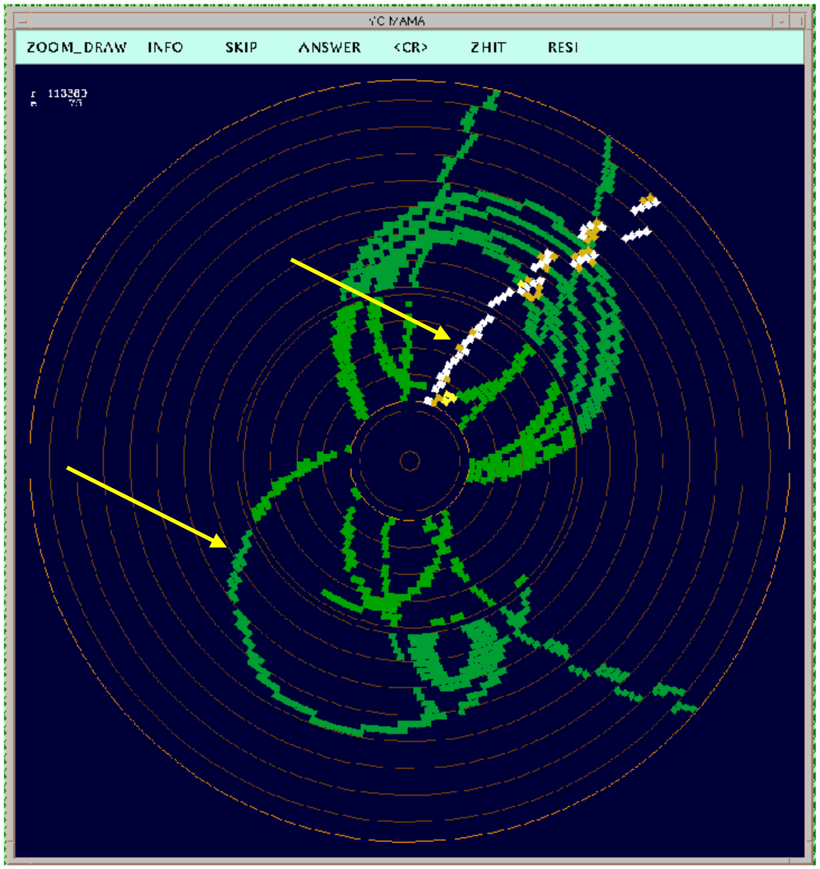
Cornell Contributions to Infrastructure: Track Reconstruction

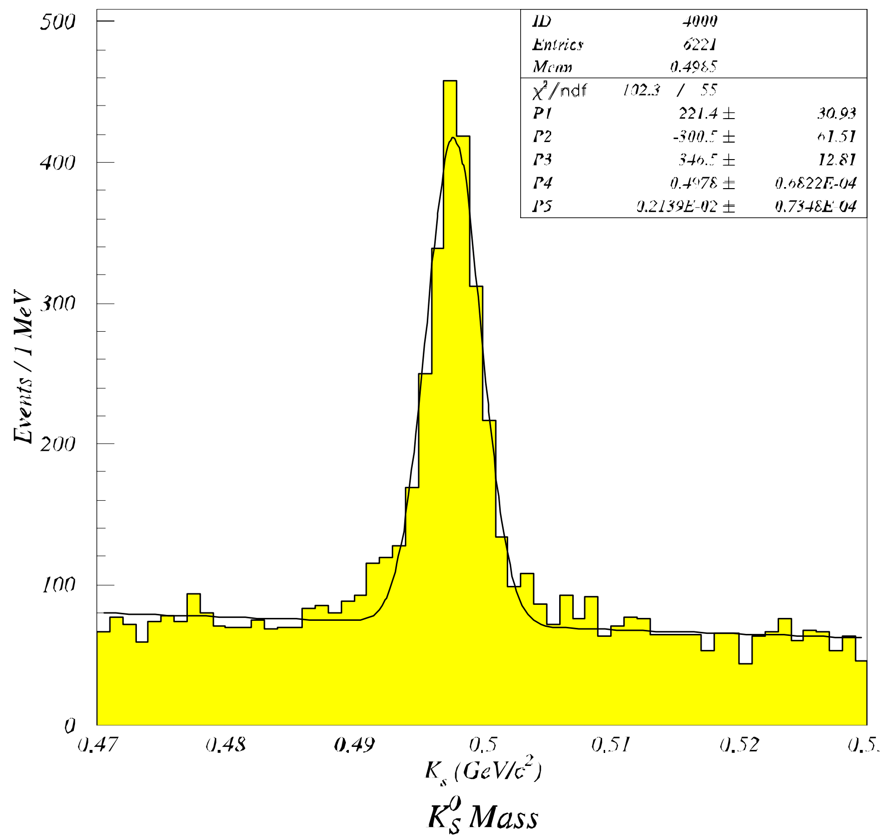
Track Finding --------------------- dpp
Calibration ------------------------- Nadia Adam, David Urner
Fitting Weights ------------------- Jim Pivarski
Alignment -------------------------- Jim Pivarski, Nadia Adam
Kalman Fitter ---------------------- Werner Sun, Jim Pivarski

