INGRID
Energy dependence of Efficiency

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Beam analysis flow chart

Make timing cluster(more than 4 hits within 100nsec)

# of active planes > 1 &&
p.e./active layer > 6.5

On time

Beam related event

# of active planes > 2 &&
p.e./active layer > 6.5

Tracking

Track matching

On time

Upstream VETO

Fiducial volume

neutrino event

Rock muon enhanced sample

- In this presentation, show efficiency of “neutrino event” selection.
  - About these event selections.
    - “# of active plane > 2 “
    - “p.e. / layer > 6.5”
    - “Upstream VETO”
    - “ Fiducial Volume”

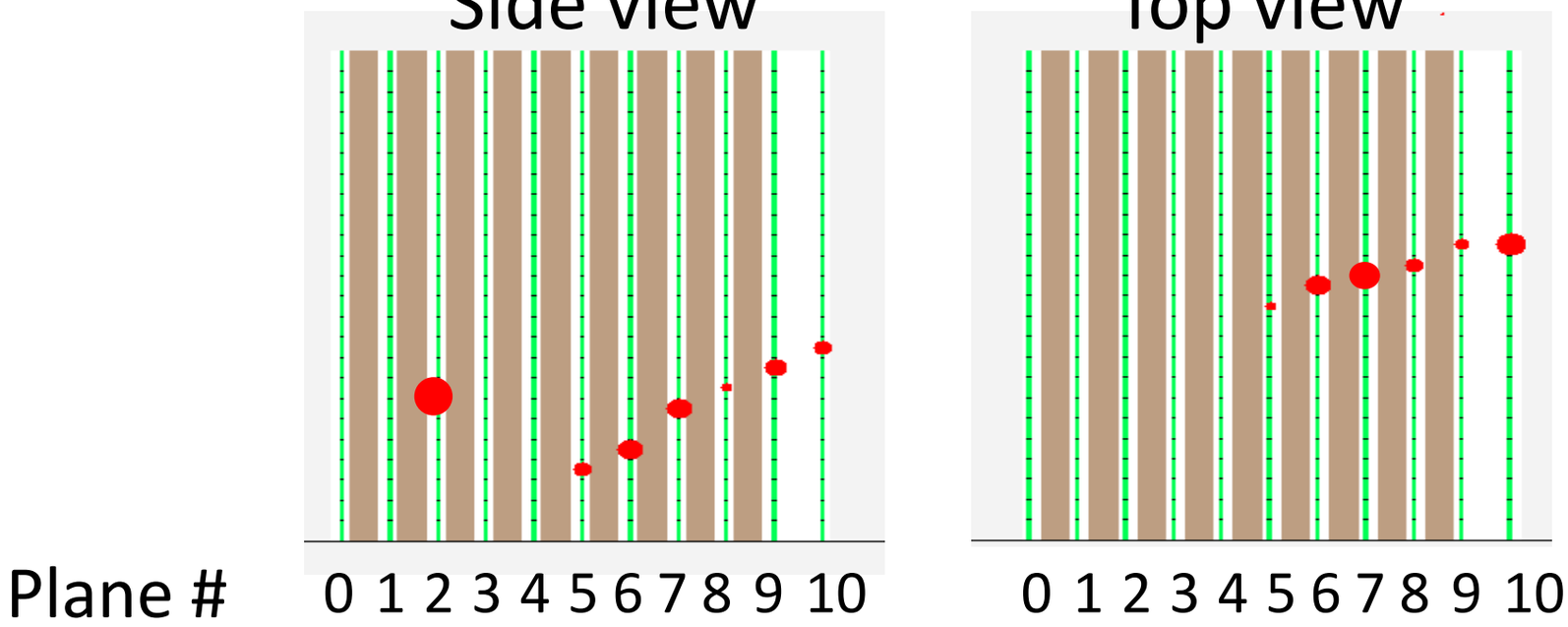
MC setting

- Jnubeam 10a
  - Horn 250kA & 250kA
  - use NEUT
  - In this MC, consider only neutrino interaction in INGRID modules. Not include Rock Muon events, MPPC noise events, cosmic events.

About “active plane” & “p.e./layer”

- Active plane(Plane#0 is not used. only plane#1 ~ 10)
  - Coincidence hit at side and top view(p.e. > 2.5 @MC)
- p.e. / active layer
  - (Total p.e. in active planes) / (# of active planes × 2)

