

dE/dx Studies

Update

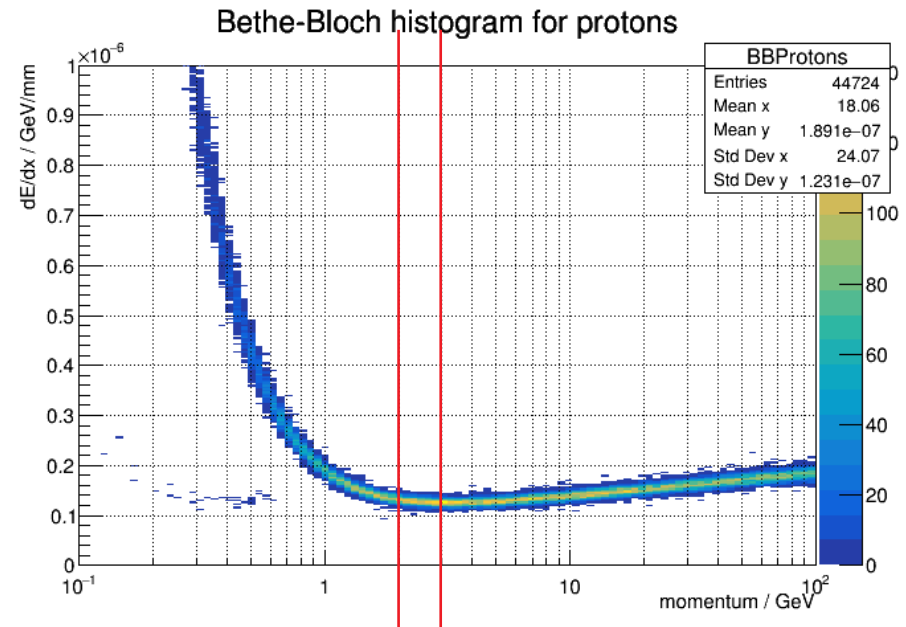
Ulrich Einhaus
ILC Physics Meeting
14.04.2018 KEK

- New version part of ILCsoft v19-06 and third test production
- Resolution
- Particle Separation
-
- dE/dx error correction issue

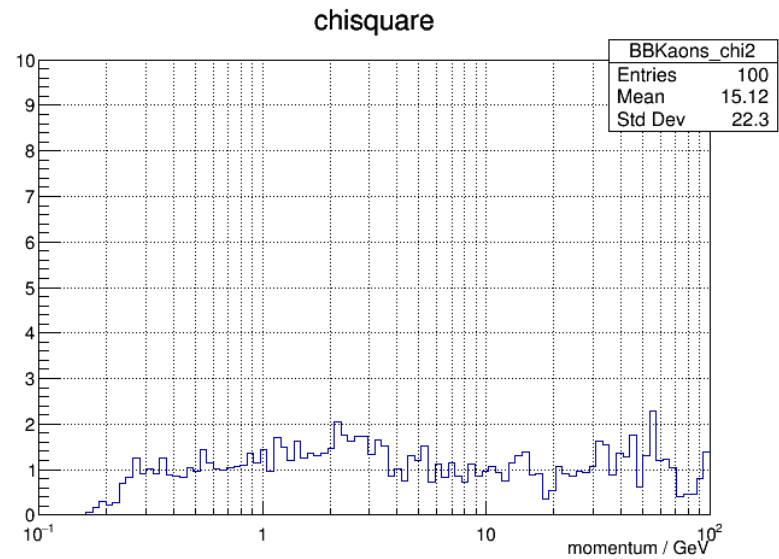
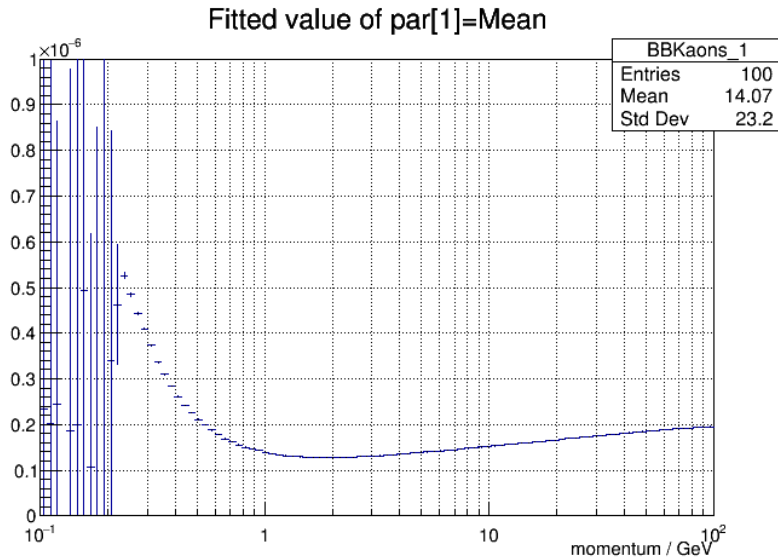
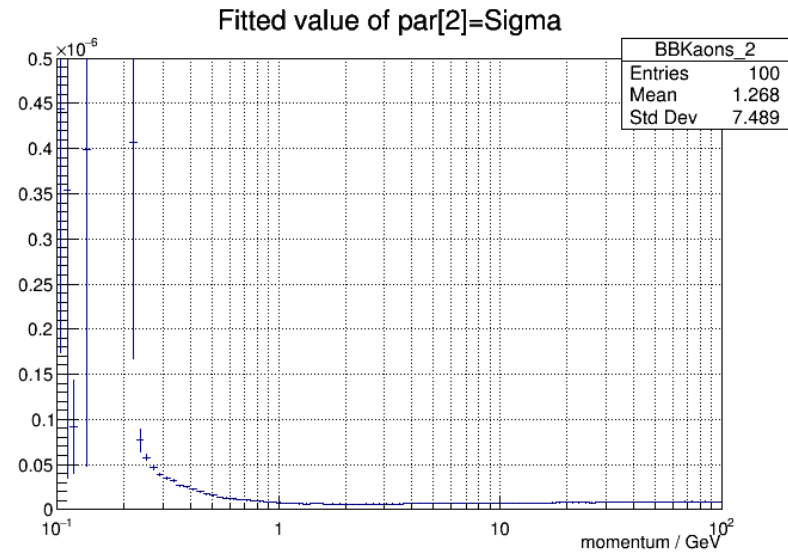
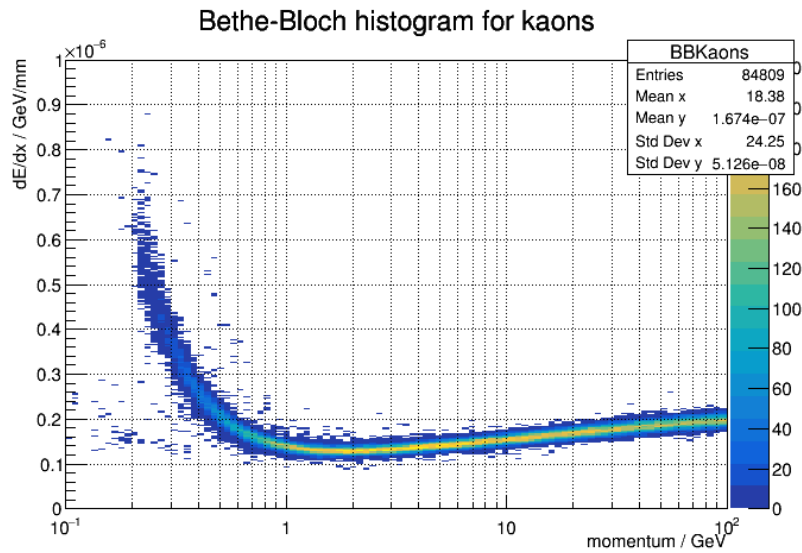


