KISS Workshop
Future Missions to Titan: Surface Sampling/Handling

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Issues Associated with Sampling Off Unstable Platforms

- **Platform stability**
- **While landers have been considered for Titan, the desire to sample more than one region has lead to consideration of an aerial platform for mobility, however:**
- Systems that are hovering/floating represent dynamically unstable sample acquisition platforms from which to react thrust/torque forces unless some means is provided to stabilize or anchor those platforms;
- Providing a means by which to apply sampling forces (e.g., drilling or digging) and react those forces through the platform such that the control system knows its state at all times and can close the force loop is not unsolvable but requires the addition of additional structure/ mechanisms/sensors to make the platform state deterministic (e.g., landing w. sufficient mass such that the platform can react forces, or anchors)—this adds mass/power/complexity to the system;
- Sampling techniques considered viable for Titan-

---Tethered drag sampler (not consistently effective for harder surfaces)

---Ultra-sonic drill (could work and has been employed in recent Europa science pod design)

---Tethered drop penetrator (could work—some issues exist w. surface topography/hardness)

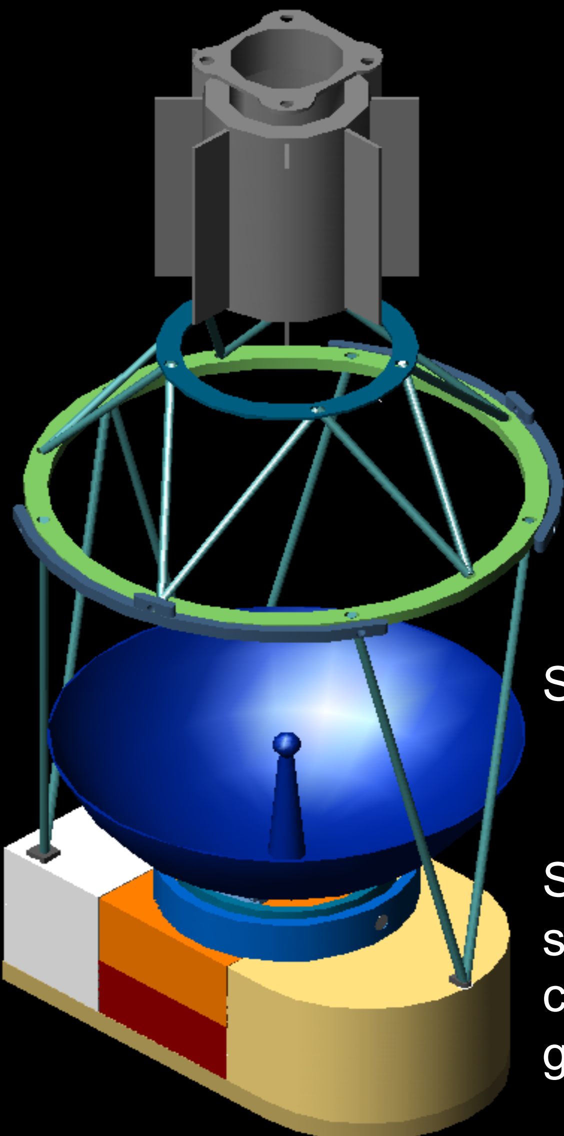
---Tethered pyro-activated penetrators (could work—some re-bound issues)

Consideration of Sample Acquisition and Handling

- **Viable Options for Sample Acquisition**
- While the USD looks promising, the device driver/piezo-actuation must be in the corer housing along with a second vertical drive mechanism---this may add more mass to each coring unit and may make core removal difficult;
- The pyro/gas activated penetrator design ensures sample acquisition and allows for straightforward sample removal/handling;
- The gravity based penetrator design ensures sample acquisition under select conditions (benign terrain) and potentially simplifies sample removal/handling;

- **Sample Handling/Interrogation**
- The systems shown here allow for the sample to be interrogated in its solid phase as well as its liquid or gas phases;

