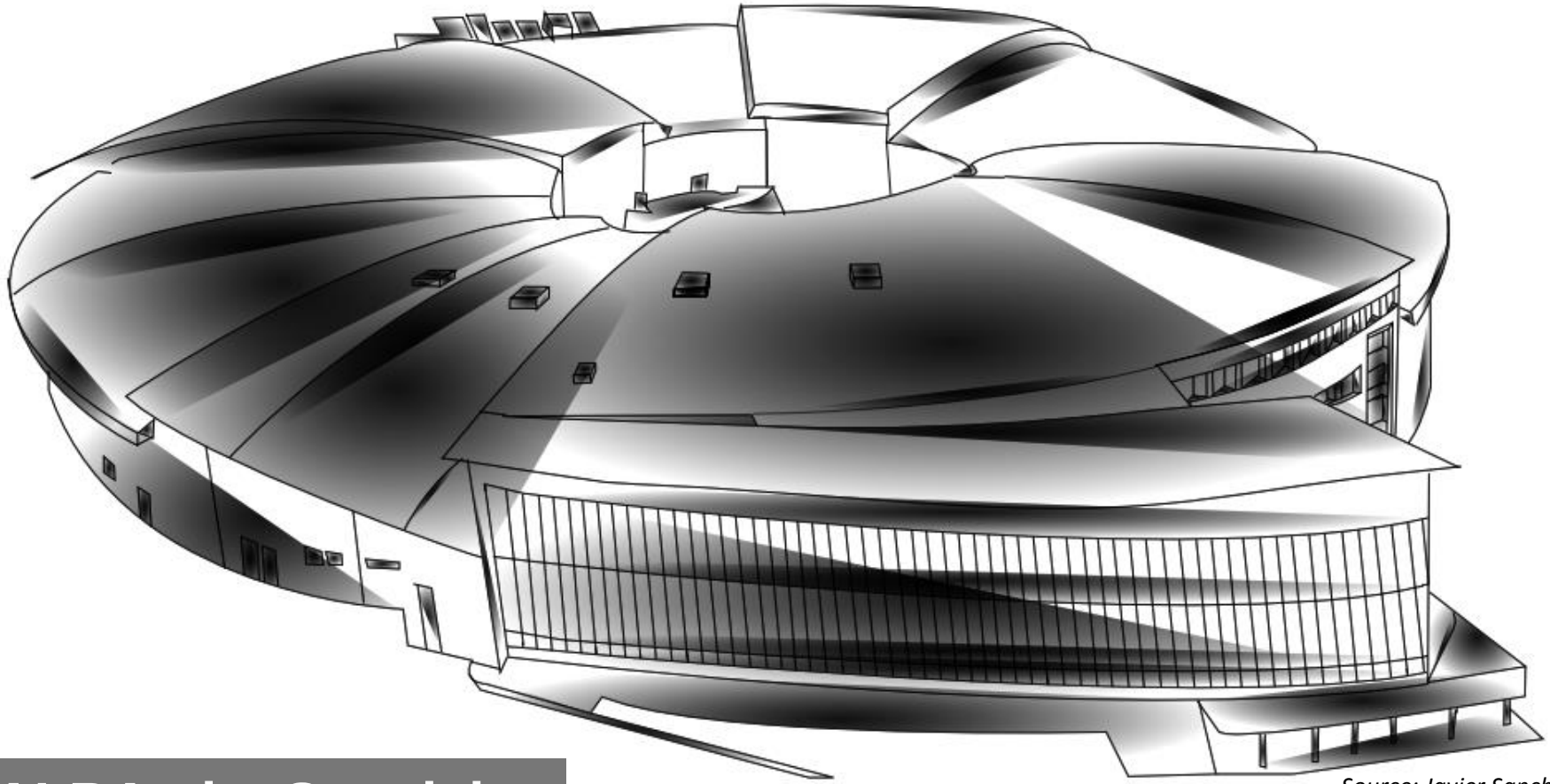


Source: Javier Sanchez Rios

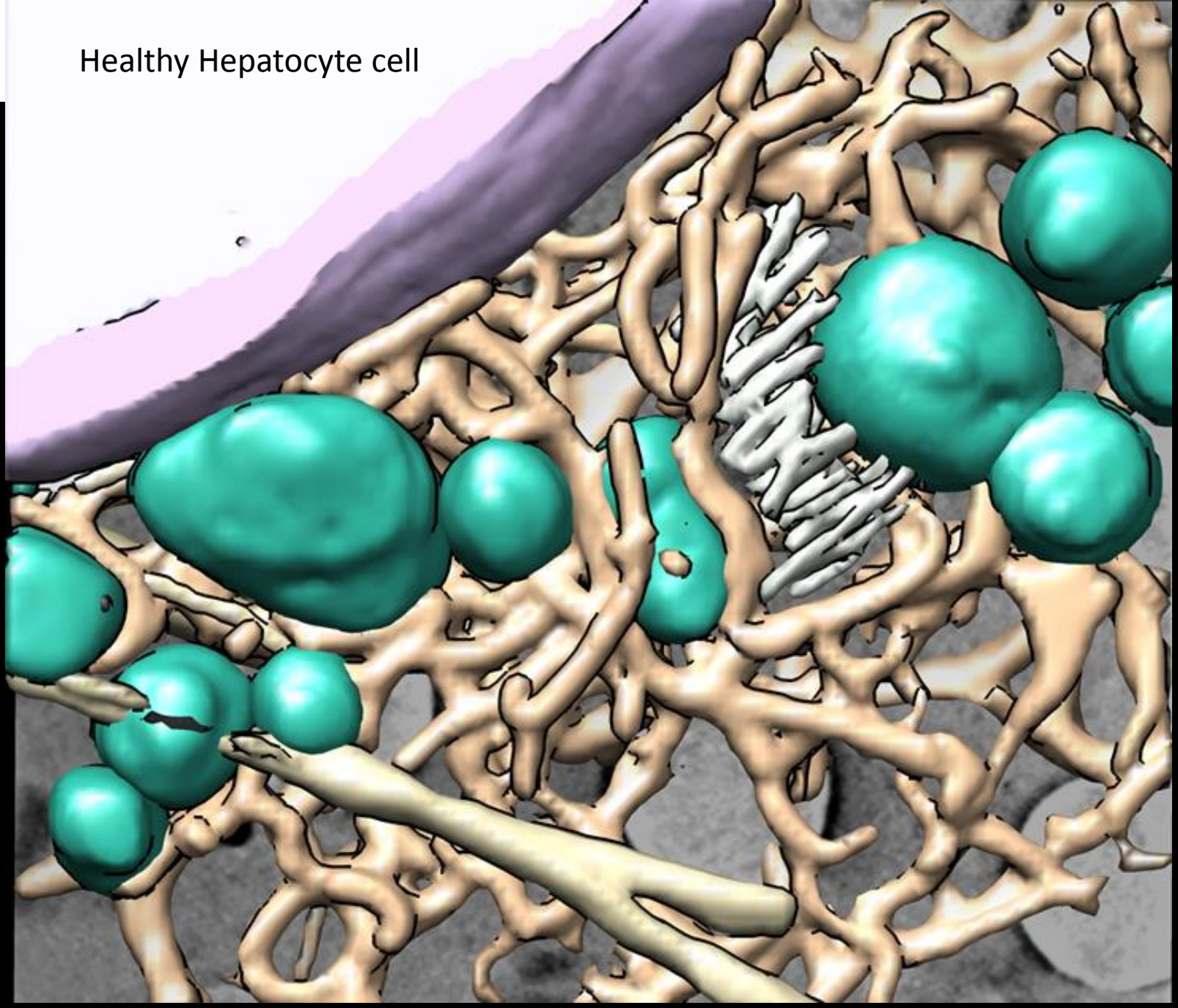
ALBA, the Spanish Synchrotron

Monasterio de Pedralbes

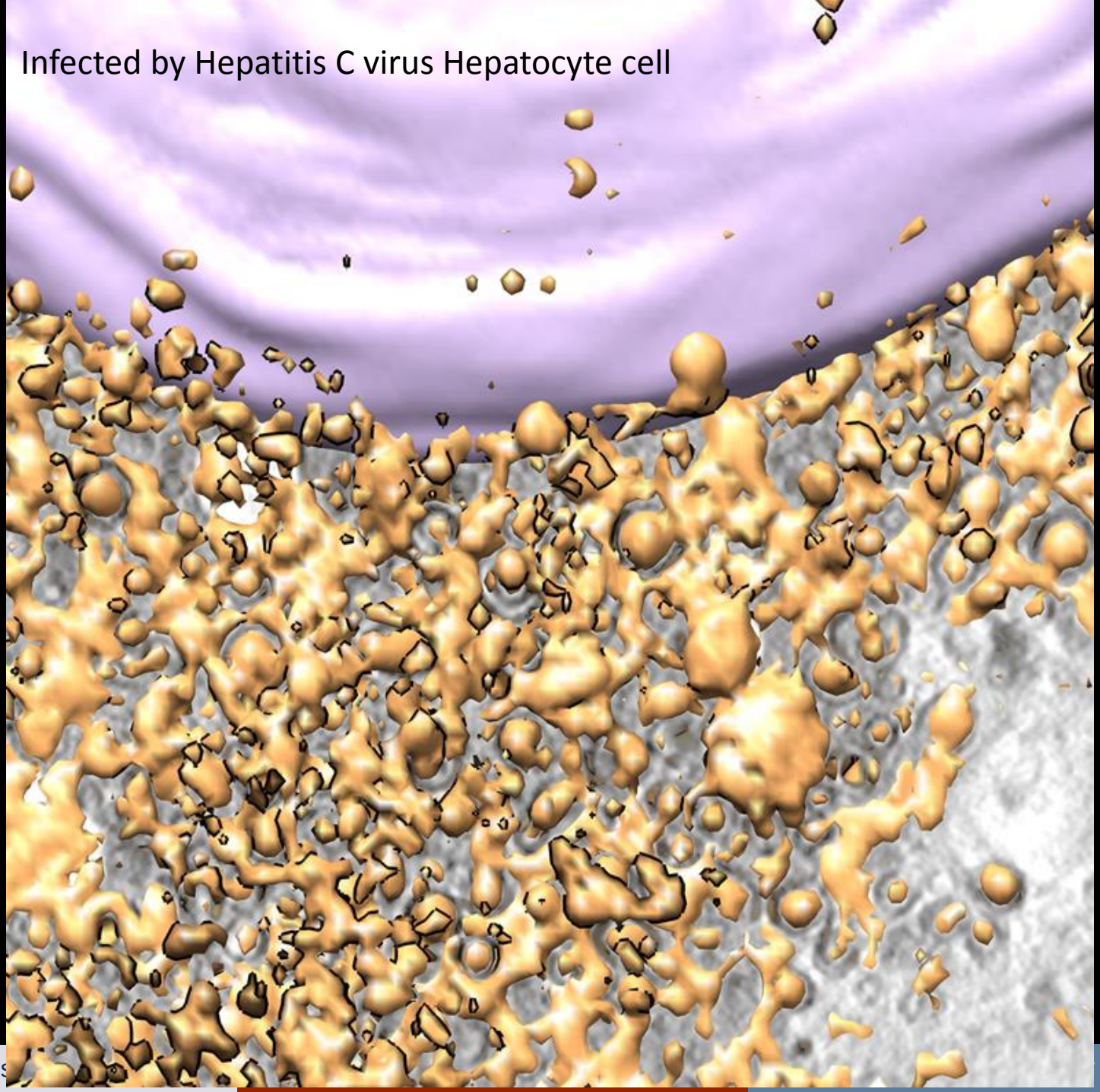
Capilla de San Miguel
Open to public after 10 years of restauration in 2015

