PROJECT PLANNING REPORT

FOR THE

PHYSICS RESEARCH AND INSTRUCTIONAL

LABORATORY REVITALIZATION

IN THE MCLENNAN PHYSICAL LABORATORIES BUILDING

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I EXECUTIVE SUMMARY

The Department of Physics at the University of Toronto is one of the leading physics research departments in North America. The department offers instruction and research across many areas of physics, from exploration geophysics to theoretical cosmology, from high temperature superconductivity to particle physics. The Department of Physics also emphasizes interdisciplinary research and many of the graduate faculty in Physics are cross-appointed to other departments of the University, including the Department of Chemistry and the Faculty of Engineering.

This project will positively impact a total of 4,514 nasm of existing laboratories and related support facilities in the McLennan Physical Laboratories Building bringing necessary upgrades to obsolete facilities that are approximately 45 years old. The facilities and dated infrastructure will be renewed, taking advantage of the large capital equipment investments accommodated in close proximity. The first phase of renovations was completed in 2008. This second phase has been submitted for funding under the federal infrastructure program, identified as the St. George Laboratory Revitalization for Physics and Chemistry.

The renovated facilities will improve capacity of both teaching and research laboratories, increasing utilization of nearby research equipment. The facilities will be used jointly by senior year undergraduates in Physics, Materials Science, and Nanotechnology in Undergraduate Research courses, along with graduate students and faculty. The new labs will be designed to support small group experiences within an interactive and integrated experimental, theoretical and computational environment. In addition, the renovation will create isolated areas for proprietary research and incubator space. The revitalized space includes significant improvements to:

- Laboratory space for faculty, graduate students, and post-doctoral researchers
- Laboratory space for senior undergraduate research courses
- Isolated areas for proprietary research
- Incubator space
- Laboratory space for the Institute for Optical Sciences

This project creates five new undergraduate teaching labs, a large student centered study/tutor/technical support area, as well as upgraded services to the building to support research needs and develop more environmentally conscious building infrastructure systems.

It is anticipated that the project can be completed in its entirety, however in the event actual costs differ, any funding shortfall will be addressed by prioritizing components within each main area of the project.

The total projected cost of the renovations is $7.5M, to be funded under the Federal Knowledge Infrastructure Program.

II PROJECT BACKGROUND

a) Membership:

Prof. Michael Luke, Chair Department of Physics
Prof. David Bailey, Associate Chair Undergraduate, Department of Physics
John Muto, Chief Administrative Officer, Department of Physics
Chris Ellenor, Graduate Student Department of Physics
Daniel Fusca, Undergraduate Student Department of Physics
Adrienne De Francesco, Assistant Dean & Director of Infrastructure Planning, Faculty of Arts & Science
Julian Binks, Director, Planning & Estimating, Capitol Projects, Real Estate Operations
Bruce Dodds, Director of Utilities, Facilities and Services
Christine Harvey-Kane, Planner, Campus and Facilities Planning
Dr. Karen Seivewright, Director, Entrepreneurship Programs, IOS

b) Terms of Reference:

1. Make recommendations for a detailed space program and functional layout for research laboratories and computational classrooms in the McLennan Physical Laboratories Building.

2. Demonstrate that the proposed space program is consistent with the Council of Ontario Universities' and the University's own space standards.

3. Identify items of deferred maintenance that should be addressed concurrently with this renovation.

4. Identify all secondary effects of implementing the plan, including space reallocations from the existing site, impact on the delivery of academic programs during construction and possible relocation if required of existing units.

5. Identify equipment and moveable furnishings necessary to the project and estimated cost.

6. Identify all data, networking and communication requirements and related costs.

7. Identify all security, occupational health and safety and accessibility requirements and related costs.

8. Determine a total project cost estimate (TPC) for the capital project including costs of implementation in phases if required, and also identifying all resource costs to the University.

9. Identify all sources of funding for capital and operating costs.

10. Complete report by May, 2009.

c) Background Information

The Department of Physics is located in the McLennan Physical Laboratories building located at 255 Huron Street, and occupies approximately 12,500 nasm. This project consists of renovations to infrastructure, upgrades to student teaching and amenities space, as well as aesthetic and functional upgrades to aging, existing spaces.

The Department of Physics at the University of Toronto is one of the top physics departments among North American public universities. In addition to housing world-leading researchers in fields as diverse as geophysics and string theory, global change science and quantum information, the department is committed to rigorous and innovative education at all levels, from the first-year of undergraduate through to graduate and postdoctoral researchers.

There are three components to this project that make up an academic or knowledge life cycle. The project ties together teaching, research and subsequent benefits to industry and society as an integrated whole rather than viewing them as separate and unrelated activities: undergraduate students are taught in modern facilities by faculty conducting cutting-edge research; this produces scientific discoveries and highly trained and creative graduates, both of which foster commercial growth and success. Finally, knowledge and facilities related to industry may then be incorporated back into the teaching laboratories, completing the academic/knowledge life cycle.

