Task 3 :
Ultrafast timing with plastic scintillators for ToF applications

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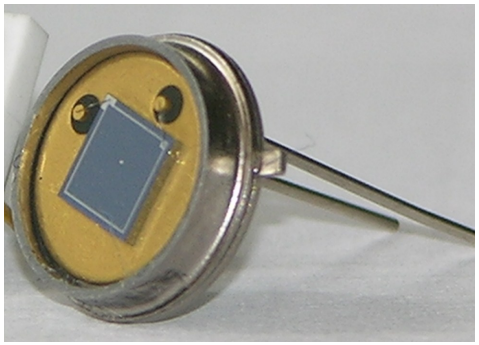
The possibility of application Scint-MAPD detectors for high resolution TOF systems (CBM, PANDA, …) has been studied.

Scntillator detectors with "blue" scintillators (20x20x20mm^3) directly coupled to Zecotek MAPDs (3 x 3 mm^2) have been used.

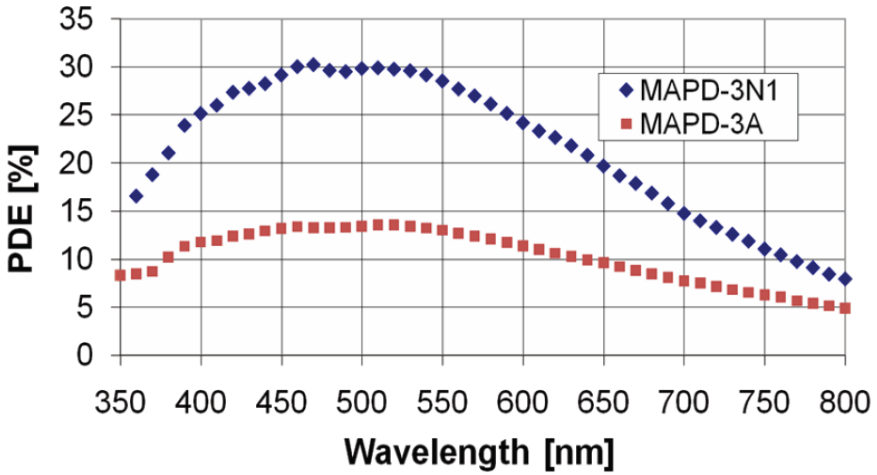
Time resolution for such type of detectors has been measured at GSI (FOPI) beam and on test beam line T10 at CERN during 2009 -2011.
Results of measurement have been presented.

Some properties of Zecotek MAPDs



Fast progress in MAPDs development:

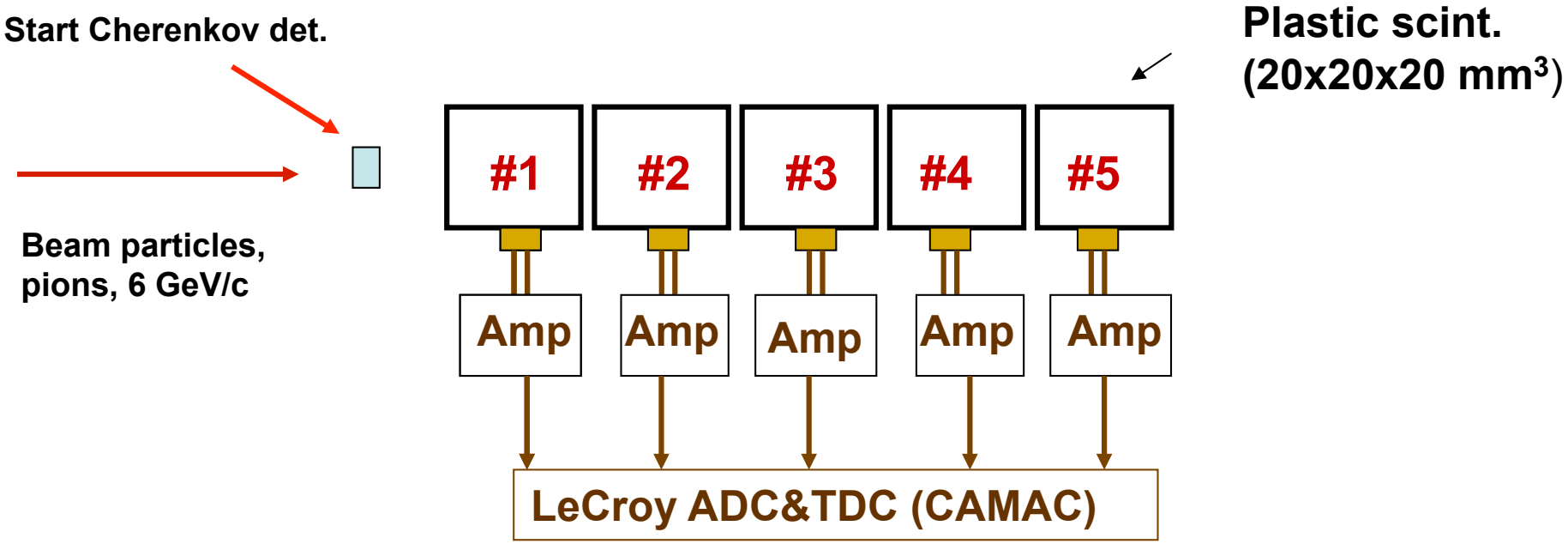
2006-2007 MAPD-3w (Micron, Russia)
2008 MAPD-3A (Zecotek)
2009 MAPD-3N (Zecotek)



