new DCH dE/dx measurement simulation in fastsim and comparison with Babar

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dE/dx simulation in FastSim

- $\langle dE/dx \rangle_{hit}$ is computed with the Bethe Bloch function and then smeared according to $\sigma(\langle dE/dx \rangle_{hit})$

(Gaussian smearing)

built-in in FastSim

- $\sigma(\langle dE/dx \rangle_{hit})$ is parameterized as

$$\sigma\left(\frac{dE}{dx}\right) = \alpha\left(\frac{dE}{dx}\right)^{\beta} dx^{\gamma}$$

where α, β, γ parameters are chosen as:

$\alpha =$ tuned on Babar data

$\beta = 1$

$\gamma =$ tuned on Babar data

step 1:determine γ

tuned according to fit in backup slide

step 2:determine α

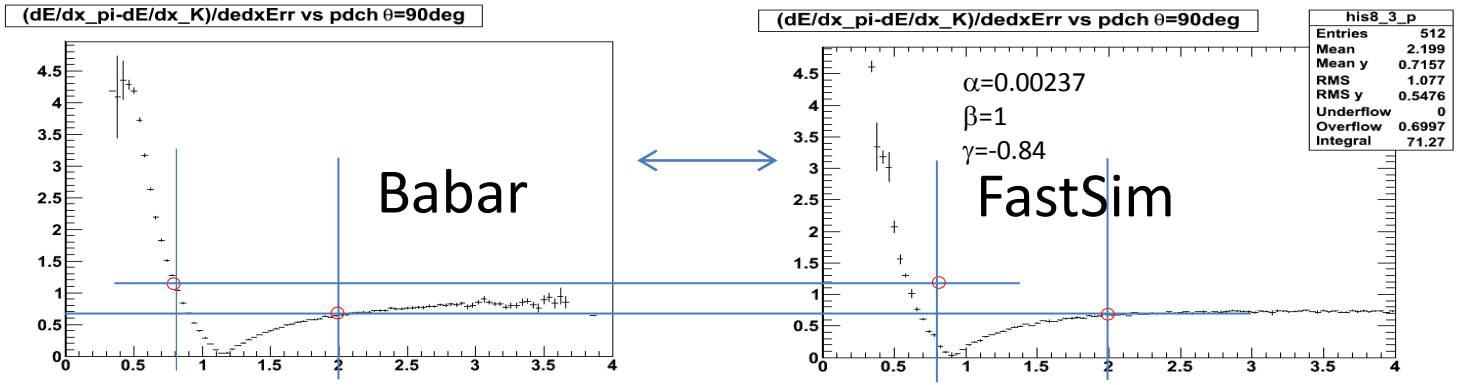
tuned according to Babar K/pi separation

- $\langle dE/dx \rangle_{track}$ is measured as a 'random' truncated average of $\langle dE/dx \rangle_{hits}$

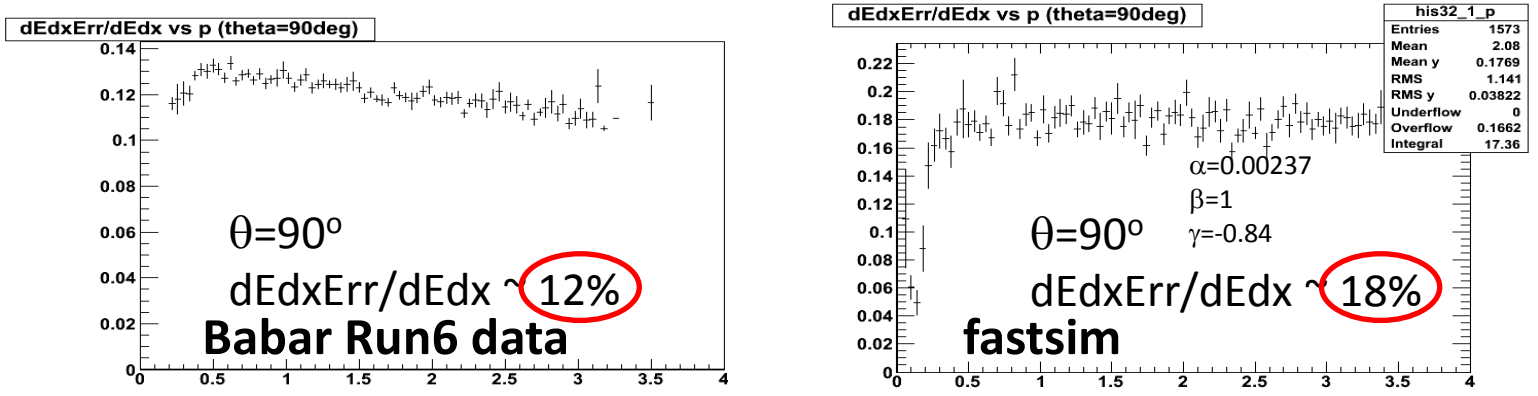
If the trunc_frac =70% then 30% of $\langle dE/dx \rangle_{hits}$ are removed randomly. $\langle dE/dx \rangle_{track}$ is the weighted mean of the remaining 70%. $\sigma^2\langle dE/dx \rangle_{track}$ is computed as the variance of the weighted average.

It is currently assumed that the DCH dE/dx performance in SuperB and Babar are similar. But impossible to find a set of α,β,γ such that the agreement between Babar and Fastsim is generally good. For example, requiring equal K/π separation at p=2GeV (θ=90deg) implies:

A) the separations at other p values do not match:

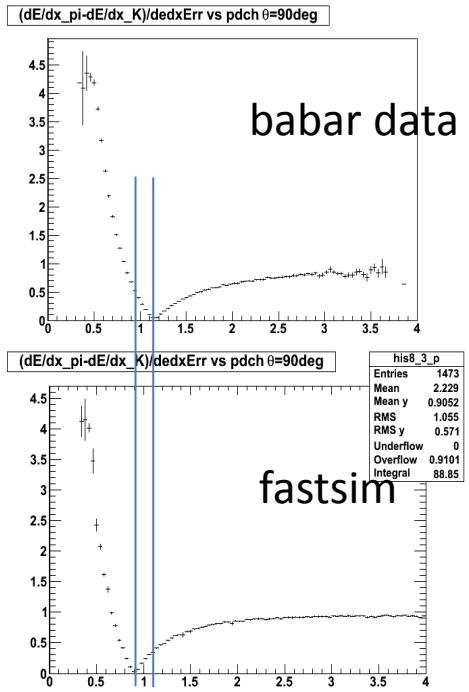


B) the relative dE/dx errors are significantly different:



π/K separation vs fastsim

- the main source of discrepancy is the different position of no-separation points
- but it's not the only one
  - i.e., translating the fastsim Bethe-Bloch to match the point of no K/π separation is not sufficient to reach a very good agreement

