PRIMEX Targets

Carbon target:

- Pyrolytic graphite, 9mm thick (5% RL)
- Low porosity compared to graphite (1% versus 10%)
- Doesn’t fragment, easier to machine than graphite
- Natural isotopic abundance, 98.89%
- Elemental analysis:

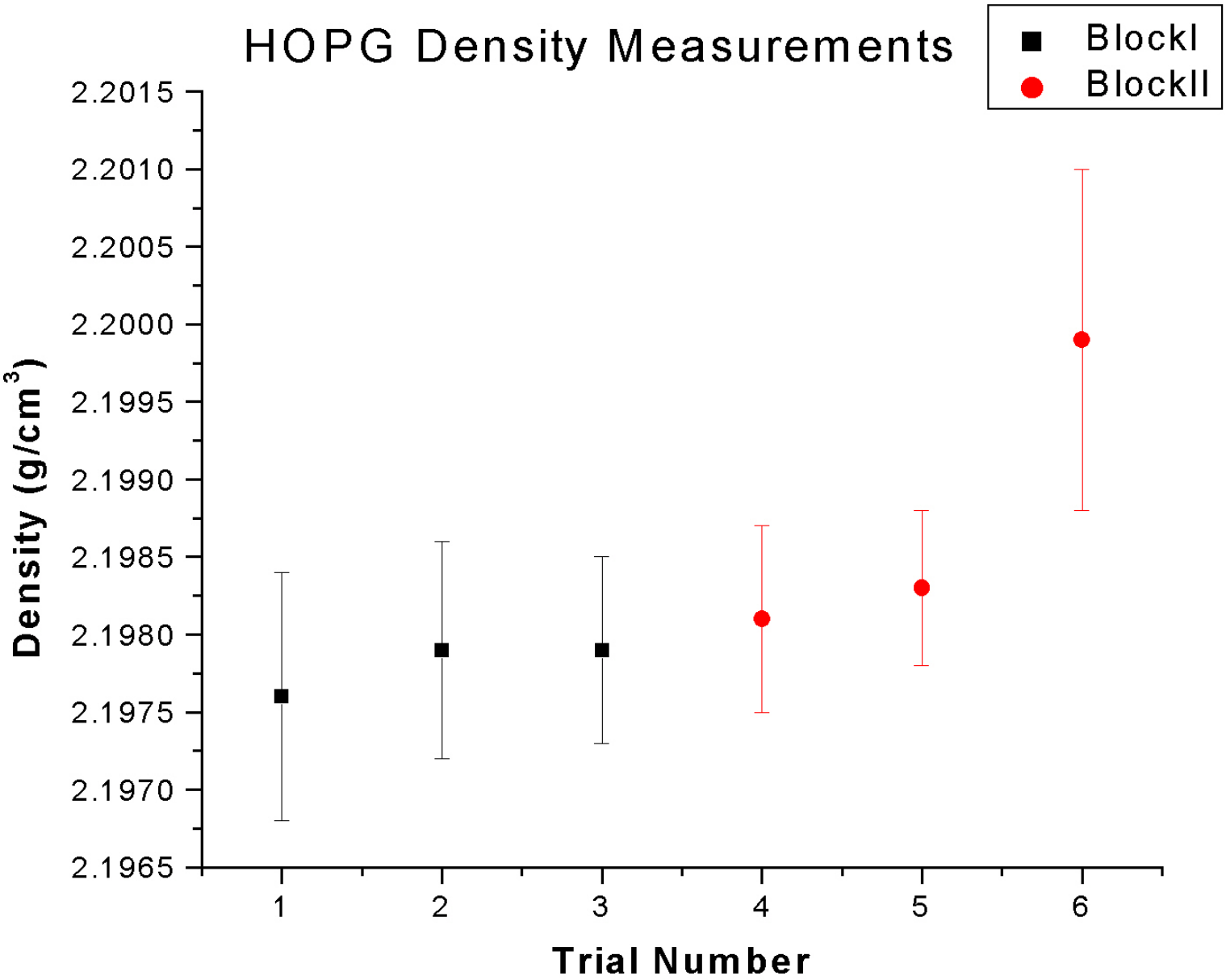
Proton induced x-ray emission (72 elements) and Combustion (CHNO)

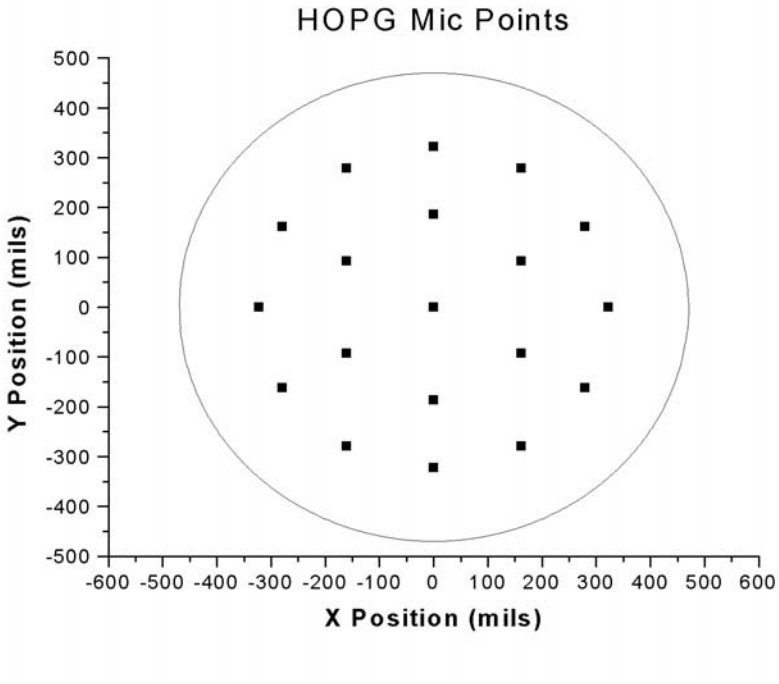
Carbon 99.63%	Aluminum .006%
Hydrogen <.10%	Silicon .006%
Nitrogen <.05%	Chlorine .003%
Oxygen 0.19%	Calcium .003%

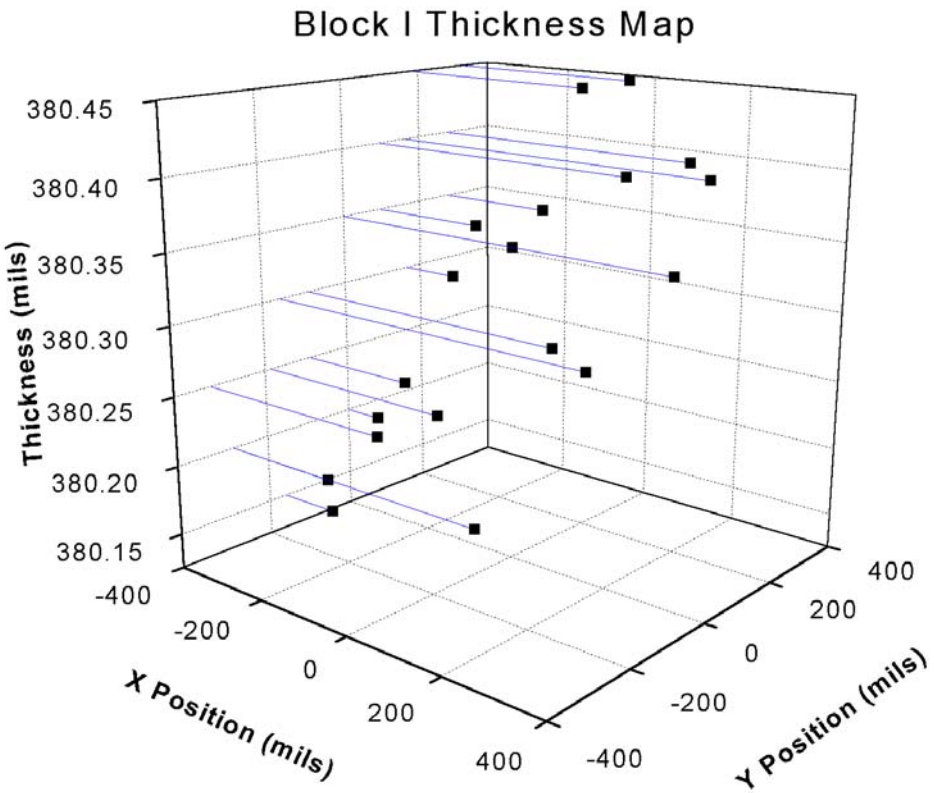
- Measuring ρt for the carbon target:

ρ measured using water displacement technique.

