

Coherent X-ray Diffraction Imaging with the XFEL

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Diamond Light Source

XFEL MID workshop

Grenoble

October 2009

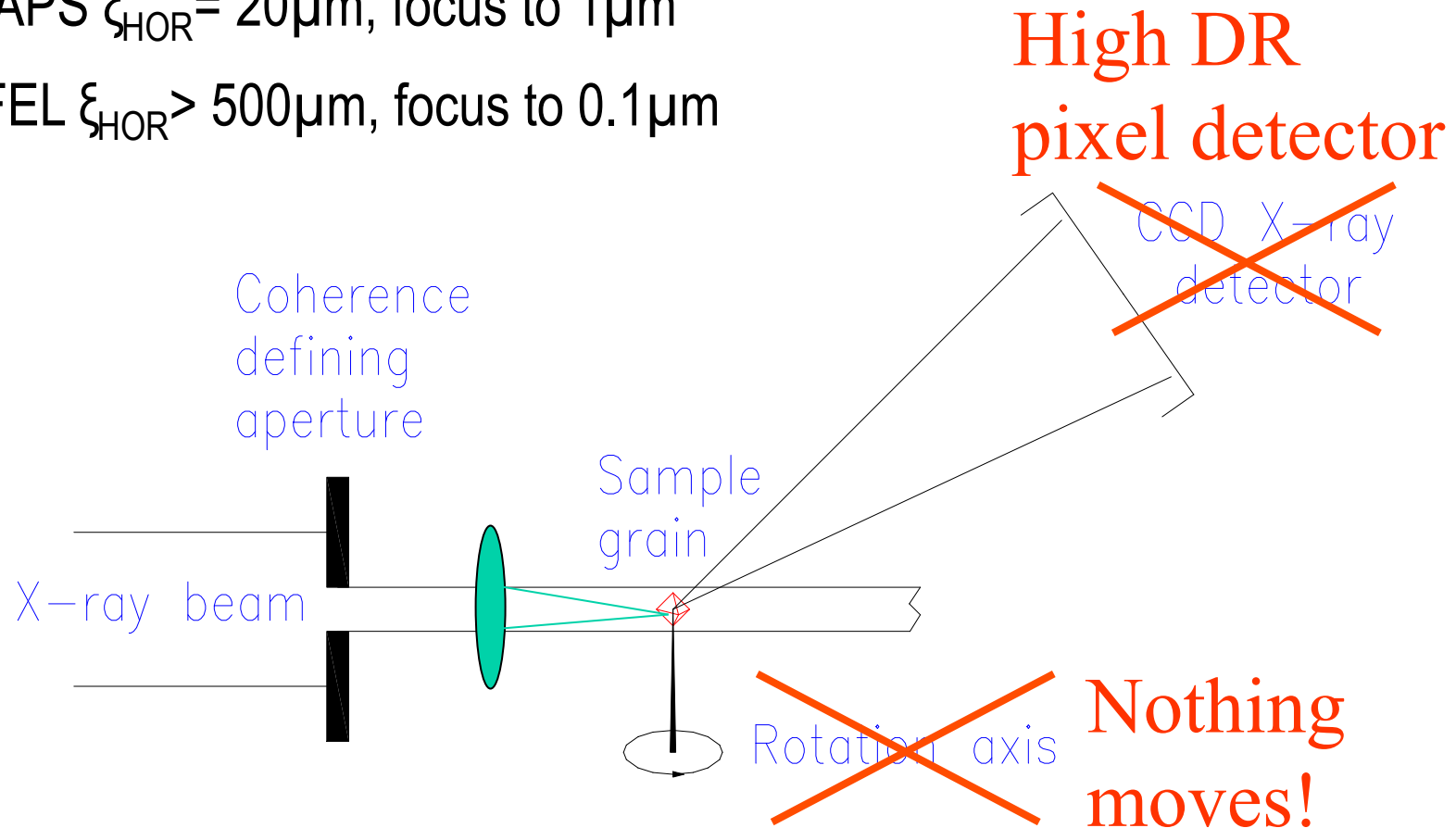
Outline

- Coherent X-ray Diffraction Imaging
- Small crystals
- Domain structures
- Fluctuations
- LCLS planning
- MID requirements

Coherent X-ray Diffraction Imaging

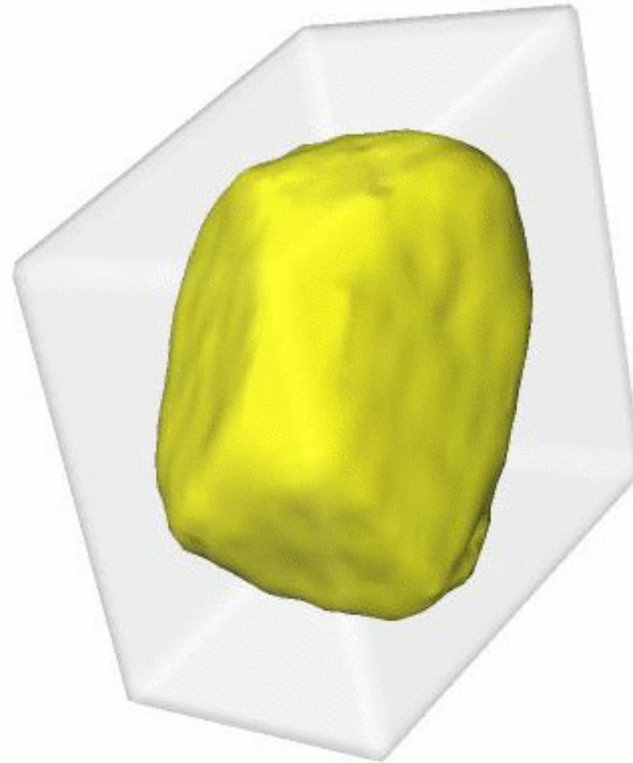
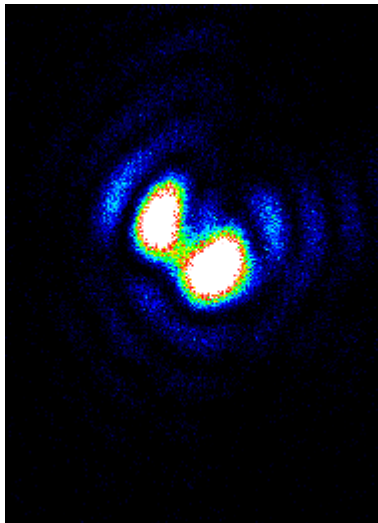
APS $\xi_{\text{HOR}} = 20\mu\text{m}$, focus to $1\mu\text{m}$

