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

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Laser-Matter Interaction Experiments

- Pump probe experiments

- Coulomb explosion experiments
  - These experiments can make “molecular movies”
How do we study these particles?

- **Spectrometer and detectors**
  - VMI (Velocity Map Imaging)

There are both ion and electron detecting sides (2 detectors)

Detectors are multi-hit compatible

Detector assembly consists of:
  - Microchannel plates (MCP)
  - Position sensitive delay-line detectors (PSDs)
    - Quad and hex-anode (4-sided and 6-sided)
Microchannel Plates (MCPs)

• Creates a cascade of electrons, generating a signal
  − Usually a set of 2 plates in chevron configuration or a set of three plates in a ‘z’ configuration

Delay-line Position Sensitive Detectors

- 2 wires for each direction: signal and reference, kept at 50 volts apart
- The time it takes for a signal to propagate to each of the corners of the detector is mathematically converted into a position

Images retrieved from: Roentdek website and manuals
Why do we need KAMP?

• Superior detection capability
  − Hex-anode adds a layer of redundancy that makes it possible to resolve signals that land near the same location around the same time

• Detects both ions and electrons simultaneously
  − This leads to new and more data that can be used in Coulomb explosion and other molecular imaging experiments
Assembly of the Detector

- Location: Clean room in JRML
- Rough procedure:
  1) Get all parts and make sure they are in order
  2) Practice assembling detector plates with “dummy” MCP
  3) Clean all parts when ready for real assembly
  4) Put together the detector, wire it, and install into the test chamber
  5) Test dark counts from the detector with oscilloscope
KAMP Main Chamber
“Dummy” MCP Installation of Detectors

- Quad-anode side
“Dummy” MCP Installation of Detectors

- Hex-anode side
True Assembly and Putting into Test Chamber

MCP wire hookups

Delay-line quad detector
True Assembly and Putting into Test Chamber

Venting the chamber

Mounting the delay-line
True Assembly and Putting into Test Chamber

Complete MCP/Delay-line Assembly!
Vacuum Technology

• To achieve very high vacuum (on the order of $10^{-9}$ Torr):

  1) Must be pumped down to about $10^{-3}$ Torr with roughing pump
  2) Pumped down further with turbo pump
  3) Baking chamber allows water to evaporate, bringing the pressure down the rest of the way

• For our purposes (in the interest of time), we will only do the first two steps now
Pumping Down the Chamber
Dark Count Testing

• What are dark counts?
  − Signals generated by the MCP automatically when voltage is applied
  − Can be used to test detectors without needing a laser or a sample
Typical Pulse Shape from MCP
Dark Count Testing: Seeing the MCP Signal
Summary and Looking Forward

- The main spectrometer chamber and quad-anode detector are assembled
- MCP signals were observed in the testing chamber
  - MCP is operational
- Same procedure needs to be repeated for hex-anode detector side
- Eventually, both detectors will be mounted in the main KAMP chamber
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References


- Roentdek website and manuals