LCD Root analysis and simulation tools

10/26/2000

M. Iwasaki
University of Oregon

LCD Root Simulation/Analysis Flow

Generator

PANDORA-PYTHIA (C++),
PYBMS, PYTHIA, ISAJET,...

Output: stdHEP (HEPEVT common)

Simulator

Fast Simulator — **For physics analysis**
Full Simulator:GISMO — **For detector study**

Output: Ascii (FastMC) or SIO binary (Full)

→ Convert to root data

Event Analysis

We use Root for FastMC and Analysis

Why Root?

1) There are many experiment groups using Root

It is very easy to get use to…

2) Many software are written by C++

Currently: GEANT4, GISMO, Pandora, …

Future: CERNLIB, PYTHIA, STDHEP, …

3) Root is maintained by many peoples in the world and there are many useful classes

Vector Matrix operations, Lorentz Boost, Rotation, ..

For example:

```
TLorentzVector  pJet1(px1,py1,pz1,E1), pJet2(px2,py2,pz2,E2);
TLorentzVector  pW = pJet1 + pJet2;
double   MassW = sqrt(pW*pW);
```

Operator Overloading

LCD Simulation/Analysis with Root

FastMC

- **Track** .. Smear & bend charged particles
  Set 5 parameter error matrix (B.Schumm)
- **Cluster** .. Smear particle position & Energy
  Cluster merging
- **IP** .. Smear position

FullMC

- **Track** .. Smear & bend charged particles
  Set 5 parameter error matrix (B.Schumm)
  Apply min-Hit & min-PT cut
  Tracking .. Not yet
- **Cluster** .. Make clusters by Cheater Algorithm
  (gather cal hits which are from the same particle)

LCD Simulation/Analysis with Root

Analysis tools

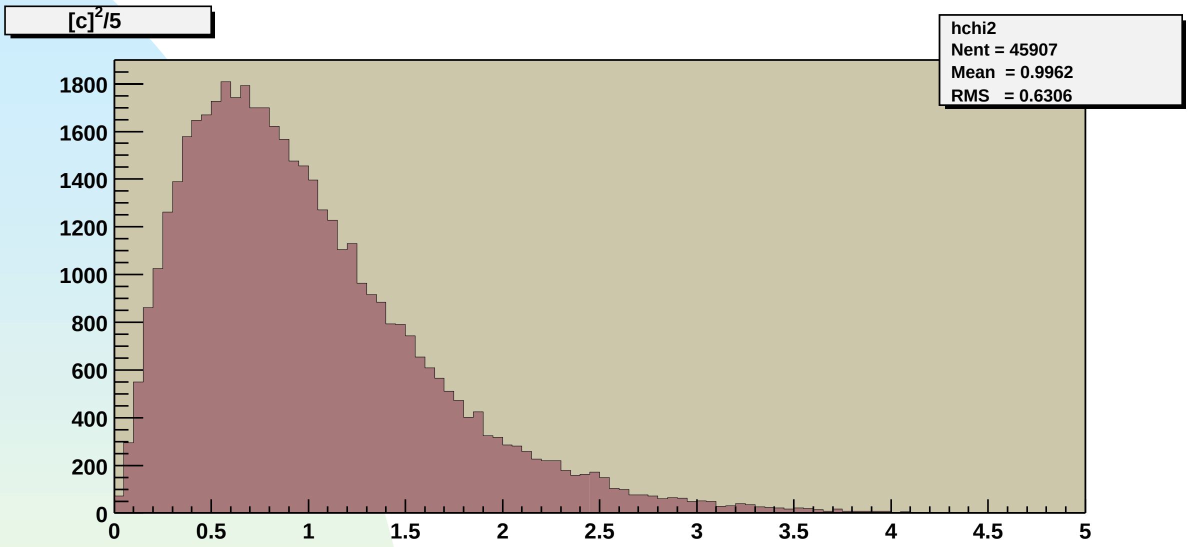
- Jet Finder … 3 kinds of algorithms
- Thrust Finder
- Particle extrapolator
- Topological Vertexing

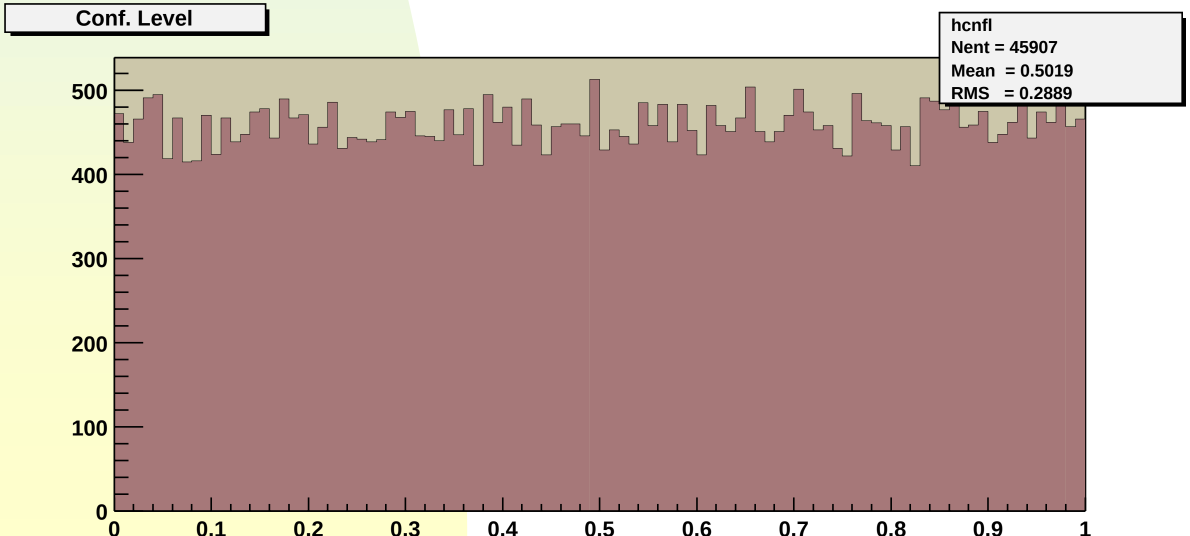
  … transrated from SLD ZVTOP (T.Abe)