In the 2004 Stepping Up Plan and subsequent 2007 revisions, the department proposed an ambitious undergraduate curriculum renewal and expansion. As part of this renewal, a master plan was drafted which reflects how curricular renewal shaped the functional uses of the aging building in which the program must be delivered, research undertaken and commercialization fostered.

The Plan would be implemented as funds became available. The first phase of the Master Plan is complete, and resulted in two new teaching labs which have changed the way physics is taught and more importantly, the way concepts are learned.

The proposed renovations to the first and second floor undergraduate laboratories are part of an ongoing, ambitious plan to completely re-vision the way that first year physics is taught, delivering an integrated, hands-on experience which has been demonstrated to greatly enhance student learning. The first two phases of this renovation have already been completed, and have been extremely well received by students and professors alike. The completion of the project outlined in the Project Planning Report will not only allow all first year laboratory-based courses to move to the new curriculum, but will allow this approach to be extended to the advanced undergraduate laboratories.

The proposals for the research laboratories in the basement of the building will address ongoing concerns about the aging infrastructure of the building – particularly leaking pipes and substandard HVAC – which are having direct detrimental effects on the productivity of our researchers in Quantum Optics, Quantum information, Photonics, and new materials.

Finally, the proposed renovations to the third floor of the undergraduate wing will further foster connections between researchers in Quantum Optics, Photonics and New Materials across the university, as well as in industry through the Institute of Optical Sciences. Renovated teaching and research laboratories on this floor will also greatly enhance our research and teaching mission in the rapidly developing area of Biological Physics.

The project described in this report completes the Master Plan and extends to research and incubation labs. It is anticipated that the full plan can be completed. There are however, areas of costing which are less clear. Accordingly, funding shortfalls will be addressed by prioritizing

components of the Plan. The highest areas of priority are undergraduate teaching and congregation spaces on the first and second floors, infrastructure repairs/renovations relating to the leaking drainage pipes and environmental controls for the basement laser labs, and the third floor incubation space

d) Statement of Academic Plan

The proposed renovations fit perfectly within the broader goals set forth in the department's 2004 Stepping UP Plan and its 2007 revisions (in which the expansion into Biological Physics and the ambitious undergraduate curriculum renewal were proposed).

The renovations to the basement lab space primarily affect researchers in the fields of experimental Quantum Optics and Condensed Matter Physics. Research in these fields has long been at the core of the Department's mission, a fact which was recognized when the bulk of the Canada Research Chairs in the Department were dedicated to these areas, under the "Nanoscience" and "Advanced Materials and Manufacturing" clusters.

Both areas have seen major investments over the past decade, in both theoretical and experimental research, through the hiring of ten new faculty members (including two senior faculty members), as well as major capital investments from both CFI and NSERC. The Quantum Optics group – whose research was described in a recent external review as being "at the highest level and …comparable to that of the best institutions in the world" – has seen its position as one of the leading research institutions for Quantum Optics in North America further enhanced with the establishment of the Institute for Optical Sciences and the Centre for Quantum Information and Quantum Control, as well as three new Canada Research Chairs. The Condensed Matter group – whose research focuses on exotic quantum materials and nanoscience – has seen tremendous renewal over the past decade, with the hiring of six faculty members (three of whom hold Canada Research Chairs). Five of the nine experimentalists in these areas whose labs will be affected by these renovations were hired in the past decade. As one measure of the caliber of researchers in these areas, three hold Canada Research Chairs, and four are Scholars, Fellows or Associates of the Canadian Institute for Advanced Research. Major awards won by members of this group include Sloan Fellowships, NSERC Steacie Fellowships, the Canadian Associate of Physicists Herzberg Medal, the Royal Society of Canada Rutherford Medal, the Premier's Platinum Research Medal, the NSERC Polanyi Award, and the King Faisal International Prize for Science

The department is home to several interdisciplinary institutes (Institute for Optical Sciences, Centre for Quantum Information and Quantum Control, and the Centre for Global Change Science), and most of the researchers in the basement labs are actively associated with at least one of these centres. Major CFI, CERC and NSERC NCE proposals in both the quantum optics and global change science fields are currently under review. Furthermore, given the huge number of faculty hires over the past decade, many of the active faculty in these areas are still in "growth" periods - growing their research groups as they become more established and have access to more funding

One growth area in the department at the moment is in the relatively new field of Biological Physics. Biological Physics is among the fastest growing subfield of physics. This is a highly interdisciplinary field, drawing on statistical mechanics, stochastic dynamics, continuum mechanics, fluid dynamics and nonlinear physics, all of which represent areas of strength within the current faculty. Advances in experimental methods have opened up strong connections between Biological Physics and the worlds of nanoscience, microfluidics, laser physics and imaging science. The interaction between physicists and biologists has become increasingly fruitful over the past decade, and as a result, the department received approval (outside the normal planning cycle) to expand in this area with one hire last year (jointly with medicine) and additionally a position being searched for this year, and a final (joint) position in the future. These positions will allow the department to play a leadership role in this exciting, interdisciplinary field,

and to enhance the educational offerings by the Department of Physics to capitalize on the tremendous student interest in this area

On the undergraduate side, the number of undergraduates studying physics as specialist, major or minor at U of T more than doubled in the past decade (460 in 2008 vs. 184 in 1998) and is almost 30% higher in 2008-09 than in 2006 (460 vs. 357). The department is currently in the process of implementing a series of curricular changes intended to dramatically grow the majors program in physics, by facilitating those students who wish to take a double major in physics and a related field. In particular, Physics has established a new "biological" stream in our majors program intended to make it attractive for life science students to do a double major with physics. As a result, the department which has approximately 76 Major students this year expects to double this number over the next decade. This target may be conservative given past performance; in 1990 when there was also a separate major stream, the enrollment was 130 major students.

