SOFT/ACE Technical Memorandum

Report no: MO-98-001-soft

Subject: **Centroid selection for trajectories**
From: Marty Olevitch, Washington U.
Date: 6 February 1998

This paper describes various procedures we use for selecting SOFT cluster centroids that are used to calculate a trajectory.

In the ideal situation, we would have one centroid in each X and Y layer. Each centroid corresponds to an X or Y fiber in one layer, the corresponding pairs of fibers $(X_1, Y_1), (X_2, Y_2), (X_3, Y_3)$ are converted into real space coordinates and a trajectory is fitted for X and Y separately. But in fact, there are multiple centroids per layer and the problem is to choose the correct ones to make the trajectory.

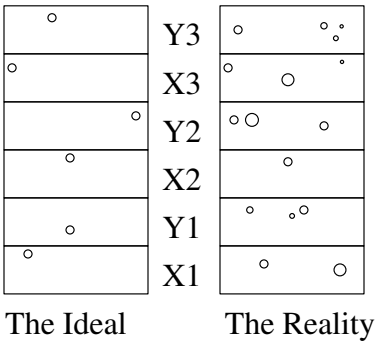

Fig. 1: pixel space

The three trajectory methods.

1. *Brightest each layer.* This is the simplest method. We pick the centroid with the highest intensity in each of the six layers, and use them to calculate the real space coordinates and construct the trajectory. Although simple, this method usually yields the correct answer. However, especially at lower Z, when the particle does not yield the brightest blobs, it tends to break down. This method is the fastest of the three.
2. *Fiber fit.* This method is a little more complex. For each axis, X and Y, we consider each combination of the triads of one centroid from each layer, starting with the brightest in each layer. We do a fit in fiber space [1] on each triad in turn, and when we find one X and one Y triad that is within our limits, we stop. The centroids in the triads are used to calculate the real space coordinates. A check on Δx and Δy of the real coordinates[2] is done. These coordinates are then used to calculate the trajectory.

[1] There is a quadratic relation of fiber ''number'' to real space coordinate, so it is possible to get an idea of the quality of a line fitted to a triad of centroids without going to the expense of calculating real space coordinates.

[2] Δx is the difference of fitted X to actual X in layer H2. Similarly, for Δy.

The advantage of fiber-fit over brightest-each-layer is that it can find a good trajectory in cases where the most intense centroid is not the correct one. However, it is about 25% slower than brightest-each-layer.

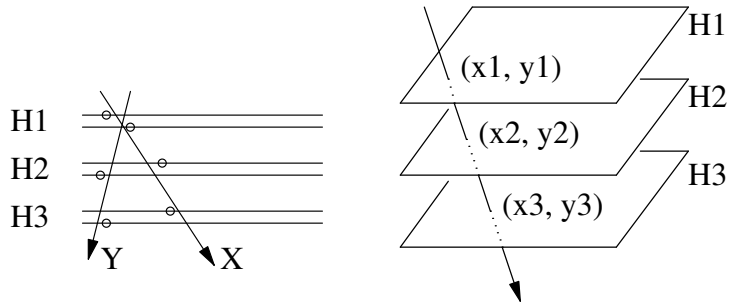

Fig 2: fiber space trajectories fitted to X and Y centroids (left) and real space diagram (right)

3. *Multi-traj.* This method considers almost all possible trajectories that can be constructed from an event and ranks them by ‘‘quality.’’ It works as follows: A) For each axis, X and Y, we consider each triad of one centroid from each layer. A fit is done in fiber space, and each triad within limits is kept for the next step. Unlike fiber-fit, we don’t stop at the first good triad, but keep track of them all. B) The triads are combined to calculate the real space coordinates, which are checked for reasonable Δx and Δy. C) Calculate the trajectory in real space for each combination of X and Y triads from step B. Finally, D) a quality factor is computed for each trajectory, and the trajectories are sorted by this quality factor and the top N are returned. This method is the slowest of the three, about twice as slow as fiber-fit, but is the most accurate. It also allows the user to evaluate any or all trajectories the program finds.

In addition, the fiber-fit and multi-traj methods both incorporate a *hopping* correction. Hopping causes the Y centroid[3] to be reported incorrectly, but it is of importance only in low-intensity centroids (such as produced by low-Z particles). The correction has the effect of creating additional centroids which are then considered in the fit stage.

Tradeoffs in using the three methods.

As far as running time goes, fiber-fit is about 1.25 times as slow as brightest-each-layer, and multitraj is in turn about 2 times as slow as fiber-fit. If the amount of running time is not an issue, then I recommend using multitraj because it is more likely to find the correct trajectory than the other two methods. On the other hand, if a speedup of a factor of two will be of importance, then consider using fiber-fit with the following caveats.

At high charge ($Z > 9.5$), fiber-fit will calculate the same charge as multitraj in approximately 98% of the trajectories. It will produce a different result in much less than 1% of the trajectories. About 1% of the trajectories were not found by fiber-fit, but were found

[3] It can also cause an error in X, but due to the arrangement of the fiber tabs, this is not significant.

by multitraj, and a slightly smaller amount were found by fiber-fit, but not multitraj.

However, at low charge (Z < 4.5), these two methods produced identical results in only 77% of the trajectories. 21% of them were not found by fiber-fit, but were found by multitraj. Slightly less than 1% were found by fiber-fit, but not multitraj, and slightlty less than 2% had different results.

The table[4] below shows all this information using data from day 357 of year 1997.

In summary, in general you should try to use multitraj. If the running time is an issue, use fiberfit for high Z if getting 98% of the data correct is adequate. Use fiberfit for low Z if you don't mind getting only ¾ of the data correct and missing another 20%.

Fiberfit vs multitraj					
Total no. trajectories	identical charge	missed by fiber-fit	missed by multitraj	different charge	charge range
12521	11220 (90%)	1104 (9%)	82 (1%)	115 (1%)	All charges
4516	3464 (77%)	942 (21%)	30 (1%)	80 (2%)	Z < 4.5
5546	5348 (96%)	132 (2%)	32 (1%)	34 (1%)	4.5 ≤ Z ≤ 9.5
2463	2408 (98%)	30 (1%)	20 (1%)	5 (<1%)	Z > 9.5

Brightest-each-layer vs multitraj					
Total no. trajectories	identical charge	missed by b.e.l.	missed by multitraj	different charge	charge range
12557	10058 (80%)	2246 (18%)	118 (1%)	135 (1%)	All charges
4521	2567 (57%)	1843 (41%)	34 (1%)	77 (2%)	Z < 4.5
5575	5111 (92%)	354 (6%)	53 (1%)	57 (1%)	4.5 ≤ Z ≤ 9.5
2475	2380 (96%)	49 (2%)	31 (1%)	15 (1%)	Z > 9.5

Acknowlegement

Joe Klarmann wrote the original fiber-fit and multi-traj.

[4] The *total no. trajectories* and *different charge* columns don't add up. This is because of four events in the first table in the *4.5 ≤ Z ≤ 9.5* category in which the fiber-fit charge is less than 4.5, but the multi-traj charge is greater than 4.5, and 14 events in the second table with a similar discrepancy. These events were counted twice in that category. It doesn't have much effect on the results.