

# Proposal for the formation of a Subatomic Physics Research Institute

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## 1 Background

The University of Saskatchewan has a long tradition of research excellence in subatomic physics. This research was primarily associated with the Saskatchewan Accelerator Laboratory (SAL) which was founded in 1963. Internationally recognized contributions were made by the SAL research team in such areas as nuclear Compton scattering, multi-nucleon photo-emission, pion photo-production, and few-body physics. This experimental program, which began around 1990, determined fundamental nuclear and nucleon properties and processes by bombarding nuclei with high energy gamma rays. Midway through this program, and in spite of excellent peer reviews, SAL was informed by NSERC that funding was to disappear and the laboratory was to be decommissioned. At the same time, the Canadian Light Source (synchrotron) proposal was rapidly advancing, although this was unrelated to the SAL shutdown. The final SAL experiment was completed on March 29, 1999, and the accelerator was shutdown. Coincidentally, within days of shutdown, the CFI (Canadian Foundation for Innovation) funding for the Canadian Light Source (CLS) was announced. The subatomic physics program at SAL, however, was finished.

It is not possible to continue, at the CLS, the research formerly conducted at SAL. The CLS facility is a stand-alone operation solely devoted to the provision of synchrotron light to the research community. This “light” is not appropriate for nuclear research since the nuclear program requires high-energy gamma rays, while the synchrotron provides visible light and low-energy X-rays. Furthermore, the present linear accelerator, which forms part of the injection system for the synchrotron, cannot be used to do subatomic physics research since the accelerator has been modified to suit the synchrotron, making it totally incompatible with any subatomic physics program. The accelerator must also be prepared to deliver electrons to the synchrotron on a moments notice, which would make any secondary application impossible.

Subatomic physics research has experienced a dramatic change in the past few years with the closure of SAL and deployment of the SAL infrastructure towards the CLS. Although CLS will use well-established subatomic physics technologies in its construction and operation, its research program falls into the broad area of materials science, and as described above, subatomic physics research cannot be carried out at CLS. Early retirements by subatomic physics faculty (Skopik, Bergstrom, Tomusiak) occurred in this transition period, and redirection of two of these positions towards CLS had further impact on subatomic physics research programs.

Despite these extensive changes, there remains an active and strong subatomic physics research program at the U. of S. Subatomic physics researchers have successfully negotiated this difficult period of transition. Drs. Kolb, Pywell, and Bergstrom (emeritus) have developed research programs involving experimental work at the University of Mainz (Germany) and Duke University (USA) facilities. This group was extremely successful in their first NSERC competition after closure of

SAL (\$705,000 over 4 years), indicative of their high-quality research. Professor Rangacharyulu has continued to focus his experimental research at KEK (Japan), and is a spokesperson for a recently-approved experiment at KVI (Netherlands). Professor Caplan has resumed his consulting activities in applied nuclear physics. Dr. Igarashi, one of the former SAL researchers, is now a research scientist working with Drs. Kolb and Pywell, and has recently become an adjunct faculty member of Physics & Engineering Physics.

Thus, the experimental subatomic physics program has made a successful transition to the post-SAL era, where the research program is no longer focussed at the U. of S., but is conducted at several international laboratories. Since travel is a natural consequence of running these experiments, a Subatomic Physics Institute would provide collegial support (non-monetary) and provide a valuable local focus for these research activities and associated graduate student training.

The theoretical subatomic physics research program has also been affected by the closure of SAL, and has also successfully negotiated the transition to the post-SAL era. Professor Tomusiak, who provided theoretical support for nuclear physics at SAL, has retired and this position has been filled by Dr. Rainer Dick, a theoretical astro-particle subatomic physicist. Dr. Dick's research program has received a strong endorsement from NSERC, with funding of \$64,000 (over two years) received in his first competition which will facilitate growth of his active research program. Dr. Steele's theoretical subatomic physics program has continued to grow in strength, supported by a substantial increase in his NSERC funding (\$88,000 over 4 years), and recent success (\$28,620 over one year) as a co-applicant in the NSERC International Collaborative Opportunities competition for *B*-physics theory research at KEK (Japan). Dr. Benmerrouche, nuclear theorist and former research associate at SAL, is now the radiation safety officer at CLS and an adjunct faculty member of Physics & Engineering Physics, and has developed new expertise in health and radiation physics.

