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Flexible R&D Promotion Instruments as a Way to Develop the Space Industry in Brazil

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Abstract

The space sector is technology-intensive with high-cost, risky and long-term projects. Encouraging technological development in the sector therefore requires specific policies capable of overcoming the sector's characteristics. Due to budgetary issues or rules that imposed greater accountability on the public manager in case of failure of technological development projects, the Brazilian space sector could not use the existing instruments for financing R&D. However, with the change in the National Innovation Law and the introduction of the technological ordering instrument (ETEC), this type of instrument began to be used by the Brazilian Space Agency in the contracting of technological projects. ETEC is a milestone, as it allows the public sector to accept that the development project may not be successful, without the public manager being held responsible for the failure. And the release of budgetary resources from the National Fund for Scientific and Technological Development allowed the adoption of subsidy notices to encourage innovation directly by private companies, a drastic historical change, since space investments were carried out through the use of public research institutes. The use of new instruments opens up new possibilities for direct incentives for the Brazilian space industry.

Keywords: space sector, Technological Ordering Instrument (ETEC), R&D

1. Introduction

Since the beginning of the space race, the space sector has been undergoing major transformations. For many years, only the State, was able to afford the high investments, bear the long execution times and the risks necessary to create and maintain space projects. Such investments justified the direct benefits, generated by technologies and space applications, and indirect ones, such as the development of industry and intellectual capital, exceed the invested costs.

However, the evolution of space technology, the extension of possible services and the increased demand for space solutions has changed this reality. The new opportunities for economic and technological exploration of space are attracting private sector investment and transforming the financing dynamics of the space sector, previously predominantly coming from the public sector. These changes in the space environment, with a decrease in State participation and growth of the private sector, is a phenomenon known as New Space and has been happening in several countries with a strong history in the sector, such as the United States, Germany, Russia and Japan.

In the case of Brazil, the sector is still very dependent on government investments, with timid participation from the private sector. However, in recent years, the public budget for the space sector has been reduced considerably. According to official data (Siop, 2022), the public budget coming from the Ministry of Science, Technology and Innovation (MCTI), destined to the Brazilian Space Agency (AEB), had its highest endowment, in 2013, when the amount reached approximately US$ 81,6 million. In 2021, however, the had dropped to around US$25 million (Siop, 2022). This real decrease in the budget have an impact on the projects carried out by the public sector and also on the resources passed on to the industry.

Due to the budgetary constraints of the Brazilian government, the incentive for private action is carried out through the use of instruments to encourage innovation that already exist and are operated by institutions other

than the Brazilian Space Agency. Such instruments are not recent and have been used by other sectors of the Brazilian economy. However, due to the characteristics of the space sector, namely, long-term investments, high cost and risk, space projects did not fit the rules of such instruments.

Recent changes, both in terms of legislation and technology, have changed the way in which space projects are financed. The creation of instruments such as the Technological Order allows the public manager to assume the risk of technological development without the pressure of being held accountable in case of project failure. Failure is an inherent characteristic of the innovation process, but without a clear provision in Brazilian legislation.

Another change was the possibility of including space projects in economic subsidy notices. That is, the State opens a public call for the purchase or development of a certain product and the resources are made available without the need for reimbursement. Obviously, the company must comply with the requirements indicated in the announcement, being accompanied by technicians from the institution throughout the development of the project. The participation of space sector in these projects became possible due to the reduction of space development costs thanks to the process of standardization and miniaturization of components. Additionally, non-compensation is an attractive feature for companies in the space sector, not only due to the high cost of the project, but also due to its particularity of dependence on government resources and non-investment of its own resources.

2. Grant Policy and the Innovation Law

In general, governments promote technological innovation through national innovation system policies, incentives for science and technology development, and support for research institutes, bringing them closer to the private sector. In this way, they sometimes use investment funds that support research and studies in the development of advanced technologies. In emerging countries, this role is of fundamental importance because the productive activity is not always mature enough to evolve on its own (Dewes, Dalmaco, & Padula, 2015).

Public procurement, direct R&D subsidies and fiscal incentives for R&D activities have been a way for the public sector to stimulate innovation policies, having as a starting point a technological challenge for the country. In these cases, the biggest problem is the risk associated with the technological development process and the accountability of the public manager in case of failure (Selviardis et al., 2023; Kleine et al., 2022).