Opening up the biological physics stream fits in well with this proposal, as Physics will need to develop advanced lab experiments in this field. It will also require the proposed renovations to the third floor teaching laboratory to obtain "wet" lab space for biological physics experiments. This will also be required for the new specialist program in Molecular Biophysics, introduced in 2008-09. This is an intensive program, essentially containing a Major in Physics along with significant contributions from Chemistry and Biochemistry, and was developed in response to a need identified by Molecular Biophysics researchers for students able to do graduate work in the field with a very quantitative physics-based background. In the coming years, this program will require new, biological physics-related experiments in the advanced lab which will be housed in the renovated advanced lab space. Anticipated growth in the program will see at steady-state 45-60 students (across 2nd, 3rd and 4th years), since in its first year it attracted 10 students. On the strength of this introductory year enrollment and with a more established program, enrollment will grow, since there is clearly tremendous student interest in Biological Physics.

On the graduate side, Physics has been very successful in the area of graduate expansion over the past few years, and has already reached 2011 targets: the number of graduate students in Physics has grown by 33% since 2004 (approximately 190 now vs. 143 then). Significant further increase in graduate enrollment is not anticipated.

Institute for Optical Sciences

The Institute was formed in 2004 as a means of delivering interconnected interdisciplinary learning, industrially driven research and technology development. The IOS aims to give all stakeholders including industry, academic members, undergraduate and graduate students, the opportunity to gain practical experience by applying a number of disciplines to real world problems. The vision is to:

- Establish a World Leading Research Institute in the field of Optics/Promotion of interdisciplinary research
- Develop a Novel Interdisciplinary Environment for the Delivery of Academic Programs
- Focus on Partnerships with Industry, transfer of Knowledge and the Commercialization of University Research

The IOS represents a new concept in commercialization of University IP in all its form. The most significant resource is the expertise gained by faculty and students by the very conduct of state-of-the-art research. This expertise has been a largely untapped resource until the formation of the IOS. The proposed spaces for the IOS will showcase the Institutes' strengths and foster an unfettered path to commercialization.

The IOS has an important role in terms of industrial outreach, technology and knowledge development and transfer – as well as the commercialization of technology. Physics has the

research facilities and dedicated staff to directly work with industry, offering a blend of expertise or technology on a real-time basis.

e) Space Requirements

The Department of Physics occupies 12,500 nasm. The planned renovations that will impact 4,514 nasm do not increase the overall inventory of the Department but rather provide upgraded, functional space that reflects the new type of learning environment and curriculum that the Department of Physics has found so successful.

II PROJECT DESCRIPTION

a) Vision Statement

Physics occupies a central role in the Faculty and in the sciences in general: as a core discipline and the most quantitative of the natural sciences, physics provides much of the intellectual infrastructure behind advances across the sciences. For the same reasons, Physics fulfills a critical educational role for students in all disciplines. A strong Physics Department is thus at the core of a strong University

The Department of Physics at the University of Toronto is unique in that it encompasses a broader range of research activities than most peer departments. In particular, almost one-third of the faculty engage in research in the Earth Sciences (geophysics and atmospheric physics) which are frequently housed in separate departments at other institutions. This provides students the opportunity for tremendous breadth in their studies and ensures great physics depth in planetary research programs. At the same time, the department has great strength in the traditional “core” areas of physics - condensed matter physics, quantum optics, subatomic physics and astrophysics. The department is also establishing a growing presence in biological physics. The strength of the department is reflected in a variety of measures including the quality of the graduates from the undergraduate and graduate programs, the rigor of the undergraduate program, the number of external awards to Physics faculty, and the high level of grant support received by the faculty.

Over the past decade, the department has undergone a very successful faculty renewal: since 1998, 26 new faculty members have been hired across the three campuses, and the average age of the faculty has dropped by almost a decade. Eight of these new faculty members hold Canada Research Chairs, eight are fellows or scholars of programs of the Canadian Institute for Advanced Research (CIfAR), and six have received Sloan Fellowships. The Canadian Association of Physicists Herzberg Medal, awarded annually to recognize outstanding achievement by a physicist under the age of 40, has gone to a member of the department for three of the past six years. These young faculty members join a cadre of senior faculty who are acknowledged world leaders in their fields, boding well for a strong and dynamic future for the department.

As fields in physics evolve, research in the department has expanded in recent years into new areas such as quantum information, string theory, planetary physics and biological physics, while fields such as atmospheric physics and geophysics have become increasingly relevant to a generation of environmentally-concerned students. At the same time, the department has moved away from lower priority fields, such as nuclear physics.

