***La luz de ALBA***

***Caterina Biscari***

***ALBA-CELLS***

# Los dos caminos principales de la física fundamental

Se producen en laboratorios las partículas microscopicas che poblaban el Universo primordial justo despues del Big Bang.

Super-Microscopios

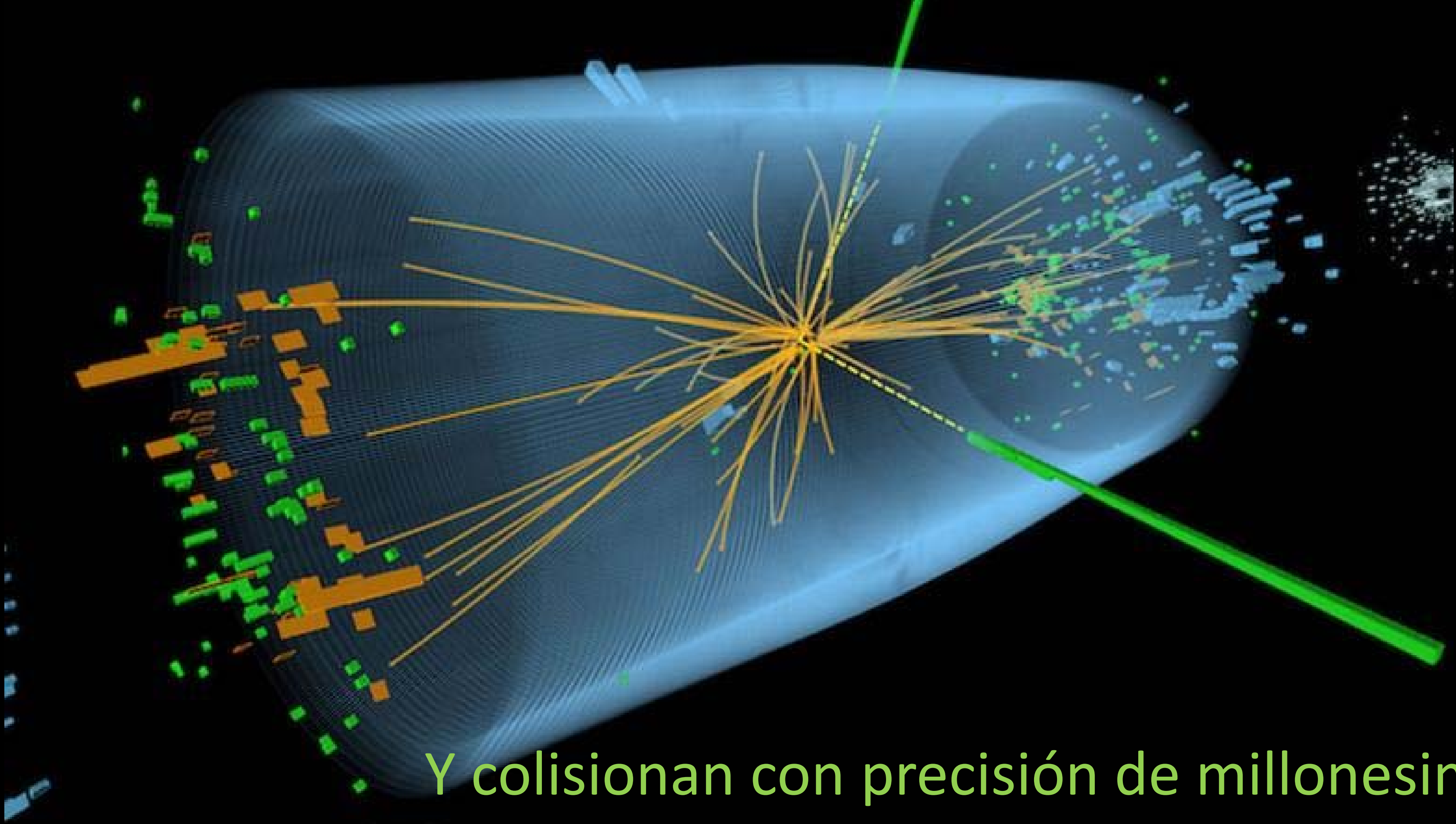
Se estudian las estructuras más grandes del cosmos, los cúmulos de galaxias, el fondo de radiación, las ondas gravitacionales

Super-Telescopios

# LHC – vista del túnel

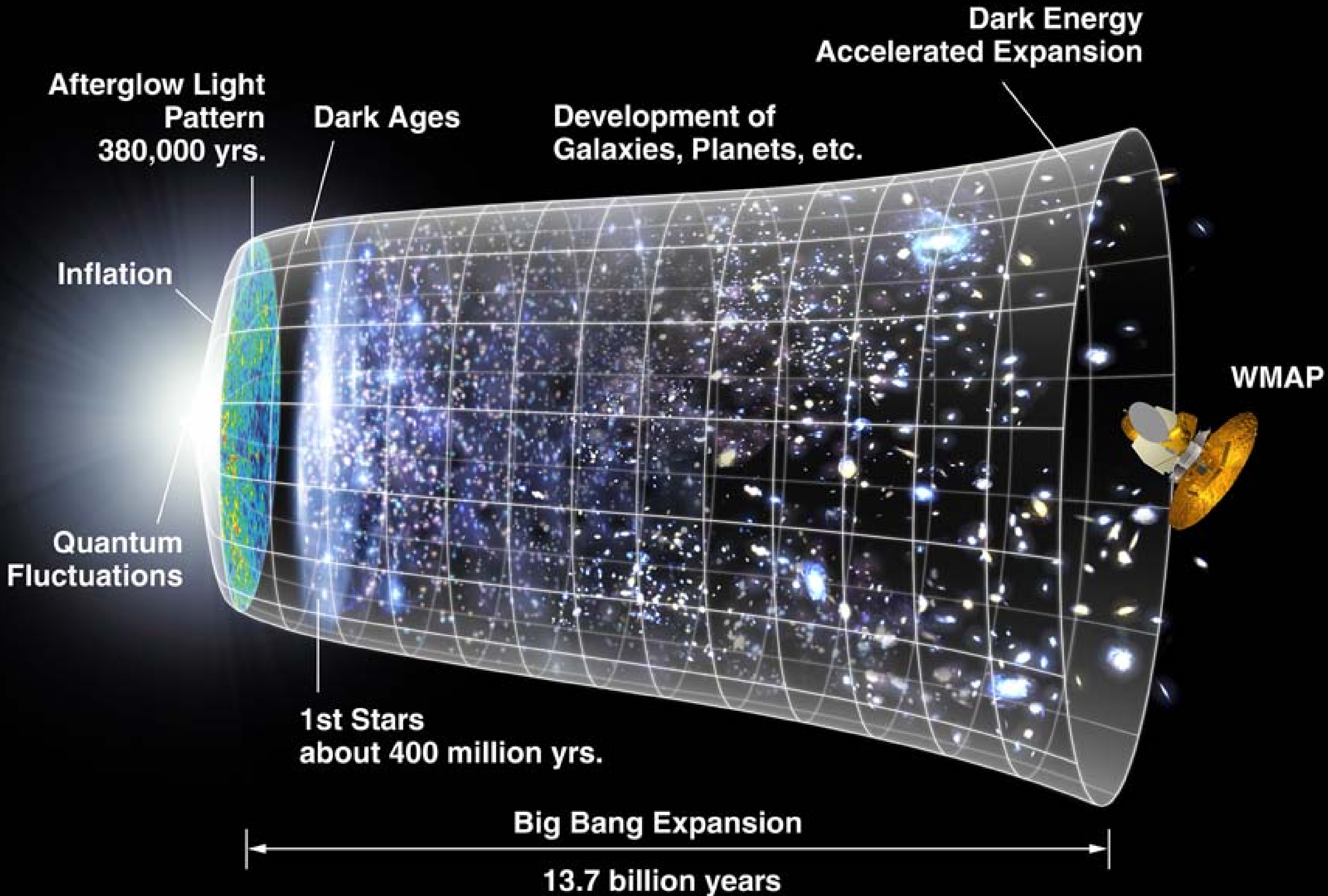
27 km enfriados a 2K (-271° C)
El lugar más frío de la tierra

# En el LHC, dos haces de protones alcanzan 6.5 TeV, 6.5 millones de millones di eV, la energía más alta obtenida en un laboratorio



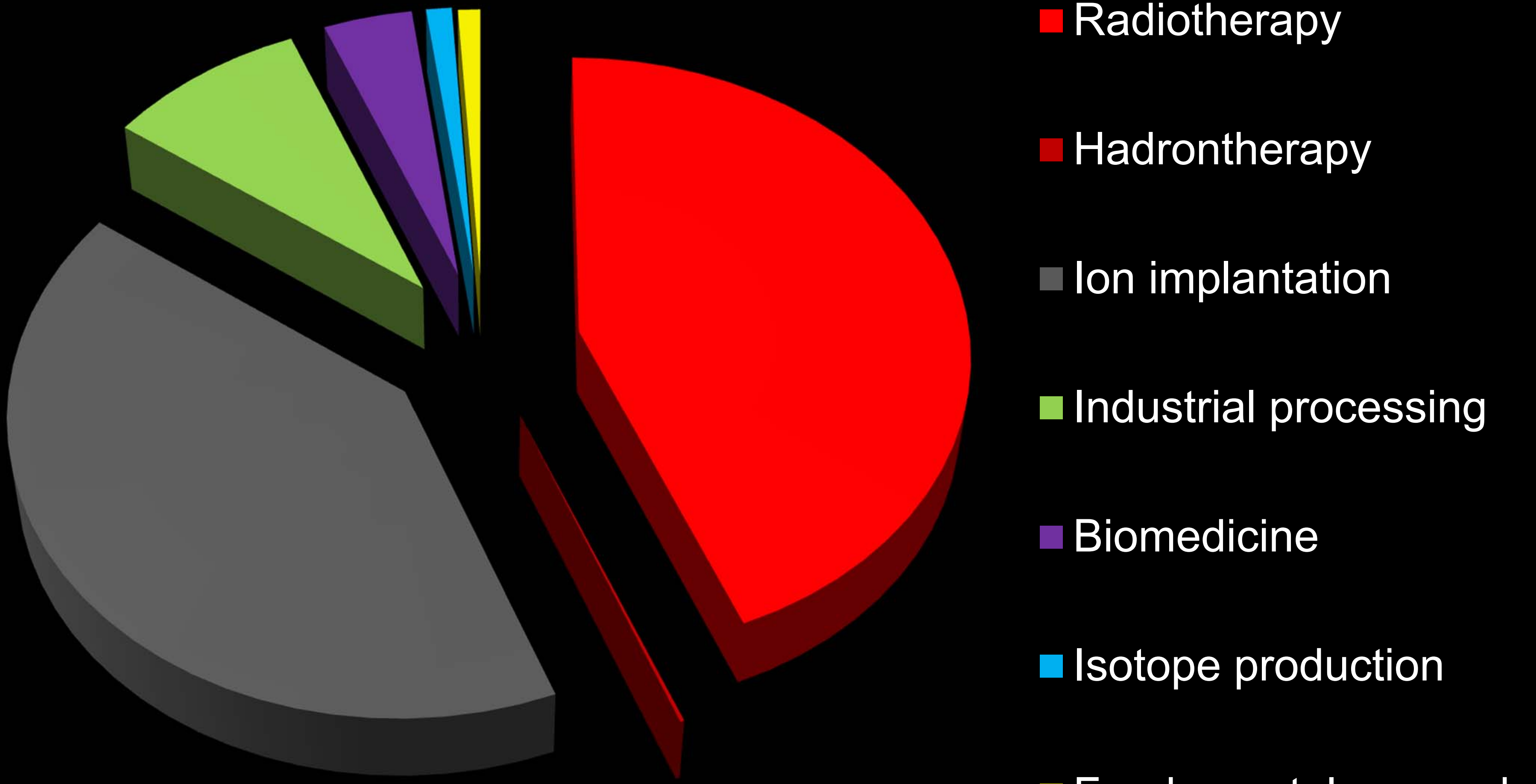
Y colisionan con precisión de millonesimas de mm en 4 puntos en el colisionador

# … para completar el modelo actual del universo




… todavía lleno de preguntas

# ~30000 aceleradores en el mundo



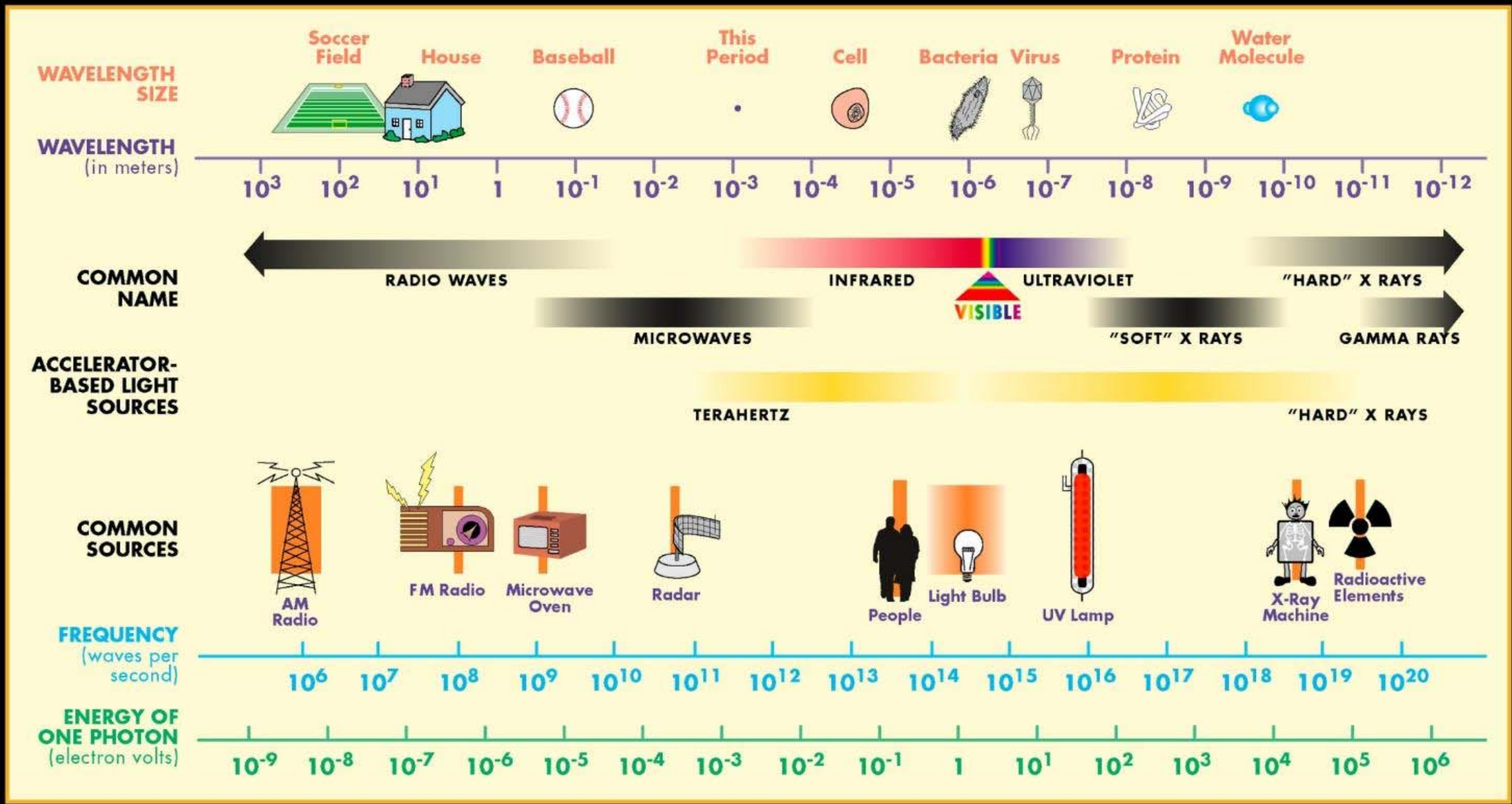
# La Luz de Sincrotrón

Crab Nebula,(www.en.wikipedia.org/wiki/Pulsar)

$$E = h\nu$$


A mayor energía del fotón, menor longitud de onda, mayor resolución

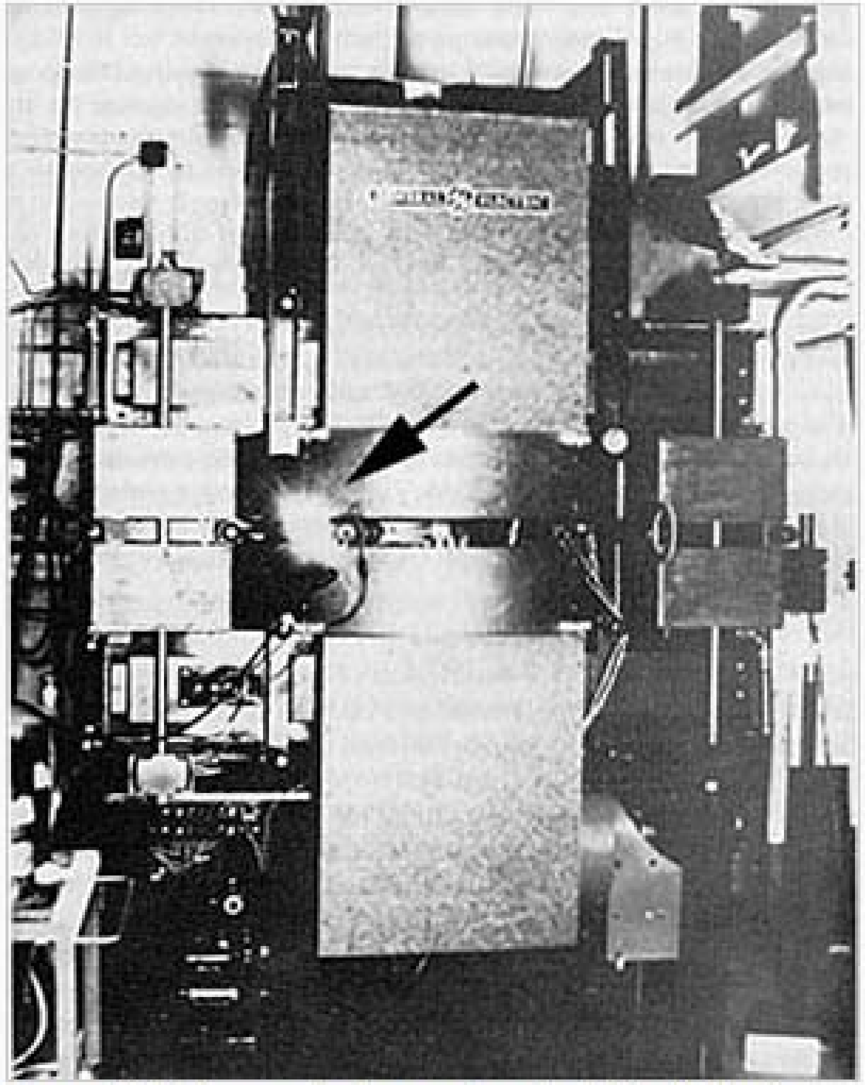
# THE ELECTROMAGNETIC SPECTRUM




Sources on earth

# Discovery of synchrotron radiation (1946)

General Electric
Synchrotron accelerator
300 MeV
2$^{nd}$ synchrotron ever built
Visible light through the glass vacuum chamber
SR had been predicted, but its frequency was not known



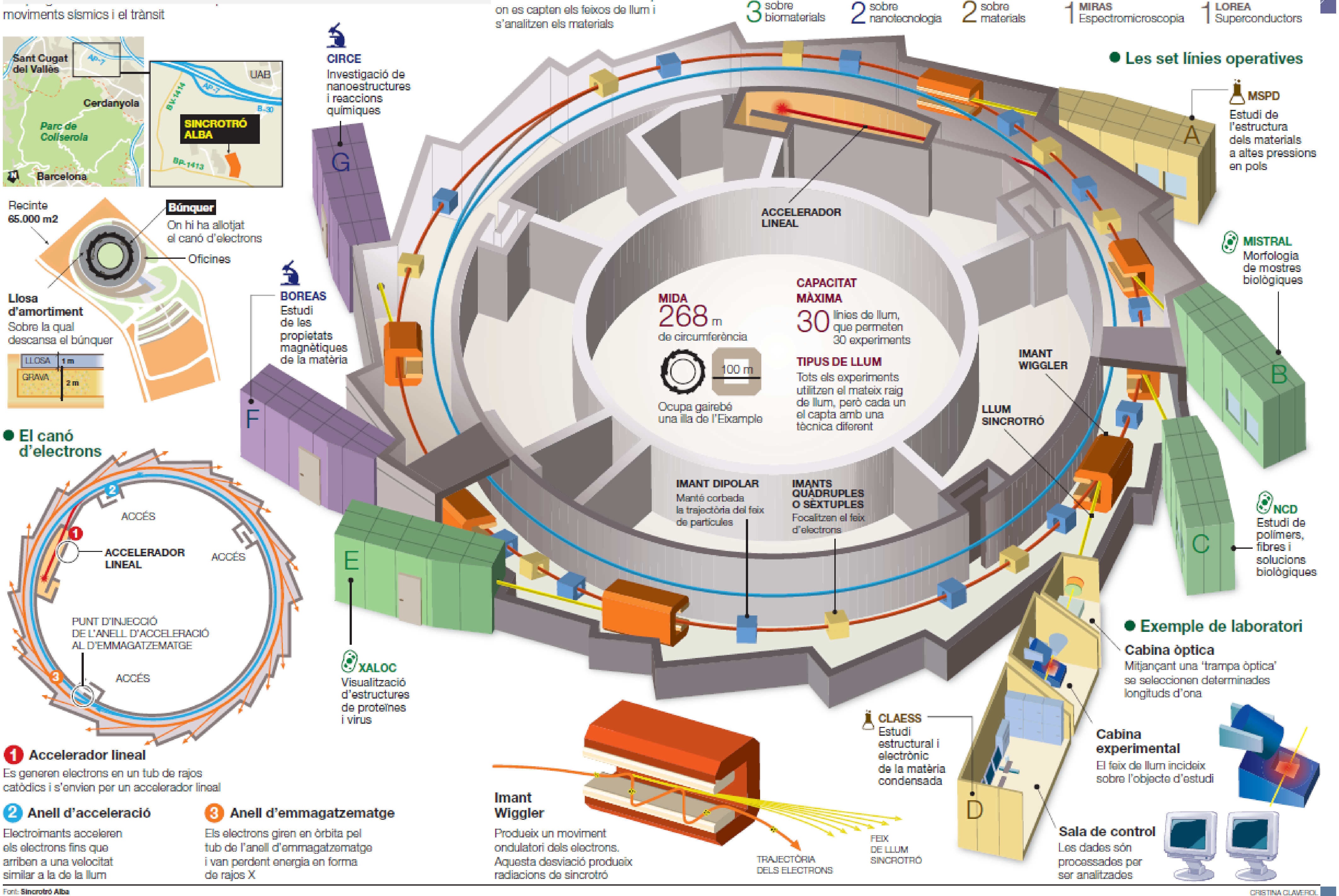
General Electric synchrotron accelerator built in 1946, the origin of the discovery of synchrotron radiation. The arrow indicates the evidence of radiation.


# 2015: ~ 50 Synchrotrons in the world

● In Operation    ○ *In Construction*

# What is a SL facility(ALBA)

El periodico 05-05-13

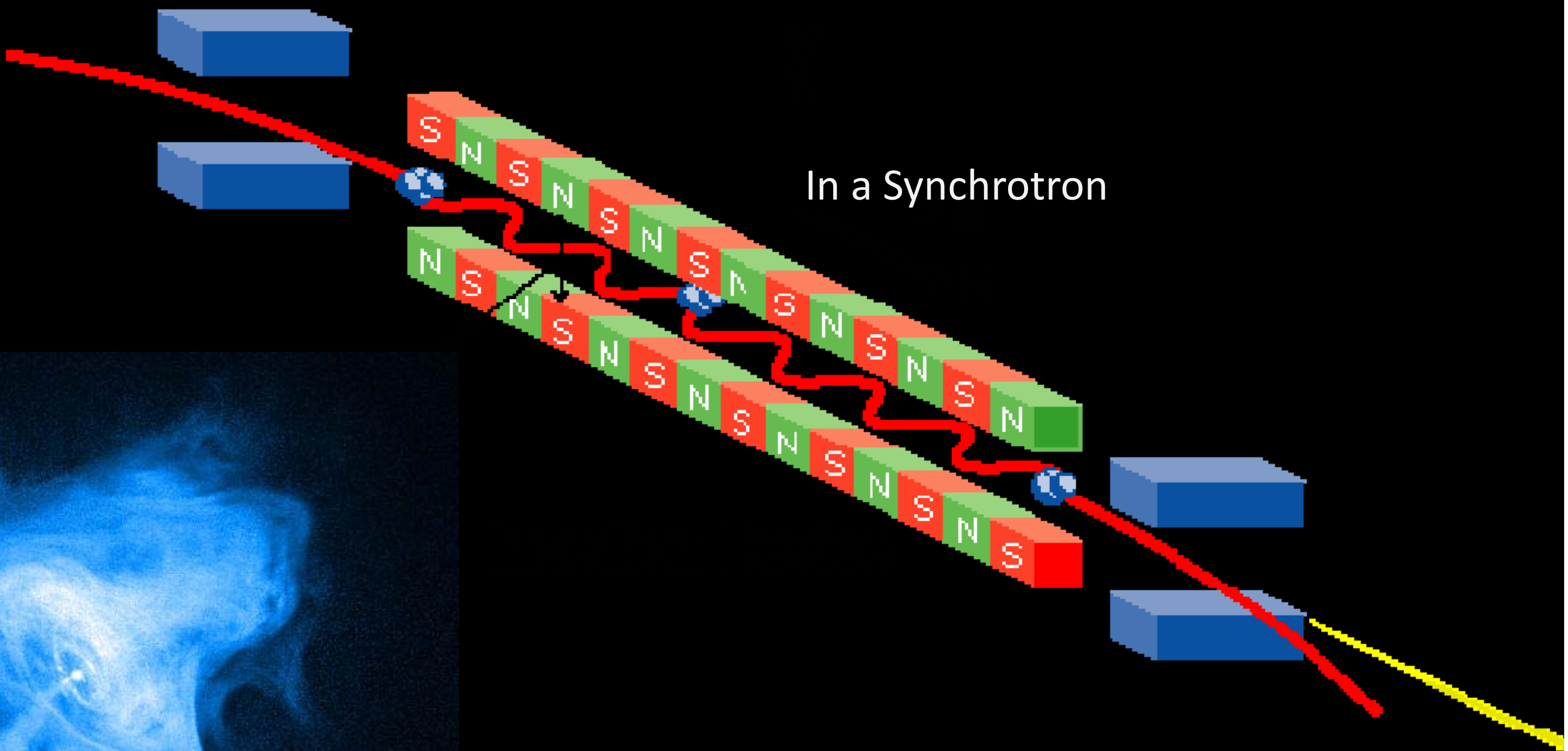


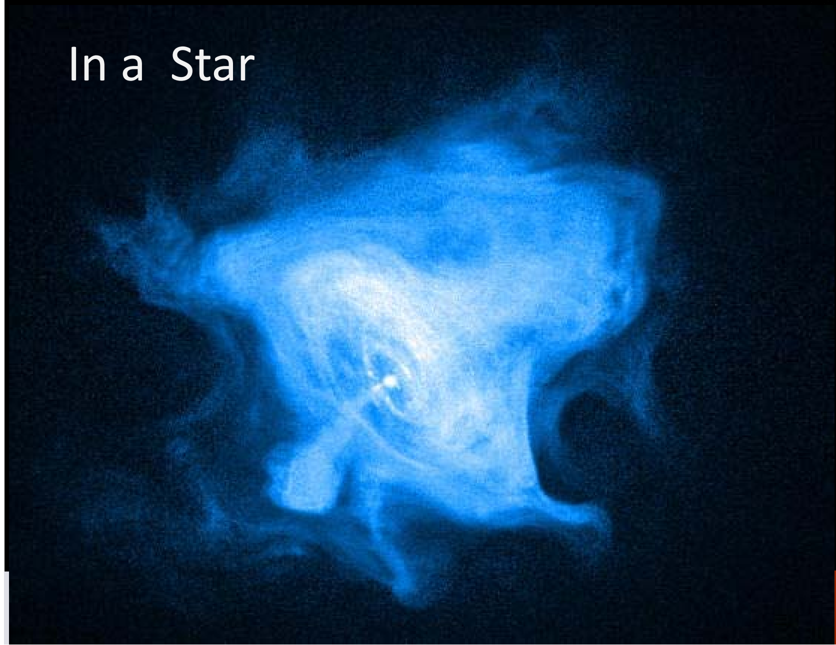
# Producing the light

electrons accelerated to almost velocity of light and introduced in a magnetic field are bent and emit photons

covering a wide range of wavelengths

depending on e- energy + magnetic field strength




ANNEAU
DE STOCKAGE
SOLEIL

## Main characteristics of SR

**Continuous Spectrum**

from infrared to X-rays

$E_{crit}$ (keV) = 0.665 $E^2$ (GeV) B(T)

**Intense**, as a narrow beam

$\Theta$(rad) = 0.51/E (MeV)

