The Improvement of Volatile Collection Via Small Satellite Instruments

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Brief History:

NASA's Stardust missions aimed to return volatile particles from Wild-2 to Earth for dissection. While this was achieved the yield was small. Due to the very nature of volatiles this task remains unimproved and out of reach.

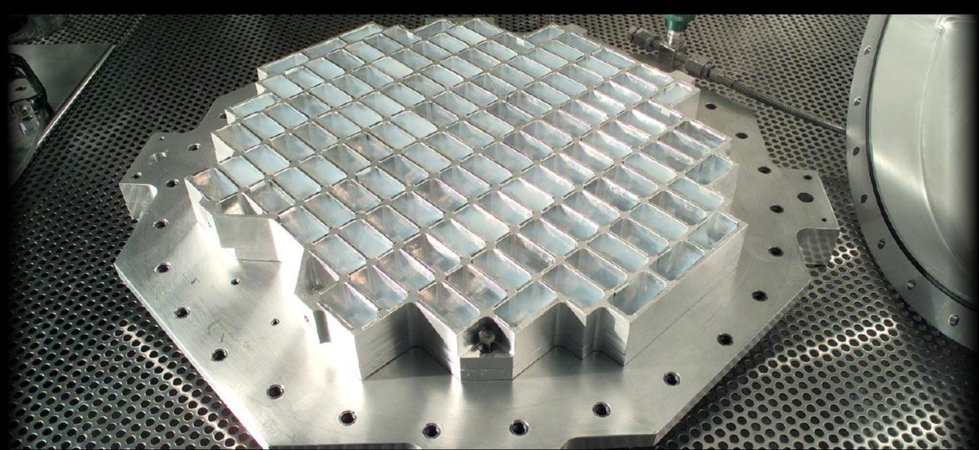


Figure 1: The avbove is NASA Stardust's Aerogel Array for volatile collection from Wild-2.

Motivation

In order to improve the yield via NASA Stardust, the accuracy of collection has been determined as the parameter that may be made more precise. Therefore, the design presented aims to collect particles from a narrow, specified region of a comet's tail. Volatile preservation may improve as a result of this , as well, as the action of the design may allow the burn off of particles to decrease. Finally, This design creates the possibility of small satellite application, increasing the opportunity for experimentation

