

Advanced Brazilian System to provide Microgravity Environment for Research, Development, and Testing

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Abstract — This work presents the system composed by the sounding rocket VSB-30, licensed to the company Avibras, and its payload Suborbital Microgravity Platform, SMP, developed with the company Orbital Engenharia. This system allows the technological innovation in many different industries by providing access to environment in microgravity for research, development, and testing. Defense, pharmaceutical, aeronautical, are electronics are examples of industries beneficiaries of research and development in microgravity environment. Microgravity research deals those phenomena that become relevant in low gravity environments. Results has the potential for breakthroughs that can not only improve life on Earth, but also allow the continuity of the space exploration. Microgravity provides an important environment for both basic and applied research in many different areas such as physics, biology, upper atmosphere, medicines, and materials. The system composed of the VSB-30 suborbital rocket and the Suborbital Microgravity Platform is a national product born in government institutes and now being marketed by Brazilian industries on a global scale.

I. INTRODUCTION

The space sector is becoming increasingly important for both military and civilian applications. A quick internet search brings news about the creation of a Space Force by the USA [1], plans to make bases on the Moon and Mars viable [2], new drugs being developed in space [3], etc. This humanity's interest in space activities needs to be supported by an understanding of the environment in which the ships are inserted. Among others, electronic systems embedded in rockets and satellites must withstand conditions different from those found on the planet's surface. Examples are endless: High-Energy Particles [4], vibration imposed by the launcher, vapor from plastic devices, electrostatic discharges, material erosion by atomic oxygen, temperature variation (-200°C to $+200^{\circ}\text{C}$, for example) etc.. Therefore, it is of utmost importance that nationalization and technological innovation in or with the use of the space segment are accompanied by the provision of an access to environment in microgravity for research, development, and testing.

Efforts towards the space now goes beyond the use of satellites as a mean to provide communications and imagery. Rockets and satellites are now also used to provide a low-gravity situation (microgravity) for experiments for both science and new products development. Microgravity corresponds to a free fall situation and may be obtained using either drop towers and drop shafts (< 10 seconds), aircraft flying parabolic trajectories (~ 20 seconds), sounding rockets (< 15 minutes), re-entry satellites (few days), unmanned satellites (weeks to months), or manned orbiting systems such as the International Space Station, ISS (days to years). [5]

Microgravity research deals those phenomena that become relevant in low gravity environments. Results has the potential for breakthroughs that can not only improve life on Earth, but also allow the continuity of the space exploration. Microgravity provides an important environment for both basic and applied research in many different areas such as physics, biology, upper atmosphere, medicines, and materials. Nevertheless, more recently, the creation of bases on both Moon and Mars, as well as exploration of asteroids resources, has increased the need for a better understand of the microgravity environment. After all, a longer stay in space make it of paramount importance the understanding of the effects of microgravity on living beings (molecules, cells, and tissues, for instance) and spacecraft systems. [6]

Interests are diverse, since governments and universities are typically interested in sciences, while private entities are more attracted by new products development and manufacturing. Despite these differences, all potential users are drawn in reliable, frequent, and cheap access to microgravity.

This work presents the system composed by the sounding rocket VSB-30 and its payload Suborbital Microgravity Platform, SMP. It is an advanced system developed by the combined efforts of research institutes of the Brazilian Air Force (Aeronautics and Space Institute, IAE, and Advanced Studies Institute, IEAv), the Brazilian Space Agency (AEB), and industries to provide microgravity environment for experiments. It is a success story in which basic research is taken to the product level, making possible the return of invested resources to Brazilian society.

II. SOUNDING ROCKETS IN THE WORLD

The use of sounding rockets (this term is equivalent here to "suborbital rockets") is a key component for the development new space systems and technologies. In 2018, ten nations launched 51 sounding rockets (26 different types), an increased number compared to previous years: United States (32), Brazil (four), China (four), India (three), Japan (two), Germany (two), Australia (one), Canada (one), Norway (one), and South Korea (one). As a common trait, all countries had a cooperation between universities, research organizations, and private entities. [7]

Twenty launch facilities (spaceports) around the world were active in 2018, with a higher concentration of spaceports in the U.S. (launches from 11 spaceports). Two of the U. S. spaceports are part of the Andoya Space Center (ASC) in Norway. 94% of these suborbital launch attempts were considered successful (48).

U.S. private and commercial companies, universities, and government organizations launched 32 suborbital in 2018, accounting for 63% of the global total number. 12% of the annual launch activity were crewed from private companies. NASA and the U.S. Department of Energy/National Nuclear Security Administration (DOE/NNSA) operated sounding rocket programs. [8]

The NASA Sounding Rocket Program (NSRP) has a long history of suborbital launches and it supports space and Earth sciences, research activities, and scientists. NSRP launch facilities incorporate a range of global participation, from U.S. Department of Defense (DoD), U.S. research agencies, and private foreign companies, to student-led university research projects.

In the past five years, the global space market has grown in value. For the first time, in 2018, commercial companies in Australia, China, and Norway conducted suborbital research. Australia's BlackSky Aerospace launched a Sighter190 research launch vehicle from their outback border region. Nammo, a Norwegian company, launched Nucleus, the first sounding rocket built and developed in Norway.

III. THE BRAZILIAN SYSTEM

The **VSB-30** is a 2-stage rocket sounding rocket based on the S30 engine with the addition of the S31 engine booster stage. The Brazilian company **Avibras Indústria Aeroespacial** received a license for the production and commercialization of VSB-30 granted by IAE on January 2020. This rocket is the most successful suborbital vehicle in the Brazilian Space Program with a record of 32 successful launches out of 33 planned missions. It was first launched on 2004 at Alcântara Launch Center and the first launch at Esrange, Sweden, took place on 2005. The VSB30 has been launched from Alcantara (Brazil), Andoya (Norway), and Esrange (Sweden).

