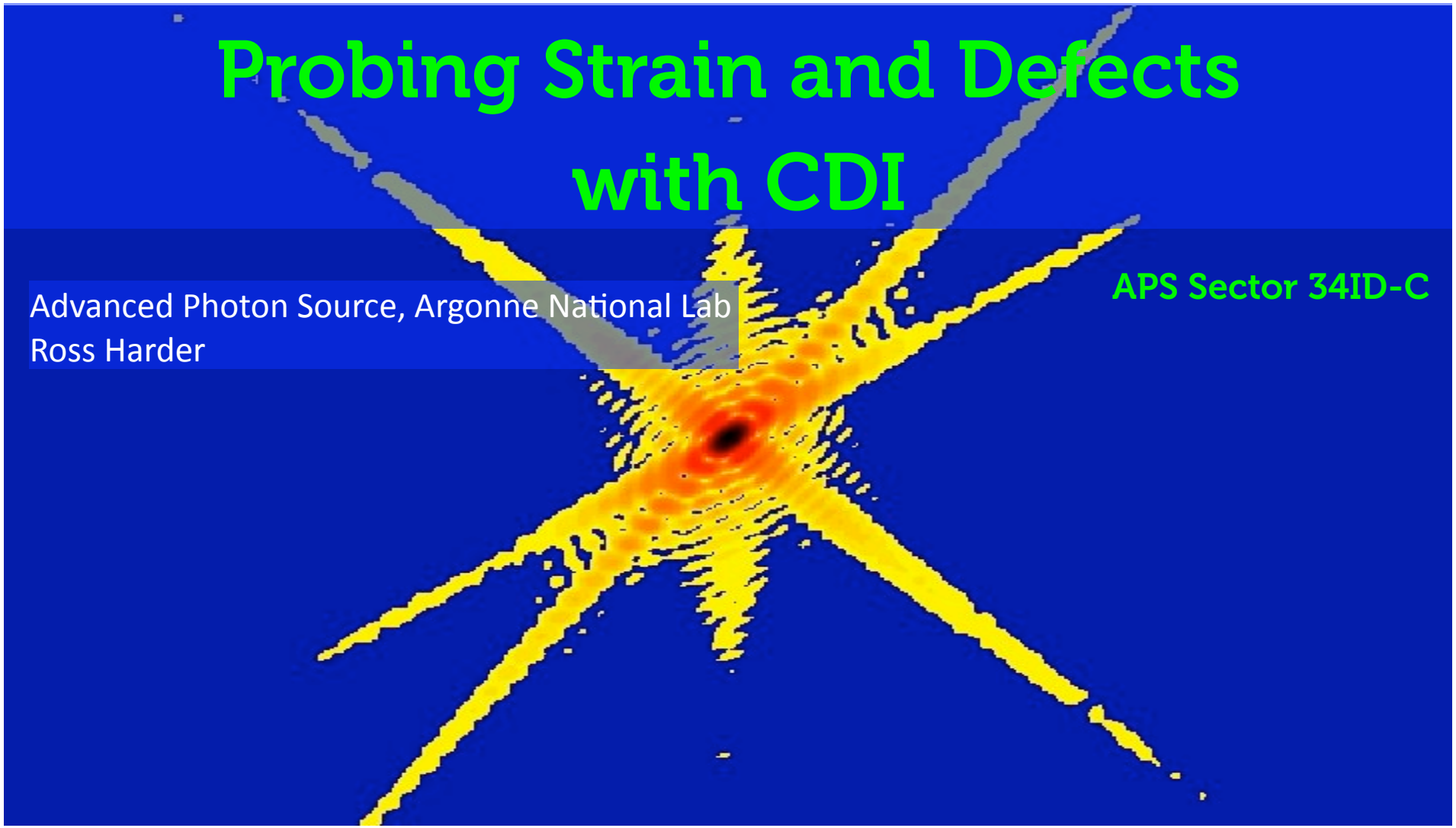
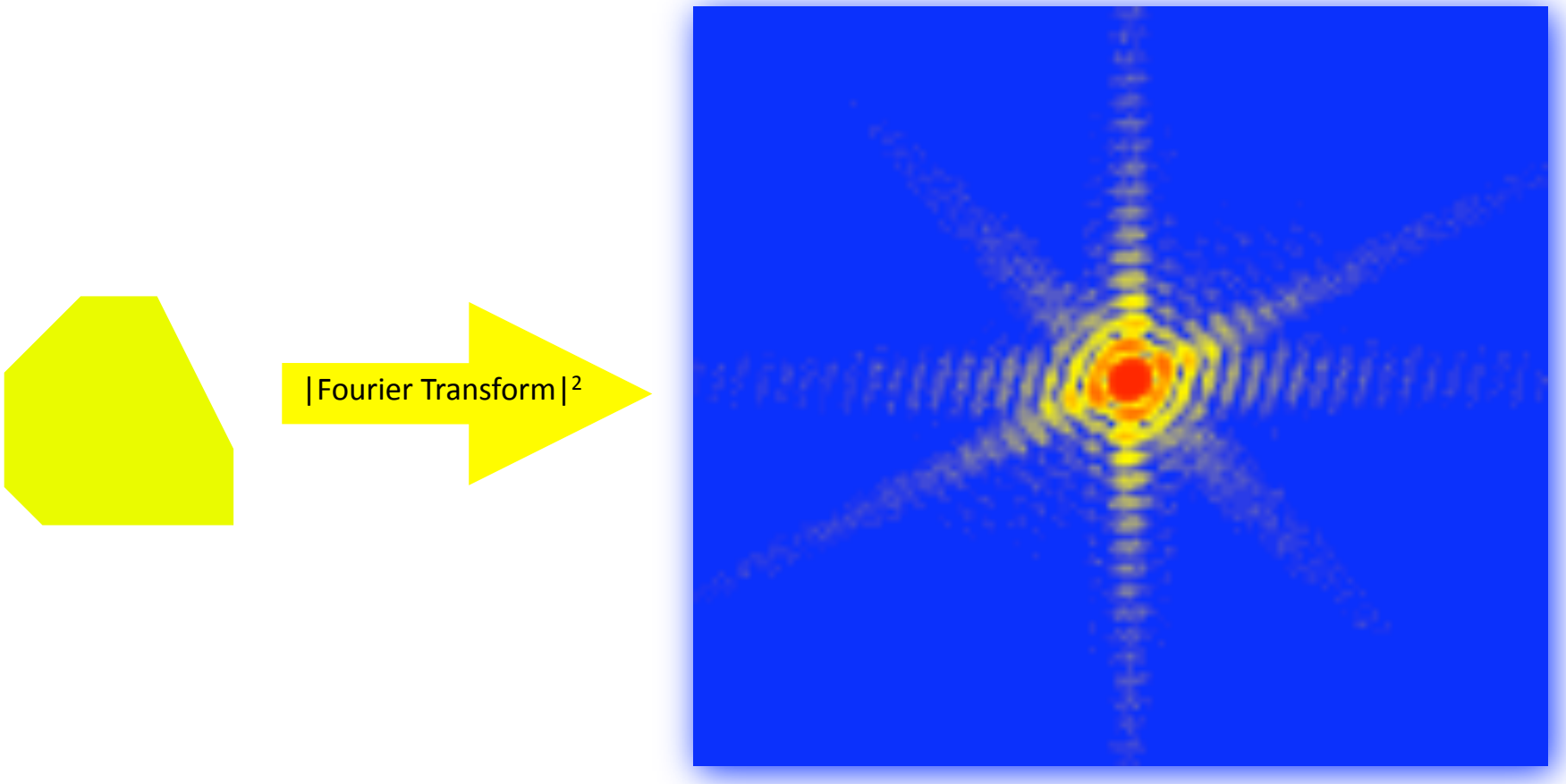
Probing Strain and Defects with CDI