Another related and important part of this puzzle is determining the entrance angle corrections,
a function of signed drift distance and signed entrance angle.
This is done by Mickhail Dubrovin (Wayne State).

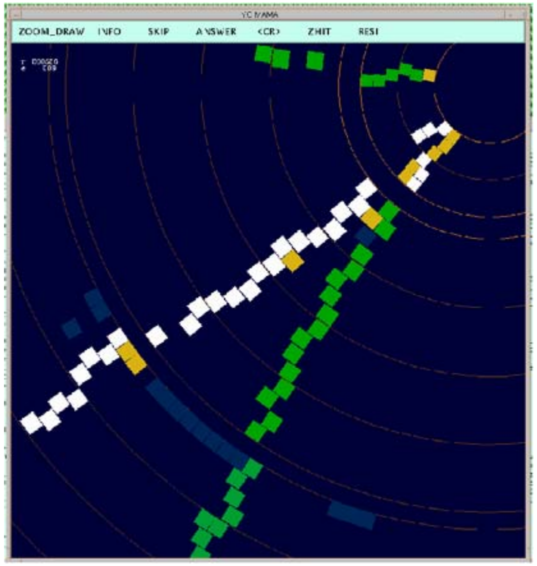
Tracking reconstruction

How to we transform the hardware output
(times and pulse heights, threshold discriminated)
to a product that provides some insight into a physical process ?