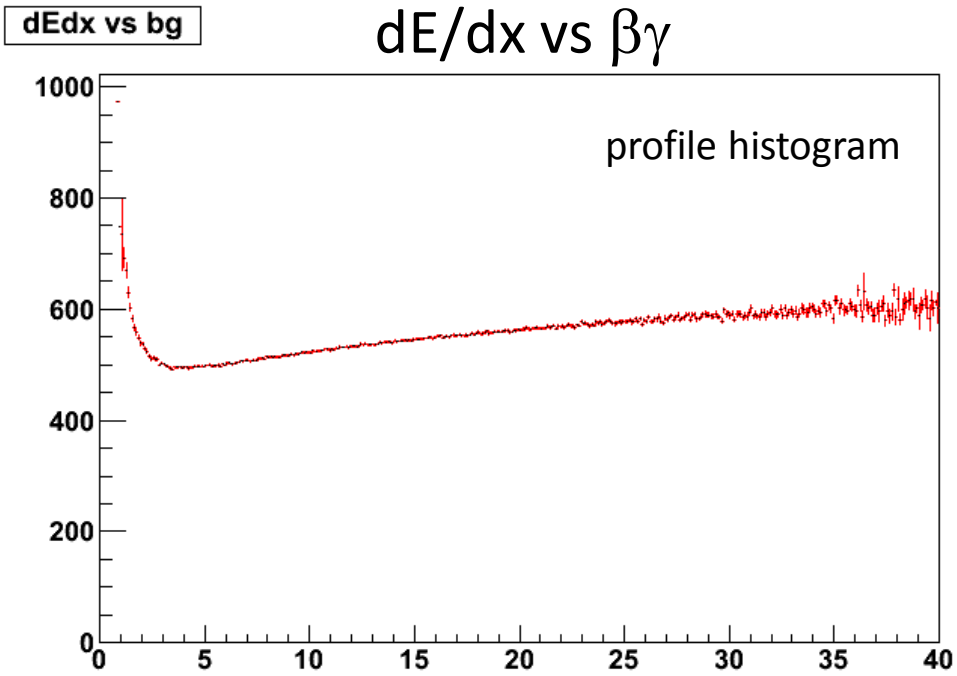


New strategy:

replace the built-in FastSim Bethe-Bloch with a function fitted on Babar data

measured dE/dx vs βγ at Babar

Babar Run6 data, pion sample



Fit the distribution with:

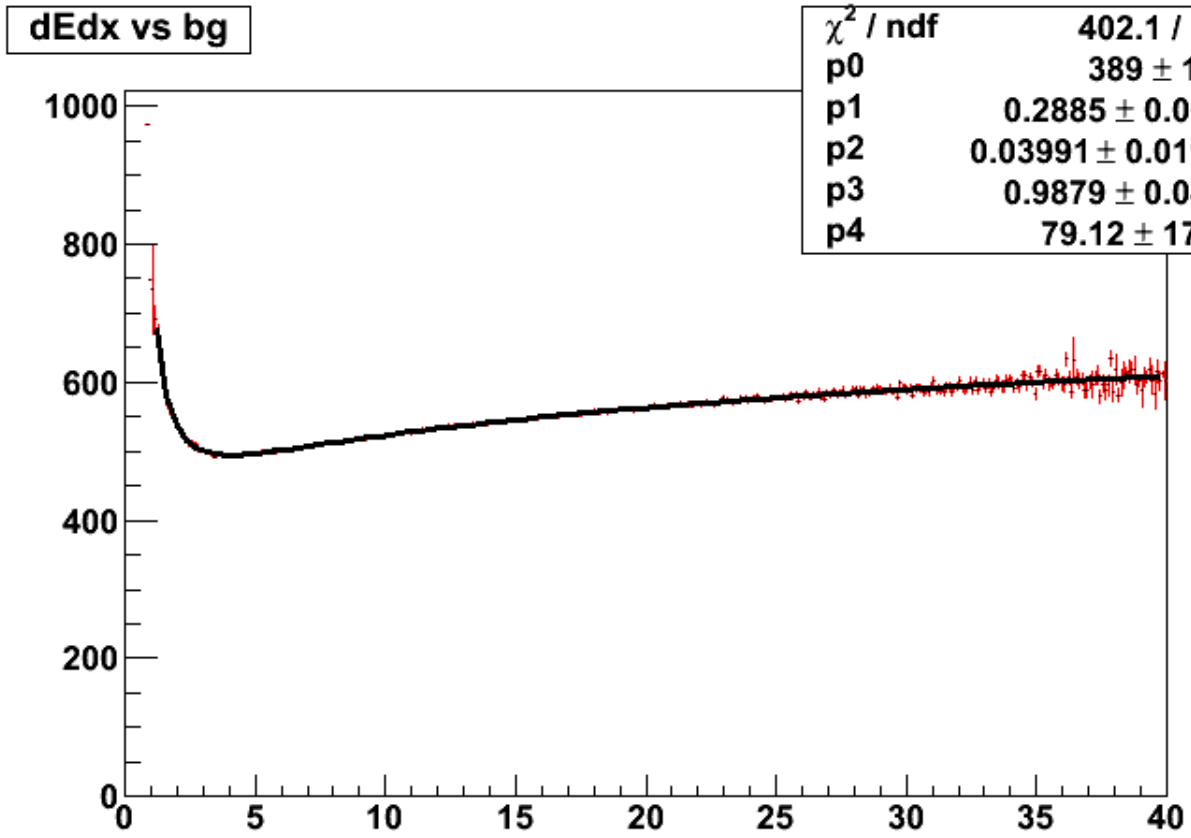
$$\mathrm{d}E/\mathrm{d}x_{\mathrm{expected}} = A \times (1 + Bx + Cx^2) \times (1 + E^{-x})^D \text{ for } 0 < x < 2,$$

$$\mathrm{d}E/\mathrm{d}x_{\mathrm{expected}} = A \times (1 + Bx) \times (1 + E^{-x})^D \text{ for } x < 0.$$

$x=\log_{10}(\beta\gamma)$

parametrization from Babar BAD1500

the fit is pretty good



{p0,…,p4}={A,…,E}

see prev. slide

Use this function to describe the mean value of the dE/dx measurement vs βγ in fastsim

Strategy

- Use the function in previous slide to describe $\langle dE/dx \rangle_{hit}$ vs $\beta\gamma$ in fastsim, instead of the built-in Bethe Bloch function

- The parameterization of the dE/dx measurement error remains the same

$$\sigma\left(\frac{dE}{dx}\right) = \alpha\left(\frac{dE}{dx}\right)^{\beta} dx^{\gamma}$$

