.25GeV



(c)  $c_2^{(1)}$  rawhit cut at 0.25GeV

Figure 9: The Mann-Whitney U values for  $\tau_{21}, \tau_{32}$  and  $c_2^{(1)}$  reconstructed from calorimeter hit at 0.25GeV cut at different collision energies correspond to different detector sizes in cluster. The energies of collision at 5, 10, 20, 40, 20, 40TeV are shown in each figure.