

SPD time resolution test

Ye Tian

Shandong University

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Time resolution of three bar test method



$$T = \frac{t_0 + t_3 + t_2 + t_5}{4} - \frac{t_1 + t_4}{2}$$

The first item is time reconstructed by top and bottom bar, the second item is time got from middle bar. The difference between these two items indicates system time resolution.

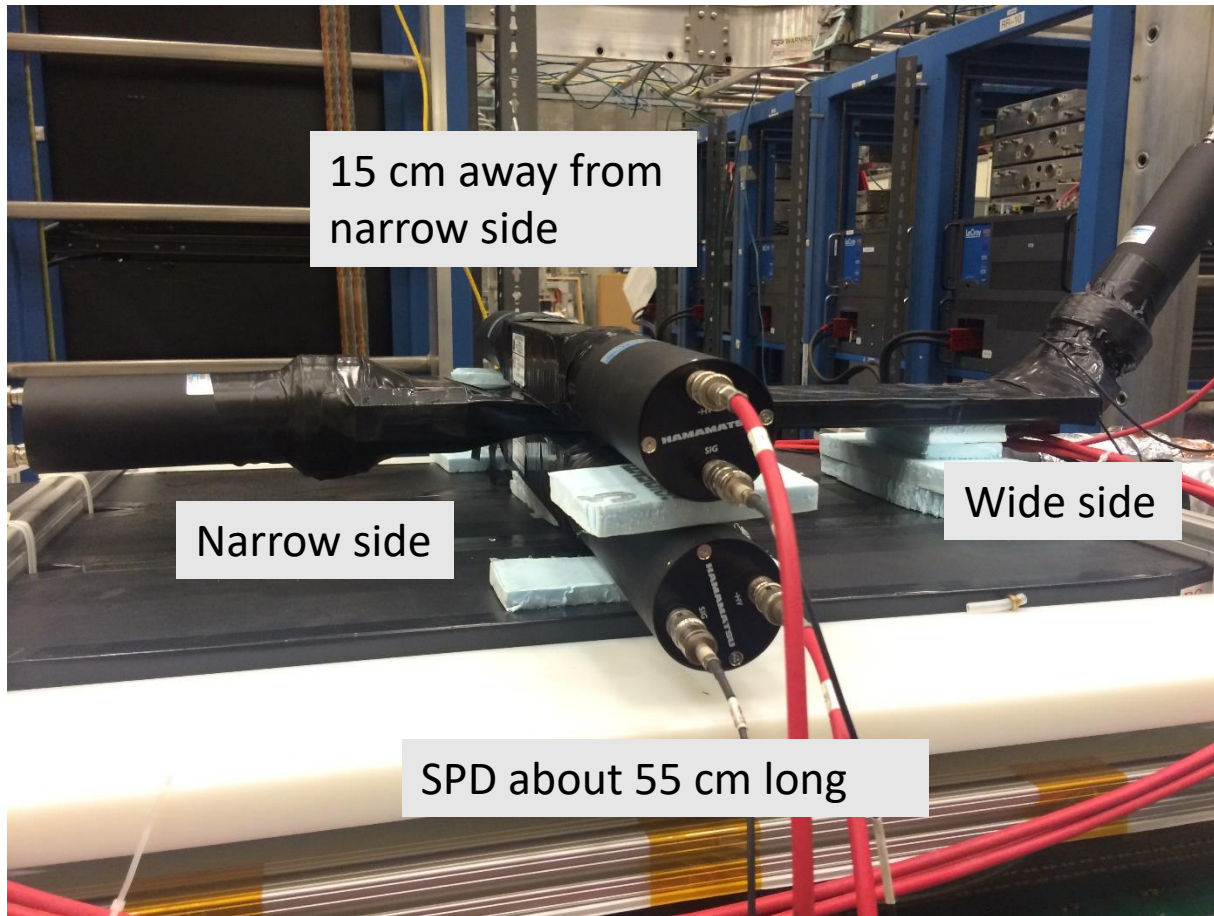
Applying assumption $\sigma_{bar} = \frac{1}{\sqrt{2}} \sigma_{PMT}$

Since every PMT is identical, scintillator time resolution will be calculated as:

$$\sigma = \sqrt{\frac{2}{3}} \sigma_T$$

Result: 82ps

FASPD time resolution test



Calculation to get time resolution:

Consider both sides PMT

$$T = \frac{t_0+t_3+t_2+t_5}{4} - \frac{t_1+t_4}{2}$$
$$\sigma_m = \text{sqrt}(\sigma_T^2 - 0.5 * \sigma_r^2)$$

Only consider one side

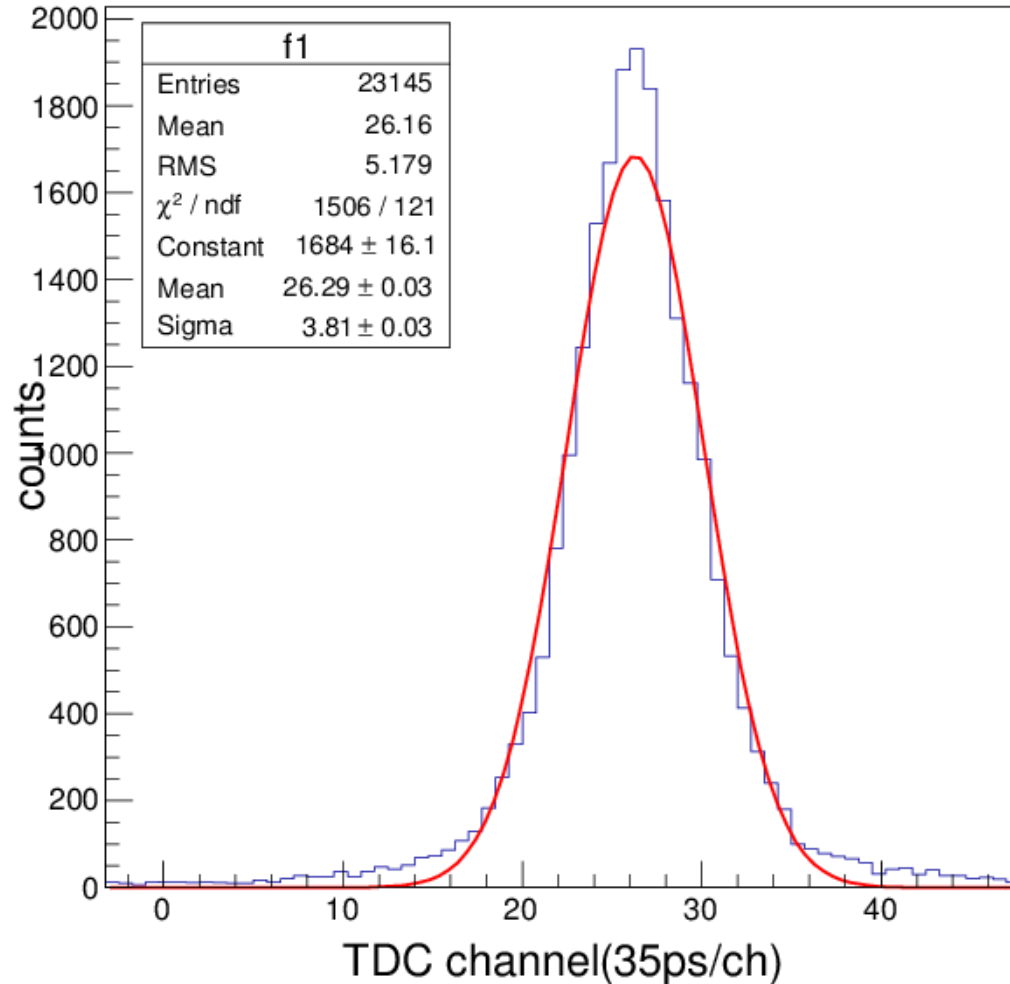
$$T = \frac{t_0+t_3+t_2+t_5}{4} - t_1 \text{ (or } t_4)$$
$$\sigma_1 = \text{sqrt}(\sigma_T^2 - 0.5 * \sigma_r^2)$$

(same as above)

