

## 4. Plan for CLS' Scientific Future

Planning for the scientific future of the CLS involves careful consideration of a number of areas:

- existing infrastructure;
- capacity for new infrastructure;
- the user community (both existing and potentials for growth);
- the current and anticipated future direction of science;
- the vision and mission of the CLS; and
- our desire for (and capability for) innovation.

In this consideration, care must be taken to ensure that both human and capital requirements are identified and that a plan is in place to secure both in a timely fashion consistent with the vision and plan for the scientific future.

When creating a comprehensive plan, some overlap in action items and deliverables at the tactical level is unavoidable, such as between Goal 1 and Goal 4, and Goal 3 and Goal 4. Care will be exercised to coordinate these deliverables so as to avoid duplication of effort.

### 4.1 Maximize the use and development of experimental facilities

The CLS will have 21 beamlines operating within the next 3 years. The CLS has one undeveloped straight section and four bending magnet ports. Based on current best practice, the straight section could support one proposal with two or three closely related facilities, and the four bending magnet ports could provide light to one facility each. Thus, if all possible photon source points are fully developed, the CLS has capacity for up to 28 to 30 experimental facilities.

#### 1. Develop a scientific plan for the last straight section.

Typically, in the life cycle of experimental facilities, the time from initial concept to funded proposal has been somewhere between 3 and 5 years, followed by a construction period of 2 to 3 years. Thus, some of the available expansion ports could potentially source operating experimental facilities in the 2016 timeframe. The CLS intends to continue to support and develop scientific excellence in the Canadian and international research communities by embarking on a process to identify how best to use these photon ports, with an initial focus on developing the last straight section. The target for this initial program is to have a funded proposal in 2013, with the facility operational in 2016. Developing a successful experimental facility requires the identification of a significant research opportunity, the development of a community in support of a proposal and the development of the proposal itself. Each of these actions is achieved by holding expert workshops or development meetings, and the plan for these workshops is discussed below.

The most promising target communities for the last remaining straight section include environmental and earth sciences and life sciences. Workshops will be held in both of these areas in 2010. Outcomes of these workshops will inform the selection of a science program to develop a full proposal in 2011.

*Deliverables/Milestones:*

- Consult the national and international user community on the development of the last available straight section
- Consult the national and international user community on the development of the vacant bend magnet photon ports.
- Identify significant novel research opportunities to exploit the development of new scientific facilities
- Hold workshops to build science cases for new experimental facilities (2010)
- Submit proposals for new experimental facilities (2011)
- Develop an upgrade plan for accelerator facilities and provide needed additional infrastructure

2. Develop an infrastructure and upgrade proposal for CLS

As the CLS matures into an operational facility that is almost fully developed, it is clear that additional support infrastructure is necessary to optimally leverage the investment in advanced scientific instrumentation. This infrastructure includes expansion of the experimental hall to support the development of the last straight section and two of the remaining bend magnet ports, additional office space and meeting rooms for staff and visiting researchers and improved amenities for users, including:

- a building expansion to support the development of the last straight section and two of the remaining bending magnet ports \*
- upgrades to the accelerator complex to enhance the quality of all research at the CLS
- a controlled access wet laboratory to support enhanced industrial programs \*
- two new multipurpose laboratories for general users \*
- seminar rooms (one seating 200, two seating 15 and four seating 6)\*
- permanent teaching space for the outreach program, including a hands-on lab\*
- space for 10 long-term visitors (sabbaticants, consultants, etc.)\*
- space for about 50 additional employees \*
- additional warehouse space for handling remote access and on-site user samples and equipment\*
- a wellness centre, including a quiet reading room, a library, fitness equipment and a day care\*
- a guest house to accommodate 40 short- to medium-term visitors\*

- cafeteria with seating for 75\*
- connecting walkway/tunnel to VIDO (to facilitate transfer of animal models with special handling requirements – human pathogens for example) and to the Western College of Veterinary Medicine (animal storage). A connecting tunnel to VIDO may simultaneously provide the large meeting room and more efficient use of a centrally-located cafeteria\*

Some of these items, such as additional office and laboratory space, as well as meeting rooms and a lecture theatre are basic infrastructure that are crucial to address the short-term needs of CLS. They represent the basic infrastructure of any major research facility. Subsequent items strongly influence the quality of life of employees and users and are already present at other synchrotrons and similar international-calibre facilities. Thus, they must be considered in the context of any plan aimed at developing the CLS to its fullest potential.