Tracks at Root

Maintained by T. Abe

Now we installed B.Schumm's 5 parameter Covariant matrix for track smearing



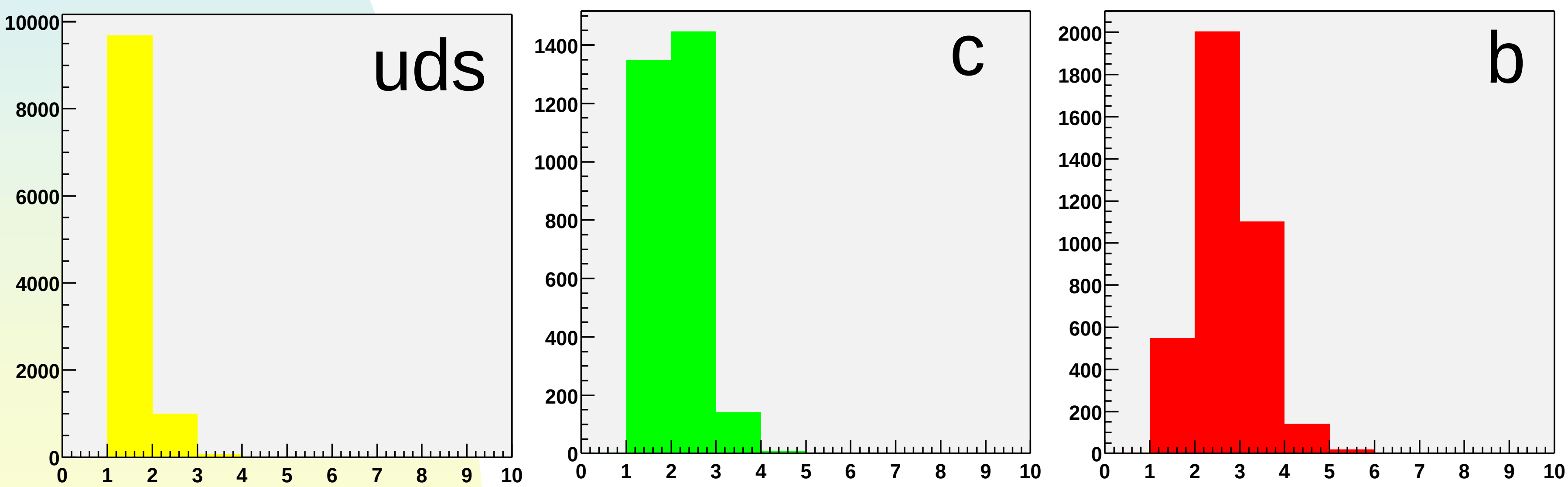


Topological vertex finder

(Translated from SLD ZVTOP: See T.Abe's talk)

Reconstruct secondary vertices in a jet

.. Find points of high overlap tracks



#Vertices reconstructed

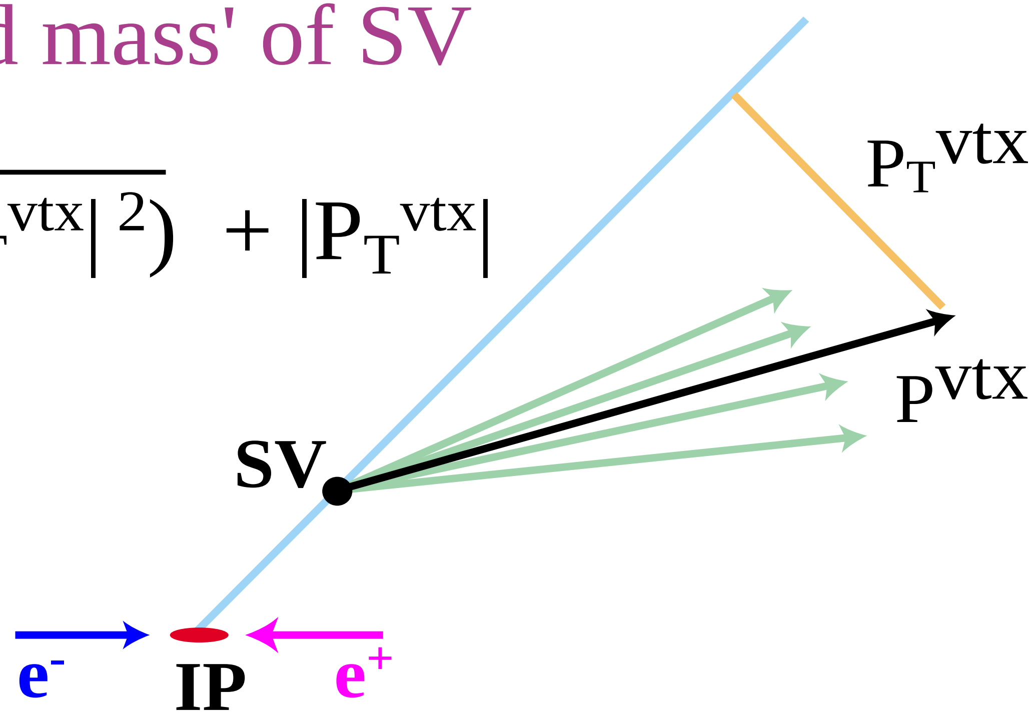
Using the information of reconstructed vertices, we can do

