

***QUANTUM EFFICIENCY AND
TOPOGRAPHY OF HEATED AND
PLASMA-CLEANED COPPER
PHOTOCATHODE SURFACES*** 

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L-3 Titan PSD ***SLAC/ PE Group***
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PAHBEB 2005; Erice, Sicily

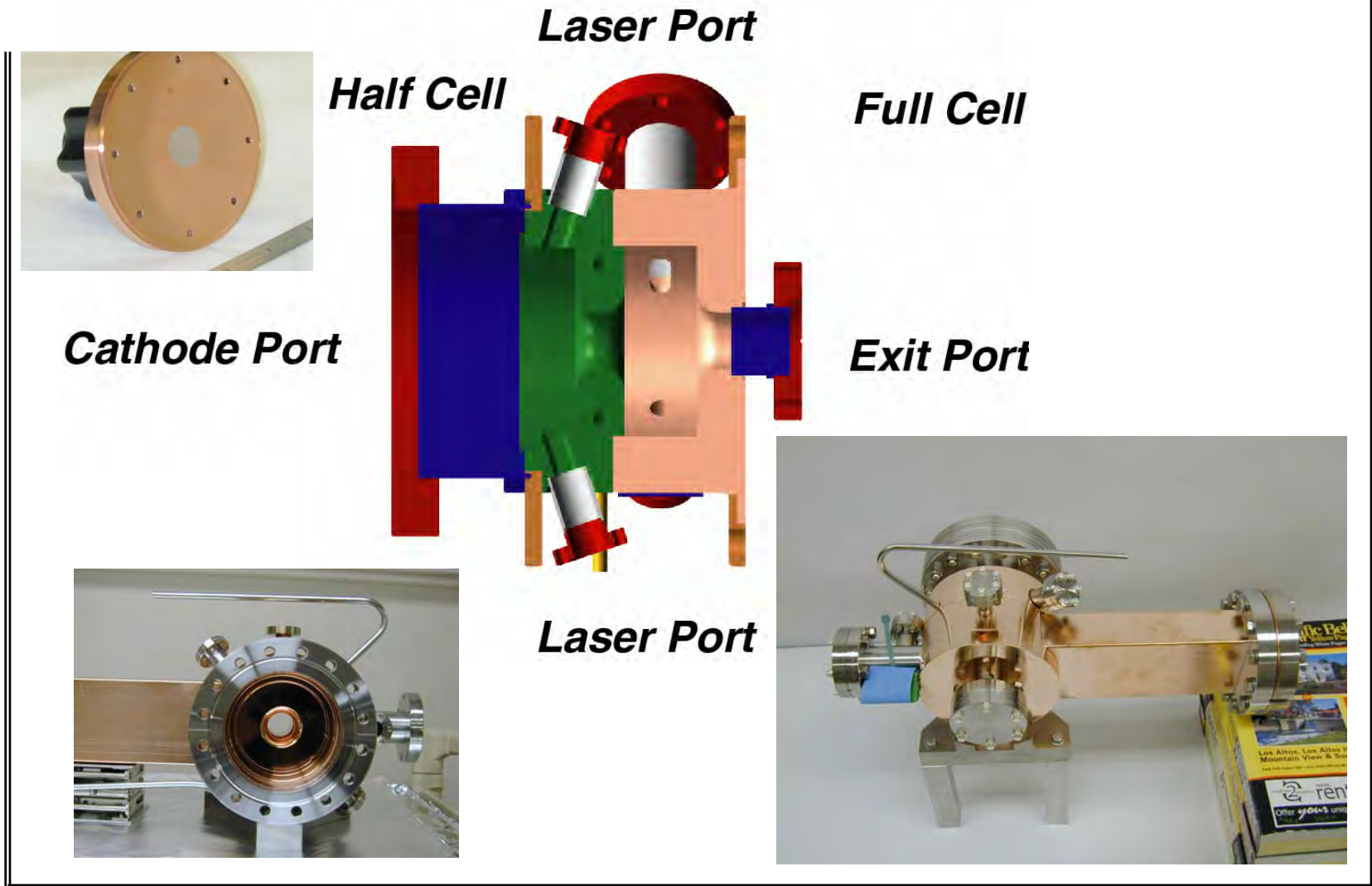


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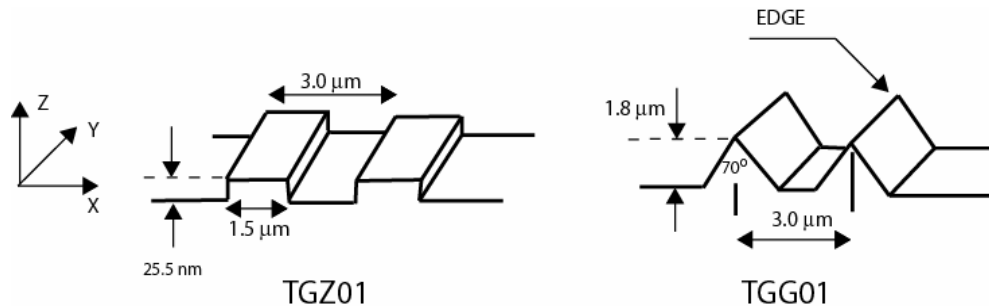
Outline

- 1. *RF Gun***
- 2. *Experiment Setup***
 - ***Surface Roughness***
 - ***X-ray Photoemission***
 - ***Quantum Efficiency***
- 3. *Results***
- 4. *Conclusions***

