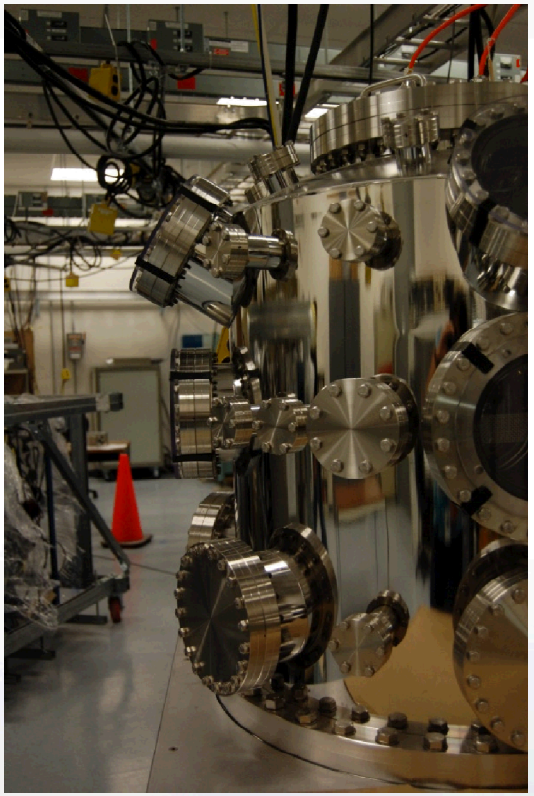
Summer Internship at the Ion Beam Laboratory

SAND2011-5239C

Brief Outline

- The Ion Beam Lab
- *In Situ* TEM Conference
- Turning Noble Gases into Solids
- Working in the lab and with lab equipment
- Learning the math behind the physics