Advanced Photon Source, Argonne National Lab
Ross Harder

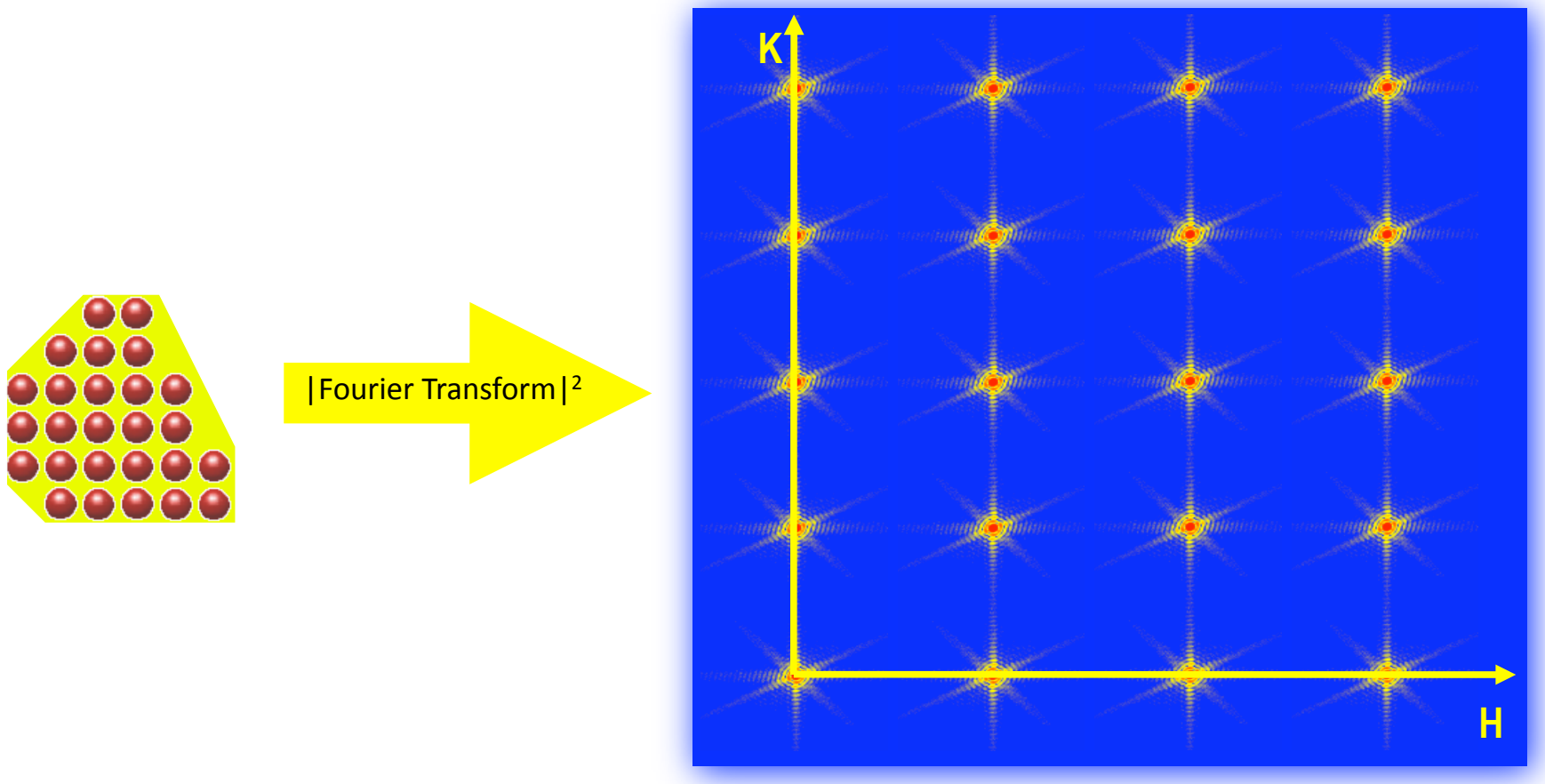
APS Sector 34ID-C



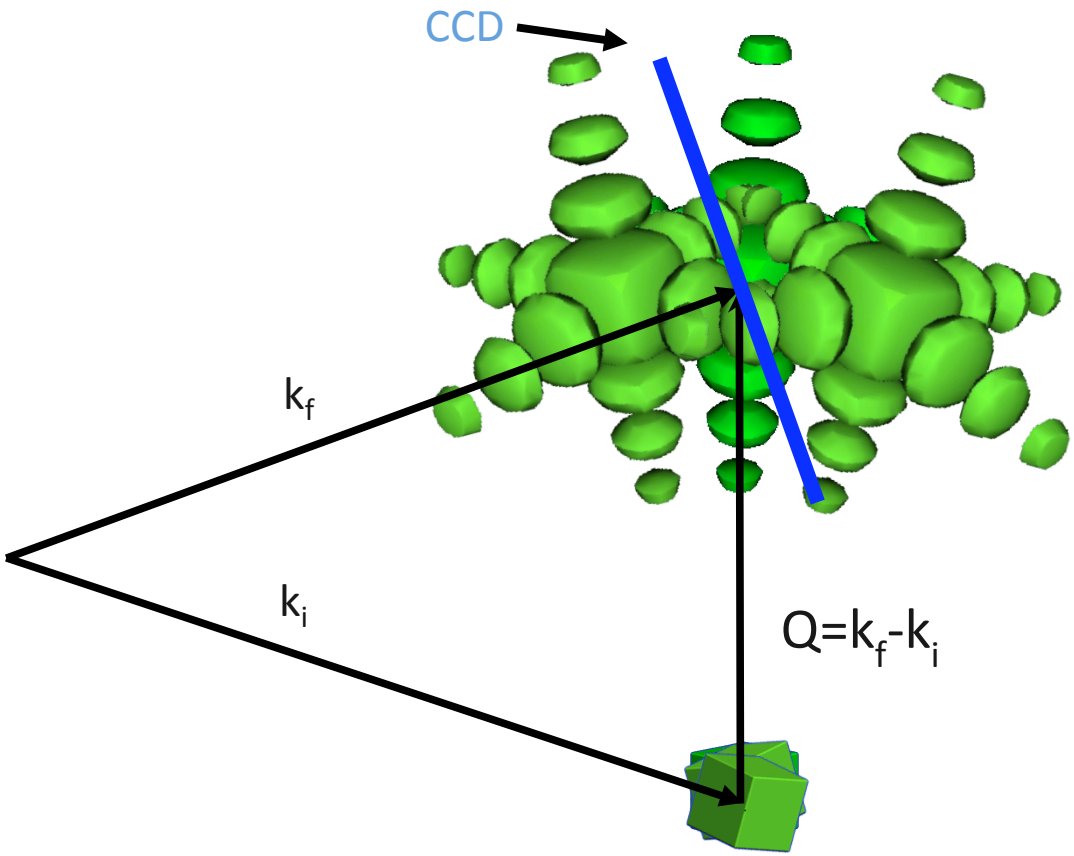
Coherent Diffraction from Crystals



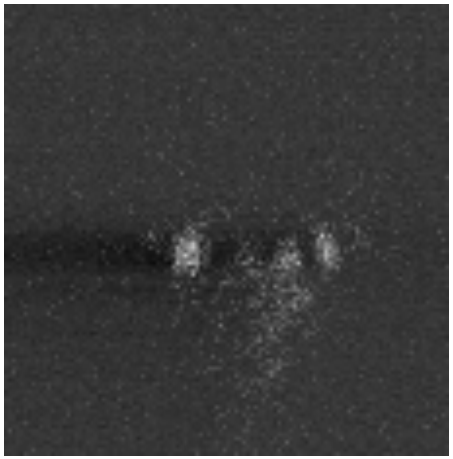
Coherent Diffraction from Crystals

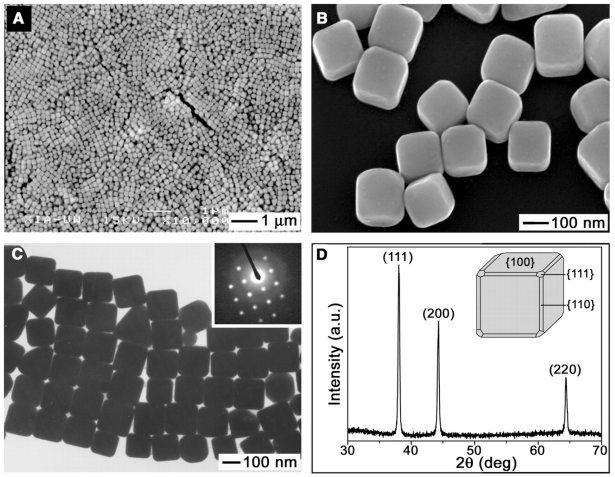


Measuring 3D CXD



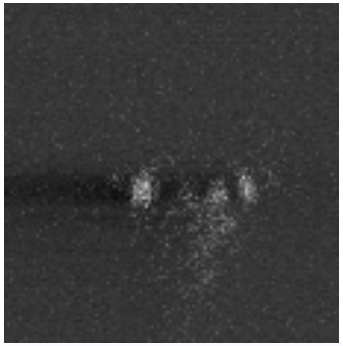
Silver Nano Cube (111)

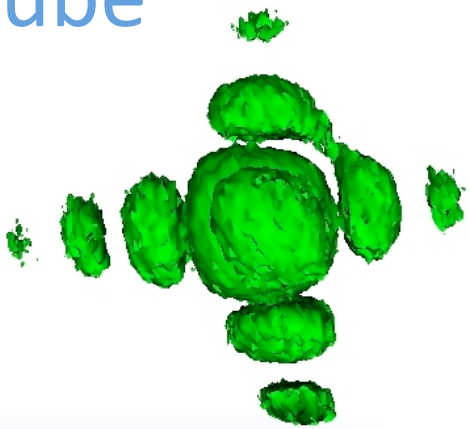


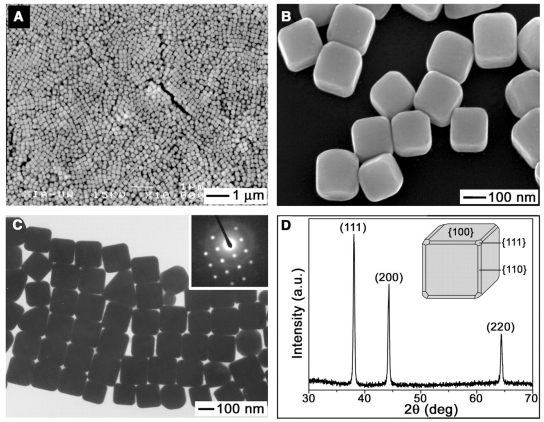


Yugang Sun and Younan Xia, Science 298 2177 (2003)