Considering the financing difficulties for the innovative process, the main instruments used by the Government to stimulate innovation are direct R&D subsidies and R&D tax credits or fiscal incentives (Kleine et al., 2022). Such tools were also used in Brazil. In the case of tax incentives, several programs were created, including the so called “Lei do Bem”, which provides for the reduction of tax obligations for investments in R&D. The “Lei do Bem” is not the focus of this article, as space companies in Brazil do not use the mechanism, since their investments are highly dependent on public resources.

For the space sector, the main instrument for encouraging innovation is the direct subsidy to innovation. The Brazilian Innovation Law was enacted in 2004 and it became known as the CT&I Legal Framework. The law provides for incentives for innovation and scientific and technological research in the productive environment and for the promotion of partnerships between universities, research institutes and companies, to encourage Science, Technology and Innovation Institutions (STIs) in the innovation process and to encourage innovation in the company (Brasil, 2004).

It is important to highlight that over the years, the public budget allocated to the space sector has faced constraints. However, as pointed out by Cabello et al. (2022), investments in space activities have increased in recent decades. In the order hand, public procurement procedures are still slow and bureaucratic, making it challenging to acquire the necessary equipment and materials for the development of space products.

For the space sector, a study carried out by Melo and Freitas (2021) indicated that the return on public investment in the main space projects carried out by the Government generated a return, direct and indirect, between nine times and sixteen times the initial values, when considered a scenario optimistic. The projects were carried out within a traditional investment model in R&D, that is, the use of public research institutes that act as prime contractors, subcontracting national private companies for the development of parts of the final product. In 2016, this law was amended, and it became known as the New Legal Framework for CT&I. The New Legal Framework promoted relevant changes and brought measures to reduce development barriers to innovation (Brasil, 2016). It also changed the understanding of some existing development instruments: economic grants and new forms of financing. These instruments were already present in previous legislation, as mechanisms to encourage competitiveness, however, only now were they categorized as instruments to stimulate innovation.

Such alterations are important for the promotion of scientific development, research and technological training.

The new research grant, for example, is a financing instrument intended for "research, technological development and innovation activities in companies, allowing its allocation for capital and current expenses, provided that they are intended for the financed activity" (Brasil, 2018).

In Brazil, this mechanism is usually operated by Finep, the government innovation financing institution, through the Research Grant Program, which aims to "increase innovation activities and increase the competitiveness of companies and the country's economy". The non-reimbursable resources are granted through public calls, intended to fund R&D projects for innovative products and processes of Brazilian companies, coming from the FNDCT (Finep, 2023). Despite being relatively new, "it can represent one of the most powerful instruments to induce the innovation process in companies and at the same time meet public interests" (Costa et al., p. 1). The main feature of this instrument is the fact that the resources are non-refundable, that is, it is not configured as a loan and does not require the payment of amounts made available by the State. The instrument seeks to encourage the development of new technologies, marked by high risk and long-term investment, which discourages companies' own investment (Gangopadhyay & Homroy, 2023).

Another substantial innovation brought about by this new legal framework is the Technological Order (Etec). Etec is a mechanism that allows the public administration to hire the private sector to carry out RD&I activities that involve technological risk, to solve a specific technical problem or to obtain an innovative product, service or process and all this can be done without a formal bidding process, as it is one of the exemption cases foreseen in the National Innovation Law (Rauen & Barbosa, 2019; Fassio et al., 2021). In this sense, public purchases made using this instrument are intended for the development of a product and/or service that does not exist on the market.

This instrument gives more security and freedom to the manager, reducing bureaucracy in the contracting process, since a bidding process is not necessary, and a contract is signed between the parties that establishes the object, the physical-financial schedule and rules on intellectual property (Rauen & Barbosa, 2019). Thus, when carrying out the process in an adequate and transparent manner, the manager is not punished if the project fails, as it is understood that the risk is inherent to the project.

3. Incentive Instruments: Technological Order (ETEC) and Public Research Grant

As we consider the particularities of the space sector, these legal frameworks brought better and more efficient foment instruments. It brought more flexible possibilities to encourage innovation for companies, as already mentioned. Among the main possibilities for the space sector, the Technological Order (ETEC) and the Research Grant public notices stand out. The main contribution is the possibility for the manager to deal with the risk involved in the project with greater flexibility. They prioritize the development attempt and allow the manager to justify the possible failure. This characteristic is essential for space projects, due to the high risk associated with such projects.

