A study of vertexing and tracking performance with JLC 3T detector

Akiya Miyamoto
KEK
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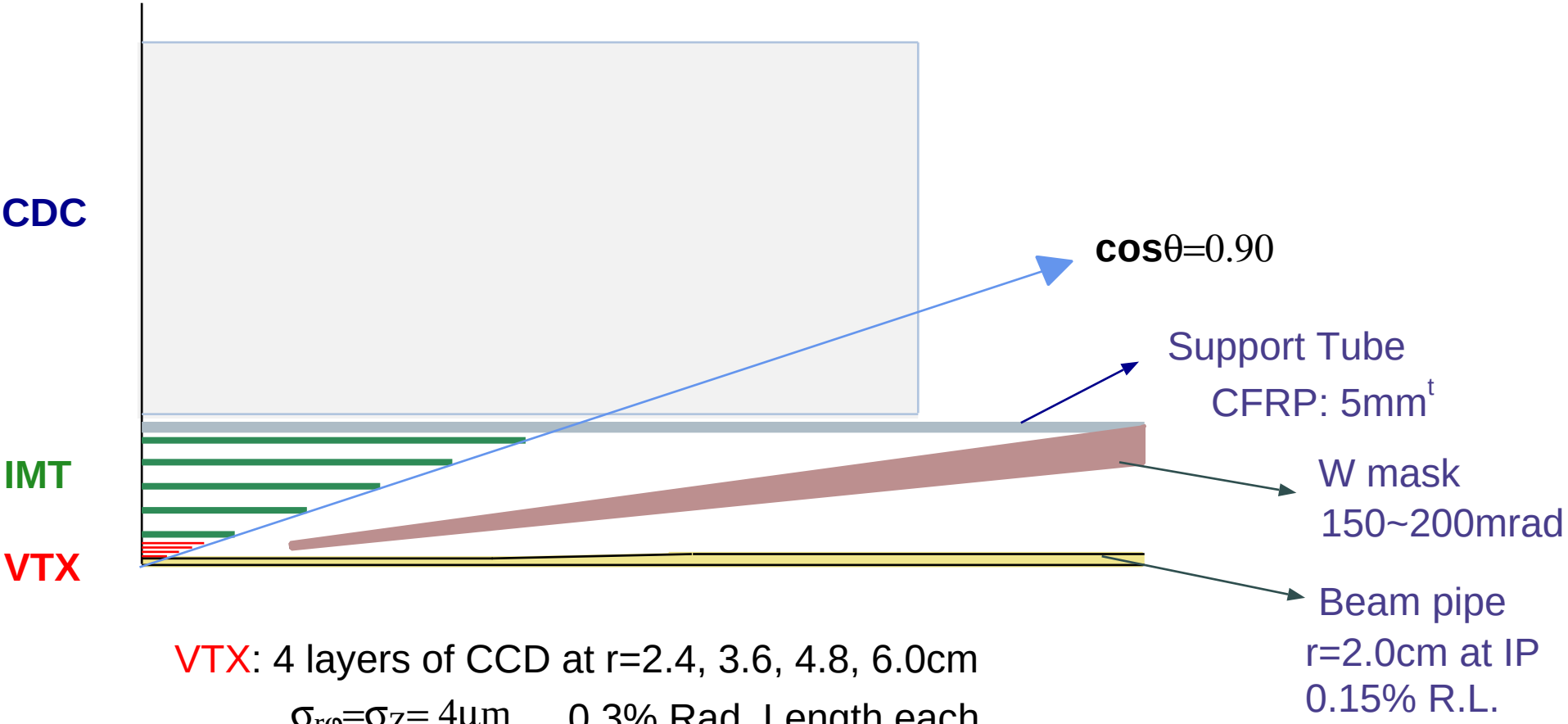
Postscript file is available at
http://www-jlc.kek.jp/~miyamoto/reports/docs/lcws2k-tracking.ps.gz

Tracking detector of JLC



VTX: 4 layers of CCD at r=2.4, 3.6, 4.8, 6.0cm

$\sigma_{r\varphi}=\sigma_Z= 4\mu m$ 0.3% Rad. Length each

IMT : 5 layers of Silicon at r=9, 16, 23, 30, 37 cm

CDC: Jet chamber, r=45 to 155cm, 50 radial sampling.

$\sigma_{r\varphi}=85\mu m$, $\sigma_Z= 3mm$

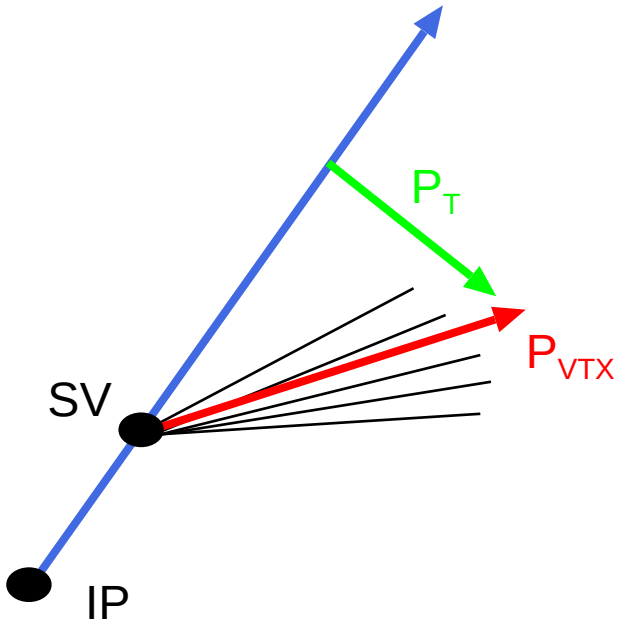
Solenoid: 3 Tesla

ZVTOP vertex tagging

thanks to Dr. David Jackson

Topological Vertex finding

Define a tube of probability along the track trajectory
and find points where trajectories overlap.



Mass tagging

Use Pt corrected mass of secondary vertex

$$M_{corr} = \sqrt{M_{VTX}^2 + P_T^2} + |P_T|$$

Study of tagging efficiency

Generated events:

$$e^+e^- \to Z/\gamma \to q\bar{q} \quad \text{at } \sqrt{s} = 91 \text{ GeV}$$
$$q = u, d, b, s, c, b$$