RTG Retention Structure Located Directly Under Balloon Opening



Steerable antenna

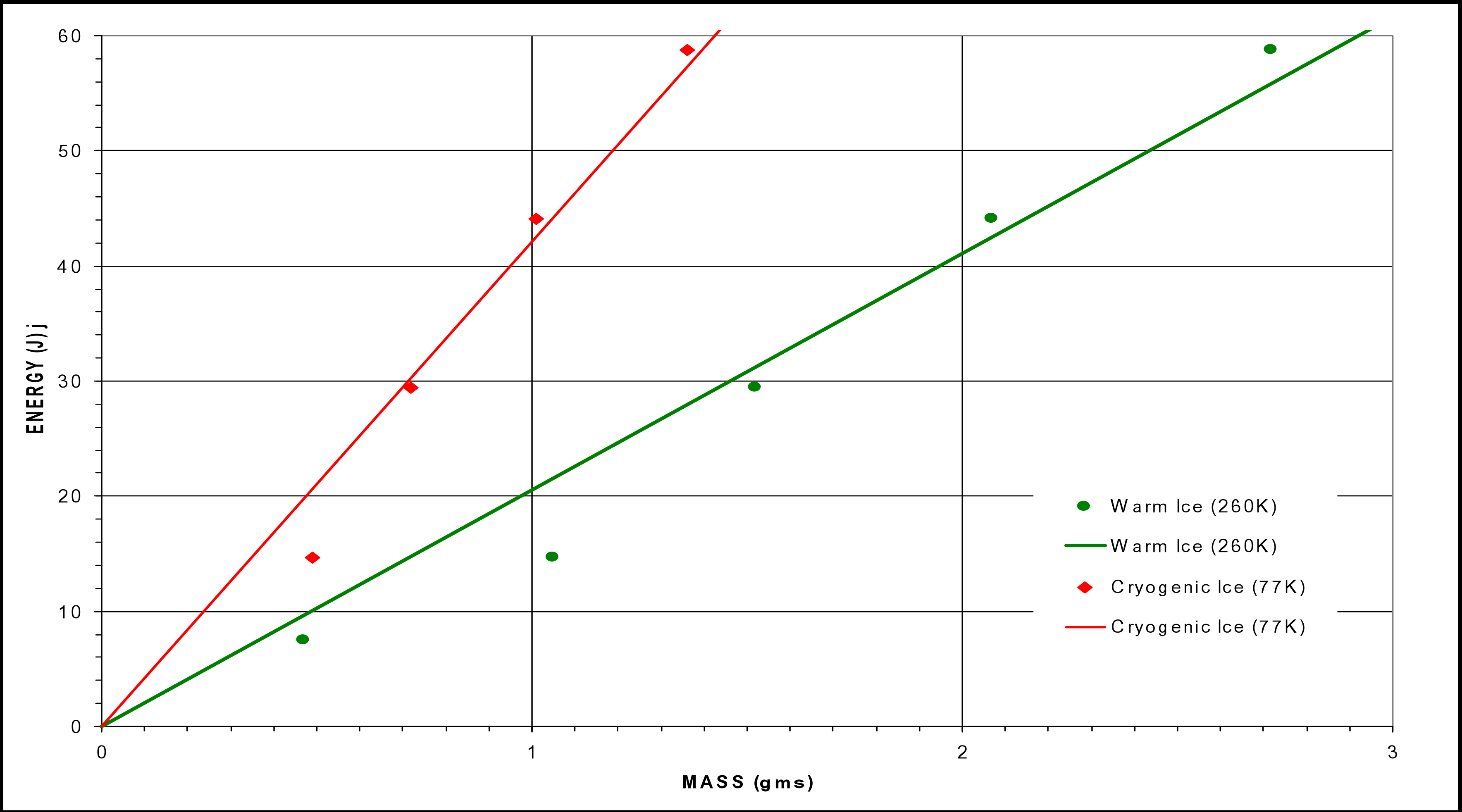
Sample acquisition/handling, science instrument payload, and control electronics located in gondola

ICE IMPACT/ANGLE TESTS

1cc of ice was collected with an impact angle of 45^{o} although this is not quite the same as hitting an off angle slope—early tests suggest that a gravity dropped probe could be capable of collecting ice samples on slopes. The active pyro-activated penetrator could collect as much as 10cc of ice.

