SIMS Analysis of C and N Fluences in Genesis Samples

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Motivation of This Study

- **C and N lie in the region of first ionization potential (FIP) that defines the onset of elemental fractionation relative to the photospheric abundances. The photospheric abundances of these elements relative to low FIP elements (e.g., Fe, Mg) are presumably well known.**

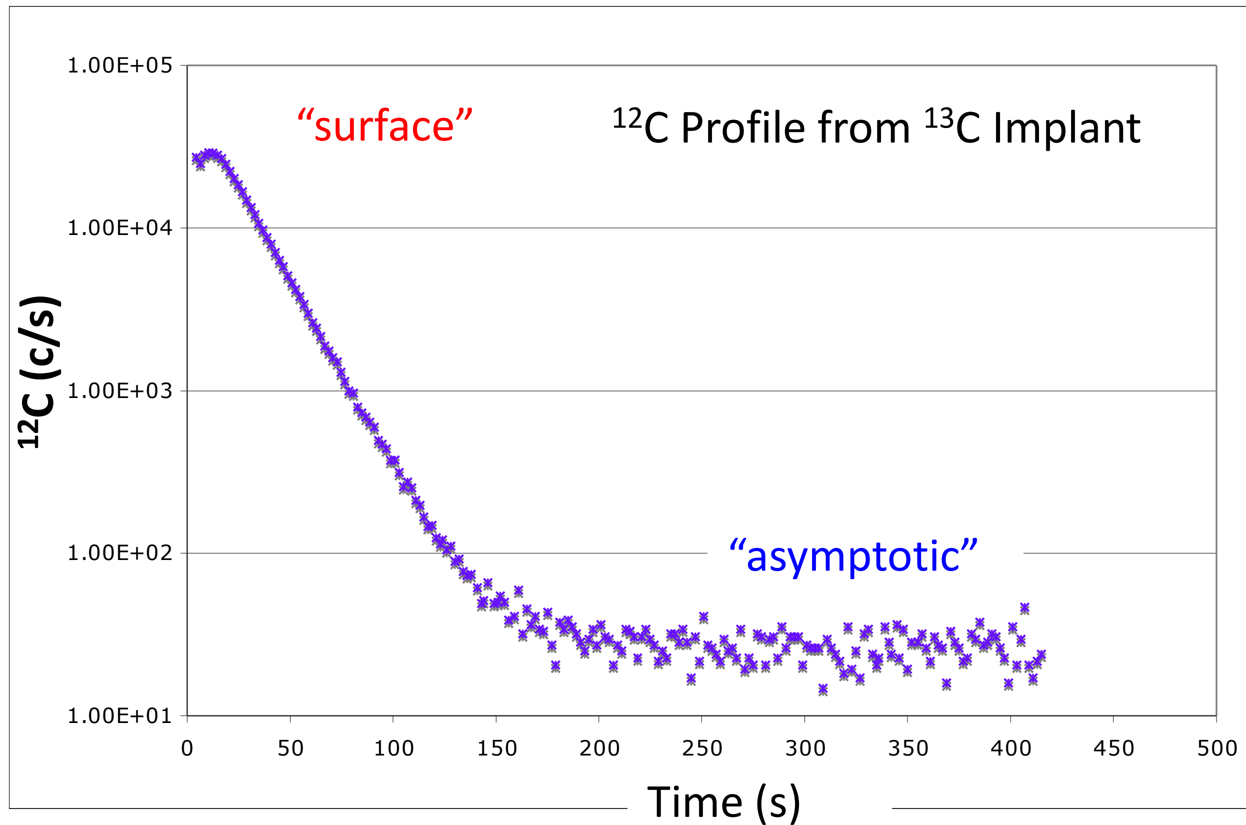
- **Improved models of the FIP elemental fractionation are crucial to evaluating the magnitude of possible isotopic fractionations of the solar wind relative to the Sun.**

- **The sensitivity to measure C and N in Genesis samples by SIMS exists, but several attempts over the past couple of years have failed because of instrumental background and surface contamination.**

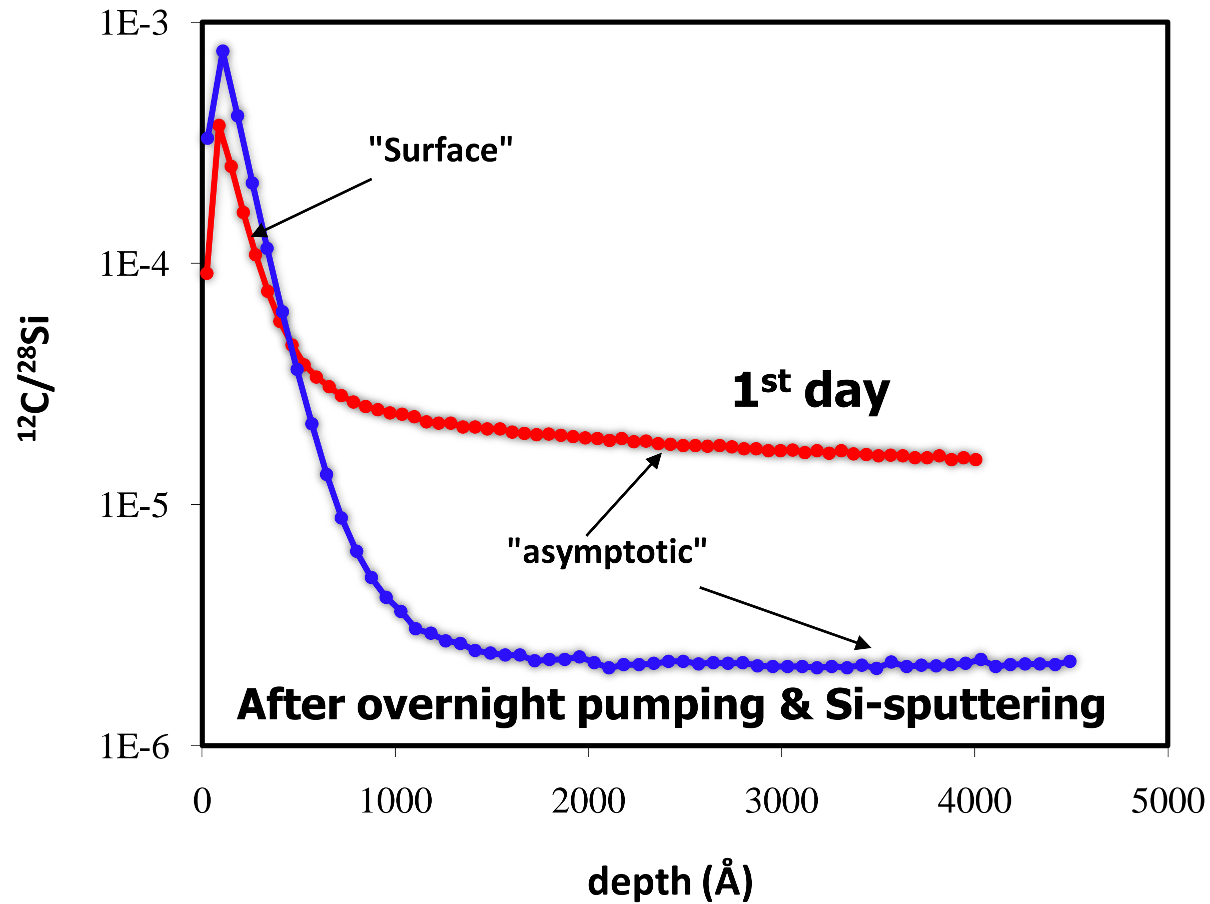
- **The best attempt to date on C and N with our new Cameca 7f-Geo.**