Fitting the BB curve

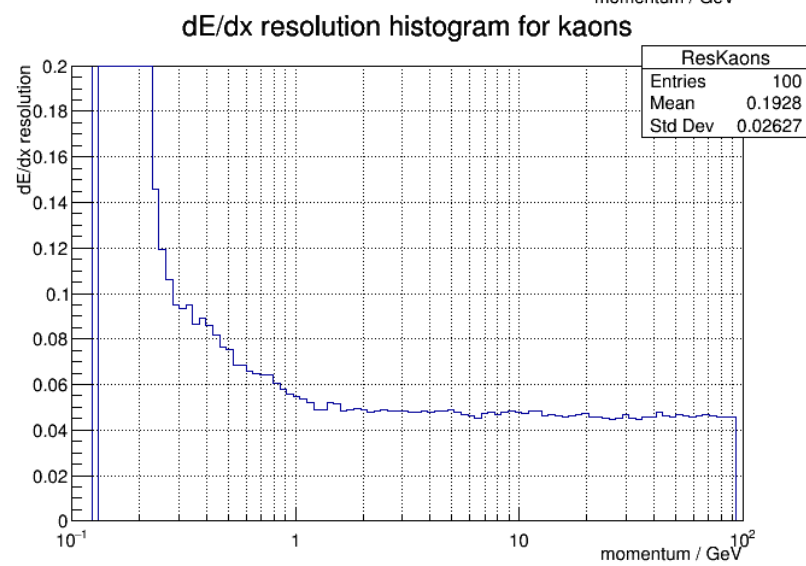
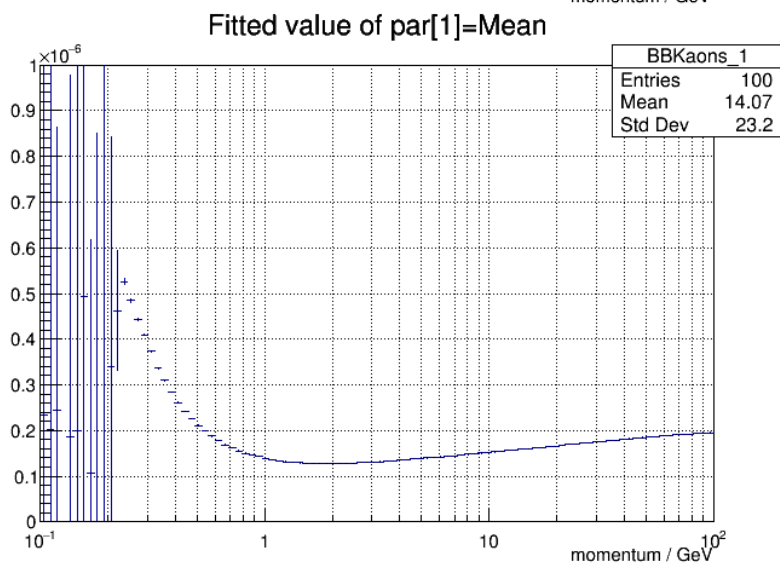
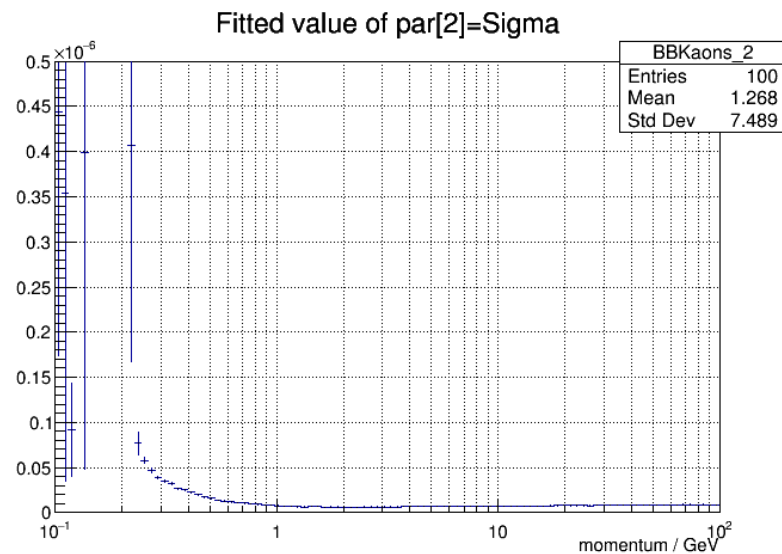
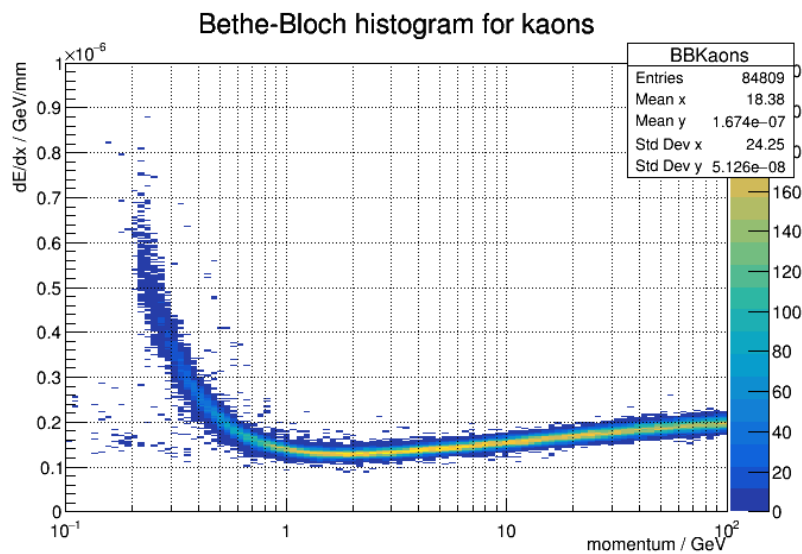
- Use TH2::FitSlicesY
- Goes through every bin in x (momentum) and fits a Gaussian to the distribution in y (dE/dx)
- Reduced (logarithmic) momentum bin number to 100
- Used all single particles files (100k per species)
→ got sufficient statistics to have good overall fit results



Fit results example

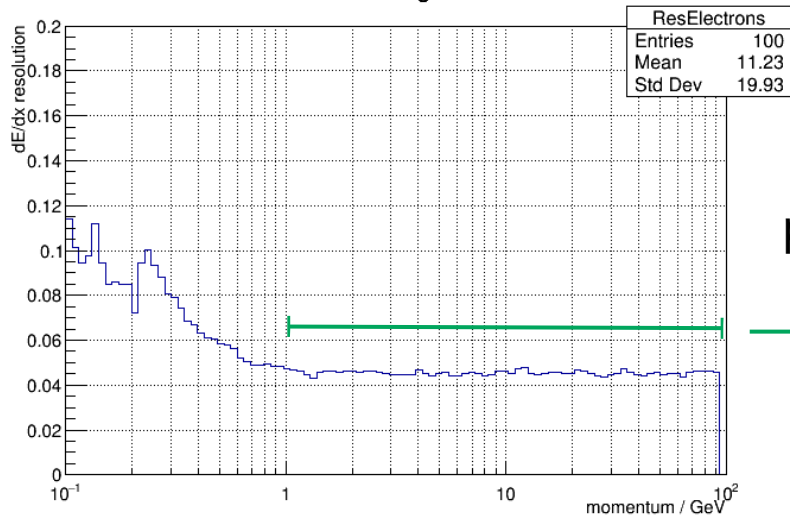


Fit results example



Resolution – different options - electrons

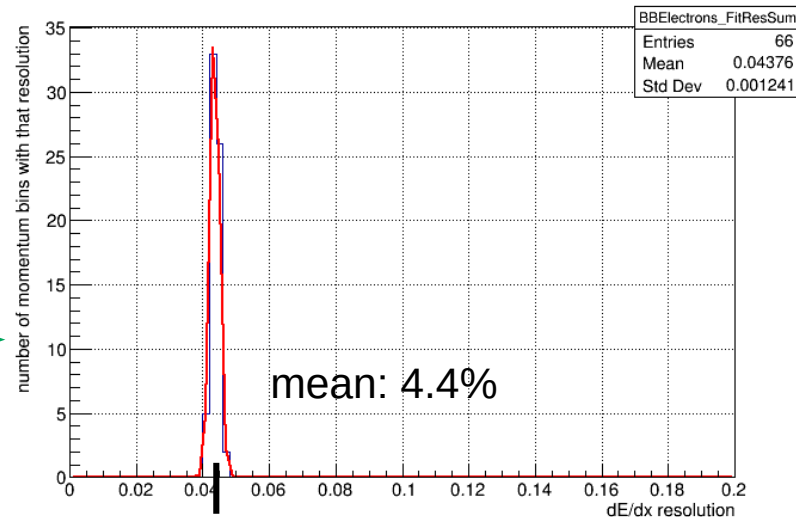
dE/dx resolution histogram for electrons



