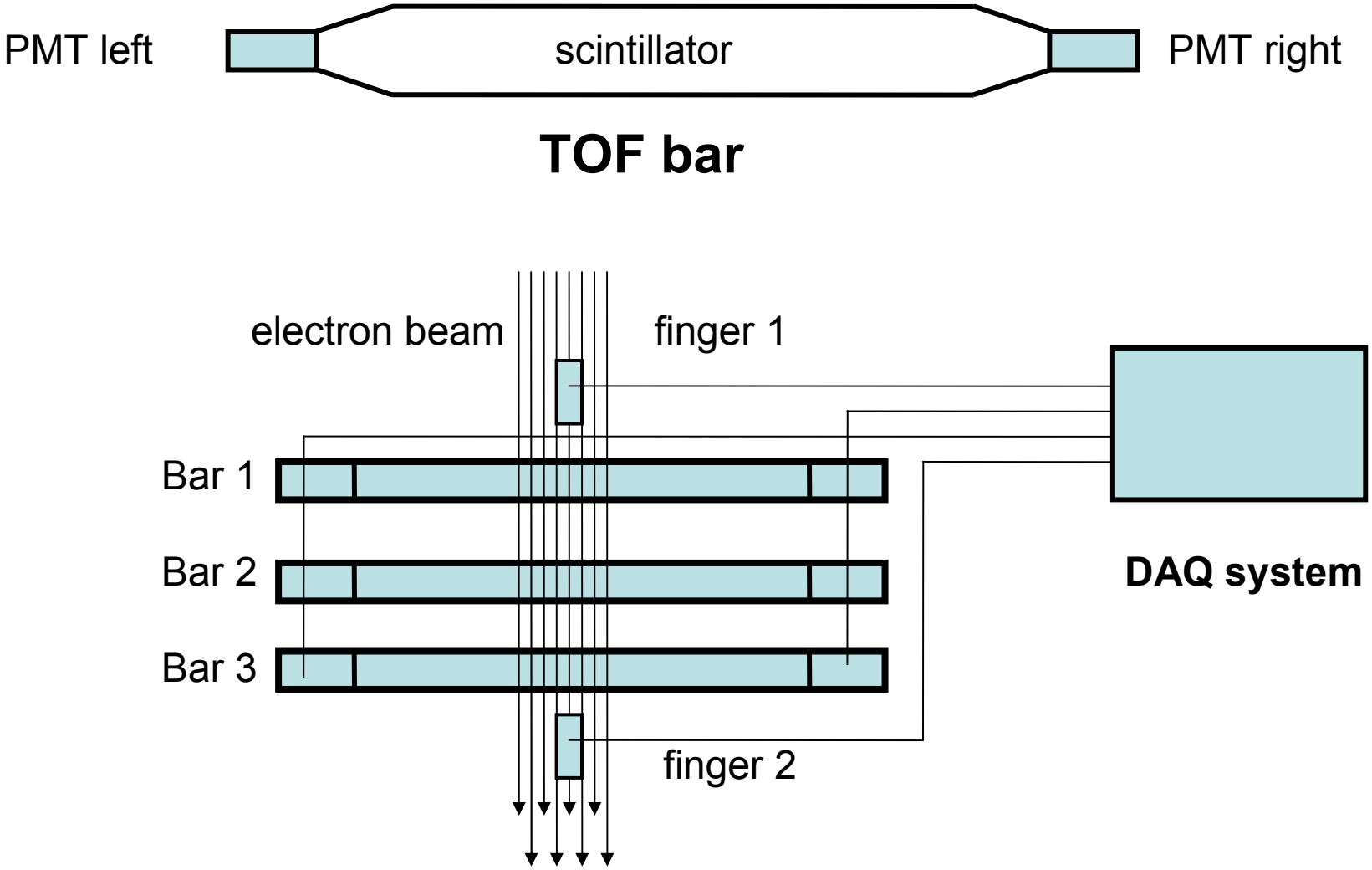
Analysis of test beam TOF data

Yordan Karadzhov

St.Kliment Ohridski University of Sofia

Layout of the TOF system in Frascati test



List of analyzed runs

Run	Energy	TDC	Splitter	Discriminator
124-133	350 MeV	V1290	Active	CAEN N417
141-149	300 MeV	V1290	Active	CAEN N417 & PLS 711
215-217	200 MeV	V1290 & V775	Passive	CAEN N417 & PLS 711
250-255	350 MeV	V1290 & V775	Passive	PLS 711
255-259	350 MeV	V775	Passive	CAEN N417
291-297	350 MeV	V1290	Passive	Ortec CF8000

Because of the poor statistics we have used chains of runs taken in same conditions (experimental setup) and same beam energies.

