Coherent X-ray Diffraction Imaging with the XFEL

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XFEL MID workshop
Grenoble
October 2009

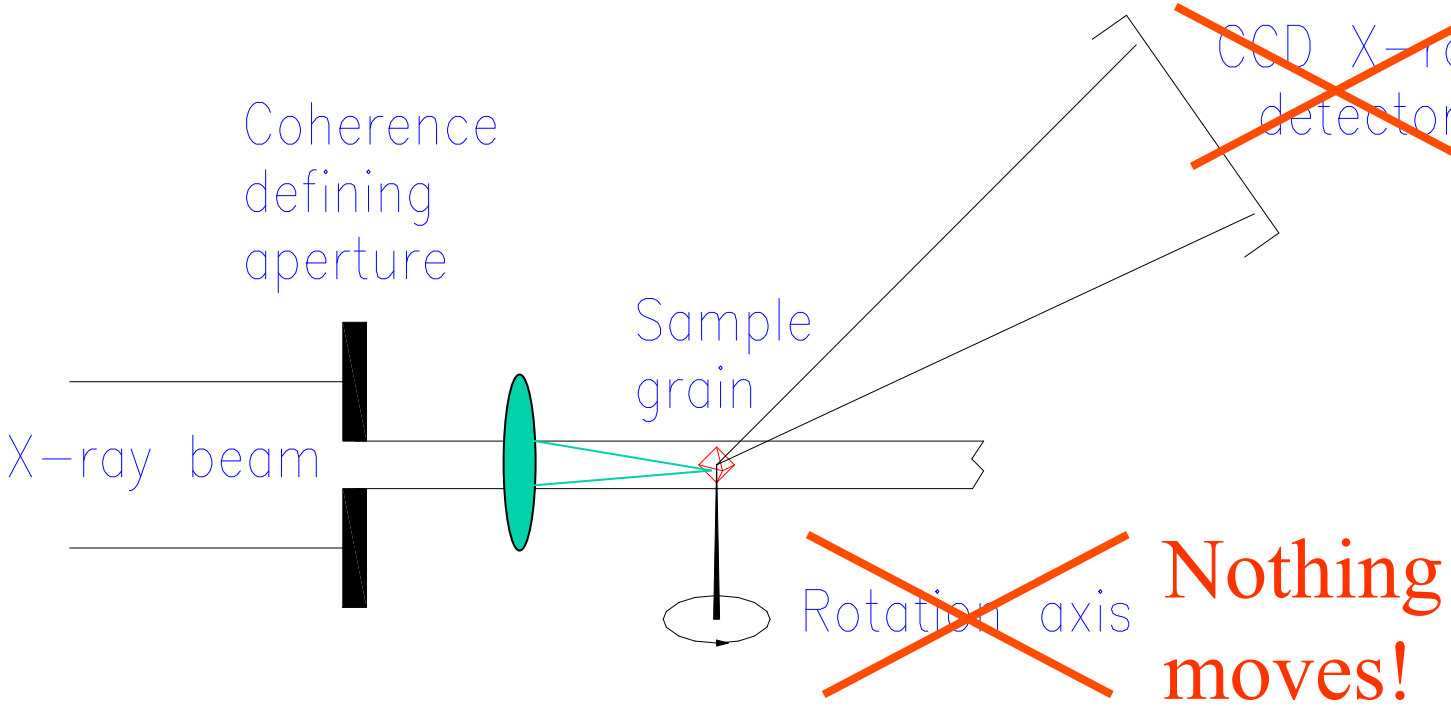
Outline

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

Coherent X-ray Diffraction Imaging

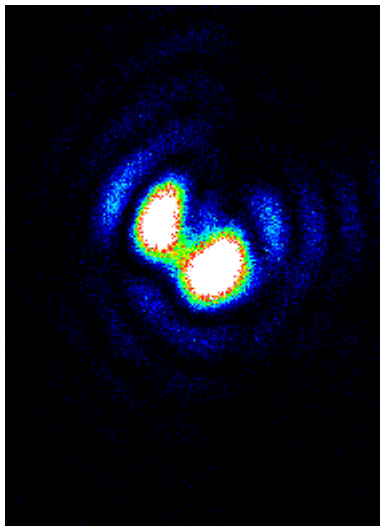
APS ξ_{HOR}= 20μm, focus to 1μm

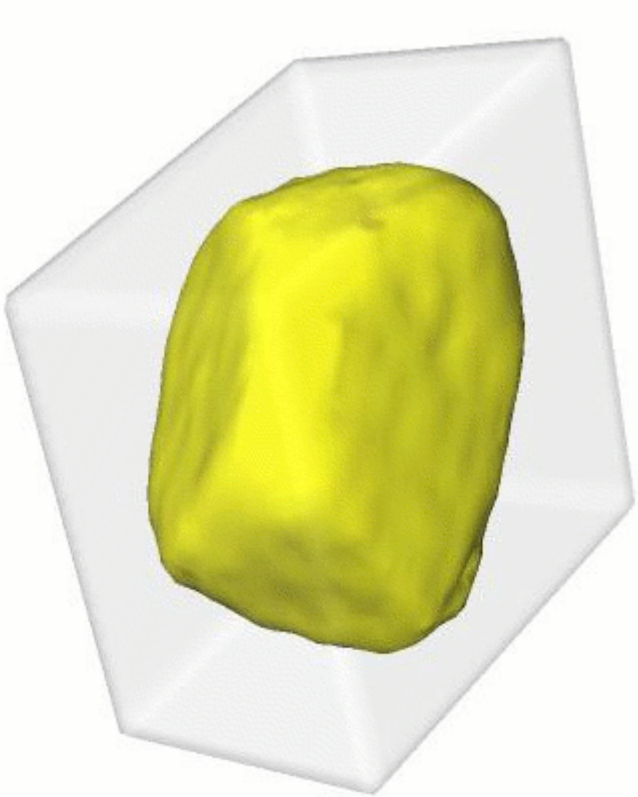
XFEL ξ_{HOR}> 500μm, focus to 0.1μm



Gold nanocrystal reconstruction

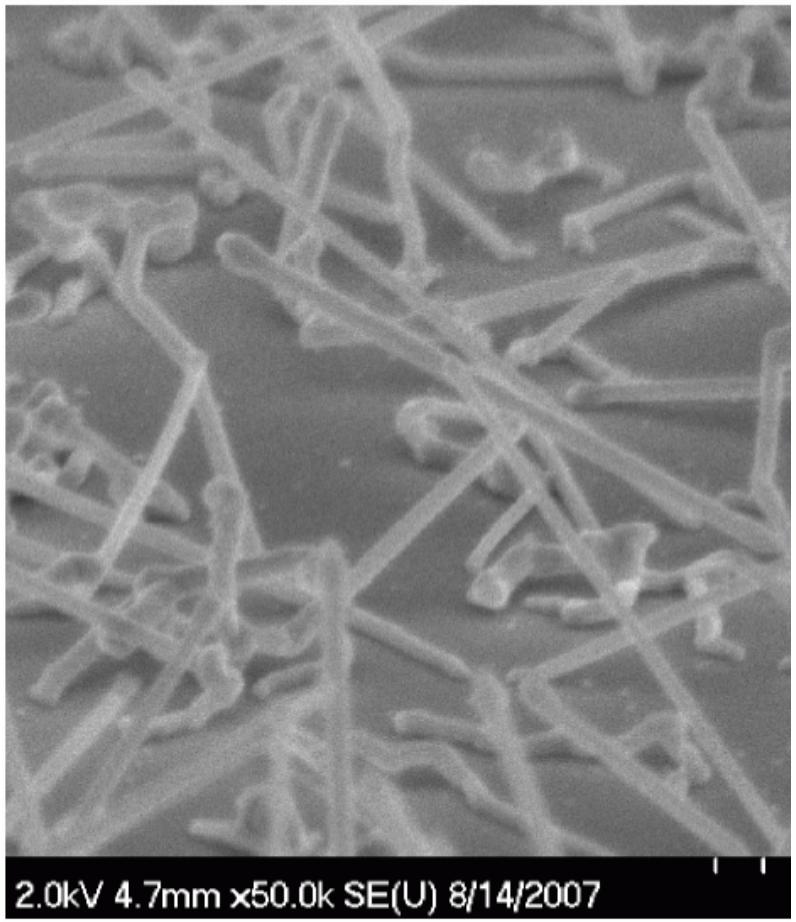
showing support used for 20 HIO followed by 10 ER