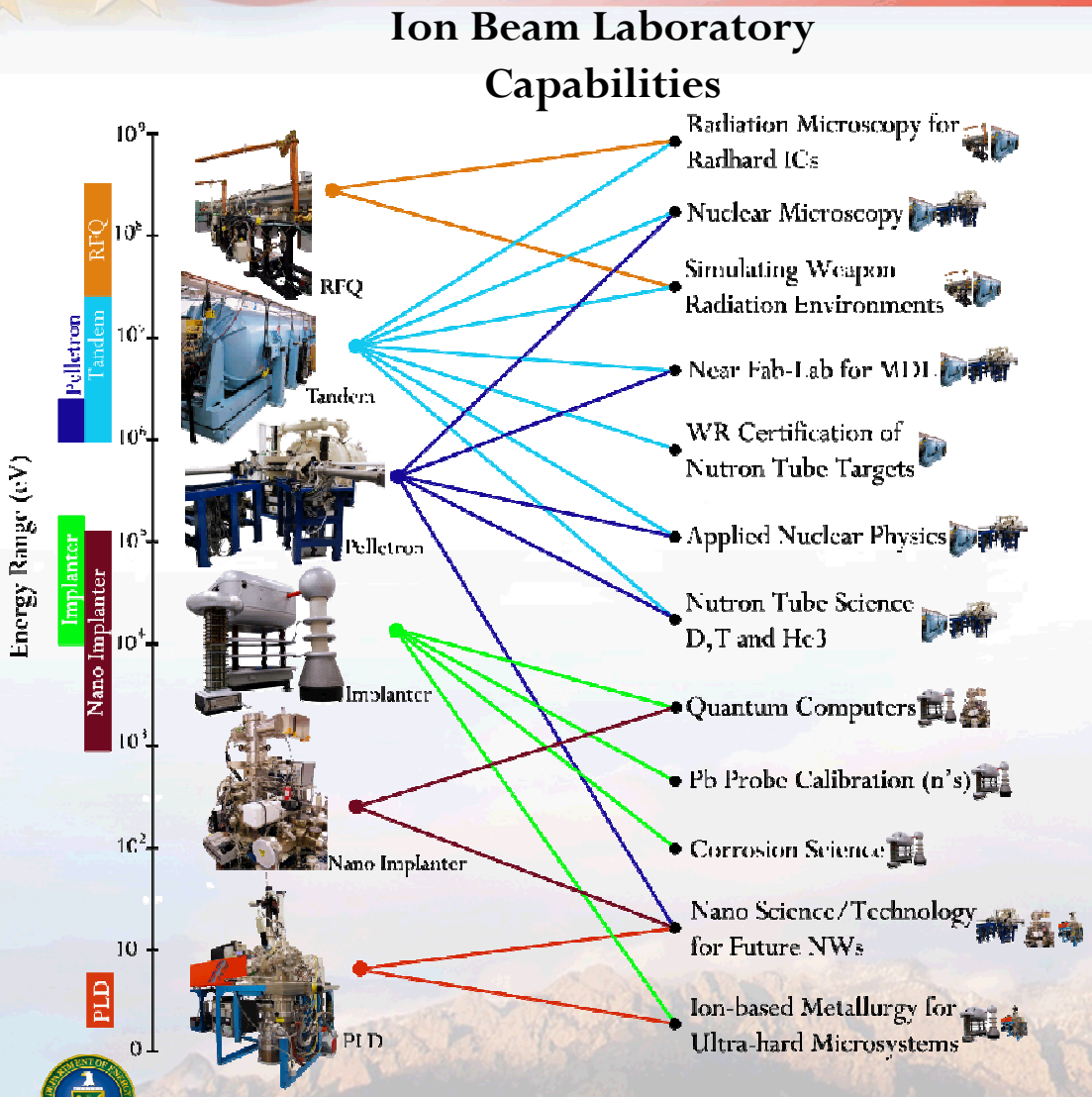
Kelsae Adame

07/27/2011

Sandia National Laboratories is a multi-program laboratory operated by Sandia Corporation, a wholly-owned subsidiary of Lockheed Martin company, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Sandia National Laboratories

Working at the Ion Beam Laboratory



- These are the machines worked with in the Ion Beam Lab.
- The Tandem, Pelletron, Implanter, and Nano-Implanter are particle accelerators.
- Particle accelerator drive various particles to high velocities and through beam lines by using electromagnetic fields.

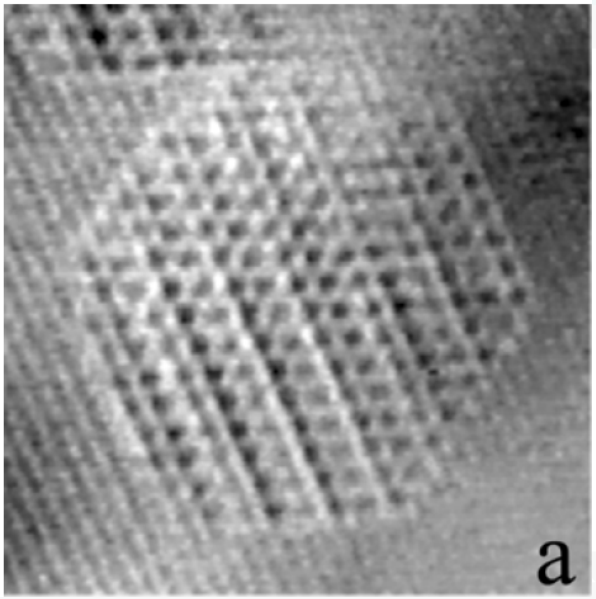
Sandia National Laboratories

My First International Conference

- The first week of work at Hotel Albuquerque. Khalid Hattar was hosting a *In Situ* TEM conference.
- Irradiating a material damages the material's microstructures which affects macro properties and the use of in situ TEM in observing the degradation of the microstructures.

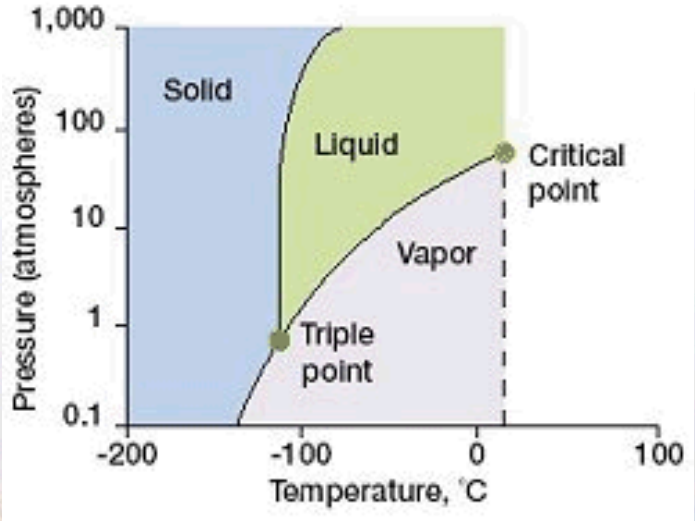
- The conference was a good introduction to the type of work that would be dealt with throughout the summer.

