



High Energy Physics in Spain (for skeptical physicists)*

π^-

k^0

π^+

p

Λ

π^-



π^-

Juan A. Fuster Verdú - IFIC, València
102nd Plenary ECFA Meeting
Barcelona-ALBA, 19-20 July 2018

* Copied from Juan Eslava Galán

Acknowledgements

Thanks for discussions, information and providing material to:

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- All Spanish groups.

Spain in Europe



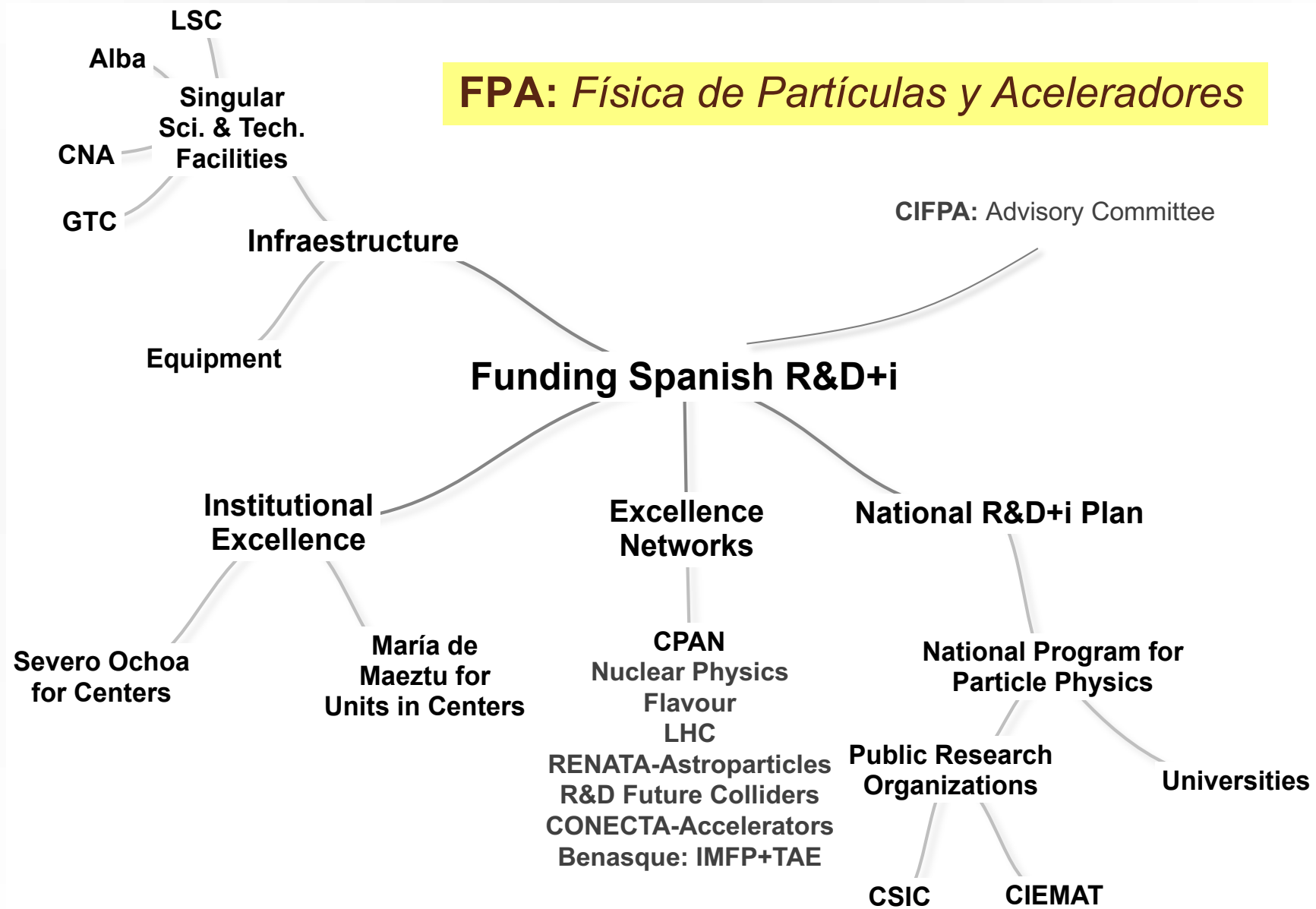
Geo. Size: 505 370 km²

Population: 46 659 302 (2018)

***9,2%-10.5% of EU population
(including-excluding UK)***

~ 8% of CERN budget.

HEP-Spain: Organization and Funding



Organization and Funding: who ?

Regional Governments

Universities: (50 public+ 33 private)

Over 18 with active programs in HEP

Some have **joint Institutes with CSIC**

IFIC Valencia

IFCA Santander

IFT Madrid

Some others are **Institutes (co-)funded by regional governments**

IFAE Barcelona

ICCUB Barcelona

CAFP Granada

IGFAE Santiago

Ministry of Science, Innovation

CSIC (Spanish Research Council)

~120 Research Institutes

IFIC,IFCA,

IEM, IFT

IAA, ICE, CNM-IMB

CIEMAT

Basic Research Dept.

+

Technology, Accelerators..)

Others co-funded

LSC

PIC

ALBA

IAC

CNA

These Institutions are the main sources providing personnel (permanent) and infrastructures

Organization and Funding: which areas ?

Collider Physics

Experiment (all) & Theory (all)

Nuclear Physics

Experiment (all) & Theory (some)

Astroparticle Physics & Neutrinos & Cosmology

Experiment (most) & Theory (some)

Information Technology

GRID (all), e-Science (some)

R&D in Accelerators and Detectors

(some)

Physics Applications

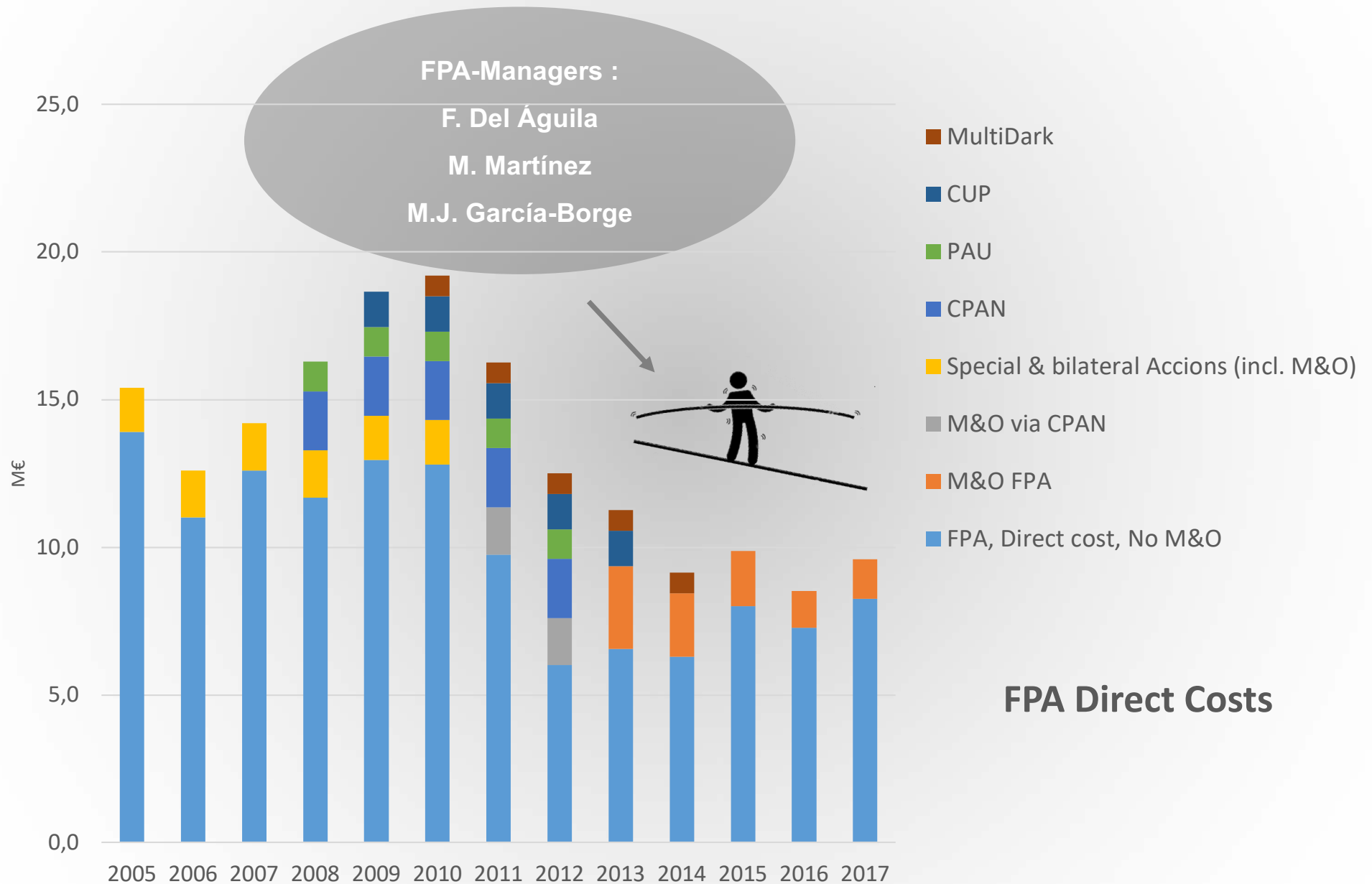
Medical Physics (some)

