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Beamlines of the Biomedical Imaging and Therapy Facility at the Canadian Light Source - Part 2.

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Abstract. The BioMedical Imaging and Therapy (BMIT) facility provides a world class facility with unique synchrotron-specific imaging and therapy capabilities. This paper describes Insertion Device (ID) beamline 05ID-2 with the beam terminated in the first experimental hutch: POE-2. The experimental methods available in POE-2 include: Microbeam Radiation Therapy (MRT), Synchrotron Stereotactic Radiation Therapy (SSRT) and absorption imaging (projection and Computed Tomography (CT)). The source for the ID beamline is a multi-pole superconductive 4.3 T wiggler, which can generate ~30 kW of radiative power and deliver dose as high as 3000 Gy/s required for MRT program. The optics in POE-1 hutch prepares either monochromatic or filtered white beam that is used in POE-2. The Double Crystal (DC), bent Laue monochromator will prepare a beam over 10 cm wide at sample point, while spanning an energy range appropriate for imaging studies of animals (20-100+ keV). The experimental hutch will have a flexible positioning system that can handle subjects up to 120 kg. Several different cameras will be available with resolutions ranging from 4 μm to 150 μm. The latest update on the status of 05B1-1 bending magnet (BM) beamline, described in Part 1 [1], is also included.

1. Introduction

The BMIT facility will provide unique synchrotron-specific X-ray imaging and therapy capabilities [2]-[3]. As compared with other biomedical facilities in the world BMIT facility implements high load positioning systems and dedicated DEI setups for both BM and ID beamlines. It will be used to address unsolved problems in medicine (human and animal), agriculture, and other biomedical sciences. The BMIT facility is accessed for experiments in two hutches, POE-2 and SOE-1 (See Figure 1 in [1]).

The ID beamline shares POE-2 with the BM beamline for experiments. One advantage is that it will be possible to quickly move the subject between the BM and ID beams in POE-2 for imaging and therapy tests or to run two sets of experiments in parallel.

The Insertion Device beamline is intended to be used for testing of new ideas in imaging and therapy and to validate techniques initially developed on the bend magnet beamline including novel monochromators designs, near-edge and multi-energy imaging systems and new dosimetry

methods. Additionally, the ID beamline will host new imaging methods, such as imaging based on structural aspects of tissues by diffraction, absorption spectroscopy imaging, fluorescence imaging, and others. Such tissue characterization methods may form the basis of programs that will translate to clinical settings.

2. Source and Front End

2.1. Insertion Device - BMIT Multi-pole (25+2) Superconducting Wiggler

The Insertion Device [see Table 1] is multi-pole, cold-bore wiggler (1.4-4.3 Tesla with a period length of 48 mm, stored energy of 27 kJ and a pole gap of 14.5 mm) uses Nb-Ti superconductive wire and was designed [4] and fabricated [5] to provide a high energy spectrum (E_C > 20 keV) with a wide beam fan (K~20).

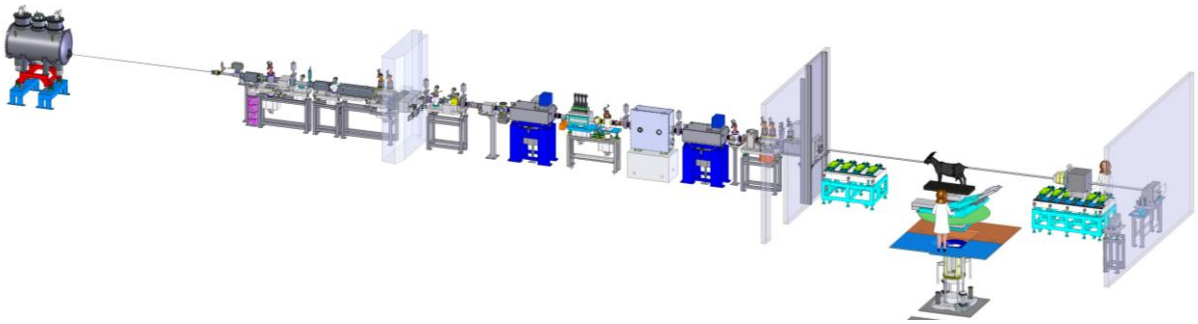

Figure 1 General Layout of 05ID-2 beamline

It has very high field/period ratio which allows effective use of radiation. Due to unique spectral properties of the source special care was required to design the shielding for the hutches [6].

Table 1 Wiggler Specifications

Parameter	**Value**	**Unit**
Magnetic Field, B_0 (max)	4.3	T
Critical Energy, E_C (max)	24	keV

on Kevlar fiber ribbons used for precise alignment of the magnet axis with e-beam axis. The magnet is energized with four 300 A/10 V power supplies. The control of the wiggler is achieved with a combination of a Junction Box and the MOXA PC and is integrated with facility EPICS system.

2.2. Front End components

The insertion device front end is typical of many CLS beamlines [7]-[8], except for the much higher power loads and radiation level observed [9]. The maximum horizontal photon beam angle is 6.4 mrad of which the ID beamline utilizes the central 4 mrad. The optics hutch allows both monochromatized beam and filtered white beam to be used in the experimental hutch. The monochromator will prepare a beam-width in excess of 100 mm with an energy range (20-100+ keV) appropriate for imaging studies in small and larger animal (up to sheep size) systems. The expected brightness of the source is $3x10^{12}$ ph/s/mA/mrad^2/0.1%BW @ 20keV.

The main components [9] of the Front End (FE) are: SC ID source, two fixed masks, (X-ray beam positioning monitor

4. POE-2 (Experimental Hutch)

POE-2 hutch was designed to accommodate as many experimental modes as possible, and to provide enough space for users to set up their own experiment equipment. The optics table in front of the hutch will hold shutters, collimators as well as ion chambers and other optical components. For the large samples we plan to use the MRT Lift [12] positioning system