IEEC
Institut d'Estudis
Espacials de Catalunya

STRATEGIC PLAN 2020-2024

IEEC Directorate
April 2020

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PREAMBLE

The former strategic plan of IEEC was approved by the Board of Trustees in February 2009 and covered the period comprised between 2008 and 2013. The analysis performed at that time was addressing the need to enhance technical and instrumental staff, the consequences of the lack of a strategy for space by the Generalitat de Catalunya, the additional difficulty that represented the dispersion of efforts in the different units, the individual expertise of the members of the scientific personnel, the role of the environment of the different university and research university campuses and the agility of the structure of IEEC for the management of its objectives.

The key lines of the plan aimed at promoting activities related to Earth observation, developing numerical simulations to exploit synergies with the Barcelona Supercomputing Center, pushing assets such as the OAdM or the MELiSSA pilot plant, collaborating with companies, developing components and subsystems as a means to enhance participation in space missions, and disseminating activities to society. In the organizational aspects, the plan was putting emphasis on rationalizing the relationships between the IEEC and the different units and on increasing bonding of researchers to IEEC. Many of those reflections continue to be valid.

Since then, however, the environment has greatly evolved. A trend for change in the space sector has been confirmed, which is qualitatively relevant and significantly expansive in the volume of its activity. Particularly important is the impending exponential growth of the so-called New Space, which is bound to facilitate access to space not only for scientific activities but also for new market applications in telecommunications and general data products. This “democratization” of the exploitation of space as a platform will certainly bring a revolution to space research and, furthermore, to our everyday life. In this rapidly-evolving context, time is ripe for a push that can boost the potential of the sector in Catalonia.

▲ A night-time picture of the Montsec Astronomical Observatory (OAdM) with its various astronomical, environmental monitoring and satellite communications infrastructures.

EXECUTIVE SUMMARY

The new global landscape provides motivation to reflect on IEEC's positioning for the future in the form of a strategic plan for the new quinquennium 2020-2024. The plan performs an in-depth study of IEEC from all points of view, including personnel, finances, productivity, facilities, projects, innovation, etc. We also analyze the external context, both considering similar research institutes at international level and the industrial landscape, in Catalonia and Europe. Future opportunities for space missions in the context of ESA and other agencies are analyzed and special attention is payed to the New Space prospects. Together with the SWOT analysis conducted, a resulting positioning of the IEEC is presented and discussed, from which updated mission, vision and values statements are presented. The ultimate objective of the strategic plan is to take IEEC to the next level in excellence and performance in the international arena. To accomplish this overarching goal, the plan defines six strategic lines and 37 subobjectives and presents 83 specific actions, which we consider in the framework of two different scenarios.

Scenario 1 assumes a stable level of structural funding, similar to that of the current allocation, and permits to accomplish about 80% (by number) of the planned actions. The essential aspects of Scenario 1 that will take IEEC on a qualitative leap forward are to: 1) Actively seeking new funding opportunities in the Horizon Europe programme; 2) Attain full internal cohesion and enhance synergistic relationships with its units; 3) Boost innovation activities and exploitation of intellectual property through contracts with industry and space agencies to generate and transfer knowledge; 4) Promote space in Catalonia, building on acquired expertise to expand into New Space; 5) Build international prestige as host of excellent students, young researchers and technicians; 6) Perform communication actions both internally and externally; and 7) Carry out activity with the utmost respect for principles such as gender equity, open policy, ethics, and sustainability.

Scenario 2 considers a 70% increase in structural funding that can greatly enhance the capabilities of IEEC and take it to a full new level of performance. The additional funding will be totally allocated to new personnel that shall provide services to IEEC members to unleash their full potential. Besides tackling all the aspects of Scenario 1, the highlights of Scenario 2 are to: 1) Create a senior engineering office to boost IEEC's know-how and portfolio of expertise and to lead large research projects and space missions; 2) Increase critical mass gathering all groups with space interest in Catalonia; 3) Perform strategic communication activities reaching out to the general public, students and media so that IEEC is recognized as a leading institution in space research; 4) Push personnel training via industry exchanges, host students and young researchers; 5) Enhance infrastructures (OAdM, labs) by providing specialized support to facilities and laboratories in synergy with the units; and 6) Become one of the reference centres in space research in Europe.

In addition, to the two scenarios, we propose a major strategic, **flagship project** with horizontal implications within the different research, industry and governmental actors of Catalonia. This flagship project is designed to take advantage of the evolving context of New Space with the aim of creating a powerful community in the Catalan landscape. Through the flagship project, IEEC can act as a tractor of the space sector and capacitate the local industry to take on future challenges that are due to appear in the coming years as access to space becomes an asset. The plan requests the allocation for initial funding for a preliminary study of the mission, including the payload, followed by a second fund allocation to complete the construction and operation phases. Time could not be more optimal for this opportunity, and IEEC and Catalonia have the chance to be at the forefront of this revolution that has just begun.

MISSION

The Institute of Space Studies of Catalonia (IEEC) is established to lead the development of activities related to space in Catalonia in its aspects of training, research, and innovation. The ultimate goal is to play a key role in the development, promotion, dissemination and transfer of knowledge of all kinds of activities, studies and projects related to space technology and scientific research from and of space, for the benefit of society.

Specifically, IEEC aims to:

- Promote astronomical and space research
- Become an internationally recognized center in order to attract talent and foster collaborations both locally and worldwide
- Be an efficient agent of knowledge, innovation and technology transfer in its field
- Carry out science awareness to society by communicating scientific culture

STRATEGIC PLAN

GENERAL OBJECTIVES

1. Follow principles of Responsible Research and Innovation (training, dissemination, transfer, ethics, gender equity, open innovation, open science, sustainable development, governance)
2. Consolidate and increase the very high productivity and impact (dissemination, incentives, large projects, Montsec)
3. Build international prestige and keep the outstanding human team and expertise (visibility, training, lifelong learning)
4. Bring IEEC together by eliminating internal barriers (transparent to institutions, communication, common facilities)
5. Exploit EU funding – Horizon Europe (specialized support, advocacy, industry)
6. Embrace all aspects of knowledge transfer (dissemination, outreach)
7. Boost innovation activities (portfolio, valorisation, EIC)
8. Consolidate expertise in space engineering (career development, attract other groups, engineering office)
9. Play a key role as a reference for national and international industry (academic partner, provider of missions, push Catalan space sector)
10. Promote the design, manufacture and launch of a full nanosatellite mission (science case, in-house technology, Montsec ground station)

STRATEGIC LINES

DEPLOYED THROUGH:

37 STRATEGIC PROPOSALS AND
83 ACTION ITEMS

1. Values: Work under RRI principles
2. Science activity: Be a reference centre at national and international level
3. Human and material resources: Enhance the efficiency of available assets
4. Organization and management: Revamp internal organization
5. Knowledge transfer: Boost transfer to the scientific, industrial and social environment
6. Funding: Improve the quality, quantity and nature

SCENARIO 1

Baseline with incremental transversal improvements

CURRENT STRUCTURAL FUNDING

SPECIFIC OBJECTIVES

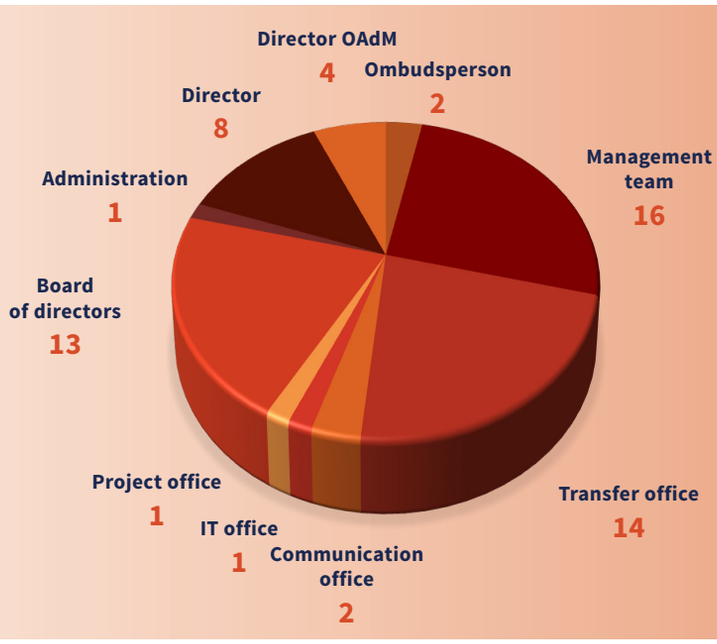
- Exploit funding opportunities in the Horizon Europe programme
- Attain full internal cohesion and enhance synergistic relationships with its units
- Boost innovation activities and exploitation of intellectual property through contracts with industry and space agencies to generate and transfer knowledge
- Promote space in Catalonia, building on acquired expertise to expand into New Space
- Build international prestige as host of excellent students, young researchers and technicians
- Perform communication actions both internally and externally
- Work under Responsible Research and Innovation principles

PERFORMANCE

80% of actions accomplished

RESPONSIBILITIES

(# OF ACTIONS)



RESOURCES

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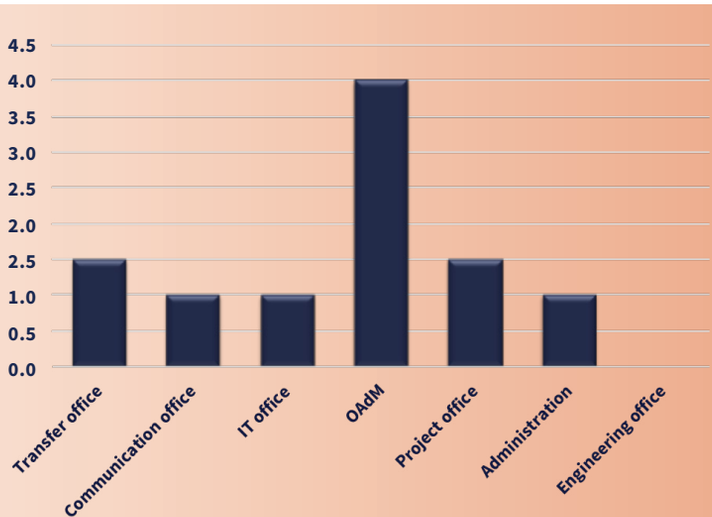


SCENARIO 2

Technology-empowering engineering unit and reaching out to the environment

FUNDING RAISED BY 410 K€/YR

SPECIFIC OBJECTIVES

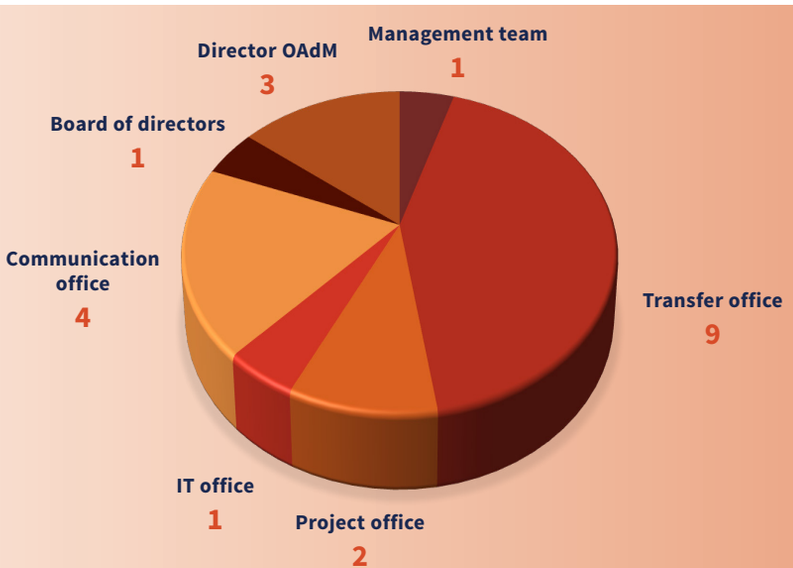
- All in Scenario 1 plus special emphasis on:
- Create a senior engineering office to lead large research projects and space missions
- Increase critical mass gathering all groups with space interest in Catalonia
- Perform strategic communication activities reaching out to the general public, students and media
- Push personnel training via industry exchanges, host students and young researchers
- Enhance infrastructures by providing specialized support to facilities and laboratories in synergy with the units
- Become one of the reference centres in space research in Europe

PERFORMANCE

100% of actions accomplished

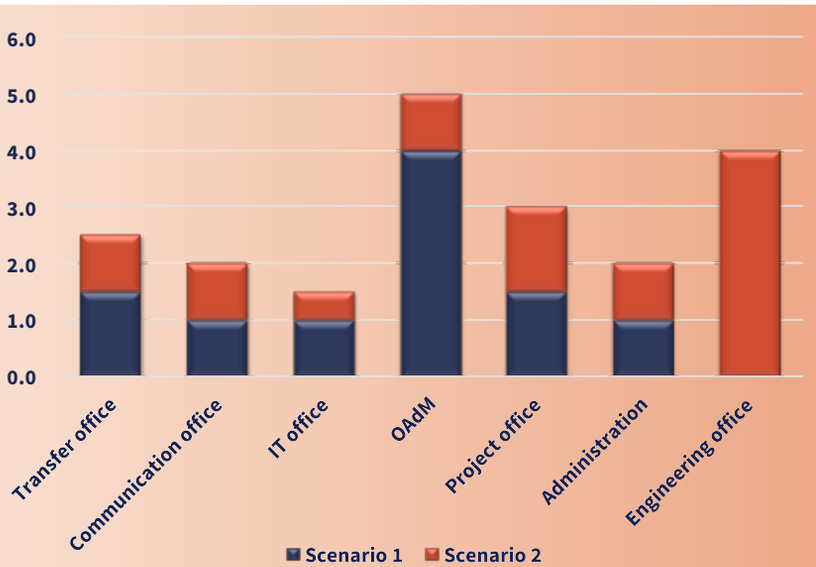
RESPONSIBILITIES

(# OF ACTIONS)



RESOURCES

(FTE)



FLAGSHIP PROJECT

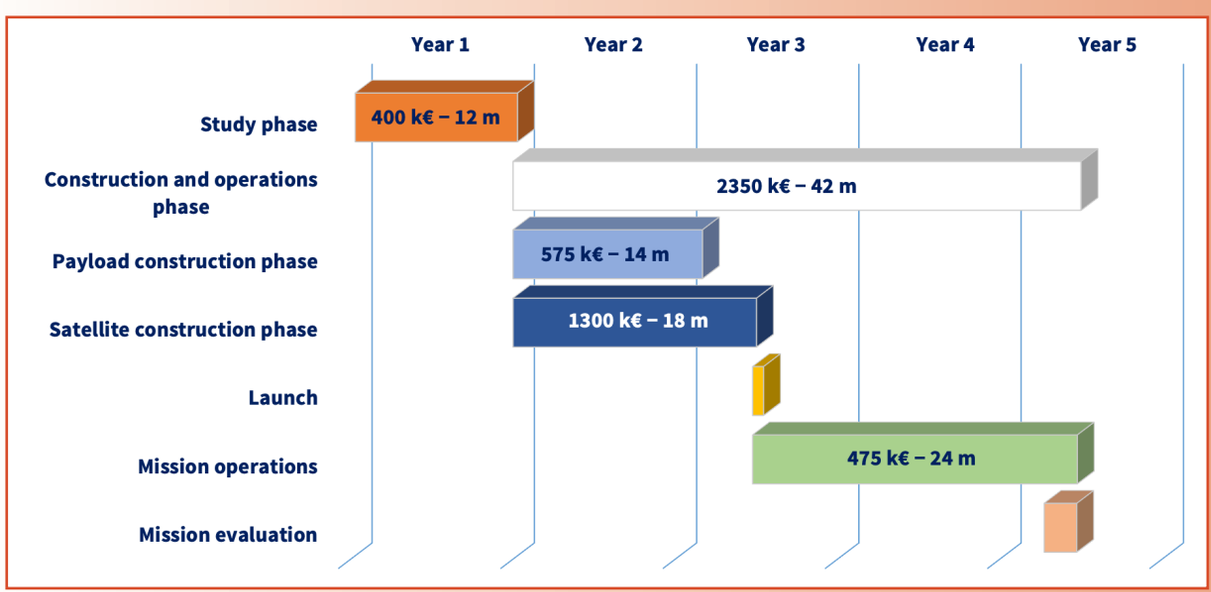
A transversal initiative to mobilize all sectors

TWO STEPS: 0.4 M€ STUDY + 2.35 M€ DESIGN, CONSTRUCTION & OPERATION

OBJECTIVES

- Create a transversal project gathering academia, industry & government
- Build community sense of local space industry
- Act as a tractor of the space sector and capacitate Catalan industry in the era of the New Space paradigm
- Place Catalonia as one of the key actors in New Space
- Perform innovative technology and science research in a topic to be selected (Earth observation, Internet of Things, technology testing, astrophysics)

RESOURCES AND CALENDAR



Montage showing Soyuz flight VS23 (credit: Arianespace) ▶ with IEEC's logo on the fairing.


IEEC

Internal analysis

The Institute of Space Studies of Catalonia

IEEC (Institut d'Estudis Espacials de Catalunya) is a research institute that studies all areas of space and space sciences, including astrophysics, cosmology, planetary science, Earth observation, and space engineering. Its mission is to push the frontiers of space research from the scientific and technological domains for the ultimate benefit of society.

The specific objectives are to:

- Promote astronomical and space research
- Become an internationally recognized centre in order to attract talent and foster collaborations both locally and worldwide
- Be an efficient agent of knowledge, innovation and technology transfer in its field
- Carry out science awareness to society by communicating scientific culture

IEEC ranks among the best international research centres, producing a large number of high-impact publications and leading key world-class projects. This is the result of over twenty years of top-quality research work in collaboration with renowned international institutions. IEEC also develops instrumentation for multiple space missions thanks to a team of engineers with extensive experience in the aerospace sector and in sectors with a high value in innovation. As a non-profit foundation, IEEC can have a versatile relationship with private industries and companies that ultimately manufacture the qualified flight hardware.

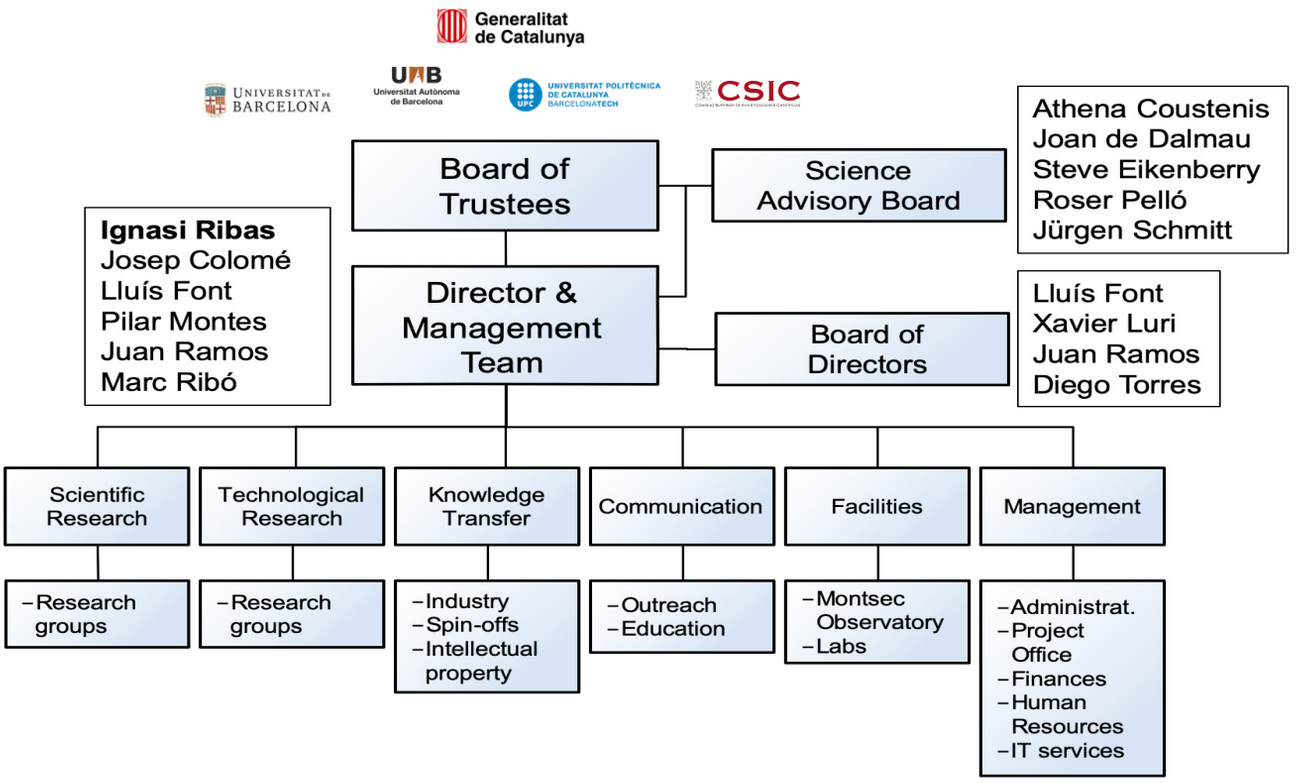
The IEEC was established in February 1996 to foster space R&D in Catalonia. It currently has a Board of Trustees composed of the Generalitat de Catalunya, the University of Barcelona (UB), the Autonomous University of Barcelona (UAB), the Polytechnic University of Catalonia (UPC), and the Spanish Research Council (CSIC). The IEEC is also part of the Institució CERCA - Centres de Recerca de Catalunya. The IEEC is structured in the form of four Research Units, each belonging to one of the Trustee institutions, which constitute the core of the R&D activity. These units were created and are governed by the rules of their respective academic institutions, which are the members of the Board of Trustees.
The Research Units are:

- Institute of Cosmos Sciences - ICCUB (UB)
- Centre of Space Studies and Research - CERES (UAB)
- Research Group in Space Sciences and Technologies - CTE (UPC)
- Institute of Space Sciences - ICE (CSIC)

The agreements between the IEEC and the academic institutions in the Board of Trustees allow for the exchange of personnel and funds. Scientists and technicians from the Research Units can simultaneously act as members of their institutions and as members of IEEC. The Research Units have full scientific and management independence. All senior scientific personnel at IEEC are affiliated staff members from one of the Research Units. In the current scheme, permanent scientist positions are not offered by IEEC but they are provided by the academic institutions in the Board of Trustees. Therefore, Research Units develop their recruiting policies with regards to faculty members, who can subsequently become IEEC members upon request as per the corresponding agreements. For this reason, and in the framework of academic independence, the main science goals of the groups and researchers at IEEC are generally driven by their respective interests and by the most relevant challenges in each field as defined by the community.