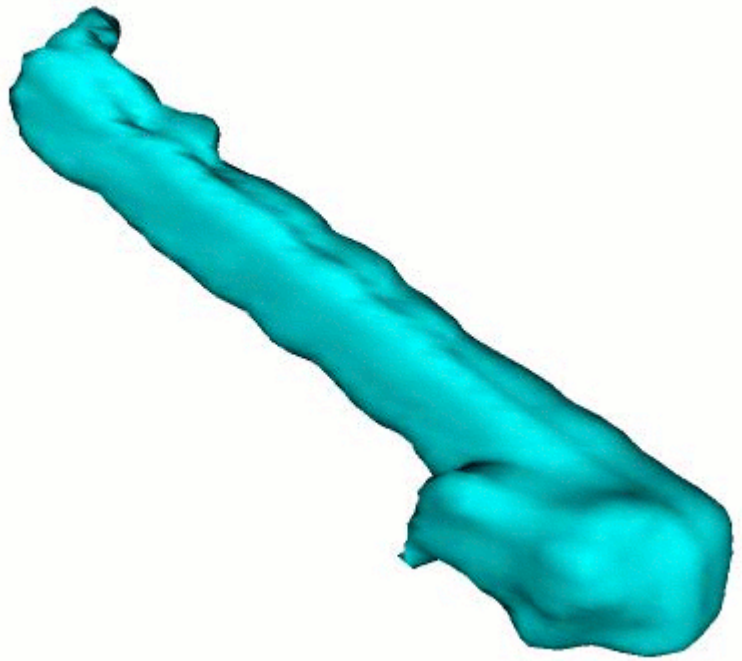


Reconstruction of InP nanowire

CVD on Si, Suneel Kodambaka, UCLA

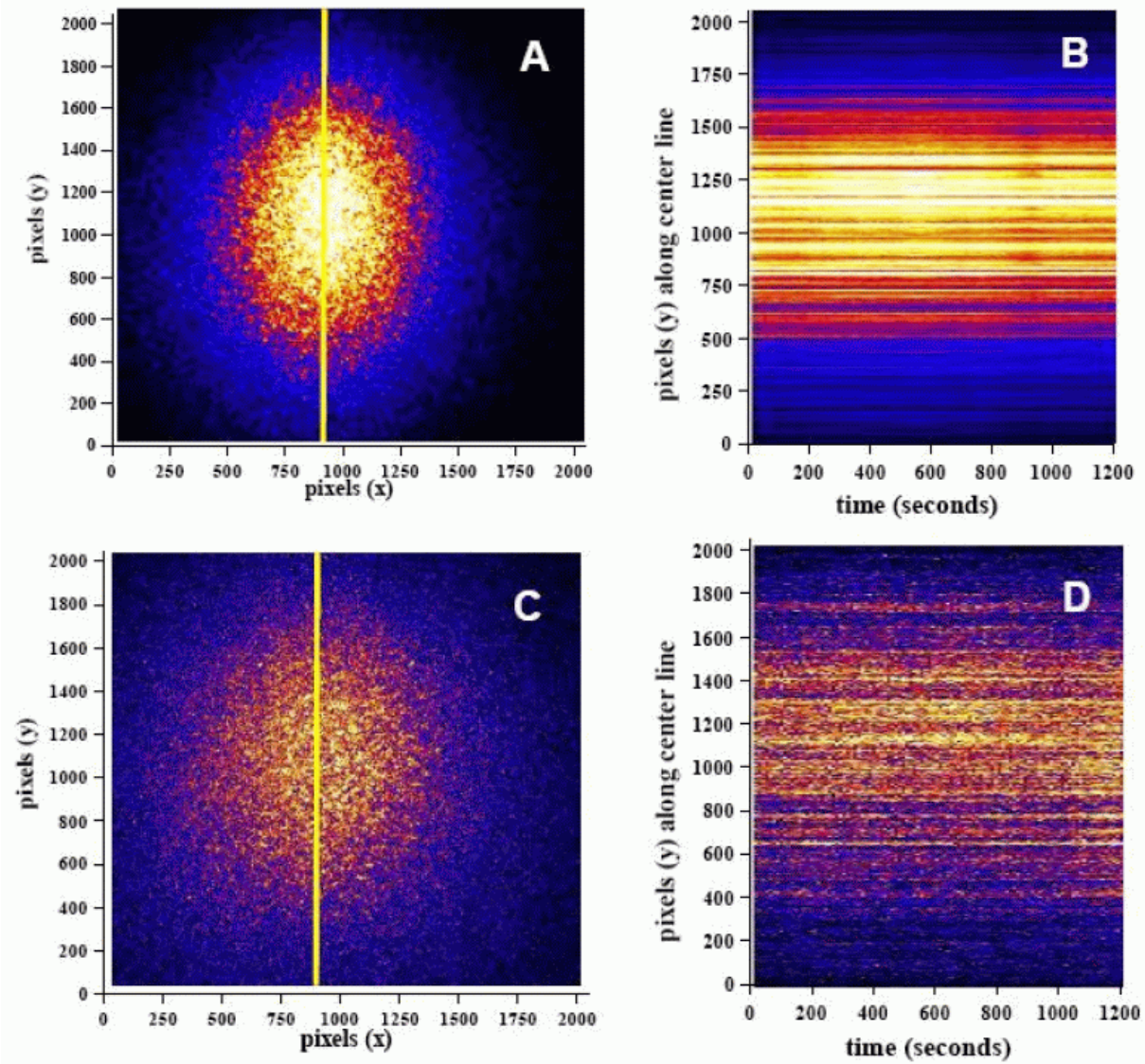


InP nanowires grown on Si (111)



$Pr_{0.5}Ca_{0.5}MnO_3$ at MnL_{III} edge (650 eV)