Fungi in the paintings detected with Synchrotron Light at ALBA

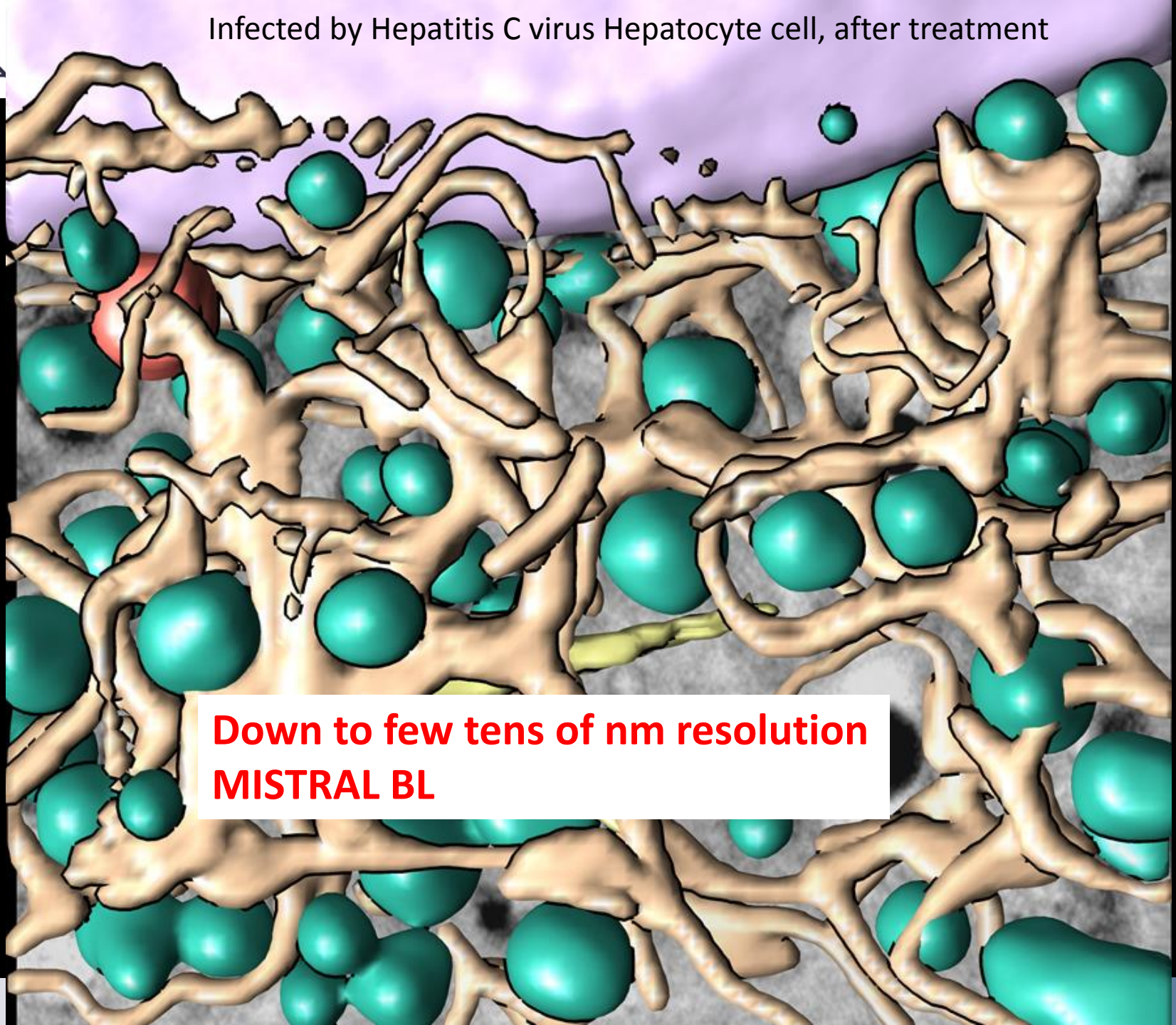
Healthy Hepatocyte cell



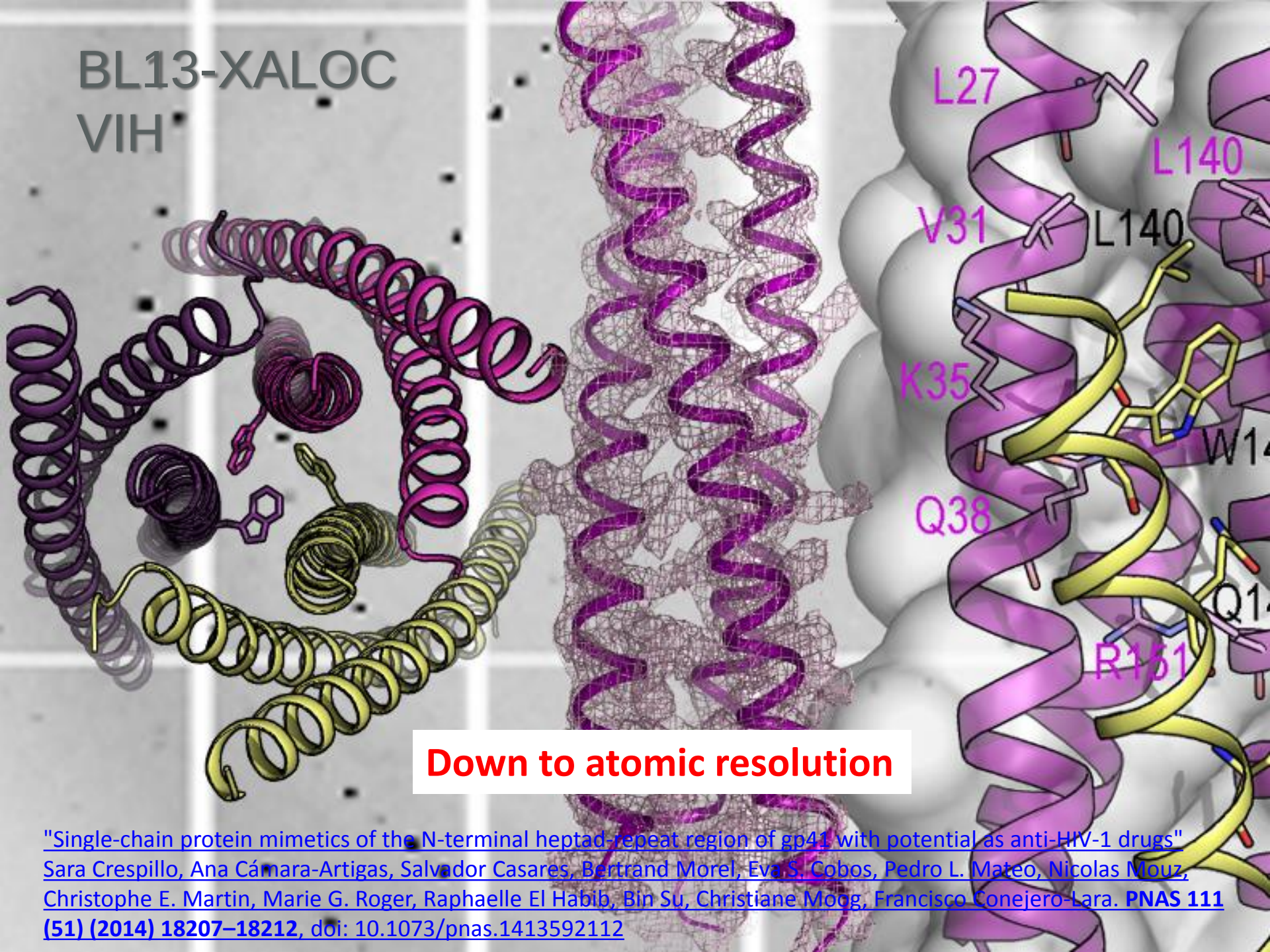
Infected by Hepatitis C virus Hepatocyte cell



Infected by Hepatitis C virus Hepatocyte cell, after treatment



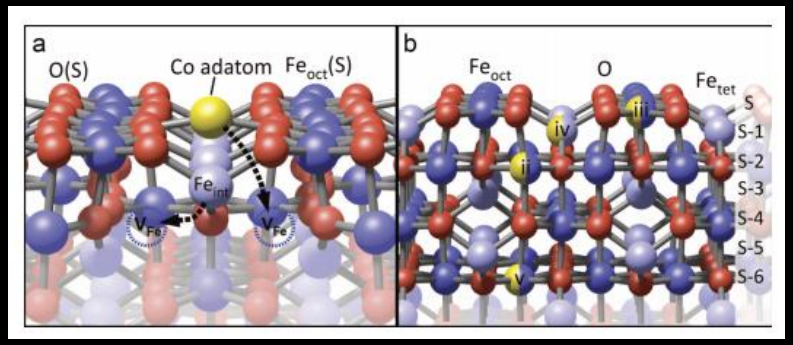
Down to few tens of nm resolution
MISTRAL BL



"Single-chain protein mimetics of the N-terminal heptad-repeat region of gp41 with potential as anti-HIV-1 drugs" Sara Crespillo, Ana Cámara-Artigas, Salvador Casares, Bertrand Morel, Eva S. Cobos, Pedro L. Mateo, Nicolas Mouz, Christophe E. Martin, Marie G. Roger, Raphaelle El Habib, Bin Su, Christiane Moog, Francisco Conejero-Lara. **PNAS 111 (51) (2014) 18207–18212**, doi: 10.1073/pnas.1413592112

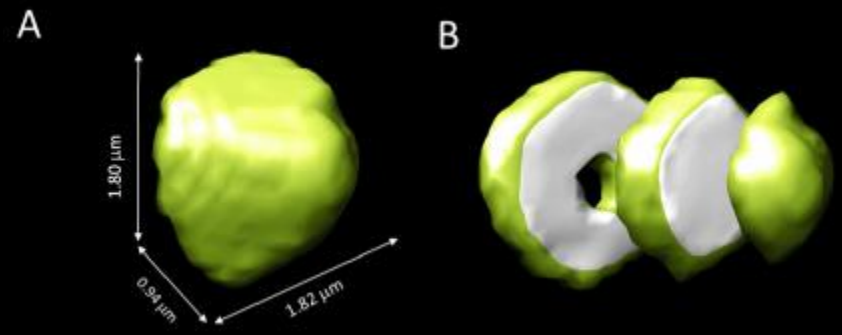
No Moore's Law for Li Batteries but intensive R&D

The first lithium ion battery was commercialized in 1991. It took the entire industry 25 years to be able to pack two times the energy in the same size battery.



Co on Fe3O4(001): Towards precise control of surface properties - CIRCE

Towards precise control of surface properties Raquel Gargallo-Caballero, Laura Martín-García, Adrián Quesada, Cecilia Granados-Miralles, Michael Foerster, Lucía Aballe, Roland Bliem, Gareth S. Parkinson, Peter Blaha, José F. Marco, and Juan de la Figuera - http://dx.doi.org/10.1063/1.4942662

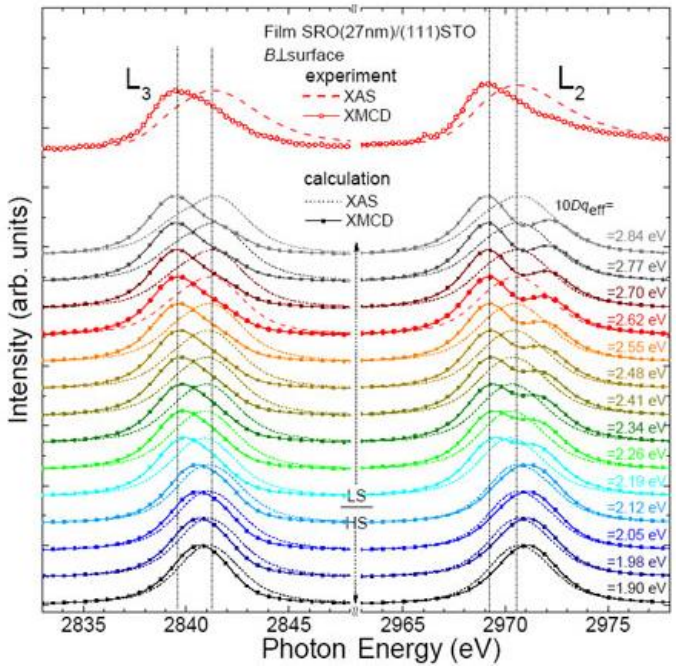


Visualizing discharge products in lithium-oxygen batteries - MISTRAL

Spatial Distributions of Discharged Products of Lithium–Oxygen Batteries Revealed by Synchrotron X-ray Transmission Microscopy - Mara Olivares-Marín[†], Andrea Sorrentino[‡], Rung-Chuan Lee[§], Eva Pereiro[‡], Nae-Lih Wu[§], and Dino Tonti[*] -
DOI: 10.1021/acs.nanolett.5b02862

