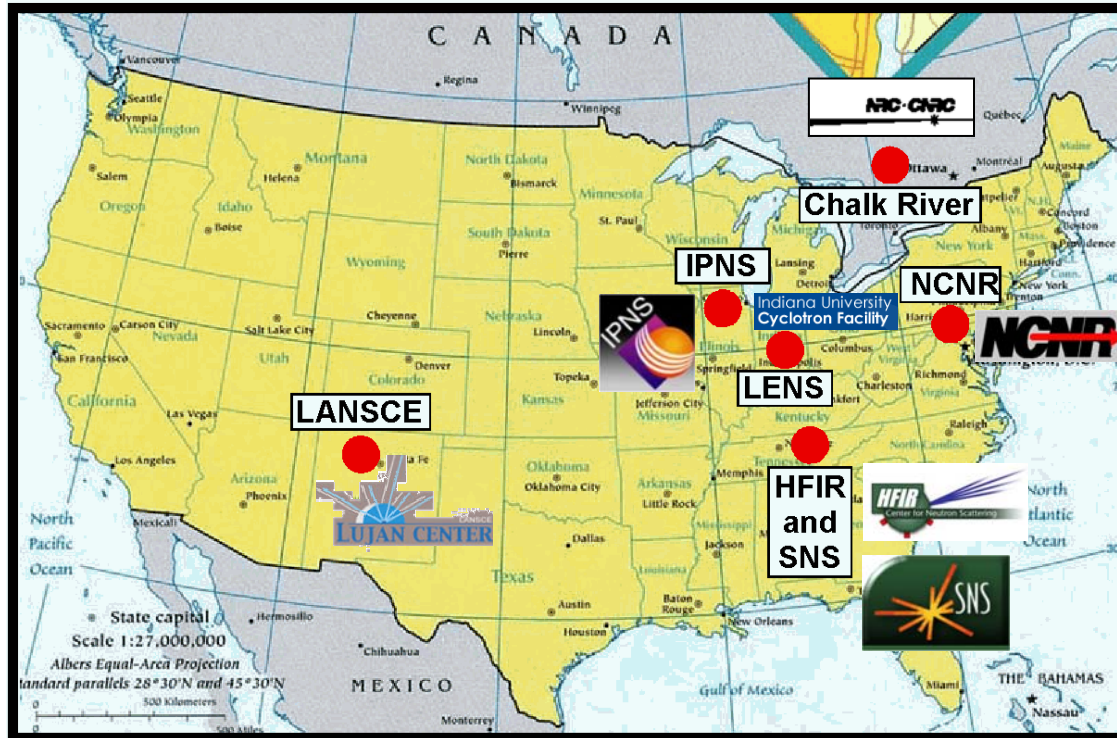


An Overview of Major North American Neutron Sources



Major North American Neutron Scattering Facilities



Robert M. Briber
Dept. of Materials Sci. & Eng.
University of Maryland
College Park, MD

Join the NSSA!
www.neutronsattering.org
Visit the NSSA table



- *Intense Pulsed Neutron Source (IPNS)* at Argonne National Lab
- *High Flux Isotope Reactor* at Oak Ridge National Lab
- *National Institute of Standards and Technology Center for Neutron Research (NCNR)*
- *Neutron Program for Materials Research* at Chalk River Laboratories (Chalk River)
- *Lujan Center* at Los Alamos Neutron Science Center (LANSCE)
- *Low Energy Neutron Source (LENS)* at the Indiana University Cyclotron Facility
- *Spallation Neutron Source (SNS)* at Oak Ridge National Lab

Information for Users



- Intense Pulsed Neutron Source at Argonne National Lab



<http://www.pns.anl.gov/>

- High Flux Isotope Reactor at Oak Ridge National Lab



<http://neutrons.ornl.gov/>

- National Institute of Standards and Technology Center for Neutron Research



<http://www.ncnr.nist.gov/>

- Neutron Program for Materials Research at Chalk River Laboratories (Chalk River)



<http://neutron.nrc-cnrc.gc.ca/home.html>

- Lujan Center at the Los Alamos Neutron Science Center (LANSCE)



<http://lansce.lanl.gov/>

- Low Energy Neutron Source at Indiana University Cyclotron Facility (LENS at IUCF)