XFEL $\xi_{\text{HOR}} > 500\mu\text{m}$, focus to $0.1\mu\text{m}$



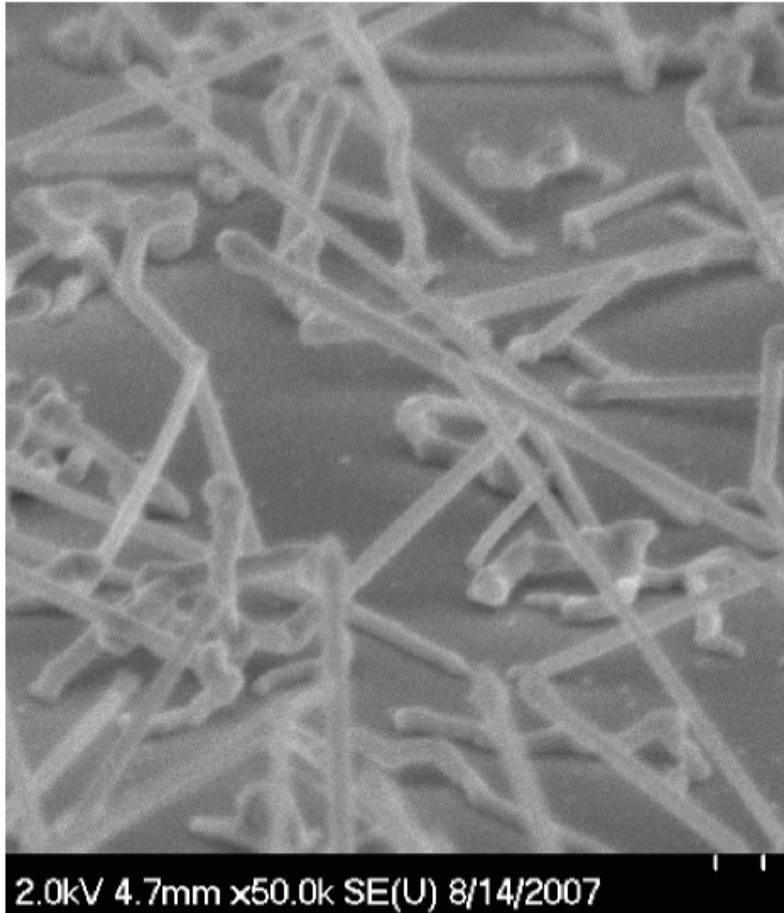
Gold nanocrystal reconstruction

showing support used for 20 HIO followed by 10 ER

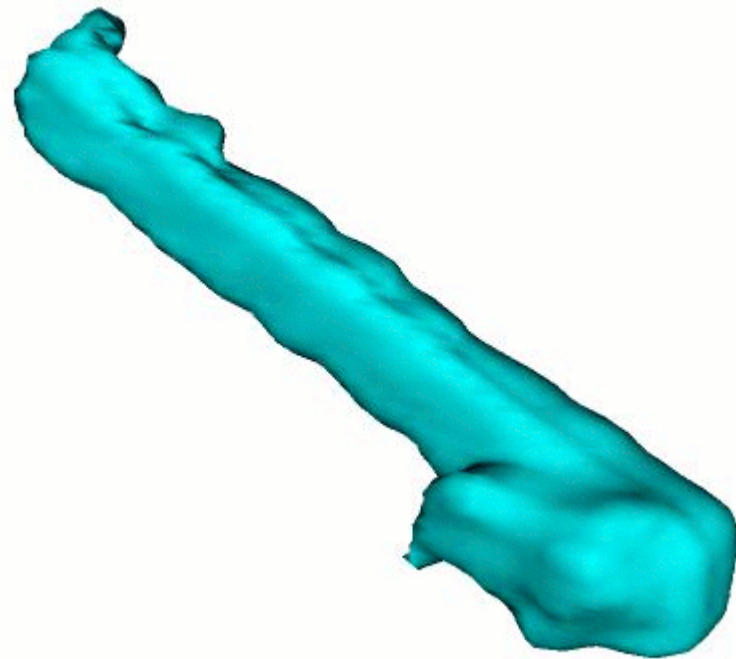


Reconstruction of InP nanowire

CVD on Si, Suneel Kodambaka, UCLA

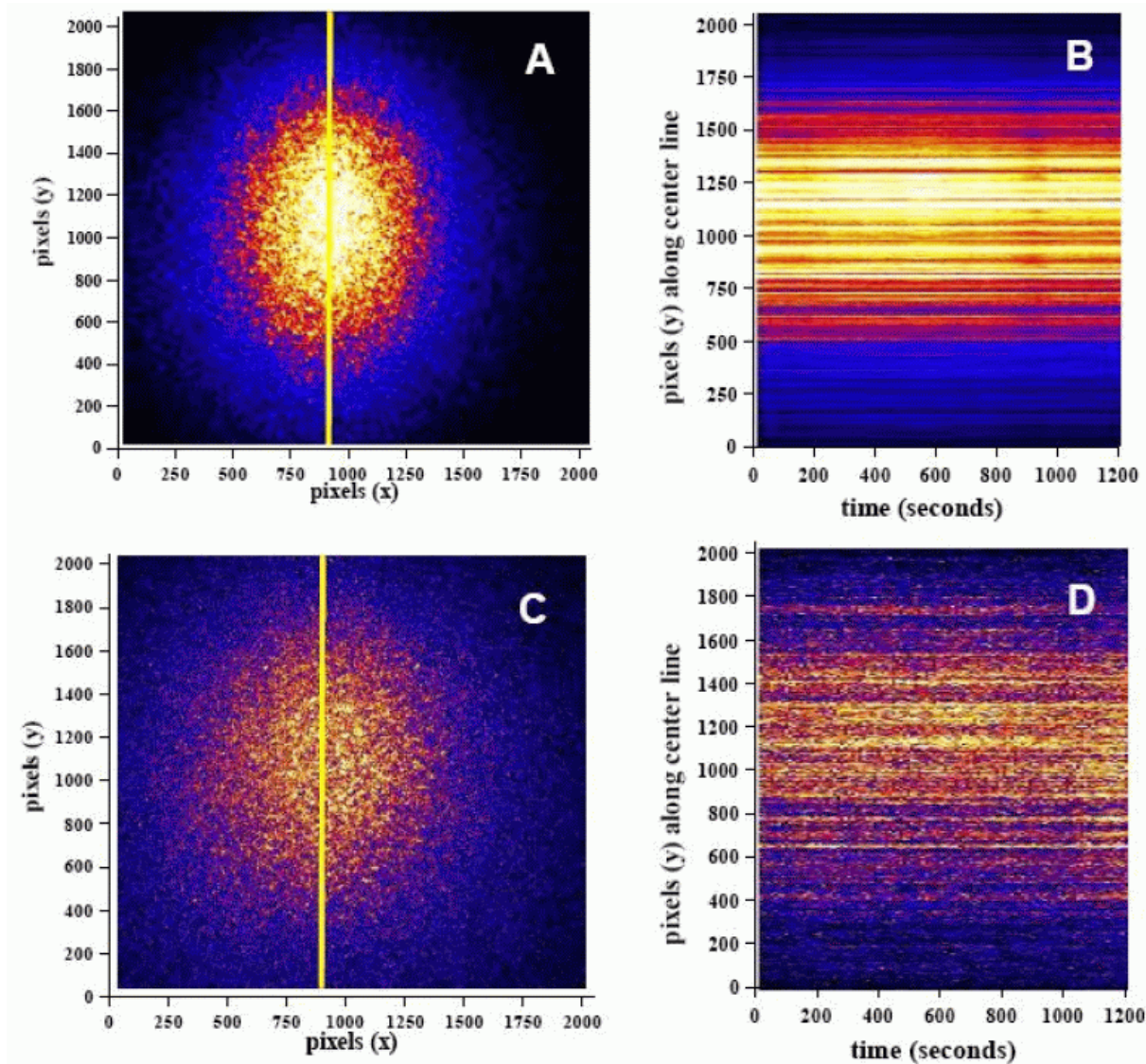


InP nanowires grown on Si (111)



$\text{Pr}_{0.5}\text{Ca}_{0.5}\text{MnO}_3$ at MnL_{III} edge (650 eV)

J. J. Turner et al, New Journal of Physics 10 053023 (2008)

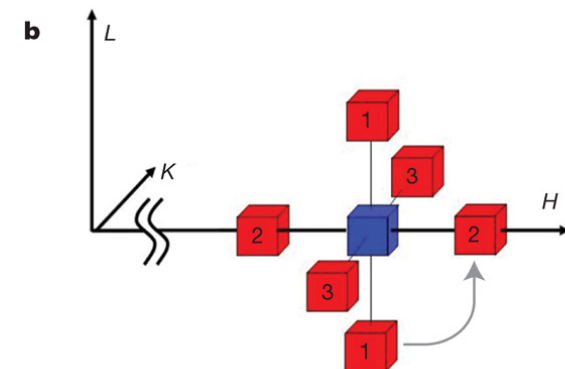
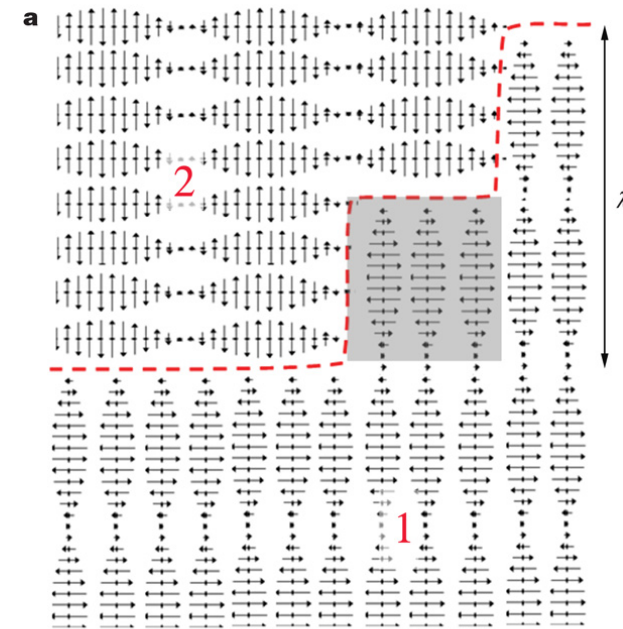
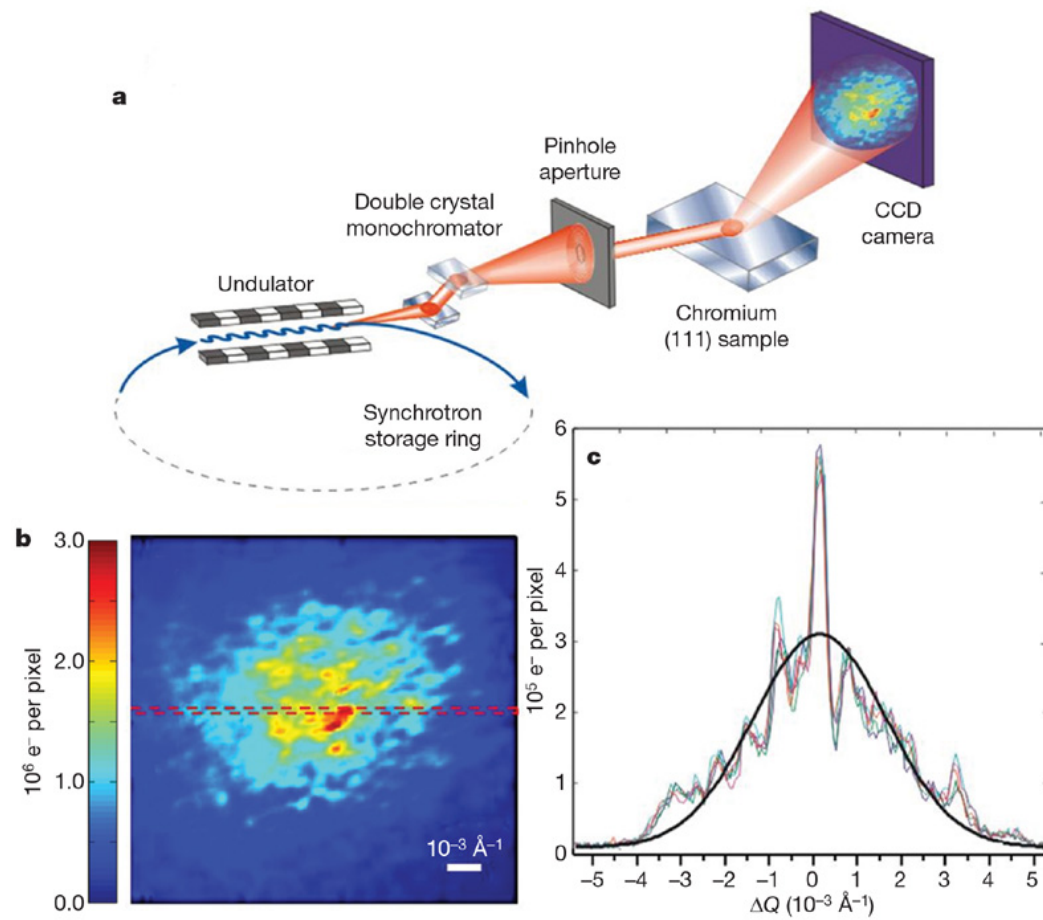


