Ghost track algorithm for LCDROOT

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12/04/2001

LCD meeting

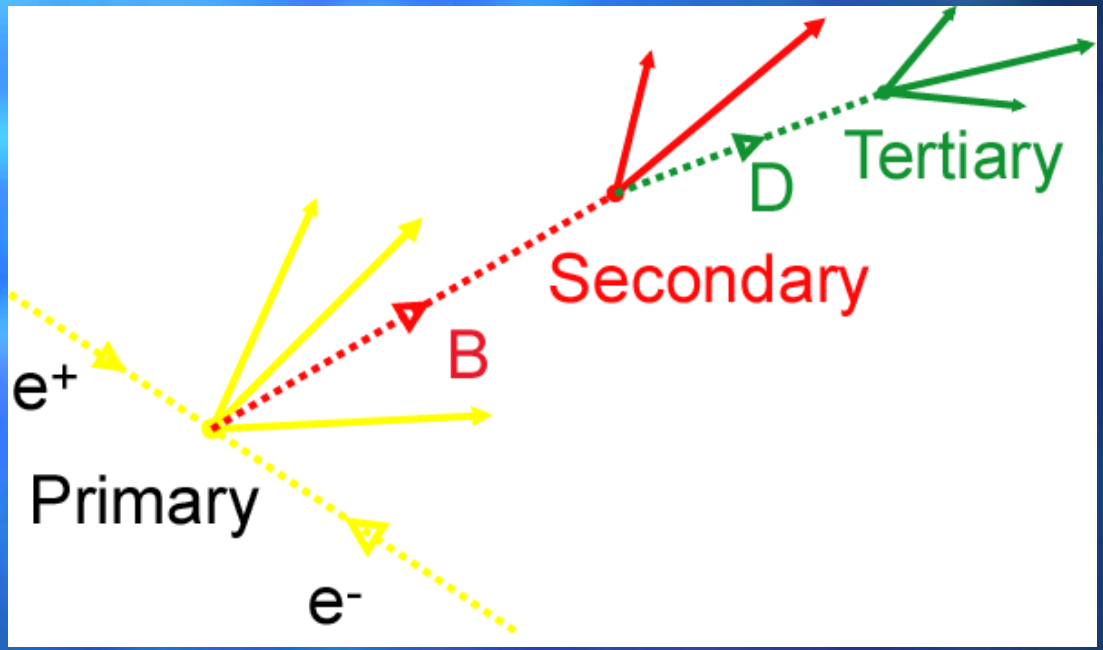
Introduction

- Heavy-flavor-jet tagging is very important to physics at future linear collliders (Higgs, top, etc).
- Original topological vertexing has been implemented in LCDROOT.
- A new topological vertexing has been developed during the Snowmass 2001, expecting improved performance.

Topics of Discussion

- Original topological vertexing
- A new topological vertexing (Ghost track algorithm)
- Neural Network for heavy flavor jet tagging

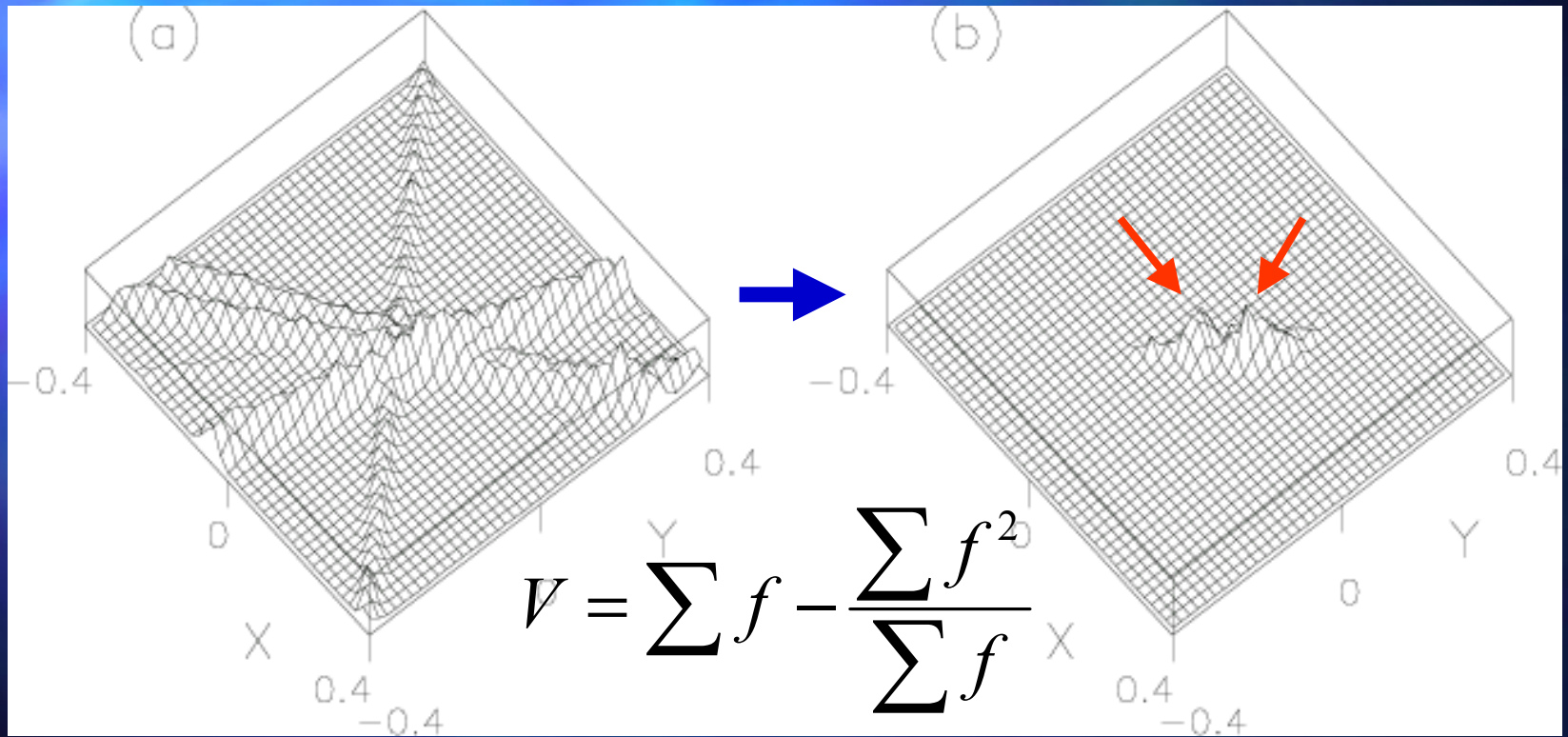
Topological vertexing



Originally this technique is developed by D.Jackson at the SLD experiment. (D.J.Jackson NIM A388, 247 (1997))

