

IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Medical Care for Humans in Space (3)

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PERSPECTIVES FOR FUTURE SPACE BIOMEDICAL RESEARCH TO ENSURE CREW HEALTH
AND PERFORMANCE FOR FUTURE HUMAN SPACE EXPLORATION MISSIONS BEYOND
LOW-EARTH ORBIT, A MULTIDISCIPLINARY APPROACH

Abstract

To achieve our collective objectives for this new era of Space Exploration, actors across the Space Sector have launched initiatives to support the advancement of scientific research and technology development, increasing the Technology Readiness Level. In 2019, CNES (French Space Agency) decided to support these efforts by joining the “Spaceships” network, coordinated by ESA (European Space Agency). SpaceshipFR operates as an agile innovation environment, a thinktank for efficiently studying future new operational concepts and technologies, linking experts from space agencies, academia, and the private sector. In this context, CNES and the French Institute for Space Physiology and Medicine Centre for Space Medicine (MEDES), convened a 2-day workshop in November 2023 to develop a roadmap for biomedical research and medical preparedness, and to devise innovative solutions to maximise astronauts’ health and well-being for future moon bases and future deep space exploration missions.

Emphasis was placed on fostering interdisciplinary collaboration, bringing together experts from diverse fields such as medicine, space science, engineering, artificial intelligence, robotics, and human factors. A variety of methodologies were used to tap into the collective intelligence of participants, fostering a dynamic and innovative environment for generating ideas.

The outcome of the workshop was the identification of six pivotal innovation topics, including the development of an integrated intelligent health support system, individual and collective behavioural health and performance initiatives, the creation of an astronaut digital twin combined with AI for health, augmented astronaut solutions, and exploration of hibernation possibilities. Each area addresses specific facets of medical challenges anticipated during Moon or Mars missions, with a focus on leveraging cutting-edge technologies, including AI and robotics. Participants also identified generic cross-projects constraints including: usual space constraints such as storage limitations, power efficiency, adaptability to microgravity or partial gravity conditions, communication delays, high reliability and robustness compatible with low or no resupply, low maintenance but also seamless integration with habitat systems, data security, privacy, compliance with ethical and regulatory aspects, and the need for advanced training methodologies such as virtual/augmented reality. Following the workshop, teams of key opinion leaders, SMEs, startups, and academics were gathered to prototype and develop projects driven by the identified innovation themes.

The pivotal topics identified during the workshop address the multifaceted challenges in human long-term space missions. This research roadmap serves as a blueprint for advancing biomedical research and medical capabilities, vital for long-term space mission success and sustainability.