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

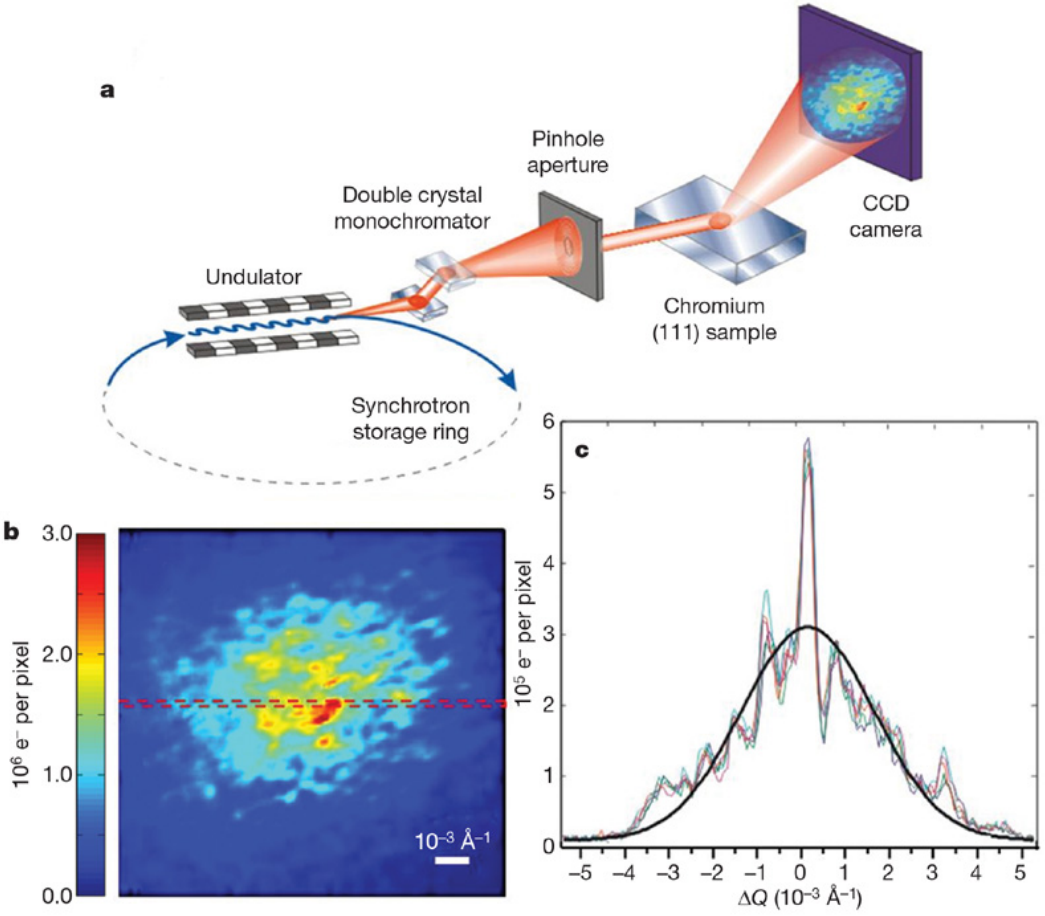


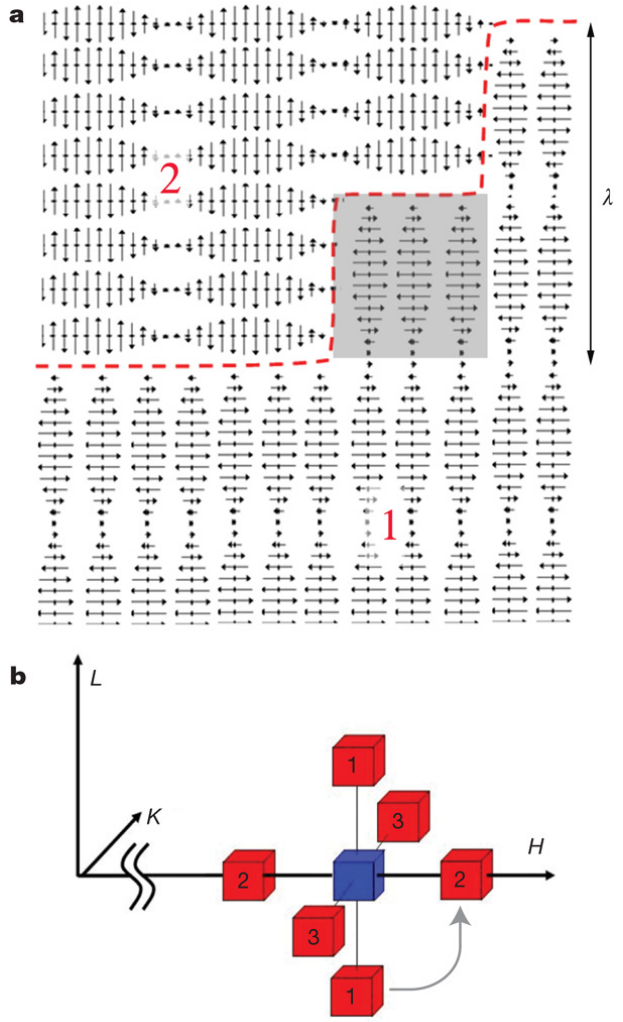
(0, ½ , 0)
Orbital ordered
T=205K

(0, ½ , 0)
Near phase transition
T=232K

Antiferromagnetic Domains in Cr

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

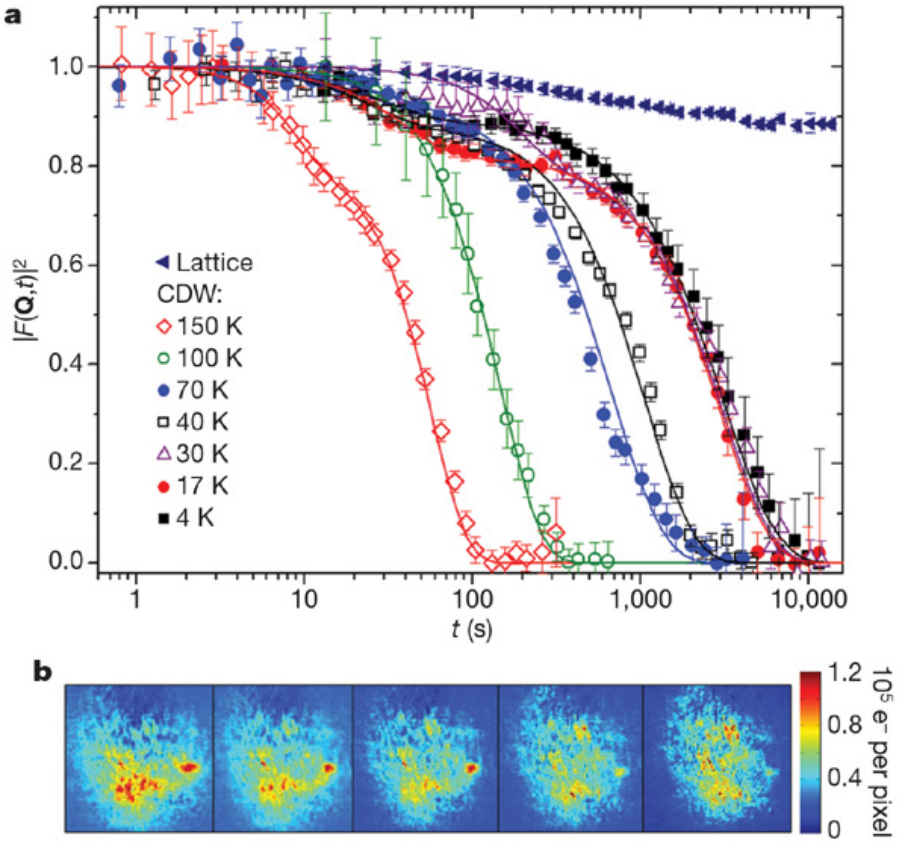


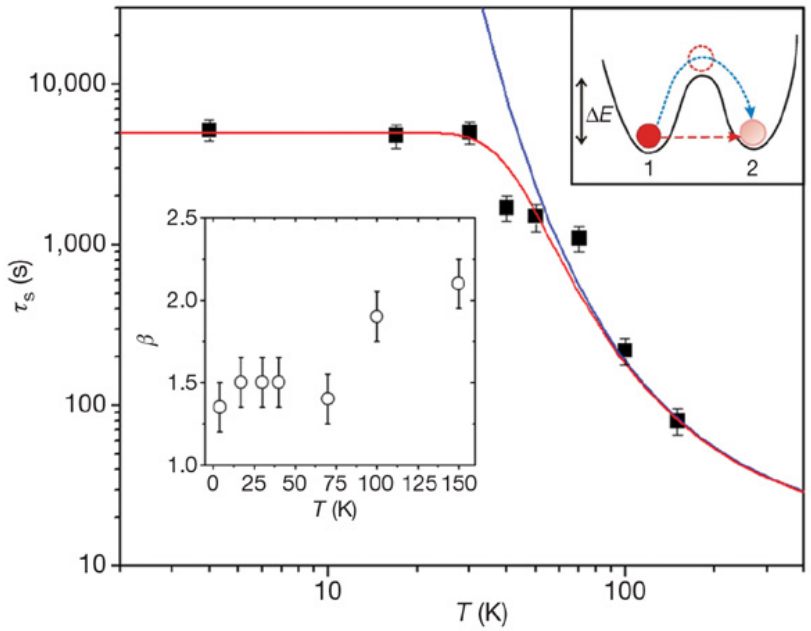


I. K. Robinson, MID 2009

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)

