Exploring the frontier of the two infinities,
from Particles to the Cosmos, with passion, spirit of
collaboration and responsibility towards the society.

Outstanding science,
with a focus on putting young talents in the best
conditions to unleash their potential

IFAE
Institut de Física d'Altes Energies

From Particles to the Cosmos

IFAE

Eugenio Coccia
Director

CERCA · BIST Barcelona Institute of Science and Technology

FUNDAT PER | FOUNDED BY

Generalitat de Catalunya · UAB Universitat Autònoma de Barcelona

IFAE at a glance

Fundat per | Founded by

Membre de | Member of

Amb el suport de | Supported by

consortium between the **Catalan Government** and **UAB** founded in **1991**.

A vibrant community of 170 people

three divisions: theory, experimental, technical + administration

basic research in fundamental physics and
applied research in instrumentation and medical applications

research lines: Particle Physics, Astroparticle Physics, Cosmology, Medical Imaging, Physics Instrumentation, Quantum Computing

collaboration in **10 international experiments** in high impact / leadership positions (ATLAS, T2K, Hyper-K, MAGIC, CTA, HERD, DES, PAU, DESI, Euclid, LSST, Virgo, Einstein Telescope)

one large engineering group (30+ engineers and technicians)

facilities: chip packaging & assembly, clean rooms, shielded room, electronics labs, optical lab, cryogenic lab, mechanical workshop (300 m^2)

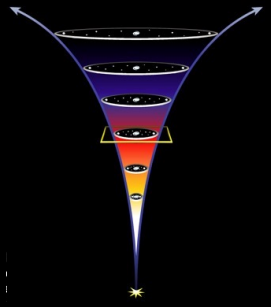
one massive data processing center: **PIC** (LHC Tier-1)

member of Barcelona Institute of Science and Technology

Three times awarded with the *Severo Ochoa* accreditation of excellence

Hottest topics in fundamental physics

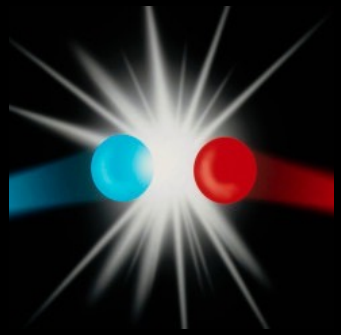
Universe



Why is the Universe expanding now faster and faster?

dark energy

Antimatter



How can it be that one part of matter in 10^9 did not annihilate with

antimatter

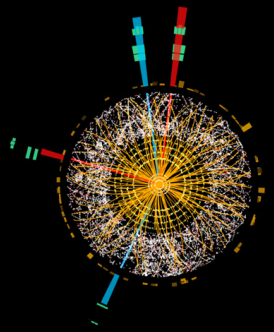
Gravity

Why is it that the majority of matter in galaxies does not emit light?

dark matter

black holes

Origin of Mass



What is the origin of the mass of all particles?

Higgs particle

But why so light?

External Scientific Committee

Barry Barish (Chairperson, Caltech)
Mar Capeans (CERN)
Anne-Isabelle Etienvre (Saclay)
Stefano Forte (INFN)
Antonio Masiero (INFN)
Marzio Nessi (CERN)
Lisa Randall (Harvard)
Alexandre Refregier (ETH)
Marjorie Shapiro (Berkeley)
Agnieszka Zalewska (IFJ Pan)

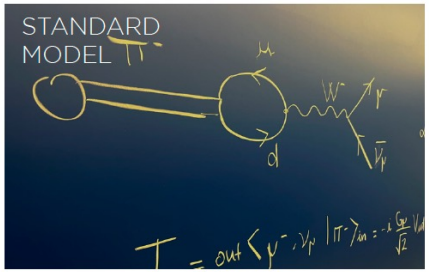
THEORY DIVISION

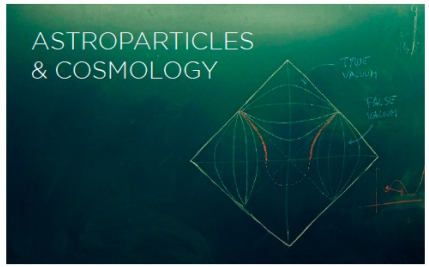
Our Theory Division works on the most intriguing open questions in fundamental physics

Research topics of the Standard Model group include applying effective field theories to different physical systems, using flavour physics as a tool for discovery, or improving the hadronic contributions to the muon anomalous magnetic moment, among others.

