HELIX INTERSECTION CODE

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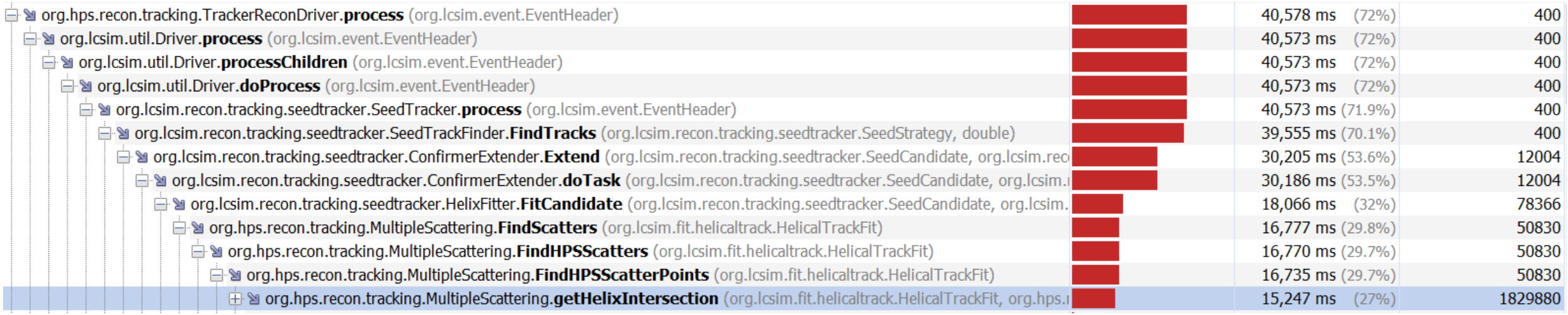
github issue 117

EVIO TO LCIO PROFILING: TRACKER RECON DRIVER



org.hps.recon.tracking.TrackerReconDriver.**process** (org.lcsim.event.EventHeader)	40,578 ms	(72%)	400
org.lcsim.util.Driver.**process** (org.lcsim.event.EventHeader)	40,573 ms	(72%)	400
org.lcsim.util.Driver.**processChildren** (org.lcsim.event.EventHeader)	40,573 ms	(72%)	400
org.lcsim.util.Driver.**doProcess** (org.lcsim.event.EventHeader)	40,573 ms	(72%)	400
org.lcsim.recon.tracking.seedtracker.SeedTracker.**process** (org.lcsim.event.EventHeader)	40,573 ms	(71.9%)	400
org.lcsim.recon.tracking.seedtracker.SeedTrackFinder.**FindTracks** (org.lcsim.recon.tracking.seedtracker.SeedStrategy, double)	39,555 ms	(70.1%)	400
org.lcsim.recon.tracking.seedtracker.ConfirmerExtender.**Extend** (org.lcsim.recon.tracking.seedtracker.SeedCandidate, org.lcsim.rec	30,205 ms	(53.6%)	12004
org.lcsim.recon.tracking.seedtracker.ConfirmerExtender.**doTask** (org.lcsim.recon.tracking.seedtracker.SeedCandidate, org.lcsim.r	30,186 ms	(53.5%)	12004
org.lcsim.recon.tracking.seedtracker.HelixFitter.**FitCandidate** (org.lcsim.recon.tracking.seedtracker.SeedCandidate, org.lcsim.	18,066 ms	(32%)	78366
org.hps.recon.tracking.MultipleScattering.**FindScatters** (org.lcsim.fit.helicaltrack.HelicalTrackFit)	16,777 ms	(29.8%)	50830
org.hps.recon.tracking.MultipleScattering.**FindHPSScatters** (org.lcsim.fit.helicaltrack.HelicalTrackFit)	16,770 ms	(29.7%)	50830
org.hps.recon.tracking.MultipleScattering.**FindHPSScatterPoints** (org.lcsim.fit.helicaltrack.HelicalTrackFit)	16,735 ms	(29.7%)	50830
org.hps.recon.tracking.MultipleScattering.**getHelixIntersection** (org.lcsim.fit.helicaltrack.HelicalTrackFit, org.hps.r	15,247 ms	(27%)	1829880

I investigated:

- Why so many calls to helix intersection code?
- Why does it take so long?
- Would speeding it up sacrifice too much accuracy?