FPA landscape

COLLIDERS	ASTRO/COSMO /NEUTRINOS/	NUCLEAR PHYS	R&D	THEORY
ATLAS	T2K	ISOLDE	ACCELERATORS	LHC Pheno
CMS	DCHOOZ	N-ToF	DETECTORS	Lattice
LHCB	WA105/protoDUNE	FAIR-RELATED	MEDICAL PHYS.	String/EFT
GRID	CAST/IAXO	AGATA		Nuclear Phys.
ILC/CLIC/FCC	LSC-RELATED (ArDM, ANAIS, NEXT, TREX,..)	OTHERS	
ALICE	DES/PAU/DESI			
	CTA			
	MAGIC			
	ANTARES/KM3NeT			
	LIGO			
	Pierre-Auger			

Mario Martínez, IMFP-2018,
Salamanca

Organization and Funding: Funding profile



Organization and Funding: Excellence Programme

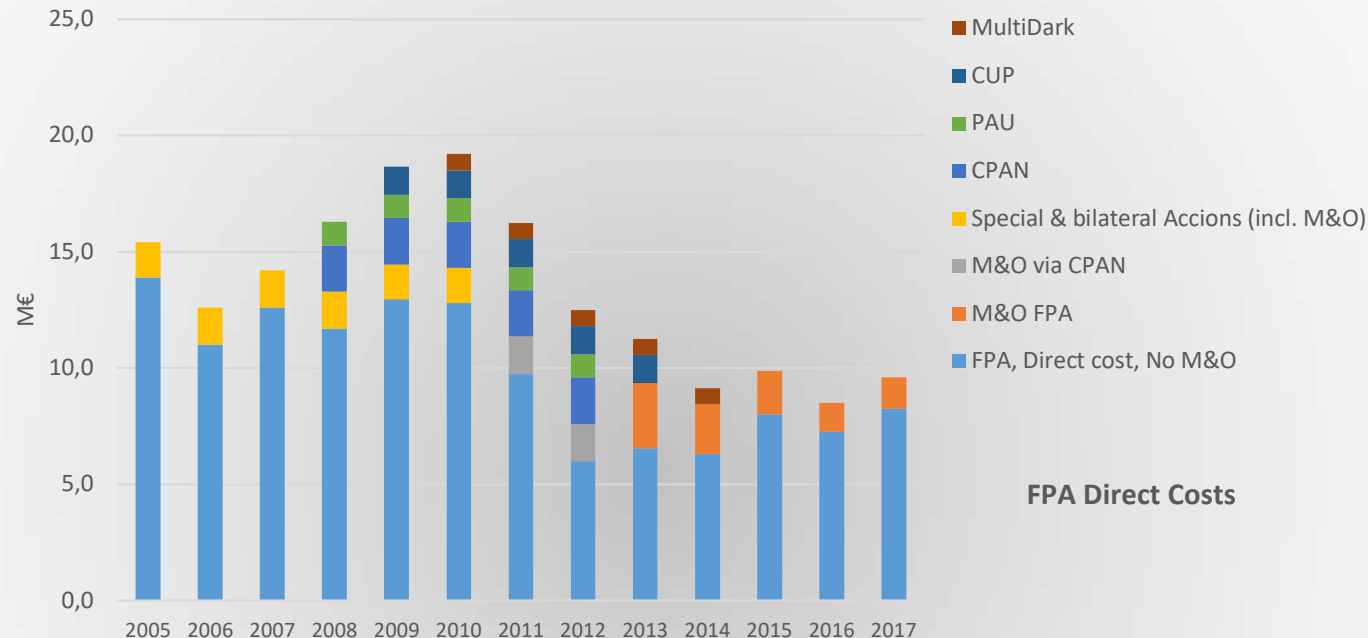
Spanish Excellence Programme (started in 2012):

These nominations represent a recognition of scientific excellence, extra funding and additional PhDs grants.

- *Severo Ochoa Centres –SO-* (1 M€/year):
 - IFT (Instituto de Física Teórica, Madrid)
 - IFAE (Institut de Física de Altes Energies, Barcelona)
 - IFIC (Institut de Física Corpuscular, València)
- *María de Maeztu Units –MdM-* (0,5 M€/year):
 - CIEMAT (Física de Partículas - Centro de Investigaciones Eneegéticas, Medioambientales y Tecnológicas, Madrid)
 - ICCUB (Institut de Ciències del Cosmos, Barcelona)
 - IGFAE (Instituto Gallego de Física de Altas Energías, Santiago de Compostela)
 - IFCA (Instituto de Física de Cantabria, Santander)

In total there are 30 SO and 23 MdM. Our field has 7 Centres (16%)

Organization and Funding: Funding profile+S8a+MdM



Period >2011 represents ~60% of previous funding in average.

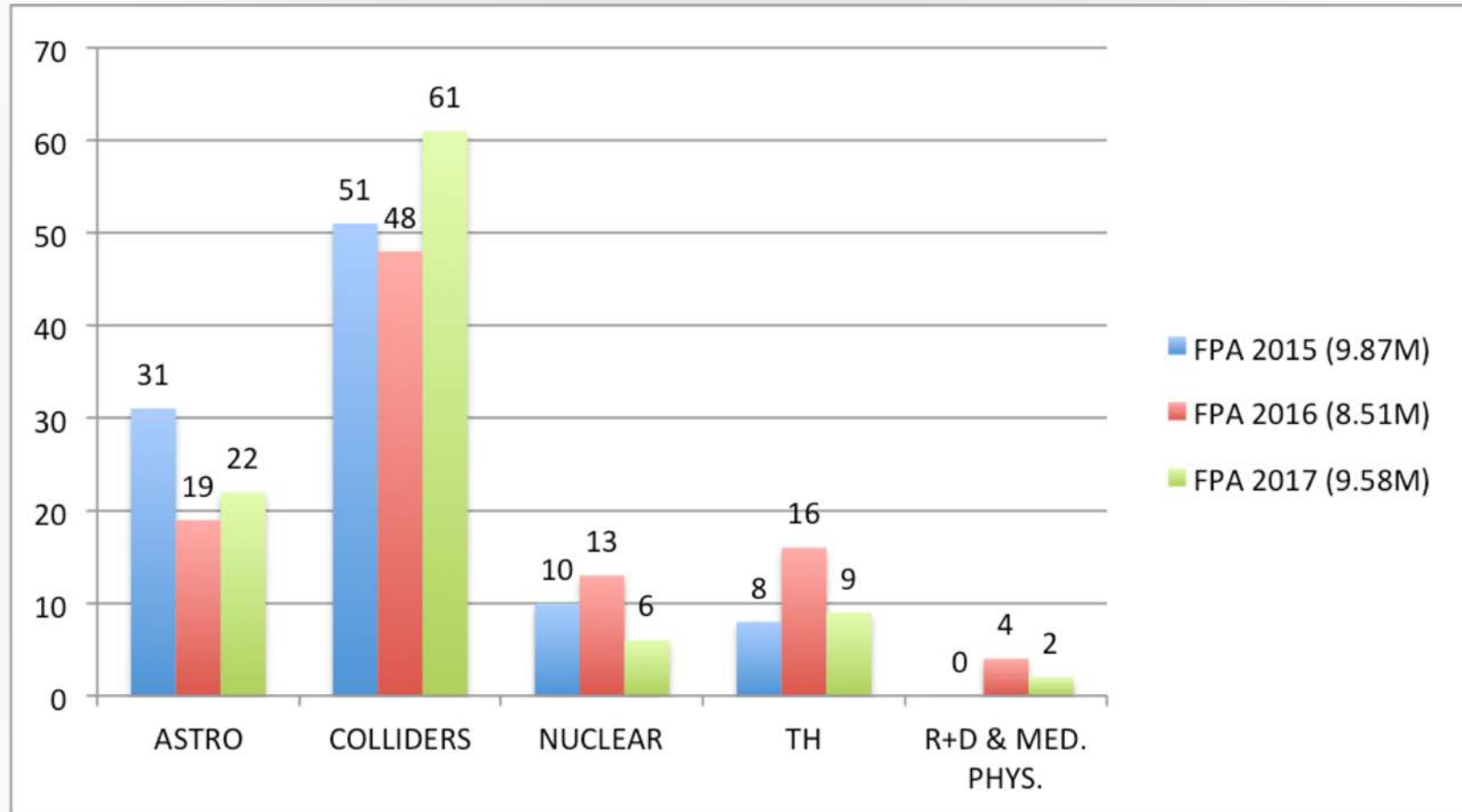
Spanish Excellence Programme (SO and MdM) helps to survive but only to some Institutes. Increases the difference between groups.

Present structure penalizes M&O contributions with additional 21%

Big challenge with present situation for HL-LHC contributions

Organization and Funding: funding per areas ?