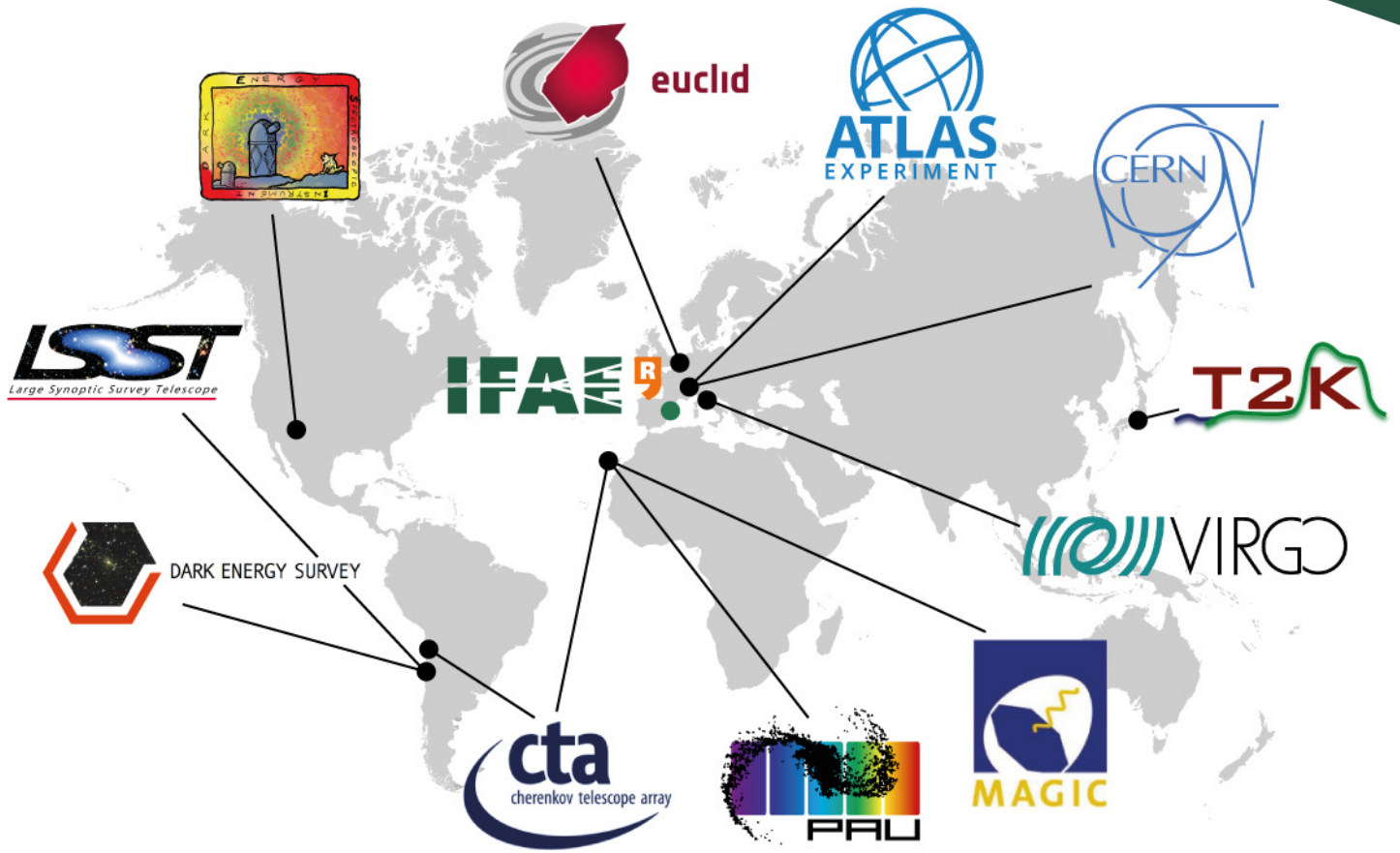
The Beyond the Standard Model group focuses on research topics needed to understand mysteries such as the origin of the Universe properties, the origin of baryons and dark matter, the hierarchy problem, and the strong CP problem, among others.