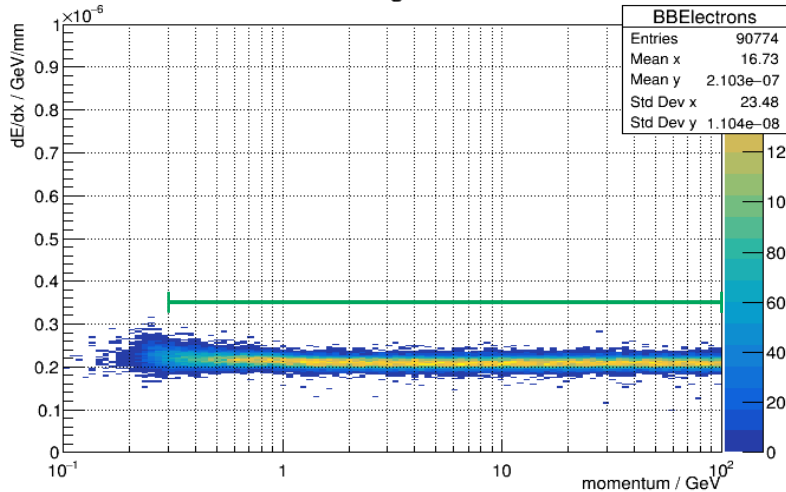
project
in y



dE/dx resolution distribution above 1 GeV for electrons from fit result



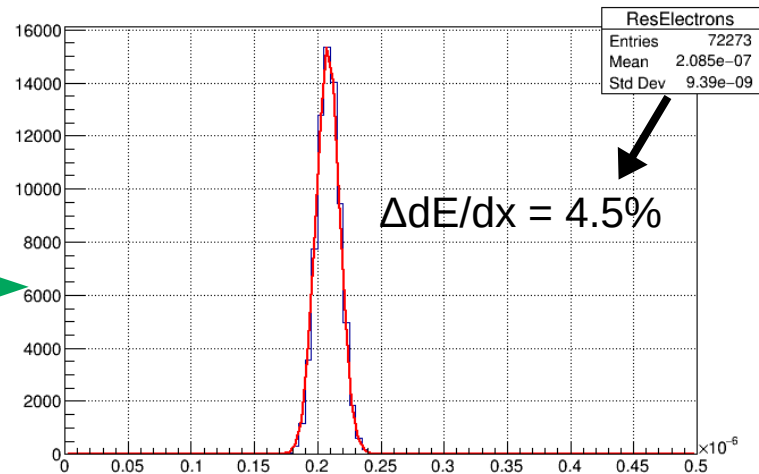
Bethe-Bloch histogram for electrons



project
in y

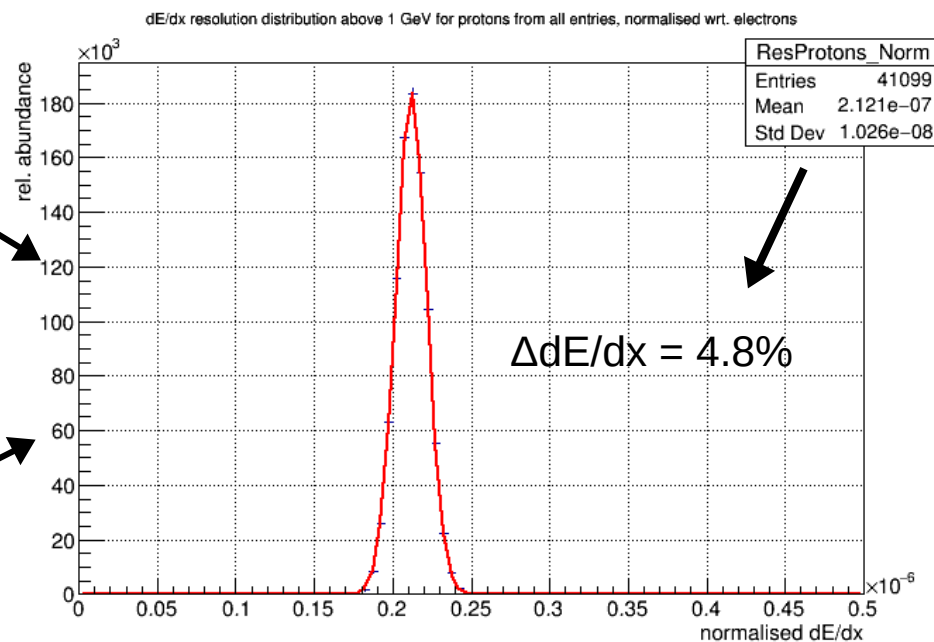
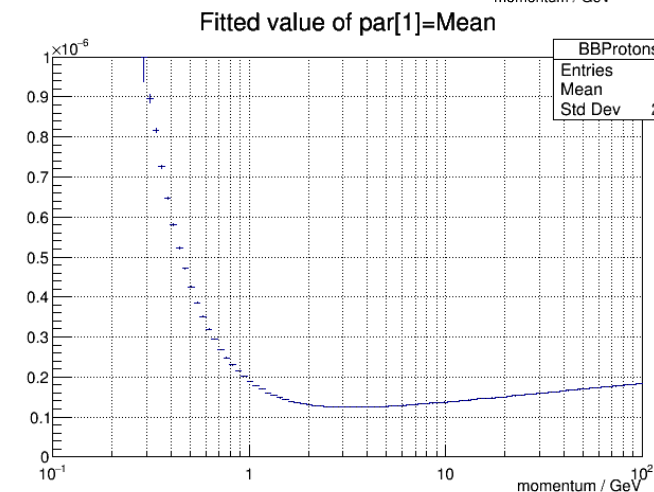
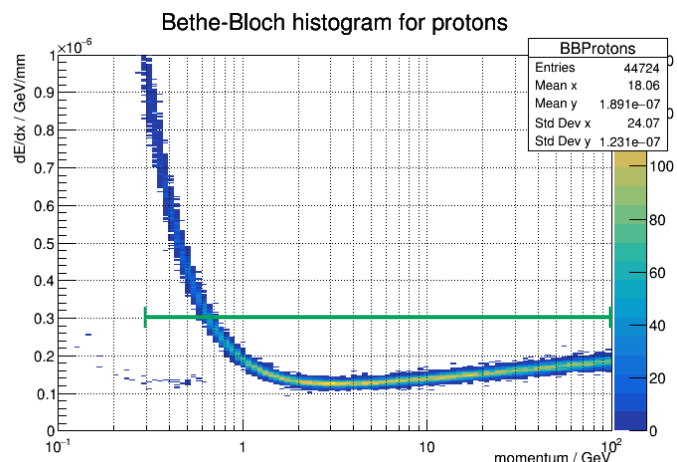


dE/dx resolution distribution above 1 GeV for electrons from all entries, not normalised

