HelicalTrackFitter Improvements

Lori Stevens (UCSC/SLAC)

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SiD Tracking Meeting

Outline

- Previous Improvements

- New Improvements: outer tracker hits

- Results

- Future Improvements

Original HelicalTrackFitter

- 3 Cartesian co-ordinate array arguments

- CircleFitter fits a circle to x-y coordinates

- If successful, SlopeInterceptLineFitter fits a line to s-z coordinates

- If successful, stores parameters and creates covariance matrix, assuming no correlation between circle and line fits.

Previous Improvements

- Can take TrackerHit list as argument

- Reorders hits: closest to furthest from origin

- Distinguishes between 3D and 2D hits

  - 3D: vertex barrel, vertex endcap, tracker endcap
  - 2D: tracker barrel

  - TrackerHit: Type 0 (3D) vs. Type 1 (2D)
  - Cartesian arrays: $dz > 0$ (3D) vs. $dz < 0$ (2D)

New Improvements

- 4 Cases:
  - Case 1: Only 3D hits (no change)
  - Case 2: 3D hits >=2; 2D hits >=1
    2D consistency check
  - Case 3: 1 3D hit; 2D hits >=2
    z segmentation fit
  - Case 4: All 2D hits (>= 3)
    z segmentation fit

Case 2: 3D >= 2, 2D >= 1 (1 of 2)

- Circle (x-y) fit for all points

- Line (s-z) fit for 3D points

- Consistency check for 2D points:

  - $z_{pred} = s_{2D}*(\tan \lambda) + z_0$

    - $\tan \lambda$ = lfit.slope( )
    - z_0 = lfit.intercept( )
    - s = arc length for 2D hit (arc length method)

Case 2: 3D >= 2, 2D >= 1 (2 of 2)

- Calculate zmin & zmax of segment for 2D hit
  - Use moduleInfo method taken from my z segmentation code (10cm segments)

- Check if predicted z lies between zmin and zmax

- Error on z calculated from errors on $\tan \lambda$ and z_0 (lfit covariance matrix), allow $3\sigma_z$

Case 3: 1 3D, 2D >= 2

- Circle (x-y) fit for all points

- ZSegment (s-z) fit for all points
  - Rich Partridge's ZSegmentFitter code
  - 2D hits: zmin & zmax calculated from moduleInfo method
  - 3D hit: zmin & zmax calculated from error on z
    - TrackerHits: get error from covariance matrix
    - Cartesian array: z error array argument required
    - Allow for $3\sigma_z$ (segment ≈ 0.05mm)

Case 4: 2D only (>= 3)

- Same as Case 3, without 3D segment calculation

- Circle (x-y) fit for all points

- ZSegment (s-z) fit for all points

Problem #1: Track Cheater

- Possible problem with track cheater
    - Hits made with TrackerHitCheater
    - Tracks made with CheatTracker
    - Driver used is CheatTrackDriver
- Showing more than 5 hits in outer tracker barrel
- Temporary solution: 2D consistency check with no more than 1st five tracker barrel hits

Findable Tracks

Only tracks with 3 or more hits are able to be fit. Tracks with less than 3 hits are cut from the track list and are not part of the total track count.

Samples

- single muon:

  muon_Theta1-179_1-50GeV_SLIC_v1r9p3_sidaug05.slcio

- qqbar:

  panpyqqbar-1-1000_SLIC_v1r9p4_sidaug05.slcio

- kshort:

  K0S_pipi_Theta45-135_5-25Gev_SLIC_v2r0p12_sid01.slcio

Results

	single muon	qqbar	kshort
Total findable tracks	9953	35039	16479
Good fits	9843	29504	14821
Failed fits	110 (1.1%)	5535 (15.8%)	1658 (10.1%)

Why such poor results?...

Problem #2: Low Momentum

- 2D consistency check (Case 2) does not take into account low momentum and/or scattering
- ZSegmentFitter ADD SOMETHING HERE
- Solution: cut out tracks with pT <= 1.0GeV

For now, redefine findable tracks:

- Tracks with 3 or more hits
- Tracks with pT > 1.0GeV

New Results (pT > 1.0GeV)

	single muon	qqbar	kshort
Total findable tracks	9221	12684	12645
Good fits	9198	12515	12617
Failed fits	23 (0.26%)	169 (1.3%)	28 (0.25%)

Better, but still room for improvement...