Structure

IEEC has a well-defined organization chart, with clear responsibilities, as shown below:



Each of the different committees meet at a certain cadence, where a review of last actions is carried out and also the upcoming plans are shared and discussed. The Board of Trustees, the highest governing board of IEEC, physically meets on a yearly basis although it has been proposed that two meetings per year take place, each with a different focus (accounting and strategic planning). The Science Advisory Board, which advises the Board of Trustees to help ensure IEEC's scientific quality, holds meetings with a periodicity not longer than once every 1.5 years, for a two-day meeting and extraordinarily at any time for matters of special urgency. The Board of Directors, which represents the four units, meets every two or three months (or in the case of events that so deserve) and all high-level matters are discussed, especially those that have institutional implications. But, besides collective face-to-face meetings, the IEEC Director and the Board of Directors maintain close contact via email and also through ad hoc one-to-one meetings. Finally, the daily routine of the institute is closely followed by the management team, which meets fortnightly and discusses all actions and results with a deep level of detail. The management structure thus ensures that the Director is well aided by several governing bodies which, at the same time, oversee their work and monitor the progress. In all cases, the measure of success is result-based. Note as well, that all institute members gather once per year at the IEEC Forum, where the new strategic actions of IEEC are presented and feedback is received.

IEEC has open, transparent and accountable operations. The management structure makes sure that all employees and affiliates have and know the proper channels to transfer suggestions, criticisms or express interest in deeper institutional involvement. Transparency is guaranteed by publishing all relevant documentation on the web, while openness and accountability are granted by ensuring that the management team is responsive to any communication or request.

Personnel

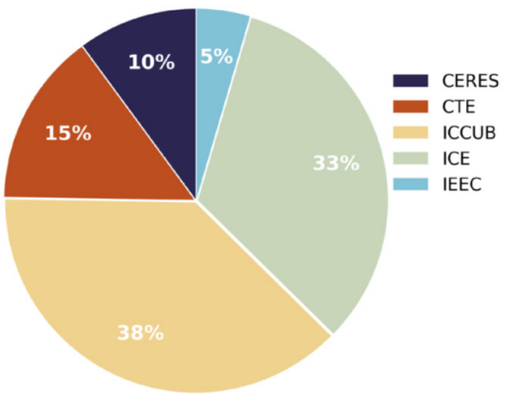
As of September 2019, the personnel of IEEC is composed of some 200 scientists and engineers, two thirds of which belong to the trustee institutions and therefore are affiliated, and one third have contracts with IEEC, mostly

through funds from the projects managed, although 10 of them are hired with funds from the contract program (structural). Out of the affiliated researchers, some 70 are faculty members (permanent staff) of the trustee institutions. The fact that senior scientific personnel is exclusively by affiliation obeys to a policy agreed by the governing bodies of IEEC. A total of 9 ICREA researchers are members of IEEC. The table and figures below show a breakdown of the personnel in different categories and contractual relationship with IEEC.

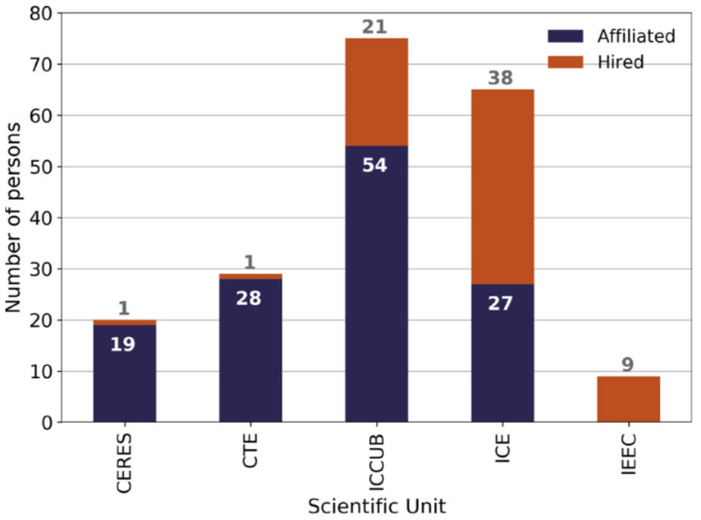
	TOTAL N. OF PERSONS			WOMEN	
	ALL	AFFILIATED	STAFF[1]	NUMBER	%
Faculty	68	66	2	13	19
Research Fellow	4	4	0	1	25
Postdoctoral Researcher	30	18	12	9	30
Staff Engineer	3	2	1	0	0
Research Engineer	35	14	21	0	0
PhD student	41	27	14	9	22
Total academic	**181**	**131**	**50**	**32**	**18**
Administration	5	0	5	4	80
Communication	1	0	1	1	100
Knowledge Transfer	4	0	4	0	0
Information Technologies	2	0	2	0	0
Facilities	3	0	3	0	0
Total non-academic	**15**	**0**	**15**	**5**	**33**
TOTAL	**196**	**131**	**65**	**37**	**19**

Note: The plots below correspond to data from 2018, while the table above is up-to-date (September 2019). Small variations can occur, but the overall distributions are unchanged.

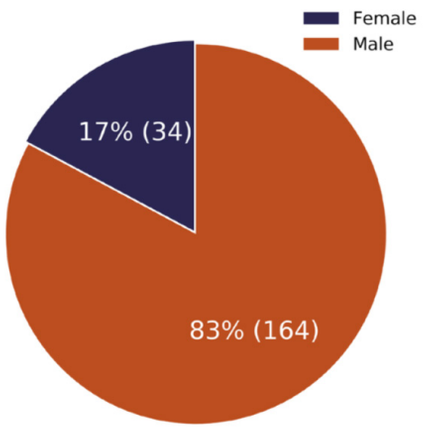
1. Directly hired by IEEC.



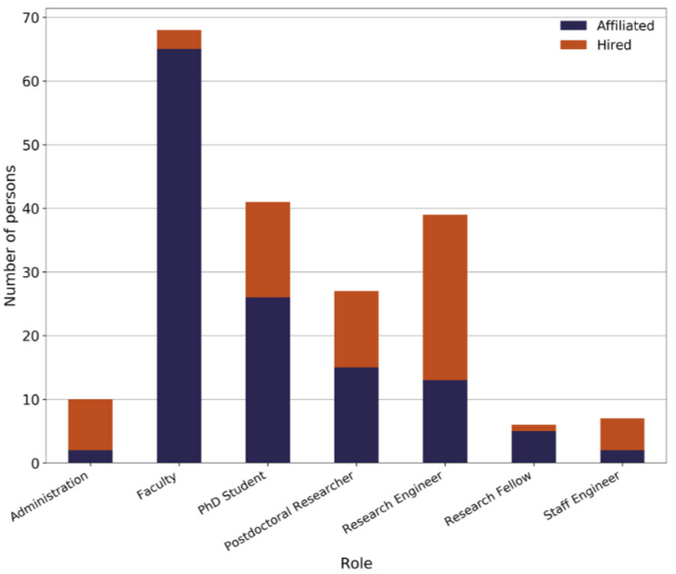
Personnel per scientific unit



Personnel per work situation and scientific unit



Personnel per gender

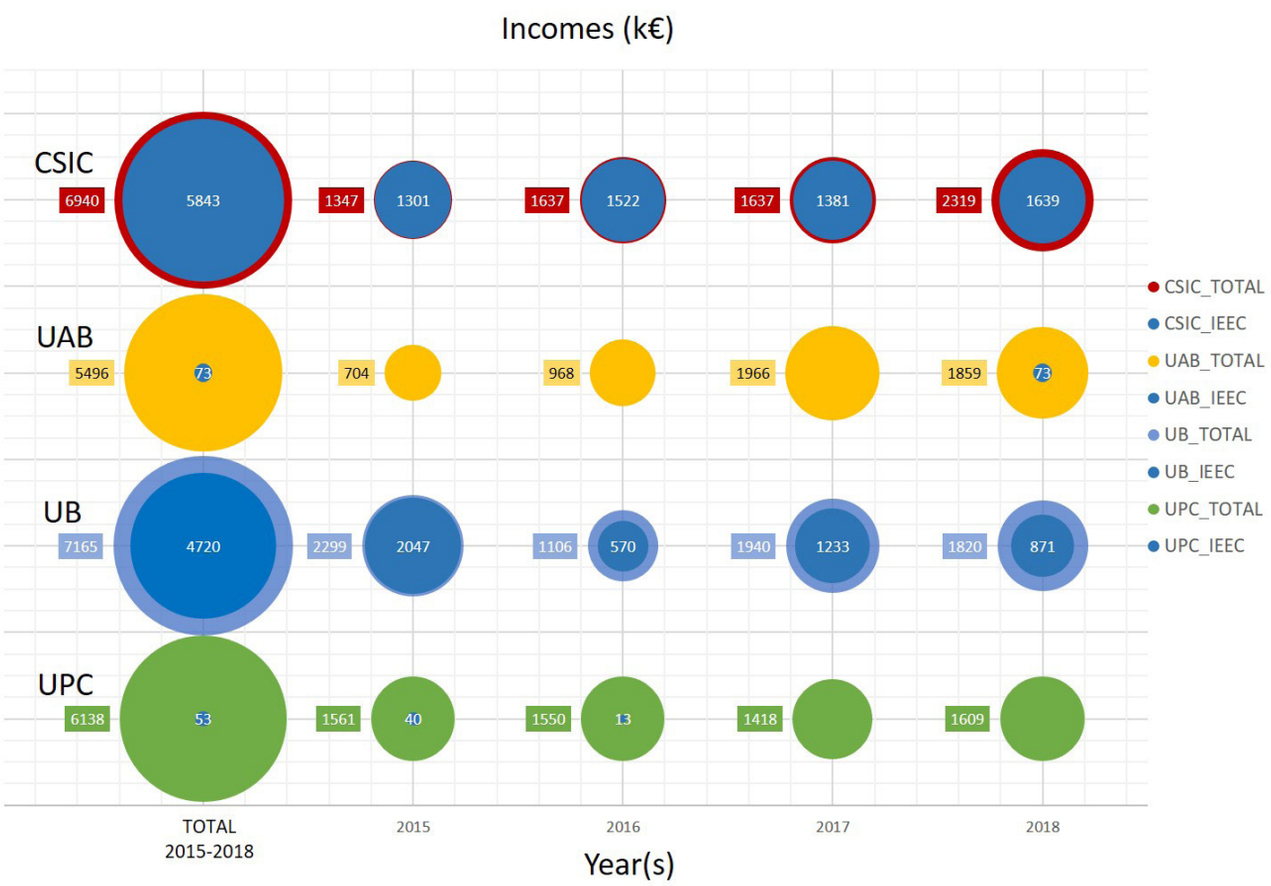


Personnel per work situation and role

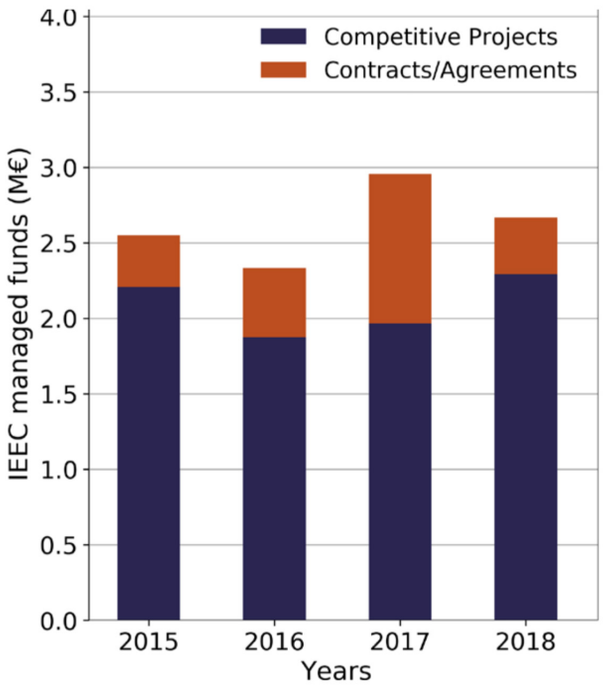
Income

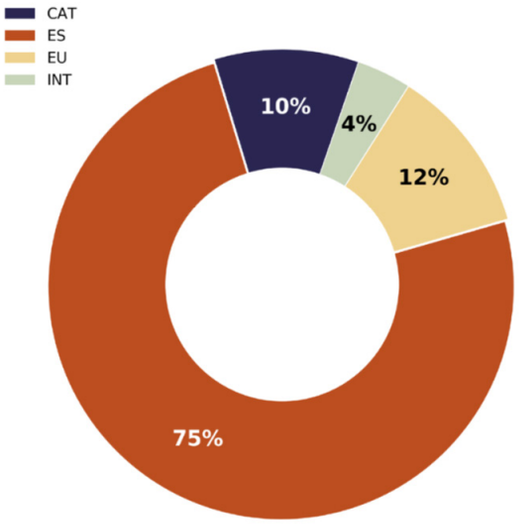
Research activities within IEEC are funded through competitive projects and industrial contracts. The total amount of resources collected by IEEC researchers was 7.7 M€ in 2018, of which IEEC directly managed a total of 2.7 M€ (including 0.35 M€ in industrial contracts). Researchers from IEEC have obtained a total of 6.95 M€ in projects of the H2020 program, of which 0.33 M€ has been managed directly by the IEEC. Furthermore, the total incomes from KTT contracts during the period 2015-2018 was 2.2 M€.

For the funds managed directly by IEEC, the plots below show the time-evolution of competitive projects and contracts from 2015 to 2018 and the relative fraction of those funds for 2018, considering different areas (Catalonia, Spain, EU and international). Further below are the main figures and plots showing the detailed break-down of funding received in 2018 through contracts and agreements (left) and competitive funding from projects with a distinction related to funding agency.



The diagrams show the funds collected by researchers from the different units of IEEC. The size of the full circle represents the total amount of funding while the inner circle has a relative surface proportional to the funds with PIs from the unit and managed via IEEC (the rest being managed by the respective mother institution). The labels indicate amounts in k€.

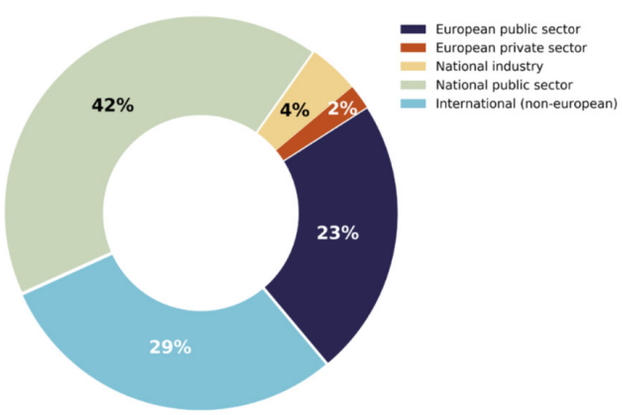




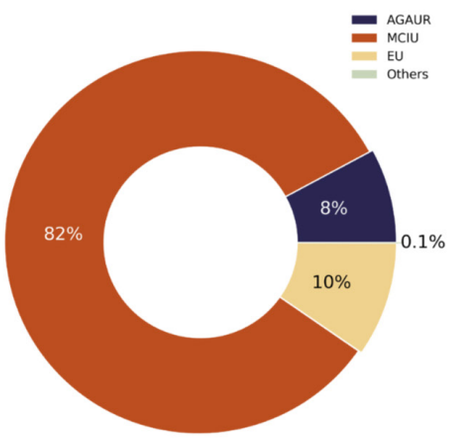
Incomes per geographical area

Contracts/Agreements	Incomes (k€)
European public sector	79.8
European private sector	7
National industry	14.5
National public sector	144.8
International (noneuropean)	102,3

Competitive Projects	Incomes (k€)
AGAUR	188.7
MCIU	1973.8
EU	229.2
Others	1.9



Incomes from contracts/agreements



Incomes from competitive projects

Budget

The base structural funding provided to IEEC by the Catalan Research Directorate is of 600 k€ per year. The competitive funding managed directly by IEEC is variable on a yearly basis, but, e.g., in 2018 this number was 2740 k€, including incomes from public calls and contracts with industry. Therefore, the relative contribution of competitive versus structural funding was 82%-18%. The two extrema during the last four years was 83%-17% in 2017 and 80%-20% in 2016.

It is worth noting that these calculations do not include the salaries and indirect costs from affiliated personnel, which (see below) amounts to an average of 70 researchers. Such salaries plus indirect costs can be estimated to be in the range of 5 M€ per year. But it should be also recalled that the total amount of competitive resources collected by IEEC researchers was 7.7 M€ in 2018. In a global, comprehensive view, taking into consideration the total structural funding (programme contract + in-kind from units) the ratio of competitive (7.7 M€) vs. structural (5.6 M€) funding would be 58%-42%.

Ordinary budget settlement

	OPERATIONS (k€)	RESEARCH (k€)	TOTAL (k€)
INCOME			
Structural funding (GenCat)	600.0	0.0	600.0
Competitive funding	0.0	2393.6	2393.6
Contracts or agreements	57.0	291.0	348.0
TOTAL INCOME	657.0	2684.6	3341.6
VARIABLE EXPENSES			
Consumables and external research supplies	0.0	851.2	851.2
Salaries: Scientific personnel in projects	0.0	1833.4	1833.4
FIXED EXPENSES			
Consumables and external supplies	59.6	0.0	59.6
Salaries: Structural scientific personnel	199.1	0.0	199.1
Salaries: Administration personnel	222.3	0.0	222.3
Professional services	160.0	0.0	160.0
TOTAL EXPENSES	641.1	2684.6	3325.7

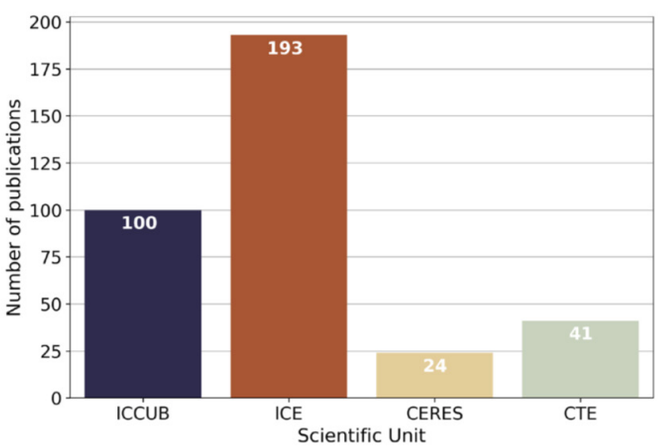
Scientific productivity

Scientific productivity in bibliometric terms shows for 2018 a total of 378 refereed publications, including three in each of the Nature and Science journals. In 30 of the publications there are authors from more than one IEEC unit. Over 85% of the publications have appeared in journals with the highest impact in their field (first quartile) and, very importantly, IEEC publications are cited up to four times more frequently than the average of the field, indicating a very high level of excellence. Most publications are associated with the area of astronomy and astrophysics, but there is also a high number of publications in other areas, especially engineering (electronics, aerospace) and geosciences (remote sensing, meteorology). Following open science policies, over 80% of IEEC publications have open access. The evolution of the productivity of the IEEC in terms of number of indexed publications (both absolute and per researcher) is growing, as shown in the following summary table.

TOTAL NUMBER OF PUBLICATIONS	TIME PERIOD			
	2015	2016	2017	2018
Total number of researchers (incl. engineers & students)	215	188	214	181[1]
Articles in peer reviewed journals (Source: Web of Science)	279	353	335	378
Number of articles per researcher	1.3	1.9	1.6	2.1
Total number of citations (Source: Web of Science)	10703	17227	11649	5426
Mean citations per article	38.3	48.8	34.8	14.4
Normalized impact factor[2]	2.4	4.1	4.3	–
% of articles in Q1 journals (Source: Web of Science)	85.3	85.5	86.6	85.7
Publications in non-indexed journals	88	126	81	99
Books	1	2	3	5
Technical notes	77	121	57	112

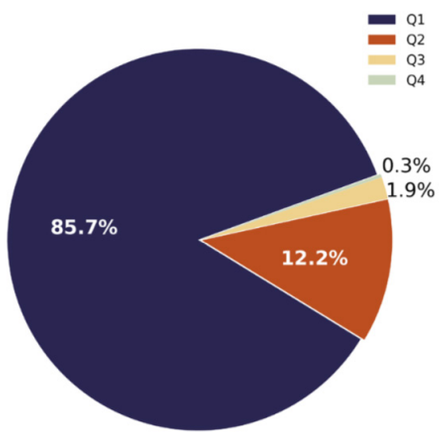
1. Note that, starting in 2018, all IEEC members had to fulfil a formal affiliation process. Prior to that, IEEC membership was loosely defined and a number of members did not use proper affiliations in publications.

2. This number is calculated as the ratio between the average number of citations per article of IEEC and the same average for the area (Astronomy & Astrophysics). Because of difficulty in accessing the latter figure, we have projected from available data from Oct 2018 assuming a constant temporal profile. No data are available for 2018 (too recent for reliable results).



Number of publications per scientific unit

The total number of publications include the 20 publications done by authors at Universitat de les Illes Balears (UIB).



Fraction of publications per journal quartile

Facilities

The IEEC manages the operations of the Astronomical Observatory of the Montsec (OAdM) and, in particular, of the 80-cm Joan Oró robotic telescope. The activities of the observatory include science observations (exoplanets, asteroids, variable stars, supernovae, etc.) and an ambitious satellite tracking program funded by the Spanish Centre for Industrial Technological Development (CDTI) through funding from the European framework program H2020. Recently VHF/UHF and S band antennas have been installed in the OAdM as an embryo of a future nanosatellite communications station. In addition, IEEC units manage other noteworthy infrastructures such as the NanoSat Lab at the UPC North Campus, the MELiSSA pilot plant (Micro-Ecological Life Support System Alternative) at the UAB campus, and several laboratories (physics, electronics, optics, radiation, integration, clean room), located both in the ICE building and in the facilities of the ICC at the UB Parc Científic.