Magnetic materials

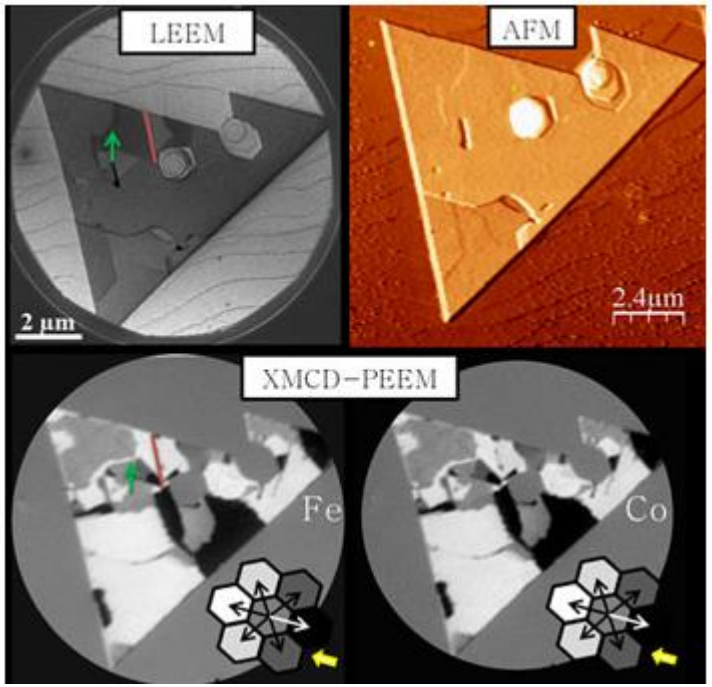
Storage devices



FERROMAGNETIC Electrically conducting layer

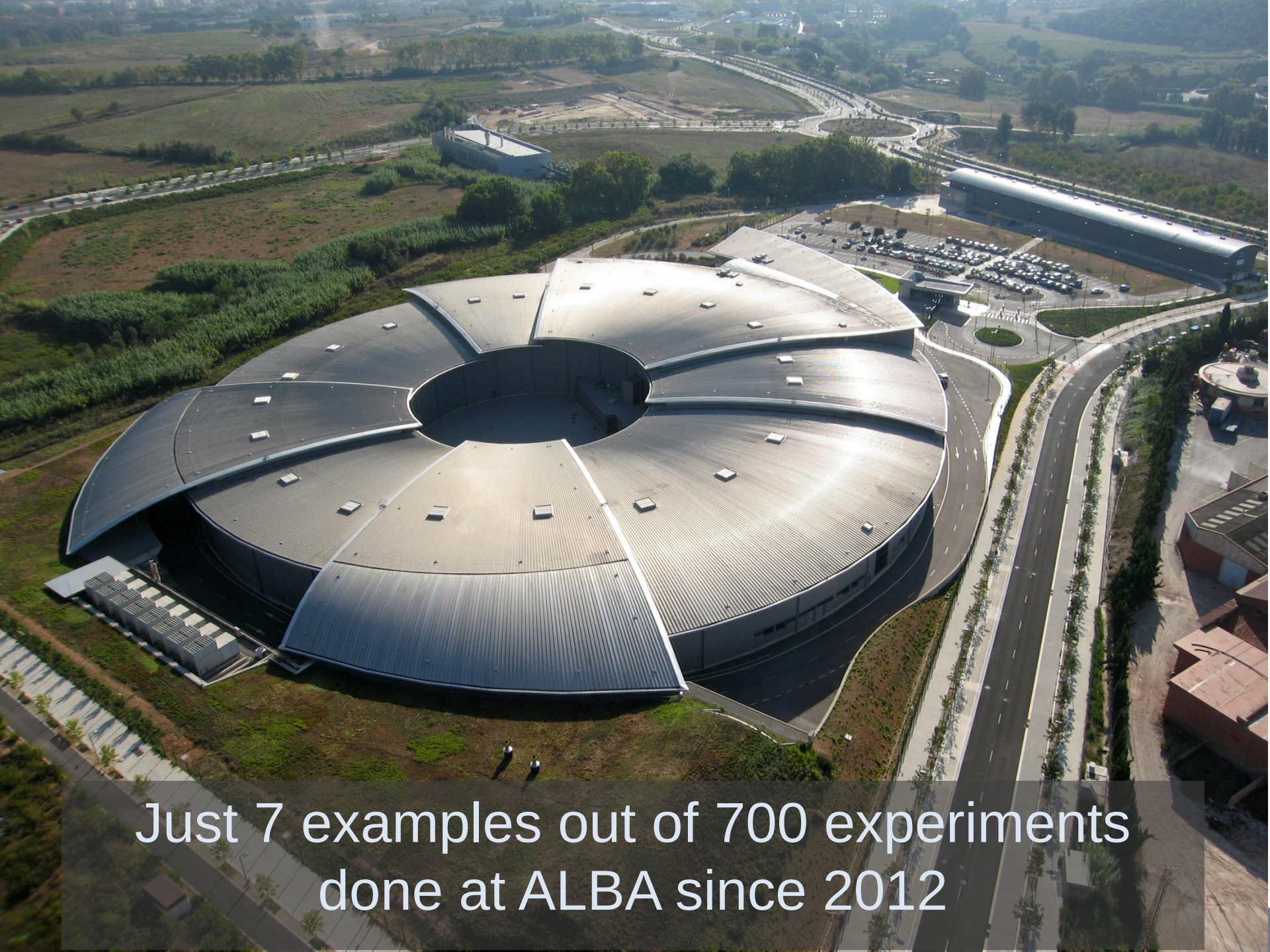
"Electronic and spin states of $SrRuO_3$ thin films: An x-ray magnetic circular dichroism study" S. Agrestini, Z. Hu, C.-Y. Kuo, M. W. Haverkort, K.-T. Ko, N. Hollmann, Q. Liu, E. Pellegrin, S. M. Valvidares, J. Herrero-Martin, P. Gargiani, P. Gegenwart, M. Schneider, S. Esser, A. Tanaka, A. C. Komarek, and L. H. Tjeng.
Physical Review B 91, 075127 (2015). DOI: http://dx.doi.org/10.1103/PhysRevB.91.075127

Spintronics



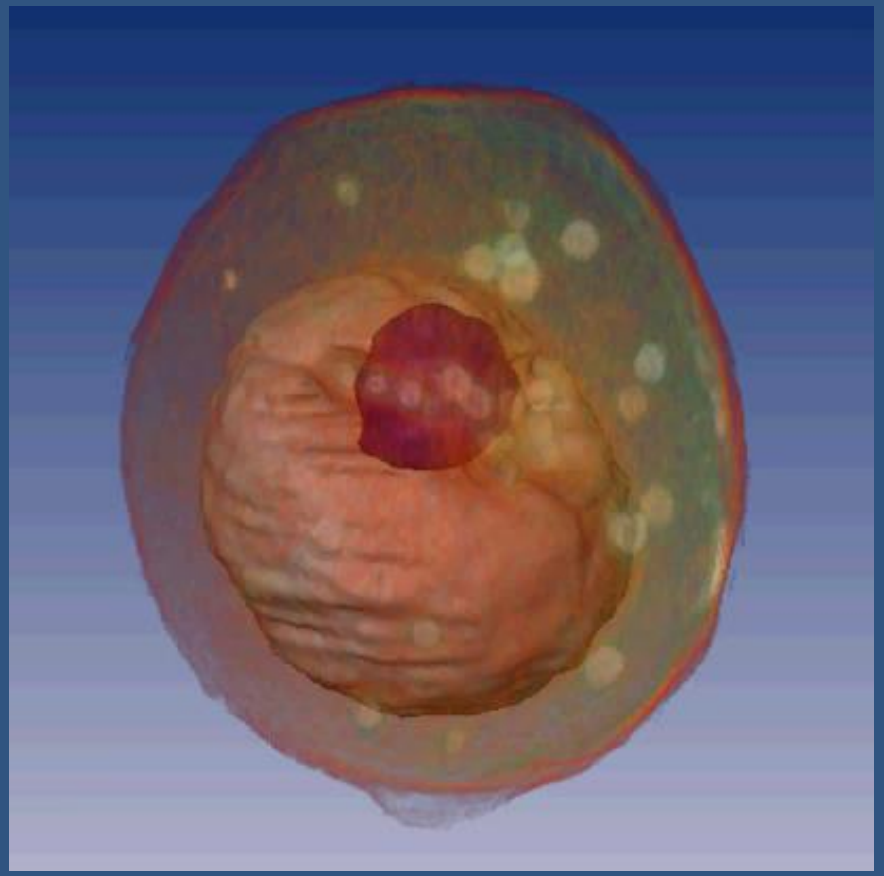
Nanostructures or cobalt ferrite islands

Reference: L. Martín-García, A. Quesada, C. Munuera, J.F. Fernández, M. García-Hernández, M. Foerster, L. Aballe, J. de la Figuera. Atomically flat ultrathin cobalt ferrite islands. Advanced Materials. DOI: 10.1002/adma.201502799


Just 7 examples out of 700 experiments
done at ALBA since 2012

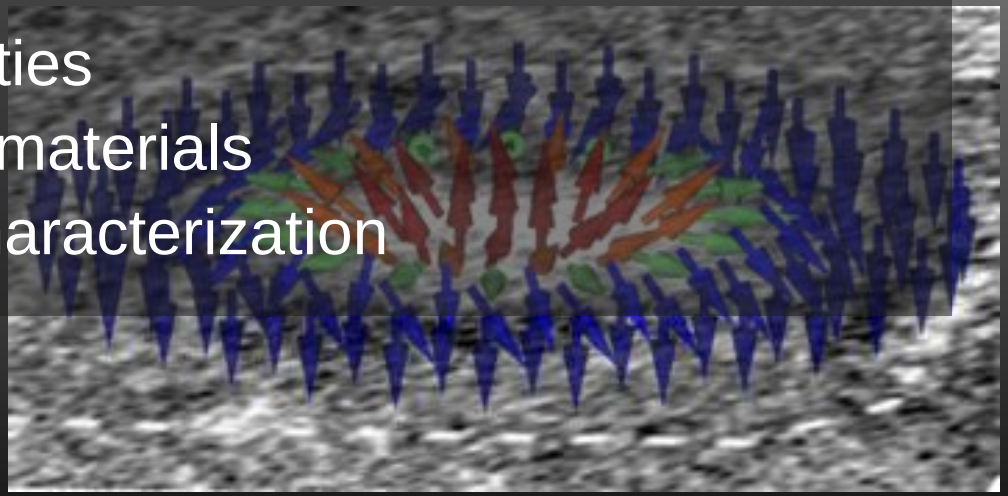
Life science, among others…

- Protein characterization
- Imaging of biological structures at cell dimensions
- Single-cell analysis, tissue analysis and bacterial identification
- Study of human and animal tissues and their reaction to drugs
- Drug development
- Food science
- Cosmetics
- Study of effects of nanomedicine in tissues



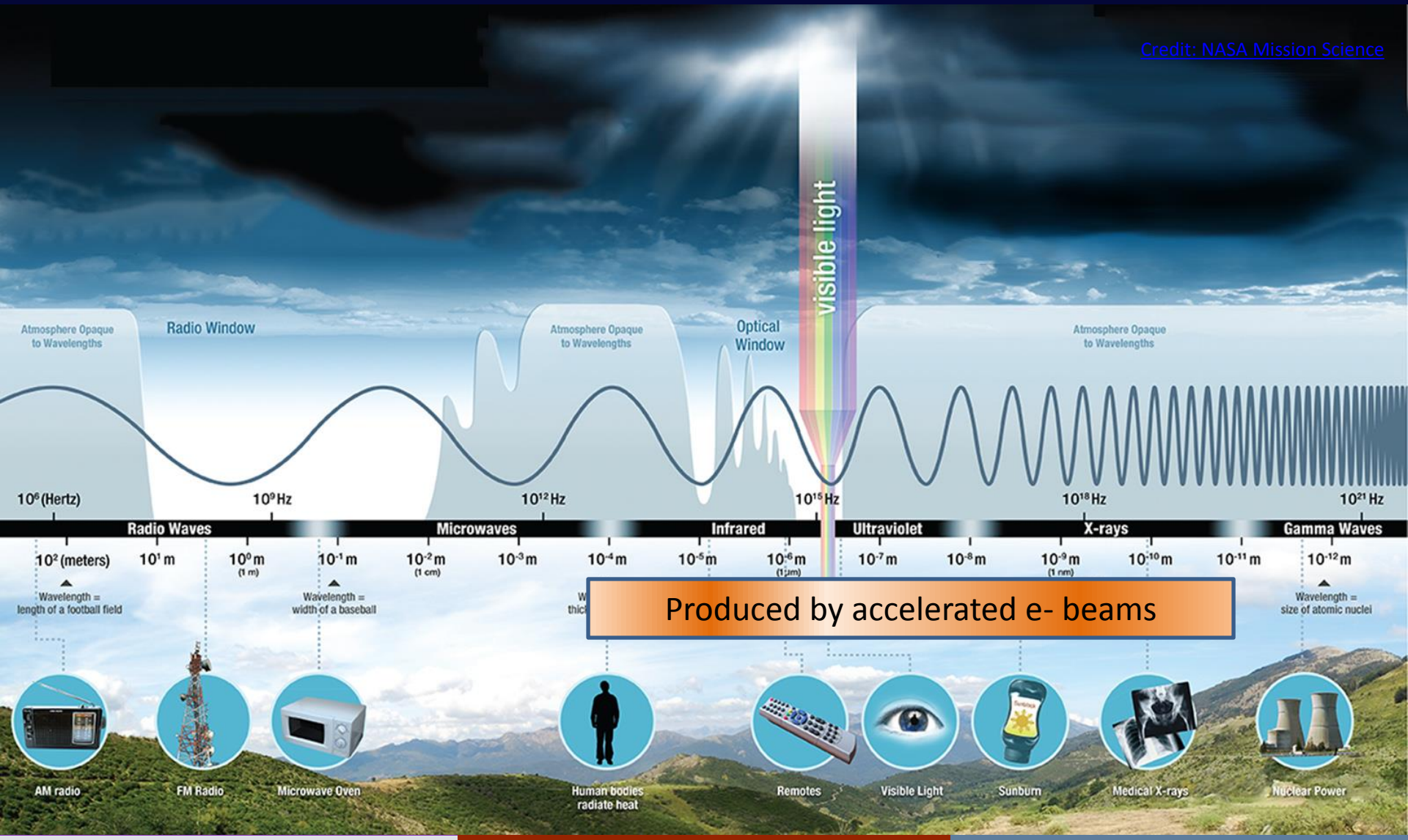
Material science, among others…

- Magnetic properties of material (see figure of skyrmions)
- Development of new catalysts
- Characterization of material for energy transfer and storing
- Soil analysis
- Chemical properties of new materials
- Mineralogical research
- Geochemistry of organic matter and minerals in geological samples
- Analysis of thin films
- Engineering material properties
- Communication technology materials
- Cultural heritage material characterization



Alba provides the eyes

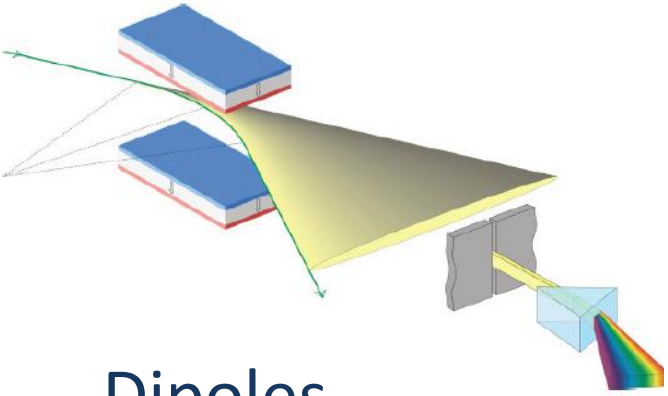
Electromagnetic radiation



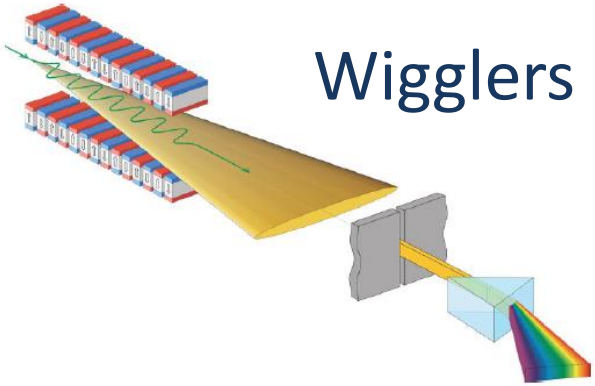
2017: ~ 50 Synchrotrons in the world, serving a community of >50000 users

