Update on Timing in EicRecon

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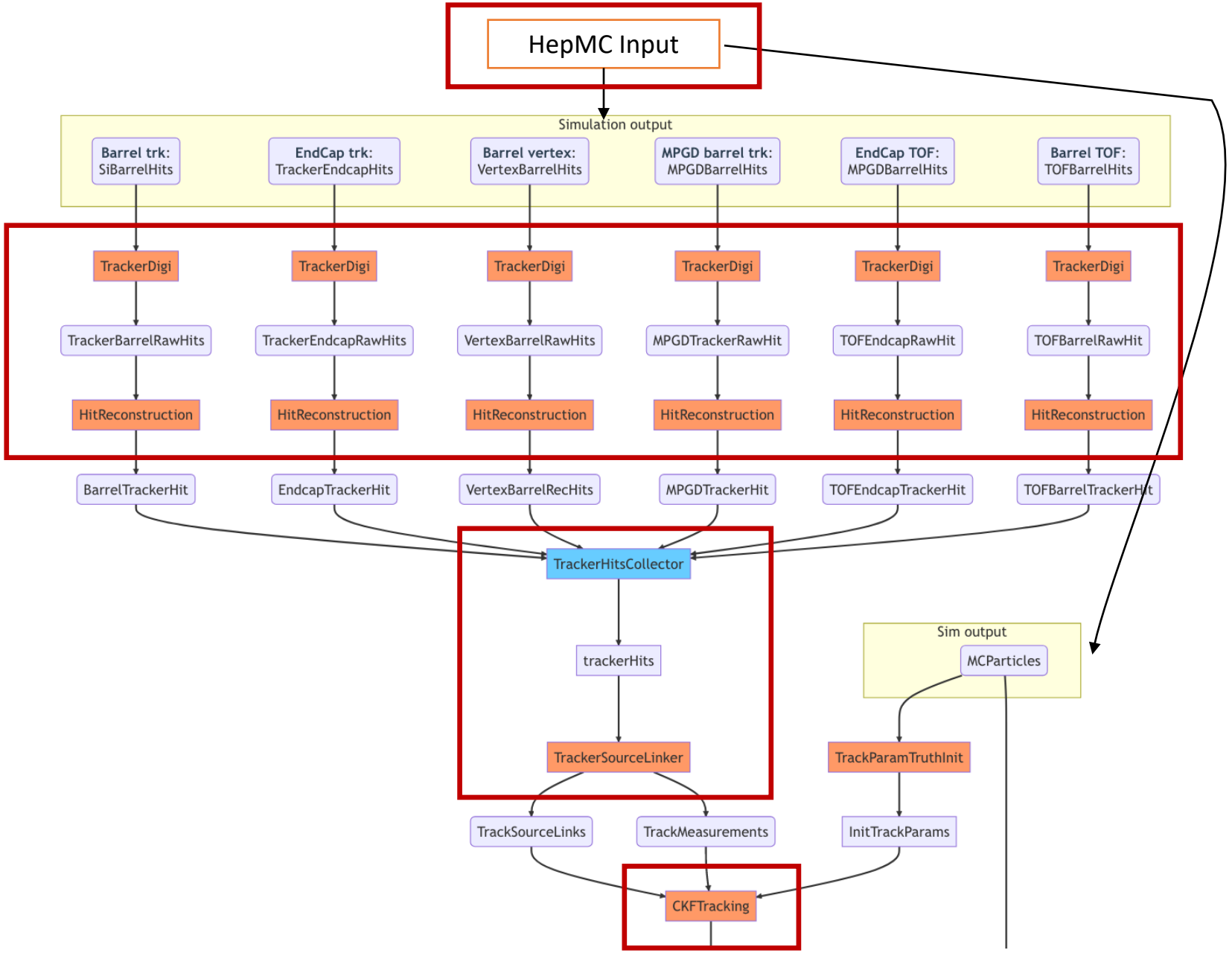
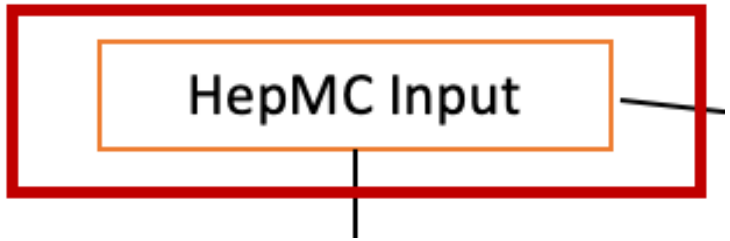
Big Thanks to Dmitry Romanov, Benjamen Sterwerf

