

# **Top-quark reconstruction with Fast Simulation**

**M. Iwasaki**  
**University of Oregon**

## At the Sitges meeting:

### **tt** → **6jets & 4jets analysis**

- **Charged/Neutral cluster separation with Track-cluster matching**
- **Reconstruction performance in Energy flow analysis**
- **B-tag effect**

## After the meeting:

- **In FastMC, set the cluster position resolution determined by FullMC**
- **Study Cluster width with FullMC**
- **Cluster merging**

# Energy flow analysis

**Charged hadron, electron**

**Tracker**



**Calorimeter**



**Neutral hadron, photon**



## Charged/Neutral cluster separation

See **Track-Cluster matching**

- **Cluster position resolution**
- **Granularity, shower width**
- **Magnetic Field**
- **Calorimeter Radius**

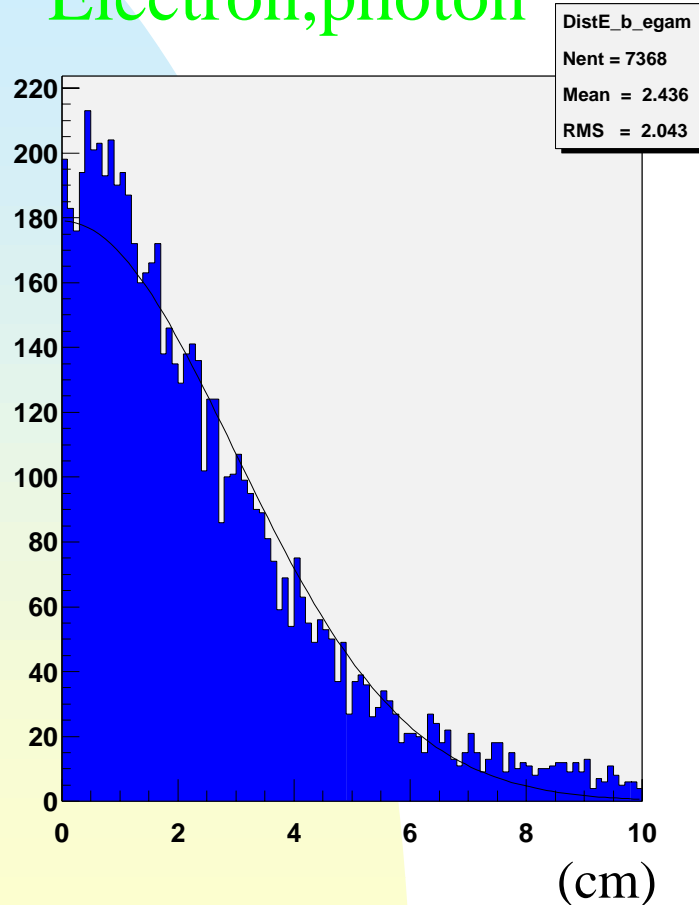


# Cluster position resolution

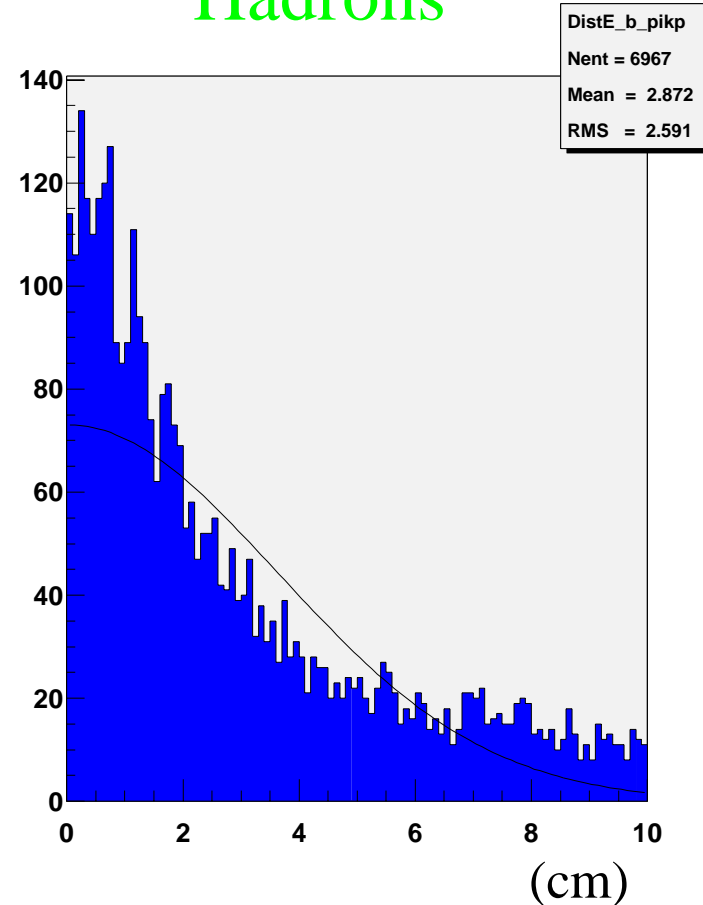
So far, we use

$\sigma = 1\text{cm}/\sqrt{E}$  for  $e,\gamma$  and  $5\text{cm}/\sqrt{E}$  for hadrons in FastMC