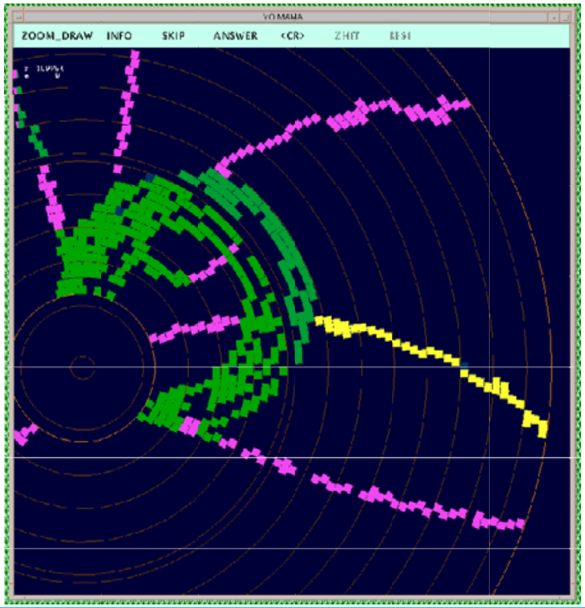
Track finding

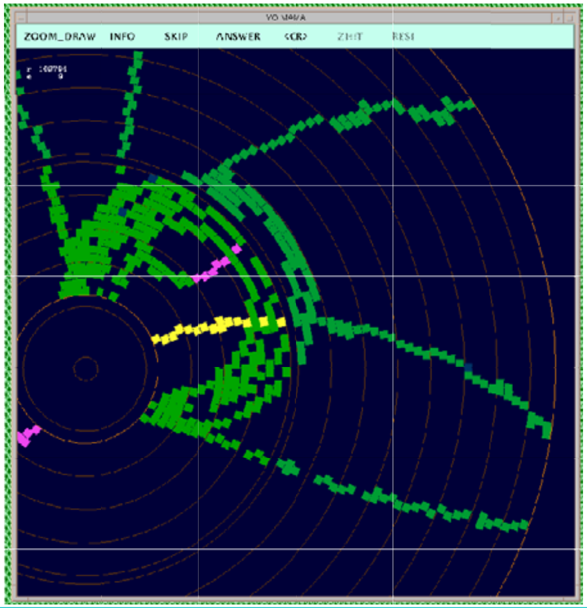


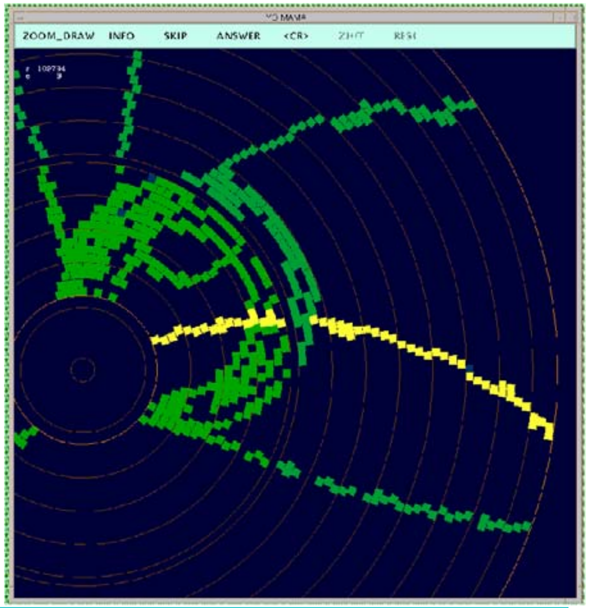
Track finding starts with the integer tracker.
"Integer because only wire locations are used (no drift times),
and because the calculations are all in integer arithmetic.

Basic clean **segments** are found, "SF".
Clean segments can be **extended**, in and out, into noisy areas.
Clean segments can be **merged** into longer segments.

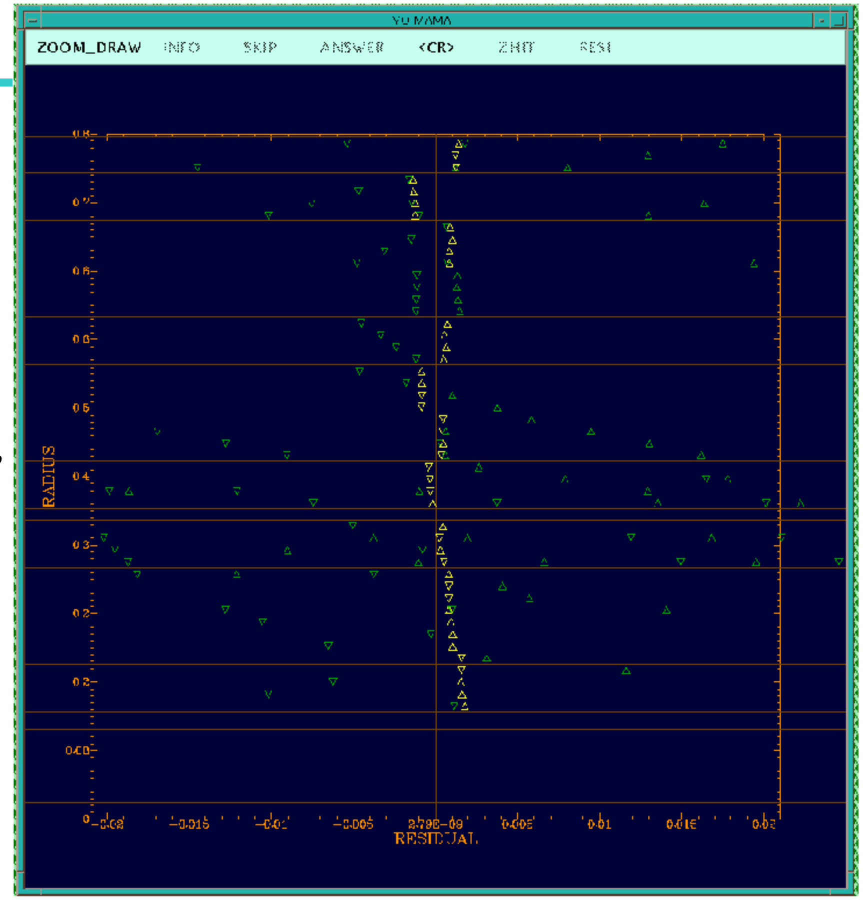
"Z" calculations are performed at each change in stereo angle.
"Z" calculations are used in the predicted wire locations
when extending inward, into the ZD.