Workflow


HepMC Input
Simulation output
Barrel trk: SiBarrelHits
EndCap trk: TrackerEndcapHits
Barrel vertex: VertexBarrelHits
MPGD barrel trk: MPGDBarrelHits
EndCap TOF: MPGDBarrelHits
Barrel TOF: TOFBarrelHits
TrackerDigi
TrackerBarrelRawHits
TrackerEndcapRawHits
VertexBarrelRawHits
MPGDTrackerRawHit
TOFEndcapRawHit
TOFBarrelRawHit
HitReconstruction
BarrelTrackerHit
EndcapTrackerHit
VertexBarrelRecHits
MPGDTrackerHit
TOFEndcapTrackerHit
TOFBarrelTrackerHit
TrackerHitsCollector
trackerHits
TrackerSourceLinker
TrackSourceLinks
TrackMeasurements
Sim output
MCParticles
TrackParamTruthInit
InitTrackParams
CKFTracking

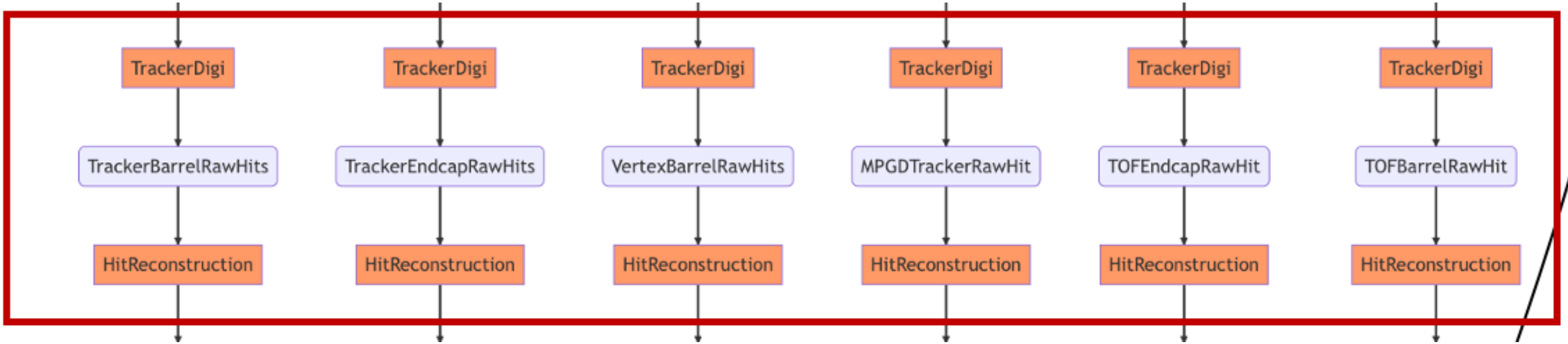


HepMC Source

Benjamen Sterwerf is working on this

- Goal:
  - Events as long as the slowest integration time (e.g. 2 μs)
  - According to their distributions, add various background sources at random times
- Now at the the testing stage
- His repository -- soon to be migrated to the central EIC Github
- Currently a jupyter notebook, soon to be translated to stand-alone python
  - well-aligned with future use as on-the-fly plugin to dd4hep?

Digitization/Integration



This is my focus

- At this step, raw hits are replaced by detector cell center
- Multiple hits in the same cell are combined

