

# Remote Handling Refurbishment Infrastructure for the ISAC High-Power Target Facility at TRIUMF

Isaac Earle<sup>1</sup>, Grant Minor<sup>1</sup>, Alexander Gottberg<sup>1,2</sup>

<sup>1</sup>TRIUMF,  
4004 Wesbrook Mall, Vancouver, BC, V6T2A3, Canada

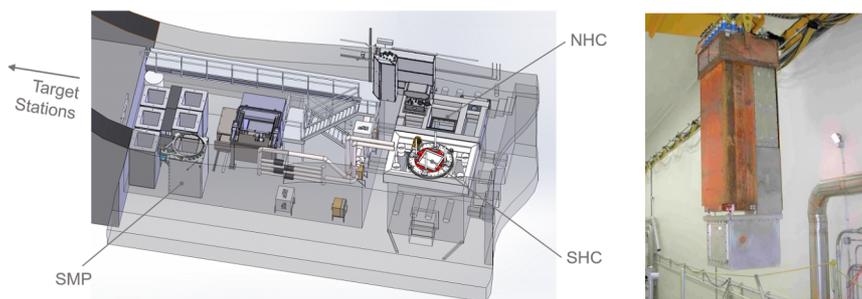
<sup>2</sup>University of Victoria,  
3800 Finnerty Rd., Victoria, BC, V8P 5C2, Canada

Corresponding Author : Isaac Earle <iearle@triumf.ca>

## 1. The ISAC Facility & Target Hall at TRIUMF

TRIUMF laboratory, Canada's particle accelerator centre, currently operates a rare isotope beam production facility called ISAC (Isotope Separator and ACcelerator) [1] which is supplied with a 500MeV proton driver beam with up to 50kW total power from TRIUMF's main cyclotron. In the ISAC facility, commissioned with first beam in 2001, the accelerated proton beam is impinged upon targets made of various materials to produce rare isotope species for studies in various different fields such as experimental nuclear physics, astrophysics, material science and nuclear medicine. The activated spent target assemblies (approximately 40 x 25 x 20cm<sup>3</sup> and up to 1Sv/hr at 0.5m) are exchanged every 3-5 weeks, with beam alternating between two different target stations. This allows continuous radioisotope production while facilitating cool-down of the spent target, remote target exchange, and remote conditioning of the new target in the off-line station.

The target stations are located within the ISAC Target Hall [2], a heavily shielded room approximately 42m x 5.5m which also houses spent target storage vaults, two hot cells, and various other support equipment. The ISAC facility was initially built with one hot cell in the Target Hall, called the South Hot Cell (SHC), located in the southern-most of two shielded cavities intended for cell installations. The SHC has a rotatable and adjustable-height support flange that can accept modules remotely. In 2019, construction and commissioning of a dedicated target exchange cell, the North Hot Cell (NHC), was completed.



**Figure 1.** Layout of the ISAC Target Hall & target module being transport by crane

## 2. ISAC Target Module Remote Handling

The replaceable target assemblies are installed onto “target modules”, large shielded assemblies approximately 3.3m tall and weighing 9000kg (Fig. 1). The modules provide shielding and all services required for target operation including vacuum, water cooling, high voltage, and diagnostic signals.

Modules are transported using the Target Hall 10t overhead crane, operated remotely from a crane control room in a safe shielded location. The Target Hall crane has redundancy built into the bridge, the trolley drive systems and the hoist. However, the crane hook rotation stage does not have a redundant backup. Because of this the SHC has so far had to be empty during periodic module moves in the Target Hall so that if hook rotation drive fails the module can be safely landed there while the crane is repaired. This frequent interruption of SHC operation has been prohibitive for long-term module refurbishments, which has developed into a main limitation of the facility. TRIUMF currently operates a fleet of four different target modules (TM1 – TM4), specified to operate at up to 60kV bias and with 100 $\mu$ A of proton beam intensity. Due to lack of regular maintenance, all four modules are suffering from reliability issues and none currently meet the full specification.