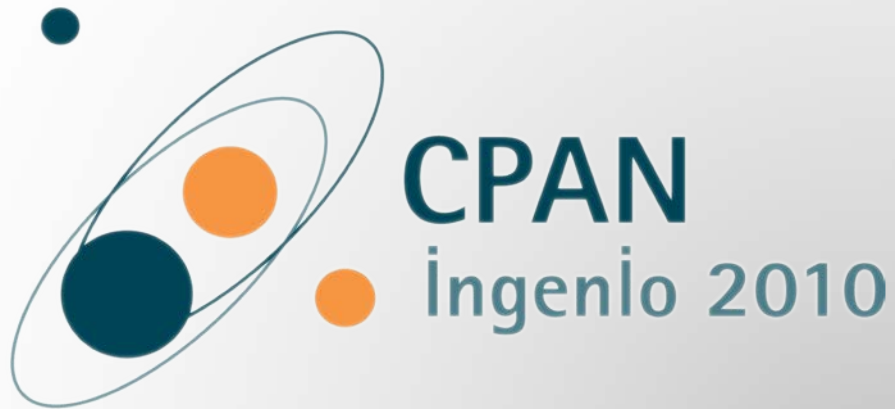
Distribution of funding per areas over past three years (%)



Astro 24%; Colliders+GRID 53%; Nuclear 10%; Theory 11%; R&D+App. 2%

Mario Martínez, IMFP-2018, Salamanca

CPAN: our most serious attempt to organize ourselves



<http://www.i-cpan.es>

Consolider – Ingenio 2010

2007 – 2015

Now: Excellence Network

“The Mother of all Networks”

Coordinators:

Antonio Pich (IFIC)

Marcos Cerrada (CIEMAT)

**NATIONAL CENTER FOR PARTICLE,
ASTROPARTICLE AND NUCLEAR PHYSICS**

A kind of “virtual” national center funded by the CONSOLIDER-INGENIO program as an *interim solution* towards a real National Centre.

The missions of this organization:

1. Creation of the National Centre for Particle, Astroparticle and Nuclear Physics.
2. Advise Ministry of strategies and priority lines of the field. **Coordination** of the Spanish participation in the large **international projects**
3. **Representation** of the Community.
4. **Human resources** (technicians, post-docs, young scientist)
5. **Technology Transfer**
6. **Scientific Training and Outreach**

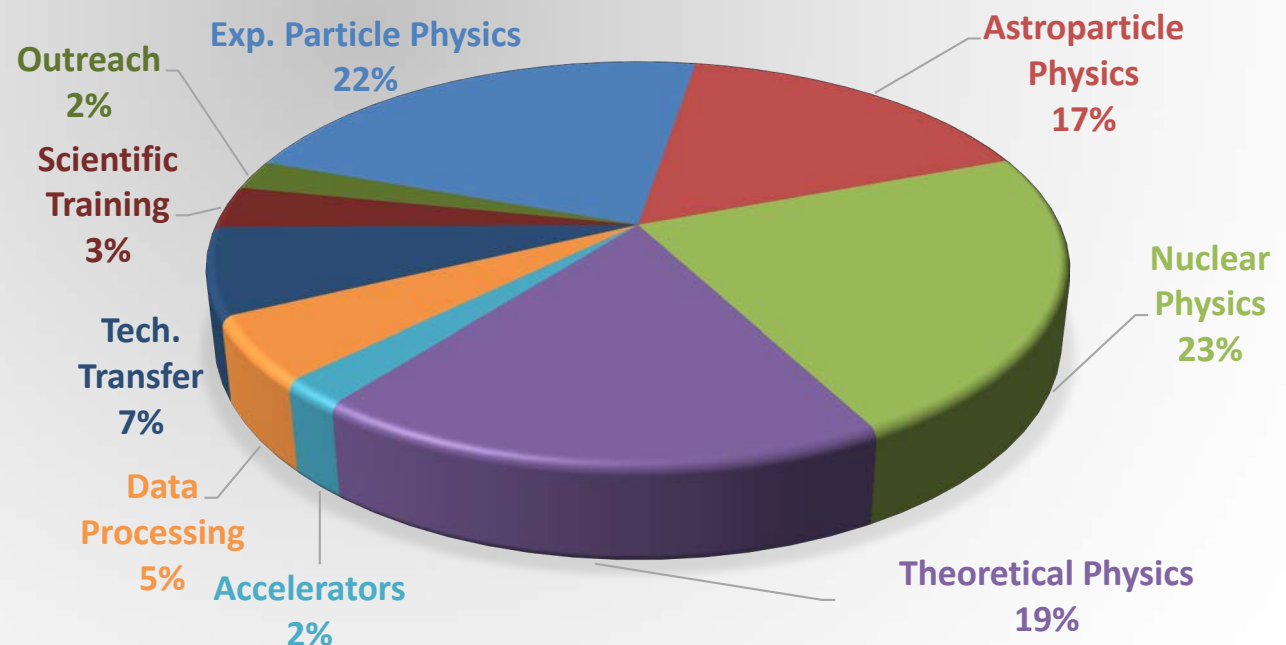
CPAN: achievements

- CPAN has helped considerably in
 - Promoted coordination actions and the strategies by the organization of >130 events (scientific meetings, workshops and conferences)
 - Helping the different areas with human resources (160 contracts)
 - And fostering Technology Transfer and Outreach
- Unfortunately, CPAN is now over.
 - We are left with a nice structure supported by small money given for networking

Waiting for better times !!

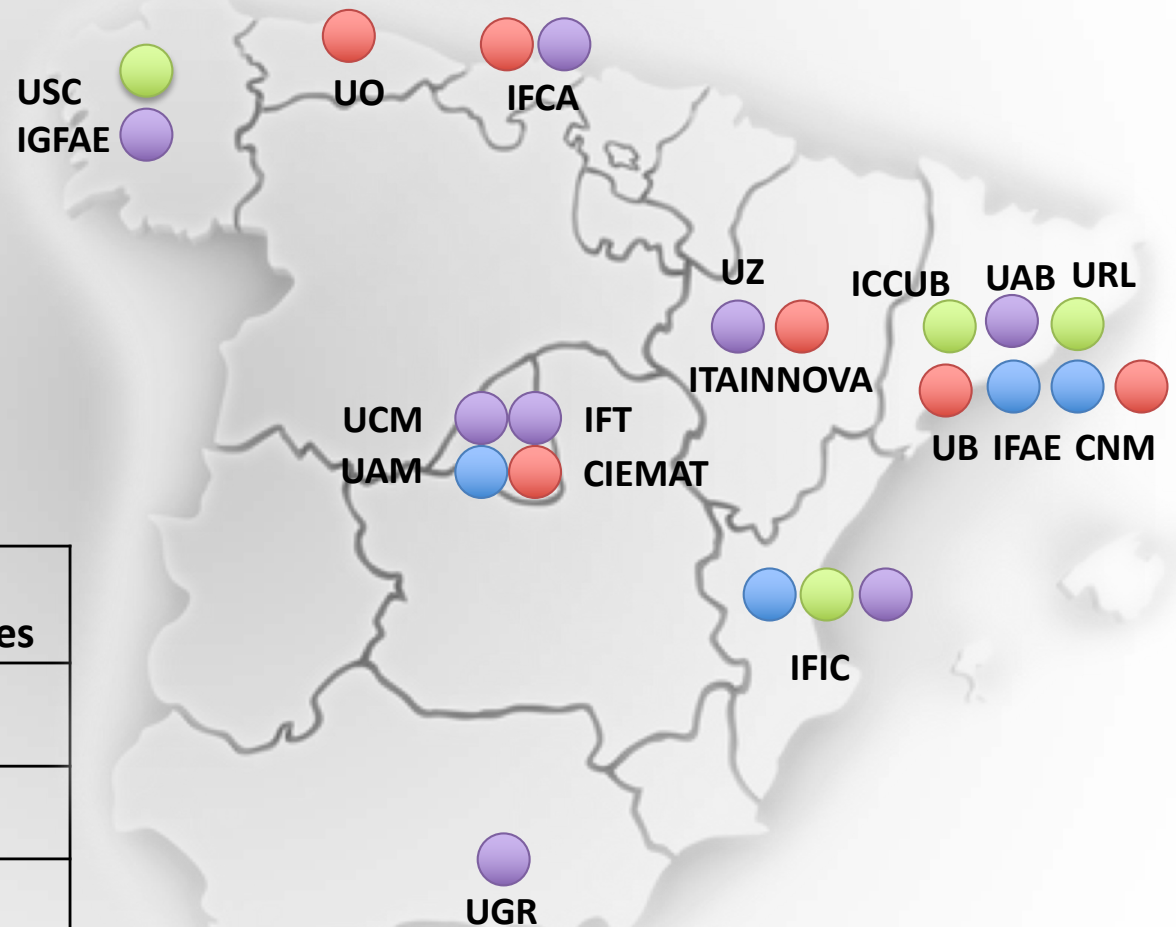
Carlos Lacasta
(2015 mid-term review)

Still true !!!



LHC & Flavour Networks

The aim of these networks is to **strengthen cooperation** among the Spanish groups involved in LHC, both **theoretical and experimental** groups, and **organize the participation in their detector upgrades** along the HL-LHC schedule.



Experiment	Number of Institutes/Universities
ATLAS	4 ●
CMS	6 ●
LHCb	4 ●
Phenomenology	8 ●

LHC & Flavour Networks



Semiconductor Tracker (SCT)
(IFIC, CNM), 1.5%

Liquid Argon Cal. (LAr)
(UAM), 3.0%

Tile Cal. (TileCal)
(IFAE, IFIC), 11.9%

Insertable B-Layer (IBL)
(IFAE, CNM), 1.3%

Operation and Physics
analyses: Higgs, top,
searches, QCD-jets, EW..

