

CIEMAT
Research Center
for Energy, Environment
and Technology



José M. Pérez
Dept. of Technology
INFIERI. 2021-08-23

A Public research institution



Ministry of Science and Innovation

Secretariat General for Research

CIEMAT

Other R&D institutions in Spain (apart from Universities)



CSIC
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS



- + Regional R&D networks (IMDEA, GUNE, CERCA, ...)
- + Consortia (ALBA, ESS-B, ...)
- + Technological Centers (AIMEN, TEKNIKER, ...)



Almería Solar Platform (PSA)



Centre for the Development of Renewable Energy Sources (CEDER)



Computing Center CETA – CIEMAT

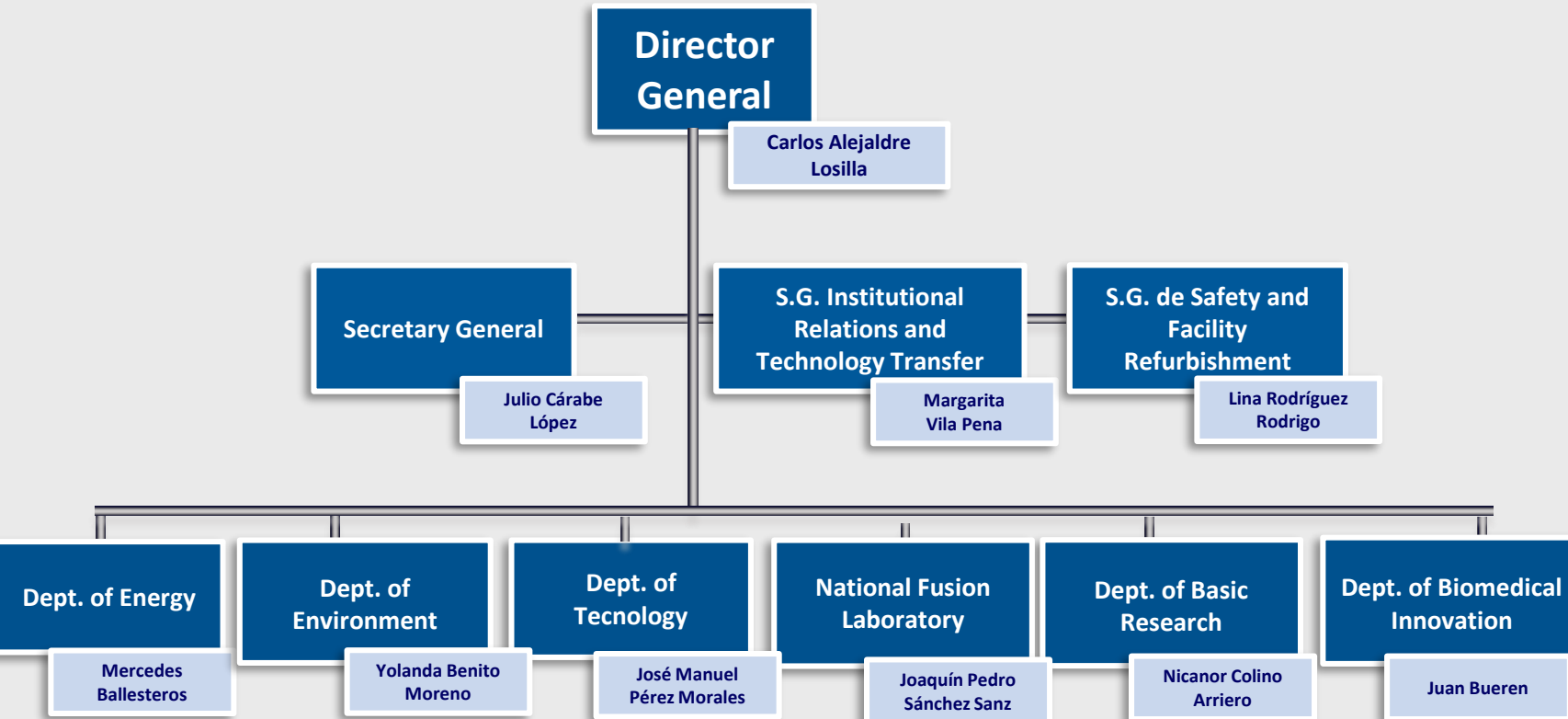


Center for Socio-Technical Research (CISOT)



Center for Studies in Environmental Law (CIEDA)

Organization Chart




Institutional Relations

General Secretariat

Safety and Facility Refurbishment



Energy



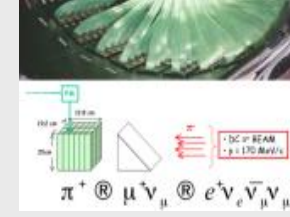
Environment



Fusion



Technology

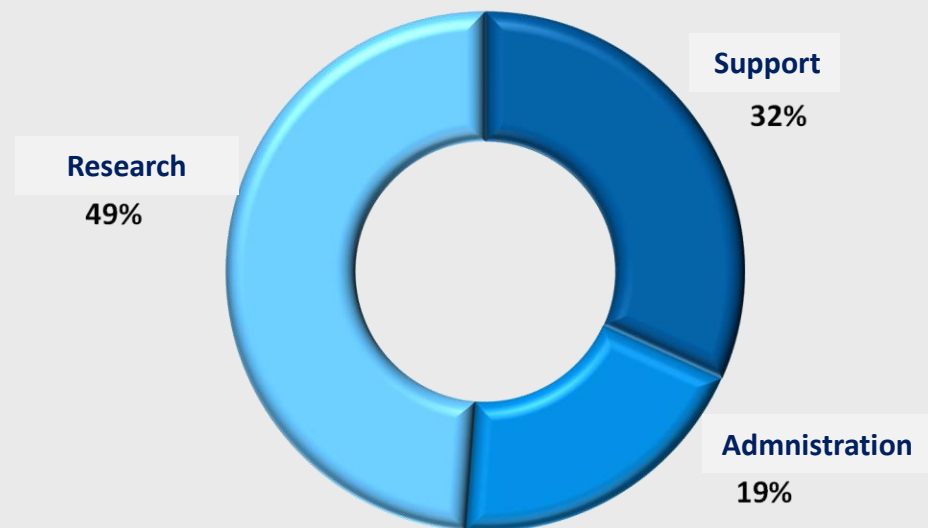
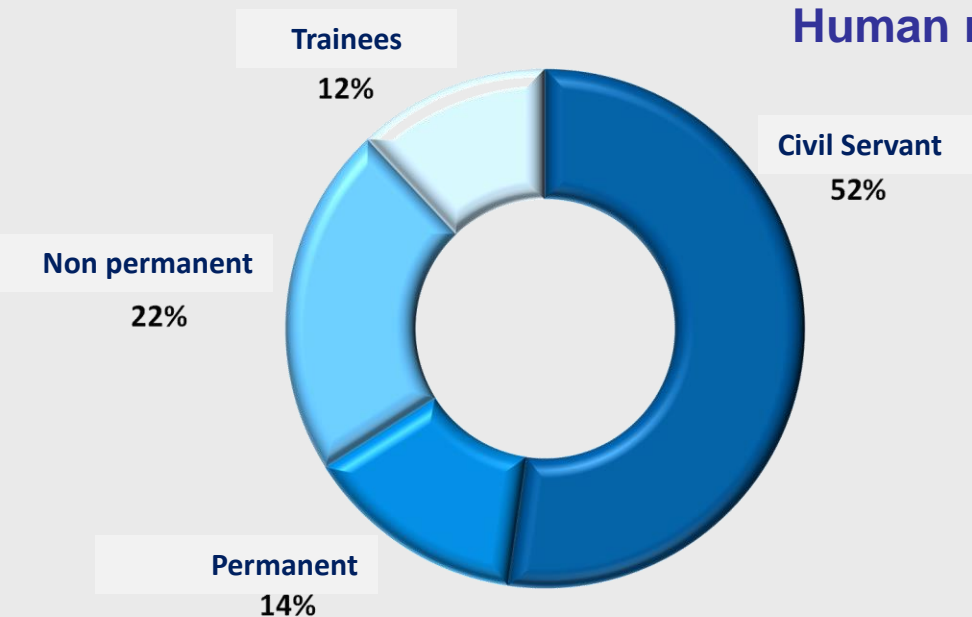


Basic Research



Biomedical Inn.

Human resources

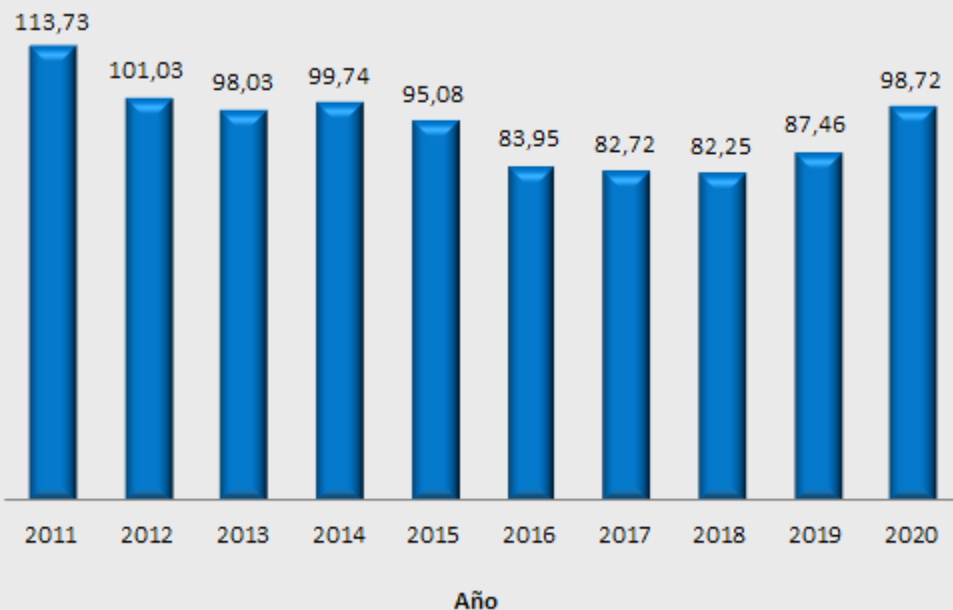


	Female	Male	Total
PhD	169	197	366
Master / Engineers	168	251	419
Bachelor	41	68	109
Technician	127	205	332
High School	24	41	65
Others	4		4
TOTAL	533	762	1.295

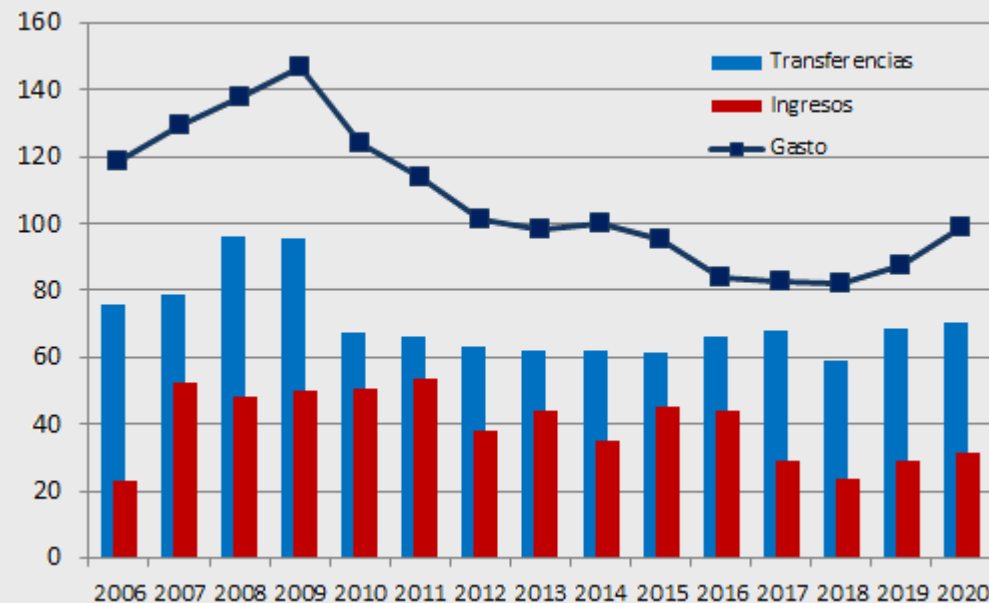
	Female	Male	Total
Madrid-Moncloa	474	675	1.149
PSA	23	33	56
CEDER	17	27	44
CETA		4	4
CISOT	6	3	9
CIEDA	4	2	6
Otras ubicaciones	9	18	27
TOTAL	533	762	1.295

CIEMAT figures

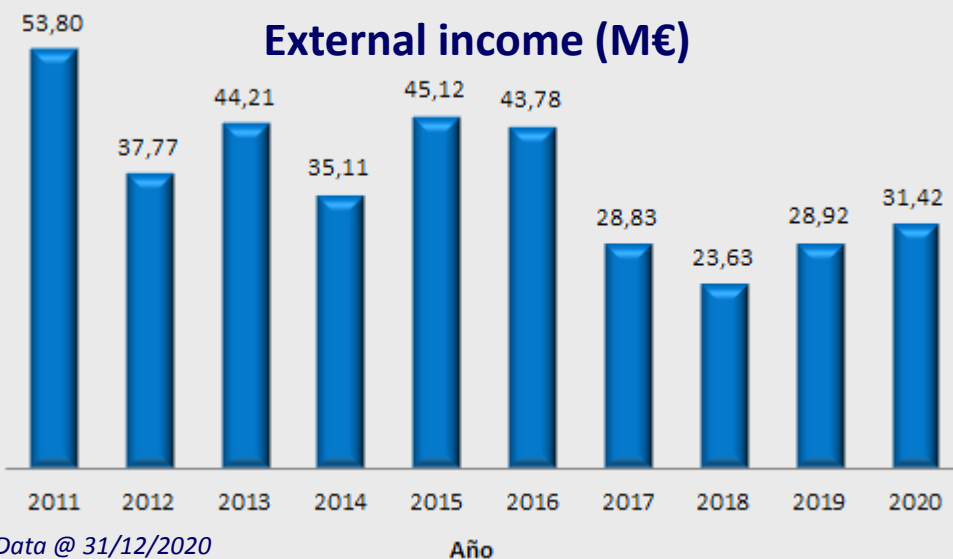
Year expenditure (€)



