



The Canadian Neutron Beam Centre at Chalk River

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Part of "Bertram Brockhouse and the History of Canadian Neutron Scattering"
Session W1-5, June 5, 2019 CAP Congress (DHP), at Simon Fraser University

Canada pioneered materials research with neutron beams.



Canadian physicist Bertram Brockhouse developed the neutron scattering method at AECL's NRX and NRU reactors in the 1950s and 60s, then joined McMaster University in 1962.



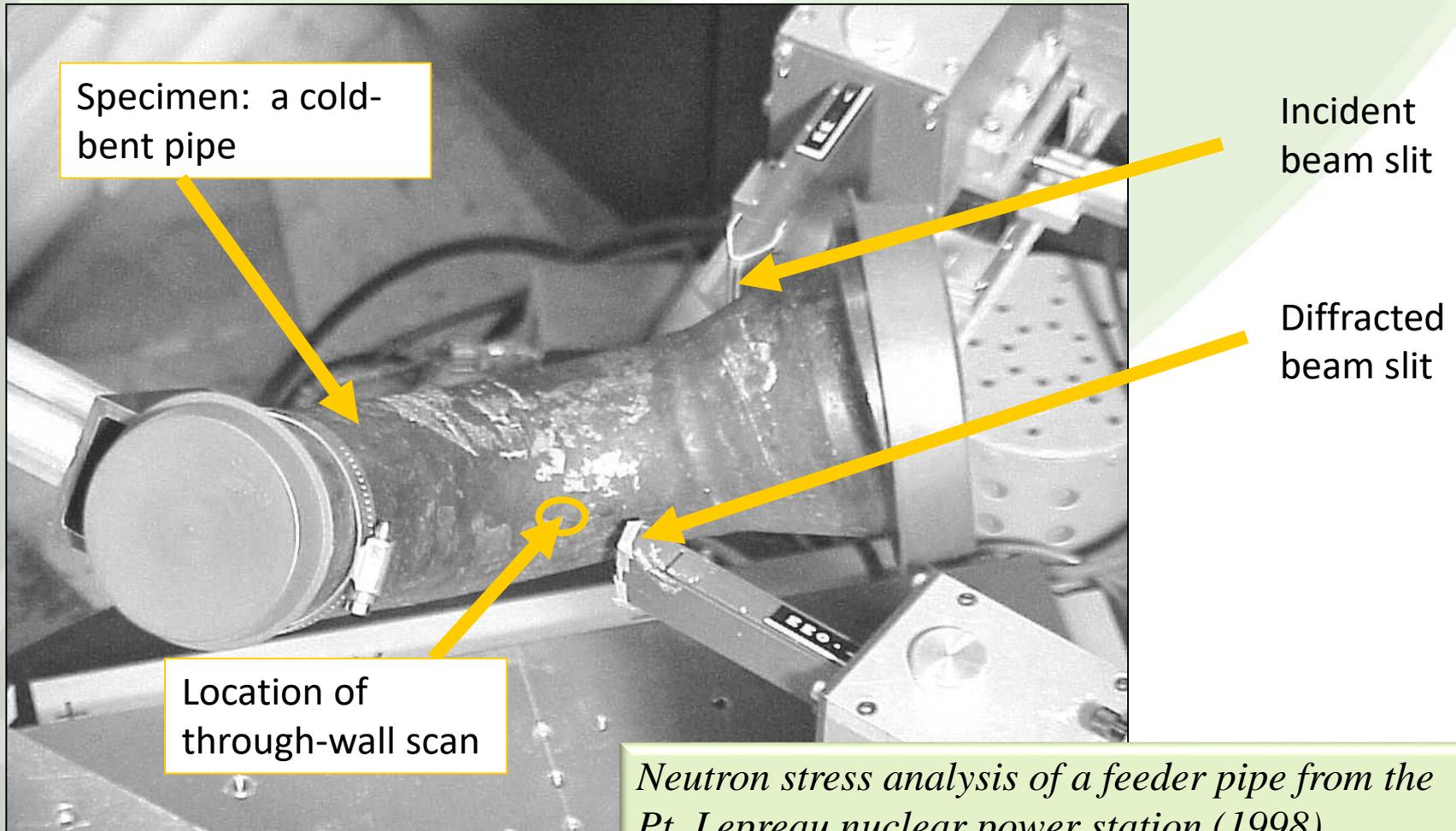
In 1994, Prof. Brockhouse shared the Nobel Prize in Physics *"for pioneering contributions to the development of neutron scattering techniques for studies of condensed matter"*

