

# BigBite DC time and position offsets optimization

Hall A Analysis Workshop

03 Dec 2008

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# Review

- Offsets definition
- Optimization method
- New offsets
- Drift time to distance conversion check
- Results and comparison
- Conclusion

# Time and position offsets, $t_0$ and $x_0$

- Each wire in DC is connected to common-stop TDC. The readout time for a wire,  $i$ , described as:

$$t_{TDC} = t_{drift} + t_{0,i}$$

where  $t_{0,i}$  includes:

- signal propagation time to TDC
  - electron propagation time to trigger detector
  - time to form the common-stop signal
- Coordinate of the hit described as:

$$x_{hit} = x_{0,i} + f(t_{drift})$$

# Optimization algorithm

- Optimization algorithm based on minimization of track  $\chi^2$ .

$$\chi^2 = \sum_i \frac{1}{\sigma_i^2} (d_i - f_i)^2$$

$d_i$  – position measured by  $i$ -th plane

$f_i$  – track intercept with  $i$ -th plane

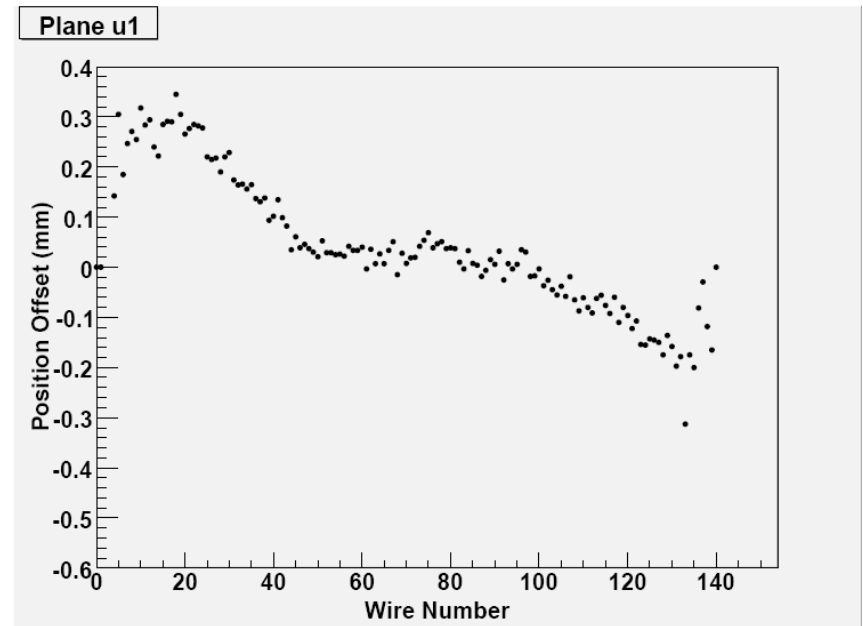
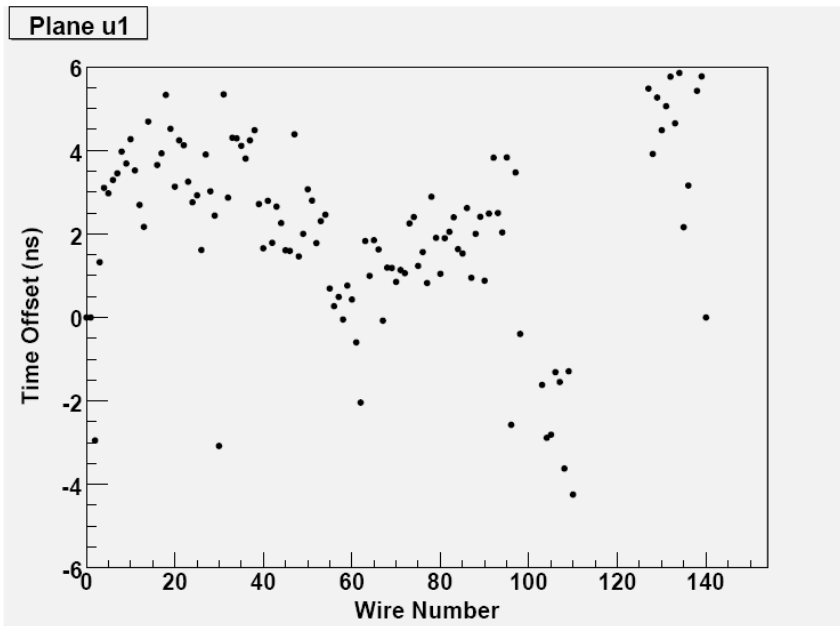
$\sigma_i$  – resolution of the  $i$ -th plane

