

FROM PARTICLES TO THE COSMOS

IFAE

IFAE
Institut
de Física
d'Altes
Energies

Report
of Activities
Summary 2015





First light of PAUCam in WHT, June 3rd 2015
Single exposure image using g r i filters

IFAE AT A GLANCE



founded in **1991**

140 people

three **divisions**: theory, experimental, technical

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

research lines: Particle Physics, Astroparticle Physics, Cosmology, Medical Imaging & Physics Instrumentation

one large **engineering** group (27 engineers and technicians)

collaboration in **8 international experiments** in high impact / leadership positions (ATLAS, MAGIC, DES, T2K, PAU, CTA, DESI, Euclid)

facilities: chip packaging & assembly, clean room, shielded room, electronics labs, optical lab, mechanical workshop (600 m²)

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

one spin-off company: **X-Ray Imatek**



SCIENCE AT IFAE

At IFAE we conduct experimental and theoretical research at the frontiers of fundamental physics, namely in Particle Physics, Astrophysics and Cosmology.

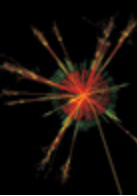
We are involved in the ATLAS project at the LHC, the T2K neutrino experiment in Japan, the MAGIC telescopes in La Palma, the Dark Energy Survey project in Chile and the Cherenkov Telescope Array, among others.

We focus our research on the hottest topics in fundamental physics from particles to the cosmos.

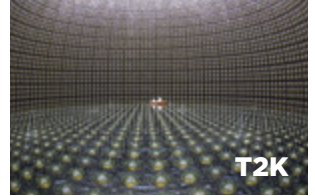
HIGGS PHYSICS
ANTIMATTER
DARK **MATTER**
DARK **ENERGY**
EXTREME **UNIVERSE**

EXPERIMENTAL
division

PARTICLE
PHYSICS



ATLAS



T2K

ASTROPARTICLES



MAGIC

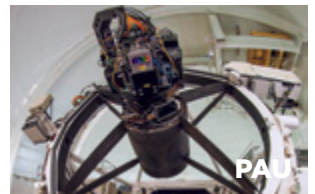


CTA

COSMOLOGY



DES



PAU



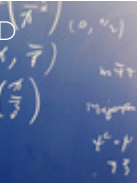
Euclid



DESI

THEORY
division

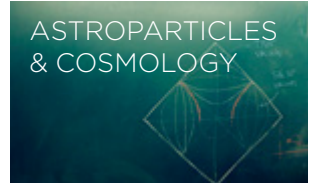
STANDARD
MODEL



BEYOND THE
STANDARD
MODEL



ASTROPARTICLES
& COSMOLOGY





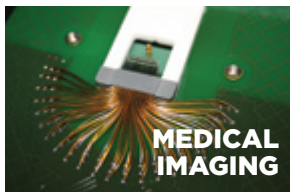
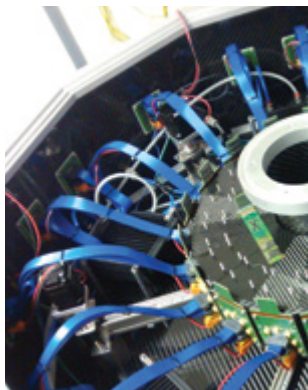
TECHNOLOGY AT IFAE

At IFAE we work at the cutting edge of detector technology developing pixel detectors for High Energy Physics, telescope cameras and detectors for medical imaging and other scientific and industrial fields.

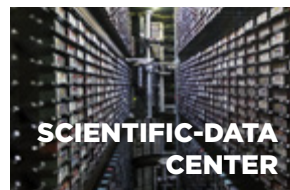
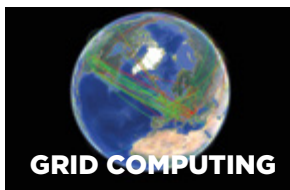
Our facilities include a microelectronics laboratory with state-of-the-art packaging and assembly technologies, a data center, a mechanical workshop, an electronics lab, an optical room and shielded room.

