Accelerator R&D at ALBA

Francis Perez

- ALBA
  - Accelerators
  - Beamlines
  - Operation
- R&D on Accelerators
  - FCC – CERN
  - CLIC – CERN
  - ELI-NP – INFN
  - RF lab
  - Magnetic lab
  - Vacuum lab

ALBA Synchrotron Light Source

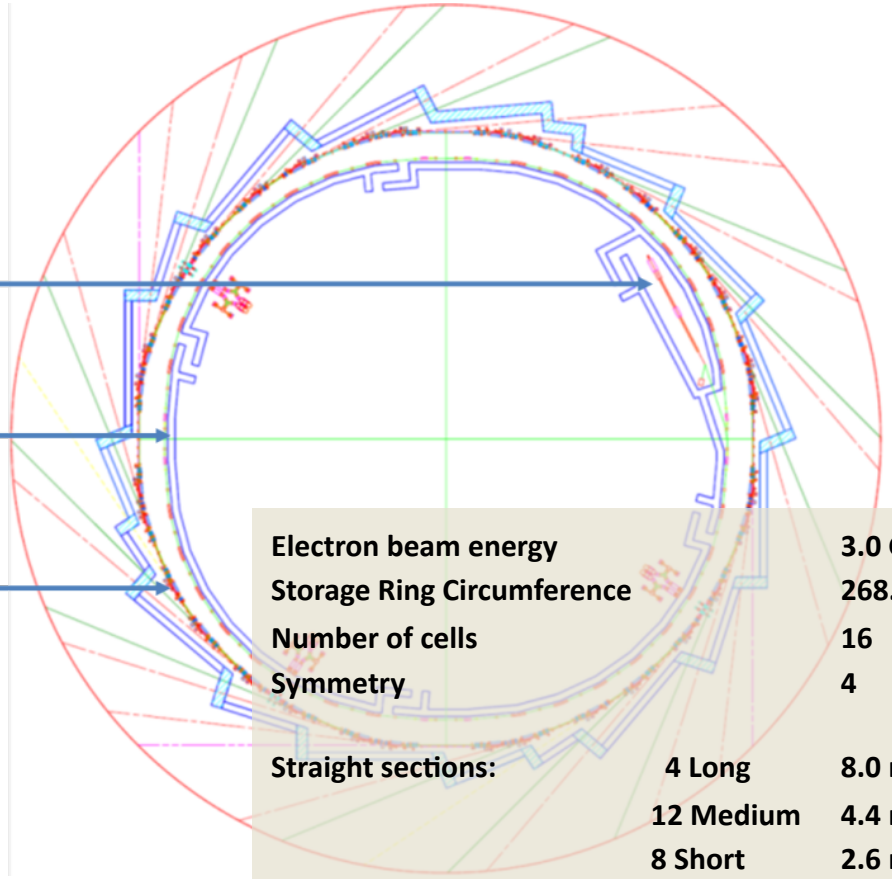
- ✓ 3 GeV electron accelerator
- ✓ 7 running beam lines + 1 in commissioning + 2 in construction
- ✓ Funding is 50% Spanish – 50% Catalan Governments
- ✓ First beam for users May 2012

ALBA Accelerators

LINAC
100 MeV

BOOSTER
100 MeV – 3 GeV

STORAGE RING
3 GeV



Electron beam energy		**3.0 GeV**	
Storage Ring Circumference		**268.8 m**	
Number of cells		**16**	
Symmetry		**4**	
Straight sections:	**4 Long**	**8.0 m**	**for 3 ID & Injection**
	12 Medium	**4.4 m**	**for 12 ID**
	8 Short	**2.6 m**	**for 2 ID & RF & Diagn**
Beam current	**250 mA**		
Emittance	**4.3 nm.rad**		
Lifetime	**> 10 h**		

ALBA Synchrotron Light Source

Approved in 2003

First users in 2012

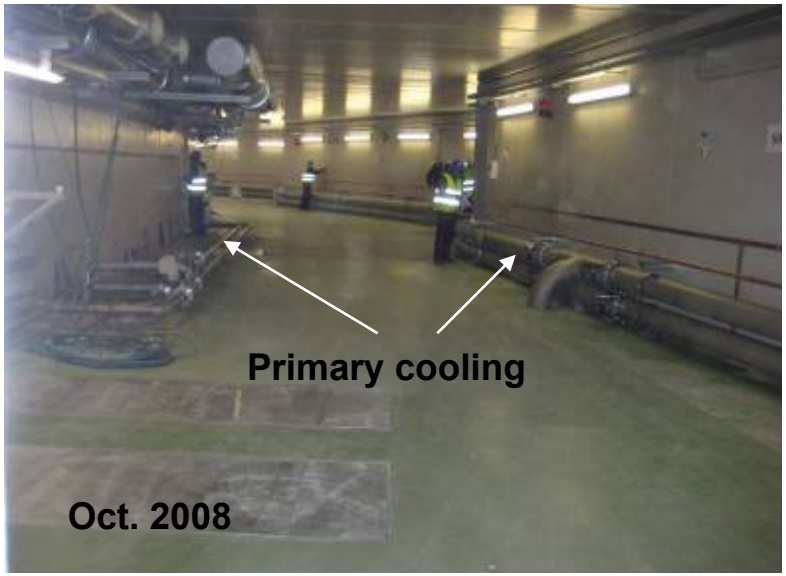
June 2006

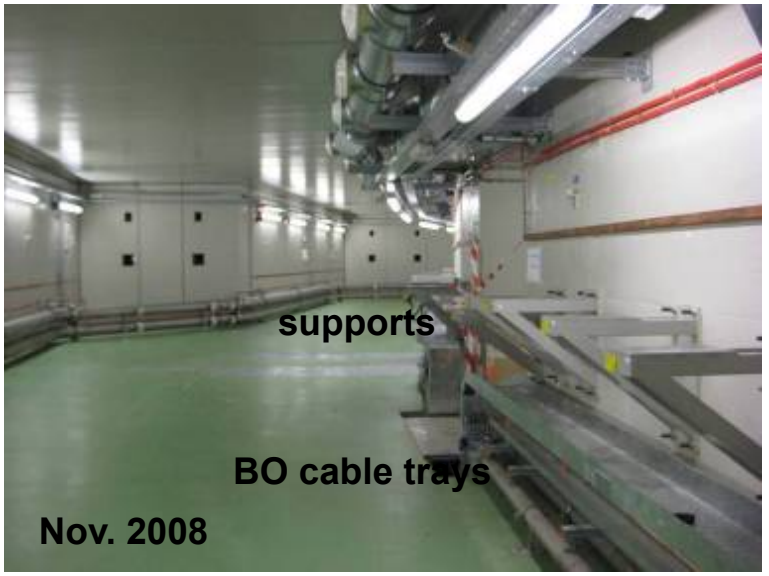
2007

2008


20-01-08


23-07-08


Primary cooling
Oct. 2008


supports
BO cable trays
Nov. 2008

2009

2010

2011

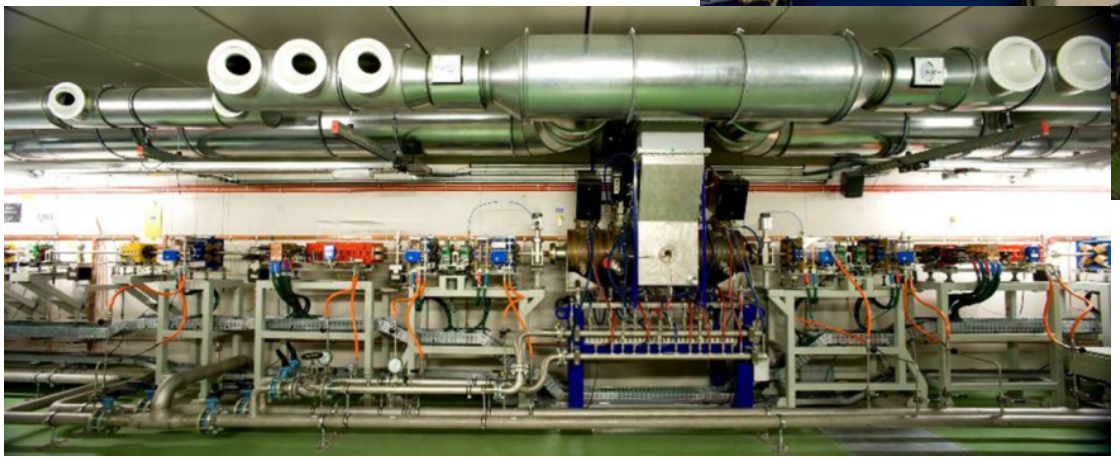
2011

Linac

Accelerate electrons from rest to 100 MeV

RF cavities 3 GHz

Repetition rate of 3 Hz



Booster

Accelerate e- from 100 MeV to 3 GeV

1 x RF cavity at 500 MHz

Repetition rate of 3 Hz

Storage Ring

Keep electrons at 3.0 GeV

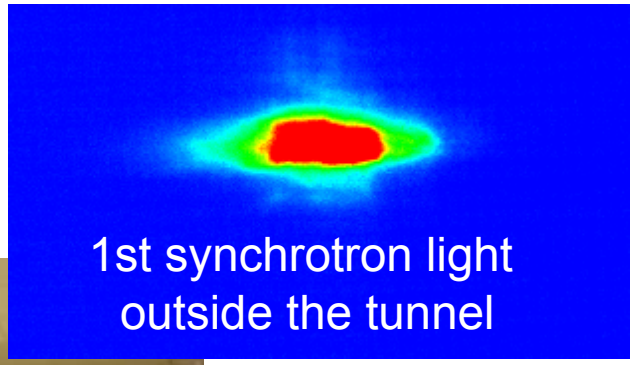
Magnets and correctors to keep the orbit (sub-μm)

