10

Institute of Theoretical and Experimental Physics

FERMILAB
SEP 29 1999
LIBRARY

A. Akindinov, V. Golovin , A. Martemianov, V. Petrov,
V. Plotnikov, A. Smirnitski, K. Voloshin

ITEP-20-99

100 psec Time-of-Flight Resolution of Dielectric Resistive Plate Chamber

Fermilab Library
0 1160 0070493 4

Moscow 1999

UDK 539.1 M-16

100 PSEC TIME-OF-FLIGHT RESOLUTION OF DIELECTRIC RESISTIVE PLATE CHAMBER: Preprint ITEP 20-99/

A.Akindinov,V.Golovin,A.Martemianov,V.Petrov,V.Plotnikov, A.Smirnitski,K.Voloshin -M., 1999 - 8p.

For the first time the MIP time-of-flight, measured by means of DRPC, showed the resolution (sigma) at the level of 100 ps.

Detector prototype with four 0.3 mm gas gaps was constructed and studied in the slopes of time-of-flight methodics development programme for the ALICE experiment at CERN.

The obtained result has been reliably confirmed. DRPC timing characteristics have been investigated under different high voltages, electronics thresholds and particle fluxes.

The work results state that the time-of-flight resolution of gaseous detectors developed within the ALICE experiment has reached the level of the best known scintillator counters.

Впервые с помощью диэлектрически-резистивной плоско-параллельной камеры получено разрешение времени пролета минимально ионизующих частиц на уровне 100 псек.

Образец-прототип детектора, имеющий 4 газовых зазора по 0.3 мм, был разработан и испытывался в рамках программы развития времяпролетной системы эксперимента ALICE в ЦЕРНе.

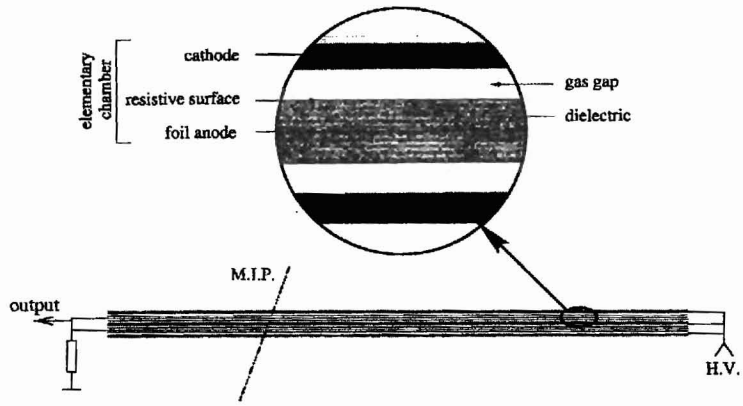
Полученный результат многократно подтвержден. Подробно исследована зависимость временного разрешения от приложенного высокого напряжения, порога чувствительности электроники и плотности потока ионизующего излучения.

Результатом измерений является вывод, что времяпролетное разрешение газоразрядных детекторов, развиваемых в рамках эксперимента ALICE, достигло уровня лучших сцинтилляционных счетчиков.

Fig. - 9, ref. - 2 name.

© Институт теоретической и экспериментальной физики, 1999

Fig. 1. DRPC construction.



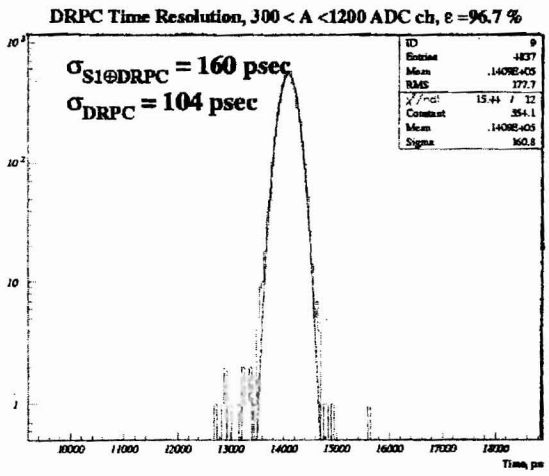
By the end of 1998 a revolutionary progress in breakdown suppression inside gaseous time-of-flight detectors was achieved, by introducing in different ways a resistivity inside the gas gap [1], [2]. Despite of this, there was a poor idea about the high timing resolution which might be in principle obtained with such detectors.

