

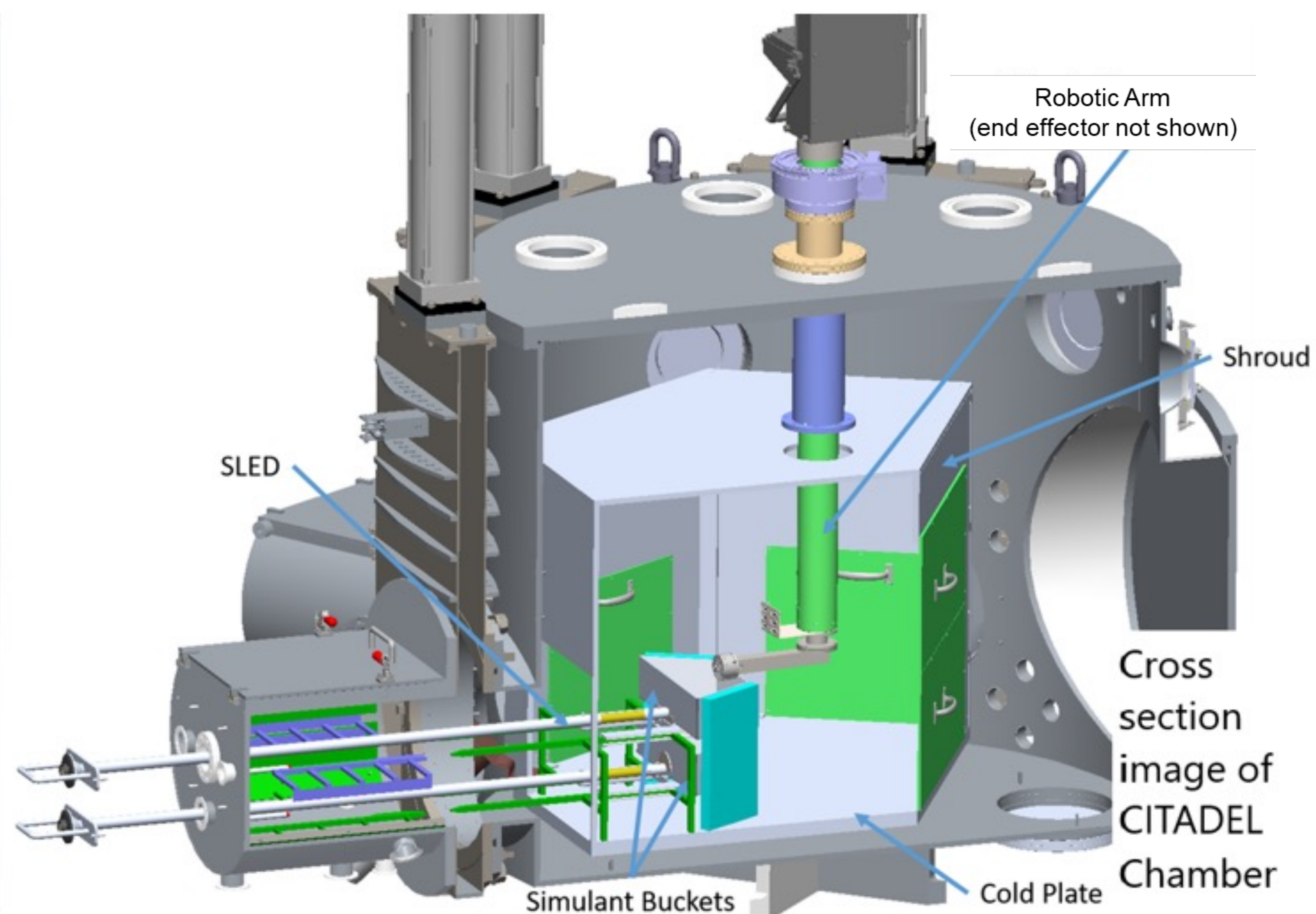
