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THERMIONIC GUN CATHODE TEMPERATURE LIMIT CHARACTERIZATION *

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Abstract

To prolong the lifetime of a thermionic gun cathode (Eimac model Y-796) it is desirable to have the cathode temperature as low as possible and will accommodate sufficient charge with adequate stability. Barium from the cathode material (tungsten body impregnated with 4BaO: CaO: Al_2O_3) eventually migrates to the grid and builds up in a pseudo-fibrous fashion. As material grows on the grid, emission from the grid grows, as "dark current" in the accelerator. Some of this dark current overlaps the RF pulse and is accelerated to whatever the pulsed beam destination is or would be. Another problem which develops is degradation of the high voltage standoff, which correlates with vacuum activity. That is, arcs begin to occur lowering reliability and necessarily lead to cathode replacement [1]. It is desirable for both cathode lifetime and minimum dark current over the lifetime to run "temperature limited" – that is, to run the lowest operable temperature of the cathode material.

SETUP

The Eimac Y-796 assembly is in a Thermionic Gun of SLAC design and installed in the CID (formerly Collider Injector Development) area of the SLAC LINAC. The voltage for the cathode filament is delivered from a "gun deck" suspended on dielectric standoff from the LINAC housing ceiling near the thermionic gun. This gun deck is at high voltage along with the gun and therefore inaccessible during gun operation due to personnel electrical and radiation protection considerations.

There are fiber optic communication cables to the gun deck from electronics outside the accelerator housing. The filament voltage monitor points are accessible when the gun is off at the gun deck, and at all times from monitor points on an electronics chassis outside the accelerator housing as well as through an ADC and its associated computer readout on the SCP (SLAC Control Program). Figure 1 shows the correlation of the monitor points on the outside electronics chassis and the program readout. The only accurate monitor is on the gun deck, but other monitors are linear with that and can be calibrated. The remote computer readout is low by about .3 Volts.

The voltage control for the filament is on the gun deck, but recently added is a remote control in the form of a dielectric rod which can be turned with a dc motor emulating a hand.

TEMPERATURE LIMITS

The voltage is varied and read back at the monitor points on the outside chassis and the computer readout. Other computer readouts are of the ground current detected in the power supply electronics and the number of pulsed electrons by beam position monitors. The power

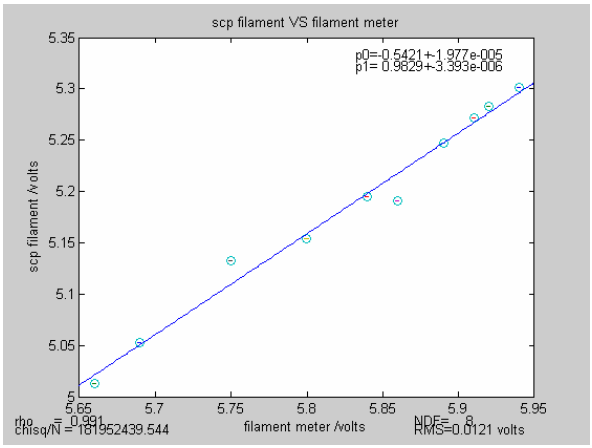

Figure 1. Fitted is the filament voltage remote readback versus a voltmeter on test points at the control chassis.

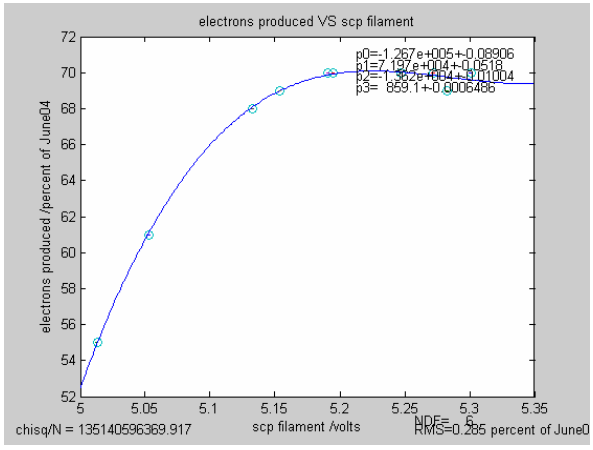

Figure 2. Fitted is the ratio of the number of electrons emitted to what was emitted near the end of the last run versus the remote cathode filament voltage readout.

electron production versus filament voltage. There is a definite "knee" in the data with optimum at about 5.2 volts which produces about 70 percent of the June reference intensity.

Ground current is show to dramatically rise above 5.2 volts on the filament in figure 3.

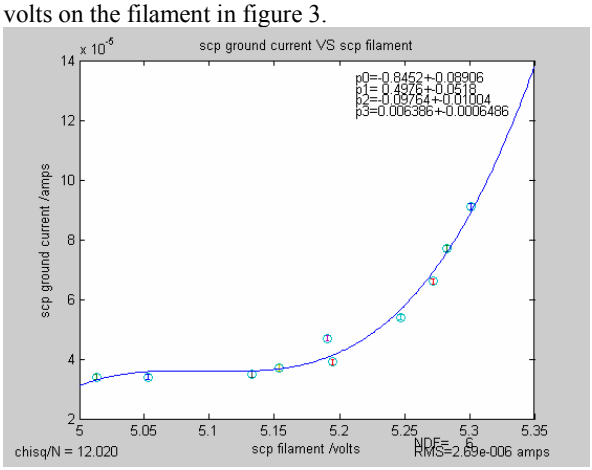

Figure 3. Ground current calibrated remote readout versus remote readout of the cathode filament voltage.

ACKNOWLEDGEMENTS

We would like to thank Mike Browne and Bill Roster for their work to modify the existing filament for remote control operation.

REFERENCES

[1] J. Turner et. al, "TGUN CATHODE CHANGE" SLACPOLSOURCENOTE TN-99-04, SLAC, November 1999.