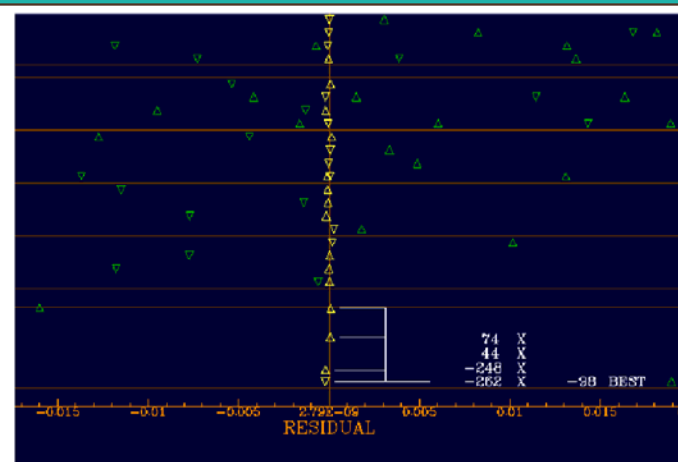






Track finding





Correlations in residuals are used in the 2^{nd} and 3^{rd} stages.

2^{nd} stage determines most of the left/right hit assignments,
uses groups of hits within super-layers with correlated residuals,
refines the $r\phi$ and z fits.

3^{rd} stage can extend the track into more ambiguous areas:
into the silicon,
extend a curling track into complicated, noisy, areas.

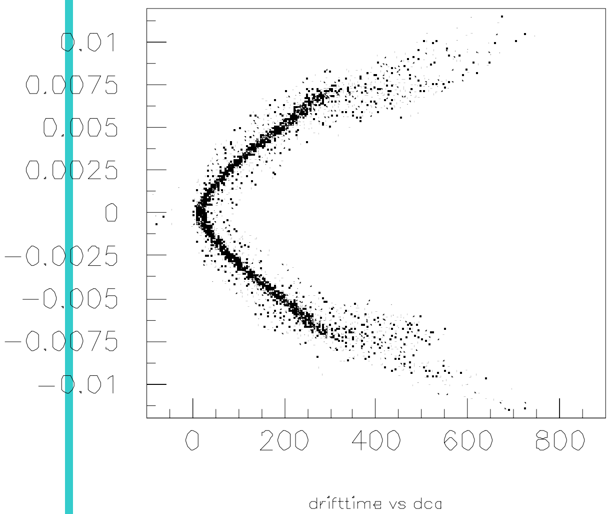
Therefore, these stages are dependent on the

t_0
drift function (time-to-distance relation)
alignment.

These stages depend on the other work that will be described.

