BaBar Tracking

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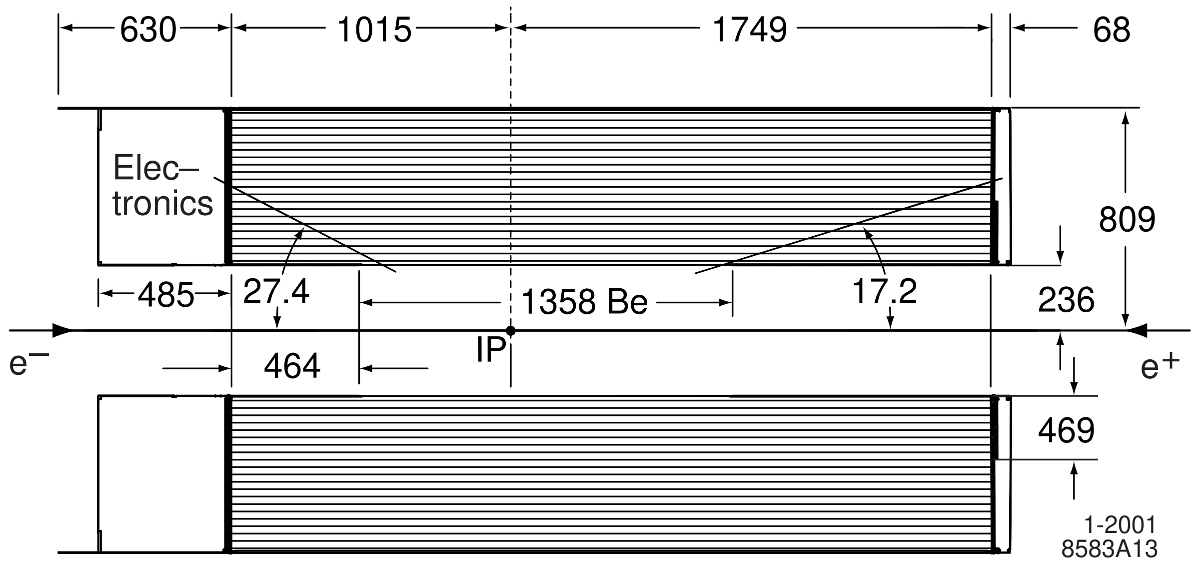
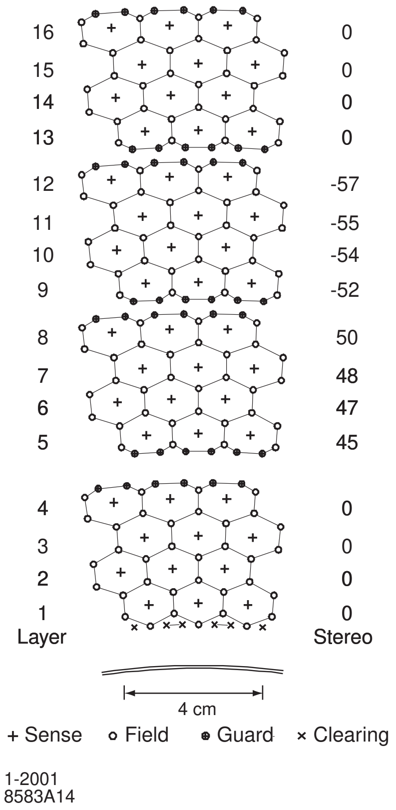
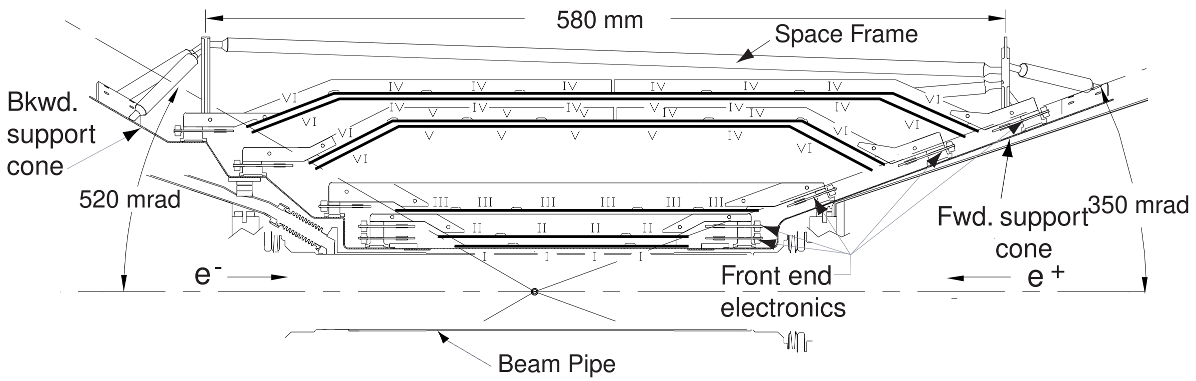
14 February 2002

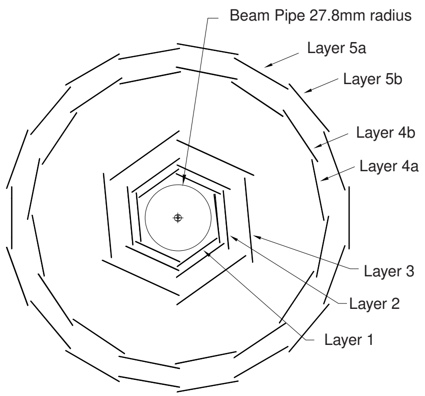
- Geometry
- Reconstruction
- Efficiency
- Track parameter resolution
- Calibration issues
  - Geometry, alignment
  - Kinematics
- Summary

BaBar tracking system



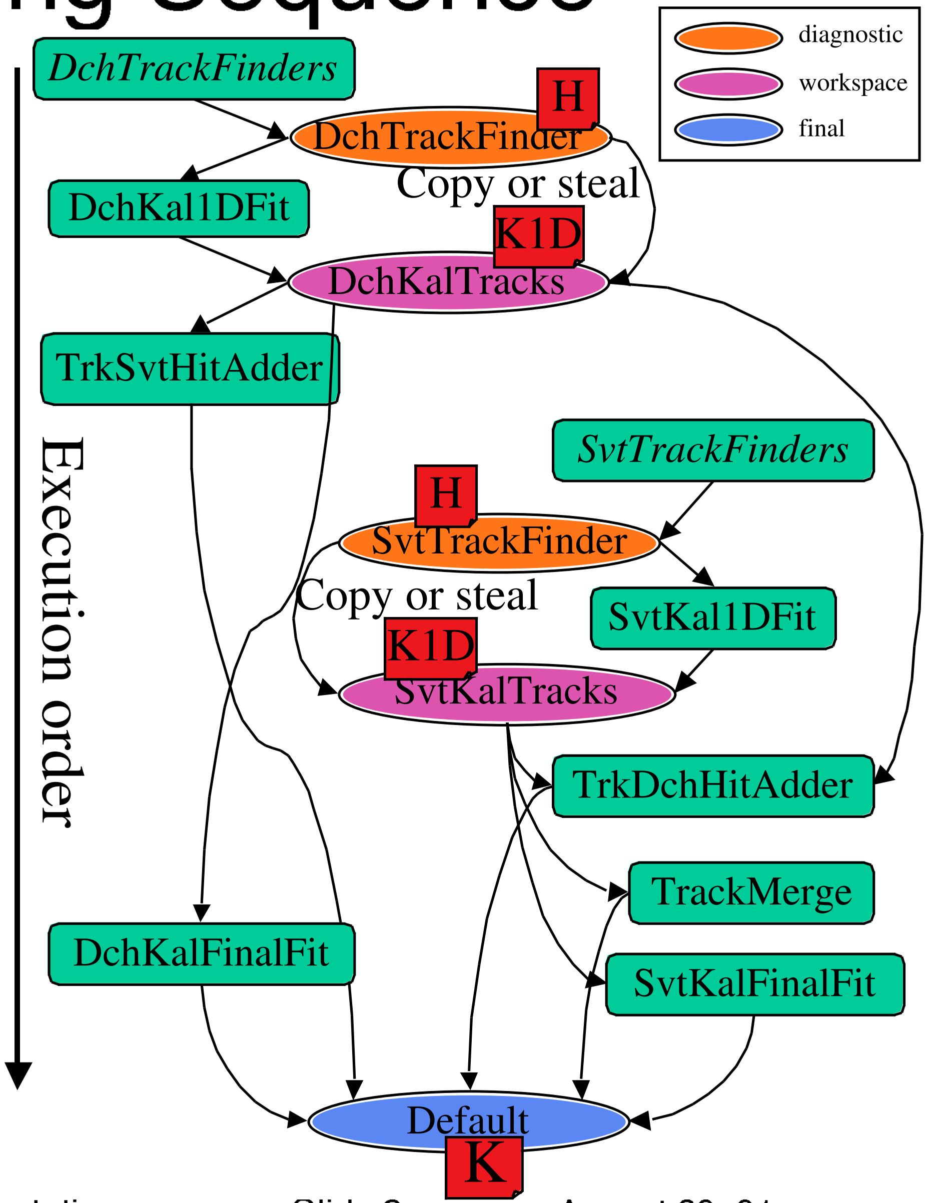






11.3.0 Tracking Sequence

- Helices Kalmanized by KalFit
  - Steal (production) or copy (diagnostics) helices
  - 1-Direction pre-fits to maximize efficiency
  - Final full fits done by 'combiners' on output
- Track Lists
  - Default has Final Tracks
  - XxxKalTracks are workspaces
- 'Combiner' modules
  - Input from XxxKalTracks list(s)
  - 'Merged' tracks move to Default
  - 'Unmerged' tracks stay behind
  - Modules can be re-ordered without reconfiguring them
  - New modules can be added
- Final KalFit instances to finalize fits of Xxx only tracks
- Minimal code changes