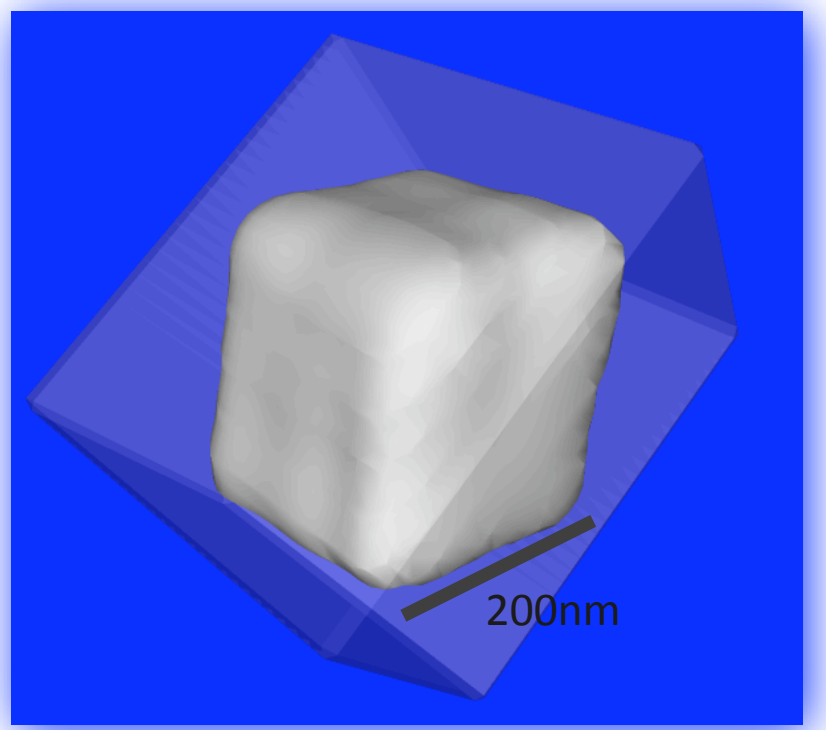
3D Ag Nano Cube

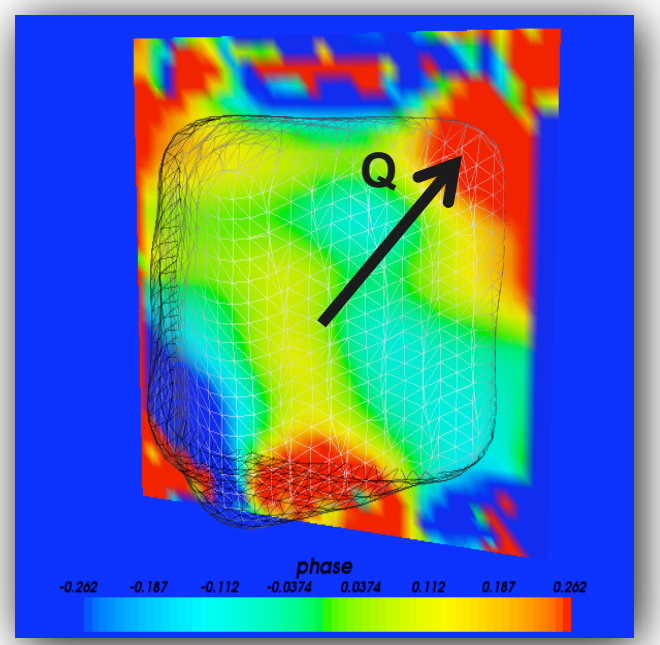




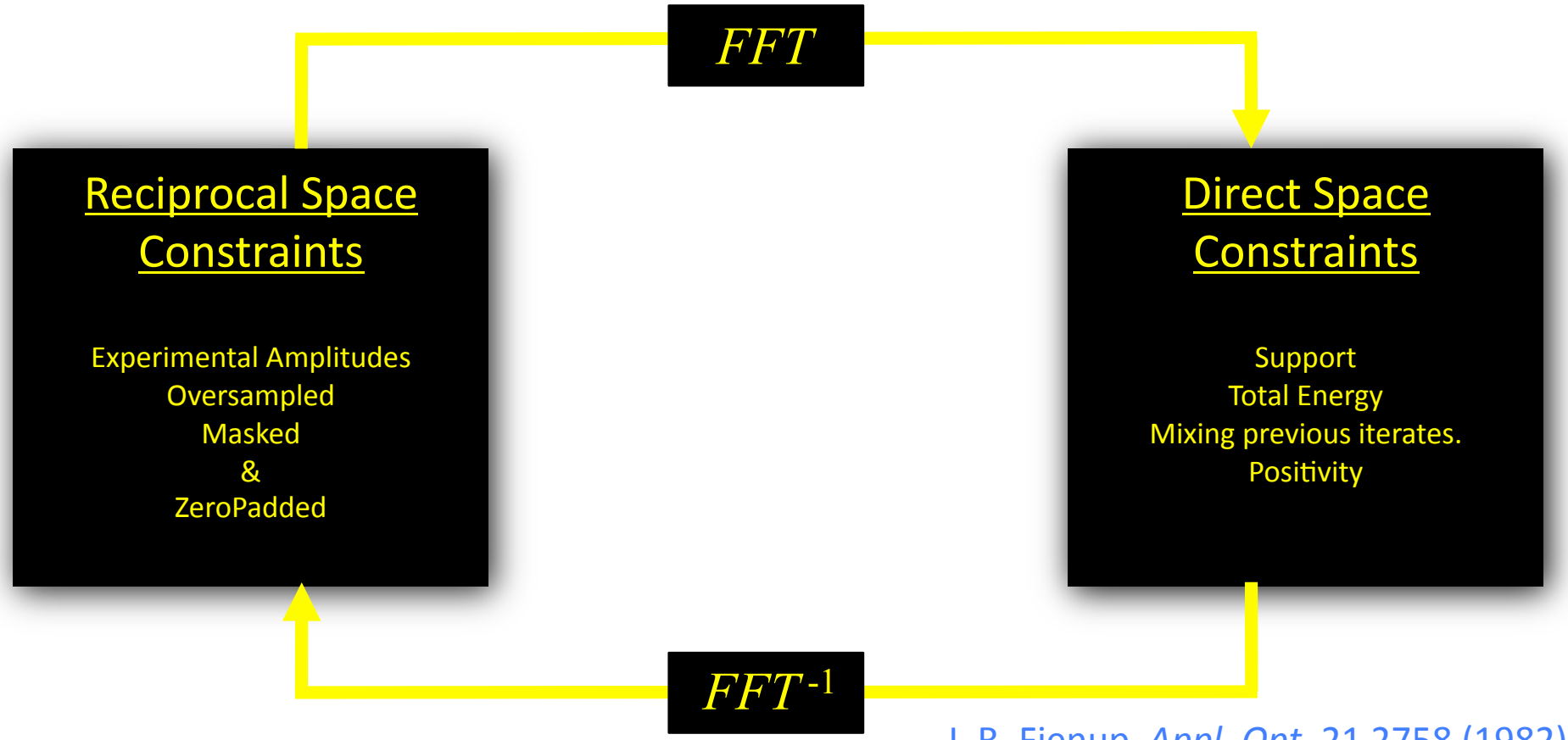


Yugang Sun and Younan Xia, Science 298 2177 (2003)



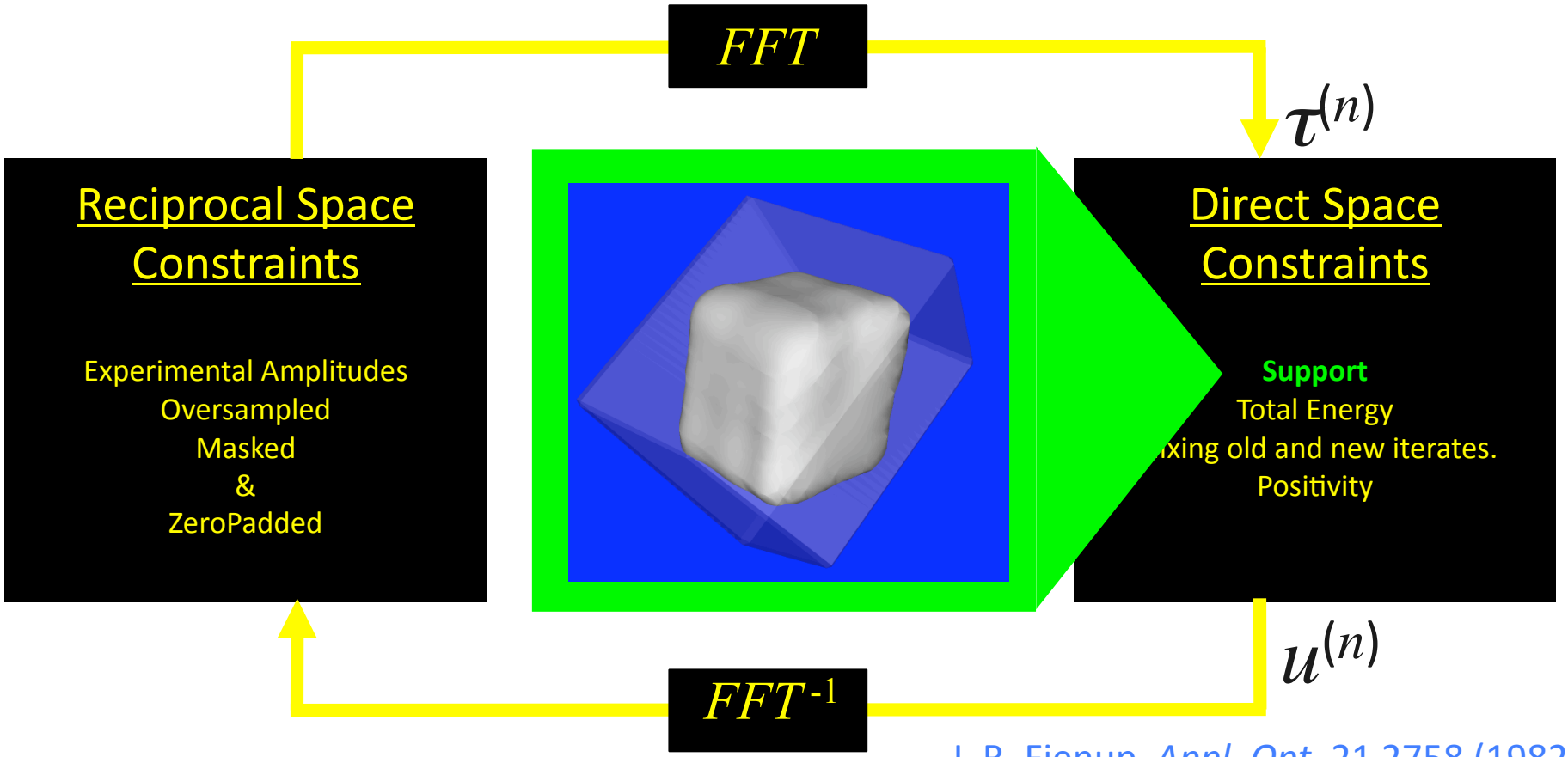


Input-Output Algorithms



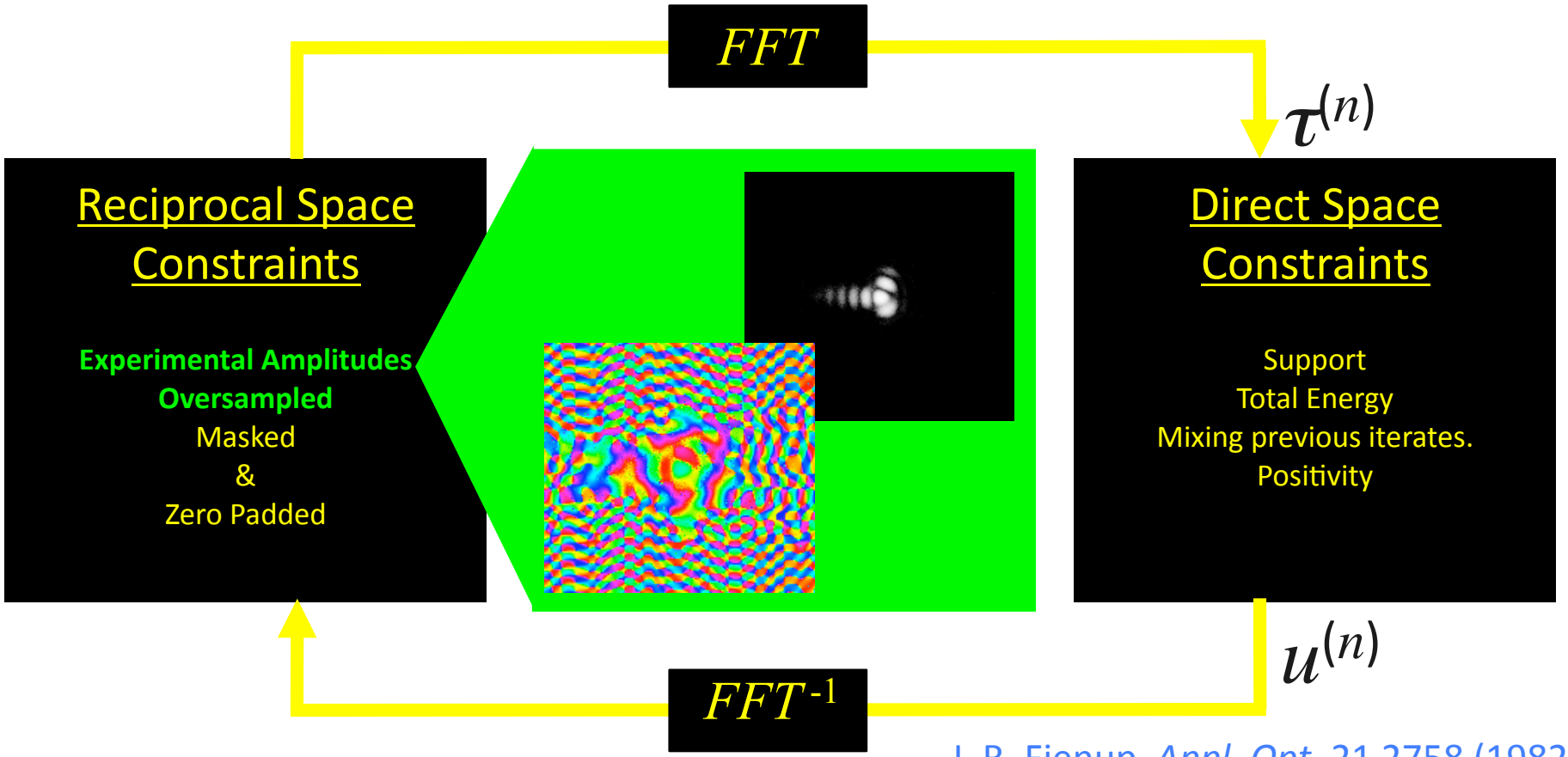
J. R. Fienup *Appl. Opt.* 21 2758 (1982)
Collins *Nature* 298, 49 (1982)
R. W. Gerchberg and W. O. Saxton *Optik* 35 237 (1972)