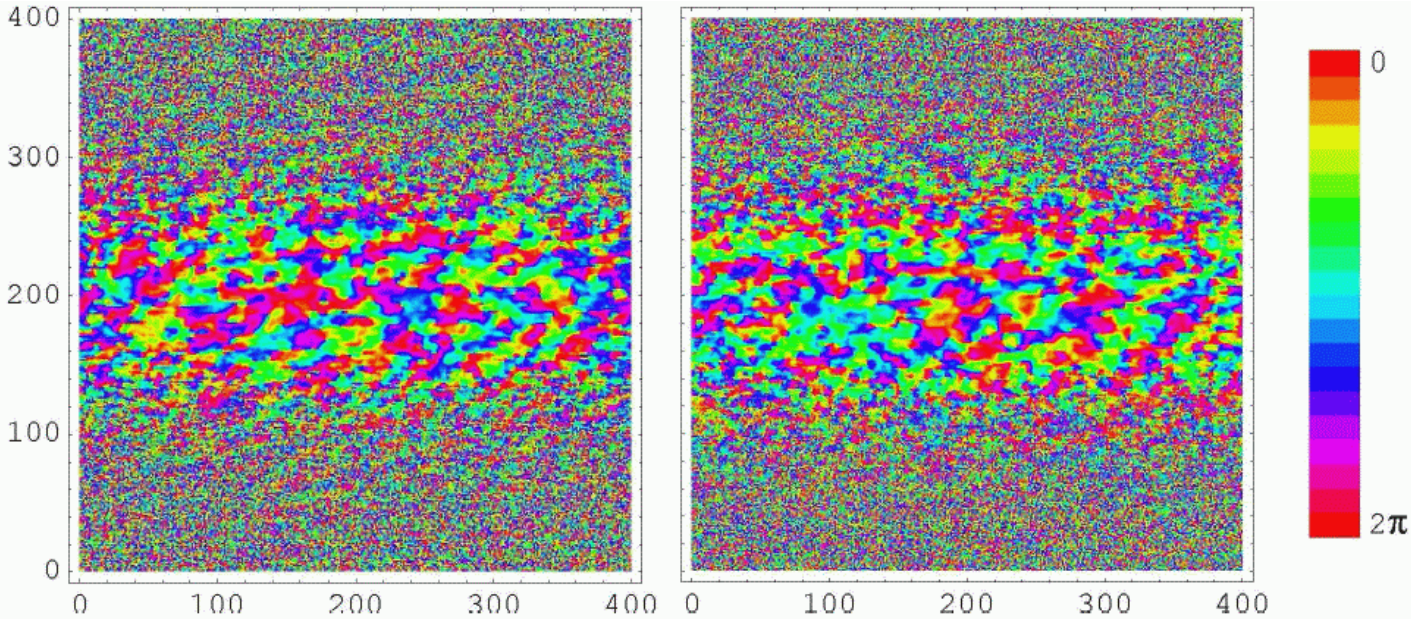
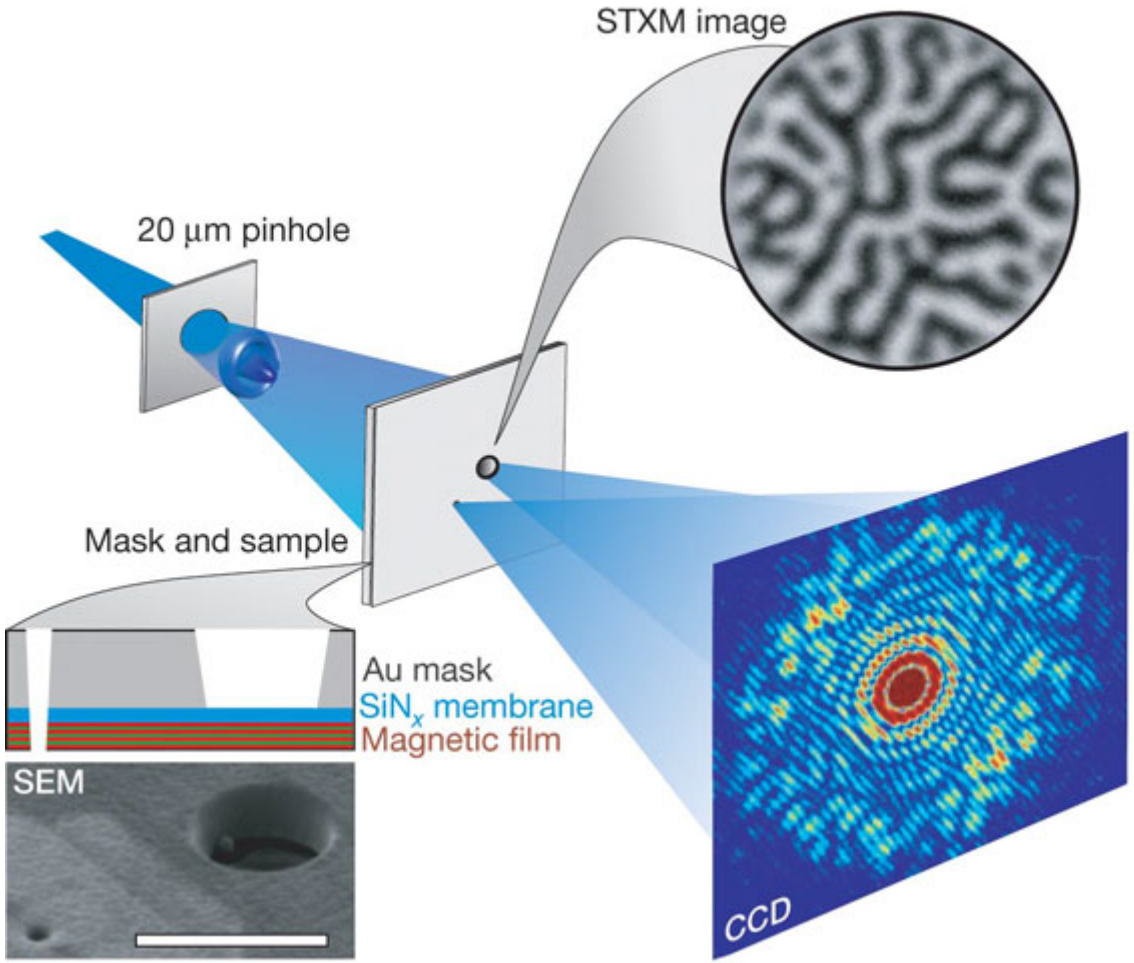


Figure 7.11: Typical reconstructed phases from runs with different combinations of algorithms and supports derived from the 2D Gaussian fit of the illumination function. Numbers in brackets denote how many iterations of the particular algorithm were done each cycle. Graphs on the left are from reconstruc-

X-ray Holography of Pt/CoML Domains

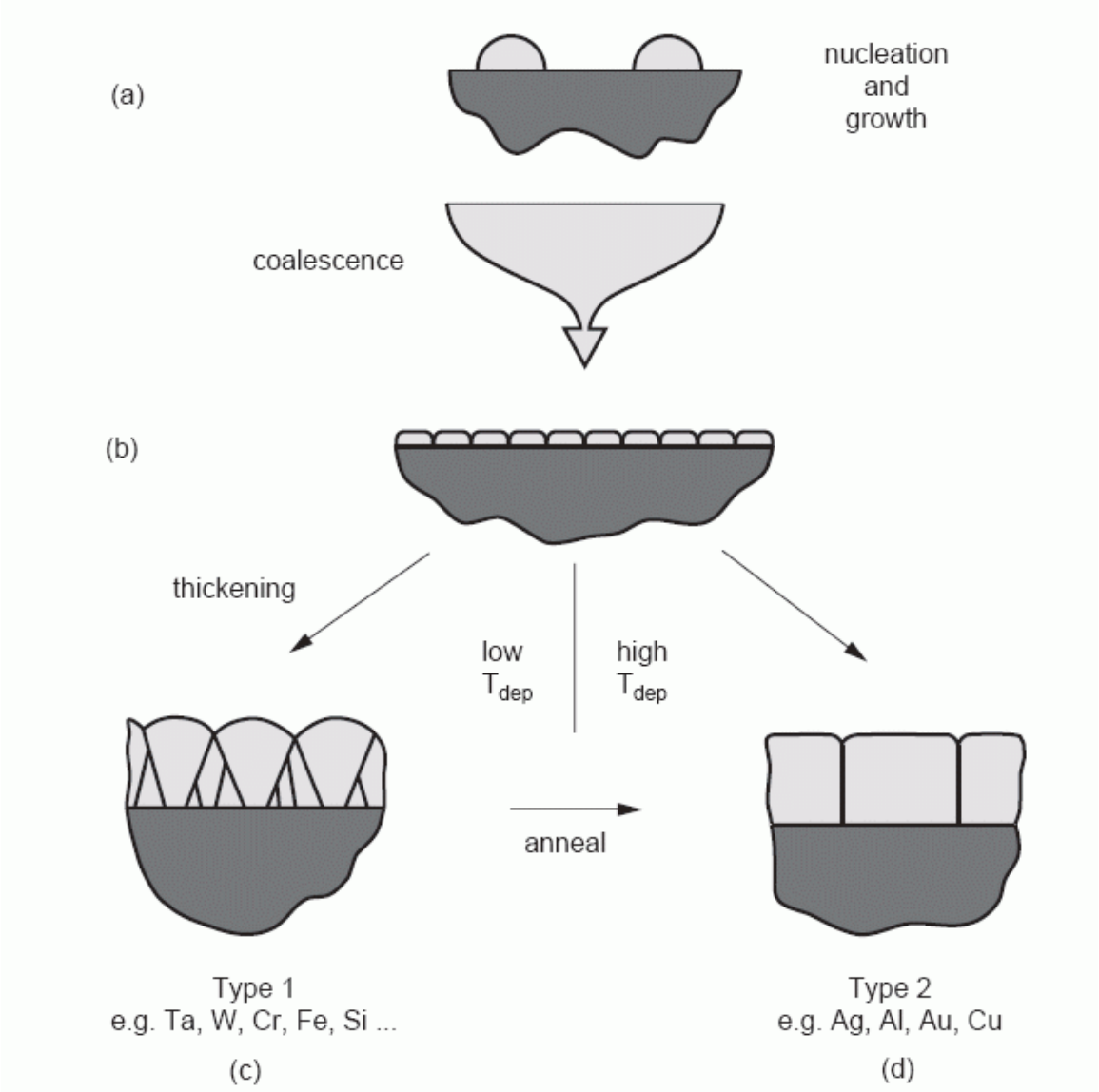
S. Eisebitt et al. Nature 432 885 (2004)



