DESCRIPTION:	Sub-surface structured diamond (Patrick Salter, Oxford)
AIM:	Imaging and C EELS mapping
SAMPLE ID:	FIB section labelled July 2015/P Salter Oxford
COMPOSITION:	Diamond; expect amorphised sub-surface channel
TEM:	13 July 2015
DOCUMENT:	Rev. 1

SUMMARY

1. An SEM image showing the location of this first cross-section is presented on page 3, with a copy of the optical image pasted below to aid navigation. The red annotation in the optical image indicates the approximate material left in the cross-section after final polishing. The section was taken through the right-most line of the set. We understand that this is not one of the lines that are required – it was intended as a quick trial run that ultimately took much longer than expected!
2. Low mag TEM images of the cross-section are presented on page 4. The section is ~11 µm wide × 12 µm deep. The majority of the material appears to be single crystalline; contrast is dominated by interference effects due to variations in sample thickness and bend angle. Many of the thickness and bend contours radiate from a central region, where the damage is located – note that there is no obvious single damage region. The lower image on page 4 has a slightly different optical configuration that minimises contrast from extraneous effects. The dashed red line encircles (judged by eye) the main damage region, which is between 1 and 6 µm beneath the surface and ~1.5 µm wide.
3. Higher mag., BF & DF TEM images of the most damaged region are presented on page 5. The tangled mess of contrast fringes is difficult to interpret but consistent with significant damage. The cross-section is actually too thick for HRTEM images with lattice resolution, so STEM imaging was tried instead.
4. A number of BF and HAADF STEM images of the same region are presented on page 6; contrast here is dominated by strain and thickness variations and the images are easier to interpret because the thickness and bend fringes seen above are now absent. Note that the sample is oriented with the surface lying to the bottom left (visible in the first image pair). The main features are consistent with dislocations. The expected central, large amorphised region is not present.
5. A typical EELS data set and 'quick and dirty' analysis is presented on page 7, using data collected from the region labelled as 'data 5' on page 6 . The top DF STEM image shows the area (labelled 'spectrum image', in green) that EELS data were acquired. The spectra are typical of (in blue) a damaged area and (in red) the main diamond. Similar to previous studies (eg. Diamond Rel. Mat. **19** (2010) 818), there is a weak peak (indicated by arrow) in the blue spectrum that is consistent with amorphised carbon and is absent from the red, diamond spectrum. A map showing where this pre-edge feature is strongest is labelled 'pre-edge' and shows a clear correlation between the location of amorphised regions and the darkest regions in the DF image at top of the page. Note that the weaker vertical stripe in the DF image is not picked out in the pre-edge plot, suggesting that this vertical feature derives from dislocations.

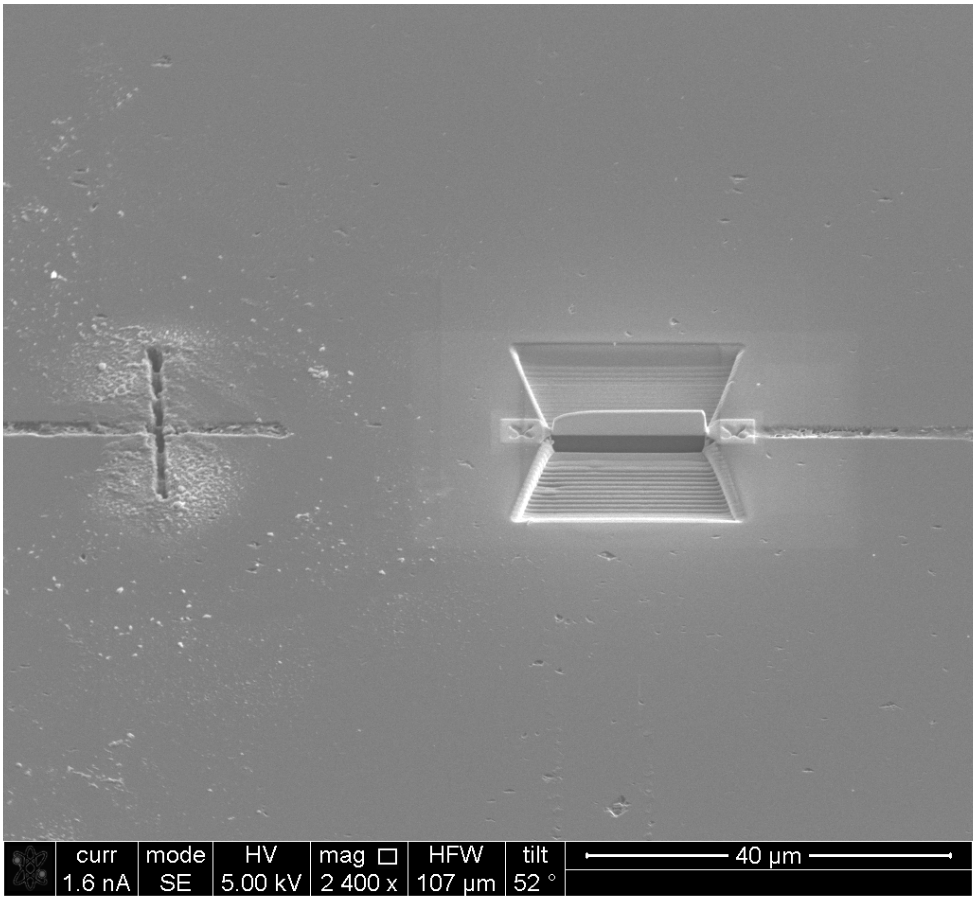
(cont).