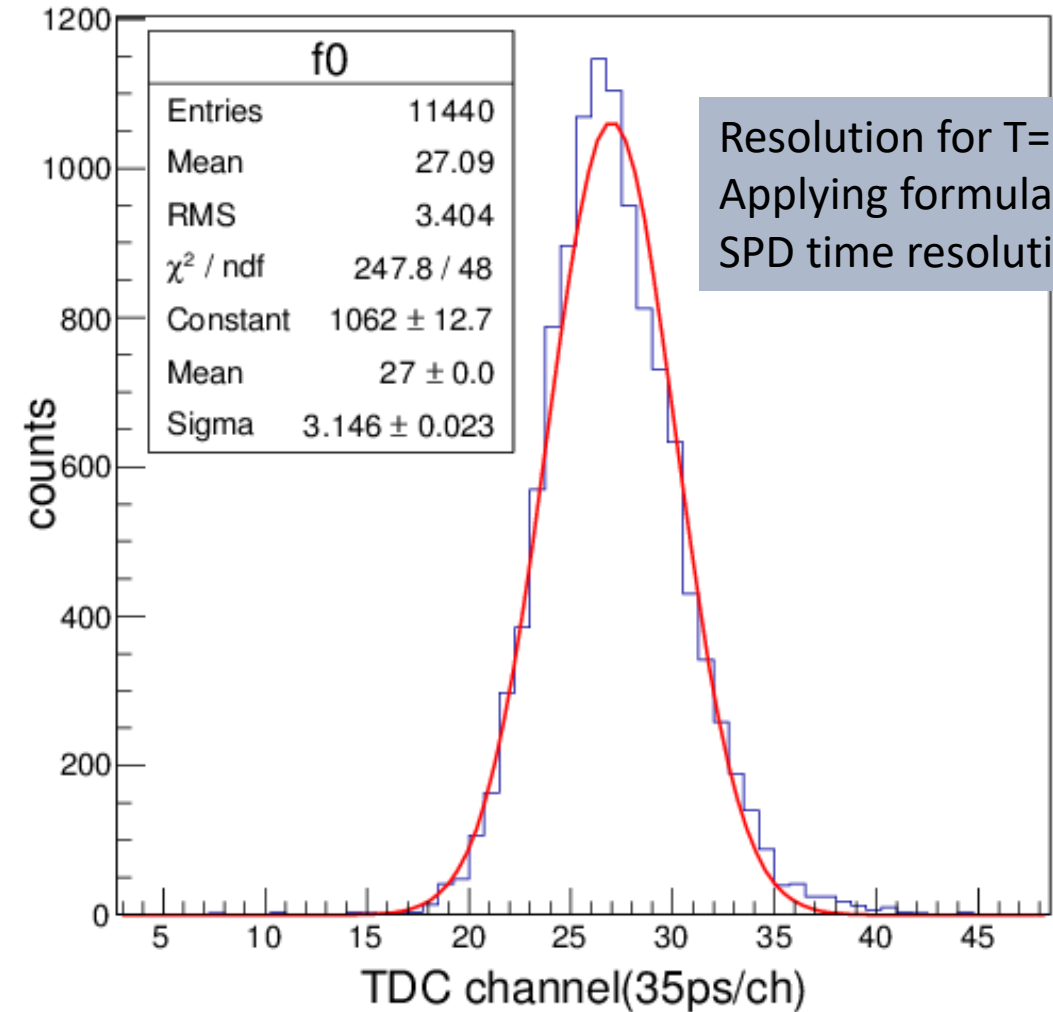
Where $\sigma_r = 82\text{ps}$

Three bar method for both sides readout

After time walk correction