Electron, photon



Hadrons

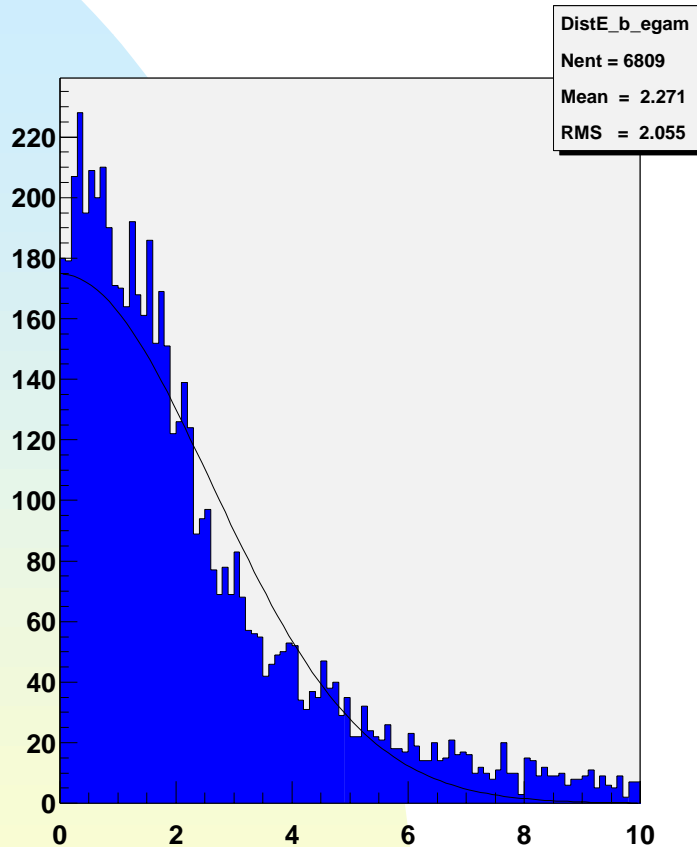


(Small)

Distance between McPart and Cluster in FullMC /  $\sqrt{E}$

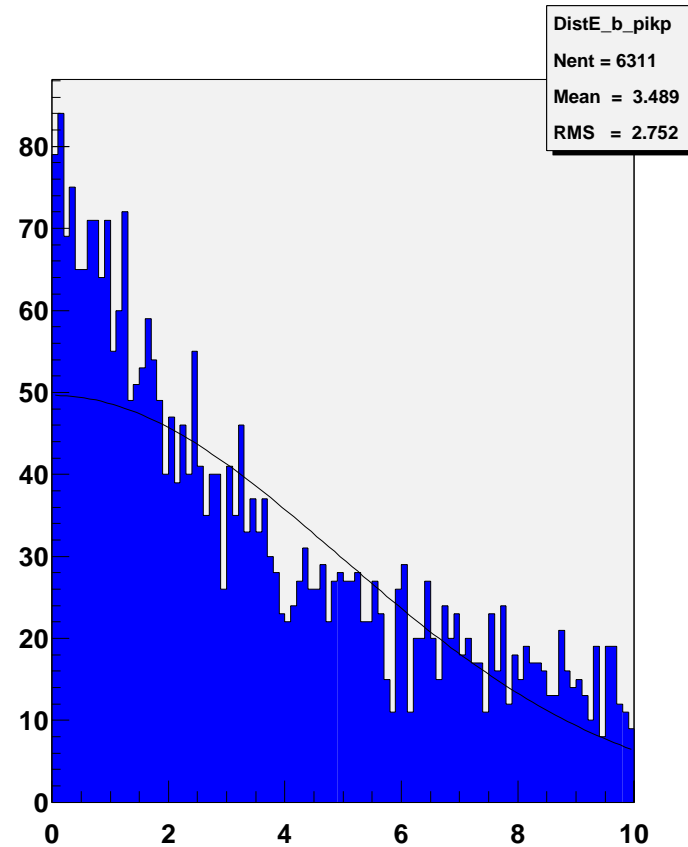
# Cluster position resolution

Electron,photon



(cm)

Hadrons

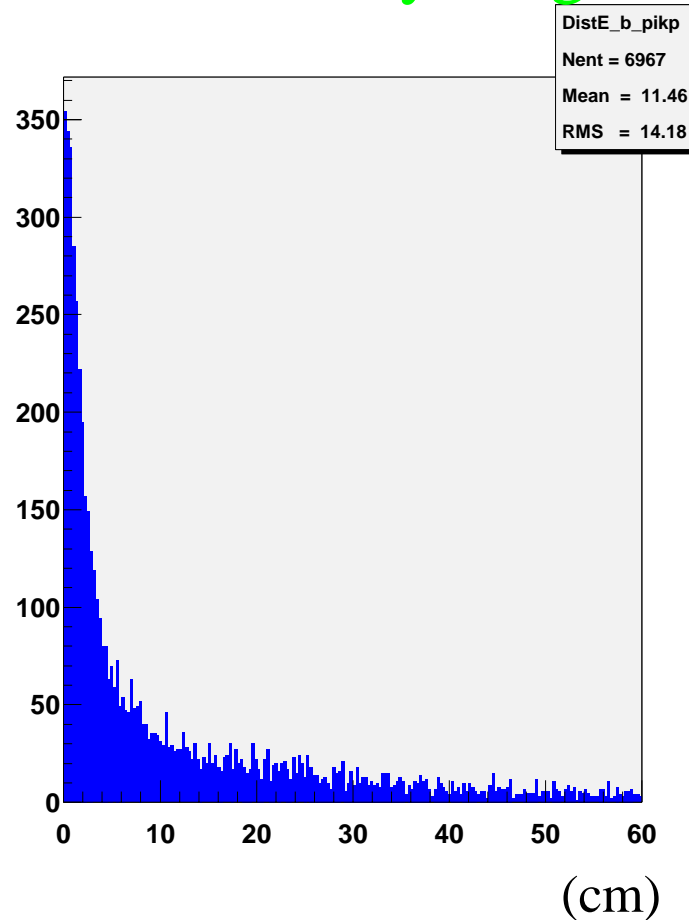


(cm)

(Large)

Distance between McPart and Cluster in FullMC /  $\sqrt{E}$

Hadrons have very long tail...