Dark energy, dark matter models, baryogenesis, gravitational wave physics, and gravity and condense matter physics are the research topics addressed by the Astroparticles and Cosmology Group.



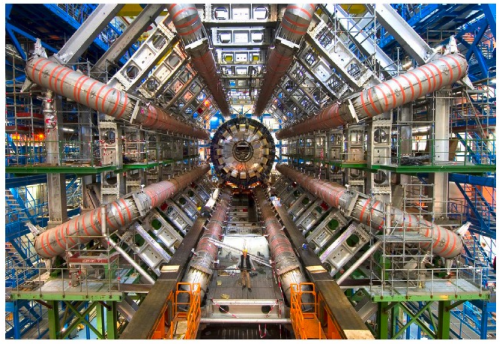


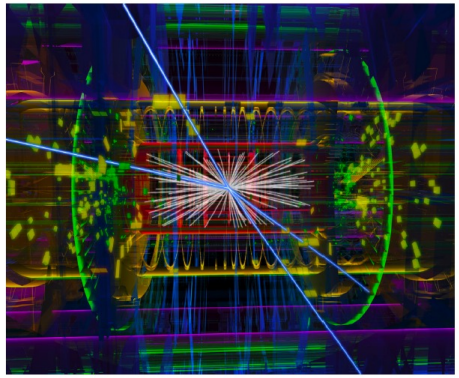
International collaborations



COLLIDER PHYSICS

ATLAS is the largest general-purpose detector at LHC, involving 3000 scientists to investigate a wide range of physics, from the Higgs boson to extra dimensions and particles that could make up dark matter.

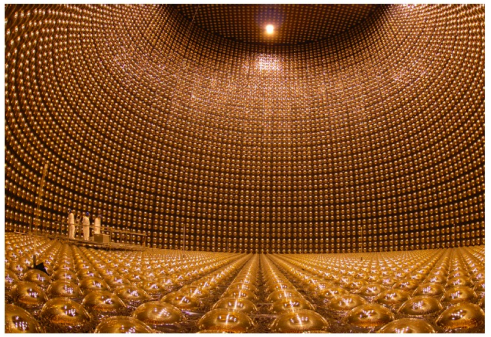


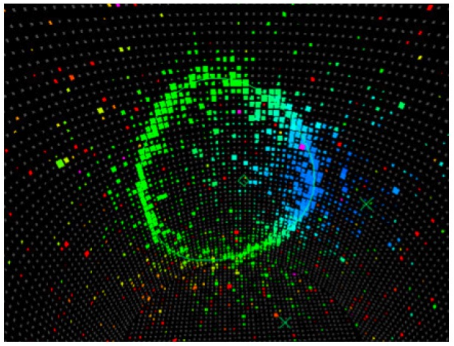


For more than 30 years we have been making important instrumentation contributions to ATLAS and have deployed a strong and rich physics analysis program.

NEUTRINO PHYSICS

We study the “ghost particle” among the fundamental particles and search for answers to why there is more matter than anti-matter in the Universe.





We have been involved since the beginning in the leading experiment in long-baseline neutrino oscillations: T2K in Japan.
We contributed to the design and construction of the near detector and made important contributions to the data analysis.

GAMMA-RAY ASTRONOMY

Our goal is to understand the most energetic phenomena in the Universe and address open questions in fundamental physics.

