Muon Momentum Resolution

Applying the Over-smearing Method

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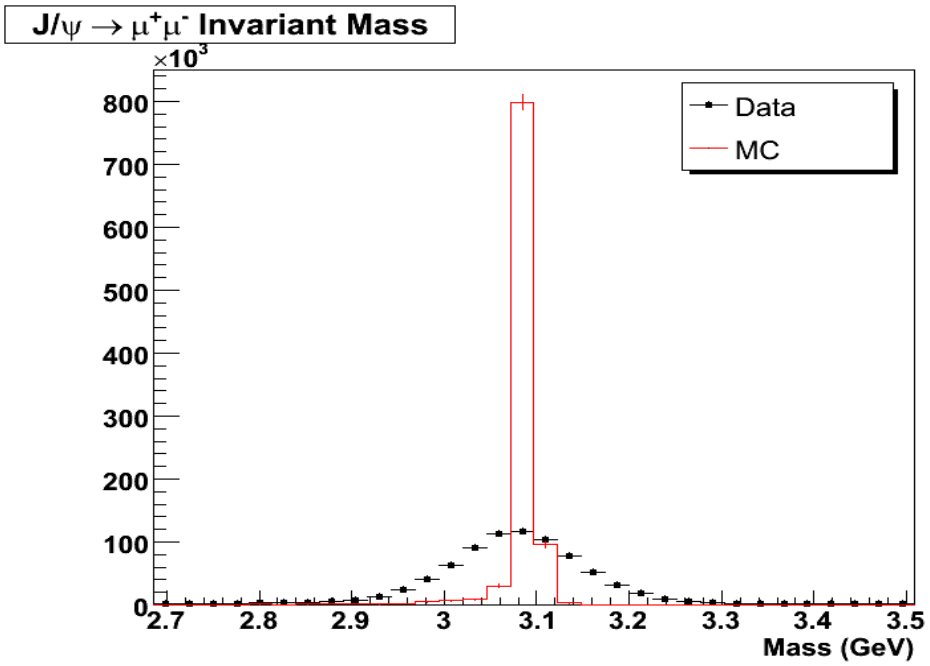
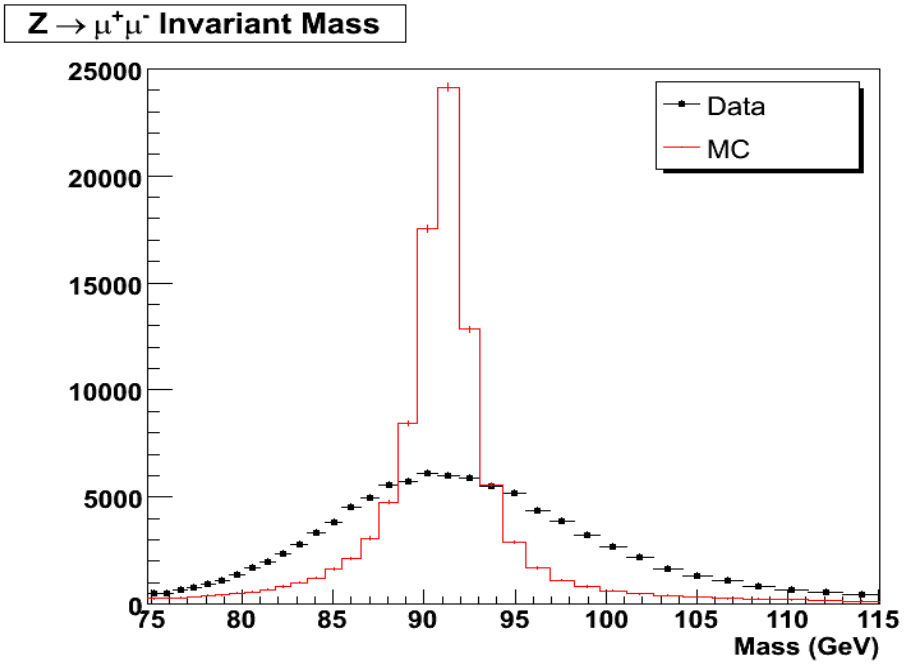
Outline

- Motivation
- Over-smear method
- Second over-smearing method
- Config sets
- Example on how to apply the method
- Status and D0 notes

Motivation

- Since MC does not match with data, we have to apply the Over-smear method in our MC.
- Real signals (Data) loose energy in the detector, which causes a larger width in resonances like J/ψ and Z invariant mass peak.
- On the other hand, we does not have this effect in MC.
- So it is necessary to find a way to make MC becomes worse.





