Advanced Test Reactor National Scientific User Facility

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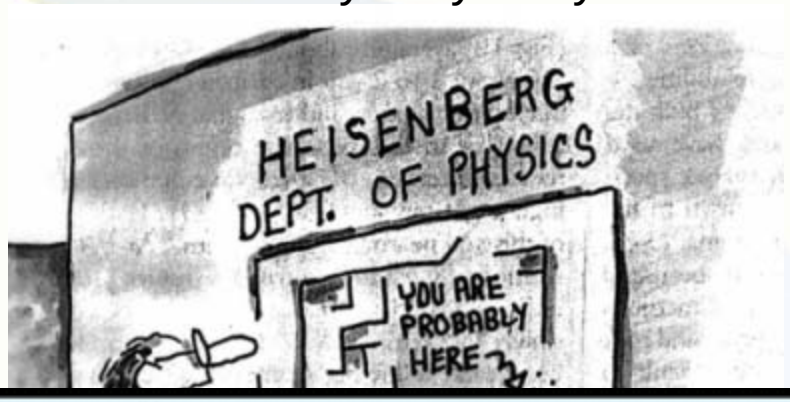
Idaho National Laboratory

ATR
National Scientific User Facility

First connect with the audience

Step 1: Try to see what audience thinks is funny
Step 2: Use Google
Step 3: Present contrasting ideas and watch audience reaction

Very “Physics”y

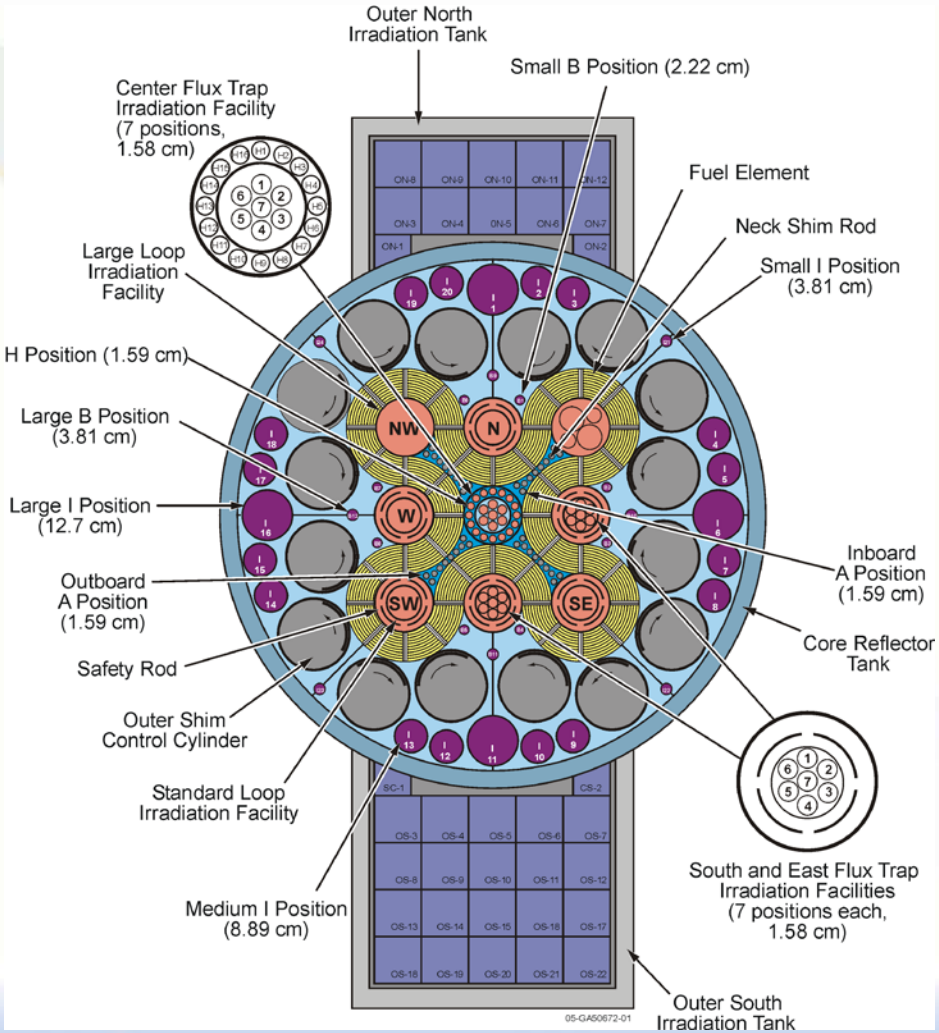


Literal

Act I: The ATR National Scientific User Facility

ATR

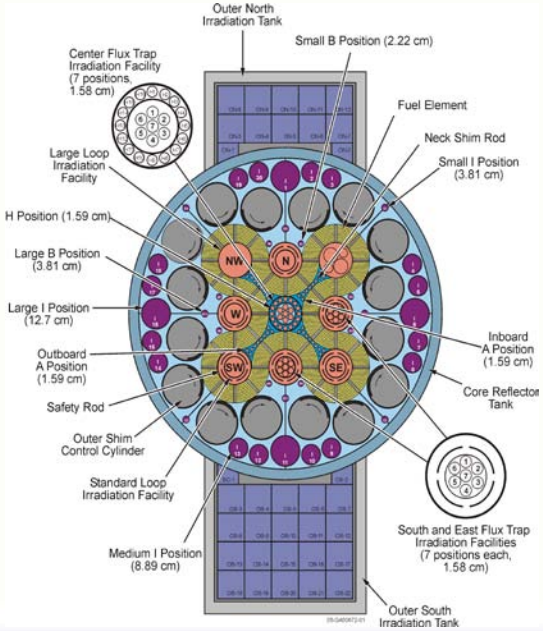
- Test size – up to 5.0” diameter
- 77 Irradiation Positions
  - 4 Flux Traps
  - 5 In-pile tubes
  - 68 in Reflector
- Approximate Peak Flux
  - 1×10^{15} n/cm^2-sec thermal
  - 5×10^{14} n/cm^2-sec fast
- Rotating Hafnium Control Cylinders – symmetrical axial flux
- Power/Flux Adjustments (Tilt) across the Core



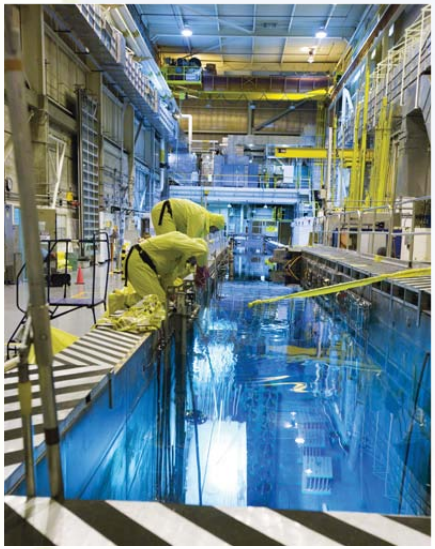
Where did we start?

Allow the research community access to test reactor space and existing post-irradiation examination capability

Advanced Test Reactor



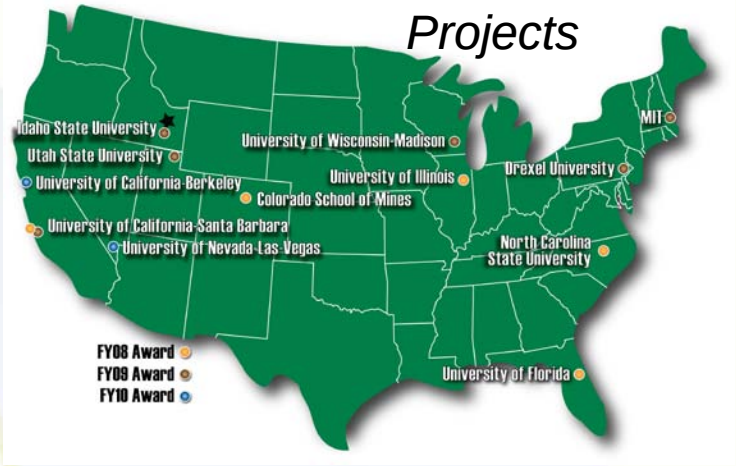
INL Examination Facilities (HFEF, EML)

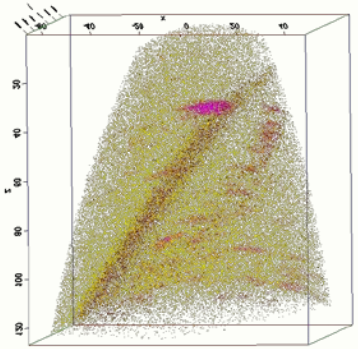


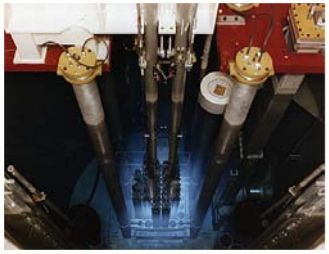
Plans to upgrade ATR by adding PWR loop and hydraulic shuttle

What have we become

- ATR
- ATR Critical Facility
- Post-irradiation Examination Sample Library/Rapid Turnaround Projects
- Significantly upgraded examination equipment
- Network of university partners providing irradiation and examination capability
- Connections to other User Facilities







