



The miracles of science™



NORTHWESTERN
UNIVERSITY



Living.
Improved daily.

20 Years of DND-CAT

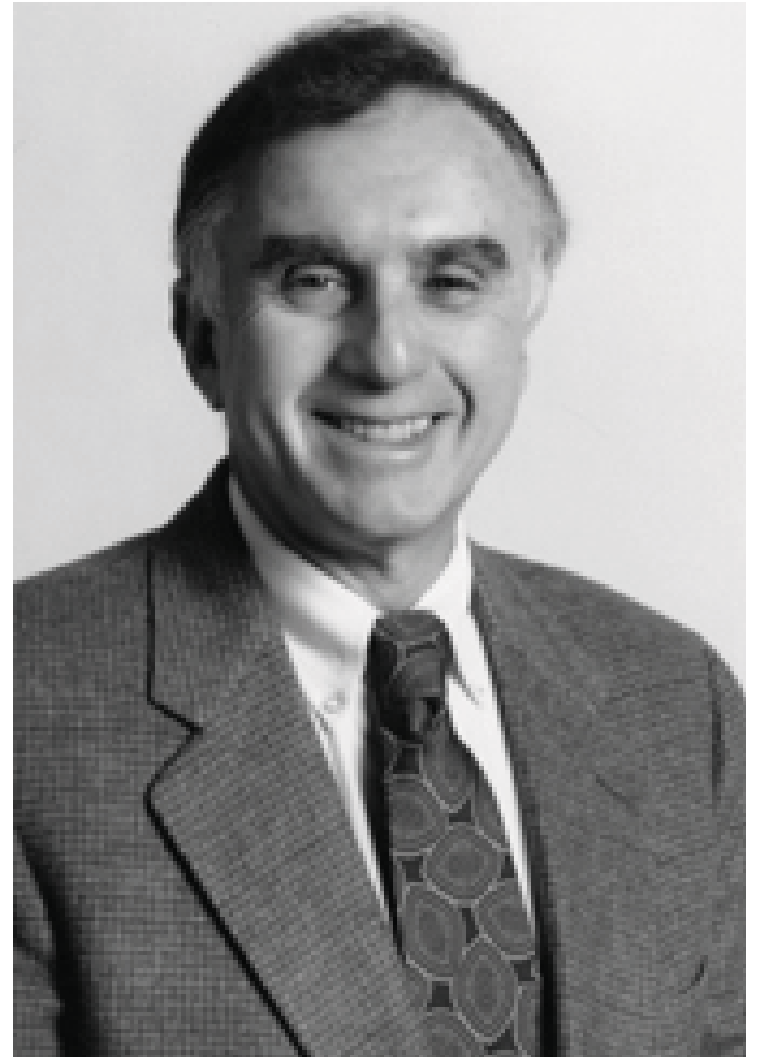
Denis T. Keane

Northwestern Synchrotron Research
Center – DND-CAT

27 June 2012

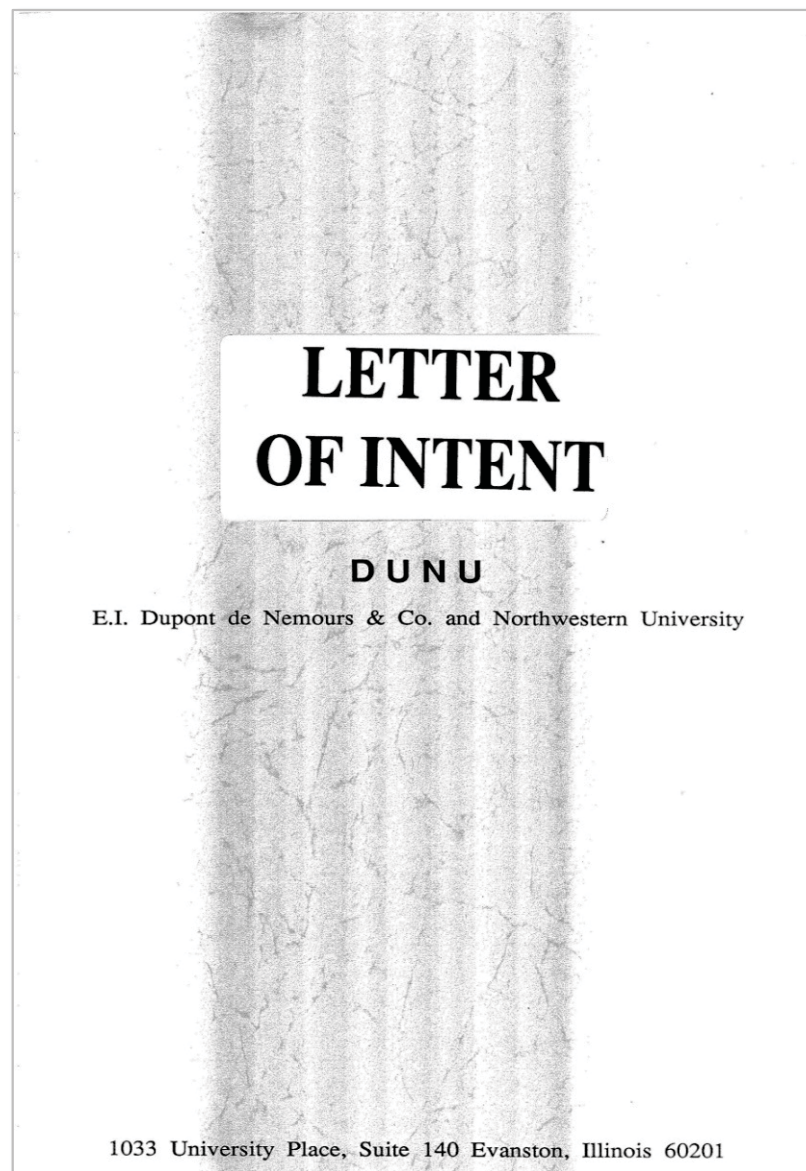
Jerry Cohen

- Initiator & Driver –
Chairman of DND-CAT
- Agreement
 - Worked with Robert Johnson of DuPont
 - 15 years (!) legal document
- At NU