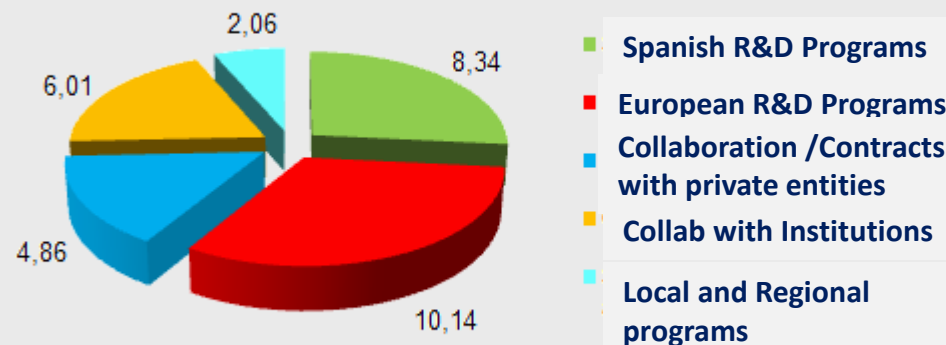
Income from the Government vs external (M€)



External income (M€)

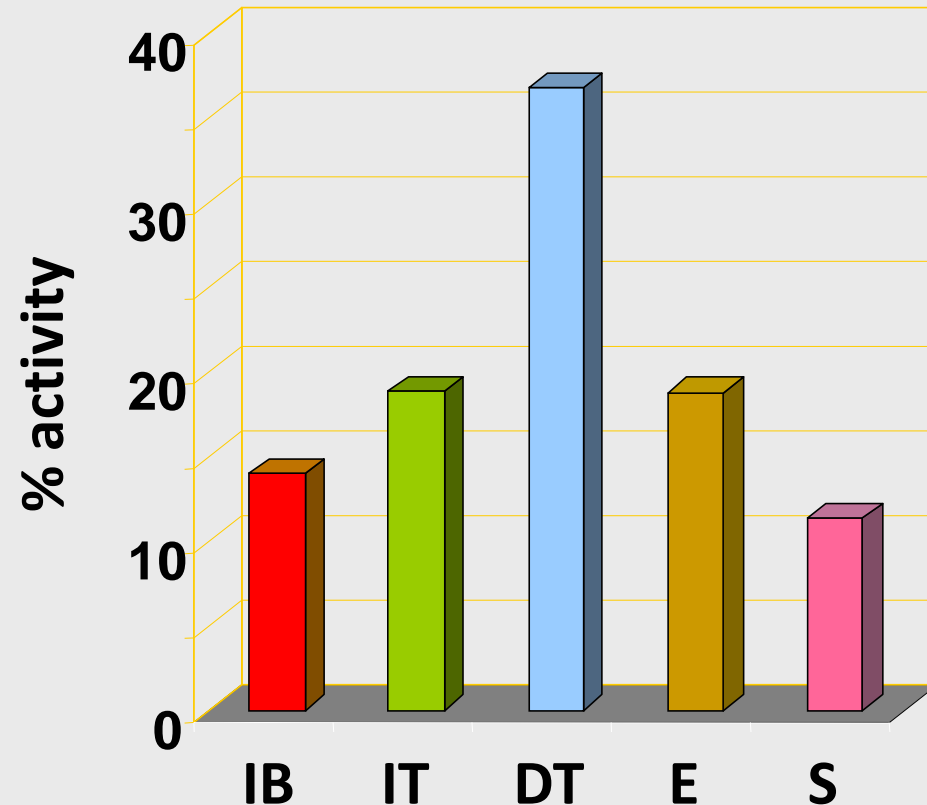


Income per funding agency 2019 (M€)



CIEMAT Profile

- IB** Basic Research
- IT** Technology Research
- DT** Technology Development
- E** Pilot and Demonstration
- S** Services



Scientific-Technical Areas

- ✧ Photovoltaic solar energy
- ✧ Wind power
- ✧ Biomass, Biofuels
- ✧ Solar thermal energy
- ✧ Energy efficiency
- ✧ Energy storage, fuel cells, GIS

- ✧ Combustion and gasification
- ✧ Nuclear safety, innovation, radioactive waste
- ✧ Fusion physics, engineering, technologies
- ✧ Sociotechnical research
- ✧ Environment
- ✧ Ionizing Radiation
- ✧ Scientific Instrumentation
- ✧ Materials and Chemistry
- ✧ Computing
- ✧ Particle Physics
- ✧ Biomedicine

Energy	Solar Thermal and Photochemical Technologies
	Renewable Energy Generation and Energy Efficiency
	Bioenergy, Bioproducts and Wastes
	Hydrogen Technologies
	Energy Storage
	Fission
	Analysis of sustainable Energy Systems
Environment	Applied Environmental Hydrogeosciences
	Soil and Climate Change
	Climate Change and Air Quality
	Radiation measurement and environmental assesment
Fusion	Science and Technology for Fusion Energy
Technology	Particle Accelerators & Electric Drives
	Medical Application of Ionizing Radiation
	Materials and Chemistry for Energy
	Scientific Computing
Particle Physics	Particle Physics and Astrophysics
Biomedicine	Biomedical Innovation
<i>PRELIMINARY (CIEMAT 2021 Strategic Research Plan. Under evaluation)</i>	

CIEMAT Facilites



Flexible Helic TJ-II



Solar Platform of Almería (PSA)



Pilot pelleting plant
(300-500 kg/h)



Pilot membrane gas separation plant



Wind Testing Laboratory



Safety System Analysis
Laboratory (Peca Facility)



Ionizing Radiation Metrology Laboratory
(LMRI)

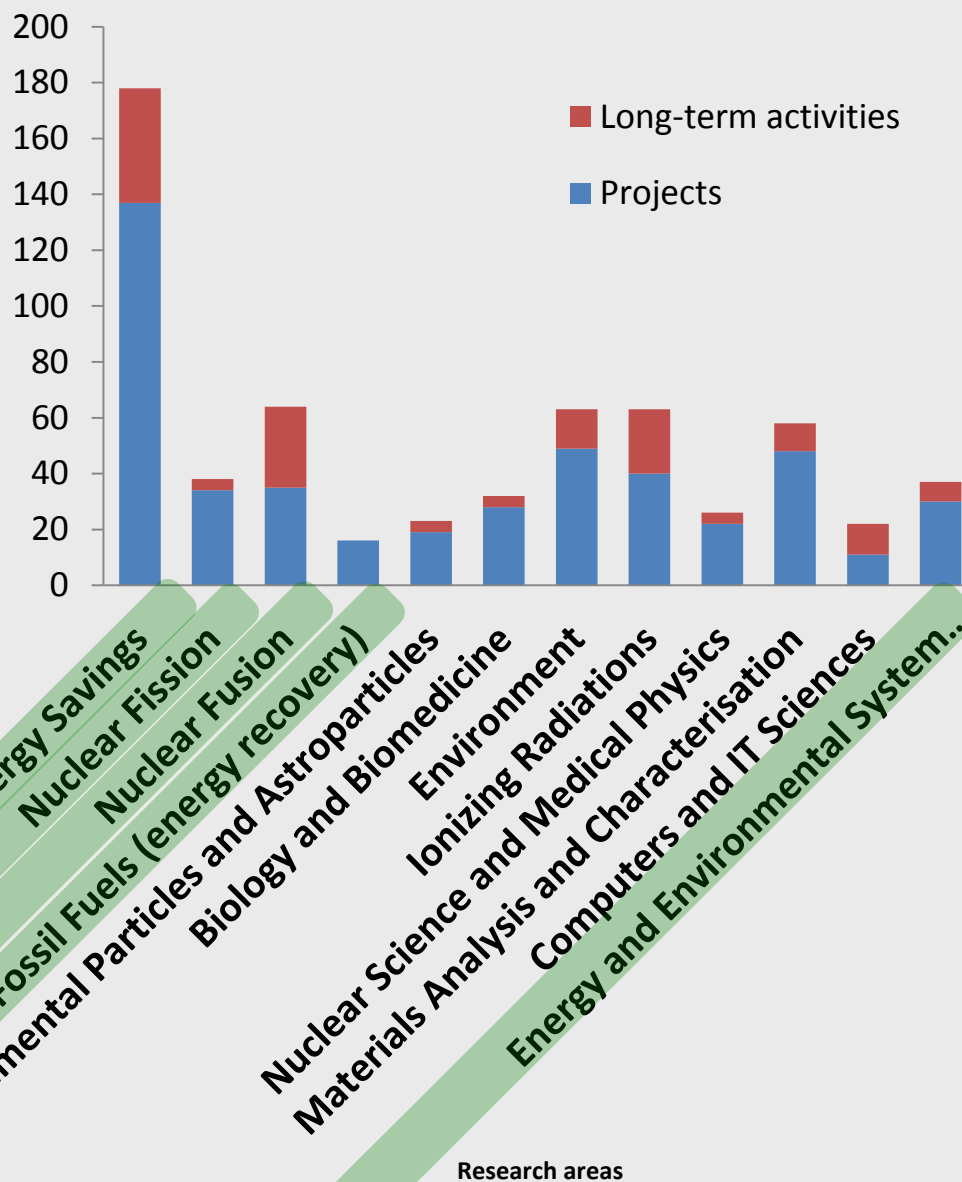


Dosimetric measurements



Radioarmacy for biomedical and
clinical applications

ENERGY



- ✧ Photovoltaic solar energy
- ✧ Wind power
- ✧ Biomass
- ✧ Biofuels
- ✧ Solar thermal energy
- ✧ Energy efficiency
- ✧ Other technologies: energy storage, fuel cells and GIS

- ✧ Nuclear safety
- ✧ Nuclear innovation
- ✧ Radioactive waste

- ✧ Fusion physics
- ✧ Fusion engineering
- ✧ Fusion technologies

- ✧ Combustion and gasification
- ✧ CO2 capture

- ✧ Sociotechnical research
- ✧ Scientific culture
- ✧ Environmental law
- ✧ Analysis of energy systems
- ✧ Intelligence and foresight

Plataforma Solar de Almeria (PSA)



2

7

9

1

10

- 1.- Central Receiver
- 2.- Parabolic troughs
- 3.- Direct Steam Generation
- 4.- Stirling Dishes
- 5.- Solar Furnace
- 6.- Water Detoxification
- 7.- Water Desalination
- 8.- Energetic Efficiency in Buildings
- 9.- Fresnel Collectors
- 10.- Advanced Technologies: gas/molten salts



HYDROSOL II



The SSPS tower



The HYDROSOL II reactor on the SSPS tower

**Hydrogen from the
sun**

GEMASOLAR: 17 MWe



304,750m² of heliostats
15 hours storage (molten salts)
Promoted by Torresol Energy / SENER+MASDAR
Receptor tested at PSA

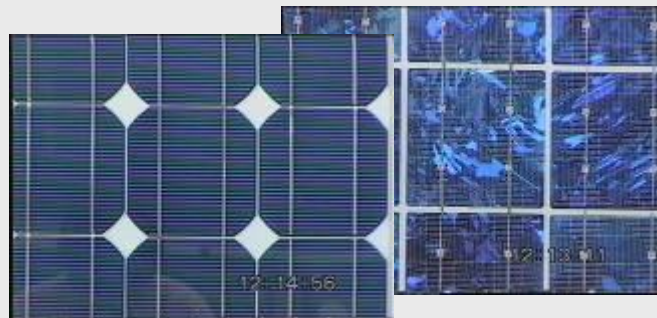
1. Deposited Silicon PV Devices Lab



2. Polycrystalline Thin-film PV Materials Lab



3. PV Components and Systems Lab



Wind Energy

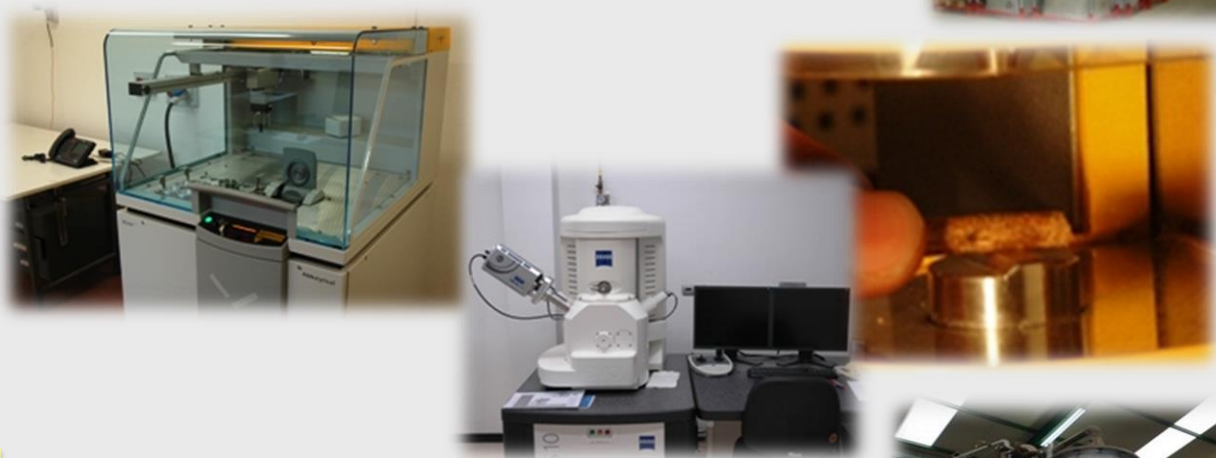


Biomass and wastes bioenergy

Crops, drying, pre-treatment and pelletizing



Biomass characterization

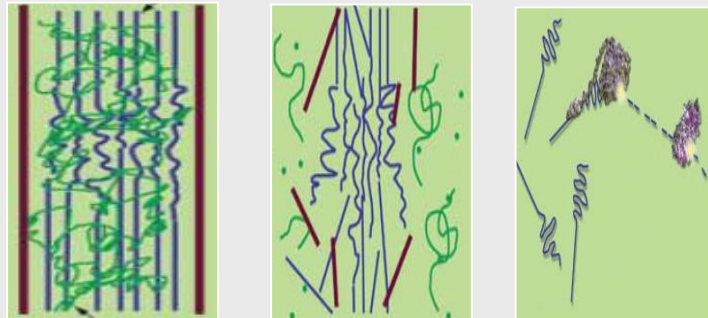


Energetic valorization



Bio-fuels and biogas

CIEMAT patent: bioethanol from lignocelulose



Pilot Plant (Alcudia) Liquid bio-fuel from Urban Solid Waste (in collaboration with IMECAL)



