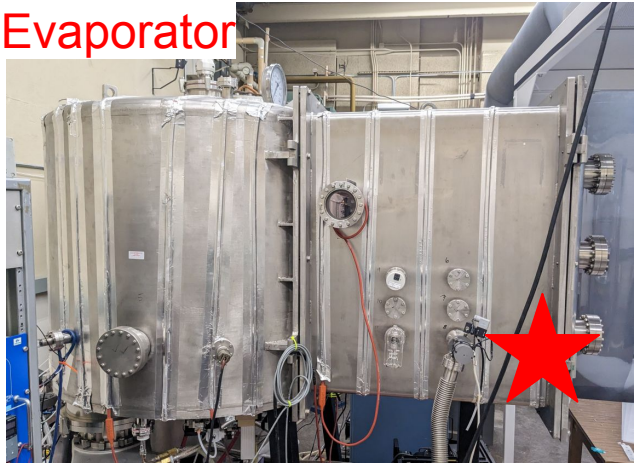
Evaporator Status and Mirror Coating Work at SBU

Wenliang Li (Bill), on behalf of SBU CFNS

Oct 19, 2023

Facility at SBU

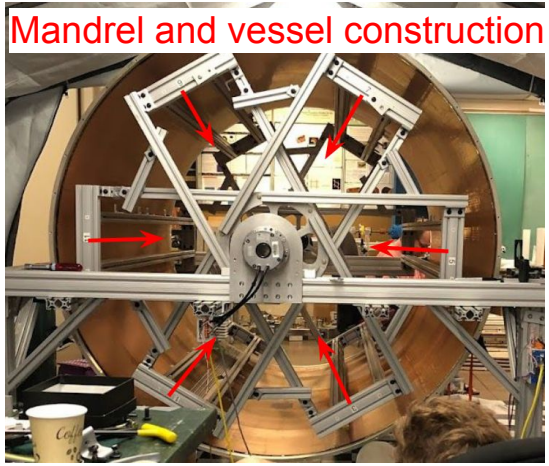
Evaporator



