### TCS Upgrade

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#### Introduction

The original TCS experiment has demonstrated the ability to create HCD plasmas whose densities are limited by impurity radiation. This was the first step toward a repeatable stellarator. The HCD plasma was created by means of helical field lines that are sustained by a set of four superconducting magnets. One of the original TCS magnets (10T) was added to the configuration, thus allowing for increased plasma density. The TCS is being extensively upgraded. All o-ring sealed flanges and all diagnostic ports have been replaced with bellows. This is necessary to maintain stress on the flanges caused by different coefficients of thermal expansion.

#### The Limiting Problem: Impurity Radiation

Secondary Engineering Challenge: **Obtaining the Large Quartz Interaction Chamber**

- The 0.4 meter diameter, 1.25 meter long quartz tube we have used in the past has two primary problems:
  - No take ports
  - Essentially not capable of holding vacuum load.
- These problems are manifested with cusp baffle, which would hold leak at 200°C, as well as the thermal loading.
- To maintain stress on the quartz caused by different coefficients of thermal expansion.
- A glow discharge system, along with Titanium getters and/or Boronization will be employed.
- Internal tantalum clad discharge tubes (LR = 6 meters) will shield the quartz confinement section to protect the quartz from the plasma. Tantalum shielding will be placed over the inside of all exposed stainless steel surfaces.
- A tantalum clad plasma chamber is shown to be highly effective at reducing contamination during capture of HCD plasmas.
- Two transition sections will be enlarged from 27 cm I.D. to a 68 cm I.D. to facilitate transport of ideal target plasmas for the RMF.
- The two transition sections will be joined to the quartz confinement section to allow passage of high temperature (approx. 500°C) gases.

#### Obtaining the Large Quartz Interaction Chamber

- This magnet is 9.5 times the size of the original TCS magnets. HCD plasma densities are limited by impurity radiation. This was the first step toward a repeatable stellarator. The HCD plasma was created by means of helical field lines that are sustained by a set of four superconducting magnets. One of the original TCS magnets (10T) was added to the configuration, thus allowing for increased plasma density. The TCS is being extensively upgraded. All o-ring sealed flanges and all diagnostic ports have been replaced with bellows.
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#### Secondary Engineering Challenge: **Constructing the Gate Magnet**

- The challenge arises because the 0.010" thick stainless steel is plasma facing, and it becomes a parameter we want control over.
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#### Obtaining the Taclad Internal Flux Rings

- We may use a set of three pieces, with around hose segment weldings.
- We are about to do a structural vacuum test