

Bio Medical Imaging & Therapy (BMIT) Beamline

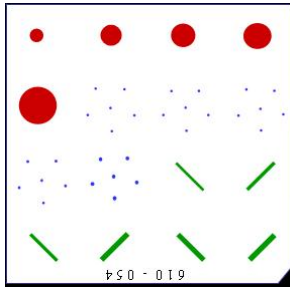
The BioMedical Imaging and Therapy beamline is designed for the purpose of imaging biological tissue and conducting radiation therapy research, and provides a world-class facility with unique synchrotron specific imaging and therapy capabilities. It will be used to address unsolved problems in medicine (human and animal), agriculture and other biomedical areas. This facility will consist of two beamlines - one using a bending magnet to produce light and one using a powerful superconducting wiggler. There will be three endstations for doing experiments. Users are protected from the radiation by lead filled walls that weigh more than 450 tons. These beamlines will provide advanced medical tissue imaging in unprecedented detail. They will be capable of several imaging techniques in both projection and computed tomography (3D) modes. Additionally, the insertion device beamline will have a capability for microbeam radiation therapy (MRT), monochromatic beam therapy methods and synchrotron stereotactic radiation therapy (SSRT). The insertion device beamline, operating within the X-ray range of 20000-100000 eV is designed for imaging and therapy research primarily in biomedical systems, from mice to horses to humans, as well as tissue specimens including plants. The BMIT facility will address the interest of scientists and clinicians to develop diagnosis and treatment techniques of cancer (breast tumours and paediatric oncology), circulatory and respiratory disease (heart disease and asthma) neurological and behavioural disease (brain and spinal cord injuries, epilepsy), reproductive dysfunction (infertility, menopause, and contraceptives), musculo-skeletal disease and kinesiology (arthritis, athletic injuries), and dental conditions (temporomandibular disease). It will also serve in the development of new imaging methods and extending present imaging capabilities. The bending magnet beamline, operating at an energy range of 8000-40000 eV, will be used for imaging experiments and for testing and developing new ideas in imaging and therapy to be later used on the insertion device beamline.

Microbeam Radiation Therapy (MRT) uses several parallel, superfine (approximately 25 μ m wide spaced approximately 200 μ m apart) beams of high energy x-rays to destroy tumour cells while minimizing the damage to surrounding healthy tissue through which they pass.

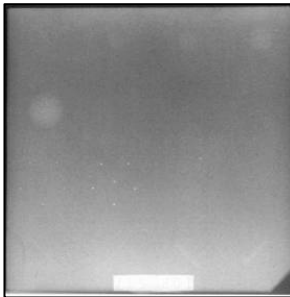
Synchrotron Stereotactic Radiotherapy (SSRT) is a technique where the target cells are loaded with high Z-elements (such as iodine or gadolinium) then irradiated with synchrotron x-rays the appropriate wavelengths to be absorbed by that specific element, essentially 'cooking' the tumour from the inside out.

Diffraction Enhanced Imaging (DEI) allows for greatly enhanced contrast of soft tissues and bones along with a reduction in the X-ray dose. This contrast in an image is a result of X-ray absorption as well as rejection of scattered beam. Diffraction Enhanced Imaging utilizes a second crystal analyzer within the experimental set up. Digital images are taken at different analyzer positions and combined to produce apparent absorption and refraction images of the object. The effects of refraction and absorption can be separated by taking two images at positions on opposing sides of the rocking curve.

To help explain, Dr. Dean Chapman (Canada Research Chair in X-Ray Imaging at the University of Saskatchewan) has provided the following images of x-ray mammography equipment tests:

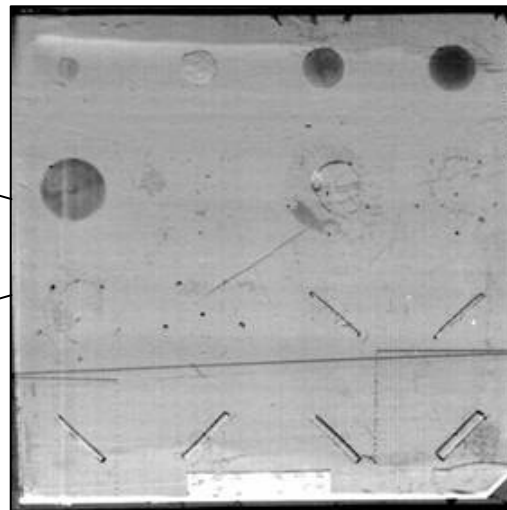
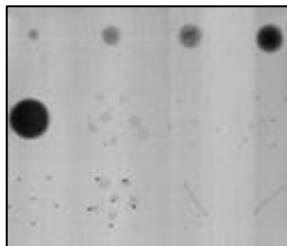
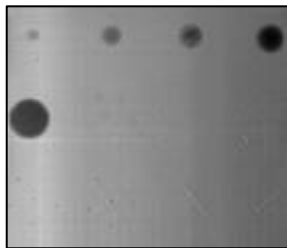


This is the 'map' of the test, a plastic surface with simulations of various types and stages of cancerous tissues affixed to it. This test is wrapped in a gelatinous bag to simulate the breast tissue and then subjected to a mammogram.



This image is a conventional X-ray of the test. Mammography equipment passes if roughly half of the features are visible.

DEI requires that two images be taken at slightly different settings. These images are digitally 'subtracted' leaving a much higher contrast image. There are a couple of new companies that are developing ways to adapt DEI techniques so that they can be used with x-ray sources that are typically used in medical facilities.





This image of a mouse is the first DEI taken at CLS (Chapman, D. et al., Canadian Light Source Activity Report 2008. p 141) Compare the detail it provides with a radiograph (or conventional x-ray).