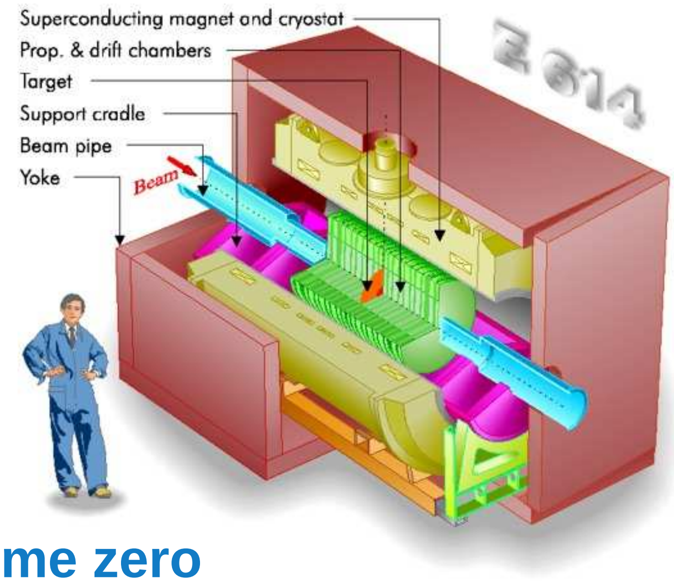
TWIST Detector

Calibrations and Response



- Efficiency
  - Field off
  - Field on
- Alignments
  - Plane translational alignments
  - Plane rotational alignments
  - Detector to field alignment
- Time zero
- STRs
  - GARFIELD
  - Data
- Resolutions
  - Field off
  - Field on

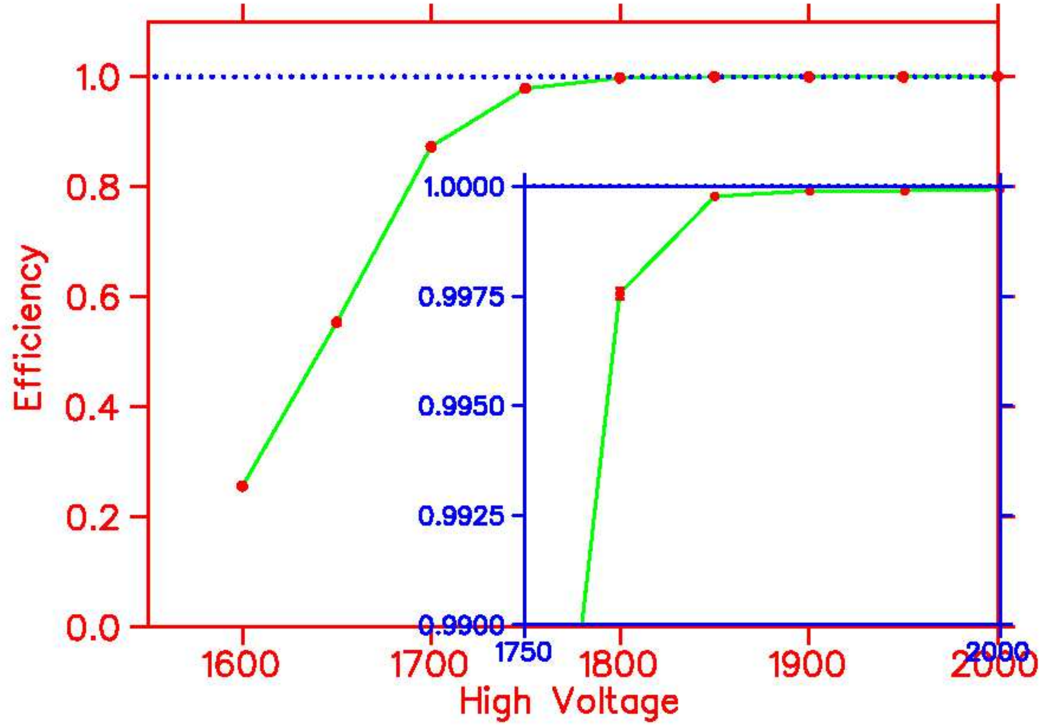
Abstract

Over the past year the TWIST detector response has been studied in great detail. The efficiency of each of the 56 DC and PC planes as a function of high voltage (for both field off and on) was calculated to determine an operating point. The efficiency curves were very similar for all DC and all PC planes, resulting in plane-to-plane variations of less than $5x10^{-4}$ for the DC planes, and less than $1x10^{-3}$ for the PC planes. Wire-by-wire efficiencies were also calculated and found to have small variations of similar magnitudes. The DC plane alignment was studied in great detail; in particular, plane translational alignments, rotational alignments, and detector alignment with respect to the magnetic field. Plane translational alignments proved possible to better than 10 microns. Similarly, plane rotational alignments of better than 10 microns at the wire ends are possible (~1 mrad). Detector alignment with respect to the magnetic field was also achieved to a few mrad accuracy. Calibrations of time zero for the chambers TDC spectra were calculated. The TDC spectra of each wire was fitted around the rising edge to obtain a relative wire-to-wire time zero alignment. The absolute time zero alignment was obtained by observing the quality of fitted tracks resulting in an accuracy < 1 ns. Space-time relations of the wire cells for both the DCs and PCs were obtained from GARFIELD. Appropriate magnetic field value, temperature, and pressure were used in these calculations. Iterations of real data to improve on the GARFIELD results will be done in the future. Intrinsic chamber resolutions were obtained for the field off case resulting in a HWHM of 85 microns for the overall residuals distribution. A detailed calculation of the DC chamber resolution as a function of distance from the wire was calculated and used for weighting the track fits. Chamber resolution for the field on case is yet to be determined.

