S01020500-IS0025

SECOND TARGET STATION (STS) PROJECT

Interface Sheet for S.03.06 Vessel Systems and S.03.07 Target Station Shielding to S.04.03 Bunker

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April 2025

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY

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Vessel Systems Lead Engineer						
Bunker Lead Engineer						
Instrument Systems Engineering						
Target Systems Engineering						

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00	Initial Release

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1. PURPOSE

This document defines the interface between Vessel Systems, Target Station Shielding and Bunker, specifically the physical interface between the Core Vessel, Core Vessel Shielding, Nozzle Extensions, Monolith Port Assemblies and the Monolith Inserts. The interface described in this document will provide inputs to the design of the Core Vessel, Core Vessel Shielding, Nozzle Extensions, Monolith Ports and Monolith Inserts. Requirements derived from this document will be included in the System Design Requirements for Vessel Systems and Bunker.

2. SCOPE

The scope of this document is the complete interface definition for the interface between Vessel Systems, Target Station Shielding and Bunker as identified in the parent Interface Control Document S01020500-IC0004 between Target Systems and Instrument Systems. This document should be read in conjunction with the Interface Drawings #: S04030200-M8U-8800-A10001, S04030200-M8U-8800-A10002, S04030200-M8U-8800-A10141, and S04030200-M8U-8800-A10208.

2.1 INTERFACING PARTS OR COMPONENTS

No.	Components (Vessel Systems)		Components (Bunker)	
	Name	Functional reference Number	Name	Functional reference Number
1	Core Vessel Beltline	S03060200-M8U-8800-A10297.asm	Upper moderator Monolith Module Assembly	S04030201-M8U-8800-A10115
			Lower moderator Monolith Module Assembly	S04030201-M8U-8800-A10000
2	Standard Nozzle Extension	S03060200-M8U-8800-A10100.asm	Upper moderator Monolith Module Assembly	S04030201-M8U-8800-A10115
			Lower moderator Monolith Module Assembly	S04030201-M8U-8800-A10000
3	QIKR Nozzle Extension	S03060000-CV-NE-QIKR-R2.asm	QIKR Monolith Module Assembly	S04030200-M8U-8800-A10010

4	Dual Channel Nozzle Extension	PORT-15-NOZZLE.asm	Dual Channel Monolith Module Assembly	DCI-STRUCTURE-ASSEMBLY-OBS.asm
5	Monolith Port assy.	STS-MONOLITH-PORT-NOZZLES.asm		

3. ACRONYMS AND DEFINITIONS

ICD Interface Control Document
IS Interface Sheet
SSC Structure, System or Component
WBS Work Breakdown Structure
CV Core Vessel
MI Monolith Insert

4. REFERENCES

4.1 DOCUMENTS APPLICABLE TO THE INTERFACING SSCS

Ref	Document Titles	Document Control System Location
[1]	Second Target Station Conceptual Design Report	
[2]	Long Monolith Insert to Nozzle and Beltline Interface Drawing	S04030200-M8U-8800-A10001.drw
[3]	Short Monolith Insert to Nozzle and Beltline Interface Drawing	S04030200-M8U-8800-A10002.drw
[4]	QIKR Monolith Insert to Nozzle and Beltline Interface Drawing	S04030200-M8U-8800-A10141.drw
[5]	Dual Port Monolith Insert to Nozzle and Beltline Interface Drawing	S04030200-M8U-8800-A10208.drw
[6]	Monolith Port Interface Drawing	S03060000-G8U-8800-A10001.drw

5. INTERFACE DEFINITION

5.1 TECHNICAL DESCRIPTION OF THE INTERFACE

In the STS design, a pulsed proton beam is transported from the accelerator to a rotating tungsten target to produce neutrons through spallation. The generated neutrons pass through a Moderator Reflector Assembly (MRA) that produces the desired cold neutrons that radiate along specific paths as they exit the moderator. The cold neutrons then pass through clearance paths within the Core Vessel (CV) shielding, through the front window of the Monolith Inserts (MI) and into the optical guides contained within the Monolith Inserts. The moment the neutrons enter the front window of the monolith inserts represents the transition of the neutron beams from Target Systems to Instrument Systems. The neutrons are transported along the beamlines to the end stations within each individual instrument.

During the conceptual design phase of the project, it was decided that a total of 22 beamlines would originate from two moderators located above and below the rotating Tungsten Target [1]. During preliminary design the number of beamlines was reduced from 22 to 18. Six beam lines will originate from the lower triangular tube moderator, and 12 beamlines will originate from the upper cylindrical moderator. Each beamline will utilize an individual monolith insert containing guide optics to direct the beam out of the monolith and towards the individual instruments. Only 8 instruments will be designed and constructed in the South Instrument Hall during the capital project. On the South side of the monolith, 9 monolith inserts will be installed, 8 with optics modules and 1 with a shielding plug. The remaining 9 ports on the North side of the monolith will have monolith plugs installed in the nozzle extensions in place of the monolith inserts.