GEM Facility

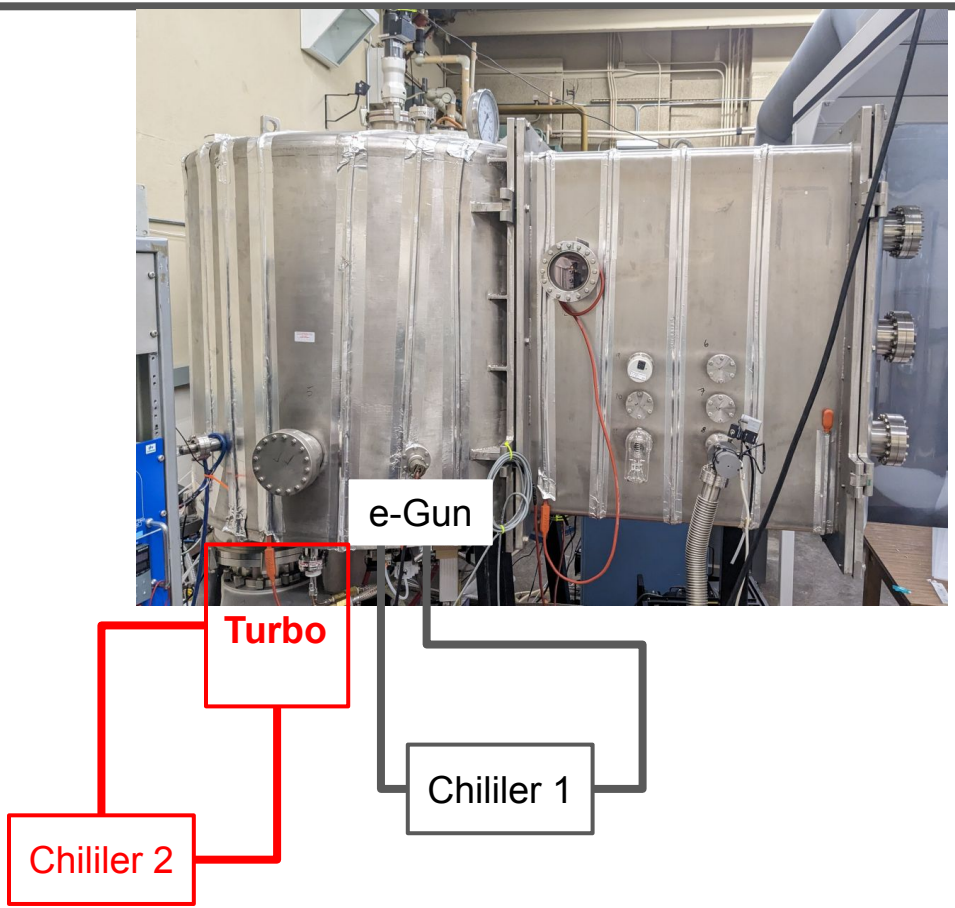
Additional High bay area

Mandrel and vessel construction



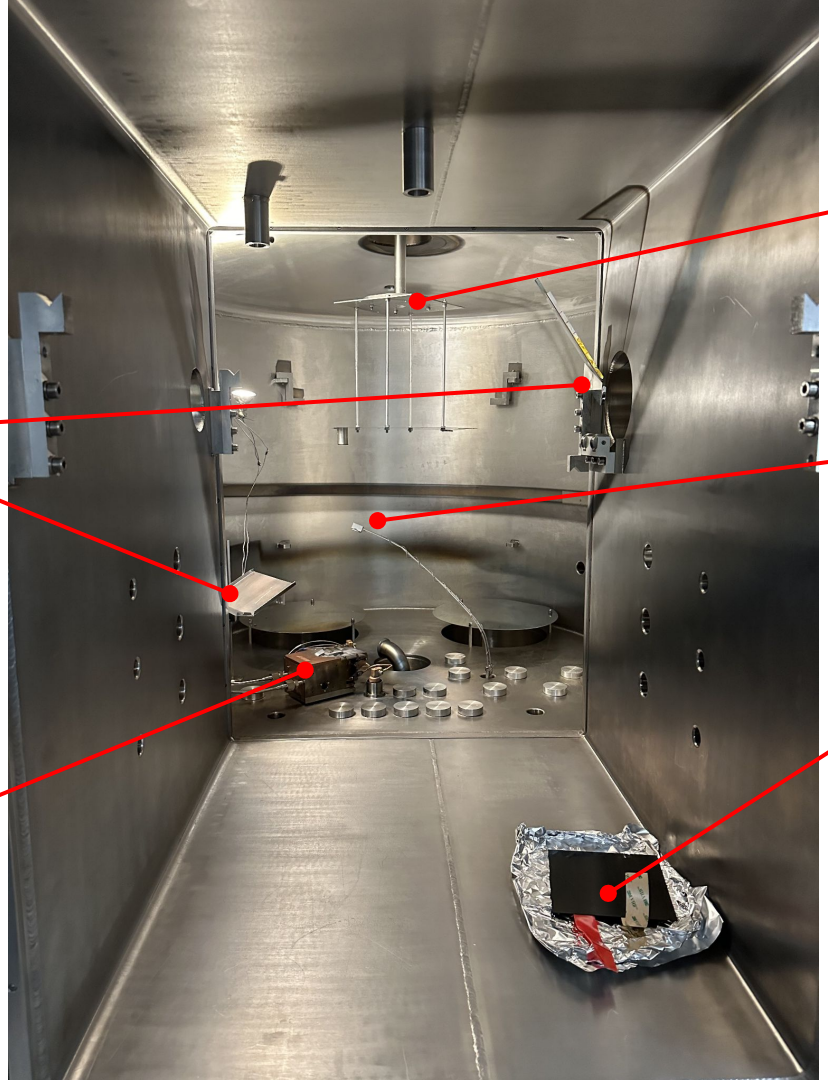
A special gratitude to Klaus in setting up many of these facility