<http://www.iucf.indiana.edu/materialscience.shtml>

- Spallation Neutron Source (SNS) at Oak Ridge National Lab



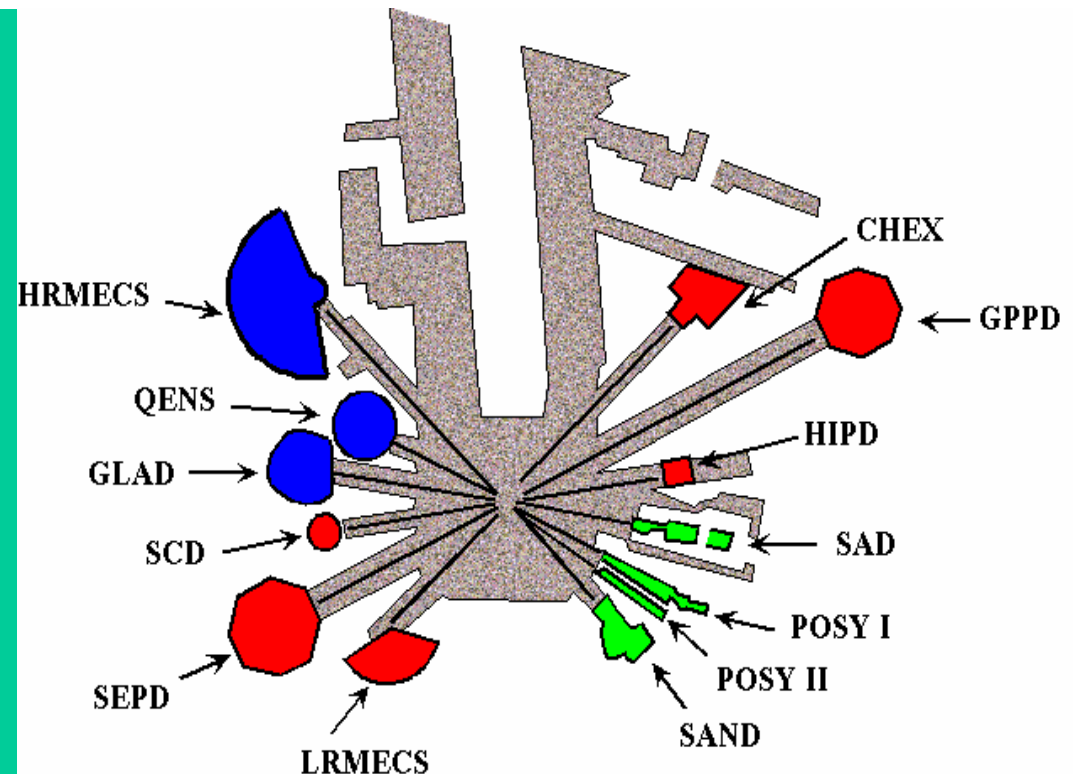
<http://www.sns.gov>



IPNS Mission and Metrics

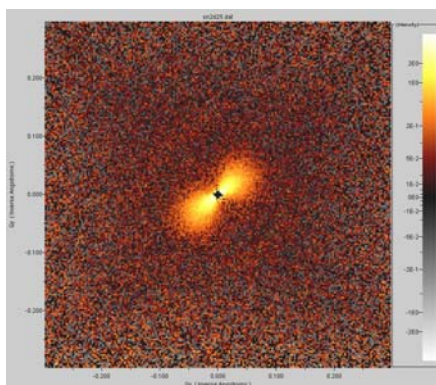
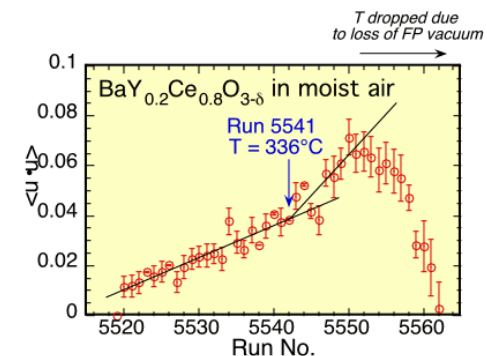
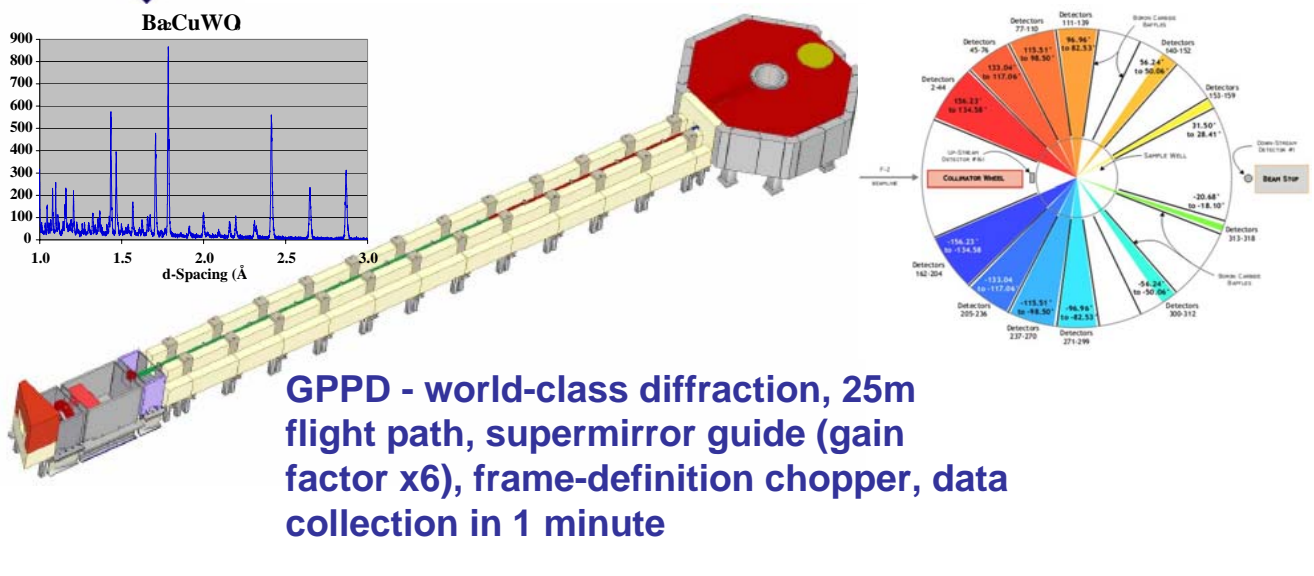
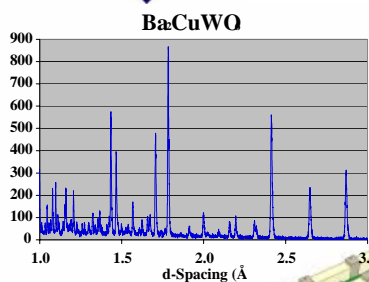
IPNS – The first user-dedicated accelerator-based neutron source in the world, commissioned in 1981. 8 billionth pulse delivered April 2004

- 400 experiments, 240 users, 150-200 publications per year
- Improvements will increase user base
 - 75% of time available to users
 - Proposal calls every 6 months
 - 95% operational reliability
 - 10 instruments in user program (13 available)
 - 26 weeks of operation
 - User friendly
 - 3-4 personnel/instrument
 - Limited travel funds available
 - New users welcome!
 - www.pns.anl.gov

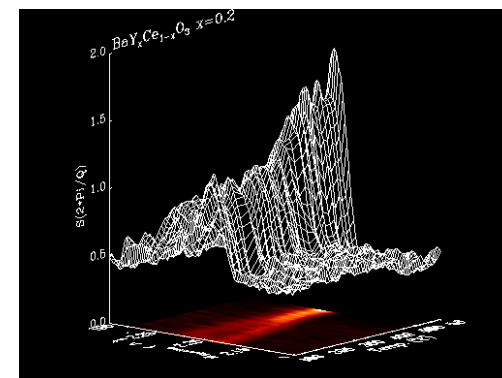
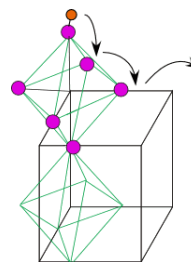
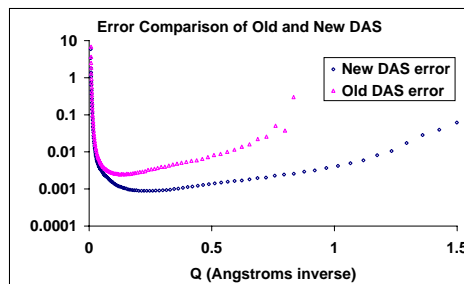




IPNS Completed Upgrades



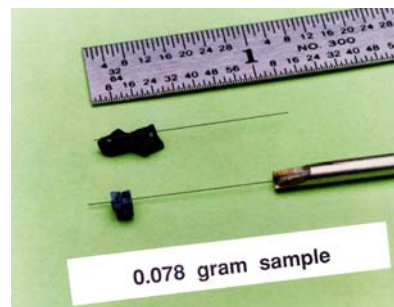
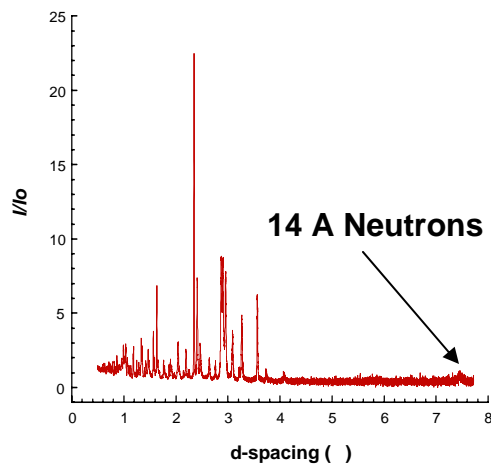
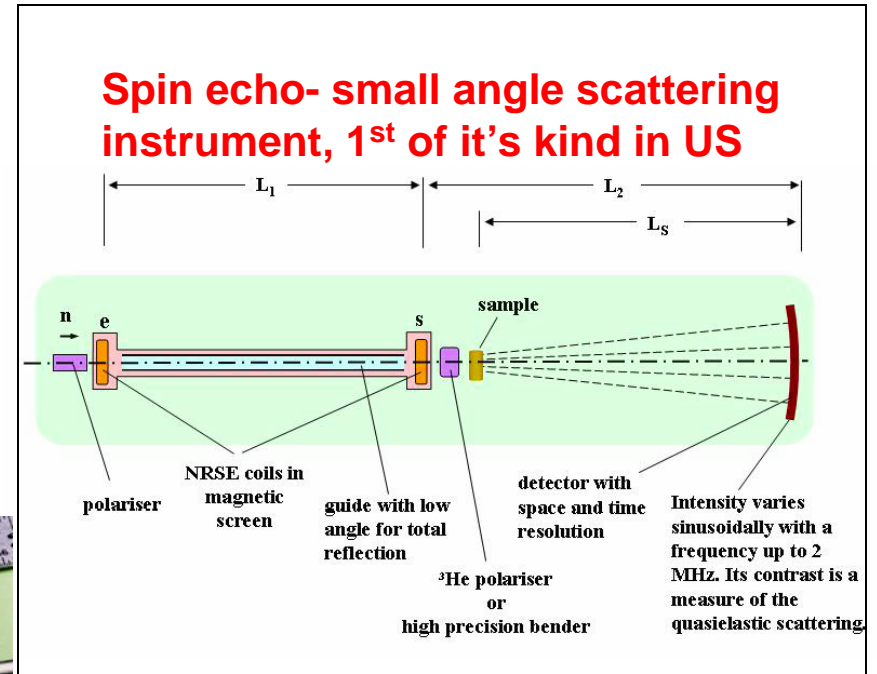
SASI (formerly SAD) - larger area detector, new DAS and scattering tank



