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EMERGING MICROGRAVITY PLATFORMS AND THEIR CAPABILITIES COMPARED TO THE TRADITIONAL OFFERING

Abstract

Experimental microgravity research has traditionally been dominated by a limited number of solutions: drop towers, parabolic flights, sounding rockets, short-duration orbital platforms (i.e. dedicated Foton and Shenzhou flights), long-duration orbital platforms (i.e. ISS). Over the years, the capabilities, advantages and shortcomings of these different venues have been well documented, and the associated procedures have been optimized. This has been done to such an extent that it used to be relatively straightforward for microgravity researchers to determine the most appropriate option to conduct their experiment depending on available budget and the nature of the phenomenon to be investigated – most notably the sensitivity to gravity residuals and characteristic time-scales.

Two important trends have and will continue to impact this situation.

First, the retirement of the ISS, currently foreseen for 2024. While it could potentially be extended a couple of years passed this deadline, it will eventually cease to operate. The long duration research that is currently conducted on-board the ISS would need to be transferred to some other platform, like e.g. the future Chinese Space Station that will be available from 2022 onwards. However, scientists would be offered also other solutions that do currently not exist.

Second, the increased maturity of the "new space" industry. A very concrete example belonging to this group is the providers of simplified and standardized access to the ISS: NanoLabs and their NanoRacks, Space Tango and their TangoLab, as well as the upcoming ICEcubes from Space Application Services. Other solutions are likely to emerge in the short- to medium-term future. One long-awaited platform is the sub-orbital vehicles, such as the Lynx of XCOR Aerospace, the SpaceShipTwo of Virgin Galactic, or the New Sheppard from Blue Origin, all of which are planning to carry scientific payloads in addition to space tourism passengers. Another example is the numerous emerging micro-launchers, such as PLD Space and Generation Orbit, which are planning to provide sounding rocket services as a secondary revenue stream generation.

In this paper, we perform a survey of all the existing and emerging microgravity platforms, both already operational and still in development. We then compare them according to a series of criteria relevant for the microgravity researchers (technical and programmatic). We also perform an anticipation effort to assess how other trends of the space industry, such as upcoming small satellite LEO constellations or the renewed interest for deep space exploration, could have an impact on microgravity research.