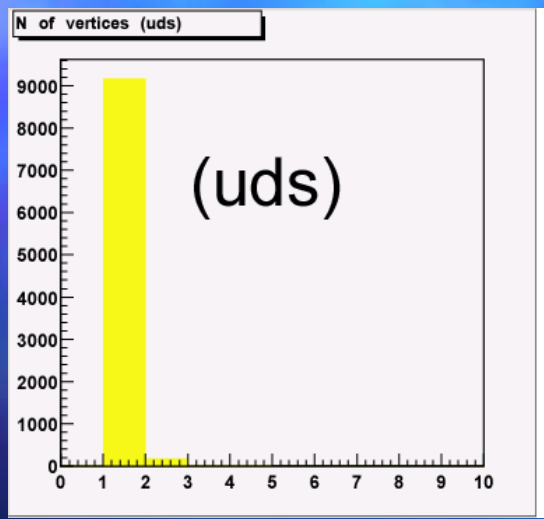
The aim of this vertexing is to fully reconstruct B decay chain.

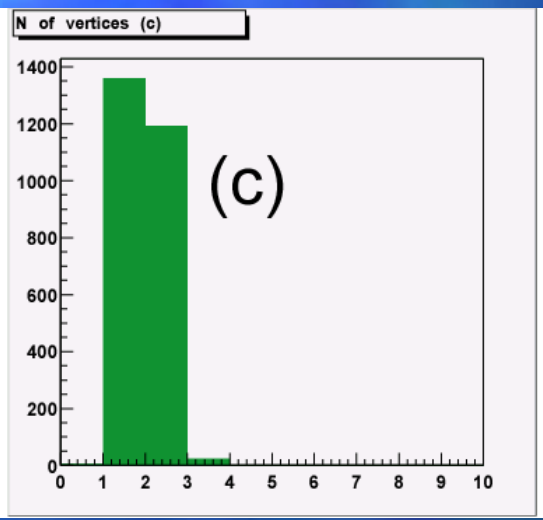
How to find vertices with the original topological vertexing?

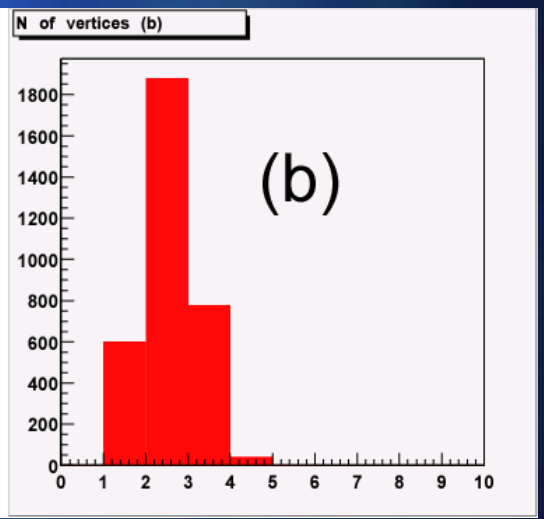


$$V = \sum f - \frac{\sum f^2}{\sum f}$$

of vertices / jet



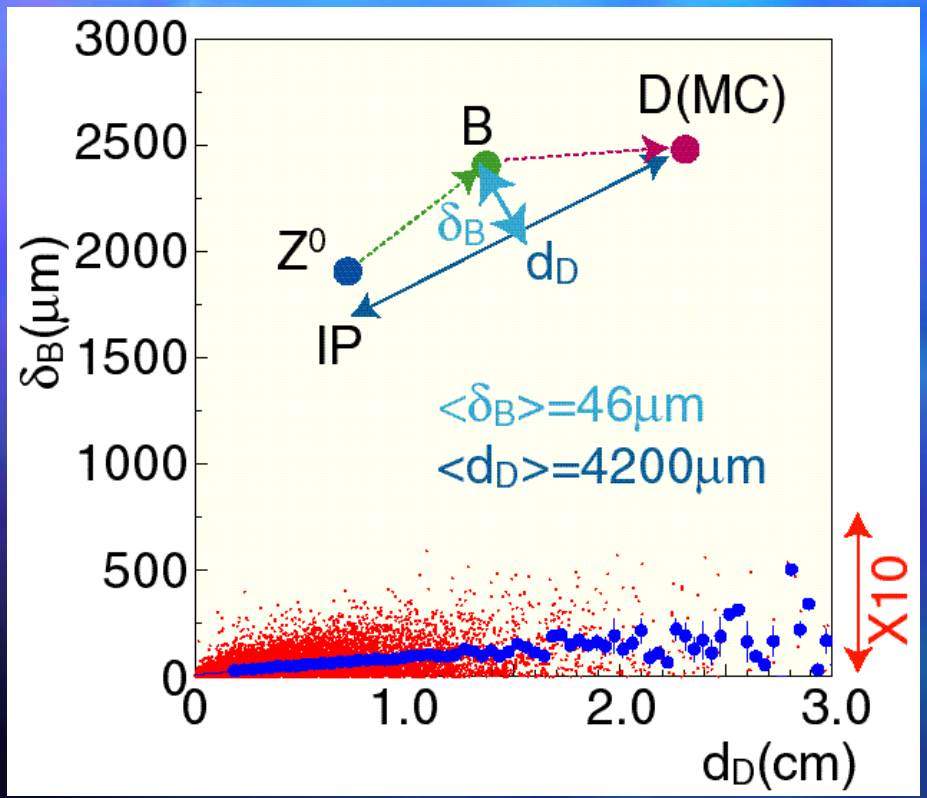




Original topological vertexing and inclusive charm-jet tagging

- With Pt-corrected mass and momentum of found secondary vertex, the vertexing has brought a remarkable success of the charm tagging for the SLD experiment.
- To find secondary vertices, you need at least two charged tracks from the vertices. For charm-jet events, about 80% of the jets satisfies the criteria. Remaining of the 20% jets has only one charged track or 0.

