

Interface Control Document **MAGNETS : VACUUM VESSEL STRUCTURE**

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National Spherical Torus eXperiment Upgrade

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Interface Control Document

MAGNETS: VACUUM VESSEL STRUCTURE

NSTX-U-ICD-MAG-VVS-0

**Revision 0
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Change Record

Revision	Date	Description of Change
0	May 16, 2019	Initial Release

References

[1] GENERAL REQUIREMENTS DOCUMENT, NSTX-U-RQMT-GRD-001-01.

[2] SYSTEM REQUIREMENTS DOCUMENT, MAGNET SYSTEMS, NSTX-U-RQMT-SRD-002-02.

[3] SYSTEM REQUIREMENTS DOCUMENT, VACUUM VESSEL AND INTERNAL HARDWARE,
NSTX-U-RQMT-SRD-004-01.

1. Purpose

This document describes the various interfaces between the following subsystems: Magnets and the Vacuum Vessel Structure. The interface locations and boundaries that connect the Magnets to the Vacuum Vessel Structure are identified based on different interface types.

2. Scope

The Magnets consists of Inner and Outer PF and TF coils, OH Solenoid, and Bus Bars. The Vacuum Vessel Structure consists of Vacuum Vessel, Umbrella Structure and Lids, Ports, and Coil supports. The scope of this document addresses any defined interfaces between these identified system elements.

3. Responsibilities

The interfaces are managed between the following organizations:

- Magnets
- Vacuum Vessel Structure
- Systems Engineering and Integration

4. Interfaces

Interface requirements in the following sections are identified with a requirement number, ICD, followed by a number [ICD-MAG-VVS-X] where “X” is a sequential count beginning with 001, MAG represents Magnets, and VVS represents Vacuum Vessel Structure. There is also a unique identifier for all interfaces in the format [#####-#####-X]. The identifier is a concatenation of two level 5 WBS values and the interface type. This is followed by an interface description and a list of references. References provide evidence pertaining to interfaces include but are not limited to drawings, calculations, or specifications. Reference also include a reference to a paragraph that identifies the set of interface definitions.

4.1. Interface Types

The top-level interface types are defined in Table 1. Within each heading, there are sub-headings to address any special sub-elements that need consideration. For example, the Mechanical has four sub-elements that need to be addressed: Structural, Spatial, Location, and Wall/Floor Penetration. For those interface types with sub-interfaces there are corresponding sub-sections.

Table 1. Interface Types

Heading	Abbreviation	Name
4.2	Me	Mechanical
4.3	Ep	Electrical Power
4.4	Si	Signal
4.5	Di	Diagnostics
4.6	Gf	Gas/Fluid
4.7	Va	Vacuum
4.8	Sw	Software
4.9	Th	Thermal
4.10	Pe	Plasma/Eddy/ Halo Current

Table 2 provides the N2 Diagram identifying all the interfaces for NSTX-U while Table 3 provides the specific details of the interface.

Table 2. N2 Diagram Interface Types.