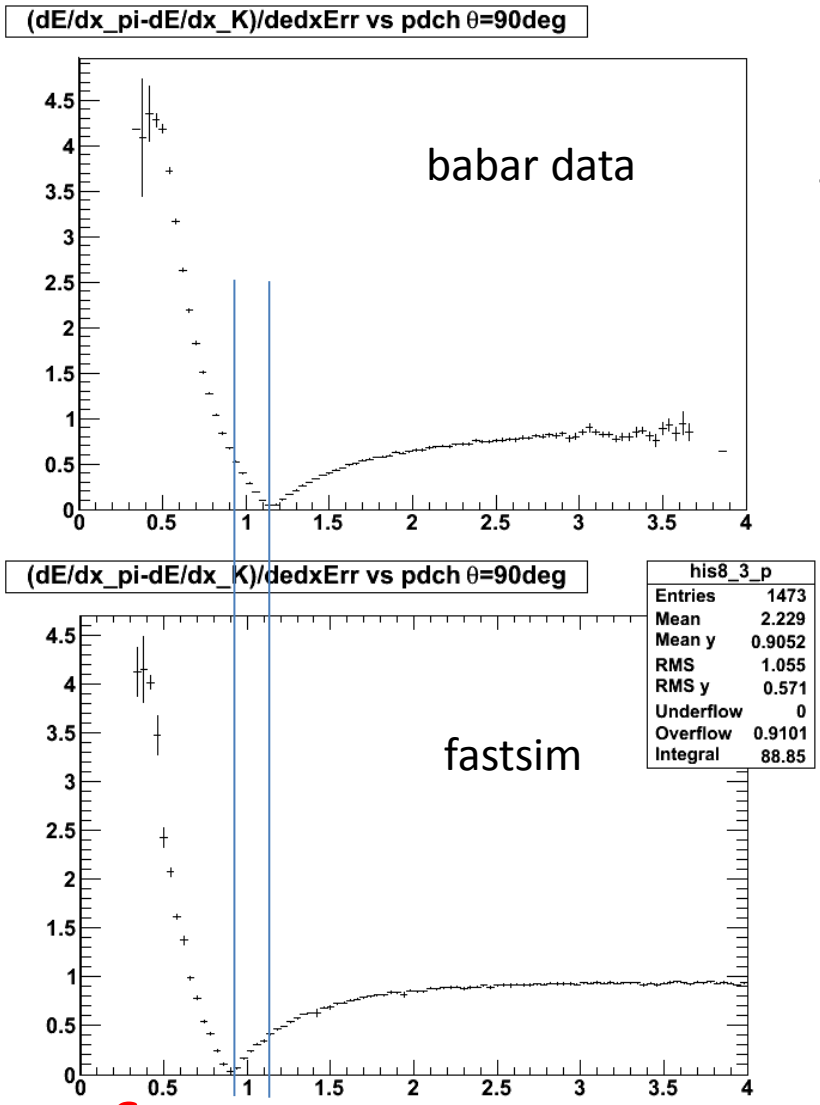
- Tune α, β, γ to match the DCH dE/dx performance in Babar run6 data

- Performance of new fastsim model in next slides refer to

α=0.00117
β=1
γ=-0.58

(quick tuning of parameters, room for further fine tuning)

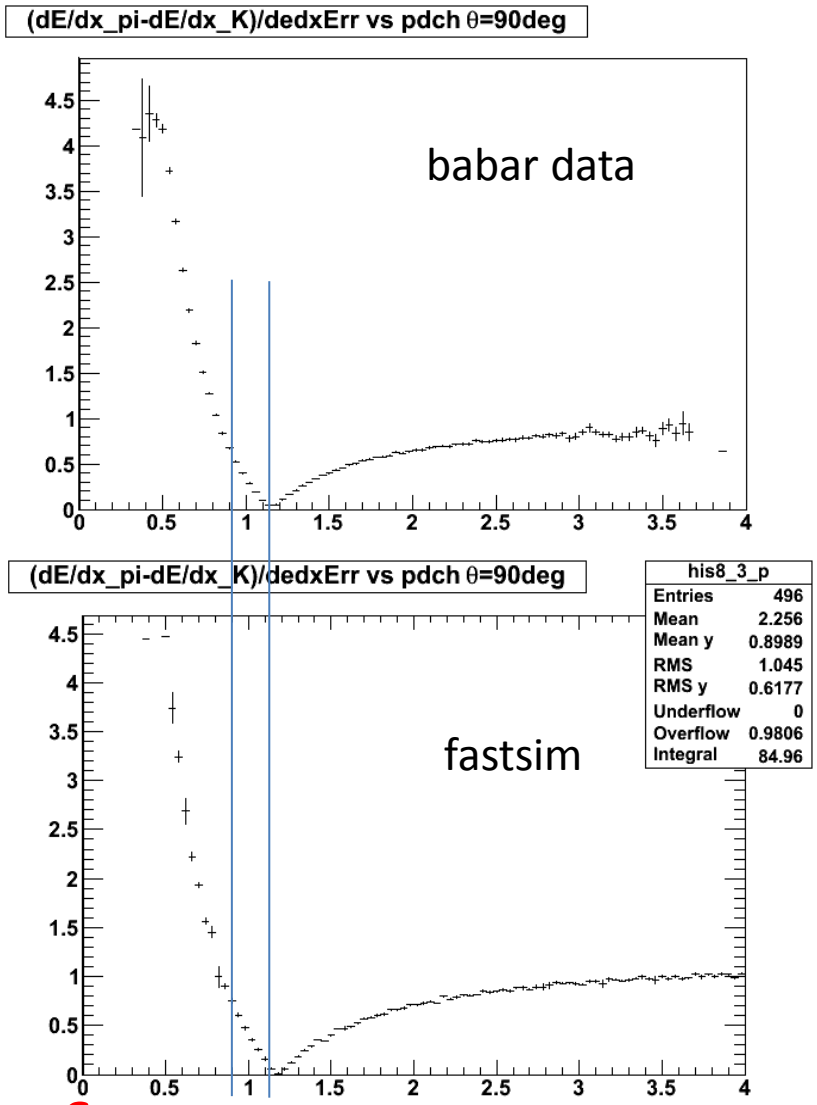
pi/K separation vs p - Babar vs fastsim



Before

The point of zero K/pi separation is at p=1.15 GeV in Babar and at p=0.90 GeV in fastsim.

