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TECHNOLOGY DEMONSTRATOR FOR A ROTATING SPACE STATION

Abstract

This paper presents an overview of a design for a large-scale technology demonstrator for a rotating space station. The technology demonstrator's purpose is twofold: to simulate Moon, Mars, Earth and other Solar System gravities in orbit for the first time; and to acquire knowledge on the command, control and operation of a large rotating structure to inform the design of a future rotating space station offering a range of simulated gravity conditions for physical and life sciences research. It also has the potential to host Earth sensing and observation instruments as secondary payloads. The design envisages a truss structure of octagonal cross-section formed into a circular open ring that resembles a giant hula-hoop. It dispenses with the bicycle-wheel approach by resolving the tensile forces that build up during spin through the ring's structure rather than through spokes and a central hub. This simplifies automated assembly, standardizes the payload types, and limits the number of launches. The technology demonstrator slowly spins up and down through a range of angular velocities to simulate different gravities, spending as much time at each as desired. Microgravity occurs at rest and Earth gravity at full spin rate. The truss structure comprises 6 identical segments. When deployed, each segment forms a 60-degree arc of 19 standard bays and one engine bay. The engine bays contain low-thrust engines that together perform spin up, spin down, attitude control and stationkeeping functions. Each segment stows as a flatpack to form one payload. The truss structure has a provisional overall diameter of 217 metres and a structural bay cross-section of 8 metres. Six launches of a Starship or SLS class vehicle can deliver the entire technology demonstrator to orbit. Roll-out photovoltaic blankets on the faces of the deployed bays provide electric power. Robotic arms mounted on the truss structure grapple incoming payloads and berth them during assembly. At the end of its mission, the technology demonstrator is dismantled. Its 6 curved segments are unberthed from each other and straightened to form 6 trussed beams for use in other orbital applications.