Proper alignment of the Monolith Inserts to the MRA located within the Core Vessel is of critical importance to the overall performance of the system. Small errors in angular and positional tolerance of the Monolith Inserts result in a degradation in neutronics performance. The mechanical support of the Monolith Inserts, the alignment of the inserts to the MRA and the flanged sealing of the CV environment at the downstream end of the Monolith Inserts are achieved through mechanical interfaces between the Monolith Inserts (Bunker) with the Core Vessel and Nozzle Extensions (Vessel Systems). The nominal gaps in between the Monolith Inserts and the Vessel Systems components will also be defined in the following section.

5.2 INTERFACE DATA

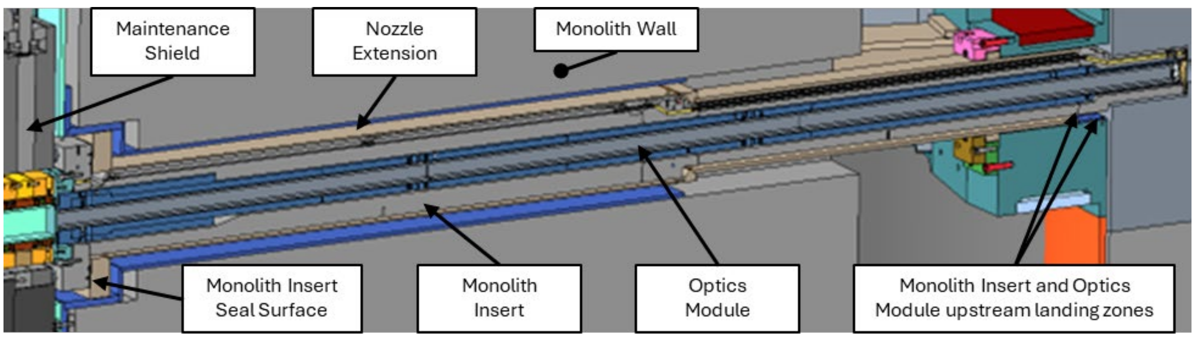

Figure 1: Cross-sectional view along a neutron beam path through the Target Systems hardware to the monolith wall in the Bunker

The basic mechanical layout of the Core Vessel and Monolith Insert assembly is shown in Figure 1 above. The core vessel beltline contains 18 rectangular ports cut through the beltline to allow the Monolith Inserts to pass through and into the Core Vessel. The MRA is precisely located within the Core Vessel to ensure that proper alignment with the beltline openings is achieved. Openings in the Core Vessel shielding allow for Monolith Insert clearance as well as neutron flight paths from the MRA to the Monolith Inserts. Nozzle extensions are aligned and bolted to the outside diameter of the Core Vessel beltline and provide an installation path for the Monolith Inserts.

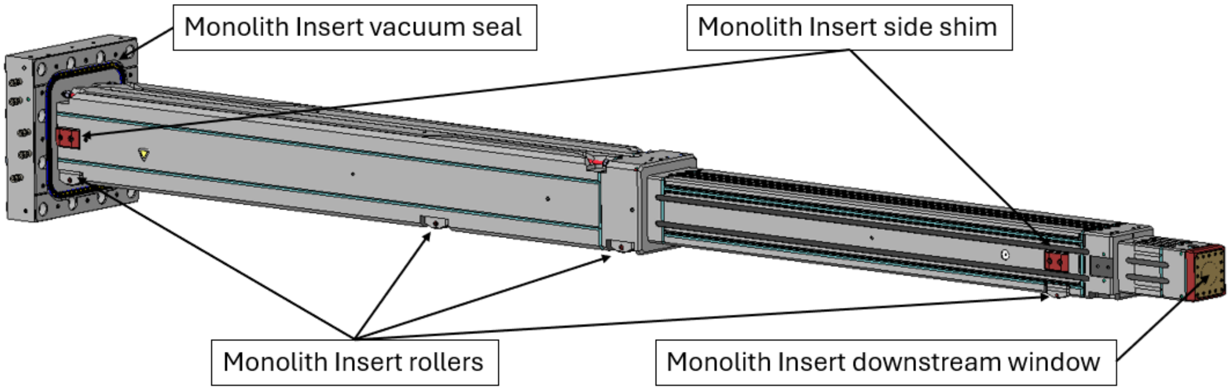

Figure 2: Monolith Insert alignment shim plates, sealing area, and roller locations.

