Polarized Cathode Development Update

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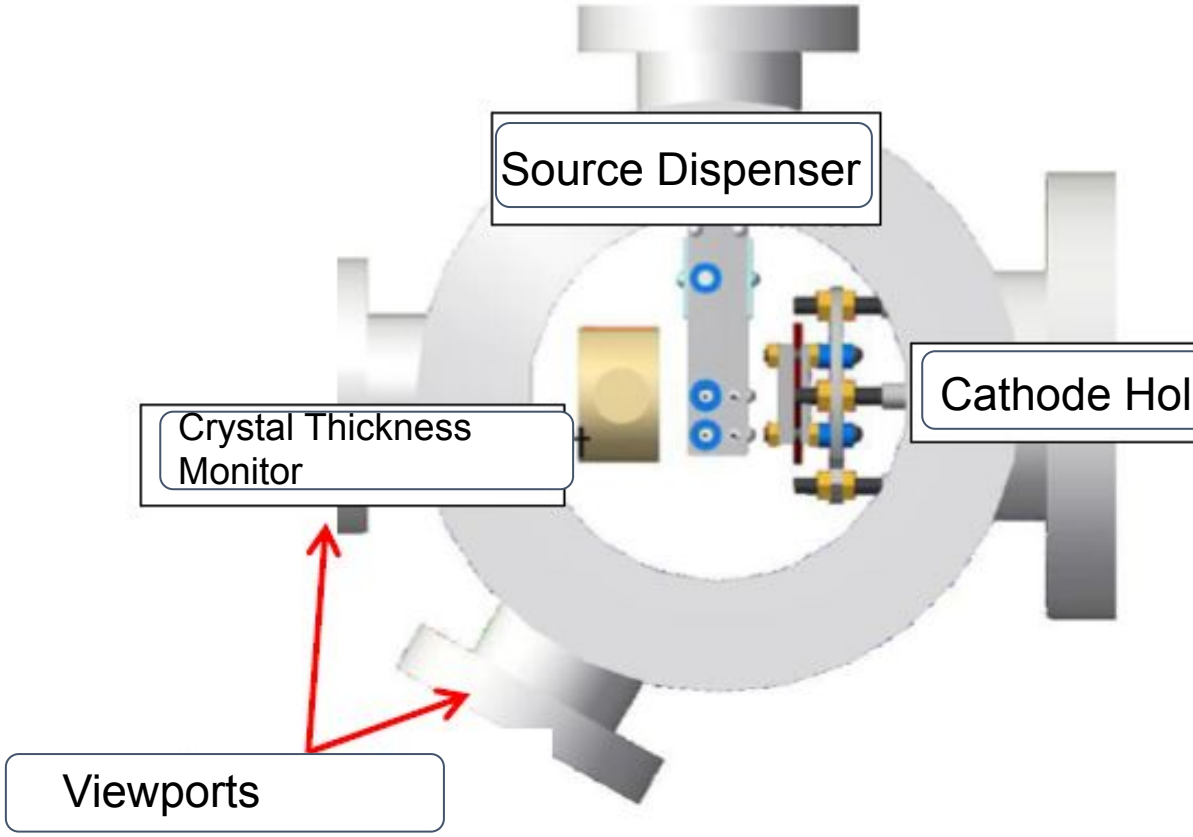
Background

- 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.
  - See Kuriki-san's talk from this week's Polarization Workshop (https://indico.belle2.org/event/7500/)for further details
- We've had a 4th-year student (Maeda Haruki) working on evaporative deposition for his thesis project (just finished this week)