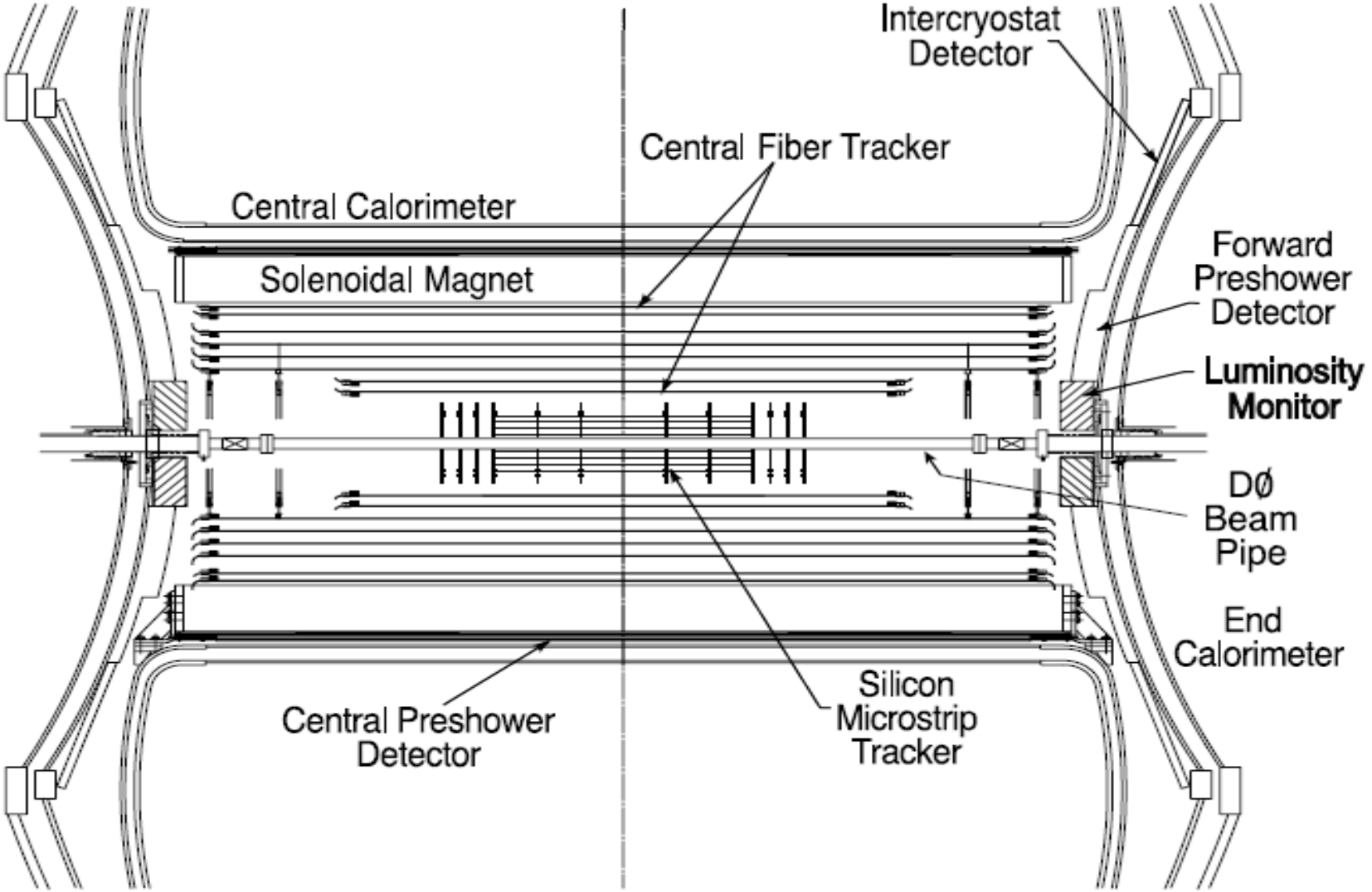
Over-smearing Method

- The over-smearing formula:

$$\frac{q}{p_T} \rightarrow \frac{q}{p_T} + \underbrace{AG_1}_{\text{Resolution effect}} + \underbrace{\frac{B\sqrt{\cosh\eta}}{p_T}G_2}_{\text{Muliple scattering effects}}$$