Vacuum Pumps (10^{-10} mbar)

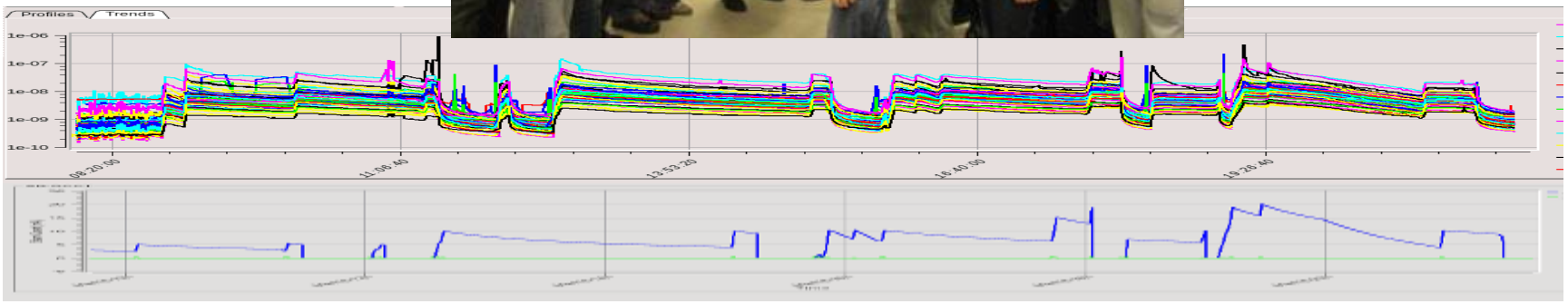
6 x RF cavities at 500 MHz

Circulating current: 250 mA

16th March 2011



1st synchrotron light outside the tunnel



7th May 2012: First official users

you are here: home → news & events → all news → the first users have started their experiments at alba

navigation

- All events
- All news
  - The first users have started their experiments at ALBA

The first users have started their experiments at ALBA

Created by Anne-Cécile KLORA — last modified May 17, 2012 12:52 PM

BOREAS is the first of ALBA 7 beamlines to be available to users.

The standard proposal 'Ferrite magnetic nanoparticles and hybrid superconducting layers: a XMCD spectroscopic study', granted with 18 shifts, started running experiments at ALBA on May 7th, 2012.

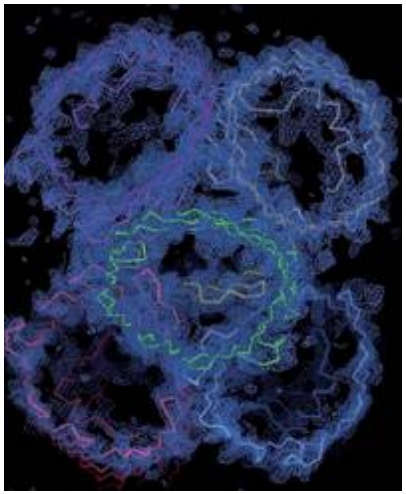
The aim of the experiment is to clarify and characterize the atomic origin of the magnetism in different ferrite nanoparticles, both in assynthetized form as well as embedded in high temperature superconductor (HTS) thin films.

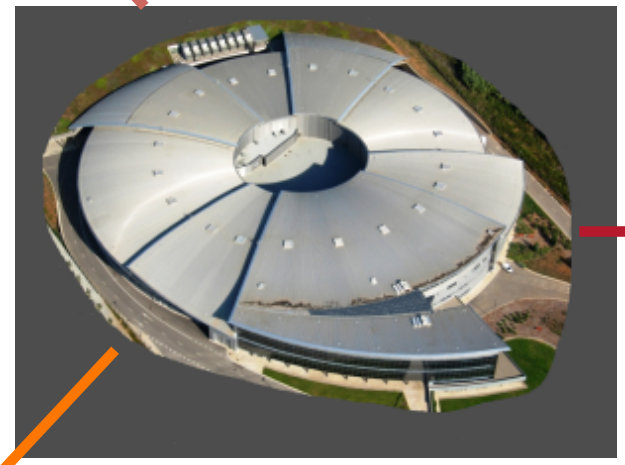
Alba would like to thank all participants in this call for proposals for their interest in our Facility and the high level of scientific proposals, as acknowledged by the Scientific Panel.

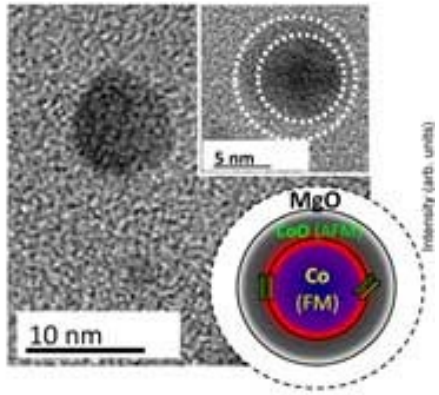
ALBA acting Director, the User Office team, the BOREAS beamline team and the first external users from Unidad de Química Inorgánica- Departamento de Química- UAB, Barcelona.