**Polarized** in the orbital plane

With **temporal structure**

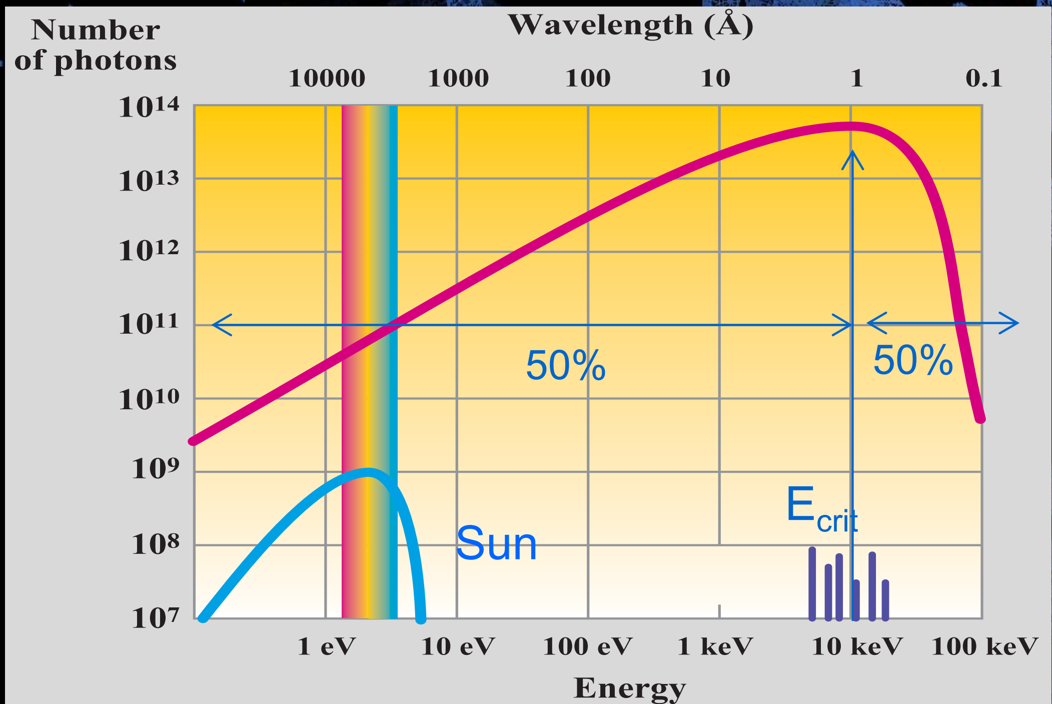
## Photon beam properties depend on accelerator characteristics

**Electron Beam Energy**

**Magnetic field**

**Current**

**Emittance**



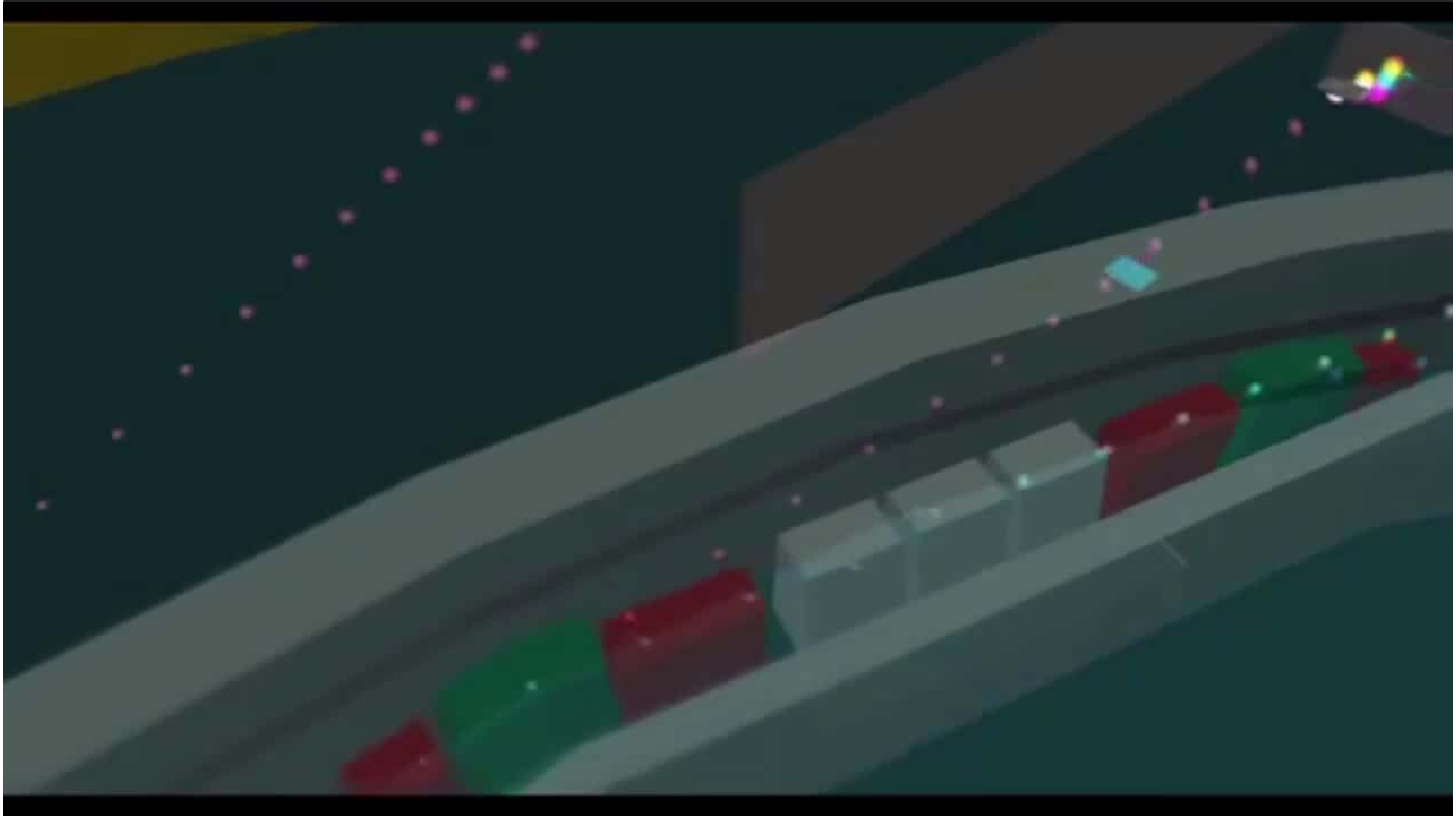

$$P_{SR} = \frac{2cr_e}{3\left(m_0c^2\right)^3}\frac{E^4}{\rho^2} = \frac{2r_ecm_0c^2}{3\rho^2}\gamma^4$$

$$\omega_c = \frac{3}{2}\frac{c}{\rho}\gamma^3$$

$$\theta_c = \frac{1}{\gamma}\left(\frac{\omega_c}{\omega}\right)^{1/3}$$

The total power is emitted half with energies above the critical one, half below.

The lowest frequency is the revolution one, the highest >10 $\omega_c$ , with exponential decay



*Elettra*

# Generations of Light Sources

1970s : 1st Generation – HEP rings used parasitically for X-ray production

1980s : 2nd Generation – Dedicated X-ray sources

1990s: 3rd Generation – Radiation facilities with wigglers, undulators, high brilliance

2010s: Ultimate Storage Rings – Diffraction limited

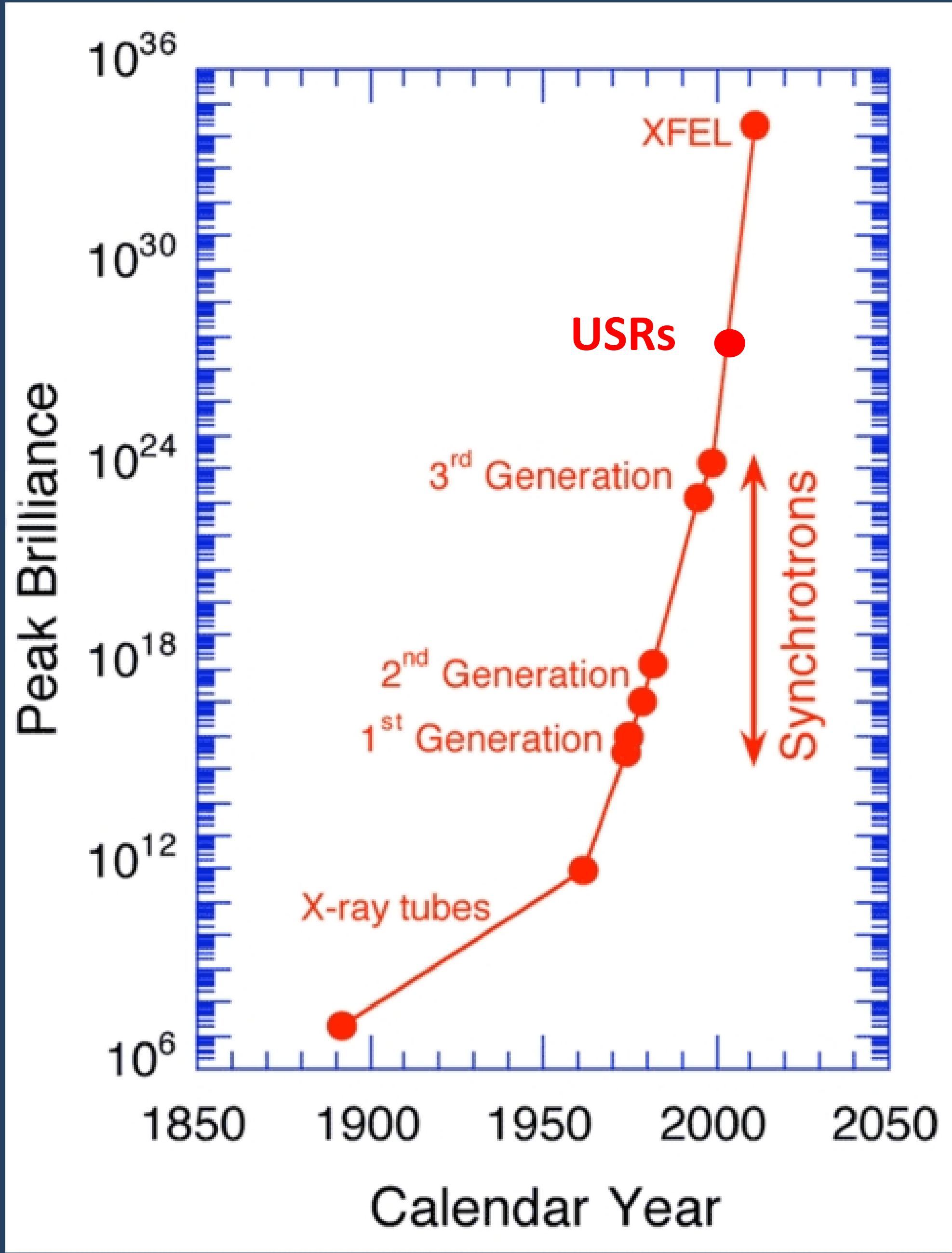
2000s: 4th Generation – Free Electron Lasers driven by Linacs

$$B = \frac{N_\gamma}{4\pi^2(\Delta\lambda/\lambda)\Delta t \Sigma_x \Sigma_{x'} \Sigma_y \Sigma_{y'}}$$

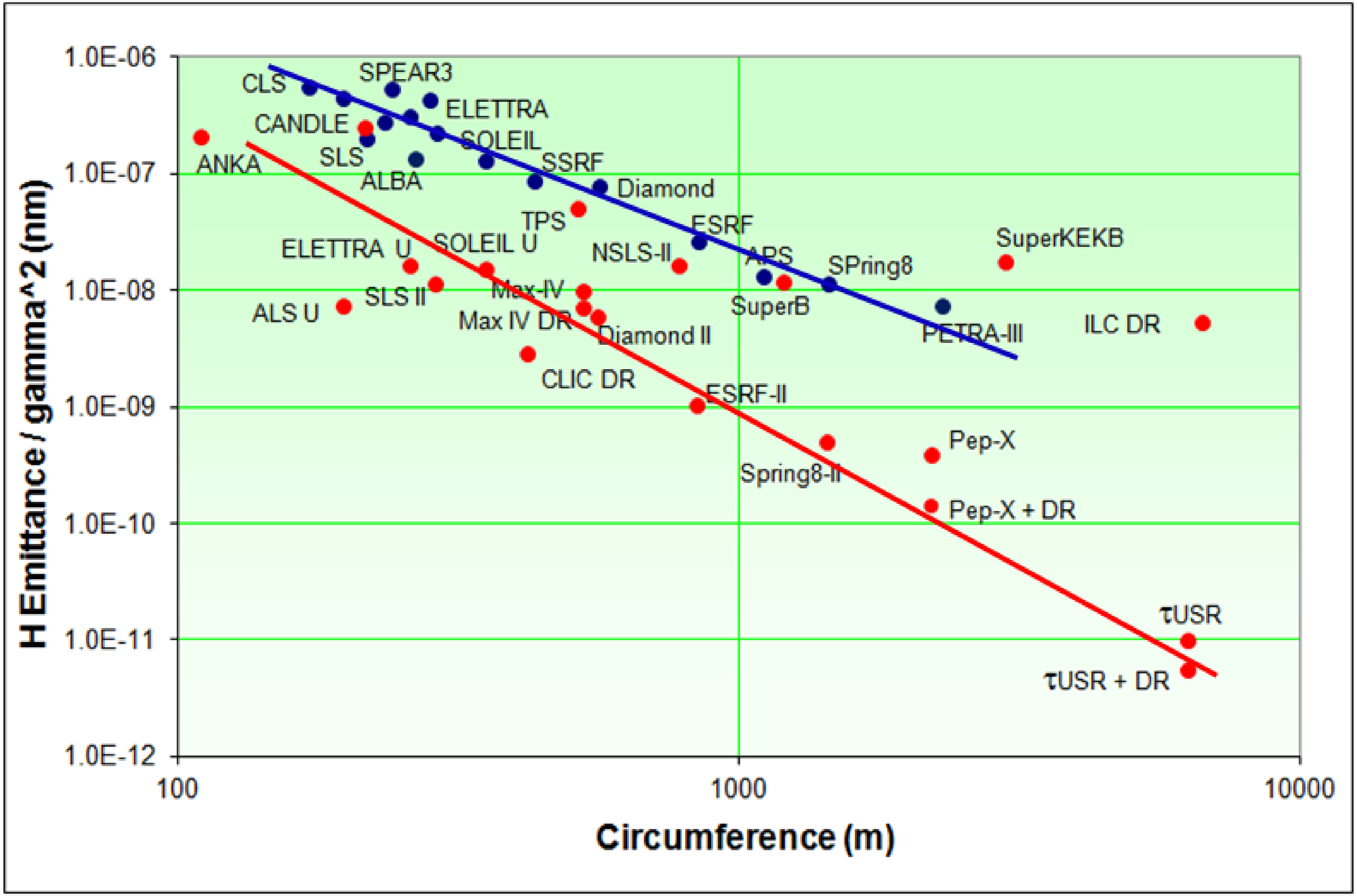
Light source brightness

photons/s/mm$^2$/mr$^2$/0.1%BW

photons per time, space, energy definition



# Emittance of 3rd generation and DL SL




Emittance normalized to beam energy vs. circumference for storage rings in operation (blue dots) and under construction or being planned (red dots). The ongoing generational change is indicated by the transition from the blue line to the red line. (R. Bartolini, LER-2014)

# From 3rd generation of beginning of century to USR

**ALBA**
2011 1st beam
3 GeV
C = 269 m
ε = 4.6 nm

Increase C
Lower ε

**NSLS II**
2014 1st beam
3 GeV
C = 620 m
ε = 1.5 nm

**MAX IV**
2015 1st beam
3 GeV
C = 528 m
ε = 0.3 nm

MBA
Lower ε



15 September '15

*(Photos approximately in scale)*

# Spain in 1992

**1985**: Spain joins the European Union

**Nineties**:

development of

Ports,

Airports,

High velocity trains

Highways

Theaters,

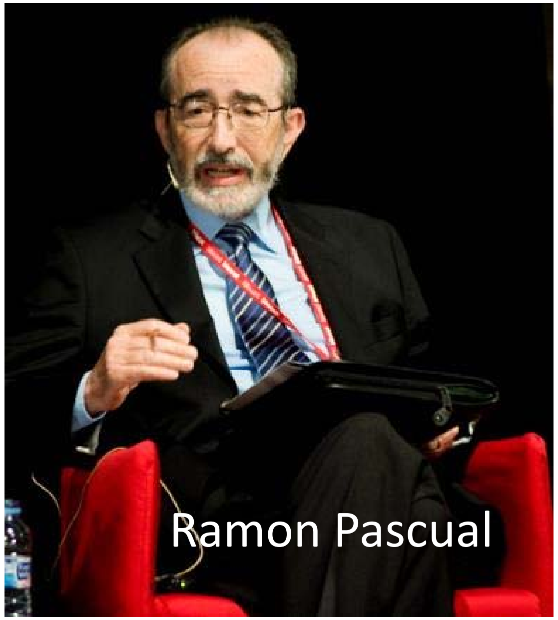
Museums

…

Olympic games in Barcelona

EXPO in Sevilla

# ALBA Dawn: the nineties



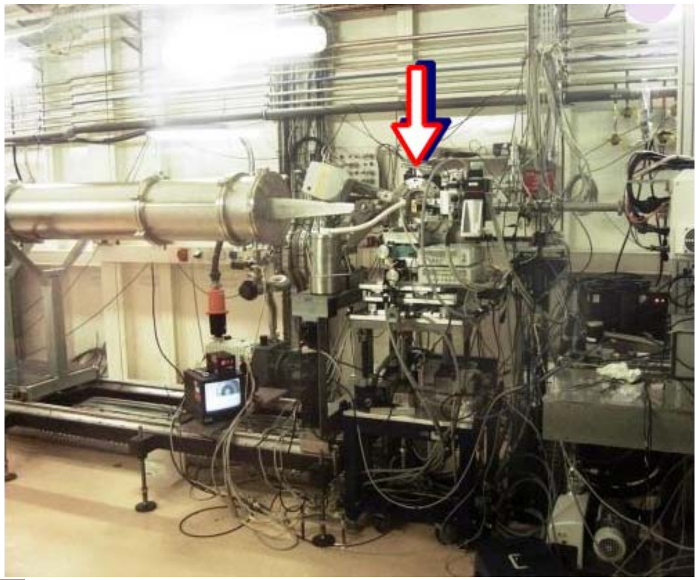


✓*Interest of a group of people in building a large infrastructure in Spain for the development of the scientific community, building-up knowledge and experience in accelerator physics, growth of industrial capacity in high technology systems*

✓1990: Proposal, lead by Juan Antonio Rubio, of building a tau-charm factory in Spain

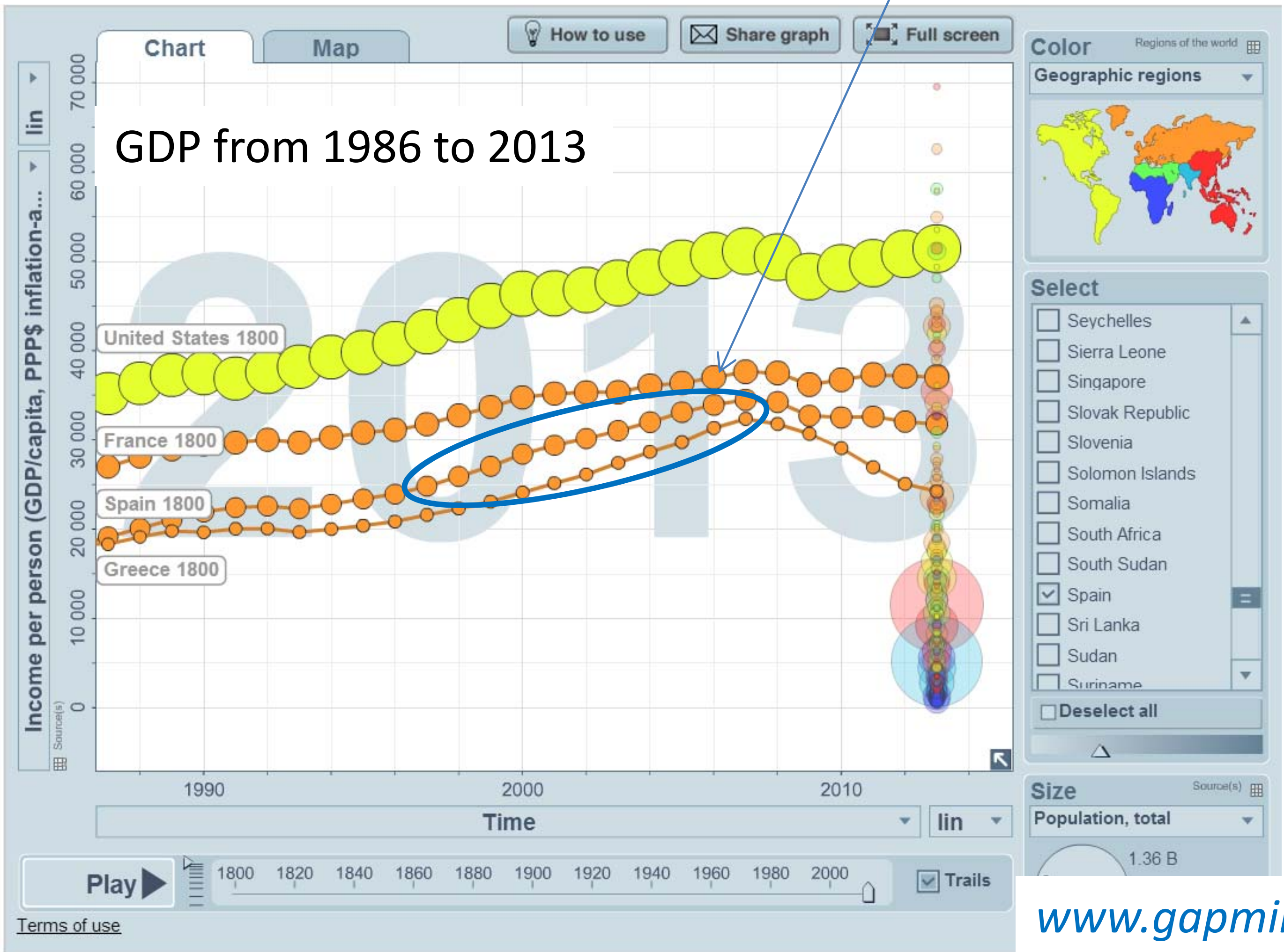
✓**1992: Proposal of building a synchrotron light facility in Catalunya**. Report 'The Synchrotron Laboratory of Catalonia', by a team headed by Joan Bordas, Salvador Ferrer and Ramon Pascual

✓1993-2003: Preparation of the group, training, feasibility studies, construction of two beamlines at ESRF, the European synchrotron at Grenoble, consortium LLS under GenCat, organization of EPAC1996 at Sitges, …



# Profiting of a healthy economic period

The Spanish economy after a slow down in the first nineties recovered at the end of the decade, with a boost which lasted until 2008




www.gapminder.org

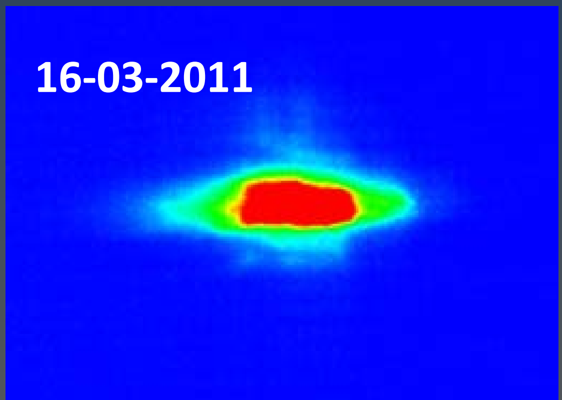
# ALBA Design: from 2003 to 2006

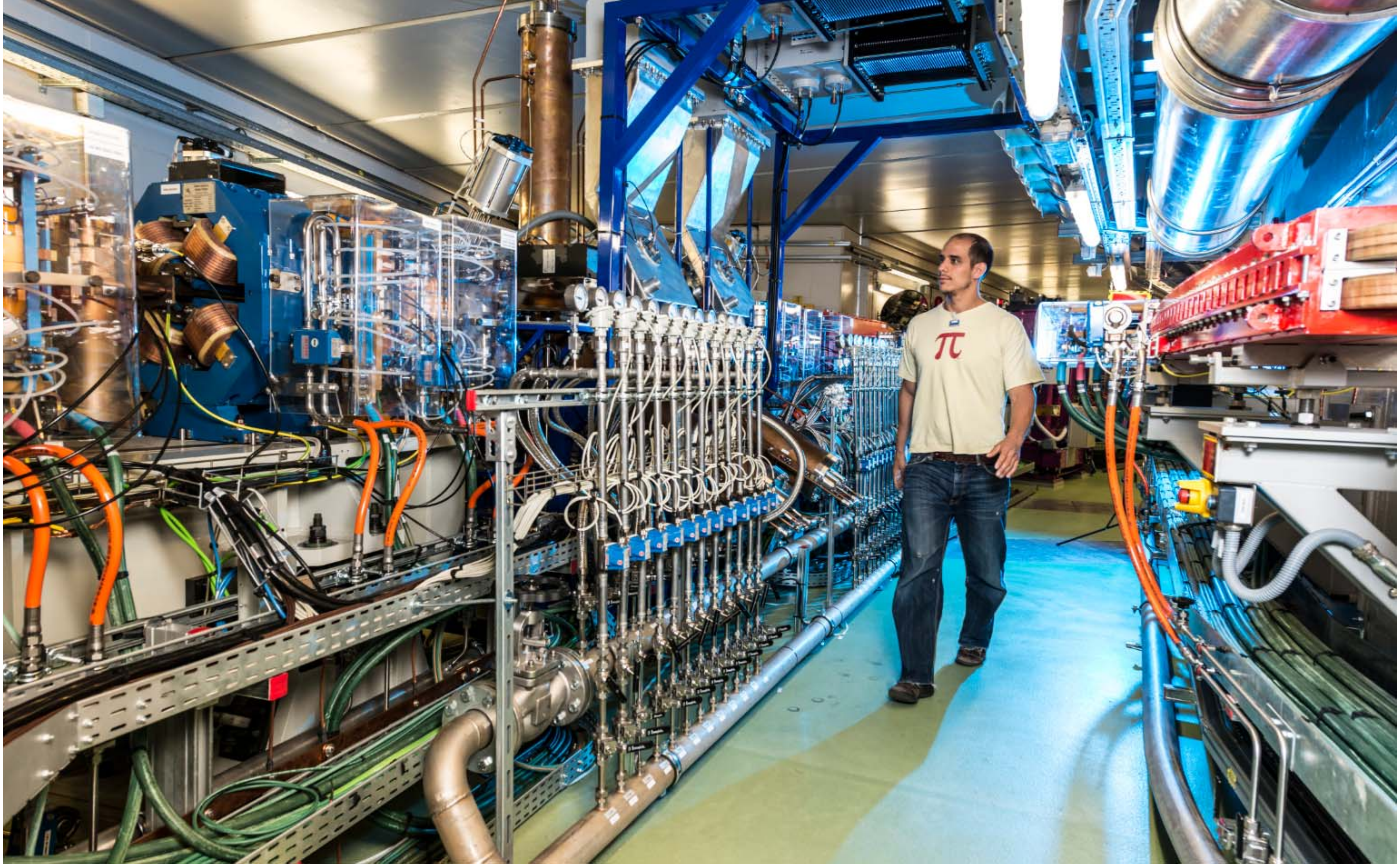
- ✓October 2003: Start of the CELLS (Construcción, Equipamiento y Explotación del Laboratorio de Luz Sincrotrón) activity
- ✓2004: The Spanish synchrotron users organization (AUSE) is created with about 200 users
- ✓July 2006: ALBA synchrotron light facility groundbreaking ceremony

# ALBA Realization: from 2006 to 2009

# ALBA: Recent history


- 22 March 2010 - Inauguration
- 16 March 2011: First Synchrotron Light in the SR
- **7 May 2012 : First external user at Boreas BL**
- 17 December 2012 : First Publication with data collected at ALBA

