

The Brazilian Research and Teaching Center in Biomedicine and Aerospace Biomedical Engineering

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Abstract

The recent engagement of Brazil in the construction and utilization of the International Space Station has motivated several Brazilian research institutions and universities to establish study centers related to Space Sciences. The Pontificia Universidade Catolica do Rio Grande do Sul (PUCRS) is no exception.

Method: The University initiated in 1993 the first degree course training students to operate commercial aircraft in South America (the School of Aeronautical Sciences. A further step was the decision to build the first Brazilian laboratory dedicated to the conduct of experiments in ground-based microgravity simulation. Established in 1998, the Microgravity Laboratory, which was located in the Instituto de Pesquisas Cientificas e Tecnologicas (IPCT), was supported by the Schools of Medicine, Aeronautical Sciences and Electrical Engineering/Biomedical Engineering. At the end of 2006, the Microgravity Laboratory became a Center and was transferred to the School of Engineering.

Results: The principal activities of the Microgravity Centre are the development of research projects related to human physiology before, during and after ground-based microgravity simulation and parabolic flights, to aviation medicine in the 21st century and to aerospace biomedical engineering.

Conclusion: The history of Brazilian, and why not say worldwide, space science should unquestionably go through PUCRS. As time passes, the pioneering spirit of our University in the aerospace area has become undeniable. This is due to the group of professionals, students, technicians and staff in general that have once worked or are still working in the Center of Microgravity, a group of faculty and students that excel in their undeniable technical-scientific qualifications. Hippokratia 2008; 12 (Suppl 1): 32-36

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The Establishment of MicroG at PUCRS

The participation of Brazil in the construction and utilization of the International Space Station has motivated various Brazilian research institutions and universities to establish centers of study related to Aerospace Science. The Pontifical Catholic University of Rio Grande do Sul (PUCRS) is no exception. With more than 50 years of tradition, PUCRS today is a leading and pioneering Brazilian University in the areas of Aeronautics and Astronautics, which is demonstrated by the creation of the first university course in South America dedicated to the qualification of commercial pilots, the School of Aeronautical Sciences, in 1993. The decision to build the first Brazilian laboratory aimed at the study of human physiology in the aerospace environment and in simulations of microgravity on earth constituted a step further.

Established in 1999, the Laboratory of Microgravity, initially located in the Institute of Scientific and Technological Research – (ISTR) – was the result of a joint effort of the School of Medicine, School of Aeronautical Sciences and the School of Engineering/Master's Program in Electrical Engineering (Area of Concentration: Information Technology; Research on

DSP & Biomedical Engineering)¹.

With its expansion, and the international acknowledgement for the pioneering and highly qualified work, in 2006 the Laboratory of Microgravity became the Center of Microgravity, and officially integrated the research of the Academic Units of PUCRS. It is currently located in Building 30 together with the School of Engineering, Block F, Room 283.

Today, the Center of Microgravity is, par excellence, a research center with both undergraduate and graduate courses in various areas of knowledge.

The objectives

The principal activity of the Center of Microgravity/FENG-PUCRS, as of now Center of MicroG, is the development of research projects relative to biomedicine before, during and after the simulations of microgravity² and parabolic flights³, for aviation medicine of the 21st century and aerospace biomedical engineering⁴.

In its creation, some directives were established for the design of the research projects and for the development of academic relations between this Center and the national and international scientific community.

Accordingly, the following rules were set:

1. To be short-term (suggested 1 to 6 months), since prolonged studies tend to jeopardize the development of the new center;

2. To be low cost, so that financial difficulties do not hinder research activities;

3. To be a motivating source for researchers, professors and students, so they:

a) Participate in the development of protocols, experimental techniques, collection and analysis of research data;

b) Present results of their studies in national and international scientific conferences;

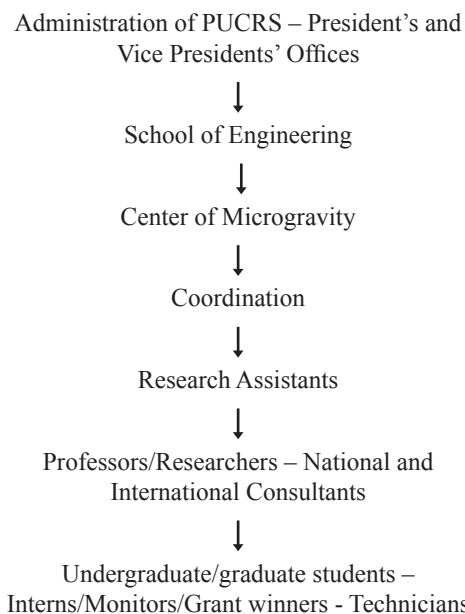
c) Publish work in scientific journals.

