

Measurement of Energy Loss and Momentum Scale from J/ψ Decays

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Introduction

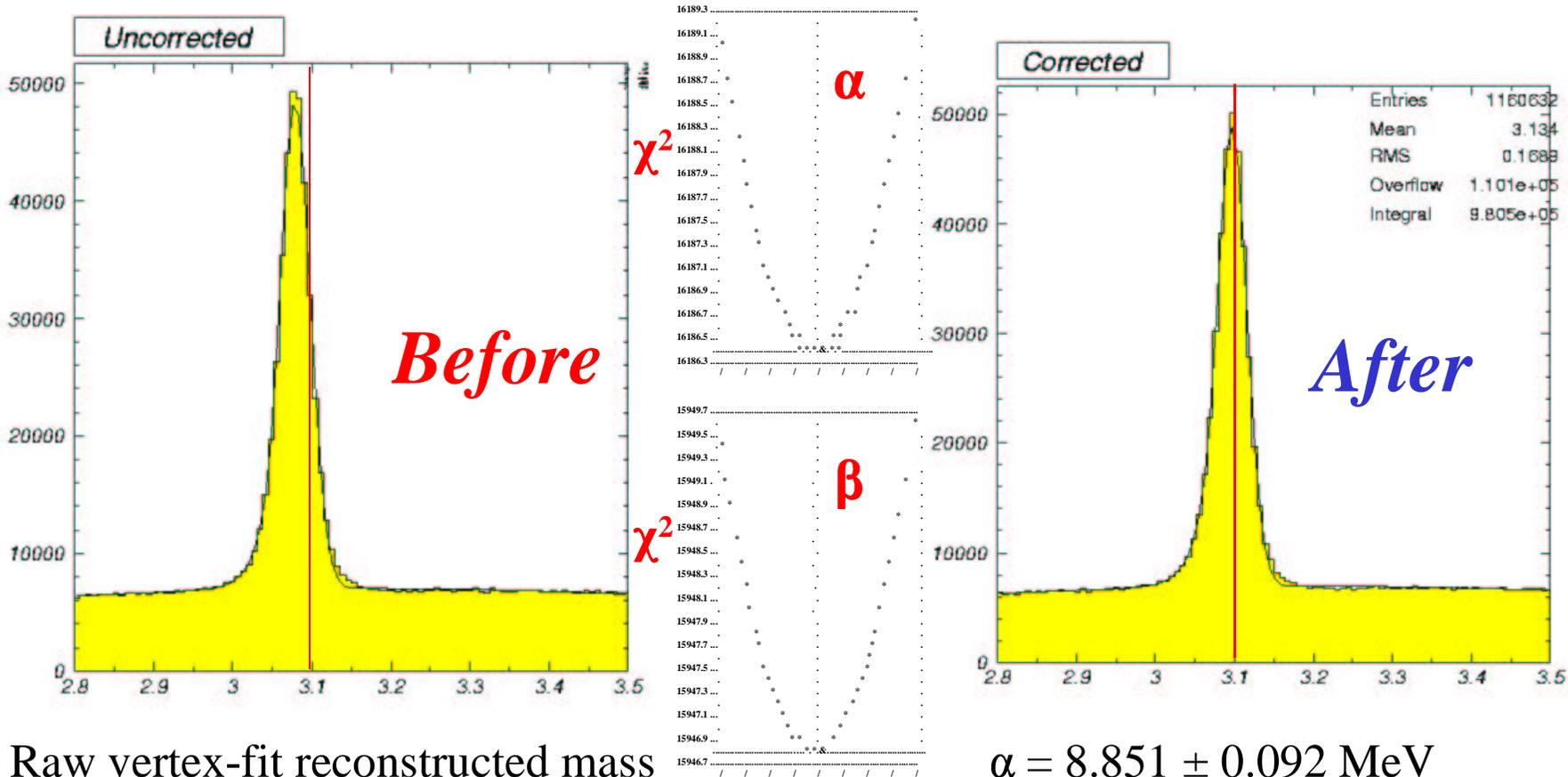
- Reconstructed ψ mass is consistently low in corrected defTracks from di-muon sample
 - Underestimate of energy loss in detector material
 - Error in magnetic field scale
- Parameterize the corrections to the $\mu^+\mu^-$ invariant mass in terms of these two quantities
 - α – mean energy lost in detector volume
 - Essentially
 - Equate p_T loss to Eloss
 - β – scale factor applied to momentum scale
- Event-by-event Minuit fit for α & β minimizes χ^2 about ψ mass (~ 3096.87 MeV)
 - Disentangle α (additive), β (multiplicative)

