***STANDARD OPERATING PROCEDURE – E007***

**Using small-angle scattering X-ray generator**

1. **Objectives**

The objective of this document is to establish standard operating procedures for using small-angle scattering X-ray generator, ensuring the safety of laboratory personnel by mitigating potential risks associated with hazardous materials, and injuries. Additionally, this SOP aims to enhance the efficiency of experimental workflows.

1. **Personal Protective Equipment**

To ensure safety when using small-angle scattering X-ray generator, appropriate personal protective equipment (PPE) must be worn. This includes:

* Long pants and closed-toe shoes to protect against spills and splashes.
* A long-sleeved, buttoned lab coat to minimize skin exposure.
* Safety glasses or goggles to protect against splashes or flying debris.
* A personal dosimeter must be worn by personnel working with x-ray.
* Disposable nitrile gloves to prevent direct contact with hazardous materials.
* Insulated gloves for handling high-voltage components, if maintenance is required.
* If the user has long hair, it should be tied back.

Laboratory workers with **pre-existing conditions,** including but not limited to allergies, immunocompromised states, chemical sensitivities, or those who are pregnant or planning pregnancies should notify their supervisors and medical specialists. Should any concerns be expressed by these workers, their job duties and activities should be reviewed.

1. **Potential Hazards**

Using small-angle scattering X-ray generator presents various hazards that must be managed to maintain a safe working environment. This includes:

* **Radiation Hazards:** Direct, prolonged exposure to X-rays can cause severe burns, DNA damage, and increased cancer risk. Scattered or leaked radiation from misaligned equipment or improper shielding.
* **Electrical Hazards:** Electrocution risk due to high-voltage components (e.g., X-ray tube, power supply). Faulty wiring or improper grounding may lead to electrical fires.
* **Mechanical Hazards:** Pinch/crush injuries from moving parts (e.g., sample stages, shutters). Vacuum-related hazards (implosion risk if equipment is compromised).
* **Bypassing Safety Circuits:** Tampering with interlocks or safety systems is prohibited unless authorized maintenance.
1. **Training / Licenses**

Ensure all personnel have received proper training on their hazards and safe handling techniques. All users that will use X-ray must complete the relevant training and undergo medical surveillance and register as a radiation worker prior to start of work.

* MC01 Radiation Safety with Unsealed Radioactive Materials
* MC02 Radiation Safety with Sealed Radioactive Materials and Irradiating Apparatus
* DC04 Electrical Safety

Ensure the licenses for the apparatus, users, and workers remain valid.

1. **Procedures**
2. Pre-Operation Checks
* The risk assessment for X-rays should be read and understood by all users prior to the use of the X-ray generator.
* Inspect the X-ray generator for any visible damage or irregularities. If the equipment does not appear to work as expected, stop all work immediately. Arrange for the equipment to be checked and repaired if necessary.
* Ensure that all safety equipment, including emergency shut-off switches, is functional.
* Check the area is free from unnecessary personnel and that warning signs are posted
1. Powering up
* Voltage and current should be slowly increased over time, rather than immediately changed to the desired number.
* Safety circuit must not be bypassed or disabled while powering up and during the use of the x-ray generator.
1. Using the X-rays
* When the X-ray Release vacuums on the camera of choice.
* The vacuum of the camera of choice should be released.
* Load sample in the cell and then close the sample cell
* Evacuate camera. It is impossible to open the shutter unless the camera(s) are under vacuum.
* Dual button shutter control is required to open two shutters. Press “Shutter open enable” button in combination with “Open”.
* Press “Close” to close the shutter.
* The CCD QUANT software is used to run experiments. When the sample has loaded, the X-ray generator does not need to be operated other than to open or close the shutter.
1. Powering Down:
* Ensure that **BOTH** cameras are under vacuum. Both vacuum valves can be closed. The vacuum controller “Start / Stop” button can be pressed to stop pumping and the vacuum controller can be turned off from the backside.
* The current can be slowly decreased by pressing the right-side button once every 3 seconds until the voltage reads 20 kV. The system will be in standby mode (**20 kV / 10 mA**).
* To shut down the system:
	1. Turn the HT key anticlockwise to the “OFF” position.
	2. Press the “OFF” button to shut the system down
* A log should be kept when using the system and when it is turned off.
1. **Incident Reporting**
* Any accidents that result in injuries must be reported to the PI and/or the departmental safety officer (DSO) immediately.
* In the case of serious incidents, immediately inform the security unit by calling the 24-hour hotline on **2358 8999**.
1. **References**
* Kwan, A. & FitzGerald, P. (2016). *SOP\_SMB027: Using small-angle scattering X-generator (SAXSess Lab).* Risk Assessment. The University of Sydney.
* Coleman, N. & Trewhella, J. (2014). *SOP SMB027.2 (JT NC 0314): Using small-angle scattering X-ray generator (SAXSess Lab).* The University of Sydney.