Canadian Institute for Neutron Scattering (CINS)
Minutes of the Annual General Meeting (AGM)
2015 November 13 & 14
University of Saskatchewan, Saskatoon, SK

The Annual General Meeting (AGM) of the Canadian Institute for Neutron Scattering (CINS) was open to all CINS members, guests and interested parties.

Present at the 2015 meeting were CINS President Chris Wiebe, CINS Board Directors John Root, Bruce Gaulin and Thad Harroun. Participating by phone/video was Niki Schrie (Secretary-Treasurer). In addition were approximately 30 members and guests, including members of the Science Council, Institutional representatives, including professors, students and other science professionals.

Friday, November 13, 2015

The 2015 CINS AGM registration and opening session convened at 1:00 PM. Opening remarks were made by Dr. Karen Chad, Vice-President Research from the University of Saskatchewan and also from the CINS President, Professor Chris Wiebe.

Dr. Neil Alexander from the Sylvia Fedoruk Centre for Nuclear Innovation led a discussion on: ***"Fostering Neutron Scattering in Canada after the NRU closes in 2018"***, with reference to a concept paper prepared for the University of Saskatchewan and the Sylvia Fedoruk Centre for Nuclear Innovation, by Dr. Daniel Banks, Canadian Neutron Beam Centre (CNBC). Daniel Banks' concept paper (known as "VINS") can be found in **Appendix A** or at http://www.cins.ca/docs/vins.pdf - **Action**: Members voted to request Chris Wiebe to confirm permission from the Fedoruk Centre, to post the VINS document on the CINS website.

The keynote speaker was Dr. Jens Dilling from TRIUMF.

A wine and cheese reception followed.

Saturday, October 15, 2014

Dr. John Root, Director, Canadian Neutron Beam Centre (CNBC) presented an ***"Update on AECL Restructuring and the Canadian Neutron Beam Centre".*** John Root's slide deck can be found in **Appendix B.**

Professor Chris Wiebe, President, Canadian Institute for Neutron Scattering (CINS) presented the ***"Status of Neutron Scattering in Canada as seen by the President of CINS"***. Chris Wiebe's slide deck can be found in **Appendix C**.

Dr. Zin Tun, Principal Research Officer, Canadian Neutron Beam Centre (CNBC) presented a ***"Report by the Committee on Options for a Future Neutron Source"***. The Committee's Report can be found in **Appendix D** or at http://www.cins.ca/docs/agm2015/Report%20to%20CINS.pdf – **Action**: Members voted to support the general principles described in the Committee's report, exploring how to manage a neutron gap with access to alternative sources, and laying the groundwork for a new domestic neutron source.

Chris Heysel, Director, Nuclear Operations & Facilities from McMaster University presented the ***"McMaster University Nuclear Facilities Overview"***. Chris Heysel's presentation can be found in **Appendix E.**

Dr. Robert Lamb, CEO from the Canadian Light Source (CLS) gave a presentation about the impact of this major beam-research facility on science, technology and society.

Professor Chris Wiebe, President, Canadian Institute for Neutron Scattering (CINS) chaired a session/discussion on ***"Now to 2020"***.

Resolution: Members voted to endorse the concept of a virtual institute for neutron scattering presented in the concept paper.

Action: Members voted to request John Root to connect with Karen Chad to explore the University of Saskatchewan's willingness to champion a future of Neutron Scattering for Canada and lead the formation of the virtual institute.

Professor Chris Wiebe, President, Canadian Institute for Neutron Scattering (CINS) chaired a session/discussion on ***"Beyond the Neutron Gap"***. **Action**: Members voted to request John Root and Chris Wiebe to connect with the Canadian Foundation for Innovation (CFI), to brief and seek advice about securing a future for Neutron Scattering in Canada.

CINS BUSINESS – Reports, Election of Science Council and Other Business

A. Approval of the Agenda

It was moved, seconded and unanimously carried – that the agenda be approved.

B. Approval of AGM Minutes (2014)

It was moved, seconded and unanimously carried - that CINS approve the 2014 Minutes from the AGM.

C. Review Actions Arising from Minutes (2014)

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D. Treasurer's Report

On behalf of Niki Schrie, Secretary-Treasurer for CINS, Chris Wiebe presented the slides prepared by Niki with respect to current institute membership and financial transactions by CINS since 2014. Niki Schrie's slide deck can be found in **Appendix F**.

E. New Board Members and Nominees for Science Council Membership

Board Membership – There was insufficient institute membership representative presence at the AGM in order to be able to vote in new CINS Board Members, as per the CINS Bylaws. A separate teleconference will need to be established for all institutional members to vote on new board members. **Action**: Chris Wiebe

Science Council Membership – Science Council members Jamie Noël and Harlyn Silverstein terms have now expired. Carl Adams expressed interest in being part of the Science Council – all were in favor – carried. **Action**: Niki Schrie to ensure the website is updated, removing Jamie and Harlyn, adding Carl. **Action**: Chris – Science Council needs a student member.

F. CINS Governance & Structure

Chris Wiebe presented a report around CINS Governance Structure, provided to him by the CINS Science Council. The Science Council indicated they would like the bylaws reviewed, and want improved communications between the Science Council and the Board of Directors. The slide deck can be found in **Appendix G**. **Action**: Thad Harroun agreed to lead a committee to bring recommendations to improve communication. The attendees felt that a review of the bylaws is premature at this time.

G. Next CINS AGM Location

Some discussion around location of the 2016 AGM, a possibility is McMaster University, Hamilton, ON, aiming for a date at the end of 2016 October. **Action: Chris**

H. Motion to Adjourn

Chris Wiebe motioned to adjourn the meeting at 6:08 PM.

****Please note that due to technical difficulties during the meeting (no audio), there are some gaps in the records of the minutes.**

Discussion on a Virtual Institute for Neutron Scattering:

A concept paper prepared for
the University of Saskatchewan
and
the Sylvia Fedoruk Centre for Nuclear Innovation
by
Canadian Nuclear Laboratories

Draft For Consultation
at the
Annual Meeting
of the
Canadian Institute For Neutron Scattering
November 13-14, 2015

Contents

1.0 Executive Summary

Neutron beams are versatile infrastructure for Canadian research on materials ranging from fundamental exploration to failure analysis of critical industrial parts, such as engines, pipelines, railroad tracks, and turbines. A renewal of this infrastructure could lead to economic and public good impacts in several focus areas of Canada's S&T strategy, including Advanced Manufacturing, Natural Resources and Energy, Health and Life Sciences, and Agriculture.

Canada's only major neutron source, the NRU reactor, will close in March 2018, and without infrastructure renewal, Canada will lose a major scientific user facility: each year, over 200 scientists, engineers, and students from universities, government labs, and industry participate in research depending on access to the six beamlines at NRU.[1] A new neutron source in Canada – if one is built – will not be fully operational for a decade or more; this time period is referred to as the 'neutron gap'. The expectation of a lengthy neutron gap and the uncertainty about a new neutron source are serious threats to Canada's materials research capabilities.

This discussion paper explores how a Virtual Institute for Neutron Scattering (VINS) could play a role in stabilizing and eventually growing the national capability for materials research by securing resources for neutron beam infrastructure. A VINS would foster this capability primarily by developing, operating and facilitating access to neutron beam instruments in Canada and at some of the best neutron sources worldwide. A VINS would also foster capability by performing research and development of equipment and techniques, providing complementary theoretical expertise and modelling facilities, supporting student training, developing applications and services to industry, and overseeing public investments.

A VINS would perform some activities at a home institution, but experimental research activities must be conducted at 'outstations' located at neutron beam labs elsewhere; for this reason the VINS is a virtual institute. Securing partnership with at least one neutron source is thus critical to a VINS.

Equally critical to a VINS is the participation of Canadian universities. The governance of the VINS should reflect a pan-Canadian approach and the strong academic interests. Positioning the VINS within the academic sector is needed to apply to the Canada Foundation for Innovation (CFI), which is the primary academic funding source for both capital projects and operations. These factors suggest that the VINS could be formed initially as a consortia or joint venture of universities.

This discussion paper provides background and preliminary analysis about a VINS for discussion by the neutron scattering community, including the science and policy context, stakeholder analysis, mission and scope, a vision for a VINS in Canada, and practical matters of governance, costs, funding sources and a possible timeframe for implementation.

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[1] Over a five-year period, CNBC research participants include more than 700 individuals from over 60 departments in over 30 Canadian universities and from over 100 foreign institutions in over 20 countries.

2.0 Background

2. 1 Science and Industry Applications of Neutron Beams

2.1.1 Neutron Beams are Tools for Studying Materials [2]

Everything is made of materials. That means the Earth, houses, food, tools, cars, computers, phones, artificial hip joints, diseases and humans - everything. Advances in materials lead to positive impacts across the spectrum of human experience and society. Such advances arise from the work of scientists in many disciplines, for example:

- Physicists study superconductors to revolutionize technologies for energy conservation, faster computers and more efficient medical diagnostics
- Chemists study the crystal structures of new materials for lithium-ion batteries, hydrogen-storage, fuel cells, or coatings for medical implants
- Engineers study how manufacturing processes affect materials at the basic level of crystal structures, looking for ways to make more reliable materials cost-effectively
- Health scientists study nano structures to design carriers for therapeutic agents that can target cancer, to design better treatments for diseases such as Infant Respiratory Distress Syndrome, or understand how bio-molecules like vitamin E function in our bodies

In all of these examples, scientists use neutron beams among various other tools to study materials, such as microscopes, X-rays, laser spectrometers and many others. Each tool reveals certain properties of materials, generating knowledge that points the direction for better understanding and improvements. Rarely does a single tool provide the complete picture.

Neutrons beams are exceptionally versatile and powerful tools for materials research because of the unique ways that neutrons interact with matter. Neutrons are neutral, sub-atomic particles, which penetrate deeply into materials. However, they are gentle probes, even of the most delicate materials, because they have low energies - one million times lower than X-rays that might be used for similar studies. Neutrons are magnetic, and allow scientists easily to learn about magnetic properties of materials at the level of molecules and crystal structures. Neutrons interact directly with atomic nuclei, and distinguish between isotopes. Notably, neutrons easily distinguish between hydrogen and deuterium, allowing scientists to focus on details of the molecular or nanostructures of polymers and biological materials, which are rich in hydrogen.

Due to these properties, neutron beams will always be an indispensable tool and cannot be replaced by other techniques.

2.1.2 Looking Ahead in Science and Engineering

As scientific inquiry evolves and engineering challenges push limits, so do scientific tools. Strong growth in the interdisciplinary areas of biochemistry and biophysics has been paralleled by the adaptation of tools from physics and chemistry to understand biologically relevant questions. While hard matter

[2] The views of the scientific community can be found in the CINS Long Range Plan: CINS. Planning to 2050 for Materials Research with Neutron Beams in Canada. http://cins.ca/reports.html#2050

continues to represent a large part of materials research, there is rapid growth in research on soft matter, including polymers, nanotechnology, life sciences and biotechnology. In parallel to this growth, neutron beam facilities have been tuning their capabilities to meet these demands. Cold neutron sources and beamlines for small-angle neutron scattering allow scientists to make observations at the length scales of large molecules like DNA and proteins, while a variety of sample chambers are employed to apply biologically relevant conditions during the experiments.

For industrial and government researchers, metallurgy will continue to be an important area of inquiry as we continue to push the limits of metals to make them lighter or able to endure high temperature differences. Reliability of these metals underlies safe and economic operations of our infrastructure, including power plants, pipelines, bridges, cars, airplanes, ships, and railroads. Industries with low tolerance for failure need to know, with certainty, all the material properties in critical components. Neutrons beams are unrivalled in their ability to directly and non-destructively determine stress, texture, and other properties deep inside metallic components, and the Canadian Neutron Beam Centre (CNBC) has led the way in this area.[3] To meet future needs of industry, a turn-key solution for stress analysis can be envisioned that integrates the neutron data with other experimental techniques and computer modelling.

Neutron imaging, analogous to x-ray photographs, holds promise as a growth area for Canadian research. Applications include:

- boosting crops yield through imaging plant roots and the micro-organisms around the roots in soil, and correlating the results with phenotype-to-genotype correlation
- identifying of water ingress to prevent failures in critical components for aerospace and oil & gas industries
- quality assurance of nuclear fuels and fuel failure analysis for the nuclear power industry
- forensic examination for the radiological and nuclear community

2.2 Federal and Provincial Policy Context

Governments in Canada are interested in considering two potentially-related investments in nuclear S&T that may have neutron beam components: (1) a nuclear innovation agenda (NIA), and (2) a new source of neutrons.

The federal position on a NIA was recently summarized thus by Natural Resources Canada (NRCan):

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[3] Several examples of current impacts arising from industrial projects at the CNBC are found in its recent activity report: Canadian Neutron Beam Centre. Activity Report to the Canadian Institute for Neutron Scattering for 2011, 2012, and 2013. http://cins.ca/reports.html#cnbc.

The government is seeking to understand the potential value to Canada of a cost-shared research and development initiative, taking into consideration benefits to Canada's innovation capacity, and potential for improved competitiveness of nuclear and non-nuclear sectors, jobs and growth.[4]

The nuclear industry, led by the Nuclear Leadership Forum, has responded to NRCan's encouragement to consider a cost-shared NIA, and is proposing to establish a framework for shared decisions about investing in nuclear science and innovation, involving federal, provincial, industrial and academic stakeholders.[5] The NLF has proposed that the framework could be a vehicle for funding projects that require access to nuclear research infrastructure or funding capital and operations of such infrastructure, which may include a new neutron source.

The federal government has expressed openness to considering co-investment in a new neutron source.[6] The Ontario Minister of Energy has spoken publicly about need to plan now for a new research reactor to replace the NRU reactor to support the nuclear industry.[7] The Government of Saskatchewan expressed interest in 2009 in building a neutron source at the University of Saskatchewan[8] as one means of building nuclear capabilities to support industry expansion in the uranium lifecycle beyond mining.[9] The province has since made parallel investments to build nuclear capabilities by establishing the Sylvia Fedoruk Canadian Centre for Nuclear Innovation in 2011. A source of neutron beams would be a valuable asset to enable research sponsored by the Fedoruk Centre and that conducted by the recently announced Phenotyping and Imaging Research Centre to be established as result of a recent $37.M award from the Canada First Research Excellence Fund. The Phenotyping and Imaging Research Centre proposes to use neutron imaging as one of its techniques to correlate genotypes and phenotypes, enabling genetic engineering of crops that are tuned to thrive in the specific environments found around the world.

2.3 Global Supply and Demand

All the North American neutron beam facilities are heavily oversubscribed[10] and the USA continues to grapple with issues of accessibility of neutron beam facilities to American scientists[11] despite increasing

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[4] "Exploring a Potential Industry-driven Nuclear Innovation Agenda", Presentation by S. Quinn of NRCan at the UNENE R&D Workshop, December 16, 2014. Former NRCan Minister Greg Rickford spoke favorably of how nuclear S&T is being applied to innovation in non-nuclear industries (Speech to Canadian Nuclear Association conference, Feb 2015).

[5] The Nuclear Leadership Forum. Enabling the Next Generation of Nuclear Science, Technology and Innovation A nuclear innovation agenda for a powerful Canada to 2040 and beyond. Draft. March 3, 2015.

[6] See for example, NRCan's Response to the Expert Review Panel on Medical Isotopes: http://www.nrcan.gc.ca/energy/uranium-nuclear/7795.

[7] Bob Chiarelli. Speech to Canadian Nuclear Association conference, Feb 2015.

[8] The Province of Saskatchewan offered in 2009 to provide 25% of both the capital and operating funds for a neutron beam facility located at the University of Saskatchewan, complementing investments at the Canadian Light Source (The Canadian Neutron Source. http://cins.ca/reports.html#isotopes1).

[9] Uranium Development Partnership. "Capturing the Full Potential of the Uranium Value Chain in Saskatchewan." 2009.

[10] For example, "[the NIST Centre for Neutron Research's] oversubscription rates by beam line are in a healthy range, averaging 2.2 over the facility, indicative of a robust and vibrant user community." (Laboratory Assessment Board. An Assessment of the National Institute of Standards and Technology Center for Neutron Research: Fiscal Year 2011. p.9. http://www.nap.edu/openbook.php?record_id=13252). The oversubscription rate is defined as the number of beam days requested by users, divided by the total number of beam days available for user access.

the supply by ramping up its new $2.2B Spallation Neutron Source (SNS, 2006) and expanding capacity at its two remaining older, NRU-vintage, facilities[12]. The shortage is in part due to closures of other US facilities at Argonne and Brookhaven labs, and most recently the user program at Los Alamos. Unless new facilities are built, the SNS could become the only major neutron beam facility in North America in the coming decades, and will be unable to meet current demand levels, even if it invests in a second target station at SNS.

Globally, most neutron beam facilities are based on aging reactors built within 20 years of the NRU reactor, and like the USA, other countries are investing or have recently invested in new or upgraded facilities, including Japan ($2.4B, 2008), Australia ($350M, 2008), Germany ($750M, 2001), UK ($280M, 2009). The European Union is now constructing a $2.5B spallation neutron facility. Materials research with neutron beams was the main reason for these investments.

2.4 Canada's Neutron Scattering Capabilities Today

Canada has built a strong international profile in materials research with neutron beams, for selected scientific domains, including applied neutron diffraction for industry, quantum materials and powder diffraction. Canada is also noted for innovation in neutron instruments, methods, and applications. Canada's neutron beam capability has four main elements:

1. One major neutron source (NRU) with an internationally competitive neutron flux.
2. A community of 250 Canadian academic, government and industrial users of neutron beams, as well as 150 foreign researchers, organized by the Canadian Institute for Neutron Scattering.
3. Six beam lines accessible by an international research community at the Canadian Neutron Beam Centre (CNBC).
4. Scientific and technical expertise at the CNBC that enables effective application of neutron methods to a wide range subject matter, and continuously advances neutron capabilities.

Some incremental capacity is available for Canadian researchers:

1. Under an arrangement to expire in 4-5 years, Canadian researchers are welcome to use up to 10% of the time of three beamlines at the Spallation Neutron Source (Oak Ridge, USA).
2. The lower-flux McMaster Nuclear Reactor (MNR) has two beamlines for commercial radiography operated by N-Ray Services Inc. for commercial applications, and a third beamline that can introduce students to neutron diffraction, and enable specimens to be aligned and evaluated prior to taking them to higher-flux sources for a full-scale experiment. A fourth beamline for small-angle neutron scattering being built by the CNBC is expected to be operable in 2019.

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[11] Henry Glyde, Robert Briber, Sunil Sinha. Committee on International Scientific Affairs of the American Physical Society. "Access to Major International X-ray and Neutron Facilities." April 30, 2009. http://www.aps.org/programs/international/resources/facilities.cfm

[12] (1) The National Institute of Standards and Technology (NIST) Centre for Neutron Research and (2) the High Flux Isotope Reactor at Oak Ridge National Laboratory.

2.4.1 Strengths and weaknesses compared to major foreign neutron beam labs

Despite the relatively low investment by Canada in the infrastructure and resulting capacity limitations, the return on investment is high compared to most foreign facilities.[13]

Strengths

- Strong international reputation supported by a competitive publications per instrument ratio[14]
- Competitive instruments for industrial applications, powder diffraction, and quantum materials
- Both the CNBC and its user community are highly collaborative with industry[15]
- More attention to teaching students and casual users, which fosters a national capability
- Being at CNL has provided complementary capabilities to handle radioactive materials and enables services for nuclear and non-nuclear industries, difficult to emulate elsewhere

Weaknesses

- Current lack of formal stakeholder involvement in funding, governance, or operations[16]
- Sub-standard staff-to-beam line ratio make 24/7 operations and user support challenging
- Operating within agencies without strong mandates to provide national user facilities
- Minimal capital investment in facilities over past 20 years[17]
- Lack of a cold source and cold neutron beamlines for polymers and bio-materials
- Small number of beamlines (6 compared to a range of 15 to 50 at foreign neutron sources) and gaps in thermal neutron capabilities (e.g. radiography)
- Fewer complementary capabilities for sample preparation, theory and modelling, and instrument development

2.5 Canadian stakeholders

The CNBC has historically operated in the international framework of a 'user-facility model,' sharing a major resource for R&D widely amongst a diverse research community. This section briefly describes the community and examines the user facility model.