CLAMBER (Puertollano) Bio-refinery and bio-products (In collaboration with IRIAF)



Micro-grid. Integrated systems

Electrofuel group



Cinetic Storage



Photovoltaic modules 85 kW



LINEA A 15 KV



wind system 60 kW



Battery Ion Li with conversor



TRAFO

Cuadro BT

Condensers



Batteries racks

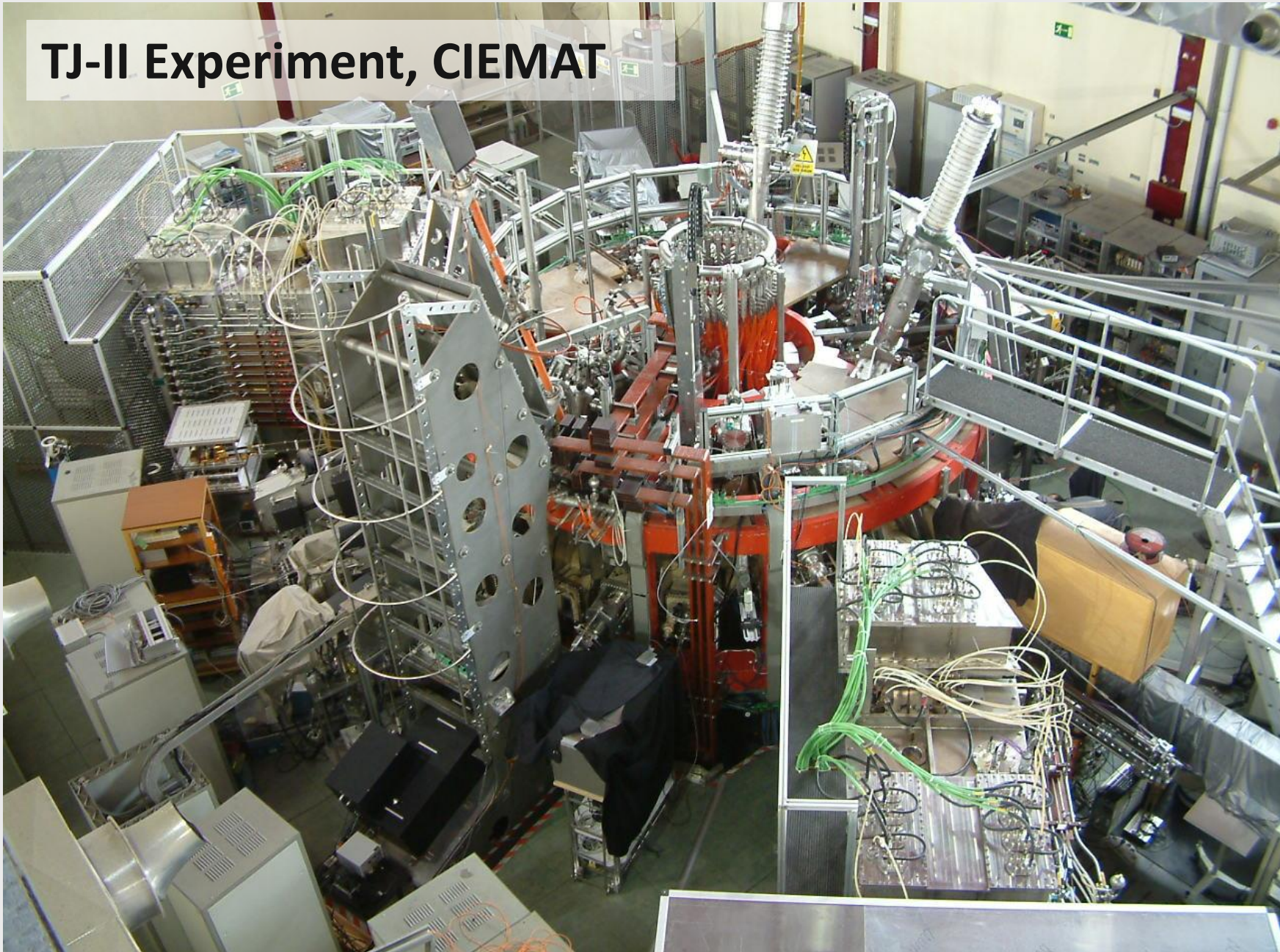


Pump 60 kW

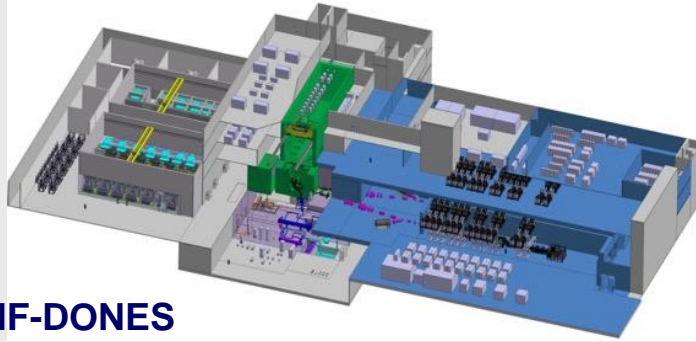
Pumping System



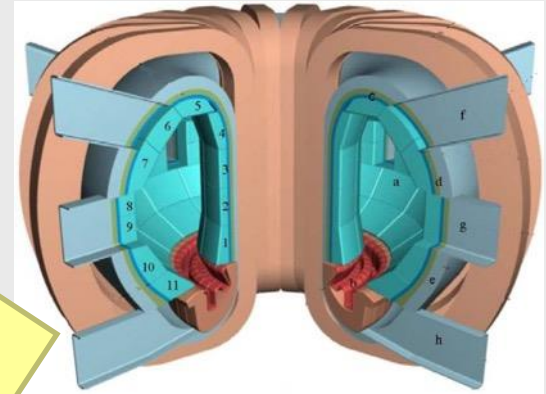
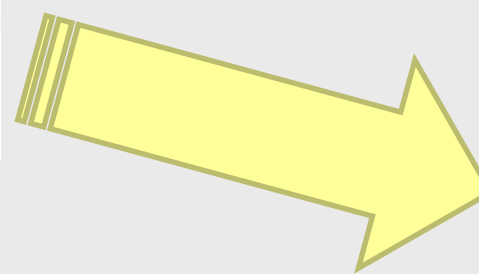
TJ-II Experiment, CIEMAT



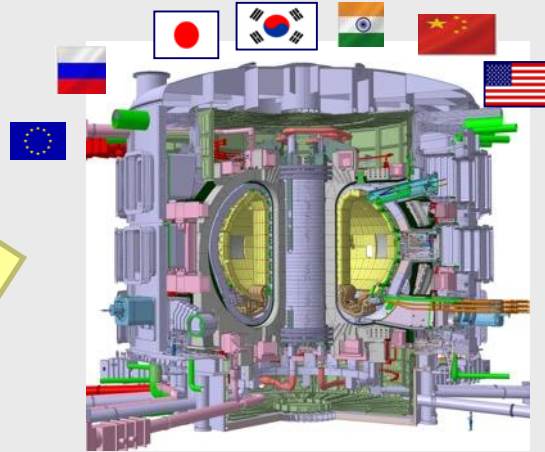
ROADMAP TOWARDS FUSION ENERGY



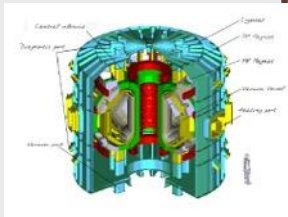
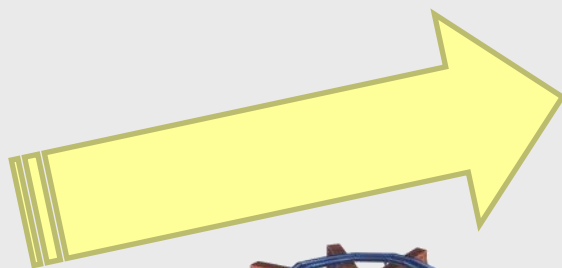
IFMIF-DONES
 D+ beam, 40 MeV, 125 mA on a Li target



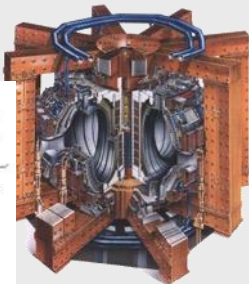
DEMO $\geq 500 \text{ MW}_{el}$:
 1-2 hours



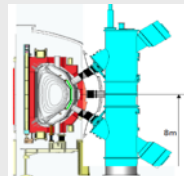
ITER – 500 MW_{th}
 300– 500 secs



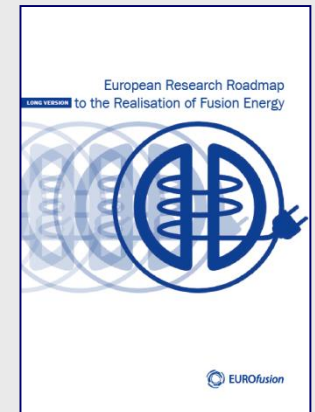
K-STAR 



JET 

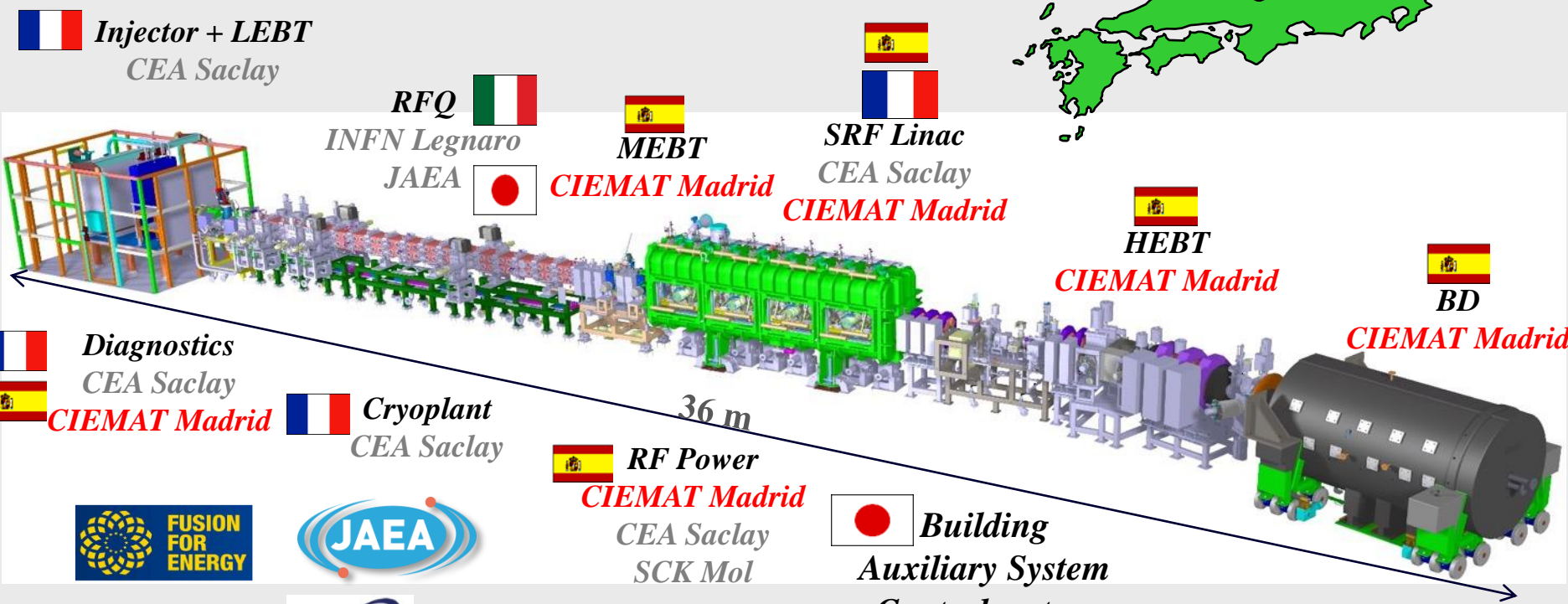
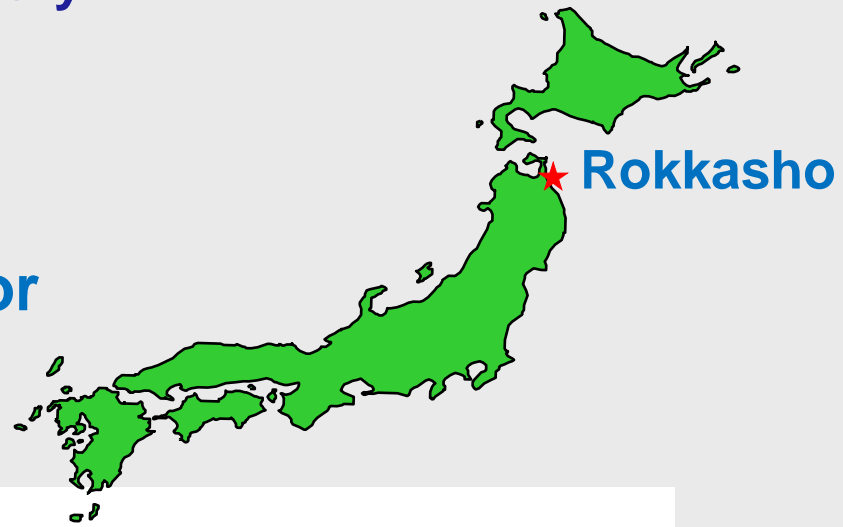


