Cesium Dispenser Photocathode Research at the University of Maryland

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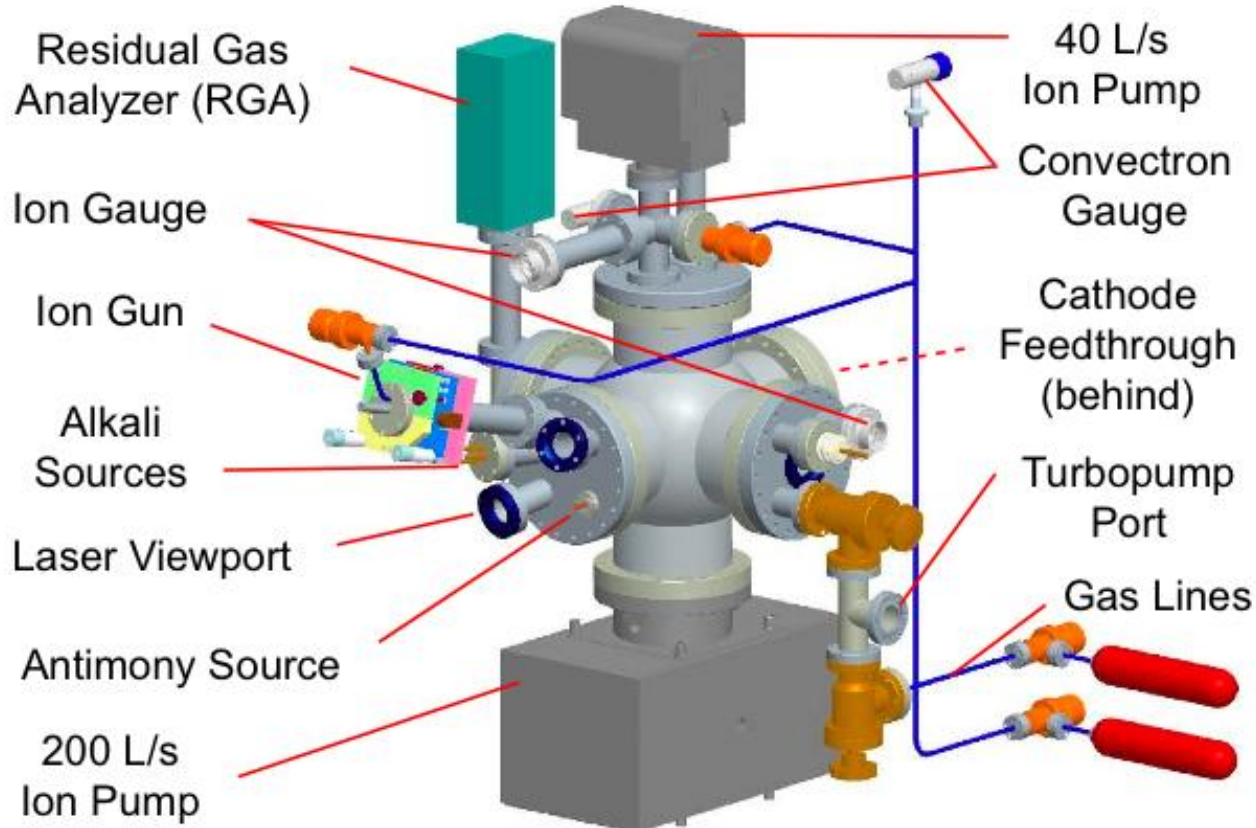
Photocathode Research Capabilities: Advanced Test Facilities

Multi-wavelength
QE measurement

Multi-alkali
cathode fabrication



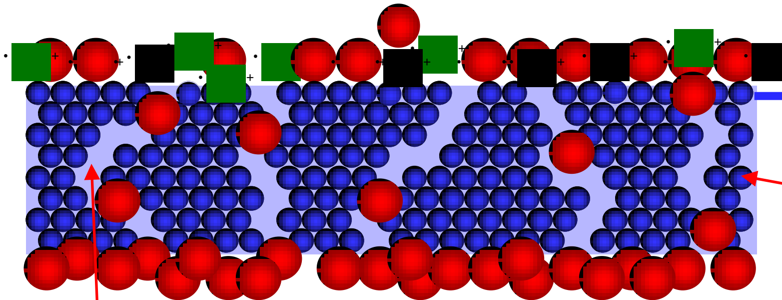
Test facility to accurately measure
Quantum Efficiency and Lifetime