1) Heavy-flavor tagging

Mass tag method:: See T.Abe's talk

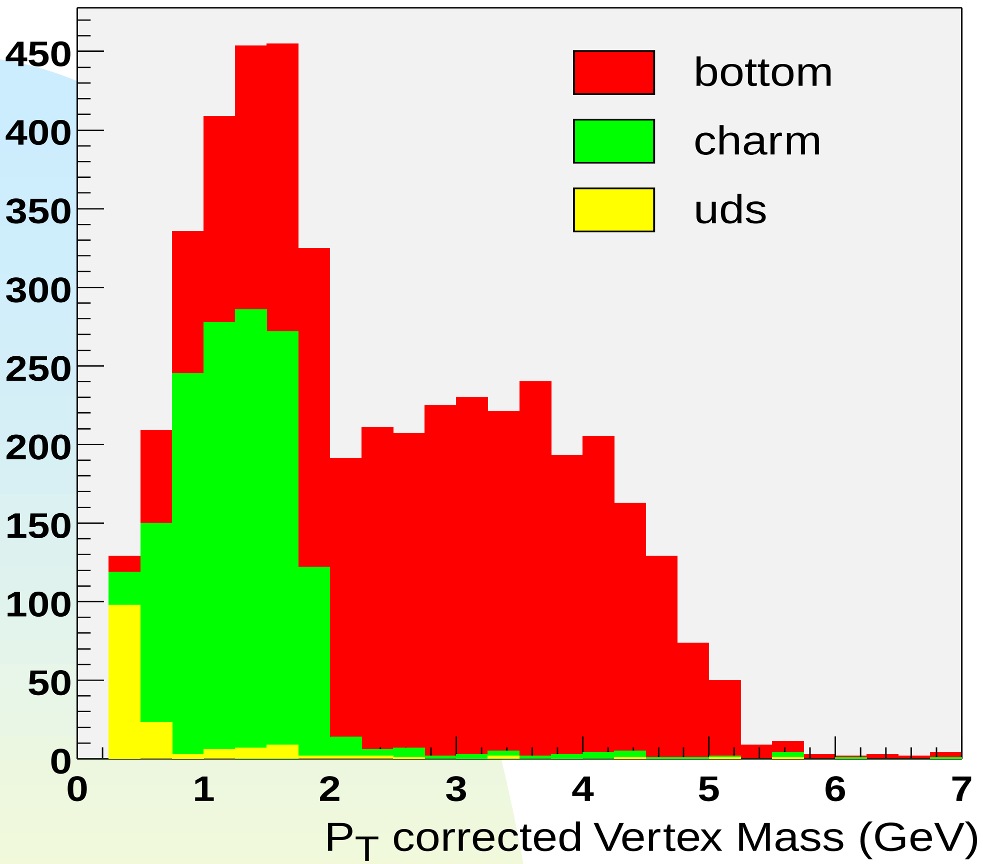
1. Reconstruct Second Vertex
2. Form 'P_T-corrected mass' of SV

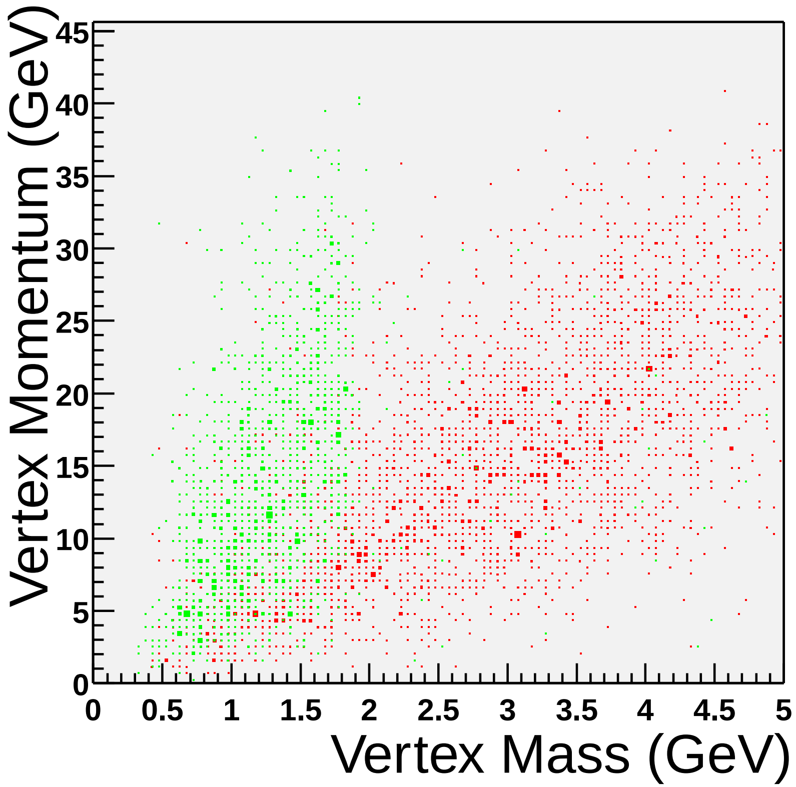
$$M_{corr.} = \sqrt{(M_{vtx}^{2} + |P_T^{vtx}|^{2})} + |P_T^{vtx}|$$



