

PLAN



Action Plan 2010-2013

Physical Sciences and
Technologies

EXECUTIVE SUMMARY



N.B.: If you require any further information about the specific content of any particular Area 5 Centre or Institute's Strategic Plan, please ask for it by sending an e-mail to: pe2010-13@csic.es. Thank you

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5 Physical Sciences and Technologies

1. GENERAL INFORMATION

Description of the area

The Physical Sciences and Technologies Areas encompasses over 20 centres and institutes at which almost 2000 people, including approximately 500 staff researchers, work on both basic and applied research.

The Area's research ranges from the study of the elementary components of matter through to the most distant galaxies, from nanoscience and microelectronics through to sensors and robotics, or from atomic and molecular physics and optics up to complex systems and statistical physics, together with mathematics and computational science and technology. A significant proportion of the Area's research takes place in an interdisciplinary context, at the frontier with other CSIC Areas, ranging from sensor applications in natural resources projects, or detectors and methods for biomedicine, to the development of new materials and detection techniques.

The area's annual scientific production exceeded 1500 publications in ISI journals, to which should be added a further 500 contributions over the same period in other journals, conference proceedings and book chapters. Over the last four years the area's researchers have been involved in almost 400 projects and other research actions, with a typical duration of between one and three years, and a budget of close to 60 million euros, of which 80% is from external funding sources. Also, an average of 80 doctoral theses a year are submitted under the supervision of researchers from the Area's centres.

Short history

(Covering the period 2006-2009)

The preceding period has witnessed the creation of two new institutes, namely the Instituto de Ciencias Matemáticas (Institute of Mathematical Sciences, IC-MAT) and the Instituto de Física Interdisciplinar y Sistemas Complejos (Institute of Interdisciplinary Physics and Complex Systems, IFISC). Both of these institutes are joint centres, the first with the Complutense, Autonomous and Carlos III Universities in Madrid, and the second with the Universitat Illes Balears. These two centres incorporate researchers from previous CSIC centres (IMAFF, IMEDEA). It is also worth mentioning that both institutes are being given new buildings, one of which has been completed (on the UIB's campus) while the other is un-

der construction (on the UAM's campus) and will also be home to the Instituto de Física Teórica (Institute of Theoretical Physics, IFT). The restructuring of the IMAFF (former Instituto de Matemáticas y Física Fundamental – Institute of Mathematics and Fundamental Physics) has been completed, with the reconfiguration of the Instituto de Física Fundamental (Institute of Fundamental Physics, IFF), within the Centro de Física Miguel Antonio Catalán (Miguel Antonio Catalán Physics Centre, CFMAC). New premises were also built for the Instituto de Microelectrónica de Sevilla (Seville Microelectronics Institute, IMSE), on the Isla de la Cartuja, and the Instituto de Ciencias Espaciales (Space Sciences Institute, ICE) building on the UAB's campus is nearing completion. The incorporation of the Laboratorio de Investigación en Tecnologías de la Combustión (Combustion Technologies Research Laboratory, LITEC) in the area is also worth mentioning. .

Mission and Vision

Mission

The fundamental mission of the CSIC's Physical Science and Technology Area is the advancement of science by addressing new challenges, ranging from a basic approach underpinned by models and theories in physics and mathematics, through to the experimental and technological perspective, where it serves as a complement to engineering.

Vision

The area is configured as a network of centres with a well-defined focus whose lines of research are at the frontiers of science in Spain and highly significant internationally. It covers the whole spectrum from basic research through to technological applications. It is supported by scientific facilities, experimental laboratories and computing centres, and it is also able to draw upon complementary resources to tackle scientific challenges at the global level in the area and take part in multidisciplinary projects. The Area is also able to attract scientists and technical staff of a high international standing and offer them an ideal setting in which to take on the scientific challenges of the 21st century, in which physics, mathematics and engineering will continue to play a central role.

The Area's coordination aims to support these initiatives by envisaging the appropriate resources for them and promoting links between centres to enhance their potential and visibility. It also has a role in promoting the centres' activities in the areas of training, technology transfer and dissemination, along with raising their internationalisation.