Muon Barrel Drift Tubes
(CIEMAT), 16%

Alignment System
(IFCA, CIEMAT), 37.7%

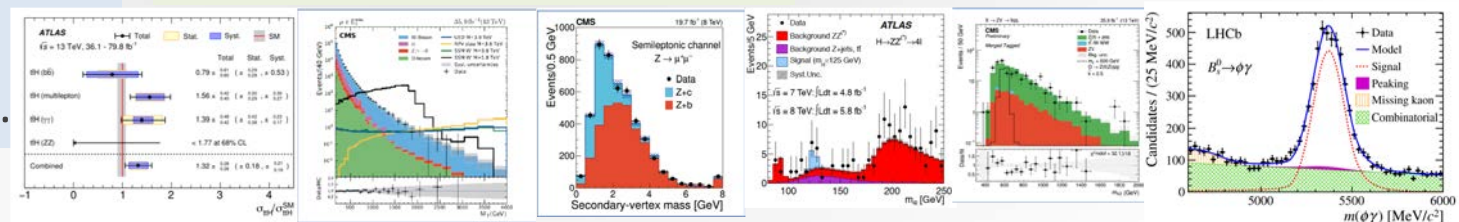
Trigger
(UAM), 0.1%

Operation and Physics
analyses: Higgs, top,
searches, QCD-jets, EW..

Silicon Tracker (ST)
(USC), 16%

Scintillator Pad Det. (SPD)
(UB, URL), 16%

Operation and Physics
analyses: Radiative decays
dipole moments for heavy
and strange baryons, $B_s \rightarrow \mu\mu$

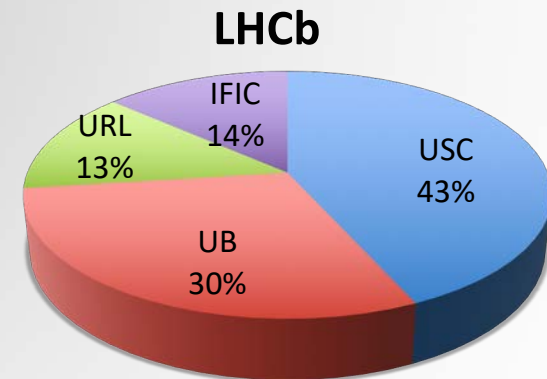
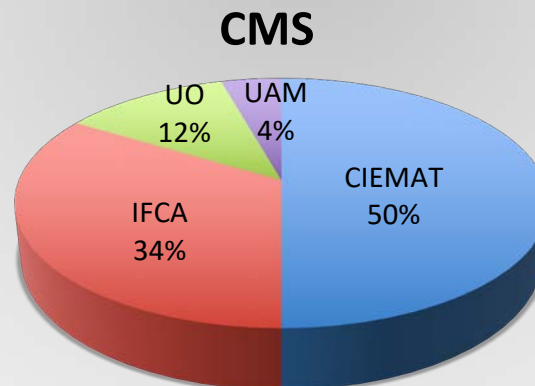
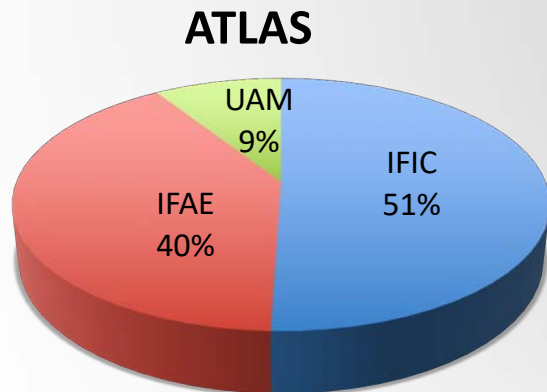


J. Fuster

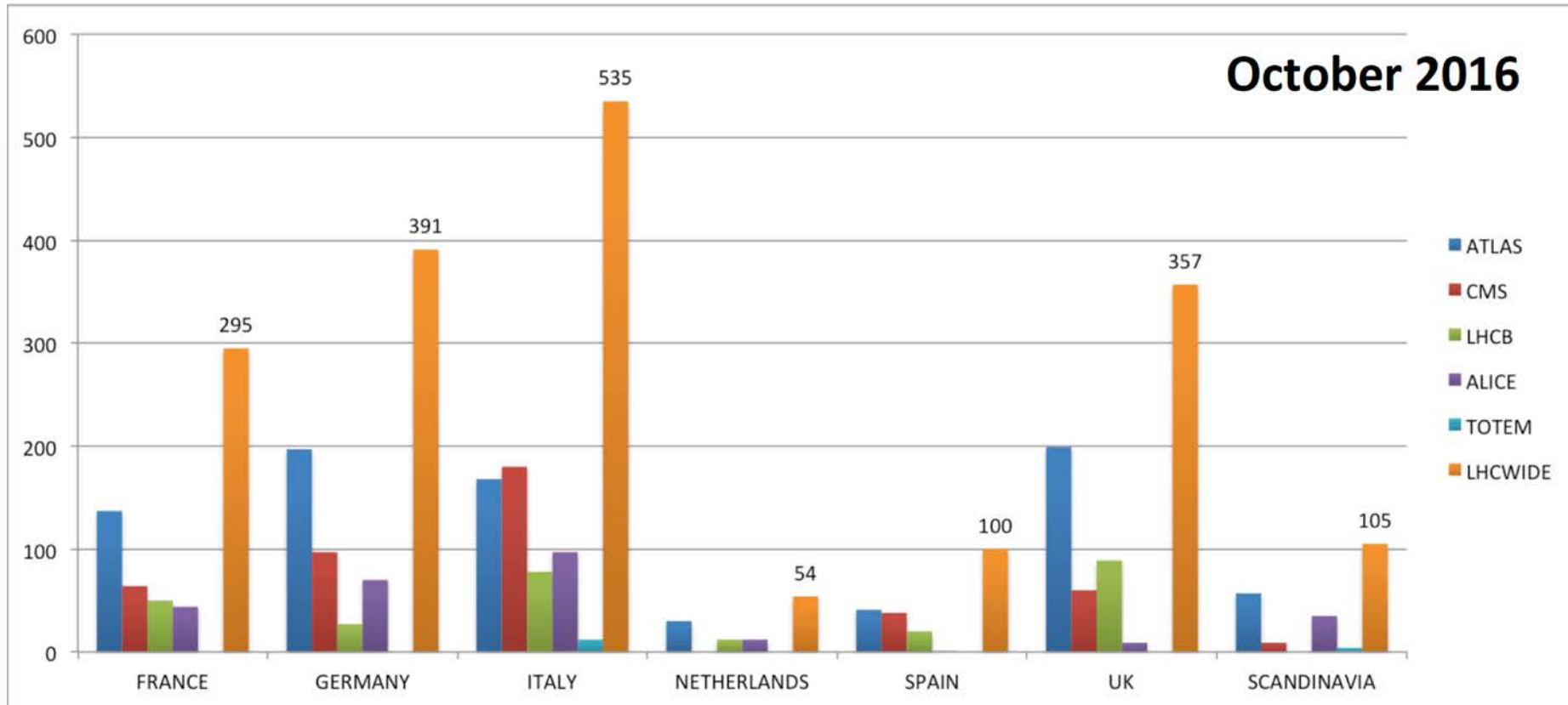
LHC & Flavour Network

Current Spanish participation in the LHC collaborations

	# of physicists, engineers and technicians	Institutions
ATLAS	90	IFIC, IFAE, UAM, (CNM)
CMS	92	CIEMAT, IFCA, UO, UAM, (ITAINOVA)
LHCb	37	USC, UB, URL, IFIC