QENS - simultaneous collection of quasi-elastic, inelastic, and diffraction data, supermirror guide (gain factor x2.5)

Pending and On-going Upgrades

SCD - new detectors and DAS have been installed, tests of focusing optics (~100 gain in 200 μ m spot), polarization tests (90% polarization of 3 \AA neutrons)



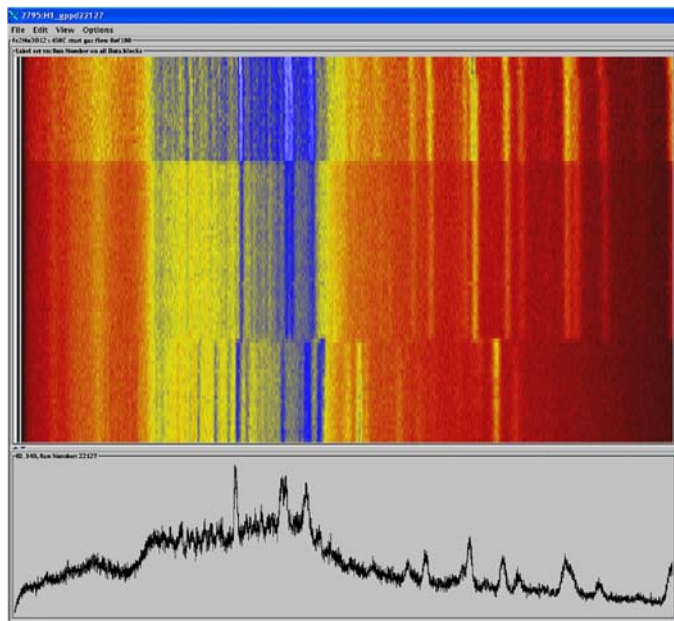
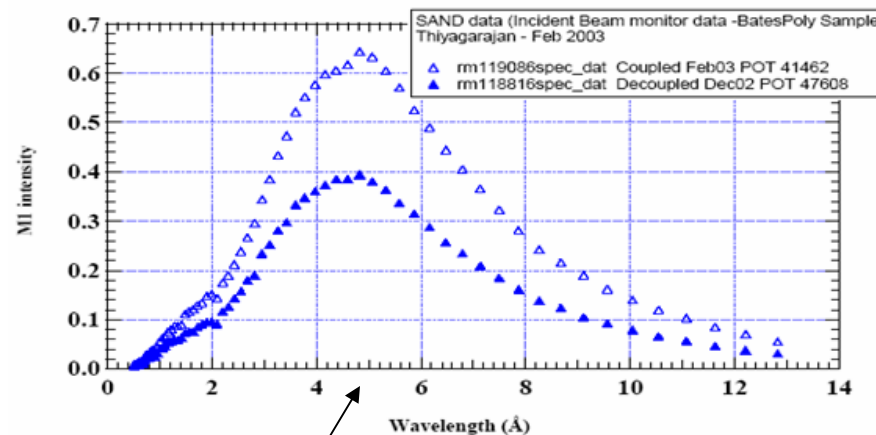
SEPD, new collimators, guide and detectors will optimize this diffractometer for magnetic, parametric studies.



IPNS Additional Capabilities



New Ancillary devices:
7T Magnet
1.5K - T - 300K
Convection Cryofurnace
In construction
20K - T - 600K



intensity boost
of 2.5 for small
angle diff. and
reflectometers
due to new
coupled solid
methane
moderator



The Center for Neutron Scattering

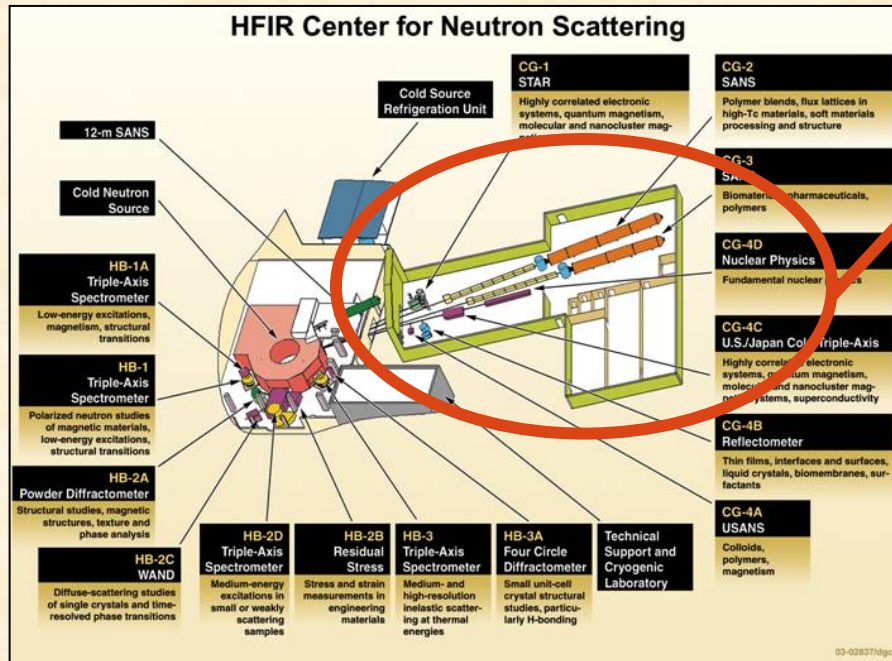


CNS Scientific Program

- Structure and dynamics of materials
- Large scale structures
- Instrument design and development

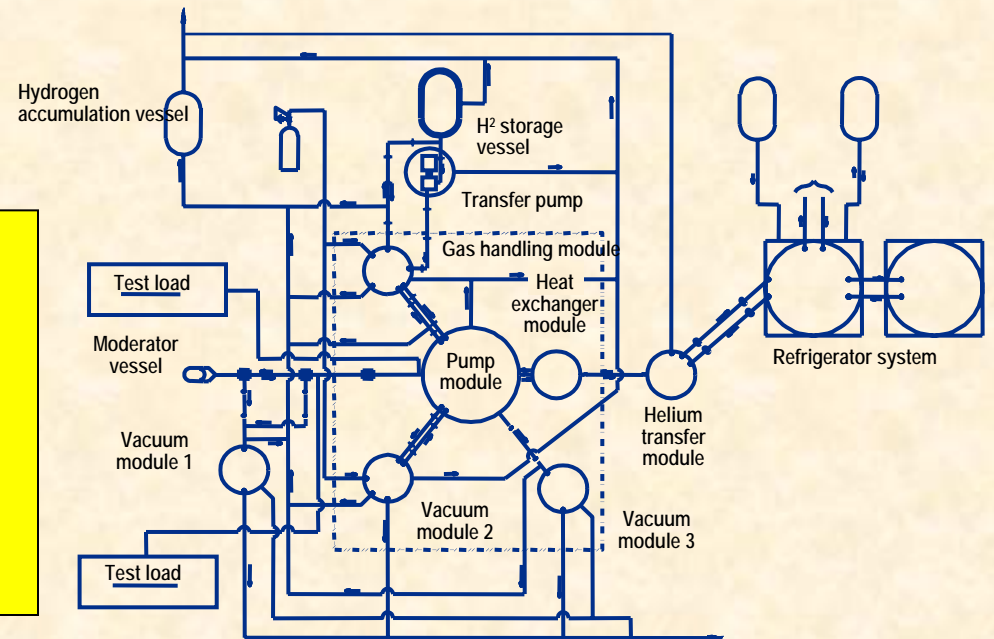
- The CNS is the only high-flux reactor-based source of neutrons in the US with 85 MW of power
- Stations for 15 beams
- Current upgrades/installation
 - Cold source and guide hall
 - Larger beam tubes for thermal instruments (complete)
 - Improved triple axis instruments (3 in user program) with new data acquisition software (SPICE)
 - Four new and upgraded instruments in '04 (one currently commissioning)
- Expanded user program begun 2003

