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MICROGRAVITY EFFECTS ON HEART VALVES BEHAVIOUR: THE HVBM EXPERIMENT ON ISS

Abstract

Long term exposure to the microgravity environment induces substantial changes in the cardiovascular system, causing a partial opening of the heart valves. This feature, together with a higher calcium concentration in blood, generated by microgravity, is expected to provoke a faster heart valve calcification process: heart failure can be a direct dramatic consequence. Therefore, whenever long "in-space" staying is foreseen, a risky heart disease, may occur. This paper presents the rationale of an experiment devoted to investigating the influence of the microgravity environment on leaflets' motion and development of the calcification process in the aortic heart valve. Such innovative experiment is under the framework of HVBM project, a collaboration between biomedical, electronic and space engineering students at Politecnico of Milano and ISAE Supaero. The project, at the abstract preparation, is competing for the final selection process of ESA programme "Orbit Your Thesis", to fly on the ISS inside the ICE Cube facility in 2022. The expected experiment outcomes are to assess and study the non-total opening of the leaflets and the calcification process acceleration, caused both by the aforementioned phenomena and by the presence of Nonequilibrium Fluctuations at molecular scale. The experiment motivations and objectives are fully detailed in the paper. The expected results can be used in the future to design possible countermeasures addressed to the well-being of astronauts. The design of the compact bench test is presented as well, being compliant with ICE Cubes facilities requirements and with Biomedical European Standards, in order to assure the comparison with existing performance parameters for bioprosthesis. The experiment is being designed to autonomously operate, thanks to a microcontroller that will automatically set the inputs and store the monitored variables. Thanks to a communication protocol settled between the ISS and ground, the team will receive the scientific data during the flying period so that they can be compared with outputs got from a specular experimental setup which will run in parallel on ground. Challenging constraints in terms of dimensions, resources and budgets are tackled: from the preliminary design activity, the on

board volume for the experiment limits to 2U, the peak power supply stays below 19 W, a 1,6 kg suffices and the whole experiment realisation would cost no more than 15000 euros. In conclusion, the paper presents the process used for the design and development parts, highlighting the critical passages and the innovative solutions adopted to build the bench test.