Efficiency

Field Off

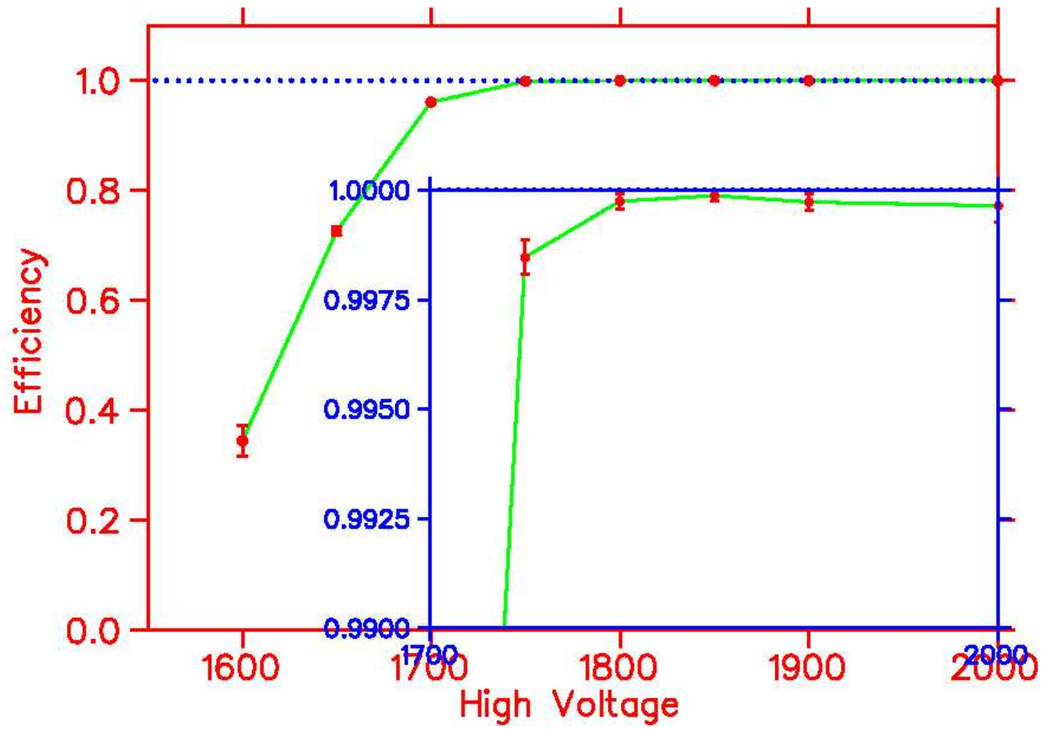
- **Data for 120 MeV/c beam particles (mostly pions).**
  - **DC Plane 13 (typical plane)**
  - **DC plane-to-plane variations < $3x10^{-4}$**
  - **PC plane-to-plane variations < $1x10^{-3}$**
  - **Same operating HV for all planes**



Efficiency

Field On

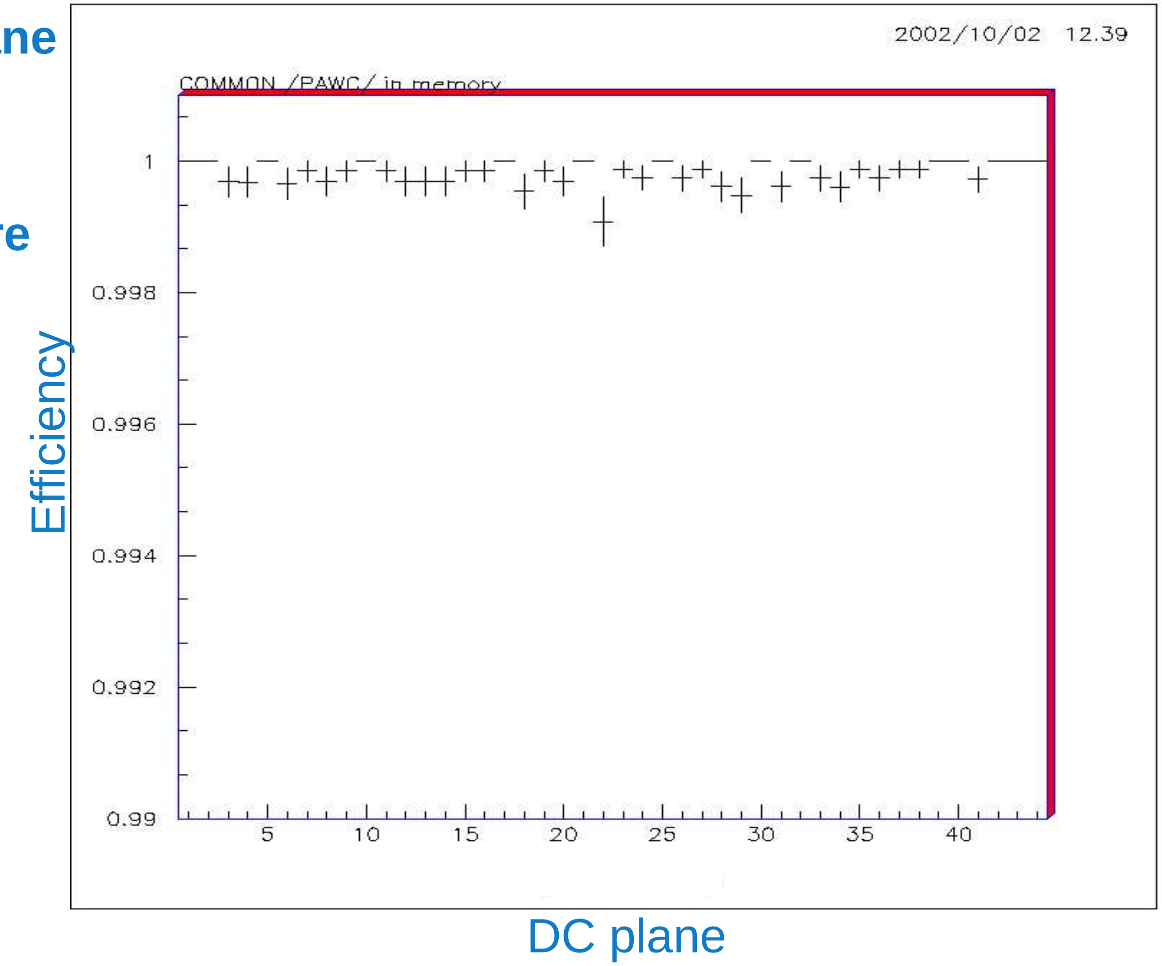
- **Data for decay positrons**
  - **DC Plane 13 (typical plane)**
  - **DC plane-to-plane variations < 5×10^{-4}**
  - **PC plane-to-plane variations < 1×10^{-3}**
  - **Similar results for field off and on.**



DC Efficiency

Plane-to-plane variations (field on)

- Small plane-to-plane variations.
- Similar wire-to-wire variations.