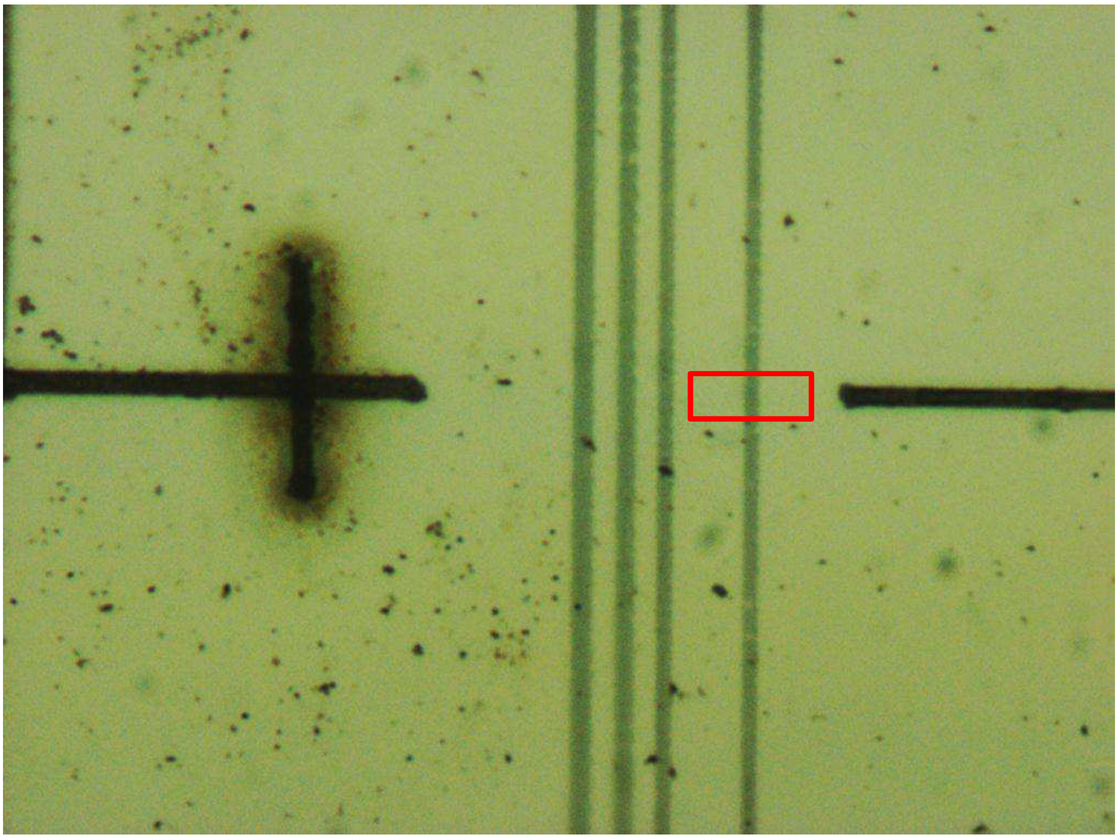
ACRONYMS

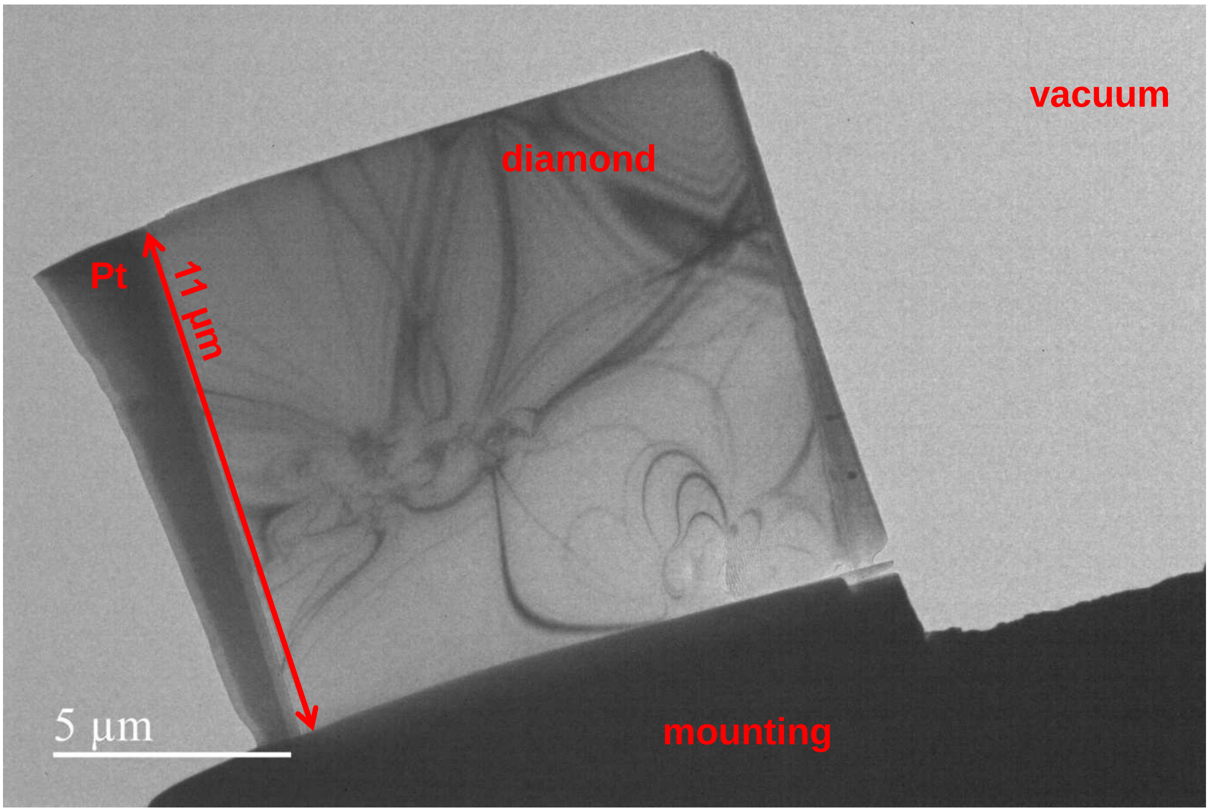
FIB	Focused ion beam
SEM	Scanning electron microscopy
TEM	Transmission electron microscopy
HRTEM	High resolution TEM
STEM	Scanning TEM