LHC & Flavour Network: # PhDs



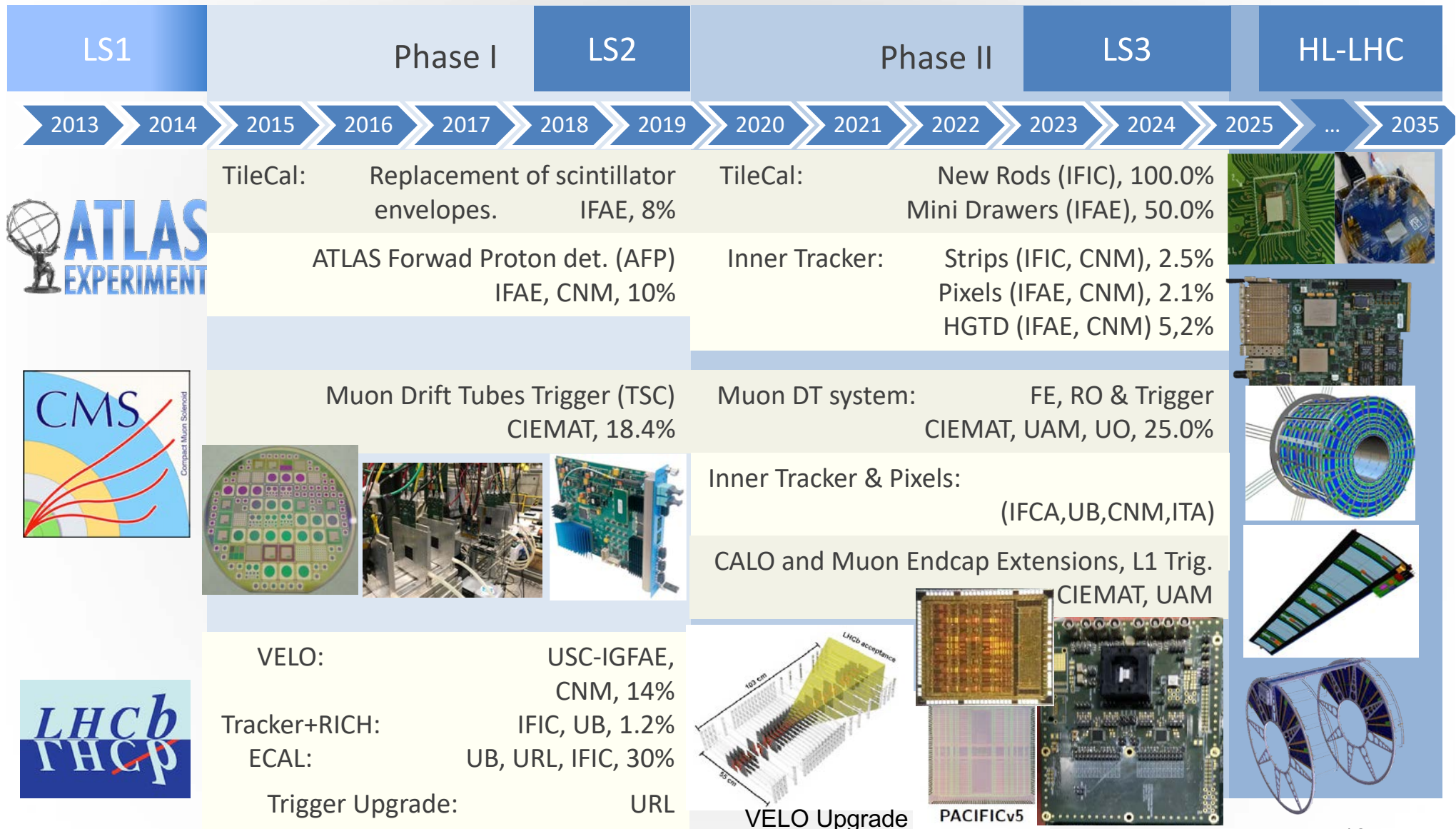
115 PhDs

October 2017	# Doctors	% in experiment
ATLAS	49	2.62
CMS	42	3.00
LHCb	24	4.67

* Spain left ALICE in July 2017

LHC & Flavour Network

The upgrades for the HL-LHC



LHC & Flavour Network: HL-LHC upgrades

- Meeting with E. Elsen (CERN Sc. Director) and C. Vela / M. Villegas in November 2017
 - We already knew the results (preliminary) of FPA2017 and gave the message we cannot push further FPA program to accommodate LHC upgrades.
 - E. Elsen and myself coordinated to give the clear message the community needs this extra 3M€ in 2018 for ATLAS and maintain it in the future for CMS and LHCb
 - Anticipated also the need to sign MoUs for upgrade early 2018 for ATLAS and CMS (LHCb MoUs never signed)
- In January 2018 MINEICO accepted to sign the MoUs for Common Funds for the ATLAS & CMS upgrades (about 1M€ per experiment)

Mario Martínez, IMFP-2018, Salamanca



Next steps

- Secure the money for upgrades for the 3 experiments
- Try again to pull M&O costs out of the FPA base funding
- 2018 is a critical year for ATLAS and CMS upgrades (TDRs, MoUs)
- Regularize LHCb MoU situation

LHC & Flavour Network: HL-LHC upgrades

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Mario Martínez, IMFP-2018, Salamanca

HL-LHC funding commitments still under discussion with Ministry !!



Next steps

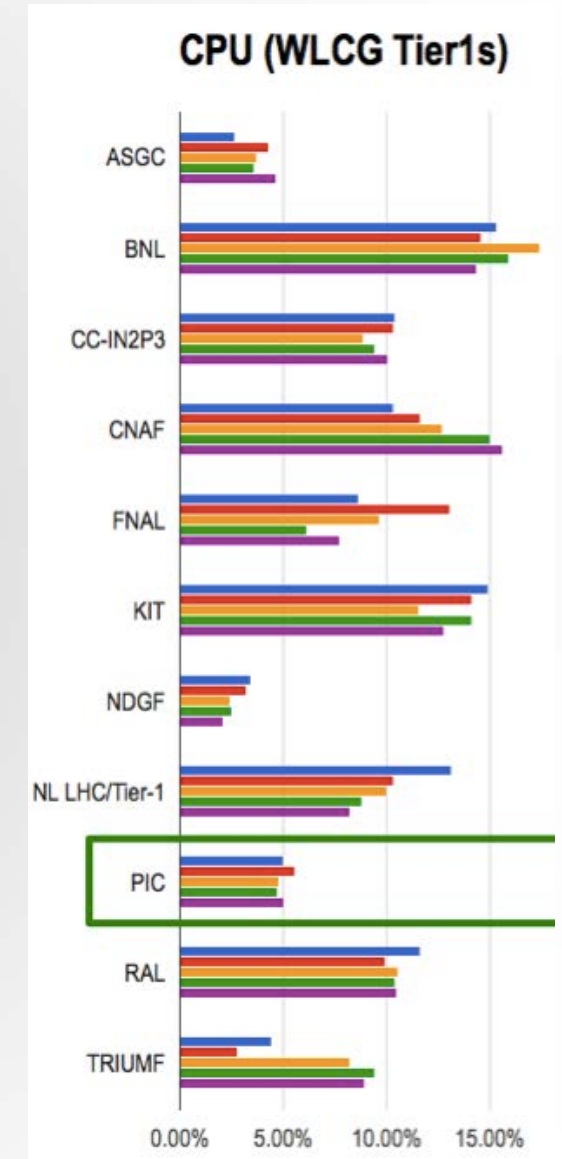
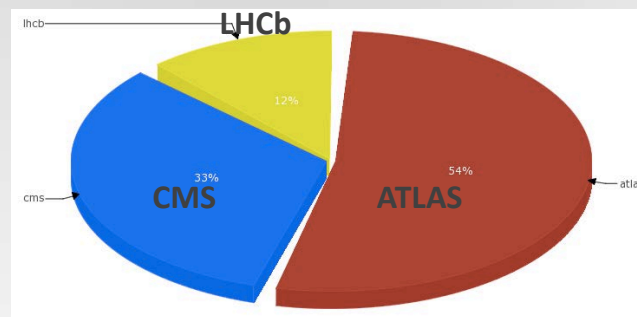
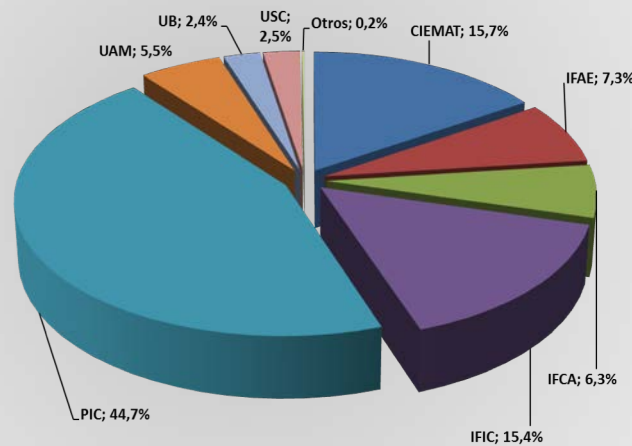
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LHC & Flavour Networks: Computing GRID

Spain has a Tier 1 (PIC) in Barcelona and three federated Tier-2 that contribute with 5% of the whole computing resources of the LHC experiments (ATLAS, CMS and LHCb).

Average funding (2007-2014)

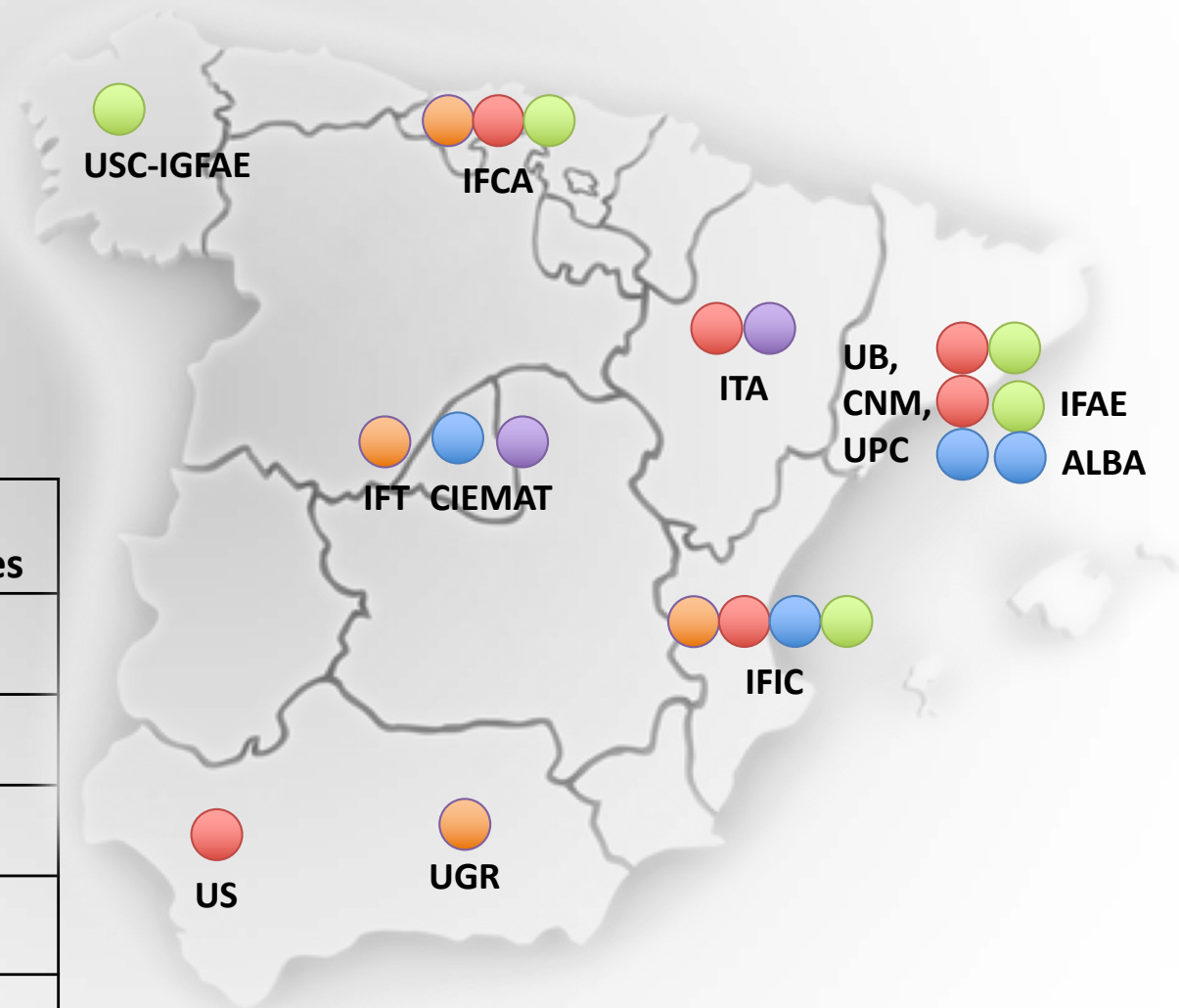
Site	k€ / year
Tier1 (PIC)	772
Tier2-ATLAS (IFIC, IFAE, UAM)	487
Tier2-CMS (CIEMAT, IFCA)	349
Tier2-LHCb (UB, USC)	111








