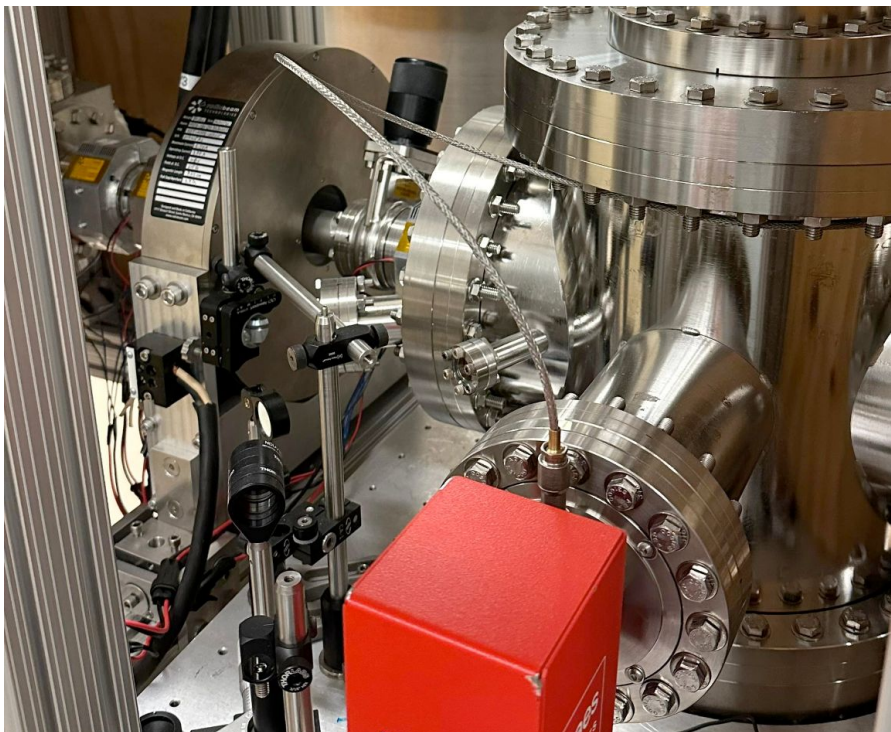


Recommissioning the 200kV Cryo Electron Gun

At ASU's Photoemission and Bright Beams Lab

The Electron Gun



To the right:

The electron gun, with
the first solenoid
visible.

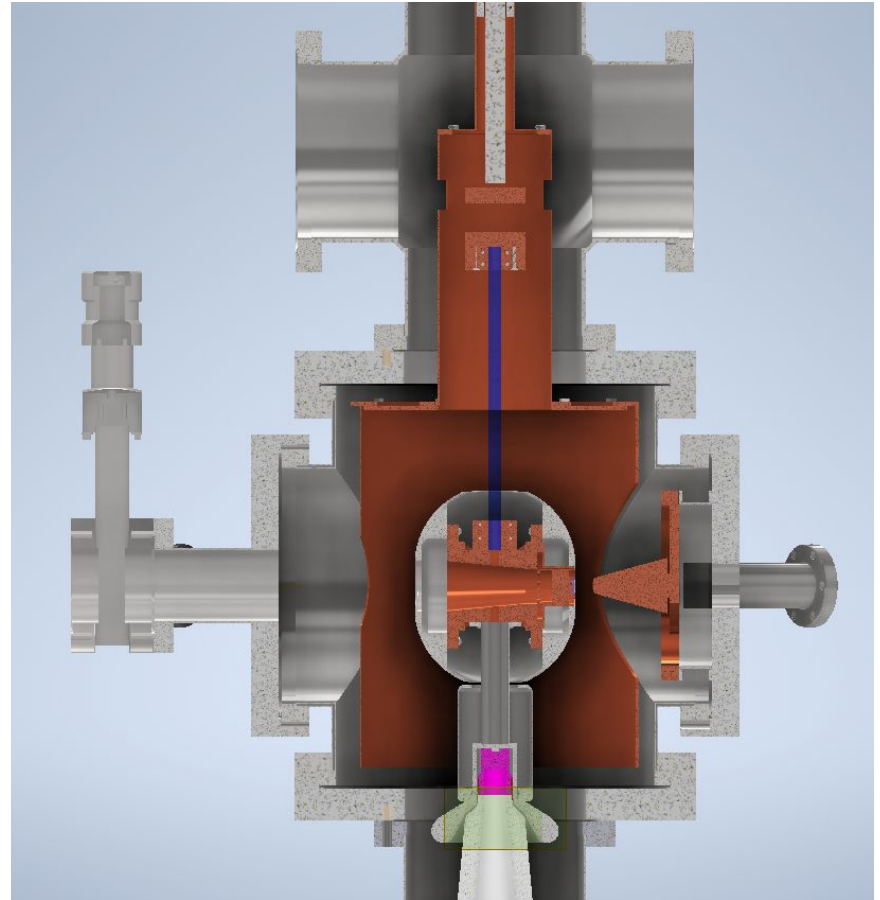
To the left:

The electron gun
clearly connected to
the beamline, with the
first solenoid and one
corrector coil clearly
visible, and two other
corrector coils partially
obscured.



Design of the Electron Gun

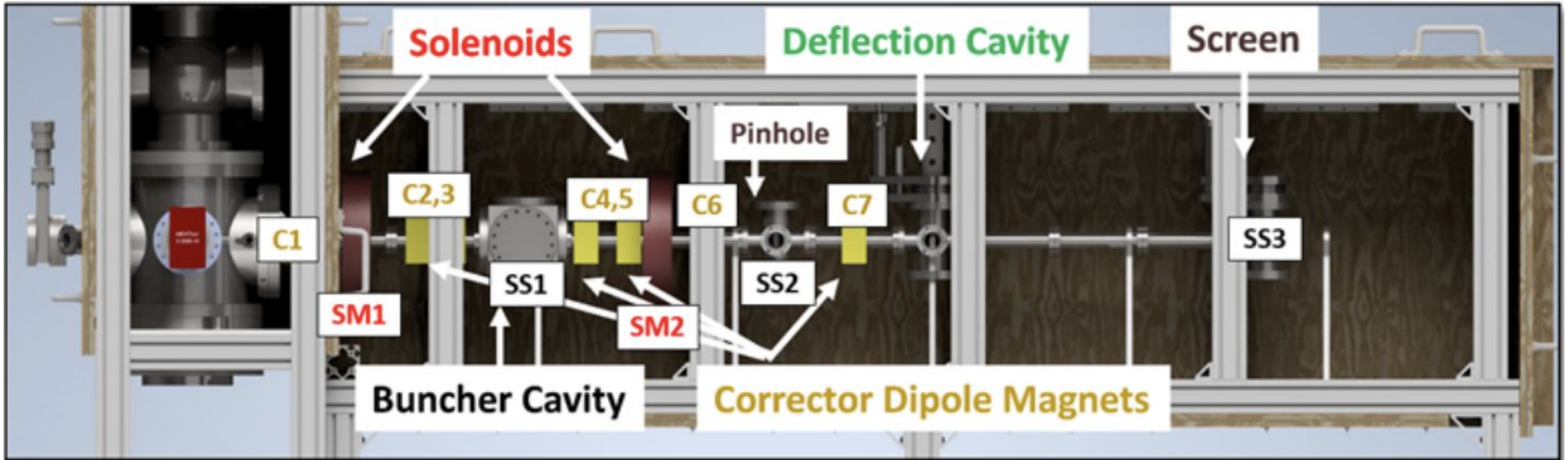
At the top of the assembly is where the cryostat from the He liquifier is inserted. A sapphire rod runs from this point down to the main assembly of the gun. The entire inner assembly is surrounded by a Cu thermal radiation shield. At the base is a ceramic HV insulator, similar to that of Cornell's gun.



