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AIM (ARTERY IN MICROGRAVITY): DESIGN AND DEVELOPMENT OF AN ICE CUBES EXPERIMENT

Abstract

The Artery In Microgravity (AIM) project is the first experiment to be selected for the "Orbit Your

Thesis!" programme of ESA Academy. It is a 2U experiment cube designed for the ICE Cubes facility on board of the International Space Station. The experiment is expected to be launched on SpaceX-20 in early 2020. The project is being developed by an international group of students from ISAE-SUPAERO and Politecnico di Torino, under the supervision of the ISAE-SUPAERO and Politecnico di Torino staff.

The experiment is a test-bench for investigating haemodynamics in microgravity focusing on coronary heart disease, the most common form of cardiovascular disease and the cause of approximately 9 million deaths every year. Coronary heart disease is caused by stenosis of the coronary artery due to the buildup of plaque. While the development of atherosclerosis is not fully understood, the primary event seems to be subtle and repeated injury to the artery walls through various mechanisms including physical stresses from disturbed flow and inflammatory stresses caused by the immune system.

In view of the very long duration missions to come, such diseases may also affect healthy astronauts in space. The blood flow will be affected by the absence of gravity, especially around any obstacle in the coronary artery flow such like plaque or a stent. Therefore, by studying the vascular haemodynamics in a healthy and an unhealthy coronary artery on Earth and in microgravity we will learn about the effect gravity plays on coronary artery haemodynamics, the effects on the performance of implantable devices and about the risks of myocardial infarction to astronauts on long-distance spaceflight.

The experimental setup consists of a closed hydraulic loop containing two models of a coronary artery in series. An electric pump and reservoir will control the flow of a blood-mimicking fluid through the system. One model of the coronary artery will contain a coronary stent. The pressure of the fluid will be studied along its path using a series of pressure sensors and a camera will visualise the flow. The same experiments will be repeated on the ground with the same conditions as the in-flight model for comparison.

The paper will outline in detail the design and development of the AIM experiment cube and the results of testing. The full data and results will be available after the completion of the mission which is expected to be between March and June 2020.