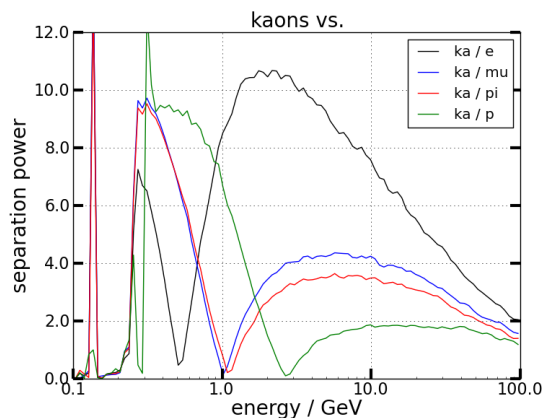
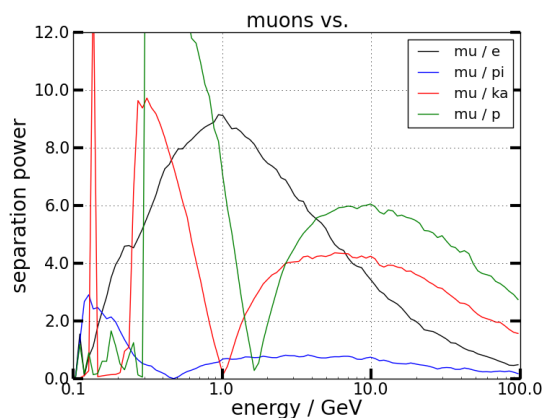
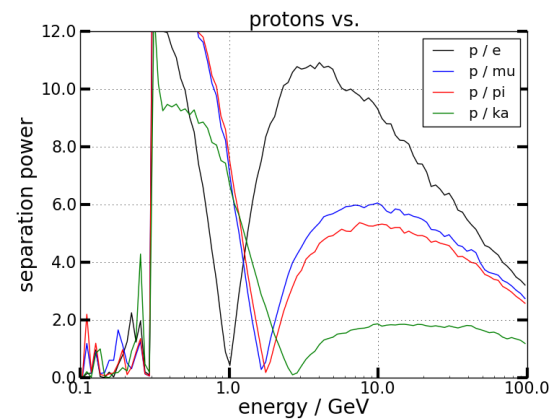
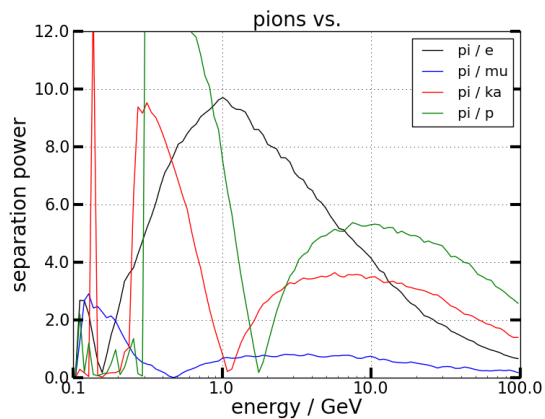
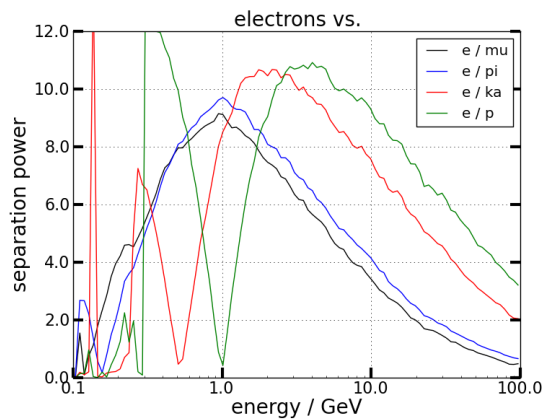


Resolution – other particles: correct for Bethe-Bloch curve

- Normalise each track entry by the fit mean value of the corresponding bin to the electron mean value (Fermi plateau)



Separation Power – Combined Plots



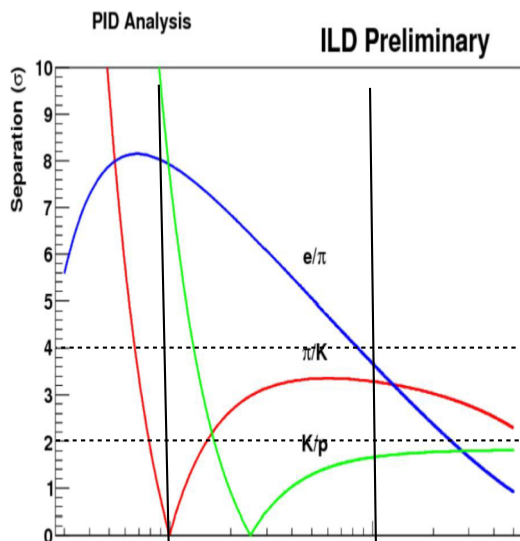
Separation power:

$$\frac{|\mu_{\pi} - \mu_K|}{\sqrt{\frac{1}{2}(\sigma_{\pi}^2 + \sigma_K^2)}}$$

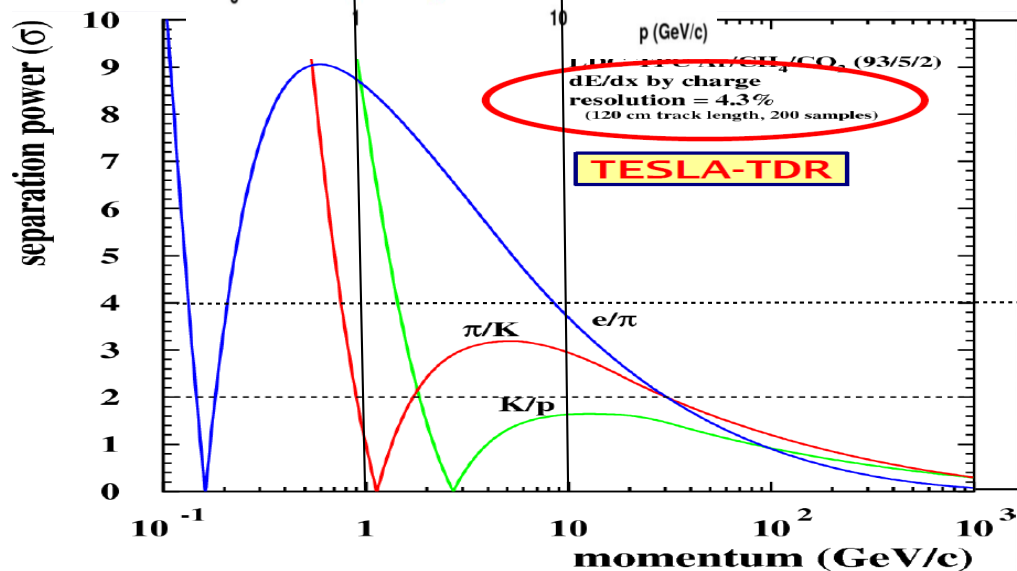


Separation Power - Comparison

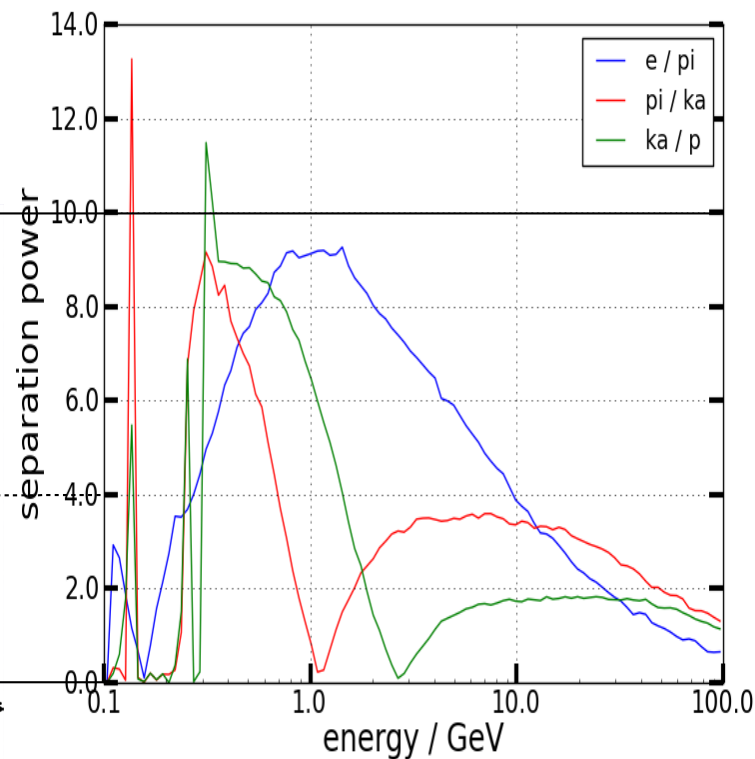
Kurata:
Particle ID
in ILD,
talk at
Calorimeter
Workshop
19.01.2018



