INGRID Work

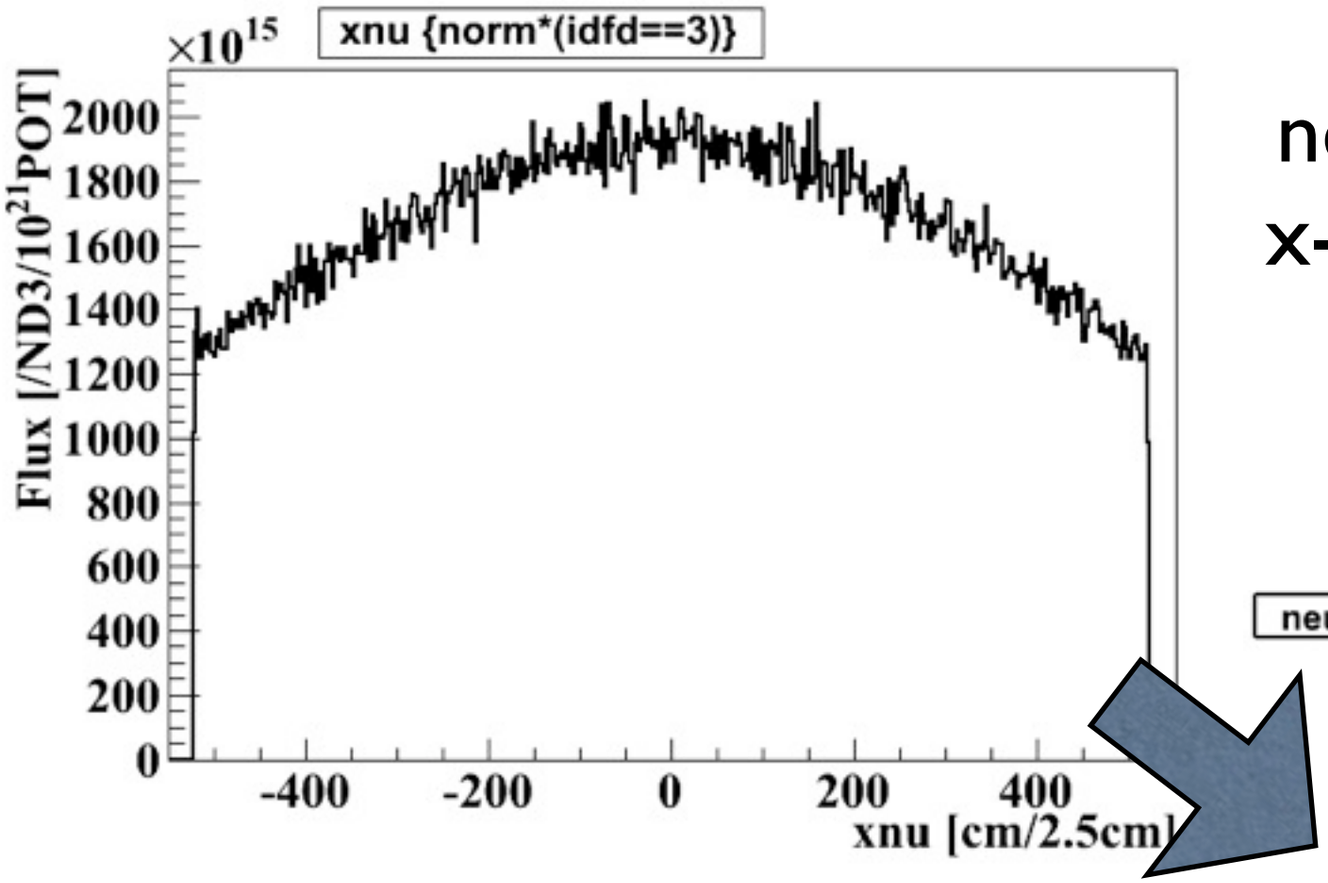
Akira Murakami

- Check Basic plot of ingrid mc
- status of ingrid mc code

setting

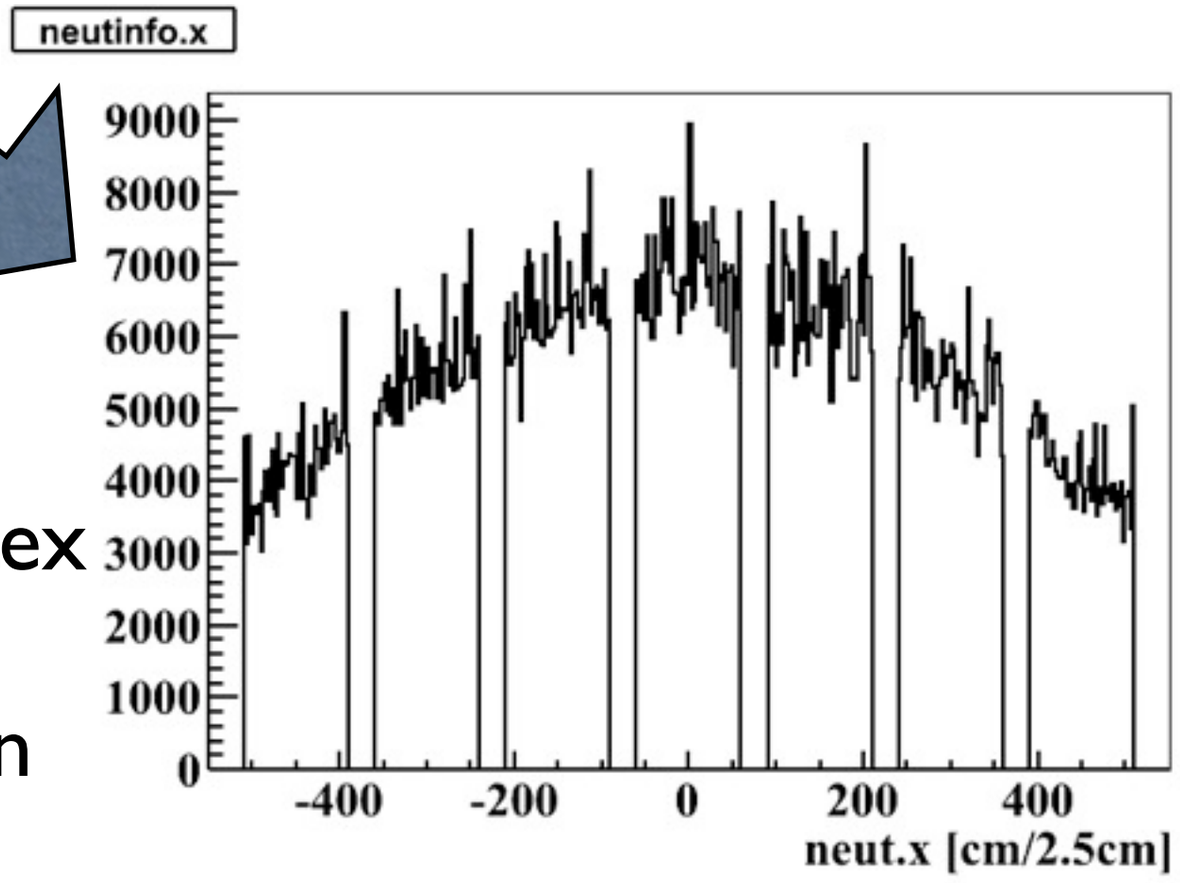
- Jnubeam : 10a
  - official flux file × 100 file
  - horn setting : all 250 kA
  - nominal beam
- Neut :
  - entry / 1 neut file = 5e4 → use all entries of 1 file
- GEANT4
  - Only numu flux

jnubeam & neut x-position distribution (ND3)