100 ps value looks as a natural limit in this sence. Basing on ALICE physical conditions, 100 ps resolution is sufficient for $\pi/K/p$ separation in a real momenta range. Methodically, 100 ps were achieved earlier only by means of modern scintillator counters and a unique Pestov counter. As an example, the timing system based on scintillators and photomultipliers, suggested for the STAR project at RHIC, provides the 100–120 ps resolution.

A detector, which timing characteristics are under investigation, is schematically shown on Fig. 1. Dielectric Resistive Plate Chamber (DRPC) consists of several ceramic plates (0.5 mm of ordinary unpolished ceramics), which form four gas gaps, each 0.3 mm wide. As was expected in advance, decreasing the gap width has rised the time resolution. The number of gaps (2 in previous version) was doubled to keep the MIP registration efficience close to 100%.

The chamber consists of two types of electrodes. Ceramic cathodes are metallised with aluminium. Dielectric-resistive electrodes are also made of ceramics metallised with aluminium on the one side and covered by evaporation with semi-conducting SiC on the other. The plates are assembled in pairs so that the metal layer, common for two gaps, is inside, and the semi-conducting layers are on gas sides. The idea of electrical connection between semi-conductor and metal is described in [1]. The detector has a square working surface 2×2 cm^2.

Fig. 2. DRPC time resolution.



Methodics used in time-of-flight resolution and registration efficiency measurements at ITEP and CERN accelerators slightly differs of that decribed in [1]. The same specially designed front-end electronics and the same gas mixture 85% $C_2H_2F_4$ + 5% isobutane + 10% SF_6 were used. The start part of the setup, based on scintillator counters, was modified, which allowed to analize information from several detectors.

The counting rate, or particle flux over the working surface, is an important parameter of the described detector type. During the measurements it was fixed at the level of 1 kHz s^{-1} cm^{-2}, which is higher than in ALICE conditions (100–200 Hz s^{-1} cm^{-2}). Special measurements with changing rate were performed to study its influence on the resolution.

The typical time-of-flight distribution summarised over the whole range of amplitudes with the total registration efficincy close to 95% is shown on Fig. 2. One can see that the standard deviation is really on the level of 100 ps, and the distribution has very unsignificant *tails*. Fig. 3 represents the same data in more details: time resolution is shown for different amplitudes in the whole range. The dependence is very slight and can be hardly seen, the resolution is close to 100 ps at all the

Fig. 3. DRPC time resolution at different signal amplitudes.

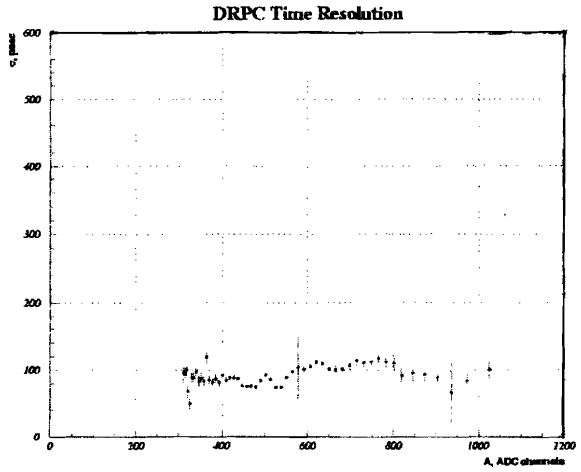
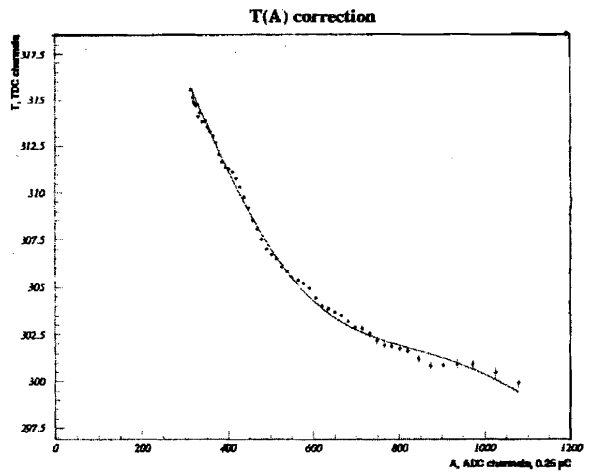


Fig. 4. Amplitude correction.



amplitudes, thus explaining the *tails* absence at Fig. 2.