FRONT-END ELECTRONICS
GRID COMPUTING
CONTROL SYSTEMS
CRYOGENICS
READ-OUT ELECTRONICS
DETECTORS

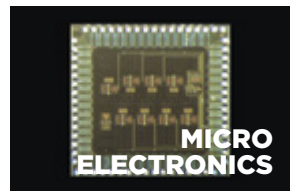
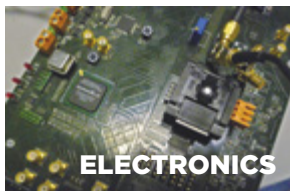
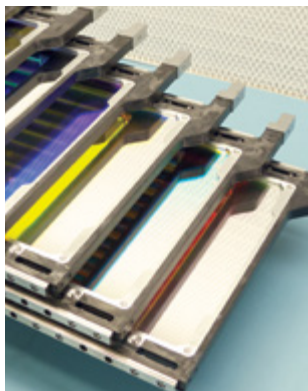
APPLIED
physics



**DATA
CENTER**



ENGINEERING

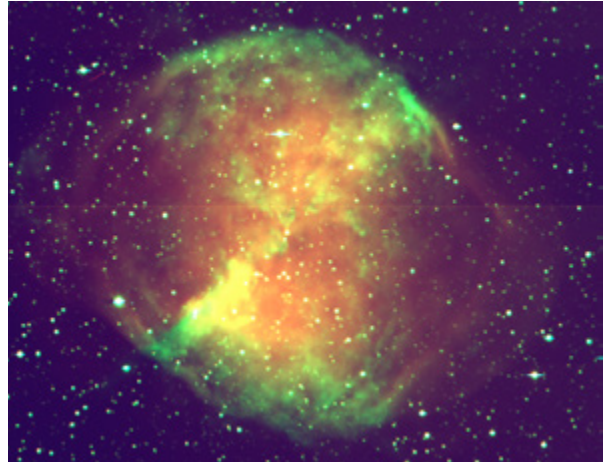


HIGHLIGHTS OF THE YEAR

PAUCAM FIRST LIGHT

On June 3rd 2015, the PAU Camera saw first light after a successful installation on the William Herschel telescope at the ORM on the island of La Palma

This instrument was designed and built at IFAE, in collaboration with the IEEC, PIC, CIEMAT and IFT/UAM, to precisely measure the distance to galaxies in order to study how the Universe is expanding ever more rapidly under the influence of the mysterious dark energy.



CTA-NORTH TO LA PALMA

The Cherenkov Telescope Array (CTA) Consortium chose La Palma as the site for its northern observatory on July 2015.

The foundation stone of the 20 telescopes of the array, the LST1, was placed on October 2015.

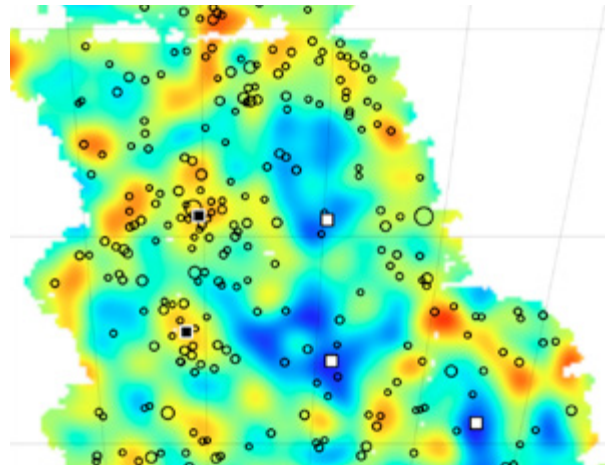
The instrument is designed to study high energy gamma rays. IFAE coordinates CTA-Spain and co-leads the LST project.

FROM PARTICLES TO THE COSMOS

DES DARK MATTER MAPS

In April 2015, The Dark Energy Survey released the first in a series of dark matter maps of the cosmos. These maps, created with one of the world's most powerful digital cameras, are the largest contiguous maps created at this level of detail and will improve our understanding of dark matter's role in the formation of galaxies.

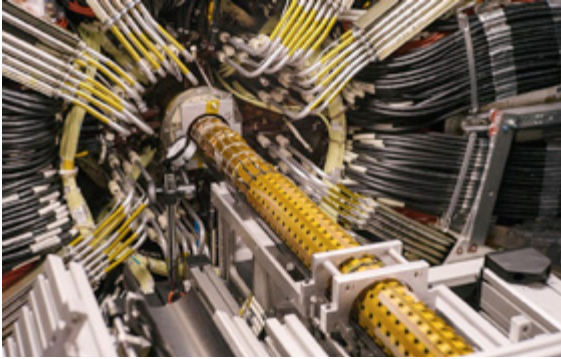
IFAE has participated in the DES project since the beginning.



