INSTITUTE FOR RESEARCH IN
ELECTRONICS
& APPLIED PHYSICS

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Photocathodes at the University of Maryland

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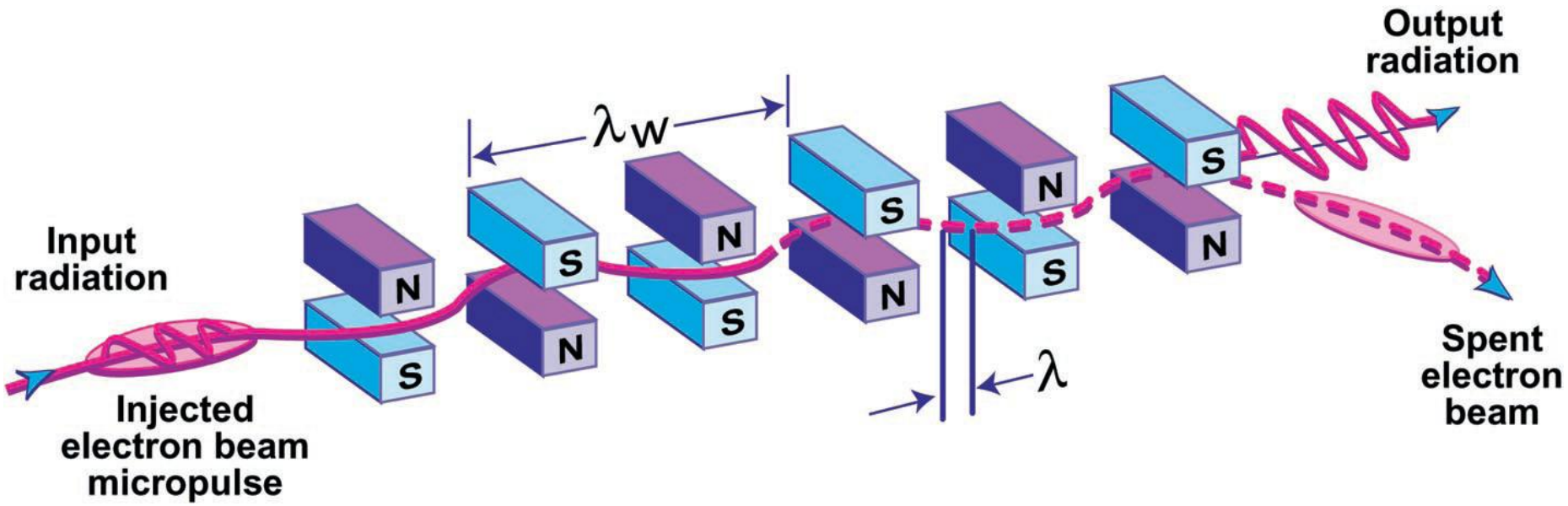
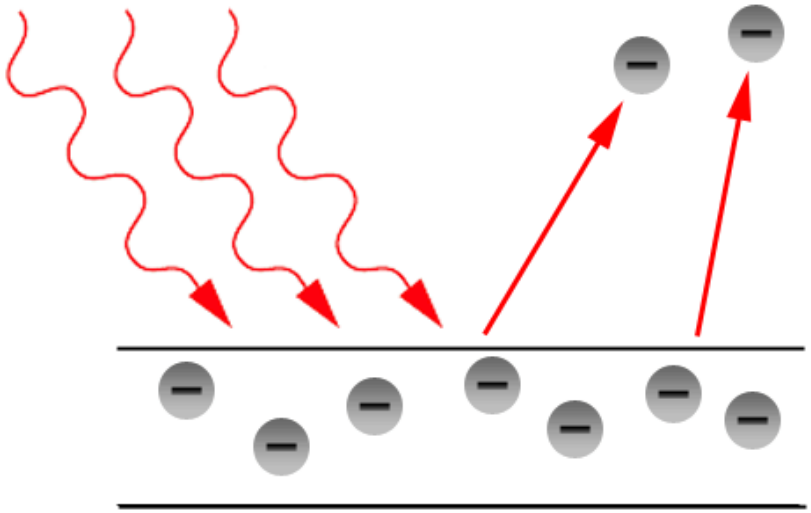