- Residual  $R_i = (d_i - f_i)$  is used to determine the quality of optimization and final resolution.

# New offsets

Time offset deviation

Position offset deviation

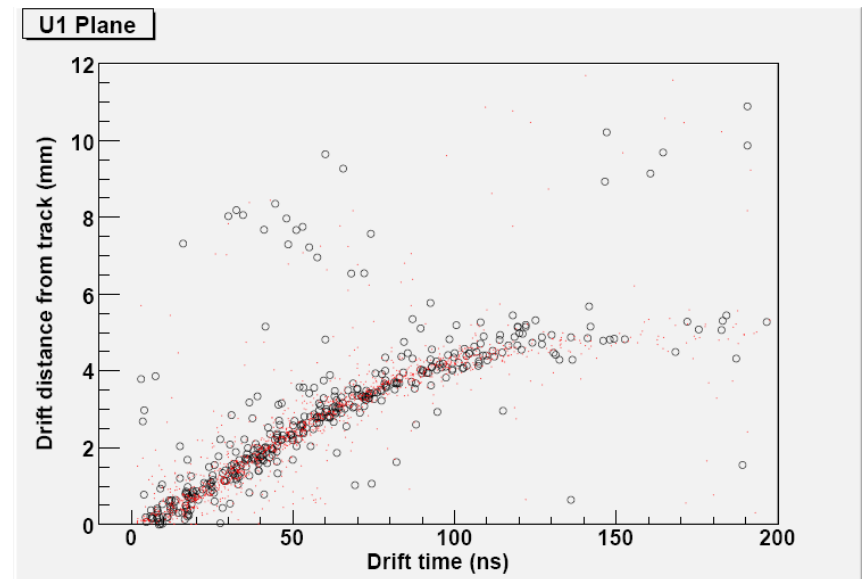
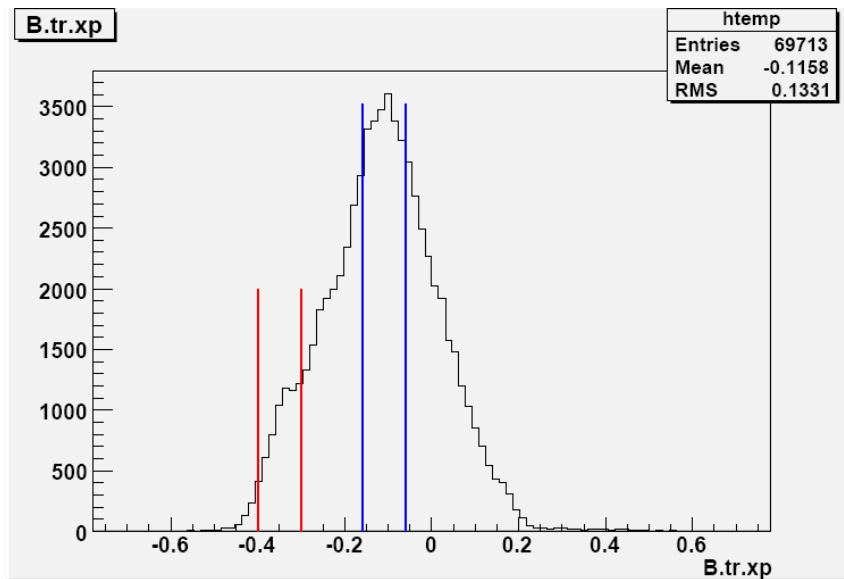


Optimization parameters – deviation of optimized time and position offsets from those in database. Units are ns and mm.