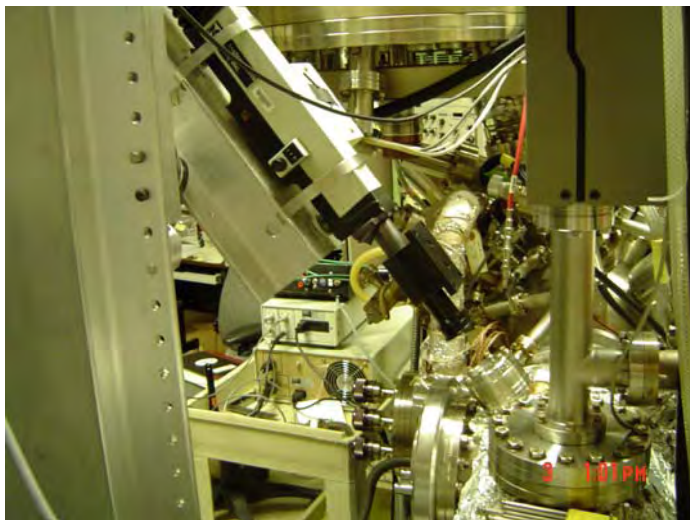
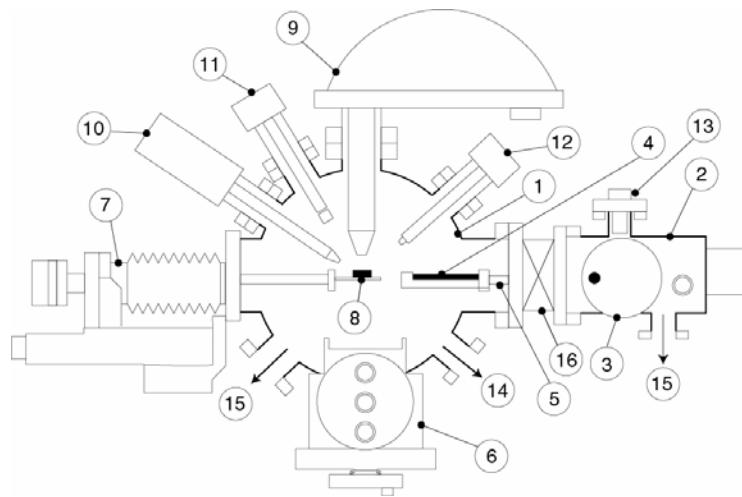
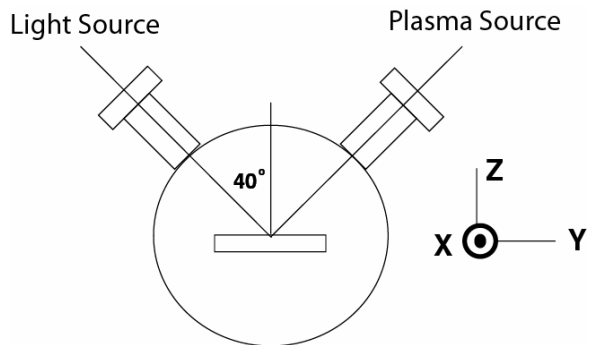


BNL/SLAC/UCLA 1.6 cell S-Band RF Gun (Weaver Modified Gun)

Burleigh ARIS – 3500 Personal Atomic Force Microscope



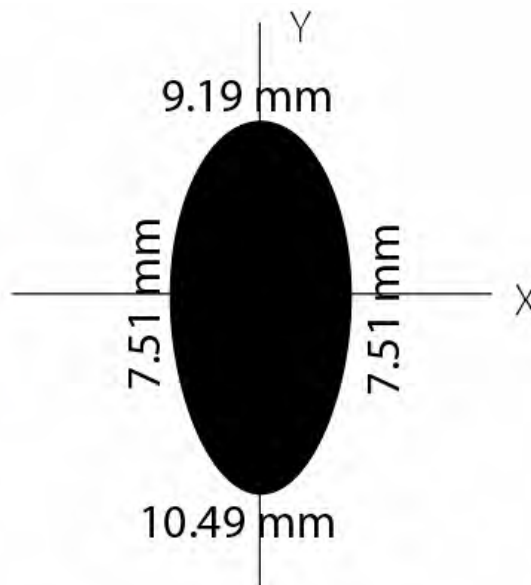
Sample Scanning Module	Scan Range	Position Resolution	Image Resolution
Long Range ARIS - 3070	XY Axes: Up to 70 μm, nonlinear Up to 65 μm, linear Z Axis : Up to 9 μm	XY Axes: < 50 Å Z Axes: < 10 Å	XY Axes: < 500 Å open loop < 2,000 Å closed loop Z Axes: < 10 Å



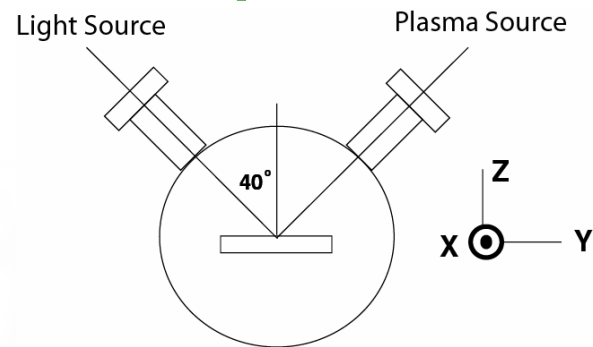
1. Analysis chamber	9. Electrostatic energy analyzer
2. Loadlock chamber	10. X-ray source
3. Sample plate entry	11. SEY/SEM electron gun
4. Sample transfer plate	12. Microfocus ion gun
5. Rack and pinion travel	13. Sputter ion gun / DUV window
6. Sample plate stage	14. To pressure gauges and RGA
7. XYZ ⊗ Omniax™	15. To vacuum pumps
8. Sample on XYZ ⊗	16. Gate valve



3.75 mm by 5.00 mm



Plasma Spot Size



XPS spot Size

UV Spot Size

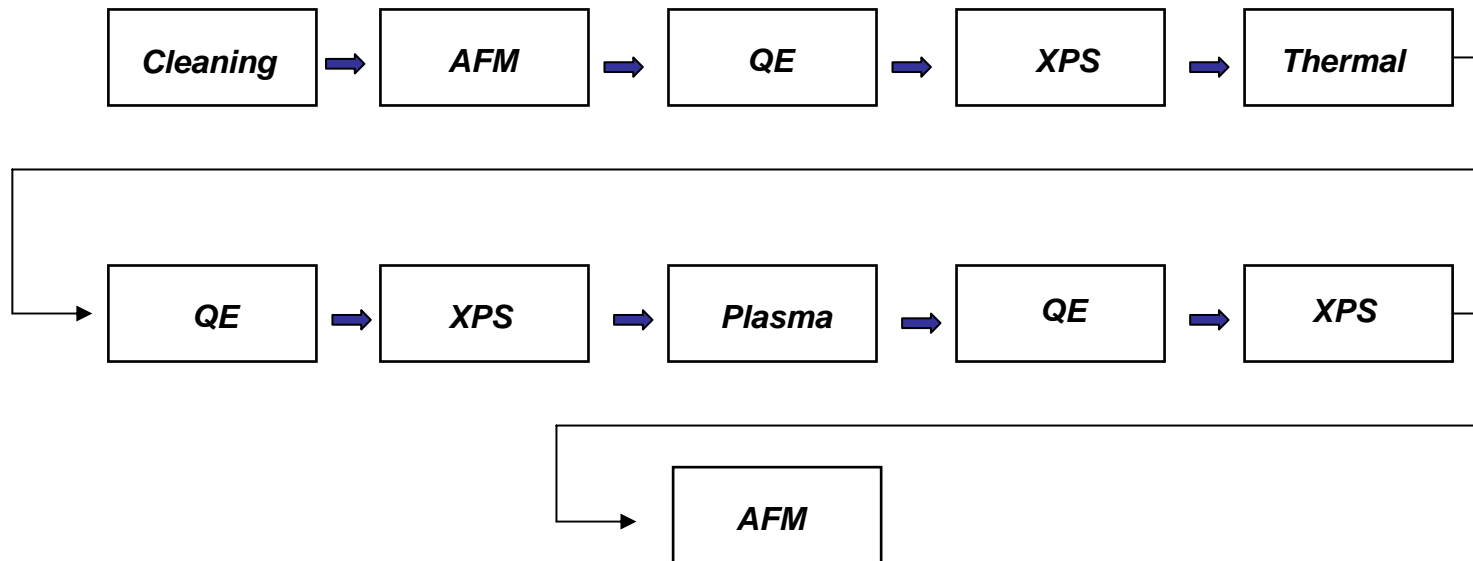
Spectral Range	200 – 800 nm
Grating Density	1200 groves/mm
Linear Dispersion	4 nm/mm
Band Pass (standard slits)	2,4,8 nm
Wavelength Accuracy	1 nm