[13] The CNBC's "industrial applied research program is the best in the world" (Peer Review of the Steacie Institute for Molecular Sciences: Final Report of the Institute Review Committee", presented to the NRC Council, October 28, 2004); An international expert panel (U.S., France, Canada) stated, "CNBC is competitive with the top scattering research facilities in the world, based on quality of research and publications." (NSERC Site Review of the Canadian Neutron Beam Centre, Feb 11, 2007).

[14] Some of this reputation is also due to other factors: Canadians of stature are active in the community of USA facilities or in the Neutron Scattering Society of America. CNBC is known for some historic achievements: Bertram Brockhouse's Nobel Prize and the neutron stress-scanner replicated at other facilities in the 80s and 90s.

[15] For example, the CNBC and its user community "has the most diversity in terms of the industries that sponsor research" compared with TRIUMF, CLS. See KPMG. "A Report on the Contribution of Nuclear Science and Technology (S&T) to Innovation." Final report prepared for Natural Resources Canada. Fall 2014. p147

[16] Today, the CNBC is the only academically-oriented user facility in Canada that is not operated by the academic sector, apart from federal astronomy facilities due to provisions of the NRC Act. The CNBC was partially supported through the granting councils from 1992 to 2013 in lieu of access fees for university researchers. With a moratorium on the NSERC Major Resources Support program, the academic community is currently without a means to contribute to the funding and governance.

[17] Investment in the global market for neutron beams is discussed in the previous section. An NRCan study found the CNBC had nearly no capital investment compared to major academic-sector facilities in Canada (e.g. TRIUMF, CLS, McMaster Nuclear Reactor) over the past 20 years (see KPMG. "A Report on the Contribution of Nuclear Science and Technology (S&T) to Innovation." Final report prepared for Natural Resources Canada. Fall 2014).

2.5.1 Academic Researchers[18]

Universities benefit both from the knowledge they generate and from the training their students receive at the user facility. Canadian academics gain access to foreign facilities and international collaborations, balanced by Canada's user facility contributing to a global network of neutron beam laboratories.[19]

The CNBC user community includes researchers from over 60 departments in 30 universities, including nearly every major university and some smaller ones. A recent study found that the geographic distribution of faculty who use the CNBC matches the distribution of universities across Canada, and the number of faculty is equal to the numbers that use TRIUMF and the Canadian Light Source (CLS), whose users tend to be more regionally aligned. Further, the faculty involved in the CNBC were found above average in both scientific stature and engagement with industry.[20] Thus, materials research with neutron beams is one of the few areas of strength in academic – industrial collaborations, where Canada otherwise ranks weakly internationally.

2.5.2 Industry Clients

Industry clients tend to come from risk-sensitive heavy industries where precise knowledge of the properties of key materials is needed to ensure reliability and meet regulatory requirements: nuclear power, aerospace, automotive, oil & gas, primary metal production and other manufacturing. These industries pay to directly employ neutron beams in failure analysis, prototyping or other R&D to improve manufacturing methods or satisfy regulators. Paid projects tend to be one-offs, urgent in the short-term, high impact and proprietary. Longer-term involvement with industry typically arises when industries pool resources (e.g. through the CANDU Owners' Group, Pipeline Research Council International) and sponsor academic or government labs to solve longer term materials problems that may benefit an entire industry.

Canadian Nuclear Laboratories (CNL) has been the CNBC's largest client outside academia. The end users of the knowledge generated for many CNL projects have been the Canadian nuclear power industry or government regulatory bodies (e.g. Canadian Nuclear Safety Commission or Health Canada). In other cases, these projects have contributed to CNL's operational needs as a nuclear site. Projects over the past three years have included nuclear forensics, nuclear waste management, quality assurance and analyses of fuel produced in the Nuclear Fuel Fabrication Facility, and studies on hydrogen in CANDU pressure tubes, understanding fuel failure, reliability of welding methods, super-critical water reactors and biological effects of radiation. Over the past 15 years, CNL frequently accessed the CNBC for nuclear fuel analysis and stress measurement in feeder tubes and feeder welds.[21]

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[18] More detail on the academic community is provided in the appendices.

[19] There is an informal *quid pro quo* arrangement in which foreign scientists are welcome at the CNBC in return. The trade balance between the number of Canadians accessing USA facilities and USA researchers accessing the CNBC is about equal.

[20] KPMG. "A Report on the Contribution of Nuclear Science and Technology (S&T) to Innovation." Final report prepared for Natural Resources Canada. Fall 2014. See pages v and 136 for the distribution and numbers of faculty. Though they represent only 0.7% of all NSERC-funded faculty, they represent 1.8% of all NSERC Canada Research Chairs, 1.3% of all NSERC Industrial Research Chairs and 2.2% of all of NSERC's Collaborative R&D grants (page 148).

[21] Daniel Banks, Ron Donaberger, Brian Leitch, Ron Rogge. (2014) Stress analysis of feeder bends using neutrons: new results and cumulative impacts. Pacific Basin Nuclear Conference. PBNC2014-186. http://pbnc2014.org/proceedings/html_files/2288.html

2.5.3 Government Clients

In addition to government clients who access the CNBC indirectly through CNL, direct government clients include Canmet, National Research Council (NRC) and the Defence R&D Canada (DRDC). Canmet and NRC typically access the CNBC to advance their R&D work with industry. DRDC typically accesses the CNBC for its own operations, for example, investigating the strength of welds on military ship hulls to manage the aging of the fleet.

2.5.4 Other Stakeholders

In addition to the many user organizations, the following parties have relevant expertise or interests in operations of a neutron beam facility:

- Canadian Nuclear Laboratories (CNL). CNL operates the former AECL Nuclear Laboratories, recently restructured by NRCan as an emerging "national nuclear laboratory,"[22] that provides S&T services to industry and the federal government.[23] In addition to its role as a user of neutron beams described above, CNL has operated the CNBC since 2013, and now employs much of the CNBC's expertise for operating the beamlines and supporting users. CNL has decades of experience operating the neutron source and providing complementary and ancillary services to the neutron beam lab, including engineering design and fabrication of beamlines, radiation protection and safety qualification, and other support services. As of Sept. 2015, CNL is managed by Canadian National Energy Alliance (CNEA), a private sector consortium (see www.cnea.co).
- National Research Council (NRC). NRC operated the CNBC for 15 years (1997 to 2013) and is the owner of the CNBC's beamlines and equipment. NRC employs the balance of CNBC's staff.
- Atomic Energy of Canada Ltd. (AECL). AECL is the owner of the assets managed by CNL, and is responsible to oversee the contract with CNEA to manage CNL. AECL is a crown corporation reporting to Natural Resources Canada (NRCan).
- Natural Resources Canada (NRCan). NRCan is responsible for nuclear policy including the nuclear innovation agenda under consideration. NRCan funds CNL to operate the NRU reactor (today, these funds also cover the CNBC's operations), perform a suite of nuclear S&T projects for federal departments, disposition federal nuclear liabilities, and upgrade facilities.
- McMaster Nuclear Reactor (MNR). MNR is the only other domestic facility with a significant flux of neutrons (described above in section 2.4). To reproduce some of the CNBC's capabilities at MNR, significant upgrades would be required to boost its operating power, operate at full capacity, expand the beam halls, and add a suite of beamlines and ancillary equipment. Boosting neutron flux beyond levels that can be achieved by only increasing the power would be a major project involving a redesign and fabrication of the reactor core.
- Canadian Institute for Neutron Scattering (CINS). CINS is a not-for-profit, volunteer-based organization that represents the Canadian scientific community of neutron beam users and promotes scientific research using neutron beams. See www.cins.ca.

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[22] "Transitioning the CNL S&T Program", Presentation by S. Bushby at the COG Workshop on Long-term R&D Strategic Plan, January 20, 2015.

[23] "The Domestic and International Nuclear Landscape: The Need for an Appropriate Canadian Long-term Nuclear ST&I Agenda", Presentation by W. Kupferschmidt at COG Workshop on Long-term R&D Strategic Planning, January 20, 2015.

3.0 A Virtual Institute for Neutron Scattering (VINS)

3.1 Planned shutdown of the NRU reactor creates a 'neutron gap'

The NRU reactor is Canada's only major neutron source, and is the source for the Canadian Neutron Beam Centre. In February 2015, the Government of Canada announced plans to close the aging NRU reactor in 2018, citing growing costs of repairs and maintenance to ensure reliable operations.[24] CNL desires to maximize value from NRU until then, including the full exploitation of neutron beams for materials research.

A new neutron source in Canada – if one is built – will not be fully operational for a decade or more; this time period is known as the 'neutron gap'. The expectation of a lengthy neutron gap, and the uncertainty whether there will be a new neutron source in the future, presents an immediate challenge for retaining neutron-beam expertise in Canada.

Based on the foregoing policy context and stakeholder analysis, this document assumes that Canada has an interest in retaining neutron beam capability during the neutron gap so that, at a minimum, decisions about a new neutron source and nuclear innovation are not undermined.[25]

3.2 Establishing a virtual institute

The neutron gap places Canada's science and innovation capabilities using neutron beams at risk. By first stabilizing and then growing these capabilities, Canada can boost industry competitiveness directly through the knowledge generated for clients or in Canada's priority areas for S&T, and indirectly through attracting, training, and retaining highly qualified people.

Establishing a VINS that operates in partnership with one or more existing neutron sources is one way to stabilize some or all of this capability for the period beyond 2018. The VINS could then act as a vehicle for the pan-Canadian community to grow by attracting further investment in neutron beam infrastructure, whether at domestic or foreign sources and to sustain a proactive outreach and educational program to foster materials research with neutron beams, to maintain this national capability in a competitive state.

[24] $465M has been allocated for repair and maintenance projects between 2008 and 2016 ("Government of Canada Announces Extension of National Research Universal (NRU) Reactor". News Release. February 6, 2015 http://news.gc.ca/web/article-en.do?mthd=index&crtr.page=2&nid=929189). March 31, 2018 is the planned closure date, according to Bob Walker, former CEO of Canadian Nuclear Laboratories ("The future of NRU and CNL." Community Information Bulletin. February 6, 2015 http://www.cnl.ca/en/home/news-and-publications/bulletins/2015/NRU_decision.aspx).

[25] A neutron gap disrupts materials research with neutron beams: users and clients turn to foreign facilities or withdraw from the field, while the national centre for the national capability is lost. If all capabilities are lost, effective exploitation of a new research reactor for neutron beam will be delayed about 10 years because (1) the new centre will lack experience in managing a user facility operation and will lack guidance for developing optimal, user-aligned functionality, and (2) the need to rebuild the user community.

3.2.1 Mission

The mission of a VINS is to advance science and innovation by fostering the national capability for materials research with neutron beams. It fosters this capability primarily by developing and operating neutron beam instruments in Canada and at some of the best neutron sources worldwide, and making them available for access by industry, government and academic R&D programs.

3.2.2 Impact areas

Neutron beams are versatile infrastructure for Canadians to perform research on materials ranging from fundamental exploration to failure analysis of critical industrial parts, such as engines, pipelines, railroad tracks, and turbines. Through strategic selection of expertise, beamlines, and in-house research, a VINS can expect to tune its widespread impacts to focus on these areas of Canada's S&T strategy[26]:

- Advanced Manufacturing: aerospace, automotive, lightweight materials and technologies, additive manufacturing, quantum materials, nanotechnology
- Natural Resources and Energy: fuel cells, nuclear energy, and pipeline safety
- Health and Life Sciences: biomedical engineering and medical technologies
- Environment and Agriculture: biotechnology

It will impact these areas by enabling the research described in section 2.1.2.

3.2.3 Scope

The scope of a VINS can include all activities instrumental to its mission and purposes that can be conducted either away from the source of neutrons or through 'outstations' at distant neutron sources. These activities may include the following:

- Securing funds and resources
    - Preparing funding applications on behalf of the neutron beam user community, submitted through the owner universities
    - Negotiating agreements with off-site neutron sources
- Performing research, development, and implementation of beamlines, methods and ancillary equipment at outstations
- Operating beamlines and associated equipment, labs and workshops at outstations
- Providing complementary theoretical and computing facilities and expertise
    - Providing specialized scientific IT services
    - Developing turn-key services for industry by integrating experimental and modelling capabilities
- Training, attracting, and retaining expertise
    - In-house research programs in select areas to build capability for the future (e.g. integrated approach to stress analysis)
    - Neutron scattering schools and workshops
    - Student scholarships
    - Research chairs

[26] Industry Canada. Canada's S&T strategy. "Seizing Canada's Moment: Moving Forward in Science, Technology and Innovation 2014." http://www.ic.gc.ca/eic/site/icgc.nsf/eng/h_07419.html

  - Outreach to potential industry clients and other new users
- Supporting clients and users
  - Assistance in proposal development, analysis and publication of results
  - Travel support to outstations
- Managing the allocation of the resources
  - User proposal review system
  - Commercial services
  - Hosting scientific advisory committees on priorities and operating policies
- Government and stakeholder relations
  - Facilitating community input and discussion
  - Organizing fora for scientific networking and policy discussion
  - Performance analysis and reporting
  - Outreach to the general public
- Other Administration
  - Facilities Management, HR, Finance, Procurement, Health, Safety and Security, including radiation protection

A ‘full-service’ VINS may perform most or all of these activities itself. The Jülich Centre for Neutron Science (JCNS, see text box on following page) in Germany is an example of such a virtual institute, which employs over 170 people in neutron scattering research, development, and beamline operations located at the virtual office and at one domestic and three foreign outstations.

Alternatively, a VINS could be a smaller scale organization that procures many of these services from third-parties such as host neutron sources, partner universities or other research organizations (e.g. National Research Council or Canadian Nuclear Laboratories). In this case, the primary activities of the VINS would be securing and directing use of funds and resources on behalf of the pan-Canadian community, providing user support and coordinating Canadian involvement in developing and operating the outstations.

3.2.4 Caveat: Not intended to replace reinvesting in a neutron source

In the Jülich example, the virtual institute model functions in part because Germany also contributes its own neutron sources for access by the global community. A VINS might not be sustained over the long term unless Canada invests in its own domestic source or substantial funds toward the capital and operating costs of a foreign neutron source.

As discussed in section 2.3, most neutron beam facilities around the world are old facilities, and the several new facilities will not replace the facilities likely to close during the next decades. When foreign partners reinvest in new facilities, Canada will be expected to invest as well by contributing to the capital and operating costs, rather than covering only the incremental costs of ‘Canadian beamlines’, if it does not contribute a source of its own to the global network of sources.

The Jülich Centre for Neutron Science (JCNS)

The Jülich Centre for Neutron Science (JCNS) in Germany was founded when the neutron beam reactor FRJ-2 at the Jülich Research Centre closed in 2006, and the beamlines were transferred to the Heinz Maier-Leibnitz Zentrum (MLZ) uses the FRM-II reactor at the Technical University of Munich as its source of neutrons.

Today, JCNS offers access to 18 beamlines at three outstations and is developing beamlines for a fourth outstation. It offers German and foreign researchers access to 11 dedicated beamlines that it operates at MLZ, which is located 6 hours' drive away from Jülich. MLZ operates the balance of its beamlines not associated with JCNS. JCNS employs 70 staff at its MLZ outstation.

JCNS offers Germany-based researchers access to a portion of the time on 6 beamlines at two foreign facilities: Institut Laue-Langevin (ILL) in France and the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory, USA. Users from German universities are eligible to obtain funds from JCNS to assist with travel, accommodation and subsistence during their beam time. JCNS employs 4 staff at its ILL outstation and 8 staff at its SNS outstation to assist with development and operation of these beamlines.

The fourth outstation is the European Spallation Source in Sweden, which is scheduled to be fully operational in 2025. JCNS employs 3 staff at its ESS outstation.

JCNS has two research divisions that perform in-house research programs in soft materials, quantum materials, and structures and dynamics of materials. These divisions also perform development of beamlines and methods. Together, these divisions employ over 80 staff.

JCNS supports these activities with a Technical Services and Administration Division, which supports its scientists in designing and constructing instruments, provides specialized scientific IT services including high performance computing and software development.

In one scenario, Canada could be asked to participate in a USA investment of $1B to build a second target station at its Spallation Neutron Source. A capital contribution of a few hundred million plus a few tens of millions per year toward operations to secure a permanent place as a junior partner could be appropriate. Such a major investment decision would less than, but still comparable to building a new domestic facility. The cost savings would need to be balanced against other factors: academic and provincial co-investment will be more difficult to achieve for a foreign facility, the responsiveness of a foreign facility to Canadian requirements will be lower, and additional time required for multi-lateral negotiations may significantly delay the project and prolong the gap period. The border will add real and perceived barriers that may inhibit Canadian usage, including usage by Canadian industry and government labs; thus, significantly more outreach activities will be required.[27] There will be reduced

[27] It is sometimes suggested to adopt the model for Canadian astronomers and nuclear particle physicists routinely rely on access to foreign facilities. The members of these research communities are specialists whose entire careers may be centered on foreign facilities with an international outlook. World-class astronomy and particle physics facilities often require multinational investments to be at the leading edge of the field. Scientific requirements dictate the geographical location of land-based telescopes. These big-science facilities help to answer fundamental questions about nature that are not the

returns on the investment in areas such as training and retention of highly qualified people within Canada, uptake of technology by Canadian firms, and spin-off benefits (e.g. local taxes and economic activity).

3.3 A Possible Future State for Neutron Scattering in Canada Facilitated by a VINS

Whether or not a Canadian VINS is a full-scale organization like JCNS, the JCNS example is suggestive of what might be done in the Canadian context:

- A VINS is formed as a pan-Canadian effort to succeed the Canadian Neutron Beam Centre as the NRU reactor closes, having active support of the administrations of a dozen or more universities and research organizations.
- The VINS secures funds and resources for capital projects and operating activities from federal and provincial agencies, and other partners.
- The VINS oversees the transfer of beamlines and equipment from the Canadian Neutron Beam Centre to one or more neutron sources.
- The VINS partners with the best and most accessible foreign neutron sources to develop and contribute to the operation of beamlines at these outstations. The VINS provides support to Canadian researchers to access them and hone their talents at leading facilities such the NIST Centre for Neutron Research and the Spallation Neutron Source.
- The VINS partners with the McMaster Nuclear Reactor to serve as the interim domestic neutron source, and invests to boost its power, operate at full capacity,[28] expand the beam halls, and add a suite of beamlines and ancillary equipment. The VINS then operates the beamlines as an outstation easily accessible by universities for training students. The VINS makes the beamlines available to foreign researchers as well as a contribution toward the global network of neutron beam facilities. The VINS studies feasibility of redesigning the reactor core to boost neutron flux further.
- Partner universities attract research chairs who will train students and perform research in the impact areas using the facilities made available through the VINS.
- The VINS and its partners perform research and development of beamlines and methods to enhance capabilities and ramp them up toward a new domestic neutron source.
- The governance of the VINS keeps university administrations engaged with the community and facilitates the formation of a unified voice regarding major investments to construct a new neutron source for Canada.

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priorities of any one country. In contrast, the composition of the neutron beam user community and the nature of the problems studied are quite different. The neutron beam user community is largely composed of casual users that require a significant degree of support. These users come from industry, government and universities for whom the barrier to access foreign facilities is significantly higher. A world-class neutron beam facility is within Canada's ability to handle as a national investment. There is no possibility that a reactor with a world-class neutron flux will become obsolete over its 50-year lifetime, because physical laws determine the upper-limit of flux. A neutron beam research facility can be built in Canada since scientific requirements do not restrict geographical location. A domestic neutron beam facility enables the entire spectrum of research, from fundamental to applied, while aligning research preferentially to address priorities in Canada's S&T Strategy.

[28] 24/7 instead of 8 hours per day, 5 days per week

3.4 Funding Framework

3.4.1 Cost planning

Figure 1 illustrates four phases of activity to implement a scenario like that described in 3.3:

1. Start-up the organizational framework (years 1-5) and build expertise and R&D programs at the home base reaching $1-2M/yr (years 4-10).
2. Establish the first outstation (years 3-14) with several beamlines as a user facility with operations of a 'CNBC-like' program at $3-6M/yr, plus $5-10M/yr for a contribution to the operating cost of the associated neutron source. In addition, there will be capital costs of building several beamlines at (or moving and adapting beamlines to) the outstation ($3-8M each).
3. Establish secondary outstations (years 6-18) with smaller programs to enable Canadian access to specialized capabilities not available at the primary outstation. These are assumed to have similar but proportionate costs for capital and operations.
4. Ramp-up toward a new neutron source (years 8-20+). If Canada invests in a new neutron source, whether in a domestic facility or a foreign partnership, an extensive R&D program to develop and build beamlines and equipment will be needed (e.g. $4-8M/yr to develop and build 12 'day-one' beamlines during more than a decade of designing, constructing, and commissioning a neutron source).[29] This R&D program could be divided between activities at the home base and at the outstations.