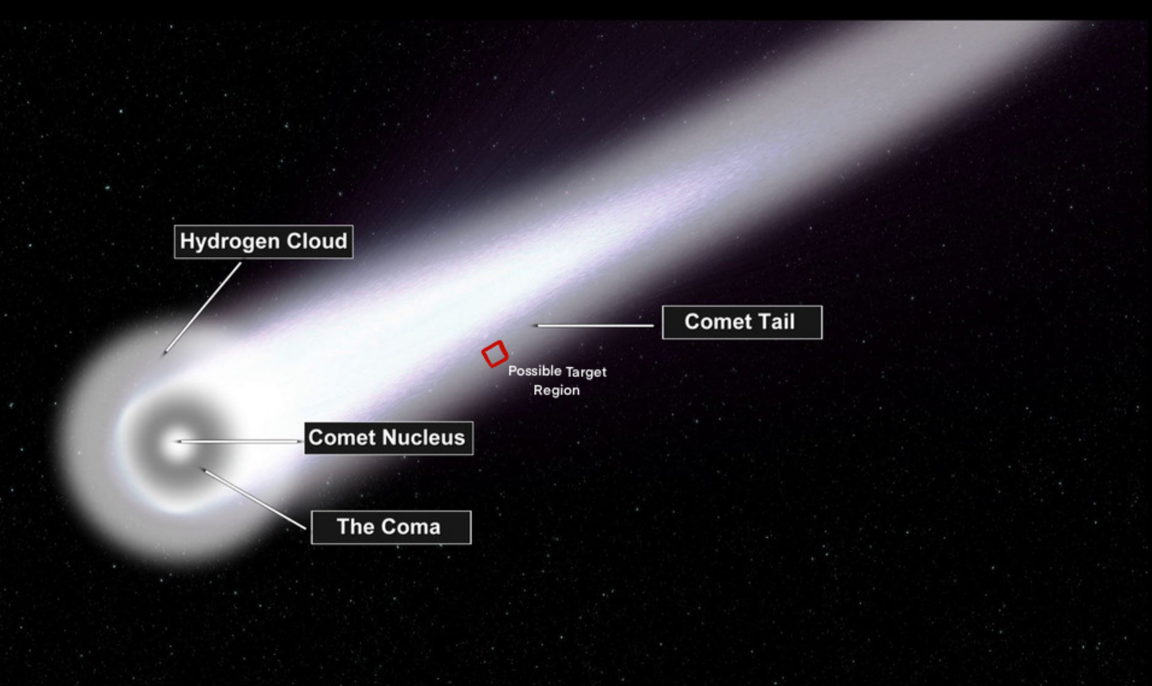
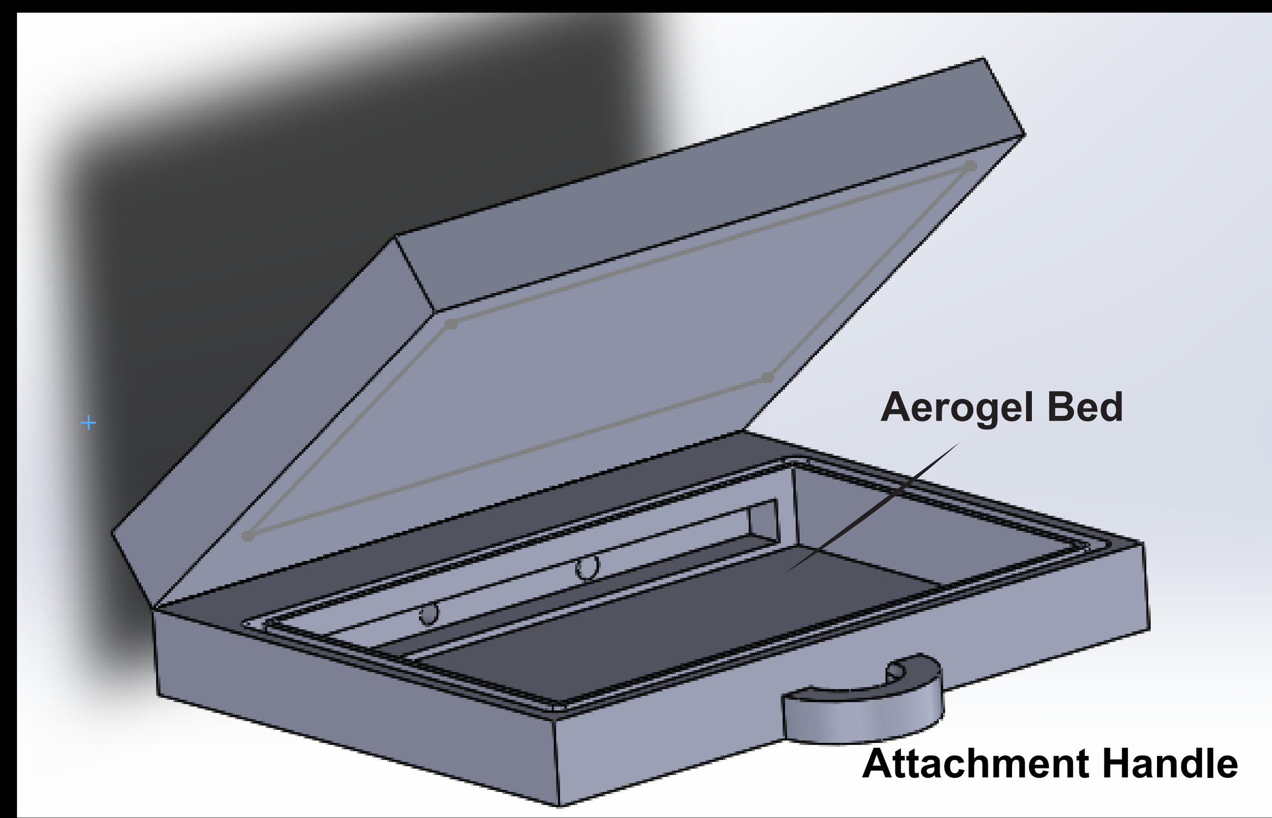


Figure 2: The above outlines a possible plan for volatile collection.