Using Quick Simulator

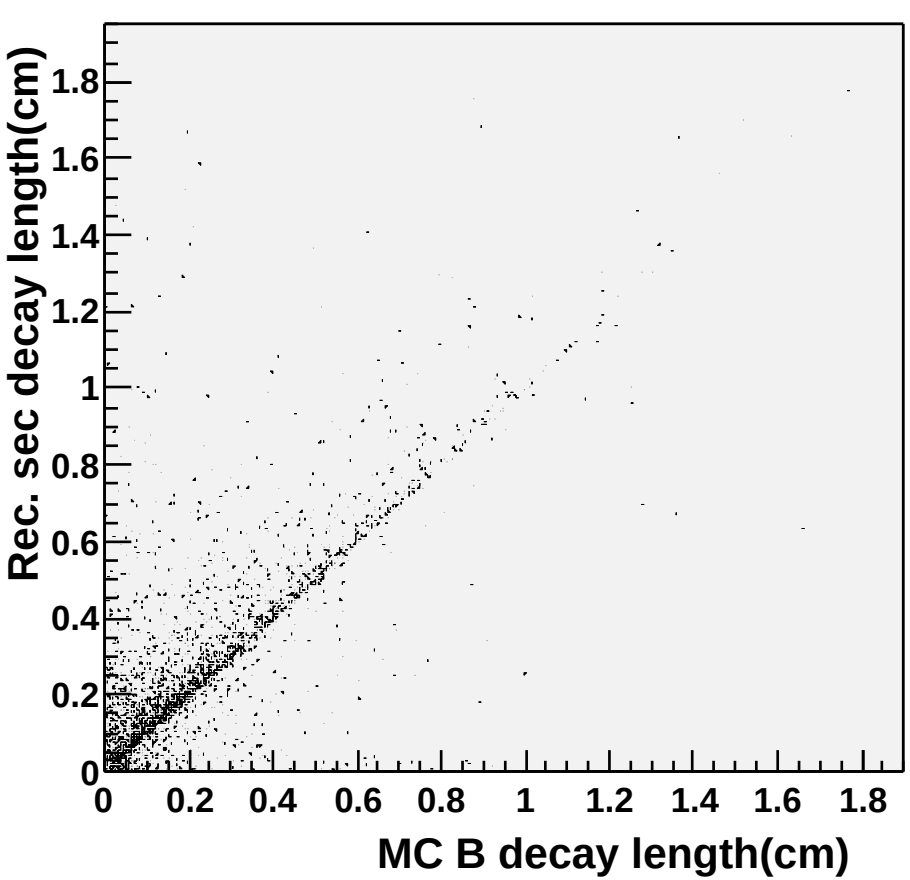
Analysis method:

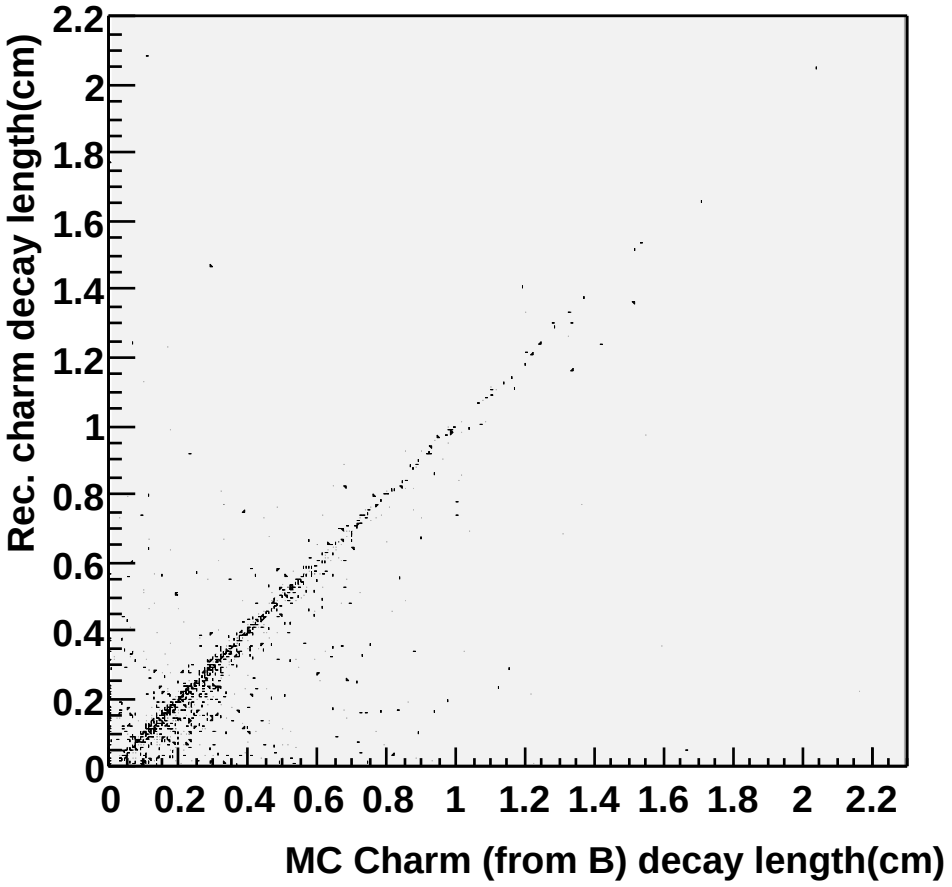
Jets reconstruction by forced-two-jets clustering.

Vertex tagging is applied to the jet, if $|\cos\theta_{jet}| < 0.8$

b and c quark tagginf efficiency and purity are studied for each jets

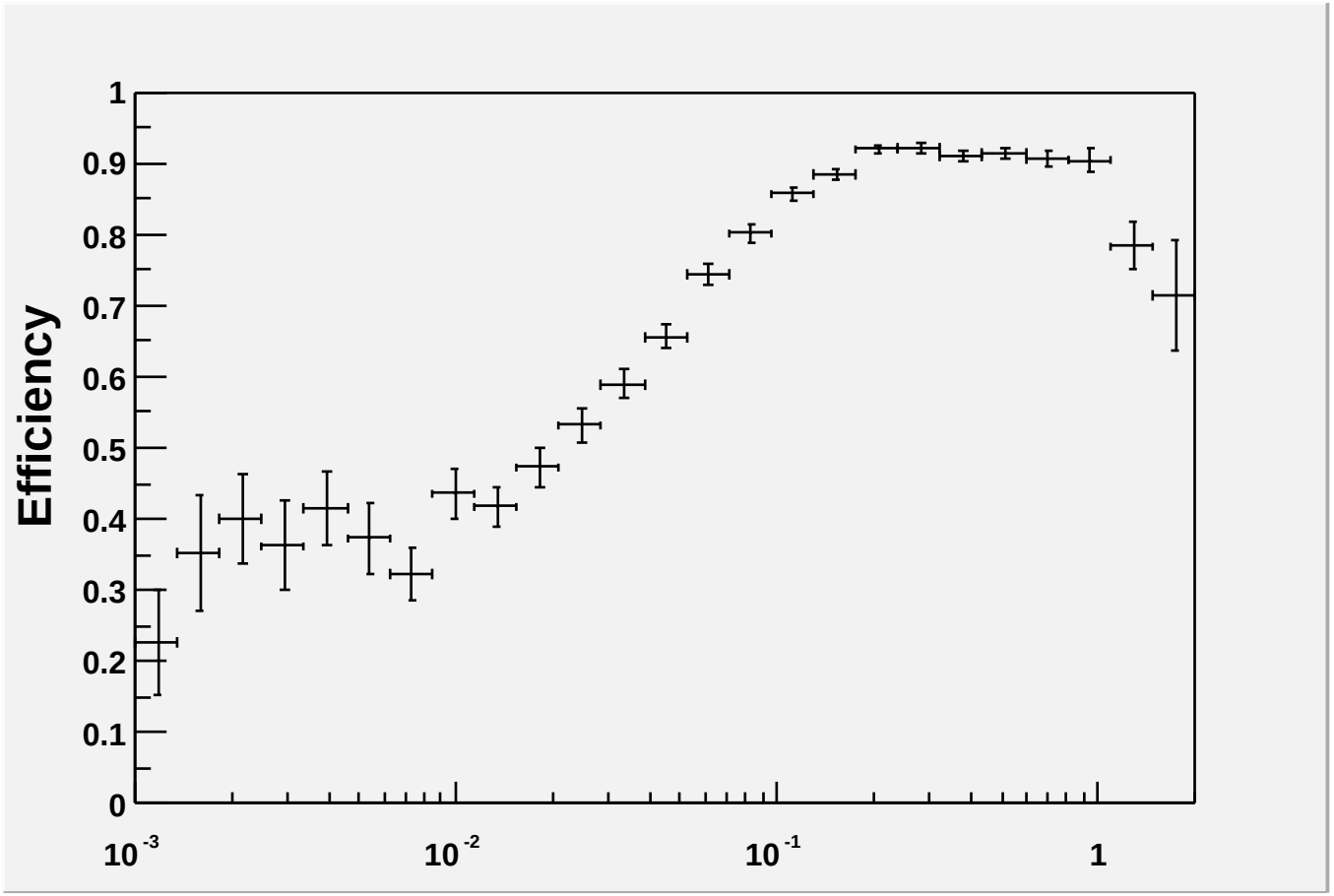
Comparison of generated vertex position and reconstructed vertex position





