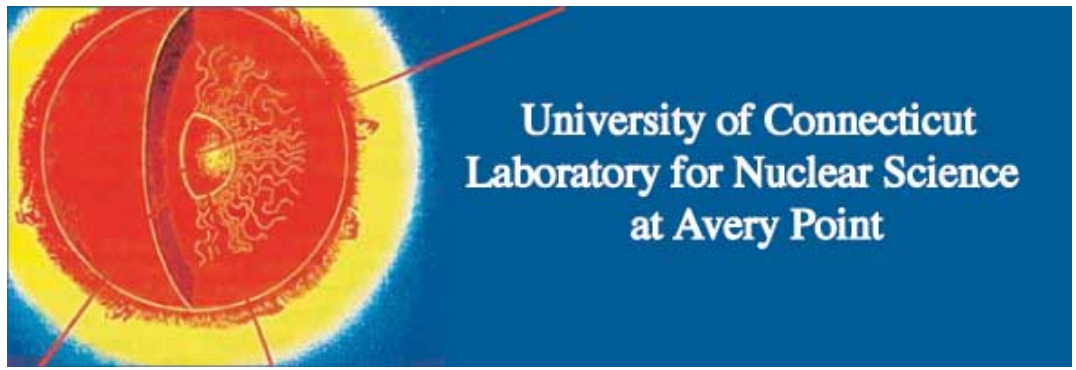
Toward measurements of neutron interactions with ^{7}Be and the primordial ^{7}Li problem



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Aryeh Weiss, Bar Ilan/HU
Dan Berkovitz, Shlomi Halfon, Danny Kijel, Arik Kreisler, Asher Shor, Ido Silverman,
Leonid Weissman, Soreq Nuclear Research Center
Michael Hass, Ish Mukul, Weizmann Institute
Emilio A. Maugeri, Rugard Dressler, Dorothea Schumann, Stephan Heinitz, Paul Scherrer Institute
Thierry Stora, ISOLDE/CERN
David Ticehurst, Calvin R. Howell, TUNL

1. **The SARAF Collaboration**
2. **The Experimental Setups: SARAF, TUNL, ISOLDE**
3. **Calibration and Analyses of CR-39 Plates**
4. **Tests: ^{10}B(n, α): low activity ^{7}Be(n, α)**
5. **Outlook, Future Plans**

CHANDA Workshop, Villigen, Switzerland, Nov. 24, 2015

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Proposal to the ISOLDE and Neutron Time-of-Flight Committee *

Implanted ^{7}Be Targets For The Study of Neutron Interactions With ^{7}Be (The "Primordial ^{7}Li Problem")

June 21, 2014

**

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* 24 Shifts approved by INTC-047

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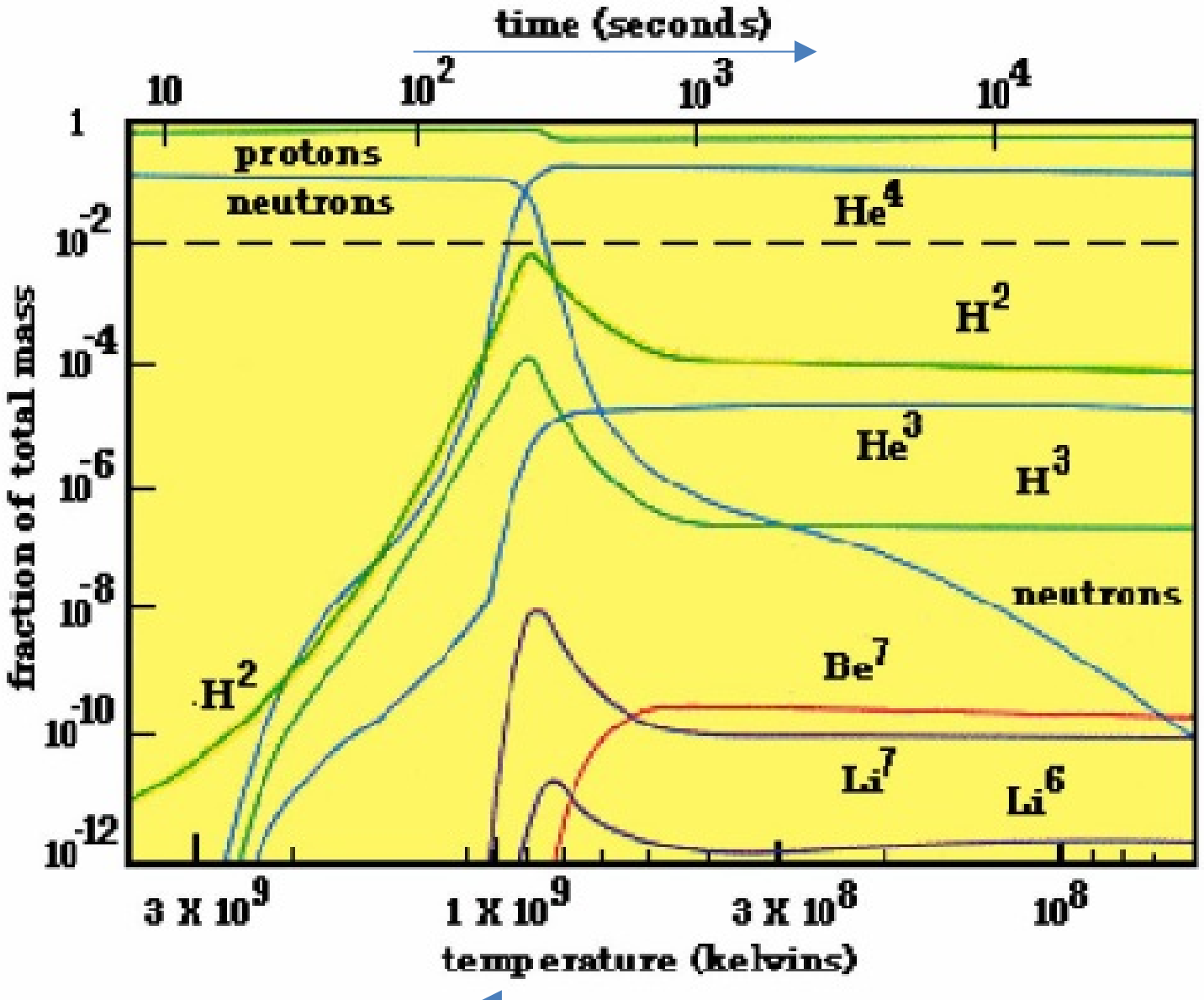
SARAF Control Room, June 23, 2015

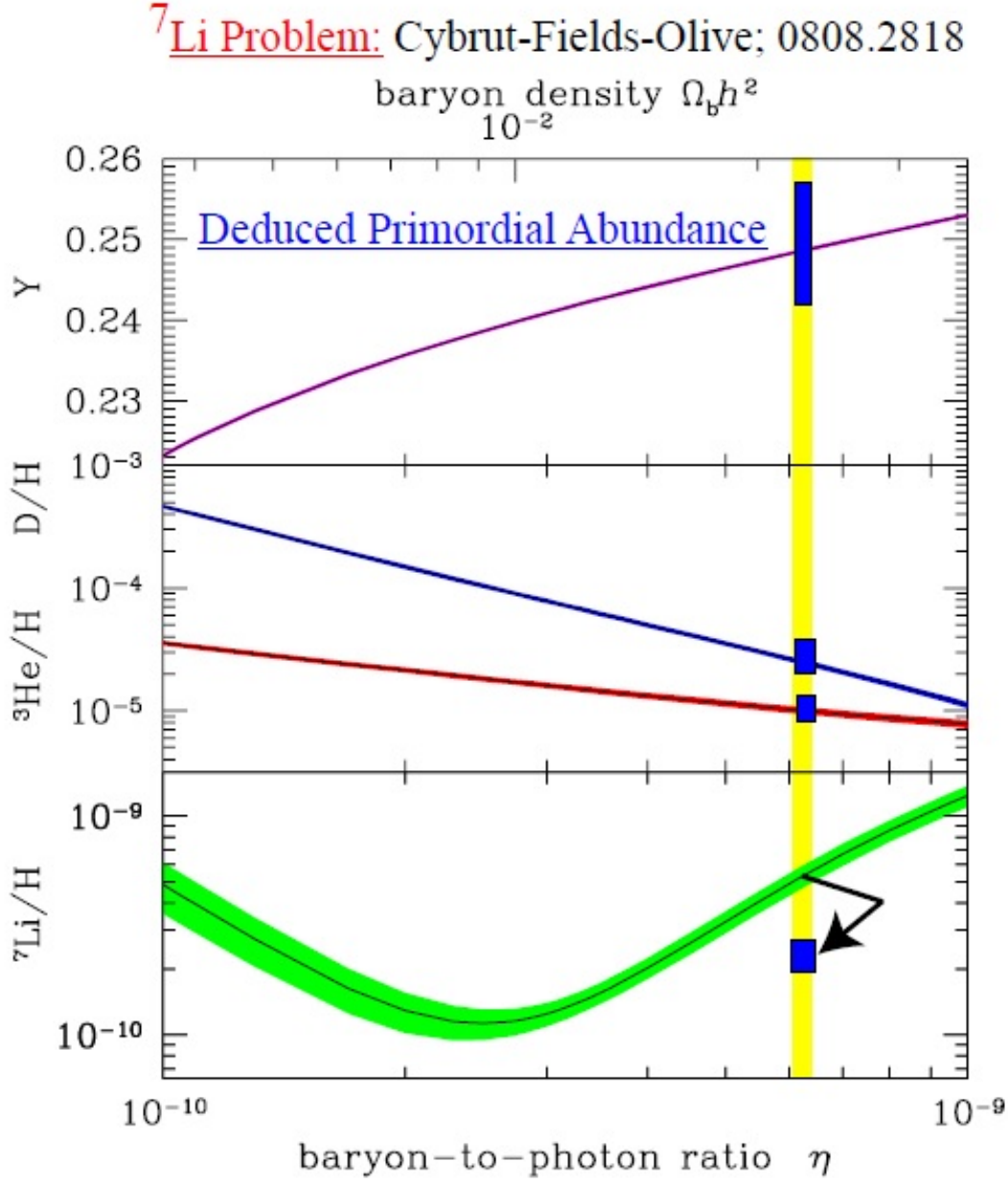
Elements produced in BBN

K.M. Nollett:

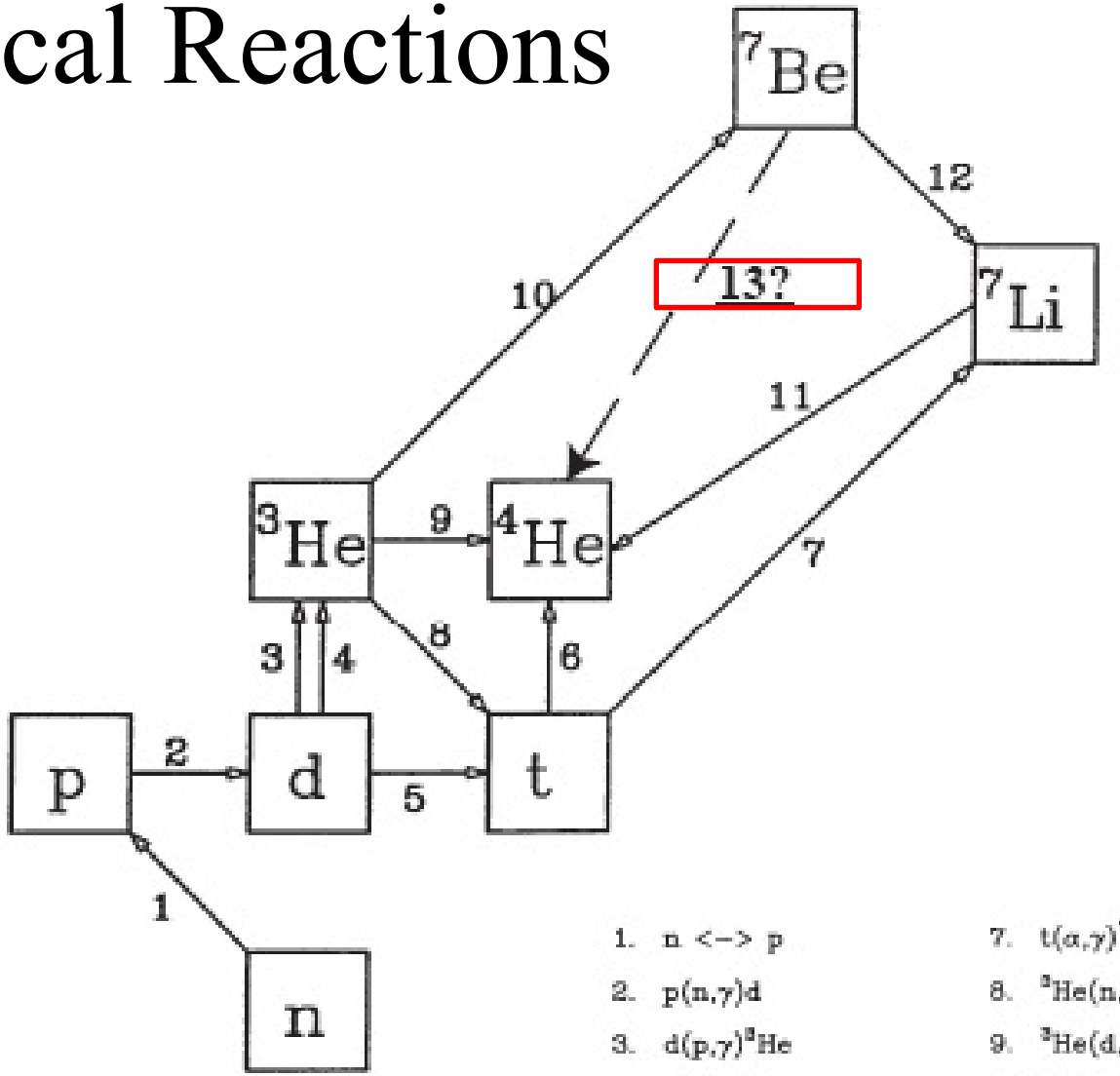
$\Omega_b h^2$(WMAP) → 95% of ^{7}Li Daughter of ^{7}Be