In Operation *In Commissioning* *In Construction*

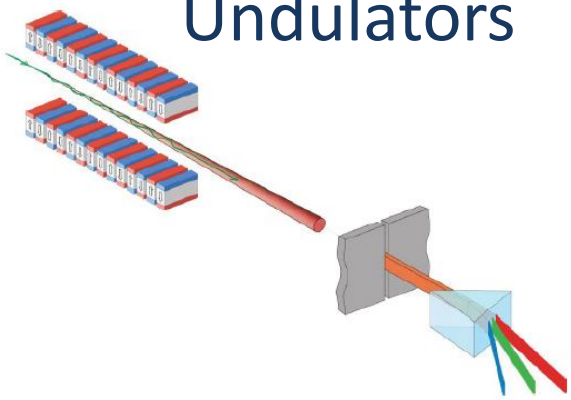
Synchrotron light production



Dipoles



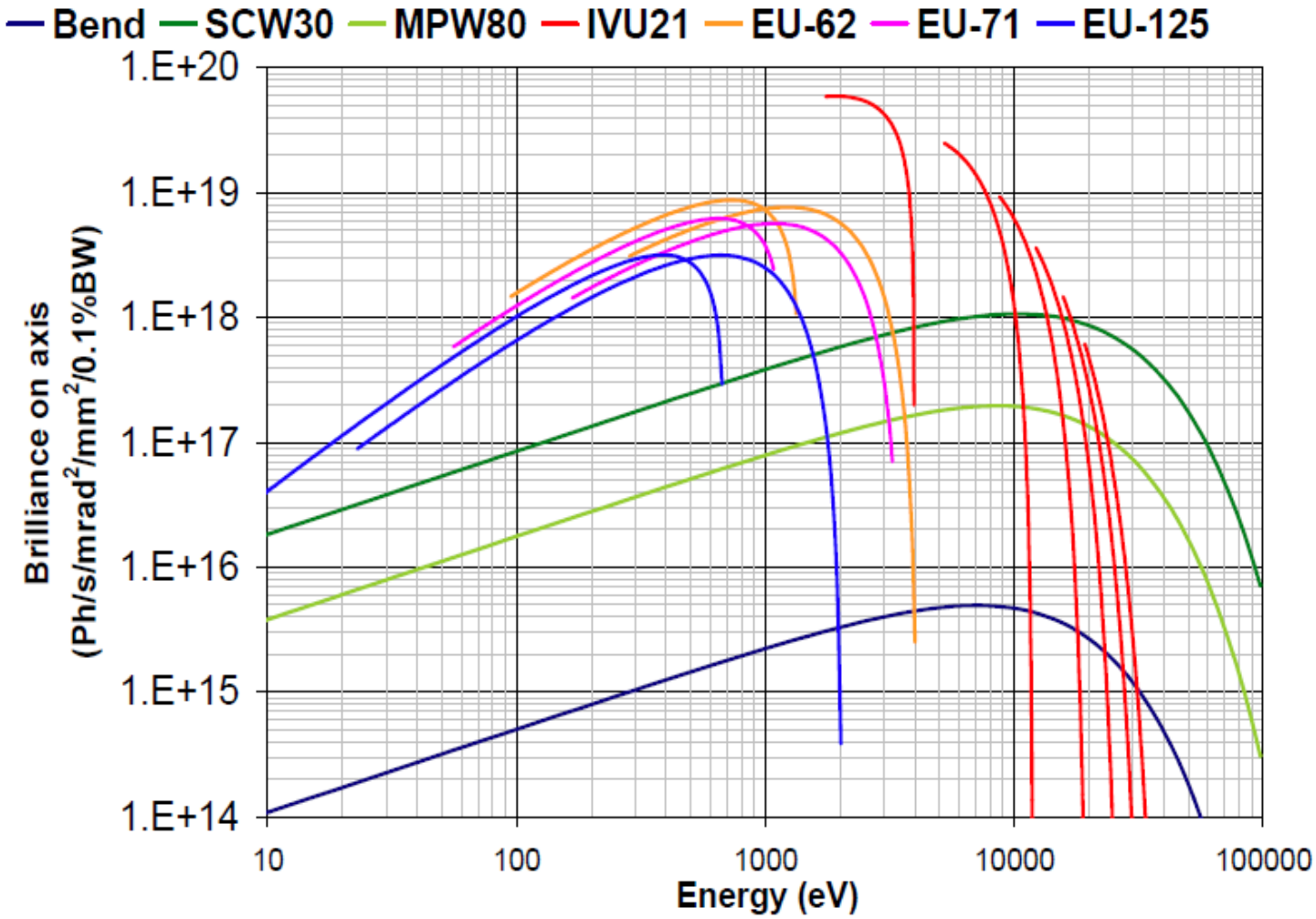
Wigglers

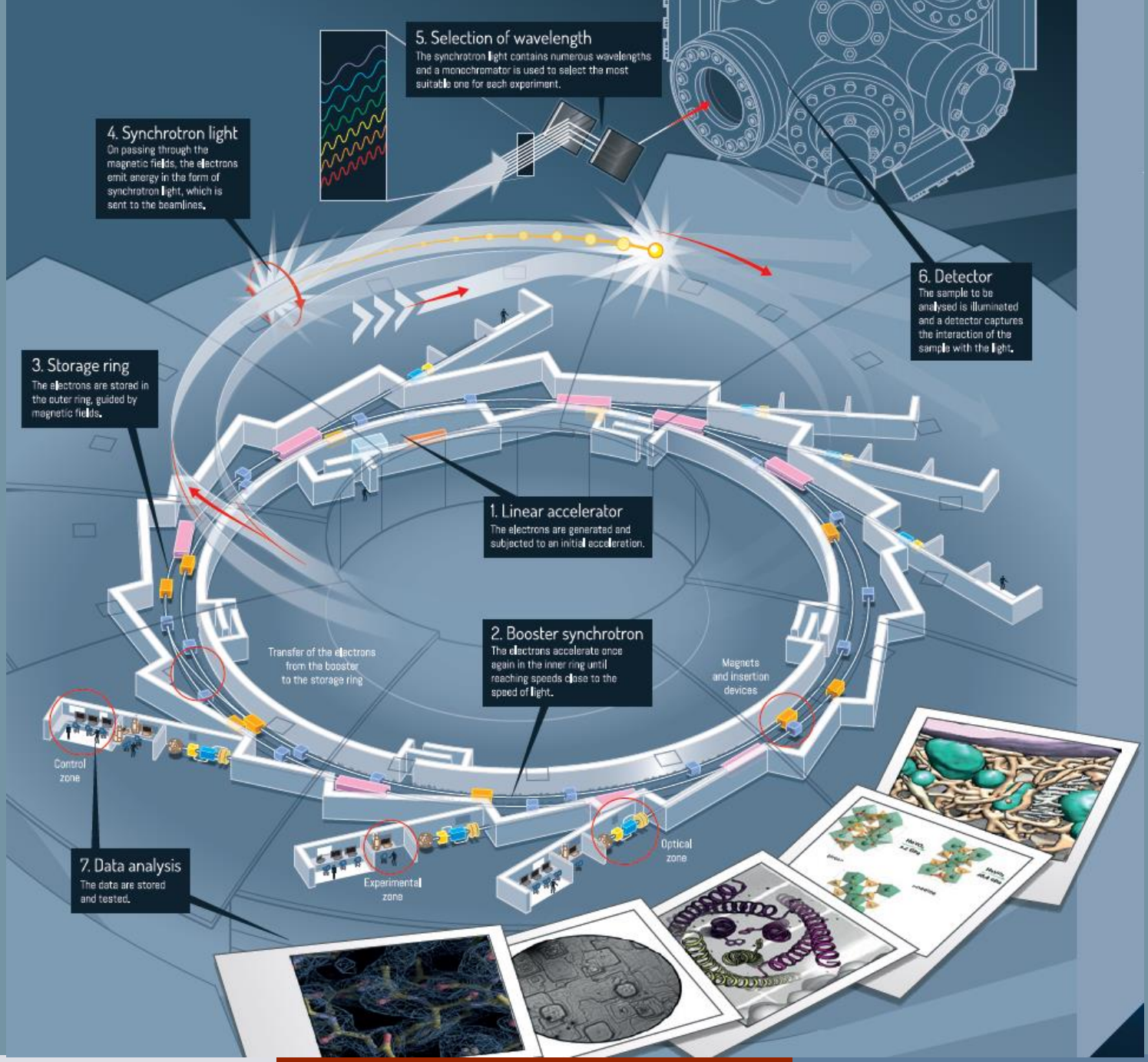


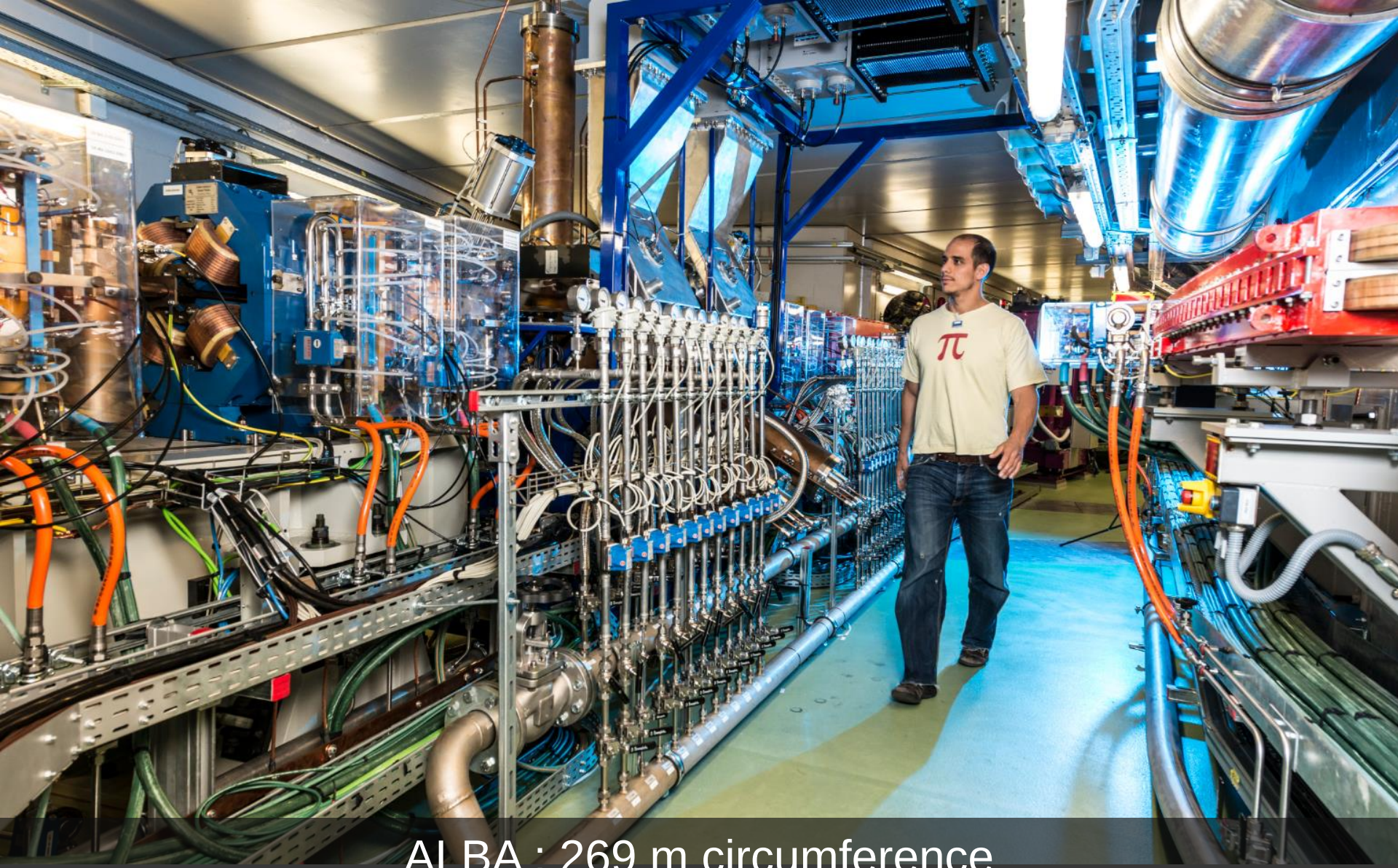
Undulators

Accelerated particles (electrons)
Magnetic fields
Optical systems

Brilliance of ALBA sources



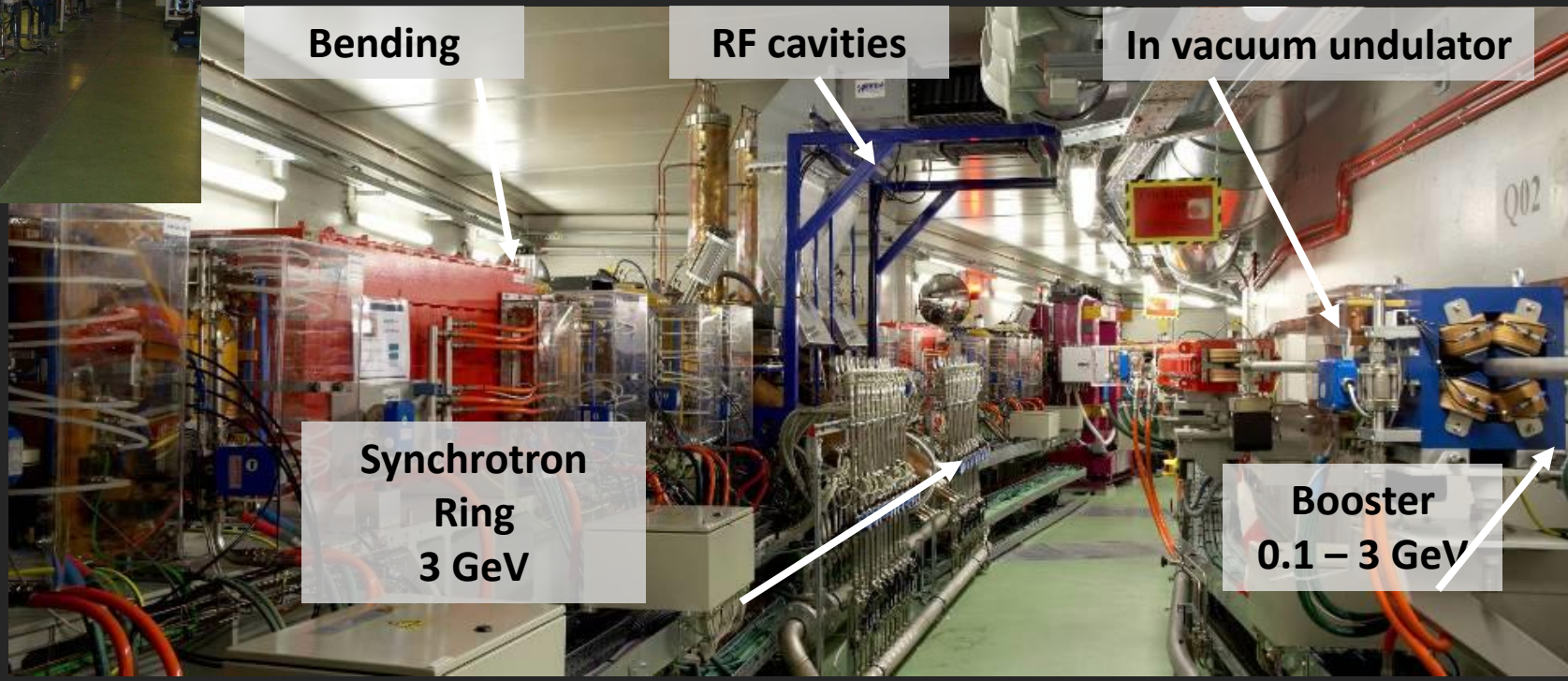

5. Selection of wavelength
The synchrotron light contains numerous wavelengths and a monochromator is used to select the most suitable one for each experiment.
4. Synchrotron light
On passing through the magnetic fields, the electrons emit energy in the form of synchrotron light, which is sent to the beamlines.
6. Detector
The sample to be analysed is illuminated and a detector captures the interaction of the sample with the light.
3. Storage ring
The electrons are stored in the outer ring, guided by magnetic fields.
1. Linear accelerator
The electrons are generated and subjected to an initial acceleration.
2. Booster synchrotron
The electrons accelerate once again in the inner ring until reaching speeds close to the speed of light.
Transfer of the electrons from the booster to the storage ring
Magnets and insertion devices
Control zone
Optical zone
Experimental zone