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Experiment Flow Chart



Copper Cylinder Polishing Procedure

Initially cleaned in the SLAC Plating Shop [1]

Mount Cu cylinders on 1-1/4" Dia. epoxy mounts

400 Grit SiC, 1x in 1:00 step, 150 RPM, contra rotation, 3 lb force, water coolant + coconut oil soap

600 Grit SiC, 3x in 1:00 steps, 150 RPM, contra rotation, 3 lb force, water coolant + coconut oil soap

change SiC paper each step

800 Grit SiC, 3X in 1:00 steps, 150 RPM, contra rotation, 3 lb force, water coolant + coconut oil soap

change SiC paper each step

6 micron diamond paste with Struers Red Lube, 1x in 5:00 step, 150 RPM, contra rotation, 3 lb force

Surface is new nylon cloth, ultrasonic clean in isopropyl alcohol

3 micron diamond suspension with Struers Red Lube, 1x in 4:00 step, 150 RPM, contra rotation, 3 lb force

Surface is new "Struers MOL" cloth, ultrasonic clean in isopropyl alcohol

1 micron diamond suspension with Struers Red Lube, 1x in 3:00 step, 150 RPM, contra rotation, 3 lb force

Surface is new "Buehler Microcloth" cloth, ultrasonic clean in isopropyl alcohol

.04 micron colloidal silica with DI water, 1x in 3:00 step, 100 RPM, contra rotation, 3 lb force

