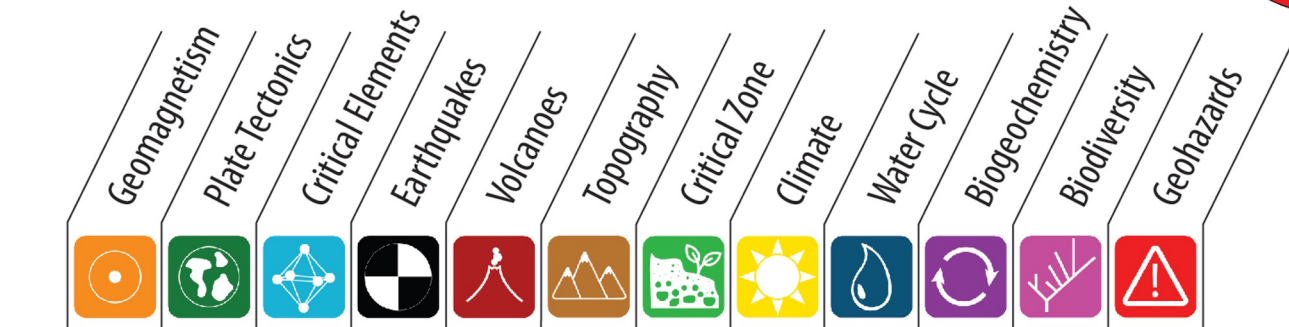


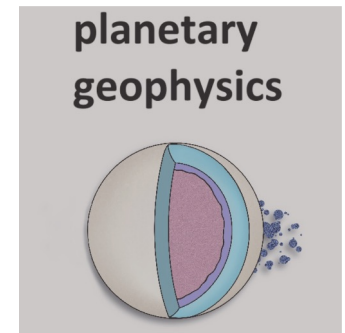
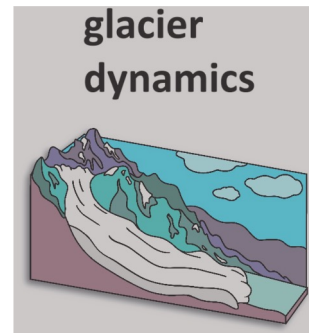
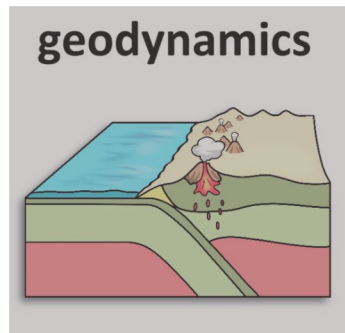
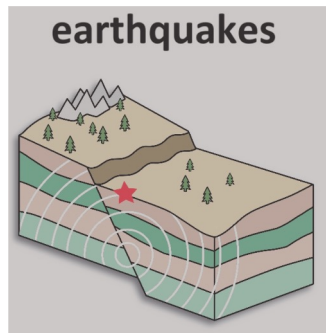
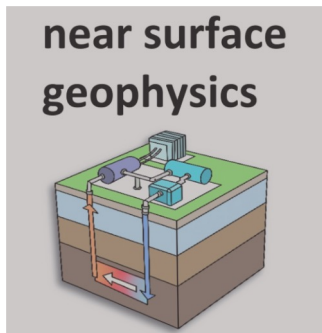
# NSF Science Priorities 2020-2030



- Earth in time



- Dynamic properties of Earth and Planetary materials



## In-Situ Studies of Rock Deformation (ISRD): Research Coordination Network

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- **Goal: Collaboration, Innovation, and Transformation**
- **Charge:** “...facilitate the integration of beamline technologies with deformation experiments and create new directions for experimental rock deformation research.”
- **Task:** Host a series of five workshops at synchrotron and neutron sources that bring together geophysicists and beamline scientists to identify pressing research challenges that can be addressed using synchrotron X-ray and neutron capabilities
  - Science Workshops:
    - CHES Workshop (June 2020, Virtual)
    - APS Workshop (January 2021, Virtual)
    - **Neutron Workshop (July 2023, in-person)**
  - Hands-on training sessions
    - Shadow a beamline user (Fall 2022, Spring 2023 APS 6-BMB)
    - AE Workshop (March 2023)
    - Tomography Workshop (January 2024, ALS)