$(0, \frac{1}{2}, 0)$
Orbital ordered
 $T = 205 \text{ K}$

$(0, \frac{1}{2}, 0)$
Near phase
transition
 $T = 232 \text{ K}$

Antiferromagnetic Domains in Cr

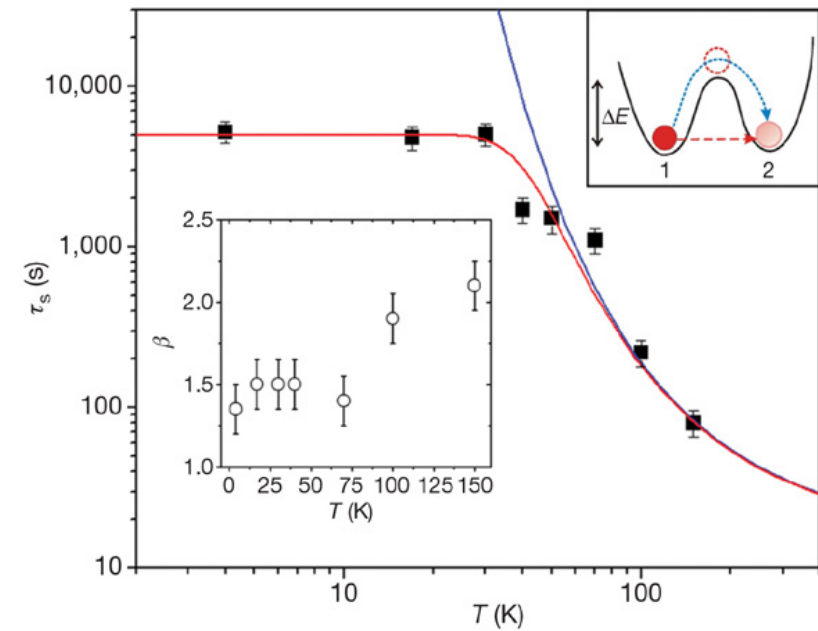
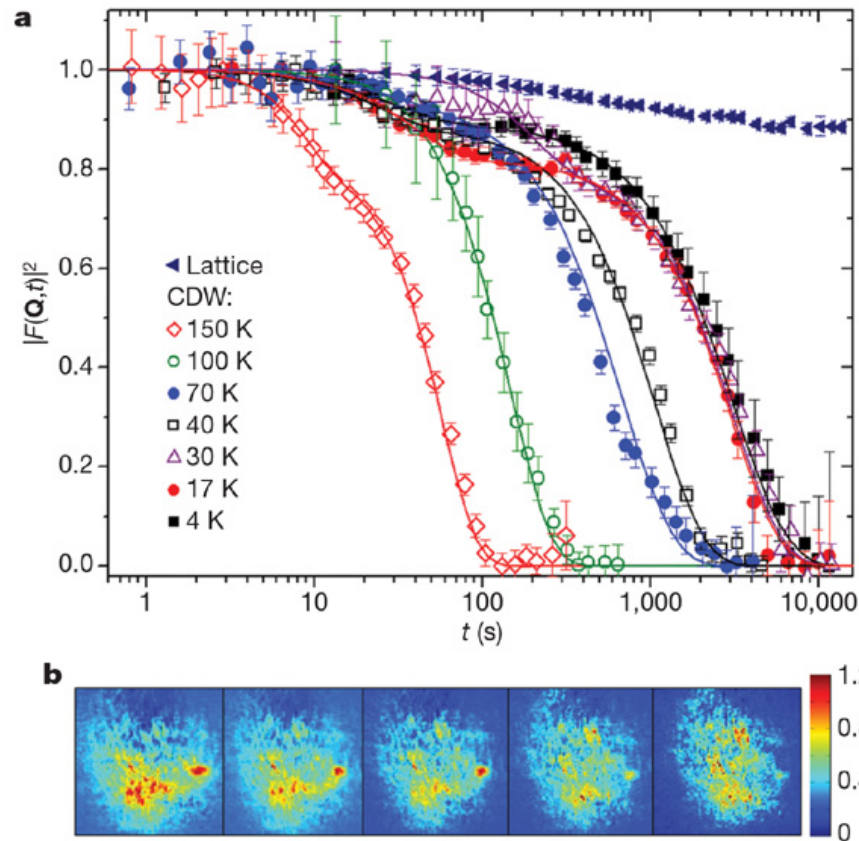
O. Shpyrko et al, Nature 447 68 (2007)



I. K. Robinson, MID 2009

XPCS of Domain Fluctuations in Cr

O. Shpyrko et al, Nature 447 68 (2007)



FeAl antiphase domains (001)

Lorenz Stadler, PhD dissertation, TU Wien (2005)