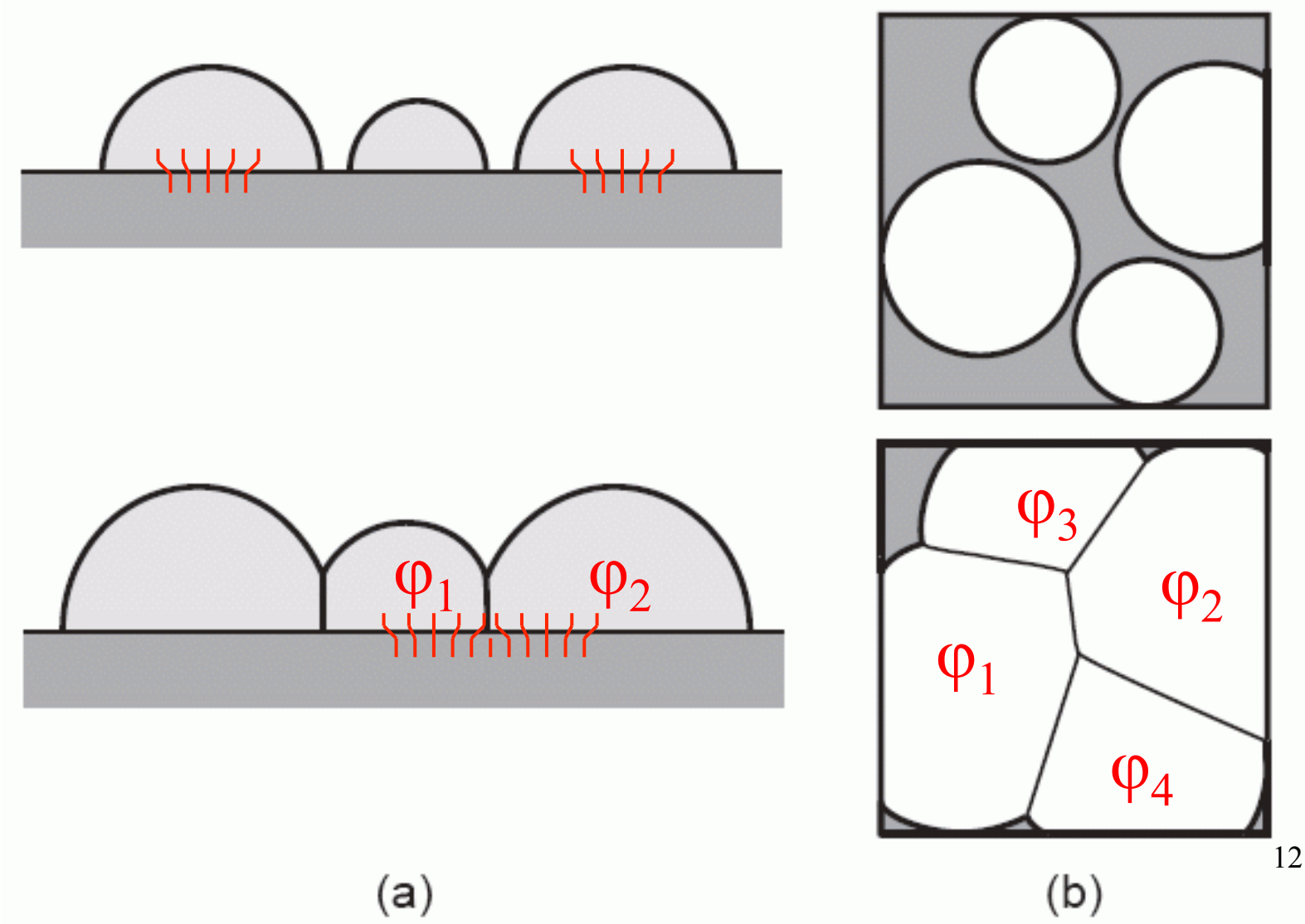
Field of view 1.5 µm

Thin film growth after deposition

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



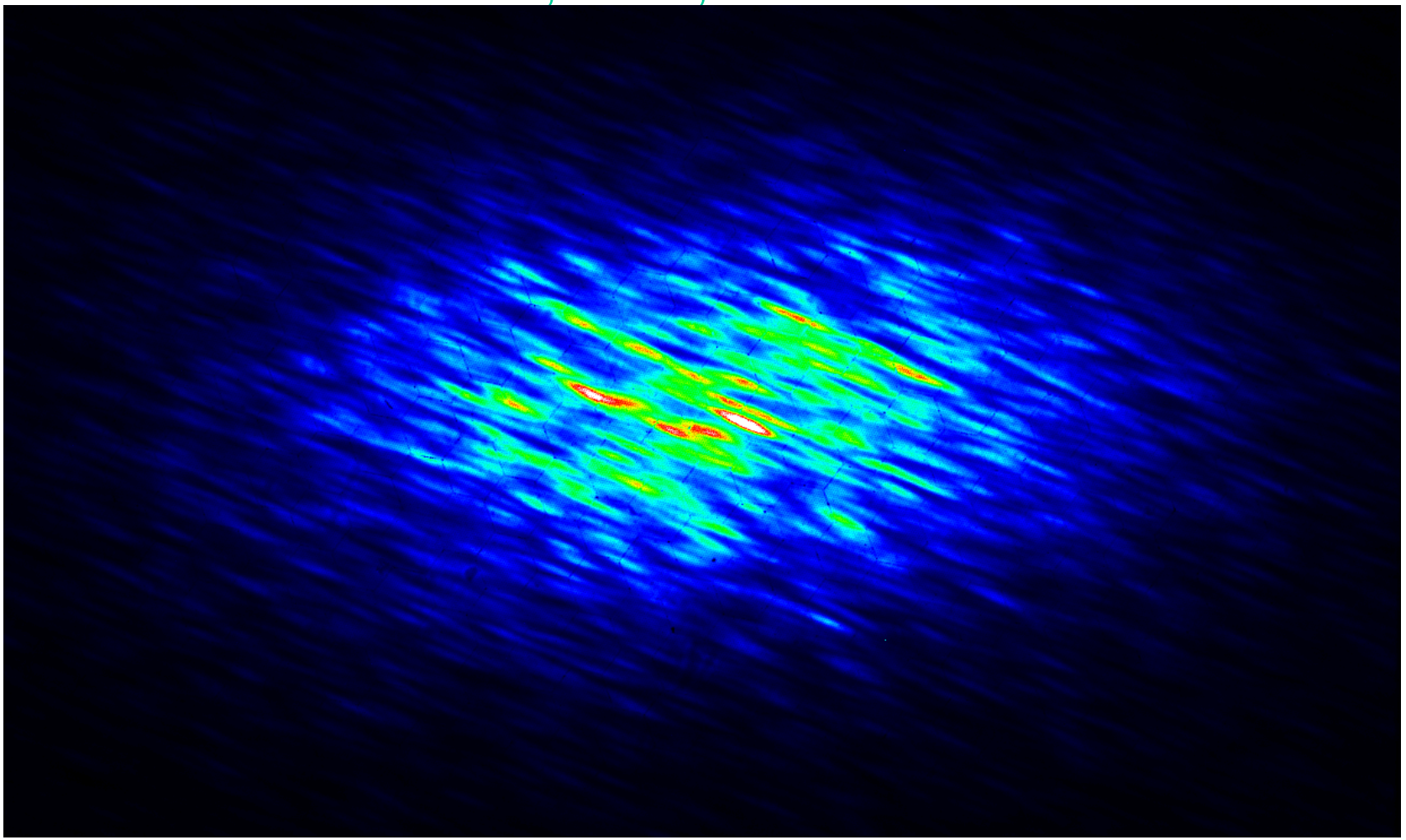
Epitaxial growth effects



Niobium (110) Thin Film Grains

1μm steps across 3μm beam of KB mirror focus

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

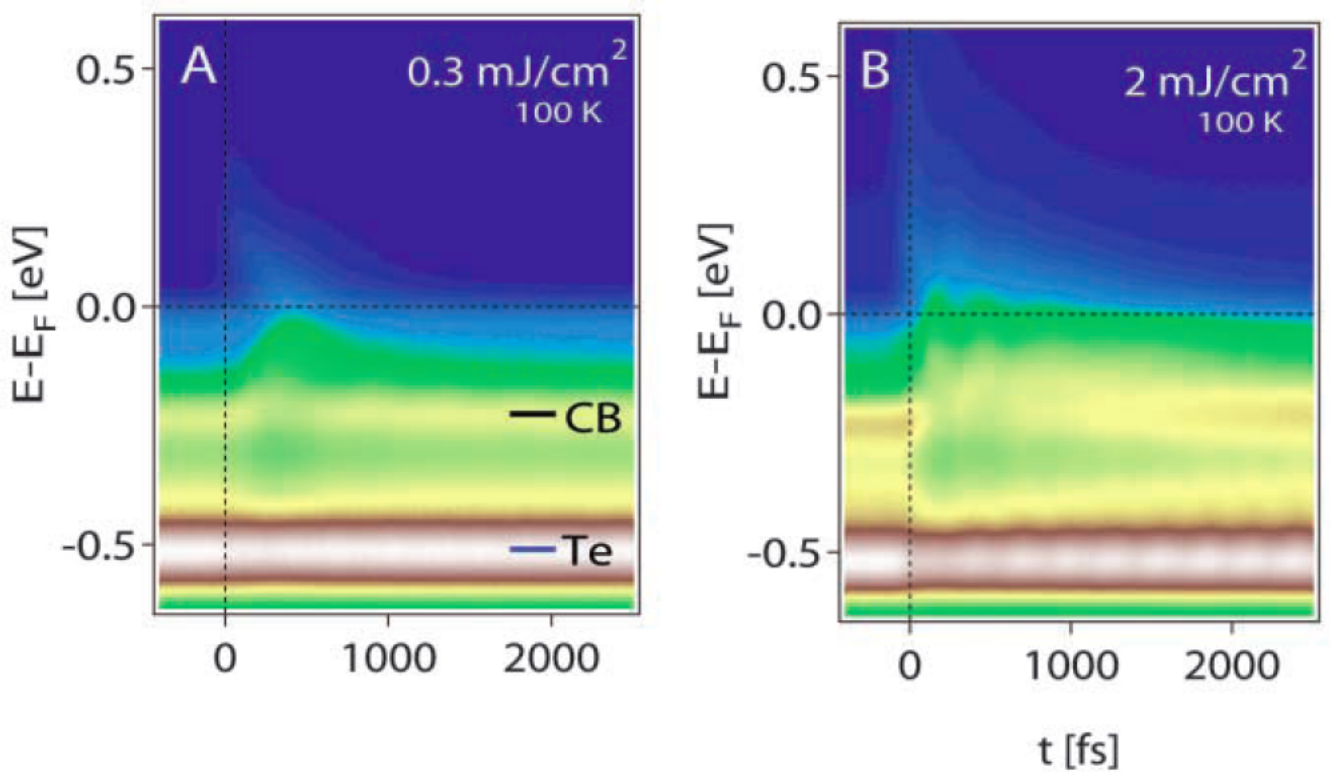


Charge Density Wave Dynamics

CDW excitation in $TbTe_3$ by 1.5eV IR pump

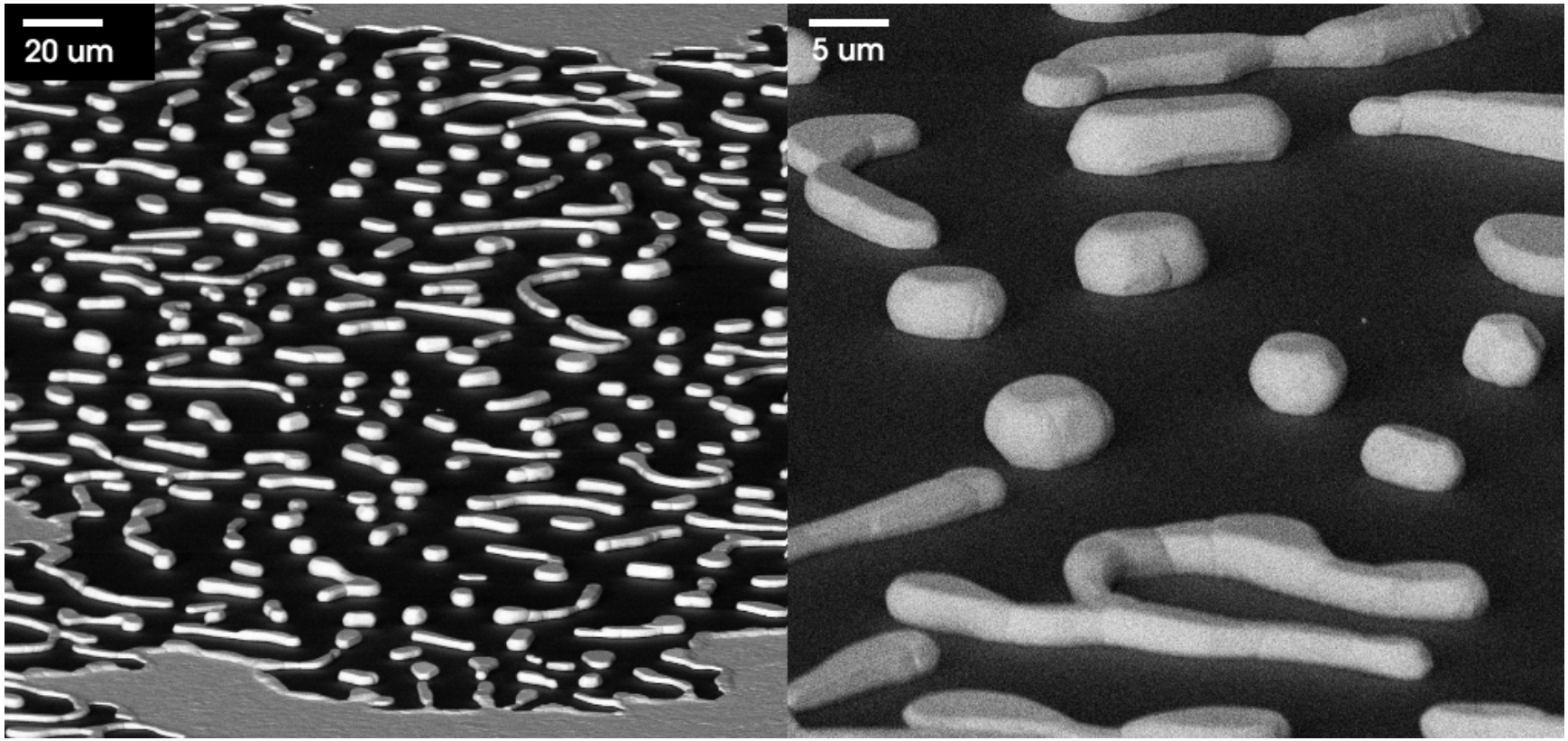
Schmitt et al, Science 321 1649 (2008)