New topological vertexing

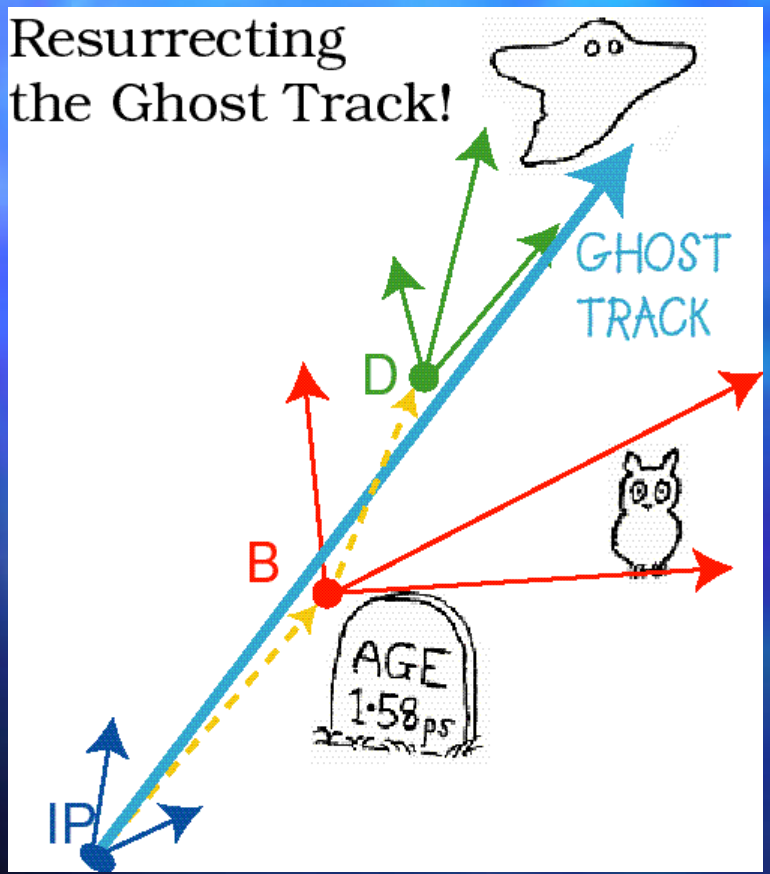


- We need a new topological vertexing to allow one prong decay vertices.

→expecting vertex reconstruction efficiency and vertex charge reconstruction purity improvement

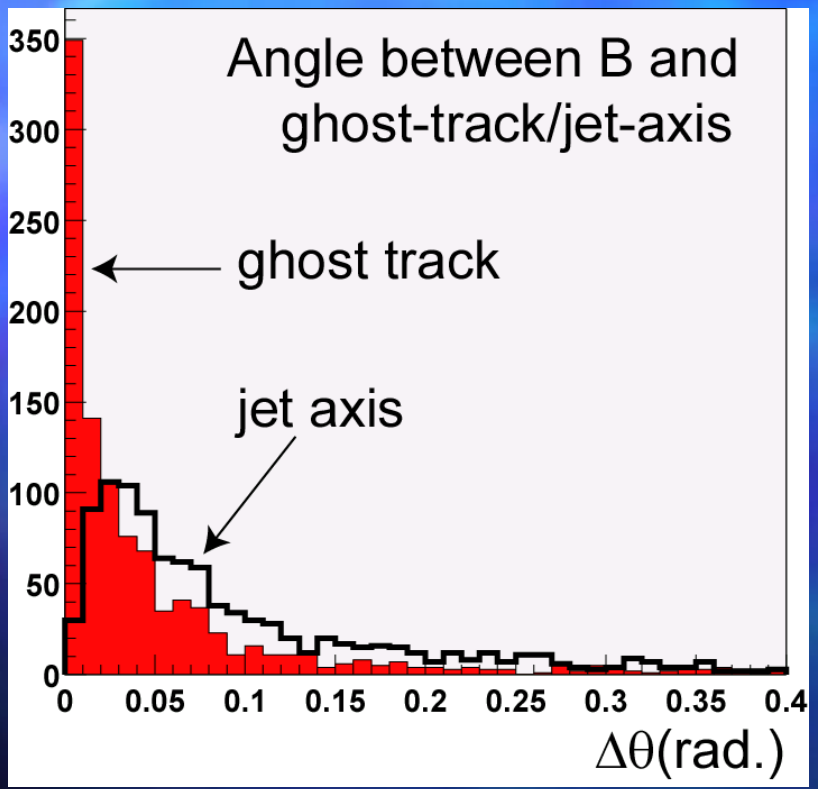
- Use straightness of B→D decay

Ghost track algorithm



- Swivel ghost in θ, ϕ until $\Sigma\chi^2$(jet trk-ghost) minimized.
- Find vertices by making vertices between tracks and the ghost track.
- Coding was done for just 4 days.

Reconstructed ghost track



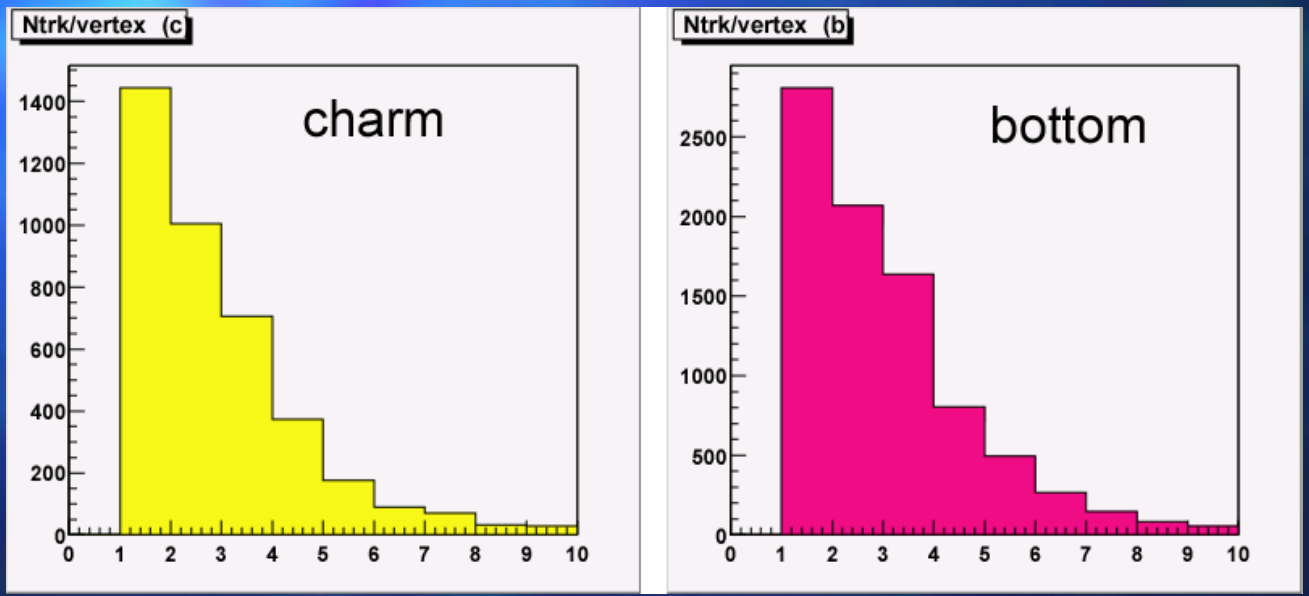
- The ghost track gives better B direction