 - Funding from State, NSF
 - DND becomes part of new University Center



DUNU-CAT Letter of Intent – December 11, 1991

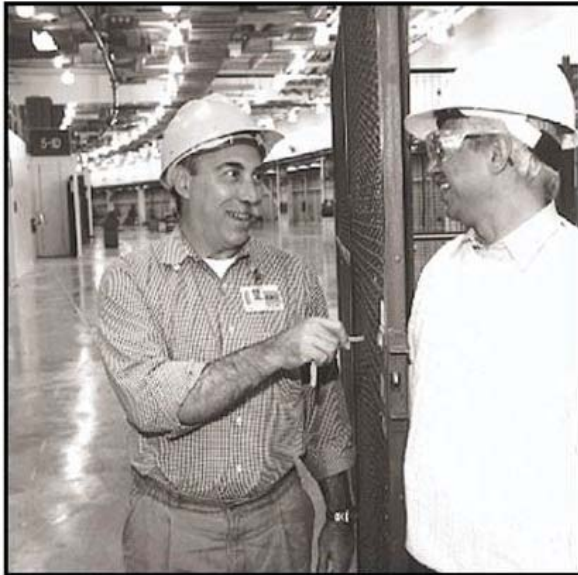
- Purpose
 - Develop, instrument and operate sector at APS
 - Improve industrial competitiveness
 - Provide technology transfer
- Materials Science and Engineering
 - Structure and Composition of surfaces and interfaces
 - Polymer physics, chemistry and engineering