Monolith Inserts are installed radially through the instrument bunker into the Core Vessel through the Nozzle Extension. The Monolith Inserts are supported at both ends using adjustable shim plates on the Monolith Inserts and corresponding precision machined landing surfaces at the outboard end of the Nozzle Extension and custom machined landing pads inside the beltline cut out of the Core Vessel. The locations of these adjustable shim plates are shown in Figure 2 above and are detailed in the Interface Drawings [2], [3], [4] and [5]. The shim plates and large end flanges are the only contact points between the Monolith Inserts and the Core Vessel and Nozzle Extensions. Machining the final thickness of these plates will be performed prior to installation to adjust the position of the Monolith Inserts relative to the MRA. Details of the shims (side location) and roller spacers (bottom location) are shown in the images below. The Monolith Inserts are mated to the downstream end of the Nozzle Extensions to form a vacuum seal that contains the Core Vessel environment.

The North Hall Monolith Plugs are similarly installed radially through the instrument bunker into the Core Vessel. The plugs interface with the Nozzle Extension flange in the same manner as the Monolith Inserts to form a vacuum seal that contains the Core Vessel environment. While the Monolith Plugs use rollers also, they are in a different configuration due to the 3-part construction of the plugs. The Monolith Plugs do not use shim plates and do not require alignment. The standard version of the Monolith Plug is used for both upper and lower moderator ports, and a dual-channel plug is used for the dual-channel ports. The subsections below outline all the interface points between Vessel Systems and Bunker in detail.

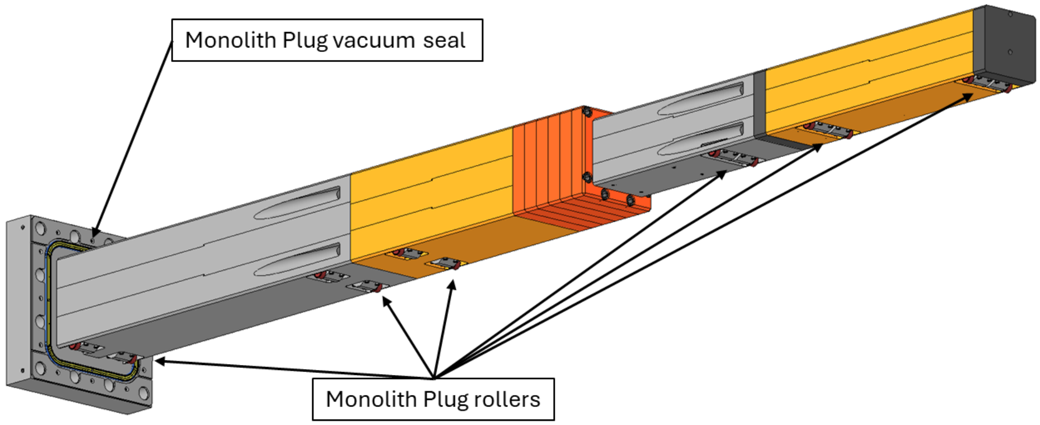

Figure 3: Monolith Plug roller and sealing area locations

5.2.1 Mechanical Support and Alignment of Monolith Inserts

Each Monolith Insert will be supported and located within the Core Vessel via two sets of alignment features as well as the downstream flanges of the Monolith Insert and Nozzle Extensions. The alignment features will help to align the Monolith Insert with the MRA, while the mating of the Monolith Insert flange with the Nozzle Extension will set the radial distance between the front window of the Monolith Insert and the MRA. The inside profile of the Nozzle Extensions and Core Vessel cutouts will be driven by the outside profile of the Monolith Inserts. The physical dimensions of each Monolith Insert are specified in order to finalize Core Vessel design. The mating features on the Nozzle Extensions and Core Vessel will also be designed to accommodate the Monolith Insert design.

The Bunker team supplies Vessel Systems with detailed Monolith Insert models and the interface drawings, in order for the interfacing features on the Nozzle Extensions, Core Vessel and Core Vessel Shielding to be finalized.

The Interface between Monolith Insert and Nozzle Extension as well as the beltline, is presented in interface drawings #: S04030200-M8U-8800-A10001[2], S04030200-M8U-8800-A10002 [3], S04030200-M8U-8800-A10141 [4], and S04030200-M8U-8800-A10208 [5]. Tolerance budgets for each system as well as minimum gaps are also shown on these interface drawings. The monolith Insert is designed with integrated features allowing the insert's installed position adjustment. The adjustment is done by sizing the features (shims) to required dimensions.