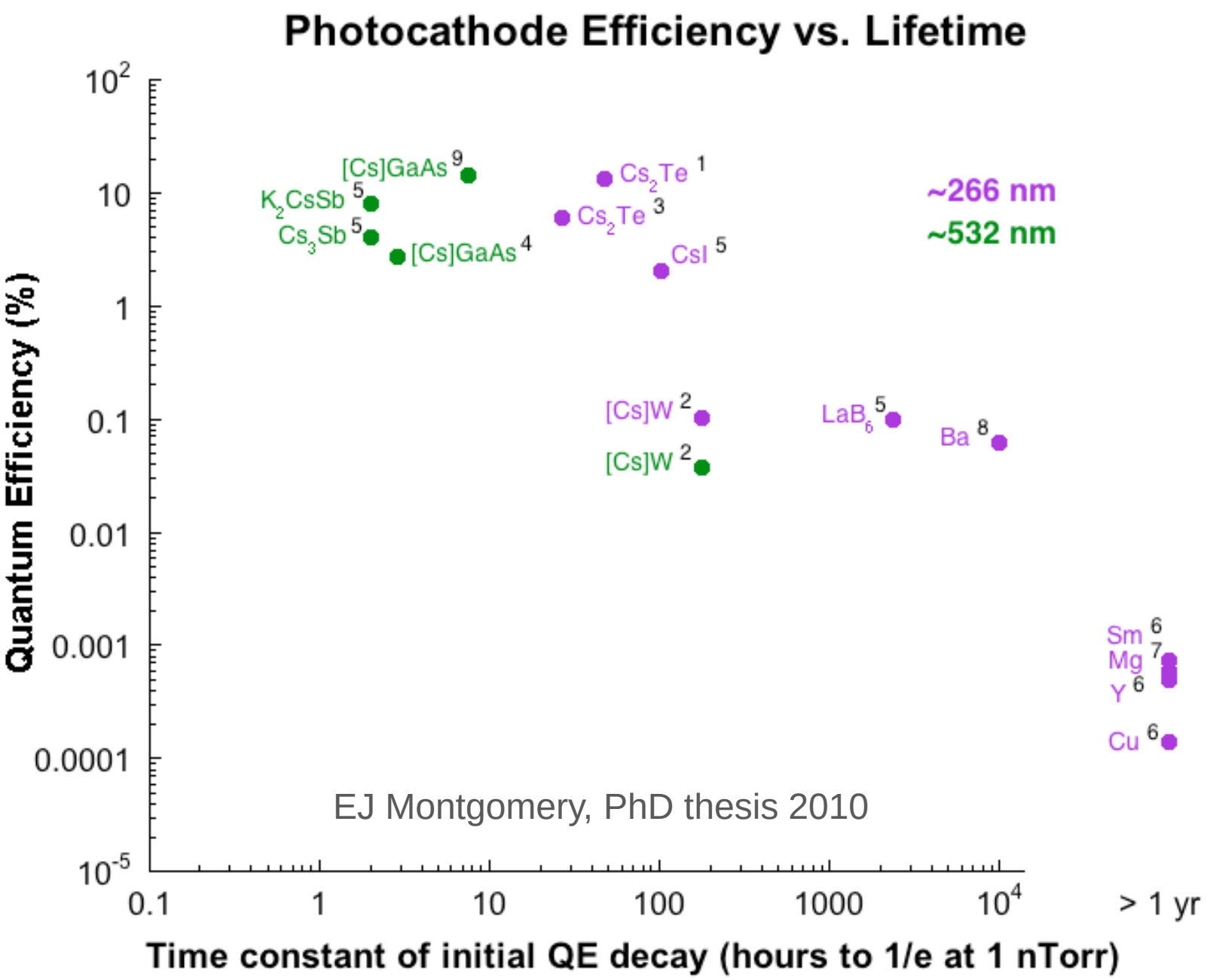
PG O'Shea & HP Freund, *Science* 8 June 2001, Vol. 292, p 1853