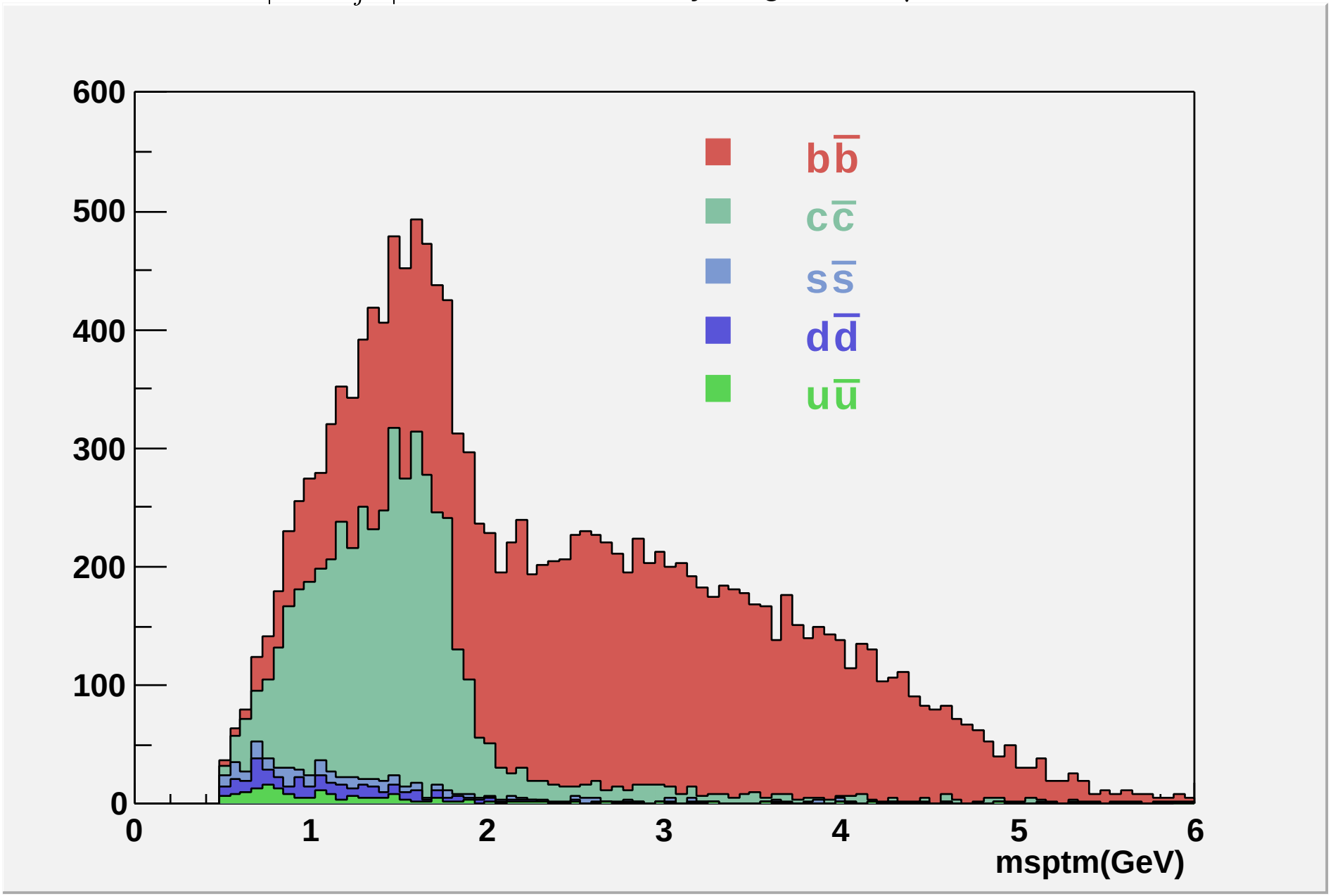
Efficiency to find secondary vertices in b quark jets