Z-X Shen ARPES group at ALS

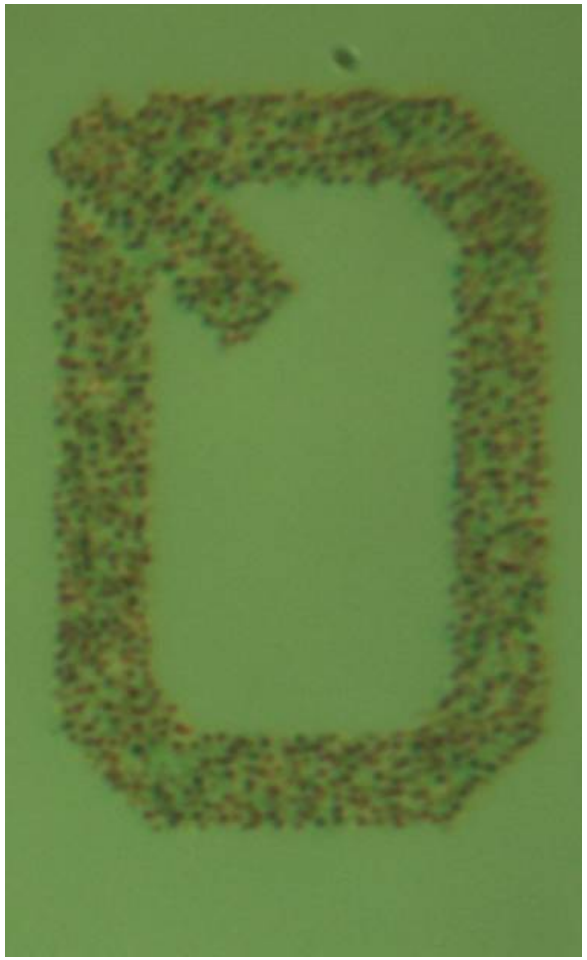


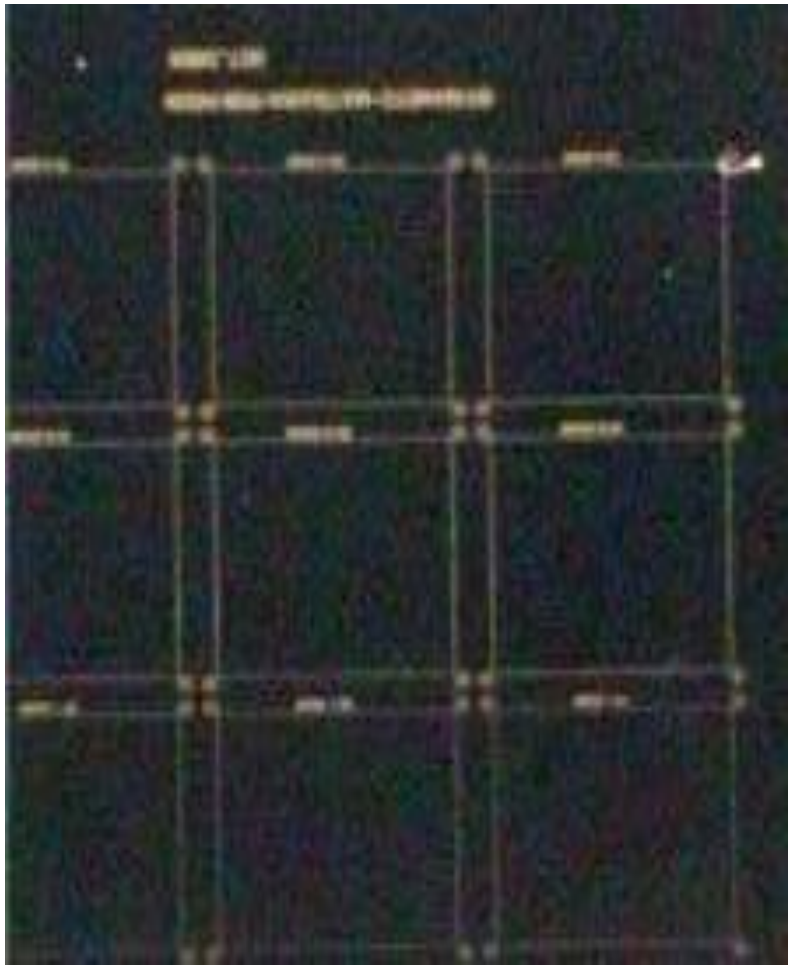
Dewetting to coalesce into crystals

Garth Williams thesis (2005)



