

# Polarized Cathode Development Update

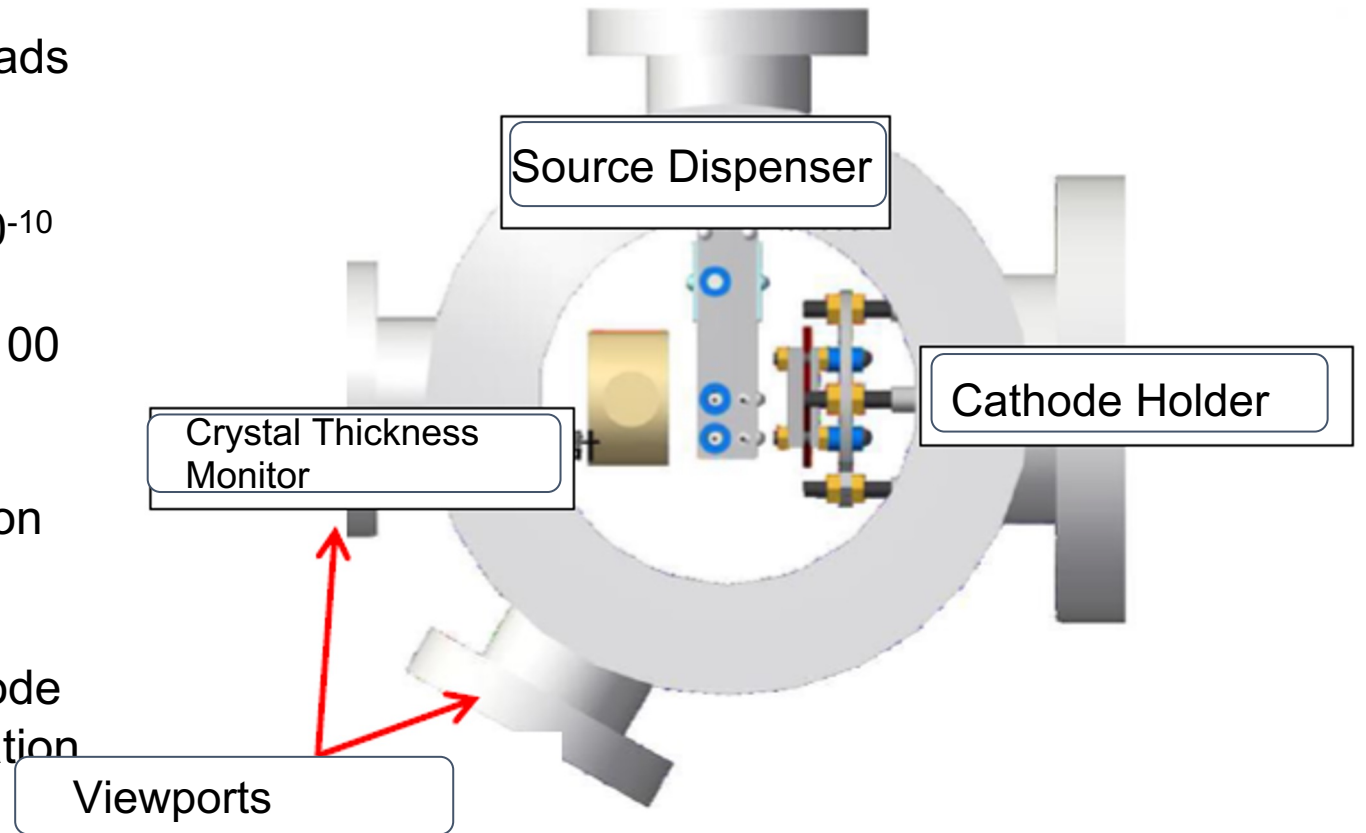
Zachary J. Liptak  
10/23/2023

# Background

- We've been working on producing polarized sources with NEA deposition.
  - QE and polarization rates are generally good, but cathode lifetimes are comparatively poor.
  - Have been working on trying to make more robust cathodes with longer lifespans by experimenting with different thin films on the base GaAs cathode layer.
  - Currently using layers of Cs, Sb, K, first to replicate prior results and then to (hopefully) improve upon them.