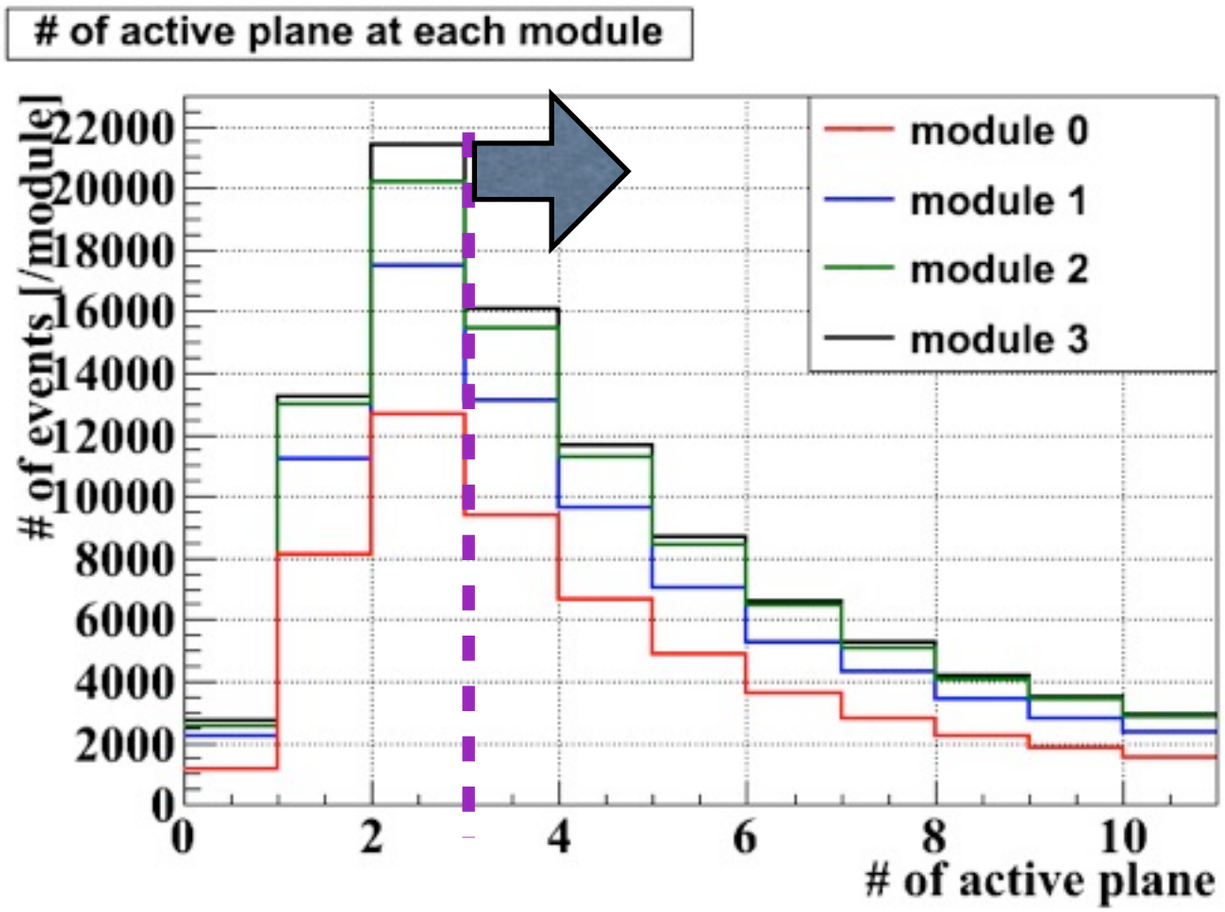
example

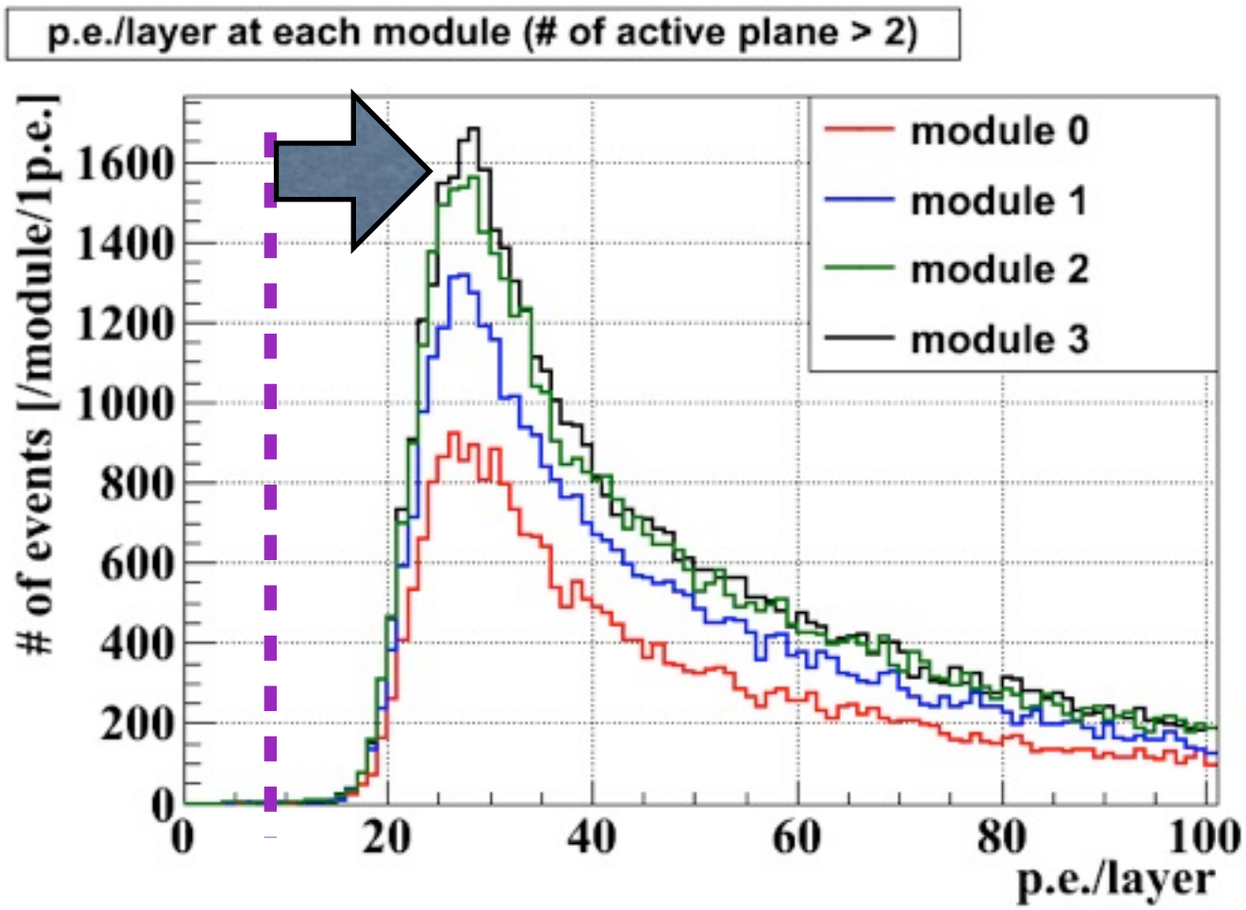


- # of active planes = 6(plane# 5 ~ 10)
- p.e. / active layer = total p.e. in plane# 5~10 / (6x2)

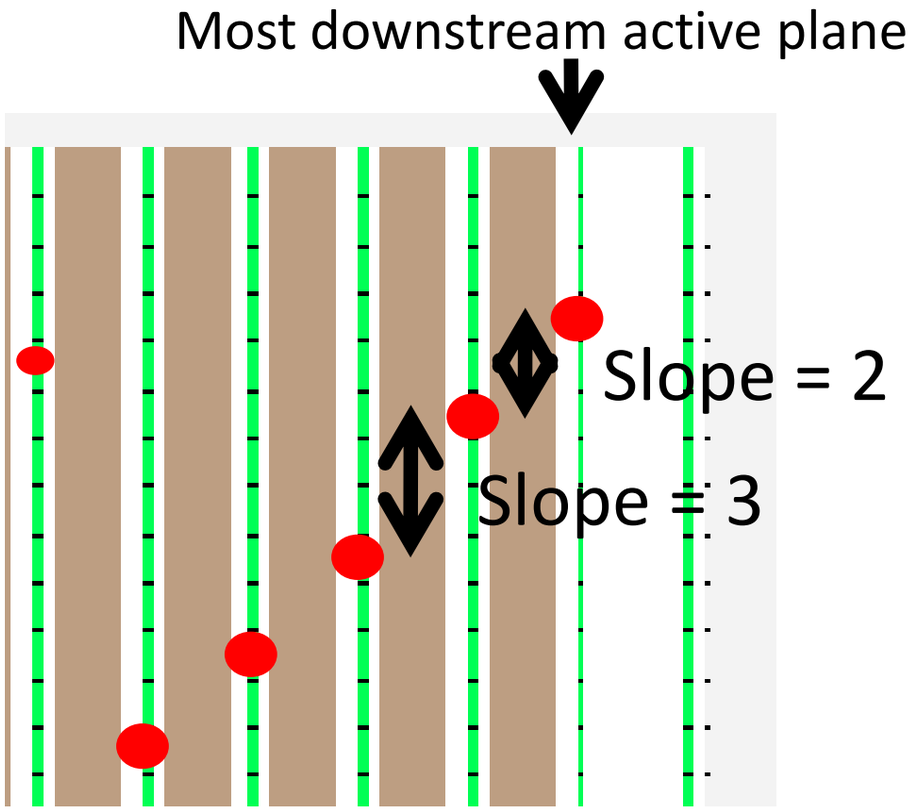
- “ # of active plane > 2 “ selection
- “ p.e. / layer > 6.5 “ selection
- For tracking, we need 3 hits at each layer.
- In beam data, there are accidental events (mainly due to MPPC noise) at low active & low p.e. region.