7. Data analysis
The data are stored and tested.



ALBA : 269 m circumference
3 GeV electrons produce synchrotron light

Accelerators: Linac, Booster and Synchrotron

LINAC: 3GHz structure, beam acceleration to 100 MeV



Booster: 250 m of circumference, one rf cavity at 500 MHz which in 145 msec accelerates beam from 100 MeV to 3GeV

Synchrotron ring: 270 m, 32 dipoles, 112 quadrupoles and 120 sextupoles. Six rf cavities maintain beam energy and lifetime


RF cavities power supply (IOTs)
Total power consumption of the facility 3.5MW
TX13


Synchrotron light (visible range)
used for electron beam diagnostics
THORLABS

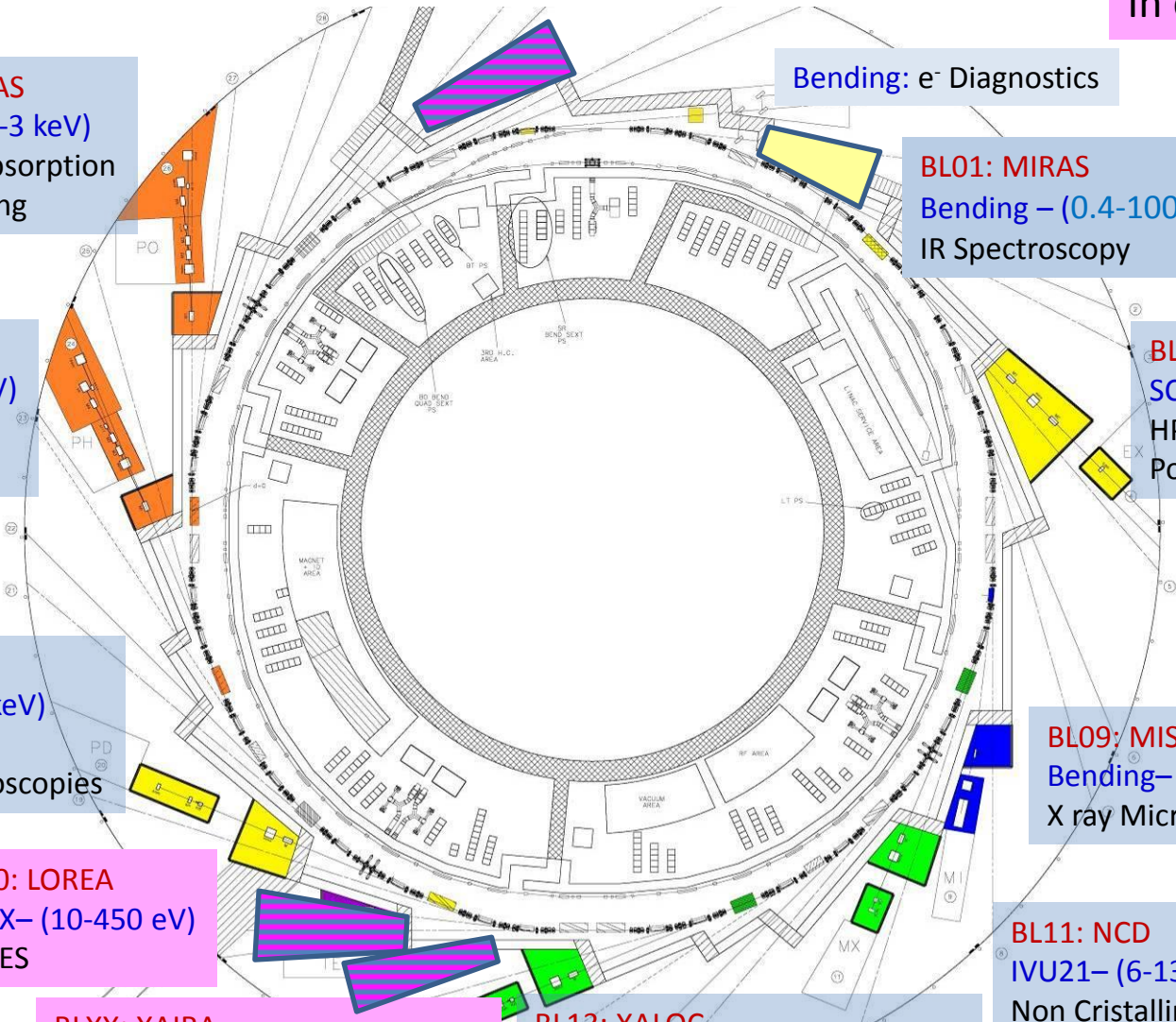
Radio protection measurements and control

Accelerator control room
Control system based on TANGO-SARDANA
Developed at ALBA in collaboration with a net of synchrotrons

Beamlines

In operation (8)

In construction (2)



BL29: BOREAS
EU71– (0.08-3 keV)
REsonant Absorption and Scattering

Bending: e^- Diagnostics

BL01: MIRAS
Bending – (0.4-100 μm)
IR Spectroscopy

BL24: CIRCE
EU62– (0.1-2 keV)
Photoemission spectroscopies

BL04: MSPD
SCW31 – (8-50 keV)
HP/HR
Powder Diffraction

BL22: CLÆSS
MPW80– (2-63 keV)
Absorption & Emission Spectroscopies

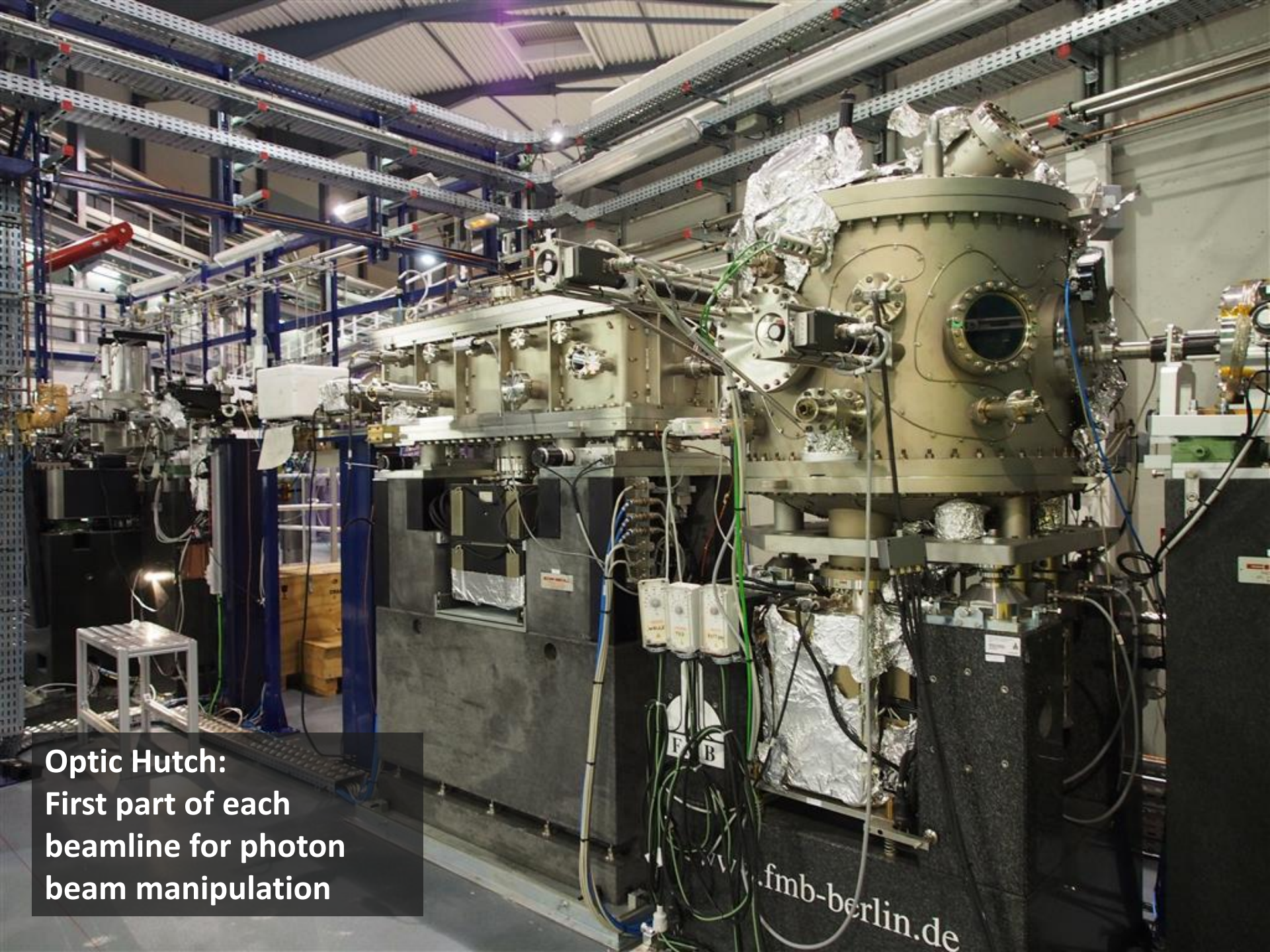
BL09: MISTRAL
Bending– (0.27-2.6 keV)
X ray Microscopy

