

Biotech Aspects of Nanotechnology Initiative

Seth Snyder
Chemistry Division
& Energy Systems



CENTER FOR NANOSCALE MATERIALS
AT
ARGONNE NATIONAL LABORATORY



\$36 M from the State of Illinois

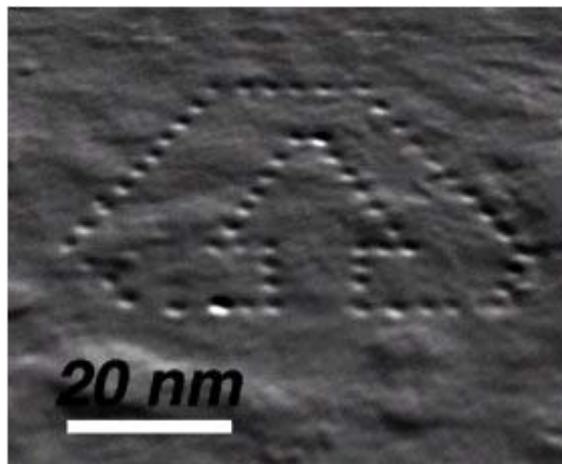
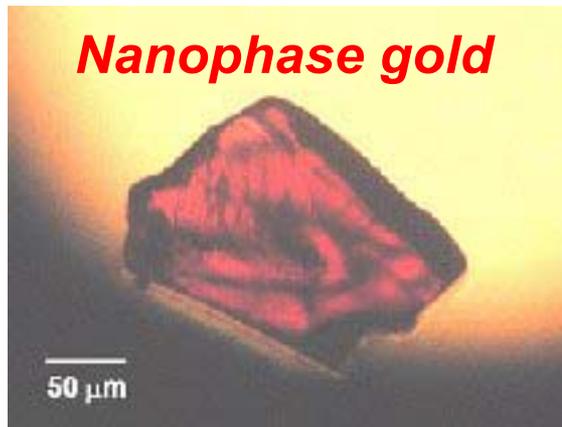
DOE considering proposal to
fund the rest of the proposed
Center for Nanoscale Materials



Argonne National Laboratory is operated
by The University of Chicago for the U.S.
Department of Energy

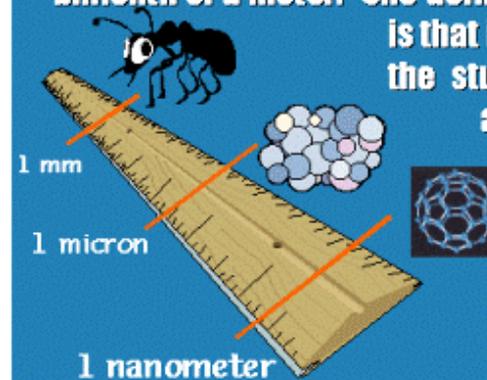


What is Nanotechnology?



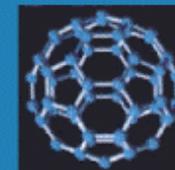
Definition of Nanoscience

The word "nano" means 10^{-9} so a nanometer is one billionth of a meter. One definition of nanoscience is that it concerns itself with the study of objects which are anywhere from hundreds to tens of nanometers in size.



Small Solids Look Different

Nanoscience would be boring if small things were just like big things. Luckily they are not. Pencil lead, graphite for example takes on all sorts of interesting shapes if it is kept from becoming a big solid.



C₆₀ The Buckyball

A Carbon Nanotube

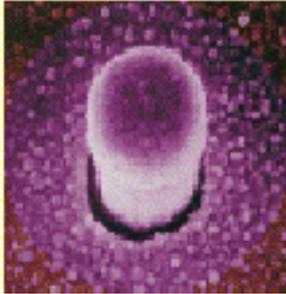


The Many Shapes of Carbon
When carbon is a pure solid it typically is found as graphite or even rarer as diamond. However, on the nanoscale carbon takes on very different structures! Rick Smalley, Bob Curl and Harry Kroto won the 1996 Nobel Prize in Chemistry for the discovery of C₆₀. Check out [Dr. Smalley's web page](#) for the latest in carbon nanoscience!