Key projects

An important aspect of the activity of IEEC is the promotion and support of a group of projects classified as strategic. Currently, these key projects, all of them with the participation of staff from more than one unit, are: the LISA mission, the CTA project (Cherenkov Telescope Array), the ARIEL mission and the nanosatellite project.

Innovation

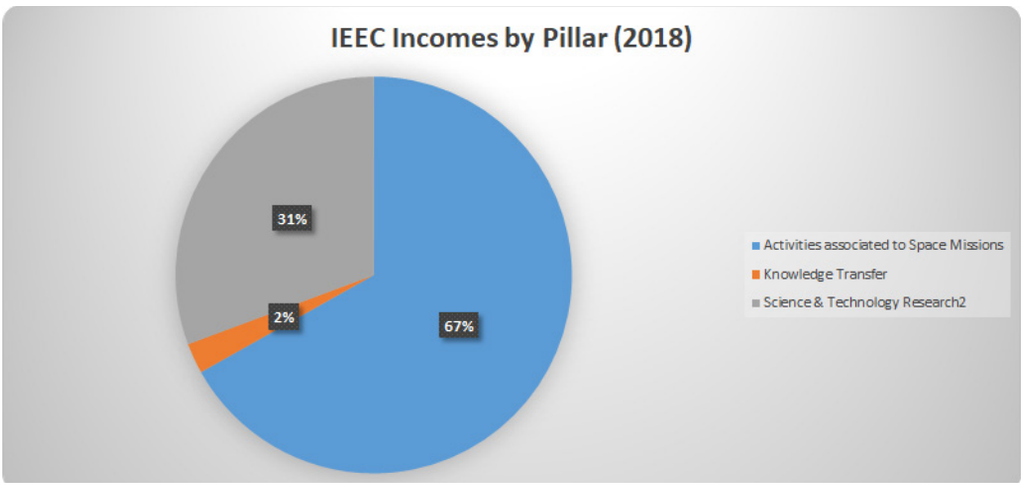
IEEC also carries out innovation and knowledge transfer activities and the results in different research areas have sparked interest of industrial, academic and government institutions around the world. Examples include the satellite tracking services at OAdM, the high-performance nanosatellite platform, the development of data compression standards and on-board data management, the solutions for high precision positioning in navigation systems, the launch of GNSS reflectometry missions for applications in ocean altimetry and Earth observation, or the development of astronomical instrumentation (electronics and mechanics). Knowledge transfer was made through direct contracts and agreements with industry, through direct contracts and agreements with agencies (ESA, GSA, EUMETSAT), government entities (China, Korea, etc.), academic institutions (Shanghai Spaceflight Institute of TT&C and Telecommunications, Tokyo University, University of Florida), and through European consortia within the framework of projects of the H2020 program.

Collaboration with space industry, especially the so-called Traditional Space and, to a lesser extent, with the New Space, has also been performed through industrial contracts funded by state-level projects (Spanish Plan Estatal de I+D+i) aimed at the construction of large scientific missions (e.g., LISA Pathfinder, Gaia, Solar Orbiter, etc.). This funding mechanism for industrial contributions is the usual for ESA missions. It requires the active participation and leadership of IEEC researchers and engineers in the definition and construction phase of the mission, in order to attain significant responsibilities and contributions for high visibility. The success of participation in those missions has a strong impact in the industrial network and allows the export of high value-added technologies. IEEC members have been particularly effective in this regard and currently lead the Spanish contribution in ESA missions such as LISA and ARIEL, and the Chinese mission participated by ESA, eXTP. Also, IEEC researchers led the development and exploitation of the instrument rohp-PAZ, aboard the Spanish PAZ satellite. This current success builds on a track record of top scientific excellence, on the technological expertise acquired over the past two decades and on the capability to manage large projects. This leadership places the IEEC among the top 5 Spanish centres with the greatest return from the ESA scientific program, along with the INTA-CAB, the IAC, the IFCA and the IAA-CSIC.

With regard to collaboration with the New Space industry, agreements have been established and technological development projects have been executed, especially in the field of Earth observation. IEEC has collaborated, for example, with companies such as Spire (UK), Tyvak (USA) and GomSpace (Denmark), and IEEC has ongoing missions for the launch of nanosatellites in the framework of technology demonstration programs of the ESA. Finally, it is worth highlighting the commitment to develop capacities of the ground segment or downstream, with a satellite communications station, and technologies for data compression, management, and processing for various applications.

Communication

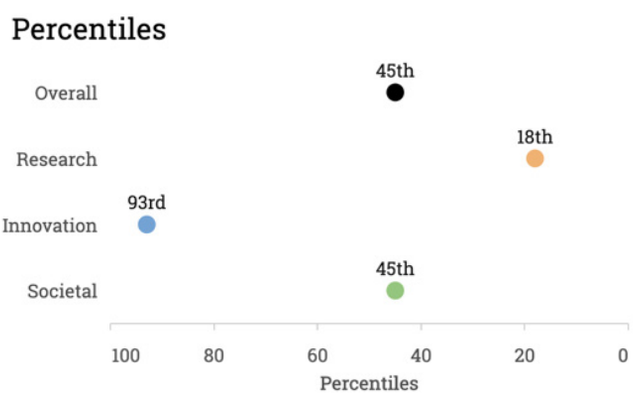
In the field of the dissemination of knowledge to the general public, IEEC promotes and participates in numerous activities, such as outreach talks, astronomical events, and media appearances. IEEC also maintains close collaboration with the main actors in the dissemination of science through the execution of joint projects, such as FCRi, CosmoCaixa, Network of Libraries, Barcelona City Council, astronomy clubs, festivals and various events, etc. Finally, IEEC has made a commitment to have a strong presence on the Internet (updating the brand image and the web in 2018) and social networks (Twitter - with 2000 followers -, Facebook, LinkedIn, etc.).



Ranking information

IEEC ranking information has been extracted from the SCIMAGO Institute Rankings:
https://www.scimagoir.com/methodology.php

Factor	Indicator	Weight
Research (50%)	Normalized Impact (NI)	13%
	Excellence with Leadership (EwL)	8%
	Output (O)	8%
	Scientific Leadership (L)	5%
	Not Own Journals (NotOJ)	3%
	Own Journals (OJ)	3%
	Excellence (Exc)	2%
	High Quality Publications (Q1)	2%
	International Collaboration (IC)	2%
	Open Access (OA)	2%
	Scientific Talent Pool (STP)	2%
Innovation (30%)	Innovative Knowledge (IK)	10%
	Patents (PT)	10%
	Technological Impact (TI)	10%
Societal (20%)	Altmetrics (AM)	10%
	Inbound Links (BN)	5%
	Web Size (WS)	5%



External analysis

Research

The IEEC research environment is confined in three well-differentiated frameworks: that of Catalonia, that of Spain and that of Europe.

Catalonia

Centres

In Catalonia, IEEC aims to bring together all the academic activities related to the use and exploration of space and at the same time act as the driving force of the sector in the industrial field. IEEC is one of the 39 CERCA centres and is partially funded by the General Directorate of Research, which allocates a contract program to cover structural expenses.

At present, most of the groups in universities and research centres in Catalonia that carry out activities in the field of space are members of the IEEC. However, not all of them are. Among non-affiliated researchers, we shall distinguish three cases: 1) members of the academic institutions of the IEEC Board of Trustees who know IEEC but prefer not to be affiliated with it due to various reasons; 2) members of the academic institutions of the IEEC Board of Trustees who do not know about IEEC or who have activities related to the space in a less direct way; and 3) members of academic institutions that do not belong to the IEEC Board of Trustees. Non-affiliates of type 1 carry out, primarily, scientific research (astrophysics, cosmology) with no involvement in instrumentation and feel that being members of IEEC does not represent a clear added value. Those of type 2 correspond to researchers with activity more focused on the technological aspects. For type 3 the information is still not systematized and is difficult to access. Other CERCA centres have activities related to space science and technology, such as the Institute of High Energy Physics (IFAE), with whom collaborations are routinely established. Also, some technological centres have a fraction of their activity, and therefore some research groups, in projects related to space. Examples are the Technological Centre of Telecommunications of Catalonia (CTTC) and the Barcelona Supercomputing Centre (BSC).

Therefore, although the IEEC is the reference institute at the Catalan level as it gathers most of the researchers in the area and that they are affiliated through its units, there are some research centres that have activity and interest in the area of space with which there could be synergies, the more relevant one being IFAE.

IFAE belongs to a similar area of knowledge. With 2018 data, it has 168 members (106 researchers, 52 technicians, 10 administrators) and a budget of 7 M€, of which 1.7 M€ corresponds to baseline funding and 5.3 M€ to competitive funding (which includes 0.75 M€ in form of contracts of transference). During 2018 IFAE published 235 refereed articles, 96% of which in first-quartile journals.

Funding

In the Catalan research ecosystem, two main factors must be considered, which are the funding from the Generalitat de Catalunya through AGAUR and the ICREA program. In Catalonia research in space is not a priority area and therefore does not have funding opportunities beyond the IEEC program contract itself and access to general calls. This includes the training programs of young researchers (industrial doctorates, recruiting new research staff, the Beatriu de Pinós program) and grants to research groups. In addition, the ICREA program, which aims to incorporate renowned researchers into the Catalan research system, is to be highlighted.

Spain

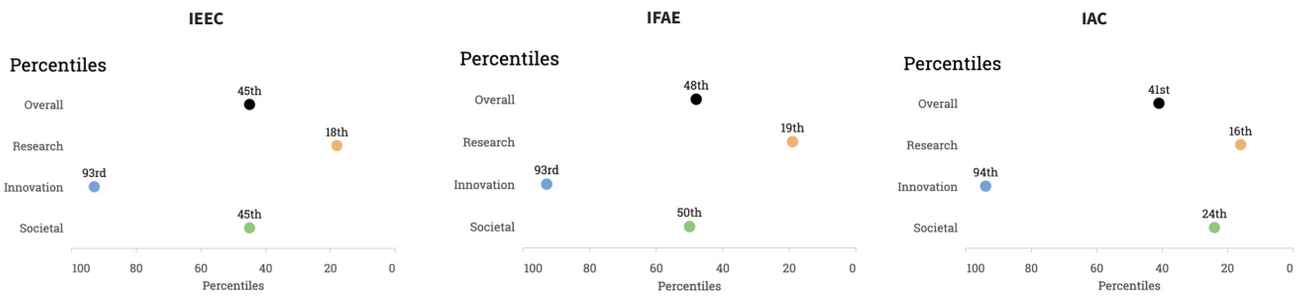
Centres

In the Spanish landscape, there are several research institutions that carry out activities in the field of space. On the one hand, it is necessary to point out some university departments. With regard to research in astrophysics and cosmology, those of the Complutense University of Madrid, the University of the Basque Country, the University of Valencia, the University of the Balearic Islands, the Autonomous University of Madrid, and the University of Granada stand out. There are also university departments with more focused groups in space technology research, which include the University of Vigo, the Polytechnic University of Madrid, the University of Cartagena, the University of Valladolid, the University of Alcalá de Henares, among others. Generally, these are departments of small or medium size that, by construction, are contextualized in higher education institutions. Regarding research institutes, in Spain we find the Institute of Astrophysics of the Canary Islands (IAC), the institutes of CSIC (IAA, IFF), the joint centres of CSIC with a university (IFCA, CAB, IFT, IFIC) and the CIEMAT. Also worth mentioning is the National Institute of Aerospace Technology (INTA) which is a Public Research Organization (OPI) that depends on the Ministry of Defence. Apart from carrying out scientific research and system development activities, it also provides services to companies and academic institutions.

The Instituto de Astrofísica de Canarias (IAC; https://www.iac.es/en) is the most similar to the IEEC, since it has a generic approach to space activities (scientific research and technology). It shall be noted, however, that the IAC acts as a manager of large

international infrastructures such as the Roque de los Muchachos Observatory (in La Palma) and the Observatorio del Teide (in Tenerife). With 2017 data, the IAC has a total of 427 people, half of whom are permanent and the other half contracted, and are distributed as 228 astrophysicists, 146 technicians and 53 administration staff. The annual funding of the IAC is 15 M€ of structural funds (10.5 M€ from the Spanish government and 4.5 M€ from the Canary Islands government) and 7.2 M€ in competitive projects. IAC has obtained a total of 11 M€ throughout the H2020 program, half of which correspond to ERC, and the other half basically to infrastructure calls and LEIT-Space. To these funds it is necessary to add those that are generated from contracts or agreements for the construction of infrastructures, whose amount is highly variable. Regarding the scientific productivity, the IAC generates about 600 refereed articles (data from 2017). The researchers of the IAC participate in a large number of large projects and space missions.

The IAC is approximately twice the size of IEEC and has the advantage of managing some large research infrastructures. However, all the (normalized) indicators, in terms of scientific productivity and competitive funding success, are very similar to IEEC's. The only relevant difference between IEEC and IAC is the amount of structural funding: 15 M€ vs. 0.6 M€ (factor of 25).



Funding

Funding of research and innovation in the Spanish environment is developed within the framework of the *Plan Estatal de Investigación Científica y Técnica y de Innovación 2017-2020*. Within this, the *Programa Estatal de Promoción del Talento y su Empleabilidad en I+D+i* includes calls for the training of junior researchers, both in the predoctoral stage (FPI, FPU), and postdoctoral stage at different levels of seniority (*Juan de la Cierva formación* and *incorporación*, *Ramón y Cajal*). Also, mention should be made of funding for the incorporation of young workers (*Garantía Juvenil*), *Personal Técnico de Apoyo* and the *Emplea* program. These subsidies to hire personnel are complemented by various calls to promote staff mobility. In addition, research grants are announced within the *Subprograma Estatal de Generación de Conocimiento*, which manages R&D projects, to which one must add those in the *Programa Estatal de I+D+i Orientado a los Retos de la Sociedad*. There are also calls for support to the institutes, such as *Severo Ochoa / María de Maeztu* and also support for research infrastructures, of which the most relevant within the framework of the IEEC is that of *Infraestructuras Científico-Técnicas Singulares* (ICTS), of potential interest to the OAdM. Support for research is complemented by the *Subprograma Estatal de I+D+i Empresarial* managed by the Centre for Industrial Technological Development (CDTI) and dedicated to the direct funding of R&D in the business environment, but with the possible participation of research institutions and infrastructures.

Europe and world

Centres

In the European and international arena, the institutions dedicated to the study and exploration of space are numerous. On the one hand, mention should be made of space agencies, such as the European Space Agency (ESA), NASA (USA), JAXA (Japan), Roscosmos (Russia), CNSA (China) or ISRO (India), as well as those from individual countries (CNRS-France, DLR-Germany, ASI-Italy, KARI-South Korea, UKSA-UK, etc.). These agencies have several scientific and technological centres (e.g., ESTEC, ESAC, ESRIN, in the case of ESA), and are typically focused on the construction and operation of space missions. Scientific research is also present, although at low priority.

Regarding research institutions, university departments and research institutes can be found, as well as the various interrelated variants. There are not many IEEC-like institutes in terms of structure. For example, the NASA Astrobiology Institute (https://nai.nasa.gov) is a distributed organization but is based on a multidisciplinary approach to a new line of research. There are also some thematic networks that go beyond pure networking activities, such as, for example, the UK-South East Physics Network (SEPNet - www.sepnet.ac.uk). The IEEC, research centre, it is more similar to classical institutes, although the comparisons are not immediate. A possible comparison is with centres present in countries of similar size in Catalonia and that group researchers in the space area. Countries such as Denmark or Austria are used frequently to make comparisons with Catalonia, due to their similar population (DK - 5.8 M, AT - 8.9 M, CAT - 7.6 M), although the GDP per capita are very different (DK - 60.7 k$, AT - 51.4 k$, CAT - 36.2 k$). In these two countries there are no institutes that gather all research interests in space, but there are those who do this partially, either in a university or in an academy of sciences.

The first case is that of DTU (Technical University of Denmark) Space (www.space.dtu.dk/english), which is presented as a National Space Institute. This university institute is made up of 165 people, including about 30 doctoral students, and annually publishes some 150 refereed articles. The total budget is 20 M€ per year, of which 8 M€ correspond to baseline funding and 12 M€ to competitive funding. Its position in SCIMAGO Institutions Rankings is unknown, since its production is integrated with that of the DTU. DTU Space is similar to IEEC in size, it has about half the productivity in terms of papers but it is highly successful in acquiring competitive funding. However, the origin of such funding (Denmark, EU) is unknown.

The Space Research Institute (Institute für Weltraum-forschung, IWF; www.iwf.oeaw.ac.at/en/home/) in Graz is an institute of the Austrian Academy of Sciences (Österreichische Akademie der Wissenschaften, ÖAW). It has a total of 100 members. During 2019 they published 190 articles in refereed journals. No economic information available. IWF addresses more specific space topics than IEEC, and not necessarily in the astrophysics context. IWF is about half the size of IEEC, its relative productivity is similar but its global positioning (SCIMAGO IR) is significantly lower.

Beyond this specific comparison, we can mention three examples of successful and internationally recognized centres: The Max Planck Institute for Astronomy (MPIA), the Netherlands Institute for Space Research (SRON) and the Harvard-Smithsonian Centre for Astrophysics (CfA).

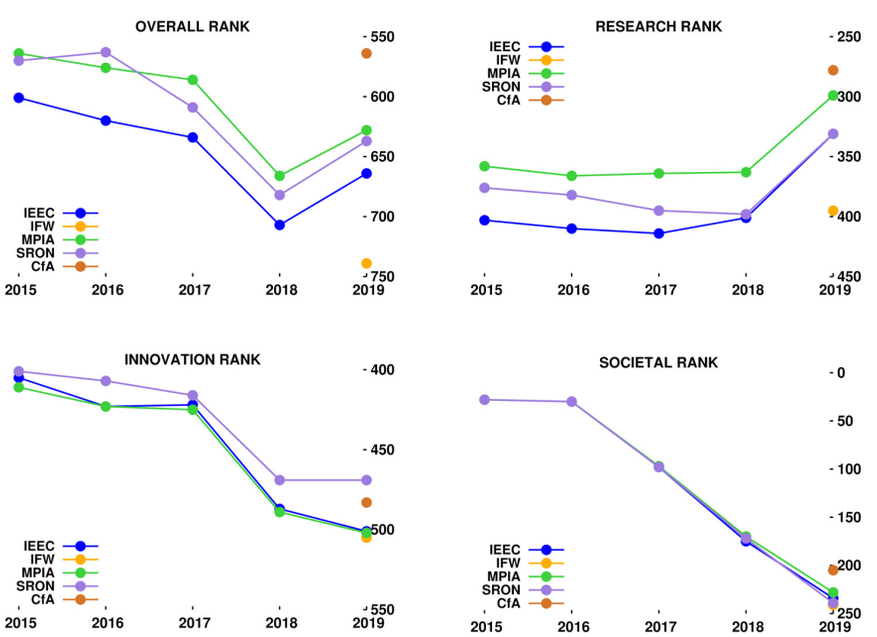
The MPIA (www.mpia.de/en) is an institute funded by the Max Planck Society (MPG) performing researching astronomy and is mainly involved in ground-based instrumentation but also in space missions. With data from 2017, the MPIA has 312 members, including 215 scientists, who have published a total of 314 refereed articles. No data on the operational budget or competitive projects are available. MPIA has similar scientific interests to IEEC but does not cover all aspects of space research (e.g., Earth observation). In terms of productivity, IEEC is superior in both the relative and absolute numbers. In terms of innovation, both IEEC and MPIA have similar rankings.

Regarding SRON (www.sron.nl), 2016 data indicate a total of 204 members (130 of whom were charged to baseline funding). It was funded with 15 M€ from the

Dutch Research Council and attracted a total of 5.1 M€ in competitive projects. No breakdown of H2020 projects is available. Its scientific productivity in the form of refereed articles was 155 publications. SRON's range of interests covers space activities quite broadly, similarly to IEEC. A comparison with IEEC shows a similar size and comparable success in obtaining competitive funding, a much lower productivity in papers, and higher rankings in innovation. The base funding multiplies by 25 that of IEEC.

The Harvard-Smithsonian CfA (https://www.cfa.harvard.edu/) has about 360 scientists and about 400 support personnel, and manages two facilities: The Fred Lawrence Whipple Observatory and the Submillimeter Array. CfA is involved in a large number of scientific research projects, as well as ground-based and space-based instrumentation. During the year 2018 CfA scientists published a total of 976 refereed articles. No economic data are available. The American system is very different but the overall scheme of IEEC and CfA are comparable. They both have affiliated personnel from other institutions (Harvard University and the Smithsonian Institution) but are gathered in the same working environment. CfA is exclusively focused on astrophysics while the range of interests of IEEC is broader. With a size that more than doubles IEEC's, the CfA is significantly more productive and its impact is higher. Also higher is the ranking of CfA in innovation.

The plots below summarize the ranking in the different indicators of the institutes mentioned above using data from the SCIMAGO Institutions Rankings:



Funding

At European level, funding is more abundant and the number and variety of calls related to space is relatively large. We are now at the point of transition from the H2020 program to the new Horizon Europe program, to which we will have to adapt and refocus as needed. In any case, many of the relevant calls for IEEC are expected to be preserved. In the science pillar, it is worth highlighting the training activities (such as Maria-Sklodowska Curie Actions in its different modalities: Individual fellowships, COFUND, ITN, RISE), calls for research infrastructures and the calls organized by the European Research Council (such as Starting Grants, Consolidator Grants, Advanced Grants, Synergy Grants, Proof of Concept). This is a highly valued funding mechanism not only because of the attractive financial resources but also because of the prestige associated with obtaining such projects. To these research funding opportunities, we must add programs in the framework of the global challenges and the industrial competitiveness, with announcements still in course of definition. Finally, the new Horizon Europe program puts special emphasis on innovation and creates the European Innovation Council. A significant increase in funding in this area is expected, that in the H2020 program was included in Leadership in Enabling & Industrial Technologies (LEITs), in which there was a section devoted to space, and within the different challenges of the society. In the case of H2020 space, the main focus was on the Copernicus program, the exploitation data from Earth observation and astrophysics space missions, and EGNSS applications. The total budget for the 2018-2020 period is 223 M€. In the new Horizon Europe program, the scope of space is explicitly included in the challenges of society, in the chapter of Digital and Industry, which has a total budget of 15,000 M€ for the whole period 2021-2027. The basic lines of space in Horizon Europe are: Galileo and EGNOS, Copernicus, Space Situational Awareness, Secure Satellite Communications, End-to-end Satellite Communications for citizens and businesses, Space ecosystem, and Space science.