Process: $e^+e^- \to Z \to b\bar{b}$ $\qquad |\cos\theta_{jet}| < 0.8$



Pt corrected Vertex Mass (MSPTM) distribution

for $|\cos\theta_{jet}| < 0.8$ and decay length > 300μm

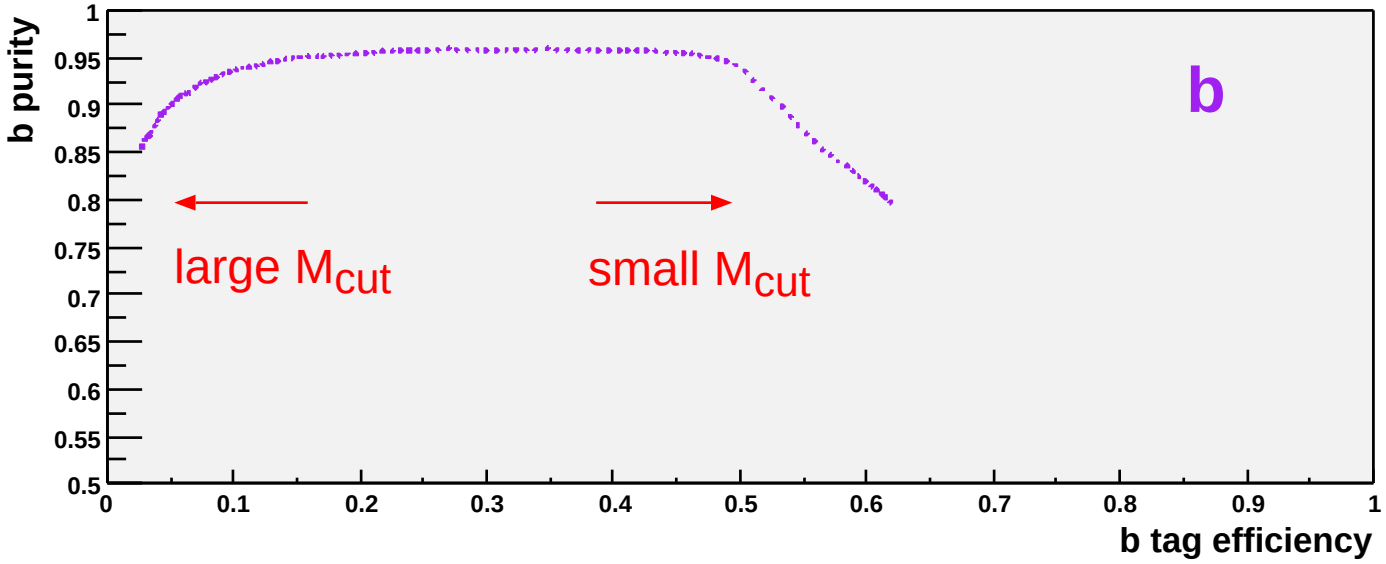


Tag efficiency and purity

for $|\cos\theta_{jet}| < 0.8$ and decay length > 300μm

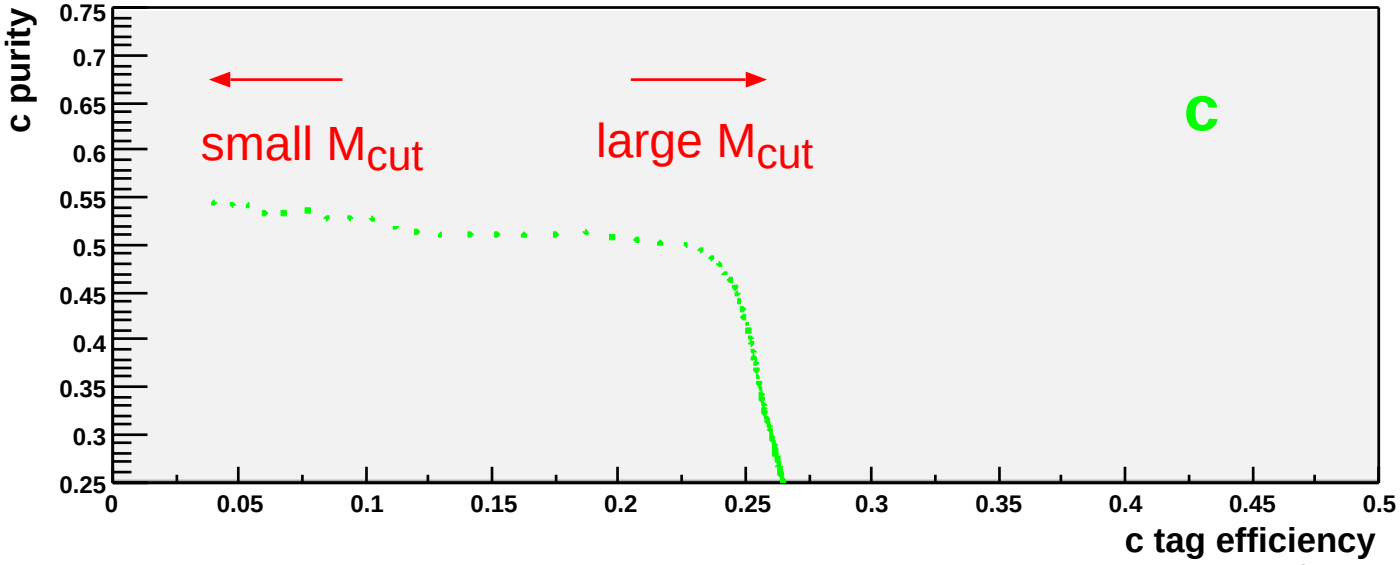
Jet is tagged as b if

MSPTM > M_{cut}



Jet is tagged as c if

0.55<MSPTM < M_{cut}



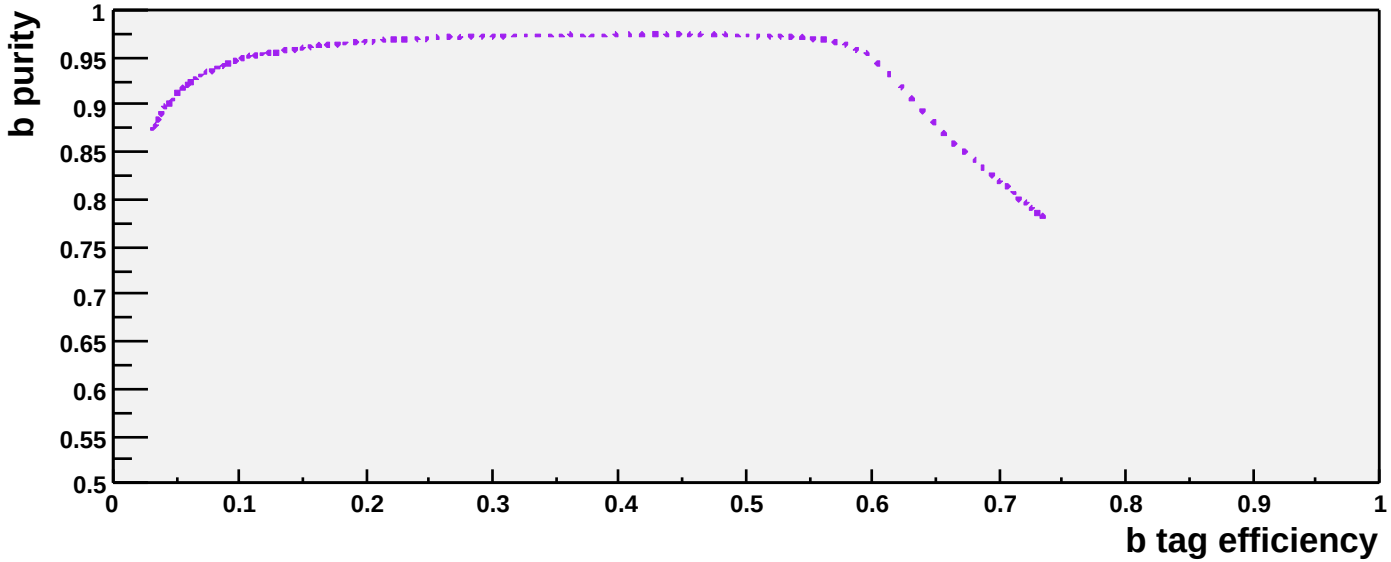
Tag efficiency and purity -II

add 5th CCD at r=1.2cm and beam pipe at r=1.0cm

for $|\cos\theta_{jet}| < 0.8$ and decay length > 150μm

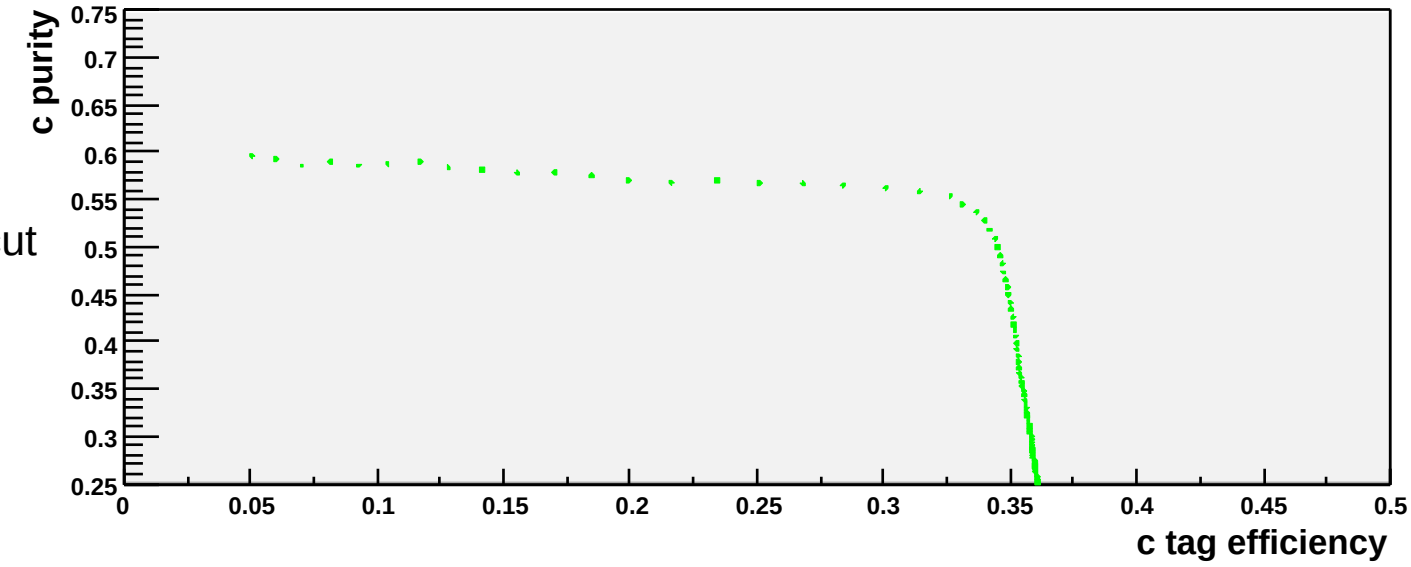
B-tag

MSPTM > M_{cut}



C-tag

0.55<MSPTM < M_{cut}



Momentum resolution JLC detector

JIM

Method: Simulate a single μ track by JIM Full detector simulator