pi/K separation vs p - Babar vs fastsim

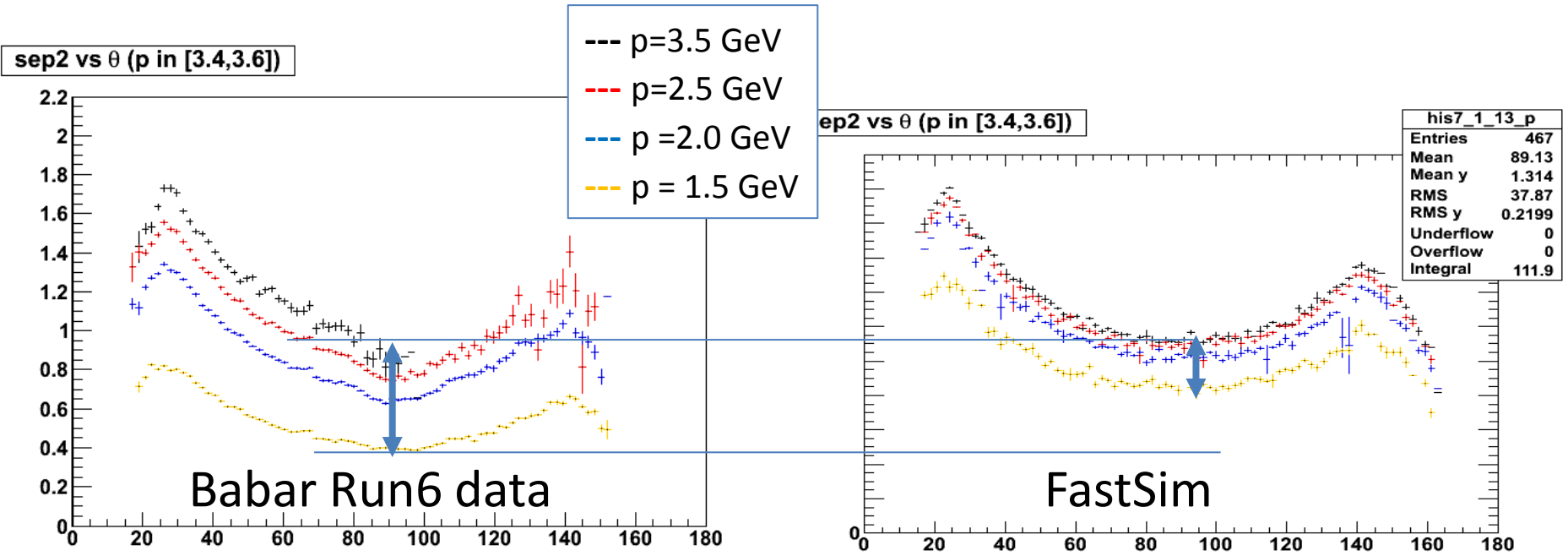


The point of zero K/pi separation is at p=1.15 GeV both in Babar and in fastsim

After

pi/K separation vs polar angle
Babar vs fastsim

separation = |dEdx_expected(pion)-dEdx_expected(kaon)|/dEdx_error

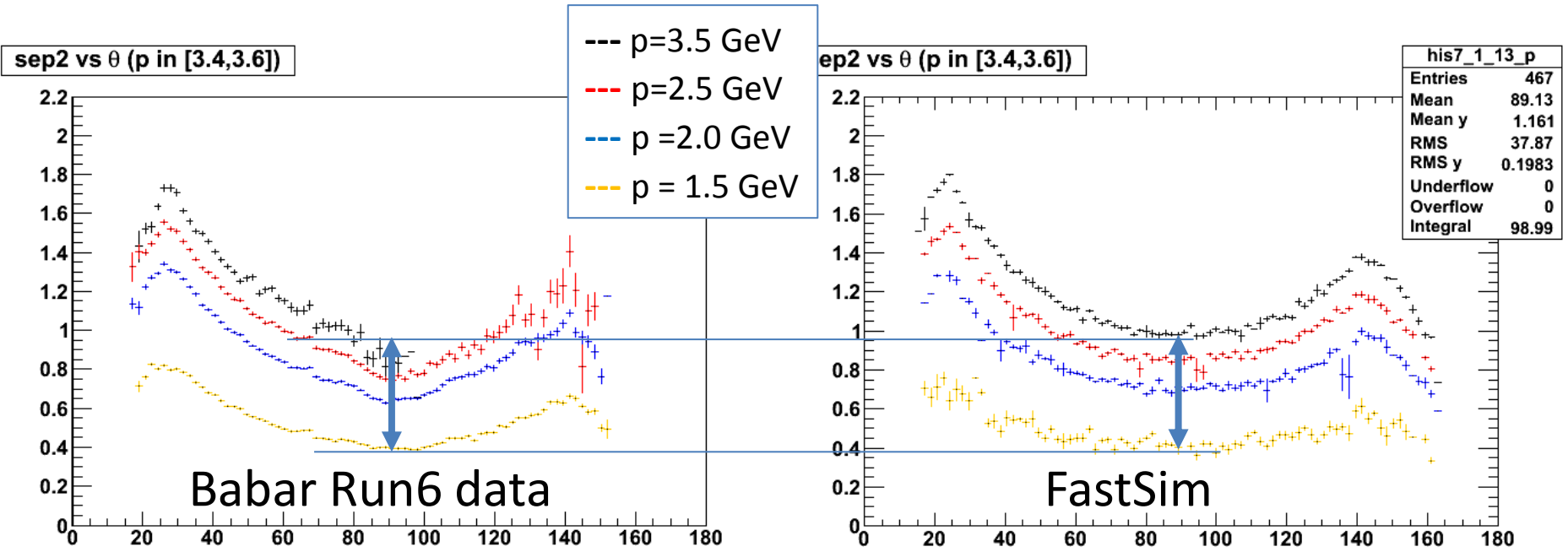


Before

tuning Babar-fastsim at a specific p value does not imply a good tuning at different p values

pi/K separation vs polar angle
Babar vs fastsim

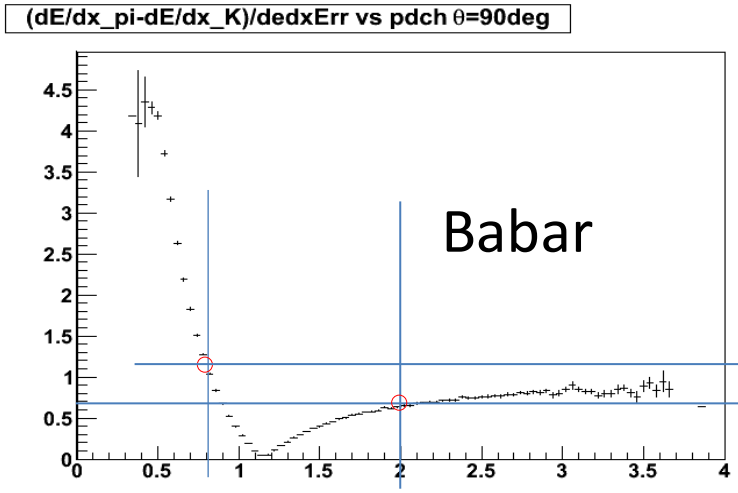
separation = |dEdx_expected(pion)-dEdx_expected(kaon)|/dEdx_error