Innovation

Industrial activity is intimately related to the technological and experimental research activity carried out at IEEC. In this sense, the industrial ecosystems at national and international levels connect with IEEC in several ways: a) in the pursuit of joint research and innovation projects; b) in the transfer of knowledge derived from the scientific work of IEEC, and that industry transfers to the market in the form of innovative industrial solutions; and c) in the subcontracting of engineering solutions that complement the activity of IEEC, but that are not part of its capacities or objectives.

The current and future situation of the space industry and its relation with the capacities of IEEC, therefore, affect the way in which IEEC contributes to generate knowledge and wealth.

Space industry in the world

The space industry in the world brings together a series of diverse sectors that are usually divided into two large groups: that dealing with the development of infrastructures and equipment, both in space and on Earth (upstream), and that referring to commercial activities based on data obtained from this infrastructure (downstream). According to the European Investment Bank, the global turnover of the sector has maintained an aggregate level of growth of 6.7% since 2005, compared to a rate of 3.5% for the whole world economy (and a significantly lower rate for Western economies). The 2040 growth forecasts made by Morgan Stanley and Merrill Lynch are cumulative growths of 5.1 and 7% respectively. According to PWC, the growth of the G-7 economies will be 1.6% and that of the world economy of 2.5%. There is no country in the world with sustained growth prospects having percentages as high as that of the space sector.

From another point of view, the space sector can be divided into two major groups: Traditional Space, which includes the institutional market (navigation, military applications, science, in-situ exploration of the universe) and commercial (communications satellites and rocket launchers); and New Space, which includes positioning, navigation, constellation of small satellites for earth observation, geoinformation, data services, Internet of Things, Internet for all, and elimination of space debris. Traditional Space is linked to large state budgets in areas such as defence, science and telecommunications. The New Space is born as an evolution that is greatly lowering the costs and with a notable reduction of risks facilitating the emergence of commercial applications that could not even be considered before. The fastest growing segments today are those related to New Space.

The technological trends that facilitate the appearance of the New Space are diverse: a) the acceleration in the generation of changes and obsolescence, as it has happened to the computer industry; b) the new manufacturing technologies (3D); c) the growing miniaturization of electronic components and sensors; d) artificial intelligence; e) the algorithms applied to image analysis, allowing to combine data from a multitude of small satellites operating in lower orbits; f) exponential growth of the data storage capacity; g) the manufacture of reusable launchers; h) the deployment of optical communications in space, which allow an activity growth impossible to achieve with radio frequency; i) the possibility of working at lower orbits, less problematic in terms of space contamination, which facilitate the use of conventional commercial components. All this has led to the fact that, from a business point of view, New Space: a) has greatly reduced the funding requirements; b) has shown many

more applications than traditional ones, including Business-to-Consumer applications; c) has shortened the maturity period of the investments; and d) has dramatically reduced the economic risk.

Most of the industrial New Space activity, 60% of the total, is being developed in the United States, except in the segment of launchers that has found its way to countries such as Russia, China or even India. The New Space can be considered as another part of the high-tech industry and not as "state industry" (at least in the European case). There are emerging non-traditional locations such as Argentina, Scotland, Silicon Valley, Uruguay, Sweden or others that benefit from environments that facilitate innovation and individual entrepreneurs with a vision that, due to the lower entry barriers, have the possibility to make projects come true. For the IEEC, this change of paradigm is an opportunity if Catalonia makes a move forward, because proximity to the industry is crucial for the New Space scheme to work.

Outlook

New Space activity is closely linked to small satellites. Most manufacturers and operators come from the United States (50%), Europe (25%) and Canada (10%) and focus fully on small platforms, without entering the world of large satellite infrastructures. In terms of applications, satellites dedicated to Earth observation dominate the landscape but predictions show that needs derived from machine-to-machine applications arising from Internet of Things will greatly increase. Examples of companies are positioning themselves in this field are Astrocast, Myriota, Fleet Space, Kepler Communications, Hiber, Helios Wire, Blink Astro (which belongs to Space Works, is presented as a company that wants to "deliver to a global network of connectivity for the IoT"), SAS (which also wants to be in the voice segment, not just data). One of the existing limitations is the launchers, but some already exist that can work from trailers of large trucks and experiencing with recoverable rockets has already begun, with the consequent reduction of cost per launch. In Catalonia, companies such as GTD (from drones), Zero2Infinity (from balloons) and Pangea Aerospace (recoverable and reusable rockets) are working on lowering the cost of launch services especially for small payloads.

The American consultant SpaceWorks elaborates a yearly report on the activity of the sector. The increase registered since 2013 of the activity of small satellites (<50 kg) is very remarkable. It is important to note that in 2011 the forecasts for the year 2020 were 100 launches, an amount already achieved in 2013.

YEAR	LAUNCHES	TOTAL 5 YEARS
2013	100	775
2014	150	
2015	125	
2016	100	
2017	300	
2018	263	1805
2019	310	
2020	361	
2021	411	
2022	460	

It is interesting to break down these satellite numbers as a function of the dedication to different market segments (military, civil – basically science and exploration of space –, and commercial) as can be seen in the following table:

YEAR RANGE	MILITARY	CIVIL	COMMERCIAL
2013-2017	31 (4%)	318 (41%)	426 (55%)
2018-2022	72 (4%)	379 (21%)	1354 (75%)

As can be seen, all segments grow in absolute numbers, but the commercial segment is by far the one with the most significant growth, doubling by itself the total number of satellites launched in the previous five-year period.

Finally, it should be noted that among the different applications (Earth observation, communications, science, technology, others), the ones that grow the most are those related to communications, although the majority of launches continue to be devoted to Earth observation.

Space industry in Spain

The space sector in Spain has been historically concentrated in Madrid because it depends almost exclusively on contracts with the State organizations, especially regarding defence, space exploration and telecommunications. Industry has developed in the Madrid area that, favoured by the system of national quotas existing in Europe, has had some relative success also outside Spain. The concentration in the Madrid area has been further favoured by the fact that companies in

the space sector have often performed activity in areas such as electronics, telecommunications, security, or large-scale engineering, which also cluster around the state capital city and largely come from privatizations of INI companies. In Seville there is an industrial cluster focused on aeronautics. The large public technological centre of the sector, the National Institute of Aerospace Technology (INTA), is also in Madrid and depends on the Ministry of Defence. In contrast to the Spanish model, in Germany, its space agency, the DRL has specialized offices in different cities around the country around which industrial and research clusters have been developed.

Space industry in Catalonia

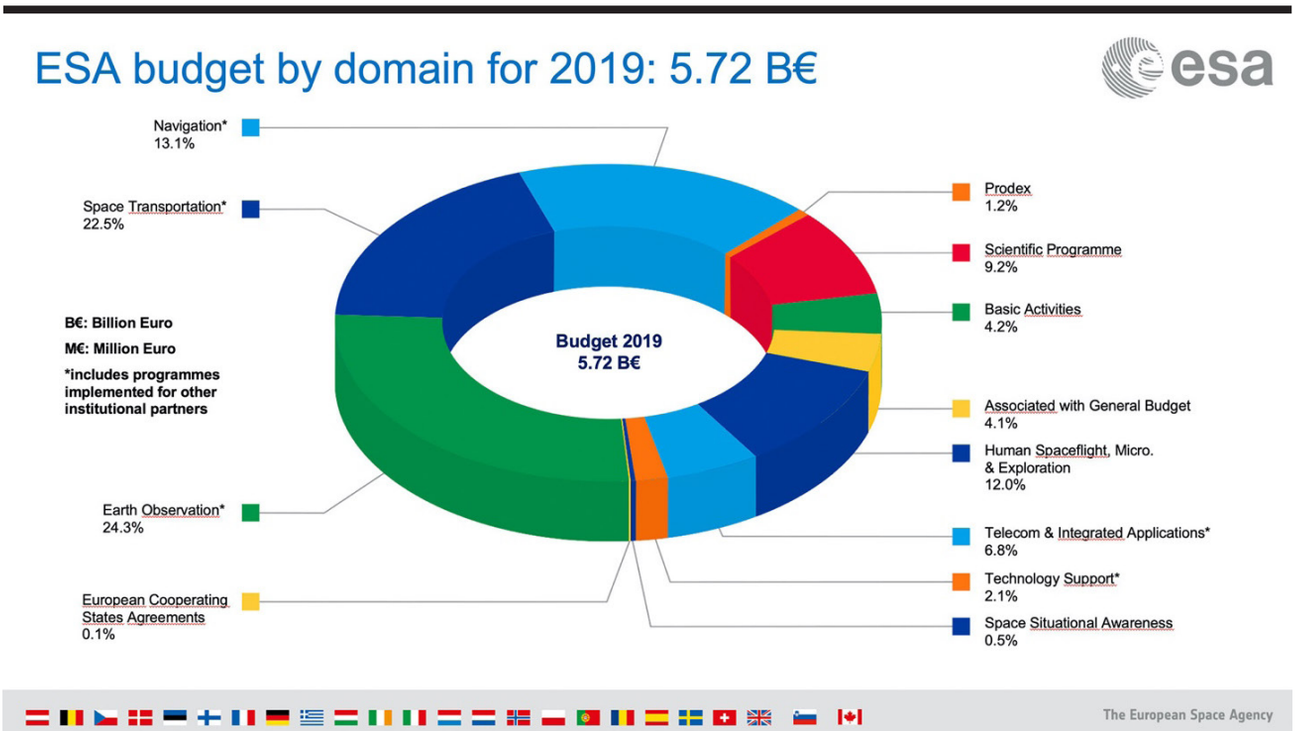
According to some data, the weight of the space industry in Barcelona can be between ten and twenty times smaller than in Madrid. But in the paradigm of the New Space, Barcelona has an opportunity, both in the construction of nanosatellites, smaller and less complex, as well as in data management and the provision of services. It can be the same as in other high-tech sectors: Barcelona attracts and has the right ecosystem (universities, research and technology centres, industry, financial centres) to get a very high yield from the growth of this sector. And, in parallel, this creates opportunities to return home for highly trained engineers in Catalonia that had to establish themselves abroad, conducting successful careers at the European Space Agency, Airbus, Thales-Alenia, NASA or other companies.

Besides IEEC itself, the existence of the research and technology centres of the field of engineering (ICFO, CIMNE, I2CAT, Eurecat, CTTC, IREC, IRTA), providing innovative solutions that the space sector can exploit by creating new commercial activities, contribute to the attractiveness of the Catalonia and Barcelona. On the contrary, it would not be realistic to say that Barcelona can attract the traditional industry of the sector with which, on the other hand, it maintains a complementarity of interests that allows for independent growth.

Relationship between IEEC and industry

The IEEC generates industrial activity in different fields, among those considered strategic for organizations such as ESA or the EU itself. The following figure shows the investment areas considered by ESA in its 2019 budget.

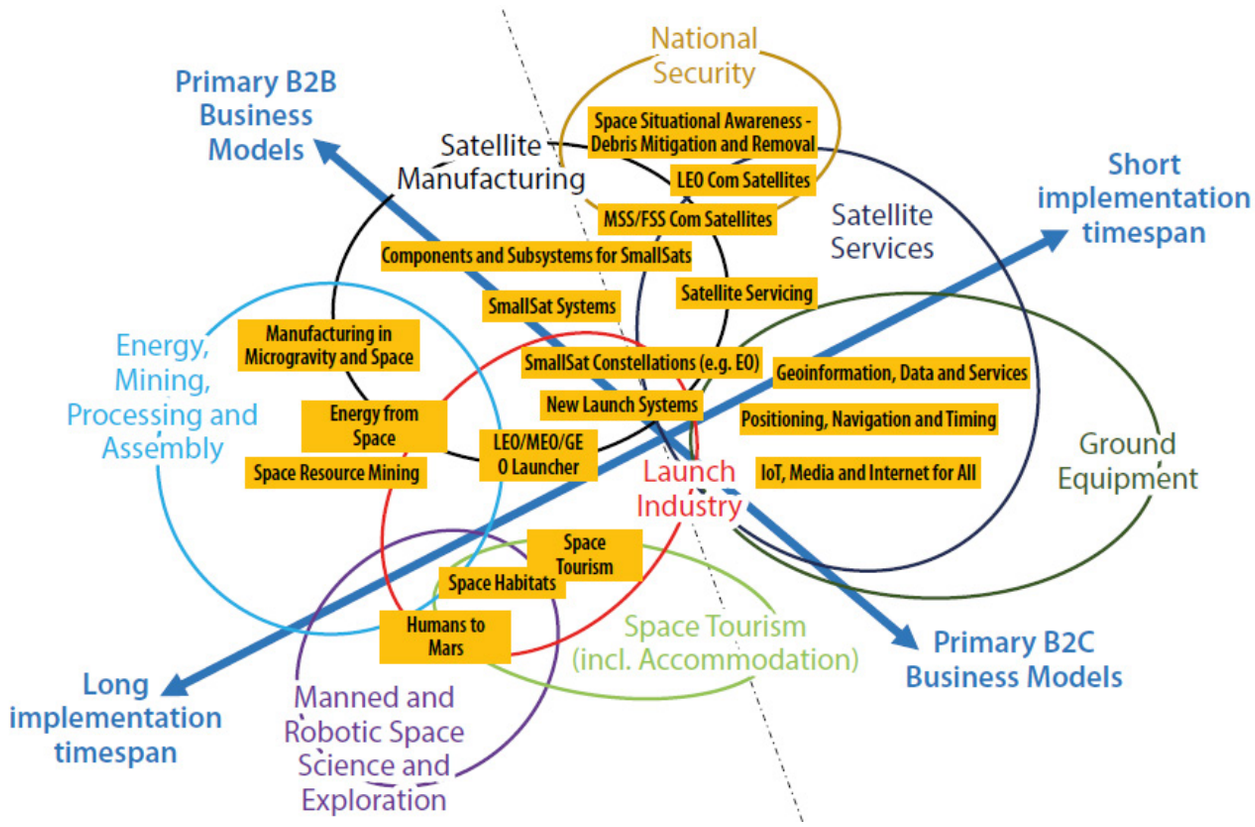
IEEC carries out activities in a large fraction of the programs considered by ESA. In particular: Navigation, Earth Observation, Space Situational Awareness, Human



Spaceflight, Moon & Exploration, Scientific Program. The same applies if we observe the industrial areas considered by the European Commission (EC) in the figure at the bottom, which presents a landscape of space business services, business models and segments (source EIB, The future of the European Space Sector, 2019).

In this sense, IEEC brings together knowledge in different strategic areas and in which funding is earmarked from European institutions. And it is one of the reasons that explains the good results with regard to indicators such as industrial contracts, and contracts with ESA and agencies such as GSA or EUMETSAT. IEEC has also played a leading role in missions of the scientific program, thanks to the impact of astrophysical research in different fields accompanied by the expertise in engineering and management. This diversity of activities aligned with European space programs has not translated into good results with regard to managed projects within the EU framework program (H2020). This can be explained by the insufficient support structure to promote the interests of the groups within the complex structure of the EC. Additionally, the disconnection of the different activities within IEEC makes it difficult to maintain a strong and consolidated position over time. This strength and competitive stability could be achieved if engineering know-how having more added value could be linked to an institutional structure that would support researchers. These two factors (the existence of corporate management and development structure and the existence of high value-added, stable engineering) is the one that is found in centres that are more successful in attracting funds from European programs, despite covering a more limited number of areas of knowledge.

With regard to the Traditional Space, IEEC can consolidate and improve its position by applying policies to promote the transfer and stabilization of knowledge. In this sector, it will continue to compete with the research centres most linked to political power and growth can occur in the medium term if the aforementioned structures are available. The most significant growth, however, can be experienced with the New Space. At the geopolitical level, IEEC is at the right place to be able to profit from the current growth of this sector. The areas of knowledge in which IEEC researchers have expertise, both upstream and downstream, as well as the university, industrial and research ecosystem in their environment represent an enormous opportunity for the next 5 years. Taking advantage will depend on having the management, innovation, transfer and engineering structures, and the necessary funding tools.



SWOT Analysis

STRENGTHS	
Scientific activity	Very high scientific productivity levels and very high impact of research results.
	The Montsec Astronomical Observatory (OAdM) is a world-class facility hosting several telescopes and instruments. The Joan Oró Telescope (TJO), operated by IEEC, is as a small-size fully robotic telescope that delivers data of high quality and produces valuable scientific results.
	IEEC is very well positioned in large international programs (space missions, ground-based instrumentation).
Organization & management	The management structure is agile and efficient.
	Because of its legal form, IEEC has contractual possibilities for long-term appointments.
Internal relations	Very multidisciplinary groups with complementary expertise that constitute the perfect combination to tackle new projects in a comprehensive way.
Knowledge transfer and innovation	A new specialized person was hired in 2018 to support KTT activities.
External communication	OAdM makes it possible to visualize the strength of space science research in Catalonia.
Funding	Certain aspects of the research activity of IEEC are very well aligned with H2020 (and Horizon Europe) challenges.
	The involvement in large projects and international space missions bound by multilateral agreements makes it possible to have access to funding.
Human resources	The human team of IEEC is extremely capable and productive.
	IEEC members constitute a very competitive and broad portfolio of expertise.
Environment	The OAdM is a facility with multiple purposes for external collaboration and with commercial interest, especially for satellite services (surveillance, tracking, communication).

WEAKNESSES	
Scientific activity	The three universities offer postgraduate training (Master courses) but there are overlaps and lack coordination.
	The success rate in H2020 Excellent Science pillar (ERC, MSCA, Research Infrastructures) could be improved.
	Although not a real weakness, there is still room for improvement in the percentage of publications with open access (currently ~80%).
Organization & management	Most senior members have a dual affiliation, which can lead to issues of synergy vs. competition.
	Certain limitations and undefinitions in the relationship models between IEEC and its units may hamper the participation of its researchers (visibility of the production, salary complements, assignment of space, overheads).
	There may be a shortage of administration resources if IEEC managed a larger volume of projects.
Internal relations	The sense of belonging to the IEEC group is highly variable and certain groups lack knowledge about the benefits provided by IEEC.
	The cross-knowledge of the groups in IEEC is suboptimal, which hampers the potential collaboration.
	There is a geographical dispersion of the units and the groups within those units, which limits casual encounters.
	No formal protocols for relationship exist beyond the Board of Directors meetings.
Knowledge transfer and innovation	The traditional space industry has a low relative weight in the Catalan landscape.
	There are no formal protocols for the relationship with the knowledge transfer structures of the units and Trustee institutions.
External communication	A shortage of resources prevents the consolidation of a proactive external communication action.
	There are no formal protocols for the relationship with the communication structures of the units and Trustee institutions.
Funding	The fraction of secured EU funding is relatively low (15%).
	The ratio of income through contracts with industry could be improved.
	There is an imbalance between structural and competitive funding: 18% – 82%. This makes it difficult to have permanent structure personnel that can keep the institute's know-how.
Human resources	The relative fraction of female to male researchers is far from equity.
	A well-defined technological career related to space does not exist.
Environment	There is a lack of relationship and mutual knowledge with the Catalan academic environment outside IEEC.

OPPORTUNITIES	
Scientific activity	The new Horizon Europe program is expected to offer new opportunities and focus shifts that should be exploited by IEEC.
	Although the usual involvement of IEEC in space missions has been through the European Space Agency (ESA), new agencies are developing ambitious space exploration programs and collaborations should be explored. In particular, the Chinese National Space Agency may offer interesting possibilities.
	New large projects and infrastructures are expected to appear at all levels (Catalan, European & World).
Organization & management	IEEC has plenty of room for improvement is providing support services for the units and in triggering synergies.
Internal relations	On certain occasions, internal funding resources can be available within IEEC to foster joint projects.
Knowledge transfer and innovation	The New Space sector is rapidly growing and opening new possibilities: nanosatellites, digitization, smart cities, Internet of Things.
External communication	The natural activity area of IEEC is very well received by the public and always sparks high media interest.
Funding	A Severo Ochoa award would boost internal funding considerably.
	The Catalan government has stated their interest to push innovation and technology transfer in the research system, which may lead to economic incentives.
Human resources	The missions in which IEEC participates are attractive to young and talented engineers.
	Barcelona is a very attractive city for young professionals, especially in the area of new technologies.
Environment	IEEC has a prominent presence in large projects (ground-based, ESA).
	There is a growing commercial interest in satellite services provided by observation and communication infrastructures
	Non-IEEC groups working in space activity in Barcelona (IFAE, CTTC, BSC...) are potential candidates to develop synergies.
	There is a growing demand of space talent by industry.

THREATS	
Scientific activity	The productivity could decrease to unforeseen external circumstances, diminishing one of IEEC's greatest assets.
Organization & management	Imbalance between success in attracting new projects and amount of administration personnel would diminish efficiency.
Internal relations	Loss of attractiveness of IEEC due to unforeseen circumstances.
Knowledge transfer and innovation	Growth limited by the relatively low structural funding.
External communication	Growth limited by the relatively low structural funding.
Funding	Depending on the (frequently changing) rules, justification of indirect costs (overheads) may be challenging as IEEC manages projects mainly from affiliated members in different locations.
	The attractiveness of IEEC is based on its flexibility and lightweight management structure. This could be threatened by an increase in bureaucratic load (e.g., by moving from private to public foundation).
Human resources	All senior scientific personnel are affiliated and defining a science policy is challenging, and also bound by the agreements with trustee institutions.
	Retaining know-how is complicated and the salaries are usually lower than in industry.
Environment	Public funding decrease
	Important context changes: natural disasters, pandemics, etc.