@MC

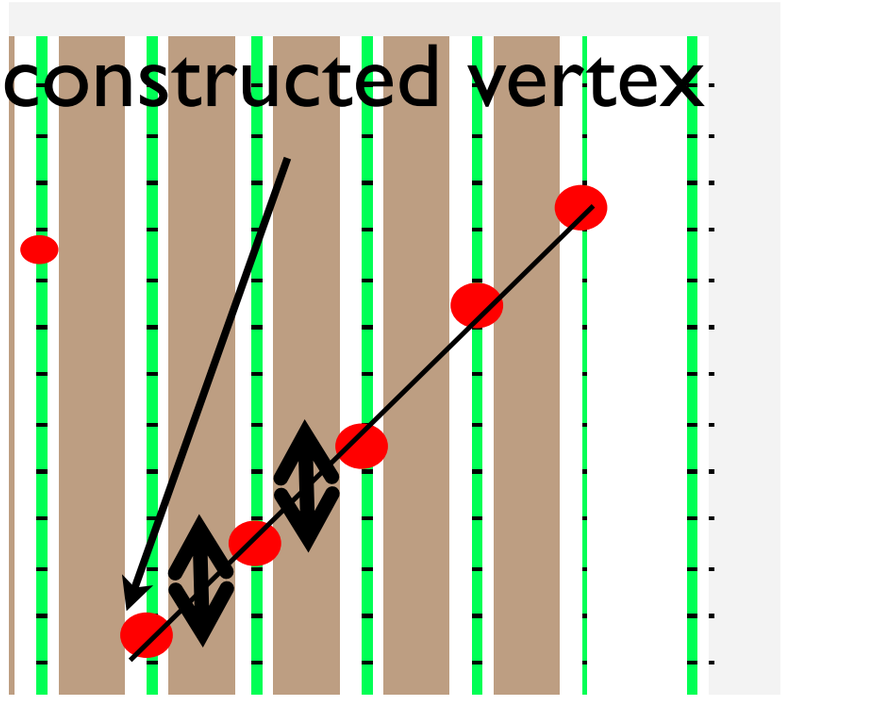

# of active plane at each module
module 0
module 1
module 2
module 3
# of events [/module]
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
2
4
6
8
10
# of active plane


p.e./layer at each module (# of active plane > 2)
module 0
module 1
module 2
module 3
# of events [/module/1p.e.]
1600
1400
1200
1000
800
600
400
200
0
0
20
40
60
80
100
p.e./layer

Tracking method



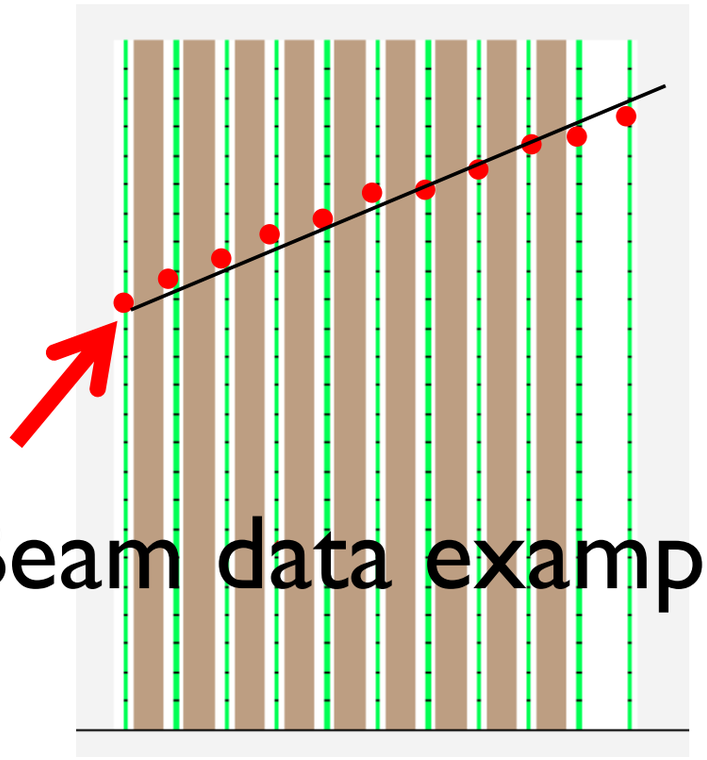
- Select most downstream active plane.
- Calculate slope b/w (it, next upstream hit plane) and (next and next next upstream hit plane). If diff. of slope < 2, it is reconstructed as track.



- Compare slope in order and diff. of slope < 2, its hit is added as the track.
- Finally, hits are fitted by least square method.