*Inner
Wall
COT*

$$p(\alpha, \beta) = \left(\frac{\beta p_T + \alpha}{\sin \theta} \right)$$

$$m(\alpha, \beta) = \sqrt{[p_1(\alpha, \beta)]^2 + [p_2(\alpha, \beta)]^2 + 2m_\mu^2 + p_1(\alpha, \beta) p_2(\alpha, \beta) \cos \Delta}$$

Dimuon Invariant Mass

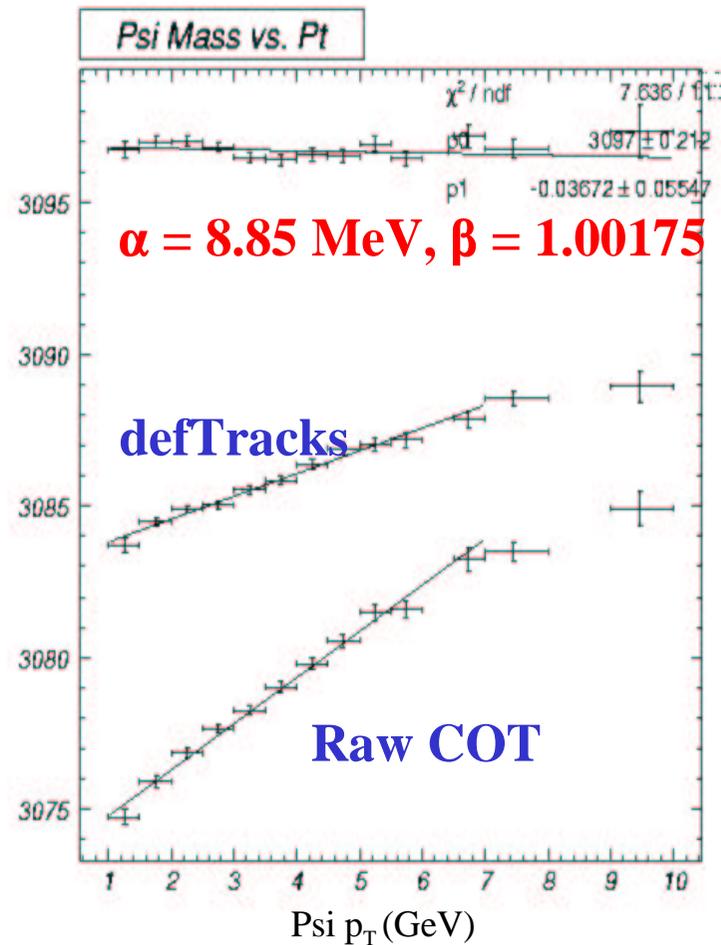


Raw vertex-fit reconstructed mass
(no e-loss)
 $m_\psi = 3079.35 \pm 0.06$ MeV
 $\sigma = 19.41 \pm 0.06$ MeV

$\alpha = 8.851 \pm 0.092$ MeV
 $\beta = 1.00175 \pm 0.00006$
 $m_\psi = 3096.88 \pm 0.06$ GeV
 $\sigma = 19.01 \pm 0.08$ MeV