While the core research mission is tied to basic, not applied, research, both the discoveries in basic research laboratories and the highly-trained scientists which they produce provide significant benefits to Canadian scientific and technological industry. By coordinating this project with the renovations to the Institute for Optical Sciences, Physics intends to enhance and grow interactions with industrial partners. The proximity of the IOS to both the research and teaching labs in the department will particularly enhance these interactions, as students and researchers may gain expertise in working with startup and established companies.

At the undergraduate level, physics primary educational vision for the next decade is one of integration. This philosophy is informed by the strong belief that at all levels, an education in physics teaches a student to “think like a physicist”, rather than simply learning a set of facts and well-defined skills. This involves analyzing problems quantitatively and building on a small set of underlying principles; it encompasses experimental measurement and theoretical and computational calculation; it fosters the ability to model physical systems and to connect these models with experimental results. It also requires students to learn to abstract and generalize

appropriately. Anecdotal evidence supports the oft-made assertion that it is precisely these skills which make physicists in demand not only in traditional physical science jobs, but in variety of fields in which the ability to think critically and analyse situations quantitatively is paramount. This vision of integration extends beyond the needs of our own students to students and departments across the University. As the skills of physicists become increasingly relevant to other fields, Physics must engage students from a variety of disciplines. The Department of Physics is already a leader in interdisciplinary research - as examples, much of the University's expertise in climate change is located in our department, as are three of the directors of AIF-funded interdisciplinary institutes. Our programs continue to evolve to reflect this. The goal is not only to enhance the quality of physics programs, but to ensure the relevance of physics across the sciences.

b) Space Programme

Basement Research Laboratories – 1 195 nasm

As discussed in the previous section, the basement laboratories of McLennan Physical Laboratories house world-leading research groups in Quantum Optics, Condensed Matter Physics and Atmospheric Physics. The facilities, covering 1,195 nasm and supported by NSERC, CFI, and other large capital investments, are world class. However, they are housed in a 1960's era building plagued by aging infrastructure which has a direct detrimental effect on research productivity.

This project serves to provide functional infrastructure services throughout a large portion of the basement laboratories. The scope of work involves upgrading the HVAC systems and repairing the leaking podium which has damaged the laser labs located in the basement of the McLennan Physical labs building

Although no architectural demolition is required, some minor demolition may be part of the infrastructure upgrades in the building.

Rooms 10-11, 18, 21, 23, 25, 33-34, 37, 54, 56-56B, 79-80, 92

First Floor – 1,053 nasm

At the same time as the research infrastructure is being enhanced, Canada's continued scientific progress depends, first and foremost, on the quality of the scientists trained at the University of Toronto. With an enviable history of training Nobel Laureates and leaders in academia and industry, U of T's Department of Physics has a strong tradition of excellence in education. The renovation of undergraduate laboratories proposed here, coupled with an ambitious new curriculum already under development will position the department at the forefront of scientific education worldwide.

In 1999-00 the enrollment was 14.5 FCE; this year it is 32.5 FCE. Four labs are proposed throughout the Physics space, and will occupy an average of 140 nasms each, and serve nearly 1,700 students. The numbers are not large, but the equipment required to run these courses takes significant space. A typical experiment needs space equivalent to a faculty sized office (13 nasm), and the total number of experiments needed is equal to the enrollment.

Portions of the first floor have already been renovated to create labs which are more than just renovated space with new equipment – they represent a new concept in learning, providing a small group experience, hands on learning and an interactive and integrated experimental, theoretical and computational environment which is revolutionizing student learning, and training students in the sophisticated skills that place physicists in such high demand in not only

traditional physical science jobs, but in a variety of fields where the ability to think critically and analyze situations is paramount. This integrated approach will be at the forefront at all levels in the department's new curriculum from introductory courses for scientists to sophisticated research projects for senior Physics and Engineering undergraduates.

This project proposes to continue on this success by creating two more undergraduate labs on the first floor, encompassing 139 nasm each for a total of 278 nasms (as well as two others on the second floor.). These labs will accommodate first year science and engineering students. One of the labs is to be a 'pod' lab in the style of the three undergraduate labs already completed on the first floor. The second teaching lab focuses on experimental physics for nearly 550 Physics Specialist and Engineering Science students, and will be a 'pod-less' lab with robust mobile furniture. This allows a flexible approach for experiments which will vary from year-to year, and sometimes week-to-week.

In the teaching of Physics to undergraduate students, especially first year students, the need for technical support and storage of varied instruments is paramount. The first year courses serve many for whom Physics is an unknown and unwelcome requirement. The idea of Physics is daunting to many and there is a fundamental need to ensure that students are made to feel at ease with the subject and with those instructors who can assist them to learn this daunting requirement.

Technical support for these students must be easily accessed and in a relaxed environment to ensure that students struggling with the information feel comfortable approaching technical staff for assistance.

Also, due to the broad-based curriculum of the first year courses, varied instrumentation and equipment to serve all facets of the coursework are required to be housed in an area out of the labs, but close enough for ease of set-up for the lab technicians.

