Visit Report: California Institute of Technology; MMRC

Date: 10/17/2019
Engineer: Zach Mehl

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Summary

Visit duration Tuesday October 15, 2019 – Wednesday October 16, 2019
Time on site: 13 hrs.

Work performed

- Carried out 6 month preventative maintenance schedule
    - Reviewed state of vacuum system:
        - All valves operating correctly
        - Analyzer base pressure at 1.5e-9 Torr
        - Load lock base pressure at 1.3e-9 Torr
        - Cryo pump He operating pressure ~ 75 psig
        - Both cryo cold heads temp metering <15K
        - Oil added to mechanical pump, was low
    - Replace ion exchange filter and particle filter on Hawk water circulator
    - Checked for leaks and topped off water level in circulator
    - Replaced xray anode
    - Checked all spot sizes and power output
    - Visually inspected lens screens
    - Checked all interlocks
    - Optimized detector voltage for optimum count rate
    - Captured and loaded new signature file
    - Tested detector dark signal without HV for noise
    - Tested fermi edge level for xray window
    - Calibrated V1 slope and offset
    - Calibrated detector width
    - Tested performance of instrument with gold against SPI standards
- Checked operation of ion gauges
- Aligned sputter gun spot with xray analysis spot
- Replaced pump and motor on Hawk water circulator
    - Flow rate improved from 1.24 to 1.45 GPH
- Checked all motor driver settings
    - Current settings are working with motors even though current is higher than normal
- Set screw on rotational axis gear extremely loose, causing bouncing and stage to get stuck occasionally
    - Vented system and tightened set screw, tested rotation before pumping back down