In all, activities during the neutron gap period could plateau over $20M/yr (figure 1).

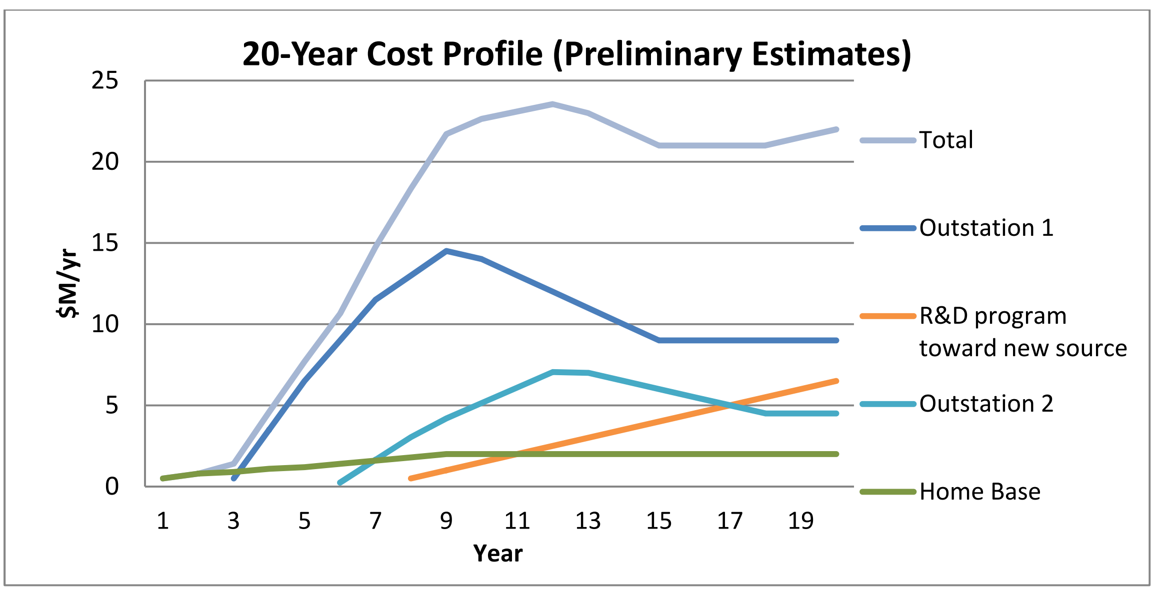

Figure 1 Preliminary cost projections over 20 years, based on table 1.

[29] Given that some of the beamline development at outstations would be transferable to a new source, the incremental 'ramp-up cost' of a new source may not appear as large as if it were a stand-alone activity.

Table 1 Preliminary order-of-magnitude cost estimates of on-going operations and capital projects. Capital costs are expressed as estimates of activity that would be sustained over several years to complete multiple sub-projects in close succession. Actual costs will depend heavily on terms negotiated with neutron sources and the selection of funded activities.

	On-going Operations ($M/yr)	Capital Projects ($M/yr)
Home Base	1-2	-
Outstation 1 (primary source)	5-10	-
Outstation 1 (primary beamlines)	3-5	3-6
Outstation 2 (source)	2-4	-
Outstation 2 (beamlines)	1-2	1-2
R&D program toward new source	1-2	3-6
Total	**13-25**	**7-14**

Some 'seed' or venture funding from the initial partners will be needed for pre-start-up phase activities before the VINS is officially formed, and possibly into the first year or two until outside funding is received. Pre-start up activities may include the business and budget planning needed to secure the support of partners, stakeholder consultations, negotiating roles and responsibilities, and scope of mission. The expertise for business planning, grant applications, negotiating with neutron sources, and feasibility studies during pre-start-up and the first few years might be procured initially from stakeholders via agreements for consulting or secondments, until the VINS recruits its own experts.

Table 2 estimates the cost of the home base in the first five years. The VINS will need to recruit an executive director in year 1, and over time an operations manager, communications officer, and an administrative assistant. The executive director will need to travel for community and government engagement. Office space and access to central services (e.g. security, IT, finance) will need to be procured from the host institution. Special overheads include administrative costs above and beyond what a host institution would typically provide. These may include recruitment costs, graphic design and communications, sponsoring or hosting events, and other outreach activities. Direct support for R&D activities at the home office in the first five years could include user support (including travel to outstations, an online proposal system) and attracting research chairs in theory and modelling.

Table 2 Preliminary estimates of cost of activities at the home office over the first five years, not including costs directly attributed to outstations.

Home Base	Year 1	Year 2	Year 3	Year 4	Year 5
Administration (Pay and Benefits)	100	250	350	400	400
Consulting or Secondments	200	400	200		
Recruited Experts (Pay and Benefits)			150	300	300
Travel	25	30	35	40	40
Rent and central services	25	50	75	100	100
Special overheads	100	50	50	50	50
User support		20	40	80	160
Research chairs (Pay and Benefits)				150	300
Total	**450**	**800**	**900**	**1120**	**1350**

3.4.2 Funding sources

Table 3 Possible funding sources

	Possible Funding Sources	Home Office	Domestic Outstation	Foreign Outstation	Use of Funds
1	Canada Foundation for Innovation (CFI)	✓	✓	✓	Capital, O&M
2	Provincial matching of CFI	✓	✓	-	Capital, O&M
3	Direct federal funding	✓	✓	✓	Capital, O&M
4	Federal regional development agencies	✓	✓		Start-up, Capital
5	Host university (in-direct costs of research)	✓	-	-	Start-up, O&M
6	Nuclear innovation agenda	-	✓	✓/-	O&M
7	R&D services for research partners	-	✓	✓/-	O&M
8	Nuclear and non-nuclear commercial clients	✓	✓	✓/-	O&M
9	Funding envelope for new neutron source	✓	✓	✓	R&D
10	Nat. Sciences and Eng. Research Council (NSERC)	✓	-	-	R&D

✓ indicates a possible funding source. ✓/- indicates location may present additional challenges to revenue from this funding source. O&M = Operations and Maintenance. R&D = Research and development activities.

The table lists possible funding sources, which are summarized as follows:

1. The main academic funding source would be the Canada Foundation for Innovation (CFI), initially for capital projects through the CFI Innovation Fund at outstations that would subsequently qualify for operating funds through the Major Science Initiatives (MSI) Fund. CFI usually contributes up to 40% to any project. In the case of MSI, the matching funds can come from any source.
2. Matching funds up to 40% are often provided by the host province.
3. Federal departments can directly support Canadian participation in international projects (e.g. NRC and CSA contribute international partnerships for facilities for astronomy and space research). NRCan and Industry Canada are the most likely federal departments to consider maintaining a Canadian neutron beam competency by support research infrastructure within its mandate.
4. Federal regional development agencies, such as Western Economic Diversification or FedDev Ontario may be sources of funds for some start-up costs, such as feasibility studies in anticipation of large capital funding applications.
5. The host university might cover some of administrative costs of maintaining the home office through in-kind contributions by providing office space and access to central support services. Over time, the host university may be able to recover its contributions through “indirect costs of research” programs from the granting agencies. The host university, with its partners, may need to provide seed funding to cover some start-up costs in the first two years while sustainable funding sources are pursued.
6. The nuclear innovation agenda under consideration – if it materializes in the form envisioned by the Nuclear Leadership Forum – could be a source of funds for operating nuclear research facilities as well to support costs of research program that may access these facilities.

7. Research partnerships could result in-kind and cash income from projects such as neutron imaging services for academic partners, providing access to governmental research bodies, participating in research partnership programs (e.g. funded through NSERC or Networks of Centres of Excellence).
8. Commercial projects for clients in the nuclear-sector might include stress analysis and other R&D services sponsored by the nuclear power industry (e.g. the CANDU Owners Group, or foreign utilities). Commercial projects could include sub-contracts through CNL for services to federal government departments.
9. If Canada invests in a new neutron source in the future, the scope of the funding envelope could include ramp-up research and development activities that foster capability so that Canada will be ready to make full use of the source as soon as it is available. Such activities were included in the scope of the funding announcement for the Canada High Arctic Research Station.[30]
10. The Natural Sciences and Engineering Research Council (NSERC) focuses on research activities[31] at universities and research partnerships with industry. NSERC may be a source of funding for research chairs and other faculty that might be jointly appointed with the VINS and a university. Users of the VINS will rely heavily on NSERC for funding their research programs to hire students and operate their labs.

3.5 Governance framework

The governance of a VINS in Canada should incorporate lessons learned from the CNBC and other major scientific facilities in Canada. While the CNBC has been the focal point of a national research community that it has helped to foster, a significant weakness in its 'user facility model' is now apparent. A major user facility cannot be sustained without either a direct government mandate to operate national facilities[32] or a means for users to cover the costs of their access, neither of which is currently in place. The research community has been and wants to be involved in paying for their access.[33] The absence of a strong university voice to secure such funds reflects two key factors: (1) previous funding arrangements achieved by the researchers via the Canadian Institute for Neutron Scattering (CINS) did not sufficiently engage university administrations, and (2) the diffused interests among many organizations and small proportion of 'professional neutron scatterers,'[34] whose careers critically depend on neutron beams, have not led to a natural champion to act on behalf of the community.

The emerging model for major scientific user facilities in Canada is to be owned and operated by the academic sector and funded mainly by the granting agencies and other government sources. The CFI is

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[30] In August 2012, the government announced plans to spend $142.4 million over the next six years on construction, equipment and start-up costs for the facility and $46.2 million during the construction period on its science and technology research program. http://pm.gc.ca/eng/news/2012/08/23/canadian-high-arctic-research-station.

[31] Since the moratorium on its MRS program in 2012 and reductions to its RTI program, NSERC has had a declining role in funding infrastructure.

[32] All other major neutron beam facilities are operated as user facilities and directly funded by governments through organizations. In Canada, a comparable example is the NRC which is mandated by law to operate federal astronomy facilities.

[33] See footnote 16 for past arrangements. A collective funding mechanism for academic access is desired because individual grants are too small to achieve significant cost recovery through direct user fees. In February 2014, CINS applied via McGill University to the CFI Major Science Initiatives Fund for 40% of the CNBC's operating cost. The application was deemed ineligible because the CNBC is affiliated with a federal agency.

[34] In contrast to 'professional neutron scatterers', are the majority of researchers in the neutron beam community who apply many techniques to solve a problem, and who access neutron beams when needed with assistance from CNBC expertise.

emerging as the lead funder of major scientific infrastructure, for both capital and operating costs, a role that was confirmed in the 2015 federal budget with $1.33B over six years for "the ongoing operations and maintenance needs of national research facilities" among other things.[35]

Today, the CNBC is the only academically-oriented user facility[36] that is not operated by the academic sector, apart from federal astronomy facilities due to provisions of the NRC Act. TRIUMF, SNOLAB, and Compute Canada are operated by consortia of universities. The CLS and Ocean Networks Canada (ONC) are operated by non-profit corporations that are wholly-owned subsidiaries of their host universities (U. Sask. and U. Vic. respectively) but are also affiliated with other universities. Smaller facilities are typically operated by their host universities.

In summary, university administrations need to be formally engaged in securing resources for and in on-going governance of user facilities that primarily serve academic researchers. Specifically, academic ownership of such facilities is critical to securing both capital and operating funds from the CFI, which then can be used to leverage matching funds.

Positioning Canadian neutron beam resources within the academic sector via a university-owned VINS addresses the critical issue of eligibility for CFI funding.

The governance of the VINS should reflect a pan-Canadian approach, while reflecting the strong academic interests. The VINS could be formed initially as a consortia or joint venture of a few key universities that seeks to expand to include all universities and other research organizations with significant activity in neutron scattering.

3.5.1 Roles and responsibilities

The consortia members control the VINS through appointing members to the board of directors via majority vote cast by the Vice Presidents of Research or a designate. Members may participate in discussions facilitated by the VINS regarding research priorities and strategies for securing resources. Member should support the consensus positions to ensure that the academic community speaks with one voice.

A lead university should be identified to coordinate efforts, guide initial formation of the VINS, and host the home office. The lead university will also channel funding applications prepared by the VINS to the CFI and other bodies appropriate (i.e. the VINS itself may not be eligible to submit proposals directly).

To ensure that the VINS is operated as a pan-Canadian effort, the board of directors is appointed based on expertise and governance experience, rather than to represent the interests of individual institutions. The board would be responsible to ensure that adequate funds are available to cover all liabilities, so that no costs for its activities are passed on to the members. The board would have fiduciary responsibility for the use of funds and operations of VINS facilities, including activities at the outstations.

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[35] http://www.budget.gc.ca/2015/docs/bb/brief-bref-eng.html

[36] Not only does the CNBC support a primarily-academic community of researchers, but the CNBC also supports the universities' education mission by providing graduate students with one-on-one, hands-on training in conducting the experiments. In addition, the CNBC hosts summer schools open to all students, and hosts groups of students as part of graduate courses at Queen's and McGill.

3.5.2 Management framework

A full-scale VINS needs both scientific leadership and strong project management and operations management, similar to other major scientific facilities (e.g. TRIUMF, CLS). As a user facility, it needs a culture that values helping others to advance their research. These factors suggest the VINS should be managed separately from the host university.

As illustrated below, external scientific advisory committees are needed to inform scientific priorities, complementing the board's expertise on good governance of scientific facilities. The R&D program, focused on beamlines and technique development, would best conducted as a collection of projects, each under a project manager. Activities at the outstations, in contrast, represent the on-going operations of the user facilities and would use a traditional organizational structure. Technical services personnel would support both R&D projects and operations. Administrative staff would assist in operating the VINS in areas beyond what can be provided by the central administration of the host university.

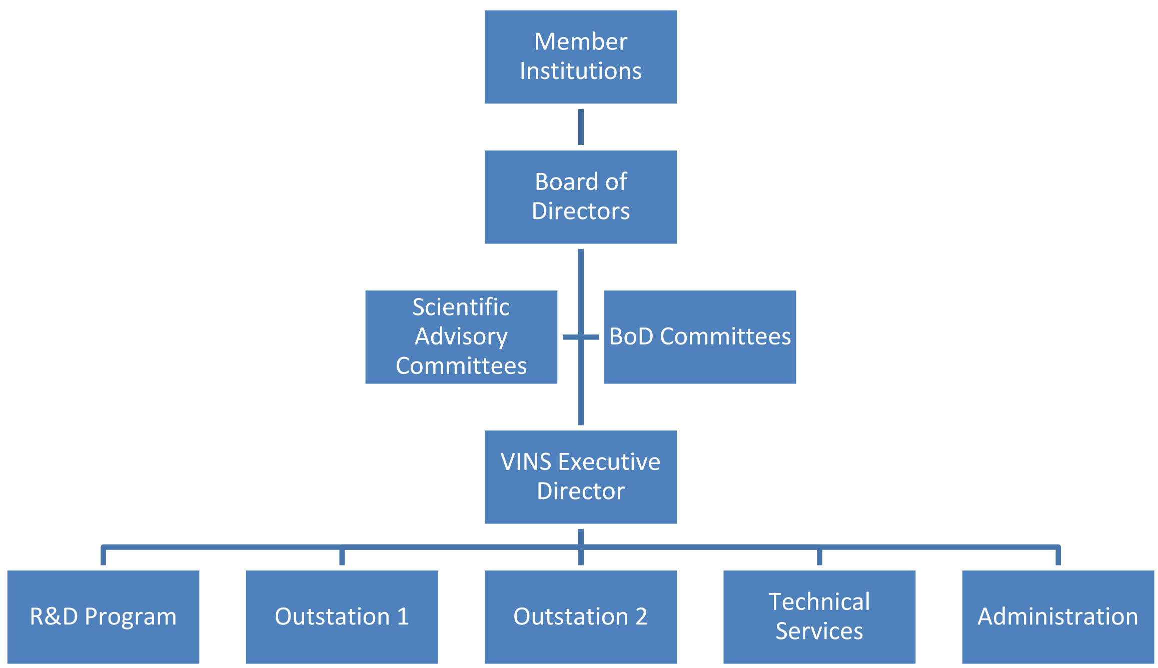

Illustration: Organizational structure of a full-scale VINS

3.6 Timelines for implementation

The following are significant factors in setting an implementation schedule:

- Government decisions about a nuclear innovation agenda or a new research reactor are not imminent, but could be made within a few years.
- CFI Innovation Fund holds competitions approximately every two years for large capital projects. The next competition may be expected in early 2016 following conclusion of CFI's current consultation on its fund architecture. CFI may take a year to complete the competition and award funds (2017).
- The NRU reactor is scheduled to close March 31, 2018.

- Executing capital projects to build beamlines can take up to several years. Moving beamlines from NRU and adapting them to a new source are significant projects, though they may take less time.
- Following construction of beamlines, the next CFI Major Science Initiatives (MSI) Fund competition could begin in 2020 to award operating funds for 2022-2027.

The first window of opportunity to secure funds for a VINS project is the next CFI Innovation Fund competition, which could finance building beamlines and equipment or moving and adapting them to another neutron source. To compete credibly in the competition, a lead university must be identified, discussions with potential partner sources should be held and a plan created for the scope of a CFI–funded project within 6 months. This short timeframe will require that discussions of the VINS should be held parallel to the CFI application.

Initially, a small-scale version of the VINS could be formed with seed funding to establish the core structure and enable it to pursue funding opportunities to be able to perform the VINS's primary activities. Until those resources are available, the VINS can begin to establish its place in the community through associated activities:

- facilitating community input and building a network of participating universities
- organizing fora for scientific networking and policy discussion
- sponsoring or organizing neutron scattering schools and workshops
- building the community through awarding student scholarships or attracting research chairs to member universities
- providing basic user support (e.g. sponsoring travel for students of member universities to conduct experiments at neutron beam labs, assistance in proposal development, analysis and publication of results)

With a successful CFI Innovation Fund award in 2017, the VINS will have a suitable context to begin performing these activities in 2018 during the neutron gap.

Appendix A – The Neutron Beam Community

Each year, over 200 scientists, engineers, and students from universities, government labs, and industry participate in research depending on access to our six neutron beam lines. Over a five-year period, CNBC research participants include more than 700 individuals from over 60 departments in over 30 Canadian universities and from over 100 foreign institutions in over 20 countries. The CNBC enables industrial research in sectors such as nuclear energy, aerospace, automotive, oil and gas, defence, and primary metal production.

Figure 2 Geographic distribution of 35 participating universities over 5 years, as well as 22 countries of foreign institutions, represented by flags.

The CNBC typically provides more than 80% of its beam time for access by external users. Canadian academics are the largest user category and directly use about half of the available beam time each year. About 100 Canadian academics each year are able to participate in research depending on access to foreign facilities, free of charge, because the CNBC grants access to foreign users in exchange.

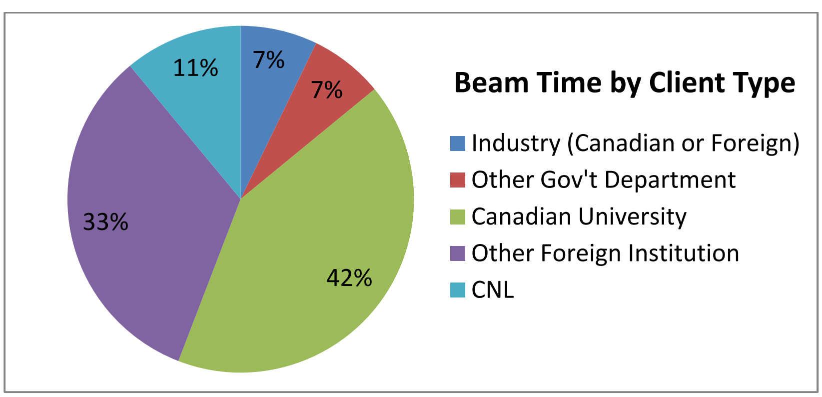

Figure 3 Fractions of neutron beam time allocated to categories of external users (FY2014-15 data). Academics use a large majority of beam time. As shown in Table B1, academics comprise about 2/3 of all foreign users. About half of the beam time granted to industry is for collaborations involving both academics and industrial researchers.