The Evaporator at SBU



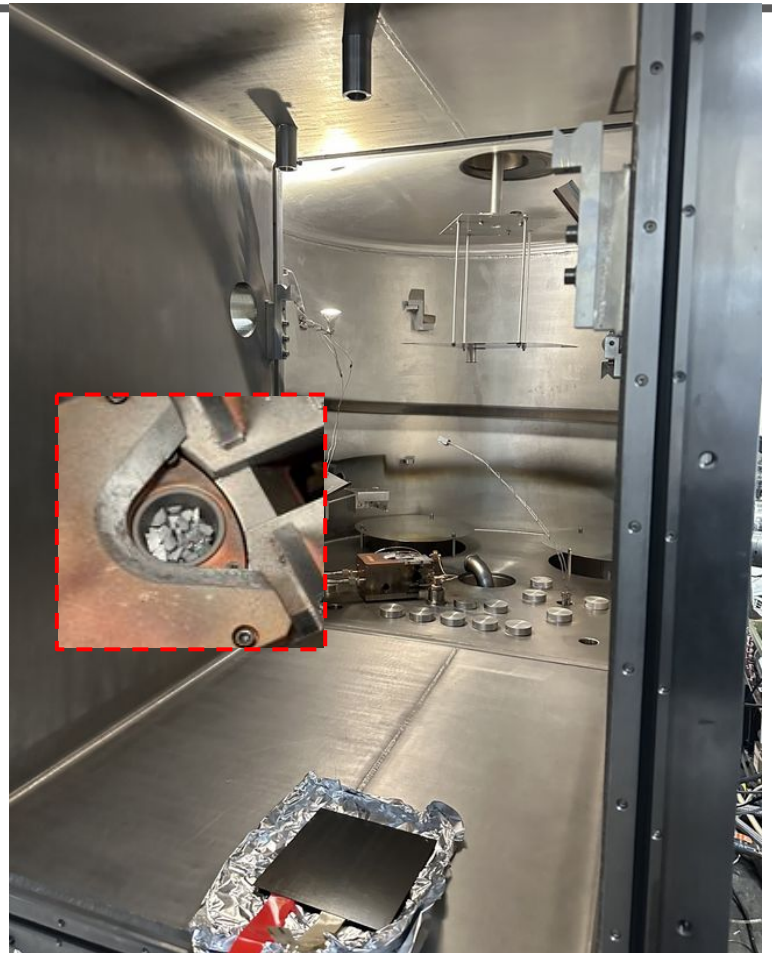
- **Where did it come from?**
  - **Made in INFN in 19??**
  - **Arrived at JLab in 199x?**
  - **Came to SBU in 199x?**

- **System consists:**
  - **Three pumping stages: rough (10-3 Torr), turbe (10-6 Torr), cryo (10-9 Torr)**
  - **Gauges**
  - **Electron gun**
  - **Thickness monitoring system**
  - **Rotation motor**
  - **Cooling system**
  - **…**

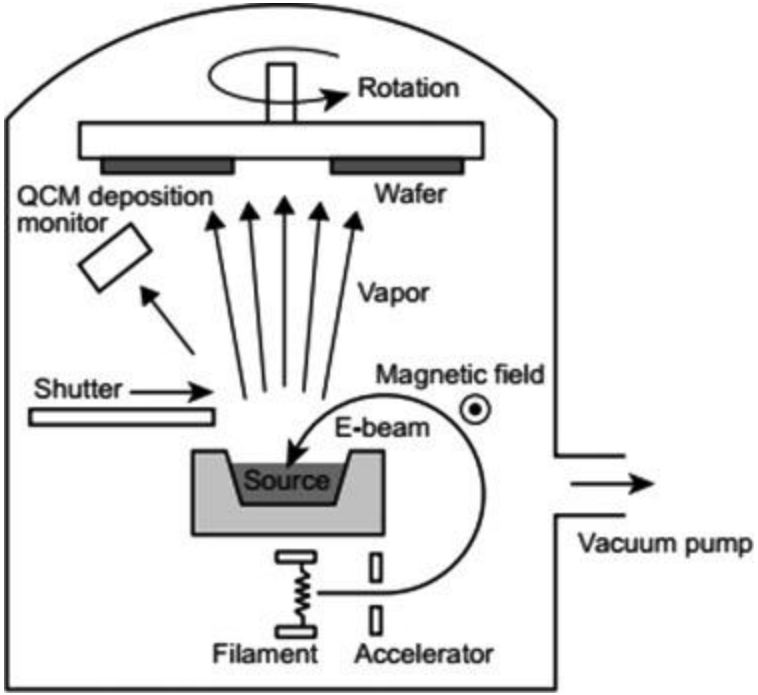

Mounting Fixture
+ Test Samples
Monitoring Mirrors
Quartz Crystal
Microbalance
Test Carbon Fiber
Sample + Tape
stability
Electron gun +
filled crucibles

Where are we? How ready are we?