4. To motivate the cooperation between Brazilian and International Universities / Institutions, aiming at researcher, student, material resource and financial exchanges;

5. To contribute to aerospace science, resulting in clear scientific, technological, social and economic benefits for society.

This last objective has brought extensive publicity for the Center of MicroG as a center of excellence in Latin America in the areas to which it is dedicated, since the publications concerning research results and achievements realized have systematically been announced by the national and international media⁵.

Administrative Structure of the Center of Microgravity



The Center of Microgravity is directly subordinate to the School of Engineering. There is a general coordinator of the MicroG, a position that is currently occupied by Professor Thais Russomano. The direct support of more than 50 interdisciplinary research projects of MicroG is given by two research assistants, Felipe P. Falcão and

Gustavo Dalmarco, both engineers, graduated in Engineering of Control and Automation from PUCRS, and hired by the School of Engineering.

The Center of Microgravity counts on the collaboration of various professors from different Academic Units of PUCRS, as indicated in Figure 1. The staff of collaborating Schools, however, is dynamic and is altered every year, as research projects are included or completed⁶. In general, each study carried out by MicroG counts on at least 4 professors from diverse but complementary areas. The Academic Units of PUCRS commonly involved in MicroG researches are listed below:

Academic Units of PUCRS members of the Center of Microgravity

(alphabetic order)

School of Biosciences

School of Aeronautical Sciences

School of Physical Education

School of Nursing, Nutrition and Physiotherapy

School of Engineering

- Department of Medicine and Mechatronics

- Department of Electric

- Master's in Electric Engineering/DSP &

- Biomedical Engineering

School of Pharmacy

School of Philosophy and the Humanities

- Department of Sociology

- Department of History

School of Physics

School of Information Science

School of Medicine

National and international consultants are officially invited to contribute to research projects, through consulting provided gratuitously in form of video-conferences. This support has been fundamental for publicizing, especially international, of works realized in MicroG. Among the international consultants, Prof. John Ernsting is a renowned professor and researcher in Aerospace Medicine of King's College London and Vice-Marshal (retired) of the British Royal Air Force, Prof. Rupert Gerzer, director of the Institute of Aerospace Medicine of the German Aerospace Center (DLR) and the ex-director of the Division of "Space Life Sciences" of NASA, Dr. Joan Vernikos.

The student body is divided in undergraduate students (interns, monitors and grant winners of scientific initiation – BPA/PUCRS, FAPERGS, CNPq) and graduate students (Master's in Electrical Engineering/Technology of Information/Line of Research – DSP & Biomedical Engineering), as indicated in Figure 2. In both cases, one clearly perceives the inclusion of various areas of knowledge in the works developed. In the same way that was made explicit in Figure 1, the staff of the undergraduate and graduate student body is dynamic and also is altered every year with the inclusion of new projects or with the conclusion of studies.