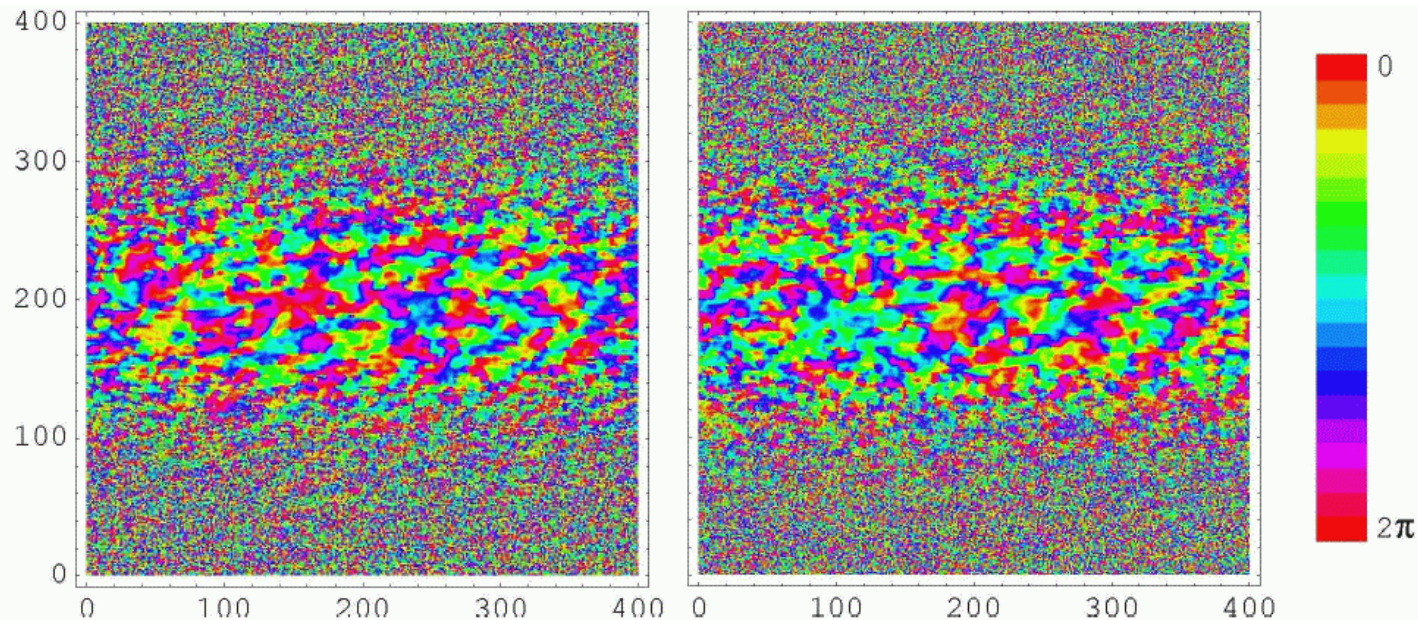
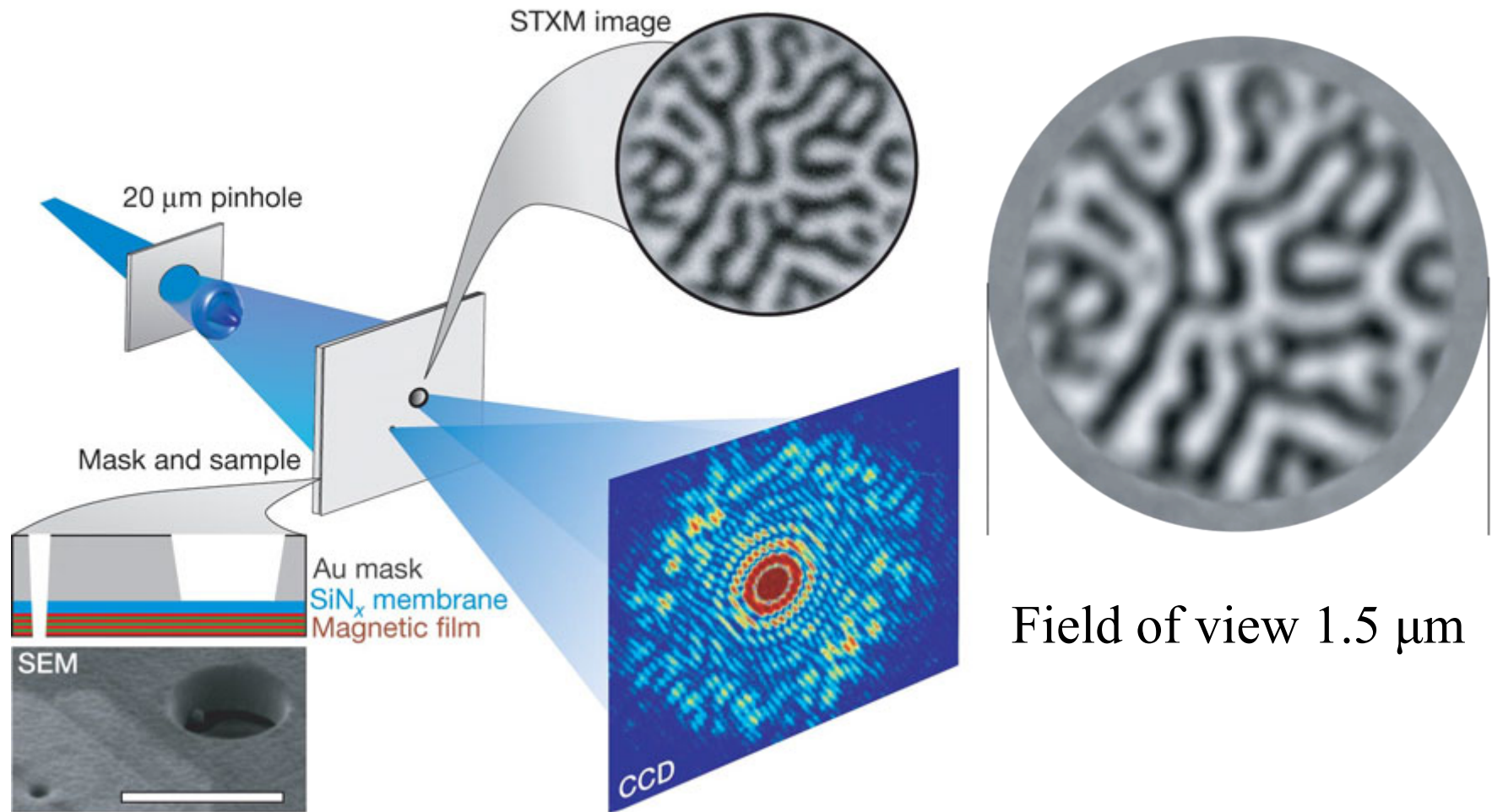


Figure 7.11: Typical reconstructed phases from runs with different combinations of algorithms and supports derived from the 2D Gaussian fit of the illumination function. Numbers in brackets denote how many iterations of the particular algorithm were done each cycle. Graphs on the left are from reconstruc-