Making Noble Gases Solid



Xe implanted in Al (Birtcher, Xe Precipitates in Aluminum)

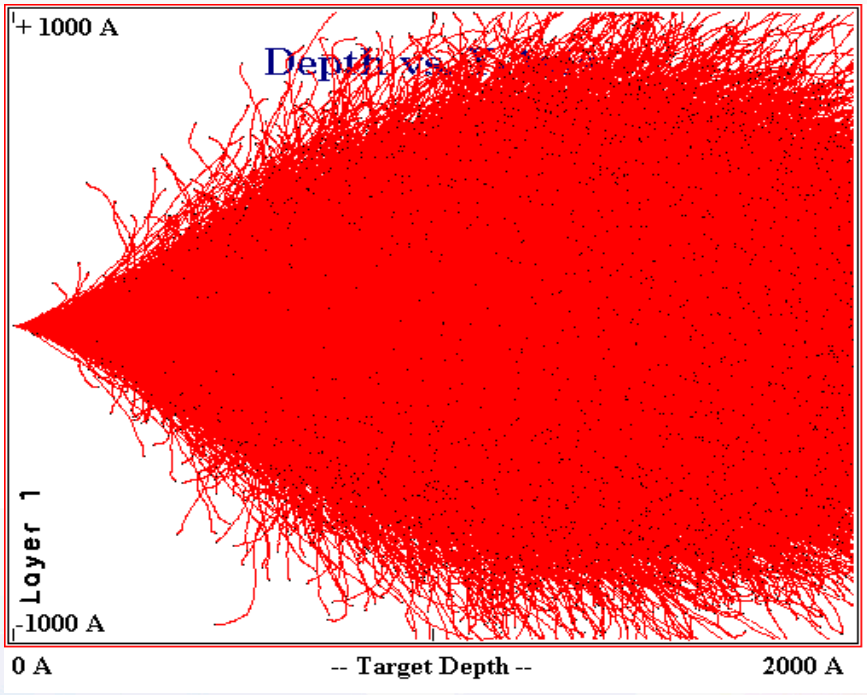
- The noble gases Krypton and Xenon were solidified by implanting them into Aluminum.
- The phase change for the experiment was done using pressure instead of temperature, as the experiment was done under room temperature conditions.
- All implications to conduct this experiment such as dose and dose rate were met.



Xe Phase Diagram

Turning a noble gas into a solid without using temperature is possible, as shown in the phase diagram.

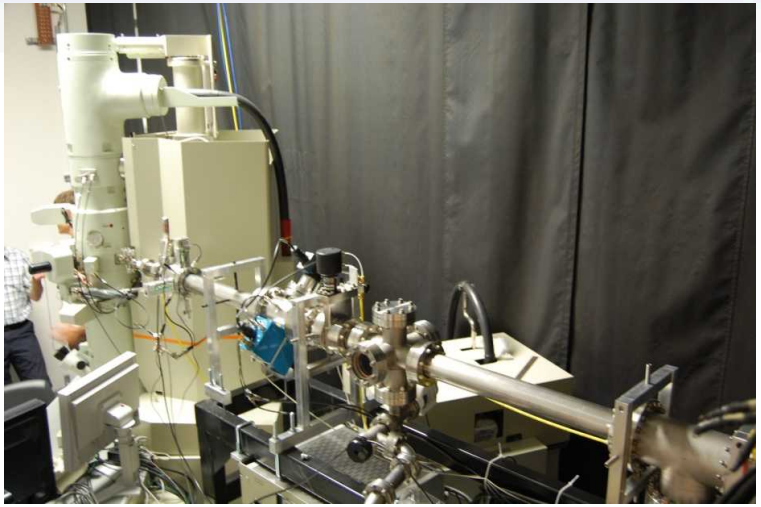
Krypton at 250 keV implanted into Aluminum

