Track Fit Overview

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Introduction

The MAUS Track Fitting Framework:

1. Digitisation
2. Clustering
3. Spacepoint Creation
4. Pattern Recognition (Spacepoint Selection)
5. **Track Fitting**

Kalman Track Fitting

The track it is performed using a Kalman Fitting routine, derived from signal analysis techniques.

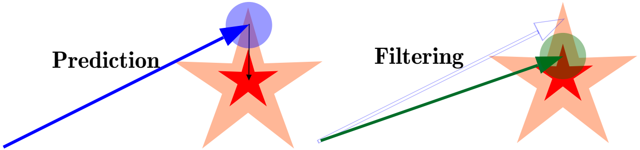
It is an optimal fitting routine, taking into account all measurement and stochastic correlations at all measurement points. No linear fitter can do better.

The key word is linear!

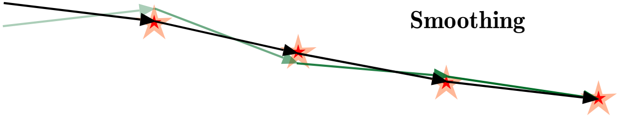
Errors are modelled as multivariate gaussian distributions (i.e. completely described by a covariance matrix) and the measurement and propagation functions are assumed to be linear.

Kalman Track Fitting

It propagates from point to point, and filters (applies the measurement to the prediction) at each measurement location.



A smoothing step then allows for the combined weight of the information to be propagated in reverse through the lenth of the track.



Straight Track Reconstruction

For the straight track fit this works very well:

Components: x, x', y, y'

Scattering	Highland formula
Energy Loss	N/A
Measurements	Quantised
Propagation	Linear

The Highland formula is a gaussian approximation for the central 98% of the scattering distirbution and is recommended by the PDG for most applications.

The straight track reconstruction has no sensitivity to energy loss as it cannot measure momentum.

Helical Track Reconstruction

For the Helical Fit:

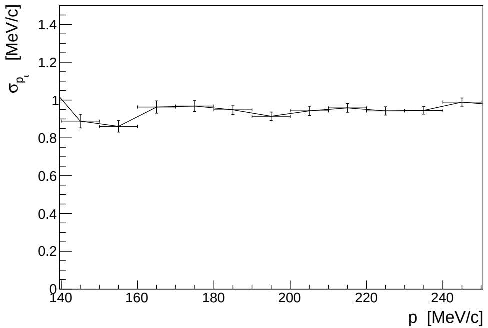
Components: x, p_x, y, p_y, $\kappa = q/p_z$

Scattering	Highland formula
Energy Loss	Bethe Formula
Measurements	Quantised
Propagation	Nonlinear (Helix)

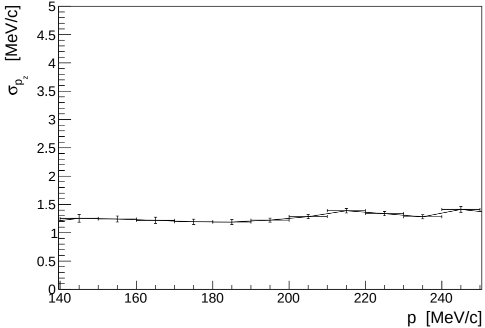
Now the Bethe formula is used and represents a gaussian approximation to mean energy loss. It has been compared with the Landau-Vavilov formula and was found to perform better as we are interested in the mean behaviour of a bunch.

The propagation is now non linear: The p_z dependence requires a first order corrections. The fitter can now be described as and "Extended Kalman Fitter", and no longer provides the optimal fit - only the optimal *linear* fit.

Performance



Transverse Momentum Resolution



Longtudinal Momentum Resolution

Effect on Efficiency

The Track Fit should not have any effect on the efficiency of the reconstruction.
Only the accuracy.

However, if the fit fails (NaN., Inf., etc) then the track is discarded.
No further processing occurs.

This is a $< 1\%$ effect.
e.g. 2 out of 1000 tracks.

Conclusions

- The track fit has been implemented, revisited, tested and used extensively,
- The algorithms have been validated to a high significance,
- The performance is on par with expectations and performs very well in ideal circumstances,
- In non-ideal circumstances there is a degradation due to the field alignment and uniformity.

At present there has not been any strong evidence pointing to the requirements for advanced fitting routines to account for discrepancies in the magnetic field.