A Biomedical Imaging Facility at the Canadian Light Source

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Introduction

The Biomedical Imaging and Therapy (BMIT) is a national facility at the Canadian Light Source[1]. It is designed for the purpose of imaging biological tissue and conducting radiation therapy research using brilliant, synchrotron x-ray light. The BMIT research facility is part of the second phase of beamlines presently being constructed at the Canadian Light Source. The facility is projected to have usable light in mid to late 2007. A layout of the beamline and facility is shown in figure 1.

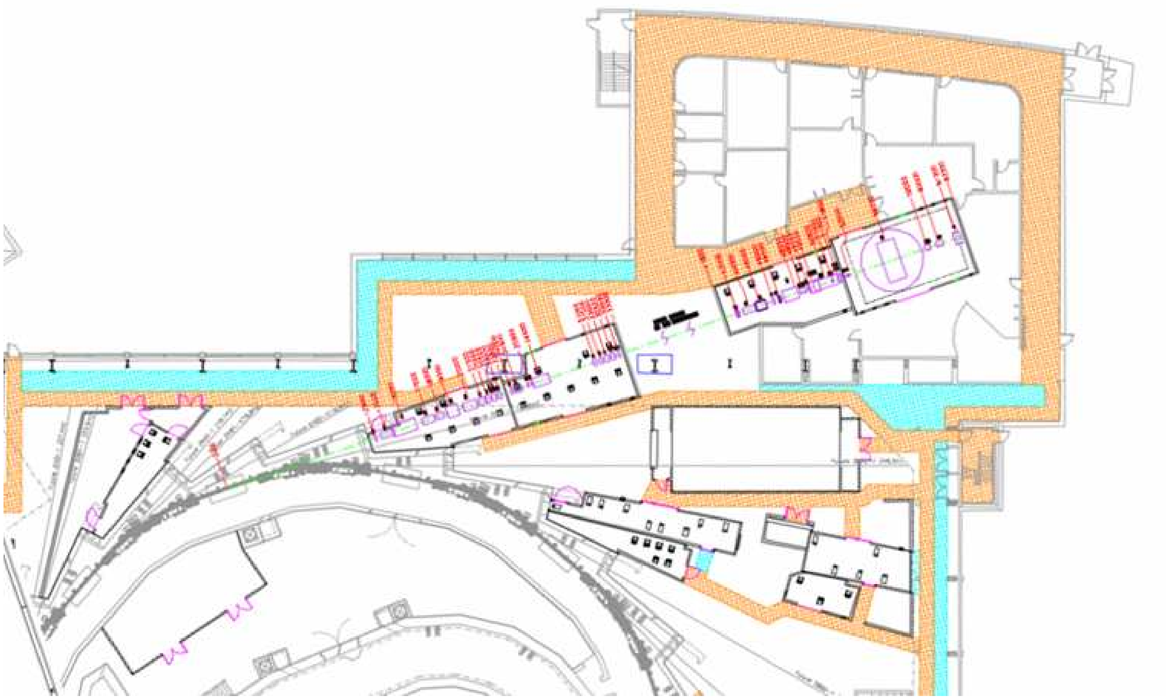

Figure 1 BMIT facility at the Canadian Light Source

Several features of this facility make it unique:

First, there are presently only two existing facilities with similar capabilities in the world, one at the European Synchrotron Radiation Facility in Grenoble, France[2] and a second at Japan's Spring-8 facility. A third is being constructed in Australia. BMIT is unique in that it is ideally located on the University of Saskatchewan's campus which exploits the proximity of the Colleges of Medicine, Veterinary Medicine and Engineering, as well as other related colleges, departments and organizations.

Second, the BMIT facility is designed to accommodate many species of animals, from mice to horses. It will have capabilities for imaging and radiation therapy research on humans, and a wide range of living animals and plants; the ability to image and treat large animals will be completely unique in the world. This flexibility will position the BMIT facility as one of the world leaders in biomedical imaging, and will greatly facilitate development of animal models of human disease as well as a potential direct benefit to animal health, which is of great importance in the western provinces.

Description

The facility includes areas for subject preparation (human, large and small animal), laboratory space for specimen preparation such as tissues, as well as beamline control and equipment areas. These areas are housed in an ~1100m^2 addition on the north face of the existing CLS. The BMIT facility will house two beamlines, one sourced from a bend magnet and the other from an insertion device. The insertion device beamline has a superconducting wiggler source that will provide the high x-ray energy spectrum (~15-100keV) necessary for the imaging and therapy programs for the bulk of the proposed research at the facility. The bend magnet beamline has a lower energy spectrum (~10-40keV) which will be used for development of new imaging and therapy methods, equipment development and testing, and for some less challenging imaging applications to remove some of the load from the insertion device beamline.

The beamline complex will have several operational modes that allow a number of synchrotron-based imaging and therapy modes[1,3]. Specifically, the imaging modes are monochromatic absorption imaging (AI), dual energy or K-edge subtraction imaging (KES)[4], phase contrast imaging (PCI)[5], diffraction enhanced imaging[6] / multiple image radiography[7] (DEI/MIR). These imaging modes can be applied in either projection (2-D) or computed tomography (3-D) mode. These methods can address research questions in human, animal, and plant systems regarding vascularization (KES), soft tissue visualization (PCI & DEI/MIR), lung development and function (KES, PCI, DEI), seed anatomy and early plant development (DEI/MIR), osteoarthritis (DEI/MIR), and cancer imaging (DEI/MIR, PCI, AI).

Microbeam Radiation Therapy[8] (MRT) and synchrotron stereotactic radiation therapy[9] (SSRT) are modalities available for radiation therapy research on the beamline. With MRT, extremely large doses of radiation can be delivered to highly targeted tumor sites while inflicting minimal damage to normal tissues. The use of monochromatic x-ray beams can also deliver targeted x-ray doses to tumors infused with a contrast material using the characteristic absorption of the contrast material in combination with a stereotactic treatment method (SSRT).