Measurement of intrinsic time resolution of the TOF bars

$$TOF_{bar2-bar1} = \frac{T^{bar2}_{left} + T^{bar2}_{right}}{2} - \frac{T^{bar1}_{left} + T^{bar1}_{right}}{2}$$

$Time_{bar2}$ $Time_{bar1}$

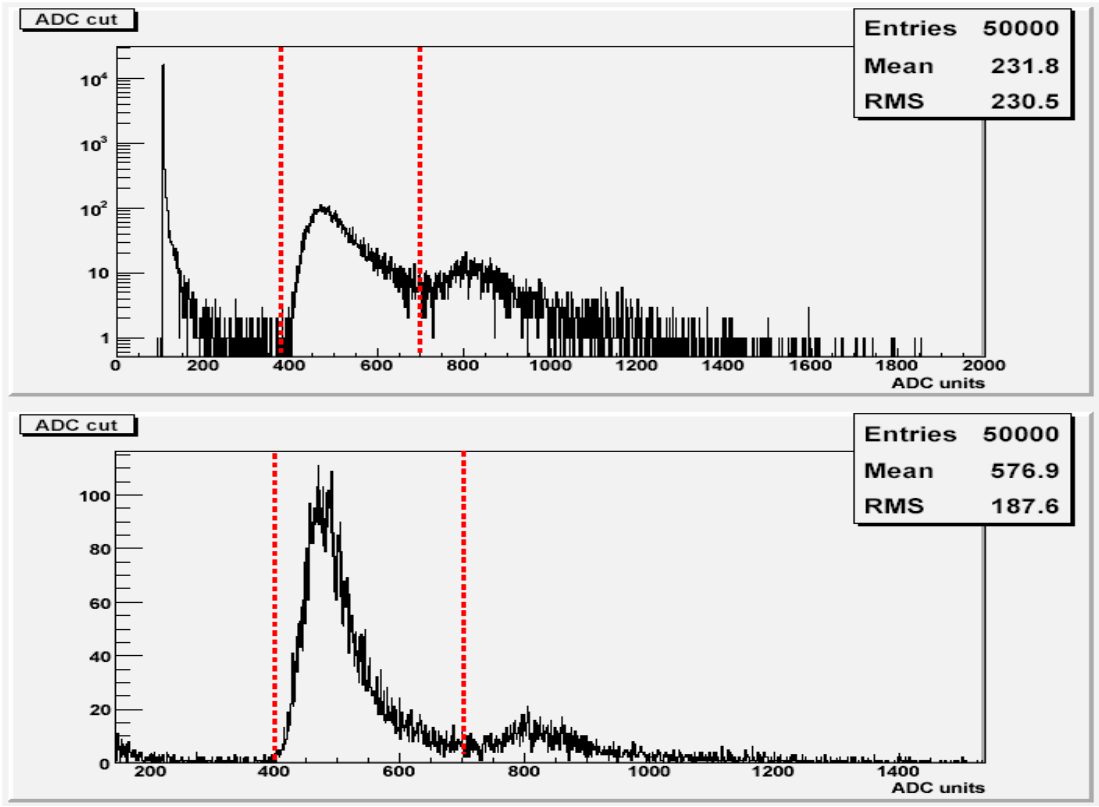
$$\sigma_{T\_bar_n} = \sigma\left(\frac{T_{left} - T_{right}}{2}\right)$$

The quantity (Tleft – Tright)/2 has the same variance as (Tleft + Tright)/2 but time jitter cancelled out, so the intrinsic time resolution of the bar could be evaluated more conveniently from its distribution.

General event selection cuts

1. Selection of single electron events

ADC pulse height distribution (left PMT of bar 1)