e and  $\gamma$   
Hadrons

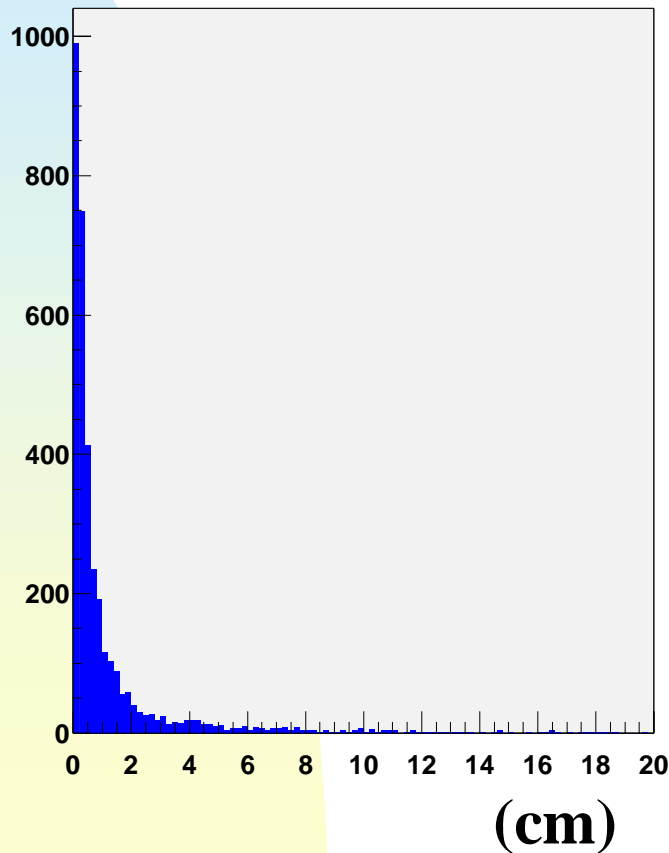
Set  $3\text{cm}/\sqrt{E}$  (both in S and L)  
Need another parameterization

# Charged/Neutral Cluster separation

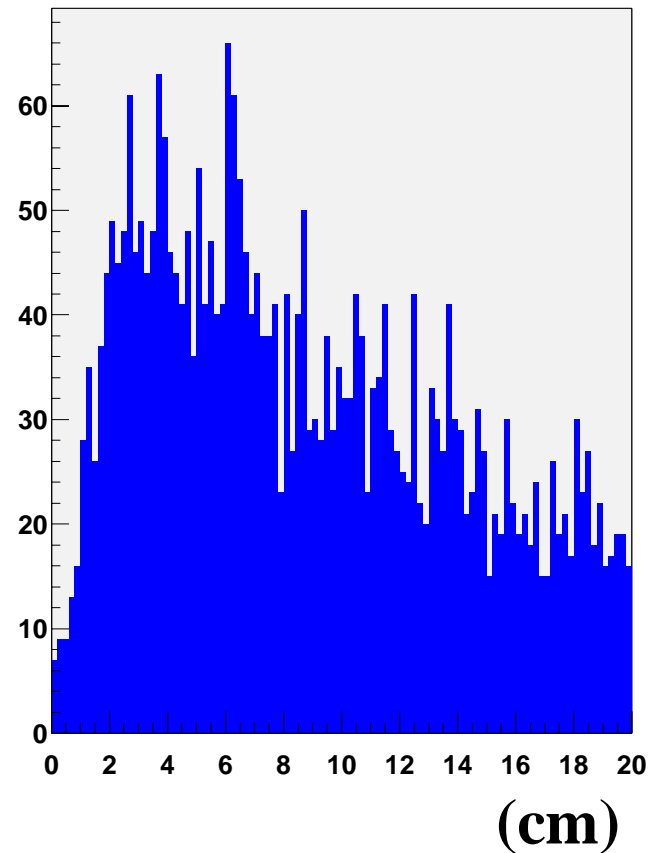
Extrapolate Charged tracks to the Cluster radius