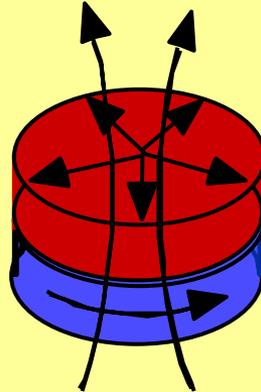


Nanoscience Vision

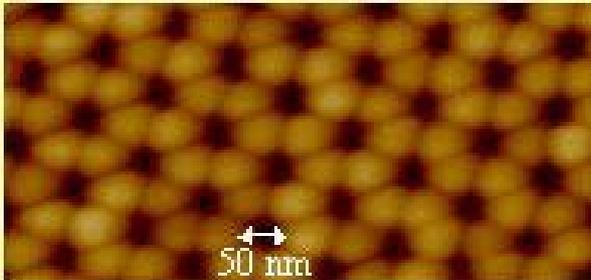
Confinement



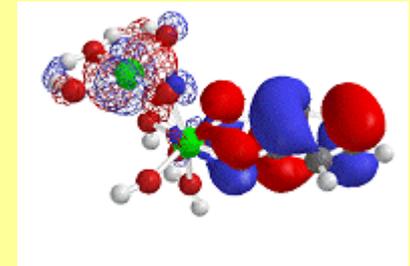
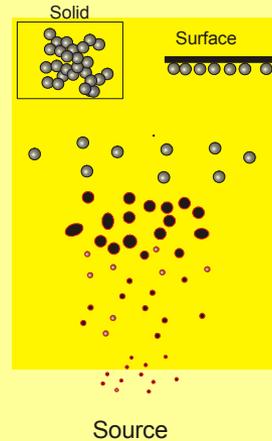
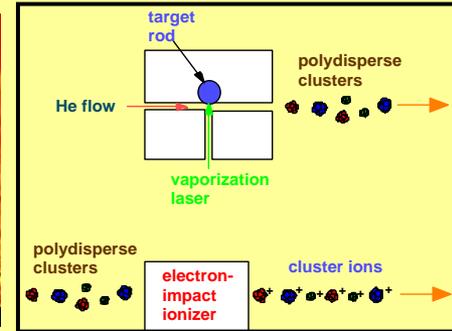
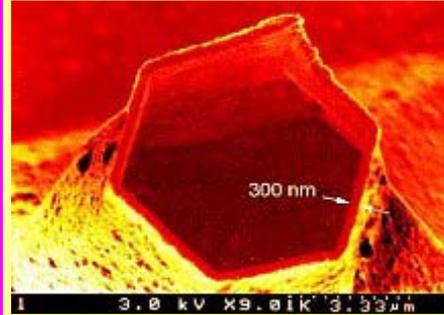
Proximity



Organization



Fabrication

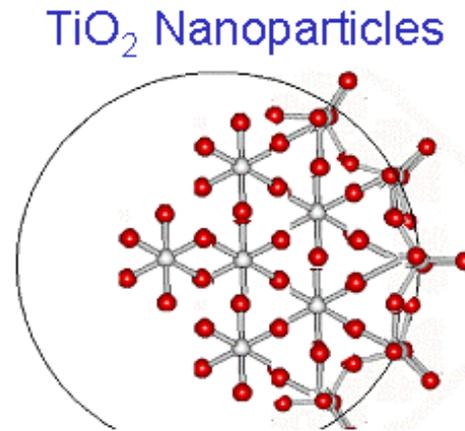
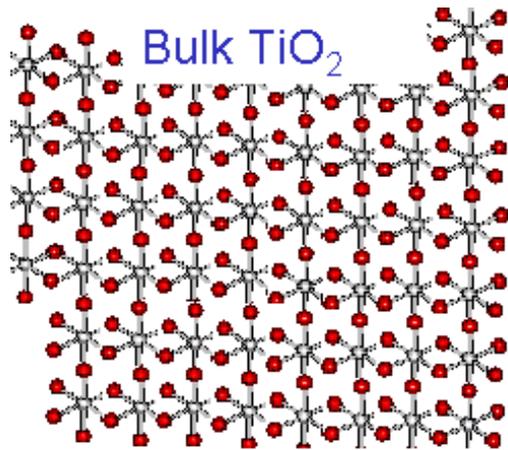