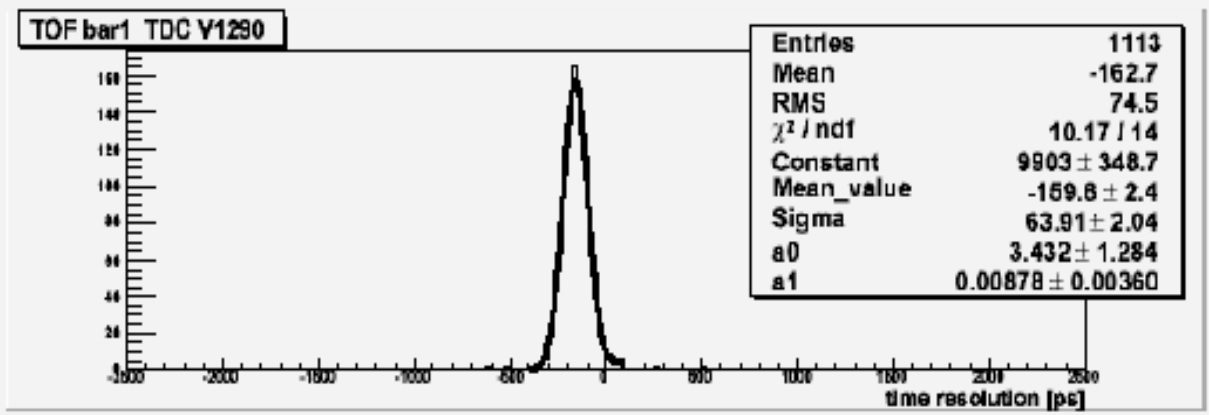


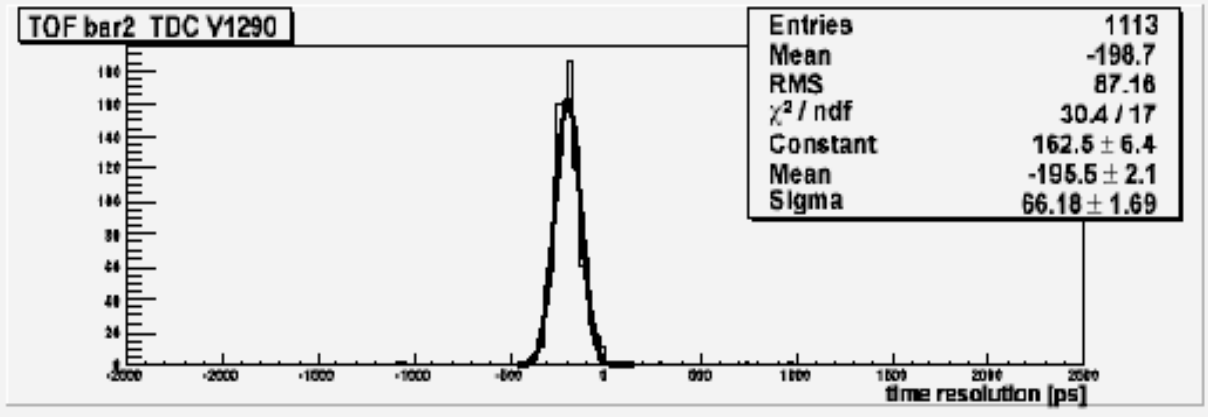
ADC spectrum in logarithmic scale

Part of the same spectrum in linear scale

2. Coincidence in both finger scintillators

Intrinsic time resolution of TOF bars
Distributions of $(T_{left} - T_{right})/2$

