Magnetic Field Testing at Argonne National Laboratory

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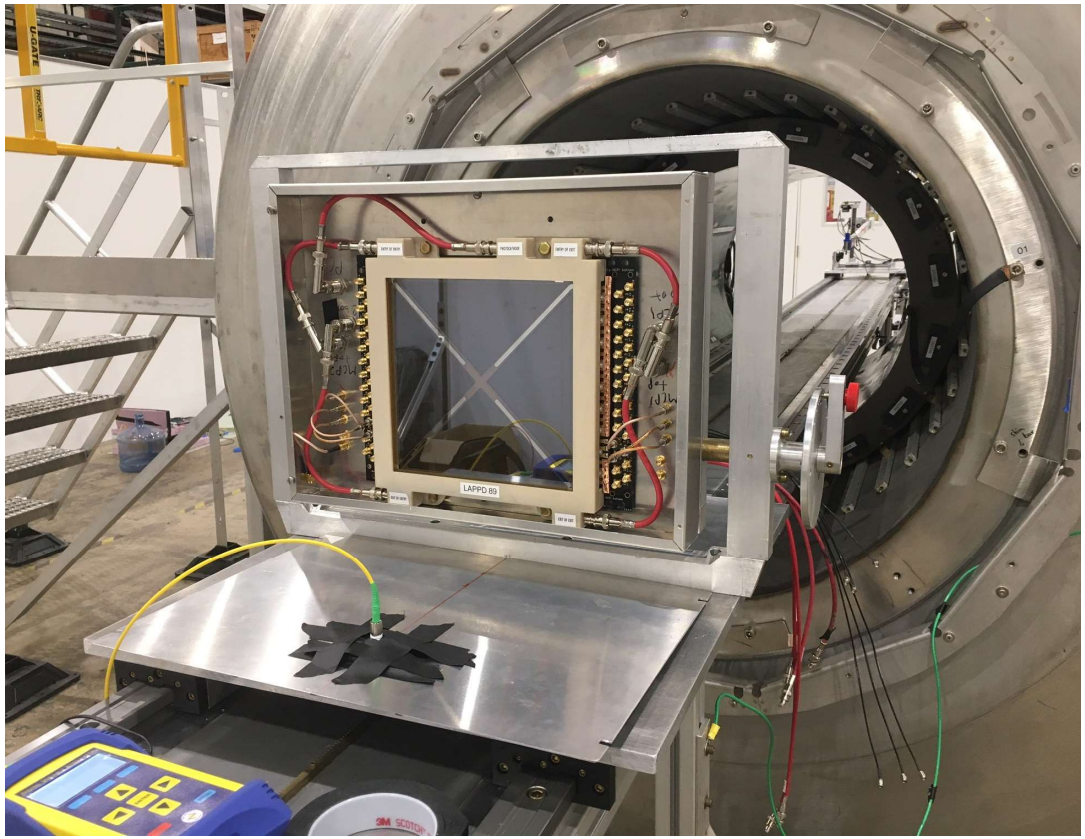
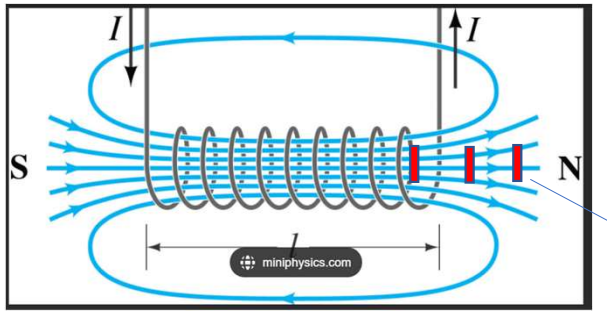
Three LAPPDs at a Solenoid Magnet