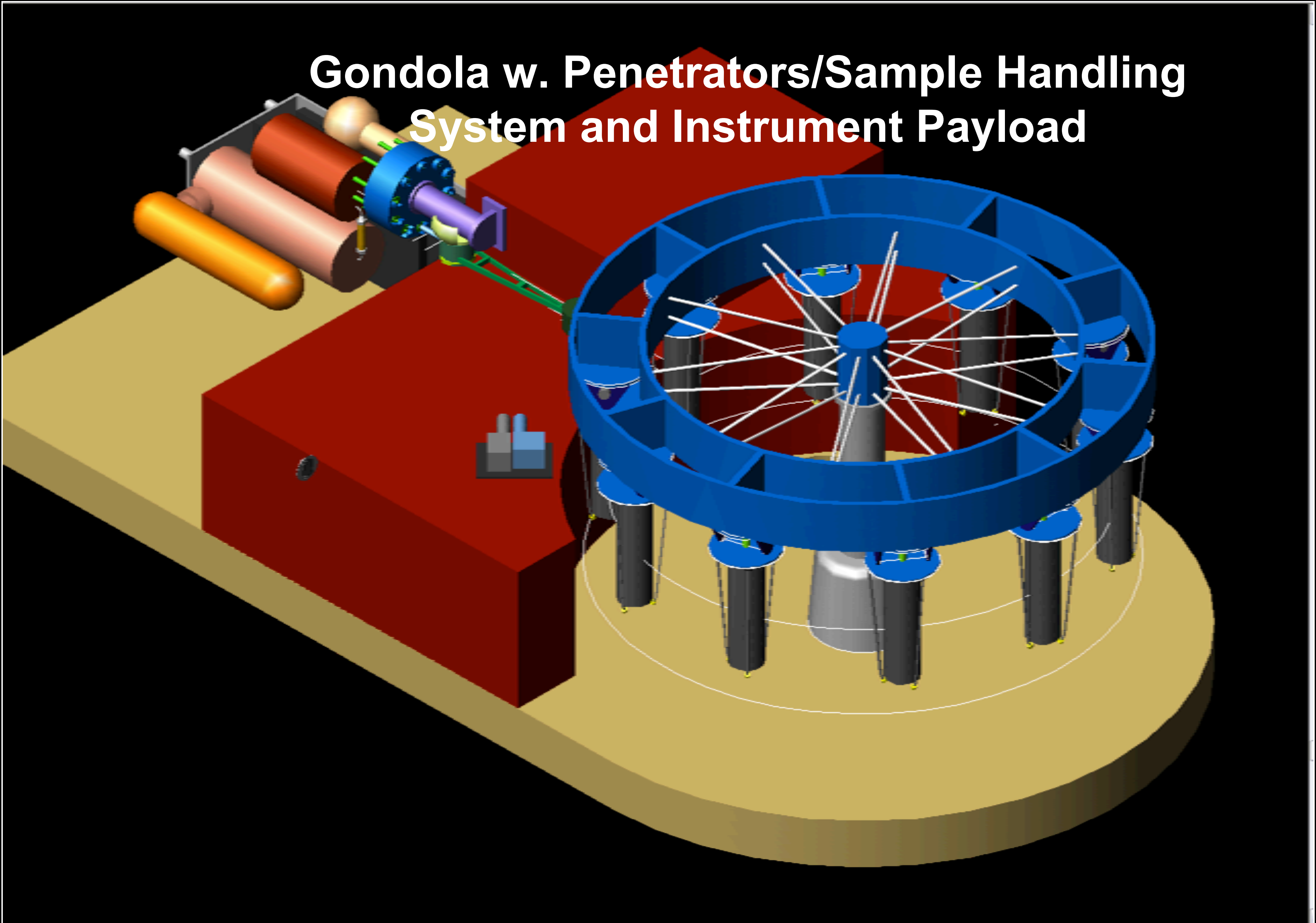
Results of Drop Tests

- Measured penetration energies required for collecting cryogenic ice (77K) and warmer ice (260K)

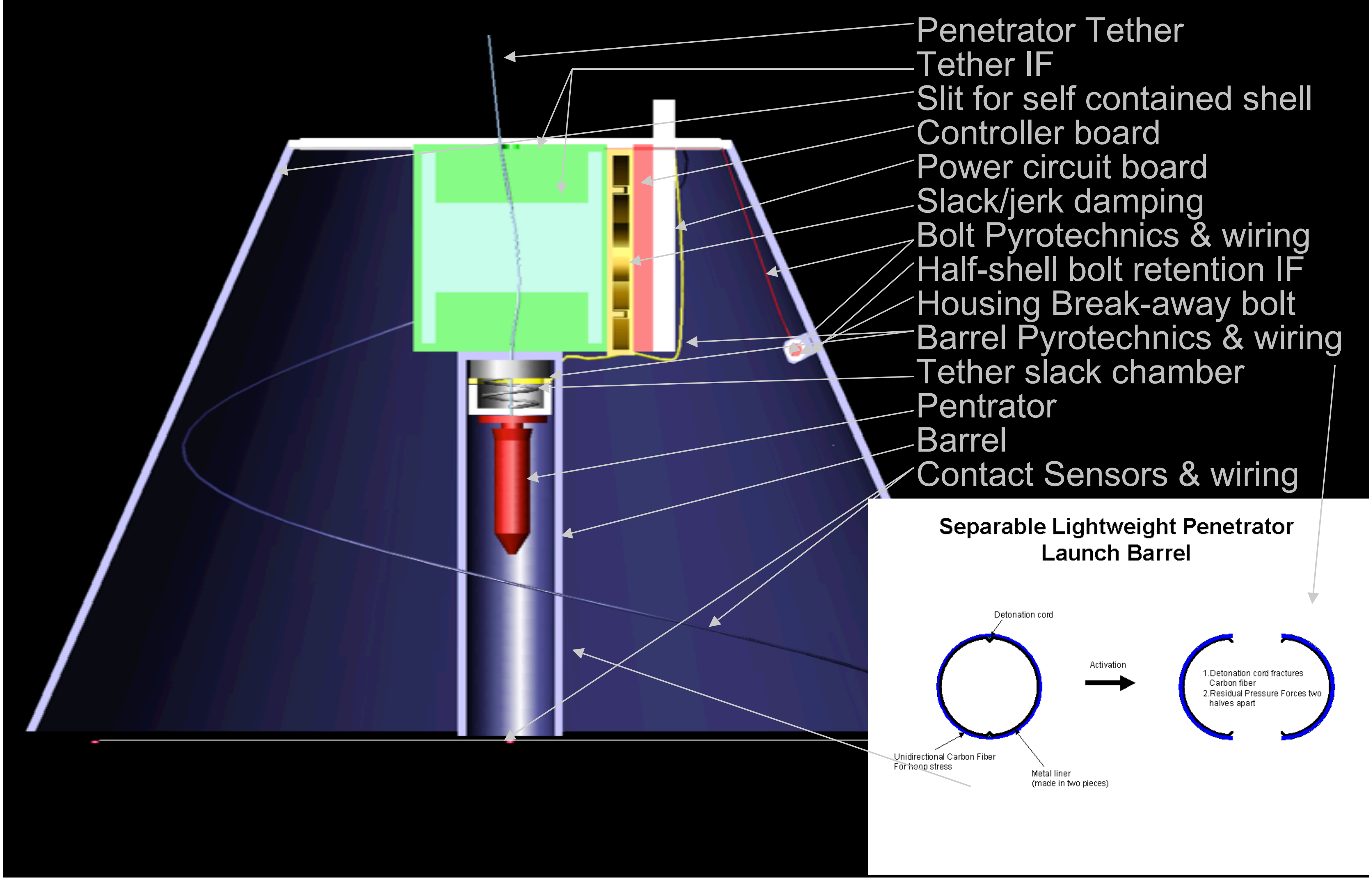


The amount of energy required to gather cryogenic ice samples (77 K) is almost exactly twice the amount of energy required to gather warmer ice samples (260 K).