DST contents

- Current DST container set for physics is “micro”:
  - ◇ Four vectors (candidates) for charged tracks & neutral clusters
  - ◇ Initial e^+e^- state four vector
  - ◇ PID info
  - ◇ Numbers of hits, cluster shape info, etc.
- Not included
  - ◇ Non-pion Kalman fits
  - ◇ Access to hits
  - ◇ Most refined material accounting in track fits

Next generation DST

- Has accurate material model in track fits
- Offers more complete “mini” DST
- (without large increase in storage requirements)

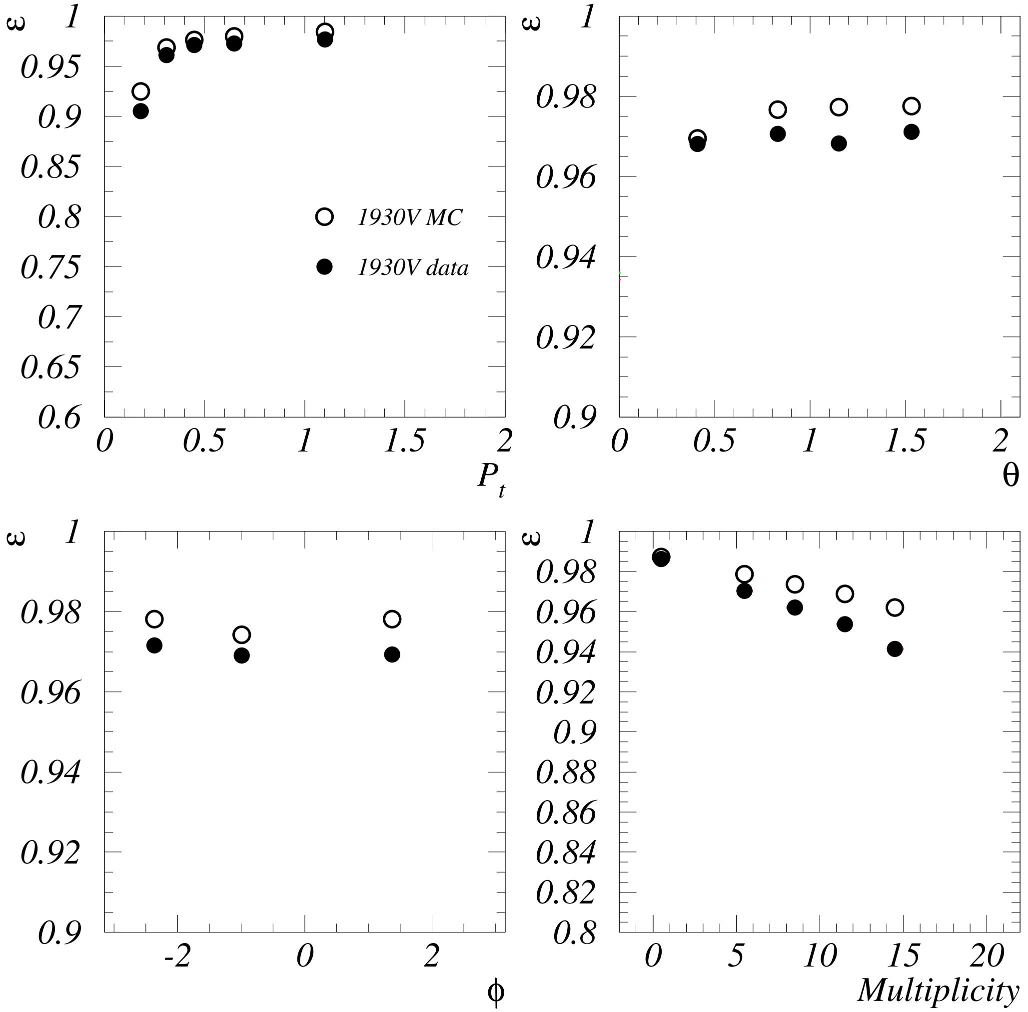
Charged track efficiency

Measure full track efficiency with Svt-only tracks

Global average data-MC difference is

$\sim 0.7\%$ per track

Tables give detailed correction