Early Years I

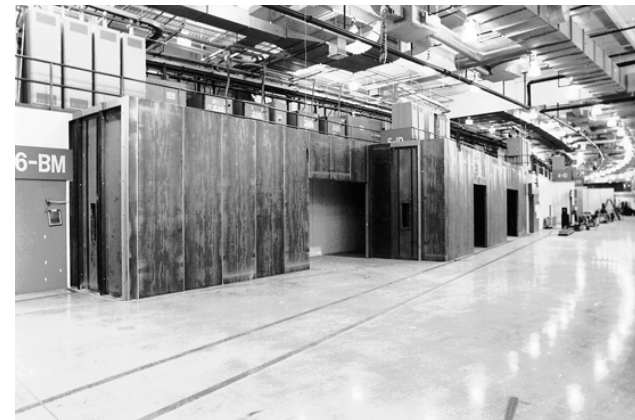
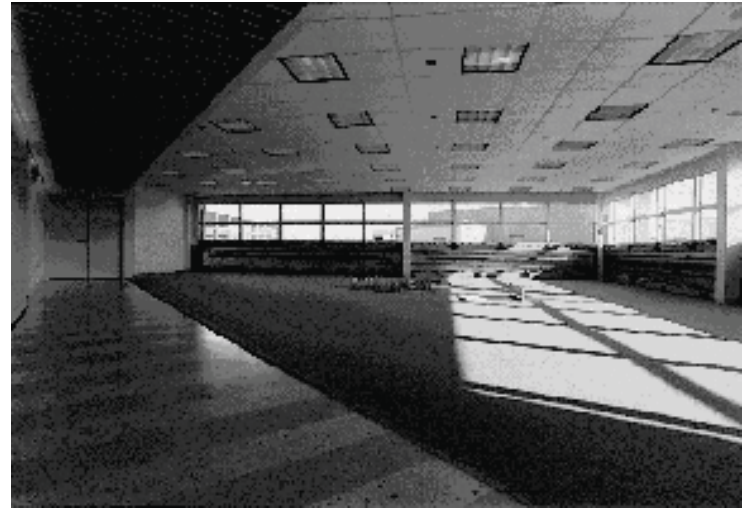
- Joe Georgopoulos
 - First DND Director to 1998
- MOU signing 1993
- First CAT on the floor (literally) – Pioneering spirit and pioneering conditions

ANL photograph 16982K #4



Early Years II

- LOM 432A offices
- First hutches 5BMA/B, 5IDA
- First light 5BM 1996
- First light 5ID 1996
- Experiments begin 5BM summer 1996
- Experiments begin 5ID early 1997

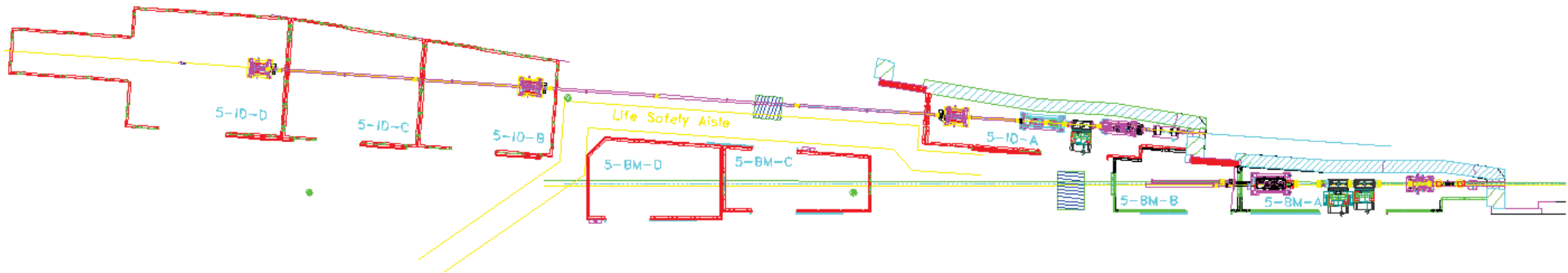


Construction to Operations

- John Quintana
 - DND Director 1998-2005
- Completing construction of 5BMC/D
- Start II then GU program