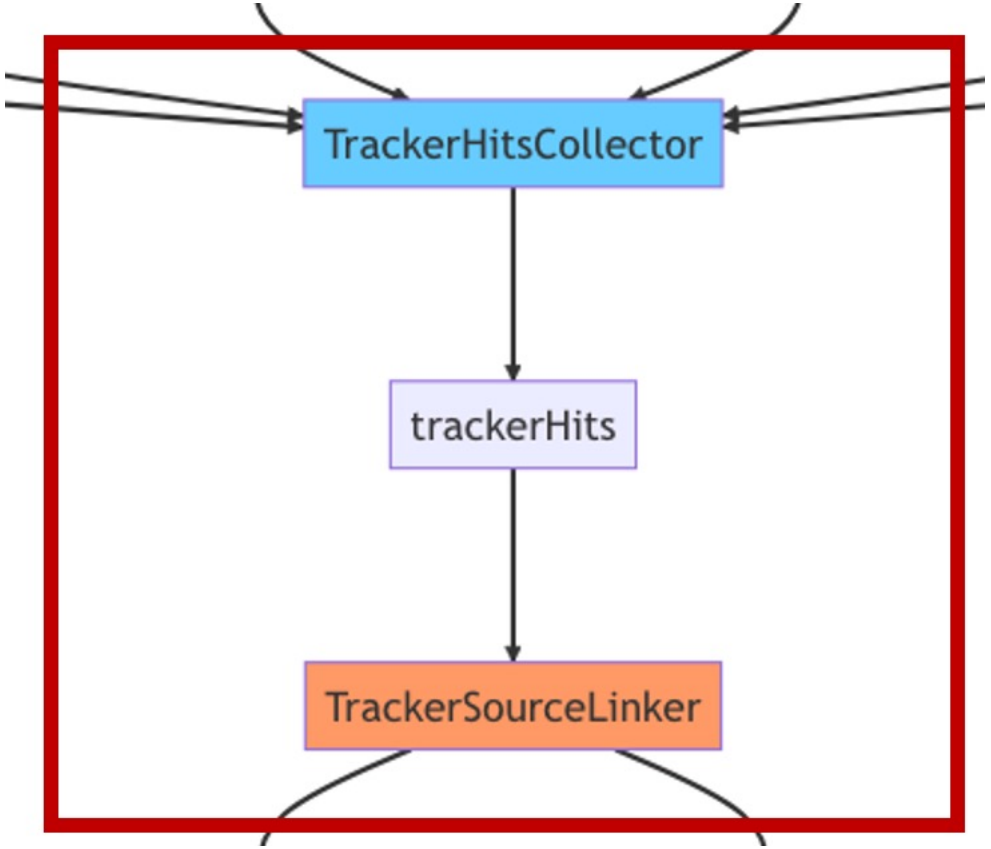
Digitization/Integration

- These tracker hits already have a time stamp. Instead of combining all raw hits into one tracker hit at the same time, generate a new one when outside the time resolution window

```
65          } else {
66              // There is previous values in the cell
67              RawHit &prev_hit = cell_hit_map[sim_hit->getCellID()];
68              m_log->debug("  Hit already exists in cell ID={}, prev. hit time: {}", sim_hit->getCellID(), prev_hit.time_stamp);
69              prev_hit.time_stamp = std::min(hit_time_stamp, prev_hit.time_stamp);  // keep earliest time for hit
70              prev_hit.charge += (std::int32_t) std::llround(sim_hit->getEDep() * 1e6);
```

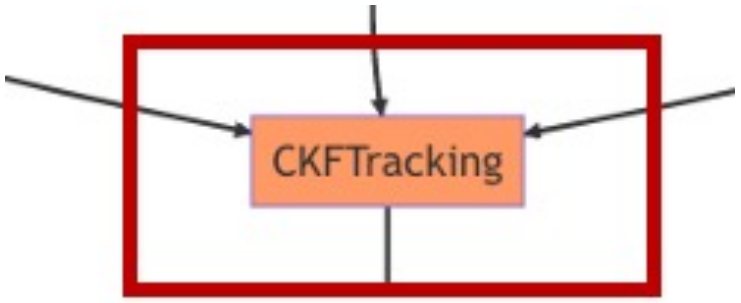
- Detectors share a digitizer algorithm, but they can be individualized and/or configured with parameters

Prepare for ACTS



Dmitry works on this

- Currently, the time stamp gets lost at this step.
- AFAIK: Relatively simple fix already exists on a different branch



Finally, Fit. Plus my Question.

This Working Group ☺

Question: I understand the fit $\chi 2$ respects the time stamp, but how so?

- Completely, with uncertainty / resolution?
- If so, we need to get that info through the SourceLinker
- If not, ACTS needs work…

Backup

Subsystem	Region	Channel Count	Threshold [keV, MeV or p.e.]	Intrinsic/dark noise rate at this threshold [Hz, noise hit per chan per second]	Analog Features				Type (A) Di Gated (eg.
					Shaping time (FWHM)	2 us (target value)	Total hit time resolution	Charge sharing	Gate on time (integration time)
MAPS	Barrel	17G	0.65 keV	10^-3 per pixel per second (limit)				1.2 at 90deg	2 us (target value)
MAPS	Disks	19G	0.65 keV	10^-3 per pixel per second (limit)				1.2 at 90deg	2 us (target value)
MPGD	Barrel	30k--60k	~0.25keV	~1	~500 ns	~20 ns	~20 ns	3-5	
LGAD	Barrel	2.4M	0.5 keV	30					
LGAD	Forward	8.9M	0.5 keV	30					
pfRICH	Backward	~70k	<0.5 p.e.	~100Hz/channel					
mRICH	Backward	69632	0.5 p.e.	TBD depending on sensor choices (as dRICH)					
DIRC	Barrel	74k	0.2 p.e.	100 Hz/channel					

- Digitization Model