Resulting position

IEEC has a very high scientific productivity, with an impact well above average, that is recognized internationally as a top centre for space science. IEEC has demonstrated to be an efficient organization to coordinate and better exploit the research potential of its different units and to optimize their outputs through a collaborative and synergistic approach. It also benefits from the potential of Barcelona to attract international talent, both because of the attractiveness of the city and its ecosystem of science and innovation. IEEC has also a good track record of cooperation with industry, especially as a consequence of the participation in ESA missions and projects, which derive in contractual relationships.

On the other hand, the dispersion of efforts, both between the different units and within each one, as a result of their peculiar organizational structure, limit the possibilities and force an extra effort of cross-communication, the promotion of cooperation and the shared use of resources, both human and technological. With a wider scope, IEEC should also aim to create synergies with the different groups of other institutions from its nearby scientific environment working also in space science and technology. IEEC and its units should strive to increase in their structural funding, without which the necessary generational replacement may be compromised. Also, the amount of funding from international projects (most notably EU funded) should increase. Although the existence of the IEEC has minimised the impact, the constraining and limiting effects on scientific activity due to excessive centralization and bureaucratization should be reversed.

The organizational and physical dispersion of the different units and the lack of internal support structures make it difficult to maximize the outputs of the otherwise outstanding human team of IEEC. On the plus side, though, the organizational flexibility also allows for interesting degrees of freedom and innovative possibilities for collaboration. The relatively low level of baseline funding and the peculiarities and restrictions imposed by competitive research funding, represents a significant hurdle in establishing a solid engineering career. This is essential to complement basic research and keep the institute's know-how. This allows projects to be optimally carried out and fosters the transfer of technology to the private sector.

The extensive experience in space- and ground-based astronomical instrumentation of all units, the proven track record of the UPC in nanosatellites and its NanoSat laboratory in particular, the MELiSSA pilot plant at the UAB, the great potential in Astrophysics of the UB and ICE, the specialized laboratories of UB and ICE and the good positioning and participation in international projects represent very important assets in the medium- and long-term future that shall be promoted. Also, the opportunities that will appear in the New Space era are expected to be very important in the innovation arena and should be taken advantage of. The organizational culture of the IEEC and its units, and that of Barcelona's scientific ecosystem, match very well with the skills and attitudes that will be needed in this paradigm.

STRATEGIC DEVELOPMENT

Mission

The Institute of Space Studies of Catalonia (IEEC) is established to lead the development of activities related to space in Catalonia in its aspects of training, research, and innovation. The ultimate goal is to play a key role in the development, promotion, dissemination and transfer of knowledge of all kinds of activities, studies and projects related to space technology and scientific research from and of space, for the benefit of society.

Vision

The vision of IEEC is that of an international centre of reference in terms of the impact of its research, that visualizes and presents the aggregate view of the research sector in space in Catalonia, that optimizes the use of available human and material resources, that promotes the presence of Catalonia in large international missions and projects, that embraces transfer of knowledge in the form of innovation, and that acts as an agent to disseminate results to society.

Strategic goals and lines of action

Based on the positioning that results from the situation analysis, nine strategic objectives have been defined and, to carry them out, six general strategic lines have been formulated, thirty-seven strategic proposals and eighty-three specific action items.

Strategic objectives

The main strategic objectives for IEEC can be summarized in the following points:

1. **Consolidate and increase the very high productivity and impact** through maximizing the dissemination of research in top-quality specialized channels (following open science policies), studying possible productivity incentives, fostering the participation in large projects and collaborations, and making optimal use of the own infrastructures such as the Montsec Astronomical Observatory (OAdM).

2. **Build international prestige and keep the outstanding human team and expertise** by enhancing the visibility of IEEC to attract international talent at all levels, being involved in training activities at graduate and postgraduate levels, fostering the coordination of universities offering master's degrees in space science and technology, and facilitate attendance to courses and internships to IEEC members along the lines of lifelong learning.

3. **Bring IEEC together by eliminating internal barriers** through pushing trustee institutions to fully acknowledge the productivity of affiliated members, enhancing internal coordination and collaboration in transversal projects, structuring the access to common facilities (laboratories) for optimal use, improving internal communication (e.g., periodic meetings, newsletter), and acting as a catalyst to increase common external projection.

4. **Exploit EU funding** through identifying, encouraging and providing specialized support to H2020/Horizon Europe Pillars 1, 2, and 3 project applications, participating in large infrastructures, carrying out advocacy actions at EU level (e.g., leading COST actions), and strengthening collaborations with industrial partners to access funding from European agencies (ESA, Copernicus, EUMETSAT, GSA).

5. **Embrace all aspects of knowledge transfer** by organizing public dissemination activities and events addressed to all audiences (channelling some of them through OAdM), promoting outreach actions, collaborating with the media and other public dissemination actors.

6 **Boost innovation activities and exploitation of intellectual property** via compiling and updating a technical portfolio of expertise, valorising in-house technologies, identifying technologies and know-how susceptible of being transferred (whether or not protected with patents), and participating in the upcoming calls of the European Innovation Council.

7 **Consolidate expertise in space engineering** through defining and executing a career development path for engineers, highlighting the activities of the different units, attracting new groups working in space research and applications, and creating an engineering office providing expert support on systems engineering, electronics and low-level software.

8 **Play a key role as a reference for national and international industry** by being a reliable academic partner in joint innovation projects and proposals, becoming a customer for space missions developed by different actors (government, space agencies, private), and, in general, promoting the growth of the space sector in Catalonia.

9 **Lead the design, manufacture and launch of a full nanosatellite mission** with a case under study (astrophysics, e.g., UV; Earth observation, e.g., soil monitoring; communication, e.g., Internet of Things (IoT) testbed; technology, e.g., quantum cryptography demonstrator) applying technologies developed in house (power supply unit, onboard computer). This has a longer timescale and is conditional to securing sufficient funds together with other actors (administration, industry, research institutes). This objective also includes the expansion of the OAdM ground station.

And all these objectives will be approached by working under the principles of **Responsible Research and Innovation (RRI) regarding training, dissemination, transfer, ethics, gender equity, open innovation, open science, sustainable development, and governance aspects**.

Strategic lines of action

1 **Values: Work under the RRI principles.**
- a Training, dissemination and transfer.
- b Ethics.
- c Gender equality.
- d Open Innovation.
- e Open Science.
- f Sustainable development.
- g Governance.

2 **Science activity: Be a reference centre at national and international level.**
- a Increase success in awarded projects of Pillar I Excellent Science of H2020/Horizon Europe.
- b Maximize the dissemination of research results in specialized channels.
- c Increase the presence of Catalonia in large international projects.
- d Strengthen collaboration in postgraduate studies where units are involved to increase international projection, application rate and prestige.
- e Involved to enhance international impact and increase demand and prestige.
- f Fulfil open science directives.

3 **Human and material resources: Enhance the efficiency of available assets.**
- a Push transversal cooperation among research groups.
- b Optimize the use of laboratories.
- c Optimize the use of OAdM.
- d Promote the definition of a technical career in the space sector.

4 **Organization and management: Revamp internal organization.**
- a Increase IEEC's critical mass of IEEC to participate in large-size projects.
- b Value the institution to attract international scientists (ICREA, RyC, JdC, BdP).
- c To be present as IEEC in key places in the national and international space research scene.
- d Optimization of operations.
- e Redefine processes and relationships between IEEC and its units to optimize operations.
- f Increase the impact of IEEC communication.
- g Attain long-term stability of qualified engineering know-how fulfilling the needs of projects.

5 **Knowledge transfer: Boost transfer to the scientific, industrial and social environment.**
- a Promote participation in H2020-Horizon Europe projects in Pillar II (Clusters), structural funds and Strengthening the European Research Area program.
- b Promote participation in pillar III H2020-Horizon Europe projects.
- c Promote participation in projects funded by the European Space Agency (ESA), EUMETSAT, and GSA.
- d Promote the participation in the knowledge industry program and similar ones.

e Promote innovation activities with industry.
f Maximize industrial exploitation of infrastructures.
g Promote collaboration with other non-IEEC space research groups in Catalonia.
h Promote the growth of the industrial space sector in Catalonia.

6 **Funding: Improve the quality, quantity and nature.**
a Improve structural funding.
b Improve funding of infrastructures.
c Maintain or increase the funding managed by IEEC in competitive calls of Catalonia and Spain.
d Increase the percentage of funding from European projects (Horizon Europe, ESA, EUMETSAT, GSA).
e Increasing funding from innovation activities.
f Enhance visibility to attract patronage activities.

Strategic plan scenarios

The plan for the six strategic lines of action is presented in 37 strategic proposals, which are subsequently implemented in the form of 83 specific action items. An additional strategic flagship project is also presented and described. The plan assigns responsibilities and a timetable to each action item and considers the additional human resources necessary for each activity and the indicators to measure its evolution. We distinguish between two scenarios and one flagship project, each with different levels of resource allocations. The text below describes the goals that can be completed for each scenario depending on this resource (funding) allocation.

Scenario 1: Baseline with incremental transversal improvements

The first scenario does not require any increase in personnel or financial resources. The key elements are redistribution and optimization of the tasks and duties associated to hired personnel using structural funding and to enhance the commitment and involvement of the management structure, namely the Management Team and the Board of Directors. And the goal is to attain a better-connected structure that is stronger in the international landscape. Although quantification of the performance is not straightforward, Scenario 1 leads to the fulfilment of 80% of the proposed actions. Note, however, that such rate considers the number of action items but not the time, complexity or breadth of each of the actions, and therefore it represents just a crude estimate. The main strategic areas that Scenario 1 addresses are:

- *Horizon Europe*: The main goal is to increase success in the various calls expected from the EU Horizon Europe programme, as compared with IEEC's performance in Horizon 2020. This will be done via support of the Transfer office by identifying relevant announcements and disseminating them internally, paying special attention to infrastructure calls, Digital and Industry cluster, COST actions, projects close to the market, European Innovation Council (EIC) actions, etc. Also, an important goal is to attract funding from other European agencies such as ESA, EUMETSAT, GSA, etc.

- *Strengthen internal ties – Internal cohesion*: IEEC has to face two significant challenges in terms of building identity and cohesion: 1) A significant fraction of members (most notably senior scientists) belong to the trustee institutions and have affiliate status and, 2) IEEC researchers work in different physical locations. To help strengthen ties, a number of actions will be executed, including the continuation of the successful yearly Forum, the publication of a quarterly newsletter, and the promotion of joint transversal activities and projects. Also, new tools will be offered to all members regarding improved Information Technologies infrastructure and management tools. From the institutional point of view, an effort will be made to set clear internal rules and cross-recognition of inputs and outputs, to establish an efficient communication with trustee institutions (with emphasis on outreach and technology transfer), to define protocols for shared use of infrastructures and to minimize duplicity of resources, to improve formal internal organization (bye-laws, IPR documentation), and to propose a salary scale that should simplify exchange between projects and units. Finally, an action will be carried out to increase the rate of affiliation to IEEC of researchers in the area of space in the trustee institutions.

- *Innovation projects*: As pointed out by different reports and administrations, innovation activities will be key to the research system in the next decade. IEEC embraces this message and plans to enhance all activities related to transfer to industry, and eventually to market. The strategic plan proposes actions to push innovation projects at all levels (Europe – EIC, AGAUR – Llavor, Producte, Mercat, MCIN – RETOS-Colaboración), to establish

regular interactions with industry, to carry out multidisciplinary joint actions with agencies, research institutions and industry embracing a broad concept of space exploitation, and to develop products generating economic value. Also, a seed funding program will be devised to fund very early stages of innovation projects holding great future potential.

- *Promotion of space in Catalonia*: The space sector is changing rapidly and new opportunities are arising. The strategy proposed has the growth of space-related activities in Catalonia as a key objective. This should be accomplished by linking IEEC with other institutions in the Catalan landscape and by ensuring that IEEC acts as representative of the common interests of affiliated researchers and institutions in the interaction with various space actors. Furthermore, IEEC will promote the creation of an association (including administration, academia, industry) to foster the space sector in Catalonia and push initiatives in the framework of New Space. In parallel, actions to increase funding from various sources (OAdM as an ICTS, infrastructure calls, support to competitive project calls, contracts with industry, patronage) will be developed.

- *International role*: A prime positioning and visibility of IEEC in the international context is key to the future success of the institute. Because of this, actions are proposed to increase high-quality productivity, to promote participation in international strategic programs and large infrastructures, and to make of OAdM a world-class facility (via new equipment, high-efficiency, optimized operations).

- *Training plan*: Although IEEC is not an academic institution, it has a very direct relationship with training activities and different levels, and has three academic institutions in its Board of Trustees. A key action for the near future is to propose a coordination board for the Master's degrees offered by the academic institutions to enhance their visibility and attract international students. At the same time, IEEC will continue to provide the means for its researchers to host students in their BSc, MSc, and PhD Thesis projects, and to recruit junior engineers to continue their training careers.

- *Targeted communication*: Communication is a key aspect in the future of IEEC. Internal communication actions (Forum, newsletter, joint activities) have already been covered above. Regarding external communication, the proposed actions include devising and implementing a broad communication strategy. Key to this strategy will be to increase the dissemination of results and news coming from the OAdM.

- *Responsible Research and Innovation – RRI*: A number of actions will be aimed at enhancing IEEC's endorsement of RRI principles. These include carrying out initiatives for lifelong training of IEEC personnel, defining the key lines of transfer of knowledge (both to society and to industry), promoting open science policies, observing ethical values in human resources, nominating an ombudsperson to improve working environment quality, and implementing policies to increase openness and transparency. Also, and very importantly, IEEC will strive to follow the Sustainable Development Goals initiative defined by the United Nations, and, particularly, in what concerns climate action.

Scenario 2: Technology-empowering engineering unit and reaching out to the environment

This scenario increases the fulfilment rate of the strategic plan by an additional 20% (by number of actions), and completes 100% of the objectives. It is important to emphasize that Scenario 2 is not just an -incremental step with respect to Scenario 1 but it implies a big qualitative change. The additional manpower allows tackling new challenges and for IEEC to reach the next stage in its potential. The second scenario calls for an increase of 5 people in the departments of technology transfer, communication, Information and Communication Technologies, OAdM and the project office, and the creation of an engineering office with a total of 4 people with expertise in systems engineering, electronics and software. It represents an extra cost of € 410,000 a year. In addition, Scenario 2 includes actions aimed at increasing European programs, implementing full Open Science and Open Innovation policies, optimizing the internal use and the external exploitation of infrastructures, increasing the cooperation between researchers of the different units and with researchers of institutions not belonging to the IEEC, promoting a full-fledged technical career, and enhancing external communication. More specifically, the key concepts associated to Scenario 2 are:

- *Engineering support unit*: A significant fraction of the additional resources of Scenario 2 will be put in establishing a Space Engineering Support Team unit. Retaining know-how is key to any organization and IEEC (and other research institutes) is especially vulnerable in the case of preserving engineering capabilities. The creation of an engineering support unit can be used to stabilize valuable senior staff and become the valuable repository of IEEC technology expertise. This group of staff IEEC engineers should cover key areas to support projects, such as software, electronics and systems engineering, which are the most in-demand and most specialized profiles related to the activities that are usually performed at IEEC.

The expertise and know-how that are based on the heritage of space missions and large infrastructures are key to lead significant contributions and play relevant roles in new space missions. They are also critical to transfer to the market research and innovation technologies produced in-house. Therefore, this group should consolidate IEEC's position in the international context by promoting the use of IEEC technologies. Many researchers would benefit from this support, which would represent in many cases the necessary added-value to increase the mission return, as measured in terms of scientific production, funding raised from competitive calls and industrial contracts devoted to both technology transfer and subcontracted activities.

On the other hand, the identified profiles for this group are in demand by industry at a national and international level, and especially by industrial sectors that are hiring qualified personnel to work on complex and innovative solutions for new market uptakes. The regular transference of this personnel from IEEC to industry is assumed as a contribution to the engineering career for many students from Catalan universities, and it is also positive for the competitiveness of Catalan industry. However, the effort made by IEEC to replace such kind of personnel and the risk assumed to accomplish the institute commitments are too high if an instrument to regulate and control this situation is not put in place. Ultimately, a space engineering support unit is necessary to compete under better conditions and to obtain a better performance for the benefit of the institute and also for the benefit of the national industrial ecosystem. Therefore, it is very important for IEEC's present and future position that this unit is created and clear procedures are defined to maximize its impact in the institute indicators.

- *More critical mass*: The exploitation of space is touching upon a variety of new areas and this naturally expands the area of interest and influence of IEEC. As part of this plan, IEEC shall reach out to researchers in the Catalan ecosystem that do not belong to trustee institutions. This will be accomplished by creating a database and by establishing communication via ad-hoc meetings, workshops, etc.
- *Strategic communication*: The communication plan will be designed as part of Scenario 1, but full deployment will not be possible without the investment of additional resources. In this scenario, actions are proposed to realize the most ambitious activities that could be part of the communication plan (e.g., off-site activities, brochures, visual materials, etc.). In addition, an effort to make IEEC more visible as a potential host of science and engineering students for their training activities will be carried out.
- *Industrial exchange*: As part of the effort to push innovation, the plan calls for the implementation of an exchange program of engineers and technicians with local industry. Furthermore, and in line with RRI principles, an action is devised to study, promote and implement open innovation methodologies that will imply a fair return to society of those activities funded with taxpayer's money.
- *Enhance infrastructures*: This is a key aspect of Scenario 2. Various actions will be established aimed at gathering a census of expertise, creating a technology portfolio, and improving cross-knowledge of engineering expertise and facilities. In addition, providing manpower to support maintenance and use of common-interest facilities managed by the units (laboratories) is foreseen, together with executing initiatives to promote their industrial use, also including OAdM. In the particular case of the OAdM, resources shall be put to increase efficiency further and to develop more challenging instrumentation, potentially as testbed for larger international facilities devoted to astronomical research and as innovative assets for space satellite communications, tracking, hazardous object awareness, etc.
- *International leadership*: An additional push to increase IEEC's international leadership can result from the actions devised in Scenario 2. The proposal is to provide specialized support to high-profile European project applications (ERC, MSCA), in particular in what concerns technical aspects, making sure that all expertise and know-how from the broad IEEC environment is made visible. Also, services to researchers in the form of project management support and via offering publication and data repository services should help increase IEEC's visibility and excellence.

Flagship towards Space Horizon – a transversal initiative to mobilize all sectors

As a complement to Scenarios 1 and 2, we propose the implementation of a complete space mission roadmap to culminate with the launch and exploitation of a satellite.

The international space context is rapidly changing as shown by the recent reports elaborated by specialized space consultants and other key actors, most notably by the European Investment Bank (EIB) for the EU Commission. The New Space term is now consolidated and describes this new era of global innovation for the space sector. According to EIB[1]: "Global competition is increasing with new entrants bringing new ambitions in space and space activities are becoming increasingly

1 https://www.eib.org/en/publications/the-future-of-the-european-space-sector-report

commercial with greater private sector involvement. Major technological shifts, such as digitalisation, miniaturisation, artificial intelligence or reusable launcher, are disrupting traditional business models in the space sector, reducing the cost of accessing and using space." Ground stations for satellite communications are also changing and innovative grid operation models are used to provide data services covering the needs of the New Space strategy. Nanosatellites (with a range of sizes) have become the standard spacecraft model and are populating the low-orbit space. All these changes are bringing new opportunities for both scientific and industrial applications.

The Catalan space sector is very well positioned to benefit from the opportunities that this new era is offering: the academic institutions (both universities and research centres) are highly valued and ranked internationally; the industrial sector is composed of consolidated companies and disruptive start-ups; and the powerful Catalan ecosystem is also composed of innovative clusters (i.e., mobility and logistics, photonics and digital security, IoT, digital industry, energy) with strong synergies with potential applications of space technologies to new sectors. However, the success of a commercially-oriented space exploitation effort requires different strategies for leadership and competitive positioning in a global context.

The proposed flagship mission in this plan hinges on the recommendations given in the EIB report entitled *The future of the European space sector* and on the strategy already applied in countries or regions having a similar context as Catalonia (Scotland, Denmark, Austria, Canada, etc.), where governmental initiatives have been defined as a catalyst for the New Space sector to grow and take advantage of the new opportunities. The IEEC proposal would be beneficial to many sectors and would require the involvement from institutions that go beyond the natural area of IEEC's Trustees. A flagship mission would act as a tractor project combining all the capacities of the Catalan space sector, together with innovative technologies from actors in other fields. Government support is key for such a flagship mission to consolidate the existing industrial and academic ecosystem. Also, it would demonstrate the capacity to cover the full breadth from the mission construction to the exploitation of its products. The initiative has the ultimate goal of consolidating a Catalan strategy to become a key player in the New Space sector in the European and world context.

IEEC can implement such public initiative, as it holds all the ingredients to lead and execute a full space mission roadmap and to maximize the mission return both in the short and long terms. IEEC could design and execute the roadmap guaranteeing the quality and excellence of its implementation. This role can be assumed by IEEC based on several strengths:

- IEEC has extensive experience on space missions, with researchers and engineers from IEEC and the Trustee institutions having participated in all the construction and exploitation phases.

- IEEC is actively training students of different profiles (i.e., physicists, aeronautic engineers, mechanical engineers, telecommunication engineers, computer engineers) coming from the Catalan universities. Students would benefit from the experience that this mission could bring to their careers. Experience indicates that students from Catalan universities show professionalism, excellent performance, curiosity and passion for space exploration. Also, IEEC is well known as an excellent place to further specialize as part of their career path towards industry or academia.

- IEEC has the capability to involve industry by following the legal procedures to guarantee public concurrence and general interest and, at the same time, it can handle tendering procedures, and evaluate the technical proposals to select and audit the execution of industrial contracts.

- IEEC has among its fundamental principles the coordination with governmental guidelines and strategies and the involvement of civil society and media.

- IEEC is committed to follow RRI principles, which also include Sustainable Development Goals, illustrating how planet protection is a main driver for the institute activities.