Cold Source and Guide Hall



- 17,000 sq. ft. guide hall – completed in 2003
- Includes 2 new labs and 2 shops

- New LH₂ cold source
 - Complete installation - 2005
 - Commissioning - 2006



OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY



Thermal Neutron Instrumentation



HB-1



HB-1A (Ames Lab)



HB-3



- HB-2 thermal guide instr. (2004)
 - US/Japan Wide Angle Neutron Diff. (HB-2C)
 - Residual Stress (HB-2B, partnering with ORNL Center for Residual Stress)
 - Refractometer & SNS Test Station HB-2D
- Powder (HB-2A) and Single Crystal (HB-3A) Diffs. (2005)

- 3 triple axis instruments in user program now
- > 3 times flux gain due to upgrades



HB-2 instruments



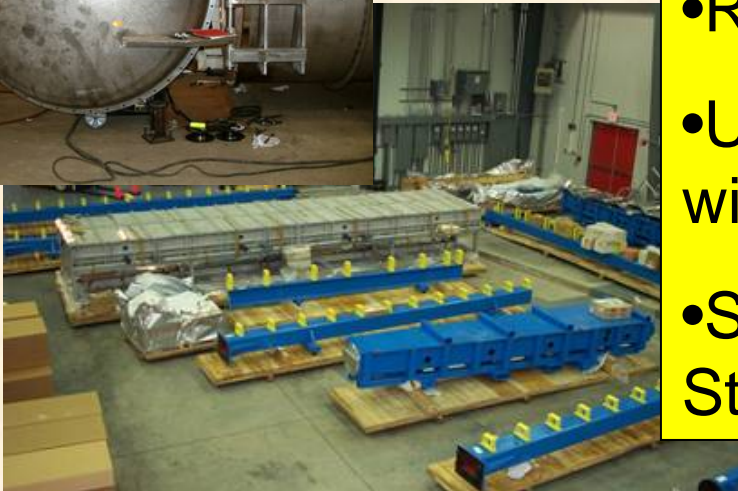
OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

Cold Instrument Guide Hall

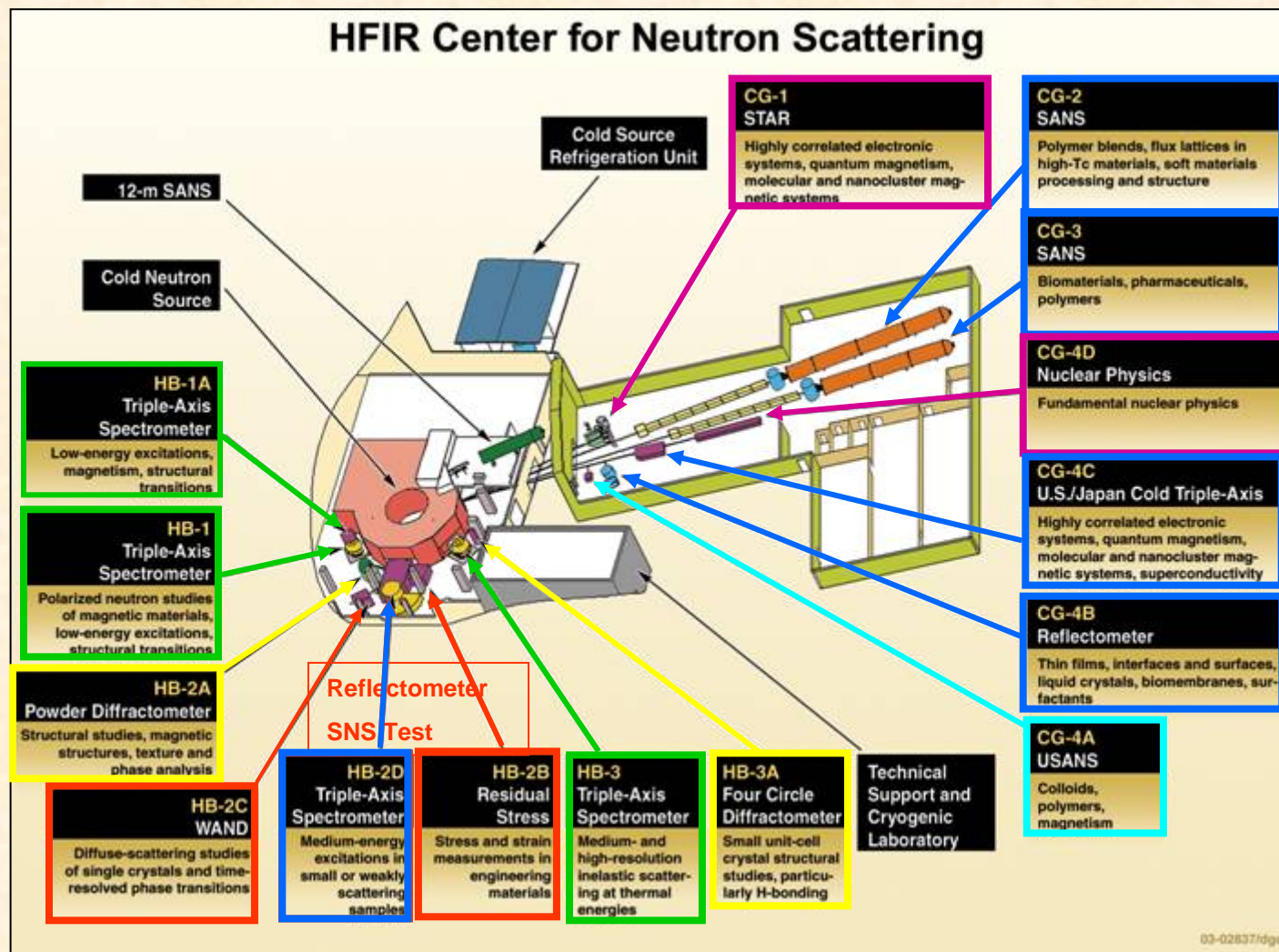


Instruments commissioning in 2006

- SANS I and SANS II
 - tanks (delivery Aug. '04)
 - Guides and enclosures received
 - 1-meter 2-d SANS detectors tested
- Reflectometer
- US/Japan cold triple axis (partnering with BNL)
- SANS II built with ORNL Center for Structural and Molecular Biology



