



PIP II BTL Workshop - Beam Absorber (25 kW)

30 Nov – 01 Dec 2022

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A Partnership of:

US/DOE

India/DAE

Italy/INFN

UK/UKRI-STFC

France/CEA, CNRS/IN2P3

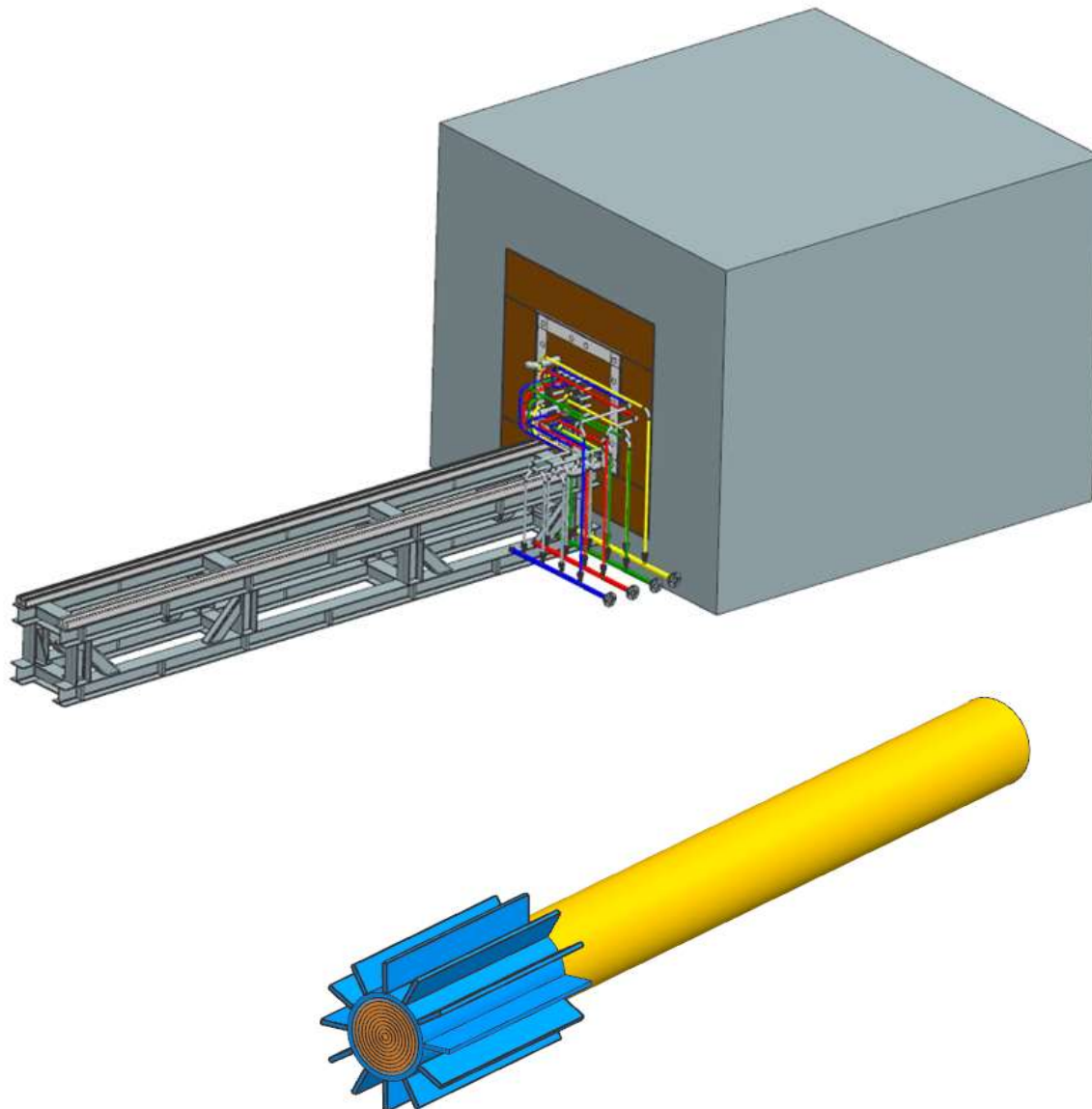
Poland/WUST



Outline

- ❖ Scope and Components Overview
- ❖ Beam Absorber:
 - Beam Absorber Details
 - Status of Thermal Design and FEA
 - Status of Mechanical Design: Absorber core and Ancillary Systems
 - Interfaces with other systems
 - a. Beam Lattice Location
 - b. Conventional Facilities (CF)
 - c. Installation and replacement
 - d. RAW System for Water Cooling
 - e. Air Circulation System
 - f. Control Systems
 - Prototype
- ❖ Vacuum Beam Window
 - Status of Design of Vacuum Window
- ❖ Summary

Scope and Components Overview



BTL Beam Absorber Features:

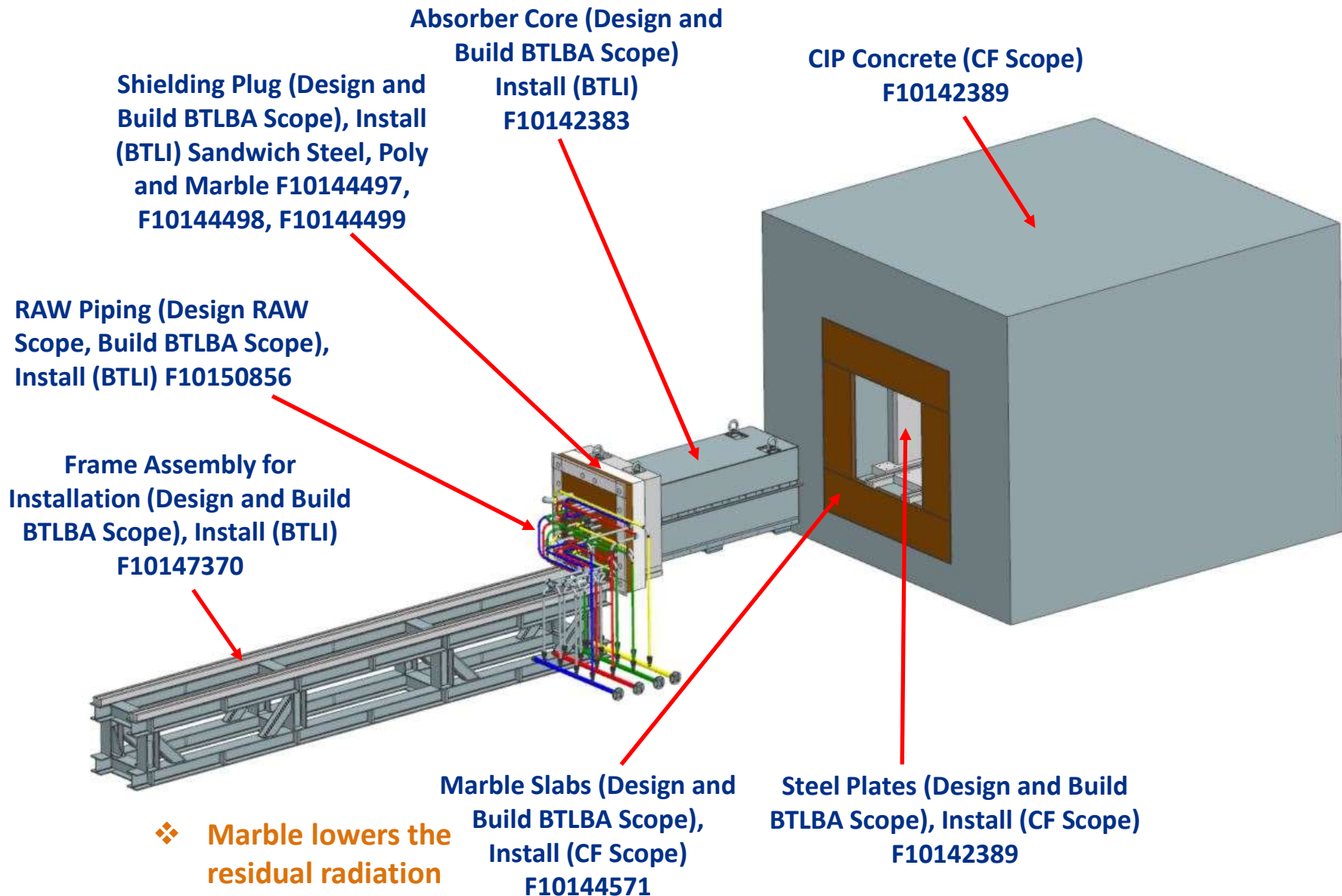
- ❖ Graphite Core Absorber
- ❖ CIP Concrete Shielding
- ❖ Designed for 1 GeV operations
- ❖ Average Beam Power of 22 kW
- ❖ Active Water and Air Circulation
- ❖ Operates with Beam Sweeping

Vacuum Beam Window Features:

- ❖ Beryllium Windows for 1 GeV Absorber
- ❖ Finned Windows Holder to enhance Heat Transfer
- ❖ Window 2-inch diameter