Storage, workshop and desk space for the lab techs will support the undergraduate labs and Physics will provide a quiet tutoring space adjacent to the tech support pod where students may meet with lab technicians to gain assistance with the course work.

Technical support and storage space for the undergraduate teaching labs is planned to be housed in a central area on the first floor, covering 112 nasm. This space will provide not only much needed workshop space for the technicians but also easily accessible equipment storage space for the varied instruments required as part of an undergraduate physics lab course.

The central core of the first floor will be completed by the addition of a large, open drop-in student study and lounge space, which will provide a shared space for students to mingle, relax, group study and share ideas in an easily accessible and comfortable area. It will be located adjacent to the Technicians space, to provide a relaxed and accessible area where a student can gain assistance with their courses through one-on-one tutoring or through peer to peer tutoring sessions

Existing lecture rooms are to be upgraded. They will be acoustically isolated to protect them from expected increased student activity on the ground floor of the building. There will also be upgrades to lighting and general room environment. The current space allocated to these rooms (210 nasm) remains unchanged.

Rooms 125, 126-128, 134, 137, first floor central core

Second Floor – 1,475 nasm

Renovated laboratories and computational classrooms for second, third and fourth year students will be based on a model similar to the first floor undergraduate labs described above. These labs would be 'pod-less', utilizing instead mobile furnishings to allow for flexibility in experiments during the senior undergraduate years. This will necessitate some demolition of interior walls to create contiguous lab space suitable for teaching labs.

A Computational Physics Lab will be created on the second floor, another pod-less style lab, but with a teaching focus on computational physics, and thus different equipment is required.

In addition, the central core of the second floor will receive much more minor aesthetic upgrades involving mould and asbestos removal and upgrade of lighting. There will also be a requirement for upgraded electrical and network feeds to these labs to keep them functional for the new technologies in demand by scientists today.

Rooms 218-219, 220A, 221- 222, 225, 227,229-230, 234-235A, 238-240, 242- 248, 250-251B, 255, 257

Third Floor – 665 nasm

Institute for Optical Sciences (IOS) – 332 nasm

The third floor of the undergraduate wing houses the institute for Optical Sciences (IOS). The Institute fosters connections between researchers in Quantum Optics, Photonics and New materials across the University, as well as in industry. At the core of the IOS' mandate is the development of constructive partnerships between university and Industry to optimally harvest the Universities intellectual capital. In the five years since its inception, it has been a great success establishing a reputation as a world-class centre and spinning off six companies: AttoDyne, NNT, Axele, Terachron, Opulux, and Femtonics (now OZ Optics).

Renovations to the IOS space will allow for improved laboratory faculties, isolated areas for proprietary research, and a proactive incubator facility in which IOS staff scientists would work directly with start up companies. These renovations include some demolition, construction of new fully fitted labs and support spaces, both full-height and half-height walls, and the installation of a kitchenette. This is renovated lab space within existing walls, and no change in space allocation is realized.

Rooms 331, 3331A, 331G, 332-332A, 335-337A,

Generic Physics Labs – 126 nasm

Space additional to the IOS space will be renovated for use by researchers and undergraduate students in Biological Physics, an area in which the Department of Physics is rapidly expanding. This new space would also accommodate research-grade laboratories with equipment to be used jointly between advanced undergraduates in Physics, Materials Science, Nanotechnology and Undergraduate research courses, along with graduate students and faculty.

These three existing labs will be renovated and finished to modern standards. These labs are currently mostly original to the building, and will require the addition of large amounts of power and data, new finishes and updated mechanical systems. These labs will remain empty of furnishings and benches to allow them to be fit out at a later date when the use of these rooms is determined.

Rooms 340, 342, 344

Physics Research & Instructional Laboratory Revitalization

Space Program

Floor	# Rms	Room Use	Nasm Per Room	Total Nasm
Basement		Infrastructure Upgrades Only		1,195
First Floor				
	1	Undergraduate 'Pod' Lab	139	139
	1	Undergraduate 'Pod-less' Lab	139	139
	1	Technologist Work & Storage Space	112	112
	1	Student Drop-in	47	47
	1	Student Lounge	406	406
	2	Lecture Halls	105	210
				1,053
Second Floor				
	2	Undergraduate 'Pod-less' labs	135	270
	1	Computational Physics Room	51	51
	30	Experimental labs	Combined	1,154
				1,475
Third Floor				
	3	Generic Physics Labs	35 (avg)	106
	1	Open Student Lab	30	30
	2	Private Rooms	14	28
	1	Optical Darkroom	25	25
	5	Research laboratories	varies	250
	1	IOS Research Labs Suite	332	332
				771
Total Nasm				4,494

c) Building Considerations

Accessibility, Access and Security

The University of Toronto is fully committed to ensure that its buildings and services are accessible to persons with disabilities. Although existing buildings regulations (Ontario Building Code) clearly define the minimally acceptable level of accommodating persons with disabilities, the design team must consider reasonable enhancements in design wherever possible.

Because of the diverse nature of the Physics Departments activities, the design must be sensitive to the needs of each specific user; research laboratories and support areas will have hours of operation that not only restrict access by the general public but also limit access to other building users, while the Incubator labs may want to restrict access to all but those who are directly a part of the specific incubator lab.

