

- *Photocathode Physics for Photoinjectors (P3) Workshop*
- *2021, Nov 10<sup>th</sup> -12<sup>th</sup> , 2021*

# Co-deposition of Cs<sub>3</sub>Sb growth on 4h-SiC

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# Photocathode needs in accelerator applications



**Electron beam required  
for e-cooling**

## **FEL sources**

Moderate currents  
Emittance improvement  
(ideally  $0.1 \mu\text{m}/\text{mm}$ )



High average current ( $> 100 \text{ mA}$ )

High bunch charge ( $1 \text{ nC}$ )

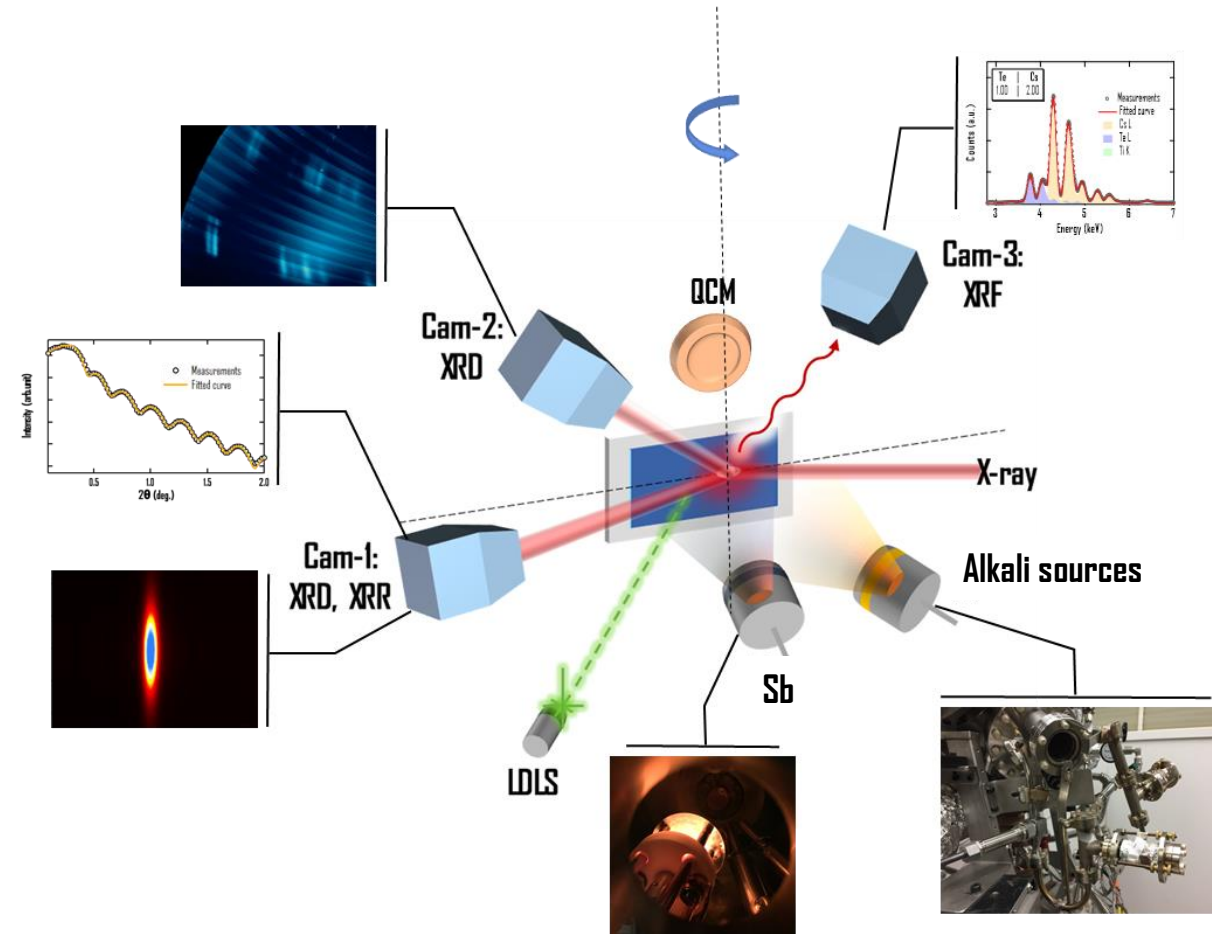
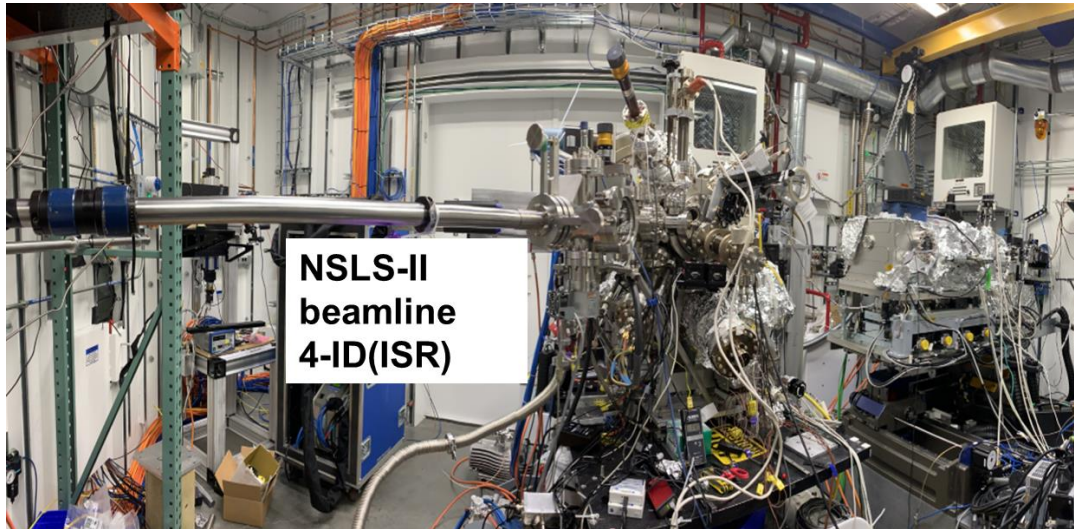
Long lifetime ( $> 1 \text{ week}$ )

