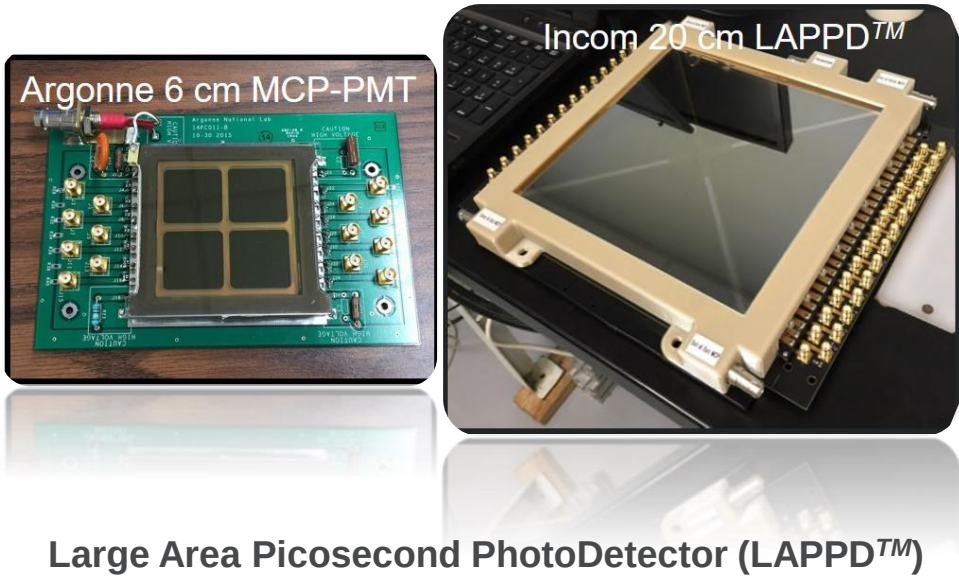
EIC-PID CONSORTIUM MEETING

# RECENT PROGRESS ON MCP-PMT/LAPPD™




**Large Area Picosecond PhotoDetector (LAPPD™)**

**JUNQI XIE**