Seventy-five project proposals submitted as part of the first five solicitations, twenty-three ongoing projects

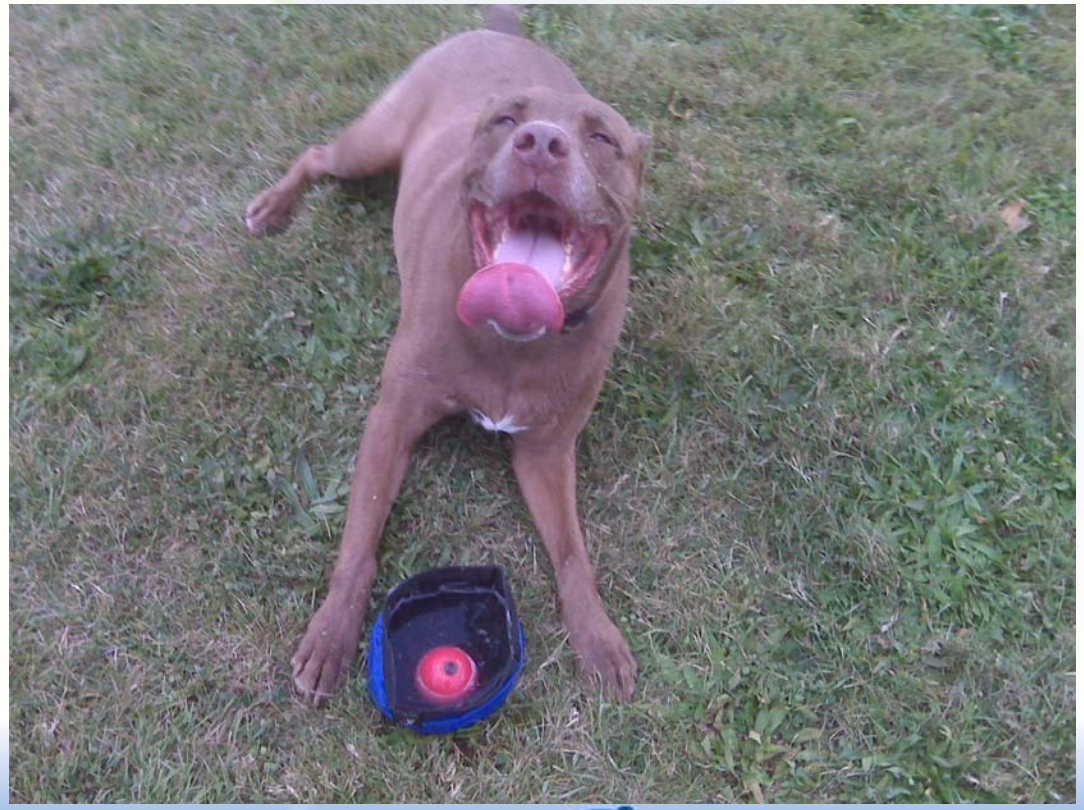
Idaho National Laboratory

University Education Programs Build a Cadre of Experimenters

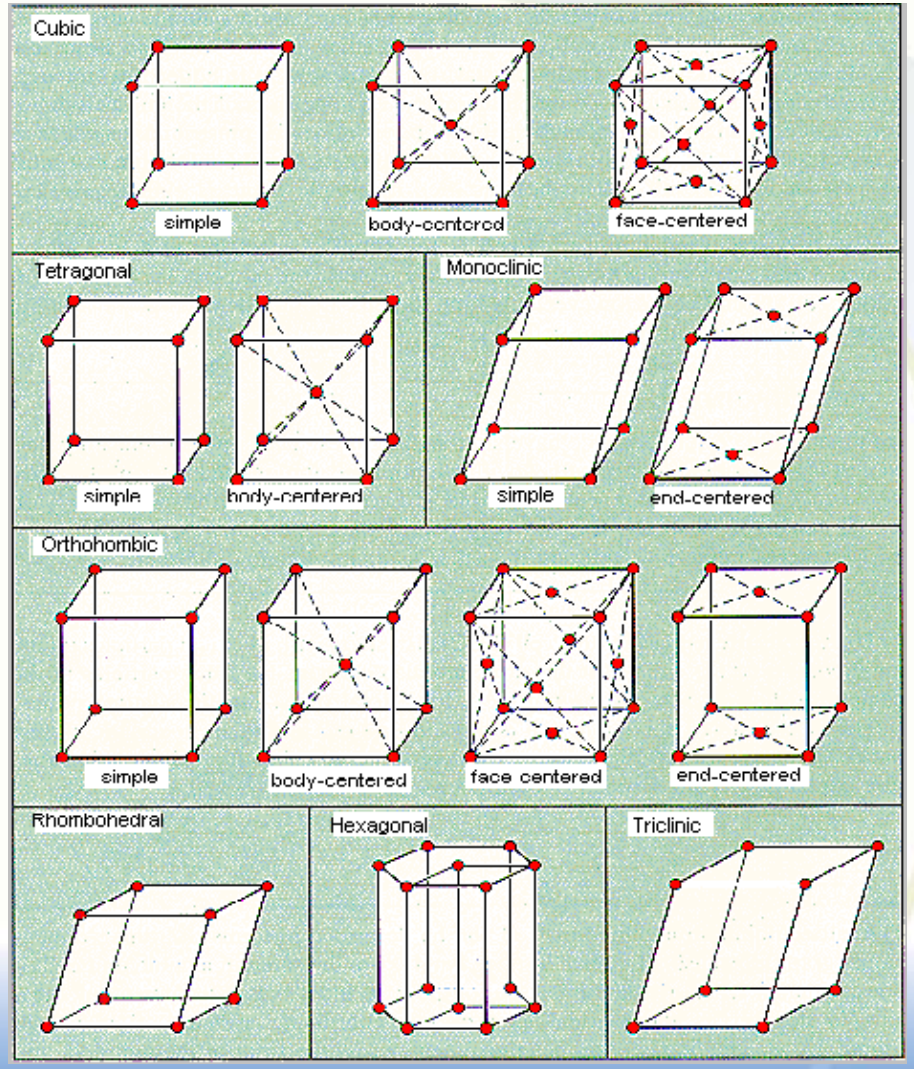
- Users Week June 6-10, 2011
  - Summer school on defects
  - Experimenter course
  - Characterization Course
  - New user workshop
  - NSUF Research Forum
  - Facility tours
- Faculty-student teams
- ANS Student conference Apr 2011
- Colloquium Series
- Reactor Testing Textbook

What is the ATR NSUF?

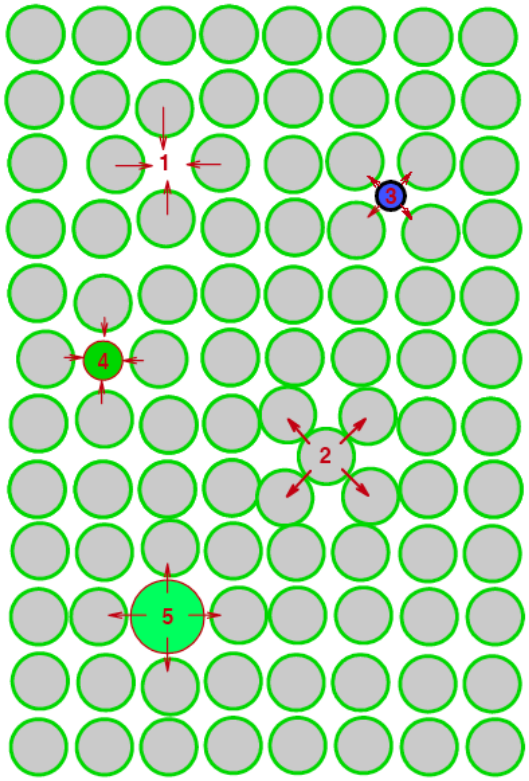
Act II: Radiation Damage to Materials



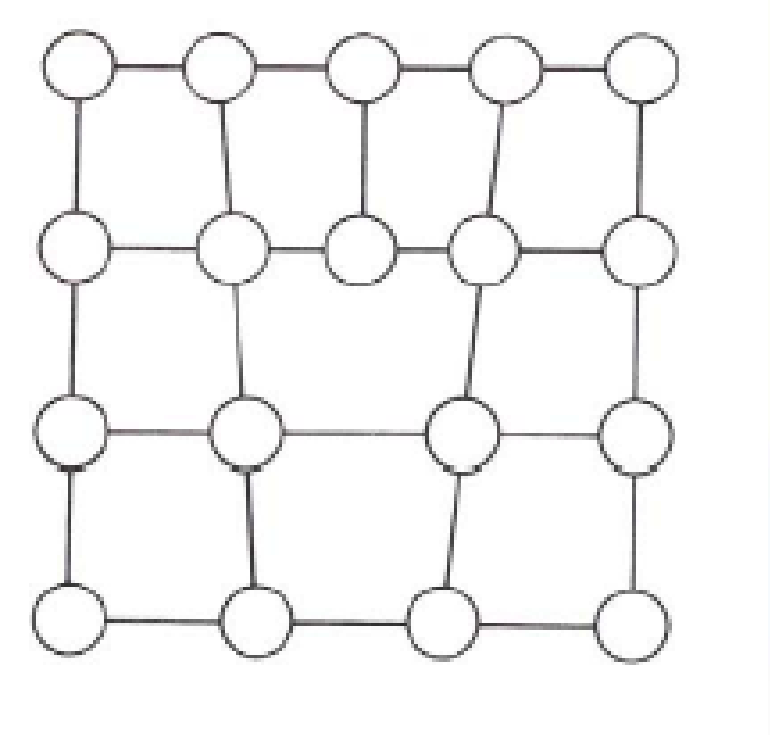
Lattice Configurations



Point Defects & Dislocations



Schematic representation of different point defects in a crystal. (1) vacancy; (2) self-interstitial; (3) interstitial impurity; (4), (5) substitutional impurities. The arrows show the local stresses introduced by the point defects.