Photocathodes



Photoelectric effect
http://commons.wikimedia.org

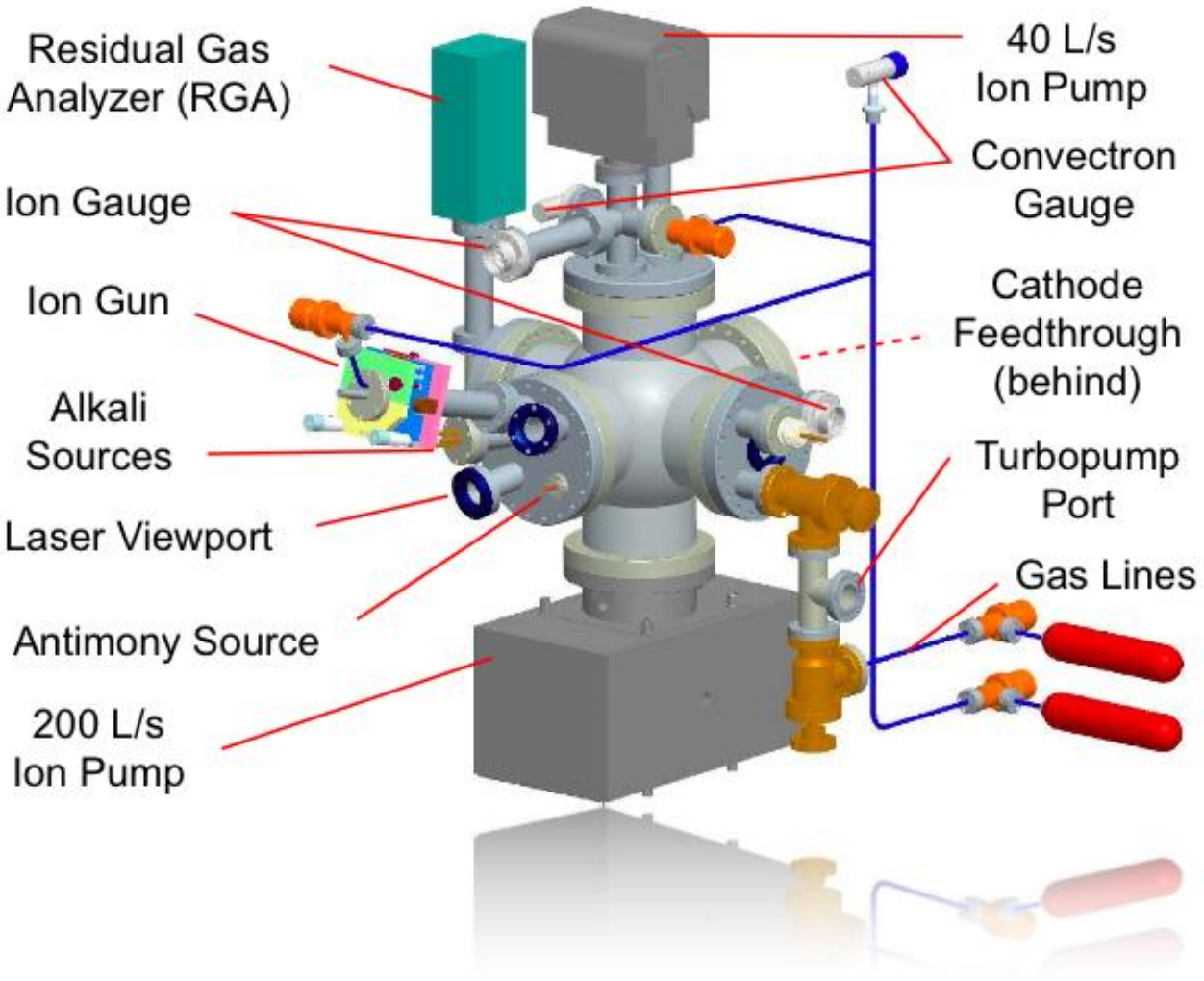
$$\text{Quantum Efficiency (QE)} = \frac{\#\text{ electrons emitted}}{\#\text{ photons incident}}$$


Photocathode Efficiency vs. Lifetime
Quantum Efficiency (%)
10^2
10
1
0.1
0.01
0.001
0.0001
10^{-5}
[Cs]GaAs 9
K_2CsSb 5
Cs_3Sb 5
[Cs]GaAs 4
Cs_2Te 1
Cs_2Te 3
CsI 5
[Cs]W 2
[Cs]W 2
LaB_6 5
Ba 8
Sm 6
Mg 7
Y 6
Cu 6
~266 nm
~532 nm
EJ Montgomery, PhD thesis 2010
0.1
1
10
100
1000
10^4
> 1 yr
Time constant of initial QE decay (hours to 1/e at 1 nTorr)