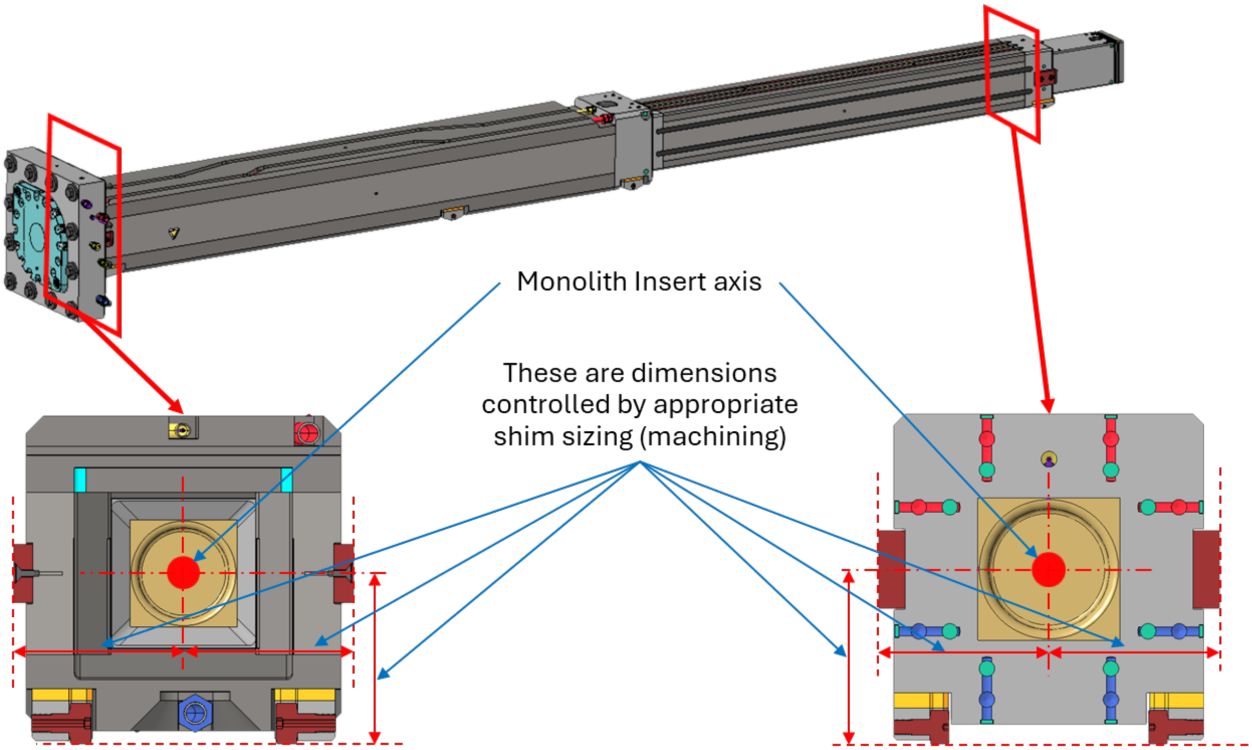

Figure 4: Section view of the Monolith Insert at each shim location showing the dimensions controlled by the shim sizing

Dimensional drawings of Monolith Insert Shims and Core Vessel landing pads are presented in [2], [3], [4] and [5]. When produced, the shims are set to the maximum size. Following scanning and characterization of the Nozzle – Beltline system and associated landing zones by the survey and alignment team after vessel installation, the shims are brought to required dimension. The following images show details of the Monolith Insert location (shims arrangement).