All in all, this flagship project is fully aligned with IEEC's strategy and with all the objectives and the implementation actions considered in scenarios 1 and 2. Therefore, the flagship project would be complementary and compatible with scenarios 1 and 2, and would be an important catalyst to boost an even more ambitious completion of the objectives of the strategic plan.

It should be noted that the approach of a strategic project involving different areas of space activity to create added value (research + service) is not new in Catalonia. Some years ago, a project was developed jointly by the Institut Cartogràfic i Geològic de Catalunya (ICGC), IEEC and other organizations, and with the participation of local industry. The project, called HUMIT, was aimed at developing a nanosatellite with payload and software processing tools able to measure soil humidity at very high precision. The products would include a data base of humidity maps of Catalonia that would be used to manage wildfire prevention and extinguishing, and that would create expertise in the field that could potentially make Catalonia leader in Europe in such kind of applications. This project was finally not implemented due to financial reasons but, if revived, it should be redefined to the present situation. However, it is a good example of the kind of project proposed here.

The New Space paradigm for satellite construction and operation, the strong industrial and academic ecosystem in Catalonia, together with the consolidated position of IEEC, makes this flagship project achievable. And it will represent a significant and exciting step forward to make space reachable to the present and future generations for them to explore, exploit and live.

Implementation of the flagship mission

The roadmap should follow the standard phases (known as phases A/B/C/D/E/F), covering mission definition and selection, construction, launch and operation. IEEC would act as the agency to collect, evaluate and select the mission goals and it would also run the tendering procedures to allocate the resources to each specific task. IEEC can use the infrastructures at its disposal (i.e., laboratories for the construction and validation of space technology, and ground station at the Montsec Astronomical Observatory for satellite communications) and internal and external experts to execute this process by applying the quality and excellence standards of the space sector.

A 2-step process will be defined to ensure a successful completion of the mission:

Mission definition and selection (Phase A: Study phase)

The precise science objective and the technological and operational design of the proposed space mission would be selected following bottom-up approach, namely via an internal call for proposals and a competitive selection process. It is foreseen that a set of key topics will be initially defined to focus the call on areas of high impact and clearly aligned with those where the Catalan space sector is showing important expertise and strong competitiveness on both upstream and downstream solutions. Possible topics considered include: Earth observation, technology testing, IoT, astrophysics, and digital security (quantum cryptography). The mission will have to be framed in the New Space paradigm, benefiting from short development time scales, low orbit and reduced dimensions (nanosatellite-like) and cost. The use of existing Catalan assets and the industrial return will also be key ingredients in the mission definition and selection, especially on the use of highly innovative technologies from the space sector and from other innovation clusters. The latter should pave the way for future exploitation opportunities and open the door for knowledge transference agreements and joint initiatives between industry and research institutions. Finally, the expected mission execution constraints will be: a construction phase not lasting more than 2 years, a mission life-time of 2 years, and a total cost capped at ~2 M€.

The aforementioned criteria would be formally stated in a call for mission proposals that would be open to public-private partnerships. A panel composed by international experts (80%) and by IEEC selected members (20%) will be appointed to evaluate the proposals. The panel will select the two best projects based on: expected impact, transversal participation of different actors from industry to academia, associated innovation, mission feasibility and exploitation plan.

A public tender would follow to obtain the preliminary design for the selected projects. A complete analysis of the mission specifications, a preliminary design and an evaluation of all the technical challenges and risks would be requested, together with a final trade-off and a final recommendation for the mission selection. The studies shall be presented to the international panel and a final down selection will be done, as a final step before starting the construction phase of the mission adopted.

The main indicators for the study phase are:

- Cost: The cost for the execution is estimated in 400 k€, covering the activities for the preparation and execution of the call and the tendering process carried out by the IEEC (2 FTE with an equivalent cost of 100 k€), the panel contribution (100 k€) and the public tender (200 k€).
- Duration: The total expected duration is 12 months.
- Deliverables: The main deliverables would be the panel report with the proposals received and the analysis made for the initial selection, the tender report with the preliminary design and trade-off conclusions, and the panel final selection report.

Mission construction, launch and exploitation (Phases B, C, D, E)

The construction, launch and exploitation phases will be carried out with the support of several offices at IEEC (project office, engineering office, communication office and administration) with a sustained effort of ~2 FTE/yr until the end of the operations phase (with a global cost of 350 k€). They will prepare and execute three main calls for tender to allocate contracts with the following objectives: payload construction; spacecraft construction, satellite integration and launch; and satellite operations. The scope, duration, cost and expected outcome for the contracts are:

- Payload construction: construction, verification and test of the payload instrument hardware, and control and processing software. Budget: ~575 k€ (approximate since cost can vary significantly depending on the mission objective). The budget includes 1.5 FTE in manpower. Duration of the contract: 14 months. Deliverables: documents, engineering model, proto-flight and flight models.
- Spacecraft construction, satellite integration and launch: construction, verification and test of the

spacecraft, assembly, integration and validation of the satellite and provision of launch services. Budget: ~1.3 M€ (approximate, depending on mission payload). The budget includes 2 FTE in manpower. Duration: 18 months. Deliverables: documents, engineering, proto-flight and flight models.

- Satellite operations: satellite communications for mission control and data retrieval based on Ground Station services. Budget: ~375 k€ for the contract (an additional cost of ~100 k€ will be allocated to the service given by the ground station at the Montsec observatory). The budget includes 3.5 FTE in manpower. Duration: 24 months. Deliverables: documents and data products.

Finally, no specific budget will be allocated for the scientific/technical exploitation of the mission. Any research and/or industrial exploitation activity should be supported by industrial revenues or other means. This will be duly evaluated during the mission selection phase in order to guarantee the expected impact.

Performance indicators

It is important to highlight that the rewards coming from this flagship project extend far beyond the actual launch and operation of the mission. Of course, the mission success will be measured by the completion of the mission objectives, after the exploitation and de-orbiting phases. However, the impact will also be measured in terms of other indicators that reflect the new opportunities the mission will have generated:

- New capacities at academic and industrial levels.
- New public and private partnership agreements for the transference of innovative technologies.
- Participation in international consortia.
- Training of students and talent attraction measured by number of theses, training courses, and participation of national and international university students.
- Dissemination and outreach actions to the general public.

There will also be qualitative indicators to measure the increase of space sector prestige in society and the achievement of a successful interdisciplinary science mission. In addition, the impact of the mission is expected extend beyond IEEC, as this project fully involves all actors of the quadruple helix (universities and research centres, industry, government and civil society and the media), following the model used for the smart specialization strategy (RIS3) of the EU. Moreover, this flagship project will even go one step further and will adopt the quintuple helix model, as this roadmap will add sustainability and environmental preservation as the fifth helix.

Lines of action

For each of the six strategic lines of action, several sub objectives have been defined and, within each of these, several specific action items have been outlined.

Strategic Line 1: Values. Work under the RRI principles

1.1 Training, dissemination and transfer

- **1.1.1** Make training actions in the framework of lifelong learning available to IEEC personnel
- **1.1.2** Define the key lines of dissemination activities with social value
- **1.1.3** Define the key lines of activities of transfer to industry

1.2 Ethics

- **1.2.1** Define action protocols to be equal opportunity employer
- **1.2.2** Activities to maintain HRS4R seal
- **1.2.3** Define functions and nominate ombudsperson of IEEC (internal) and establish a coordination with CERCA's ombudsperson

1.3 Gender equality

- **1.3.1** Create and maintain favourable conditions for women, assuring the absence of any gender discrimination to fully exploit skilled human capital
- **1.3.2** Ensure that gender equity policies (SOC members, invited speakers, lecturers) are applied to meetings, workshops and schools organized by IEEC

1.4 Open innovation

- **1.4.1** Disseminate internally the procedures to implement open innovation methodologies in accordance with EU recommendations as provided in the new framework programme (Horizon Europe)

1.5 Open science

- **1.5.1** Internally disseminating procedures for publishing articles in open access, either by publishing open journals or by ensuring that authors place their publications in specialized repositories
- **1.5.2** Providing data repository services to researchers to follow open data policies. Coordination with the CERCA institution

1.6 Sustainable development

- **1.6.1** Provide IEEC researchers with the tools they need to minimize travel linked to their activity
- **1.6.2** Define measures to minimize the environmental impact of IEEC's infrastructures and technology developments
- **1.6.3** Promote the study of climate change

1.7 Governance

- **1.7.1** Implement policies to increase openness, transparency and accountability in the way that IEEC is organized and how future challenges are decided

Strategic Line 2: Scientific activity. Be an international centre of reference

2.1 Training, dissemination and transfer

- **2.1.1** Support ERC applications, or equivalent, by IEEC researchers, incorporating all capacities and assets
- **2.1.2** Promote Marie S. Curie European projects (Individual fellowships, COFUND, ITN, RISE)
- **2.1.3** Promote Research Infrastructures European projects
- **2.1.4** Analyse programmes in the new Horizon Europe, develop in-house newsletters and specifically train scientific and support staff

2.2 Maximize the dissemination of research results in specialized channels

- **2.2.1** Study possible internal incentives to productivity will be studied (awards, mentions, etc.)
- **2.2.2** Make recommendations to publish in high-impact journals (Q1) to maintain the current ratio
- **2.2.3** Disseminate OAdM's research results in specialized channels

2.3 Increase the presence of Catalonia in large international projects

- **2.3.1** Identify and promote the participation of researchers in strategic projects: space agencies (ESA, NASA, JAXA, CSA), large infrastructures (SKA, CTA, LSST, etc.)
- **2.3.2** Design and execute seed funding for projects of high potential at very early stages

2.4 Strengthen collaboration in postgraduate studies where units are involved to increase international projection, application rate and prestige

- **2.4.1** Create a coordination group with representatives from the different Master's degrees

2.5 Fulfil open science directives

- **2.5.1** Increase ratio of open-access articles

Strategic Line 3: Human and material resources. Enhance the efficiency of available assets

3.1 Push transversal cooperation among research groups

- **3.1.1** Promote the organization of meetings
- **3.1.2** Development a regular publication of a newsletter
- **3.1.3** Promote the affiliation to IEEC of all research groups in the area of space belonging to the units
- **3.1.4** Promote joint activities between researchers in different units
- **3.1.5** Acquire precise knowledge on engineering expertise to be shared between the units
- **3.1.6** Seek funding, either structural or otherwise, to foster transversal projects

3.8 Optimize the use of laboratories

- **3.8.1** Establish protocols of shared use with researchers from IEEC
- **3.8.2** Provide support resources for maintenance and use
- **3.8.3** Establish a coordination group to minimize duplicity of resources
- **3.8.4** Optimize use of OAdM
- **3.8.5** Promote the definition of a technical career in the space sector

3.9 Optimize use of OAdM

- **3.9.1** Maintain operations at OAdM
- **3.9.2** Maximize scientific outcome evaluating improvements and new equipment
- **3.9.3** Maximize the scientific return of TJO increasing the efficiency of operations

3.10 Promote the definition of a technical career in the space sector

- **3.10.1** Present IEEC as a hosting institute for external courses, and BSc, MSc and PhD Theses
- **3.10.2** Raise awareness among IEEC staff on the recruitment of junior engineers
- **3.10.3** Make available to IEEC technicians training activities in the context of lifelong learning
- **3.10.4** Promote stays and exchanges of IEEC technicians with local enterprises and industry

Strategic Line 4: Organization and management. Revamp internal organization

4.1 Increase IEEC's critical mass to participate in large-size projects

- **4.1.1** Make an inventory of the different groups working in space belonging to institutions outside IEEC
- **4.1.2** Formalization of the link between researchers from other institutions and IEEC

4.2 Value the institution to attract international scientists (ICREA, RyC, JdC, BdP)

- **4.2.1** Increase productivity and impact

4.3 To be present as IEEC in key places in the national and international space research scene

- **4.3.1** Make IEEC visible (participating in calls and meetings) to interact with the main players (CDTI, ACCIO, EU, ESA, ESO, etc.), so that it acts as a valid representative of the joint interests

4.4 Optimization of operations

- **4.4.1** Update and improvement of internal regulations (bye-laws)
- **4.4.2** Establishment of the policy of intellectual property management
- **4.4.3** Management and improvement of the IT infrastructure
- **4.4.4** Management and improvement in the project management procedures
- **4.4.5** Implementation and maintenance of management tools improving user interaction

4.5 Redefine processes and relationships between IEEC and the units to optimize operations

- **4.5.1** Clarification of economic relationships between IEEC and its units
- **4.5.2** Improving the visibility of the scientific production of researchers for the purpose of personal recognition and assignment of material resources by the units
- **4.5.3** Establish regular communications between IEEC and the communication offices of the institutions of the units
- **4.5.4** Establish regular communications between IEEC and the transfer offices of the institutions of the units

4.6 Increase the impact of IEEC communication

- **4.6.1** Definition of a communication plan
- **4.6.2** Execution of a communication plan
- **4.6.3** Carry out scientific communication: activities aimed at the general public, media
- **4.6.4** Carry out scientific communication from the OAdM: activities aimed at the general public, media

4.7 Attain long-term stability of qualified engineering know-how fulfilling the needs of projects

- **4.7.1** Create an engineering office with expertise in key areas (systems, electronics and software engineering) to support projects
- **4.7.2** Establish a salary scale that simplifies transfer of staff between projects and units

Strategic Line 5: Knowledge transfer. Boost transfer to the scientific, industrial, and social environment

5.1 Promote participation in European H2020-Horizon Europe projects in pillar II (Clusters), structural funds and the Strengthening the European Research Area program

- **5.1.1** Promote applications of the Digital and Industry cluster
- **5.1.2** Promote COST action applications
- **5.1.3** Identify and promote the participation of researchers in technological projects close to the market: EIT Urban Mobility, RIS3CAT Communities

5.2 Promote participation in pillar III H2020-Horizon Europe projects

- **5.2.1** Promote applications within the framework of the European Innovation Council (FET, CSA)

5.3 Promote participation in projects funded by the European Space Agency (ESA), EUMETSAT and GSA

- **5.3.1** Promote ITT applications for programs CTP, GSTP, ARTES, etc.

5.4 Promote participation in the knowledge industry program and similar ones

- **5.4.1** Promote the participation in projects for calls such as Llavor, Poducte, Mercat (AGAUR, CDTI), and RETOS-COLABORACION

5.5 Promote innovation activities with industry

- **5.5.1** Promote the regular interrelation between industry and research through formal and informal mechanisms, to disseminate the technology portfolio
- **5.5.2** Explore joint actions with other agencies (e.g., EAA, networks, ...)
- **5.5.3** Carry out activities to generate economic value (products delivered, patents, spin off)

5.6 Maximize industrial exploitation of infrastructures

- **5.6.1** Marketing of data provided by telescopes, satellite communication stations, etc., at the OAdM
- **5.6.2** Promote the industrial exploitation of laboratories

5.7 Promote collaboration with other non-IEEC space research groups in Catalonia

- **5.7.1** Define and execute collaboration formulas (face to face meetings, workshops, distribution of a newsletter, invitation to forums)

5.8 Promote the growth of an industrial sector in Catalonia

- **5.8.1** Promote the creation of a space interest association to seize the opportunities of New Space

Strategic Line 6: Funding. Improve the quality, quantity and nature

6.1 Improve structural funding

- **6.1.1** Analyze the feasibility for applying for the Severo Ochoa award
- **6.1.2** Maintain and consolidate a high standard of excellence to maximize public and private fundraising
- **6.1.3** Promote participation in programme Europa Redes y gestores

6.2 Improve funding of infrastructures

- **6.2.1** Explore possibilities for OAdM designation as an ICTS or similar
- **6.2.2** Respond to calls for structural funds for infrastructure and equipment

6.3 Maintain or increase funding managed by IEEC in competitive calls from Catalonia and Spain

- **6.3.1** Support project applications and provide project management help

6.4 Increase the percentage of funding from European projects (Horizon Europe, ESA, EUMETSAT, GSA)

- **6.4.1** Support project applications and provide project management help

6.5 Increase funding from innovation activities

- **6.5.1** Establish agreements and contracts with companies, especially those in the New Space sector

6.6 Enhance visibility to attract patronage activities

- **6.6.1** Promote the establishment of sponsorship agreements by companies and entities

Flagship transversal project: Lead and execute a full space mission

F.1 Define and execute a space mission to act as a tractor programme for the Catalan space sector and following the NewSpace paradigm

- **F.1.1** Space mission roadmap
- **F.1.2** Call for proposals and mission selection
- **F.1.3** Industrial tendering for spacecraft, launch and operations covering phases A/B/C/D/E/F
- **F.1.4** Industrial tendering for payload/s covering phases A/B/C/D/E/F
- **F.1.5** Execution of phase A (Feasibility)
- **F.1.6** Execution of phase B (Preliminary Definition)
- **F.1.7** Execution of phase C (Detailed Definition)
- **F.1.8** Execution of phase D (Qualification and Production)
- **F.1.9** Execution of phase E (Launch and Operations)
- **F.1.10** Execution of phase F (Disposal)
- **F.1.11** Mission evaluation

ACTION ITEMS FILE CARDS

The details of the plan are specified through a number of action items that are structured in the form of file cards. These cards also serve the purpose to provide the key performance indicators and the deliverables associated with the lines of action. Within each sub-objective, several action items are defined, each of them including a responsible person, a calendar, resources needed for each of the funding scenarios, indicators, and current and final values. The example below shows how to read the file cards and the actual file cards of all objectives and sub-objectives are provided next.

General title of the objective within the action line

Actual sub-objective to which the file card refers

Detailed explanation justifying sub-objective context and goals

LINE OF ACTION			
1. VALUES			
OBJECTIVE	**Work under the RRI principles**		
Sub-objective	**1.2. Ethics**		
Comments	IEEC has been promoting research integrity in all aspects of work related to our activity since the very beginning. IEEC has just adopted the CERCA Code of Conduct, as approved by its Board of Trustees in June 2019. Also, IEEC officially adhered to the principles of the Charter and Code of Human Resources Strategy for Researchers (HRS4R) and such status will be maintained over the next quinquennium. Attention to minorities and to the role of women in science and technology are key factors in maintaining equal-opportunity employer practices. To further emphasize this attitude, we plan to carry out a number of actions directed to all members. IEEC will promote the reconciliation of professional, private and family life of all employees, men and women, by allowing flexible working hours to suit the different life patterns, needs and interests of both female and male employees. Also, IEEC will nominate an "ombudsperson" that will supervise such policies and that will participate in the resolution of possible conflicts involving institute members or between institute members and its directorate. The ombudsperson will coordinate with the equivalent figure established by the CERCA institution.		
Ref.	1.2.1	1.2.2	1.2.3
Actions	Define action protocols to be equal opportunity employer	Activities to maintain HRS4R seal	Define functions and nominate ombudsperson of IEEC (internal) and establish a coordination with CERCA's ombudsperson
Responsible	Board of Directors	Board of Directors	Board of Directors
Calendar	2020	2020-2024	Q1-Q2 2020
Resources Sc 1	0.0	0.0	0.0
Resources Sc 2	0.0	0.0	0.0
Indicators	Document	Seal	Document
Current value	0	1	0
Final value	1	1	1

Person, team, or service responsible for carrying out the action

Deliverables and results to perform an objective assessment of the success of the action, with current and final expected values given

Resources needed in units of full-time equivalents (FTE) from hired personnel to complete the action, and broken down for each scenario (1&2)

Date or date range during which the action will be executed (Q=yearly quarter)

Specific actions, each withtitle and reference no.

