ENGINEERING THE SNS RTBT/TARGET INTERFACE FOR REMOTE HANDLING *

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Abstract

The SNS facility is designed for a 1.4MW 1.0GeV proton beam and the interface region of this beam with the Hg spallation target will be highly activated. This installation is located about fifteen feet below the access floor Fig. 1 and the activity levels in the RTBT/Target interface are sufficiently high to warrant the application of Remote Handling (RH) techniques. The installed components are manufactured from radiation hard materials with serviceability beyond the lifetime of the machine, and all connections and mechanisms have been simplified to allow remote handling. The application of pneumatics to facilitate the assembly of major components and to the operation of moveable diagnostics has produced some unique design solutions.

SPECIFICATION AND DESIGN REQUIREMENTS

The large components need to be quick and easy to install and remove. All of the components, except the HARP Diagnostic, must be suitable for a 30 to 40 years operational lifetime. (Fit and Forget).

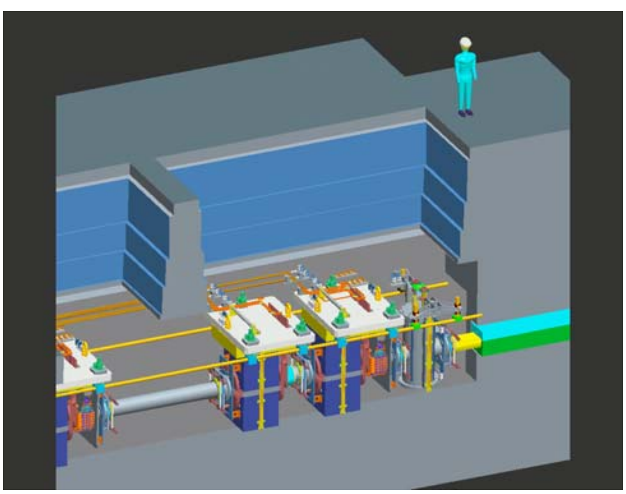

Figure 1: Access to component for installation/servicing.

The highly activated components must be shielded when they are removed. All of the service connections must be quick to operate and/or simple to remote handle because of the activity levels.

* SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy. SNS is a collaboration of six US National Laboratories: Argonne National Laboratory (ANL), Brookhaven National Laboratory (BNL), Thomas Jefferson National Accelerator Facility (TJNAF), Los Alamos National Laboratory (LANL), Lawrence Berkeley National Laboratory (LBNL), and Oak Ridge National Laboratory (ORNL).

The Harp must be able to be withdrawn from the beam when not in use, to extend its operational lifetime, be relocated into the beam to within 1 mm, and permit easy replacement of an expired Harp. The Harp vessel has to cope with a leak from the XFD water cooled Proton Beam Window.

36Q85 MAGNET ASSEMBLIES

Design Features Fig. 2

Mineral Insulated Rad-Hard Coils are used. It has Integral Support/Shielding with Three Point Rail Mounting.

Integral Lifting Attachments are included and the Bus/Water Connections above Shielding. The Assembly plus shielding Flask is Designed within the capacity of the 50 Ton Crane Limit. These Assemblies were manufactured by BNL.

Remote Vacuum Clamps [1], Helicoflex Delta Vacuum Seals, Co-Axial Vacuum Bellows, and Quick Release Water Connectors [1], Power, and Signal/Control Cable Fittings, were designed and fitted at ORNL/SNS.

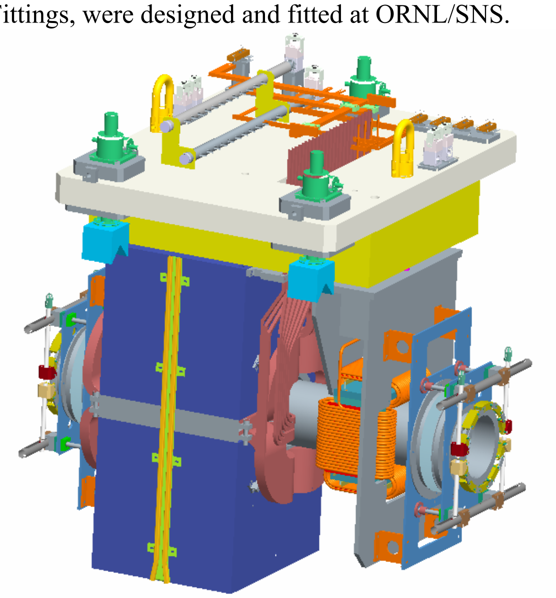

Figure 2: 36Q85 magnet assembly.