BL20: LOREA
EUXX– (10-450 eV)
ARPES

BL11: NCD
IVU21– (6-13 keV)
Non Cristalline Diffraction
SAXS/WAXS

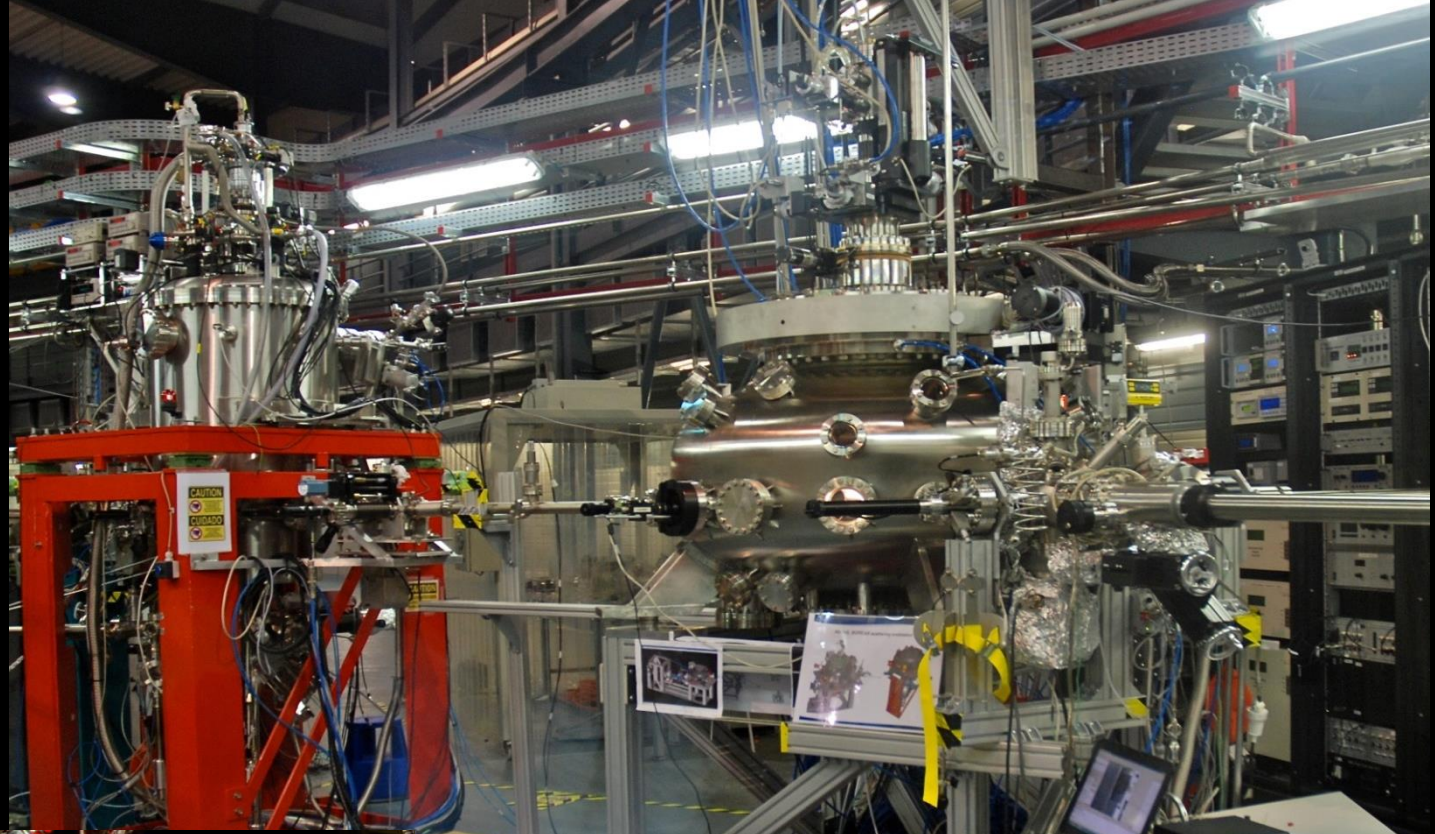
BLXX: XAIRA
IVUXX (~5-25 keV)
Macromolecular Cristallography

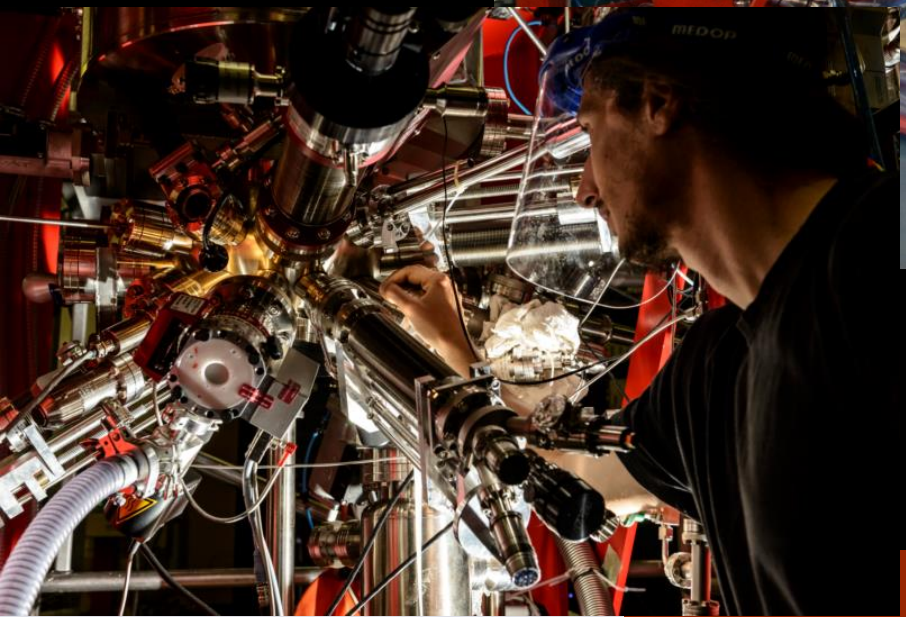
BL13: XALOC
IVU21 – (5-22 keV)
Macromolecular Cristallography


Optic Hutch:
First part of each beamline for photon beam manipulation
.fmb-berlin.de

XALOC
Protein crystallography diffraction

BOREAS





Soft X-ray absorption Spectroscopy and Dichroism techniques
Resonant soft X-ray reflectivity, resonant magnetic scattering and GISAXS

Mistral - Imaging

Only two other similar Microscopes in the world: BESSY-II and ALS

ALBA is a Research Infrastructure

National public institution with 50% national + 50% regional funding (MINECO and GenCat Ministry of Research University and industry)

International staff, international users, international collaborations

History

2003 Project approval

2006 Construction start

2012 Operation start

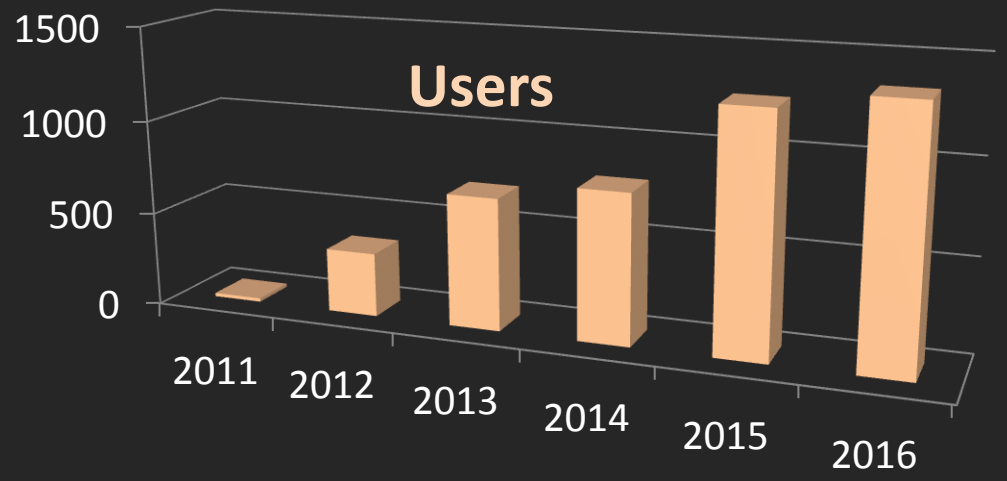
Phase I: 7BLs

2014 Phase II construction start

2016 8th BL in operation

Phase III construction start

Design — *Construction & commissioning* — *Operation consolidation* — *Expansion*



USERS

Academic

Joint academic and industrial

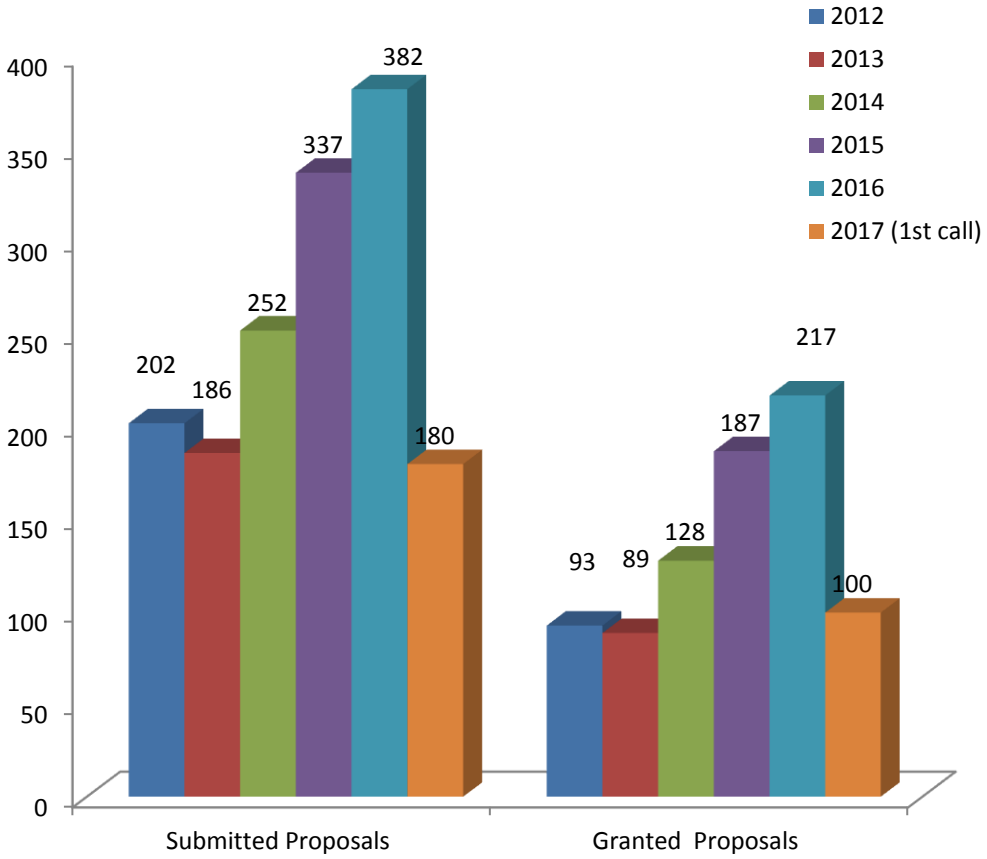
Industrial

Competitive and free access
Public results

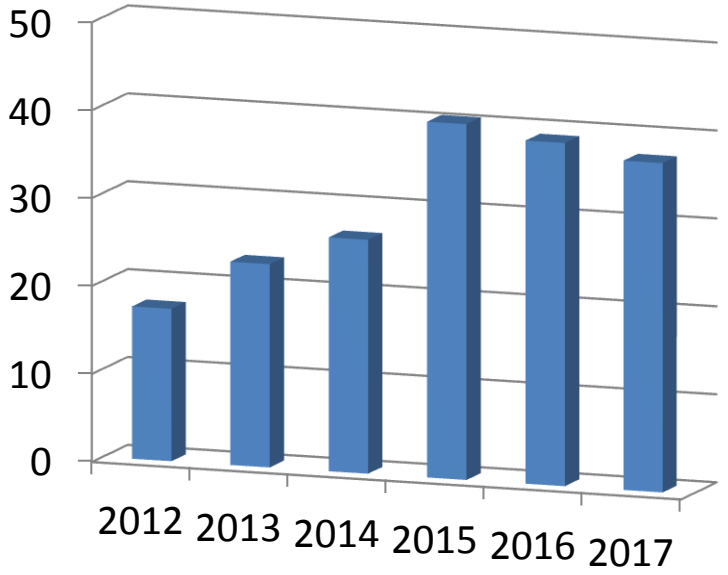
Direct access covering operational costs
Private results