CURRENT CODE

- For each track seed (hits triplet), Extend calls findHPSScatterPoints for each possible track extension into each subsequent layer
- For a given track, findHPSScatterPoints calls getHelixIntersection for each sensor
- getHelixIntersection steps:
  - Approximate calculation of helix intersection pt with sensor plane
  - Determine whether intersection pt falls within boundaries of sensor, +/- isInside tolerance (1 mm)
  - If so, proceed to iterative calculation (convergence precision $\varepsilon = 10^{-4}$ mm, typically requires 2-3 iterations)
  - Determine whether more precise intersection pt is within boundaries of sensor

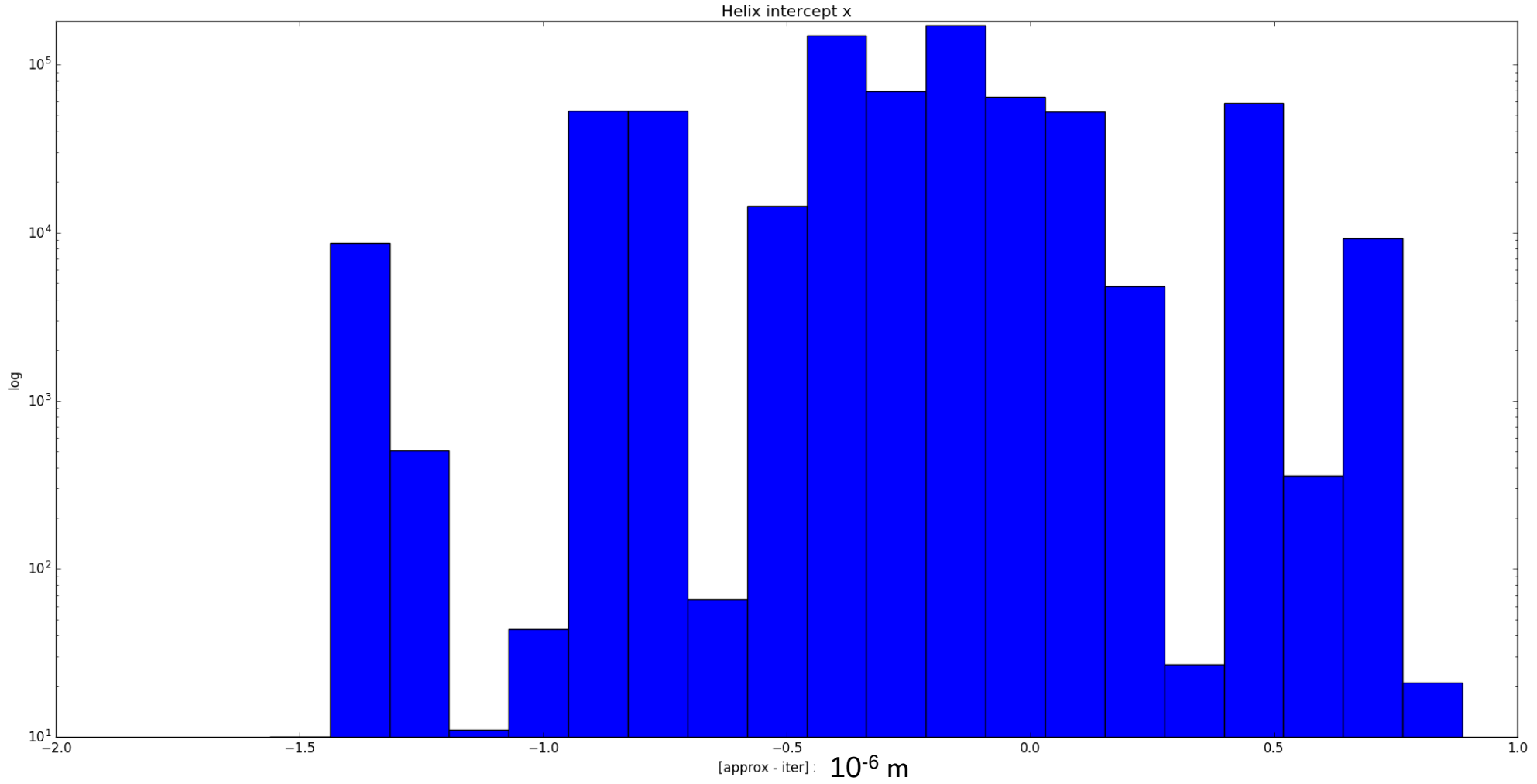
CURRENT CODE

org.hps.recon.tracking.MultipleScattering.**getHelixIntersection** (org.lcsim.fit.helicaltrack.HelicalTrackFit, org.hp		15,145 ms (26.9%)	1829880
org.hps.recon.tracking.TrackUtils.**getHelixPlaneIntercept** (org.lcsim.fit.helicaltrack.HelicalTrackFit, hep.phy		4,429 ms (7.9%)	638006
org.hps.recon.tracking.WTrack.**getHelixAndPlaneIntercept** (hep.physics.vec.Hep3Vector, hep.physics.ve	iterative	2,688 ms (4.8%)	638006
org.hps.recon.tracking.WTrack.**getHelixParametersAtPathLength** (double, hep.physics.vec.Hep3Vector		1,152 ms (2%)	638006
org.hps.recon.tracking.WTrack.**<init>** (org.lcsim.fit.helicaltrack.HelicalTrackFit, double)		463 ms (0.8%)	638006
Self time		112 ms (0.2%)	638006
hep.physics.vec.BasicHep3Vector.**<init>** (double, double, double)		11.9 ms (0%)	638006
