

# BigBite DC time and position offsets optimization

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# 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  $\chi^2$ .

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

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

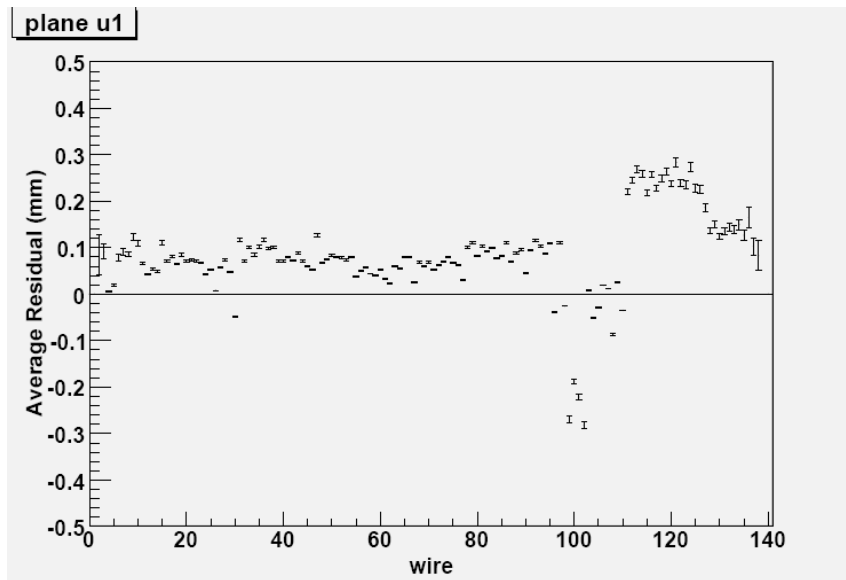
$f_i$  – track intercept with  $i$ -th plane

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

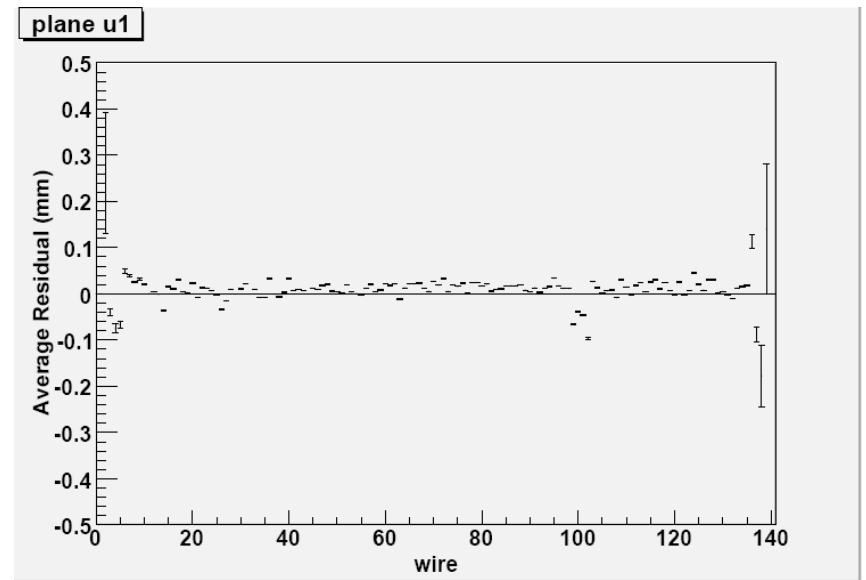
- Residual  $R_i = (d_i - f_i)$  is used to determine the quality of optimization and final resolution.