Transition to a user facility for materials research with neutron beams ~1985

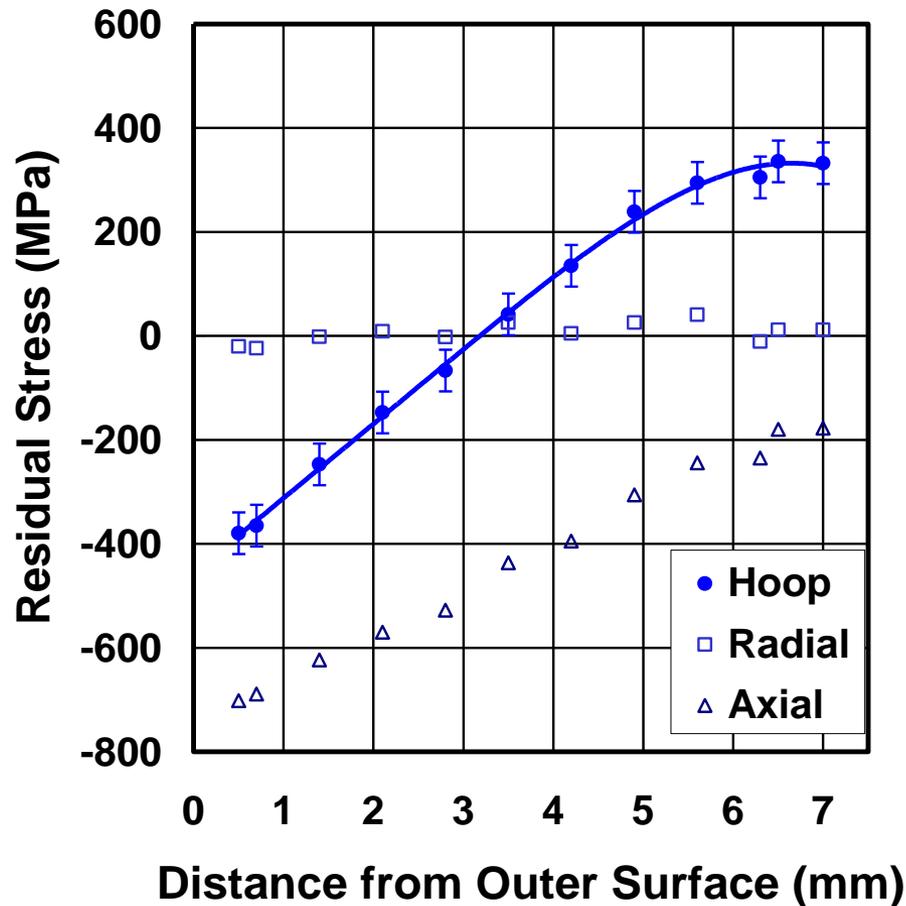


- DUALSPEC – jointly funded by AECL and NSERC (via McMaster University)
- Establishment of Canadian Institute for Neutron Scattering (CINS)
- Establishment of user access through beam-time proposals, peer review, annual reporting...

Stress-scanning developed ~ 1985



Non-destructive stress scanning is practical



These results provided confidence:

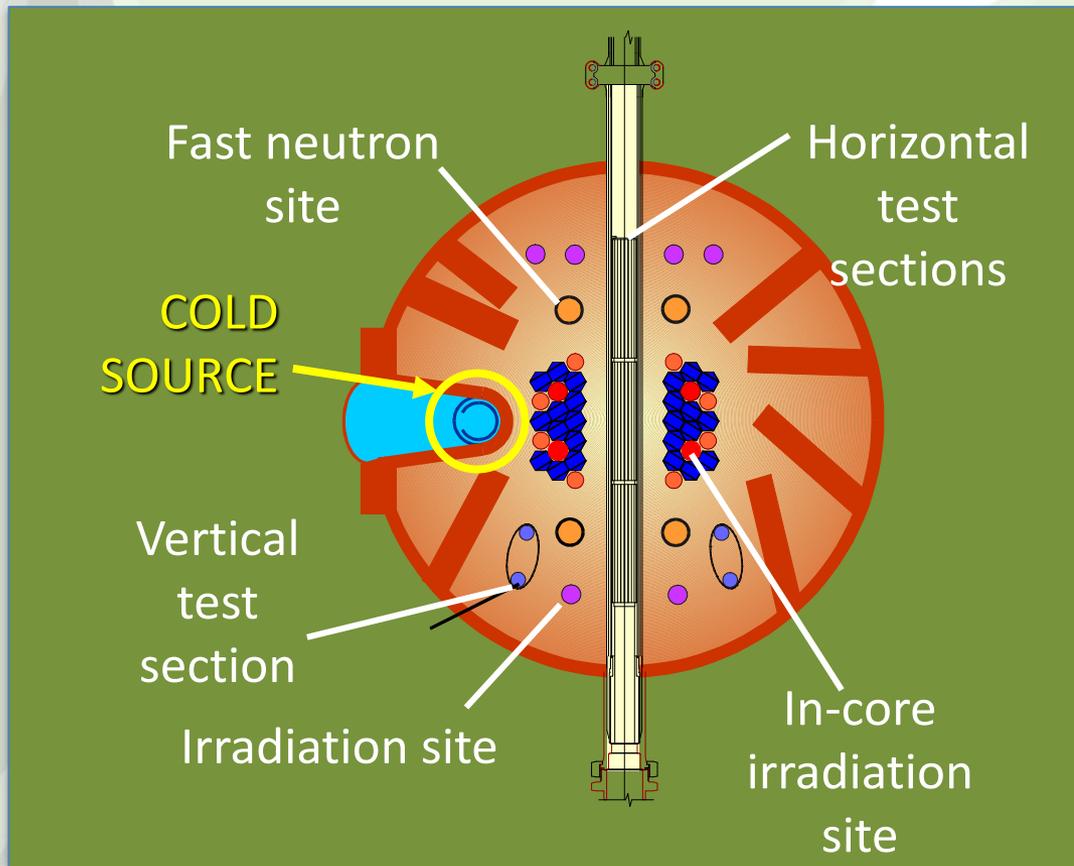
- About restarting Pt Lepreau nuclear power station after a leak
- About the condition of feeders throughout the CANDU fleet
- About specifications for manufacturing practice

Saved \$100Ms of maintenance cost and minimized radiation exposure of workers

Transition of stewardship from AECL to NRC

Year	Transition
1996	AECL gives one year notice. CINS / User community writes letters of concern. NRCan, Industry Canada, NRC, NSERC provide \$1.5M x 3 years.
1997	NRC takes temporary responsibility of neutron beam program.
1998	NRC + AECL develop a proposal to replace the NRU reactor with a new, Canadian Neutron Facility (CNF) – NRU to close in 2005.
1999	NRC commits A-Base funding. (60%) NSERC Major Facilities Access grant is secured. (30%) Industry fees-for-service support operation. (10%)
2000	Canadian Neutron Beam Centre is set to be “lively and growing”. AECL pulls out of CNF proposal to focus on Adv CANDU Reactor.

Canadian Neutron Facility (CNF)

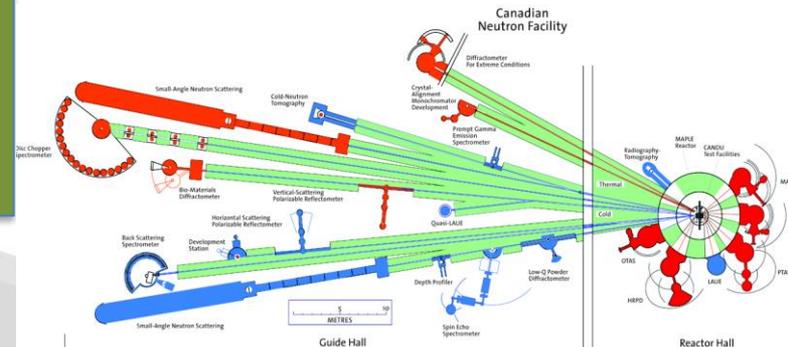


For neutron beams and in-core irradiations (fuel tests).

No isotope production.

Endorsed by federal cabinet committee in 1999.

CINS developed a Long-range Plan for neutron beam instruments at CNF in 1998.