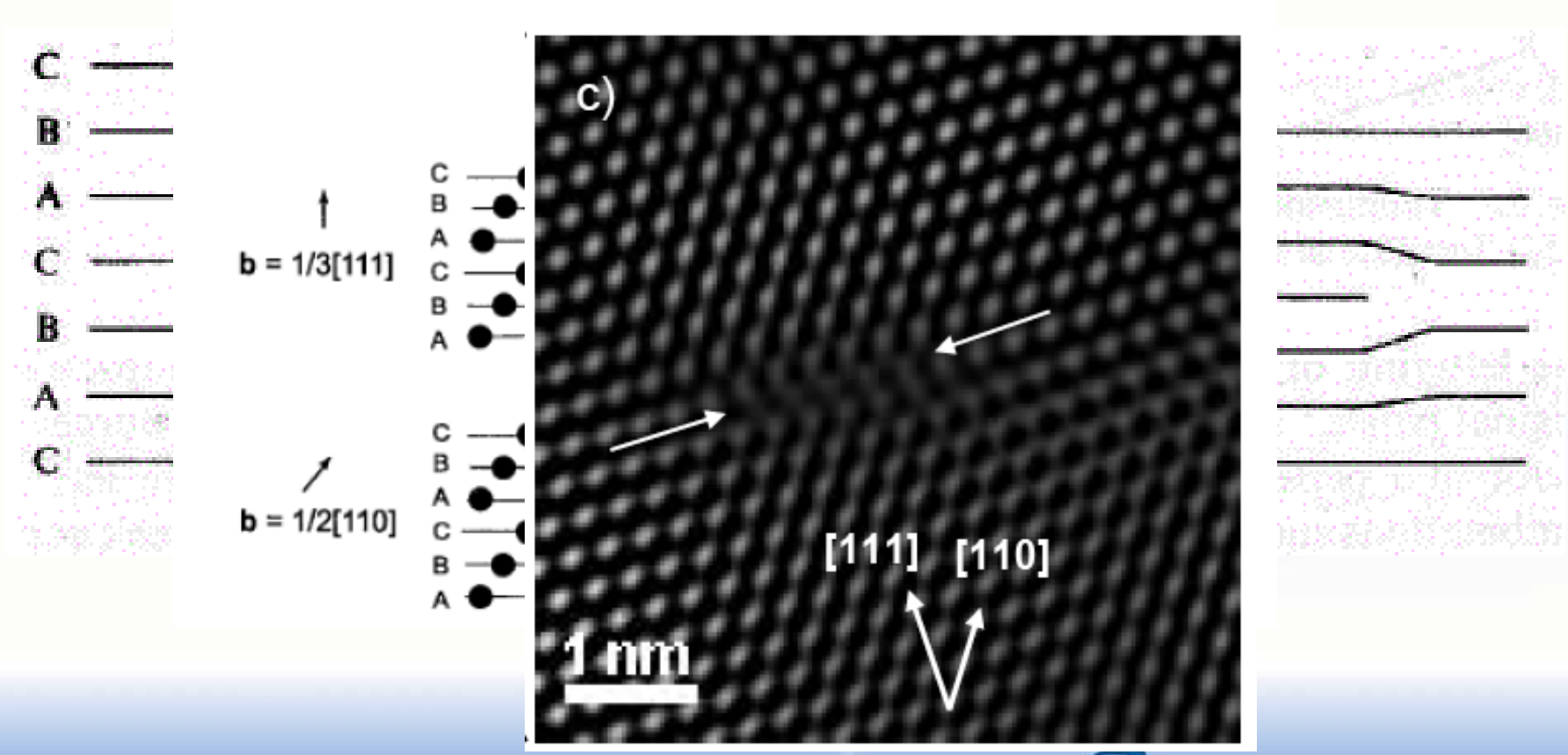


Edge Dislocation

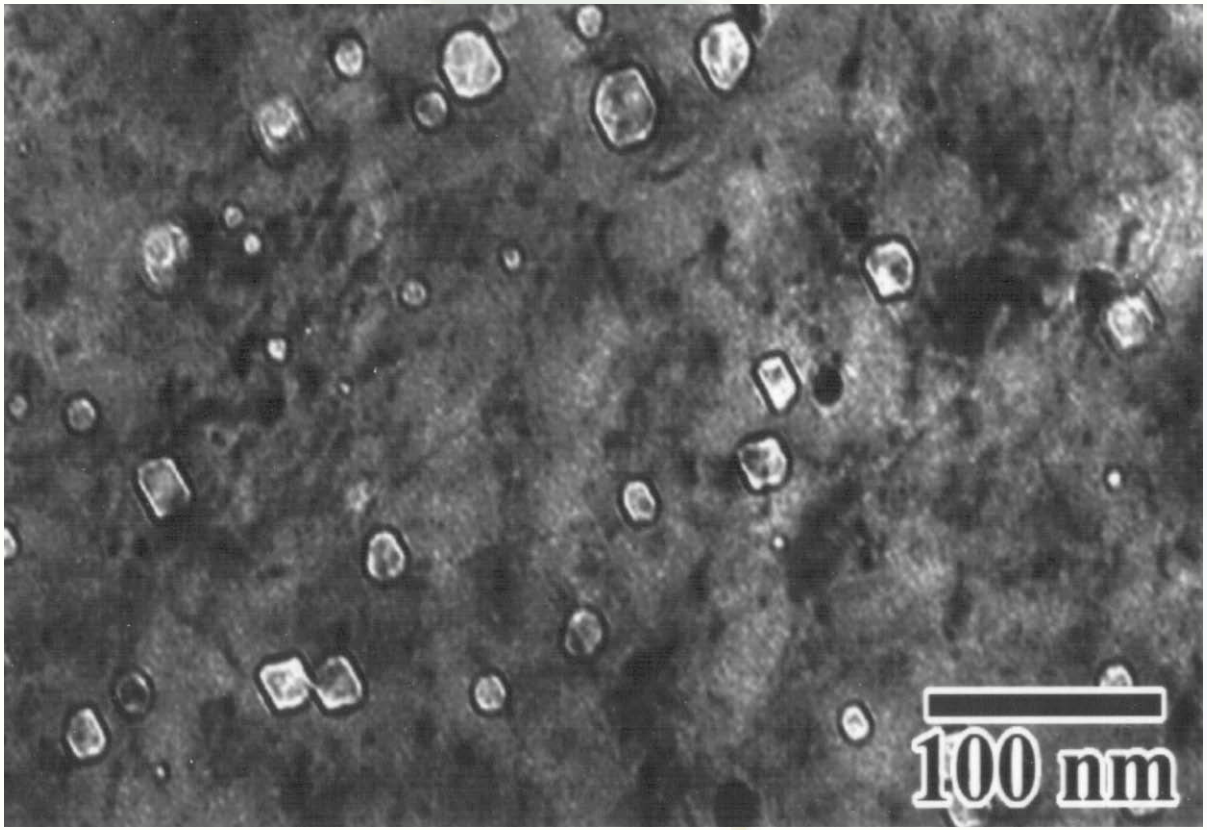
www.people.virginia.edu/~lz2n/ mse201/mse201-defects.pdf