Beamline Layout and Programs



5IDB: Powder Diffraction , Fiber Diffraction

5IDC: Surface Science

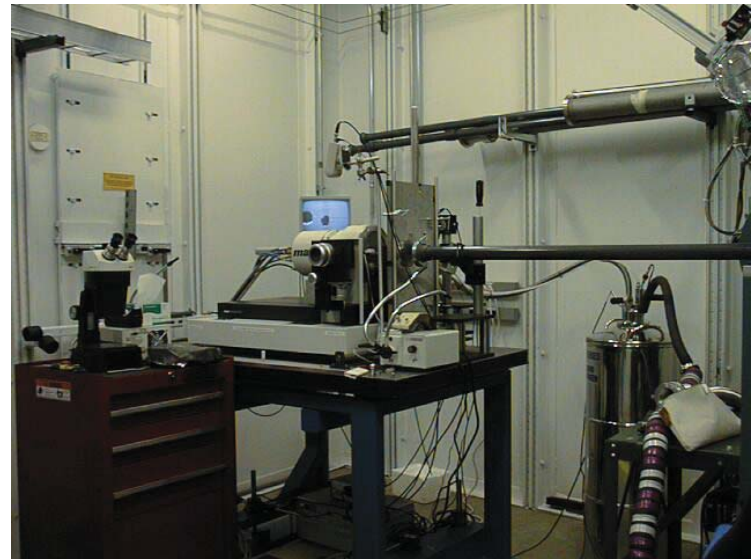
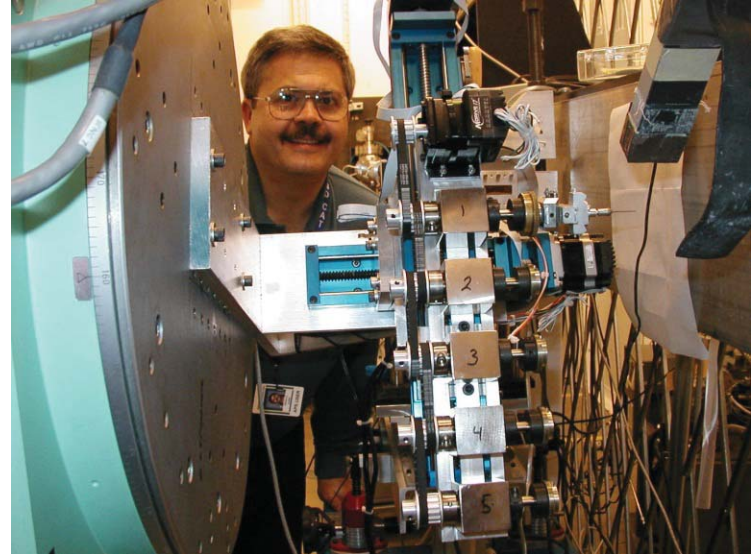
5IDD: SAXS/WAXS