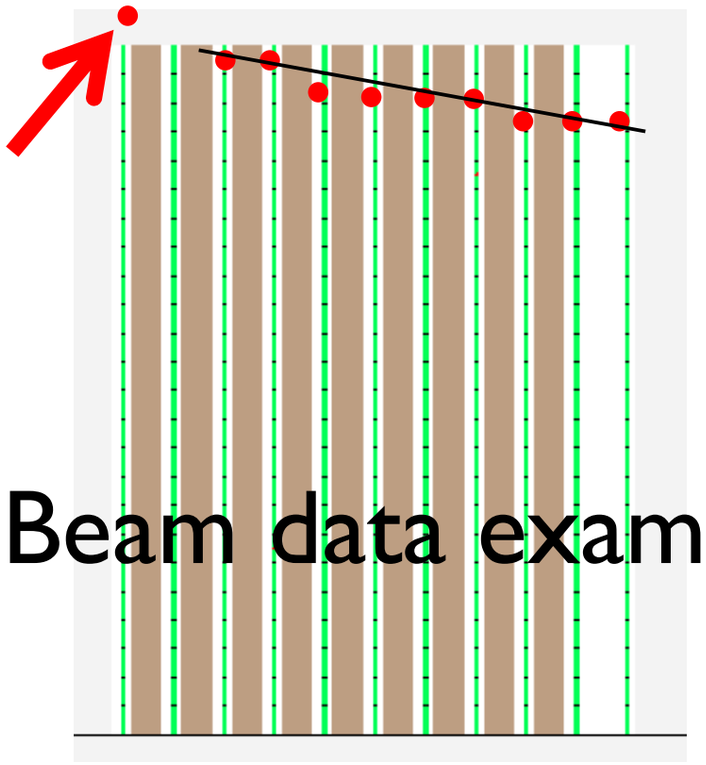
Upstream VETO

1. Recon. vertex is first plane.



Beam data example

2. Upstream VETO has hit.



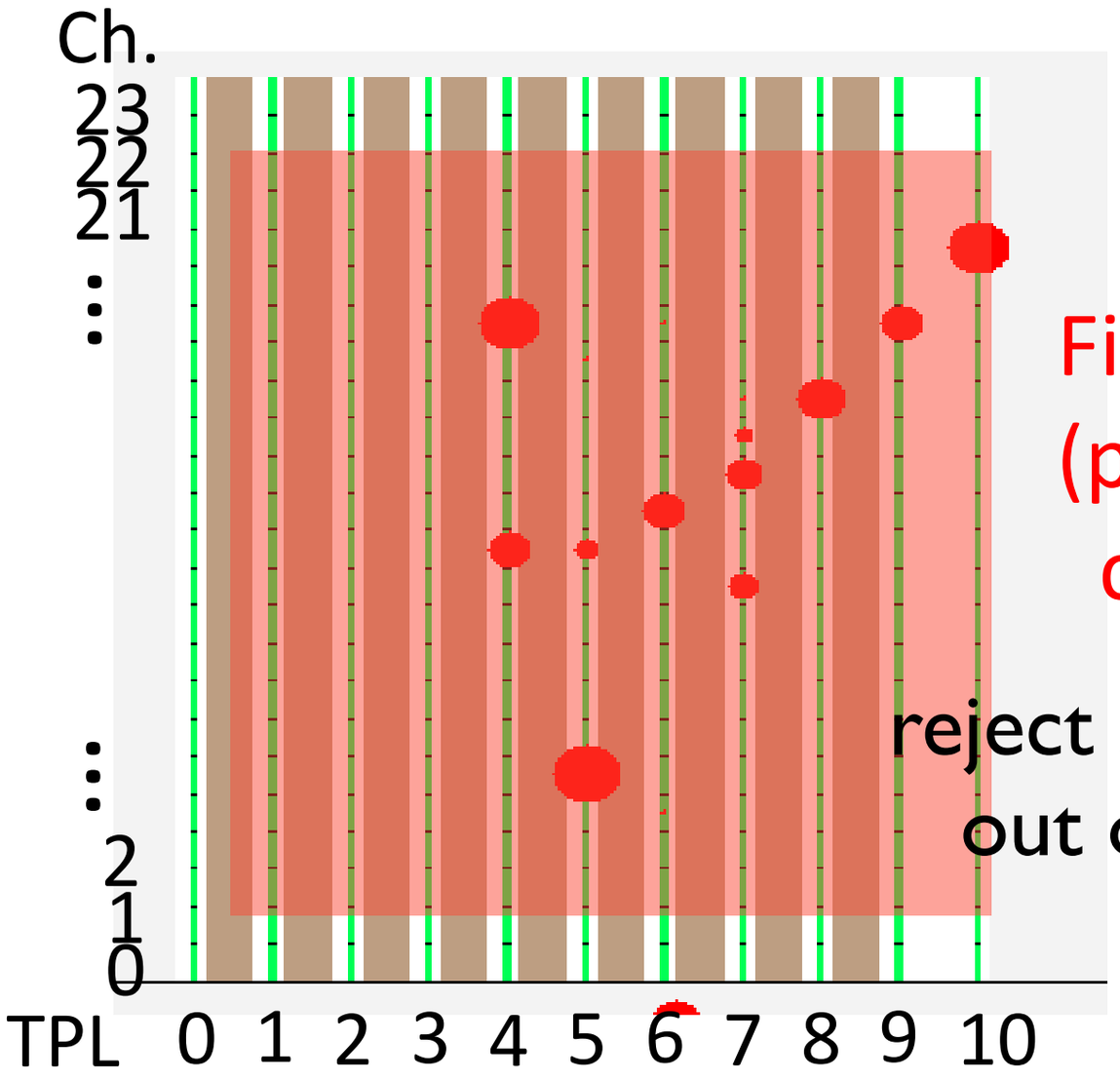
Beam data example

reject

Fiducial volume cut

Because there is a gap(10~20cm) b/w tracking planes and VETO, particle from out side can not be rejected.

➡ We defined fiducial volume and selected the event whose vertex is within fiducial.



Event selection

- Cut level 1 : # of active plane > 2
- Cut level 2 : Cut level 1 & p.e. / layer > 6.5
- Cut level 3 : Cut level 2 & Upstream veto
- Cut level 4 : Cut level 3 & Fidicual cut → “neutrino event” selection

