THREE POINT HELIX CHECK ERRORS

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github issue 126

See last week's software meeting for technical details
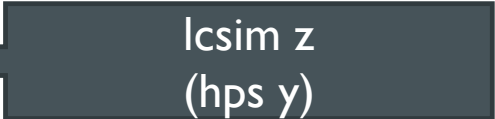
DOWN THE RABBIT-HOLE

- org.lcsim.recon.tracking.seedtracker.FastCheck ▶ ThreePointHelixCheck
  triplet-finding for track seeds

  - For each of the 3 hits, calculates contribution to *z error* ← lcsim z (hps y)

    ```
    dztot += _nsig * Math.sqrt(hit.getCovMatrix()[5]);
    ```

  - Then
    ```
    //  Add multiple scattering error here - for now, just set it to 1 mm
    dztot += 1.;   dztot += _nsig * MSerror;
    ```

  - Compares *total z error* to *(predicted – actual) z position* of middle hit

    ```
    if (Math.abs(zpred - z[1]) > dztot) return false;
    ```

- Implementing a proper MSerror makes ~no difference to tracking output. Why?

- Because *even without any MSerror*, dztot is far bigger than zpred-z[1], meaning no seeds get thrown out here anyway

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DOWN THE RABBIT-HOLE

- Why is this potentially a problem?

    - We do want to avoid throwing out decent candidates at seeding stage, but if we're not throwing out any seeds, we might as well not bother with this check at all

    - Intuitively, dztot *should* be dominated by MSerror. But it *is* dominated by hit errors.

- Why are the hit errors so big?

    1. Big _nsig

    2. Big hit.getCovMatrix()[5]

    3. Contributions summed linearly, not in quadrature

OPTIONS

A. "Make seeding cuts great again" to throw out some seeds
   - Look at distributions of (phat.u) to get proper uncertainty for it
   - Revisit strip.du() values (issue 135)
   - Perform dedicated studies to decide value of _nsig

B. Decide it's OK to keep all seeds
   - Simply eliminate dztot cut in ThreePointHelixCheck since it's not accomplishing anything

- Performed reco and CPU Time profiles with
   - Aggressive (A): dztot summed in quadrature, _nsig=3, CovMatrix[5] /= 10
   - Conservative (A): dztot summed in quadrature, _nsig=5, CovMatrix[5] /= 4
   - (B)

OPTIONS

- dztot cut takes up very little time (~0.1% of total TrackerReconDriver)

- Aggressive seeding cuts save significant time (~20% of total TrackerReconDriver)