A new approach for developing infrastructure:



D3 Neutron Reflectometer

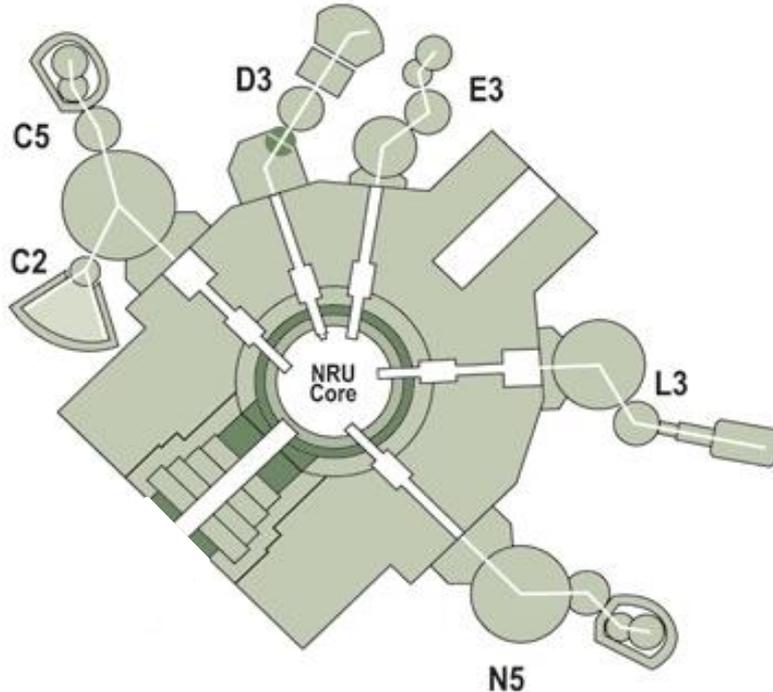
Commissioned 2007

Project led by Western University, and a consortium of 12 other universities from across Canada.

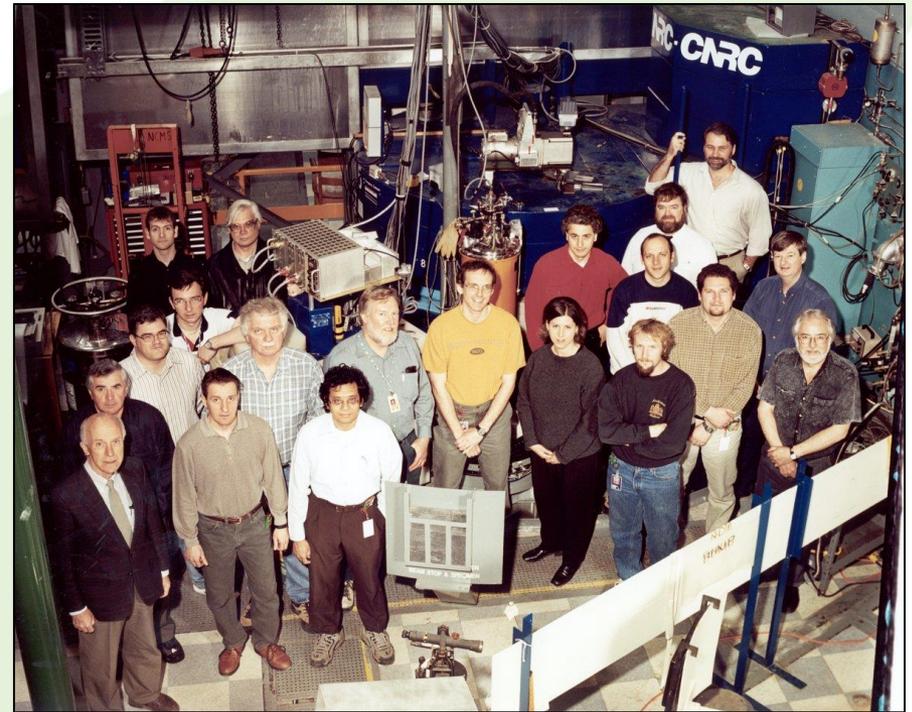
Project was funded by:

- Canada Foundation for Innovation (CFI) – 40%
- Province of Ontario – 40%
- National Research Council

The peak of the CNBC (2002-2008)