Future accelerators network

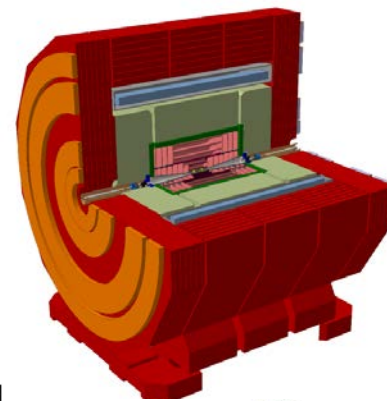
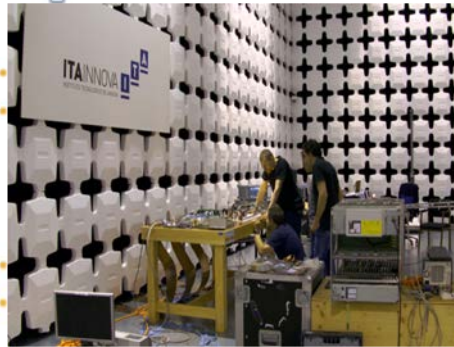
This network coordinates the activities on **physics studies** and development of **new technologies** for **future colliders** like ILC, CLIC, FCC, etc. including both detector and accelerator activities

Covers: Physics studies, Detector R&D and Accelerator R&D



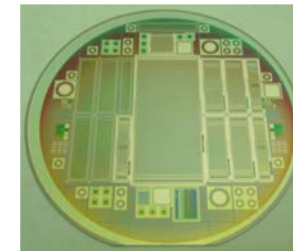
Activity	Number of Institutes/Universities
Accelerator	4 
Si/Tracking	6 
Si/Pixel	5 
Calorimetry	2 
Phenomenology	4 

Future accelerators network

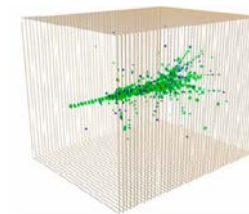
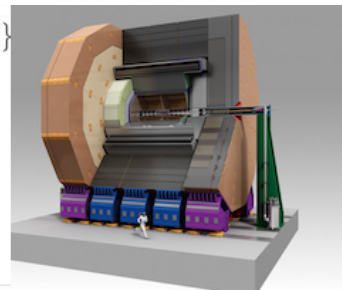
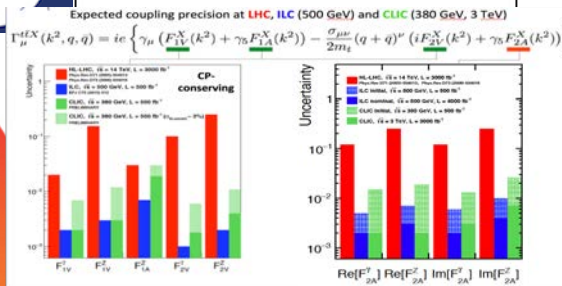


Pixel Detector
Encapsulation
R/O electronics
FOS env. monitor

Light Mechanical Structures.

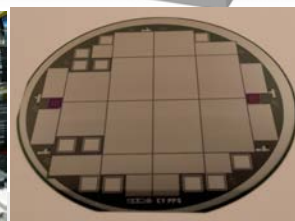


Microchannel cooling.
CMOS SPAD
Powering
 μ -strip sensors



- Charge division
- LGAD

RO Electronics

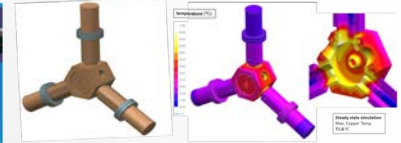
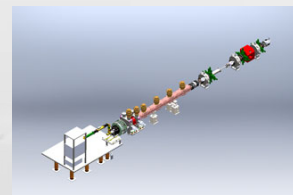
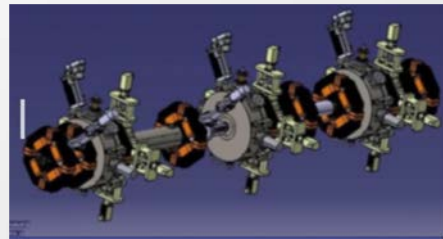
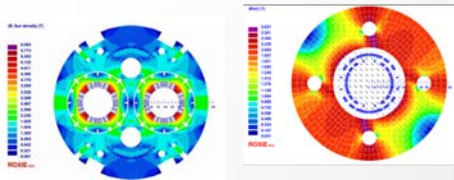


SDHCAL
Semidigital
Hadronic
Calorimeter



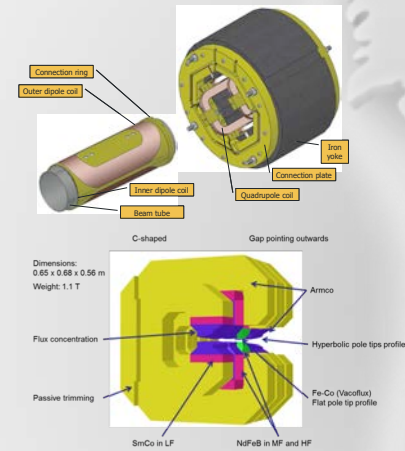
Accelerators:
See talk by F. Pérez

Accelerators



COordinación
Nacional
Española para la
Ciencia y
Tecnología de
Aceleradores

See talk by F. Pérez

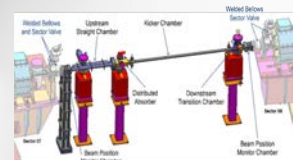


Bilbao
ESS

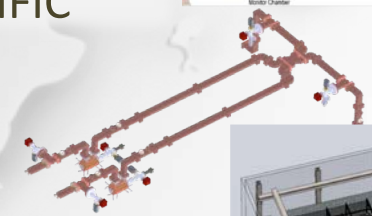
Madrid
CIEMAT, CMAM-UAM



Barcelona
UPC, ALBA

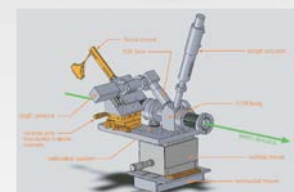
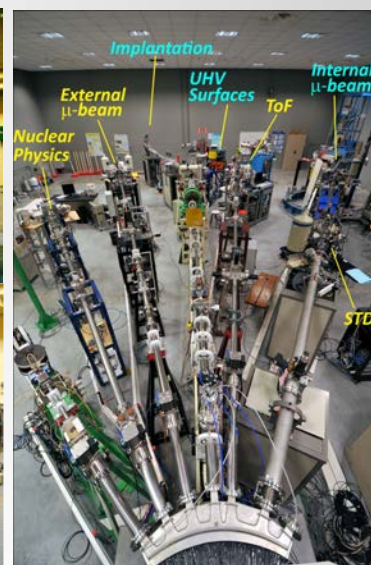


Valencia
IFIC

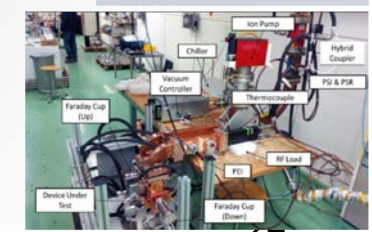
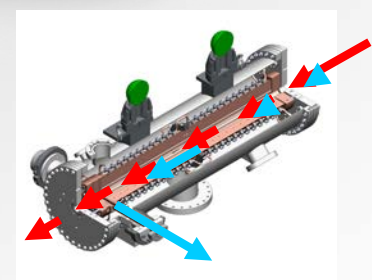


Huelva
UHU

Sevilla
CNA



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Z-T

Astroparticle & Neutrinos & Cosmology: RENATA network



RENATA

Spanish National Astroparticle Network

19 Institutions

34 research groups

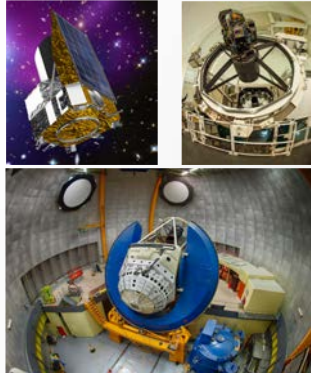
**approx. 200
researchers**
(including PhD stud.)