## Reminder: Evaporative Deposition Setup and Procedure

- GaAs substrate prepared (cleaned) and affixed to holder
- Cs, K dispensers attached to holder and Sb beads placed into a conducting wire basket
- Chamber is baked, degassed, etc., to get to working vacuum environment (ideally  $10^{-9}$  or  $10^{-10}$  Pa)
- Voltage attached to heated cathode ( $\sim 1-2$  kV, 100 C) consistently
- Voltage applied to terminals for Sb, K, Cs in sequence to cause evaporation, with evaporation confirmed via rise in pressure
- Thickness measured with a thin-film monitor – piezoelectric crystal inserted opposite the cathode holder, measures deposition via changing vibration frequency of inserted crystal
- QE is measured at each step by illuminating the cathode with a Xe lamp filtered through a grating to select wavelengths from 300 - 950 nm and output current from cathode is recorded



# Previous Experimental Run

- First attempt at an experimental run: ended with data consistent with 0 → no conclusive evidence of cathode production
- Second run done in 2 stages:
  - 250 Å Sb + 600 Å (total) Cs + K in 50 Å layers

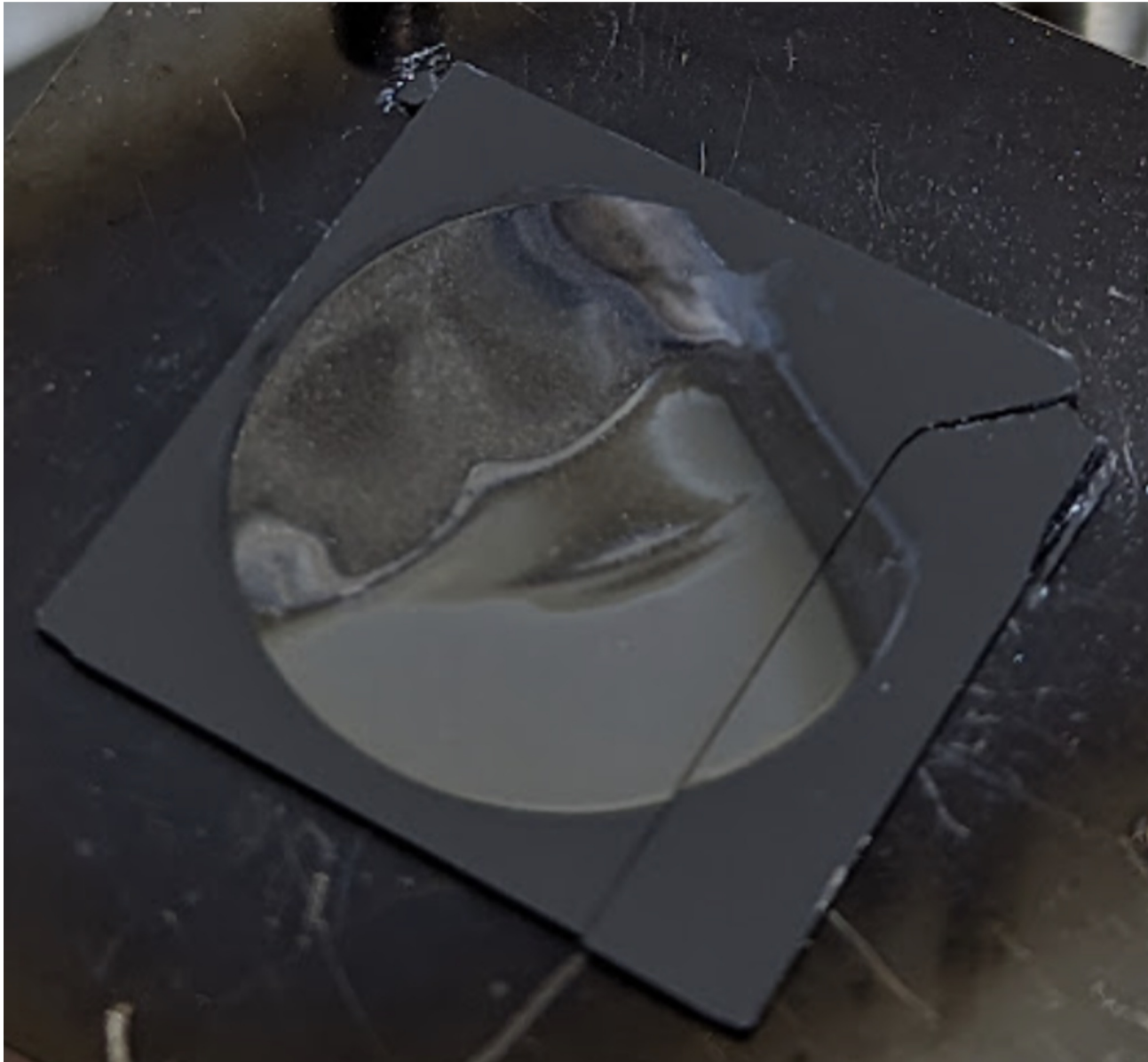
Wavelength (nm) / Energy (eV)	Measured QE (%)	Error (%)
350 / 3.54	1.83E-02	1.42E-03
890/1.39	-1.4E-04	1.83E-04

- Increased K + Cs deposits to a total of 1250 Å

Wavelength (nm) / Energy (eV)	Measured QE (%)	Error (%)
350 / 3.54	3.44E-02	1.38E-03
890/1.39	2.16E-04	2.06E-04