Thickness measurements using a $\pm .05$ mil accuracy micrometer with .25” diameter head.


HOPG Density Measurements
BlockI
BlockII
Density (g/cm3)
2.2015
2.2010
2.2005
2.2000
2.1995
2.1990
2.1985
2.1980
2.1975
2.1970
2.1965
1
2
3
4
5
6
Trial Number


HOPG Mic Points
Y Position (mils)
500
400
300
200
100
0
-100
-200
-300
-400
-500
-600 -500 -400 -300 -200 -100 0 100 200 300 400 500 600
X Position (mils)


Block I Thickness Map
Thickness (mils)
380.45
380.40
380.35
380.30
380.25
380.20
380.15
-400
-200
0
200
400
X Position (mils)
400
200
0
-200
-400
Y Position (mils)

Metal foil targets

- ^{120}Sn: 98.29% enrichment, 440 mg/cm^2, $\Delta\rho/\rho \cong .21\%$
- ^{208}Pb: 99.09% enrichment, 330 mg/cm^2, $\Delta\rho/\rho \cong .04\%$

Measuring target thickness using x-ray attentuation

Step 1: Establish calibration points.

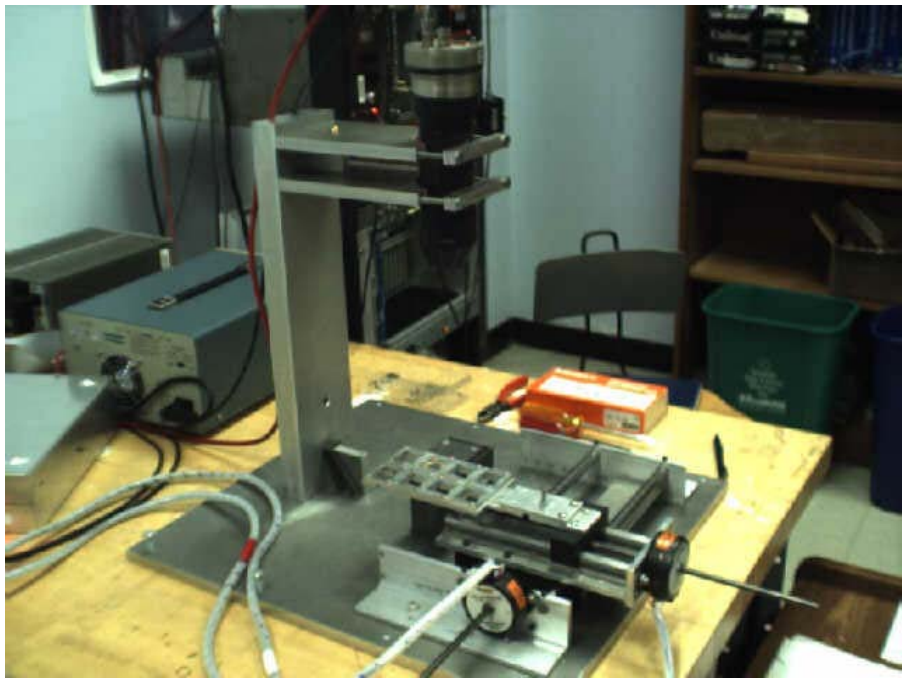
• Measure target thickness with micrometer at 4 target points (upper left, upper right, lower left, lower right of target center)

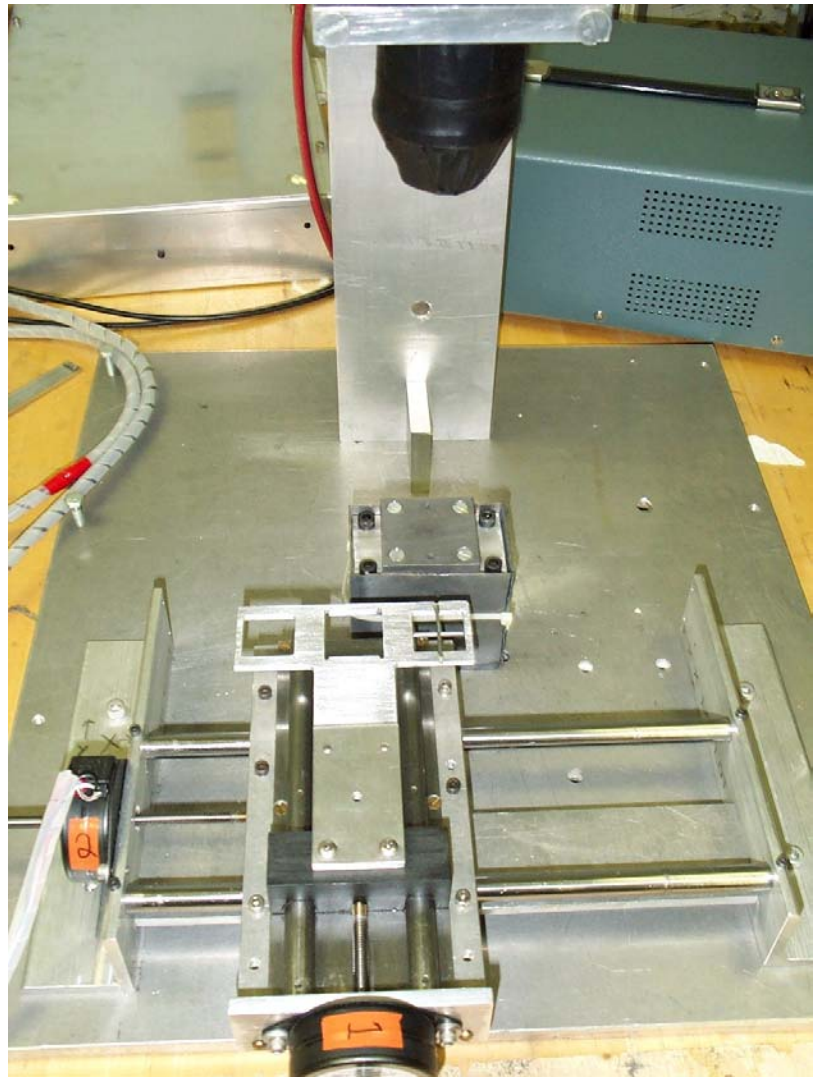
• Make x-ray attenuation measurements (2 mm spot size) at the same points.

