Project name: **Radiation Beam Characterization and Dosimetry for Radiobiological Experiments at the SARRP Facility**

Introduction

The study of the biological effects of ionizing radiation plays a crucial role in the development of modern radiotherapy techniques for cancer treatment. In recent years, radiobiological experiments involving laboratory animals have become increasingly important due to two major advances: (1) the development of sophisticated animal tumor models with clinically relevant microenvironments and (2) the availability of image-guided irradiation systems that closely reproduce clinical radiotherapy procedures.

In addition to oncology research, investigations of radiation effects on the central nervous system are of significant interest in the field of space radiobiology, where accurate assessment of radiation-induced biological responses is required.

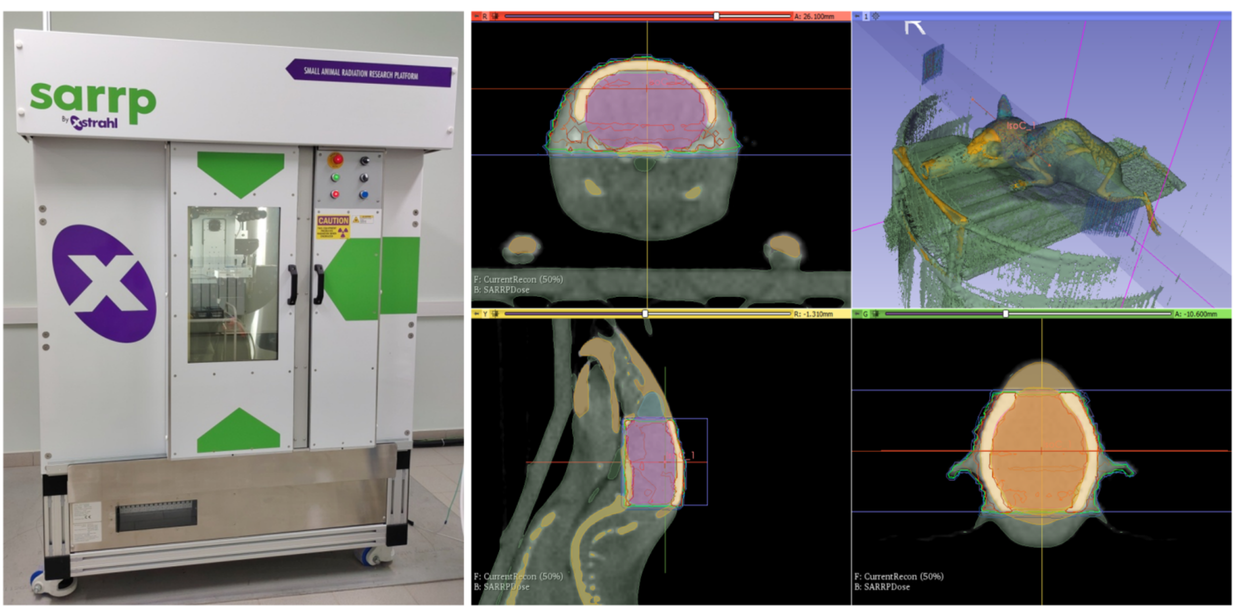

Figure 1: Left: Small Animal Radiation Research Platform (SARRP). Right: Examples of treatment planning in the MuriPlan TPS

The Small Animal Radiation Research Platform (SARRP, Figure 1) is a dedicated image-guided irradiation system designed for high-precision radiobiological studies. The experimental workflow consists of three major stages:

1. Acquisition of computed tomography (CT) images and three-dimensional reconstruction of the subject anatomy.

2. Contouring of the planning target volume (PTV) and organs at risk (OAR), followed by treatment planning using the MuriPlan treatment planning system (TPS).

3. Transfer of irradiation parameters to the SARRP control system and delivery of the planned radiation treatment (Figure 2).

Accurate characterization of the radiation beam is essential for ensuring the reliability, reproducibility, and comparability of radiobiological experiments. This requires both absolute and relative dosimetry performed using calibrated instrumentation and established dosimetric protocols. In addition, knowledge of photon energy spectra is important for understanding beam quality and radiation interactions within biological tissues.