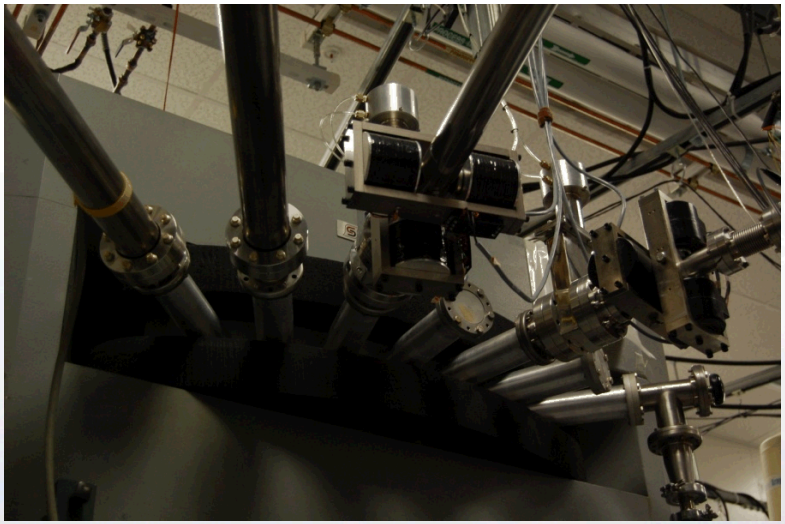


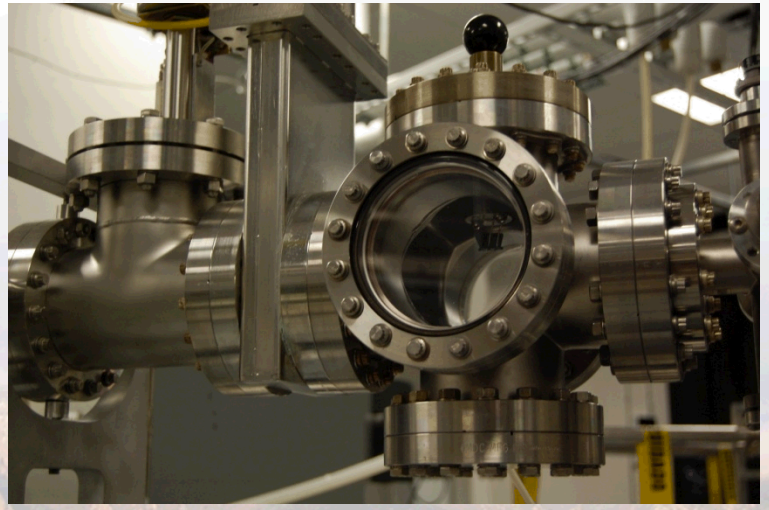
- A SRIM (Stopping Range of Ions in Matter) program was used to determine the ion distributions from each implantation condition.
- Depth vs. Y-Axis plot done by using the SRIM program. (Was done for both Kr and Xe).
- The plot shows possible ion distributions of Krypton implanted into Aluminum. The Krypton goes through the Aluminum and each line shows the probable path and depth of an ion.
- Thank you to Bruce McWatters who did all of the implantation work.

Working in the Lab

- The Ion Beam Lab was recently built, and much of the lab equipment was unorganized.
- Developed a new organizational system to optimize efficiency of the Ion Beam Laboratory.
- Assembled a vacuum system onto the end of a beam line.







Working with all of the lab equipment helped teach what the function of each piece is for.

Crystallography

- Crystal structure models were made to better understand the way different materials are configured.
- Prepped Al on Si samples by heating up the aluminum to get rid of any dirt or oils and then placed the aluminum on the silicon.

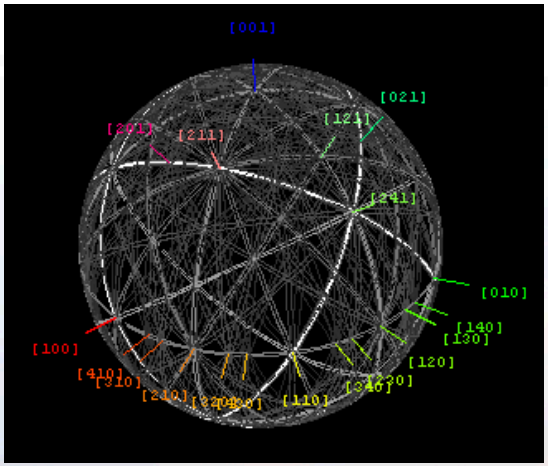


Fig. 1 Kikuchi model

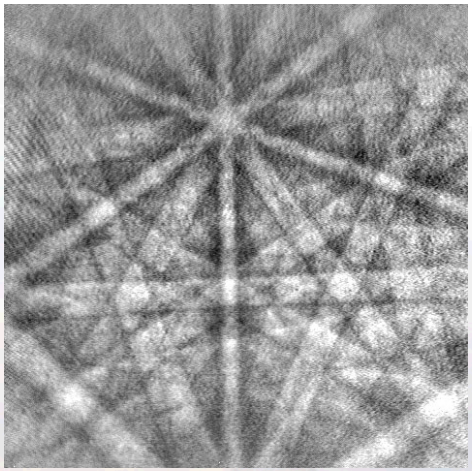


Fig. 2 Actual Kikuchi lines

(Fig. 1) Kikuchi lines form bands in electron diffraction. The lines form as electrons are diffracted off the plane of a material. The lines act as road maps in orientation space, and can be used to determine the arrangement of atoms in a material.