Validation: P_T Dependence

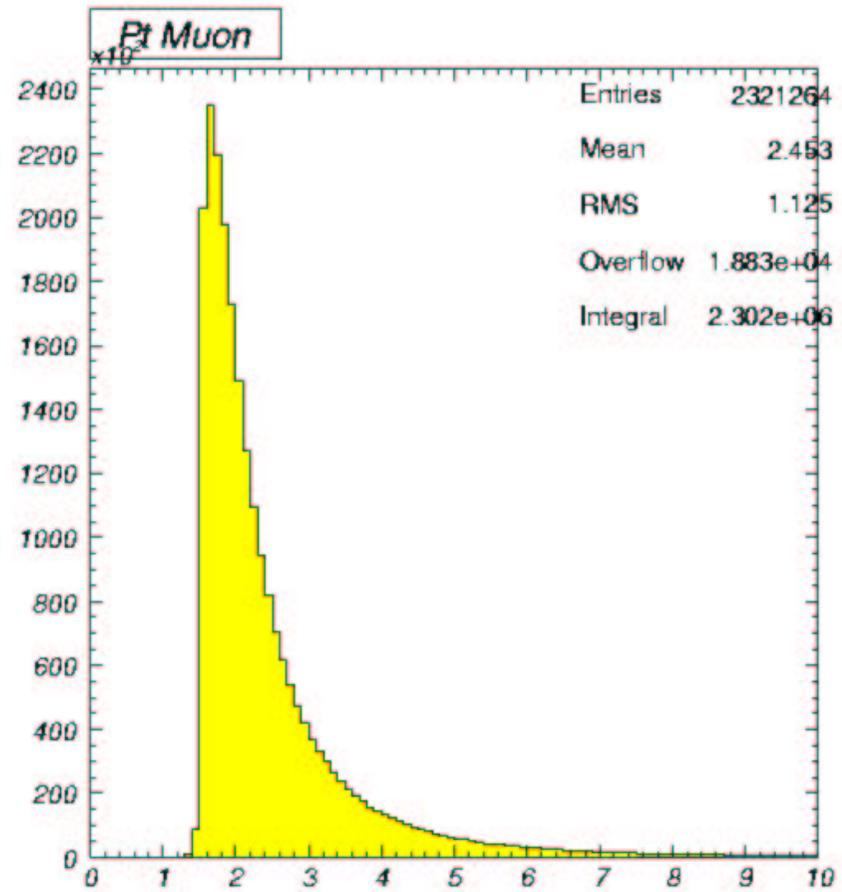
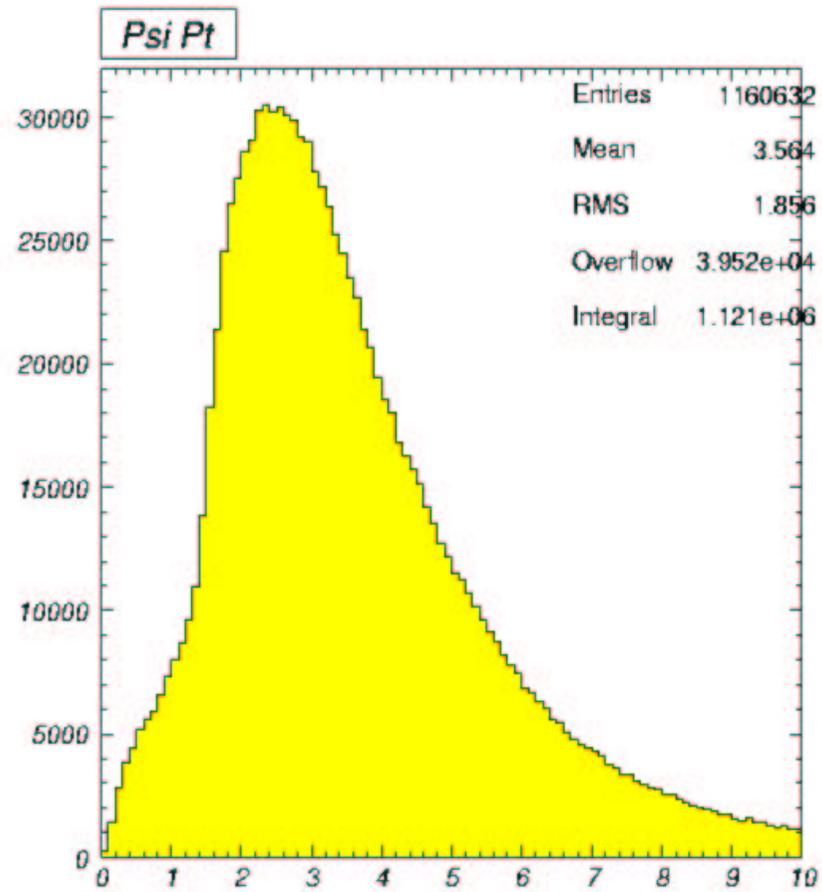
- Raw Tracks show strong mass dependence on ψ p_T
 - After corrections, mass vs. p_T should be a constant
- This set of parameters indeed eliminates dependence
 - α , β corrected line has slope consistent with zero