3.1 Technological Order (ETEC)

Technological Order is a relatively new mechanism in Brazil and still little used by the public administration. Between 2010 and 2022, only 93 Technological Orders were held in the country (Rauen, 2019; Rauen, 2023).

Considering that the Brazilian Space Program has a great demand for innovative technological solutions, in 2019, the Brazilian Space Agency began the process of carrying out a Technological Order (Vellasco, 2020; Nascimento et al., 2022). It is important to point out that the space sector in Brazil faces difficulties with trade embargoes and with the inherent complexity of the technological development of space artifacts. In this sense, a Technological Order presents the least bureaucratic possibility for the development, purchase, provision of services and contracting of technological solutions. It also provides remuneration for partial deliveries, and eventual failures do not bring a burden to the executing companies, provided they are well grounded and within the legality (AEB, 2020b).

These advantages make this purchase instrument favorable in relation to international bidding, since it promotes the training of the national industry and it takes into consideration the fact that Brazilian companies, due to their size and financial potential, are usually unable to contribute resources and bear risks of this budgetary magnitude (AEB, 2020b).

The technological solution to be contracted through Technological Order arose due to a failure in the national market in space systems for navigation and control of rockets. After technological prioritization listed by the Brazilian Space Program Development Committee, the need to develop an Inertial Navigation System solution was perceived. Investment in the technological development of such a system directly contributes to the sector

and allows, among other advantages, for Brazil to master critical technologies, develop satellite launch vehicles and thus approach space autonomy (Nascimento et al., 2022).

Also in 2020, a public consultation notice was published, which includes the rules and criteria with the aim of gathering information from potential stakeholders in technological development (AEB, 2020c).

After analyzing the information sent by interested suppliers, in the second half of 2020, the term of reference was published with the objective of developing an Inertial Navigation System solution in 6 stages of a Technological Order execution. To qualify the supplier for the first stage of Technological Order, it was necessary to deliver a Technological Development and Innovation Project (AEB, 2020d). This preliminary phase included the manifestation of interest by five consortia (totaling thirteen companies) in acting as providers of technological development. The five proposals presented were qualified for the first stage, as the team of evaluators considered that "there were chances of success for the problem posed by term of reference" (Nascimento et al., 2022, p. 522).

The contracts were signed at a fixed price, worth approximately US$ 3 million, with a deadline for product delivery until April 2021 (Nascimento et al., 2022, p. 524). The Technological Order model allows the number of contracted companies to be reduced throughout the process, as it is perceived that a certain company/consortium has not reached the desired level of development. Also, when reaching the end of the process, the Brazilian Space Agency could decide that the final product also did not meet the requirements in the term of reference and, therefore, not carry out the purchases defined in the notice.

The second stage foreseen in the term of reference was carried out in November and December 2021. After negotiations with suppliers, so far, only two have been selected. The contracts were signed in December 2021, also at a fixed price, this time worth approximately a little over US$ 2 million. The deliveries of "models for the development of inertial sensors, auxiliary sensors and electronics associated with the Inertial Measurement Unit and signal processing" were scheduled for 2022 (Nascimento et al., 2022).

The rest of the planning continued with the manufacture of qualification models for inertial sensors, complementary sensors and electronics associated with the Inertial Measurement Unit. Inertial Measurement Unit development model, on-board computer and navigation processing software (third stage); Inertial Measurement Unit qualification model, auxiliary sensors, on-board computer and navigation processing software (fourth step): complete Inertial Navigation System qualification model (fifth step); and the delivery of four prototype Inertial Navigation System flight models (sixth stage) (Nascimento et al., 2022, p. 524).

It must be reinforced that the Technological Order model allows for robust monitoring and control throughout the process, culminating in the creation of norms and procedures both in public administration and in companies, in addition to the development of manufacturing and testing means in industry.

When it comes to the Brazilian Space Agency, Technological Order has considerably modified the model historically adopted by the Agency. As the Brazilian Space Agency was created in 1994 and its first contest was held only in 2014, that is, 20 years after its creation, this implied the absence of a qualified technical body. Thus, the method adopted helped stimulate the technological development of the space sector consisted of the decentralization of resources.