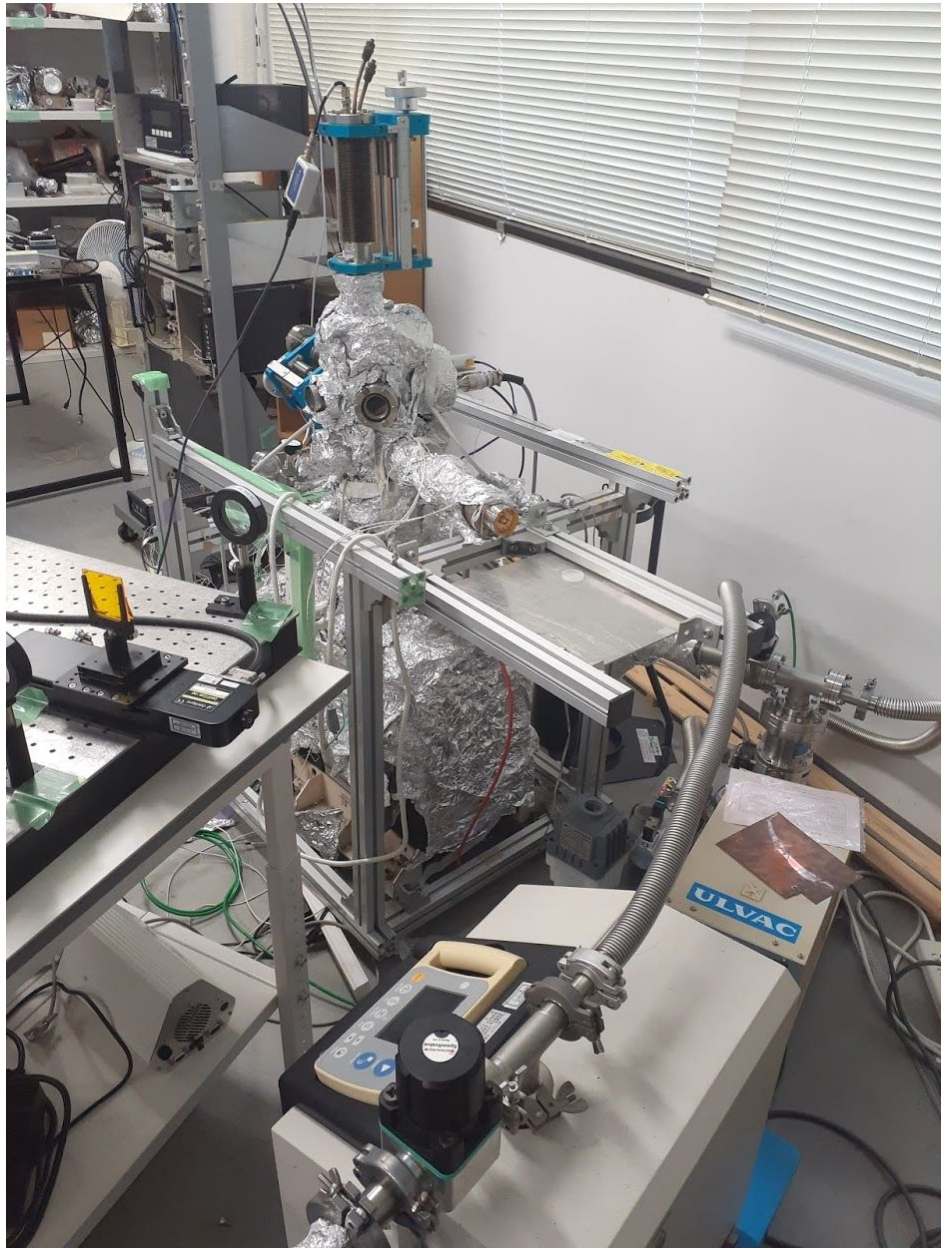
Reminder: Evaporative Deposition Setup and Procedure