Generated hit points of CDC and VTX are smeared by assumed resolution

CDC signal and VTX signal are fitted by helixes separetely

Helix parameter: $\mathbf{a} = (dr, \varphi_0, \kappa, dz, \tan\lambda)$ defined at pivot (x_0, y_0, z_0)

To get CDC-VTX combined track parameter,

Pivot of CDC track is moved to that of VTX,

When moved, energy loss and increase of error matrix of helix are corrected

Support tube and a sum of VTX and IMT are same matterial thickness.

Then, CDC helix and VTX helix are averaged with a weight according to their error matrix.

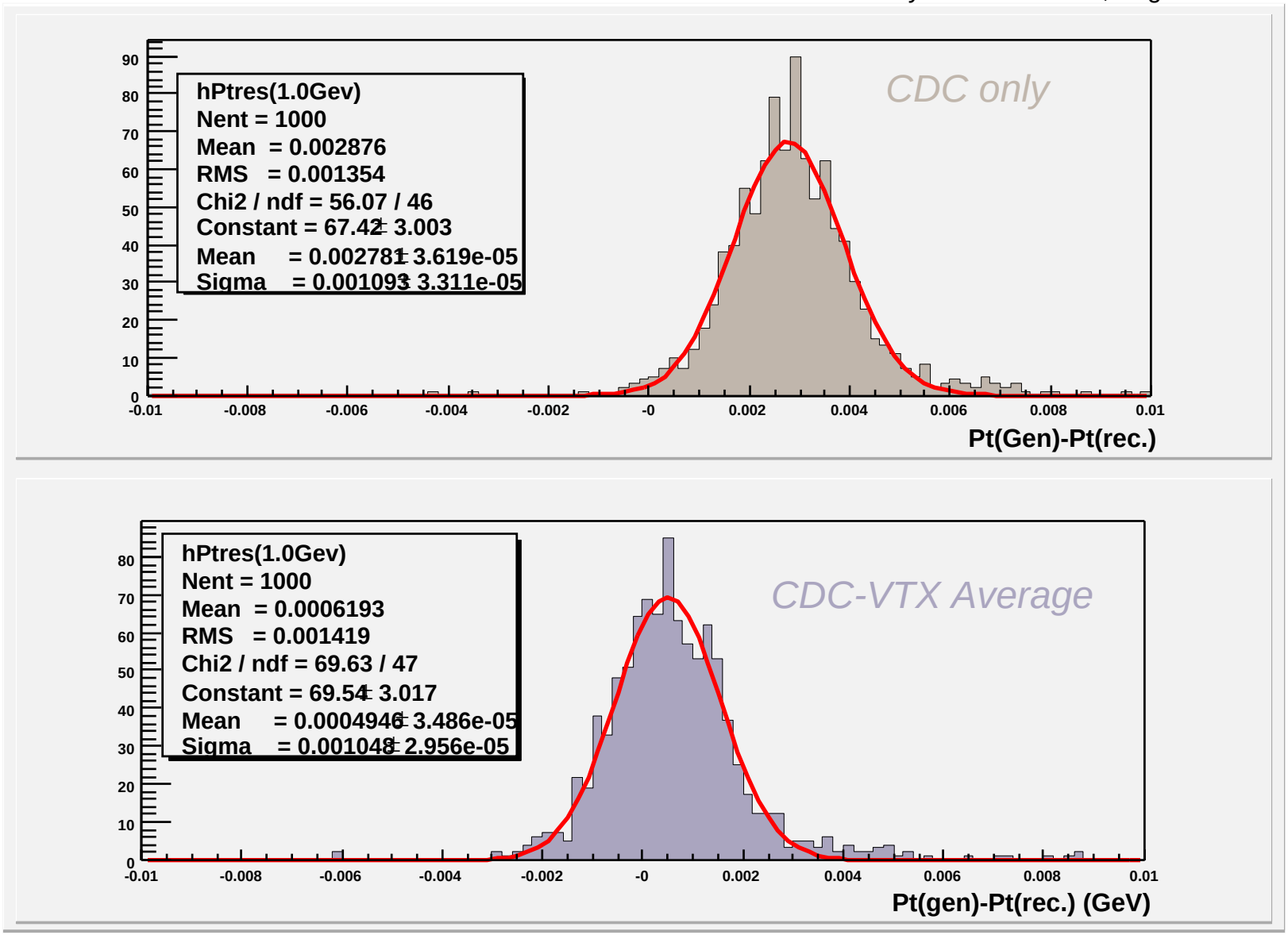
This method does not require minimization such as kink fitting.

Good results can be obtained, as long as multiple-scattering is gaussian and no large enrgy loss in the matterial.