JT-SU 



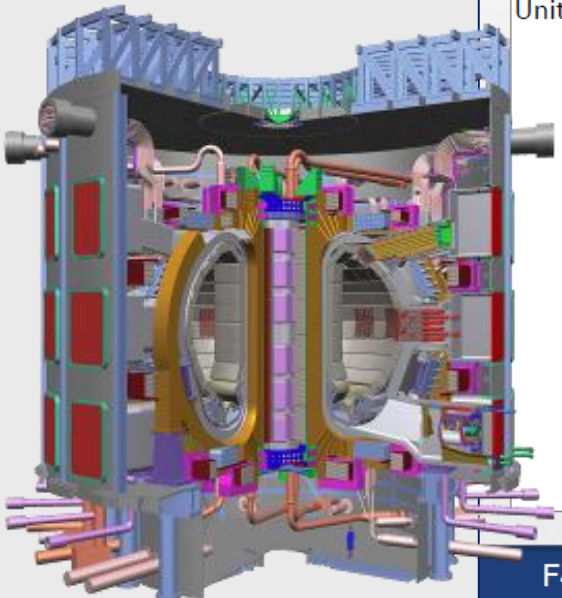
Position on IFMIF-DONES gained through significant CIEMAT involvement in the preparatory R&D project (Japan)

LIPAc Linear IFMIF Prototype Accelerator

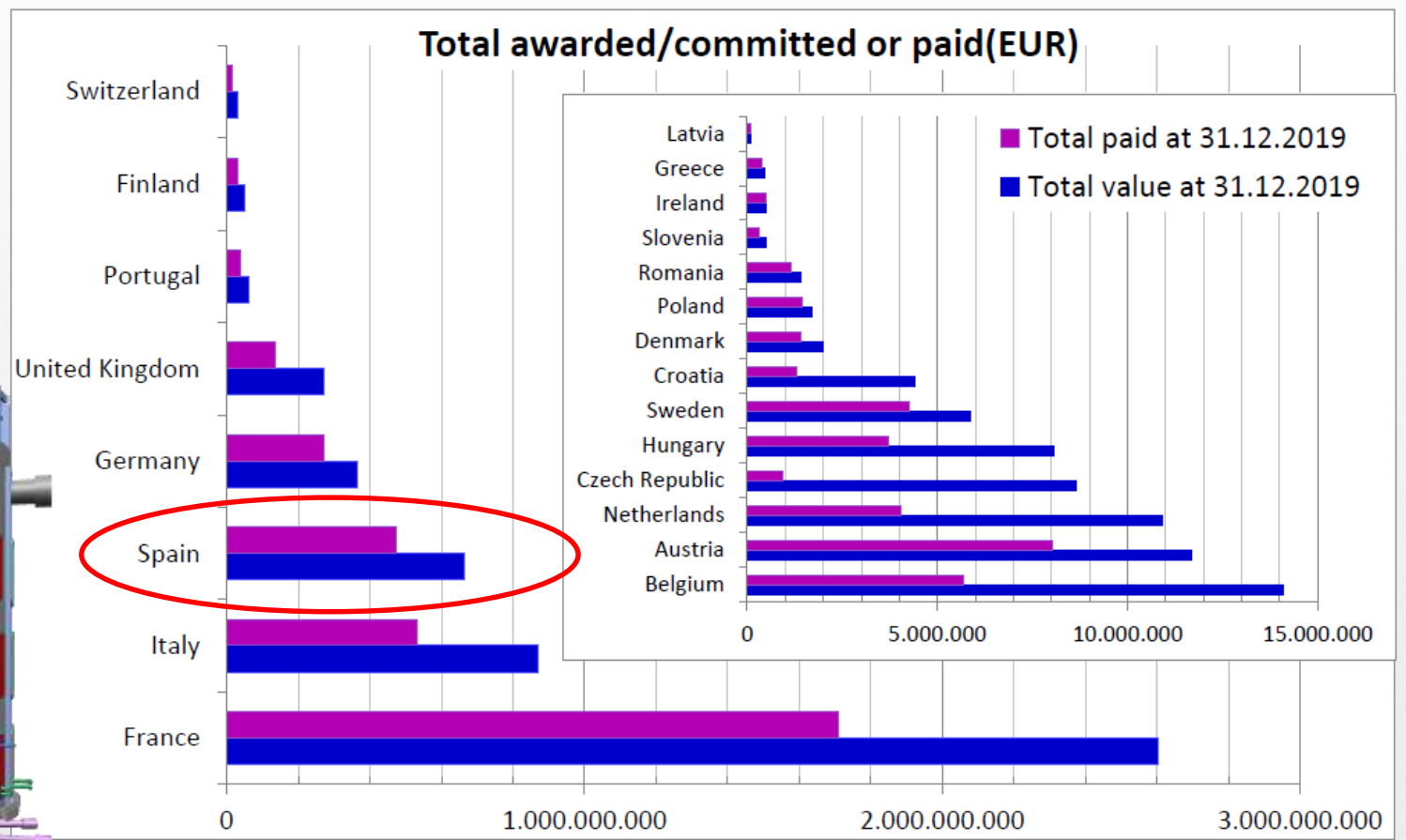


The precursor to unprecedented figures of national industrial return

Cumulative budget awarded to EU industries in contracts for ITER construction



TOTAL DISTRIBUTION EU CONTRACTS



Low & Intermediate Level Radioactive Wastes

- Characterization, treatment, conditioning, and clean-up of L&IL rad. waste
- Irradiated Graphite

High Level Radioactive Wastes

- Irradiated nuclear fuel behavior, characterization, treatment, conditioning
- Fuel reprocessing
- Hydro- and Pyro- metallurgical long lived nuclide partitioning.

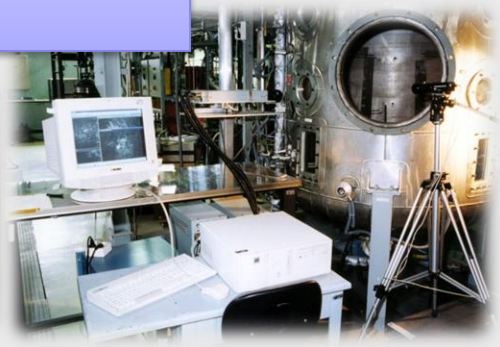
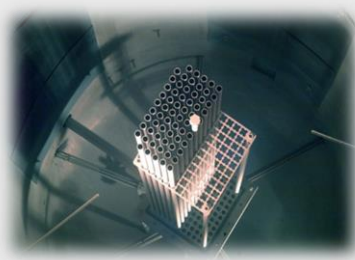


Nuclear Safety

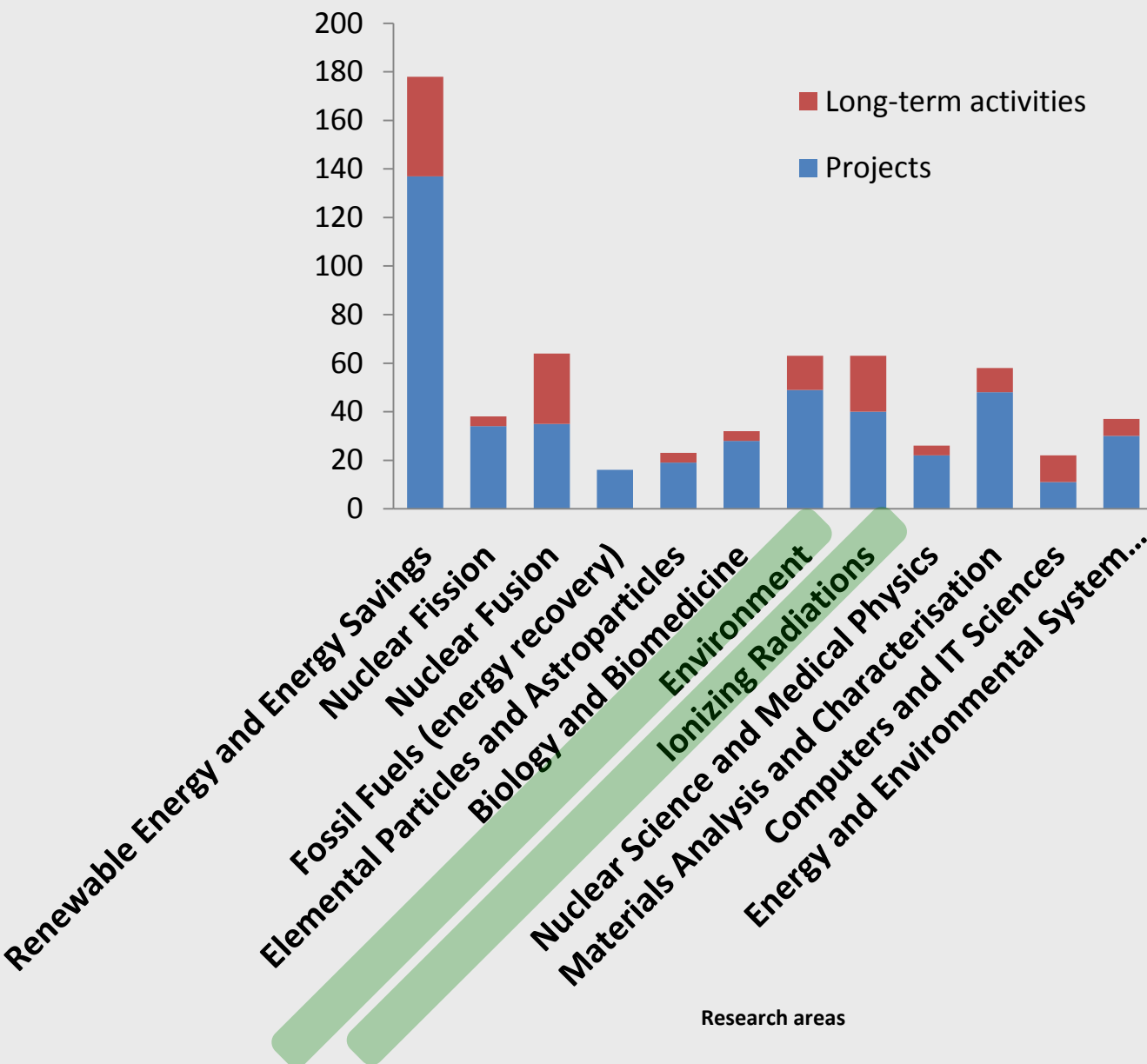
- Severe accidents
- Safety of spent fuel
- High burn-up fuel
- Safety of future reactors
- Safety Fuel in ATC (interim storage)
- Fukushima accident

Nuclear Innovation

- Advanced nuclear fuel cycles
- Subcritical reactors for waste minimization
- Generation IV reactors
- Nuclear waste transmutation



Environmental research



- ✧ Air pollution
- ✧ Soil and environmental geology
- ✧ Climate change

- ✧ Public and environmental radiological protection
- ✧ Environmental radioactivity and radiation surveillance
- ✧ Ionizing radiation dosimetry
- ✧ Remediation and rehabilitation of contaminated land
- ✧ Physical chemistry of actinides and fission products
- ✧ Ionizing radiation metrology (LMRI)



SCIENTIFIC BASE

► Atmosphere

- Emissions of pollutants
- Atmospheric processes

► Soils and Geology

- Climate variability
- Edaphic processes



TRACING MONITORING

- Atmosphere (GEI's emissions, others indicators)
- Terrestrial ecosystems (cycle C and N)
- Soils and Geology: Edaphic characterization
- Paleoclimate records

IMPACT

- Atmosphere: Air quality-
feedbacks
- Ecosystems / Vulnerability
- Soils
- Population
- Social perception

ADAPTATION / MITIGATION

- Terrestrial ecosystems
- Environmental technologies (CO₂ capture and storage)
- Alternative/renewable energies
- Socio-economic aspects
- Future scenarios



Soil and Environmental Geology



Soil Conservation and Recuperation

Environmental Geology

✚ Soil conservation: biodiversity, improvement of practices, study and erosion control, national parks, protection of Antarctica.

✚ Contaminated sites: recovery of industrial and mine areas. Socio-economical alternatives. Land use recommendations. Ecological restoration.

✚ Agriculture areas: sustainable agriculture regarding local circular economy. Rational use of resources. Precision agriculture regarding climate change.

✚ Organic waste: recovery of organic matter and biogas production. Circular economy.

✚ Deep geological disposal: characterization of materials and processes that define the behavior of radioactive waste storage

✚ Near surface disposal of radioactive waste: security and licensing of them through hydrogeological and hydrochemical studies

✚ Climate change: paleoclimate studies





Air quality and global change

Pollutant Emissions

Modeling and Ecotoxicology of Atmospheric Pollution

Characterization of Atmospheric Pollution and POPs

- ⇒ **Physical and chemical processes** of pollutants and the effects on eco and agrosystems
- ⇒ **Methodologies and techniques** for the diagnosis, control, prediction, reduction, mitigation or elimination of pollution
- ⇒ **Measuring instruments** for contaminants, software and mathematical models, analytical techniques
- ⇒ **Emission filtering and elimination systems**
- ⇒ **Collaboration** with administrations and companies
 - ⇒ **Management Commitments with Ministries**
 - ⇒ **Action in emergency situations**

Ocem - Ciemat
Oficina para el Control de Emisiones de las Grandes Instalaciones de Combustión

PARQUE ESPAÑOL DE GRANDES INSTALACIONES DE COMBUSTIÓN



Medida de gases y partículas (sonda extractiva multiorificio)
T = 313K
P = 52.7 Pa
V_{max} = 40m/s

Tomografía de gases
Medida de gases y partículas (extracción)
Detección Lambda de gases

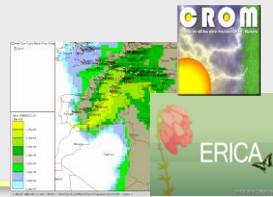
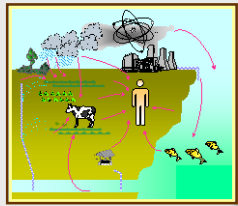
Punto 1: Plano de medida en caída
T = 900 K
P = 117.7 Pa
V = 200m/s

Punto 2: Nivel de tránsito en chimenea

Conducto: 35 m.