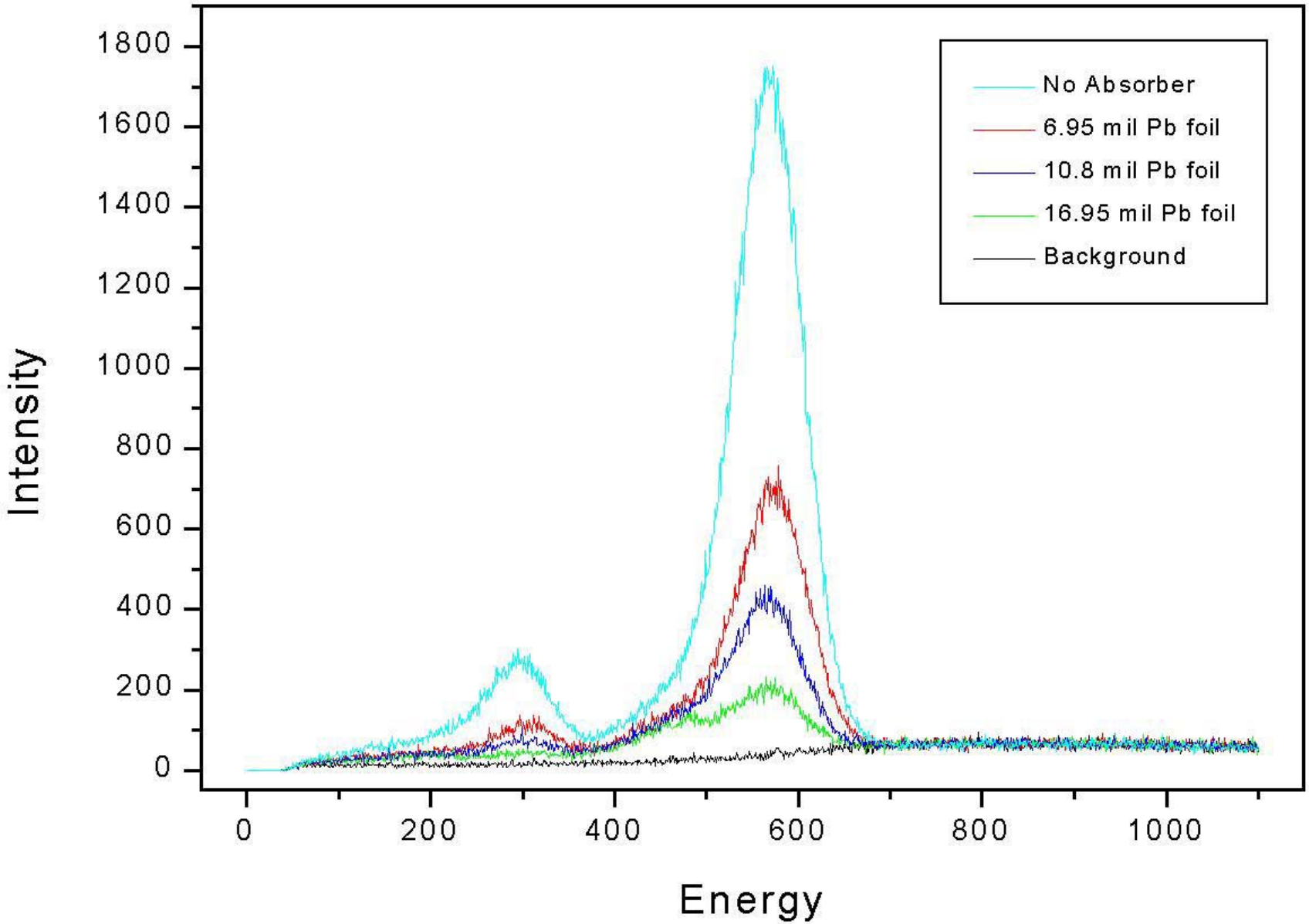
Step 2: Measure x-ray attenuation attenuation at other points on the target