- Active area: 3x3 mm^2
- Number of pixel: 15000/mm^2 (40000/mm^2)
- Gain ~ 10^5
- Voltage ~ 90 V
- Dark current < 50 nA
- PDE ~ 30% for blue-green light
- Single electron noise ~ 0.3 MHz/mm^2
- Rise Time ~ 4 ns

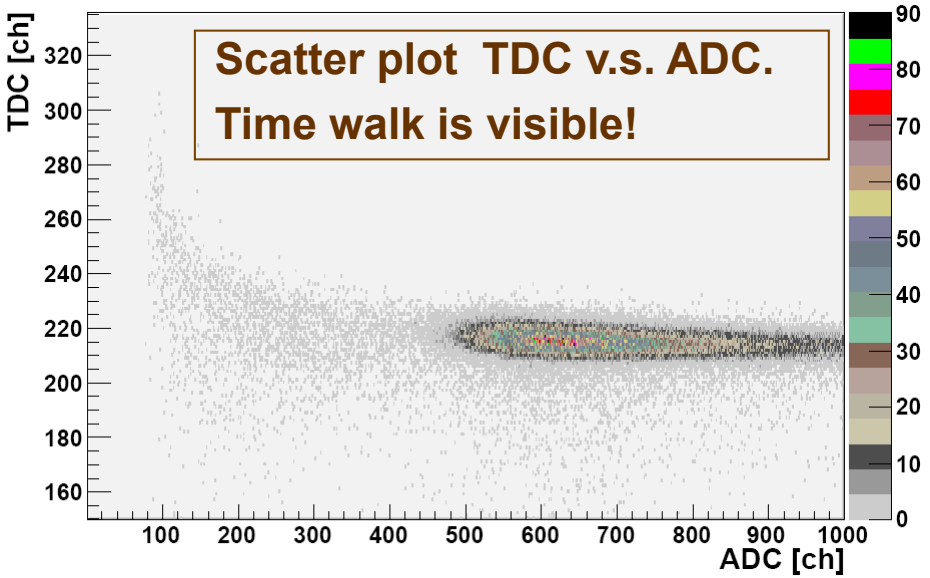
High PDE values (~25-30%) for blue light and relatively short rise time of ~4 ns make very attractive the use of these MAPDs for granulated TOF systems like CBM TOF-wall.