Surface is new "Struers OP-S" cloth

Ultrasonic clean in isopropyl alcohol

Dry with Nitrogen

Remove epoxy mounts and swab non polished Cu surfaces with acetone

Ultrasonic clean in isopropyl alcohol

Dry with Nitrogen

Ultrasonic clean in Hexane

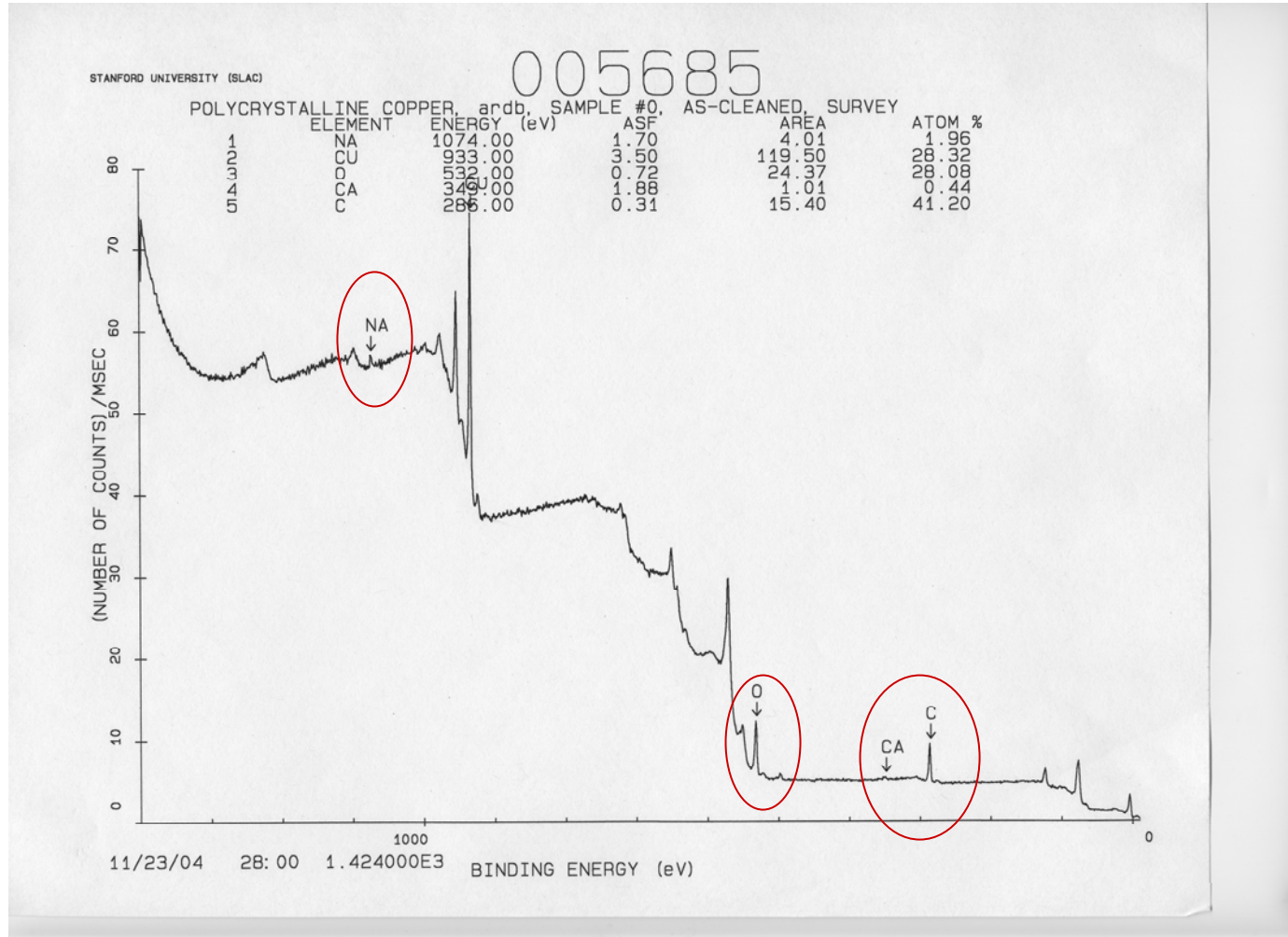
Store Cu cylinders in Hexane



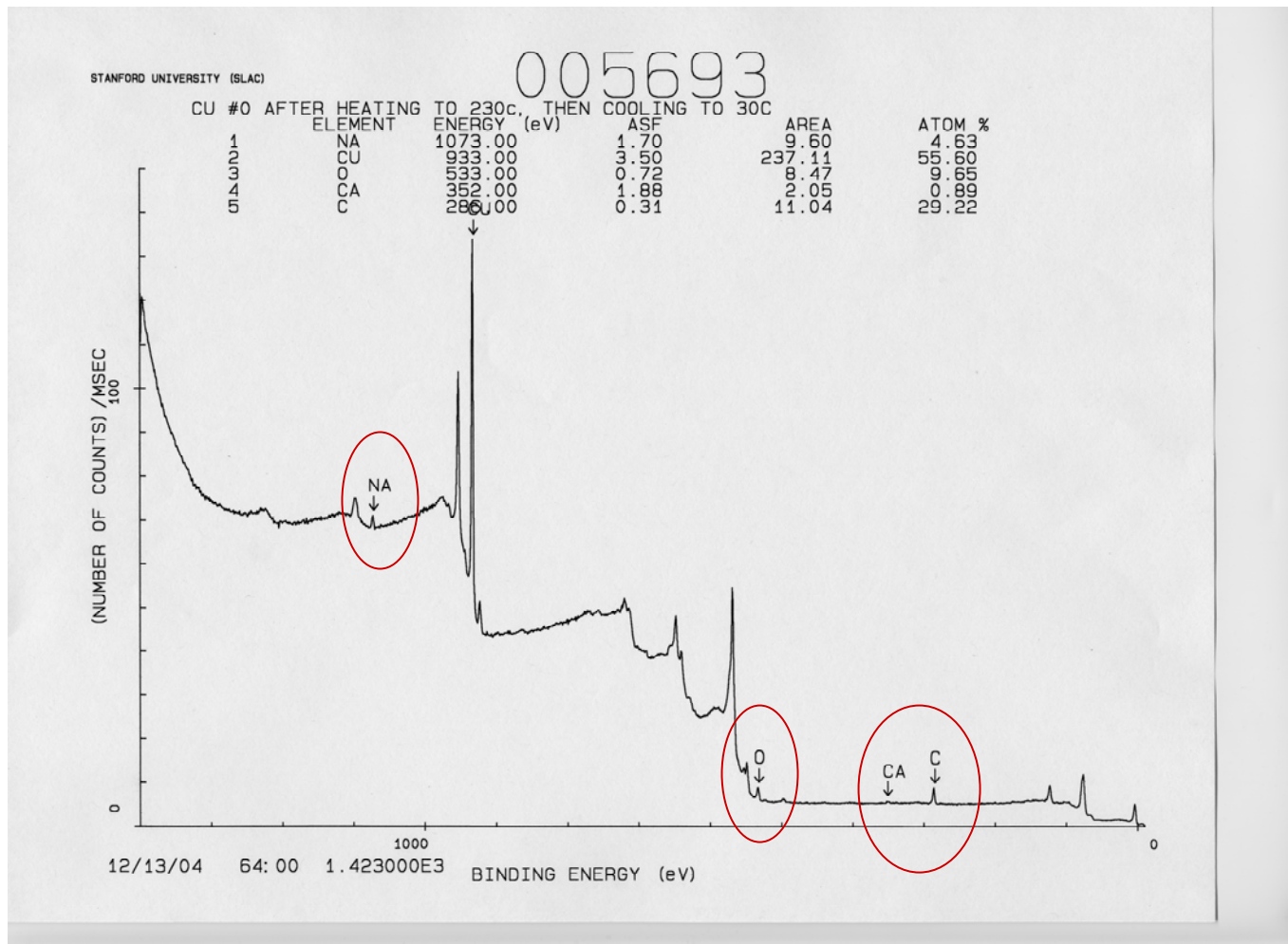
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As Cleaned