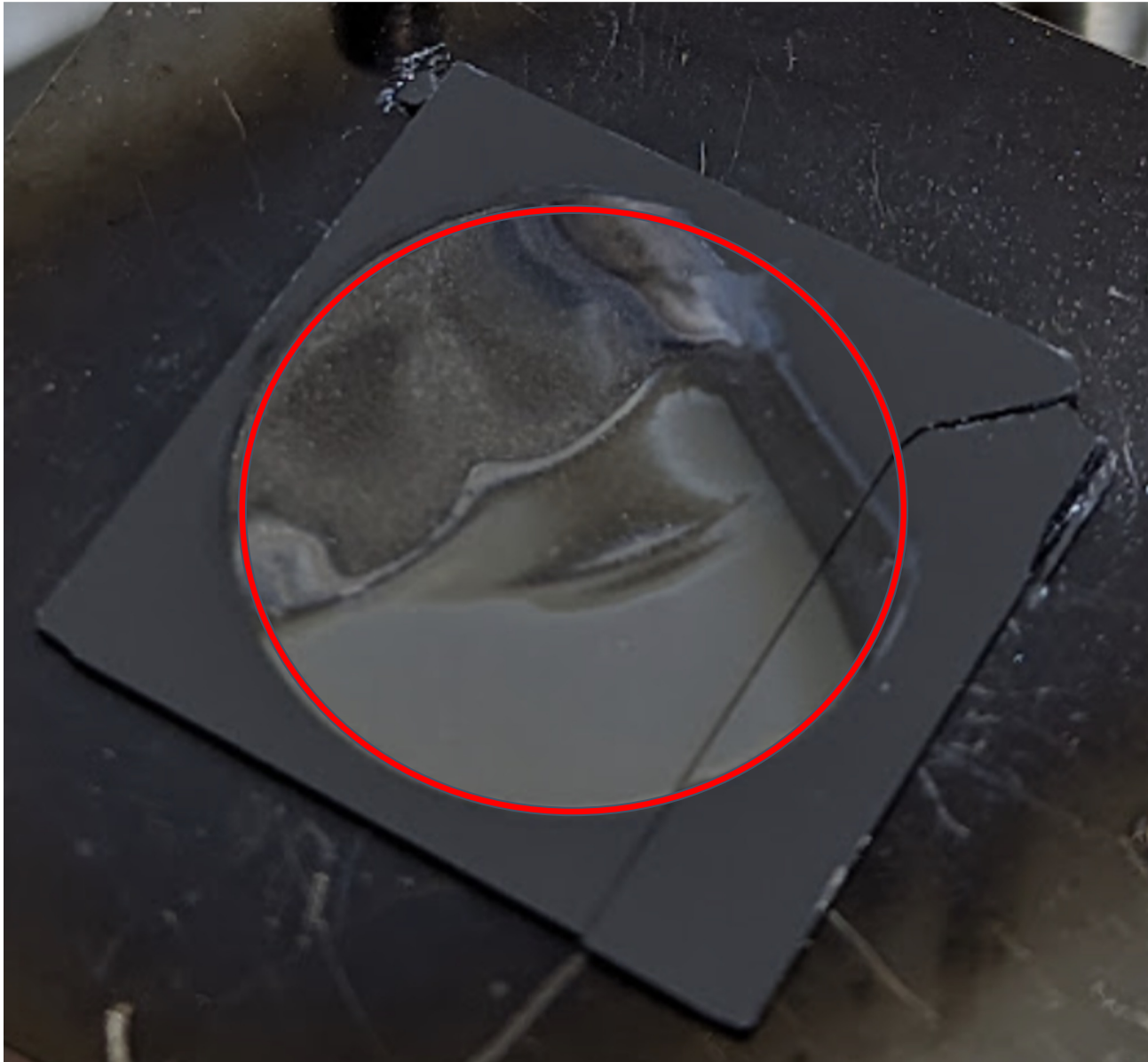
- Evaporative deposition has produced a working cathode with QE around  $\sim(3.44 \pm .14) \times 10^{-2} \%$

# Cathode Inspection



After the experiment, we removed the cathode from the vacuum chamber and inspected it visually.