Plots aligned for matching axes



this work



Hauschildt: Gaseous Tracking and dE/dx at Future Colliders,
Talk at CERN particle physics seminar, 05.07.2007



- Track::dEdxError should reflect the width of the dE/dx distribution
- Formula for dE/dx error was questioned
- Two independent quantities go in:
 - Track length
 - Number of hits / readout granularity
- Consistent with former observation from experiments, summary e. g. in Blum, Rolandi: Particle detection with drift chambers, 1993



dE/dx error formula

- Current formula:
$$\Delta \frac{dE}{dx} = \frac{dE}{dx} \cdot 4.7\% \cdot \left(\frac{L}{1\text{ m}}\right)^{-0.34} \cdot N_{trunc}^{-0.45}$$

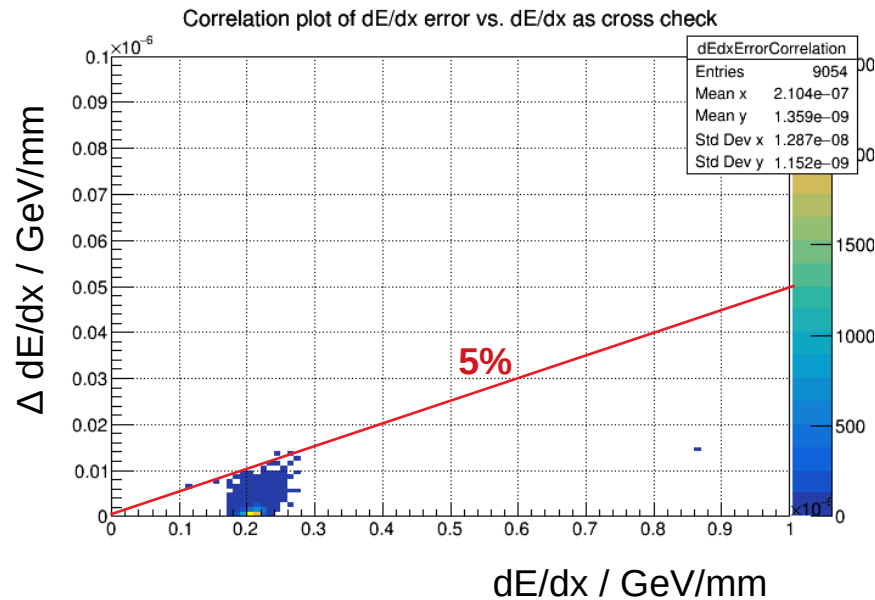
- Proposed formula:
$$\Delta \frac{dE}{dx} = \frac{dE}{dx} \cdot 4.7\% \cdot \left(\frac{L}{N_{Hit} \cdot 6\text{ mm}}\right)^{-0.34} \cdot \left(\frac{N_{Hit}}{220}\right)^{-0.45}$$

- Exponents should be checked!
Does the errors match our observed dE/dx distribution width?

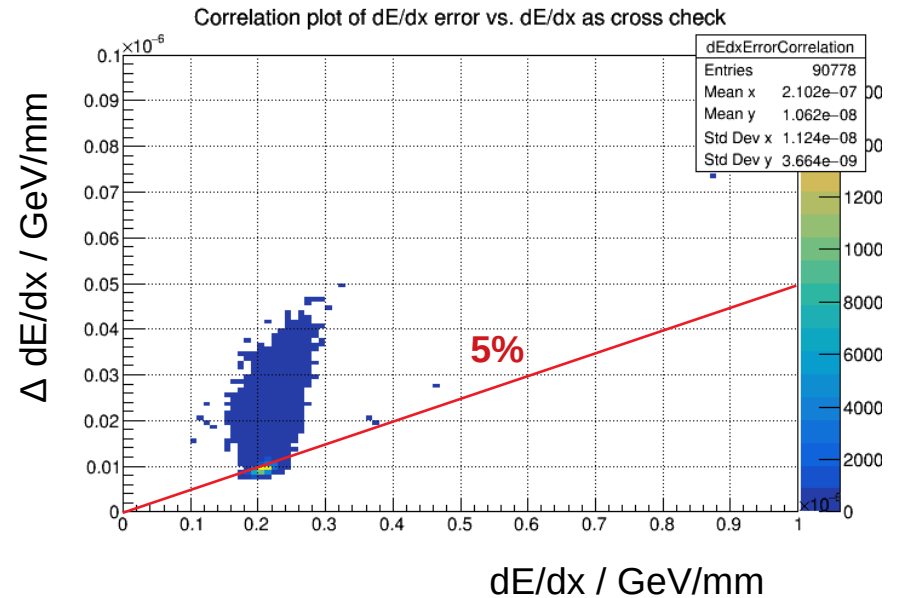


Overall scale

Current:



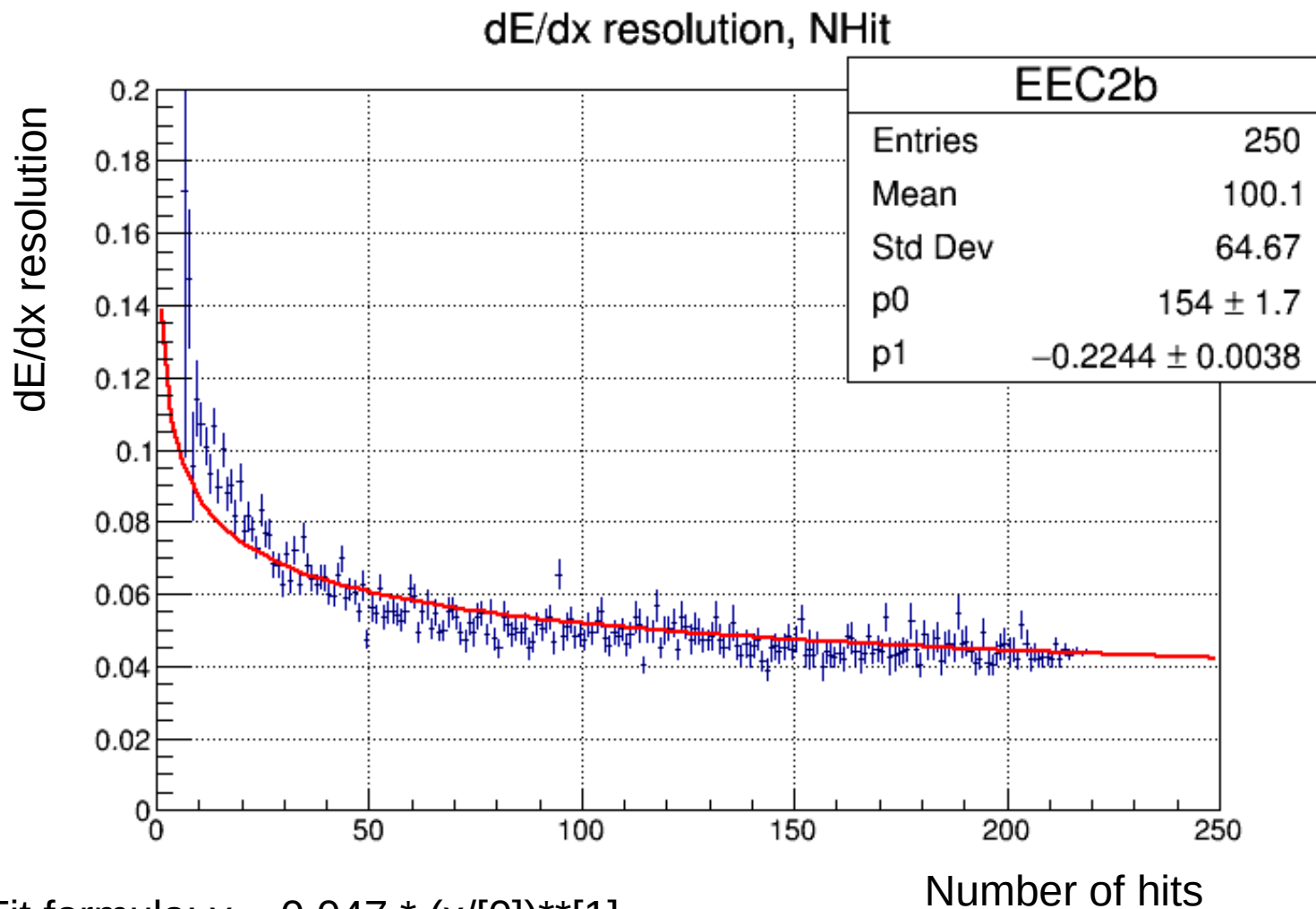
Proposed:



