Tuning SVT dE/dx using BaBar Data

John Walsh
INFN, Pisa

Fastsim, May 27, 2010

Study Babar PID Ntuples

- Following Matteo's work for DCH, using channel

$$D^{*+} \to D^0\pi^+, D^0 \to K^-\pi^+$$

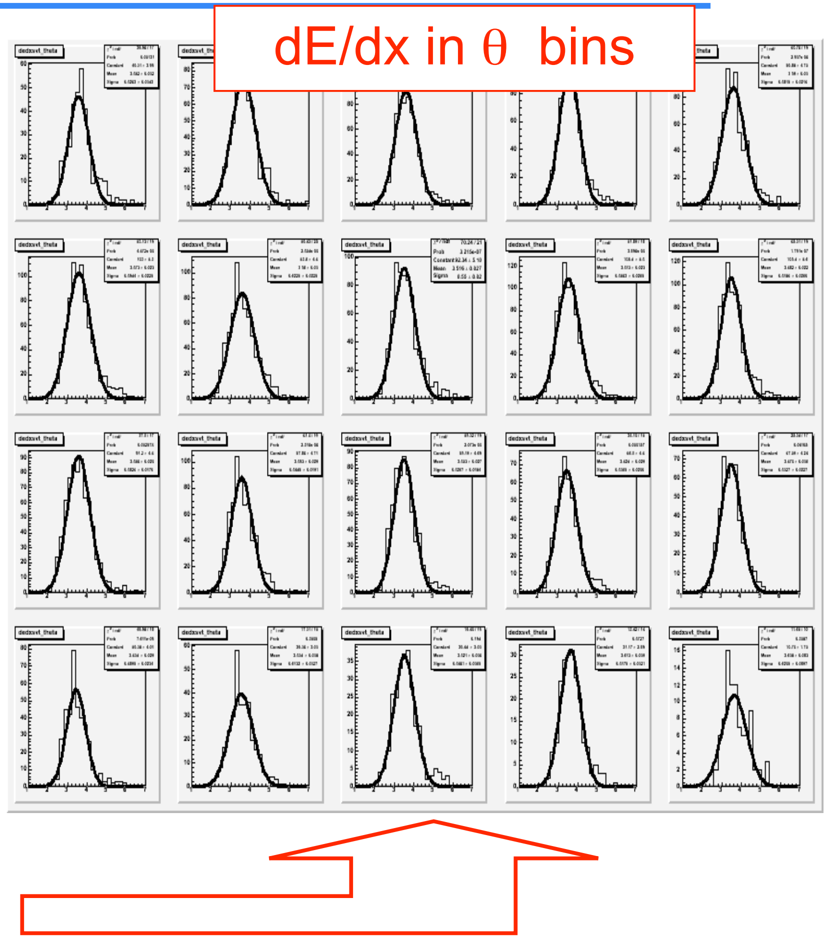
- Gives pions in range: [0.05,~4.5] GeV
  - kaons in range: [0.4, ~4.5] GeV
- Goal: determine constants α, β, γ in Fastsim parameterization of dE/dx width:

$$\sigma_{hit} = \alpha < dE/dx >^{\beta} dx^{\gamma}$$

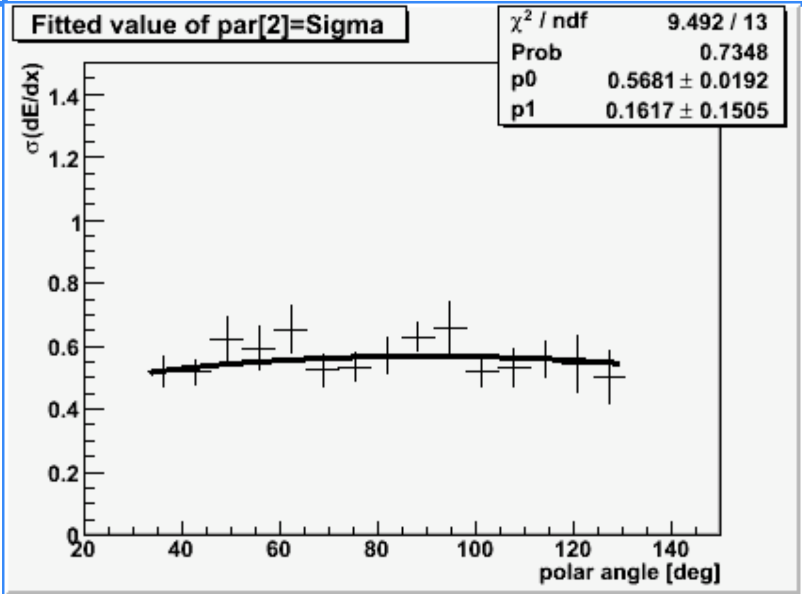
Fit for γ $\quad \sigma_{hit} = \alpha < dE/dx >^{\beta} dx^{\gamma}$