*Deliverables/Milestones:*

- Conduct stakeholder forums (staff, users) to prioritize support infrastructure needs (2010)
- Seek out capital funding sources for developing support infrastructure (2011)

## 4.2 Grow the User Community

The CLS functions primarily as a user support facility. While many facilities are already at an optimal usage level, as new facilities become operational, and to stay current with and relevant to the research aims of the larger community, systematic development of our research community, both applied and academic, is crucial. To achieve optimal usage of the full facility, and the best and most productive science outcomes, CLS plans to work towards a doubling of its user community over the next three to five years. One additional principle investigator typically increases the pool of users by three to five people. Thus, adding one principle investigator per operating beamline next year would translate to about 40 new users. As a stretch target, CLS is proposing to attempt to annually attract one new international principle investigator and two new Canadian principle investigators per operating beamline in the next three to five years. In order to grow the community appropriately, CLS is developing a formal “mentors” team consisting of senior CLS staff and high profile CLS users. One or more members of this team will visit strategically targeted institutions and individual researchers.

### 1. Establish an international mentorship program.

The aim of this program is to attract 14 new international users in the next year and in each subsequent year. Basing this goal on current experience, visiting seven or eight international facilities will be required.

*Deliverable/Milestone:*

- Attract one new international principle investigator per operating beamline, per year, with focus on newly operational facilities and those that are not yet fully subscribed.
- Visit seven to eight international facilities annually

## 2. Establish a Canadian mentorship program.

Consistent with the above discussion, a reasonable stretch target is to attract, on average, one new principle investigator per operating beamline per year. In this discussion, it is recognized that some facilities are already operating at close to an optimal level. The success of these facilities will develop their communities with less focused attention from the CLS; instead, attention will be concentrated on newly operational facilities and on those whose use is not yet optimal.

Getting two new Canadian users per beamline per year could be achieved by a combination of visiting Canadian universities and continuing to hold targeted workshops in Canada. The CLS plans to visit 5 universities per year, and arrange time to speak with department members to learn their research needs and how we might be able to contribute to their research. At each university, CLS plans to visit the faculties of Medicine, Chemistry, and Physics, as these departments are most likely to utilize our facility, as well as other departments that may seem appropriate at specific universities. A second focus of this mentorship program will be to attract “non-conventional users” from departments that are not directly connected to natural sciences.

### *Deliverables/Milestones:*

- Attract two new Canadian principle investigators per operating beamline per year
- Hold targeted science workshops across Canada to promote the CLS and mentorship initiatives
- Visit five Canadian universities annually, targeting faculties of medicine, chemistry and physics.
- Workshops to inform the community development/mentorship process: CLS also plans to hold two targeted workshops each year for the next 2 years as community development workshops, one workshop for a next generation light source, and two workshops to develop proposals for the last straight section.

## **4.3 Examine all possibilities for future machine upgrades**

The major relevant parameters to consider for upgrade are stability, reliability, current and emittance, since these parameters directly affect the efficiency and capability of the scientific program at the CLS. In addition, upgrades that affect time-dependent experiments as well as pump probe experiments should be considered. Plans are already in place for enhancements that would deliver improved stability (top-up mode) and higher current (500 mA) (c.f. Goal 3).

### 1. Improve beam emittance

Most third generation sources, such as the CLS, are designed to deliver low emittance photon beams for those experiments that require the “brightest” photon beams (the ability to focus the largest number of photons into a very small spot is limited by the emittance of the electron storage ring). While there are a number of schemes which could lower the emittance of the storage ring, it is not clear exactly which scientific programs would benefit from this type of upgrade.