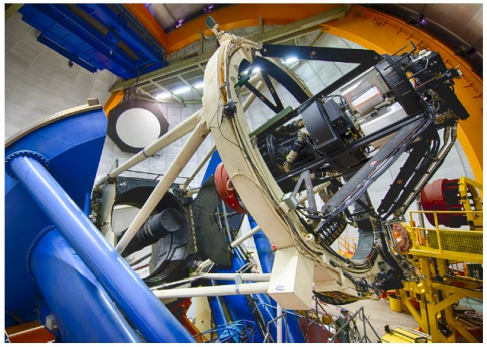
We lead the most relevant Gamma-ray Astronomy international collaborations (MAGIC, CTA).

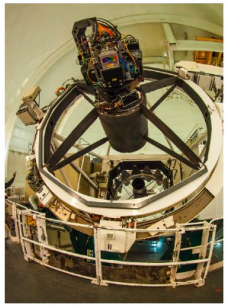
We are leaders in the construction of cutting-edge instrumentation: the Gamma-ray group has led the construction of the photosensor cameras for the MAGIC-1 telescope and the CTA Large Sized Telescopes (LST).

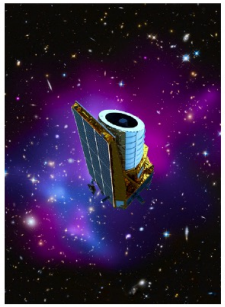
OBSERVATIONAL **COSMOLOGY**

Our main goal is to shed light on the nature of the mysterious dark energy, responsible for the current accelerated expansion of the Universe.

We participate in the leading international collaborations such as DES, DESI, Euclid, LSST and we are a partner of PAUS.



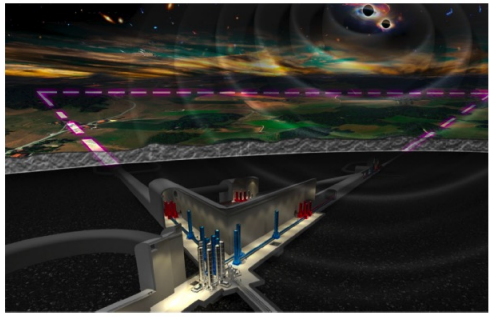




GRAVITATIONAL WAVES

In 2019, we initiated a long-term experimental involvement in the Virgo ground-based Fabry-Perot interferometer, with the emphasis of studying fundamental physics using GWs.

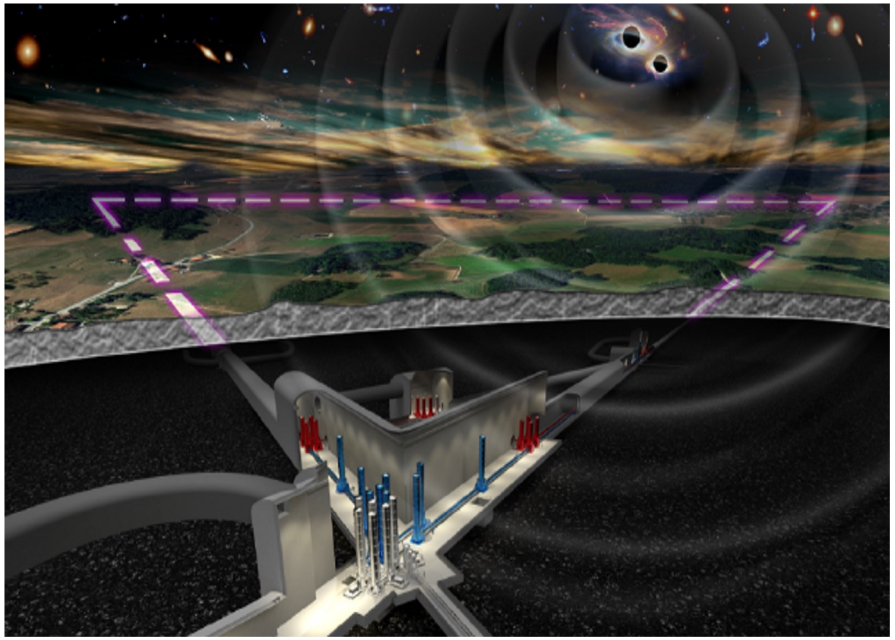
We are a member institution in the VIRGO collaboration and this opened a long-term research line related to GWs detection using terrestrial interferometry.