→ can correct missing particle (ν) effect in jet reconstruction

→ May contribute to improve di-jet mass reconstruction

of tracks in a vertex

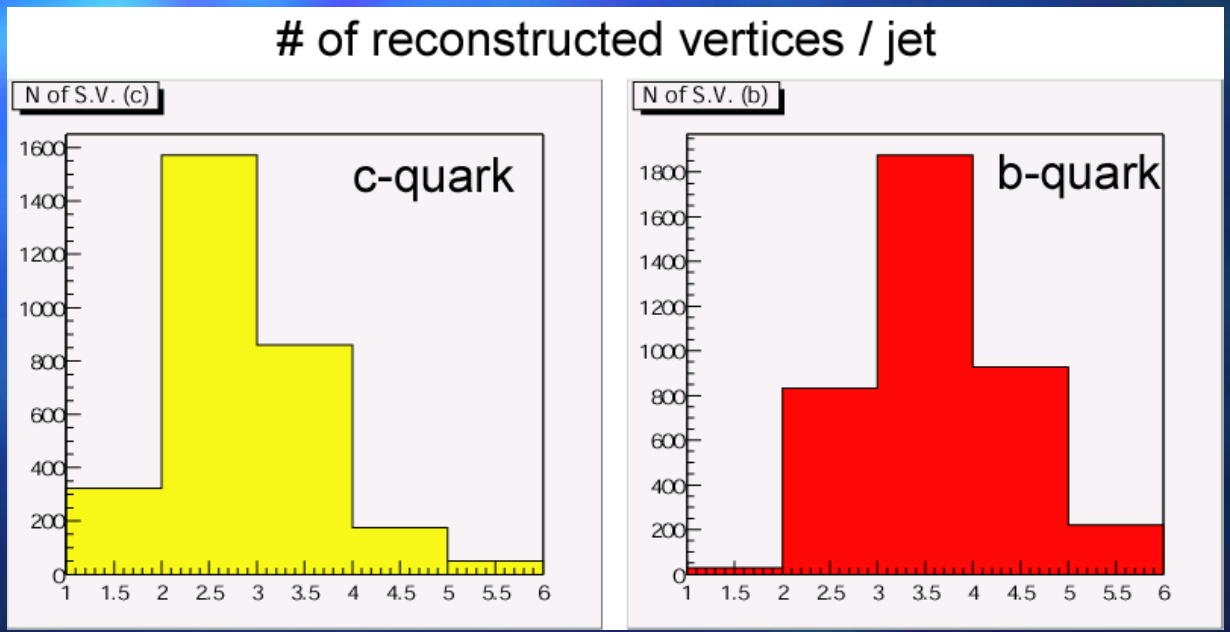
- The ghost-track algorithm gives one-prong vertecies.



of reconstructed vertices/jet

- The algorithm gives more efficient vertexing.
- But purity gets lower.

→ need another idea to improve the purity.