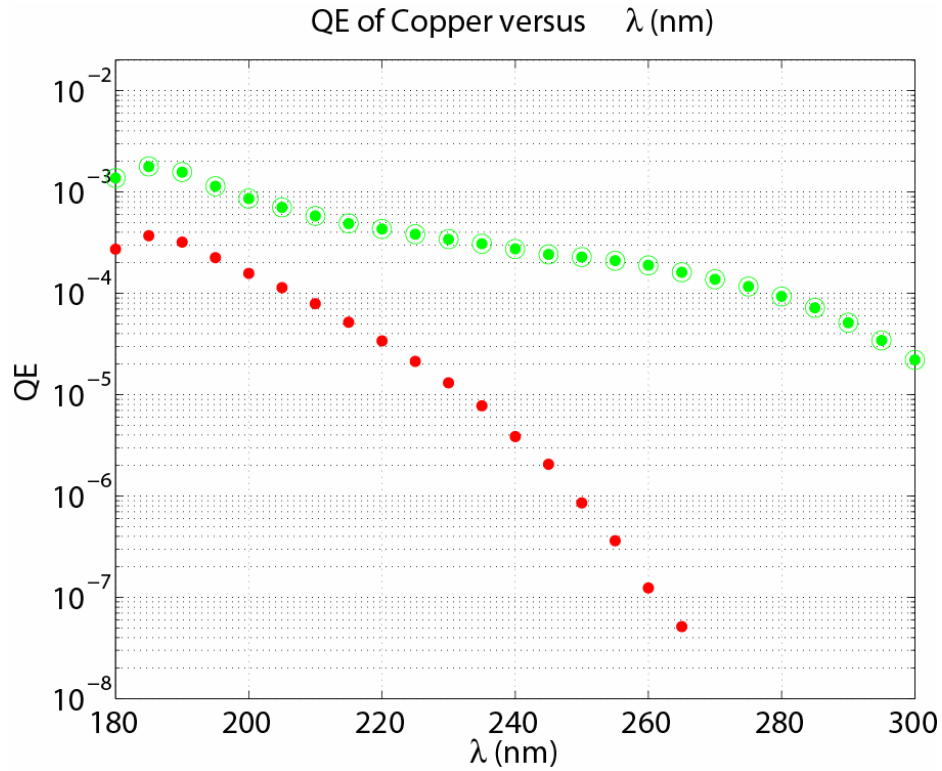
Thermal Bake 230 °C



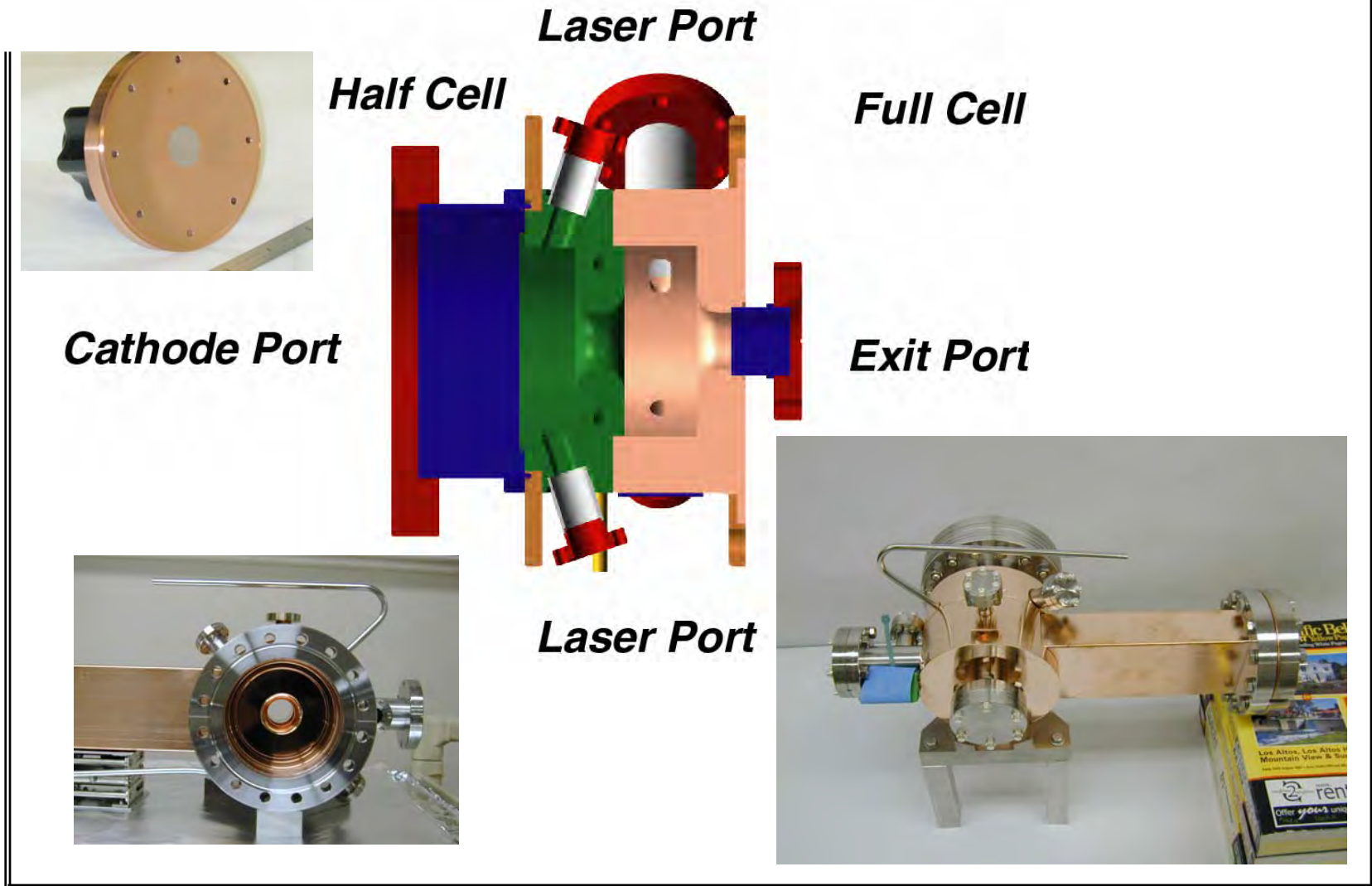


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Neglect QE < 190 nm

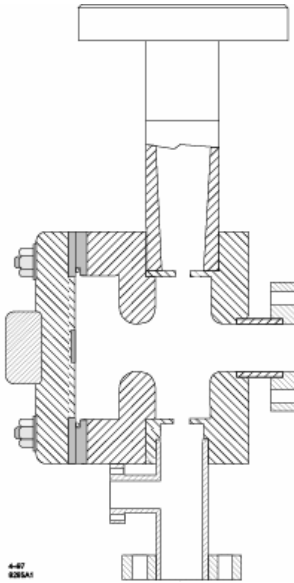


BNL/SLAC/UCLA 1.6 cell S-Band RF Gun (Weaver Modified Gun)