Input Output Algorithms



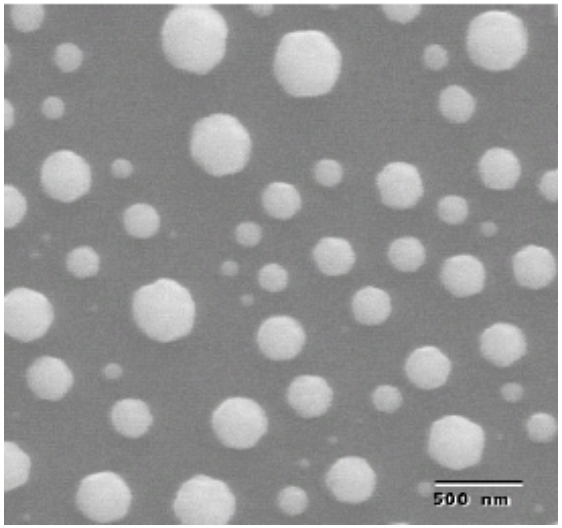
J. R. Fienup *Appl. Opt.* 21 2758 (1982)
Collins *Nature* 298, 49 (1982)
R. W. Gerchberg and W. O. Saxton *Optik* 35 237 (1972)

Input Output Algorithms

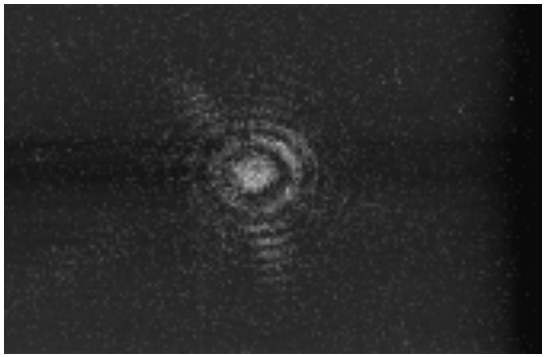


J. R. Fienup *Appl. Opt.* 21 2758 (1982)
Collins *Nature* 298, 49 (1982)
R. W. Gerchberg and W. O. Saxton *Optik* 35 237 (1972)

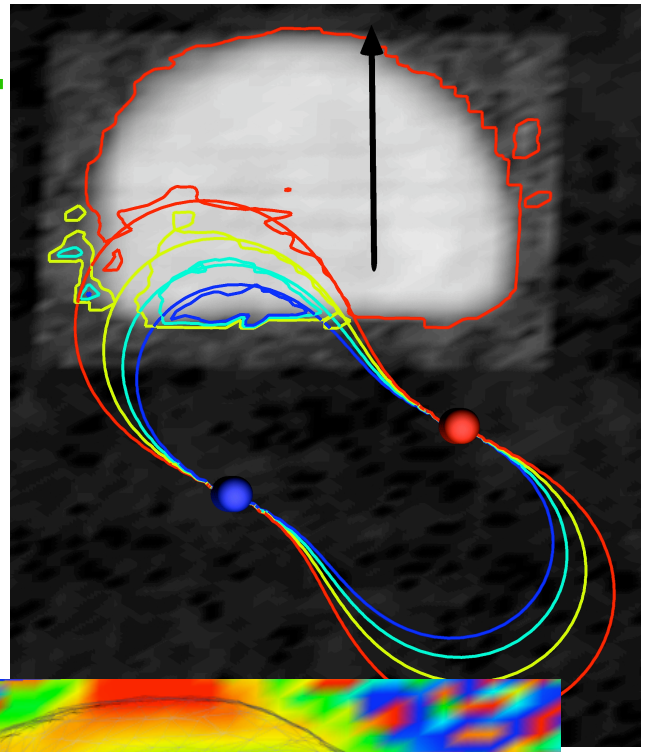
3D Reconstruction of Lead



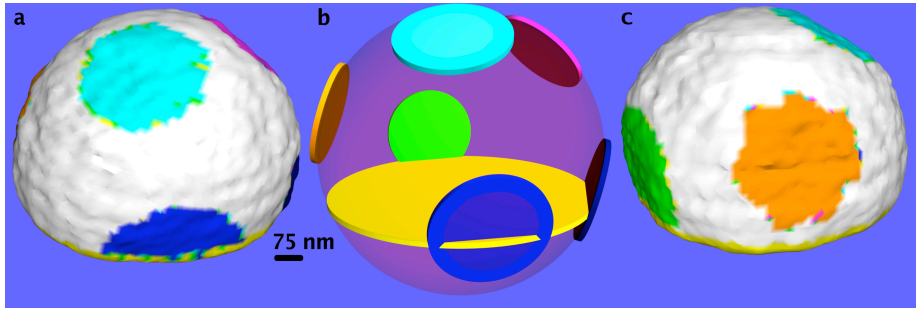
(111) Bragg spot

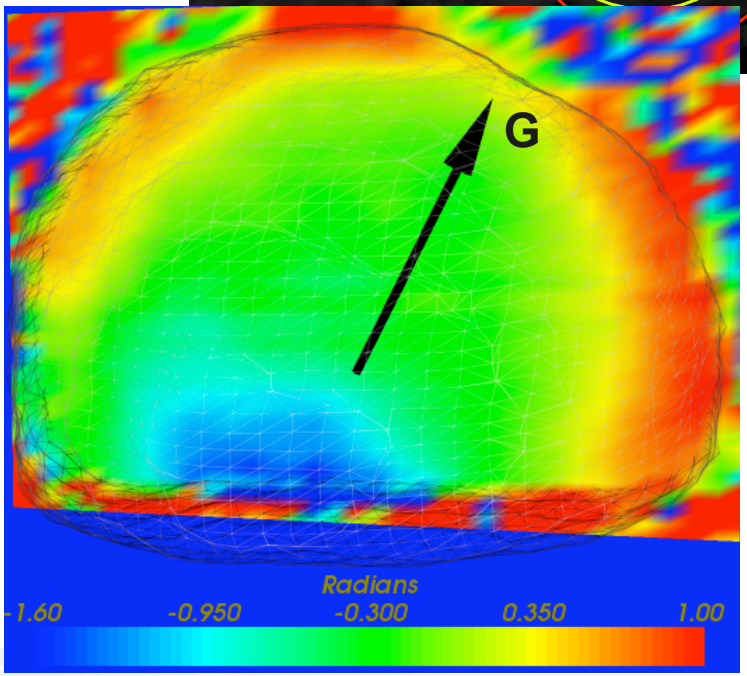


7.9 hour scan
2.1 hour x-ray exposure

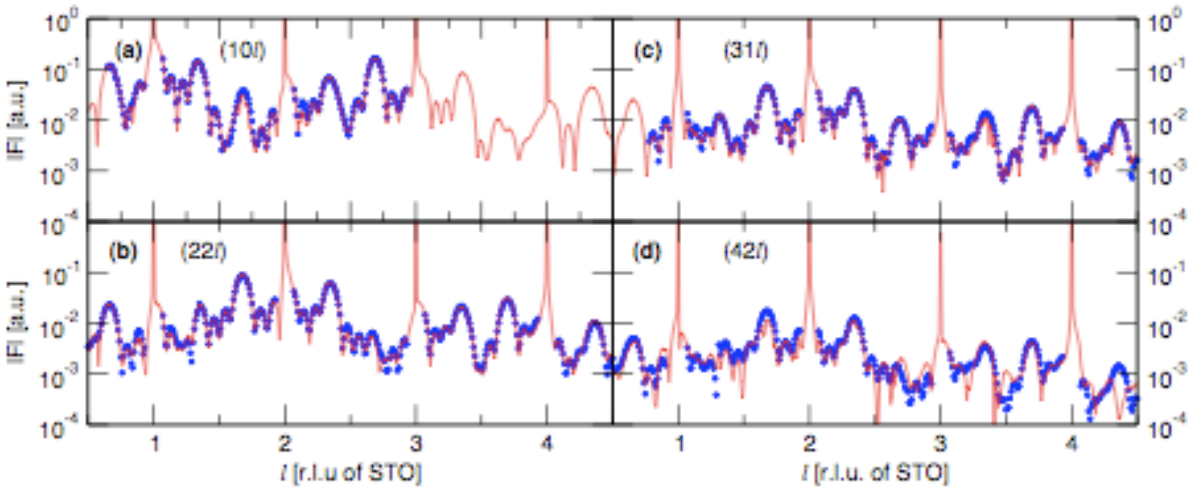


Nature, Vol. 442 p. 63 (July 6 2006)
PhysRevB.76.115425 (2007)