We are also involved in Einstein Telescope (ET), a project recognized in the ESFRI roadmap.

IFAE researchers cover the role of Chair of the ET Collaboration Board and leaders of the European project ET-Preparatory Phase to address the prerequisites for the approval, construction and operation of ET.

IFAE leads an international project to pave the way for the Einstein Telescope



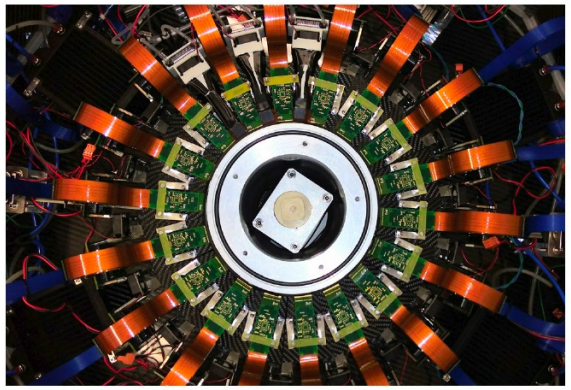
The **Preparatory Phase for the Einstein Telescope Gravitational Wave Observatory (ET-PP)** is a Horizon Europe INFRA-DEV project to address the fundamental prerequisites for the approval, construction and operation of the Einstein Telescope. The Institut de Física d'Altes Energies (IFAE) is the coordinator institution of this project that will run for 4 years with a total budget of 3.45M€ and comprises leading research centers from 11 countries.

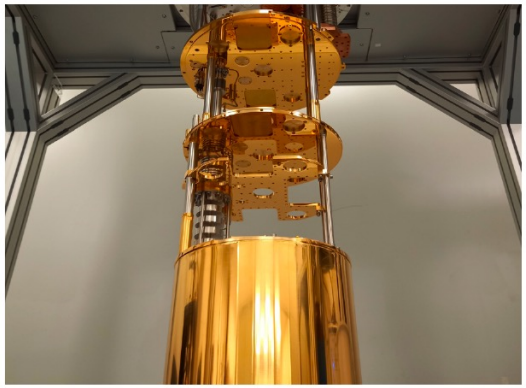
APPLIED PHYSICS

MEDICAL PHYSICS

Since 1999, we are using our expertise with sophisticated radiation detectors to develop advanced medical imaging devices.

We've developed 3 spin-off companies and several patents with our technologies.



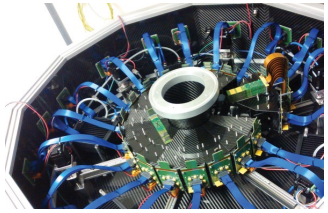


QUANTUM COMPUTING TECHNOLOGIES

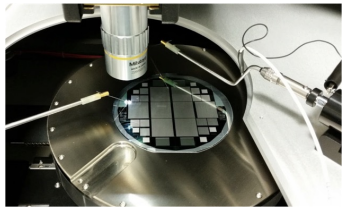
We are the leading national laboratory developing superconducting qubits for quantum computing applications in quantum annealing and the interaction of qubits with high energy radiation.

We've developed 1 spin-off with our technologies.