Actually Fig. 2 shows the result of the amplitude correction. Such a correction influences the timing distribution in a strong way, the correction quality may be checked on Fig. 4.

The amplutude spectrum from the amplifier output is shown on Fig. 5. More specifically, it shows the charge integrated by charge-sencitive ADC. Although the front-end electronics is not linear in the whole range of amplitudes, it may be clearly seen that the amplitude spectrum shape has a pick, staying far from the pedestal bounder, on a slightly changing background. Such amplitudes correspond to gas amplification of 10^7 and allow to obtain excellent registration efficiency at different high voltages and high electronics thresholds. The efficiency dependence over the high voltage and the threshold is shown on Fig. 6. Even at 100 mV threshold there is a clear efficiency plateau, close to 100%.

The fact that the time-of-flight resolution does not depend on the high voltage and the threshold is illustrated on Fig. 7.

All the described data was obtained at a fixed rate. A special experiment was performed to study the rate influence. Fig. !!!8!!! shows the dependence of the

Fig. 5. DRPC registration efficiency.

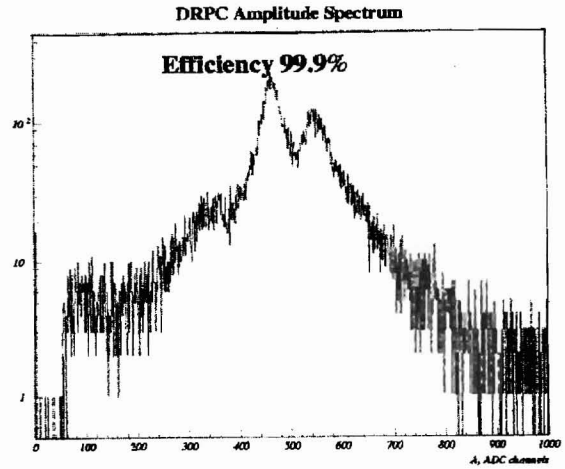


Fig. 6. DRPC registration efficiency vs high voltage at different thresholds.

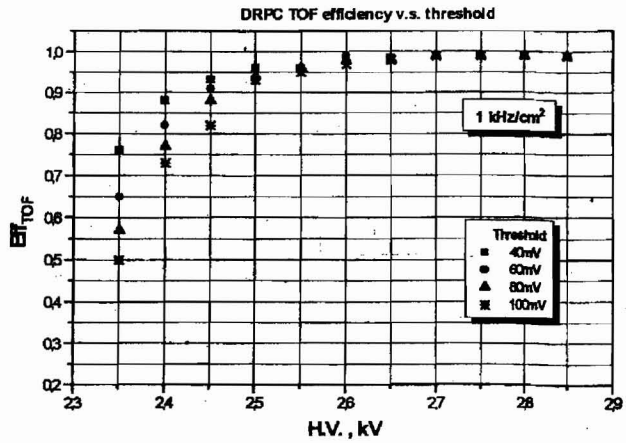
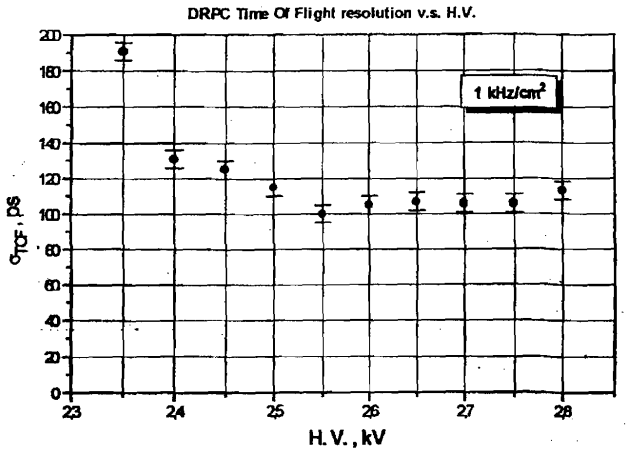


Fig. 7. DRPC time-of-flight resolution at different high voltages and thresholds.