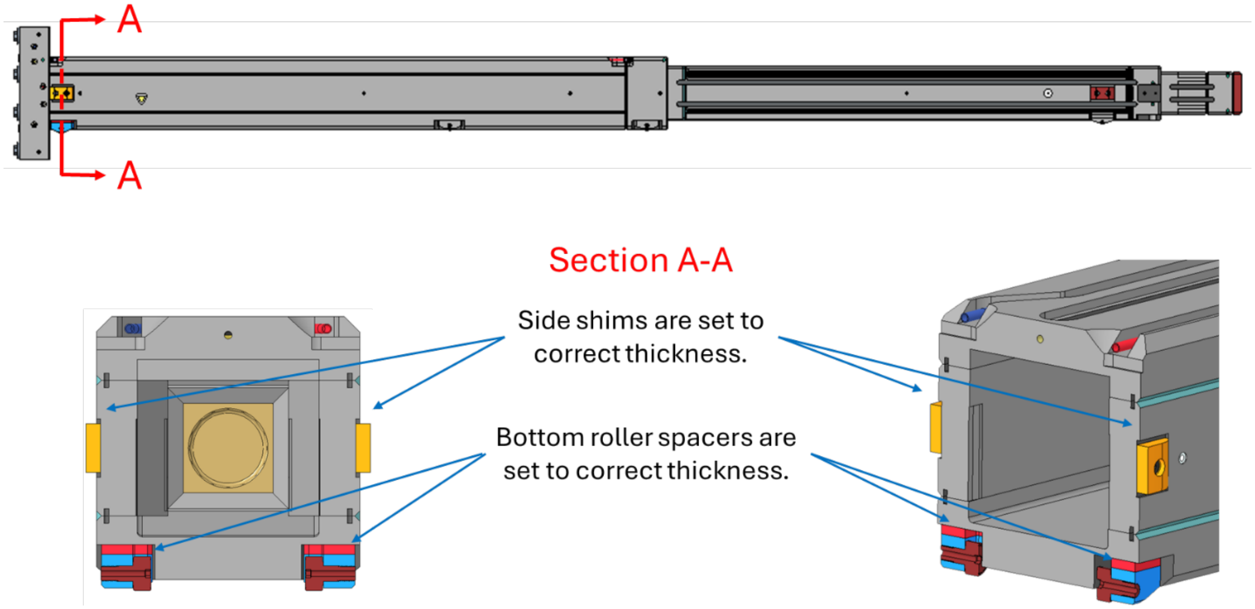

Figure 5: Details of the Monolith Insert positioning features

Landing zones corresponding to shims mounted on Monolith Inserts are defined in context of the Nozzle Extension and Beltline assembly.

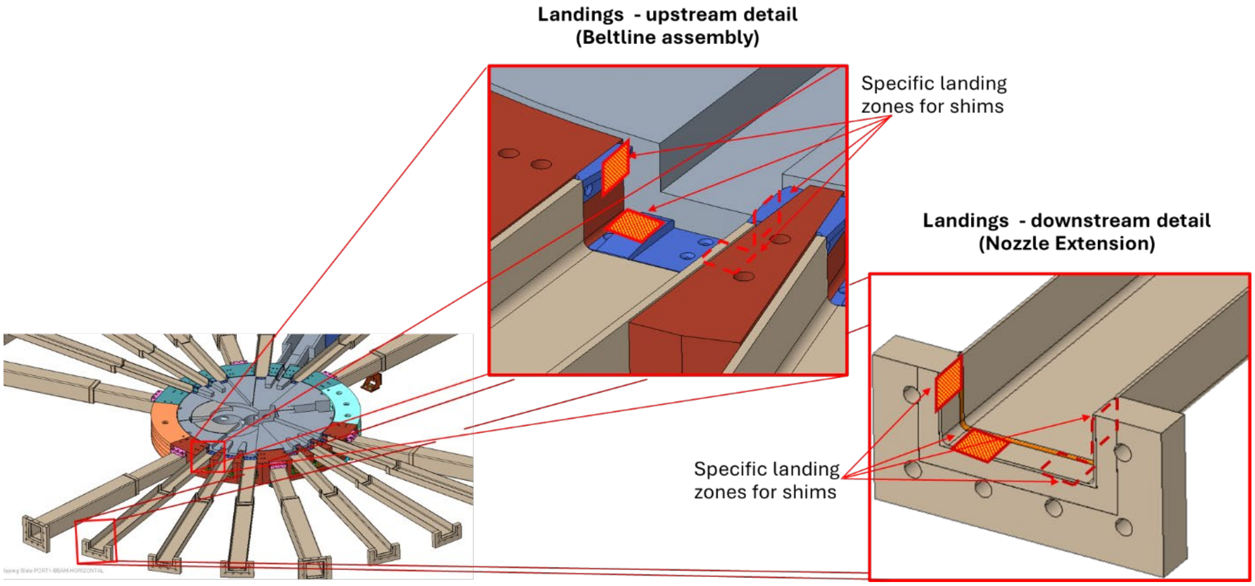

Figure 6: Identified landing zones where Monolith Insert shims will mate with the Nozzle Extension and Beltline assembly

5.2.2 Vacuum / Pressure Seals

The Core Vessel environment is carried in between the Monolith Inserts and the Nozzle Extensions. Seals are made at the bunker side flanged interface between the Monolith Inserts and the Nozzle Extensions. The seal will be integrated into the Monolith Insert, with a smooth mating seal surface on the Nozzle Extension. The dimensions and orientation of the seal are shown in [2], [3], [4], and [5]. The seals must be able to withstand the radiation they will be exposed to while maintaining sealing performance over a pressure range of 0-30 PSIA. They will be configured as a double seal, with provisions to monitor the interstitial space for leaks. The targeted leak rate for these seals is 1x10^-5 std. CC/s of helium. The North Hall Monolith Plugs employ the same seal design as the Monolith Inserts.