Performance Data

Survey

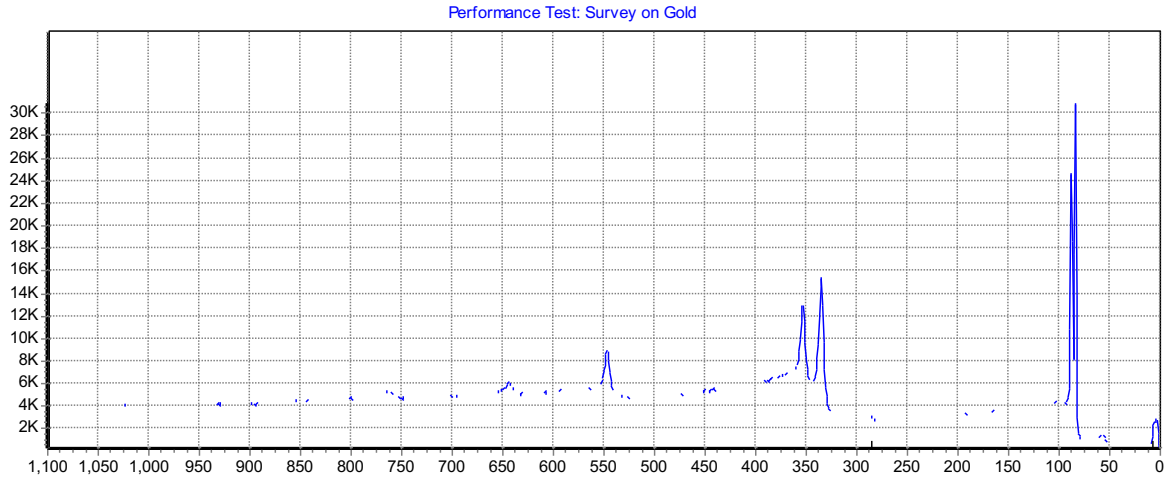

Figure 1 - Survey on gold sample after calibration

Survey recipe:
Spot 800
Res4
1 ev/st
100 ms/step

Detector Performance

Signature

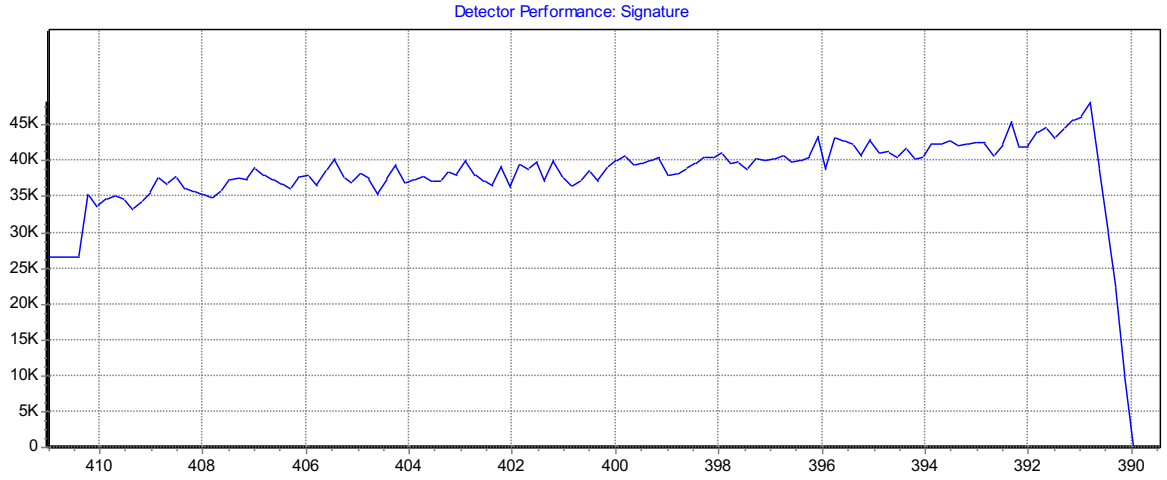

Figure 2 - Detector signature capture in unscanned mode, Res4, 600 micron spot, 90 seconds of acquisition

Dark Signal

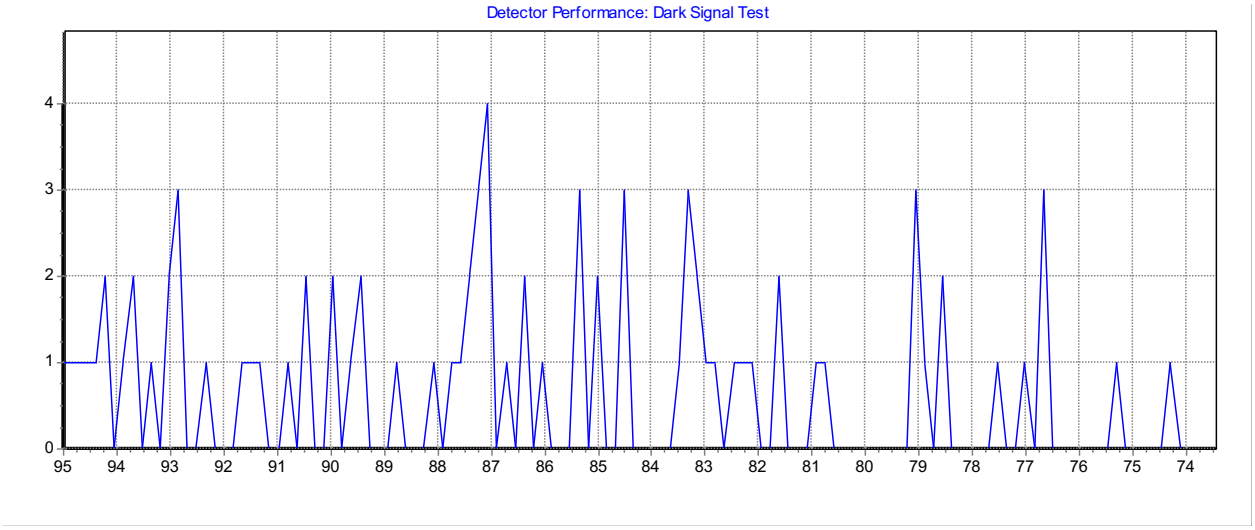

Figure 3 - Detector dark signal; captured in unscanned mode, Res4, HV powered off, 60 seconds of acquisition

