BioMedical Imaging and Therapy (BMIT) Facility: Beamline 05B1-1

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Beamline Overview

Status	Design/Construction
Source	Bending Magnet
Monochromator	Double Crystal Mono (Bragg)
Spectral range	8 – 40 keV
Brightness	1.5×10^{11} ph/s/mr^2/0.1%bw/mA @ 10 keV
Resolving power	10^{-4}
Beam size	231 mm (V) x 4.6 mm (H) @ 23 m

Introduction

The BMIT labs will provide a world class facility with unique synchrotron specific imaging and therapy capabilities. It will be used to attack unsolved problems in both human and veterinary medicine, agriculture and other biomedical areas.

The bend magnet beamline is intended to be the location where new ideas in imaging and therapy are tested and validated for eventual translation to BMIT's insertion device beamline 05ID-2.

Science

The bend magnet will mirror some of the ID capabilities with computed tomography (CT), diffraction enhanced imaging (DEI) and phase contrast imaging in both CT and planar modes. This ability can help expand the experimental program of BMIT. Additionally, 05B1-1 will host new imaging methods, such as imaging based on structural aspects of tissues by diffraction, absorption spectroscopy imaging, and fluorescence imaging, among others. These new tissue characterization methods may form the basis of programs that will be transferred to beamline 05ID-2 or even to clinical settings.

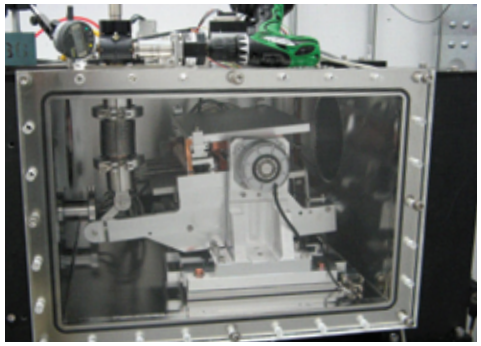

Figure 2 DEI Mono – side view

Layout

Front End & Optics Hutch

The front end of 05B1-1 is typical of many CLS beamlines except for the wide horizontal beam required for the wide field of view imaging program. The optics hutch allows both monochromatized beam and filtered white beam to be used in the experimental hutch. The monochromator is unique in that it will prepare a beam in excess of 20 cm wide in the experimental hutch while spanning an energy range appropriate for imaging studies in small and larger animal systems up to the size of a sheep.

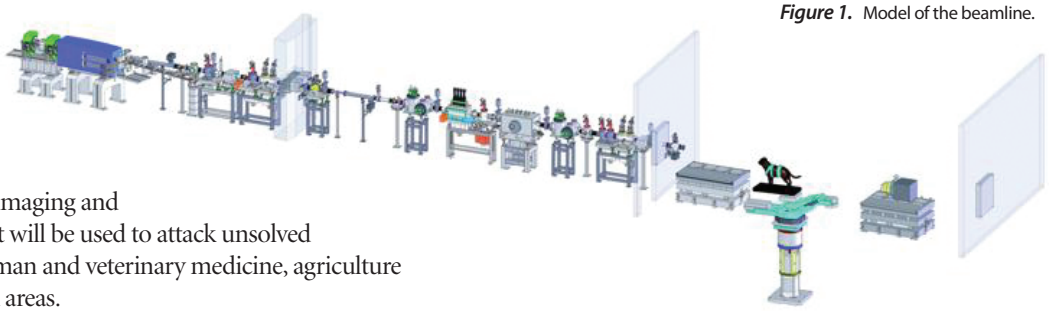

Figure 1. Model of the beamline.

Experimental hutch

The experimental hutch will have a flexible positioning system which will allow imaging (CT and planar imaging) as well as radiation therapy application with both filtered white and monochromatic X-ray beams. The monochromatic spectral range will span 8–40 keV.

Performance

The CLS built monochromator was successfully tested in November 2007 (see Timelines). The tests were carried out using the bending magnet port in the SYLMAND POE with an "in-house" analyzer system. The mono is designed for a wide beam application using 254 x 100 x 24 mm, large Si (220) ±0.05° crystals. These crystals are utilized to cover the higher energy range of the beamline, 20–90 keV. From the initial tests it appears that this monochromator is as stable as any commercially available mechanism. It is very pleasing to see that we can lead in the development of new instrumentation.