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Cathode Port

Half Cell

Laser Port

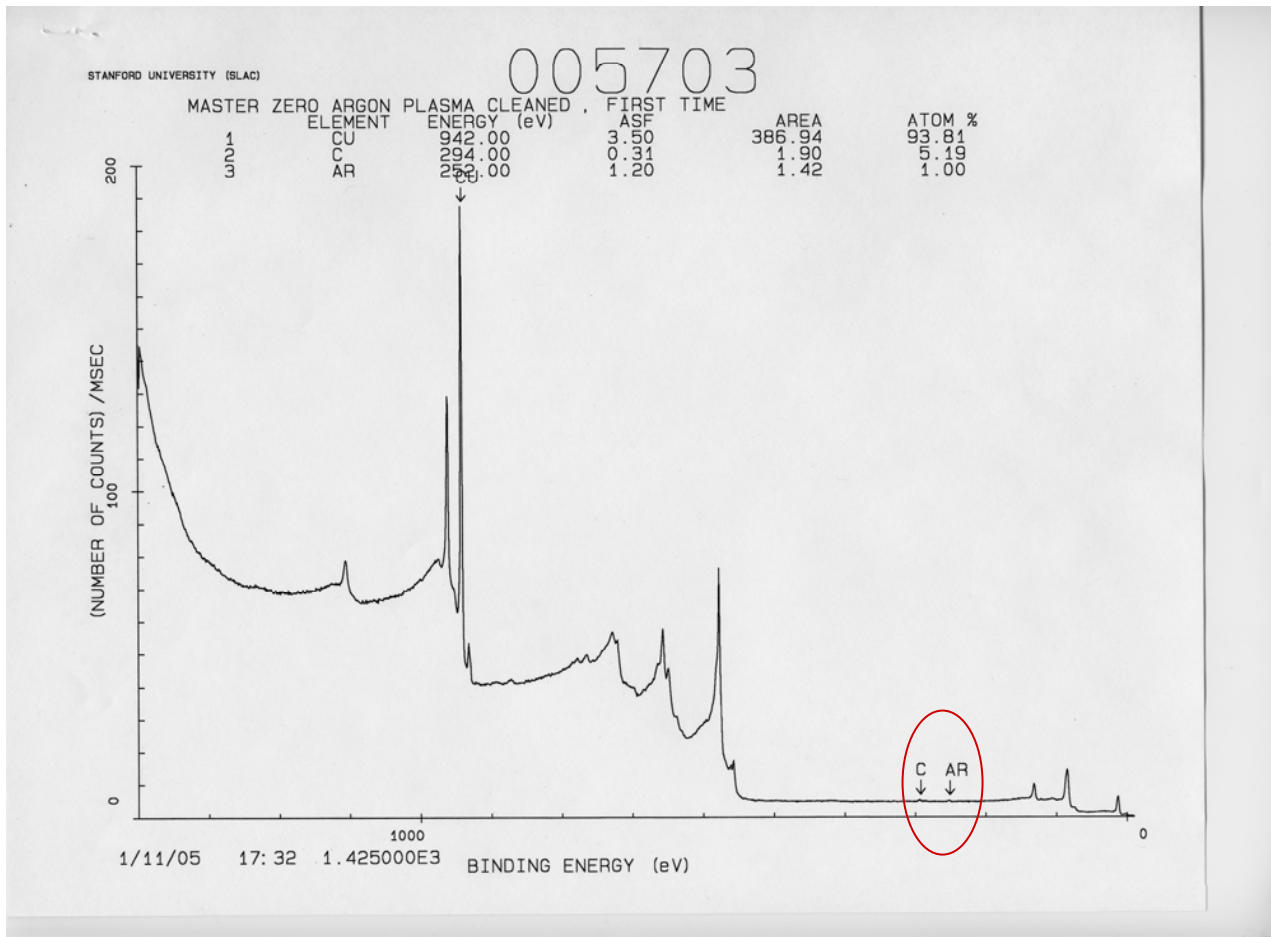
Full Cell

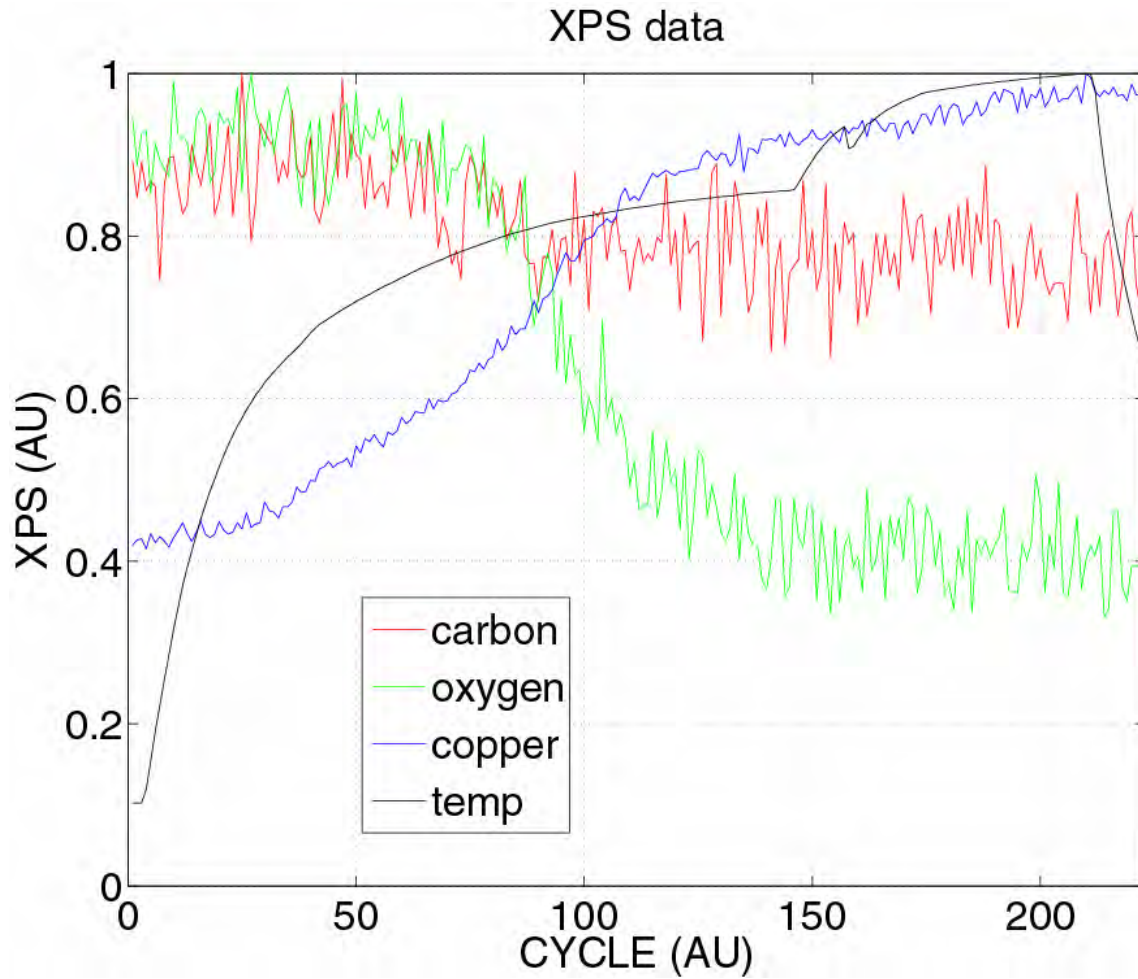
Exit Port



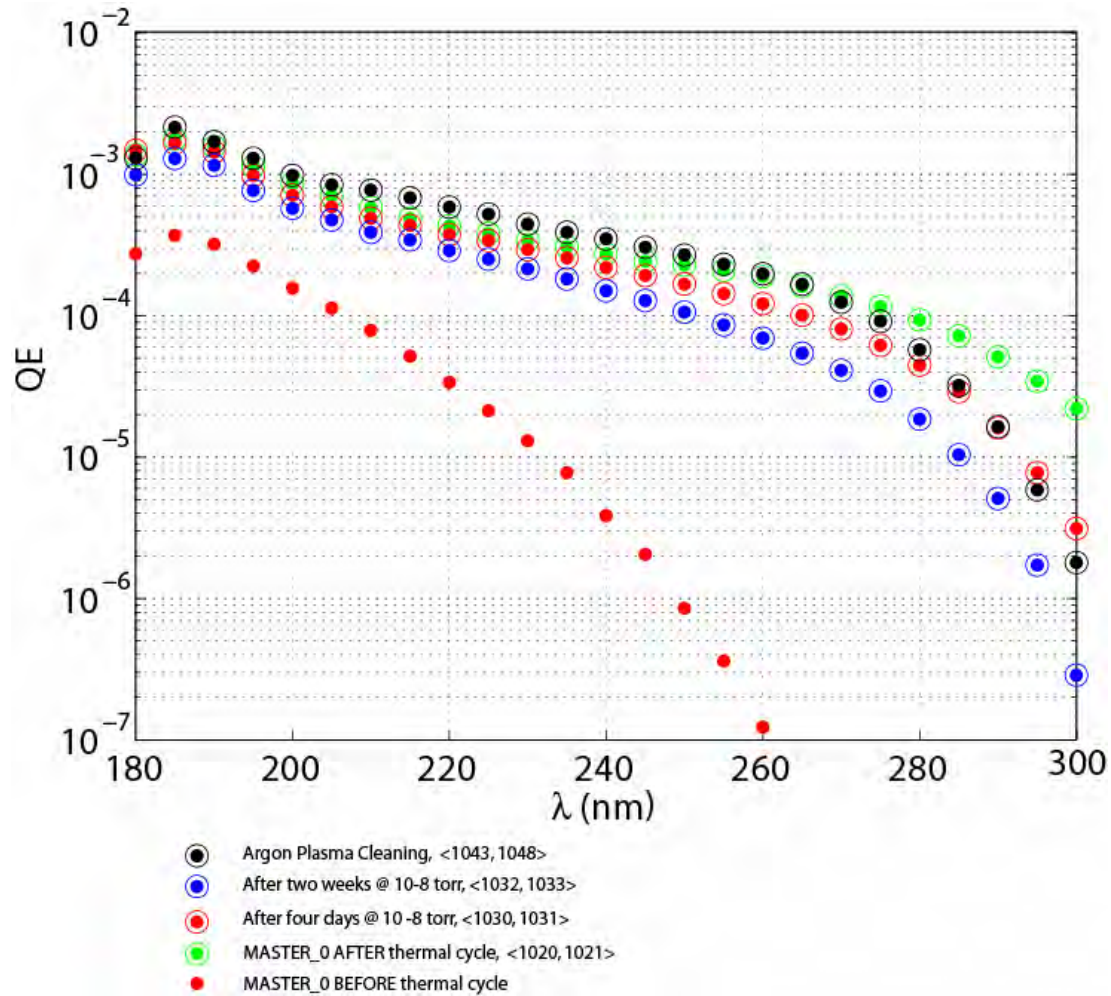
Laser Port

Thermal Bake 230 °C and Argon Ion Cleaning



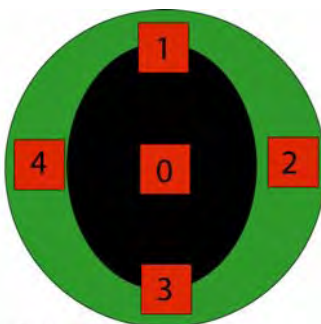


$\Delta T = 2 \text{ hours}$



QE @ 266 nm = 2.7 × 10⁻⁴

ELEMENT	5685	5693	5702	5703
Sodium (Na)	1.96	4.63	1.74	-----
Copper (Cu)	28.32	55.60	45.58	93.81
Oxygen (O)	28.08	9.65	12.87	-----