Characterization

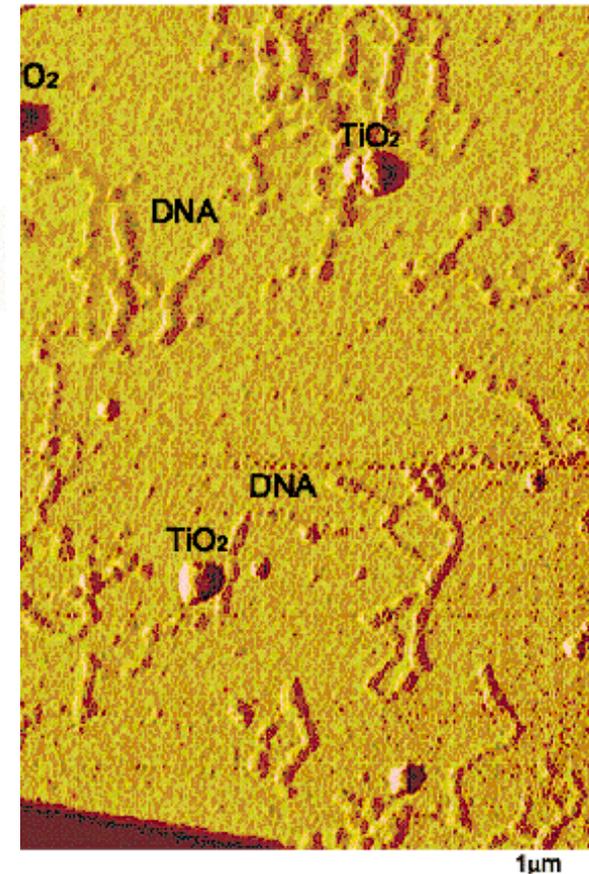
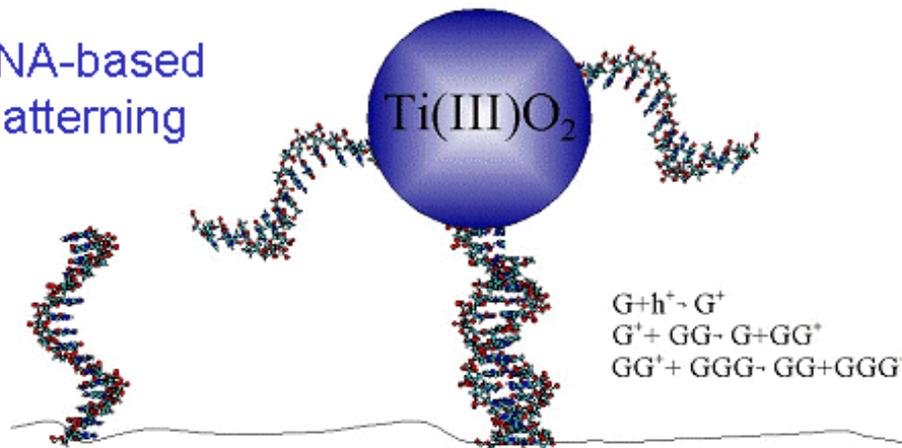
Computer Simulation