BTL Beam Absorber

BTL Beam Absorber Details – Exploded View

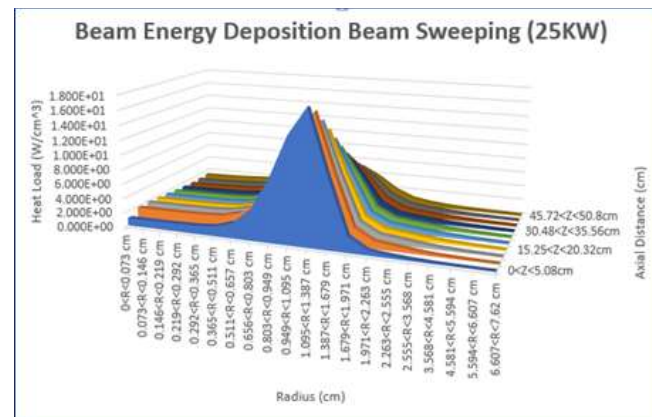
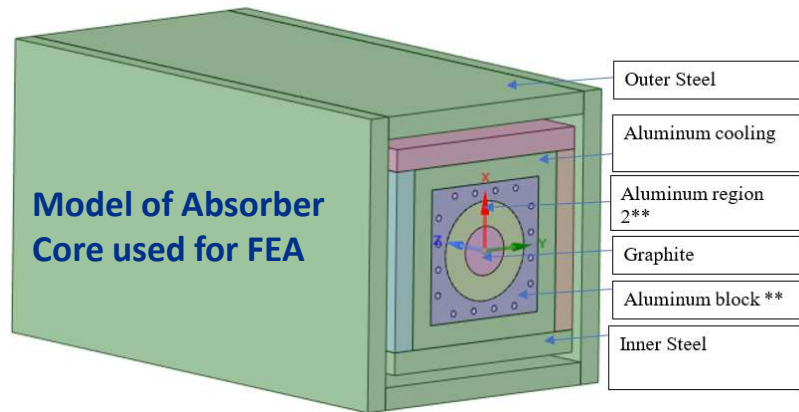


Status of Thermal Design and FEA

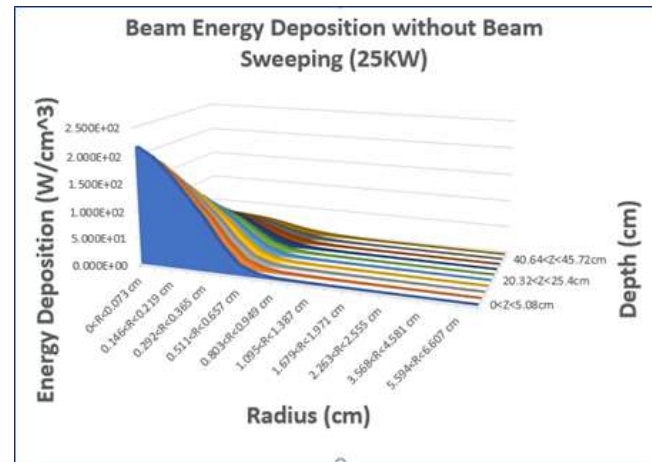
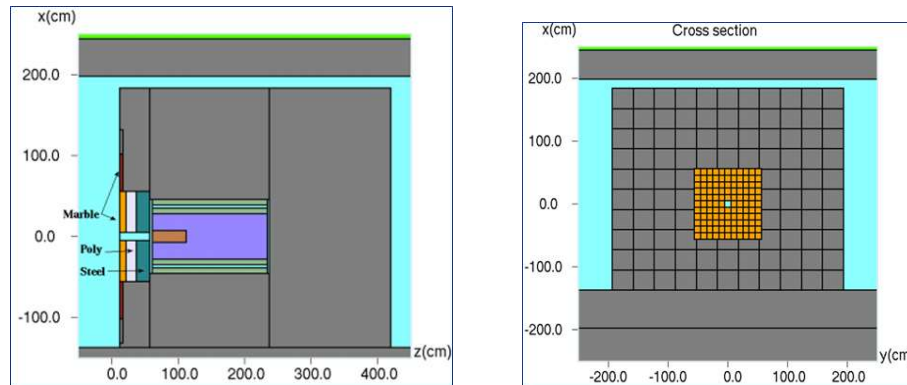
Final Design Review (FDR) completed 18 May 2021. All documentation available at: <https://indico.fnal.gov/event/24089/>

Items included in FDR:

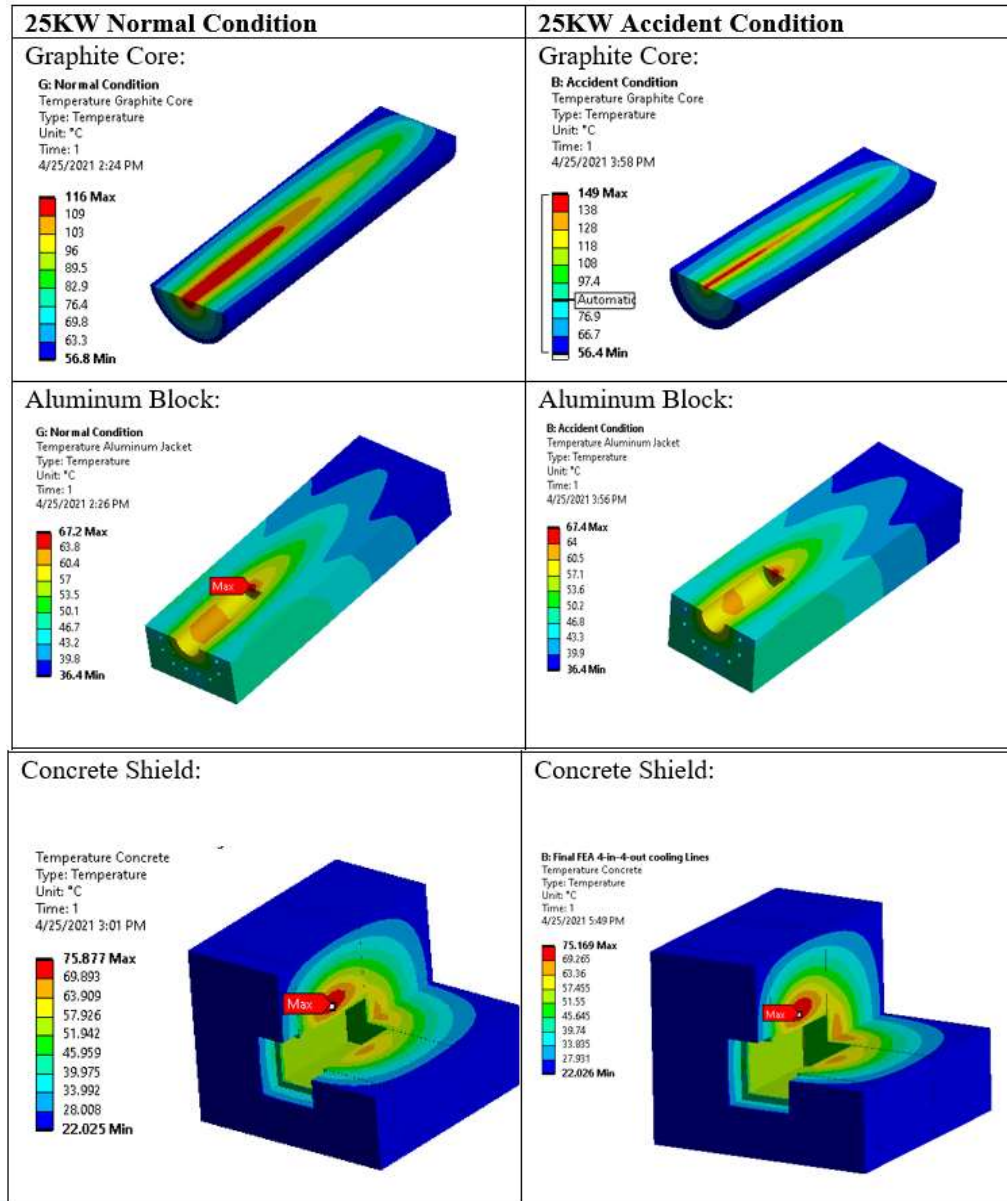
- ❖ Thermal design completed for normal operating and accident condition (accident means beam sweeping failed).