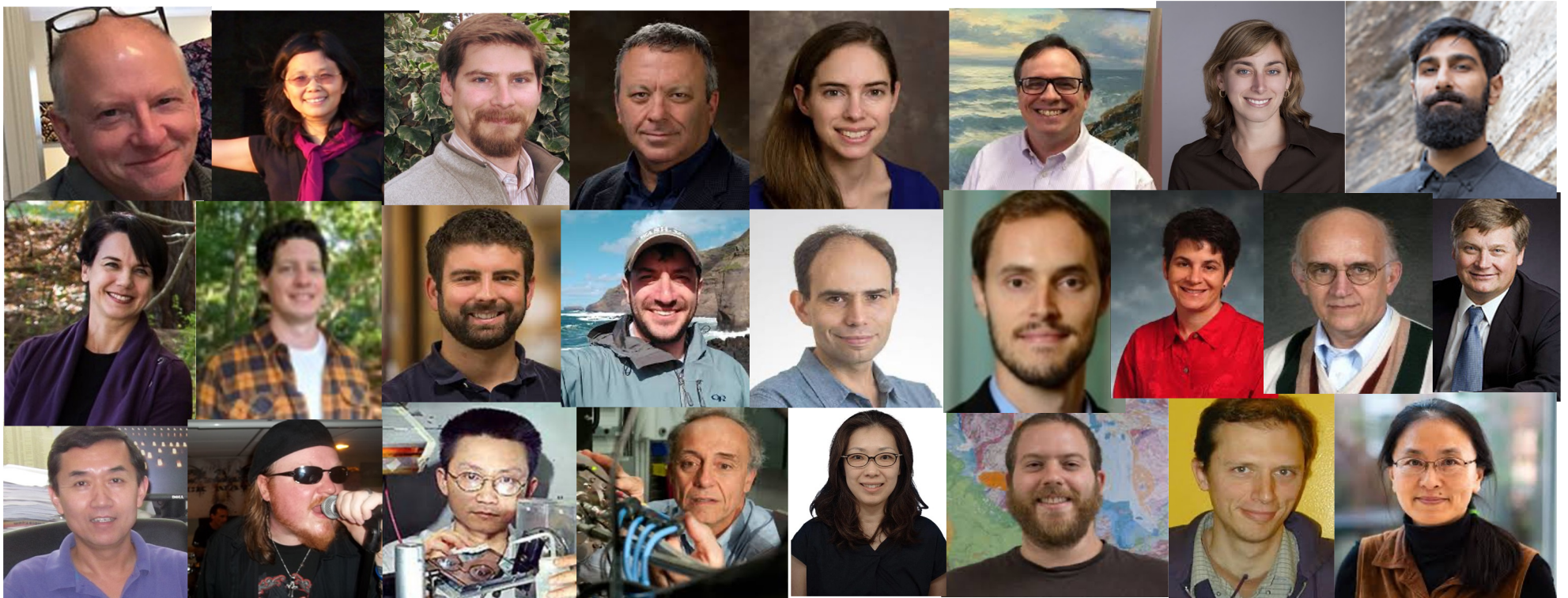


EAR-1926627



# Collaboration, Innovation and Transformation

- Steering Committee





# Collaboration, Innovation and Transformation

- Advisory Committee



Robert Farla

# Neutrons & NIST



***Daniel S. Hussey***

*Physical Measurement Lab*

National Institute of Standards and Technology

# NIST Neutron Imaging Team

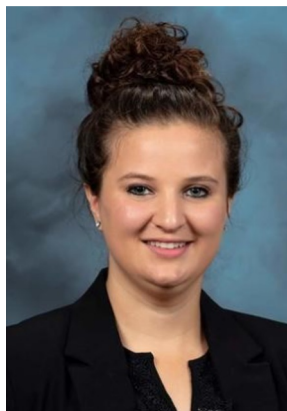
Postdocs



Youngju Kim,  
APR 2021-



M. Cyrus Daugherty,  
FEB 2021-



Victoria DiStefano, 2019-2020,  
Now AAAS Fellow w/ DOE OS

Staff



Jacob M. LaManna



Eli Baltic



Daniel S. Hussey



David L. Jacobson

# INFER Collaboration

Name	Affiliation
Hunter Meyer	LSU, Physics
Joyoni Dey	LSU, Physics
Peter Bajcsy	NIST, ITL
Pushkar Sathe	NIST, ITL
Katie M. Weigandt	NIST, NCNR
Paul A. Kienzle	NIST, NCNR
Ryan P. Murphy	NIST, NCNR
Caitlyn Wolf	NIST, NCNR
Hubert King	NIST, NCNR
Daniel S. Hussey	NIST, PML
David L. Jacobson	NIST, PML
Jacob M. LaManna	NIST, PML
M. Cyrus Daugherty	NIST, PML
Michael G. Huber	NIST, PML
Nikolai N. Klimov	NIST, PML
Sarah Robinson	NIST, PML
Youngju Kim	UMD PREP Post Doc
Dimitry Pushin	University of Waterloo
Dusan Sarenac	University of Waterloo
Connor Kapahi	University of Waterloo
Atishay Jain	Brown University
Ritambhara Singh	Brown University

## **Session:** Synchrotron X-ray and Neutron Characterization of Geomeedia for Energy Applications (MR019)

Static and dynamic synchrotron X-ray and neutron techniques have increasingly been applied to geologic systems to observe nanoscale structure, reaction, and transport in porous geomeedia. In addition to *ex situ* characterization, these techniques can be applied in conjunction with environmental cells to enable *in situ* measurements at field conditions. This session focuses on the application of synchrotron X-ray and neutron techniques for energy-related systems including hydrocarbon recovery, carbon mineralization, geologic hydrogen storage, methane storage, compressed air energy storage, geothermal systems, etc., as well as the advancement of X-ray and neutron techniques, tools, and data interpretation for geologic systems.

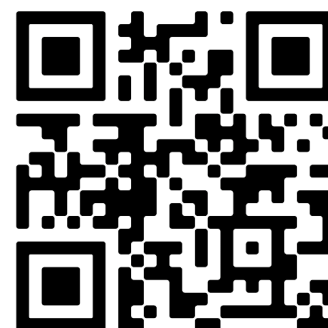
**Conveners:** Chelsea Neil<sup>1</sup>, Hongwu Xu<sup>1,2</sup>, Qingyun Li<sup>3</sup>