# Drift time conversion check

Out of plane angle  
distribution

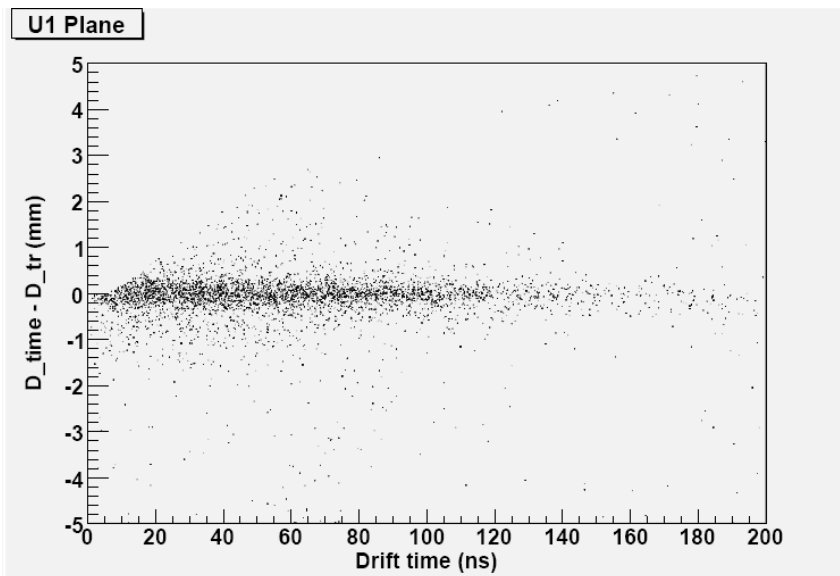
Distance calculated from  
track vs drift time



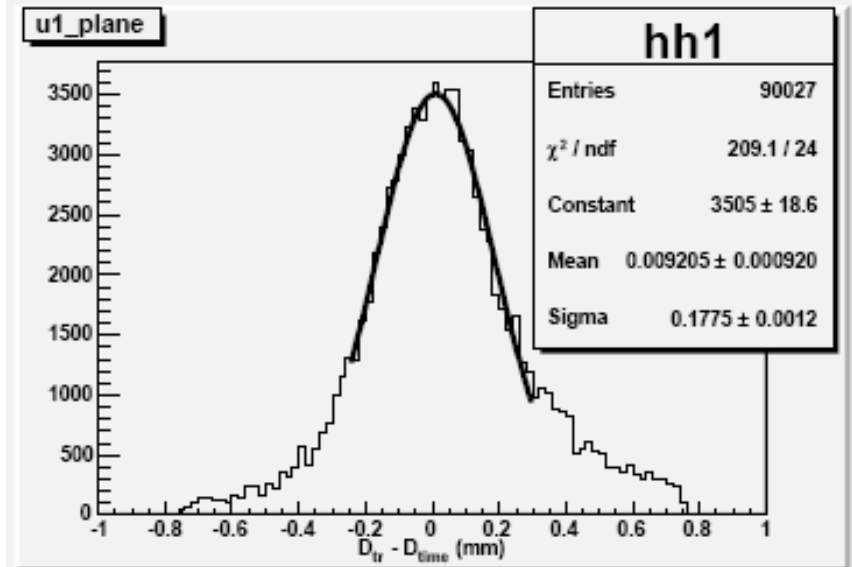
Red dots reproduce central region cut on angle  
Black circles reproduce side region cut on angle

# Drift time conversion check

Difference between distance from track and distance from measured drift time vs drift time