Plasma Facing Components	Me,Th,Pe		Me,Th,Va,Pe						Me	Me	Me,Pe		Me			
	In-Vessel Structure	Me,Di,Pe			Th			Me,Th,Pe	Me		Me,Di,Pe			Di		
		Vacuum Vessel Structure			Me,Va	Me,Va	Me	Me,Th,Pe	Me	Me,Va	Me,Di,Va		Si	Di,Si		
		Va	Centerstack Structure			Va,Th	Me,Gf	Me	Me	Me				Di		
		Me	Me,Th,Ep	Magnets				Me			Di		Si	Di		
Si		Me,Va			Heating Systems		Gf	Th		Me		Gf,Si	Si	Si	Si	
					Si,Va,Me,Sw,Gf	Vacuum Pumping System		Si	Si	Gf,Si	Si		Si,Va	Si	Si	
				Gf,Si			Coolant System	Gf				Gf,Sw	Si,Sw	Si		
	Th,Gf	Ep,Di,Th,Va	Ep,Gf,Th,Pe		Si		Si	Bakeout System						Me	Si,Me	
			Gf,Va	Gf,Va	Ep	Gf,Si			Gas Delivery System	Me	Va		Si,Sw	Si	Si	
		Gf	Si			Si,Gf,Va		Gf	Wall Conditioning System				Si,Sw	Si	Si	
		Me,Va	Me,Va	Me	Me	Gf,Si	Gf			Va,Ep	Diagnostics		Si,Sw	Si	Si	Si
				Ep	Ep	Ep	Ep	Ep	Ep	Ep	Ep	Power Systems	Si	Ep,Si	Ep,Si,Di,Gf	Ep
					Si					Me,Si	Si		Centralized Instrumentation and Control	Si,Me		
										Sw		Si	Si,Sw	Integrated Machine Operations		
								Ep							Operations & Safety Systems	
Me		Me	Me	Me	Me	Me		Me	Me	Me	Me	Me	Me	Me	Me,Ep	D-Site Locations (Test Cell)

Table 3. Callout.

Vacuum Vessel Structure	
Me	Magnets

The remainder of this document addresses each of the interfaces. Note the template includes a paragraph heading for each interface and a table for each interface type. In the event there is no interface, the table will remain blank with a blank row.

The following paragraphs in Section 4 address each of the interfaces, and Section 5 addresses any off-project interfaces. Off-project interfaces are those external interfaces that interact with the NSTX-U system.

4.2. Mechanical Interfaces

This paragraph addresses any type of mechanical interfaces that include a structural, spatial, location dependent interfaces or areas where penetrations into a wall or floor are required. These are identified independently as interface parameters will likely be different.

4.2.1. Structural Interfaces

This identifies any interfaces between system elements that require a structural interface. This could be based on various forces placed on the system and by the system.

Identifier	Interface	References
1.1.3.4- 1.1.2.3.2-S	Some inner-PF and PF-2 lead supports are mounted to the PF-3 coil support.	See Paragraph 4.2.1.1
1.1.3.4- 1.1.2.1.2-S	Supports for the -1a, -1b, & -1c leads are supported from the umbrella structure.	See Paragraph 4.2.1.2
1.1.3.3.1- 1.1.2.1.2-S	Torque is transferred to the Upper Umbrella structure through the spoked lid at the interface between the torque plate of the TF Inner Legs and the spoked lid.	See Paragraph 4.2.1.3, Drawing DC1325
1.1.3.5- 1.1.2.1.1-S	The RWM coils are mounted directly to the vessel.	See Paragraph 4.2.1.4, Drawing DC1326

4.2.1.1. Inner PF Bus - PF-3 Supports

ICD-MAG-VVS-001: The Inner PF hard-bus support bracket (red) is attached to PF-3 supports as shown in Figure 1.