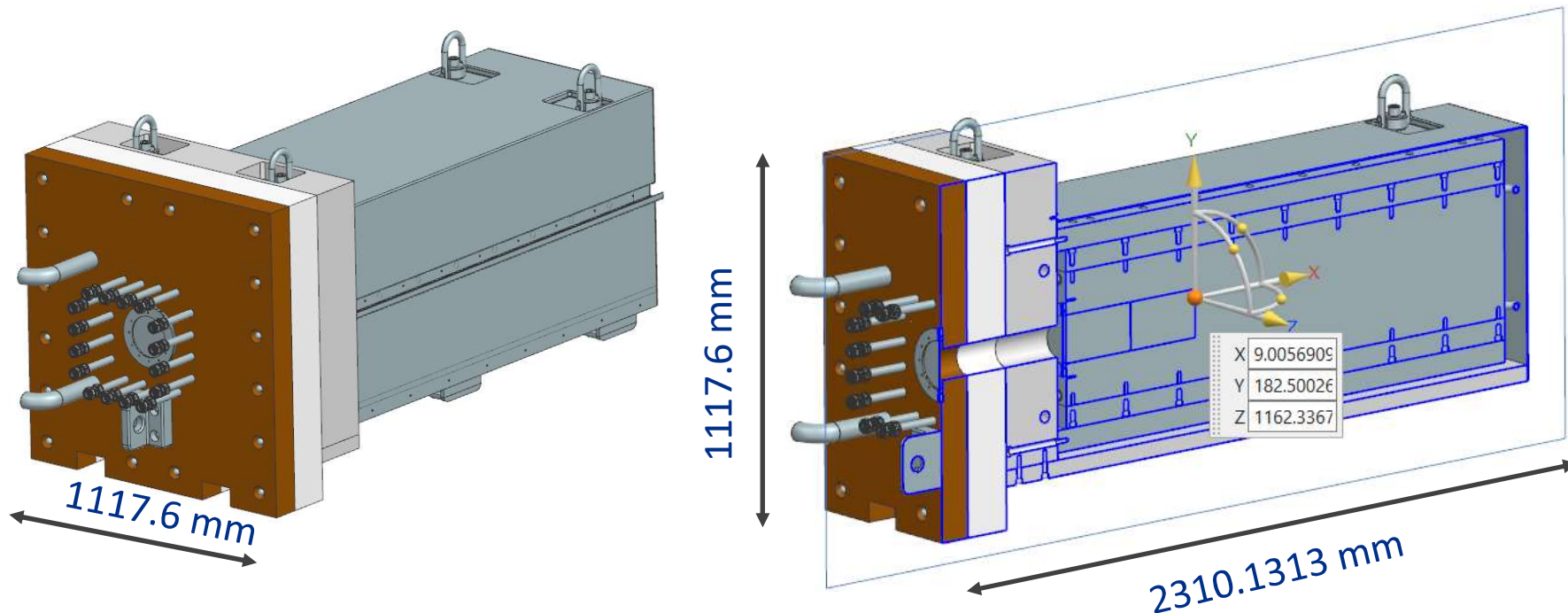
MARS Model



Status of Thermal Design and FEA (contd.)



Status of Mechanical Design – Absorber Core



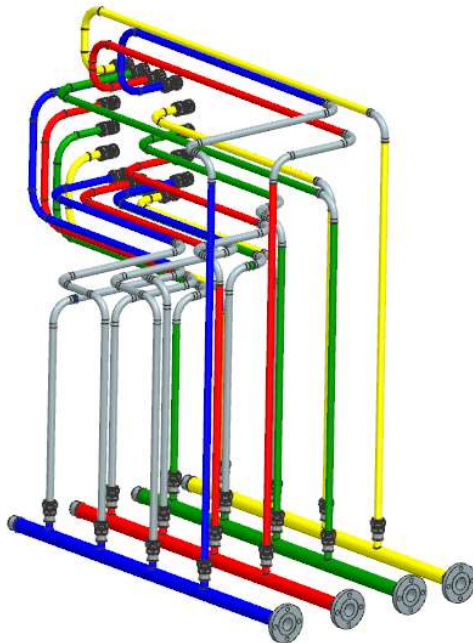
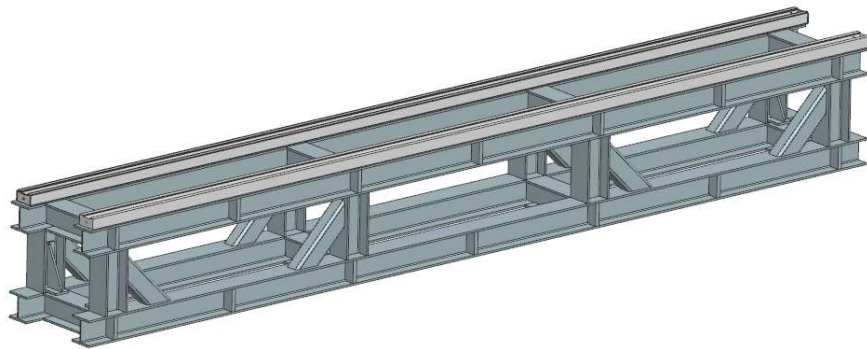
Some Design Metrics:

- ❖ Design maturity ~ 95% (details next slide)
- ❖ Mass of Core Assembly ~ 15060 lbs (does not include hardware and other common parts)
- ❖ Assembly bounding box (dimensions) shown above
- ❖ Teamcenter Number: F10142383

Status of Mechanical Design – Absorber Core

| Component/Assembly | Percentage of Completion | Comments |
|---|--------------------------|--|
| Absorber Core Assembly | 95 % | All components/parts designed |
| Hardware such as bolts, studs, screws, etc. | 60 % | Location and size determined and need to add to the assembly |
| Common parts such as fittings, adapters, etc. | 60 % | Need to ensure compatibility to metric units |
| Diagnostics such as thermocouples | 40 % | Final selection of type and location to be determined |
| Other items, lifting hooks, Hilman rollers | 90% | Verify compatibility with the design |
| Preliminary Drawings | 90 % | Checking in process |
| Prototype of shrink fit, weld samples | WIP | One graphite core is available |

Status of Ancillary Systems



Installation frame assembly:

- ✓ Preliminary Design completed
- ✓ Preliminary Drawings completed
- ... Structural FEA in progress
- ... Minor design adjustments in progress (rail for Hilman)
- ... Length may change (discussed in interface section later in the slides)

RAW Piping Routing:

- ✓ Preliminary Design completed
- ✓ Preliminary Drawings completed
- ... Fabrication technique (bend/weld pipes) in progress
- ... Possible weld samples studies