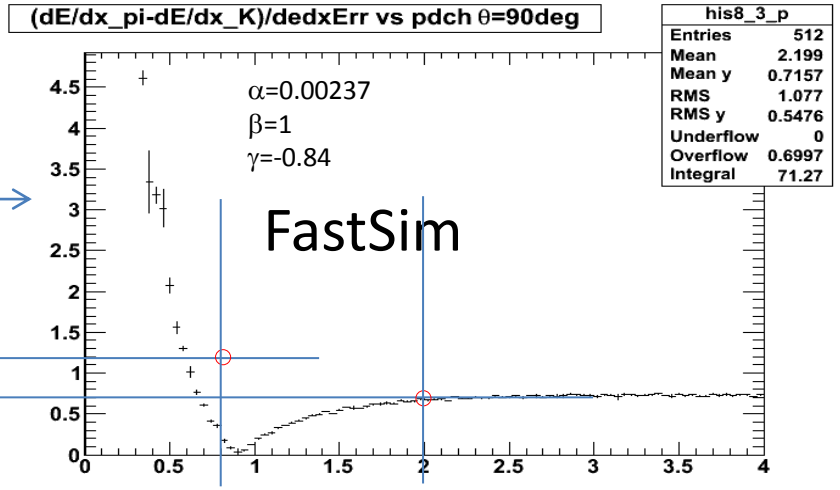


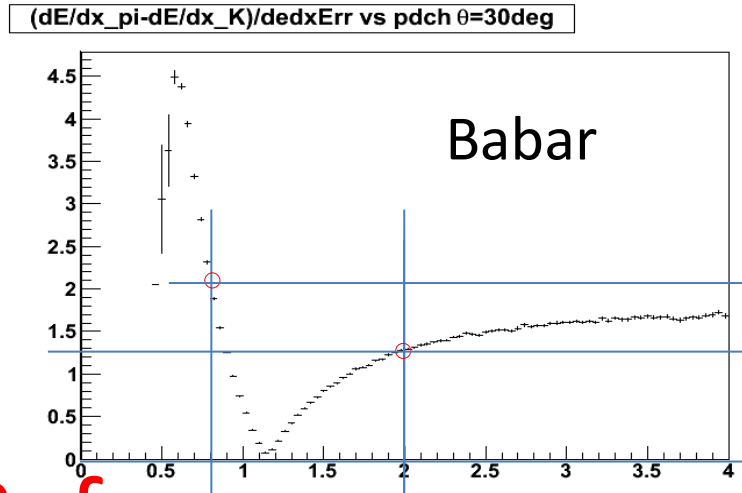
After

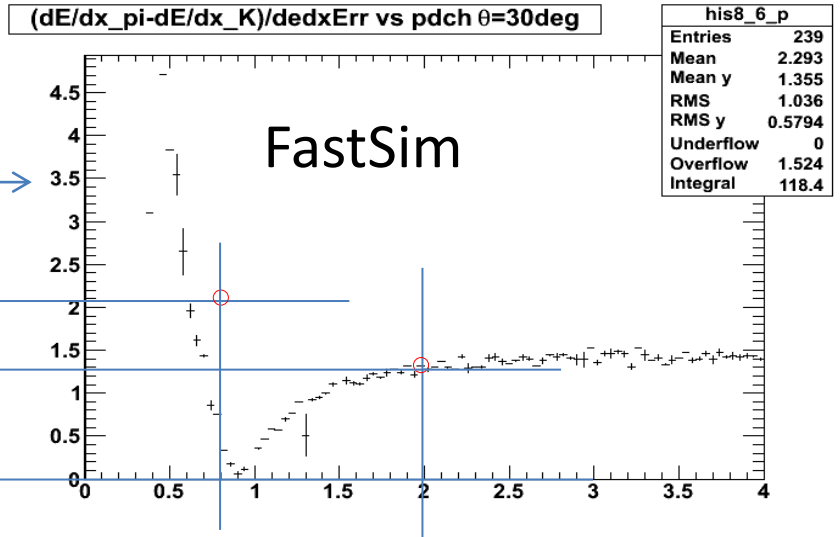
the level of agreement is much more uniform throughout the p range