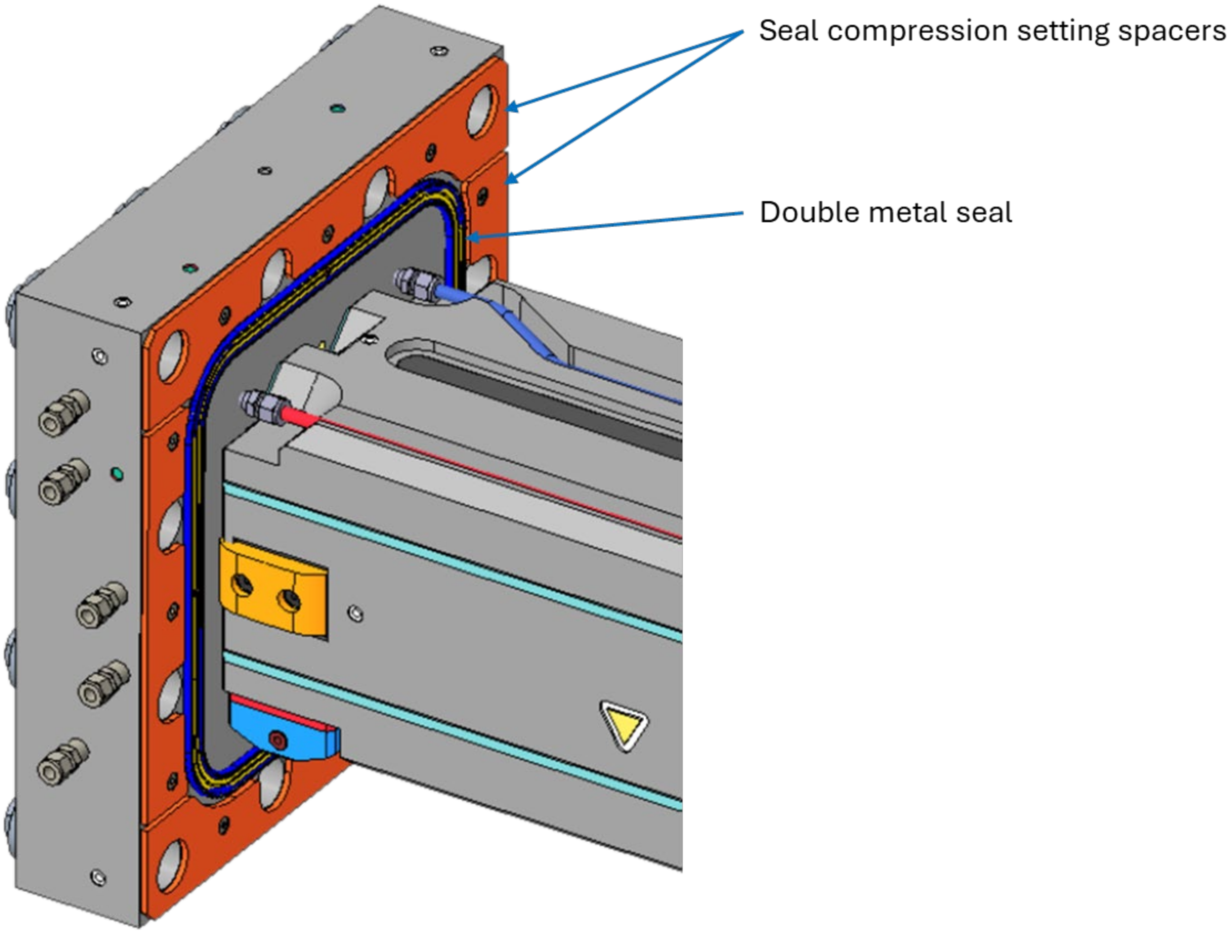

Figure 7: Seal layout of the Standard Monolith Insert and Nozzle Extension flange interface

5.2.3 Loads transfer

When fully inserted, Monolith Insert rests on its upstream and downstream roller sets, which transfer the load further onto Nozzle extension and beltline. During the process of insertion, there will be Transitional Load along the Nozzle Extension, as the Insert is pushed in. The heaviest load that is transferred onto the Nozzle Extension and beltline is the Dual-Channel Monolith Plug. Due to the additional shielding, each plug is heavier than the insert for the same port type. The load cases of the plugs also differ due to the alternate roller configuration used on the plugs. Load amplitudes and positions for both the Monolith Inserts and Monolith Plugs are presented in [2], [3], [4] and [5].