Reproducible

## **Ultrafast Electron Diffraction/Microscopy**

High brightness  
Very low current  
Short pulse duration

# Cathode Material development @BNL : In situ and real time x-ray characterization



## Growth controls:

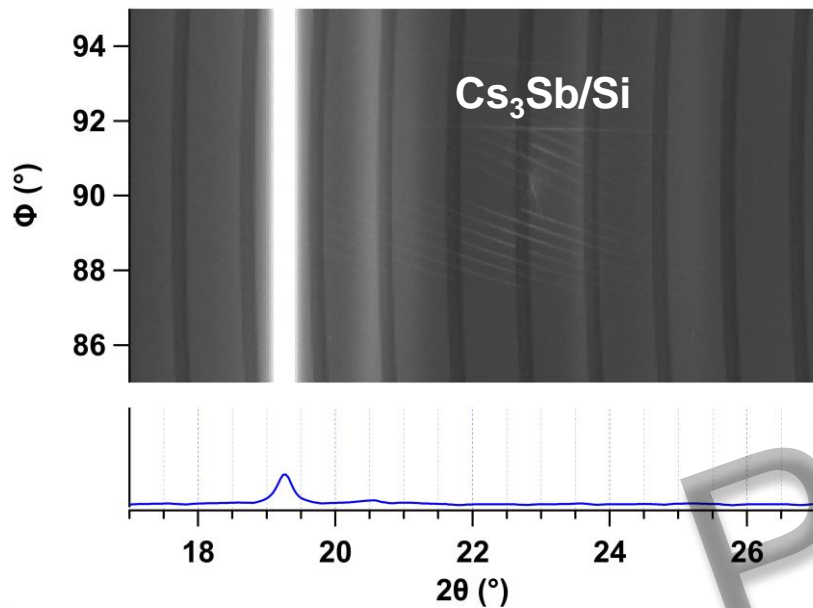
- $T_{\text{sub}}$
- Flux rate

## Characterization:

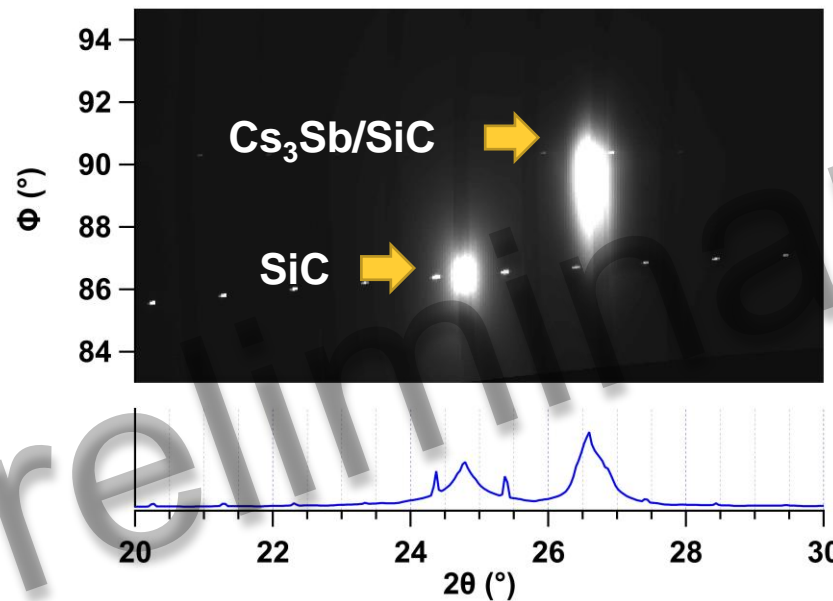
- QCM