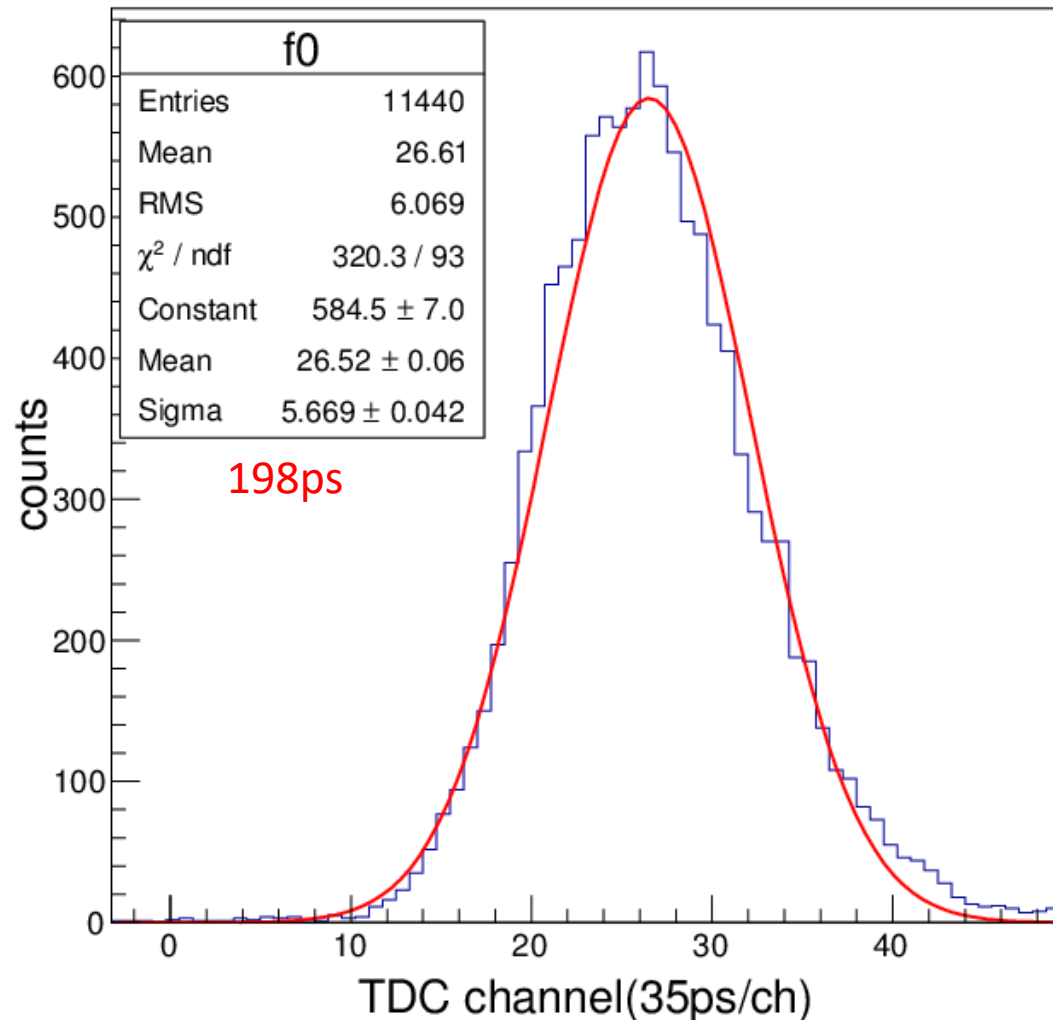
Add FADC cut



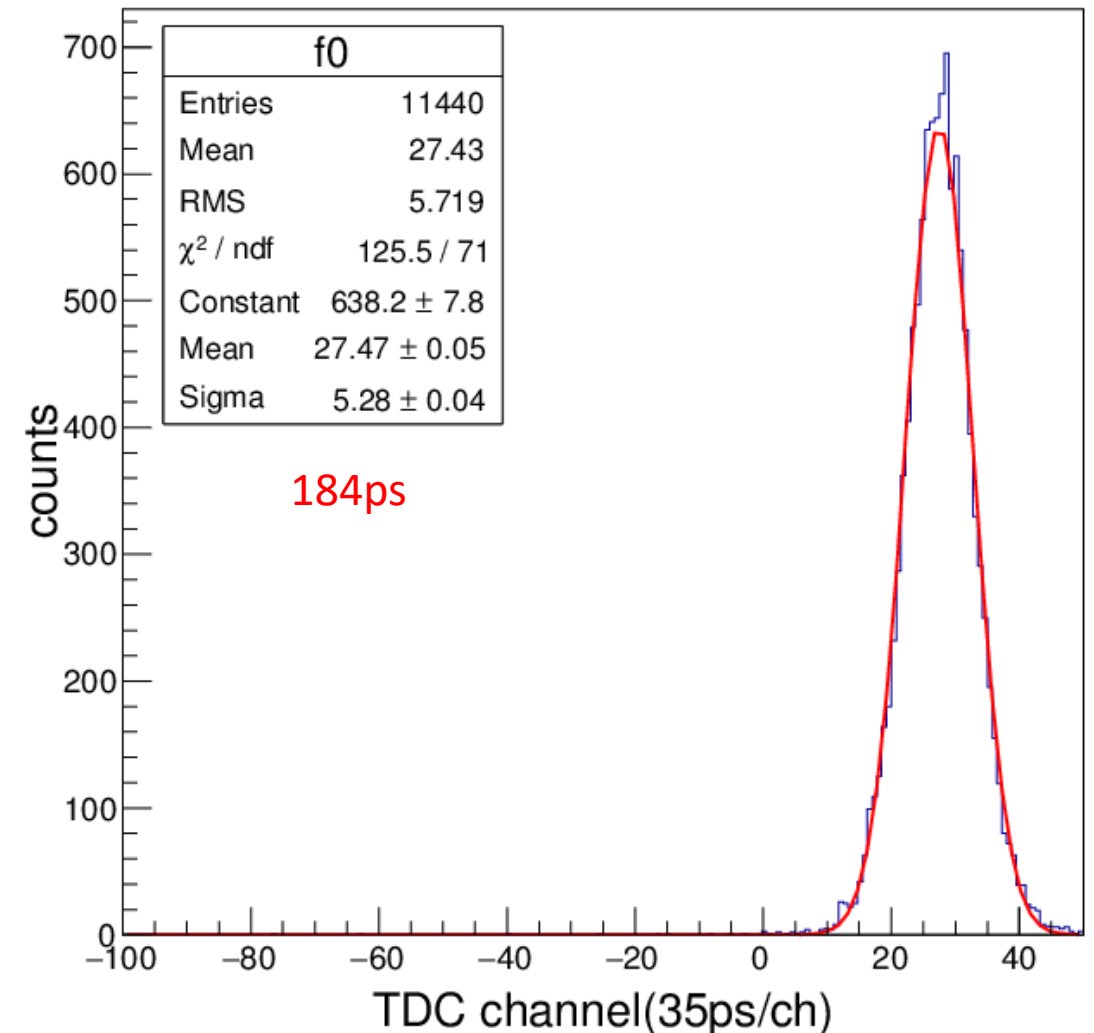
Resolution for $T = 110\text{ps}$
Applying formula
SPD time resolution: **93ps**