- Seeding cuts do affect final tracking results in MC as well as data
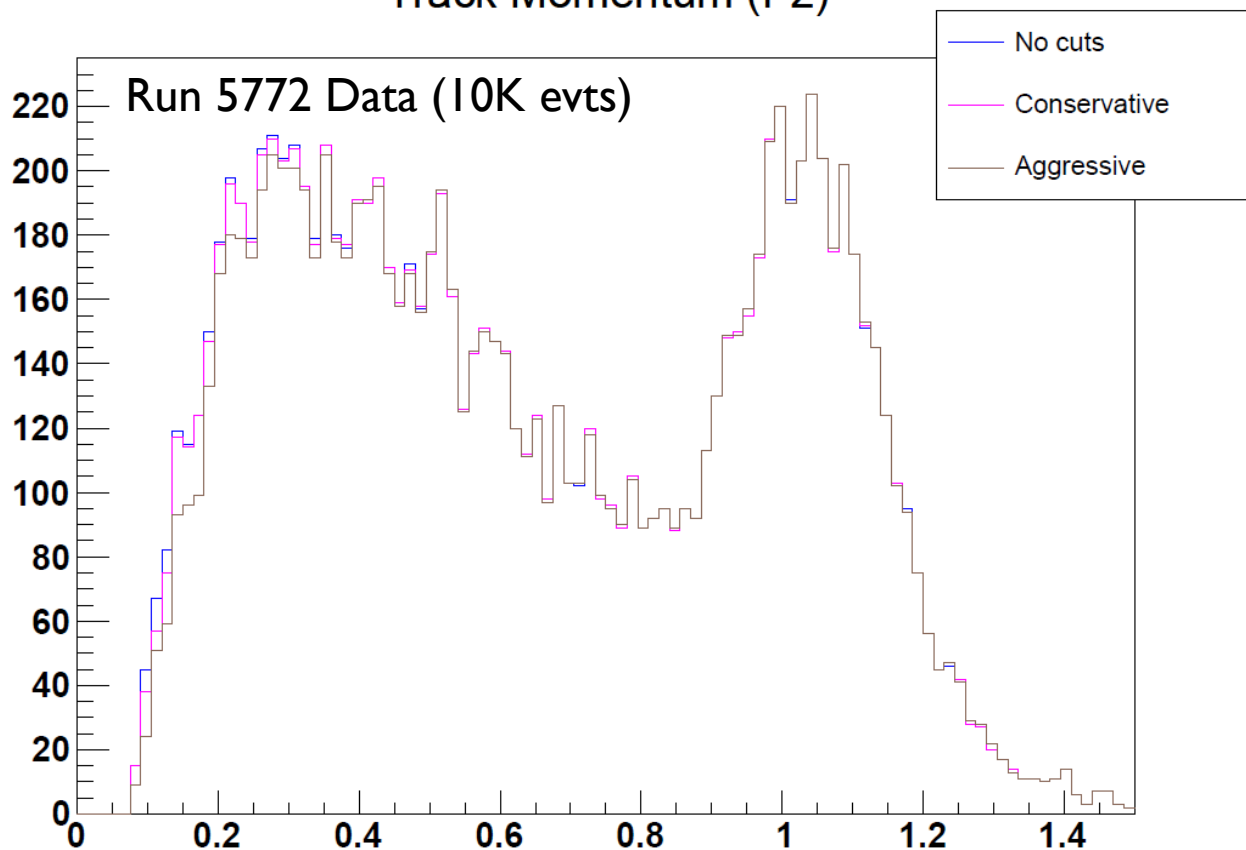
  - Less effect at high p_T

	#Tracks (1700 MC Prompt A' Events)	#Tracks (10K Data Run 5772 Events)	TrackerReconDriver time (500 Data Events) [ns]
(B)	2421	11329	12980
Conservative (A)	2216	11290	
Aggressive (A)	2211	11084	10670

OPTIONS

Track Momentum (Pz)

Prompt A' MC (1700 evts)

Track Momentum (Pz)