Interface – Beam Lattice

Interface with Beam Lattice

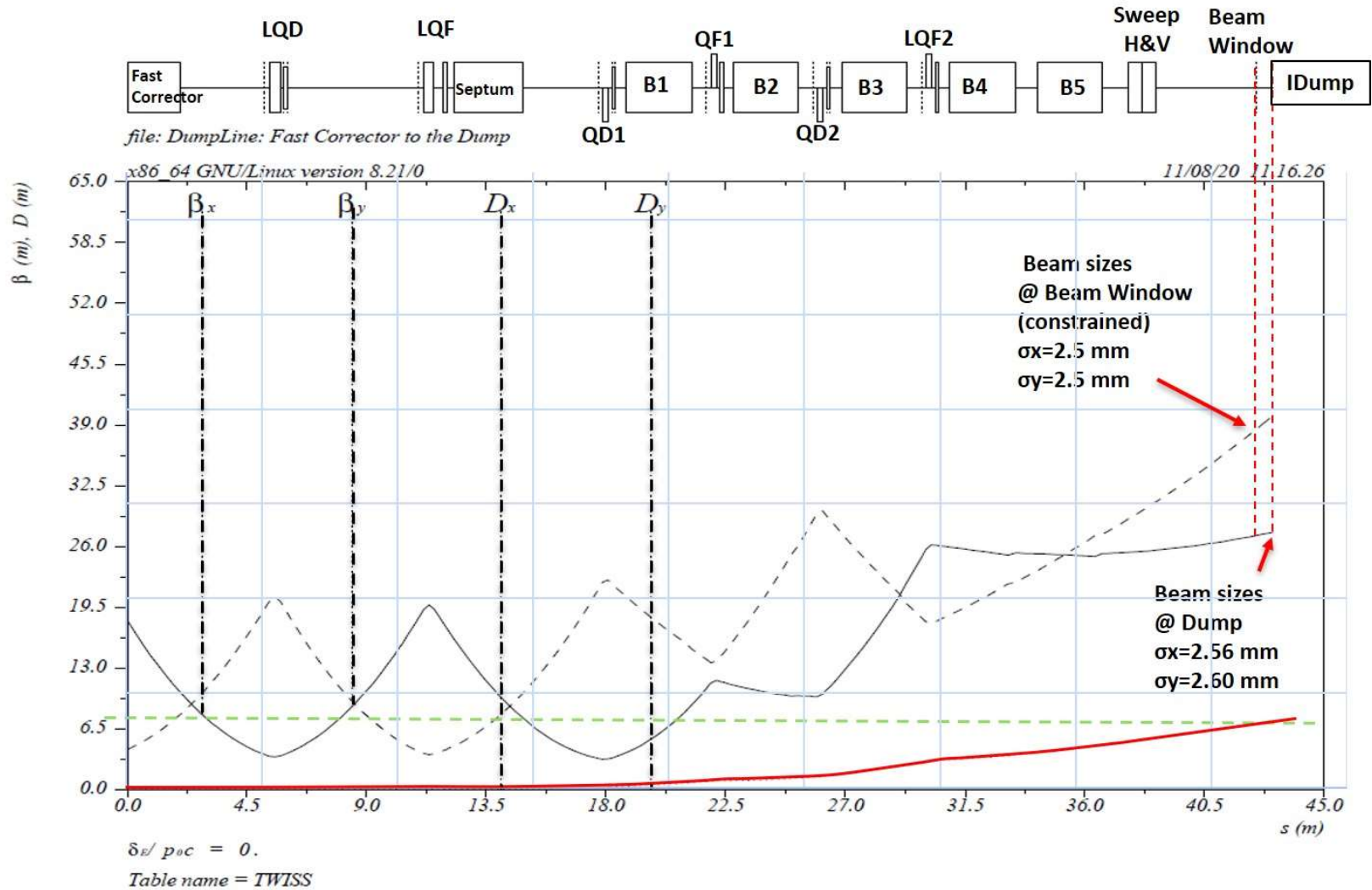


Image Courtesy of Meiqin Xiao

Critical Dimensions

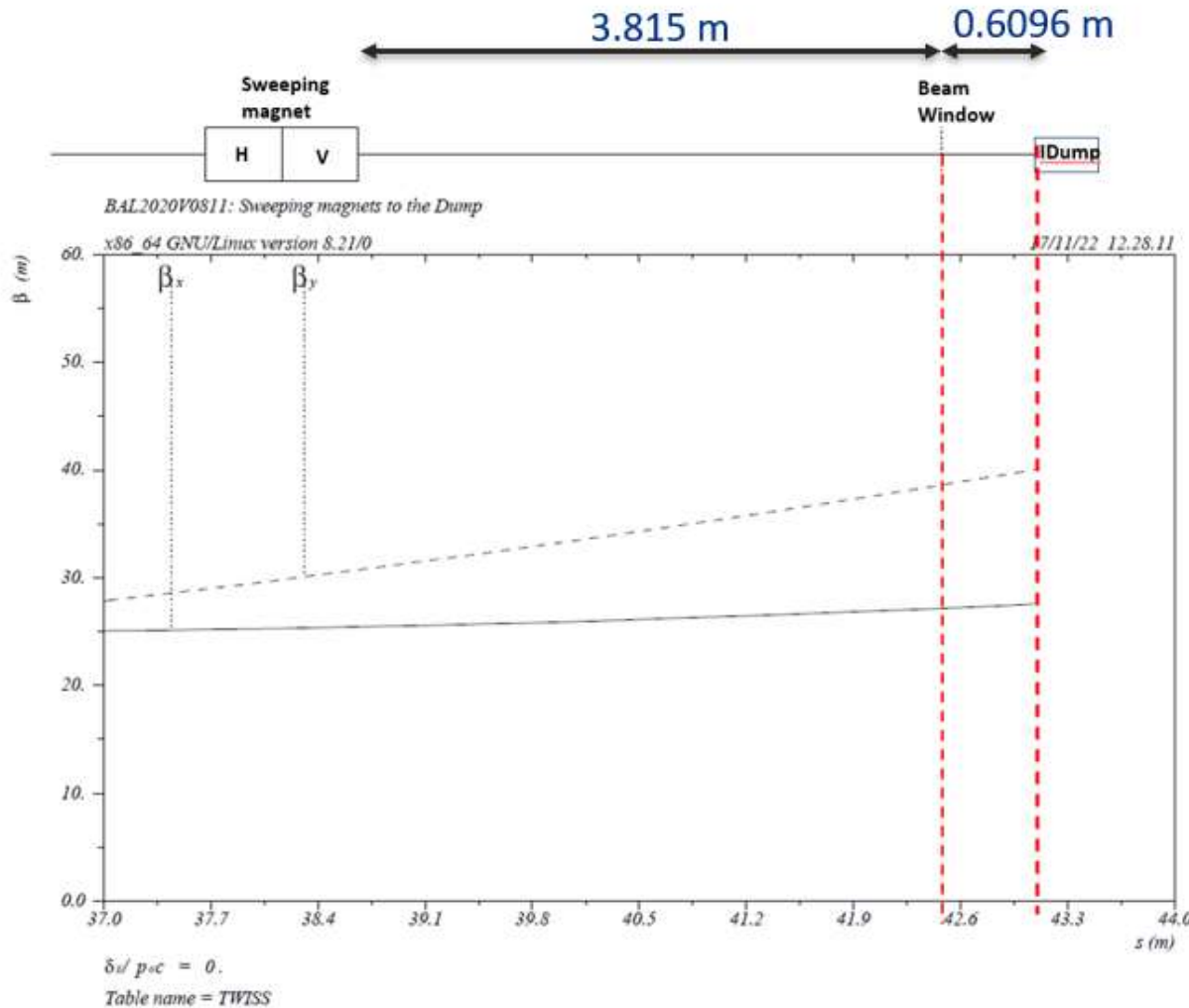
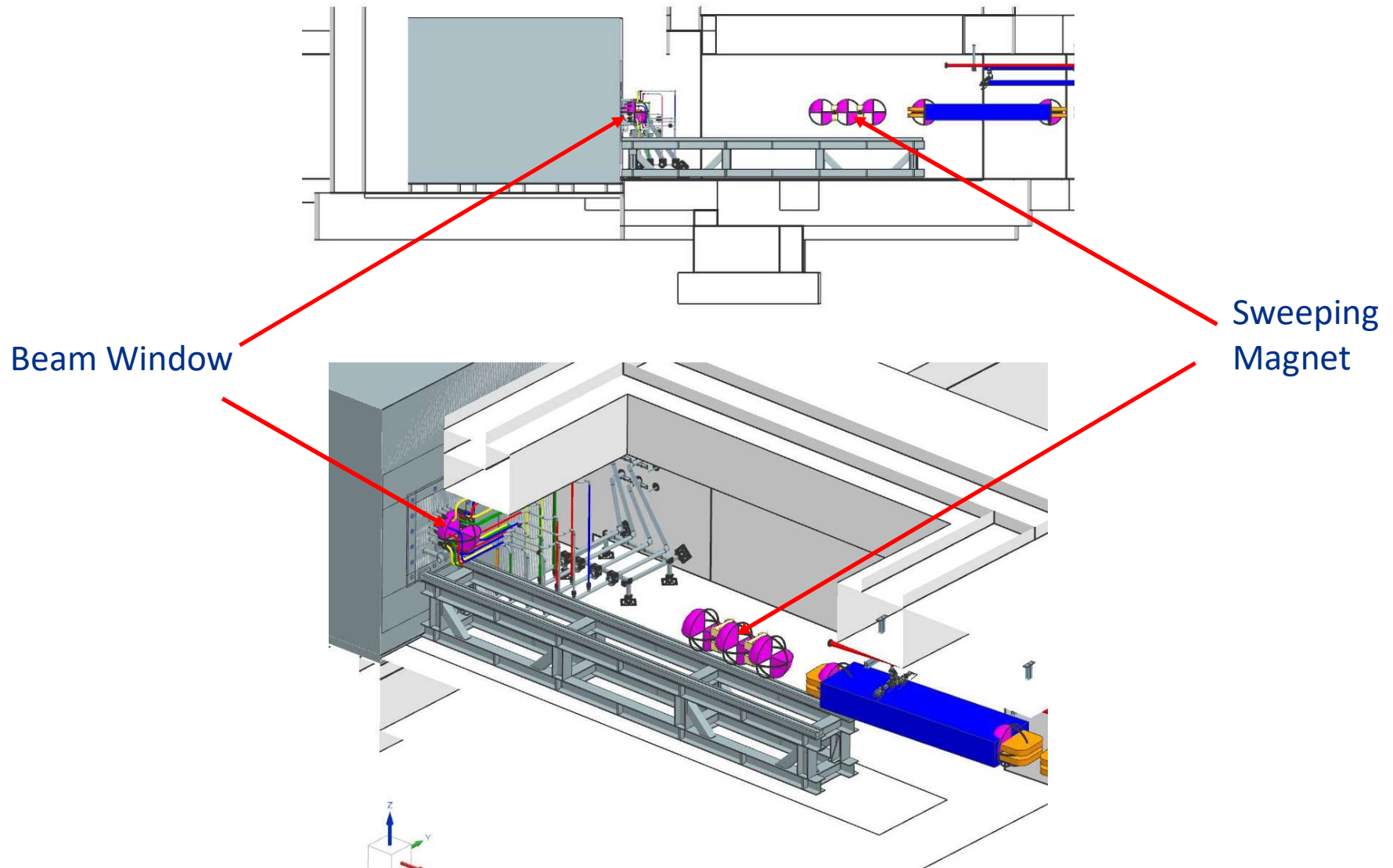