Surface X-ray Diffraction



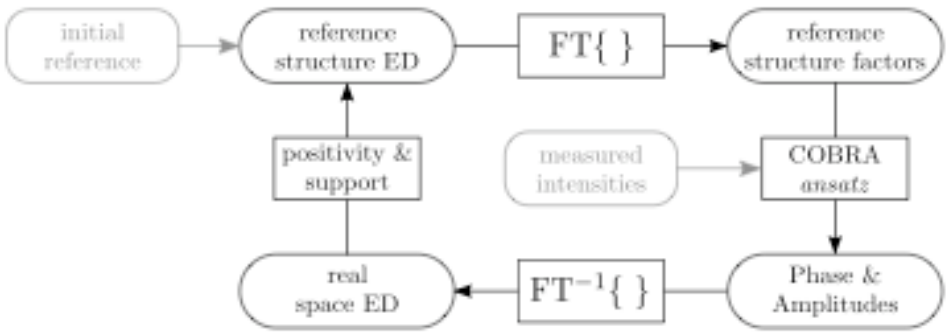
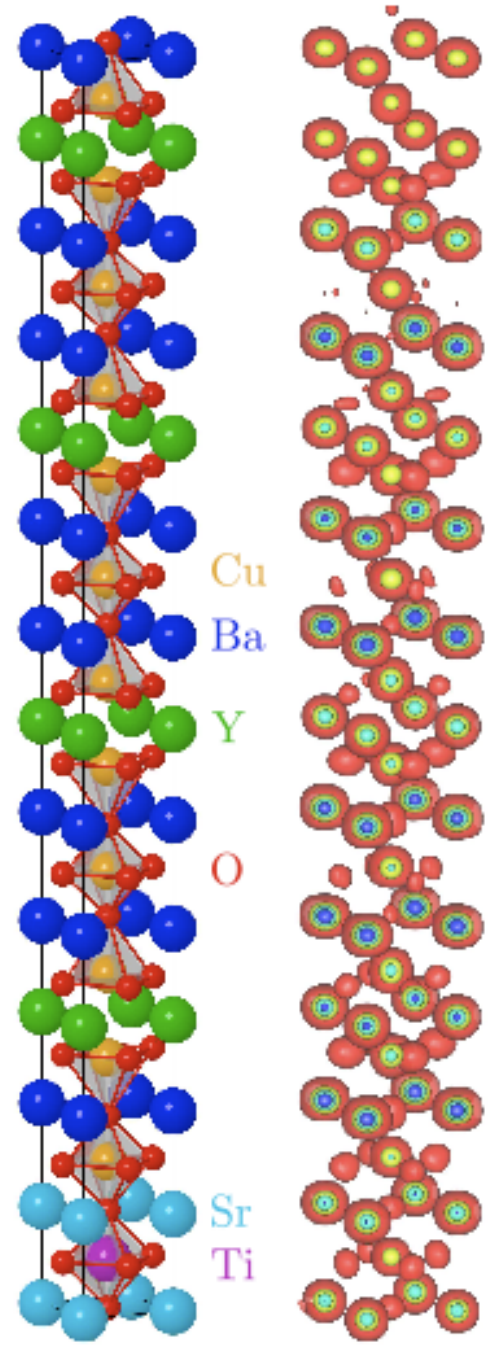


Figure 3.7: Iteration scheme of the COBRA method.

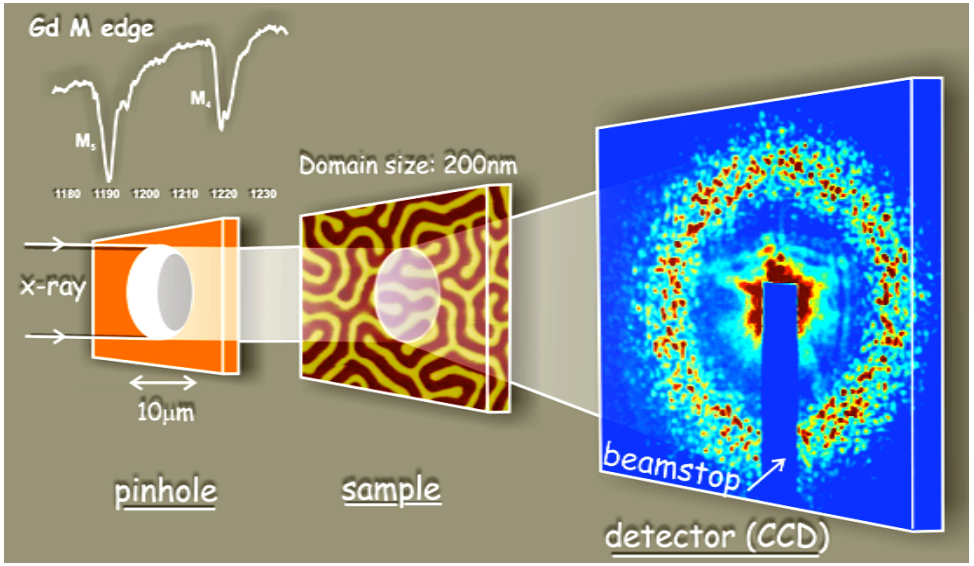


(a) Model (b) DCAF

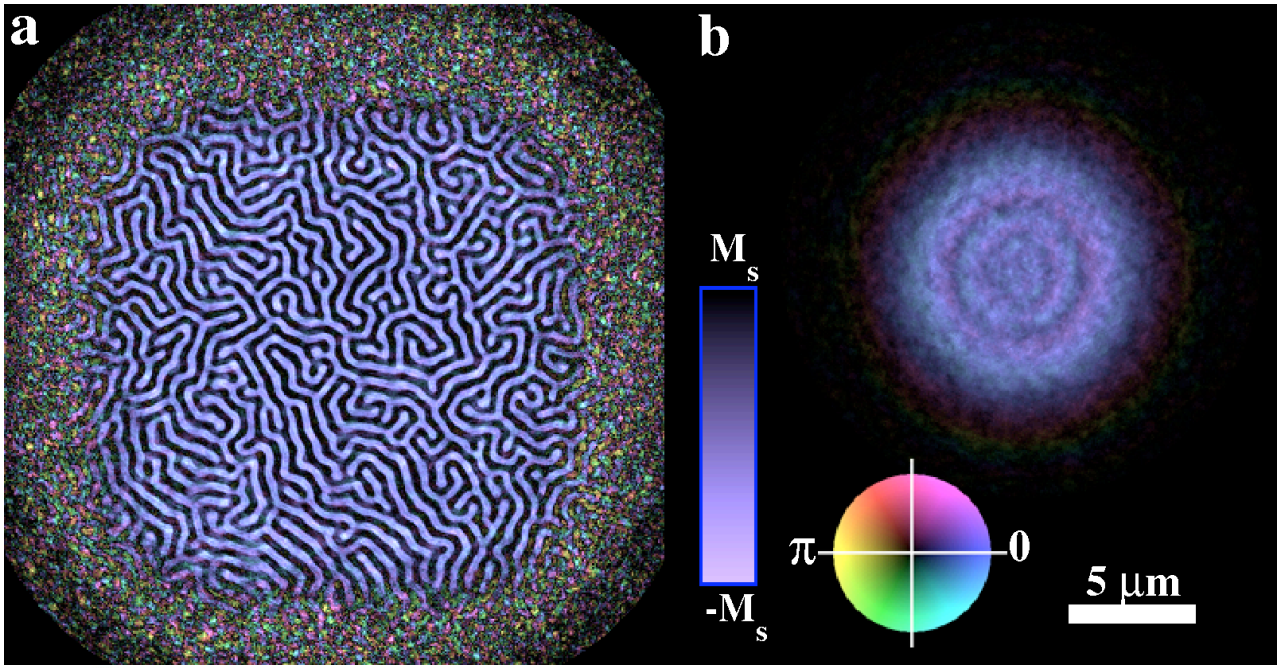
Schlepütz et al.
Structure of ultrathin heteroepitaxial superconducting YBCO films.
Phys. Rev. B (2010) vol. 81 (17) pp. 174520

Scanning CDI @ APS 2-ID-B (Ptychography)

Imaging an “arbitrary” field of view at high resolution.



Tripathi et al. Dichroic coherent diffractive imaging. Proceedings of the National Academy of Sciences (2011) vol. 108 (33) pp. 13393-13398

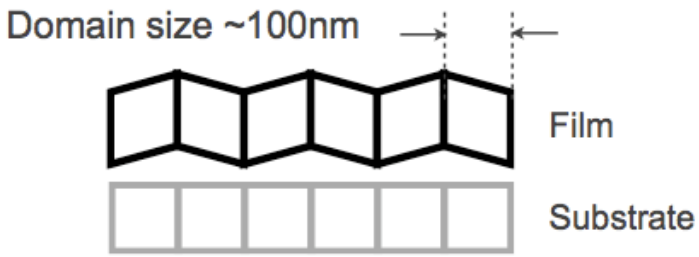


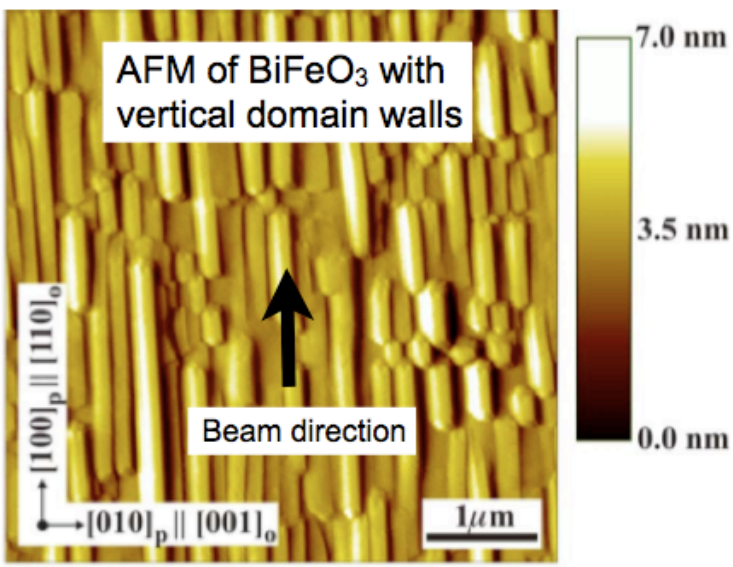
Magnetic Maze Domains in Gd/Fe Multilayers

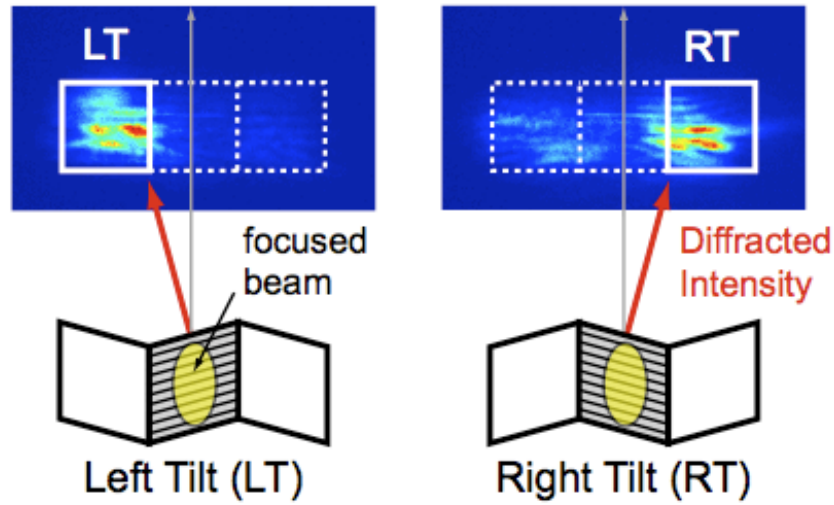
Bragg Scanning CDI @ APS 26-ID

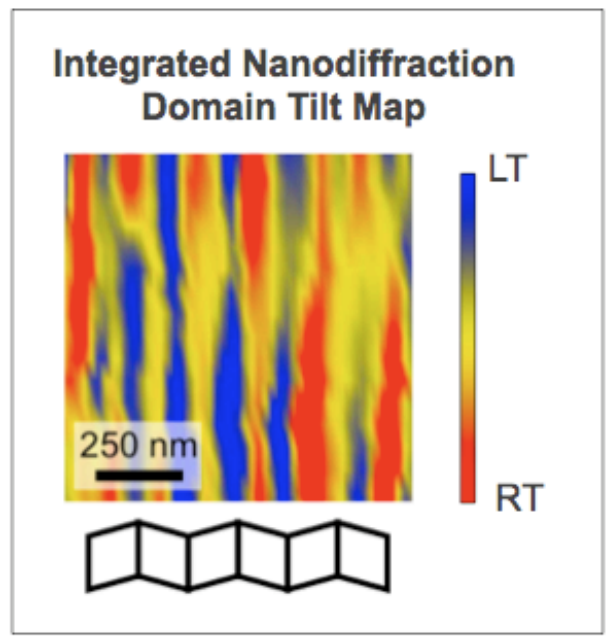
$BiFeO_3$ samples courtesy of
Chad Folkman (ANL-MSD) &
Professor Chang-Beom Eom (UW-Madison)