→ calculate efficiency of each cut level

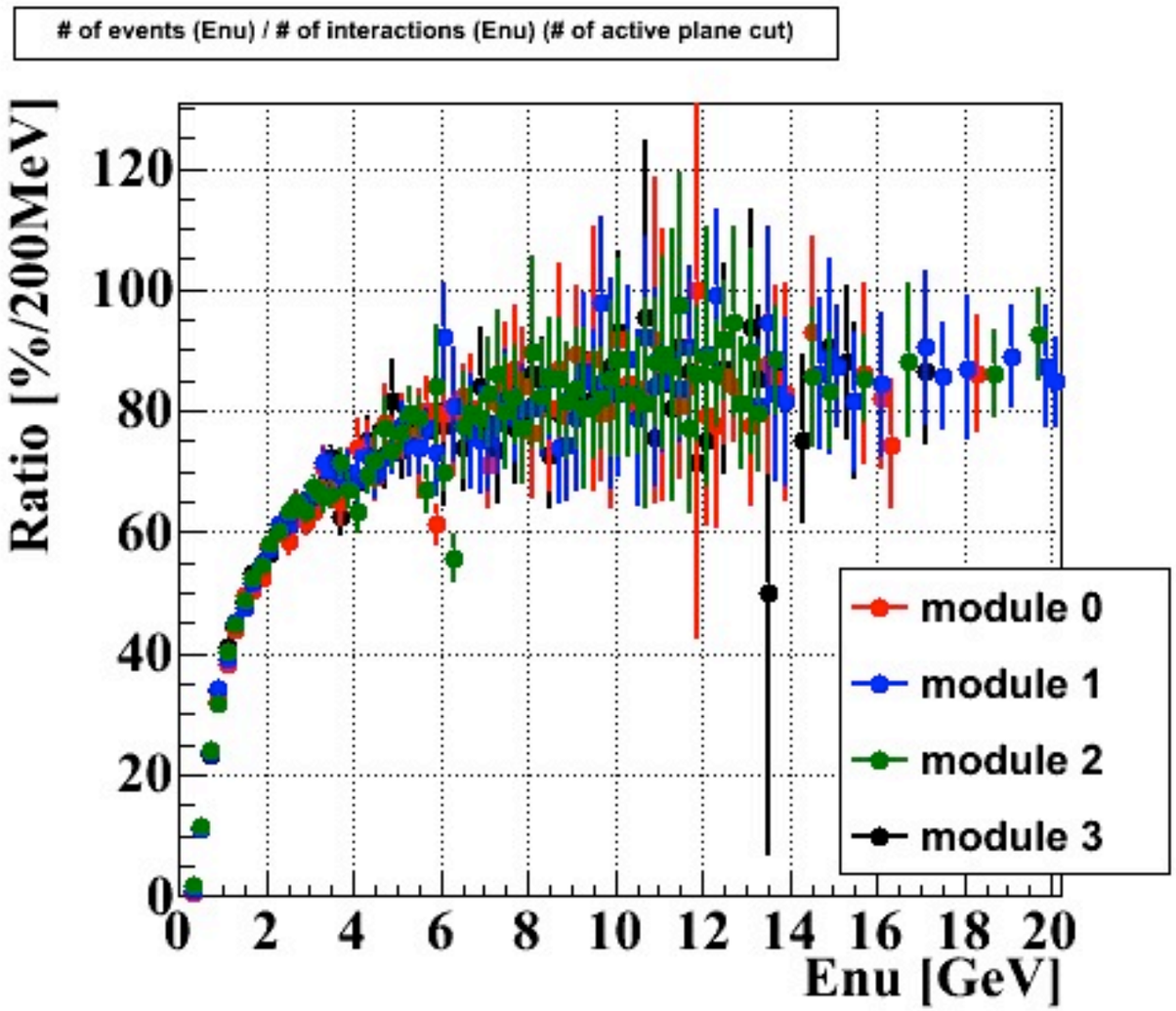
In this study, only about ND3

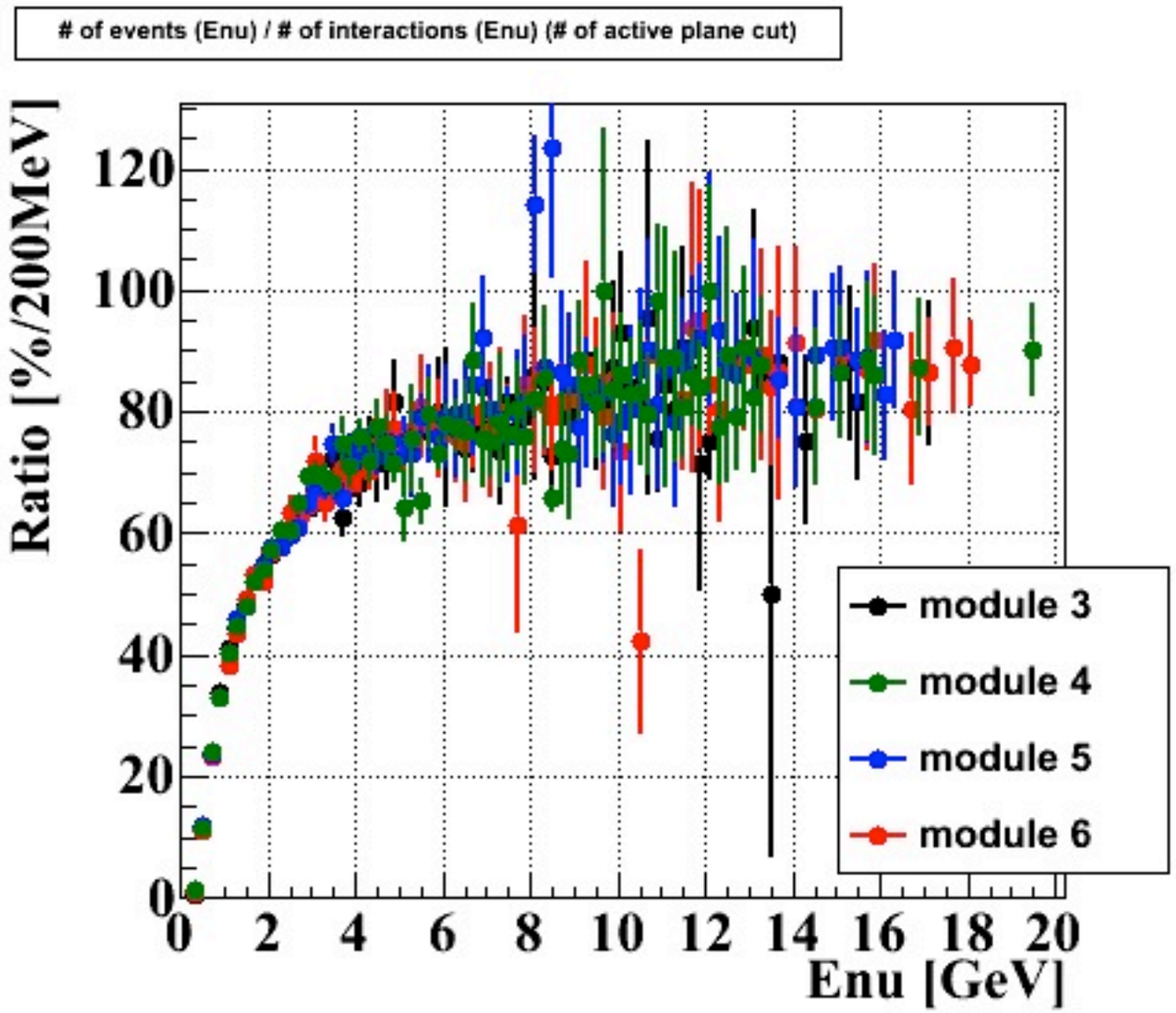
$$Efficiency(E) = \phi(E) / \int N(E) dE$$