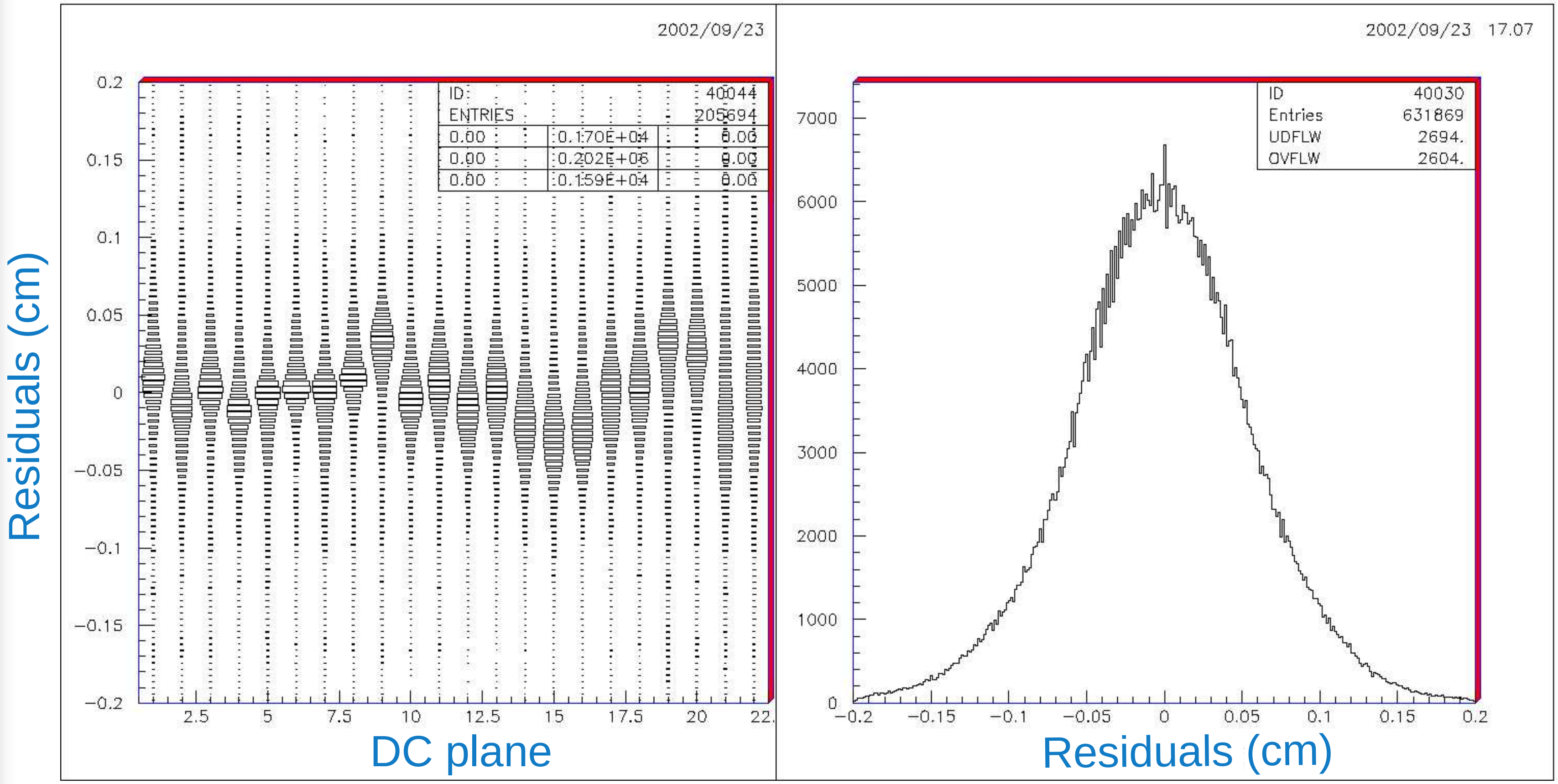


Translational Alignment

Plane Residuals

- **Data for 120 MeV/c beam particles (field off).**

Before alignments:

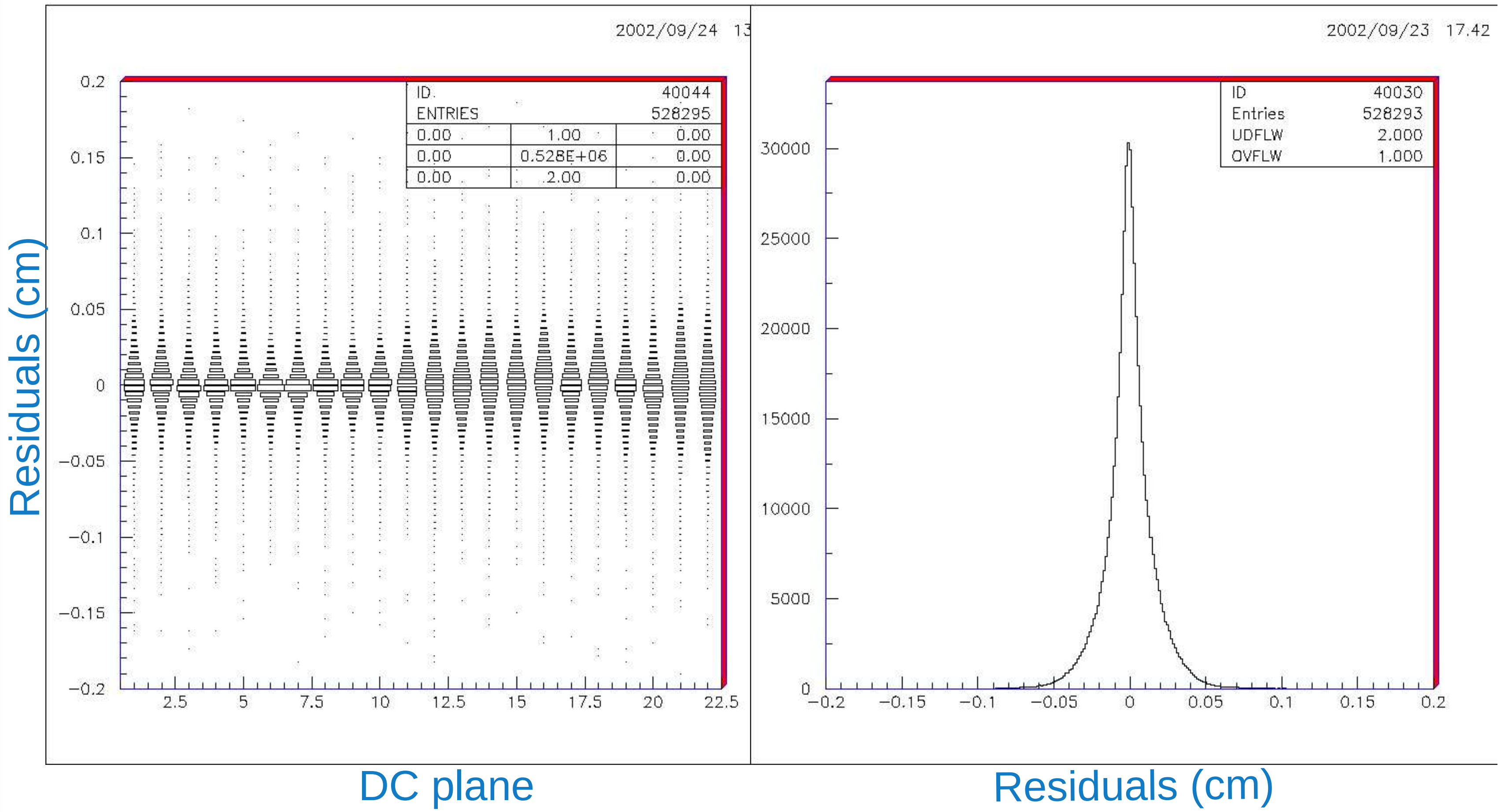


Translational Alignment

Plane Residuals

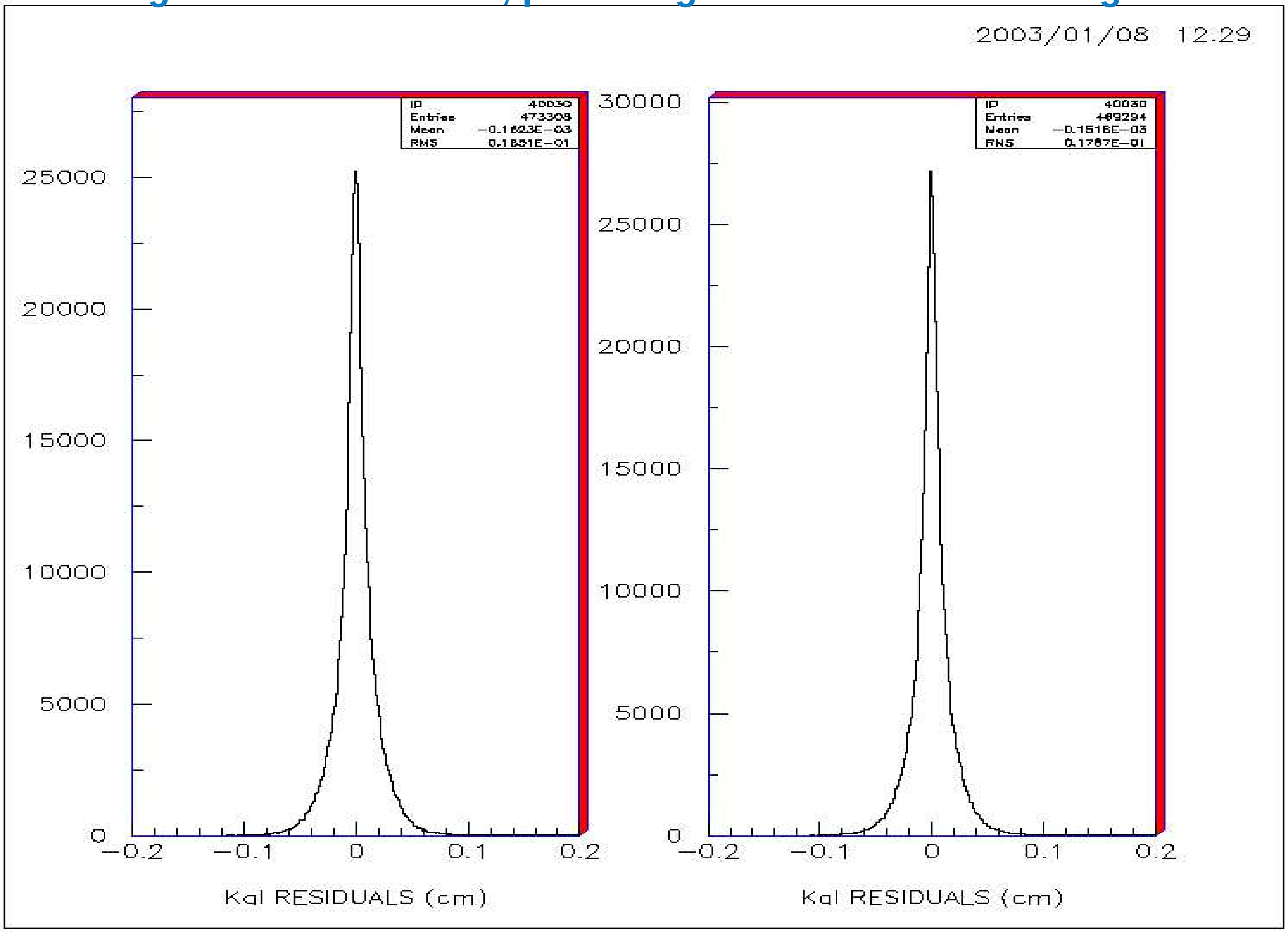
- **Iterative process establishes plane position corrections.**

After alignments:



Detector Stability

- **Similar residual widths and shape reflects detector stability througout running period.**
- **Among other calibrations, plane alignments have not changed.**

