

IAF SPACE EXPLORATION SYMPOSIUM (A3)  
Solar System Exploration including Ocean Worlds (5)Author: Mr. Carlo Bianco  
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## PRE-PHASE A STUDY OF A CREWED FLY-BY OF VENUS

**Abstract**

Space agencies in the International Space Exploration Coordination Group (ISECG) are committed to a concerted effort to put into effect the Moon-and-on-to-Mars strategy, envisioned in the Global Exploration Roadmap (GER) for expanding human presence in the solar system. In line with the GER vision, it is possible to consider new opportunities such as the inclusion of a Venus fly-by in crewed missions headed to Mars, both to enhance the scientific return and to preserve the overall affordability of the Martian mission. Indeed, a Venus fly-by could provide unprecedented data for the scientific characterization of the most Earth-like location in the Solar System, as well as pioneer dedicated crewed orbital missions.

Within the frame of the SpacE Exploration and Development Systems (SEEDS) program, a pre-phase A study of a manned fly-by of Venus as part of a Mars-bound trajectory is conducted. The introduction of the Venusian leg is compared to traditional Earth-Mars transfers in terms of propulsive effort and overall mission duration, and the resulting potential trajectories are traded-off against the useful time window and altitude at which operations are conducted. The envisioned operations from orbit are of the human-in-the-loop type and involve the deployment and active control of a variety of:

- aerial platforms, to characterize the dynamics and composition of the upper and lower atmosphere
- surface platforms, to investigate the interior of the planet as well as the surface-atmosphere interface.

Sufficiently long time windows with near-zero communication delay are evaluated for atmospheric sample retrieval, quick in-situ science or sample return from the surface, and aerial surveys. In this way, the scientific return is maximized while still meeting the trajectory-design constraints. Finally, orbital, atmospheric and surface assets and operations are properly combined to provide a suite of mission concepts that build on the synergies between humans and robotic platforms.

In a more sustainable system-of-systems scenario, which fosters the cooperation between space agencies to give new momentum to the exploration of Venus, the manned fly-by is treated as temporary support from orbit to stand-alone robotic missions to Venus.

The SEEDS program relies on the collaboration of Politecnico di Torino (Italy), ISAE-Supaero (France), and University of Leicester (UK) with active support by Thales Alenia Space, the Italian Space Agency, and the European Space Agency. The XIII edition of the Master has seen an international team of students dealing with the development of future manned and unmanned exploration missions to Venus.