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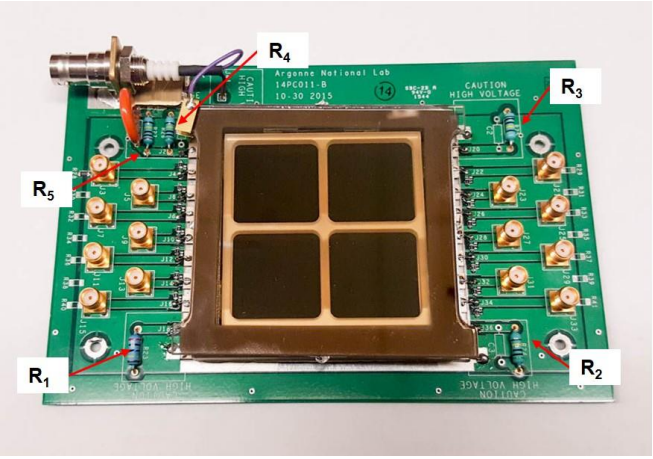
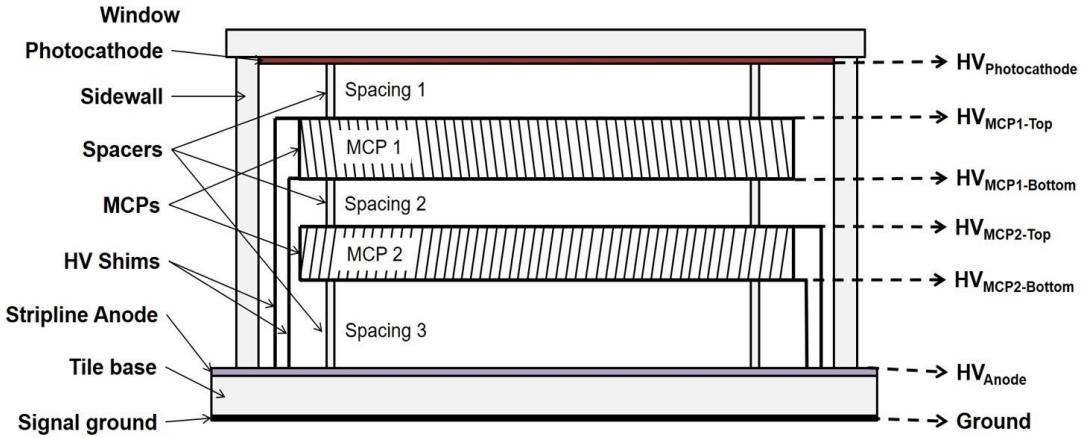
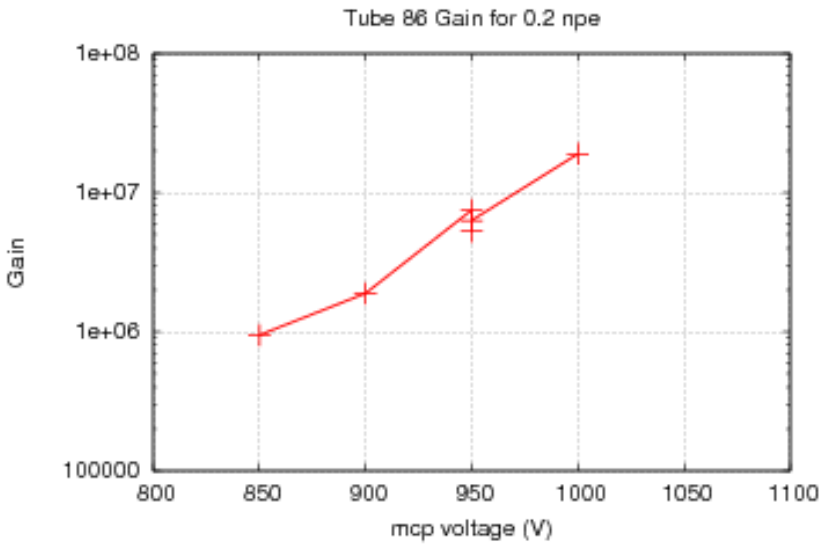
# ANL Version 4 MCP-PMT