Table B1 Users over four years (FY2011/12-2014/15). Users include researchers who proposed the research granted beam time or were present for the experiment.

Sector	Canadian	Foreign	Total
Academic	145	120	365
Industry	10	13	23
Government	34	26	60
Total	**189**	**159**	**348**

Table B2 Research Participants over four years. Research Participants include users plus co-authors of papers arsing from the research.

Sector	Canadian	Foreign	Total
Academic	208	216	424
Industry	11	16	27
Government	44	128	172
Total	**263**	**360**	**623**

The CNBC's academic clients cover a broad spectrum of disciplines. In 2014, for example, the CNBC's academic research participants consisted of 88 individuals from 30 departments in 19 Canadian universities, distributed across disciplines, as illustrated in Figure 4.

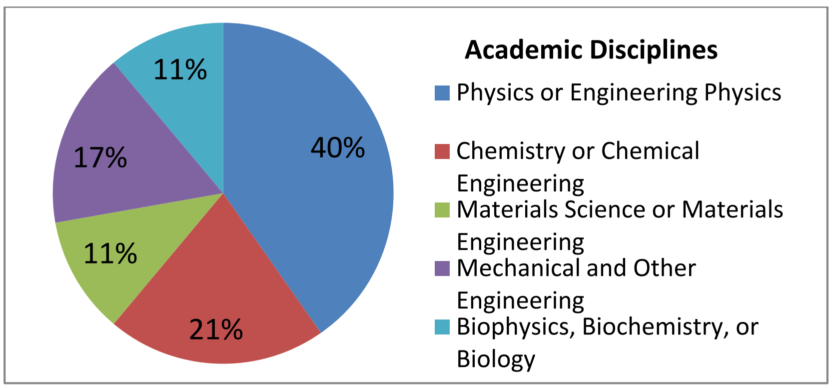

Figure 4 Distribution of Canadian academic research participants across disciplines

Higher education's greatest contribution is in training students in essential S&T skills.[37] Most research professors that access neutron beams for studying materials rely on the local expertise of the CNBC.[38] Typically, over 30 students and postdocs per year visit the CNBC to use the beamlines for their research.[39]

[37] "The research conducted in our universities and teaching hospitals educates students in advanced fields of knowledge. Some will become the researchers of tomorrow. Others will follow a range of practical pursuits in all sectors of the economy." Industry Canada. *Mobilizing Science and Technology to Canada's Advantage*. 2007. pp.35-36.

[38] For example, most research professors that are neutron beams users are experts in particular problems in engineering, physics, chemistry, or biology, and in several methods of studying materials that underlie these problems, but most do not use neutron beams frequently enough to fully specialize in applying neutron beams to study materials. With nearly every academic proposal, one or more students are advancing their research skills through interacting with local experts regarding the conceptual design, sample preparation, conducting the experiment, or interpreting the data and publishing the results.

[39] In 2011-2014, there have been 242 visits by 137 students and 20 post-doctoral fellows for research and education purposes, many of whom visited more than once.

Appendix B – Key Universities

Following is a list of key universities with interest in neutron beams. Names of key principal investigators are listed[40]. These researchers have collectively benefitted from about $25M-worth of access to the CNBC over 5 years to advance their research programs, free of direct charge.

McGill University

McGill has benefitted from $5.4M-worth of access to the CNBC over 5 years to advance the research programs of Stephen Yue (Materials Engineering), Chris Barrett (Chemistry) and Dominic Ryan (Physics). Because Prof. Ryan was President of CINS, he held the NSERC Major Resources Support grant for 2007-2012 that supported access to the CNBC, and McGill administered the funds valued at $1.3M/yr. McGill supported the grant renewal application in 2012 and a recent application to CFI for $4.4M/yr in operating funds for the CNBC. The McGill Centre for Physics of Materials sponsors a physics graduate course on research techniques (PHYS-659) and relies on the CNBC for hands-on demonstration of neutron scattering methods.

McMaster University

McMaster has benefitted from $6.2M-worth of access to the CNBC over 5 years to advance the research programs of Bruce Gaulin (Physics), Graeme Luke (Physics), Maikel Rheinstadter (Physics), Cecile Fradin (Physics), John Greedan (Chemistry), and Peidong Wu (Mechanical Engineering). Prof. Gaulin is a former President of CINS and of the Neutron Scattering Society of America. The CNBC complements facilities at the Brockhouse Institute for Materials Research of which he is the Director. The CNBC recently assisted Prof. Gaulin to build a CFI-funded neutron beamline at the McMaster reactor, and is now helping to build a second beamline funded at $7M by CFI. McMaster's AVP-Research, Fiona McNeill, is a former neutron scatterer. McMaster also has broader interests in nuclear S&T through its nuclear engineering and nuclear medicine programs.

University of Saskatchewan

The University of Saskatchewan (U of S) has benefitted from $330K-worth of access to the CNBC over the past two years to advance the research programs of Ian Burgess (Chemistry). Although new to neutron beams, U of S has a strong record in materials research via the Canadian Light Source (CLS), and is a key player in helping the province to achieve its goal of expanding its expertise and capabilities in nuclear S&T. In 2009, the U of S formally expressed interest in a hosting a neutron source on its campus that would complement the Canadian Light Source[41]. In 2011, the provincially-funded Fedoruk Centre was formed as a subsidiary of U of S to place Saskatchewan among global leaders in nuclear research, development and training. One of the Centre's activities is to fund research in Saskatchewan that uses nuclear-based methods, such as neutron beams.

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[40] E.g. those who accessed the CNBC in FY2011-12 to FY2013-14.

[41] "The Canadian Neutron Source." July 2009. Accessed from: http://cins.ca/reports.html.

University of British Columbia

UBC has benefitted from $2.4M-worth of access to the CNBC over 5 years to advance the research programs of Warren Poole (Materials Engineering), Lukas Bichler (Materials Engineering), Chad Sinclair (Materials Engineering), Doug Bonn (Physics) and Walter Hardy (Physics). The CNBC supports MAGnet, an NSERC network led by Prof. Poole, and recently hosted a post-doc to support MAGnet research projects requiring access to the CNBC. The CNBC supported projects led by Prof. Bichler as part of AUTO21, an NCE network.

Dalhousie University

Dalhousie University has benefitted from $1.5M-worth of access to the CNBC over 5 years to advance the research programs of Ted Monchesky (Physics and Atmospheric Science), and Paul Bishop (Process Engineering and Applied Science). The CNBC complements facilities such as the Institute for Materials Research. The President of Dalhousie, Richard Florizone, is familiar with the CNBC and the need for a new research reactor for Canada, having recently served as VP-Finance at U of S, where he participated in the province's uranium development partnership project, articulating the value of materials research with a research reactor, provided executive support for the establishment of the Sylvia Fedoruk Canadian Centre for Nuclear Innovation, and discussed the possibility of a new "Canadian Neutron Source" at the U of S with CINS members at their annual general meeting in Saskatoon in 2010.

University of Alberta

The University of Alberta has benefitted from $2.8M-worth of access to the CNBC over 5 years to advance the research programs of Hani Henein and David Mitlin (both from Chemical and Materials Engineering). The CNBC complements facilities at the National Institute for Nanotechnology. The President of U. Alberta, Indira Samarasekera, is a former neutron scatterer. U. Alberta has shown leadership in supporting user facilities sited elsewhere by contributing to the Canadian Light Source.

Queen's University

Queen's has benefitted from $4.0M-worth of access to the CNBC over 5 years to advance the research programs of Lynann Clapham (Physics), Rick Holt (Emeritus, Materials Engineering), and Mark Daymond (Materials Engineering). Prof. Clapham is Associate Dean (Academic). An engineering graduate course on research techniques (MECH-851) relies on the CNBC for hands-on demonstrations. Queen's U. also has broader interests in nuclear S&T through its nuclear engineering programs.

Western University

Western has benefitted from $2.4M-worth of access to the CNBC over 5 years to advance the research programs of David Shoesmith, and Clara Wren (both from Chemistry). Western University also successfully led a CFI-funded proposal, supported by 12 universities, to build a $2.4M neutron reflectometer at the CNBC, which was completed in 2007. The CNBC operates the reflectometer as part of its suite of 6 beamlines for access by the user community. The CNBC complements facilities at Surface Science Western.

CANADIAN NEUTRON BEAM CENTRE
Probing Materials for Science and Industry

Update on AECL Restructuring and the Canadian Neutron Beam Centre

Annual General Meeting of the Canadian Institute for Neutron Scattering

University of Saskatchewan *November 14, 2015*

John.Root@cnl.ca

Timeline of Events affecting CNBC

Date	Event
2013 Mar	**MOU 2013-2015**: AECL and NRC agreed to maintain the CNBC until a federal government decision about a 'nuclear innovation agenda'. NRC provided resources. AECL operated and covered all costs of CNBC.
2014 Nov	AECL nuclear laboratories was divided: • Canadian Nuclear Laboratories Ltd (CNL), a private company • AECL, a small Crown Corporation
2015 Feb	**The federal government announced its plan to close NRU in 2018**
2015 Jun	Canadian National Energy Alliance (CNEA), a consortium of private companies, was identified as the preferred bidder to manage CNL
2015 Aug	CNL created a Neutron Scattering Branch (NSB)
2015 Aug	Half of the CNBC staff resigned from NRC, accepting positions with CNL
2015 Aug	**MOU 2015-2019**: CNL and NRC agreed to maintain the CNBC 'for the anticipated operating life of the National Research Universal (NRU) reactor.'
2015 Sep	The sole share of CNL was transferred from AECL to CNEA

What CNEA and CNL are expected to do

Canada's Objective is that the Contractor will "...significantly transform AECL's Nuclear Laboratories to ensure that [Canadian Nuclear Laboratories] leverages its capabilities and resources to successfully: **deliver nuclear S&T-related products and services to government and third-party customers**, and fulfil decommissioning and waste management needs, collectively the 'Primary Missions', while containing and reducing costs and financial risks for Canadian taxpayers over time."

CNEA Shareholders:

- CH2M Hill Canada Limited
- EnergySolutions Canada Group Ltd
- SNC-Lavalin Inc.
- Fluor Government Group - Canada Ltd

What CNBC is expected to do until NRU closes

CNBC: John Root

Enable hundreds of users to apply uniquely powerful neutron instruments and methods to advance programs of materials research and development.

CNL – NSB:

Mike O'Kane

Ron, Helmut, Zahra,Dimitry, Michael, Chad, Raymond, Roxana

CNL – Other

PDFs: Syed, Julien, Ahmed

AP: Lee

CLT: Harry

412: Randy

NRC (cnbc):

John Root

Daniel, Dave, Derrick,Jimmy, Mark, Niki, Shutao, Zin

Neutron beam lines: C5, C2, D3, E3, L3, N5

Ancillary Equipment

Resources, 2015 Nov 1

Principles

- Safe workplace
- Cohesive, synergistic team, aligned with CNL direction
- Maximizing the value and impact produced by NRU until it shuts down

Membrane bioelectricity – **U of S**

CNBC Challenges

- Retaining the staff complement for sustainable operation
- Maintaining staff morale and cohesion
- Sustaining high performance in times of uncertainty
- Fostering a vigorous and engaged user community
- Establishing partnerships to support a user-facility mission
- Settling a roadmap for the future of neutron scattering in Canada

Gaps in the CNBC staff complement have accumulated since ~2010

April 1, 2015	Sci. & Eng.	Tech.	Mgt / Admin	Post-Docs	**TOTAL**	Students	Emeritus
Full Strength	14	11	3	2-5	**28 + Post-docs**	1	1
Gaps	4	4	1	< 3	**9 + Post-docs**		

What can CINS and its members do?

Honour the CINS Objectives

✓Encourage Canadian scientists to persist boldly, as CNBC users.

- Organize schools and workshops.
- Reach out to new users, students, and industry collaborators.
- Communicate, advocate, collaborate, participate, facilitate ...

✓Seize this leadership opportunity.

- Help bridge the coming neutron gap, sustaining community capability.
- Renew Canada's future capabilities for materials research with neutron beams.
- Participate in national conversations and decision-making processes.
- Express support and thanks to your colleagues at Chalk River.

✓Lead, support, coordinate proposals for the tools we need:

- A world-class neutron source;
- World-class neutron beam instruments; and
- The operating support and framework that is most effective for users.

✓Earn credibility: be responsible, respectful, resourceful.

Status of Neutron Scattering in Canada

Chris Wiebe, CINS President

Closure of NRU in 2018

- On Feb. 6, 2015, it was announced that the NRU would shut down in 2018
- John Root has outlined some of the issues associated with this (and the new contractor taking over operations, CNEA).
- While this is a very frustrating and stressful situation for us all, in some sense it provides an opportunity for growth. However, this opportunity will need (1) a clear vision for a future source and (2) a plan to manage the "neutron gap" in the near future.

THE GLOBE AND MAIL

CHRIS WIEBE

Investments in Canadian labs win Nobel Prizes

CHRIS WIEBE
Contributed to The Globe and Mail
Published Tuesday, Oct. 06, 2015 5:59PM EDT
Last updated Tuesday, Oct. 06, 2015 6:01PM EDT

Chris Wiebe is president of the Canadian Institute for Neutron Scattering and Canada Research Chair in Quantum Materials Discovery, University of Winnipeg.

On behalf of the Canadian neutron scattering community, I would like to congratulate Arthur McDonald and Takaaki Kajita for their 2015 Nobel Prize in Physics. Their discoveries of neutrino oscillations and neutrino mass have forever changed the landscape of modern physics. It is worth noting that Dr. McDonald, a Canadian, completed much of his work using the Sudbury Neutrino Observatory.

We, as Canadians, should be proud of his accomplishments, which were made possible only with key investments in national laboratories. Canada has a proud tradition of supporting such large science initiatives, which have paid off in not only Nobel Prizes, but also in the advancement of knowledge and the development of new technologies.

On Feb. 6, 2015, the federal government announced the shutdown of the National Research Universal (NRU) reactor at Chalk River, Ont. The decommissioning process will begin after March 31, 2018, ending an era of nuclear research and economic development in this region that started in 1957. Without a clear nuclear science agenda, it is uncertain how Canada will carry on with nuclear science.

Full article has been posted to the CINS website: www.cins.ca

Mind the gap!

- The neutron "gap" is real and needs to be addressed as soon as possible.
- Keeping neutron scattering talent in Canada has been one of my top priorities.
- (1) VINS meeting – Saskatoon, summer of 2015. This was also a first step in assembling a **consortium** of universities together in supporting a new source.
- White paper produced (presented last night).
- (2) McMaster reactor expansion could also allow for more instruments and staff at Mac (see upcoming talks).

Other options

- Zin Tun will be giving a presentation later on his report that he prepared for CINS on new neutron sources.
- Several CINS Board members have been involved with discussing Canada's presence at foreign sources. Bruce Gaulin has talked to NIST and the ORNL.
- Canadian presence at the ORNL: currently Canada has increased access to SNS instruments (VULCAN, SEQUOIA, and ARCS). This access will end soon (2018?). Funding will be needed to continue to have this access. Possibility for Canadian scientists at ORNL more permanently?
- NIST: Bruce has started preliminary talks with Dan Neumann to have increased Canadian access to the NCNR.
- John Root is also exploring arrangements with other sources (ILL). Buying a share? (1 % of ~50 beamlines?)

A lesson from astronomers

- The CINS community would benefit from looking at other scientific disciplines support “big science” projects.
- When astronomers want a telescope, all of the interested parties have a consistent vision that they present to funding agencies (led by a consortium of universities).
- This is what we need for a new source – a consistent vision. The vision can evolve over time, but we need universities to be on the same page and form a consortium (with several lead institutions).
- Saskatchewan and McMaster have recently made steps to take leadership positions for a new neutron source in Canada.

The planned Thirty Meter Telescope (artist rendition) that the federal government recently supported For $243.5 M/10 years (announced April 6, 2015).

CAP Meeting

- CINS had a presence at the CAP meeting this year (Edmonton, AB)
- We had three sessions – John Root gave an update to the community. We also had a chance to speak at the Science Policy meeting, and a meeting with the CAP executive.

Results from CAP

- (1) CAP support of a new source
- (2) CAP resources – lobbying!
- (3) Special edition in PiC about neutron scattering at Chalk River
- General information – the community was not well informed, in general, about what is going on at Chalk River
- Connection made with Ted Hsu as a possible future Board Member (very positive)

Workshop and summer schools

- No summer school in 2015 – to resume in 2016
- Two workshops have been proposed – the first on magnetism to be held in February 2016 (reading week: Feb. 16 – 20)
- We decided this year to have a different sort of educational experience – more concentrated workshops that can have more research focus.
- The next one will likely be in biomaterials or applied materials science.

Other activities

- CINS LRP update: The CINS LRP has been type set and needs one last read through before distribution. This will happen over the next few weeks and then be published to our website.
- Revision of by laws – more on this in the business section of CINS
- I have been reaching out to MPs (pre election) to educate them on neutron sources in Canada. I had some success with a meeting with Lawrence Toet (Conservative MP). Of course, there is a new government now.
- We need to make contact with the new government as soon as possible to articulate our vision. They are looking for ready projects!

Business meeting agenda

- (1) Approval of agenda
- (2) Treasurer’s report
- (3) Science Council report on by laws
- (4) Election of Science Council members
- (5) Other business

Ad hoc Committee on Options for Neutron Sources in Canada

Report to the CINS membership
June 2015

1. Introduction

The *ad hoc* Committee on Options for Neutron Sources in Canada[1] was formed at the 2014 AGM following an extensive discussion on future neutron sources for Canada. The discussion was supported by an overview of options prepared for the membership.[2] The Committee's mandate was to explore the cost and benefits of the identified options, and report back in the new year, with recommendations that may affect the next edition of the long range plan.[3]

This report contains information obtained from publically accessible websites, and from communications with employees of Canadian Nuclear Laboratories (CNL, the organization that now operates Chalk River Labs), McMaster University, TRIUMF, the Canadian Light Source, KAERI (South Korea), and INVAP (Argentina).

The most significant development for CINS since the 2014 AGM is the announcement by the Government of Canada to permanently shut down the NRU Reactor in March 2018.[4] The Committee thus felt it necessary to present their recommendations in the form of an action plan. The plan is subdivided into two periods: now to 2018, and the long range plan beyond 2018.

We hereby invite feedback from the general membership on the action plan. Your views can be communicated to the Committee via the CINS Science Council by email to council@cins.ca.

2. Possible Neutron Sources for Canada

The Committee found all options discussed at the 2014 AGM are feasible, though some are more practical or desirable.

2.1 A multi-purpose research reactor at Chalk River

In response to the announcement of the 2018 NRU shutdown, CNL is conducting an assessment of the business case for a new neutron source. If CNL pursues a new neutron source it would likely be a multi-purpose research reactor because of its interests in in-core irradiation of fuels and materials as services to industry. However, the planning is at a very preliminary stage and

[1] The committee is composed of a chair and the members of the science council: Zin Tun (chair, Canadian Neutron Beam Centre), Chris Wiebe (U. Winnipeg), Jamie Noel (Western U.), Maikel Rheinstadter (McMaster U.), Zahra Yamani (Canadian Neutron Beam Centre), and Harlyn Silverstein (U. Manitoba).
[2] Zin Tun. Possible Neutron Sources for Canada beyond NRU Reactor: A Review prepared for Discussion at CINS AGM 2014. http://cins.ca/meetings/2014/4p1_n_sources_review_ZT_oct30.pdf
[3] See 2014 AGM minutes: http://cins.ca/docs/agm2014/CINS%20AGM%202014%20Minutes.pdf.
[4] See discussion and links to original sources provided at: http://cins.ca/news.html#NRU-closure-2018.

CNL does not view a decision on a new reactor as imminent. Given the long lead times generally required for building a reactor, this Committee estimates that a new neutron source at Chalk River, if built, will not be operational until 2028 or later.

