Test of the HAMAMATSU R5505 fine-mesh phototube in magnetic fields

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The proposed photon detector [1] for ANKE has to be operated in the magnetic environment of the stray field of a 1.6 T dipole. The field strength at the positions of the single modules is $B \leq 0.2$ T. To exploit the fast timing of the detector material $PbWO_4$ [2], it is necessary to use photomultipliers for readout rather than slow conventional photodiodes or avalanche photodiodes (APD). Using an APD one can reach a time resolution of ≈ 1 ns, but its noise in combination with the low light output of $PbWO_4$ makes it unsuitable for this application. While photodiodes are insensitive to external magnetic fields, only special fine-mesh phototubes can be operated in such an evironment. These are insensitive to magnetic fields parallel to the multiplier axis (up to B$\leq$ 1 T), but have to be shielded against the transversal field component. Since the photon detector is of spherical shape, all directions of the magnetic field are equally important with respect to the multiplier axis.
The only commercially available model of this fine-mesh type (Hamamatsu R5505), has been tested intensively. Figure 1 shows some test results for the unshielded tube. As expected, with the field parallel to the multiplier axis almost no effect on the amplification is seen, but using a perpendicular field the output already drops down at 0.02 T.

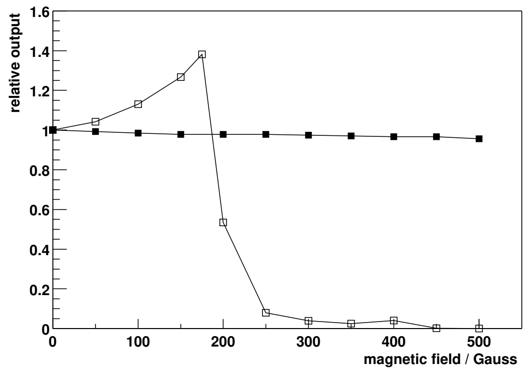

Figure 1: The behaviour of an unshielded R5505-tube within a magnetic field. The relative angles between the magnetic field and the tube axis are 0° (closed symbols) and 90° (open symbols), respectively.

In fig. 2 the same situation is shown using a shielding tube of soft iron (wall thicknesses 1 mm and 2 mm): the undisturbed range extends to at least 0.12 T. From this it is concluded that the existing stray field at ANKE can be handled with a shielding thickness of 3 mm.
These studies have been performed in a static magnetic field. During the experiment the multipliers have to withstand the ramping between two accelerator cycles and the amplification has to recover to the same value in all data taking cycles. This

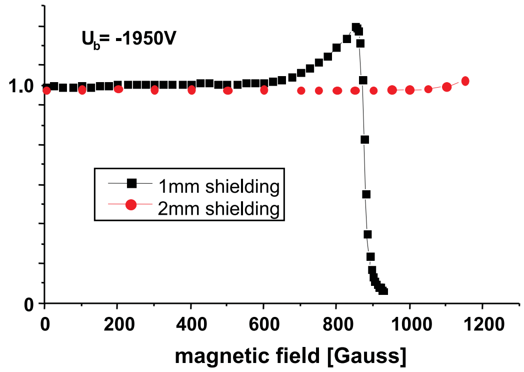

Figure 2: Shielded R5505-tube (1mm/2mm soft iron) in a magnetic field up to 0.12 T. The magnetic field is oriented perpendicular to the multiplier axis.

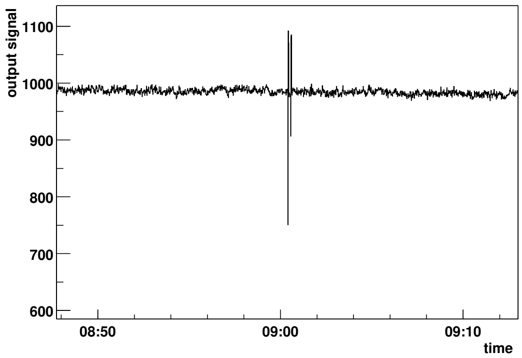

Figure 3: The behaviour of the shielded R5505-tube (3mm soft iron) at the designated position under experimental conditions at ANKE. The pulse height is plotted as a function of time. While the two peaks originate from the ramping of the magnet, the amplification before and after each ramping is essentially unchanged.

has been checked during an ANKE beam time in September 2000. The phototubes were illuminated with LEDs and positioned in front of the dipole magnet. As shown in fig. 3 the ramping (i.e. the change of the magnetic field during acceleration of the COSY beam) has some effect on the pulse height of the multiplier, but the output within a beam cycle (flat top) is stable and has the same value before and after each acceleration. This means that the R5505 meets the demands for the proposed photon detector at ANKE.

References

[1] M. Büscher et al., COSY Proposal #83: A photon detector for COSY, November 2000.

[2] V. Hejny et al., $PbWO_4$ as a scintillator material for a photon detector at ANKE/COSY, IKP Annual Report, 1999.

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