Run 5772 Data (10K evts)
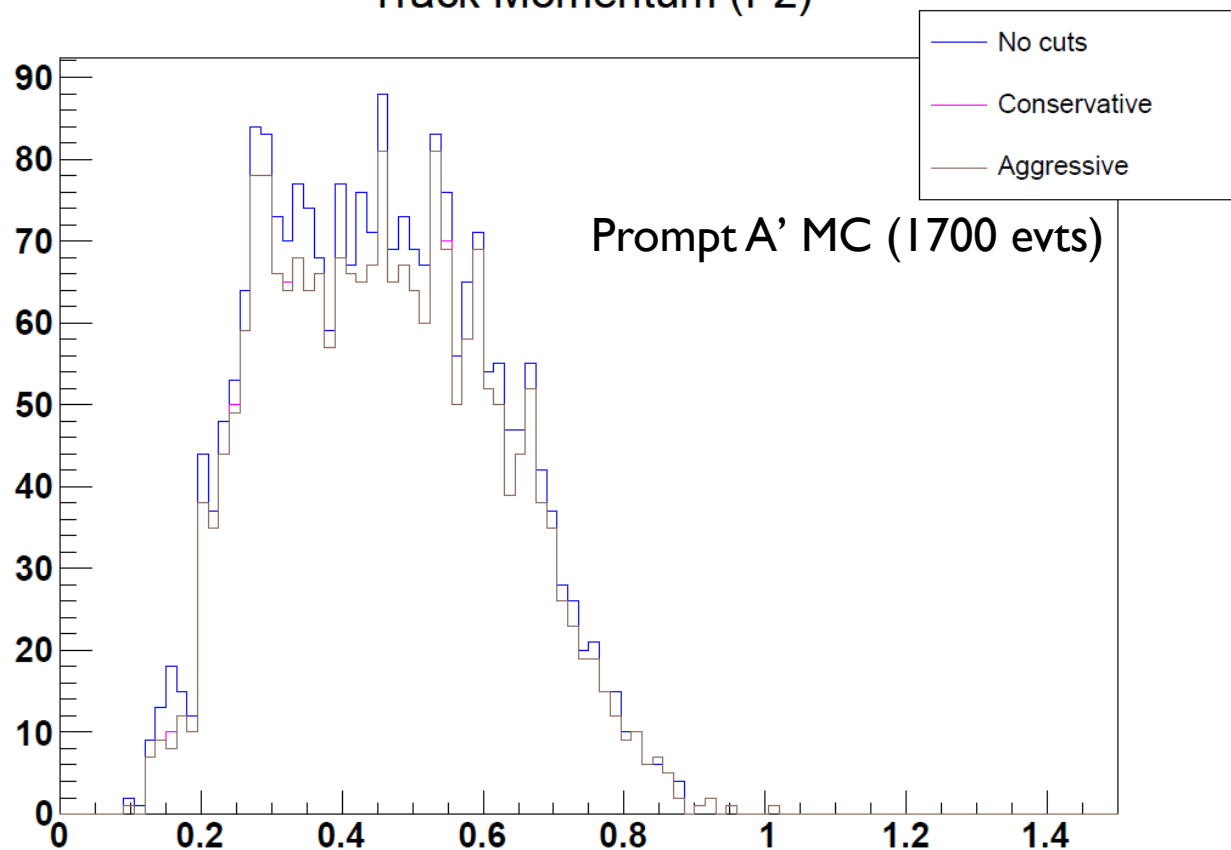
PROFILER: AGGRESSIVE (A)