CDC and VTX averaged helix parameter

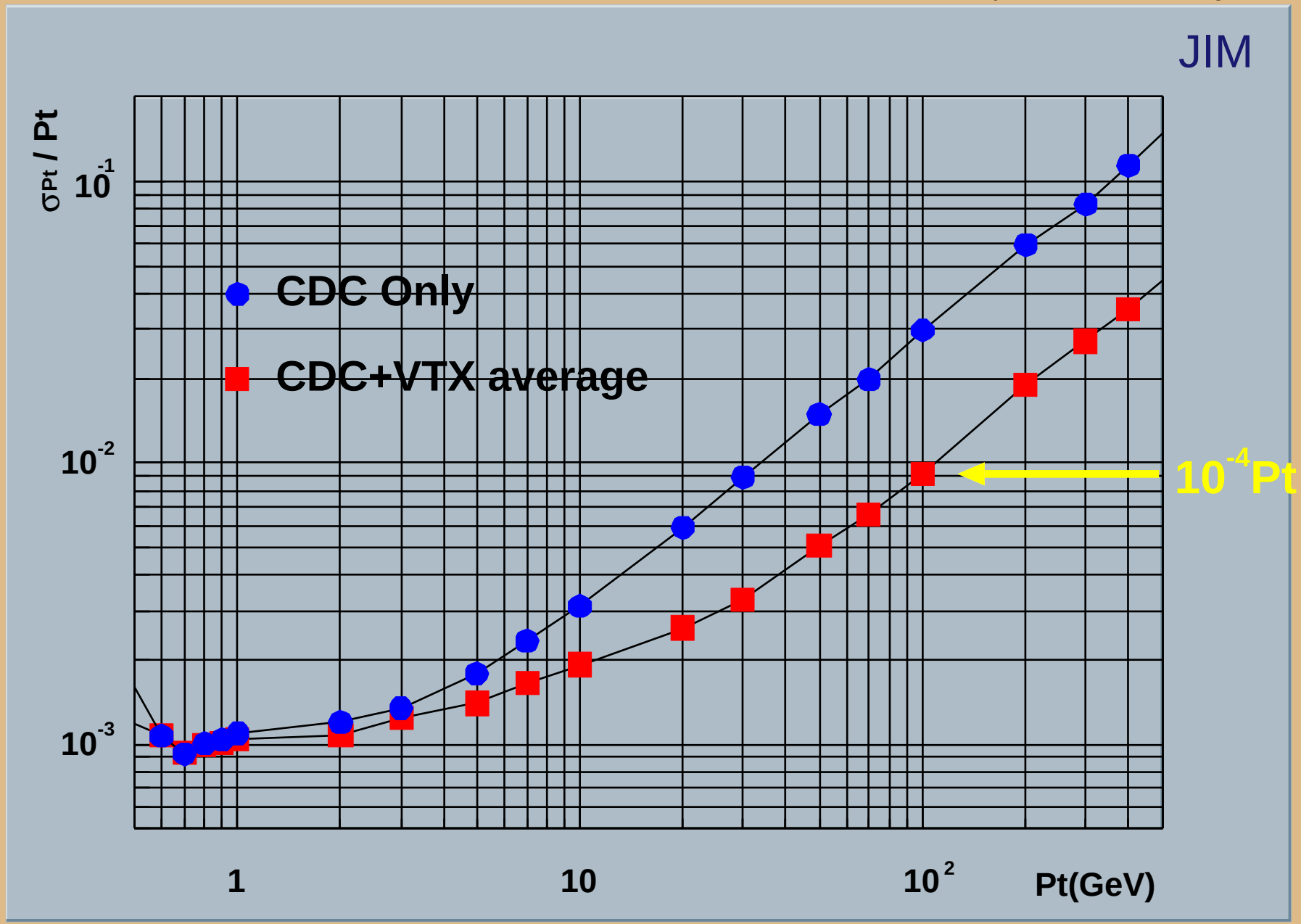
1GeV μ track by JIM

by Sezaki Tadashi, Saga Univ.



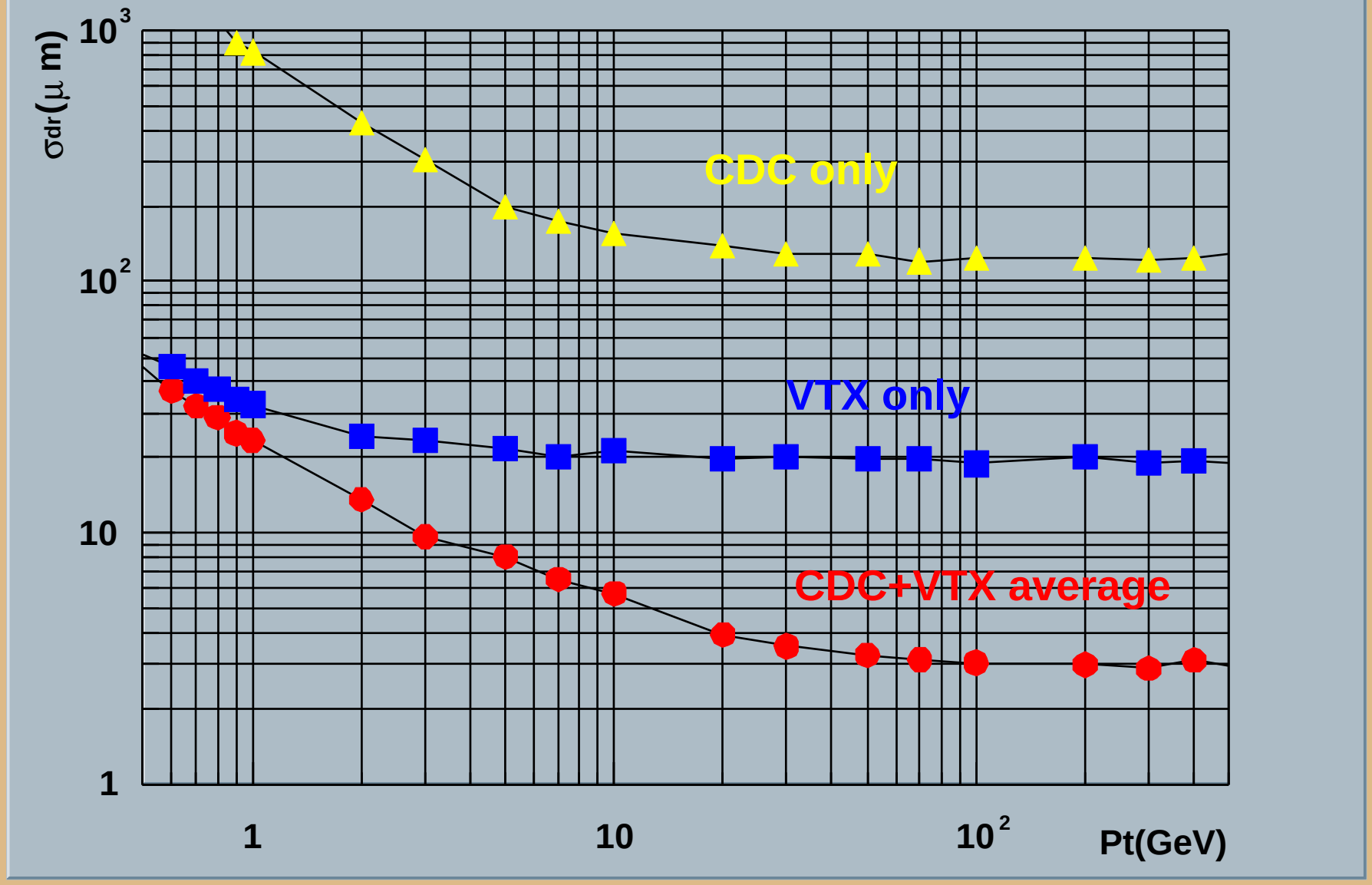
Momentum resolution by μ track

by Tadashi Sezaki, Saga Univ.



Impact parameter resolution by μ track

by Tadashi Sezaki, Saga Univ.



Missing mass resolution

Process: $e^+e^- \to ZH \to \ell^+\ell^- X$

A channel to search Higgs indepentantly with its decay mode

Γ_H can be determined

Only $\ell = \mu$ is considered here

Event Generation:

By PhysSim generator (Helas/Bases/Spring) and JIM (Geant3), only $\mu^\pm$

Including Beamstrulung spectrum of JLC-I X-300GeV parameter
and +\- 0.5% intial energy spread

Generation is performed at $\sqrt{s} = 250GeV$

Event selection and missing mass:

Require : (1) # of sample wire = # of wire in radial direction
(2) $80 < M_{\mu^+\mu^-} < 100$