<sup>1</sup> Los Alamos National Laboratory

<sup>2</sup> Arizona State University

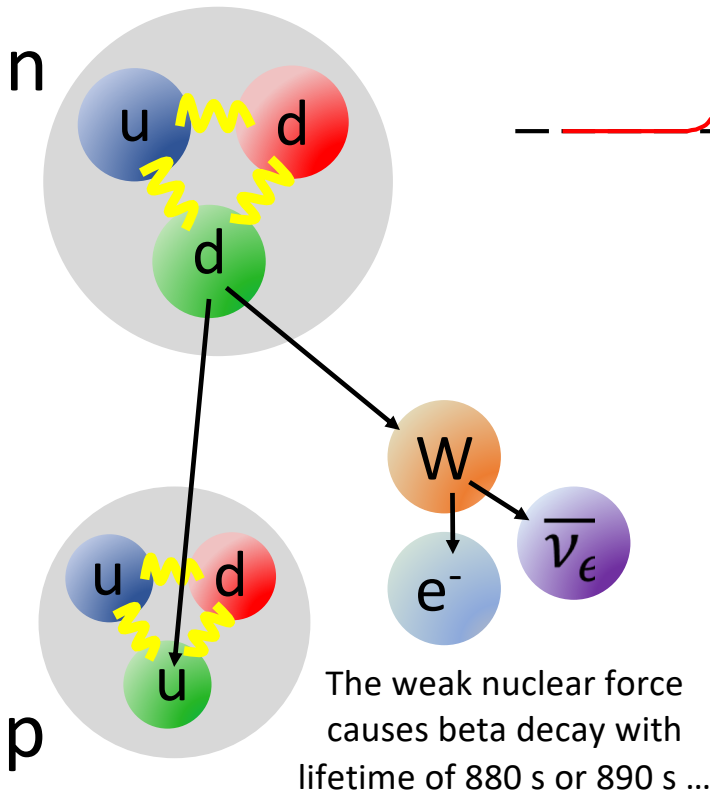
<sup>3</sup> Stony Brook University

**Scan to open  
the session  
website and  
submit an  
abstract!**



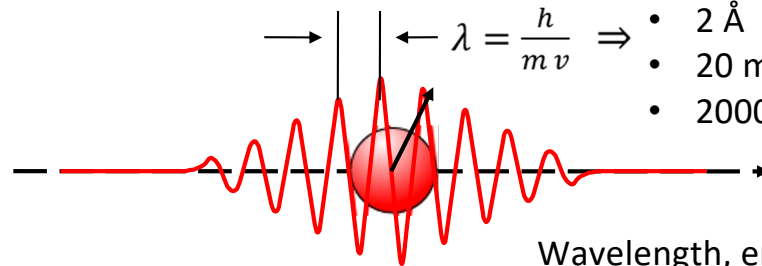
# The free neutron

Electrically neutral, neutrons  
Interact with matter primarily  
via the strong nuclear force

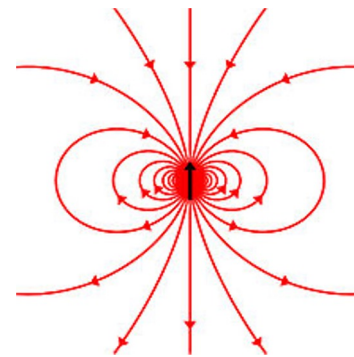


The "Rule of 2's"

- 2 Å
- 20 meV
- 2000 m/s



Wavelength, energy are  
well-tuned for studying  
condensed matter

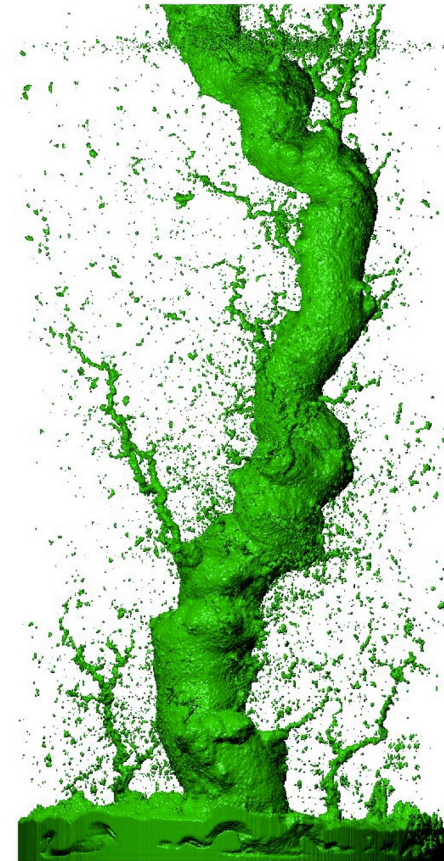
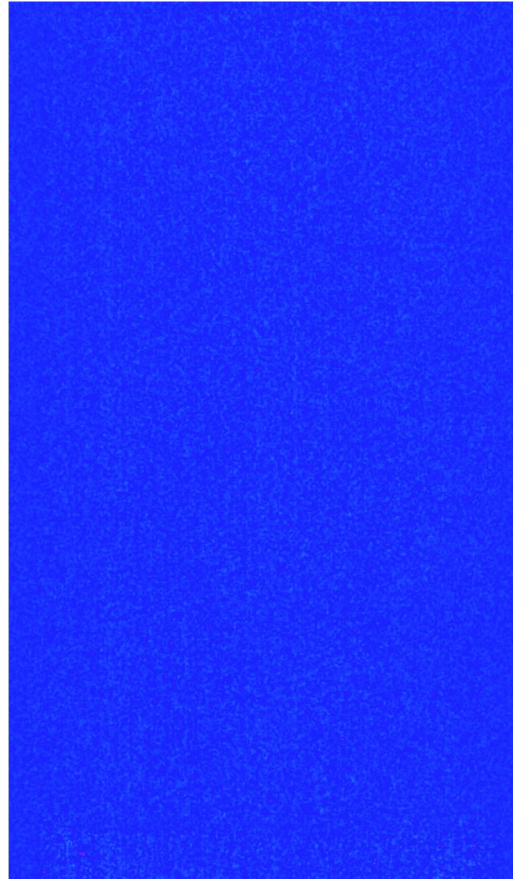
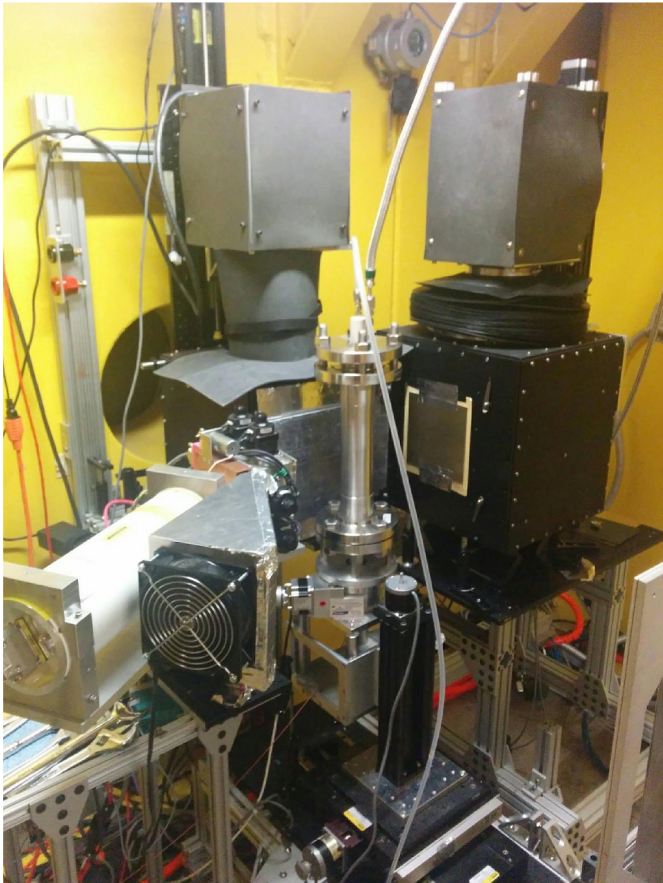