LINE OF ACTION				
1. VALUES				
OBJECTIVE		**Work under the RRI principles**		
Sub-objective		**1.1. Training, dissemination and transfer**		
Comments		One of the highlights of IEEC's approach is the social value of its activities and the awareness that its main asset is its staff. Actions will be taken to involve staff in a continuing education scheme and also to ensure that dissemination and transfer is carried out responsibly.		
Ref.		1.1.1	1.1.2	1.1.3
Actions		Make training actions in the framework of lifelong learning available to IEEC personnel	Define the key lines of dissemination activities with social value	Define the key lines of activities of transfer to industry
Responsible		Management team	Management team	Management team
Calendar		2020-2024	2020	2020
Resources	**Sc 1**	0.0	0.0	0.0
	Sc 2	0.0	0.0	0.0
Indicators		Number of actions	Document	Document
Current value		1/yr	0	0
Final value		3/yr	1	1

LINE OF ACTION				
1. VALUES				
OBJECTIVE		**Work under the RRI principles**		
Sub-objective		**1.2. Ethics**		
Comments		IEEC has been promoting research integrity in all aspects of work related to our activity since the very beginning. IEEC has just adopted the CERCA Code of Conduct, as approved by its Board of Trustees in June 2019. Also, IEEC officially adhered to the principles of the Charter and Code of Human Resources Strategy for Researchers (HRS4R) and such status will be maintained over the next quinquennium. Attention to minorities and to the role of women in science and technology are key factors in maintaining equal-opportunity employer practices. To further emphasize this attitude, we plan to carry out a number of actions directed to all members. IEEC will promote the reconciliation of professional, private and family life of all employees, men and women, by allowing flexible working hours to suit the different life patterns, needs and interests of both female and male employees. Also, IEEC will nominate an "ombudsperson" that will supervise such policies and that will participate in the resolution of possible conflicts involving institute members or between institute members and its directorate. The ombudsperson will coordinate with the equivalent figure established by the CERCA institution.		
Ref.		1.2.1	1.2.2	1.2.3
Actions		Define action protocols to be equal opportunity employer	Activities to maintain HRS4R seal	Define functions and nominate ombudsperson of IEEC (internal) and establish a coordination with CERCA's ombudsperson
Responsible		Board of Directors	Board of Directors	Board of Directors
Calendar		2020	2020-2024	Q1-Q2 2020
Resources	**Sc 1**	0.0	0.0	0.0
	Sc 2	0.0	0.0	0.0
Indicators		Document	Seal	Document
Current value		0	1	0
Final value		1	1	1

LINE OF ACTION			
1. VALUES			
OBJECTIVE		**Work under the RRI principles**	
Sub-objective		**1.3. Gender equality**	
Comments		Equity between women and men is one of core values of society and is supported and encouraged by national and European legislation. Gender Equality continues to be one of the global priorities of UNESCO and the European Commission. The IEEC ombudsperson will oversee that all IEEC policies are free of gender discrimination and that they are gender balanced as much as possible. In terms of the employees, we are aiming at increasing the female/male ratio to 30/70. A more equal value does not realistic given the strong existing bias in the engineering profiles. In the particular cases of science meetings and activities, an overall 50/50 balance will be actively pursued.	
Ref.		1.3.1	1.3.2
Actions		Create and maintain favourable conditions for women, assuring the absence of any gender discrimination to fully exploit skilled human capital	Ensure that gender equity policies (SOC members, invited speakers, lecturers) are applied to meetings, workshops and schools organized by IEEC
Responsible		Ombudsperson	Ombudsperson
Calendar		Q3 2020-2024 (dep. 1.2.3)	Q3 2020-2024 (dep. 1.2.3)
Resources	**Sc 1**	0.0	0.0
	Sc 2	0.0	0.0
Indicators		Gender balance	Gender balance
Current value		17%-83%	Unknown
Final value		30%-70%	50%-50%

LINE OF ACTION		
1. VALUES		
OBJECTIVE		**Work under the RRI principles**
Sub-objective		**1.4. Open Innovation**
Comments		IEEC advocates for a collaborative approach in the technology R&D&I and promotes joint actions and interactions between research institutions, agencies and industrial actors. Therefore, we put emphasis on the collaborative dimension and co-creation to address new technological challenges and reach a high-level maturity of the implemented solutions for successful applicability in space missions or ground experiments. We prioritize the Open Innovation model and apply technology transfer policies that go beyond knowledge protection. However, we modulate the protection policies (patenting, defensive publication, open access) depending on the funding profile of the technological R&D activity and the relevance of the knowledge measured in terms of competitiveness for present and future opportunities. In particular, technical documents for ESA missions are usually confidential and are delivered to the mission partners and to the evaluating panels following the ESA protection rules.
Ref.		1.4.1
Actions		Disseminate internally the procedures to implement open innovation methodologies in accordance with EU recommendations as provided in the new framework programme (Horizon Europe).
Responsible		Transfer office
Calendar		2020
Resources	**Sc 1**	0.0
	Sc 2	0.1
Indicators		Document / info session
Current value		0
Final value		1

LINE OF ACTION			
1. VALUES			
OBJECTIVE		**Work under the RRI principles**	
Sub-objective		**1.5. Open Science**	
Comments		IEEC is strongly committed to open access policies so that publicly-funded research is made available to all the public. Most of the journals in which our community usually publishes (A&A, MNRAS, ApJ, ApJ, PRL, PRD, Remote Sensing, etc.) has a full (gold) open access policy. To alleviate the journal restrictions, we follow the procedure of posting all our research publications in public repositories following the so-called green open access policy. IEEC members will be urged to embrace this policy via some informative sessions and documents that will be distributed institute-wide. In addition, and following new EU directives, we will create local repositories for data (and publications if necessary) to ensure that relevant research data are preserved and openly accessible to other researchers and any interested actors.	
Ref.		1.5.1	1.5.2
Actions		Internally disseminating procedures for publishing articles in open access, either by publishing open journals or by ensuring that authors place their publications in specialized repositories	Providing data repository services to researchers to follow open data policies. Coordination with the CERCA institution
Responsible		Communication office	IT office
Calendar		2020	2020
Resources	**Sc 1**	0.0	0.0
	Sc 2	0.1	0.2
Indicators		Document / info session	Repository
Current value		0	0
Final value		1	1

LINE OF ACTION					
1. VALUES					
OBJECTIVE		**Work under the RRI principles**			
Sub-objective		**1.6. Sustainable development**			
Comments		Among the Sustainable Development Goals some link directly with IEEC and its members at different levels. Of course, we can positively contribute at least to Goal 4 (Quality Education), Goal 5 (Gender Equality), Goal 9 (Industry, Innovation, and Infrastructure), and Goal 12 (Responsible Consumption and Production). But Goal 13 (Climate Action) is more directly linked to the activity and interest of IEEC. Various actions will be taken to ensure that the ecological footprint of IEEC (and its members) is minimized, by encouraging sustainable transportation methods and offering tools to minimize travel. Also, IEEC infrastructures will make steps towards cleaner operations (reducing non-clean energy consumption) and self-sustainability. Furthermore, the research of IEEC of the Earth system, climate, and climate change will be encouraged and pushed forward with special interest.			
Ref.		1.6.1		1.6.2	1.6.3
Actions		Provide IEEC researchers with the tools they need to minimize travel linked to their activity		Define measures to minimize the environmental impact of IEEC's infrastructures and technology developments	Promote the study of climate change
Responsible		Management team		Management team	Management team
Calendar		2020-2021		2020-2021	2020-2024
Resources	**Sc 1**	0.0		0.0	0.0
	Sc 2	0.0		0.0	0.0
Indicators		Provided tools	Variation of IEEC's ecological footprint	Document	Scientific production
Current value		3 Zoom licenses + video-conferencing equipment	TBD	0	Unknown
Final value		Increase	Decrease	1	Increase

LINE OF ACTION		
1. VALUES		
OBJECTIVE		**Work under the RRI principles**
Sub-objective		**1.7. Governance**
Comments		IEEC will continue to aim at having open, transparent and accountable operations. The management structure will continue to be well defined and operational, and we will ensure that all employees and affiliates have and know the proper channels to transfer suggestions, criticisms or express interest in deeper institutional involvement. Transparency will be ensured by publishing all relevant documentation on the web, while openness and accountability will be emphasized by celebrating member forums once a year and by ensuring that the management team is responsive to any communication or request.
Ref.		1.7.1
Actions		Implement policies to increase openness, transparency and accountability in the way that IEEC is organized and how future challenges are decided
Responsible		Board of Directors
Calendar		2020-2024
Resources	**Sc 1**	0.0
	Sc 2	0.0
Indicators		Document / Information in web /Forum
Current value		0
Final value		1

LINE OF ACTION				
2. SCIENTIFIC ACTIVITY				
OBJECTIVE	**Be a reference centre at national and international level**			
Sub-objective	**2.1. Increase success rate in awarded projects of Pillar I Excellent Science of H2020/Horizon Europe programmes**			
Comments	As mentioned in the SWOT analysis, the relatively low percentage of funding received from H2020 European projects is a weakness of IEEC. To increase this success rate, a collection of measures will be implemented to explicitly support Pillar I applications. These are essentially scientific proposals where the role of the group (and PI in some cases) is the deciding factor. The Transfer office will support ERC and MSCA applications by preparing realistic budgets and, in particular, advising on the technical aspects if existing. This includes necessary hardware and software developments, and the motivation is to provide more solid grounds to the application by including IEEC's expertise and technical capabilities. In the case of infrastructure calls, the implication may be potentially stronger because the relative weight of engineering-related aspects is greater. It is also worth noting that in 2020 the H2020 program will finalize and the Horizon Europe program (2021-2027) will begin. As the specific information on the call is received, the Transfer office will analyse and present it to the IEEC groups, in particular looking for new opportunities.			
Ref.	2.1.1	2.1.2	2.1.3	2.1.4
Actions	Support ERC applications, or equivalent, by IEEC researchers, incorporating all capacities and assets	Promote Marie S. Curie European projects (Individual fellowships, COFUND, ITN, RISE)	Promote Research Infrastructures European projects	Analyse programs in the new Horizon Europe, develop in-house newsletters and specifically train scientific and support staff
Responsible	Transfer office	Transfer office	Transfer office	Transfer office
Calendar	2020-2024	2020-2024	2020-2024	2020-2024
Resources **Sc 1**	0.0	0.0	0.1	0.1
Sc 2	0.2	0.1	0.1	0.1
Indicators	Number of applications that receive support	Number of awarded fellowships	Participation in project applications	Document / info session
Current value	0	1.5/yr	0	0
Final value	2/yr	2/yr	2 (5 yr)	1

LINE OF ACTION				
2. SCIENTIFIC ACTIVITY				
OBJECTIVE		**Be a reference centre at national and international level**		
Sub-objective		**2.2. Maximize the dissemination of research results in specialized channels**		
Comments		The high scientific productivity of IEEC and the high impact of its results is one of the greatest strengths. The actions are aimed at maintaining and increasing, if possible, the international positioning in this regard. In particular, potential economic incentives or in-kind productivity incentives will be studied. Informative actions will also be taken to increase the fraction of articles and results published in first quartile journals of the corresponding research area, to achieve at least 85% of each year's production. Aiming at a higher value is not realistic since in the context of space missions, technical publications often appear in more specialized (and lower impact factor) journals. Finally, in the specific case of the OAdM, the international dissemination of its research results (through articles or professional congresses) will be pushed.		
Ref.		2.2.1	2.2.2	2.2.3
Actions		Study possible internal incentives to productivity will be studied (awards, mentions, etc.)	Make recommendations to publish in high-impact journals (Q1) to maintain the current ratio	Disseminate OAdM's research results in specialized channels
Responsible		Management team	Management team	Director OAdM
Calendar		2020	2020	2020-2024
Resources	**Sc 1**	0.0	0.0	0.0
	Sc 2	0.0	0.0	0.0
Indicators		N/A	% of Q1 publications	Meetings and publications
Current value			85%	10/yr
Final value			85%	20/yr

LINE OF ACTION			
2. SCIENTIFIC ACTIVITY			
OBJECTIVE		**Be a reference centre at national and international level**	
Sub-objective		**2.3. Increase the presence of Catalonia in large international projects**	
Comments		IEEC is currently involved in a number of large ground instrumentation projects (including some of the most ambitious future infrastructures) and also in space missions from various agencies (ESA, NASA, CNSA, etc.). It is necessary to continue and increase the presence in projects that will dominate large science of the next decade and to play an increasingly relevant role, pushing the visibility. Full leadership is unlikely given the funding scenario in the IEEC context (Spain and Catalonia), but efforts should be directed to make participation as relevant as possible. It is also possible that projects are identified in a very nascent state but with strong potential. An example is possible space missions related to quantum cryptography. In these cases, a seed funding programme will be established that will allow the initial studies to be carried out until a solid enough case is developed and that they are self-financed. Structural resources will not be allocated for this action, but remnants and overheads of other projects will be used where possible.	
Ref.		2.3.1	2.3.2
Actions		Identify and promote the participation of researchers in strategic projects: space agencies (ESA, NASA, JAXA, CSA), large infrastructures (SKA, CTA, LSST, etc.)	Design and execute seed funding for projects of high potential at very early stages
Responsible		Transfer office	Management team
Calendar		2020-2024	2020-2024
Resources	**Sc 1**	0.1	0.0
	Sc 2	0.1	0.0
Indicators		Number of large projects with participation	Funding programme
Current value		17	0
Final value		20	1

LINE OF ACTION		
2. SCIENTIFIC ACTIVITY		
OBJECTIVE		**Be a reference centre at national and international level**
Sub-objective		**2.4. Strengthen collaboration in postgraduate studies where units are involved to increase international projection, application rate and prestige**
Comments		Several postgraduate (Masters) degrees are currently offered in the IEEC institutional environment. While these are courses that have a sufficient number of students to be viable, there are times when they get dangerously close to the minimum threshold. Some overlaps and many potential synergies have been identified. The IEEC will promote the creation of a coordinating body so that these synergies can be exploited, overlaps are minimized and joint actions are established for collective benefit.
Ref.		2.4.1
Actions		Create a coordination group with representatives from the different Master's degrees
Responsible		Board of Directors
Calendar		2020
Resources	**Sc 1**	0.0
	Sc 2	0.0
Indicators		Coordination group
Current value		0
Final value		1

LINE OF ACTION		
2. SCIENTIFIC ACTIVITY		
OBJECTIVE		**Be a reference centre at national and international level**
Sub-objective		**2.5. Fulfil open science directives**
Comments		As a result of active open science policies, it is expected to move from the current 80% of free access articles to 90%. Most of them are not published in gold open access journals, because they are not widely recognized in the area, but IEEC members will be encouraged to make all their articles available via green open access repositories.
Ref.		2.5.1
Actions		Increase ratio of open-access articles
Responsible		Management team
Calendar		2020-2024
Resources	**Sc 1**	0.0
	Sc 2	0.0
Indicators		% of open-access articles
Current value		80%
Final value		90%

LINE OF ACTION							
3. HUMAN AND MATERIAL RESOURCES							
OBJECTIVE	**Enhance the efficiency of available assets**						
Sub-objective	**3.1. Push transversal cooperation among research groups**						
Comments	Interrelation between members, particularly those working in different units, is one of the key factors to enhance the capabilities of IEEC. A series of actions will be taken to make IEEC gather the maximum number of researchers in the area of space from its trustee institutions and at the same time to increase internal communication, through meetings, a newsletter, etc. Collaborative projects between researchers and groups from different units will also be promoted, and funding will be actively sought to support these activities. Finally, another essential point will be to obtain accurate and detailed information on the capabilities and expertise of the different IEEC groups in order to compose a technological portfolio to be used for projects and transfer activities.						
Ref.	3.1.1	3.1.2	3.1.3	3.1.4	3.1.5		3.1.6
Actions	Promote the organization of meetings for members at large and for group leaders	Development a regular publication of quarterly a newsletter	Promote the affiliation to IEEC of all research groups in the area of space belonging to the units	Promote joint activities between researchers in different units	Acquire precise knowledge on engineering expertise to be shared between the units		Seek funding, either structural or otherwise, to foster transversal projects
Responsible	Management team	Communica-tion office	Board of Directors	Management team	Transfer office		Director
Calendar	2020-2024	2020-2024	2020	2020-2024	2020-2021		2020-2024
Resources **Sc 1**	0.0	0.2	0.0	0.0	0.0		0.0
Sc 2	0.0	0.2	0.0	0.0	0.1		0.0
Indicators	Forum & meetings	Document	Percentage of affiliated faculty members	Number of joint activities	Census of capac-ities and personnel	Techno-logy portfolio	
Current value	1/yr	0	85%	40/yr	0	0	
Final value	1/yr + 1/yr	4/yr	95%	50/yr	1	1	

LINE OF ACTION			
3. HUMAN AND MATERIAL RESOURCES			
OBJECTIVE	**Enhance the efficiency of available assets**		
Sub-objective	**3.2. Optimize the use of laboratories**		
Comments	The IEEC units, with the support of the IEEC, have been able to develop a set of infrastructures of great importance to the activities of the space sector. Currently there is no coordination between these facilities so that the access protocols for IEEC researchers are not enhanced and there is also the possibility of unnecessary overlaps and overheads for using external facilities despite having -Available within the IEEC. Work will be done to coordinate these infrastructures and to establish the access method for IEEC users who do not belong to the same group or unit. In addition, the IEEC will act to provide active support to these facilities by providing a transversal laboratory technician.		
Ref.	3.2.1	3.2.2	3.2.3
Actions	Establish protocols of shared use with researchers from IEEC	Provide support resources for maintenance and use	Establish a coordination group to minimize duplicity of resources
Responsible	Management team	Management team	Board of Directors
Calendar	2020	2020-2024	2020
Resources **Sc 1**	0.0	0.0	0.0
Resources **Sc 2**	0.0	1.0	0.0
Indicators	Document	Personnel	Coordination group
Current value	2020	0	0
Final value	1	1	1

LINE OF ACTION			
3. HUMAN AND MATERIAL RESOURCES			
OBJECTIVE	**Enhance the efficiency of available assets**		
Sub-objective	**3.3. Optimize use of OAdM**		
Comments	The OAdM is the largest infrastructure managed by the IEEC and is therefore its main asset, but it is also an extraordinary platform for technical innovations and transfer activities. The plan is to maintain the high quality of the OAdM operations but at the same time to explore new instrumentation and improvements in order to increase its international competitiveness. In the particular case of the TJO, which is the direct responsibility of the IEEC, developments will be studied and implemented to increase efficiency and minimize useless time, reaching a duty cycle of 85%, which is at the level (and above) that of the best telescopes in the world.		
Ref.	3.3.1	3.3.2	3.3.3
Actions	Maintain operations at OAdM	Maximize scientific outcome evaluating improvements and new equipment	Maximize the scientific return of TJO increasing the efficiency of operations
Responsible	Director OAdM	Director OAdM	Director OAdM
Calendar	2020-2024	2020-2024	2020-2024
Resources **Sc 1**	3.0	0.2	0.3
Sc 2	3.0	0.8	0.5
Indicators	Annual report	New instrumental projects	Duty cycle
Current value	1	0.5/yr	81.2%
Final value	1	1/yr	85%

LINE OF ACTION					
3. HUMAN AND MATERIAL RESOURCES					
OBJECTIVE		**Enhance the efficiency of available assets**			
Sub-objective		**3.4. Promote the definition of a technical career in the space sector**			
Comments		The technical career in space in the academic environment is poorly defined. Young students often face difficulty deciding the next steps in their training and specialization. IEEC, as a directly involved actor, will be proactive in contacting the departments teaching undergraduate and postgraduate degrees to offer internship, undergraduate, master's and doctoral degree projects, also considering the possibilities offered by industrial doctorates. Awareness-raising activities will also be carried out for our staff to propose projects along these lines. For technicians already hired at IEEC, training actions will be promoted allowing them to expand their knowledge in new technologies and also enhance exchanges and stays with industry.			
Ref.		3.4.1	3.4.2	3.4.3	3.4.4
Actions		Present IEEC as a hosting institute for external courses, and BSc, MSc and PhD Theses	Raise awareness among IEEC staff on the recruitment of junior engineers	Make available to IEEC technicians training activities in the context of lifelong learning	Promote stays and exchanges of IEEC technicians with local enterprises and industry
Responsible		Communication office	Management team	Management team	Transfer office
Calendar		2020-2024	2020-2024	2020-2024	2020-2024
Resources	**Sc 1**	0.0	0.0	0.0	0.0
	Sc 2	0.1	0.0	0.0	0.1
Indicators		Introduce information in webpage	Proposed projects	Number of actions	Number of exchanges
Current value		0	Unknown	1/yr	0
Final value		1	Increase	2/yr	2

LINE OF ACTION			
4. ORGANIZATION AND MANAGEMENT			
OBJECTIVE		**Revamp internal organization**	
Sub-objective		**4.1. Increase IEEC's critical mass to participate in large-size projects**	
Comments		The concept of making the IEEC bring together the interests of researchers in Catalonia in space extends beyond the standard institutions. An inventory will be made of these groups and a figure will formally articulate which will allow those who wish to have a status of IEEC members.	
Ref.		4.1.1	4.1.2
Actions		Make an inventory of the different groups working in space belonging to institutions outside IEEC	Formalization of the link between researchers from other institutions and IEEC
Responsible		Transfer office	Director
Calendar		2020-2021	2020
Resources	**Sc 1**	0.0	0.0
	Sc 2	0.1	0.0
Indicators		Database	Document
Current value		0	0
Final value		1	1

LINE OF ACTION		
4. ORGANIZATION AND MANAGEMENT		
OBJECTIVE		**Revamp internal organization**
Sub-objective		**4.2. Value the institution to attract international scientists (ICREA, RyC, JdC, BdP)**
Comments		IEEC should have high visibility to attract international talent in a way that complements the activities carried out by the units. The new personnel that can be incorporated in the form of ICREA, RyC, JdC and BdP will be associated to one of the units. The aim is to achieve a high productivity and impact so that IEEC appears in high positions in the international rankings, improving on those of previous editions.
Ref.		4.2.1
Actions		Increase productivity and impact
Responsible		Director
Calendar		2020-2024
Resources	**Sc 1**	0.0
	Sc 2	0.0
Indicators		International rankings
Current value		45th decile
Final value		35th decile

LINE OF ACTION		
4. ORGANIZATION AND MANAGEMENT		
OBJECTIVE		**Revamp internal organization**
Sub-objective		**4.3. To be present as IEEC in key places in the national and international space research scene**
Comments		IEEC must be visible to research funding organizations and entities as the representative of the joint interests of its members. Therefore, a scheme in which IEEC acts as the contact point in relevant forums and when interacting with the actors deemed appropriate shall be promoted.
Ref.		4.3.1
Actions		Make IEEC visible (participating in calls and meetings) to interact with the main players (CDTI, ACCIO, EU, ESA, ESO, etc.), so that it acts as a valid representative of the joint interests
Responsible		Director
Calendar		2020-2024
Resources	**Sc 1**	0.0
	Sc 2	0.0
Indicators		
Current value		
Final value		

LINE OF ACTION						
4. ORGANIZATION AND MANAGEMENT						
OBJECTIVE		**Revamp internal organization**				
Sub-objective		**4.4. Optimization of operations**				
Comments		Although considerable progress has been made in this aspect, IEEC shall continue to define and formalize internal regulations and processes. This includes updating the already obsolete internal bye-laws and a clear definition of intellectual property management. The standard procedures related to computer infrastructure, project management and administration and management tasks should also be maintained and improved.				
Ref.		4.4.1	4.4.2	4.4.3	4.4.4	4.4.5
Actions		Update and improvement of internal regulations (bye-laws)	Establishment of the policy of intellectual property management	Management and improvement of the IT infrastructure	Management and improvement in the project management procedures	Implementation and maintenance of management tools improving user interaction
Responsible		Board of Directors	Board of Directors	IT office	Project office	Administration/ Management
Calendar		2020-2021	2020	2020-2024	2020-2024	2020
Resources	**Sc 1**	0.0	0.0	1.0	1.0	2.0
	Sc 2	0.0	0.0	1.0	2.0	2.0
Indicators		New bye-laws	Document	Document	Document	New management software suite and intranet
Current value		0	0	0	0	0
Final value		1	1	1	1	1