Celda de Ensayos de Turborreactores

Radiation measurement, social and environmental assesment



Radiation measurement, social and environmental assesment

ENVIRONMENTAL RADIACTIVITY AND RADIATION SURVEILLANCE

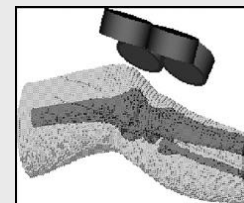
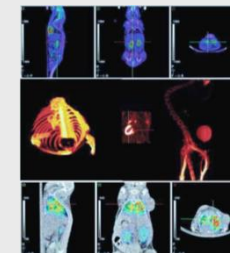
RADIATION PROTECTION OF THE PUBLIC AND THE ENVIRONMENT

RADIATION DOSIMETRY

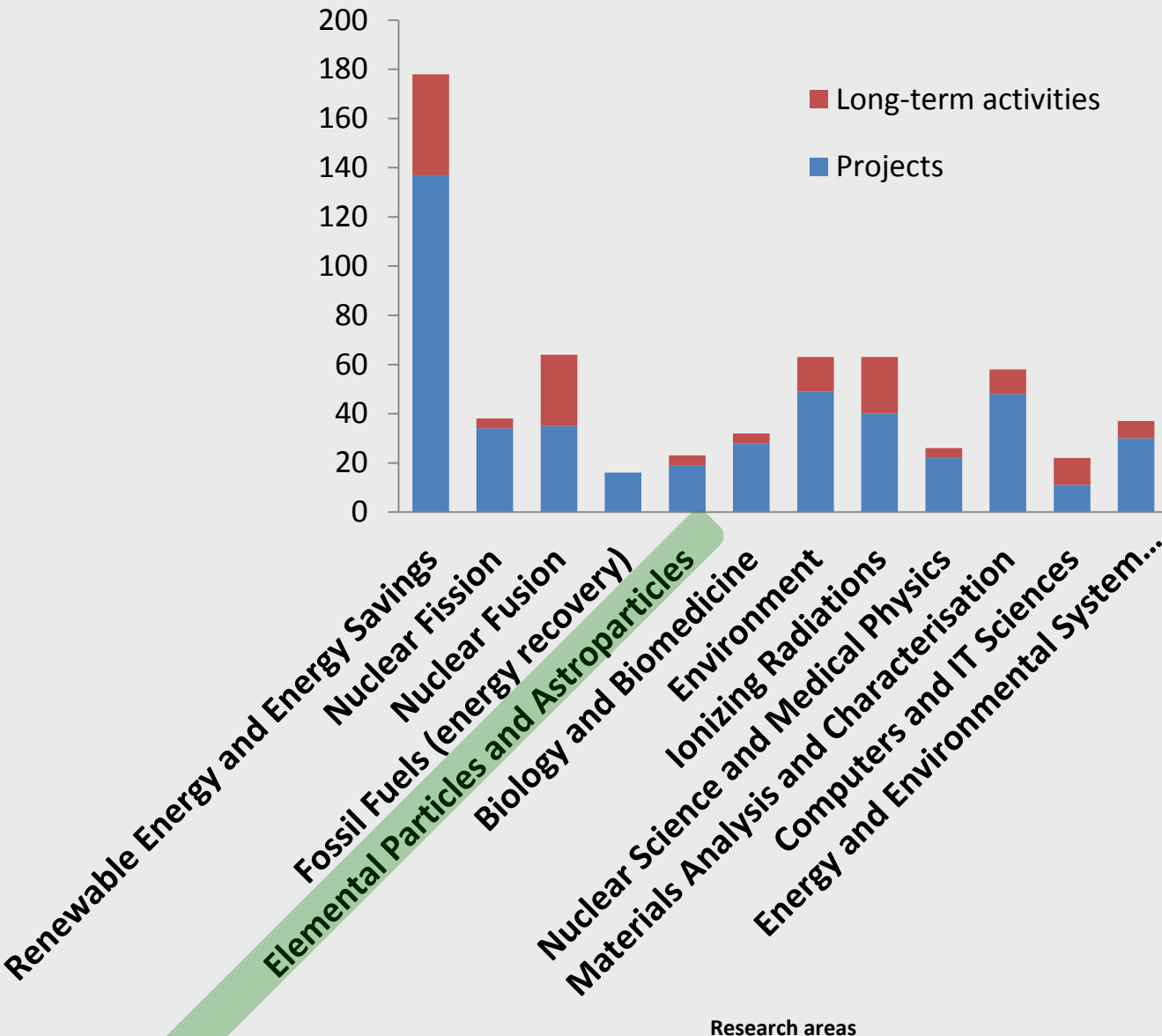
APPLICATIONS OF RADIOISOTOPES IN BIOMEDICINE

PHYSICO-CHEMISTRY OF ACTINIDES AND FISSION PRODUCTS

- ⇒ **Radioactivity in the environment**
 - ⇒ Surveillance and control
 - ⇒ Advice to Public Institutions
- ⇒ **Radiation dosimetry**
 - ⇒ National reference center, accredited by ENAC
 - ⇒ **R+D+i in the improvement of measurement capabilities and dose evaluation. EURADOS.**
- ⇒ **Processes of retention and transport of radioactive contaminants in the environment**
- ⇒ **Protection of the public and the environment**
 - ⇒ Criteria, methods of evaluation and monitoring of radiological risk from natural and artificial sources
 - ⇒ Emergency situations
- ⇒ **Geological dating by thermoluminescence**
- ⇒ **Radioisotope applications in medicine**



Particle Physics



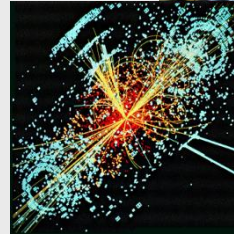
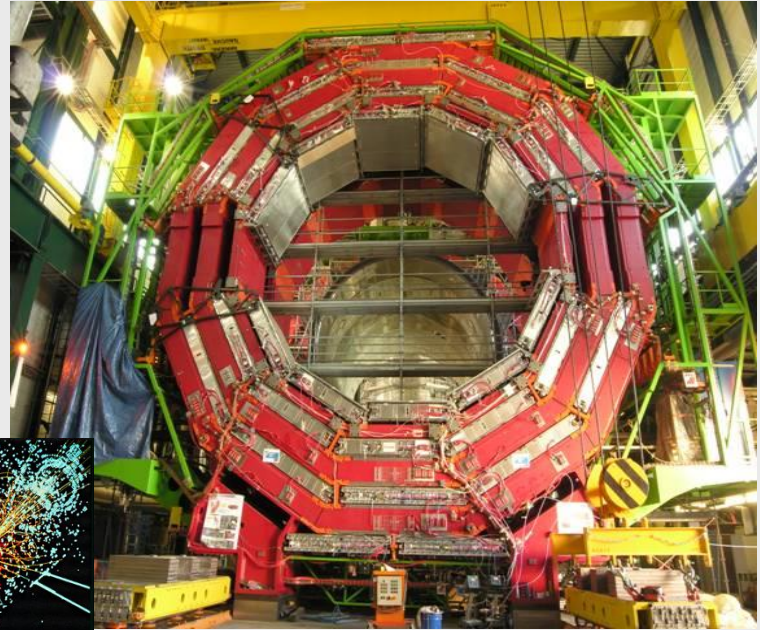
- ✧ High-energy experimental physics
- ✧ Particle astrophysics
- ✧ Data processing centers for LHC and parallel computing

Experimental High Energy Physics

Our Flagship Project:
The CMS Experiment at the LHC

Main responsibilities:
*The Barrel Muon Chambers and
the CMS Alignment System*

Other ongoing projects:

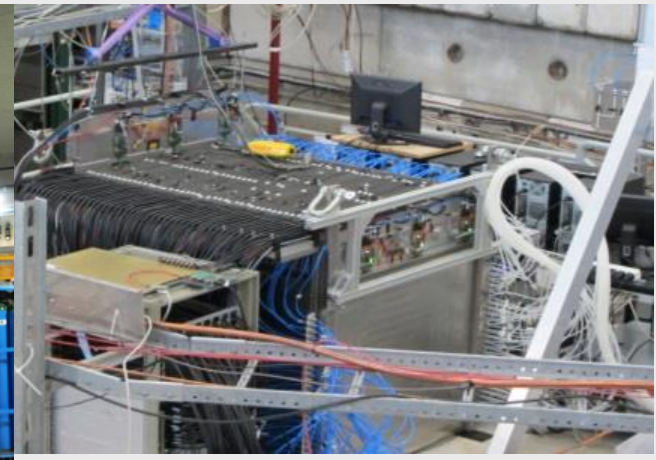
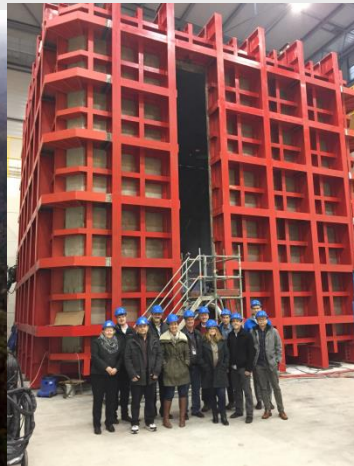
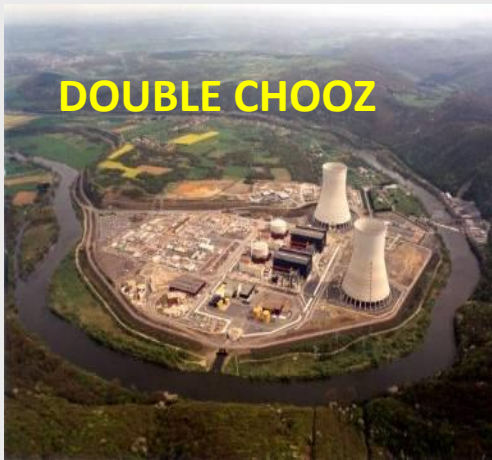


Neutrino oscillations

WA105-DUNE

ArDM at the LSC

CALICE

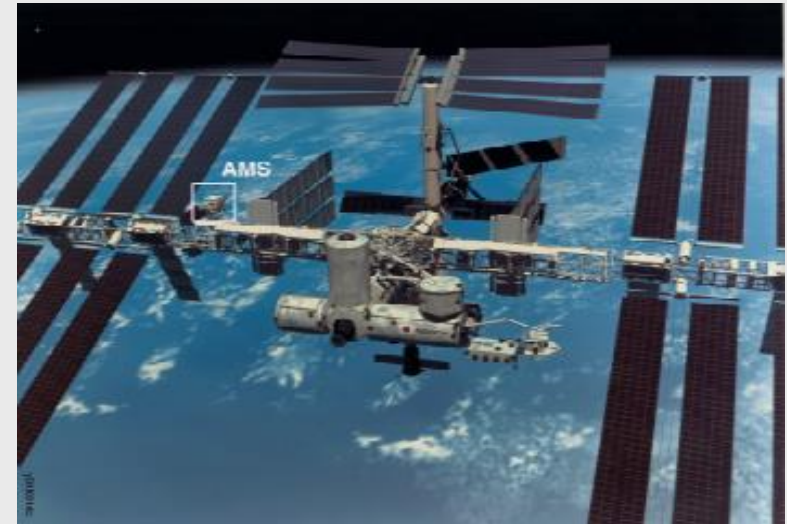


Astroparticle Physics

Main goals:

- Search for evidence of dark matter
- Search for antimatter

AMS: RICH detector built and assembled at CIEMAT



THE AMS Experiment at the ISS

Ongoing projects:

Gamma ray Astronomy

CTA



Dark Energy Survey

DES

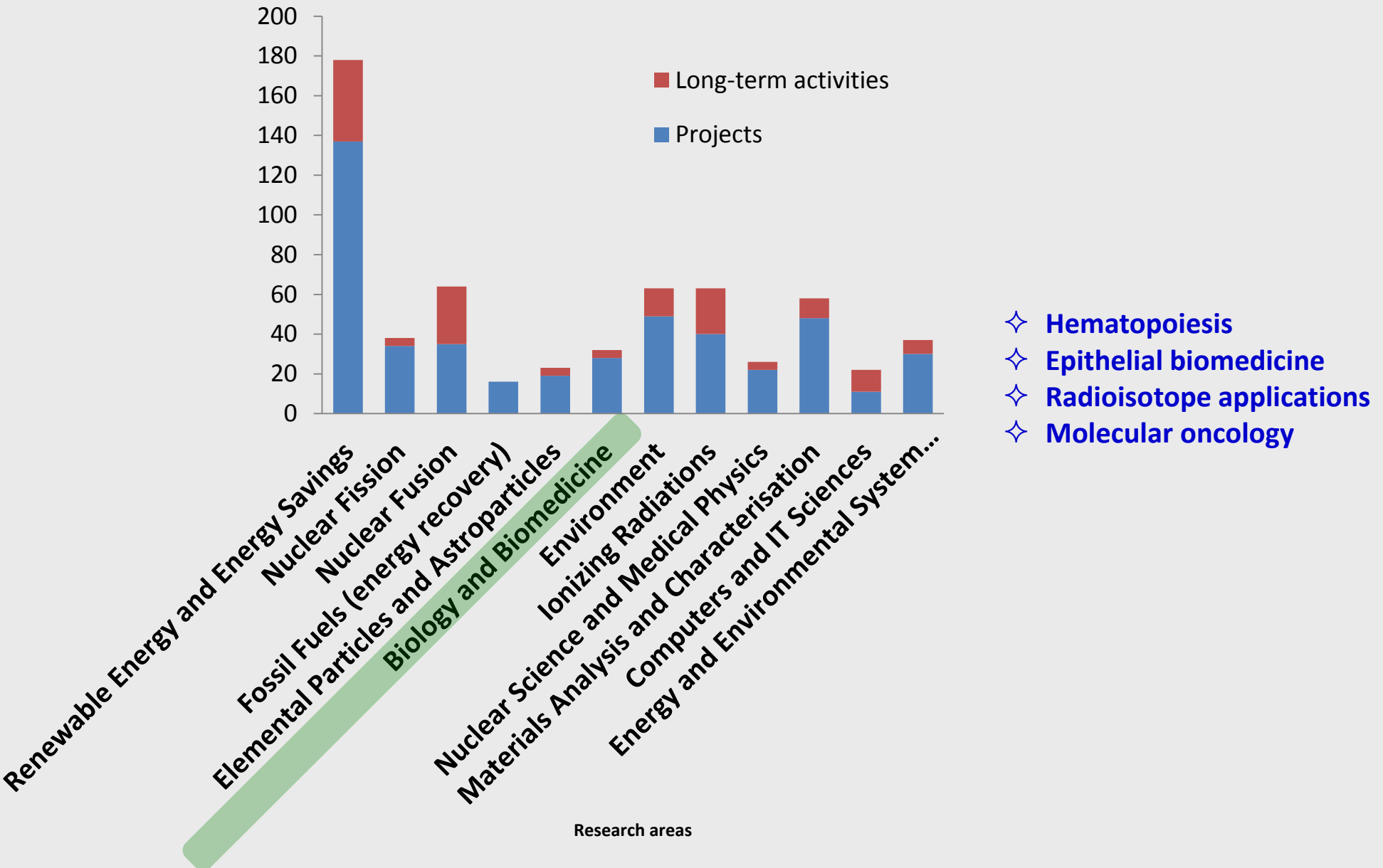


GRID computing

PIC. TIER-1 at LHC



Biomedical Innovation



Biomedical Innovation

Innovative translational research to improve the diagnosis and treatment of a number of inherited and acquired pathologies through modern techniques of genetics and molecular and cellular biology

Our research should facilitate the *transfer of innovative diagnostic and therapeutic procedures* to hospitals and pharmaceutical and biotech companies

Medicina regenerativa: Regeneración de piel

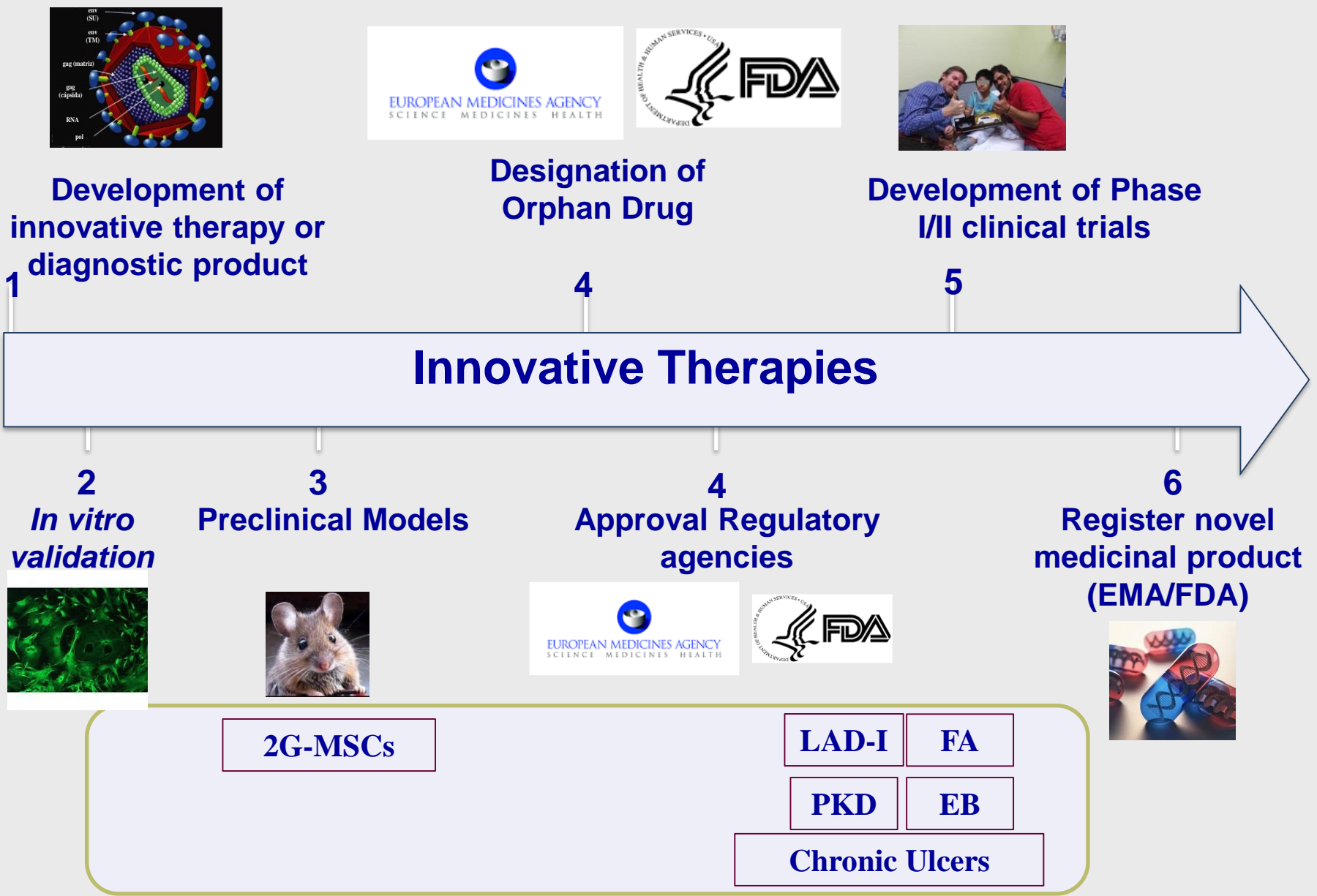


Major Research lines:

- Pathophysiology and animal models of disease
- Genomic diagnosis of hereditary and acquired diseases
- Preclinical and clinical cell therapy
- Preclinical and clinical gene therapy and gene editing



Development of Innovative Medicinal Products





Facilities



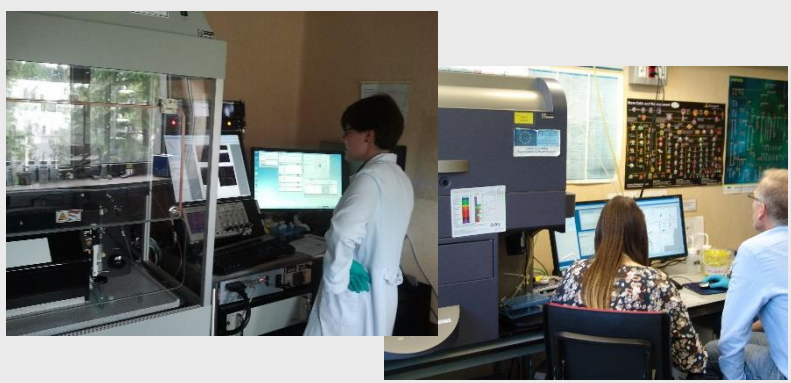
Animal Facility



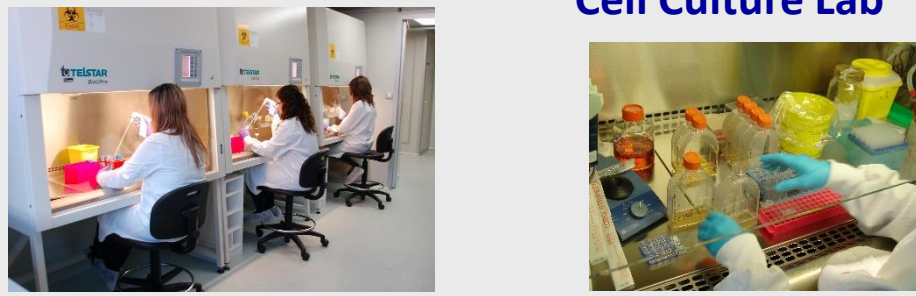
GMP Lab for Clinics Production



Cytometry and Cell Sorting: LACISEP



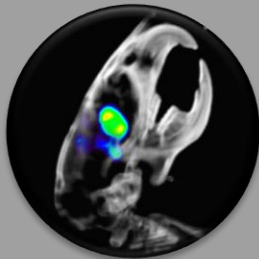
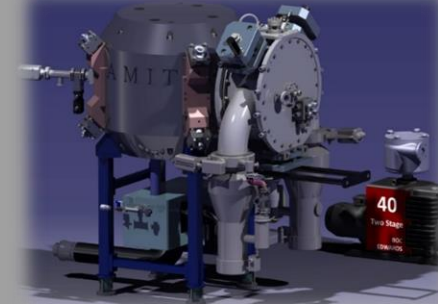
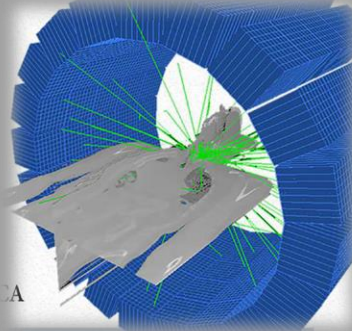
Cell Culture Lab



Histology and Microscopy Labs

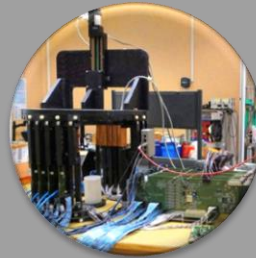


Medical Applications of Ionizing Radiations



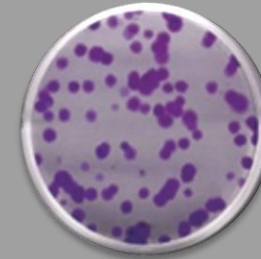
Radioisotopes

Applications in preclinical research on potential therapeutic and diagnostic agents.



Medical Physics

Instrumentation and tools in nuclear medicine and radiotherapy

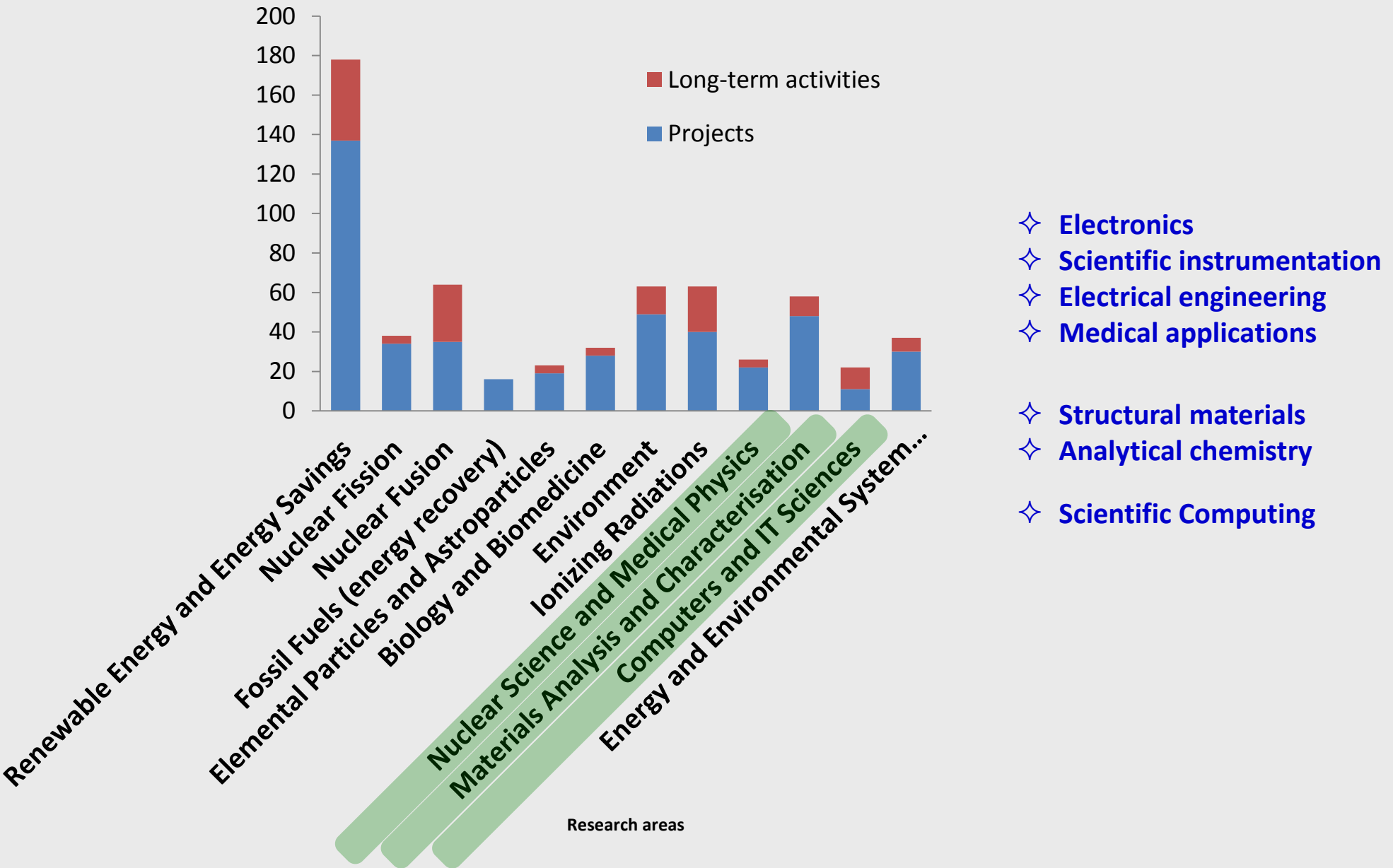


Radiobiology

Radiobiological effects in particle therapy (proton and carbon ions) and FLASH radiotherapy