- **Combined FIB and NanoSIMS approach for "backside" profiling.**

Two Sources of Background



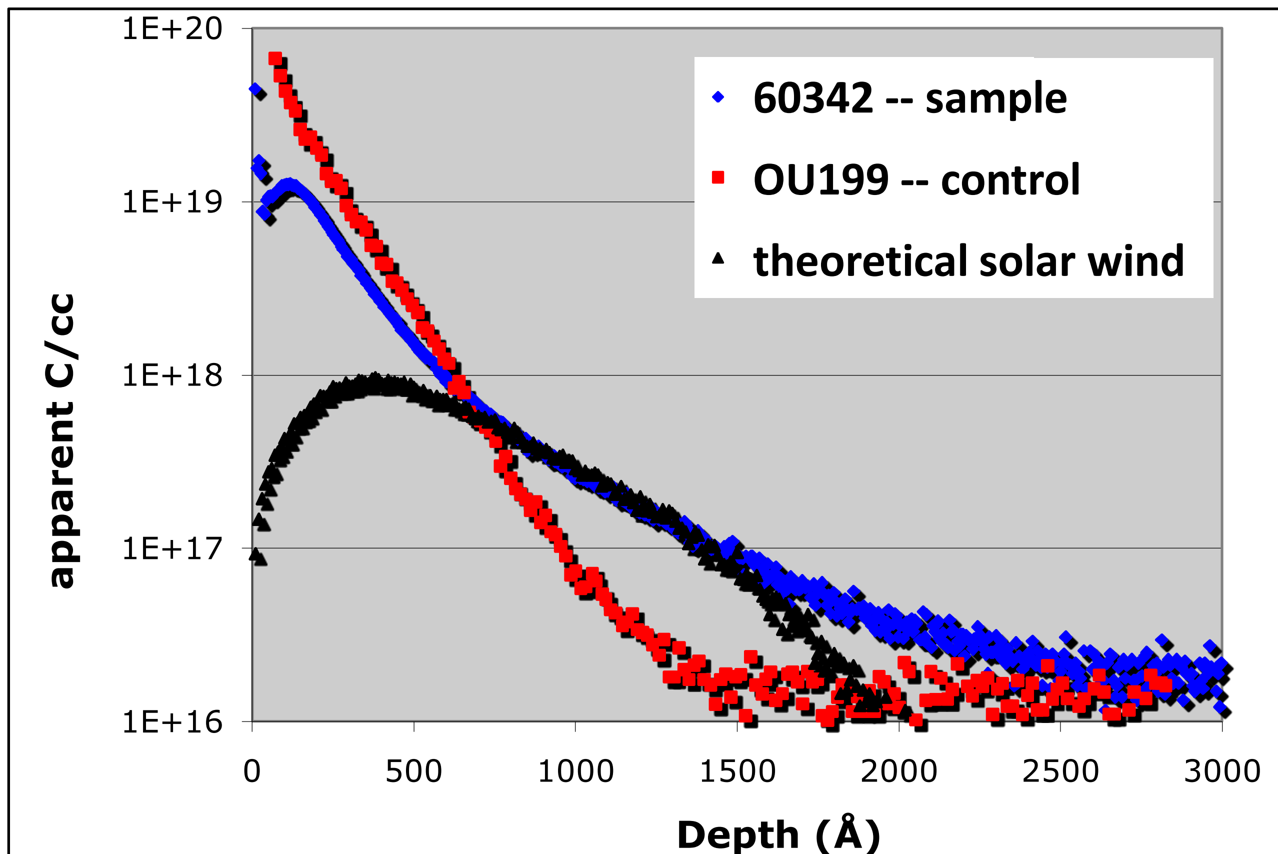
Reduce “Asymptotic” Background



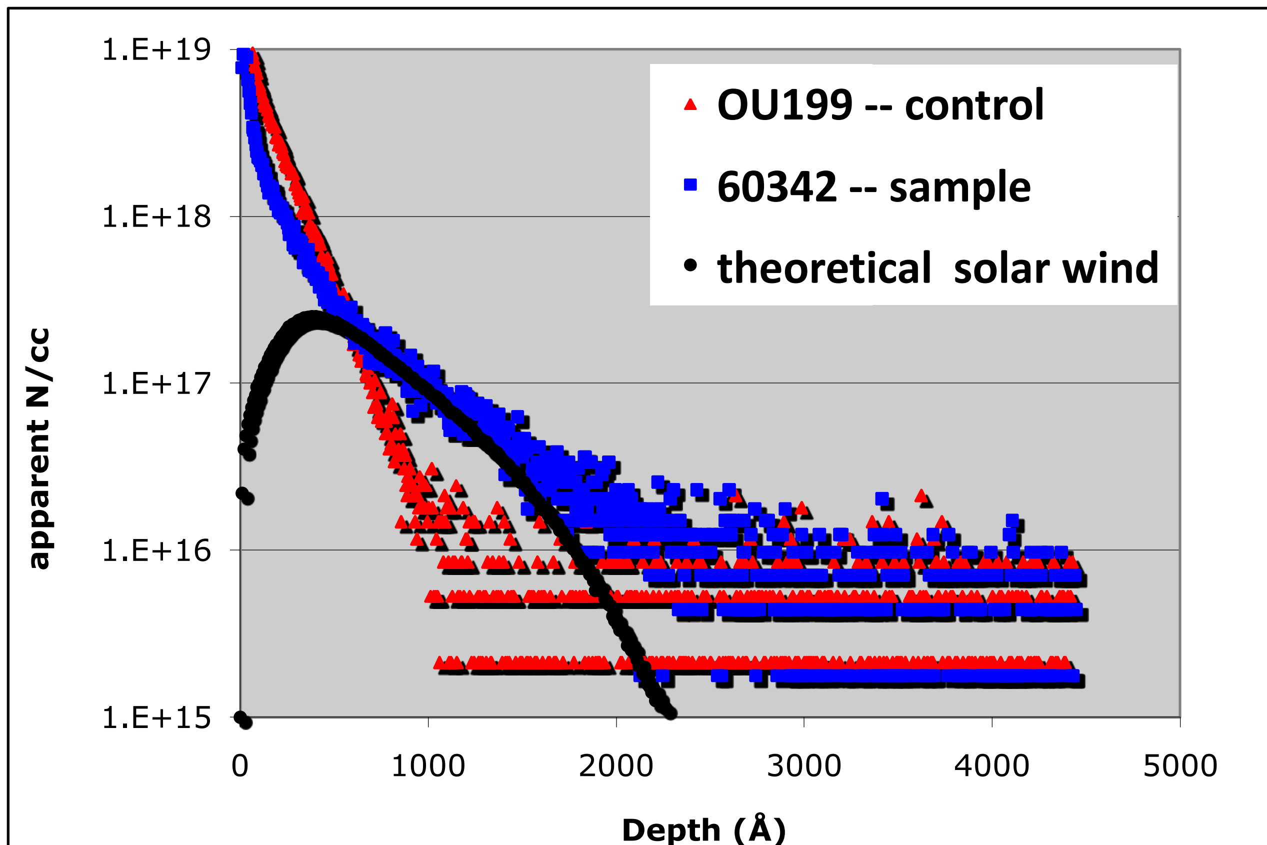
Analytical Conditions – 7f Geo

- **Primary beam: Cs+, 10 keV, ~9 nA**
- **Secondary HV: -5 or -10 keV**
- **MRP: ~6000 → $^{29}Si^{13}C$; $^{28}Si^{14}N$**
- **Field aperture: 50 µm**
- **Raster size: 100 micron**
- **Sputtering rate: ~ 5 Å/sec**
- **Overnight sputtering Si**

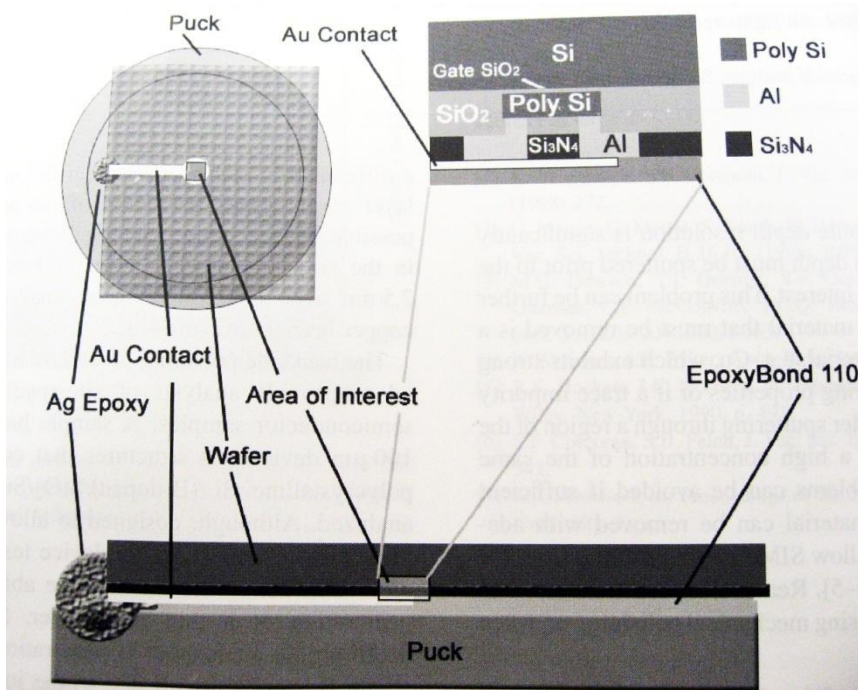
^{12}C Profiles in Control & 60342

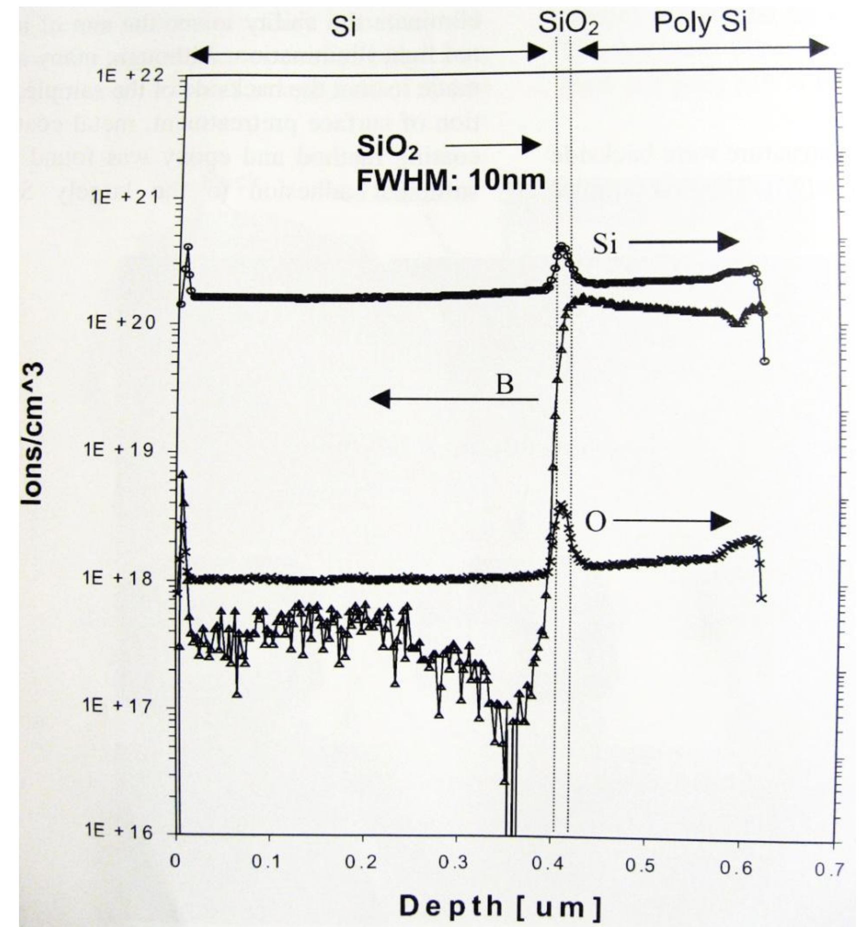


^{15}N Profiles in Control & 60342



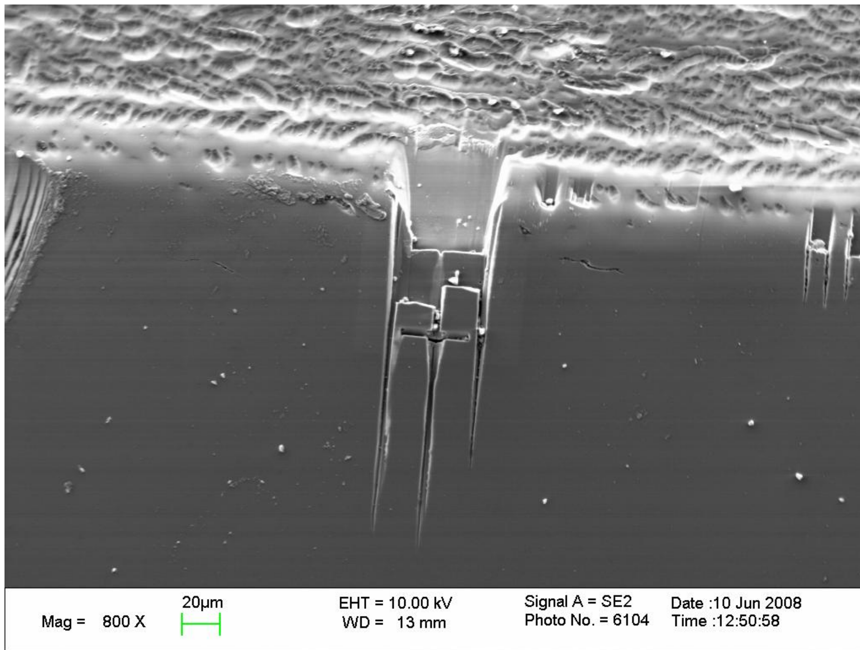
Backside Profiling – Solution for Surface Contamination?