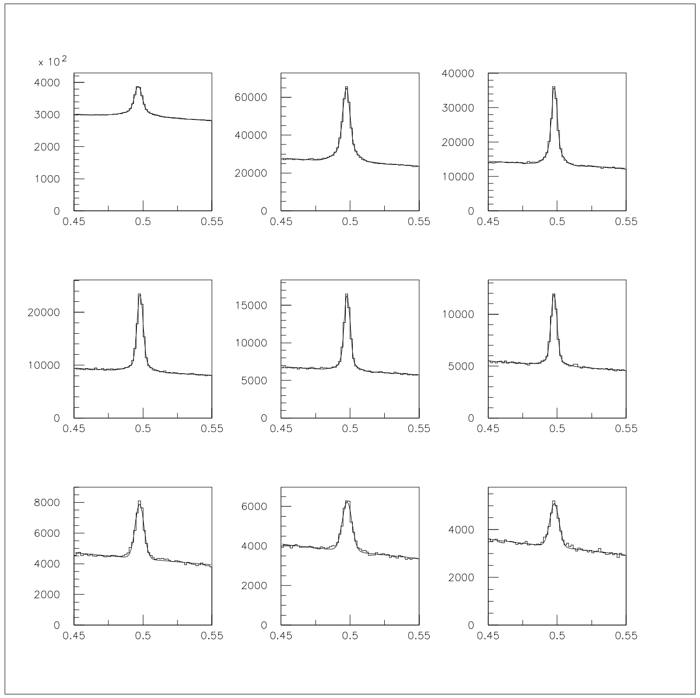


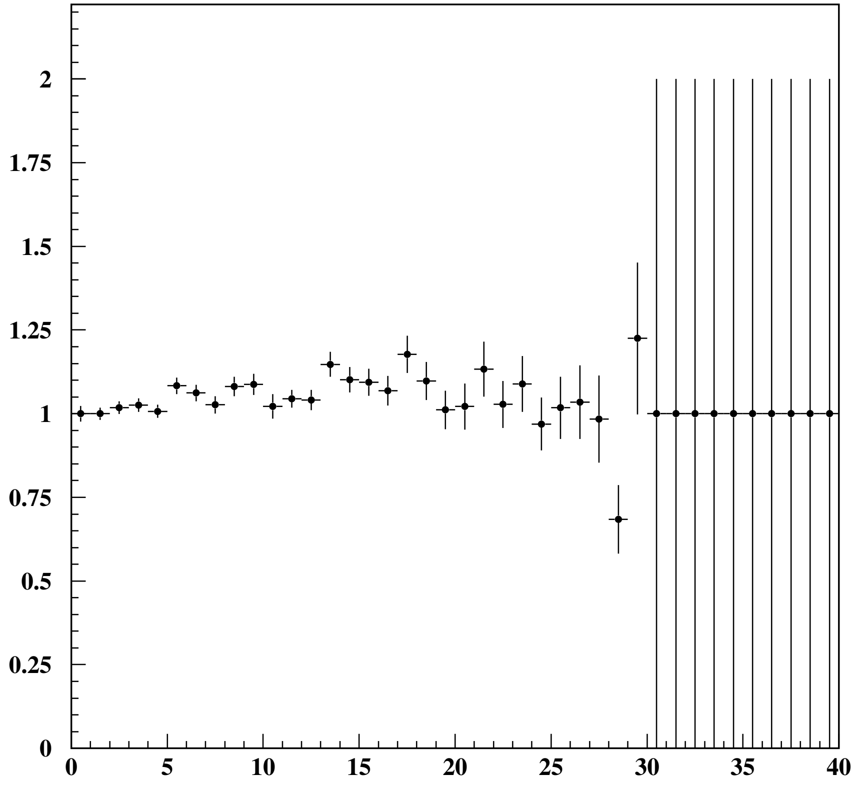
K_s^0 Efficiency Correction

Given efficiency to

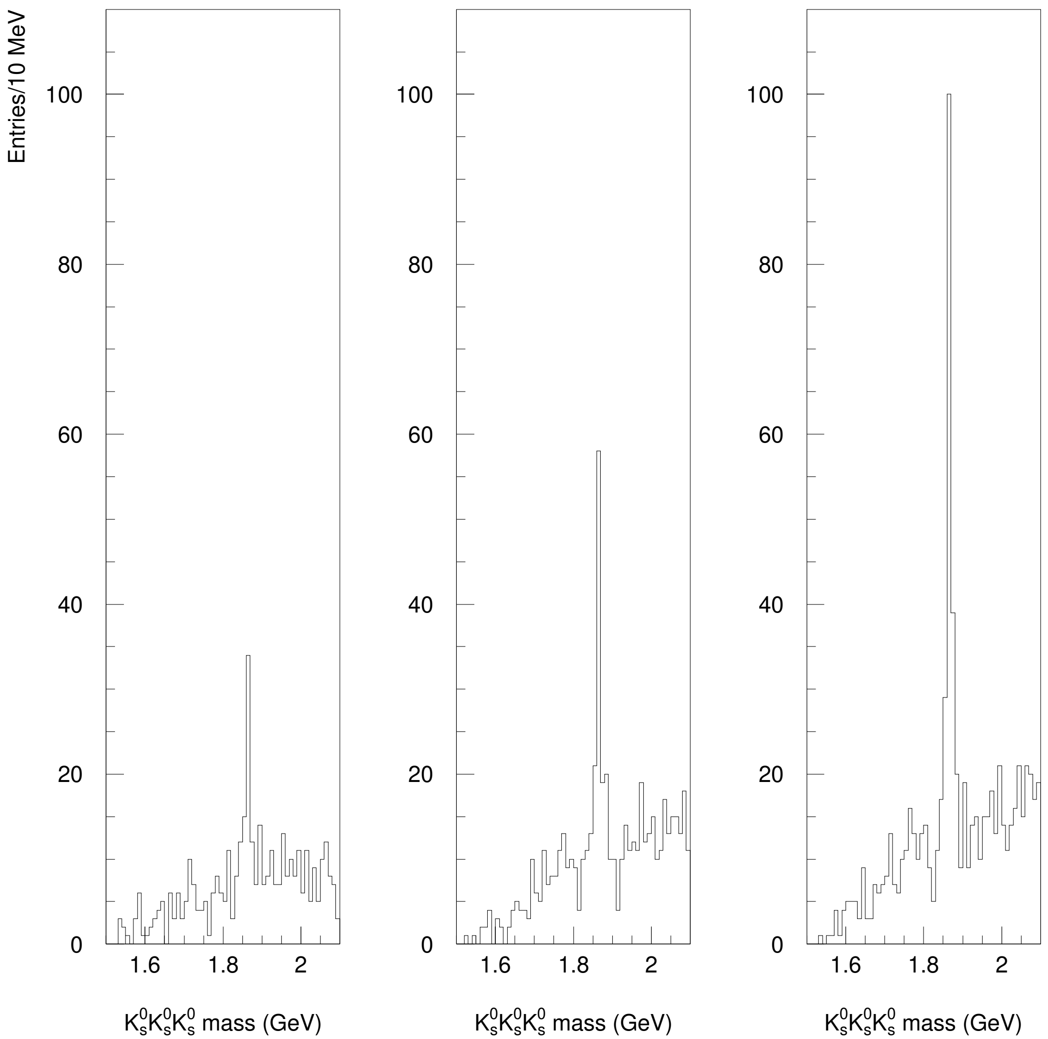
- find two prompt tracks
- fit them as a vertex

Multiply by this flight length dependent factor $\frac{\text{data}}{\text{MC}}$





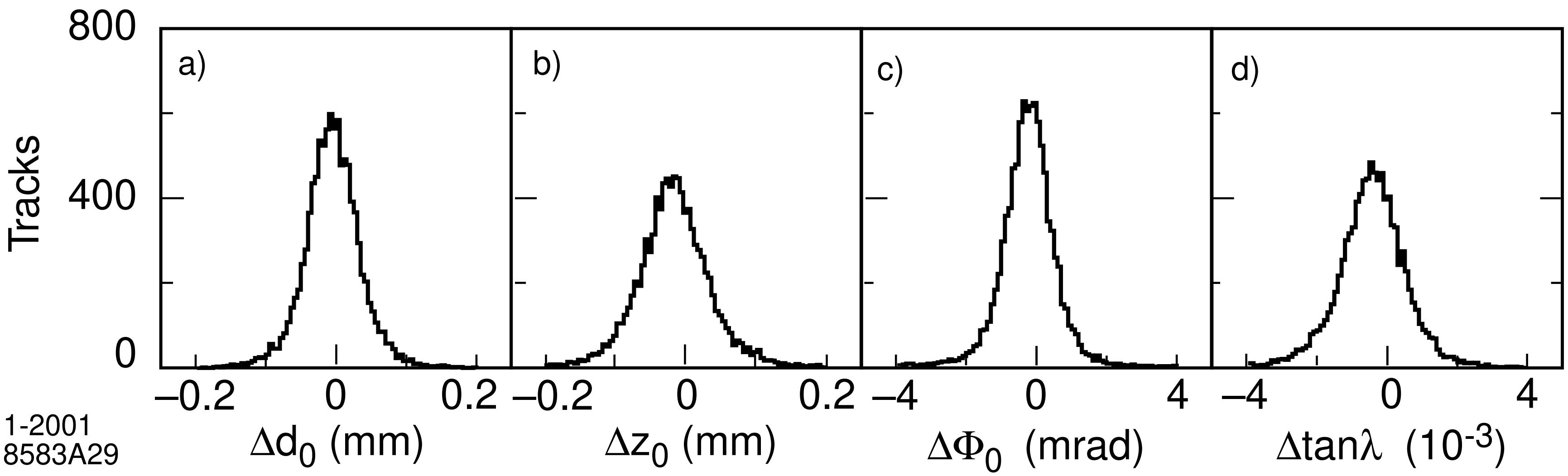
$D^0 \rightarrow K_s^0 K_s^0 K_s^0$



Left: 1900 V; Mid: 1960 V; Right: 1930 V, latest reco

Track parameter resolution

Vertex and angles, from cosmic ray down-up difference. $p_t > 3$ GeV/c



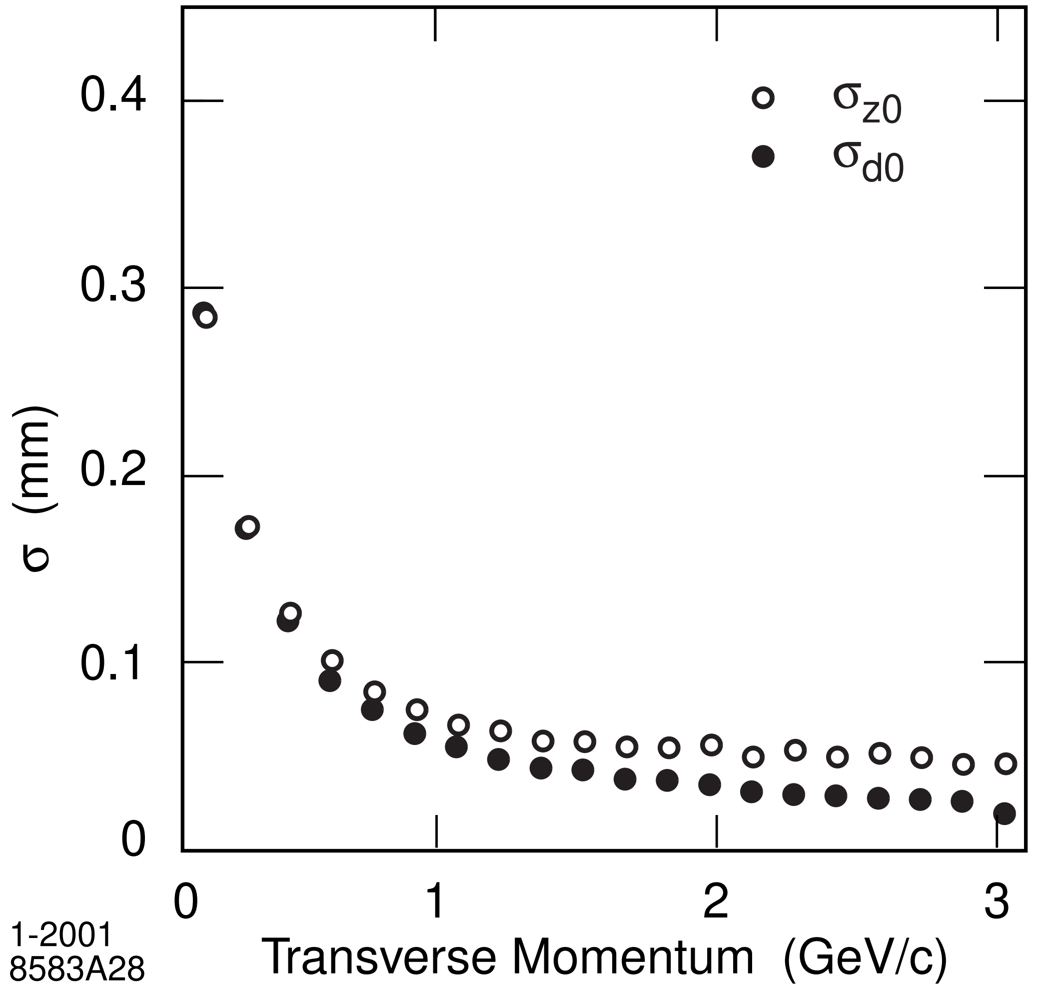
$$\sigma(d_0) = 23\ \mu\text{m} \qquad \sigma(\phi_0) = 0.43\ \text{mrad}$$

$$\sigma(z_0) = 29\ \mu\text{m} \qquad \sigma(\tan\lambda) = 0.33 \cdot 10^{-3}$$