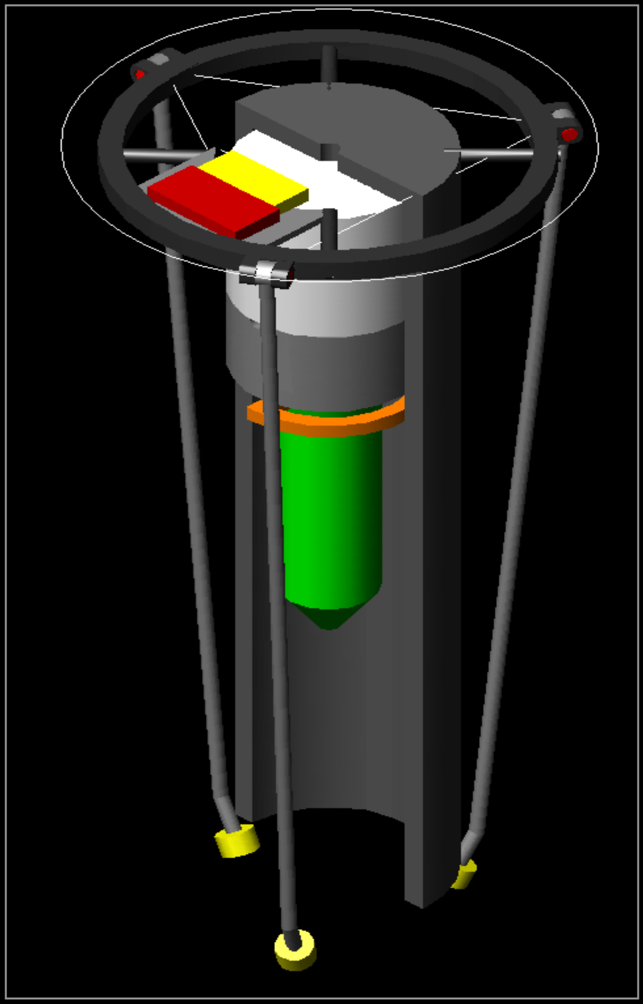
Gondola w. Penetrators/Sample Handling System and Instrument Payload