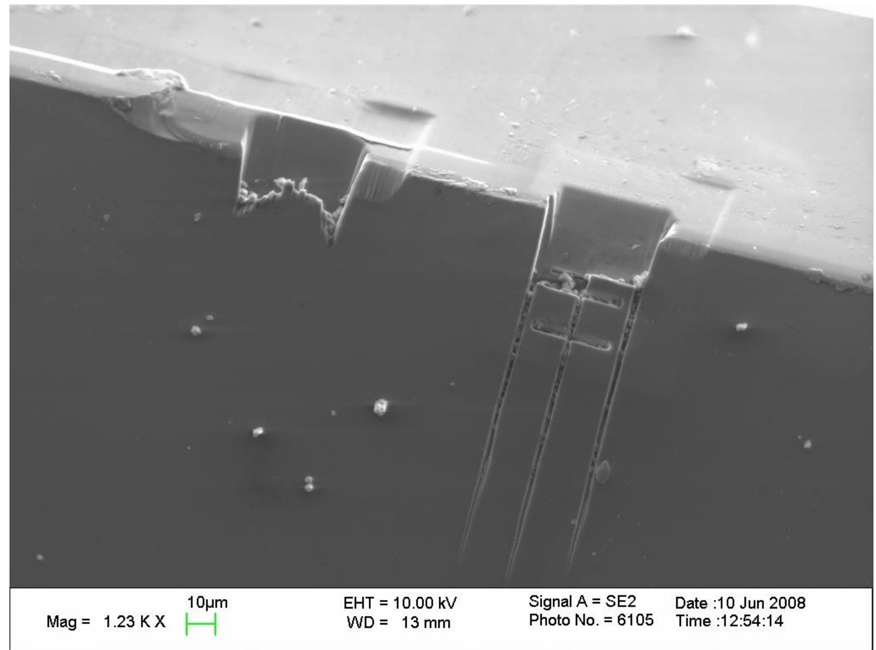




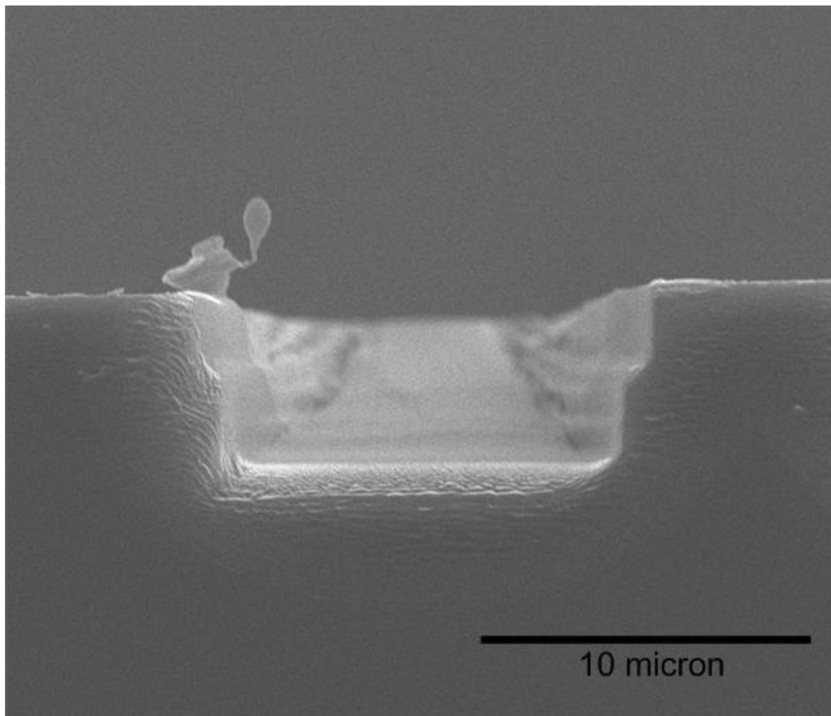
Gu et al. (2004)

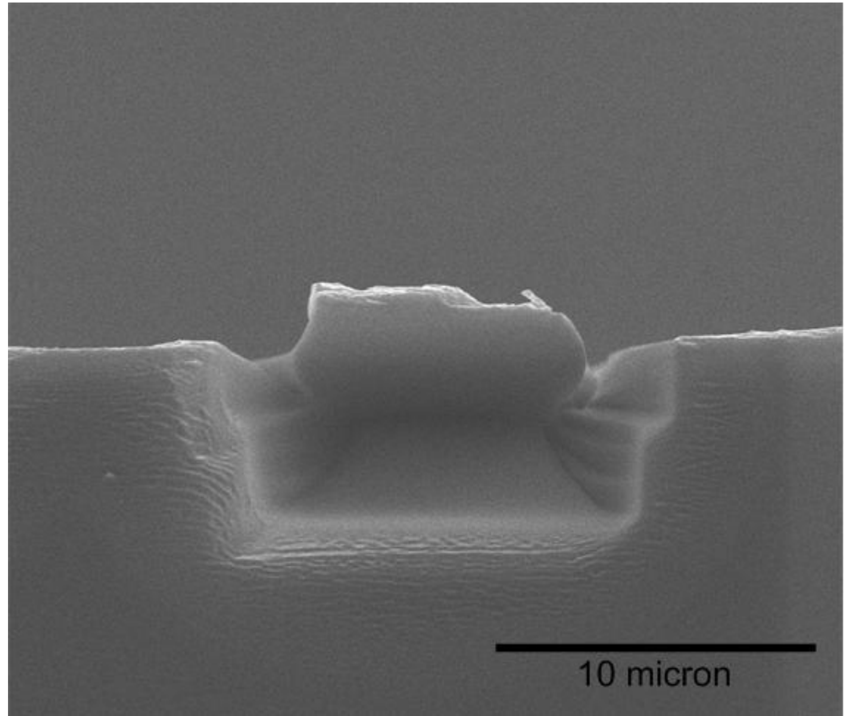
"Micro-scale" backside profiling? --preparing samples for NanoSIMS with FIB