The Primordial ^{7}Li Problem

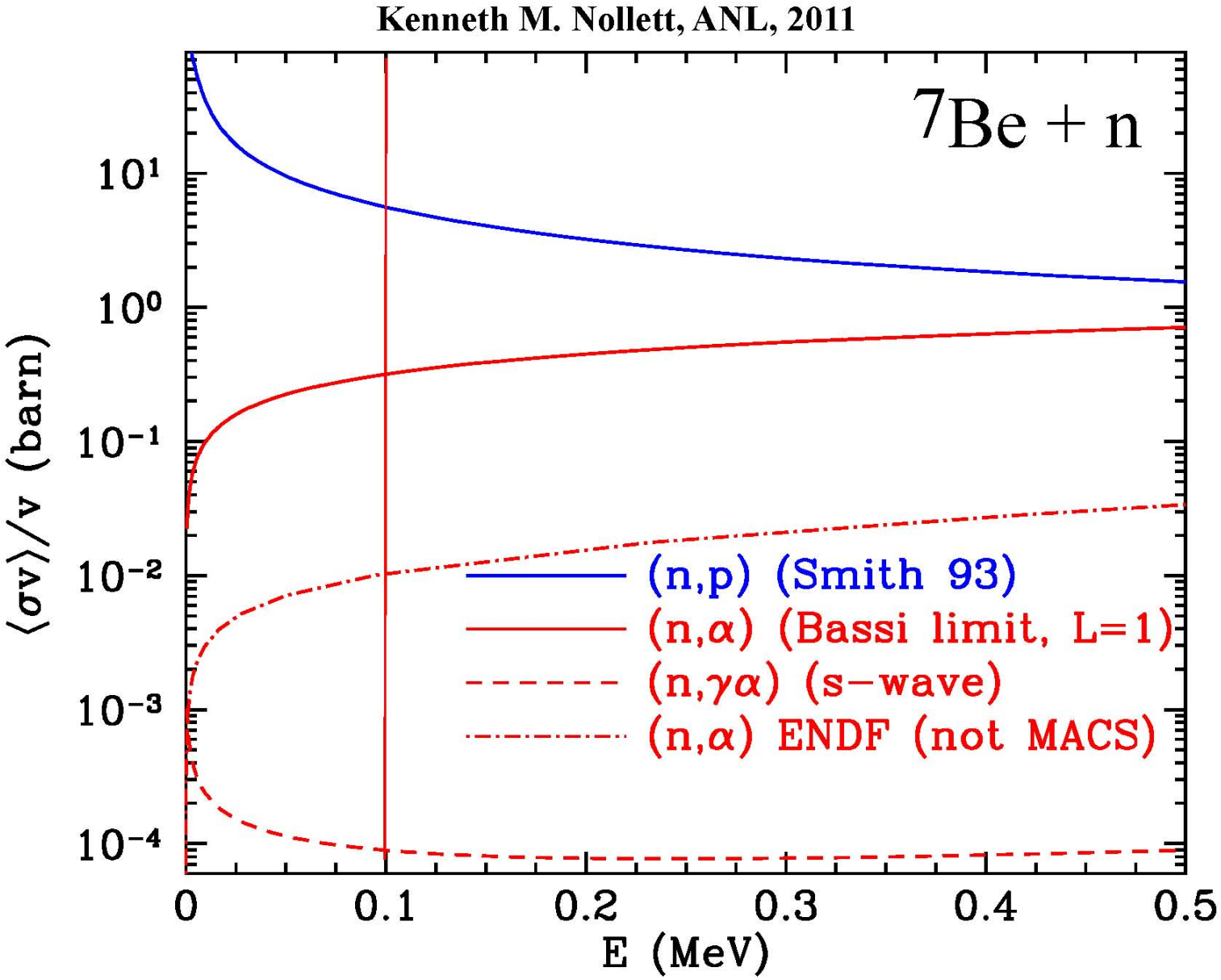


Canonical Reactions

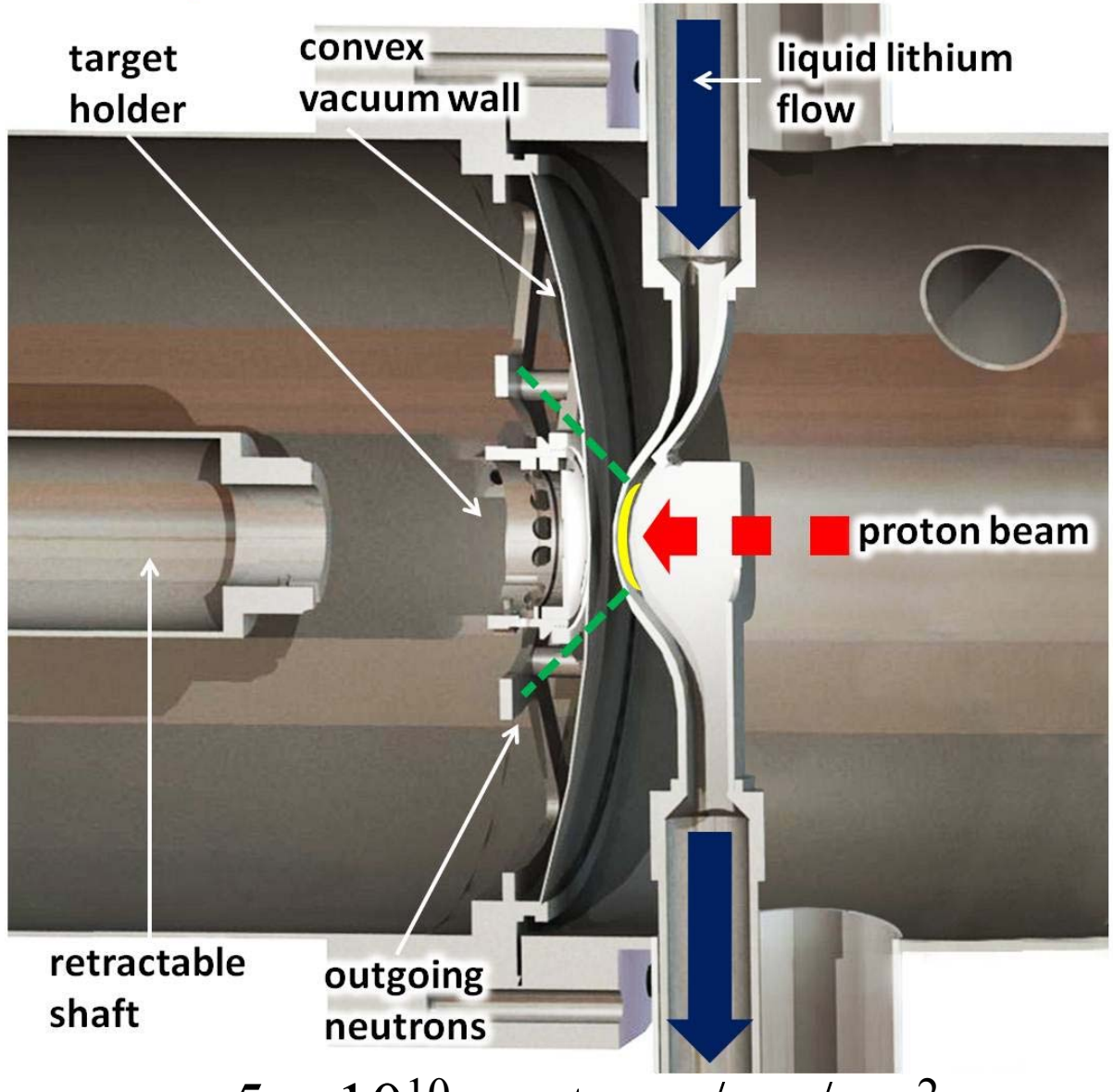


1. n <-> p
2. p(n,γ)d
3. d(p,γ)^{3}He
4. d(d,n)^{3}He
5. d(d,p)t
6. t(d,n)^{4}He
7. t(α,γ)^{7}Li
8. ^{3}He(n,p)t
9. ^{3}He(d,p)^{4}He
10. ^{3}He(α,γ)^{7}Be
11. ^{7}Li(p,α)^{4}He
12. ^{7}Be(n,p)^{7}Li
13. ^{7}Be(n,α)^{4}He?

