Assembly and Commissioning of a New Multi-hit Charged-Particle Detector for Experimental Studies of Laser-Matter Interactions

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Background

Velocity-map imaging (VMI) spectrometers are used in pump-probe experiments at the JR Macdonald Laboratory (JRML).

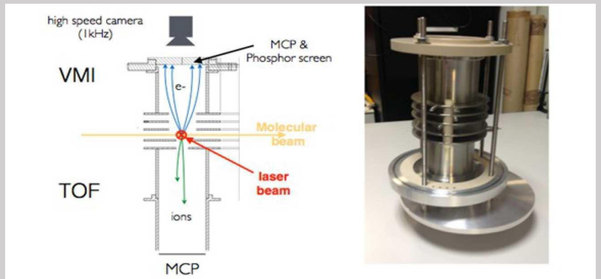
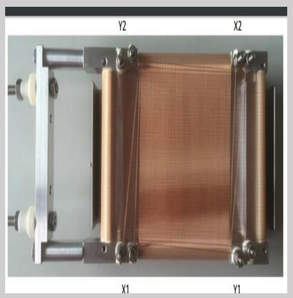
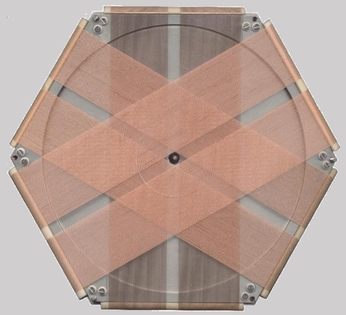


Diagram of a VMI spectrometer. [1]

The current COLTRIMS setup at the JRML only has quad-anode position sensitive detectors in its spectrometer. The new spectrometer, the Kansas Atomic and Molecular Physics instrument, has a hex-anode position detector that allows for greater precision and the recording of more resolved hits during a pump-probe experiment.



The quad-anode position detector. [2]



The hex-anode position detector. [2]

A microchannel plate (MCP) is used in the spectrometer detectors. It is arranged in a z-configuration with three individual MCP plates. The MCP construction creates a cascade of electrons that goes on to hit a position-sensitive detector.

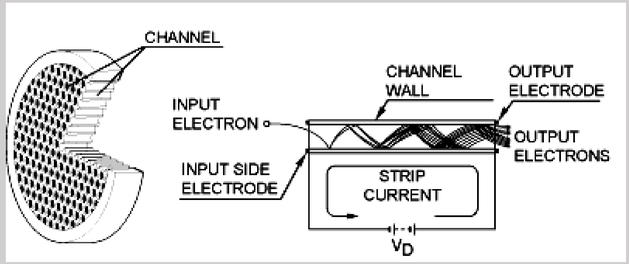


Diagram of a MCP. [3]

The position-sensitive detector has 2 layers of paired wires (in the quad-anode case) or 3 layers of paired wires (in the hex-anode case). The position of a fragment hitting the detector is mathematically constructed from the times it takes for the signal to propagate along the wire to each of either four or six corners. The mathematical operations to resolve the positions of fragments hitting the hex-anode are included below from the manual:

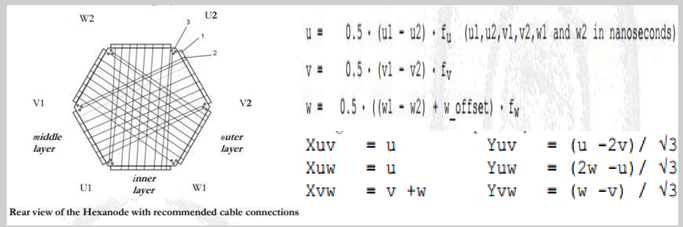
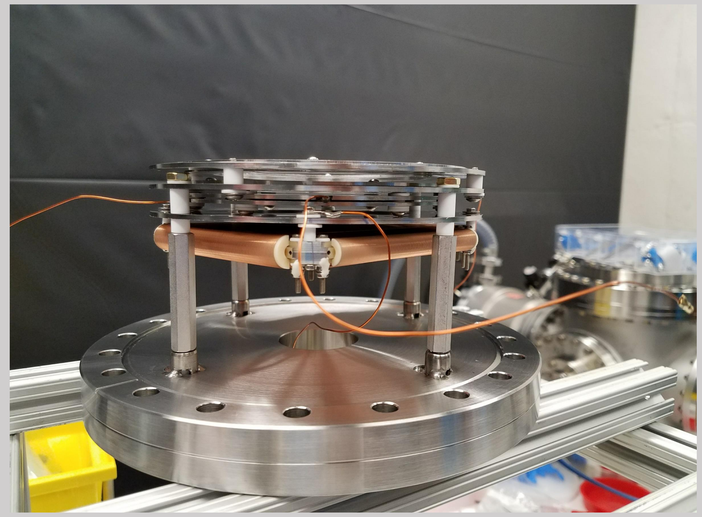
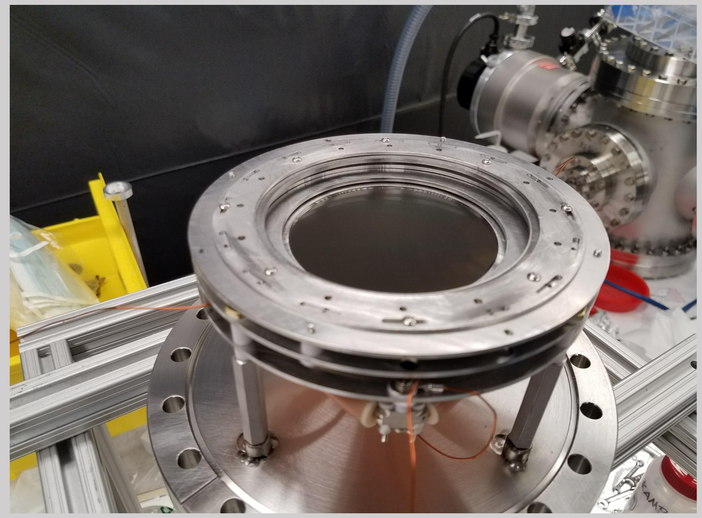


Diagram and mathematical operations to determine position on a hex-anode detector. [2]

Complete Installation

A complete assembly was then done with the real MCP and delay-line position sensitive detector (for quad only).





Complete assembly of the plates, MCP, and delay-line (quad side only).

References:
1. Imperial College London. "Coupling of charge migration and nuclear dynamics." n.d, n.p. Accessed 25 July 2017.
2. Roendek Handels: Delayline Detectors webpage
3. Maharjan, Chakra M. "Momentum Imaging Studies of Electron and Ion Dynamics in a Strong Laser Field." Kansas State University, 2007.

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