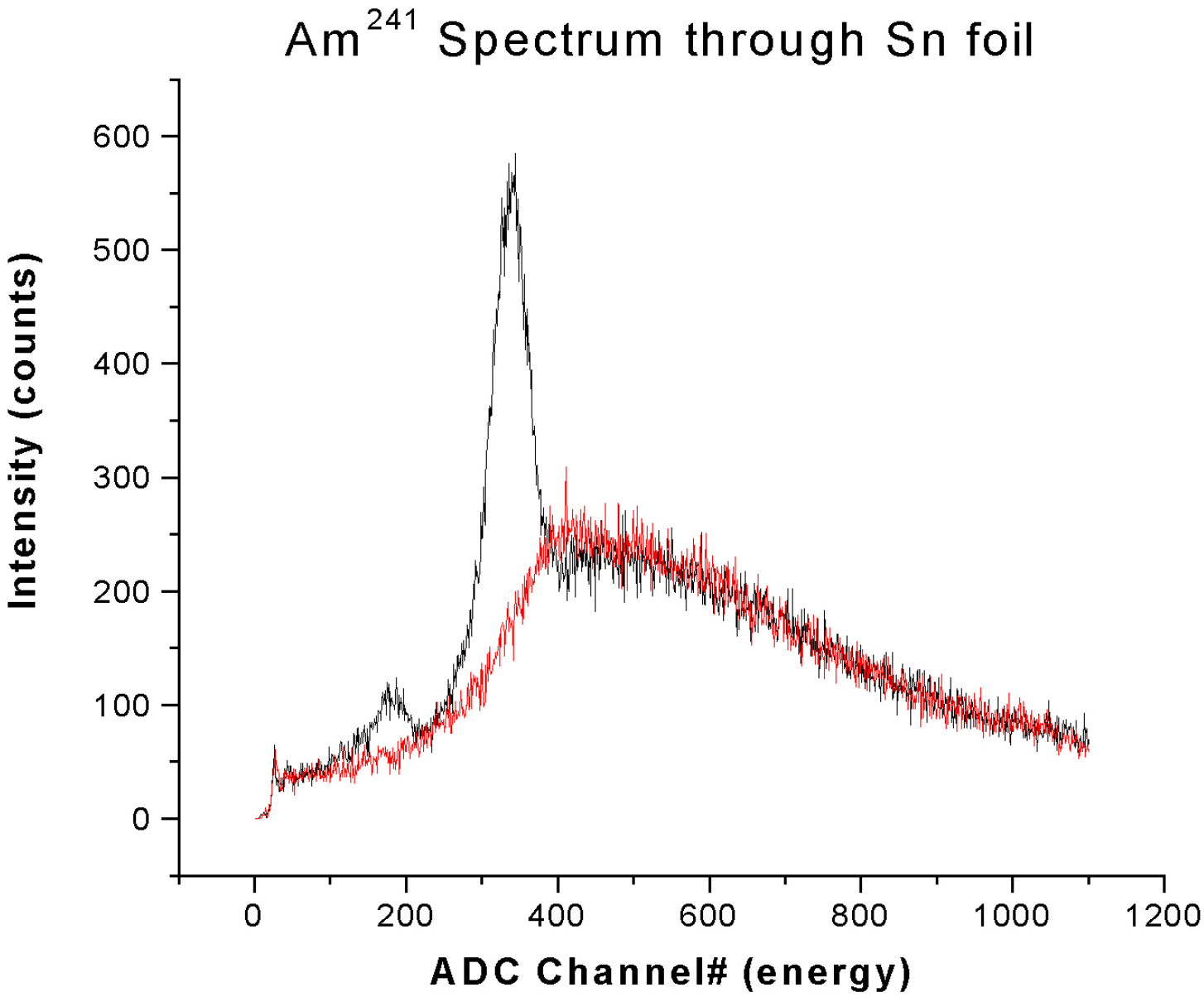
X-Ray Target Scanner

The Old Setup

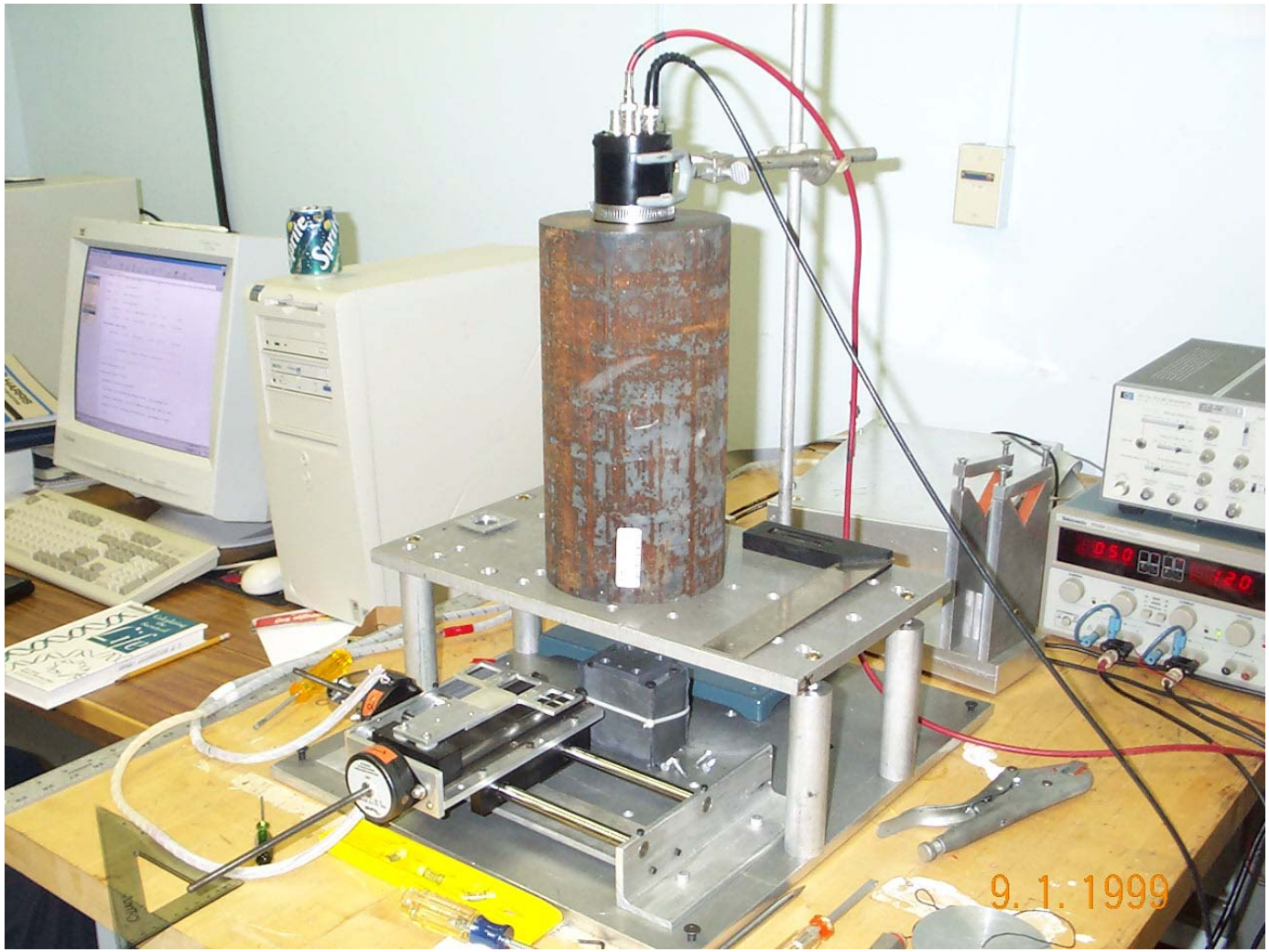


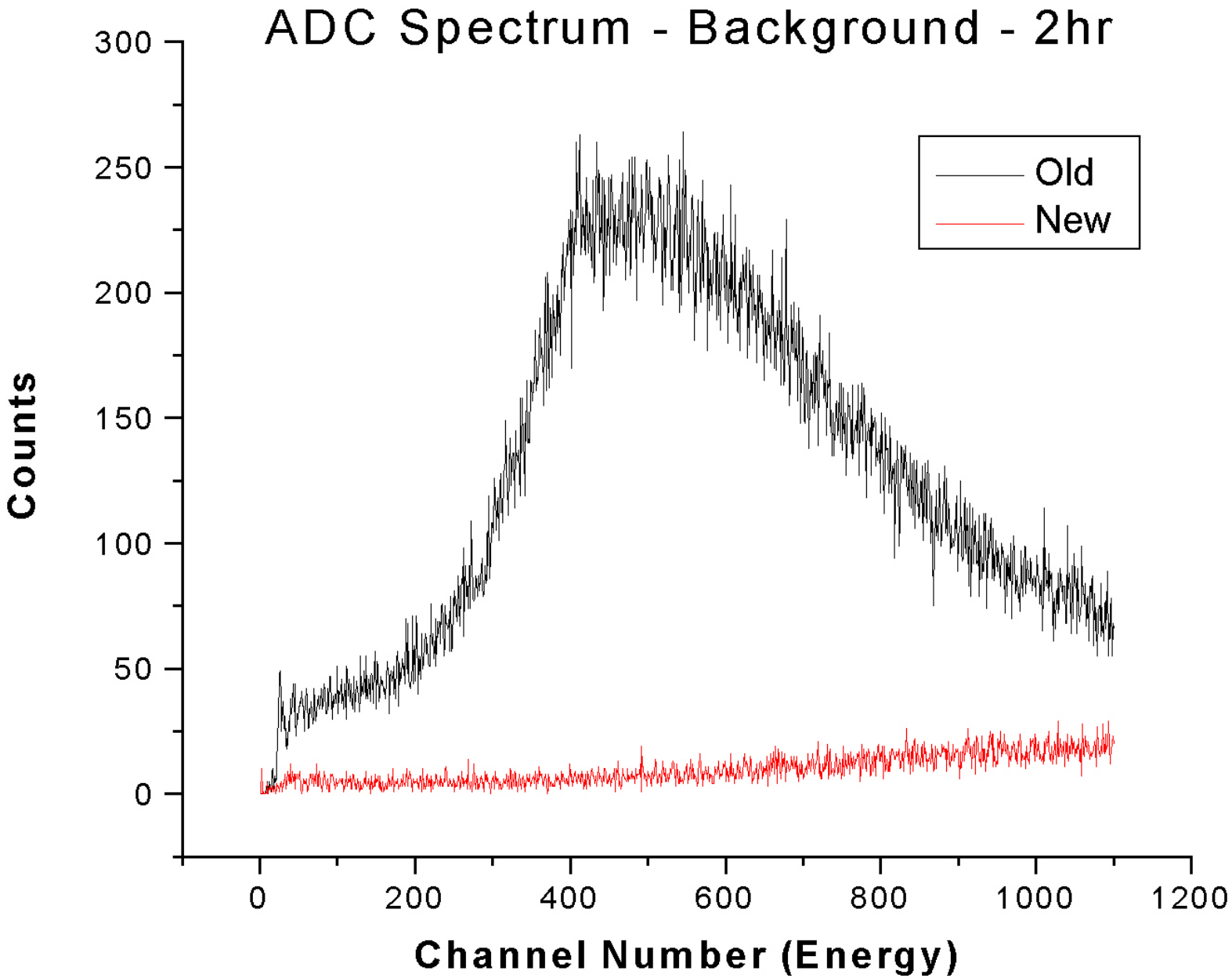



No Absorber
6.95 mil Pb foil
10.8 mil Pb foil
16.95 mil Pb foil
Background
Intensity
Energy
0
200
400
600
800
1000
1200
1400
1600
1800


Am241 Spectrum through Sn foil
Intensity (counts)
0
100
200
300
400
500
600
0
200
400
600
800
1000
1200
ADC Channel# (energy)

The new setup




ADC Spectrum - Background - 2hr
Old
New
Counts
Channel Number (Energy)
0
50
100
150
200
250
300
0
200
400
600
800
1000
1200