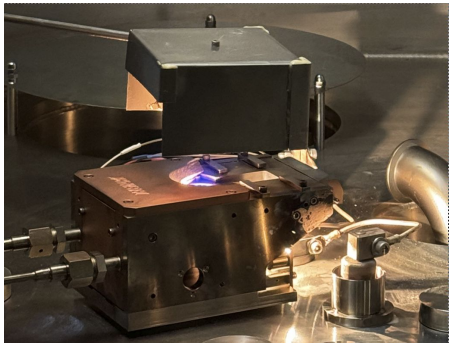
- **Water cooling system Stability** ✓
  - 24 hour continuous operation
- **Vacuum quality** ✓
  - $3x10^{-6}$ Torr (current configuration limit)
- **Tape stability** ✓
  - Stickiness and outgassing test
- **Rotation Motor** ✓
  - Continuous 1 hour operating ~ 1 rev/s



How does a evaporator work?

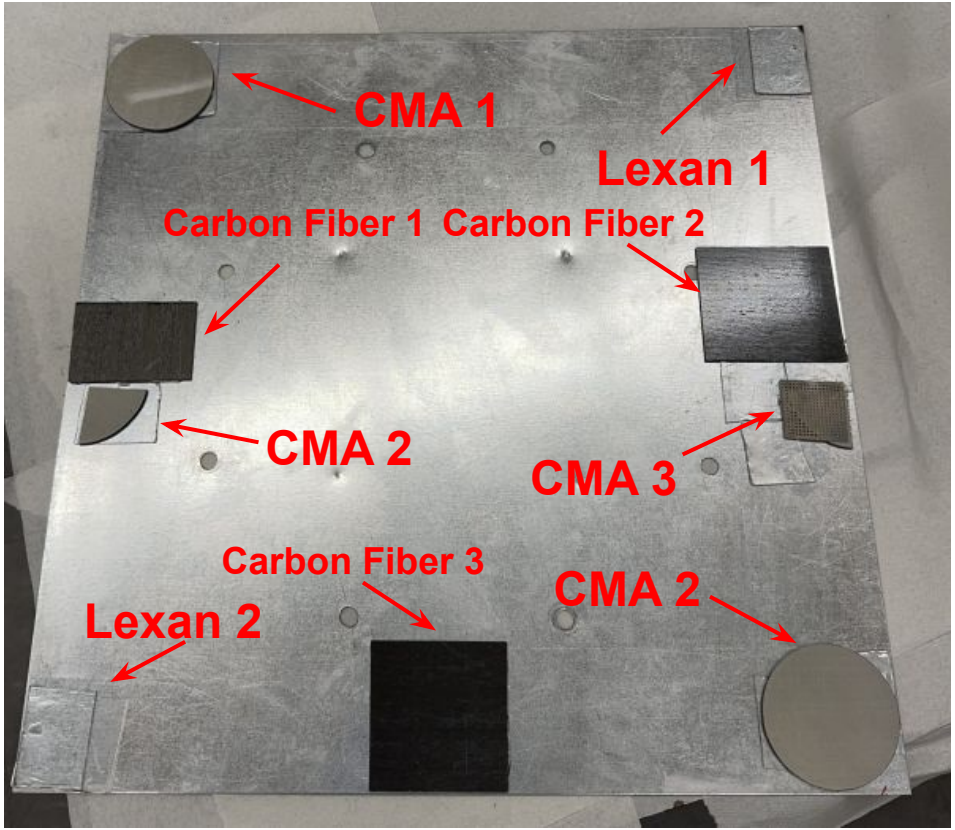


- Substrate mount
- Pump down (6 hours)
  - Vacuum: 10^{-6} Torr
- Ramp the electron gun (20 mins)
  - 6.6kV @ 100 mA
- Evaporate
  - Cr as primer base (100 nm in 10 mins)
  - Al (300 nm in 30 mins)