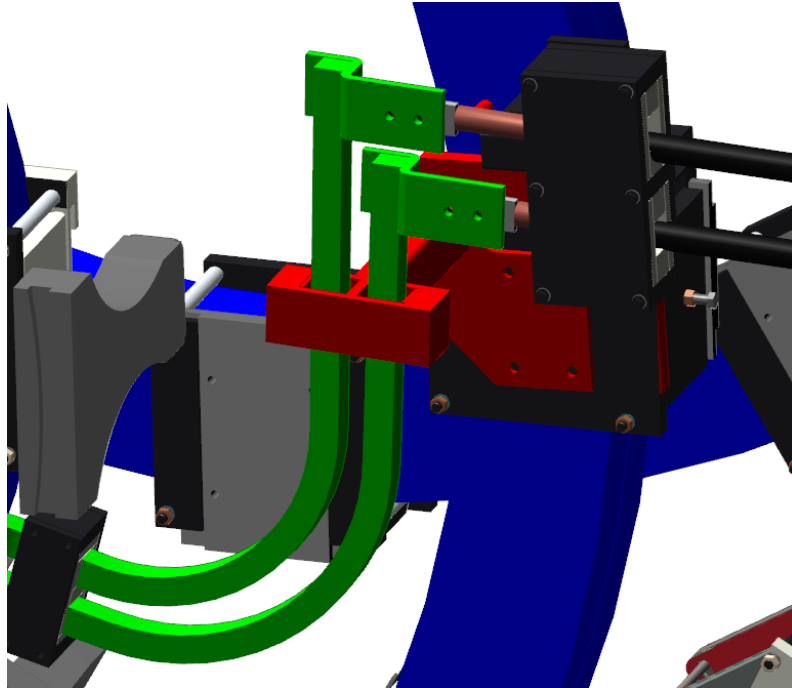


Figure 1. Hard-bus Support structures on the PF-3 support

4.2.1.2. Inner PF Leads - Umbrella Structure

ICD-MAG-VVS-002: The interface is a support connected to the umbrella to support the hard-bus. An example of the upper interfaces is provided in Figure 2. The is connected to the umbrella (not shown), represented red plate with welded studs in the foreground.

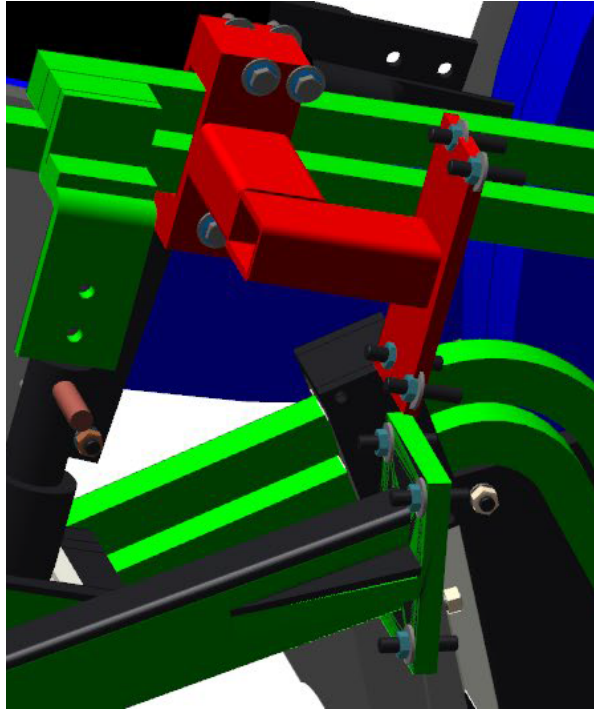


Figure 2. Bar Bar Supports

ICD-MAG-VVS-003: The interface is connected using bars that are welded to the umbrella. The structural support is bolted to the plate to allow removal of the support.

4.2.1.3. Upper Umbrella - Inner Legs

ICD-MAG-VVS-004: The torque plate, shown in Figure 3, connects the inner TF upper legs and the lid.

