PMT Gain & Resolution Measurements in High Magnetic Fields

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Major Components

Magnet:
- superconducting solenoid
- max. field: 5.1 T at 82.8 A
- 12.7-cm (5-inch) diameter warm bore
- length of bore: 76.2 cm (30 inch)
- central field inhomogeneity: $\leq 5 \times 10^{-5}$ over a cylindrical volume of a diameter of 1.5 cm and length of 5 cm

Test Box:
- non-magnetic, light-tight
- cylindrical shape: $d_{in} \sim 4.5$ inch, $L \sim 18$ inch
- allows for rotation of sensors
- LED light source
## PMT Properties

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<tr>
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<tbody>
<tr>
<td>R11102</td>
<td>13.7</td>
<td>4.61</td>
<td>3.2</td>
<td>34</td>
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<tr>
<td>H6152-70</td>
<td>12.8</td>
<td>3.1</td>
<td>1.5</td>
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<tr>
<td>H6614-70</td>
<td>8.0</td>
<td>6.0</td>
<td>2.5</td>
<td>9.5</td>
<td>0.44</td>
<td>1e7</td>
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</table>
Sensor Orientation Capabilities

- Holder: balance of magnetic torque
- Turntable: rotation about $Y(Y')$ axis

$\varphi$: rotation about $Z'$

$\theta$: rotation about $Y(Y')$

$Z'$ (along sensor's axis)

$Z$ (along $B$-field)
Data were taken at a series of angles between 0° and 50° for magnetic fields up to 1.9 T.

Between 35° and 45° the relative amplitudes are approximately the same.

The analysis with the full statistics is shown.
H6614-70 Comparison to INFN

M. Bonesini et al. NIM A 572 (2007) 465

H6614-70 Relative Amplitude, HV = 2.0 kV

2in FMPMT

Amplitude(B)/Amplitude(B=0)

Magnetic Field [T]

G(B)/G(B=0 T)

B(T)
Data were taken at a series of angles between 0° and 50° for magnetic fields up to 1.9 T.

The timing resolutions were scaled to account for the loss of light collected as the PMT was rotated wrt the LED fiber.

The analysis with the full statistics is shown.
H6614-70 Comparison to INFN

M. Bonesini et al. NIM A 572 (2007) 465
Data were taken at a series of amplitudes with the pulse generator at 0 T and 0 degrees.

- Number of photoelectrons = amplitude/single photoelectron
- $\tau_{\text{LED}}$: LED capacitance, expected to be $\sim 1$ ns
Data were taken at a set of angles ~ 35° wrt the field:

- \( \theta = 35^\circ \) and \( \phi = 0^\circ \)
- \( \theta = 325^\circ \) and \( \phi = 0^\circ \)
- \( \theta = 35^\circ \) and \( \phi = 90^\circ \)
- \( \theta = 215^\circ \) and \( \phi = 0^\circ \)

No discernible difference is seen for \( \pm 35^\circ \) and \( \phi = 0^\circ \) or \( 90^\circ \)
H6614-70 Symmetry Check

- Data were taken at a set of angles $\sim 35^\circ$ wrt the field:
  - $\theta = 35^\circ$ and $\phi = 0^\circ$
  - $\theta = 325^\circ$ and $\phi = 0^\circ$
  - $\theta = 35^\circ$ and $\phi = 90^\circ$
  - $\theta = 215^\circ$ and $\phi = 0^\circ$
- No discernible difference is seen for $\pm 35^\circ$ and $\phi = 0^\circ$ or $90^\circ$
Data were taken at a series of angles between 0° and 40° for magnetic fields up to 1.4 T.

Between 30° and 40° the relative amplitudes are approximately the same.

It appears that at 330° (-30°) that the relative amplitude is a bit better than +30°.
Data were taken at a series of angles between 0° and 40° for magnetic fields up to 1.4 T.

The timing resolutions were scaled to account for the loss of light collection as the PMT was rotated with respect to the LED fiber.