Linking TiO₂ Nanoparticles to DNA



DNA-based
patterning



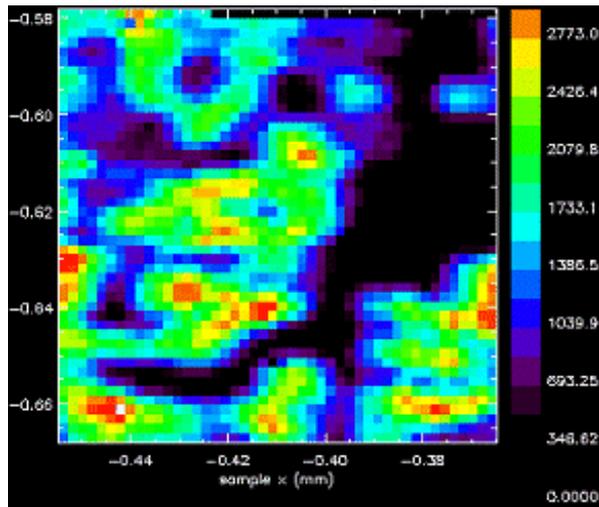
Atomic Force
Microscopy



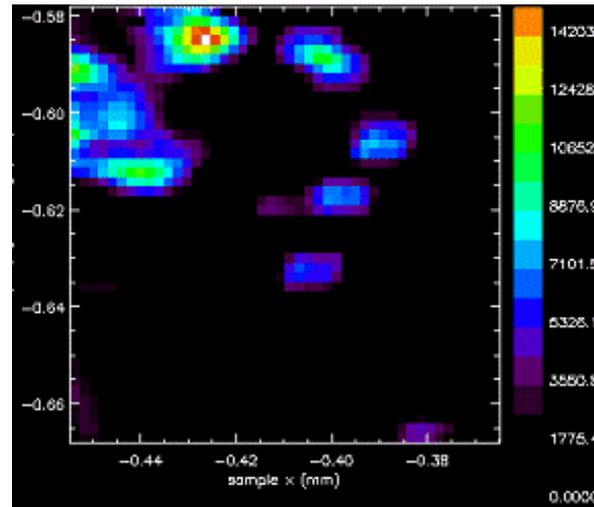
TiO₂/DNA Hybrid Nanoparticles in Cells

X-ray microprobe imaging at the APS

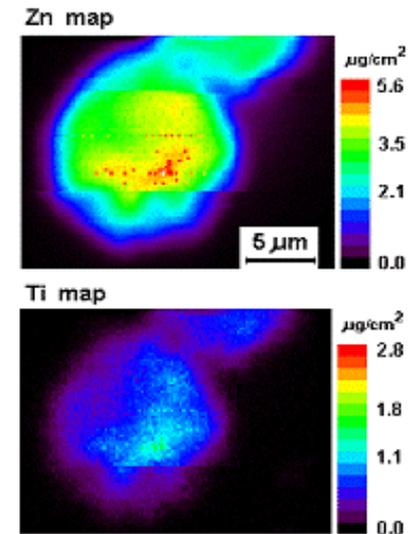
Cell outline obtained by monitoring Zn



Ti localized in the cells



Extracted nucleus

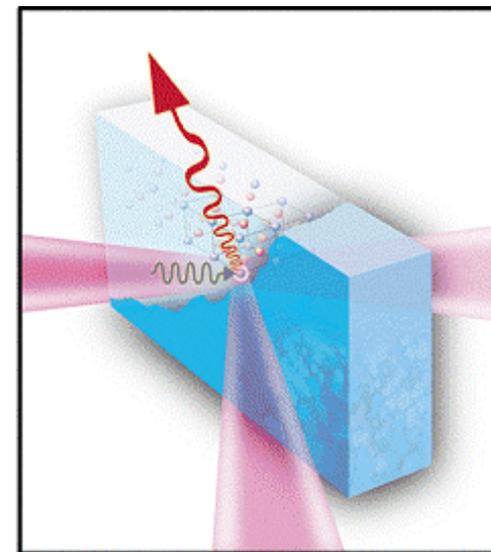
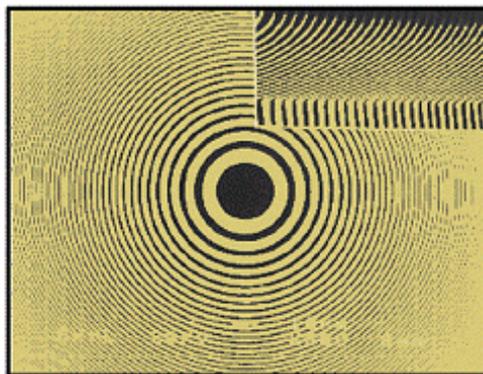


X-ray microprobe reveals incorporation of TiO₂ linked to complementary DNA into the nucleus. This opens the opportunity for gene sensors and even gene surgery



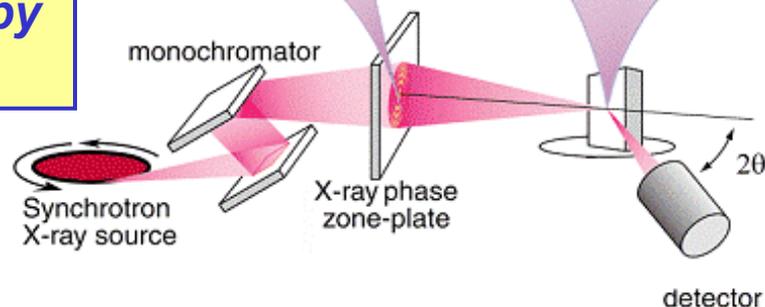
X-Ray Microscopy at APS in NANOCAT

Significantly higher resolution imaging than currently available!

