Application of crossed-wire detectors to multi-fragmentation studies

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The study of multiple ionization and fragmentation of 'small' poly-atomic molecules, as e.g. H_2O, CH_4, or C_{60}, is the subject of many recent experimental and theoretical studies. Typical research topics are for example the observation of characteristic fragmentation patterns, cross section measurements, and the analysis of the fragmentation dynamics which involves the measurement of fragment momenta, kinetic energies and angular correlations. All these problems require the coincident detection of multiple particles with a position- and time-sensitive detector. Such a multi-particle detector must be able to resolve particles which arrive "at the same time" at different detector positions. A straight-forward solution to this problem is a MCP-detector with a multi-segment anode which clearly has the required multi-hit capability, good time-resolution ($<$ 1ns) and low dead time (see contribution of S. Martin). The position-resolution is in this approach a direct function of the number of segments: for a resolution of $\Delta x \approx 2$ mm about 200 segments, amplifiers and TDC channels are needed – a complex and expensive solution.

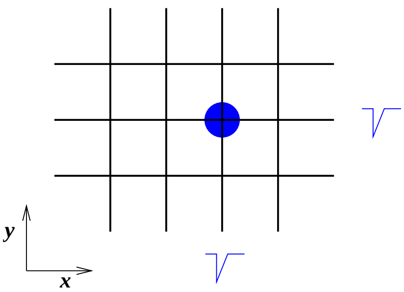

Fig. 1: crossed-wire principle

An alternative to the multisegment anode can be found in the *crossed-wire anode* which consists of independent x- and y-wires. An electron cloud from the channelplates hitting at a crossing of two wires will result in coincident pulses on these wires which are registered by a time-to-digital converter (TDC). With this technique a significant reduction in complexity and cost of electronic equipment is achieved: only $2 \cdot N$ channels are needed to distinguish between N^2 different positions. In our detectors the wires are realized by etched structures on a printed circuit board [1] to enhance the efficiency and signal height. These anodes have a good time-resolution of ≈ 270 ps (limited by TDC) and a medium position resolution of typically 1–2 mm. They may be operated at high count rates and are capable of multi-particle detection even if particles arrive at the same time.

Our experience has shown that crossed-wire detectors are well suited for fragmentation studies [e.g. 2–5], especially in systems where several fragments with equal m/q occur. As an example Fig. 2 shows the two particle coincidences observed in collisions of 300 keV Ne^+ with C_{60}. In such collisions we observed multi-fragmentations with 7 coincident C^+ fragments.

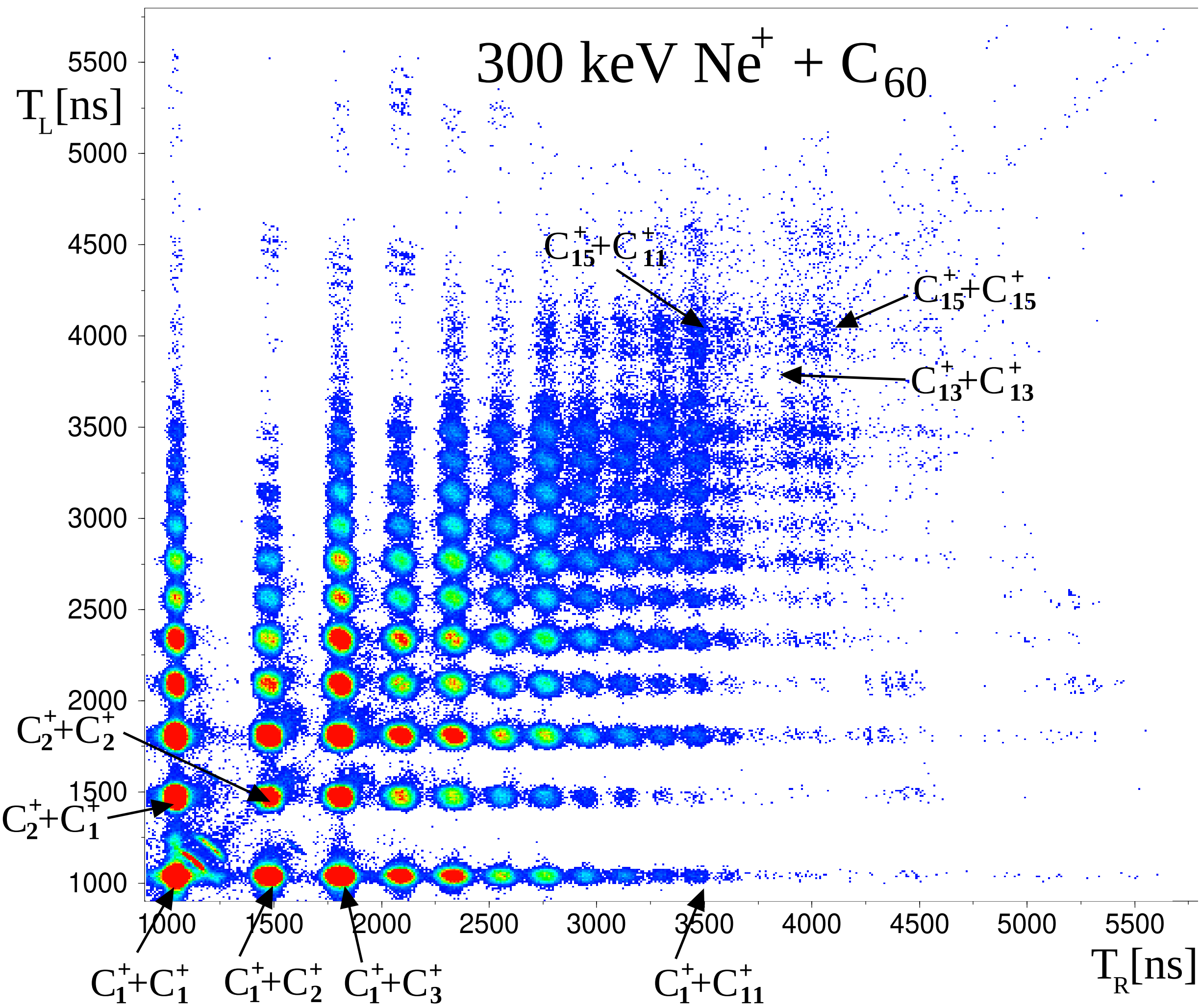

Fig. 2: Coincidence map of correlated two-fragment events from collisions of 300 keV Ne^+ with C_{60}. T_R and T_L are the flight times of the fragments which hit the detector at the right- and leftmost position; the number of events increases from blue to red.

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