Scientific areas in ALBA

LIFE SCIENCE

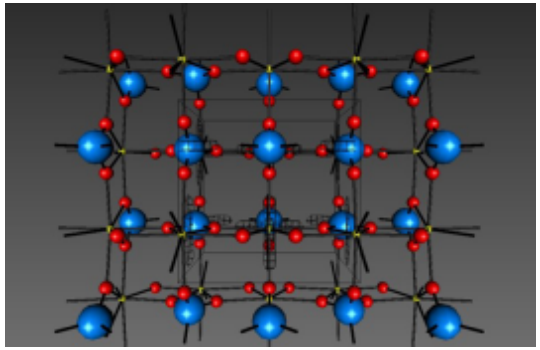






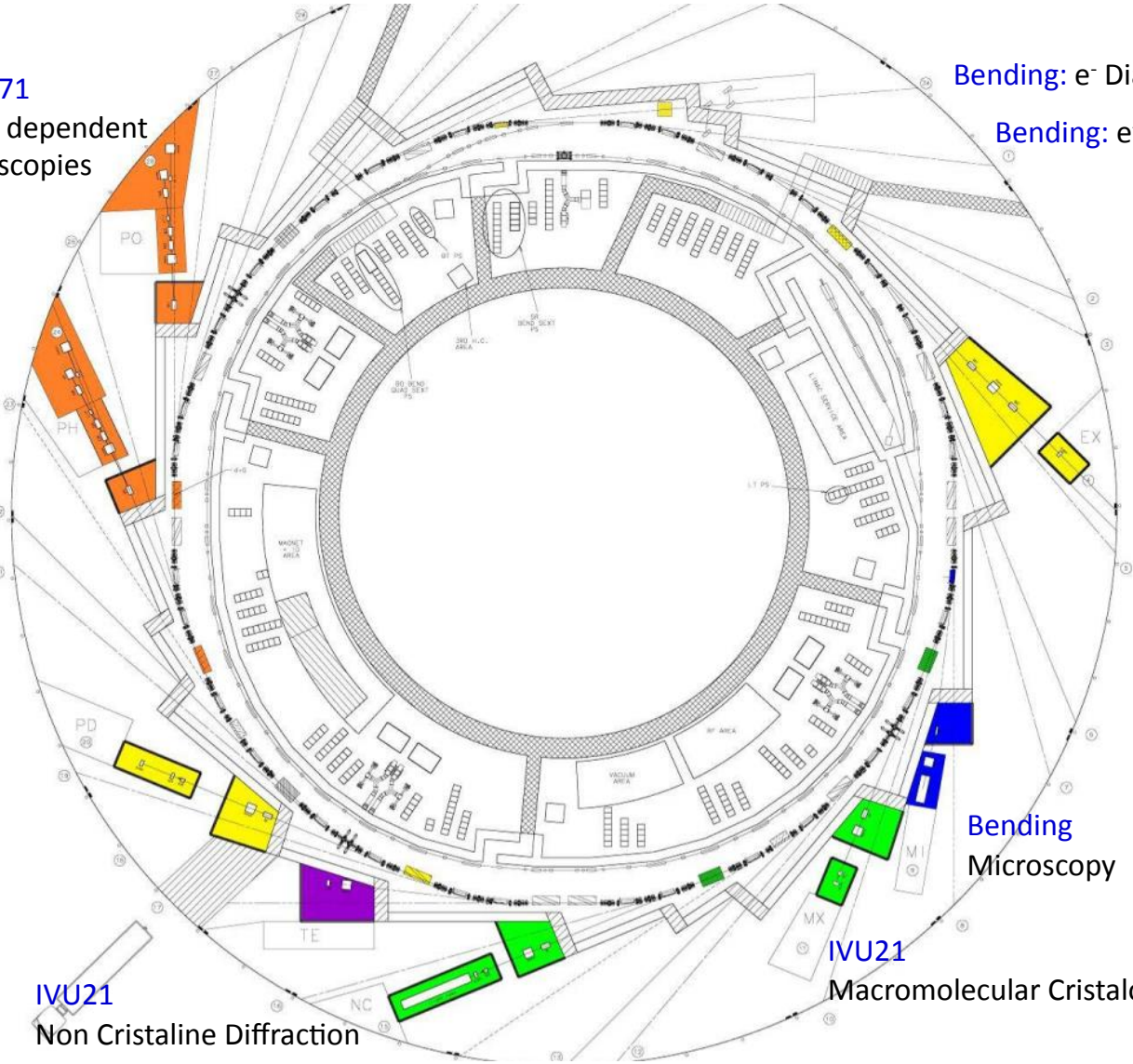
CONDENSED MATTER

CHEMISTRY



photon energy:
from UV up to hard
X-ray of tens of keV

ALBA BEAMLINES



EU71
Polarization dependent spectroscopies

EU62
Photoemission spectroscopies

W65
XAS

IVU21
Non Cristaline Diffraction

Bending: e^- Diagnostics

Bending: e^- Diagnostics

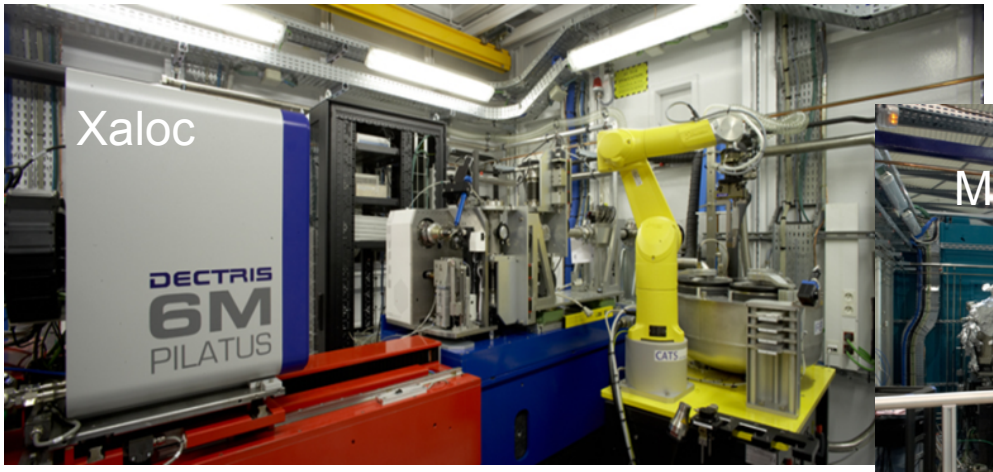
SCW30
EXAFS

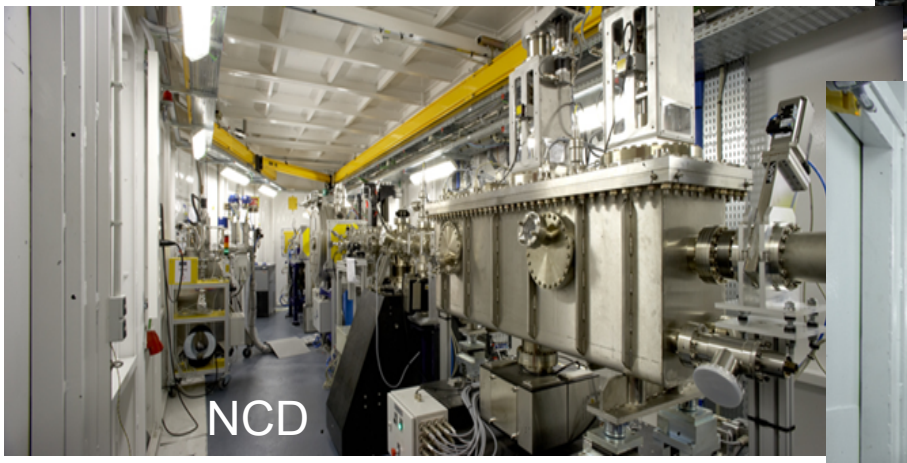
Bending
Microscopy

IVU21
Macromolecular Cristalography

ALBA BEAMLINES

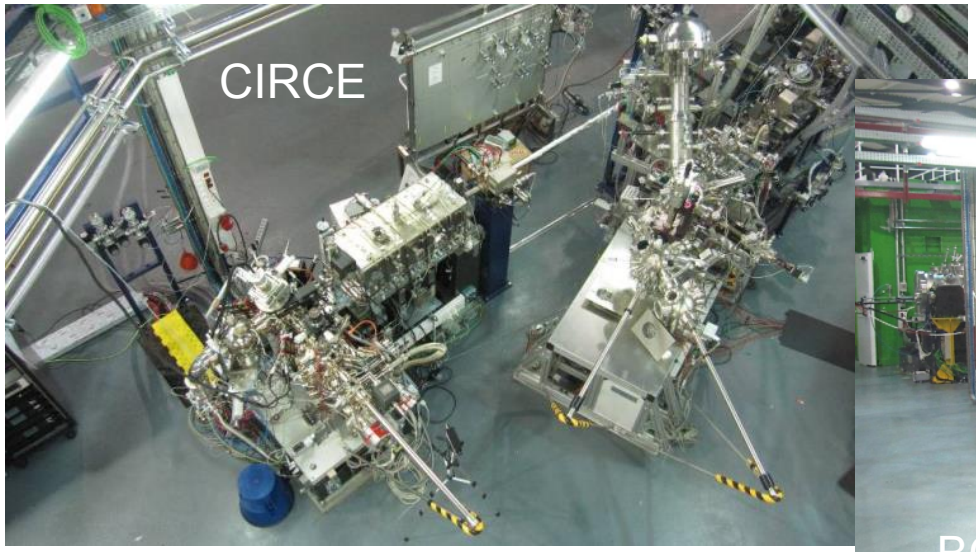
Some pictures

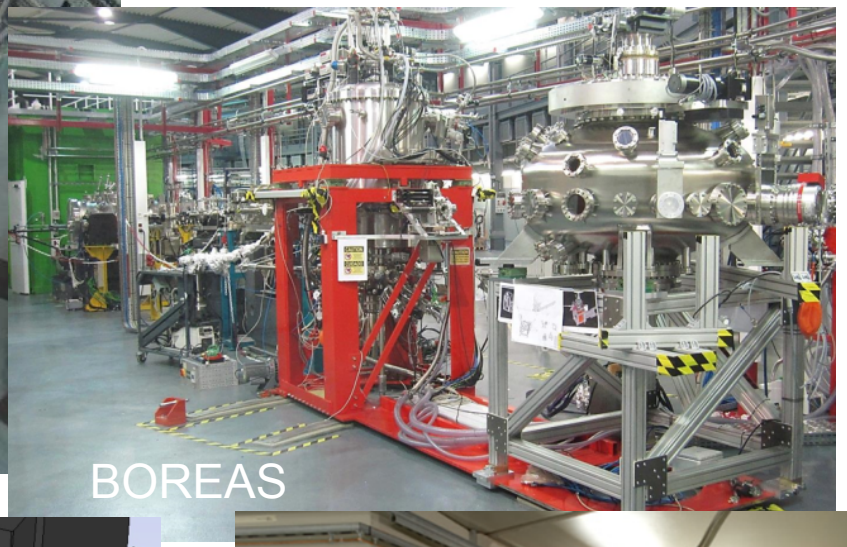


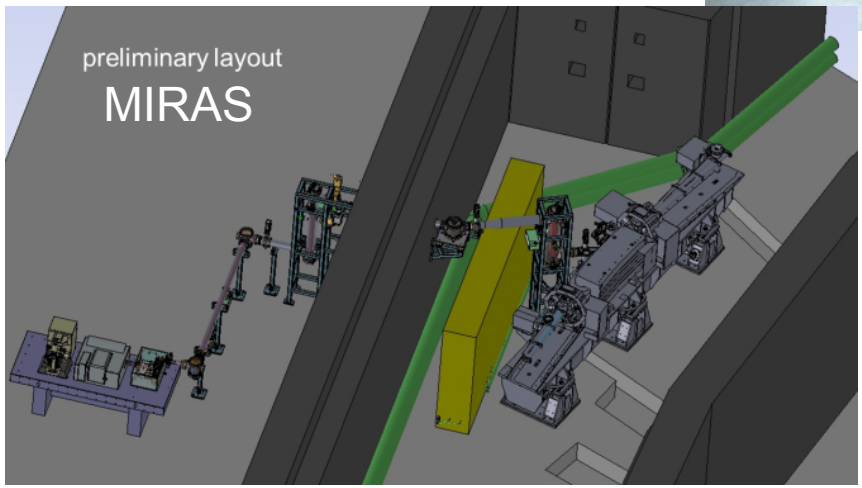


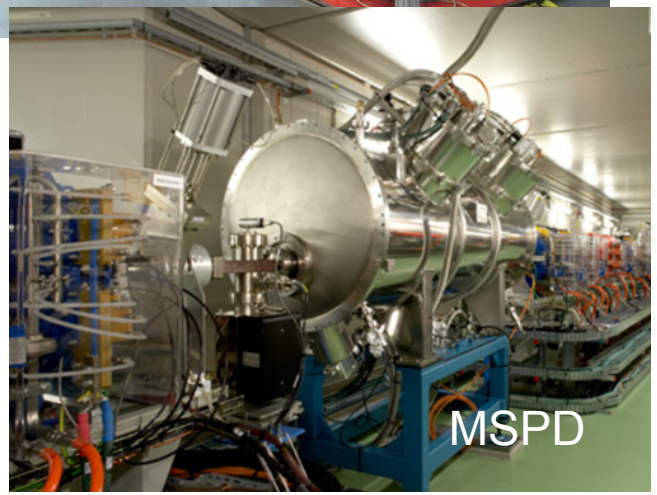
ALBA BEAMLINES

Some pictures









Operation 2016

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		

Weekday	January Day	Week	Shift M	A	N	February Day	Week	Shift M	A	N	March Day	Week	Shift M	A	N	April Day	Week	Shift M	A	N	May Day	Week	Shift M	A	N	June Day	Week	Shift M	A	N	July Day	Week	Shift M	A	N	August Day	Week	Shift M	A	N	September Day	Week	Shift M	A	N	October Day	Week	Shift M	A	N	November Day	Week	Shift M	A	N	December Day	Week	Shift M	A	N
Mo																																			1	31	Off	Off	Off																									
Tu											1		W	W	W																				2		Off	Off	Off										1		BL	BL	BL									
We											2		M	M	M											1		BL	BL	BL						3		Off	Off	Off										2		BL	BL	BL									