# Cathode Inspection

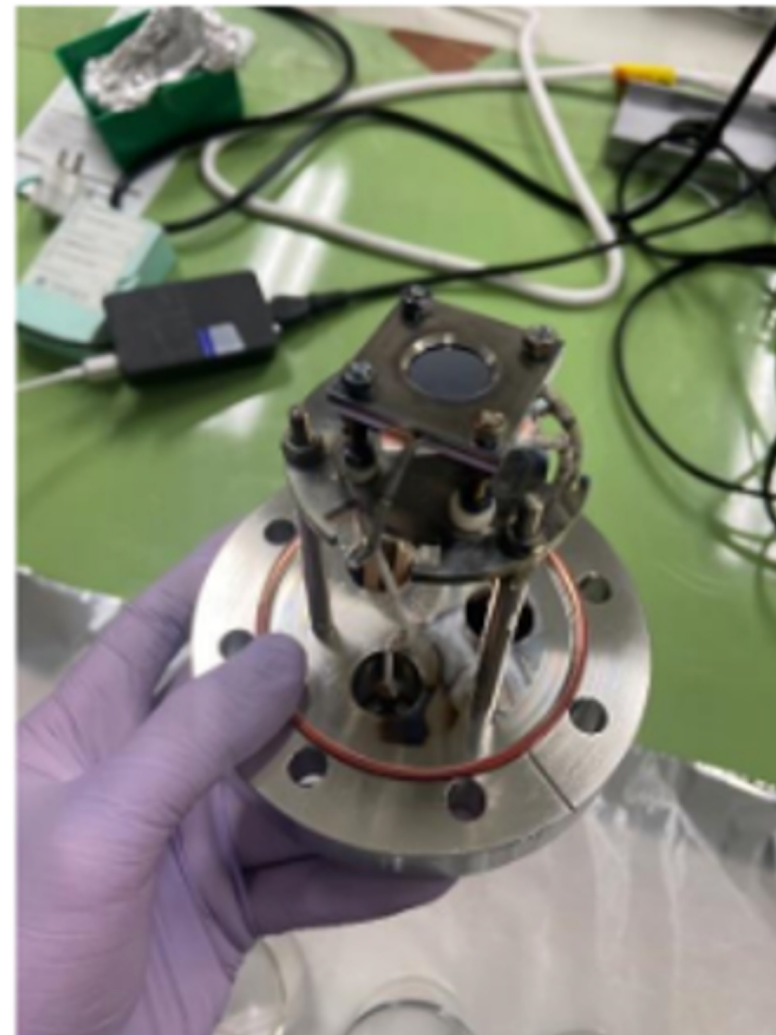
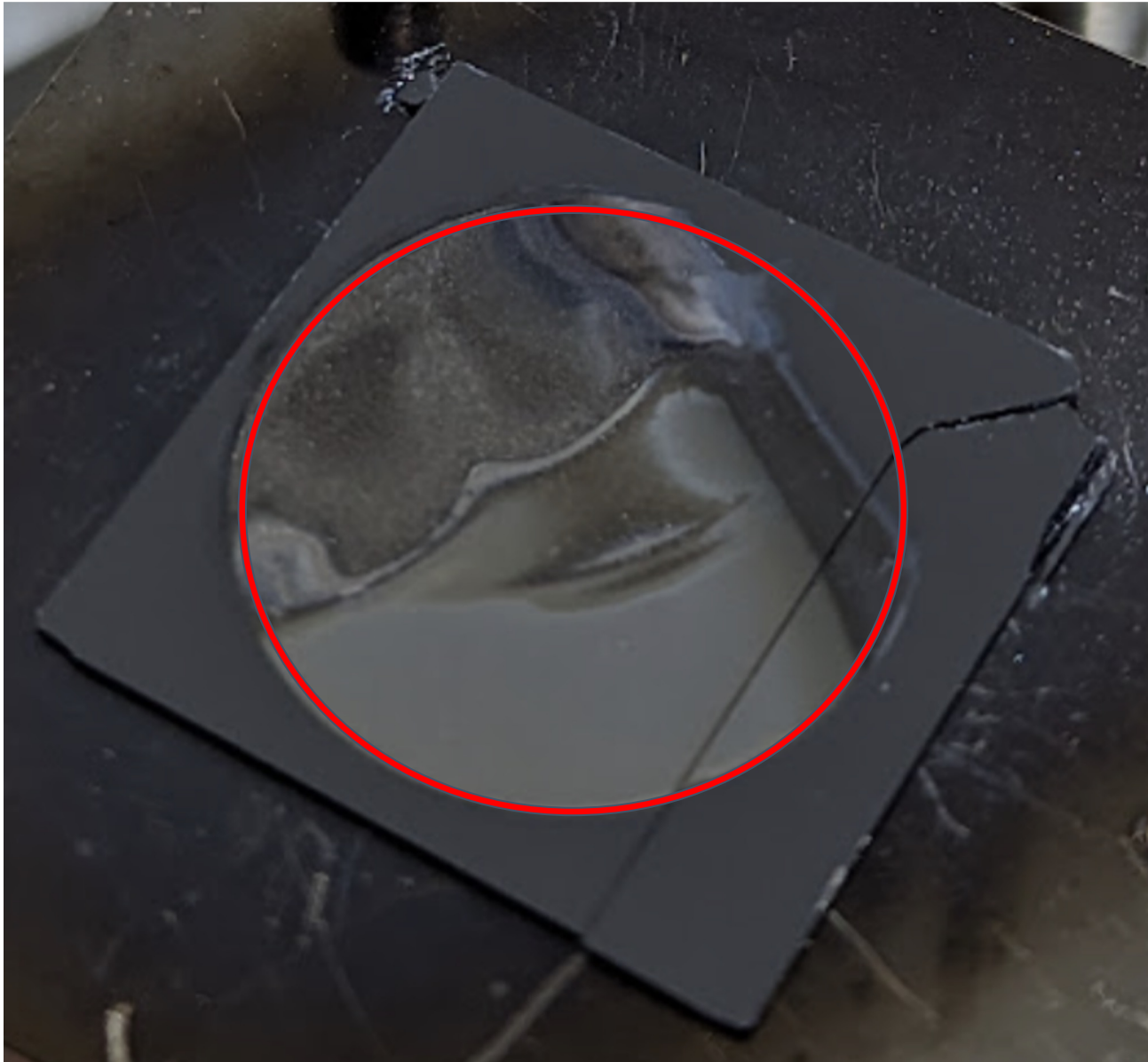


