Update on neutron background
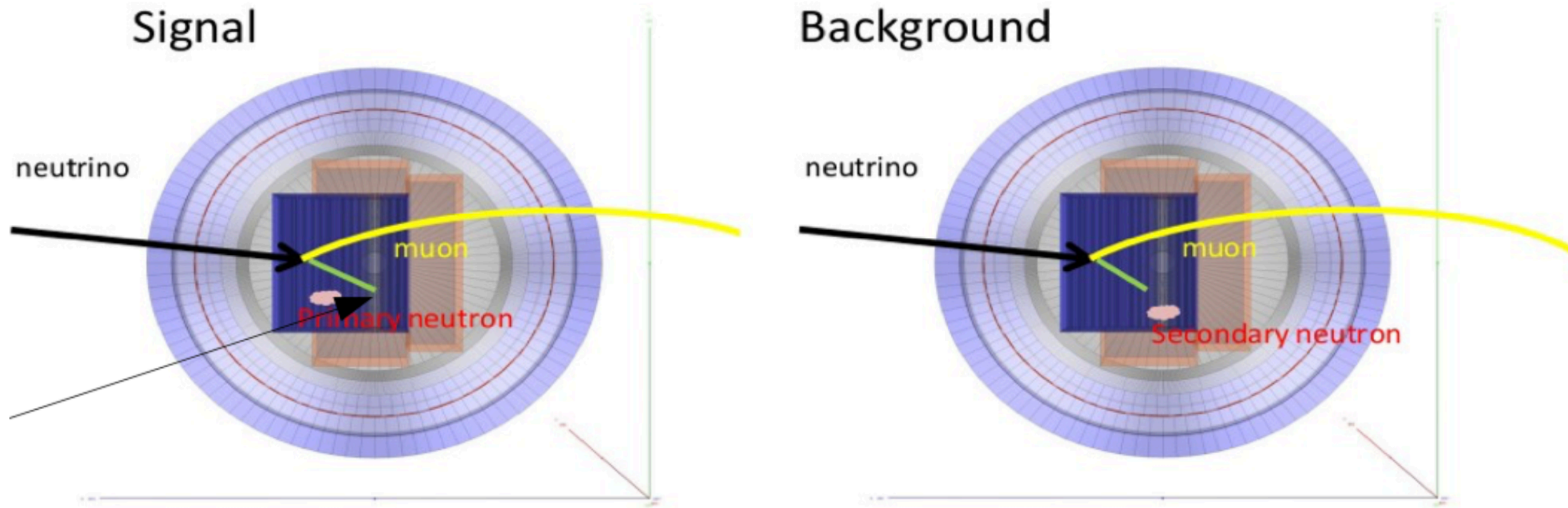
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Introduction

- **There are 3 categories for the first hit in time:**
  - **primary neutron: neutron from vertex**
  - **secondary neutron: neutron from other place**
  - **the others**

- **We made a training sample with these definition for BDT:**
  - **signal (primary neutron + secondary neutron)**
 - **background (the others)**

Introduction

- **We have a reconstruction ready by Clark. A more complete description: https://indico.fnal.gov/event/22617/contributions/197701/attachments/135065/167347/software-3dst-tpc-ecal-200924.pdf**

- **What do we have:**
  - reconstructed objects including tracks, clusters, vertices.
  - each object has a list of information such as dedx, track length, energy deposit, position, direction etc.
  - true information are available for each of the reconstructed objects.

- **Full simulation chain: GENIE → edep-sim → erep-sim (detector response) → cube reconstruction → ntuple building → higher level analyses**

- **An event display can be used to understand the reconstructed objects.**
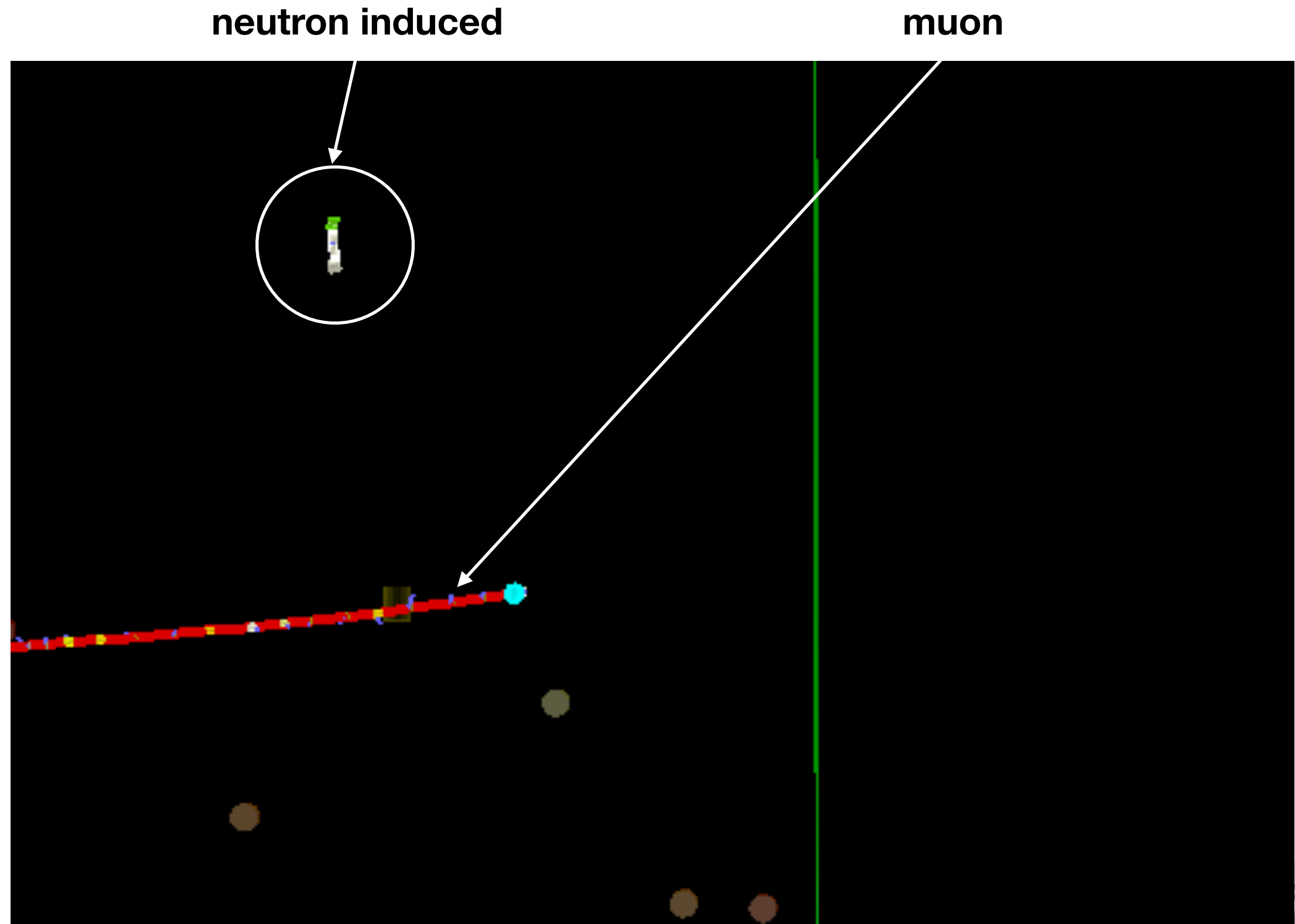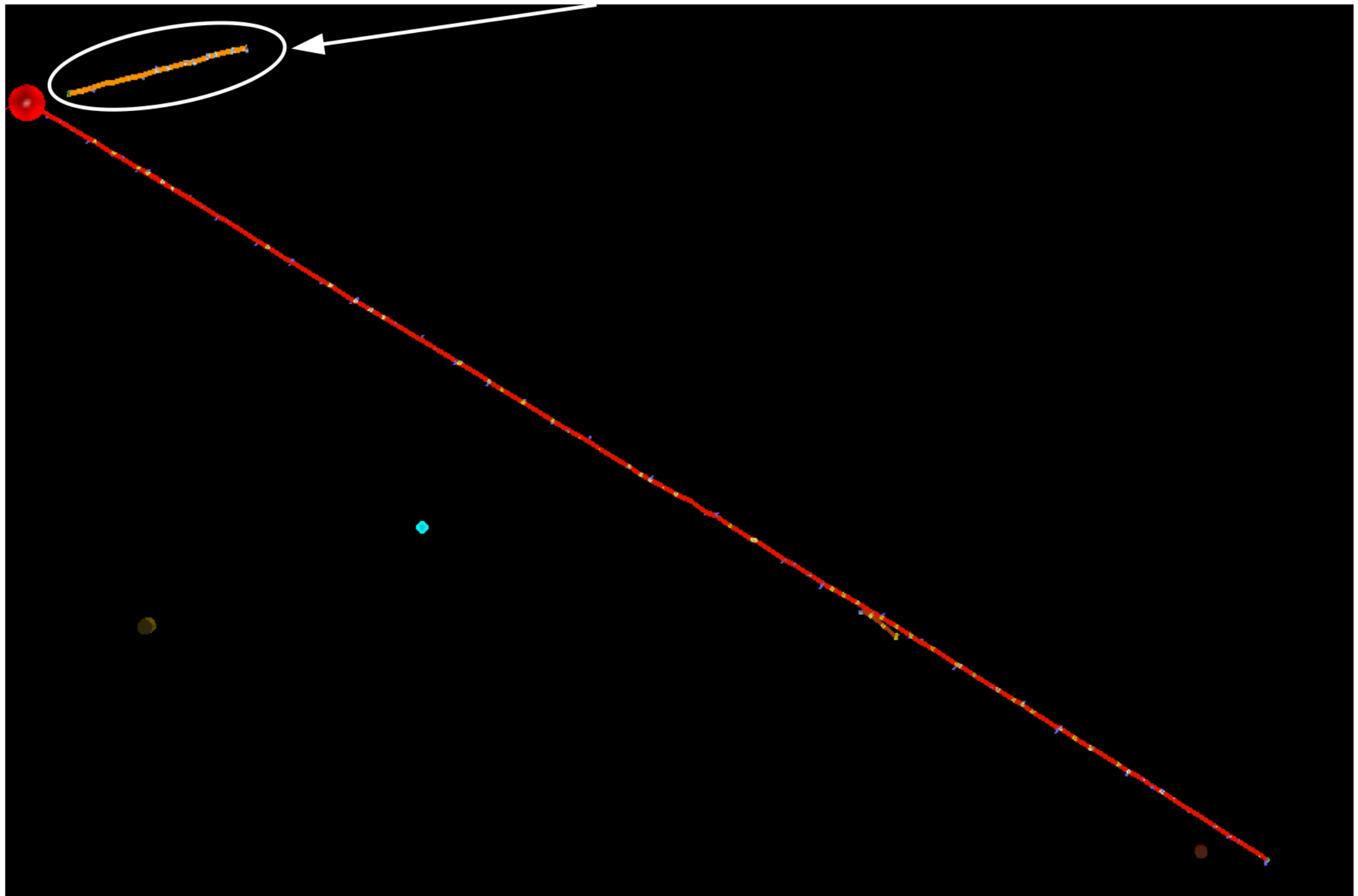
Neutron-induced signature