Vacancy & Interstitial Loops

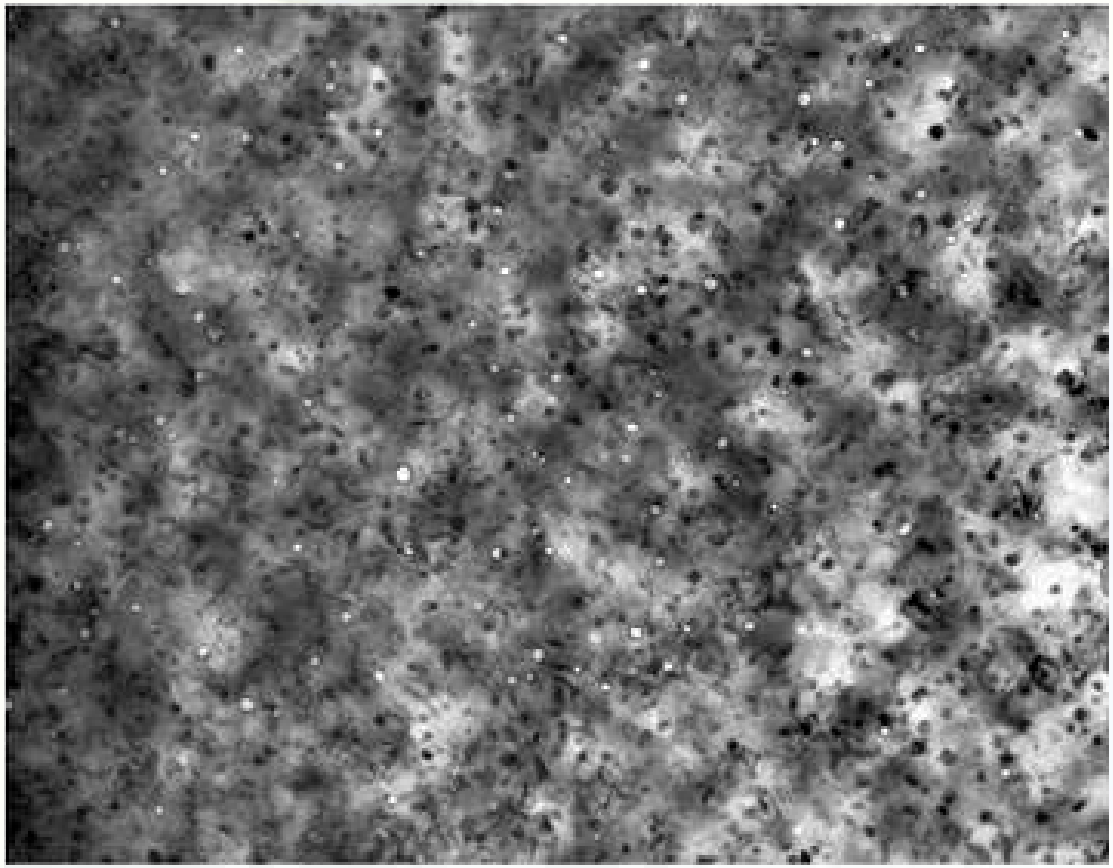
http://www-classes.usc.edu/engr/ms/125/MDA125/defects_files/frame.htm



Voids in Stainless Steel

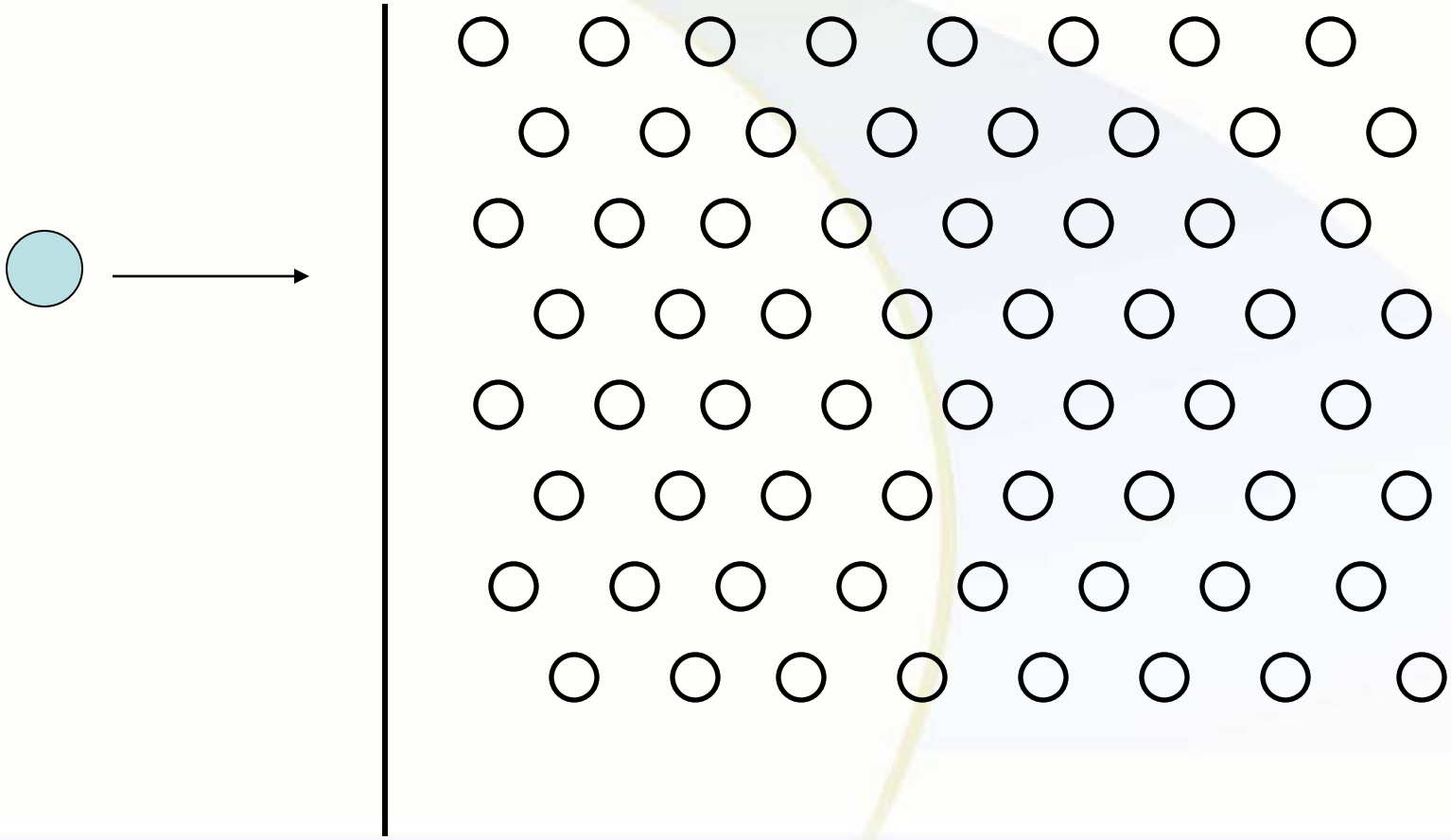


Carbide Precipitates & Voids



100 nm

Radiation Damage Simple Picture



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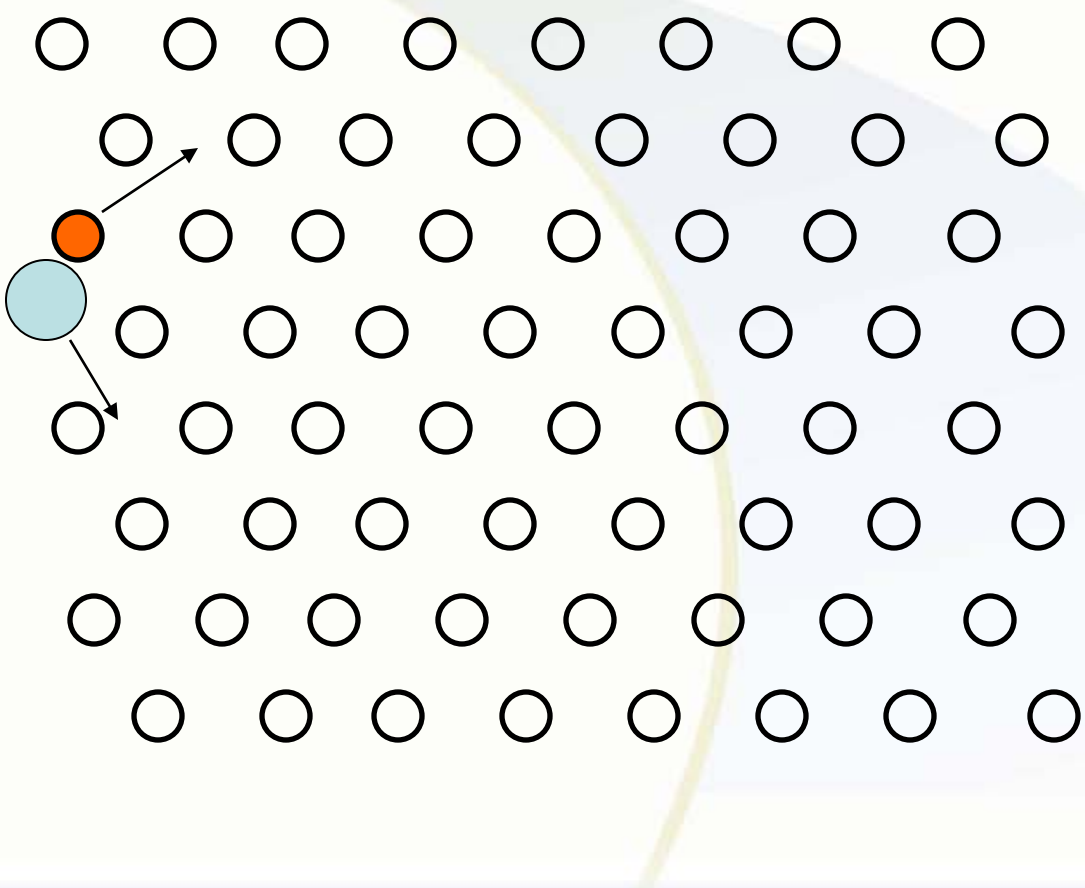