Then see the Cluster-Track matching distance for the nearest track

Cluster = Track

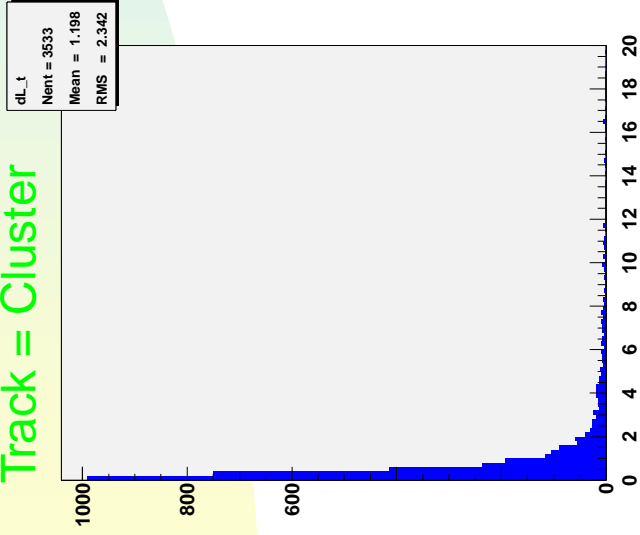


photon

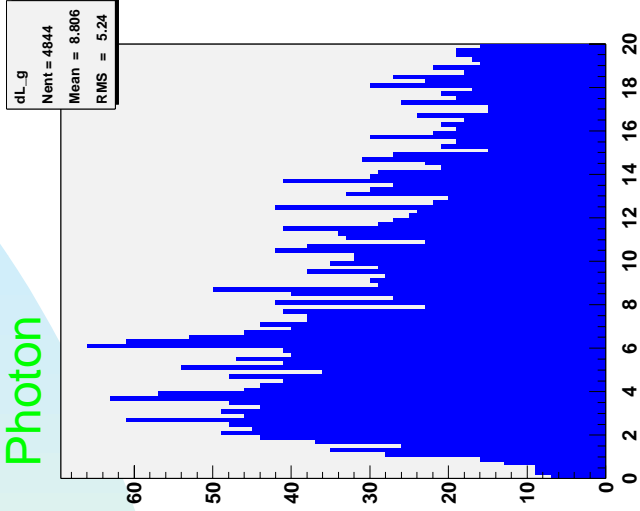


Small

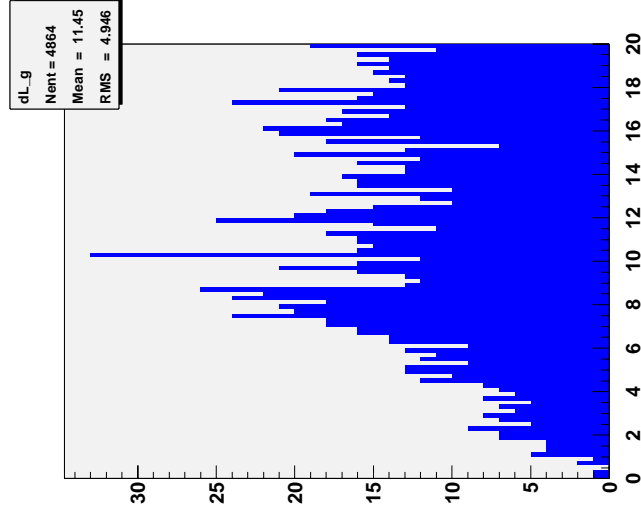
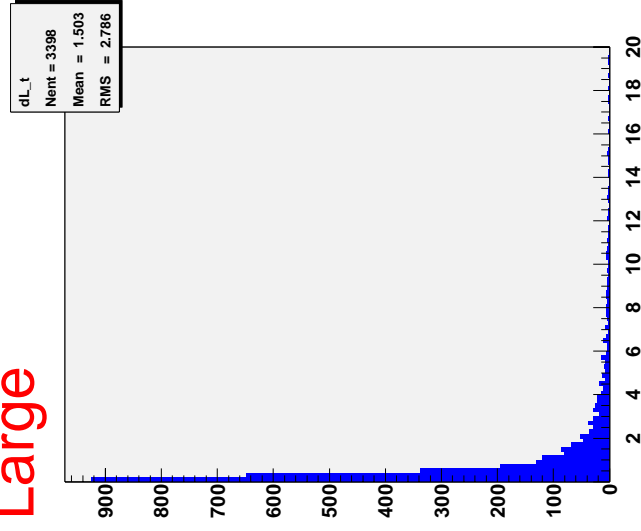
Track = Cluster



Photon



Large



	Small	Large
	B= 6T, R = 75cm	3T, 2m
Charged cluster rejection	86 %	85 %
Neutral cluster efficiency	95 %	99 %

Track-cluster separation ..  $B \cdot R^2$

B=3T, R=2m corresponds to B = 6T, R = 1,4m

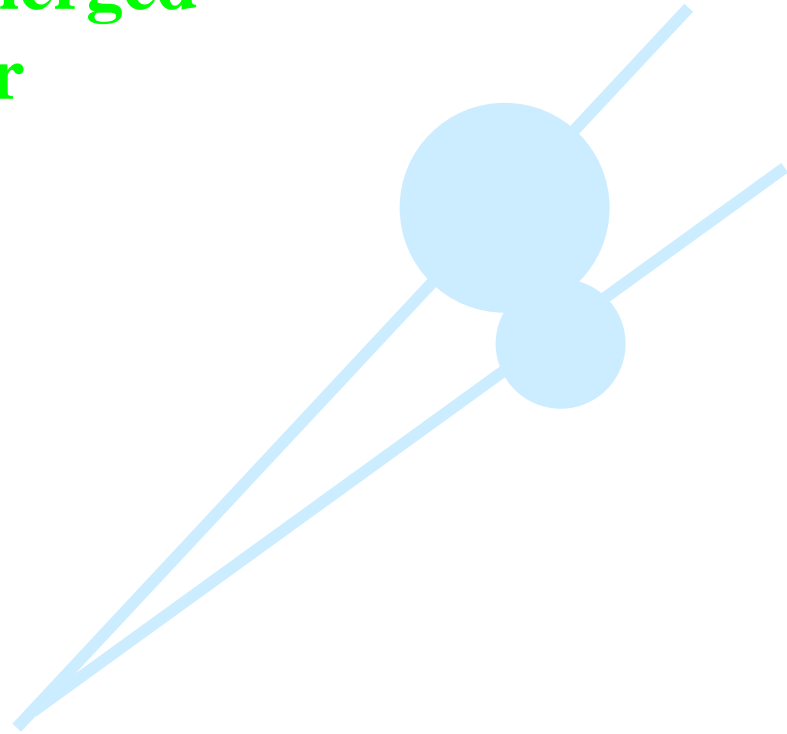
At Sitges .. Charged cluster rejection	96 %	97 %
Neutral cluster efficiency	95 %	99 %

- 1cm/E position smearing
- Using McPart momentum instead of Track momentum when extrapolate the track (Bug)