Again, due to the absence of a qualified technical staff and adequate guidance for technological development, the research institutes participating in National Space Activities Development System (SINDAE), National Space Research Institute (INPE) and Institute of Aeronautics and Space (IAE), had the power to define the projects to be financed by the Agency. Thus, the model consisted of the definition of projects by the institutes, the decentralization of resources by the Brazilian Space Agency and the subcontracting of companies by the institutes for the development of parts of the project. The institutes acted, therefore, as prime contractors, a role that in general, to strengthen the role of industry, should be performed by the private sector.

3.2 Statistics and Data Analysis

Analysis of data and the reporting of the results of those analyses are fundamental aspects of the conduct of research. Accurate, unbiased, complete, and insightful reporting of the analytic treatment of data (be it quantitative or qualitative) must be a component of all research reports. Researchers in the field of psychology use numerous approaches to the analysis of data, and no one approach is uniformly preferred as long as the method is appropriate to the research questions being asked and the nature of the data collected. The methods used must support their analytic burdens, including robustness to violations of the assumptions that underlie them, and they must provide clear, unequivocal insights into the data.

3.3 Research Grant

The research grant is an important instrument to encourage RD&I, aimed at technological training and the country's national and regional development (BRASIL, 2016). The program is based on granting non-refundable public resources to public or private companies of all sizes, especially micro and small companies, with the aim of stimulating competitiveness and the national economy (Finep, 2022a).

Nasa has a similar program, the Space Technology Research Grants (STRG) that "features a low TRL (Technology Readiness Level) technology portfolio of groundbreaking research in advanced space technology". The main objective is to challenge the academic researchers to study and to develop ideas "that are critical to making science, space travel, and exploration more effective, affordable, and sustainable" (Nasa, 2023)

The year 2022 represented a great advance for the space sector in the use of this mechanism to promote innovation to meet the demands of the sector. This opportunity came about after the release of the National Fund for Scientific and Technological Development. The amounts available for use in 2022 reached a little over US$2 billion (Senado, 2022). Thus, three public selections for a research grant were launched using non-refundable resources from the FNDCT (AEB, 2022b).

The first public selection for a research grant for Innovation was published in February 2022 for the technological development of a prototype of training rocket – Rockets for Training. This product consisted of the development of a suborbital vehicle, including all ground equipment and at least one launch at one of the Brazilian Launch Centers, with a forecast for recovery and reuse of components after launch (Finep, 2022b).

This announcement is important for the Brazilian space sector, as it enables the training of national teams in the development of suborbital vehicles, as well as in the process of launching vehicles for teams allocated in launch centers. The development of suborbital and training vehicles allows, in addition to offering training opportunities for teams, to encourage the training of the national industrial workforce and access the international market for this product, with the possibility of export.

Another opportunity identified with this development was the possibility for Brazil to enter the satellite launch market from the Alcântara Space Center (CEA). By hiring training rockets, the Brazilian Air Force can train its workforce dedicated to managing the center, in order to offer higher quality services to private companies that may use the center.

For this development, the funds committed around US$ 3 million. Brazilian companies of any size could submit proposals, either individually or in a consortium (Finep, 2022b). The project must be executed within 36 months after the disclosure of the final result.

The final result of the selection was published on the Finep website, on August 15th, 2022. The classified company was DeltaV Engenharia Espacial LTDA. Another three companies were classified outside the resource limit. In addition, three were not classified, as detailed in Table 2.

Table 2. Result of the Training Rocket Grant Notice

Proposal Classified Within Resource Limit	
Company	**Project Value[1]**
DeltaV Space Engineering Ltd.	BRL 8,189,770.17 US$ 1,608,992.17
Proposals Ranked Outside the Resource Limit	
Company	
Edge of Space Industria, Comércio, Assessoria e Engenharia LTD.	
ACRUX LTDA. ME	
PION Labs Engenharia LTD.	
Unclassified Proposals	
Company	
RK Industria E Comercio LTDA. - BRVANT	
ALGCOM Indústria E Serviços Em Telecomunicações LTDA.	
Interface Intelligent Systems Ltd. ME	

Source: Finep, 2022b.

The second public selection for a research grant for Innovation was published in June 2022 (Finep, 2022c) and had as its object the development of a small high Resolution earth observation satellite. The objective was to select an innovation project that contemplates the "project development, construction of parts and pieces,

systems engineering, integration, tests and flight model of a Small Earth Observation Satellite" (Finep, 2022c, p. 1).

