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Thermal Imaging and Current Emission Measurements
On a Large Thermionic Dispenser Cathode

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Lansce-9

Workshop on Cathodes for Relativistic Electron Beams
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Hardware identical to DARHT-2 is being tested on the CTS.
On the CTS, a unique current emission diagnostic is being used to characterize cathode quality.
At temperatures of interest blackbody radiation peaks at about 2 microns.
However photon flux is most sensitive to temperature on the short wavelength side of the peak.
Radial profile was adjustable but not optimal with a dual heater design
Best case temperature uniformity with dual heater design
CTS Data- Thermal imaging has revealed a ~25°C cold spot where the filament leads enter and exit the cathode.
Emission is uniform when the cathode operates in the fully space-charge limited regime.
Data in the FSCL regime scales as $V^{3/2}$ to within a few %. At lower temperature emission is not fully SCL so scaling is slightly less than 3/2.
Emission becomes non-uniform at lower temperature.
The model predictions are sensitive to both the average value of the work function and the rms width of the distribution.
A single work function distribution fits all the I-V curve data taken at various temperatures.
A slightly higher work function with a larger rms spread fits the up position data where the cathode is cooler and has a larger temperature variation.
The work function parameters from the up-position produces a poor fit for the down-position data.
SUMMARY

• Thermal imaging of an 8” and 6.5” cathode has been performed.
• A dual heater design was only moderately successful in making a uniform temperature profile.
• A non-axisymmetric cold spot is created where the filament enters and exits the cathode.
• A unique diagnostic has been developed to study the current emission uniformity of large thermionic cathodes.
• Emission has been studied from the FSCL regime to the TL regime over a range of cathode temperatures.
• A model that uses a work function distribution function fits the data very well. A work function of about 1.8 eV produces the best fit to the measurements. The rms spread of the work function is correlated with the measured temperature gradients.