- Initially fit calibration data to the form

$$I(t) = I_0 B(t) e^{-t/\lambda}$$

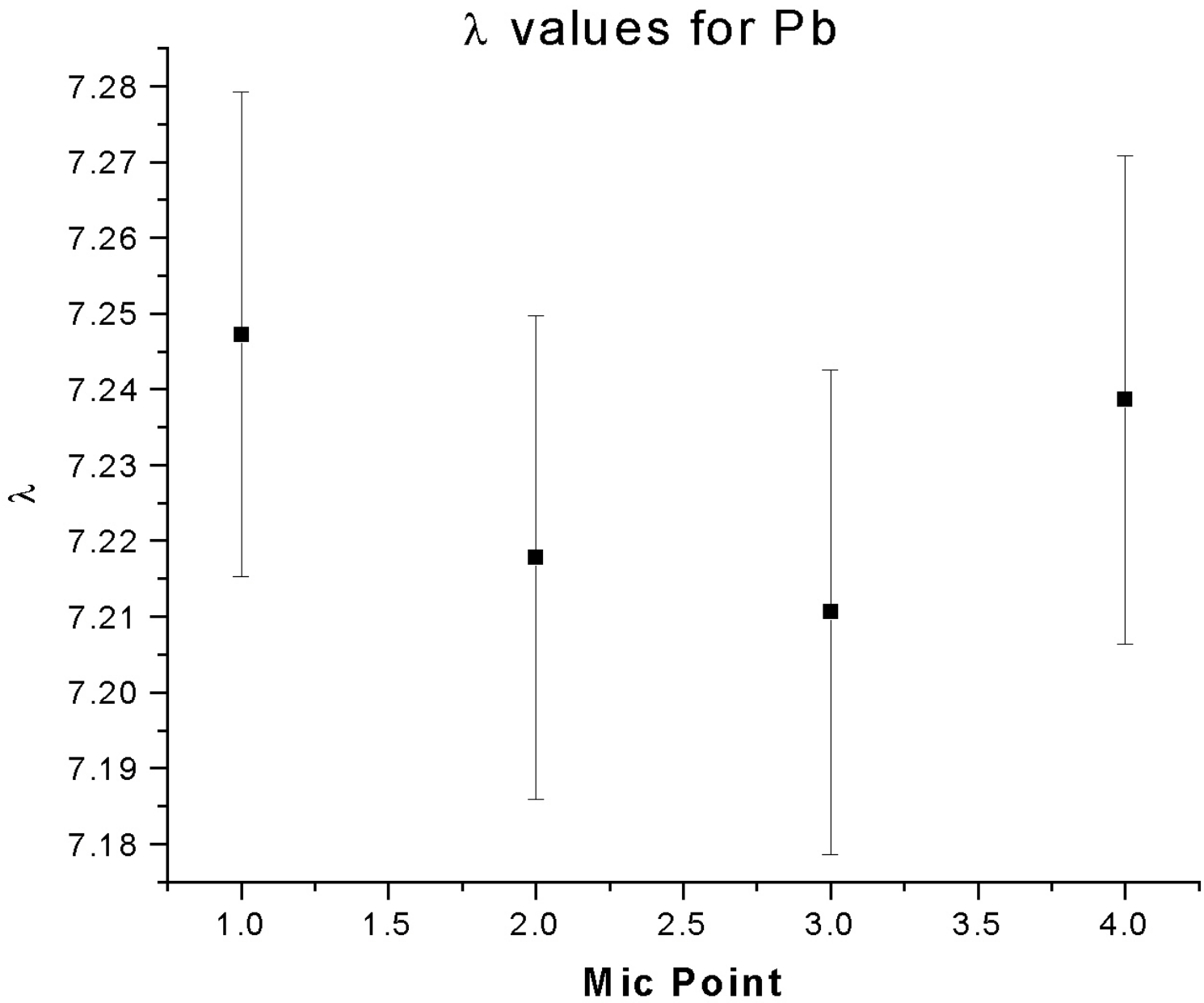
$$B(t) = 1 + b\frac{t}{\lambda}$$

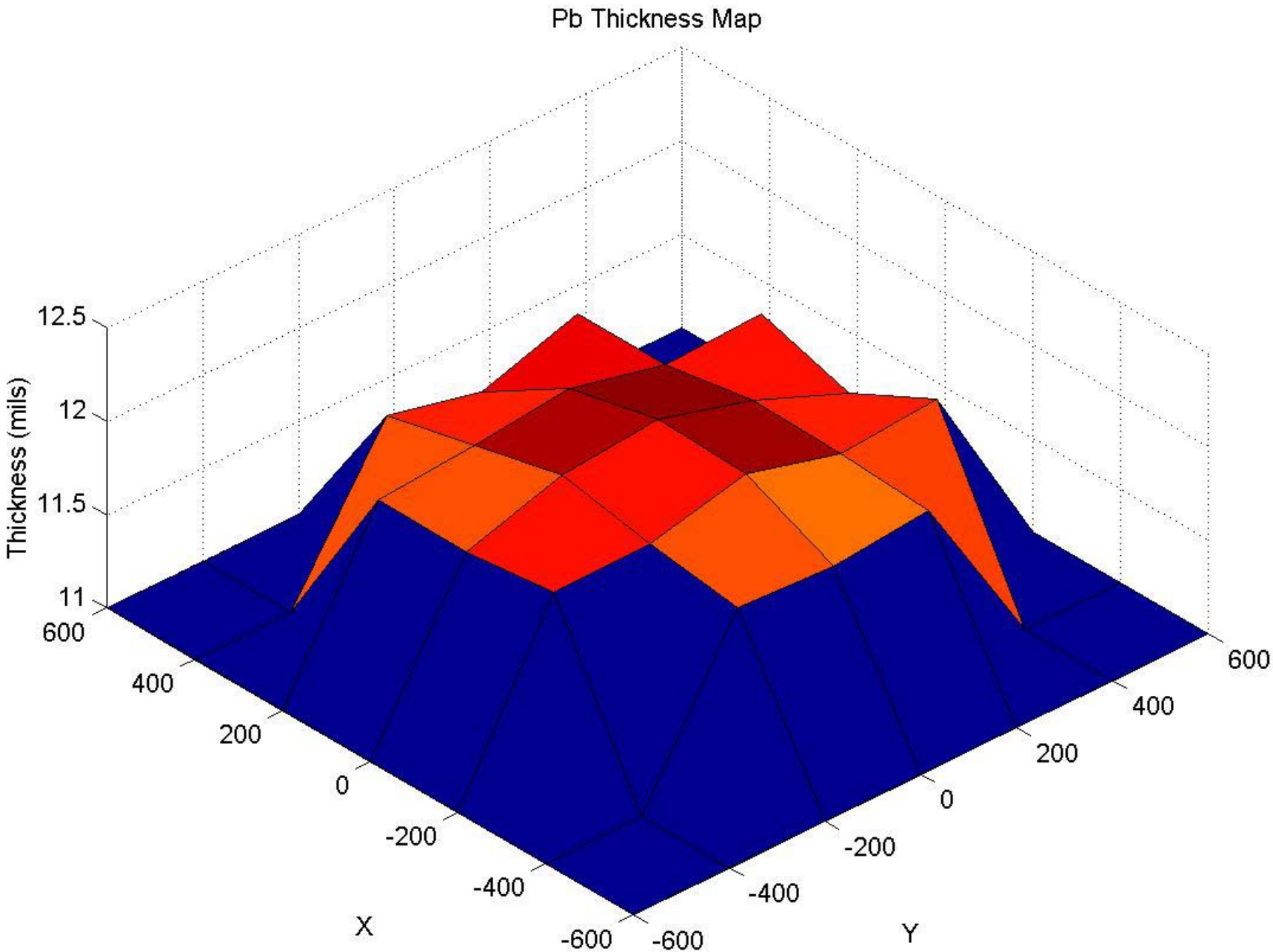
with λ from the literature, b from a fit to data