The definition of the invitation to bid for a small earth observation satellite is an important step towards Brazilian technological development. Historically, earth observation satellites produced in Brazil (internally or in cooperation with China – China Brazil Earth Resources Satellite - CBERS project) are medium or large. The choice for a small satellite is in line with the New Space model, which requires lower cost products with lower technological risk.

The choice of this type of satellite is also in line with the needs of the Brazilian economy for solutions. Due to the continental dimensions of Brazil, the need for spatial solutions goes through several segments: monitoring of biomes, solutions for monitoring agricultural production, monitoring of natural disasters and solutions for monitoring public works and cities.

The public notice, like the previous one, also allows for direct training of the national industry, which is currently unable to enter the international market due to the lack of a "flight history". Flight history is the use of parts/products developed by companies in launches. The international market only accepts products that have already been used in space missions to guarantee their quality and efficiency. Due to the lack of national missions and the restricted participation of the national industry in the projects already developed so far, the parts produced by the national industry do not have the necessary "flight history" to export and become international suppliers to the space sector. Few companies managed to qualify to enter the international market.

Resources for this technological development amounted to almost US$ 100 million. For the event, Brazilian companies were considered eligible, in arrangements of at least six companies, with the mandatory participation of "one Brazilian institution of science and technology with notorious expertise, infrastructure and human resources for the development of satellite technologies" (Finep, 2022c, p. 2). The arrangement had, necessarily, one proposing company and the others as co-executors (FINEP, 2022c). After the disclosure of the final result, the consortium must execute the project within 36 (thirty-six) months.

The final result of the selection was announced on November 25th, 2022. Three proposals were approved and classified, two of which outside the limit of approved resources. Consortia approved and classified within and outside the resource limit are listed in Table 3, below.

Table 3. Result of the Grant Notice for the development of a small satellite for high resolution Earth Observation

Proposal Approved and Classified Within the Limit of Allocated Resources	
Company	**Project Value[1]**
Visiona Tecnologia Espacial SA	
Coexecutor:	
Fibraforte Engenharia Industria e Comércio LTDA.	BRL 231,418,117.11
Opto Tecnologia Optronica LTD. Equatorial Sistemas Ltda.	US$ 45,465,248.94
Orbital Engenharia SA	
Kryptus Information Security SA	
Proposals Approved and Classified Outside the Limit of Approved Resources	
Company	
Concert Technologies S/A	
Co-executors:	
CRON – Sistemas e Tecnologias LTDA.	
Sonaca Brazil Ltd.	
DESAER – Desenvolvimento Aeronáutico LTDA.	
Horuseye Tech Engenharia De Sistemas Ltda.	
CRIAR – Projects, Systems and Digital Automation LTDA.	
Ivision Image and Vision Systems SA	
Etsys Indústria E Tecnologia Em Sistemas LTDA ME	
Coexecutor:	
Metalcard Indústria e Serviços de Usinagem LTDA.	
CRIAR – Projects, Systems and Digital Automation LTDA.	
Edge of Space Industria, Comercio, Assessoria e Engenharia LTD.	
RF COM Sistemas Eirelli.	
Propertech Tecnologia Ltda	

Source: Finep, 2022c.

The third and last public selection for innovation research grant was published in August 2022 and had as its object the development of at least two prototypes of Small Launch Vehicle for Launching Nano and/or Microsatellites (Finep, 2022d).

It is important to point out that since 1978, Brazil has been trying to develop a launch vehicle (AEB, 2020a), with the project called Satellite Launch Vehicle (VLS). The first prototype was developed only in 1997. Two launch attempts were unsuccessful. In 2003, on the third attempt, there was an accident that resulted in the death of twenty-one Brazilian researchers.

After analyzing the causes of the accident, the project was remodeled for a smaller vehicle, called the Microsatellite Launch Vehicle. Even with the reduction of the project, for several reasons, among them international embargoes and the contingency of resources, meant that the project was still not finalized. The development is in charge of the Institute of Aeronautics and Space, linked to the Ministry of Defense, the body responsible for the launch vehicle segment.

Thus, the choice to develop two prototypes of a Small Launch Vehicle to Launch Nano and/or Microsatellites seeks to transfer the construction challenge to the national industry. Brazil has already mastered the development of a Suborbital Vehicle, the VSB-30, developed in partnership with the German Space Agency.