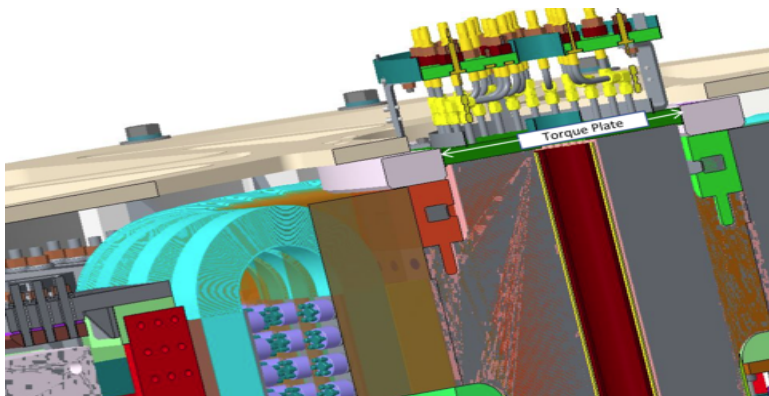


Figure 3 Bus Bar through Lower Umbrella

4.2.1.4. RWM - Umbrella

ICD-MAG-VVS-005: The RWM (yellow) is mounted to the vessel using a clamp. The clamp consists of two components 1) part of the clamp is welded to the vessel. 2) the other parts screw the RWM coil in place as shown in Figure 4 . The assembly is identified in drawing DC1326 Sheets 28 and 29.

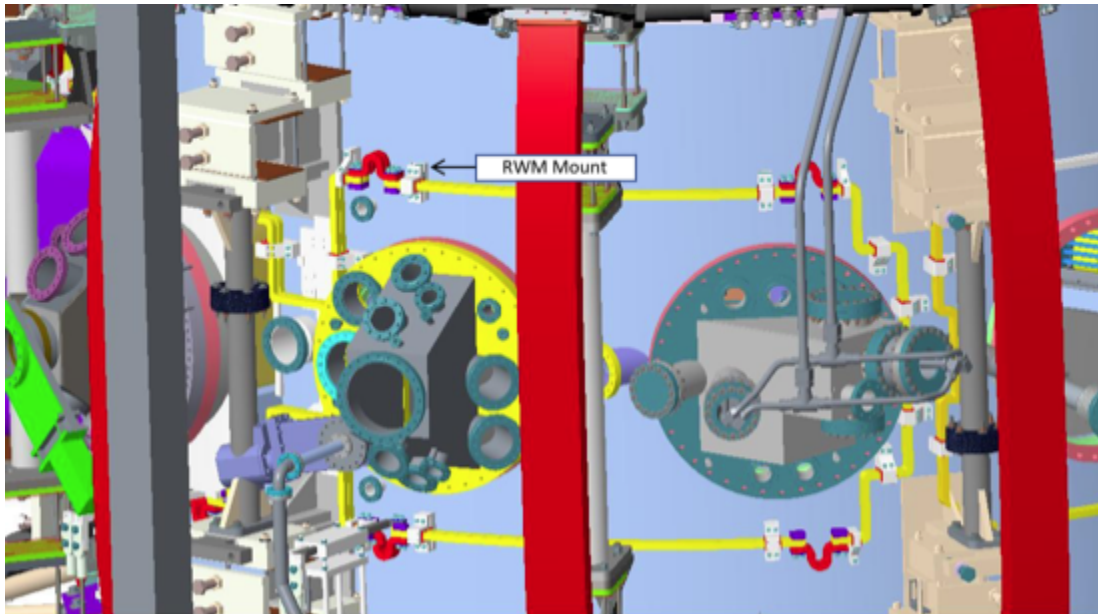


Figure 4. RWM Coil Assembly

4.2.2. Spatial Interface

This identifies any interfaces between the system elements pertaining to spatial restrictions or constraints.

Identifier	Interface	References
1.1.3.4- 1.1.2.1.2-Sp	Bus bars for the PF-1a, -1b, -1c, and -2 coils enter/leave the umbrella structure through the arches.	See Paragraph 4.2.2.1
1.1.3.4- 1.1.2.1.2-Sp	Bus bars for the TF and OH coils enter the umbrella through the opening in the spoked lid.	See Paragraph 4.2.2.1, DC1738,

4.2.2.1. Inner PF - Umbrella

ICD-MAG-VVS-004: The hard-bus for the Inner PF's are run through the scallops of the umbrella as shown in Figure 5.