BREAKTHROUGH PRIZE

On November 2015, several international experimental collaborations studying neutrino oscillation were awarded the prestigious Breakthrough Prize for Fundamental Physics, for their role in the discovery and study of neutrino oscillation.

IFAE members from the neutrino group were awarded for their contribution to the T2K experiment and its predecessor K2K.



LHC RUN2 & ATLAS PIXELS

After a 2-year shutdown, CERN's Large Hadron Collider started its Run 2 on June 2015 providing the experiments with collisions at the unprecedented energy of 13 TeV.

For this Run2 of the LHC, the ATLAS Pixels group at IFAE has made critical contributions to the IBL detector that is now taking data in the core of the ATLAS detector.

IFAE MICROELECTRONICS LAB

In 2015 the IFAE microelectronics laboratory was equipped with state-of-the-art packaging and assembly technologies, including automated wire-bonding, flip-chip and device inspection facilities hosted in a clean room.

IFAE expertise in microelectronics is focused on the development of solid-state radiation pixel detectors for high energy physics experiments and medical radiology.



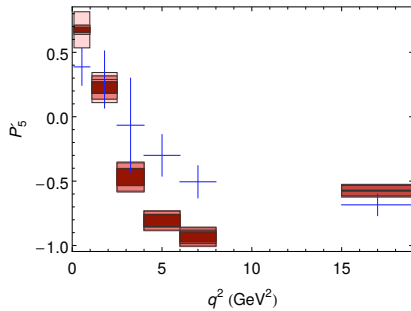
IFAE JOINS THE BIST

Six top Catalan research centres have created "The Barcelona Institute of Science and Technology" (BIST) to pursue joint scientific endeavours.

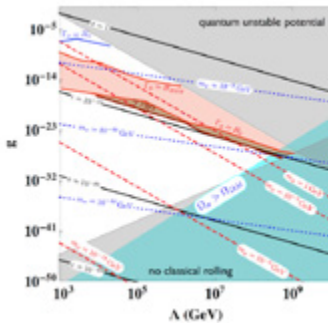
The Barcelona Institute emerges as one of the leading scientific institutes in Europe and will coordinate and promote joint research strategies, transfer of technology, and graduate programs.

IFAE THEORY DIVISION

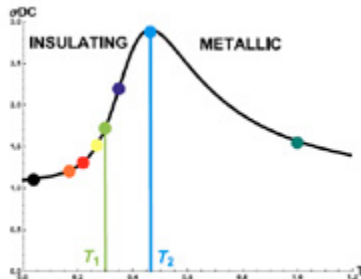
The research activities of the Theory Division during 2015 continued along three lines: Standard Model Physics, Beyond the Standard Model and Astroparticle Physics & Cosmology. These are three of the highlights of the research in the division:



New LHC data has confirmed an anomaly in the decay distribution $B \rightarrow K^* \mu^+ \mu^-$ when compared to the Standard Model prediction, using an observable put forward by physicists in the division.



A new, elegant mechanism to solve the hierarchy problem in the Standard Model appeared in 2015. One of the fundamental papers in its development was written by a collaboration of six theoretical physicists at IFAE. The mechanism is based on the interplay between two axion-like scalars and the Higgs particle in the early universe.



The very powerful gravity/gauge duality conjecture has been used to study condensed matter systems and, in particular, to successfully model metal/insulator transitions driven by electron-phonon interactions.