- Overall scale issue is separately corrected for later in the PID tools



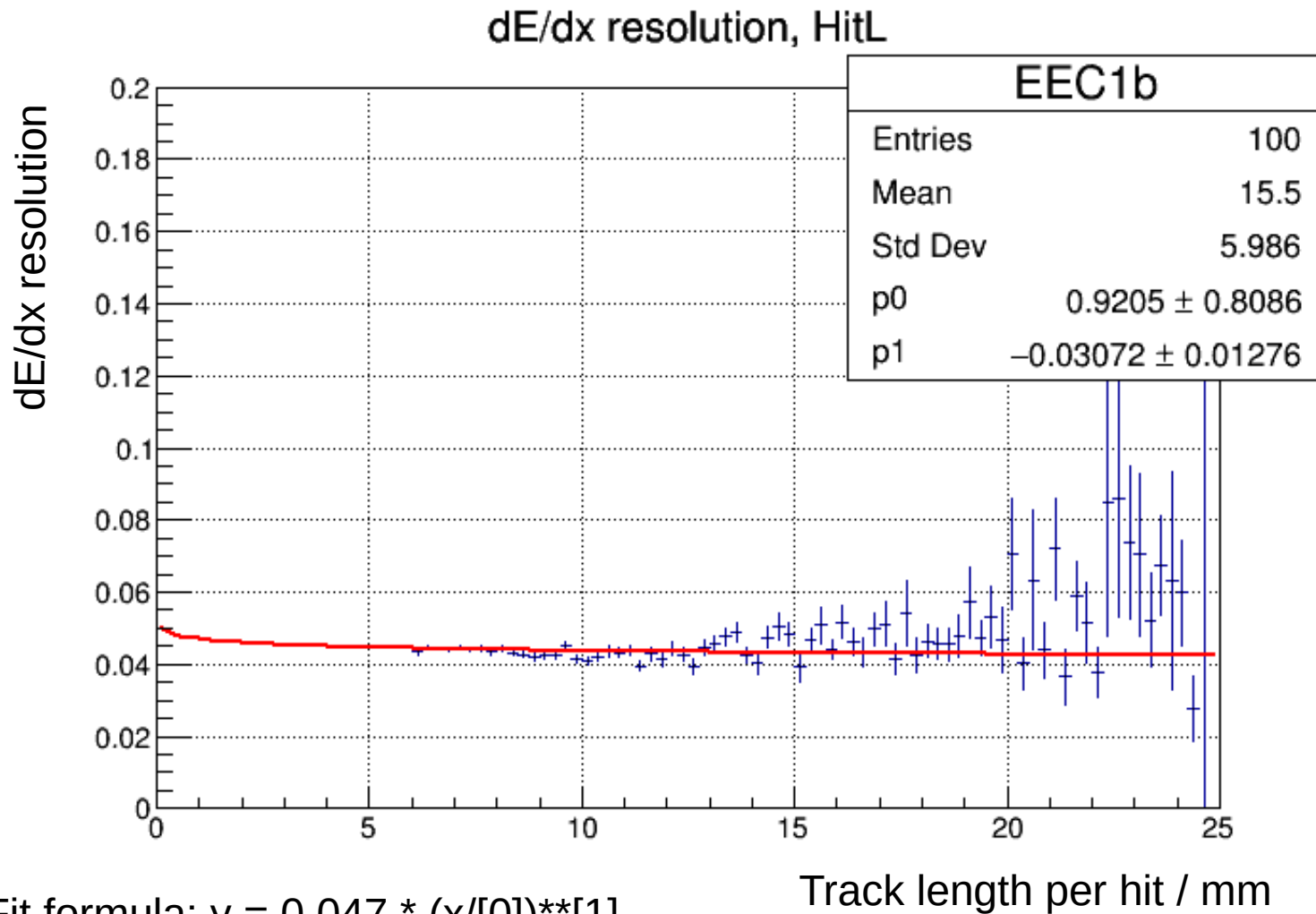
Dependence on number of hits



Fit formula: $y = 0.047 * (x/[0])**[1]$



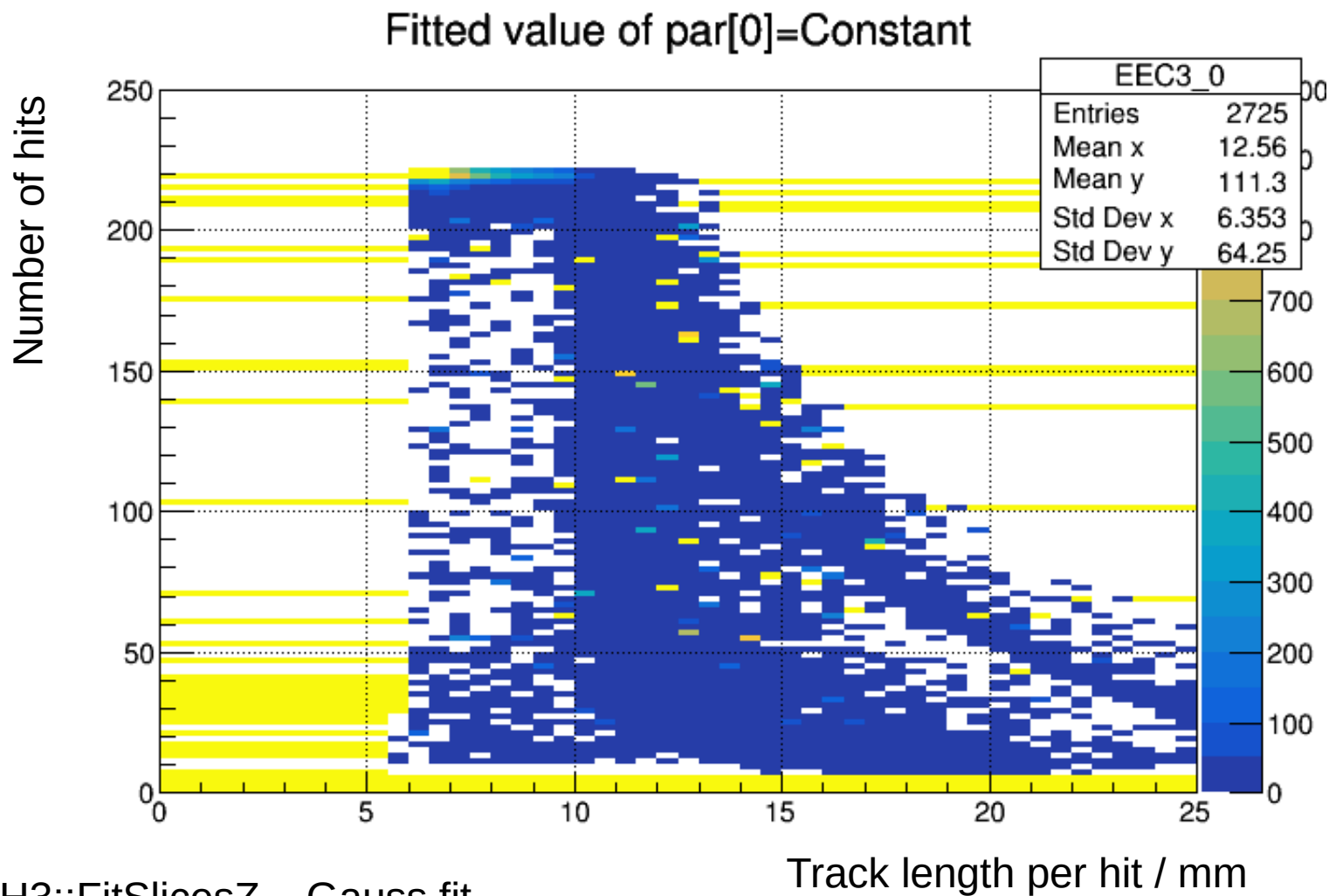
Dependence on track length



Fit formula: $y = 0.047 * (x/[0])**[1]$



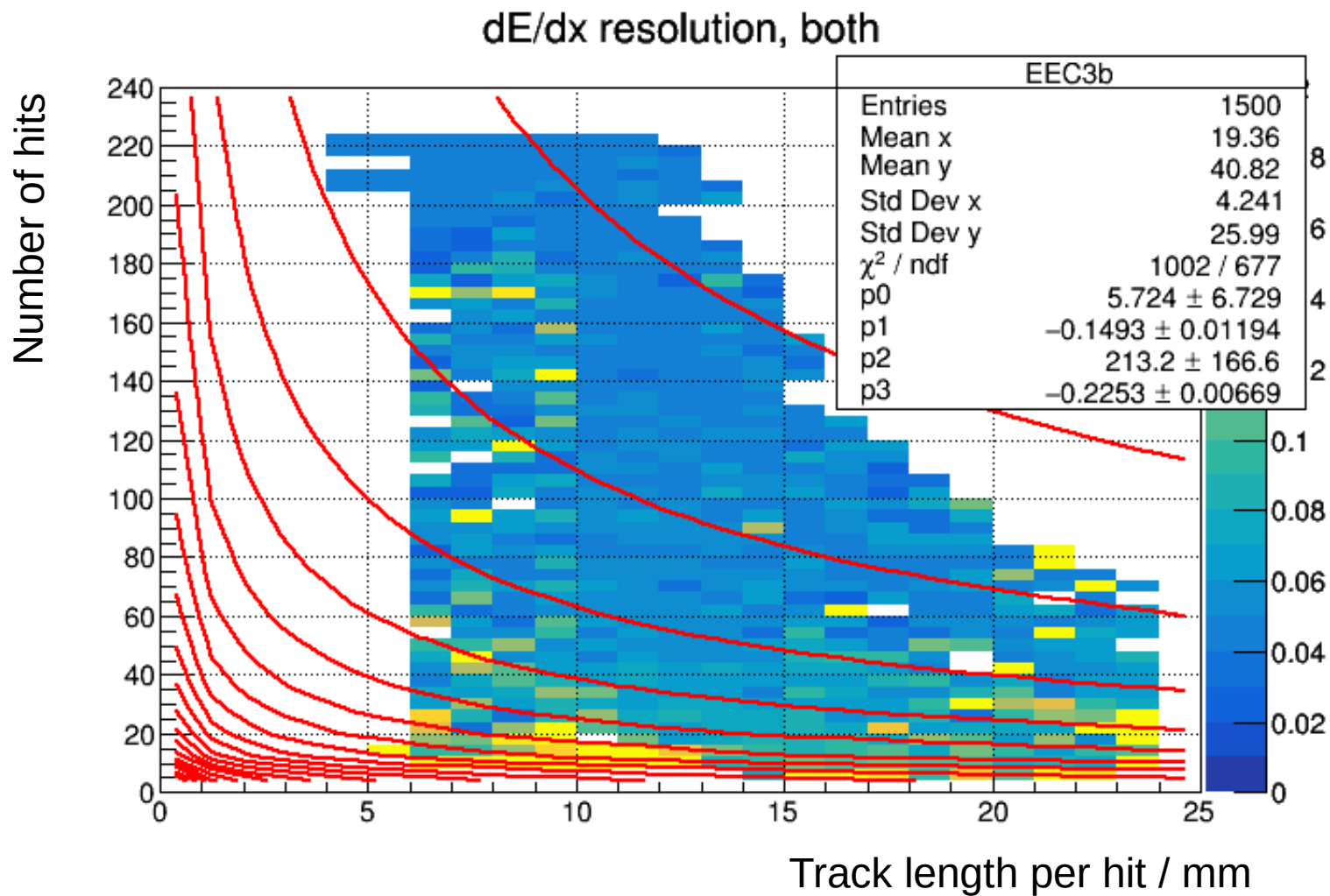
Dependence on both at once



TH3::FitSlicesZ – Gauss fit
Here: amplitude (constant)

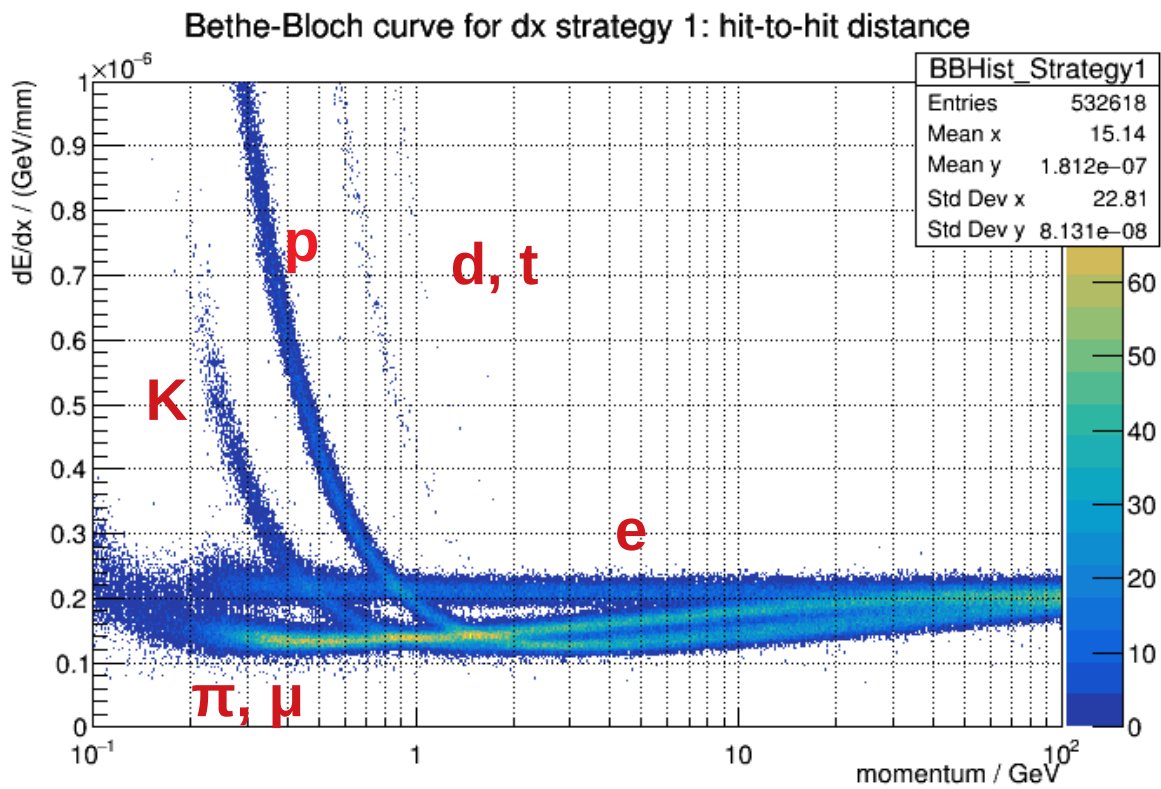