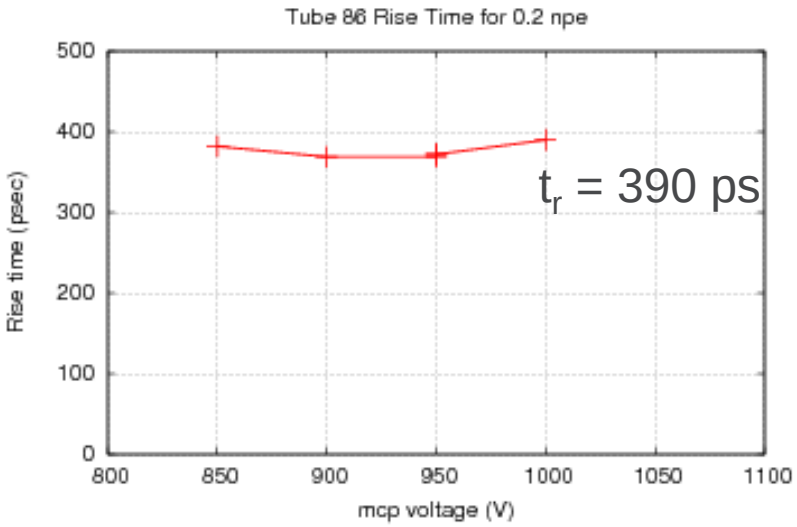


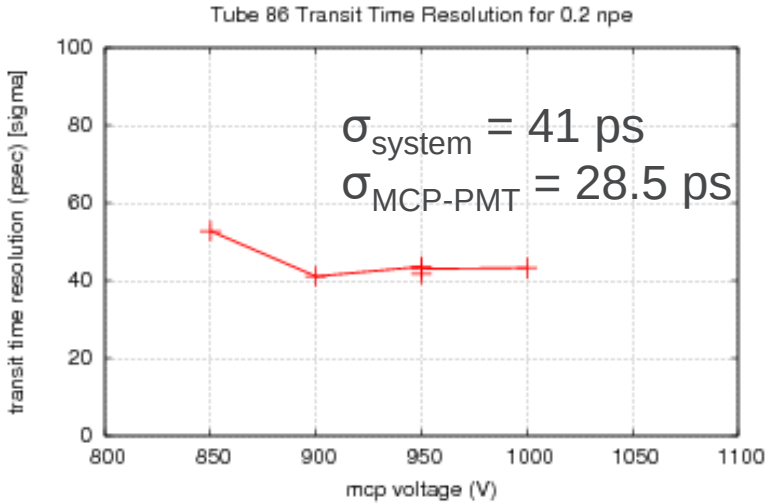



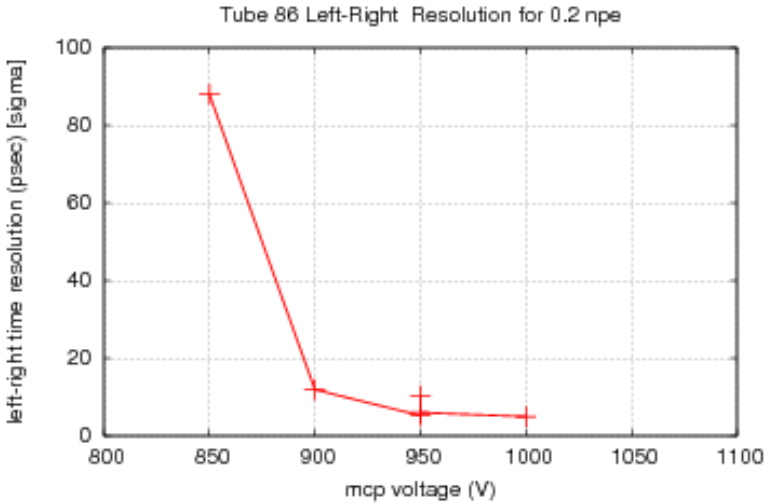

| | | ANL Version 2<br>Standard 20 μm MCP-PMT | ANL Version 3<br>10 μm MCP-PMT<br>without reduced spacing | ANL Version 4<br>10 μm MCP-PMT<br>with reduced spacing |
|---|---|---|---|---|
| **MCP** | Pore size | 20 μm | 10 μm | 10 μm |
| | Length to diameter ratio (L/d) | 60:1 | 60:1 | 60:1 |
| | Thickness | 1.2 mm | 0.6 mm | 0.6 mm |
| | Open area ratio | 60 % | 70 % | 70 % |
| | Bias angle | 8º | 13º | 13º |
| **Detector geometry** | Window thickness | 2.75 mm | 2.75 mm | 2.75 mm |
| | Spacing 1 | 3.25 mm | 2.25 mm | 2.25 mm |
| | Spacing 2 | 1.75 mm | 2.0 mm | 0.7 mm |
| | Spacing 3 | 2.0 mm | 4.0 mm | 1.1 mm |
| | Shims | 0.3 mm | 0.3 mm | 0.3 mm |
| | Tile base thickness | 2.75 mm | 2.75 mm | 2.75 mm |
| **MCP-PMT stack** | Internal stack height | **9.70 mm** | **9.75 mm** | **5.55 mm** |
| | Total stack height | 15.20 mm | 15.25 mm | 11.05 mm |