ALIGNMENT

Precision Thomson rail system is used as datum for height. Dowel pins and guides are used to set the axial position of all components. All components have a three point pre-set mounting with transverse and height adjustment. Magnet field measurements were done at BNL and fiducialized to magnetic center, with additional fiducials attached to the top shielding of magnet. For

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initial installation assemblies are fiducialize to rails and beam-line center on a tunnel replica jig frame Fig. 3 prior to installation. Survey will check the location by line of sight in the RTBT and correlate to the top fiducials. For a component replacement the fiducialization will be carried out on a replica jig frame prior to installation and checked using the fiducials on the top of the component.

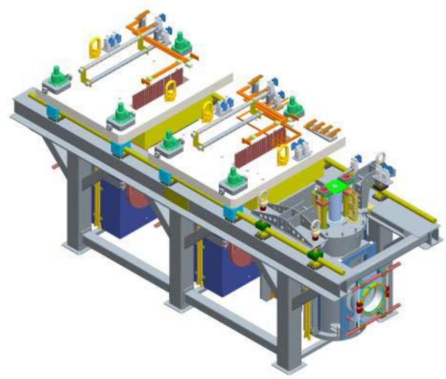

Figure 3: Tunnel replica jig frame.

HARP ASSEMBLY

Design Features Fig. 4

The HARP Diagnostic (Manufactured by LANL) is insertable. (16” x 7.5” aperture with 24.6” x 19” x 5” overall dimensions, wt ~ 33lbs.). It can be aligned to within 1mm of the Beam-line Reference with a stroke duration of ~ 30 seconds. The HARP, mechanism and Vessel Top Plate can be removed while the Vacuum Vessel remains in place. The assembly incorporates a BPM adjacent to the end of the flight tube and Beam shape monitor upstream of the HARP. Graphalloy is used for the Linear Drive Guides and the vessel has three-point Kinematic Rail Mounting. The Co-axial Vacuum Bellows and Remote Vacuum Clamp are integral with the vessel assembly. The sump on the Vacuum Vessel has a Pumping port & RAD-Hard Hygrometer to identify water leaks from the proton beam window.

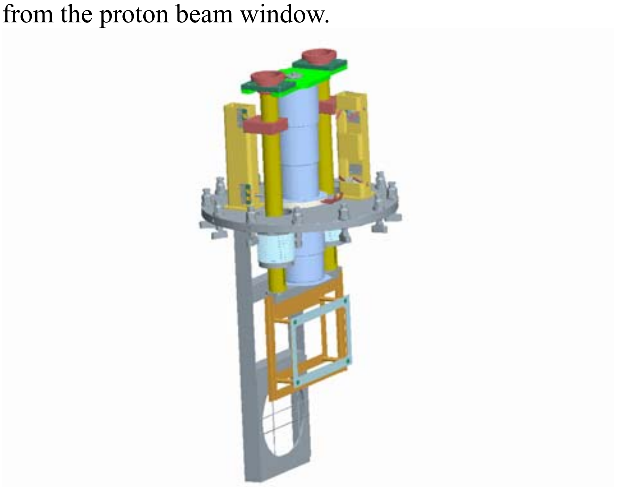

Figure 4: HARP mechanism.

HARP Operation

The insertion and removal of the Harp is achieved by the inflation, in turn, of a bellows above the mounting flange and one below. The constricted release of air from the opposing bellows acts as a damper to control the movements, and the bellows are prevented from “squirming” by telescopic support tubes. The movement is accurately guided by Graphalloy bearings on a pair of 3 inch diameter bellows sealed tubes, which also act as the feed through for the signal cables from the Harp. Air operated latches accurately locate the Harp at the inserted and out positions. A number of micro switches indicate the positions of the Harp and the latches, sending signals to a PLC, which in turn controls the sequence of operations via a pneumatic control logic panel.

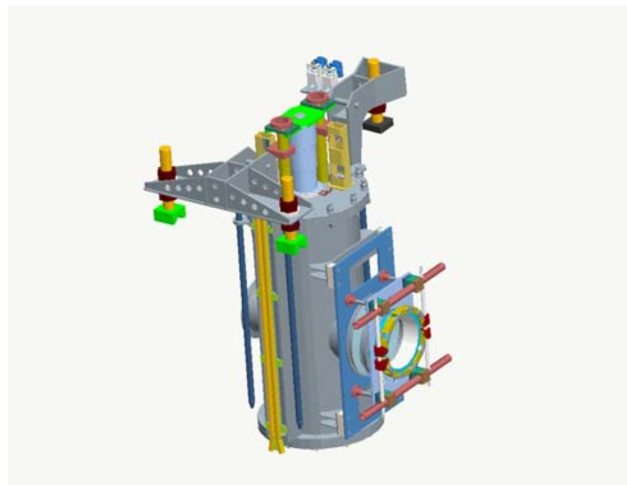

Figure 5: HARP vessel assembly.