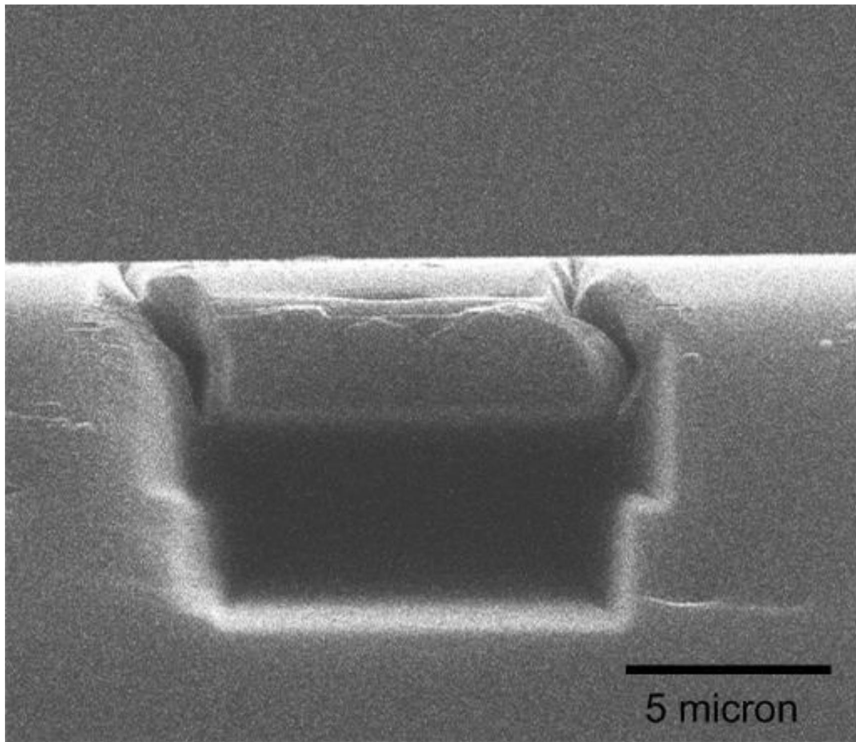


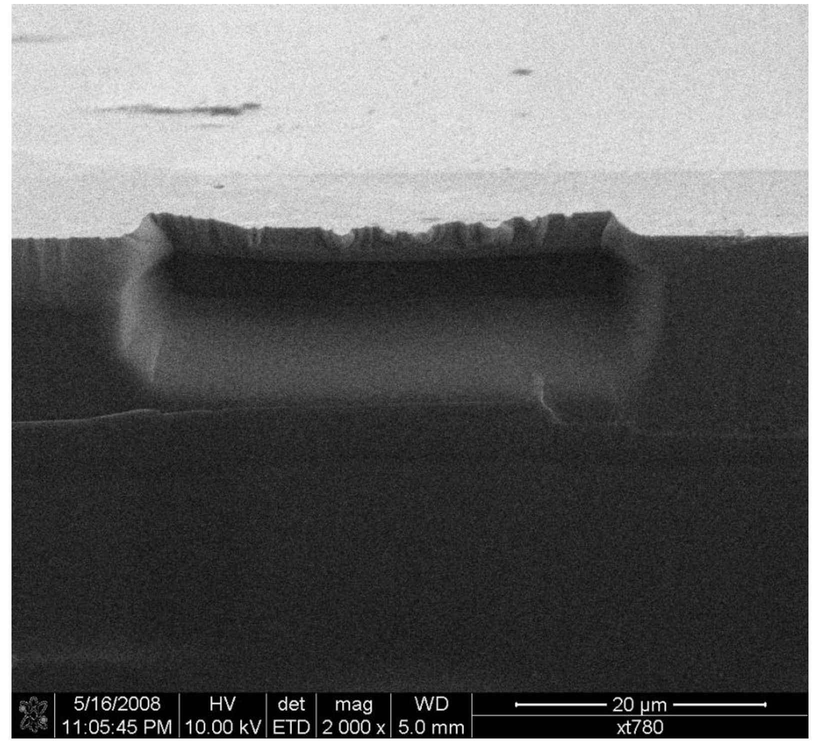


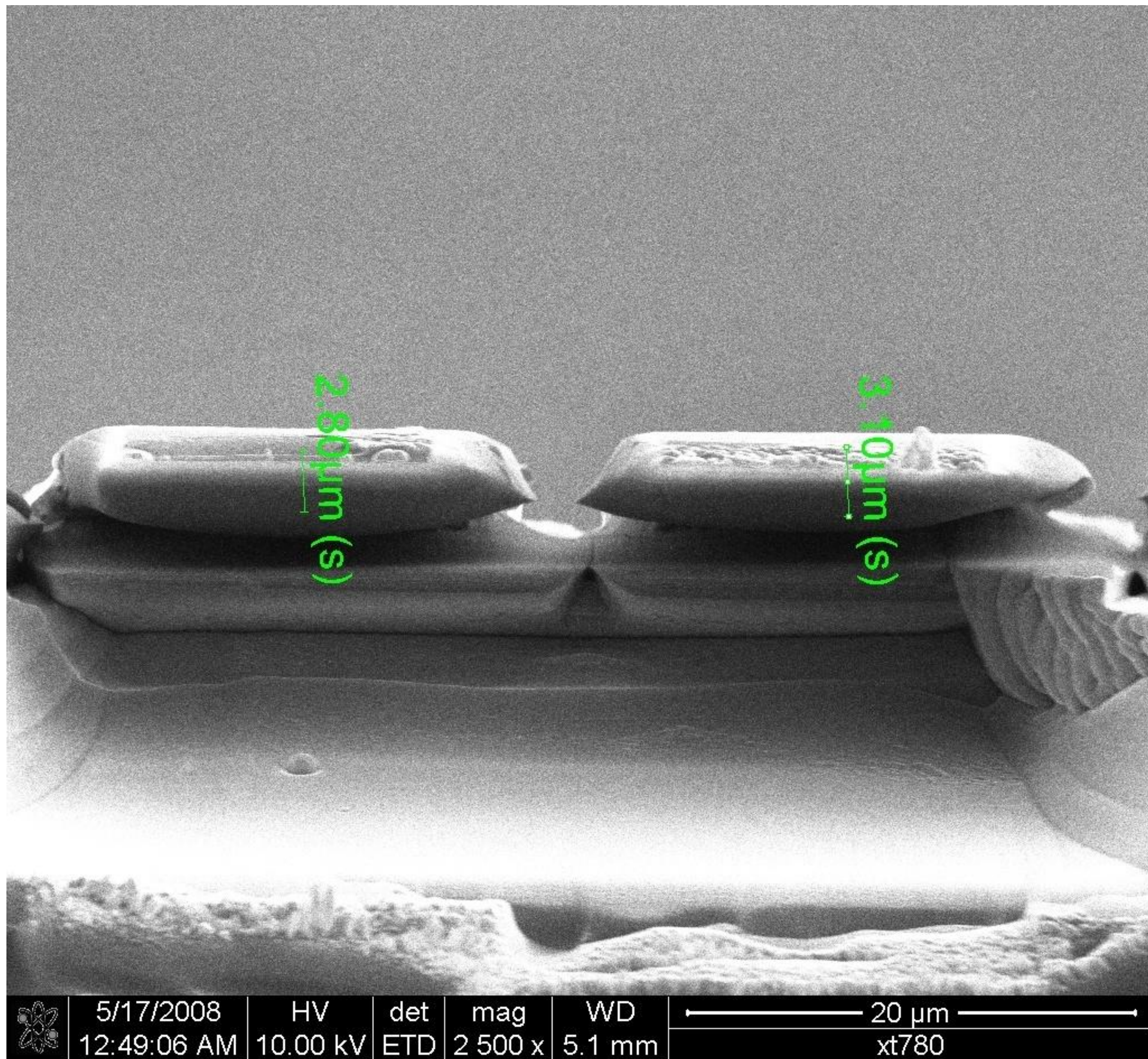
(SEM images from Caltech FIB)


10 micron


10 micron


5 micron


5/16/2008
11:05:45 PM
HV
10.00 kV
det
ETD
mag
2 000 x
WD
5.0 mm
20 µm
xt780



2.80μm (s)
3.10μm (s)
5/17/2008
12:49:06 AM
HV
10.00 kV
det
ETD
mag
2 500 x
WD
5.1 mm
20 μm
xt780

Mag = 300 X

100µm

EHT = 8.00 kV
WD = 5 mm

Signal A = SE2
Photo No. = 5783

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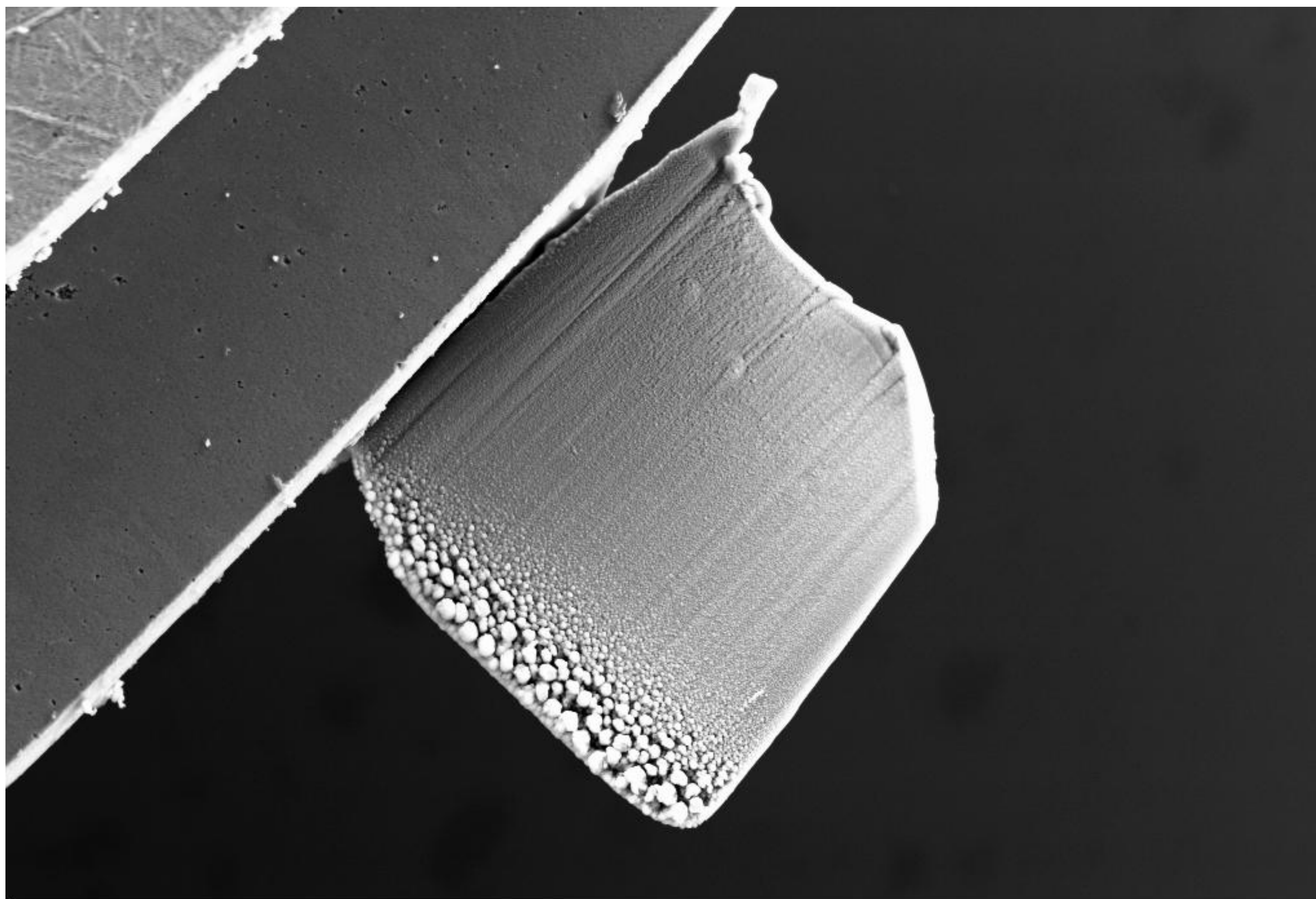
Time :9:37:48


