SVT dE/dx in Fastsim

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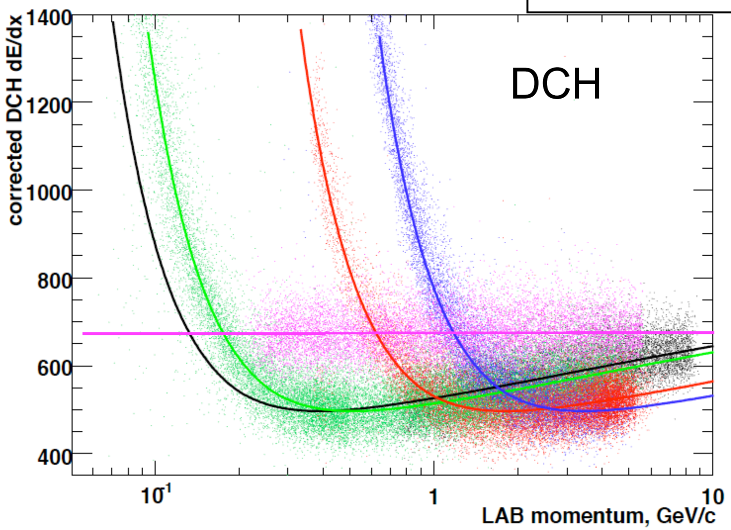
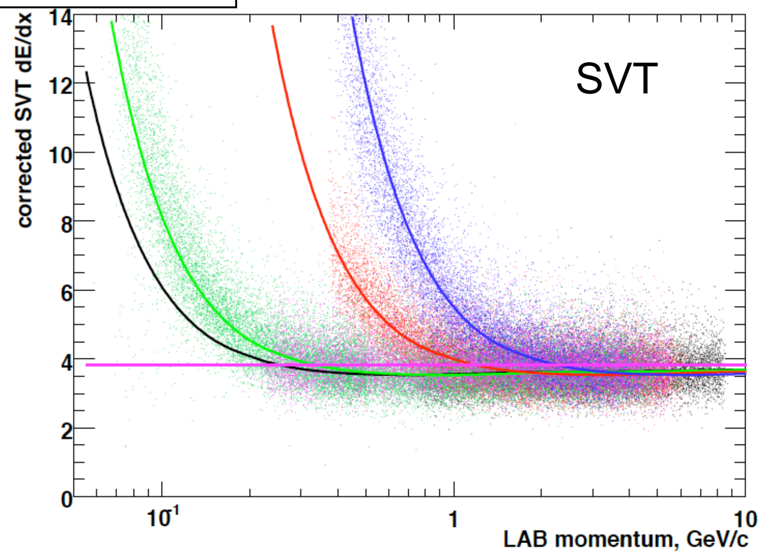
SVT dE/dx

- Clearly, DCH and DIRC are most important systems for particle ID
- However, SVT dE/dx measurements can be important, especially for low-p_t tracks (e.g. soft pions from D* decays)
- SVT dE/dx measurements have been used in BaBar PID algorithms
- Let's get it into FastSim

BaBar dE/dx - BAD 1500





SuperB SVT dE/dx

- We can expect SVT dE/dx performance in SuperB to be similar to that of BaBar
  - Layer 0 (the main difference between SuperB and BaBar SVT) will have no dE/dx information
  - Layers 1-5 will have different readout electronics. We're not yet able to predict the dE/dx performance for the proposed electronics
    - BaBar: ATOM chip: Time Over Threshold (logarithmic) determination of charge
    - SuperB: FSSR2 chip: 3 bits of analog charge readout
  - Still, let's use BaBar performance as a reasonable baseline for Fastsim.
- BaBar dE/dx resolution: ~16% for MIPs (at track level)

Fastsim Implementation

- Follow work done for DCH by Matteo Rama (thanks to Matteo)
- For each hit (actually, track/detector intersection) calculate dE/dx value
  1. calc. average expected value from Bethe-Bloch
  2. calc. uncertainty on average (see following slide)
  3. use random Gaussian generator to calculate actual value of hit dE/dx
- Note: Gaussian distribution is not quite right, but good enough and it makes life simpler