Instrument Installation Schedule



2003 ■

2004 ■

2005 ■

2006 ■

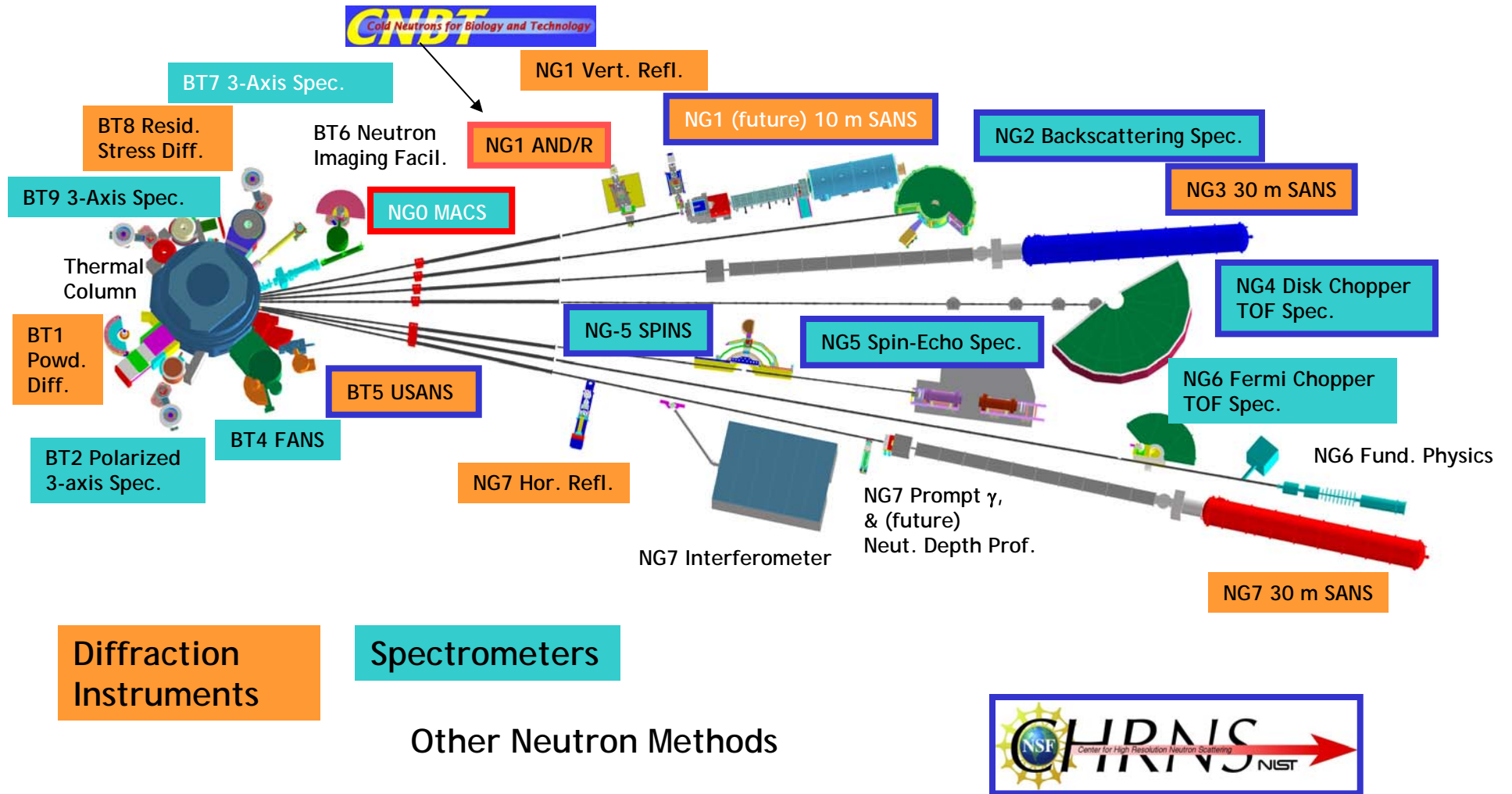
2007 ■

2008 ■

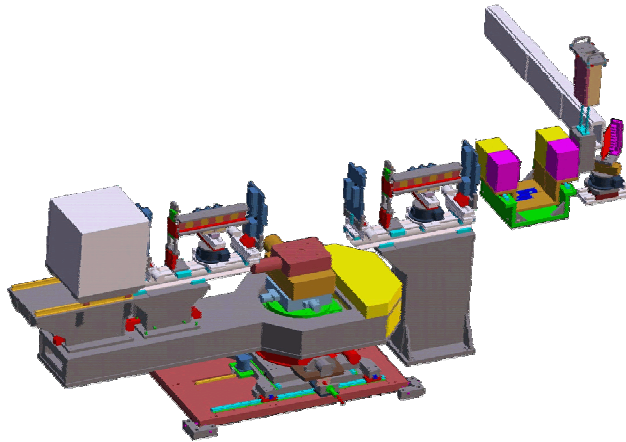
NIST Center for Neutron Research



In 2003 there were 1928 Research Participants from >150 universities, 41 US corps., 31 US govt. labs, 19 NIST divs. & off.



Cold Neutrons for Biology and Technology

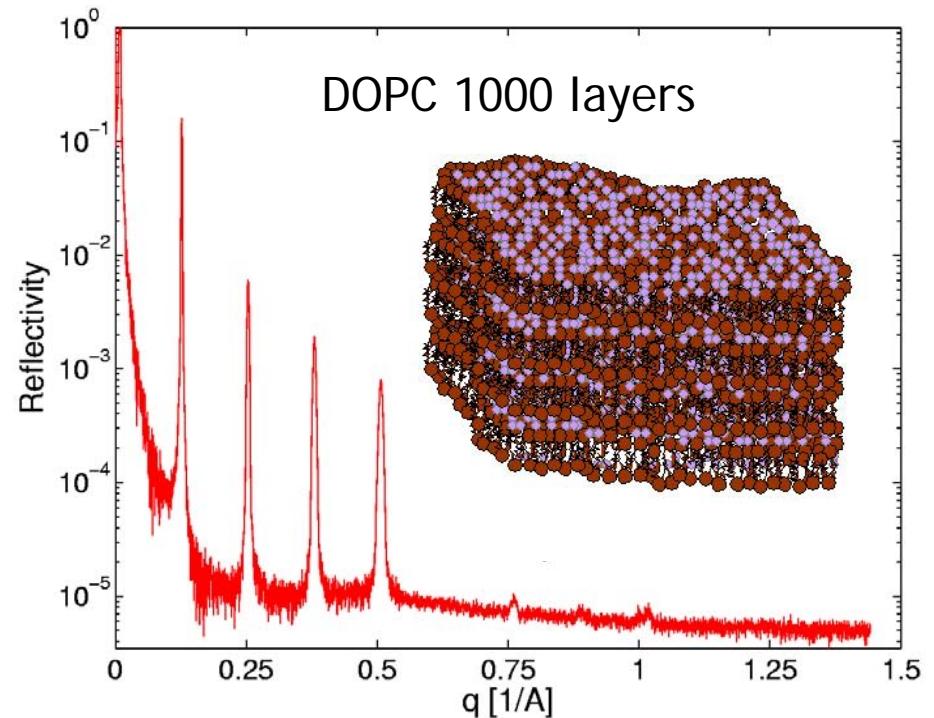


Consortium:

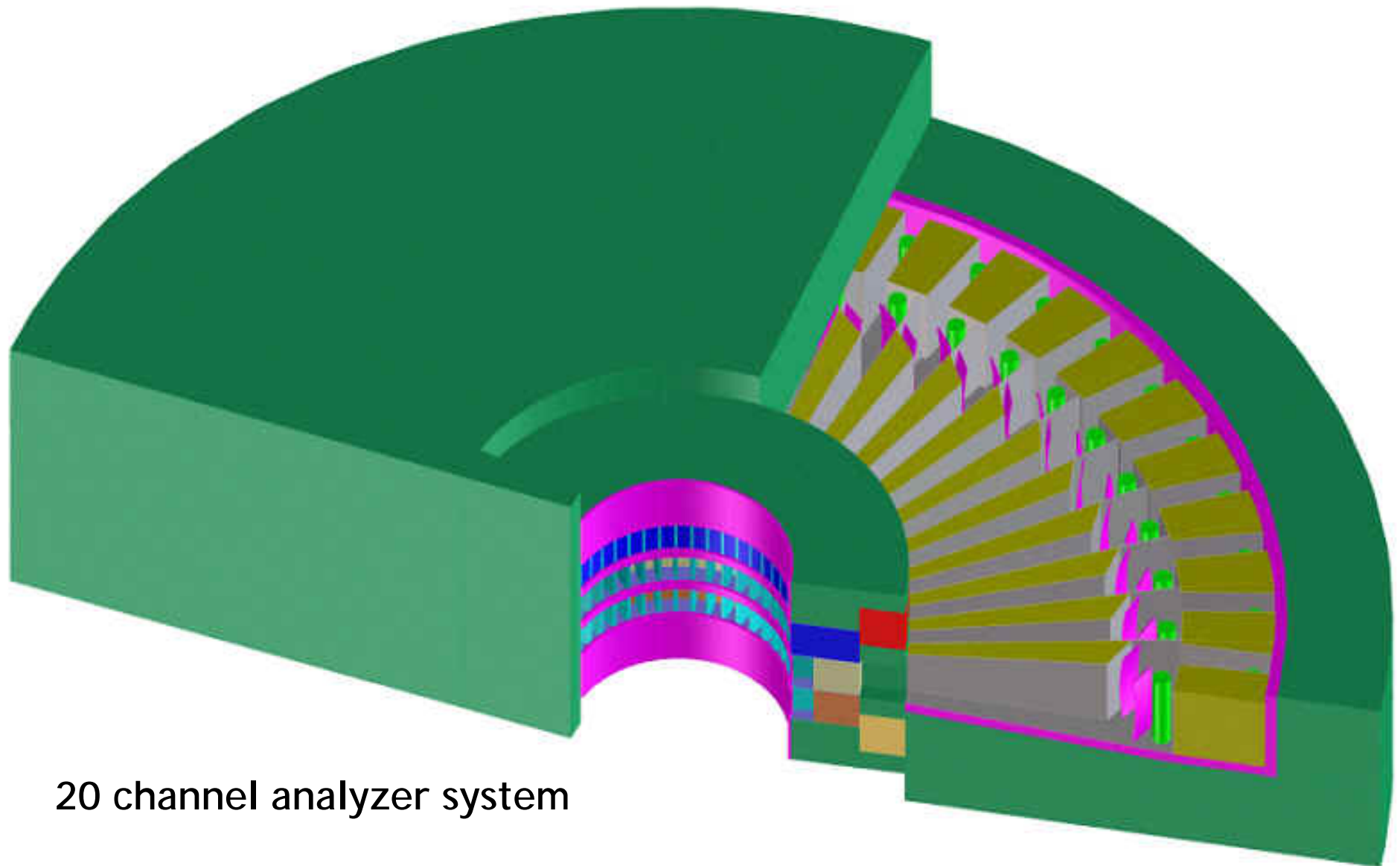
UC Irvine, Johns Hopkins U, U Penn, Rice U, Duke U,
Carnegie Mellon U, NIST, LANL, and NIH.

AND/R

- vertical sample reflectometer
- biological membrane research
- polarized neutron capability
- 2-D position sensitive detector (off-specular reflection capability)
- 10^{-8} reflectivity capability



MACS: Multi-Analyzer Crystal Spectrometer



20 channel analyzer system

Future Directions

Optimize for

- MACS (double)
- Thermal 3

Utilize Broad

- Spin Echo
- "MAGNIFIE"
- Laue Diffraction
- Neutron In



BT7 3-axis

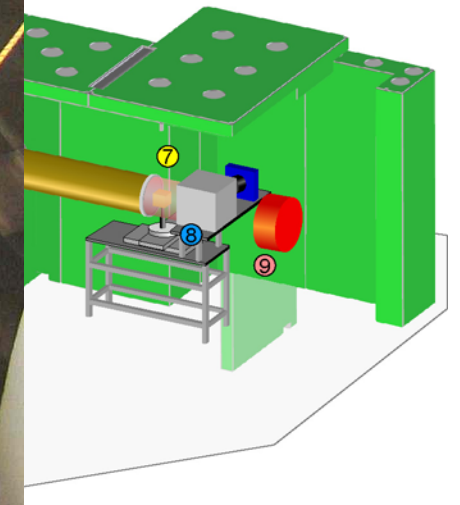
Photo: 5/26/04

at the NCNR



(important methods)

Engineering Facility



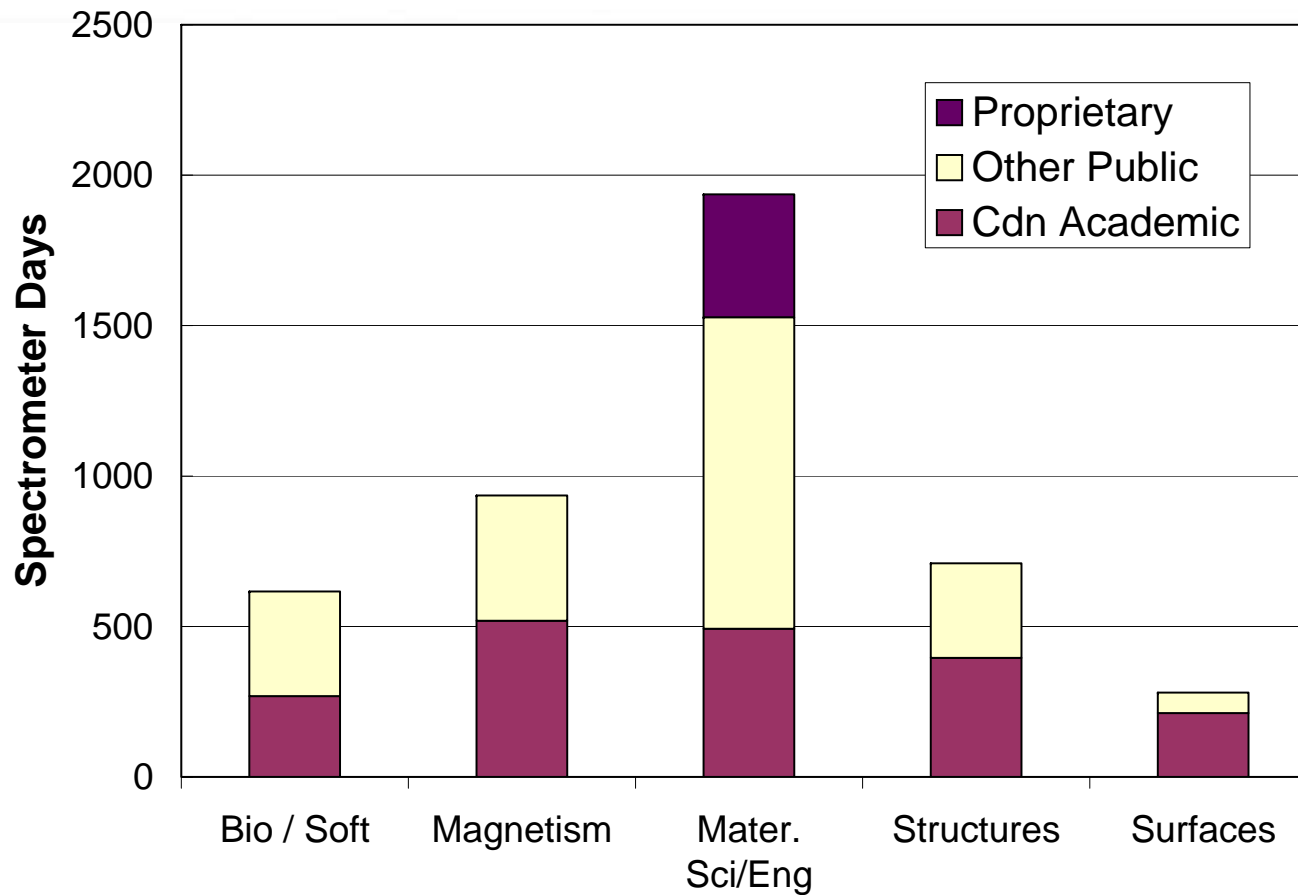
NRU REACTOR: a multipurpose facility



Canada's neutron source is the NRU reactor at Chalk River Laboratories

- NRU began operating in 1957
- Multi-purpose thermal neutron source (120 MW_{th})
 - Production of medical isotopes
 - Testing of components for nuclear power stations
 - **Neutron scattering experiments on materials of all kinds**
- Flux $\sim 3 \times 10^{18}/\text{m}^2/\text{s}$
- On-power fuelling: 80% availability
- Continuous proposal process

RESEARCH AREAS



Breakdown of ~4500 spectrometer days 2001-2003.

