MICROFLUIDIC LAB-ON-CHIP PLATFORM FOR BIO-NANOSATELLITE (LAB-PAYLOAD)

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There is an increase in demand for bio-nanosatellites and biomedical methodologies as a result of experiments conducted in microgravity [1] and radiation conditions. Currently, the latest trend is to replace the experiments carried out by cosmonauts at the International Space Station (ISS) with research performed with the use of autonomous nanosatellites. Satellites in CubeSat standard are increasingly used not only in the telecommunications industry, but also in the pharmaceutical and bio-medical industries [2]. One of the main elements of the structure of this type of satellites is the payload, in which planned bio-medical experiments are placed.

This paper describes the lab-on-chip platform for the first Polish biological nanosatellite of the Cube Sat type with a size of 2U (10x10x20 cm^3). The proposed platform enables long-term cultivation of 3 biological experiments simultaneously and providing them with appropriate growth conditions (Fig. 1a). This platform is equipped with lab-on-chips dedicated to each of the cultures, a container with a nutrient solution, a medium dosing system, an optical detection system, lighting, a heating system and sensors for reading temperature, humidity, pressure and radiation inside thermos.

The conducted research allowed for the development of dedicated glass lab-chips for the long-term cultivation of fungi (*Fusarium culmorum*), cancer cells (UMUC-3, RT-112, HaCaT), mouse T lymphocytes and a micropot made by 3D printing. A very important element was the implementation of the mechanical structure of the lab-payload with the placement of individual biological experiments so that they would survive the elevation to low Earth orbit (LEO) and could be carried out in space conditions. It was particularly important to design a special housing for the lab-chip that would allow the detection and lighting system to be mounted just above its surface. All mechanical elements are made of PEEK material, which will provide an appropriate thermal shield for biological samples (Fig. 1b).

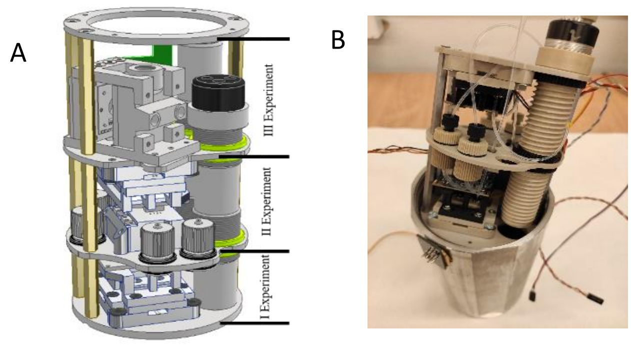

Fig 1.Construction of lab-payload: a) scheme, b) real view

Fig 2. Lab-payload in RPM

The operation and cooperation of all lab-payload components in simulated microgravity conditions using a random positioning machine (RPM) was verified (Fig. 2). Lab-payload was also integrated with the satellite structure. The presented first Polish bio-nanosatellite will be placed on LEO in December 2021.

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[1] M. Bizzarri et al., How microgravity affects the biology of living systems, BioMed Research International, 2015

[2] A.J. Ricco et al., BioSentinel: A 6U Nanosatelite for Deep-Space Biological Sciance, IEEE Aerospace and Electronic Systems Magazine, vol. 35, 2020