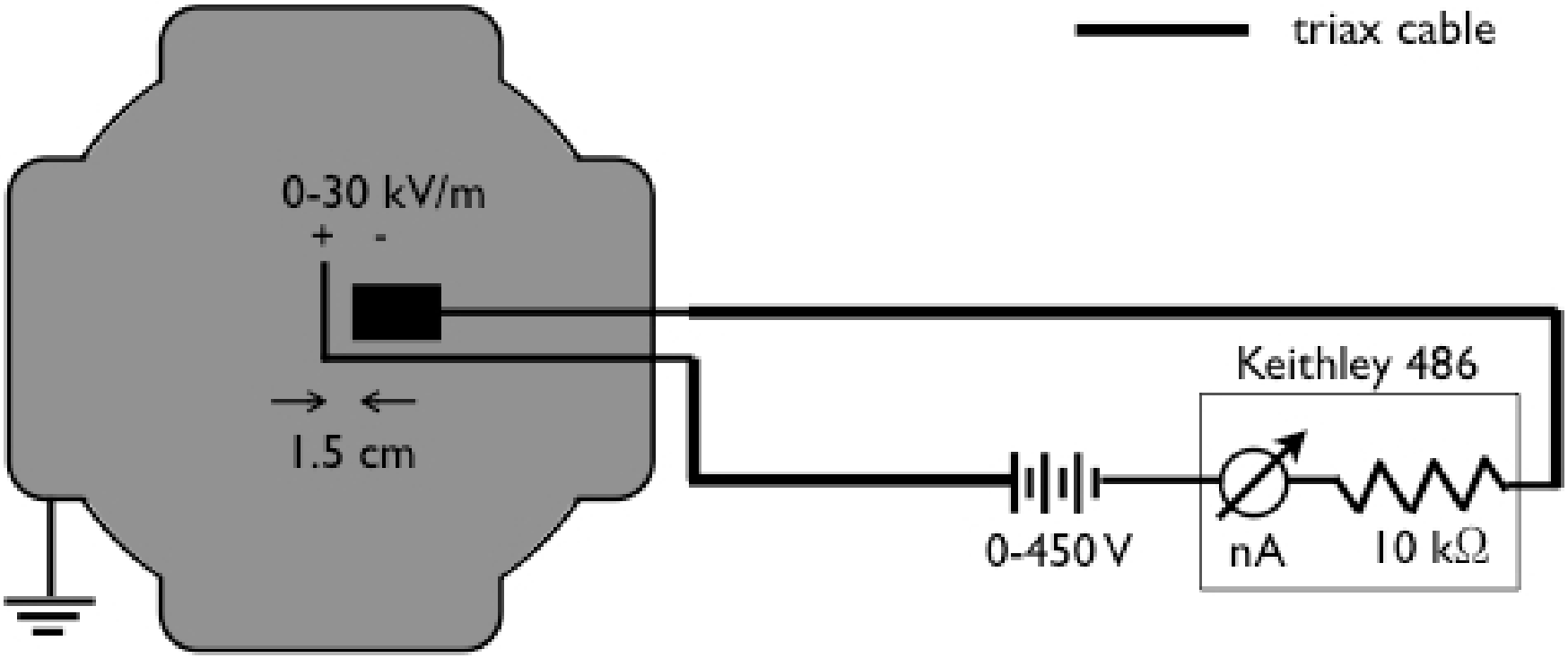
Test Facility

Multi-wavelength QE measurement