Th											3		M	M	M											2		BL	BL	BL						4		Off	Off	Off	1		M	M	M					3		BL	BL	BL	1		BL	BL	BL			
Fr	1		W	W	W						4		BL	BL	BL	1		BL	BL	BL						3		BL	BL	BL	1		BL	BL	BL	5		Off	Off	Off	2		M	M	M					4		BL	BL	BL	2		BL	BL	BL			
Sa	2		W	W	W						5		BL	BL	BL	2		BL	BL	BL						4		BL	BL	BL	2		W	W	W	6		Off	Off	Off	3		M	M	M	1		M	M	M	5		BL	BL	BL	3		BL	BL	BL			
Su	3		W	W	W						6		BL	BL	BL	3		BL	BL	BL	1		W	W	W	5		M	M	M	3		W	W	W	7		Off	Off	Off	4		M	M	M	2		M	M	M	6		M	M	M	4		BL	BL	BL			
Mo	4	1	Off	Off	Off	1	5	M	M	M	7	10	M	M	M	4	14	M	M	M	2	18	SPK	W	W	6	23	BL	BL	BL	4	27	M	M	M	8	32	Off	Off	Off	5	36	BL	BL	BL	3	40	W	W	W	7	45	BL	BL	BL	5	49	M	M	M
Tu	5		Off	Off	Off	2		BL	BL	BL	8		BL	BL	BL	5		BL	BL	BL	3		SPK	W	W	7		BL	BL	BL	5		BL	BL	BL	9		Off	Off	Off	6		BL	BL	BL	4		W	W	W	8		BL	BL	BL	6		M	M	M
We	6		Off	Off	Off	3		BL	BL	BL	9		BL	BL	BL	6		BL	BL	BL	4		W	W	W	8		BL	BL	BL	6		BL	BL	BL	10		Off	Off	Off	7		BL	BL	BL	5		W	W	W	9		BL	BL	BL	7		BL	BL	BL
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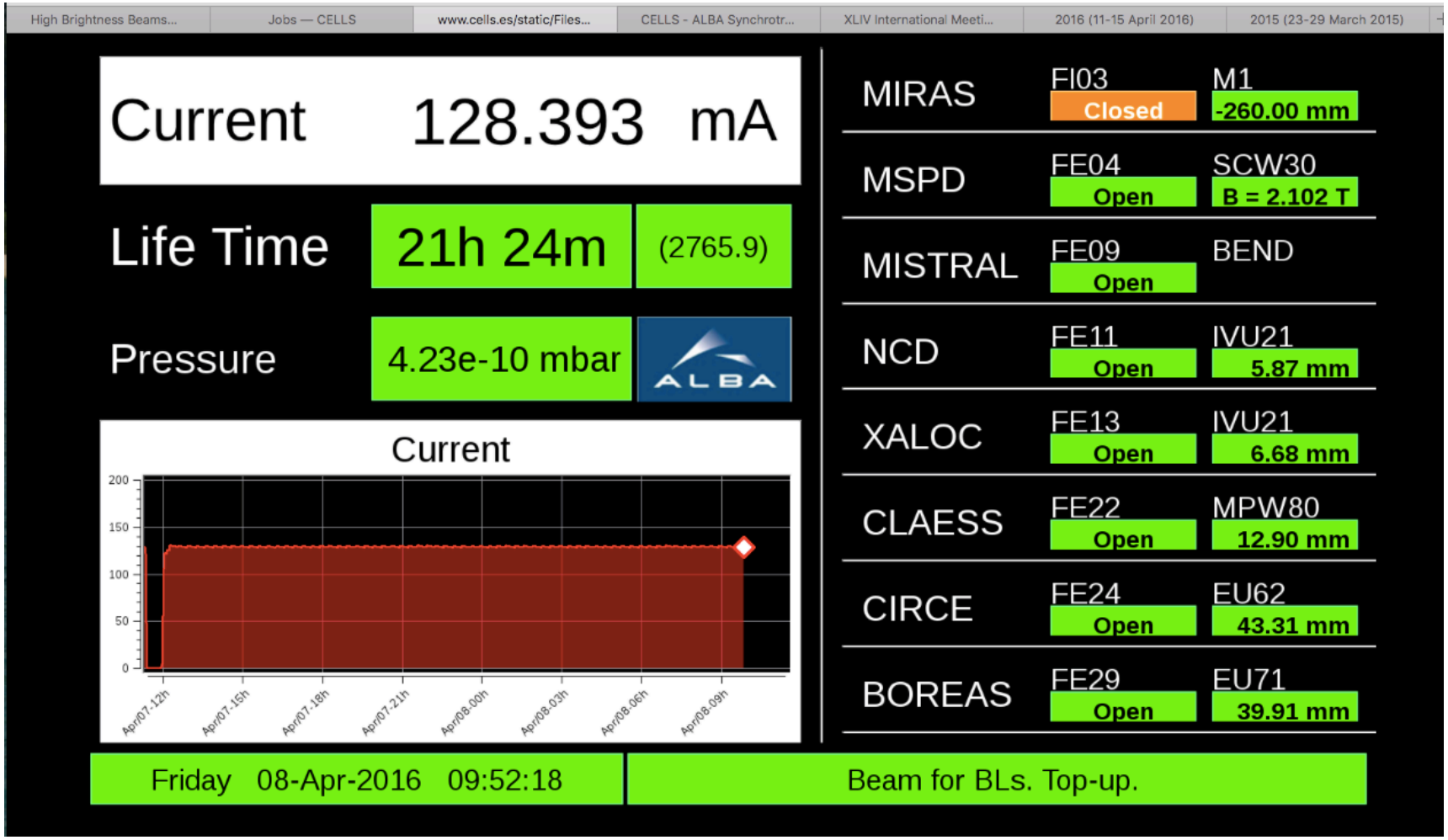
Su	31		M	M	M	28		W	W	W											29		W	W	W						31		Off	Off	Off										30		BL	BL	BL									
Mo						29	9	W	W	W											30	22	M	M	M																						31	44	M	M	M									
Tu																					31		BL	BL	BL																																	
We																																																															
Th																																																															

