2ND LAPPD WORKSHOP, OCT 26, 2022

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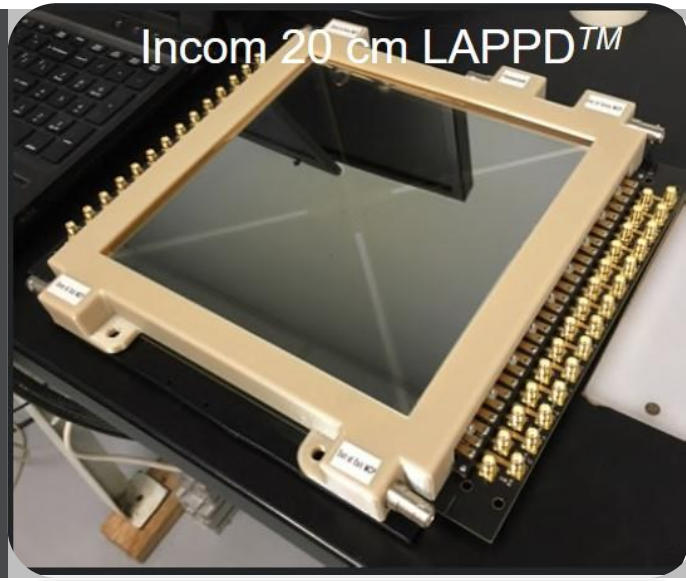
MAGNETIC FIELD TESTING OF LAPPD AT ARGONNE NATIONAL LABORATORY



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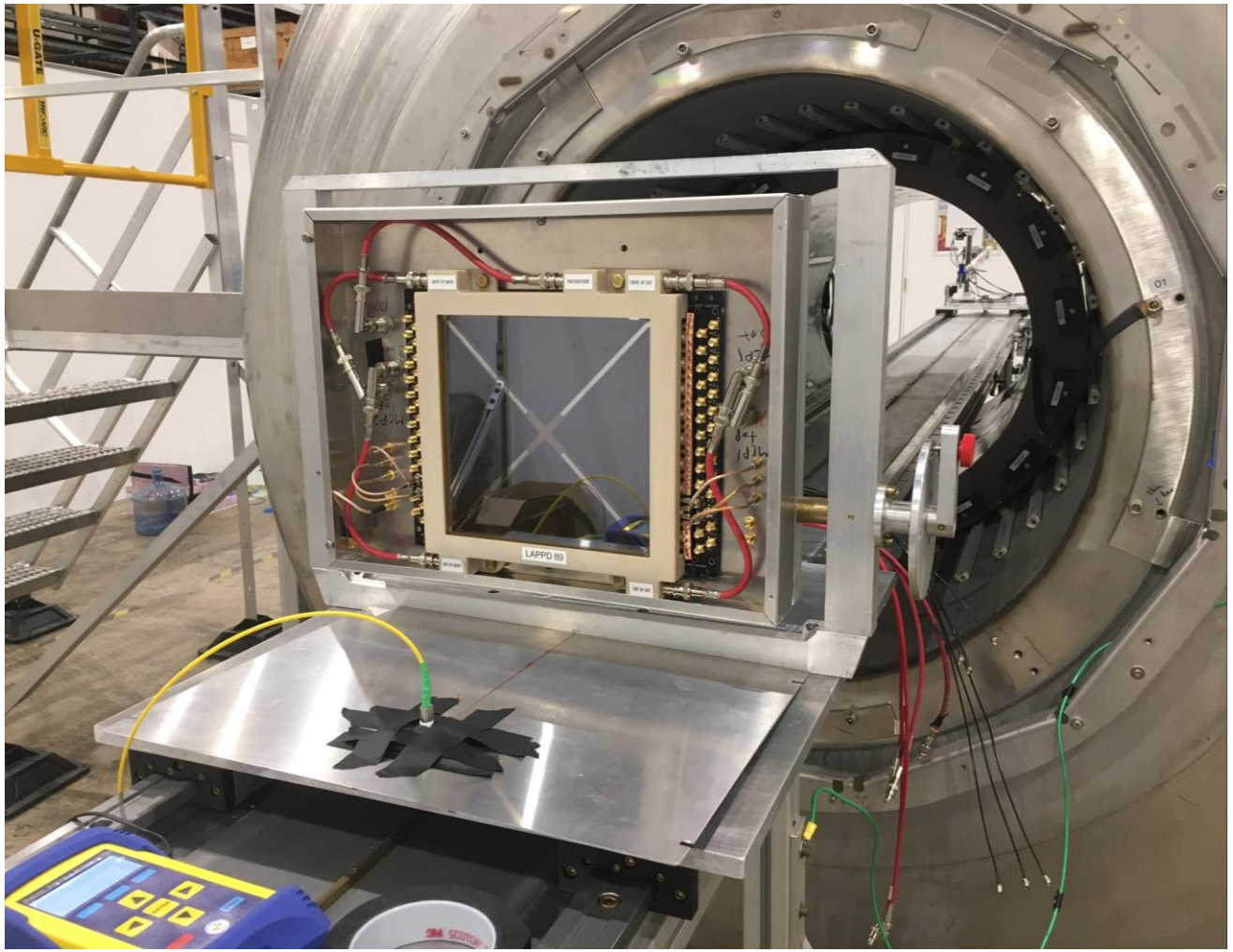
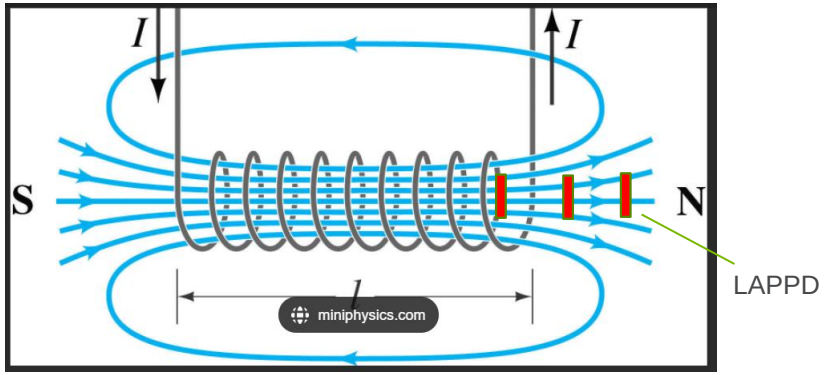
LAPPDS AT G-2 SOLENOID MAGNET