Φ(E) : # of detected neutrino events

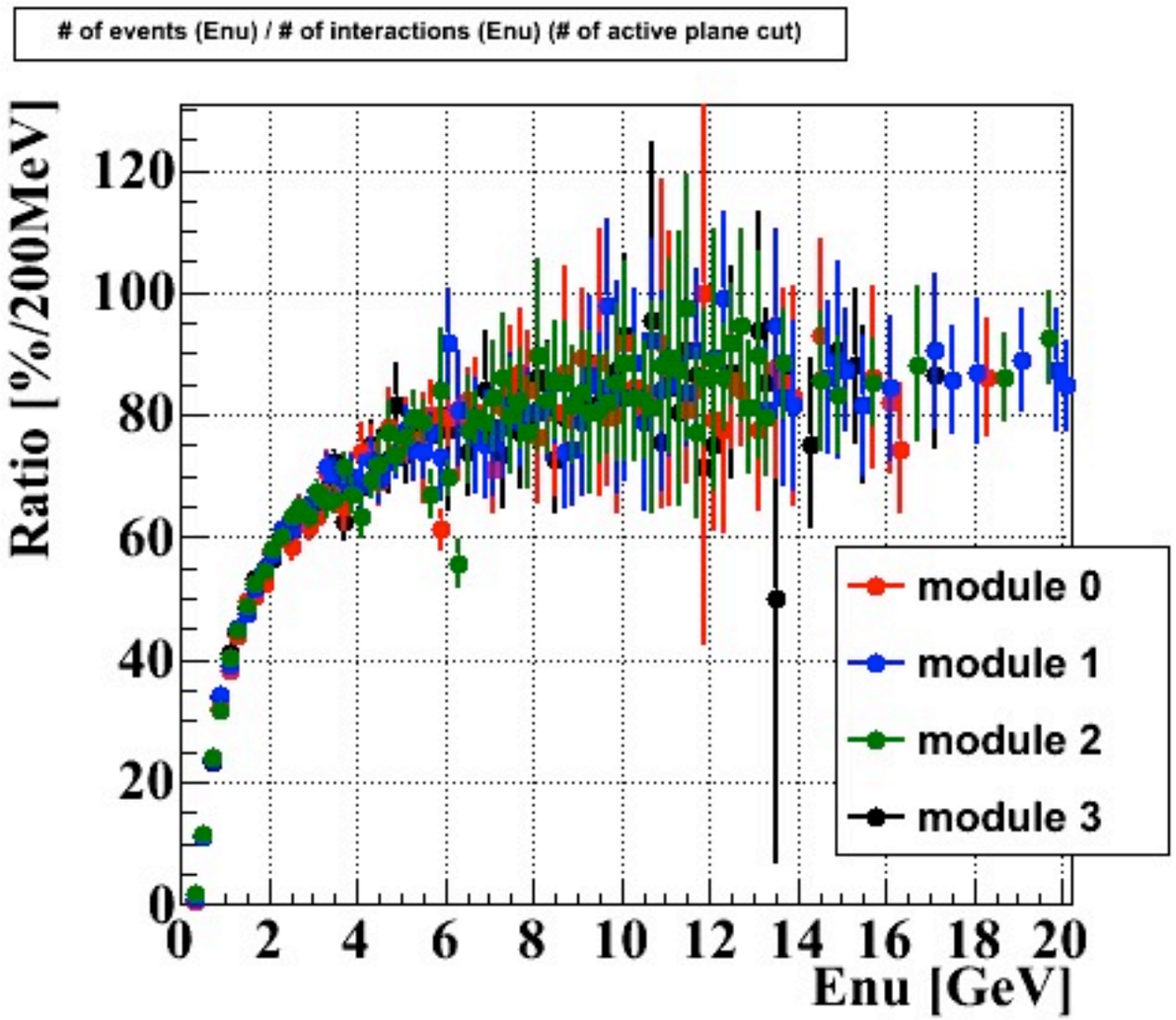
N(E) : # of generated neutrino event

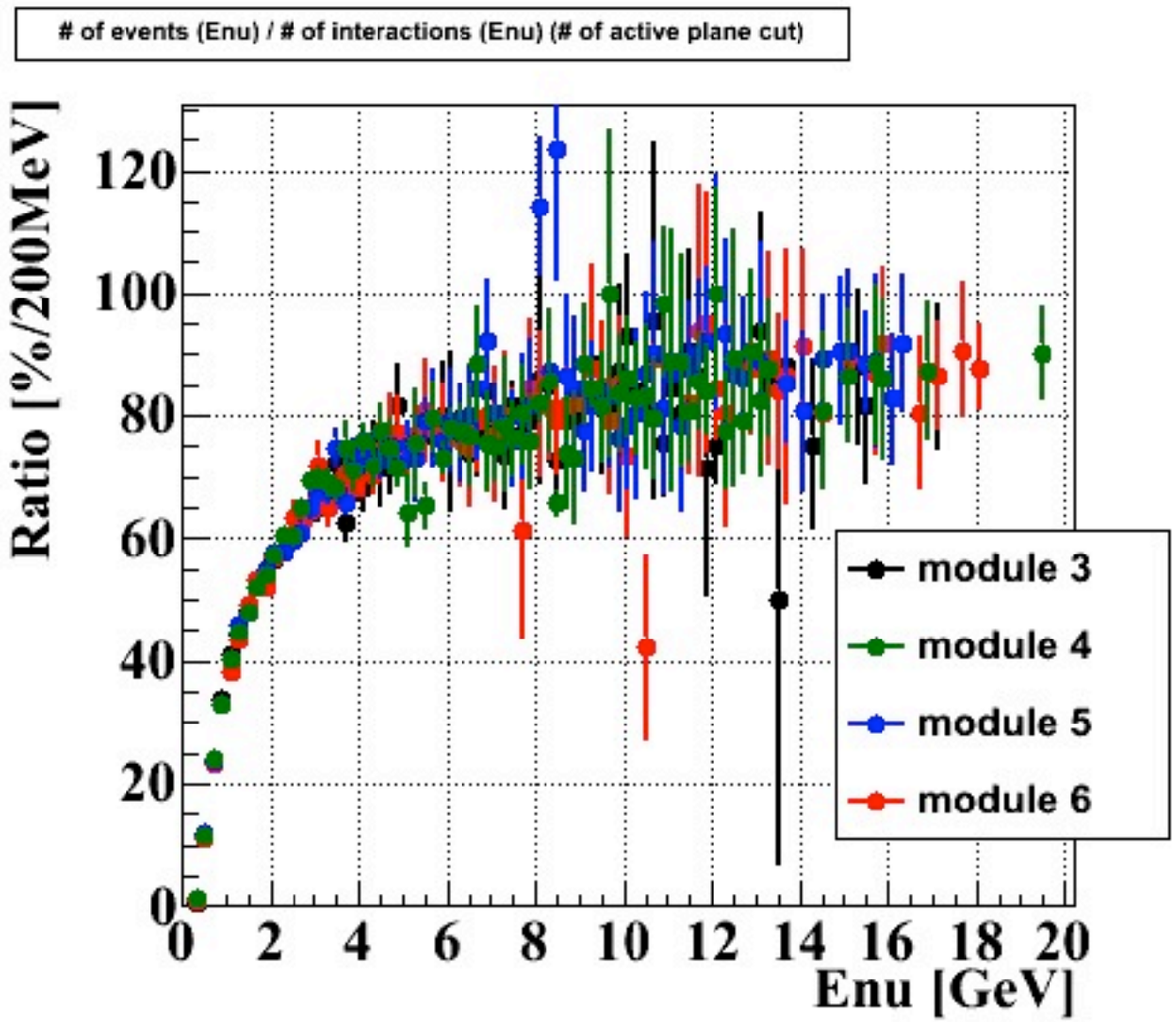
Cut level 1


# of events (Enu) / # of interactions (Enu) (# of active plane cut)
Ratio [%/200MeV]
Enu [GeV]
module 0
module 1
module 2
module 3