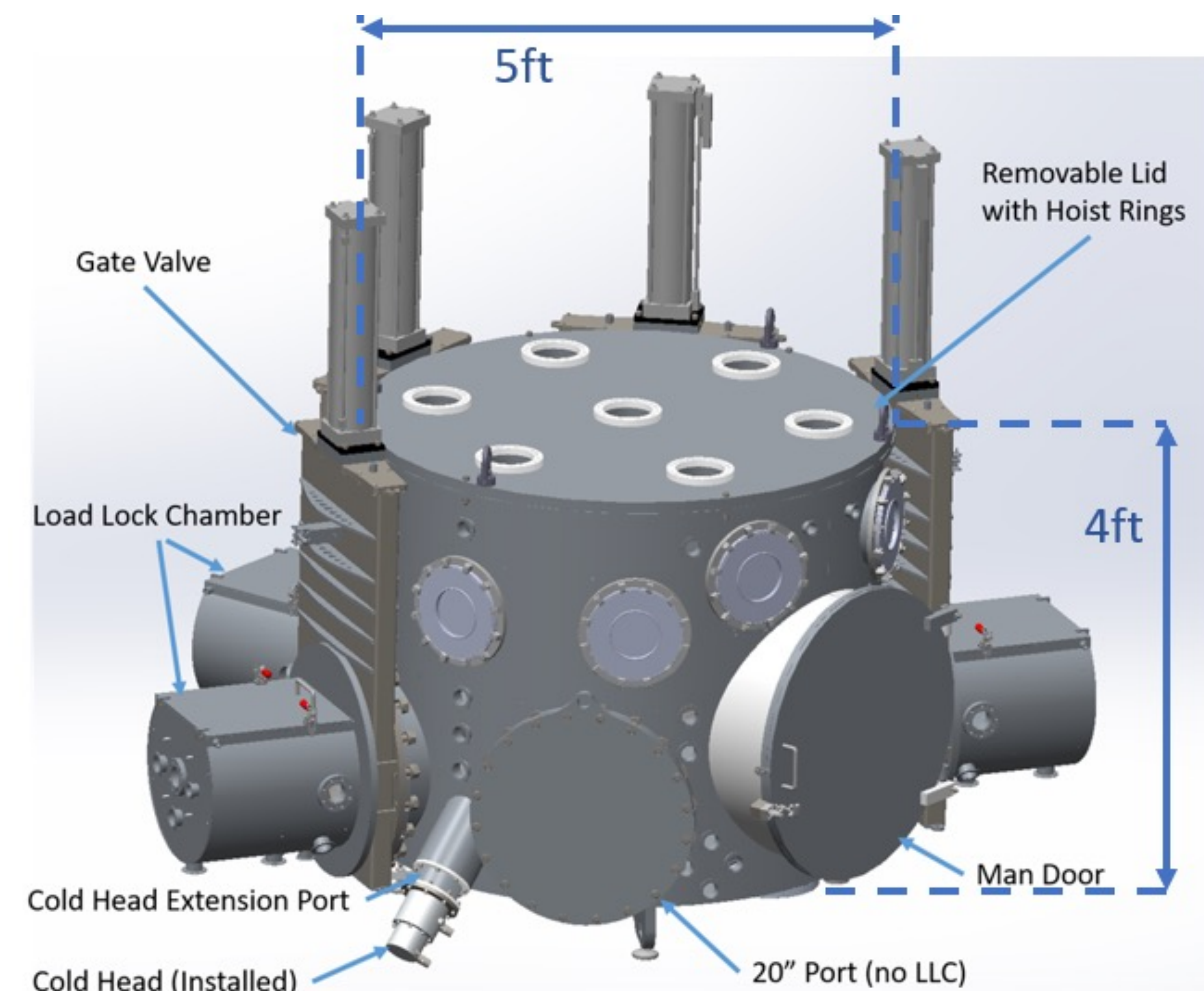
CITADEL