# Version 4 MCP-PMT Performance



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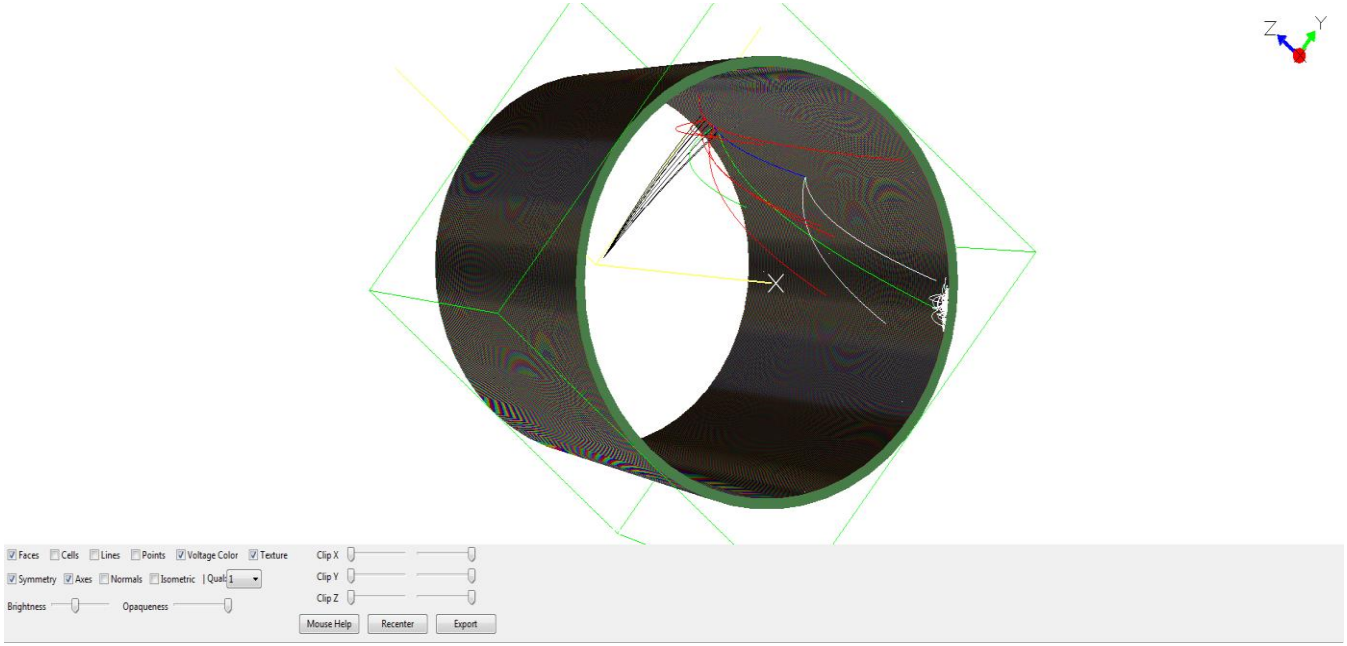
# Argonne MCP-PMT Performance comparison

| | | ANL Version 2<br>Standard 20 μm MCP-PMT | ANL Version 3<br>10 μm MCP-PMT<br>without reduced spacing | ANL Version 4<br>10 μm MCP-PMT<br>with reduced spacing |
|---|---|---|---|---|
| **Gain Characteristic** | Gain | $1.35 \times 10^7$ | $3.05 \times 10^6$ | $2.0 \times 10^7$ |
| **Time Characteristic** | Rise time | 536 ps | 439 ps | 390 ps |
| | Timing distribution RMS | 204 ps | 106 ps | 109 ps |
| | System resolution | 70.0 ps | 37.2 ps | 41 ps |
| | Time resolution | **63 ps** | **20 ps** | **28.5 ps** |
| | Differential time spread | 11 ps | 7 ps | 7 ps |
| | Spatial resolution | 0.83 mm | 0.53 mm | 0.53 mm |
| **Magnetic Field** | Magnetic field tolerance | **0.7 Tesla** | **1.3 Tesla** | |

Version 4 shows higher gain, faster rise time, but same/slightly worse timing resolution comparing to version 3
MCP variation? Bias Voltage variation? Need further test to explain.

**B field performance test is scheduled 5/13/2019 – 5/24/2019**
**Moving in facility today.**

# MCP simulation with SIMION: pore model



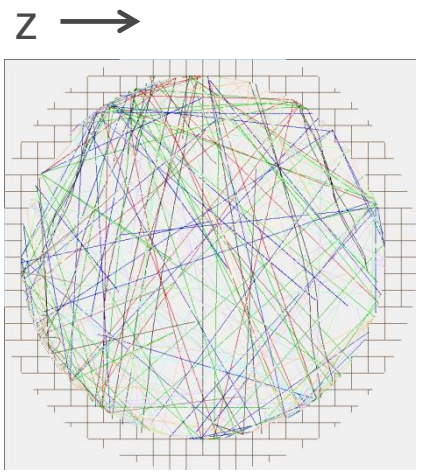

Cylinder pore model with potential gradient defined (can be scaled)
Validation of the secondary emission model
SIMION smooths adjacent grids in this geometry.