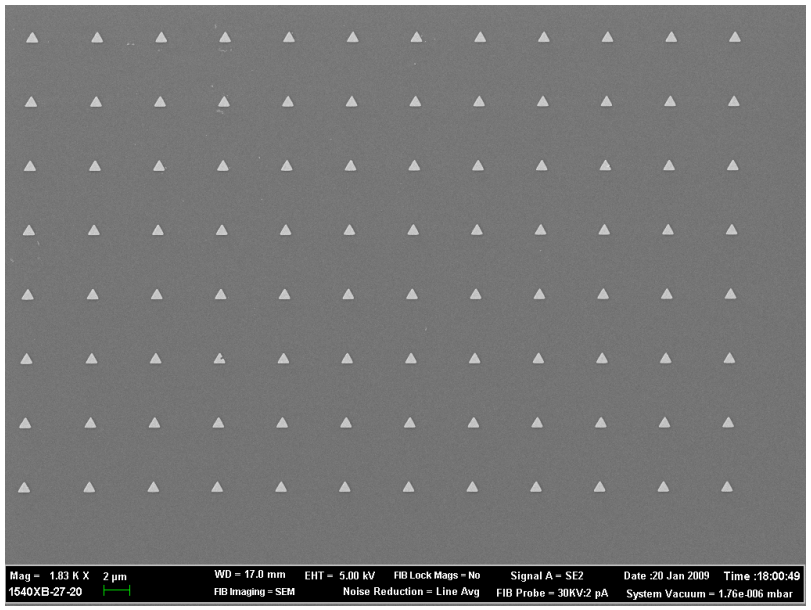
Annealing of Patterned Substrates

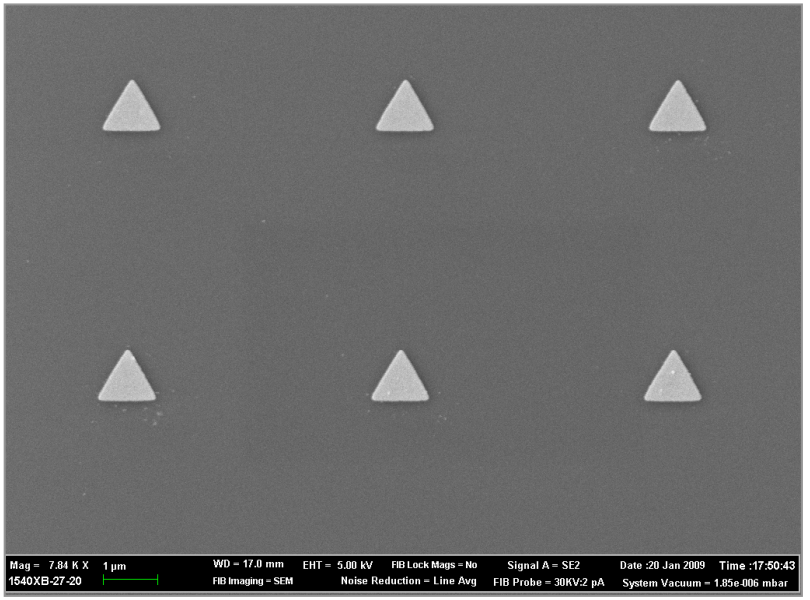




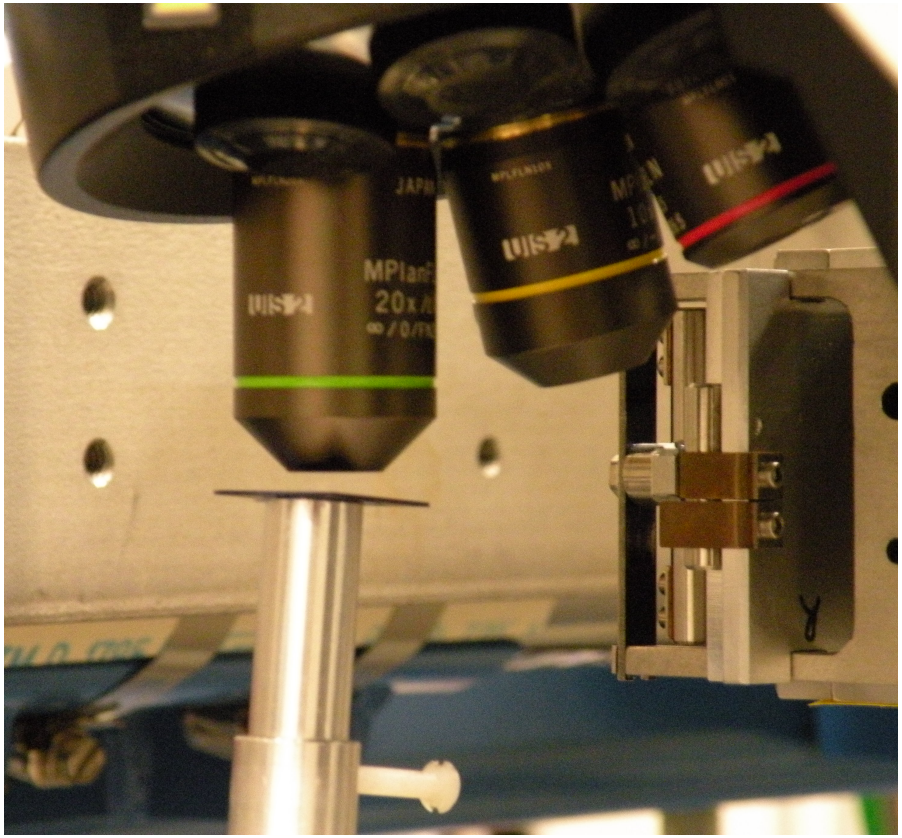
Patterned Au nanocrystal samples

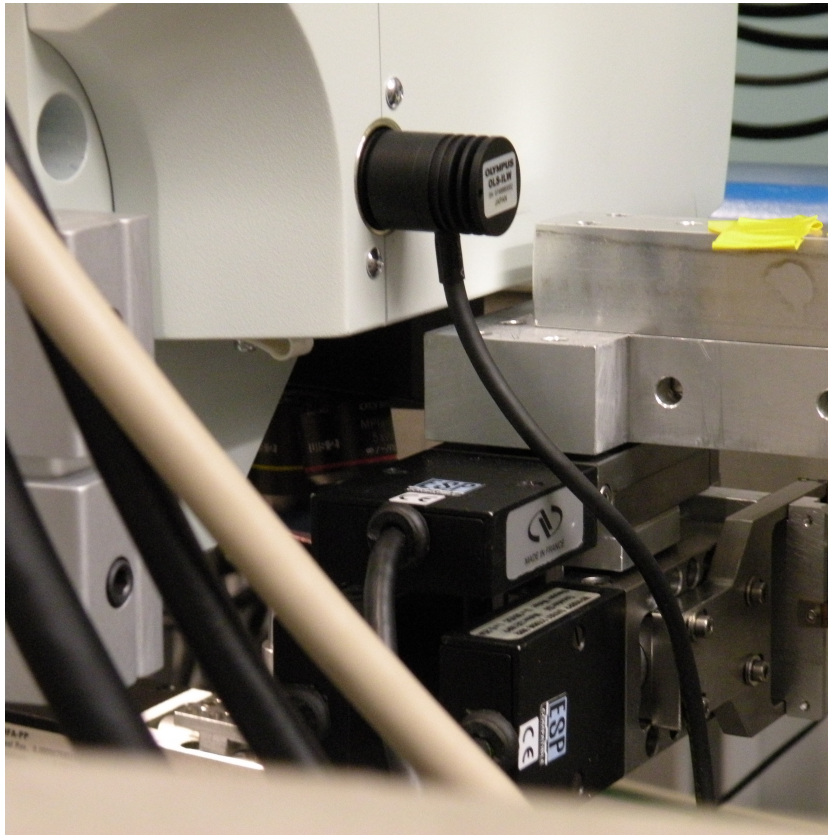
N. Shimamoto, Waseda University, Japan

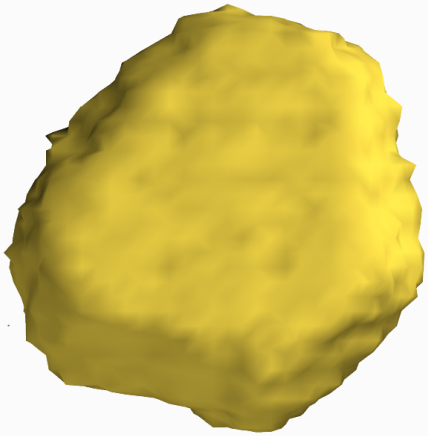




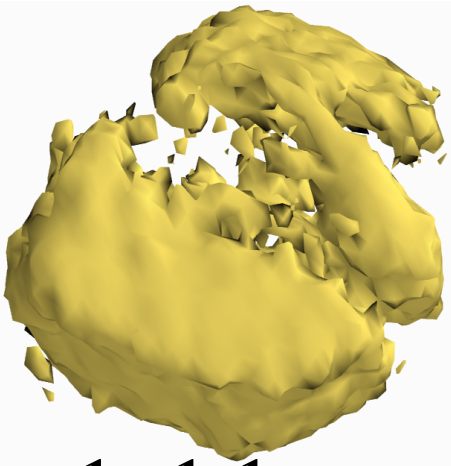
Confocal Alignment Microscope







1,1,-1



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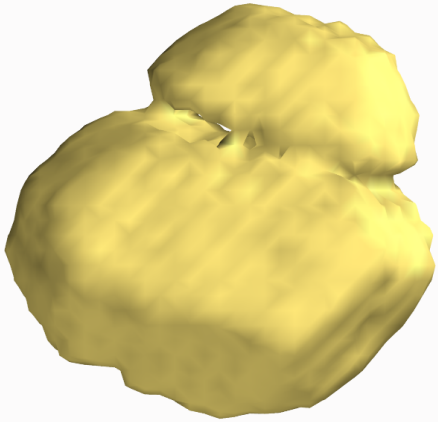