3. Identify heavy-quark signals

Bottom 2.0<M   Charm 0.6<M<2.0 GeV



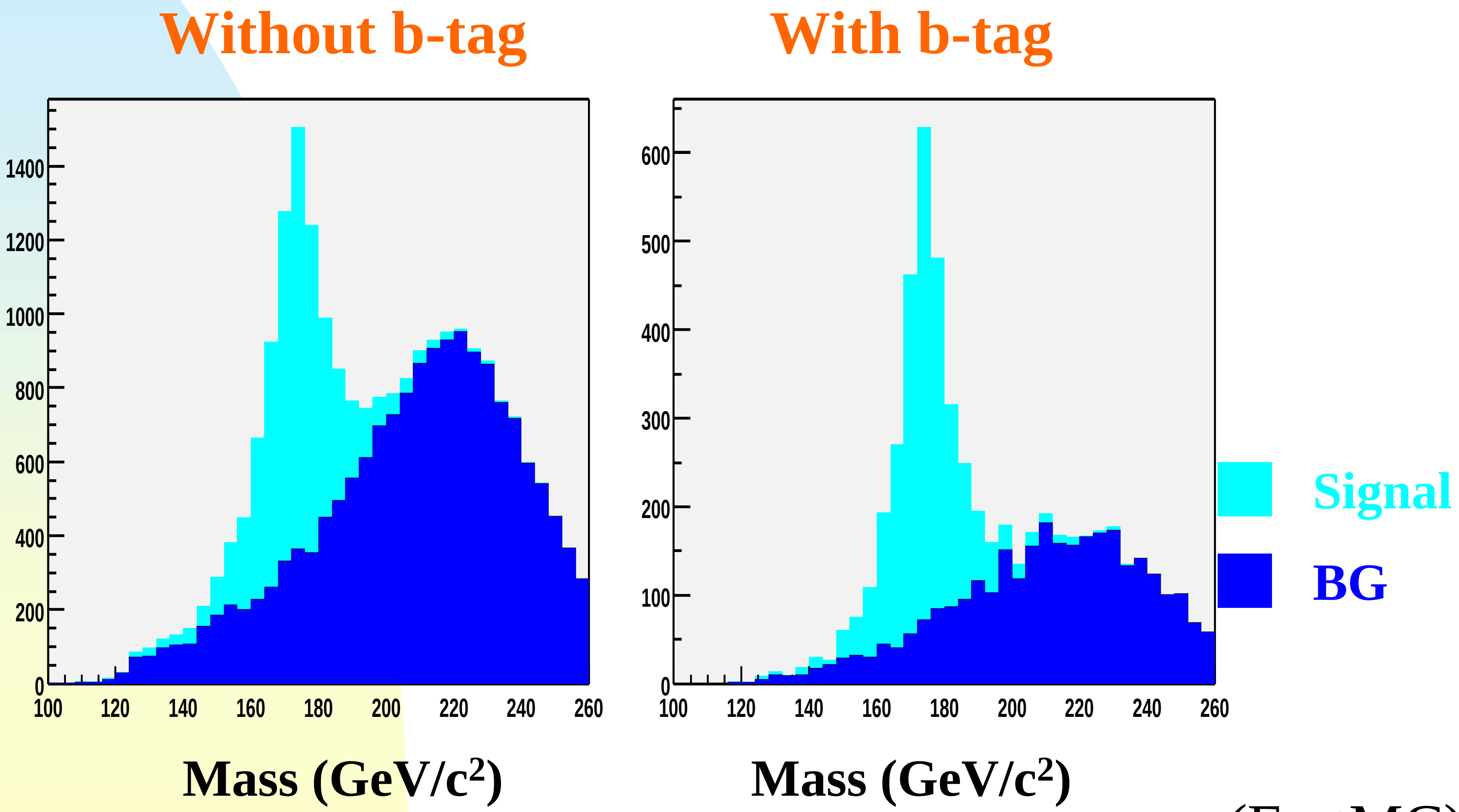


b-quark efficiency 60% (50% :SLD) purity 98% (98%)

c-quark efficiency 30% (16%) purity 80% (70%)

Analysis example:

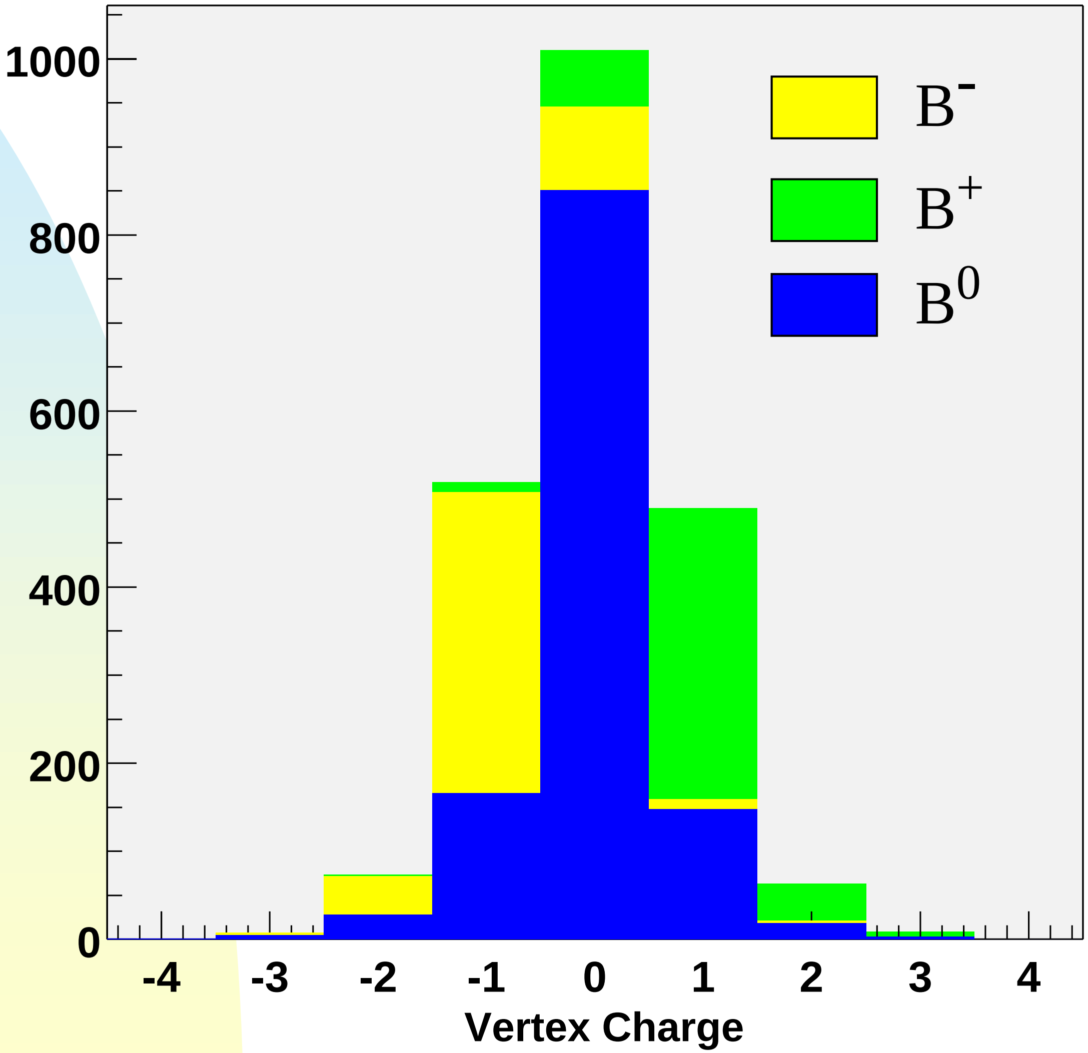
Reconstruction of t-quark mass in tt→ 6jets event