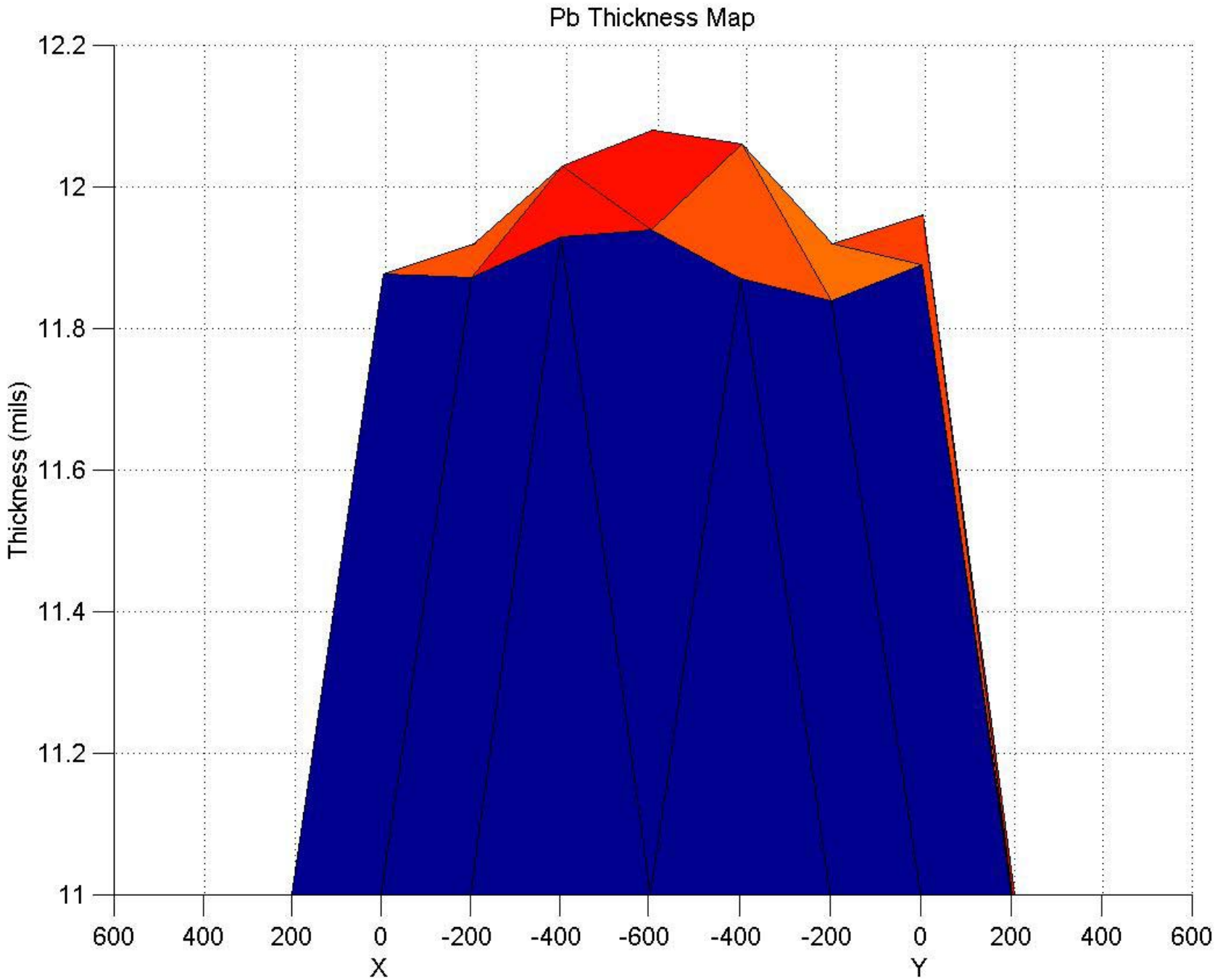
- Found that bt/λ is small for our targets (.067 and .15 for Pb and Sn). This justifies fitting calibration data with simple exponential form,