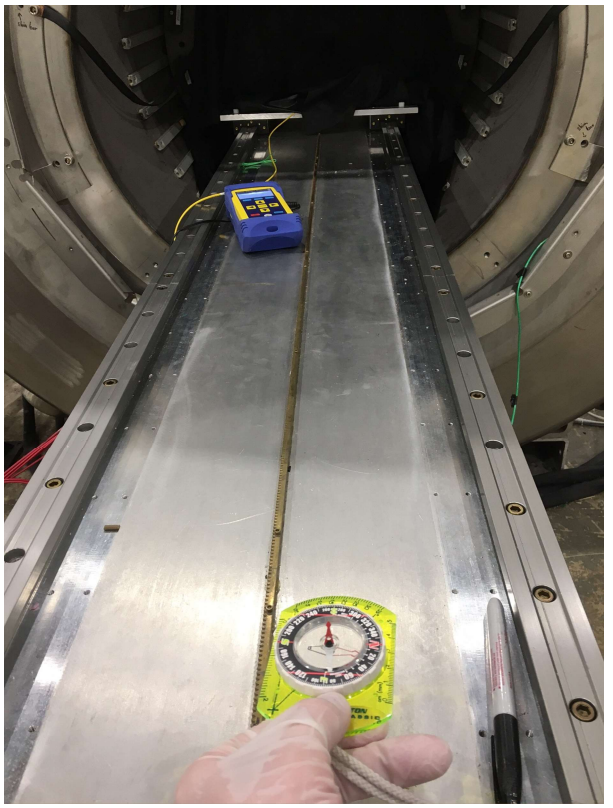
- Two stripline LAPPDs
  - 118, 20 um
  - 89, 10 um
  - One capacitively-coupled LAPPD: 126
- Magnetic field strength: 0.02 T to 1.4 T
- Stronger fields are possible with a modification of the dark box frame
- Dark box
  - Aluminum case
  - Laser input fixed in the center near the bottom – on the centerline 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
- Data products
  - Gain
  - Position
  - Position resolution
  - Transit Time Spread
  - Afterpulse rate



Magnetic Field Orientation

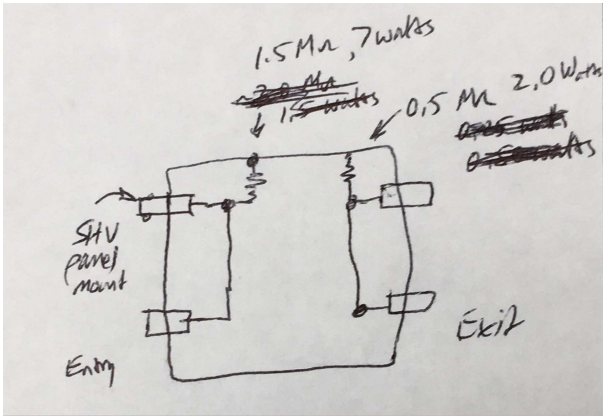
- A solenoidal magnetic field should be parallel to the interior walls of the magnet while inside the bore
- The field should curve away from the center line outside the magnet.
- Along the outside the magnet, the field has periodic **N** and **S** orientation – some type of active field control
- At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