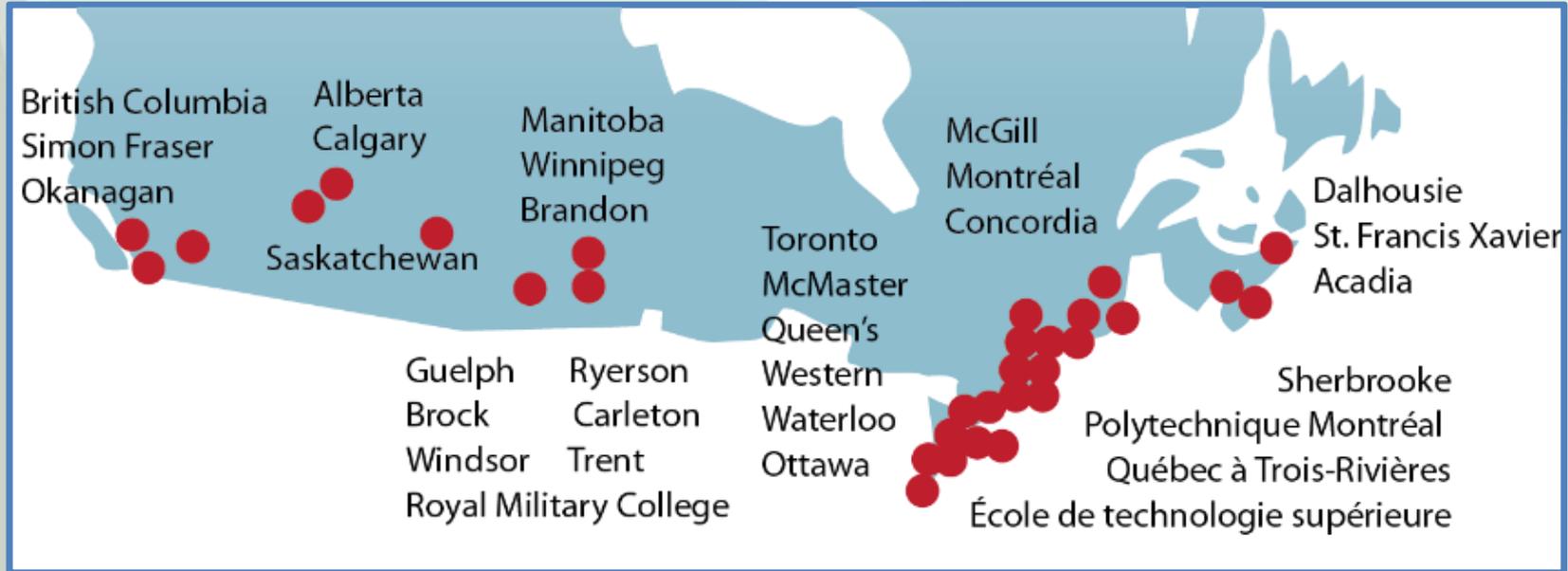


NRU Reactor with 6 neutron beams fully subscribed.



- 24/7 operation
- 5 beams for R&D on 'hard materials'
- 1 beam for R&D on thin films (D3)
- ~20 staff members