Neutron-induced signature

neutron induced **muon**
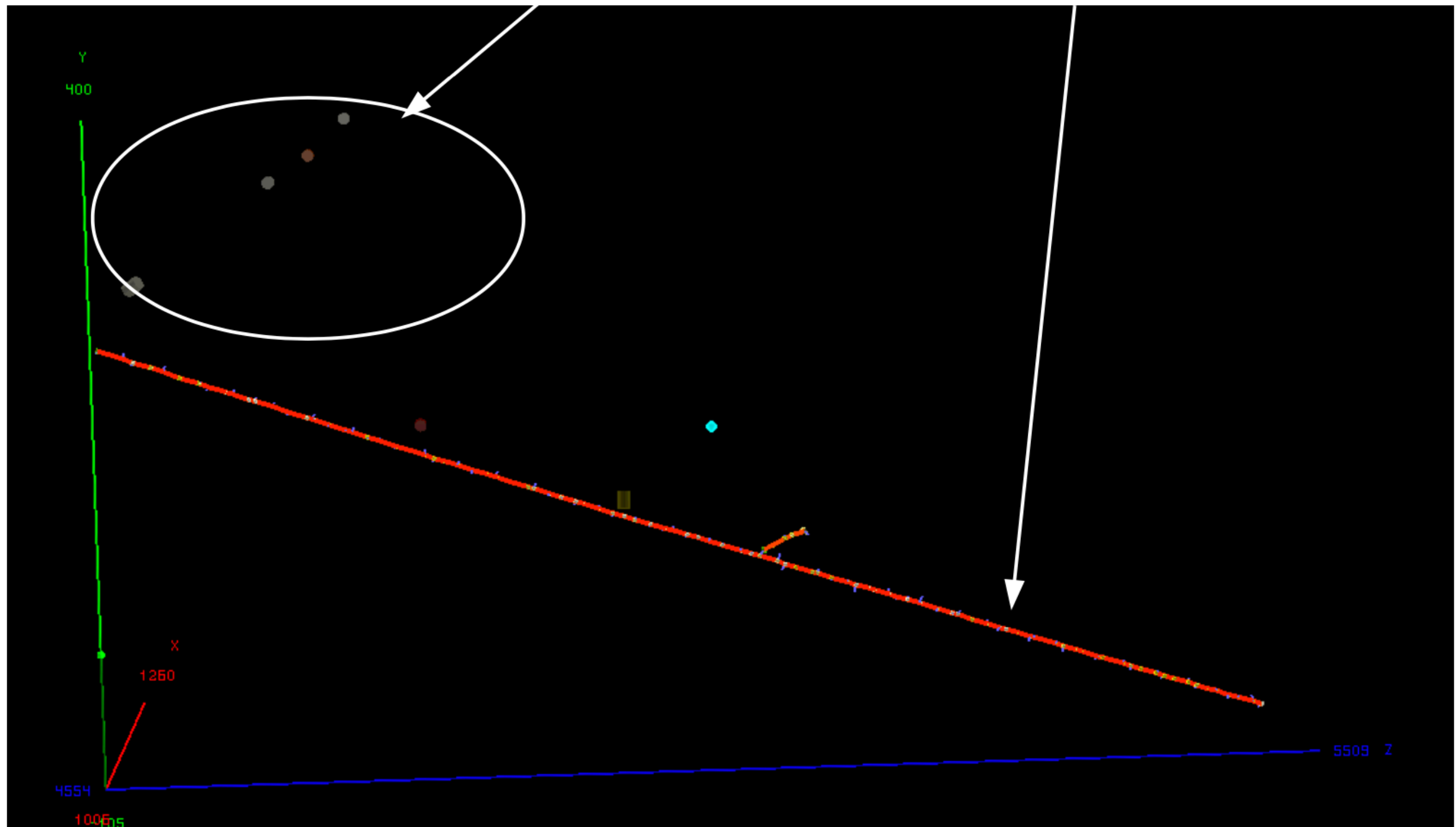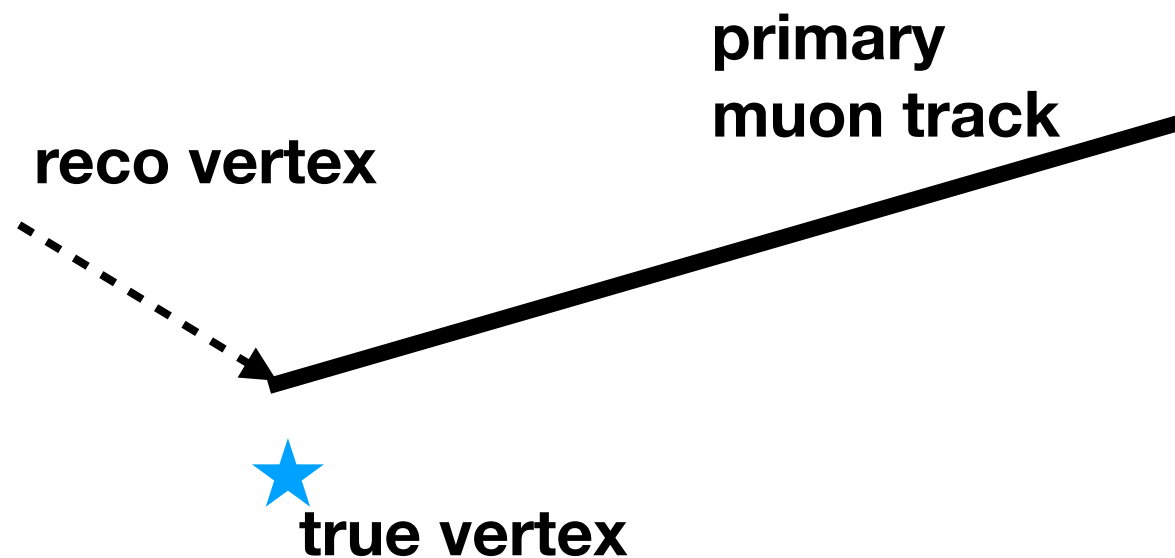
Neutron-induced signature

