

IAF SPACE EXPLORATION SYMPOSIUM (A3)  
Space Exploration Overview (1)

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## TECHNOLOGICAL CHALLENGES OF VENUS EXPLORATION

**Abstract**

Its lively geological activity as well as the traces of past surface water make Venus one of the most interesting destinations in the Solar System. Nevertheless, due to its harsh and challenging environment, only a limited number of missions have attempted to explore the planet and many questions about its evolution remain unanswered. In this perspective, Venus missions may shed light on the early history of its atmosphere, highlighting the different evolutionary path with respect to the Earth.

Within the frame of the XIII edition of International Specializing Master programme in Space Exploration and Development Systems (SEEDS), a study on the technological challenges of Venus missions is carried out, identifying the hardships related to atmospheric and surface exploration. Current technological gaps are highlighted and a technology development path is proposed, with the end goal to enable Venus missions, both for in-situ analysis and sample retrieval. Technology limitations affect different phases of the Venus missions, including entry, fly-by, descent and landing. Although some advanced technologies have already been tested in short-duration missions, long term missions are needed to establish proper conditions for a successful deployment of the instruments. The importance of aerial mobility is explored, taking into account the Venus Aerial Platform (VAP) proposal (Cutts et al., 2018) and comparing several solutions with different control techniques. Furthermore, several atmosphere sample collection strategies are analysed, including the skimmer manoeuvre that allows minimum thermal protection. Conversely, for the sampling collection on the ground, a more sophisticated thermal protection is required in order to guarantee the survival of the sampling robots for an adequate time. Finally, advanced cooling systems can play a significant role, especially if coupled with materials resistant to high temperatures and withstanding

corrosive conditions.

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.