Building Systems Improvement Requirements

It should be remembered that the McLennan Physics Building is a significant user of energy and is also a major user of water. Any changes planned for this building should make reduction of these expensive resources a priority.

It is understood that the Faculty of Arts and Science's ambition is a number of laboratory renovations in the basement, second and third floors.

Hazardous Materials

A summary of the presence of asbestos containing materials is included as an Appendix. Detailed information can be obtained from the University's asbestos inventory system upon request. Prior to planning any renovation or demolition project a pre-construction survey must be carried out.

Heating, Ventilation and Air Conditioning Systems

A number of laser installations are located in the basement. During the 'shoulder' periods of the year – spring and fall – when the main chiller water supply from the central plant in the Bahen Centre is not operating, relative humidity levels may rise to a point where the electronic equipment becomes inoperable. A solution to this that the designers should consider is the installation of a winterized stand alone refrigeration system sized for this purpose as well as providing back-up should the main systems fail at any time. As well, it is recommended that the amount of direct city water cooling of research equipment be reduced by the introduction of air-cooled media for cooling the lasers ad other critical equipment.

If the computer lab planned for the second floor has substantial load, the design should incorporate revisions to the cooling system to suit.

If the third floor laser lab is included in the scope of the renovations, the air conditioning equipment serving this space should be replaced.

The control valves on all three floors should be replaced.

Plumbing

There have been a number of incidents of leakage from cast iron drain lines in the basement. These lines drain the roof above the labs and run above complex laser experiments and set-ups. The roof at the first floor street level of the building comprises the podium around the building exterior. As the drainage pipes are failing, and failing over research which is difficult to work above, a solution to the overall drainage of the podium needs to be found and implemented so that leaks will not continue to damage equipment and research on the basement level.

Electrical Power

Within the last two years, the source of the chilled water used for air conditioning the building was changed from a plant inside the Physics building to the central plant at the Bahen Centre. The old chillers were removed, freeing up additional power capacity.

The transformers, switchboard and high voltage switchgear as well as the distribution panels are original equipment. While there may be a few years of service left before replacement becomes

a priority, the extent of the renovations planned may require replacement of some or all of these components at this time.

Fire Prevention

Sprinkler protection may be required by Building Code for any areas undergoing major renovation.

Elevators

No elevator issues will impact this renovation

Building Fabric/Envelope

No building fabric or envelope issues that require inclusions in the renovations have been noted.

d) Environmental Impacts

The University of Toronto is strongly committed to the development and maintenance of exemplary strategies that are aimed at enhancing not only the campus but also the global environment. This commitment is set out in the University's *Environmental Protection Policy*, dated 7 March 1994 (Appendix A).

On campus, buildings represent the single most important element that affects the environment; they give it a recognizable form and are major consumers of natural resources in their construction and operation. Building design professionals have an inherent responsibility to foster good environmental practices as do building users and University administrators.

In order to encourage building designs that meets the University's environmental policy, an environmental section has been incorporated into the University's *Design Standards Manual*. This section obligates the design team to adhere to a set of environmental design principles which will be followed as each component part is completed.

e) Schedule

This project will proceed with implementation once funding commitments are in place. All work is expected to be completed by the end of 2010.

IV RESOURCE IMPLICATIONS

a) Total Project Cost Estimate

The total project cost estimate (TPC) for the project is $7,500,000, which includes estimates or allowances for the following:

- Construction costs (assuming lump sum type of tender to qualified general contractors in fall, 2009)
- Contingencies
- Taxes
- Hazardous waste removal
- Demolition
- Decommission of labs being vacated

- Permits and insurance
- Professional fees, architect, engineer, misc. consultants (LEED, etc.), project management
- Commissioning
- Escalation
- Moving and staging,

This cost is broken down as follows (within each section in order of priority):

Infrastructure Allowance for basement labs to repair leaking pipes due to podium drainage issues; and To provide sufficient temperature and humidity control for basement laser labs during shoulder seasons Replacement of city water cooled systems used for cooling lasers in basement labs, with efficient closed loop systems	$1,500,000
Teaching Spaces Allowance for renovations to two first floor undergraduate teaching labs and student congregation space; and Two second floor pod-less labs and one computational lab Renovations to 30 second floor undergraduate experimental labs	$5,000,000
Research and Incubation Space First Priority Allowance for renovations to Institute for Optical Sciences space Allowance for renovations to three generic Physics research labs on the third floor	$1,000,000

b) Operating Costs

The project incorporates energy saving initiatives with increased usage. It is anticipated therefore, that the operating costs will remain the same, i.e. that the increased usage will be offset by energy saving measures.

c) Funding Sources

This project is being submitted under the Federal Knowledge Infrastructure Program, identified as the St George Laboratory Revitalization for Physics and Chemistry. The Ontario government, in its budget of March 26, 2009, affirmed commitment to matching federal capital infrastructure investments in the Knowledge Infrastructure Program. No borrowing is required.