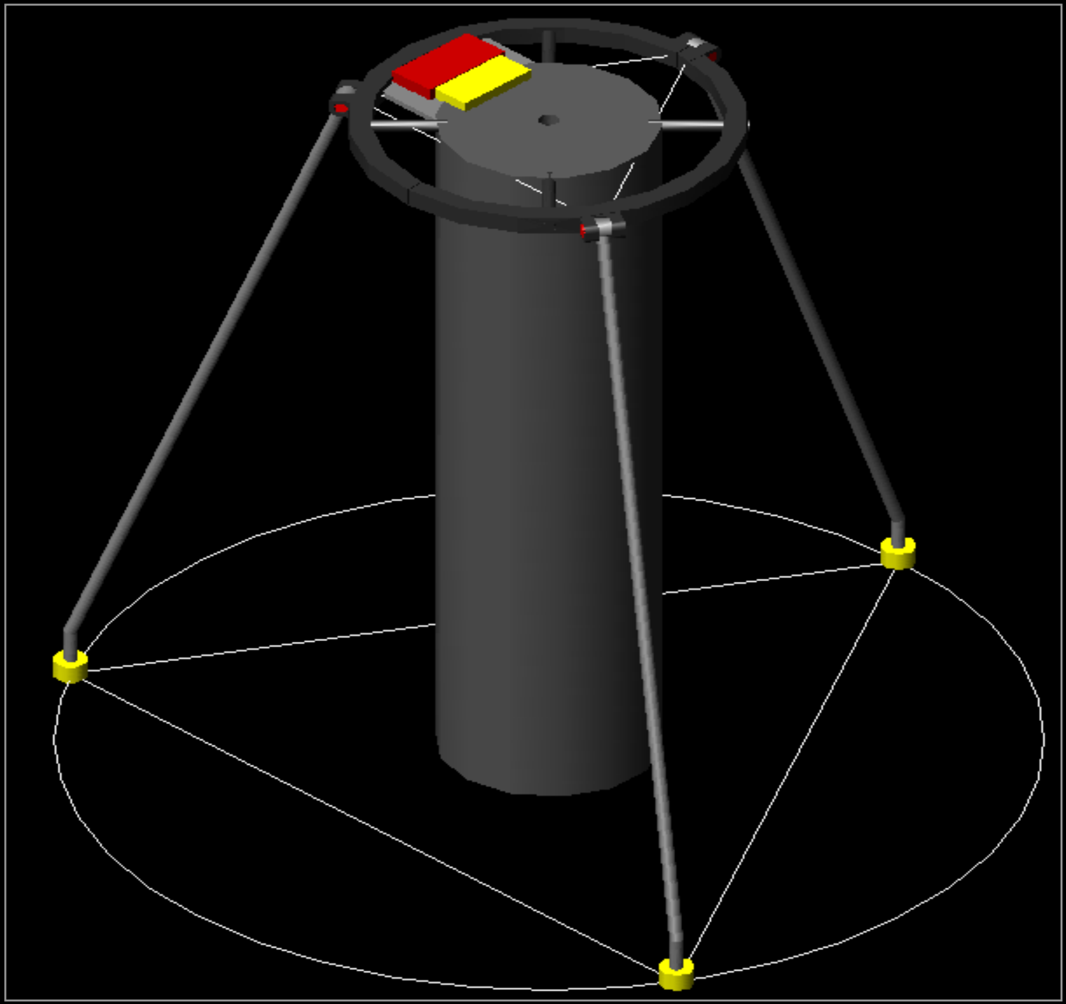


Active Sampling Device Sectional Slice

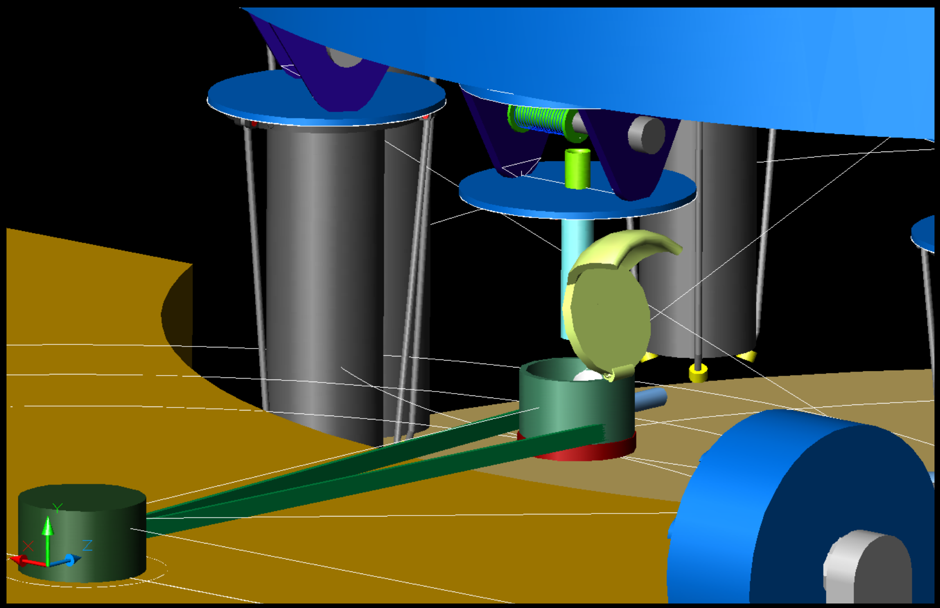


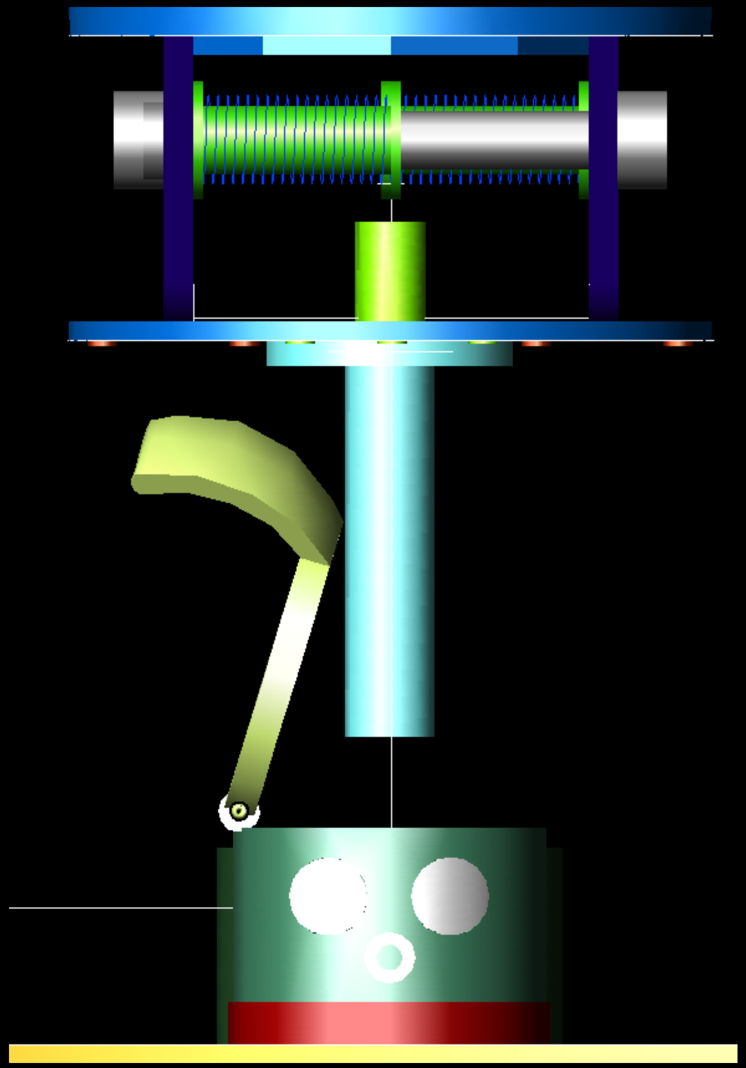
Flight Design Concept



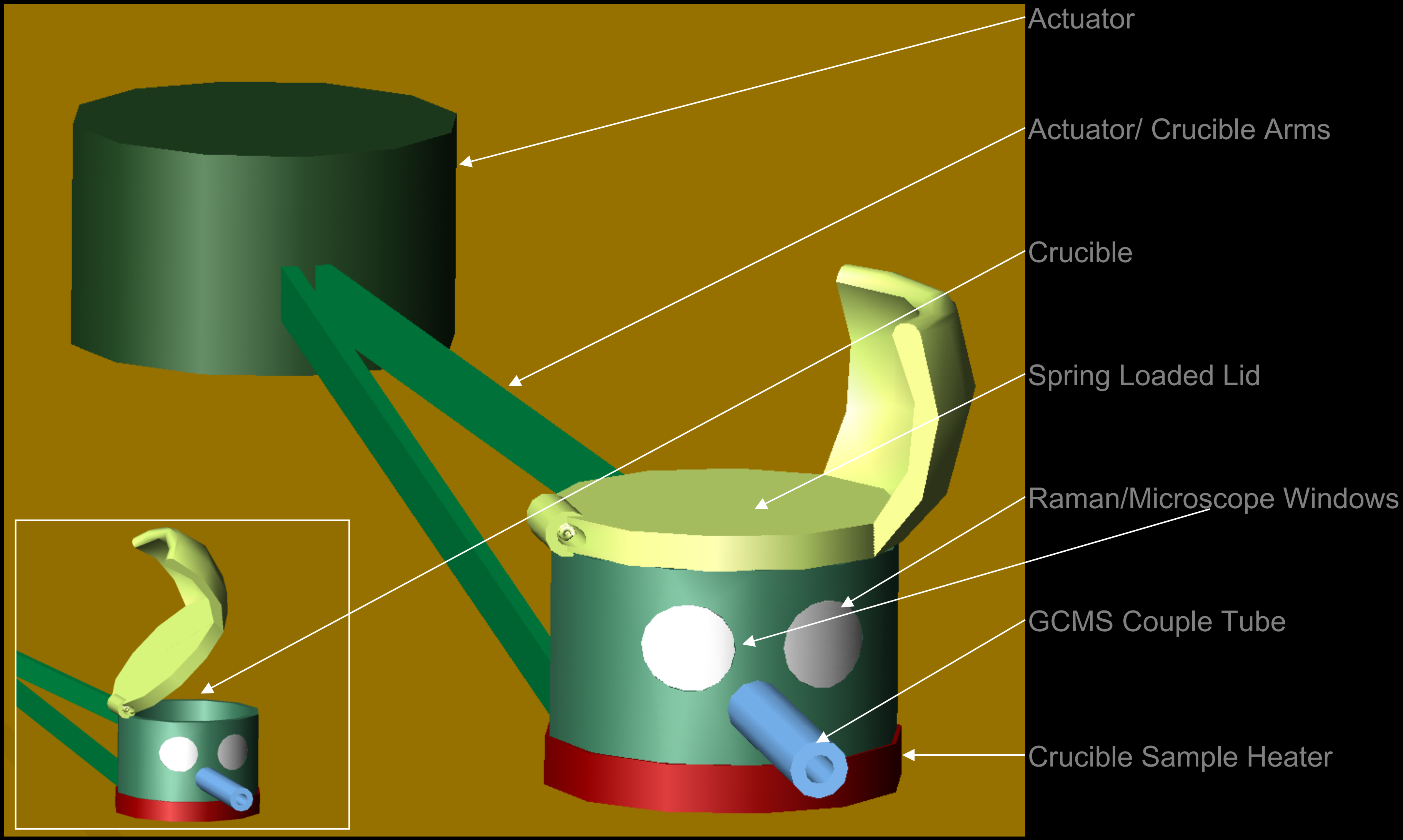


Sample Delivery to Crucible

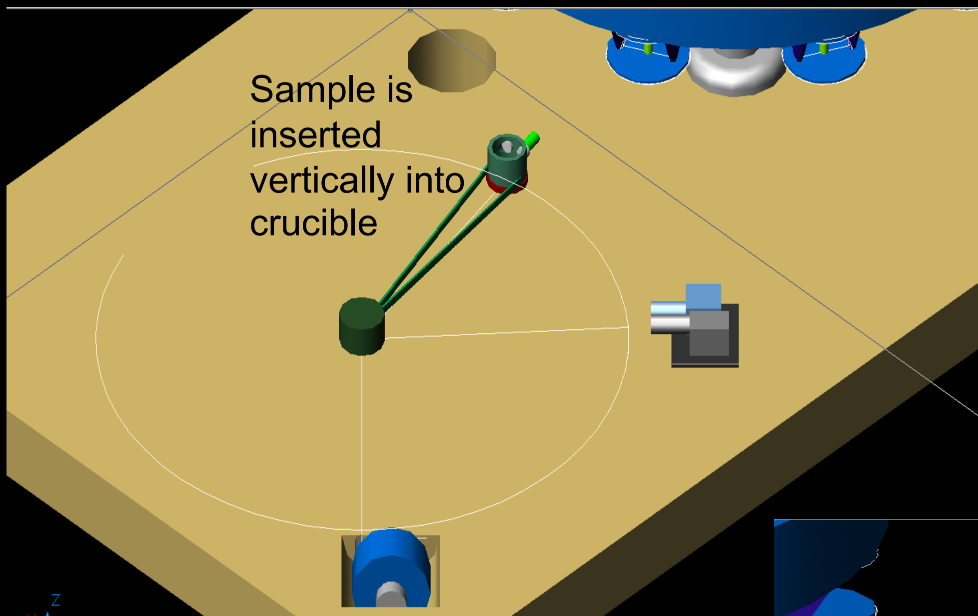