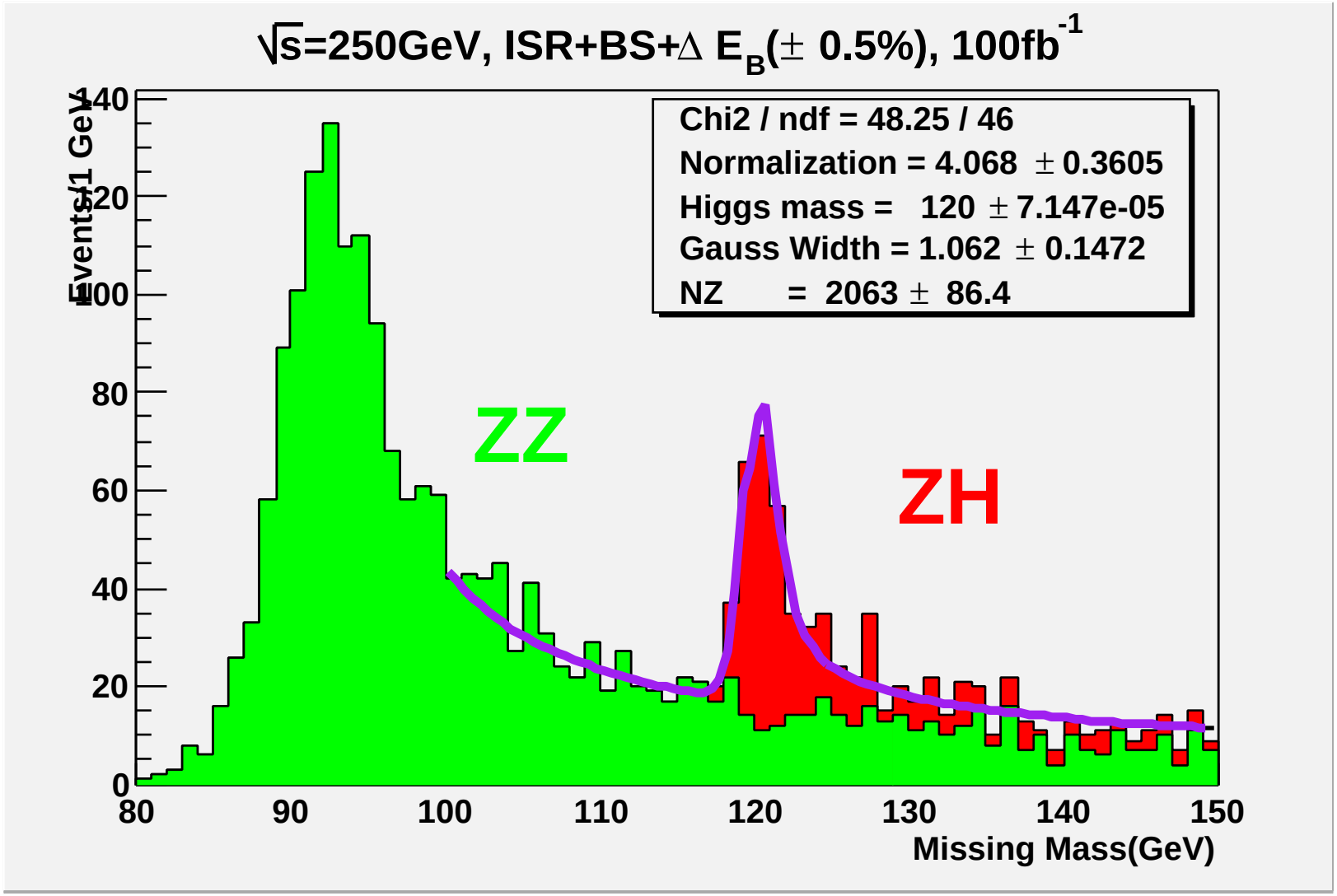
$$M_H^2 = (p_{cm} - p_1 - p_2)^2$$

$p_{cm} = (\sqrt{s}, 0, 0, 0)$ 4 momentum of initial state

p_1, p_2 4 momentum of $\mu^\pm$

Missing mass of $\mu^+\mu^-$ system

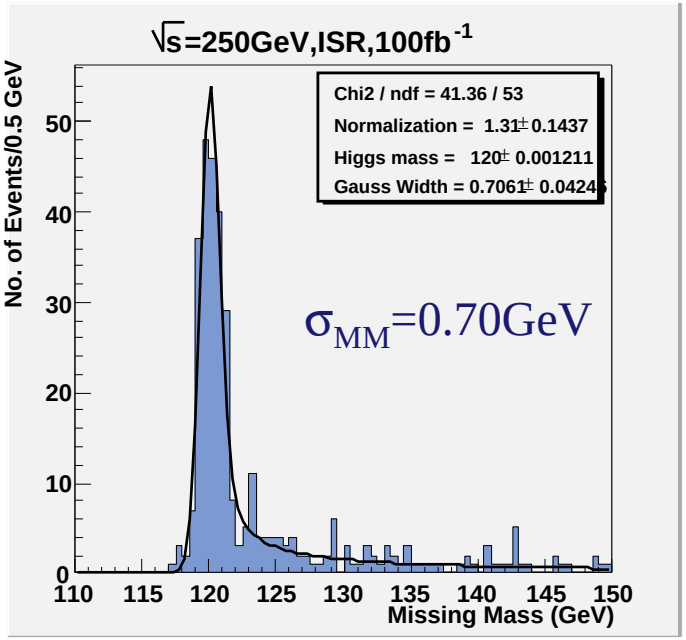
JIM

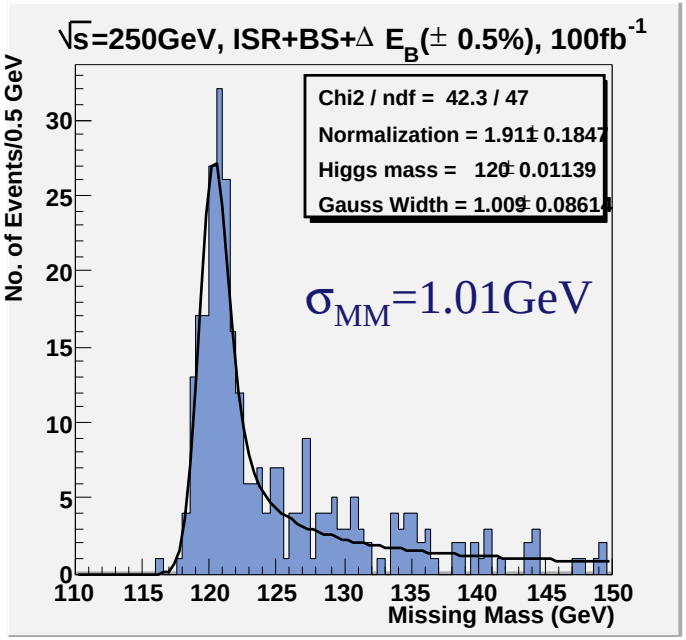


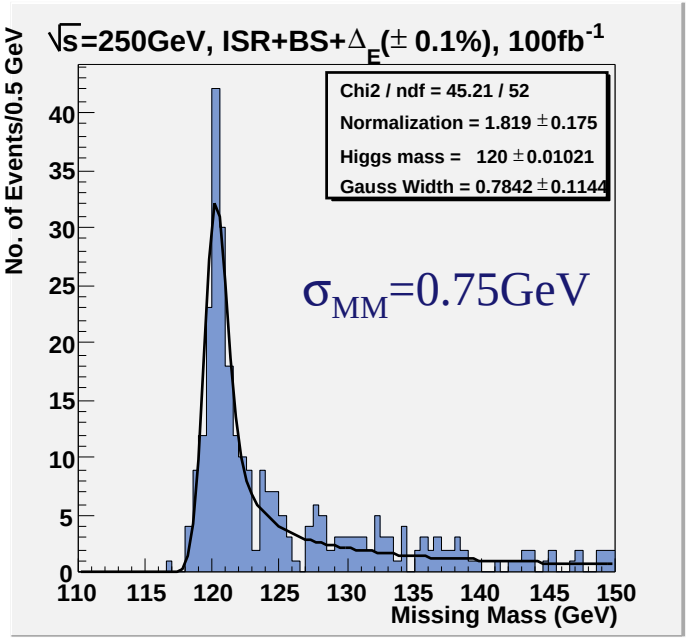
Fit function: Gaus + (M_H-Bremstralung spectrum) + (M_Z - Bremstralung spectrum)

