A Technology Transfer Example for the Case of a Solid Target Station

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Abstract. This paper is comprised of two parts. First, the technology transfer process from TRIUMF to licensee, for a Solid Target Station (STS) technology, circa 2005, capable of 15 kW beam power is described with ‘lessons-learned’. Second, technical evolutions are described for D-Pace’s resultant industrial versions of the technology: (i) nominal TRIUMF design with 5° target bombardment glancing angle; and (ii) design with 90° angle.

1. Introduction of Nominal Solid Target Station Specifications. The TRIUMF Solid Target Station (STS) technology (Figure 1) is specified to handle 15 kW beam power into the target station (typically 500 µA H+ @ 30 MeV). The beam passes through a graphite beam halo scraper with current readback (aperture: 22 mm vertical x 44 mm horizontal) capable of intercepting 60 W beam power at interlock trip current (2 µA), but typically intercepting no beam current. The beam then passes through Top/Bottom/Left/Right collimators with beam current readback that defines a target aperture size (6.45 mm vertical x 30 mm horizontal). The collimators handle 1.35 kW beam power at interlock trip (45 µA trip) but nominally intercept 0.6 kW on each collimator to ensure beam is broad on target. The nominal licensed technology has target glancing angle of 5°, so the beam deposition area is 74 mm x 30 mm. The mounted target has a secondary electron catcher (+100 V bias), and average proton current on target: 420 µA (12.6 kW).

2. Technology Transfer Process. TRIUMF utilized a template license agreement. Key features were: (i) appendices to clearly specify technology, (ii) statements that the lab’s technology documentation shall be provided “as is”, (iii) terms permitting licensee to contract lab technical staff for questions, clarifications, and design review (iv) payments on royalty basis against actual sales (i.e. no up front payments other than labour for technical assistance), (v) terms protecting lab scientists right to publish and to collaborate globally. Note, lab inter-departmental dynamics can play a role (i.e. the technology transfer group, administration, and researchers may have different mandates). A key innovation was for a lab point person to be established to interface with the licensee, and with TRIUMF’s internal departments. It is important for the licensee to realize the lab is not generally in the business of technology transfer. Lab staff had not planned to collect technical papers, design notes, drawings, 3D models, manuals, procedures, specifications, and bills of material; nor to provide contextual information through visits, and conference calls. The licensee requires to be patient and to maintain dialog, and to work through issues with the lab point person. The licensee must assess the demand/market for the technology within the context of the company direction, ensure company capacity, resources, and skills are in place to effectively industrialize the lab technology including filling in missing details. Licensee requires awareness that knowledge may not be documented and may reside in the “heads” of lab technical staff.

3. Nominal Industrial Evolution 1. This design version retained the licensed TRIUMF STS performance specifications, but it was modified due to: (i) Obsolescence of Commercial Parts: vacuum pumps, valves, and motors required re-specification to available equivalents, and interfacing components required re-design. (ii) Precision Alignment/Handling of Target: To improve ease of alignment of components which control the target transport/sealing positioning, precision adjustment (2 degrees translation, 1 degree rotation) of the target manipulator stage relative to the target receive station was introduced by replacing plain bushings with spherical bushings, and by adding keyways and threaded alignment adjusters. Additional keyways and alignment adjusters were added between the landing terminal and support frame. Independent precision adjustment capability of the vacuum box relative to the frame, and the manipulator assembly was achieved in a similar manner. Final alignment of the target manipulator mechanism is achievable to ±0.05 mm and was confirmed by Co-ordinate Measurement Machine (CMM). (iii) Collimator positioning was subject to an angular displacement due to gravity, and forces imparted by the cooling water cooling tubing resulting in a ±0.5 mm displacement transverse to the beam due to tolerance stack-up. TRIUMF had appropriately addressed this issue through a craftsperson approach in the past. For our industrial system, precision was improved to ±0.1 mm by addition of a saddle bracket component. This feature also ensured the collimator aperture remained fixed.

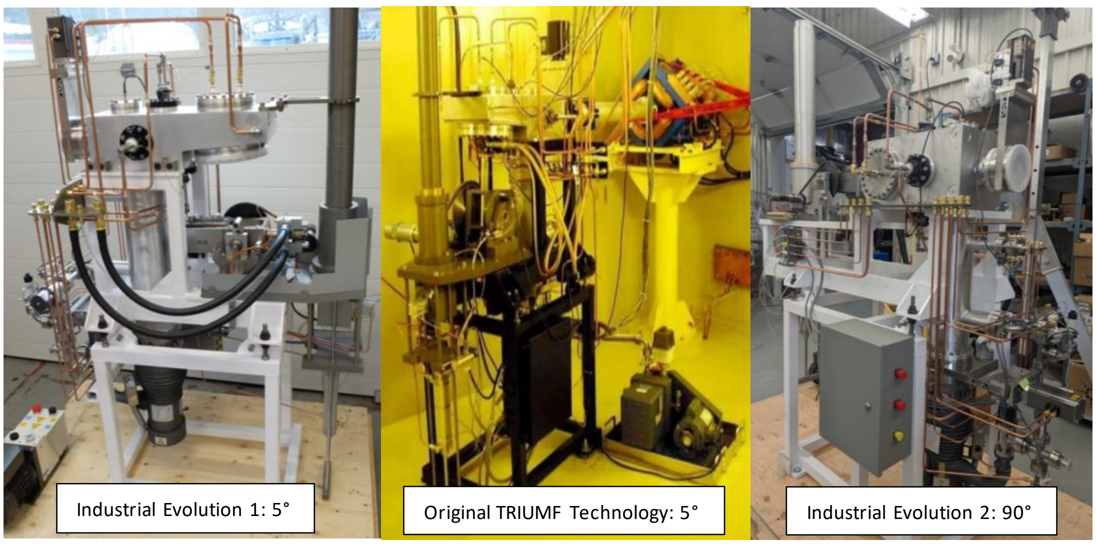

Figure 1. TRIUMF licensed Solid Target Station technology, and two industrial evolutions.

4. Industrial Evolution 2. The nominal beam-power specifications were maintained, but modifications for beam strike normal to the target face (90° glancing angle, refer to Figure 1) were implemented. The collimator side widths were increased from 40 mm to 60 mm, and the collimator defined target aperture is 40 mm x 40 mm. Consequently, the beam halo scraper dimensions became 55 mm x 55 mm, and a modified secondary electron catcher's internal dimensions were increased to 64 mm x 64 mm. The target is sealed to the vacuum chamber in a rear-entry mode, and the robotic manipulator arm now rotates by 180° from the landing terminal of the pneumatic transfer system (100 mm internal diameter piping for target transport cannisters i.e. "rabbits"). All precision adjustment features from evolution 1 were maintained, and mounts for Spherically Mounted Retro-reflectors (SMR) for accurate station alignment were incorporated.

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