Errors will cause wrong assignments.
But required accuracy is about 500 µm.

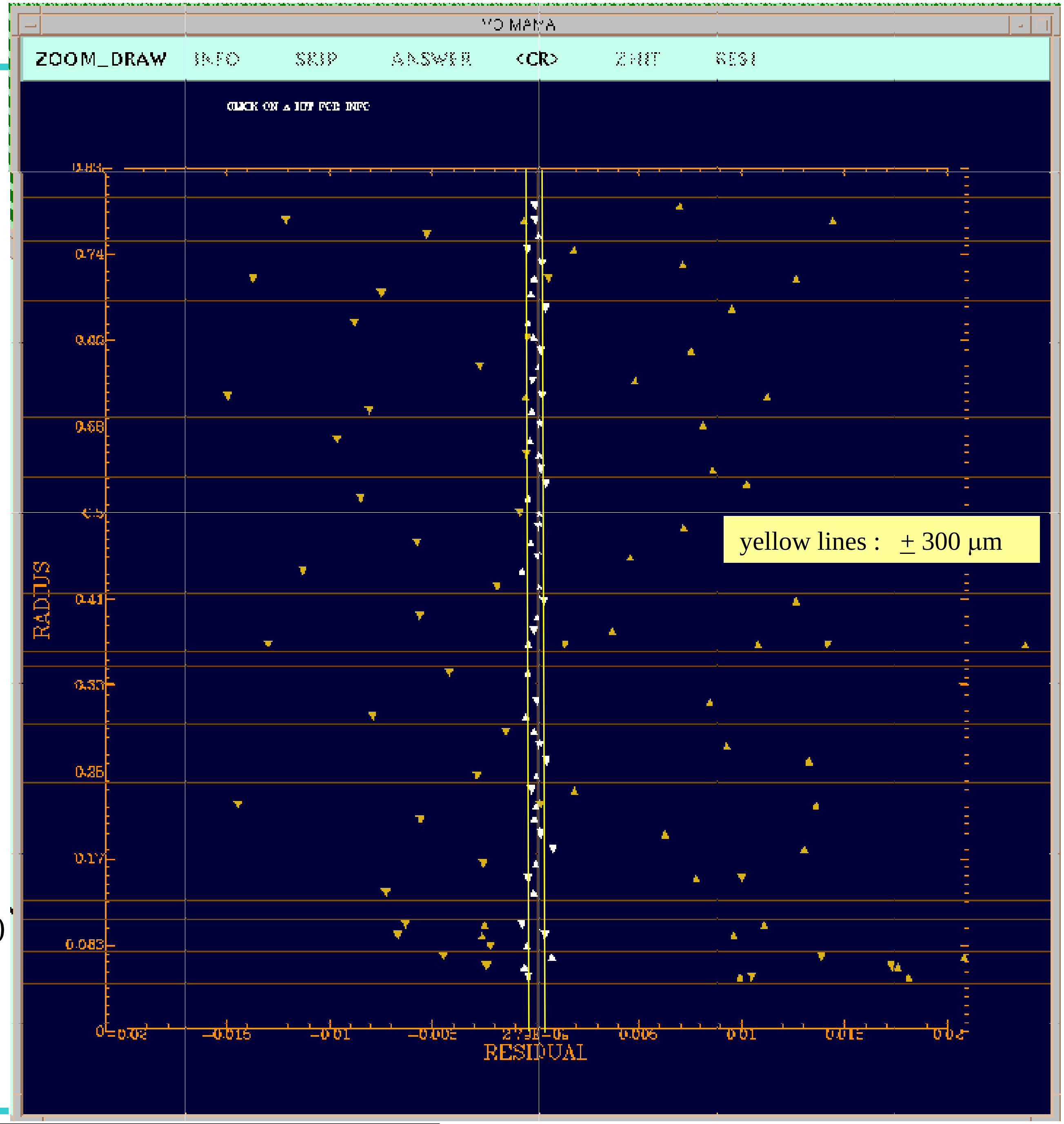
calibration



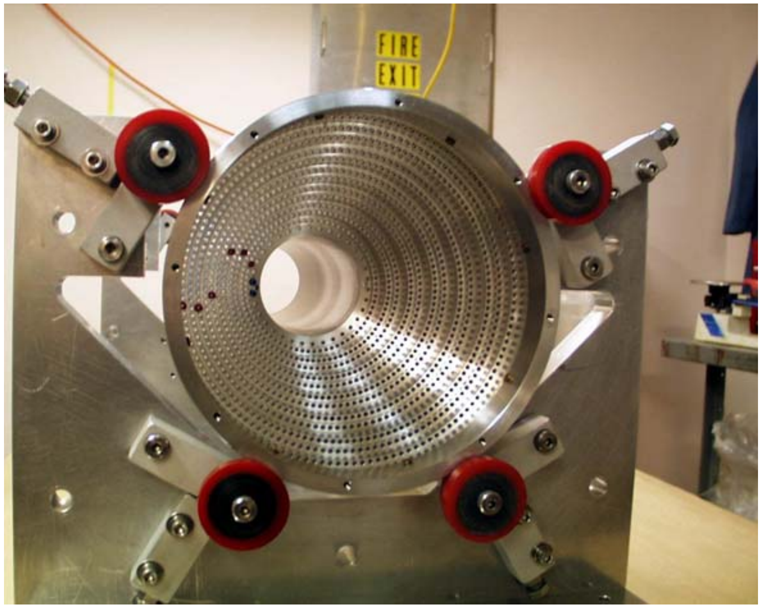
Calibration includes the time-to-distance relation and t_0.