LINE OF ACTION					
4. ORGANIZATION AND MANAGEMENT					
OBJECTIVE		**Revamp internal organization**			
Sub-objective		**4.5. Redefine processes and relationships between IEEC and the units to optimize operations**			
Comments		Apart from ensuring that IEEC researchers and infrastructure have good coordination and mutual knowledge, coordination with the trustee institutions is also of great importance. To this end, regular meetings of the communication and transfer offices will be held with the corresponding communication and OTRI offices of the trustee institutions in order to maximize mutual visibility and productivity. Actions will also be taken to structure the economic relations between IEEC and the units, and work will be done to ensure that the inputs and outputs of the members affiliated with IEEC have the proper visibility and recognition from their parent institution, with the benefits and compensations that come from this.			
Ref.		4.5.1	4.5.2	4.5.3	4.5.4
Actions		Clarification of economic relationships between IEEC and its units	Improving the visibility of the scientific production of researchers for the purpose of personal recognition and assignment of material resources by the units	Establish regular communications between IEEC and the communication offices of the institutions of the units	Establish regular communications between IEEC and the transfer offices of the institutions of the units
Responsible		Board of Directors	Board of Directors	Communication office	Transfer office
Calendar		2021-2022	2021-2022	2020-2024	2020-2024
Resources	**Sc 1**	0.0	0.0	0.1	0.1
	Sc 2	0.0	0.0	0.1	0.1
Indicators		New bye-laws	N/A	Periodic meetings	Periodic meetings
Current value		0		~0	~0
Final value		1		Biennial meetings x 4 institutions	Biennial meetings x 4 institutions

LINE OF ACTION				
4. ORGANIZATION AND MANAGEMENT				
OBJECTIVE	**Revamp internal organization**			
Sub-objective	**4.6. Increase the impact of IEEC communication**			
Comments	Communication is currently one of the key aspects of any research institution. A communication plan will be designed and implemented to improve IEEC's positioning in social impact indexes. The various dissemination and outreach activities will also be maintained and expanded, with special attention to those involving the OAdM.			
Ref.	4.6.1	4.6.2	4.6.3	4.6.4
Actions	Definition of a communication plan	Execution of a communication plan	Carry out scientific communication: activities aimed at the general public, media	Carry out scientific communication from the OAdM: activities aimed at the general public, media
Responsible	Director	Communication office	Communication office	Director OAdM
Calendar	2020-2021	2020-2024	2020-2024	2020-2024
Resources Sc 1	0.0	0.2	0.3	0.2
Resources Sc 2	0.0	0.5	0.8	0.2
Indicators	Document	Increase in Societal Rank	Outreach activities	Outreach activities
Current value	0	45th decile	140/yr	20/yr
Final value	1	35th decile	200/yr	30/yr

LINE OF ACTION			
4. ORGANIZATION AND MANAGEMENT			
OBJECTIVE		**Revamp internal organization**	
Sub-objective		**4.7. Attain long-term stability of qualified engineering know-how fulfilling the needs of projects**	
Comments		The stabilization of IEEC's knowledge and expertise in the technological field is a major challenge. Despite the fact that IEEC has palliative mechanisms for making long-term contracts, the inherent limitations, the relative shortage of future prospects and the lack of a clear career path for senior staff are serious handicap. One of the actions will aim to establish a salary scale that is homogeneous throughout IEEC and also in line with the salary scales used by the trustee institutions. This will facilitate the visibility of perspectives for progress and at the same time will allow for smoother internal mobility of the technical staff (between projects and between contracting institutions). In addition, the creation of a technical engineering office is proposed so that it can be used to stabilize valuable senior staff and become the most valuable repository of IEEC technology expertise. This group of staff IEEC engineers should cover key areas to support projects, such as software, electronics and systems engineering, which are the most in-demand and most specialized profiles related to the activities that are usually performed at IEEC.	
Ref.		4.7.1	4.7.2
Actions		Create an engineering office with expertise in key areas (systems, electronics and software engineering) to support projects	Establish a salary scale that simplifies transfer of staff between projects and units
Responsible		Board of Directors	Board of Directors
Calendar		2020-2024	2020
Resources	**Sc 1**	0.0	0.0
	Sc 2	3.0	0.0
Indicators		Engineering office	Salary scale
Current value		0	0
Final value		1	1

LINE OF ACTION				
5. KNOWLEDGE TRANSFER				
OBJECTIVE		**Boost transfer to the scientific, industrial, and social environment**		
Sub-objective		**5.1. Promote participation in European H2020-Horizon Europe projects in pillar II (Clusters), structural funds and the Strengthening the European Research Area program**		
Comments		IEEC will promote applications for projects related to networking, technological research and knowledge transfer in European calls. Industrial collaboration and innovation are priority lines in the European framework programs. Support will be provided in preparing proposals for the remaining funding calls for the H2020 program, included in Pillar II (Industrial Leadership), and for calls for the new Horizon Europe program (cluster Digital, Industry and Space, Joint Research Centre, etc.). Contributions will be made to defining the work programs of the different funding cycles, in coordination with the European offices and regional contact points. It is also especially important to enable participation in European initiatives that promote local clusters (structural funds, RIS3CAT, etc.), and in which space technology brings in a high added value in technological innovation.		
Ref.		5.1.1	5.1.2	5.1.3
Actions		Promote applications of the Digital and Industry cluster	Promote COST action applications	Identify and promote the participation of researchers in technological projects close to the market: EIT Urban Mobility, RIS3CAT Communities
Responsible		Transfer office	Transfer office	Transfer office
Calendar		2020-2024	2020-2024	2020-2024
Resources	**Sc 1**	0.2	0.1	0.1
	Sc 2	0.2	0.1	0.1
Indicators		Participation in submitted projects	Participation in submitted projects	Participation in projects
Current value		~0	2 (3 years)	Unknown
Final value		1/yr	3 (total 5 years)	Increase

LINE OF ACTION		
5. KNOWLEDGE TRANSFER		
OBJECTIVE		**Boost transfer to the scientific, industrial, and social environment**
Sub-objective		**5.2. Promote participation in pillar III H2020-Horizon Europe projects**
Comments		The transfer office will also promote the submission of project applications in the calls of the new European Innovation Council, in the ways that are deemed appropriate. It is especially important to promote participation in funding programs for emerging activities, both those specific to high-innovation technologies (e.g., Future and Emerging Technologies - FET) and network-oriented ones (e.g., Coordination and Support Action - CSA), which are the basis for future specific calls. These programs are bottom-up and offer the possibility to fit low-TRL research activities developed in house.
Ref.		5.2.1
Actions		Promote applications within the framework of the European Innovation Council (FET, CSA)
Responsible		Transfer office
Calendar		2020-2024
Resources	**Sc 1**	0.1
	Sc 2	0.1
Indicators		Participation in submitted projects
Current value		0
Final value		2 (total 5 years)

LINE OF ACTION		
5. KNOWLEDGE TRANSFER		
OBJECTIVE		**Boost transfer to the scientific, industrial, and social environment**
Sub-objective		**5.3. Promote participation in projects funded by the European Space Agency (ESA), EUMETSAT and GSA**
Comments		IEEC has been very successful in securing projects funded by space, navigation and Earth observation agencies. The plan is to continue with this high success rate and further increase the competitiveness in order to attract more resources from the growing expertise and capacities of the institute. The consolidation of the technological portfolio, together with the provision of appropriate internal and external communication mechanisms, will allow the transfer office to act proactively in this promotion. In such sense, lobbying with various agencies and with state representatives (CDTI, INTA) is instrumental in guiding internal actions toward programs and calls that are most likely to succeed.
Ref.		5.3.1
Actions		Promote ITT applications for programs CTP, GSTP, ARTES, etc.
Responsible		Transfer office
Calendar		2020-2024
Resources	**Sc 1**	0.1
	Sc 2	0.1
Indicators		Number of awarded projects
Current value		1/yr
Final value		2/yr

LINE OF ACTION		
5. KNOWLEDGE TRANSFER		
OBJECTIVE		**Boost transfer to the scientific, industrial, and social environment**
Sub-objective		**5.4. Promote participation in the knowledge industry program and similar ones**
Comments		Other close-to-market initiatives will also be studied and participated in, with industrial applications focused on providing consumer services. IEEC has experience in participating in public programs aimed at these goals and has submitted proposals at both local and national levels in different calls. A systematic analysis of our own technologies will allow us to determine the level of maturity and select those that are most likely to succeed for this kind of transfer program.
Ref.		5.4.1
Actions		Promote the participation in projects for calls such as Llavor, Poducte, Mercat (AGAUR, CDTI), and RETOS-COLABORACION
Responsible		Transfer office
Calendar		2020-2024
Resources	**Sc 1**	0.1
	Sc 2	0.1
Indicators		Participation in submitted projects
Current value		1
Final value		2 (total 5 years)

LINE OF ACTION			
5. KNOWLEDGE TRANSFER			
OBJECTIVE	**Boost transfer to the scientific, industrial, and social environment**		
Sub-objective	**5.5. Promote innovation activities with industry**		
Comments	In most cases, innovation activities carried out by IEEC involve the collaboration with industrial partners. In this way the TRL of the technologies produced can be increased and the time-to-market reduced. On the other hand, these collaborations allow for the diversification of the application of space technologies. IEEC has a track record of collaboration with the main industries in the space sector, both in Catalonia and in Spain, but it should expand the network towards strategic sectors, such as mobility and transport, energy efficiency, etc. In this sense, IEEC has also participated in the creation of a consortium with other CERCA centres to promote transfer of knowledge to the market. This initiative, called the Aggregate Acceleration Entity, is awaiting funding allocation but it has already allowed for a sectorial collaborative network. The maturity of existing innovation activities at IEEC, measured from the quality standards applied in product production, ensures that IEEC can directly benefit from this academic and industrial network and its promotion.		
Ref.	5.5.1	5.5.2	5.5.3
Actions	Promote the regular interrelation between industry and research through formal and informal mechanisms, to disseminate the technology portfolio	Explore joint actions with other agencies (e.g., EAA, networks, ...)	Carry out activities to generate economic value (products delivered, patents, spin off)
Responsible	Transfer office	Transfer office	Transfer office
Calendar	2020-2024	2020-2024	2020-2024
Resources **Sc 1**	0.1	0.1	0.1
Sc 2	0.1	0.1	0.1
Indicators	Number of projects with participating industrial partners	N/A	Delivered products
Current value	7		10/yr
Final value	10		15/yr

LINE OF ACTION			
5. KNOWLEDGE TRANSFER			
OBJECTIVE		**Boost transfer to the scientific, industrial, and social environment**	
Sub-objective		**5.6. Maximize industrial exploitation of infrastructures**	
Comments		The New Space sector is inducing significant changes in the space sector and is generating new needs. The increasing number of satellites orbiting Earth, both in geostationary orbits (GEO) and low orbits (LEO), has led to the need to improve their positioning and to the creation of an infrastructure monitoring the risk of collisions. Similarly, the need to establish satellite communications is also growing, and a larger network of ground stations for satellite communications is required. And finally, new specialized industry is growing with the manufacture and integration of small satellites, dedicated to cover a market that is different from the classic space industry. These changes create opportunities for the exploitation of IEEC's infrastructure, in particular the OAdM and the various laboratories in the units. The OAdM is part of a European satellite tracking and detection network and has a communications station under construction. Similarly, laboratories such as the NanoSat Lab, or the available radiation and clean room laboratories are of enormous potential for providing test and validation services for satellite component manufacturing companies, among others.	
Ref.		5.6.1	5.6.2
Actions		Marketing of data provided by telescopes, satellite communication stations, etc., at the OAdM	Promote the industrial exploitation of laboratories
Responsible		Director OAdM	Transfer office
Calendar		2020-2024	2020-2024
Resources	**Sc 1**	0.5	0.0
	Sc 2	1.0	0.1
Indicators		Agreements and contracts	Industrial contracts
Current value		3/yr	0
Final value		4/yr	2/yr

LINE OF ACTION	
5. KNOWLEDGE TRANSFER	
OBJECTIVE	**Boost transfer to the scientific, industrial, and social environment**
Sub-objective	**5.7. Promote collaboration with other non-IEEC space research groups in Catalonia**
Comments	In Catalonia there are different research centres and university groups with specific knowledge in the area of space that are highly competitive and aligned with the interests of IEEC. Some examples are the activities carried out by BSC, CTTC, i2CAT, IFAE, etc. In addition, many of these initiatives generate a large number of applications in diverse markets with high technological and industrial value. The mutual knowledge and collaboration of IEEC with its academic environment is essential to correctly measure the capacity of the space sector in Catalonia and the wealth it generates, both directly and indirectly.
Ref.	5.7.1
Actions	Define and execute collaboration formulas (face to face meetings, workshops, distribution of a newsletter, invitation to forums)
Responsible	Transfer office
Calendar	2020-2024
Resources **Sc 1**	0.0
Resources **Sc 2**	0.1
Indicators	Collaboration actions
Current value	0
Final value	2/yr

LINE OF ACTION		
5. KNOWLEDGE TRANSFER		
OBJECTIVE		**Boost transfer to the scientific, industrial, and social environment**
Sub-objective		**5.8. Promote the growth of an industrial sector in Catalonia**
Comments		The space sector in Catalonia has sufficiently strong capabilities to compete worldwide. Academic institutions have international prestige and technology export is successful as shown by numerous industrial contracts with international agencies and by the participation in high-tech innovation developments. The range of upstream and downstream actors gives a high level of diversification, which has traditionally been considered a negative factor due to the lack of large tractor industry in space. However, the situation is ideally poised to take advantage of the opportunities that New Space offers. New Space requires industry with agile productive models and great innovation capabilities. It is therefore necessary to have R&D capacity or to establish agreements with research centres, such as IEEC, to constantly produce new solutions generating new applications and new markets. Thus, the existence of a strong industrial sector in Catalonia has clear benefits for IEEC and its knowledge transfer opportunities. Public-private collaboration with the industrial sector enables the promotion of joint initiatives, the attraction of international investments and collaborations, and the consolidation of a professional sector that retains talent in a ecosystem of which IEEC is a part. Creating an industrial association is of great interest to IEEC and would be an important step in increasing the role of the sector and promoting regional, national and international actions to consolidate and further increase it.
Ref.		5.8.1
Actions		Promote the creation of a space interest association to seize the opportunities of New Space
Responsible		Director
Calendar		2020-2021
Resources	**Sc 1**	0.0
	Sc 2	0.0
Indicators		Association
Current value		0
Final value		1

LINE OF ACTION			
6. FUNDING			
OBJECTIVE	**Improve the quality, quantity and nature**		
Sub-objective	**6.1. Improve structural funding**		
Comments	A number of IEEC members are part of two María de Maeztu units (UPC and UB) and it is not clear if IEEC globally qualifies to apply to the Severo Ochoa award. Possibilities in this regard will be studied in detail, and the opportunity and need to apply in one of the future calls will be evaluated. In any case, we will work to maintain a high standard of excellence in all aspects in order to achieve the best evaluations and opt for economic incentives that will improve baseline funding and make IEEC highly valued as a potential industry partner. Every effort will also be made to secure financial support for management through specific calls for applications.		
Ref.	6.1.1	6.1.2	6.1.3
Actions	Analyse the feasibility for applying for the Severo Ochoa award	Maintain and consolidate a high standard of excellence to maximize public and private fundraising	Promote participation in program Europa Redes y gestores
Responsible	Board of Directors	Director	Transfer office
Calendar	2020-2021	2020-2024	2020-2024
Resources **Sc 1**	0.0	0.0	0.0
Sc 2	0.0	0.0	0.1
Indicators	Document	CERCA evaluation	Participation in submitted projects
Current value	0	A-	0
Final value	1	A	2 (total 5 years)

LINE OF ACTION			
6. FUNDING			
OBJECTIVE		**Improve the quality, quantity and nature**	
Sub-objective		**6.2. Improve funding of infrastructures**	
Comments		There are several options to increase funding for IEEC infrastructure. On the one hand, IEEC shall respond to calls for projects that have such purpose, and although they often require co-funding, they can be a good complement to investments made with structural funds. Classifying a facility as a Scientific and Technical Singular Infrastructure (ICTS) gives access to funding lines for improvement actions. The OAdM meets all the requirements except for the total budget. It will be necessary to study whether there is a way to opt for this classification or an alternative that is less restrictive.	
Ref.		6.2.1	6.2.2
Actions		Explore possibilities for OAdM designation as an ICTS or similar	Respond to calls for structural funds for infrastructure and equipment
Responsible		Director OAdM	Management team
Calendar		2020-2024	2020-2024
Resources	**Sc 1**	0.0	0.0
	Sc 2	0.0	0.0
Indicators		Document	Participation in submitted projects
Current value		0	0
Final value		1	2 (total 5 years)

LINE OF ACTION		
6. FUNDING		
OBJECTIVE		**Improve the quality, quantity and nature**
Sub-objective		**6.3. Maintain or increase funding managed by IEEC in competitive calls from Catalonia and Spain**
Comments		The aim is to significantly increase the success in obtaining competitive funding from calls issued at the Catalonia and Spain levels as a result of the actions detailed above, in particular the actions of sub-objectives 2.3, 3.1, 4.1, 4.2 and 4.3.
Ref.		6.3.1
Actions		Support project applications and provide project management help
Responsible		Project office
Calendar		2020-2024
Resources	**Sc 1**	0.4
	Sc 2	0.5
Indicators		Funding received
Current value		2.0 M€/yr
Final value		3.0 M€/yr

LINE OF ACTION	
6. FUNDING	
OBJECTIVE	**Improve the quality, quantity and nature**
Sub-objective	**6.4. Increase the percentage of funding from European projects (Horizon Europe, ESA, EUMETSAT, GSA)**
Comments	The aim is to significantly increase the success of obtaining competitive funding in European calls as a result of the actions detailed above, in particular the actions of subobjectives 2.1, 2.3, 3.1, 4.1, 4.2, 4.3, 5.1, 5.2 and 5.3.

6. FUNDING		
Ref.		6.4.1
Actions		Support project applications and provide project management help
Responsible		Project office
Calendar		2020-2024
Resources	**Sc 1**	0.1
	Sc 2	0.5
Indicators		Funding received
Current value		0.3 M€/yr
Final value		1.5 M€/yr

LINE OF ACTION		
6. FUNDING		
OBJECTIVE		**Improve the quality, quantity and nature**
Sub-objective		**6.5. Increase funding from innovation activities**
Comments		New Space industry focus on the commercial market and need to offer highly competitive and ever-changing solutions. It is therefore an attractive sector to incorporate innovative technologies resulting from IEEC's research activity through valorising intellectual property. It represents an opportunity with a clear projection of growth and it is important to take the opportunity to consolidate and extend transfer agreements and contracts with companies, while continuing to promote agreements with companies in the traditional sector. In addition, IEEC has carried out internal valuation actions and has the sufficient structure to promote transfer to the productive sector, maximizing the return to the institute.
Ref.		6.5.1
Actions		Establish agreements and contracts with companies, especially those in the New Space sector
Responsible		Transfer office
Calendar		2020-2024
Resources	**Sc 1**	0.1
	Sc 2	0.1
Indicators		Funding received
Current value		400 k€/yr
Final value		500 k€/yr

LINE OF ACTION		
6. FUNDING		
OBJECTIVE		**Improve the quality, quantity and nature**
Sub-objective		**6.6. Enhance visibility to attract patronage activities**
Comments		High visibility and good positioning as a leading institute in research and space applications can help to attract donations from foundations and companies, so that they can fund and sponsor specific actions that are endorsed by IEEC's quality seal.
Ref.		6.6.1
Actions		Promote the establishment of sponsorship agreements by companies and entities
Responsible		Director
Calendar		
Resources	**Sc 1**	0.0
	Sc 2	0.0
Indicators		N/A
Current value		
Final value		

LINE OF ACTION								
F. FLAGSHIP SPACE MISSION								
OBJECTIVE	**Lead and execute a full space mission**							
Sub-objective	**F.1. Define and execute a space mission to act as a tractor programme for the Catalan space sector and following the NewSpace paradigm**							
Comments	A flagship mission is proposed with the objective to act as a tractor project combining all the capacities of the Catalan space sector, together with disruptive innovation technologies from actors in the area of space and others. Government support is key for such flagship mission to become the consolidation of the existing academic and industrial framework. IEEC can lead this public initiative as it holds all the ingredients to lead and execute a full space mission roadmap.							
Ref.	F.1.1	F.1.2	F.1.3	F.1.4	F.1.5	F.1.6		
Actions	Space mission roadmap, Call for proposals and pre-selection	Tendering for mission assessment (phase A)	Execution of phase A (Feasibility and Assessment) and down-selection	Industrial tendering for payload construction covering phases B/C/D	Industrial tendering for spacecraft construction, satellite integration and launch covering phases B/C/D	Industrial tendering for satellite operations covering phases E/F		
Responsible	Board of Directors	Project office & Engineering office	Project office & Engineering office	Project office & Engineering office	Project office & Engineering office	Project office & Engineering office		
Calendar	Q3-Q4 2020	Q4 2020	Q1-Q2 2021	Q3 2021	Q3 2021	Q3 2021		
Resources								
FTE	0.5	0.5	1.00	0.5	0.5	0.5		
k€	50	200	50	500	1200	200		
Indicators	Document	Document	Document	Document	Document	Document		
Current value	0	0	0	0	0	0		
Final value	1	1	1	1	1	1		

Ref.	F.1.7	F.1.8		F.1.9		F.1.10	F.1.11	F.1.12
Actions	Execution of phase B (Preliminary Definition)	Execution of phase C (Detailed Definition)		Execution of phase D (Qualification and Production)		Execution of phase E (Launch and Operations)	Execution of phase F (Disposal)	Mission evaluation
Responsible	Project office & Engineering office	Project office & Engineering office		Project office & Engineering office		Project office & Engineering office	Project office & Engineering office	Board of Directors
Calendar	Q4 2021	Q1-Q2 2022		Q3-Q4 2022		Q1 2023 - Q4 2024	Q4 2024	Q4 2024
Resources								
FTE	0.5	1.00		1.00		2.50	0.25	0.25
k€						100		
Indicators	Document	Document	S/C & P/L Engineering Models	Document	S/C & P/L Proto-flight and flight Models	Document	Document	Document
Current value	0	0	0	0	0	0	0	0
Final value	1	1	2	1	2	1	1	1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Espacials de Catalunya
Institució
CERCA
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de Catalunya
Generalitat
de Catalunya
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UAB
Universitat Autònoma
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UPC
Universitat Politècnica
de Catalunya
BarcelonaTech
CSIC
Consejo Superior de Investigaciones Científicas