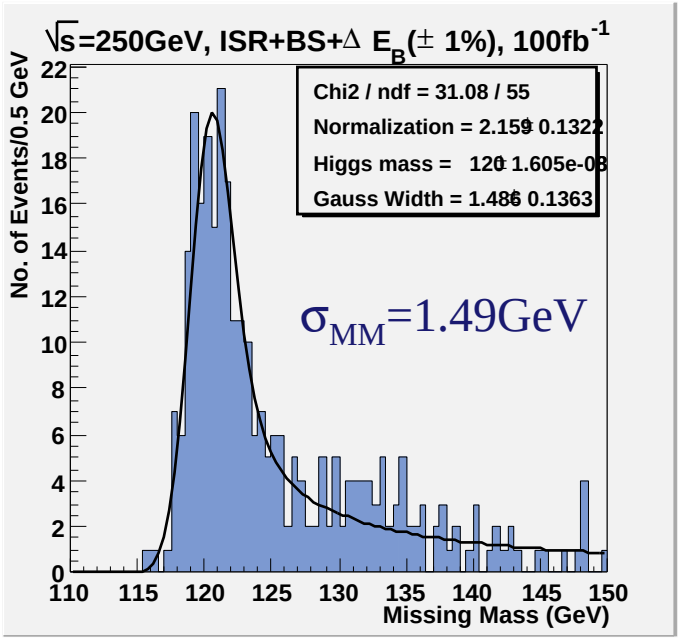
Missing mass resolution and initial beam energy spread

JIM



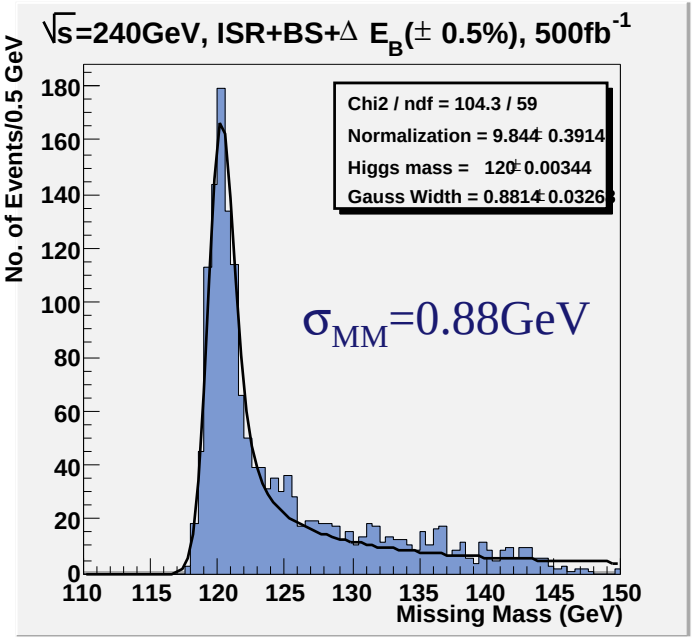






Missing mass resolution and center-of-mass energy

JIM

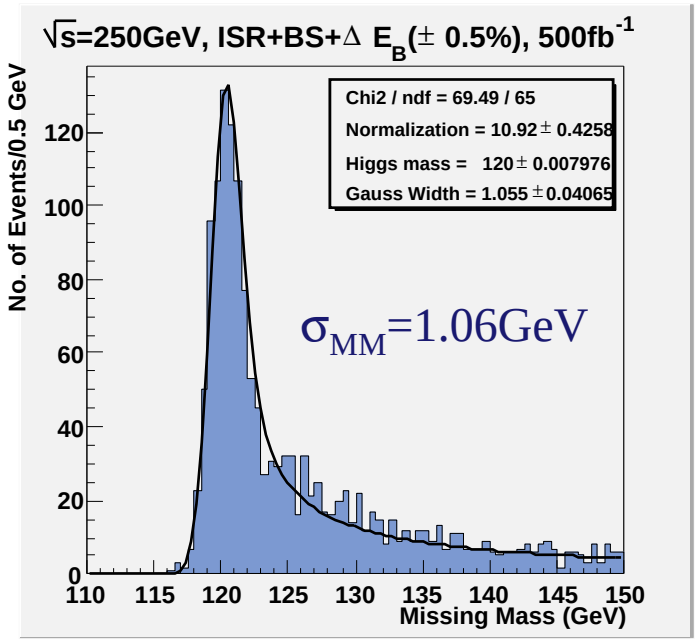


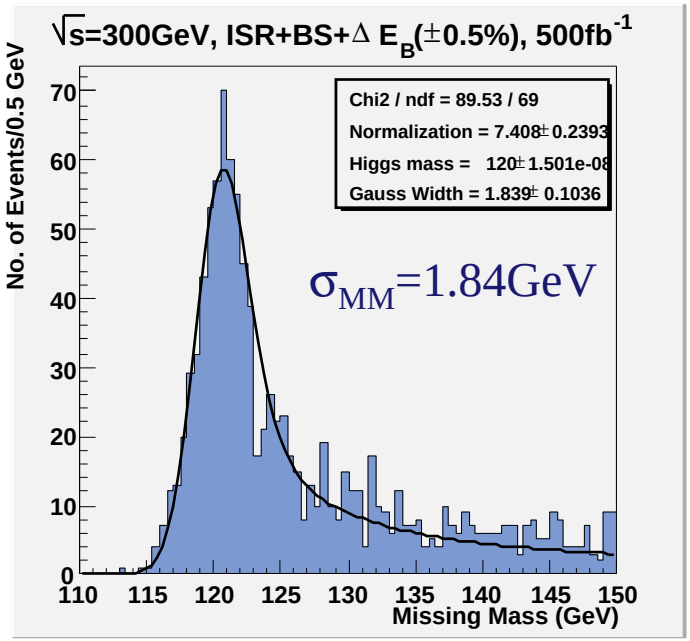
$$m_{MM}^2 = s - 2E_Z\sqrt{s} + m_z^2$$

$$\Delta m_{MM} \sim (-2\frac{\sqrt{s}}{m_{MM}} + \frac{m_Z^2}{p_\mu m_{MM}})\Delta p_\mu$$

$$(\text{neglect } \Delta\sqrt{s} \text{ and } \Delta\cos\theta_{\mu^+\mu^-})$$

$\sqrt{s}$	300	250	GeV
$< p_t(\mu) >$	64	50	GeV
Δp_μ	0.41	0.25	GeV
$(-\frac{\sqrt{s}}{m_H} + \frac{m_z^2}{m_{MM}p_\mu})$	3.9	2.8	
Δm_{MM}	1.6	0.7	GeV





Summary

1. Efficiency and purity of heavy quark tagging is studies using ZVTOP.

   Some tuning of ZVTOP parameters is necessary to get better efficiency and purity.

   4CCDs → 5 CCDs, $\Delta\eta_b, \Delta\eta_c \sim 10\%$

2. Mometum resolution of tracking system is studied using JIM Full detector simulator

   At $\sqrt{s} = 240\ \mathrm{GeV}$, the missing mass resolution of Higgs of mass 120 GeV is

   $$\sigma_{MM} = 0.9\mathrm{GeV}$$