BF/DF	Bright field/ dark field
HAADF	High angle annular dark field (STEM)
EELS	Electron energy loss spectroscopy
EDX	Energy dispersive x-ray (analysis)
SAED	Selected area electron diffraction

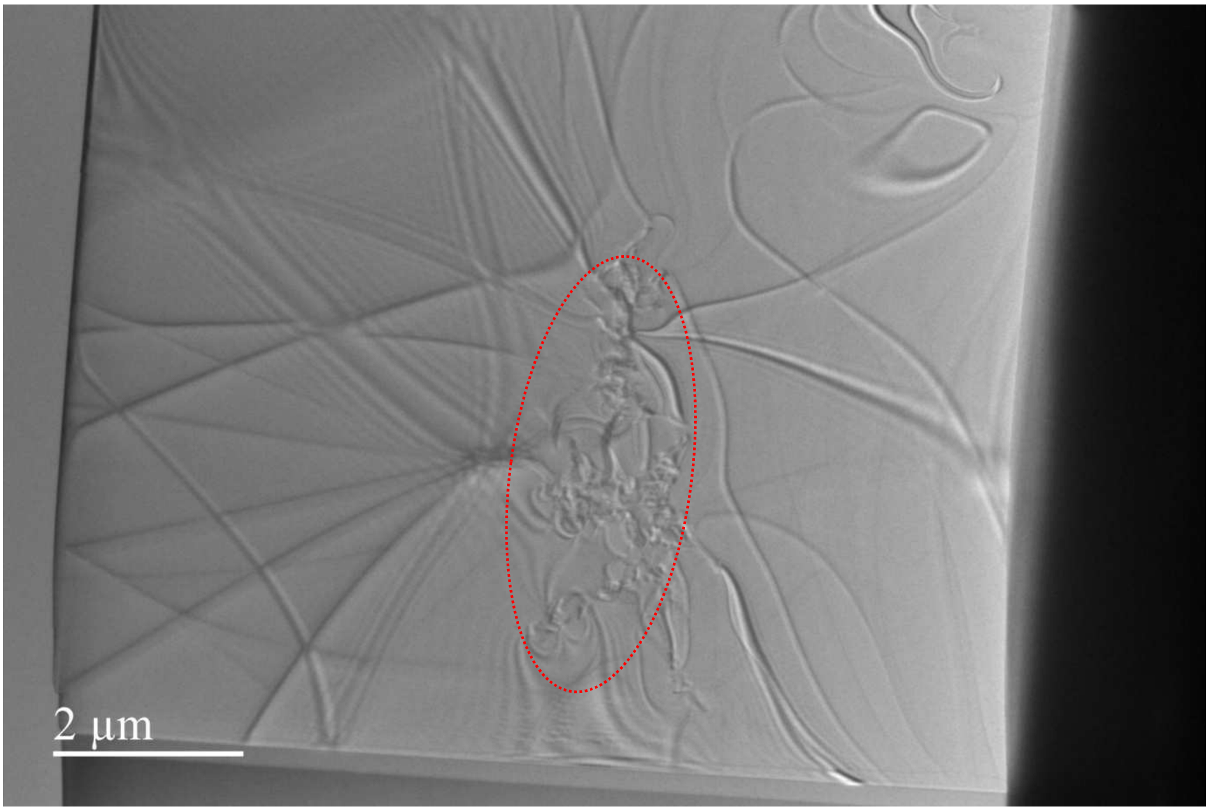
SUMMARY (cont.)