Characterization of Quantum Efficiency and Robustness of Cesium-Based Photocathodes, E. J. Montgomery, Doctor of Philosophy, Department of Physics, University of Maryland (2010)

Demonstration of Cesium Dispenser

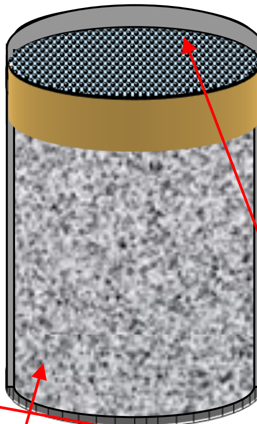
Goal: **Automated in-situ re-cesiation**

Photo emissive surface



Cs Na K

Sb

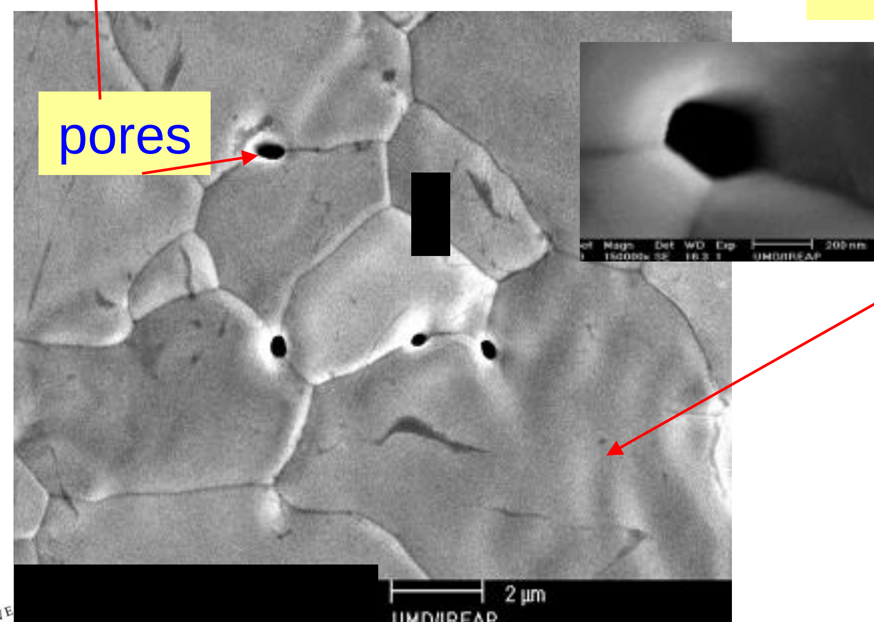


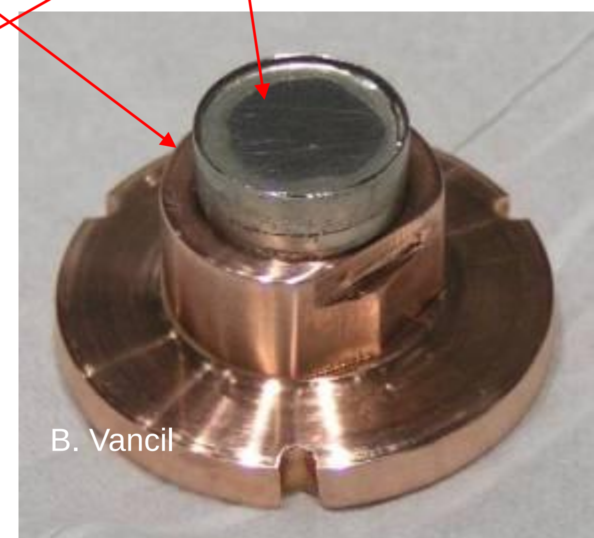
E. J. Montgomery, D. W. Feldman, P. G. O'Shea, Z. Pan, N. Sennett, K. L. Jensen and N. A. Moody. DEPS 10th Dir. Energ. Symp., Huntsville, AL, (2007).