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Siglas	Institutos del Área en creación	Localización	Tipo
CAR	Automation and Robotics	Madrid	Joint CSIC-UPM
C A A - END	Applied Acoustics and Non-destructive Testing	Madrid	Joint CSIC-UPM

INSTITUTOS DEL CSIC EN EL ÁREA DE CIENCIAS Y TECNOLOGÍAS FÍSICAS					
CAB	Astrobiology Centre (Joint INTA) – Madrid	ASTRO	IMB	Barcelona Microelectronics Institute – Barcelona	NANO MICRO
IAA	Andalusia Astrophysics Institute – Granada	ASTRO	IMM	Madrid Microelectronics Institute – Madrid	NANO
ICE	Institute of Space Sciences (Joint IECC) – Barcelona	ASTRO	IMSE	Seville Microelectronics Institute – Seville	MICRO
ICMAT	Institute of Mathematical Sciences (Joint UAM-UC3UCM) - Madrid	MATH	IO	Institute of Optics – Madrid	OPT NANO
IEM	Materials Structure Institute – Madrid	MOL FPAN QFISES OPT ASTRO NANO	IRI	Robotics and Industrial Informatics Institute (Joint UPC) – Barcelona	TEC ICT
IFCA	Institute of Particle Physics (Joint UV) - Santander	ASTRO FPAN ICT QFISES	LITEC	Combustion Technologies Research Laboratory (Joint UZ, DGA) – Zaragoza	TEC
IFIC	Institute of Particle Physics (Joint UV) -- Valencia	FPAN	CAR	Automation and Robotics Centre (Joint UPM) – Madrid	TEC ICT
IFISC	Institute of Interdisciplinary Physics and Complex Systems (Joint UIB) – Palma de Mallorca	QFISES OPT	CAA- END	Centre for Acoustics and Non-destructive Testing (Joint UPM) – Madrid	TEC

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IFT	Theoretical Physics Institute (Joint UAM) - Madrid	FPAN QFISES	IA	Acoustics Institute – Madrid	TEC
IIIA	Artificial Intelligence Institute – Barcelona	ICT	IFA	Applied Physics Institute – Madrid	TEC OPT ICT
IFF	Fundamental Physics Institute – Madrid	MOL QFISES	IAI	Industrial Automation Institute - Madrid	TEC ICT

It should also be recalled that three of the Area's centres (IMB, IMM and IMS) are effectively grouped together under the Centro Nacional de Microelectrónica (National Microelectronics Centre).

It is also worth noting that when drawing up this strategic plan it was considered appropriate, at the request of the centre itself and with the advice of the International Expert Panel, to reassign one of the Area's centre's, namely the Observatorio del Ebro (River Ebro Observatory), to the Natural Resources Area.

As a final note, the Area has direct links with several Horizontal Units and a number of unique scientific/technical facilities (ICTS in their Spanish initials) in which the CSIC is involved.

Initials	Facility	Location	Type
SB-CNM	National Microelectronics Centre Clean Room	Barcelona	ICTS UUHH CSIC
CAHA	German Spanish Astronomical Centre (Calar Alto)	Madrid	ICTS Joint CSIC- MPG
CNA	National Accelerators Centre	Seville	ICTS Joint CSIC- US-JA

2. CRITICAL ANALYSIS OF THE AREA

SWOT ANALYSIS

The main points of the SWOT analysis are outlined below, differentiating between those considered common to the CSIC as a whole and those specific to the Physical Science and Technologies Area:

Weaknesses

Common

- Lack of a career structure for technical personnel
- Difficulties of management and administration
- Multitude of sources of funding and diversity of scientific policies

Specific to the Physical S/T Area

- Limited collaboration on development and innovation with companies
- Dispersion of initiatives and lack of critical mass in research lines
- Limited cooperation between the Area's lines and centres
- Limited exploitation of equipment
- Limited visibility (at national, regional and international level) of some groups
- Outdated structure at several institutes
- Large percentage of scientific workforce close to retirement at some centres
- Lack of leadership by some groups in international forums and initiatives

Threats

Common

- Stagnation in management tasks and administration of centres and projects, particularly in the case of hiring of personnel
- Reduced funding opportunities due to external conditions.

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Specific to the Physical S/T Area

- Commitments on projects with limited viability and scientific interest.
- Attractiveness of other institutions due to their flexibility when hiring excellent scientists.