The VSB-30 is used to deploy the re-usable **Suborbital Microgravity Platform SMP** in a microgravity environment to conduct the experiments. The development of SMP is inserted in the context of the successful Microgravity Program of the Brazilian Space Agency (AEB). This SMP was developed by a combined effort of IAE, AEB, Finep, and the company **Orbital Engenharia**. The SMP communicates with ground stations to transmit telemetry data and video in real time; and receive, decode, and distribute remote controls for experiments. The SMP provides a microgravity environment with acceleration lower than 0.2mg ($2 \cdot 10^{-4}\text{g}$) for 6 min in altitudes above 125km (78mi). The SMP has a modular mechanical/electrical architecture that allows independent equipment design, assembling and testing before subsystems integration and system compatibility tests.

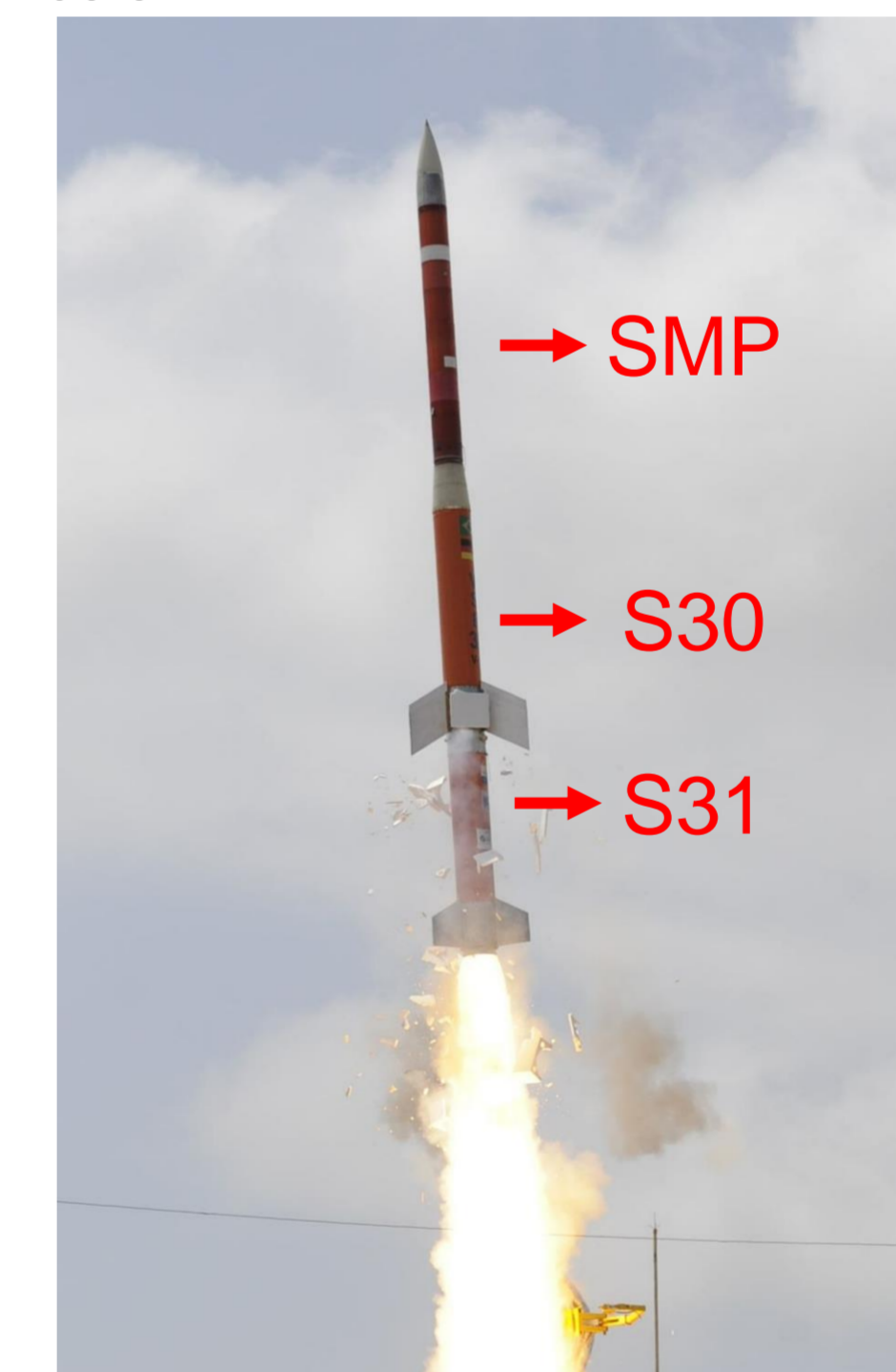


Fig. 1. Brazilian system for research and development in a Microgravity environment.

IV. CONCLUSION

Space technologies have received the attention of governments, universities and companies due to the need for new military systems and products for human consumption. An example is the understanding of nature needs studies in a high atmosphere and in a low gravity environment for an adequate understanding of natural phenomena (physics, chemistry, biology, etc.). Another is the prospect of accelerating the development of new products (such as medicines, materials, new microchips) and testing the reliability and resilience of electronic systems.

The system composed of the VSB-30 suborbital rocket and the Suborbital Microgravity Platform is a national product born in government institutes and now being marketed by Brazilian industries on a global scale.

The success resulting from this effort is a pride for Brazil.

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