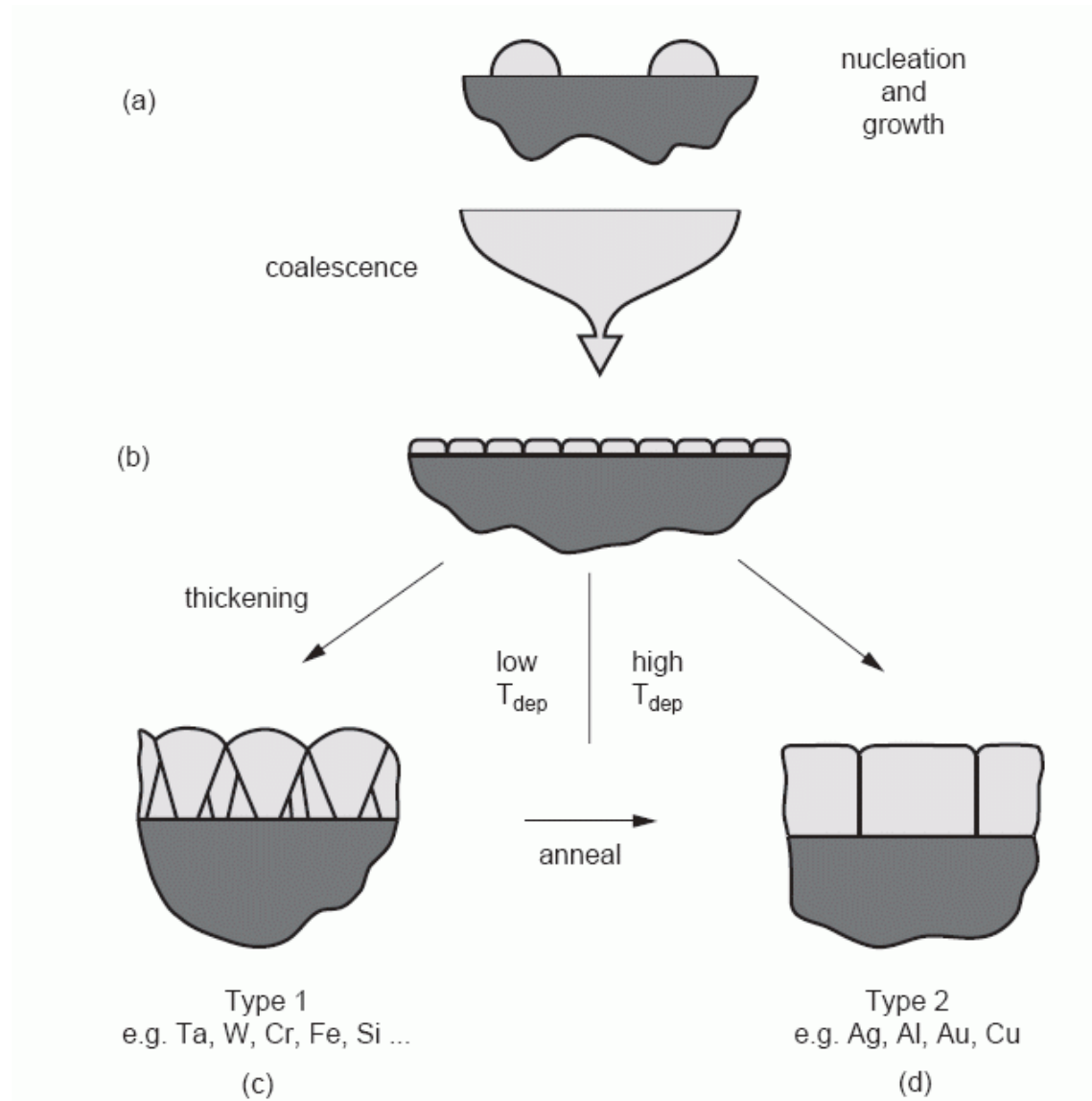
X-ray Holography of Pt/CoML Domains

S. Eisebitt et al. Nature 432 885 (2004)

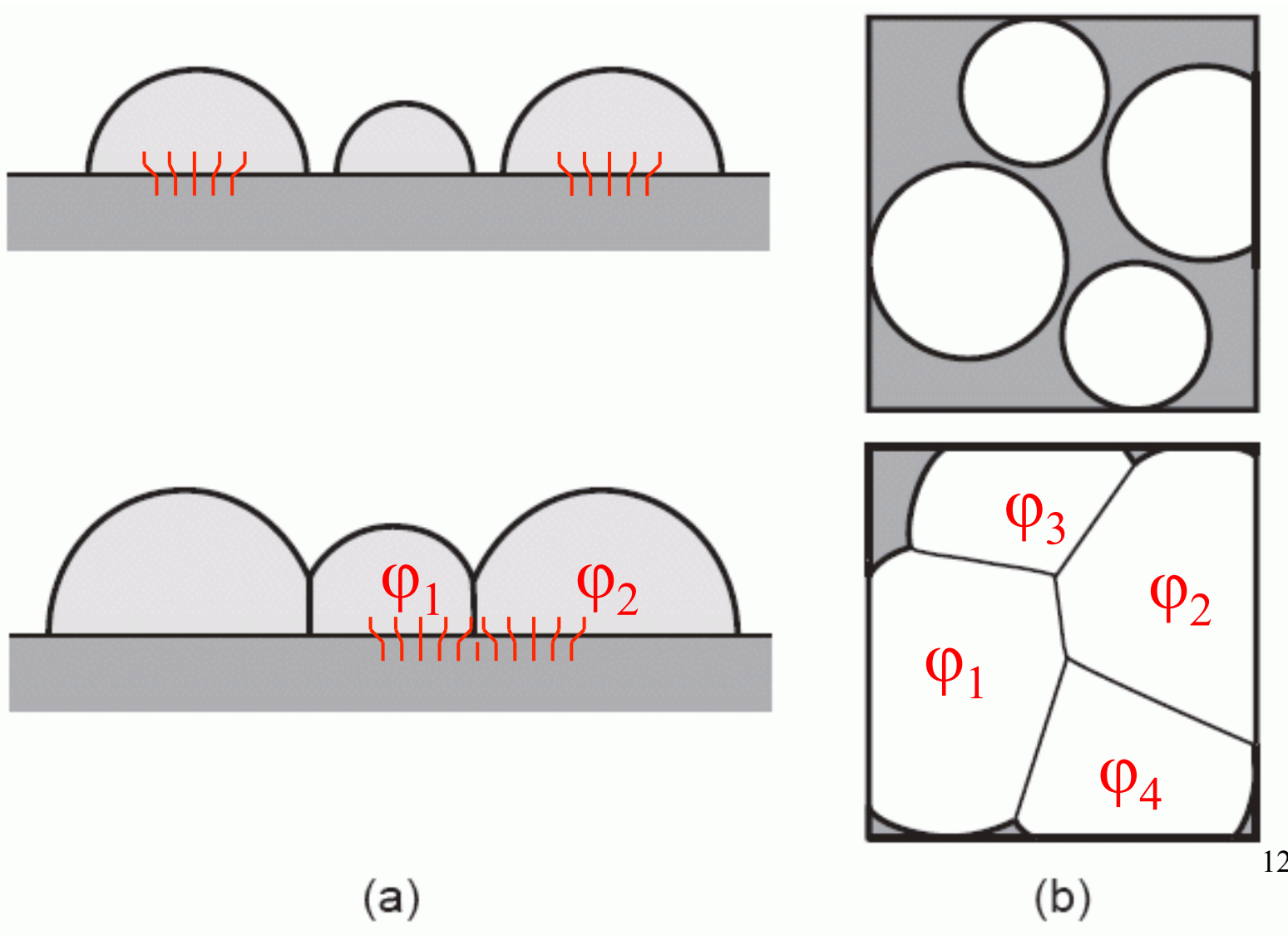


Thin film growth after deposition

C. V. Thompson, Annu. Rev. Mater. Sci. 2000. 30:159–90



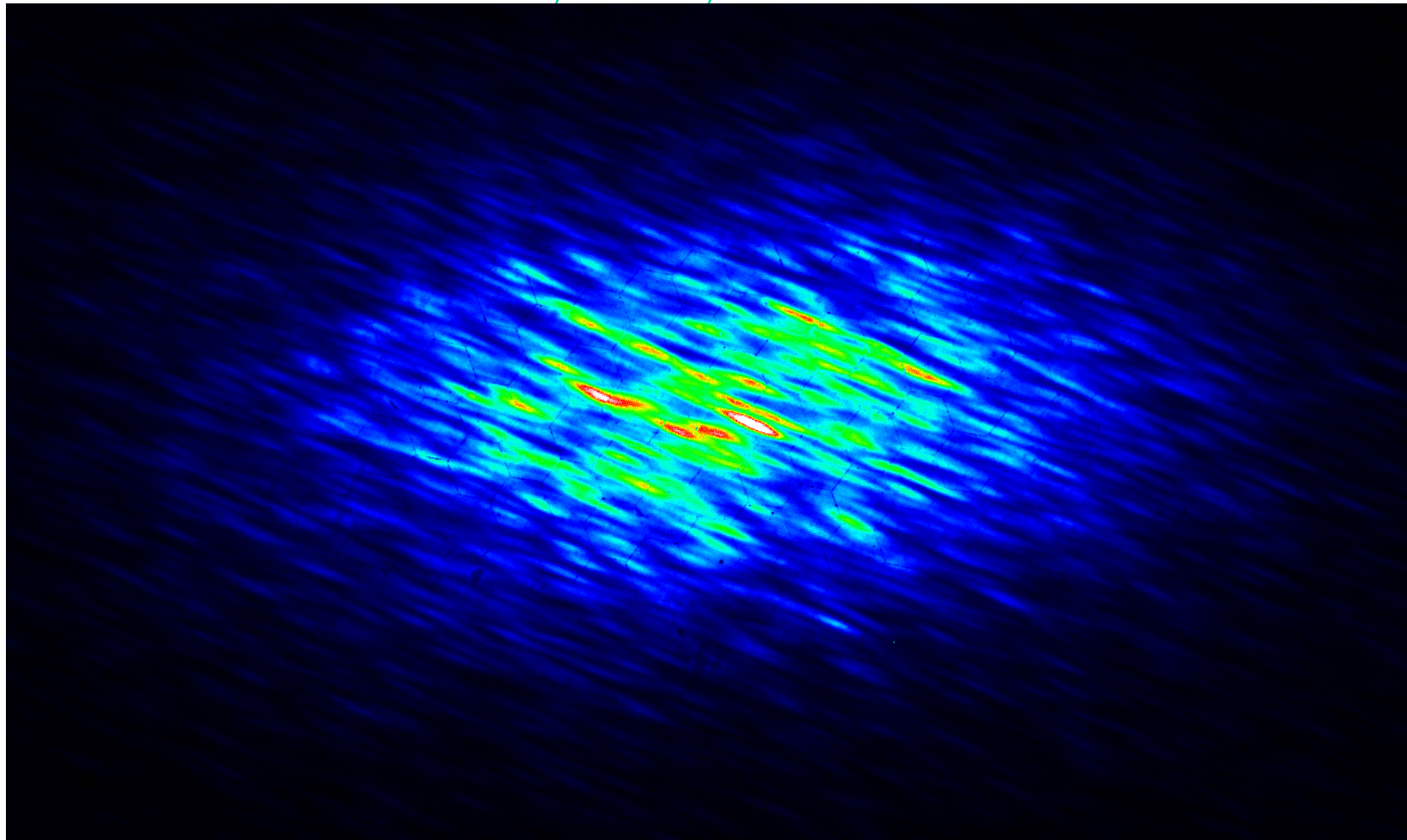
Epitaxial growth effects



Niobium (110) Thin Film Grains