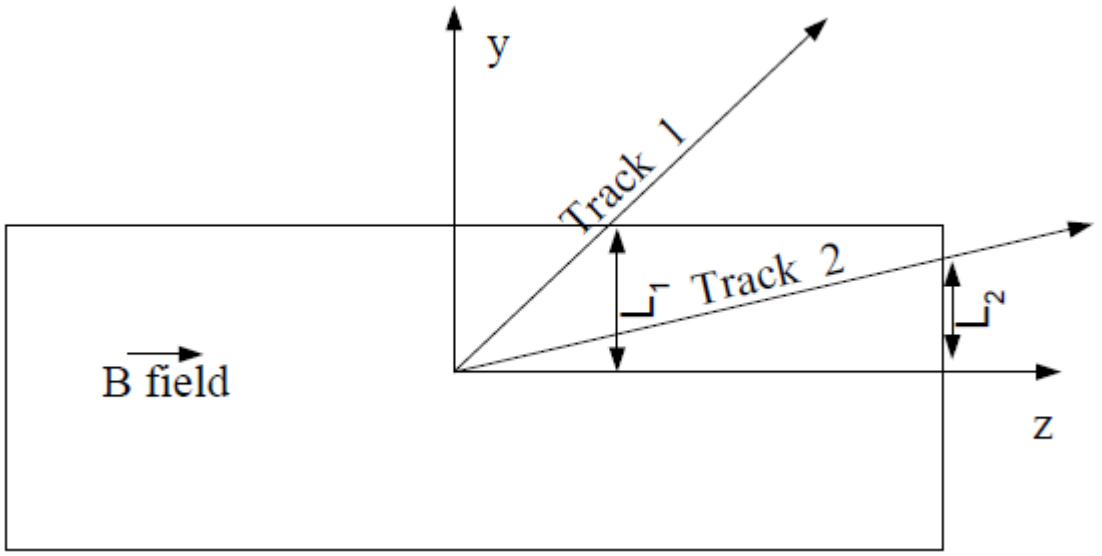
- G_1 and G_2 are 2 independent random numbers distributed according a Gaussian function with a mean value of 0 and a width of 1.
- A and B are over-smearing parameters to be determined for different muon track types:
  - Track type 1: mu with SMT hits and $|\eta_{CFT}| < 1.6$
  - Track type 2: mu with SMT hits and $|\eta_{CFT}| > 1.6$
  - Track type 3: mu without SMT hits.

CFT: Centra Fiber Tracker in Detail



Understanding LeverArm Formula

- Considering a picture from the CFT in longitudinal cut.
- LeverArm is arm (radius) of the CFT where we have muon track.



Second Over-smearing Method

- The over-smearing formula with Double-Gaussian and Lever Arm:
  - If rnd > C:

$$\frac{q}{p_T} \rightarrow (1+S) \times \left\{ \frac{q}{p_T} + \underbrace{AG_1 \times \frac{R_{\mathrm{CFT}}^2}{L^2}}_{\text{Resolution effect}} + \underbrace{\frac{B\sqrt{\cosh\eta}}{p_T} G_2}_{\text{Multiple scattering effects}} \right\}$$

  - else:

$$\frac{q}{p_T} \rightarrow (1+S) \times \left\{ \frac{q}{p_T} + D \times G_3 \times \frac{R_{\mathrm{CFT}}^2}{L^2} + \frac{B\sqrt{\cosh\eta}}{p_T} G_2 \right\}$$

- G_1, G_2 and G_3 are 3 independent random numbers distributed according a Gaussian function with a mean value of 0 and a width of 1.
- A, B, C and D are over-smearing parameters to be determined for different muon track types.
- *R* = outer most CFT radius; *L* = LeverArm with Hit Mask information.