- XRD
- XRR
- XRF
- QE

# Co deposition of $\text{Cs}_3\text{Sb}$ on 4-H SiC: Post growth Characterization

## X-ray Diffraction

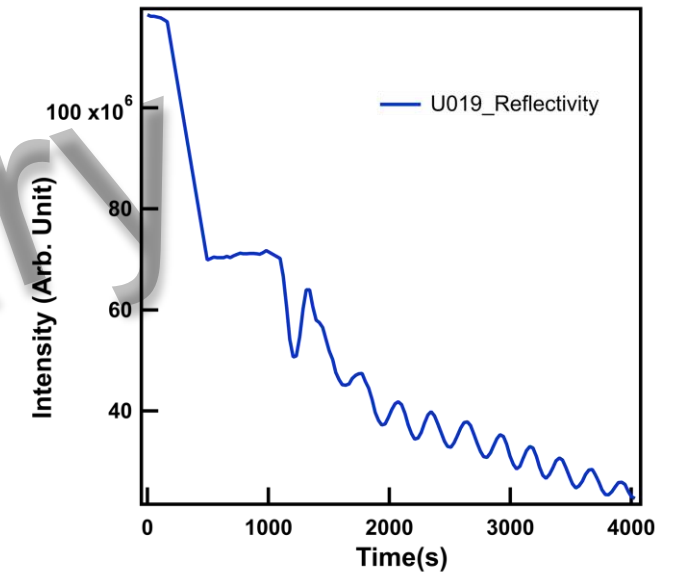


Film thickness 48.1 nm



Film thickness 20.5 nm

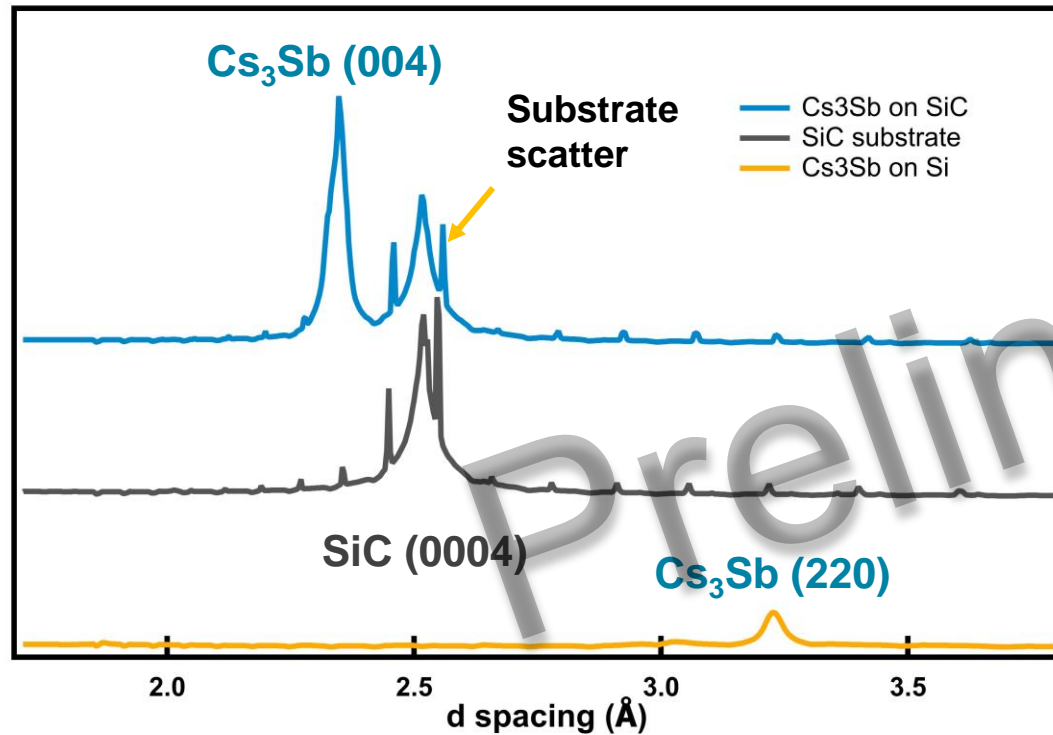
## X-ray reflectivity during growth



- Smooth film during growth
- Highly textured on SiC
- Possible epitaxy?

