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DEVELOPING MODERN BIOMEDICAL IMAGING AND THERAPY FACILITY AT THE SYNCHROTRON – CHALLENGES AND UNKNOWNS

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The BioMedical Imaging and Therapy (BMIT) laboratory will provide a world class facility with unique synchrotron-specific imaging and therapy capabilities. The facility consists of the Insertion Device (ID) beamline 05ID-2 and the bend magnet (BM) beamline 05B1-1. These beamlines are designed for imaging and therapy research primarily in biomedical systems, as well as tissue specimens including plants. The experimental methods available include: Microbeam Radiation Therapy (MRT), Synchrotron Stereotactic Radiation Therapy (SSRT) and imaging (KES, DEI, projection and computed tomography) [1].

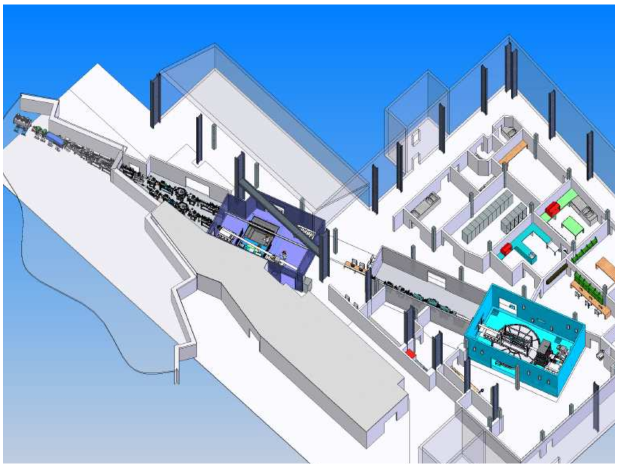

Figure 1. Top view of the BMIT hutches and laboratories.

Proposed research program defines the technical requirements for the facility [2] that includes the hutches and accompanying laboratories including patient and animal preparation rooms. Biomedical programs in general require wide and uniform beam (10-20 cm required, up to 40-50 cm is preferred), which in turn necessitates either very wide beam (the maximum horizontal photon beam angle for 05B1-1 is 19.54 mrad of which the BM beamline utilizes 10 mrad) or a large distance from the source (60 meters for the 05ID-2 line). Such wide beams require specialised imaging device – cameras.

Samples can vary from very small to very large and heavy (hundreds of kilograms). They need to be restrained, which requires a variety of different holders and restraint systems. Large samples require very large hutches and preparation areas with the appropriate entrances and doors. When dealing with live subjects one has to minimise the delivered dose, in case of imaging, cameras with very fast readout times are needed.

The therapy experiments on the other hand, require delivery of dose as high as 3000 Gy/s (MRT program). To generate such dose in BMIT case a custom multi-pole superconductive 4.3 T wiggler is required; it can generate 30 kW of radiative power (500 mA, 2.9 GeV).

This paper describes the pathway for the development of BMIT facility as well as challenges faced during development, such as space requirements for the positioning system than can handle hundreds of kilograms loads with the required accuracy.

Most challenging components of the beamlines are identified: Insertion Device, filters, shutters including collimators and beam-stops, monochromators, X-ray windows, positioning systems and the cameras. An important part of the project is the personnel and patient safety system.

When starting the biomedical program of such scale all the regulatory issues related to facility design and operation need to be reviewed. As it turned out, the cost of implementing the proper air handling system was one of the main cost driving factors for this project.

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References

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