After the experiment, we removed the cathode from the vacuum chamber and inspected it visually.

We found that the base (Sb) was applied over most of the available surface (red circle), but one section was uncovered.



# Cathode Inspection



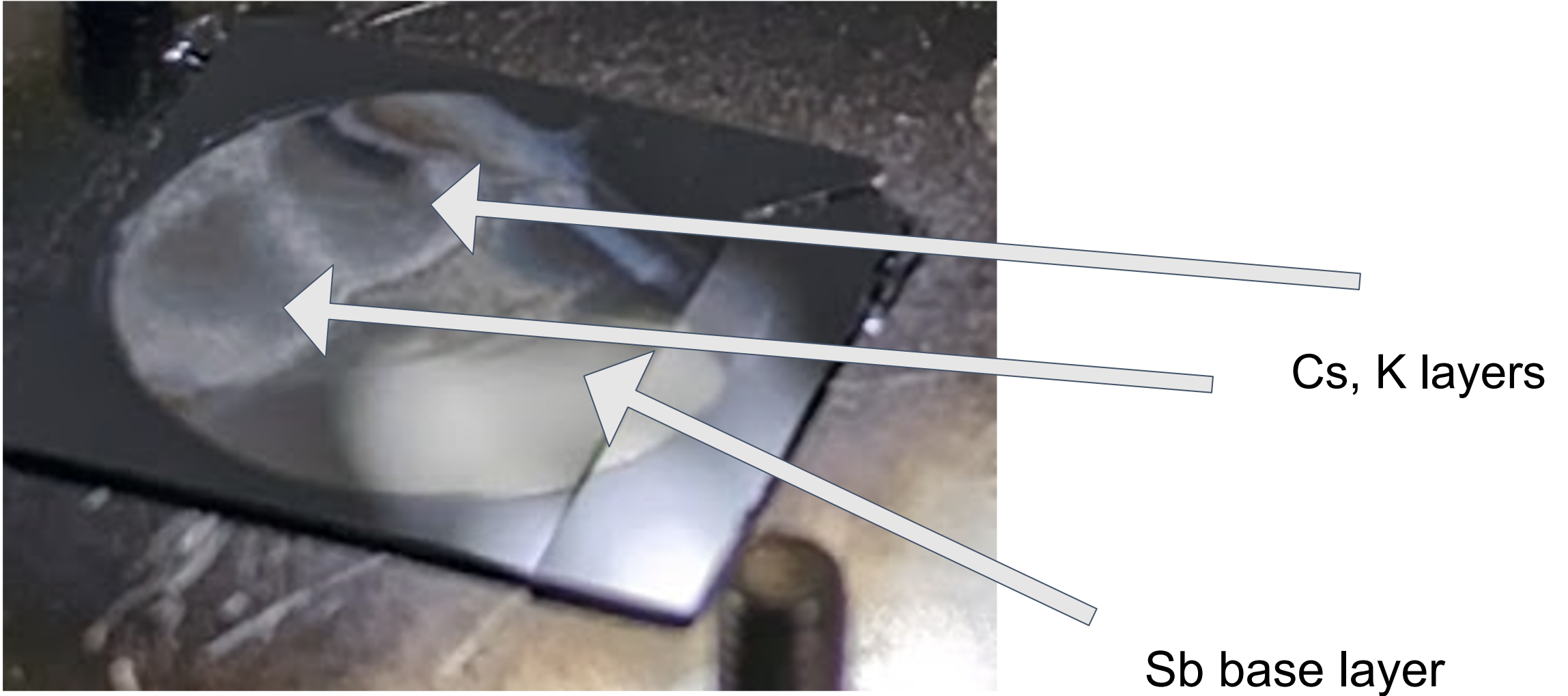
cf. before insertion

# Material Deposition



Cs and K only covered smaller sections of the cathode face, presumably closest to their respective dispensers.