Image Courtesy of Meiqin Xiao

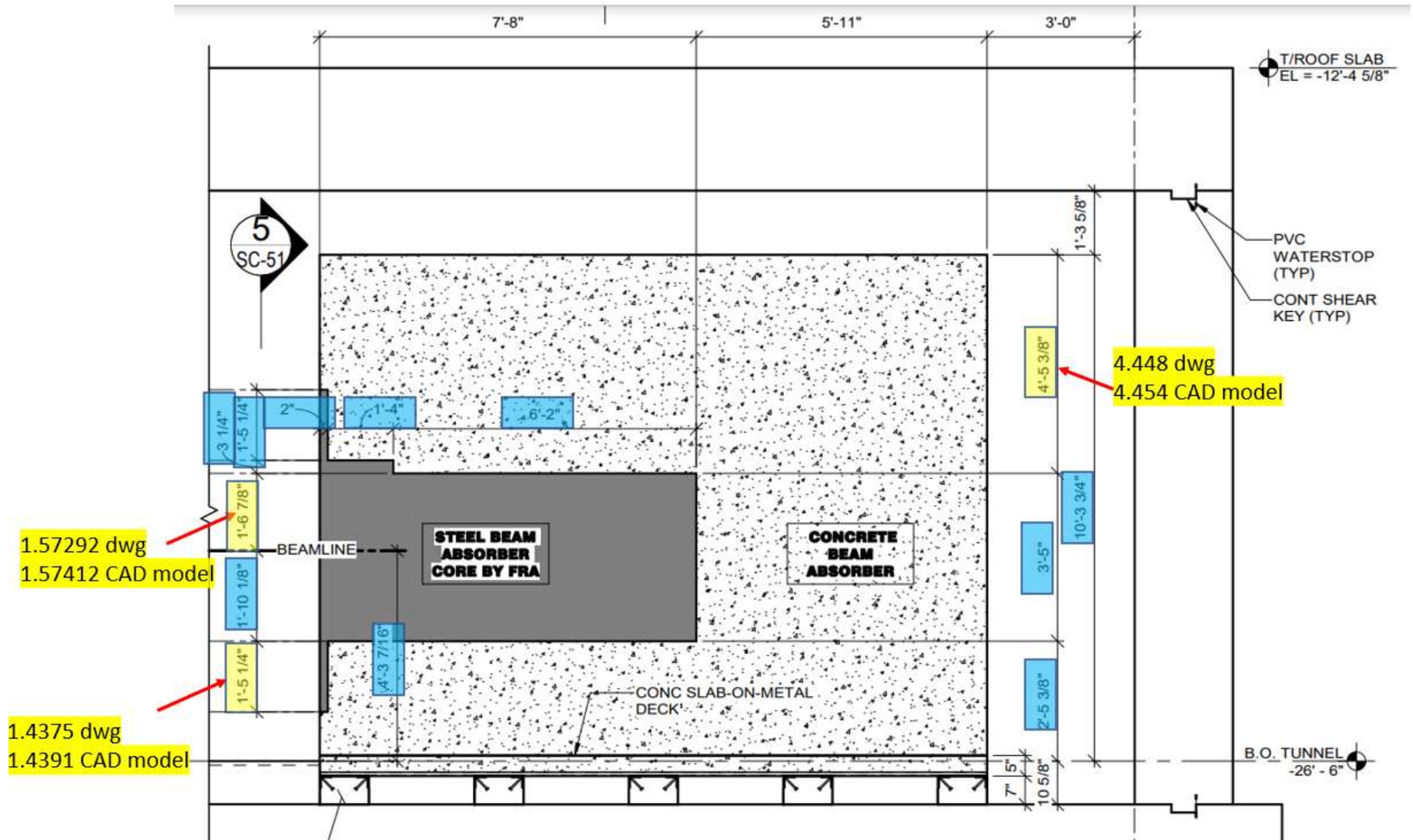
- ❖ The distance between the exit of the sweeping magnet and the Beam Window is 3.815 m (150.2 inches)
- ❖ The distance between the beam window and the Graphite Core is 0.6096 m (24 inches)
- ❖ The distance between the face of the shielding and the Beam Window is 0.1174 m (4.622 inches)