2µm
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EHT = 8.00 kV
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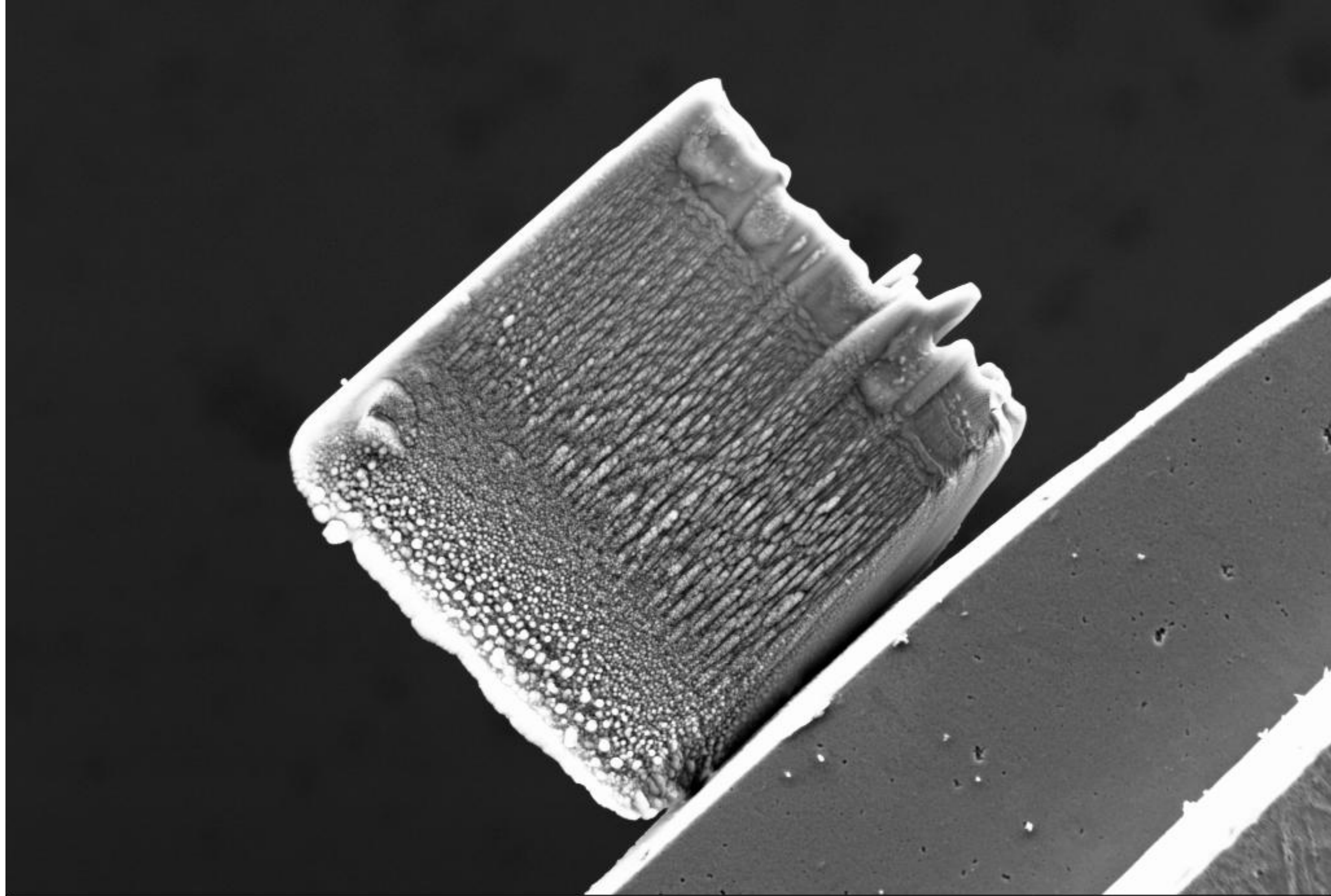
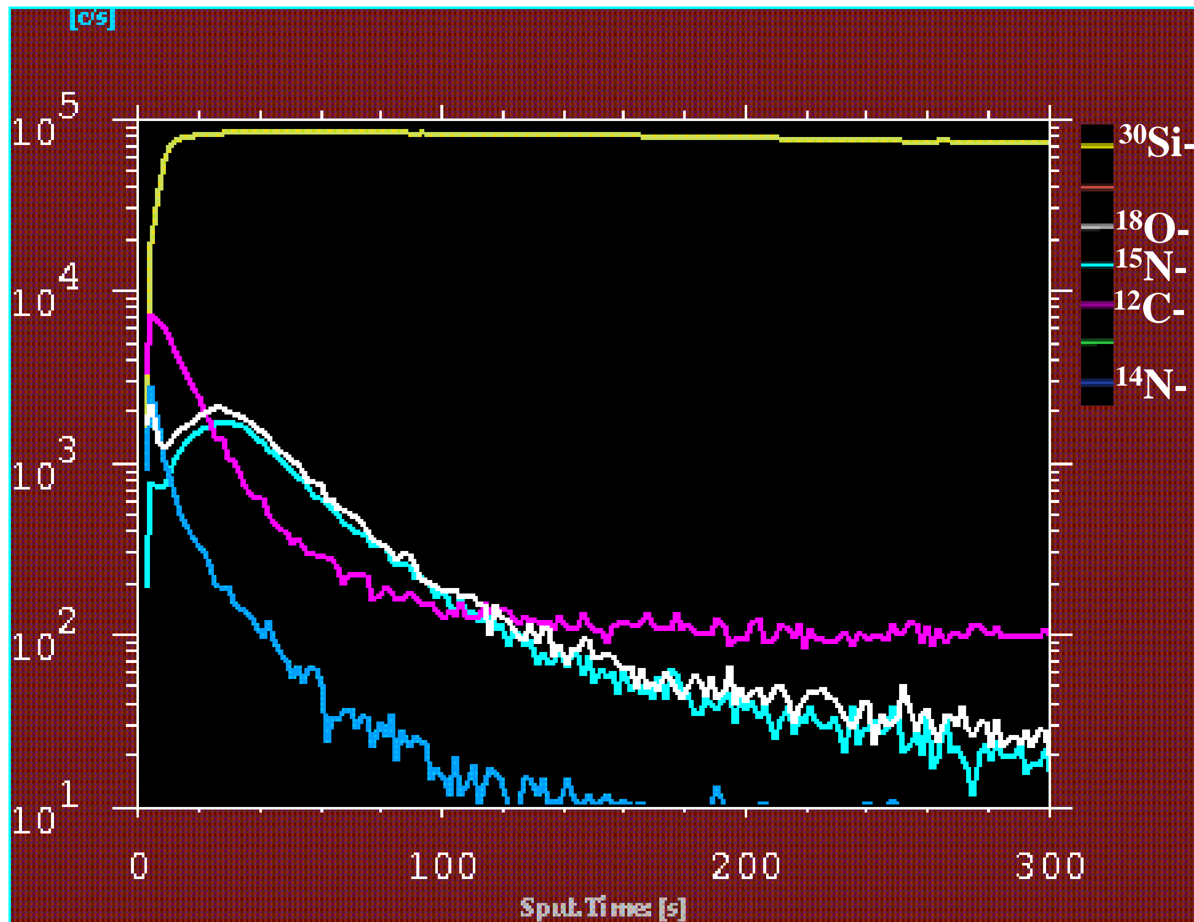


2µm
Mag = 9.00 K X
EHT = 8.00 kV
WD = 5 mm
Signal A = SE2
Photo No. = 5781
Date :4 Jun 2008
Time :9:32:32

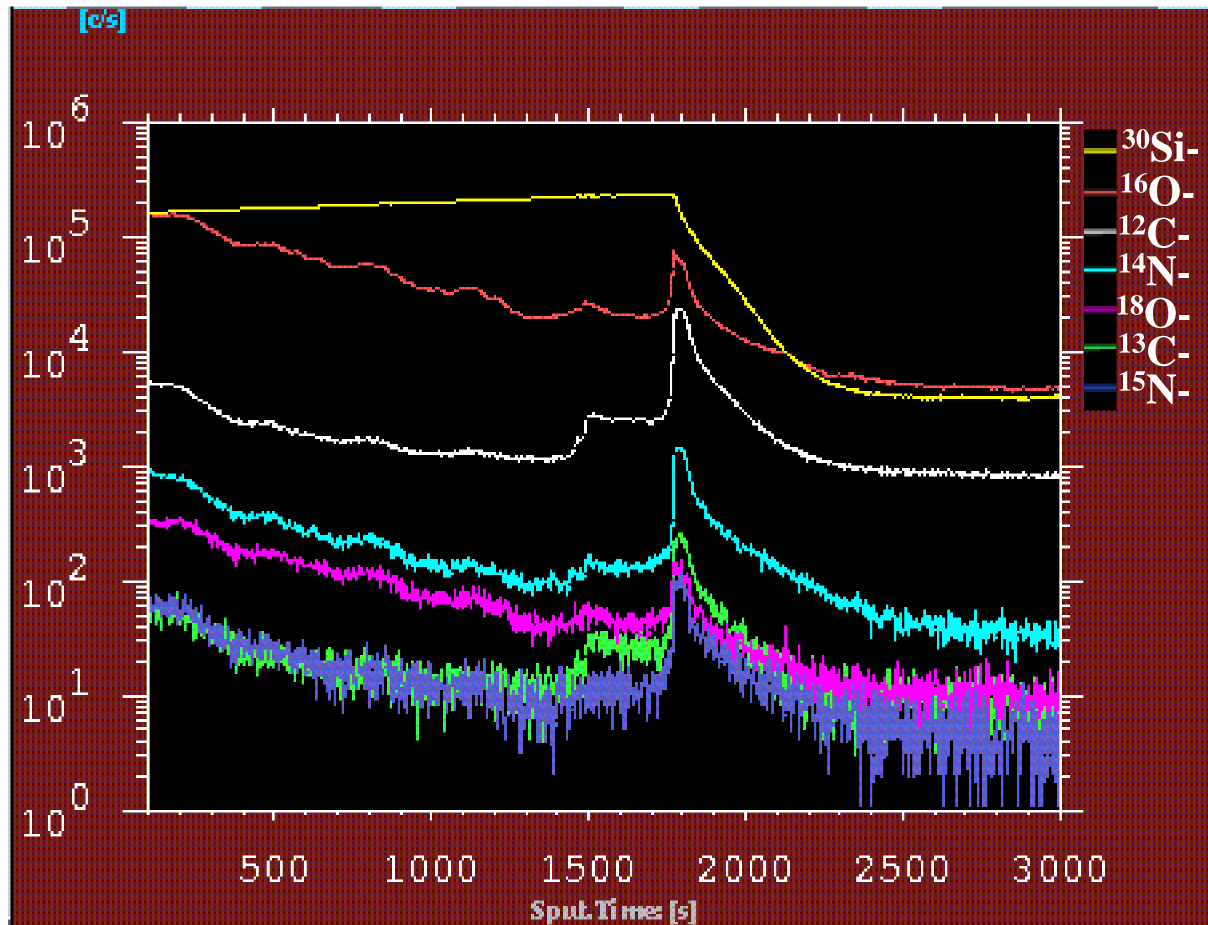
Analytical Conditions – NanoSIMS 50L

- **7 detectors set up for masses: $^{12}C^-$, $^{13}C^-$, $^{16}O^-$, $^{18}O^-$, $^{28}Si^-$, $^{14}N^{28}Si^-$, and $^{15}N^{28}Si^-$**
- **Cs+ beam current on samples (FCo): ~ 15 – 30 pA**
- **Raster size: 3x3 µm (2x2 µm gating)**
- **Sputtering rate: ~4 -- 8 Å/sec**