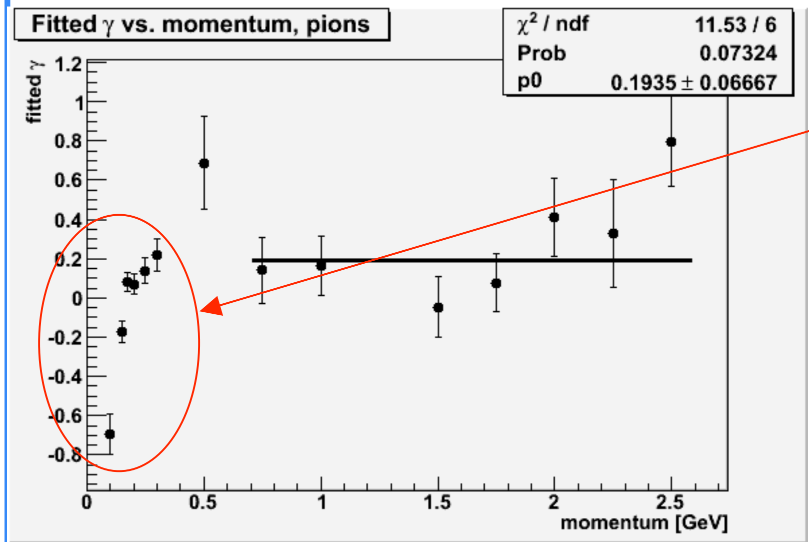
- Idea: $dx \propto 1/\sin\theta$ so for fixed <dE/dx> (and straight tracks), a plot of σ(dE/dx) vs. theta will yield γ
- SVT: confine to barrel region: $33^{o} < \theta < 130^{o}$
- Ensure constant <dE/dx> by selecting tracks with fixed momentum: p ~ 1 GeV
- Obtain σ_{trk} by fitting dE/dx distribution in bins of θ with a simple Gaussian function
- Assume error on track dE/dx scaled with sqrt(N):

$$\sigma_{hit} = \sqrt{N}\sigma_{trk}$$



Fit for γ (II)





- Fit gives:

$$\gamma = -p_1 = -0.16 \pm 0.15$$

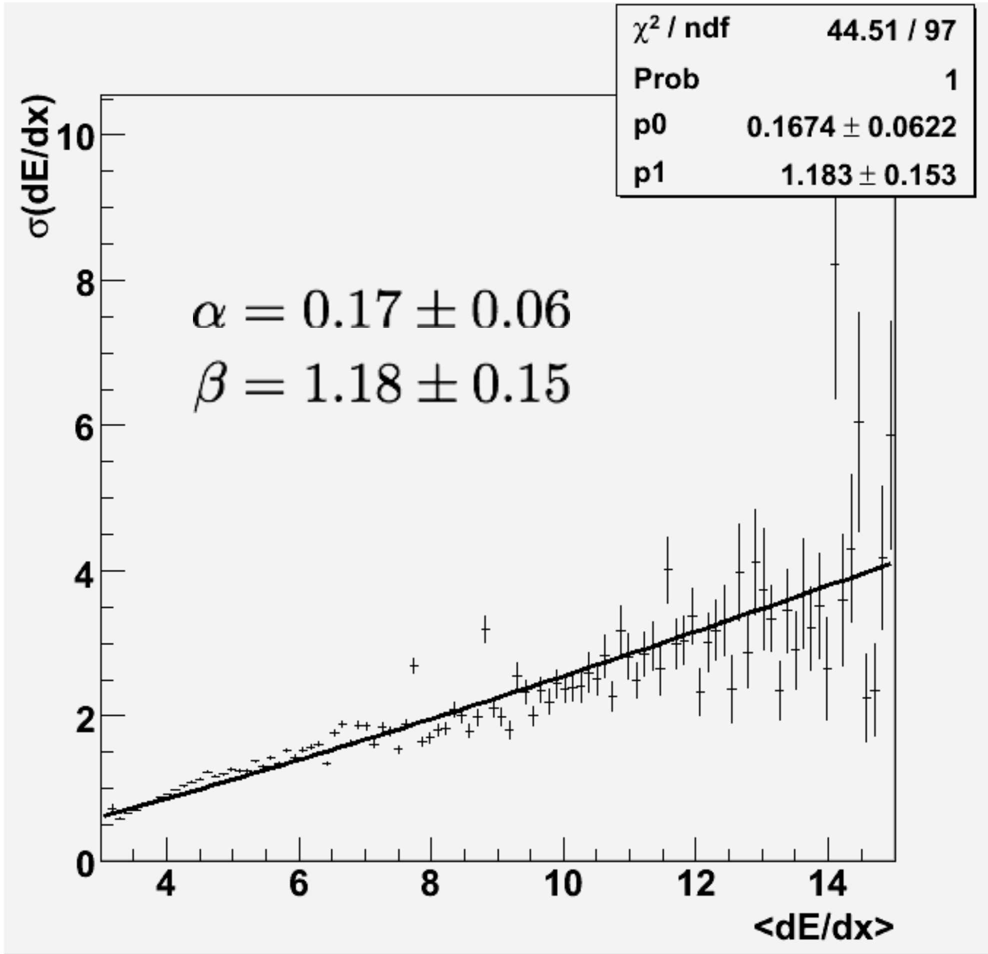
- Assumed value is -0.5
- Check for other values of momentum
- At low-p, curving tracks invalidates $dx \propto 1/\sin\theta$
- Fit at high momentum yields γ = -0.2