ACADEMIC USERS submit their proposals through public calls

SUBMITTED AND GRANTED PROPOSALS

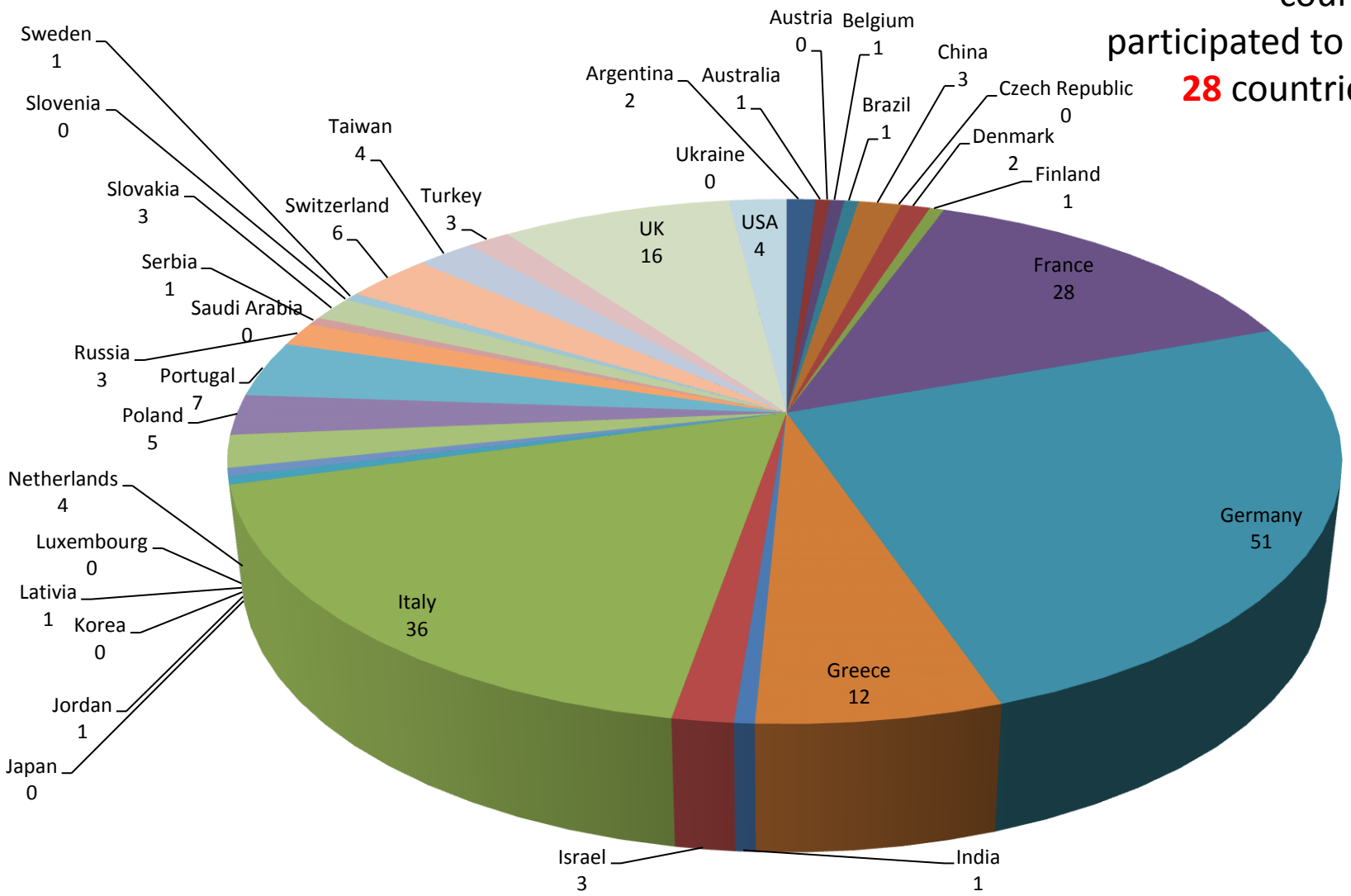


Proposal international percentage (%)

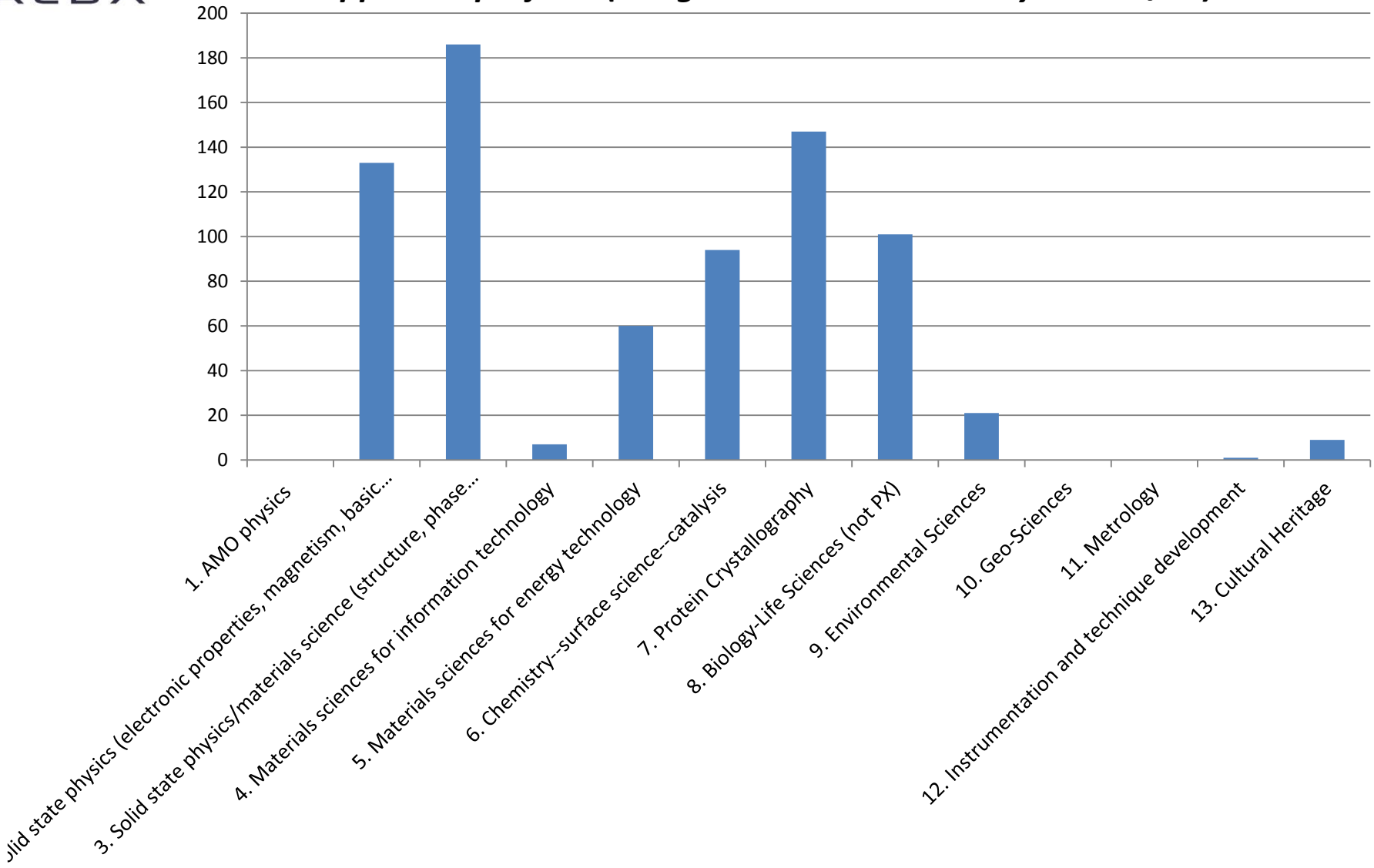


International granted Proposals since 2012

Summing up all calls, up to **35** different countries have participated to ALBA calls **28** countries granted



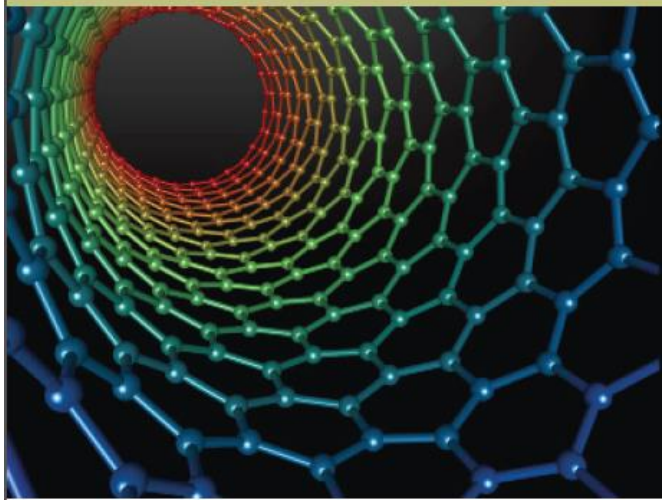
Approved projects (integrated over last three years-14/16)



Industrial users (www.cells.es/en/industry/services)

The services may include mail-in, pre and post experiment support, data treatment, experimental reports, advice on synchrotron techniques, etc

ELECTRONIC AND MAGNETIC STRUCTURE OF MATTER

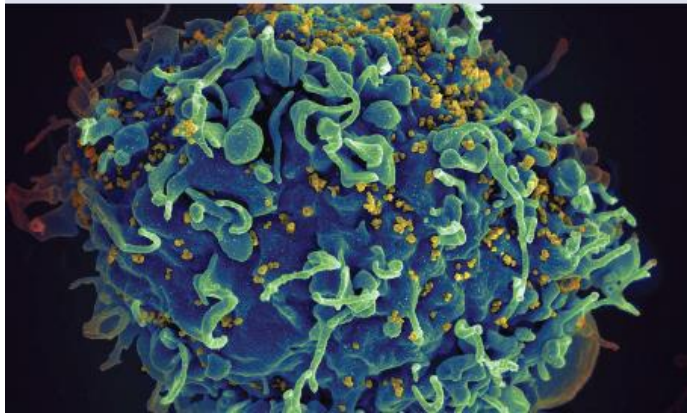


- **Magnetic (nano)materials**
  Data storage
- **Energy**
  Batteries, solar cells, combustion, fuel cells, oil and gas
- **Nanotechnology**
  Nanoparticles, Nanoelectronics, Semiconductors
- **Advanced materials**
  Magnetic, Superconductors, Multilayers

Industrial users -2

- **Health and Healthcare**
  Cosmetics, Biotomography, Emulsions and Gels
- **Food and agriculture**
  Food ingredients, Toxins, Plants
- **Pharmaceutical**
  Structural Biology, Drug discovery, Excipient phase, Polymorphs, Drug characterization

LIFE SCIENCE AND SOFT CONDENSED MATTER



CHEMISTRY AND MATERIAL SCIENCE

- **Chemistry**
  Catalysis, Plastics, Polymers, Pigments, Adhesives, Textiles, Cements, Ceramics, Glasses
- **Environmental science**
  Soils, Pollutants
- **Cultural heritage, Paleontology, Archeology**
  Ancient materials, Painting, Pottery
- **Automotive and aerospace**
  Coating, Motor oil, Corrosion, Plastics

One example of industrial use

Artax, is developing a **new generation of oral compounds against autoimmune diseases. Artax compounds prevent T lymphocytes from responding against antigens but preserves their protective role against infection by pathogens**. Such modulatory control of T cells allows the **development of new treatments for a wide range of inflammatory and autoimmune diseases**