Numubar CC

neutron-induced

Selection of reco vertex

- **We assume the muon can be identified.**

- **We choose the end point of the muon as a reco vertex.**

- **We might be able to choose the starting point of the muon track as a reco vertex by using time information.**

primary muon track

reco vertex

true vertex

Selection of channel

- **After selecting the vertex, we count how many tracks are associated to the vertex.**

- **The associated track is the track which has end point within vertex activity. The vertex activity is 3 cm for this analysis.**

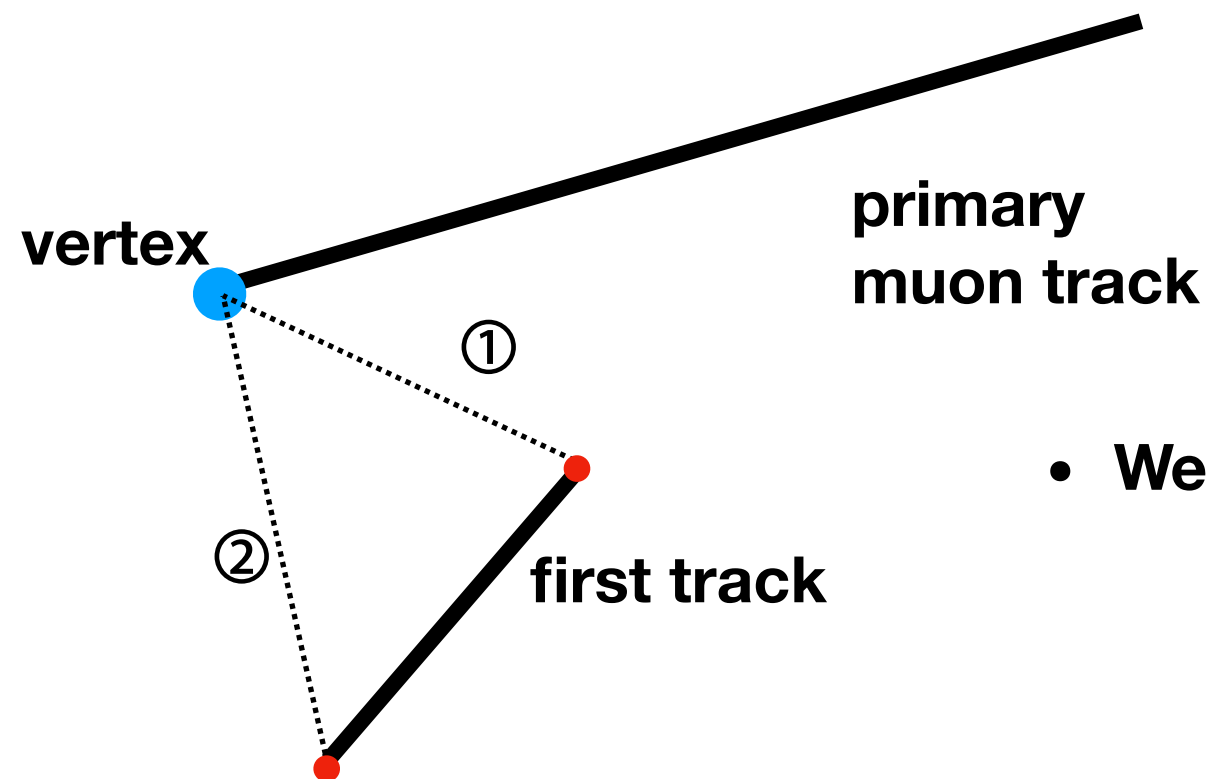- **If the number of associated track is 1 we thought of the event as single track event and so on.**