# Results

Before optimization



After optimization

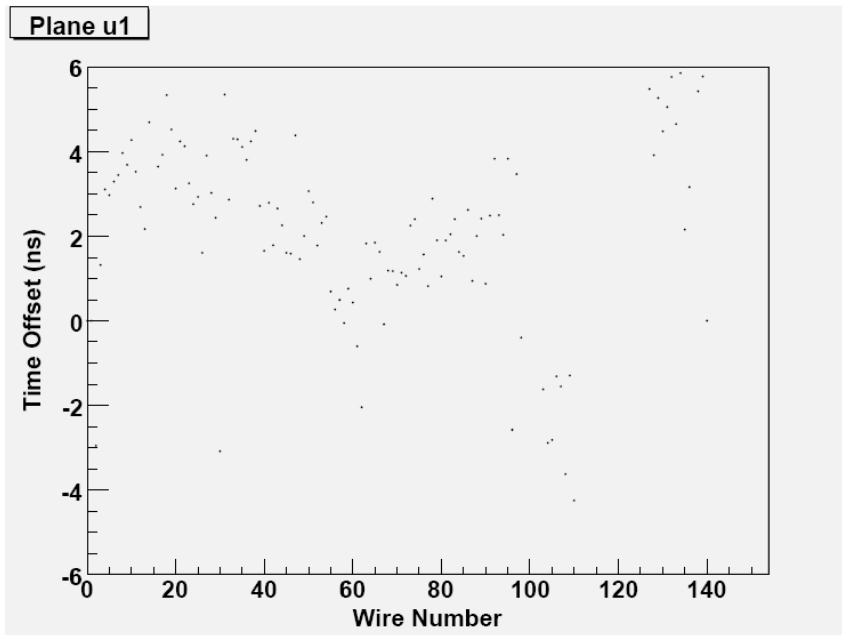


Average residual vs wire number for plane U1,  
units are mm.

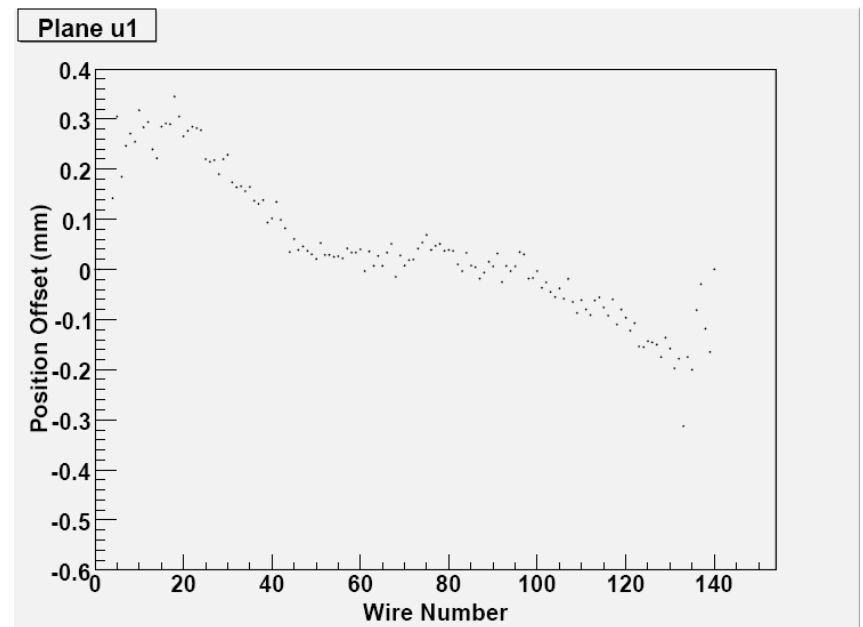
Values are aligned around zero, as it supposed to be

# Results

## Time offset deviation



## Position offset deviation



Optimization parameters – deviation of optimized time and position offsets from those in database.

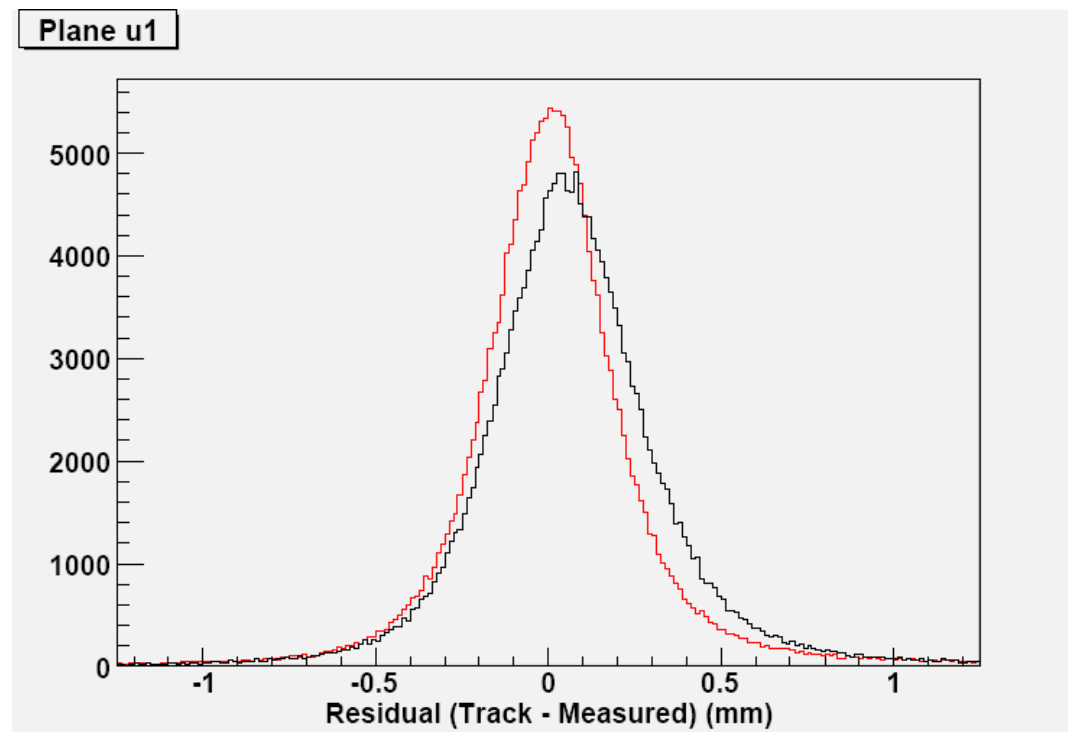
Units are ns and mm.

