MRIF Request for Project Funding:

CSUNS: the Canadian Spallation Ultracold Neutron Source

Project leader: J. W. Martin, University of Winnipeg

Manitoba collaborators:

P. Carlson, S. Kondratchuk, C. Saunders, Acsion Industries J. Birchall, M. Gericke, S.A. Page, W.T.H. van Oers, Univ. Manitoba

Research partners:



S. Page – STEM / MRIF Presentation: CSUNS Project



The CSUNS project:

- A \$10M capital project to build the world's highest density source of ultra cold neutrons, in Canada, for pure and applied physics and materials research
- Led by Prof. Jeff Martin, University of Winnipeg
- Located in Vancouver, BC, to utilize TRIUMF's high intensity proton beams for neutron production
- Intellectual and technical leadership from researchers and industrial partners in the province of Manitoba











Our funding request:



Canada Foundation for Innovation Fondation canadienne pour l'innovation

CFI New Initiatives Fund (J. Martin, PI):	in, PI): \$4,225,000.	
Contributions from eligible partners:	s: \$6,675,000.	
Total project cost:	\$10,900,000 .	
Partner contributions (\$6,675,000.)		
Federal government (TRIUMF):	in-kind: \$2,000,000.	
Provincial government (MRIF):	cash: \$225,000.	
Other government sources (Japan):	in-kind: \$4,000,000.	
Corporations / firms (Acsion, MB):	in-kind \$450,000.	

Requested MRIF contribution is highly leveraged: x 50 for the project overall x 3 for the contributions from Manitoba govt. & industry



Federal partnership :

ANADA'S NATIONAL LABORATORY FOR PARTICLE AND NUCLEAR PHYSICS

Owned and operated as a joint venture by a consortium of Canadian universities via a contribution through the National Research Council Canada





• Nuclear physics researchers from UW and UM conduct experiments at TRIUMF and utilize the lab's infrastructure

RIUMF

• Univ. of Manitoba has recently Become a full member of the TRIUMF consortium (2009)

New 5 year plan proposal – CSUNS Project

University-led Initiatives Based at TRIUMF

6.4.1	Introduction	
6.4.2	Canadian Spallation Ultracold Neutron Source: UCN	
6.4.3	Gamma-Ray Infrastructure for Fundamental Investigations of Nuclei: GRIFFIN	
6.4.4	ISAC Charged-Particle Spectroscopy Station: IRIS	



Manitoba research and innovation partnerships

MRIF request: \$225,000 over 4 years Acsion Industries (ANC Inc.) \$450,000 over 4 years

- Funds will support personnel in Manitoba working on technical design of the project.
- Specifically, ANC will collaborate with UW to train graduate students and postdoctoral fellows in computer modeling of neutron transport in the CSUNS source.

•This will enable us to provide unique and invaluable training to students in Manitoba. Expertise gained will be applicable to alternative energy / nuclear reactor design, nuclear safety, and nuclear medicine – key areas in which only a handful of institutions across the country are currently able to provide training and job skills.





Welcome to Acsion

Acsion Industries focuses on the science of safety; protecting the public (radiation safety and health protection consulting services), protecting patients (medical products); protecting farmers and consumers (crop enhancements; food treatment; pharmaceuticals; waste products). Originally established in 1985 as a Canadian National Laboratory, Acsion has gained a strong reputation for excellence and expertise in all aspects of radiation, including electron beam treatment technologies.

Acsion operates our own electron beam treatment centre to commercialize specific radiation-related technologies and for training safety professionals. We also supply consulting services in all aspects of industrial and radiation safety to utilities, engineering companies and research institutions through a division called Acsion Nuclear Consultants or <u>ANC</u>.

Acsion is ISO 9001-2000 registered.

Acsion Industries Box 429 Pinawa, Manitoba ROE 1L0 **ACSION:** a Manitoba hi-tech company specializing in radiation interactions and safety as well as application of radiation to **Advanced Manufacturing** techniques. Ideally suited for the CSUNS project, and contributing \$450k in-kind towards the technical design.



Making Medical Products Safer

Acsion is the leader in adapting electron beam (e-beam) processing to the development of new medical devices.

READ MORE

2/19/2009

S. Page – STEM / MRIF Presentation: CSUNS Project



Relation to Government-wide Priorities

Strategic Priorities:

Advanced Manufacturing & Alternative Energy Developments

 advanced understanding of neutron interactions with matter – key for design of next generation nuclear reactors (e.g. replacement for 50 year old Chalk River reactor that the world relies on for medical isotope production)

- design and construction of next generation neutron particle detectors widely applicable to radiation safety monitoring in Manitoba & elsewhere
- Iow energy neutrons at CSUNS will provide an important new probe of material surface properties at the nano-scale. (we already collaborate on detector development with the Nano System Fabrication Lab at the University of Manitoba)



Need for Infrastructure / Funding

- The requested MRIF support is crucial to funding of this unique fundamental and applied research tool: the Canadian Spallation Ultracold Neutron Source
- CSUNS cannot be successful without expert attention to technical design
- the requested MRIF contribution will directly support hi-tech manpower in the province of Manitoba, addressing key technical design issues for CSUNS

• personnel will receive state-of-the-art training in key technical areas in collaboration with Acsion, Ind. that would not otherwise be available

The CSUNS project will be a **world leading facility** for neutron research that will attract researchers from around the world. It will utilize existing provincial hi-tech resources to train expert manpower in the province, which will enhance the innovative capacity of research in Manitoba.