reco vertex

primary muon track

another primary track

vertex activity
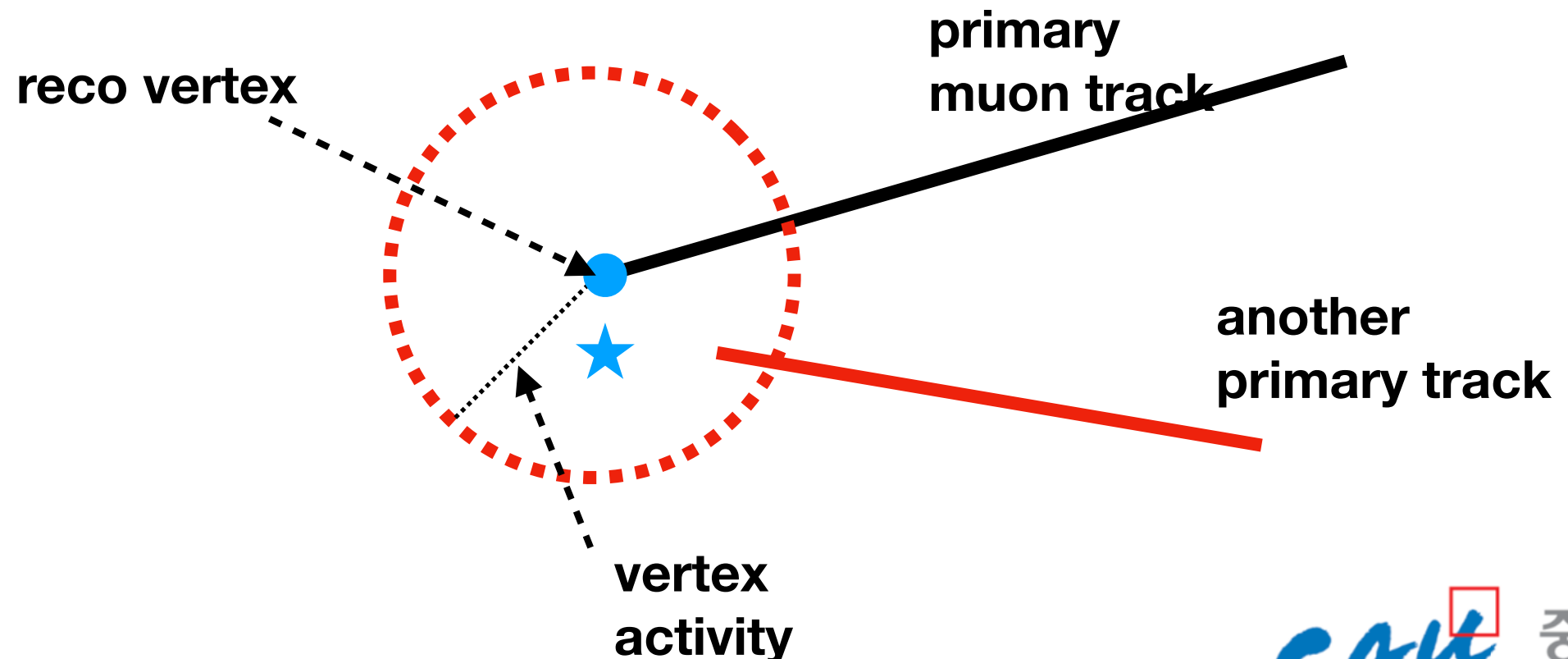
Definition of variable

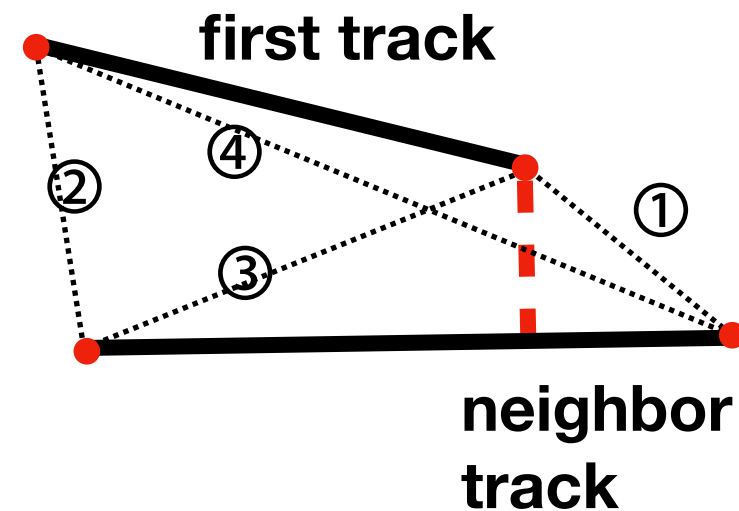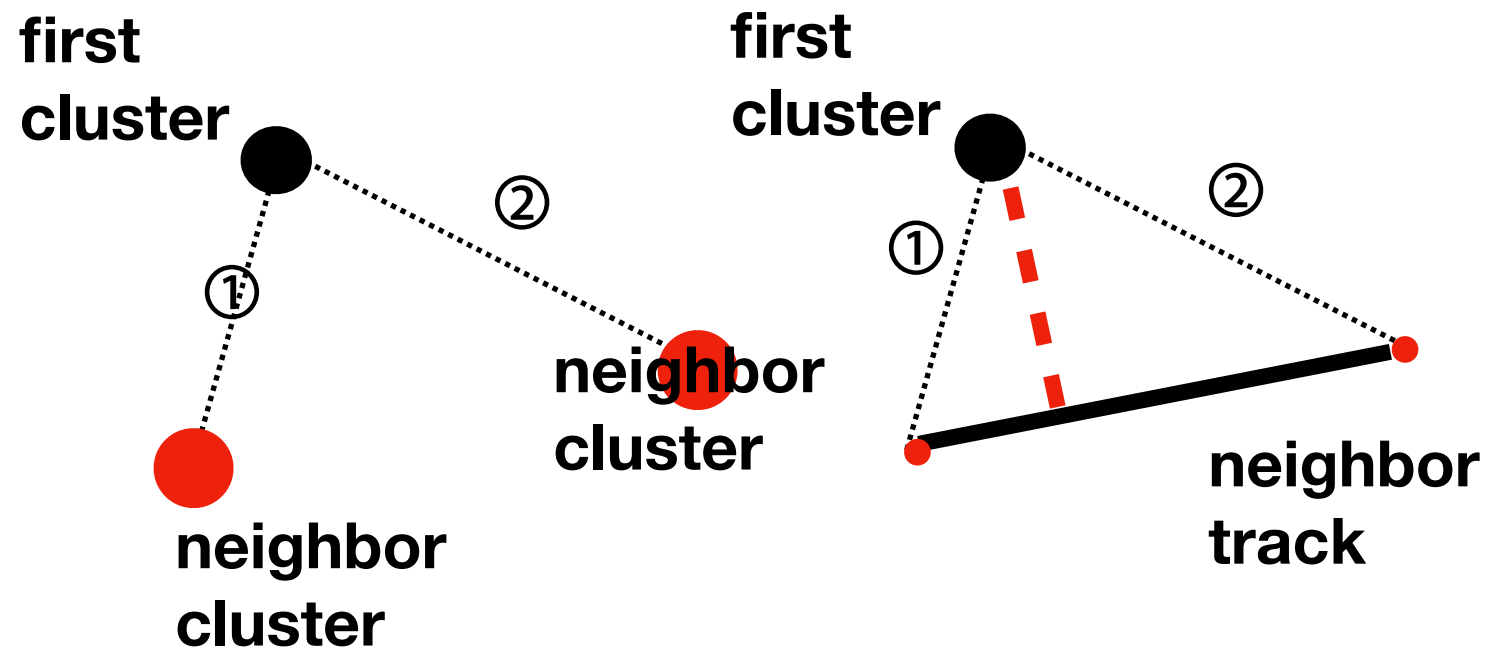- **We first looked at the first object (either track or cluster) in time.**
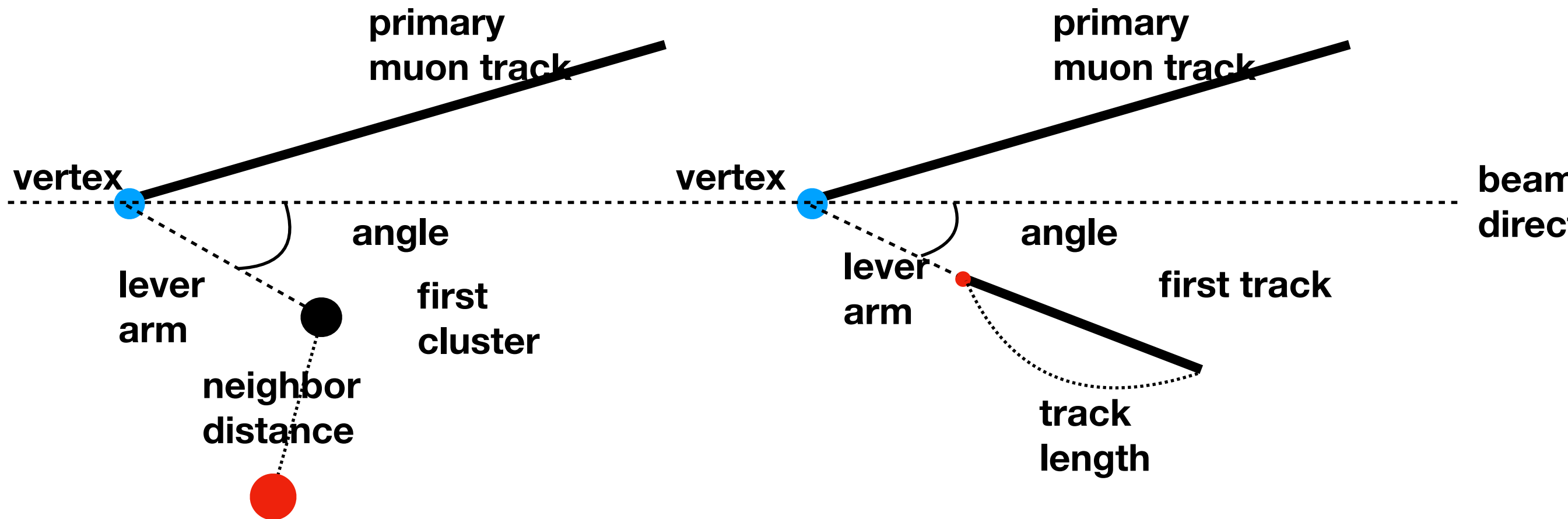