hep.physics.vec.VecOp.**inverse** (hep.physics.vec.Hep3Matrix)	[goat]	4,364 ms (7.7%)	4297766
org.lcsim.detector.Transform3D.**transformed** (hep.physics.vec.Hep3Vector)		1,486 ms (2.6%)	4297766
org.lcsim.fit.helicaltrack.HelixUtils.**PathToXPlane** (org.lcsim.fit.helicaltrack.HelicalTrackFit, double, double, in		1,354 ms (2.4%)	1829880
hep.physics.vec.VecOp.**mult** (hep.physics.vec.Hep3Matrix, hep.physics.vec.Hep3Vector)		910 ms (1.6%)	6127646
org.lcsim.fit.helicaltrack.HelixUtils.**PointOnHelix** (org.lcsim.fit.helicaltrack.HelicalTrackFit, double)		766 ms (1.4%)	1829880
Self time		689 ms (1.2%)	1829880
org.lcsim.fit.helicaltrack.HelixUtils.**Direction** (org.lcsim.fit.helicaltrack.HelicalTrackFit, double)		509 ms (0.9%)	1829880
org.lcsim.detector.Transform3D.**rotated** (hep.physics.vec.Hep3Vector)		311 ms (0.6%)	1829880

MODIFYING THE CODE

- I reduced #calls to getHelixIntersection by skipping sensors in layers >3 we know the track won't hit
  - Assume the track hits *top* or *bottom* but not both
  - Assume track cannot hit both *hole* and *slot* in same half-module
- I added doIterative switch to getHelixIntersection: when off, only performs approximate calculation
  - Turned it off for Extend steps, but back on for final track fits
- Assessment:
  - Approximate vs iterative results for individual helix intersection points (underway)
  - Time savings according to profiler (underway)
  - Performance studies (to do)