CO-AXIAL BELLOWS FOR RH VACUUM CONNECTIONS

These have been designed to produce a guided axial movement by pressurizing and evacuating the interspace between the co-axial bellows which produces the clearance necessary between the adjoining component flanges to permit installation and removal. Fig. 6.

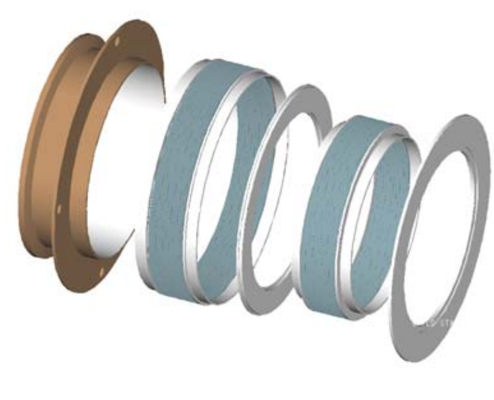

Figure 6: Co-axial bellows construction.

PROTOTYPING AND VALIDATION

A rig Fig. 7 has been manufactured for testing the 17 inch vacuum connection and clamp to prove principle. (6 inch version already proven).

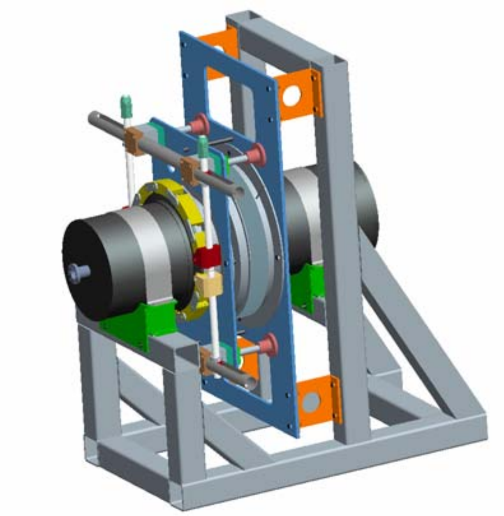

Figure 7: RH vacuum connection and clamp test rig.

The Harp insertion mechanism and pneumatic PLC controlled operating system Fig. 8 has been assembled to validate the design principle.

Figure 8: HARP mechanism test stand.

Various RH couplings and connectors Figs. 9, 10, 11 have been developed for cooling, power, signal and control.

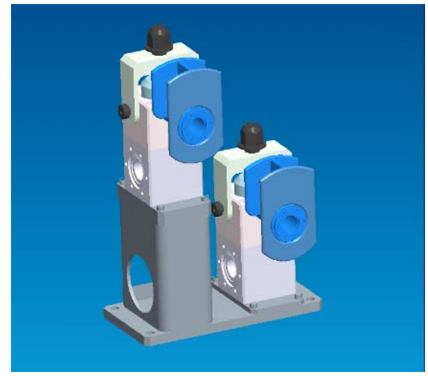

Figure 9: RH water cooling connectors.

Figure 10: RH HARP and signal and control cable connector.

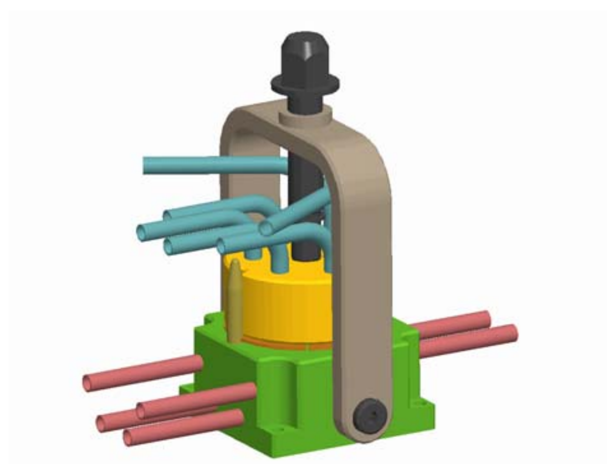

Figure 11: RH HARP six-way air control connector.

SUMMARY

The components described are due for installation by the end of November 2005 after the testing phase has been completed successfully.

REFERENCE

[1] Murdoch G.R. et al, 'Handling High Activity Components on the SNS (Collimators & Linac Passive Dump Windows)'. HALO'03.