NEW INSTRUMENTS

- 5 Existing Thermal Neutron Spectrometers
- 2 under development
 - Reflectometer
 - Low Angle Scattering Instrument with 2D detector

Reflectometer

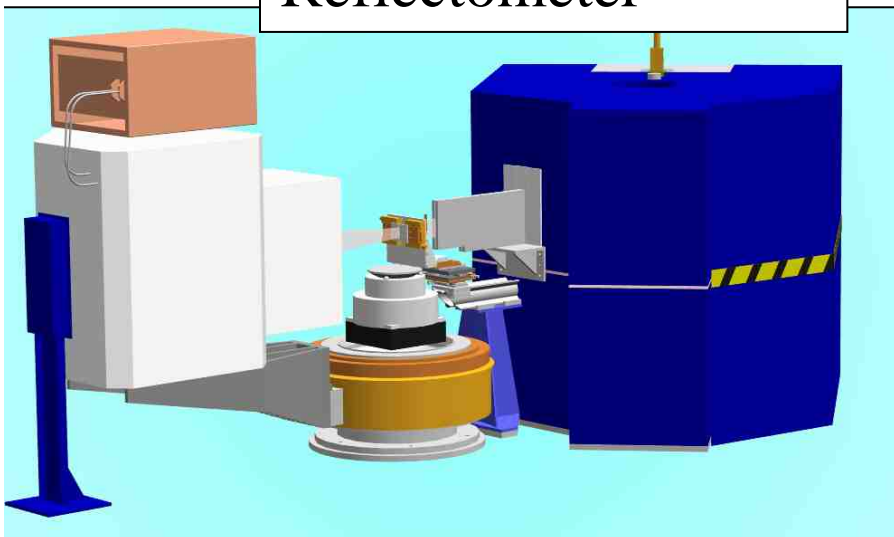
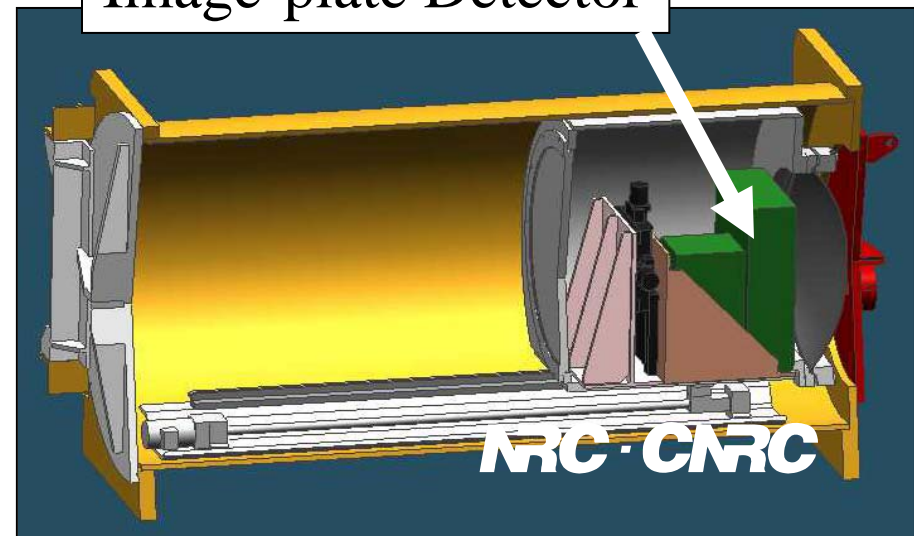


Image-plate Detector



THE FUTURE: Canadian Neutron Facility



Options under evaluation by NRC

“An opportunity for governments to invest strategically in Canada’s infrastructure for science and industry.”

A multi-purpose neutron source with power and flexibility to meet the needs of the next 40 years.