2.2 The Saskatchewan initiative

In 2010, the Government of Saskatchewan and the University of Saskatchewan jointly proposed to the Federal Government to build a research reactor in Saskatchewan for neutron beams and medical isotope production.[5] In the proposal, Saskatchewan will contribute 50% of the project development cost, 25% of the construction cost and another 25% of the operating cost of the facility. At the time, the Federal Government was considering various ways of producing medical isotopes, and responded to the idea of a new research reactor, thus:

> A research reactor serves many missions. The need for a new reactor for these other purposes would need to be based on a thorough assessment of the missions, including neutron scattering and R&D for the nuclear industry, and consideration of the appropriate sharing of costs among the many users and beneficiaries of such a facility. This assessment is outside the scope of this response.[6]

Subsequent communications from Natural Resources Canada (NRCan) indicated that the federal government needed to complete related tasks before it would have the resources to consider a new reactor.[7] Thus, the Saskatchewan initiative is believed to be on hold at least until the restructuring of CNL is complete.

On the provincial side, Saskatchewan has pursued complementary initiatives in the meantime to develop nuclear capabilities through the establishment of the Fedoruk Centre. Thus, we believe that the province is still genuinely interested, though some details of the original proposal may no longer be up to date.

The Saskatchewan proposal is modelled after the Australian OPAL Reactor, supplied by INVAP of Argentina. INVAP confirmed to us that they are keen to supply a turn-key facility to Canada. For the reactor, cold source, two initial guides and the guide hall building, but excluding instruments is estimated to be in the range $300 - 500M (US). These numbers are consistent with those used in the 2010 Saskatchewan proposal.

Another active reactor vendor globally is KAERI, South Korea. KAERI indicated to us that they also are interested in building a research reactor for Canada. However, KAERI is building or upgrading reactors in three different countries and estimates that it will be another 5 years before it could take on a new international project.

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[5] Government of Saskatchewan. The Canadian Neutron Source: Securing the Future of Medical Isotopes and Neutron Science In Canada. July 31, 2009. http://www.gov.sk.ca/adx/aspx/adxGetMedia.aspx?mediaId=883&PN=Shared

[6] Natural Resources Canada. Government of Canada Response to the Report of the Expert Review Panel on Medical Isotope Production. March 31, 2010. http://www.nrcan.gc.ca/energy/uranium-nuclear/7795.

[7] For example, in NRCan's presentation at the Canadian Association of Physicists Congress in June 2010, it confirmed that the restructuring of AECL (now CNL) would be dealt with first.

2.3 A new core for McMaster Nuclear Reactor

The McMaster Nuclear Reactor (MNR) upgrade discussed at the AGM was based on the 1993 proposal by the University.[8] Since the proposal calls for replacing the current core with a MAPLE-type core, it requires a vendor who is experienced in the MAPLE technology and is willing to retrofit a new core in an existing reactor. The second requirement is not trivial; most vendors would rather build a new reactor than do a one-time retrofitting project.

The original developer of the MAPLE technology was AECL, which has been divided into Candu Energy and CNL. CNL operates the research facilities at Chalk River, and is expecting new management later in 2015. Approaching CNL to inquire about revitalizing the MAPLE technology for a project like upgrading MNR will thus need to wait for another one year or so.

Another reactor vendor experienced in the MAPLE technology is KAERI. KAERI might consider supplying a MAPLE core, but is more likely to be interested in supplying a new reactor to Canada. However, as stated above (Sec 2.2), due to their current work load, they will not be able to start working on the project for next 5 years. KAERI indicated that knowing the preliminary timeline would be useful for their long range planning.

Renewed interest by the CINS Science Council in a McMaster upgrade led us to consider if a higher flux could be obtained by reconfiguring the current core. By scaling the flux/power ratio inversely with the ^{235}U inventory in the core, it is estimated that a core of 9×6 $inch^2$ footprint and 8 inch height will yield an unperturbed core flux of 2.6×10^{14} $neutrons/cm^2/sec$ at 6 MW thermal power. For such a small core to achieve criticality, the fuel must be surrounded by a beryllium reflector. CNL is interested in this idea, not only for the possibility of the MNR upgrade but also as a basic concept for new small high-brilliance neutron sources. In the 2015/16 fiscal year, CNL plans to do a generic feasibility study on this concept. If proven feasible, this will be an attractive option; however, prior acceptance by the University and approval by the Reactor Operations are required to apply this idea specifically to MNR.

2.4 Spallation sources

Unlike a research reactor, no contractor is able to build a turn-key spallation neutron facility. This is because the expertise required for various components is so diverse and each highly specialized. Consequently, the construction must be managed by a group of in-house scientists and engineers. Many subsystems can, and will be contracted out, but the overall design authority rests with the host organization.

In Canada, two prime locations with required expertise are CLS (Saskatoon) and TRIUMF (Vancouver). In addition, pockets of expertise exist in various Canadian universities and private companies (for example, the BC based company EBCO Industries) that could potentially design and build the required accelerator. Augmenting this are scientists and engineers whom could be attracted to Canada from other countries for specific technologies (e.g. liquid spallation target). Hence, a spallation source in Canada is technically feasible.

[8] A Proposal to Upgrade McMaster Nuclear Reactor. October 8, 1993. http://cins.ca/docs/MNR_1993.pdf.

This Committee has contacted the Directors of CLS and TRIUMF for more information. The direct quotes extracted from the replies effectively summarize the current thinking at these facilities with respect to building a spallation neutron source.

Response from CLS

> The provincial government still remains very favorable to "things nuclear" as evidenced by the establishment of the Fedoruk Centre here at the University. With the recent success of accelerator production of medical isotopes the focus is back on accelerators as well.
>
> However, for neutron scattering, the province is more likely to be supportive of a research reactor instead of a spallation source.

Response from TRIUMF

> If the science case for a DC source is compelling, then Canada should consider building such a facility. But if the science can be addressed only at a pulsed facility, Canada is better off using SNS. It would be very hard to justify building a lesser facility in Vancouver given that Canada has already made contributions to SNS.
>
> TRIUMF's highest priority over the next five years is completion of ARIEL, our new rare isotope ISOL facility. Beta NMR will be among the first science capabilities enabled by ARIEL. Beta NMR is complementary to neutron scattering because it measures magnetic properties locally in position space, as opposed to momentum space. TRIUMF will certainly be working to grow its user community in this important area. Beta NMR does not replace neutron scattering, but it does open up new opportunities for material characterization.
>
> What's beyond ARIEL? TRIUMF will start thinking about that in the next year or so, in close collaboration with the Canadian community. There are lots of ideas on the table, and there is no reason why a DC neutron source could not be among them. At its core, TRIUMF responds to the needs of the Canadian university community. If the community decides that such a source is the next move, we will respond appropriately.

The responses above indicate TRIUMF is open to the idea of considering a spallation neutron source. When the TRIUMF management starts thinking of what they should do beyond ARIEL by 2016, CINS should be ready to make a meaningful input. As such, we need to have settled the "pulsed vs. DC source" question within a year.

3. The Path Forward – a Recommendation

In light of the announcement for NRU shutdown in 2018, CNL is planning for a 'neutron gap'. Further, CNL plans to take full advantage of the remaining three years of NRU operation to maximize benefit from the reactor, and will continue operating the Canadian Neutron Beam Centre (CNBC). It is expected that the CNBC will continue to offer access to neutron beams to the user community, to the maximum extent possible through March 2018.[9]

The Committee has developed an action plan to preserve the Canadian neutron scattering program based in Canada beyond 2018. We believe the plan will lead to retention of neutron scattering expertise while minimizing disruption in the user support currently provided by the CNBC at Chalk River.

The plan outlined below is a recommendation by this Committee. The Committee is seeking feedback, comments and suggestions through an iterative consultative process to arrive at a plan that can be ultimately approved by the CINS board and the membership.

The text below is written in its final form if no modification is needed. As such, the phrase "CINS recommend", for instance, means "the majority of CINS members recommend".

3.1 Immediate Action Plan – Now to 2018

1. After the announcement of new management for CNL, which is expected in mid-2015, CINS will collaborate with CNL or universities interested in neutron scattering to explore how part of the CNBC's operations at Chalk River can be moved to MNR. The goal is to obtain approval in principle from McMaster University to host national research infrastructure with the reactor operating at full power and on a 24-hour basis, subject to funding availability (see point #4) and negotiation of formal agreements between all stakeholders.

2. With its relatively low flux, MNR is unlikely to be able to fulfill all the requirements of CINS users. Hence, CINS will collaborate with CNL or universities interested in neutron scattering to work out a plan, separate from point #1 above, to transfer part of CNBC's operations to a foreign source. Oak Ridge National Laboratory (ORNL) is the most logical location since Canada has already made significant contributions to two instruments at SNS, namely VULCAN and SEQUOIA and these instruments are aligned with two of Canada's areas of expertise in neutron scattering: quantum materials and metallurgical materials engineering.

3. Though CINS members may be interested in access to all types of instruments at both SNS and HFIR, for the period leading up to 2018 CINS should focus on securing access to VULCAN and SEQUOIA as high priority items. To enable a smooth transition, we recommend that those who may support or use these instruments after 2018 seek to gain operational experience by performing experiments on them before the NRU shutdown.

4. Significant funds will be required for capital projects (acquiring, upgrading or relocating and adapting equipment) and for operations beyond 2018. CINS will play a role in identifying potential funding sources, preparing the required applications, and securing the support of our university administrators. We, the members, pledge to take part proactively in these activities. The amounts needed may be on the order $5-10M for capital and $10M annually for operations.

[9] See discussion and links to original sources provided at: http://cins.ca/news.html#NRU-closure-2018.

CINS will seek to play a stronger role in the governance of the resulting facilities for neutron beams, which may include oversight of funds and operations.

5. CINS support CNL's plan to use NRU to its full capacity to the end. We recommend that no spectrometer parts or ancillary equipment needed at NRU be transferred to MNR, or to any off-site location, prior to the final shutdown.

6. The spectrometer structures designed for NRU are not suitable for MNR. Even though most of them will fit physically, they will encroach into the adjacent beam port areas. Also, moving neutron activated spectrometer components is not easy (and expensive). Thus, CINS should support projects to build or upgrade instruments at MNR where moving them from NRU is more difficult or inconsistent with point 5.

7. To ensure a smooth transition, the following three instruments should be given high priority to be in operation at MNR by 2018:

- MacSANS, a new CFI-funded small-angle neutron scattering (SANS) instrument, which is currently in the design stage and is planned to be complete in 2018.
- An upgraded McMaster Alignment Diffractometer (MAD) that can be configured as needed, either as a reflectometer or as a diffractometer.
- A new powder diffractometer with a very large multi-wire detector.

Together with the two ORNL beamlines identified above, this suite of five instruments would be well aligned with the distribution of Canada's areas of expertise in neutron scattering.

8. For the powder diffractometer at MNR, a 1200-wire detector with 0.1°-resolution, if available, is recommended for two reasons: it will help to compensate for the relatively low flux of MNR, and also simplify the instrument design by not requiring the ability to move to cover a sufficiently large range of 2θ.

9. Options to increase core flux at MNR should be actively explored. Of particular interest are ways of increasing the flux without a long shutdown of MNR (for example, by reconfiguring, rather than replacing, the core). In the interest of avoiding another major disruption, the upgrade, if feasible, should be delayed at least for a few years beyond 2018.

3.2 Planning for 2018-2028 and beyond

The resources established at MNR and ORNL should collectively act as the national neutron scattering infrastructure for Canada that continues to welcome both Canadian and international users.

CINS should continue to pursue a sustainable neutron scattering program for the long term. To this end, CINS's activities should include the following:

1. Continue efforts towards building a new neutron source in Canada, whether a research reactor or a spallation source.

2. Be an active partner with other stakeholders in any effort to pursue a new neutron source. It is anticipated that by 2020 CINS will have a demonstrated track record of participating in operations of a user facility on a modest budget (Section 3.1, point #4). This will enable CINS to make a meaningful contribution to this partnership.

3. Determine the source requirements, for example, in the case of a spallation source: pulsed vs. DC source (within the next 2 yrs).

4. If reconfiguring the MNR core to increase neutron flux is shown to be feasible without a long shutdown, partner with other stakeholders to secure funds for the project.

5. Maintain the momentum to upgrade MNR to a much higher flux (complete replacement of the core as proposed in 1993). Explore whether a partnership between CNL and KAERI makes sense, and if the MAPLE technology is still the best solution. Upgrading MNR to a higher flux level and installing a cold-source are highly desirable. However, the upgrades should ideally happen after Canada has built another major neutron source. A strategy based on two neutron sources is required to avoid another neutron drought in Canada.

McMaster University

CINS
CANADIAN INSTITUTE FOR NEUTRON SCATTERING

McMaster University Nuclear Facilities Overview

McMaster Nuclear Reactor

Chris Heysel
Director
Nuclear Operations and Facilities

Nuclear Facilities at McMaster

1) **Nuclear Facilities at McMaster - MNR**
2) **The Present**
3) **The Future**
4) **The Gap**
5) **Summary**

McMaster University

McMaster University

- Medium sized, research intensive university located in Hamilton, Ontario
- About
  - 23,000 full time undergraduates
  - 3,500 graduate students
  - 7,000 staff
- Research Budget ~ $400 Million annually
- Total Operating Budget close to $1 Billion annually

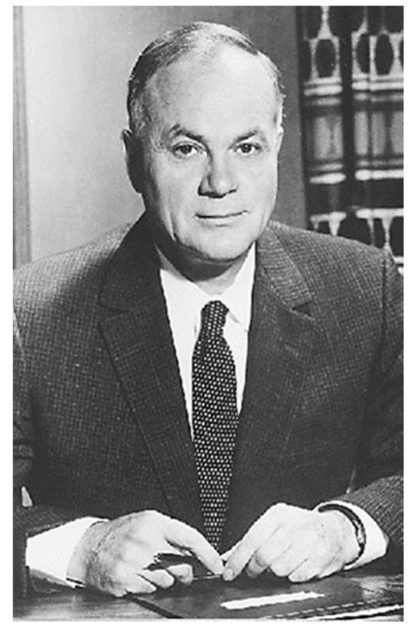
McMaster – Unique Nuclear Infrastructure

Nuclear Facilities	7	1 Research Reactor w. Isotope Production Facilities 3 Accelerators 2 Class II Irradiators 1 Cyclotron Production and Research Facility State of the Art High Level Lab Facility - 24000 sq ft
Other CNSC Licenses	2	Consolidated Radioisotope Human Research Studies
Radioisotope Lab Permits (highest current project approval)	248	210 Basic 19 Intermediate 5 High 14 Sealed Source and Device
Approved Projects	179	NSERC, CIHR funded studies (basic science, health and preclinical experiments)
Authorized Users/Workers	868	Internationally recognized Health Physics training and support programs

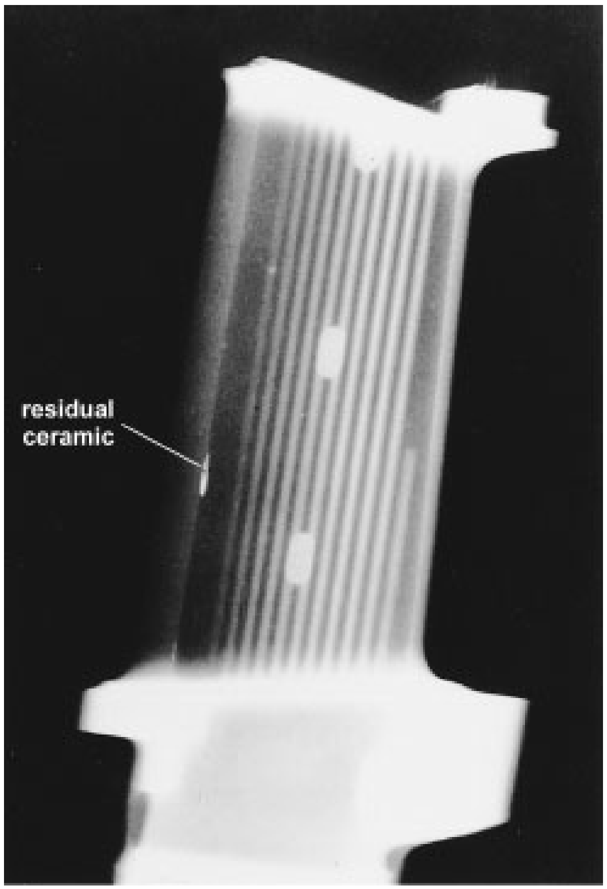
McMaster University

MNR – The Beginning

- The first dedicated research building on campus was the Nuclear Research Building (opened in 1950)
- 1951 – Clinical research lab for use of isotopes in medicine was established
- Dr. Thode recognized the importance of a nuclear reactor on campus for research and education – by Fall of 1955 it was decided that a reactor was essential to expansion of science programs, to support the planned engineering school and to establish isotope development and production
- Successfully lobbied and secured funding by June 1956 (Cost ~$2 M)
- MNR was the first nuclear reactor on a university campus in the British Commonwealth
- First went critical in April 1957



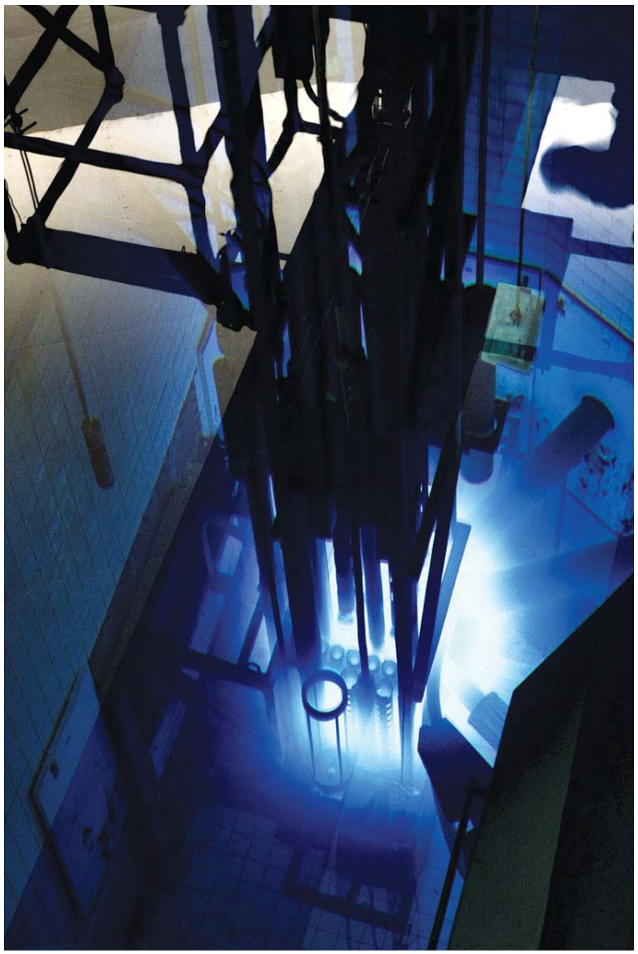
McMaster Nuclear Reactor Missions



MNR Supports Aircraft Safety

- Education: Students from Physics, Engineering, Chemistry, Geology, Medical & Health Physics and Health Sciences use the facility – “hands-on” educational experience
- Research: 100 Canadian and International Researchers
- Industry Support: Dozens of companies use the analytical services provided by the reactor
- Community Outreach: Over 2500 visitors each year
- Commercial Activities: Support and enable R&D and education (self sufficient – no government or University funding)
- Local Economic Impact: 35 Direct Jobs and about >250 Indirect Jobs