Furthering Local Research Synergies

The project builds on the existing excellence in neutron physics research that has been established at the Universities of Winnipeg and Manitoba and is currently supported by NSERC and the CFI program, including previous contributions from MRIF:

- Univ. of Winnipeg: (J. Martin, CFI) Subatomic Physics Detector Laboratory
- Univ. of Manitoba: (M. Gericke, CFI)
 Development Laboratory for New Particle Detector Technology
- UW / UM collaboration on neutron physics research (NSERC)
- UW & UM subatomic group collaborations with the UM Nano-Fabrication Lab in neutron detector design and construction
- UW / Acsion / CancerCare collaboration in development of curricula for health and radiation physics



Examples of work done / underway in Manitoba:

1. Silicon detector development for neutron physics research



CFI approved funding; includes parts for the construction of an ion (proton) source (Dave Harrison, M.Sc. project).

2/19/2009

S. Page – STEM / MRIF Presentation: CSUNS Project



2. A high precision, position sensitive detector for low energy neutrons, machined and assembled here.





Supporting Recruitment and Retention of HQP

- all of the requested MRIF funds will be spent directly for training of HQP, which will involve undergraduate and graduate students well as postdoctoral fellows
- approval of the CSUNS project will be followed by funding requests to NSERC for the subsequent experimental program, which will involve additional recruitment and training of HQP in Manitoba.

(we already support 2 students, 1 summer research assistant, and have made an offer to a postdoctoral research associate for this program, amounting to approx. \$110k per year of support from NSERC.)

- collaboration with Acsion Ind., allows for expansion of effort in this hi-tech area in the industrial sector
- trainees will also be qualified for positions in medical physics research, materials research, and application of computer modeling to hi-tech industrial problems.
- international nature of the project will allow us to recruit additional HQP from outside the province to work here.



Encouragement of Collaboration / Partnerships

- establishment of a new partnership between U. Winnipeg and Acsion Industries
- builds on existing research partnership between UW and UM personnel
- builds a new partnership between UW and TRIUMF, and enhances existing ties between UM and TRIUMF / National Research Council of Canada
- the Manitoba-led CSUNS research team has formed a new Canadian collaboration including scientists from Simon Fraser Univ., Univ. Northern BC and TRIUMF
- CSUNS is already a major international collaboration between Canadian and Japanese scientists and funding agencies (\$4M in-kind contribution) including KEK, Osaka Univ., Univ. of Tokyo, and the Japanese Society for the Promotion of Science
- builds on existing collaborations between UW and Cancercare Manitoba and PET lab at the Health Sciences Centre



Potential Benefits to Manitoba

- enhancement of capacity for leading edge fundamental research in Manitoba, building on strengths at the Universities of Winnipeg and Manitoba
- economic growth in the hi-tech sector via collaboration with Acsion Industries
- potential spin-offs in development of new radiation detectors, collaborations on radiation and health safety applications
- attraction of federal funding via CFI, NSERC to support training of HQP



In closing – Key Reasons to approve MRIF Support:

- 1. The CSUNS ultra cold neutron source will be best in the world, and the only UCN source in North America, with undisputed intellectual leadership centered in Manitoba.
- 2. The project builds on a strategic partnership in fundamental physics research between the Universities of Winnipeg and Manitoba already established as leaders in key aspects of neutron physics in Canada.
- 3. The requested funds are highly leveraged in the context of the project as a whole, and will have a crucial impact on its development.
- 4. Funds will be spent on manpower and student training in Manitoba. *Attraction of manpower and training of students has already begun!*
- 5. Prior CFI funding, with MRIF support, will be used to develop new detector technologies for and with the UCN source.
- 6. Partnership with Acsion technologies inc. will stimulate hi-tech in Manitoba



CSUNS timeline

- 2008: CFI NIF proposal submitted
 - In-kind contributions from Japan, TRIUMF and Manitoba!!!
- 2009-12:
 - develop UCN source in Japan
 - preparations and design in Canada
 - develop neutron lifetime collaboration, proposal, and experiment
- 2012-13: Install, commission at TRIUMF
- 2012-15: First experiments (n-lifetime, gravity)



What are neutrons?

- Neutrons are a basic constituent of matter.
 - The atomic nucleus is made of neutrons and protons.



property	neutron	proton
electric charge	0	1e
mass	1 u	1 u
quark content	udd	uud

A neutron walks into a bar, sits down, and orders a drink. Finishing, he asks, "How much?" The bartender replies, "For you, no charge."

- when freed from a nucleus, they decay

• Discovered by Chadwick in 1932 (Nobel Prize).



Ultracold Neutrons (UCN)

- UCN are neutrons that are moving so slowly that they are totally reflected from surfaces of materials; as a result, they can be confined in material bottles for long periods of time.
- Temperature: < 0.004 degrees above absolute zero, corresponding to speeds < 30 km /hr
- Interactions:
 - gravity: max height ~ 3 m above earth's surface
 - weak interaction (neutron decay fundamental process)
 - magnetic fields
 - strong interaction with nuclei
- Experiments at UCN sources are sensitivity limited by UCN density. The CSUNS source at TRIUMF will be a world leader in this regard.







UCN Source in Osaka, Japan - low intensity prototype for CSUNS



UCN Research

1.Discovery type frontier physics: astrophysics, fundamental particle physics, (origins of the Universe, big-picture questions)

2.Materials science: nanometer distance surface science with neutrons interactions – room temperature and cold fluid properties

3.Pushing the envelope on detector development, with applications to diagnostics in medicine and environmental monitoring.

4.Pushing the envelope on neutron transport simulations with important applications to nuclear reactor safety (partnership with Manitoba based Acsion Technologies)