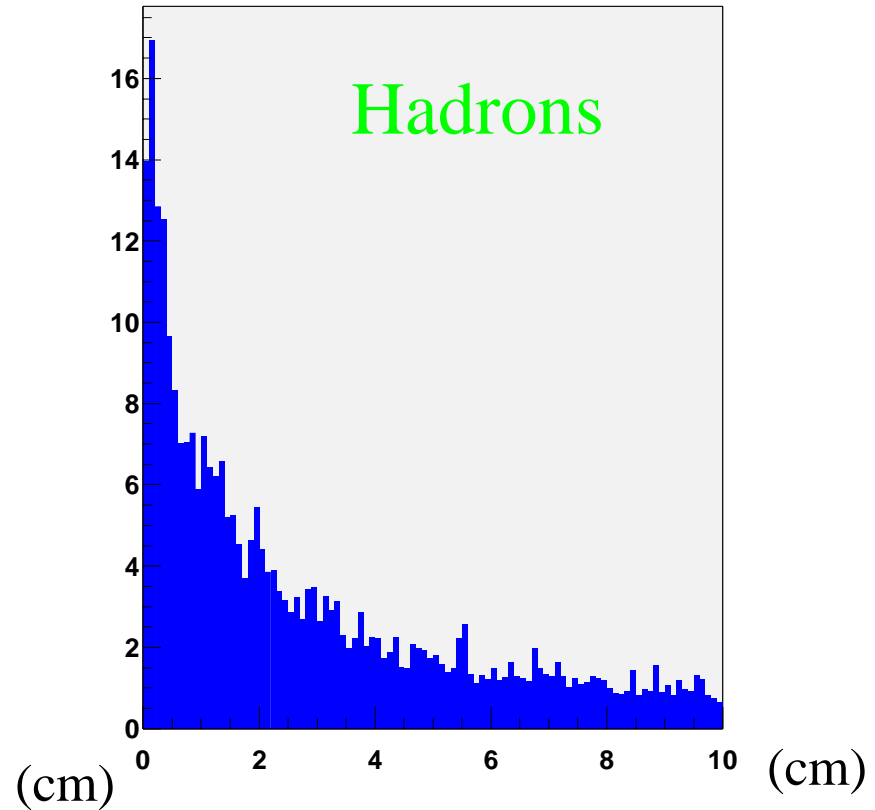
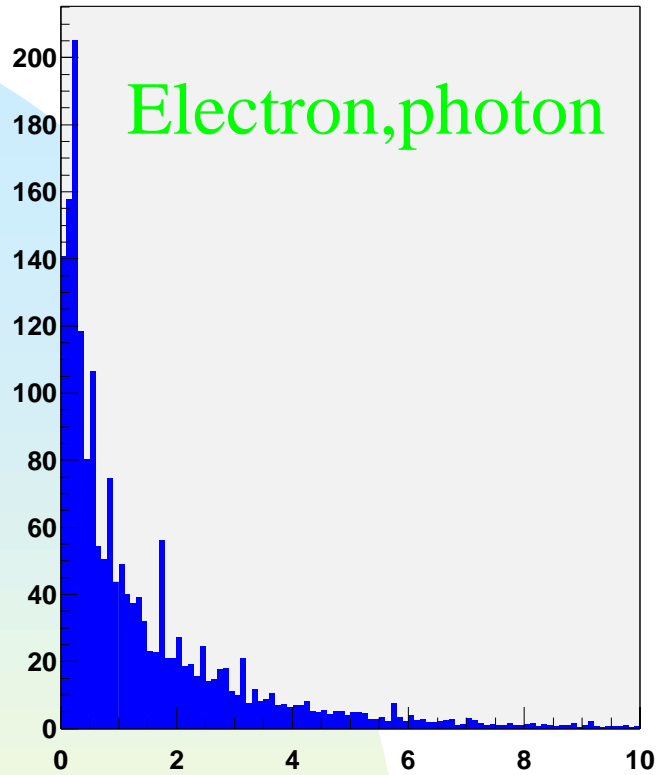
## Cluster merging effect

The fast simulator does not have Cluster width yet

Near clusters might be merged  
and regard as one cluster



# Transverse Cluster width at FullMC



Distance between McPart and CAL Hit

Small  $1.3 \pm 0.3$  cm

$3.2 \pm 0.3$  cm

Large  $1.3 \pm 0.4$  cm

$3.5 \pm 0.4$  cm

## Cluster merging effect

### Transverse cluster width

	Small	Large
2× Moliere radius(EM)	1.5cm(W)	2.5cm(Pb)
e, $\gamma$ cluster width	1.3cm	1.3 cm
Granularity: 20mrad	~1.5cm	> 4.0cm