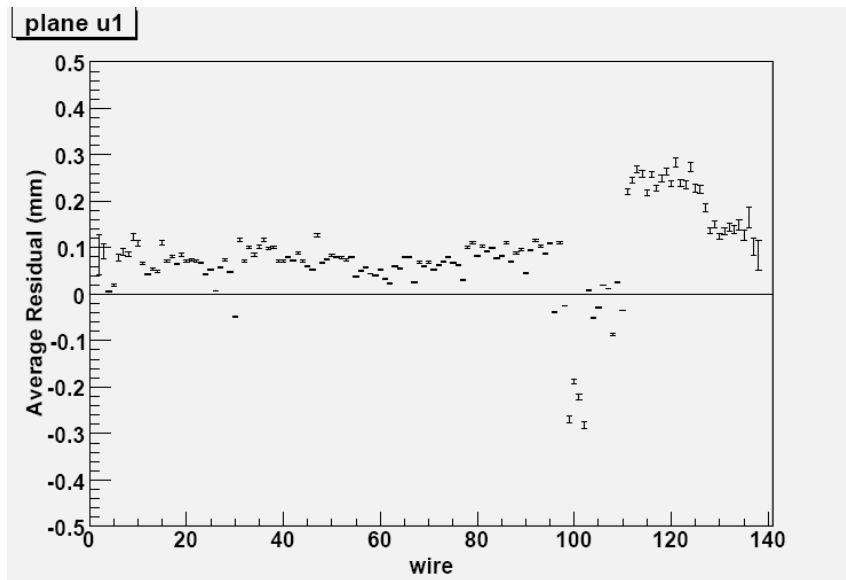


Difference between distance from track and distance from measured drift time

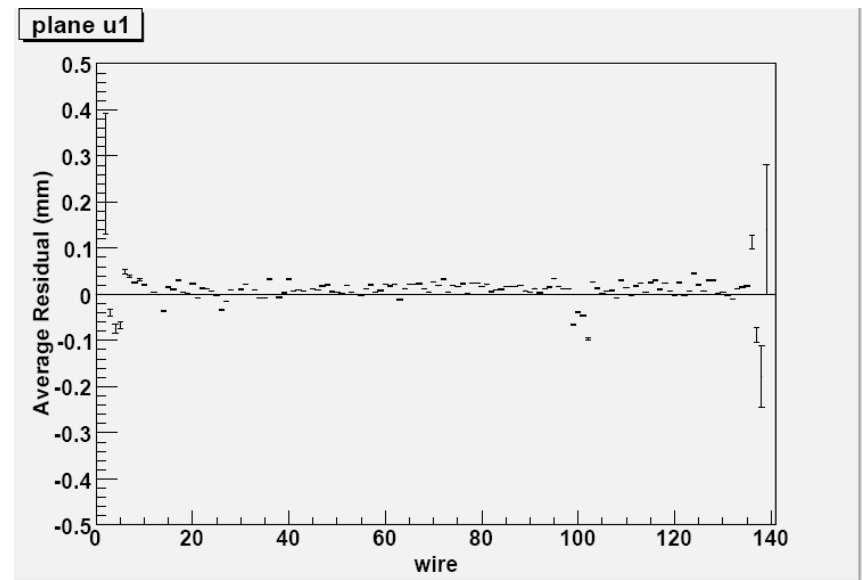


# Results

Before optimization



After optimization



Average residual vs wire number for plane U1, units are mm.

Values are aligned around zero.

