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PERFORMANCE OF GAASP/GAAS SUPERLATTICE PHOTOCATHODES IN HIGH ENERGY EXPERIMENTS USING POLARIZED ELECTRONS*

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The GaAsP/GaAs strained superlattice photocathode structure has proven to be a significant advance for polarized electron sources operating with high peak currents per microbunch and relatively low duty factor. This is the characteristic type of operation for SLAC and is also planned for the ILC. This superlattice structure was studied at SLAC [1], and an optimum variation was chosen for the final stage of E-158, a high-energy parity violating experiment at SLAC. Following E-158, the polarized source was maintained on standby with the cathode being re-cesiated about once a week while a thermionic gun, which is installed in parallel with the polarized gun, supplied the linac electron beams. However, in the summer of 2005, while the thermionic gun was disabled, the polarized electron source was again used to provide electron beams for the linac. The performance of the photocathode 24 months after its only activation is described and factors making this possible are discussed.

1. Photocathode History and Operation

The cathode was installed in the preparation chamber in June 2003, heat-cleaned once at restricted high temperatures, activated with Cs and NF_3, inserted into the

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gun under vacuum, and thereafter only Cs was added periodically and *in situ*. This cathode provided a highly polarized (~90%), high intensity (~5x10^{11} e^- per square-shaped macropulse of ~300 ns) pulse during a dedicated 2-month run at 120 Hz. In the summer of 2005, the cathode was used to support PEPII operations 2005 (30 Hz, 2*10^{10} e^- per pulse, 2 ns pulse). At the end of this period the cathode was in use for more than 900 days, while it delivered electrons for the accelerator for almost 200 days. During the entire time, about 160 (automated) cesiations have been performed in 5 to 6 day intervals. RGA measurements near the gun indicate a total residual gas pressure of 10^{-11} Torr. Excluding H_2, the vacuum near the cathode is less than 10^{-12} Torr (Figure 1). Quantum efficiency (QE) profile measurements of the 2-cm-diameter emitting area have been performed several times since installation of the cathode. During this time the QE profile showed a small decrease near the center of the cathode, which can be attributed to 'back–bombardment' of the cathode's surface by residual ions. Our experience shows that recovery of the original QE profile by re-cesiation is only partly possible. However, for our operating conditions this is a negligible phenomenon as the QE monitor indicates stable performance throughout this time (Figure 2). Due to operational constraints, polarization measurements could not be performed after September 2003. Nevertheless, our results show that GaAsP/GaAs superlattice photocathodes can be low–maintenance, highly reliable e^- sources for future high energy physics projects such as the International Linear Collider.

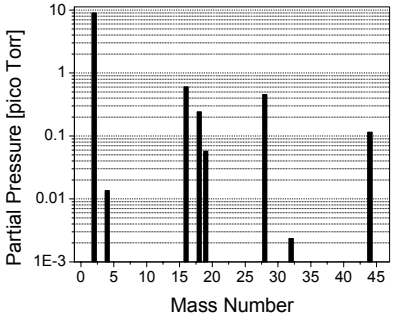

Figure 1:Residual Gas Analysis near Photocathode.

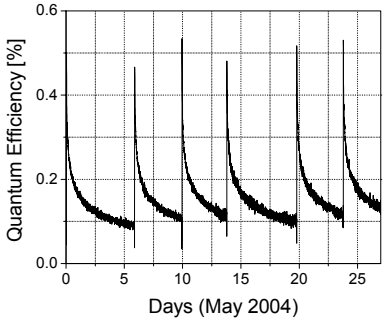

Figure 2: Quantum efficiency monitor showing cesiation cycle of 5 – 6 days.

References

1. T. Maruyama et al., *Appl. Phys. Lett.* **85**, 2640 (2004).