### Merging probability (transverse only)

	13mrad	20mrad	30mrad(JLC)
Small	3.2%	6.3%	11.6%
Large		6.6%	11.7%

# $tt \rightarrow 6\text{jets}$ reconstruction

**Generator:: PANDORA-PYTHIA(6.1)**

**Includes initial-state radiation**

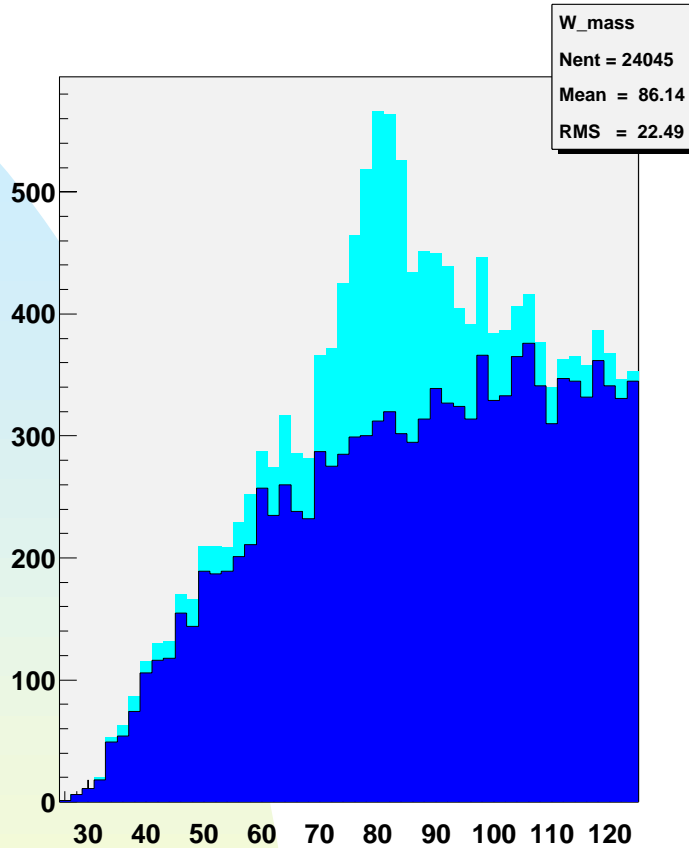
**+ beam spread**

$$\mathbf{E_{cm} = 500\text{GeV}, m_t = 175\text{GeV}}$$

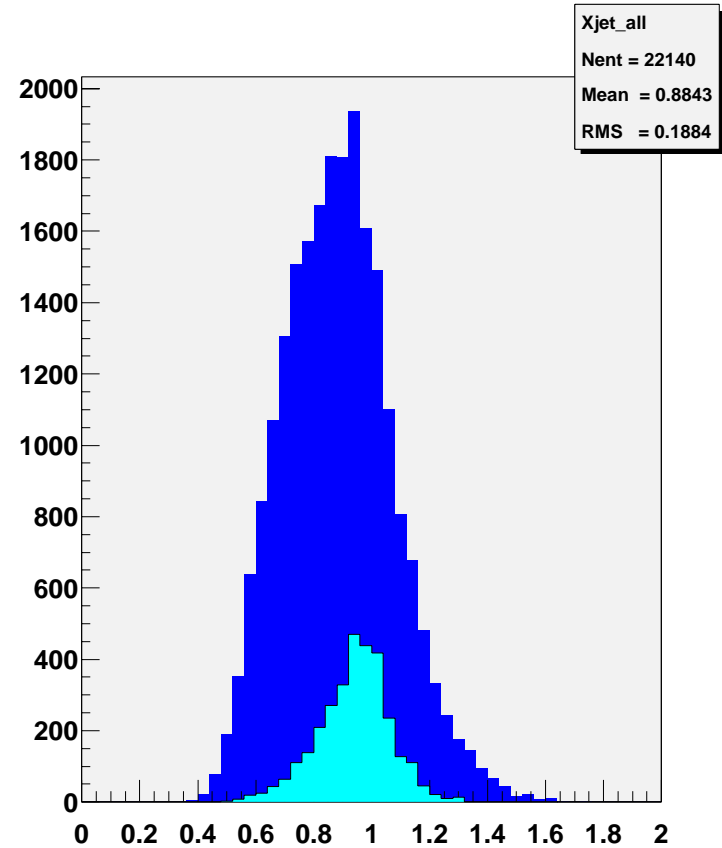
Event selection:

- Require # of jets  $\geq 6$  jets at  $y_{\text{cut}} = 0.004$  with Jade clustering  
.. then change the  $y_{\text{cut}}$  and forced to have 6 jets
- W Mass cut  $m_{2\text{jets}} \sim m_W \pm 12 \text{ GeV}$
- Energy fraction  $X_{\text{jet}} \equiv E_{3\text{jet}}/E_{\text{beam}}$   $0.95 < X_{\text{jet}} < 1.05$
- Regard top candidate..  $m_{3\text{jets}} \sim m_t \pm 10 \text{ GeV}$