Signal to Background

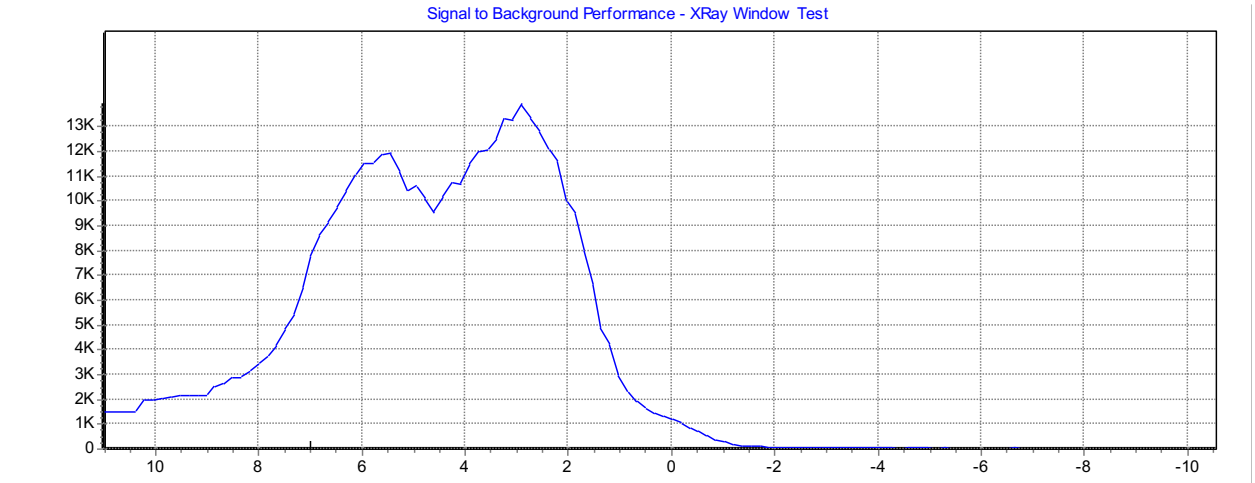

Figure 4 - Fermi edge level data taken with 600 micron spot, Res 4, 60 seconds of acquisition

Signal to Background calculation:

	Actual Measurement
Peak Valence Band Counts	13908
Average Background Counts	57.7
Ratio Peak/Background	241.0398614

*A ratio of greater than 200:1 signifies an intact xray window

Gold Performance

Gold Diagonal:

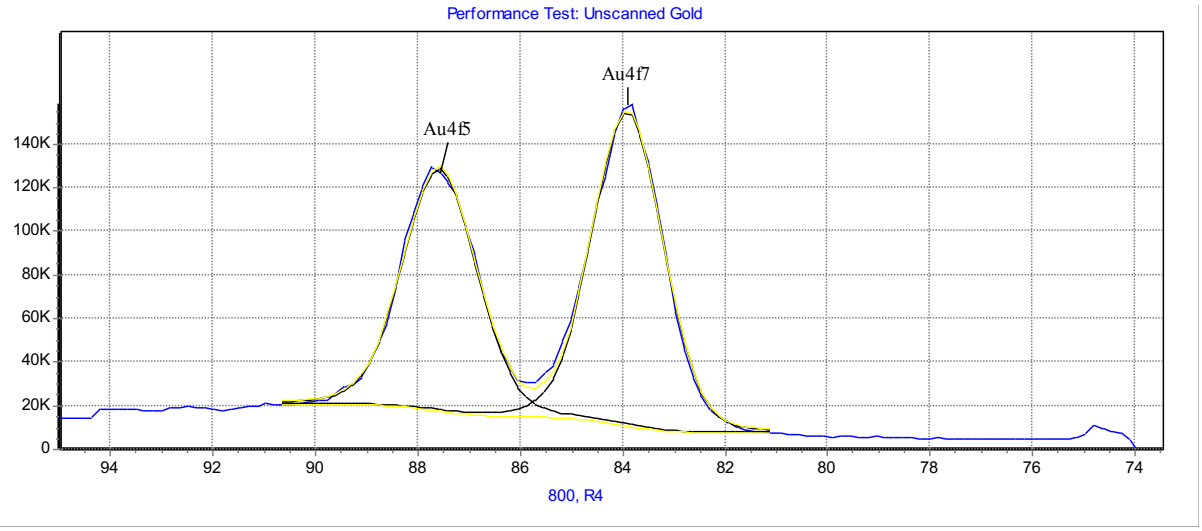

Figure 5 - Performance test on gold; taken with 800 micron spot, Res 4, 60 seconds unscanned acquisition

Peak ID	Adj'ed Be	Area	FWHM	% Gauss
Au4f7	83.912	1517986	1.634	86.803
Au4f5	87.58	1227854	1.682	84.233