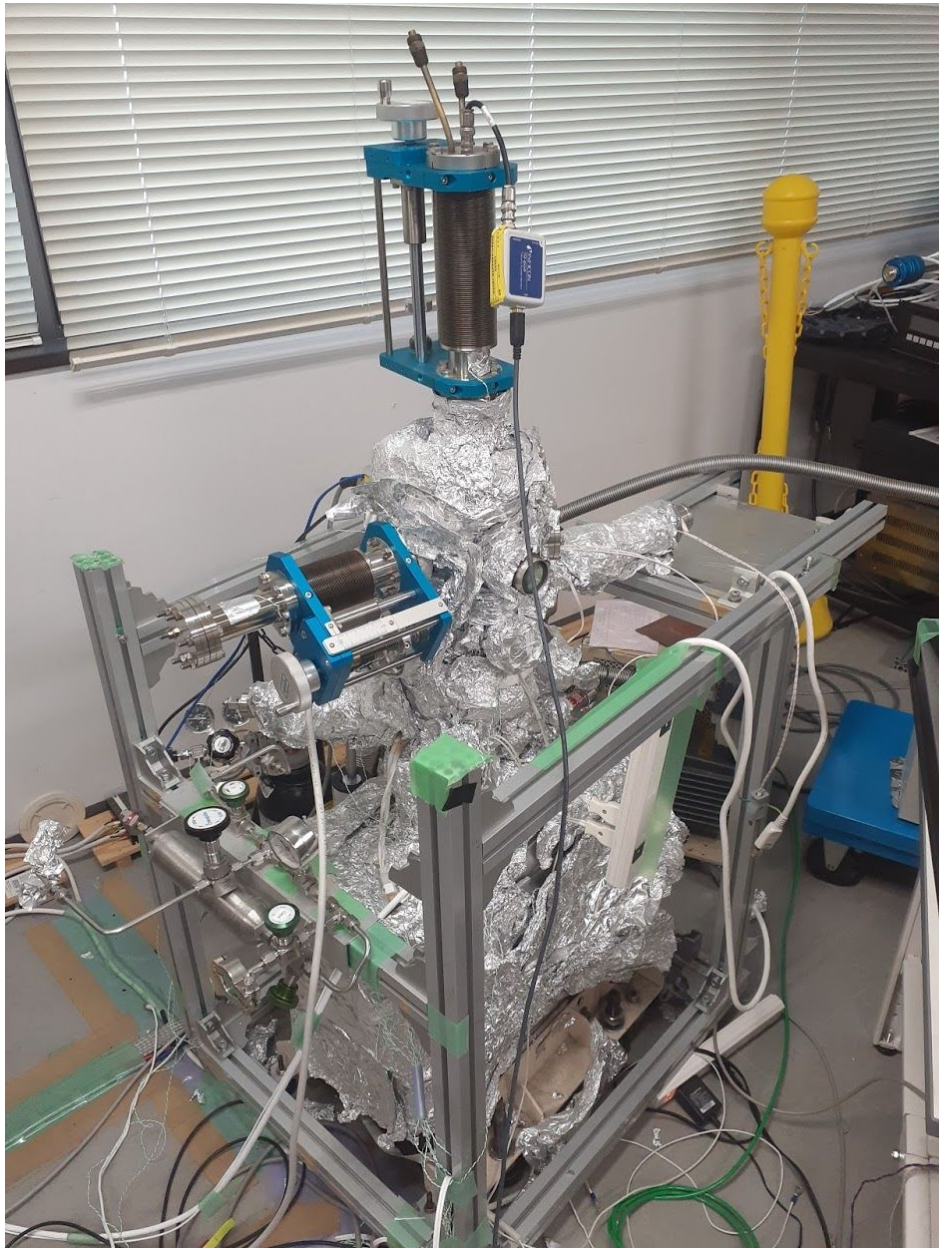
- GaAs substrate prepared (cleaned) and affixed to holder
- Cs, K dispensers attached to holder and Sb beads placed into a conducting wire basket

- Chamber is baked, degassed, etc., to get to working vacuum environment (ideally 10^{-9} or 10^{-10} Pa)
- Voltage attached to heated cathode (~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



Our Setup: Vacuum Chamber





Our Setup: Xenon lamp

Used for testing QE response from cathode with tunable wavelengths

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 ~$(3.44 \pm .14) \times 10^{-2}$ %

Summary and Future Plans

- Recent run of evaporative deposition of Sb K Cs on GaAs cathode has shown a measurable QE, demonstrating activation, but improvement for use as an NEA cathode is needed.
- Next steps (during Spring):
  - Demonstrate runs with thinner depositions and introduction of pure O_2
    - Demonstrate conclusive NEA behavior
  - Replicate lifetime measurements
  - Investigate uniformity of deposition on cathode face
- Needed Improvement:
  - Improvements to optical focusing system to increase power on cathode face (--> improved signal)
- Note: Japan-side application to the US-Japan application was submitted and made it to the hearing stage – waiting on results; if approved, would receive money for DC gun/Wien filter design work