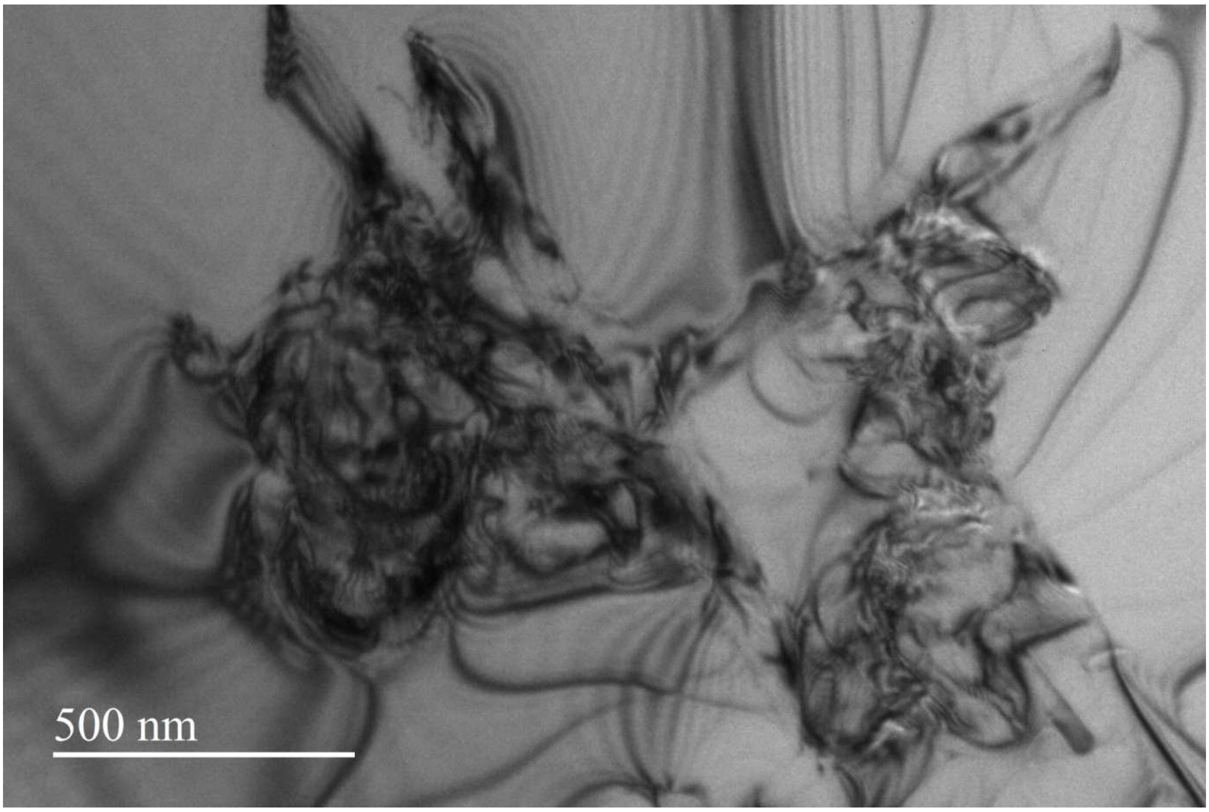
6. Two other EELS data sets are presented on pages 8 and 9, collected from the main defect region. Both data sets show the amorphised C to be contained within a number of small, oval-shaped patches that are ~150nm long. Not all of the features observable in DF imaging are consistent with amorphisation and rather appear to be consistent with strain fields established around defects such as dislocations – perhaps these defects relive strain induced by the amorphous patches.