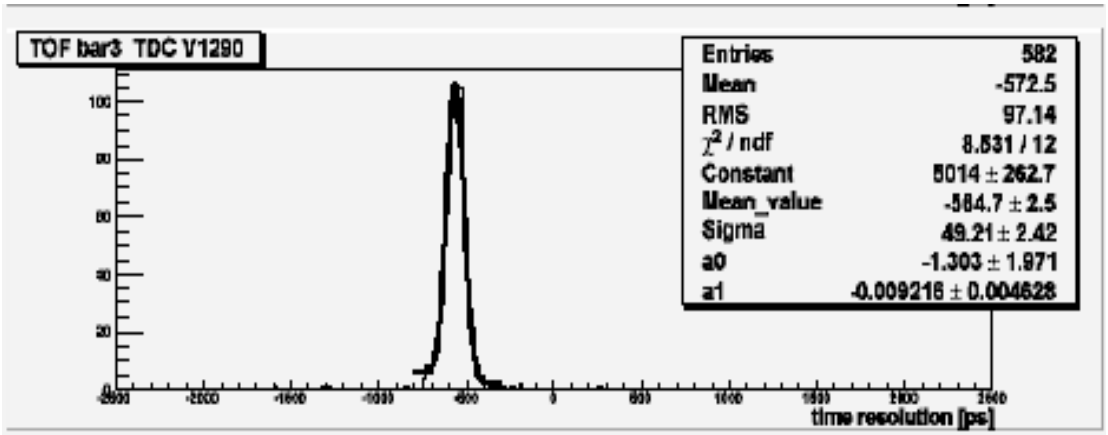


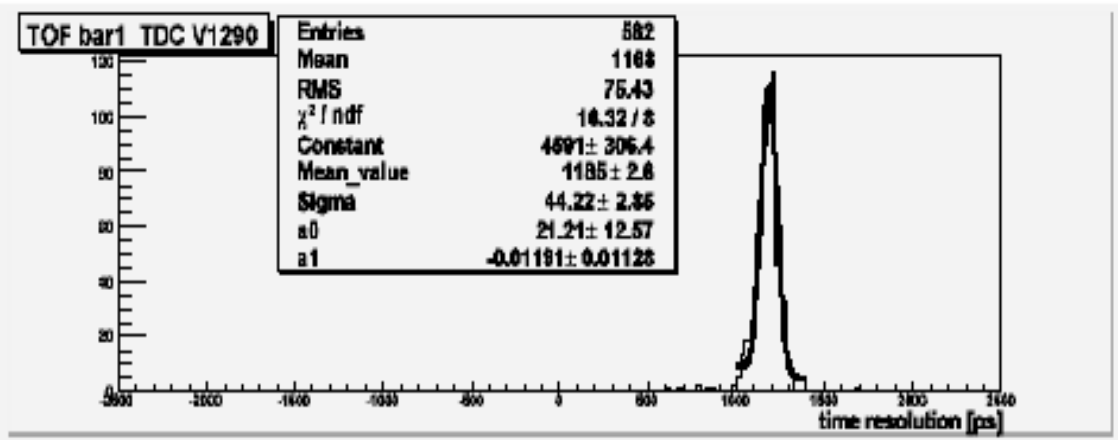


Bicorn BC420 - 4cm thick
impact point at 10cm from centre
Discr CAEN N417
Active splitter
σ = 63.9 ps

Bicron BC420 - 4cm thick
impact point at centre
Discr PLS 711
Active splitter
σ = 66.2 ps

Intrinsic time resolution of TOF bars
Distributions of $(T_{left} - T_{right})/2$





Bicron BC404 - 6cm thick
impact point at centre
Discr PLS 711
Passive splitter
σ = 49.21 ps

Bicron BC420 - 4cm thick
impact at centre
Discr CAEN N417
Passive splitter
σ = 44.22 ps

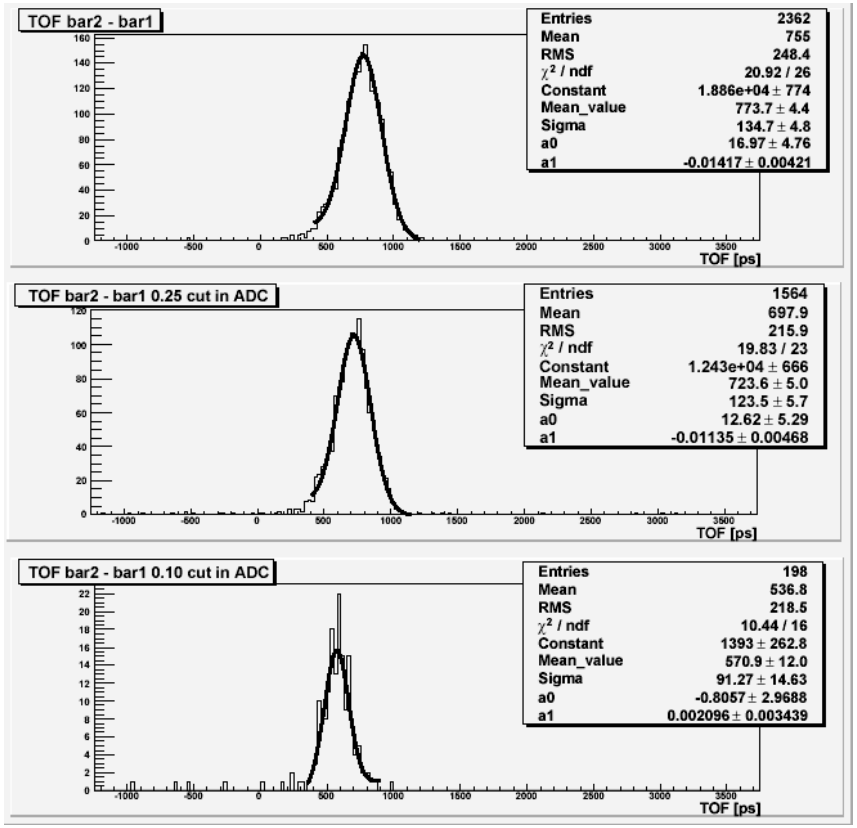
Time of Flight and Time-walk effect

- Because of leading edge discriminator has been used for the time measurements, the time-walk effect should occur.

- Time-walk should affect the measured TOF especially in cases when we have different total charge collected in the bars.

