HIT TIMING

TRACKING MEETING

DEC 10 2018

MIRIAM DIAMOND

CODE CHANGES

- hps-java currently includes T0Err in ShapeFitParameters attached to FittedRawTrackerHit
- But, not propagated to hit clusters
  - SiTrackerHitStrip1D object (used internally) has no T0err
- Then, not propagated to 3D hits
  - HelicalTrackHit object (used internally) has no T0err either
- TrackerHit object (persistified in lcio) has no T0err, so need new GenericObjects and LCRelations to store time errors associated with 2D or 3D hits

- iss329 provides "hooks" in the code to fix these issues
- But only works if original T0Err is correct… which it's not!

ISS329: HIT CLUSTERING & 2D HIT OBJECTS

- tracking/DataTrackerHitDriver.java : creates hit clusters using StripClusterer, then makes list of SiTrackerHitStrip1D objects (used internally) and stores them in lcio as TrackerHits
  - StripClusterer uses ClusteringAlgorithm and SiliconResolutionModel
- Added boolean switch doHitTimeErrors. If enabled:
  - Uses TimedSiliconResolutionModel, and enables doHitTimeErrors, in the StripClusterer
  - StripCluster creates HpsSiTrackerHitStrip1D objects (used internally)
  - Creates list of HitTimeData objects, and list of LCRelations between them and SiTrackerHitStrip1D objects, then stores them in lcio
- tracking/HitTimeData.java : new GenericObject that currently just contains one entry in List<Double>
- tracking/TimedSiliconResolutionModel.java : child of DefaultSiliconResolutionModel, with getTime() method added
- tracking/HpsSiTrackerHitStrip1D.java : child of SiTrackerHitStrip1D, with double timeError (and getter and setter methods) added

ISS329: HIT CLUSTERING & 2D HIT OBJECTS

- getTime() method in TimedSiliconResolutionModel : returns Pair of doubles representing cluster time and error. Cluster time calculation should probably be changed, but for now it is kept the same, with error calculated accordingly

```
public class TimedSiliconResolutionModel extends DefaultSiliconResolutionModel {
    @Override
    public Pair<Double, Double> getTime(List<FittedRawTrackerHit> cluster) {
        double time_sum = 0;
        double signal_sum = 0;
        double err_sum = 0;

        for (FittedRawTrackerHit hit : cluster) {

            double signal = hit.getAmp();
            double time = hit.getT0();
            time_sum += time * signal * signal;
            signal_sum += signal * signal;
            err_sum += Math.pow(hit.getT0Err(), 2) * Math.pow(signal, 4);
        }
        return new Pair<Double, Double>(time_sum / signal_sum, Math.sqrt(err_sum) / signal_sum);
    }
}
```

ISS329: 3D HIT OBJECTS

- tracking/HelicalTrackHitDriver.java : makes HelicalTrackCross objects from SiTrackerHitStrip1D objects, then makes list of HelicalTrackHit objects (used internally), then stores them in lcio as TrackerHit objects
- Added boolean switch doHitTimeErrors. If enabled:
  - Fetches hit time errors of SiTrackerHitStrip1D objects
  - For each HelicalTrackCross, calls new calculateHitTimeError() method in tracking/TrackerHitUtils.java (assumes HelicalTrackCross time is simply the average of the two SiTrackerHitStrip1D times)
  - Creates list of HitTimeData objects, and list of LCRelations between them and HelicalTrackHit objects, then stores them in lcio

T0ERR ISSUES

- T0Err stored along with T0 in ShapeFitParameters object, attached to FittedRawTrackerHit
- But often, T0Err, is NaN!
- Sho: "T0Err comes directly from Minuit (just the Minuit error - not Minos). The HPS code wrapped around Minuit doesn't check the Minuit state; it is guided only by the chisq of various Minuit attempts. So it is totally possible for the best fit to correspond to what Minuit considers a bad state. Since the chisq function is not well behaved (nonparabolic minima), this is not uncommon"
- Code: fitShape(), doRecursiveFit(), minuitFit() methods
  - https://github.com/JeffersonLab/hps-java/blob/master/tracking/src/main/java/org/hps/recon/tracking/ShaperLinearFitAlgorithm.java#L92
  - https://github.com/JeffersonLab/hps-java/blob/master/tracking/src/main/java/org/hps/recon/tracking/ShaperLinearFitAlgorithm.java#L177
  - https://github.com/JeffersonLab/hps-java/blob/master/tracking/src/main/java/org/hps/recon/tracking/ShaperLinearFitAlgorithm.java#L291

WHY DOES HIT TIME ERROR MATTER, ANYWAY?

- Implement tighter requirements on times of hits on track?
  - In SeedTracker (HitTimeTrackCheck)
  - In MOUSE cuts
- Include timing in track χ^2 ?
- When propagated to track time, may affect track-cluster Δt (currently in MOUSE cuts)?

- So, it's worth someone's effort to take on the project of fixing the T0Err!