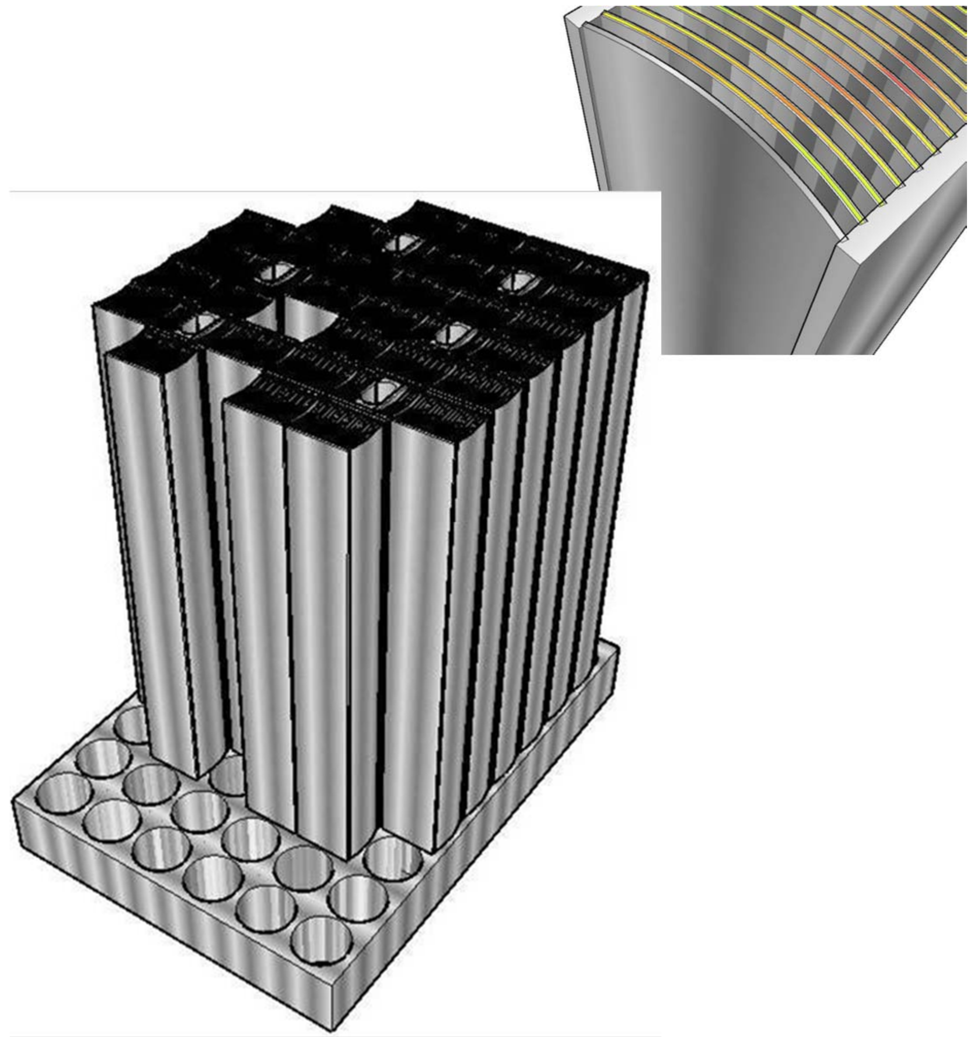
McMaster Nuclear Reactor



- Full Concrete Containment Structure
- Current Ten Operating Licence (2024)
- 5 MW MTR Design
- Currently 3MW 16x5
- Array of research facilities
- Flexible research and education tool
- Provides medical and industrial isotopes
- Operating Efficiency = 85%

MNR Core

- 9 x 6 grid
- 6 control assemblies
- 28-31 standard assemblies (LEU)
- 1 Regulating Rod
- 5 Shim-Safety Rods held by electro-magnets
- ~5.3 kg U-235 in operating core



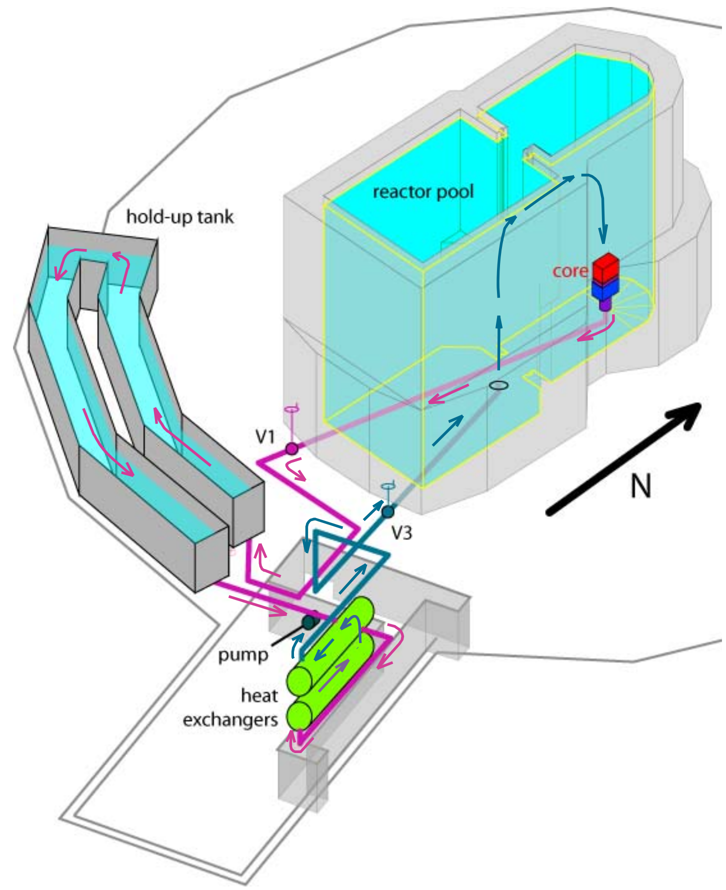
Reactor Coolant Primary Circuit

- Sub-cooled pool water flows by gravity (drains) through reactor core (400,000 litres)

  Downward flow is passive

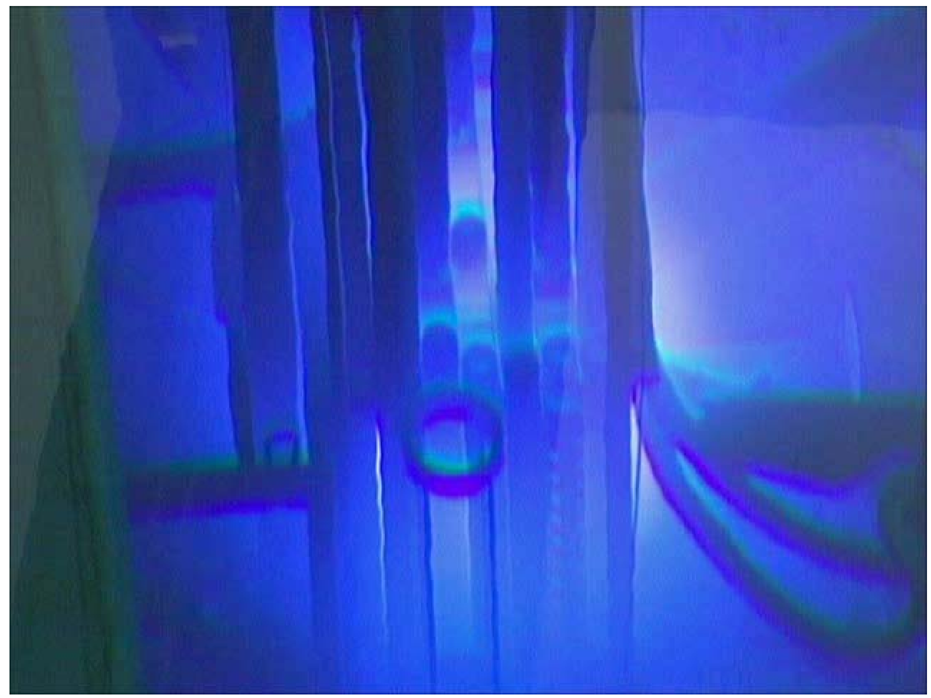
- Pool water provides cooling and shielding
- Heat Exchangers remove the heat of fission

  Forced flow required for significant power increases



Core and Irradiation Facilities

- 6 radial beam tubes
- 1 in-core high flux site
- 7 graphite & 1 Be irradiation reflectors
- Numerous Isotope Production Sites
- 3 “rabbit” terminals
- Pass-through to a 10kCi (^{60}Co) connected Hotcell

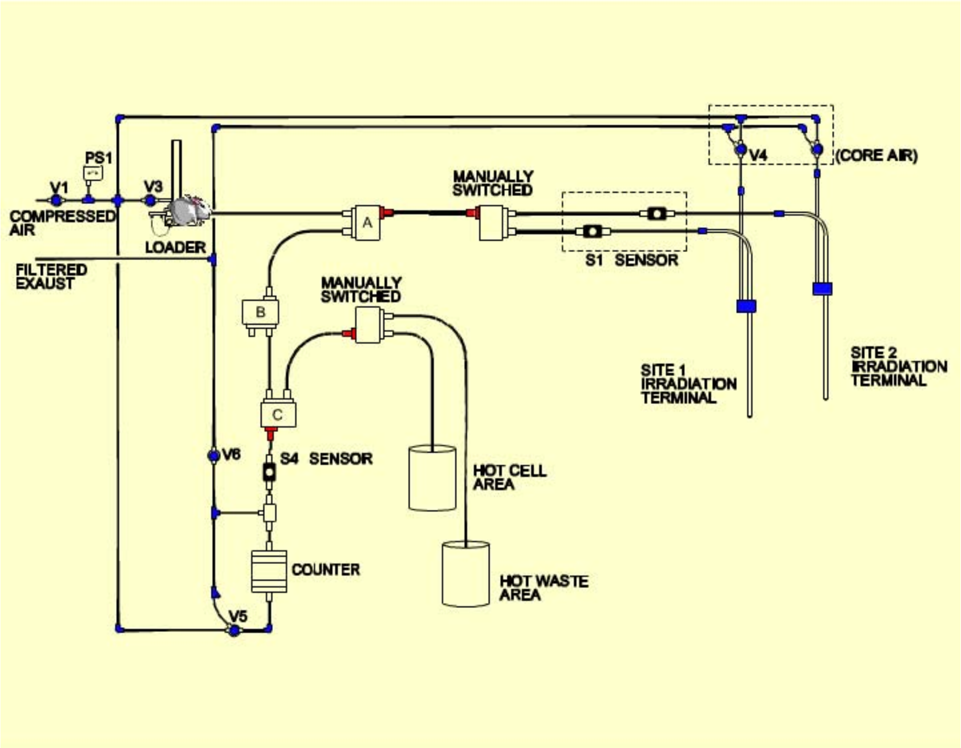


Neutron Activation Analysis

- Short Lived Activation Analysis (Al, Ca, Cl, Dy, F, I, In, K, Mg, Mn, Na, Rh, Se, Ti, V)

- Delayed Neutron Counting (U235)

- Prompt Gamma (B, Cd, Eu, Gd, and Sm)



Used in in support of environmental, geological, archeometry, tissue and environment sample analysis

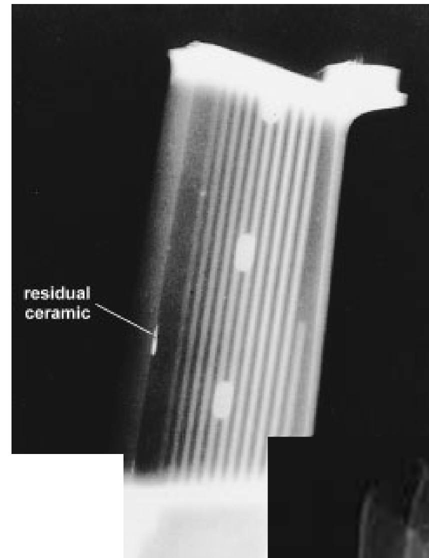
Medical Isotope Program

- McMaster University currently produces I-125 which is used in the treatment of prostate cancer and supplies seed manufacturers around the world (**200 dads-a-day!**)
- Other isotopes under development include: I-131, Lu-177, Re-186/188, etc..

McMaster University

Beam Ports

- **BP 1 :** **Neutron Radiography**
- **BP 2 : Neutron Radiography (turbine blades)**
- **BP 3 :** **Prompt Gamma**
- **BP 4 :** **SANS and Guide Hall**
- **BP 5 :** **MIPBF to Guide Hall**
- **BP 6 :** **MAD McMaster Alignment Diffractometer**

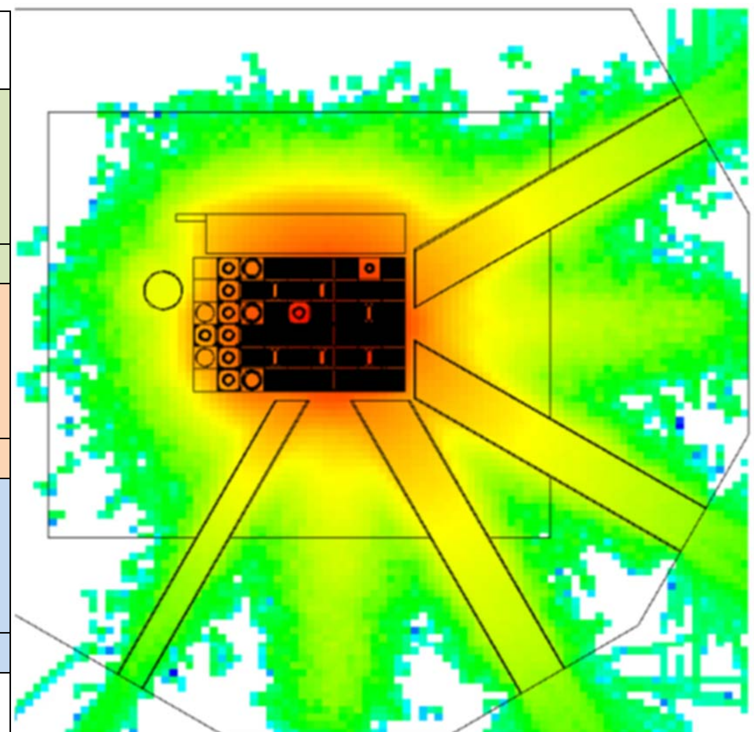


MNR Flux Estimates

NEUTRON FLUX ESTIMATES

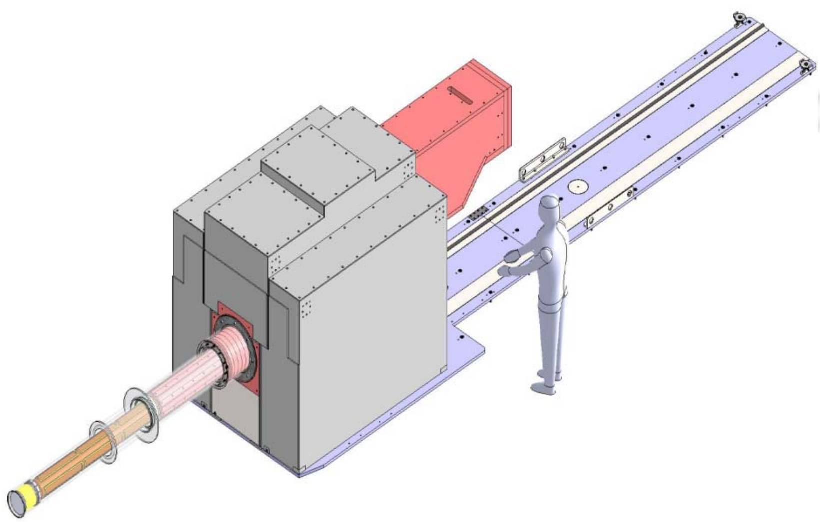
Site Vessel	BT1 core	BT2 core	BT3 core	BT4 core	BT5 core	BT6 core
Flux/MW						
thermal	2.41E+12	3.89E+12	2.45E+12	2.72E+12	3.79E+12	3.23E+12
epi	5.43E+11	1.00E+12	6.18E+11	6.82E+11	1.01E+12	6.39E+11
fast	1.03E+12	2.06E+12	1.09E+12	1.29E+12	1.99E+12	1.12E+12
total	**3.99E+12**	**6.95E+12**	**4.16E+12**	**4.69E+12**	**6.80E+12**	**4.99E+12**
3MW flux						
thermal	7.24E+12	1.17E+13	7.36E+12	8.17E+12	1.14E+13	9.70E+12
epi	1.63E+12	3.00E+12	1.85E+12	2.05E+12	3.03E+12	1.92E+12
fast	3.10E+12	6.18E+12	3.28E+12	3.86E+12	5.98E+12	3.36E+12
total	**1.20E+13**	**2.08E+13**	**1.25E+13**	**1.41E+13**	**2.04E+13**	**1.50E+13**
5MW Flux						
thermal	1.21E+13	1.94E+13	1.23E+13	1.36E+13	1.90E+13	1.62E+13
epi	2.71E+12	5.00E+12	3.09E+12	3.41E+12	5.05E+12	3.20E+12
fast	5.17E+12	1.03E+13	5.46E+12	6.43E+12	9.97E+12	5.59E+12
total	**1.99E+13**	**3.47E+13**	**2.08E+13**	**2.35E+13**	**3.40E+13**	**2.50E+13**
% thermal	60%	56%	59%	58%	56%	65%
% epi	14%	14%	15%	15%	15%	13%
% fast	26%	30%	26%	27%	29%	22%

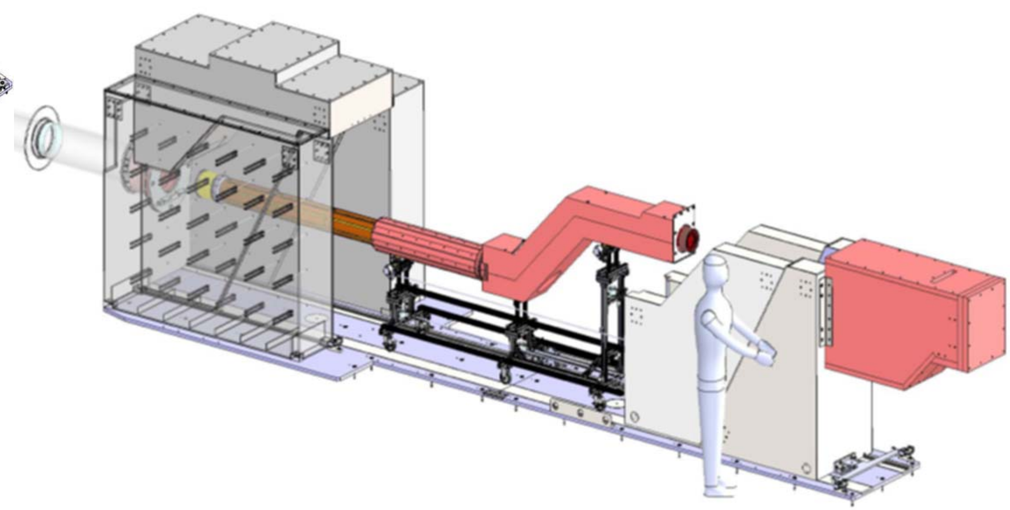
note: BP values are taken at beam axis just outboard of core-side faceplate.