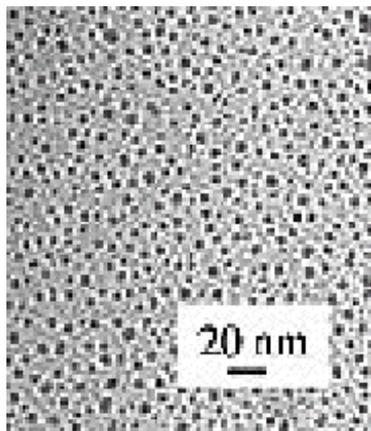


Complementary facilities:

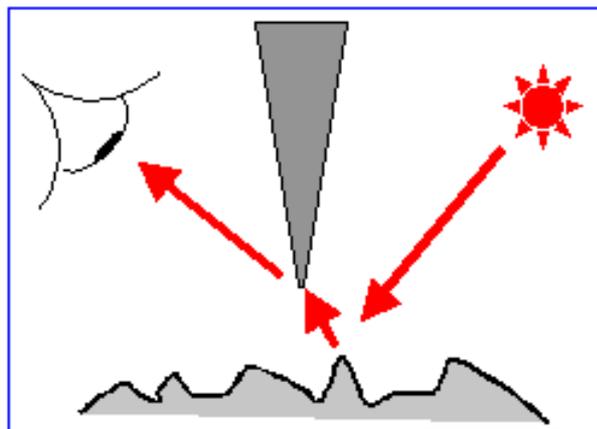
- **Advanced Electron Microscopy**
- **Scanning Probe Microscopy**



NSOM of Silver Nanoparticles

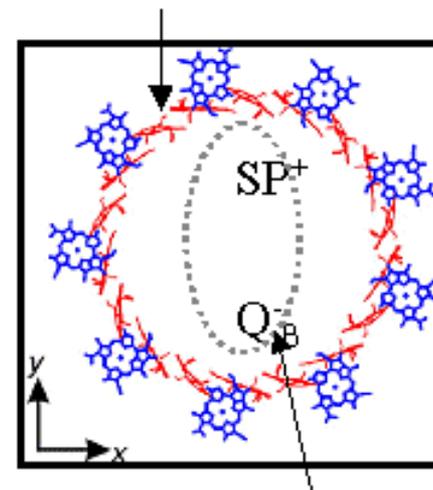
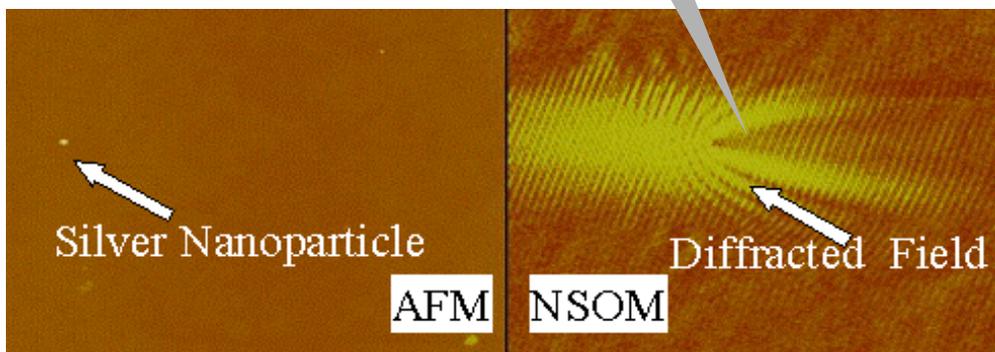


Silver nanoparticles



Vibrating tip

A new method for ultra-sensitive, single molecule biomolecule (protein) sensors?



