Qweak Main Detector PMT magnetic field shield Test

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Abstract:

Initial test of Qweak 5" PMT's magnetic shielding were performed with pulsed LED. The signal magnitude variation without a magnetic shield about 10% were seen in the earth's field. With a magnetic shield installed variation in magnitude were reduced to less than 1%.

Introduction

The main detector of Qweak experiment is a octagonal array of quartz Cerenkov detectors. Each detector will consist from highly transparent 200 cm long fused silica radiator (glued from two 100 cm long pieces) bars. Light-guides will be glued to each end to couple the light into 5" diameter photo-cathode PMT's (xp4572B). Due to limited access PMT's could be coupled to the light-guide only at 90 deg. Hence the PMT magnetic shielding could be only up to the edge of photo-cathode.

Fig.1: Schematics and geometry of Qweak quartz detector module.)
Quartz detectors will be at z=570 cm and R=328 cm relative to the center of the magnet. Calculations by W. Falk (U. Manitoba) indicate that the stray field from QTOR at the main detector position have a total magnitude less than 0.1 Gauss. So the earth's field is expected to dominate. Of course, still could be some dependence from orientation of the PMT relative to the magnetic field of the earth.

Initial test of Qweak 5" PMT's magnetic shielding were performed with pulsed LED. Short description and results of these measurements presented below.

**Measurements**

The PMT's installed in a small dark box. A pulsed LED was used as a light source. PMT operated at 1400 kV using a new HV base with a gain of ~10^6. Signal amplitude was read out by ADC. Measurement of the direction and magnitude of earth field was done with compass and Gauss/Tesla Meter "Model 4048", and was found that maximum value of the field is about 0.5 G.

Two sets of measurements were performed in 3 different positioning. The points on the plots are for 0 degree - PMT photocathode faced to East, for 90 degree - PMT photocathode faced to North and for -90 degree - PMT photocathode faced to South. Test for with Gauss/Tesla Meter show that the mu metal shielding for PMT does excellent job. Without shielding the value of field was ~ 0.5 G, with shielding Tesla meter shows only ~ 0.01G.

The PMT signal magnitude was measured when the small "dark box" was rotated in the earth's field first without magnetic shield, and with mu metal magnetic shielding (the standard one made by Electron Tubes for this PMT, which we are planning to use in Qweak experiment).

Maximum amplitude of PMT without shielding was observed when PMT photo-cathode at +90 deg relative to the field direction. Strong effect from magnetic field was found when PMT axis along the earth field direction.

Overall, without magnetic shield, variations about 10% were seen as in a figure below on the left.

With a magnetic shield installed, variation in magnitude were reduced to less than 1% as seen in the figure on the right. This improvement is particularly impressive given that, in current design of the detector, the PMT face is flush with the opening of the cylindrical magnetic shield.
Fig. 2: The PMT signal magnitude variation in the earth field without (left panel) and with (right panel) magnetic shield.

**Conclusion:**

The mu metal shielding of PMT does excellent job in shielding magnetic field. These results are encouraging but preliminary since linear focused dynodes are especially sensitive in one direction transverse to the dynode chain and this worse-case condition may not have been probed.