5BMC: Tomography and Powder Diffraction

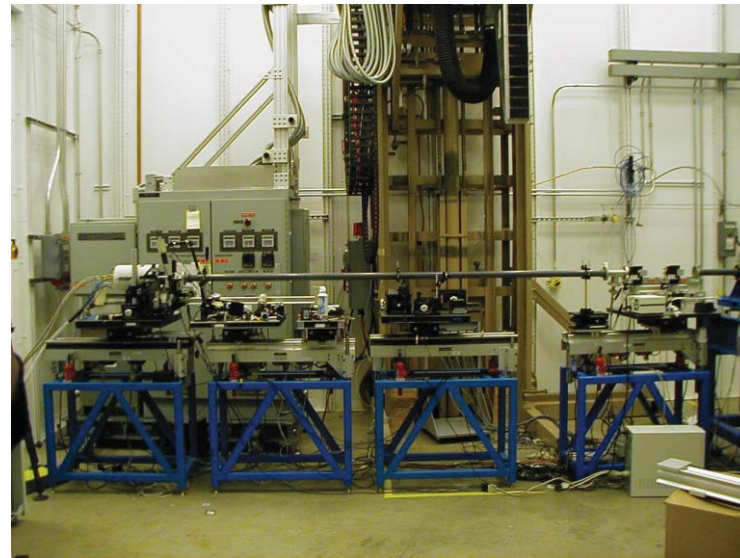
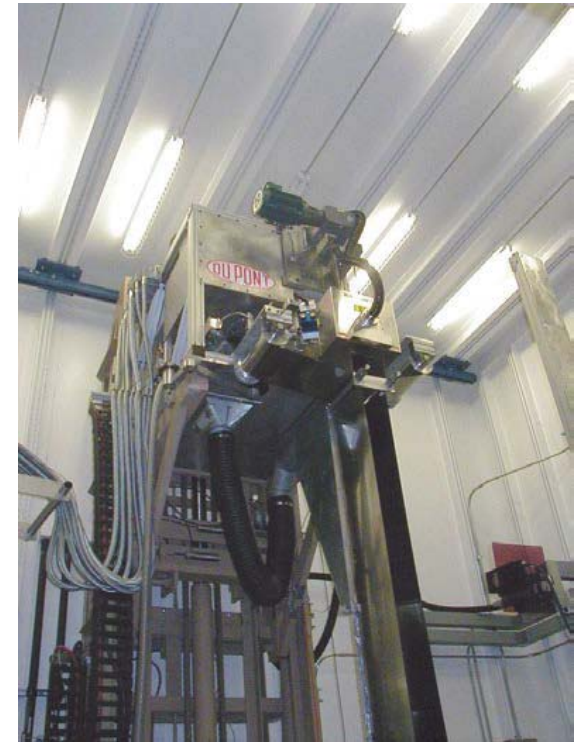
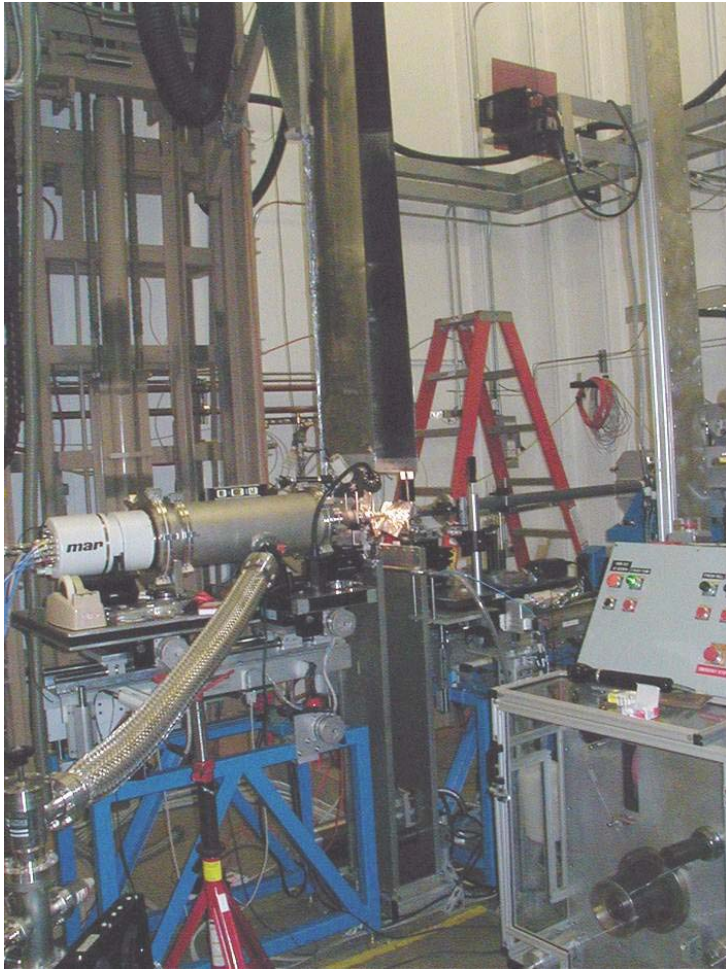
5BMD: EXAFS, High Energy Scattering, and
General Diffraction/Scattering