Spin 1/2 particle "sees"  
EM fields, Polarize by:

- ☐ Spin-dependent absorption
- ☐ Change in angle of reflection



# Wormhole formation in Indiana Limestone



# The Challenge of Neutron Scattering: Low Brightness

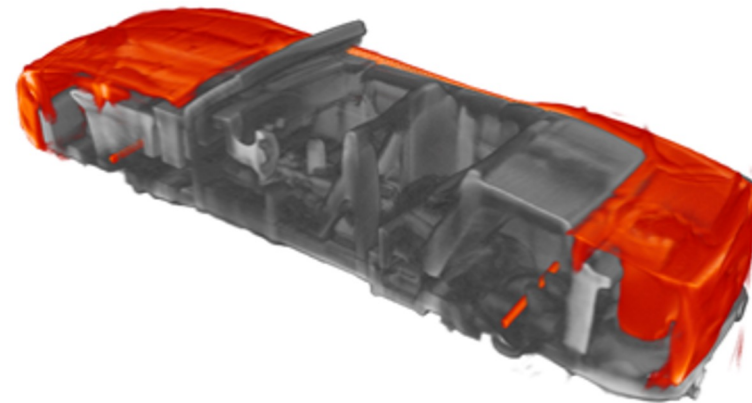
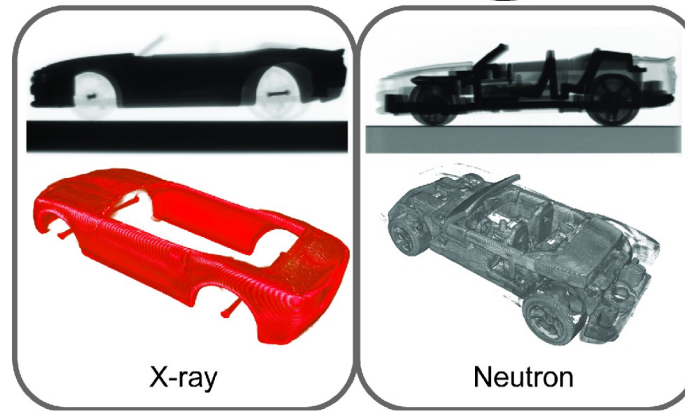
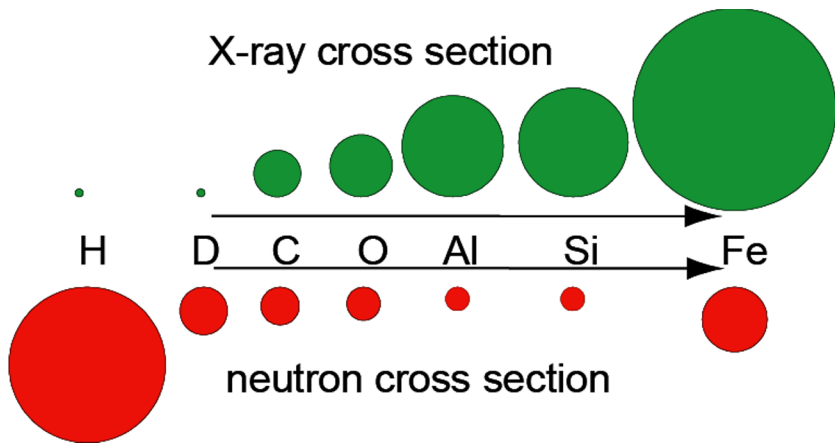