Uncertainty on hit dE/dx

- Parameterize, as for DCH, as:

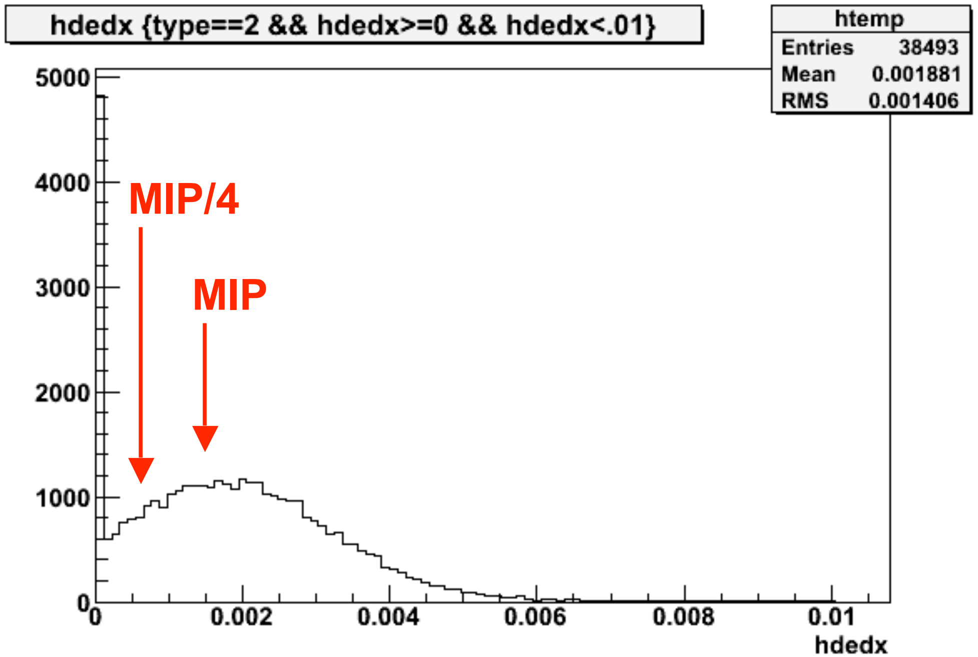
$$\sigma_{dE/dx} = p_1 \left[\frac{\langle dE/dx \rangle}{1.622 \times 10^{-3}} \right]^{p2} dx^{p3}$$

dE/dx of MIP

- We then set:
  - p_2 = 1 and p_3 = -0.5 (BAD 1500)
  - adjust p_1 to give desired resolution

Threshold effect

- Given our method, we will sometimes generate a negative value of hit dE/dx
- The code sets all negative values to zero.
- However, any hit with deposited charge below some threshold will not be registered as a hit.



- So, if hit below specifiable threshold, generate a new value.
- Typical threshold=MIP/4
- We do not throw away hits $\Rightarrow$ hit efficiency is taken into account elsewhere in Fastsim code

Double-sided silicon devices

- Charge deposited by a track passing through the silicon is measured twice -- on the ϕ-side and on the z-side.
- Two sources of fluctuations, then:
  1. actual charge deposited fluctuates according to the usual Landau distribution -- **common to ϕ- and z-sides**
  2. additional fluctuations originating in the readout -- potentially **different for the ϕ- and z-sides**.