Early Scientific Program I

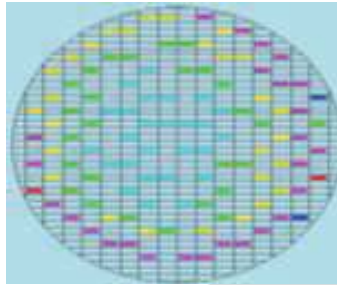
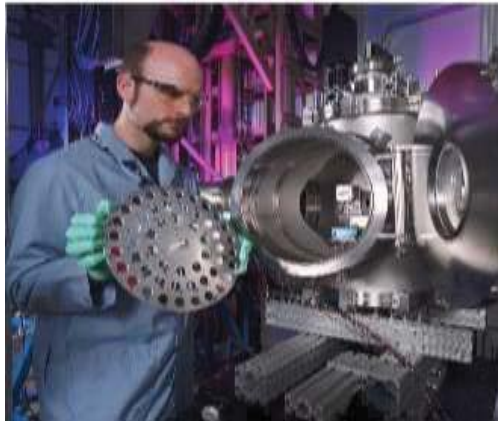
- Materials Science, Polymers, Catalysis
- Macromolecular Crystallography joins
 - Brings Mar133
 - Papers in Nature, Science, etc.



DuPont Fiber Spinner 5IDD



Impact for the Global Semiconductor Industry



○ Single Wafer

○ High Sensitivity & High Throughput

○ Wafer Mapping

○ In-house Capabilities

○ Commercial, In-Fab Capabilities



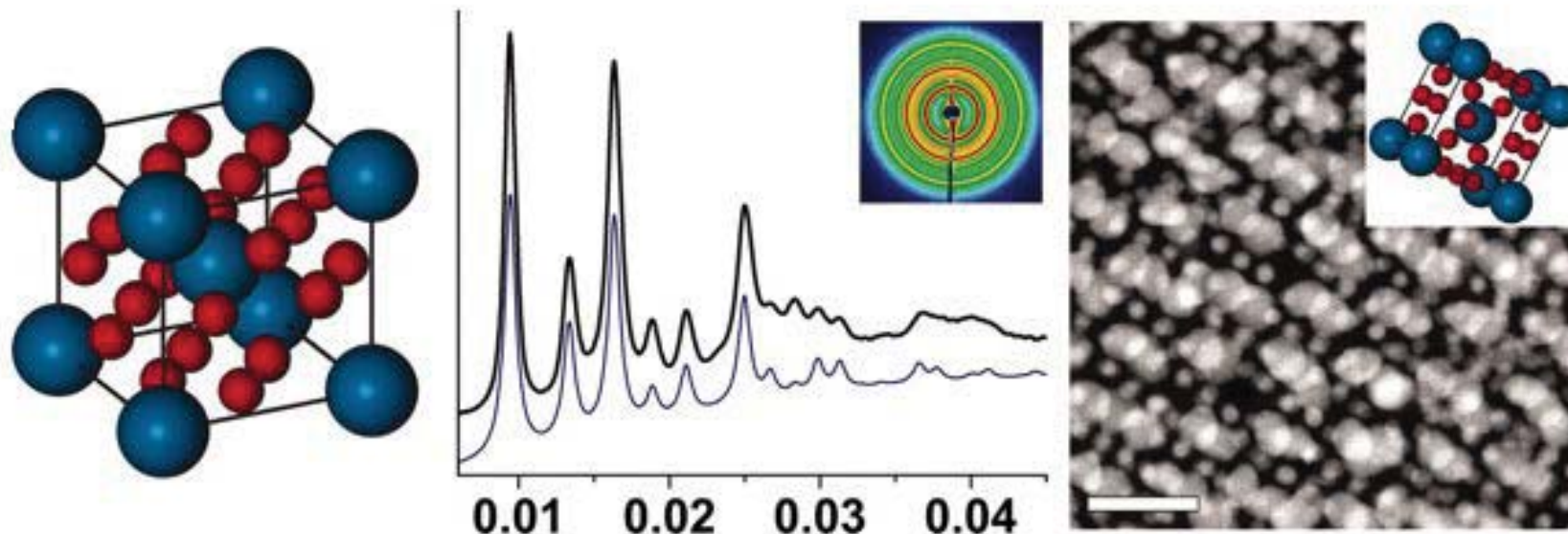
The Dow Chemical Company Synchrotron Team