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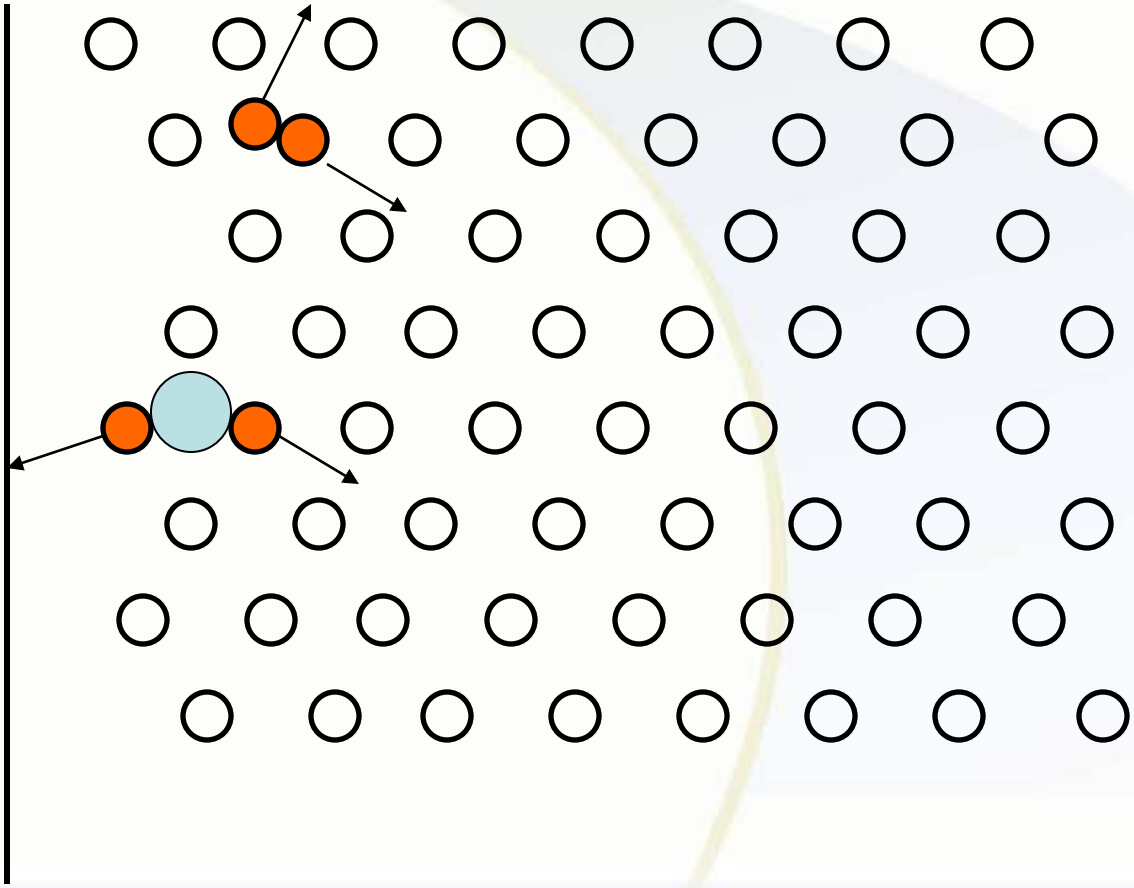

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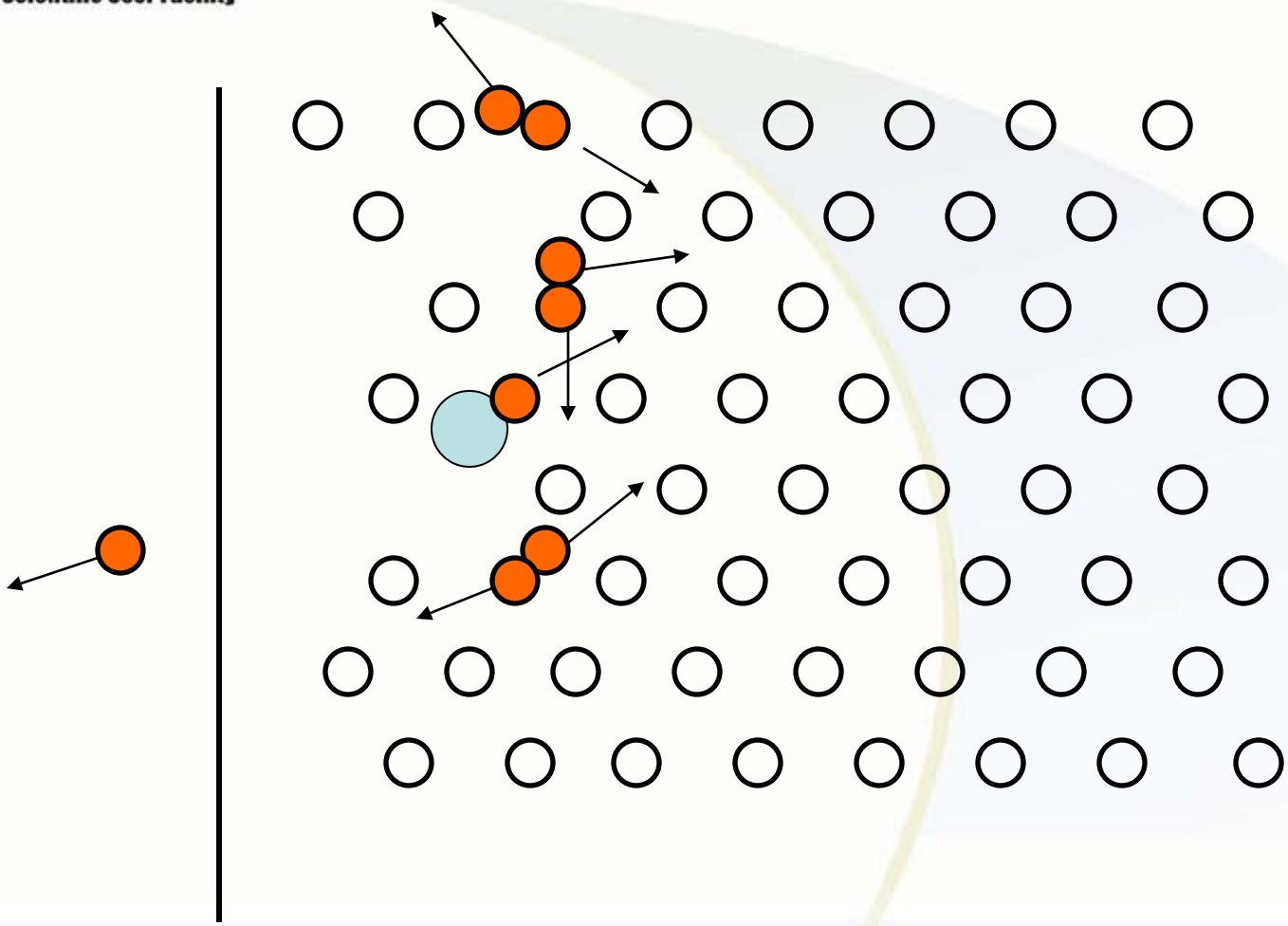
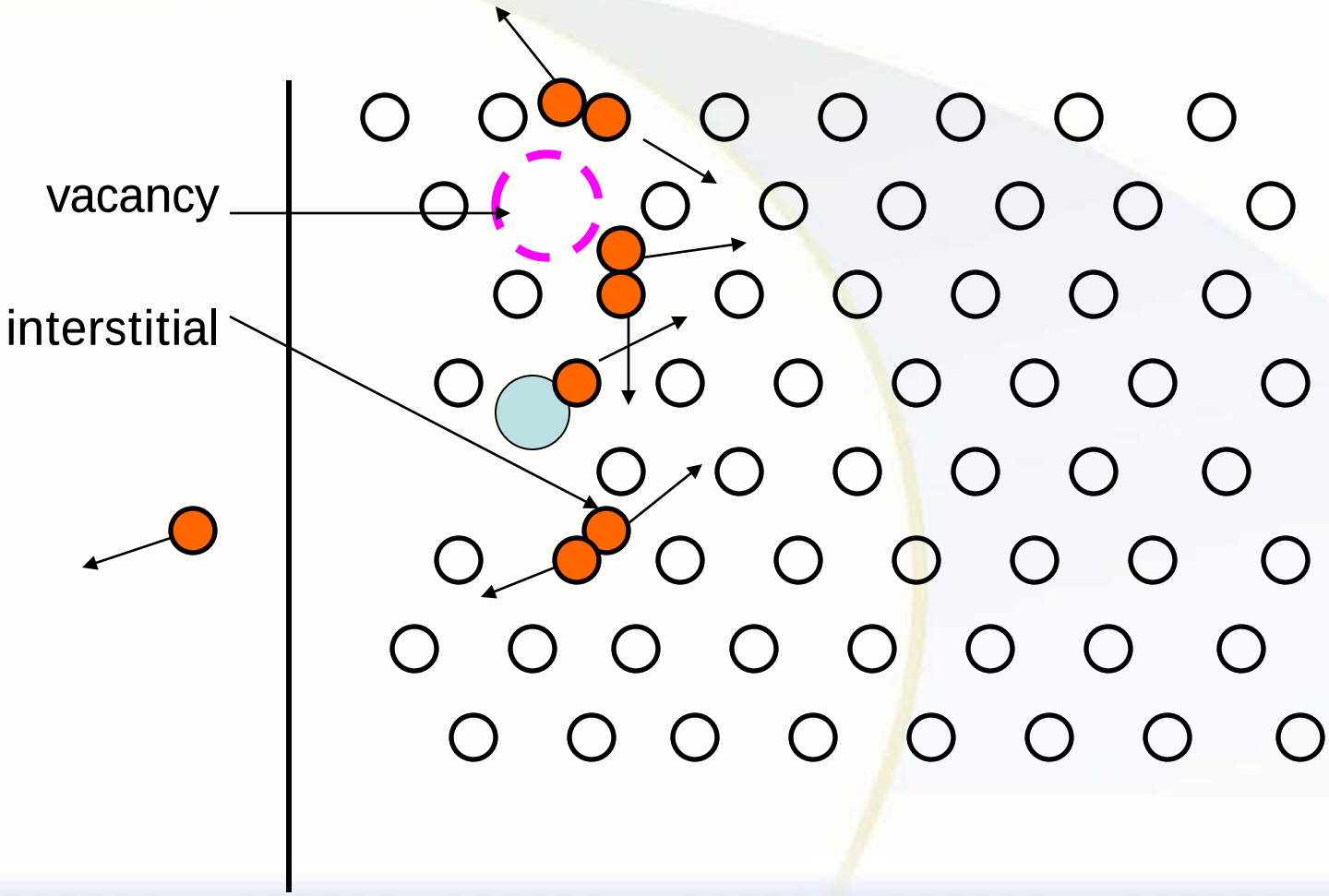
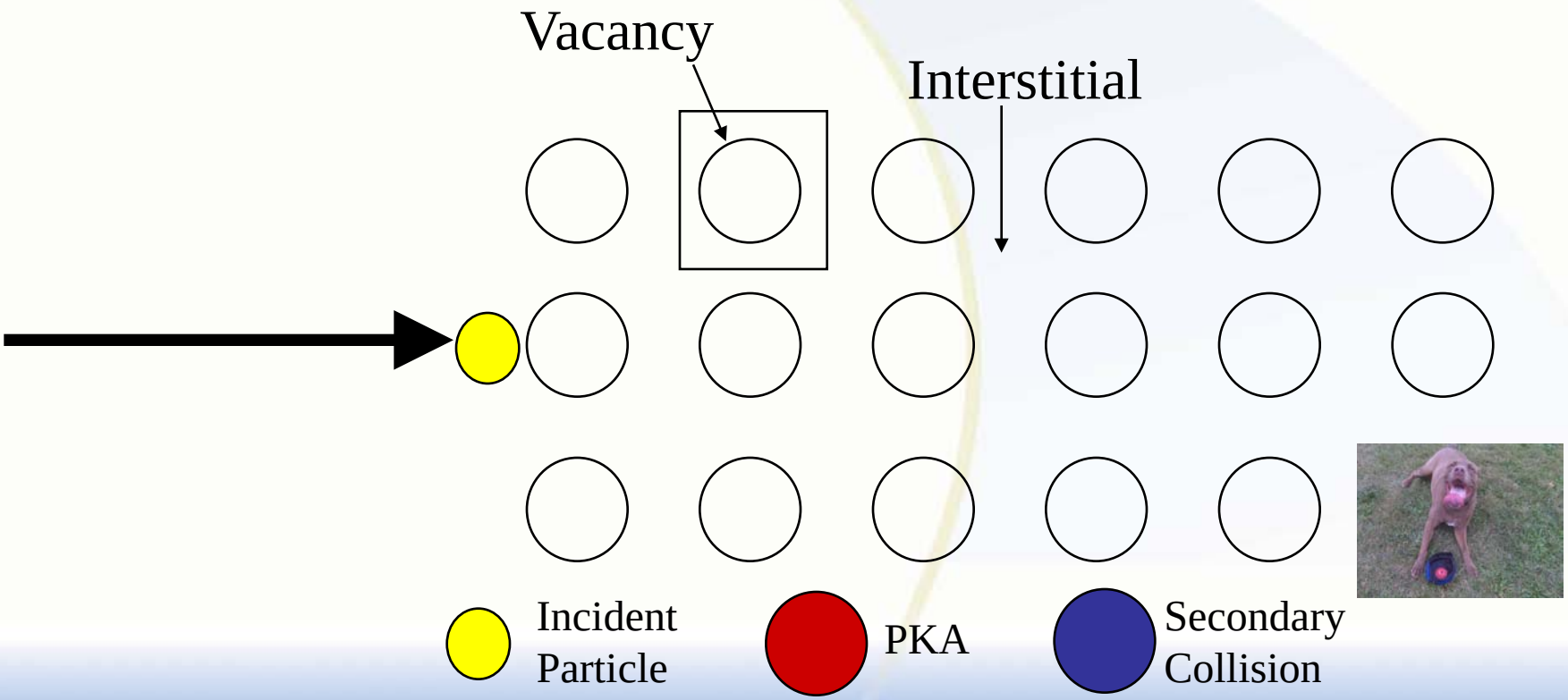