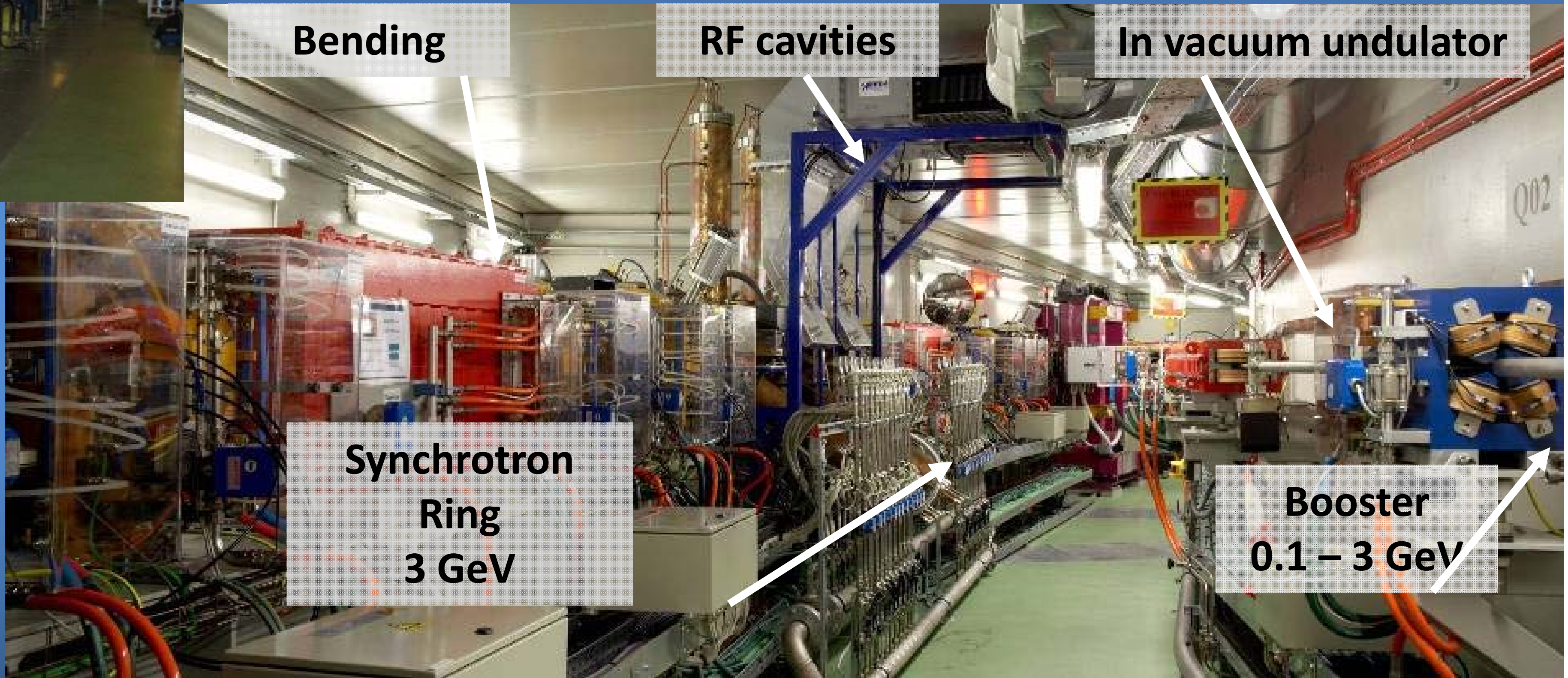


ALBA : 270 m de circumferencia

# Accelerators: Linac, Booster and Synchrotron

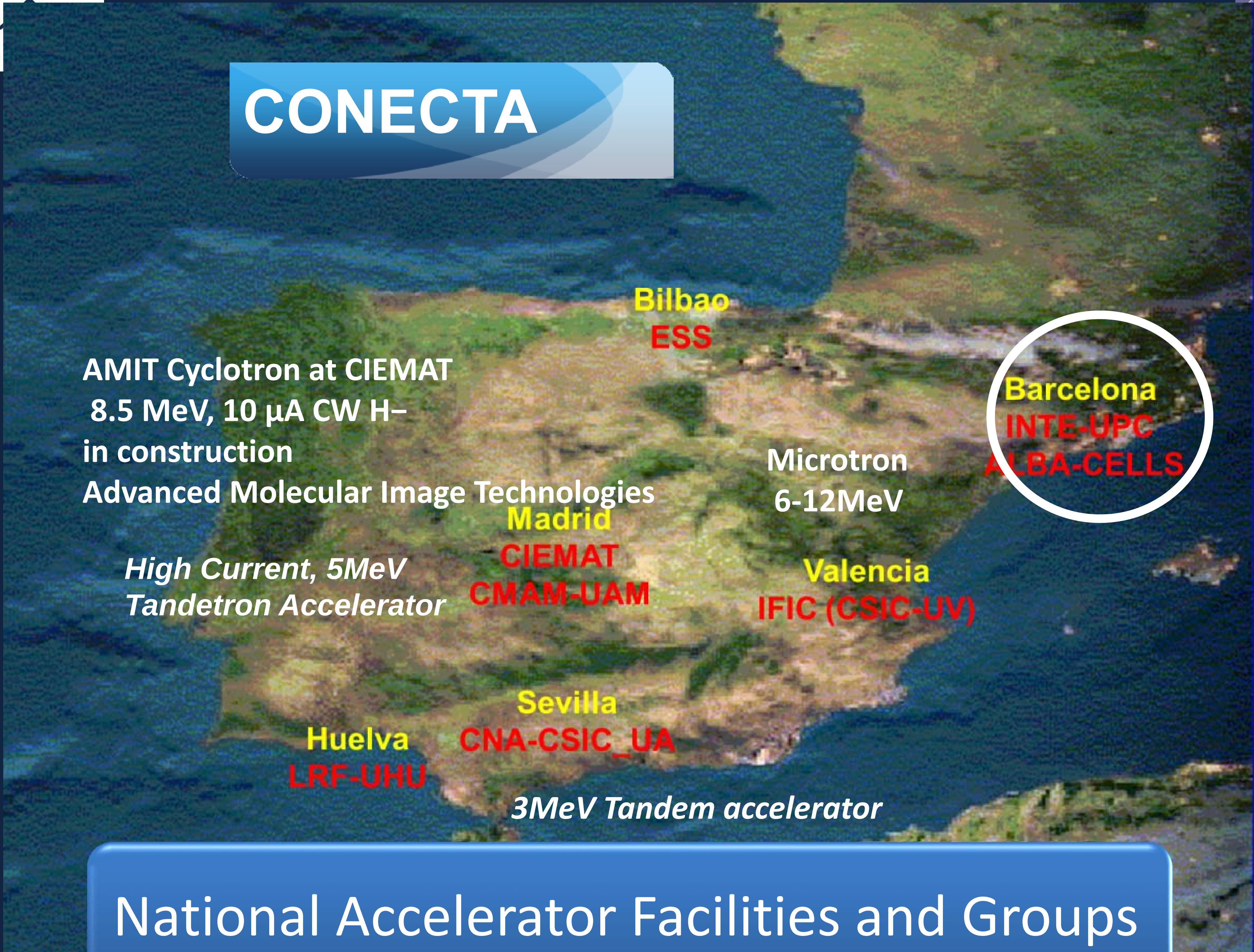
LINAC: 3GHz structure, beam acceleration to 100 MeV




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

# CONECTA




## National Accelerator Facilities and Groups

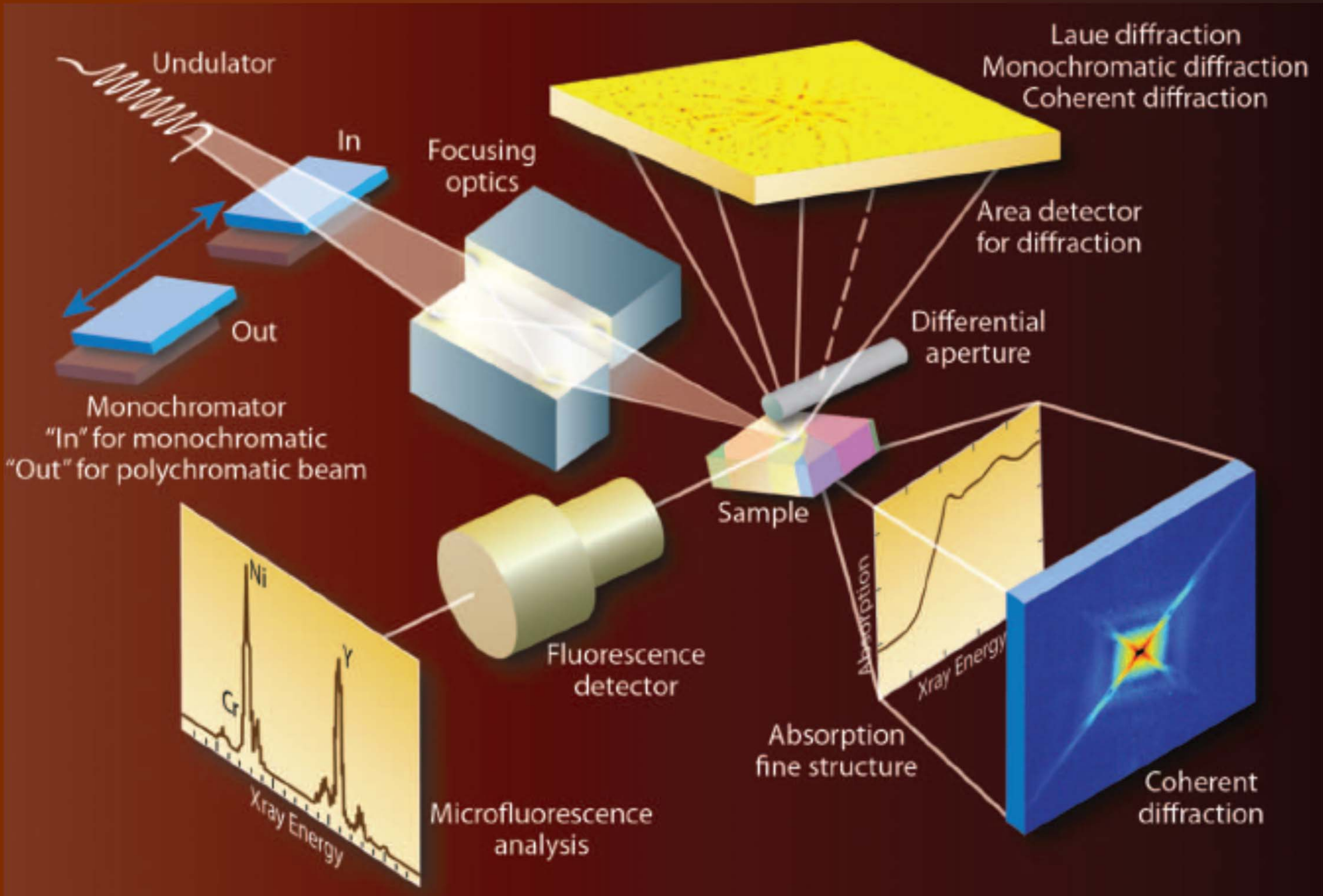
# Buildings

ALBA is sited on a plot of land of about 60000 $m^2$, placed within the Parc de l'ALBA area, The architectural complex consists of three main areas/buildings: technical buildings - of ca. 7500 $m^2$ -, the main Hall – of ca. 18500 $m^2$ - placed over the slab but with decoupled foundations, and the office/personnel wing – with ca. 4000 $m^2$

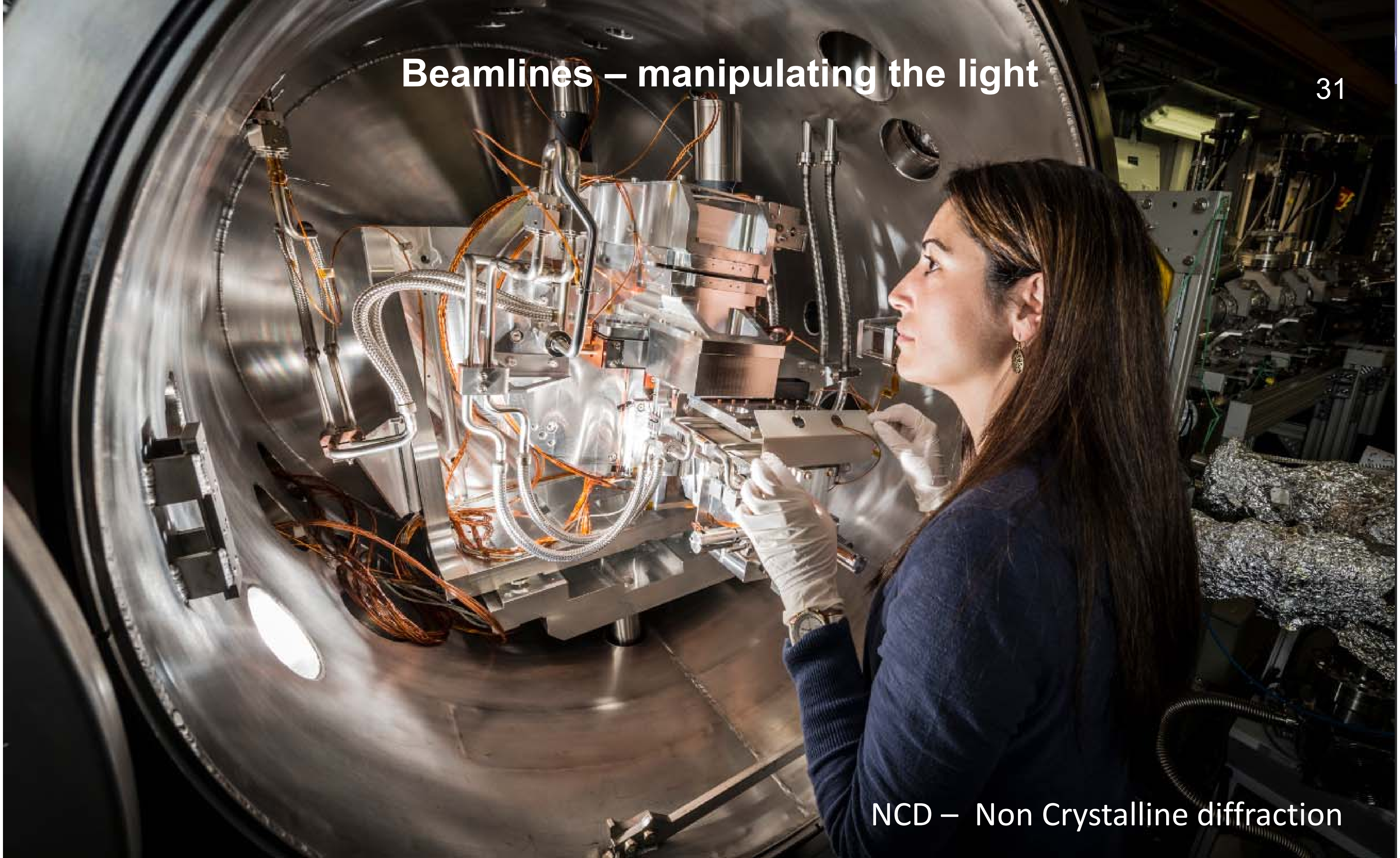
**The main building of the Alba synchrotron is snail shaped and has a diameter of more than 140 meters. It contains the most important elements of this scientific facility:**

- **The accelerators.**
- **Experimental hall with capacity for up to 29 BL.**
- **An office annex, two secondary structures that contain auxiliary technical facilities.**

# Using the light

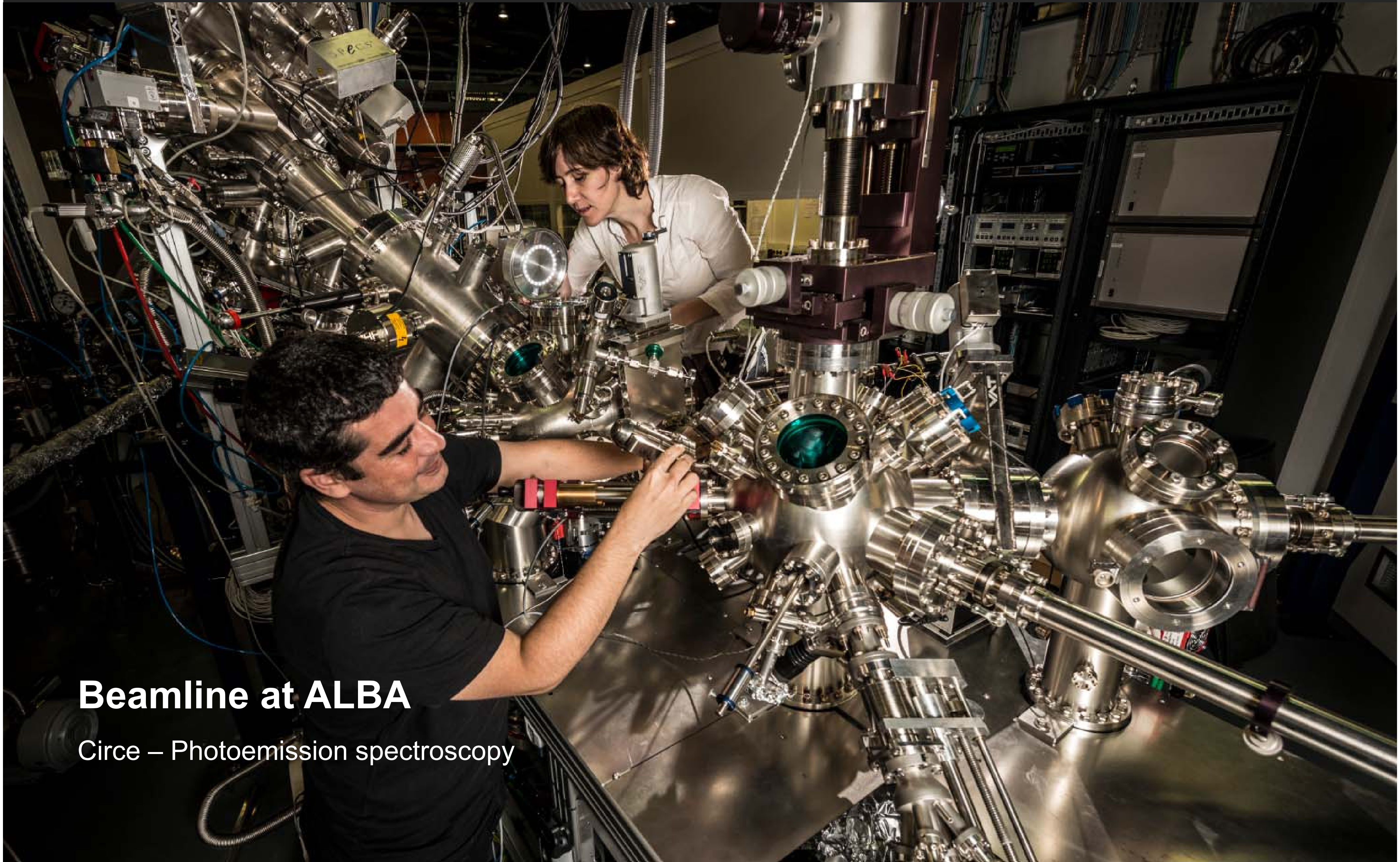


# Beamlines – manipulating the light



NCD – Non Crystalline diffraction

Crystals, mirrors, cooling systems, vacuum systems, alignment, controls, detectors, data storing, data analysis




# Beamline at ALBA

Circe – Photoemission spectroscopy

# Phase I Instruments in ALBA

Resonant Absorption and Scattering, Magnetism, magnetic structures
**BOREAS**: Hector & MARES

Material Science & Powder Diffraction
**MSPD**: HR & HP

Photoemission Spectroscopy and Microscopy, Nanoscience, Magnetic domains, Surface Chemistry
**CIRCE**: PEEM & NAPP

Non cristalline Diffraction biological fibres, polymers, solutions
**NCD**

Cryogenic tomography of biological objects and magnetic domains Soft X-Ray Microscopy
**MISTRAL**

Macromolecular Cristallography, Proteins - **XALOC**

Core Level Absorption Emission Spectroscopy Materials science, chemistry, time resolved studies, cultural heritage,
**CLAESS**

# Interaction of light with matter

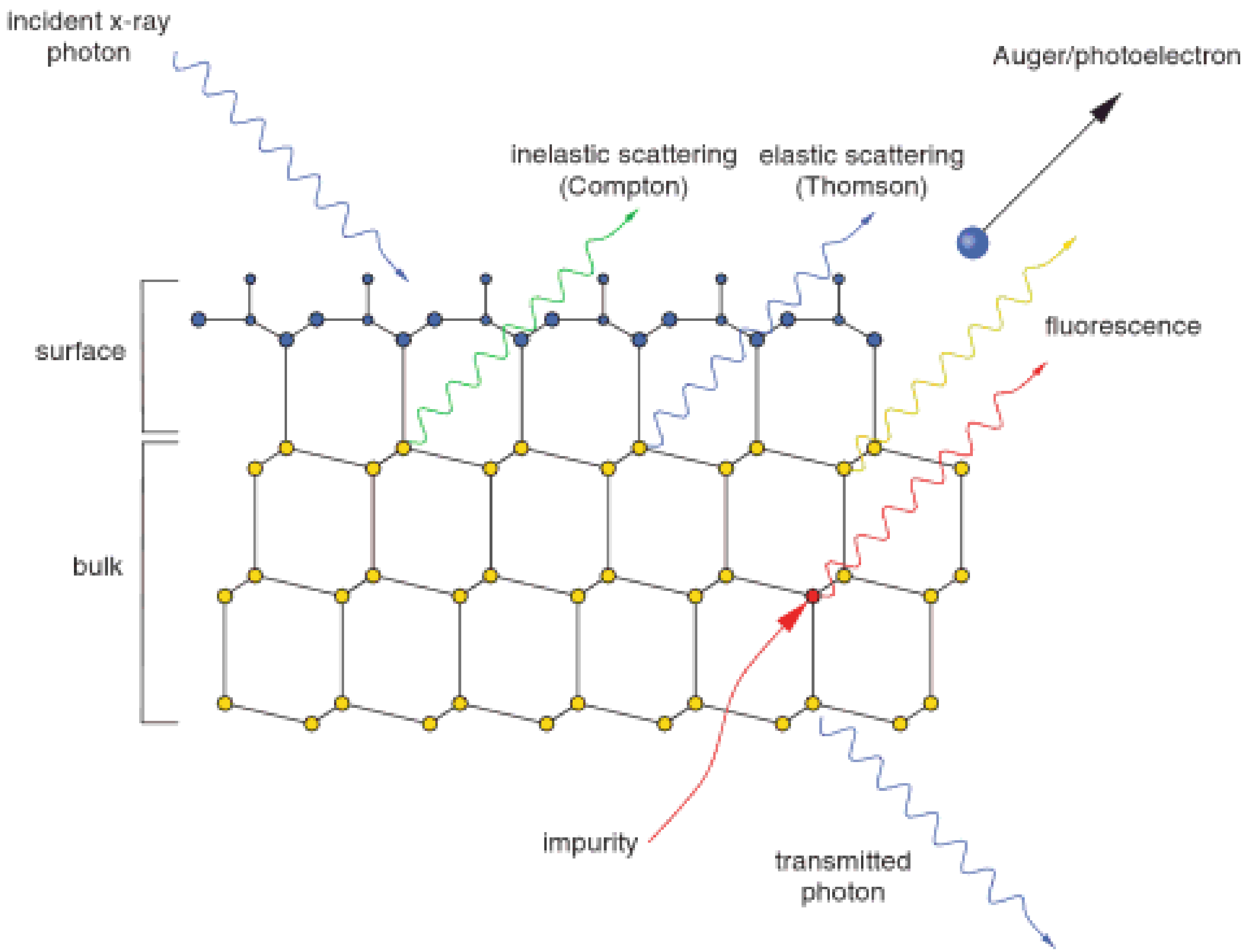


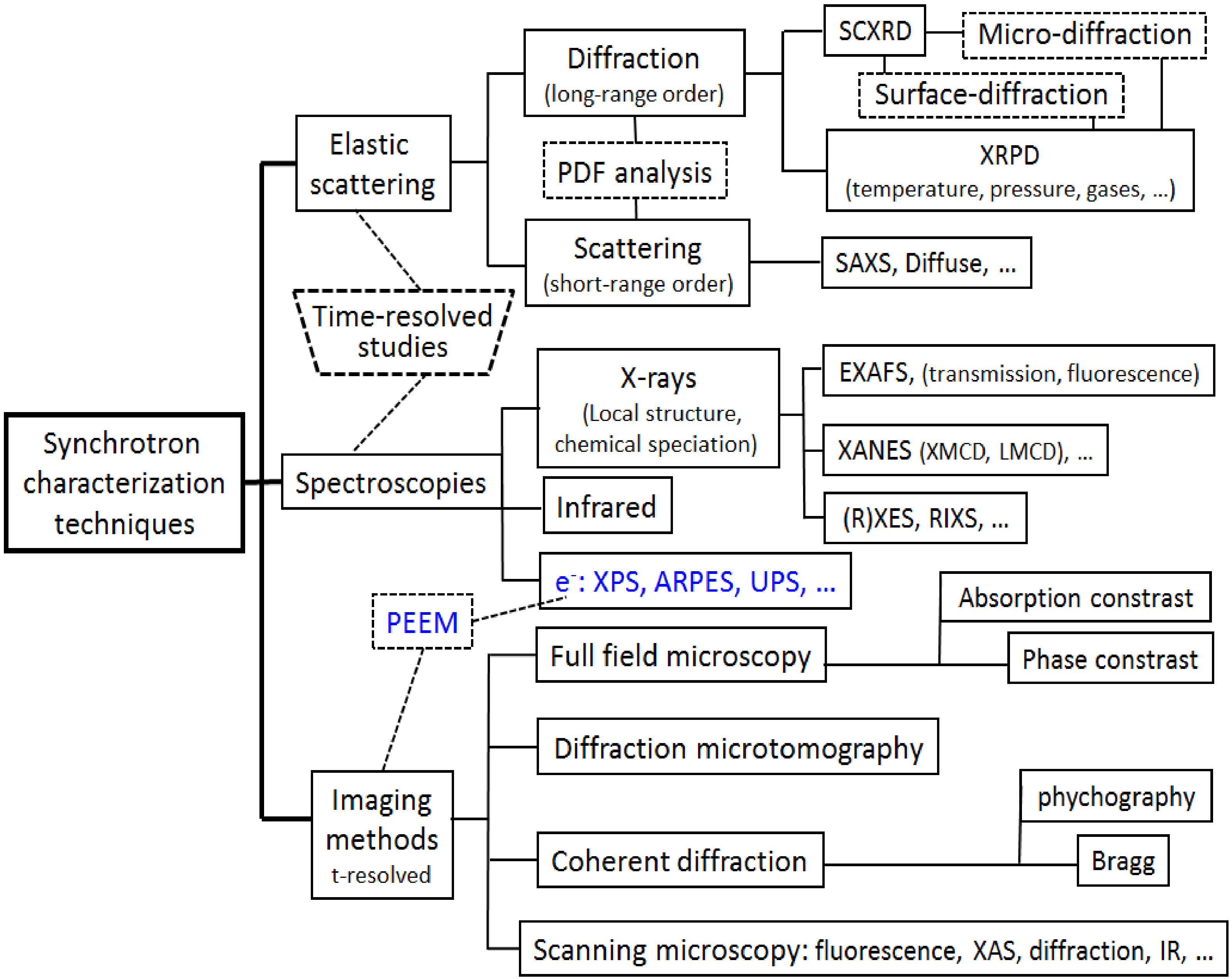

***Figure 2.1*** *The interaction of x-rays with matter. Surface (and interface) regions of a solid or liquid material are characterized by physical properties and structures that may differ significantly from those of the bulk structure. The x-rays may be elastically or inelastically scattered, or absorbed, in which case electrons or lower-energy photons can be emitted. If none of the above occur, the photon is transmitted through the sample.*

From 'An Introduction to Synchrotron Radiation' Philip Willmott

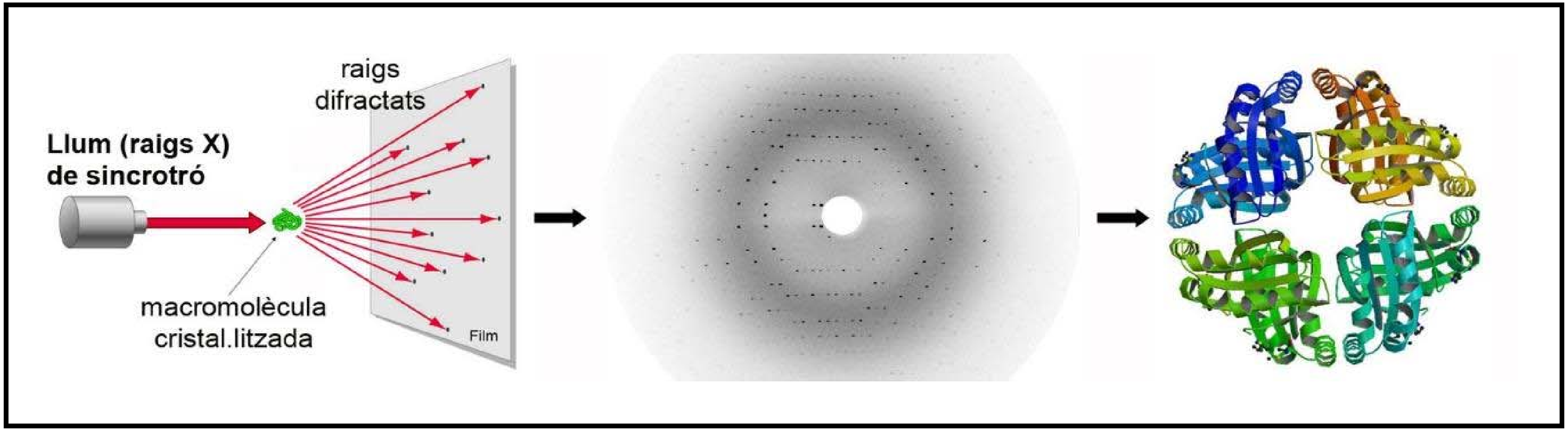
Photons and electrons produced by the interaction carry information on matter structure and composition

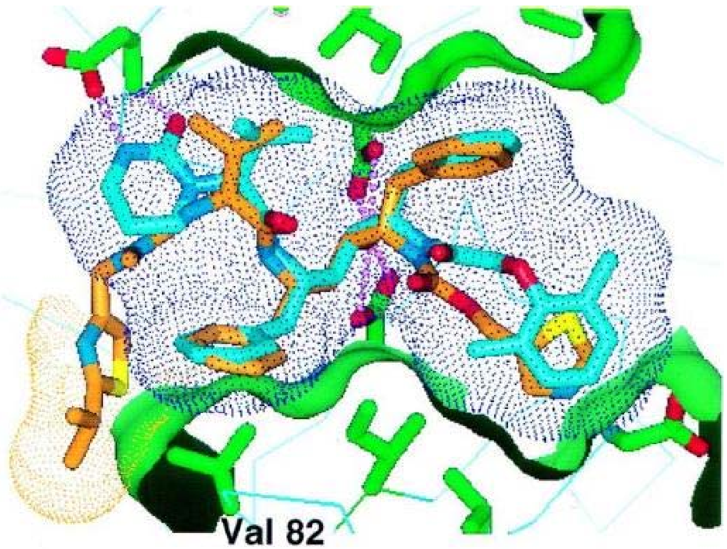
*"The usefulness of synchrotron light is limited only by our imagination"*

Sir Gustav Nossal

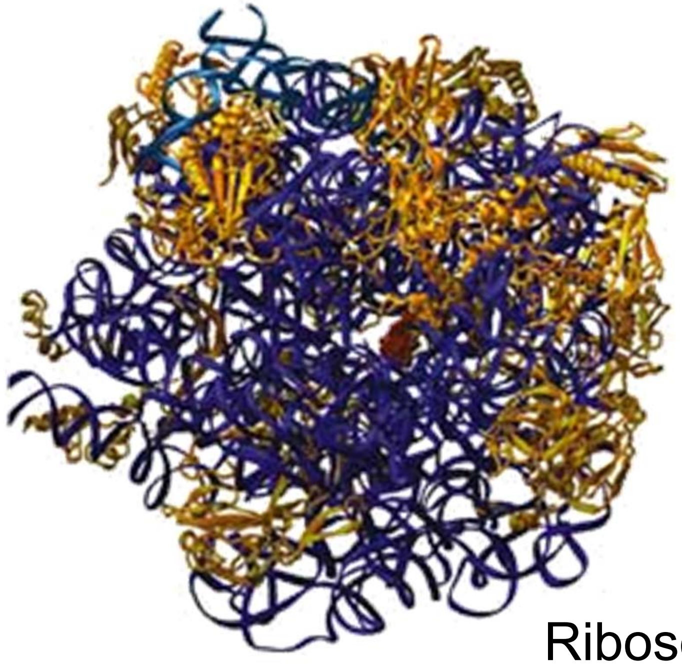

Synchrotron characterization techniques
Elastic scattering
Diffraction (long-range order)
SCXRD
Micro-diffraction
Surface-diffraction
XRPD (temperature, pressure, gases, ...)
PDF analysis
Scattering (short-range order)
SAXS, Diffuse, ...
Time-resolved studies
Spectroscopies
X-rays (Local structure, chemical speciation)
EXAFS, (transmission, fluorescence)
XANES (XMCD, LMCD), ...
(R)XES, RIXS, ...
Infrared
e⁻: XPS, ARPES, UPS, ...
PEEM
Imaging methods t-resolved
Full field microscopy
Absorption constrast
Phase constrast
Diffraction microtomography
Coherent diffraction
phychography
Bragg
Scanning microscopy: fluorescence, XAS, diffraction, IR, ...