Reactor Neutron Source



Gen-3 Synchrotron

# Complementarity of multimodal data can enable new science



# New Instruments and Neutron Sources are coming on-line



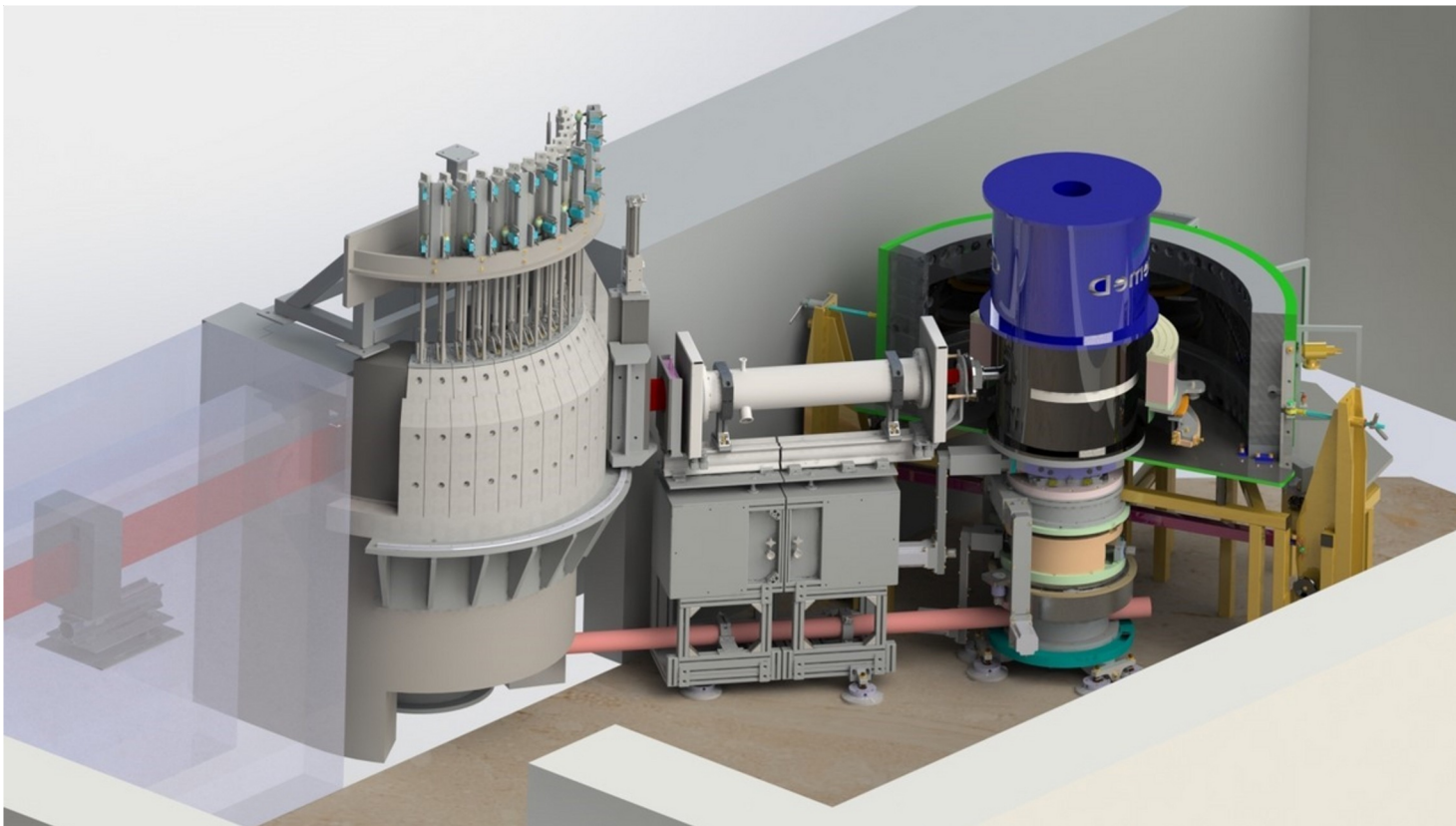
European Spallation Source  
Lund, Sweden  
Heloisa Bordallo, Thursday AM

# New Instruments and Neutron Sources are coming on-line



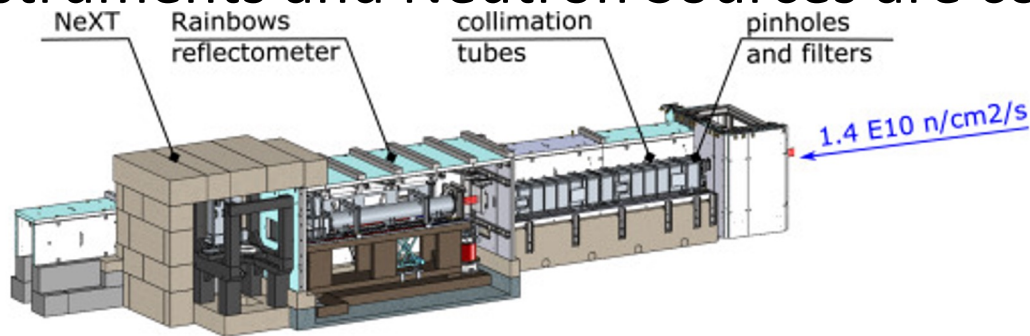
VENUS @Spallation Neutron Source  
Oakridge, TN  
Hassina Bilheux, Thursday AM

## New Instruments and Neutron Sources are coming on-line

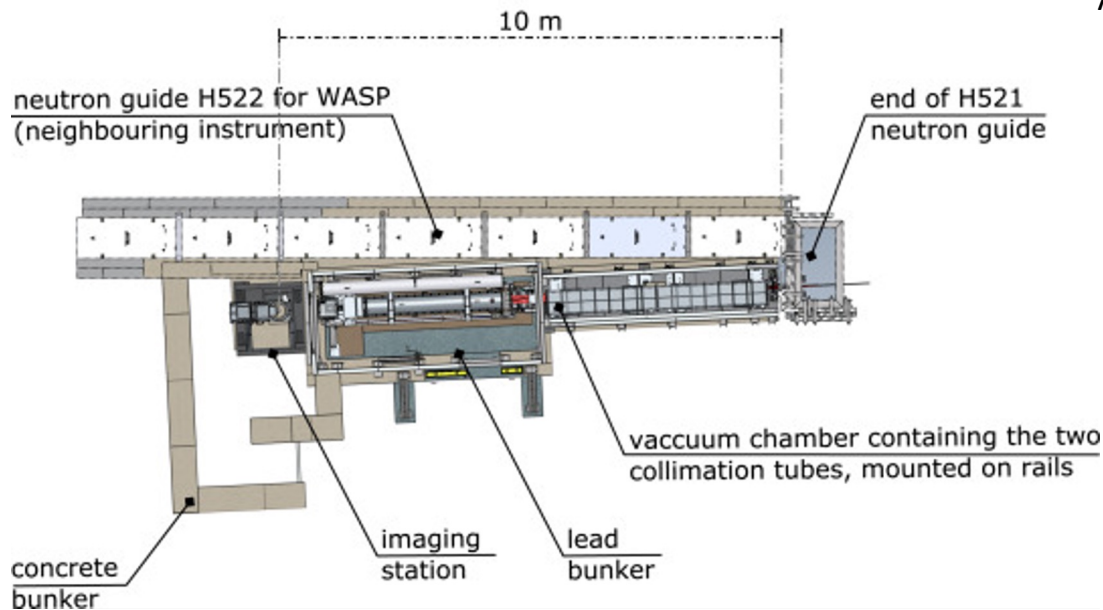


XtremeD at the Institut Laue-Langevin  
Grenoble, France  
Javier Campo, Wednesday AM