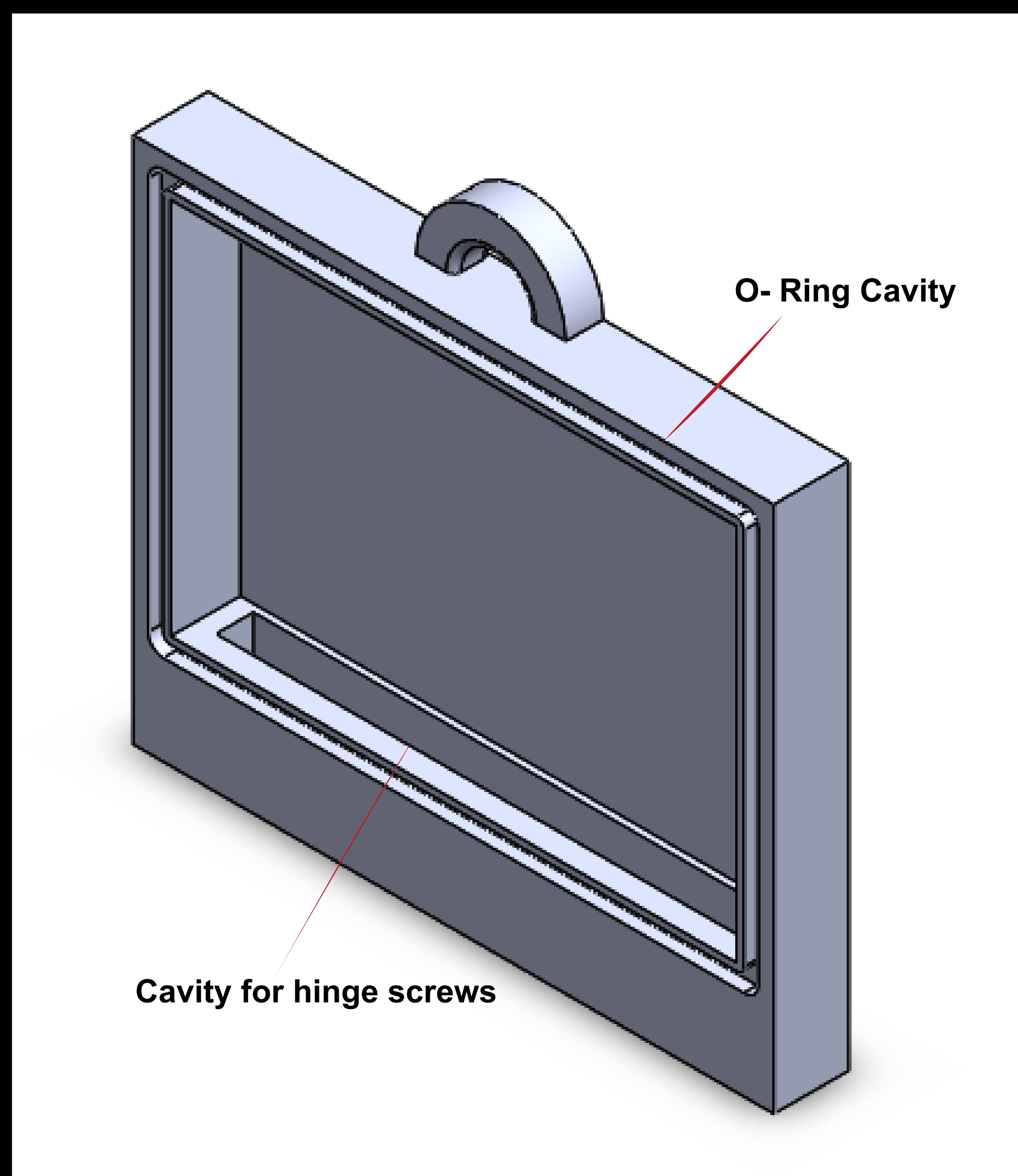
Aerogel and Water:

The above image shows a silica aerogel tiles response to a drop of water being placed on its surface. This testing was done at room temperature and was done to initialize the sensitivity of the aerogel to liquid particles. The testing revealed that the surface of aerogel is not hydrophobic, as displayed by the crater left by the water droplet. Thus crater was approximateky 2.5 mm tin depth and formed in its entirety in under 4 minutes after the drop was placed on the surface.