Compilation of Cross-Sections

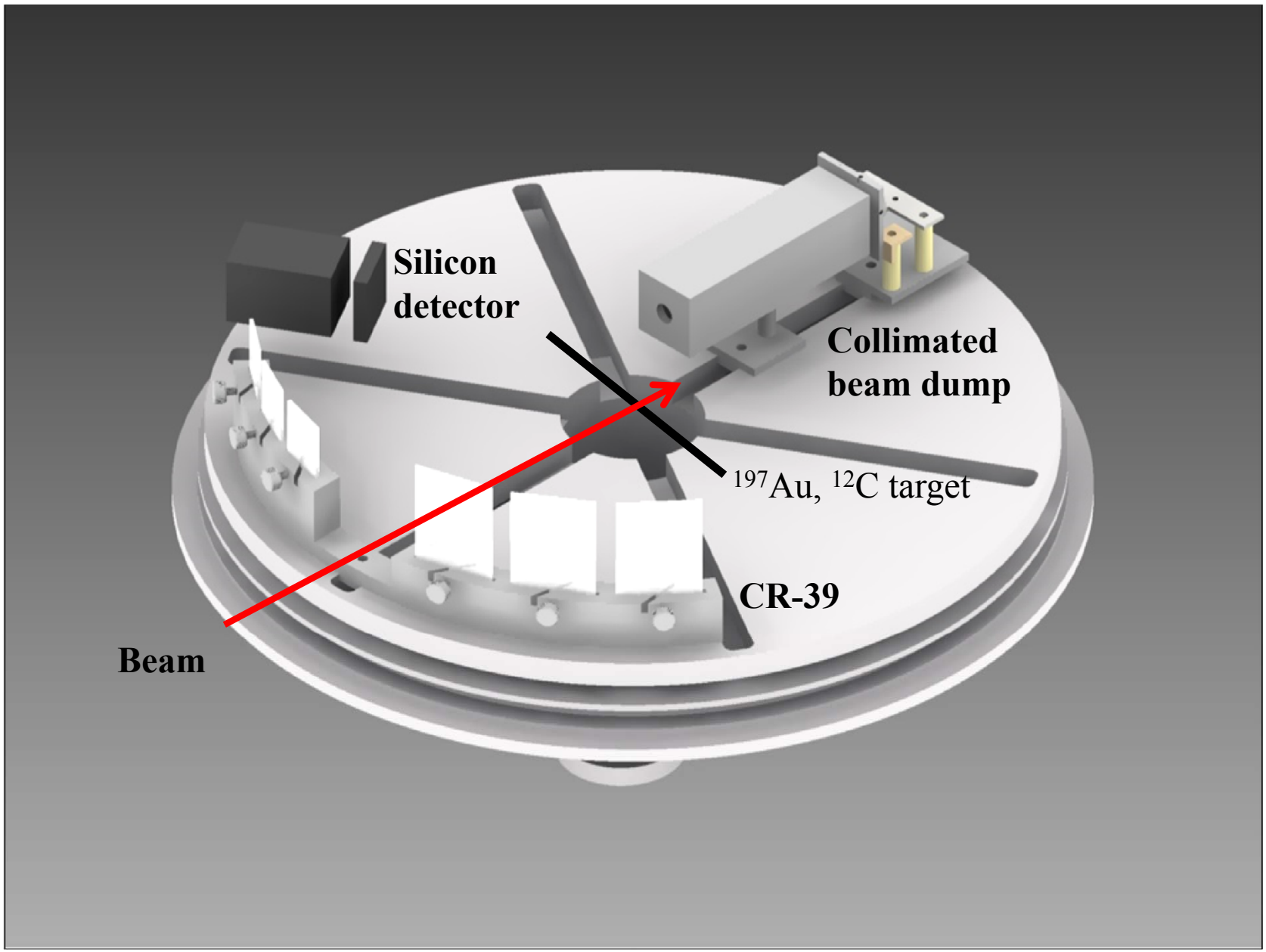


SARAF Setup

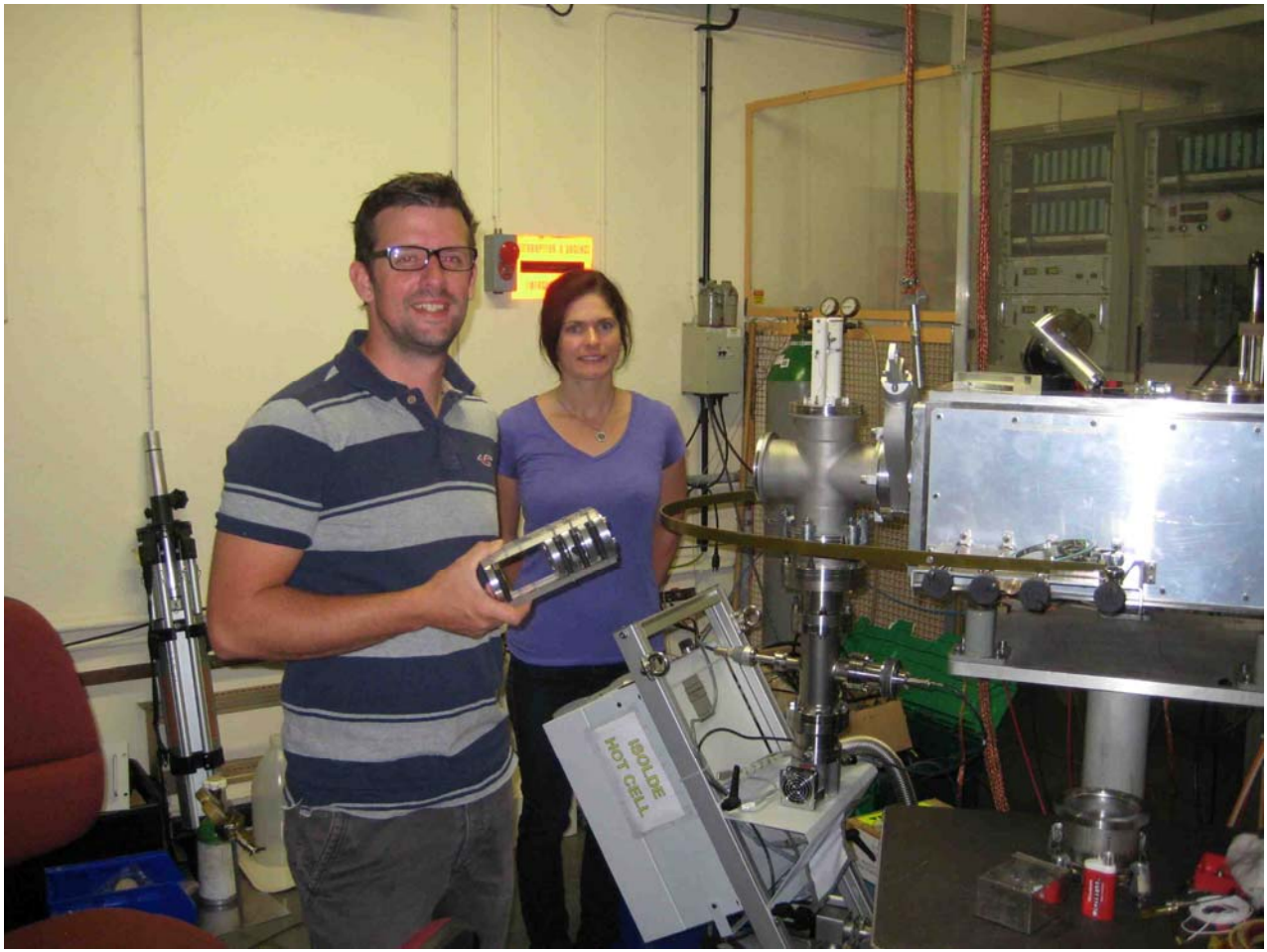


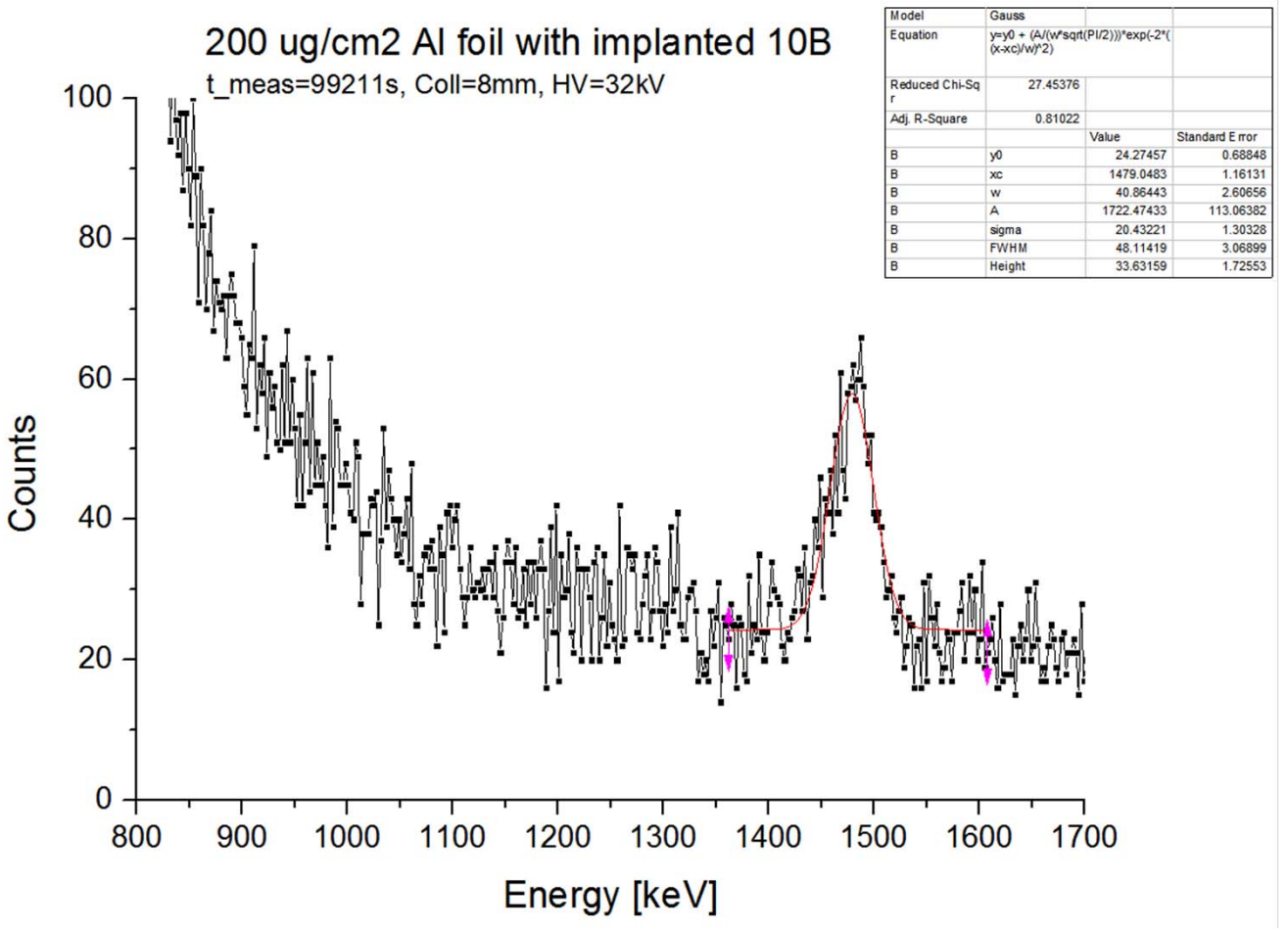
5 x 10^{10}-neutrons/sec/cm^2

TUNL CR-39 Calibration Setup



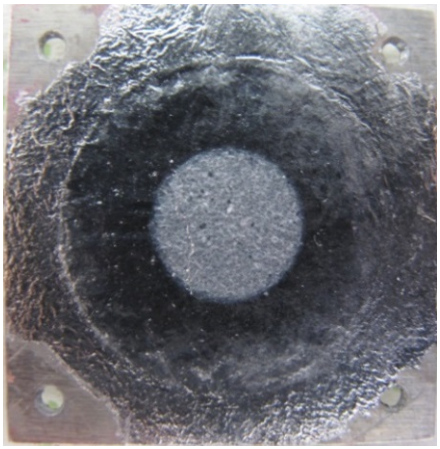
Implantation Setup at ISOLDE, June 2014

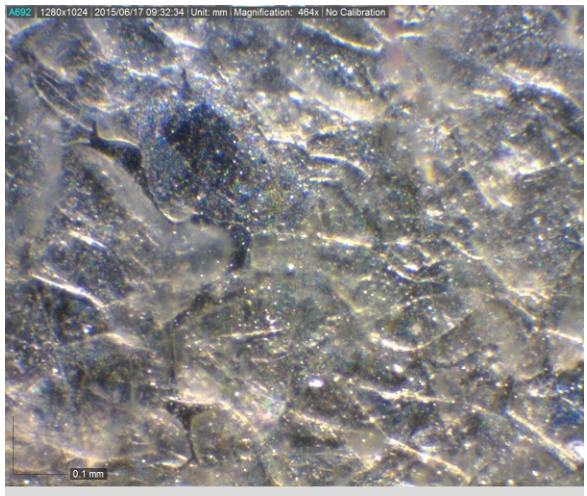


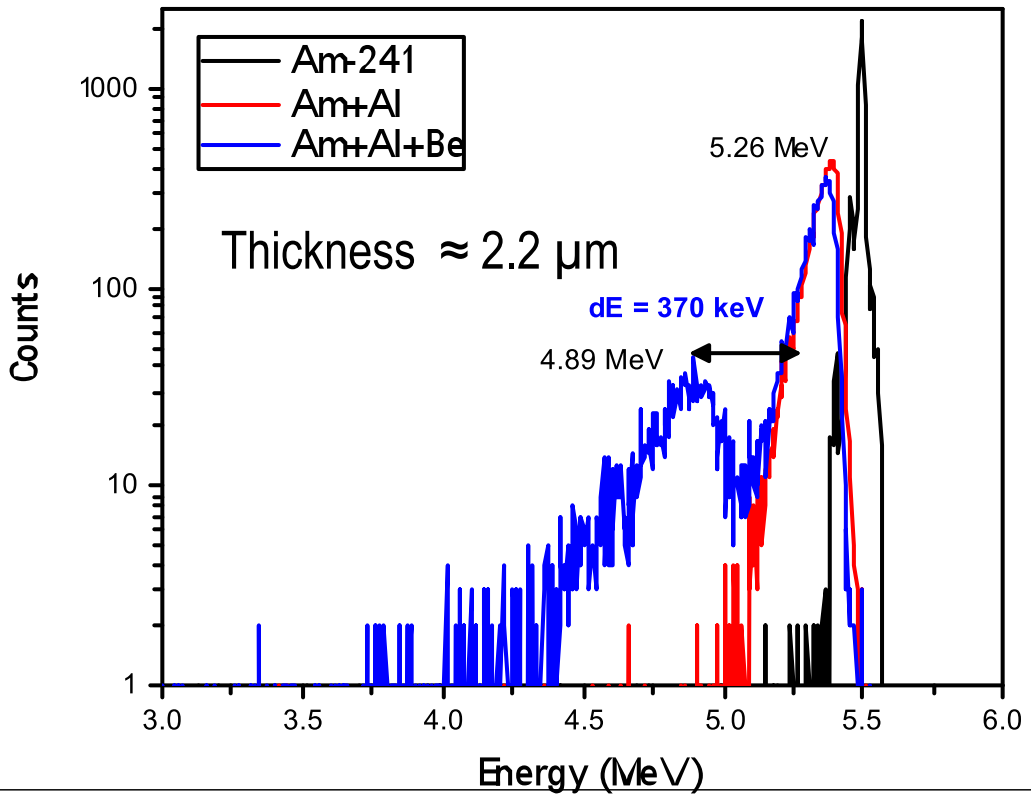


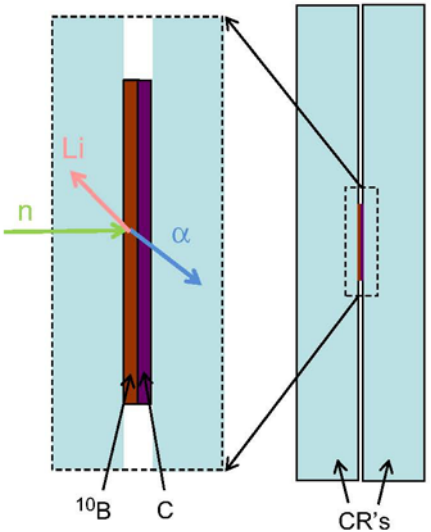
Model	Gauss		
Equation	y=y0 + (A/(w*sqrt(PI/2)))*exp(-2*((x-xc)/w)^2)		
Reduced Chi-Sqr	27.45376		
Adj. R-Square	0.81022		
		Value	Standard Error
B	y0	24.27457	0.68848
B	xc	1479.0483	1.16131
B	w	40.86443	2.60656
B	A	1722.47433	113.06382
B	sigma	20.43221	1.30328
B	FWHM	48.11419	3.06899
B	Height	33.63159	1.72553