(FastMC)

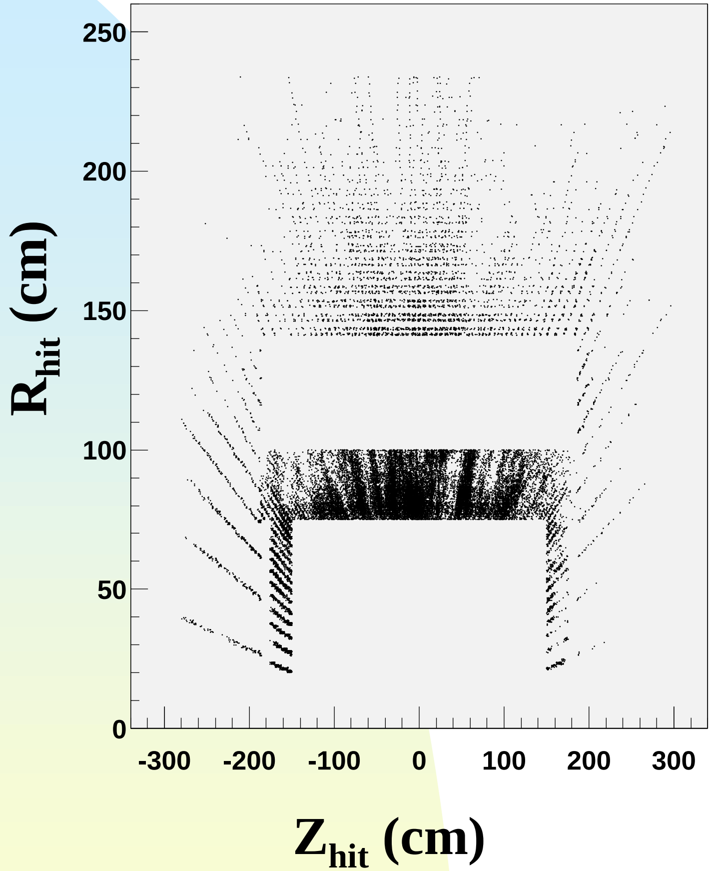
2) Charge separation

See also T.Abe's talk

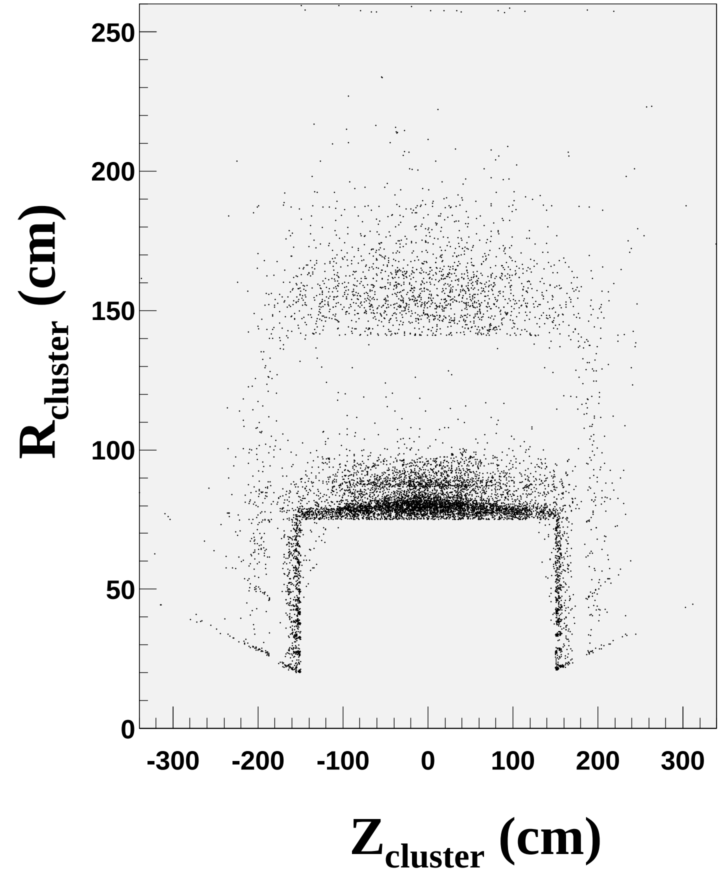


Clusters at Root

Calorimeter Hits



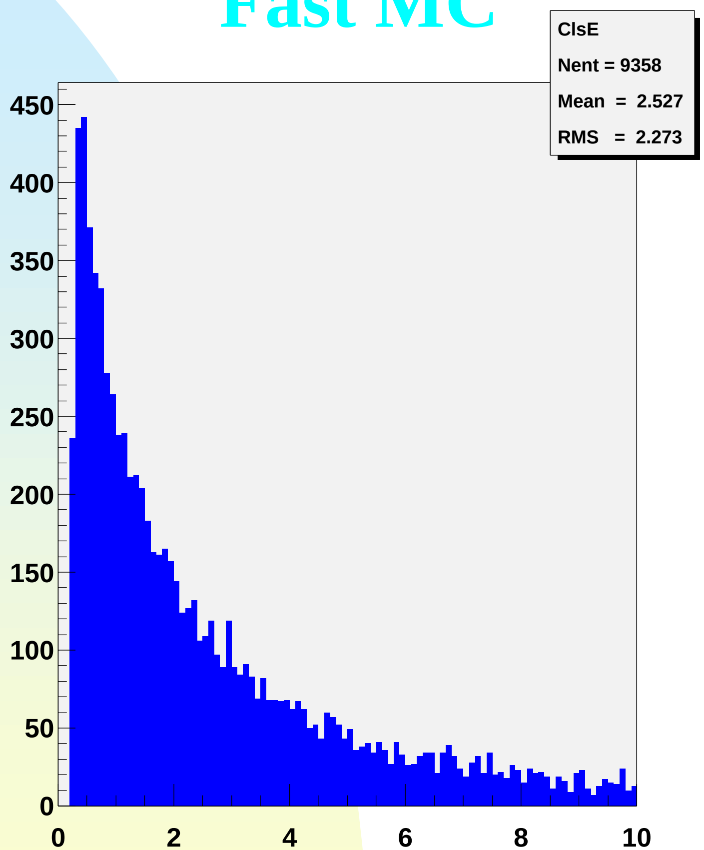
Clusters



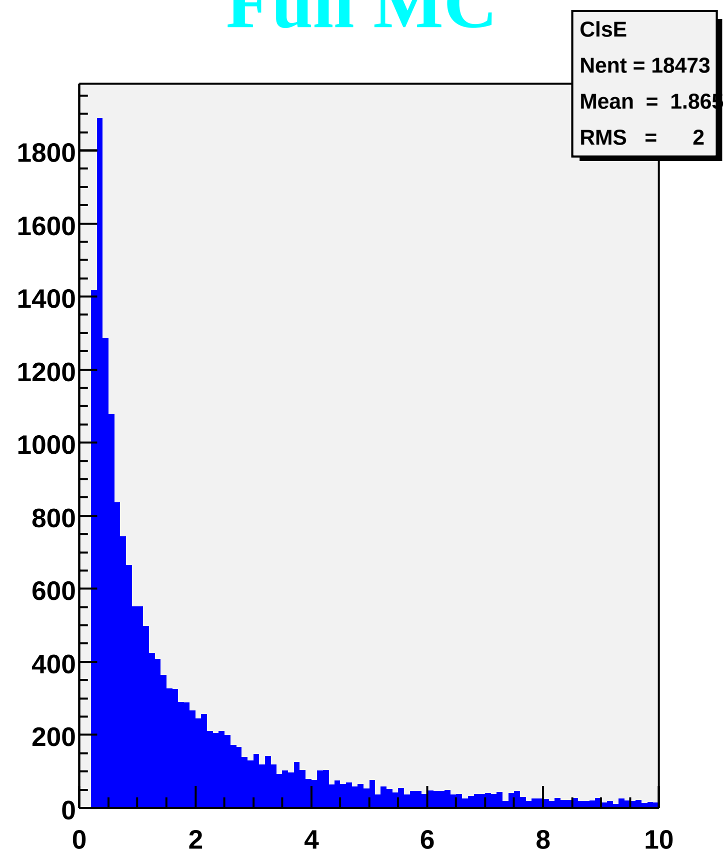
(Full MC)

Clusters at Root