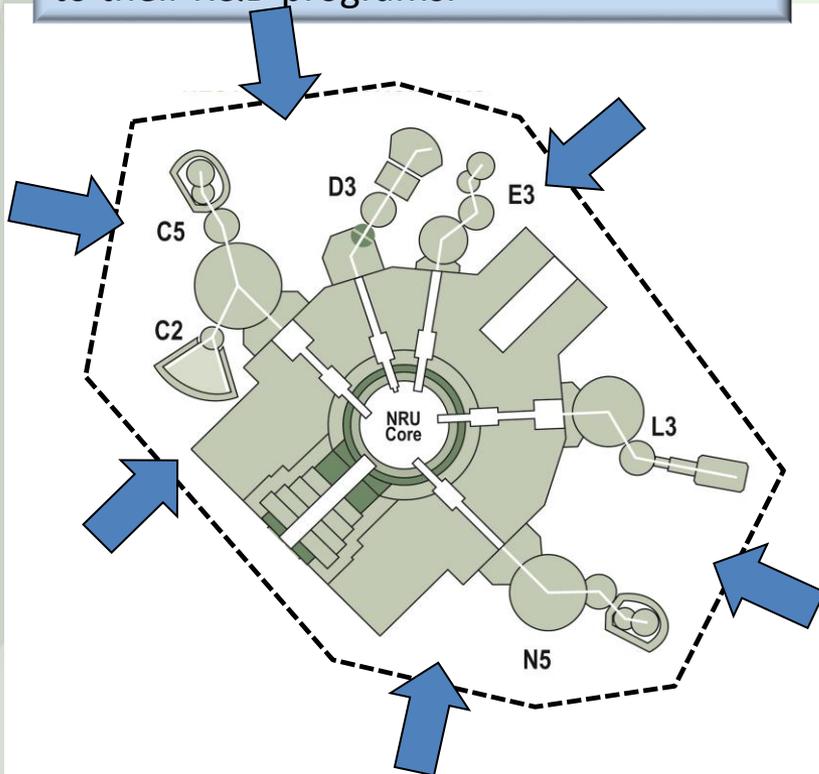
CNBC peak performance in 5-year period



- Over 700 Research Participants from university, industry, government labs.
- Over 30 universities across Canada.
- Over 100 foreign institutions in collaboration with Canadians at the CNBC.
- Average of \$350K per year of industry income ~ 10% of CNBC operation
- Neutrons provided free of charge from AECL's NRU reactor

The “CNBC way” for user access

CNBC technical and professional people formed a ‘human interface’, enabling users and clients to apply neutron beams to their R&D programs.



- > 90% beam time for user-driven Projects
- Local contacts linked to Project by subject-matter expertise, not beamline.
- 10% of users’ careers were highly focused on neutron scattering while 90% used neutrons infrequently and needed more support throughout the Project cycle.
- Proposals welcomed any time.
- Immediate internal review of feasibility and safety, then external peer review of scientific merit, then scheduling
- “Oversubscription rate” concept irrelevant
- Access for proprietary research arranged through a service agreement, with full cost recovery, and no IP retained by CNBC

Introducing new users to neutron scattering

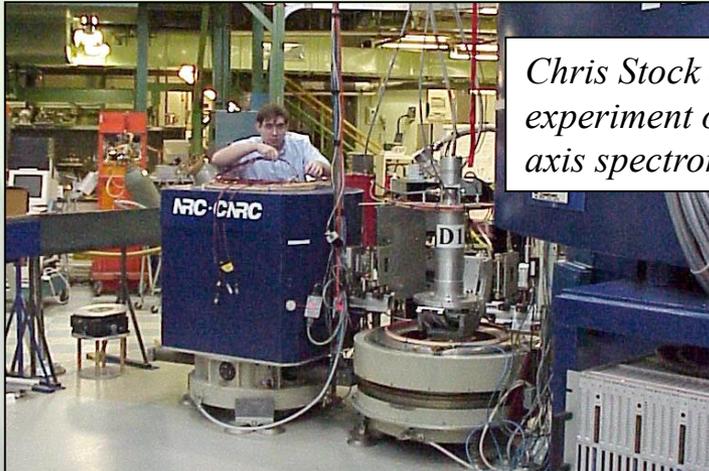


11TH CANADIAN NEUTRON SCATTERING
SUMMER SCHOOL

CHALK RIVER LABORATORIES

MAY 8-13, 2011

Hands-on experience for young researchers.



Chris Stock (Toronto) setting up an experiment on YBCO at the C5 triple-axis spectrometer.



Stephanie Stafford (Kinectrics) and Paula Mosbrucker (Queen's) set up a neutron-based texture measurement.



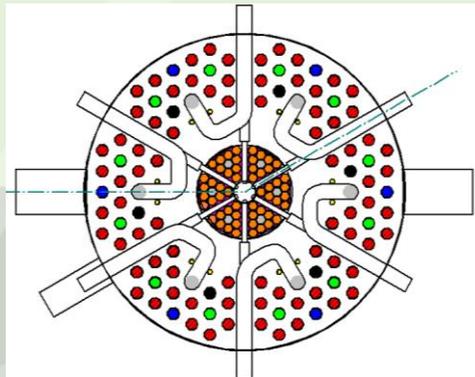
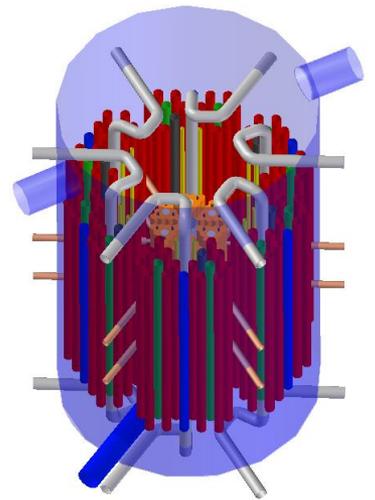
Ron Donaberger demonstrates stress measurements in a CANDU feeder.