Similar to LHC-
Community

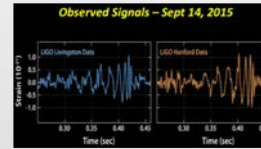
Numbers refer to # of research groups

Astroparticle & Neutrinos & Cosmology

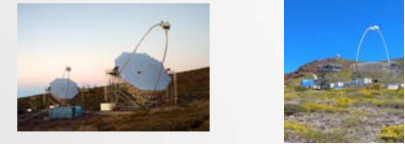
Topics and Experiments



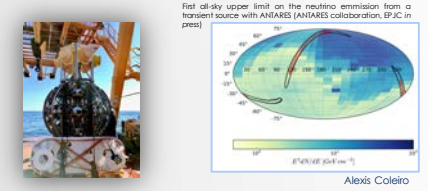
Cosmology & Dark energy
(Planck, Euclid, Quijote, DES, PAU...)



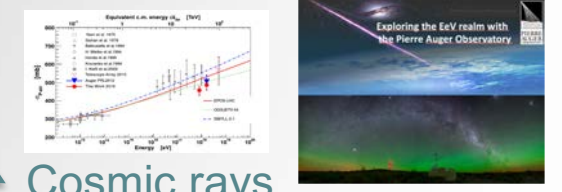
Gravitational waves
(GEO, LIGO, LISA)



Gamma-ray astronomy
(MAGIC, CTA)



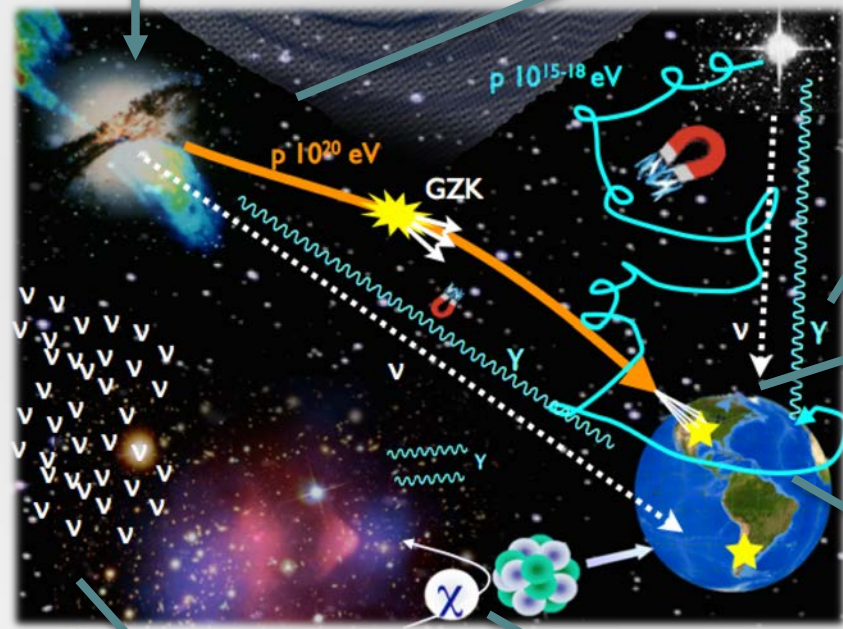
Neutrino astronomy
(Antares, KM3NeT)



Cosmic rays
(Auger, AMS, JEM-EUSO)

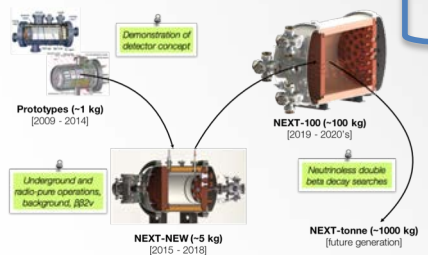


Dark matter detection
(ANAIS, CAST, IAXO, Rosebud, CDMS...)



Theoretical
Astroparticle
physics:

Quite some
groups.

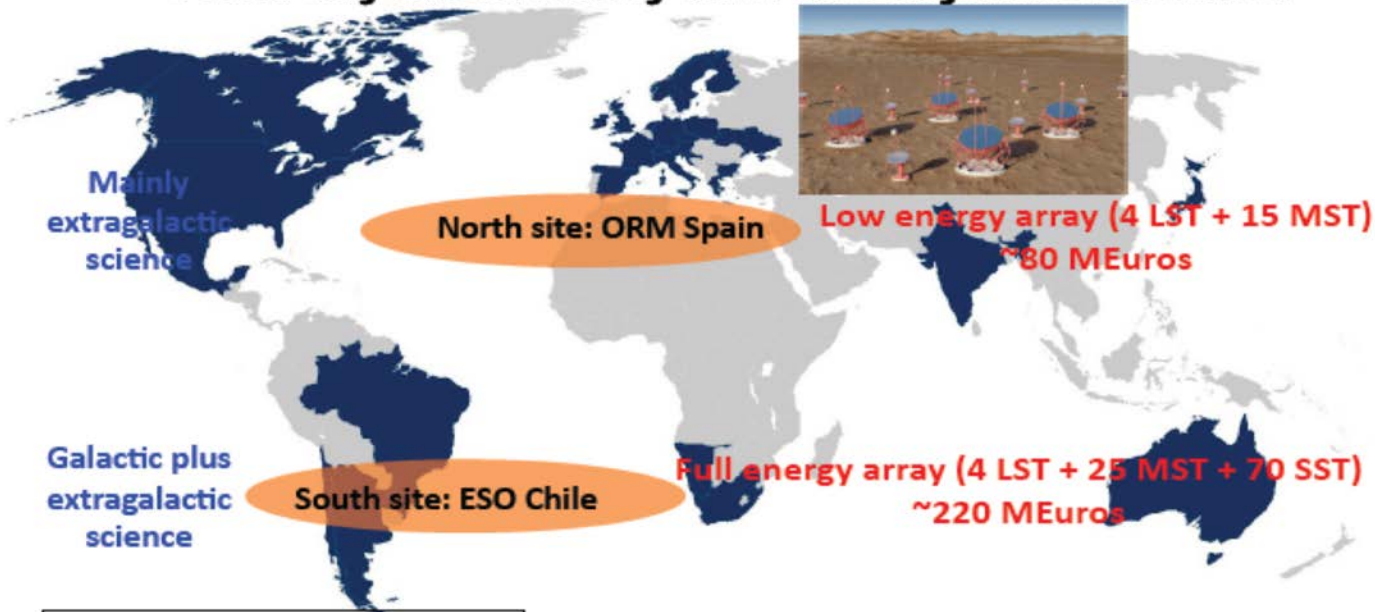


Neutrino experiments
(Double Chooz, DUNE, NEXT, T2K, SuperK...)

Astroparticle & Neutrinos & Cosmology: CTA

The CTA Project

A full-sky observatory with two asymmetric sites:



Roque de los Muchachos Observatory

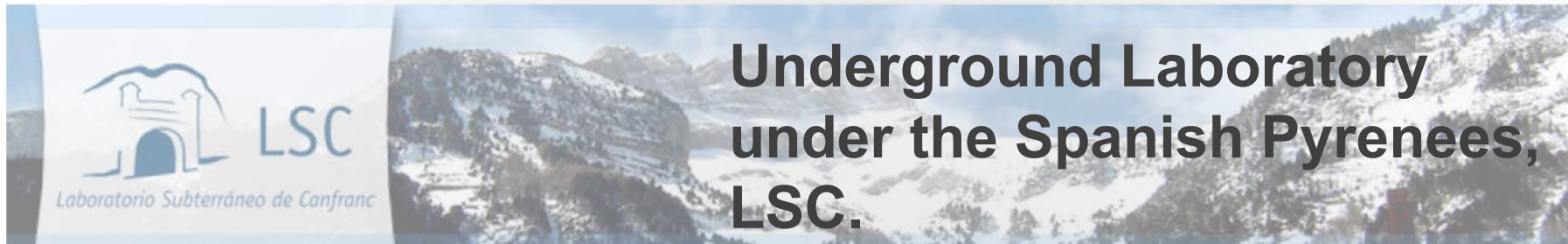
La Palma (Canary islands), hosts MAGIC, recently chosen as northern site of the Cherenkov Telescope Array (CTA)

A global endeavor:
31 countries
1270 members
424 FTE

- High priority in ESFRI, ApPEC, Astronet,...
- Total cost O(300 MEuros)
- Construction starting 2015-2016
- Full operation 2020-2021

The IAC will have a mayor role in CTA, with a very significant investment made by our Ministry and Europe

Astroparticle & Neutrinos & Cosmology: Canfranc



Depth of 2500 m water eq.