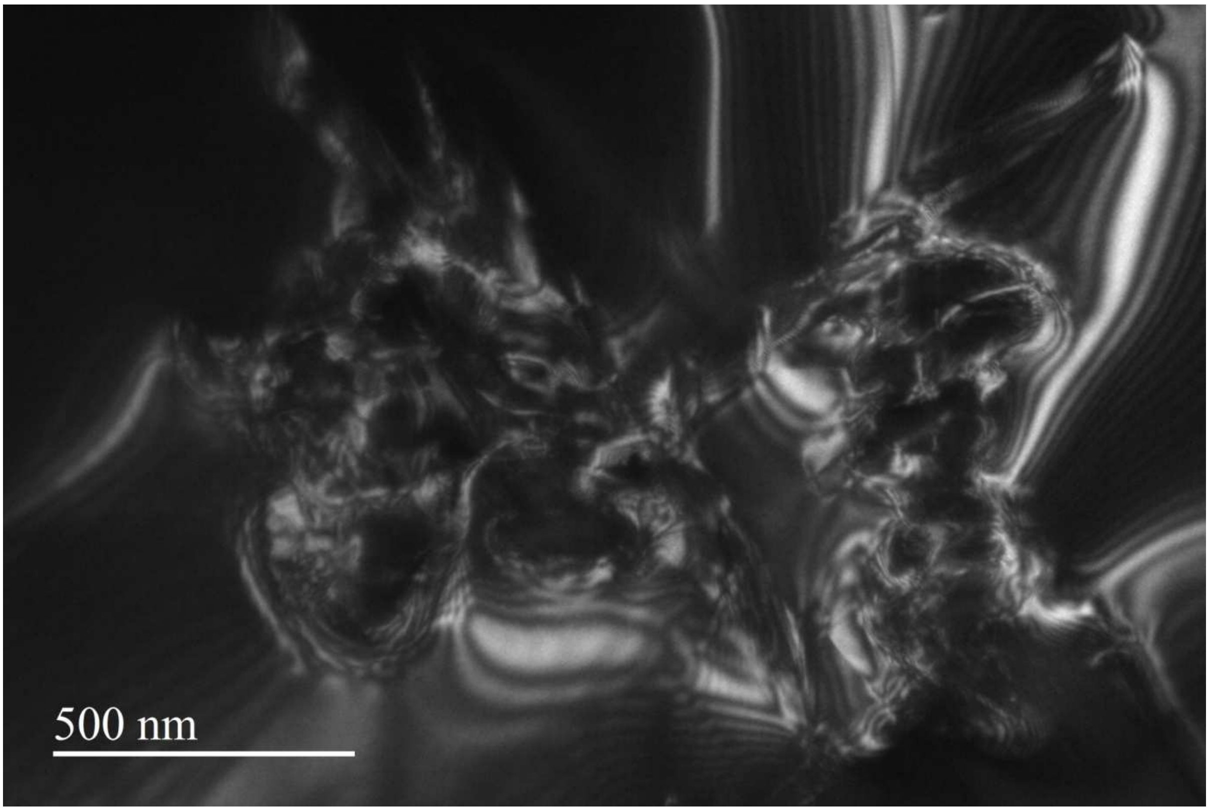

curr
1.6 nA
mode
SE
HV
5.00 kV
mag
2 400 x
HFW
107 µm
tilt
52 °
40 µm

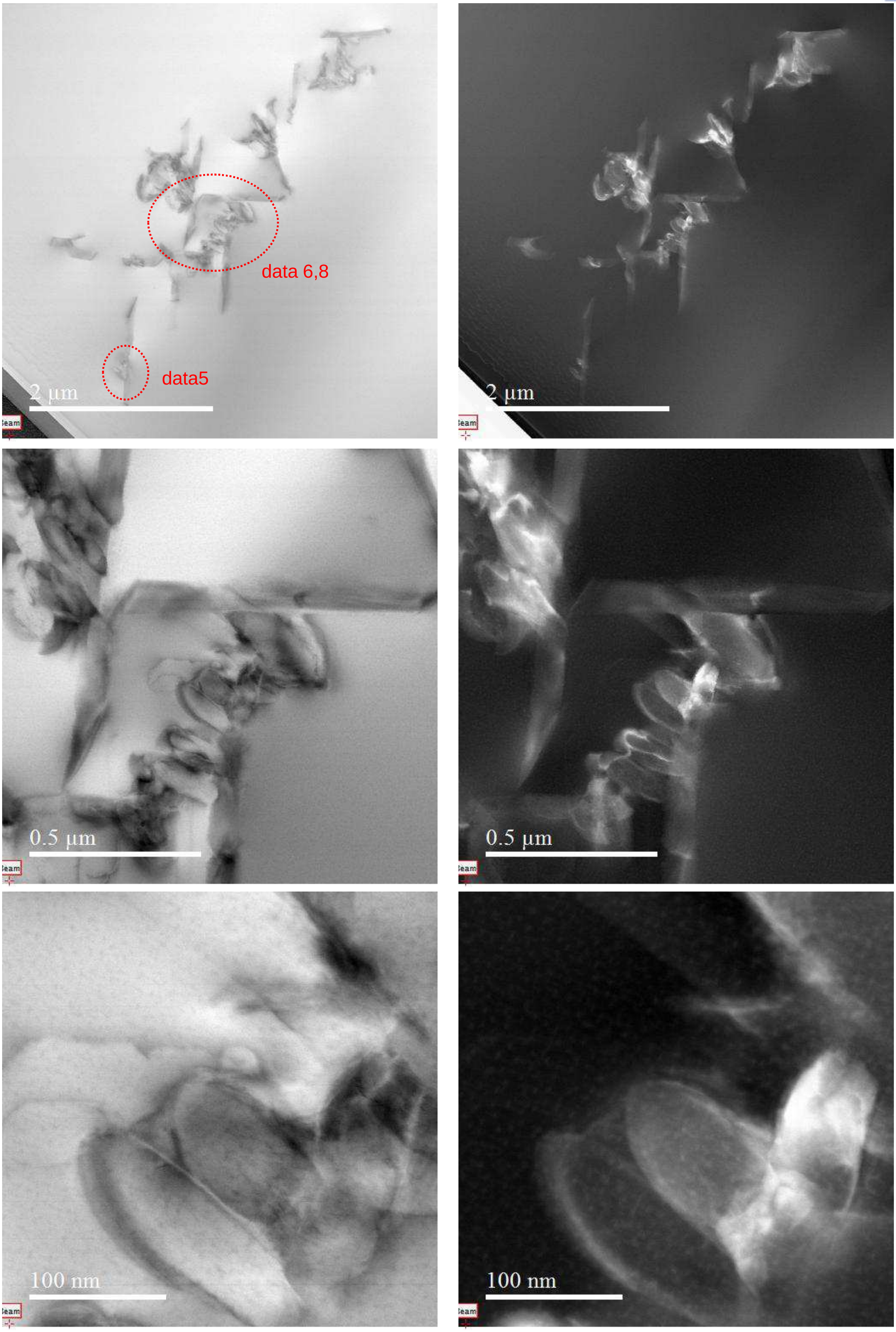



vacuum
diamond
Pt
11 µm
5 µm
mounting