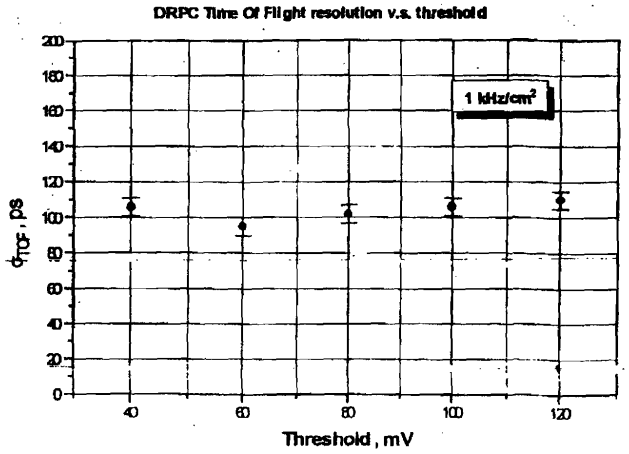


Fig. 8. Counting rate dependance of the DRPC time-of-flight resolution.

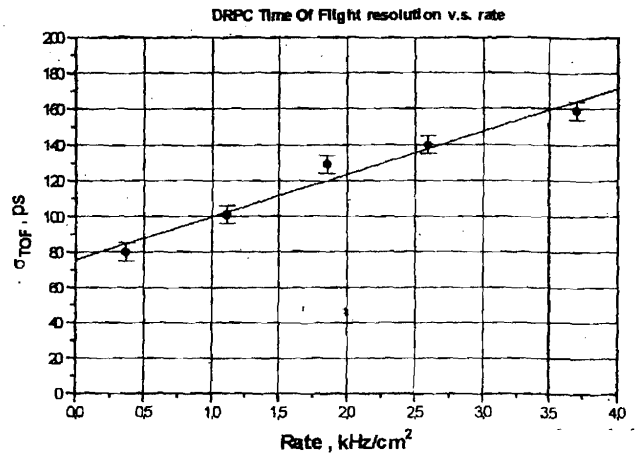
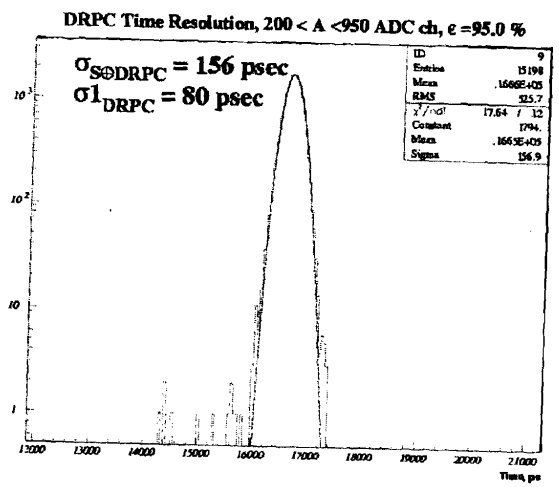


Fig. 9. DRPC time resolution at low particle fluxes.



resolution over the particle flux at 40 mV threshold. The resolution increases with the load to 150 ps. But at ALICE conditions (the very beginning of the scale) it may be expected to equal to 80 ps. Fig. 9 shows the low load resolution in detail. The distribution is still very clear with the *tails* admixture on less than 10^{-3} level.

References

[1] *A. Akindinov et al.* Preprint ITEP 45-98.

[2] *P. Fonte, A. Smirnitski and C. Williams* Preprint CERN EP-99-068.

А.Акиндинов, В.Головин и др.

100-пикосекундное разрешение при измерении времени пролета диэлектрически-резистивной плоско-параллельной камерой.

Подписано к печати 21.06.99 Формат 60x90 1/16
Усл.-печ.л.0,5 Уч.-изд.л.0,3. Тираж 221 экз. Заказ 20.
Индекс 3649

Отпечатано в ИТЭФ, 117259, Москва, Б.Черемушкинская, 25