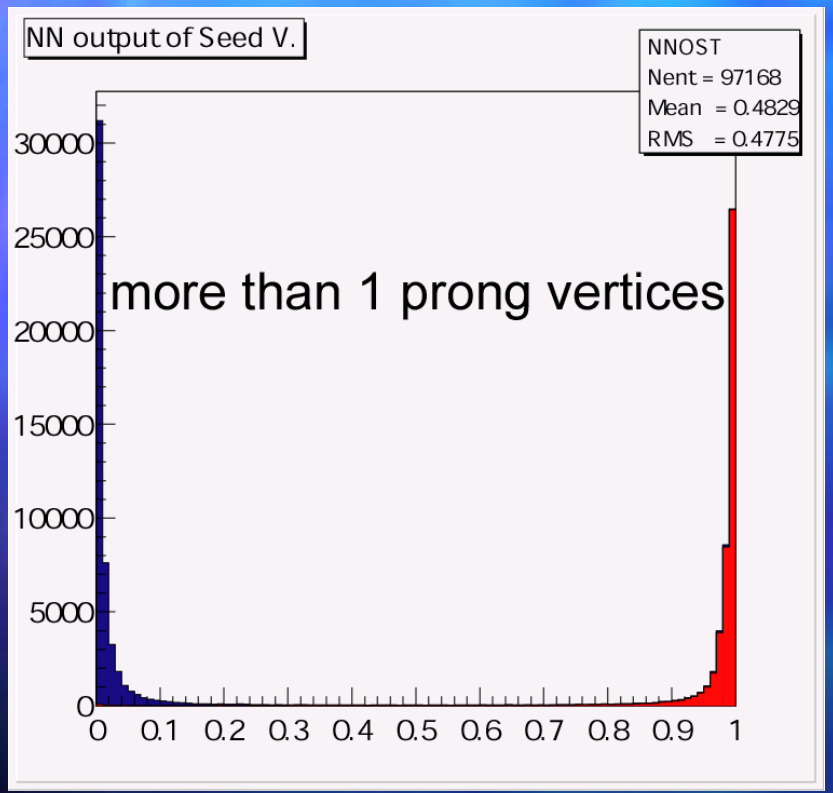


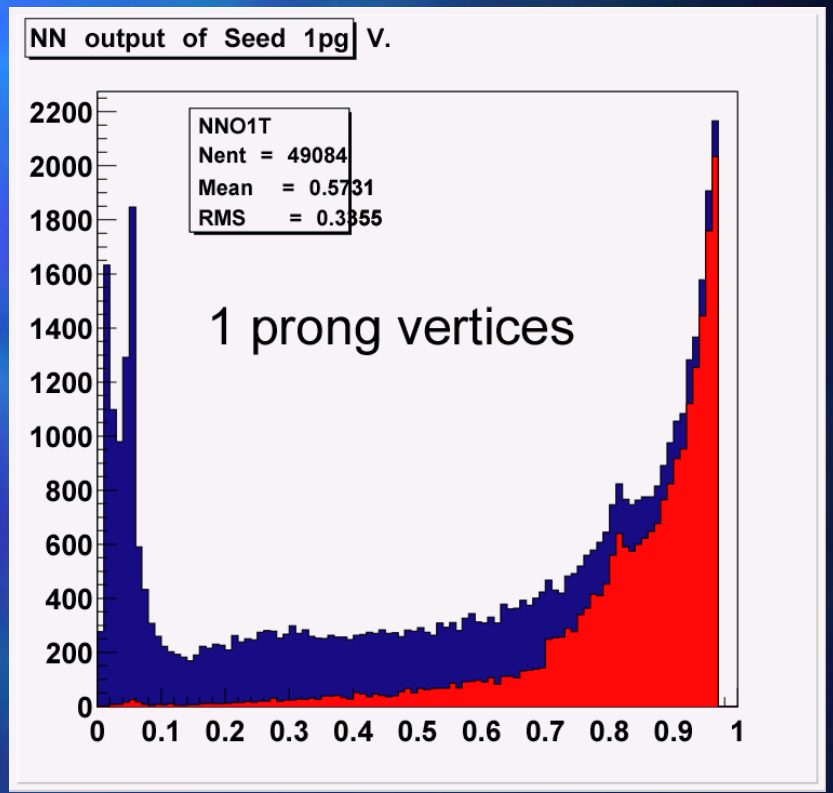
N.N. for jet flavor tagging

- I prepare three N.N.s

1. Seed vertex finder
2. Track attachment for the vertices
3. Jet flavor separation

N.N. for seed vertex finder





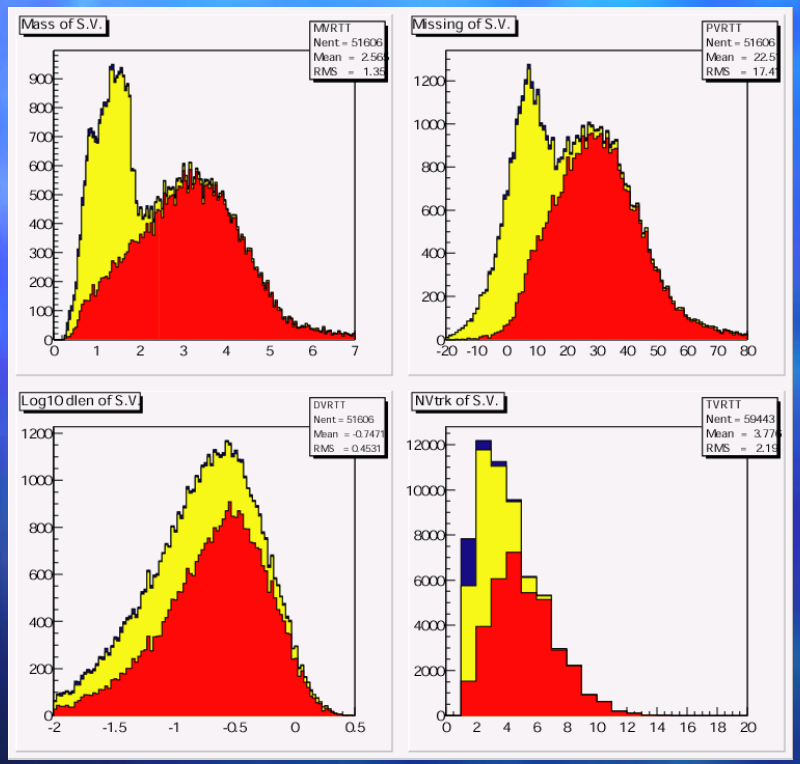
N.N. for jet flavor separation

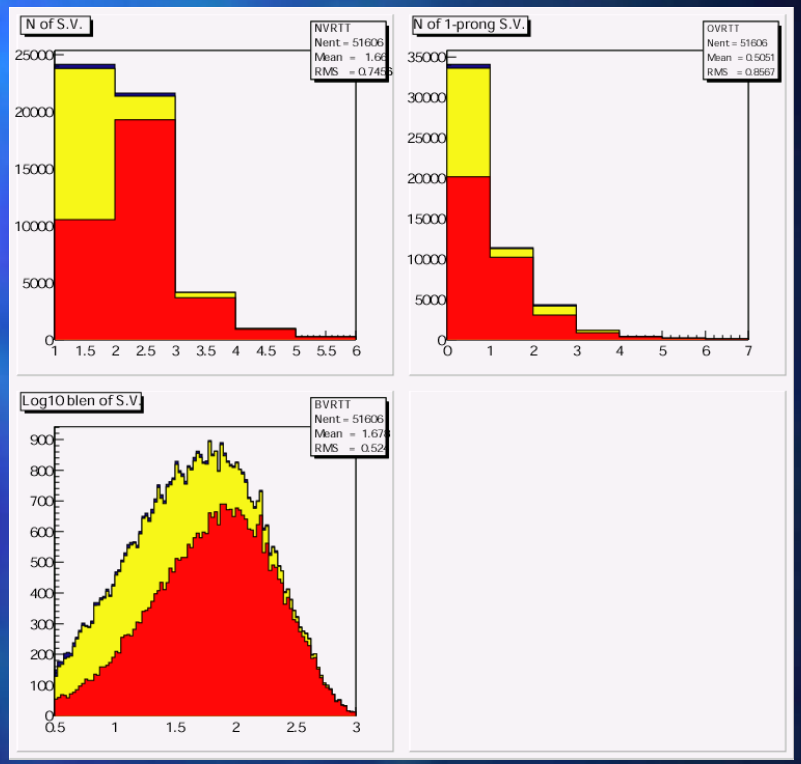
- I classify jets as follows:

1. More than 1 prong vertex
2. Only 1 prong vertex (new)
3. No vertex (new)

- For each case, I trained N.N.
- Each N.N. has 2 output nodes corresponding to b-jet and c-jet.