# New Instruments and Neutron Sources are coming on-line

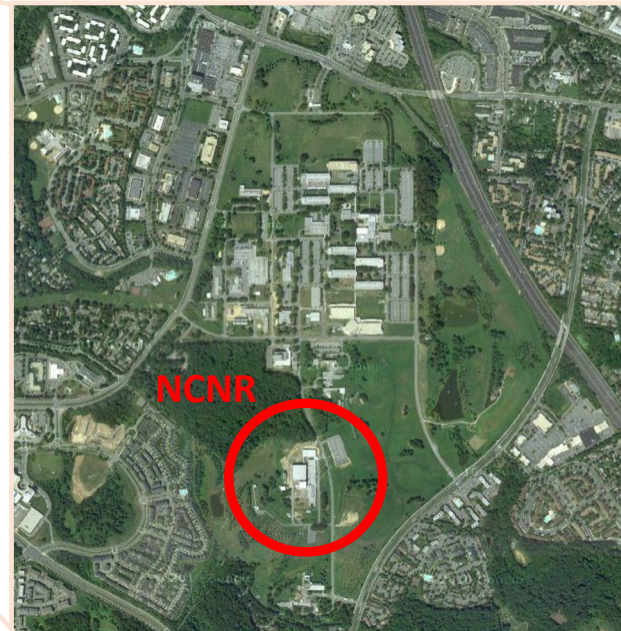
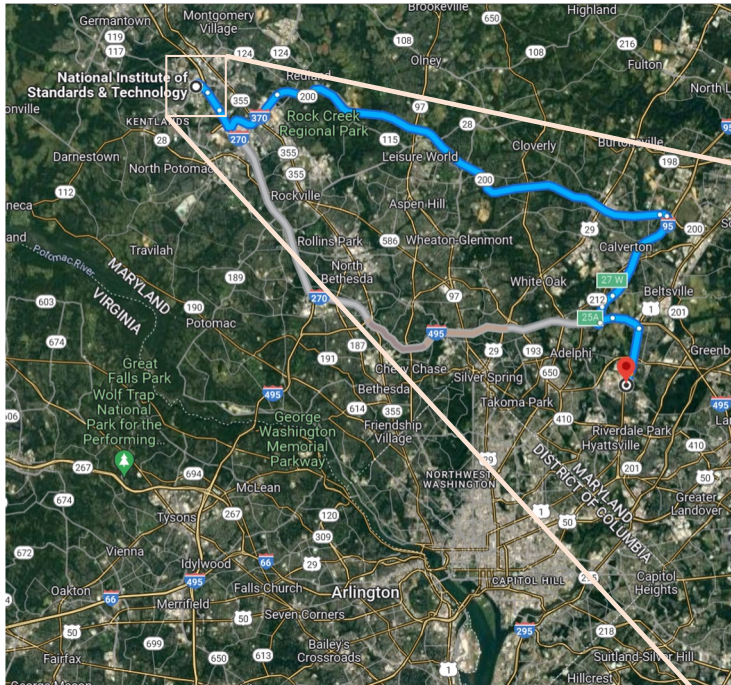


NeXT-Grenoble at the Institute Laue-Langevin  
Grenoble, France  
Alessandro Tengattini, Tuesday AM



# National Institute of Standards and Technology (NIST, in USA)

- Main Campus Located in Gaithersburg, MD USA
- Satellites in Boulder, CO and Charleston, SC
- ~15 miles north of Washington D.C.
- Established 1901, First U.S. National Lab
- 650 acres, 3000 staff, 3000 associates, 4 Nobel Laureates





# NIST Center for Neutron Research (NCNR)

- 20 MW Research Reactor
- Operating since 1967, re-licensed to run (at least) until 2029
- Largest neutron scattering user program in the U.S.
- 28 thermal and cold neutron scattering and imaging facilities