Radiation Damage Simple Picture

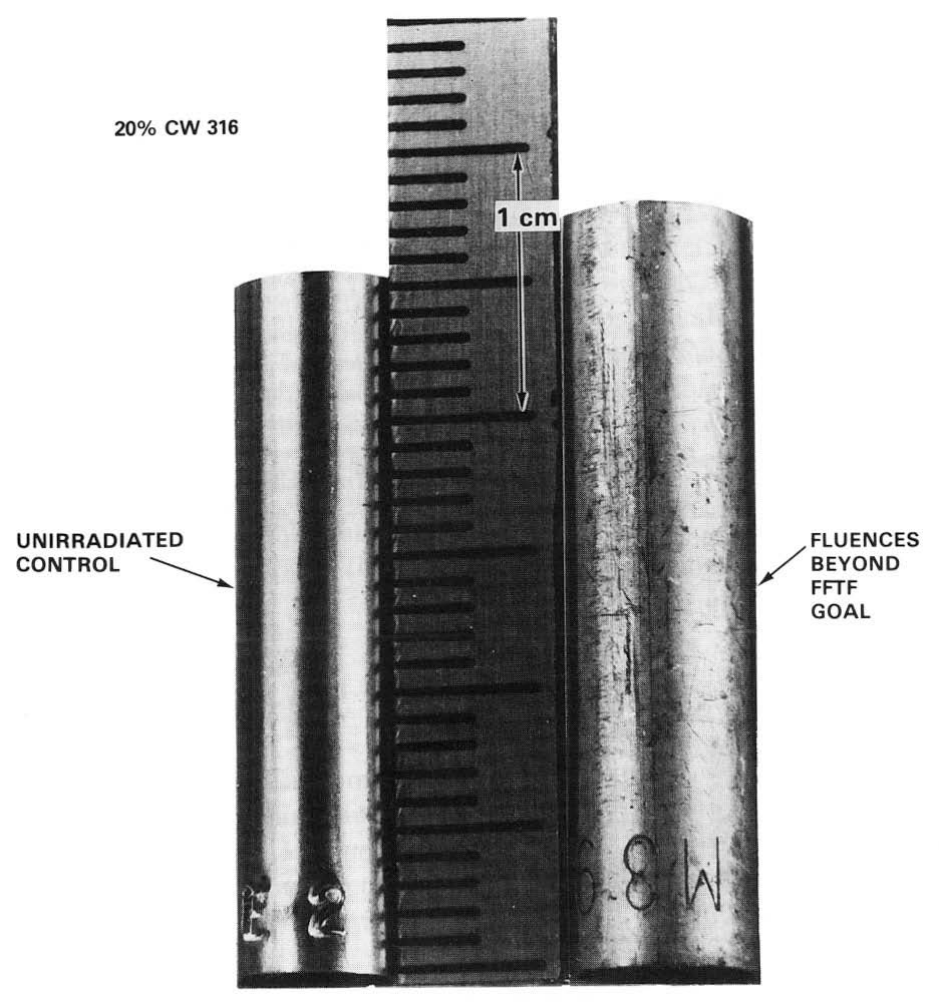


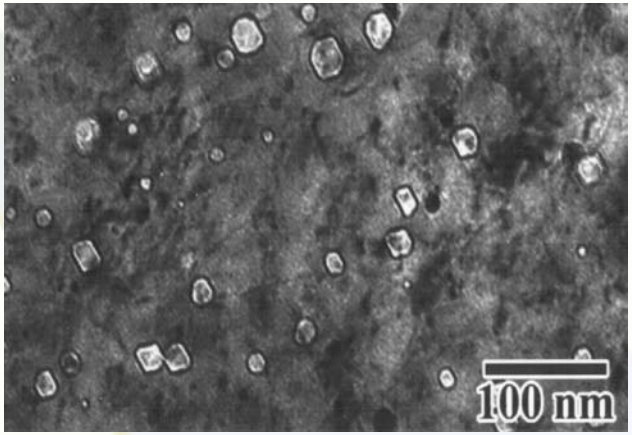
Radiation Damage Simple Picture

- **Primary Damage – 10^{-11} seconds**
- **Migration of Defects – seconds**
- **Property Changes – hours, days, months**