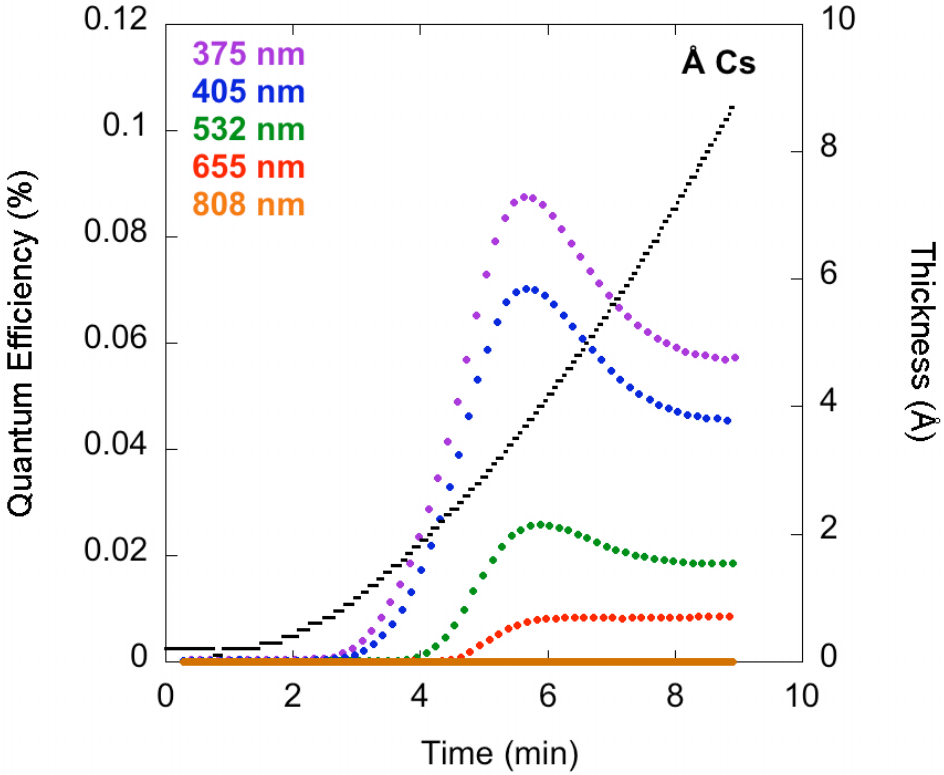
Multi-alkali cathode fabrication



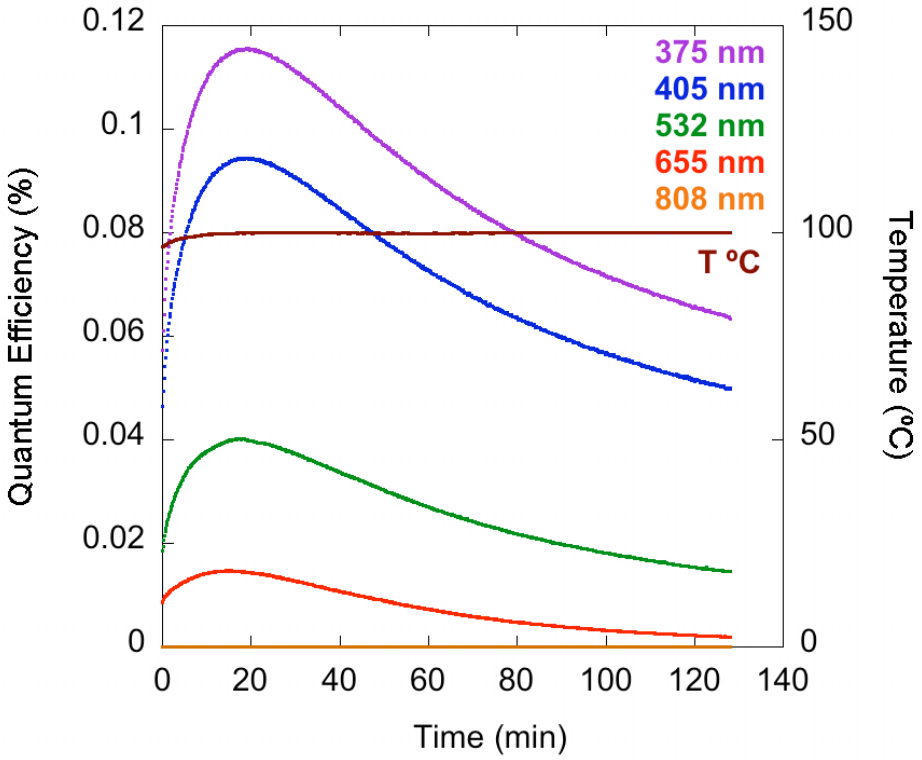