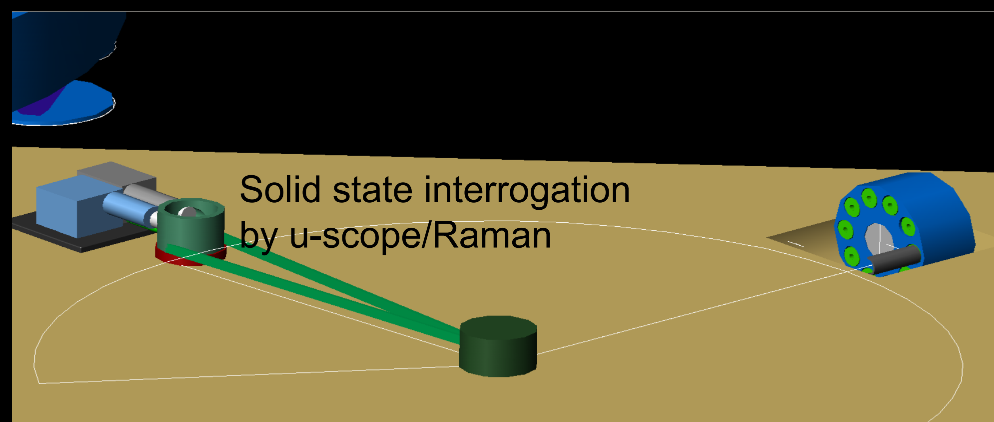


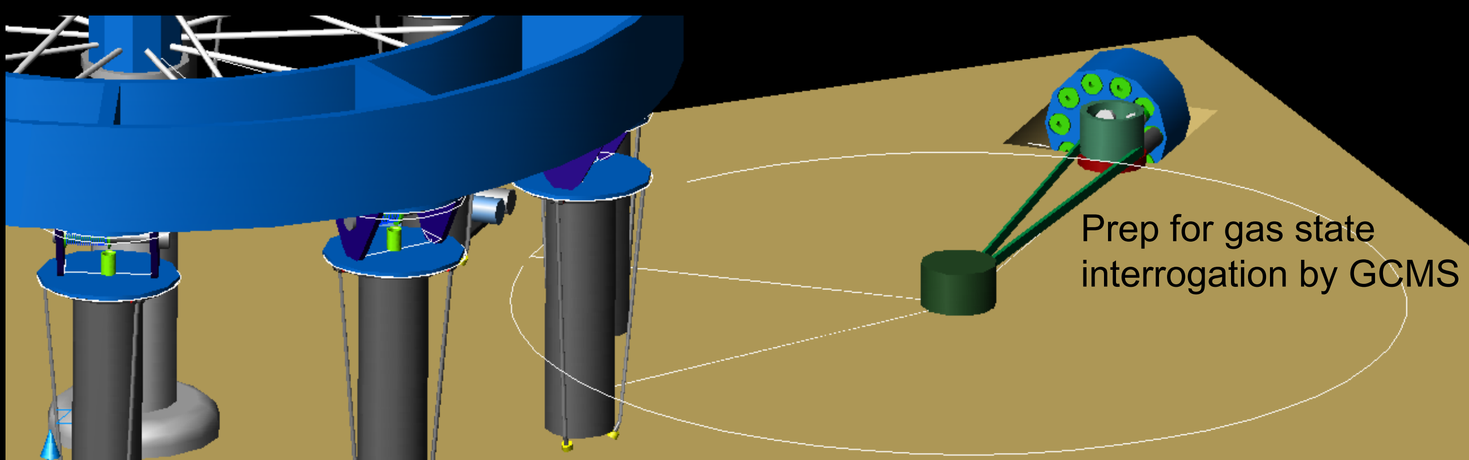
Configuration: Sample Crucible



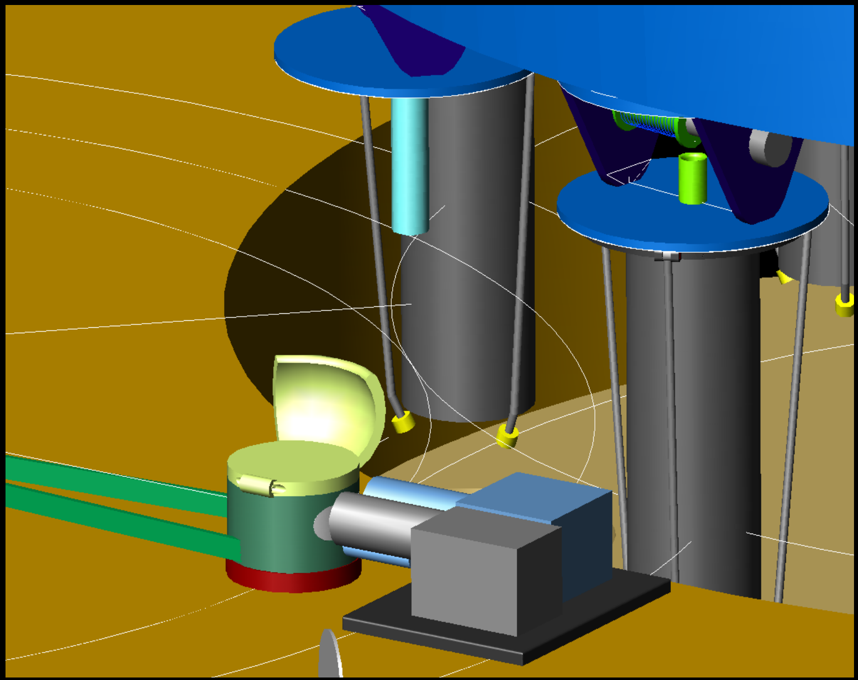
Sample Interrogation/ Handling Concept

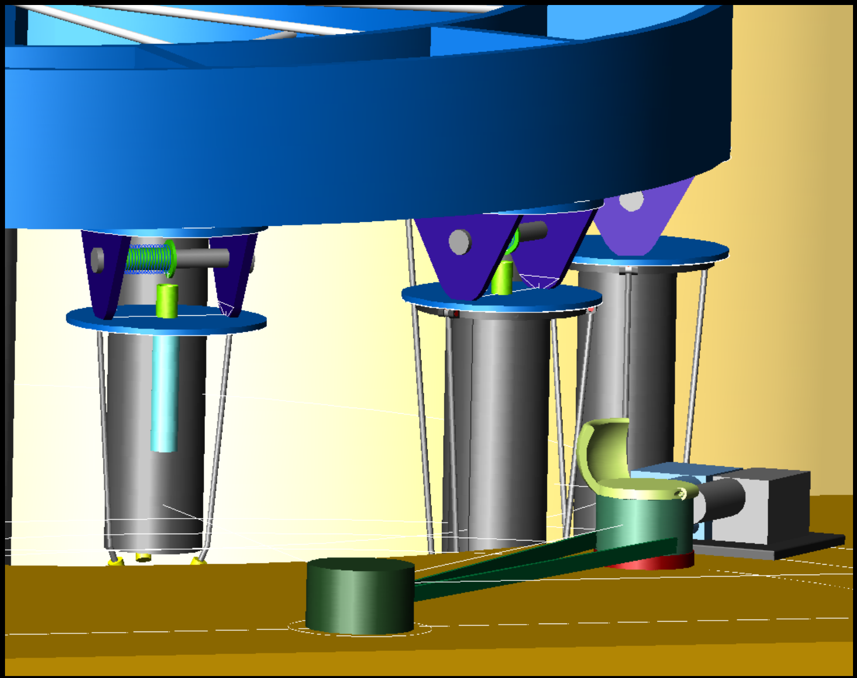


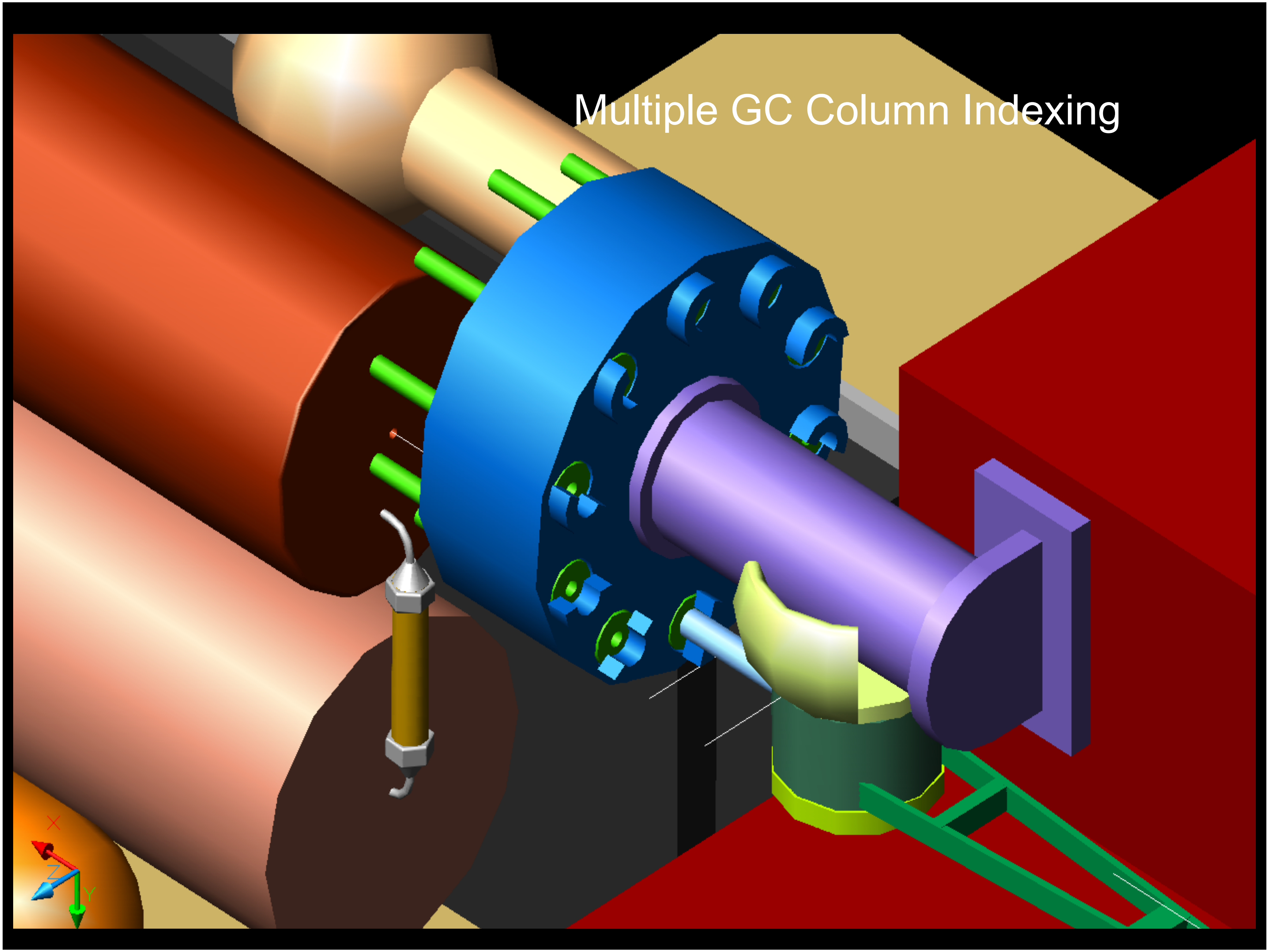




Crucible Being Viewed by Microscope/Raman






Multiple GC Column Indexing
X
Z
Y

Work Done for Europa Sample Handling Which Might Have Application to Titan

- The three-phase sample processing cycle utilizes the ability of the Raman fiber optic detector head to make measurements of the crystalline material, after it is injected into the sample chamber and resting within the cup of the solid wick material, without having to be in contact with the sample. Upon melting, the sample is interrogated by the ion-micro-electrodes. As a liquid the sample is wicked into the GC and heated to a vapor. The complete sample chamber design is shown in the following figure.