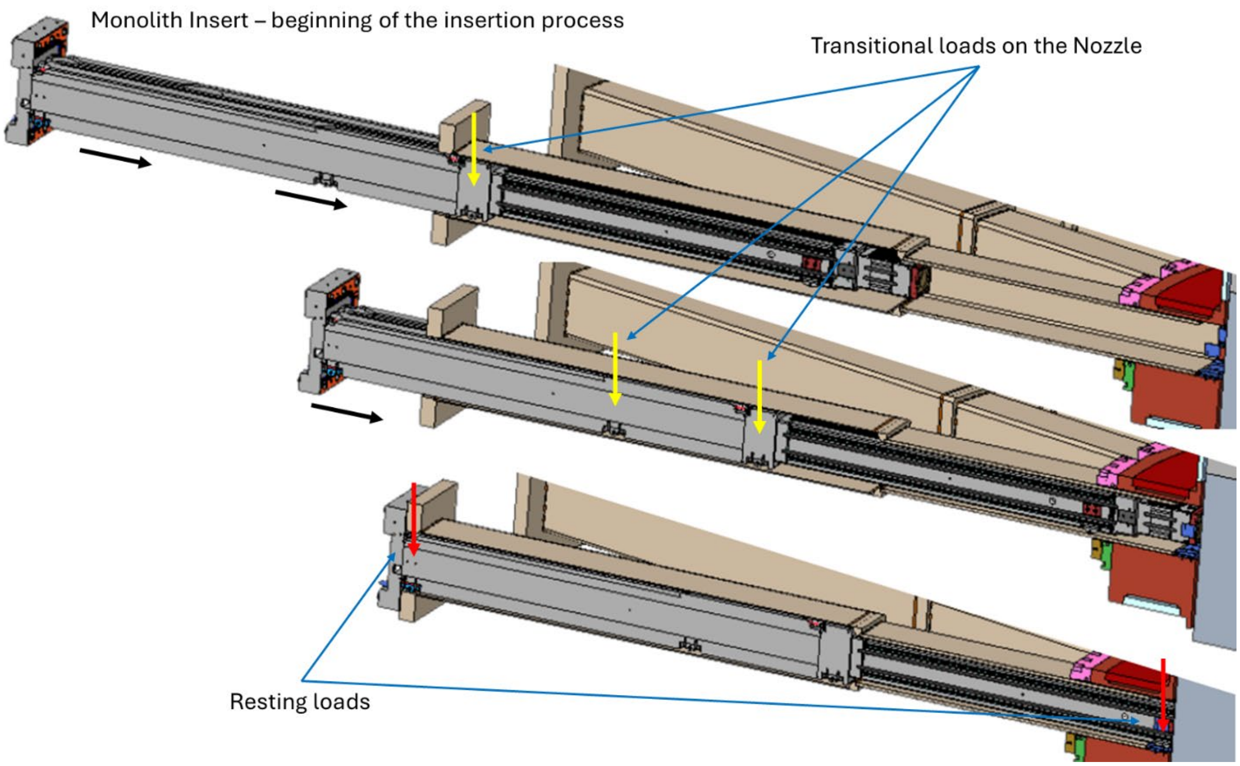

Figure 8: Mechanical loading of Nozzle during insertion process

5.2.4 Monolith Ports

The monolith ports consist of steel structures embedded into the monolith concrete that form openings for the nozzle extensions. The monolith port assemblies also form a depression in the outside surface of the monolith concrete to provide clearance for the downstream flanges of the nozzle extensions, monolith inserts, and monolith insert utility connections. The overall design, fabrication and installation of the monolith ports are the responsibility of Conventional Facilities, with the internal profile being defined by Vessel Systems. The interface between VS and Bunker ensures that the VS inside profile design provides the necessary clearance for the monolith insert utility lines. Interface drawing S03060000-G8U-8800-A10001 shows the monolith port assembly inside profile dimensions being provided to Conventional Facilities. Figure 9 shows the monolith port support brackets that will support and align the outside flange of the nozzle extensions while providing clearance for the Monolith Port utility lines.