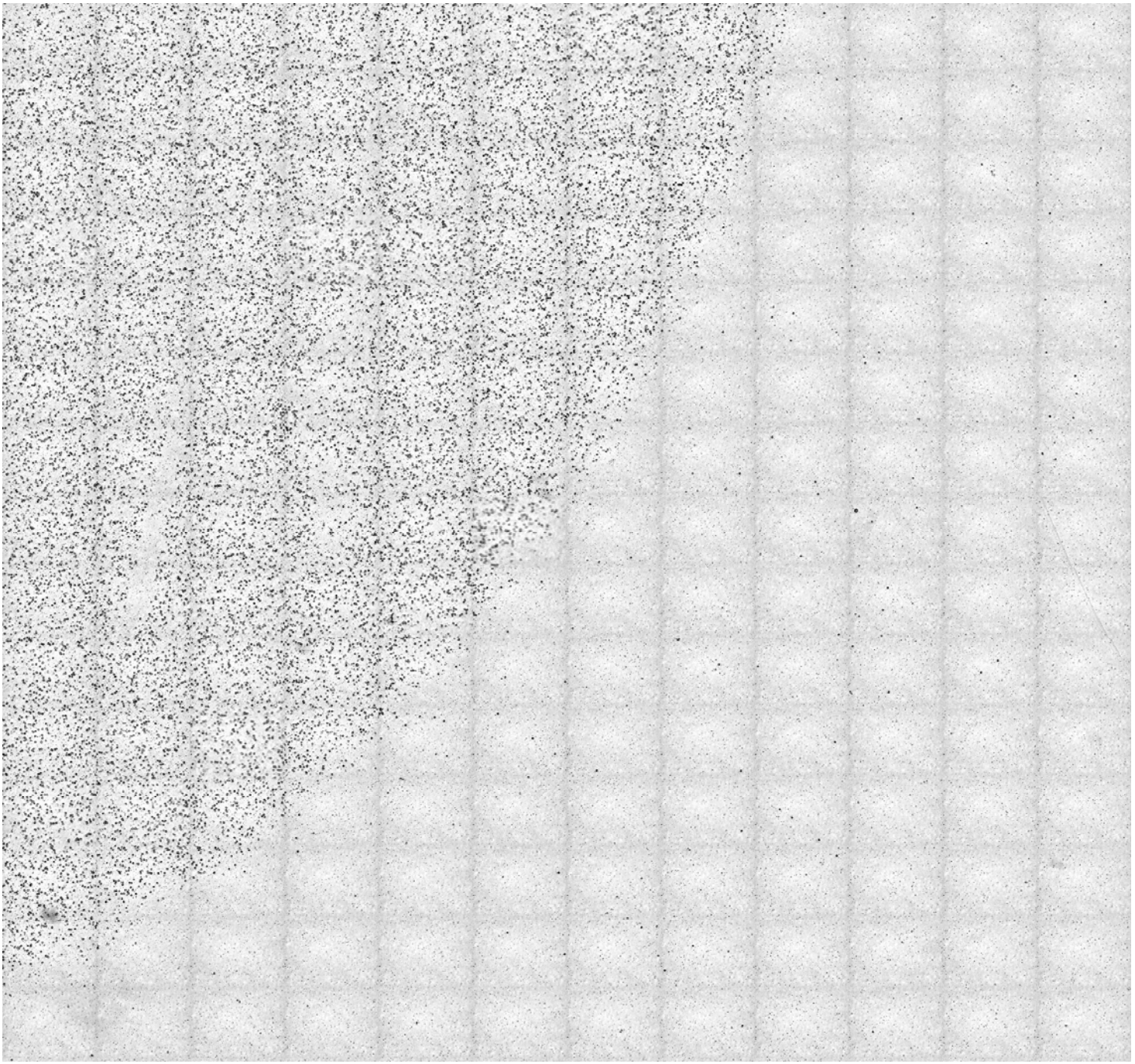
1 µm target after molecular plating



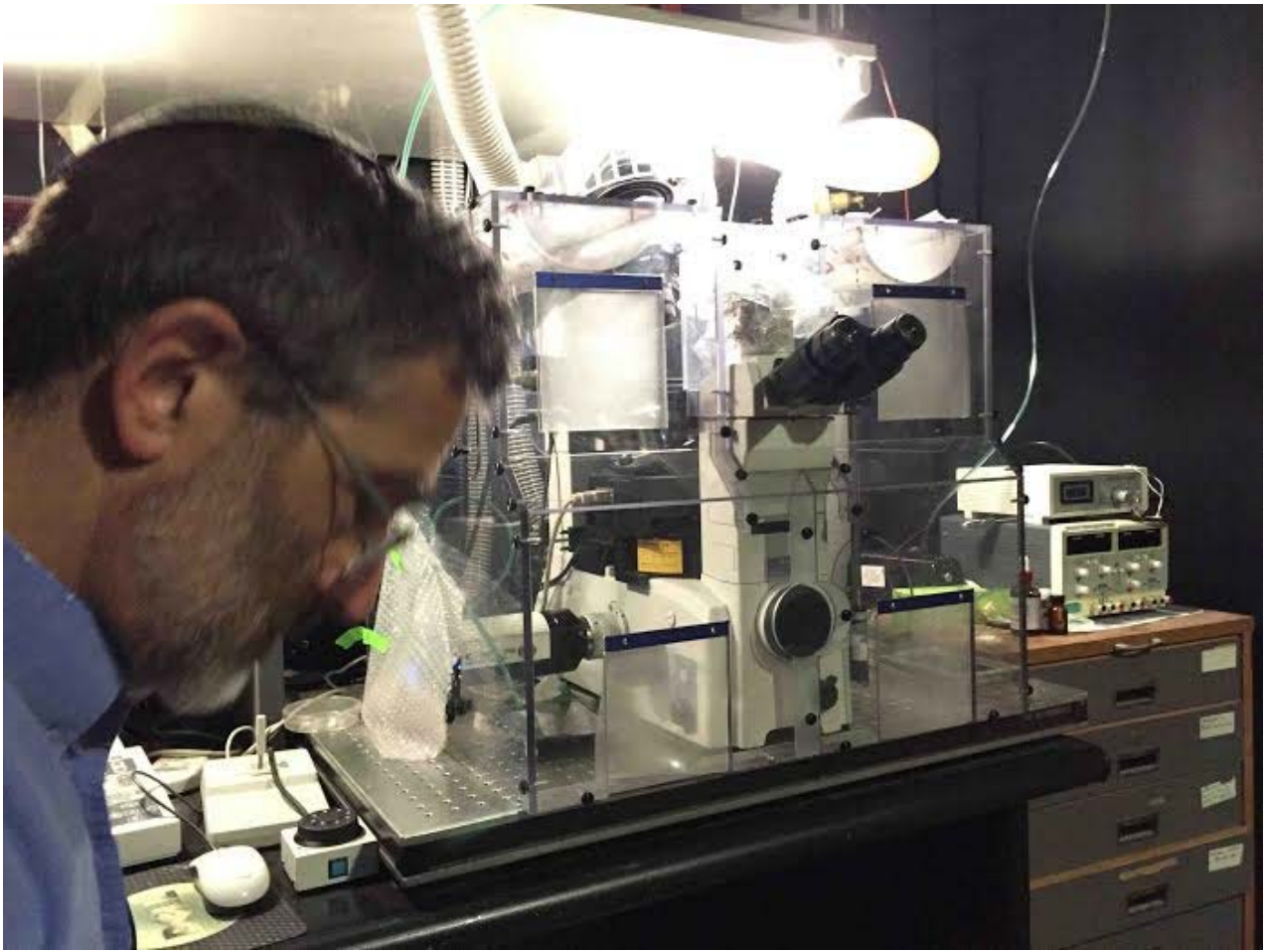





Li
n
α
^{10}B
C
CR's

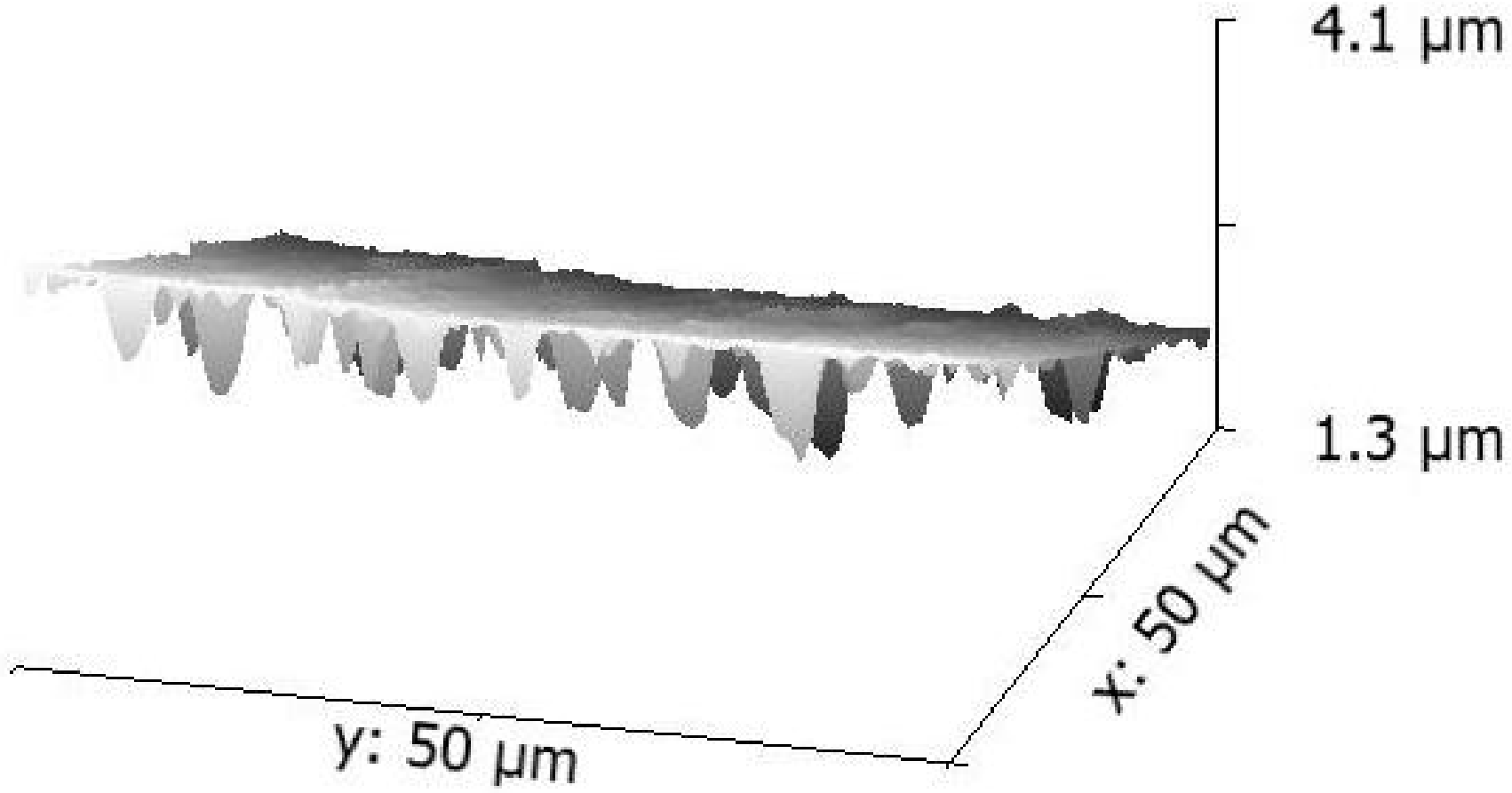


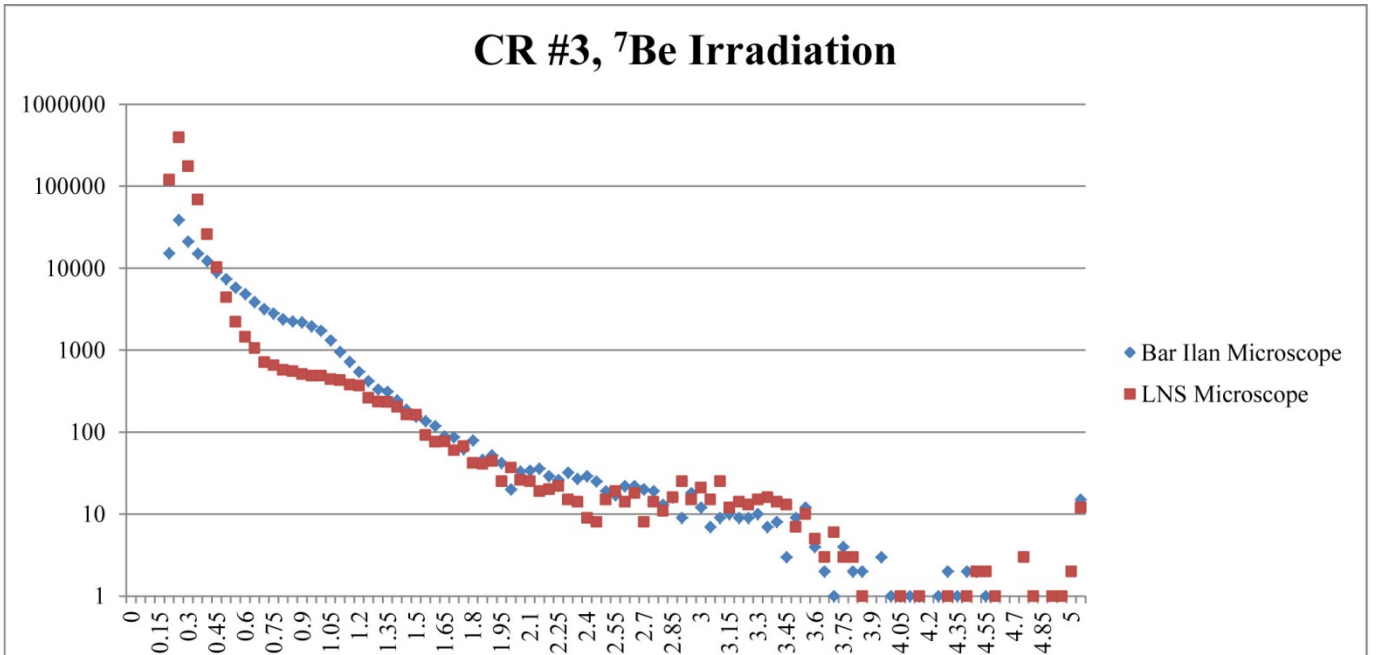

AFM

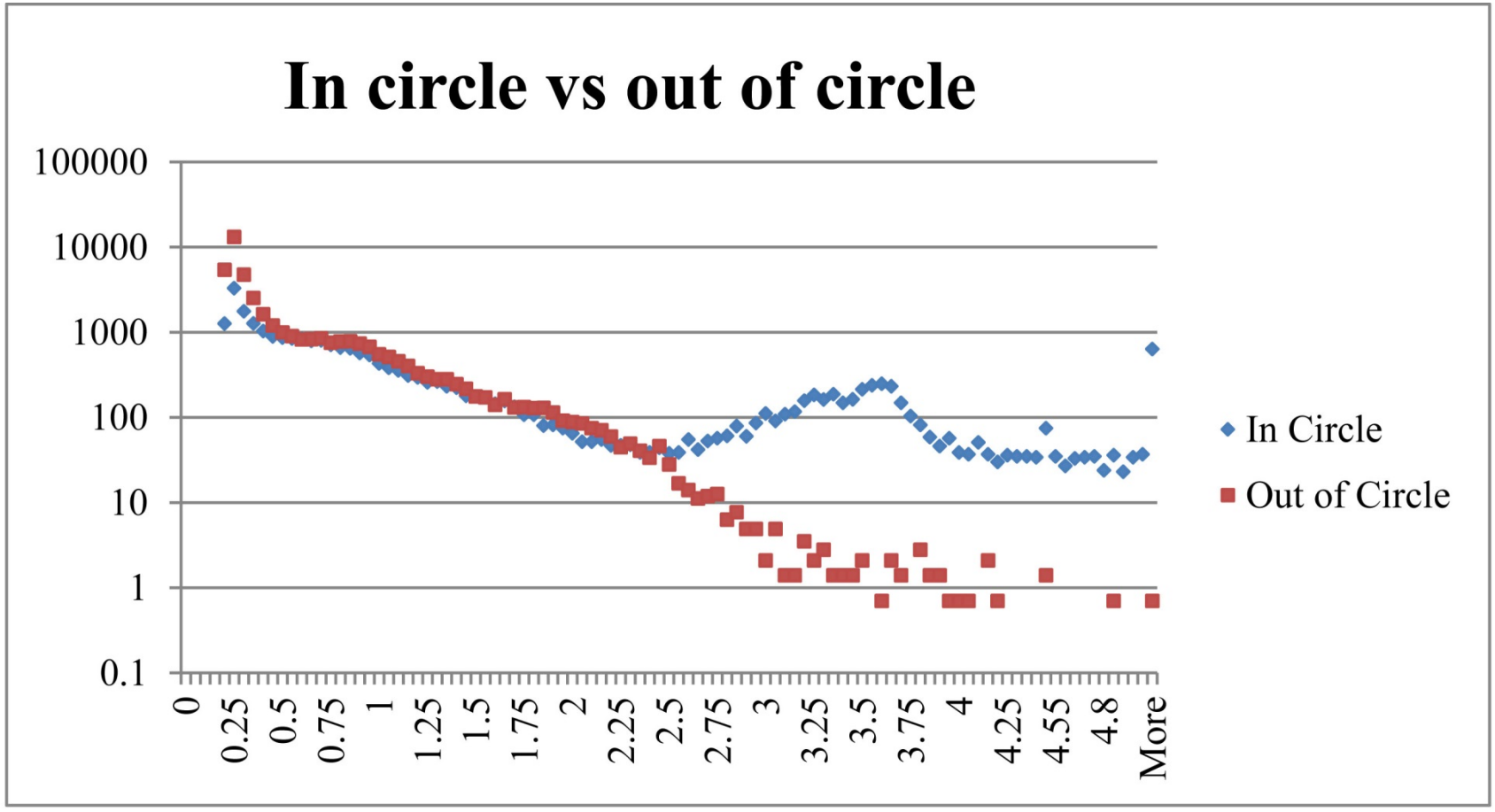



Freezer

