CISLUNAR INTERCHANGEABLE OBSERVATORY FOR HELIOPHYSICS (CLIOH): A DEEP SPACE GATEWAY SOLAR VIEWING PLATFORM FOR TECHNOLOGY DEVELOPMENT AND RESEARCH PAYLOADS. S. Savage[1], E. DeLuca[2], P. Cheimets[2], L. Golub[2], K. Kobayashi[1], D. McKenzie[1], L. Rachmeler[1], A. Winebarger[1], [1]NASA MSFC, NSSTC ST13, 320 Sparkman, Dr. Huntsville, AL 35805 – sabrina.savage@nasa.gov, [2]Harvard-Smithsonian Astrophysical Observatory, 60 Garden St. Cambridge, MA 02138

Abstract: The Deep Space Gateway (DSG) has the potential to serve as an invaluable location for a solar viewing platform that can accommodate multiple payloads on a rotating basis. Through the use of standardized payload canisters that dock interchangeably, several payloads can be tested and operated through the shared resources of the platform and exchanged on a schedule compliant with launch availability. The CisLunar Interchangeable Observatory for Heliophysics (CLIOH), comprised of a pointing platform and the payloads, allows for the testing and utilization of cutting edge technology prior to, or in lieu of, investment in accommodations on a free flyer explorer-sized spacecraft, thereby substantially reducing technological and financial risk.

Comparable to the International Space Station (ISS), the DSG provides the capacity for high telemetry rates and power supply. Being within range of a launch vehicle also potentially permits the ability to repair or swap expendable equipment or to refill consumables – options that are not available to free flyer missions. Advantages over the ISS include notable reduction in the contamination and vibration environment due to less human and vehicular activity. In addition, there is the potential for increased solar viewing and a more stable thermal environment, depending upon the orbit. MSFC has performed a preliminary design study on a version intended for installation on the ISS; however, the ISS was deemed to not have suitable capability for accommodating the operational volume of the observatory.

The cislunar orbit also allows for the testing of technologies in an operational deep space radiation environment, critical for equipment such as advanced detectors and associated electronics. The low lunar orbit is the least conducive option, insofar as viewing and thermal stability are concerned, for the successful implementation of this observatory concept.

Instruments suitable for this platform are those that require observations taken above the earth's atmosphere for an extended period of time (e.g., to capture flares and coronal mass ejection events). Such opportunities that would benefit from the DSG instead of Low Cost Access to Space options include situations wherein sounding rocket flights provide insufficient elapsed viewing periods, balloons fail to achieve appropriate altitudes, cubesat volumes and pointing capabilities are too limited, and the ISS is unable to accommodate the payload (either due to ISS capacity or payload requirements). Also, instruments that are deemed operational, but require regular input of consumables which inhibit their lifetimes on free flyer spacecraft, could be considered for such an accessible platform.

Despite sounding rocket flights being too limited in duration for many types of instrumentation, the rocket program has proven to be a remarkably successful avenue for demonstrating technology using shared resources, interfaces, and integration procedures. The foundation of the CLIOH concept is modeled after the sounding rocket interchangeability of payloads using a common infrastructure for mechanical design as well as documentation, testing, and verification. Another key advantage of the CLIOH platform is that it is designed to accommodate multiple instruments operating simultaneously. This versatility lowers risks, reduces cost, and elevates the platform's (and, in turn, the DSG's) return on investment.

An example payload that could be well accommodated in this paradigm and that offers considerable benefit to the DSG is the Coronal Spectrographic Imager in the EUV (COSIE), an instrument under consideration for installation on an external ISS mount. This particular instrument provides wide field images of the high temperature plasma in the corona, including the disk of the sun, which provides a considerable advantage over traditional coronagraphs. This type of instrumentation is relevant to the purpose of the DSG as it would greatly benefit deep space travel by providing timely, detailed information concerning coronal mass ejection trajectories and energetics.

The DSG platform would allow for instrumentation, such as COSIE, to be tested and to potentially provide operational information to astronauts and high altitude orbiting satellites. These instruments could then be uninstalled from the platform and replaced by subsequent solar viewing instrumentation that have been integrated into the standard packaging.

While the concept proposed here is intended for Heliophysics use, the design could also be repurposed. For example, a parallel platform design could accommodate earth viewing instrumentation to observe large scale magnetosphere features by simply changing the pointing target (noting, however, that all of the instruments on one platform would necessarily be focused on the same general target). In addition, some payloads would not rely on pointing at all, such as those installed for radiation environment testing.

A bonus feature of the interchangeable design is that instruments can be provided by domestic and international entities via standardized interfaces and integration practices through a range of funding mechanisms.

Based on the preliminary design work performed by MSFC, an observatory such as this would have the following requirements (all values are approximate). The initial design considered a maximum of 4 instrument slots based on two 18-inch [primary] and two 10-inch [secondary] diameter canisters, akin to sounding rocket skins; however, this would need to be revisited based on the accommodations available from a DSG module.

- Mass: ~200 kg for the platform; ~50 – 100 kg per instrument
- Power: 120 Vdc & 28 Vdc for the platform; 224 W @ 28 Vdc for the primary instruments; 112 W @ 28 Vdc for the secondary instruments
- Cost: ~$30M for the platform (ISS design only); ~$20-50M per instrument (highly variable due to radiation environment)
- Volume (static, based on an ISS Flight Releasable Attachment Mechanism): 47” x 41” x 78”
- Telemetry: ~ 15 Mbits/second, continuous (adjustable, depends on established Concept of Operations plan)
- Crew interaction, via a robotic arm, would be necessary for the installation of the platform as well as installation and removal of the instruments. Astronauts may also be needed special circumstances, such as the replacement of consumables. The crew is not expected to be needed for any observatory operations nor are spacewalks anticipated.
- Desired deep space gateway orbits: NHRO, EMDRO, or EML2 (LLO is not suitable; ELO is moderately suitable).
- A static holding platform and robotic arm would be needed during installation and exchange. Temperature control options may need to be considered. Module ephemeris information would be needed by the platform in order to control pointing stability.