The development of a small vehicle is important for increasing competitiveness in relation to the international launch market. New Space and the introduction of small satellites created a cadence of launches never seen before. Thus, large launch vehicles are not capable of supporting the amount of space artifacts placed in orbit. Therefore, there is an international race for the development of small vehicles.

A feature of this type of vehicle is that launches can be carried out in a short time. The use of large vehicles requires waiting for a specific launch date, which often may not suit the customer's needs. Thus, a market is created for smaller launchers that have the ability to meet customer demands in a shorter period of time. The development of a small national product has the capacity to enter this market.

The resources committed to this development were limited to the amount of US$ 75 million. For the event, Brazilian companies were considered eligible, in arrangements of at least four companies, with one company acting as bidder and the others as co-executors. The deadline for carrying out the project is also up to 36 months (Finep, 2022d).

The preliminary result of the Selection was released on December 12th, 2022. Three proposals were qualified in this phase and two were not qualified. Qualified and non-qualified consortia are listed in Table 4 below. The process is in the resource evaluation phase (Finep, 2022d).

Table 4. Preliminary result of the Grant Announcement for the development of two prototypes of Small Launch Vehicle for Launching Nano and/or Microsatellites

Qualified Proposals	
Company	**Project Value**[1]
Avibras Industria Aeroespacial SA Coexecutor: Castro Leite Consulting Ltd. ME. Edge Of Space Industria, Comercio, Assessoria e Engenharia LTD. Legado Usinagem LTD. Orbital Engenharia SA Pion Labs Engenharia LTDA	BRL 195,119,972.93 US$ 38,333,982.89
Cenic Engenharia Indústria E Comércio LTDA. Co-executors: Concert Technologies SA Schelim Engineering Eirelli. Plasmahub Ambiental Ind. Eng. Exp. And Imp. LTD. Etsys Indústria E Tecnologia Em Sistemas LTDA.	BRL 192,033,780.00 US$ 37,727,658.15
Akaer Engenharia SA Coexecutor: ACRUX LTDA. Breng Engineering And Technology Ltd. Essado De Morais LTDA.	BRL 185,347,482.72 US$ 36,414,043.76

Proposals Not Qualified
Company
SIATT - Engenharia, Industria E Comercio LTDA. Co-executors: Turbomachine Vehicles And Motors Ltd. Hyperlift - Aerospace & Defense LTD. Alkimat Technology Ltd. - EPP. Orsatti E Pinheiro Engenharia LTDA. - PPE Autaza Tecnologia SA Advantage Engineering Ltd.
C6 Launch Systems and Services Do Brasil LTDA. Coexecutor: GNC Sistemas Cr ficas LTDA. Mira Artis Strategic Products. Globo Central De Usinagem Ltd.

Source: Finep, 2022d.

4. Final Comments

The introduction of new forms of contracting under the New Legal Framework for Science and Technology allowed the AEB to recover part of its ability to define the projects to be developed, by contracting directly with the industry. It is important to highlight that the institutes are not left out of this process, as they are essential for supporting the development process and providing support through the use of their facilities to carry out the necessary tests throughout the project.

The technological Order mechanism was a milestone for the space sector, as it marks the change in the way Brazilian Space Agency operates, adhering to the New Space, and with the focus on strengthening the national industry, creating national capacities and seeking the possibility of insertion in the international market.

The return of grant notices is also important, as they allow the request directly to the industry for products capable of generating national competences, guaranteeing the country's autonomy in the international scenario and the insertion of the industry in the global chain of national value.

Such instruments are important to generate the "flight history" so necessary so that national companies can more easily access the international market, in addition to strengthening the national market.

It can be seen, therefore, that the instruments create the opportunity for Brazil to stop operating in the so-called Old Space and start operating in the New Space, with projects led by the national industry. It allows the role of the State to become one of simply indicating the macro requirements of the projects and the industry to assume the development process.

Authors Contributions

Authors contributed equally to the study. All authors read and approved the final manuscript.

Competing Interests

Szimanski, D. P., Melo, M. C. S. and Freitas, L. H. M. work at the Brazilian Space Agency. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Notes

Note 1. Exchange rate on June 1, 2023.

Note 2. Exchange rate on June 1, 2023.