Next step: fit for β $\sigma_{hit} = \alpha < dE/dx >^{\beta} dx^{\gamma}$

- Would like to plot observed σ_{trk} scaled by sqrt(N) and $(1/\sin\theta)^{\gamma}$ vs. <dE/dx>
- This would require determining σ(dE/dx) in 2-D grid of θ and <dE/dx> $\Rightarrow$ not practical given stats
  - as before, fit Gaussian to dE/dx distribution but now in bins of <dE/dx> (instead of θ)
- As an approximation, assume γ=0 for this step (recall we found γ=-0.2 previously)
- Include pions over full momentum range — we're particularly interested in low-p (high <dE/dx>)

Fit for β (II)

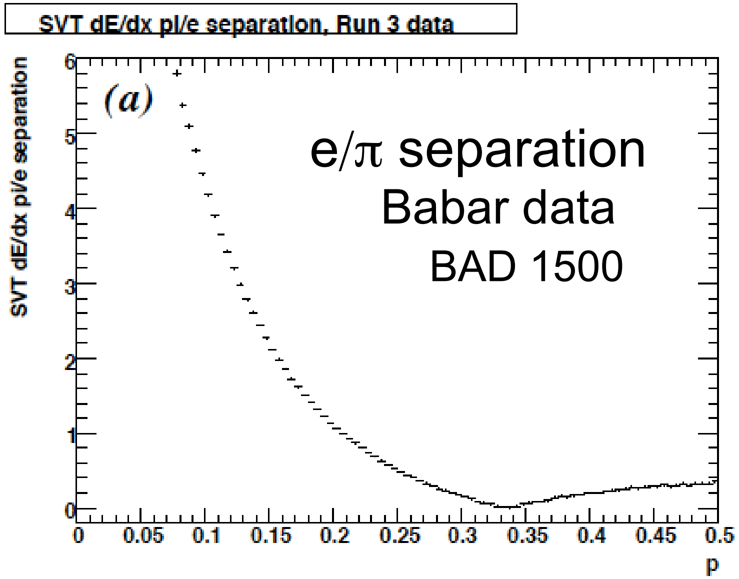
- Not a good fit – there’s a lot more structure than can be described by $y=\alpha x^{\beta}$
- All points given equal weight in fit
- An alternative fit with 3rd-order polynomial yields better results – but I don’t want to change model at this point
- The results are probably a reasonable description for fastsim

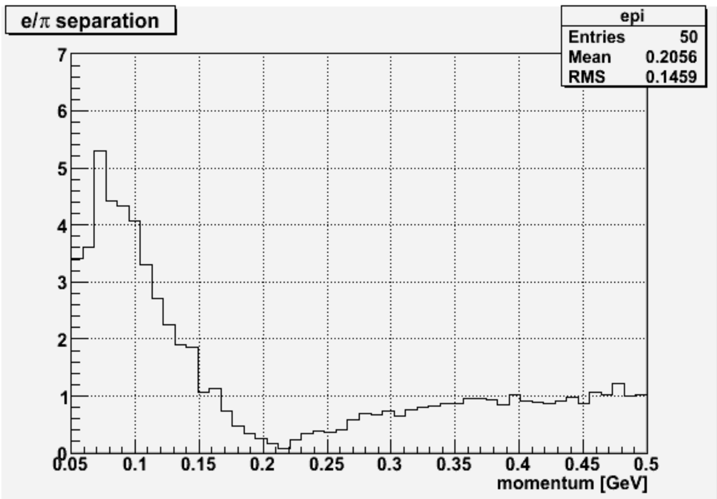


Putting it into fastsim

- The value of α must be re-scaled for fastsim, since dE/dx units are different in BaBar data and fastsim
- An additional tweak was necessary due to $\gamma=0$ assumption when determining α, β
- Look at e/π, K/π separation in fastsim