Strengths

Common

- Quality of research groups
- International positioning
- National leadership
- Attractive institution for researchers
- Scientific workforce with a high percentage of young researchers

Specific to the Physical S/T Area

- Excellent basic research
- Equipment and laboratories
- Real technology transfer capacity
- Involvement in advanced training
- Existence of a realistic strategic plan

Opportunities

Common

- Participation in FP7
- Collaboration with other European research organisations
- Development of the CSIC as an Agency
- Initiatives through the Fundación CSIC

Specific to the Physical S/T Area

- Positioning in international initiatives (ERC, ESFRI, ESA, CERN, ESO, etc.)
- Use of technology transfer instruments (CENIT, TRACE), particularly in activities linked to the development of instrumentation

- Involvement in multidisciplinary projects in collaboration with other CSIC centres
- Development of national benchmark centres and infrastructure
- New initiatives with universities and regional governments

HORIZONTAL ANALYSIS OF THE RESEARCH LINES

During the process of preparation of the action plan, the centres proposed an extensive list of research lines (see table below). The external advisory panel evaluated these proposals and rated most of them as good or excellent, although it also suggested that some should not be supported, either because they would be more appropriate as sub-lines or because their scientific objectives were limited. These recommendations have now been taken into account and are reflected in each centre's plans.

In order to facilitate a critical analysis of these research lines, they have been integrated into the following broader horizontal thematic areas:

- ASTROPHYSICS AND SPACE SCIENCES (**ASTRO**)
- PARTICLE PHYSICS, ASTROPARTICLES AND NUCLEAR PHYSICS (**FPAN**)
- ATOMIC AND MOLECULAR PHYSICS (**MOL**)
- OPTICS (**OPT**)
- COMPLEX SYSTEMS AND STATISTICAL PHYSICS (**QFISES**)
- MATHEMATICS (**MATH**)
- PHYSICAL TECHNOLOGIES (**TEC**)
- NANOSCIENCE AND NANOTECHNOLOGY (**NANO**)
- INTEGRATED MICRO AND NANO SYSTEMS (**MICRO**)
- COMPUTING SCIENCES AND TECHNOLOGIES (**ICT**)

The table below gives a complete list of the research lines, grouped into these thematic areas:

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Thematic area	Research line	Institute
ASTRO	Development of advanced instrumentation	CAB
	Evolution and characterisation of living environments in the solar system	CAB
	Galaxy formation and evolution	CAB
	Formation and evolution of the interstellar medium, stars and planets	CAB
	Molecular evolution and adaptation	CAB
	Compact objects and relativistic phenomena	IAA
	Galaxies, gravitation and cosmology	IAA
	Galaxy clustering and physics of the dark universe	IAA
	Physics of the interstellar medium	IAA
	Solar and planetary science	IAA
	Stellar physics	IAA
	The Milky Way and the Local Group	IAA
	Integrated spatial and earth-based approach to frontier problems in geophysics	ICE
	Observational and theoretical studies of the extreme universe.	ICE
	The cosmic cycle (birth, evolution and death of stars and planetary systems)	ICE
	Understanding the Universe on the largest scales	ICE
	Gravitation and cosmology	IEM
	Galaxies and AGNs (Active Galactic Nuclei)	IFCA
	Observational cosmology and instrumentation	IFCA
FPAN	Nuclear physics	IEM
	High energy physics and instrumentation	IFCA
	Accelerator-based high energy experimental physics	IFIC
	Astroparticle and neutrino experimental physics	IFIC
	Experimental nuclear physics	IFIC
	Phenomenology in high energy physics	IFIC
	High energy mathematical and theoretical physics	IFIC
	Medical applications of nuclear and particle physics	IFIC
	Nuclear and many body theory	IFIC
	QCD (quantitative chromodynamics) and strong interactions	IFIC
	Theoretical physics of astroparticles and cosmology	IFIC
	The origin of mass	IFT
	Origin and composition of the Universe	IFT
	Quantum fields, gravity and strings	IFT
MATH	Algebraic geometry and mathematical physics	ICMAT
	Differential geometry, symplectic forms and geometric mechanics	ICMAT
	Mathematical analysis, differential equations and applications	ICMAT