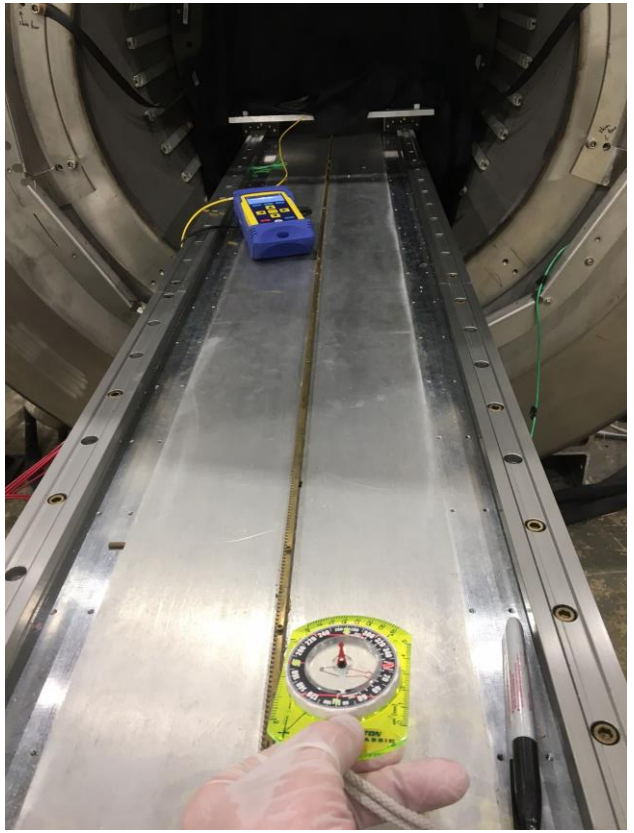
- Two stripline LAPPDs received:
  - # 118, 20 um MCP pore size (completed)
  - # 89, 10 um MCP pore size (data under analysi)
- One capacitively-coupled LAPPD received:
  - # 126, 20 um MCP pore size (readout electronics does not work inside magnet field, no data was taken)
- Magnetic field strength: 0.02 T to 1.4 T
- Dark box
  - Aluminum case
  - Laser input fixed in the center near the bottom – on the centerline of the solenoid when the LAPPD is vertical.
- Rotation in the magnetic field:
  - LAPPD tips into or out of the region of stronger magnetic field
  - Move the LAPPD in or out at each angle to compensate for the change in field strength