Fast MC



Full MC



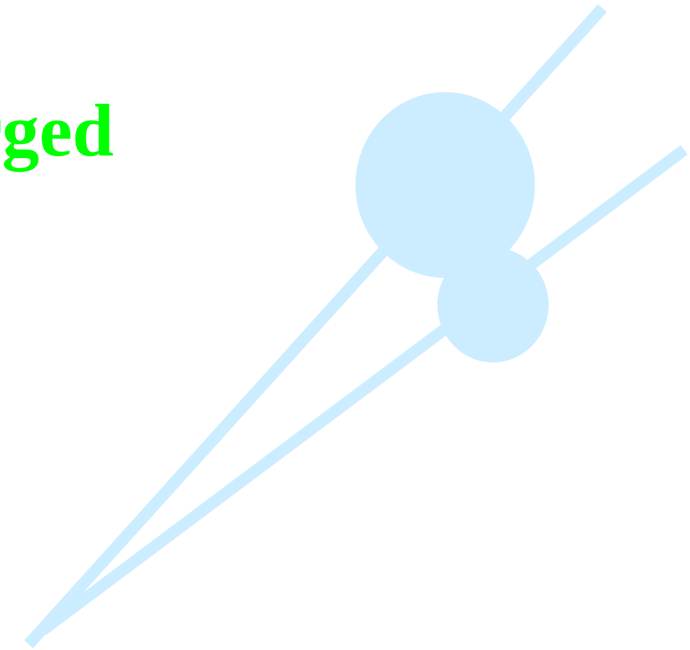
Cluster Energy(GeV)

Energy scale for Full :: determined by μ

Cluster merging effect

The fast simulator does not have Cluster width yet

Near clusters might be merged
and regard as one cluster



Merging probability (transverse only)