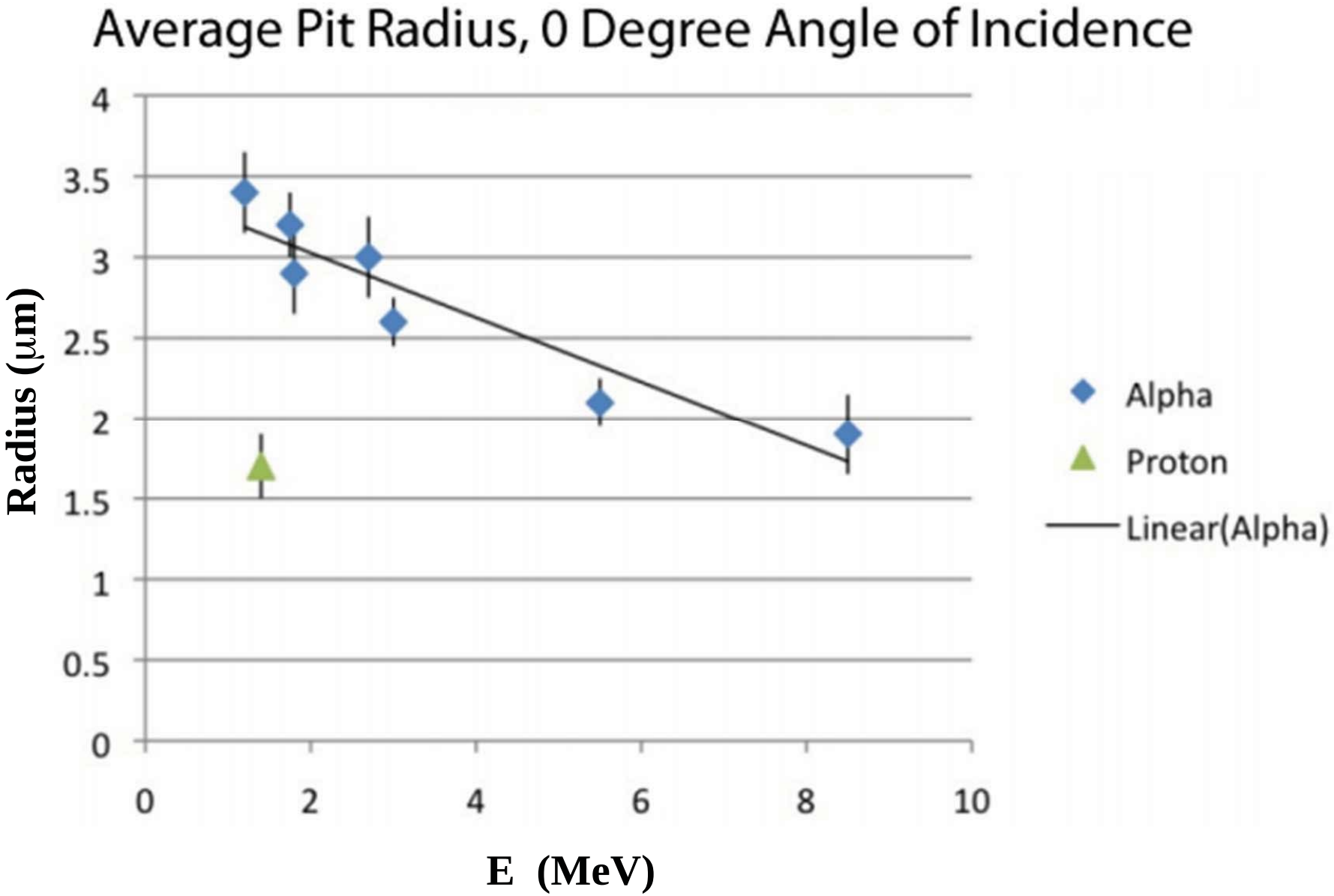
y: 50 µm
x: 50 µm

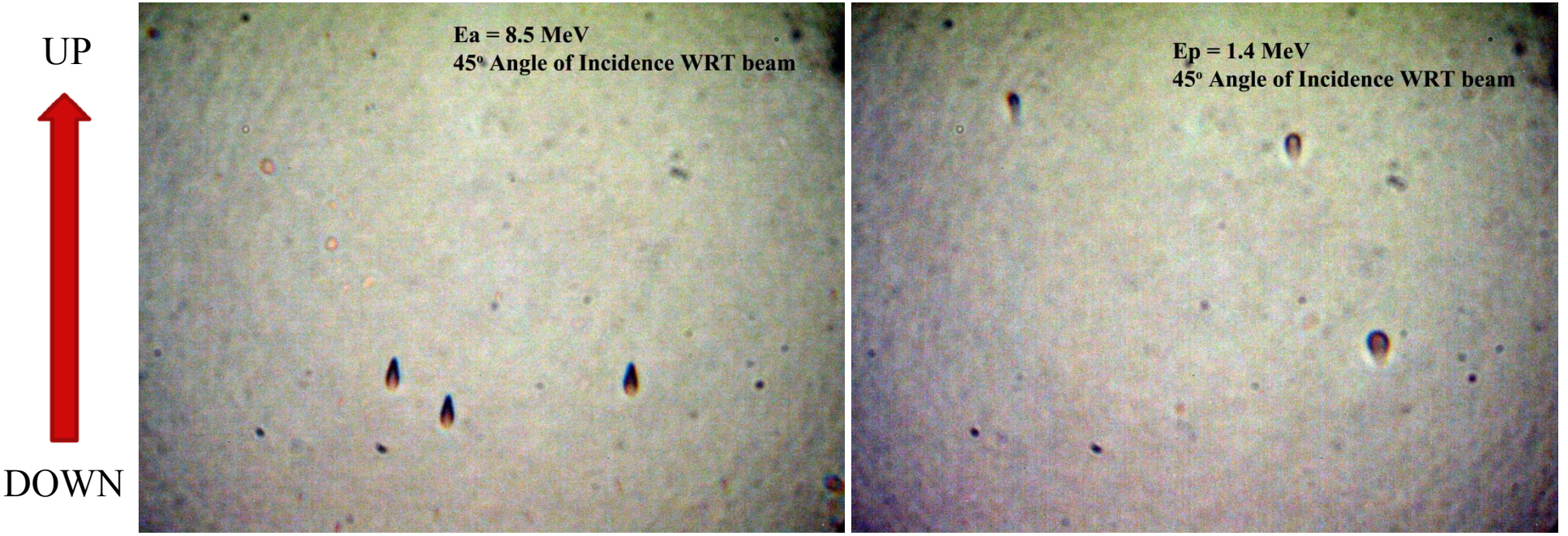

4.1 µm
1.3 µm
x: 50 µm
y: 50 µm


CR #3, 7Be Irradiation
1000000
100000
10000
1000
100
10
1
0
0.15
0.3
0.45
0.6
0.75
0.9
1.05
1.2
1.35
1.5
1.65
1.8
1.95
2.1
2.25
2.4
2.55
2.7
2.85
3
3.15
3.3