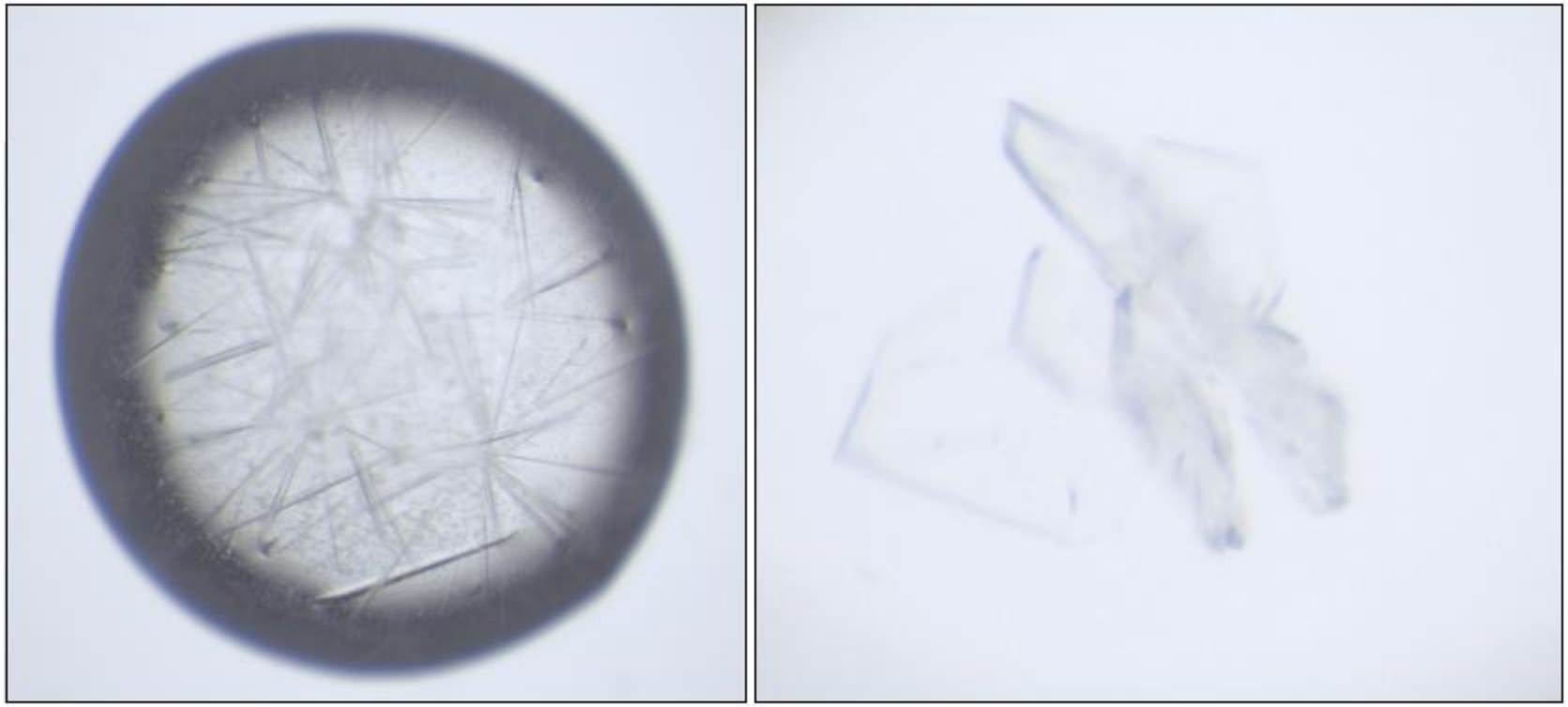
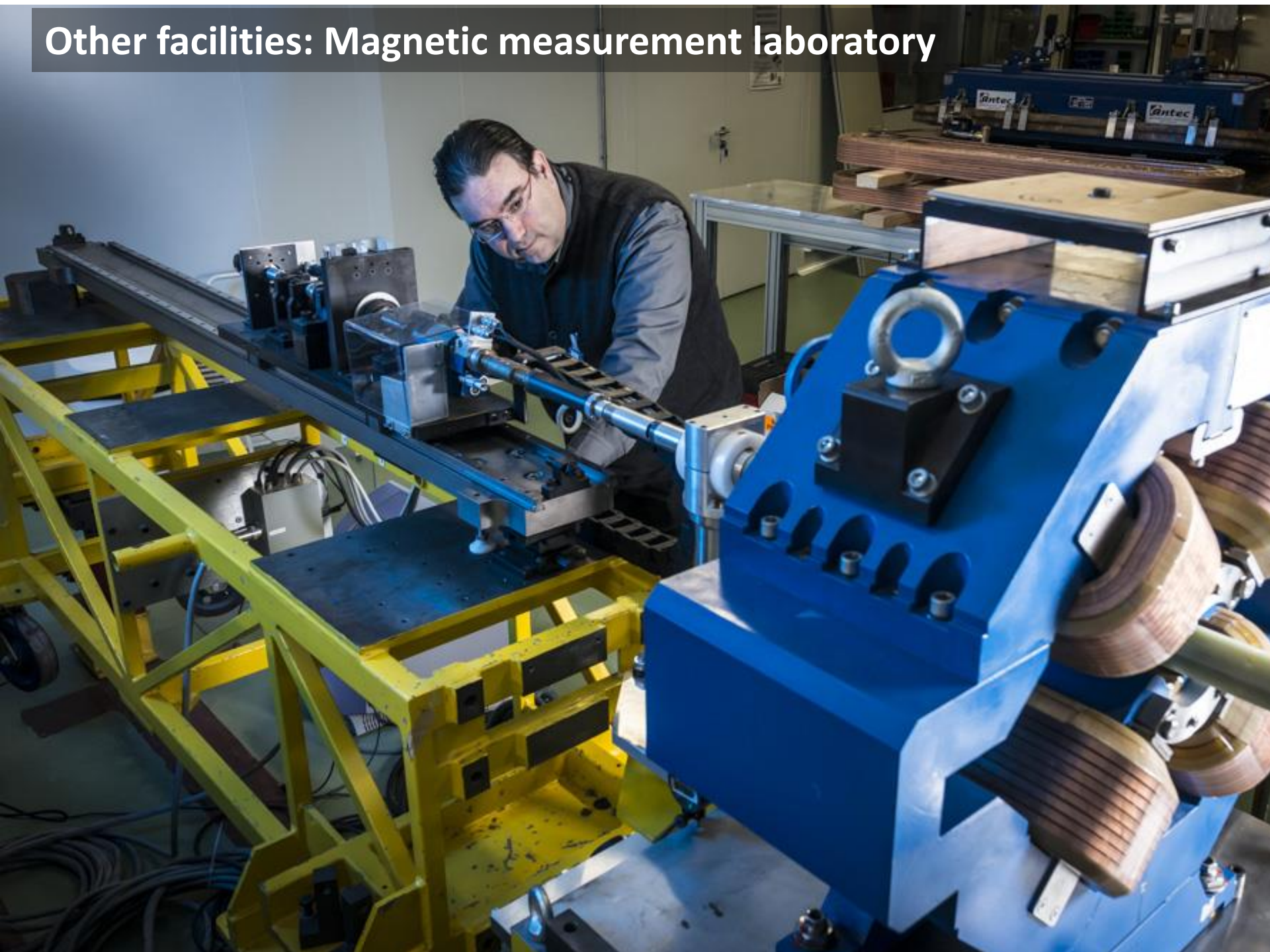


Fig. Crystals ob [illegible] © Artax Biopharma

Artax to resolve the first ever structure of its target protein

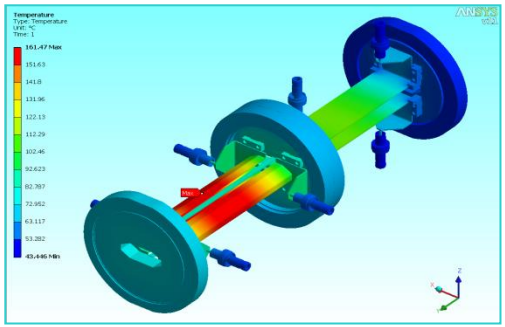
Other facilities: Magnetic measurement laboratory



Other facilities: Clean room for vacuum systems

Other facilities: Biology laboratory

Technology Transfer



Production

Innovative Designs

Industries

Other scientific infrastructures, national and international

Inside Parc de l'ALBA

CONSORCI URBANÍSTIC DEL CENTRE DIRECCIONAL DE CERDANYOLA DEL VALLÈS

PARCDEL'ALBA

PARC DE L'ALBA IS A STRATEGIC PROJECT FOR THE ECONOMIC AND SOCIAL DEVELOPMENT OF CATALONIA, SPAIN AND SOUTHERN EUROPE

ECONOMIC DEVELOPMENT:
ADVANCED COMPANIES AND INSTITUTIONS

SOCIAL DEVELOPMENT:
INNOVATIVE SERVICES AND DWELLINGS

PROTECTION OF NATURAL ENVIRONMENT:
ECOSYSTEMS AND GREEN AREAS NETWORK

Universidad Autónoma de Barcelona

UAB
Universitat Autònoma de Barcelona

Study Abroad | Research | Life on campus | About the UAB

Promoting knowledge, encouraging innovation

The UAB in the rankings

1 — **THE World University Rankings (THE WUR 2015-2016)** In Spain, the UAB ranks first

2 — **Scimago Institution Rankings World Report (SIR WR 2014)** Second university in Spain in volume of scientific activity

10 — **QS Top 50 Under 50 Ranking (QS 50u50 2015)** The UAB ranks 10th in the world ranking

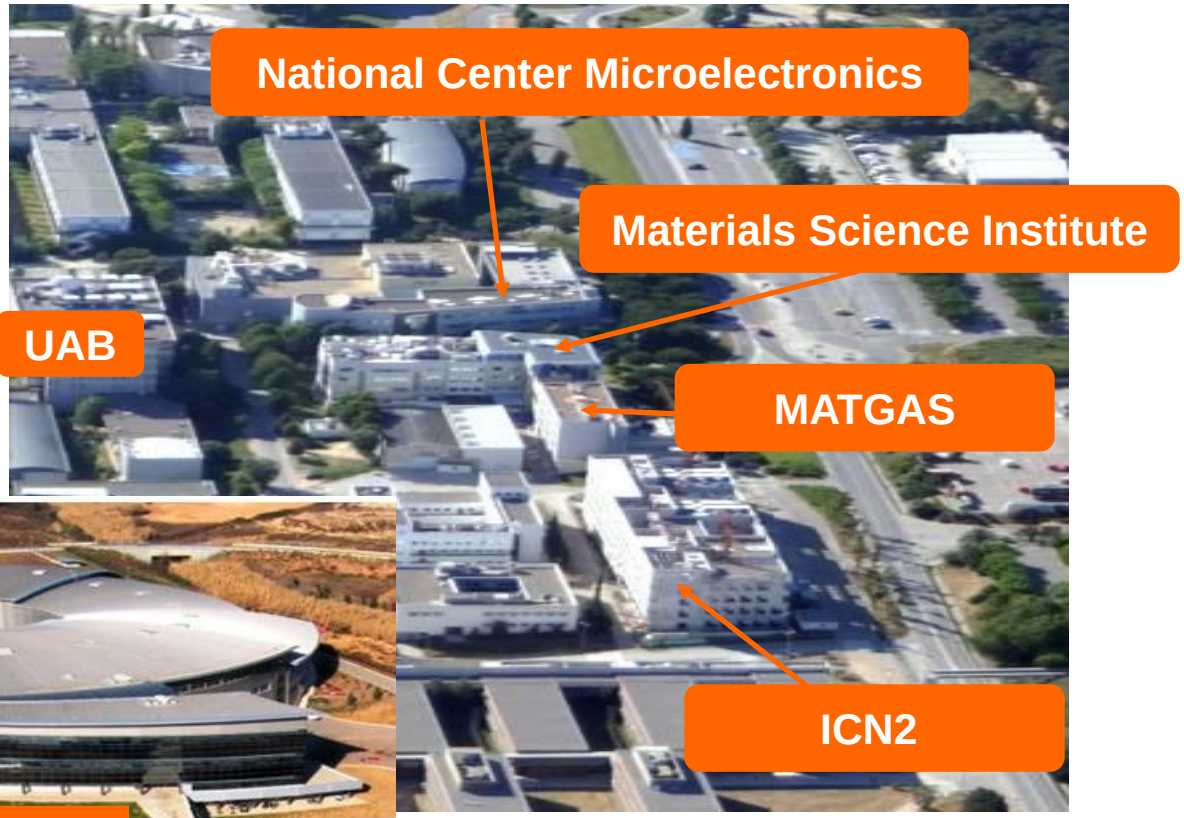
On 26 November 2009, the Universitat Autònoma de Barcelona obtained recognition as a Campus of International Excellence.

UABCIE
CAMPUS OF INTERNATIONAL EXCELLENCE

The 4 Centres of Excellence “Severo Ochoa” and the 2 Units of Excellence “María de Maeztu” are located in the UAB campus. The UAB campus is the University with the highest number of institutes with scientific excellence distinction that exists in Spain.

bnc-b
BARCELONA NANOTECHNOLOGY CLUSTER-BELLATERRA

Parc de Recerca UAB



ALBA Synchrotron

A cluster with nearly 750 scientists and technicians in the areas of Materials, Micro and Nanotechnologies

Life Science
few example of privileged users from Barcelona area

IRB BARCELONA
INSTITUTE FOR RESEARCH IN BIOMEDICINE

ibmb
Institut de Biologia Molecular de Barcelona
Molecular Biology Institute of Barcelona CSIC

UAB
Universitat Autònoma de Barcelona

UNIVERSITAT DE BARCELONA

CRG
Centre for Genomic Regulation

upf. Universitat Pompeu Fabra Barcelona

Vall d'Hebron Institut de Recerca VHIR

209 people
27% women
21% international
Student program

18 June 2016 - Open Day

https://www.flickr.com/photos/109150753@N07/sets/72157670177623405

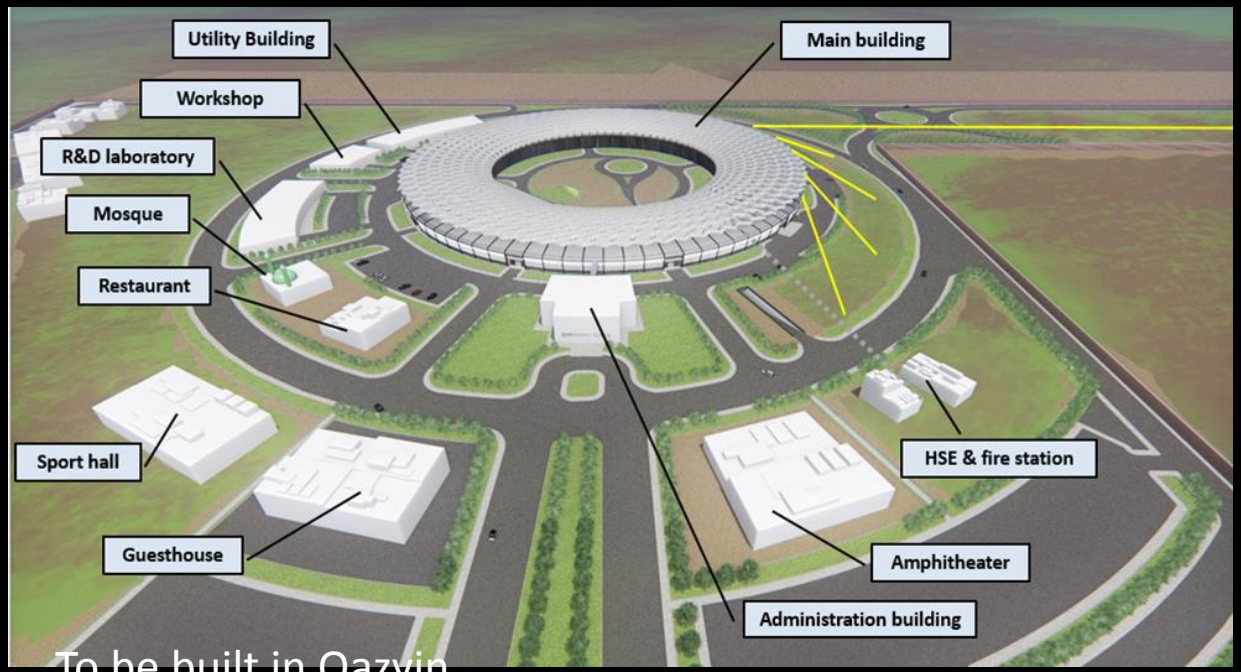
The 5th edition of the ALBA Open Day took place on the 18th June, achieving a new record of participants: 2,130 people enjoyed a day of science with their families.

The participants also had the opportunity to use an audio guide which offered information about the different stops in the itinerary.

Sponsored by Spanish Foundation for Science and Technology (FECYT) - Spanish Ministry of Economy and Competitiveness, La Caixa Foundation and the Catalan Government.

Opening to participation from other countries

ILSF (Iranian future synchrotron) association to ALBA (2017)
Iranian usage of 1% beamtime at 1% operational cost



To be built in Qazvin


Thank you for the attention