### 3. Target Module Maintenance and Repairs

Repairs and component replacement on each module typically requires 2-4 weeks in the SHC with rotatable support flange (several months of preparation are required in advance to manufacture replacement parts and plan the work). Until completion of the NHC in Spring of 2019 the SHC has been the only location where routine target changes can be performed, the interruptions from which severely hindered module maintenance efforts. Furthermore, until completion of the Safe Module Parking (SMP) project, scheduled for completion in mid-2019, modules in the SHC must be removed from the cell any time a different module is transported in the Target Hall, which occurs approximately once per week.

Completion of the NHC and SMP projects will allow the SHC to become a dedicated module maintenance cell. This will enable TRIUMF to implement a sustained refurbishment strategy in which each module will undergo repairs and preventative maintenance in the SHC once every four years on a rotating basis.

### 4. North Hot Cell

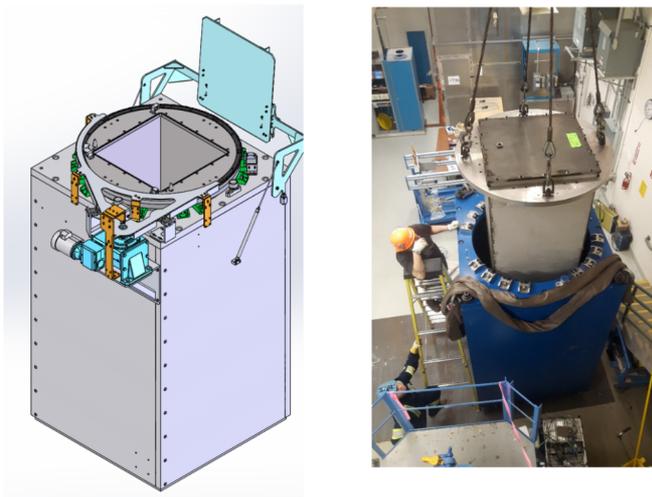
The ISAC North Hot Cell system is a dedicated target exchange hot cell located on the B2 (sub-basement) level of the ISAC Target Hall in a shielded room, directly north of the SHC. The NHC is designed to accommodate removal and installation of targets on the module, helium leak checking water and vacuum connections, electrical checks of the target, post-irradiation examination of target assemblies, and target waste packaging. The NHC project was initiated in Spring of 2016 and completed in March 2019.



**Figure 2.** North Hot Cell interior 3D model and interior / exterior photos of completed installation

## 5. Safe Module Parking

The SMP system is a storage location for ISAC target modules. A steel shielding enclosure (blue structure in Fig. 3) allows for dose rates compatible with human occupancy even with a recently irradiated target module present. The modules are supported by a rotatable flange, which allows the system to function as a redundancy for Target Hall crane hook rotation. The flange is connected to a vacuum vessel below, which prevents the spread of radioactive contamination from the modules. It also allows for a vacuum to be pulled on the vessel, facilitating leak checking of modules in the SMP and safe storage of modules with oxygen sensitive targets. The SMP has local and remote controls and camera views on the support flange for remote rotational alignment to the module. The SMP project was initiated in mid-2017 and is scheduled for completion in mid-2019.



**Figure 3.** 3D model of the SMP assembly & installation of vessel into shield box

## 6. Conclusion

With the North Hot Cell recently commissioned and the Safe Module Parking system scheduled for completion this year, module refurbishment work will soon proceed unhindered in the SHC. This will allow TRIUMF to restore the fleet of target modules to their design specifications and to perform the required on-going maintenance to ensure reliable delivery of rare isotope beam in the ISAC facility for years to come.

## References

1. J. Dilling, R. Krucken, G. Ball. (2014). ISAC Overview, *Hyperfine Interactions*, Vol. 225, pp 1-9
2. G. Minor, I. Earle, A. Gottberg. (2017). High Power ISOL Radioactive Target Remote Handling at TRIUMF, Hotlab 2017 – Annual Meeting on Hot Laboratories and Remote Handling. Mito, Japan