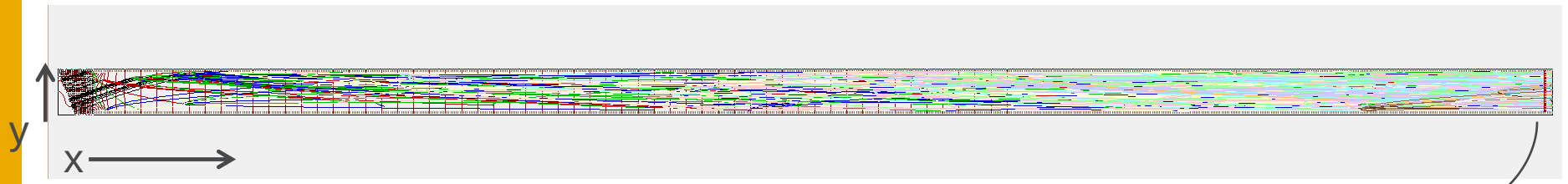
# MCP simulation: single MCP

One pore with chamfered end
1 grid unit = 1 micron scale (to us)

Reads left to right; uses widescreen monitors efficiently

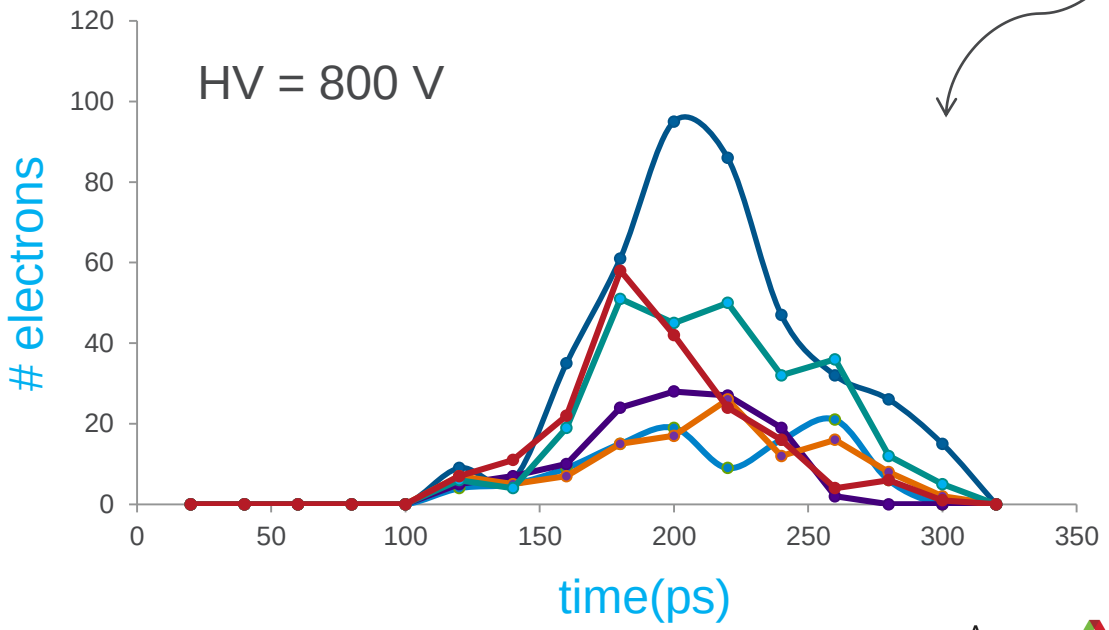
Colors represent different “generations” of electrons as they are amplified down the pore.




TOF can be logged thru a crossing plane (or at an anode) – shown are a series of simulated detection pulses.

Each curve is a histogram of transit times for that initial $e^-$ hit.

