Recent Changes in GENFIT

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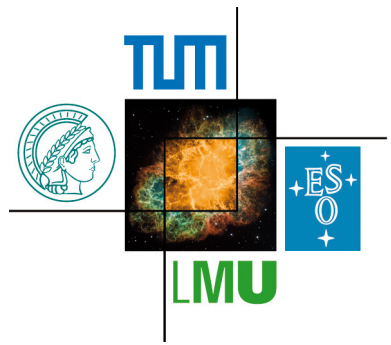

Recent Developments

1. faster and more accurate averaging formula
2. schema evolution for pruning, enabled by default
3. SVD hit handling in DAF fixed
4. Geant4-based material handling

Averaging Formula

Just a hobby of mine ...

Kalman smoother calculates average between forward and backwards hits. This is needed for calculation of residuals along the track.

- I derived and implemented a numerically more stable of doing these averages
- the procedure has general applicability to averaging, i.e. calculating the wighted average of (x_1, C_1), (x_2, C_2)
- once one casts it into the right language, the method is actually a textbook method for minimizing χ^2
- therefore I'm not going to bore you with linear algebra

Anyway, it's now the default in GENFIT as it's also faster than the standard formula. If you're really curious about it, it's documented by a long comment in `MeasuredStateOnPlane.cc`.

Pruning Enabled by Default

Saving disk space

GENFIT tracks are large objects. Most of the time we don't need the detailed information they provide:

- vertexing (and thus physics) needs the track parameters at the innermost point
- extrapolation to outer detectors needs the track parameters at outermost point
- $\mathrm{d}E/\mathrm{d}x$ needs track length at intermediate steps
- and nothing else (residuals, reference trajectory, forward and backwards fit separately, etc.)

In GENFIT we provide a means of doing away with unnecessary information ("pruning"). This is now enabled by default: once all the modules added by `add_reconstruction` are processed, all tracks are pruned except for the information in the first and last track points (thanks to Christian Pulvermacher).

SVD hit handling

Ever since we switched to the DAF as default, SVD hits were not dealt with correctly:

- U and V hits were combined and thus competing
- therefore we used only half the information: essentially the direction with the higher residual was thrown out

In the process of dealing with this, I found an error in the handling of the wedged sensors (double counting of angle of wedged strips, present since the switch to GENFIT2), which didn't have an effect until I un-combined U and V hits.

- I fixed both issues
- the fix for the DAF is not yet live, because Tadeas needs to update the GBL interface, and his master's exams were more important

Geant4-based material handling

- track fitting needs to know about materials
- it uses these to account for energy loss and multiple scattering uncertainties
- this is non-trivial as I also need to know how far we can extrapolate before crossing a boundary

We currently use the ROOT `TGeo` for this. This has the disadvantage that we need to build this from our Geant4 geometry duplicating all objects in memory.

- I was invited to Karlsruhe last week
- at Martin Heck's suggestion, I implemented an alternative that uses the Geant4 geometry directly
- as of yesterday evening, it works, but a momentum bias remains, material appears to be underestimated (what a joy to match Geant4's units to those of GENFIT and `basf2`!)
- as of my last benchmark the `GenFitterModule` is only 10% slower than `TGeo`, but I didn't yet try optimising it