In summary, the subatomic physics research group has made a successful transition from the SAL to CLS eras at the University of Saskatchewan. However, recent interactions with external agencies (*e.g.* NSERC, Perimeter Institute for Theoretical Physics) and external research groups indicate a perception that the U. of S. no longer has a subatomic physics research program. Thus as a natural step in the University's transition from SAL to CLS, we wish to form a University-recognized subatomic physics research institute. As outlined below, the formation of this research institute will:

1. provide a focus for subatomic physics research, and
2. facilitate communication with external agencies, researchers, and prospective graduate students.

## 2 Preliminary Consultation

The concept of a Subatomic Physics Research Institute was initially discussed with the Acting Dean (Dr. Neal) and Acting Associate Dean Science (Dr. Bunt) of the College of Arts & Science, and the Head of Physics & Engineering Physics (Dr. Hirose). Their letters of support were submitted along with our letter of intent. Feedback from the VP Research was solicited at every stage leading to this proposal. We have recently discussed the submission of this formal proposal with Dr. Coates since he was not in the position of Dean of Arts & Science when the letter of intent was submitted, and his letter of support is being sent separately from this document.

## 3 The Subatomic Physics Research Institute

### 3.1 Mandate

Promotion and facilitation of research in pure and applied subatomic physics.

### 3.2 Impact and Activities of the Proposed Institute

The following is a brief outline of the activities and impact of the institute. We reinforce that the need for the Institute arises from the University's transition from SAL to CLS, and is a natural step in this process. As outlined below, the Institute will have impact in three main areas:

1. research,
2. teaching & training of students,
3. promotion & outreach.

A theme that runs through all these areas is the importance of the formal existence of a research institute to facilitate interactions with groups external to the University: funding agencies, subatomic physics research community, industry, prospective students, and the general public.

#### 1. Research

- (a) enhanced profile to facilitate relationships with funding agencies (*e.g.* NSERC reallocation exercise)
- (b) enhanced profile for research activities nationally and internationally
- (c) structure needed to replace SAL and provide collegial support for research at international facilities
- (d) possibility of competition for new funding opportunities
- (e) enhances traditional area of research strength at U. of S.
- (f) structure to foster a seminar series and collaborative work with visiting researchers
- (g) facilitate industrial research partnerships
- (h) improved ability to organize and seek external funding for conferences and symposia (*e.g.* Steele and Rangacharyulu were members of the Quantum Physics Centennial Symposium organizing committee)

#### 2. Teaching/Training

- (a) development of new undergraduate/graduate courses using shared expertise, particularly in particle physics and applied nuclear science
- (b) coordinate graduate course offerings for student training
- (c) identifiable group for recruitment of summer research students
- (d) applied aspect complements and supports engineering physics activities in department
- (e) enhanced profile for recruitment of graduate students
- (f) improve graduate student experience by strengthened identity for peer group support
- (g) seminar series and conference/symposia to enhance graduate student education

- (h) facilitate industrial internship opportunities

### 3. Promotion and Community Outreach

- (a) identifiable and organized unit for public and university inquiries
- (b) improved profile for news media communications
- (c) focus for educational outreach activities (*e.g.* high school cosmic-ray project, CAMECO nuclear science unit for high-school teachers)
- (d) enhanced possibility of public lectures with external sponsorship

In the period between the submission of our letter of intent and this proposal, a number of the above activities have been initiated or implemented. The subatomic seminar series (see <http://nucleus.usask.ca>) has been started, and three seminars were held this term. This series has been successful in terms of enhancing our graduate student experience, and has been valuable to researchers by providing a focus for subatomic physics research. We were pleased at the significant attendance from faculty and staff outside the field of subatomic physics.

The authors of this proposal were also involved in the recent revision, revitalization, and development of graduate courses relevant to the training of subatomic physics students (Phys 882.3: Quantum Mechanics and Phys 883.3: Quantum Field Theory). There was also involvement in the modification of Physics & Engineering Physics graduate program requirements to include Phys 882 in the list of required courses, an important topic for students in condensed matter physics (*e.g.* CLS researchers) as well as subatomic physics. All these items have been approved by the department and submitted to the College of Graduate Studies & Research.

Finally, we have been extremely active in the development of summer undergraduate research projects with five students who are working with authors of this proposal. Three of these students are recipients of NSERC undergraduate summer research awards.

We believe that these are important preliminary accomplishments indicative of the future contributions that can be made by the Subatomic Physics Research Institute.