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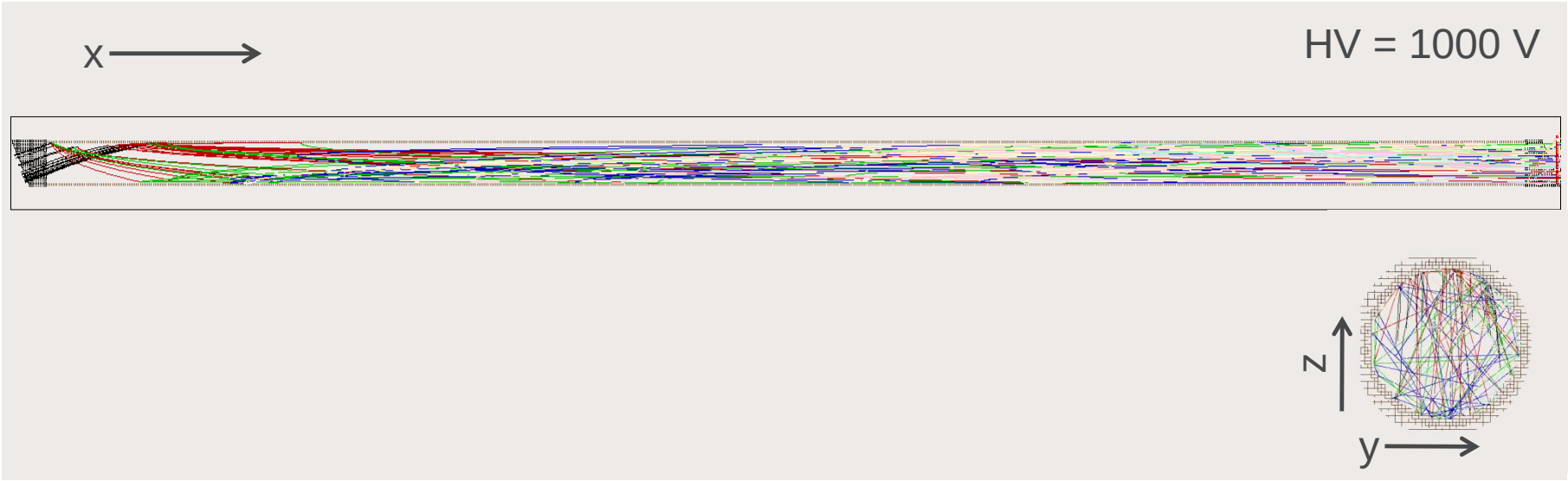
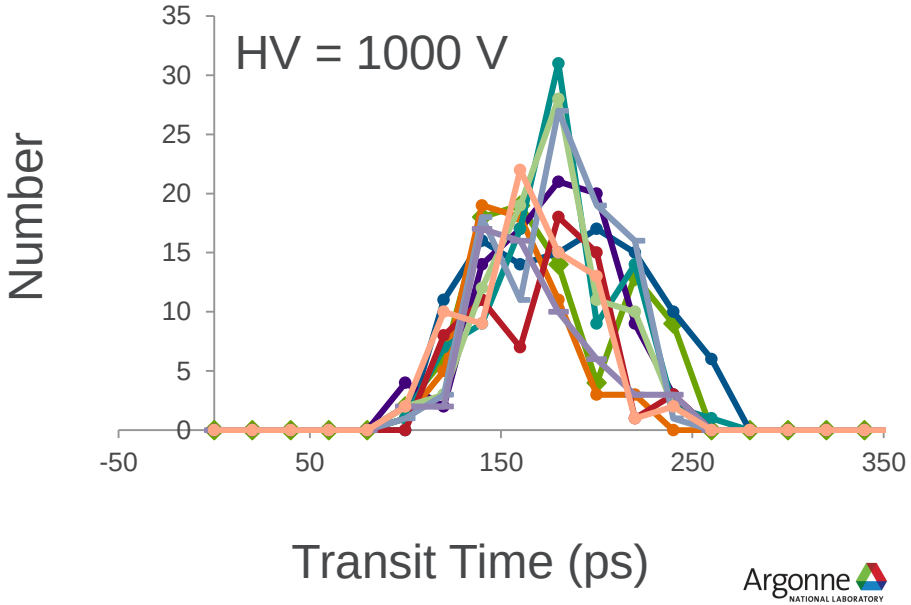
# MCP simulation: single MCP




10 trajectory runs at 1000V bias (vs previous 800V).