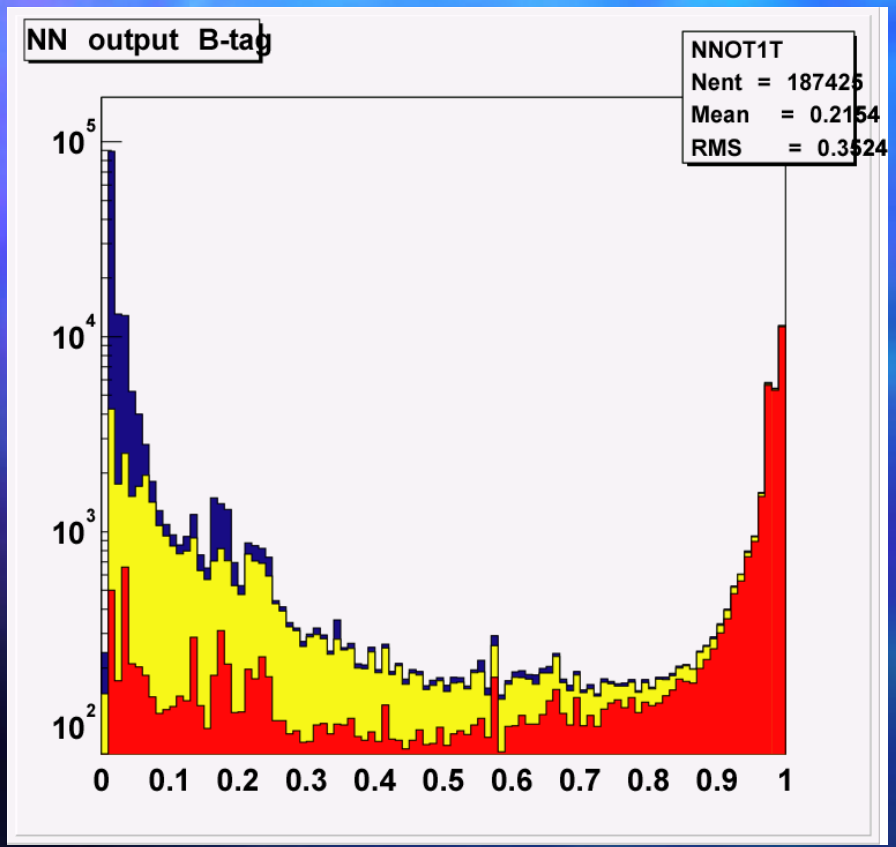
Inputs of N.N. for jet flavor tag

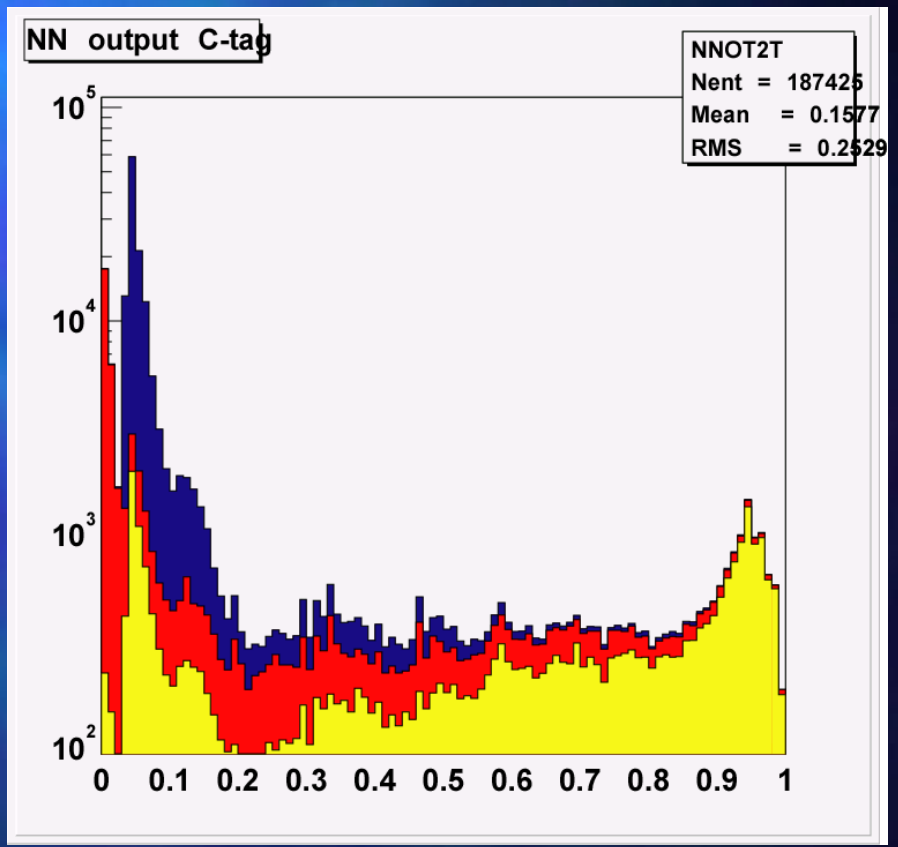




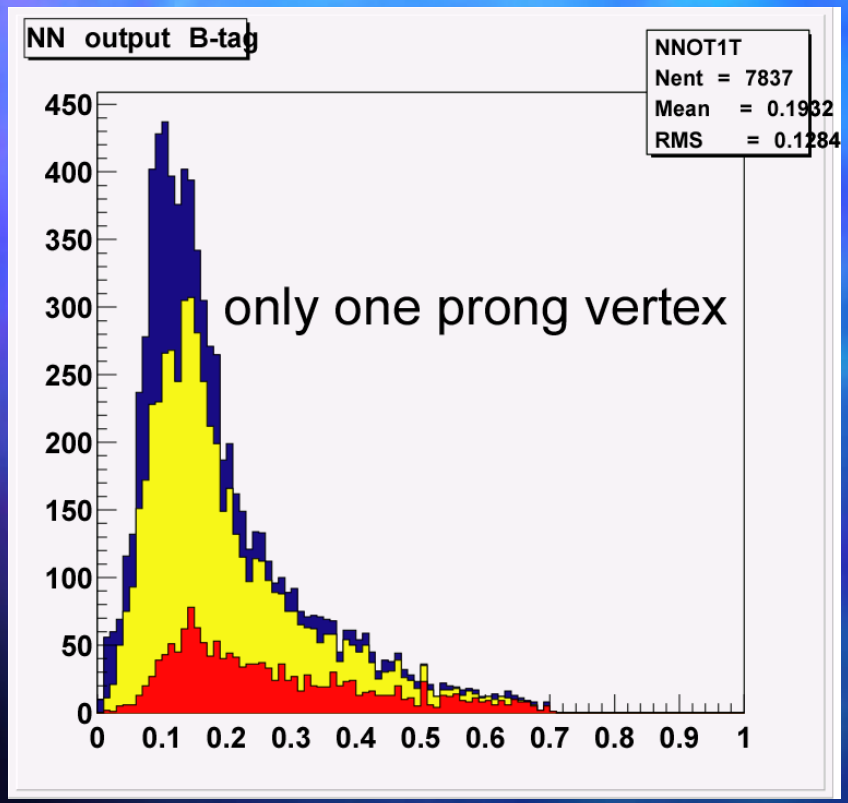
- For case (1)