Coated samples from 2nd Evaporation

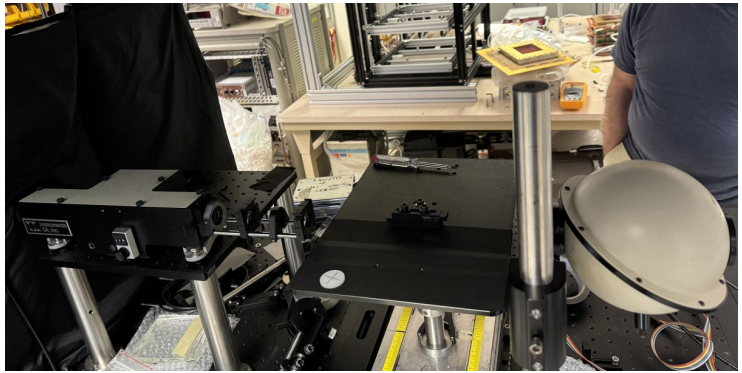
Surface roughness: 200 nm (ISO N4 polished surface)



Surface roughness: 20 nm (ISO N1 polished surface)

Timeline

- **2023 Summer, Preparation and equipment refurbishment**
- **2023 Nov, first coating**
- **2023 Dec, 2nd coating. Characterization and validate the mirror**
  - Existing setup at BNL and JLab
- **2024 Jan - April, coating the pfRICH mirrors**
- **2024 April, Upgrade in preparation of LGC**
- **2024 Oct, coating at an industrial level coating**



Evaporation Condition for Different Requirement

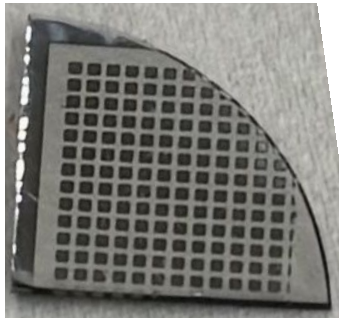
Requirement	SoLID LGC	EIC dRICH	SoLID HGC	EIC pfRICH
Wavelength	> 180 nm	> 200 nm	> 220 nm	> 300 nm
Vacuum	10^{-9} Torr (Cryopump)		10^{-6} Torr (Turbopump)	
Material	Cr + Al + MgF_2		Cr + Al	
Substrate heating	Yes, 300℃		Not needed	
Surface smoothing	Ionized Gun		Ionized Gun	
	Beyond current capability			

Documentation, monitoring, prediction and Q&A

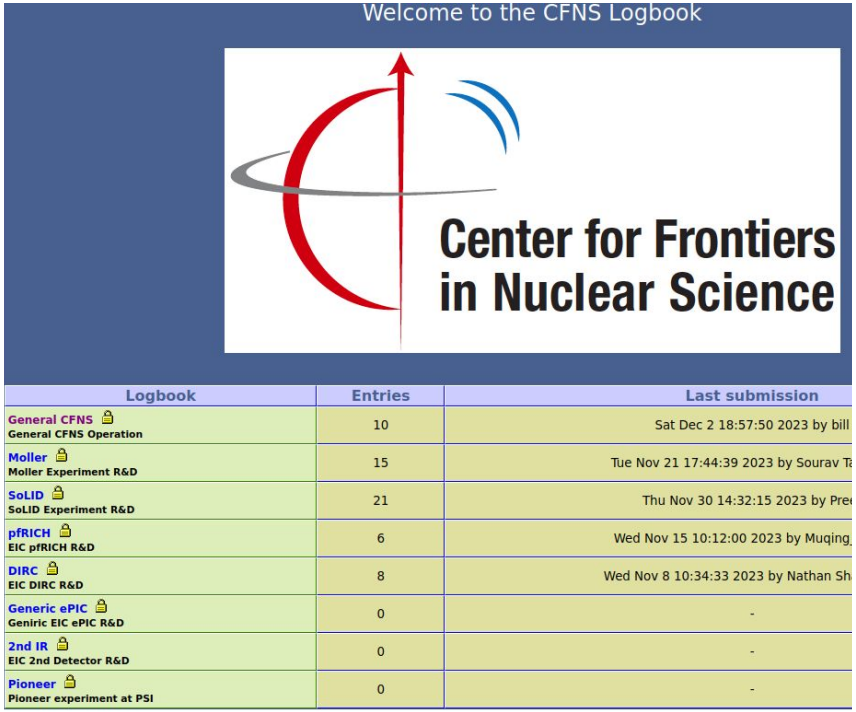
- **Estimating the evaporation depth**

$$\Phi_e = \frac{\alpha_e N_A (P_v - P_h)}{\sqrt{2\pi M R T}}$$

- **Depth measurement at SBU**



- **Smooth measurement**
- **Documentation: a dedicated elog server**
  - https://elog.cfnssbu.physics.sunysb.edu