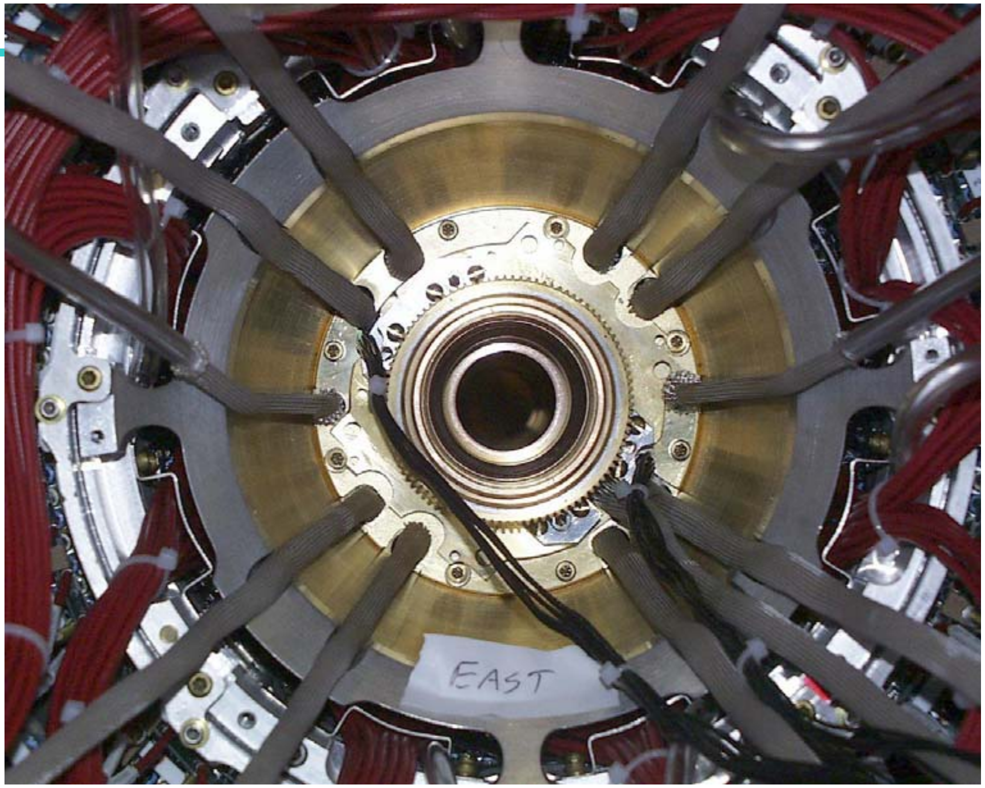
The time-to-distance relation used in track finding is single-sided and has no propagation correction, matches the needs of finding.