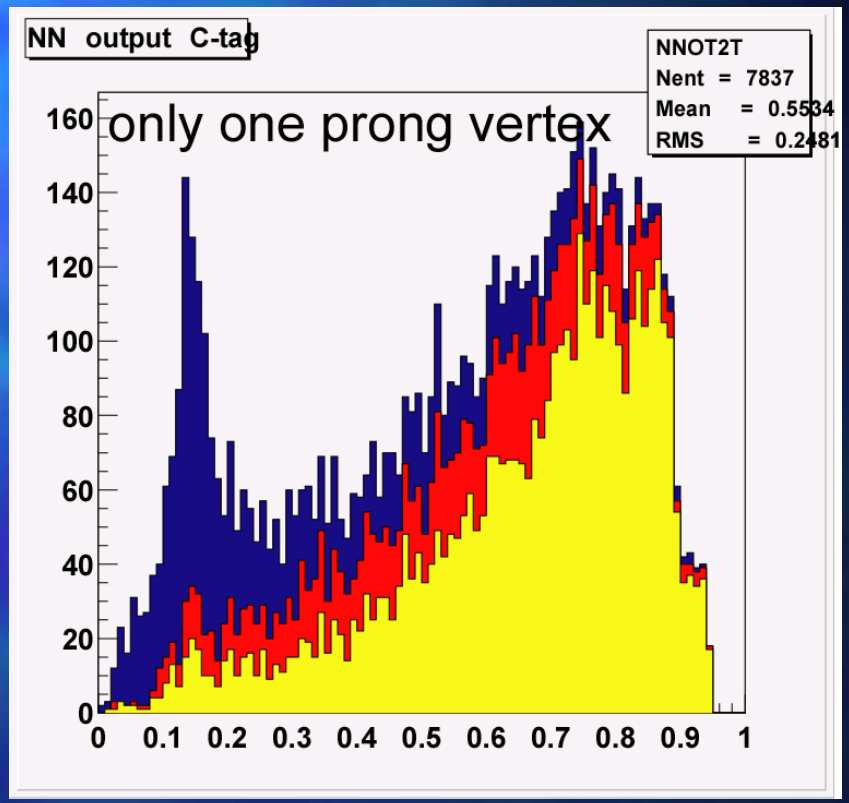
N.N. for jet flavor tag (1)