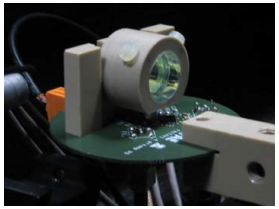
Technology and infrastructure



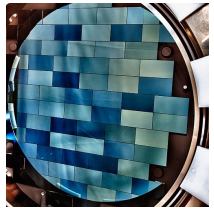
Medical imaging:
high resolution PET



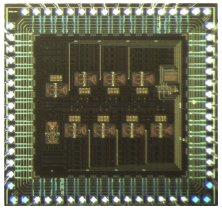
Novel 3D pixel silicon
detectors for LHC



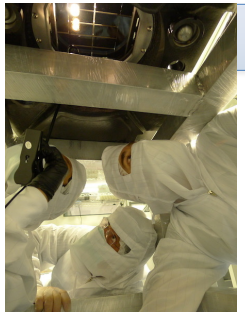
Silicon
photomultipliers



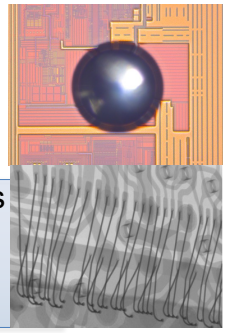
Large area
CCD readout



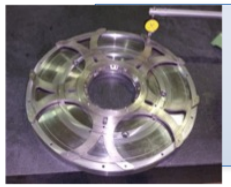
ASIC design



Clean rooms

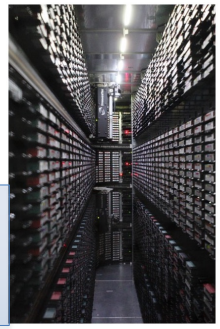


Microelectronics
integration:
bump & wire
bonding



Precision
mechanics:
design and
manufacturing

Massive data
processing
center



SCIENTIFIC OUTPUT

372
NUMBER OF INDEXED JOURNAL ARTICLES

82%
% ARTICLES IN FIRST QUARTILE JOURNALS

5.1
AVERAGE JOURNAL IMPACT FACTOR (IF)

TOP 5 JOURNALS WHERE IFAE PUBLISHED MOST FREQUENTLY IN 2022	NUMBER OF ARTICLES
Journal Of High Energy Physics	73
Monthly Notices Of The Royal Astronomical Society	68
Physical Review D	46
European Physical Journal C	35
Astronomy & Astrophysics	28

TOP 5 JOURNALS (BY IF) WHERE IFAE PUBLISHED IN 2022	
Living Reviews In Relativity	1
Nature Physics	1
Physical Review X	2
Astrophysical Journal Letters	19
Physical Review Letters	15

DOCTORAL THESES: 8

NUMBER OF PRESENTATIONS AT INTERNATIONAL CONFERENCES: 121

PROJECTS

29	10	15	5	2
MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD	EUROPEAN COMISSION	AGÈNCIA DE GESTIÓ D'AJUTS UNIVERSITARIS I DE RECERCA	FUNDACIÓ BANCARIA LA CAIXA	BIST

INTERNATIONAL COLLABORATIONS

TECHNOLOGY TRANSFER

The KTT unit at IFAE promotes the valorisation and exploitation of new technological solutions for societal and industrial challenges.

42%	30	3.2M€
OF OUR PORTFOLIO OF TECHNOLOGIES IS LICENSED FOR INDUSTRIAL APPLICATIONS	PRIVATE COMPANIES ENGAGED IN COLLABORATIVE R&D PROJECTS WITH IFAE	VENTURE CAPITAL RAISED BY SPIN-OFFS PARTICIPATED BY IFAE

SPIN-OFFS

QILIMANJARO QUANTUM TECH

Qilimanjaro's mission is to develop fast-to-market app-specific analog quantum computers with true quantum benefits by co-designing chips & algorithms and bypassing the qubit fragility barrier.

www.qilimanjaro.tech

Deep Detection

Deep Detection develops multispectral x-ray cameras with photon counting techniques for industrial inspection and material separation.

deepdetection.tech

baretek

Baretek offers microelectronic servcies for research, health and industry. The microelectronic assembly services include: state-of-the-art ASIC, FPGA and microcontroller assembly technologies.