Pulls in these variables (dominated by Svt) are within 10% of unity

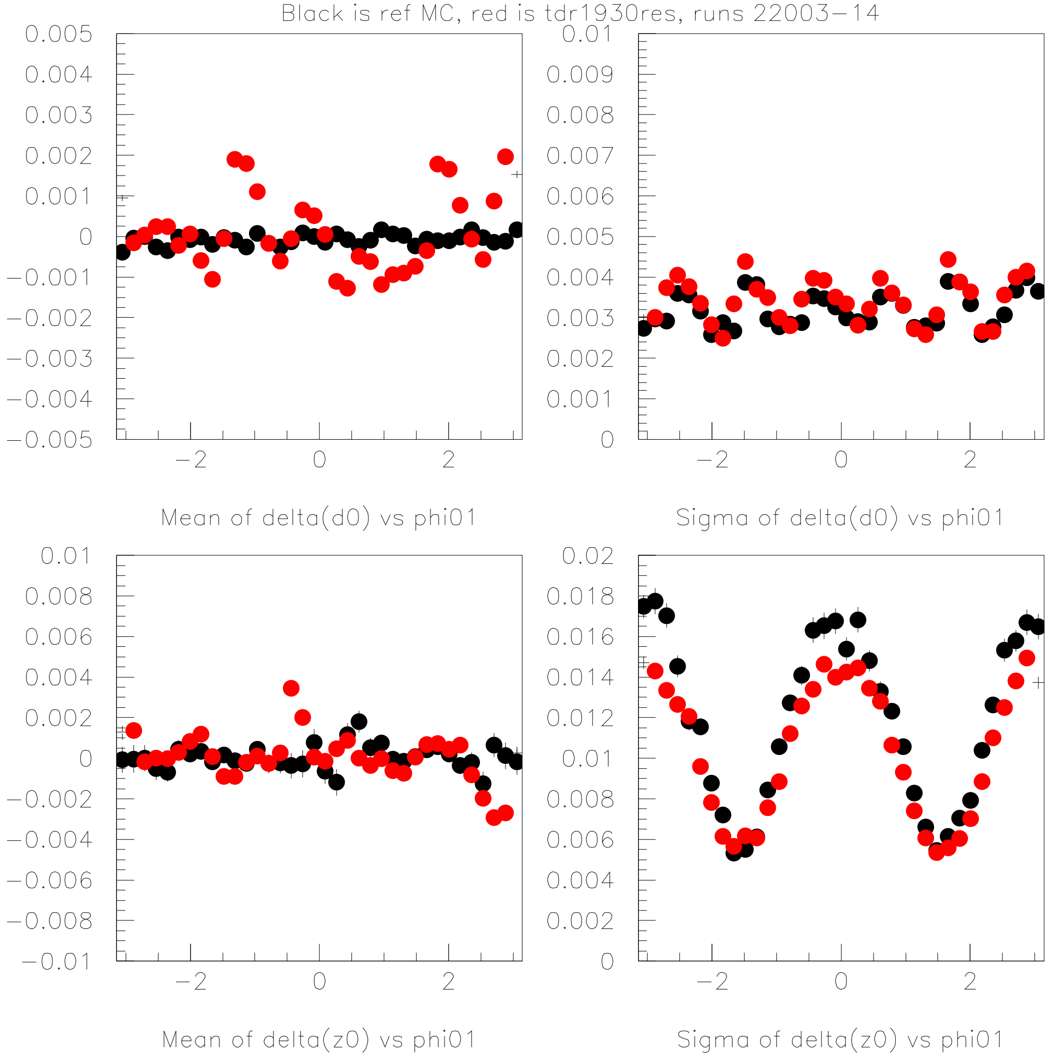
Impact parameter resolution vs p_t

(Corrected for decays and vertexing errors)



Impact parameter alignment biases

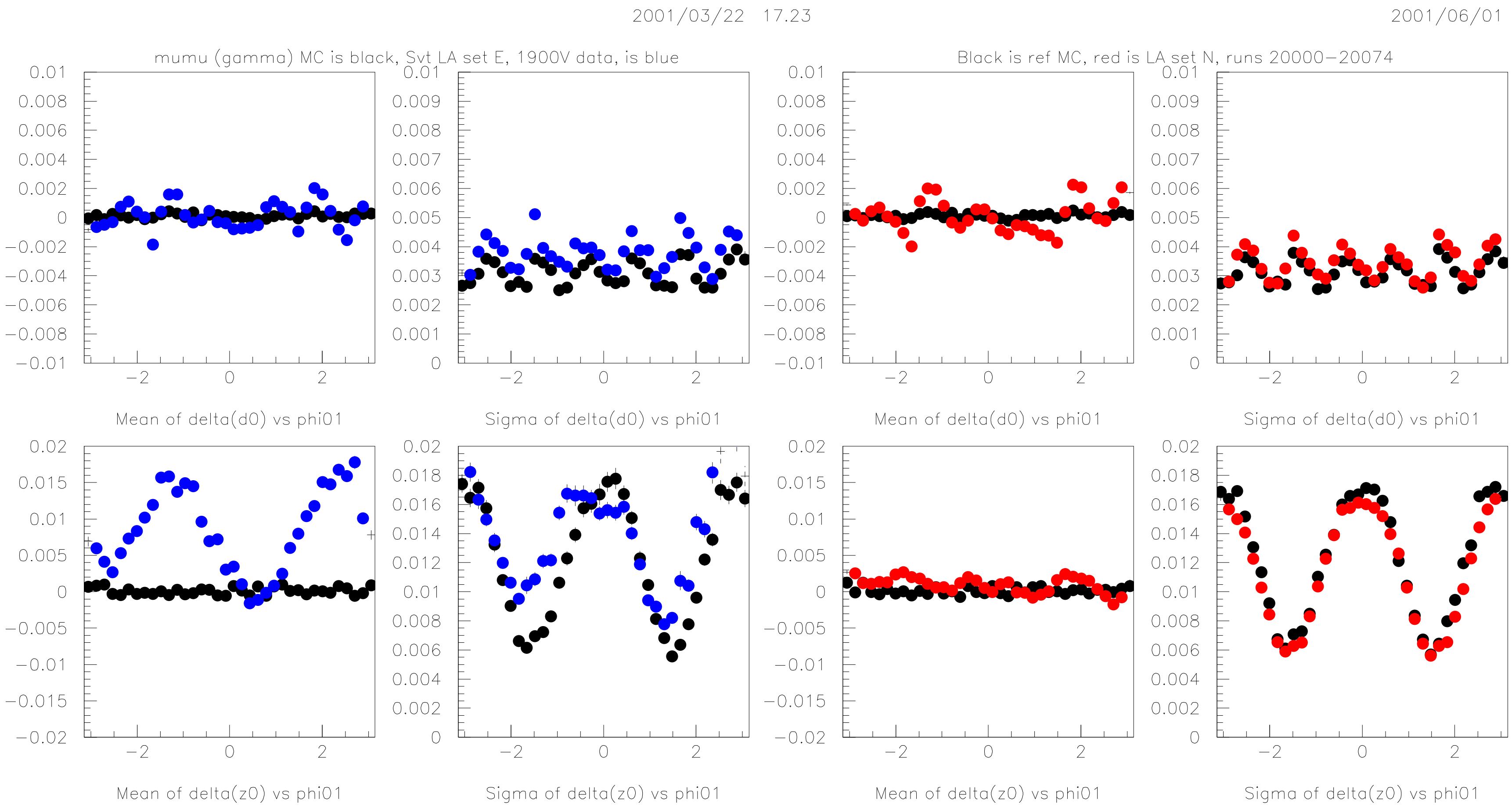
Muon pair d_0 and z_0 miss distances vs ϕ (black is MC, red data)