⊟ ⊾ org.hps.recon.tracking.TrackerReconDriver.**process** (org.lcsim.event.EventHeader)	10,670 ms	(3.5%)	500
⊟ ⊾ org.lcsim.util.Driver.**process** (org.lcsim.event.EventHeader)	10,665 ms	(3.5%)	500
⊟ ⊾ org.lcsim.util.Driver.**processChildren** (org.lcsim.event.EventHeader)	10,664 ms	(3.5%)	500
⊟ ⊾ org.lcsim.util.Driver.**doProcess** (org.lcsim.event.EventHeader)	10,664 ms	(3.5%)	500
⊟ ⊾ org.hps.recon.tracking.SeedTracker.**process** (org.lcsim.event.EventHeader)	10,663 ms	(3.5%)	500
⊟ ⊾ org.lcsim.recon.tracking.seedtracker.SeedTrackFinder.**FindTracks** (org.lcsim.recon.tracking.seedtracker.SeedStrategy, double	9,729 ms	(3.2%)	500
⊞ ⊾ org.lcsim.recon.tracking.seedtracker.ConfirmerExtender.**Extend** (org.lcsim.recon.tracking.seedtracker.SeedCandidate, org.l	6,046 ms	(2%)	3955
⊞ ⊾ org.lcsim.recon.tracking.seedtracker.ConfirmerExtender.**Confirm** (org.lcsim.recon.tracking.seedtracker.SeedCandidate, org.	1,852 ms	(0.6%)	1933
⊞ ⊾ org.lcsim.recon.tracking.seedtracker.HelixFitter.**FitCandidate** (org.lcsim.recon.tracking.seedtracker.SeedCandidate, org.lcs	1,504 ms	(0.5%)	2055
⊞ ⊾ org.hps.recon.tracking.FastCheck.**ThreePointHelixCheck** (org.lcsim.fit.helicaltrack.HelicalTrackHit, org.lcsim.fit.helicaltra	227 ms	(0.1%)	4730
⊞ ⊾ org.hps.recon.tracking.FastCheck.**TwoPointCircleCheck** (org.lcsim.fit.helicaltrack.HelicalTrackHit, org.lcsim.fit.helicaltrack	41.9 ms	(0%)	1663
◷ Self time	25.2 ms	(0%)	500
⊞ ⊾ org.hps.recon.tracking.HitTimeTrackCheck.**checkSeed** (org.lcsim.recon.tracking.seedtracker.SeedCandidate)	11.6 ms	(0%)	13060
⊞ ⊾ org.lcsim.recon.tracking.seedtracker.SeedSectoring.**<init>** (org.lcsim.recon.tracking.seedtracker.HitManager, org.lcsim.rec	10.4 ms	(0%)	500
⊞ ⊾ org.lcsim.recon.tracking.seedtracker.SeedCandidate.**addHit** (org.lcsim.fit.helicaltrack.HelicalTrackHit)	8.46 ms	(0%)	36436
◷ org.lcsim.recon.tracking.seedtracker.SeedCandidate.**<init>** (org.lcsim.recon.tracking.seedtracker.SeedStrategy, double)	1.44 ms	(0%)	15853
◷ org.lcsim.recon.tracking.seedtracker.FastCheck.**setDoSectorBinCheck** (org.lcsim.recon.tracking.seedtracker.SectorManage	0.054 ms	(0%)	500
⊞ ⊾ org.lcsim.recon.tracking.seedtracker.HelixFitter.**FitCandidate** (org.lcsim.recon.tracking.seedtracker.SeedCandidate, org.lcsim.	872 ms	(0.3%)	1692
⊞ ⊾ org.lcsim.recon.tracking.seedtracker.MakeTracks.**Process** (org.lcsim.event.EventHeader, java.util.List, double)	25.2 ms	(0%)	500
⊞ ⊾ org.lcsim.recon.tracking.seedtracker.HitManager.**OrganizeHits** (java.util.List)	20.6 ms	(0%)	500
◷ Self time	9.44 ms	(0%)	500
⊞ ⊾ org.hps.recon.tracking.FastCheck.**<init>** (org.lcsim.recon.tracking.seedtracker.SeedStrategy, double, org.lcsim.recon.tracking	4.87 ms	(0%)	500
◷ org.lcsim.recon.tracking.seedtracker.SeedTrackFinder.**clearTrackSeedList** ()	0.687 ms	(0%)	1000
⊞ ⊾ org.lcsim.event.base.BaseLCSimEvent.**get** (Class, String)	0.555 ms	(0%)	500
◷ org.lcsim.recon.tracking.seedtracker.FastCheck.**<clinit>**	0.008 ms	(0%)	1

PROFILER: (B)