QE Circuit



Cesium

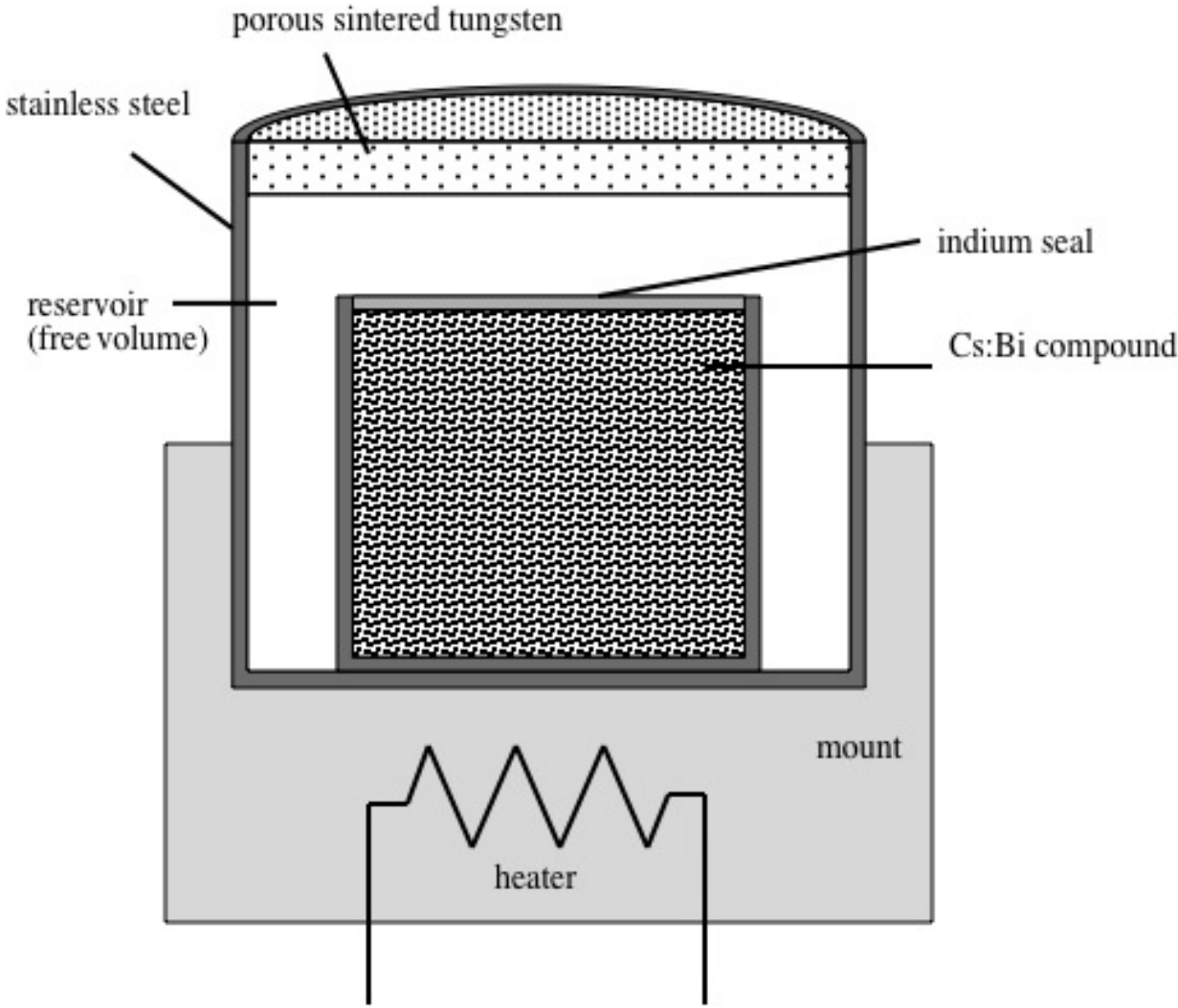


Cs:W deposition (100 °C)