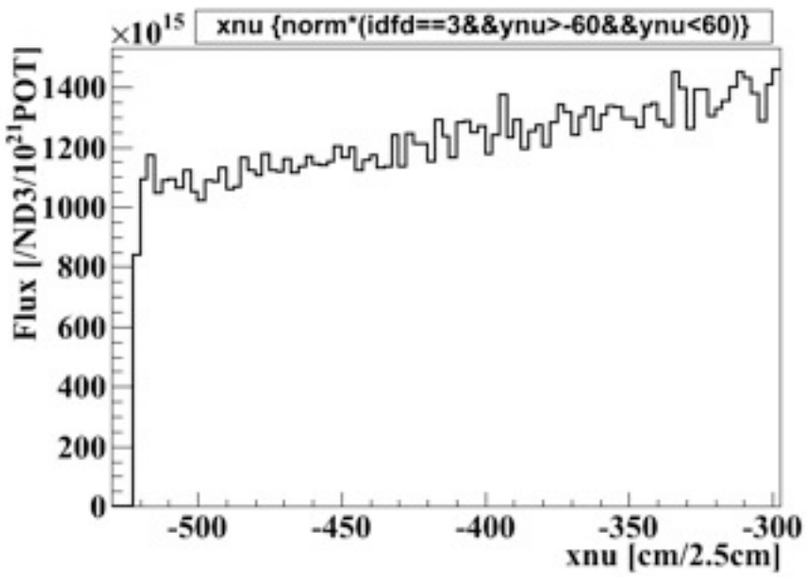


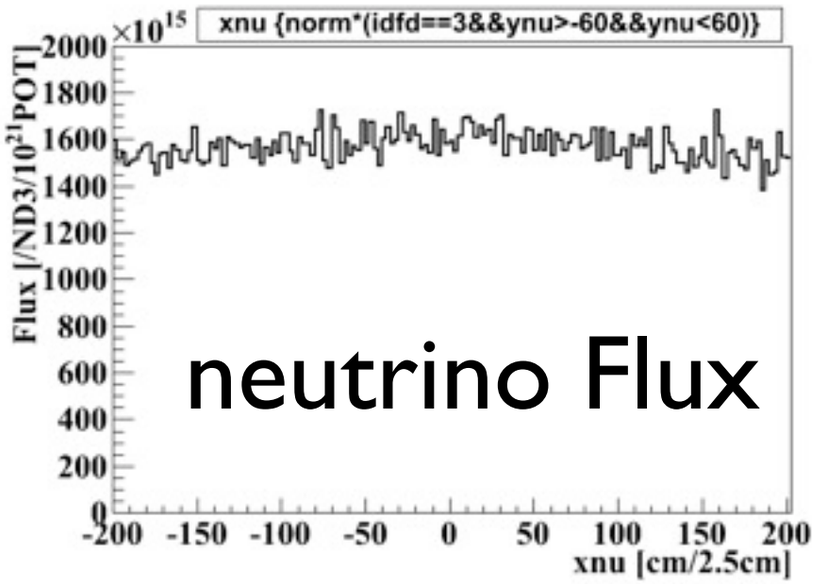
neutrino flux
x-distribution

neutrino interaction vertex
x-distribution
after apply cross-section

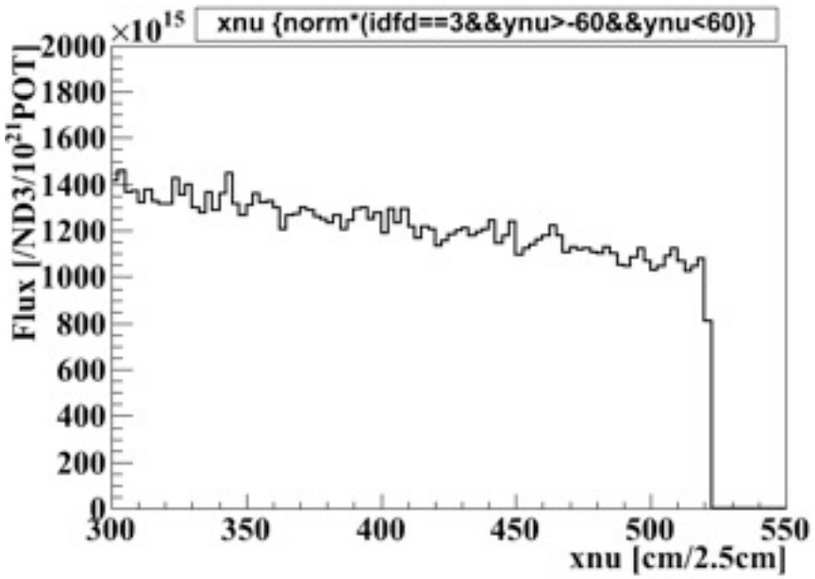


About Module 0,3,6

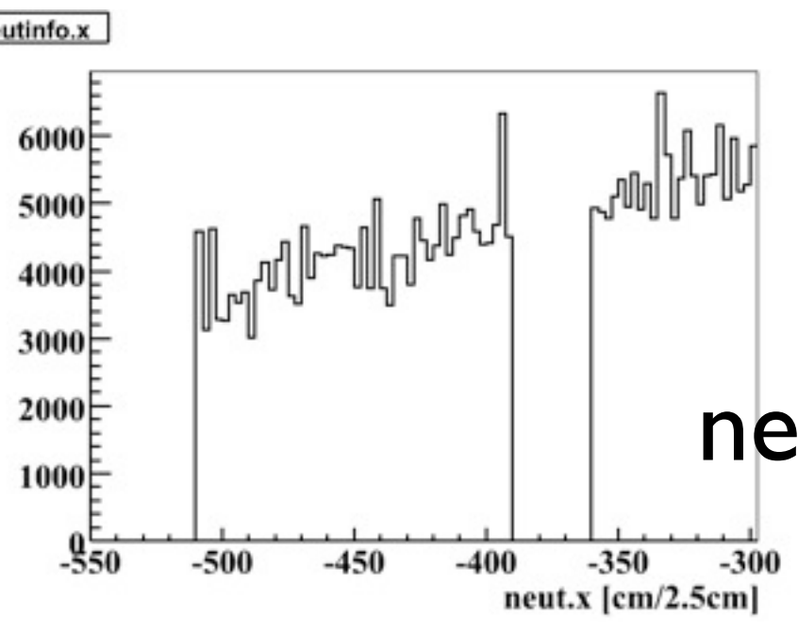




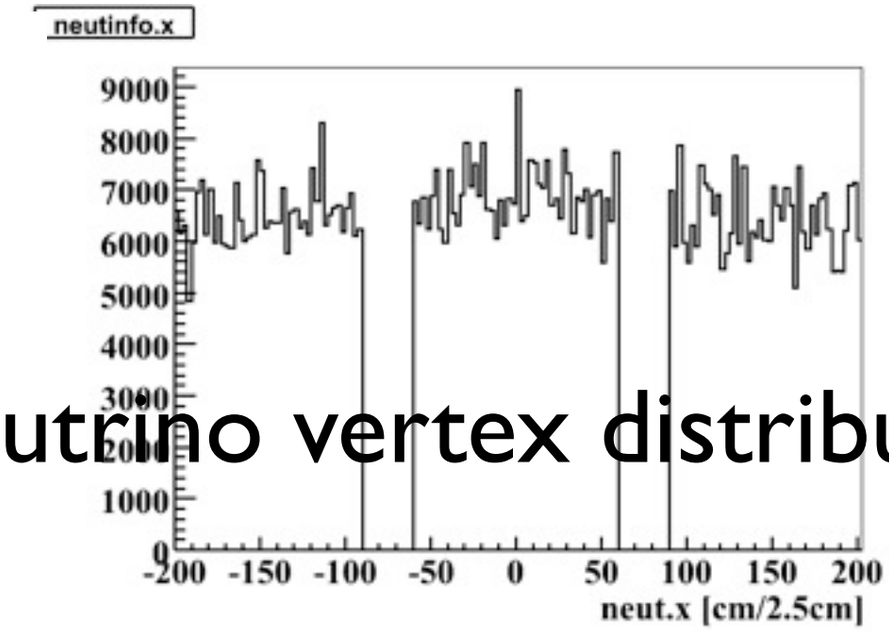
neutrino Flux



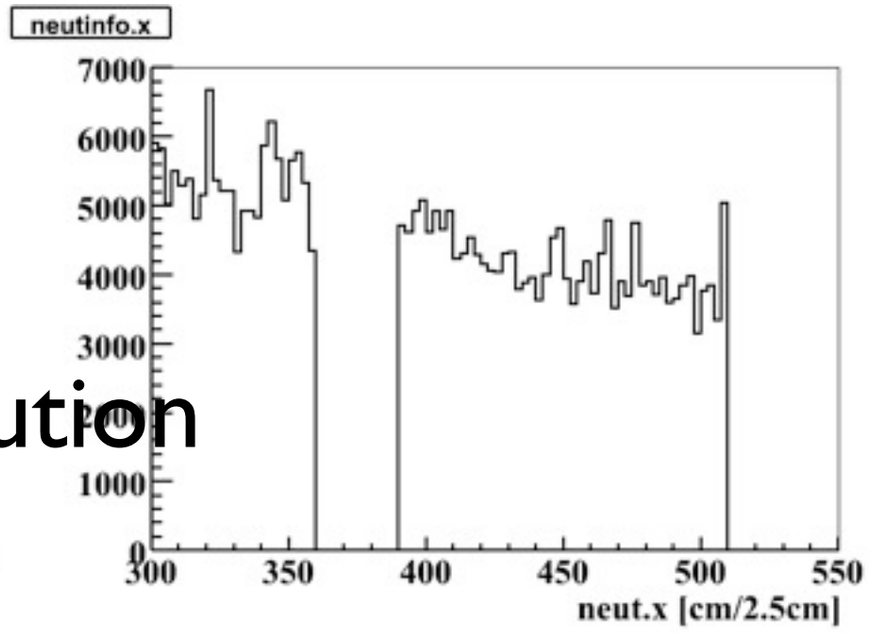
around module 0
x-direction



around module 3
x-direction

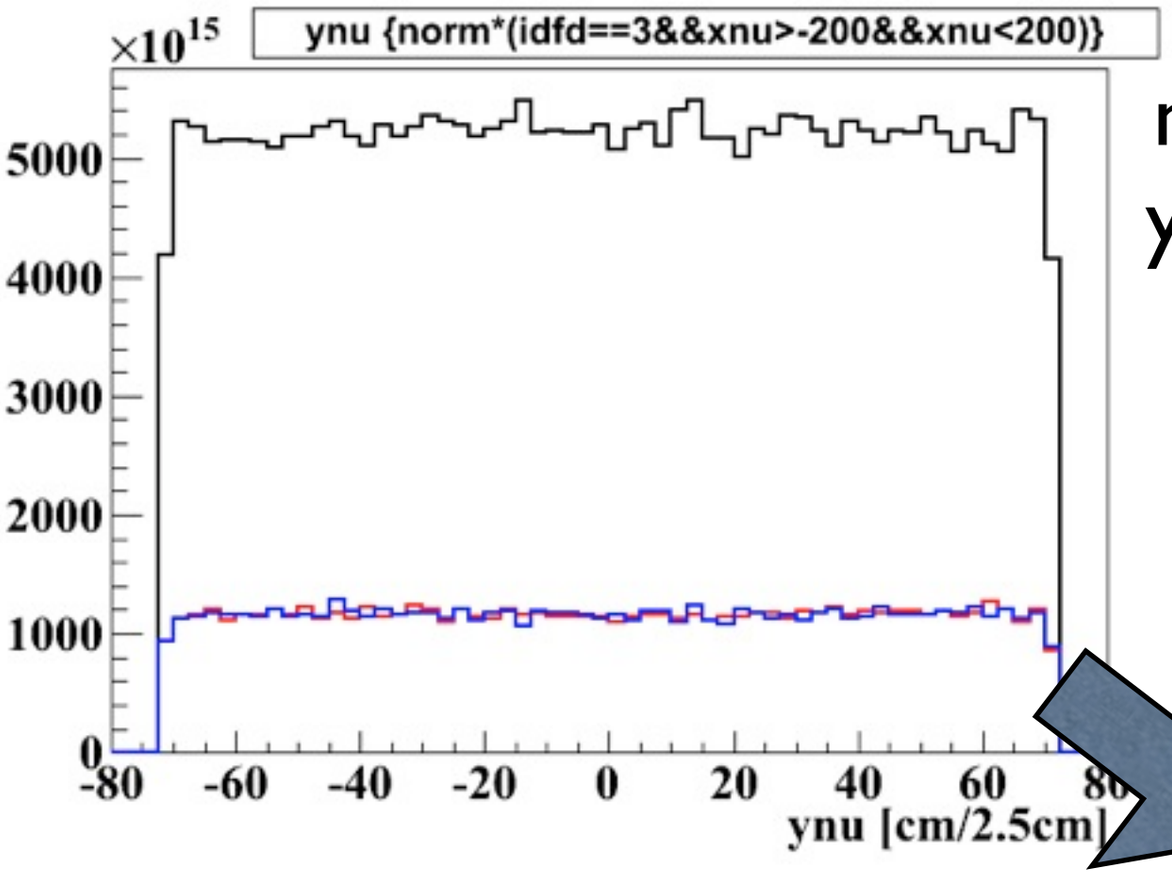


around module 6
x-direction



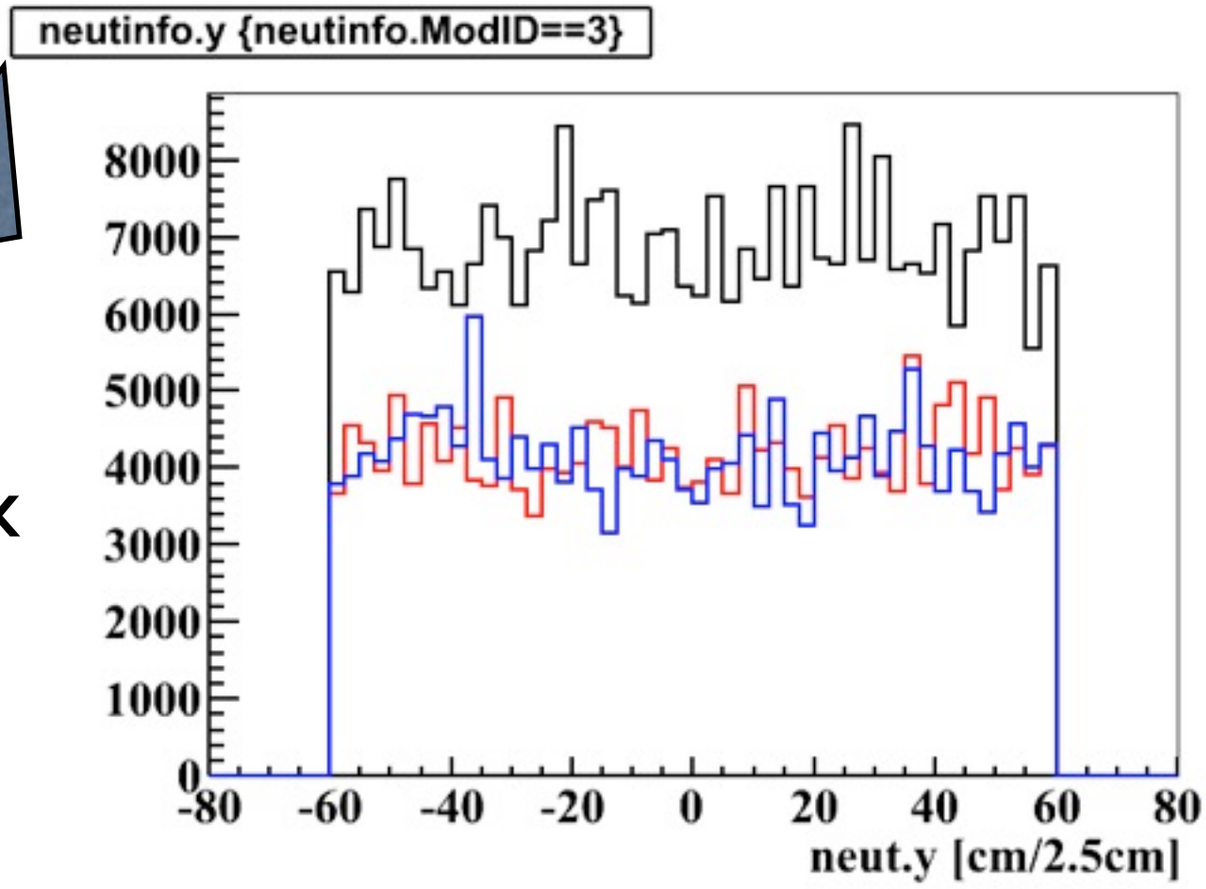
neutrino vertex distribution

jnubeam & neut y-position distribution (ND3)