Growth & Transitions

- Success of MX leads to new LS-CAT
- Quintana moves to APS management in 2005
- New focus at 5ID on SAXS/WAXS and BioSAXS



Emulating — and Surpassing — Nature (NU/ANL)



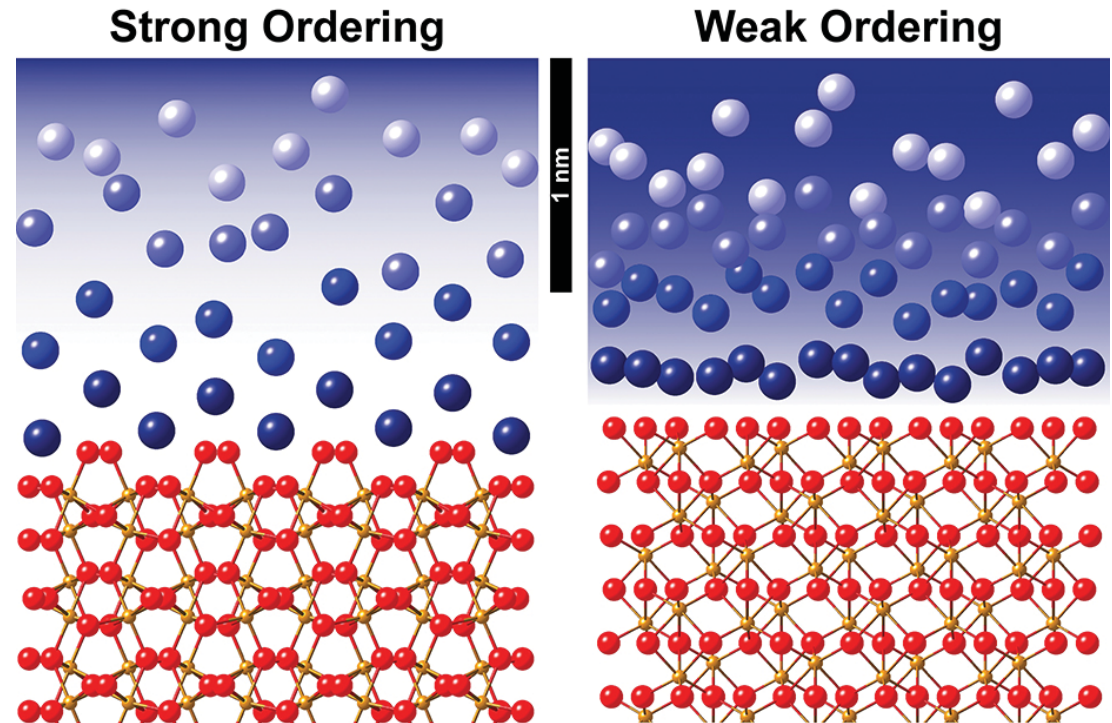
Example of an isostructural superlattice, Cs_6C_{60} lattices. L. to r.: model unit cell (not to scale); 1-D and 2-D (inset) SAXS diffraction patterns; TEM image of resin-embedded superlattices, with the unit cell viewed along the appropriate projection axis (inset). (From Macfarlane et al., *Science* **334**, 204 [2011]).