Cs:W evaporation

Cesium Rejuvenation

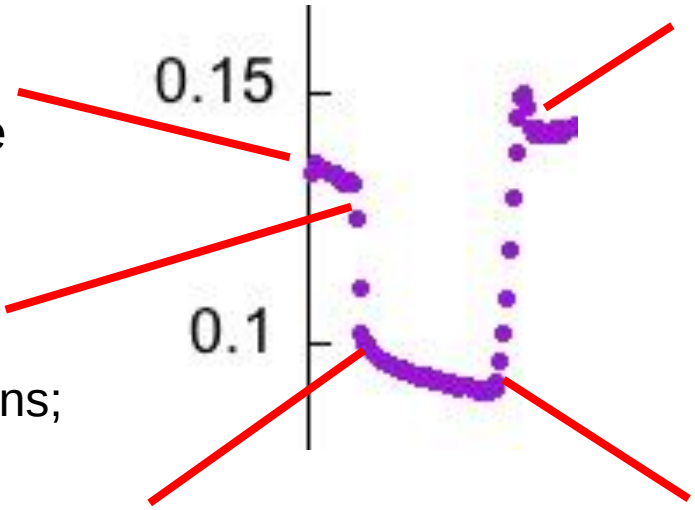


Chromate free, clean release

Activation ~300 ºC

CO_2 Rejuvenation test

1. Initial QE:
Cs on clean substrate



5. Recesiation ends: note full rejuvenation of QE

2. Exposure to gas begins;
QE depreciates

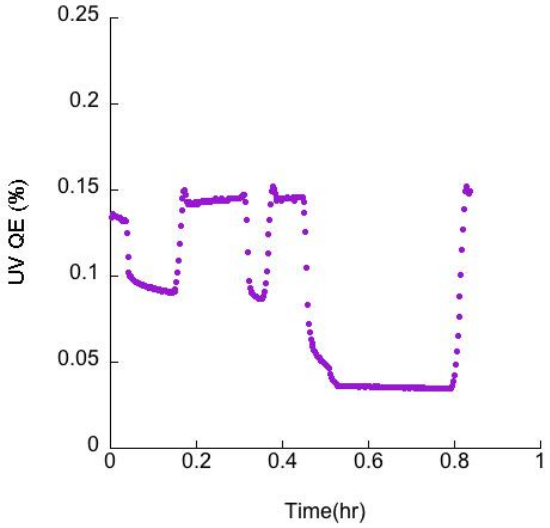
4. Recesiation begins

3. Gas exposure stops

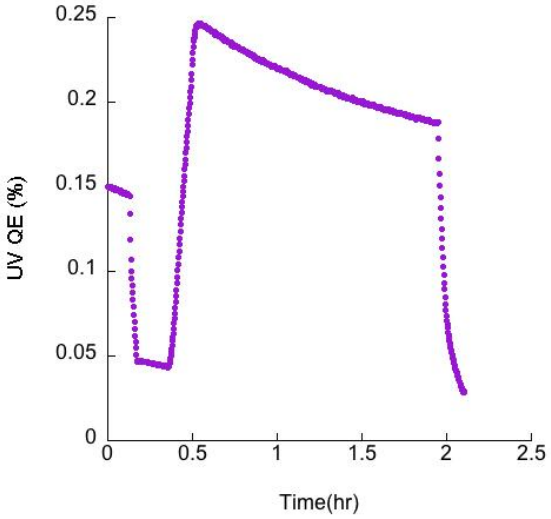
Cs:Ag

More Tests

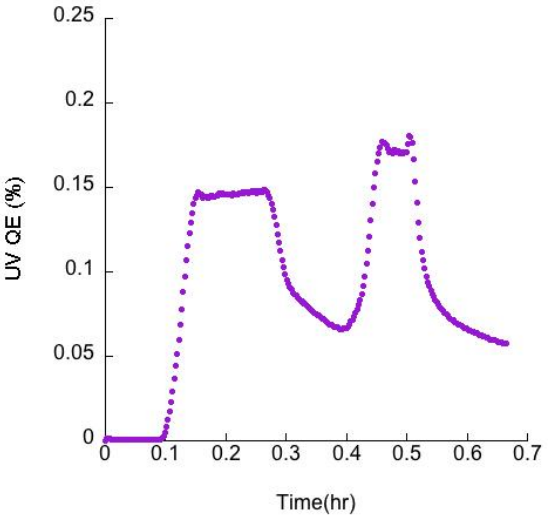
CO_2



O_2

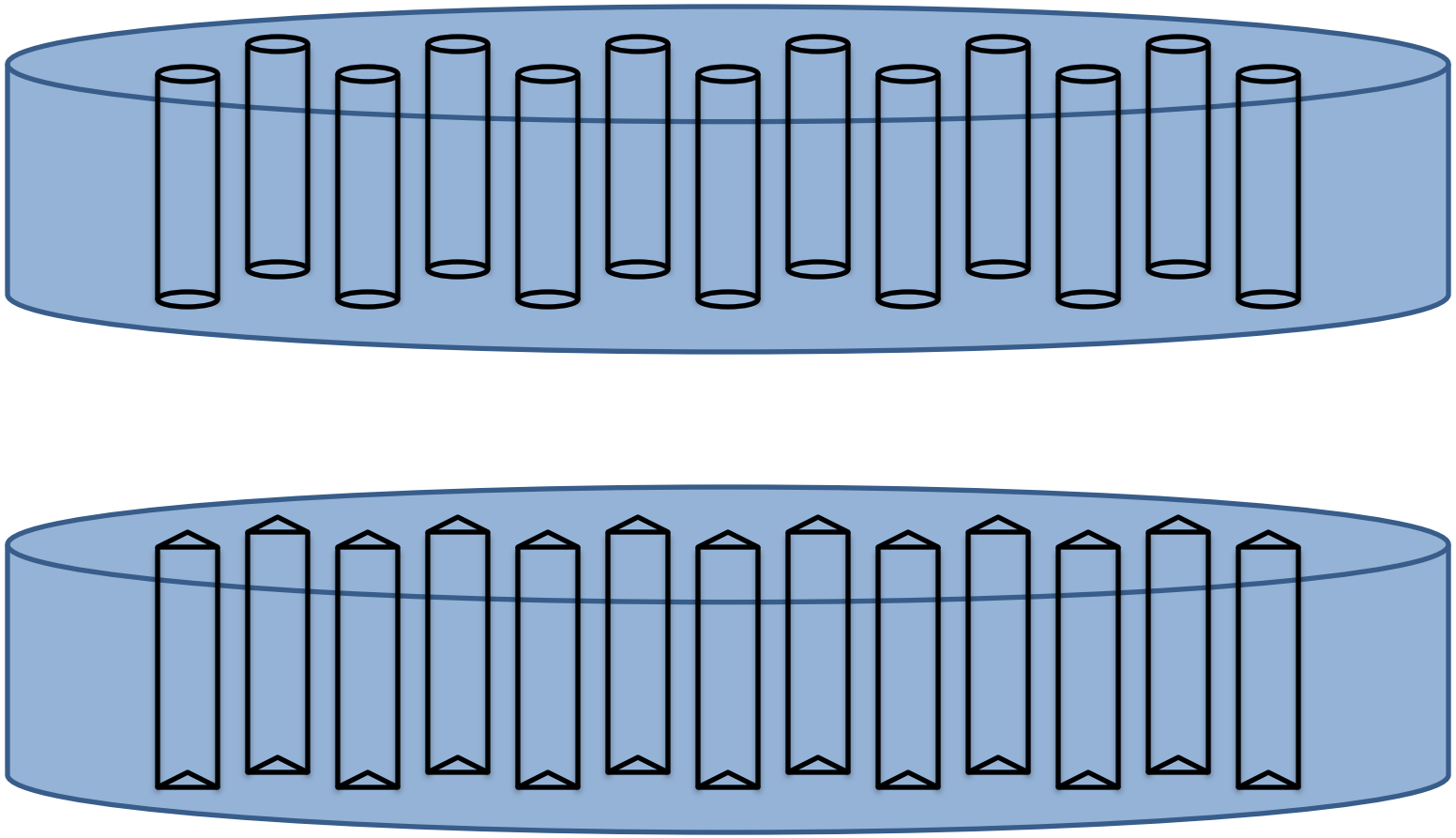


N_2O



Cs:Ag

Mass Flow Rate

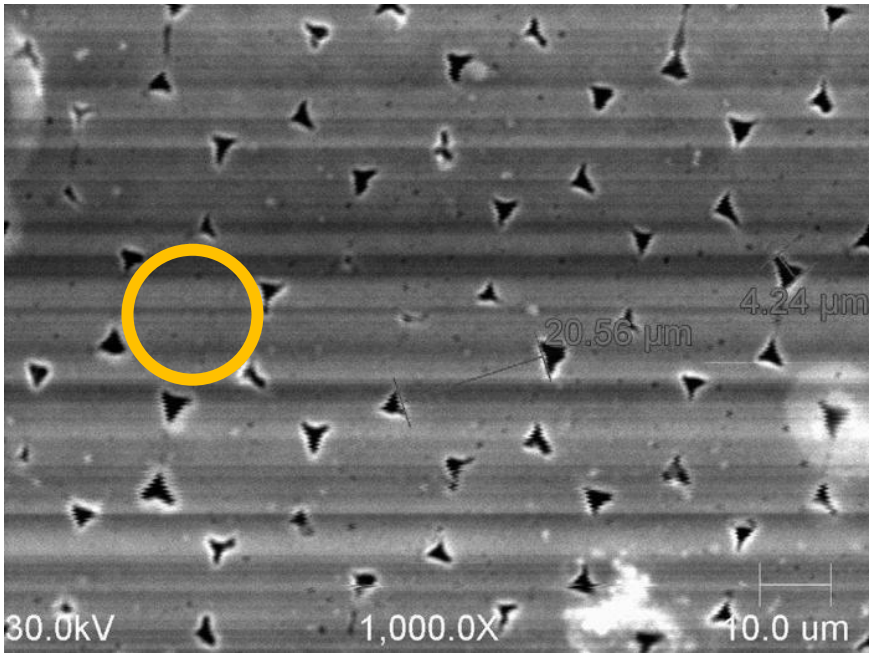


Mass Flow Rate (1 pore)

$$Q \sim \frac{D^3}{L}$$

D	Pore size (i.e. radius)
L	Pore length

Mass Flow Rate



R.L. Ives et al., IEEE Trans. Elec. Devices, 52 (12) 2005

Wire Diameter: 20 to 8 microns

$$Q_{total} \sim Q_{pore} N_{pore}$$

Constant number of pores	$Q_{total} \sim \frac{D^3}{L}$	Q decreases by 94%
Constant cathode area	$Q_{total} \sim \frac{D}{L}$	Q decreases by 60%

Summary & Outlook

- About a half monolayer of Cs increases QE
- Cs dispenser design prolongs lifetime
- Need to control Cs flow rate before tests in other systems
- Test new photocathodes