Where are fits failing?

	failed fits	2D check	ZSegment fit	ZSegment fit, 1 3D hit
single muon	110	60	46	4
muon > 1GeV	23	23	0	0
qqbar	5535	4633	646	256
qqbar > 1GeV	169	161	2	6
kshort	1658	747	714	197
kshort > 1GeV	28	24	3	1

2D hit check seems to be main culprit

How many hits are passing/failing? (pT > 1.0GeV)

	single muon	qqbar	kshort
Total hits	29533	29775	7136
Passed	29504	29545	7104
Failed	29 (0.11%)	230 (0.81%)	32 (0.43%)

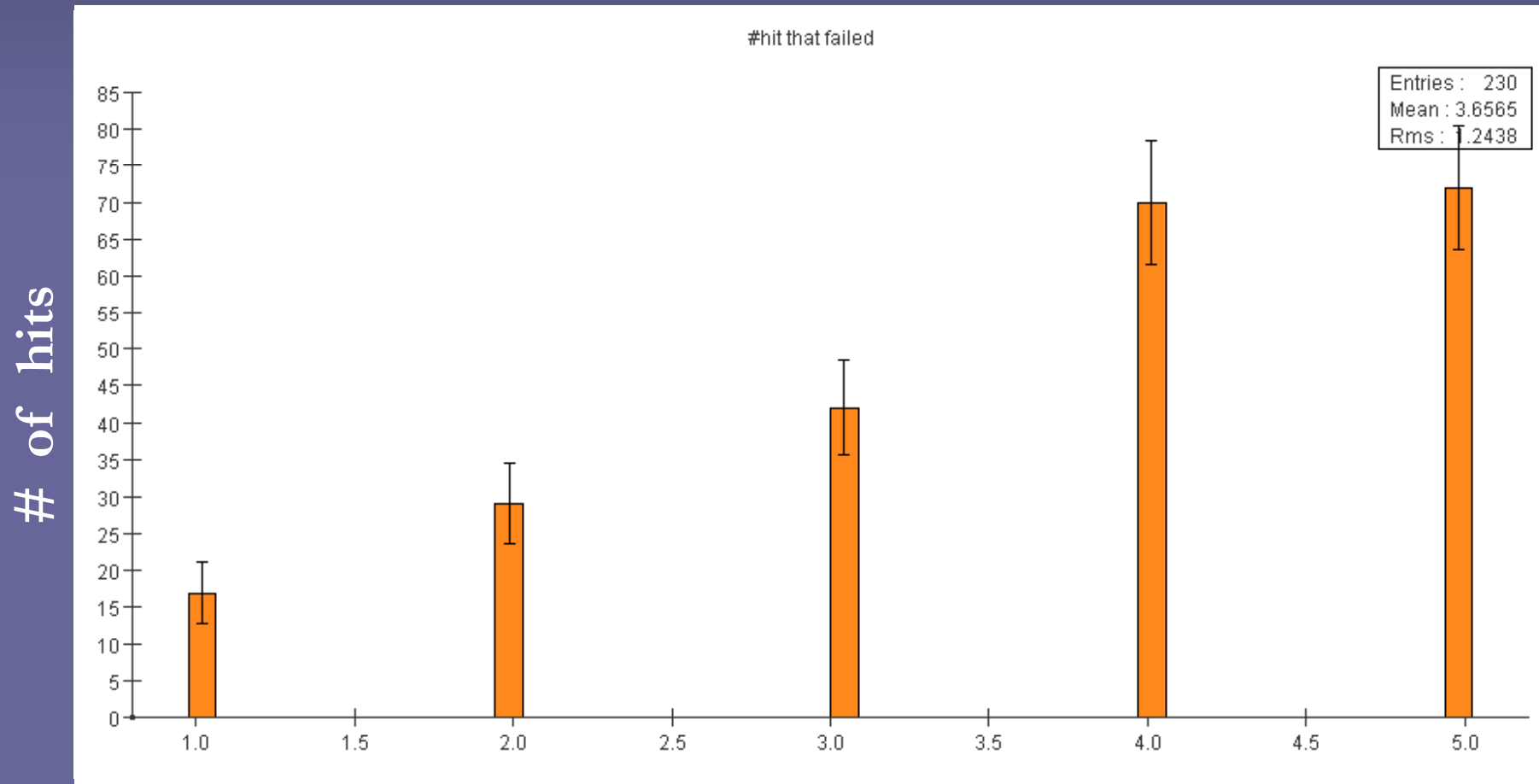Well, not too bad...I wonder which hits failed?