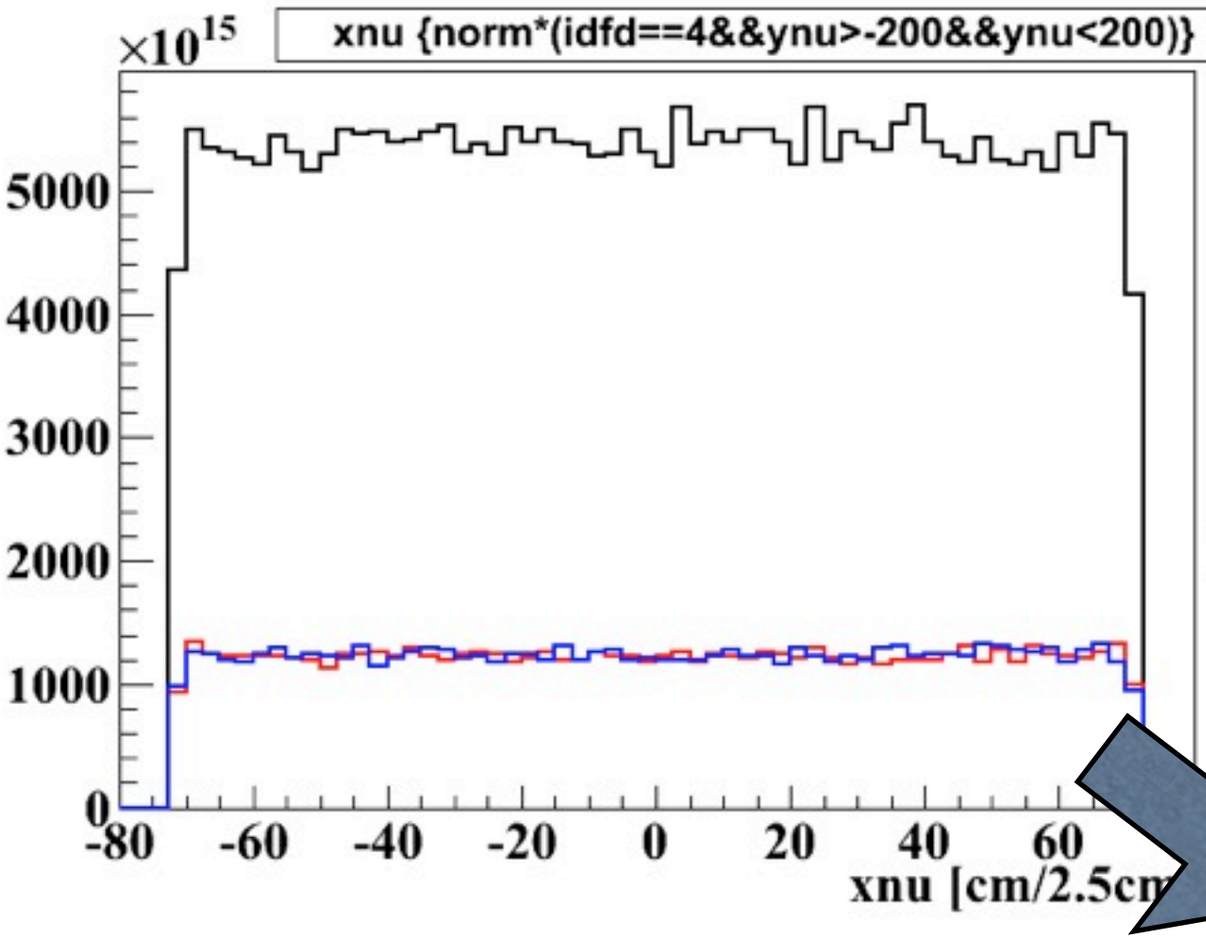
neutrino flux
y-distribution

module 0
module 3
module 6



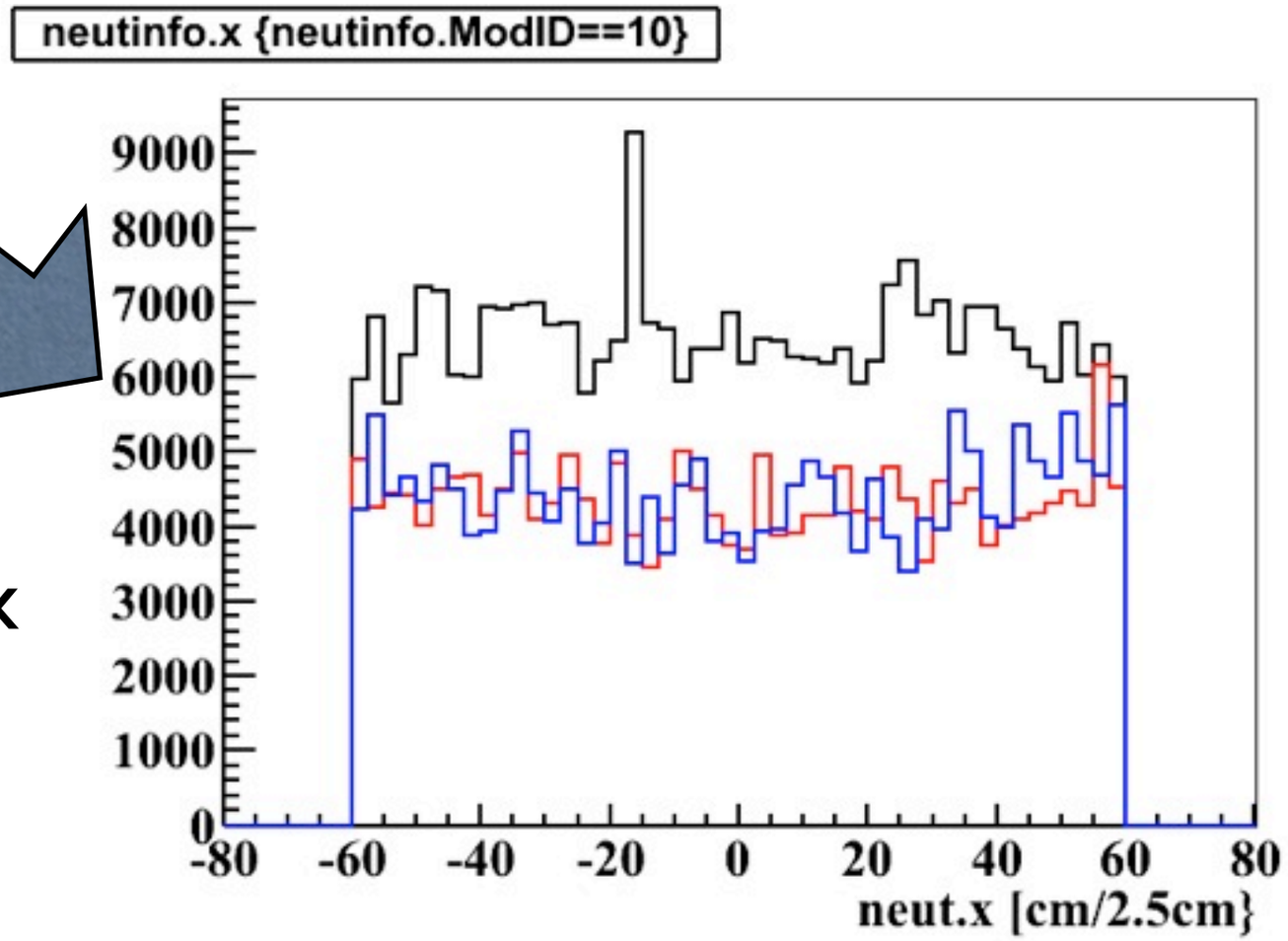
neutrino interaction vertex
y-distribution
after apply cross-section

jnubeam & neut x-position distribution (ND4)



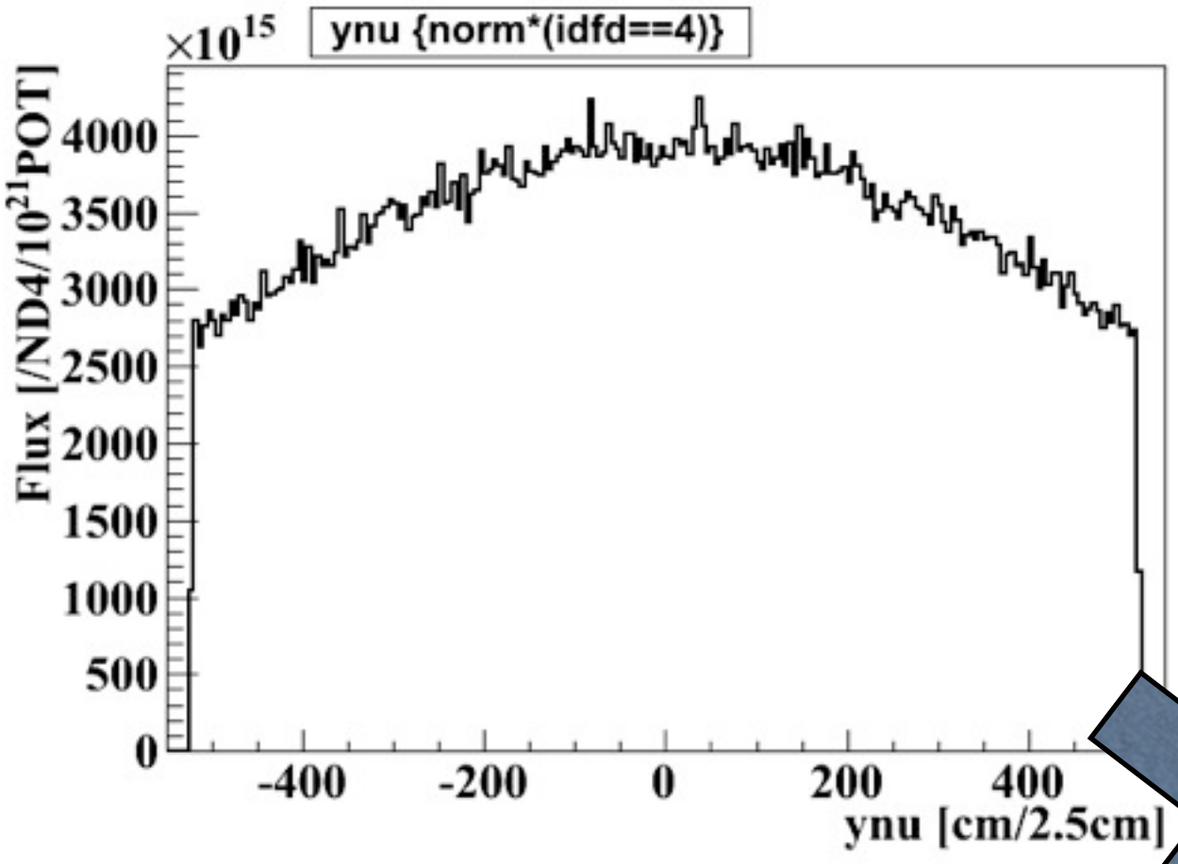
neutrino flux
x-distribution

module 0
module 3
module 6



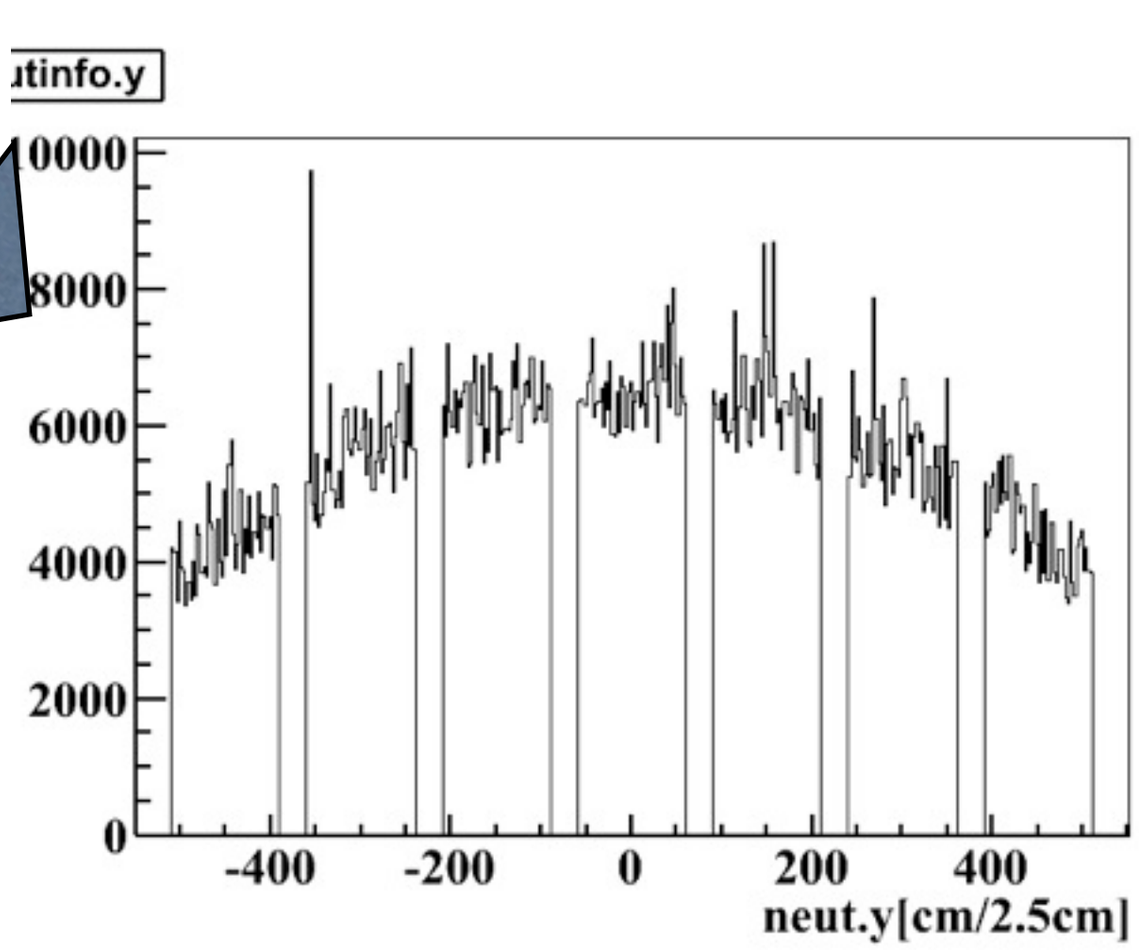
neutrino interaction vertex
x-distribution
after apply cross-section

jnubeam & neut y-position distribution (ND4)

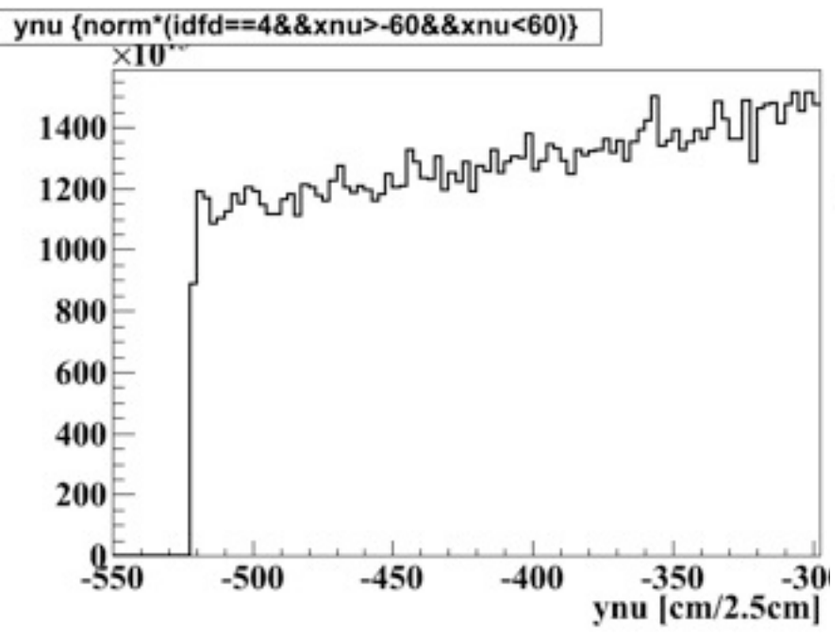


neutrino flux
y-distribution

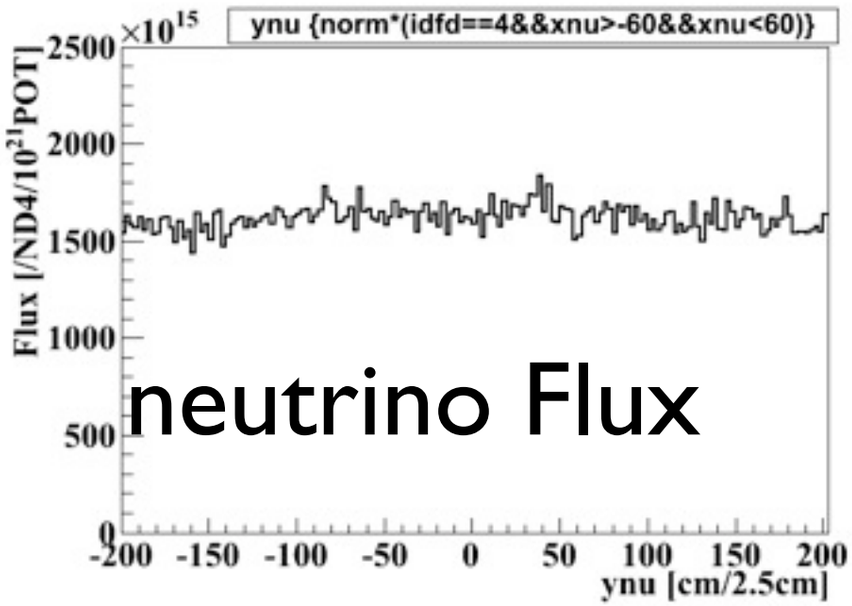
neutrino interaction vertex
y-distribution
after apply cross-section