pi/K separation vs p - Babar vs fastsim





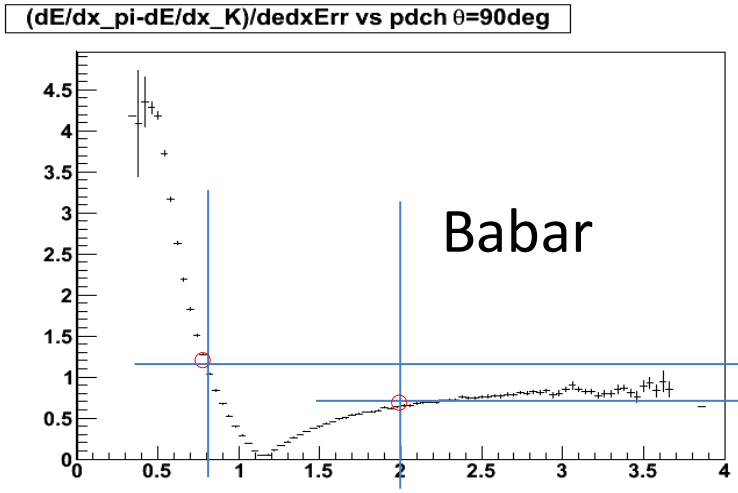


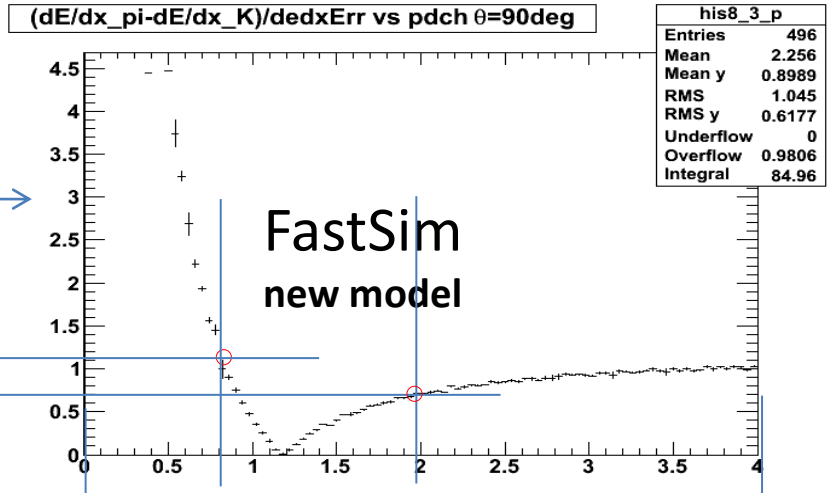


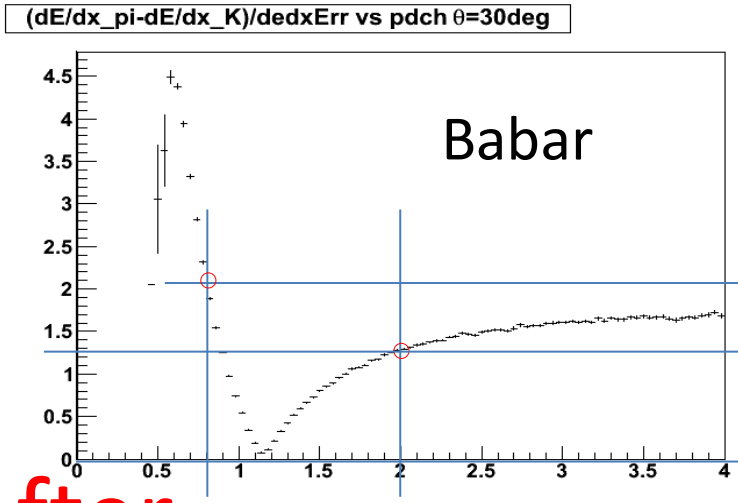
Before

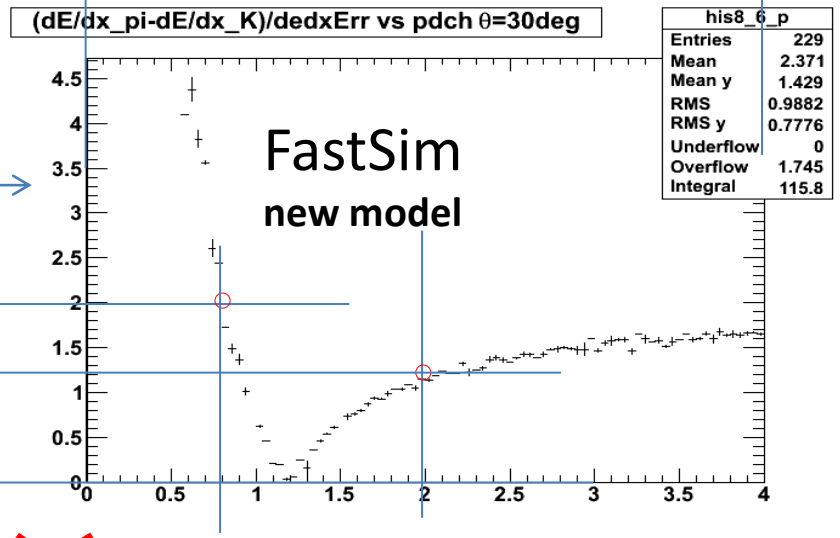
K/pi separation agreement not good in all momentum range