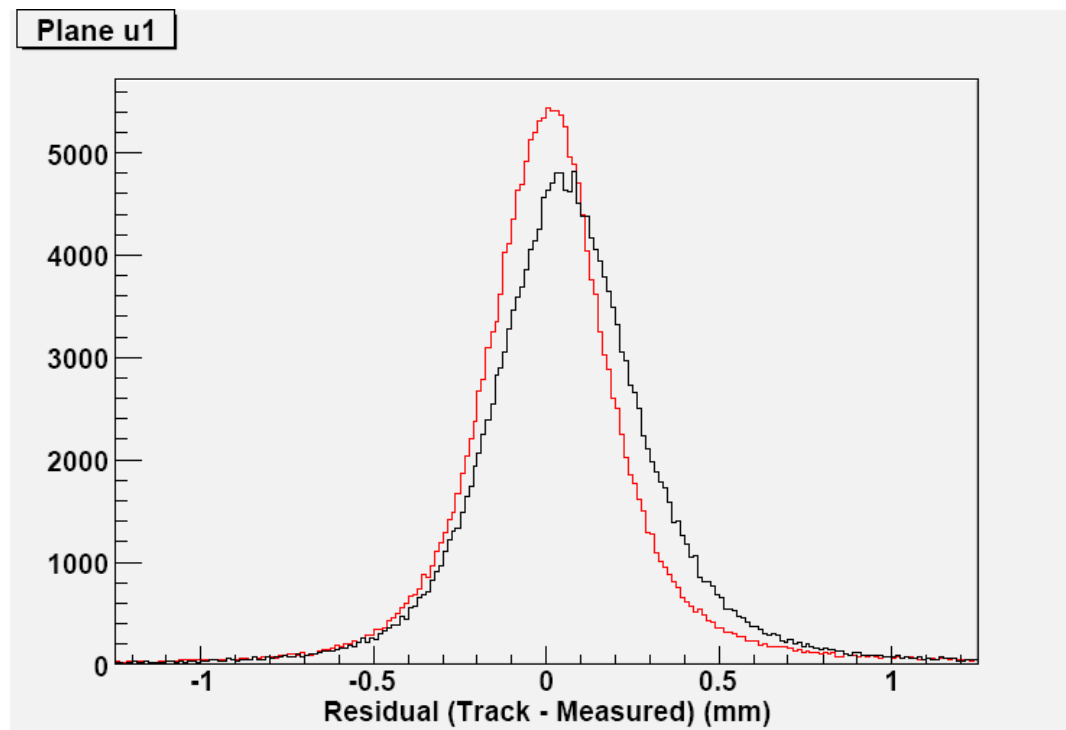


# Results

Residual (mm) for plane U1.

Red – after optimization, Black before optimization.

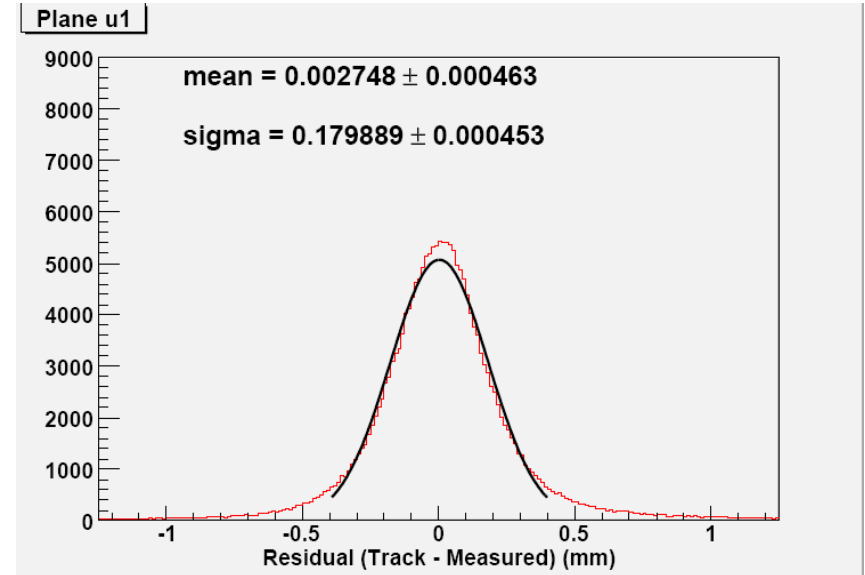
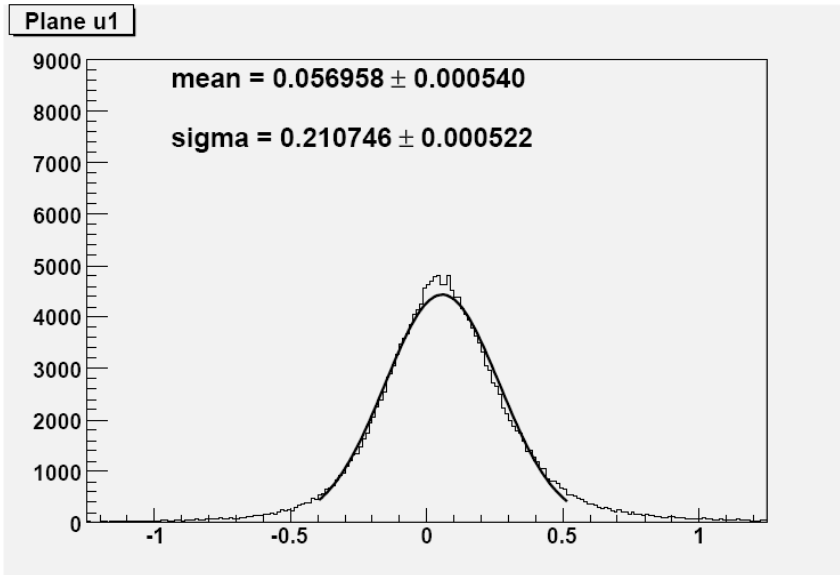
Significant improvement of resolution.