About Module 7,10,13

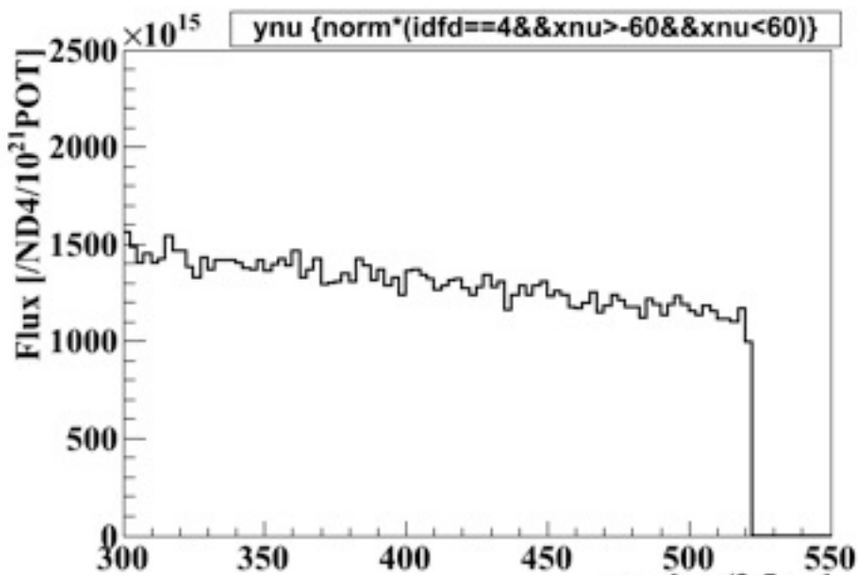


around module 7
y-direction

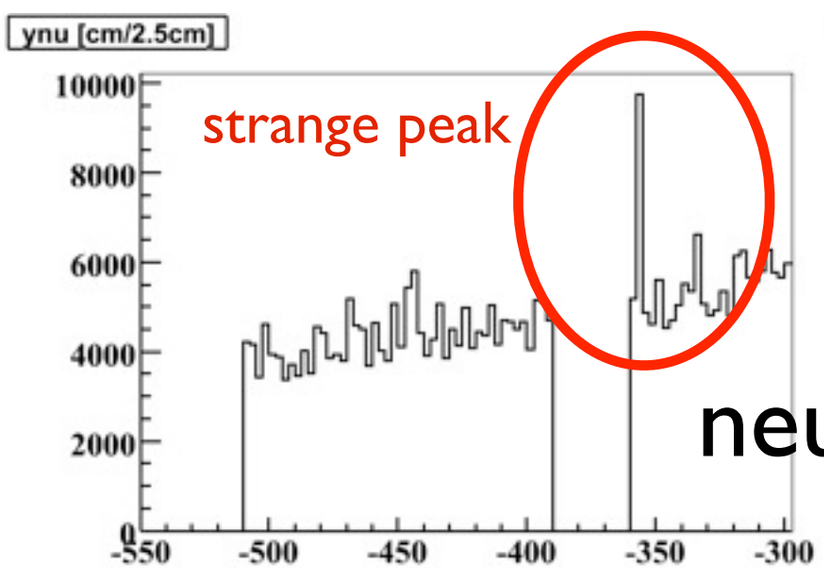


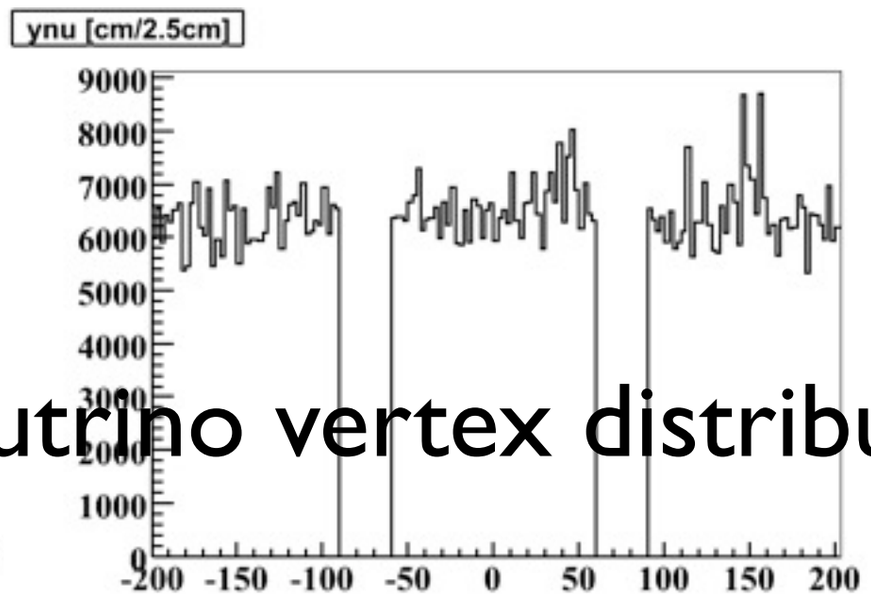
neutrino Flux

around module 10
y-direction

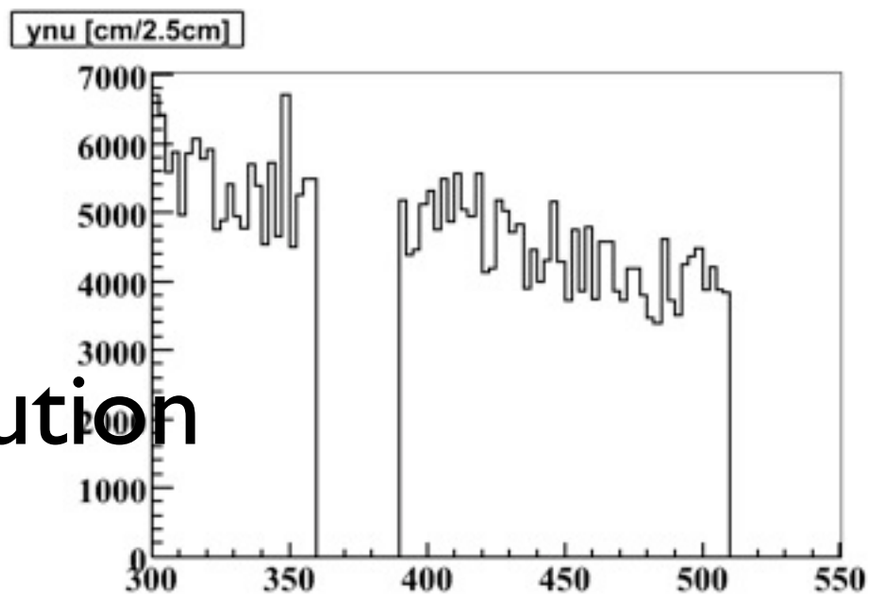


around module 13
y-direction

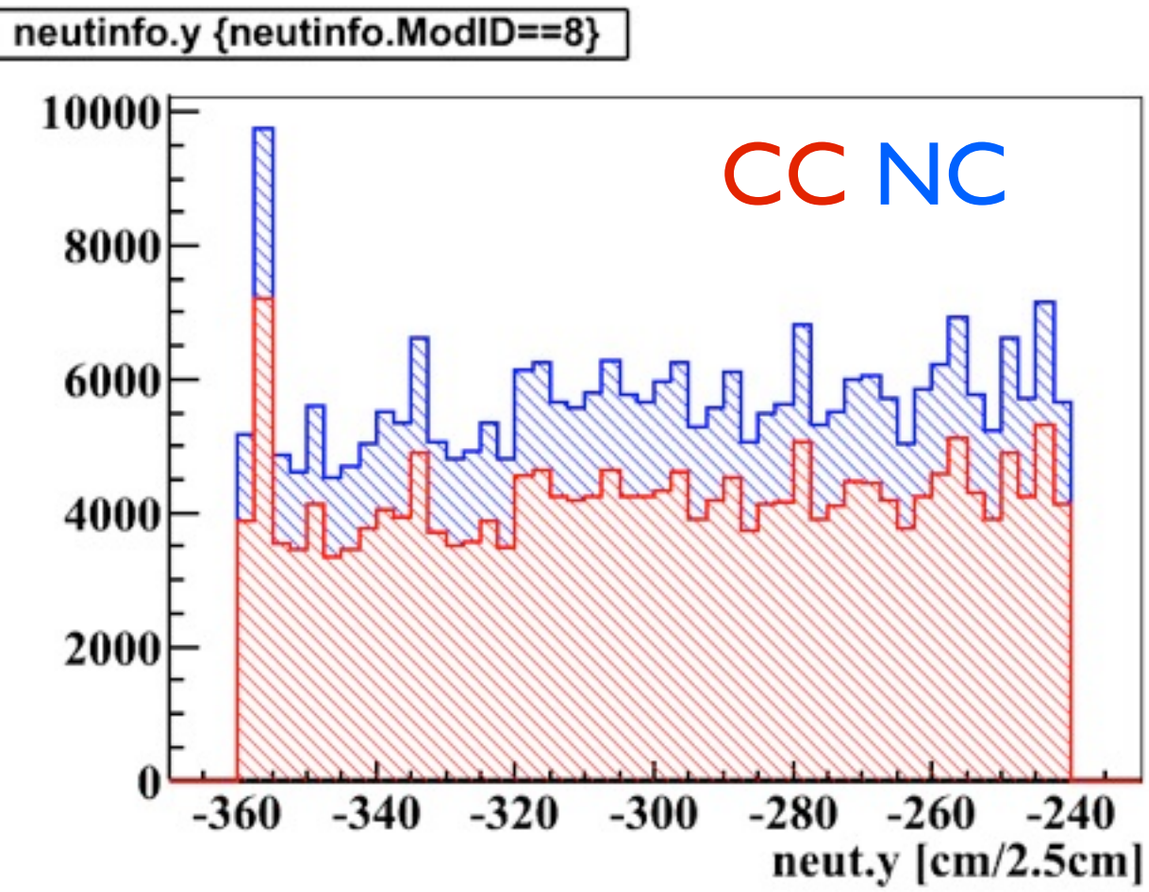


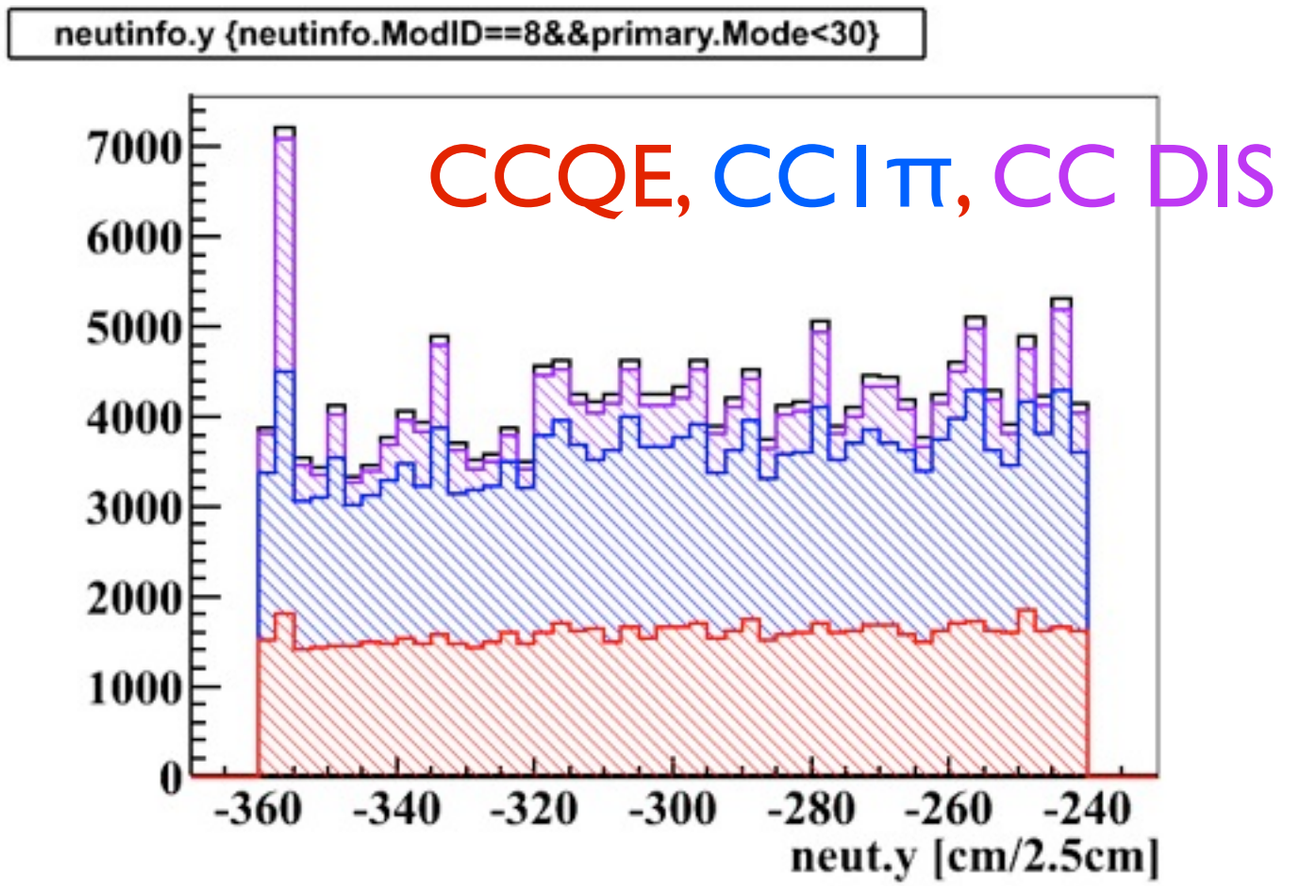


neutrino vertex distribution



detail of strange peak





the strange peak is due to CC interaction

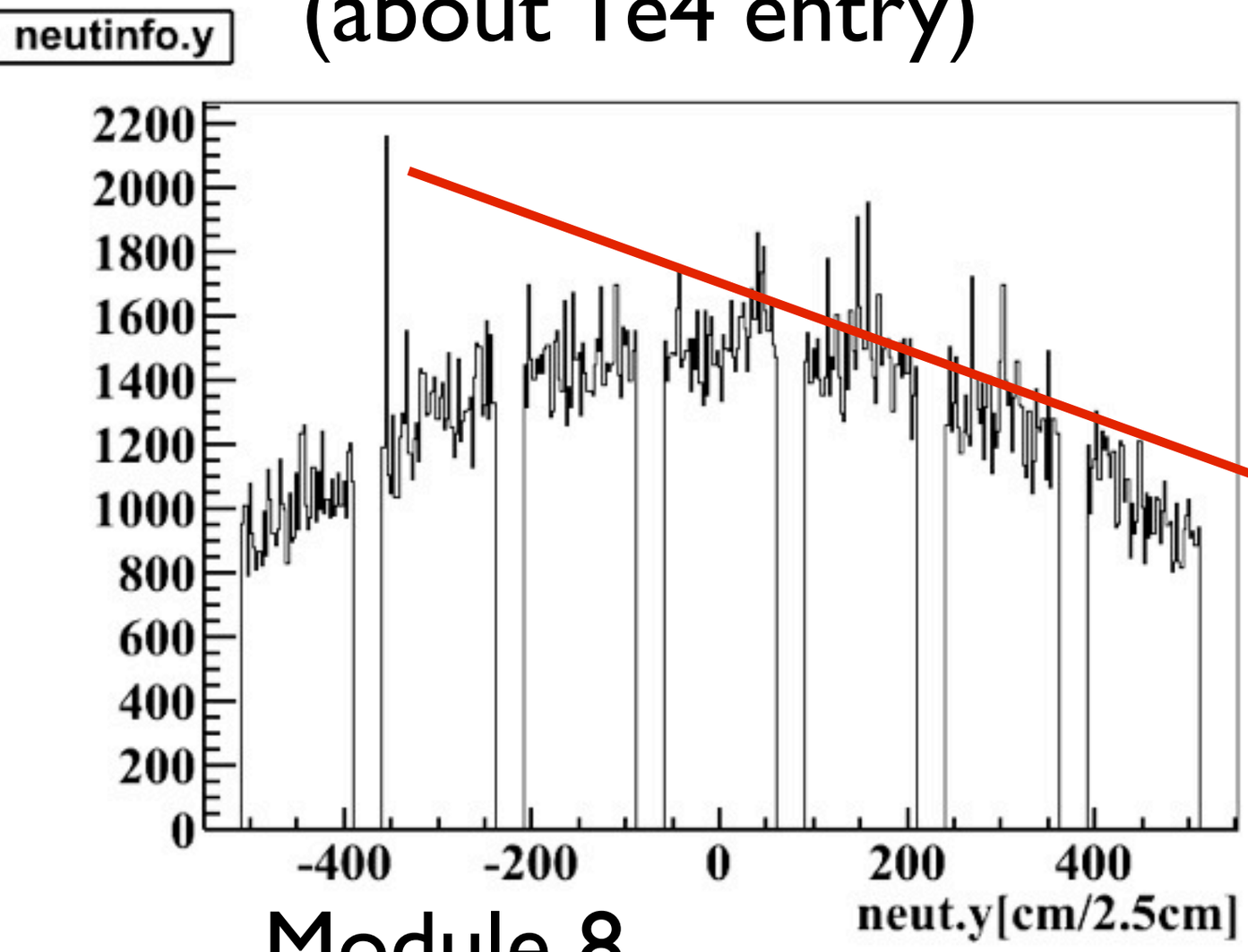
CC-DIS interaction seems to be due to this peak.

at making neut file, use same entry from one jnubeam flux file ???

→ change to use only first 20000 entry from one neut file at INGRID MC

but, not change ...

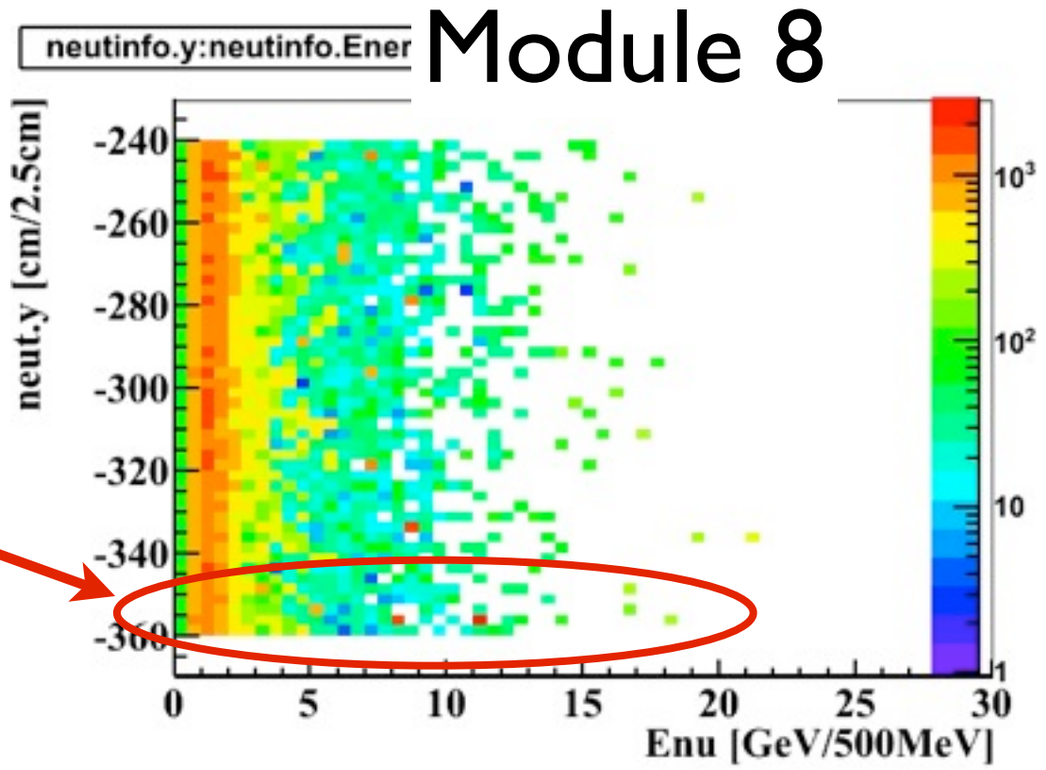
(about 1e4 entry)

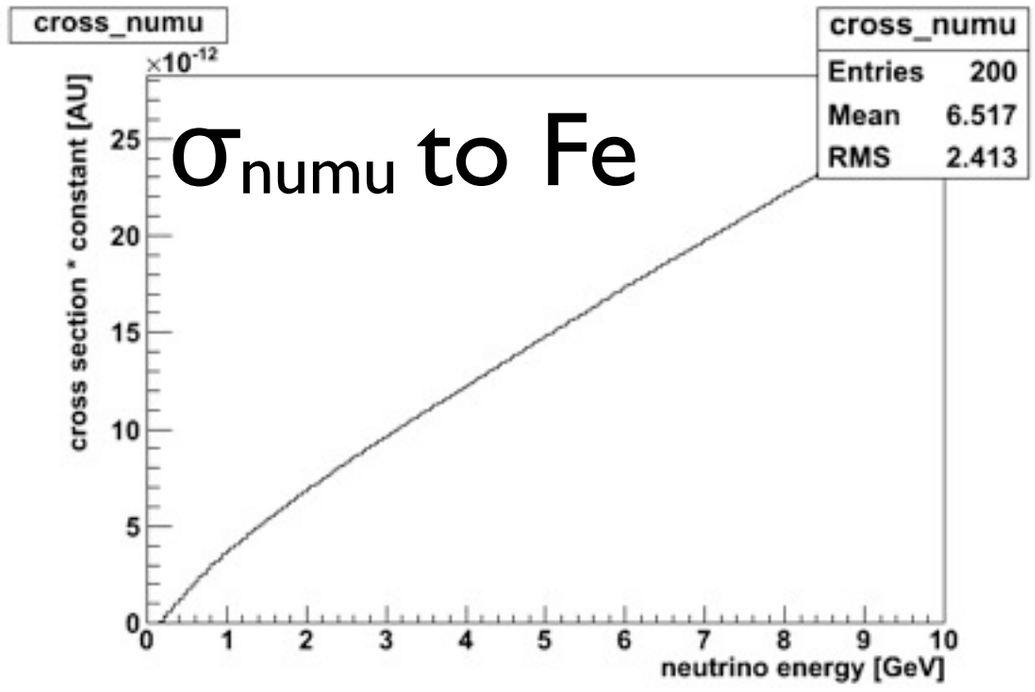


Module 8

(about 5e4 entry)