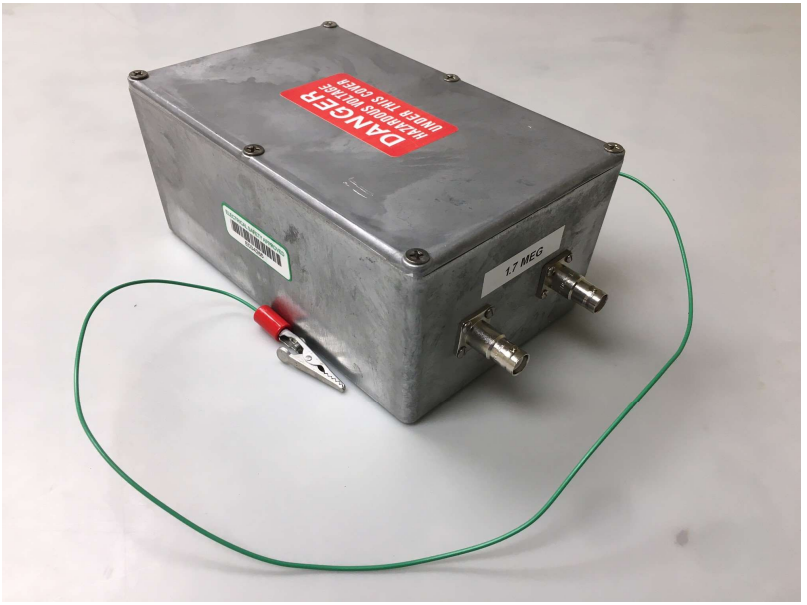


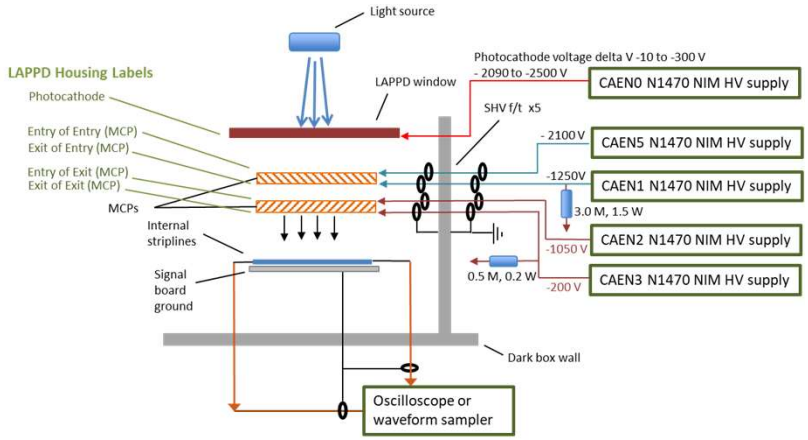


High Voltages

- 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

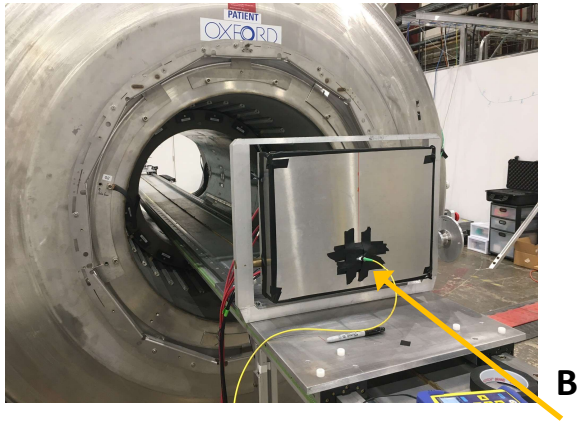


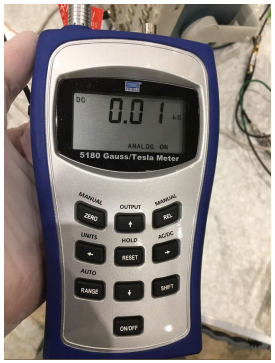


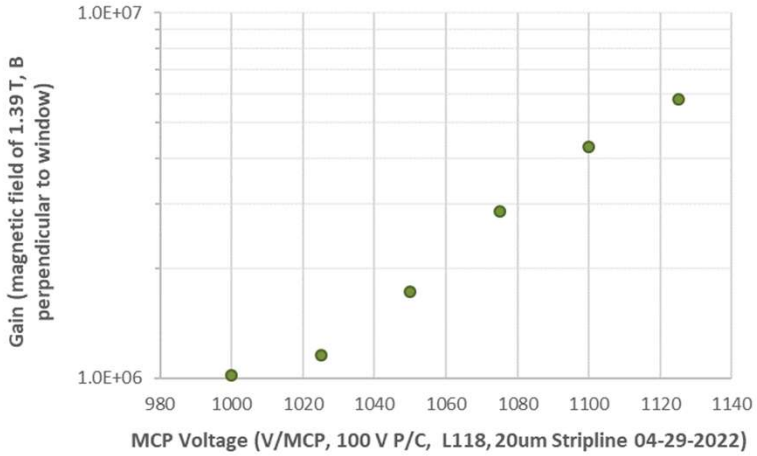


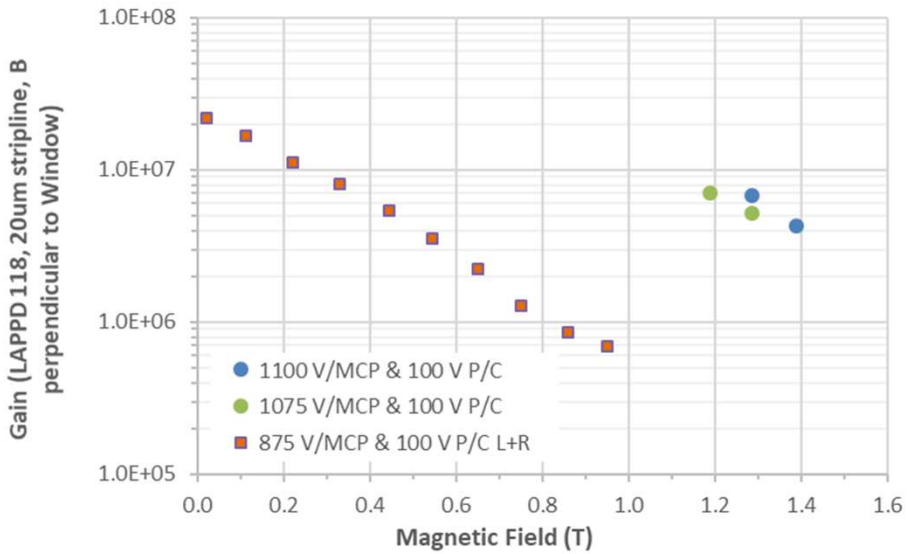
Gain vs. Magnetic Field Strength, B || P/C e-

- LAPPDs were pushed toward the solenoid and stronger magnetic field in steps
- B Field was measured with a gaussmeter at each step, units of kGauss
- 1 T = 10 kGauss
- Earth's field is 0.5 Gauss
- The gain decreased with increasing magnetic field strength.
- Gain could be recovered with a higher MCP voltage.
- Dark rates decreased even in the 0.02 T field (200 Gauss, 400x Earth's field)