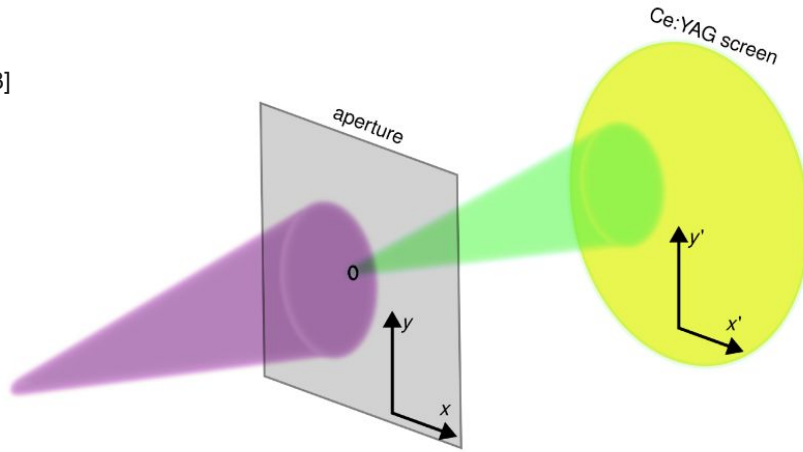
Beamline

The electron beam begins from the gun on the left and travels to the right.

[1]



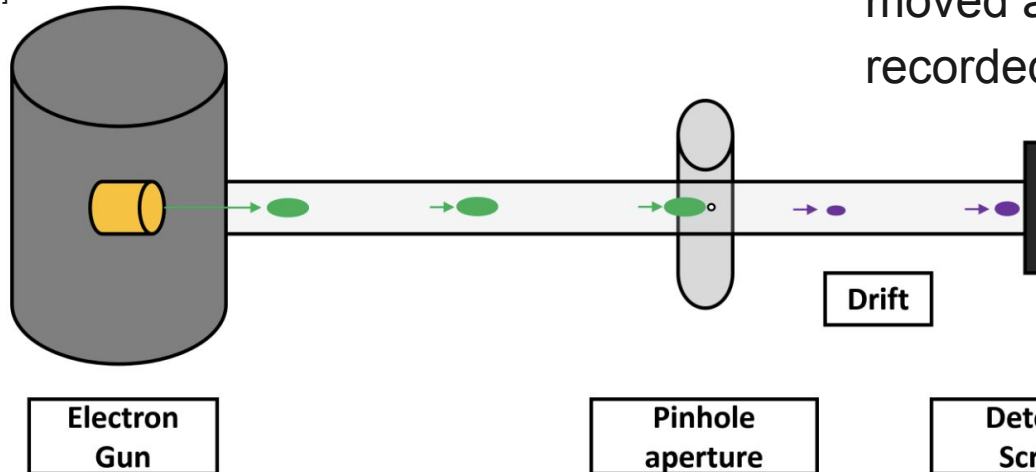
[3]



Operation of the Electron Gun with Pinhole Scan Technique

Using corrector coils, the beamline is moved about the pinhole and x,y values are recorded.

[1]



The cropped portion of the beam then passes through to the detector, where its momentum can be ascertained.

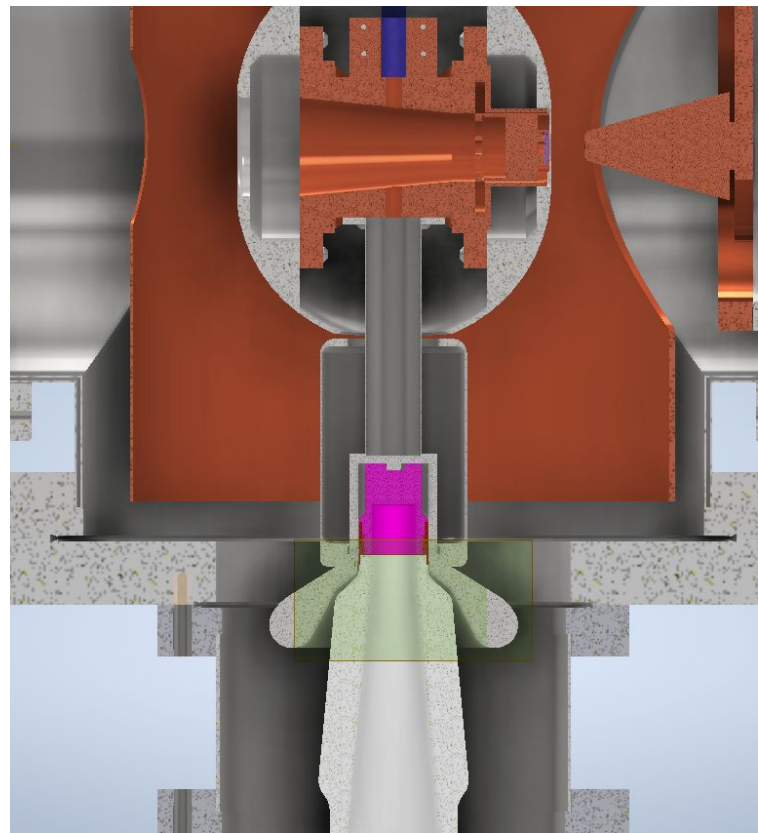
Recommissioning

Due to arcing and field electron emissions, accelerating voltage was capped around 120kV.