1 μm steps across 3 μm beam of KB mirror focus

Richard Bean, I-16, Nb110-35 Jan 2009

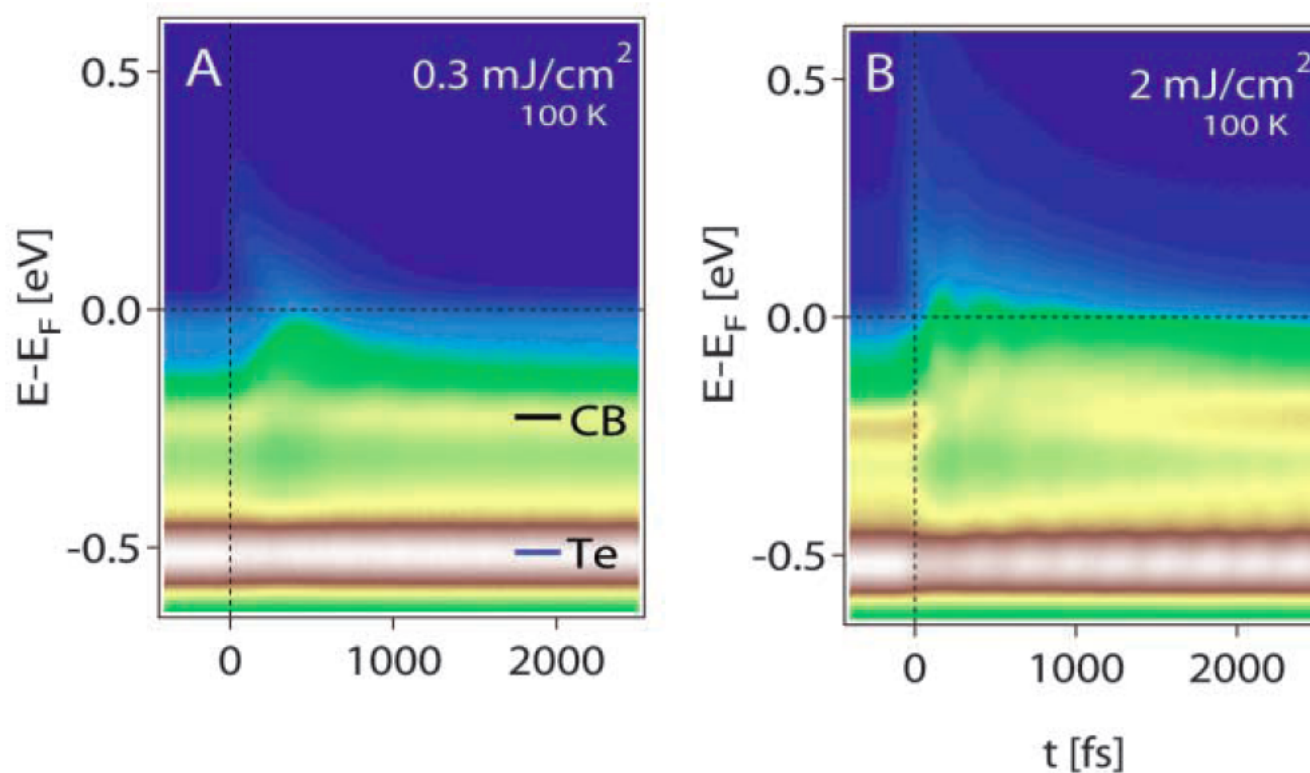


Charge Density Wave Dynamics

CDW excitation in TbTe_3 by 1.5eV IR pump

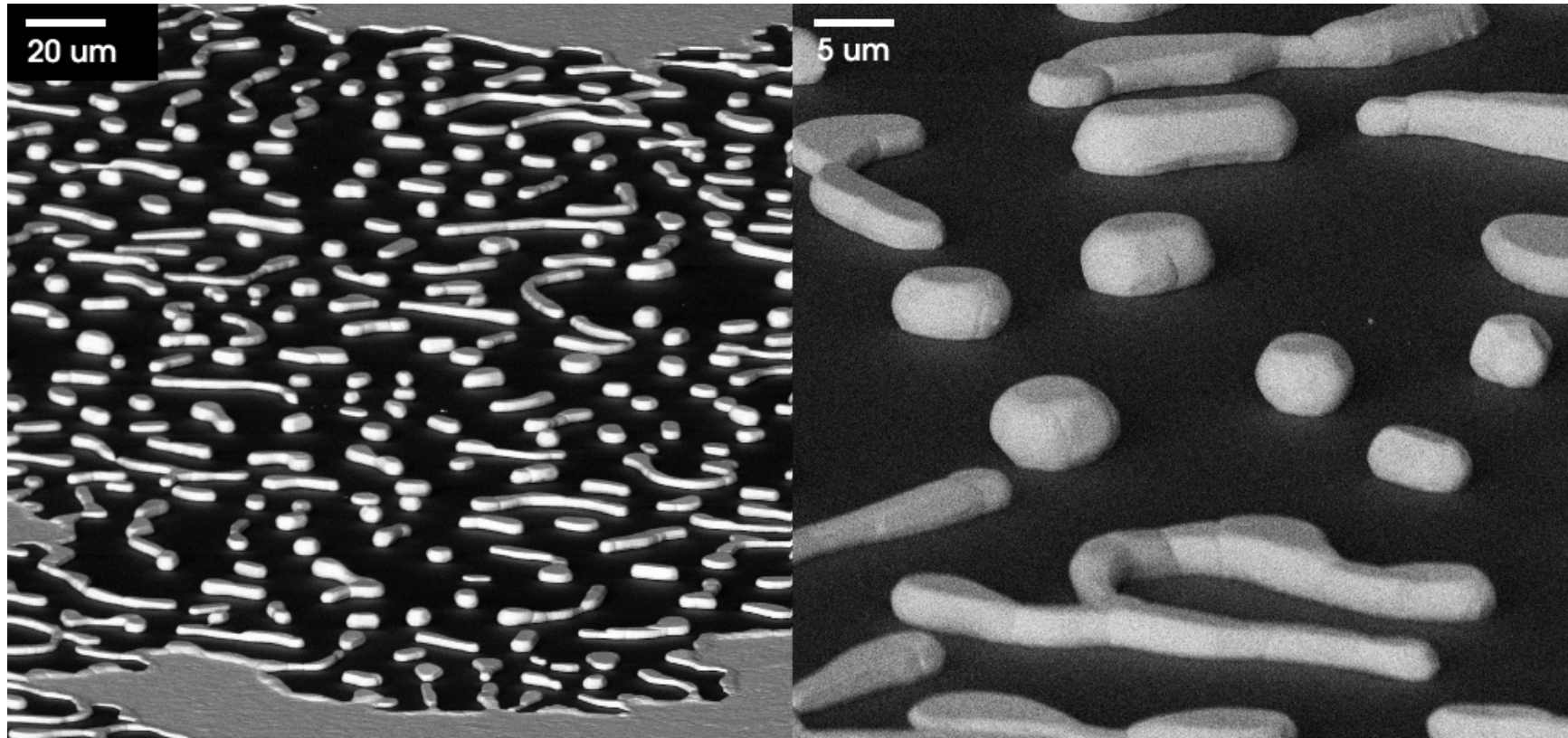
Schmitt et al, Science 321 1649 (2008)

Z-X Shen ARPES group at ALS

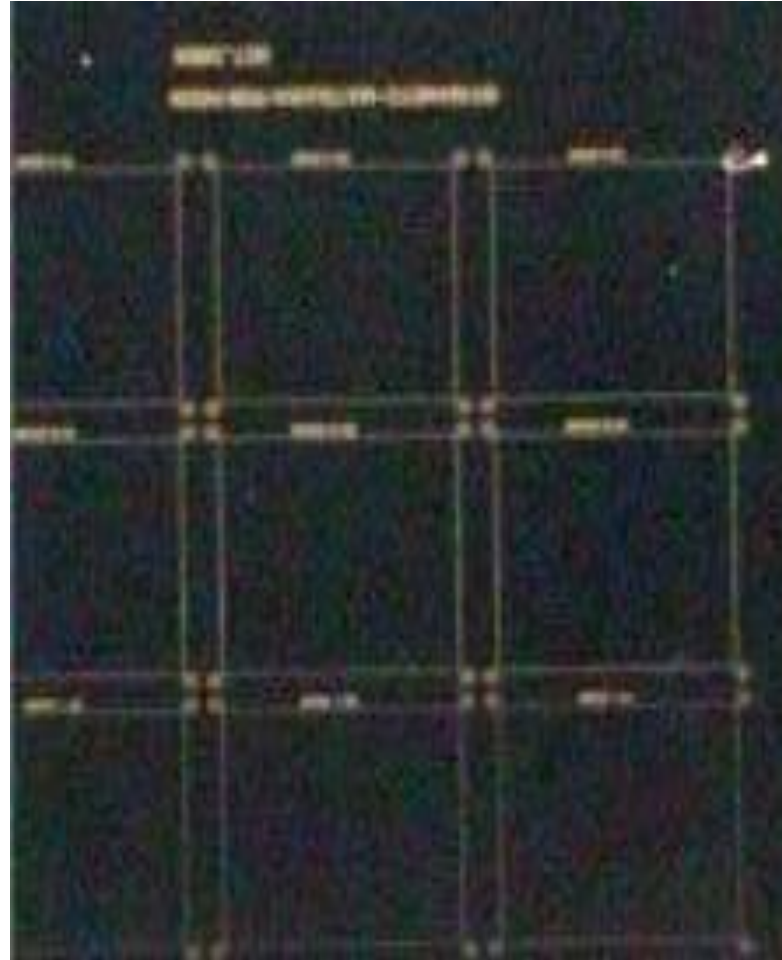
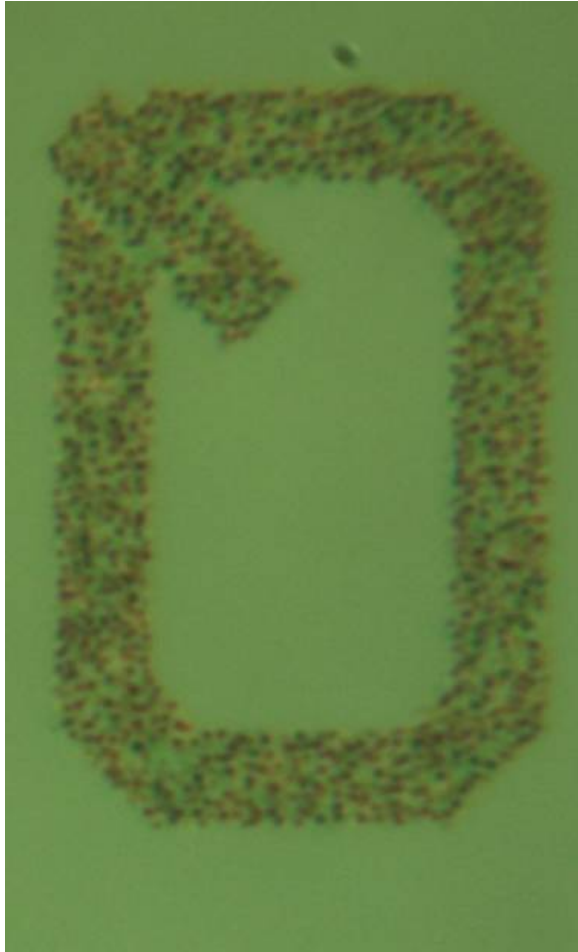