(At the time of making this display) the ZD has imperfect t_0, resulting in an E/W difference, and, sometimes, wrong assignments.
Correction is iterative.



alignment





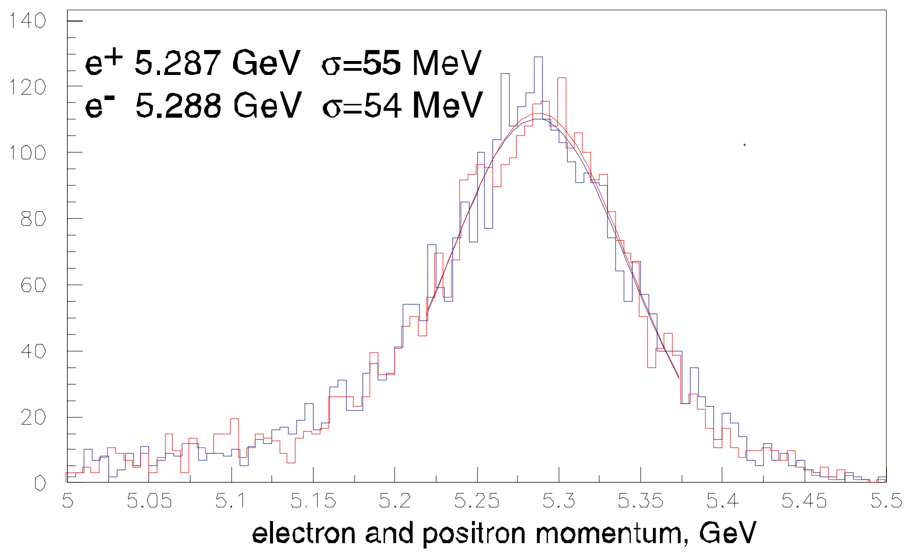
Alignment covers a broad range of problems.

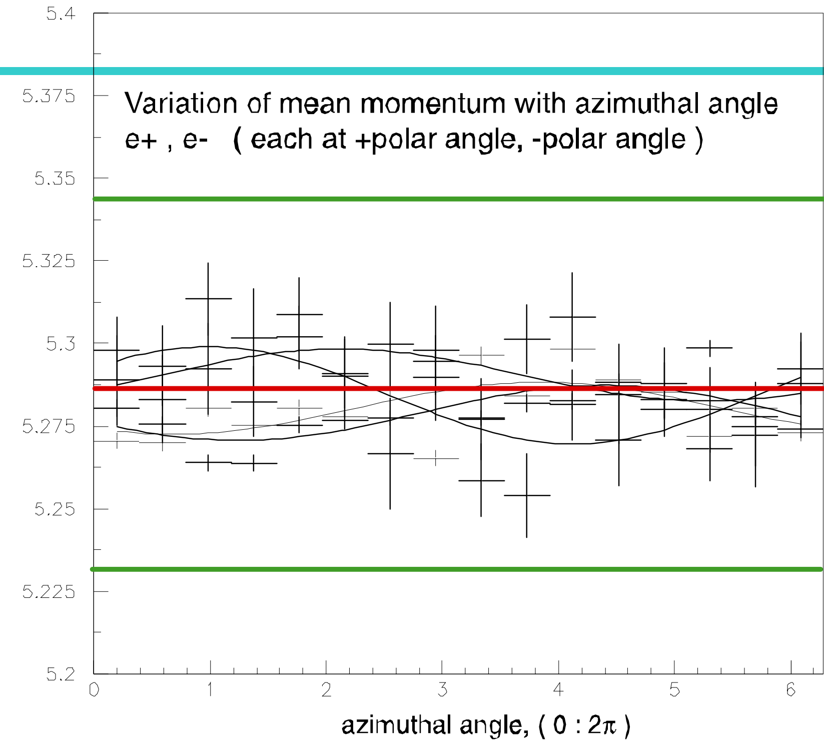
Rotation of one endplate to the other, twist. **DR3**: 0±.002 inch/diameter, **DR2**: .014, **ZD**: .002 (smaller diameter)

