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Europa Ice Penetrator

Towards a Hybrid Ice-Penetrating System

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A beyond low Earth orbit (LEO) interplanetary mission to Jupiter's Galilean satellite Europa would enable low-cost scientific studies of Europa's ice shell and hypothesized subsurface ocean. In this paper, we survey previous ice melting and drilling technologies for our analysis of a small spacecraft compatible device, known as an ice-penetrating system (IPS), capable of traversing the several kilometer thick ice shell of Europa in order to deliver a submersible payload to the subsurface ocean. In our study, we assume a baseline 25 km ice shell thickness for the investigation of the power requirements and total penetration time (TPT) for three IPS classes: thermal, mechanical, and hybrid. A 2000 W thermal IPS was found to have a TPT of approximately four and a half years with an improvement in performance at warm ice temperatures (260-273 K). A mechanical IPS of varying average drilling power, in the range of 60-100 W, demonstrates minimum theoretical values of TPT in years, although the build-up of ice and salt chips and the temperature of the medium are assumed to significantly diminish IPS performance. Lastly, a 70-2000 W hybrid (melting and drilling) IPS unit was found to complete its mission in approximately one and a half years, nearly three times faster than a 2000 W thermal IPS of the same cross sectional area. This hybrid IPS was found to be the most favorable ice-penetrating method to penetrate a hypothesized 25 km thick ice shell on Europa. The use of IPS is one possible method of accessing Europa's, as well as other icy bodies, subsurface oceans, and will substantially enrich our knowledge of possible past and current life elsewhere in the solar system.

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