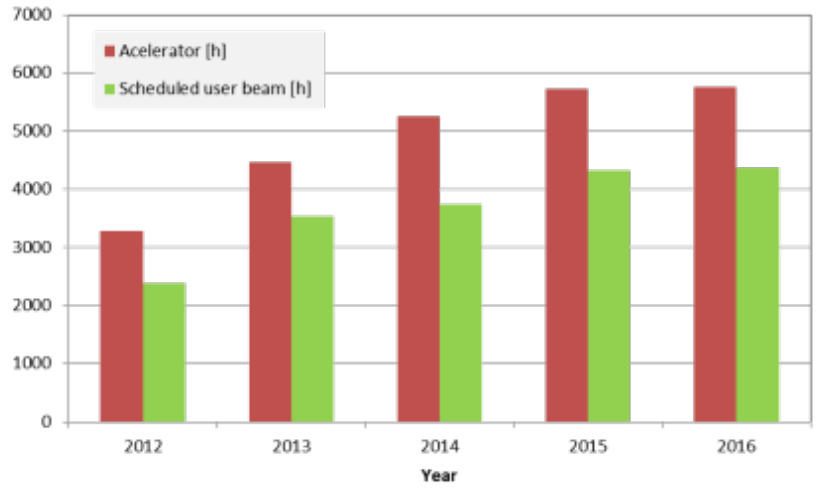
Scheduled Accelerator Operation [h]	5744
Scheduled User Beam [h]	4368
Operation	24/24h - 7/7d

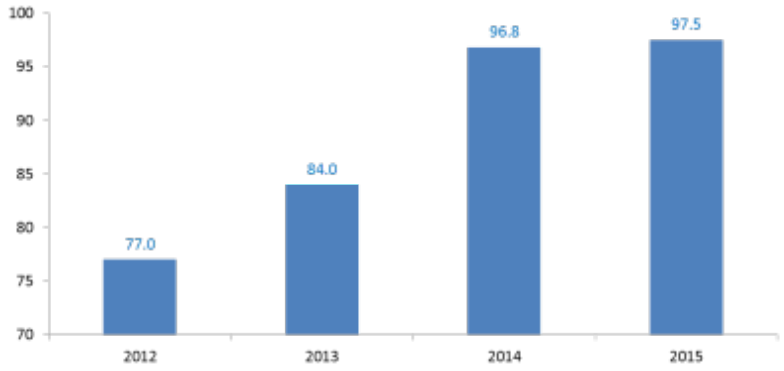
Operation 2016



Operation

	2012		2013		2014		2015		2016	
Total Scheduled [h]	3280		4464		5240		5728		5760	
Accelerators [h]	892	27.2%	924	20.7%	1352	25.8%	1408	24.6%	1392	24.2%
Beam lines [h]	2388	72.8%	3540	79.3%	3888	74.2%	4320	75.4%	4368	75.8%
BL Availability	77.0%		83.8%		96.8%		**97.3%**			
MTBF [h]	21.0		25.0		33.7		**51.4**			
MTTR [h]	1.0		0.8		1.1		**1.4**			






The ALBA Team
We are today ~200

The ALBA Team Expertise

Inside ALBA Dampy Cavity

- Accelerator beam dynamics
- Accelerators operation
- RF systems and test laboratory
- Magnetic structures design and measurements laboratory
- Ultra High Vacuum systems design and test laboratory
- Beam diagnostics and test laboratory
- Real time control systems and data acquisition
- High power and high stability power supplies
- High precision mechanics
- High speed electronics, synchronisation and timing systems
- Survey, alignment and vibrational measurements

Magnets

Diagnostics

RF Cavities

Control System

Timing

Digital Electronics

Vacuum

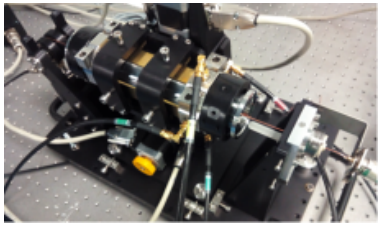
International Collaborations

- FCC - Future Circular Collider

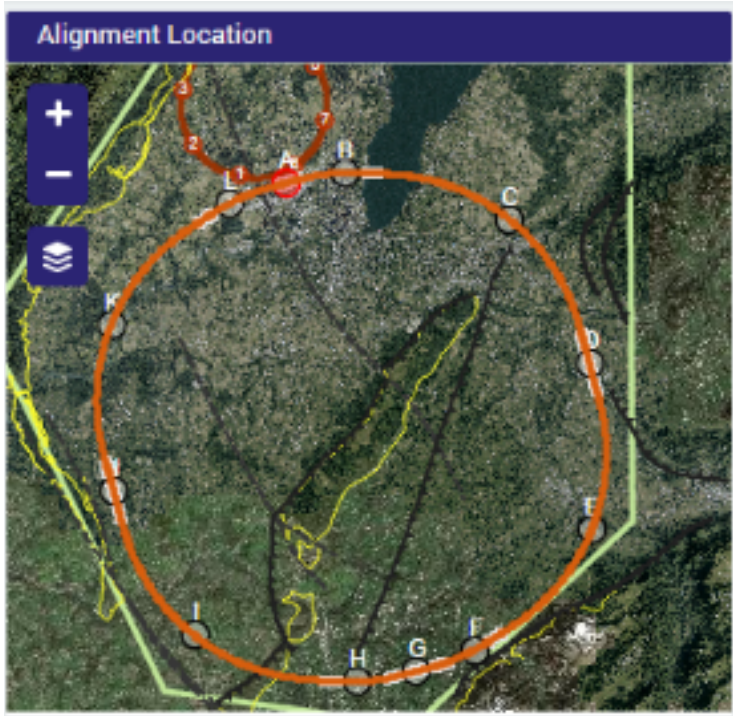
  EU H2020 Project EuroCirCol
  - WP4: Cryogenic Beam Vacuum System

- Collaboration with CLIC-CERN:
  - WP1: Damping Ring Stripline Kicker test
  - WP2: Collective Effects
  - WP3: Beam Instrumentation & Diagnostics
  - WP4: 1.5 GHz RF System

- Collaboration with INFN for the ELI-NP project
  - WP1: Magnetic simulations
  - WP2: BPM measurements



