Prototype tests for the ALICE TRD

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The ALICE Transition Radiation Detector (TRD) has been designed to improve the pion rejection capability of the ALICE detector by at least a factor of 100 for momenta above 2 GeV/c [1]. To demonstrate that this goal is achievable, during the last year we have conducted prototype tests at the pion (with natural electron content) beam facility at GSI Darmstadt. A complete description of the experimental setup and of the results (including references) can be found in [2]. Many types of radiators were tested, composed of foils, fibres and foams.Here we summarize the results concerning the pion rejection performance in case of a fibres (of 17 μm diameter) radiator, which was established to be the best candidate for the final radiator.

The measured distributions of energy deposit over the depth of a drift chamber have been employed as probability distributions in simulations aimed at determining the pion rejection factor for the proposed configuration of the ALICE TRD with 6 layers. To extract the pion rejection factor we have studied three different methods: i) truncated mean of integrated energy deposit, TMQ; ii) likelihood on integrated energy deposit, L-Q; iii) bidimensional likelihood on energy deposit and position of the largest cluster found in the drift region of the DC, L-QX. Cuts of certain electron efficiency were involved on the likelihood distributions and the pion efficiency is derived within these cuts.

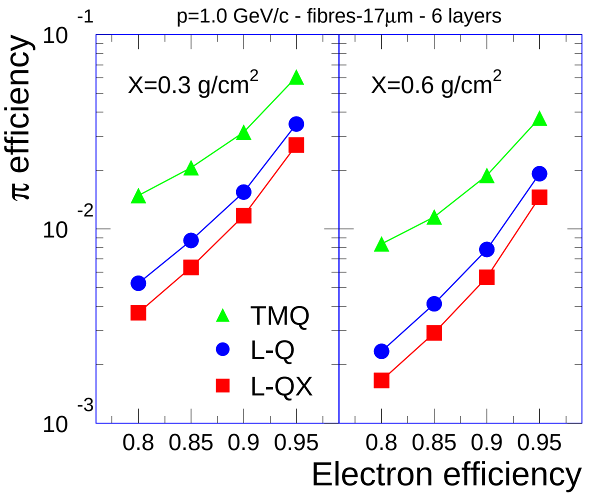

Figure 1: The pion efficiency as function of electron efficiency using the three methods discussed in the text.

In Fig. 1 we present the pion efficiency (the inverse of the rejection factor) as function of electron efficiency (90% electron efficiency is the commonly used value) in case of fibres radiators for the momentum of 1 GeV/c. The three methods introduced above are compared. The truncated mean method, although it delivers sizeably worse identification, has the advantage of being very easy to use, being advantageous especially for an on-line identification. The bidimensional likelihood delivers the best rejection factor. In general, the three methods employed here give results in good agreement with earlier studies.

By doubling the equivalent thickness of the radiator from X=0.3 g/cm^2 (left panel of Fig. 1) to X=0.6 g/cm^2 (right panel) one gains a factor of about 2 in pion rejection power. However, it remains to be seen how the additional material will influence (by producing secondary particles) the performance of the TRD itself and of other ALICE sub-detectors.

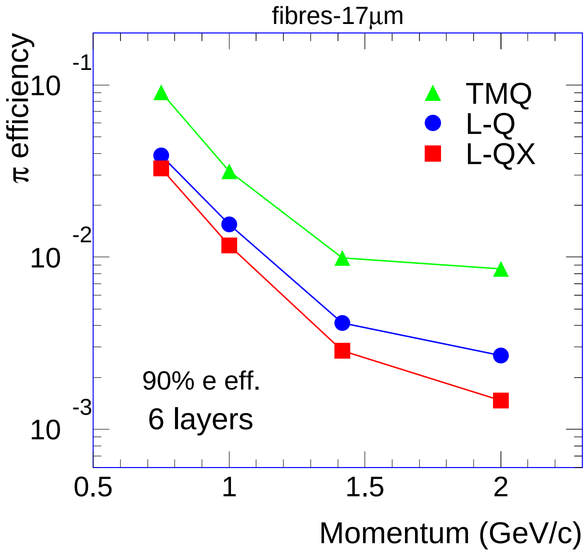

Figure 2: Pion efficiency as function of momentum for a radiator with 17 μm fibres.

The pion efficiency at 90% electron efficiency as function of momentum is shown in Fig. 2. The steep decrease of pion efficiency at momenta around 1 GeV/c is due to the onset of TR production. Towards our highest momentum value, 2 GeV/c, the pion efficiency reaches a saturation, determined by the TR yield saturation and by the pion relativistic rise. Due to these effects the pion rejection is expected to get slightly worse for momenta above 3 GeV/c. As one can see in Fig. 2, at the momentum of 2 GeV/c the pion rejection factor of 300 to 600 achieved during these tests is above the required value for the ALICE TRD. However, one has to bear in mind that a significant worsening of TRD performance has been registered when going from prototype tests to real detectors. This can be the effect of detector loads in a multiparticle environment. On the other hand, impressive pion rejection factors of 1000 and above have been achieved in full size TRDs, i.e. by the HERMES experiment.

References

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

[2] A. Andronic et al., nucl-ex/0102017 (accepted to IEEE Trans. Nucl. Sc.)