Dewetting to coalesce into crystals

Garth Williams thesis (2005)

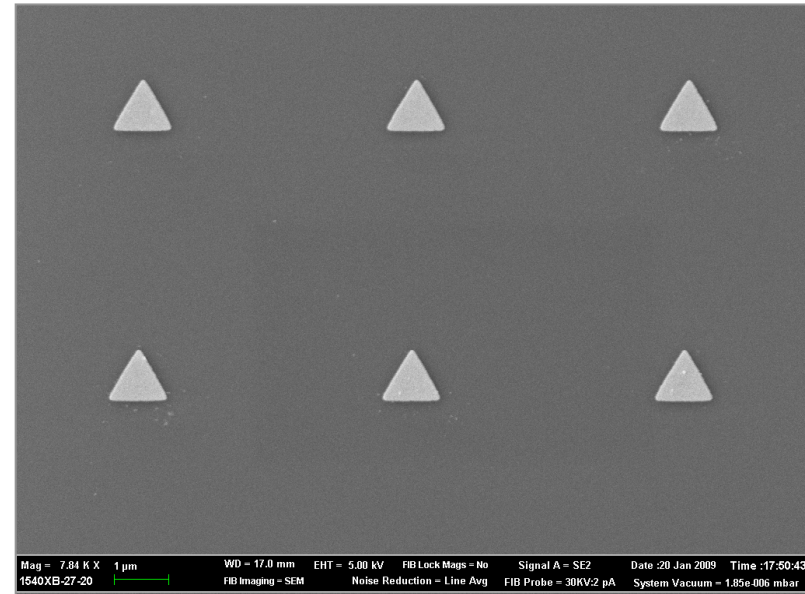
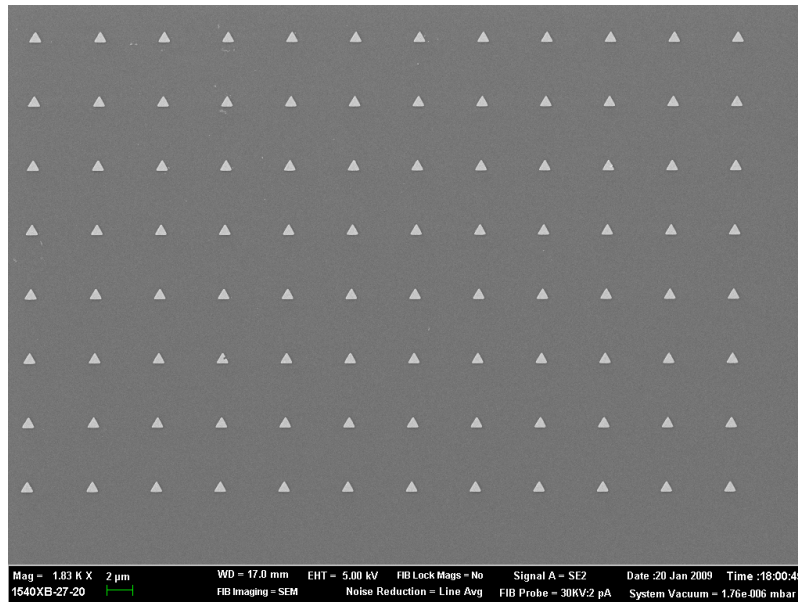


Annealing of Patterned Substrates

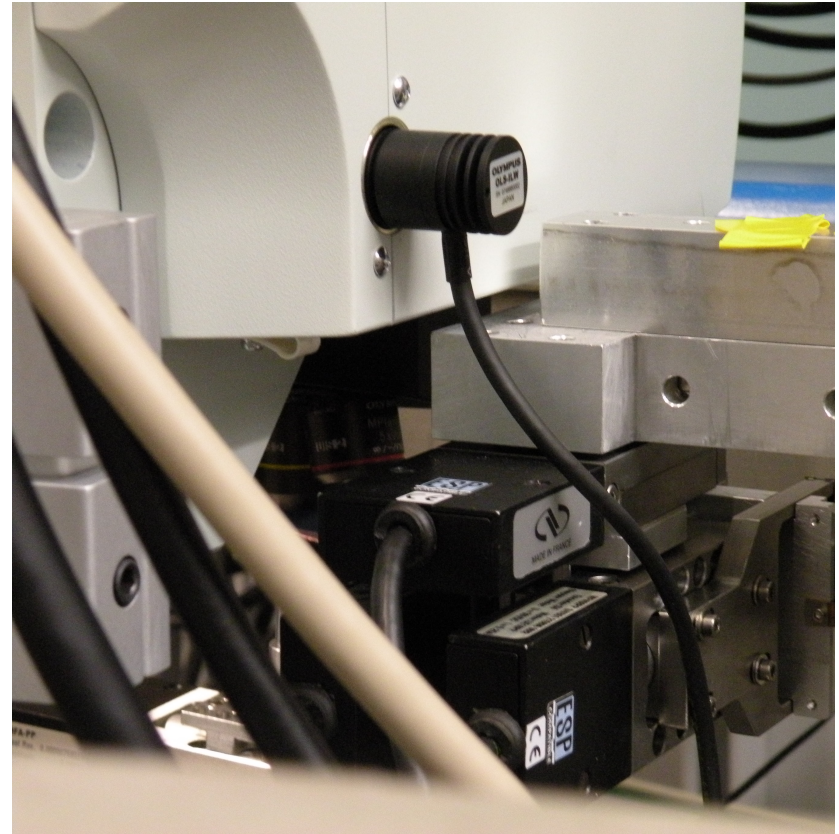
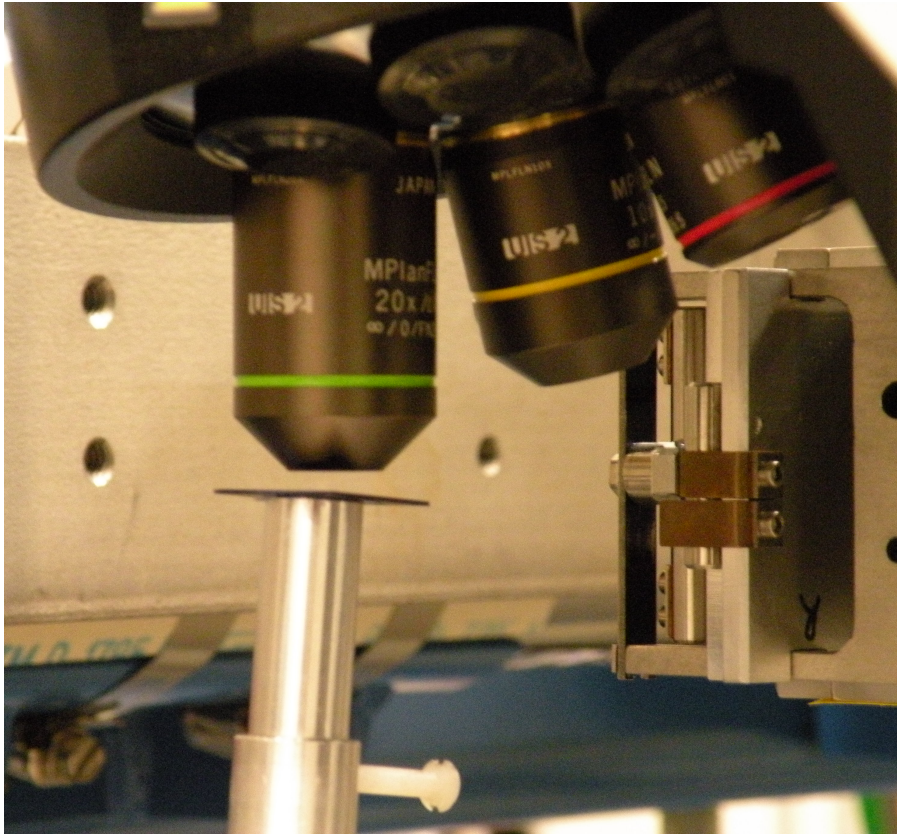