These reflect Svt internal alignment

Better than previous year

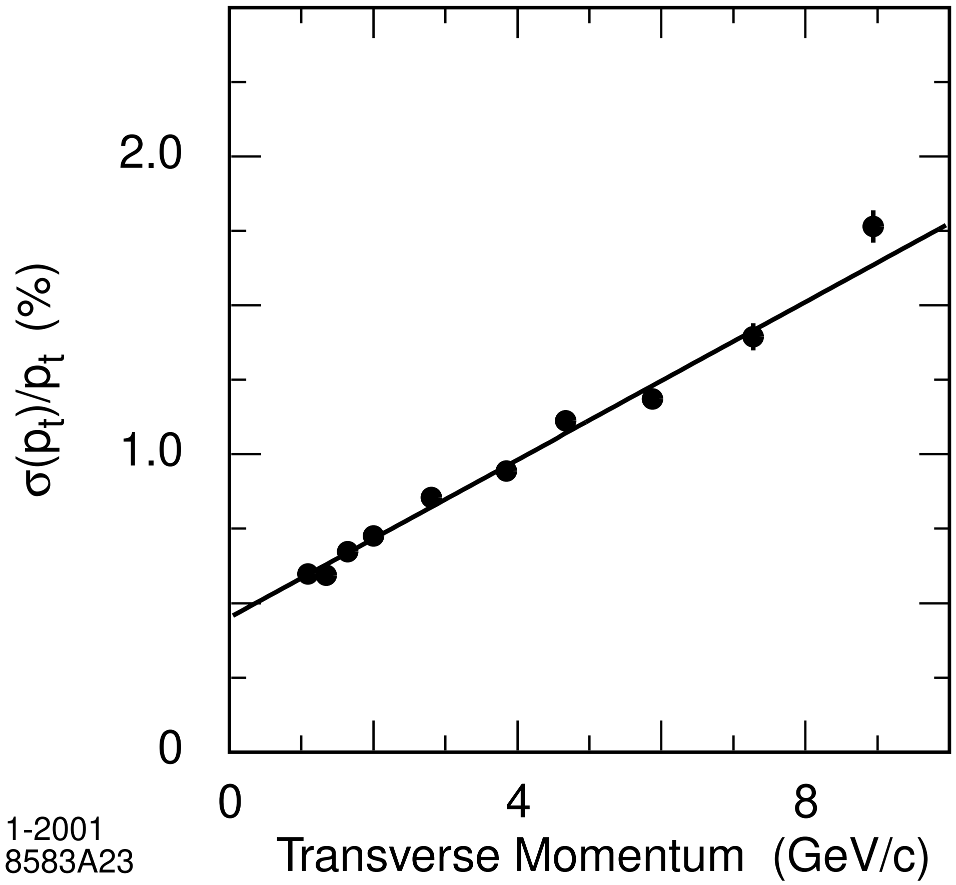
Muon pair impact parameter d_0 and z_0 miss distances vs ϕ
(black is MC, color data)



Run 1 old processing, (svt set E) Run 2 OPR

Track P_T resolution

Cosmic ray down-up difference



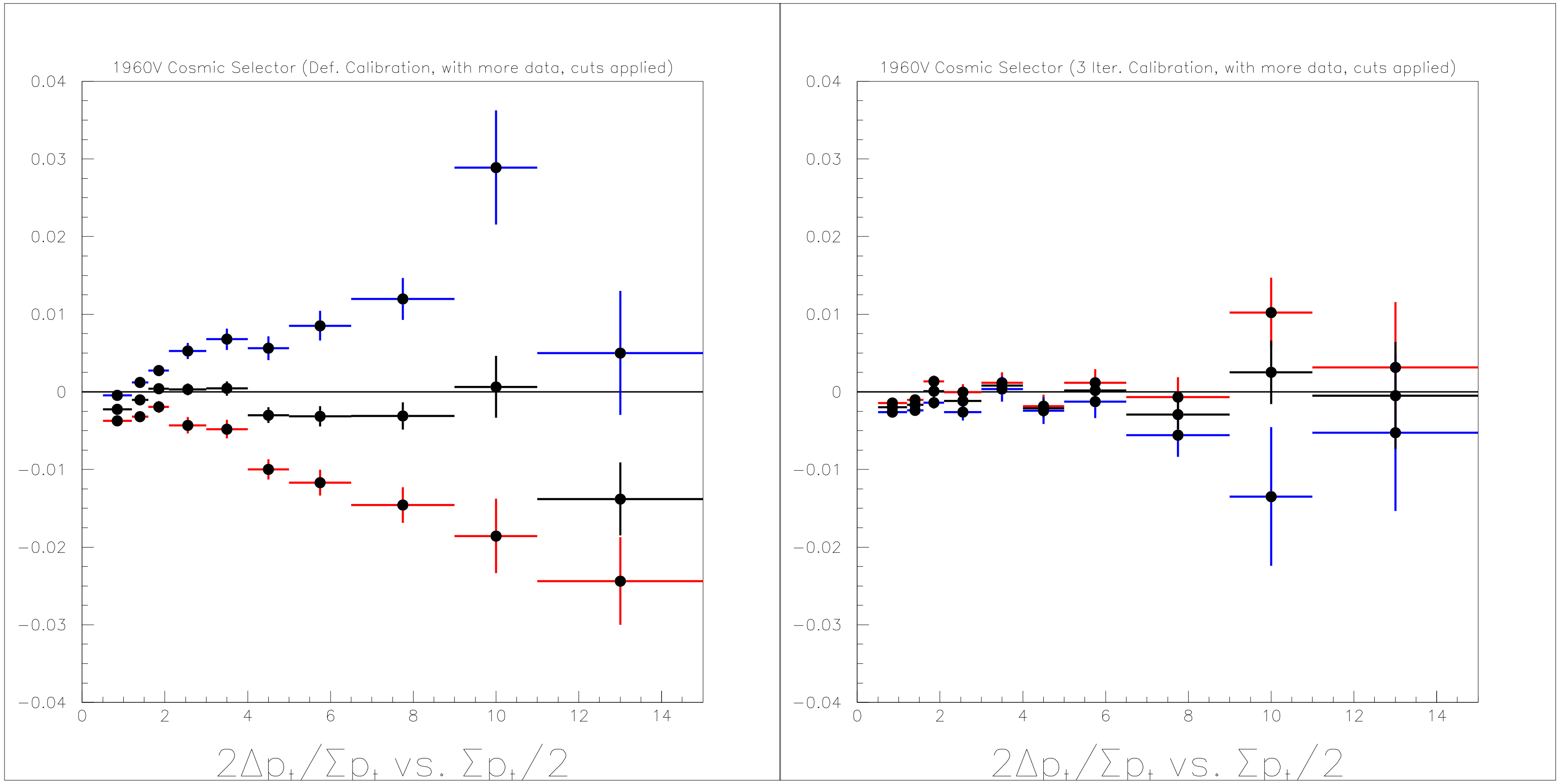
$$\sigma(p_t)/p_t = [(0.13 \pm 0.01) \cdot p_t + (0.45 \pm 0.03)]\,\%$$

Pull is about 1.3, based on Dch single hit resolution

P_T bias

Here for 1960 V Positive (negative) charged Dch-only tracks in cosmics

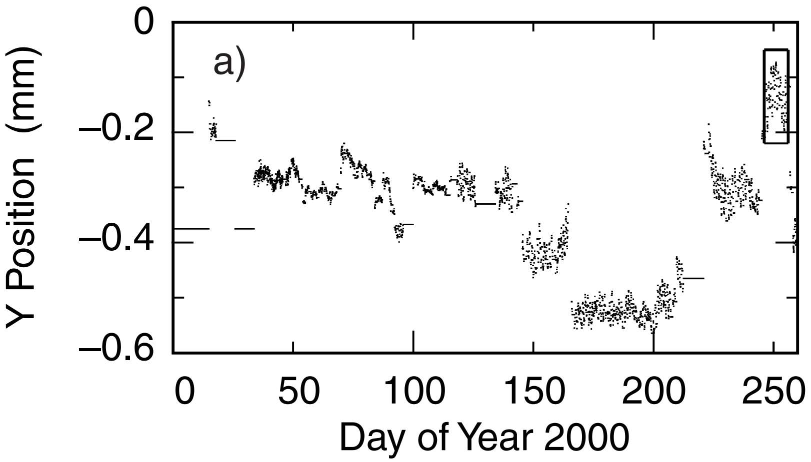
Earlier Dch time to distance Current calibration