Enclosed Aerogel Design



O-Ring View:



Experimental Results:

Through experimentation via Thermal Vacuum Chamber, results indicate that aerogel may be a hydrophilic material. The thermal vacuum chamber was set to 0 degrees Celsius and the sample was placed inside at .046 Torr for approximately 28 hours. After removal, the tile was shown to have a loss of 287.2 mg. After removal this mass loss decreased as the tile was exposed to ambient surroundings. This supports the idea of aerogel being hydrophilic and supports the initial claim that an enclosure is necessary for aerogel to retain particle volume in vacuum.

Challenges:

One of the challenges that this project faced was the manner in which to go about research. Without access to a gun that could propel particles at velocities of kilometers per second into aerogel, it was difficult to replicate the environment being studied. The thought of mounting an aerogel sample upon the payload of a solar balloon was considered, however, as gathered from the flux analysis plot below, the volume of possible particles to collect was insignificant for the amount of time a balloon could be in the atmosphere. Therefore, efforts have been refocused to analyze the volatility of water in aerogel in vacuum.

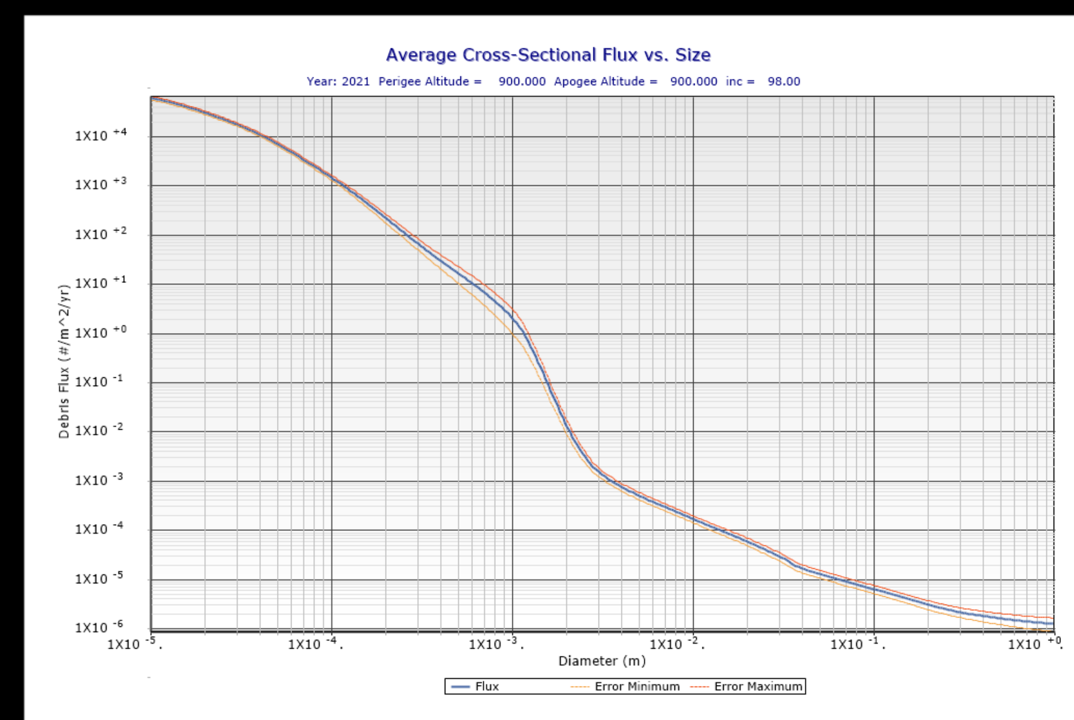


Figure 3: The above is a flux analysis via Ordem 3.1 of orbital debris.

Future Research:

Due to a lack of redundancy in experimentation, the results experienced are not entirely conclusive. However, based on the loss of mass in the TVAC it can be hypothesized that lowering the temperature in vacuum would assist the aerogel in retaining volume. In the future a possible route of research would be to employ a two stage Peltier cooler. This could be employed to test the hypothesis of increased volume retained at cooler temperatures. Finally an eventual goal would be to test a working design of the enclosure fitted with the O-ing in the TVAC. This would help to prove the device's necessity and importance in improving volatile collection.