Sintered Tungsten Disk

Cs reservoir

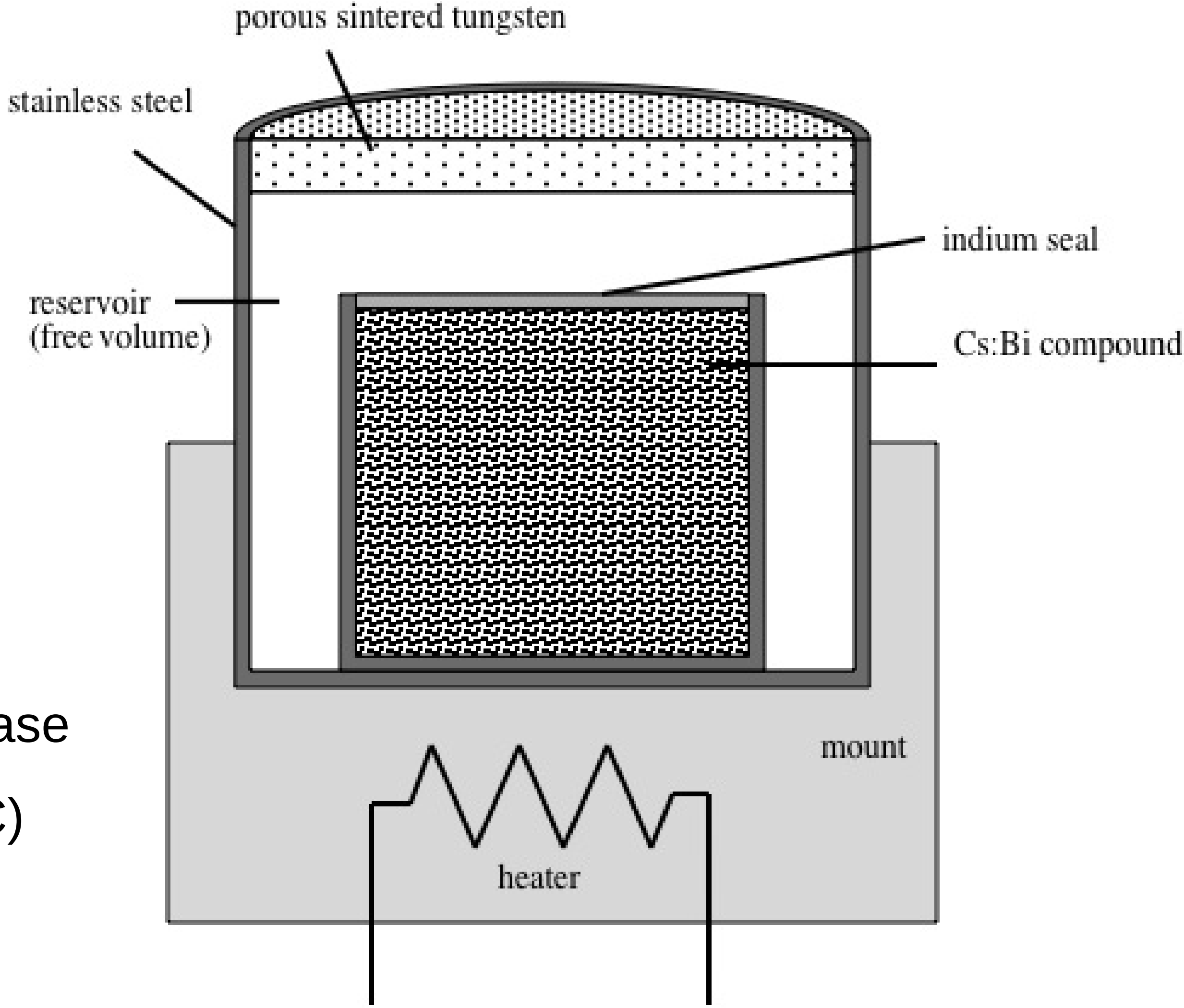
pores





Lifetime of Cs:W extended 10x

Second Generation Cesium Dispenser



Chromate free, clean release

Cooler activation (~300 ºC)

