Improving the Operational Lifetime of the CEBAF Photo-Gun by Anode Biasing

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The operating lifetime of GaAs-based photocathodes in DC high voltage electron photo-guns is dominated by the ionization rate of residual beamline gas molecules. Ions created within the photo-gun potential are accelerated toward the photocathode, leading to a reduction of the photocathode quantum efficiency (QE). In this work, experiments were performed to quantify the improvement in photocathode charge lifetime by biasing the photo-gun anode with a positive voltage, which repels ions generated downstream of the anode. The method was tested by successively applying and removing the anode bias voltage of the CEBAF photo-gun at the Thomas Jefferson National Accelerator Facility over many months of beam production. The photocathode charge lifetime improved by almost a factor of two when the anode was biased compared to the usual grounded configuration. Simulations were performed using the particle tracking code General Particle Tracer (GPT) with a new custom element and electric field models of the CEBAF photo-gun made using CST Microwave Studio software to explain the improvement. The experiment results and conclusions supported by the GPT simulations will be presented.

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