# Protein crystallography



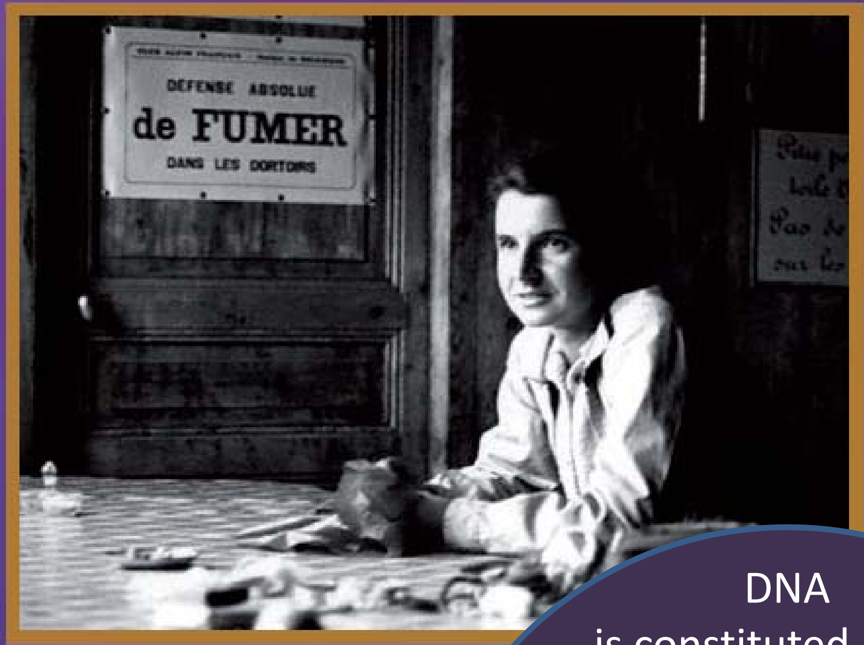




HIV proteasa



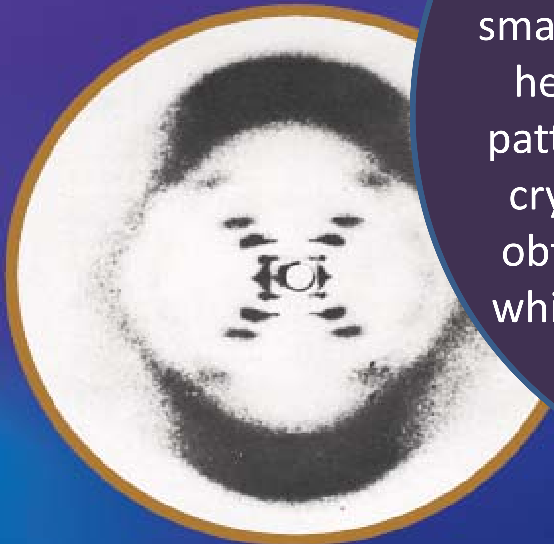
Ribosoma

Sham *et al.* ANTIMICROBIAL AGENTS AND CHEMOTHERAPY (1998)



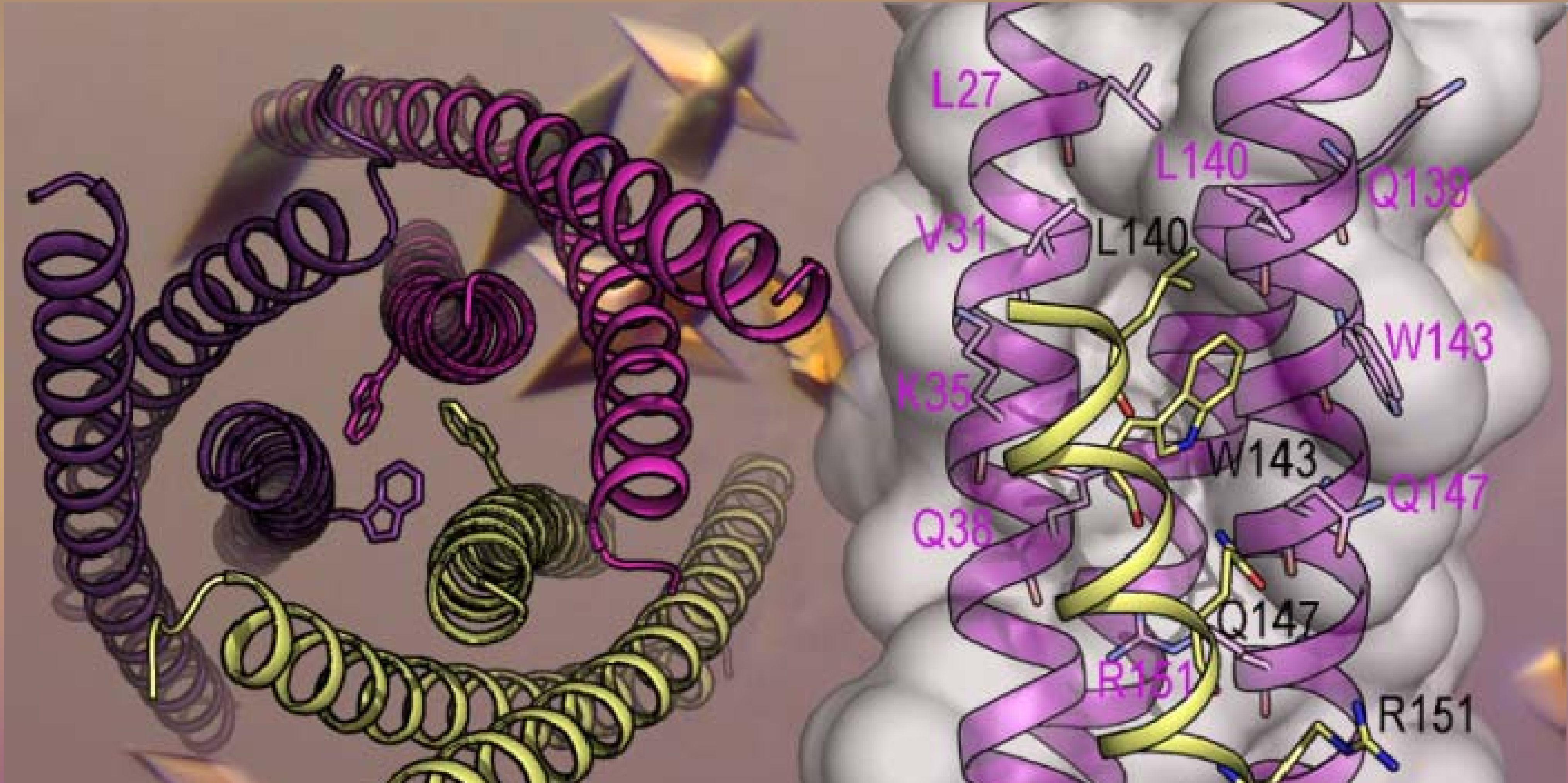

# DNA and X Rays

**1952**
**Photo 51:**
**first image by X-ray diffraction**



DNA
is constituted by two complementary filaments formed by regular sequences of small molecules, forming double helixes. It was the diffraction pattern of X rays from a pseudo crystal formed by DNA fibers, obtained by Rosalind Franklin, which allowed determining the form of this molecules.

# Drug development
# Synthetic protein miming AIDS virus



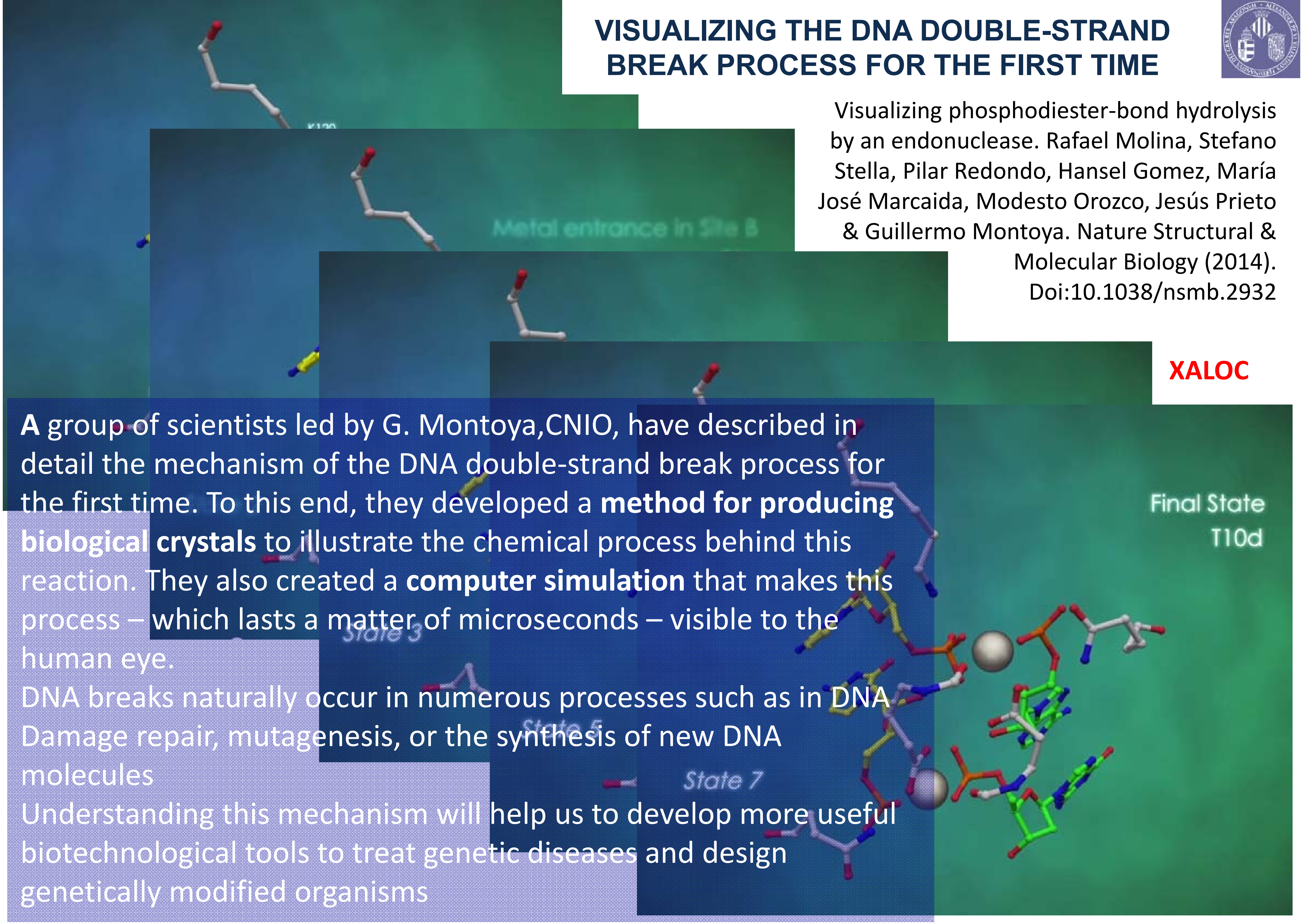

Single-chain protein mimetics of the N-terminal heptad-repeat region of gp41 with potential as anti-HIV-1 drugs"
Sara Crespillo, Ana Cámara-Artigas, Salvador Casares, Bertrand Morel, Eva S. Cobos, Pedro L. Mateo, Nicolas Mouz, Christophe E. Martin, Marie G. Roger, Raphaelle El Habib, Bin Su, Christiane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

at XALOC beamline at ALBA

# VISUALIZING THE DNA DOUBLE-STRAND BREAK PROCESS FOR THE FIRST TIME

Visualizing phosphodiester-bond hydrolysis by an endonuclease. Rafael Molina, Stefano Stella, Pilar Redondo, Hansel Gomez, María José Marcaida, Modesto Orozco, Jesús Prieto & Guillermo Montoya. Nature Structural & Molecular Biology (2014). Doi:10.1038/nsmb.2932

**XALOC**



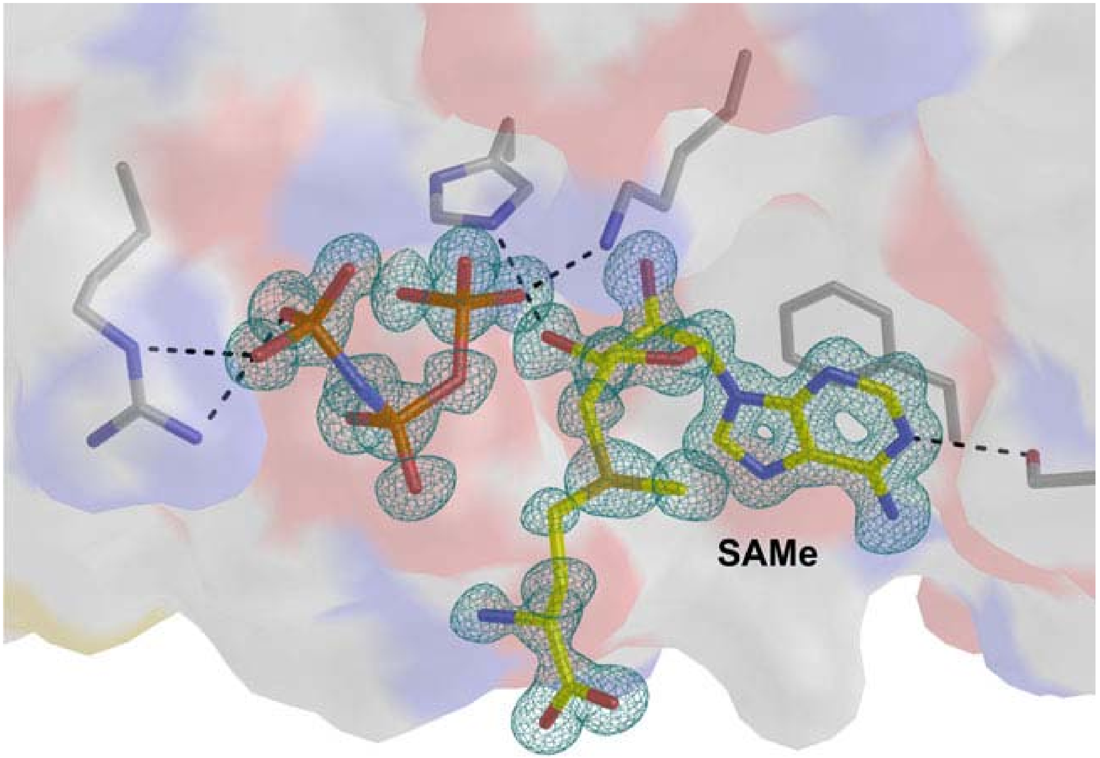

**A** group of scientists led by G. Montoya,CNIO, have described in detail the mechanism of the DNA double-strand break process for the first time. To this end, they developed a **method for producing biological crystals** to illustrate the chemical process behind this reaction. They also created a **computer simulation** that makes this process – which lasts a matter of microseconds – visible to the human eye.

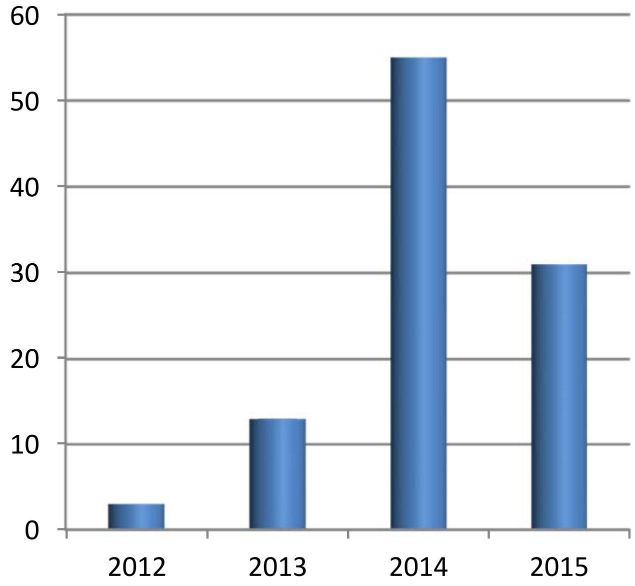
DNA breaks naturally occur in numerous processes such as in DNA Damage repair, mutagenesis, or the synthesis of new DNA molecules

Understanding this mechanism will help us to develop more useful biotechnological tools to treat genetic diseases and design genetically modified organisms

# Scientific highlights

Scientists from CIC bioGUNE, University of Liverpool and Cedars-Sinai hospital in California measured at XALOC an enzime related to colon and liver cancer for the development of highly targeted drugs that act exclusively on this enzyme, regulating cancer cell growth.




**Deposited PDB structures**
**Those corresponding to 2015 in progress**
**Total number 102**
**biosync.sbkb.org/stats.do?stats_sec=RGNL&stats_focus_lvl=RGNL&stats_region=European**


**Reference**: Ben Murraya, Svetlana V. Antonyuk, Alberto Marina, Shelly C. Lu, Jose M. Mato, S. Samar Hasnain, and Adriana L. Rojas. "Crystallography captures catalytic steps in human methionine adenosyltransferase enzymes". PNAS (2016). doi: 10.1073/pnas.1510959113

# Nobel prices for research with synchrotron light sources

**1997 - Chemistry Nobel to Boyer and Walker**

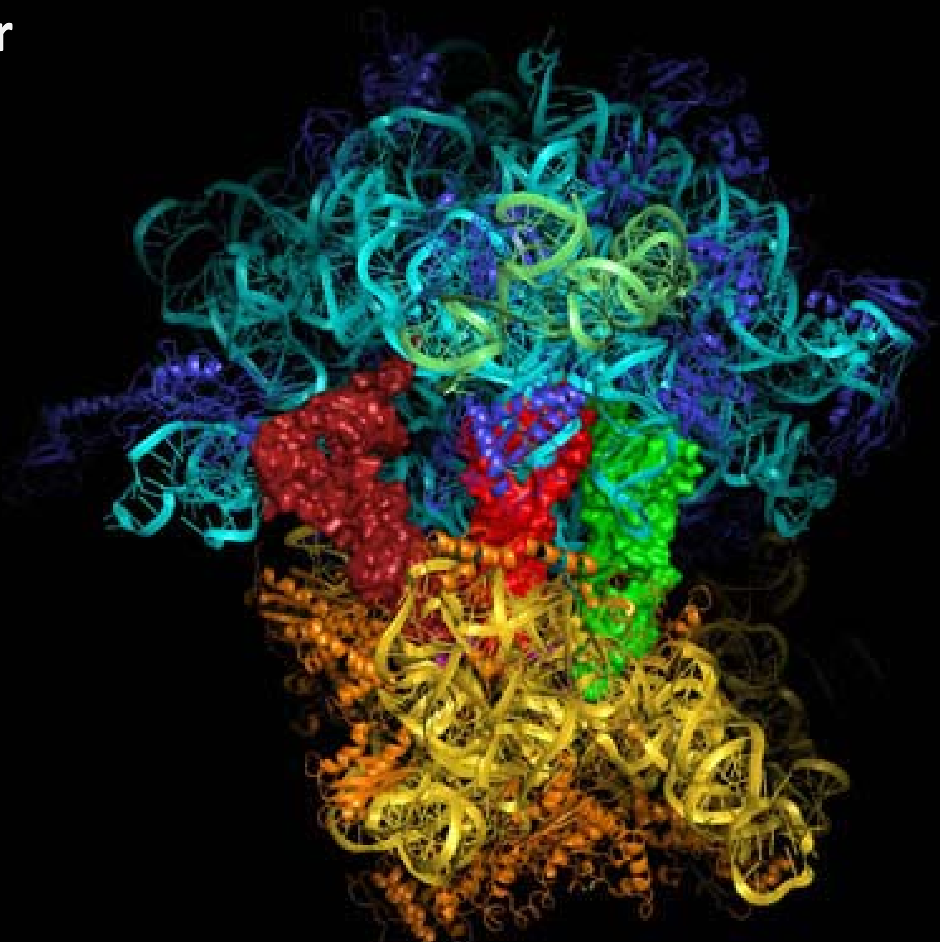
**2003 - Chemistry Nobel to Agre and MacKinnon**

**2006 – Chemistry Nobel to Kornberg**

**2009 - Chemistry Nobel  to Ramakrishnan, Steitz and Yonath**

**2012 - Chemistry Nobel to Lefkowitz adnd Kobilka**

**2013 – Medicine Nobel to Rothman, Schekman and Südhof**



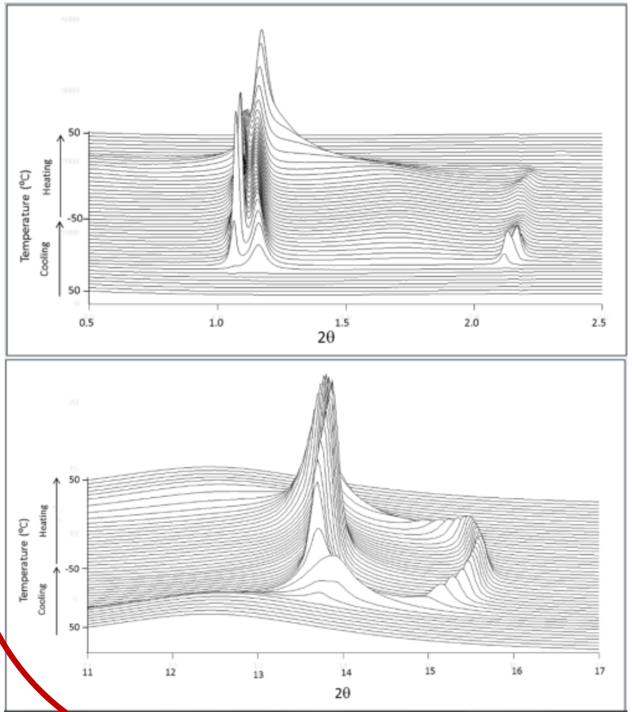
*Protein synthesis, cells communication, ribosome structure, who have solved the mystery of how the cell organizes its transport system, nanoscience*

Dr. Peter Doherty, Nobel prize of Medicine: "Synchrotron light is presently fundamental for 80% of research and development of drugs

Studying Chocolate at **NCD**

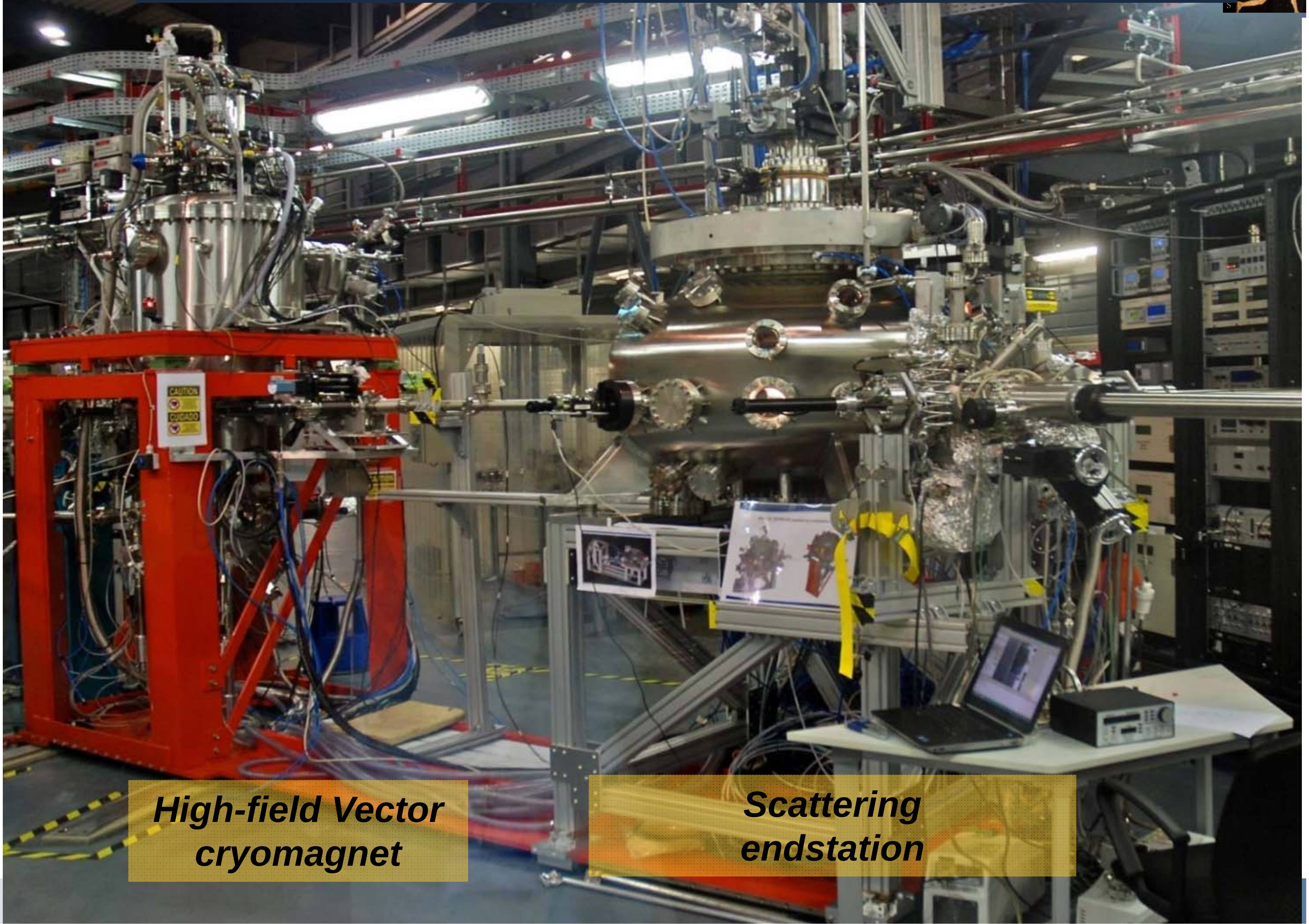
## Polymorphic study of alimentary triacylglycerols

Researchers from the Department of Crystallography and Mineralogy at the Faculty of Geology (University of Barcelona) have analysed the crystallization and polymorphic behaviour of lipid materials from pure triacylglycerol components to end food products




SAXS (up) and WAXS (bottom) patterns for cocoa butter obtained by cooling the sample from the melt (50ºC) to -50ºC and subsequently heated to 50ºC.