MAGNETIC FIELD ORIENTATION

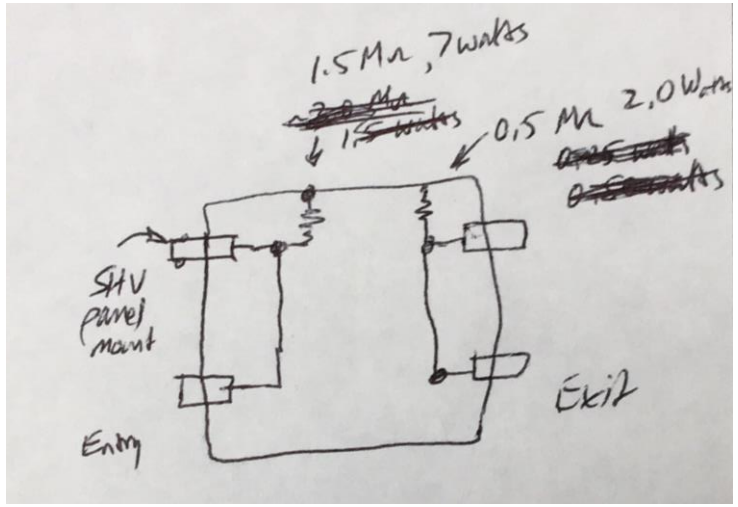


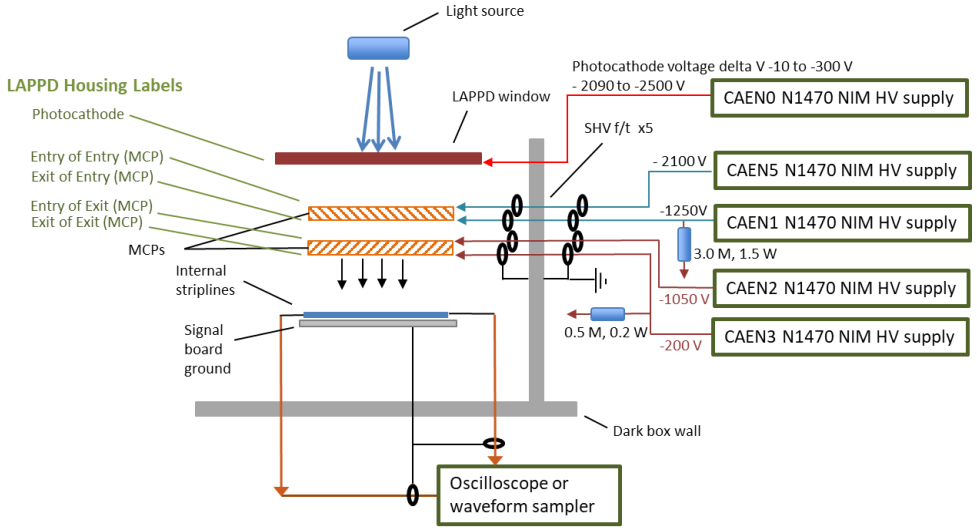
- A solenoidal magnetic field should be parallel to the interior walls of the magnet while inside the bore
- The field should curve away from the center line outside the magnet.
- Along the outside the magnet, the field has periodic **N** and **S** orientation – some type of active field control
- At ANL, the **N** direction is into the magnet

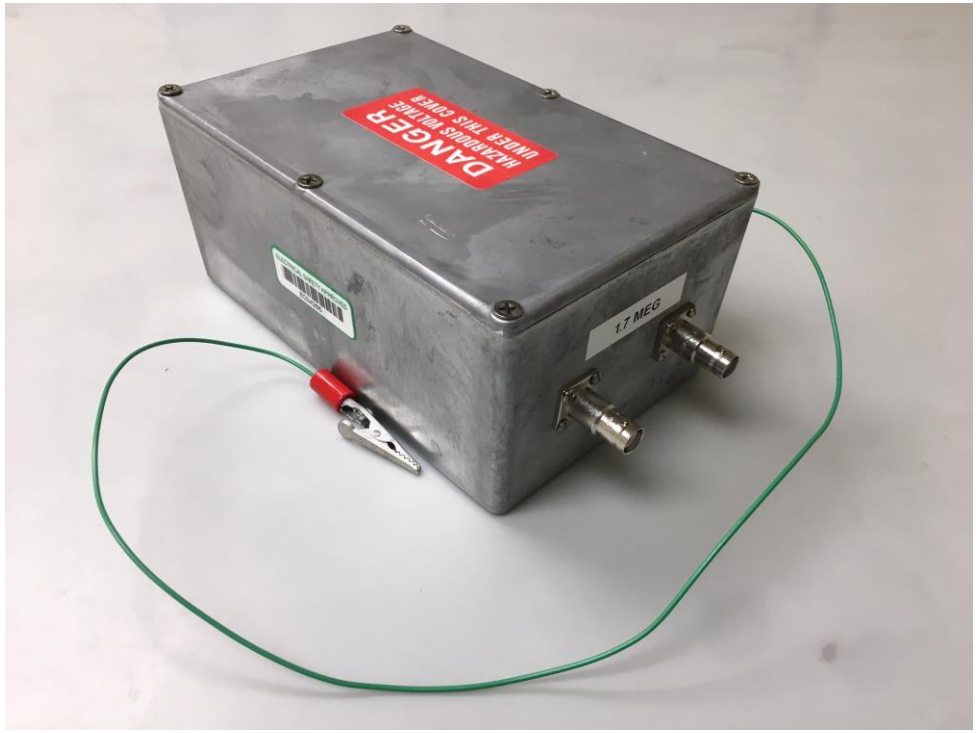


HIGH VOLTAGES

- Five high voltages
  - Two separate MCP current circuits
  - Maximum current delivery
- Initial tests of LAPPD 118 and then LAPPD 89 were restricted by the current capacity of the ANL ISeg HV supplies
- A higher current Caen N1470 was used to finish LAPPD 89 and LAPPD 126 testing







