Canada Foundation for Innovation
Fondation canadienne pour l'innovation

Notice of Intent to Submit an Application
New Initiatives Fund (NIF)

Date submitted (dd/mm/yyyy) : 27/06/2008 **Project no:** 19280

Project title: Canadian Spallation Ultracold Neutron Source

Language of application:

☒ English ☐ French

Applicant institution: The University of Winnipeg

Collaborating institution(s):

University of Manitoba, Simon Fraser University, University of Northern British Columbia, TRIUMF.

Designated Project Leader

Name: Jeffery Martin
Title/position: Assistant Professor
Department: Physics

Proposal focus: Research proposal

Research discipline/field

Primary: PHYSICS
Primary sub-discipline: Nuclear Physics
Secondary: PHYSICS
Secondary sub-discipline: Particle Physics
Tertiary: PHYSICS
Tertiary sub-discipline: Weak Interactions

Area of application

Primary: Other research
Secondary:

Keywords:

ultracold neutrons, spallation, neutron physics, neutron moderators, surface nanoscience, materials science, electric dipole moments, weak interactions, beta decay, gravity

Estimated total project cost: $10,000,000
Amount requested from the CFI: $4,000,000 (40.00%)

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Principal Users

Researcher Name	Institution/Organization	Department/Division
Jeffery Martin	University of Winnipeg	Department of Physics
James Birchall	University of Manitoba	Department of Physics and Astronomy
Lothar Buchmann	TRIUMF	Science Division
Charles Davis	TRIUMF	Science Division
Michael Gericke	University of Manitoba	Department of Physics and Astronomy
Michael Hayden	Simon Fraser University	Department of Physics
Elie Korkmaz	University of Northern British Columbia	Physics
Shelley Page	University of Manitoba	Department of Physics and Astronomy
Willem van Oers	University of Manitoba	Department of Physics and Astronomy
Yasuhiro Masuda	KEK (Japan)	Physics

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Infrastructure Project Overview

We propose the construction of the world's highest density source of ultracold neutrons (UCN), the Canadian Spallation Ultracold Neutron Source (CSUNS). The project would be a collaborative effort between Canada, Japan, and the US.

A window of opportunity exists to capitalize on the successes of Japanese collaborators developing new technology to produce UCN, allowing the Canadian project to surpass other proposed sources elsewhere. The UCN source would be located in Canada at TRIUMF, Vancouver, BC. This location is ideal because of the high-intensity high-energy proton beam available, which is used to drive the UCN source. The truly high density that could be obtained at TRIUMF would allow a class of precision measurements of the fundamental properties of the neutron to be conducted with significantly higher precision than any other UCN source. The project would therefore make a major impact on studies of fundamental physics with UCN. Funding for physics experiments would be requested in the future from a combination of NSERC, Japanese, and other international sources. Being the most intense source of ultracold neutrons in the world, the source would attract many international users to Canada.

The UCN source technology is a so-called superthermal source based on downscattering of cold neutrons (CN) in superfluid liquid helium. Neutrons are liberated by proton-induced spallation from a tungsten target. The neutrons are moderated in room temperature and 20 K cold moderators. The resultant cold neutrons are down-scattered by phonons in superfluid 4He (He-II) to UCN energies. UCN are transmitted through guide tubes to experiments.

The experiments that would be conducted initially at CSUNS would be measurements of the neutron lifetime, of neutron energy levels in the earth's gravitational field, and of the neutron electric dipole moment. These are the highest priority experiments for this field, and would represent a long-term experimental program in Canada.

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Project Description

Additional details about the infrastructure, principal area(s) of research to be enabled by the infrastructure and the area of application of the research.

The CSUNS project is a collaborative effort between Canada, Japan, and the US, and would be located at TRIUMF. The infrastructure that is required is as follows: a fast kicker magnet to divert the proton beam to the UCN source, a fully instrumented beamline to deliver the proton beam, a tungsten spallation target and associated handling and cooling equipment, the cryostat containing the UCN source itself and associated cryogenic equipment, and, finally, radiation shielding in the form of steel and concrete blocks. In-kind and matching funds would be supplied by a combination of TRIUMF (NRC) and Japanese sources.

The fundamental neutron physics experiments that would be conducted using the UCN source are as follows:

* A precision measurement of the neutron lifetime, a critical parameter in astrophysics and for searches for new physics beyond the standard model of particle physics.

* Precise spectroscopy of the quantized energy levels of neutrons confined above a mirror in the earth's gravitational field. This experiment would test theories of modifications to gravity, predicted by string-theory motivated models involving extra dimensions.

* A search for a non-zero neutron electric dipole moment. Such an experiment aims to search for an explanation of the predominance of matter over antimatter in the universe, and is a very sensitive probe of new physics.

The project would represent a new direction in subatomic physics in Canada, and would increase involvement in Canada's scientific program from new users outside Canada.