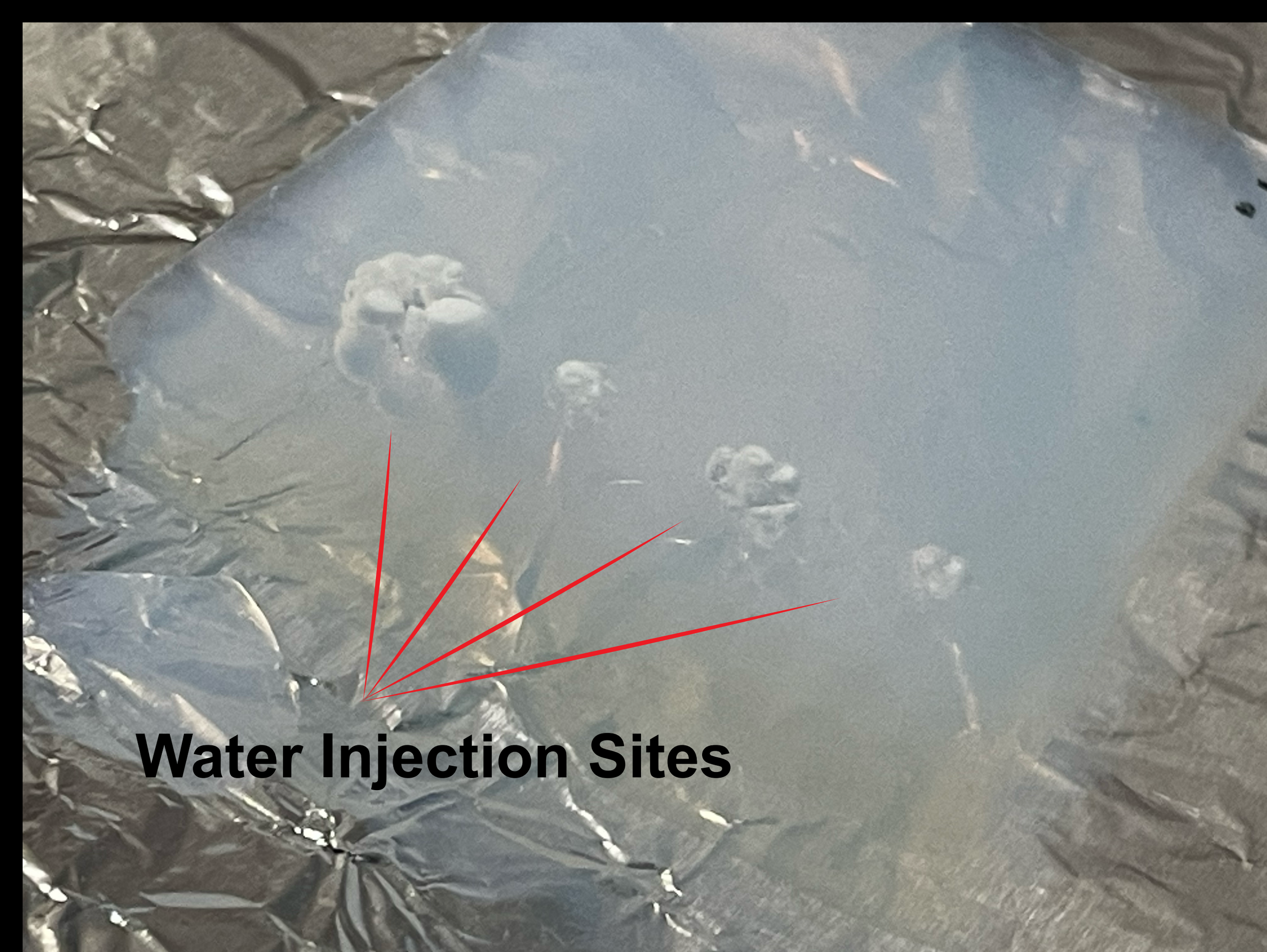


Figure 4: The above image is the aerogel sample after removal from the TVAC