<http://www.cnf.gc.ca>

NRC · CNRC

Lujan Center at the Los Alamos Neutron Science Center



Lujan Center

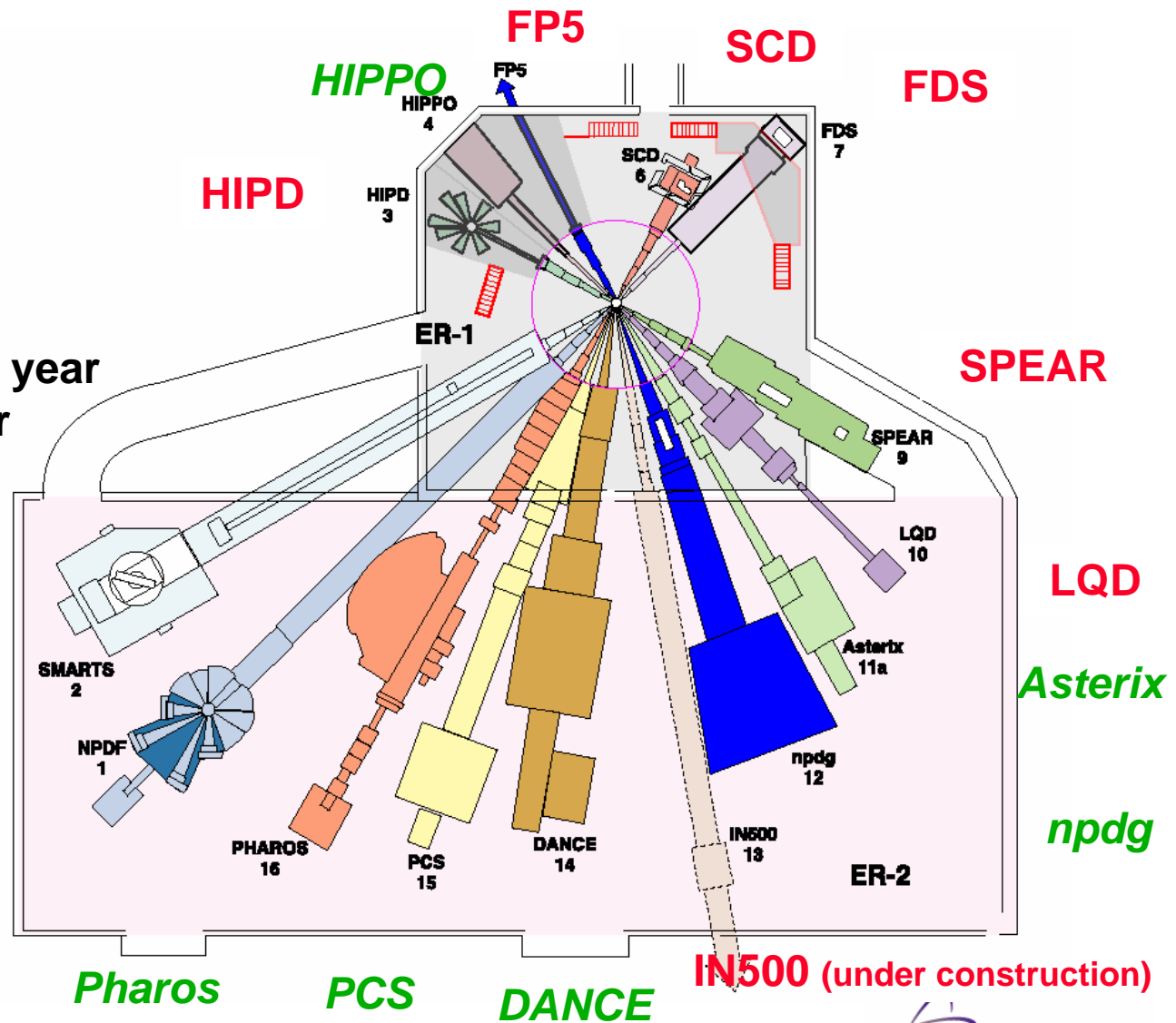


- operation: 8 months per year
- 2 proposal calls per year

- Four new & two rebuilt scattering instruments:
FPs 1, 2, 4, 11, 15, 16

SMARTS

NPDF



Pharos

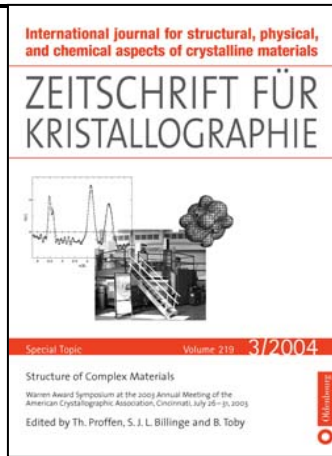
PCS

DANCE

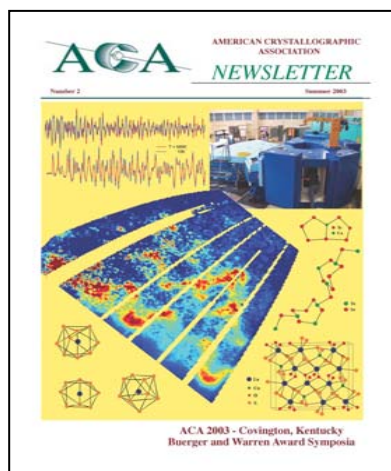
IN500 (under construction)

NPDF: Neutron Powder Diffractometer

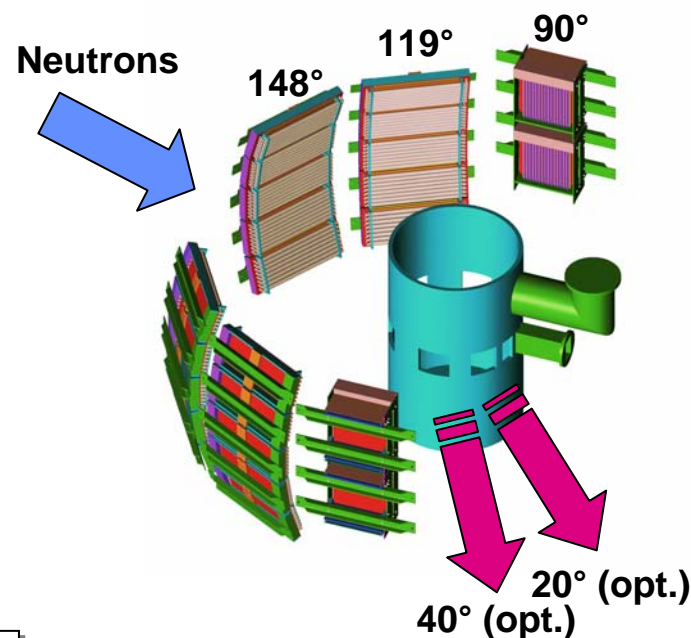
Optimized for Pair Distribution Function analyses



Zeitschrift fuer Kristallographie, Structure of complex materials, 219 (2004)



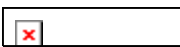
ACA newsletter, Summer 2003



- 160 PSDs in backscattering
- 124 SED tubes at 90°
- Low-angle detectors in future

Instrument scientist: Thomas Proffen
tproffen@lanl.gov

- High resolution: $\Delta d/d \sim 0.15\%$ in backscattering
- Environment: 10-700 K
- Typical data-collection time: 2 hours
 > 1000 data sets collected in 2002-03
- Upgraded (from NPD) completed 9/27/2002 in only **nine** months
- Funded in part by NSF in consortium of 5 universities



ASTERIX – Polarized-beam Reflectometer – New in 2002 (with 11T applied field capability)

- Polarized and non-polarized beam operation
- Vertical sample geometry (SPEAR reflectometer – horizontal)
- Range of reflectivity down to 1×10^{-7}
- PSD accumulates both specular and non-specular reflectivity
- First in US with polarized beam at 11 T



Mike Fitzsimmons,
Instrument
Scientist

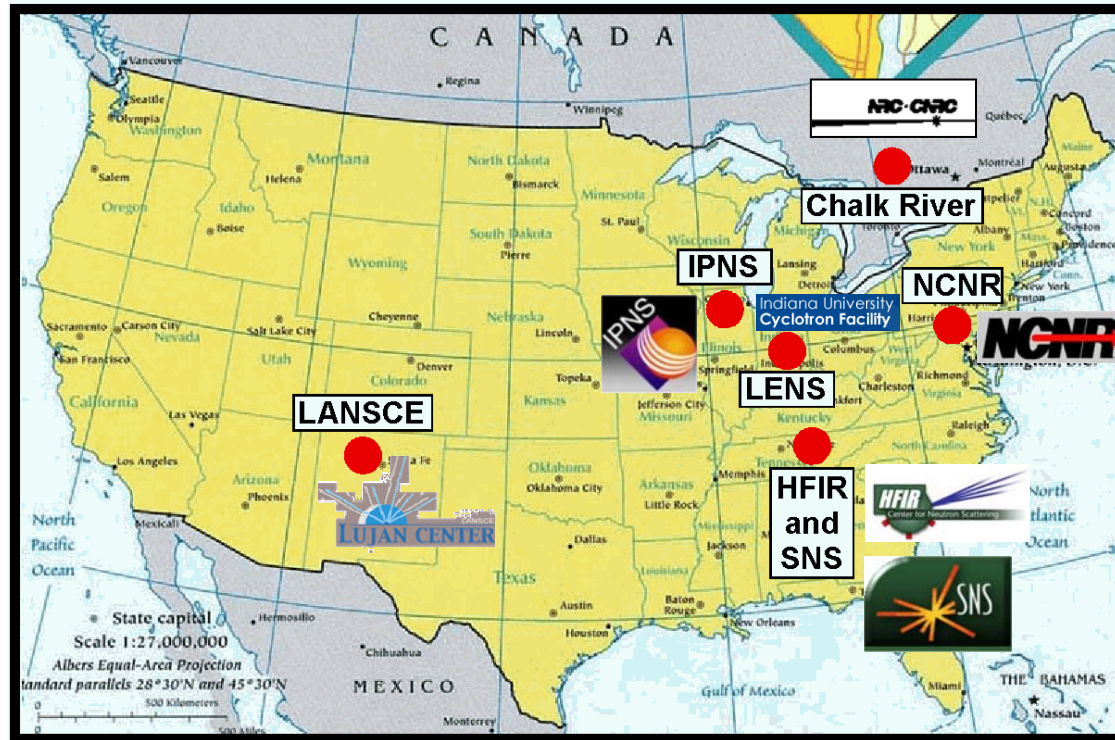
Upgrades at LANSCE and the Lujan Center 2005-2010

- **“LANSCE-R Project” will revitalize the accelerator for life extension, higher reliability, and enable future advanced spallation sources**
 - ca \$100M beginning in FY07
 - Funded by NNSA
- **“LANSCE Capability Upgrade Project” will enhance sources at LANSCE for neutron scattering and fundamental physics**
 - Ca \$200M beginning in FY09
 - Partnerships being sought
- **Instruments under consideration**
 - New: Backscattering Spectrometer
 - New: IN500 (feasibility test underway)
 - New: LAPTRON (High P Diffraction and Radiography)
 - Upgrade: Single crystal diffraction, Small-angle

An Overview of Major North American Neutron Sources



Major North American Neutron Scattering Facilities



Acknowledgements

- *Intense Pulsed Neutron Source* **Ray Teller**
- *High Flux Isotope Reactor* **Greg Smith**
- *Center for Neutron Research* **Ron Cappelletti, Dan Neumann**
- *Chalk River* **Alastair McIvor, John Root**
- *Lujan Center* **Jim Rhyne, Al Hurd**