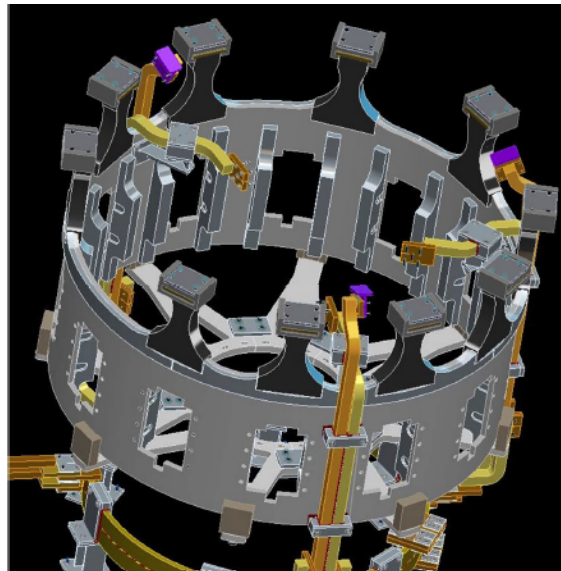
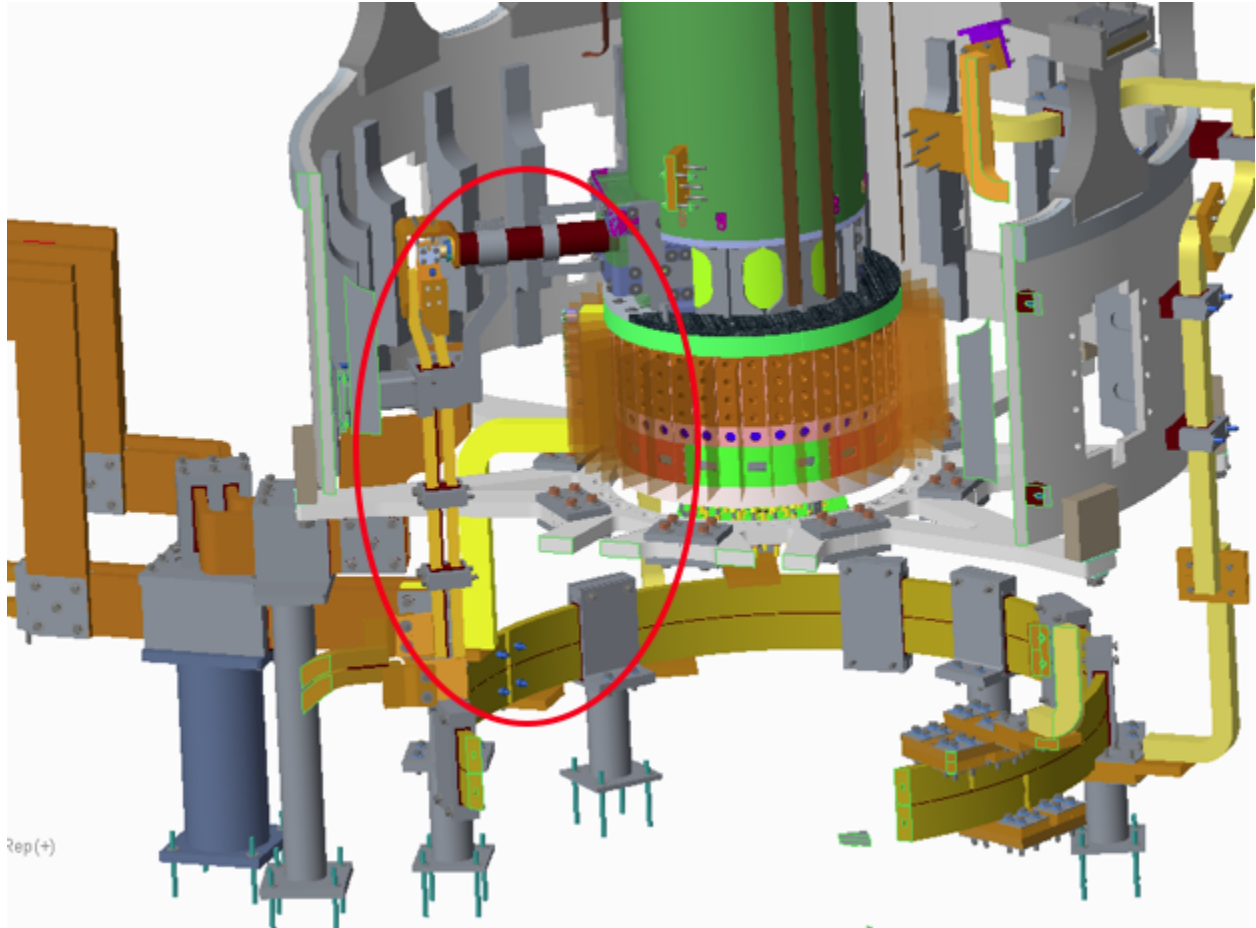