FCC Project
Future Circular Collider
100 TeV pp collider



90 – 100 Km

Horizon 2020
H2020-INFRADEV-1-2014-1
RIA action, proposal number 654305

Four technical
Work Packages:
One lead by ALBA-CELLS

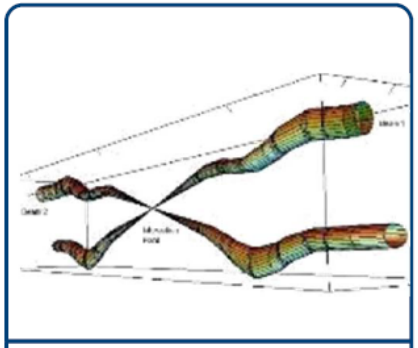
The Future Circular Collider study

EC Funded Scope

Lead: **CEA**
A. Chancé

Co-Lead: CERN
D. Schulte

Arc Design



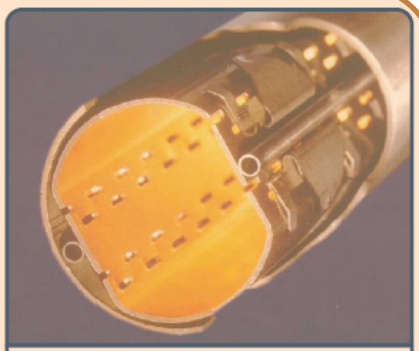
EIR Design

Lead: **JAI**
A. Seryi

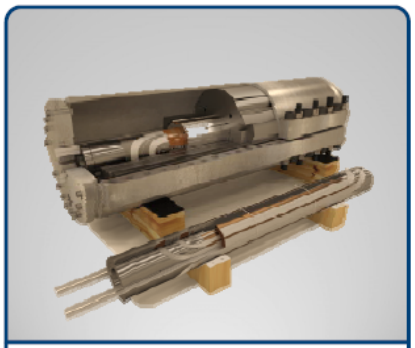
Co-Lead: CERN
D. Schulte

Lead: **CELLS**
F. Perez

Co-Lead: CERN
P. Chiggiato



Cryo Beam Vacuum

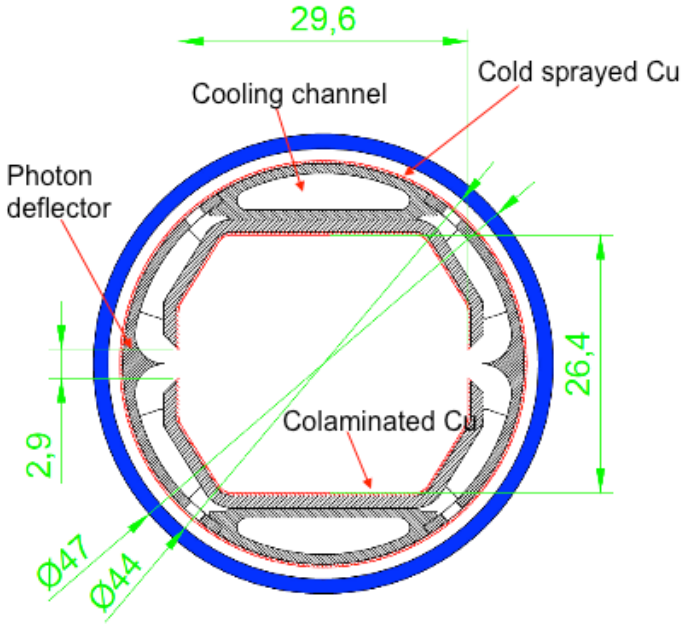


High Field Magnet

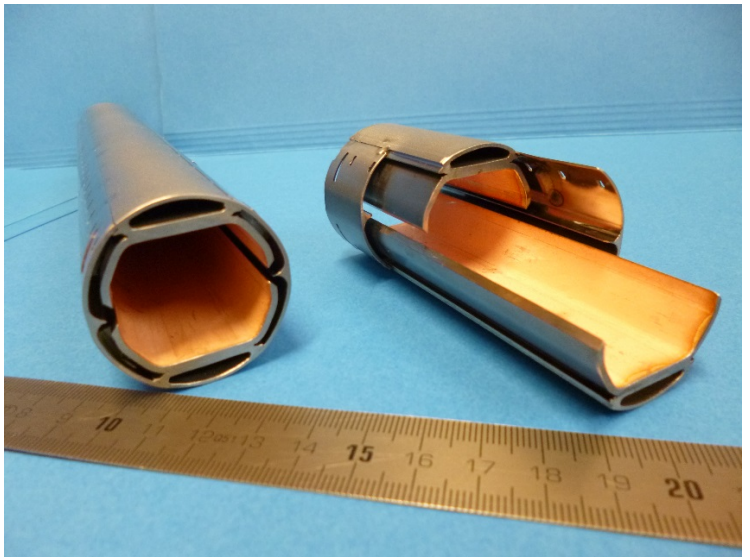
Lead: **CERN**
L. Bottura

Co-Lead: **TBA**
TBA

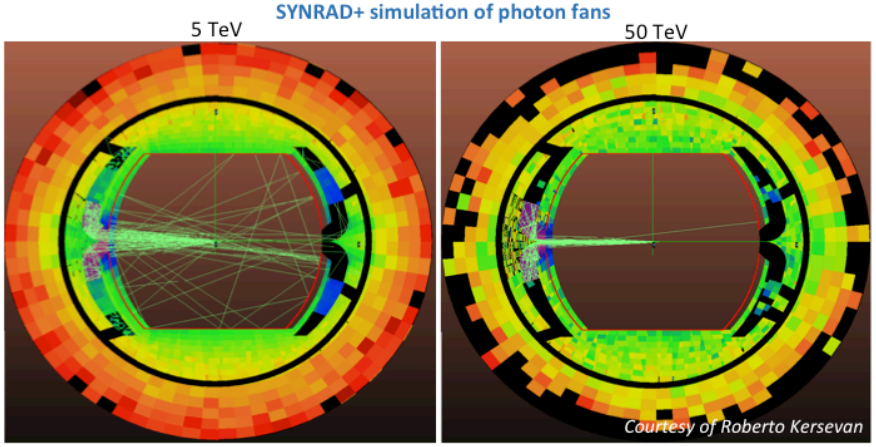
Design, Prototyping and Tests of the FCC-hh Vacuum Beam Screen



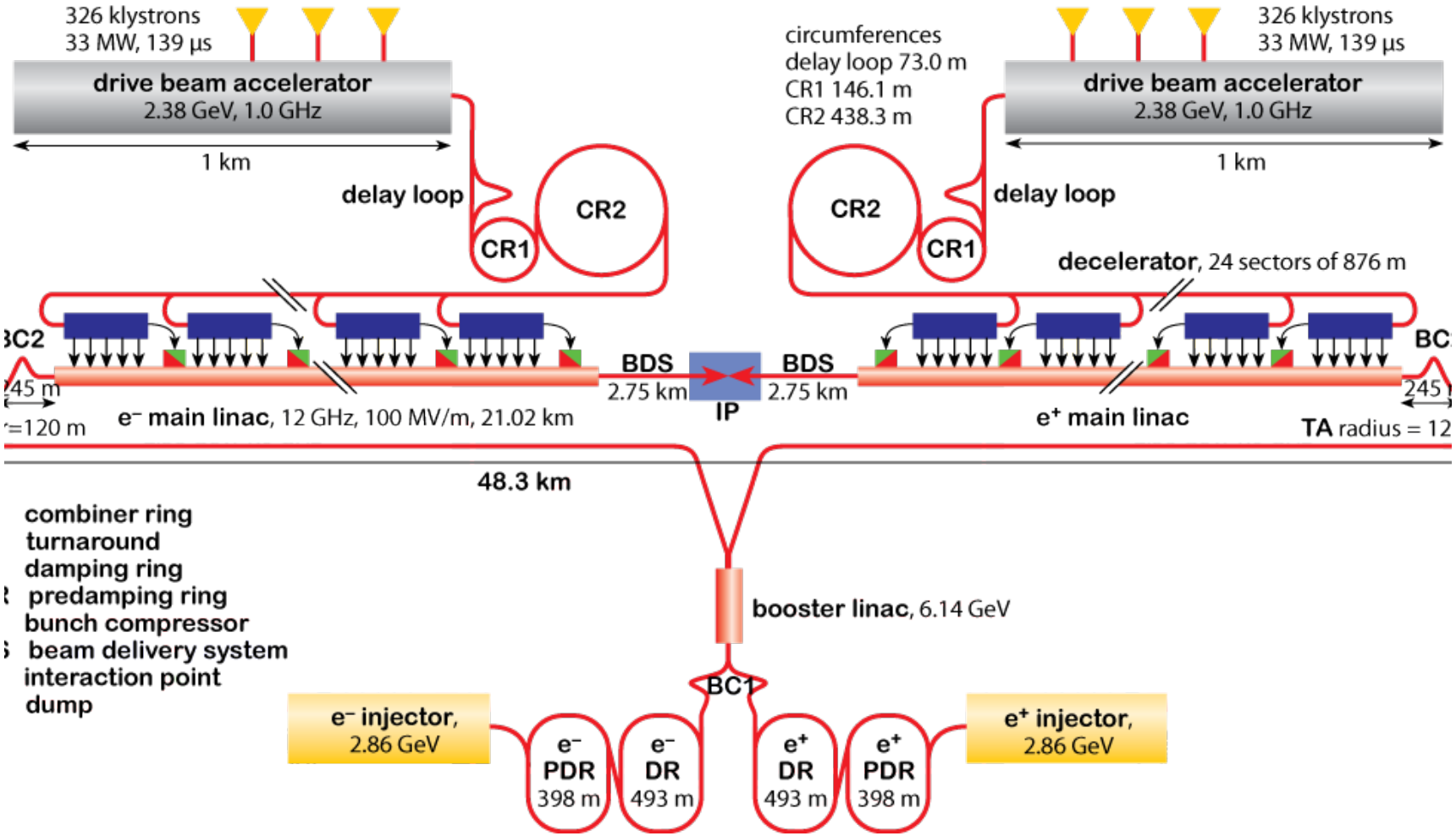
Prototyping ongoing



SYNRAD+ simulation of photon fans



CLIC Project
Compact Linear Collider



CLIC Collaboration

- **Contract KT with CERN**

  for the contribution of ALBA to the CLIC study on 26th May 2015.