⊟ ⌐ org.hps.recon.tracking.TrackerReconDriver.**process** (org.lcsim.event.EventHeader)	12,980 ms (4.3%)	500
⊟ ⌐ org.lcsim.util.Driver.**process** (org.lcsim.event.EventHeader)	12,975 ms (4.3%)	500
⊟ ⌐ org.lcsim.util.Driver.**processChildren** (org.lcsim.event.EventHeader)	12,975 ms (4.3%)	500
⊟ ⌐ org.lcsim.util.Driver.**doProcess** (org.lcsim.event.EventHeader)	12,974 ms (4.3%)	500
⊟ ⌐ org.hps.recon.tracking.SeedTracker.**process** (org.lcsim.event.EventHeader)	12,974 ms (4.3%)	500
⊟ ⌐ org.lcsim.recon.tracking.seedtracker.SeedTrackFinder.**FindTracks** (org.lcsim.recon.tracking.seedtracker.SeedStrategy, double)	12,046 ms (4%)	500
⊞ ⌐ org.lcsim.recon.tracking.seedtracker.ConfirmerExtender.**Extend** (org.lcsim.recon.tracking.seedtracker.SeedCandidate, org.l	7,370 ms (2.4%)	5163
⊞ ⌐ org.lcsim.recon.tracking.seedtracker.ConfirmerExtender.**Confirm** (org.lcsim.recon.tracking.seedtracker.SeedCandidate, org.	2,401 ms (0.8%)	2462
⊞ ⌐ org.lcsim.recon.tracking.seedtracker.HelixFitter.**FitCandidate** (org.lcsim.recon.tracking.seedtracker.SeedCandidate, org.lcs	1,950 ms (0.6%)	2758
⊞ ⌐ org.hps.recon.tracking.FastCheck.**ThreePointHelixCheck** (org.lcsim.fit.helicaltrack.HelicalTrackHit, org.lcsim.fit.helicaltra	213 ms (0.1%)	4730
⊞ ⌐ org.hps.recon.tracking.FastCheck.**TwoPointCircleCheck** (org.lcsim.fit.helicaltrack.HelicalTrackHit, org.lcsim.fit.helicaltrack	41.9 ms (0%)	1663
⌚ Self time	34.1 ms (0%)	500
⊞ ⌐ org.hps.recon.tracking.HitTimeTrackCheck.**checkSeed** (org.lcsim.recon.tracking.seedtracker.SeedCandidate)	14.6 ms (0%)	13598
⊞ ⌐ org.lcsim.recon.tracking.seedtracker.SeedSectoring.**<init>** (org.lcsim.recon.tracking.seedtracker.HitManager, org.lcsim.reco	11.5 ms (0%)	500
⊞ ⌐ org.lcsim.recon.tracking.seedtracker.SeedCandidate.**addHit** (org.lcsim.fit.helicaltrack.HelicalTrackHit)	7.68 ms (0%)	36436
⌚ org.lcsim.recon.tracking.seedtracker.SeedCandidate.**<init>** (org.lcsim.recon.tracking.seedtracker.SeedStrategy, double)	1.46 ms (0%)	15853
⌚ org.lcsim.recon.tracking.seedtracker.FastCheck.**setDoSectorBinCheck** (org.lcsim.recon.tracking.seedtracker.SectorManage	0.046 ms (0%)	500
⊞ ⌐ org.lcsim.recon.tracking.seedtracker.HelixFitter.**FitCandidate** (org.lcsim.recon.tracking.seedtracker.SeedCandidate, org.lcsim.	867 ms (0.3%)	1740
⊞ ⌐ org.lcsim.recon.tracking.seedtracker.HitManager.**OrganizeHits** (java.util.List)	22.6 ms (0%)	500
⊞ ⌐ org.lcsim.recon.tracking.seedtracker.MakeTracks.**Process** (org.lcsim.event.EventHeader, java.util.List, double)	21.3 ms (0%)	500
⌚ Self time	9.54 ms (0%)	500
⊞ ⌐ org.hps.recon.tracking.FastCheck.**<init>** (org.lcsim.recon.tracking.seedtracker.SeedStrategy, double, org.lcsim.recon.tracking	4.66 ms (0%)	500
⌚ org.lcsim.recon.tracking.seedtracker.SeedTrackFinder.**clearTrackSeedList** ()	0.780 ms (0%)	1000
⊞ ⌐ org.lcsim.event.base.BaseLCSimEvent.**get** (Class, String)	0.547 ms (0%)	500
⌚ org.lcsim.recon.tracking.seedtracker.FastCheck.**<clinit>**	0.008 ms (0%)	1

SEEDS AT AGGRESSIVE (A)

Seeds Kept

Entries   49358

Math.*abs*(zpred − z[1])

Seeds Thrown Out

Entries   14028