Time of Flight and Time-walk effect Run 124-133

The time-walk effect can be suppressed by imposing a constraint on difference of ADC pulse heights (signals with same pulse heights will have approximately same time-walk).



no constraint

σ = 134.7 ps

$$\frac{\left|ADC^{bar1}{}_{rightPMT} - ADC^{bar2}{}_{rightPMT}\right|}{ADC^{bar1}{}_{rightPMT}} < 0.25$$

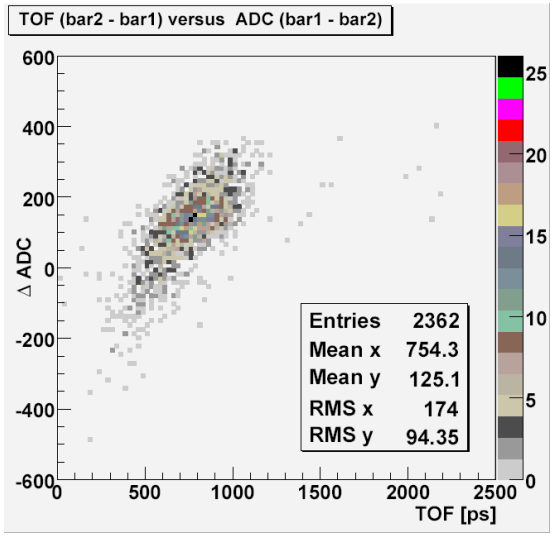
σ = 123.5 ps

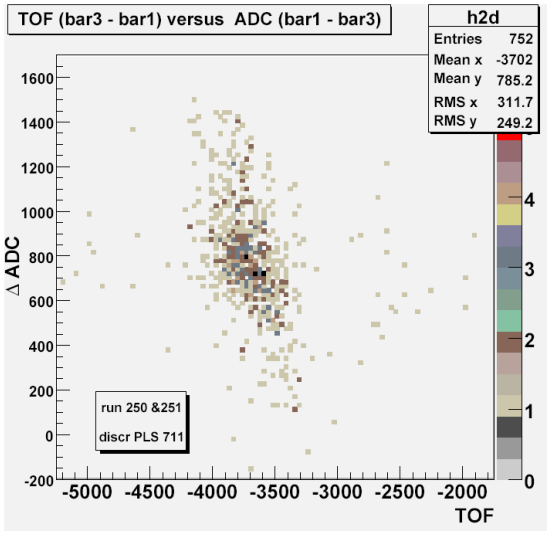
$$\frac{\left|ADC^{bar1}{}_{rightPMT} - ADC^{bar2}{}_{rightPMT}\right|}{ADC^{bar1}{}_{rightPMT}} < 0.10$$

