

**Center Stack Upgrades (CSU)  
Vacuum Vessel  
Multi Point Thomson Scattering (MPTS)**

**DESIGN**

**General:**

Changes to the vessel vacuum interfaces are required due to the modified laser beams path due to the increase in the diameter of the center stack to 24.8 inches and the addition of a 3<sup>rd</sup> laser beam. The locations affected are at the mid plane ports of the space between Bays F & G, Bay L and Bay F.

The changes at the laser beams & calibration probe vessel entrance and laser beams vessel exit are significant, while the change to Bay F is minor.

## Specifics:

1. The design drivers are:

- a. Minimize the changes to the current collection optics (Optics Box, mirror and fiber bundles).
- b. Minimize the shift in position of the laser VV interface (West).
- c. Maintain current dimensions and spacing of laser beams at the VV input point and center stack.

Diameters are 1.5 to 2.0 mm and the center to center spacing is 2.5 mm at the input point and 6 mm with 7mm at the center stack.

- d. Distance from 2 laser beams center, to center stack tile surface — 5 to 10 cm.
- e. Provide space for a 3<sup>rd</sup> laser beam, same as existing beams.

The design drivers are:

- f. Provide a minimum clearance of 2.5 inches (6.4 cm) from a laser surface to a VV exit point feature
- g. Provide an external dump for the laser beams with a reflected energy path time of less than 45 nanoseconds.
- h. View out to  $R=155$  cm

## 2. **LASER FLIGHT TUBE – CALIBRATION PROBE**

- a. The laser input port shifted west of current position, approximately 2 inches.
- b. Elliptical penetration encompassing the two present vacuum interfaces (laser and alignment probe).

1.50 inch thick elliptical plug with vacuum interfaces for the laser beams and calibration probe, 3.00 inch diameter tubes.

- c. Ex vessel laser flight tube will shift to the East about 9 inches at the laser optics enclosure. The flight tube supports will be repositioned and modified.

## VV-Bay L

### e. **Lasers:**

The **2 laser beams** centerline to center stack tile surface clearance is 8 cm.

The 3rd laser to be placed into the mid plane, adjacent to the 2<sup>nd</sup> laser (away from the center stack) with the same spacing as the existing lasers.

### **Clearances at Bay L:**

1. #1 laser Surface to East Side \_ 8.7 cm  
#3 laser Surface West Side \_ 7.3 cm

### f. **MPTS** \_\_ 8 inch OD tube, 10 inch CF flange for the exiting **laser** beam.

A ceramic to metal adapter, bellows and 8 inch port TIV, each with 10 CF provided.

The TIV (shutter) is located outside of the ceramic to metal adapter and bellows. Support is common to bellows and dump tube.

## **VV-Bay L**

- g. Space between Bays L and K for the vertical legs of the RWM coils, approximately 0.25 inch to L and 0.32 to K.

The Bay JK cap design effort is evaluating adding 0.4 inch space at Bay L.

- h. A local platform is required for access to Bay L mid plane components.

## **3. VACUUM VESSEL BAY F**

Machine a small chamfer of approximately  $\frac{1}{4}$  inch by 10 inch high at the vessel ID at the mid plane to permit a view of  $R=155$  cm with no vignetting. Additional optics design required and “as built” Romer arm measurements required before the cut is defined.

The chamfer would be similar to the Bay H modification for High K Scattering.