Dante: a heavy-ion detector based on MCPs for the Clara-Prisma setup

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INTRODUCTION

The γ-ray array Clara coupled to the large acceptance magnetic spectrometer Prisma allows the study of moderately neutron-rich nuclei populated at medium-high spin via multi-nucleon transfer and deep-inelastic reactions [1, 2]. The setup provides correlations between the in-beam prompt γ rays detected in Clara with the reaction products analysed by Prisma, which are univocally identified in atomic number Z and mass A. Nevertheless, all the Clara events which are outside the Prisma acceptance, do not present enough information to Doppler correct the prompt γ rays, i.e. those events do not contribute to the gated γ-γ coincidence matrices. In order to recover those events, the Dante array (Detector Array for multi-Nucleon Transfer Ejectiles) is being built at Lnl. Dante is a heavy-ion position-sensitive ancillary array based on Micro-Channel Plates (MCP). This detector will allow to reconstruct kinematically event-by-event and perform the Doppler correction of the prompt γ rays detected in Clara.

THE DANTE ARRAY

Dante (Detector Array for multi-Nucleon Transfer Ejectiles) is a heavy-ion position-sensitive ancillary array based on Micro-Channel Plates (MCP), being built at Laboratori Nazionali di Legnaro, that will be installed in the reaction chamber of the Clara-Prisma setup. The first prototypes of the Dante array have been built and tested at the beginning of June 2005. They present a very similar configuration to the start detector of the Prisma spectrometer [3]. Each detector consists of a mylar foil, at the entrance, for electron production, followed by two Micro-Channel-Plates (MCP), of dimensions (40×60 mm^2), mounted in Chevron configuration. The position-sensitive anode consists of two orthogonal delay lines made from copper wires with a diameter of 100 μm, which are placed in such a way that a tin-coated cooper wire alternates with an isolated copper wire. These wires are connected to a low-noise differential preamplifier, in order to minimize the influence of fast signals from the MCP and are wound around a frame of two plexigas rods. The rods present different diameters in each direction X and Y, in order to keep them insulated from each other and both of them from the steel reflection plate for electrons. The delay line is attached to the printed board circuit where the preamplifiers are mounted. Figure 1 (left) shows a lateral photograph of a MCP prototype. The X and Y position are obtained from the difference in arrival time of the signal at one end of the corresponding delay line with respect to a reference time signal. The reference time signal is derived from the second MCP through a capacitor. The rise time of the fast time signals is around 2-3 ns.

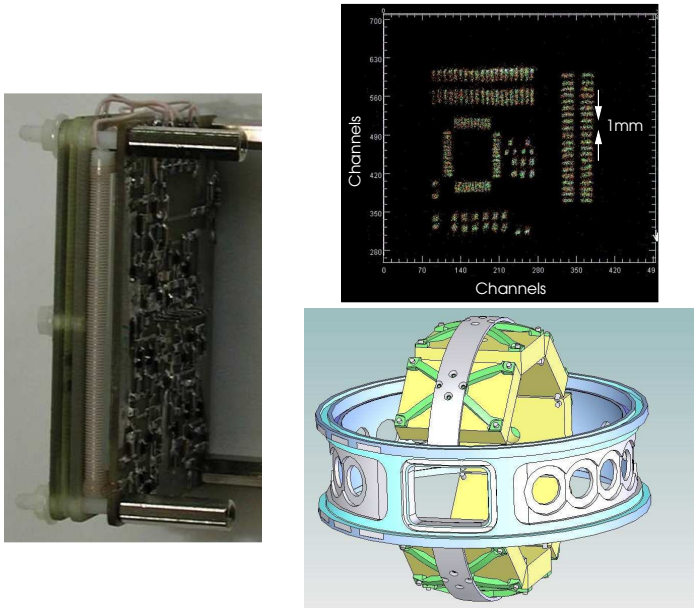

FIG. 1: View of one of the MCP prototypes of the Dante array to be installed at the Clara-Prisma setup at Lnl (left). Two-dimensional X-Y spectrum obtained from the MCP prototype detector where a suitable mask was placed in front, the test was performed with an α source (top right). Design of the Dante array at a configuration angle of 90^o (bottom right).

The position and time resolution of the first DANTE prototype was measured placing an α source of ^{241}Am in front of the detector. The position resolution was measured to be better that 1 mm. Figure 1 (top right) shows a two dimensional X-Y spectrum obtained placing a mask with narrow slits (1 mm) in front of the MCP entrance surface. The time resolution was extracted from a Time-Of-Flight (TOF) measurement. A small CORSET-type detector [4], providing the start signal, was placed between the α source and the DANTE prototype at around 15 cm, which provided the stop signal. The time resolution was measured in this configuration to be around 130 ps.

The final design of the DANTE array aims at maximizing the detection efficiency for the reaction products in combination with the γ-γ coincidences measured with the CLARA array. As a consequence, the MCP detectors will be placed around the grazing angle, where the cross section is largest. Figure 1 (bottom right) shows the configuration of DANTE at 90^o within the reaction chamber of CLARA. The configuration of the array will be flexible and would be varied depending on the grazing angle of the reaction.

SUMMARY

In summary, the new ancillary MCP-based heavy-ion detector, being built at LNL, has been described. This ancillary detector will allow to measure γ-γ Doppler-corrected coincidences, for the events outside the acceptance of PRISMA. The commissioning will take place at the beginning of 2006.

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