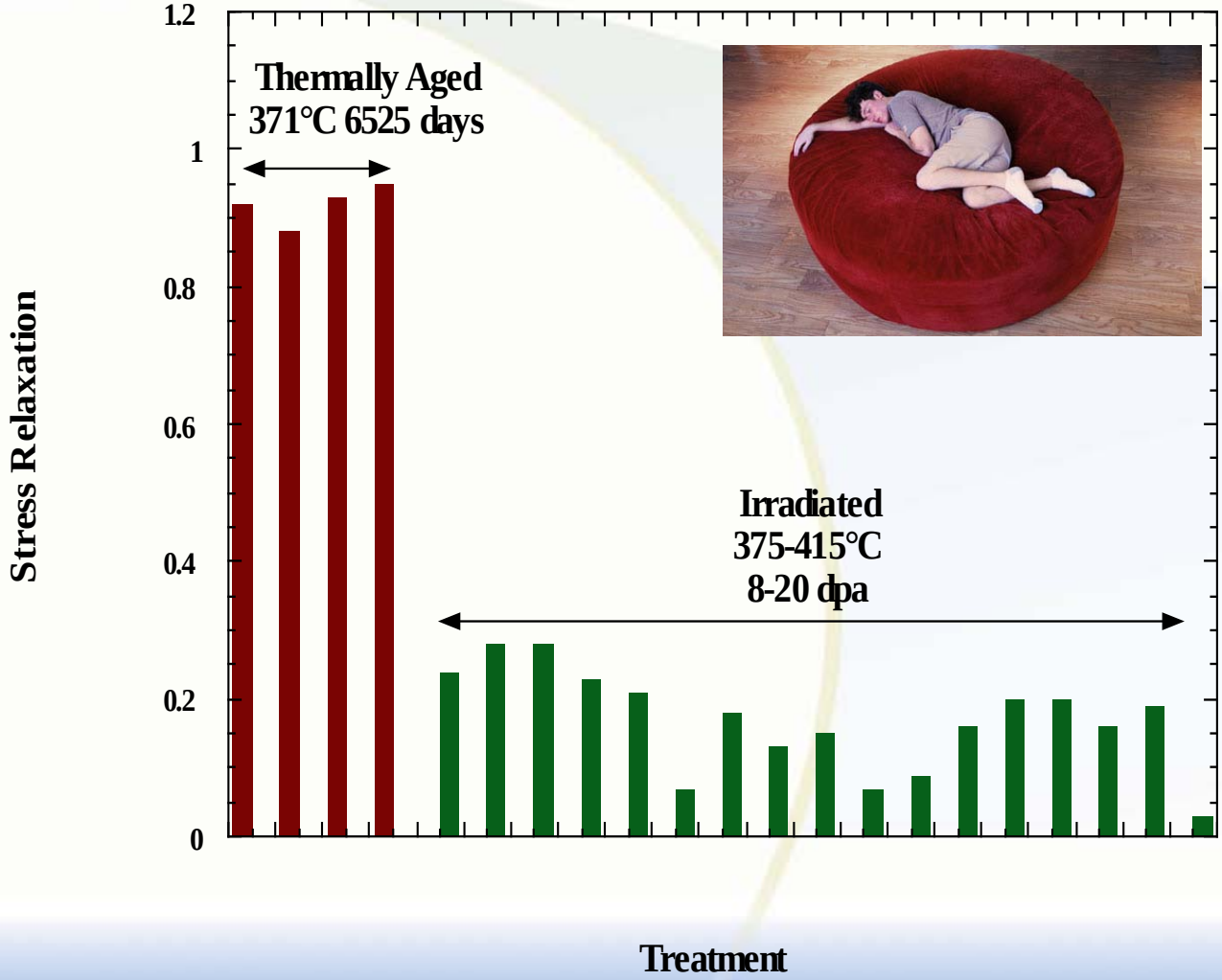


Easily Observed Swelling





Radiation-Induced Stress Relaxation

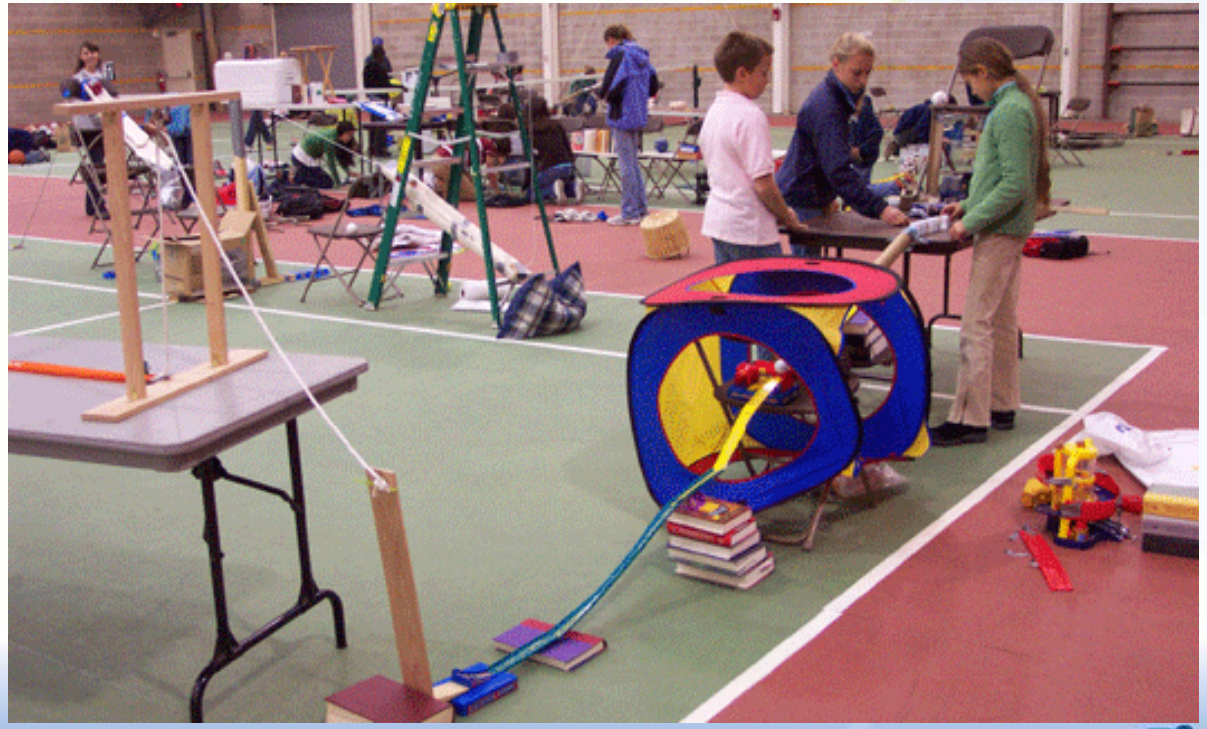


Intermission

Like the real theater, you should now:

- Stand up
- Stretch
- Act pompous

Act III: Some ATR Projects



Irradiation of Potential Inert Matrix Materials

University: University of Florida
University Investigator: Prof. Juan Claudio Nino, Materials Science & Engineering
INL Investigator: Pavel G. Medvedev

Project Goal:. Evaluation of the irradiation stability of potential IM materials and the investigation of irradiation-structure-property relationships.

Sample Types: Ceramic discs of the following compositions for were loaded: $MgO{\cdot}1.5Al_2O_3$, $MgAl_2O_4$, MgO, $Nd_2Zr_2O_7$, $0.7MgO\text{-}0.3Nd_2Zr_2O_7$, and Mg_2SnO_4.

Two specimen geometries were loaded, one for thermal diffusivity measurements and another for TEM characterization .

The specimens have now been irradiated at ~ 350 and 700 ° C to a damage level of ~1 and 2 dpa in three capsules. The PIE plan documentation for first capsule has been completed.

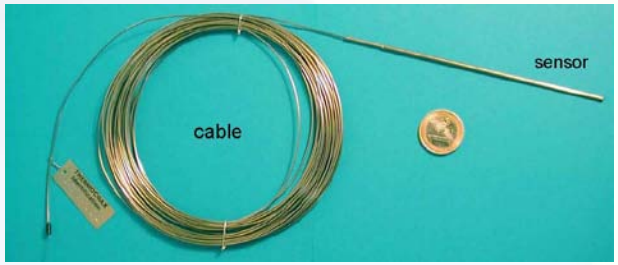
Real Time ATR-C Flux Sensors

University: Idaho State University
University Investigator: George R. Imel
INL Investigator: Joy Rempe

Project Goal: To develop active neutron monitoring systems that can be used in ATR-C. Both thermal and fast monitors will be developed in conjunction with CEA in France, and tested in the ATR-C

Sensor Types:
- *Fission chambers*
- *(U-235, Pu-239, U-238) and self powered neutron detectors (SPND).*