# Absorption and scattering - BOREAS at ALBA



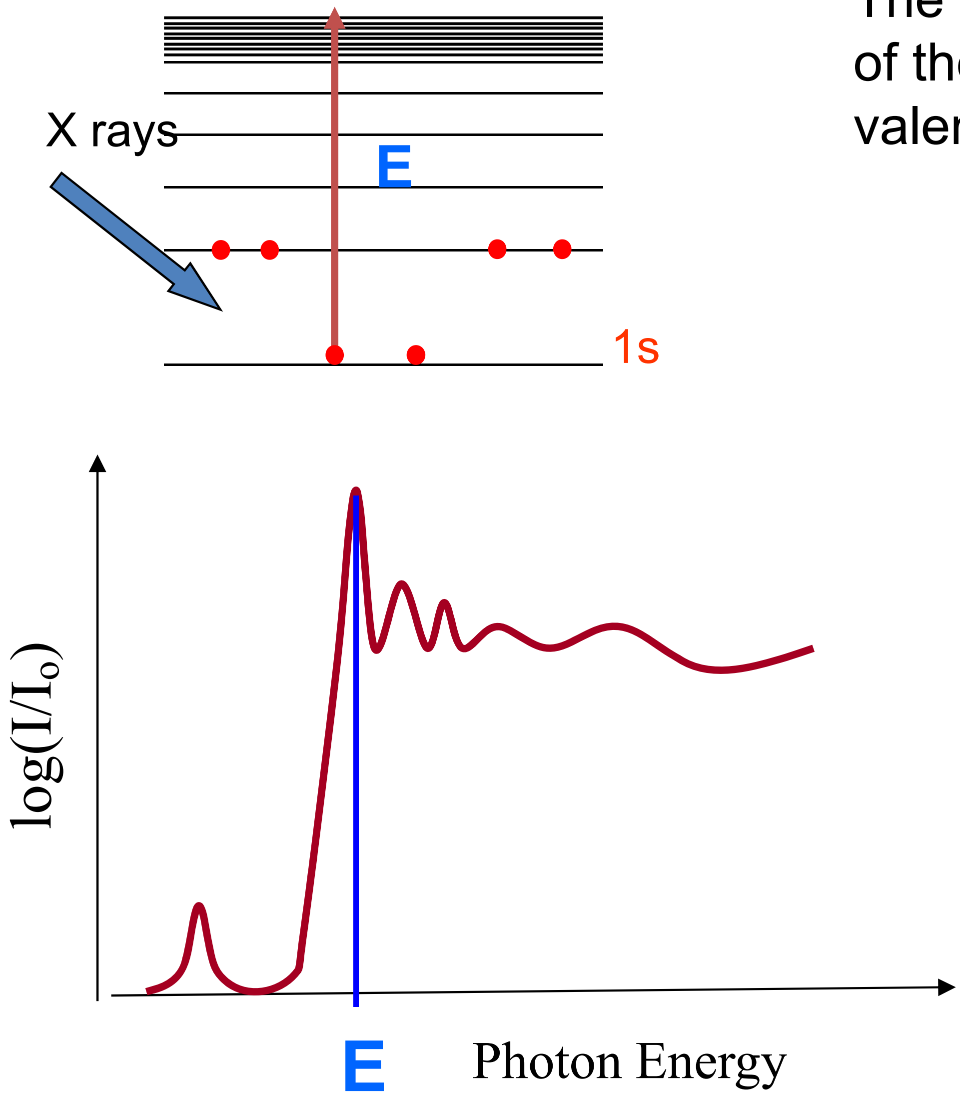

***High-field Vector cryomagnet***

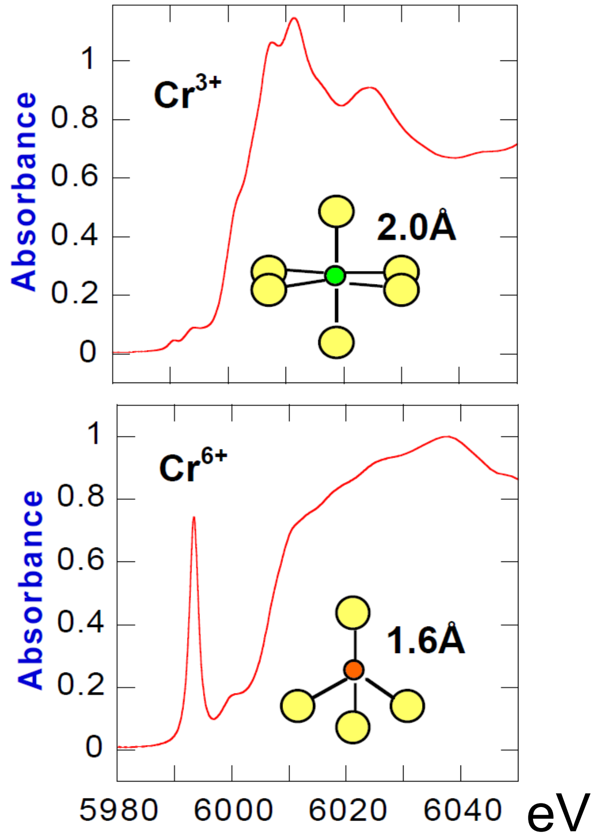
***Scattering endstation***

# X ray absorption spectroscopy

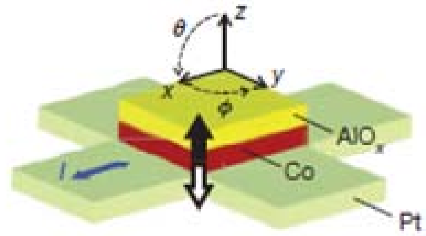
Absorption of X rays occurs at well defined energies characteristic of the absorbing atoms

The absorption energy and the fine structure of the absorption spectra are sensitive to the valence state of the absorbing atom



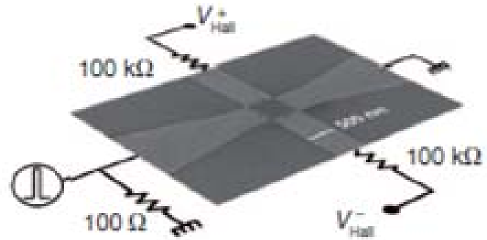
**@ BOREAS**




## Materials for batteries

**Spin-orbit fields mechanisms for in-plane current induced magnetization reversal of magnetic tunnel junctions, and their optimization**

**Fieldlike and antidamping spin-orbit torques in as-grown and annealed Ta/CoFeB/MgO layers**



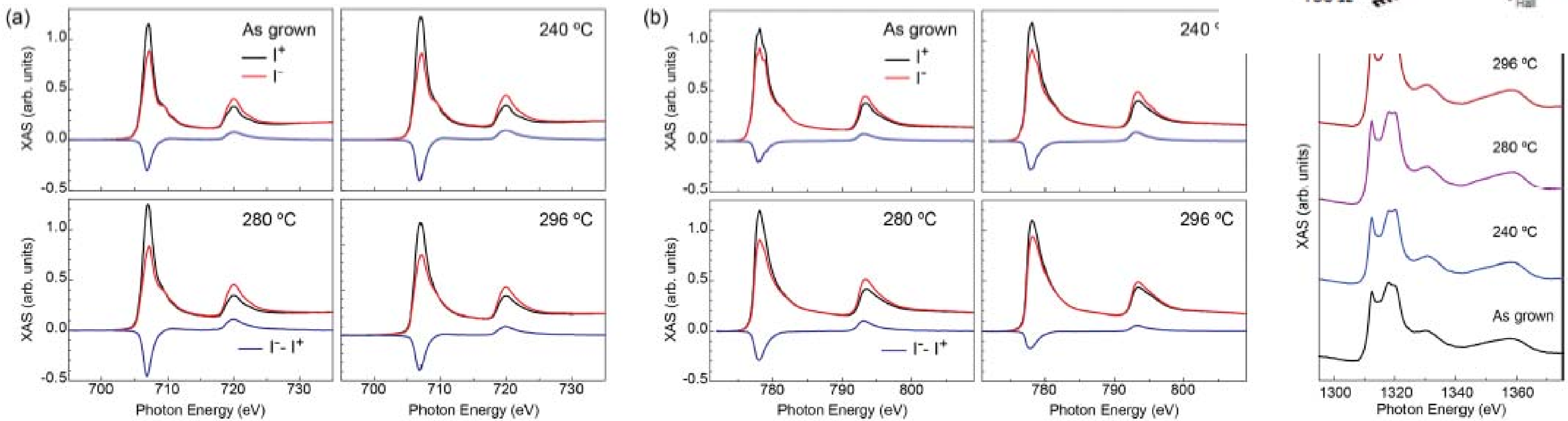
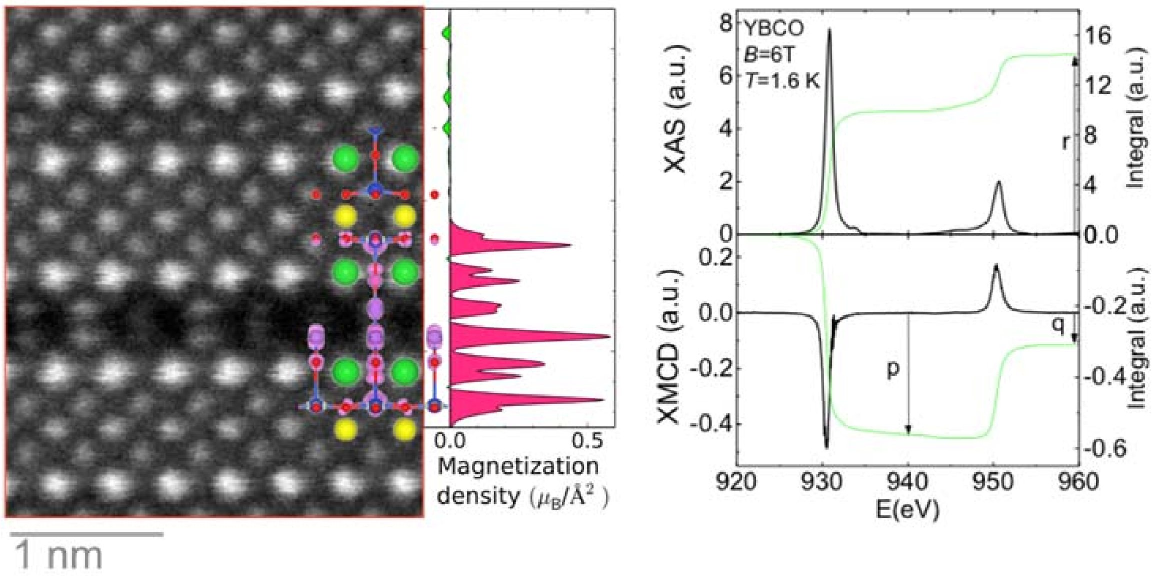




FIG. 4. (Color online) X-ray-absorption and magnetic circular dichroism spectra of as-grown and annealed Ta/CoFeB/MgO trilayers measured at the Fe $L_{2,3}$ edges (a), Co $L_{2,3}$ edges (b), and Mg $K$ edge (c). The spectra were recorded at normal incidence at room temperature in a magnetic field of 1 T.

Physical review **B 89** 214419 (2014)

# Emerging dilute ferromagnetism in high-$T_c$ superconductors driven by point defect clusters at CLAESS

Results reveal the coexistence of ferromagnetic interactions much closer to high Tc superconductivity than previously suspected



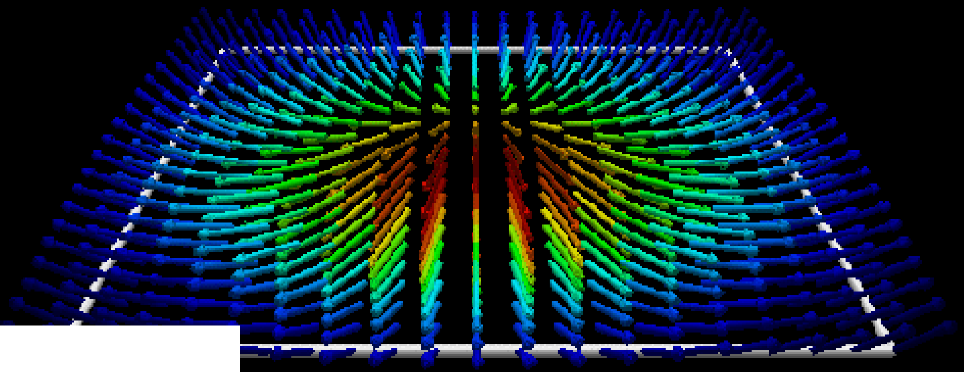

Caption:
Left panel, Z-contrast atomic resolution image of the YBCO lattice with an Y124 intergrowth imaged along the [010] direction. The dimmer contrast in the double Cu ($2V_{Cu}$) chain is due to the presence of Cu vacancies ($2V_{Cu}$). The inset shows the isosurface plot showing the spin density associated with a $2V_{Cu}+3V_O$ defect along with an integrated magnetization/area profile along the z-axis. Right panel, Cu $L_{2,3}$

J. Gazquez, R. Guzman, R. Mishra, E. Bartolomé, J. Salafranca, C. Magén, M. Varela, M. Coll, A. Palau, S. M. Valvidares, P. Gargiani8, E. Pellegrin, J. Herrero-Martin, S. J. Pennycook, S.T. Pantelides, **T. Puig, X. Obradors** – in publication

(Premis Ciutat de Barcelona 2015)

# Magnetic skyrmions, for new data storage and processing systems development

**These nanoscale magnetic structures have been observed at room temperature in materials compatible with industrial conditions. This breaks an important barrier for their use as nanoscale information carriers in our computers. Results - obtained at the CIRCE beamline - have been published in Nature Nanotechnology**



www.tcm.phy.cam.ac.uk/~nrc25/projects/skyrmions.html

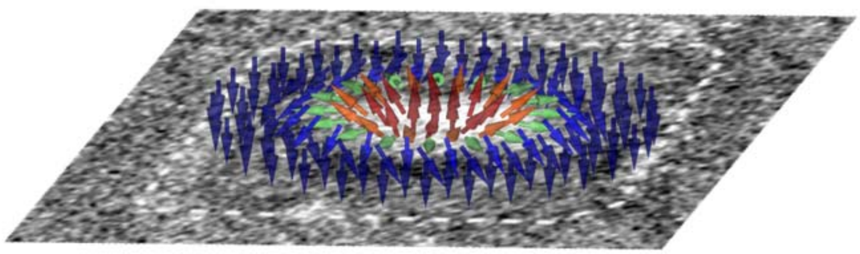


Fig. 1: Sketch of the spin structure of a magnetic skyrmion.

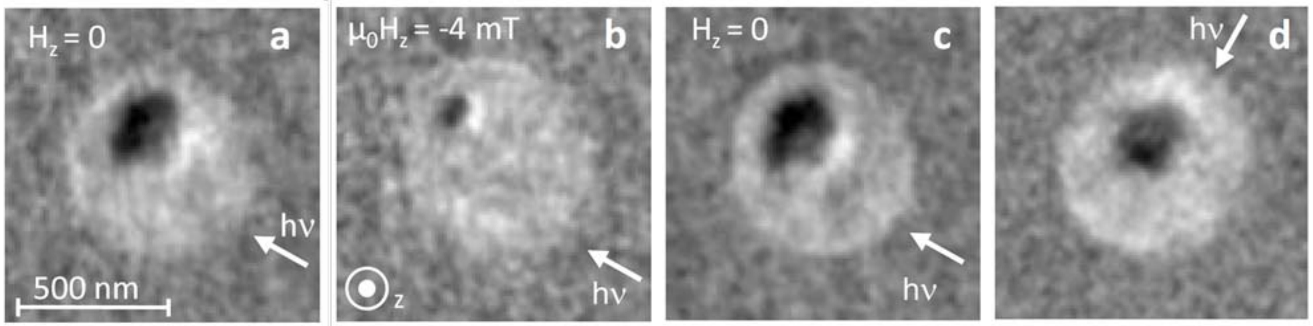
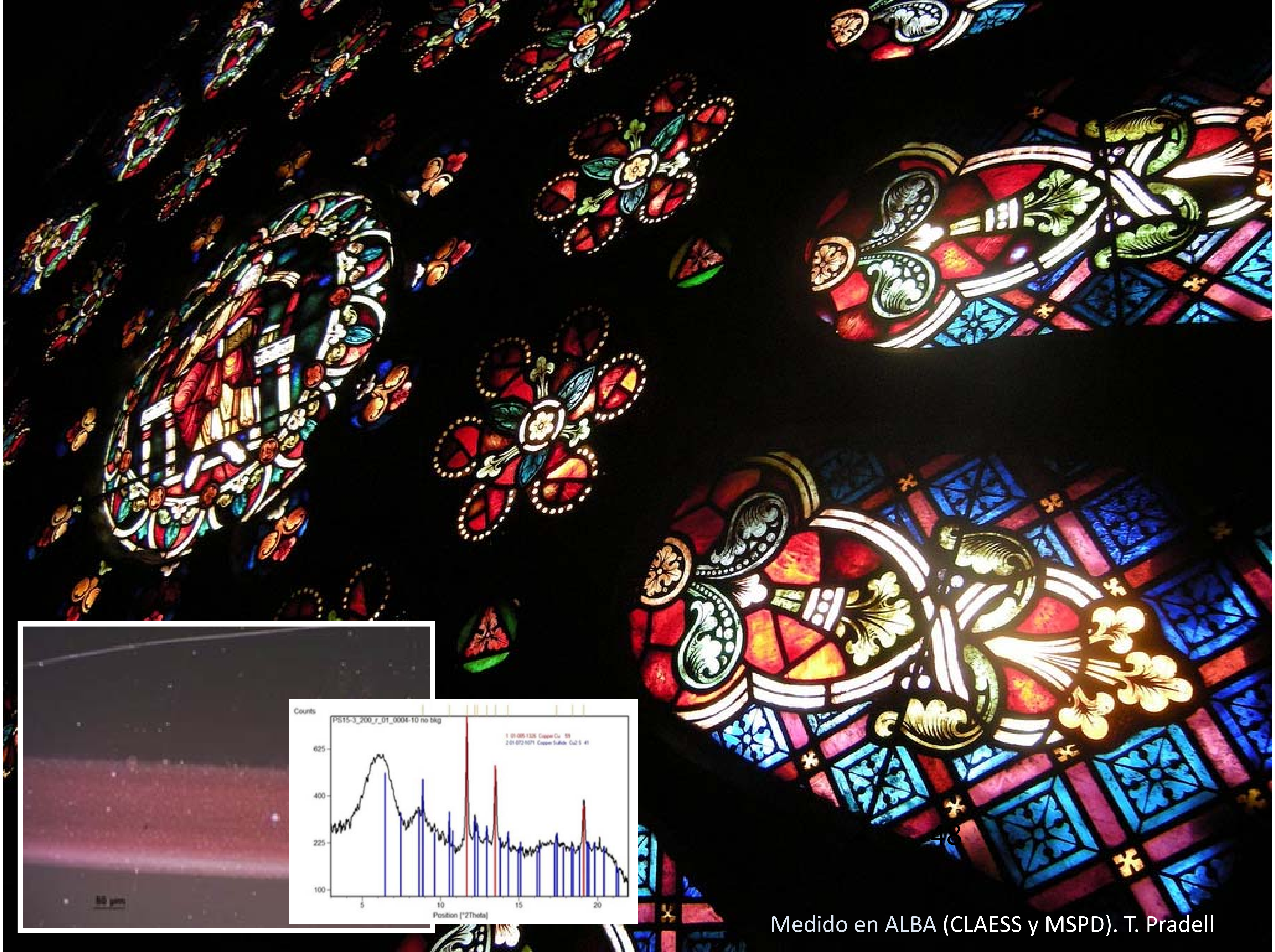



Fig. 2: (a) Magnetic microscopy image of a skyrmion in a Pt/Co/MgO nanostructure. Within the white dot (magnetization pointing down), a circular black/white contrast is visible which corresponds to the in-plane magnetisation components. In the skyrmion center, dark grey, the magnetization points up. The grazing X-ray beam incidence is indicated by the arrow (b). The skyrmion contracts under an applied magnetic field of 4mT and relaxes again when removing it (c). (d) The chiral skyrmion spin structure is confirmed by rotating the contrast direction (beam incidence) by 90°.


Reference: Olivier Boulle, Jan Vogel, Hongxin Yang, Stefania Pizzini, Dayane de Souza Chaves,Andrea Locatelli, Tevfik Onur Mentes, Alessandro Sala, Liliana D. Buda-Prejbeanu, Olivier Klein, Mohamed Belmeguenai, Yves Roussigné, Andrey Stashkevich, Salim Mourad Chérif, Lucia Aballe, Michael Foerster, Mairbek Chshiev, Stéphane Auffret, Ioan Mihai Miron &Gilles Gaudin. "Room temperature chiral magnetic skyrmions in ultrathin magnetic nanostructures" Nature Nanotechnology (2016). doi: 10.1038/nnano.2015.315




Medido en ALBA (CLAESS y MSPD). T. Pradell

# Mistral - Transmission Soft X-Ray Microscopy at ALBA

Photon source: dipole
$\rho$ = 7.6 m

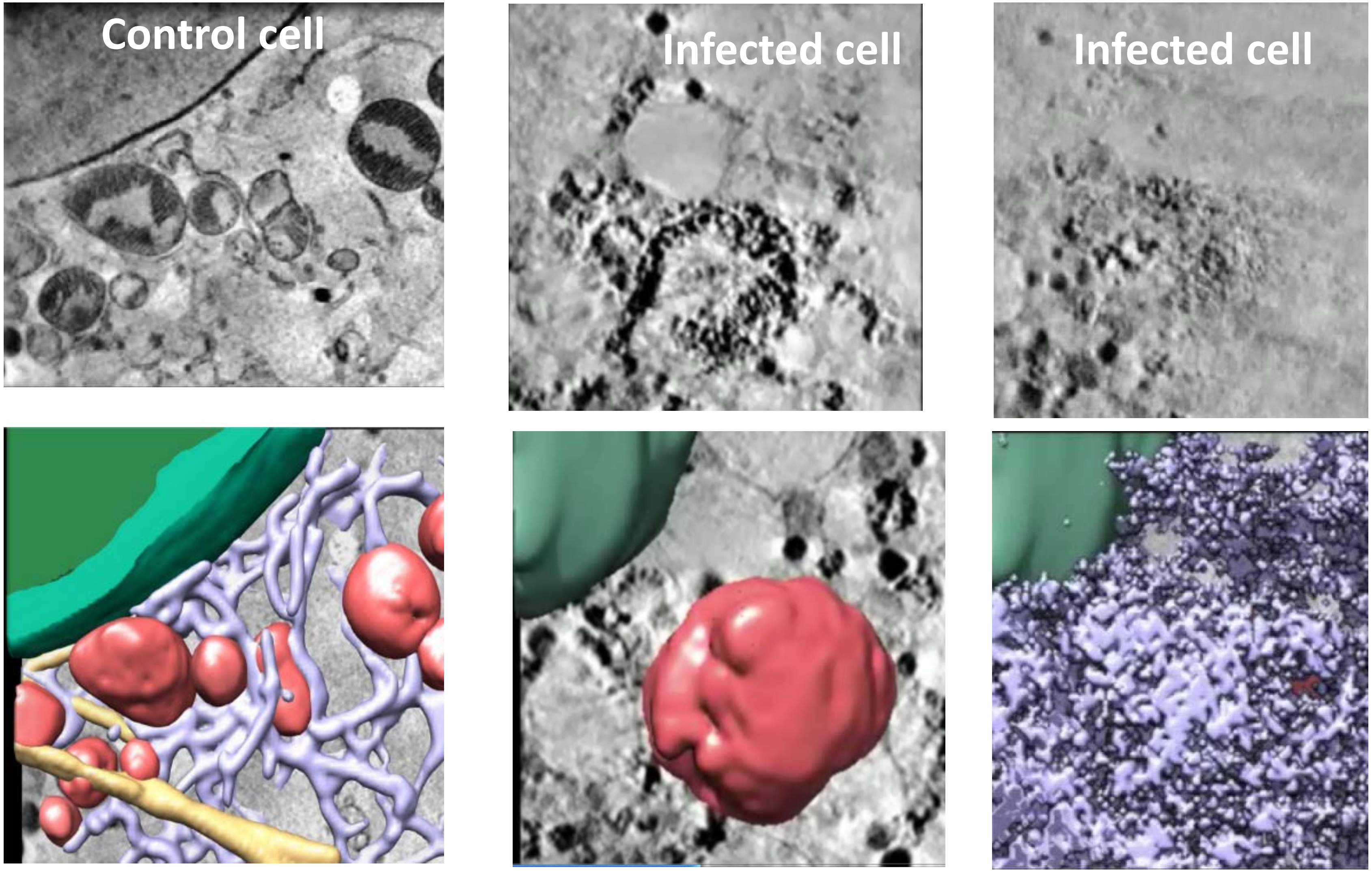

Only two other similar Microscopes in the world: BESSY-II and ALS

KB mirror pair, entrance and exit slits
Plane grating monochromator
Refocusing mirror
Microscope

- Cryo nano-tomography in water window and multi-keV spectral regions for biological applications.
- Spectroscopic imaging.
- Present photon energy range: 270 to 1200 eV, upgradable to 2600 eV in the future.
- 30 nm 2D resolution

# IMAGING Studies of Hepatitis_C in humans

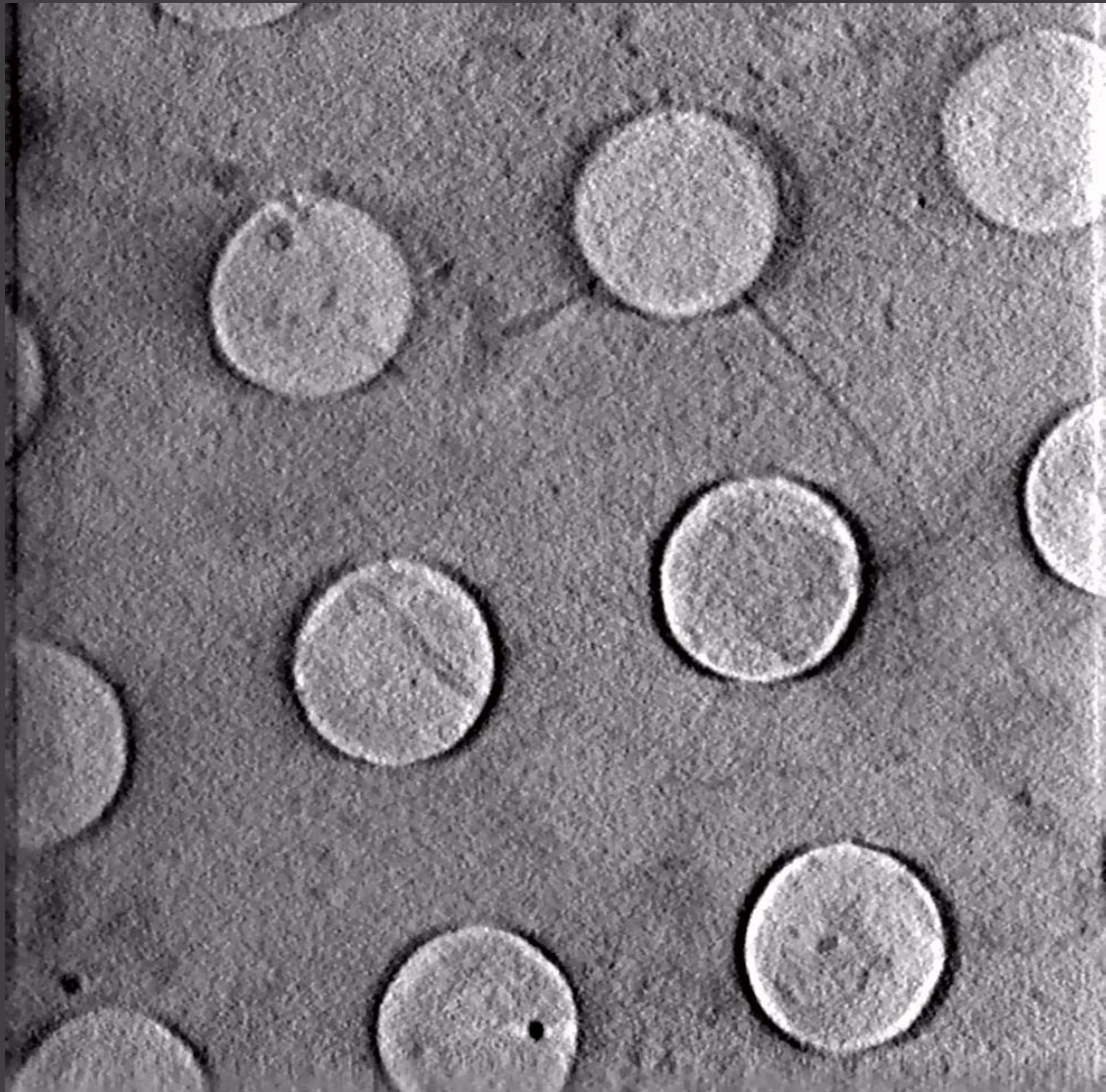
## at MISTRAL @ ALBA




**Virtual slices of a reconstructed volume of Huh-7.5 cells (human hepatocyte cell line)**

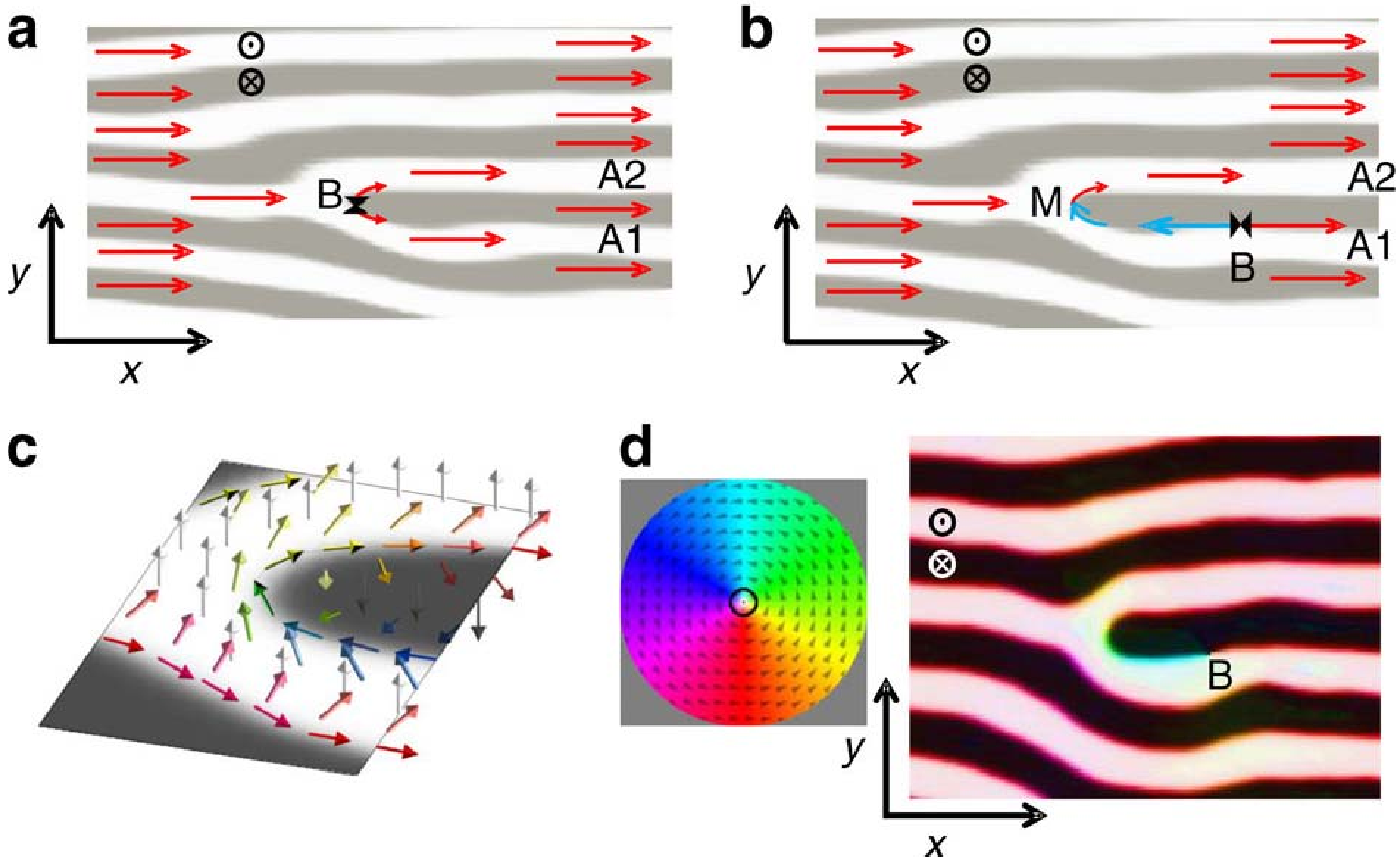
**Endoplasmic reticulum Mitochondria Golgi Apparatus Nuclear membrane**