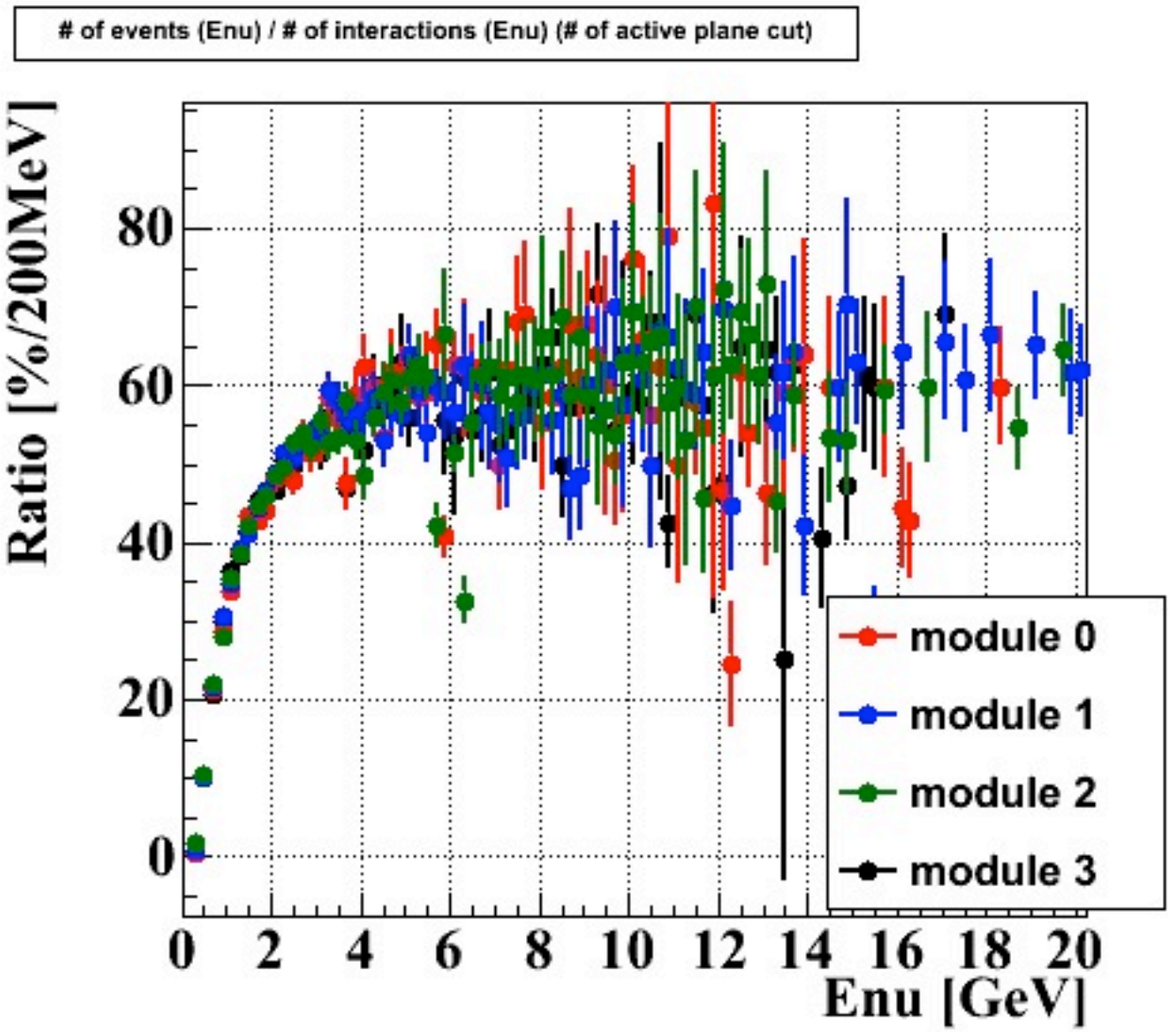

# of events (Enu) / # of interactions (Enu) (# of active plane cut)
Ratio [%/200MeV]
Enu [GeV]
module 3
module 4
module 5
module 6

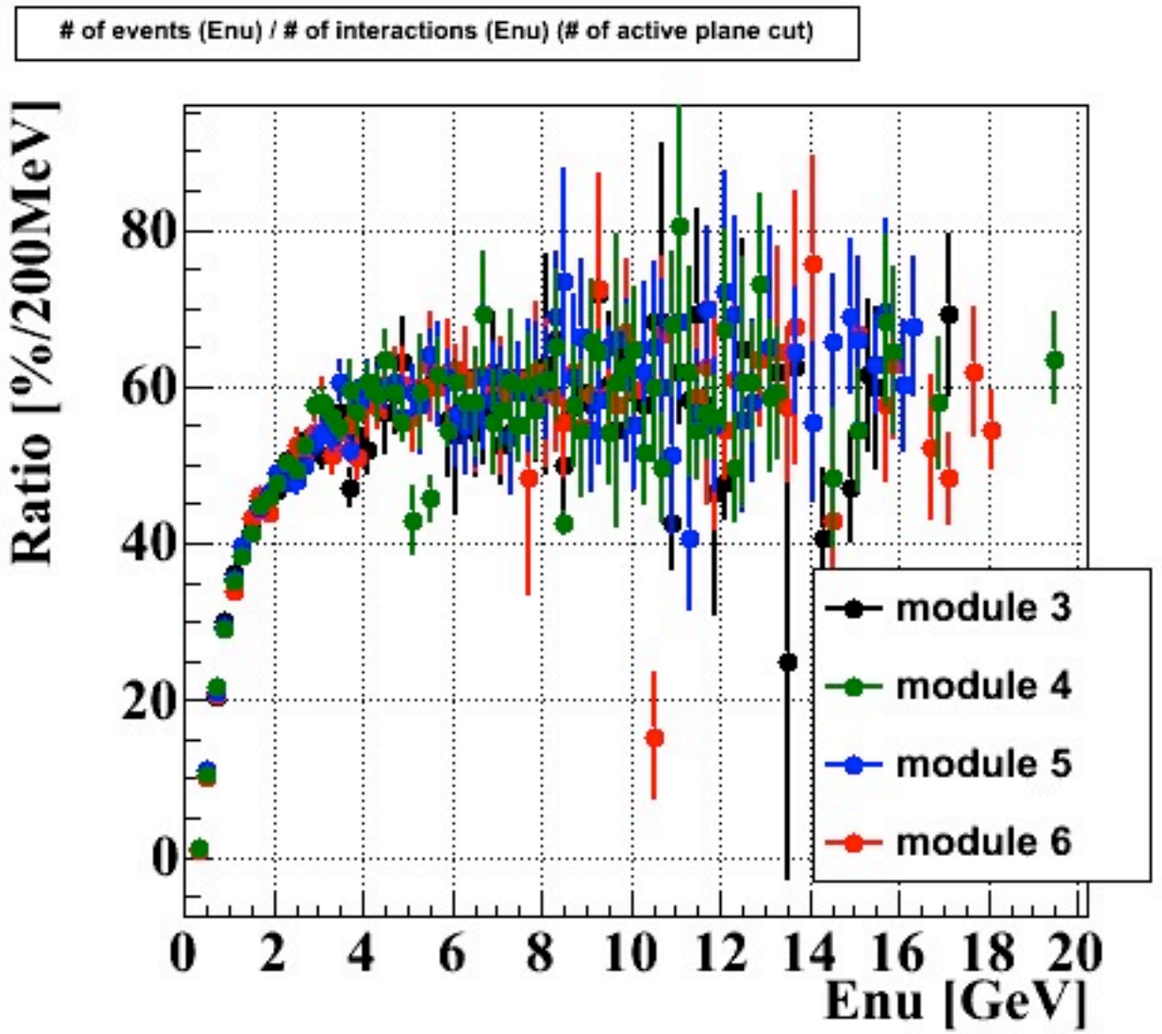
Cut Level 2


# of events (Enu) / # of interactions (Enu) (# of active plane cut)
Ratio [%/200MeV]
Enu [GeV]
module 0
module 1
module 2
module 3