Partnering with Biotech Efforts

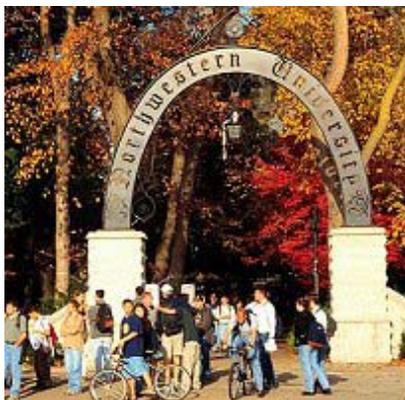
- **Biotechnology Applications**
 - Bio-based Chemicals → Nanoencapsulation of enzymes in synthetic clays for conversion of biobased feedstocks
 - Delivery of energy based on photosynthetic systems
 - Bio-inspired soft materials
- **Structural Genomics**
 - Protein structures in solution by X-ray scattering and NMR
- **Functional Genomics**
 - Characterizing proteins with MALDI-TOF Mass Spectrometry



Argonne's Partners



THE UNIVERSITY OF
CHICAGO



ILLINOIS INSTITUTE
OF TECHNOLOGY
Transforming Lives. Inventing the Future. www.iit.edu

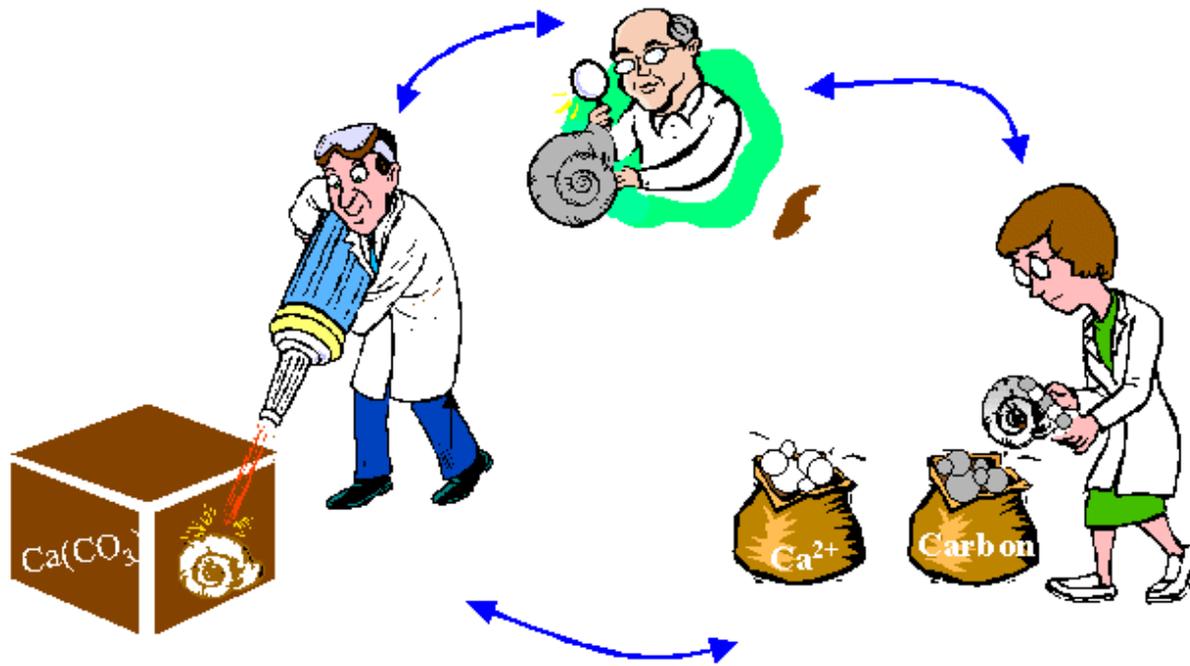
UNIVERSITY OF ILLINOIS
at Urbana-Champaign

Northern Illinois University



Argonne National Laboratory is operated by The University of Chicago for the U.S. Department of Energy

Regional Impact



- Research collaborations
- Training
- Technology transfer

The merging of materials-chemical-biological sciences at the Center for Nanoscale Materials will enable researchers in the region to address fundamental scientific issues and technological solutions.



Credits

TiO₂ – DNA Hybrid Nanoparticle Project

Tijana Rajh, Marion Thurnauer – Chemistry Division

Gayle Woloschak, Tatjana Paunesku – Biosciences Division

Jorg Maser – Advanced Photon Source

Contact info: Rajh 630-252-3542 rajh@anl.gov

Silver Nanoparticle – NSOM Project

Gary Wiederrecht, Greg Wurtz, Nada Dimitrijevic, Alex Trifunac
– Chemistry Division

Contact info: Wiederrecht 630-252-6963 wiederrecht@anl.gov