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MOL	Theoretical physics of molecules, clusters and extended media	IFF
	Experimental molecular physics	IEM
	Macromolecular physics	IEM
	Physics of nanostructures and biosystems	IEM
MICRO	Integrated Digital Circuits	CNM-IMS
	Analogue and mixed signal integrated circuits	CNM-IMS
	Integrated Micro and Nano Systems	CNM-IMS
	Power systems and devices	CNM-IMB
	Transducers for chemical and biochemical sensing	CNM-IMB
	Integrated circuits and systems	CNM-IMB
NANO	Nanophotonics and opto-electronic structures for devices in ICTs, health and energy	CNM-IMM
	Nanoscale imaging, Nanolithography and Nanomechanical Biosensors	CNM-IMM
	<i>Nanomanufacture and functional properties of nanostructures</i>	CNM-IMB
	<i>Integrated Micro and Nano Biosystems</i>	CNM-IMB
	<i>Integration of micro and nanotechnologies</i>	CNM-IMB
	Non-linear optics and nano-photonics	IO
OPT	Photonics, nanostructures and ultrafast science	IO
	Imaging and Vision	IO
	<i>Non-linear and dynamic optics of opto-electronic devices.</i>	IFISC
TEC	Robotics	IRI
	Combustion and energy	LITEC
	Fluid dynamics	LITEC
ICT	Advanced computation and e-Science	IFCA
	GRID and e-Science	IFIC
	Learning systems	IIIA
	Logic and reasoning	IIIA
	Multi-agent systems	IIIA
QFISES	Statistical physics	IEM
	Dynamics and fluctuations in non-linear systems	IFCA
	Meteorology and climate change	IFCA
	Quantum information	IFF
	<i>Quantum physics: photons, electrons and information</i>	IFISC
	<i>Dynamics of fluids, biofluids and fluids of geophysical interest</i>	IFISC
	<i>Biological physics and non-linear phenomena in ecology and physiology</i>	IFISC
	<i>Dynamics and collective phenomena in social systems</i>	IFISC
Theoretical condensed matter and quantum information	IFT	

3. ANALYSIS OF THE AREA'S 2006-2009 STRATEGIC PLAN

The evaluation of the 2010-2013 Strategic Plan for the Area's centres revealed that, overall, the centres have met the targets set in the preceding plan, and the scores on the indicators for the majority of their research lines were ranked as high or even excellent. Qualitatively, research in the centres made significant progress during the period, consolidating or significantly boosting scientific results. In quantitative terms, the indicators of scientific and technical output were met, as is shown in the corresponding annual reports (PCO 2006, PCO 2007, PCO 2008).

As regards the actions envisaged in the CSIC's 2006-2009 Action Plan, the RETICULA strategic line, the axis for physics and mathematics, three of the envisaged actions have been completed or are in progress: The Instituto de Ciencias Matemáticas (Institute of Mathematical Sciences, ICMAT) was created and assigned its initial staff. It will be located with the Instituto de Física Teórica (Institute of Theoretical Physics) in the new Centro de Matemática y Física Teórica (Mathematics and Theoretical Physics Centre), whose building is currently under construction on the UAM's campus and is due to be completed in 2010. Similarly, the Instituto de Física Interdisciplinar y Sistemas Complejos (Institute of Interdisciplinary Physics and Complex Systems, IFISC), a joint centre with the University of the Balearic Islands, was created in 2009 and is based on the UIB's campus. The other planned action, the creation of the Instituto de Astrofísica Espacial (Institute of Spatial Astrophysics) as a joint centre linked to ESA (European Space Agency) in collaboration with INTA and CDTI, was not possible, although the restructuring of the Centro de Astrobiología (Astrobiology Centre, CAB), a joint centre with INTA, has made it possible to unify and significantly strengthen the initiatives in the area in the Madrid Region.

The more specific actions underway that were set out in the Area's Strategic Plan include the restructuring of CETEF and the institutes assigned to this centre, as already mentioned.

The CSIC has also supported the two CONSOLIDER actions to strengthen scientific communities as set out in the Strategic Plan. These initiatives are i-MATH, aimed at the mathematics community, and CPAN, aimed at that of particle physics, astroparticles and nuclear physics. We hope to make progress in 2009 and 2010 on establishing the corresponding National Centres, or similar bodies, as these CONSOLIDER actions intend, and in which it is expected that the CSIC will have a significant role in coordinating.

Another of the envisaged actions, namely support for European FAIR initiative in Nuclear Physics, is also progressing satisfactorily, and a recruitment competition for scientific and technical staff has been run.