V RECOMMENDATIONS

THAT the Planning and Budget Committee recommend to the Academic Board:

1. THAT the Project Planning Report for the Physics Research and Instructional laboratory Revitalization in the McLennan Physical Laboratories Building be approved in principle.

2. THAT the project scope, comprising renovations of approximately 4,514 nasm at a total project cost of $7.5 million be approved, subject to the receipt of funding.

APPENDIX A – SCOPE OF PROJECT/PHASING/SECONDARY EFFECTS

1.0 Research Laboratory Infrastructure Upgrades

1.1 Rooms 10/11/18/21/33/33A/34/37/54/56/56B; HVAC Upgrades

Scope of Project

The purpose of this project is to provide upgraded HVAC services to these research labs, with a combined area of 1,195 nasm. This renovation includes the installation of an additional chiller to allow the labs to continue to enjoy a constrained temperature variable, and thus to remain operational during the shoulder seasons.

Due to the nature of the research equipment within the labs, most equipment will need to be crated on site in order to provide protection to the equipment while the work is going on overhead. It is unrealistic to try to vacate these labs for the HVAC upgrades to occur

Phasing Plans & Staging of Work

Each lab will need to be scheduled and coordinated on an individual basis, through discussions with the individual principal Investigators for each lab.

Project Schedule

Each lab will need to be scheduled and coordinated on an individual basis, through discussions with the individual principal Investigators for each lab.

2.0 Undergraduate Teaching Labs

2.1 Rooms 126(part)/126B; Pod-style Teaching Labs

Scope of Project

The purpose of this project is to provide one 139 nasm undergraduate teaching lab set up for pod-style learning within renovated space in the McLennan Physical Labs building.

- Room 126B is a 51 nasm room that will be renovated and combined for this purpose
- Room 126 is a 374.38 nasm room, of which part of it will be renovated and combined for this purpose.

This renovation includes demolition of a demising wall, removal of any asbestos or hazardous materials, and removal of aged electrical and mechanical systems

The renovation work will include new electrical, data and mechanical services. There will also be fixed pod-style work areas, audio-visual equipment, and glazing into the corridor.

This teaching lab will be approximately 139 nasm when completed.

Phasing Plans & Staging of Work

This lab will need to be renovated over the summer period, as it is required for teaching otherwise

Project Schedule

TBD

2.2 Rooms 126(part)/127/128/222/239; Pod-less Teaching Labs

Scope of Project

The purpose of this project is to provide two undergraduate teaching labs at 139 nasm each, set up for flexible learning, within renovated space in the McLennan Physical Labs building.

- Room 126 is a 374.38 nasm room, of which part of it will be renovated and combined for this purpose
- Room 127 is a 28.7 nasm room that will be renovated and combined for this purpose.
- Room 128 is a 64.65 nasm room, of which part of it will be renovated and combined for this purpose, providing one lab on the first floor of 139 nasm.
- Room 222 is a 138.07 nasm room, which will be renovated into a teaching lab
- Room 239 is a 137 nasm room, which will be renovated into a teaching lab

This renovation includes demolition of demising walls, removal of any asbestos or hazardous materials, and removal of aged electrical and mechanical systems

The renovation work will include new electrical, data and mechanical services. There will also be audio-visual equipment, and glazing into the corridor.

Phasing Plans & Staging of Work

These labs will need to be renovated over the summer period, as they are required for teaching otherwise

Project Schedule

TBD

2.3 Rooms 218/219/221/221A/221B/221C/221D/221E/225/227/229/230/234/234A/ 234B/235A/238/239/240/242/243/244/245/246/247/248/250/251/251A/251B/255/; Experimental Labs

Scope of Project

The purpose of this project is to upgrade existing experimental and labs within renovated space in the McLennan Physical Labs building. Combined, these renovations cover 1,154.39 nasm.

This renovation includes upgrades necessary to improve the environment, including removal of old flooring and any hazardous materials, and upgrade of aged electrical and mechanical systems

The renovation work will include additional electrical and data outlets, new flooring and paint, and radiation source shielding as required.

Phasing Plans & Staging of Work

TBD

Project Schedule

TBD

3.0 Student Support and Lounge Renovations

3.1 Rooms 125(part)/126(part)/136K; Study Lounge/Technologists Space/Storage

Scope of Project

The purpose of this project is to provide undergraduate study and lounge space, as well as quieter study space, technician workspace and equipment storage, within renovated space in the McLennan Physical Labs building.

- Room 125 is a 377.82 nasm room, of which part of it will be renovated and combined for this purpose
- Room 126 is a 374.38 nasm room, of which part of it will be renovated and combined for this purpose.
- Room 136K is a 42.68 nasm corridor that will be absorbed and combined for this purpose

This renovation includes demolition of demising walls, removal of any asbestos or hazardous materials, and removal of aged electrical and mechanical systems

The renovation work will include upgraded electrical, data and mechanical services, the creation of student lounge space and study space, and the creation of a technician's pod which will house workstations, storage, workbench area and quiet study area.

- Technologist Work and Storage space: 112.8 nasm
- Student Drop-in: 46.9 nasm
- Student Lounge: 406.0 nasm

Phasing Plans & Staging of Work

This area will not be able to be completed until the 2 undergraduate labs on the first floor have been completed.