Calcium (Ca)	0.44	0.89	1.17	-----
Carbon (C)	41.20	29.22	38.64	5.19
Argon (Ar)	----	----	----	1.00

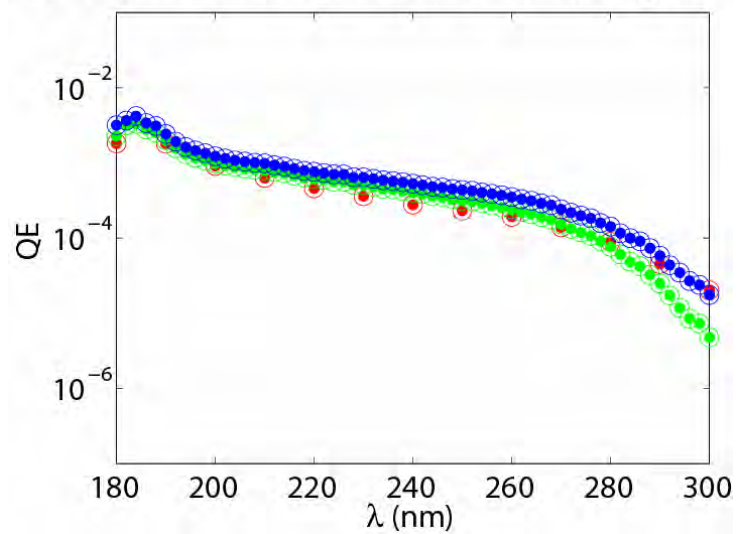


Copper Sample ●
 Plasma Spot Size ●
 XPS Spot Size ●

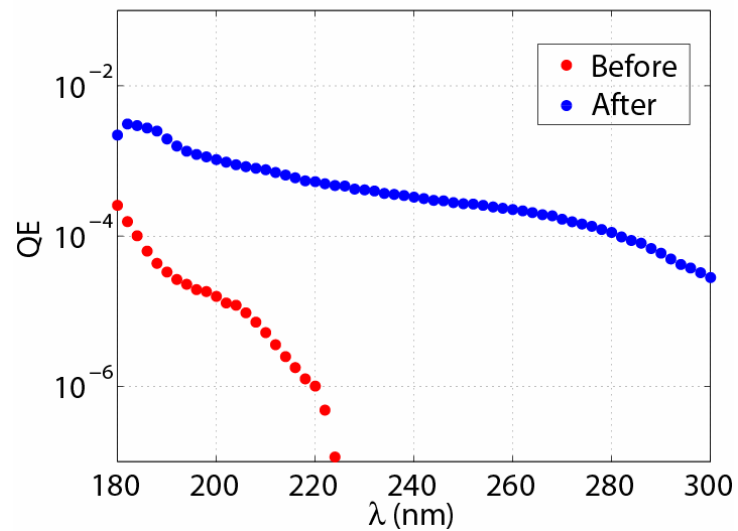
Element	2D XPS Position				
	0	1	2	3	4
	5704	5705	5706	5707	5708
Copper (Cu)	93.45	94.44	95.66	94.69	92.59
Carbon (C)	5.21	4.28	3.20	4.00	5.93
Argon (Ar)	1.34	1.28	1.13	0.31	1.47
Oxygen (O)	-----	-----	-----	-----	-----
Sodium (Na)	-----	-----	-----	-----	-----
Calcium (Ca)	-----	-----	-----	-----	-----