Readout only by one side

Readout by wide side

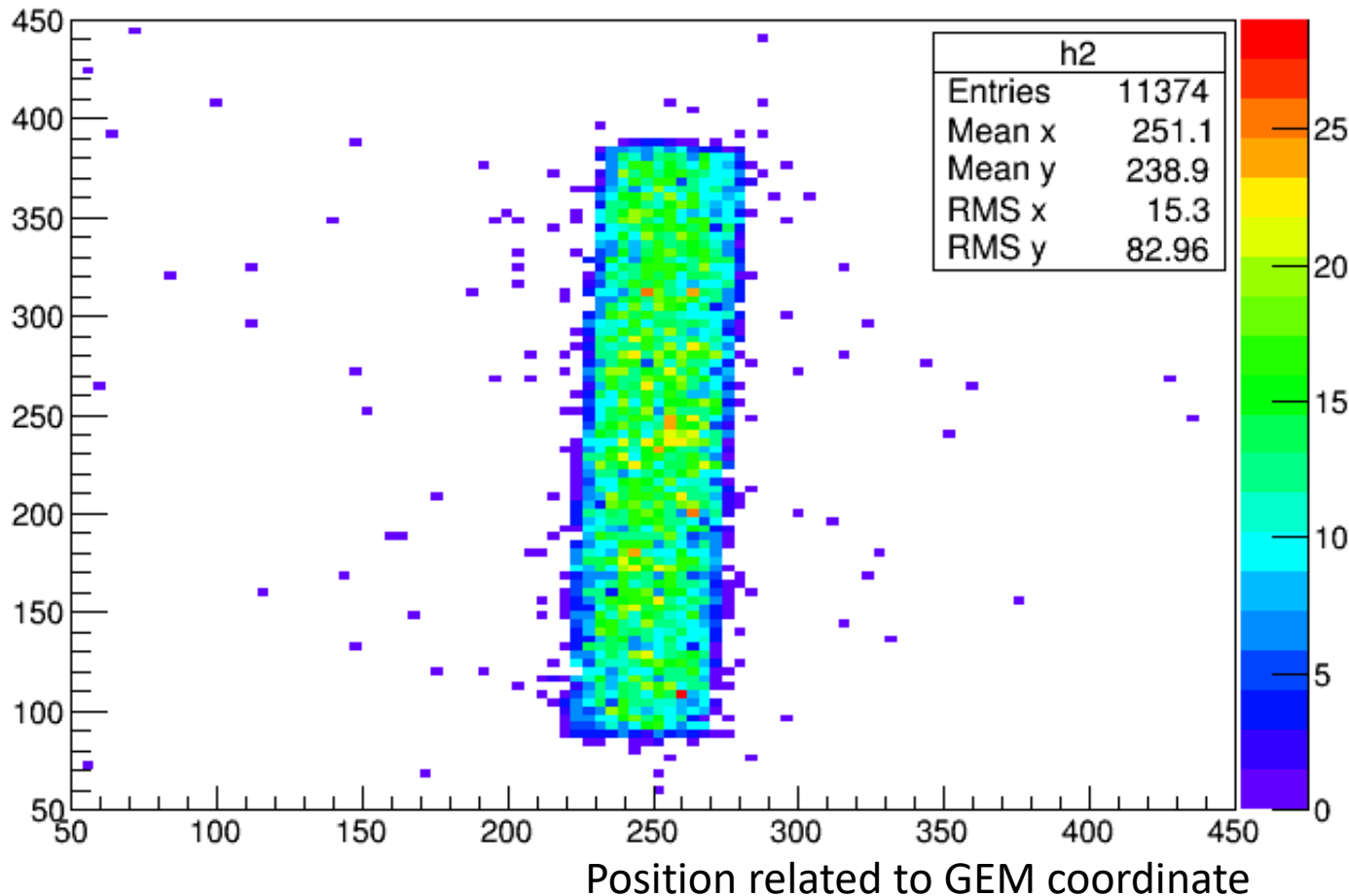


Readout by narrow side