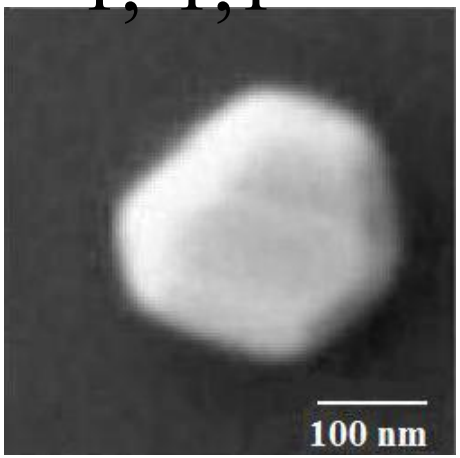
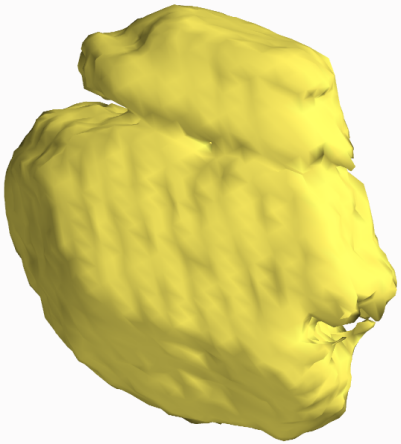
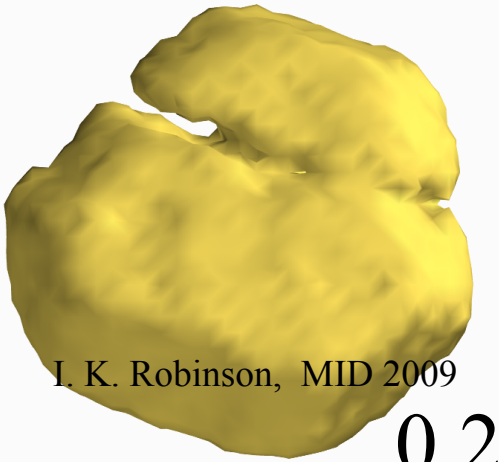


-1,1,1



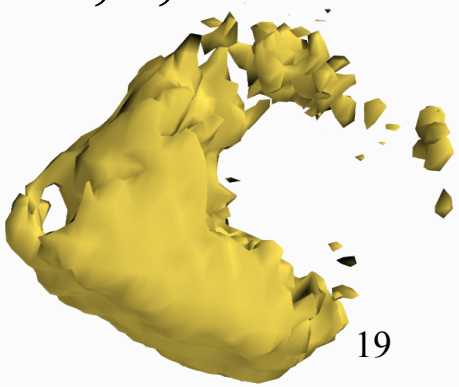
2,0,0





0,2,0

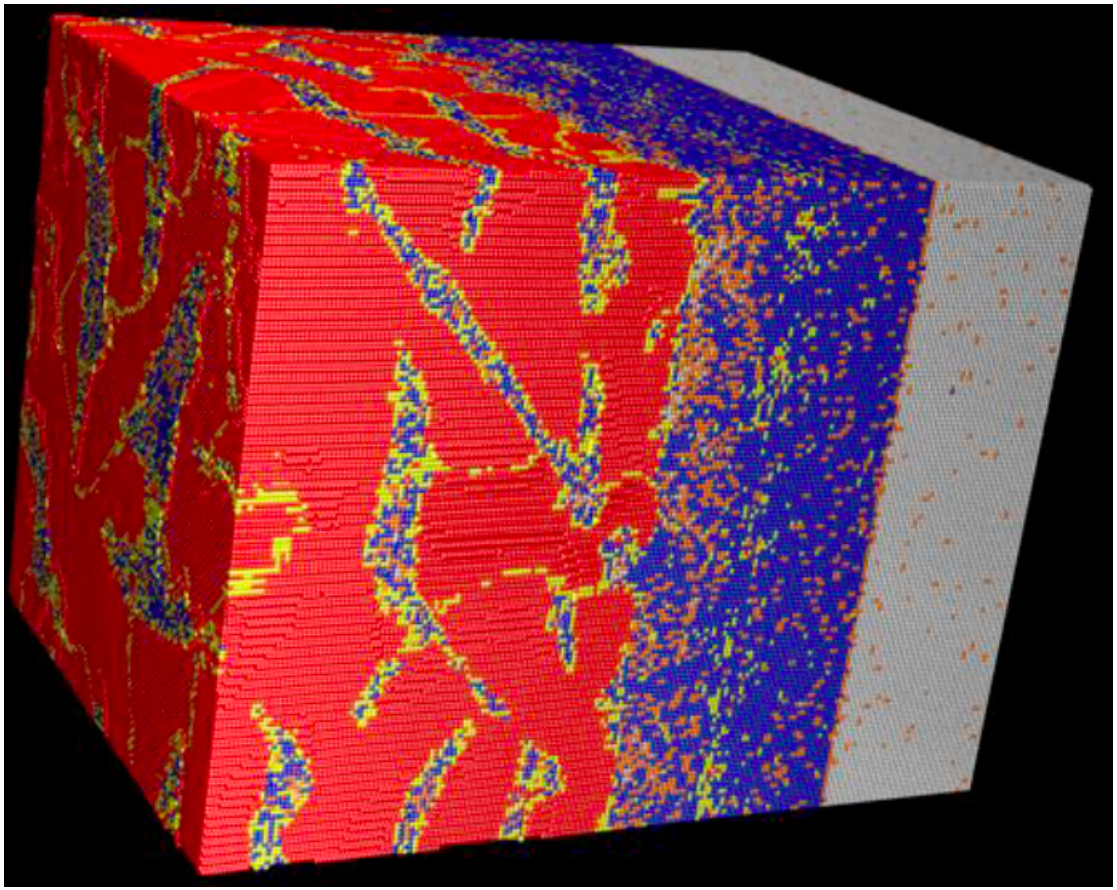
0,0,2



MD simulation of Shock Wave

Damage in Fe along (001) direction

K Kadau, TC Germann, PS Lomdahl, and BL Holian. Science, 296 1681 2002



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 $>10^5$