# Cs<sub>3</sub>Sb on 4-H SiC: Post growth Characterization

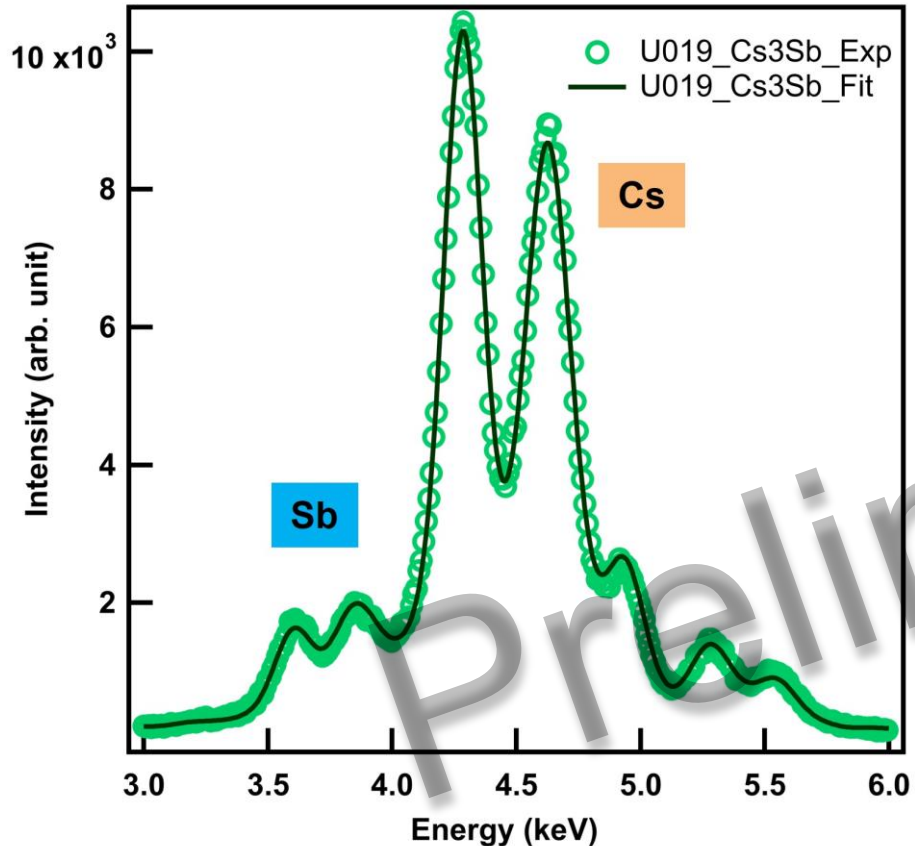
## X-ray Diffraction



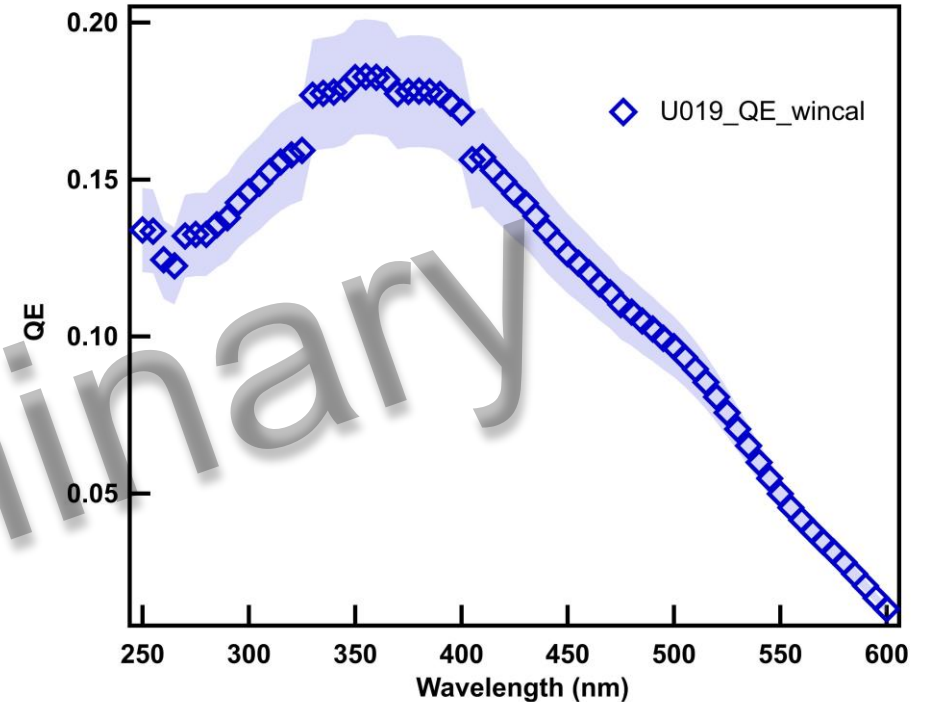
Diffraction peak	D spacing (Å)
Cs <sub>3</sub> Sb (004)	2.34
SiC (0004)	2.51
Cs <sub>3</sub> Sb (220)	3.23