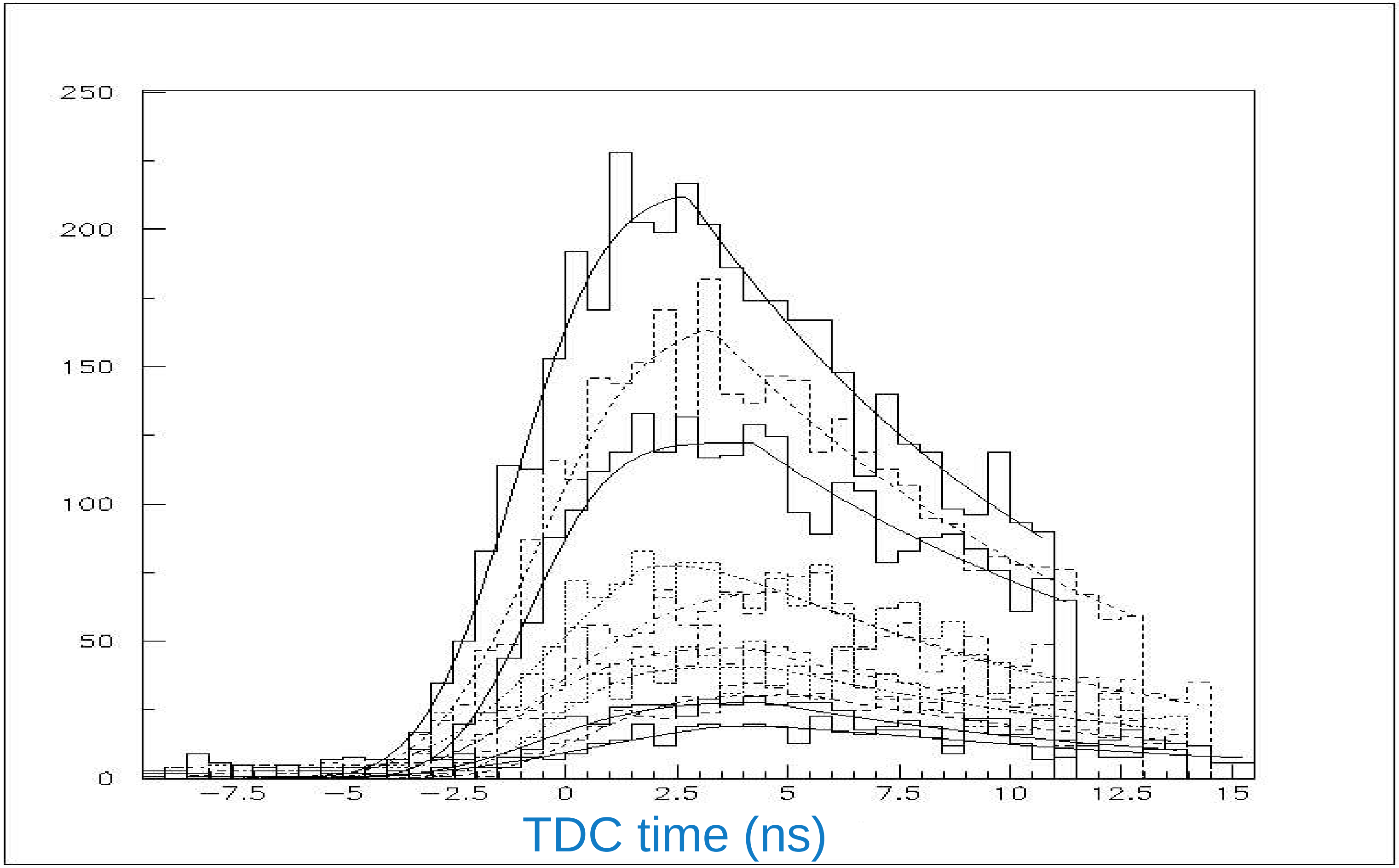


May 30, 2002 Dec 9, 2002

Time Zero

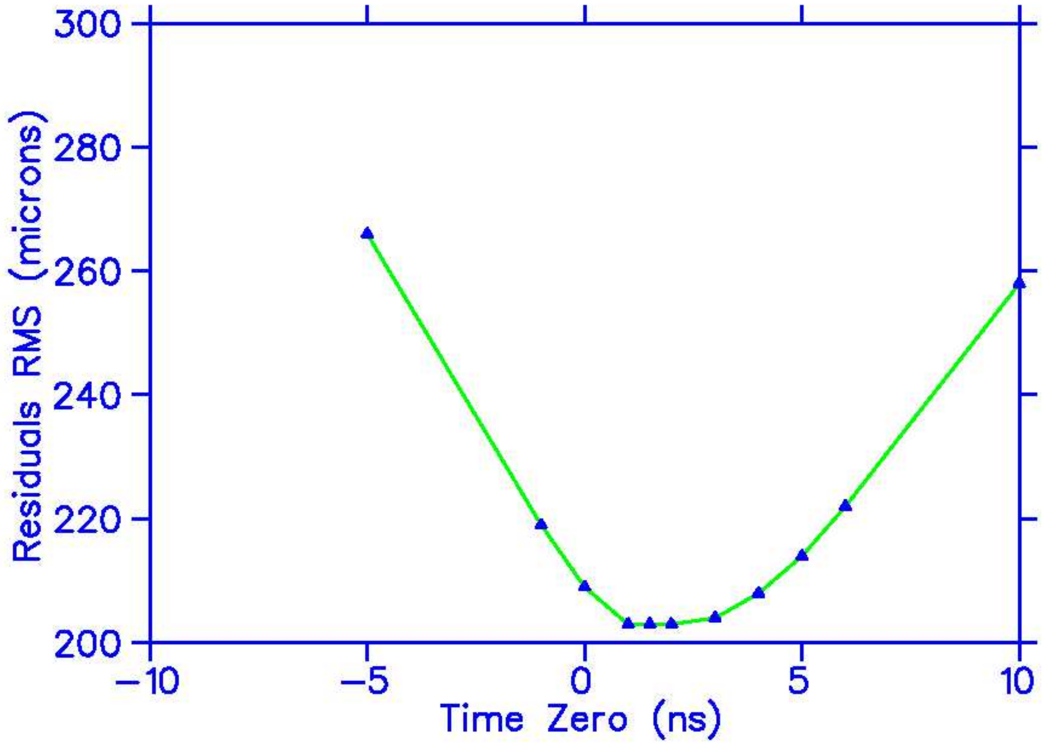
Fitting the "rising edge"

- Time zero precision achieved < 1 ns.
- TOF correction included.



