Prototype tests for the ALICE TRD

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A proposal to add a Transition Radiation Detector (TRD) [1] to the ALICE experiment [2] was approved by the LHCC in May 1999. Increasing the pion rejection power by a factor of 100, the TRD will allow to study many aspects of dielectron physics, among them the production of quarkonia like J/Ψ, Ψ' and the members of the Υ family, as well as the production of open charm and beauty [1].

The ALICE TRD (see ref. [3] for a review on TRDs) will be the first such detector covering the interaction zone in full azimuth. As any TRD, it will be composed of a radiator (foils or fibres, not yet established) and a detector, which in our case is a Time Expansion Chamber (TEC). It has a 3 cm drift zone and an amplification zone of 6 mm, the readout being done on a chevron pad plane (chevron width - 10 mm, anode wire pitch - 5 mm). Each pad needs a preamplifier (PA) whose output is fed into a Flash-ADC (FADC), sampling with a frequency of around 25 MHz a drift time of up to 2 μs. With a pad size of 4.5 cm^2 and six layers, the total number of channels will be up to 1.2 million, depending on the final geometrical configuration. The detection gas of TEC will be a Xe-based mixture to allow an efficient absorption of the TR photons with typical energies between 4 and 30 keV.

A prototype of a TEC has been built at GSI and has been tested with Ar-based gas mixtures, using Fe source of 5.9 keV and cosmic rays. A FADC system with 100 MHz sampling is used, integrated in a VME-based data acquisition system.

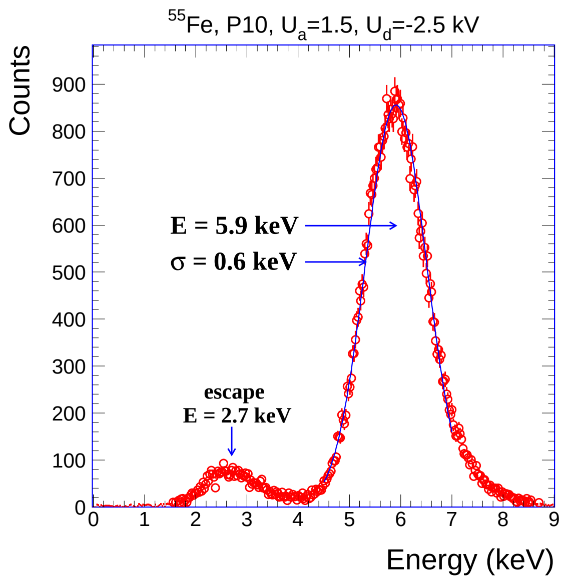

Figure 1: Fe source spectrum in TEC, using P10 gas.

Fig. 1 presents a spectrum of Fe source obtained by integrating the FADC pulse on three adjacent pads to account for the charge sharing. The resolution at the main peak of 5.9 keV is around 10%, obtained from a gaussian fit which is also plotted in Fig. 1.

Our simulations showed that the electron identification is significantly improved by using, along with the pulse height, the drift time information [1]. The need for FADCs is determined as well by the necessary tracking capabilities in conjunction with the trigger option for electrons with momenta greater than 3 GeV/c [1]. Fig. 2 presents an example of drift time distribution of the pulse height on two adjacent pads, obtained in a cosmic-ray event. The origin is arbitrarily shifted at ~0.4 μs and the total drift time is in this case ~1.2 μs. One can recognize the individual clusters at the same drift time on each pad, a result of the charge sharing on the chevron pads. By studying the arrival time distribution of the clusters we established the role of the electron attachment for different quencher types and oxygen content of the gas. A 10% reduction of the average pulse height was observed at 500 ppm O_2 when using CH_4 as quencher and at 20 ppm for the Ar-CO_2 mixture.

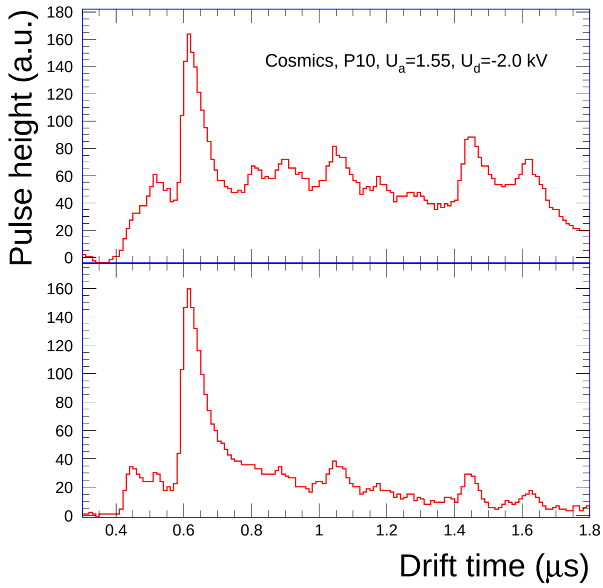

Figure 2: A cosmic-ray event on two adjacent TEC pads.

Tests with secondary beams from the GSI pion beam facility will be conducted to determine in detail the position resolution of the TEC and its pion rejection capability for Xe-based gas mixtures. These tests will also be used to decide on the radiator design and to evaluate current options for the readout electronics.

References

[1] TRD Proposal, CERN/LHCC 99-13, available at: *http://www-aix.gsi.de/~alice/proposal.ps.gz*

[2] ALICE Proposal, CERN/LHCC 95-71

[3] B. Dolgoshein, Nucl. Instr. and Meth. in Phys. Res. A **326**, 434 (1993)