Figure 5. Hardbus through the lower umbrella arches

4.2.2.2. TF/OH Bus Bars - Spoked Lid

ICD-MAG-VVS-005: The OH Bus Bar enters through the lower lid as shown in the red ellipse in Figure 7. The OH coaxial cable (brown/grey) runs perpendicular to the umbrella and bus bar. Figure 8 provides a plan view of the Lid with OH Coaxial Cable (green ellipse).



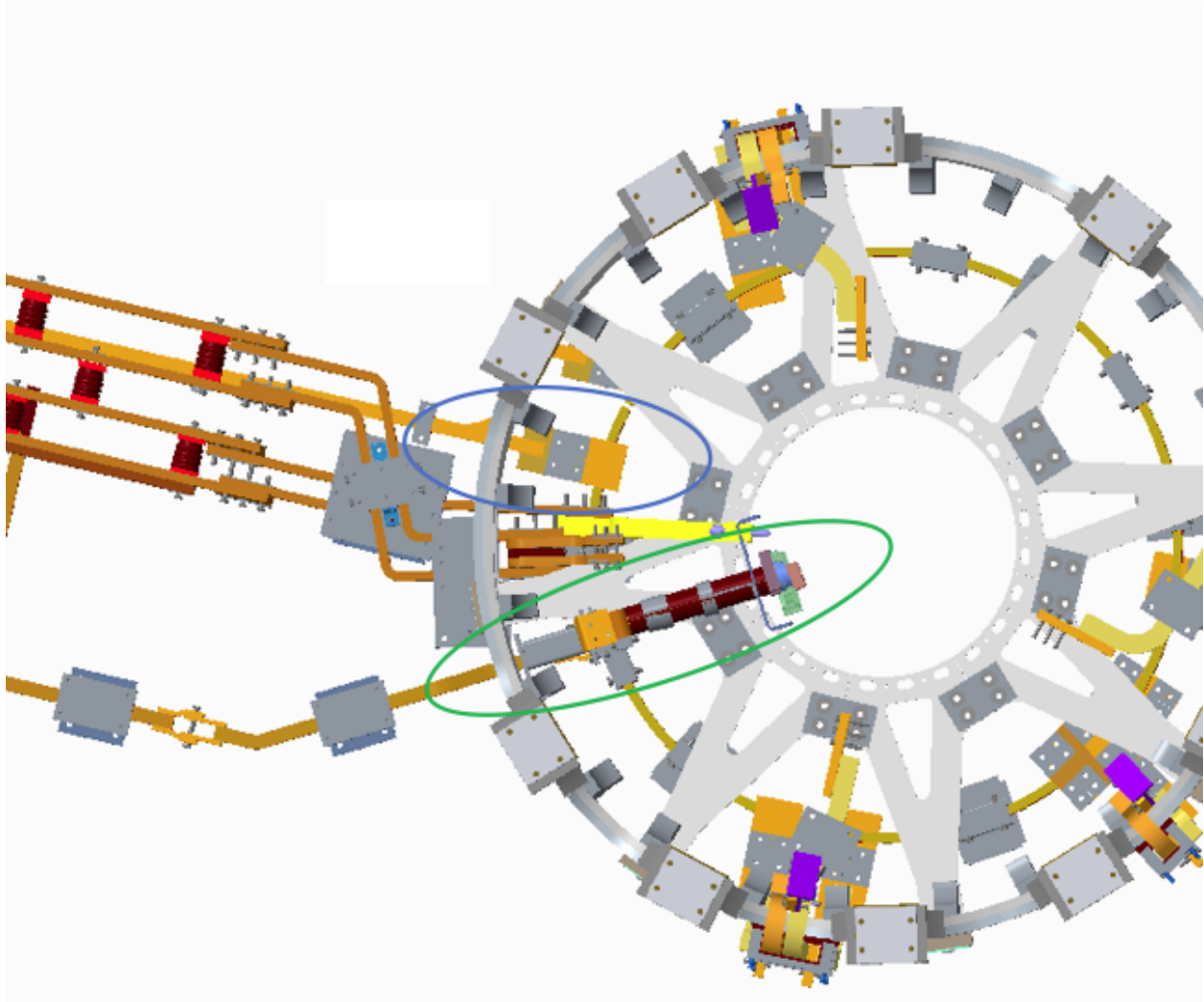


Figure 8. Plan View of Lower Lid and Bus Bars

ICD-MAG-VVS-006: The TF Coil runs under and through the lid as shown in Figure 9. The red ellipse shows the entry under the lid for connection to the TF flag. Figure 8 shows the location of the TF bus bar as indicated by the blue ellipse.