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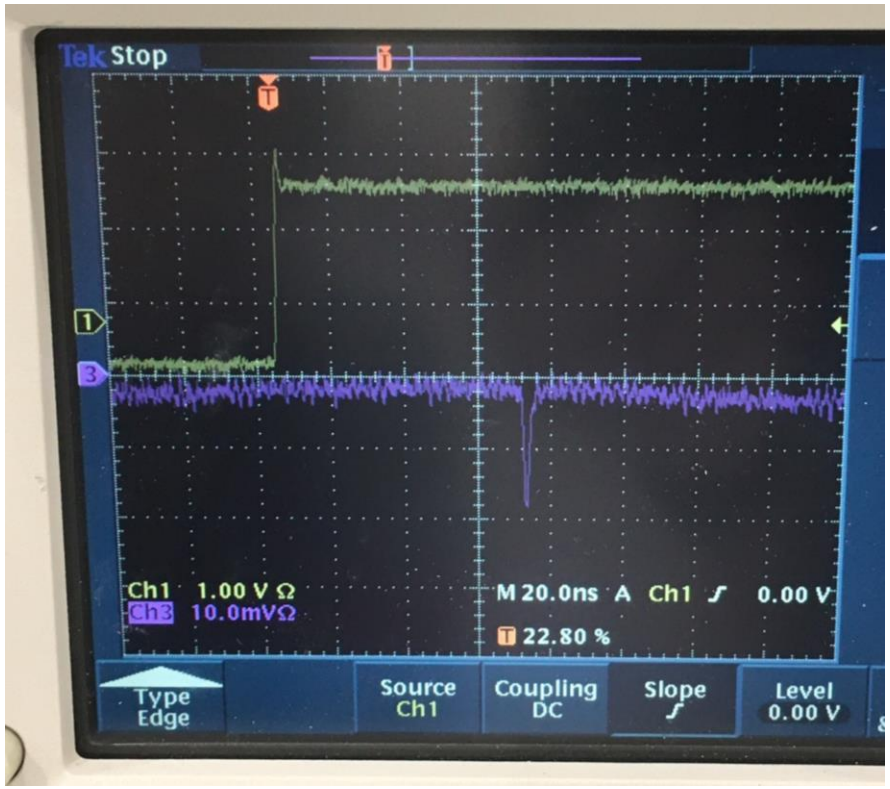
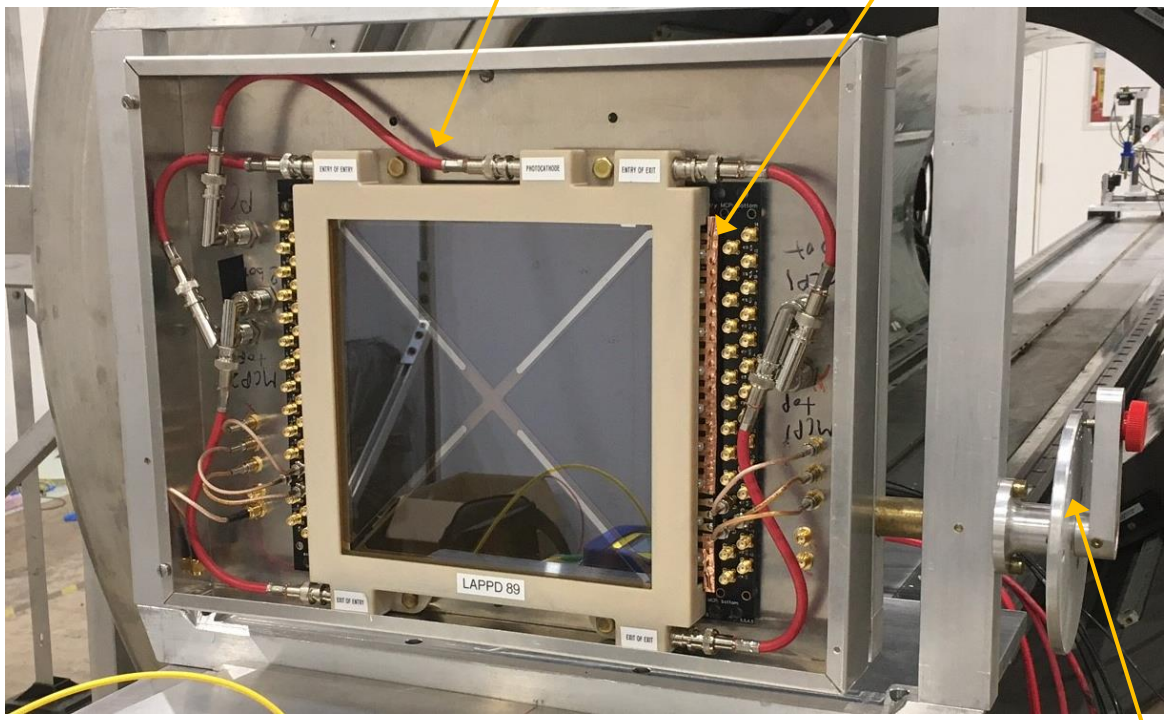
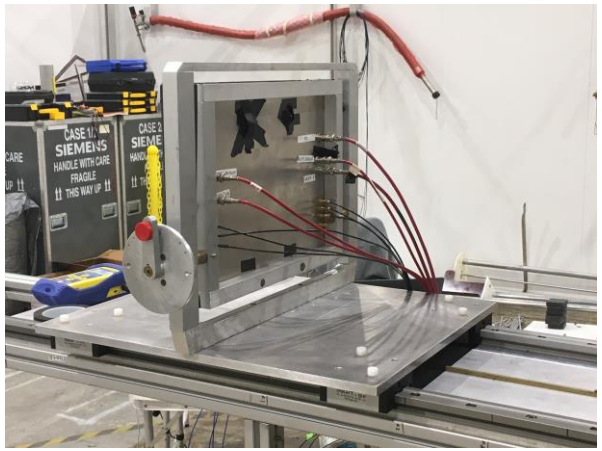
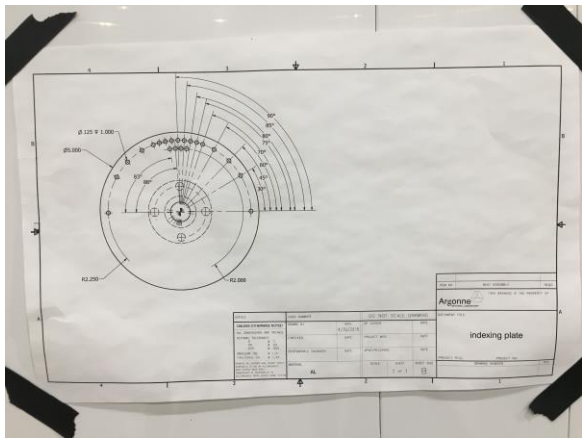
HIGH VOLTAGE AND SIGNAL CONNECTIONS