Config settings

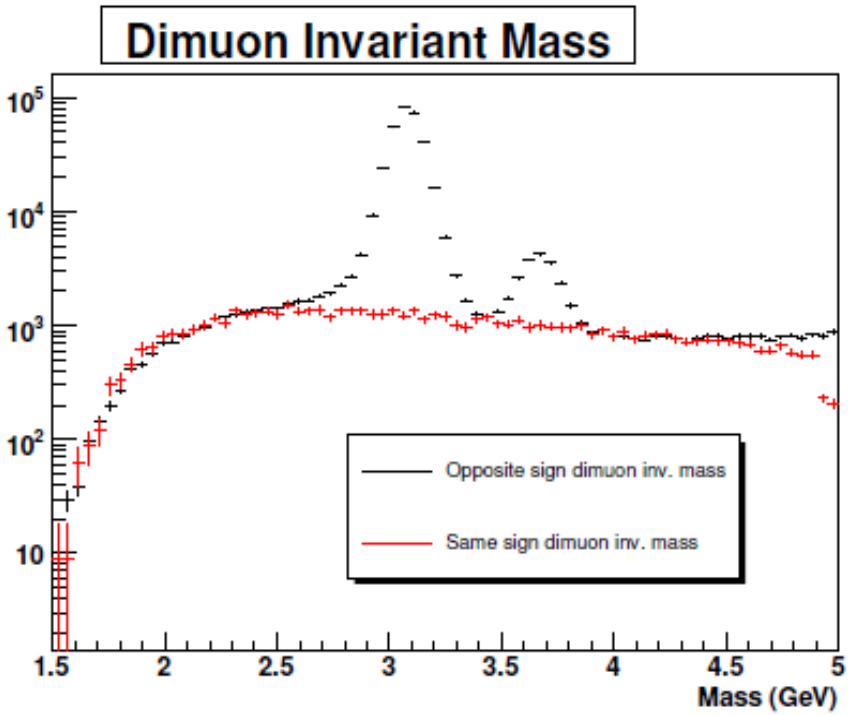
- Selection:
  - $Z \rightarrow \mu^+ + \mu^-$
  - $J/\psi \rightarrow \mu^+ + \mu^-$
- Recover: p20
- DataSet: pre and post-shutdow'07
- MC events processed by Alpgen
- Di-muon invariant mass around

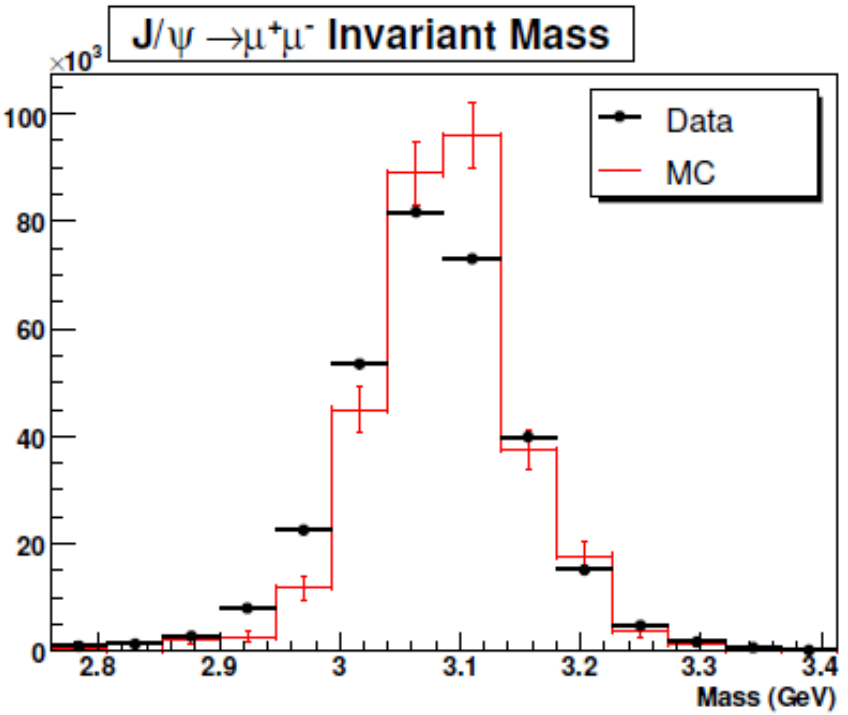
Z and J/ψ

- 2 muons
- Opposite charge
- Loose quality
- Loose track quality
- 1 tight and 1 loose isolated muon
- Cuts:
  - Z: $p_T > 20$ GeV
  - J/ψ: $p_T > 3$ GeV
- $|\Delta Z(\mu 1, \mu 2)| < 3$ cm
- $A = |\Delta\phi(\mu_1,\mu_2) + \theta\mu_1 + \theta\mu_2 + 2\pi| > 0.05$

Applying the Over-smearing Method

- Over-smearing parameters are calculated using both J/ψ and Z resonances.
- Firstly, we have to subtract the background from J/ψ. That is, cut out the samesign events (left plot).
- Then shift MC regarding integrals (right plot).