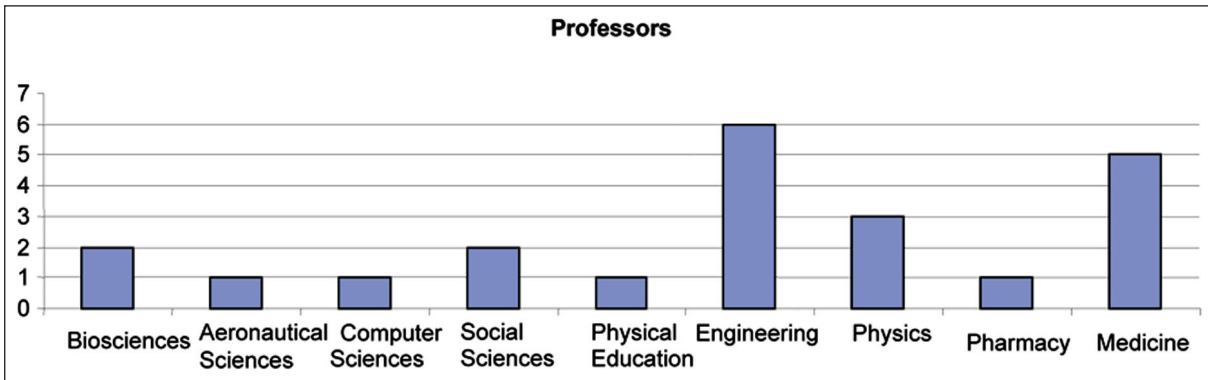


Figure 1: Distribution of the collaborating staff in projects of MicroG (updated to May, 2007).

Table 1 identifies the areas of study of MicroG and its corresponding research areas, within which professors, researchers, national and international consultants, as well as PUCRS undergraduate and graduate students perform in an interdisciplinary way.

Table 1: Area of study and lines of research of MicroG

Areas of Study	Research Areas
Aerospace Physiology	Simulation of microG and hyperG Hypoxia Experiments in parabolic flights
Aerospace Medicine	Commercial aviation in the 21 st century
Biomedical Engineering	Aerospace Biomedical Eng.
Aerospace Pharmacology	Aerospace Pharmacological Techniques
Computation & Telecommunication	Telemedicine Virtual Reality
Physics & Astrophysics	Hyper gravity Radiations
Sociology & History	Aerospace History
Physiotherapy	Aerospace Physiotherapy
Science of Sports & Biomechanics	Aerospace Biomechanics

Thanks to a series of official accords and the informal support, settled from the beginning (Figure 3) with renowned international teaching and research institutions in the areas of biomedicine and aerospace biomedical engineering, there has always been an important exchange between students, professors and researchers. To be mentioned are the Department of Applied Human Physiology & Aerospace Medicine of King’s College London⁷, the Institute of Aerospace Medicine of the German Aerospace Center⁸, the European Space Agency (ESA) – through campaigns of parabolic flights – and the North American Space Agency (NASA). In the same way, experts from other countries and students from foreign teaching institutions visit MicroG periodically (Figure 4).

The success of the work developed by MicroG can be clearly identified by the number of annual publications, both nationally and internationally. Figure 5 clearly shows the quantitative and qualitative scientific development, as the results obtained in the projects of MicroG have been made public. The number of international publications is today the mark of excellence of this genuinely interdisciplinary research center.

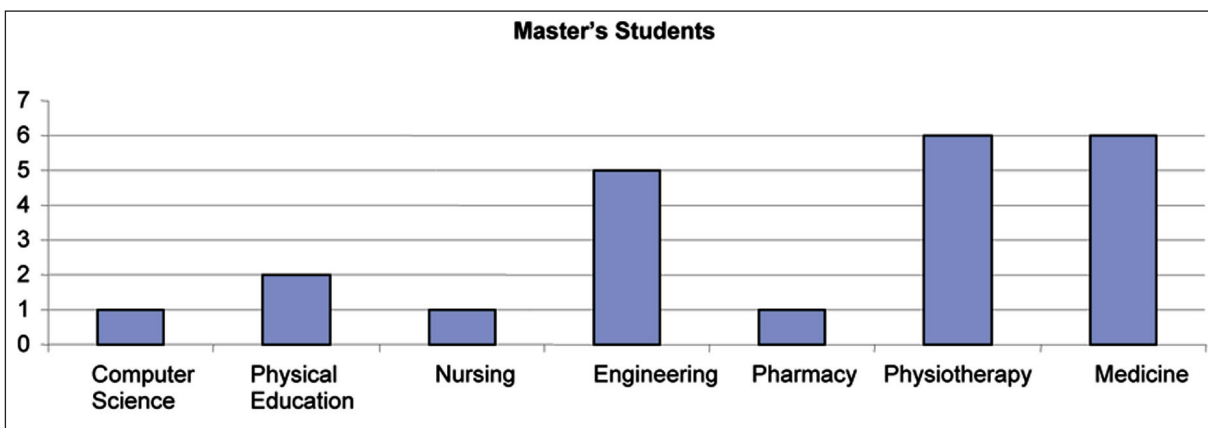


Figure 2. Distribution of the staff of PUCRS graduate students who develop projects in MicroG (updated to May, 2007).