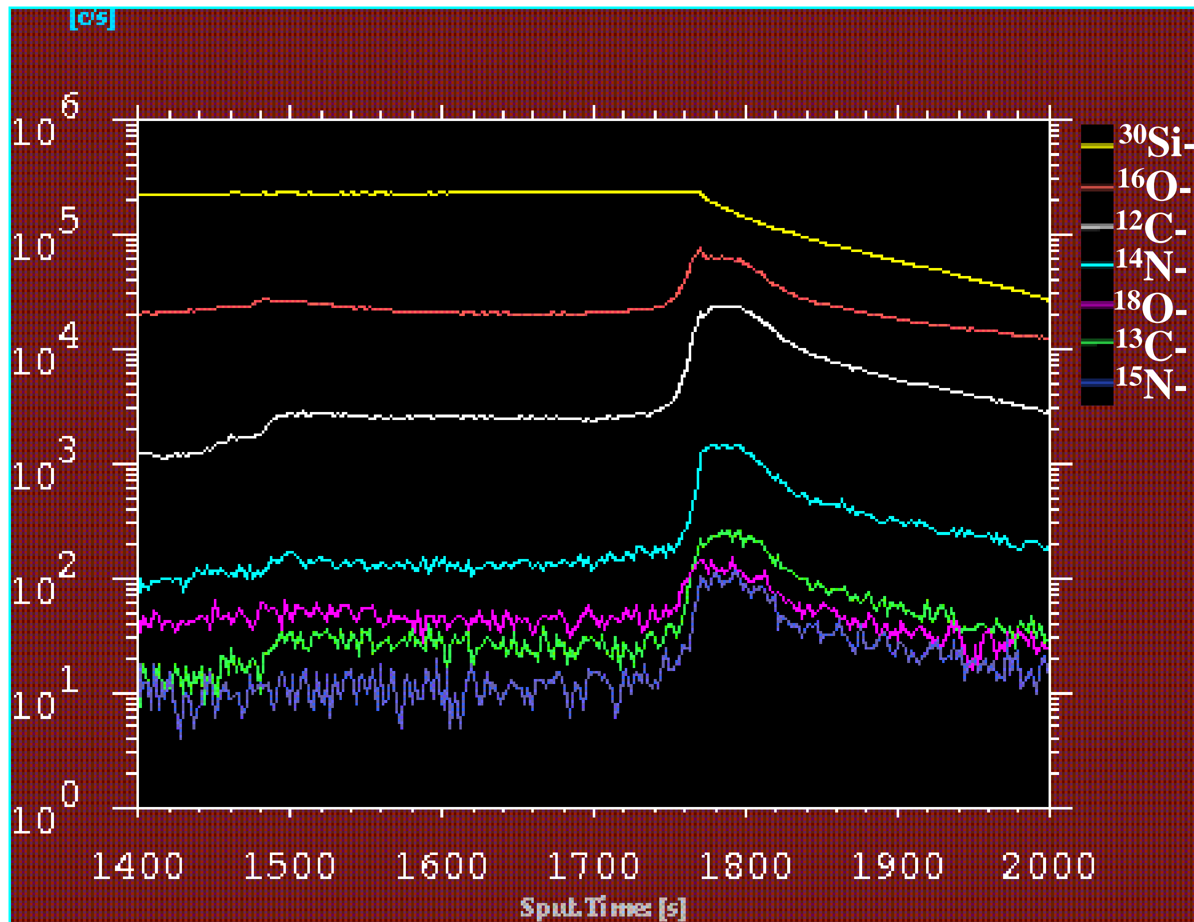
Profiles of an ^{15}N & ^{18}O Implant– HRL99, 9



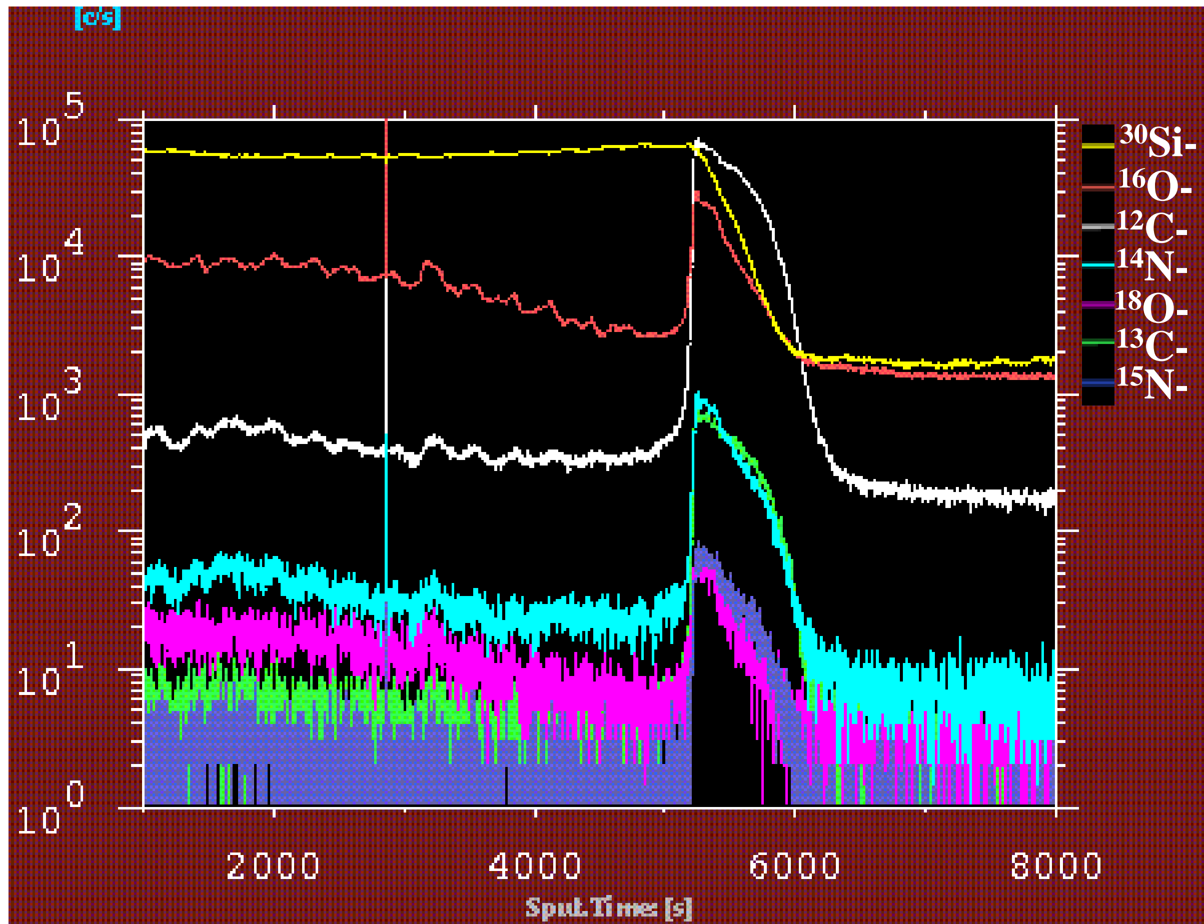
Spot-1 on the FIB Cut-out of ^{13}C Implant



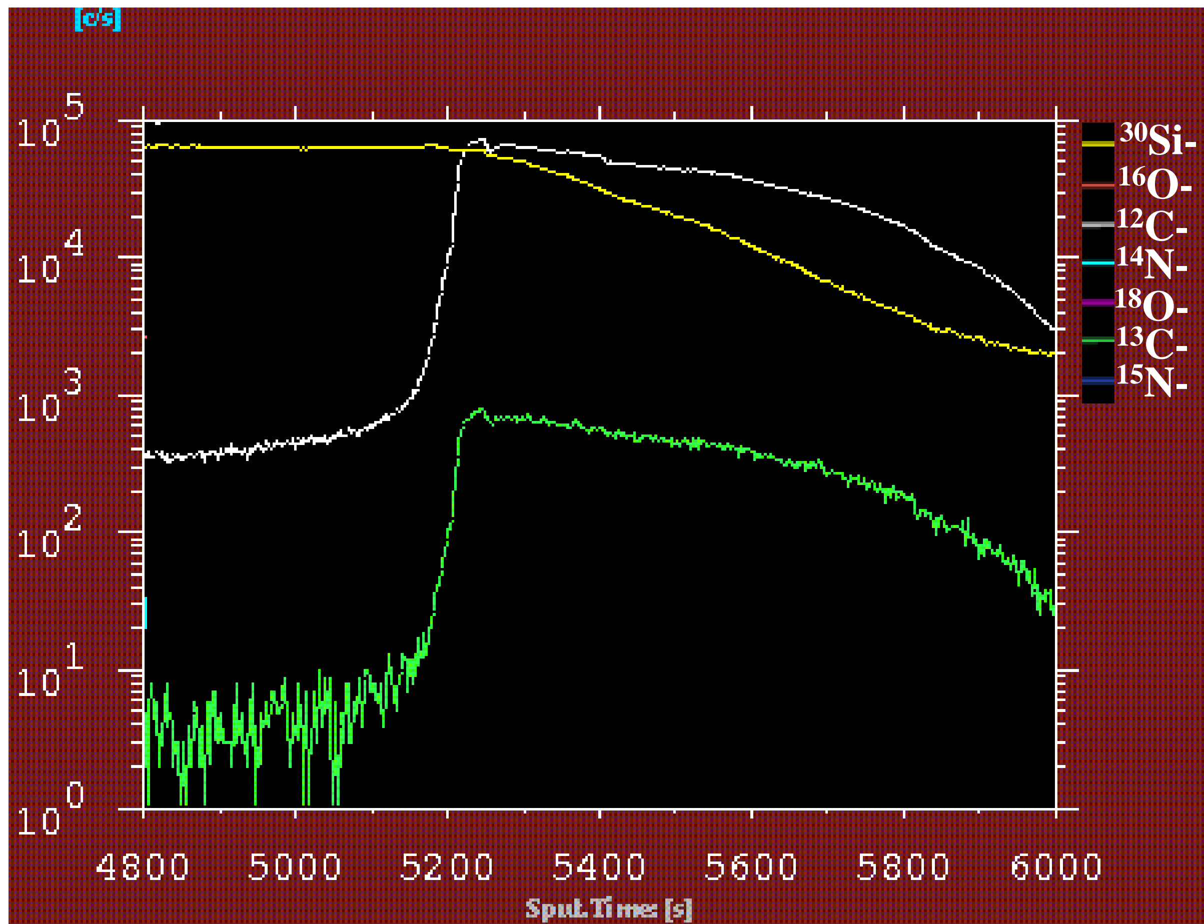
Spot-1 on the FIB Cut-out of ^{13}C Implant