Scanning CDI
Stephan Hruszkewycz

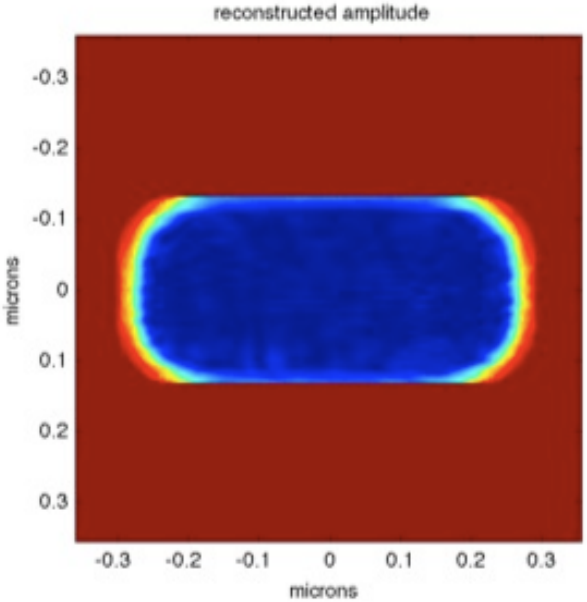


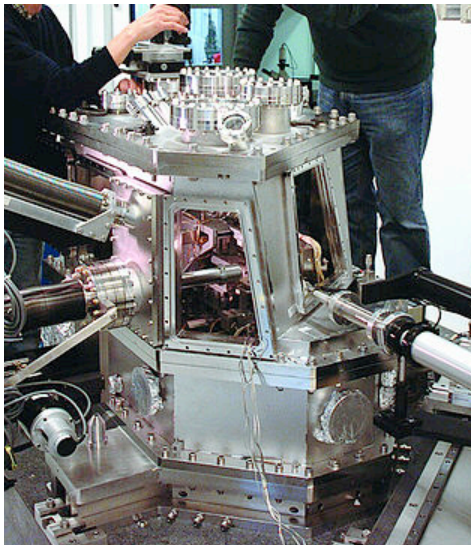


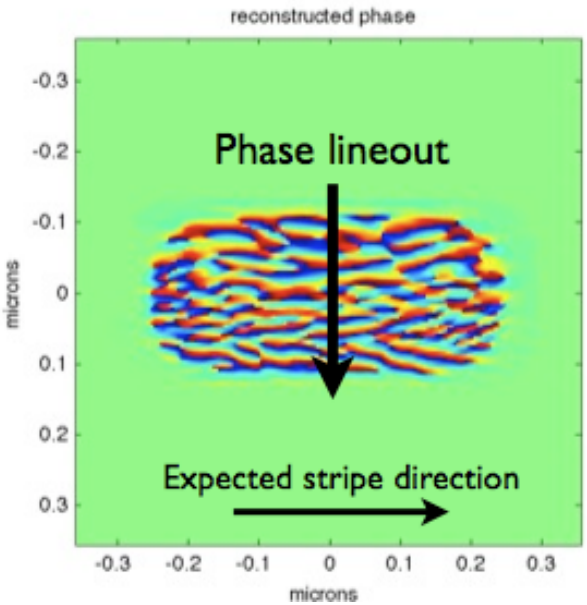




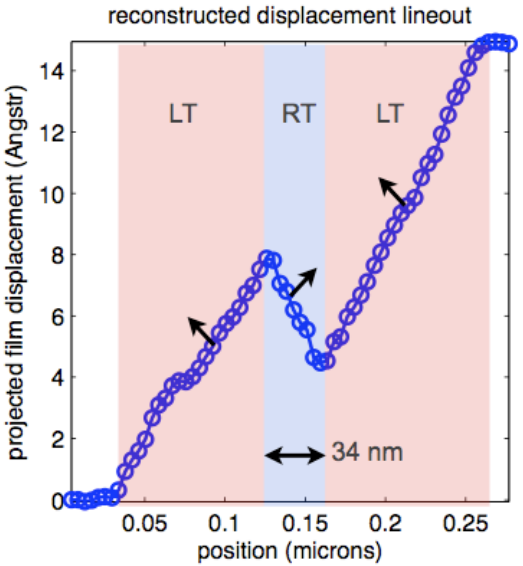
Bragg Scanning CDI @ APS 26-ID





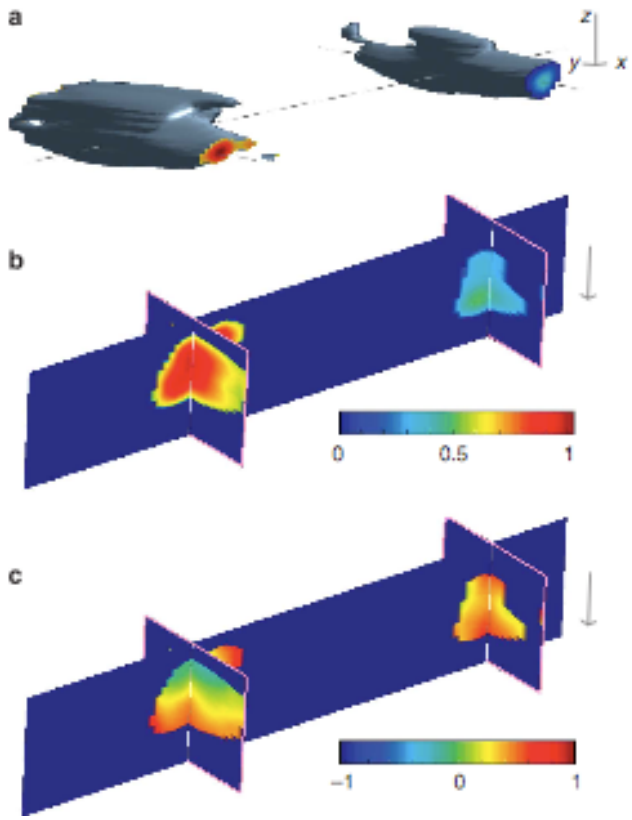


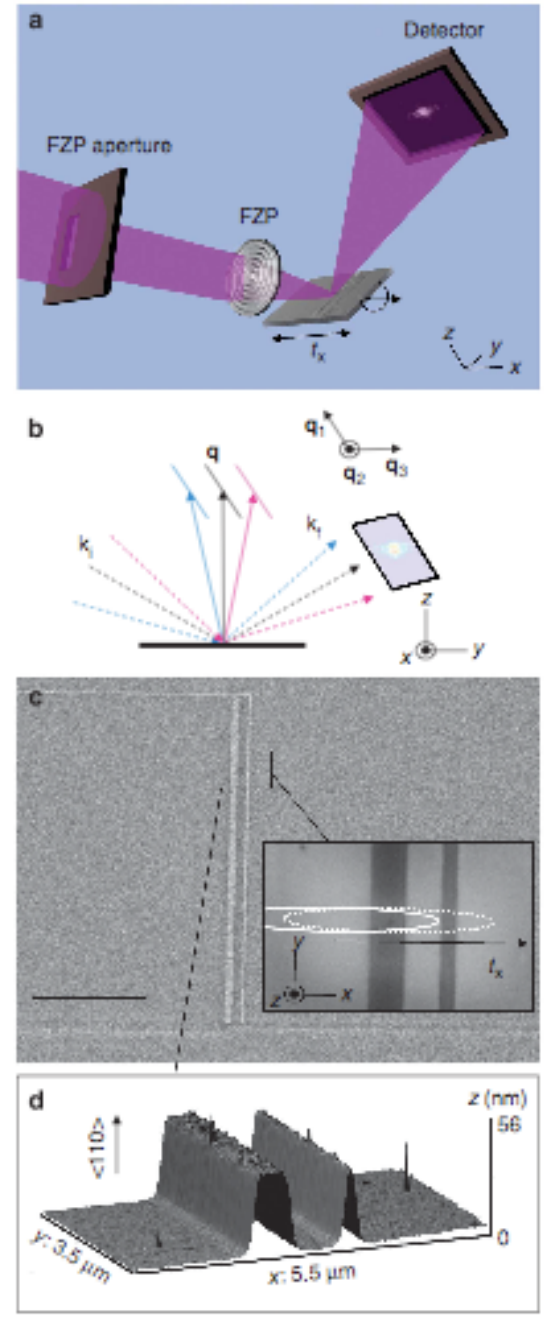
Is interferometer stabilized sample/optics required?