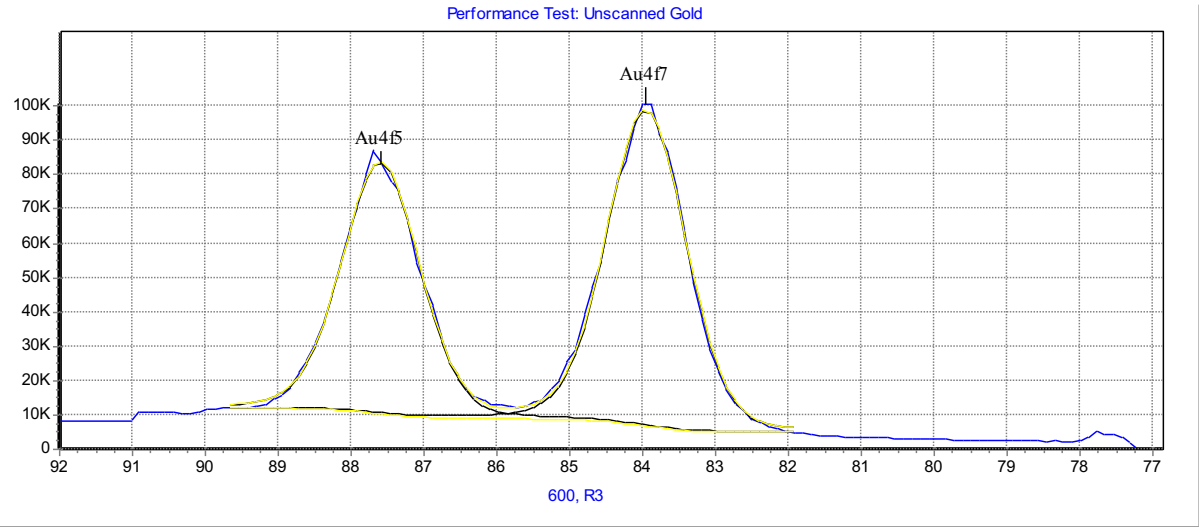

Figure 6- Performance test on gold; taken with 600 micron spot, Res 3, 60 seconds unscanned acquisition

Peak ID	Adj'ed Be	Area	FWHM	% Gauss
Au4f7	83.952	1122483	1.273	85.37
Au4f5	87.597	883139	1.253	84.132

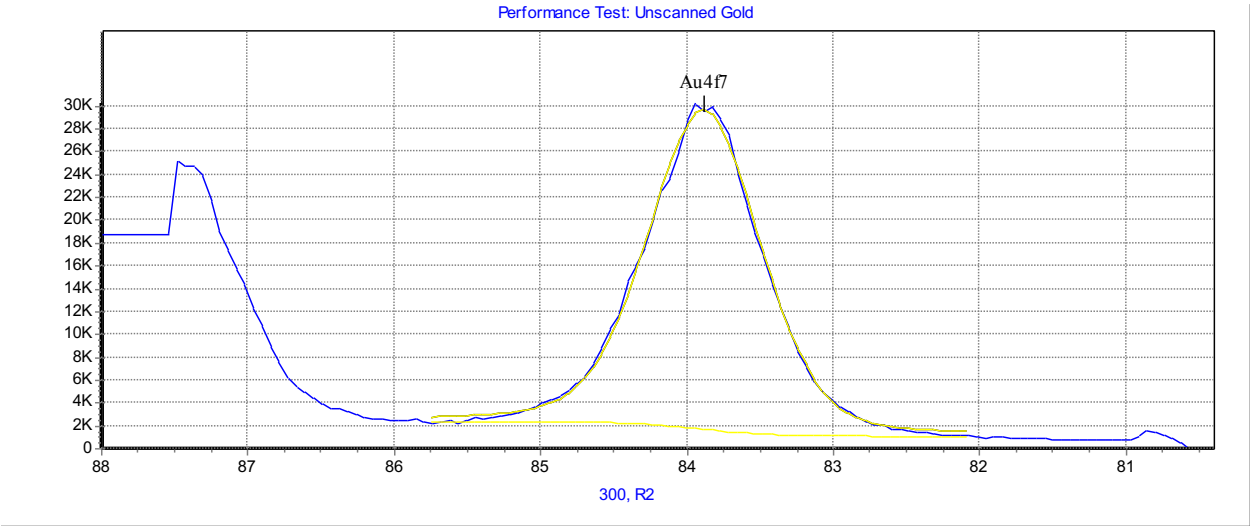

Figure 7 - Performance test on gold; taken using 300 micron spot, Res2, 60 seconds of unscanned acquisition