- Three strips, both ends were brought out to a Caen DT5742 DRS_4 waveform sampler.
- Five high voltages were brought in.
- Excellent pulse waveforms from the stripline LAPPDs.



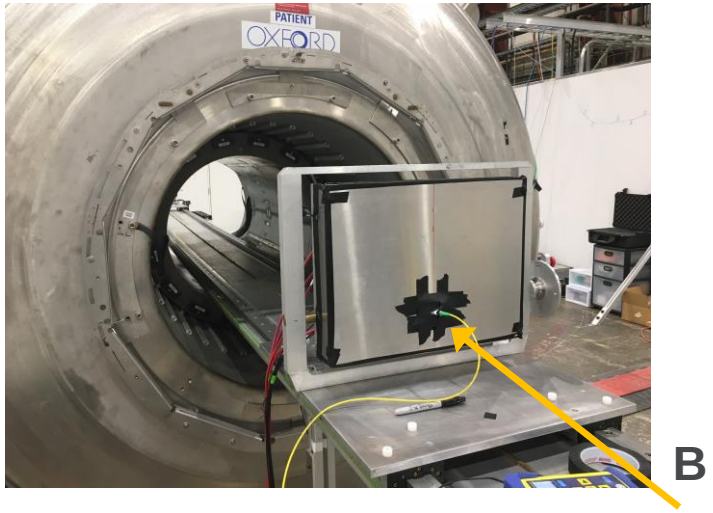


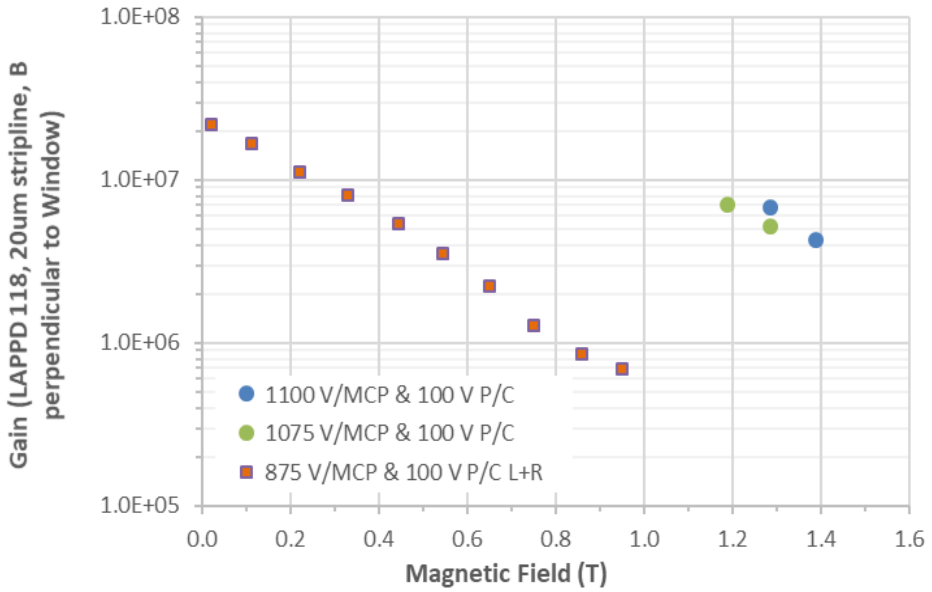


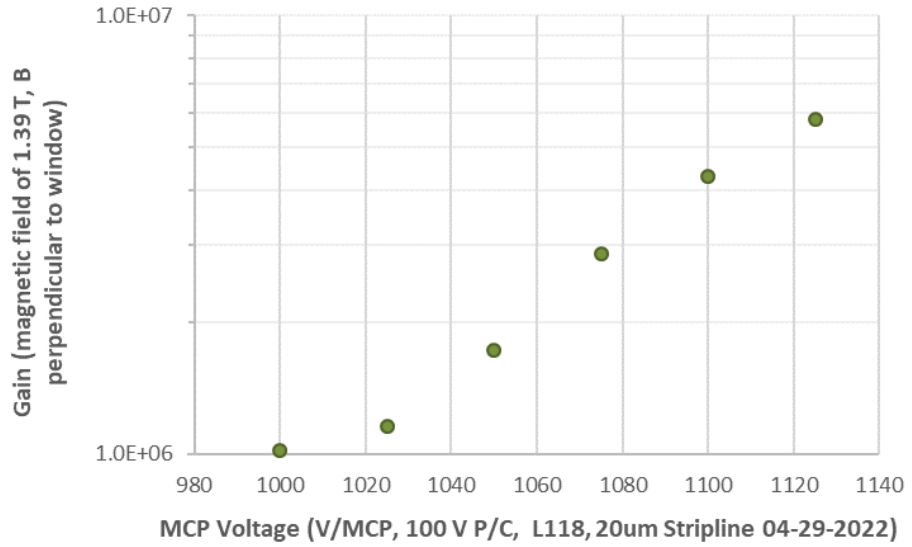


GAIN VS. MAGNETIC FIELD STRENGTH, B || P/C E-

- LAPPD shows similar behavior trends as R&D MCP-PMT
- Gain is shown as a function of magnetic field strength. The gain declined from over $2x10^7$ to $7x10^5$ as the field strength was increased from 0.02 T to ~0.9 T. It was recovered at higher field strengths by increasing the MCP voltages.