Time resolution with tracking

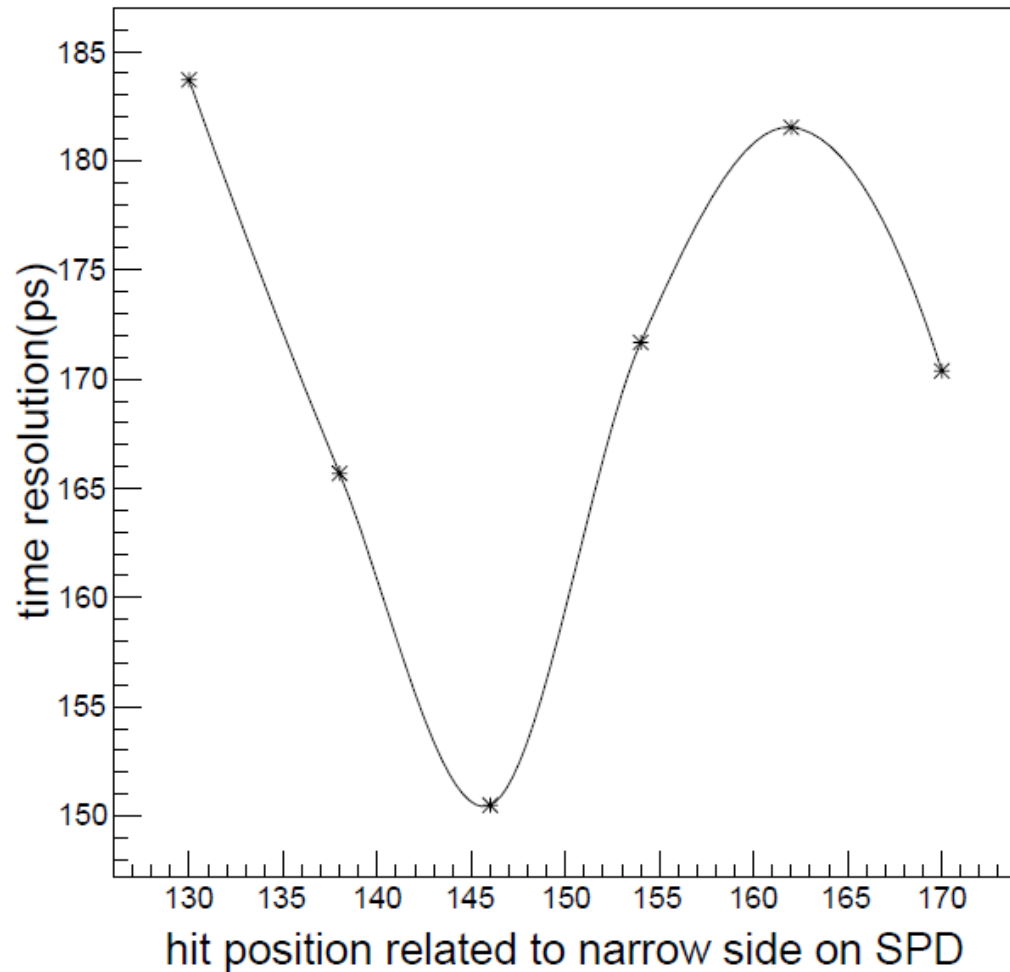
Hit position on SPD plain(Unit: mm)