Peak ID	Adj'ed Be	Area	FWHM	% Gauss
Au4f7	83.884	491568	0.903	75.196

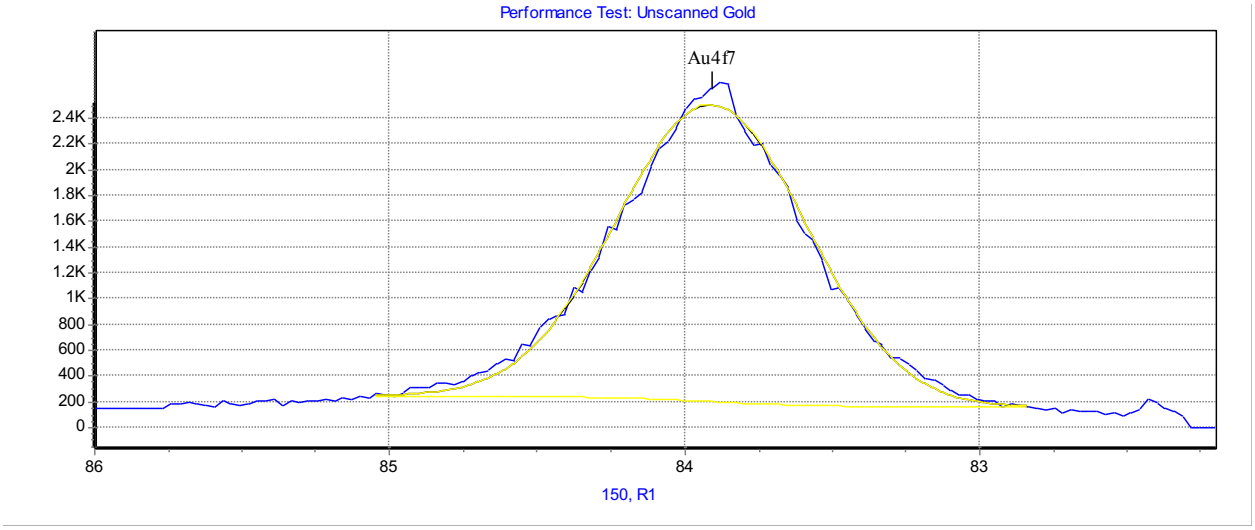

Figure 8 - Performance test on gold; taken with 150 micron spot, Res1, 60 seconds of unscanned acquisition

Peak ID	Adj'ed Be	Area	FWHM	% Gauss
Au4f7	83.909	63664	0.755	100

Gold Diagonal performance:

Unscanned Performance

BE - 84 eV 1 minute acquisition

RESOLUTION	SPOT SIZE							
	150 micron		300 micron		600 micron		800 micron	
	SPEC	ACT	SPEC	ACT	SPEC	ACT	SPEC	ACT
RES 1 - 25eV								
RESOLUTION	0.75	0.75	0.77		0.90		1.00	
AREA - K CNT	30.00	63.00	120.00		180.00		250.00	
RES 2 - 50eV								
RESOLUTION	0.85		0.90	0.90	1.05		1.10	
AREA - K CNT	50.00		200.00	491.00	280.00		480.00	
RES 3 - 100eV								
RESOLUTION	1.20		1.25		1.40	1.27	1.38	
AREA - K CNT	70.00		280.00		410.00	1122.00	600.00	
RES 4 - 150eV								
RESOLUTION	1.42		1.45		1.70		1.65	1.64
AREA - K CNT	80.00		320.00		470.00		700.00	1517.00

Appendix – Electronics Documentation

9600 X-Ray Controller

Service Physics Model 9603 X-Ray System
PARAMETER TABLES

COMPANY	Cal Tech MMRC	
CUSTOMER	Bruce B.	
DATE	10/15/2019	COMMENT:
TEST		
ENGINEER	Zach Mehl	

Gun Info

S/N	N/A
Date Installed	N/A - pre 2017
Notes	Extra thick copper gasket

SPOT SIZES

	100	200	400	800	L1	L2	L3
I Out	1.48	4.99	9.94	19.9	4.99	9.94	19.9
I Fil	1.12	1.13	1.14	1.15	1.13	1.14	1.14
V 2KV	2.31	2.31	2.31	2.31	2.31	2.31	2.31
I 2KV	6.27	6.95	7.43	7.95	6.92	7.4	7.93
VQ	0.01	0.02	0.01	0.02	0.01	0.38	0.32
VF	8.42	8.48	8.43	8.56	8.4	8.41	8.63

V1 calibration results