3D Bragg Scanning CDI @ ESRF ID01 ☹

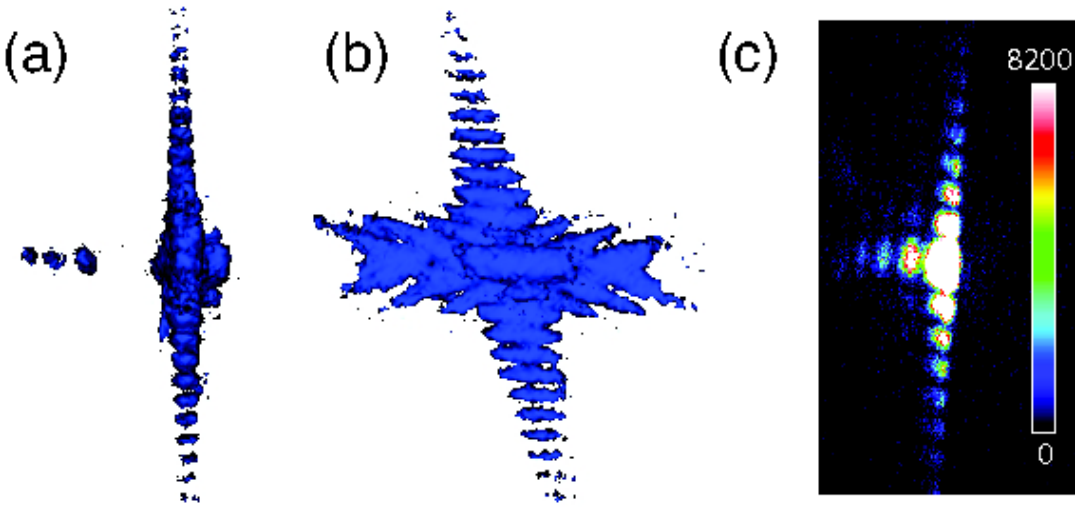
Imaging Silicon On Insulator (SOI) structures in 3D





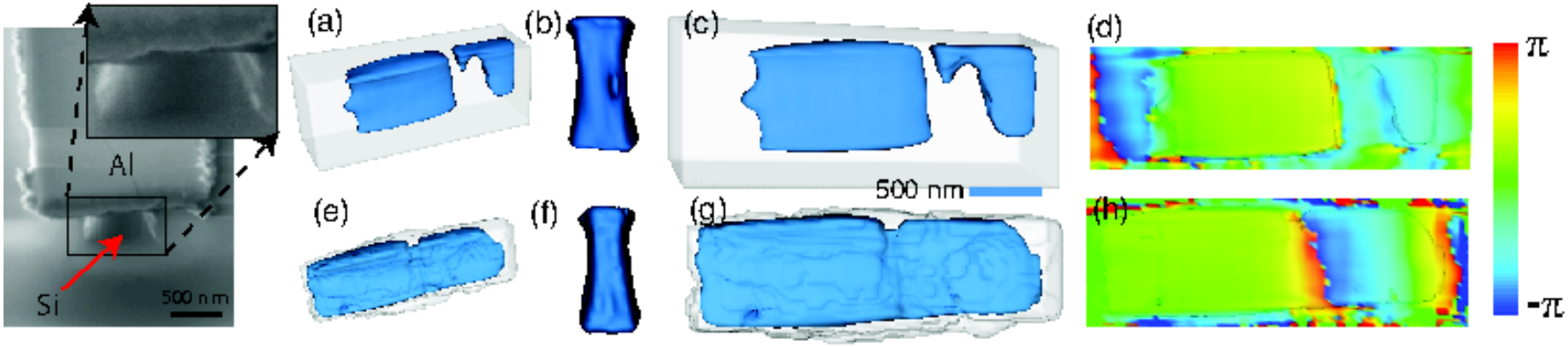
Godard et al.
Three-dimensional high-resolution quantitative microscopy of extended crystals.
Nat Commun (2011) vol. 2 pp. 568

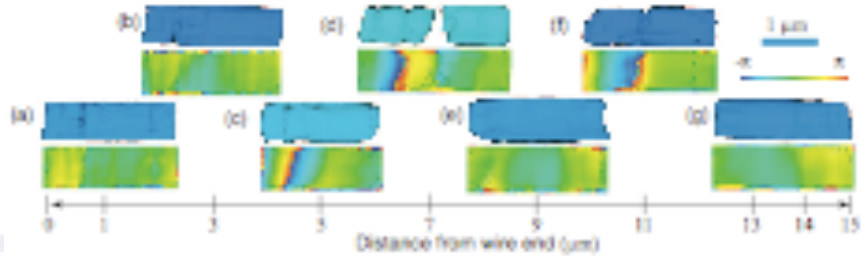
Highly Strained crystals?



Silicon on Insulator (SOI)
Reactive Ion Etched from a thin film
to form nanostructured “bars” or “wires”

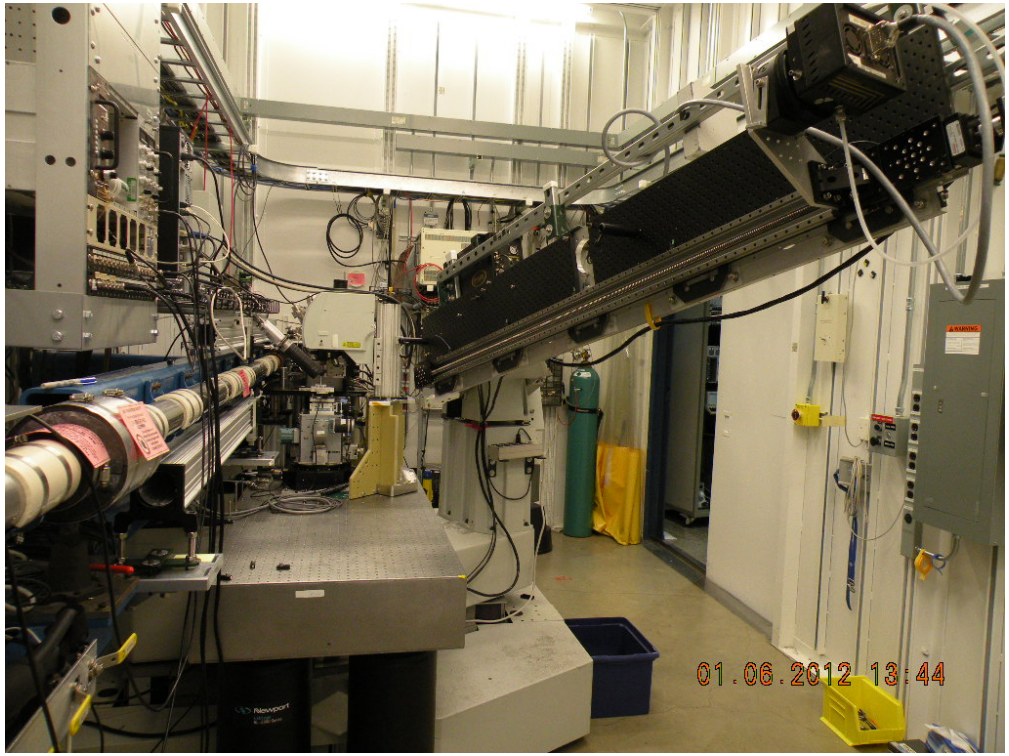
Imaged in sections at APS 34-ID-C

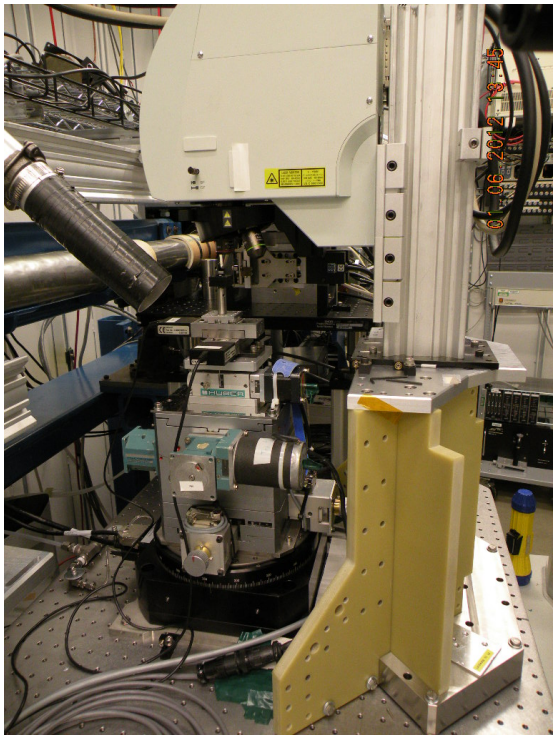




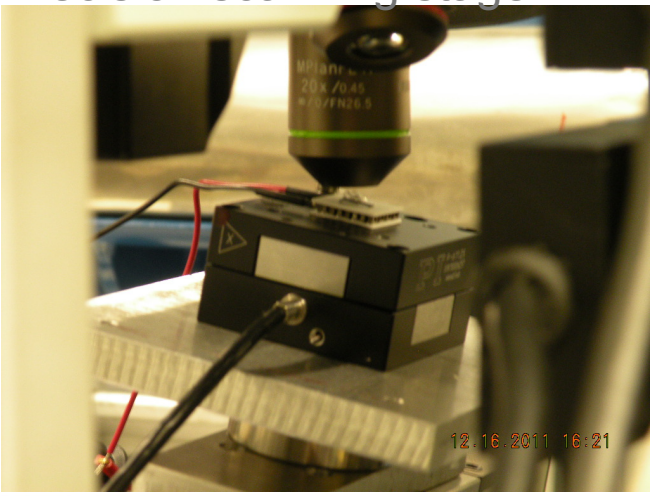
Huang et al.
Physical Review B (2011) vol. 83 (22) pp. 224109