e/π separation

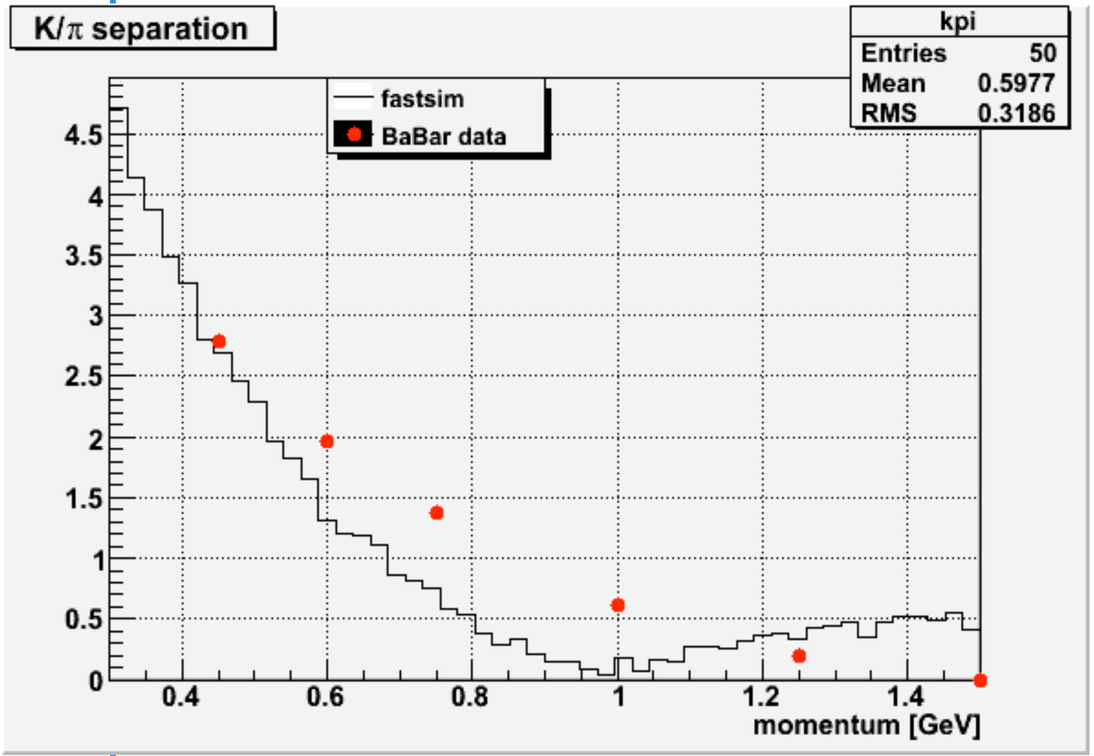




- Minimum of distribution is different in data and fastsim
- Separation at high-p is better in fastsim (1σ) than in data (0.3σ)

- One reason for this: we have been tuning the dE/dx error using the data, but the central value (<dE/dx>) in fastsim is calculated from Bethe-Bloch curve – there is no handle for tuning it
  - using BB, e and π cross at 0.2 GeV – you can't change that by adjusting σ(dE/dx)
  - the discrepancy at high-p is also caused by a difference in <dE/dx>, not in σ(dE/dx)

K/π separation



- Minimum of distribution is different in data and fastsim
- Need to extend plot to higher momentum, but I already know that
  - fastsim (.5σ) is better than data (~.2σ)
- This is probably the level of agreement that we can get without modifying how we generate <dE/dx>

Conclusions

- I've tuned the fastsim SVT dE/dx parameters based on study of Babar PID ntuples
- This has not solved two problems for PID selectors:
  - K/π separation minimum shifted w.r.t data – overlaps with DCH
  - fastsim separation power too great at high-p
- Both of these problems arise because the values of mean dE/dx generated in fastsim (from Bethe-Bloch) do not correspond to those found in BaBar data
- Nevertheless, the resulting description of SVT dE/dx in fastsim seems pretty reasonable (even though it doesn't match Babar exactly).

extra slide

Minimum in K/π separation

- In Babar, the momentum where the K/π separation goes to 0 is 1.7 GeV for SVT and 1.1 GeV for DCH
  - I.e. they are not the same, so all momenta are “covered” by either SVT or DCH
- In fastsim, the 0-point occurs at the same value (0.9 GeV) for SVT and DCH, leading to a “hole” in the coverage