Takeaways: slower deposition from dispensers (to allow gas to diffuse in chamber), lateral position adjustments needed during deposition

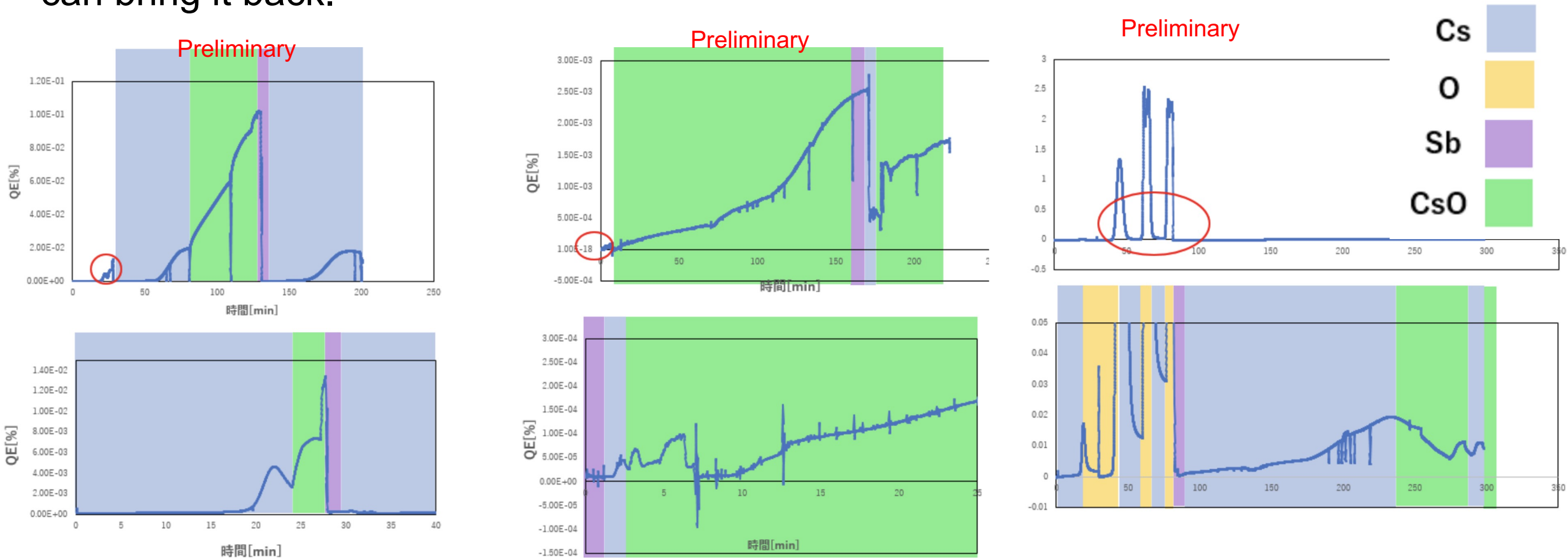
# Next Run (now)

- Attempting a new run considering the lessons learned from this experience and with updated vacuum conditions.
  - Vacuum chamber flanges checked, cleaned and gaskets replaced -> OOM improvement in vacuum now ( $10^{-9}$  Pa)
- Updating analysis tools to give faster and more reliable results
- Aiming to get material for a paper in the next few months

# Progress at Nagoya (L. Guo, Y. Wakita)

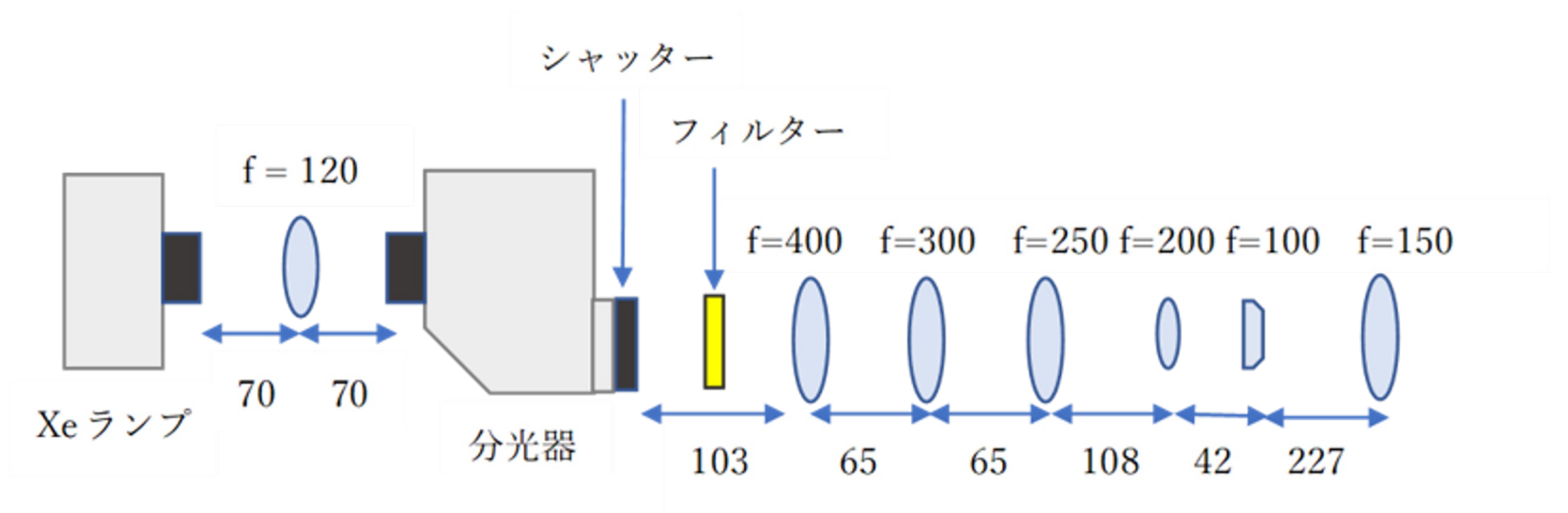
Our colleagues at Nagoya are doing similar studies Sb, CsO, Cs and O in thin films. Preliminary results from Spring are displayed here.