- At a field strength of 1.39 T, the gain was recovered to $6x10^6$ by significantly increasing the MCP voltages.







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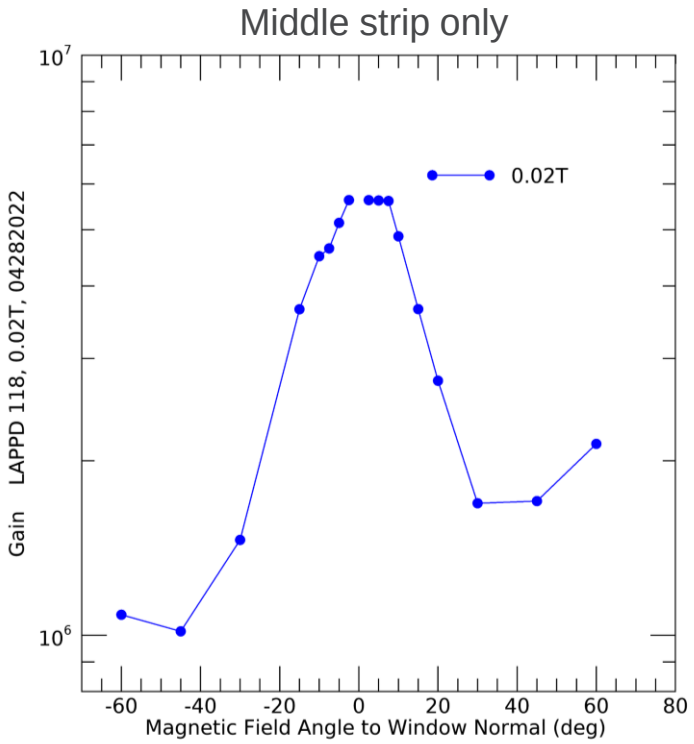
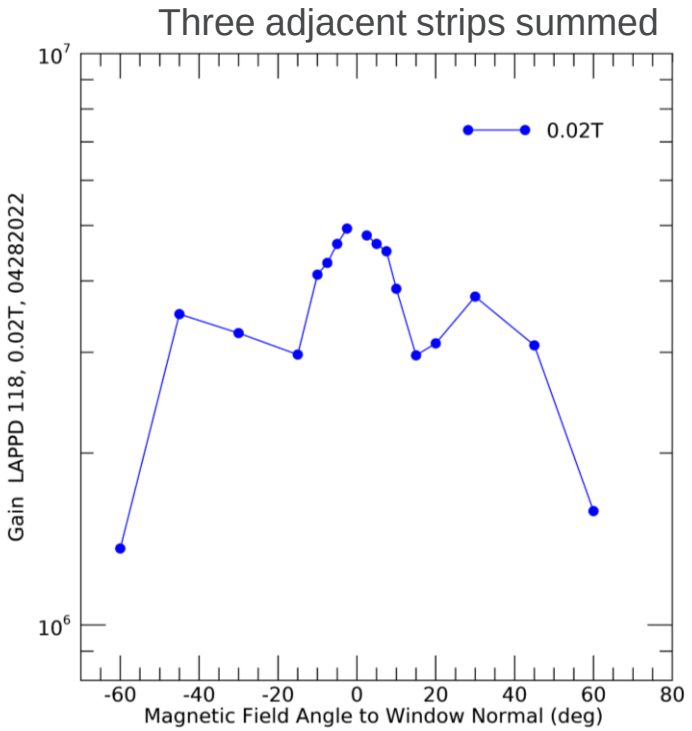
GAIN VS. ROTATION ANGLE AT SMALL B FIELD: 0.02 T

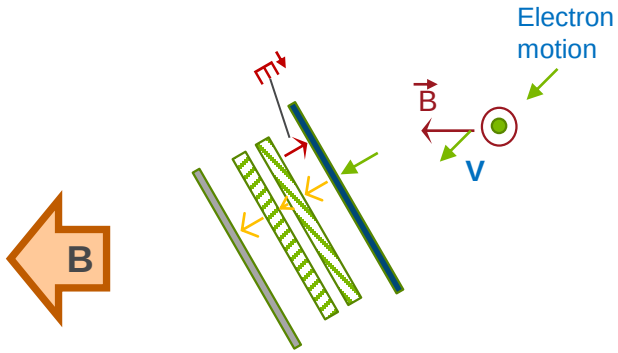




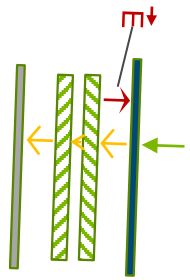
- Gain decreases as the LAPPD is rotated
- B field is no longer parallel to photoelectron motion
- Signal electron cluster landing zone on the anode **moves** with relative B angles

