Executive Summary

The PISCES Lab, as part of UC San Diego's Center for Energy Research, utilizes thermal desorption spectroscopy (TDS) to analyze the performance of wall materials in nuclear fusion reactors. This research is conducted as part of a multinational project, known as ITER, that aims to decrease the reliance on carbon energy by developing the world's first nuclear fusion power producing energy system.

This project was sponsored by the PISCES Lab to increase the throughput of samples tested each workday. Their current TDS system was only able to test one sample in a day, as the system must be brought to atmospheric pressure to exchange samples and many hours are required to bring the system back to vacuum pressures.

Desired Results of the Project:

- A sample loading system that has the potential to be completely autonomous
- System that can test at least 5 samples in a single workday

Major Requirements:

- System that is compatible for ultra high vacuum pressures: 1.33×10^{-7} Pa (10^{-9} torr)
- Materials in heating area can withstand temperatures of up to 1100 C
- All components in the system are resistant to outgassing
- Thermocouple remains in contact during testing, but can be moved out of the way during sample exchange

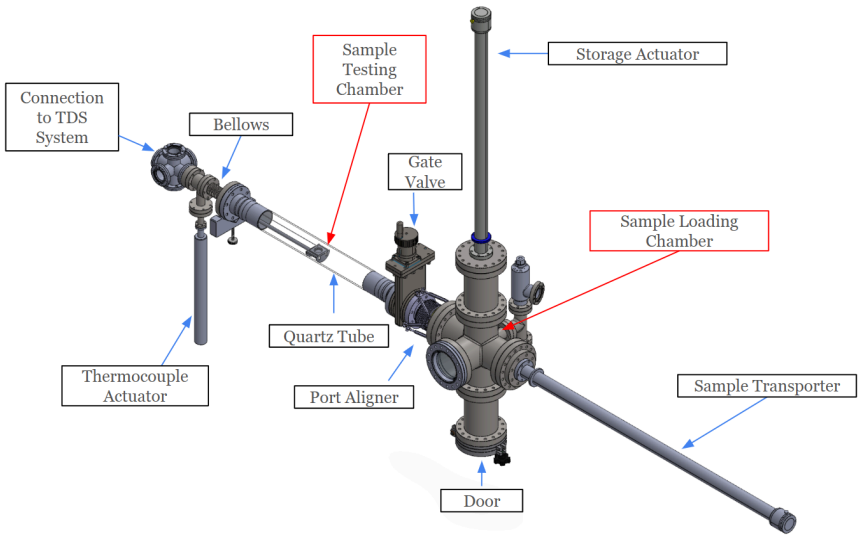

Figure 1: CAD of the Final Design

The design, as shown in Figure 1, consists of various components: a horizontal manipulator, a vertical manipulator, a thermocouple manipulator, sample holding elevator, quartz sample holders, quartz testing chamber, quartz pedestal, and grabber.

With the ability to test eight samples in a single workday, this design satisfies the design requirement. The horizontal manipulator provides for 1 meter of travel, allowing for the samples to be transported from their storage elevator to the quartz pedestal. The vertical manipulator also features 1 meter of travel, allowing for the storage elevator to travel through the bottom door and the scientists to be able to exchange samples with ease. All components in the direct heating zone are made from quartz and all metals used in the design are made from stainless steel, allowing for resistance to heating and resistance to outgassing.

Due to long lead times of various components, all quartz components were modeled with acrylic models and the sample transporter was modeled with a shorter horizontal actuator with the same degrees of freedom as the final actuator. During final testing, the temporary sample transporter was inconsistent in its ability to extend the grabber, due to the actuator's poor magnetic coupling. This problem is fixed with the inclusion of the finalized sample transporter, which has stronger coupling.

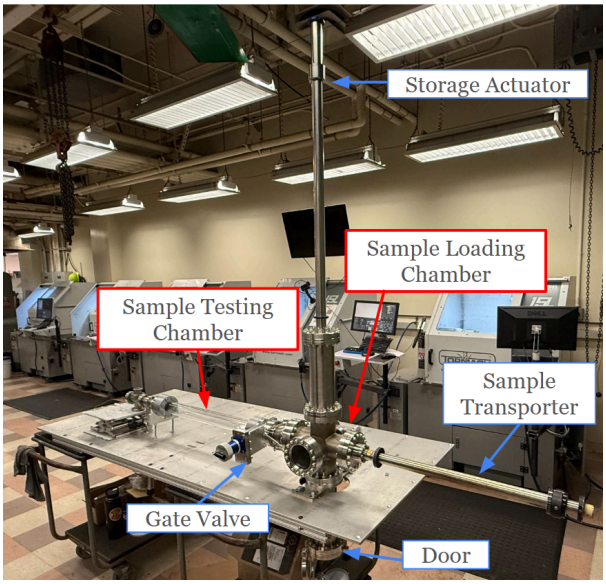

Figure 2: Final Assembly

In testing the finalized assembly, as pictured in Figure 2, the sample loading process for an individual sample was roughly 15 minutes. Accounting for the 1 hour of testing per sample and the 15 minutes of loading per sample, 8 samples are able to be tested in a 10 hour time frame. This system increases the sample throughput by a factor of 8.