3.45
3.6
3.75
3.9
4.05
4.2
4.35
4.55
4.7
4.85
5
Bar Ilan Microscope
LNS Microscope

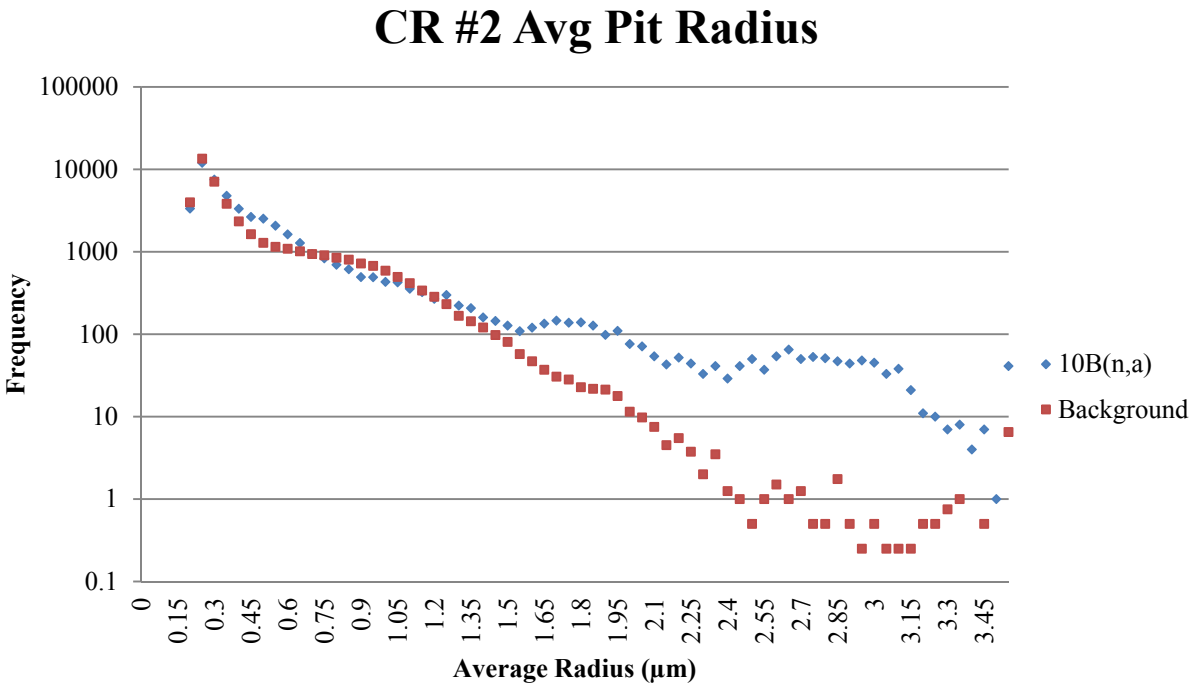

In circle vs out of circle
100000
10000
1000
100
10
1
0.1
0
0.25
0.5
0.75
1
1.25
1.5
1.75
2
2.25
2.5
2.75
3
3.25
3.5
3.75
4
4.25
4.55
4.8
More
In Circle
Out of Circle