Time Zero

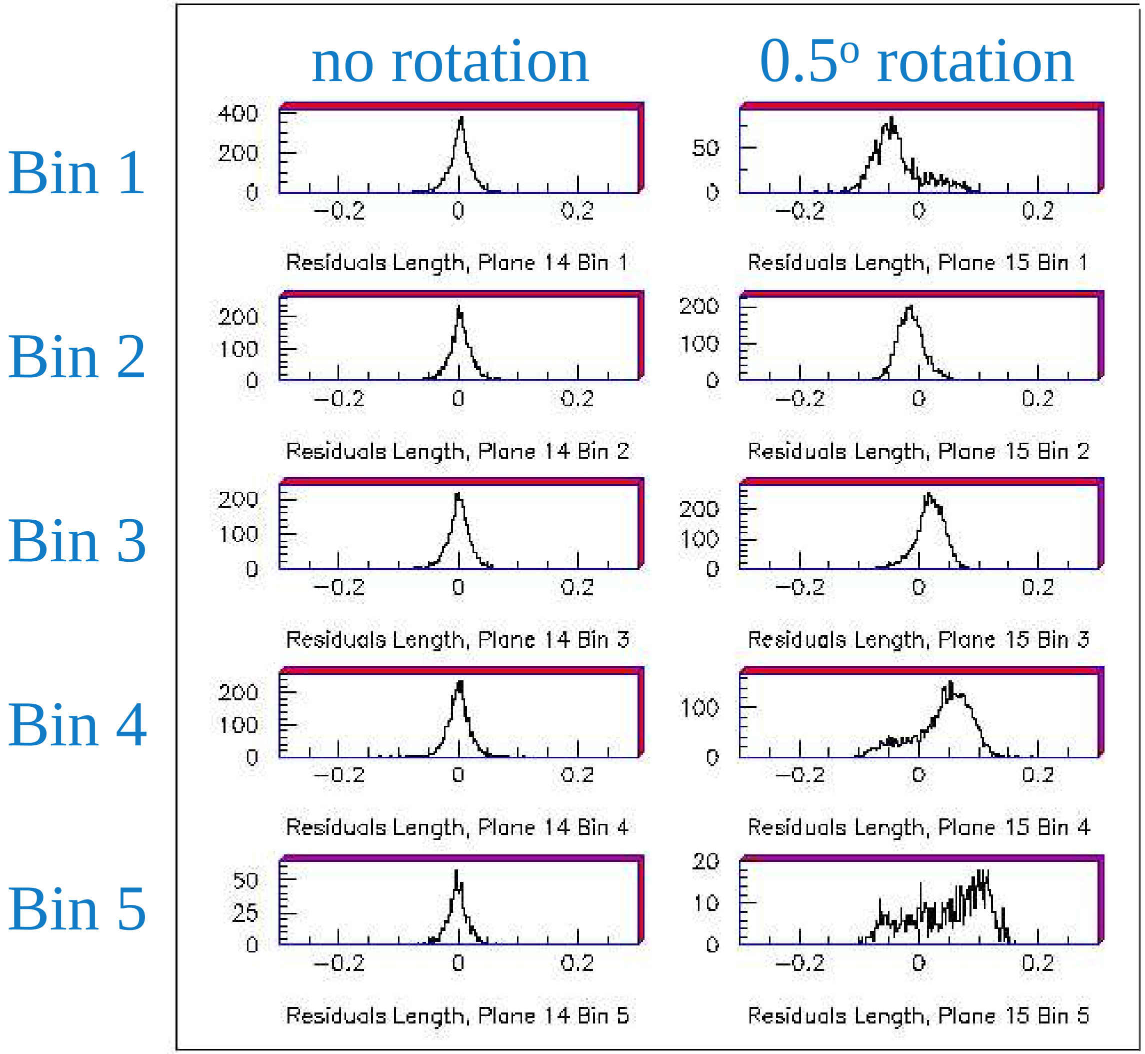
Global shift

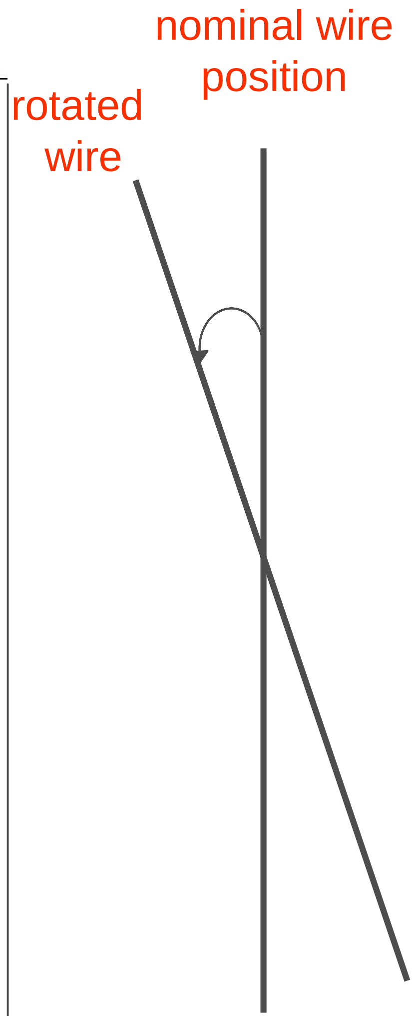


Rotational Alignment

Method

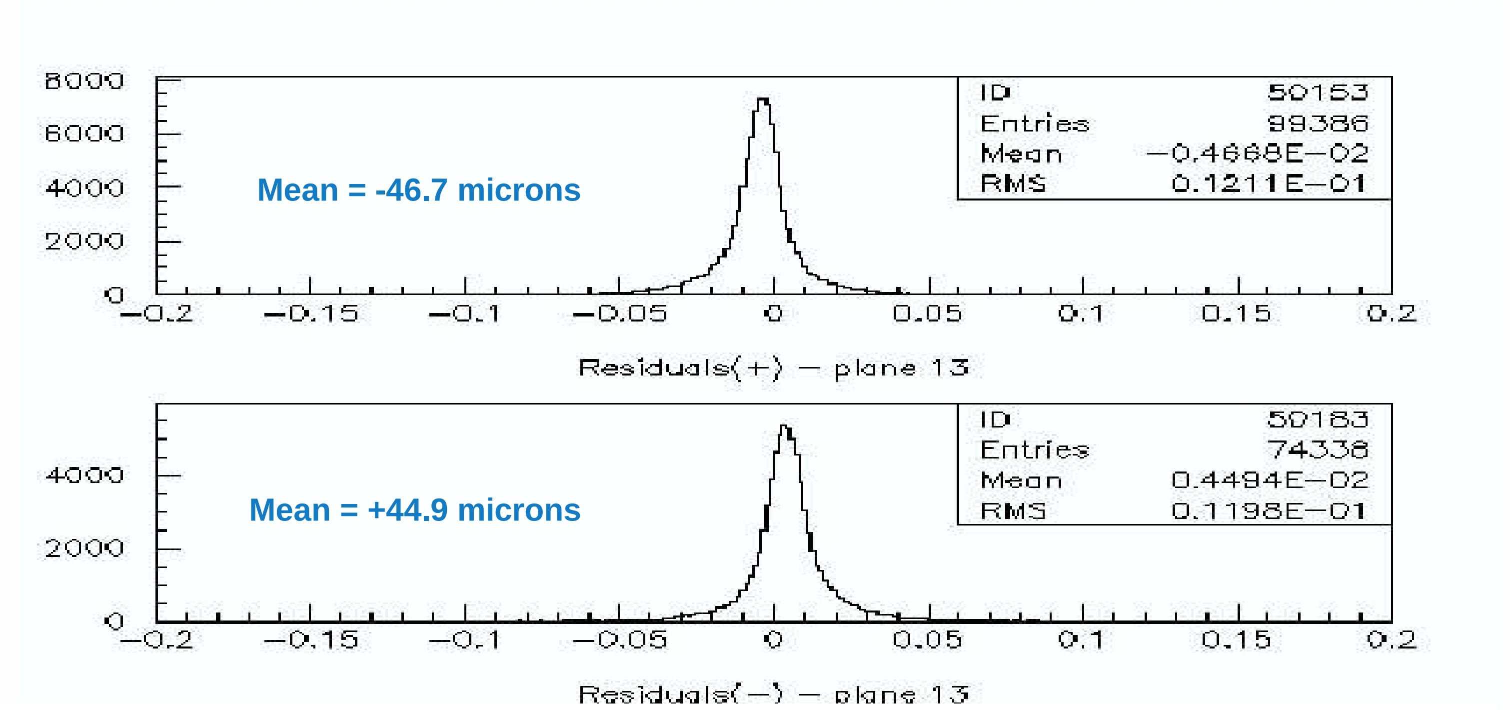
- **Residuals binned along the wire length (in 5 bins).**