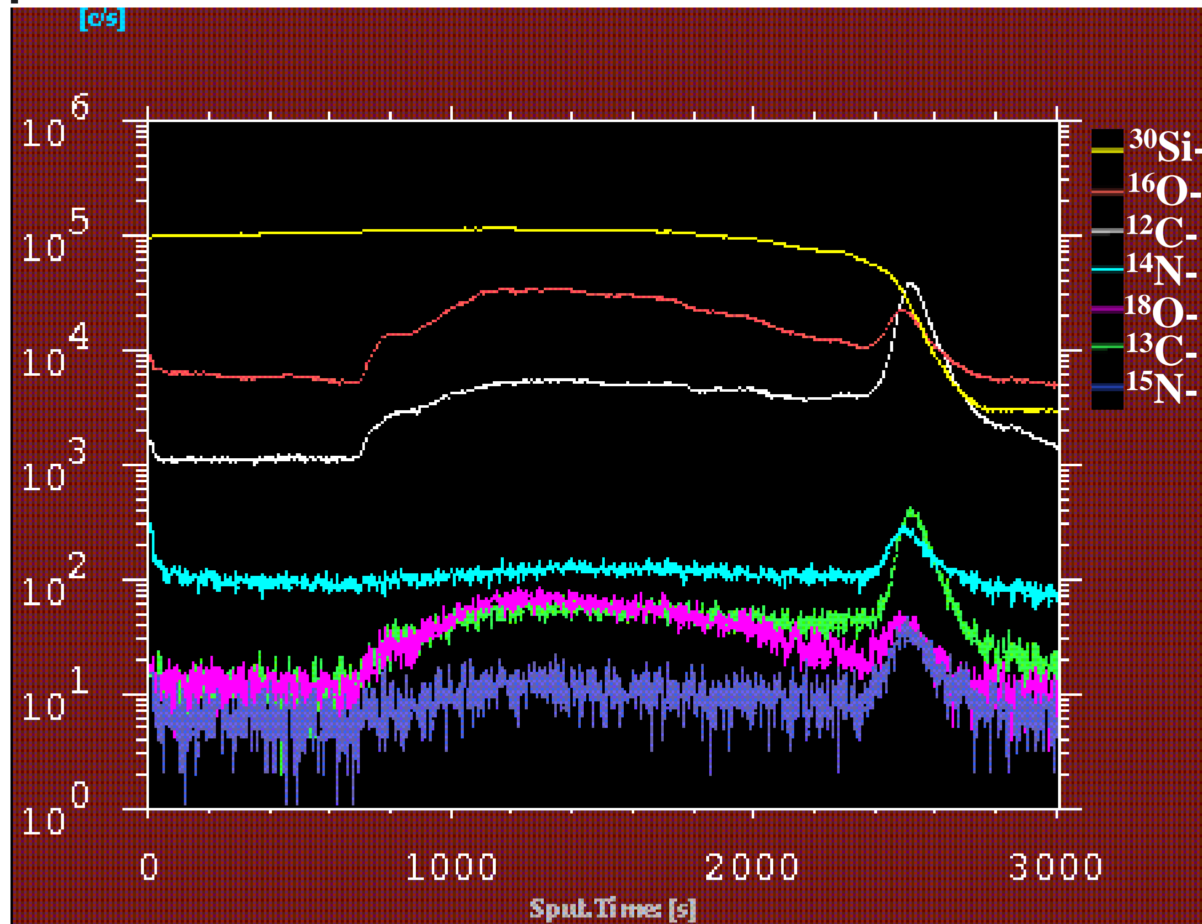
Spot-4 on the FIB Cut-out of ^{13}C Implant