Canadian Neutron Centre (CNC) Proposal



- Developed with Interagency Working Group: NRC, NRCan, AECL, Industry Canada (2005-2007)
- Multipurpose reactor for all three missions: (1) Isotope production (2) nuclear fuel testing (3) materials research with neutron beams
- CINS committee documented neutron-beam user requirements

Atfield Core



- The CNC proposal was submitted to NRCan in 2009, responding to the “Isotope Crisis”, caused by an unplanned 6-week outage of the NRU reactor in 2007.
- Worse...a 15 month outage 2009-2010!

Transition of stewardship from NRC to AECL

Year	Transition
2012	<p>NSERC places moratorium on Major Resource Support program.</p> <p>NRC decides stewardship of the CNBC is not aligned with mandate.</p> <p>Federal gov't directs AECL and NRC to maintain CNBC as a potential part of a Nuclear Innovation Agenda after AECL restructured.</p>
2013	<p>AECL takes over operation of the CNBC while NRC retains assets and employees to support the CNBC operation.</p>
2015	<p>A private management company, Canadian Nuclear Laboratories, takes over operation of Chalk River, including the CNBC.</p> <p>Federal government announces the NRU reactor will close in 2018.</p> <p>CINS user community approaches University Execs for help.</p>

Neutron Scattering – A Major Science Facility

NATURAL RESOURCES

- Stewardship by Atomic Energy of Canada Limited (until 1997)
- Attached to AECL's NRU reactor
- "Nice to have neutron beams but normally unimportant compared to nuclear energy R&D or isotope production"



SCIENCE or INDUSTRY

- Stewardship by NRC (1997-2012)
- Attached to AECL's NRU reactor
- A scientific resource for university research, education, and service to industry
- Part of the complete set of tools for materials research

A Carty



National SA

A McDonald



Nobel Laureate

K Duncan



Science Minister

M Nemer



Chief SA

R O'Reilly Runte



CEO of CFI

The Canadian Neutron Initiative (CNI)



In 2016, a working group was formed “to establish a university-led, pan-Canadian framework for stewardship of Canada’s capacity for materials research with neutron beams, building on existing national and international resources”

1. Develop neutron beams at McMaster Nuclear Reactor
2. Gain Canadian access to foreign neutron beam facilities
3. Coordinate outreach and user support, nationally

Executive Leaders:

Dr. Karen Chad, VP Research, USask (chair)

Dr. Robert Baker, VP Research, McMaster

Prof. Thad Harroun, President of CINS

Dr. John Barrett, President, C N A

Disruption of Canadian neutron beam program



Canada's main source of neutron beams, the NRU reactor, started operating on November 3, 1957 and was shut down on March 31, 2018 for financial reasons. An agreement for Canadian access to the US Spallation Neutron Source expired then, too.

NRU was a world-class, multipurpose research reactor, delivering many outcomes simultaneously:

- Producing isotopes for industry, and medicine (eg Cobalt-60)
- Testing fuels and materials for nuclear energy technology

AND

- Producing neutron beams for materials research applicable to many sectors: energy, health, manufacturing, transportation...

The CNBC Team crossed the finish line running



March 28, 2018: after enabling 800 research participants in the last five years to apply neutron beam methods to advance science and industry.

Special Thanks

Alastair McIvor and Daniel Banks supported the Canadian Neutron Beam Centre by analyzing facility performance, developing communication tools and web content, and drafting briefing notes or substantial documents for stakeholders within AECL, NRC, government agencies, decision-makers and the public from 2001-2007 and 2008-2019, respectively.

References

This presentation is based on

Root, Banks: *Physics in Canada* / Vol. 74, No. 1-2, pp 13-16 (2018)

See more of Daniel's work at:

<http://cins.ca/discover/>

<http://cins.ca/resources/cnbc/>

<http://cins.ca/resources/policy/>

See Alastair's summary of NRU impacts (TED Talk):

<https://www.youtube.com/watch?v=083OPkgCqBQ>