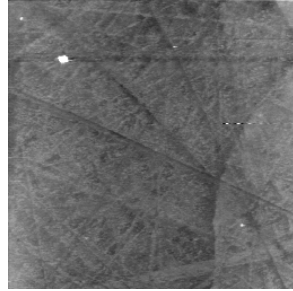
PCC-1

PCC-1 QE BEFORE & AFTER Plasma & Thermal Cycle

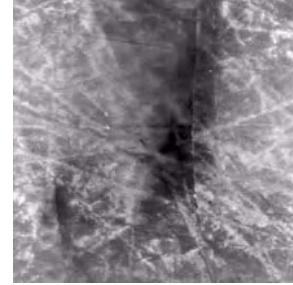


PCC-1 QE BEFORE and AFTER Thermal Cycle





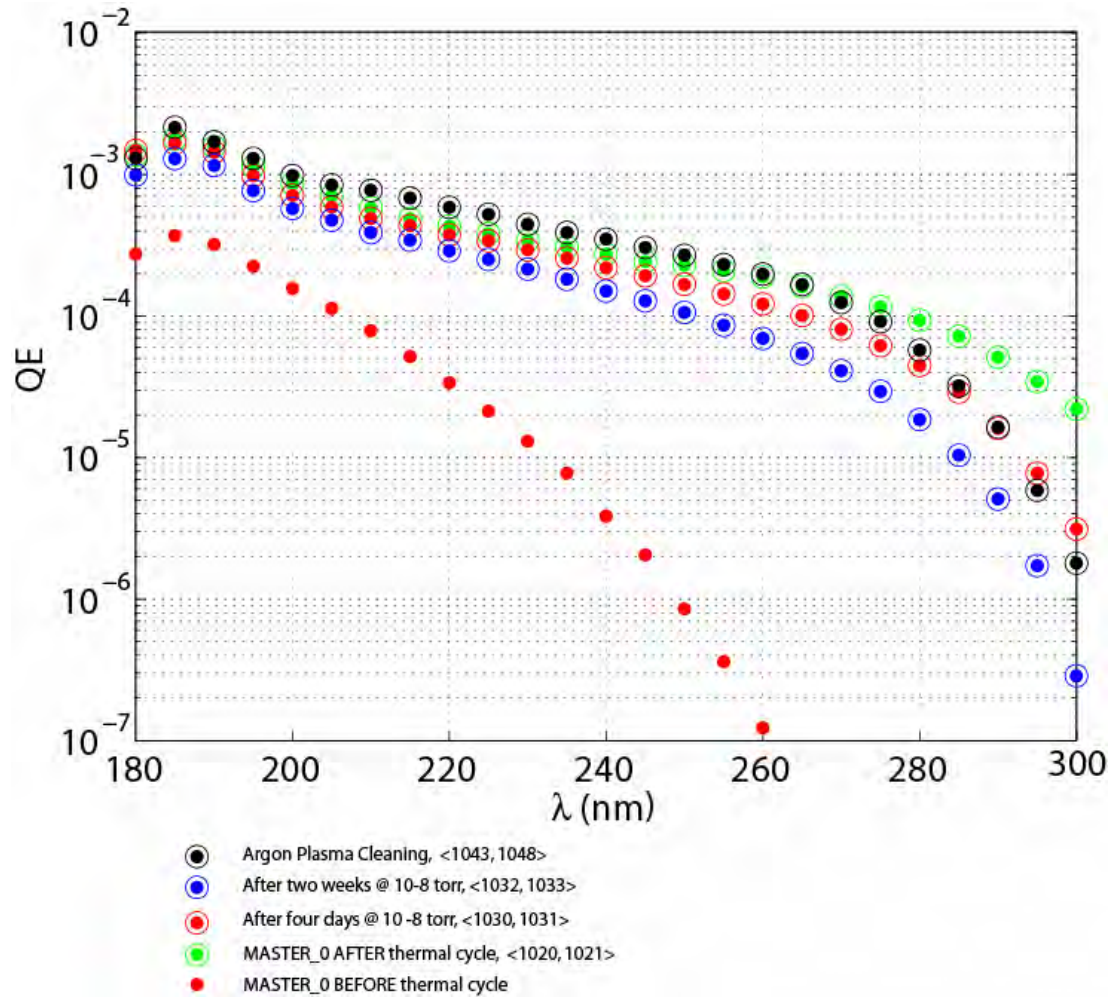
Master_0



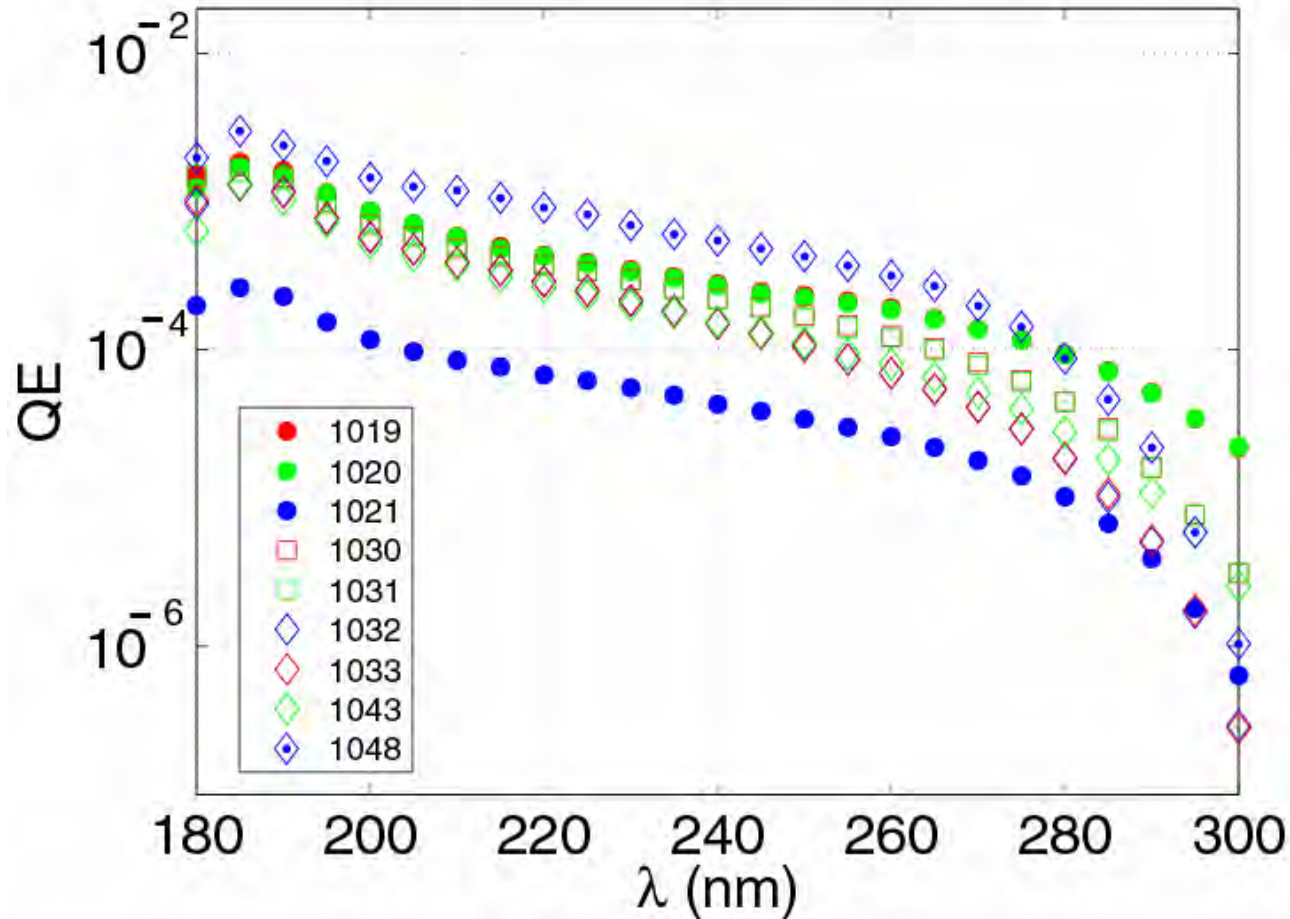
PCC-1

	Before		After	
	R _a (nm)	R _{pp} (nm)	R _a (nm)	R _{pp} (nm)
Master_0	12.3	17.2	15.8	20.1
PCC-1	14.0	17.9	20.7	25.8

QE Time Dependence



QE of Copper versus λ (nm)



$QE @ 266 \text{ nm} = 2.7 \times 10^{-4}$