pi/K separation vs p - Babar vs fastsim





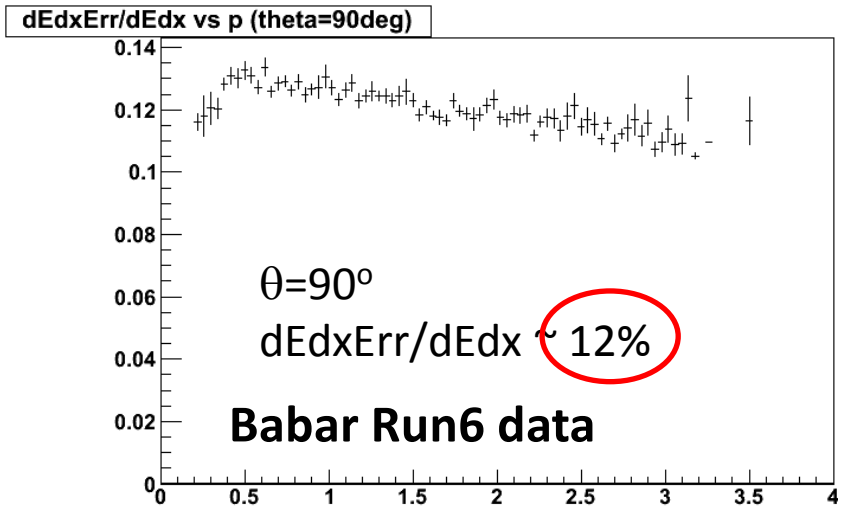


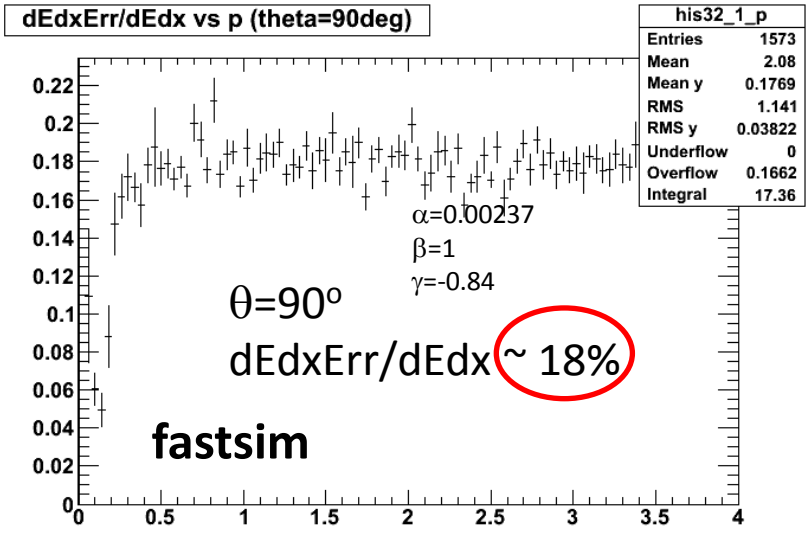


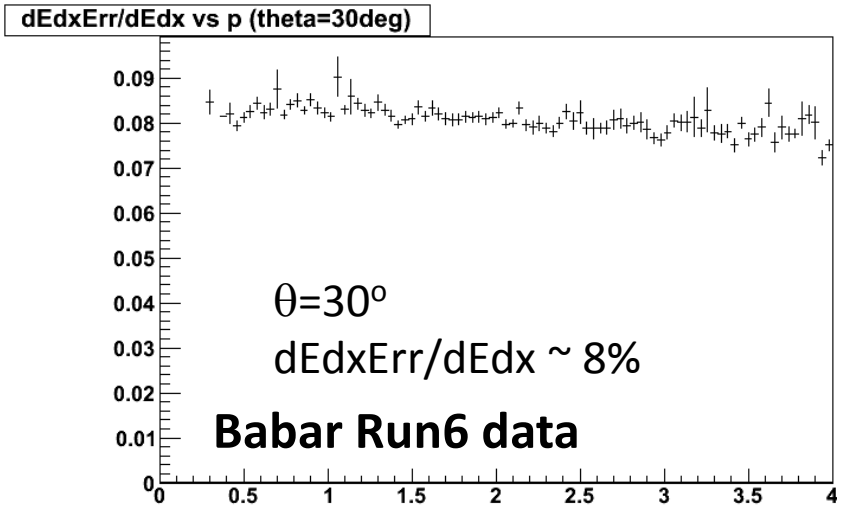
After

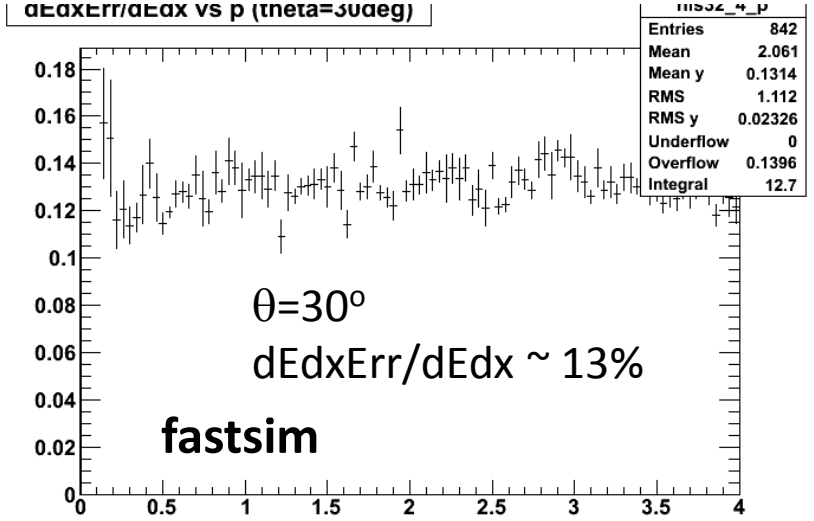
K/pi separation agreement ~~not~~ good in all momentum range