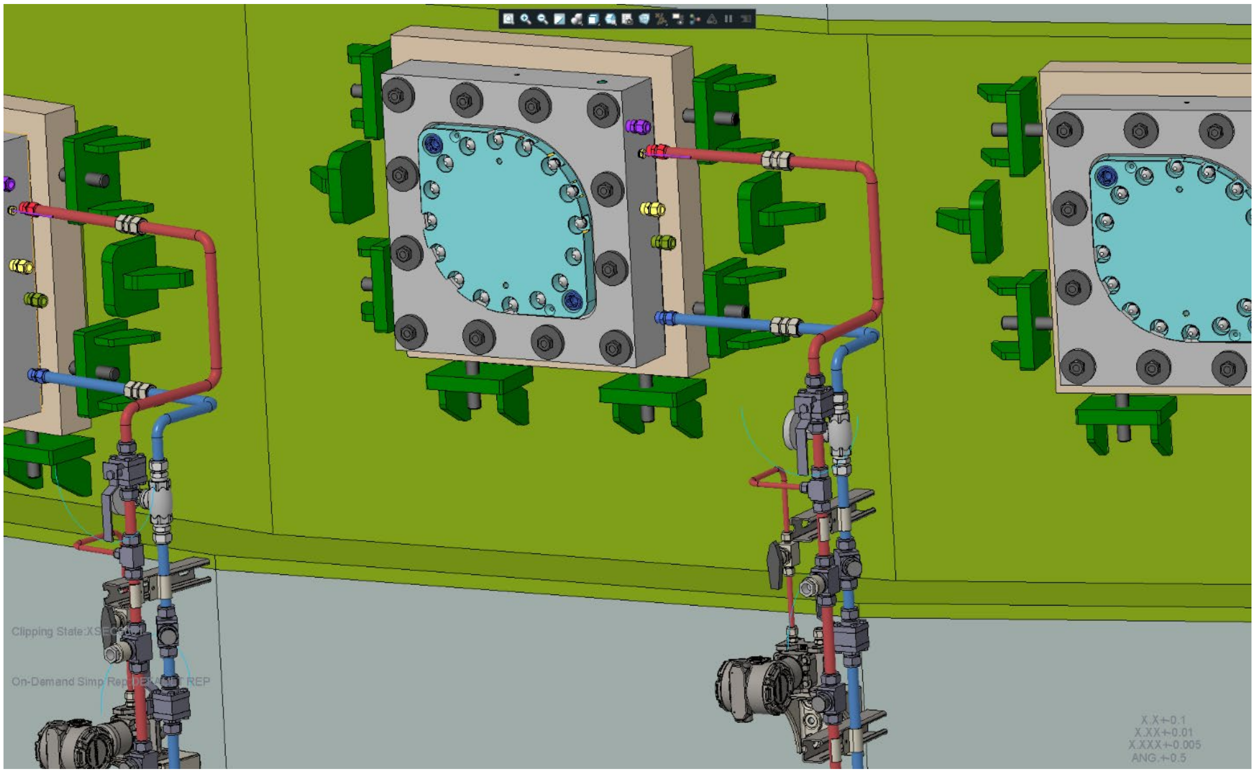

Figure 9: Monolith Port model showing support bracket details and proper clearance for Monolith Insert utility lines

5.2.5 Neutron Flight Path

Vessel Systems is responsible for providing a clear neutron flight path between the viewed face of the moderator reflector assembly and the viewing windows of the monolith inserts. The ideal path of each neutron beam path is defined by the MRA to Instrument Systems interface sheet S01020500-IS0023. Vessel Systems will provide the following clearance through the Vessel Systems hardware centered on the beam paths defined by Interface Sheet S01020500-IS0023. Round clearance holes will be provided for each beamport with Table 1 showing the nominal clearance diameter as well as the upper and lower limits of clearance for each beam path.

Table 1: Neutron flight path clearances through Vessel Systems hardware for each beamline

Beamline	Nom. Clearance Dia.	Lower Clearance Dia.	Upper Clearance Dia.
1 (Standard)	90 mm	80 mm	100 mm
2 (QIKR)	60 mm	50 mm	70 mm
3 (Standard)	90 mm	80 mm	100 mm
4 (Standard)	90 mm	80 mm	100 mm
5 (Standard)	90 mm	80 mm	100 mm
6 (Standard)	90 mm	80 mm	100 mm
7 (Standard)	90 mm	80 mm	100 mm
8 (Standard)	90 mm	80 mm	100 mm
9 (Standard)	90 mm	80 mm	100 mm
10 (Standard)	90 mm	80 mm	100 mm

11 (Standard)	90 mm	80 mm	100 mm
12 (Standard)	90 mm	80 mm	100 mm
13 (Standard)	90 mm	80 mm	100 mm
14 (Standard)	90 mm	80 mm	100 mm
15 (Dual Channel)	90 mm	80 mm	100 mm
16 (Dual Channel)	90 mm	80 mm	100 mm
17 (Standard)	90 mm	80 mm	100 mm
18 (Standard)	90 mm	80 mm	100 mm