Project Schedule

TBD

4.0 Upgrades to Existing Student Learning Space

4.1 Rooms 134/137; Lecture Halls

Scope of Project

The purpose of this project is to upgrade two existing lecture halls within renovated space in the McLennan Physical Labs building.

- Room 134 is a 105.84 nasm room that will be upgraded
- Room 137 is a 105.75 nasm room that will be upgraded.

This renovation includes acoustically isolating these rooms from adjacent study areas and each other, improvement to existing lighting, and aesthetic upgrades to the spaces

Phasing Plans & Staging of Work

This area will have to be scheduled for the summer months, as they are in use during the school year.

Project Schedule

TBD

4.2 Room 257; Computational Physics Room

Scope of Project

The purpose of this project is to upgrade an existing 50.7 nasm drop-in room for advanced students within existing renovated space in the McLennan Physical laboratories building

This renovation includes upgrades necessary to improve the environment, including removal of old flooring and any hazardous materials, and upgrade of aged electrical and mechanical systems

The renovation work will include additional electrical and data outlets, new flooring and paint.

Phasing Plans & Staging of Work

As this space is heavily utilized by students, it would be preferable to conduct the renovations during summer or over the Christmas break. If this is not feasible, Physics would be able to take this room out of service for a few weeks while renovations are occurring.

Project Schedule

TBD

5.0 Generic Physics Labs

5.1 Rooms 340/342/344; Generic Physics labs

Scope of Project

The purpose of this project is to upgrade 3 existing research labs and create 3 generic labs within renovated space in the McLennan Physical Labs building.

- Room 340 is a 38.16 nasm room that will be completely renovated and upgraded
- Room 342 is a 34.73 nasm room that will be completely renovated and upgraded.
- Room 344 is a 34.64 nasm room that will be completely renovated and upgraded

This renovation includes gutting the existing labs, removal of any hazardous materials, and removal of aged electrical and mechanical systems

The renovation work will include new electrical and mechanical services, upgraded data and communication lines, replacement of finishes, improvement of lighting and aesthetic upgrades. These labs are to provide generic space which can be used for varying functions as the need arises in the future.

Phasing Plans & Staging of Work

This project can be scheduled for any time, however the existing tenants will need to be vacated prior to any work taking place.

Project Schedule

TBD

6.0 Institute for Optical Sciences Lab Renovation

6.1 Room 332(part): Open Student Area

Scope of Project

The purpose of this project is to create a 30 nasm shared student area within the IOS space in the McLennan Physical Labs building.

The renovation work will include additional electrical and data to serve 8 students, cooling for and water hookups for lasers, as well as new furniture and furnishings.

Phasing Plans & Staging of Work

TBD.

Project Schedule

TBD

6.2 Rooms 332A/332B: Private Rooms

Scope of Project

The purpose of this project is to create 2 shared private experimentation spaces of 14.1 nasm each within existing room 332, part of the IOS space in the McLennan Physical Labs building.

The renovation work will include the addition of a demising wall and door, additional electrical and data to serve 2 persons, temperature and humidity control 24 hours/7 days per week, replacement of ceiling tiles, as well as new furniture and furnishings.

Phasing Plans & Staging of Work

TBD.

Project Schedule

TBD

6.3 Rooms 335A: Optical Darkroom

Scope of Project

The purpose of this project is to create a 25 nasm laboratory for light sensitive optical experiments and training, within the IOS space in the McLennan Physical Labs building.

The renovation work will include the addition of a demising wall and light control vestibule, additional power and data drops, temperature and humidity control 24 hours/7 days per week, new optical station, computer control station and optical components storage cabinet, and replacement of ceiling tiles.

Phasing Plans & Staging of Work

TBD.

Project Schedule

TBD

6.4 Rooms 331A/335/336/337/337A; Research Laboratories

Scope of Project

The purpose of this project is to create numerous research laboratories, within the IOS space in the McLennan Physical Labs building.

- 331A at 88.45 nasm; create a Characterization Instrument lab for research in Near-field Raman Spectroscopy, Surface Profilometry, Ellipsometry, Spectrofluorimetry, Spectrophotometry and optical microscopy.

- 335 at 26.37 nasm; create a Research Laboratory to be equipped with the biological and chemical instruments for development of bio-optical devices. The lab will need to accommodate student work space.

- 336 at 48.31 nasm; create a research lab compete with Electronics workbench and Computer research lab with workstations

- 337 at 43.12 nasm; create a Research Laboratory with lasers, motorized stages, fiber optics tools and other optics and opto-mechanics for test and characterization of optical devices. The lab will need to accommodate student work space.

- 337A at 43.66 nasm; create a University Research Laboratory for a femtosecond laser / flow cytometer combination. The lab will accommodate a laminar flow hood and an optical bench as well as student work space.

The renovation work will include additional power and data drops, temperature and humidity control 24 hours/7 days per week, new furniture and furnishings as well as equipment, upgraded lighting and mechanical services, fume hood (335) and replacement of ceiling tiles.

Phasing Plans & Staging of Work

TBD.

Project Schedule

TBD