Dependence on both at once



- Overall scale is corrected by the proposed formula
- Expected dependencies are not sufficiently reflected in observed dE/dx distribution width - neither for proposed, nor for current formula!
- More correlation on momentum, drift, etc. could cause this
- A dedicated study may be necessary
- Decision by software conveners: keep current formula
- Consequences unknown & current performance sufficient





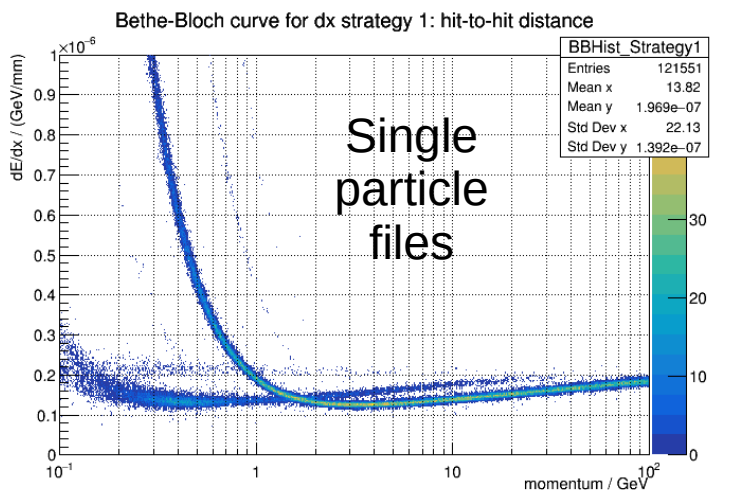
Thanks!