McMaster Intense Positron Facility

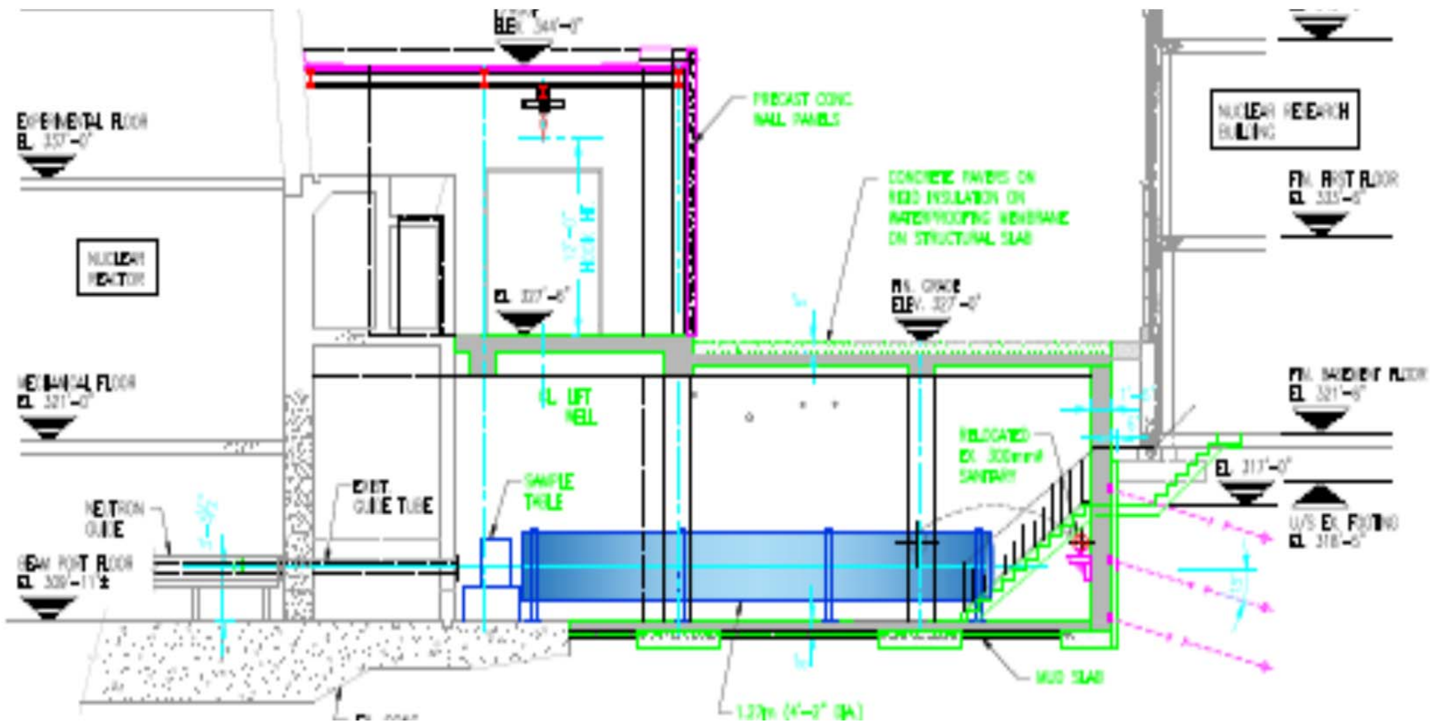
- The MIPBF will be the only intense source in Canada and one of four in the world
- Installation and commissioning over the next few months
- Good Accelerator/Reactor project





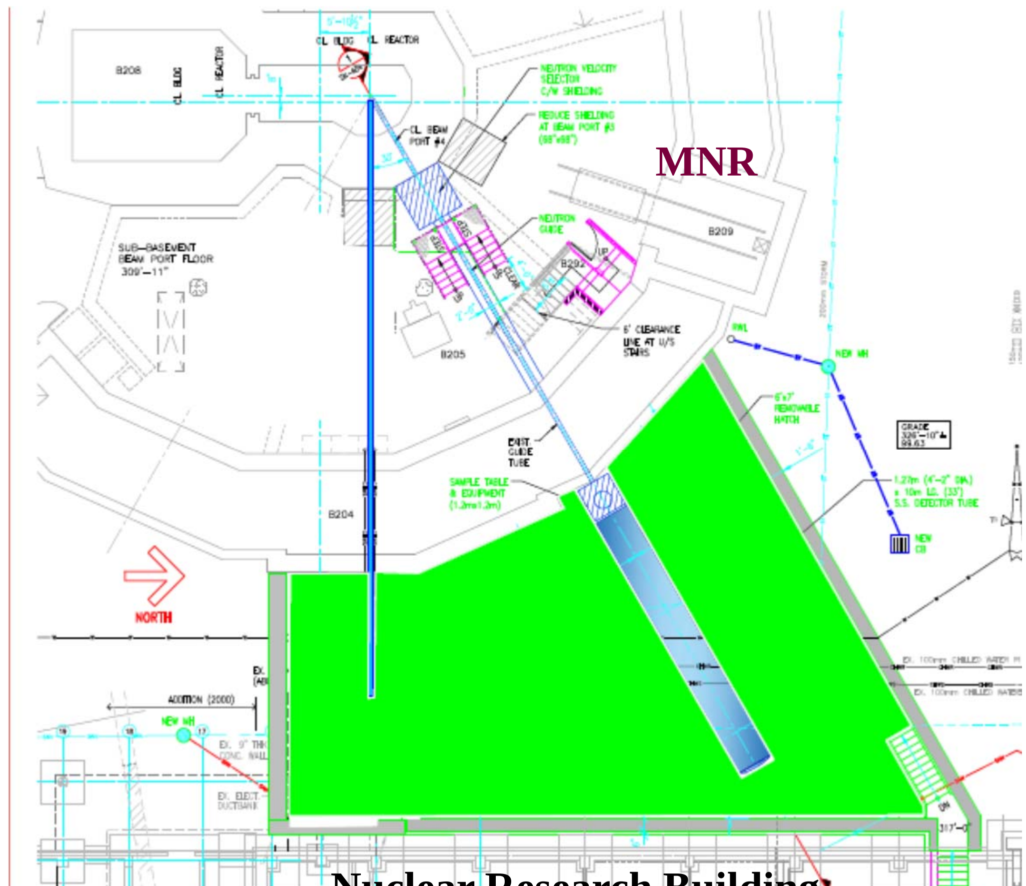
SANS Facility

- Construction to Start 2016
- Operational Q3 2017



Guide Hall (Reactor Funded)

- Below Grade, outside of Containment
- Provide Direct Access to SANS and MIPBF for Researchers from the Nuclear Research Bldg
- Original Designed allowed for future Guide Hall
- ~3500 sq. ft. of additional research space
- Funding Approved by University this summer

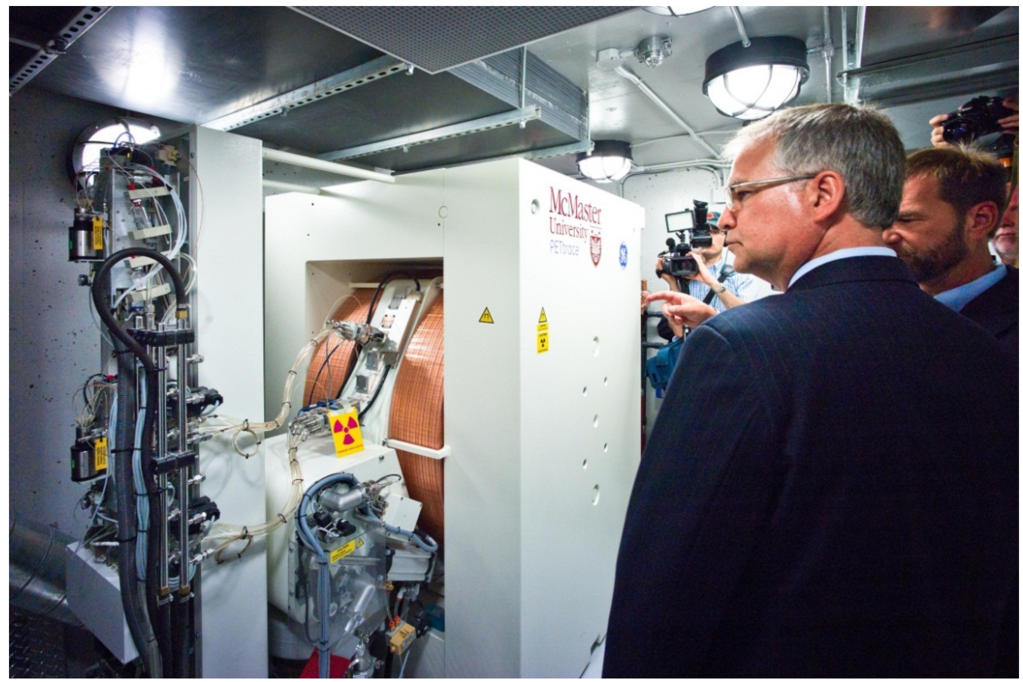


McMaster Accelerator Laboratory

- 1.25MV Tandetron Tandem accelerator
- μBeam Microprobe Facility
- Model KN 3MV Van De Graaff Accelerator
- Taylor Cesium Source Irradiator

McMaster University Cyclotron Facility

- 6.7 $M Facility funded through the Knowledge Infrastructure Project
- 16.4 MeV GE PETtrace cyclotron
- Supporting Production/Research Facilities
- Partnership between the CPDC and the University
- Research Facilities to develop new cyclotron based isotopes



McMaster University Cyclotron Facility

- Completes the suite of medical isotope facilities
- Enhance & augment medical isotope research
- Build a symbiotic relationship with MNR (cyclotron isotope to diagnose disease followed by a reactor analogue to cure the disease)
- Production license last summer
- Isotopes: ^{18}F, ^{99}Tc, ^{124}I

High Level Laboratory Facility

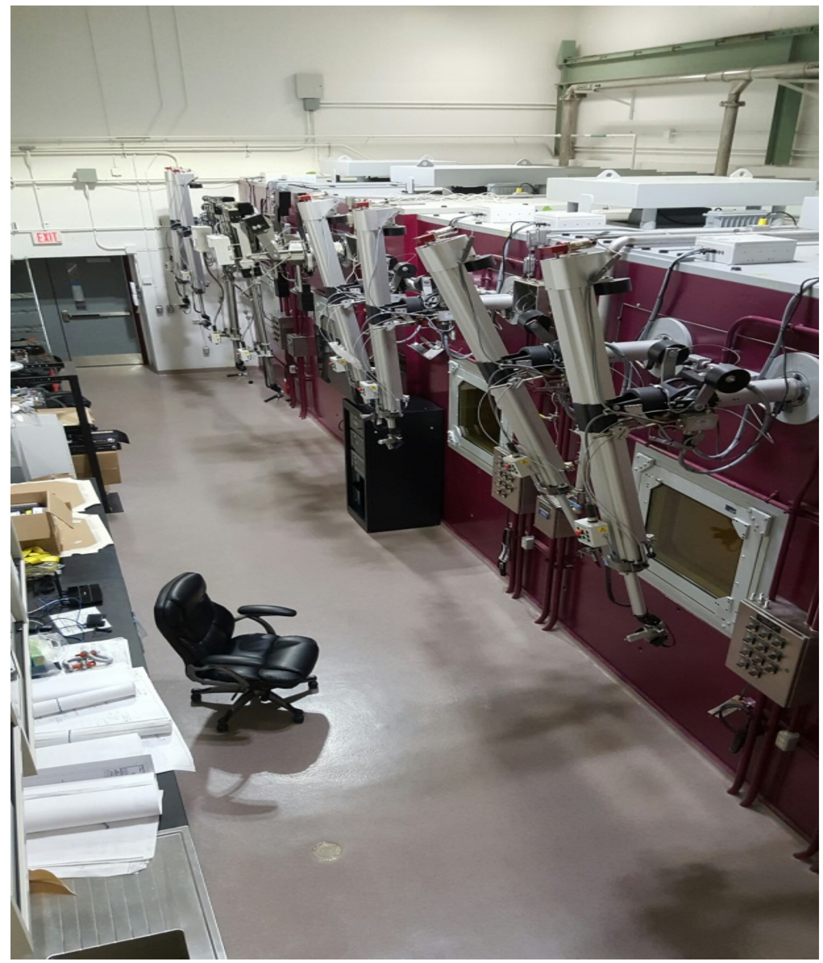
- 24,000 ft^2 CNSC Licensed Facility (only one like it at a Canadian University)
- Licensed to handle small through large quantities of radioactive material
- 35 Licensed Laboratories
- Access Control (security)
- 5 Radiopharmaceutical Hot cells
- Radio-chemists and Radio-biologists work their magic
- Transforming Radioisotopes into clinical impacts

Centre for Advanced Nuclear Systems (CANS)

- Five Cell Connected Arrangement:

Receiving, Machining, Open Canyon Cell

- In cell tools: Lathe, mill, cutoff saw, grinder
- In cell testing: Electro-hydraulic test frame, Fatigue tester, Tensile tester, 2 optical microscopes
- Out of cell testing: TEM, SEM/FIB
- Commissioning Phase



Success Leads to Success

Year	Award	Purpose
2008	$25 M CECR grant $13 M (Renewal)	To establish the CPDC
2009	$22 M KIP	Expand Medical Isotope R&D activities
2009	$ 7 M CFI	Installation of a positron beam at MNR
2009	$23 M CFI	Establishment of a state of the art shielded facility (CANS: PIE & MI)
2012	$8 M CFI	Establishment of a state of the art Research facility (SANS)
TOTAL	**~$100 M**	

McMaster University

University Reactor Survival Guide

SENIOR MANAGEMENT SUPPORT

New President appointed to the University in 1995. First major decision is to reverse the reactor shutdown

2 last VPRs from Engineering with nuclear R&D

Education & Research

FINANCIAL STABILITY

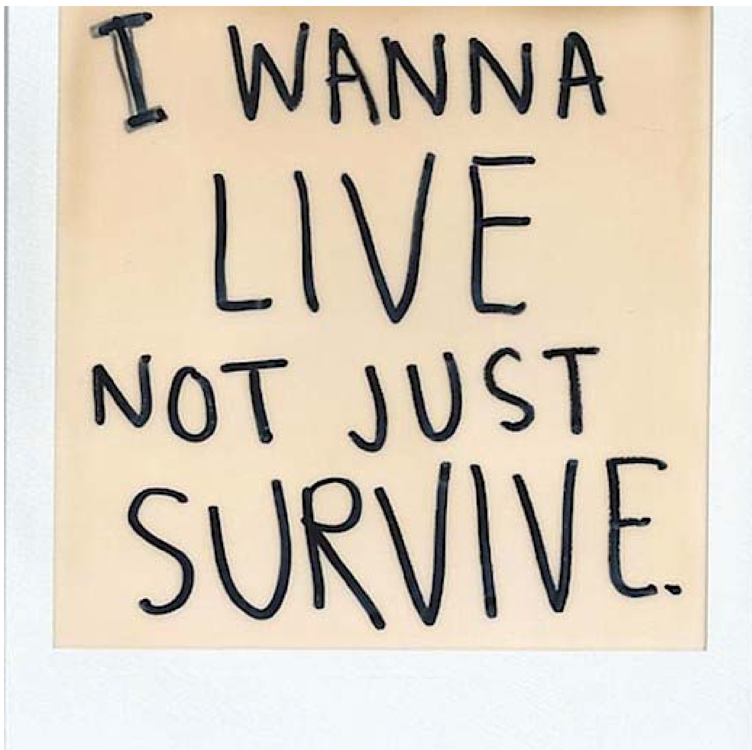
Business Plan executed and reactor slowly achieves required stability

REGULATORY CONFIDENCE

Reactor maintains its operating license.
In 2002 receives a five year license.
In 2007 receives a seven year license.
In 2024 receives a ten year licence

ON-GOING PROCESS OF BALANCING THE ENTERPRISE !

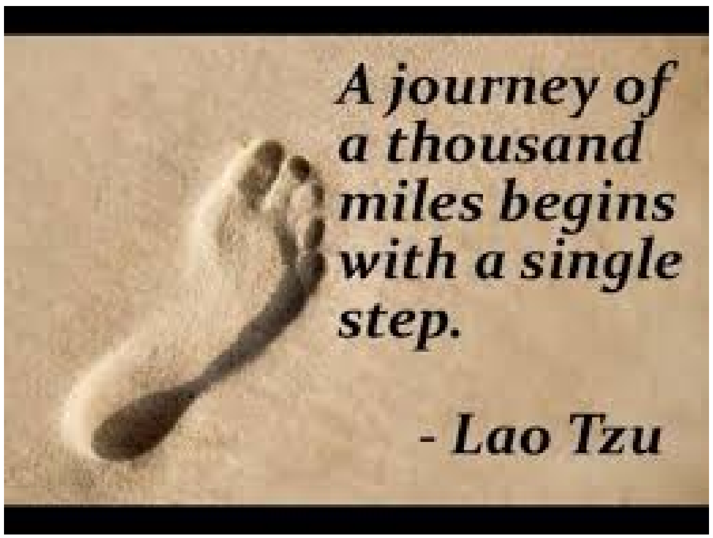
The Future



- The Key to a future in which MNR will thrive is source of Government funding
- Need to fulfill a need for the Government
- Need = S & T Alignment

McMaster University

What Are We Doing

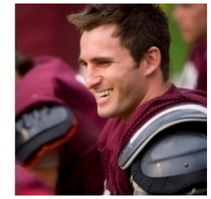


- Business Model has Researchers and Students as our Shareholders
- Income directed to securing the asset and investing in R&D
- Sponsor Students (Co-ops/PDFs)
- MIPBF
- Guide Hall (2.6 MAC + 2 MNR)

McMaster University

Next Steps

- In order to maximise the R&D impact of MNR we need to revert to a 24/7 5 MW Operating cycle.
- Assessing a Business Plan
- Preparing an application for a MSI
- To be successful we need Support from the R&D community
- CINS seen as the “KEY” partnership to success



MSI

- LOI submitted
  - Feedback not positive but useful
- Decision taken to proceed with NOI
  - Articulate our R&D story
  - Stakeholder engagement
  - Vehicle for a discussion about MNR and the Neutron Gap
- Starting to form Partnership agreements
- Due to the University by Nov. 30th !!
- Due to CFI by December 22nd

Managing a “Potential” N Gap

<u>What can Mac do?</u>

Reduce the Gap

- Expand Commercial activates at NRU - new playing field
- Expand R&D Collaborations with NRU – renewed CNL focus

Help Fill a Gap

- Increase Operating Cycle 24/5 or 7
- Increase power
- Uprate reactor
- MNR MAPLE

INPUT REQUIRED !

Summary

- McMaster University has an unique suite of Canadian University Nuclear Infrastructure

- Significant expansion continues at the University to drive Innovation in radiation sciences

- The University is assessing how it contribute to the a potential neutron gap and expand the R&D role of MNR

McMaster University

Acknowledgements

This presentation is a compilation of a number of individuals' work and past presentations including: Mike Butler, Dave Tucker, Kurt Stoll, Simon Day, Rob Pasuta, Alice Pidruczny, Charles Blahnik, Andrea Armstrong

Thank You for your attention

Questions?

CINS AGM
Secretary-Treasurer Report

Niki Schrie

2015 November 13-14

CINS INSTITUTE MEMBERS

(in good standing 2015-16)

Institute Name	Institute Representative
National Research Council	Dr. Dennis Klug
University of British Columbia	Professor Warren Poole
University of Saskatchewan	Dr. Neil Alexander
University of Winnipeg	Professor Chris Wiebe

CINS FINANCIAL TRANSACTIONS

(2014 Nov to Present)

$	Date	Description
		Debits
-$84.87	2014 Nov	Carl Adams - Reimbursement for Telephone Charges
-$826.54	2015 Jan	Aramak Catering – 2014 CINS AGM Catering
-$20.00	2015 Jan	Niki Schrie – Reimbursement Corporation Filing (Industry Canada)
-$1374.00	2015 June	Bond Editing Services – CINS Long Range Plan
		Credits
+$14,000.00	2015 Nov-Present	Institute Membership Fees – Received (includes backdated fees)
$22,262.44	2015 Nov 01	**Current Account Balance**
		Commitments
-$6000.00	2016 Mar	Review Engagement for YRS 2010, 2011, 2012, 2013, 2014, 2015
-$2000.00	2015 Nov	Ashley Gadd – CINS Long Range Plan Layout & Design
-$5000.00	2016 Feb	2016 February Winter Workshop (Chalk River)
-$6000.00	2015 Nov	Board Member Travel to AGM
-$1000.00	2015 Nov	Student Travel to AGM (posters)
$2,262.44		**Account Balance with Commitments Considered**

CINS Constitution Review and possible suggestions for improvements

Draft Prepared for Science Council Consideration

Oct 23, 2015

Resources

- CINS AGM 2013 minutes: http://cins.ca/docs/agm2013/cins_agm_minutes_with_appdx.pdf
- Overview of proposed changes to CINS governing documents: http://cins.ca/docs/agm2013/NFP%20transition%20overview%20and%20org%20chart%202013%2008%2015.pdf
- CINS Corporate Information:
  http://www.cins.ca/about.html#corp
- CINS Operating Policies: http://cins.ca/docs/CINS_operating_policies%202013%2010%2026.pdf
- CINS Bylaws:
  http://cins.ca/docs/CINS_by-laws%202013%2010%2026.pdf
- CAP Governance and Bylaws:
  http://www.cap.ca/en/about-cap/new-cap-cnca-laws
- IPP (Institute of Particle Physics, a Canadian organization) Governance and Bylaws:
  http://www.ipp.ca/governance/index.shtml
  http://www.ipp.ca/policies/by-laws.shtml#__RefHeading__719_824854585
- APS Governance and Bylaws: http://www.aps.org/about/governance/documents/index.cfm

Note that direct quotes from any of these documents or others in this file are in GREEN and in quotations to be easily recognizable. The BOLD font is to emphasize that part of the statement.

