ACTS – GSF Implementation Status

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ACTS Fitter discussion

Introduction

- Gaussian Sum Fitter – extension of Kalman-Fitter for non-Gaussian noise
  - Uses Gaussian-Mixtures as track states
- Main sources:
  - Thomas Martin Atkinson: Electron Reconstruction with the ATLAS Inner Detector
  - R. Frühwirth: Track fitting with non-Gaussian noise
  - Athena source code

Recap: Multi Stepper

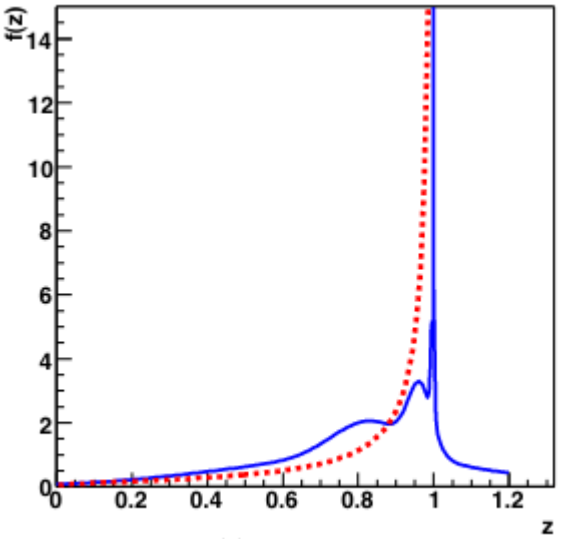
- Dedicated Stepper Type for GSF
  - Interfaces as a single component state to the Navigator
  - Interfaces as a multi component state to the GSF-Actor
- Two different Implementations
  - Loop *(Loops over a vector of* `EigenStepper` *states)*
  - SIMD *(Uses SIMD parallel data structures)*

Implementation: Propagation

- Smoothing requires backward propagation
- Unlike in the `Acts::KalmanFitter`: Three calls to `.propagate(…)` in the GSF fit-function.
  - Forward, backward, return-to-perigee
  - Less branches, less boolean checking
  - **Performance impact expected?**

Implementation: Bethe-Heitler-Distribution

- Energy loss is Bethe-Heitler-distributed
  - Each component “spawns” N_c new components
  - Reduction required (merging)
- Implementation copied from Athena
  - 6 component representation as 5th-order polynomial in *t*



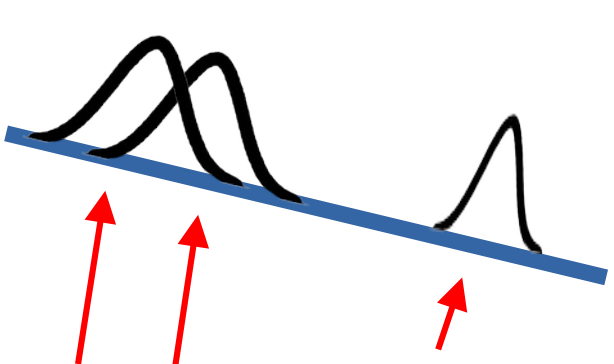
(f) $N_{el} = 6$

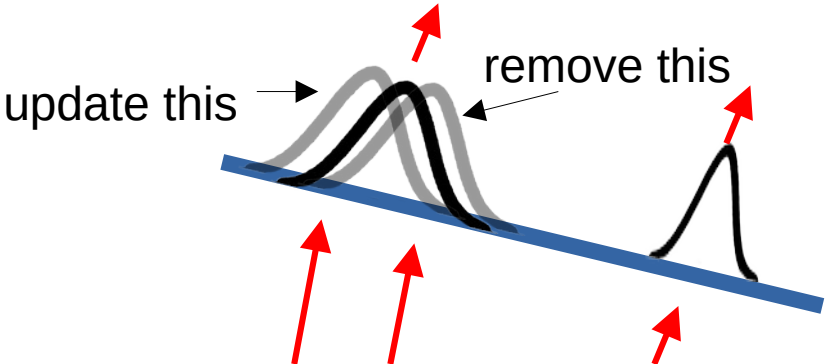
$$f(z) = \frac{(-\ln(z))^{c-1})}{\Gamma(c)}, \qquad \text{with} \qquad c = \frac{t}{\ln(2)},$$

$$z = \frac{E_f}{E_i}. \qquad\qquad t = \frac{x}{x_0},$$

Implementation: Component Reuse

- Can reuse `Acts::MultiTrajectory`
  - And thus the `Acts::GainMatrixUpdater`
  - **But:** Need to store weights (at the moment with `std::map<size_t, double>`)
  - Component merging seems not to be a problem:





Integration in Examples Framework

- `Acts::GaussianSumFitter::fit(...)` returns a `Acts::KalmanFitterResult`
  - Directly usable with `ActsExamples::TrackFittingAlgorithm`

Next steps

- Can a weight-field be added to the `MultiTrajectory`?
- Debugging, Refactoring, etc.
- Test with more complicated setups than Telescope detector
  - Component loss not yet fully implemented
  - Do some statistical analysis