GAIN VS. ROTATION ANGLE: 0.02 T

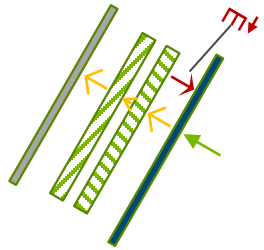
- Pulse height distributions show motion of electrons from one strip to another
- Striplines are in and out of the page
- Motion of electrons appears to be perpendicular to strips, instead of parallel to strip



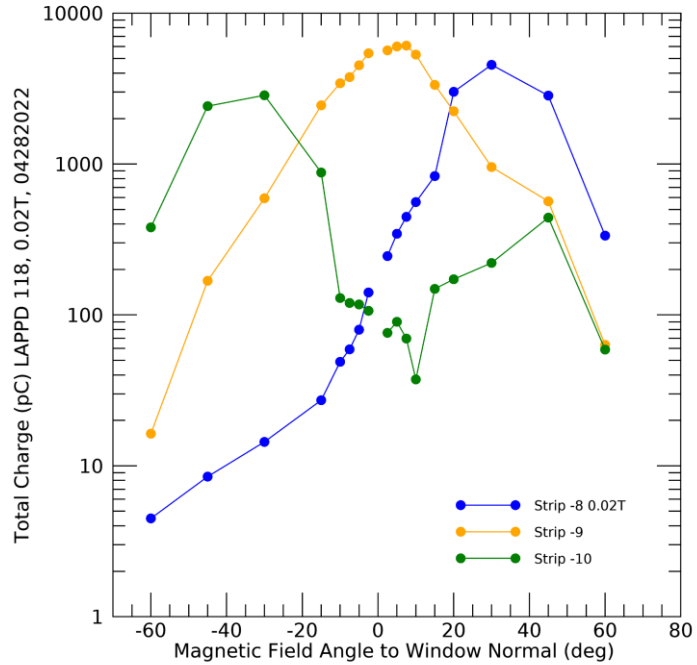
30 deg: top of LAPPD toward magnet

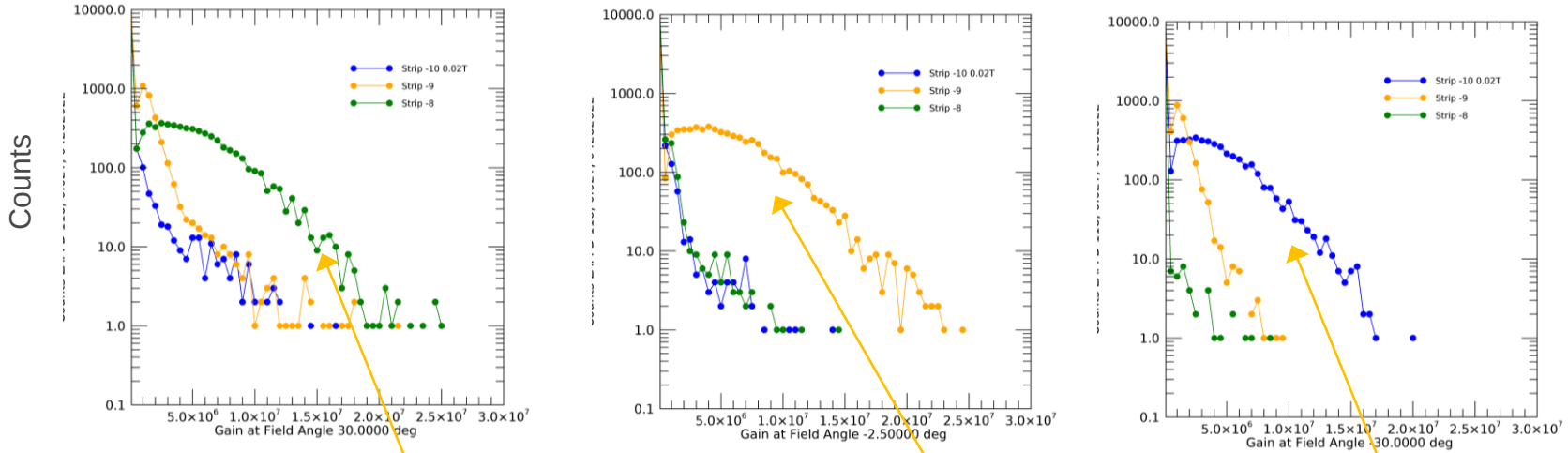


-2.5 deg: LAPPD ~ vertical



30 deg: top of LAPPD away from magnet

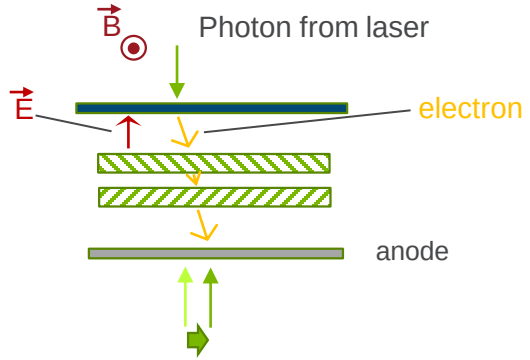




Adjacent strip on one side (-8)