## 4 Initial List of Involved Academic Units

Faculty and students associated with the Department of Physics & Engineering Physics are the primary source of research in subatomic physics. The following Physics & Engineering Physics faculty and students will have Institute involvement:

- Faculty: Caplan, Dick, Kolb, Pywell, Rangacharyulu, Steele; Bergstrom (emeritus); Benmerrouche, Igarashi (adjuncts)
- Postdoctoral fellows: Hornidge, Ahmed
- Graduate Students: Harnett, Ives, Lepage, Polachic, Regier (current students); McArthur, Adeyoyi (prospective, beginning fall 2001)

We anticipate that graduate student numbers will be increasing with the solid funding and active research program planned by the experimental nuclear physics team. University staff members listed above (Benmerrouche and Igarashi) have adjunct appointments to facilitate involvement with graduate students. In particular, Dr. Igarashi is currently involved in the supervision of one student.

## 5 Organizational Structure

The structure of the proposed institute will be open and collegial. The initial Institute Members will be the faculty members listed as authors of this proposal and given in the previous section. Additions to the Institute membership requires the approval of current members, but will otherwise be completely open to U. of S. faculty and researchers who have research interests in pure or applied subatomic physics and who wish to make contributions towards the mandate and activities of the Institute. For example, nuclear medicine researchers at the Saskatoon Cancer Centre, accelerator physicists at CLS, and faculty in the Department of Mathematics & Statistics might have an interest in the Institute and could make significant contributions. If the formation of the Institute is approved, then we will issue an open invitation for involvement to the University community. We are also receptive to involvement of industrial researchers or faculty from other Universities where overlap with Institute activities occurs. For example, the high school outreach Cosmic Ray project and pursuit of industrial internships described earlier could lead naturally to such involvement.

The Institute Members will elect an Institute Representative, who will serve as the contact person for communications between the Institute, University, external agencies, and general public. This role will be reconsidered annually to accommodate sabbatical leaves and the changing research, teaching, and administrative demands on the members. The Institute Representative will ultimately be responsible for reporting on the Institute activities to the University.

## 6 Impact on Resources

We emphasize that a major purpose for forming the Institute is *not* to pursue additional resources within the University, but to create an identifiable unit for communications internal and external to the University, to intensify research, and to enhance the student experience.

The individuals making up the initial Institute members have well-funded research programs with the associated resource implications of an active program, such as office space for faculty, researchers, graduate students, and summer students. In addition, laboratory space is still needed for detector and hardware development for subatomic physics experiments carried out at the external facilities described earlier. These resource needs have already been addressed within the Department of Physics & Engineering Physics since they are an issue between individual faculty and Department Heads. The role of the Institute in these matters would be to coordinate these resource requests when appropriate.

Computational infrastructure, which suffered upon SAL's closure, has been re-developed with individual research funds. Funding of graduate and undergraduate students remains the responsibility of individual researchers, and competition for scholarships would occur within the department of the student's supervisor.

The development of a subatomic physics seminar series places a slight incremental demand on classroom space of approximately one hour per week. Room 175 Physics was used for our seminar series in the past term without placing undue strain on the space. Visiting collaborators are one source for external speakers; we will also make suggestions for applications to the visiting lecturer's fund.

One of the important roles of the Institute will be communication. To minimize the traditional communications costs of printed materials, the Institute will exploit electronic communications using the computer resources and skills associated with our research. For example, an Institute website will be developed and hosted on one of our research computers, and the website will be used as part of our graduate student recruitment strategy.

The use of external research facilities, such as the University of Mainz and Duke University accelerators, by Drs. Kolb, Pywell, Bergstrom, and Igarashi is a common practice in subatomic physics since accelerator facilities are rare—SAL was the only accelerator facility located at a Canadian university. Travel to distant labs to conduct research is the usual mode of operation for virtually all experimentalists in subatomic physics. This research is typically a collaborative effort between various institutions. For instance, at the Duke University facility the former SAL researchers currently collaborate with researchers from Duke University, University of Virginia, North Carolina State University, and Chapel Hill University. Researchers from each institution contribute expertise and/or equipment to the research project. User fees are not charged to academic researchers.

If University budgetary support for the Institute is a possibility, then a modest annual budget of approximately \$5,000 would allow us to have an excellent seminar series, featuring external speakers and public lectures, and cover printed media communications costs. However, we emphasize that the activities of the Institute are *not contingent* on the existence of support beyond that which is accessible to the individual Institute members.