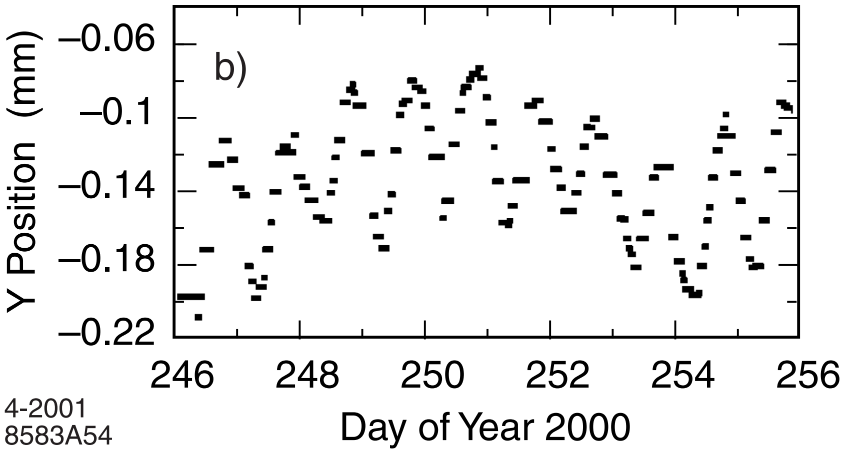
Much better p_T matching

Global alignment and Svt motion

Long term

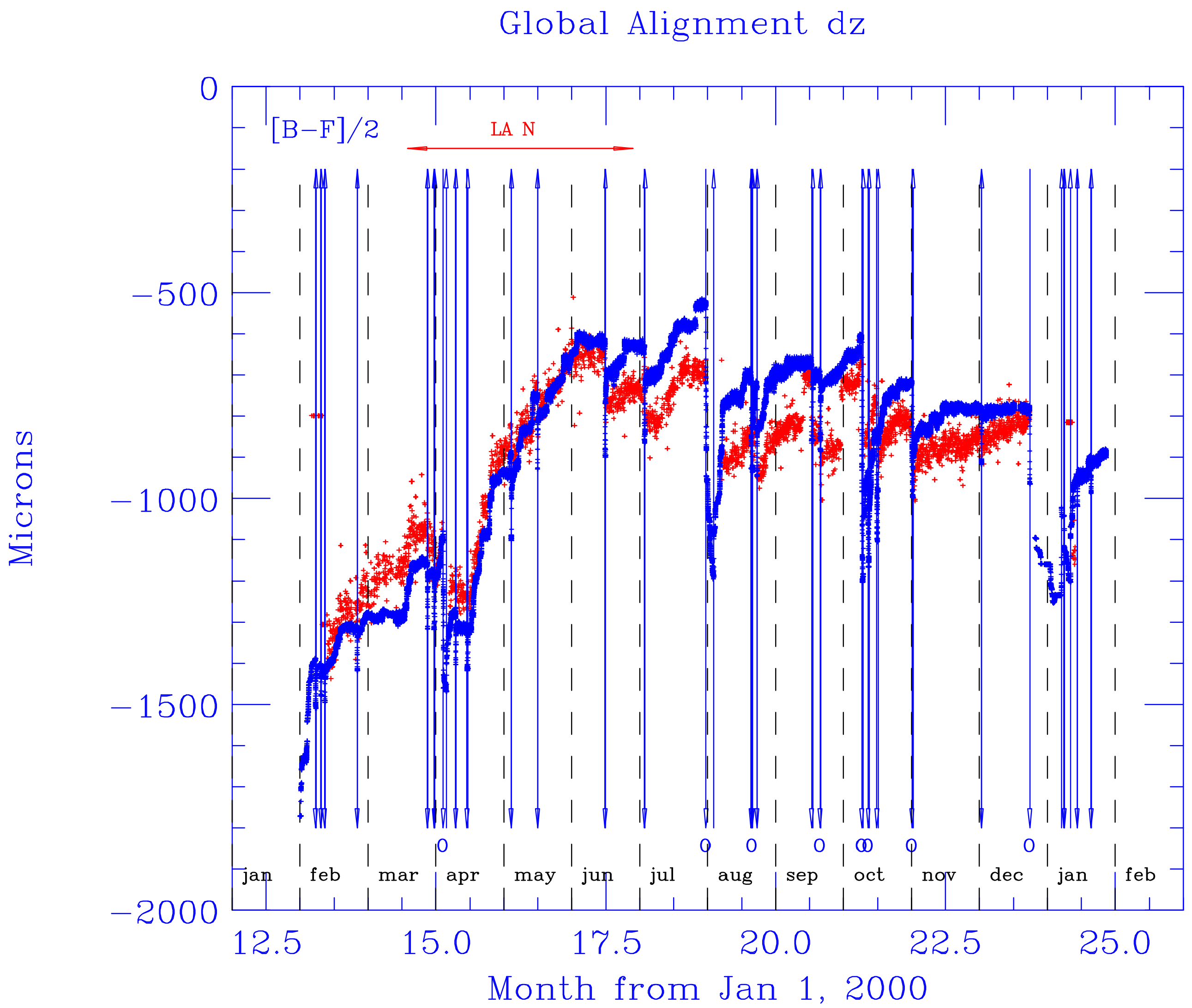


Diurnal



Motions are well tracked by rolling online calibration (μ pairs)

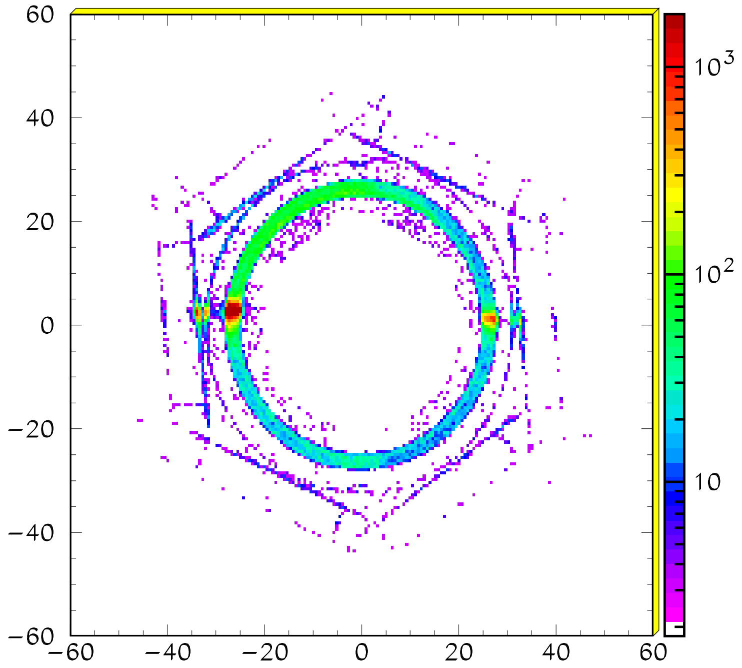
Compare Global alignment with mechanical sensor

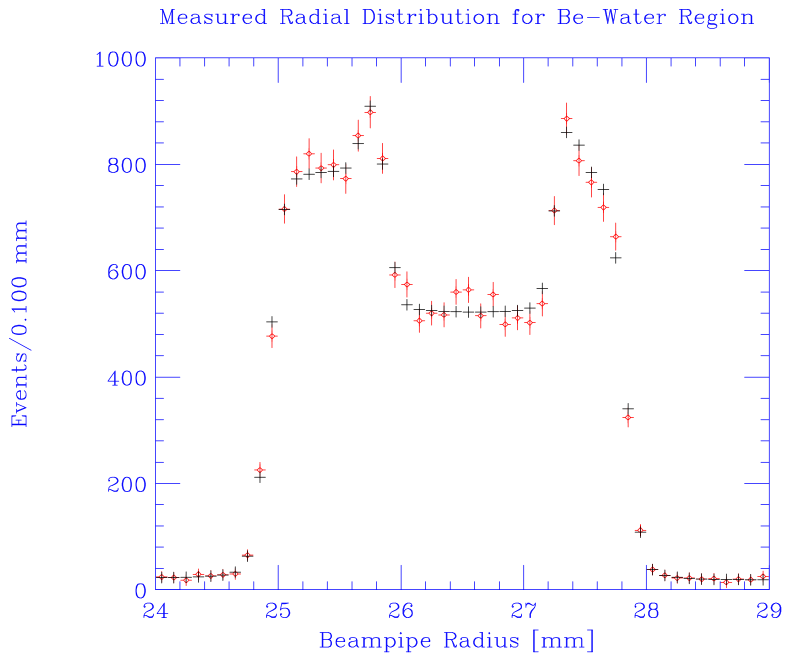


Global alignment; Mech. sensor. Vertical arrows indicate solenoid transitions on/off.