baretek.eu.com

HUMAN RESOURCES

EXPERIMENTAL DIVISION

26	21	35
FACULTY	POST-DOCTORAL RESEARCHERS	DOCTORAL STUDENTS

THEORY DIVISION

15	6	4
FACULTY	POST-DOCTORAL RESEARCHERS	DOCTORAL STUDENTS

TECHNICAL SERVICES

23	25
	PIC

RESEARCH SUPPORT

15

annualreport.ifae.es

7 ICREA research professors
(4 in the last two years)

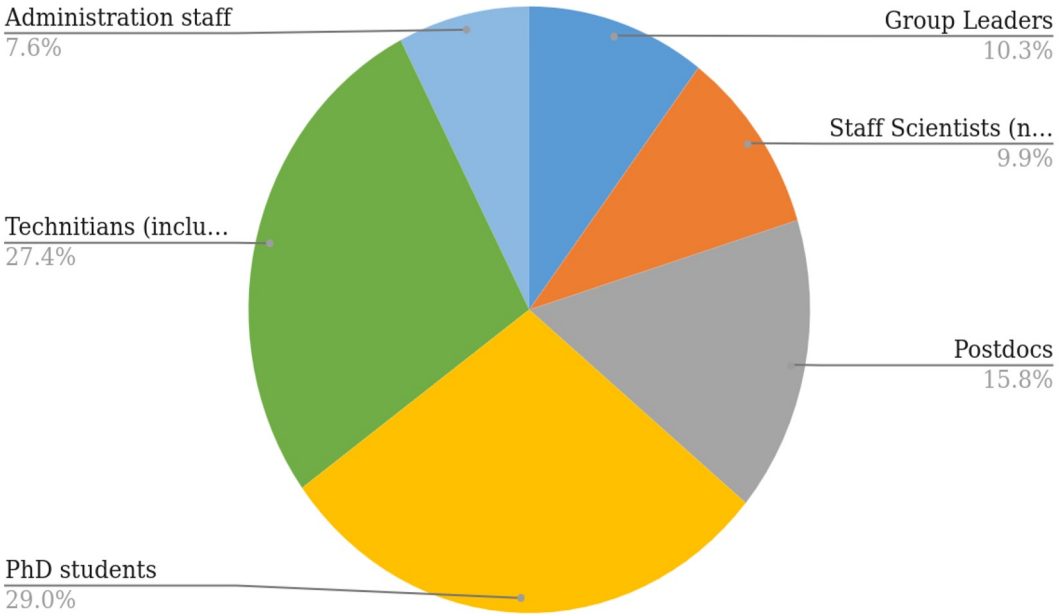
3 ERC in the last two years

The Chair of Scientific Committee is a Nobel Laureate (Barry Barish)