Rotational Alignment

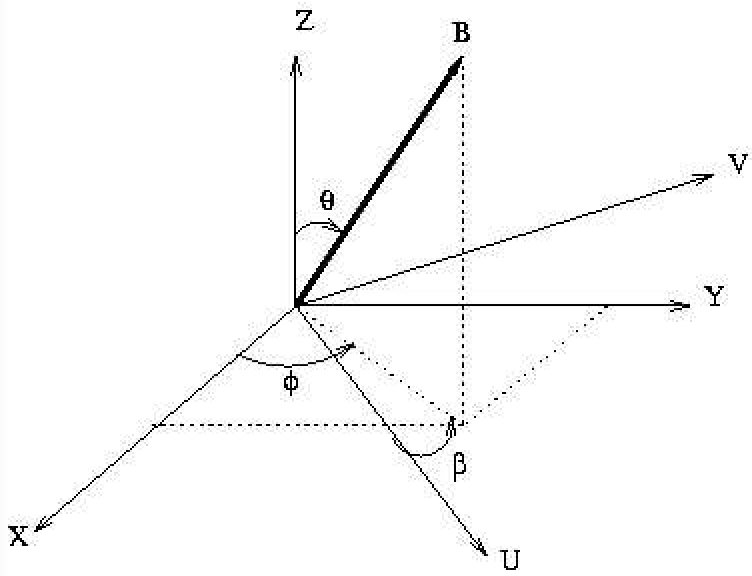
Example: plane 13

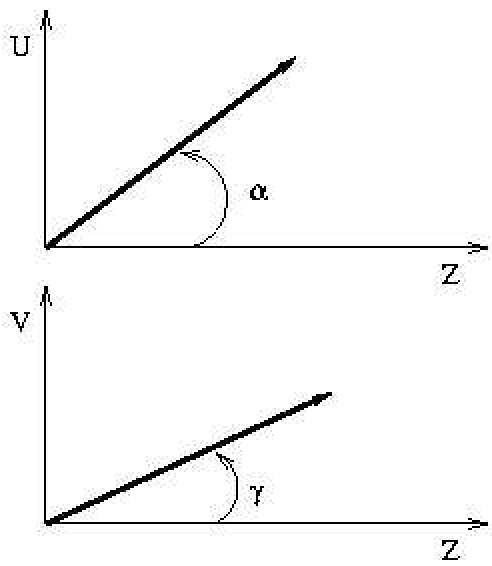


Detector to Field Alignment

Coordinate systems

- **Method**
  - **Rotate detector relative to field in GEANT.**
  - **Find the mean of the U and V positions in each chamber layer for decay positron tracks.**

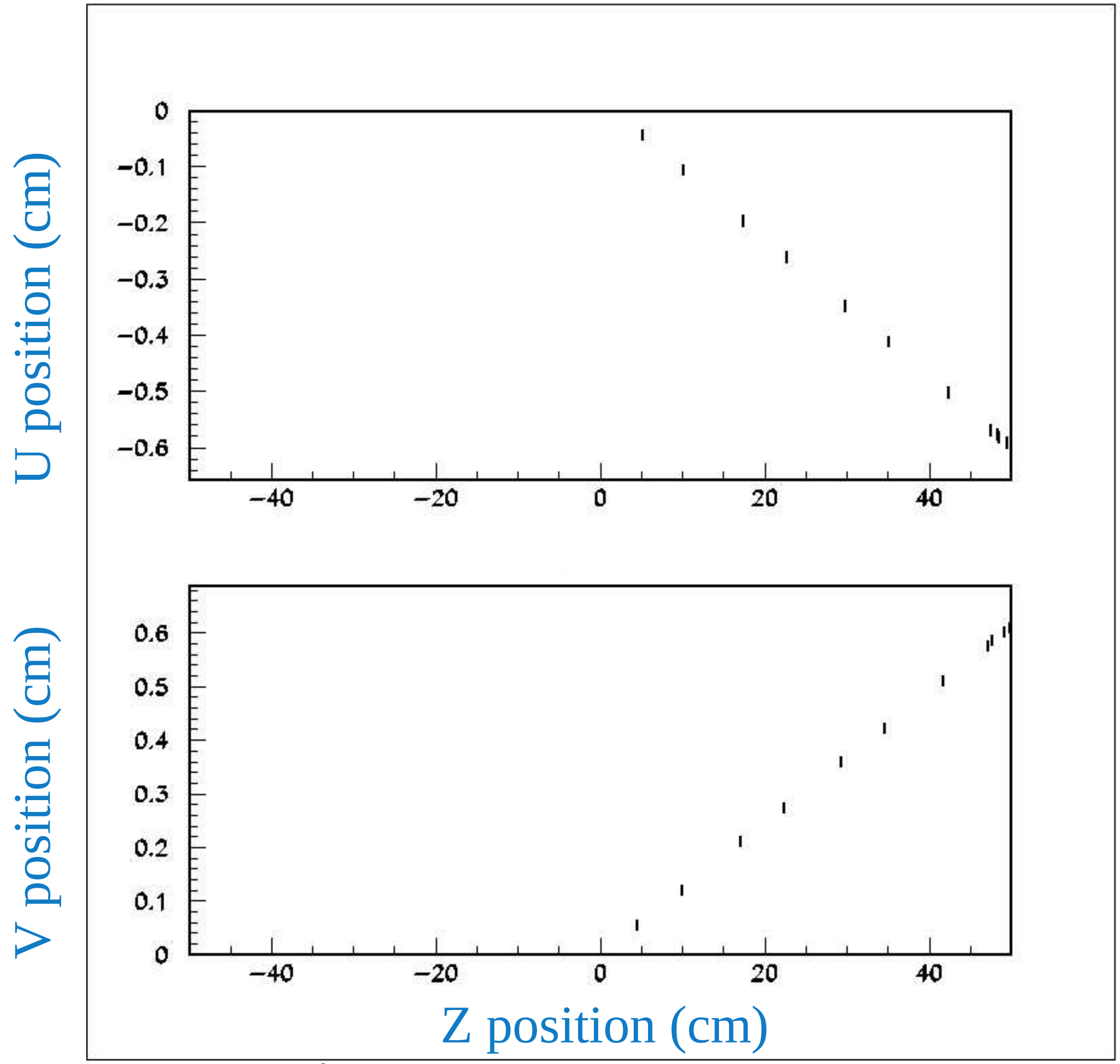




Detector to Field Alignment

Monte Carlo studies

- **Rotate detector with respect to B field by**
  - **$\theta = 1^o$.**
  - **$\phi = 0^o$.**
- **Mean of the U and V positions in each chamber layer for decay positron tracks.**