CEA fission chambers



SPNDs

BTB fission chambers

XRD and XAFS study of Irradiated Binary Carbides

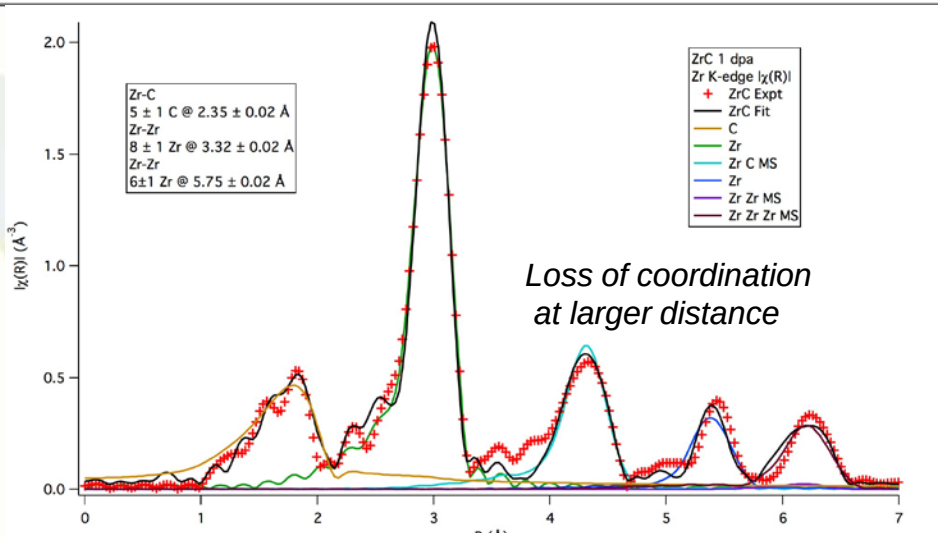
ATR National Scientific User Facility

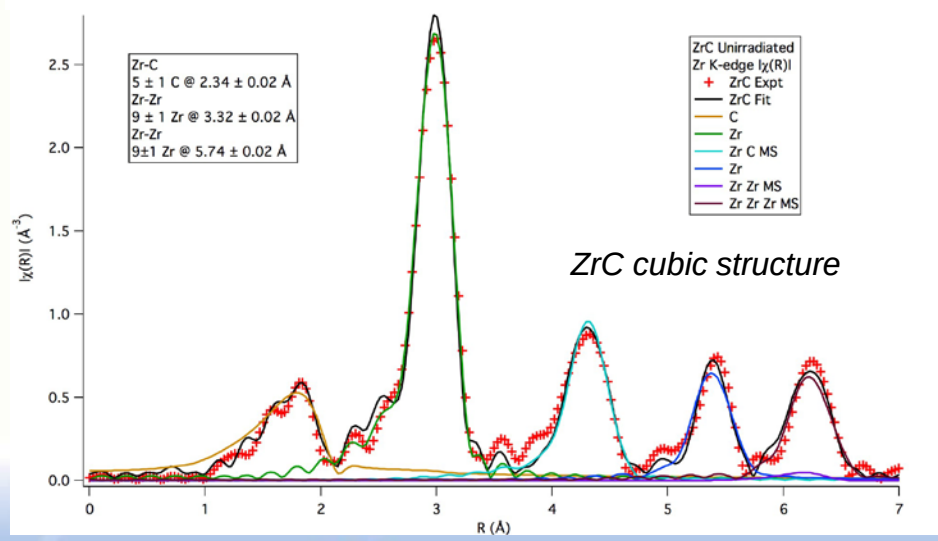
Illinois Institute of Technology
Jeff Terry
Mitch Meyer

Project Goal: Characterization of radiation damage in binary carbides and nitrides irradiated to 1 dpa at 800 ° C in the Advanced Test Reactor

Sample Types: ZrC, TiC, TiN, ZrN, AlN, SiC – 3 mm TEM disks

Measurements: X-ray Absorption Spectroscopy





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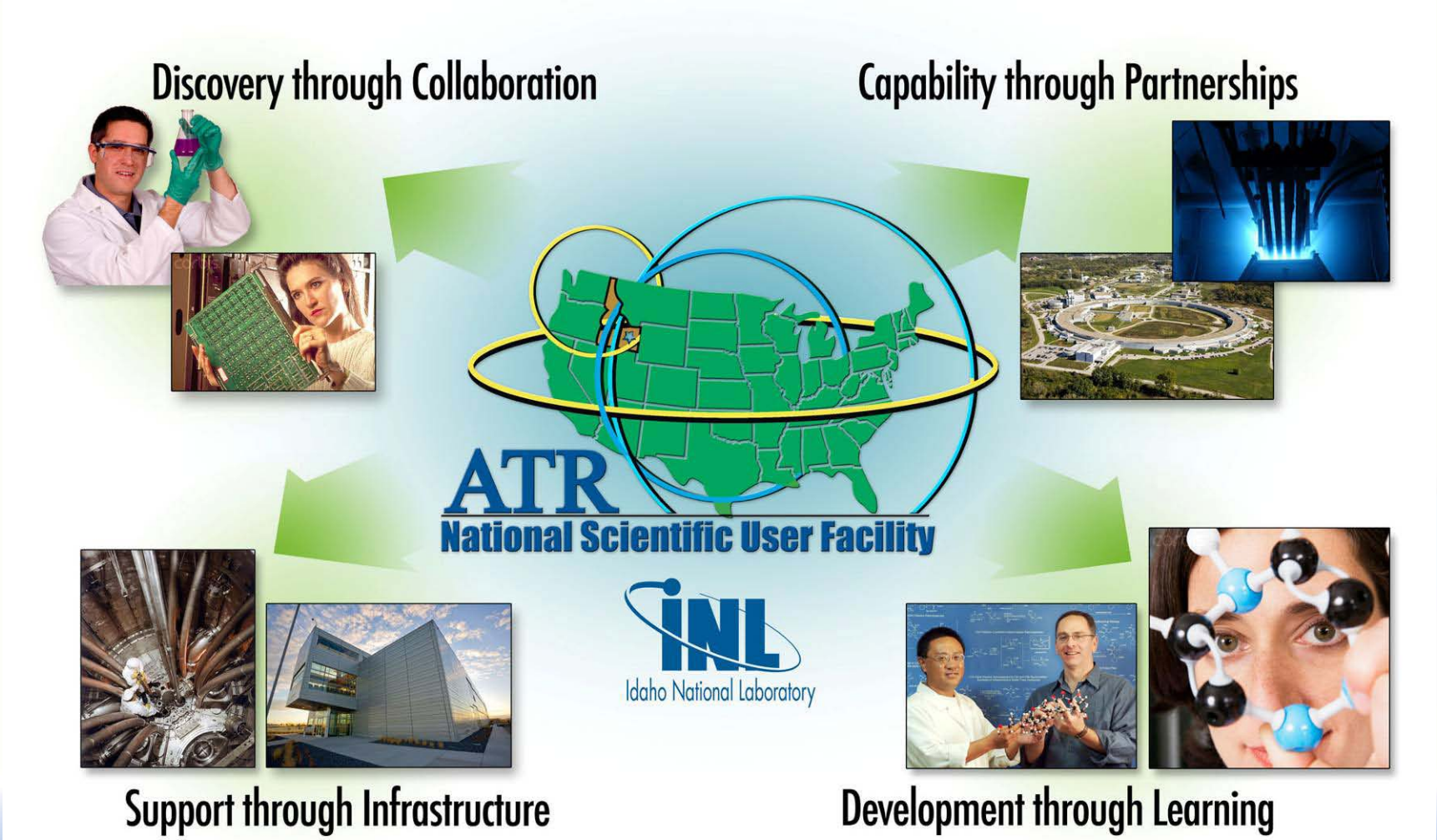
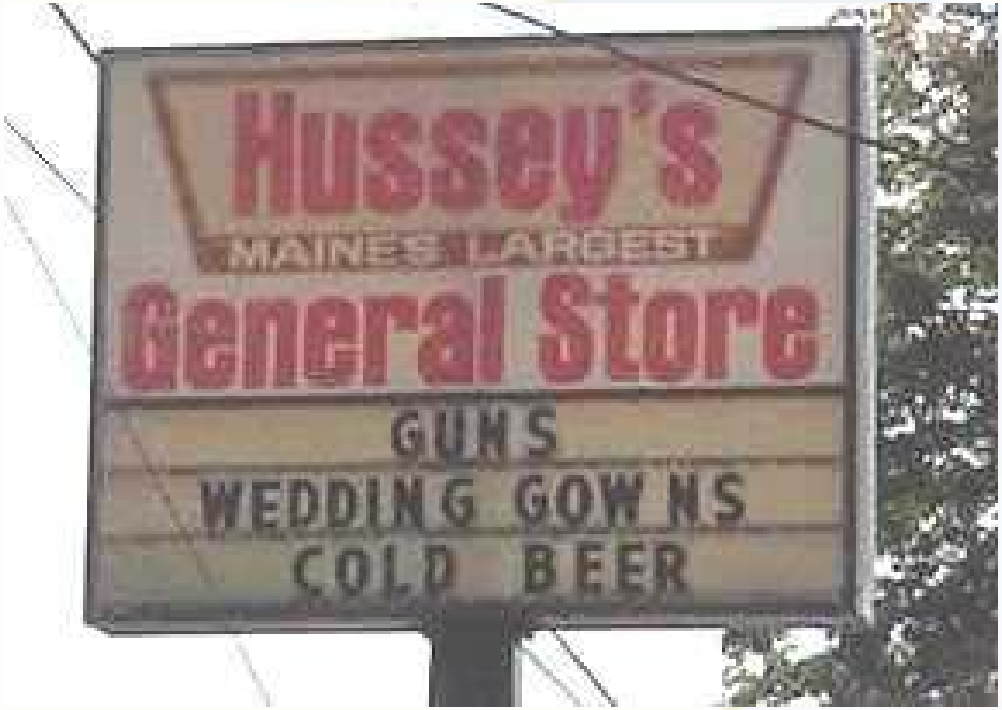
ATR National Scientific User Facility: Prototyping the Lab of the Future



Focal Point for Innovation — Stewards of the National Nuclear Capability

Combining Tools to Get a Better Answer



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"We used the NSUF for our recent experiments and were extremely pleased with our results and the friendly NSUF staff"

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