Adding Sb layers to preserve lattice strain abruptly drops QE, but further CsO layers can bring it back.



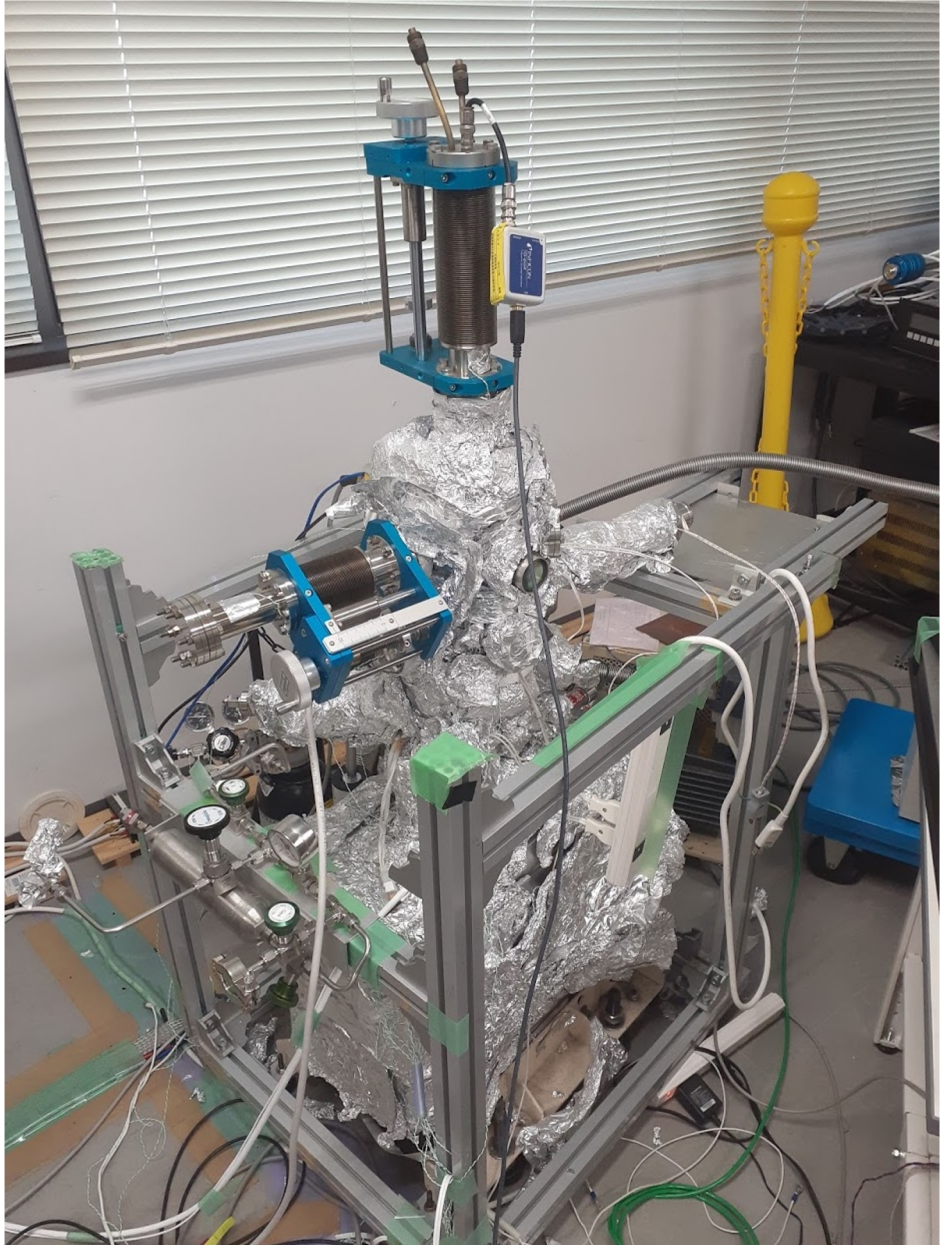
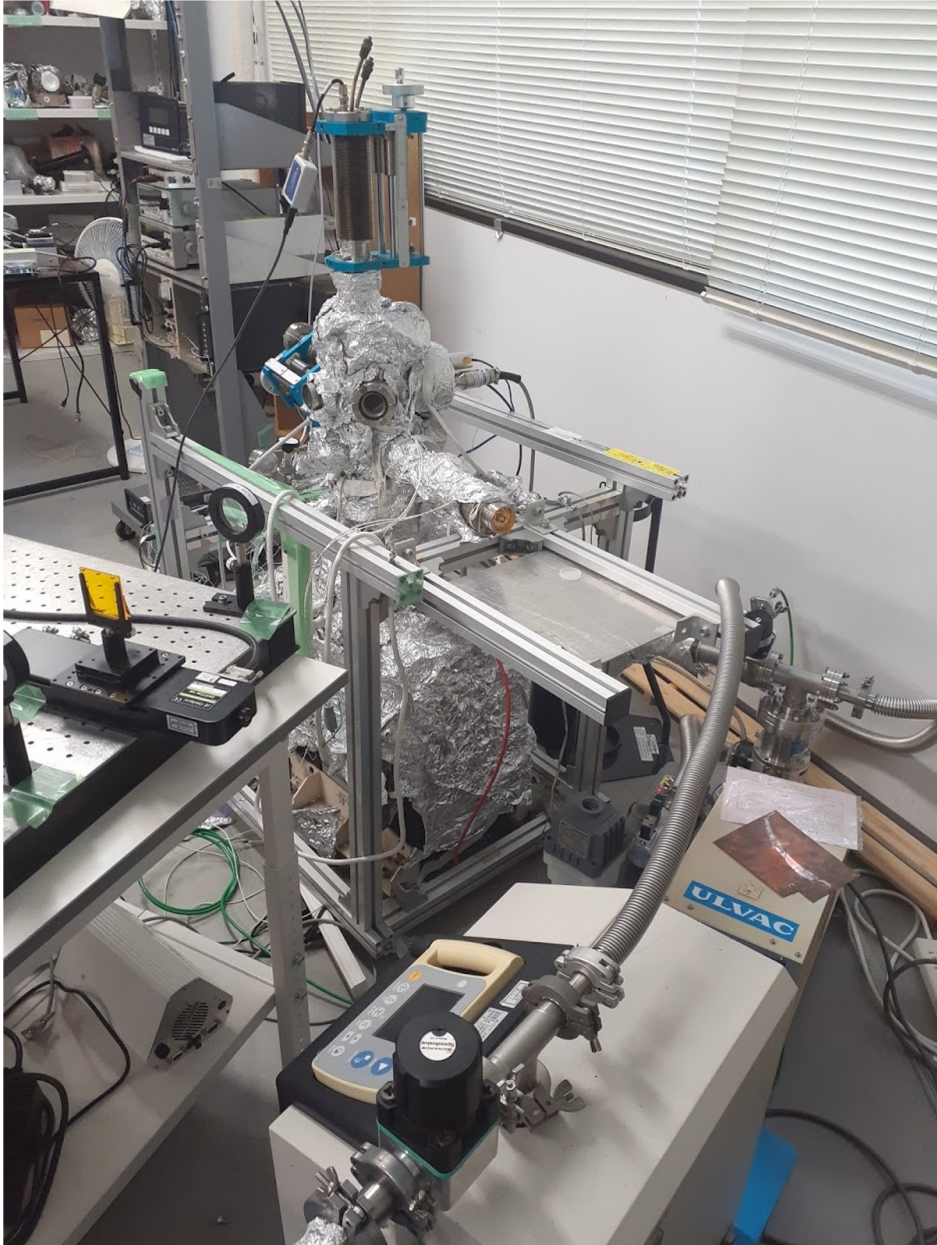
# SKB Source Area Status

- I spoke with Yoshida-san about the linac source area recently about the status of the source area
- → tried to enter, but my radiation clearance prohibited me. Will try again at my next KEK visit (most likely November)
- → if the beam is in operation, won't be able to get close.
  
- He mentioned that the current electron source area already has DC guns at 0° and 90°, and that there likely isn't space to add a new gun or merge a new beamline.
- There is a thermal gun outside the fence... could this be replaced with a DC gun in the future? (my own thought)
  
- When I get a chance to visit the beamline, I'll update with photos to show current layout and circulate to the group along with any other information from talking with Yoshida-san or other source/linac people.





# Our Setup: Vacuum Chamber





# Our Setup: Xenon lamp

Used for testing QE response from cathode with tunable wavelengths