*E. Pereiro et al.- ALBA, in publication*



# Nano-magnetism for magnetic storage of digital data

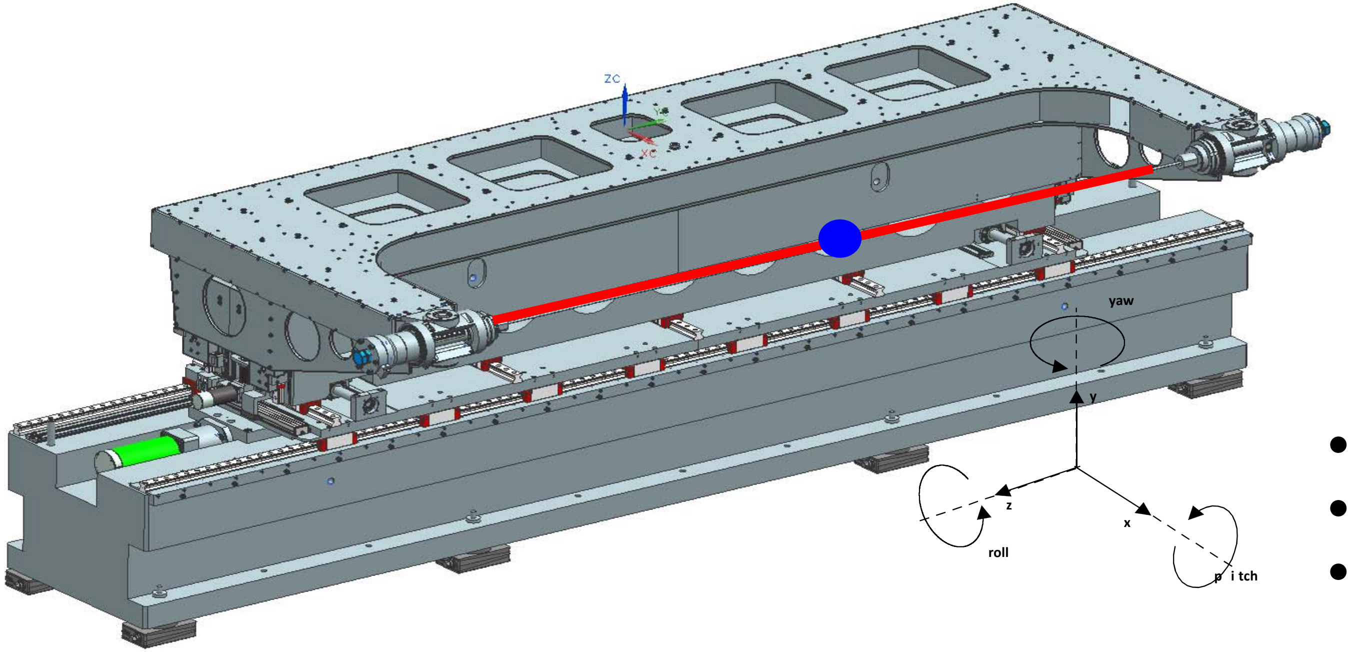
**Visualization and analysis of the properties and magnetic defects of materials at the nanoscale.** Magnetic devices are based on stacks of ultrathin films of different magnetic characteristics which can influence their behavior. Nowadays, one of the hot research topics is the interaction of these films, how to improve their fabrication and define their magnetic characterization.




at MISTRAL

Nanoscale imaging of buried topological defects with quantitative X-ray magnetic microscopy, C. Blanco-Roldán, C. Quirós, A. Sorrentino, A. Hierro-Rodríguez, L. M. Álvarez-Prado, R. Valcárcel, M. Duch, N. Torras, J. Esteve, J. I. Martín,M. Vélez, J. M. Alameda, E. Pereiro & S. Ferrer
Nature Communications 6, Article number: 8196 doi:10.1038/ncomms9196

# Magnetic measurement bench




| Magnitudes on top of Hall probe | Values |
| --- | --- |
| X stroke | 0.233 m |
| Y stroke | 0.092 m |
| Z stroke | 1.282 m |
| On-the-fly velocity | $13 \cdot 10^{-3}$ m/s |

- High mechanical accuracy
- High electronic accuracy
- High accessibility

# SESAME @ Amman

All dipoles measured in our magnetic measurement lab and shipped to Jordan: view at SESAME hall (30-11-15)

SYNCHROTRON-LIGHT FOR EXPERIMENTAL SCIENCE AND APPLICATIONS IN THE MIDDLE EAST -

Developed under the auspices of UNESCO

*In construction*

# Operation calendar (2016)

~5800 hours of operation

## ALBA Operations Calendar 2016

| | | |
|---|---|---|
| BL operation | BL | BL users and commissioning |
| M operation | M | Start up and optimization of accelerators with beam |
| Shutdown Warm | W | No beam. Services ON. |
| Shutdown OFF | Off | No beam. No cooling water. |
| Public & CELLS holiday | | |

| | January | | | | | February | | | | | March | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Shift | | | | | Shift | | | | | Shift | | |
| Weekday | Day | Week | M | A | N | Day | Week | M | A | N | Day | Week | M | A | N |
| Mo | | | | | | | | | | | | | | | |
| Tu | | | | | | | | | | | 1 | | W | W | W |
| We | | | | | | | | | | | 2 | | M | M | M |
| Th | | | | | | | | | | | 3 | | M | M | M |
| Fr | 1 | | W | W | W | | | | | | 4 | | BL | BL | BL |
| Sa | 2 | | W | W | W | | | | | | 5 | | BL | BL | BL |
| Su | 3 | | W | W | W | | | | | | 6 | | BL | BL | BL |
| Mo | 4 | 1 | Off | Off | Off | 1 | 5 | M | M | M | 7 | 10 | M | M | M |
| Tu | 5 | | Off | Off | Off | 2 | | BL | BL | BL | 8 | | BL | BL | BL |
| We | 6 | | Off | Off | Off | 3 | | BL | BL | BL | 9 | | BL | BL | BL |
| Th | 7 | | Off | Off | Off | 4 | | BL | BL | BL | 10 | | BL | BL | BL |
| Fr | 8 | | Off | Off | Off | 5 | | BL | BL | BL | 11 | | BL | BL | BL |
| Sa | 9 | | Off | Off | Off | 6 | | BL | BL | BL | 12 | | BL | BL | BL |
| Su | 10 | | Off | Off | Off | 7 | | BL | BL | BL | 13 | | M | M | M |
| Mo | 11 | 2 | Off | Off | Off | 8 | 6 | M | M | M | 14 | 11 | BL | BL | BL |
| Tu | 12 | | Off | Off | Off | 9 | | BL | BL | BL | 15 | | BL | BL | BL |
| We | 13 | | Off | Off | Off | 10 | | BL | BL | BL | 16 | | BL | BL | BL |
| Th | 14 | | Off | Off | Off | 11 | | BL | BL | BL | 17 | | BL | BL | BL |
| Fr | 15 | | W | W | W | 12 | | BL | BL | BL | 18 | | BL | BL | BL |
| Sa | 16 | | PSS | W | W | 13 | | BL | BL | BL | 19 | | W | W | W |
| Su | 17 | | W | W | W | 14 | | M | M | M | 20 | | W | W | W |
| Mo | 18 | 3 | W | W | W | 15 | 7 | BL | BL | BL | 21 | 12 | W | W | W |
| Tu | 19 | | W | W | W | 16 | | BL | BL | BL | 22 | | W | W | W |
| We | 20 | | W | W | W | 17 | | BL | BL | BL | 23 | | W | W | W |
| Th | 21 | | W | W | W | 18 | | BL | BL | BL | 24 | | W | W | W |
| Fr | 22 | | W | W | W | 19 | | BL | BL | BL | 25 | | W | W | W |
| Sa | 23 | | W | W | W | 20 | | BL | BL | BL | 26 | | W | W | W |
| Su | 24 | | W | W | W | 21 | | M | M | M | 27 | | W | W | W |
| Mo | 25 | 4 | M | M | W | 22 | 8 | BL | BL | BL | 28 | 13 | W | W | W |
| Tu | 26 | | M | M | W | 23 | | BL | BL | BL | 29 | | W | W | W |
| We | 27 | | M | M | M | 24 | | BL | BL | BL | 30 | | M | M | M |
| Th | 28 | | M | M | M | 25 | | BL | BL | BL | 31 | | M | M | M |
| Fr | 29 | | M | M | M | 26 | | BL | BL | BL | | | | | |
| Sa | 30 | | M | M | M | 27 | | W | W | W | | | | | |
| Su | 31 | | M | M | M | 28 | | W | W | W | | | | | |
| Mo | | | | | | 29 | 9 | W | W | W | | | | | |
| Tu | | | | | | | | | | | | | | | |
| We | | | | | | | | | | | | | | | |
| Th | | | | | | | | | | | | | | | |

| | April | | | | | May | | | | | June | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Shift | | | | | Shift | | | | | Shift | | |
| Weekday | Day | Week | M | A | N | Day | Week | M | A | N | Day | Week | M | A | N |
| Mo | | | | | | | | | | | | | | | |
| Tu | | | | | | | | | | | | | | | |
| We | | | | | | | | | | | 1 | | BL | BL | BL |
| Th | | | | | | | | | | | 2 | | BL | BL | BL |
| Fr | 1 | | BL | BL | BL | | | | | | 3 | | BL | BL | BL |
| Sa | 2 | | BL | BL | BL | | | | | | 4 | | BL | BL | BL |
| Su | 3 | | BL | BL | BL | 1 | | W | W | W | 5 | | M | M | M |
| Mo | 4 | 14 | M | M | M | 2 | 18 | SPR | W | W | 6 | 23 | BL | BL | BL |
| Tu | 5 | | BL | BL | BL | 3 | | SPR | W | W | 7 | | BL | BL | BL |
| We | 6 | | BL | BL | BL | 4 | | W | W | W | 8 | | BL | BL | BL |
| Th | 7 | | BL | BL | BL | 5 | | W | W | W | 9 | | BL | BL | BL |
| Fr | 8 | | BL | BL | BL | 6 | | W | W | W | 10 | | BL | BL | BL |
| Sa | 9 | | BL | BL | BL | 7 | | W | W | W | 11 | | BL | BL | BL |
| Su | 10 | | BL | BL | BL | 8 | | W | W | W | 12 | | M | M | M |
| Mo | 11 | 15 | M | M | M | 9 | 19 | M | M | M | 13 | 24 | PSS | W | W |
| Tu | 12 | | BL | BL | BL | 10 | | M | M | M | 14 | | PSS | W | W |
| We | 13 | | BL | BL | BL | 11 | | BL | BL | BL | 15 | | W | W | W |
| Th | 14 | | BL | BL | BL | 12 | | BL | BL | BL | 16 | | W | W | W |
| Fr | 15 | | BL | BL | BL | 13 | | BL | BL | BL | 17 | | W | W | W |
| Sa | 16 | | BL | BL | BL | 14 | | BL | BL | BL | 18 | | W | W | W |
| Su | 17 | | BL | BL | BL | 15 | | BL | BL | BL | 19 | | W | W | W |
| Mo | 18 | 16 | M | M | M | 16 | 20 | M | M | M | 20 | 25 | M | M | M |
| Tu | 19 | | BL | BL | BL | 17 | | BL | BL | BL | 21 | | M | M | M |
| We | 20 | | BL | BL | BL | 18 | | BL | BL | BL | 22 | | BL | BL | BL |
| Th | 21 | | BL | BL | BL | 19 | | BL | BL | BL | 23 | | BL | BL | BL |
| Fr | 22 | | BL | BL | BL | 20 | | BL | BL | BL | 24 | | BL | BL | BL |
| Sa | 23 | | BL | BL | BL | 21 | | BL | BL | BL | 25 | | BL | BL | BL |
| Su | 24 | | M | M | M | 22 | | BL | BL | BL | 26 | | BL | BL | BL |
| Mo | 25 | 17 | BL | BL | BL | 23 | 21 | M | M | M | 27 | 26 | M | M | M |
| Tu | 26 | | BL | BL | BL | 24 | | BL | BL | BL | 28 | | BL | BL | BL |
| We | 27 | | BL | BL | BL | 25 | | BL | BL | BL | 29 | | BL | BL | BL |
| Th | 28 | | BL | BL | BL | 26 | | BL | BL | BL | 30 | | BL | BL | BL |
| Fr | 29 | | BL | BL | BL | 27 | | BL | BL | BL | | | | | |
| Sa | 30 | | W | W | W | 28 | | W | W | W | | | | | |
| Su | | | | | | 29 | | W | W | W | | | | | |
| Mo | | | | | | 30 | 22 | M | M | M | | | | | |
| Tu | | | | | | 31 | | BL | BL | BL | | | | | |
| We | | | | | | | | | | | | | | | |
| Th | | | | | | | | | | | | | | | |

| | July | | | | | August | | | | | September | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Shift | | | | | Shift | | | | | Shift | | |
| Weekday | Day | Week | M | A | N | Day | Week | M | A | N | Day | Week | M | A | N |
| Mo | | | | | | 1 | 31 | Off | Off | Off | | | | | |
| Tu | | | | | | 2 | | Off | Off | Off | | | | | |
| We | | | | | | 3 | | Off | Off | Off | | | | | |
| Th | | | | | | 4 | | Off | Off | Off | 1 | | M | M | M |
| Fr | 1 | | BL | BL | BL | 5 | | Off | Off | Off | 2 | | M | M | M |
| Sa | 2 | | W | W | W | 6 | | Off | Off | Off | 3 | | M | M | M |
| Su | 3 | | W | W | W | 7 | | Off | Off | Off | 4 | | M | M | M |
| Mo | 4 | 27 | M | M | M | 8 | 32 | Off | Off | Off | 5 | 36 | BL | BL | BL |
| Tu | 5 | | BL | BL | BL | 9 | | Off | Off | Off | 6 | | BL | BL | BL |
| We | 6 | | BL | BL | BL | 10 | | Off | Off | Off | 7 | | BL | BL | BL |
| Th | 7 | | BL | BL | BL | 11 | | Off | Off | Off | 8 | | BL | BL | BL |
| Fr | 8 | | BL | BL | BL | 12 | | Off | Off | Off | 9 | | BL | BL | BL |
| Sa | 9 | | BL | BL | BL | 13 | | Off | Off | Off | 10 | | BL | BL | BL |
| Su | 10 | | BL | BL | BL | 14 | | Off | Off | Off | 11 | | M | M | M |
| Mo | 11 | 28 | M | M | M | 15 | 33 | Off | Off | Off | 12 | 37 | BL | BL | BL |
| Tu | 12 | | BL | BL | BL | 16 | | Off | Off | Off | 13 | | BL | BL | BL |
| We | 13 | | BL | BL | BL | 17 | | Off | Off | Off | 14 | | BL | BL | BL |
| Th | 14 | | BL | BL | BL | 18 | | Off | Off | Off | 15 | | M | W | M |
| Fr | 15 | | BL | BL | BL | 19 | | Off | Off | Off | 16 | | BL | BL | BL |
| Sa | 16 | | BL | BL | BL | 20 | | Off | Off | Off | 17 | | BL | BL | BL |
| Su | 17 | | M | M | M | 21 | | Off | Off | Off | 18 | | BL | BL | BL |
| Mo | 18 | 29 | BL | BL | BL | 22 | 34 | W | W | W | 19 | 38 | M | M | M |
| Tu | 19 | | BL | BL | BL | 23 | | W | W | W | 20 | | BL | BL | BL |
| We | 20 | | BL | BL | BL | 24 | | W | W | W | 21 | | BL | BL | BL |
| Th | 21 | | BL | BL | BL | 25 | | W | W | W | 22 | | BL | BL | BL |
| Fr | 22 | | W | W | W | 26 | | W | W | W | 23 | | BL | BL | BL |
| Sa | 23 | | W | W | W | 27 | | W | W | W | 24 | | BL | BL | BL |
| Su | 24 | | W | W | W | 28 | | W | W | W | 25 | | M | M | M |
| Mo | 25 | 30 | Off | Off | Off | 29 | 35 | W | W | W | 26 | 39 | BL | BL | BL |
| Tu | 26 | | Off | Off | Off | 30 | | M | M | W | 27 | | BL | BL | BL |
| We | 27 | | Off | Off | Off | 31 | | M | M | W | 28 | | BL | BL | BL |
| Th | 28 | | Off | Off | Off | | | | | | 29 | | BL | BL | BL |
| Fr | 29 | | Off | Off | Off | | | | | | 30 | | BL | BL | BL |
| Sa | 30 | | Off | Off | Off | | | | | | | | | | |
| Su | 31 | | Off | Off | Off | | | | | | | | | | |
| Mo | | | | | | | | | | | | | | | |
| Tu | | | | | | | | | | | | | | | |
| We | | | | | | | | | | | | | | | |
| Th | | | | | | | | | | | | | | | |

| | October | | | | | November | | | | | December | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Shift | | | | | Shift | | | | | Shift | | |
| Weekday | Day | Week | M | A | N | Day | Week | M | A | N | Day | Week | M | A | N |
| Mo | | | | | | | | | | | | | | | |
| Tu | | | | | | 1 | | BL | BL | BL | | | | | |
| We | | | | | | 2 | | BL | BL | BL | | | | | |
| Th | | | | | | 3 | | BL | BL | BL | 1 | | BL | BL | BL |
| Fr | | | | | | 4 | | BL | BL | BL | 2 | | BL | BL | BL |
| Sa | 1 | | M | M | M | 5 | | BL | BL | BL | 3 | | BL | BL | BL |
| Su | 2 | | M | M | M | 6 | | M | M | M | 4 | | BL | BL | BL |
| Mo | 3 | 40 | W | W | W | 7 | 45 | BL | BL | BL | 5 | 49 | M | M | M |
| Tu | 4 | | W | W | W | 8 | | BL | BL | BL | 6 | | M | M | M |
| We | 5 | | W | W | W | 9 | | BL | BL | BL | 7 | | BL | BL | BL |
| Th | 6 | | W | W | W | 10 | | BL | BL | BL | 8 | | BL | BL | BL |
| Fr | 7 | | W | W | W | 11 | | BL | BL | BL | 9 | | BL | BL | BL |
| Sa | 8 | | W | W | W | 12 | | W | W | W | 10 | | BL | BL | BL |
| Su | 9 | | W | W | W | 13 | | W | W | W | 11 | | BL | BL | BL |
| Mo | 10 | 41 | M | M | M | 14 | 46 | PSS | W | W | 12 | 50 | M | M | M |
| Tu | 11 | | M | M | M | 15 | | PSS | W | W | 13 | | BL | BL | BL |
| We | 12 | | BL | BL | BL | 16 | | W | W | W | 14 | | BL | BL | BL |
| Th | 13 | | BL | BL | BL | 17 | | W | W | W | 15 | | BL | BL | BL |
| Fr | 14 | | BL | BL | BL | 18 | | W | W | W | 16 | | BL | BL | BL |
| Sa | 15 | | BL | BL | BL | 19 | | W | W | W | 17 | | BL | BL | BL |
| Su | 16 | | BL | BL | BL | 20 | | W | W | W | 18 | | M | M | M |
| Mo | 17 | 42 | M | M | M | 21 | 47 | M | M | M | 19 | 51 | BL | BL | BL |
| Tu | 18 | | BL | BL | BL | 22 | | M | M | M | 20 | | BL | BL | BL |
| We | 19 | | BL | BL | BL | 23 | | BL | BL | BL | 21 | | BL | BL | BL |
| Th | 20 | | BL | BL | BL | 24 | | BL | BL | BL | 22 | | BL | BL | BL |
| Fr | 21 | | BL | BL | BL | 25 | | BL | BL | BL | 23 | | W | W | W |
| Sa | 22 | | W | W | W | 26 | | BL | BL | BL | 24 | | W | W | W |
| Su | 23 | | W | W | W | 27 | | BL | BL | BL | 25 | | W | W | W |
| Mo | 24 | 43 | M | M | M | 28 | 48 | M | M | M | 26 | 52 | W | W | W |
| Tu | 25 | | BL | BL | BL | 29 | | BL | BL | BL | 27 | | W | W | W |
| We | 26 | | BL | BL | BL | 30 | | BL | BL | BL | 28 | | W | W | W |
| Th | 27 | | BL | BL | BL | | | | | | 29 | | W | W | W |
| Fr | 28 | | BL | BL | BL | | | | | | 30 | | W | W | W |
| Sa | 29 | | BL | BL | BL | | | | | | 31 | | W | W | W |
| Su | 30 | | BL | BL | BL | | | | | | | | | | |
| Mo | 31 | 44 | M | M | M | | | | | | | | | | |
| Tu | | | | | | | | | | | | | | | |
| We | | | | | | | | | | | | | | | |
| Th | | | | | | | | | | | | | | | |

Beam for Users | Accelerator Development and Maintenance

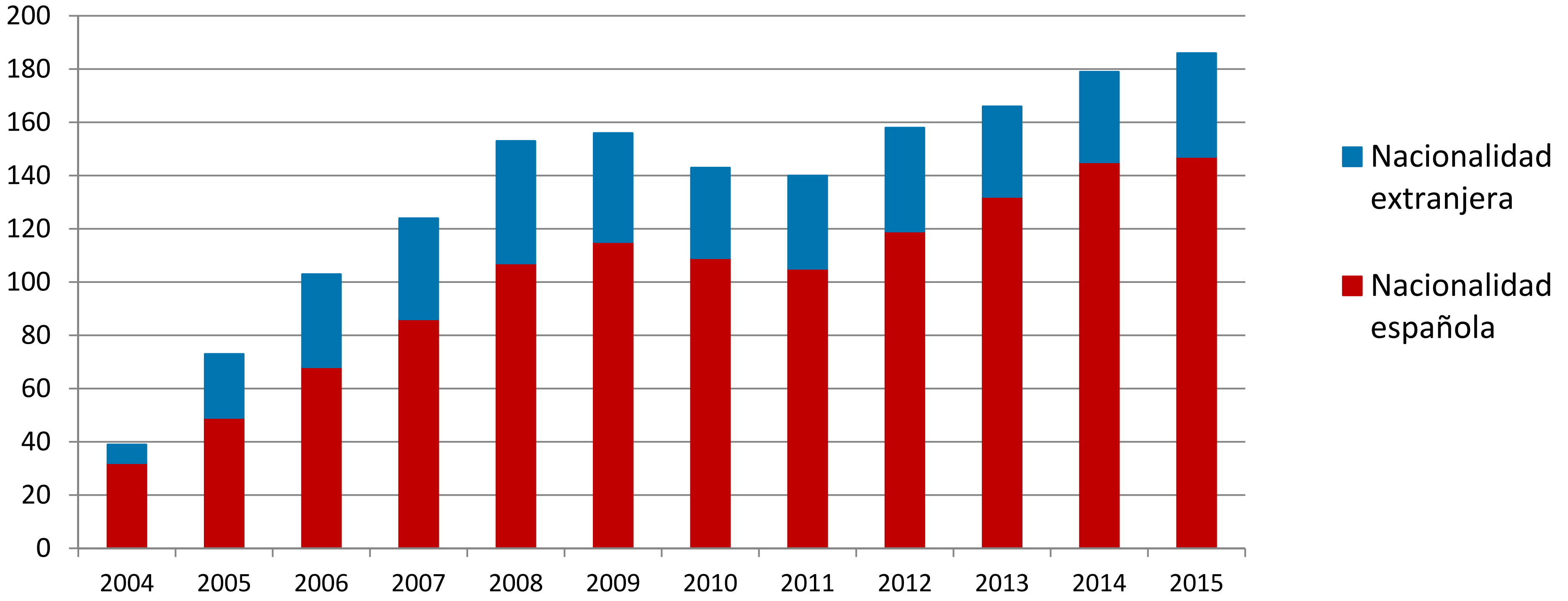
Shutdown Systems off | Shutdown - Basic systems on

# Staff

TODAY

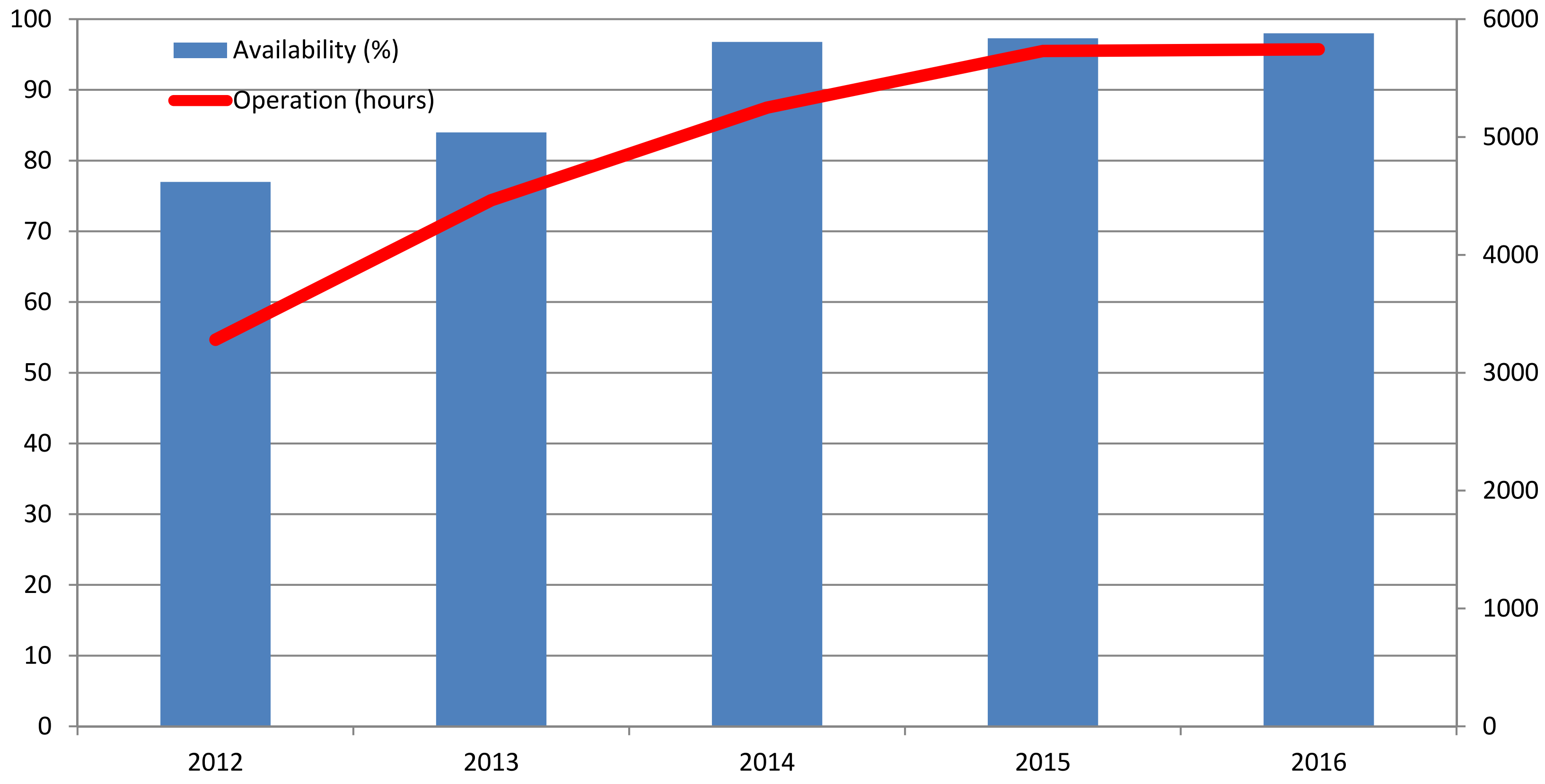
- International representation 20%
- Women percentage 25%
- 187 people + Students