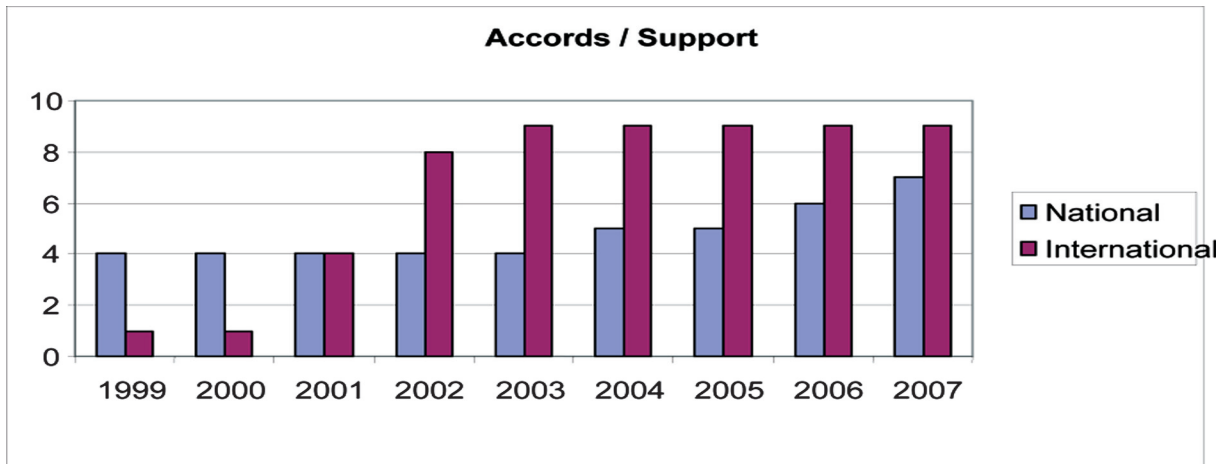


Figure 3: National and international accords between MicroG and national and international centers of excellence in biomedicine and aerospace biomedical engineering.

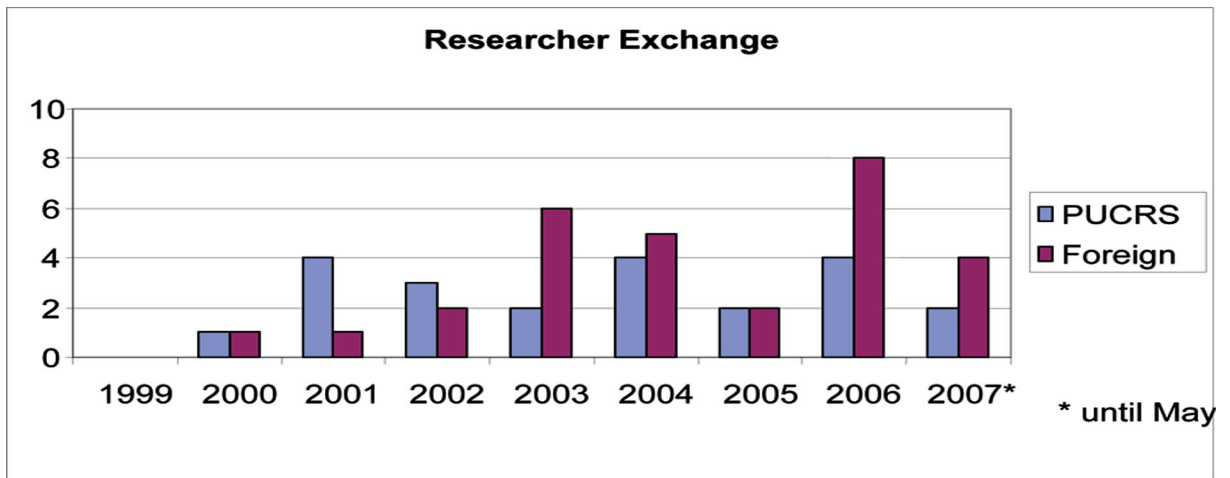


Figure 4: Researcher exchange, including students, between PUCRS and international centers of excellence in biomedicine and aerospace biomedical engineering.