Conclusions

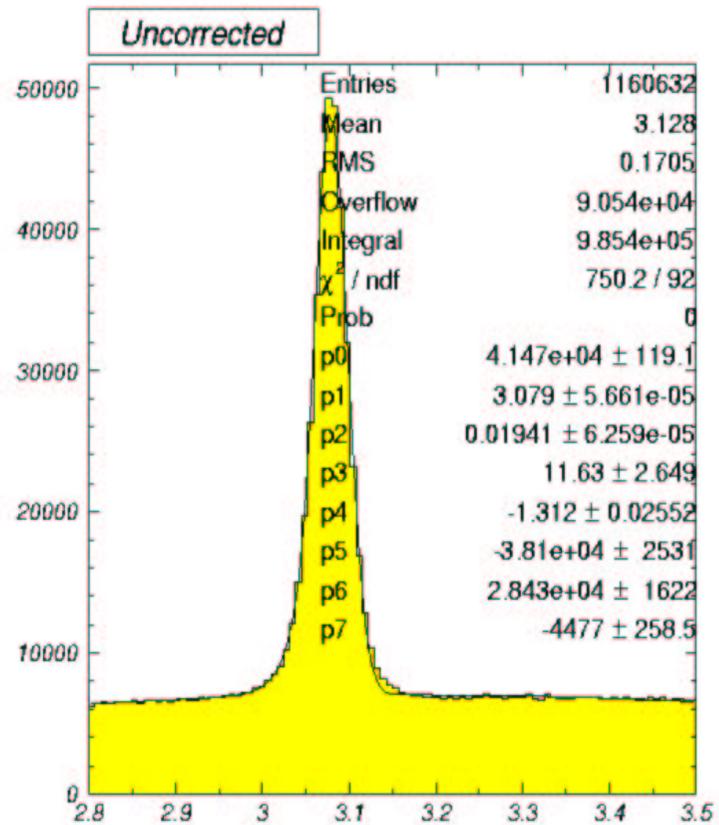
- Our measurement:
 - *On average*, energy loss corrections in defTrack material description are low by $\sim 8\%$
 - The magnetic field scale is low by $\sim 0.2\%$
- These findings agree with recent studies from MIT & Duke
- Extend method to be useful in creating map of the material in the detector