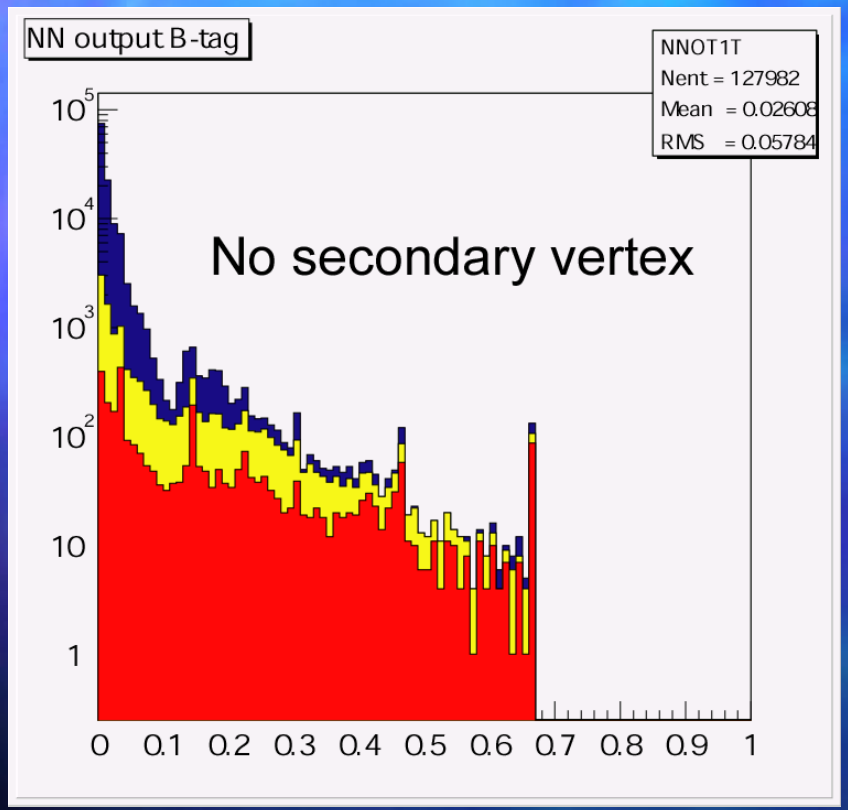


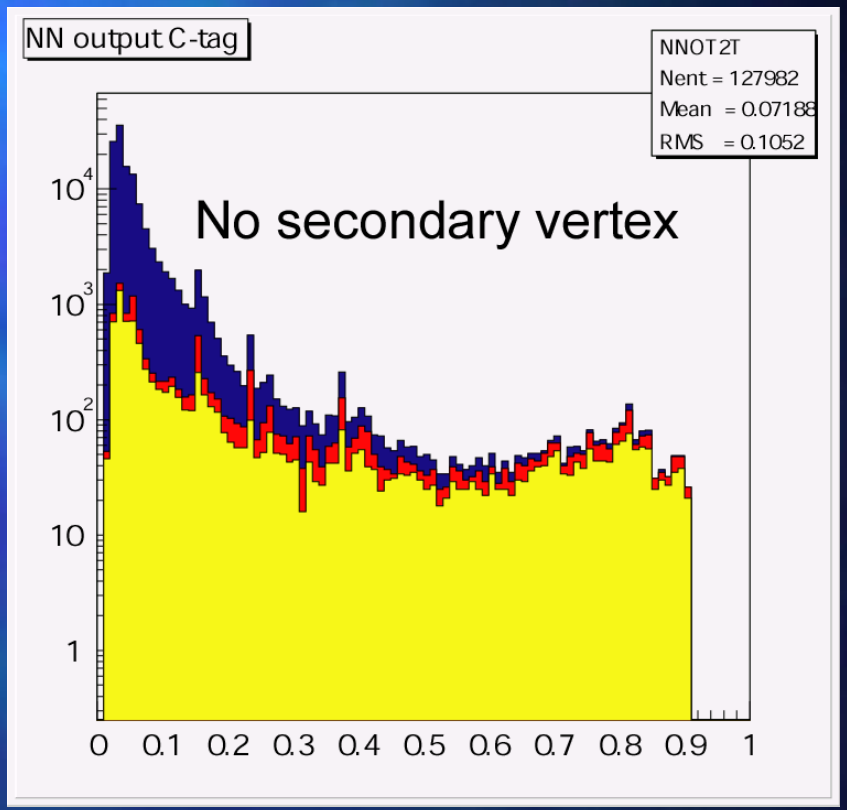
N.N. for jet flavor tag (2)



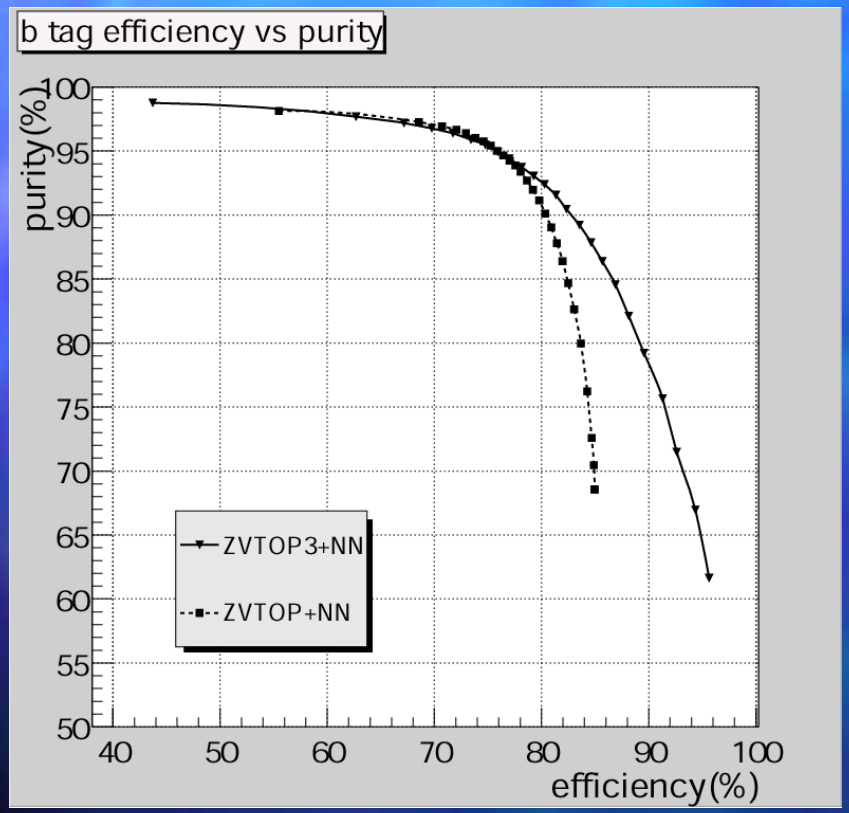


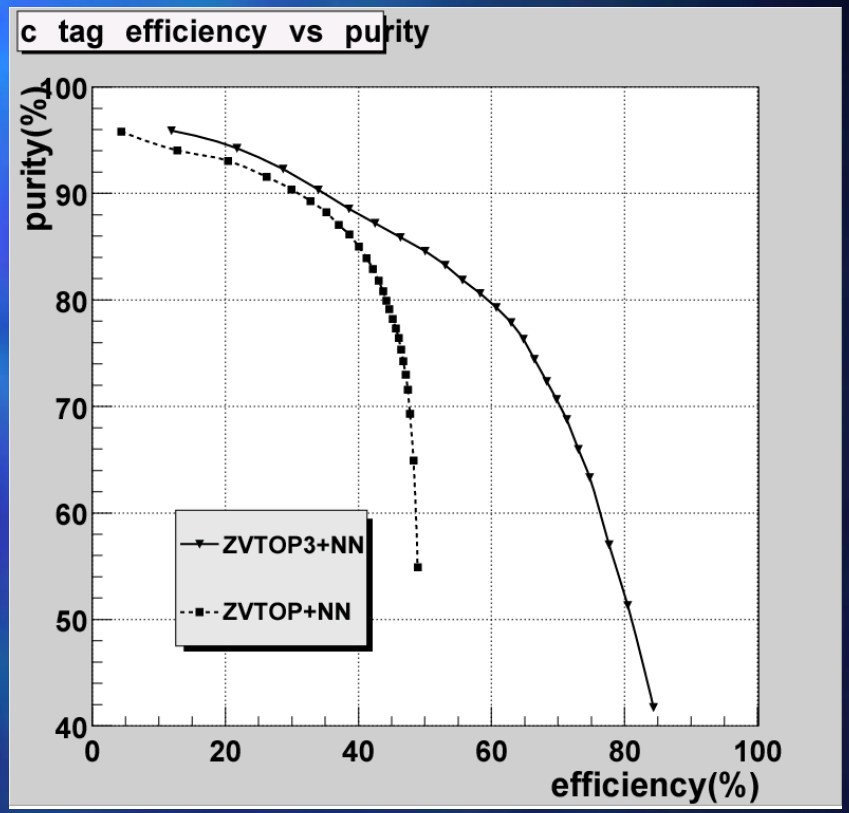
N.N. for jet flavor tag (3)





Performance





For an user's benefit

- In these study, I used Z→qq events @ Ecm=91.26GeV.
- Since we are interesting in Higgs and top physics @ Ecm=500GeV, I also trained the N.N.s using ZH events @Ecm=500GeV.
- LCDROOT V3.4 has this new feature.

Summary and Next Steps

- I have developed a new topological vertex finder and can get significant improvement.
- Check performance of vertex charge reconstruction
- Charm-tagging is a crucial issue for study of vertex detector design.

  →Aaron has started a detailed study of heavy-flavor-jet tagging under various vertex detector configuration.