Different from DCH

- The code has been designed to allow for both types, although only the first type has actually been implemented
  - ϕ- and z-side dE/dx have the same value, for now.
  - adding the additional side-dependent smearing is straightforward

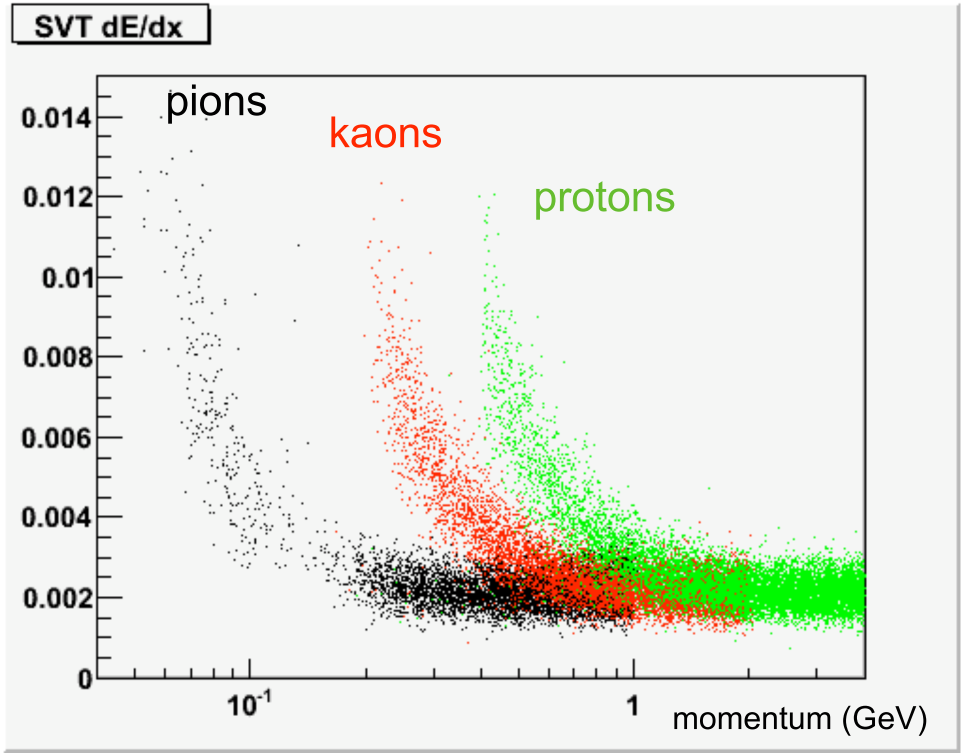
Track dE/dx

- The dE/dx of a track is simply the truncated mean of the values of hit dE/dx for that track
- The truncation fraction is specified as a configuration parameter
- The averaging algorithm does not take into account correlations between the ϕ- and z-sides
  - this leads to an underestimate of the track dE/dx uncertainty
- The code can easily accommodate any averaging algorithm that we want to write

Calibration

- Only the crudest of calibrations performed
- Procedure:
  - adjust hit uncertainty parameter p_1 to give desired track dE/dx resolution of 16% for minimum ionizing pions

- Should do:
  - check hit-level dE/dx resolution
  - check resolution as a function of:
    - polar angle
    - <dE/dx>
    - etc.
  - check K/π separation as fcn of momentum



Fastsim code

- Started with Matteo's design, but made some modifications to accommodate two SVT views for a single charge deposit
- `PacTrkdEdxMeas` - new class that generates the hit dE/dx values for both DCH and SVT.
- `PacTrkHitMeas` - now optionally takes `PacTrkdEdxMeas*` argument in c'tor. Non-zero for DCH and Silicon strips
- `PacTrkHitViewSvt` - will handle ϕ- and z-side independent smearing (when implemented)
- `PacMicroAdapter` - adds SVT dE/dx info to PidQual object
- `BtaPidQual::dEdXSvt()` (and related functions) provides SVT dE/dx to PID algorithms
- `Si_Measures_baseline.xml` - contains dE/dx parameters for SVT

Summary

- SVT dE/dx now implemented in Fastsim
- Reasonable results already available via the BtaPidQual object $\Rightarrow$ PID algorithms can start using SVT dE/dx
- Crude calibration gives correct resolution for MIPs

- To Do List:
  - more thorough calibration
  - implement independent smearing for ϕ- and z-sides
  - develop more realistic truncating/average algorithm for calculating track dE/dx from hit values