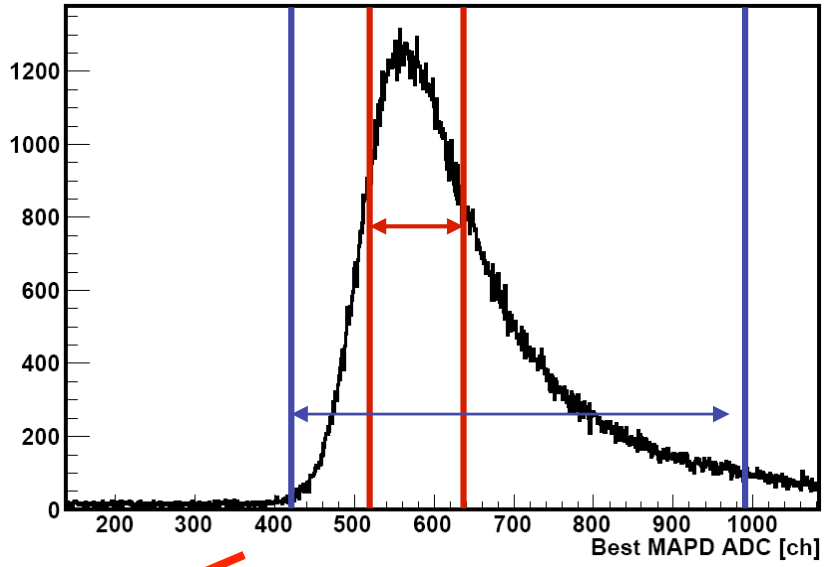
T10 beam test setup at CERN

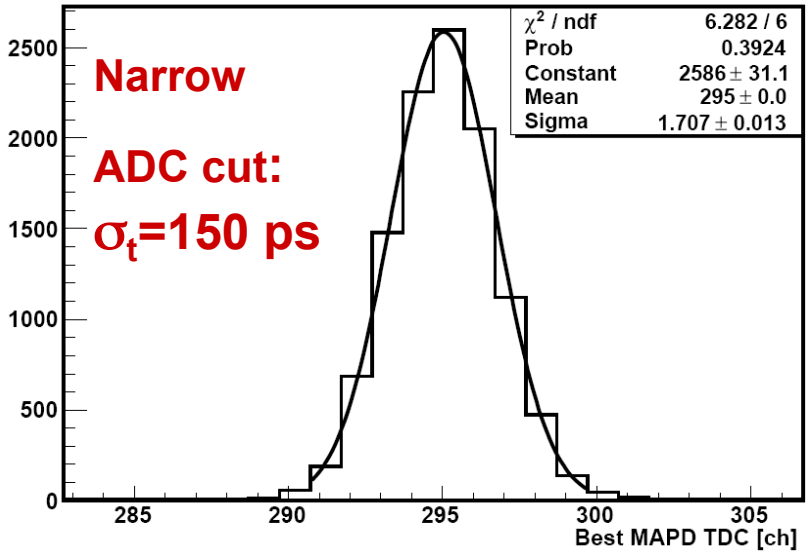


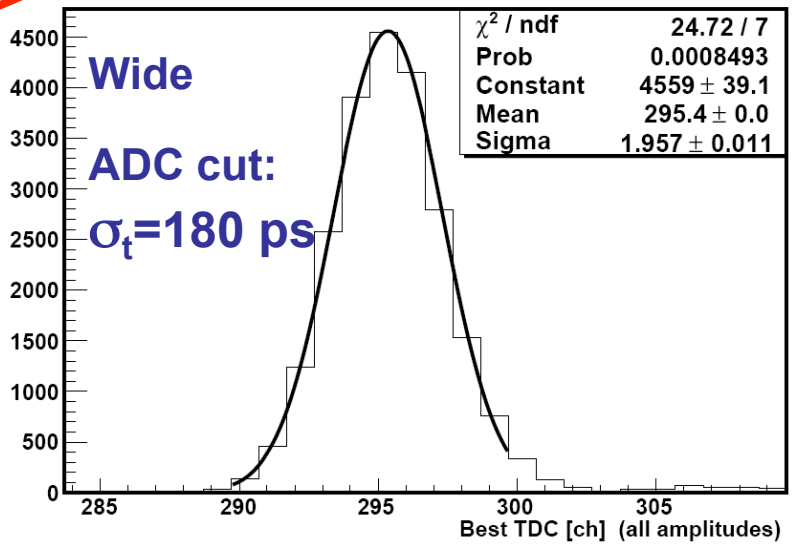
- Start detector with quartz radiator has time resolution st~30 ps;
- Five Scint+MAPD individual counters are tested;
- Amplifier with input impedance 4 Ohm and G~150 is used;

Time resolution for detector #4



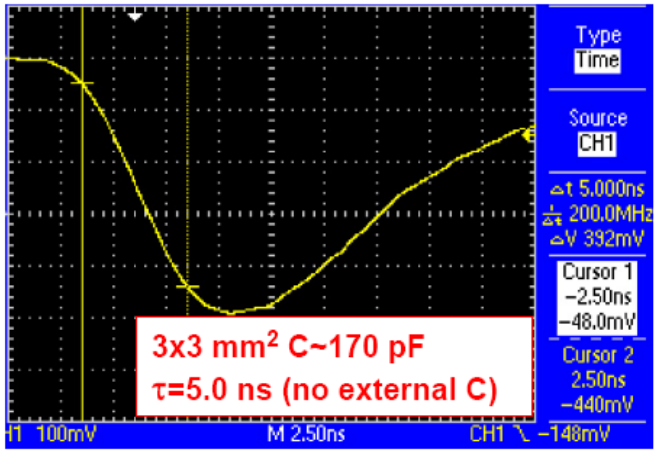






A few comments to TOF measurements:

- The amplifier with low input impedance (<10 Ohm), gain~150 and bandwidth~300 MHz was used.
- Measurements were done with Leading Edge Discriminator (CAEN, mod.84).
- The discriminator threshold was set to 30 mV.
- The signal amplitude from Scintillator+MAPD counter is one order higher.
- Rise time of MAPD-3N is about 5nsec.



How to improve TOF resolution?

Use MAPDs with

- shorter rise time (now it is ~4 ns)
- higher PDE value (now it is ~25% for blue light)

It is expected to have from Zecotek such improved MAPDs in October 2011.

- Use of a few MAPDs per one scintillator

- New approaches in the signal processing

Study of new approach in time measurement

Use of new CAEN electronics-
DT5742 12 bit 5 GS/s Switched Capacitor ADC based on DRS4 chip
(Paul Scherrer Institute design) to digitize the shape of signal.

At present, we have test run at T10 beam line at CERN (26 September -10 October 2011).

One of the goal of ongoing test run is to compare MAPD time resolution with standard electronics using leading edge discriminator with one using Switched Capacitor ADC.

First test results will appear soon.