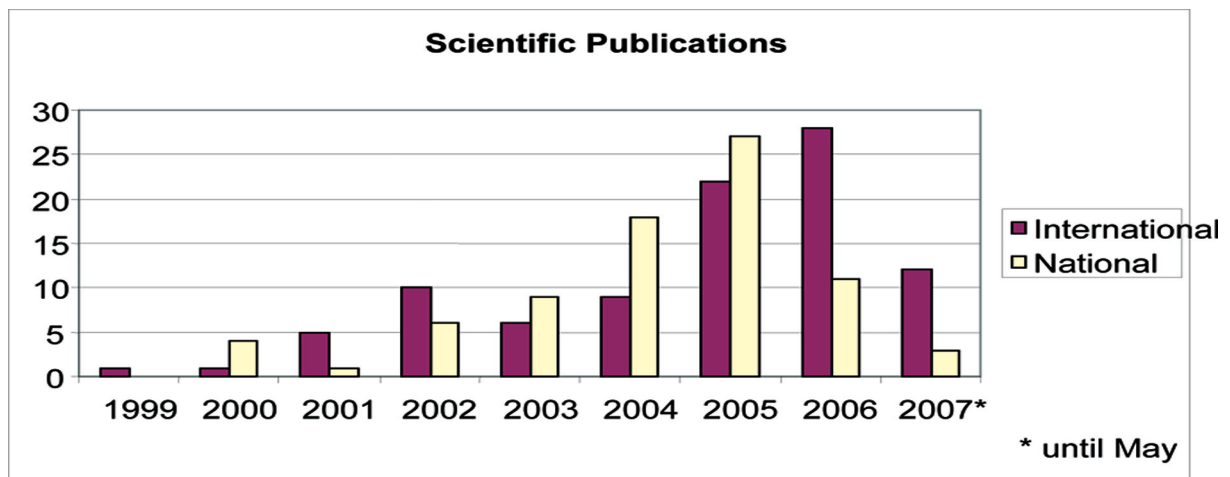


Figure 5: Number of annual scientific publications (national and international) of MicroG.

Conclusion

In national and international conferences, as well as in interviews for the local and national media, it has been repeatedly stated that the history of Brazilian, and why not say worldwide, space science should unquestionably go through PUCRS. As time passes, the pioneering spirit of our University in the aerospace area has become undeniable. This is due to the group of professionals, students, technicians and staff in general that have once worked or are still working in the Center of Microgravity, a group of faculty and students that excel in their undeniable technical-scientific qualifications.

References

1. Russomano T. The microgravity laboratory/IPCT-PUCRS. The first Brazilian space life sciences center. *Aviat Space Environ Med* 2002; 73: 521
2. Russomano T, Santos M, Andrade L, et al. O efeito da escopolamina na performance mental durante simulação de microgravidade. *Scientia Medica* 2005; 15: 90 - 97
3. Evetts S, Evetts L, Russomano T, Castro J, Ernsting J. An Assessment of the Feasibility and Effectiveness of a Method of Performing Cardiopulmonary Resuscitation during Microgravity. In: 75th Annual Scientific Meeting Aerospace Medicine Association, Anchorage, Alaska, 2004, pp 130
4. Russomano T, Evetts S, Castro J, et al. A device for sampling arterialized earlobe blood in austere environments. *Aviat Space Environ Med* 2006; 77: 453 – 455
5. Russomano T. Editorial: Nova recomendação médica da NASA baseada em estudo publicado na Revista Scientia Médica. *Scientia Medica* 2005; 15: 88 – 89
6. Leyes R, Cambraia R, Bacim F, et al. Development of walking pattern evaluation system for hypogravity simulation. In: IEEE 2006 International Conference of the Engineering in Medicine and Biology Society, New York, 2006.
7. Santos M, Bosquillon C, Falcão F, et al. Development of a Diffusion Chamber to Evaluate In Vitro Respiratory Epithelial Cell Layer Permeability in Microgravity. In: 54th International Congress of Aviation and Space Medicine, Bangalore, 2006.
8. Russomano T, Allan J, Beck L, et al. Development of a lower body negative pressure box with an environmental control system for physiological studies. *Adv Space Res* 2006; 38: 1233 – 1239