With a program of experiments on

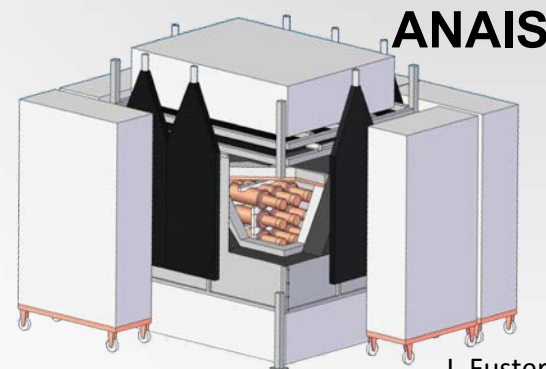
- Neutrino Physics (2β -decay)
- Dark Matter Searches
- GeoScience



SuperKGD

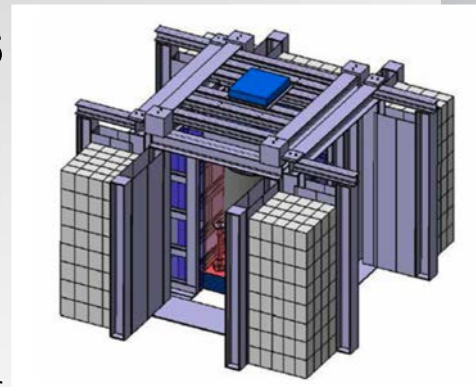


ArDM



ANAIS

J. Fuster



NEXT

Nuclear Physics



USC

UCA

USAL

UAB, UB, UPC

UAM, UCM,

IFF, IEM, CIEMAT

~200 physicists & engineers

UEX

IFIC, UPV

USE, CNA

UHU

UGR

14 University groups

3 CSIC institutes

CIEMAT

12 Exp. Groups

9 Theory groups.

Nuclear Physics

Spanish groups participate in the design of experiments at FAIR since 2004.



NUSTAR collab.

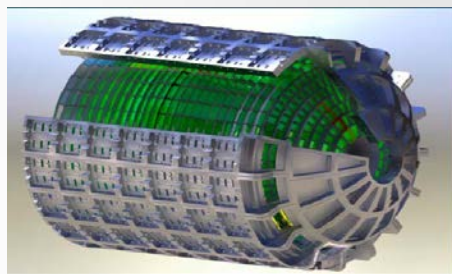
DESPEC
FATIMA (UCM)



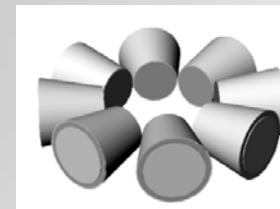
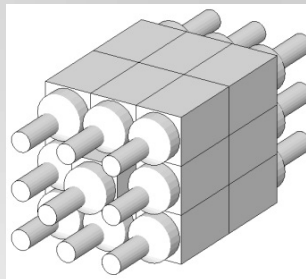
DESPEC
BELEN (UPC)



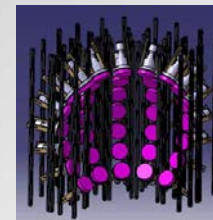
R3B
CALIFA (USC, IEM, IFIC)



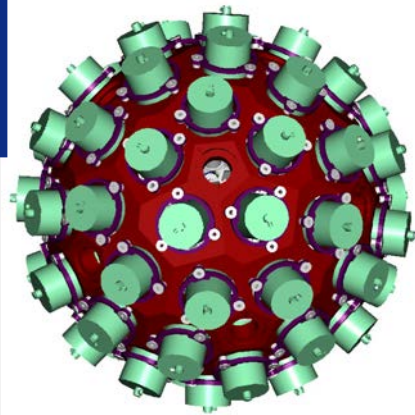
DESPEC
DTAS (IFIC)



DESPEC
Monster (Ciemat)



Nuclear Physics



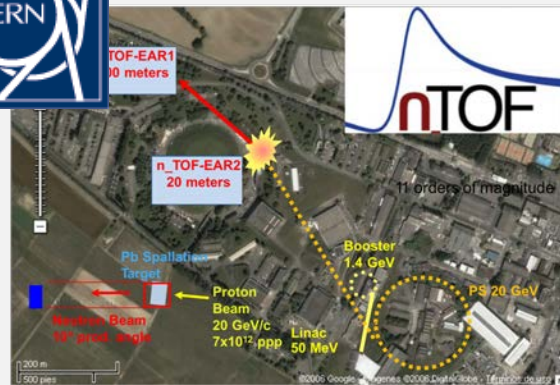
AGATA

IEM

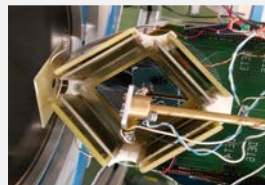
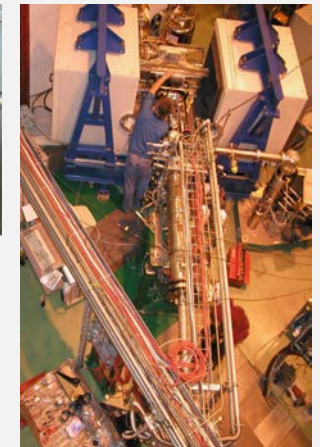
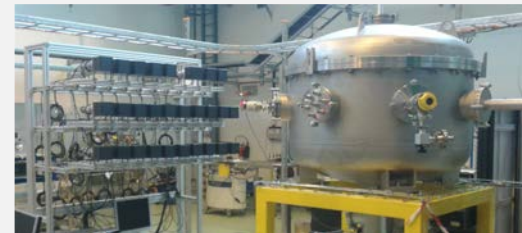
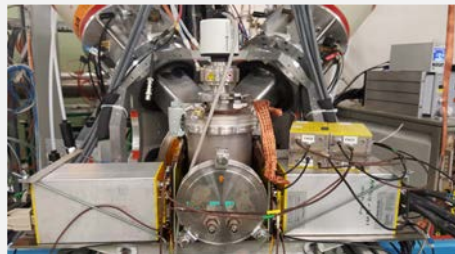
IFIC

UAM

Univ. Salamanca



Ciemat, IFIC, USC, USE, UPC



IDS

Scattering Chamber + Detectors

TAS

Outreach & technology Transfer & Training/Education

Most Institutes and Universities organize:

- an “open day”, guided visits to the labs.
- “Science coffee” , pint of science
- The night of researchers
- Conference cycles

Spain is part of the IPPOG programme

- Master Classes
- CERN beamline contest



Several **spin-off companies** have been created from Particle or Nuclear Physics groups in Spain on different fields.



Gamma Unit Advanced Location Imager - GUALI



University of Zaragoza and Benasque Centre coordinate:

- IMFP- Spanish Winter Meeting
- TAE (Spanish HEP school)

Characterization of nuclear fuel rods





As for science:

HEP in Spain is very active and enthusiastic in both theoretical and experimental particle, astroparticle, neutrinos and nuclear physics.

The Spanish HEP community is a fundamental partner of most of the relevant experiments in the field. It is also very much engaged in the efforts towards seeking for the future of the field.

Spanish physicists play important roles and responsibilities in many experiments and facilities such LHC-experiments, CTA, ISOLDE, etc..

The size of the community is however still below average compared to most of EU countries.



As for funding:

Most of Ministerial structures/calls have disappeared making very unnatural and complicated to keep international cooperation. Examples are:

- our contribution to common funds. Nowadays it is even more expensive as it is charged with indirect costs (21%) and this fact reduces the available funds for other activities,
- HEP-networks play and have played an excellent role in helping to organize our community –with little money- but today most of them have very minimal or inexistent funding.

The situation is critical specially in view of HL-LHC upgrades. An increase of the budget is essential. New FPA scientific manager, Maria Jsé García-Borge, will need to face this challenge with the new Spanish governmental authorities.

The programme of scientific Excellence (SO and MdM) mitigates some of these effects but only applies to some Institutes.

Recently our FPA manager, Mario Martínez, has been replaced by María José García-Borge

(after 3 years mandate)

Thanks Mario for your work and effort

Welcome María José and good luck !!

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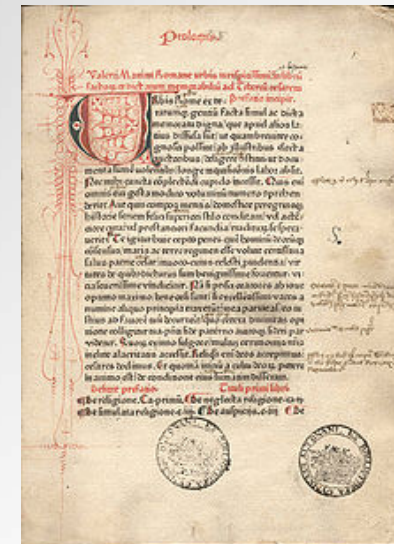


They berated a Spartan because
Increparon a un espartano porque,
although he was one-legged, he was going to a battle
aunque era cojo, iba a una batalla
and he responded
y el respondió
that his purpose was to fight not to flee
su propósito era luchar no huir

Valerio Máximo, año 31

Factorum et dictorum memorabilium

(Hechos y dichos memorables)



Classics always help !!

They berated a Spartan because

Increparon a un espartano porque,

although he was one-legged, he was going to a battle

aunque era cojo, iba a una batalla

and he responded

y el respondió

that his purpose was to fight not to flee

su propósito era luchar no huir

Yes, agreed, classics help in understanding,

but

ECFA support more appreciated