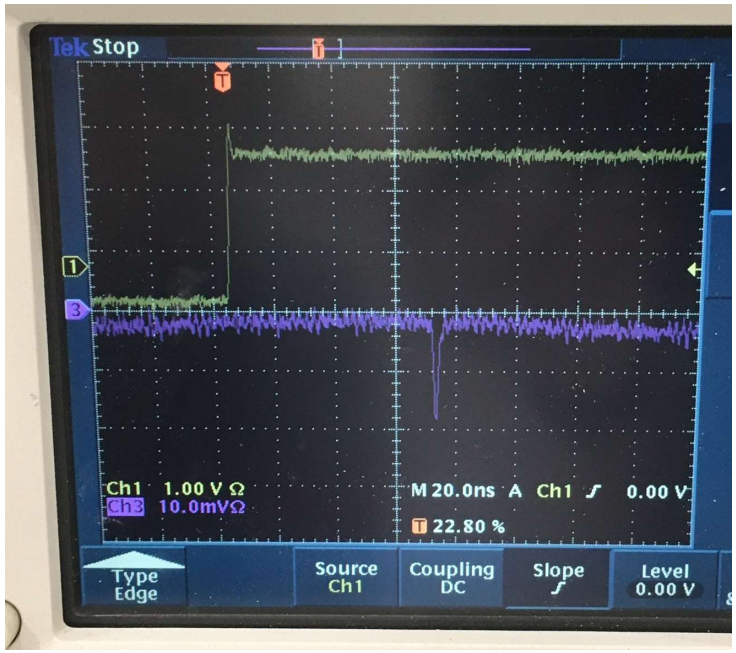






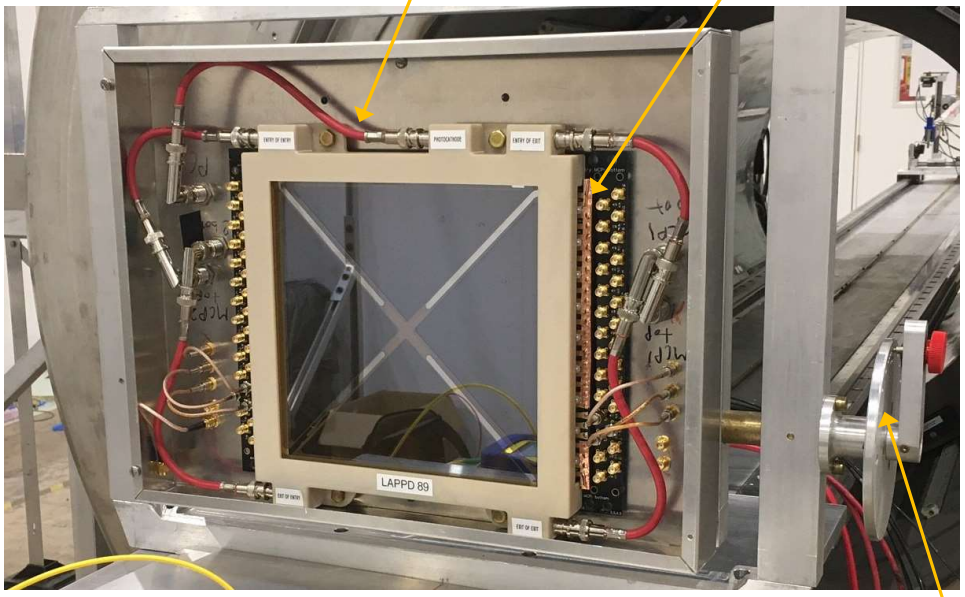
High Voltage and Signal Connections

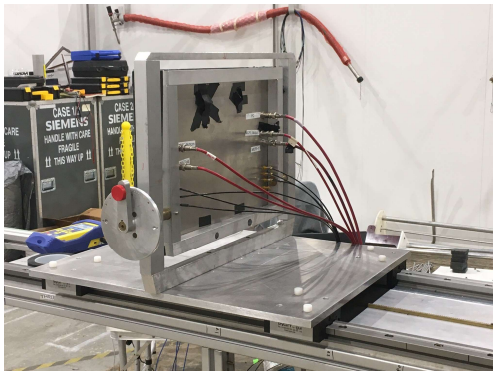
- Three strips, both ends were brought out to a Caen DT5742 DRS_4 waveform sampler.
- Five high voltages were brought in.
- Excellent pulse waveforms from the stripline LAPPDs.