*Deliverables/Milestones:*

- Work with the Accelerator Operations Division to determine which scientific instruments would benefit from an upgrade to improve the emittance, what the cost of that upgrade would be, and when it could be delivered. In addition, this program would investigate proposed lattice changes (such as superconducting bending magnets to replace one or more bend magnets in the storage ring, or replacing bending magnets with a novel arrangement of variable field magnets specifically optimized to reduce lattice emission). (2011)

2. Conduct workshops to explore novel machines and next generation light sources.

While thoughts in these areas have not yet firmed, some proposals have been considered, including:

- Counter propagating electrons and positrons in the same storage ring. This may be possible once top-up and more RF power are available, and has the potential benefit that one or more very sophisticated beamlines could be built in which pump/probe experiments with full control of photon energy and polarizability in both the pump and the probe would be possible.
- Producing a 'small' free electron laser test bed\*
- Modifying the dipole and multipole structure in the existing storage ring for improved natural emittance\*

Several possibilities exist for novel machines that could be considered by an international workshop.

*Deliverables/Milestones:*

- Hold a workshop to explore ways to move beyond current facility limits to remain relevant in the international context and to innovate and enable new research directions. (2010-2011)

#### **4.4 Develop laser capabilities to support materials science**

Current directions in material science make advanced laser capability an almost indispensable tool. For example, the ability to laser align molecules within a sample to enhance polarization effects enables a range of new science capabilities and would be applicable to a number of existing experimental facilities. In addition, laser-based pump probe experiments and time slicing experiments would represent a significant enhancement to the range of science the CLS could investigate. The femtosecond laser community in Canada has already shown a real interest in developing programs at the CLS.

1. Investigate the development of laser capabilities at the CLS.

CLS plans to hold a targeted laser and fast timing workshop in 2010. This workshop would identify next steps and put in place a strategy to fund and implement laser capabilities at the CLS.

*Deliverables/Milestones:*

- Hold laser and fast timing workshop to identify next steps (2010)

#### **4.5 Create a Theory Group to support user and mentorship programs**

Modern synchrotron light sources are increasingly recognizing the need to provide better theoretical support to their user communities, especially in light of the growth and expansion of those communities.

##### **1. Establish a Theory Group at the CLS.**

An innovative partnership program is proposed in which the CLS would identify one or more partner Canadian universities. To participate in this program, a partner university would have an open tenured position for a theorist in a relevant discipline. The CLS would work with the partner university to recruit an appropriate junior level theorist and CLS would fully fund that theorist to work at CLS and with the user community for the first three years of the six-year (maximum) tenure track process. During this time, the faculty member would be resident at the CLS and travel to the partner university as required, and would engage with a user community and experimental program of interest to the theorist. During the last three years of the program, the theorist would be resident at the partner university and travel to the CLS as required. In the last three years, the CLS would fund a pro-rated portion of the salary and expenses of this individual. At the conclusion of the program, the position holder would be the responsibility of the partner university. This program has the benefit of fully integrating theorists and experimentalists and providing better theoretical support to our user community than the CLS could provide independently.

##### *Deliverables/Milestones:*

- Develop tenure-track joint partnership program between the CLS and Canadian universities.

#### **4.6 Establish an X-ray instrumentation and development program**

##### **1. Develop enhanced X-ray and optical instrumentation.**

To enable the ability to develop and characterize sophisticated materials, the CLS requires enhanced instrumentation in a number of specific areas, such as:

- To improve optical performance and minimize beamline downtime, a Laue camera and rotating anode X-ray source is envisioned;
- Acquire a sputtering/laser deposition system to increase CLS ability to develop and characterize sophisticated materials;
- Develop a polarimeter and other general instrumentation to monitor the degree and direction of polarization of both very soft (10s of eV) and soft (100s of eV) photons is needed. CLS proposes to develop a generally available polarimeter for this purpose; and

- Innovations in optical instrumentation to enable more precise control of photon beams and to enable dynamical aberration correction are proposed.

*Deliverables/Milestones:*

- Acquire a Laue camera and rotating anode X-ray source\*
- Acquire a sputtering/laser deposition system\*
- Develop a polarimeter and other general instrumentation to monitor the degree and direction of polarization of both very soft (10s of eV) and soft (100s of eV) photons\*
- Develop tools and methods to enable more precise control and dynamic aberration correction of photon beams