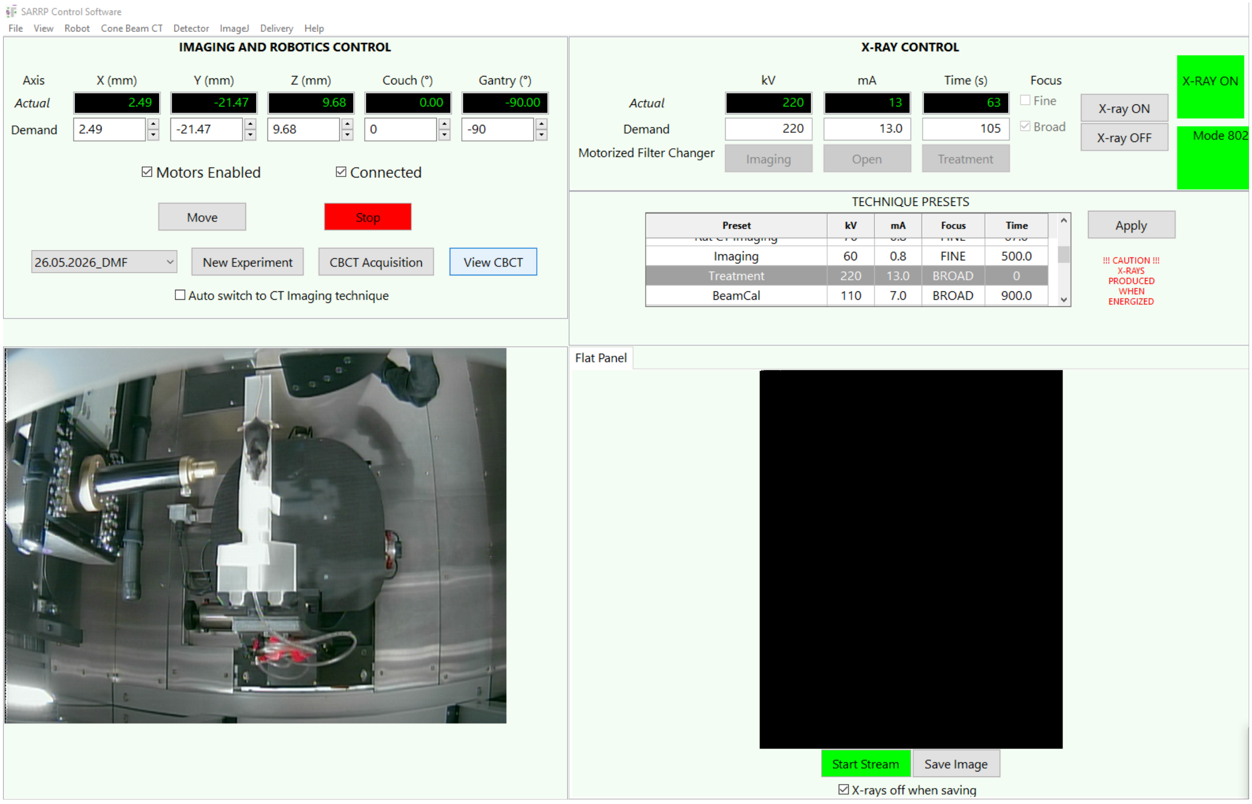

Figure 2: SARRP control software of irradiation unit

Project Objectives

The project aims to provide students with practical experience in radiation beam characterization, dosimetry, and treatment planning for preclinical radiobiological research.

Practical Tasks

1. Calculation and analysis of X-ray photon spectra for different SARRP operating conditions using the SpekPy Python package.

2. Absolute dosimetry measurements using a PTW Unidos electrometer and calibrated ionization chambers (Farmer-type and plane-parallel chambers).

3. Relative dosimetry using EBT3 and EBT4 radiochromic films, including evaluation of beam profiles and dose uniformity.

4. Treatment planning for small-animal irradiation experiments using the MuriPlan treatment planning system.

Expected Learning Outcomes

By the end of the project, students will be able to:

- calculate and analyze kilovoltage X-ray spectra;
- perform absolute and relative dosimetric measurements;
- evaluate basic X-ray beam characteristics and dose distributions;
- use radiochromic film dosimetry techniques;
- create and evaluate irradiation plans in the MuriPlan TPS;
- understand quality assurance requirements for preclinical irradiation experiments.

Prerequisites

1. Basic Python programming skills;
2. Basic knowledge of radiometry and radiation dosimetry;
3. Basic understanding of radiotherapy principles.

Number of Participants: up to 2 persons.

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