Module 8



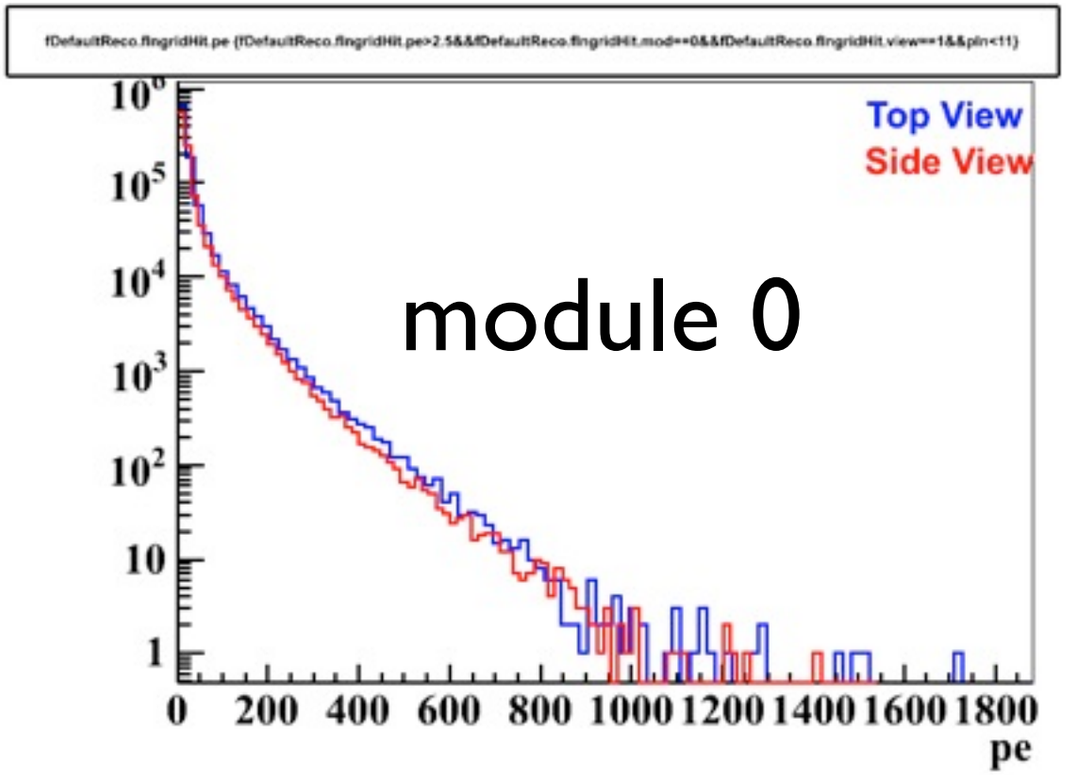


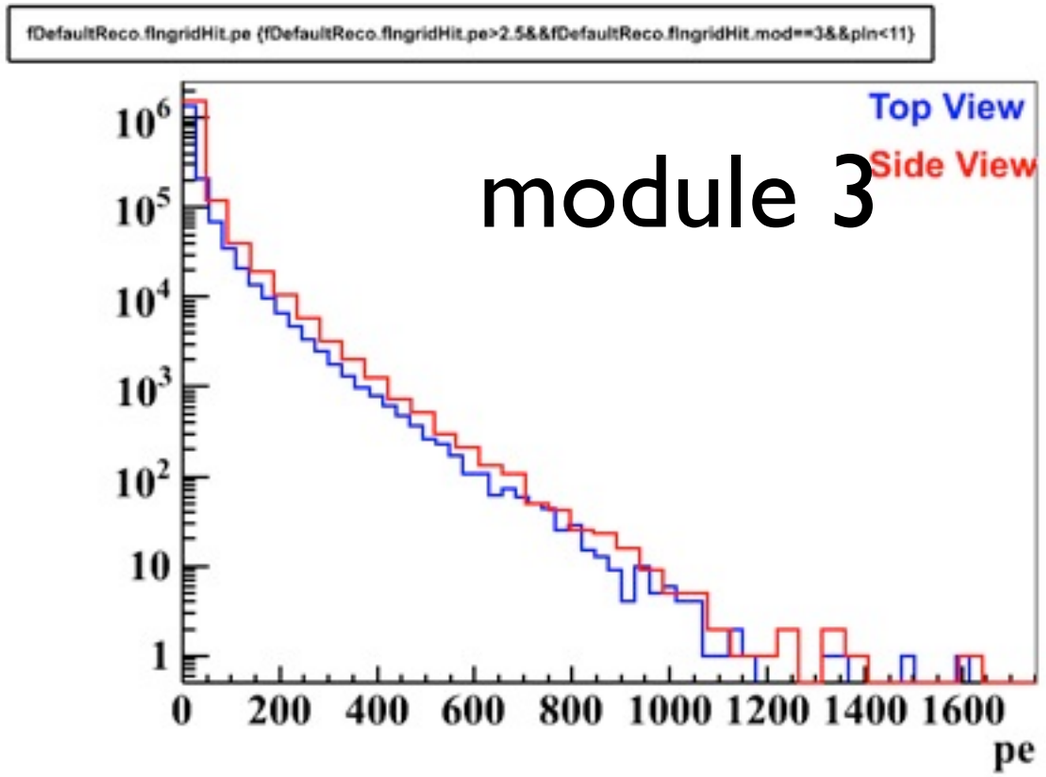
σ_{numu} to Fe

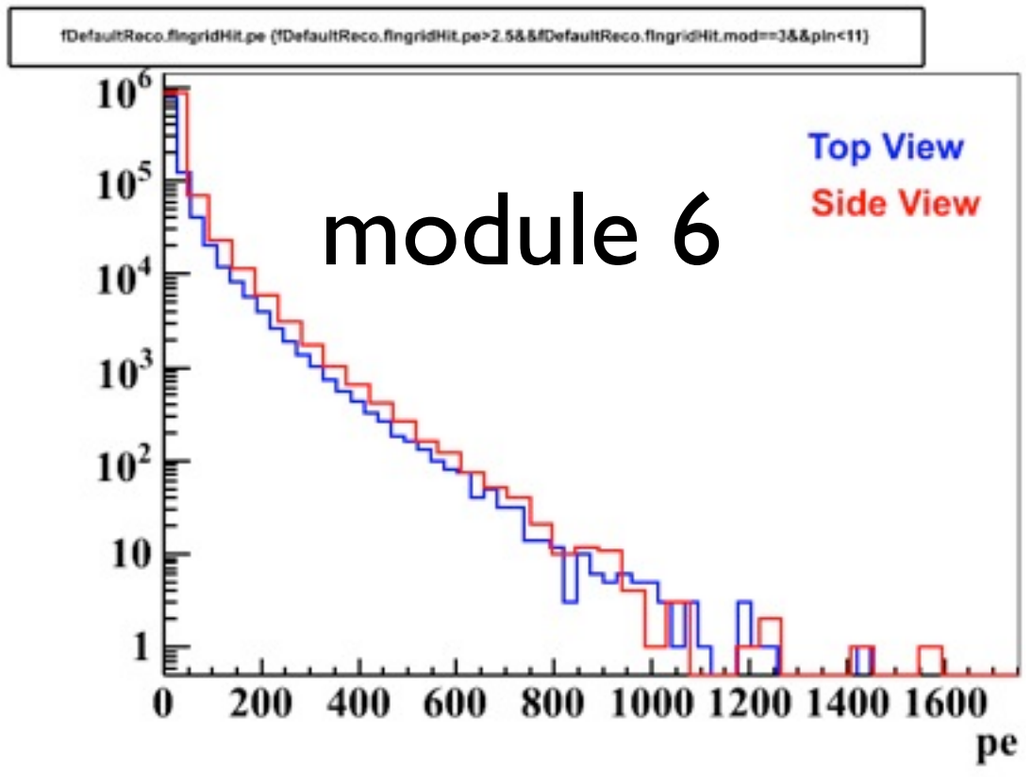
basic plot

- for compare beam data to MC data
- simple plot
  - Beam data include MPPC noise, but MC data not yet.
  - for remove noise signal, should be applied “active plane>1 && p.e./layer > 6.5”
- In this report, I demonstrate no cut basic plot

