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DESIGN OF A FAST INTERSTELLAR MEDIUM EXPLORATION MISSION REACHING 200 AU IN  
25 YEARS

**Abstract**

To this date, only five space probes have been sent to an interstellar trajectory, including four of them that have been launched nearly 50 years ago or more. The study of the pre-interstellar medium remains a subject of scientific interest, and could take advantage of the advancement of sensors, in-space propulsion and satellite platform technologies, both in term of performance and weight. Along its path, the probe could achieve various scientific goals, such as measuring the cosmic ray flux outside the solar cavity, collecting interplanetary dust to measure chemical composition gradients, calibrating sensors through Earth observation or performing a Kuiper belt object flyby. However, the time necessary to reach the interstellar medium remains a challenge, and it is important to optimize the mission in order to enable a scientific return in a “reasonable” time. In this paper, we present the successful results of a feasibility study done by a working group of the French aerospace learned society 3AF. The objective of this study is to re-visit the subject of interstellar mission design, with an ambitious goal: reaching 200 Astronomical Units in 25 years, relying on state-of-art technologies only. In addition, it is essential to note that the mission design will be compatible with Europe’s heaviest existing launcher Ariane 64. This is a significant difference with an analog mission previously proposed by John Hopkins University, for which NASA’s Space Launch System (SLS) was considered. After a literature review of similar projects and studies, we discuss the Earth-departure strategy, the transfer strategy and the spacecraft’s propulsive architecture. The main results show that the 200 AU/25 years goal is feasible. The mission strategy relies on the use of an efficient combination of cryogenic propulsion, electric propulsion (with HET thrusters) and eventually classic monopropellant propulsion along with a sub GTO launch and a propulsive boost

during Jupiter swing-by. While the paper is focused primarily on mission design and optimization, we also present the spacecraft overall design and discuss the scientific reward according to possible sensors and telecommunication equipment.