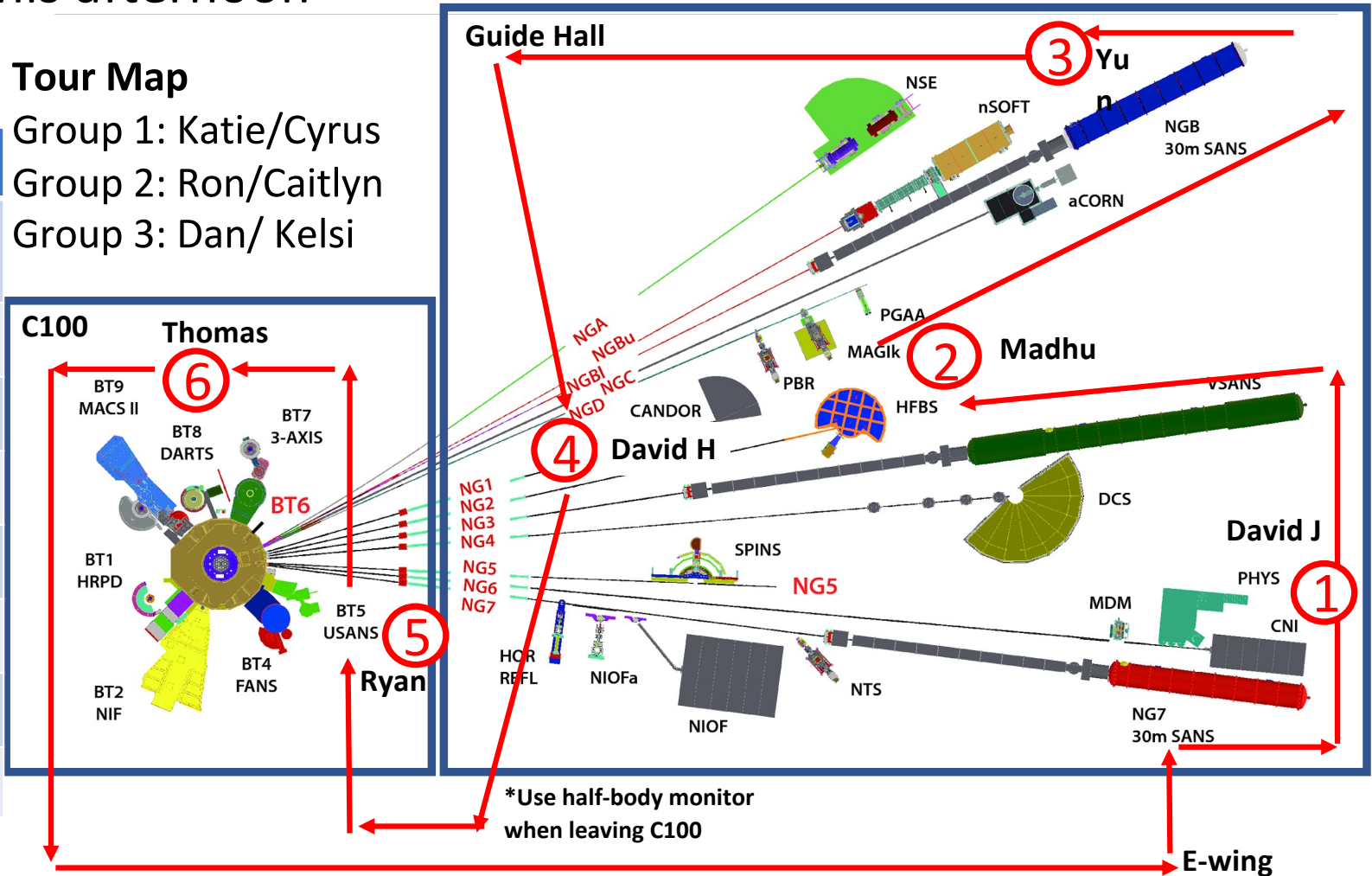


# NCNR Tour this afternoon

## Tour Map

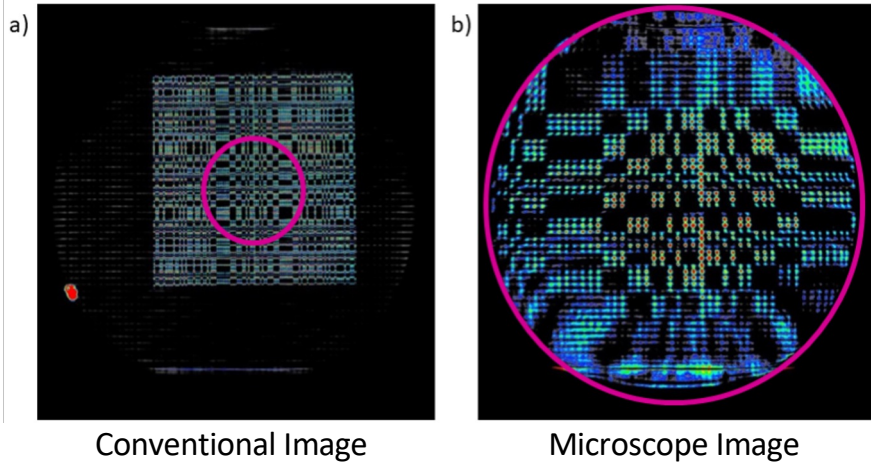
Group 1: Katie/Cyrus  
 Group 2: Ron/Caitlyn  
 Group 3: Dan/ Kelsi

Stop #	Time
0	2:30-2:45 Tour Lobby
1	2:50-3:05 Check in/Intro to NCNR
2	3:05-3:20 Stops 1,2,3
3	3:20-3:35 Stops 2,3,4
4	3:35-3:50 Stops 3,4,5
5	3:50-4:05 Stops 4,5,6
6	3:50-4:05 Stops 5,6,1
6	4:05-4:20 Stops 6,1,2
	Back to Lobby