Finally, it should be noted that in 2008 a specific action on the topic of the Grid and eScience was begun, with the installation of significant computing resources in IFCA, IFIC and IAA, and the setting up of a project running throughout 2009 and 2010 in the framework of national and international collaborations (Red Española de e-Ciencia, Iniciativa Grid Nacional and the European Grid Initiative, EGI).

4. OBJECTIVES 2010-13

GENERAL OBJECTIVES

1. Developing the initiatives proposed for the various research lines through projects that are relevant and excellent on the national and international level, making a significant contribution to the advancement of knowledge.
2. Increasing technology transfer activities, especially those with a clear final impact on society.
3. Bringing the research carried out at the CSIC's institutes to society, and in particular to potential scientists of the future.

SPECIFIC OBJECTIVES

1. Promoting participation in important international projects, particularly at European level, in collaboration with other European institutions (CNRS, MPG, CNR), in the framework of FP7 or linked to ESFRI initiatives.
2. Consolidating the CSIC's leadership and presence in scientific structures of relevance for the analysis of new projects and initiatives and their support and development.
3. Implementing mechanisms for proposing and supporting the implementation of interdisciplinary projects, in particular those linked to the CSIC's strategic axes.
4. Supporting the production of patents and the creation of technology-based companies.

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5. Developing the centres' internal and external services, by implementing a catalogue of services and the corresponding procedures.
6. Establishing the active participation of the CSIC in scientific dissemination tasks in the area, and in training activities, particularly at the master and doctoral level, in direct collaboration with the universities.

5. RESEARCH STRATEGY AND ENVISAGED ACTIONS

The strategies to develop are defined based on those defined by the institutes in their action plans, and those which can be envisaged globally from the SWOT analysis.

6.1 Allocation of resources, staff and scientific equipment, to institutes

The institutes' strategic plans include an application for human and financial resources. During the negotiation process these applications have been reviewed and a proposal agreed which enables the scientific and technical objectives envisaged to be achieved, together with their corresponding indicators (see table in section 7). This proposal for the assignment of resources is summarised in the table submitted in section 6.8. As well as the scientific/technical staff, the monitoring of management and other personnel supporting the general running of the centres will be considered.

6.2 Collaboration between institutes

Participation in the various forms of thematic collaboration between institutes will be supported, including both those linked to CONSOLIDER initiatives in progress (some of which have as their explicit goal the establishment of new national centres in their thematic area) and other existing networks. In particular, initiatives to improve the leadership role or visibility of the CSIC's researchers will be supported.

6.3 Participation in interdisciplinary initiatives

The institutes' potential for participation in the CSIC's strategic axes and other possible interdisciplinary initiatives will be examined, and contact between areas promoted with a view to establishing the framework of collaboration within the CSIC to permit their development.

6.4 Bolstering knowledge transfer.

Mechanisms to promote technology transfer will be examined jointly with the Oficina de Transferencia de Tecnología (Technology Transfer Office) and the relevant Institutional Delegations. These will range from assigning specific support personnel (JAE-Transfer programme) to assessing researchers' CVs with a view to promotion. Contact with relevant segments of industry will be encouraged and monitored.

6.5 Participation in the training of new researchers

Efforts will be made to establish a suitable framework for the participation of CSIC researchers in master and doctoral programmes at universities to ensure the recognition of this activity and reinforce contacts with the pool of young researchers. In particular, care will be taken to ensure that this participation is reflected in specific agreements, as already exist with a number of universities, and the take-up of JAE-Intro grants will be promoted and monitored.

6.6 Dissemination of Science in Society

The preparation of presentations and teaching materials to bring the research performed at the institutes closer to the general public, and to young people in particular, will be promoted. This will support the initiatives proposed by the CSIC's Scientific Culture Area.

6.7 Creation of new institutes

As already mentioned, at the time of drawing up this Action Plan, three of the Area's centres were undergoing restructuring in order to create two new mixed centres, run jointly with the Madrid Polytechnic University (UPM). These will be located on the new Alcobendas campus.

Moreover, we also expect to be able to exploit the additional technology transfer potential of several relevant lines through possible new initiatives with a number of universities, with which contact has been made and with which there is experience of scientific and technical cooperation. These initiatives will be defined in more detail during the implementation of the plan.

CSIC