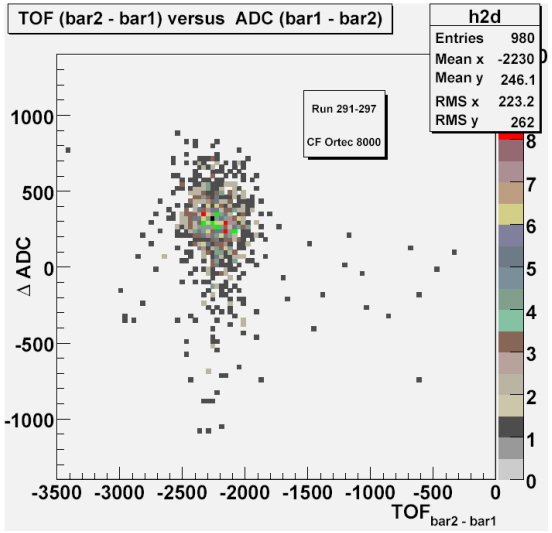
σ = 91.27 ps

Time Of Flight and Time-walk effect

Comparison between different discriminators



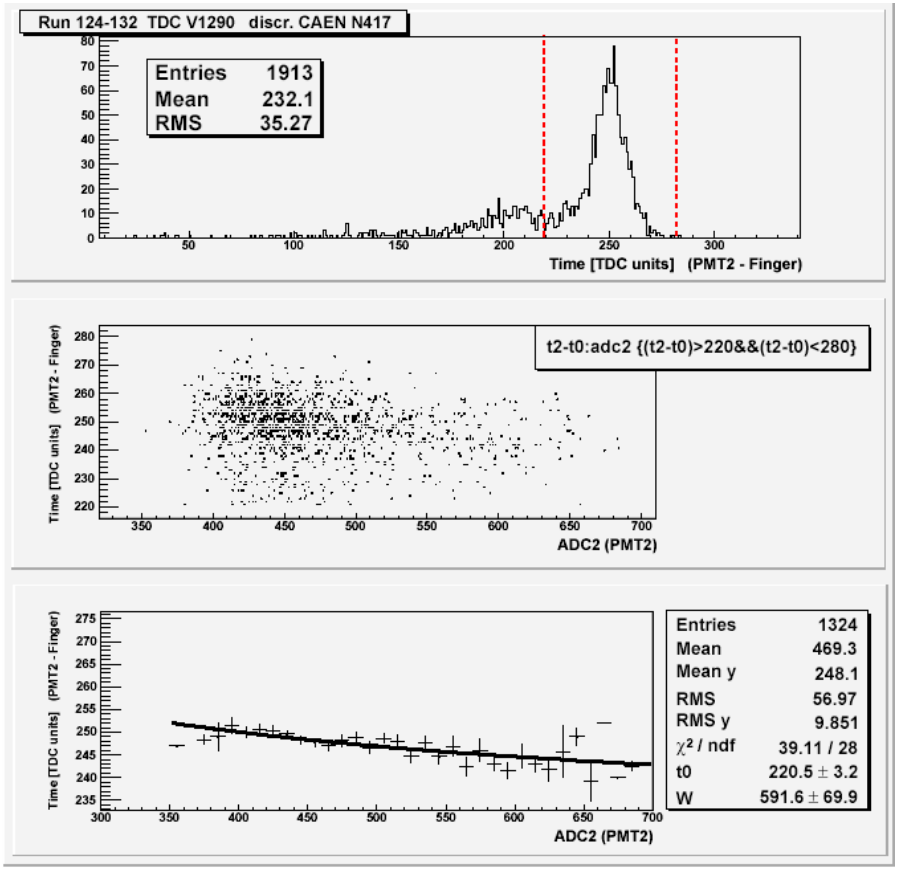




Discr CAEN N417 **Discr PLS 711** **Discr CF Ortec8000**

$$\Delta ADC = \frac{ADC^{bar_i}{}_{right} + ADC^{bar_i}{}_{left}}{2} - \frac{ADC^{bar_j}{}_{right} + ADC^{bar_j}{}_{left}}{2}$$

