# Test-beam Aging Studies of a TMAE Prototype for the HERA–B RICH

M. Atiya[1], D. Brommelsiek[2], Th. Hamacher[3], M. Ispiryan[4], S. Korpar[5,6], P. Krizan[6,7], K. Lau[4], P. Maas[2], J. McGill[3], J. Pyrlik[4], K. Reeves[3], P. Rose[4], J. Rosen[2], A. S. Schwarz[8], R. Schwitters[3], and M. Staric[6]

presented by **Kwong Lau**

*1) Brookhaven National Laboratory, Upton, NY 11973, USA*
*2) Northwestern University, Evanston, IL 60208, USA*
*3) University of Texas, Austin, TX 78712, USA*
*4) University of Houston, Houston, TX 77204, USA*
*5) University of Maribor, Maribor, Slovenia*
*6) J. Stefan Institute, 1001 Ljubljana, Slovenia*
*7) University of Ljubljana, 1001 Ljubljana, Slovenia*
*8) Deutsches Elektronensynchrotron (DESY), 22603 Hamburg, Germany*

We report on aging measurements of a 64-cell proportional chamber Cherenkov photon detector prototype operating in a methane/TMAE gas mixture. The cells of the chamber, 100 mm long and $8 \times 8$ mm$^2$ in area, were constructed with brass cathode and 45 $\mu$m gold-plated tungsten anode wire. Aging was achieved by exposing the chamber to UV light from a deuterium lamp up to photon rates of 3 MHz/cm$^2$ for several weeks while the chamber was being studied in a DESY electron test beam. The photon-detection efficiency of the chamber was determined by measuring the number of Cherenkov photons emitted by 3 GeV electrons in a radiator consisting of 5 m of Argon. The pulse height distribution of the chamber was continuously monitored during the aging process. We found significant loss of chamber gain after an exposure equivalent to about 2 mC of charge deposited on the cell.

**Summary of Talk:** This talk reports on the aging measurements of a prototype TMAE photon detector for the HERA–B RICH. The HERA–B experiment was designed to operate at interaction rates up to 40 MHz. The particle identification system, a Ring Imaging Cherenkov (RICH) detector consisting of a 2.75 m long $C_4F_{10}$ radiator, is expected to reach peak photon rate of 3 MHz/cm$^2$. Aging of TMAE-based proportional chambers has been observed at OMEGA and SLD. A first HERA–B photon detector prototype chamber, consisting of 1024 $8 \times 8$ mm$^2$ cells using 25 $\mu$m wire operated with a TMAE/methane mixture at room temperature, indicated a 50% loss of gain after being exposed to a dose equivalent to about one HERA–B day. To find out if this rapid aging of TMAE-based proportional chambers can be slowed down, a second-generation 64-cell prototype was built with 45 $\mu$m wires and tested in an electron beam at DESY. The goal was to expose the chamber to radiation conditions as close as possible to those of HERA–B and to measure the Cherenkov photon detection efficiency during this aging process. We have monitored all the relevant environmental factors so that they can be corrected for in the analysis. The chamber assembly was housed in a 90 mm$^2$ square stainless steel tube fitted with a quartz window on one side and a flange to hold and seal the backplane on the other. An all stainless steel gas system has been built to vacuum specifications. Methane of 99.99% purity was first passed through an Oxisorb filter to remove residual water and oxygen. Regulated by electronic mass flow controllers, part of the flow was then forced through a TMAE-filled bubbler at room temperature and, mixed with the other part, was fed into the chamber. Prior to using this TMAE in the prototype chamber, the TMAE was washed with nitrogen until about 5% of the liquid was evaporated. For the normal operation of the chamber, we choose a flow rate of 10 cm$^3$/min through the bubbler and the bypass, yielding a TMAE/$CH_4$ mixture with a photon absorption length of approximately 5 cm. About one chamber volume of gas was exchanged per hour. We applied negative high voltage through a 1 M$\Omega$ resistor to the cathode planes; the wires were at ground potential. An operating point of 2650 V was used to achieve a gain of 200,000, determined from the measured current and the count-rate projected to 0 V threshold. The chamber was mounted on the upper quartz window of a 5 m long radiator tank, filled with argon, situated at the T24 3 GeV electron test beam at the DESY synchrotron. To achieve an even photon flux comparable to that in the HERA–B RICH, a UV light source was placed at the focus of the mirror on the outside of the radiator tank. The source consisted of a variable pin hole in front of a matte quartz plate illuminated by a deuterium lamp (Hamamatsu L5499-50). The light input to the chamber was monitored continuously by a UV PMT (Hamamatsu R2059) placed next to the chamber. The PMT was fitted with an interference-type filter (Oriel

200-N-2D) to limit the sensitivity to 200$\pm$11.3 nm. To test different exposure rates the chamber was divided into four equal quadrants Q1–Q4 by a removable mask (an aluminum plate with different size hole patterns) with transmissions of 100% (Q4), 64% (Q1), 32% (Q2) and 0% (Q3). The charge deposited on the wires, added by quadrant, was measured directly by an electrometer (Keithley 6517). The AC part of the signal was read by four 16-channel low noise charge sensitive preamplifiers. The pulse-height spectrum was determined automatically about every half hour, by taking a threshold curve for all 64 channels with a programmable discriminator. Every 1–3 days, aging was interrupted for about an hour by turning the deuterium lamp off. The electron beam was turned on. Runs of about 10,000 triggers with counting rates and TDC information for all 64 wires were taken. The triggers were created by a 3-fold coincidence of a beam scintillator and two small tracking chambers. The two sets of data were used to collect as much information as possible during the aging process of the TMAE chamber. First, the number of detected Cherenkov photons produced by relativistic electrons in an argon radiator is an absolute measure of the chamber efficiency. The number of detected photons in the prototype chamber in the wavelength range 150–220 nm was estimated with a model to be 11.2$\pm$1.5 photons per track, which agrees well with the measured number of 11.5 photons before aging. Second, the continuously monitored environmental parameters and the frequently measured charge distribution of each wire allow an easy detection of changes in the gain of the wire. Both efficiency and gain of the exposed chamber quadrant Q4 dropped during the first two days to less than half of their initial values. After two days the drop in gain and efficiency of Q4 slowed to about 10% per week. The gain of the unexposed quadrant Q3 dropped to about two-third of its initial value during the first day, then continues to fall at about 3% per week. The efficiency of Q3, with larger uncertainty, also dropped to two-thirds of its initial value after the first day of exposure.