Using controlled emission events, field emitters can be degraded.

Despite our success in minimising field emission events, a current with an apparent Ohmic relationship to accelerating voltage appeared.

Could be caused by a deposition of conducting steel or copper from the field emitter degradation.



Shown above:

The lower section of the gun, including the ceramic HV insulator.

Effect of Pinhole Size on Mean Transverse Energy

$$F(x) = \frac{e^2}{4\pi\epsilon_0} \left[- \sum_{m=0}^{\infty} \frac{1}{(2ma + 2x)^2} + \sum_{n=1}^{\infty} \frac{1}{(2na - 2x)^2} \right]$$

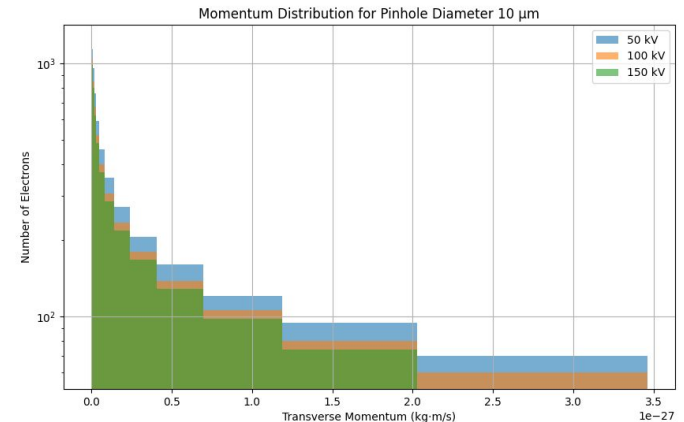
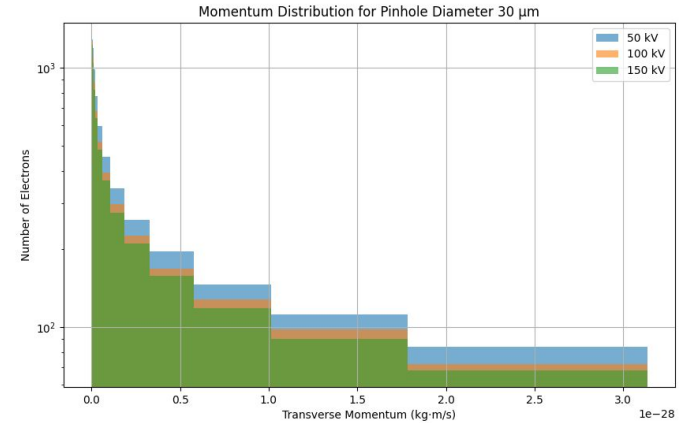
Experiments with pinholes of length 100μm and diameters 10μm and 30μm, it was found that the 10μm pinhole yielded abnormally large values of MTE. We considered the possibility of electron interaction with induced surface charged on the pinhole. We took the case of a charge placed between infinitely long grounded parallel plates as an approximation.

Results of Exploration

We found a negative correlation between pinhole diameter and transverse momentum.

In both instances, however, the effect was quite negligible compared to the experimentally found momentum effects.

Surface charge effects likely not a major factor in abnormal MTE values.



Going Forward: Determining the Maximum Resolution

Sources of limits on resolution:

- Variations in accelerating voltage;
- Fluctuations in current supplied to corrector coils and solenoids;
- Vibration of the pinhole relative to the gun;
- Hardware limitations such as pinhole size and the resolution of the detector screen.

Citations

1. Gevorkyan, G, et al. "Design of a 200 kV DC Cryocooled Photoemission Gun For Photocathode Investigations."
2. Cardenas, C. "Commissioning a Photocathode Test Bed Accelerator."
3. Gordon, M, et al. "Four-dimensional emittance measurements of ultrafast electron diffraction optics corrected up to sextupole order."