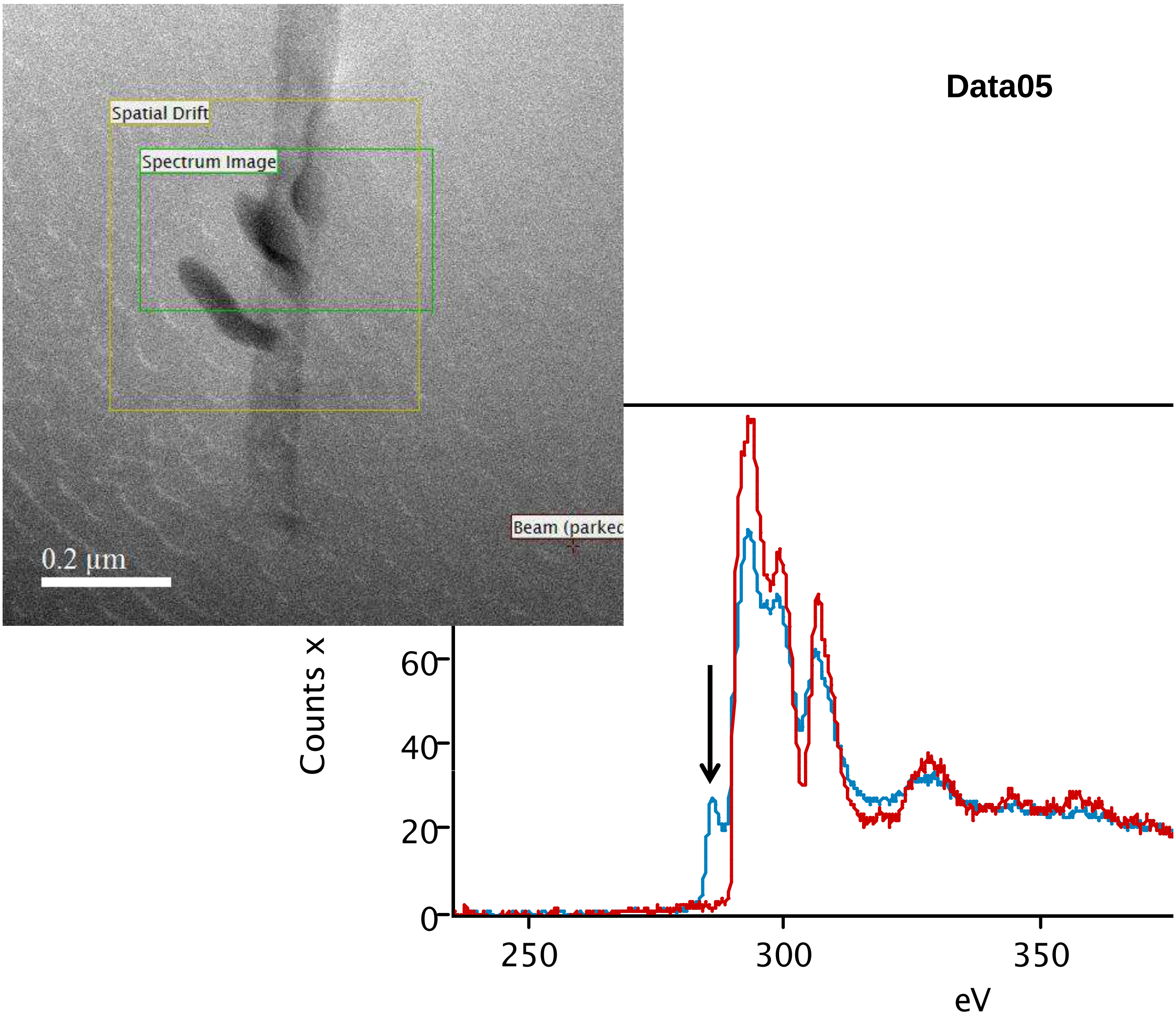

2 µm


500 nm

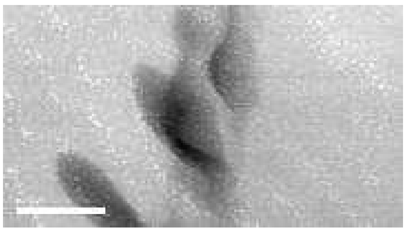

500 nm


data 6,8
data5
2 µm
2 µm
0.5 µm
0.5 µm
100 nm
100 nm

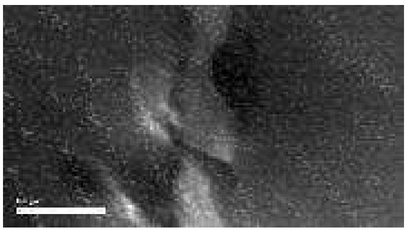