CR Calibration Graph




UP
DOWN
Ea = 8.5 MeV
45° Angle of Incidence WRT beam
Ep = 1.4 MeV
45° Angle of Incidence WRT beam

$^{10}B(n,\alpha)^{7}Li$

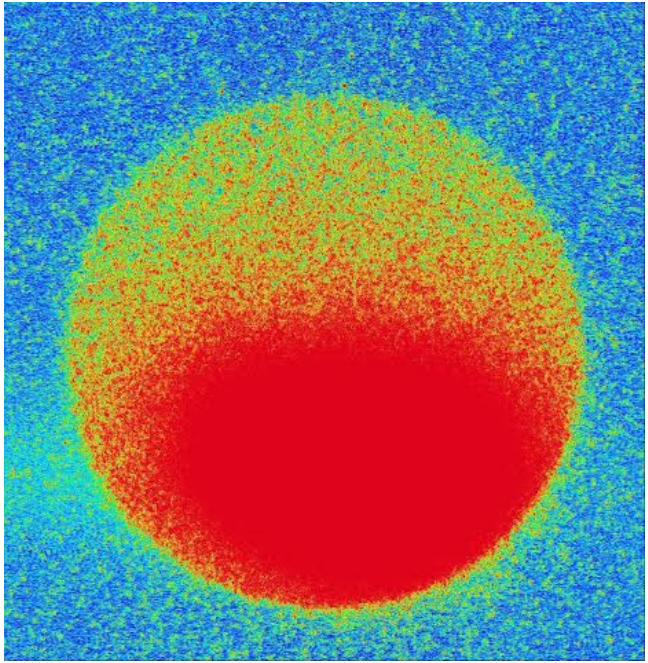


Background ($\geq$ 1.5 μm) = 14,466 $\frac{pits}{cm^2}$

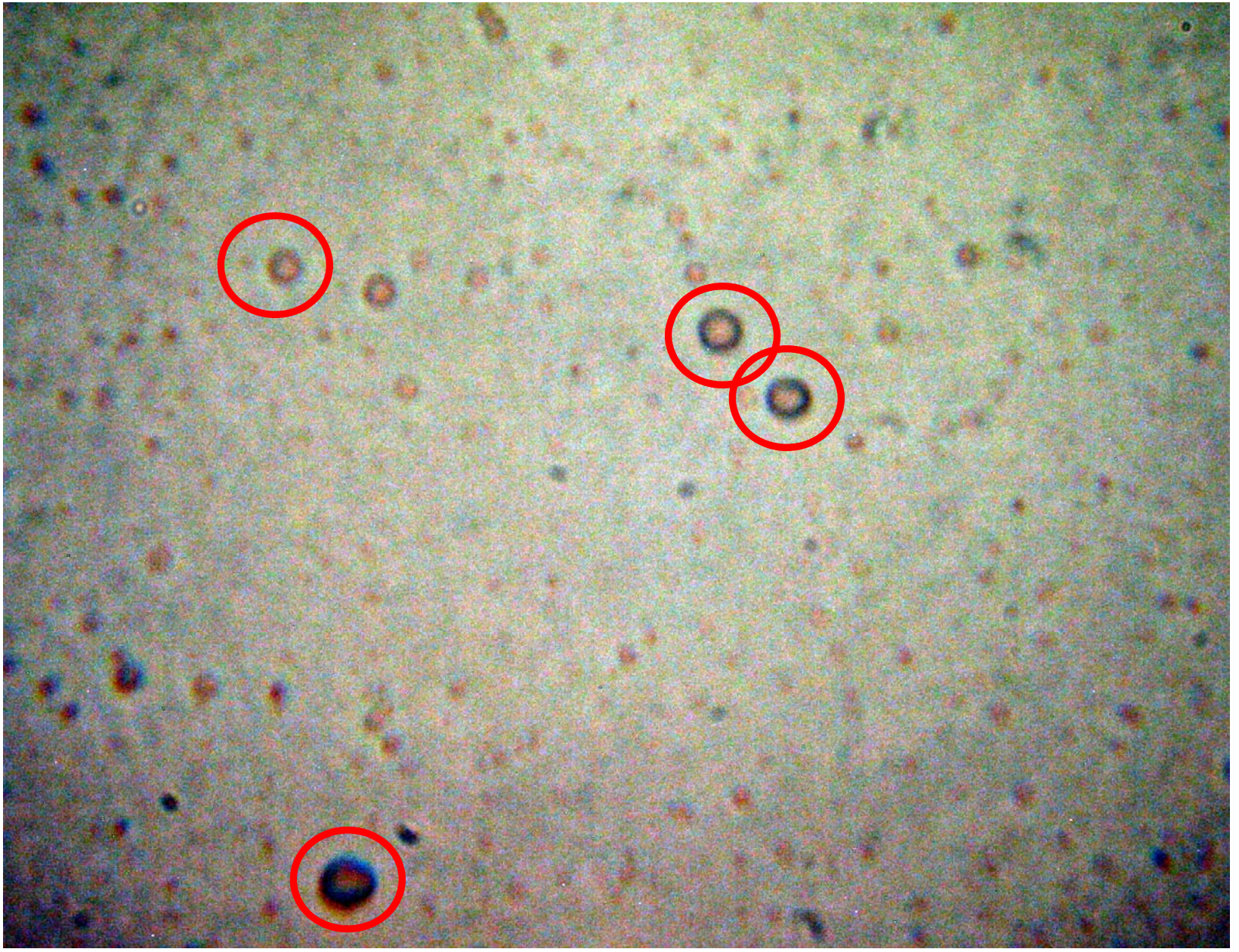
Gold foil activation:

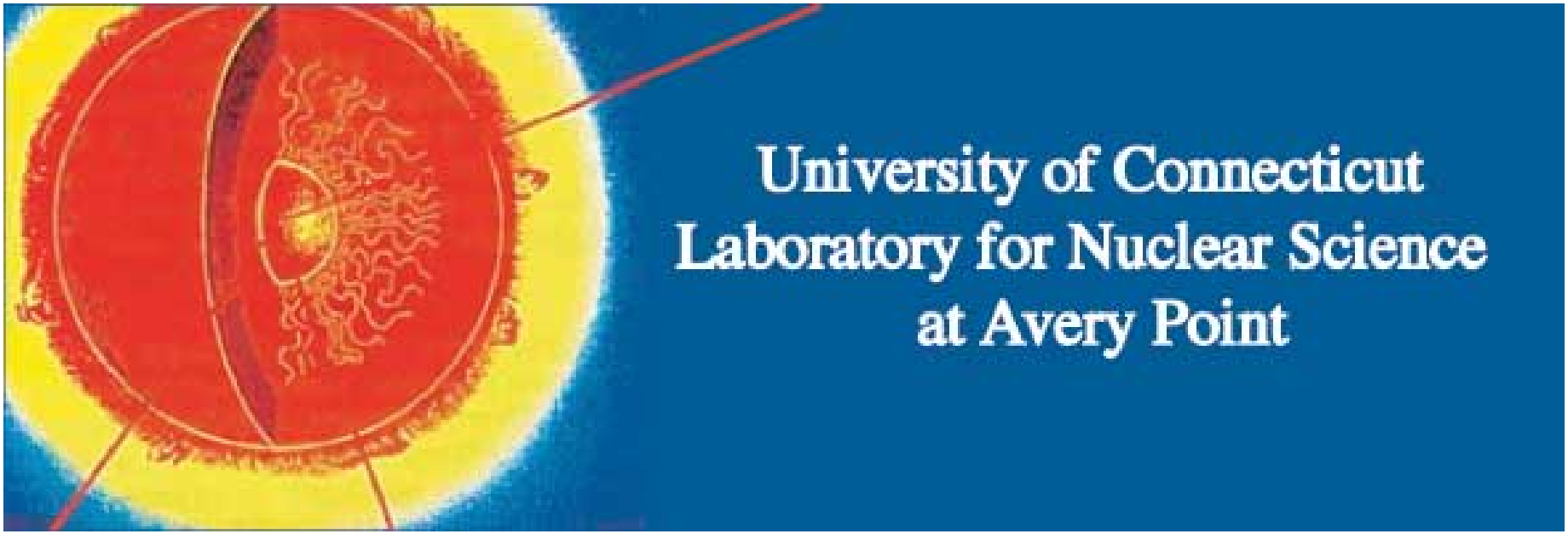
$n_{beam} = 1.16\ x\ 10^{14} neutrons/cm^2$

Neutron Sensitivity $\leq 1.27\ x\ 10^{-10}$



^{7}Be(n,p): measured pits





Conclusion/Outlook

1. Successful setup, tested with ^{10}B target.
2. CR-39 detector calibration in progress.
3. Low activity ^{7}Be target prepared and shipped.
4. High activity 5 GBq ^{7}Be target will follow in near future.