*Maintaining the CELLS structure defined in 2004*



# Availability
# & operation hours

(%) 77.0 84.0 96.8 97.3 98.1*




* Until 08-03-16

# Beam for users

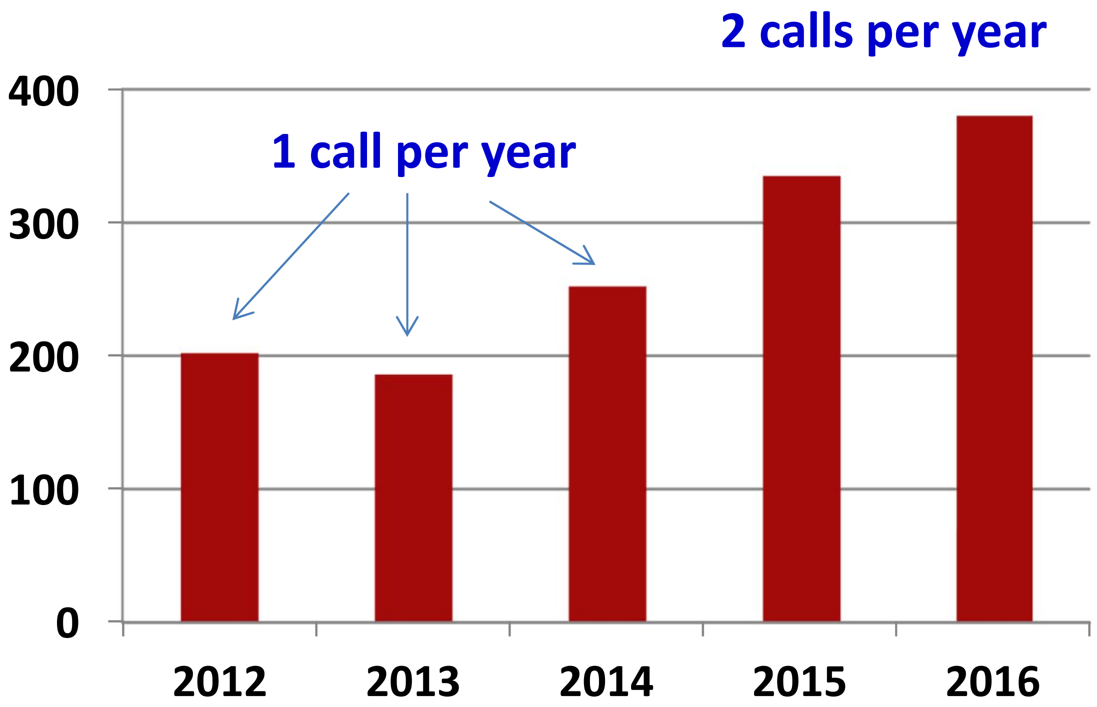
| | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| Accelerator operation [h] | 3280 | 4464 | 5250 | 5730 | 5744 |
| Scheduled user beam [h] | 2387 | 3540 | 3888 | 4320 | 4368 |
| Availability [%] | 77.0 | 83.8 | 96.8 | 97.3 | 98.1* |
| MTBF [h] | 21.0 | 25.0 | 33.7 | 51.4 | 50* |
| MTTR [h] | 1.0 | 0.8 | 1.1 | 1.4 | 0.9* |

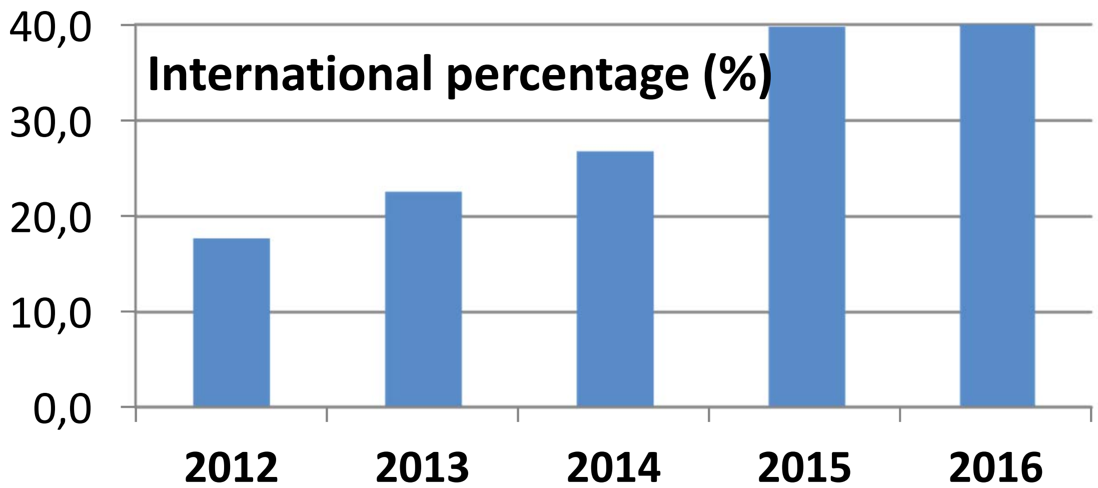
Beam for BLs: scheduled user beam, including injection time
MTBF: Mean time between failures
MTTR: Mean time to have the beam back
* Until 08-03-16

**For comparison (18 operating years, 41 BLs and about 700 staff)**

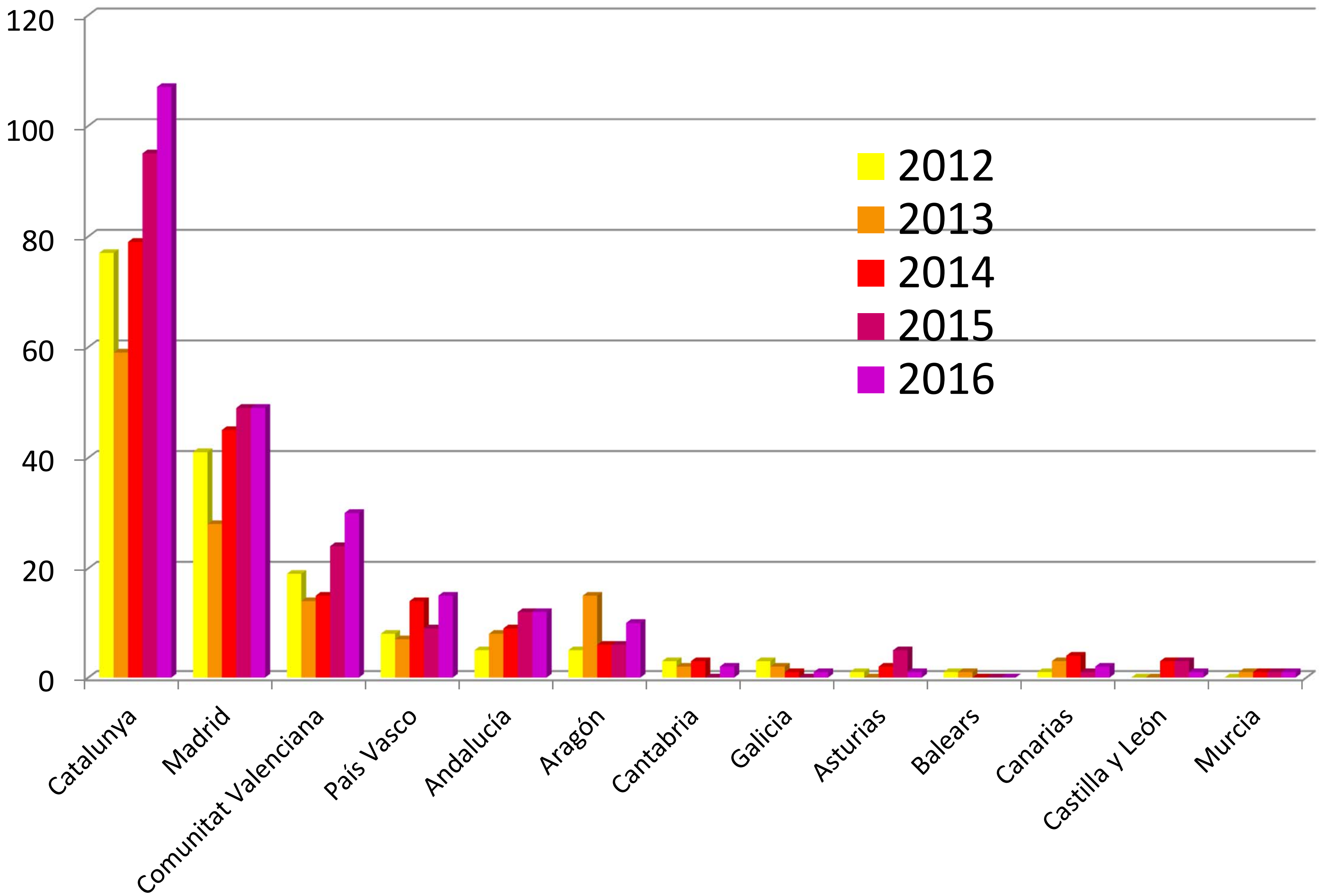
| ESRF | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|
| Availability (%) | 98.9 | 98.6 | 98.9 | 99.1 | 98.1 |
| MTBF (h) | 108 | 60 | 80 | 106 | 76 |
| MTTR(h) | 1.2 | 0.9 | 0.9 | 0.9 | 1.4 |

# User calls

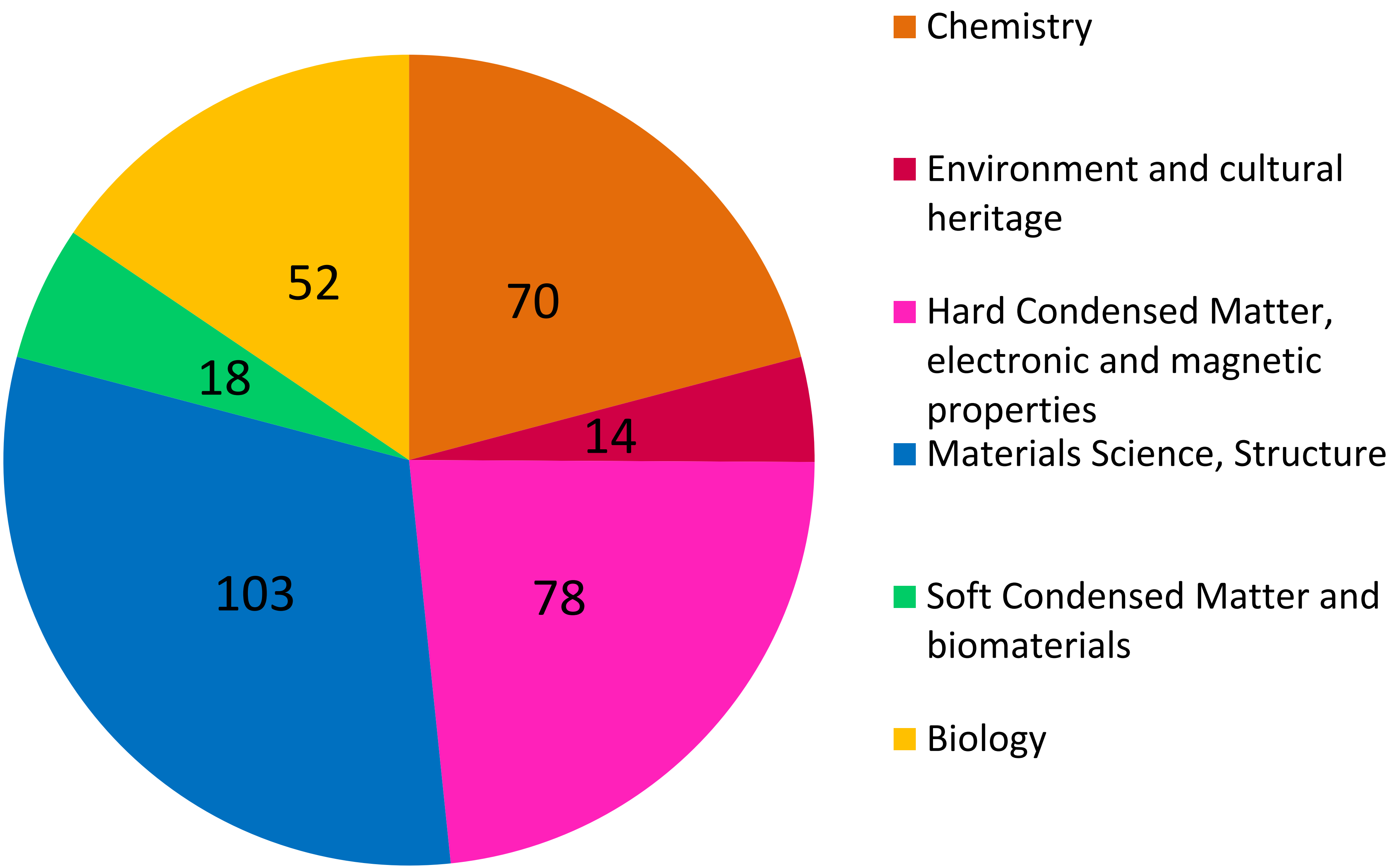

2 calls per year
1 call per year
400
300
200
100
0
2012
2013
2014
2015
2016


40,0
30,0
20,0
10,0
0,0
International percentage (%)
2012
2013
2014
2015
2016

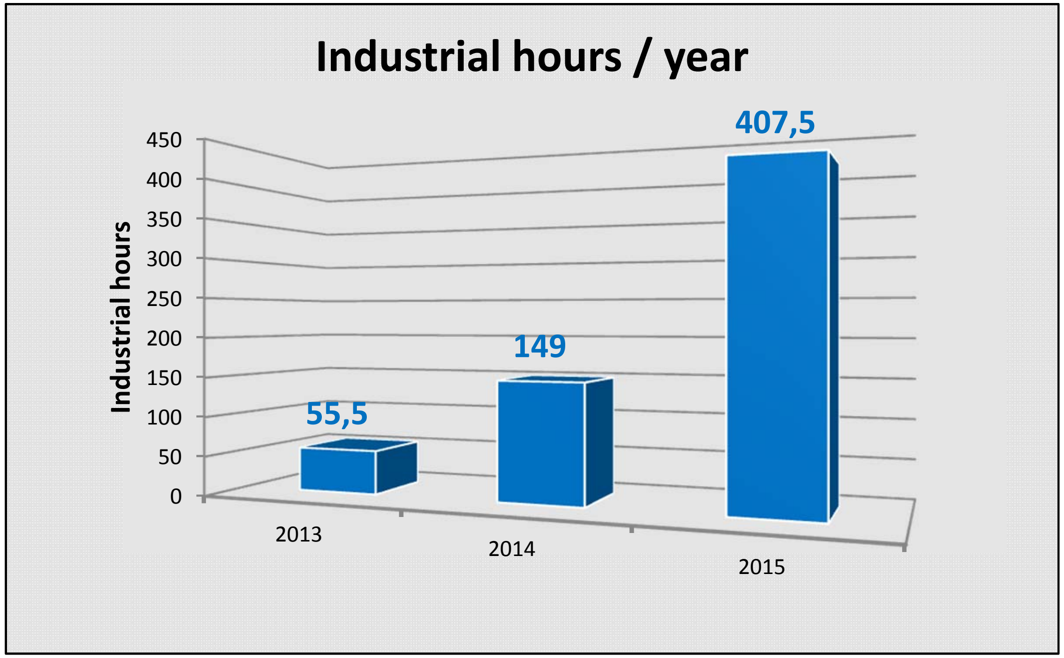
# CCAA Submitted Spanish Proposals

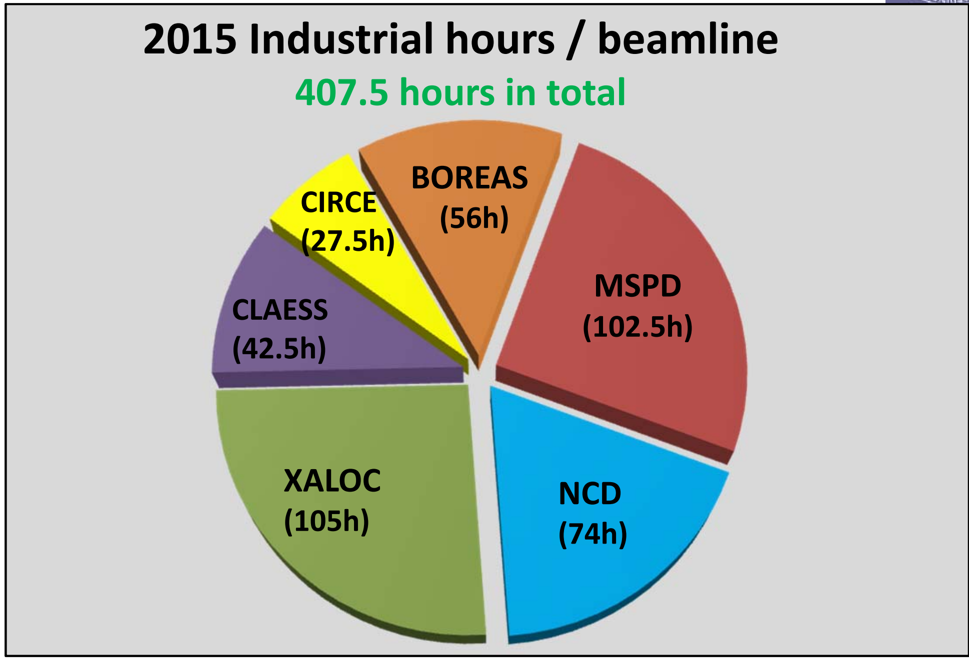


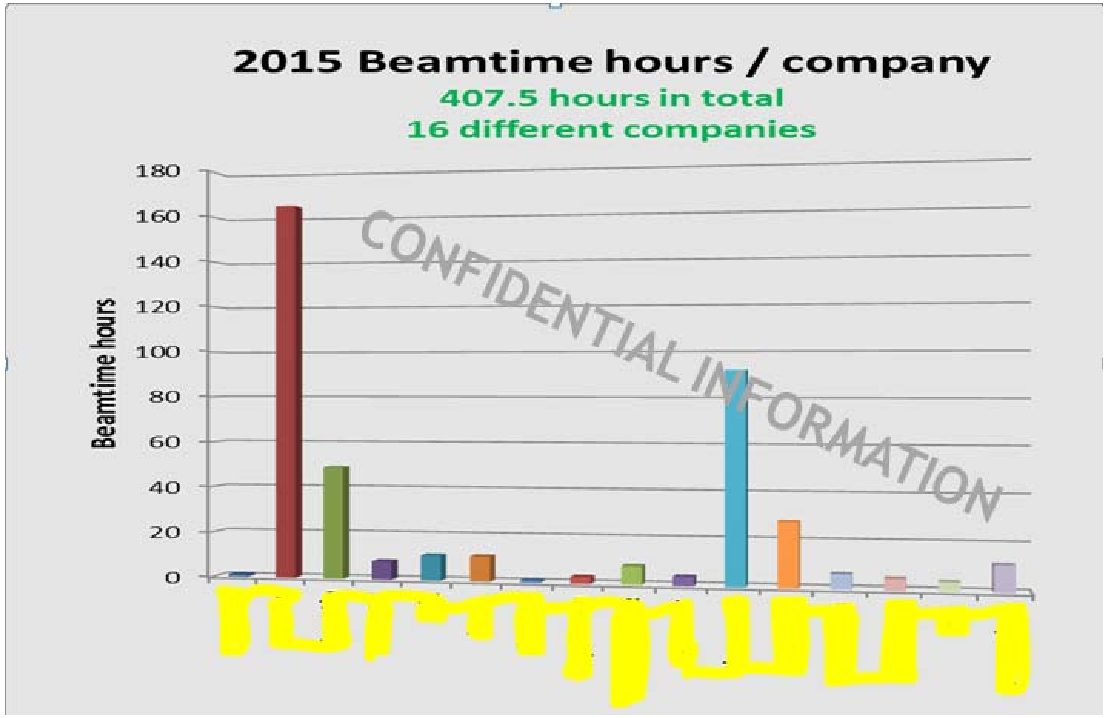
# Research Areas (2015)



# INDUSTRIAL BEAMTIME AND BEAMLINES



Aplicaciones del sincrotrón ALBA en la Industria Química y de Materiales

# Workshop on SL applications in Chemistry and Material Science 15 April 2014

Illustrate ALBA industrial applications in Chemistry and Materials Sciences, how beamlines can be used to **solve complex structures of cement, pigment or food components**, how SL can help to promote cleaner energy (through catalytic processes to control vehicle emissions or developing n... cells), the role that SL can play to imp... **...netics and other healthcare products** s... ...ampoo, soap, etc.

**About 50 participants per workshop**

# Aplicaciones del Sincrotrón ALBA en la industria farmacéutica

...6 ...015

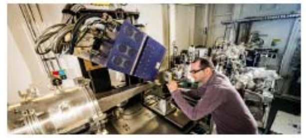
**Sincrotrón ALBA**
Ctra. BP 1413, km. 3,3
Cerdanyola del Vallès

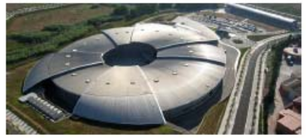
...bjetivo de la reunión es **mostrar ... las empresas farmacéuticas las aplicaciones de la luz sincrotrón.**

Durante la reunión, se abordarán algunas de las técnicas disponibles en ALBA: desde la **difracción de polvo, absorción, SAXS, WAXS, cristalografía de macromoléculas y microscopía de rayos X.**

Se incluye la **caracterización de los principios activos y la biología estructural para el diseño de fármacos**, entre otros.

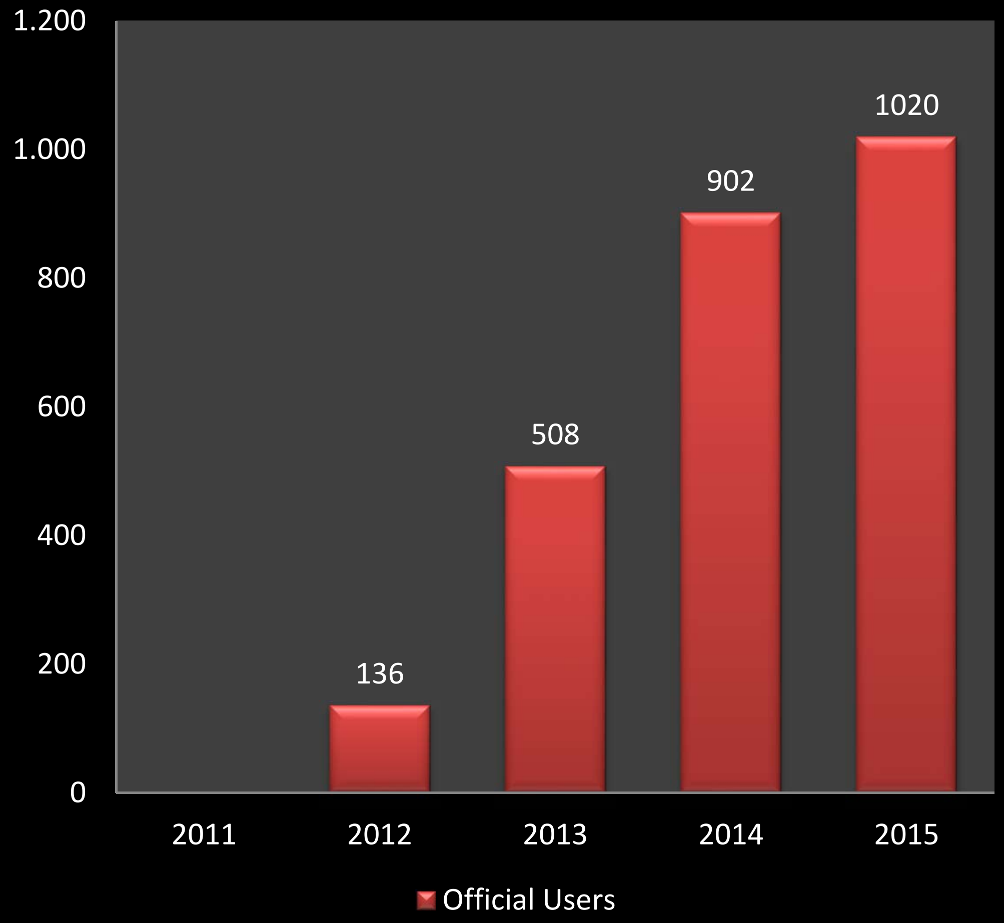
El evento está programado en diferentes sesiones incluyendo **charlas de empresas clientes, sesión de pósters y visita a las instalaciones** con el fin de promover el intercambio y discusiones con el público asistente.

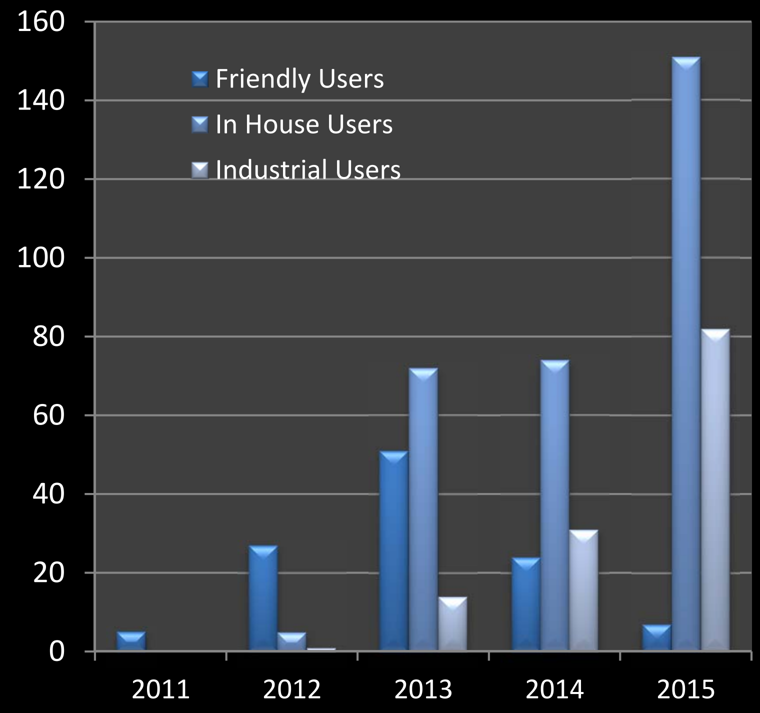




**Entrada GRATUITA**
**Es necesario registrarse antes del 4 de Mayo de 2015**
https://indico.cells.es/indico/event/28

# Users in ALBA
(3110 @ 31-Dec-15)

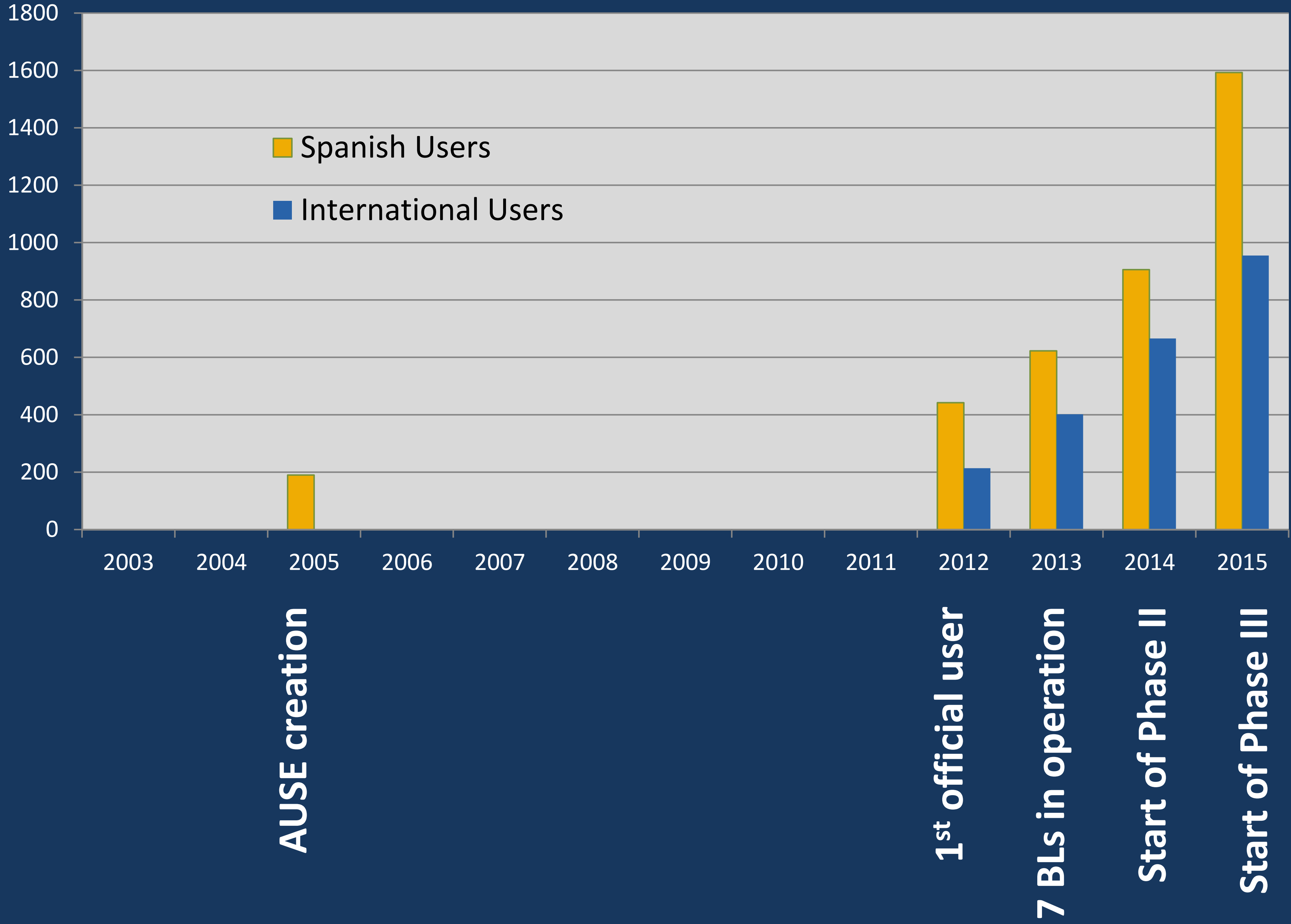



6th cycle started on February 4th , will run until end of June

7th user call for experiments to be granted in 2nd 2016 semester is open

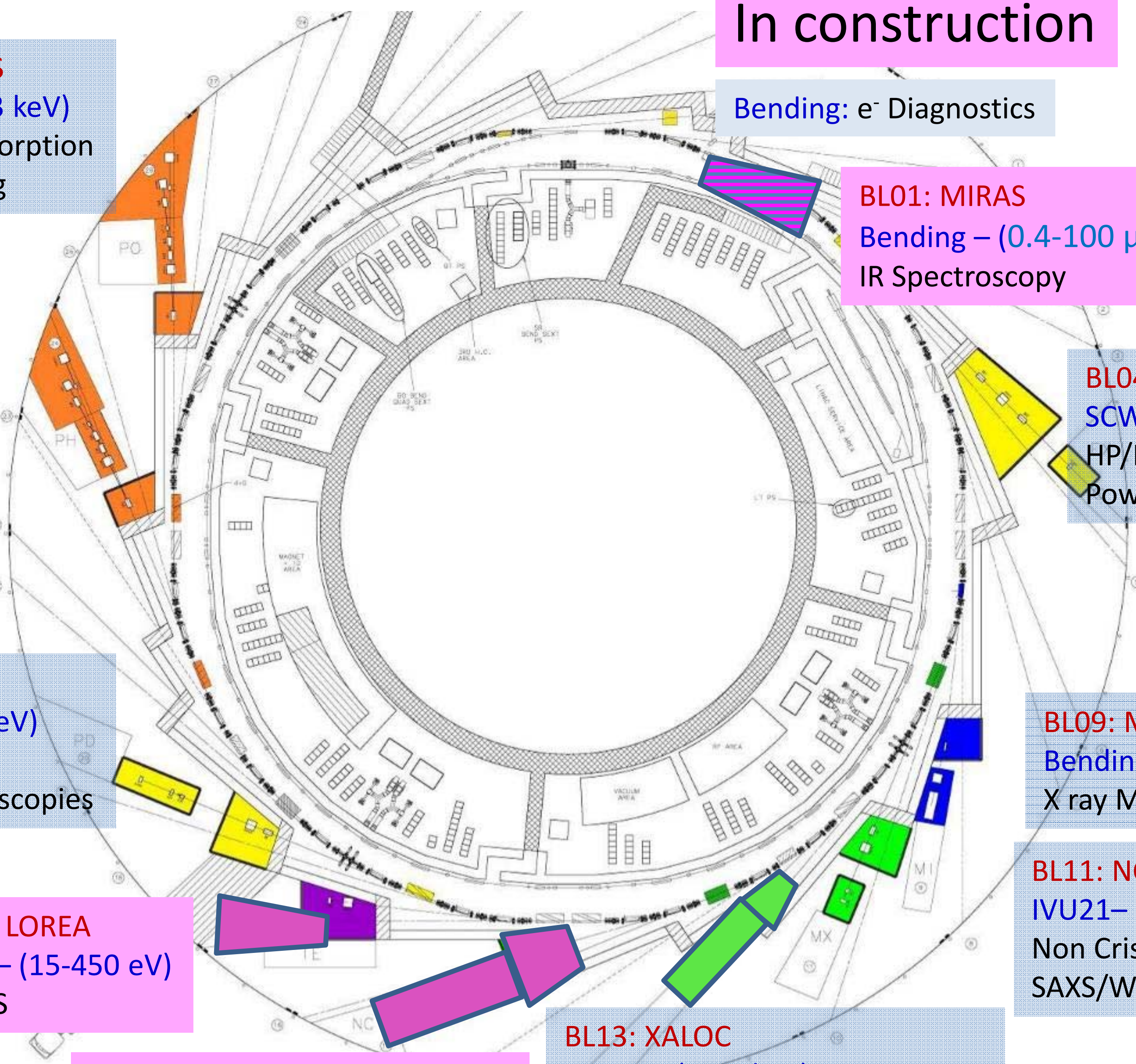
# SL User community in Spain and ALBA scientific production