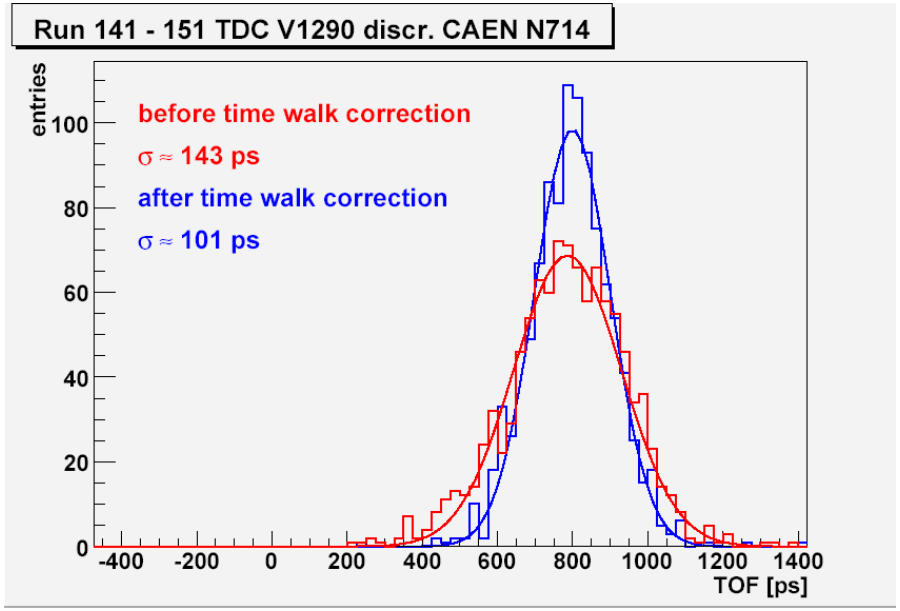
Time-walk corrections

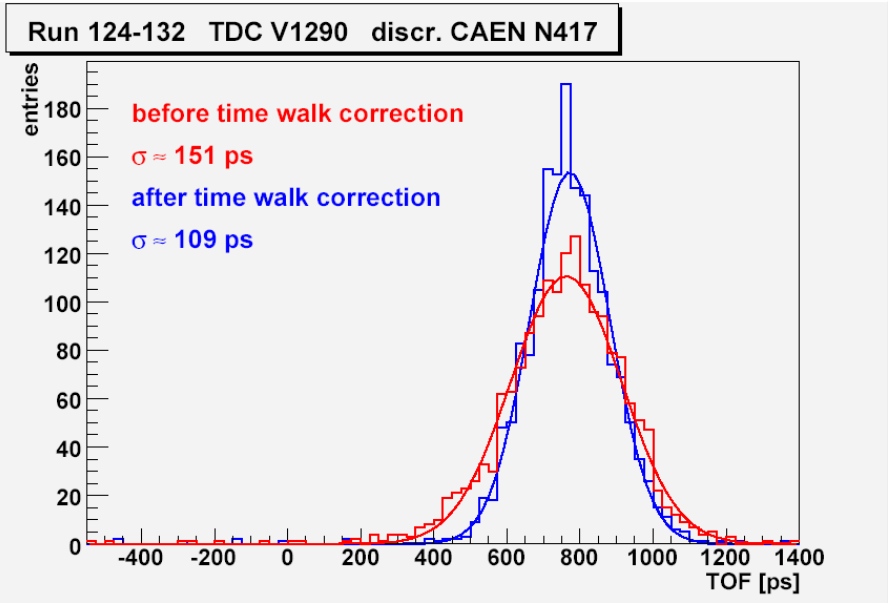


$$\delta t = W\left(\frac{1}{\sqrt{Q_0}} - \frac{1}{\sqrt{Q}}\right)$$

Time correction is parameterized as a function of collected charge Q . Q_0 is the reference charge and W is a free parameter.

Time-walk corrections

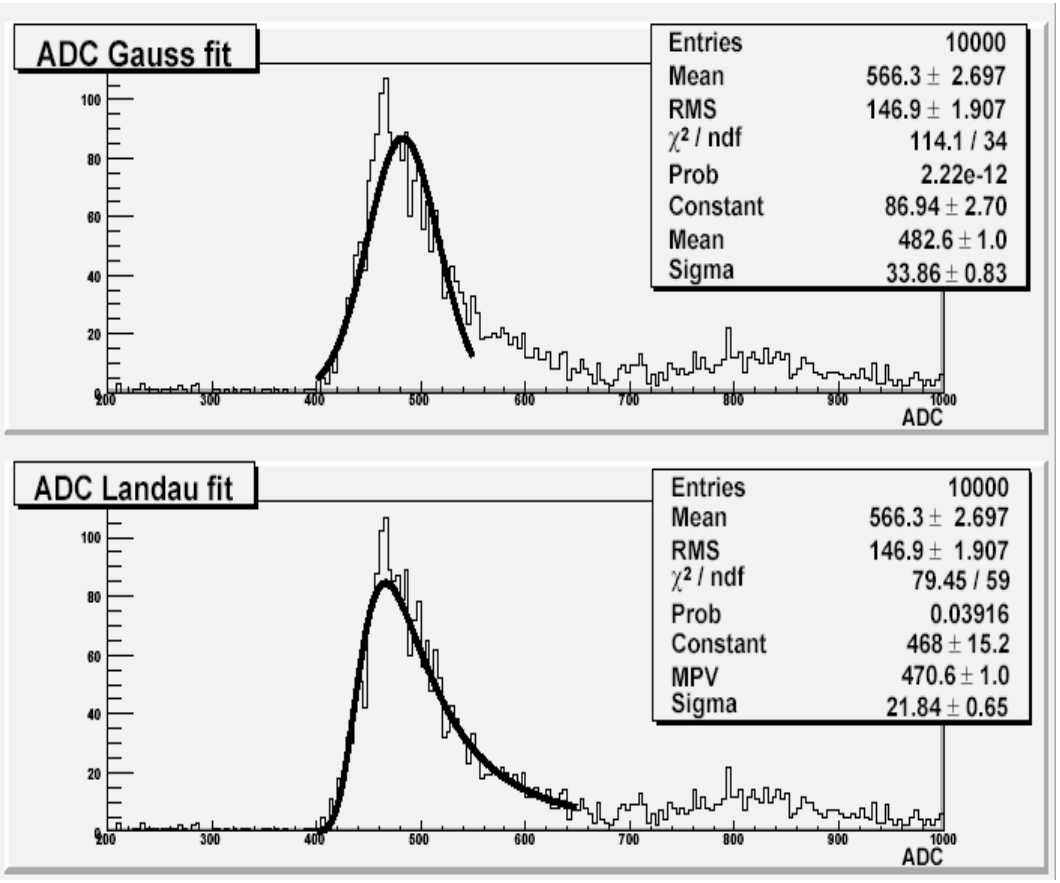




It is seen that time-walk correction reduces distribution widths by ~30% (~40 ps).