Scanning CDI
@ APS 34-ID-C





Precision scanning stage



Scanning X-ray Diffraction Microscopy @ APS 34-ID-C

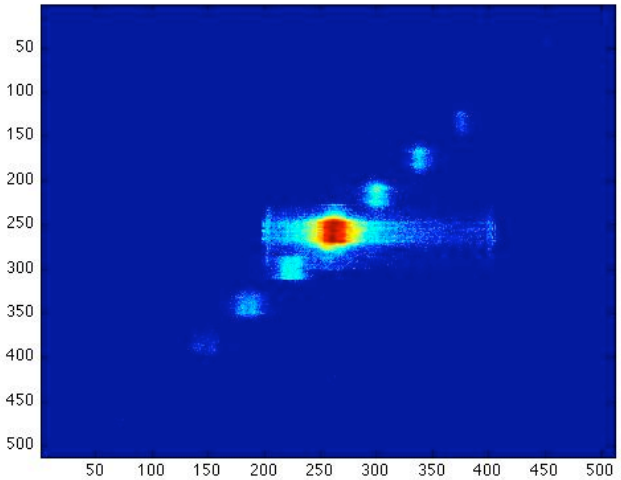
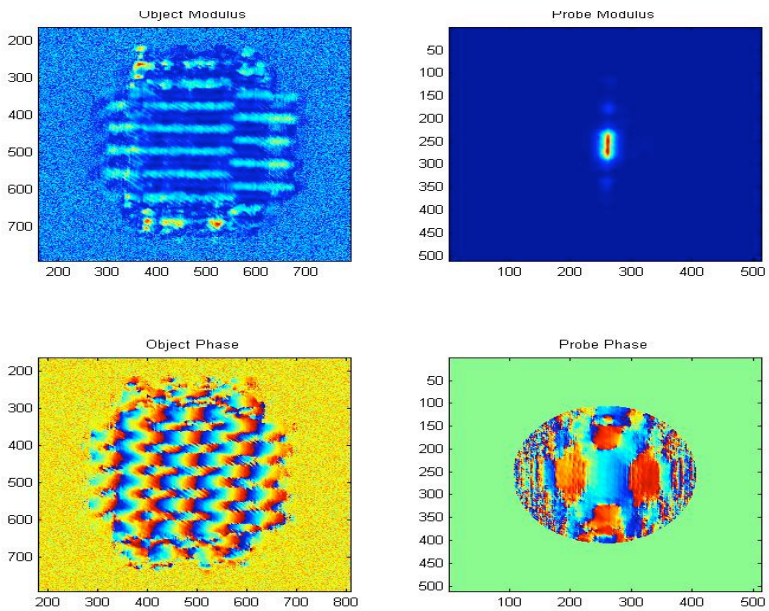
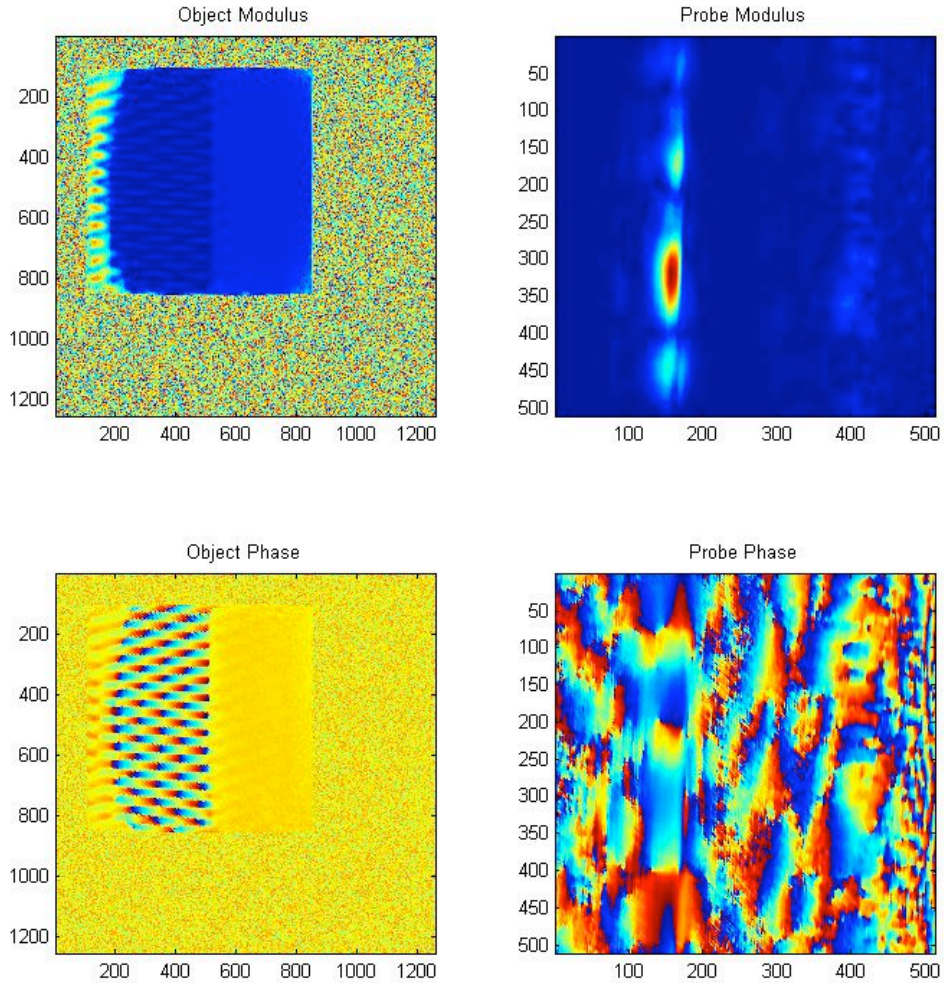


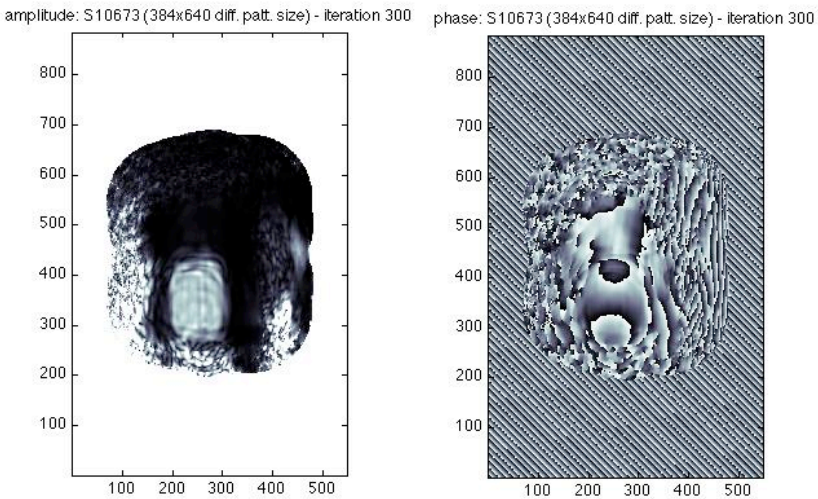
Image regions of a fresnel zoneplate using a beam focused by KB mirrors

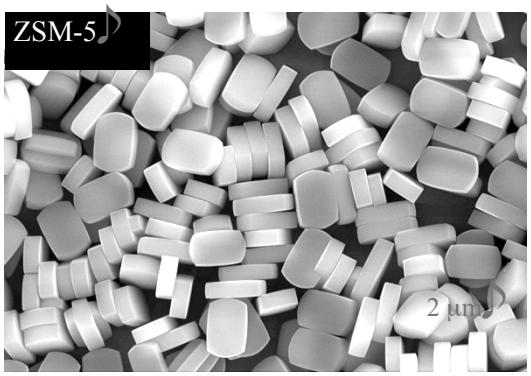


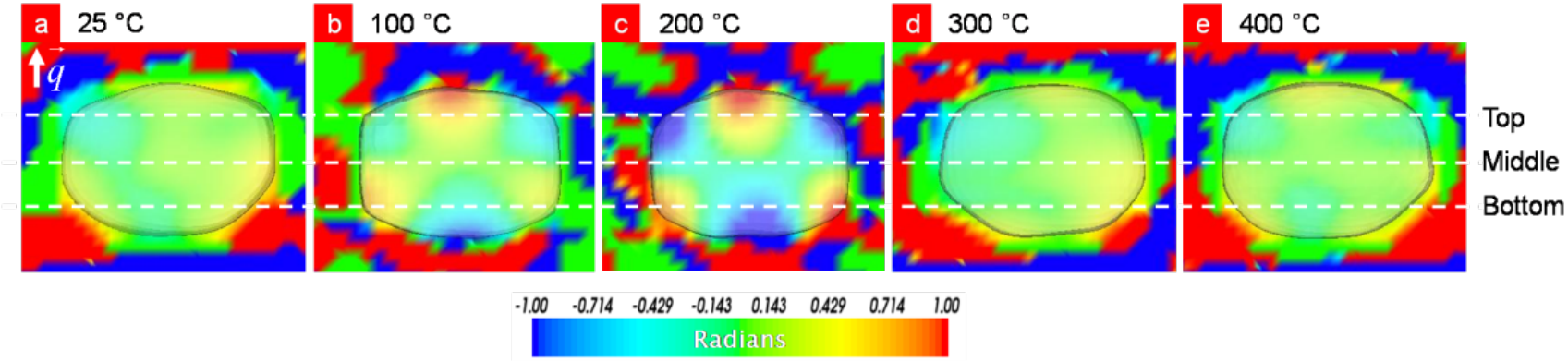


Bragg Scanning X-ray Diffraction Microscopy @ APS 34-ID-C

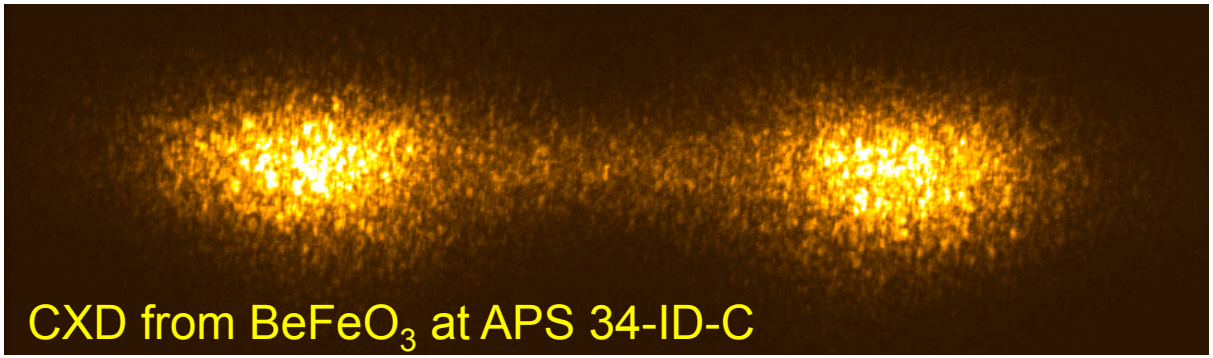
Imaging a zeolite microcrystal using the 200 Bragg peak



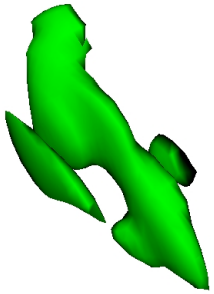


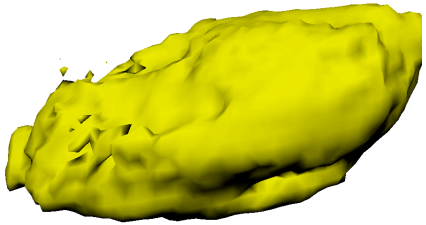


Thank You

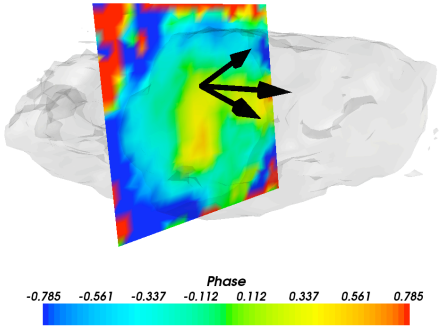


Lignocelluloses in corn stover

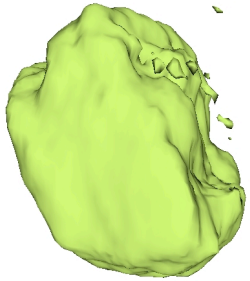


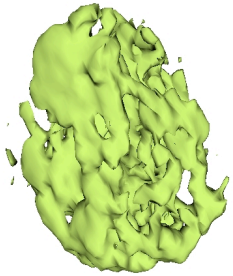


Gold at 3GPa



Dealloying of Ag/Au nanocrystal





Use of the Advanced Photon Source was supported by the U. S. Department of Energy, Office of Science, Office of Basic Energy Sciences, under Contract No. DE-AC02-06CH11357.