p.e. distribution

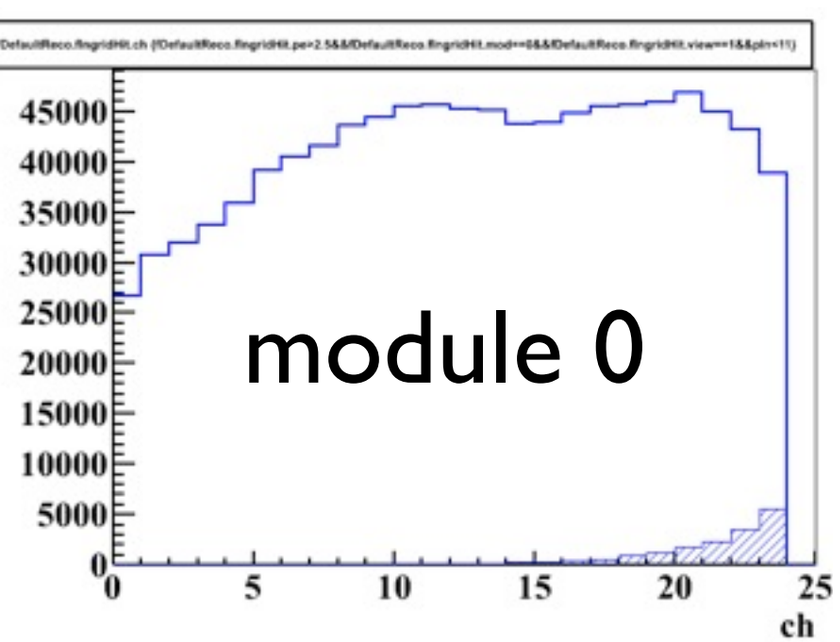


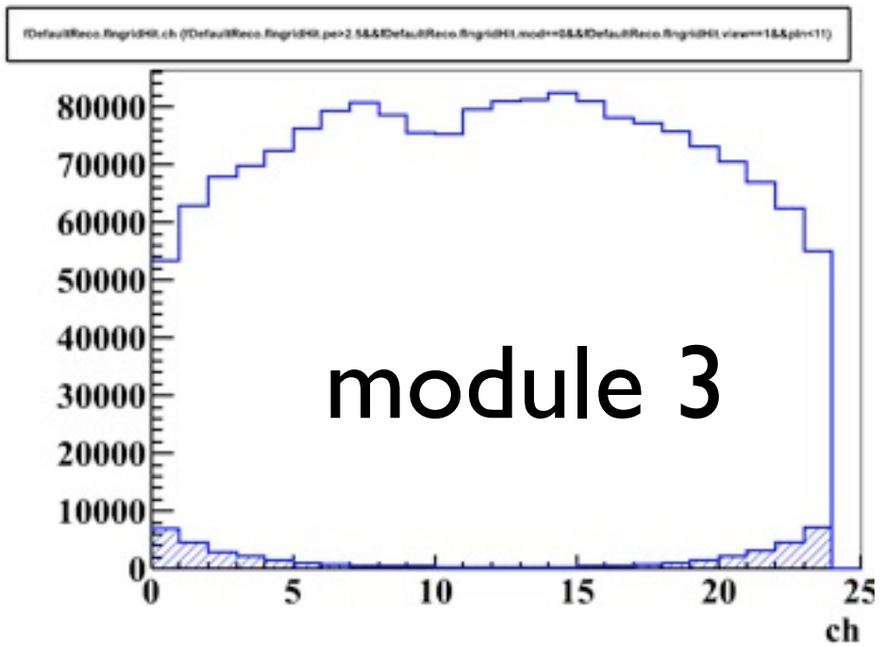


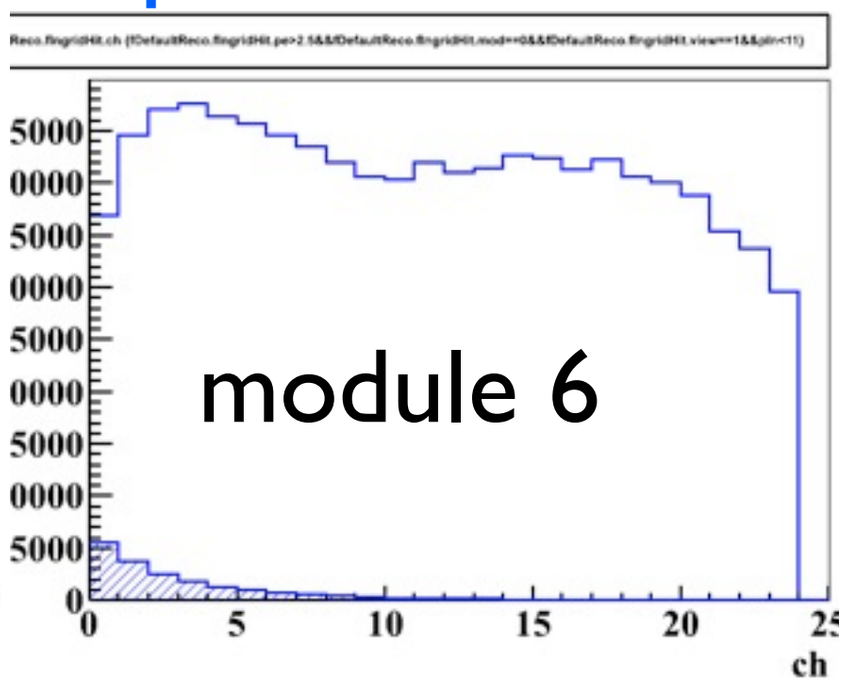


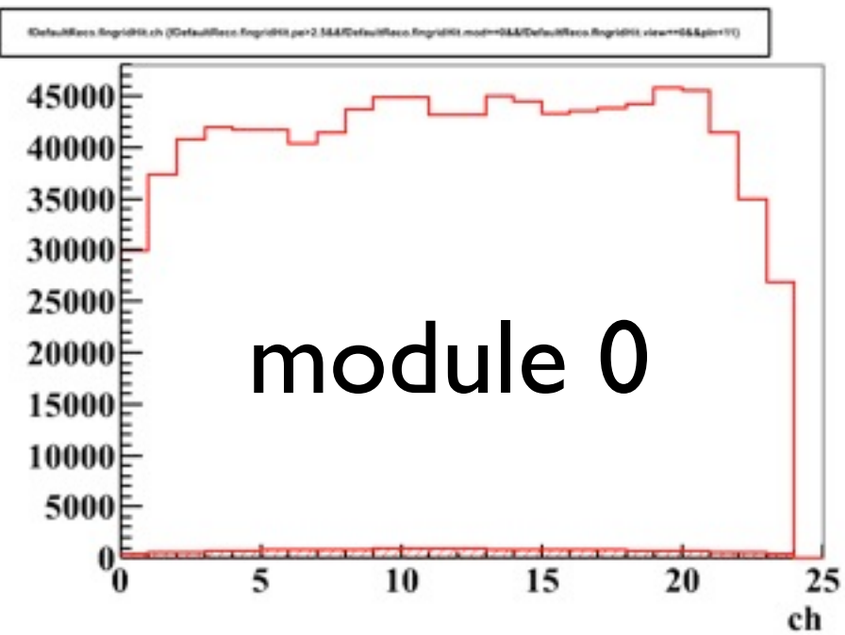
hit ch distribution

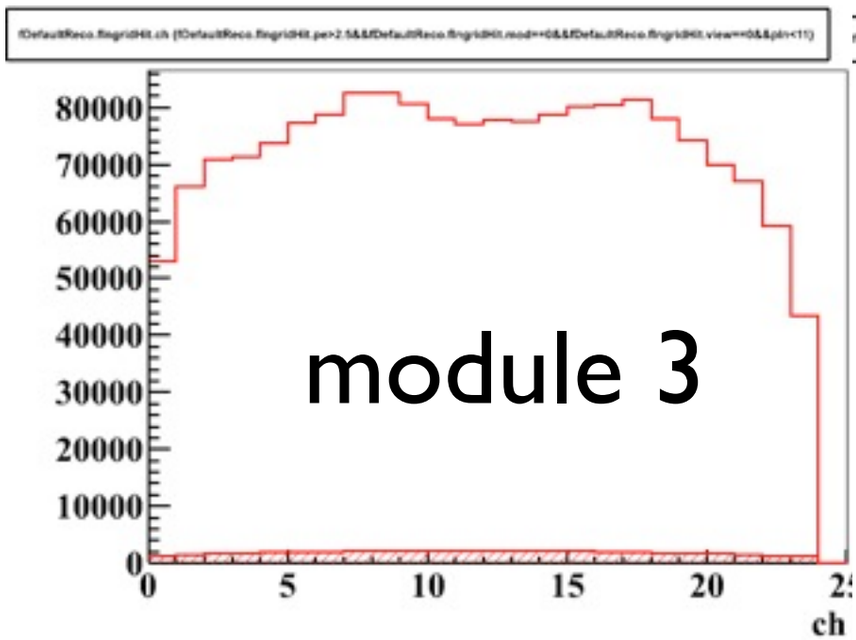
Topview Sideview

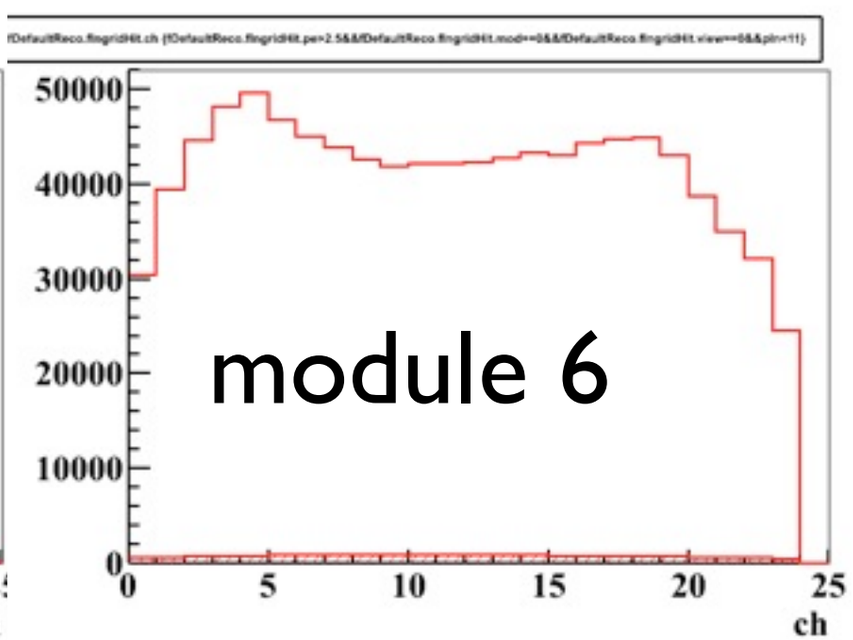










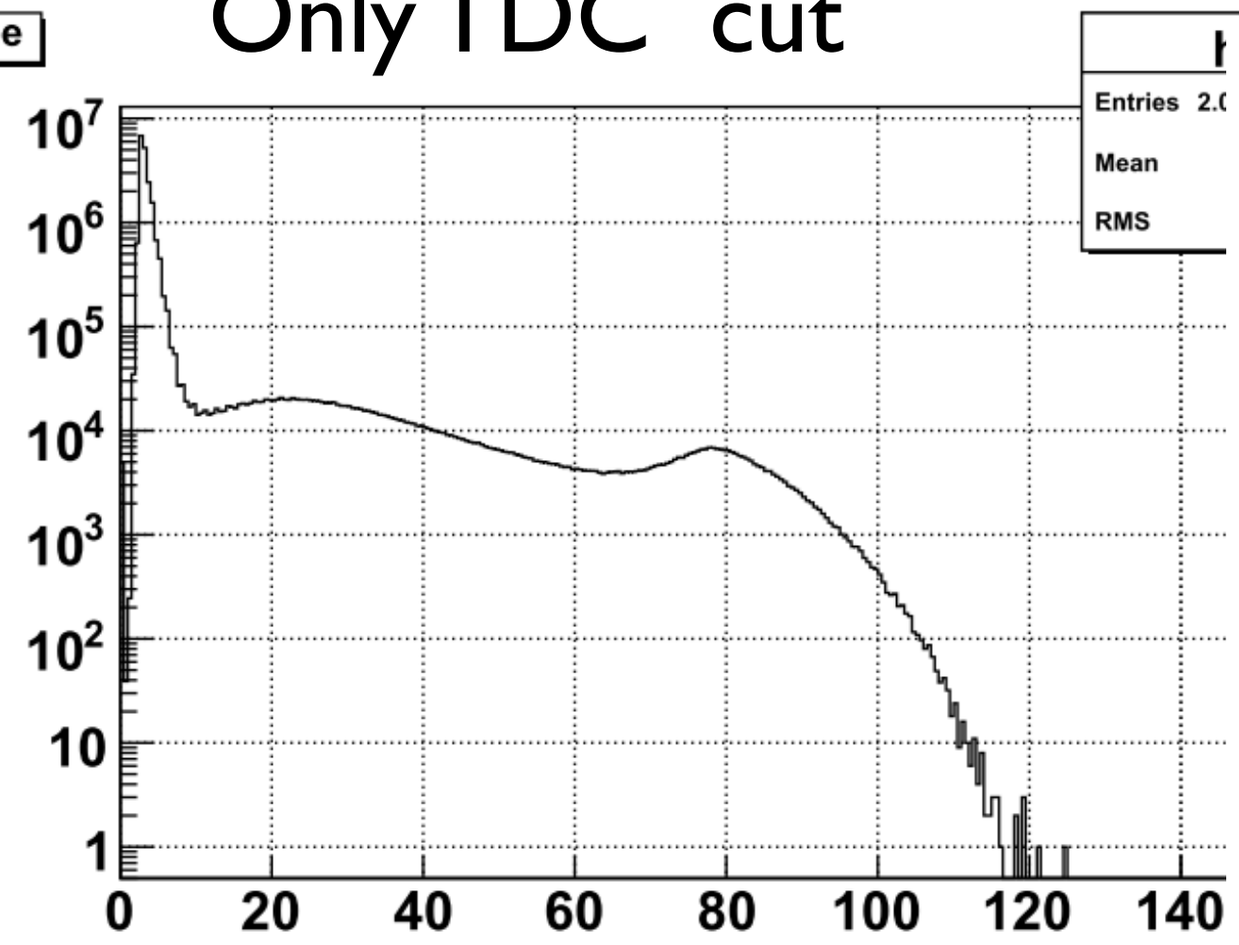


Line : all hit in module

mesh range : hit in out of module (not vertex module)

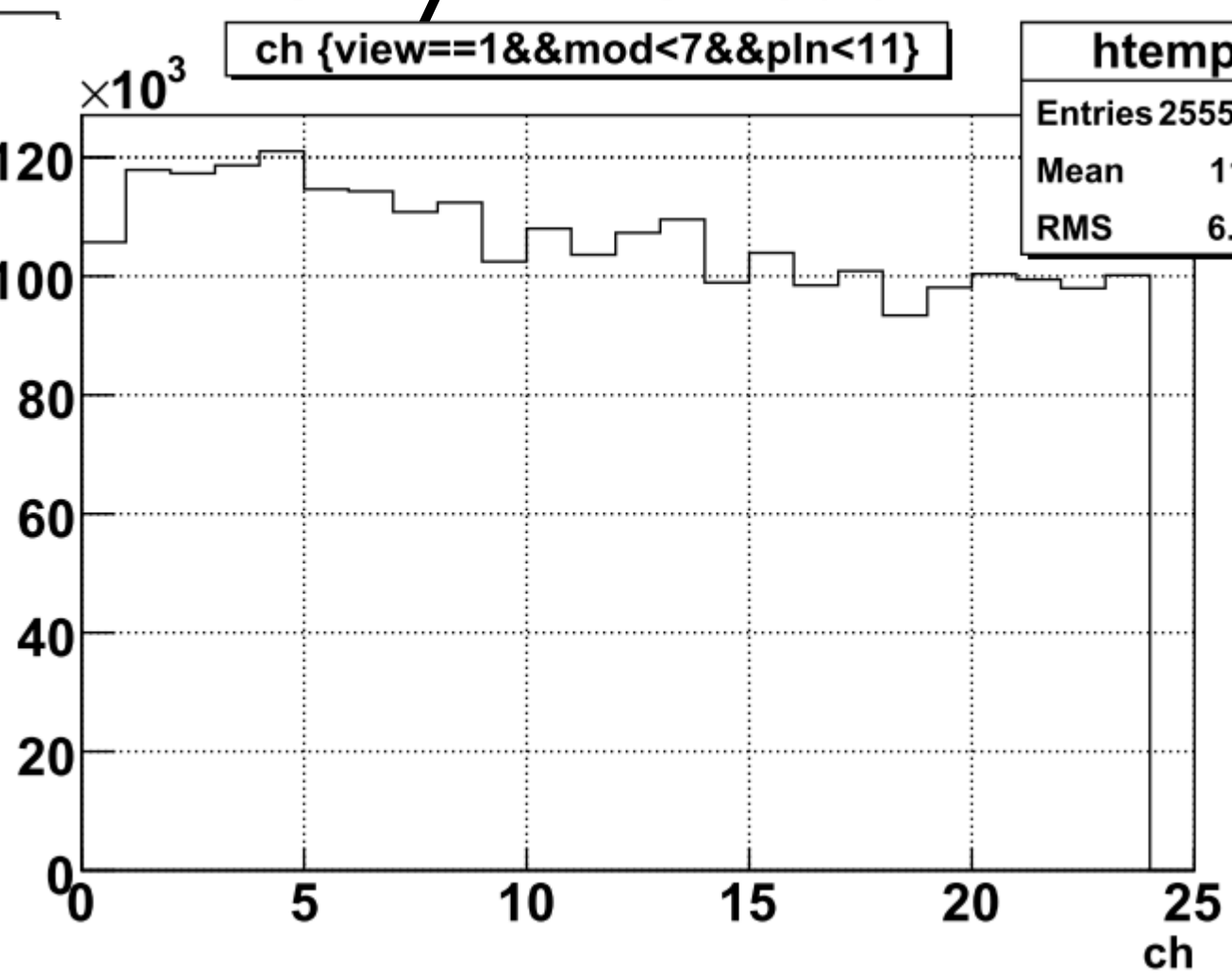
beam data

All ch
Only TDC cut



pe

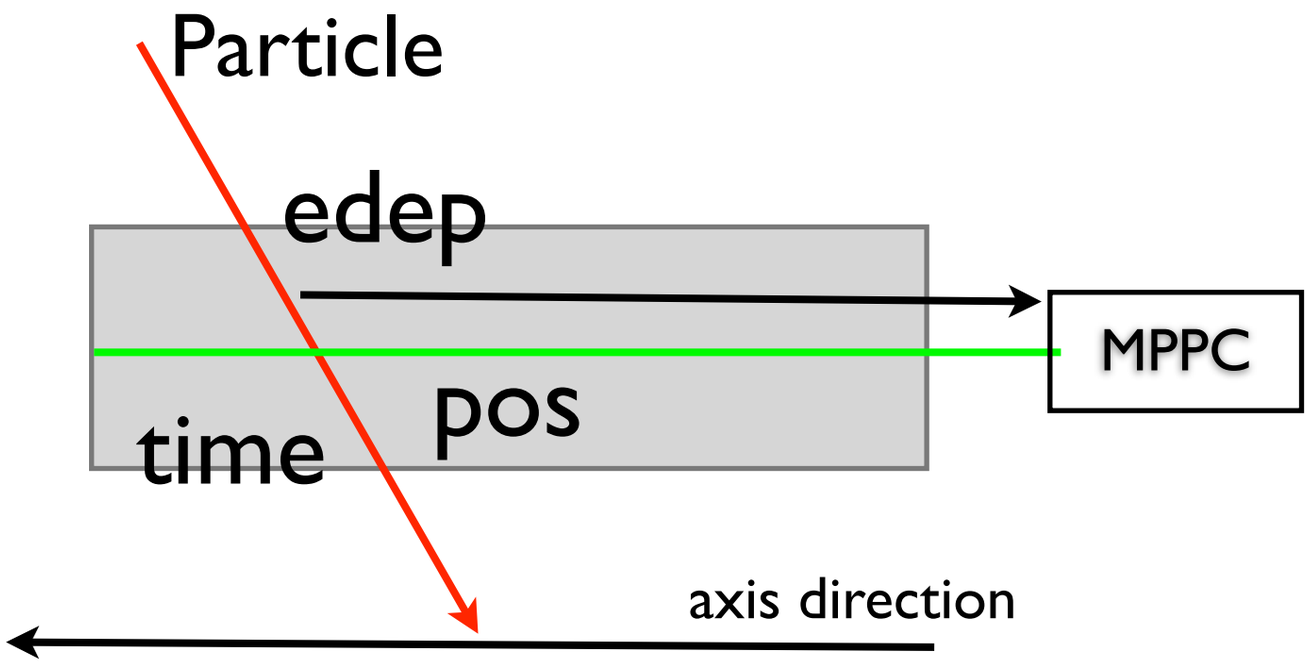
All ch
Only TDC cut

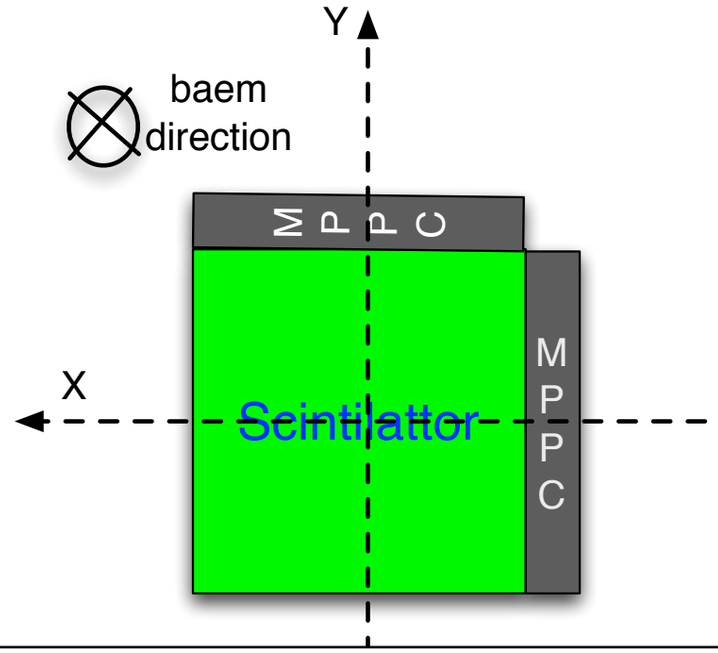


horizontal modules
top view

tuning MC

- Add simple detector response function
  - Fiber attenuation
    - fluctuation from p.e. statistics
- change physics list
  - GEANT4 example list → QGSP





scilen = 120 cm
att = attenuation length = 247.1 cm
TransTimeInFIber
= 1[cm] / (2.8×10^{10}[cm/s])$\times10^{9}$ [nsec/s]
MeV2PE = 2.6 MeV /15 p.e.

```
void IngridResponse::ApplyFiberResponse(G4double* edep,
G4double* time, G4int view, G4ThreeVector pos)
{
   G4double x = 0.;

   if( view==topview ) x = fabs(scilen/2. + pos[1]/cm);
   else if( view==sideview ) x = fabs(scilen/2. + pos[0]/cm);

   // attenuation
   *edep *= exp(-x/att);

   // delay in fiber
   *time = *time + TransTimeInFiber*x;

  return;
}
```

```
//
void IngridResponse::ApplyMPPCResponse
(G4double edep, G4double* pe)
{
   // energy to p.e.
   *pe = edep*MeV2PE;

   // Poisson statistics & 1 pe resolution
   G4double npe = CLHEP::RandPoisson::shoot(*pe);
   *pe = npe;

  return;
}
```