# Results

Residual (mm) for plane U1.

Red – after optimization, Black before optimization.

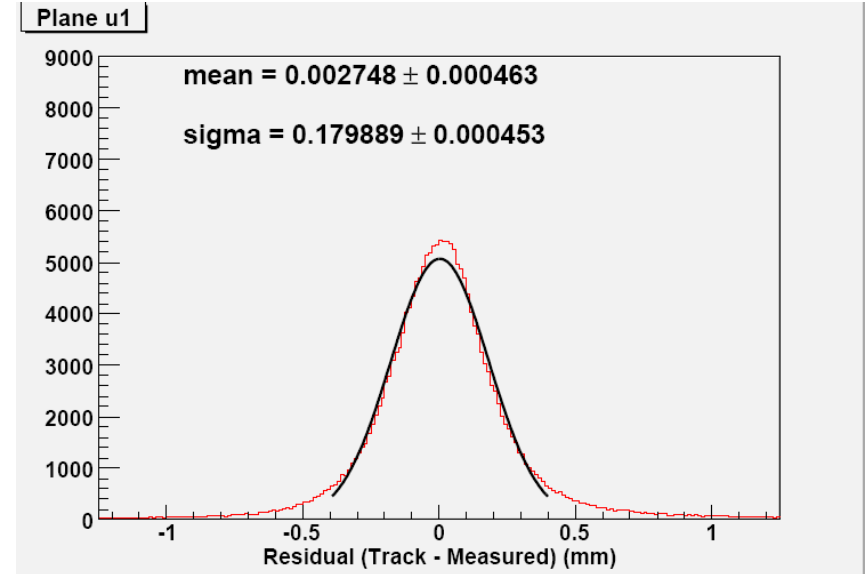
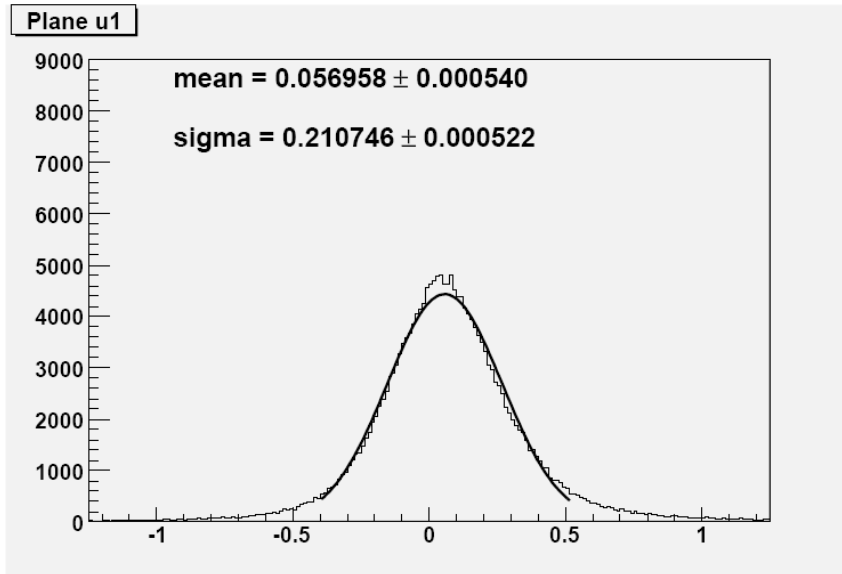
Significant improvement of resolution.



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

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.