Interface with Sweeping Magnet



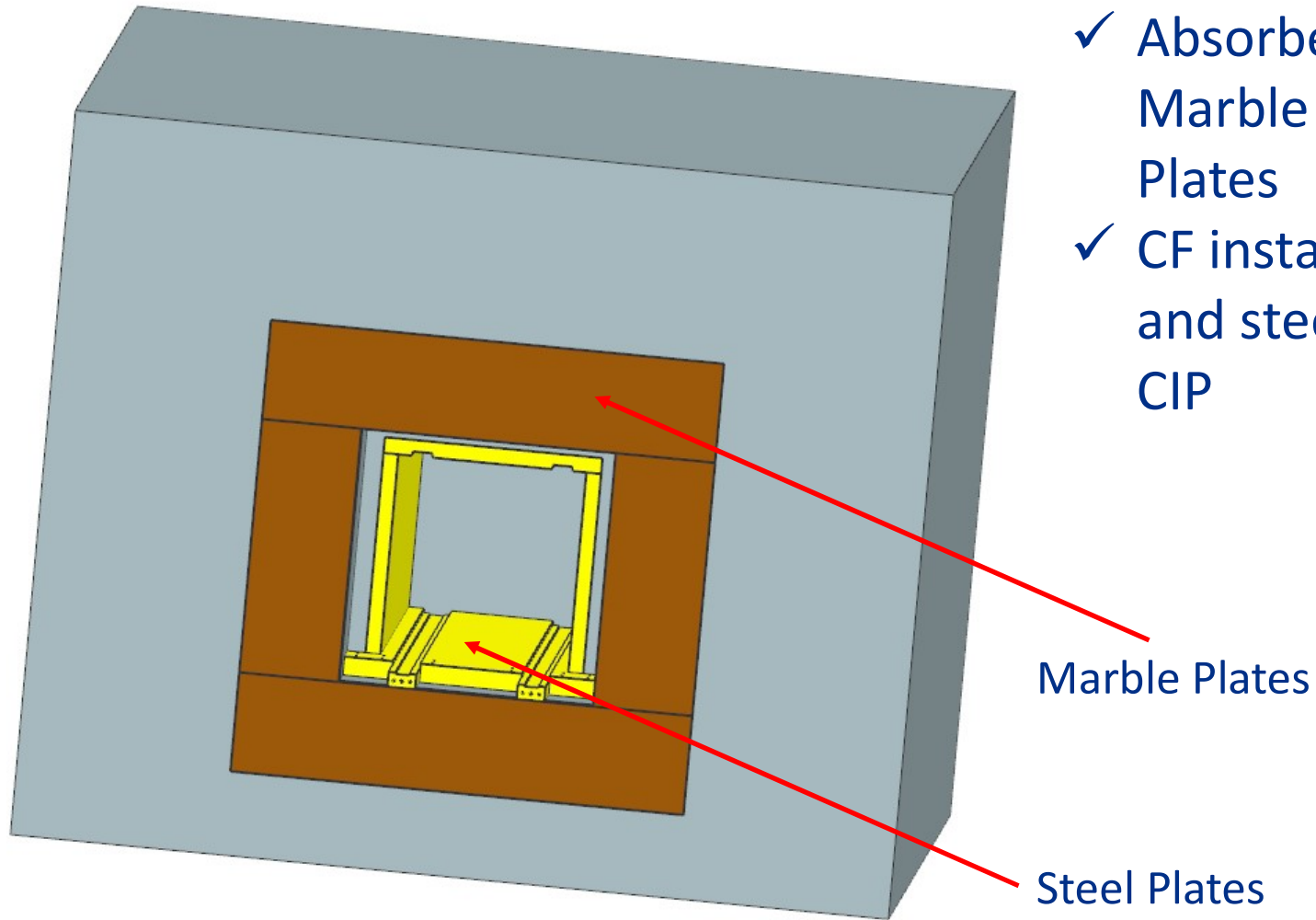
Interface – Conventional Facilities

CIP Concrete Dimensions Comparison



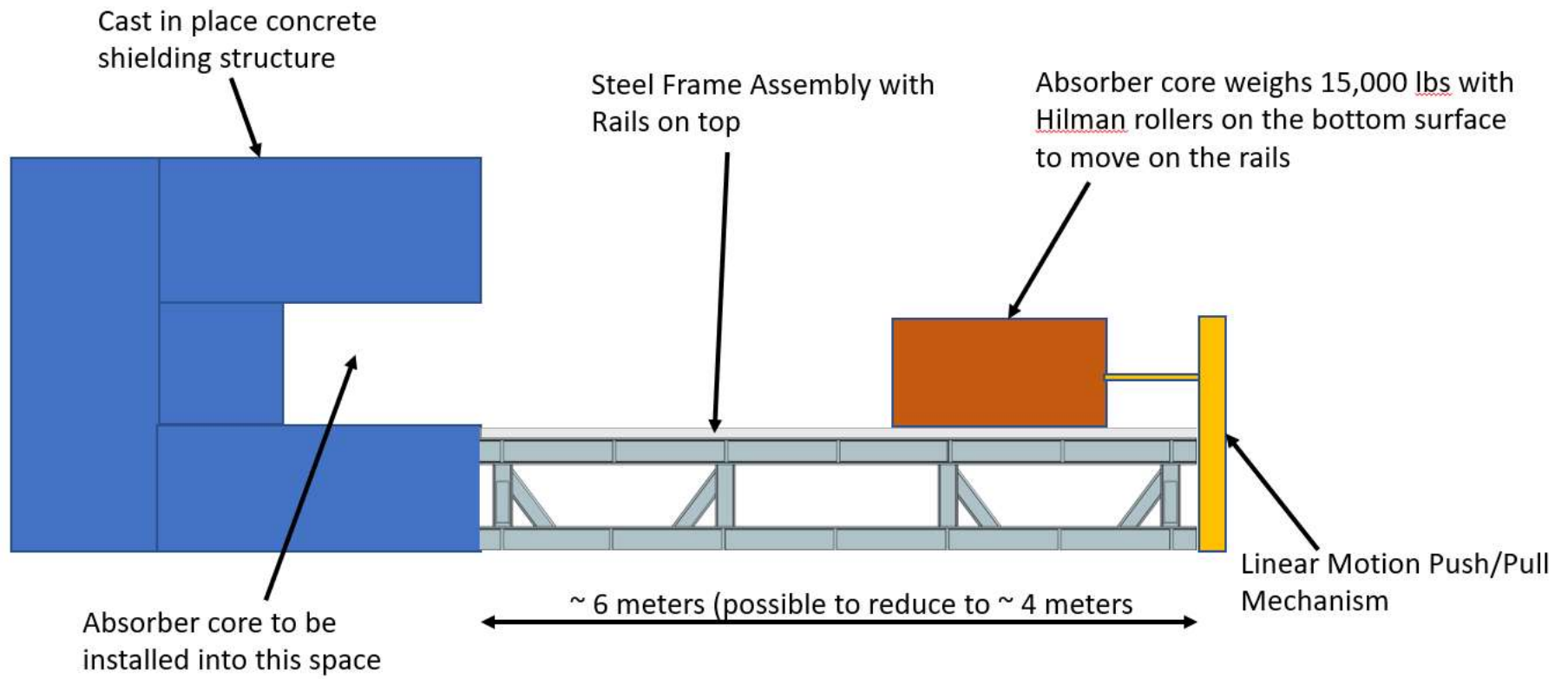
Cast-in-Place Concrete Provided by CF

- ✓ Absorber provides Marble and Steel Plates
- ✓ CF installs the marble and steel plates in the CIP



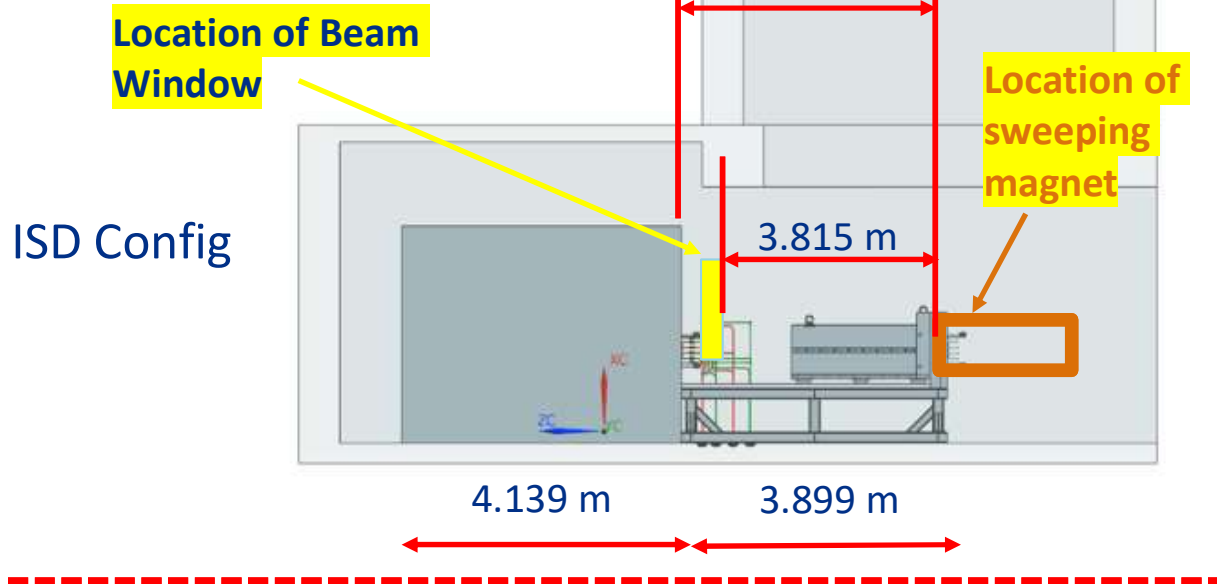
Interface – Installation

Installation of Absorber Core



Sweeping Magnet and Installation Frame small Gap/Interference

Location of beam window and sweeping magnet images NOT TO SCALE



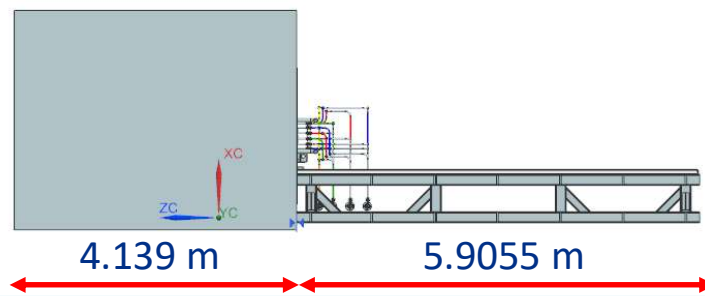
ISD Config:

- The gap between the installation frame assembly and the sweeping magnet is too small (33.4 mm)

Solutions:

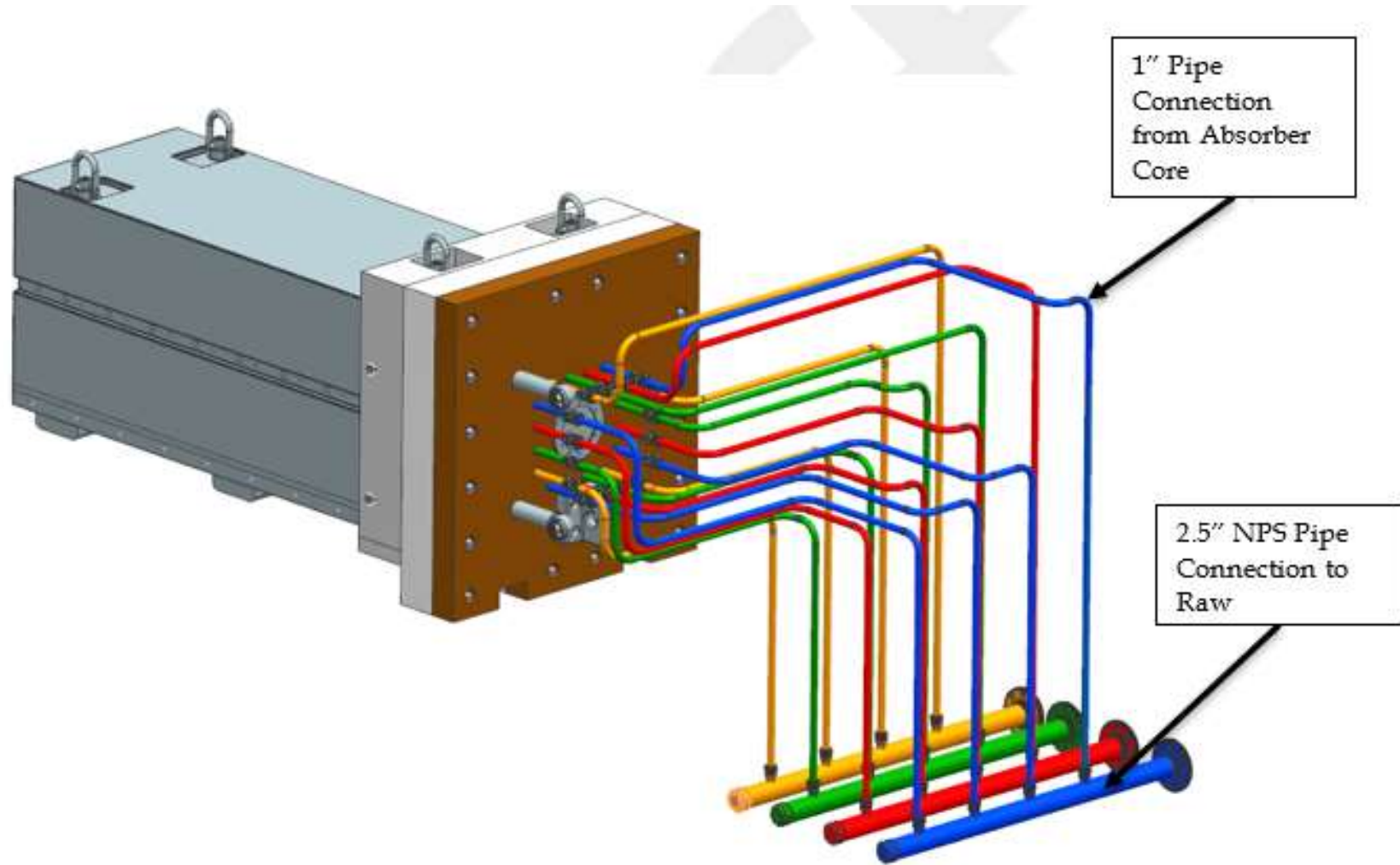
- Extend the frame to accommodate the sweeping magnet (WIP).
- Sequence the installation such that Absorber gets installed first and sweeping magnet gets installed later.