- **1. lever arm: distance between vertex and the object**
  2. clusterE or trackE: total energy deposit of the object
  3. angle: angle between object and beam direction
  4. neighbor distance: closest distance to the neighboring objects
  5. track length (for track only)
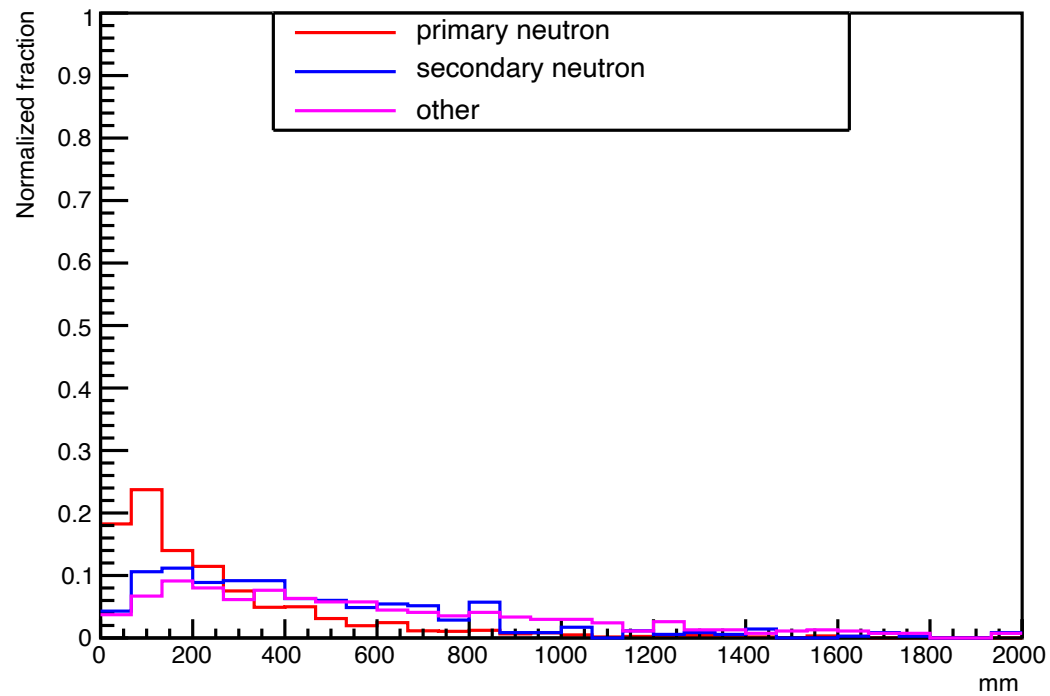
Definition of variable