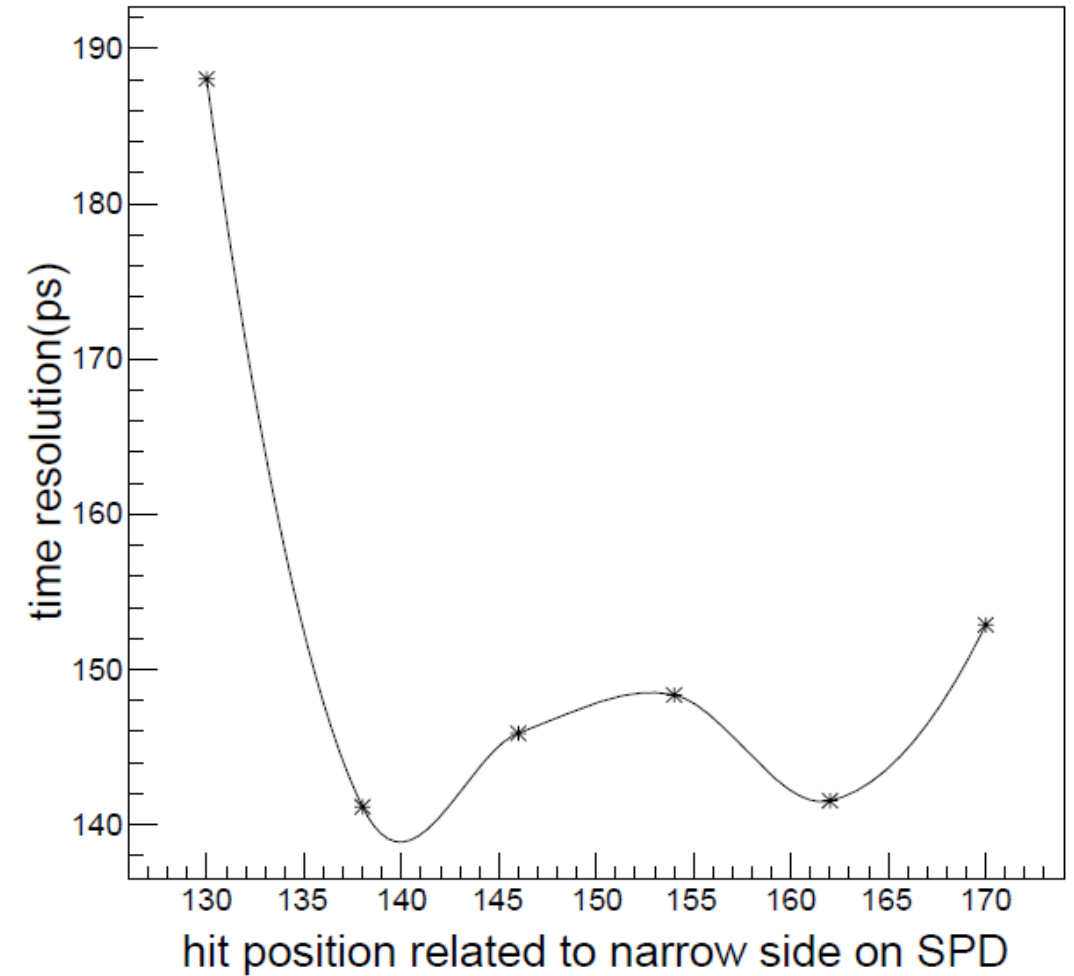
- Using three layers GEM (5 in total)
 - Single track efficiency: 25%(all three layers fired)
 - Get 65000 original events, after all cuts, only **2500** good events left
- Cut:
- ✓ SPD TDC cut
 - ✓ FADC cut
 - ✓ Single track cut

SPD time resolution result with tracking

time resolution readout by wide side



time resolution readout by narrow side



Conclusion

- GEM shows good tracking to help get more precious time resolution
- The time resolution of narrow side(near) is just a little better than wide side
- With tracking both sides could get about 150ps time resolution

Typical SPD time resolution distribution with position cut(low statistics)