Center strip (-9)

Adjacent strip on the other side (-10)



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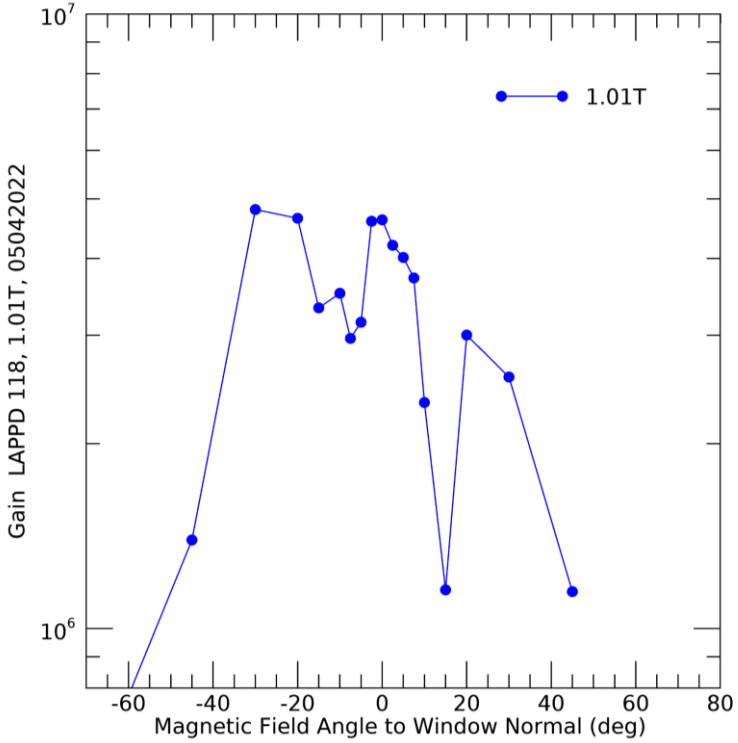
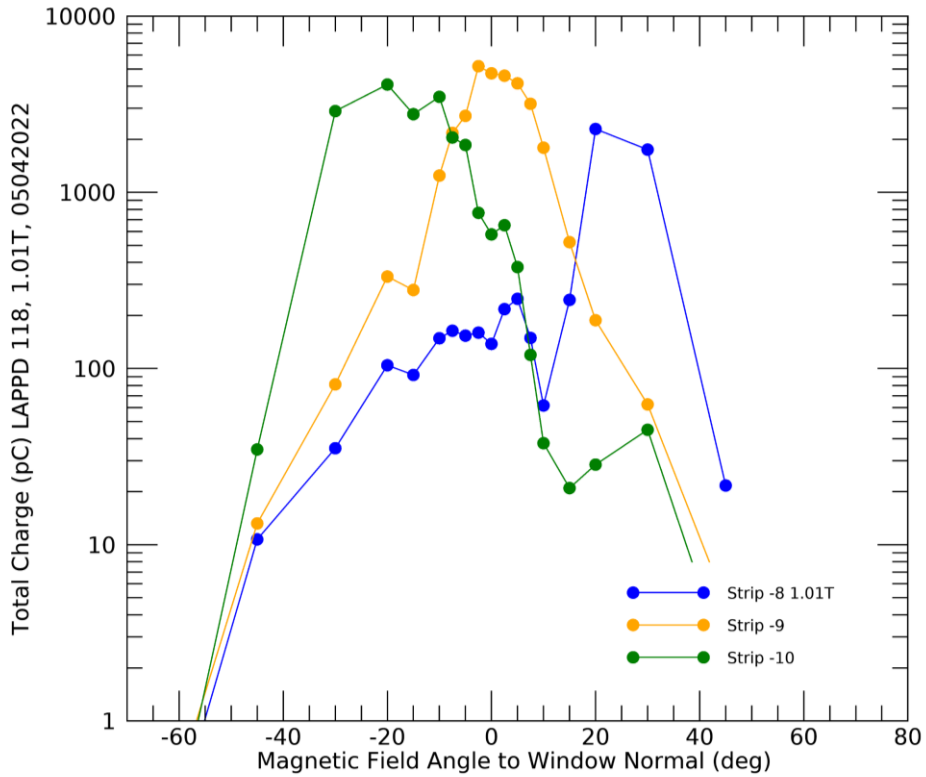
GAIN VS. ROTATION ANGLE AT LARGER B FIELD: 1 T





- Similar behavior as in small B field.
- Stronger angle affection in larger B field.
- Signal electron cluster landing zone on the anode **moves** with relative B angles.

SUMMARY

- Stripline LAPPDs were tested in Argonne g-2 magnet facility, serve as baseline performance of LAPPD in magnetic field.
- The LAPPD shows similar behavior trends as previous R&D MCP-PMT.
- LAPPD gain decreases as magnetic field increases, the gain can be recovered by increasing the MCP bias voltage.
- The signal cluster moves as the B field direction changes.

- Future test of mature LAPPD/HRPPD will be performed in early 2023.

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And many others …

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Thank you for your attention!

Questions?