Detector to Field Alignment

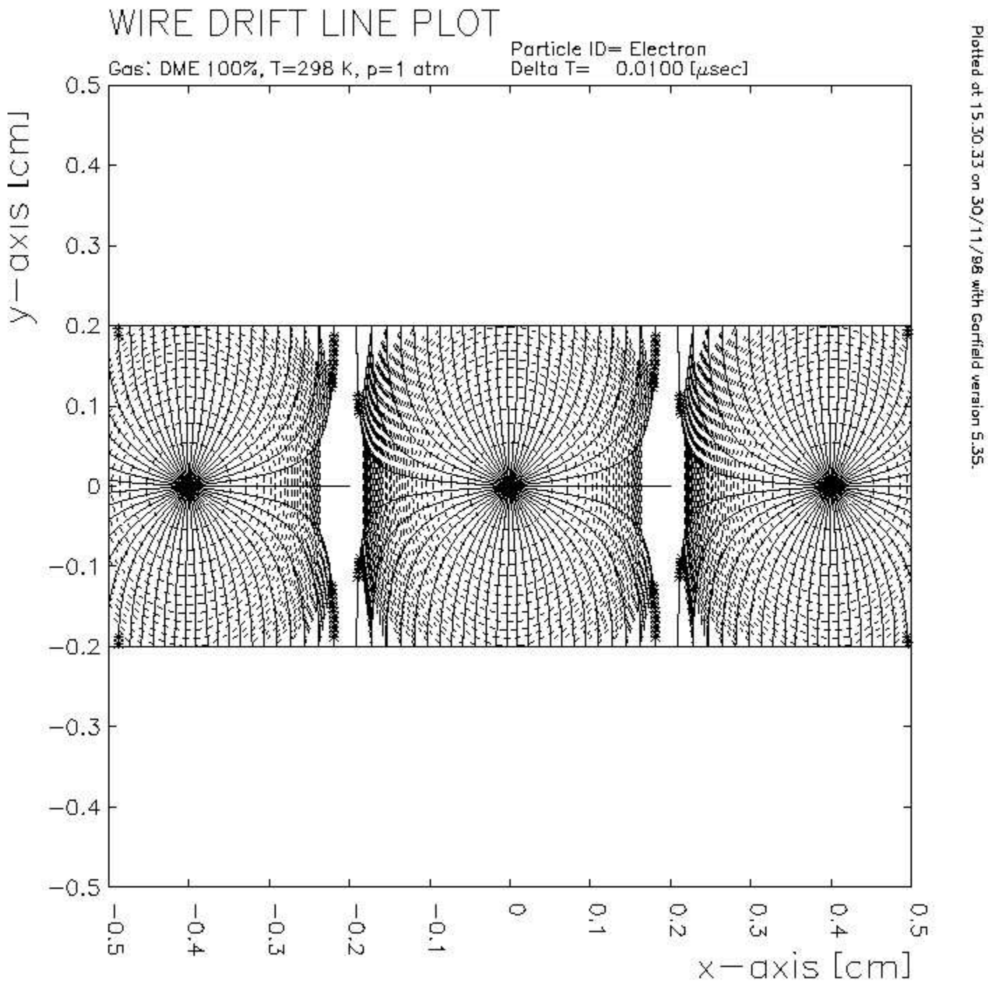
Data

- Can detect misalignments of few mrad
- Detector and B field are aligned to within few mrad
- Precision required ~ 10 mrad

$$\tan\alpha \sim 3 \times 10^{-04}$$
$$\tan\gamma \sim 2 \times 10^{-04}$$

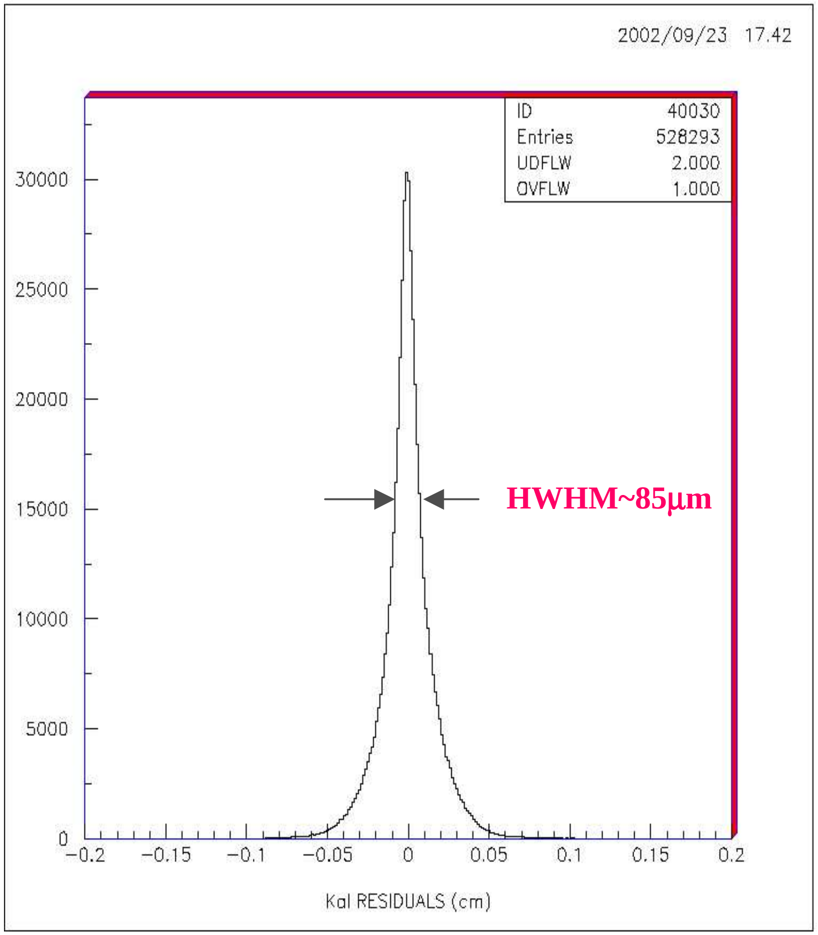
STRs

- Currently determined from GARFIELD
  - 2-D matrix d = d(t,θ).
  - Residuals reflect reasonable accuracy from GARFIELD.
  - Various GARFIELD files are generated for the appropriate field, pressure & temperature.
  - Resolution shows that GARFIELD is fairly accurate.
- Can be determined from data through iterations
  - Use decay positrons.



Resolution

Field off



Field on

- DME timing properties are very similar between field on and field off.
- Intrinsic chamber resolution should be similar.
- Observed residual widths of decay positrons is a convolution of intrinsic chamber resolution and MS effects.
- Konstantin will talk more about field on case.

Summary

- Chamber efficiency was determined for all planes
  - High efficiencies obtained (over 99.9% for all DC planes).
  - Small plane-to-plane and wire-to-wire variations.
  - High voltage and threshold studies done.
- Detailed detector alignment studies were conducted
  - Plane translational alignments of better than 10 microns were achieved.
  - Plane rotational alignments of better than 1 mrad were achieved.
  - Detector to field alignments are obtained at the few mrad level.
- Time zero fits to the TDC spectrum are determined
  - Time zero determined for every DC and PC wire.
  - Time zero determined to better than 1 ns.
- STRs are presently calculated from GARFIELD
  - Calculations done with appropriate B field pressure and temperature.
  - Data iterations to improve on GARFIELD are planned.
- DC chamber resolution determined for field off
  - Resolution determined as a function of distance from the wire and used in the fit.
  - Overall residuals for field off show a HWHM of 85 microns.
  - Field on calculations are in progress.