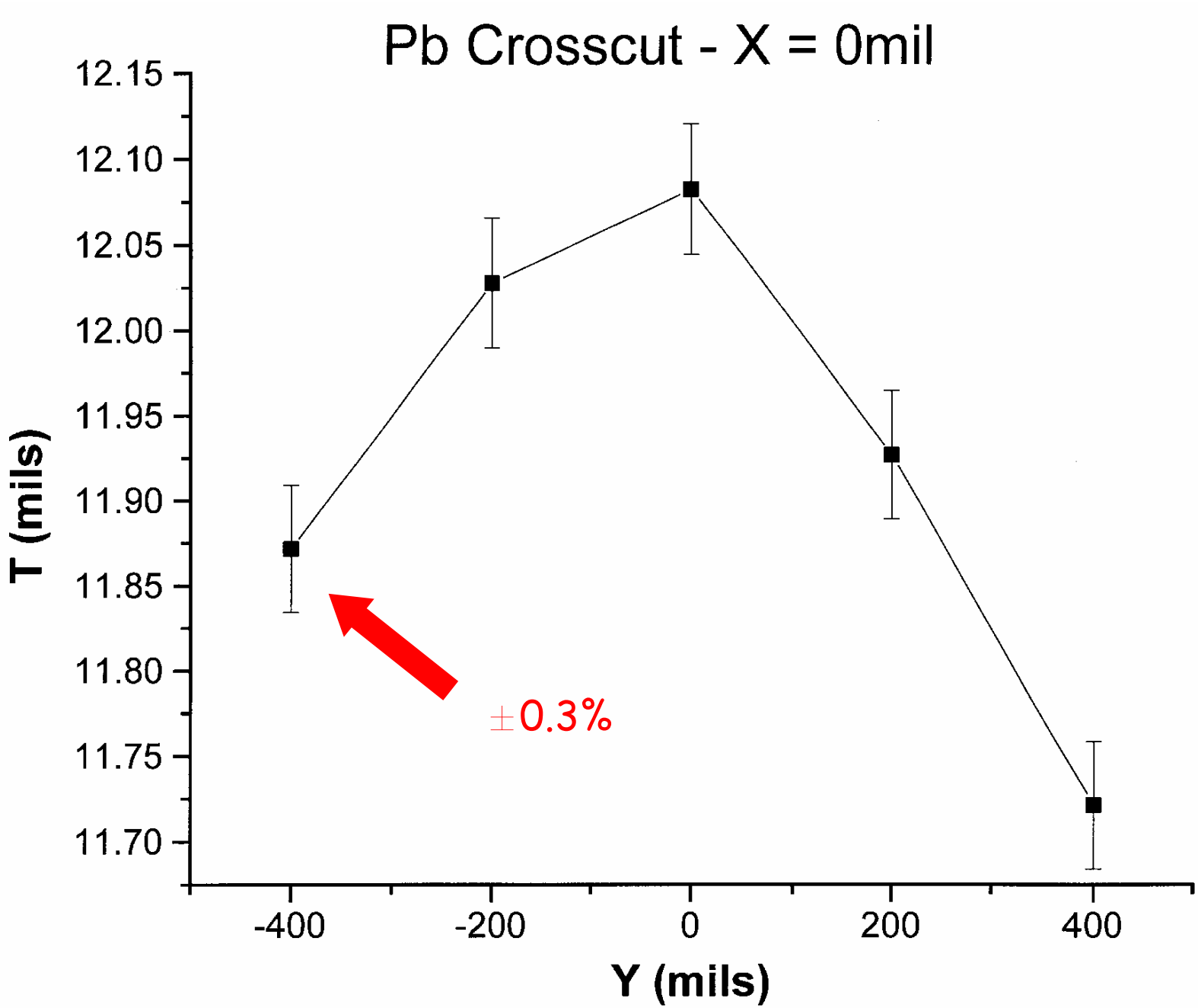
$$I(t) = I_0 e^{-t/\lambda'}$$

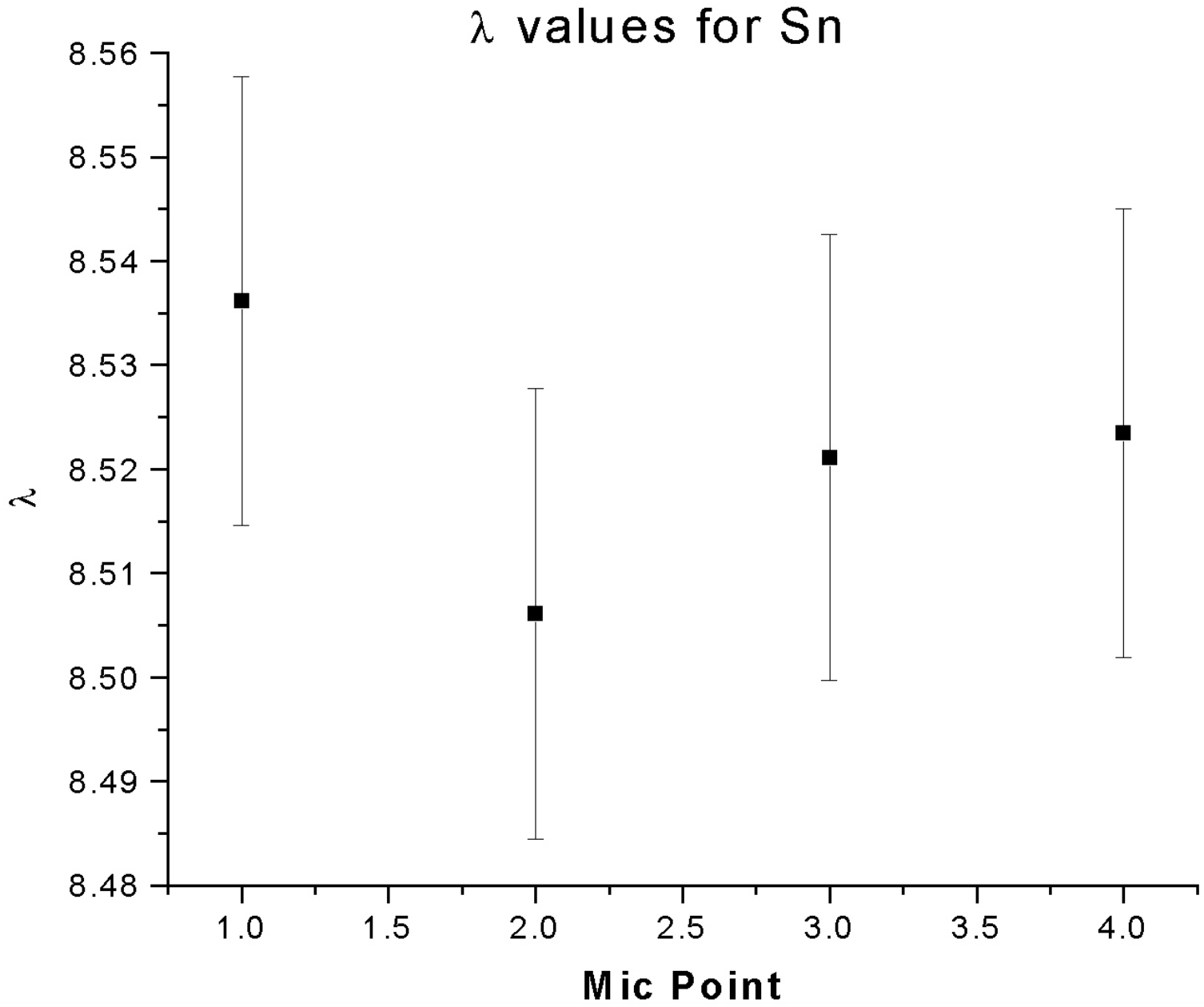
where λ' is fit to the data. (Our values for λ' are very close to values in the literature)

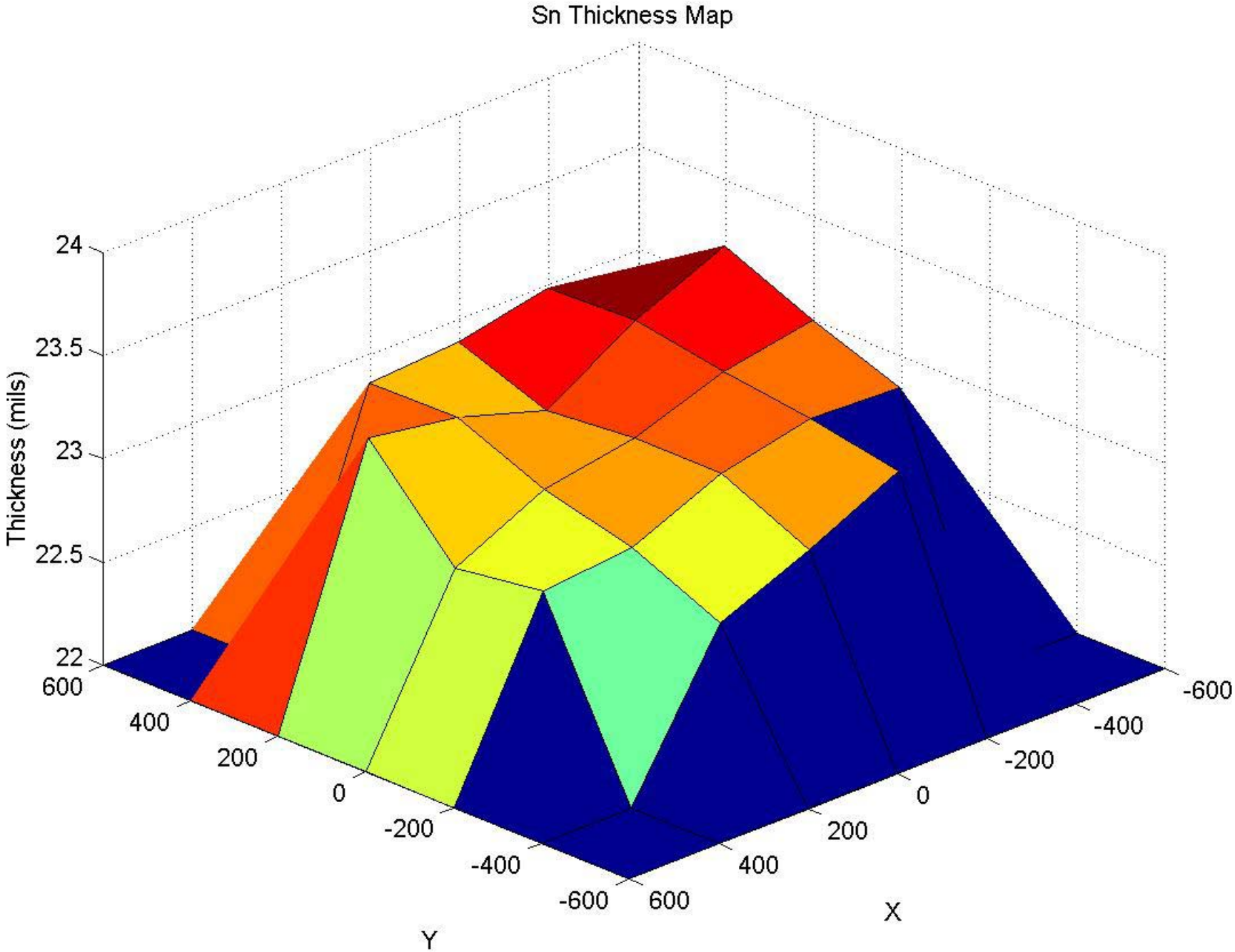

λ values for Pb
7.28
7.27
7.26
7.25
7.24
7.23
7.22
7.21
7.20
7.19
7.18
λ
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Mic Point