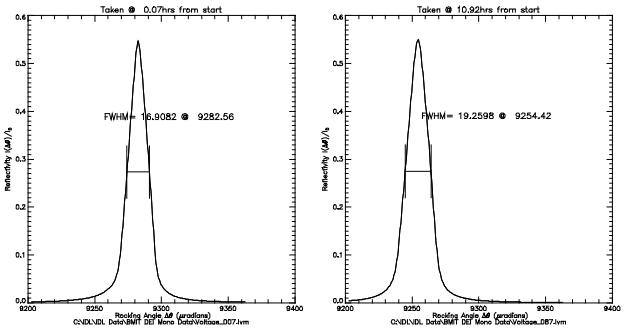

Figure 3 First (left) and last (right) rocking curves of the DEI mono crystal.

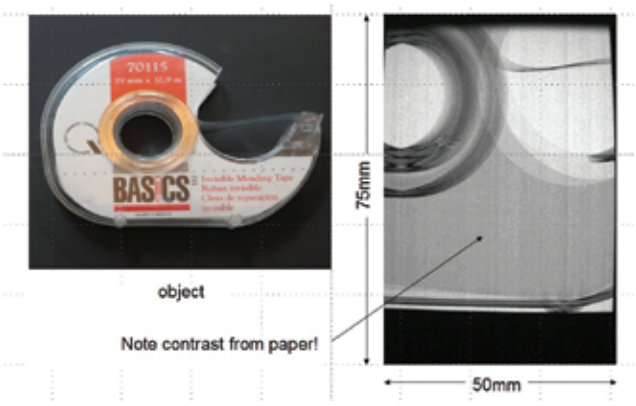

Figure 4 First image at analyzer peak, 22 keV, Si (1,1,1).

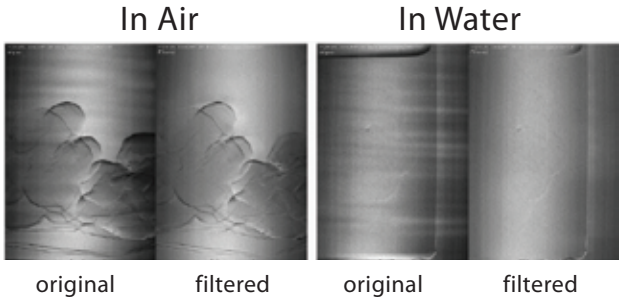

Figure 5 Porcine ovaries with Si(3,3,3) at 42 keV. Samples courtesy Gregg Adams, images acquired by Brian Bewer and Honglin Zhang.

BMIT Beam Team Executive

The BMIT beam team includes researchers from across Canada. Members of the beamteam executive include:

- Gregg Adams, Western College of Veterinary Medicine, University of Saskatchewan
- Kaiser Ali, Saskatoon Cancer Centre, University of Saskatchewan
- Dean Chapman, Anatomy & Cell Biology, University of Saskatchewan
- Gino Fallone, Cross Cancer Institute, University of Alberta
- Bernie Juurlink, Anatomy & Cell Biology, University of Saskatchewan
- Ed Kendall, Biochemistry, University of Saskatchewan
- Robert Leclair, Physics, Laurentian University
- Bruce McManus, Pathology & Lab Med, University of British Columbia
- Corey Miller, Medical Imaging, Saskatoon Health Region
- Stephen Pistorius, Medical Physics, CancerCare Manitoba
- Declan Quinn, College of Medicine, University of Saskatchewan
- Tomasz W. Wysokinski, Beamline Scientist, CLS

Conclusion

The BMIT bend magnet beamline will provide a testing ground for many of the ID components including monochromators and detectors, a place to develop new imaging technologies, as well as offloading some of the imaging research from the ID beamline.

References

http://www.lightsource.ca/experimental/bmit.php

T. W. Wysokinski, D. Chapman, G. Adams, M. Renier, P. Suortti, and W. Thomlinson, NIMA 582 (1) (2007) 73-76.

Acknowledgements

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Timelines:

Date	Item
July 2007	Hutches Installed
November 2007	DEI Mono test
March 2008	05B1-1 Installation Starts
June 2008	ACIS system V&V
July 2008	Radiation Survey
August 2008	X-ray Optics Installation
September 2008	05B1-1 Commissioning Starts