- Completely new nanostructures built using nanoparticles as "atoms" and DNA as "bonds"
- Comparisons of model with data obtained at Dow-Northwestern-DuPont CAT 5-ID show basic design rules, promise possibility of creating a variety of new materials for catalysis, electronics, optics, biomedicine, energy generation, storage and conversion technologies

R.J. Macfarlane (Northwestern Univ.), B. Lee (ANL), M.R. Jones, N. Harris, G.C. Schatz, C.A. Mirkin (Northwestern Univ.)

Disordered Water on Mineral Surfaces (DND GU)

- Research at Dow-Northwestern-DuPont CAT 5-ID precisely determined nanoscopic arrangement, disorder of first few molecular layers of water residing on surfaces of Fe_2O_3 , Al_2O_3
- Suggests that mineral surfaces in general will show either strong or weak ordering of water
- Mineral surface adsorption of heavy metals affected by properties of water near surface



Many mineral surfaces, such as the (012) surfaces of iron and aluminum oxides (left side of figure), which consist of iron or aluminum (small gold spheres) and oxygen atoms (red spheres), induce strong local ordering of water molecules (blue spheres), with the transition to disordered bulk water occurring 2 to 3 nm from the surface. The (001) surfaces of iron and aluminum oxide, however, induce only weak local ordering of water (right side of figure) and the transition to bulk-like water occurs much closer to the mineral surface.

J. G. Catalano (Washington Univ.)

DND Science & Technology

– Publications

- 610 journal articles in APS Publications database
 - 8 in **Nature**, 7 in **Science**

– Education

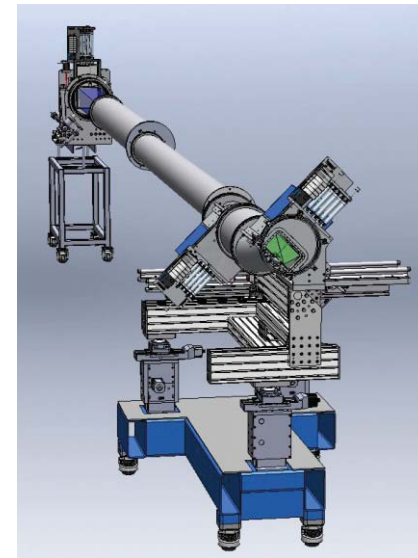
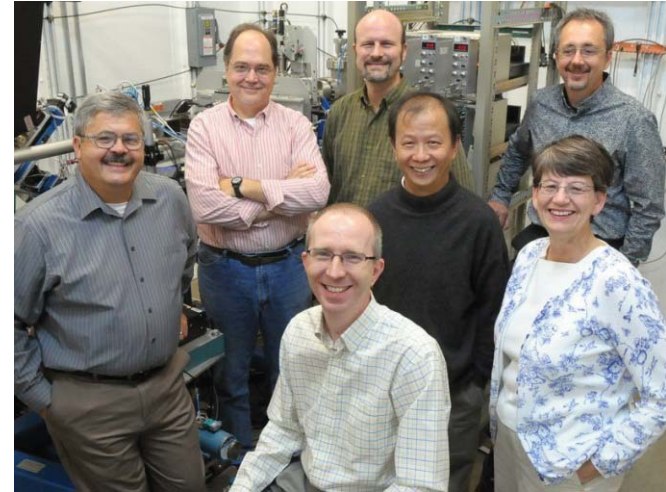
- 49 Dissertations in database
 - Probably undercounted

– Community

- 170 articles by General Users at DND-CAT
- Staff members work with APS committees, panels, schools, etc.

Operations and Horizons

- Small but expert DND staff
- New detectors and new opportunities
 - First Mar133
 - First Mar225
 - Soon – first Rayonix frame transfer CCDs
- Updated optics



20 years truly worth celebrating