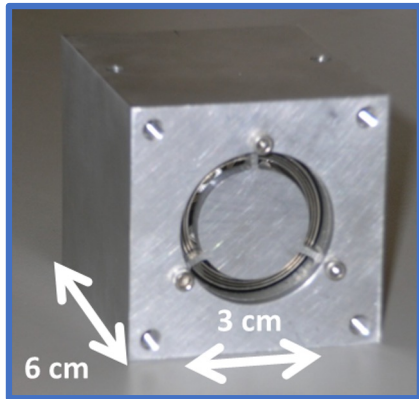


# Two Instrument Development Projects I'm excited about

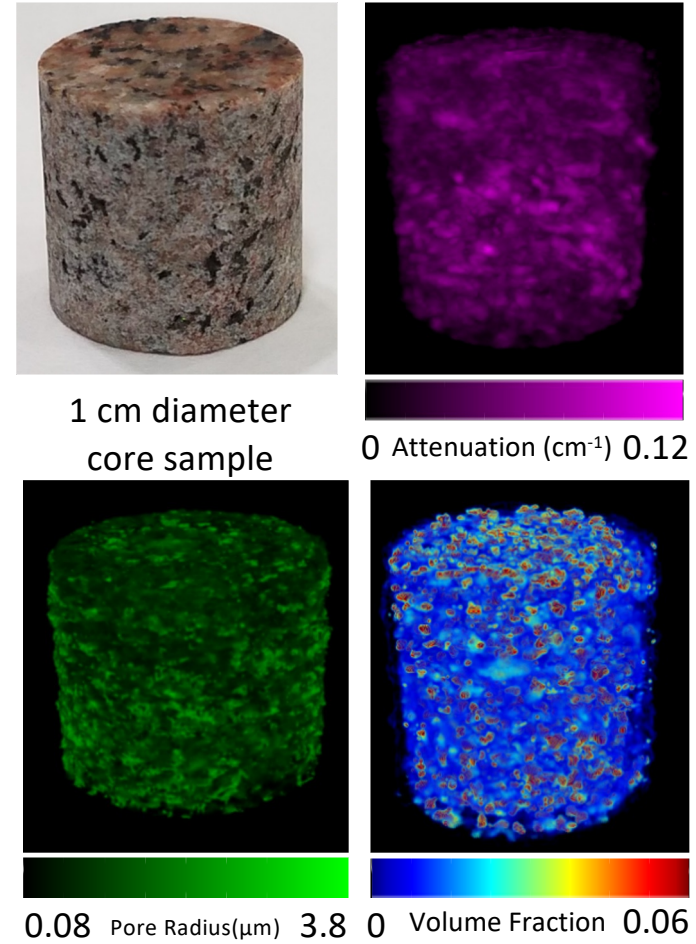
## Neutron Microscope based on Wolter optics



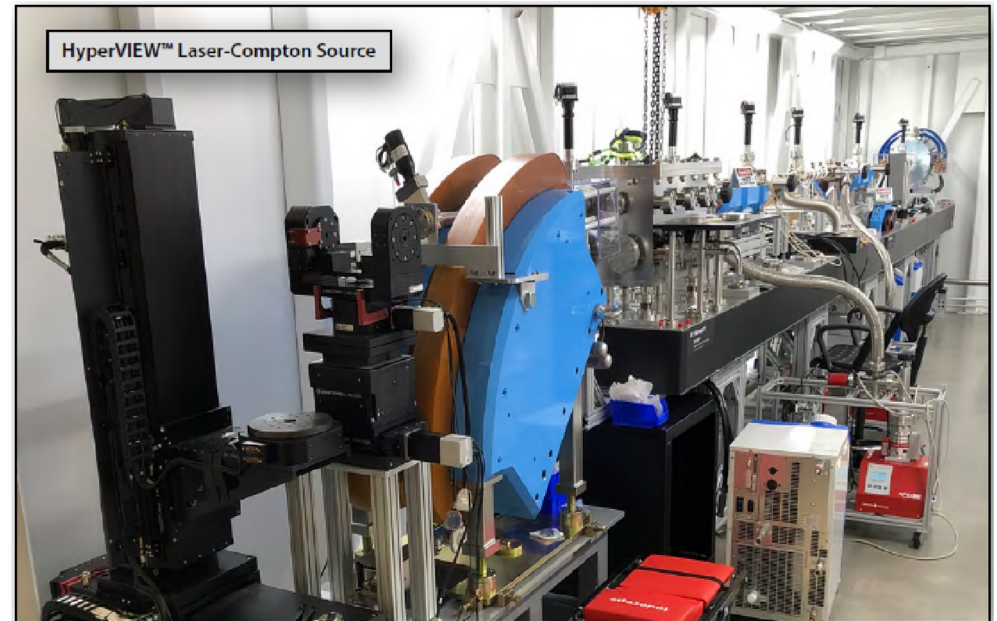
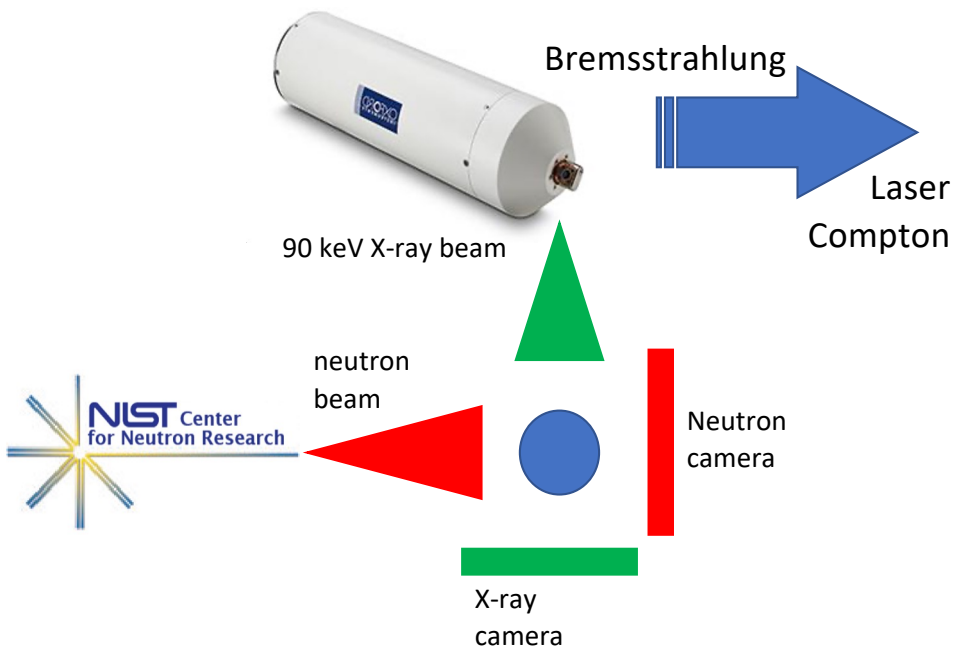
Expect a gain of 10,000 in flux for spatial resolution few micrometers



## Neutron Dark Field Imaging of Hierarchical Structures



If Wolter optics perform, it may warrant upgrading the X-ray source



X-rays generated from Inverse Compton Scattering from 100 MeV electrons and 1  $\mu\text{m}$  lasers  
Shown: Lumitron's LINAC ([www.lumitronxrays.com](http://www.lumitronxrays.com))

We are all here to share our expertise and to learn from one another.

