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Emittance Studies of the BNL/SLAC/UCLA 1.6 cell Photocathode rf Gun*

D. T. Palmer*, X. J. Wang†, R. H. Miller*, M. Babzien†, I. Ben-Zvi†, C. Pellegrini**, J. Sheehan†, J. Skaritka†, H. Winick*, M. Woodle†, V. Yakimenko†

*Stanford Linear Accelerator Center, Stanford University, Stanford, CA 94309
†Brookhaven National Laboratory, Accelerator Test Facility, Upton, NY 11973
**University of California Los Angeles, Department of Physics, Los Angeles, CA 90095

Abstract

The symmetrized 1.6 cell S-band photocathode gun developed by the BNL / SLAC / UCLA collaboration is in operation at the Brookhaven Accelerator Test Facility(ATF). A novel emittance compensation solenoid magnet has also been designed, built and is in operation at the ATF. These two subsystems form an emittance compensated photoinjector used for beam dynamics, advanced acceleration and free electron laser experiments at the ATF. The highest acceleration field achieved on the copper cathode is 150 $\frac{\mathrm{MV}}{\mathrm{m}}$, and the guns normal operating field is 130 $\frac{\mathrm{MV}}{\mathrm{m}}$. The maximum rf pulse length is 3μs. The transverse emittance of the photoelectron beam were measured for various injection parameters. The 1 nC emittance results are presented along with electron bunch length measurements that indicated that at above the 400 pC, space charge bunch lengthening is occurring. The thermal emittance, ϵ_o, of the copper cathode has been measured.

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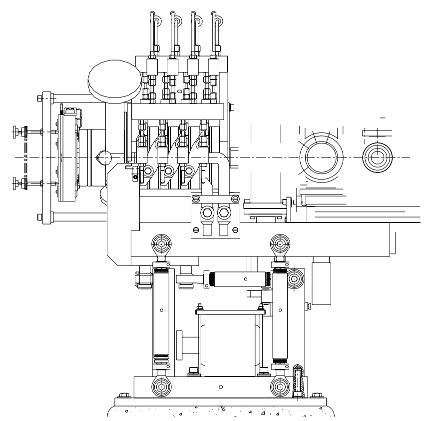
1 INTRODUCTION

The BNL/SLAC/UCLA S-band emittance compensated [1] photoinjector has been installed at the Brookhaven Accelerator Test Facility(ATF) as the electron source for beam dynamics studies, laser acceleration and free electron laser experiments. The 1.6 cell rf gun is powered by a single XK-5 klystron, and is equipped with a single emittance compensation solenoidal magnet. There is a short drift space between the photoinjector and the input to the first of two SLAC three meter travelling wave accelerating sections. This low energy drift space contains a copper mirror that can be used in either transition radiation studies or laser alignment. There is also a beam profile monitor/Faraday plate located 66.4 cm from the cathode plane. The photoinjector beam line layout is presented in figure 1.

The high energy beam transport system consists of nine quadrupole magnets, an energy spectrometer, an energy selection slit and a high-energy Faraday cup. Diagnostics located in the high energy transport consist of beam profile monitors and strip lines. The strip lines are used for an on line laser/rf phase stability monitor.

The drive laser is a Nd:YAG master oscillator/power amplifier system. A diode pumped oscillator mode locked at 81.6 MHz produces 21 psec FWHM pulses at 100 mW of average power. Gated pulses seed two flash lamp



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