Absolute length scale

Electroproduced protons probe physical elements, establish absolute scale





In red : Data

In Black : Fit to the beam pipe material distribution

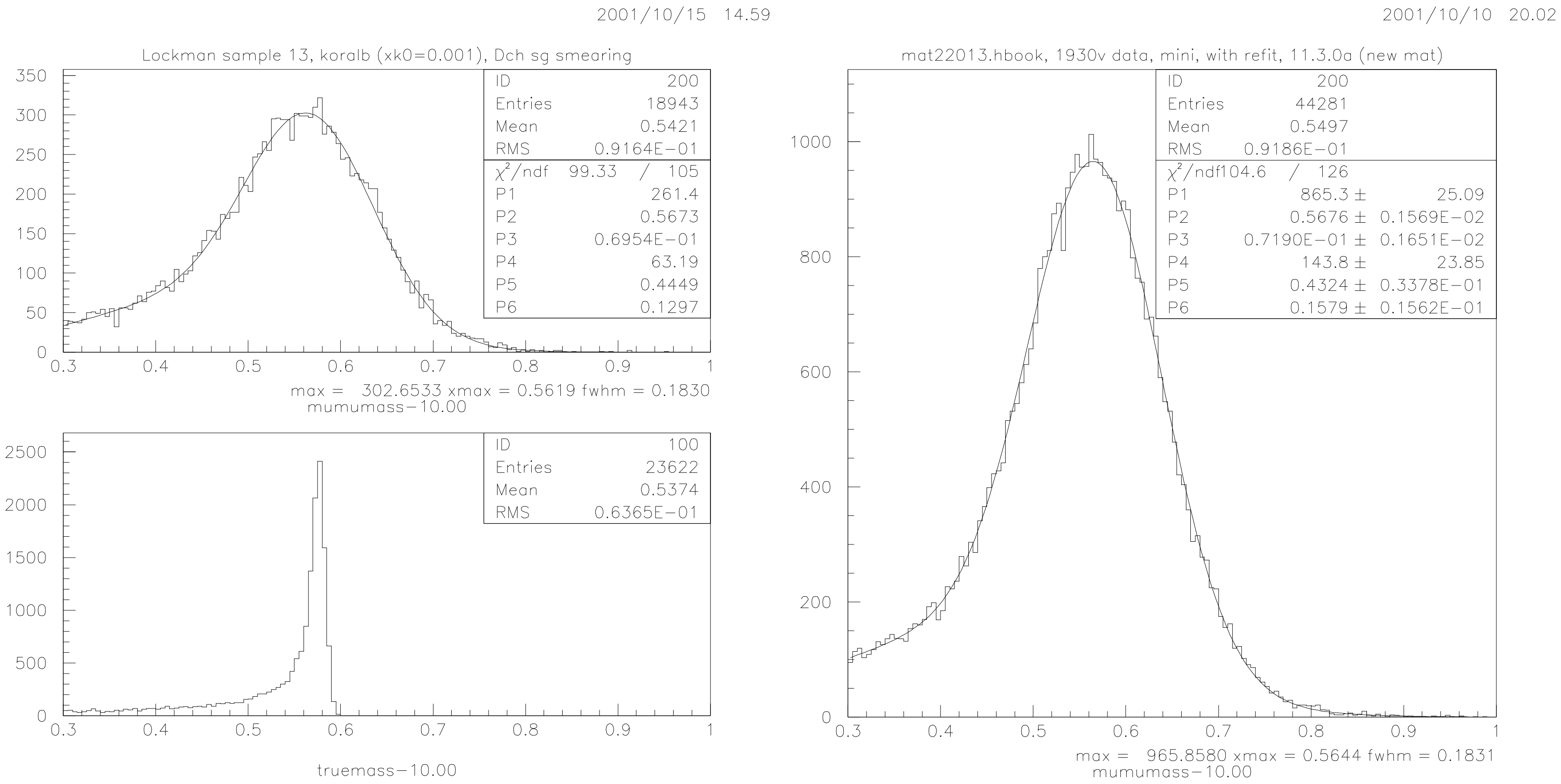
Find the detector's radial scale correction is $3 \pm 1 \times 10^{-3}$; similarly for z

Mass biases?

Several calibration points studied, e.g.,

- $\Upsilon(4S) \to \mu^+\mu^-$
- ΔE in $B^0 \to D^-(\to K^+\pi^-\pi^-)\pi^+$
- $K_s^0 \to \pi^+\pi^-$
- $J/\psi \to \mu^+\mu^-$
- $D^0 \to K^-\pi^+$

$M(\Upsilon(4S) \to \mu\mu)$, MC (KORALB, $k0 = 1$ KeV); Run2 Data

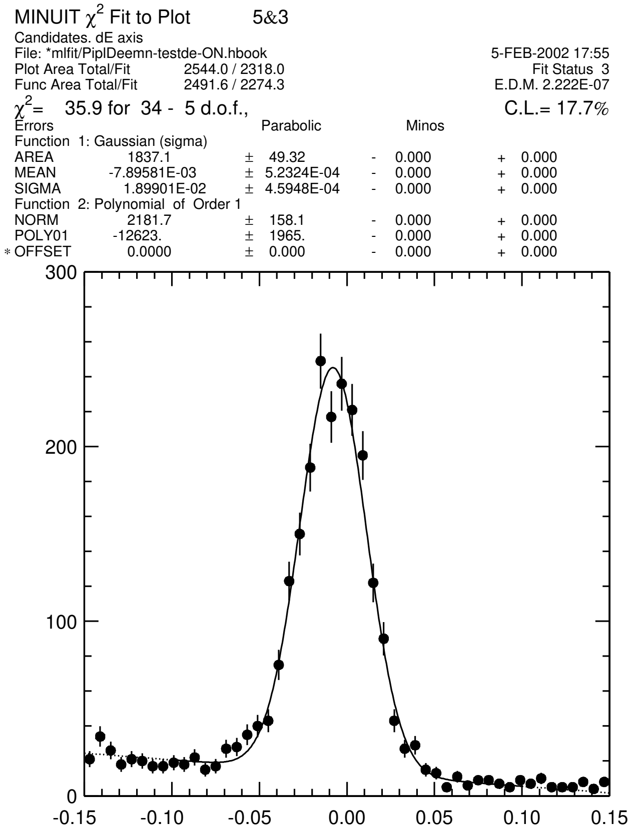


MC peak mass $= 10562 \pm 1.4$ MeV/c^2, FWHM $= 183 \pm 1.5$ MeV/c^2

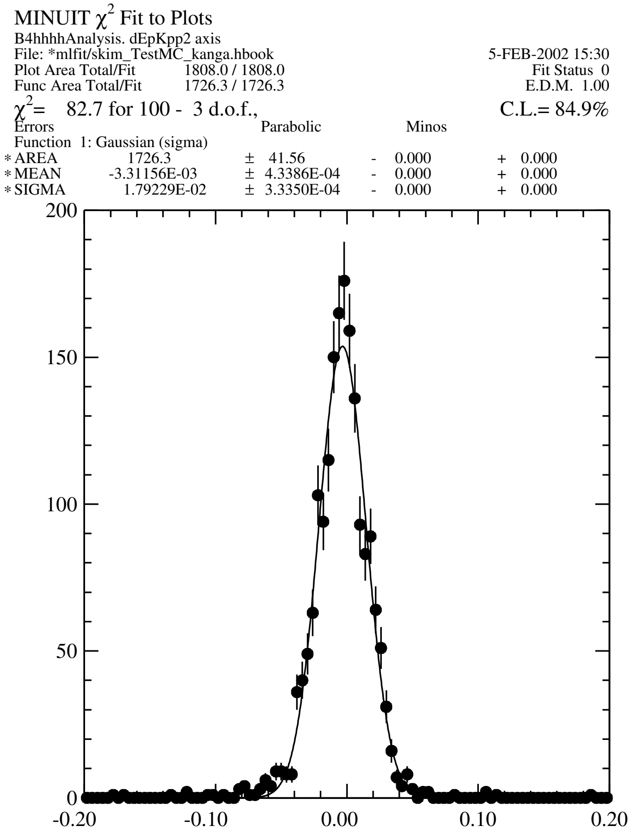
data peak mass $= 10564$ MeV/c^2, FWHM $= 183$ MeV/c^2

$B^0 \to D^-\pi^+ \to (K^+\pi^-\pi^-)\pi^+$ (Revised)