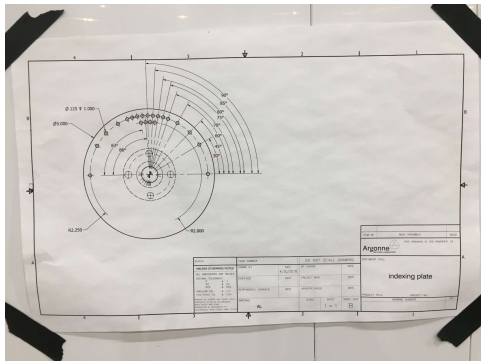


High voltage interior cables

Unused striplines grounded to SMA shields, both sides



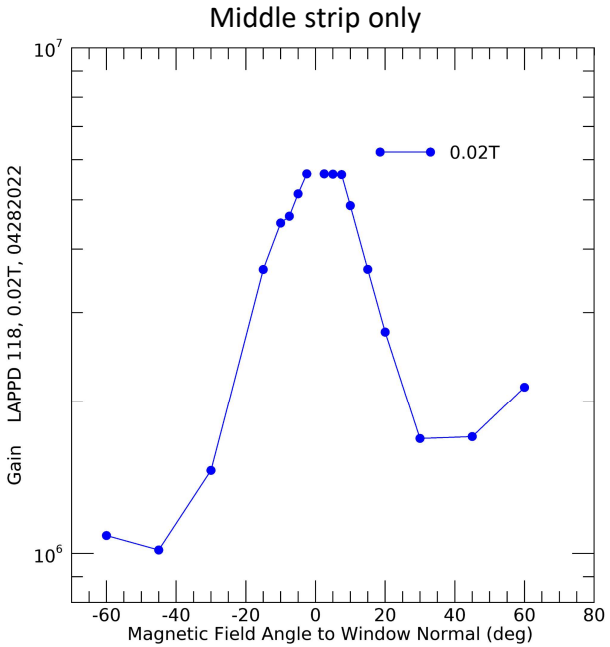


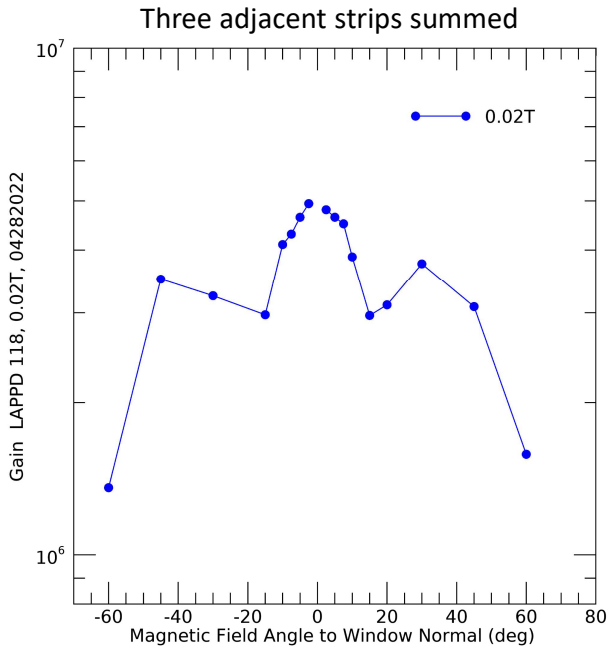


Rotation – discrete positions set with holes

Gain vs. Rotation Angle: LAPPD 118

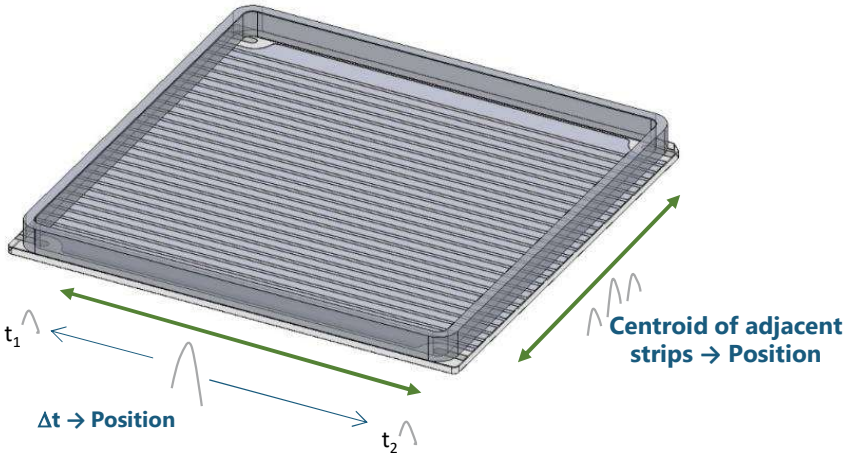
- Gain decreases as the LAPPD is rotated, and the B field is no longer parallel to photoelectron motion.
- Electron landing zone on the anode **moves** with relative B angle

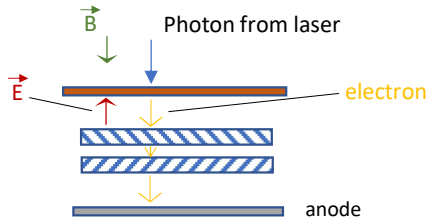




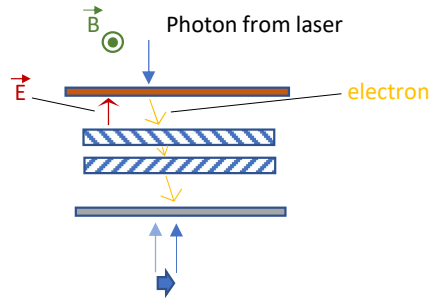
Position on the Stripline LAPPD

- Position along striplines: derived from relative arrival time of pulses at each end of the strip – timing leads to position resolution.
- Position across striplines: derived from centroid of charge on each strip. Pitch drives resolution.