Unique technologies used in this proposal are cryogenics, vacuum technologies, nuclear instrumentation, RF technology, and superconducting technology. Many of these technologies are common to the medical field, and there is typically a large cross-over in personnel. Neutron transport issues in the UCN source are similar to those encountered in the design of future nuclear reactors. Acsion Industries, a Manitoba business with expertise in this area, has therefore expressed a strong interest in the project and it is probable that some in-kind contribution to the project would come from Acsion. The project therefore satisfies the People, Knowledge, and Entrepreneurial Advantages mentioned in Canada's S&T priorities. It also promotes world-class excellence by targeting an area of strength in basic research.

In our proposal, more names would appear, but the list has been truncated to suit the format of this notice of intent.

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Fund Requirements

Explanation of the infrastructure project's classification as a New Initiatives Fund application.

The Canadian Spallation Ultracold Neutron Source project is truly a world-class new intiative which has not previously been supported by CFI. The appropriate CFI fund is therefore the New Initiatives Fund (NIF).

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Suggested Reviewers

The CFI reserves the right to make its own selection of reviewers.

REVIEWER 1

Name: Robert Tribble

Institution/organization: Foreign - University - Other

If "Foreign", please specify: Texas A&M University

Country: UNITED STATES

Email 1: tribble@comp.tamu.edu

Email 2:

Online CV or Biography: http://cyclotron.tamu.edu/tribble

Telephone: 979-845-1411

Fax: 979-845-1899

Expertise keyword(s): weak interactions, nuclear reactions at low and high energy and nuclear astrophysics

REVIEWER 2

Name: Garth Huber

Institution/organization: University of Regina

If "Foreign", please specify:

Country: CANADA

Email 1: huberg@uregina.ca

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Online CV or Biography: http://lichen.phys.uregina.ca

Telephone: 306-585-4240

Fax: 306-585-5659

Expertise keyword(s): hadron structure, electron scattering

Applicant institution: The University of Winnipeg **Project no:** 19280

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Suggested Reviewers

The CFI reserves the right to make its own selection of reviewers.

REVIEWER 3

Name: Jeffrey Nico

Institution/organization: Foreign - Federal Government - Other

If "Foreign", please specify: National Institute of Standards and Technology

Country: UNITED STATES

Email 1: jeffrey.nico@nist.gov

Email 2:

Online CV or Biography:

Telephone: 301-975-4663

Fax:

Expertise keyword(s): neutron physics

REVIEWER 4

Name: Andrzej Czarnecki

Institution/organization: University of Alberta

If "Foreign", please specify:

Country: CANADA

Email 1: czar@phys.ualberta.ca

Email 2:

Online CV or Biography: http://www.phys.ualberta.ca/~czar

Telephone: 780-492-5510

Fax: 780-492-0714

Expertise keyword(s): theoretical subatomic physics, electroweak physics

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Suggested Reviewers

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REVIEWER 5

Name: Paul Garrett

Institution/organization: University of Guelph

If "Foreign", please specify:

Country: CANADA

Email 1: pgarrett@physics.uoguelph.ca

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Online CV or Biography: http://www.physics.uoguelph.ca/www_physics/personal_site.php?idx=176

Telephone: 519-824-4120 Ext. 52192

Fax: 519-836-9967

Expertise keyword(s): Structure of exotic nuclei and nuclear states, precision tests of the Standard Model, nuclear reaction dynamics

REVIEWER 6

Name: John Hardy

Institution/organization: Foreign - University - Other

If "Foreign", please specify: Texas A&M University

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Fax:

Expertise keyword(s): nuclear physics, beta decay

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Suggested Reviewers

The CFI reserves the right to make its own selection of reviewers.

REVIEWER 7

Name: Randy Lewis

Institution/organization: York University

If "Foreign", please specify:

Country: CANADA

Email 1: randy.lewis@yorku.ca

Email 2:

Online CV or Biography:

Telephone:

Fax:

Expertise keyword(s): theoretical and computational particle physics, lattice QCD, chiral perturbation theory, heavy quark effective theory

REVIEWER 8

Name: Edward J Stephenson

Institution/organization: Foreign - University - Other

If "Foreign", please specify: Indiana University

Country: UNITED STATES

Email 1: stephene@indiana.edu

Email 2:

Online CV or Biography:

Telephone: 812-855-5469

Fax:

Expertise keyword(s): deuteron electric dipole moment search, neutron decay, intermediate energy physics

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Suggested Reviewers

The CFI reserves the right to make its own selection of reviewers.

REVIEWER 9

Name: Arthur M McDonald

Institution/organization: Queen's University

If "Foreign", please specify:

Country: CANADA

Email 1: McDonald@sno.phy.Queensu.ca

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Online CV or Biography: http://www.sno.phy.queensu.ca/people/mcdonald.html

Telephone: 613-533-2702

Fax:

Expertise keyword(s): electroweak interactions, neutrino physics

REVIEWER 10

Name:

Institution/organization:

If "Foreign", please specify:

Country:

Email 1:

Email 2:

Online CV or Biography:

Telephone:

Fax:

Expertise keyword(s):