vertex

**primary
muon track**

①

first track

②

- **We choose shorter one as a lever arm (①)**

**first
cluster**

②

①

**neighbor
cluster**

**first
cluster**

①

②

**neighbor
track**

first track

②

④

③

①

**neighbor
track**

**neighbor
cluster**

- **We choose the shortest one as a neighbor distance (①)
This can be improved (red dashed line).**

CAU 중앙대학교
CHUNG-ANG UNIVERSITY

Variable distributions - cluster
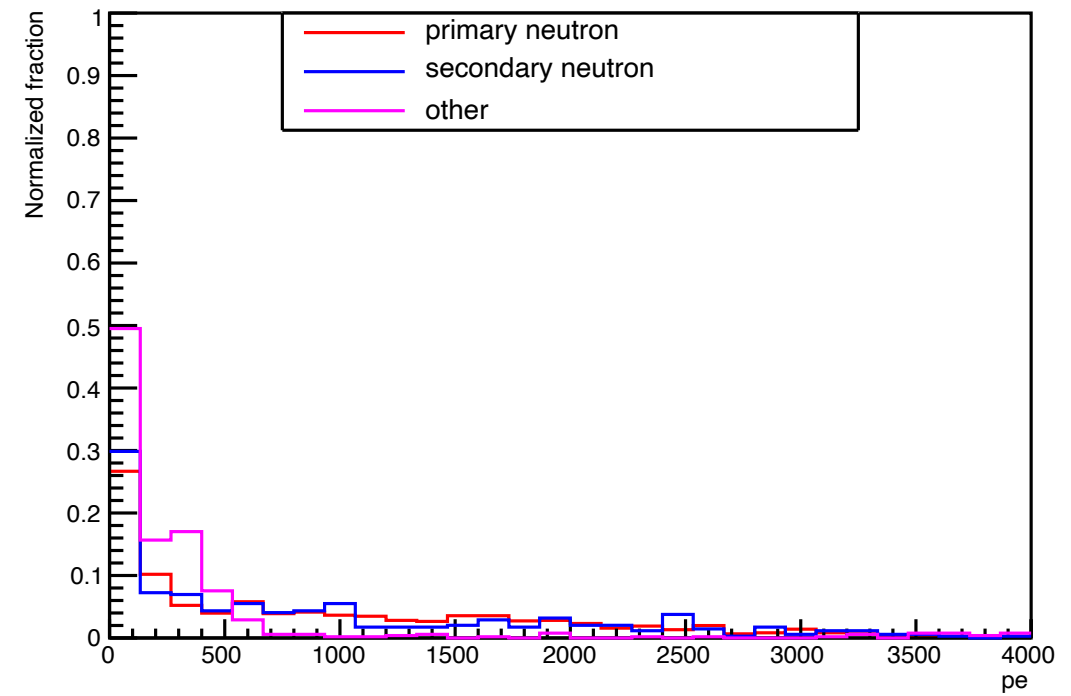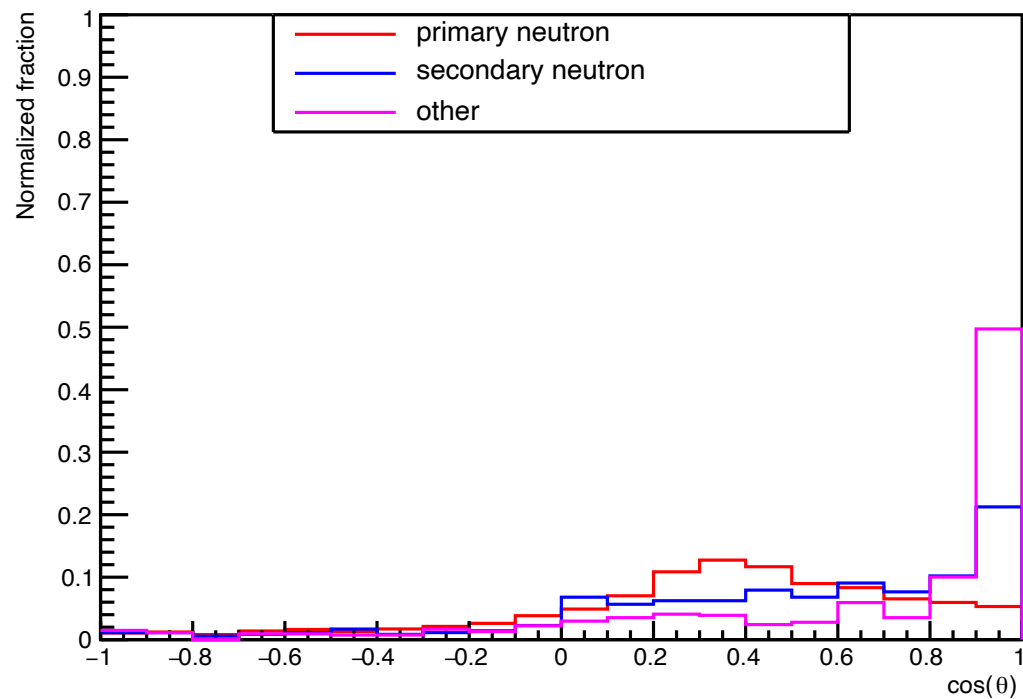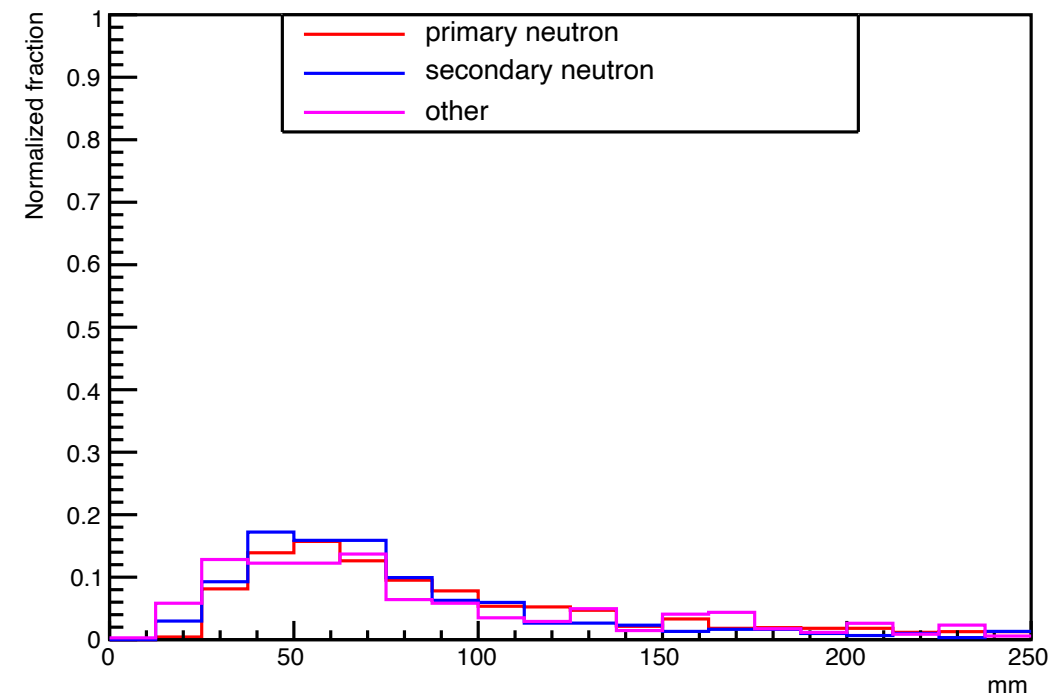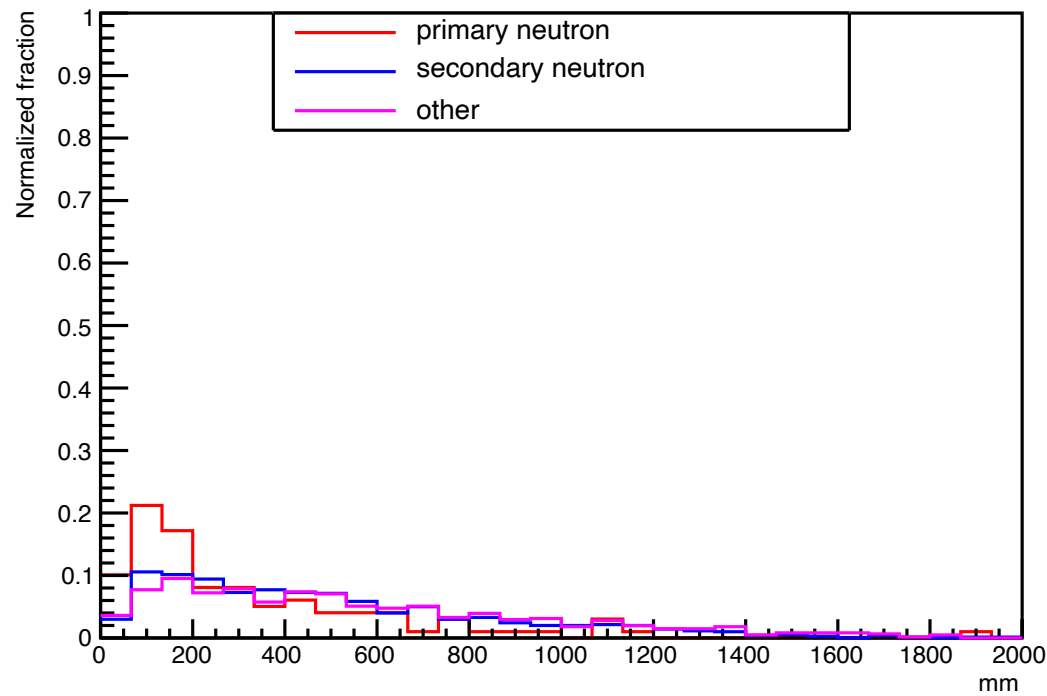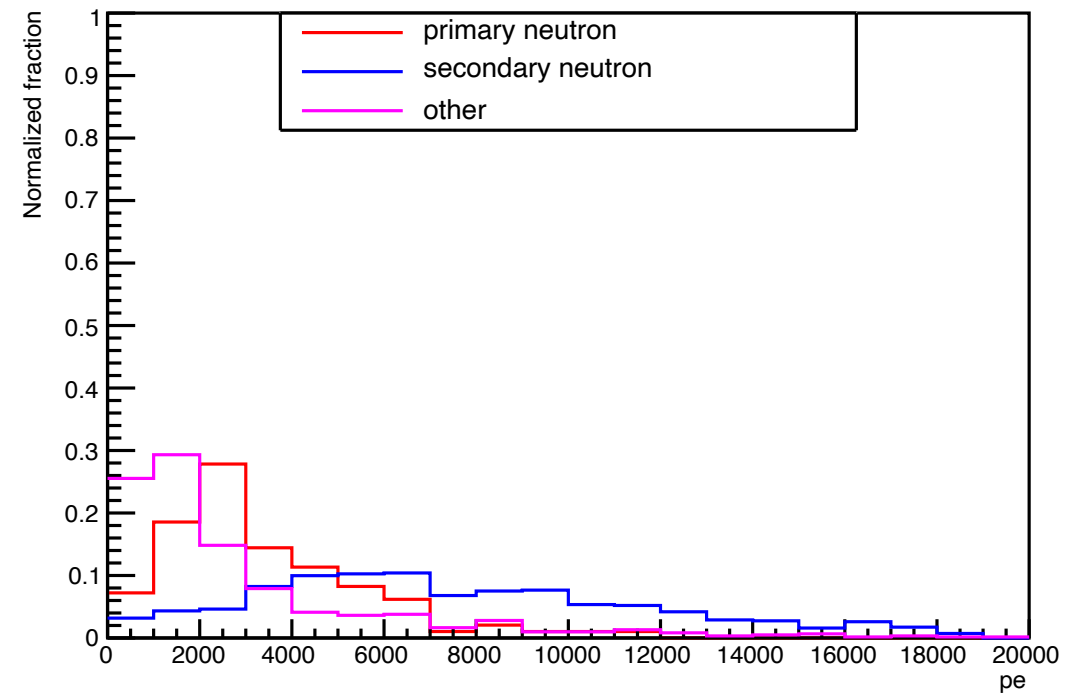
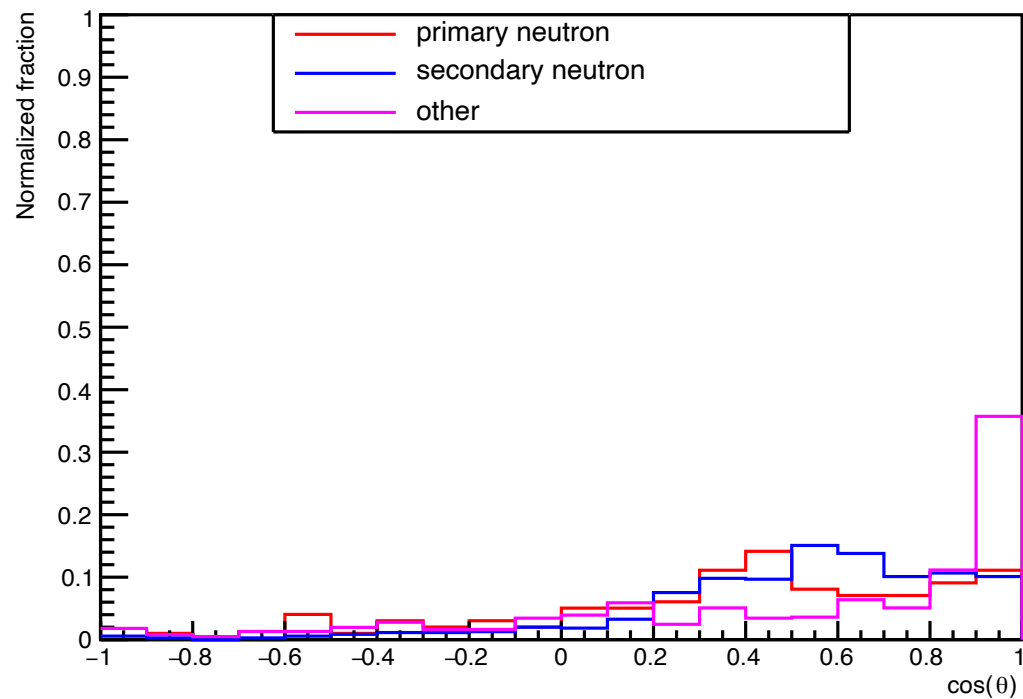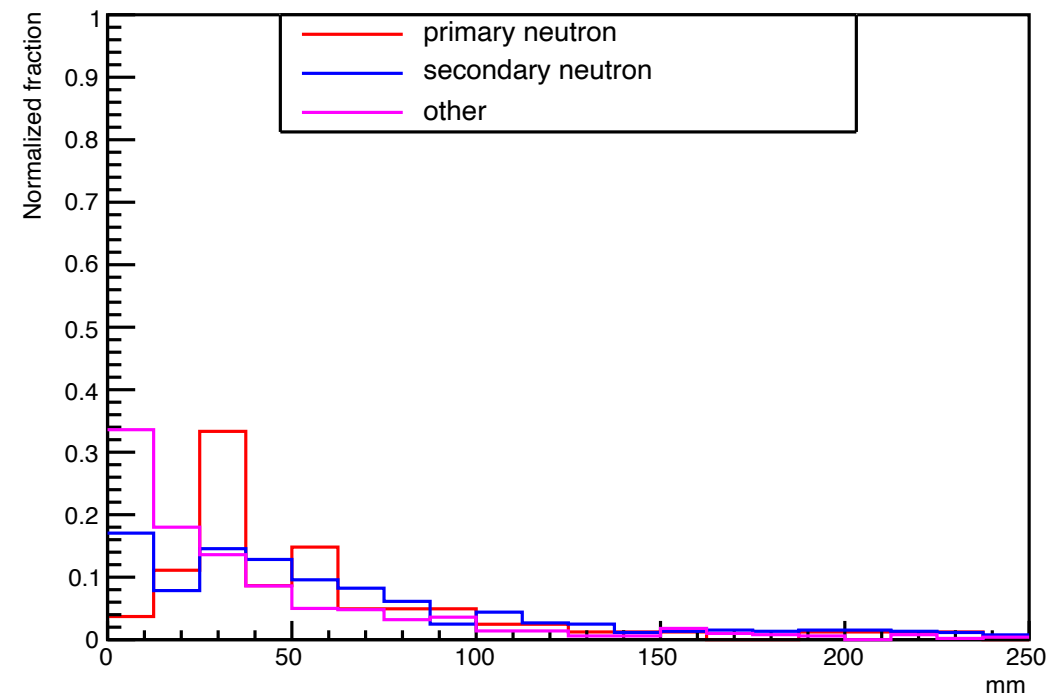# Variable distributions - track