Rotation of the an element, such as the **ZD**, relative to a larger system. **DR3 rings**: on order of .003 inch/diameter.

Translations in x-y-z. There are independent translations of the **ZD** on East and West.
These are all on the order of .010 inch, 250 µm. **DR3 rings**: on order of .005 inch
These do not affect track finding, but greatly affect track fitting.

alignment





The miss-alignments discussed on the previous page can be determined with tracks in the calibration process. They show up as shifts and oscillations of the Bhabha momentum.

The miss-alignments can also be determined in a dedicated study of residuals, where the (group of) layer(s) is deweighted in the fit.

Alignment is an iterative process, with the **calibration**

Jim will discuss current work on the more perplexing alignment issues which can be interpreted as
- possible physical imperfections of detector elements,
- misunderstanding of the charge collection center / electrical center / wire center / and geometric center of cells.

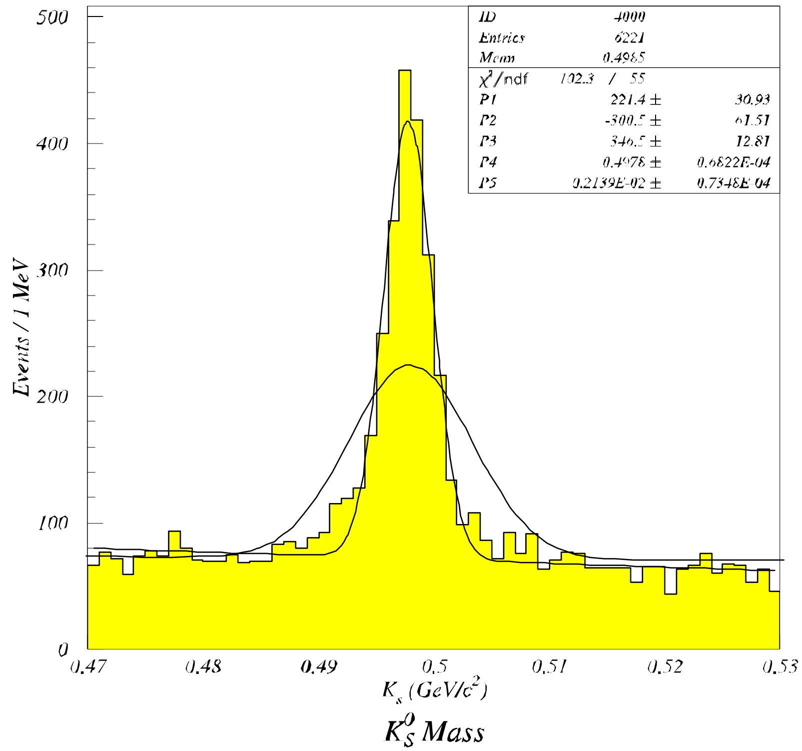
DR2 was abounding with these types of problems Jim will describe. However, we did not know the shape of the endplate nor could we use the stereo wire measurements to determine it.

Final fitter

The track finding process includes χ^2 fits in projections.
It does not provide precision measurements.

Finder fitting: K0 resolution is $\sigma \simeq 5$ Mev.

After Kalman fitter: K0 resolution is $\sigma \simeq 2$ Mev.



The Kalman fitter includes the
best interpretation of the electronic signals
translated into hit positions and accuracies.

It starts with the hits from the finder, then

includes…

- calibration,
- alignment,
- fitting weights, and hit deletion.