P_T Distributions

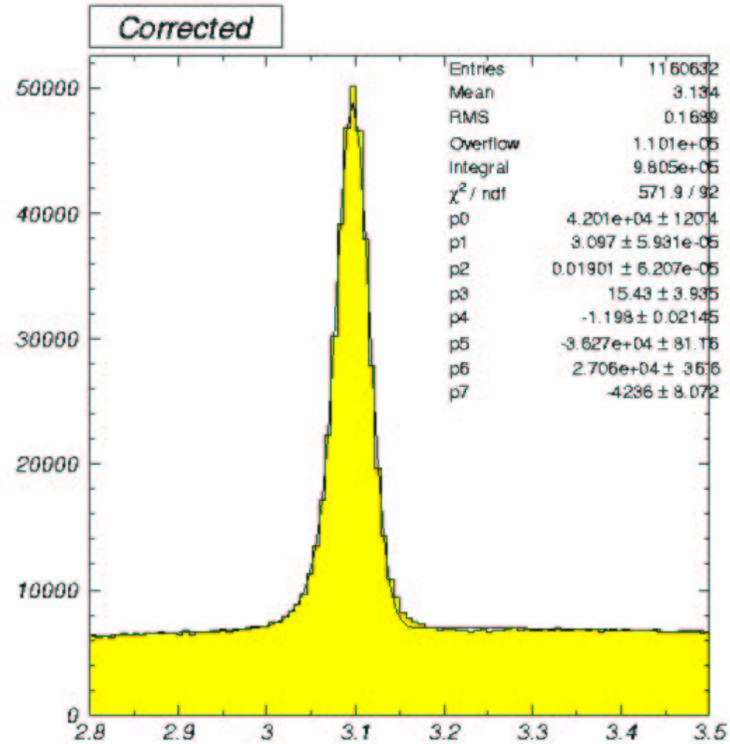
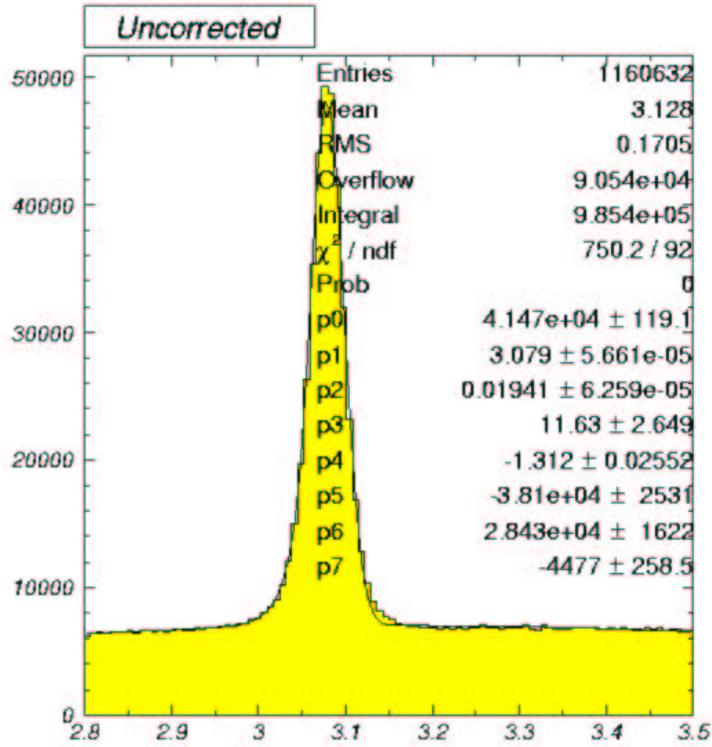


Crystal Ball Function

- Models radiative tail of the reconstructed mass distribution
 - Gaussian to right of tail
 - Power law on left
 - Quadratic background



Fit Parameters



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(no e-loss)

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$$\sigma = 19.41 \pm 0.06 \text{ MeV}$$

$$\alpha = 8.851 \pm 0.092 \text{ MeV}$$

$$\beta = 1.00175 \pm 0.00006$$

$$m_\psi = 3096.88 \pm 0.06 \text{ GeV}$$

$$\sigma = 19.01 \pm 0.08 \text{ MeV}$$

Data

- Data taken from the jbot0 sample
 - Runs 138k-152k
- Muon cuts
 - >2 Si hits
 - $|z| < 50\text{cm}$, $|\Delta z| < 2\text{cm}$
 - $|\eta| < 0.6$
 - $P_T > 1.5 \text{ GeV}$
 - $\chi^2 < 9$
 - $N_{\text{COT Hits}} > 20$
 - $L_{xy} / \sigma(L_{xy}) < 3$
 - In Minuit fit, mass is within 3σ ($\sim 60 \text{ MeV}$) of peak

Z Test

- Divide data into +z/-z sets and compare fit results
 - $z > 0$
 - $\alpha = 9.084 \pm 0.236 \text{ MeV}$, $\beta = 1.00165 \pm 0.00012$
 - $z < 0$
 - $\alpha = 8.816 \pm 0.145 \text{ MeV}$, $\beta = 1.00176 \pm 0.00009$