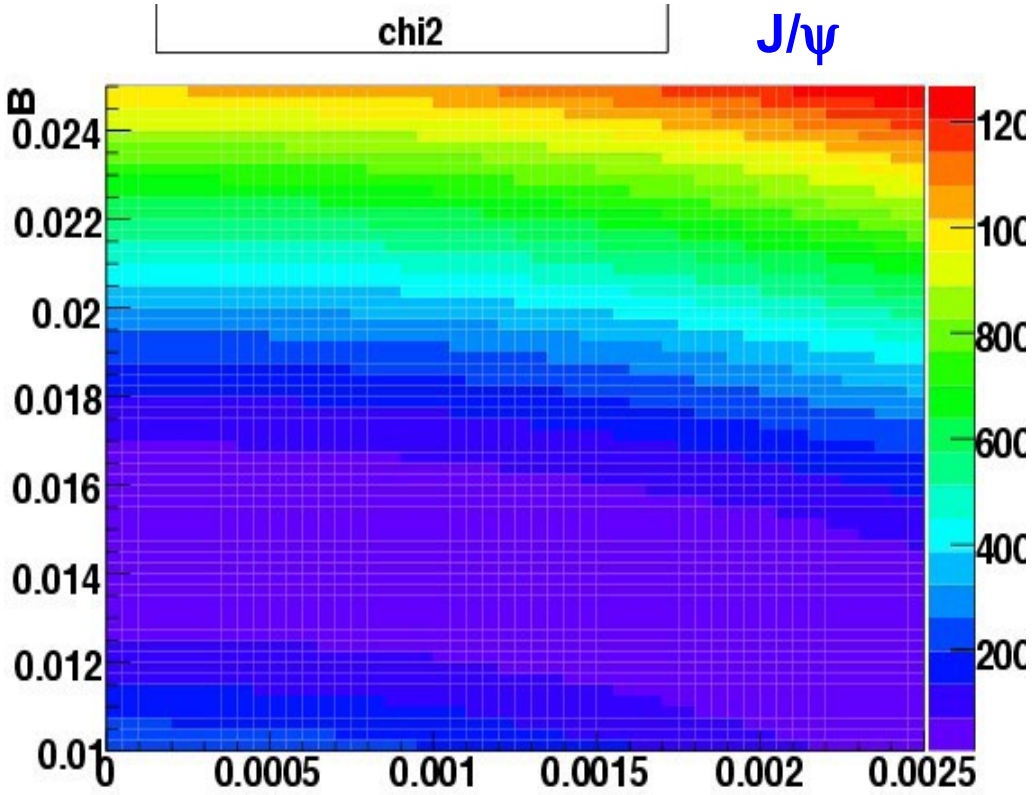


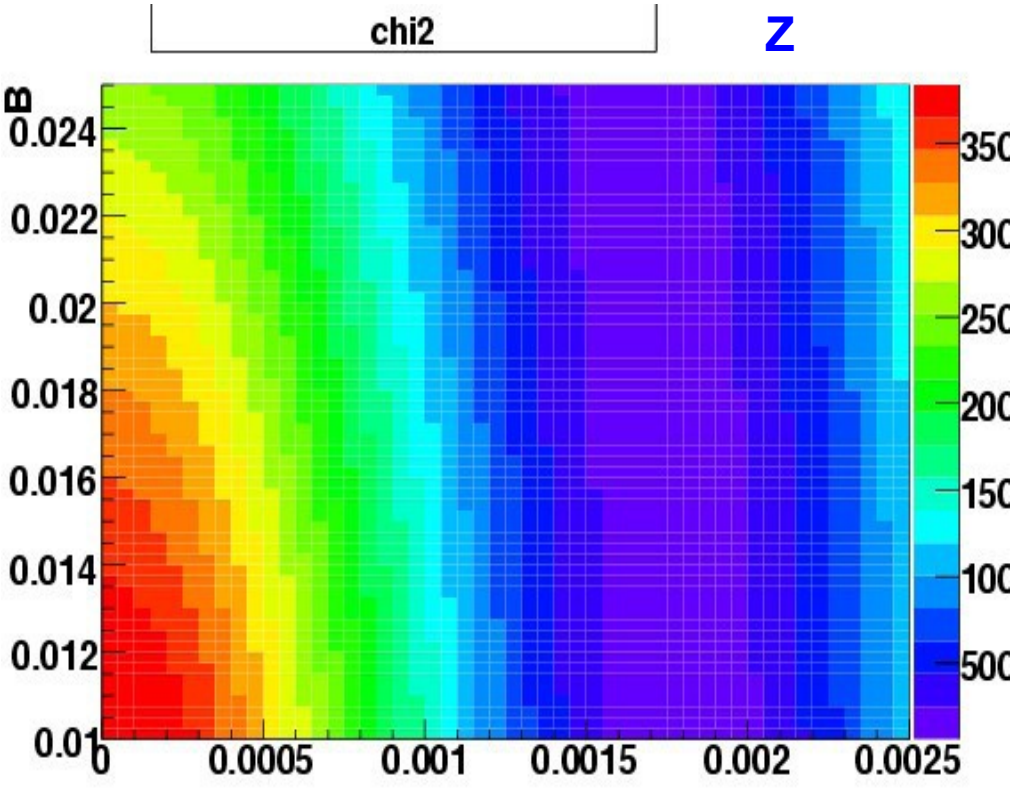
Applying the Over-smearing Method

- χ^2 is calculated taking this formula into account:
-
-

$$\chi^2 = \sum_{i=0}^{\mathrm{nbins}} \frac{(n_{i\,\mathrm{data}} - S \times n_{i\,\mathrm{MC}})^2}{n_{i\,\mathrm{data}} + S^2 \times n_{i\,\mathrm{MC}}}$$

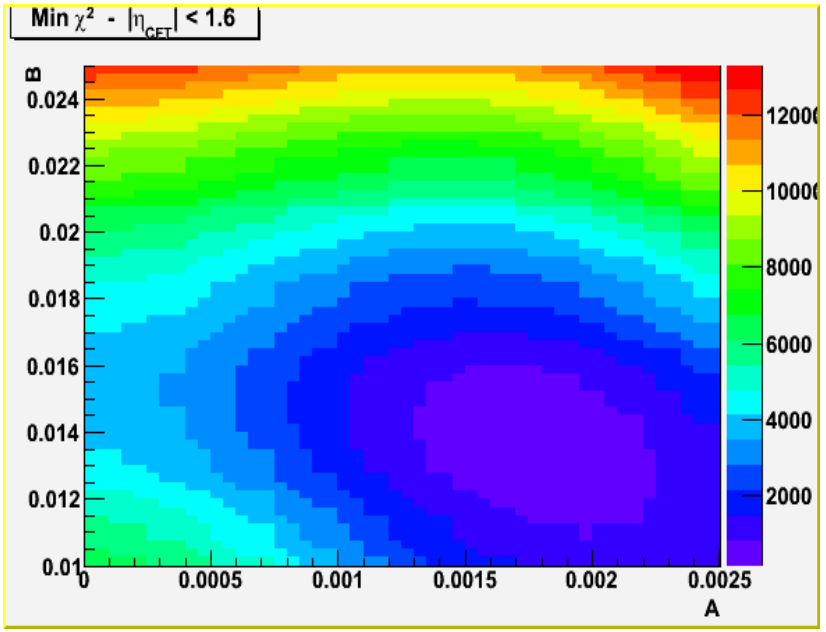
- Applying the over-smearing formula → A and B parameters.
- Two chi2 maps from both resonances:

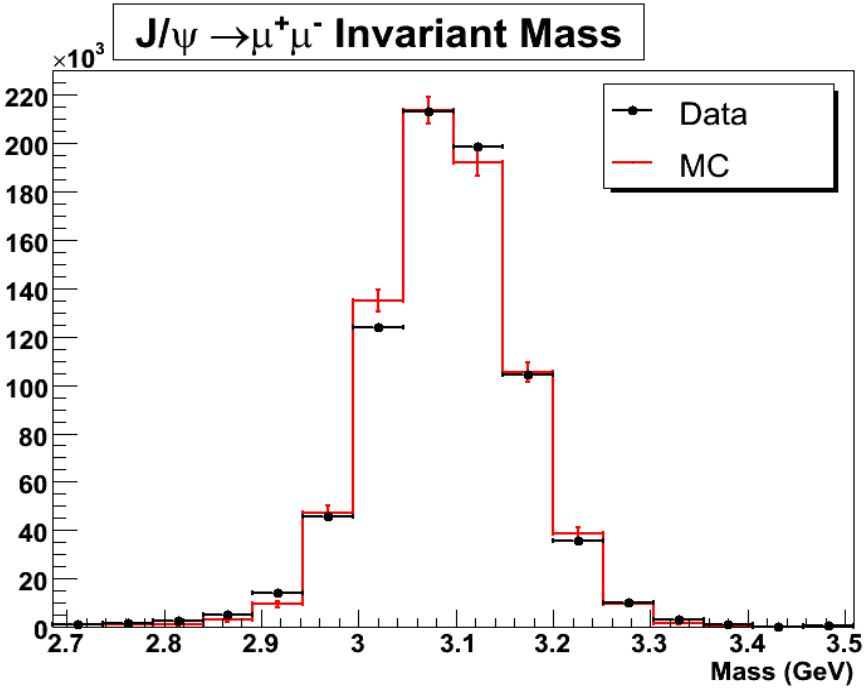


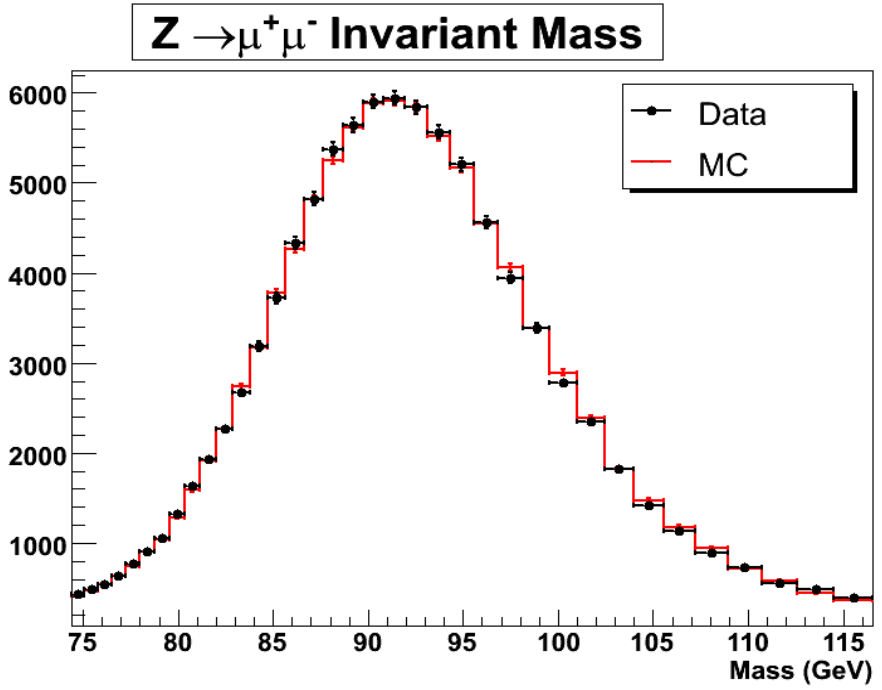


Applying the Over-smearing Method

- Combing both χ^2 maps:
- A and B correspond to the minimum value in χ^2 map.
- C and D parameters are calculated in the same way.







Status and D0 note

- My work is different, but using the same method:
  - Instead of use reconstructed MC (passed by detector corrections), I have to calculate the resolution parameters (generated MC).
- Parameter resolutions have been calculated for RunII2b-1 and RunII2b-2 Data sets.
- D0 note in preparation:

Muon Momentum Over-Smearing Update for p20 Data

A. Croc[1], B. Tuchming[1], V. Sharyy[1], F. Déliot[1], H. Greenlee[2], M. Cooke[2], A.S. Santos [3], M. Vesterinen[4] and T.R. Wyatt[4]

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Status and D0 note

- Other D0 note being prepared and will be sent to colaboration review soon.
- MuID group:

v1.1, March 1, 2010 DØ Note 6025

Muon Identification Certification for the Summer 2009 Extended Dataset (Run IIb-1 and -2)

Oleg Brandt[a,b], SungWoong Cho[c], Michael Cooke[b], Michael Eads[d], Dave Hedin[g], Jeong Ku Lim[c], Angelo Santos[h], Sung Park[c], Boris Tuchming[f], Yuriy Yatsunenko[d], SungWoo Youn[b]

for the DØ Muon Algorithms and Identification group.