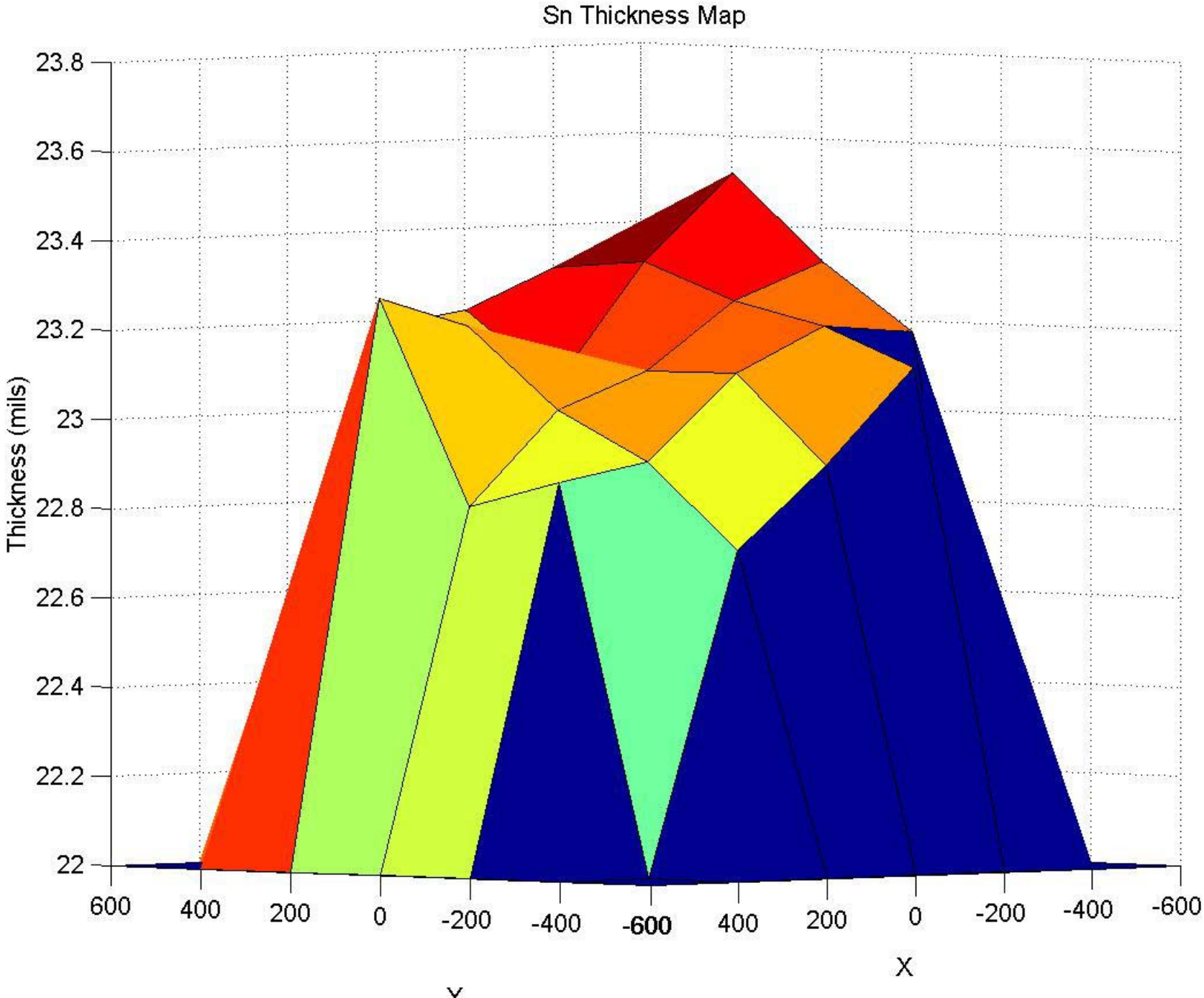

Pb Thickness Map
Thickness (mils)
12.5
12
11.5
11
600
400
200
0
-200
-400
-600
X
-600
-400
-200
0
200
400
600
Y

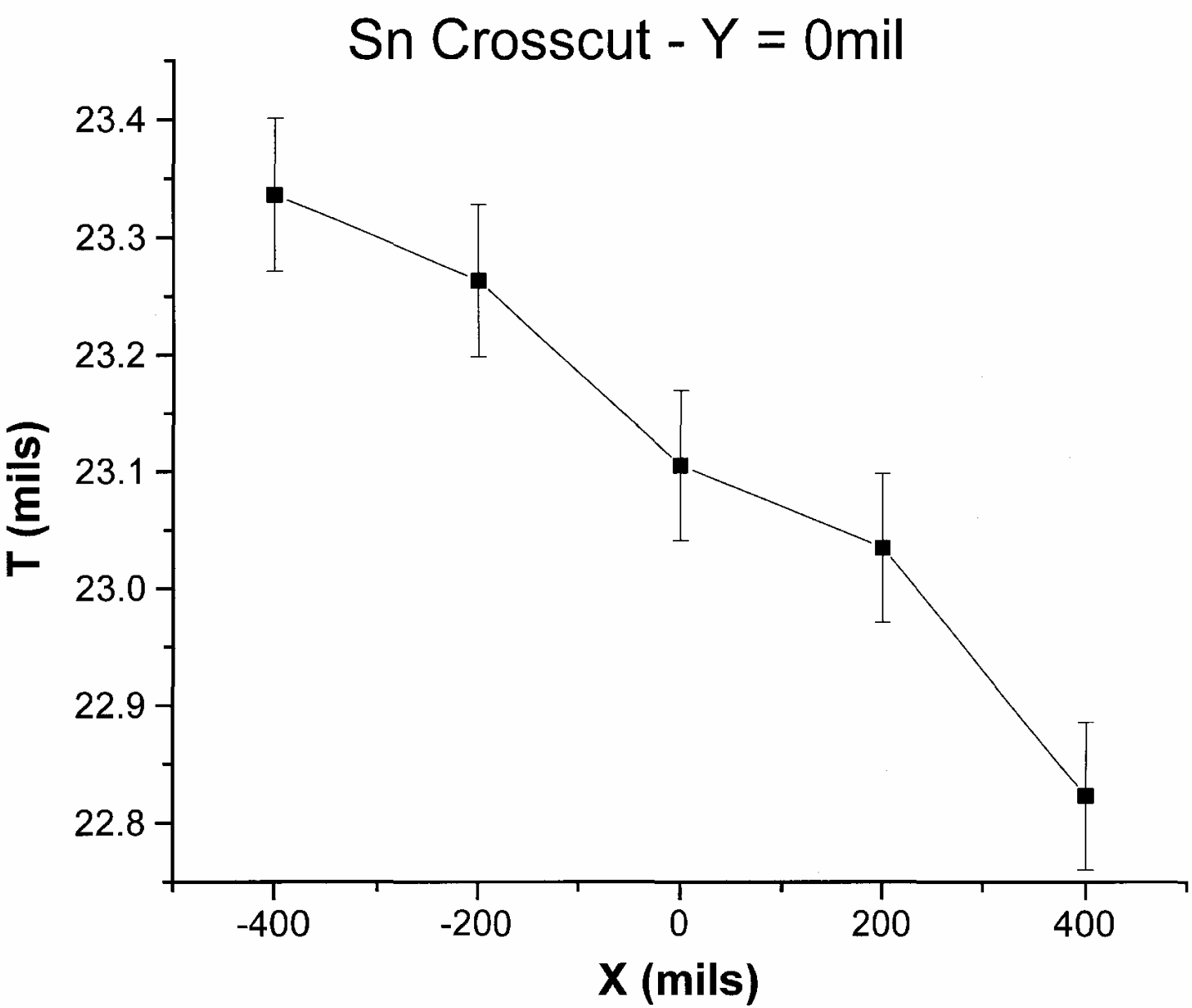

Pb Thickness Map
12.2
12
11.8
11.6
11.4
11.2
11
Thickness (mils)
600
400
200
0
-200
-400
-600
-400
-200
0
200
400
600
X
Y


Pb Crosscut - X = 0mil
12.15
12.10
12.05
12.00
11.95
11.90
11.85
11.80
11.75
11.70
T (mils)
-400
-200
0
200
400
Y (mils)
±0.3%


λ values for Sn
8.56
8.55
8.54
8.53
8.52
8.51
8.50
8.49
8.48
λ
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Mic Point


Sn Thickness Map
Thickness (mils)
24
23.5
23
22.5
22
600
400
200
0
-200
-400
-600
Y
600
400
200
0
-200
-400
-600
X


Sn Thickness Map
Thickness (mils)
23.8
23.6
23.4
23.2
23
22.8
22.6
22.4
22.2
22
600
400
200
0
-200
-400
-600
400
200
0
-200
-400
-600
X
Y


Sn Crosscut - Y = 0mil
T (mils)
23.4
23.3
23.2
23.1
23.0
22.9
22.8
-400
-200
0
200
400
X (mils)

Next steps:

- Repeat Sn and Pb x-ray scans using 100 mil grid steps.
- x-ray the graphite target to ensure the target density is uniform.

After completion of PRIMEX run:

- x-ray scans with Lanthanum chloride scintillator (4% energy resolution and 25 ns decay time, versus 7% and 230 ns for NaI). New product from Saint-Gobain.
- Remove target foils from frames and measure Sn and Pb density at $\pm$.5% level. Need a slightly more accurate scale (have $\pm$1 mg, need $\pm$.5 mg)

Many thanks to the students!

Eric Clinton. UMass, Ph.D. on PRIMEX.

John Myers. Microsoft?

Ryan McWilliams. UC Berkeley, Ph.D. student in Earth Sciences.

Phil Martel. UMass B.S. in Physics, Spring '04.