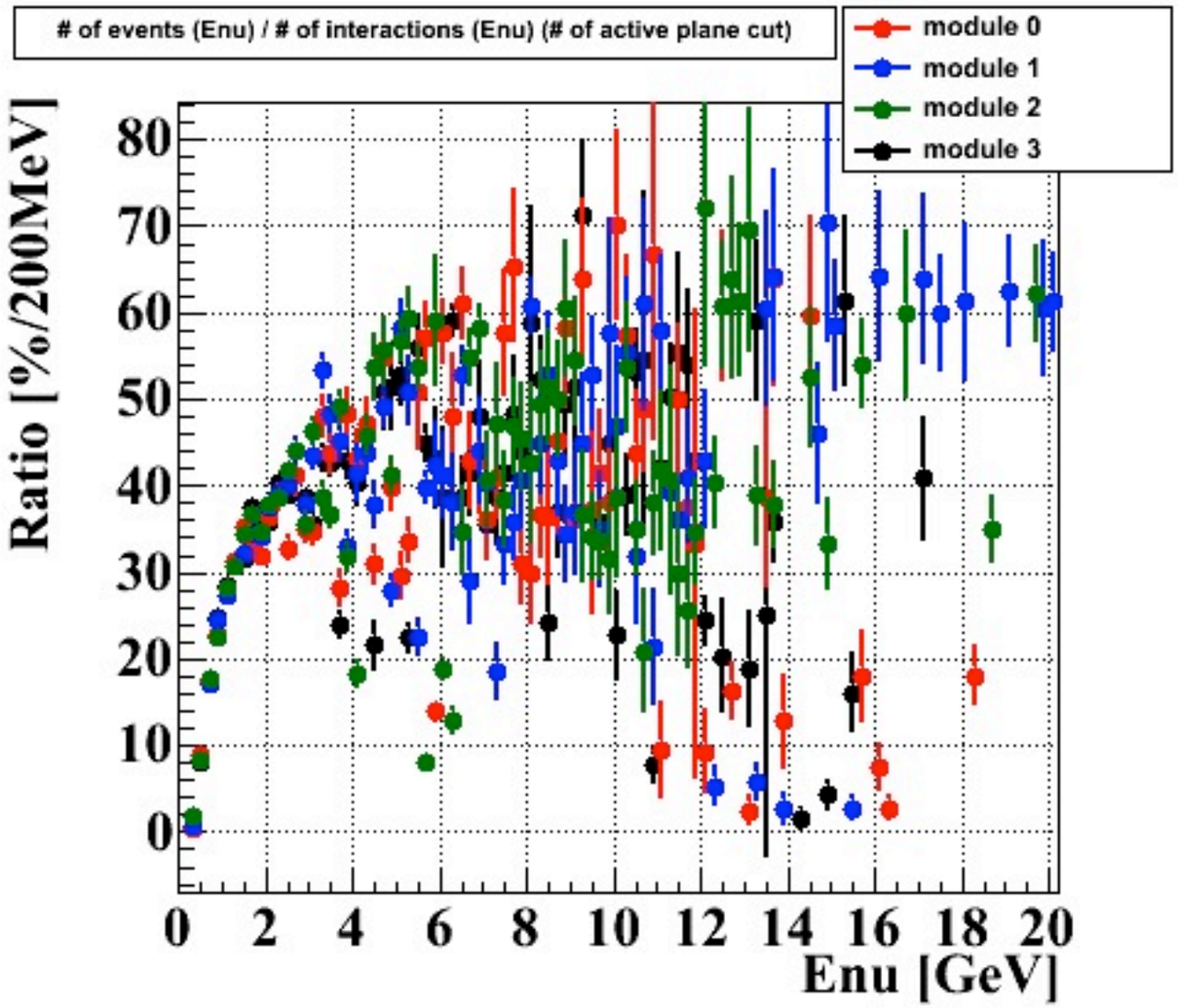

# of events (Enu) / # of interactions (Enu) (# of active plane cut)
Ratio [%/200MeV]
Enu [GeV]
module 3
module 4
module 5
module 6

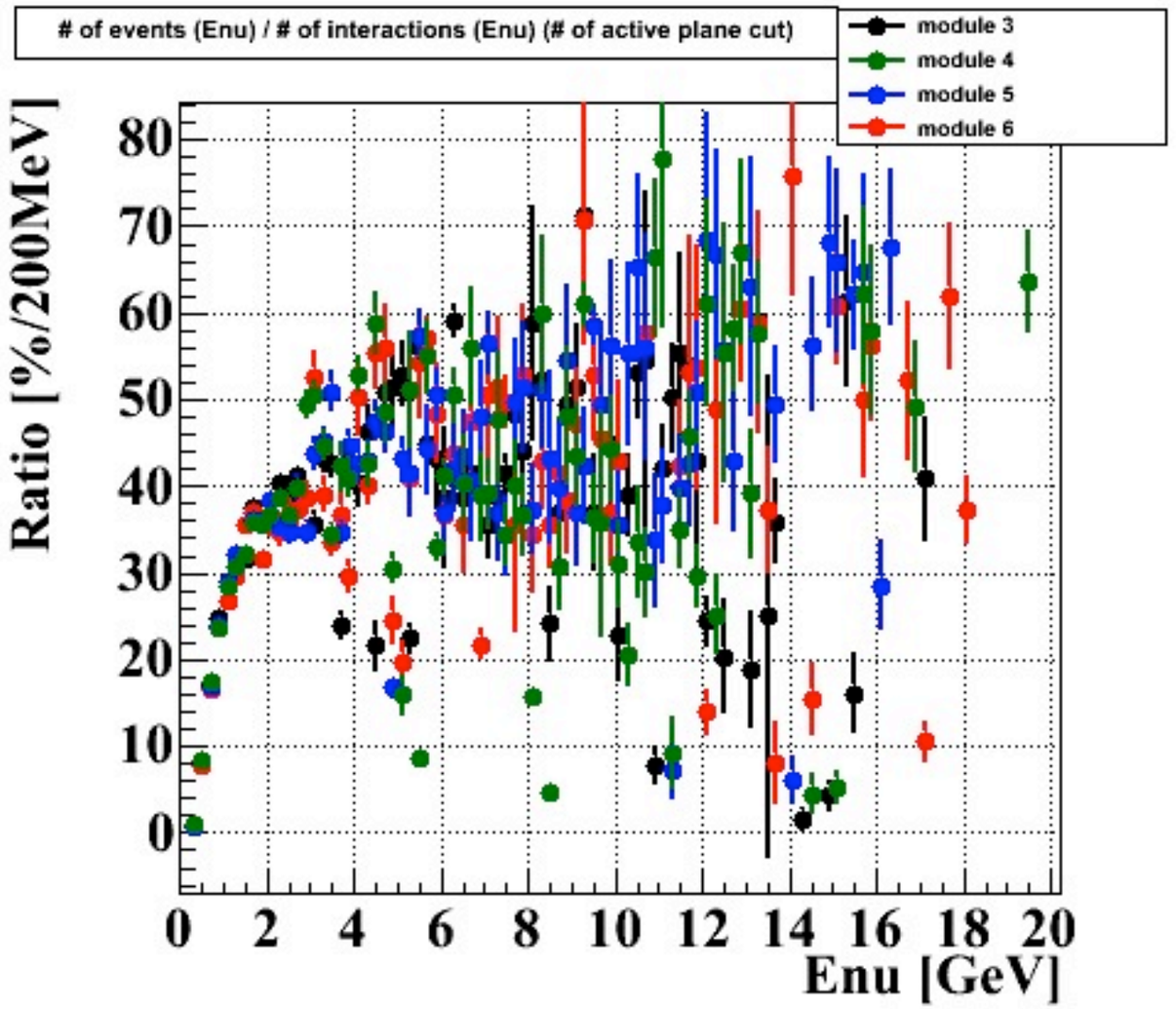
Cut Level 3


# of events (Enu) / # of interactions (Enu) (# of active plane cut)
Ratio [%/200MeV]
Enu [GeV]
module 0
module 1
module 2
module 3


# of events (Enu) / # of interactions (Enu) (# of active plane cut)
Ratio [%/200MeV]
Enu [GeV]
module 3
module 4
module 5
module 6

Cut Level 4


# of events (Enu) / # of interactions (Enu) (# of active plane cut)
module 0
module 1
module 2
module 3
Ratio [%/200MeV]
Enu [GeV]


# of events (Enu) / # of interactions (Enu) (# of active plane cut)
module 3
module 4
module 5
module 6
Ratio [%/200MeV]
Enu [GeV]

Cut Level 4 (at low Enu)