# tt → 6jets reconstruction



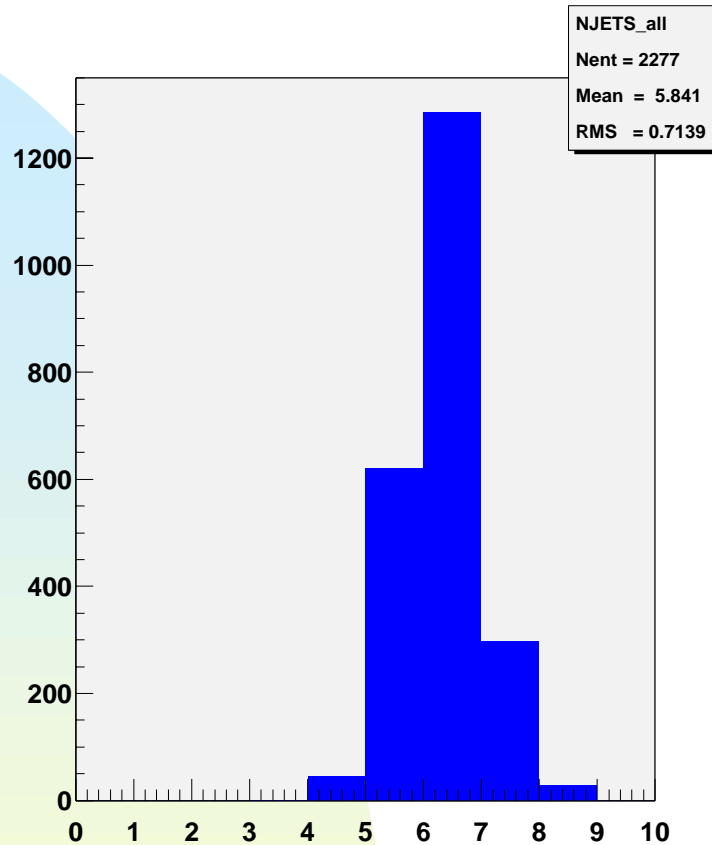
Mass<sub>2jets</sub>



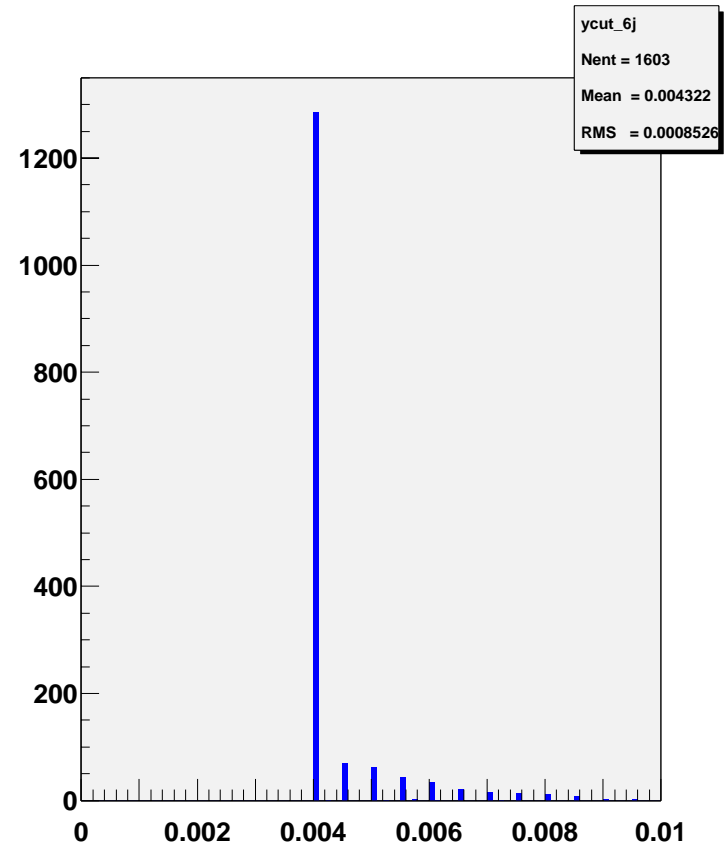
X<sub>3jets</sub>

Reconstructed W mass resolution ~8.4 GeV

# $tt \rightarrow 6\text{jets}$ reconstruction



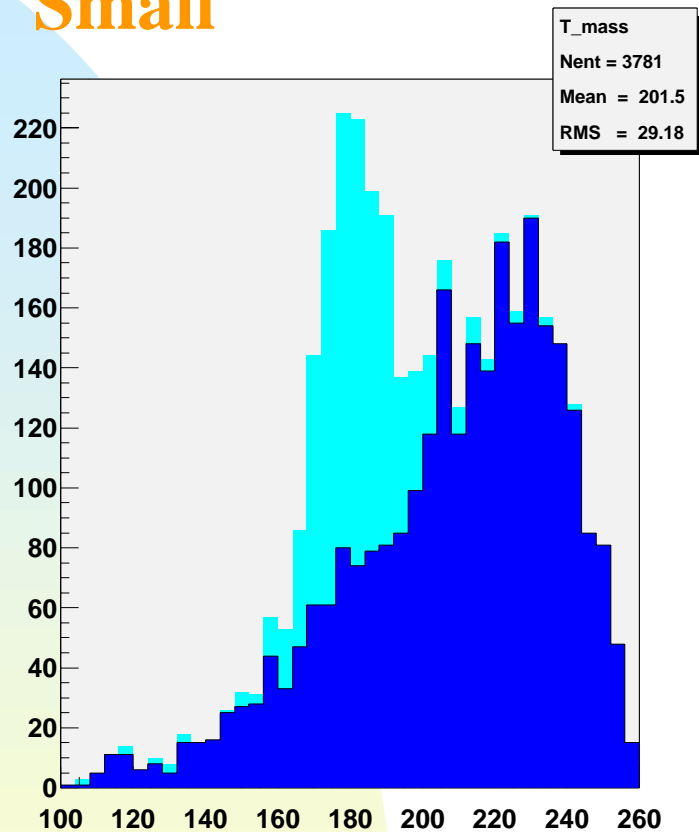
# of Jets



Ycut which gives 6-jets

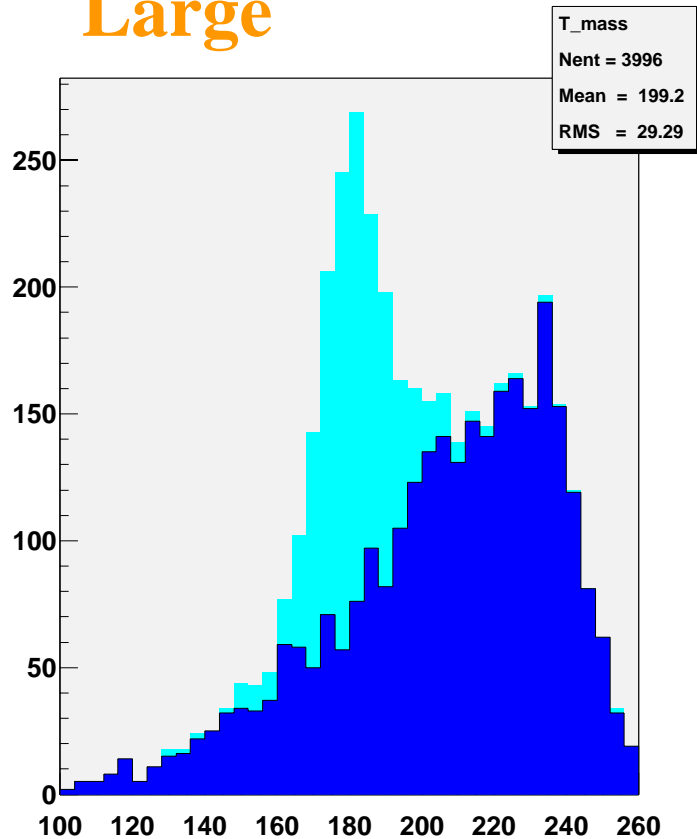
# tt → 6jets reconstruction

## Small



$Mass_{3jets}$

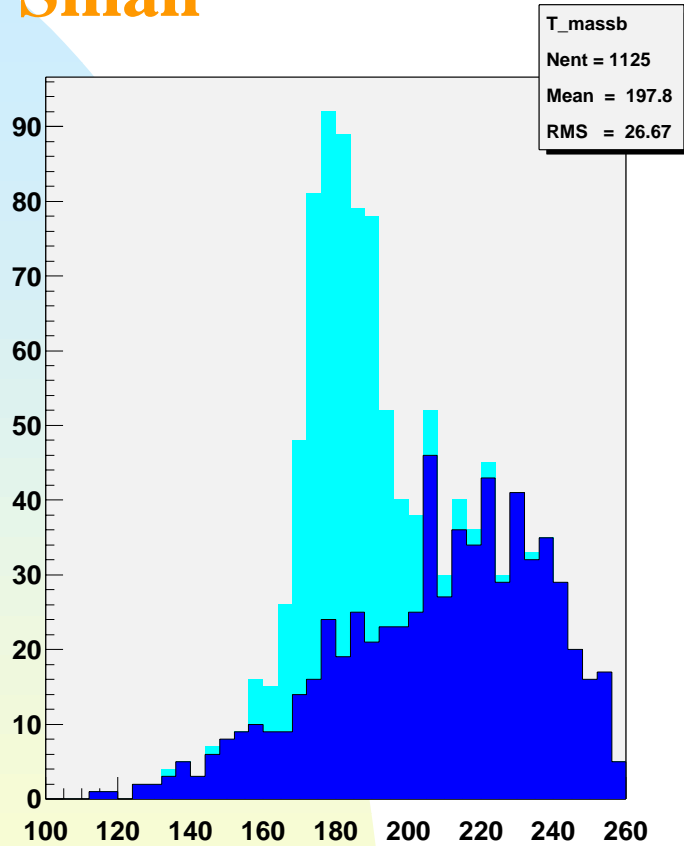
## Large



$Mass_{3jets}$

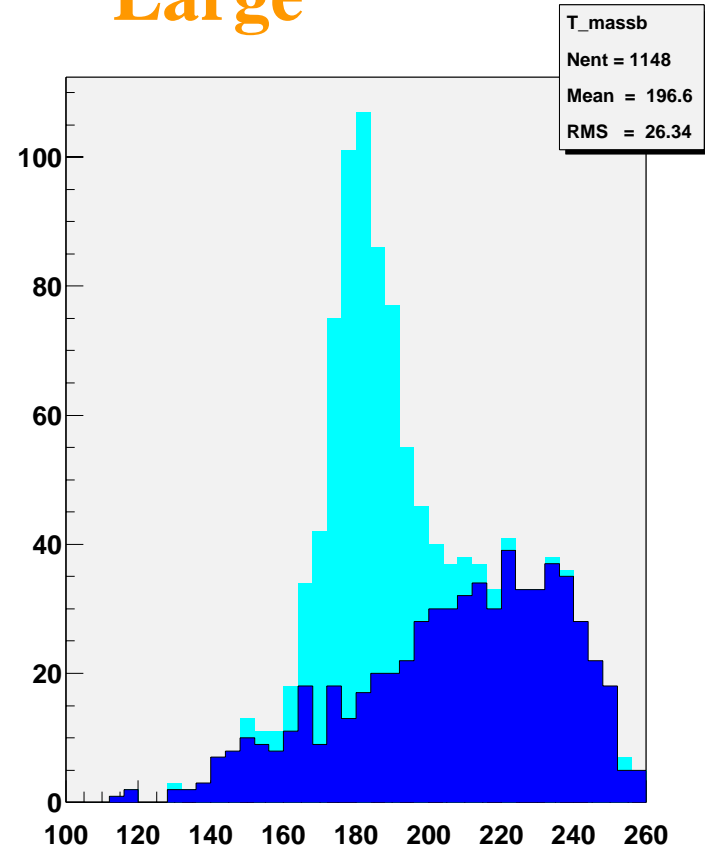
# $tt \rightarrow 6\text{jets}$ reconstruction (with b-tag)

Small



$Mass_{3\text{jets}}$

Large



$Mass_{3\text{jets}}$

Merging size	No-merge	13 mrad	20 mrad	30 mrad
<b>Small</b>				
# Top candidates	906	924	914	840
Signal	572	598	588	542
$\sigma_{\text{Mass}}$ (GeV)	$10.4 \pm 0.3$	$10.2 \pm 0.4$	$10.1 \pm 0.3$	$10.3 \pm 0.3$
$\sigma_{\text{Angle}}$ (mrad)	$57 \pm 2$	$61 \pm 3$	$65 \pm 3$	$69 \pm 3$
<b>Large</b>				
# Top candidates	1006		961	841
Signal	678		663	537
$\sigma_{\text{Mass}}$ (GeV)	$9.8 \pm 0.5$		$10.0 \pm 0.3$	$10.8 \pm 0.4$
$\sigma_{\text{Angle}}$ (mrad)	$57 \pm 3$		$59 \pm 3$	$67 \pm 3$

Small ... need more radius??

# Summary

Using Fast Simulator, we study  $t\bar{t} \rightarrow 6\text{jets}$  reconstruction

- Using FullMC, study the cluster position resolution  
Need some parameterization for hadrons
- Neutral/Charged cluster separation  
Need to see longitudinal segmentation and calorimeter radius effect
- Various FastMC parameter should be determined by FullMC  
Need more study using FullMC
- Need to optimize the top-quark selection cut