Further Measurements of Photocathode Operational Lifetime at Beam Intensity > 1mA using the CEBAF 100 kV DC GaAs Photogun

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Photocathode operational lifetime of modern DC high voltage GaAs photoguns is limited primarily by ion back-bombardment, the mechanism where residual gas at the cathode/anode gap is ionized by the extracted electron beam and back accelerated toward the photocathode. It is widely believed the ions damage the GaAs crystal structure or sputter away the chemicals that are used to create the negative electron affinity condition of the photocathode. This work extends beyond research aimed at better appreciating the mechanisms that limit photocathode lifetime at high current (> 1 mA). Specifically, the performance of a new 100 kV DC load lock photogun will be described. Although it is difficult to measure directly, we believe the new load lock gun design has better vacuum conditions compared to the previous gun design, which is studied by measuring photocathode lifetime. In addition, lifetime measurements were performed using an activated photocathode coated with hydrogen. These photocathodes begin with lower quantum efficiency but, exhibit increased quantum efficiency concurrent with ion back-bombardment, and consequently enhanced operational lifetime. Finally, lifetime measurements were performed using a biased anode electrode, to investigate quantum efficiency decay associated with ion production outside the gun vacuum chamber.

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