# Beamlines

In operation

In construction



Bending: e⁻ Diagnostics

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

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

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

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

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

BLXX: uFOCUS PX
Macromolecular Cristallography

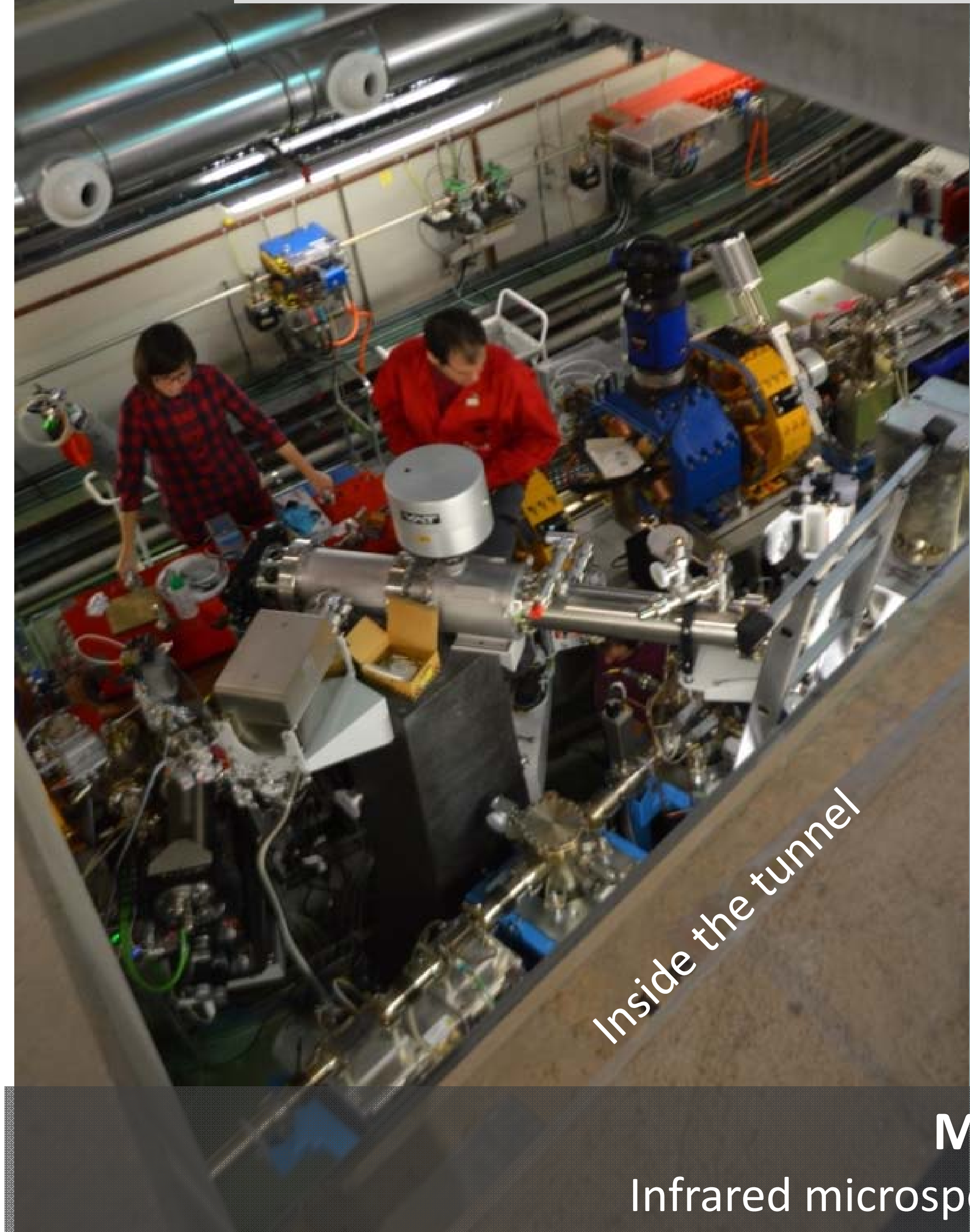
BL20: LOREA
EUXX– (15-450 eV)
ARPES

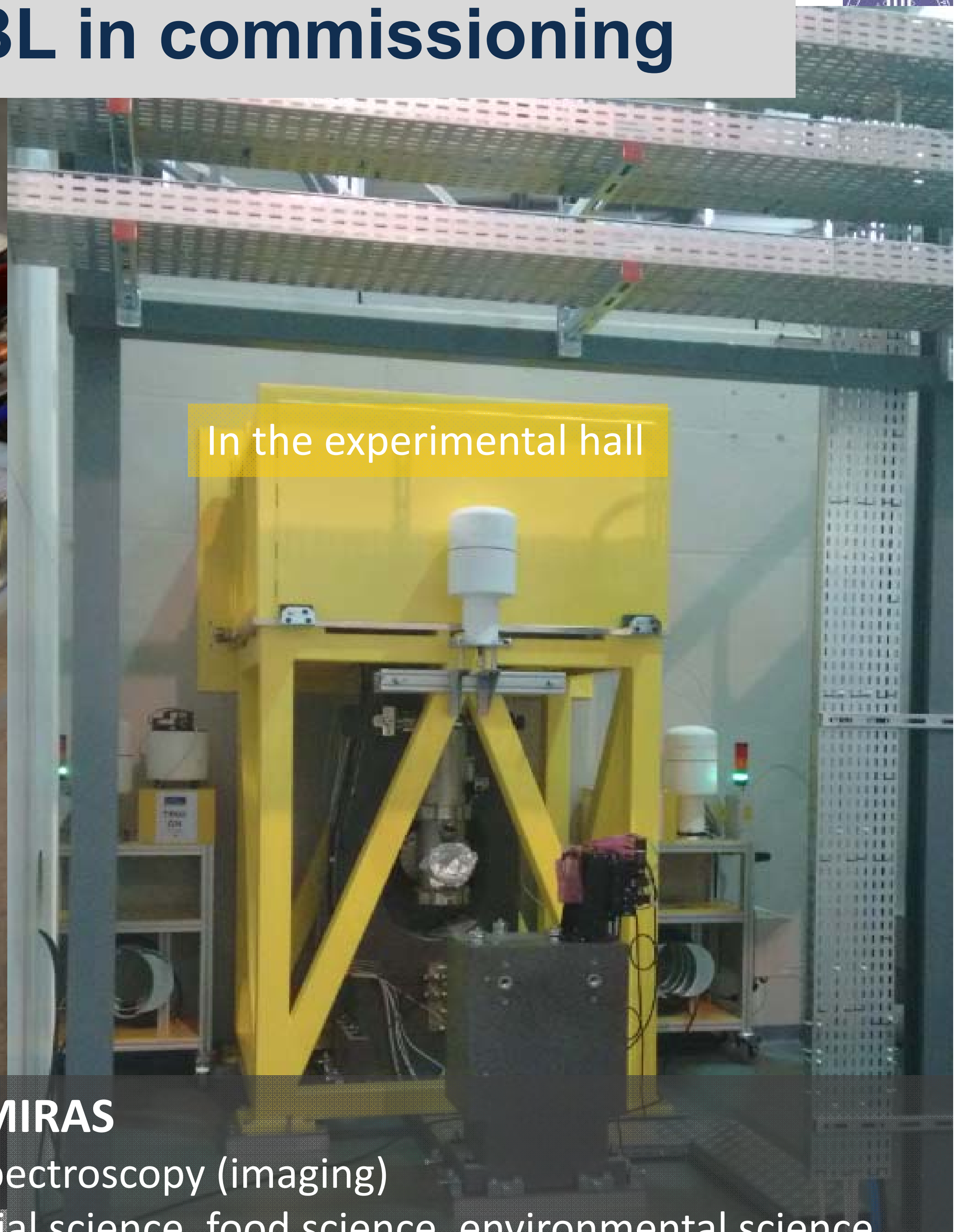
BL22: CLÆSS
MPW80– (2-63 keV)
Absorption &
Emission Spectroscopies

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

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

# MIRAS: the 8th BL in commissioning



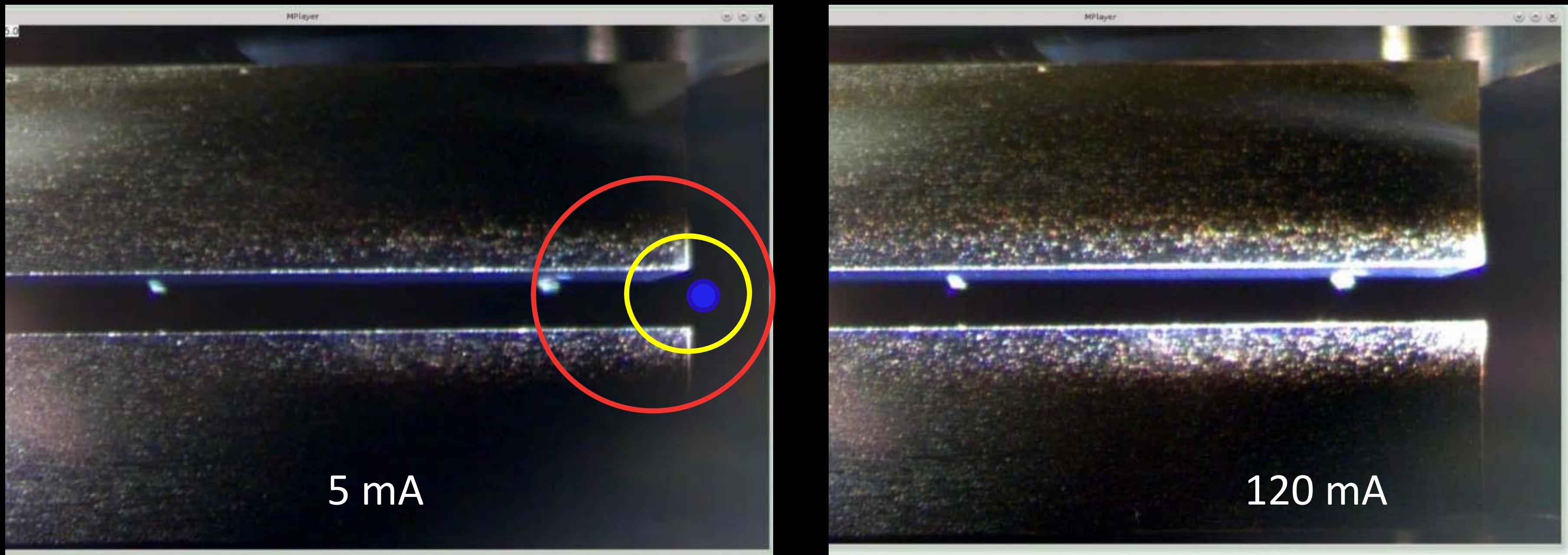

**MIRAS**

Infrared microspectroscopy (imaging)

Fields: bioscience, cultural heritage, material science, food science, environmental science

# Successful test of first SR light on the MIRAS M1 mirror inside the vacuum chamber (31-1-16)

- The mirror was inserted and aligned using a very low current of electrons
- Then the e- current was slowly increased up to 120 mA, checking temperatures and vacuum pressure

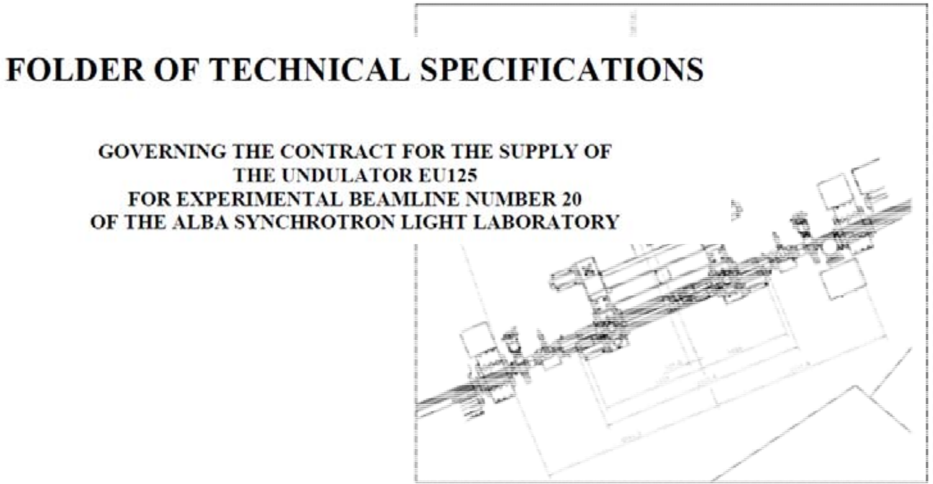


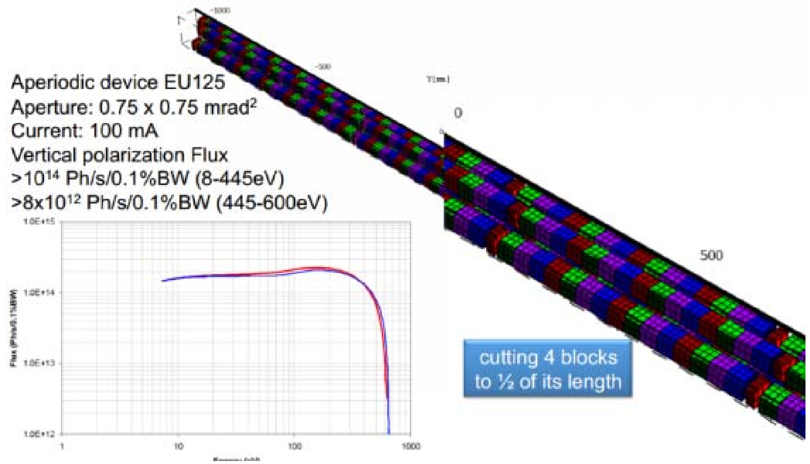

Infrared
Visible
High energy photons

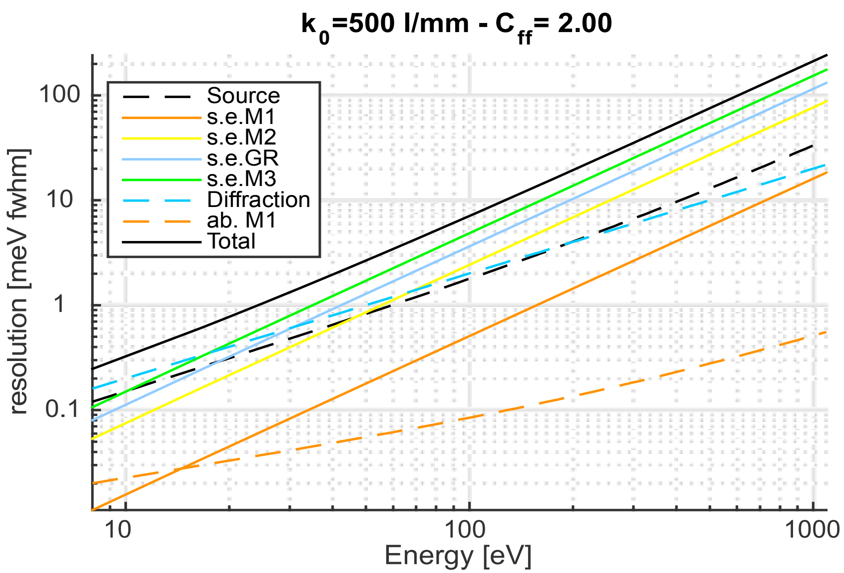
# LOREA: the 9th BL in advanced state of design

Angle-resolved Photoemission Spectroscopy

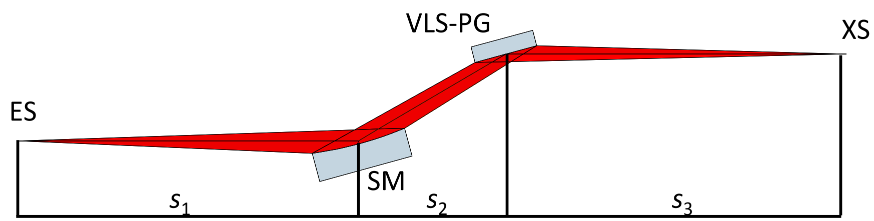
Fields: solid state physics, electron correlated materials, graphene…



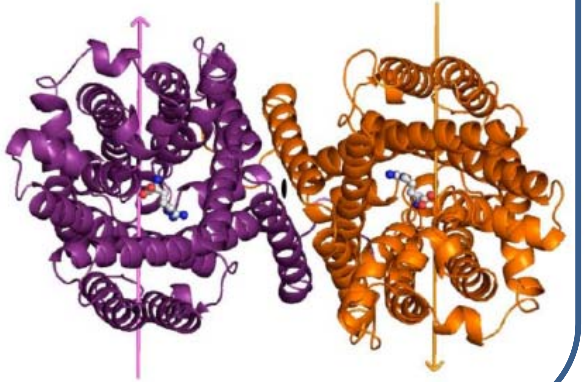




*Resolution of the cPGM in the range 10-1000eV*

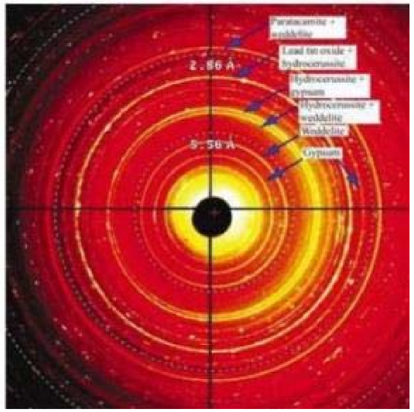


# Phase III: Six projects evaluated by SAC – Dec 2014

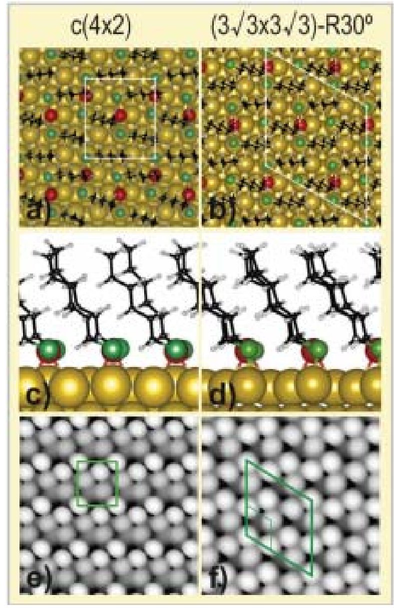
Microcrystals,
Proteins at microfocus PX



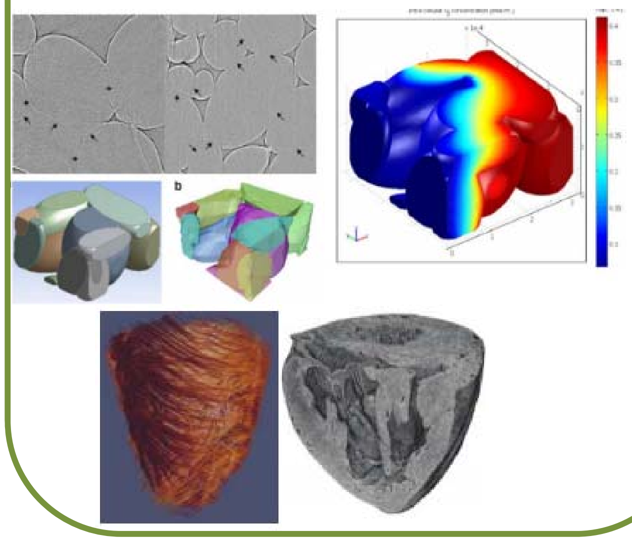
Nano technology, earth and environmental sciences, cultural heritage and bio-medicine at submicron diffraction, flourescence and absorption



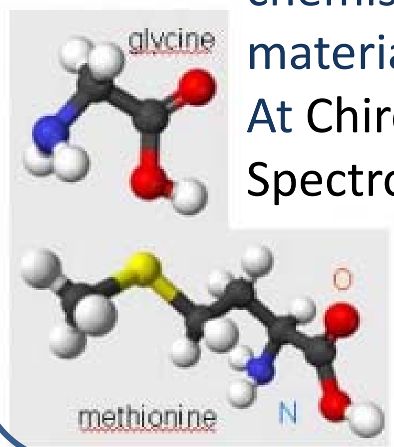
Nanostructures, surface-interface, catalysis at surface-interface diffraction



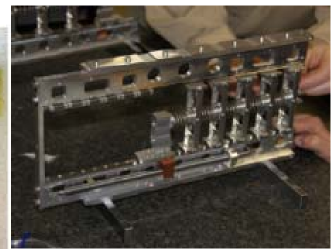

Food science, geology, material science, Life science, medicine, paleontology at Fast Tomography



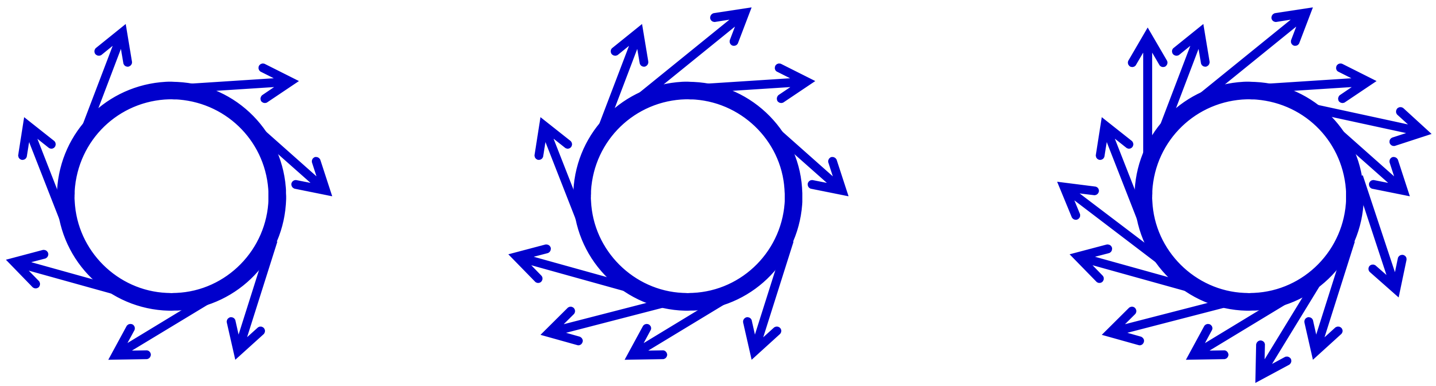
Bioscience, chemistry, materials
At Chiroptical Spectroscopy




Detector and instrument developments at Notos



# 2016: ALBA es un laboratorio nacional



Day-One
2012
7 Beamlines

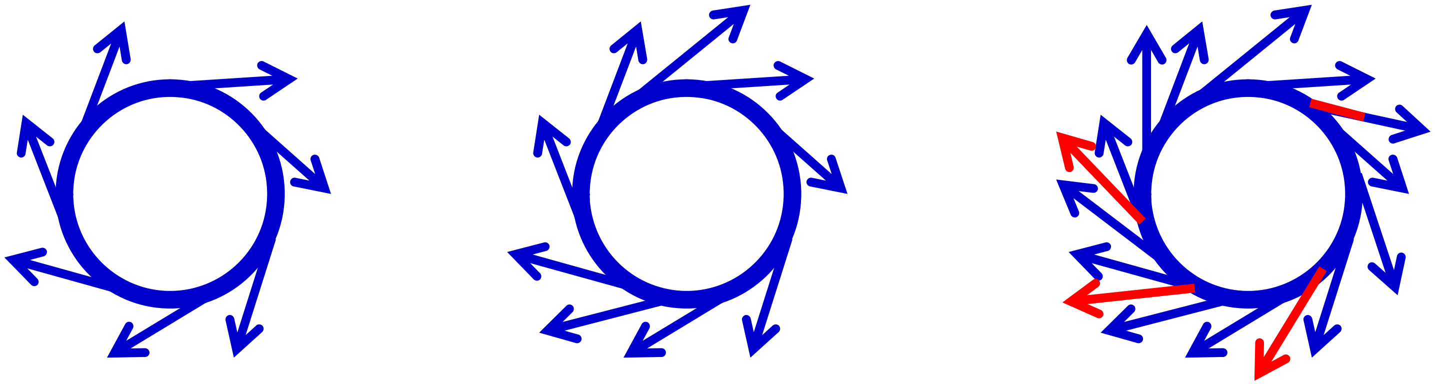
Phase II
2014-2018
7+2 Beamlines

Phase III
2015-2020
7+2+5 Beamlines
(one in construction)

ICTS (Instalacion Cientifico-Tecnologica Singular), financiada por MINECO (50%) y GenCat (50%)

Centro de excelencia cientifica, servicio a usuarios, desarrollo tecnologico, colaboracion con instituciones nacionales e internacionales, centro de formacion para estudiantes (FP, grado, PhD) y empleo joven

# En el futuro: Laboratorio nacional con participacion Internacional y/o Privada a traves de PBLs (Partners BeamLines) o Asociacion



| Day-One | Phase II | Phase III |
| --- | --- | --- |
| 2012 | 2014-2018 | 2015-2020 |
| 7 Beamlines | 7+2 Beamlines | 7+2+5 Beamlines |
| | | In the future |

*Up to a total number of 15 beam-ports are still available*

# Más de 2000 visitantes en el último Open Day

# Próximo Open Day : 18 Junio 2016

*(Controlar en [www.cells.es](http://www.cells.es) cuando registrarse)*

Left, view of the experimental hall with the Accelerators exhibition area. Next, one moment during the music performance and a girl completing the treasure hunt.
@Pepo Segura - Sincrotrón ALBA


Diploma photo at the Kids area. Next, a volunteer explains the difference between the magnets used in ALBA. @Pepo Segura - Sincrotrón ALBA


Gracias por
vuestra atención