# Cs<sub>3</sub>Sb on 4-H SiC: Post growth Characterization

## X-ray Fluorescence



## Spectral Response

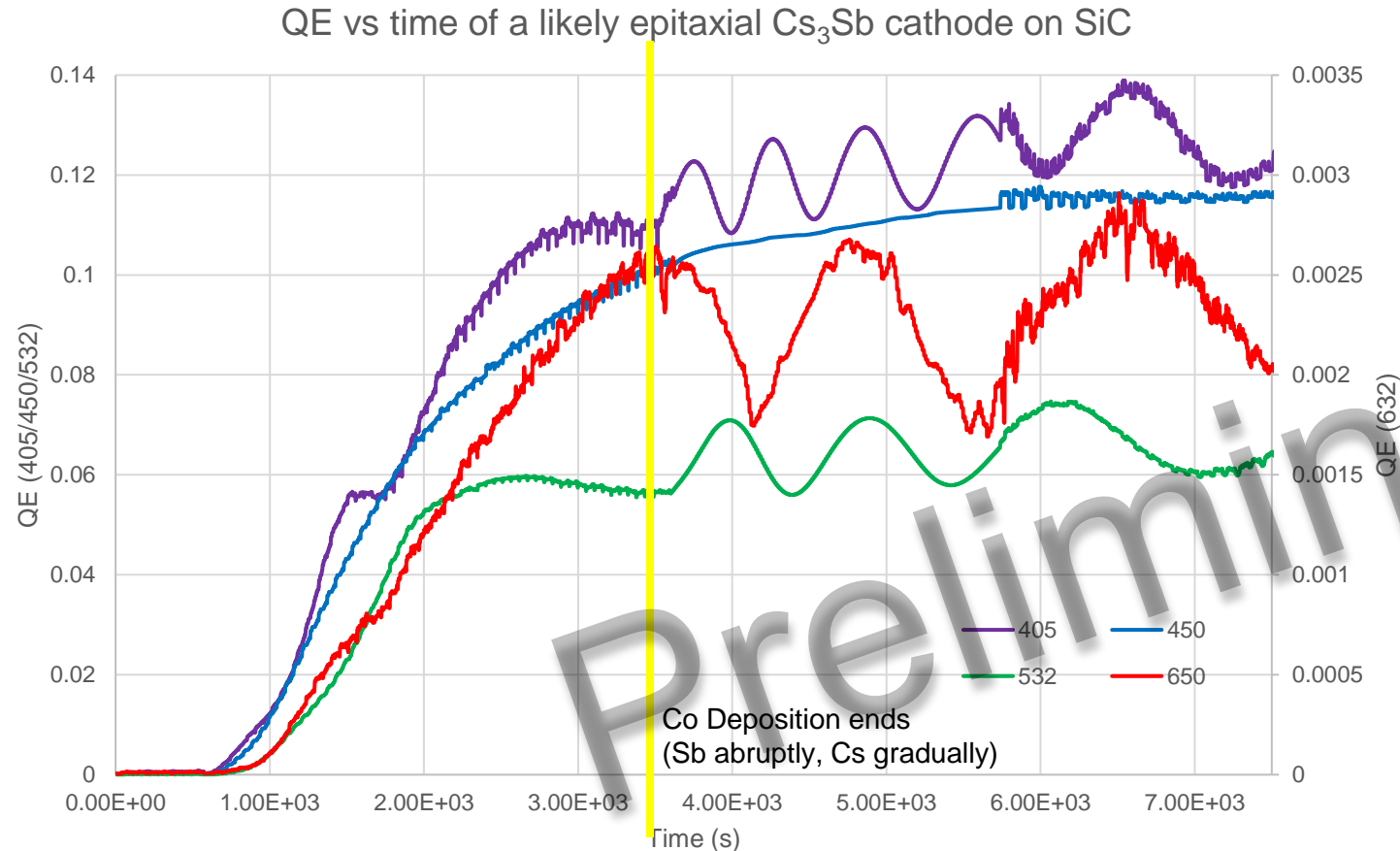


	K/Sb	Cs/Sb
Cs <sub>3</sub> Sb/4H-SiC	/	2.95

- 350 nm (peak): 18.2%
- 530 nm: 7%



# Cs<sub>3</sub>Sb on 4-H SiC: QE oscillation vs wavelength



- Cathode is evolving after growth is stopped and substrate cooling down.
- Change of index of refraction
- Loss of material

# Summary

- Here we report evidence for the nucleation of  $\text{Cs}_3\text{Sb}$  on Hexagonal SiC. The film was grown to near optically dense thickness, and x-ray diffraction revealed the alignment of the cubic CsSb to the substrate peaks of the SiC. The resulting film was remarkably smooth. The QE was respectable (18.2% at 350 nm, 7% at 532 nm).

# Acknowledgements

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