Current Config in Teamcenter



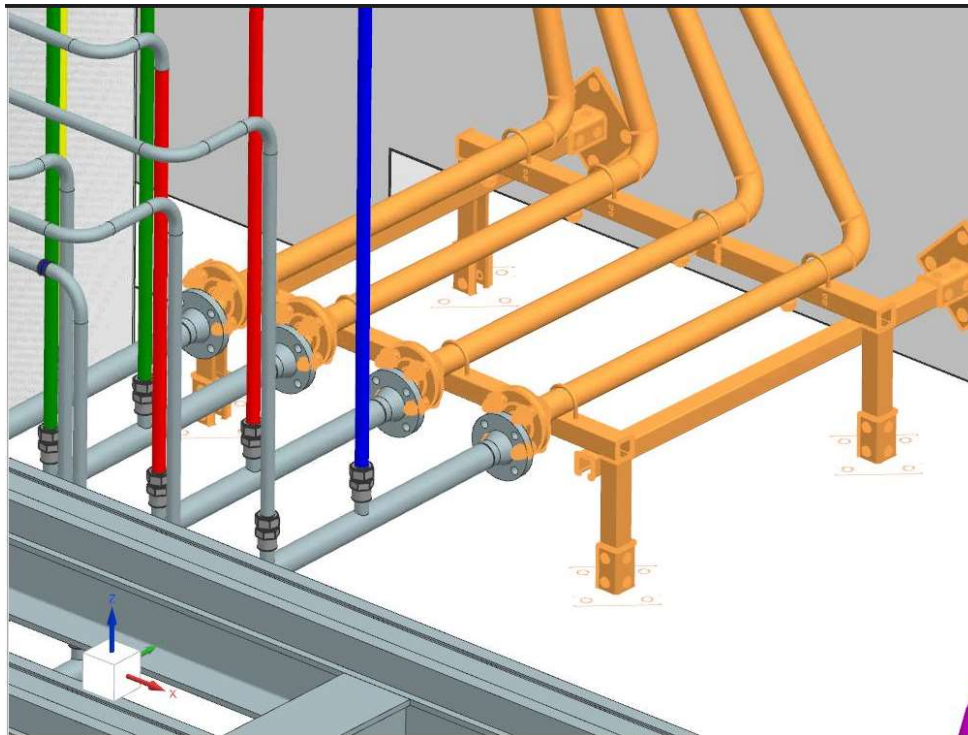
Interface – RAW System

RAW Piping Layout



Interfaces for RAW system

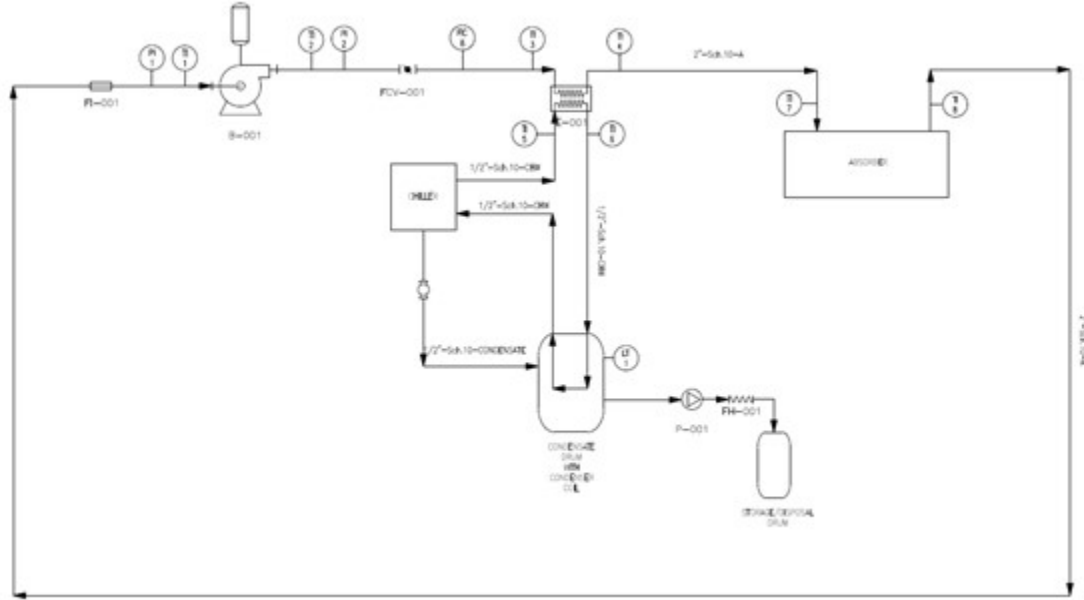
- ❖ BTLBA shall provide the flow rate, pipe size connections, and pressure requirements for the RAW Skid interface with the Beam Absorber.
- ❖ Bldgl shall design the RAW system
- ❖ BTLBA will procure the RAW system
- ❖ BTLI shall install the RAW Skid and make final connections between the RAW system and the Beam Absorber.



Interface – Air Circulation System

Status of Air Circulation System

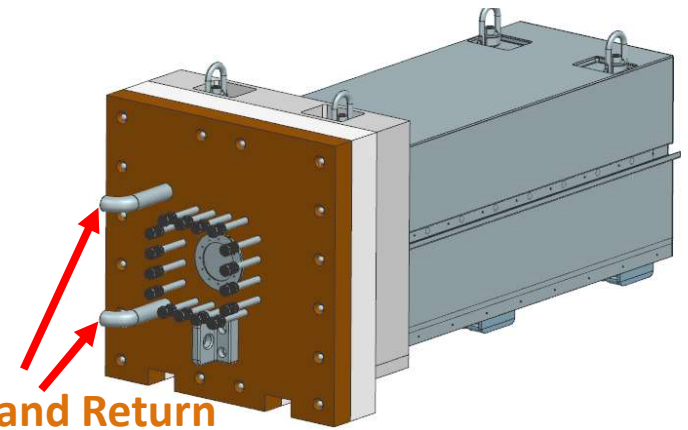
- Preliminary P&ID Drawn:



- ✓ Preliminary Design Completed. Work done so far:
 - ✓ Major equipment selected and sized based on current requirements.
 - ✓ Interfaces addressed, CF penetrations and sleeves, location of skid in the RAW room and location of storage tank and chiller in service building
 - ✓ Preliminary P&ID drawn

Next Steps:

- ... Determine any changes to requirements
- ... Revise major equipment sizing based on updated requirements
- ... Complete skid drawings and pipe layout drawings
- ... Finalize piping connection type between air system and absorber



Interface – Control Systems

Thermocouples for the Absorber

- ❖ The absorber temperature needs to be monitored using Thermocouples.
- ❖ Absorber provides the Thermocouples and the locations and wire routing info.
- ❖ Control Systems provide controls/readback
- ❖ Thermocouple J-Type will be used

Full Size Prototype of Shrink Fit

Shrink Fit Example from g-2 Beam Dump

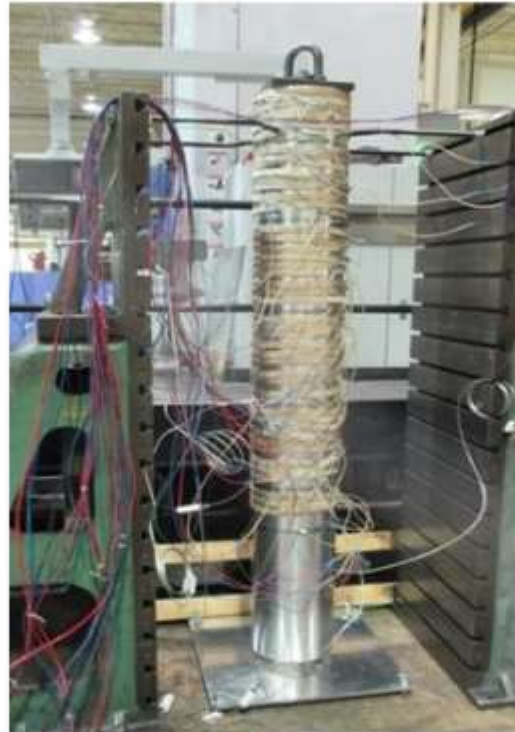


Water line channels machined



Heating tapes for shrink-fit process

- 5 zones for temperature control
- 3 band heaters per zone
- Each band heater 1.2kW, w/ a total 18 kW heating power
- wrap the whole mess in 2" thick ceramic wool
- First shrink fit at about 160°C, second shrink fit at 180°C +
- Last shrink fit at about 200°C



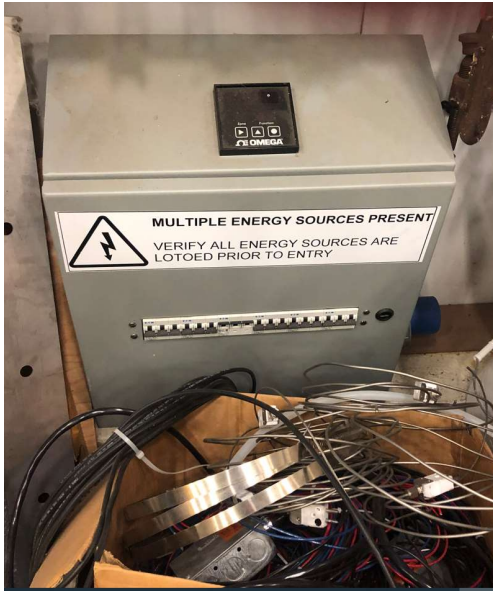
Water lines in place



Core shrink-fit into aluminum sleeve

What is Available and What is Needed?