Second Generation Cesium Dispenser

Comparison of 1st and 2nd generation cathode operation

Gen.	Activation	Rejuvenate Turn-On	Normal Operation	Tungsten Density	Substrate Thickness	Reservoir: Cs mass, material
1	425 ºC +	~50 ºC	175 ºC	70%	1.0 mm	200 mg, CrCs2O4:Ti
2	**273 ºC +**	<80 ºC	**150 ºC**	60%	0.5 mm	500 mg, Cs:Bi

Key finding: Cs:Bi provides cooler, cleaner operation and thinner, less dense tungsten diffuses Cs better

Rejuvenation of Contaminated Cs-Based Cathode

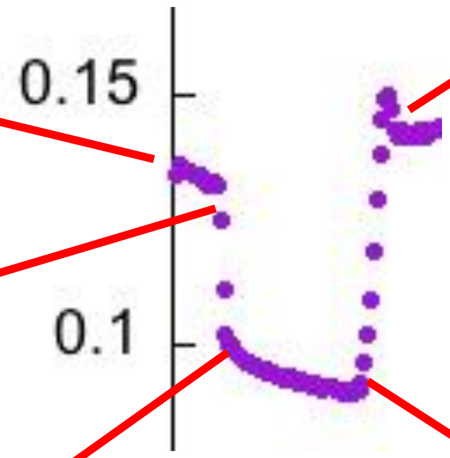
What ails the patient? Contamination-induced cesium loss.

Prescribed “cure”: recesiation.

Test methodology:

1. Initial QE:
Cs on clean substrate

5. Recesiation ends: note full rejuvenation of QE



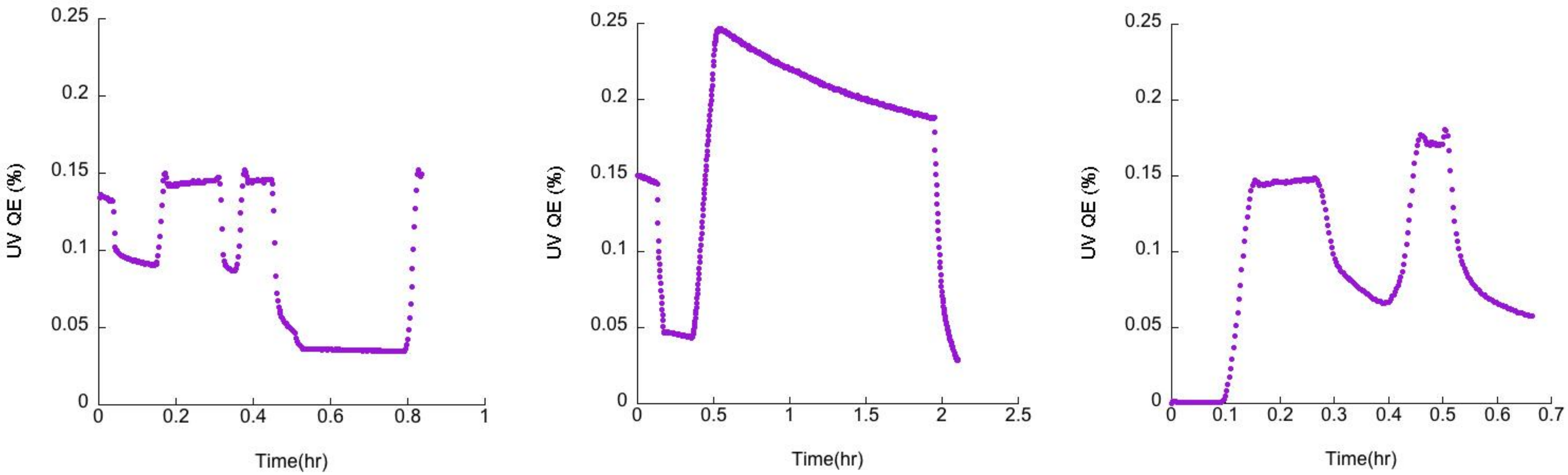
2. Exposure to gas begins; QE depreciates

4. Recesiation begins

3. Gas exposure stops

Rejuvenation of Contaminated Cs-Based Cathode

CO_2 O_2 N_2O



Key finding: recesiation reverses contamination. The dispenser concept is supported.