APPROXIMATE VS ITERATIVE : HELIX INTERSECTION POINTS



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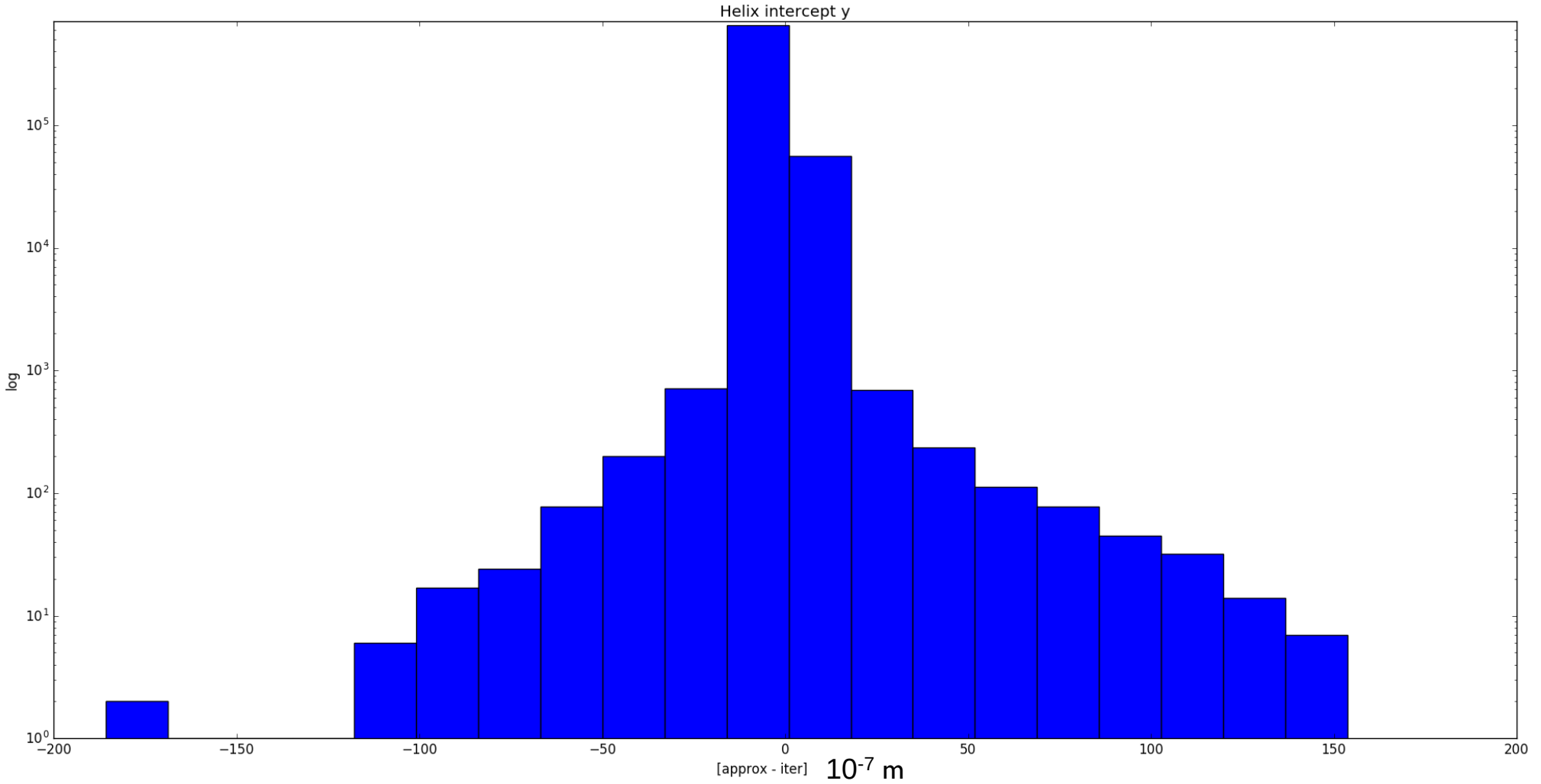

APPROXIMATE VS ITERATIVE : HELIX INTERSECTION POINTS