SCIENTIFIC OUTPUT IN 2015

181

NUMBER
OF INDEXED
JOURNAL
ARTICLES

89.5%

% ARTICLES
IN FIRST QUARTILE
JOURNALS

5.2

AVERAGE
JOURNAL
IMPACT
FACTOR (IF)

TOP 5 JOURNALS (BY IF) WHERE IFAE PUBLISHED IN 2015

	NUMBER OF ARTICLES
Rev. Mod. Phys. (IF 29.6)	1
Phys. Rev. Lett. (IF 7.5)	16
Phys. Lett. B (IF 6.1)	14
J. High Energy Phys. (IF 6.1)	38
Astrophys. J. (IF 5.9)	5

TOP 5 JOURNALS WHERE IFAE PUBLISHED MOST FREQUENTLY

J. High Energy Phys. (IF 6.1)	38
Phys. Rev. D (IF 4.6)	35
Eur. Phys. J. (IF 5.0)	26
Phys. Rev. Lett. (IF 7.5)	16
Mon. Not. Roy. Astron. Soc. (IF 5.1)	16

DOCTORAL THESES: 10

NUMBER OF PRESENTATIONS AT INTERNATIONAL CONFERENCES: 151

HUMAN RESOURCES IN 2015



EXPERIMENTAL DIVISION

23

FACULTY

19

POST-DOCTORAL
RESEARCHERS

29

DOCTORAL
STUDENTS

THEORY DIVISION

14

FACULTY

4

POST-DOCTORAL
RESEARCHERS

12

DOCTORAL
STUDENTS

TECHNICAL SERVICES

25

RESEARCH SUPPORT

12

PROJECTS IN 2015

21

MINISTERIO DE
ECONOMÍA Y
COMPETITIVIDAD

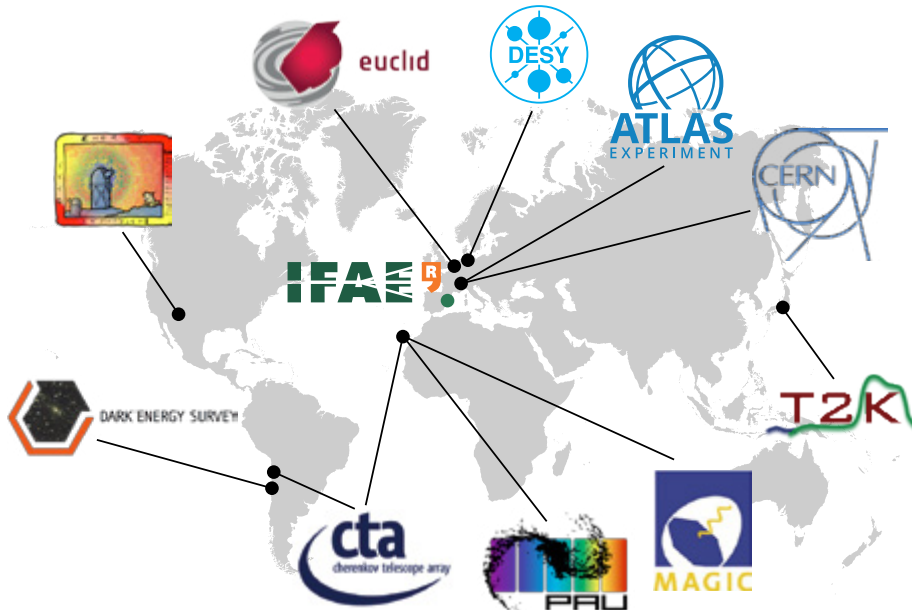
6

EUROPEAN
COMMISSION

3

AGÈNCIA DE
GESTIÓ D'AJUTS
UNIVERSITARIS I
DE RECERCA

INTERNATIONAL COLLABORATIONS



TECHNOLOGY TRANSFER IN 2015



IFAE performs frontier research in particle physics, astrophysics, and cosmology, fields of knowledge requiring advanced engineering, electronics and software technologies not existing in the market. IFAE research & engineering teams develop their own technology, transferring it to industry by means of joint ventures, partnerships, R&D agreements, technical services based on singular scientific infrastructures, training sessions, consultancy, licensing and spin-off creation.

0.4M€

COMPETITIVE FUNDS
FOR COLLABORATIVE
RESEARCH ACTIONS
WITH PRIVATE SECTOR

1

PCT APPLICATION
IN RADIATION
DETECTION

125K€

NON COMPETITIVE FUNDS
COMING FROM INDUSTRIAL
AGREEMENTS AND SERVICES
OFFERED TO EXTERNAL
ENTITIES

1

EUROPEAN PATENT
APPLICATION FILED
IN MEDICAL IMAGING



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Obra Social "la Caixa"