single muon
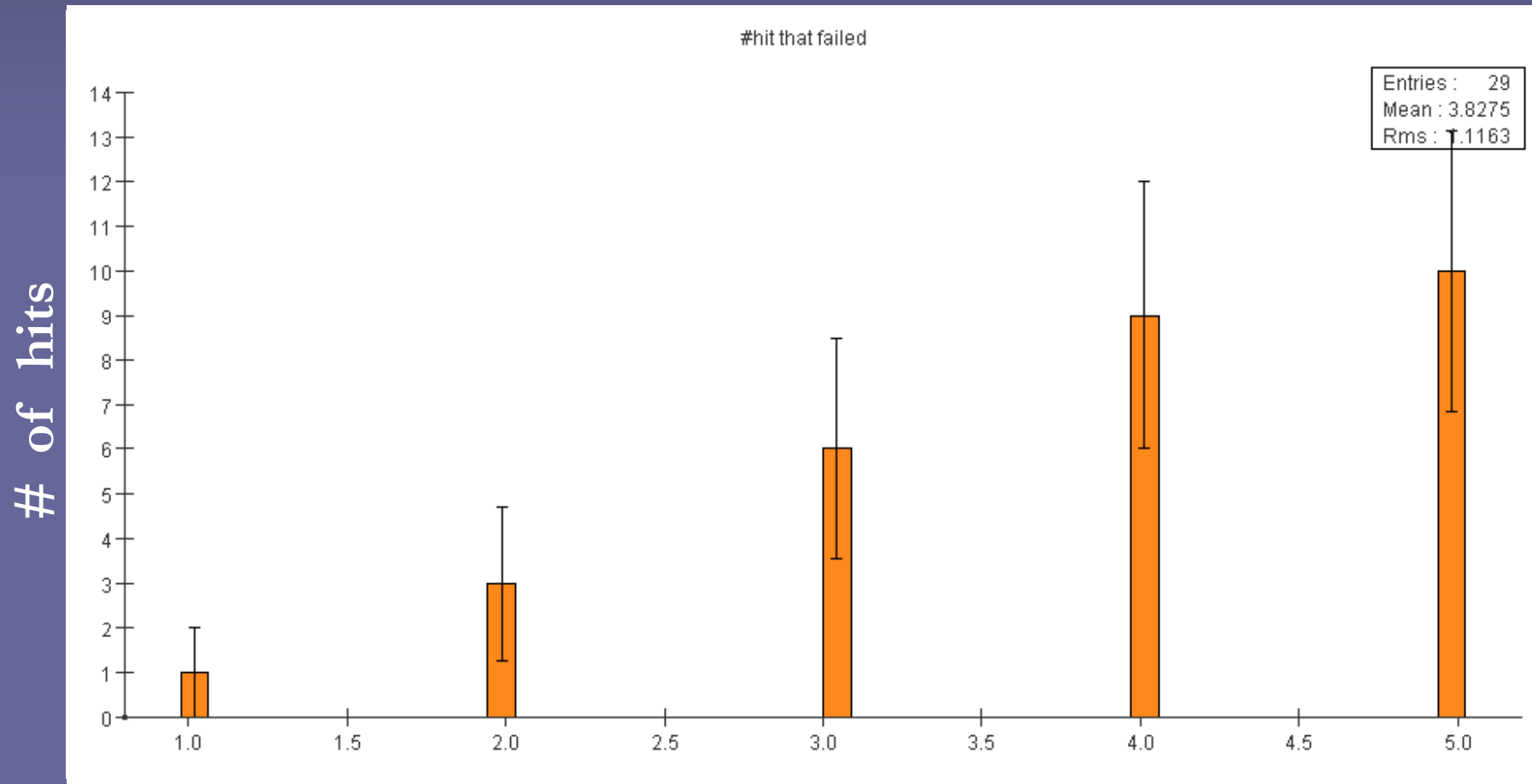
Layer in outer tracker barrel (1 = inner layer, 5 = outer layer)
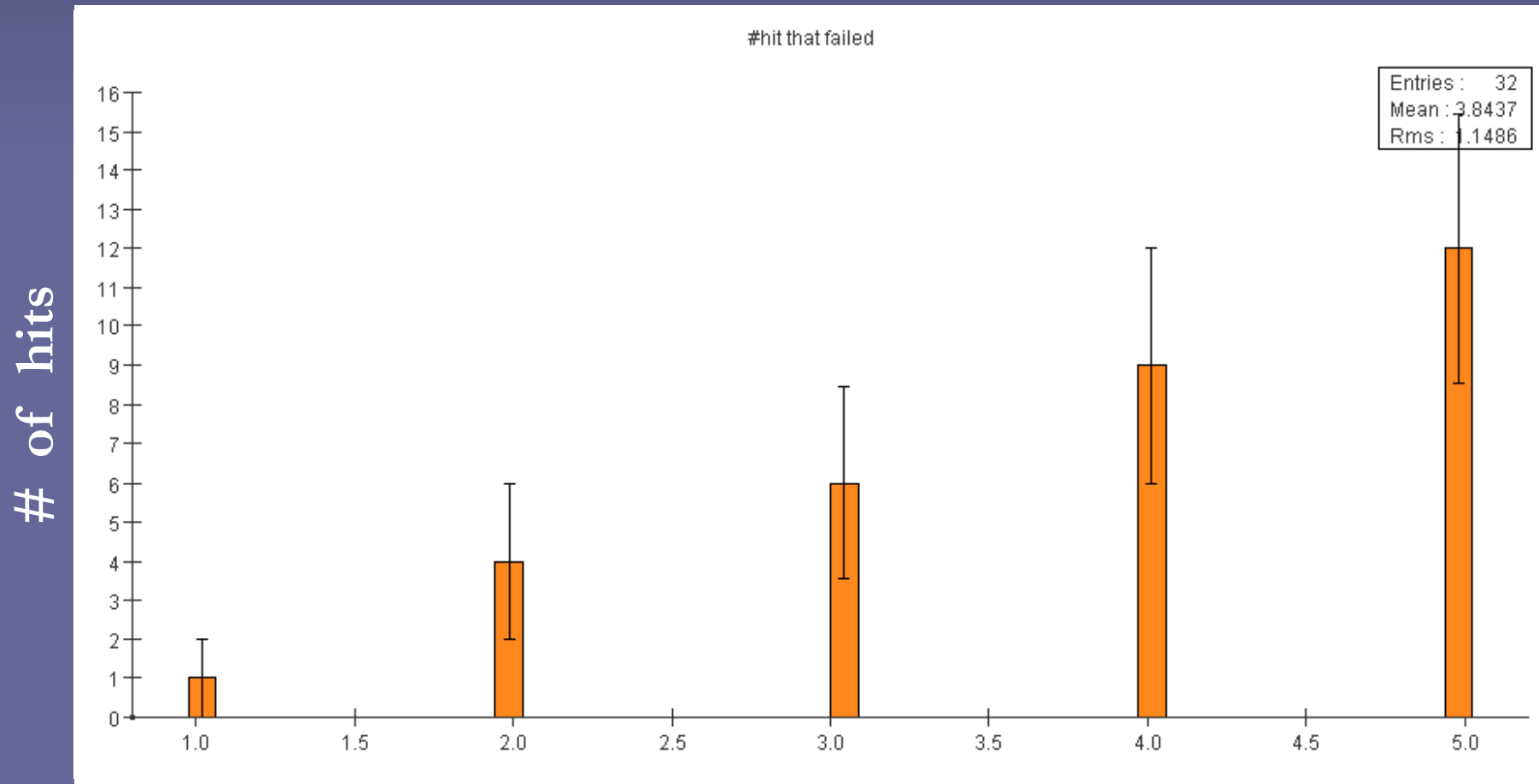
qqbar

# of hits

Layer in outer tracker barrel (1 = inner layer, 5 = outer layer)

kshort

Layer in outer tracker barrel (1 = inner layer, 5 = outer layer)

Looking at 3 or 4 outer barrel hits

	Pass fit (4 hits)	Fail fit (4 hits)	Pass fit (3 hits)	Fail fit (3 hits)
Single muon	9209	12 (.13%)	9213	8 (.09%)
qqbar	12563	121 (.95%)	12617	67 (0.53%)
kshort	12627	18 (0.14%)	12634	11 (.09%)

Future Improvements

- Check for problems with Track Cheater

- Need to account for scattering and low momentum tracks

- Study ZSegmentFitter more