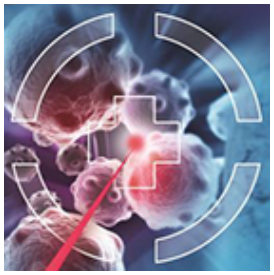

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PADC nuclear track detector for ion spectroscopy in laser-plasma acceleration

The transparent polymer polyallyl-diglycol-carbonate (PADC), also known as CR-39, is widely used for ion detection in laser-plasma interactions. It allows for detection of single protons and ions via formation of microscopic tracks after etching in NaOH or KOH solutions. PADC combines a high sensitivity and high specificity with inertness towards electromagnetic noise.

We have developed techniques for the identification of different ion species and for the determination of particle energies based on the track characteristics. At the 3 MV tandem accelerator of CNA (Seville) about 300 CR-39 calibration samples have been irradiated with monoenergetic proton and carbon ion beams. These allow for systematic studies of the corresponding track diameters over a wide range of incident energies. Different etching conditions, especially concerning the temperature and etching time, have been tested to find an optimum procedure for particle identification. We have observed significant differences in the response of two types of PADC plastics.

Specific hardware and software have been developed and tested to meet the requirements on track analysis for spectroscopic purposes. Ideally, the entire surface of the CR-39 plates is scanned with resolution better than 1 µm to guarantee a precise determination of the track diameters. We have compared three different options comprising two commercial track readers and a laboratory microscope with home-made data acquisition system. The scanning procedures give rise to more than 100 microscopic images for each CR-39 plate. Further, we have developed algorithms for the automatic identification of circular patterns (up to several thousand per image) and the measurement of their sizes. These techniques have been successfully applied to laser-accelerated protons with energies up to 2.2 MeV. They may be useful as well for the precise characterization of ions in nuclear or biomedical applications.

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