- Four Work Packages:
  - WP1: Damping Ring Stripline Kicker test (M.Barnes & M.Pont)

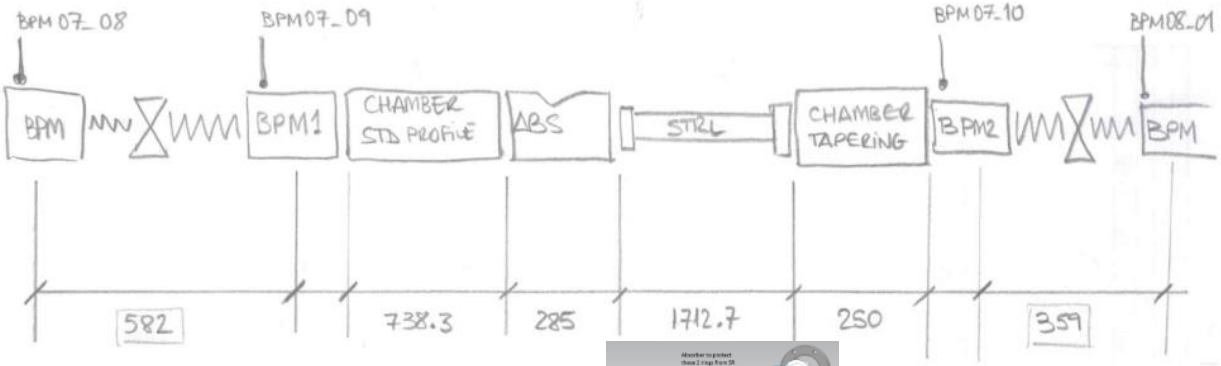
    The Stripline Kicker of the CLIC Damping Ring will be installed at ALBA for testing its performance in terms of stability
  - WP2: Collective Effects (G.Rumolo & U.Iriso)

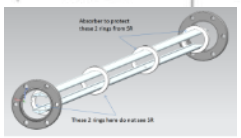
    ALBA Storage Ring will be used for test bench of beam instabilities computations
  - WP3: Beam Instrumentation & Diagnostics (F.Rondarolo & U.Iriso)

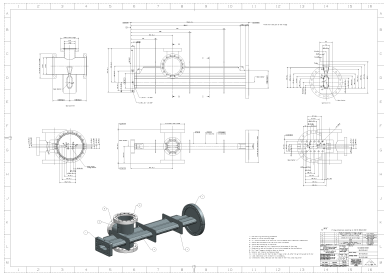
    Development of new fast and high resolution instrumentation is being developed and tested at ALBA
  - WP4: 1.5 GHz RF System (H.Schmickler & F. Perez)

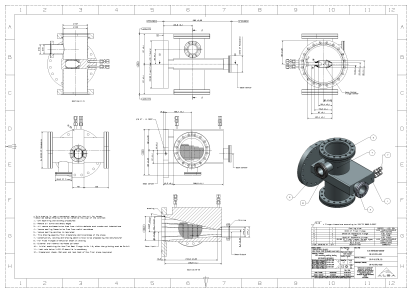
    The RF system for the CLIC Damping Ring will be designed by ALBA

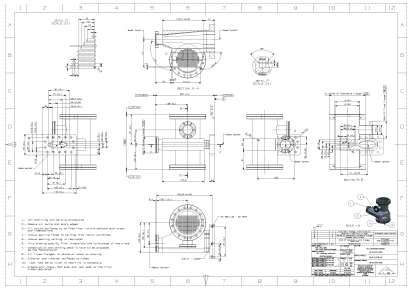
WP1: DR Stripline Kicker test
Design vacuum chamber transitions

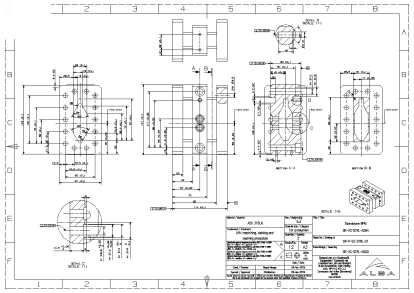






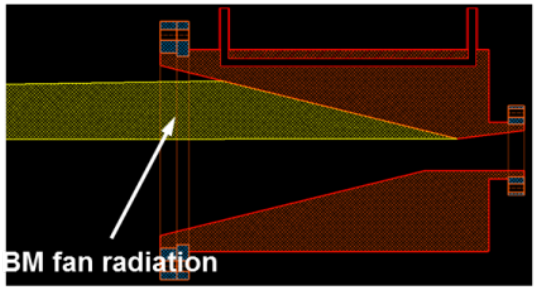


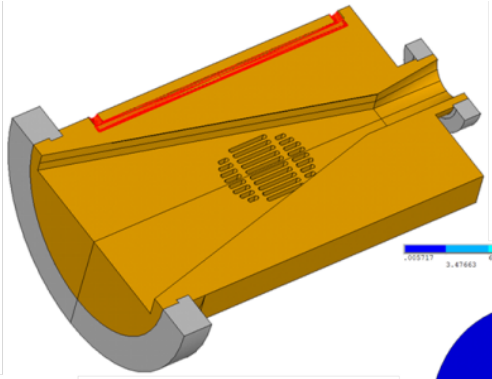


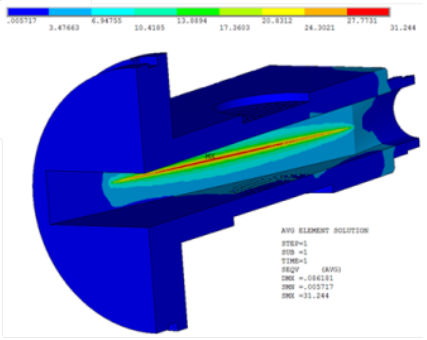


WP1: DR Stripline Kicker test
Design vacuum chamber transitions

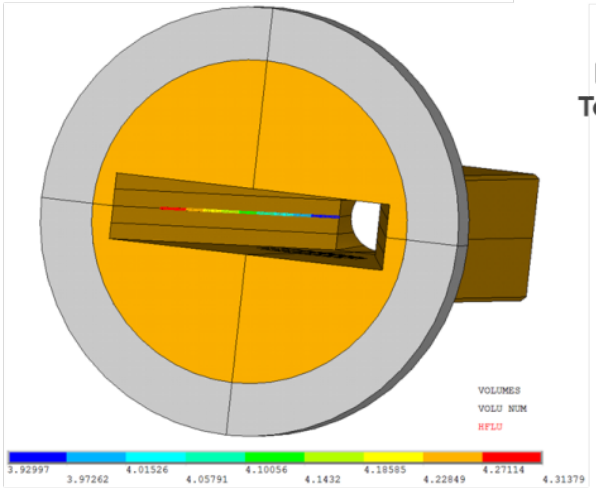
FEA of the radiation absorber (Temp, stress, strain)