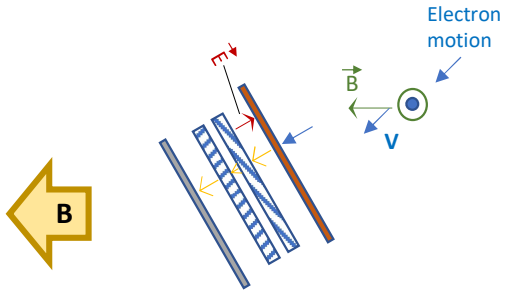
Electron flight path undeviated if electric field is parallel to magnetic field

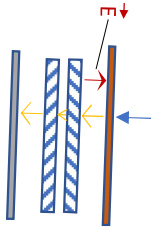


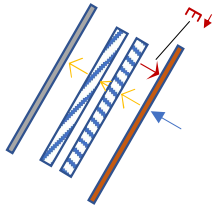
Electron flight path **is** deviated if electric field is perpendicular to magnetic field

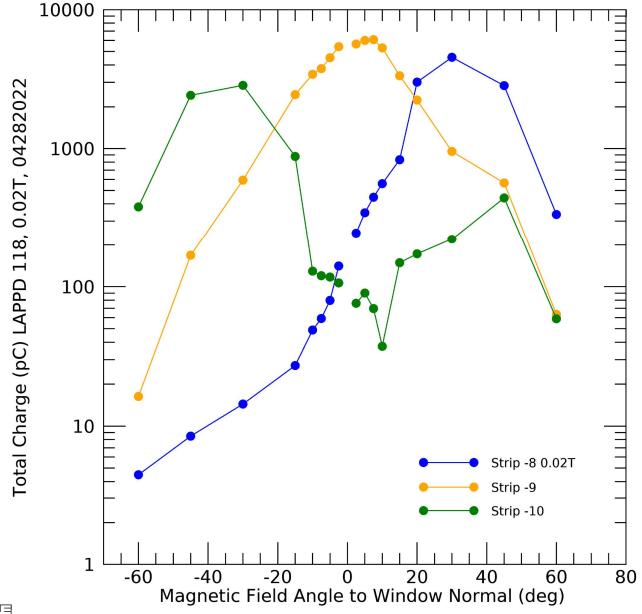
Gain vs. Rotation Angle: LAPPD 118

- 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 – position data

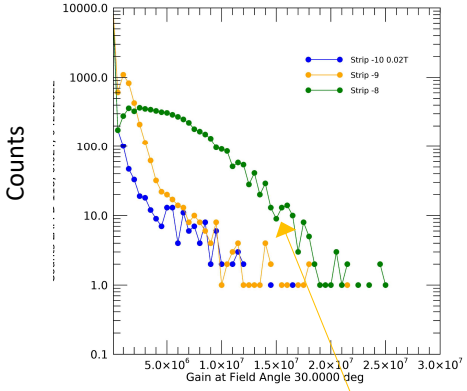






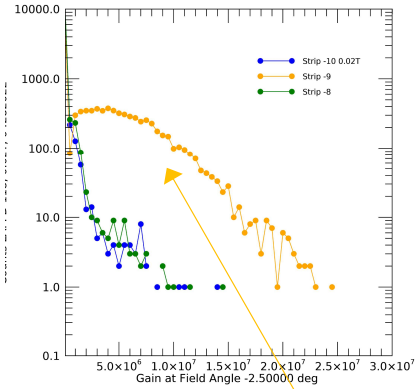


30 deg: top of LAPPD toward magnet



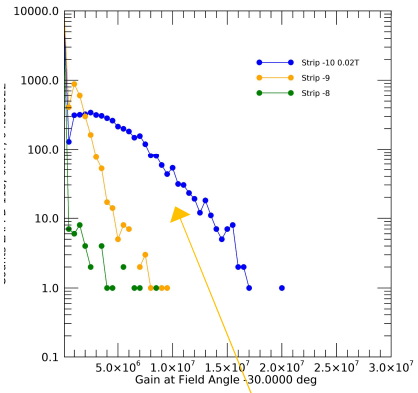
Adjacent strip on one side (-8)

-2.5 deg: LAPPD ~ vertical



Center strip (-9)

30 deg: top of LAPPD away from magnet



Adjacent strip on the other side (-10)