Backup

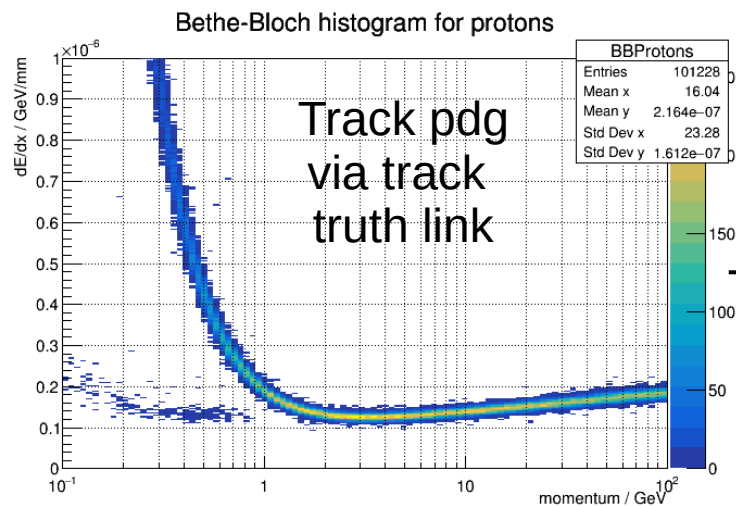


Separate Particle Species

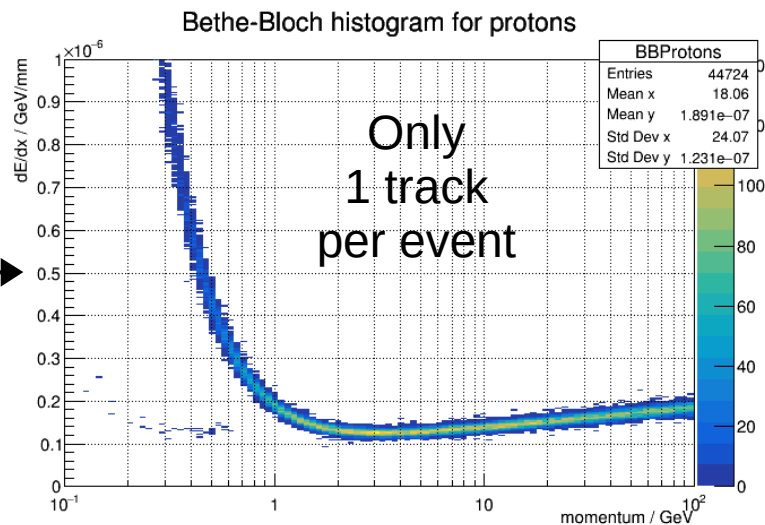


Single
particle
files

- Base files of single particles had impurities from hard scattering
- Got pdg from Track2MCTruth instead, remaining impurities from backscattered particles
- Mostly eliminated by using only 1 track per event
- Example: protons



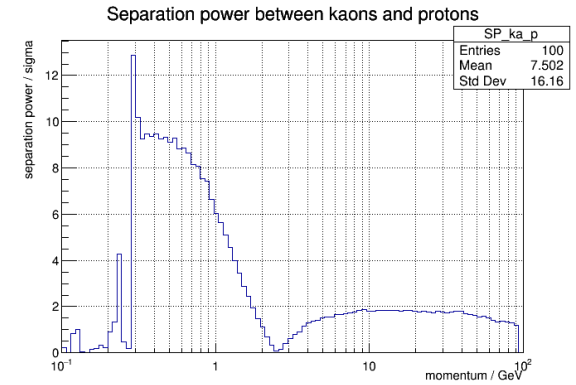
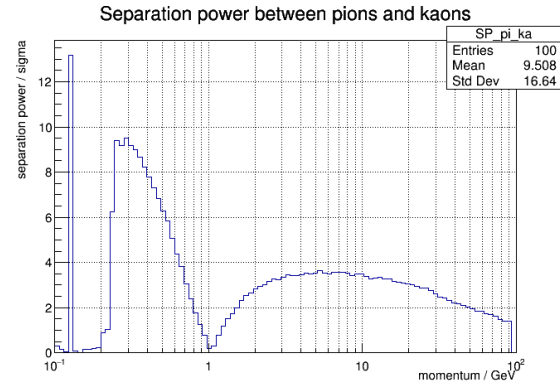
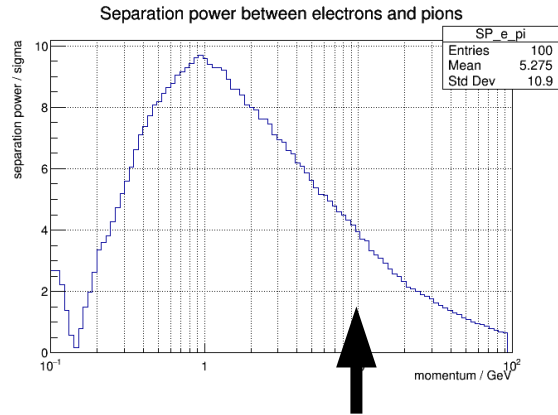
Track pdg
via track
truth link



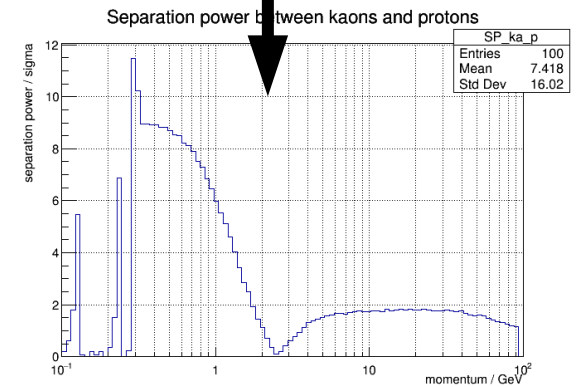
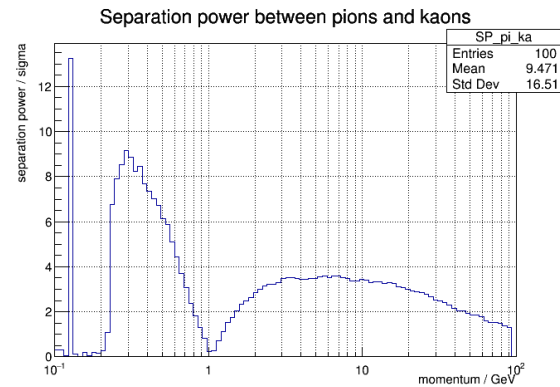
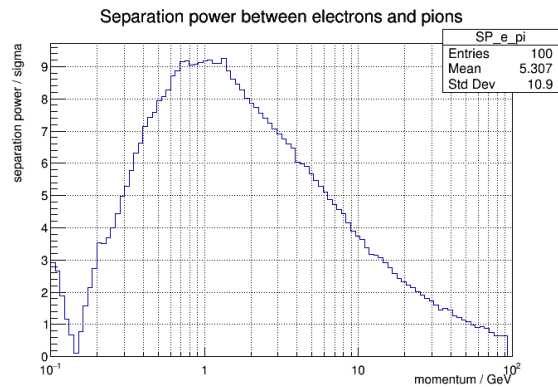
Only
1 track
per event



dx Strategy Comparison



Strategy 1 is very similar, maybe slightly better than strategy 3



dx Strategy Comparison

- Strategy 1 is very similar to, maybe slightly better than strategy 3
- Difference plot:

