



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.recon.tracking.seedtracker.SeedCandidate)	30,205 ms (53.6%)	12004
org.lcsim.recon.tracking.seedtracker.ConfirmerExtender.doTask (org.lcsim.recon.tracking.seedtracker.SeedCandidate, org.lcsim.recon.tracking.seedtracker.SeedCandidate)	30,186 ms (53.5%)	12004
org.lcsim.recon.tracking.seedtracker.HelixFitter.FitCandidate (org.lcsim.recon.tracking.seedtracker.SeedCandidate, org.lcsim.recon.tracking.seedtracker.SeedCandidate)	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.recon.tracking.MultipleScattering)	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 $\epsilon = 10^{-4}$ mm, typically requires 2-3 iterations)
 - Determine whether more precise intersection pt is within boundaries of sensor

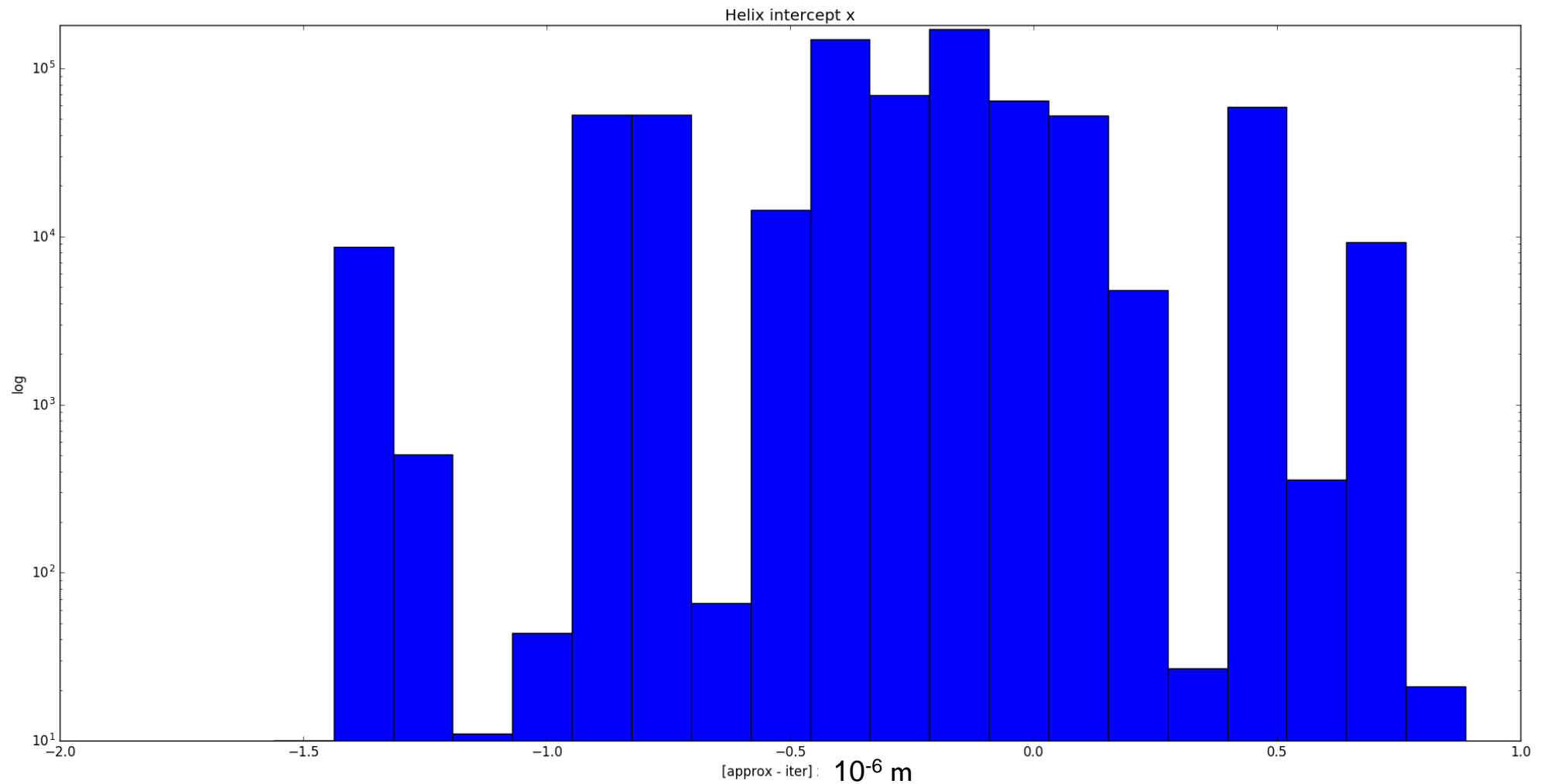
CURRENT CODE

org.hps.recon.tracking.MultipleScattering. getHelixIntersection (org.lcsim.fit.helicaltrack.HelicalTrackFit, org.hps.recon.tracking.TrackUtils)		15,145 ms (26.9%)	1829880
org.hps.recon.tracking.TrackUtils. getHelixPlaneIntercept (org.lcsim.fit.helicaltrack.HelicalTrackFit, hep.physics.vec.Hep3Vector)		4,429 ms (7.9%)	638006
org.hps.recon.tracking.WTrack. getHelixAndPlaneIntercept (hep.physics.vec.Hep3Vector, hep.physics.vec.Hep3Vector)	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, int)		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

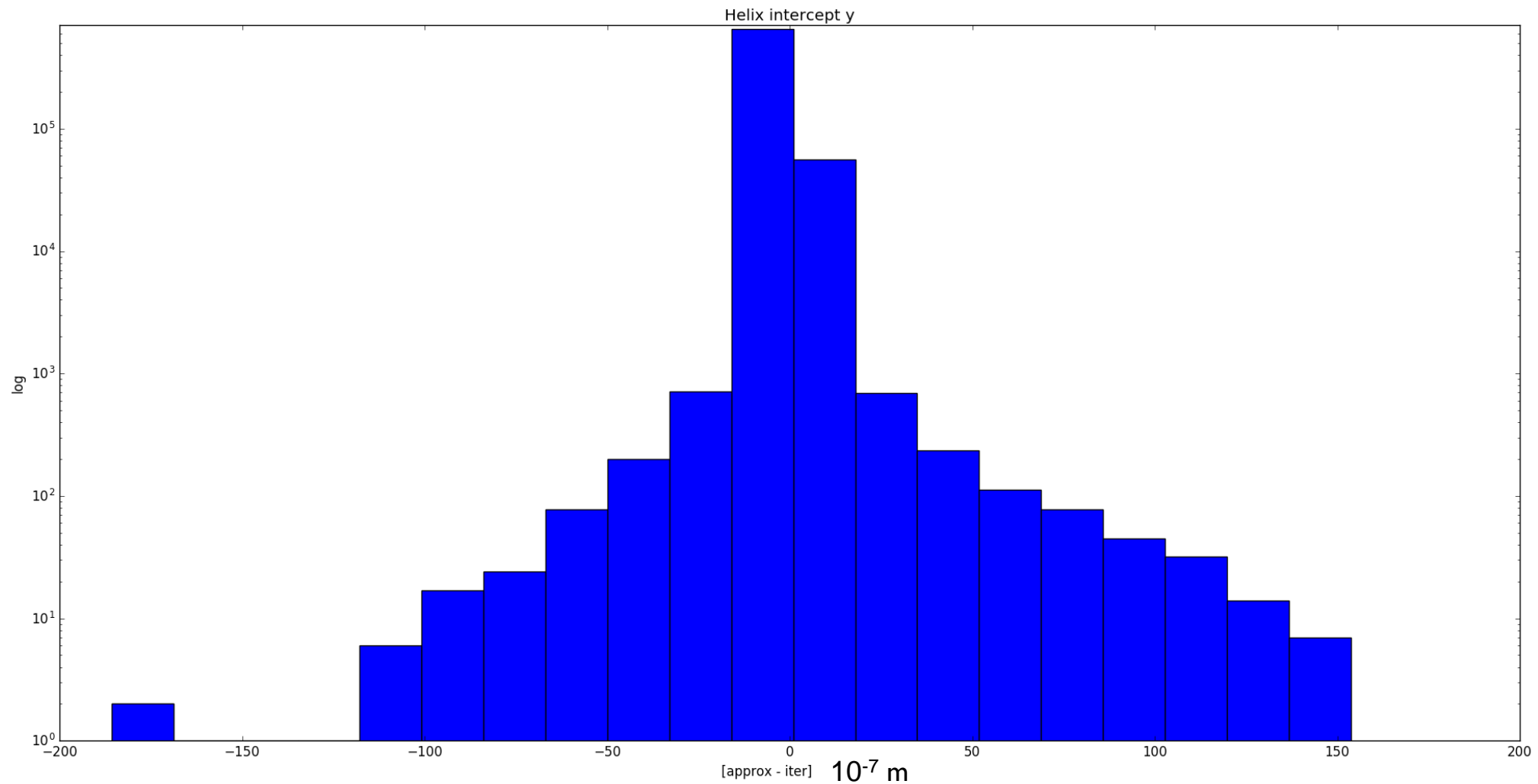
MODIFYING THE CODE

- 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 dolterative 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)**

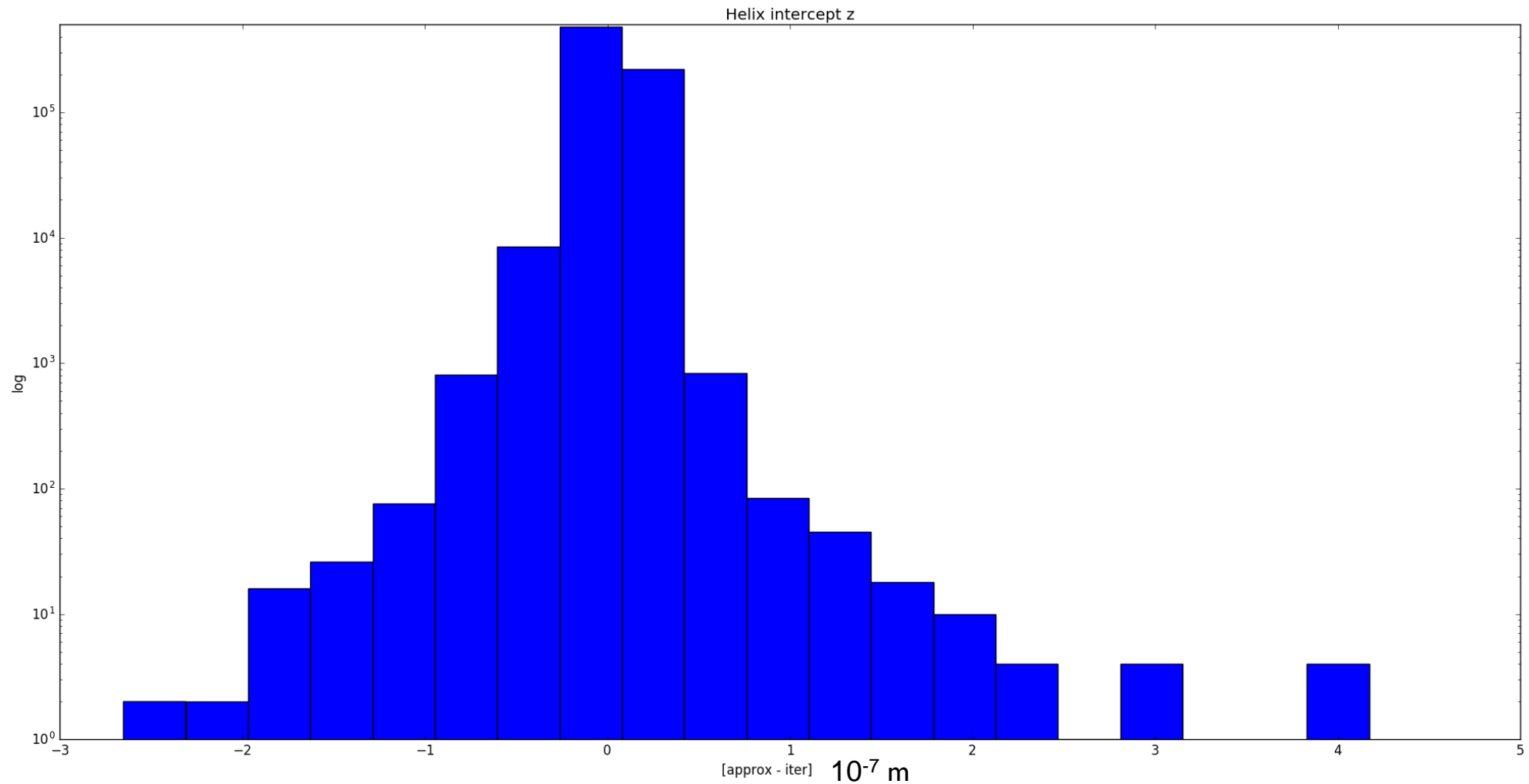
APPROXIMATE VS ITERATIVE : HELIX INTERSECTION POINTS



APPROXIMATE VS ITERATIVE : HELIX INTERSECTION POINTS



APPROXIMATE VS ITERATIVE : HELIX INTERSECTION POINTS



TIME SAVINGS

Current

Modified

org.lcsim.recon.tracking.seedtracker.HelixFitter. FitCandidate (org.lcsim.recon.tracking.seedtracker.SeedCandidate, org.lcsim. ...)	20,528 ms (34.8%)
org.hps.recon.tracking.MultipleScattering. FindScatters (org.lcsim.fit.helicaltrack.HelicalTrackFit)	19,113 ms (32.4%)
org.hps.recon.tracking.MultipleScattering. FindHPSScatters (org.lcsim.fit.helicaltrack.HelicalTrackFit)	19,106 ms (32.4%)
org.hps.recon.tracking.MultipleScattering. FindHPSScatterPoints (org.lcsim.fit.helicaltrack.HelicalTrackFit)	19,060 ms (32.4%)
org.hps.recon.tracking.MultipleScattering. getHelixIntersection (org.lcsim.fit.helicaltrack.HelicalTrackFit, org.hps. ...)	17,181 ms (29.2%)
org.hps.recon.tracking.MultipleScattering. getHelixIntersection (org.lcsim.fit.helicaltrack.HelicalTrackFit, org.hps. ...)	17,041 ms (28.9%)
org.hps.recon.tracking.TrackUtils. getHelixPlaneIntercept (org.lcsim.fit.helicaltrack.HelicalTrackFit, hep.phy ...)	5,359 ms (9.1%)
hep.physics.vec.VecOp. inverse (hep.physics.vec.Hep3Matrix)	3,725 ms (6.3%)
org.lcsim.fit.helicaltrack.HelixUtils. PathToXPlane (org.lcsim.fit.helicaltrack.HelicalTrackFit, double, double, in ...)	1,621 ms (2.8%)
org.lcsim.detector.Transform3D. transformed (hep.physics.vec.Hep3Vector)	1,615 ms (2.7%)
hep.physics.vec.VecOp. mult (hep.physics.vec.Hep3Matrix, hep.physics.vec.Hep3Vector)	1,289 ms (2.2%)

org.lcsim.recon.tracking.seedtracker.HelixFitter. FitCandidate (org.lcsim.recon.tracking.seedtracker.SeedCandidate, org.lcsim. ...)	19,693 ms (26.9%)
org.hps.recon.tracking.MultipleScattering. FindScatters (org.lcsim.fit.helicaltrack.HelicalTrackFit)	17,327 ms (23.7%)
org.hps.recon.tracking.MultipleScattering. FindHPSScatters (org.lcsim.fit.helicaltrack.HelicalTrackFit)	17,316 ms (23.7%)
org.hps.recon.tracking.MultipleScattering. FindHPSScatterPoints (org.lcsim.fit.helicaltrack.HelicalTrackFit)	17,257 ms (23.6%)
org.hps.recon.tracking.MultipleScattering. getHelixIntersection (org.lcsim.fit.helicaltrack.HelicalTrackFit, org.hps. ...)	11,000 ms (15%)
org.hps.recon.tracking.TrackUtils. getHelixPlaneIntercept (org.lcsim.fit.helicaltrack.HelicalTrackFit, hep.physic ...)	2,414 ms (3.3%)
org.lcsim.detector.Transform3D. transformed (hep.physics.vec.Hep3Vector)	1,892 ms (2.6%)
org.lcsim.fit.helicaltrack.HelixUtils. PathToXPlane (org.lcsim.fit.helicaltrack.HelicalTrackFit, double, double, int)	1,758 ms (2.4%)
hep.physics.vec.VecOp. mult (hep.physics.vec.Hep3Matrix, hep.physics.vec.Hep3Vector)	1,422 ms (1.9%)
org.lcsim.fit.helicaltrack.HelixUtils. PointOnHelix (org.lcsim.fit.helicaltrack.HelicalTrackFit, double)	1,046 ms (1.4%)