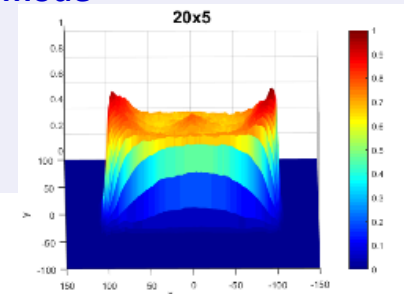
Scientific Instrumentation and other technological areas



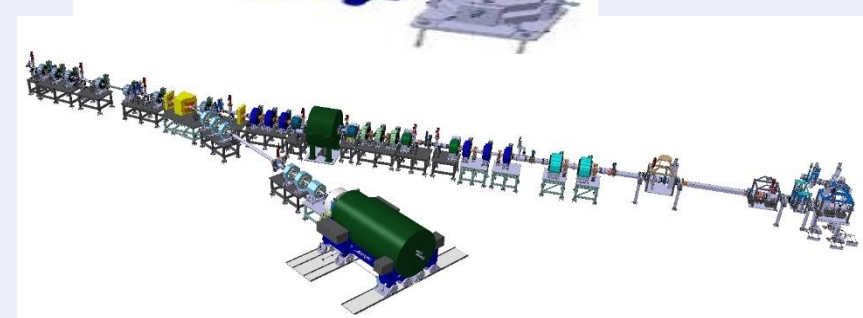
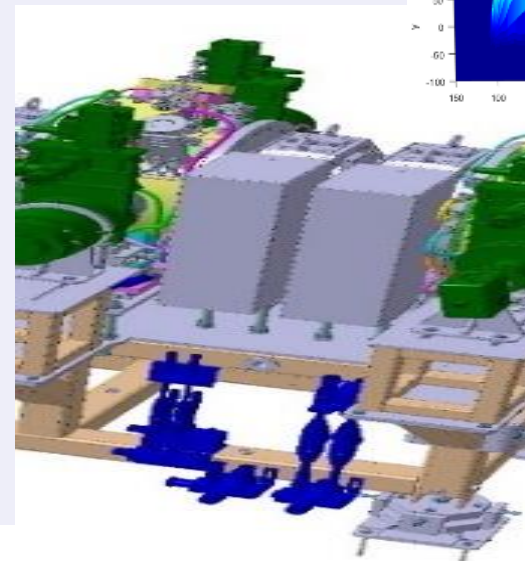
Neutron sources for fusion development



- 125 mA, 40 MeV deuteron beam continuous mode
- 5MW



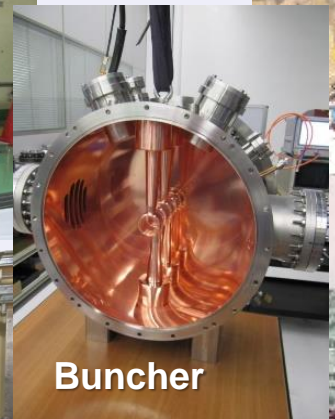
DONES



LIPAC



MEBT



Buncher



Diagnostics Plate



HEBT



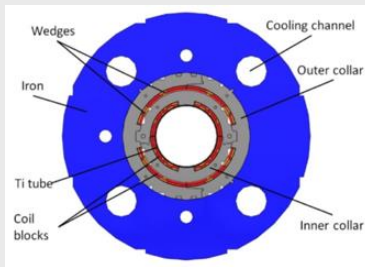
LIPAc construction for phase B+ completed in March 2020

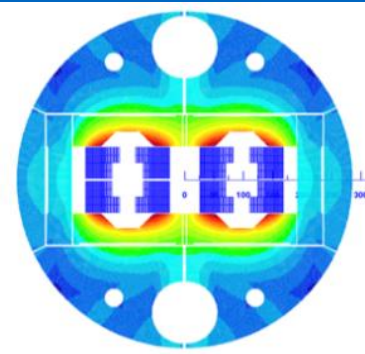


World record achieved in 2019. 125 mA of D+ up to 5 MeV

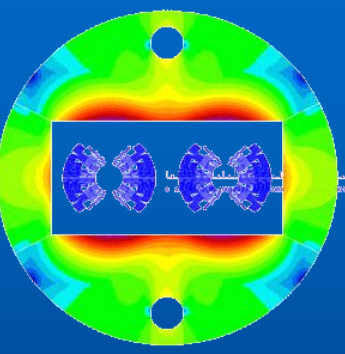
CIEMAT contribution to the European High Field Magnet Program

1. Commitment for HL-LHC:
An in-kind contribution for delivering 18+3 MCBXF-type orbit corrector superconducting magnets (shot: 11+1+2 prot; long: 6+1 prototype)
2. The construction of a laboratory for HFM prototyping
3. Contributing to the development of HFM prototypes > 15 T.

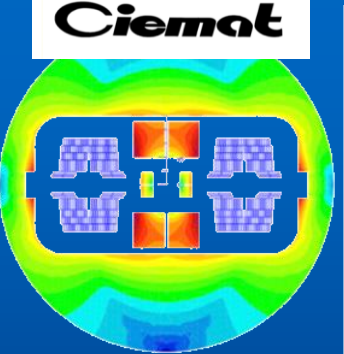




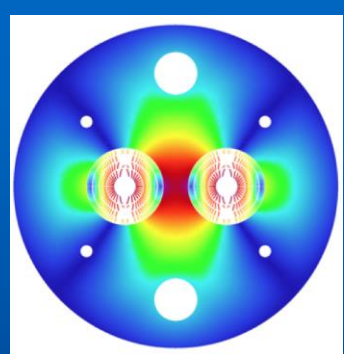
blocks



$\cos(\theta)$



common coil

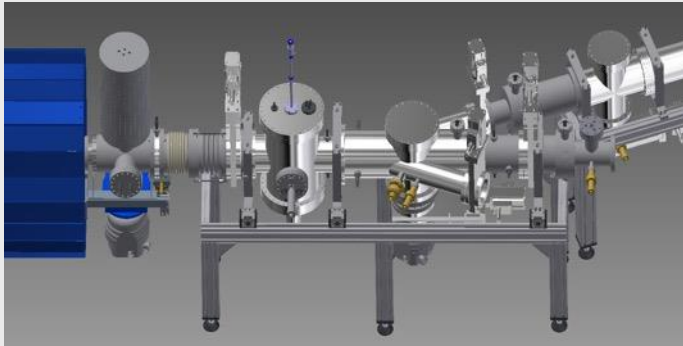


CCT

Simplified mechanics and manufacturing ?

Medical Ion Beam Therapy

Aim: C6+ ion-beam LINACs.
(CERN, HITRI-PLUS, ARIES, SEEIIST & National programs)



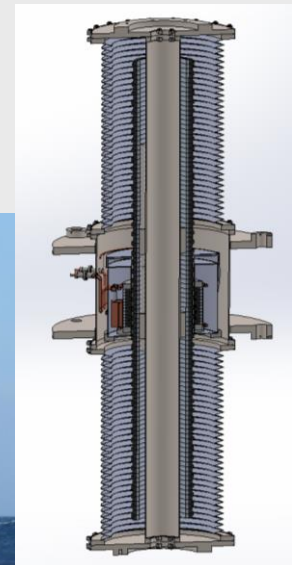
PET Isotope production

Compact accelerators for research PET radioisotopes



Energy and transport applications

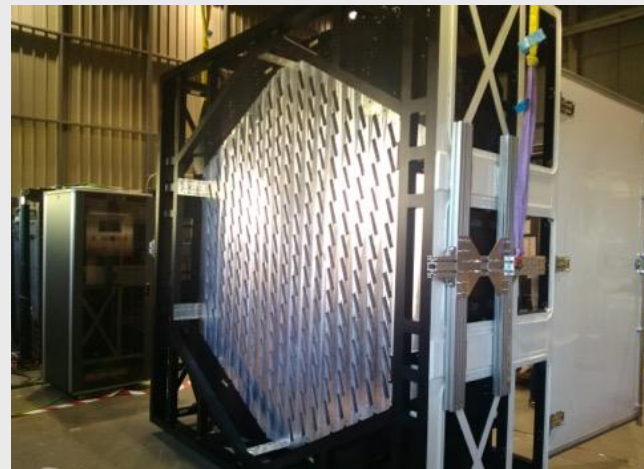
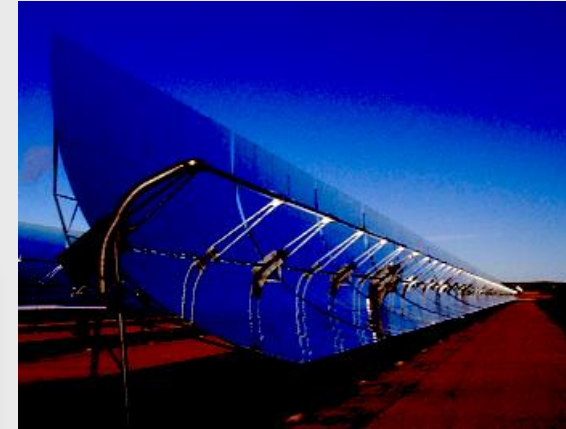
(Examples of on-going discussions with industry and academia: a) Ultrafast Transportation System b) Ocean Energy Extraction Systems



The activity of CIEMAT

1. Medium-large dimension projects
 2. Institutional presence at internacional level
 3. Close collaboration with the industry
- Technological development projects,
 - Near to the productive sector
 - In the field of applied physics-engineering

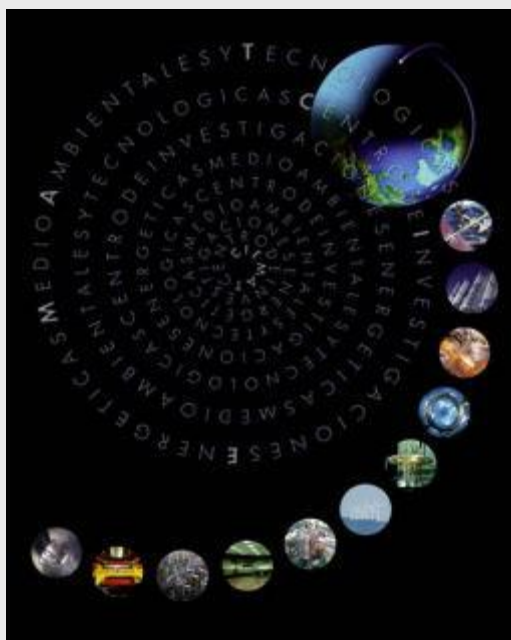
Long times for technology transfer (when compared with other sectors)



In summary, CIEMAT

- is a public research center focused on energy, environment and technological related topics;
- it aims at covering the whole path from basic research to service provider;
- its activity is closer to technological development, if compared with other research institutions;
- it has links with large facilities and research and technological platforms and agencies.

Currently, involved on a Strategic Plan, than will focus our organization and internal rules towards our a number a key research activities





**Thank you very much
for your attention**

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Dept. of Technology
jm.perez@ciemat.es



GOBIERNO
DE ESPAÑA

MINISTERIO
DE CIENCIA
E INNOVACIÓN

Ciemat Centro de Investigaciones
Energéticas, Medioambientales
y Tecnológicas

- Participación en el **Grupo de Trabajo** (GT) creado por el Ministerio de Transición Ecológica para realizar las aportaciones a la dimensión 5 (Investigación, Innovación y Competitividad).
- GT constituido por representantes del MITECO, MICINN, AEI, CDTI, IDAE y **CIEMAT** (único OPI participante)
- Trabajo realizado por **ALINNE**: relevante para la definición de los objetivos de I+i+c y tecnologías prioritarias