Controller



Graphite Core - 1



Thermocouple J Type - 5

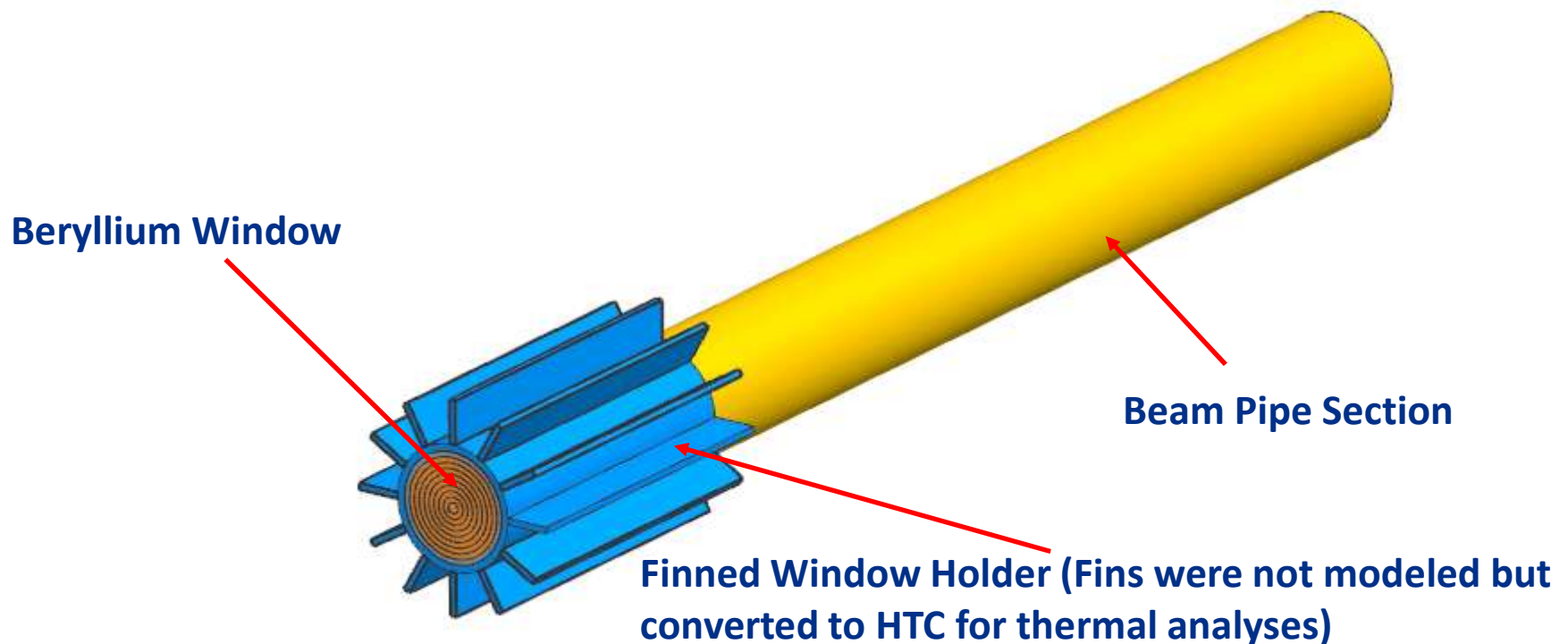


- ✓ A controller, a Graphite cylinder and 5 J-Type Thermocouples are available from the APO beam absorber build
- ... Budgetary estimate in progress
- ... Need one more Graphite cylinder
- ... Need final drawings of Aluminum Block and Graphite Core
- ... May need smaller components such as extra heater tapes and thermocouples

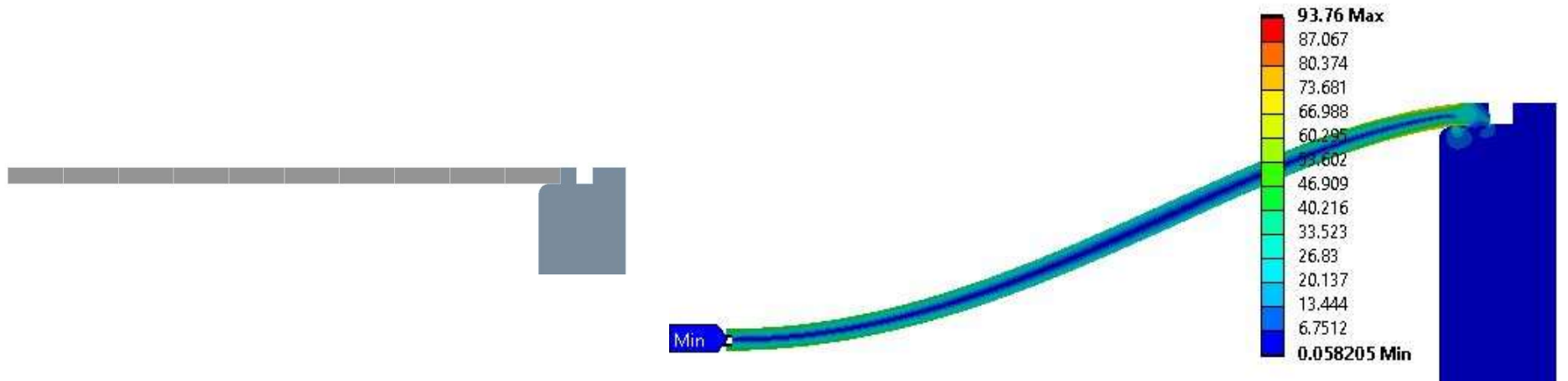
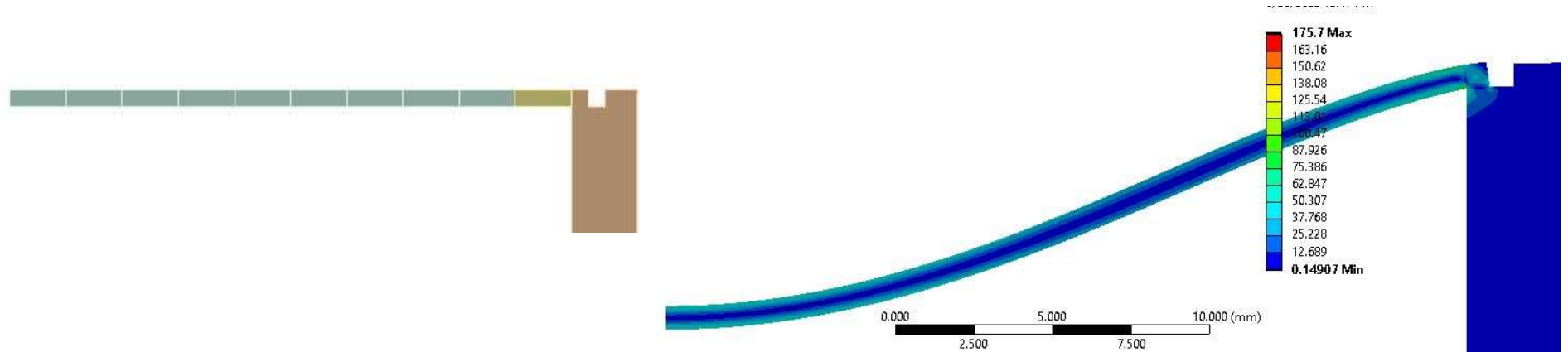
Vacuum Beam Window

Status of Design for Vacuum Windows

- ✓ Preliminary Design completed
 - ✓ Window material will be Beryllium
- ... FEA for final design in progress
- ... Engineering Note in Progress



Status of Design for Vacuum Windows (WIP)



Summary

- ✓ Final Design Review (FDR) of the BTL Beam Absorber is complete.
- ✓ We understand the current status and future work that needs to be performed.
- ... We understand the interfaces as well and are working toward resolving outstanding issues as discussed in the interface slides in this talk.
- ✓ We have also completed a preliminary design of the vacuum beam window.
- ... The FEA work for the vacuum beam window is underway.

Questions

Time to Steady State with Water Cooling