Data05



HAADF

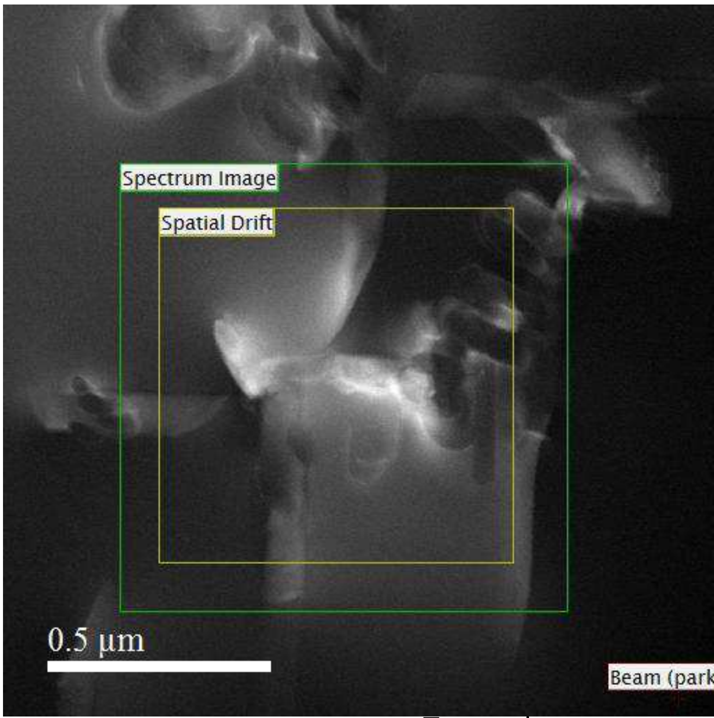


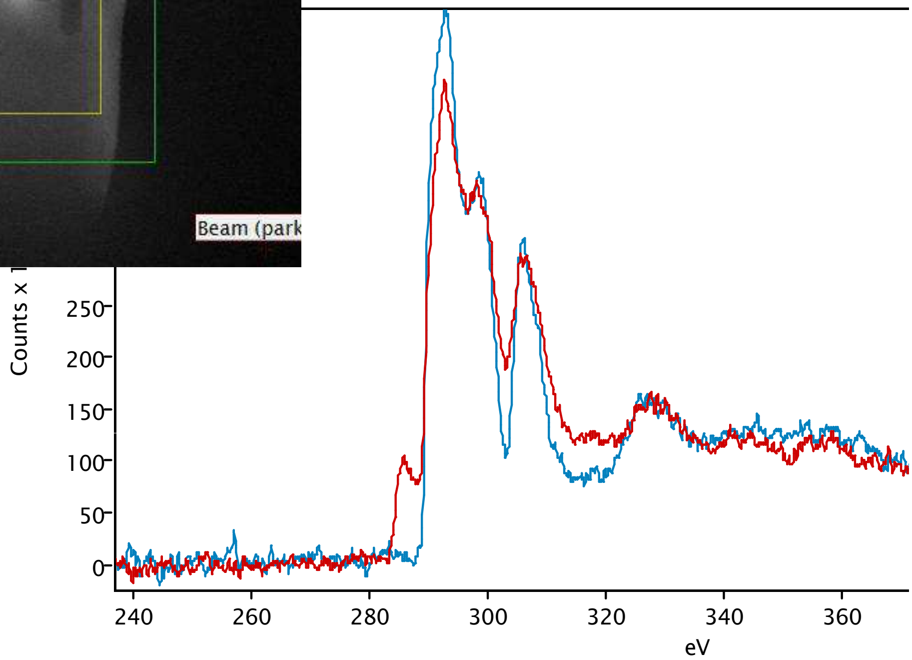
ADF



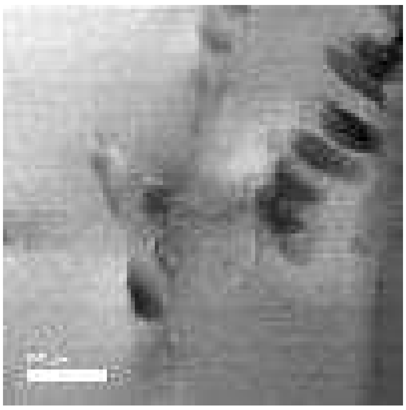
pre-edge

Data07

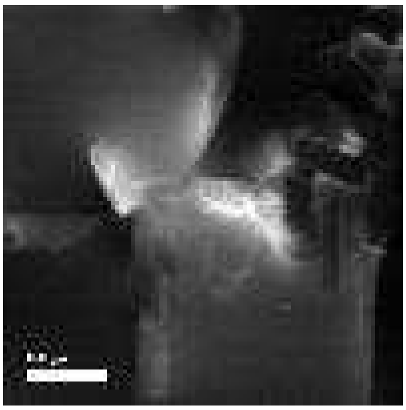