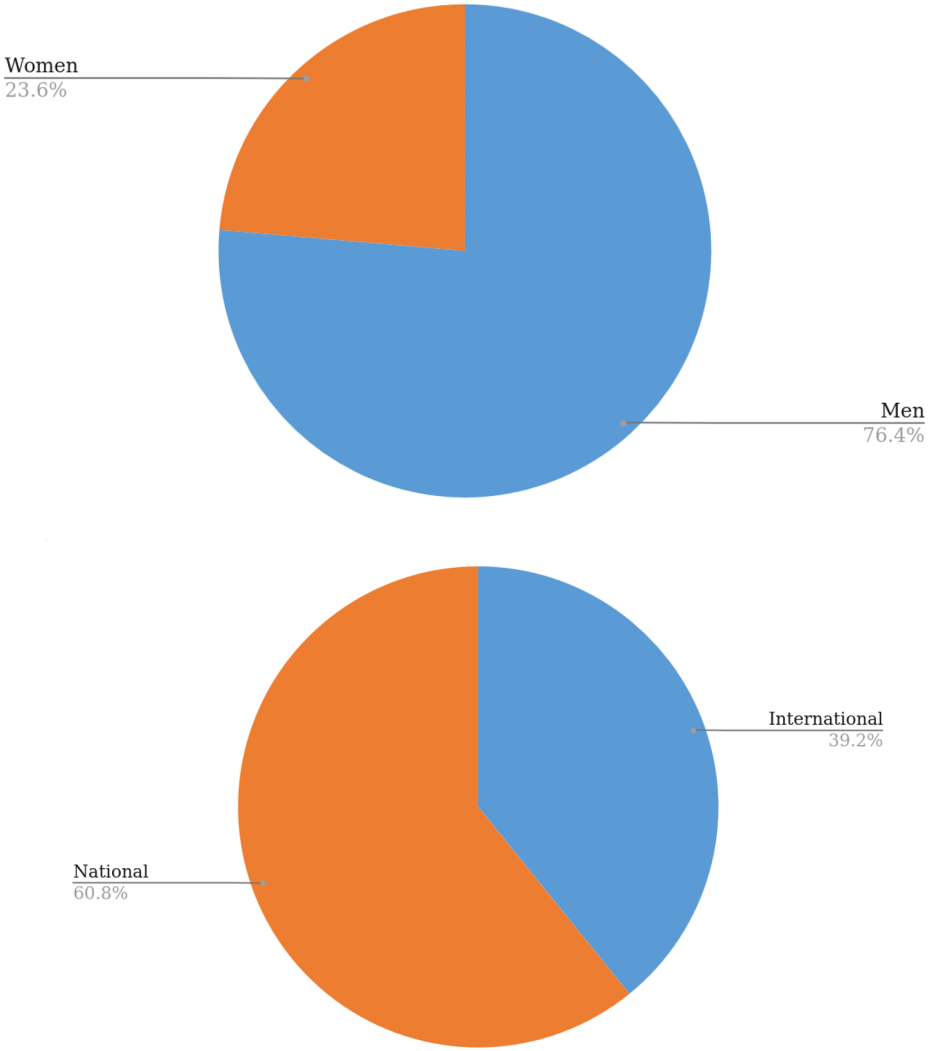
Breakthrough Prize Awardees

IFAE is Leader of the Spanish New Generation Europe Plan on HEAstrophysics

Total [FTE]



All Staff



bist SCIENTIFIC COMMUNITY

CRG IBEC ICFO ICIQ ICN2 IFAE IRB BARCELONA

Table 3. International Benchmarking by institutes (2016-2024)

Institute	AR	HCP	% HCP	Citations	Cit/AR
Massachusetts Institute of Technology (MIT)	62,539	3,168	5.07%	2,829,838	45,25
BIST	**10,283**	**370**	**3.6%**	**384,032**	**37.35**
California Institute of Technology (CALTECH)	31,214	1,242	3.98%	1,155,517	37.02
Weizmann Institute of Science (WIS)	12,471	461	3.7%	459,499	36.85
Imperial College London (ICL)	79,971	2,821	3.53%	2,744,180	34.31
Leibniz Association	57,888	1,255	2.17%	1,489,607	25.73
RIKEN	24,969	520	2.08%	621,414	24.89

Source: Science Citation Index Expanded.

1.2. Publications by centers

For the seven BIST centers, the distribution is as follows (in alphabetical order):

- Catalan Institute of Nanoscience and Nanotechnology (ICN2): 1,605 publications
- Center for Genomic Regulation (CRG): 2,016 publications
- Institute for Bioengineering of Catalonia (IBEC): 1,225 publications (since July 2017)
- Institute for High Energy Physics (IFAE): 2,038 publications
- Institute for Research in Biomedicine (IRB Barcelona): 1,281 publications
- Institute of Chemical Research of Catalonia (ICIQ): 1,275 publications
- Institute of Photonic Sciences (ICFO): 2,286 publications

From **Bibliometric report of the scientific production, Barcelona Institute of Science and Technology (October 2015 – September 2024)**

Benvinguts!

Welcome
Benvenuto
Bienvenue
Willkommen
Bienvenido
欢迎
ようこそ
Добро пожаловать
أهلاً وسهلاً
환영합니다