Abstract

Space Launch System Payload Stage Capability for Ultra-High Characteristic Energy Missions

Rob Stough[1]

(1) NASA Marshall Space Flight Center

The Space Launch System (SLS) vehicle is NASA's cornerstone capability for a new era of human and robotic exploration of deep space. The unrivalled performance of SLS provides the capability to launch the first woman and next man to walk on the lunar surface and to support development of a sustained human presence in cislunar space, and ultimately human missions to Mars. As an evolvable capability with unique launch performance, the opportunities enabled by SLS also include game-changing benefits for science missions, including probes to the outer solar system and beyond.

For the last two years, the SLS Program has worked with the Interstellar Probe team at the Johns Hopkins University Applied Physics Laboratory (APL) to provide data that describe how SLS could support a mission that would break through the boundary of the heliosphere and into pristine interstellar space only a decade after launch, enabling earlier science return and greatly increasing spacecraft life in the interstellar medium. In record-breaking time, the ISP as launched on SLS may answer questions raised by the extended mission of NASA's Voyager spacecraft. While SLS and its efficient Exploration Upper Stage (EUS) offer benefits for exploration of the outer planets, adding one or more additional stages to this architecture makes it even more capable for missions beyond our solar system, offering more realistically appealing flight times that would allow the mission scientists to reap the rewards of exploration.

During the time the SLS Program has been working with the Interstellar Probe team, it has identified an expedited path to the Block 2 capability planned for the Interstellar Probe mission, and further matured performance numbers for diverse multi-stage configurations using a combination of commercially available liquid hydrogen (LH2)/liquid oxygen (LOX) upper stages and solid motor kick stages. That work has demonstrated the SLS payload stage capability provides significant benefits and opens trade space for multiple missions in consideration during planning for the next Planetary Science and Astrobiology Decadal Survey.

This presentation details the significant benefits SLS can provides for very high characteristic (C3) energy missions by coupling the capabilities of SLS to current commercial rocket propulsion stage systems. These capabilities are explored specifically in the context of an Interstellar Probe architecture in which a small, capable science probe, coupled with carefully tailored mission design trajectories, could be used to explore the outer solar system and the interstellar medium. The presentation will also address the operational logistics of integrating such a mission, explaining the options available for "non-standard" SLS payloads, including processing those with radioisotope power generators or additional propulsion stages.

An SLS system overview and capabilities will be presented, along with vehicle configuration and orbit performance capability studies, explaining how SLS is enabling for a variety of high-energy science

mission profiles, including launching an exploratory probe bound for interstellar space only a decade after launch.