RUN1+2 DATA

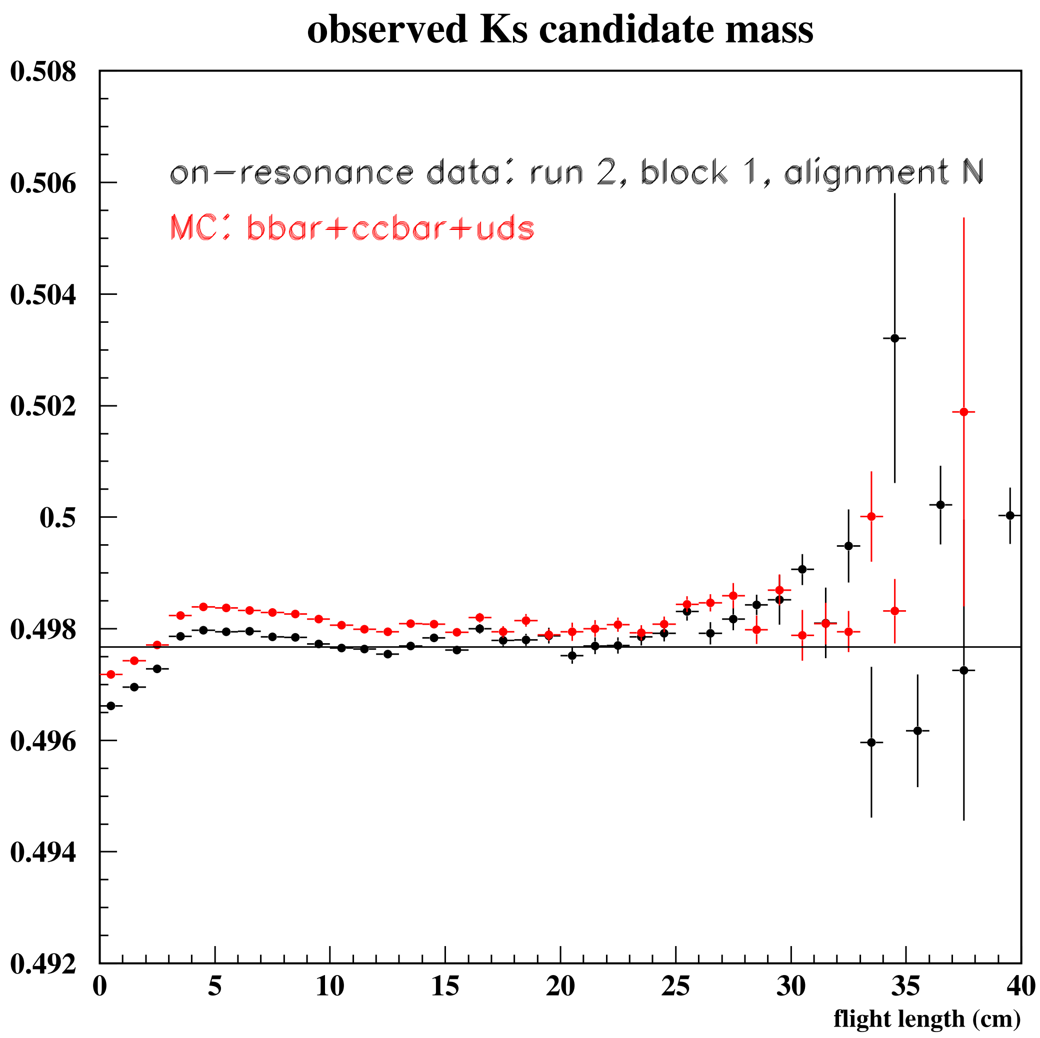


SP4 MC



ΔE m	-7.9 ± 0.5 MeV	-3.3 ± 0.4 MeV
$\Delta E\ \sigma$	19.0 ± 0.5 MeV	17.9 ± 0.3 MeV

$K_s^0 \longrightarrow \pi^+\pi^-$



- Point at zero decay length will increase with full material model in reco
- Rise with R will decrease with fits that compute energy loss from the decay point, rather than from the origin
- data-MC difference ($\sim 0.5\ \mathrm{MeV/c^2}$)?

J/ψ mass study

- For 1900 V data, $\Delta m = -1.7 \pm 0.2$ MeV/c^2
- For 1960 V data, $\Delta m = -1.5 \pm 0.2$ MeV/c^2

... relative to MC. For 2001,

- For 1930 V data,
  $\Delta m = -3.4 \pm 0.3 - (-1.7 \pm 0.1) = -1.7 \pm 0.3$ MeV/c^2

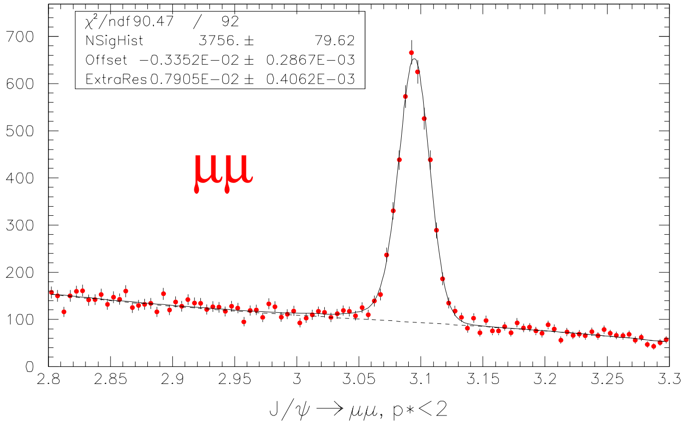
from the top distribution on the next page.

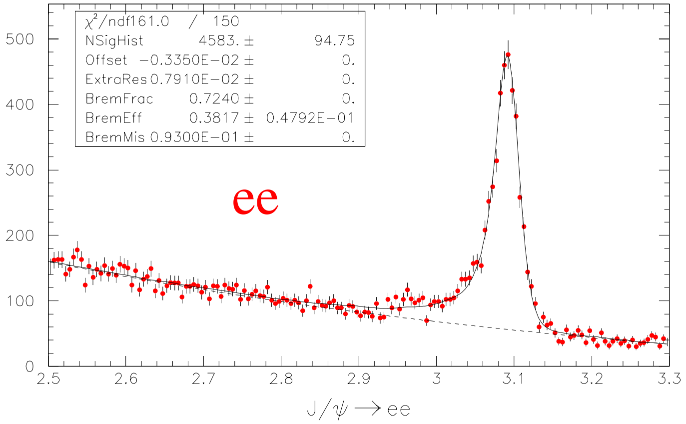
J/ψ mass resolution (RUN2)

- J/ψ →μμ mass resolution
  RUN 2 (DCH HV=1930V):
  12.3 ± 0.3 MeV

MC: 12.0 ± 0.1

RUN 1:
13.0 ± 0.3 MeV (1900V)
11.4 ± 0.3 MeV (1960V)



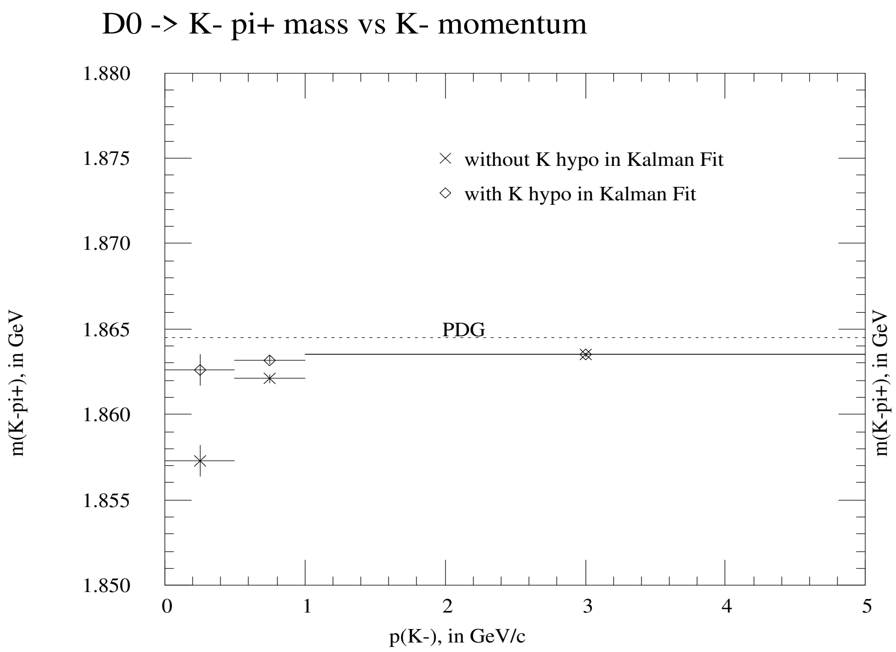


June 26 2001 Kenji Abe

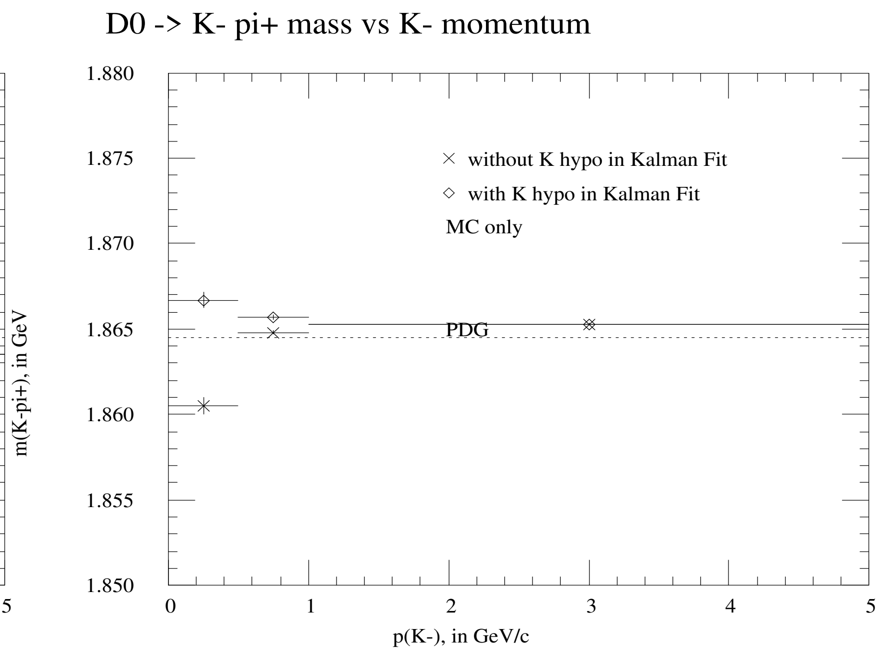
Mean mass - PDG $(\mu\mu) = -3.4 \pm 0.3 \ \mathrm{MeV/c^2}$

D^0 mass

(We currently have only pion Kalman fit available)



Run1 data



MC

Note that for all D, D_s the absolute mass comparison includes uncertainty of $\pm 0.5\ \mathrm{MeV/c}^2$ in the PDG world average.

Summary

- The *BABAR* tracking system performs at or very near its design specs
- Some outstanding calibration issues
  - ◇ Further refine Svt internal alignment
  - ◇ Small Dch geometry bias
  - ◇ Small bias in reconstructed masses (magnetization field?)
- Developing data summary layer ("mini") with access to
  - ◇ All track fit hypotheses
  - ◇ Material traversed vs track length (Vees)