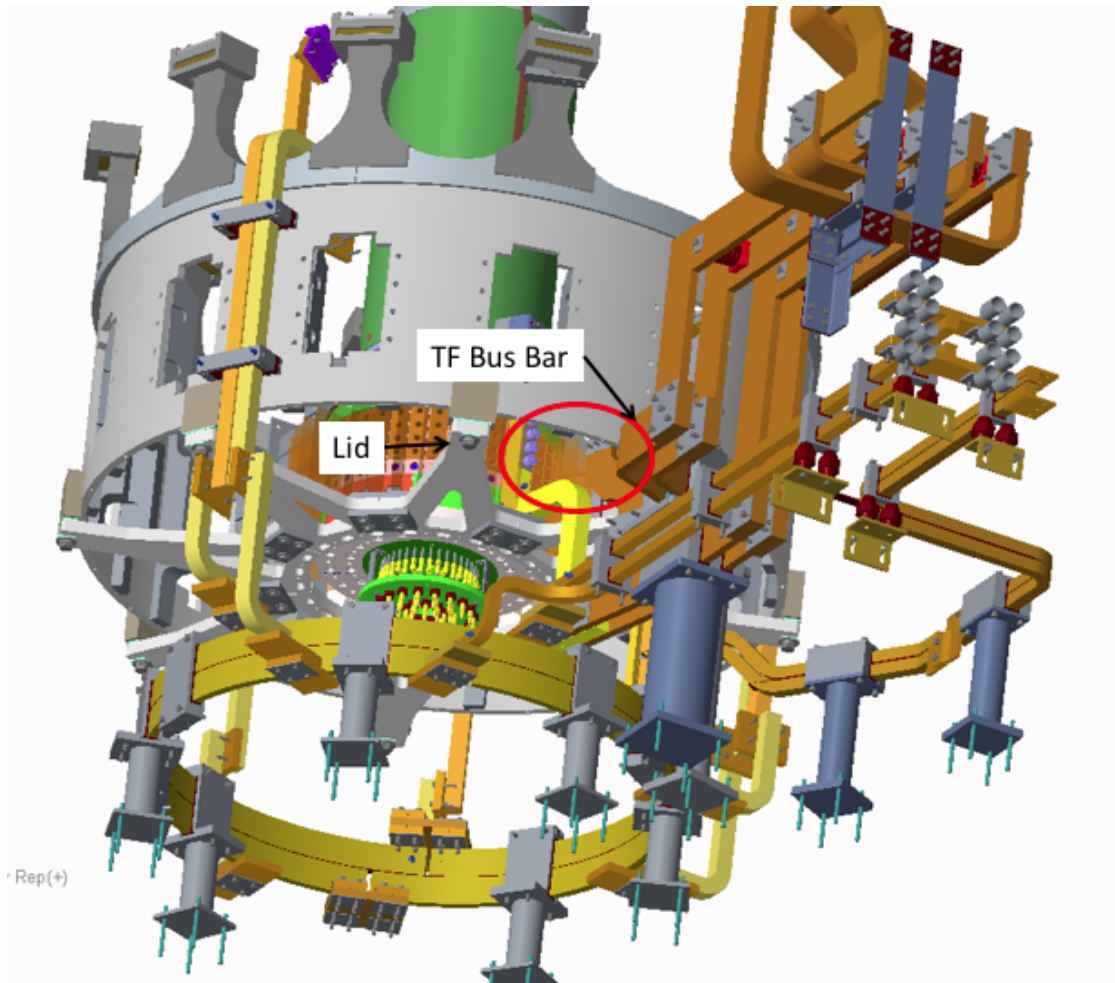


Figure 7. TF Coil through the Lid

4.2.3. Location Interfaces

This identifies any interfaces between the system elements that have any particular dependencies on element location or location constraints.

Identifier	Interface	References
N/A		

4.2.4. Wall/Floor Penetration Interfaces

This identifies any interfaces between the system elements any penetrations or modifications to the wall or floor of the D-Site building.

Identifier	Interface	References
N/A		

4.3. Electrical Power Interfaces

This identifies any interfaces between the system elements requiring AC, DC, rectification or power conditioning.

Identifier	Interface	References
N/A		

4.4. Signal Interfaces

This identifies any interfaces between the system elements and signals that are used to either send or receive control information or data. It explicitly includes the type of physical interface such as Ethernet or Fiber Optic or any specific protocols.

Identifier	Interface	References
N/A		

4.5. Diagnostic Interfaces

This identifies any interfaces between the system elements with any instrumentation or diagnostic equipment to collect performance data.

Identifier	Interface	References
N/A		

4.6. Gas/Fluid Interfaces

This paragraph has two different types of interfaces: Gas and Fluid.

4.6.1. Gas Interfaces

This identifies any interfaces between the system elements that use any type of gas (e.g., He).

Identifier	Interface	References
N/A		

4.6.2. Fluid Interfaces

This identifies any interfaces between the system elements that use any type of fluid (e.g., ionized water).

Identifier	Interface	References
N/A		

4.7. Vacuum Interfaces

This identifies any interfaces between the system elements that pertain to the Vacuum.

Identifier	Interface	References
N/A		

4.8. Software Interfaces

This identifies any interfaces between the system elements that use software that may exchange interfaces with other software components. This includes application programming interfaces (APIs) or any other exchange of information between different software applications.

Identifier	Interface	References
N/A		

4.9. Thermal Interfaces

This identifies any interfaces between the system elements that pertain to Thermal characteristics.

Identifier	Interface	References
N/A		

4.10. Plasma Interfaces

This paragraph has two different types of interfaces: Plasma and Eddy/Halo Current.

4.10.1. Plasma Interfaces

This identifies any interfaces between the system elements with the Plasma.

Identifier	Interface	References
N/A		

4.10.2. Eddy/Halo Current Interfaces

This identifies any interfaces between the system elements with the Eddy/Halo Currents.

Identifier	Interface	References

N/A		
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5. Off-Project Interfaces

The off-project interfaces are components that are not specifically part of the NSTX-U system. They may include external systems and interfaces where the program has little control over a part of the interface. They are provided for completeness.

There are no external interfaces.