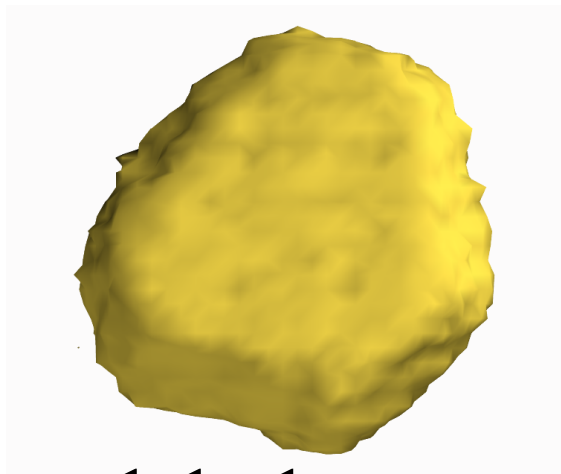
Patterned Au nanocrystal samples

N. Shimamoto, Waseda University, Japan

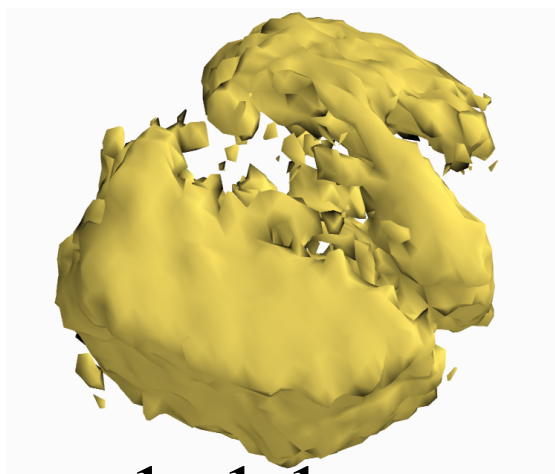


Confocal Alignment Microscope

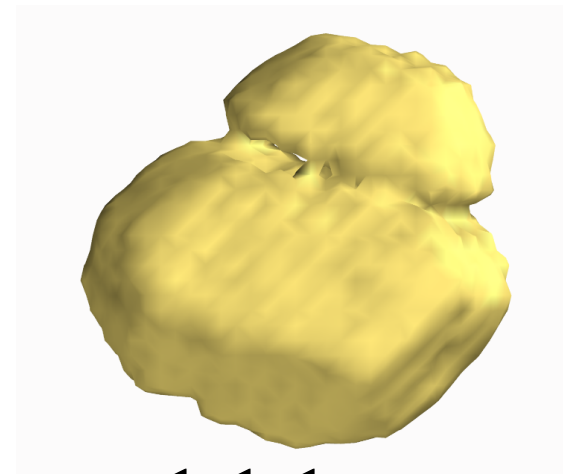




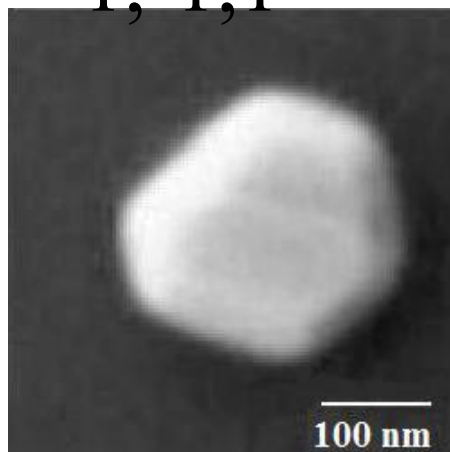
1,1,-1



1,-1,1

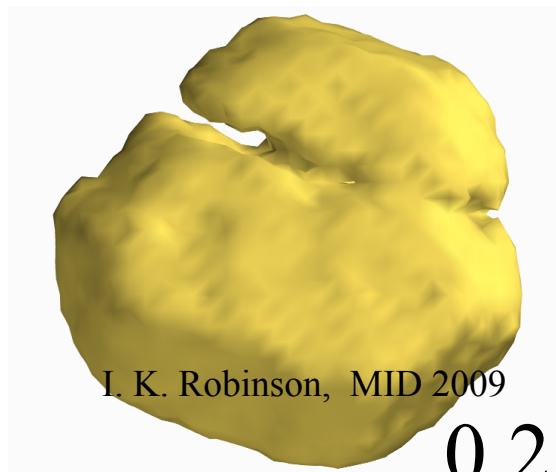
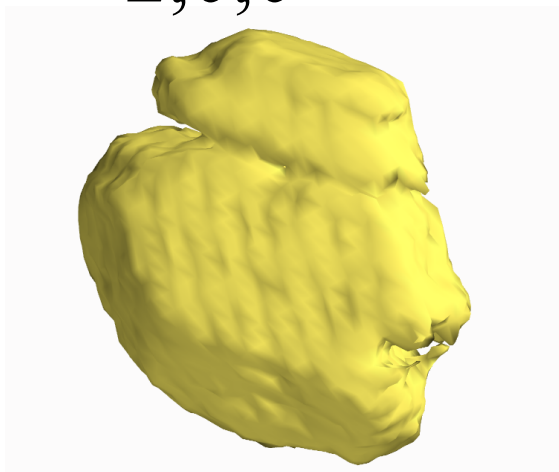


-1,1,1



100 nm

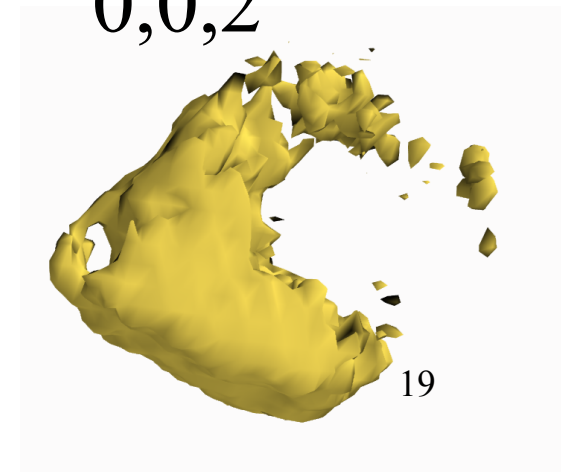
2,0,0



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0,2,0

0,0,2



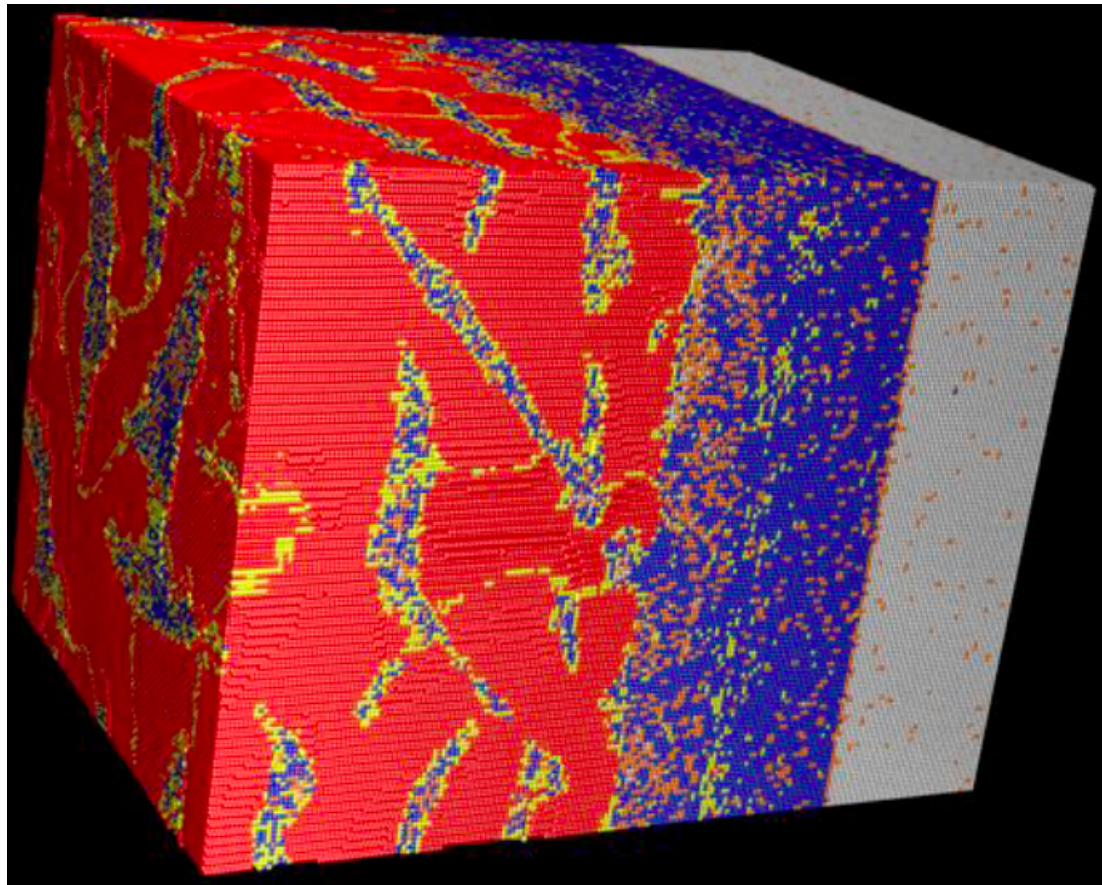
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MD simulation of Shock Wave

Damage in Fe along (001) direction

K Kadau, TC Germann, PS Lomdahl, and BL Holian.

Science, 296 1681 2002



I. K. Robinson, MID 2009

MID requirements

- Pump laser excitation source
- X-ray focussing system
- Goniometer, XYZ positioner
- Optical alignment system
- DETECTOR
 - Far from sample (robot arm?)
 - Memory on pixel (500 channels)
 - Dynamic range $>10^5$