Towards a Robust, Efficient Dispenser Photocathode: the Effect of Recesiation on Quantum Efficiency, E. J. Montgomery, P. Z. Pan, J. Leung, D. W. Feldman, P. G. O'Shea and K. L. Jensen. AIP Conf. Proc., 1086, 599 (2009).

UMD Photocathode Development
Strategic Summary

ISSUE

- State-of-the-art photocathodes advantageous for high power FELs suffer from short life or low efficiency

GOAL

- 2% quantum efficiency long-lived dispenser photocathode

APPROACH

- Synergistic Theory and Experiment while training future DE scientists

ACCOMPLISHMENTS

- Four concurrent "Expeditions" to advance the state-of-the-art

A1: Cesium Dispenser Photocathode

A2: QE of Cesium-coated Metals

A3: Cesium Loss and Recesiation

A4: High QE Semiconductors

- 2nd gen. dispenser, validated predictive theory, contamination "cure" by recesiation, percent-level QE, ready to move to gun testing

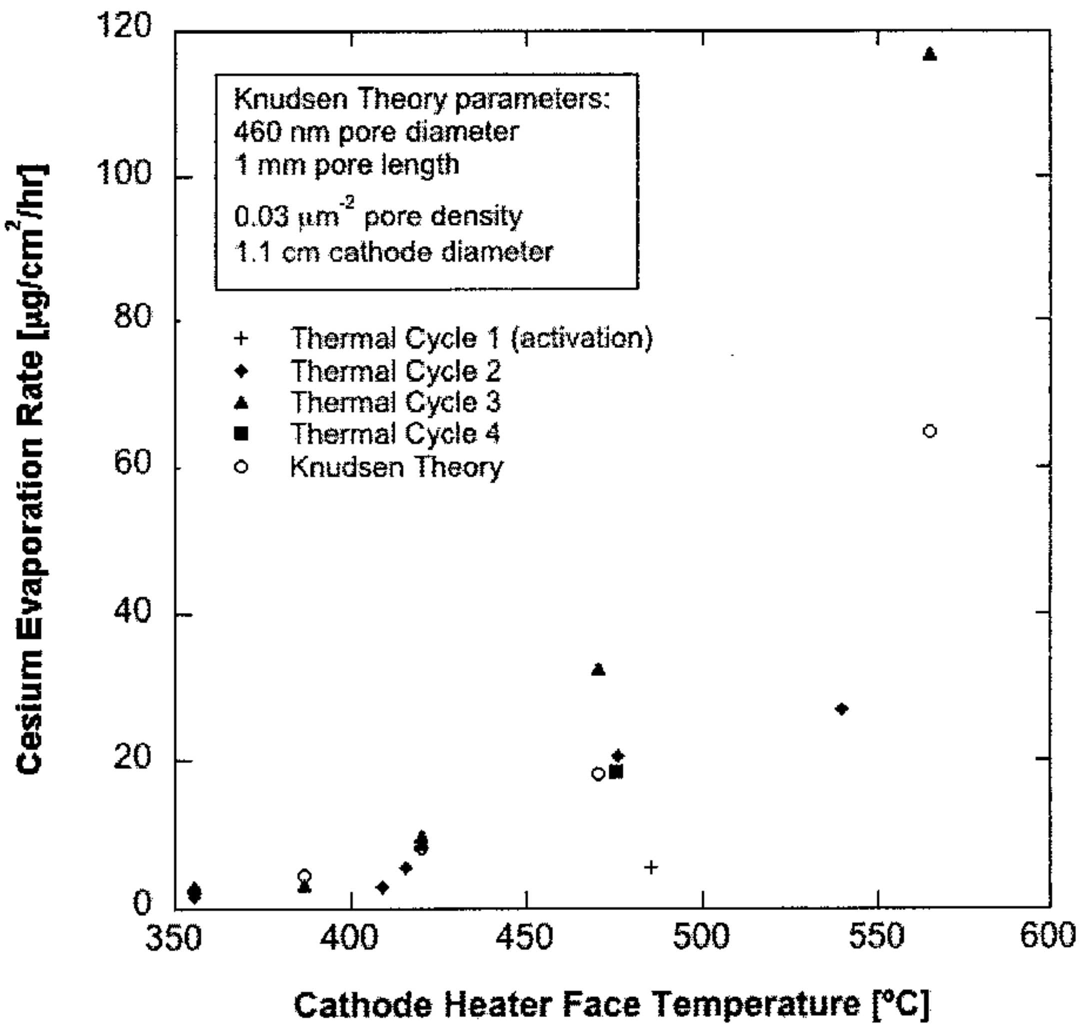
Cesium Emission

Cs-Sb

- QE = 10%, evaporated Cs
- QE = 1%, in situ Cs

Cs-W

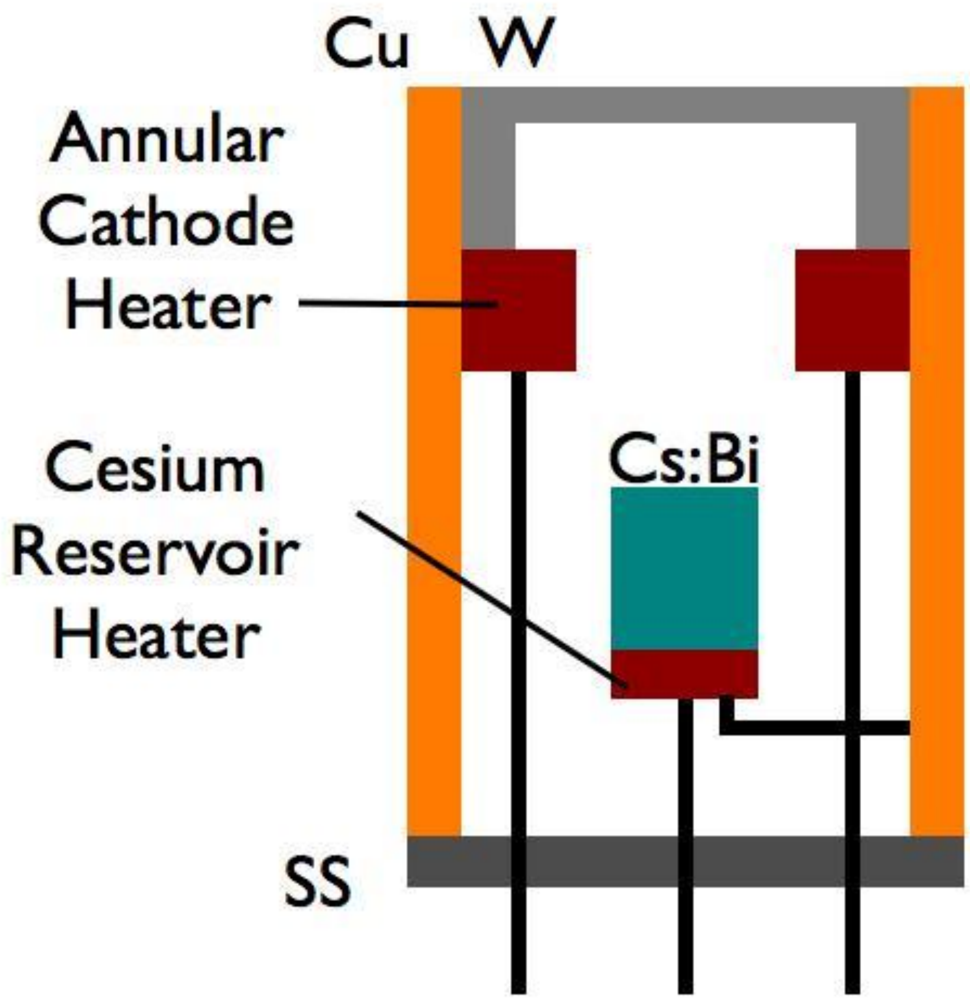
- Test Cs emission
- QE ~0.1 %



Limiting Cs Emission: Option 1

Decouple Cs source temp. from the diffusion barrier temp.

- Put as much space between the Cs reservoir and cathode as possible



Limiting Cs Emission: Option 2

Eliminate temp. as the means of activation

- Heat to activation temp.
- Lower to operation temp.
- Break glass