HAADF

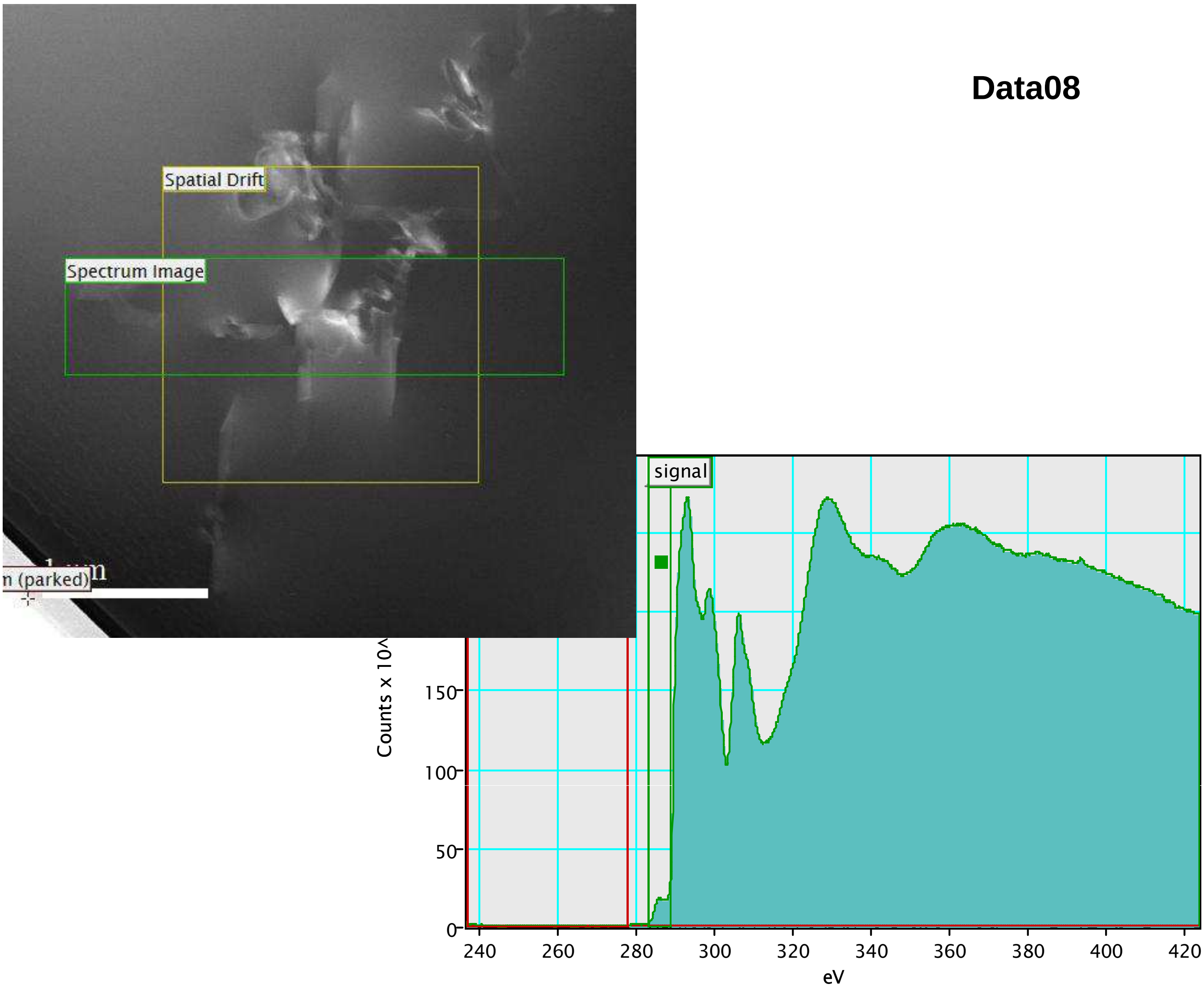


ADF

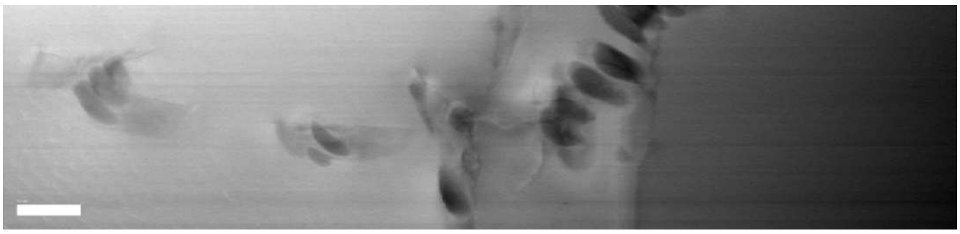


pre-edge

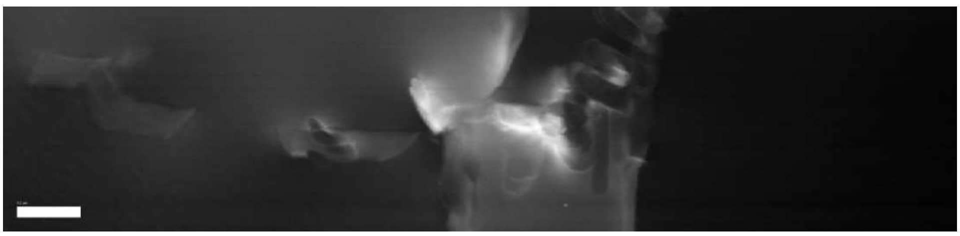
Data08



HAADF



ADF



pre-edge