dE/dx resolution – Babar vs fastsim





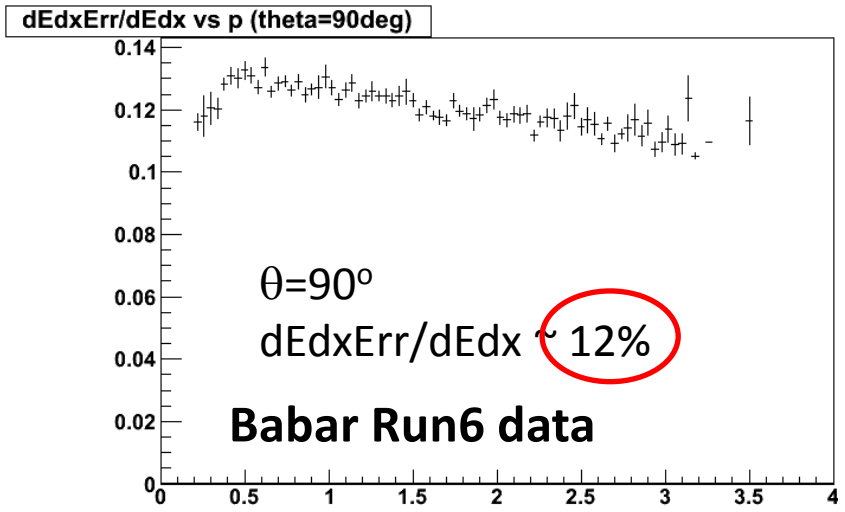


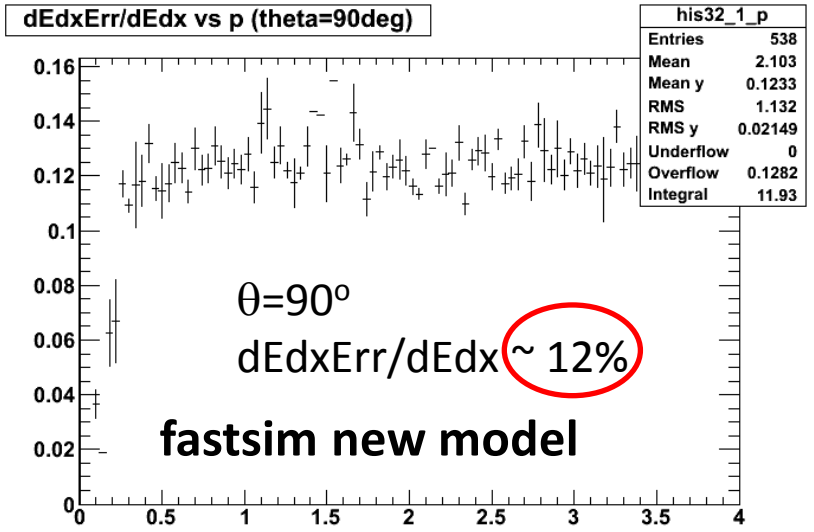


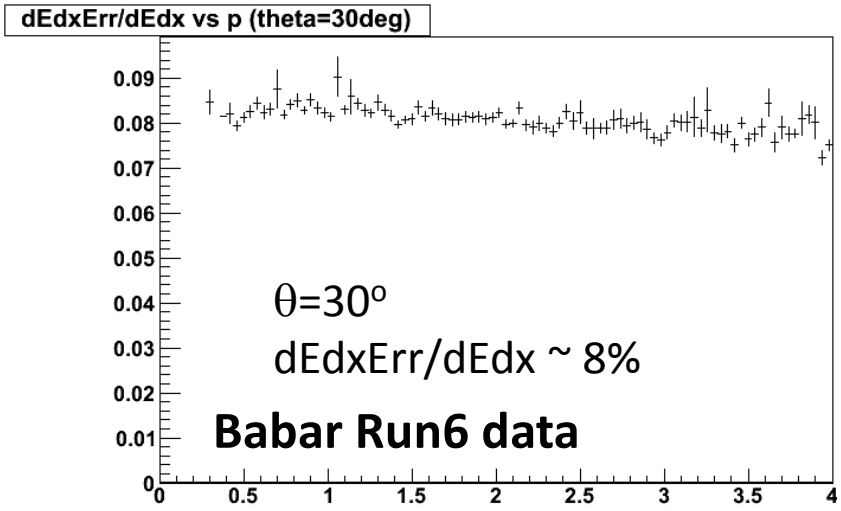
Before

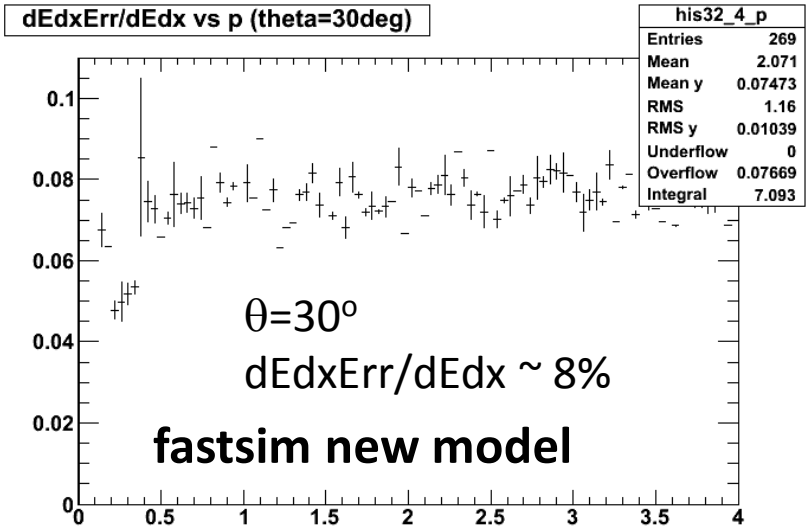
not possible to tune the K/pi separation and dE/dx resolution at the same time

dE/dx resolution – Babar vs fastsim









After

~~not~~ possible to tune the K/pi separation and dE/dx resolution at the same time

Proposal

- Describe the mean value of the measured DCH $\langle dE/dx \rangle_{hit}$ in fastsim using the function that fits dE/dx vs $\beta\gamma$ in Babar data (see sl. 4)

- The parameterization of the dE/dx measurement error remains the same

$$\sigma\left(\frac{dE}{dx}\right) = \alpha\left(\frac{dE}{dx}\right)^{\beta} dx^{\gamma}$$

- The algorithm to reconstruct the dE/dx measurement of the *track* remains the same ('random' truncation, see backup slide)

- Tune α, β, γ to match the DCH dE/dx performance in Babar
  - a reasonable set of parameters based on Babar Run6 tuning is

    α=0.00117

    β=1

    γ=-0.58

- The agreement between fastsim and Babar with the new model is quite satisfactory

Proposal

two-fold advantage

- performance can be tuned to be very similar to Babar performance
- ‘random truncation’ feature is kept ➔ use of DCH dE/dx in PID selectors requires minimum amount of work

Code

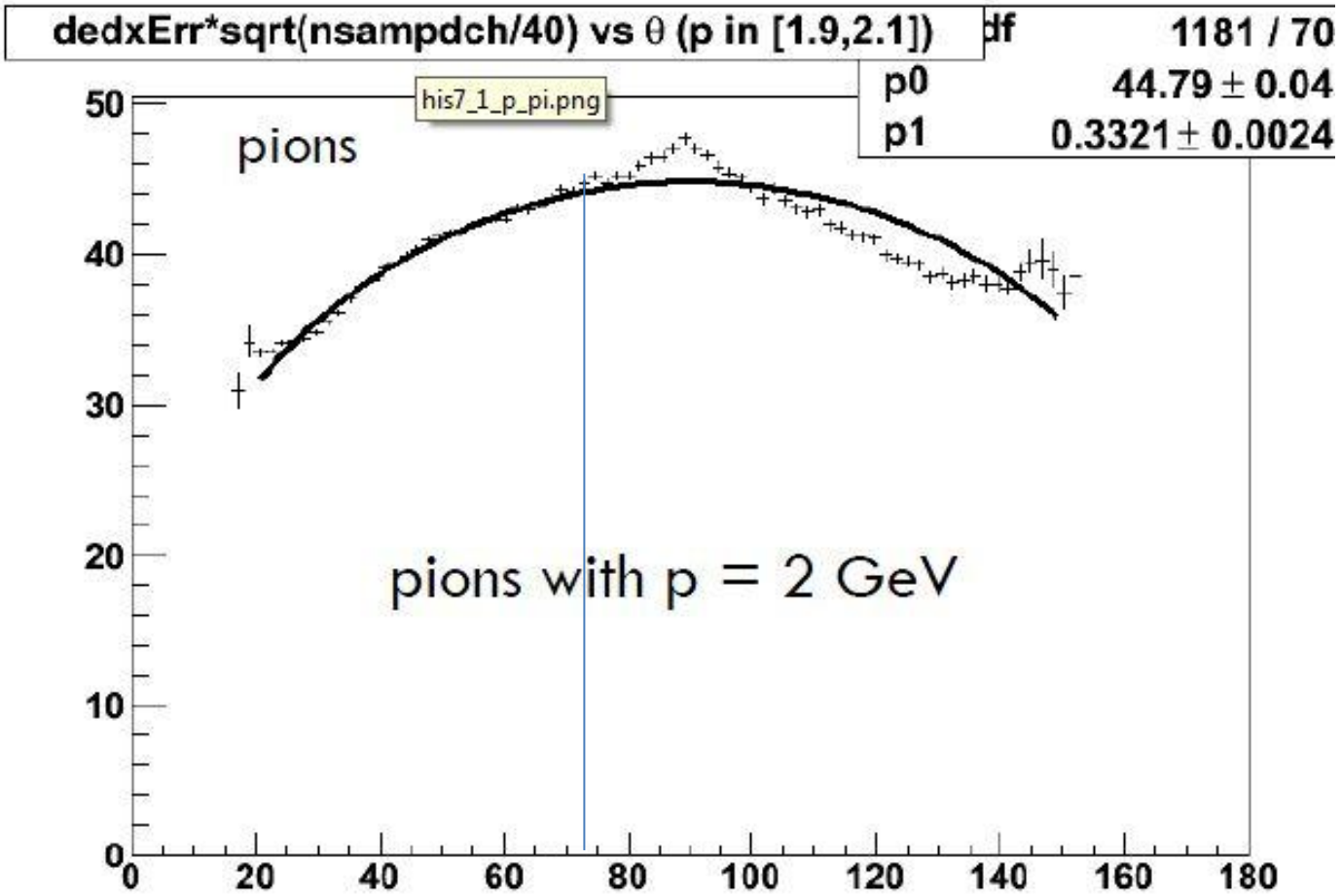
- Code with new <dE/dx> function available in SVN (trunk of PacTrk, rev>=2941)
  - V0.3.1 + developers' patch (instructions in FastSim User Guide)

- <dE/dx> function parameters hard-coded at the moment
  - Eventually they could be set through the xml interface

It will be the default in FastSim V0.3.2 (currently planned release date: week of June 18)

backup

Babar data: modelization of dE/dx error vs polar angle



dEdx_error*sqrt(nsampDch) vs polar angle for 2GeV pions.

The function fits well the distribution between θ=30 and 70. At θ=90 the fit function underestimates the error. Note the asymmetry between fwd and bwd directions