(Fig. 2) A real look at Kikuchi lines. A one dimensional plane is usually seen rather than a sphere of bands as seen in fig. 1.

Understanding the Math Behind the Physics

• In the instance that an ion is headed towards an atom with a larger mass and a collision occurs, the Conservation of Energy and the Conservation of Momentum equations can be used to algebraically derive the Rutherford Backscatter equation. The backscatter equation is also viable with Kikuchi diffraction and lines.

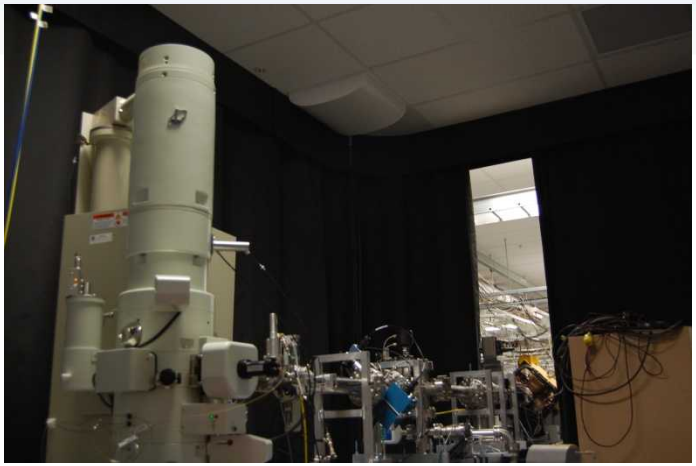
The equations:

$\frac{1}{2} m_1 v_o^2 = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$ (Conservation of Energy) and $m_1 v_o = -m_1 v_1 + m_2 v_2$ (Conservation of Momentum)

Were derived to get:

$$E_2 = \frac{4 m_1 m_2}{(m_1 + m_2)^2} \quad \text{(RBS)}$$

Acknowledgements and Conclusions

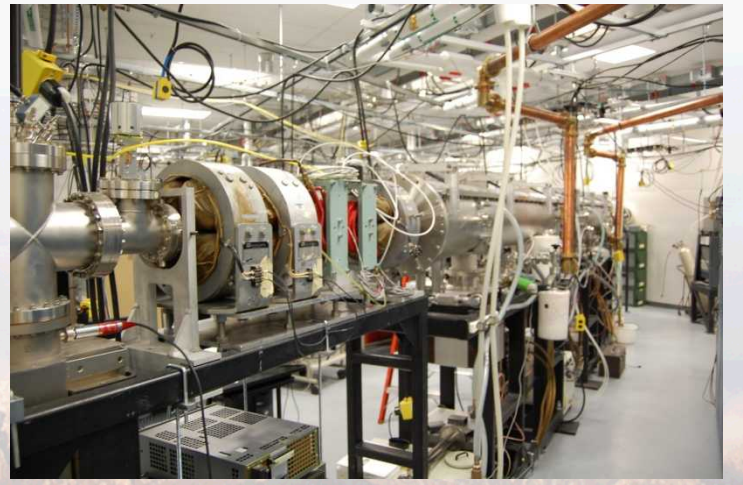


Conclusion: Working in the Ion Beam Lab was a privilege this summer, and there was much to learn about materials and the accelerators dealt with in the building.

Brief Overview

- The Ion Beam Lab
- *In Situ* TEM Conference
- Turning Noble Gases into Solids
- Working in the lab and with lab equipment
- Learning the math behind the physics

A special thanks to all the people listed below and to the rest of the department that worked with me and helped me to learn over the course of the summer. I'd also like to thank the STAR program for giving me the opportunity and experience to work at Sandia National Labs.



STAR PROGRAM™

Acknowledgements

Khalid, Hattar ; Barney, Doyle; Janelle, Branson; Paolo, Rossi; Brad, Yates; Melissa, Dosanjh; Eric, Gross; Dan, Buller; Daniel, Perry; Bruce McWatters

Sandia National Laboratories