Number of photo-electrons

$$N_{pe} \approx \left(\frac{\langle ADCcounts \rangle}{\sigma_{ADC}} \right)^2$$



$$N_{pe} \approx 203$$

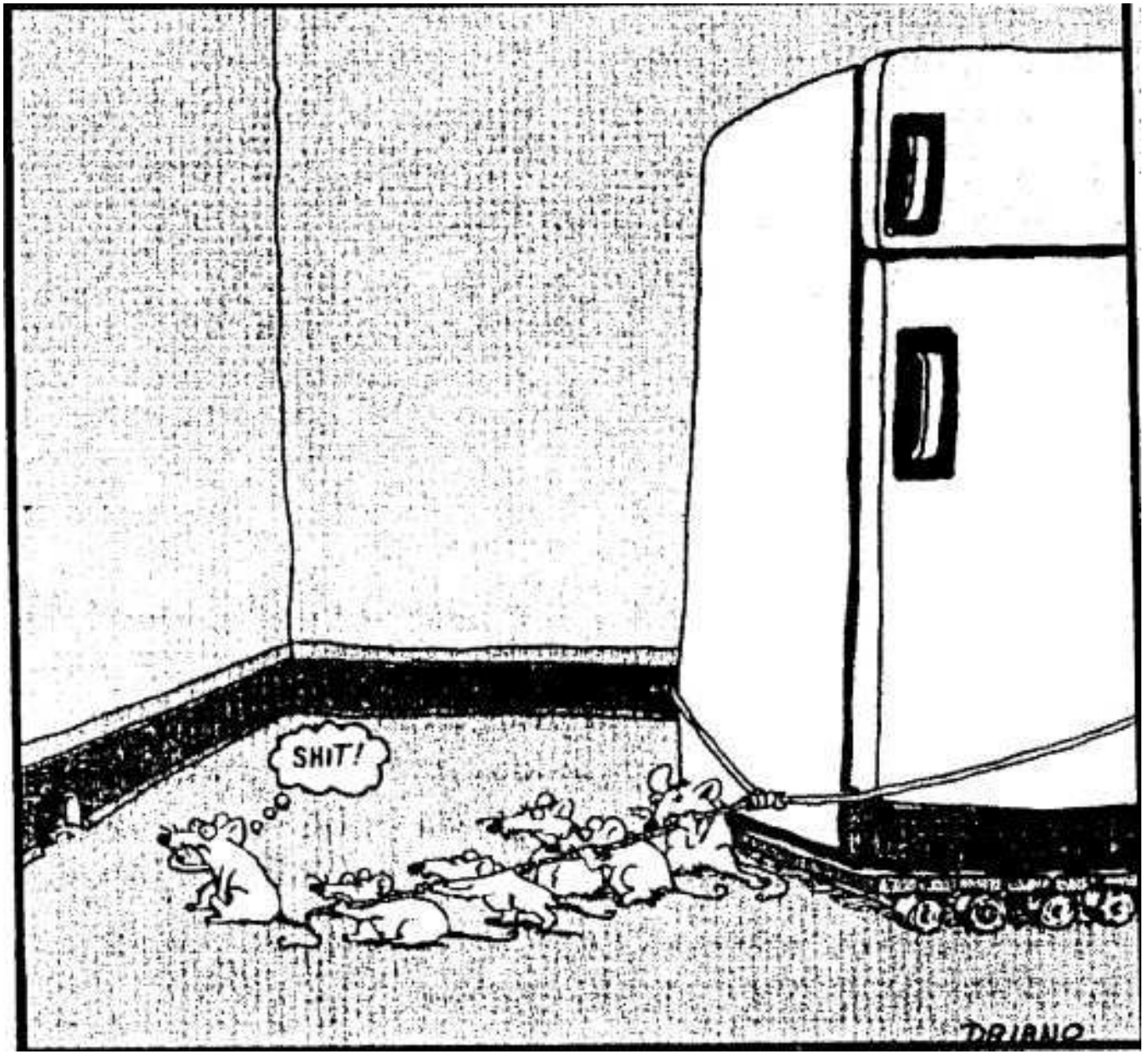
This result is impact by systematic effects like gain fluctuations and good(bad) scintillator-PMT coupling.

For all analyzed runs Npe is In the range 200 ÷ 300 and in agreement with GUIDEIT simulations

Conclusions

- Intrinsic resolution of the bars made of BC404 and BC420 is satisfactory and it is in the range ~ 45 ÷ 65 ps.
- Passive splitter gives better performance than active.
- The effect of time-walk is significant and should be corrected for.
- N_{pe}/*single electron* is in the range 200 ÷ 300 and this is in agreement with simulations.

MICE note "Study of the MICE TOF prototypes performance at the BTF test beam" is under preparation and will be available soon.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