Sample physics list

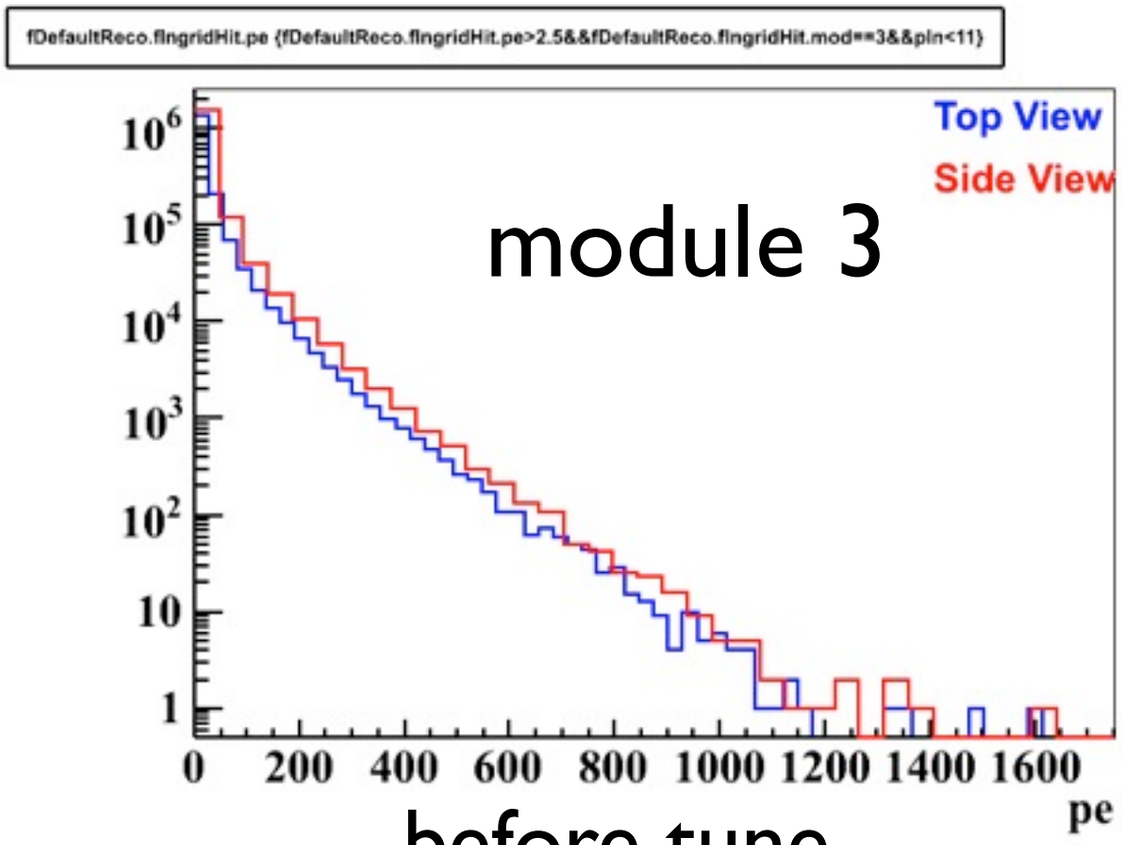
```
defaultCutValue = 1.0*mm;
 SetVerboseLevel(1);

 // General Physics
 RegisterPhysics( new ExN04GeneralPhysics("general") );

 // EM Physics
 RegisterPhysics( new ExN04EMPhysics("standard EM"));

// Muon Physics
RegisterPhysics(  new ExN04MuonPhysics("muon"));

 // Hadron Physics
RegisterPhysics(  new ExN04HadronPhysics("hadron"));

// Ion Physics
RegisterPhysics( new ExN04IonPhysics("ion"));
```

Physics list ~ QGSP ~

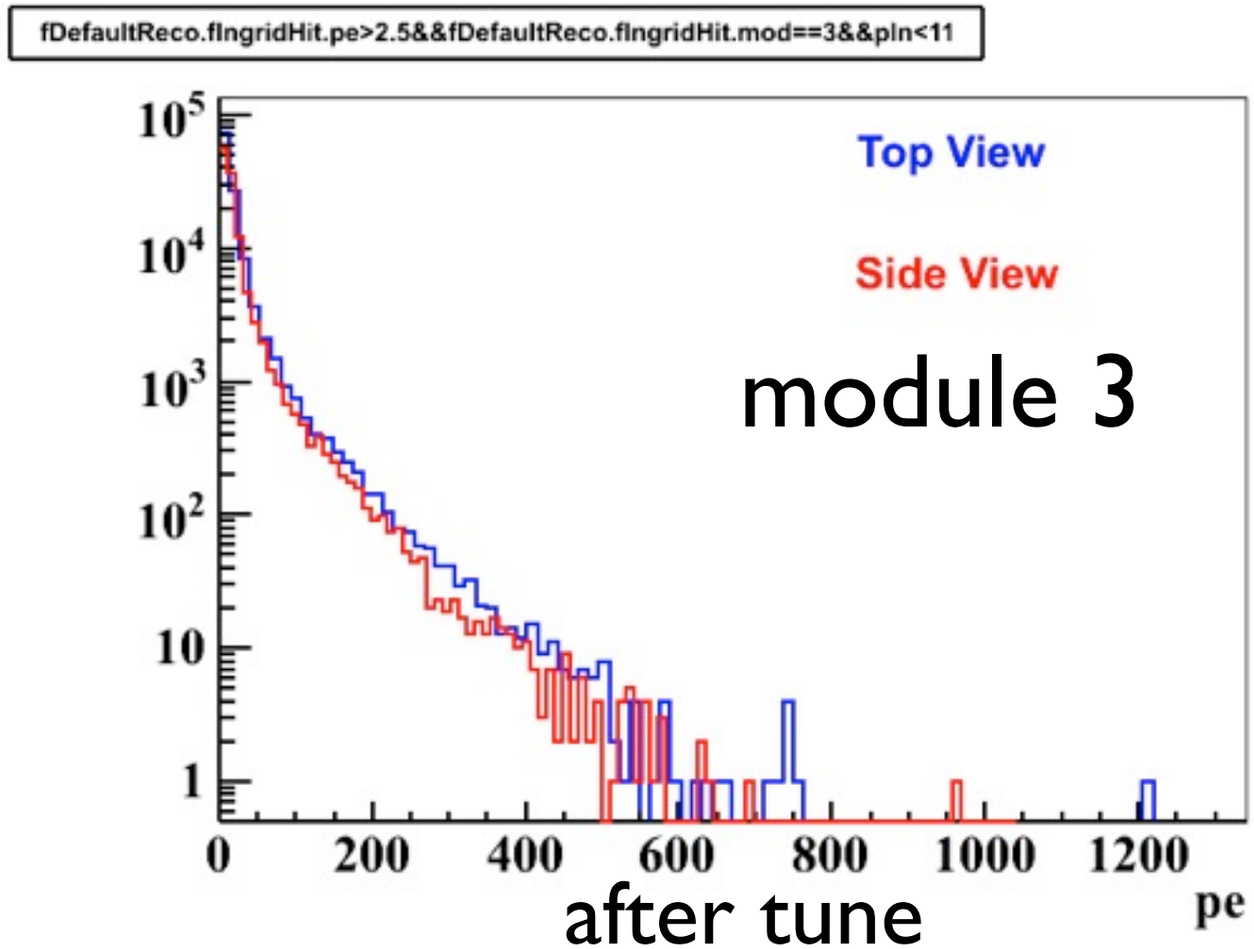
```
// EM Physics
this->RegisterPhysics( new G4EmStandardPhysics(ver));

// Synchroton Radiation & GN Physics
this->RegisterPhysics( new G4EmExtraPhysics("extra EM"));

// Decays
this->RegisterPhysics( new G4DecayPhysics("decay",ver) );

 // Hadron Elastic scattering
this-> RegisterPhysics( new G4HadronElasticPhysics("elastic",ver,false));

 // Hadron Physics
 G4bool quasiElastic;
this->RegisterPhysics( new HadronPhysicsQGSP("hadron",quasiElastic=true));

// Stopping Physics
this->RegisterPhysics( new G4QStoppingPhysics("stopping"));

// Ion Physics
this->RegisterPhysics( new G4IonPhysics("ion"));

// Neutron tracking cut
this->RegisterPhysics( new G4NeutronTrackingCut("Neutron tracking cut", ver));
```

→ Need check each Physics model & difference from example list

p.e. distribution after tuning



before tune
(5e4 neut int × 100 file)

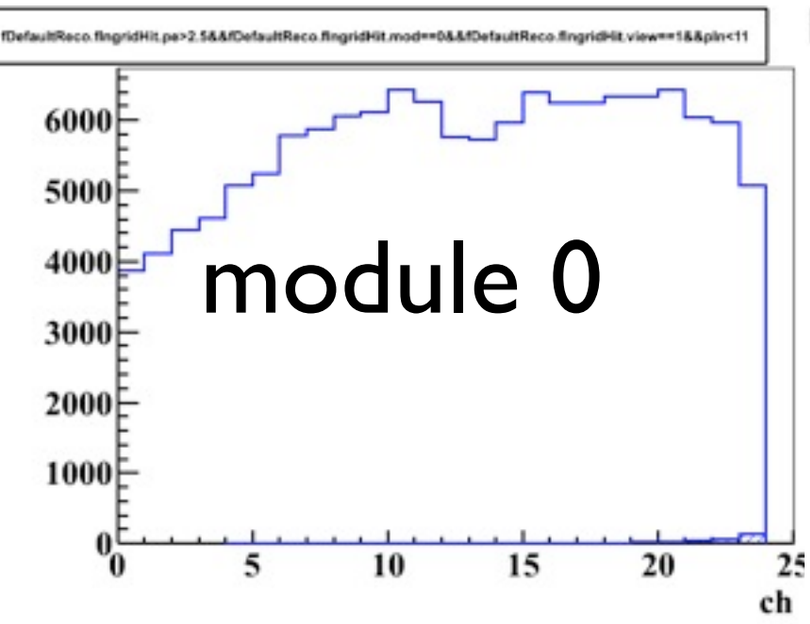


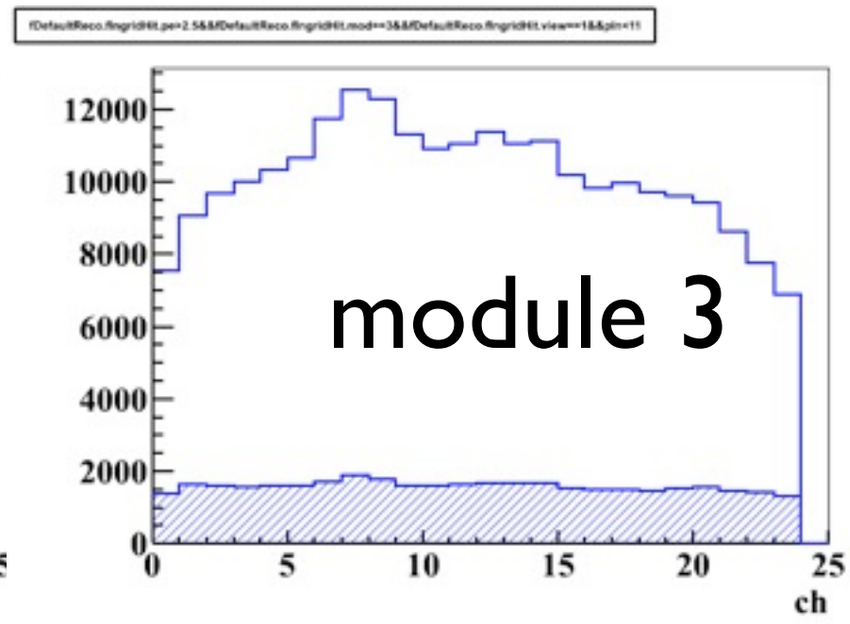
after tune
(2e4 neut int × 10 file)

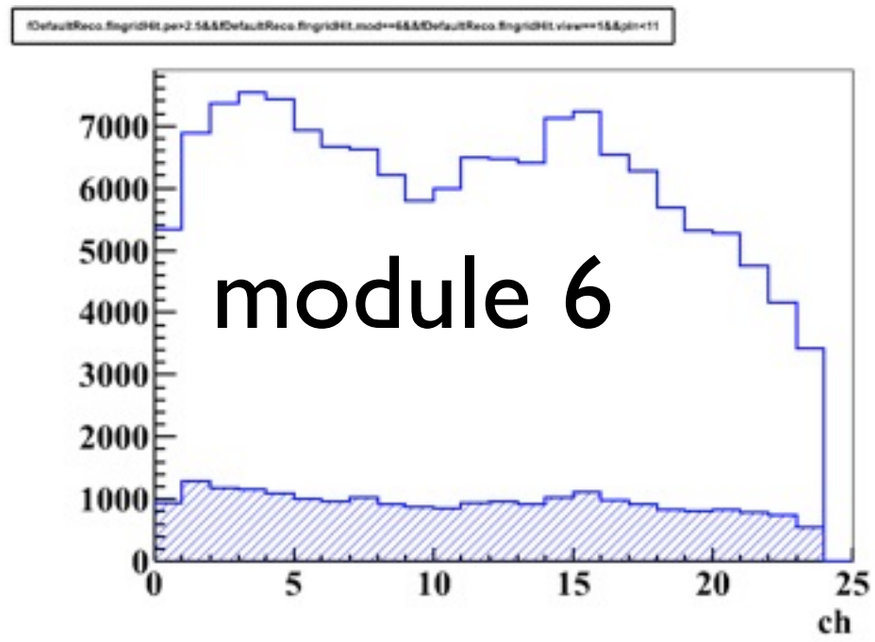
mean of pe is shifted to low.
→ It seems to be showed p.e. attenuation effect
→ not enough bug check.

seems to be bug...

Topview







progress analysis & tuning...

- MC tuting
  - Many tune points (cross-talk&after pulse, mppc noise, mppc resolution)
  - example : quenching effect of scintillator (Birk's formula)

$$dL/dx = \frac{A * dE/Dx}{1 + kB * dE/dx} \rightarrow \frac{A}{kB} = constant(dE/dx \rightarrow large)$$

L : output of light yield
E : energy deposit
A : absolute scintillation efficiency
kB : constant (calc from beam test)

Birk's formula at SciBooNE

```
////////////////////////////////////////////////////////////////////////////
void SBsimSciBarResponse::BirksSaturation(G4double* edeposit, G4Track* aTrack)
////////////////////////////////////////////////////////////////////////////
{
  const G4double CBIRKS = sbcard->Birks;

  G4double             kineticE = aTrack->GetKineticEnergy();
  G4ParticleDefinition* particle = aTrack->GetDefinition();
  G4Material*          material = aTrack->GetMaterial();

  if(particle->GetPDGCharge()==0) return;

  G4double dedx = emcal.GetDEDX(kineticE, particle, material)/(MeV/cm);
  *edeposit /=  (1.+CBIRKS*dedx);

  return;
}
```

Birks = 0.028 (they obtained the value by beam test)

→ INGRID scintillator is same material as SciBooNE.

We can use this value tempolary ?