Logbook	Entries	Last submission
General CFNS General CFNS Operation	10	Sat Dec 2 18:57:50 2023 by bill
Moller Moller Experiment R&D	15	Tue Nov 21 17:44:39 2023 by Sourav T
SoLID SoLID Experiment R&D	21	Thu Nov 30 14:32:15 2023 by Pre
pfRICH EIC pfRICH R&D	6	Wed Nov 15 10:12:00 2023 by Muqing
DIRC EIC DIRC R&D	8	Wed Nov 8 10:34:33 2023 by Nathan Sh
Generic ePIC Geniric EIC ePIC R&D	0	-
2nd IR EIC 2nd Detector R&D	0	-
Pioneer Pioneer experiment at PSI	0	-

Next Step from Here

- **Gaining experience in coating**
  - **Introduce a cleaning precedure**
  - Optimizing configuration and personnel training

- **Gradual improvements towards MgF_2 coating**
  - Cryopump repairment
  - Installing ionized Ar Gun
  - Installing the heater
  - Can the substrate take heat? How to cool down?

- **Significant effort and resources needed to achieve the LGC mirror coating capability and performing coating at a industrial level**

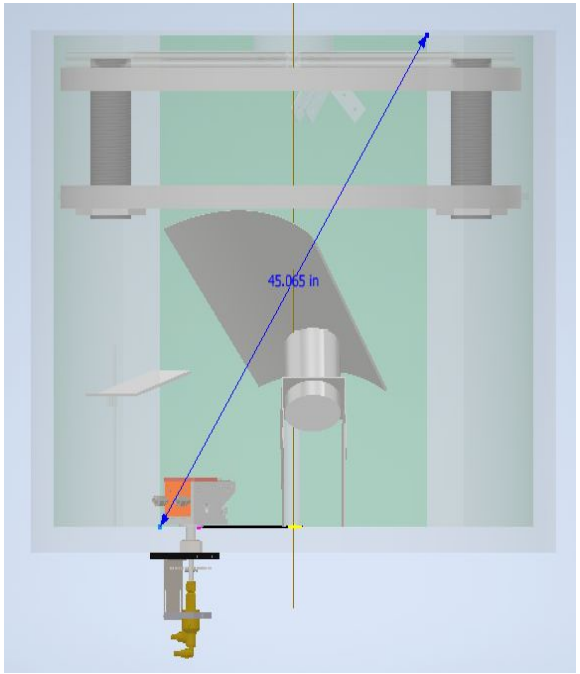
Acknowledgement

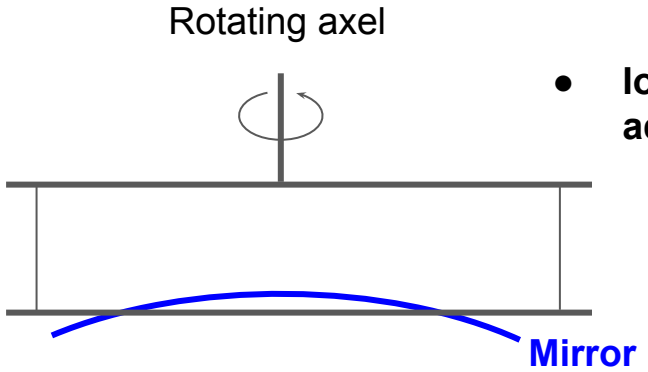
- **Stony Brook team: Charles (postdoc), Jaydeep (postdoc), Kong Tu (BNL staff scientist), Preet Mann (undergraduate), Muqing Wang (undergraduate).**

- **Thanks to the help from sPhenix colleagues from SBU: Ross Corliss, Vassu Doomra (Ph.D. student).**