Transit time is shorter as expected
Transit times are still consistent pulse to pulse.

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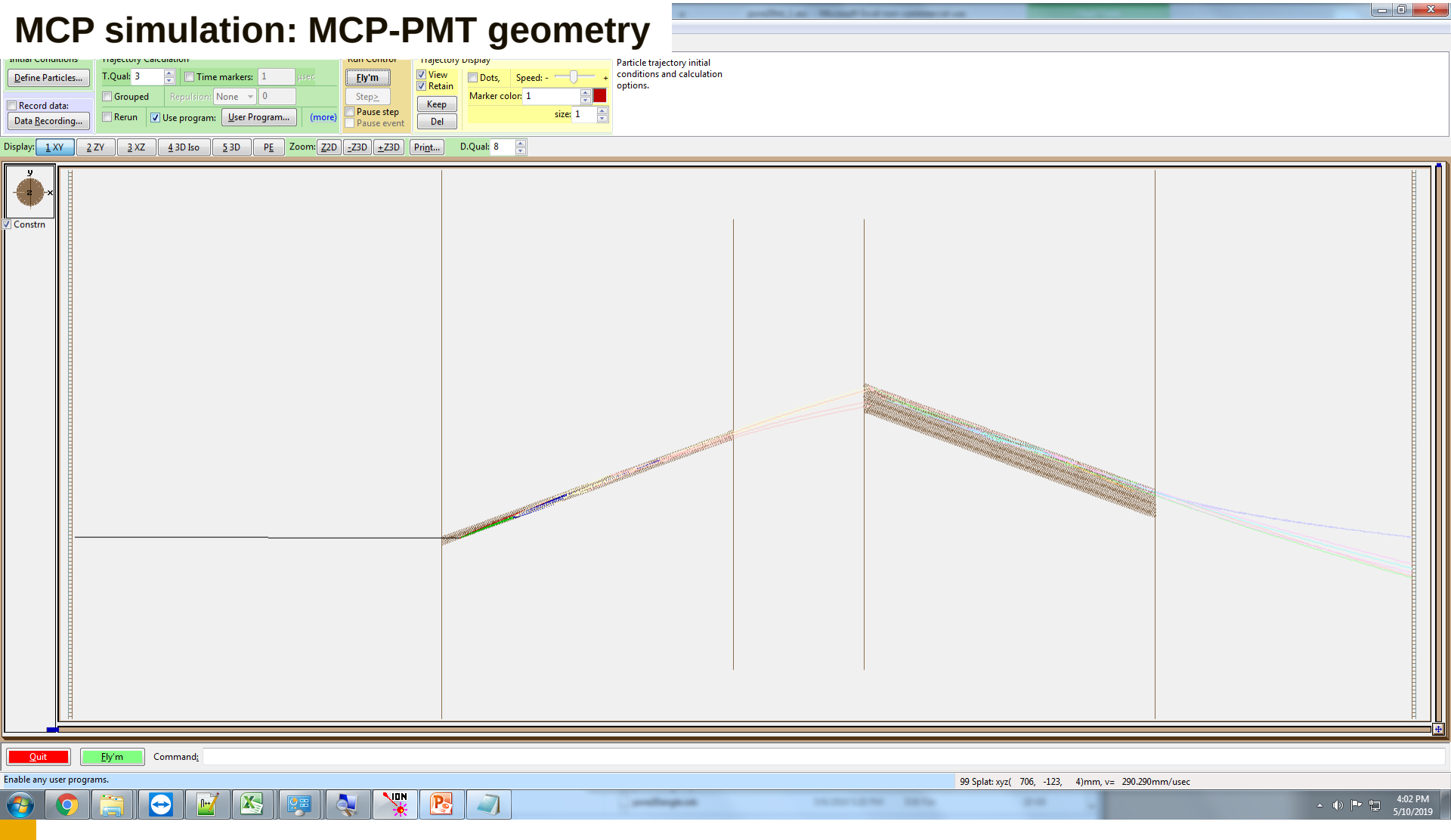
# MCP simulation: MCP-PMT geometry




PC

1st MCP

2nd MCP

Anodes

Setting up the MCP-PMT geometry

Adjusting parameters for reasonable results

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