lever arm, track

trackE, track

angle, track
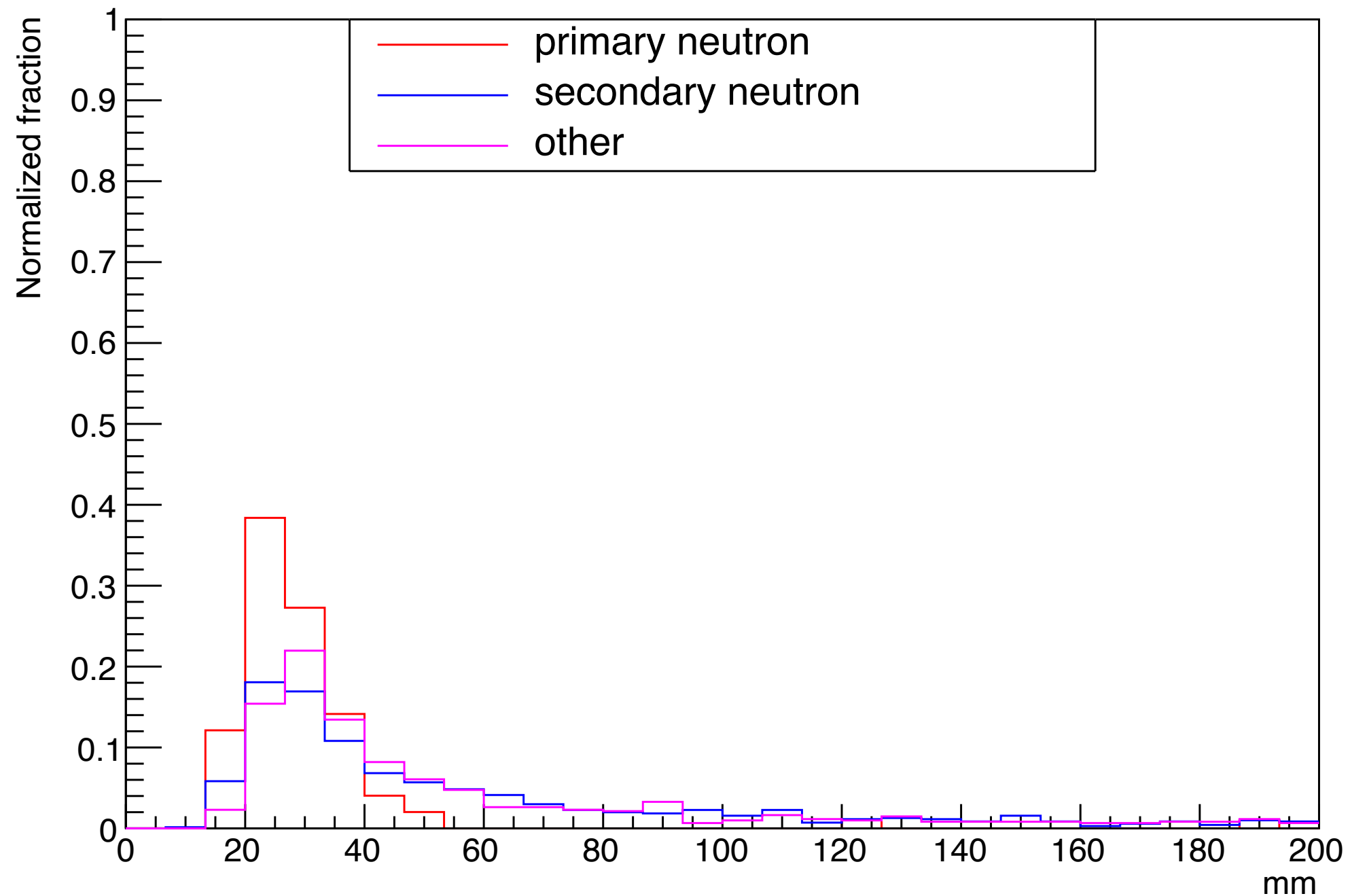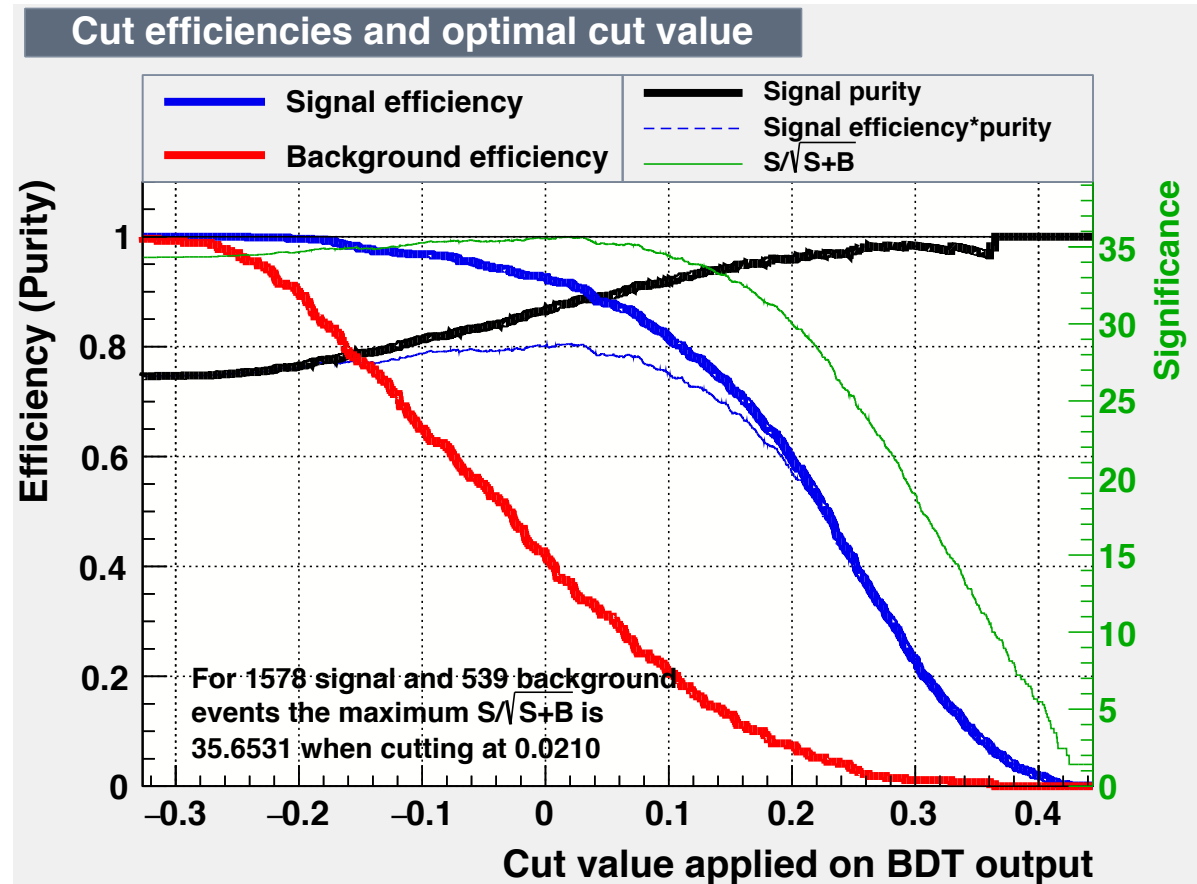

neighbor distance, track
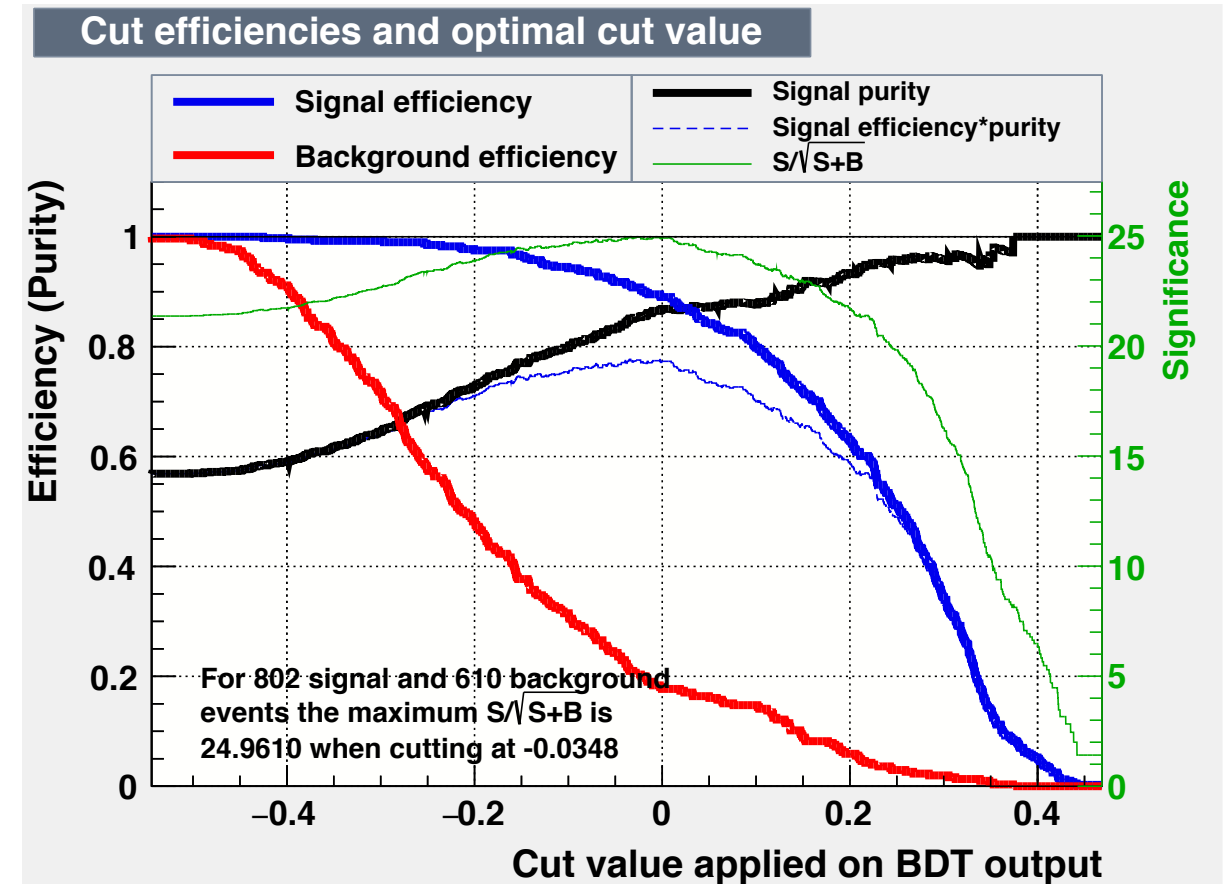
Variable distributions - track

track length, track

BDT results

cluster

track

- **Signal : primary + secondary neutron, background : the others**

- **Both cluster and track, we can get high purity.**

- **Result of cluster is slightly better than track.**

Summary

- **We are looking at reconstructed object.**

- **We defined variables, trained BDT as before.**

- **For single track event, we can get high purity.**

- **We plan to investigate 2 track channel with additional variable.**