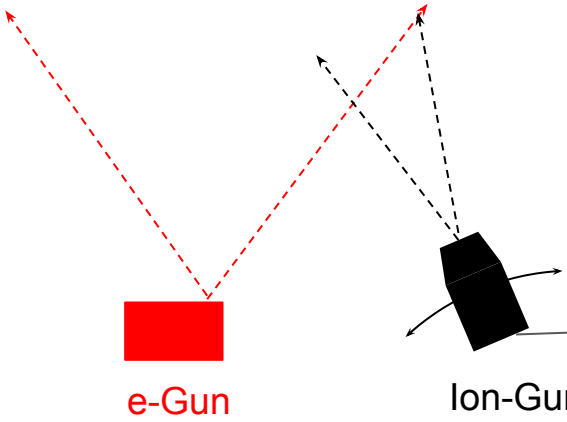
- **Thanks to the help from former CFNS members: Klaus and Prakhar.**

A Clean Space for Staging and Mount/Dismount Mirrors

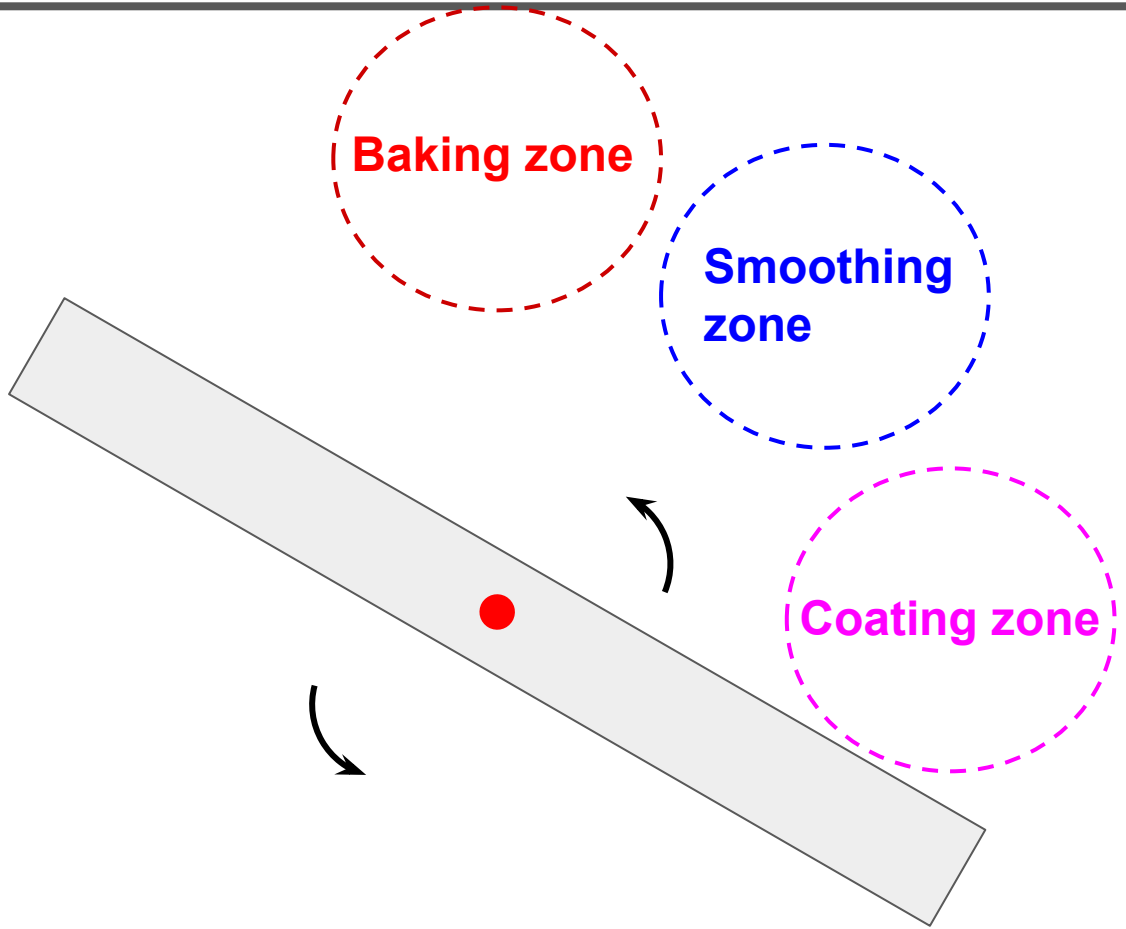




- **Ion source required pitch adjustment under high vacuum**
  - A remote control vacuum compatible stage is a must for large size mirrors
  - Thanks to mirror rotation, yaw angle is not needed



A Cartoonish view on deposition process



Sample Surface Roughness