	13mrad	20mrad(NLC)	30mrad(JLC)
Small	2.7%	5.4%	10.0%
Large		5.1%	9.4%

For Energy flow analysis

We'll see Track-Cluster matching to separate charged/neutral clusters

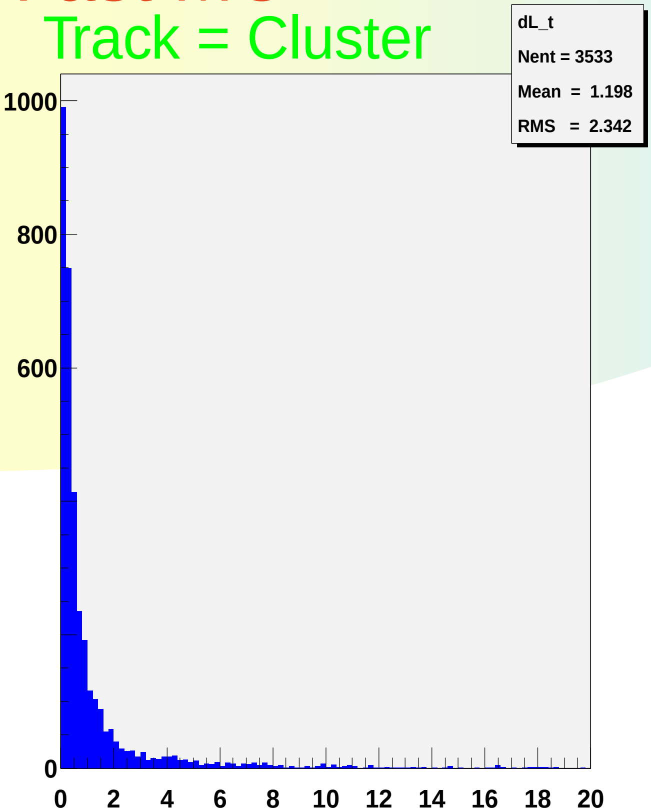
We need realistic

- **Cluster position resolution**
- **Cluster width(spread)**

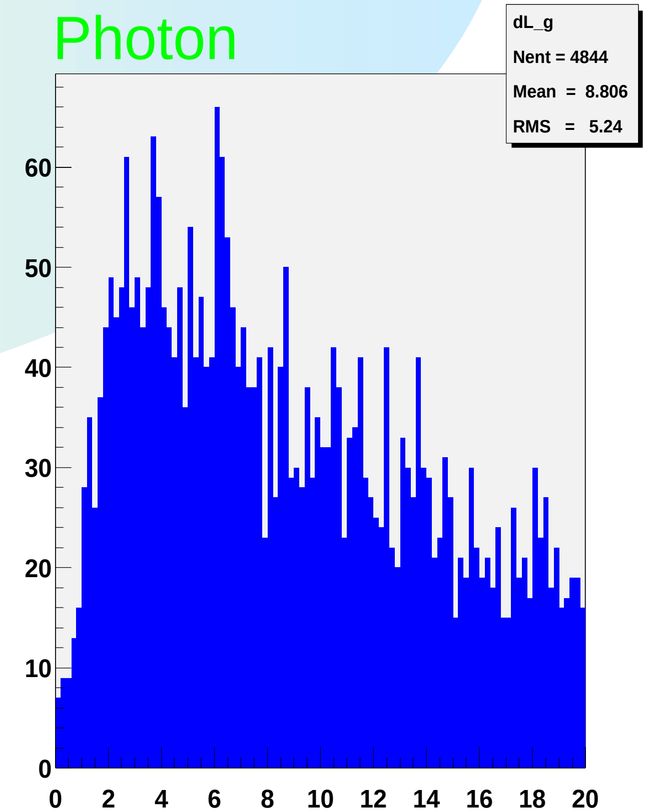
in our Simulator

Fast MC

Track = Cluster

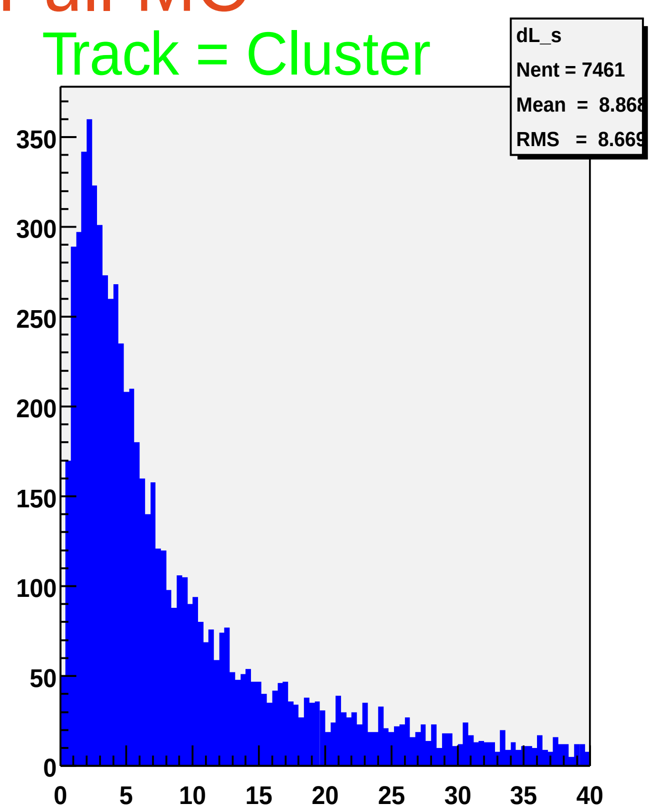


Photon

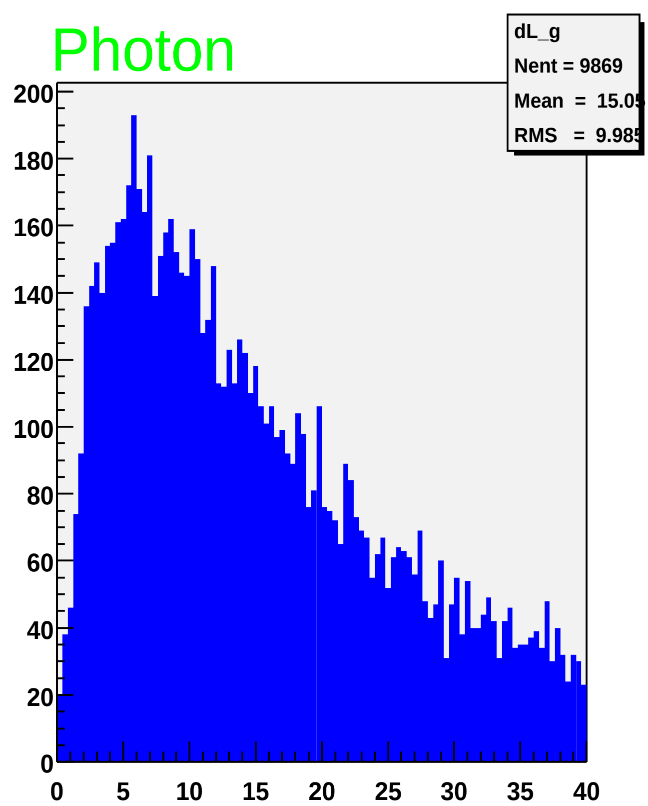


Full MC

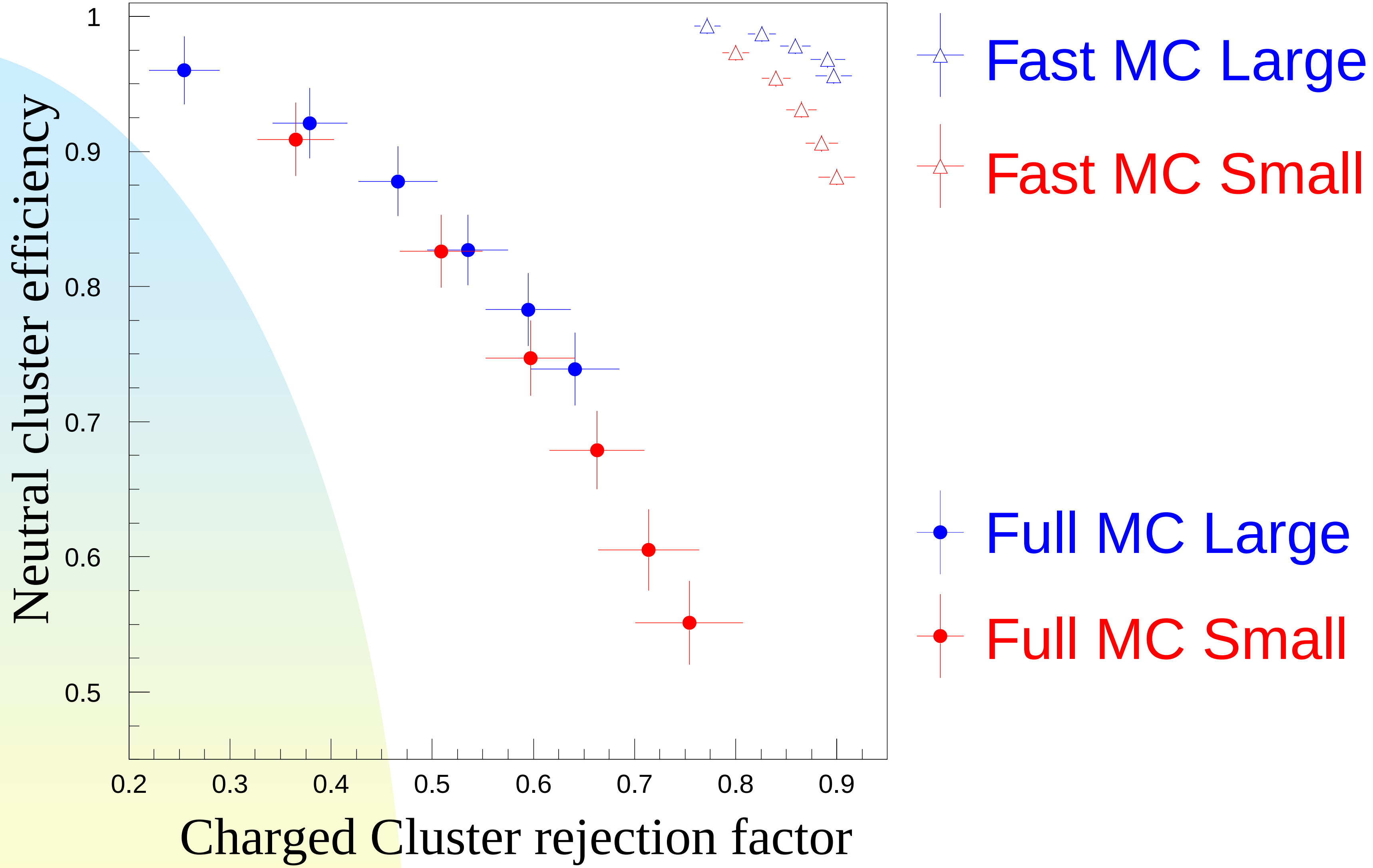
Track = Cluster



Photon



Charged/Neutral cluster separation performance



Very much different between FastMC and Full MC

→ Need tune up the FastMC

Summary

1) Root analysis tools work well

Especially Topological Vertexing is the excellent tool for Heavy-flavor tagging

2) For Fast MC → Need detail studies using FullMC to input the realistic detector parameters

In particular for Calorimeter

(Need to make Cal hits, like JLC quick simulator??)

There is a LCD ROOT Analysis tutorial page! (Under construction)

URL:
http://www-sldnt.slac.stanford.edu/nld/New/Docs/LCD_Root/root.htm