Cryogenic Ice Transfer, Acquisition Development, & Excavation Laboratory

Wade Smith, Esteben Rodriguez, Rebecca Perkins, Kristo Kriechbaum, Eric Roberts
Jet Propulsion Laboratory, California Institute of Technology

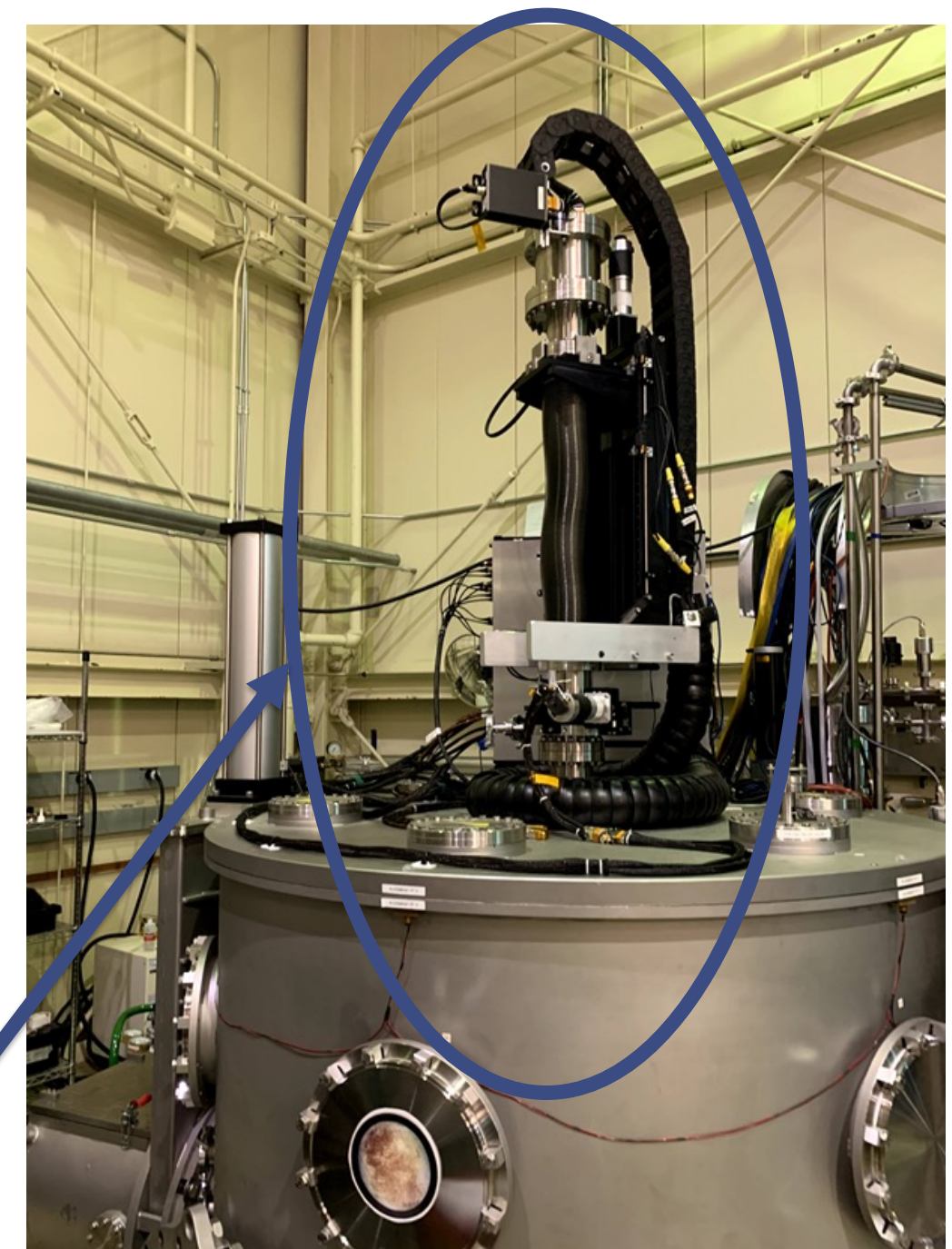
December 2022

CITADEL is a one-of-a-kind icy world environment simulator. JPL is using CITADEL to conduct research for excavating, collecting, and transporting a sample from an icy world, whether from the surface or plume.



CITADEL Overview

- Primary function: investigate, sample, collect, and transfer icy simulants in a high vacuum cryogenic environment.
- Vacuum chamber capable of achieving pressure lower than 10^{-6} torr and temperatures lower than 100K (-173 C).
- Chamber approximate dimensions:
 - External: 4ft (height) x 5ft (diameter)
 - Inside Shroud: 2.8ft x 3.9ft x 2.6ft (HxLxW)
- Up to four Load Lock Chambers can be used to load sample buckets and other hardware in and out of the main chamber without breaking environmental configuration
- 3-DOF manipulator arm, plus end effector, can be used to interact with the sample buckets
- Separate pneumatic system can be used to transfer simulant to a variety of sample containers



Summary of past, present, and future test programs utilizing CITADEL to conduct its research.

Test Program	Test Objective	Test Results
PISTOL(Pneumatic Icy Sample Transfer On Lander)	Icy simulant transfer in cryogenic vacuum environment	Successful transfer of icy simulant in cryogenic vacuum environment
Enceladus Dual Rasp	Collection and transfer of granular icy simulant in cryogenic vacuum environment	Successfully collected and transferred granular icy simulant in cryogenic vacuum environment
ICECAP (Ice Cutting and Encapsulation via Centrifugal Acceleration and Pneumatics)	Sample cutting, collection, and transfer of solid icy simulant in cryogenic vacuum environment	Successfully cut, collected, and transferred icy simulant in cryogenic vacuum environment
Sample Integrity	Investigation into simulant temperature increase during sampling operations	Developed test plan, to be completed in 2023
NESC Astronaut Glove	Verify thermal performance for next generation NASA astronaut glove	Upcoming spring/summer 2023
Enceladus Plume	Create and capture gaseous plume with entrained ice particles in cryogenic vacuum environment	Upcoming summer/fall 2023