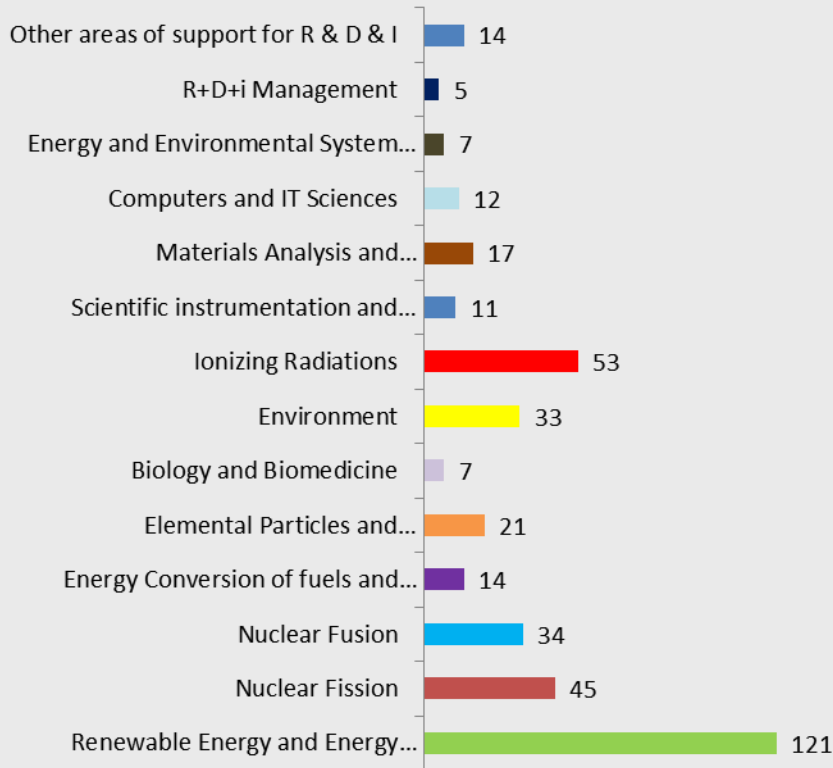


Aportaciones realizadas por CIEMAT que se incluyen en el PNIEC

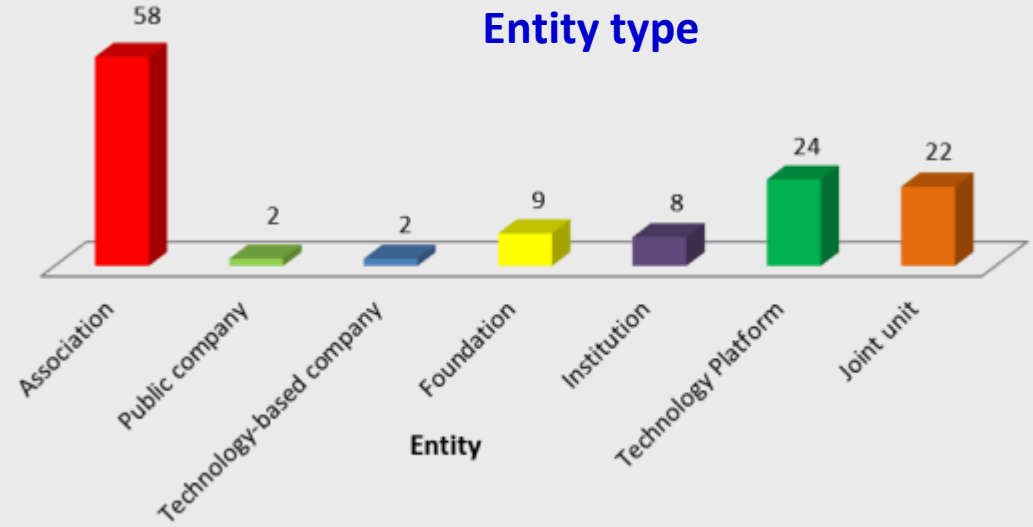
1. **Acción Estratégica en Energía y Cambio Climático en la futura Estrategia española de ciencia y tecnología y de innovación 2021-2028 y en el futuro Plan estatal de investigación científica, técnica y de innovación 2021-2024.**
2. **Objetivo de inversión anual en I+D+i no menos del 2,5% del PIB durante los próximos cuarenta años, de manera constante, con independencia de los ciclos económicos.**
3. **Mención explícita que CIEMAT, junto con la AEI y el CDTI, son los organismos del Ministerio de Ciencia, Innovación y Universidades responsables de desarrollar la I+D en el sector de la energía.**
4. **Mención explícita a la utilización de la herramienta TIMES-Spain, desarrollada por el CIEMAT, para realizar el análisis del sistema energético y su prospectiva.**

CIEMAT Institutional Presence

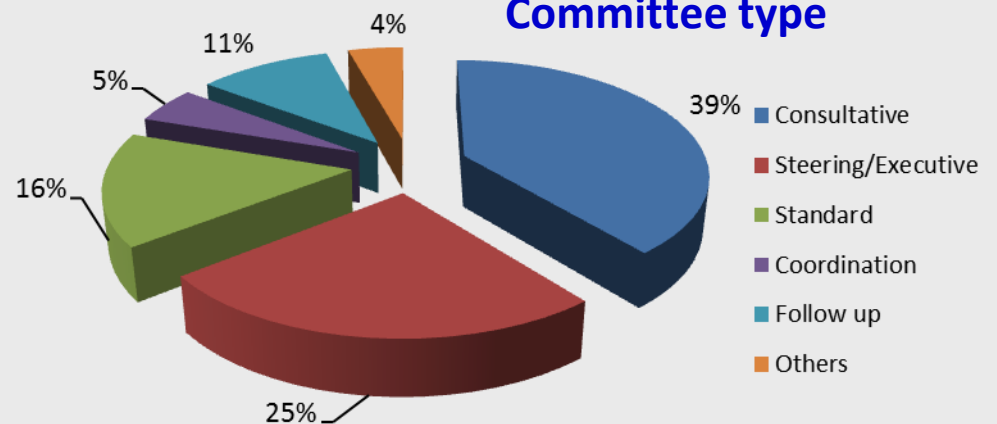
Committees by scientific area



Entity type

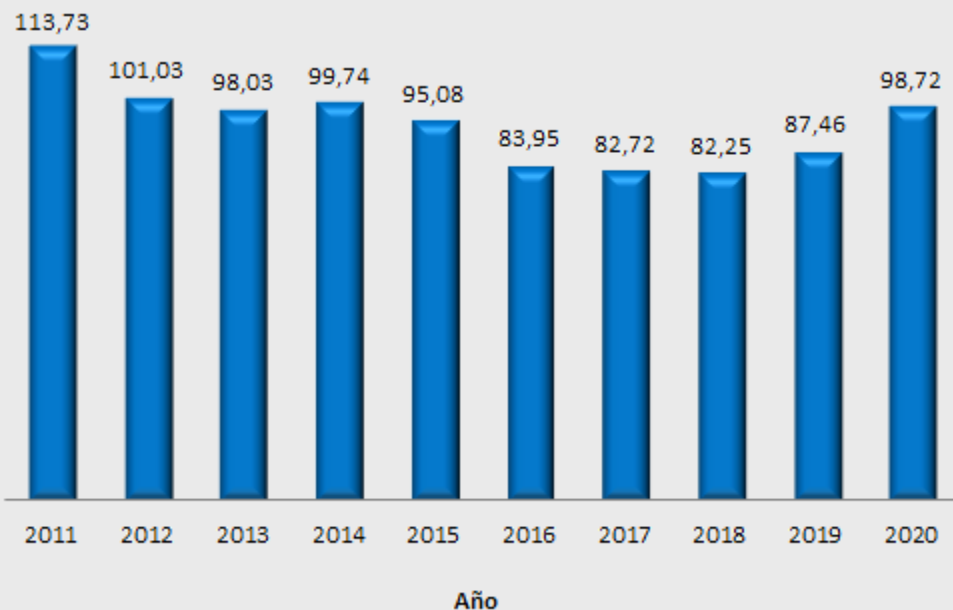


Committee type

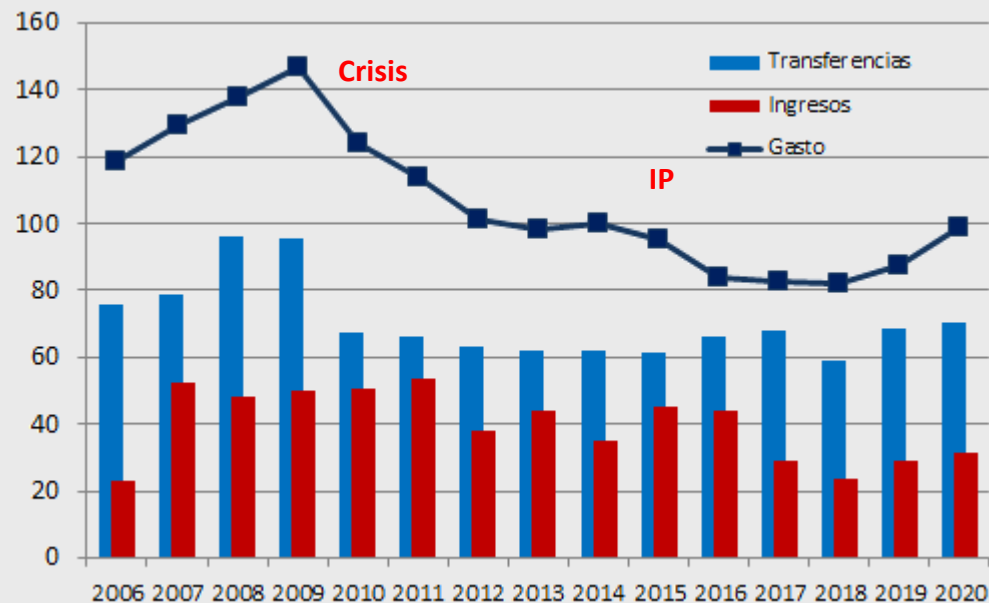


CIEMAT figures

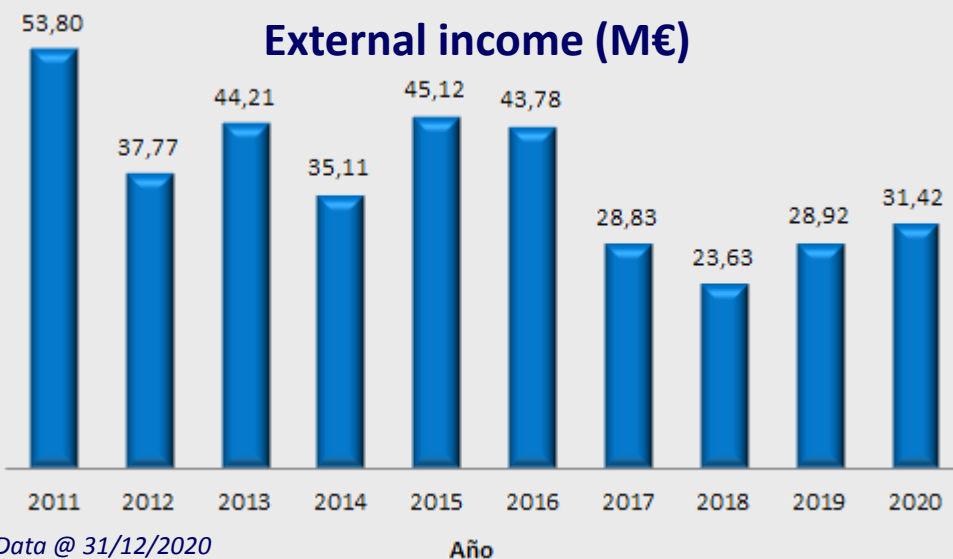
Year expenditure (€)



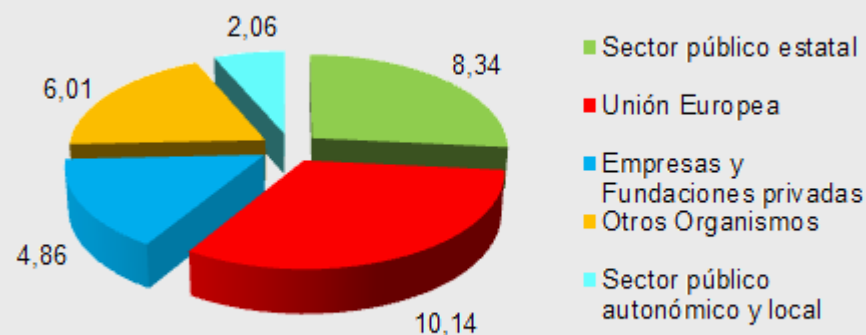
Income from the Government vs external (M€)



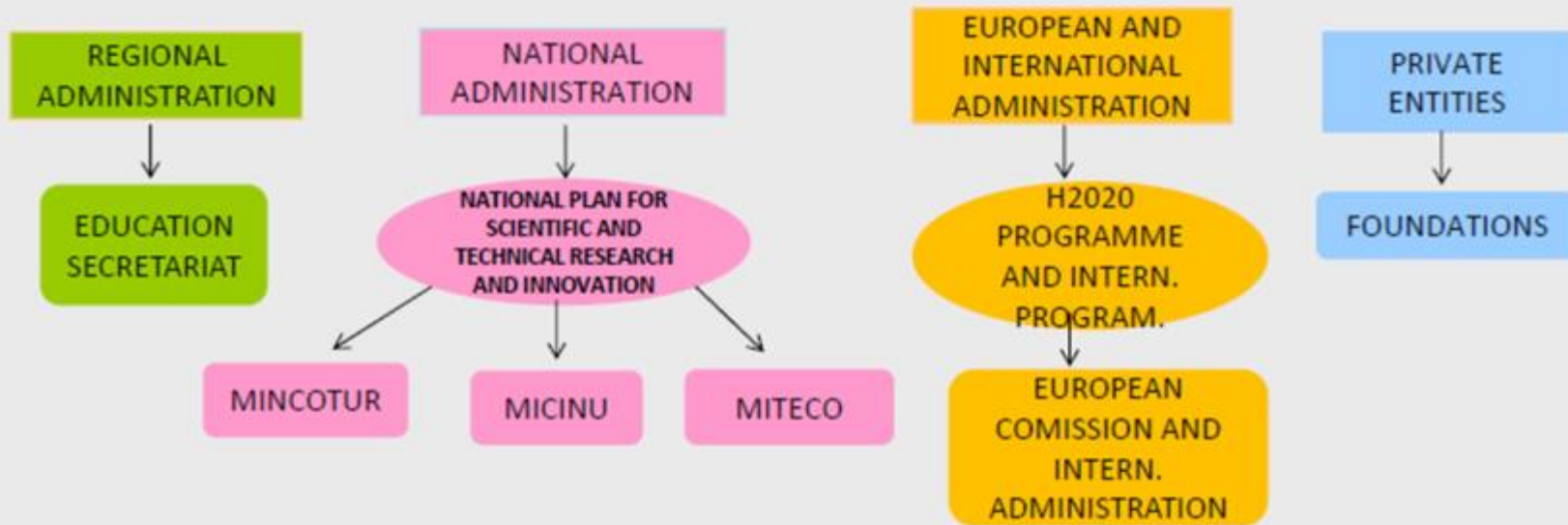
External income (M€)



Income per funding agency 2019 (M€)



REGULAR RESEARCH- Calls



RESEARCH Collaboration with institutions- Agreements



Biomedical Innovation



Ambition: Potentiate the CIEMAT's Mission on Technology in the field of Translational Biotechnology

How: By means of the creation of a new Research Area on Biomedical Innovation



Strategic Alliances:

- *CiberER*
- *CiberOnc*
- *Hosp Fund. Jiménez Díaz*
- *Hospital 12 Octubre*
- *Universidad Carlos III*



CIEMAT. International Presence