# Results

Before optimization

After optimization



Residual distribution for plane U1, units are mm.

Resolution after optimization  $< 200\mu\text{m}$ .

# Results

Plane	Before Optimization		After Optimization	
	Mean	Sigma	Mean	Sigma
U1	0.0569 ± 0.00054	0.2107 ± 0.00052	0.0027 ± 0.00046	0.1798 ± 0.00045
U2	0.0424 ± 0.00052	0.2037 ± 0.00050	0.0036 ± 0.00045	0.1777 ± 0.00044
U3	-0.0062 ± 0.00073	0.2863 ± 0.00069	0.0047 ± 0.00063	0.2474 ± 0.00062
U4	-0.0200 ± 0.00055	0.2203 ± 0.00052	0.0042 ± 0.00049	0.1959 ± 0.00048
U5	-0.0356 ± 0.00057	0.2275 ± 0.00056	0.0036 ± 0.00053	0.2070 ± 0.00052
V1	0.0523 ± 0.00059	0.2326 ± 0.00056	0.0006 ± 0.00051	0.1999 ± 0.00049
V2	0.0892 ± 0.00063	0.2484 ± 0.00061	0.0014 ± 0.00051	0.1976 ± 0.00049
V3	-0.0288 ± 0.00077	0.3073 ± 0.00074	0.0209 ± 0.00070	0.2794 ± 0.00068
V4	-0.0361 ± 0.00059	0.2433 ± 0.00057	0.0121 ± 0.00051	0.2093 ± 0.00051
V5	-0.0452 ± 0.00065	0.2675 ± 0.00063	0.0019 ± 0.00051	0.2059 ± 0.00049
X1	0.0713 ± 0.00056	0.2253 ± 0.00054	0.0028 ± 0.00049	0.1966 ± 0.00047
X2	0.0722 ± 0.00055	0.2220 ± 0.00054	-0.0030 ± 0.00048	0.1932 ± 0.00047
X3	0.0114 ± 0.00072	0.2953 ± 0.00069	0.0039 ± 0.00063	0.2582 ± 0.00062
X4	-0.0213 ± 0.00066	0.2686 ± 0.00063	0.0053 ± 0.00051	0.2095 ± 0.00051
X5	-0.0336 ± 0.00065	0.2634 ± 0.00061	0.0053 ± 0.00052	0.2099 ± 0.00051

Mean and sigma of residual distribution for all planes before and after optimization

# Conclusion

- Method of finding time and position offsets based on minimization of track  $\chi^2$  shows significant improvement of resolution.
- For most of the planes (except planes in 2-nd chamber) the resolution **under 200  $\mu\text{m}$**  was achieved.