Spot-4 on the FIB Cut-out of ^{13}C Implant

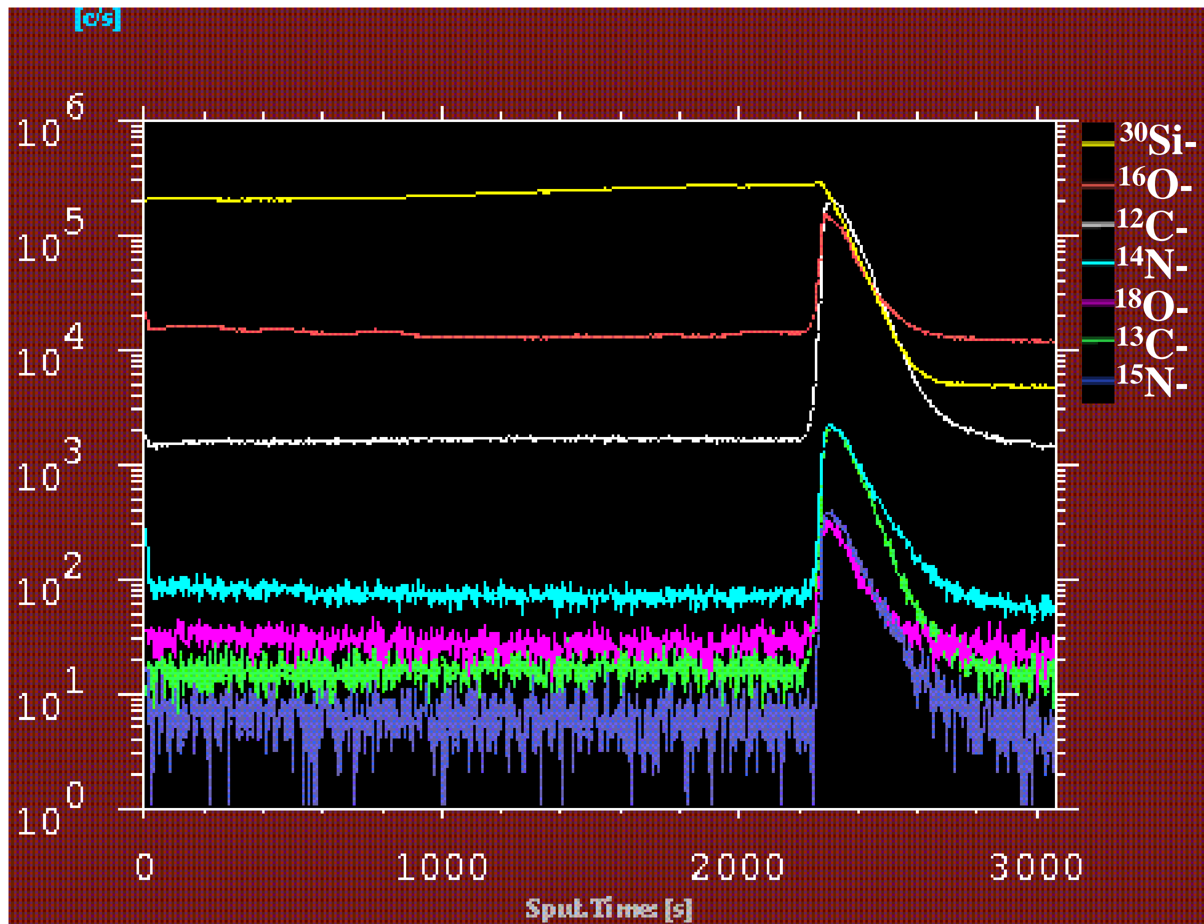


Spot-1 on the FIB Cut-out of Flight Sample 60342

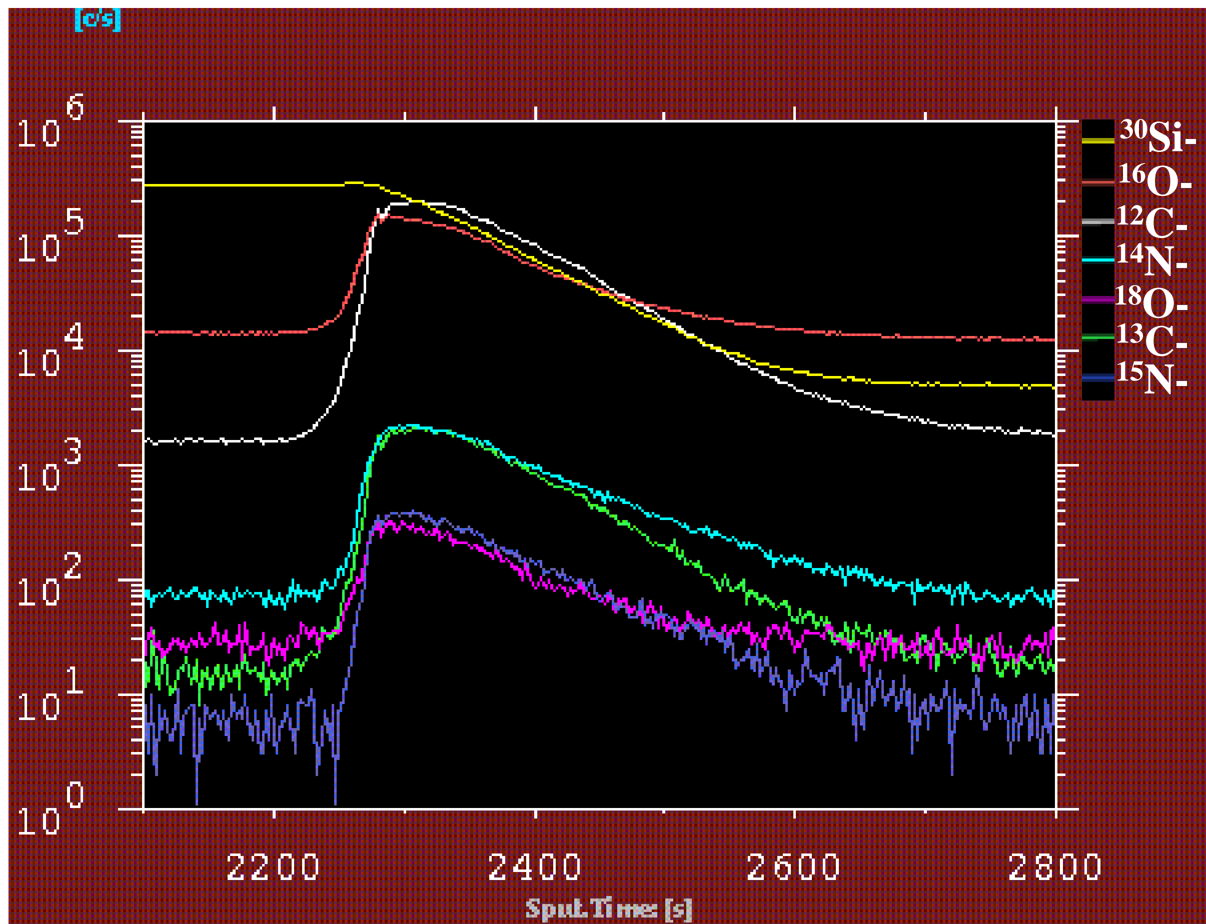


contamination?

Spot-2 on the FIB Cut-out of Flight Sample 60342

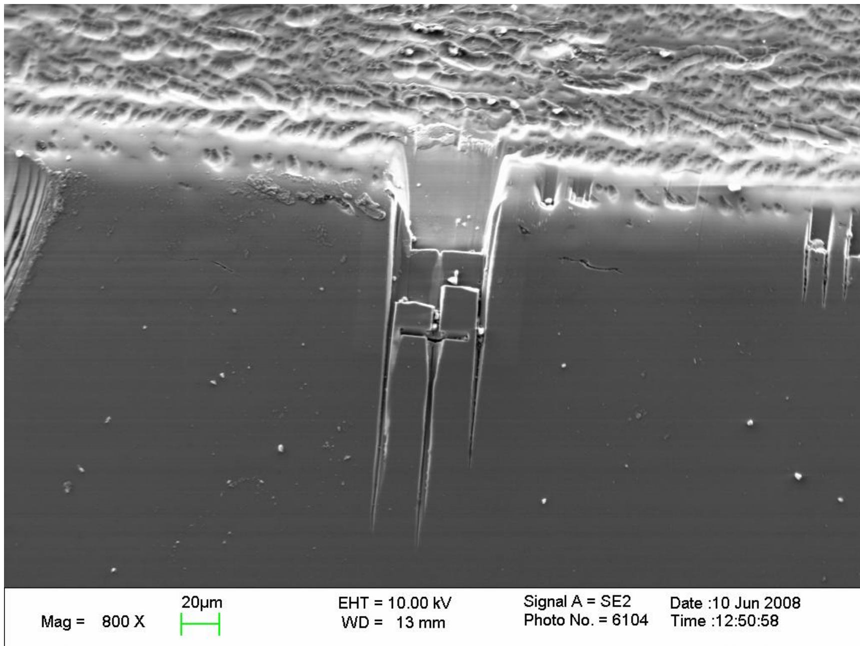


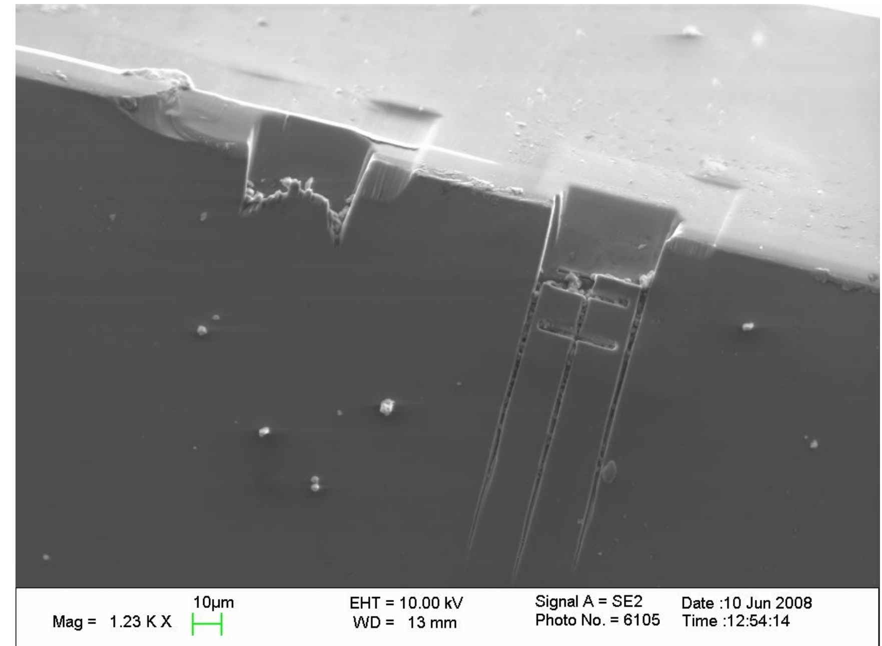
Spot-2 on the FIB Cut-out of Flight Sample 60342



Possible Causes for No Implant Profiles

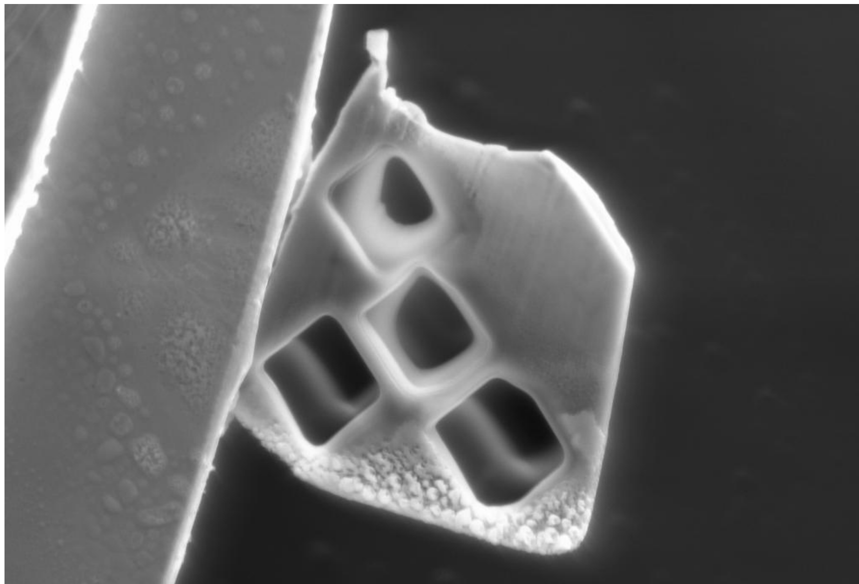
- **FIB "grazes" away the top layer of the ^{13}C implant**
- **No ^{13}C implant along the edge being cut out.**

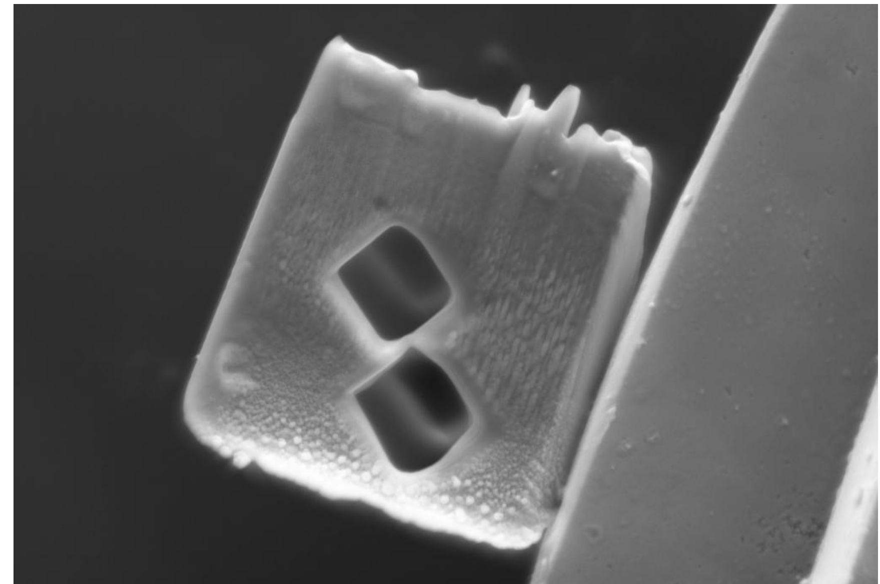




More Possible Causes for No Implant Profiles

- **Backsides of the FIB cut-outs are not parallel to the sample surfaces**
- **FIB cut-outs are not mounted parallel to the substrate surface.**





- **Low "asymptotic” background can be achieved in SIMS instruments for C and N. However, an apparent surface contamination component makes SIMS analysis of C and N fluences in Genesis samples extremely difficult, despite serious attempts to clean the samples.**

- **Our best profiling attempt to date indicate the presence of solar wind C and N in Genesis samples, though no quantification can be made.**

- **Backside profiling of Genesis samples with combined FIB and NanoSIMS techniques could provide a new approach for measuring C and N fluences of solar wind.**