Background

Pre-2013 CINS Structure

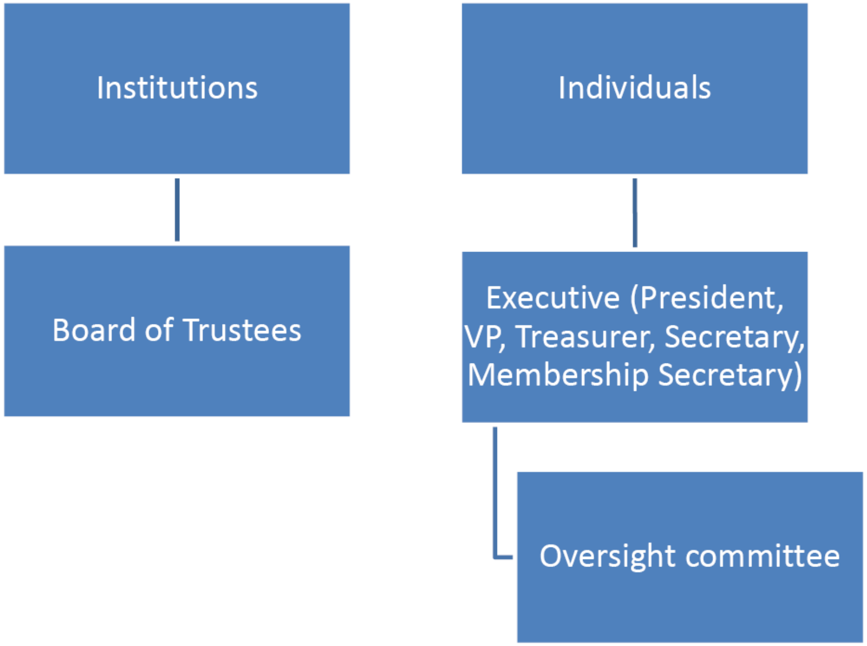
http://cins.ca/docs/agm2013/NFP%20transition%20overview%20and%20org%20chart%202013%2008%2015.pdf

Key points of the old model:

•"Each member institution appoints a trustee (typically a researcher) to the Board of Trustees, which is responsible for approving a budget and acts as a nominating committee for the election of the executive.

•The officers, each with prescribed duties, form an executive committee that oversees all functions of CINS.

•An oversight committee, including mainly members from outside the executive, meet to review the performance of the CNBC with respect to use of the NSERC MRS funds, and reported to through the CINS executive to NSERC."



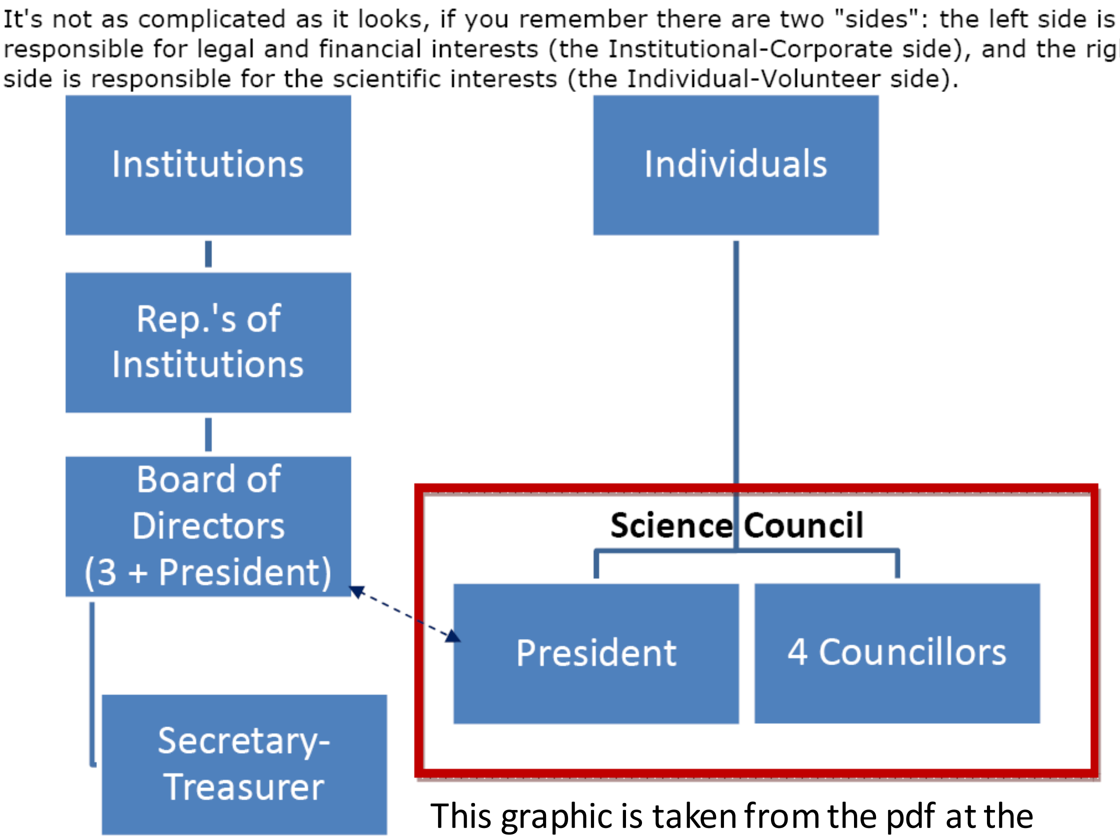
This graphic is taken from the pdf at the link given on the top of the page.

Background

Post-2013 CINS Structure

http://cins.ca/docs/agm2013/NFP%20transition%20overview%20and%20org%20chart%202013%2008%2015.pdf

"The requirement by the government for new articles and bylaws created an opportunity to revisit the structure of CINS and implement improvements discussed at the 2012 CINS AGM. **In particular, those discussions considered how to position CINS as a organization able to receive and distribute large sums of grant money to support neutron scattering."**



This graphic is taken from the pdf at the link given on the top of the page.

Note that this requirement was for ALL such organizations such as CAP and IPP chose differently how they accomplish it.

Background

How the changes were implemented, excerpts from the minutes of 2013CINS AGM: http://cins.ca/docs/agm2013/cins_agm_minutes_with_appdx.pdf

"One of the main changes to the Not-for-profit Corporations Act is that organizations cannot have appointed or ex-officio governing boards. **Governing boards must be elected from the membership**. When considering last year's discussion of CINS strengthening its international credibility, this suggests CINS might be able to position itself to handle larger quantities of money, **i.e. to conduct the science functions of CRL.**

The new structure for the governing board is such that dues-paying institutional members provide representatives, who elect directors to the board at a meeting of institutional members, prior to the annual general meeting of the individual members. The Board of Directors will have three members (to start) and the President of the Science Council, and conduct the general management and direction CINS. Individual members will then elect five representatives to a Science Council, to carry out the scientific and educational mandates of CINS. The President is the liaison between the Science Council and the Board of Directors."

Where we are today?

Strong initiative from both McMaster and USask to get involved with the vacuum created by NRU SD in 2018.

- With the current model, there are only 5 institutions that have paid their dues and have voting rights. We are currently also $14,700 behind in dues (!). Is the $700/institution too high? Should we go to a individual member model? (eg. The CAP model?)
- Current model doesn't allow the individual members to participate and contribute in a democratic manner.
- Limited communication between the Science Council and the Board. How can this be improved?
- Should we change the by laws with respect to the rights and responsibilities of the SC and Board?

The IPP example, another Canadian Institute

If we are going to continue with existing model, then perhaps we can learn from how IPP has given more voice/right to its individual members, here is a short list taken from their bylaws (http://www.ipp.ca/policies/by-laws.shtml), note Trustees in their case is equivalent to BoD in our case: "**The Institute of Particle Physics is a non-profit corporation owned by the Institutional Members and operated by the Institutional and Individual Members for the benefit of particle physics research in Canada**. The Institutional Members appoint a Board of Trustees which has the legal responsibility for the actions of the Institute. The Individual Members elect a Council which is responsible for the Scientific program and the operation of the Institute. The IPP Council is chaired by the Director of IPP, who is appointed by the Board of Trustees and ratified by the Individual Members."

1. On admission of new Institutional members:

   "Any institute, laboratory, Canadian charitable organization and any establishment of the Government of Canada which is actively involved in Particle Physics may be determined to be eligible for admission to the corporation as an institutional member **upon receiving the approval of a majority of the Trustees**, and any such organization or establishment shall become a member when it gives written notice to the secretary of its acceptance of membership."

2. On number of votes from each institution to ensure all members from that institute have a voice:

   "Each institutional member shall be entitled to one vote at each general or special meeting of institutional members of the corporation, provided that each institutional member shall be entitled to one additional vote for each individual member of the corporation who is a member of the staff or faculty of such institutional member at the time any such meeting is held."

The IPP example, another Canadian Institute

3. On admission/termination of new individual members:

   "Any individual who has sufficient training and competence to enable such individual to play a significant role in the activities of the corporation and who is already a resident of Canada or employed by a Canadian Institution may be admitted to the corporation as an individual member upon receiving the approval of a majority of the Trustees, acting on the advice of council. Such individuals shall cause themselves to be listed, at the time of their application for approval, as either an experimental physicist or a theoretical physicist. An individual membership may be terminated by a resolution of **a majority of the Trustees** when, in their opinion **and on the advice of council** that individual has ceased to play a significant role in the activities of the corporation, and is not likely to resume such a role."

4. On individual members right to be at the meetings of Institutional members:

   "Any individual member shall have the right to attend but not to vote at any general or special meeting of institutional members of the corporation and shall have the right to attend and exercise one vote at any general or special meeting of the individual members."

5. On the voting requirement for the Trustees:

   "The affairs of the corporation shall be managed by a Board of six Trustees, of whom a majority of the Trustees holding office for the time being shall constitute a quorum. Every question at meetings of the Trustees shall be decided by a majority of the votes duly cast on the question. In the case of an equality of votes, the person presiding at the meeting of Trustees shall have a second or casting vote."

The IPP example, another Canadian Institute

6. On election of new members for the Board of Trustees:

   "At each annual meeting of institutional members held to elect Trustees, two Trustees shall be elected to hold office until the third annual meeting of institutional members following such election, to replace the Trustees who retire from office at each such annual meeting of institutional members on the expiration of the term for which the Trustees were elected. Should any member of the Board of Trustees be unable to fulfill his/her term of office due to absence, disability, resignation, death or any other cause, the institutional members at any meeting following notification that an office of Trustee has become vacant, may in their discretion but need not, elect a Trustee to hold office for the unexpired portion of the prior Trustee's term provided, however, that if failure to so elect a new Trustee would create the situation where there would be no quorum of the Board, a new Trustee shall be so elected."

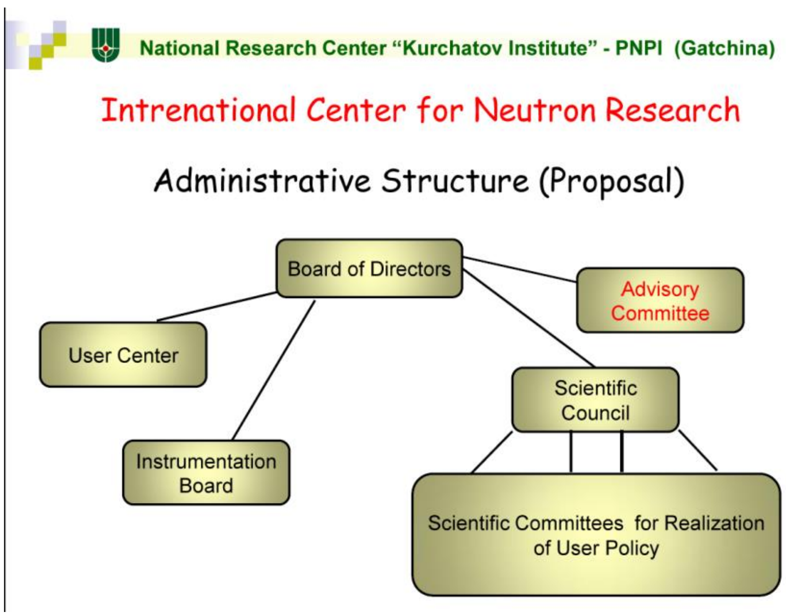
7. On how the Board of Trustees treats the advice from the Council:

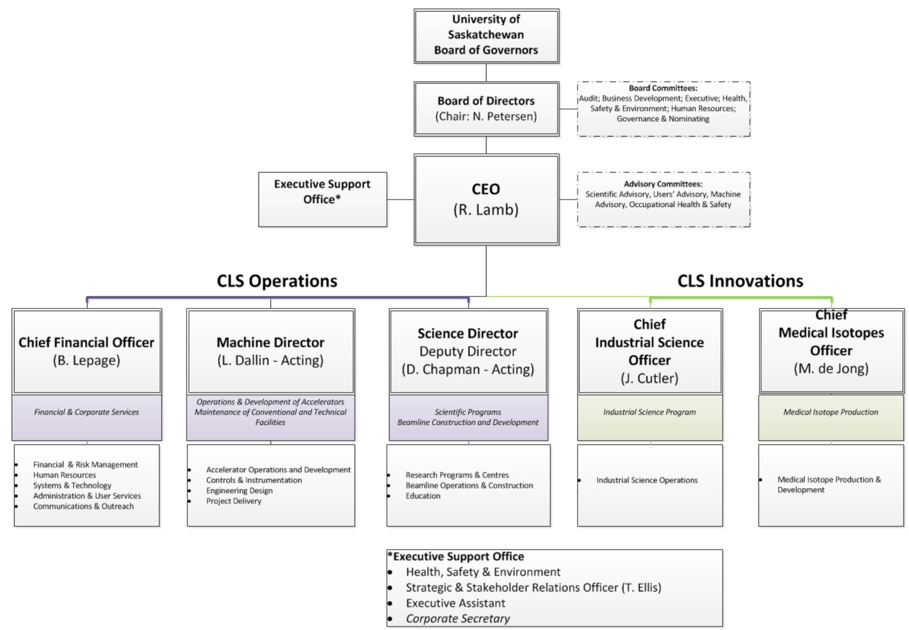
   "The Board of Trustees, **by unanimous vote**, may refuse to approve or follow any action of council."

Other examples

We need to make sure that it is structured such that the BoD's is working for the organization advancing their goals and not the other way around. Possible models are:

CLS Light Source: http://www.lightsource.ca/about/orgchart.php



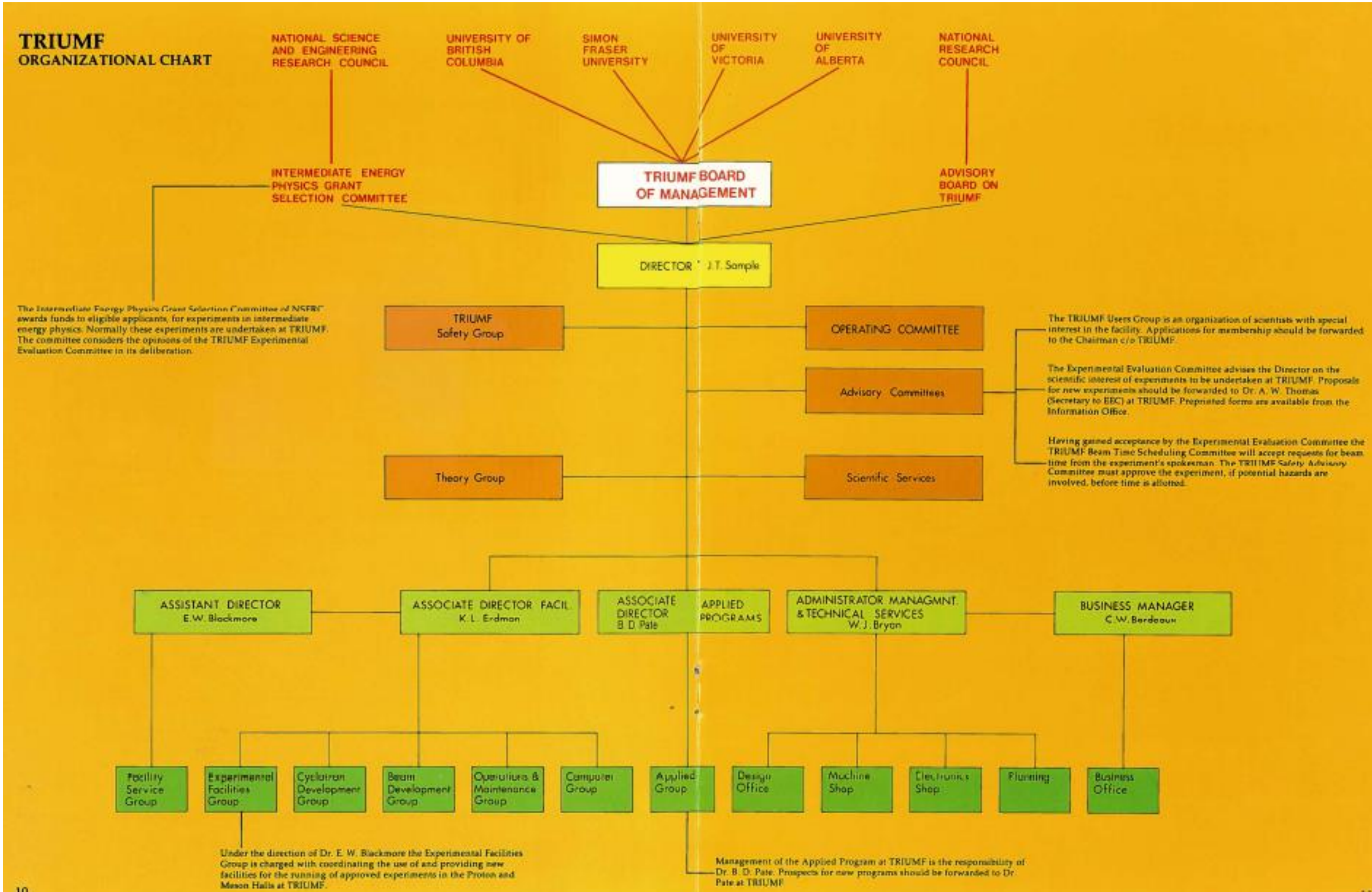


Taken from the Minutes of 2013 CINS AGM:
http://cins.ca/docs/agm2013/cins_agm_minutes_with_appdx.pdf

Other examples

This is from Triumf website related to their Governance:

http://www.triumf.ca/sites/default/files/annual_financial_admin_1979-80.PDF



Other examples

http://www.triumf.ca/home/about-triumf/governance/board-management

Home » About TRIUMF » Governance & Organization » Board of Management

Board of Management

TRIUMF is owned and operated as a joint venture by a consortium of universities. The joint venture agreement constitutes a Board of Management to oversee TRIUMF. The TRIUMF Board of Management is made up of membership from the Member and Joint Member Universities. It is responsible for the operation, supervision and control of TRIUMF. The duties of the Board include policy-making, determination of the budget, and fund raising.

The Board meets two times per year. It maintains several standing committees for detailed monitoring of TRIUMF.

- Safety & Security
- Finance
- Personnel & Administration
- Innovations & Industrial Partnerships
- Audit Committee

The Board's major duties include:

- Determine all policy matters relating to the operation of TRIUMF
- Regularly review the operation and strategic plan of TRIUMF
- Appoint Associate Members of TRIUMF
- Appoint the Director of TRIUMF
- Establish a Finance Committee
- Establish a Personnel and Administration Committee
- Establish a Safety & Security Committee
- Establish ad hoc committees
- Cause the Director to have prepared a Plan which shall be in conformity with the Contribution Agreement entered into between TRIUMF and the National Research Council
- Review and monitor the performance of TRIUMF Accelerators, Inc., the legal entity holding the operating license from the Canadian Nuclear Safety Commission.

Membership has Advantages

TRIUMF is focused. In order to deliver world-class science and maintain its international reputation, the laboratory relies on the involvement of and input from its members in setting the priorities of the research program. This involvement begins with the appointment on the Board of Management with voting privileges for the strategic direction of TRIUMF. Membership in the TRIUMF consortium provides the opportunity not only to enhance the synergy among the laboratory and its member

universities, but it also grants instant access to a network of international scientific leaders and decision-makers, cutting-edge research results and technology and highly skilled technical and engineering support. Membership can also offer joint or reciprocal faculty appointments.

Be a part of the future...Be a part of TRIUMF.

Action item

- I propose that we establish an oversight committee to review the bylaws to address these concerns and try to improve the current structure of CINS (which is evolving).
- This committee would report back to the Board and Science Council with a list of recommendations to tweak our current structure.
- Do I have any volunteers?