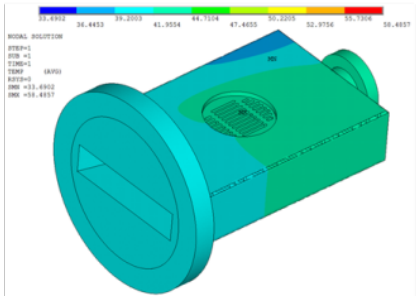






Pa $_{MAX}$ = 4.3 W/mm^2
Total Power = 782.7 W



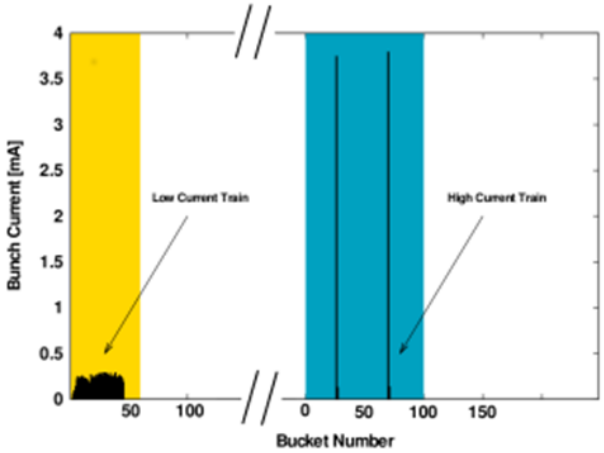


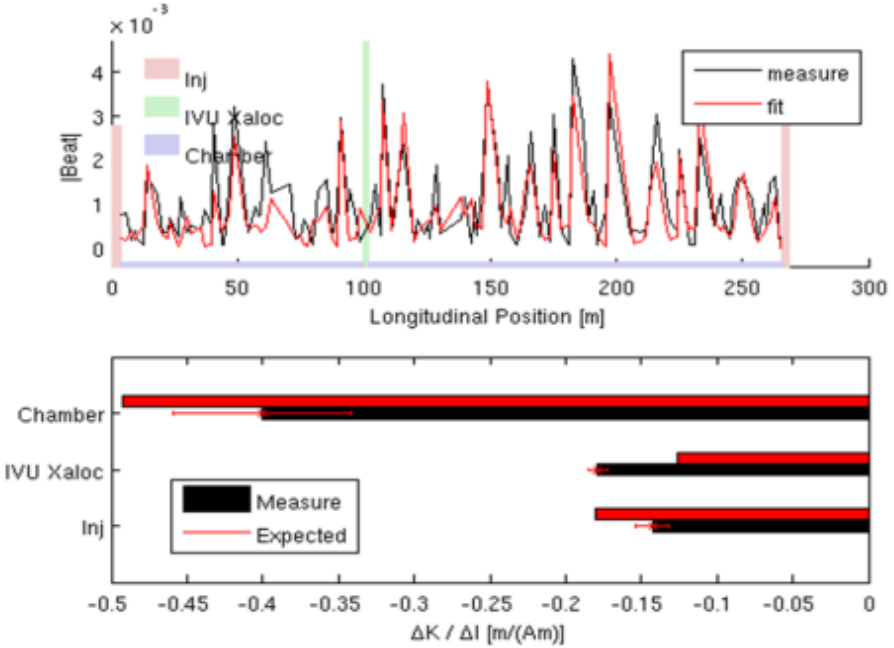
WP2: Transverse Impedance Measurements

- A transverse impedance source produces a small defocusing kick:

$$\Delta K \propto Q \times Im(Z)$$

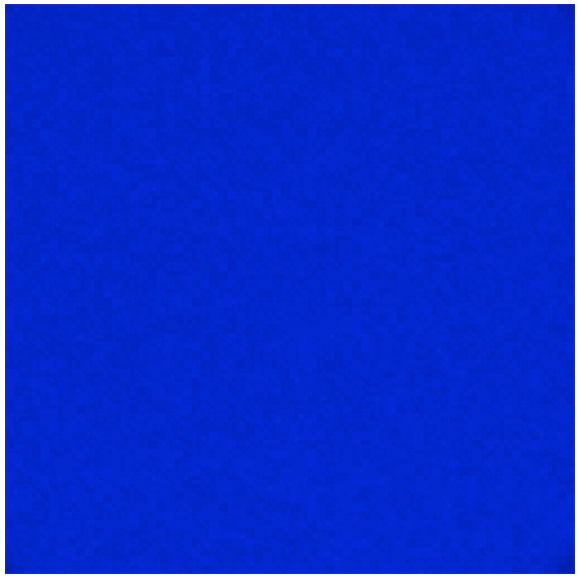
- The bunch charge dependency of such defocusing kick provides the key to disentangle the small contribution produced by each impedance source from the dominating focusing effects due to the machine optics.

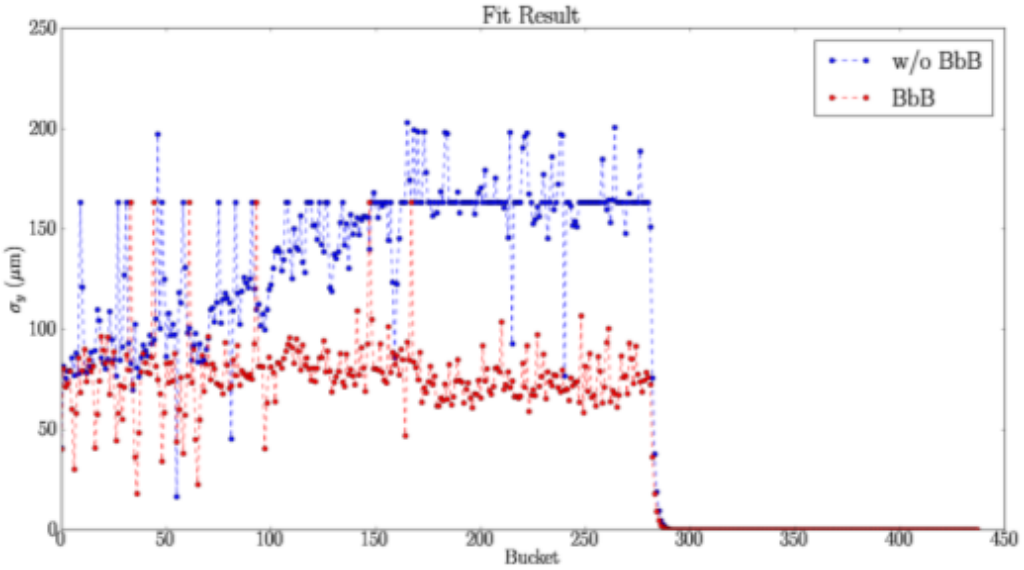


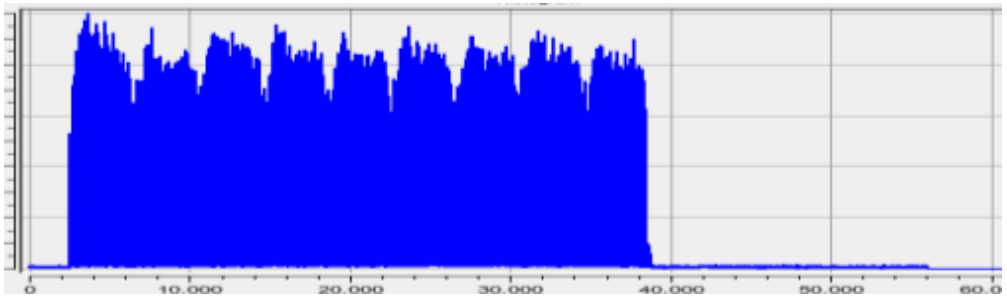


WP3: Instrumentation
Interferometry Measurements

Bunch by bunch beam size measurements using Fast Gated Camera





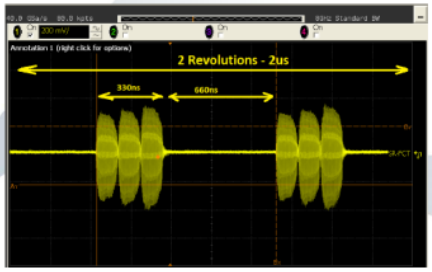


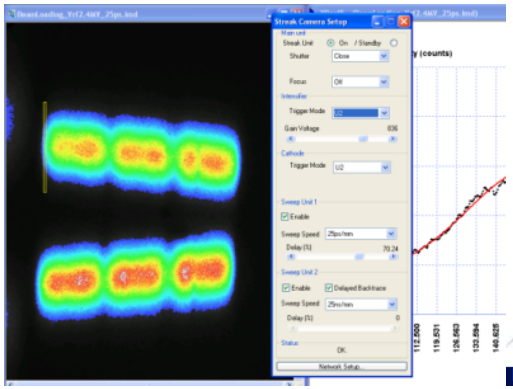
WP4: Desing RF 1.5 GHz

Measurement of beam loading induced phase shift

FF Loop for beam loading compensation

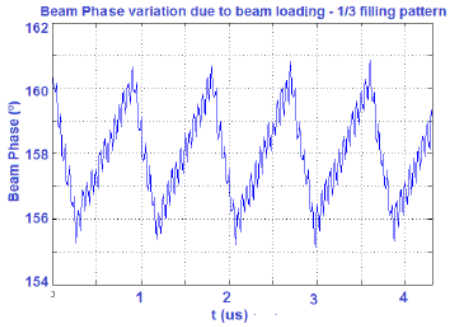
- ✓ **In Normal Operation: Effect of beam loading negligible**
  - *Revolution frequency ~ 1MHz*
  - *90% Filling Pattern*
  - *10 trains: 10 x (32 bunches + 12 empty buckets)*
- ✓ **Filling pattern modifed to 1/3 to be able to measure beam loading effect**

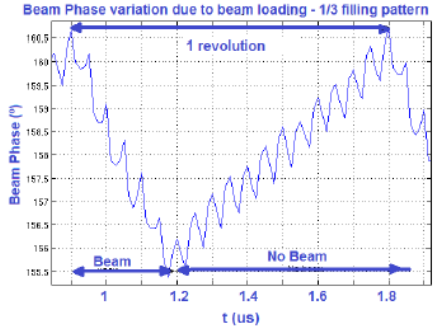




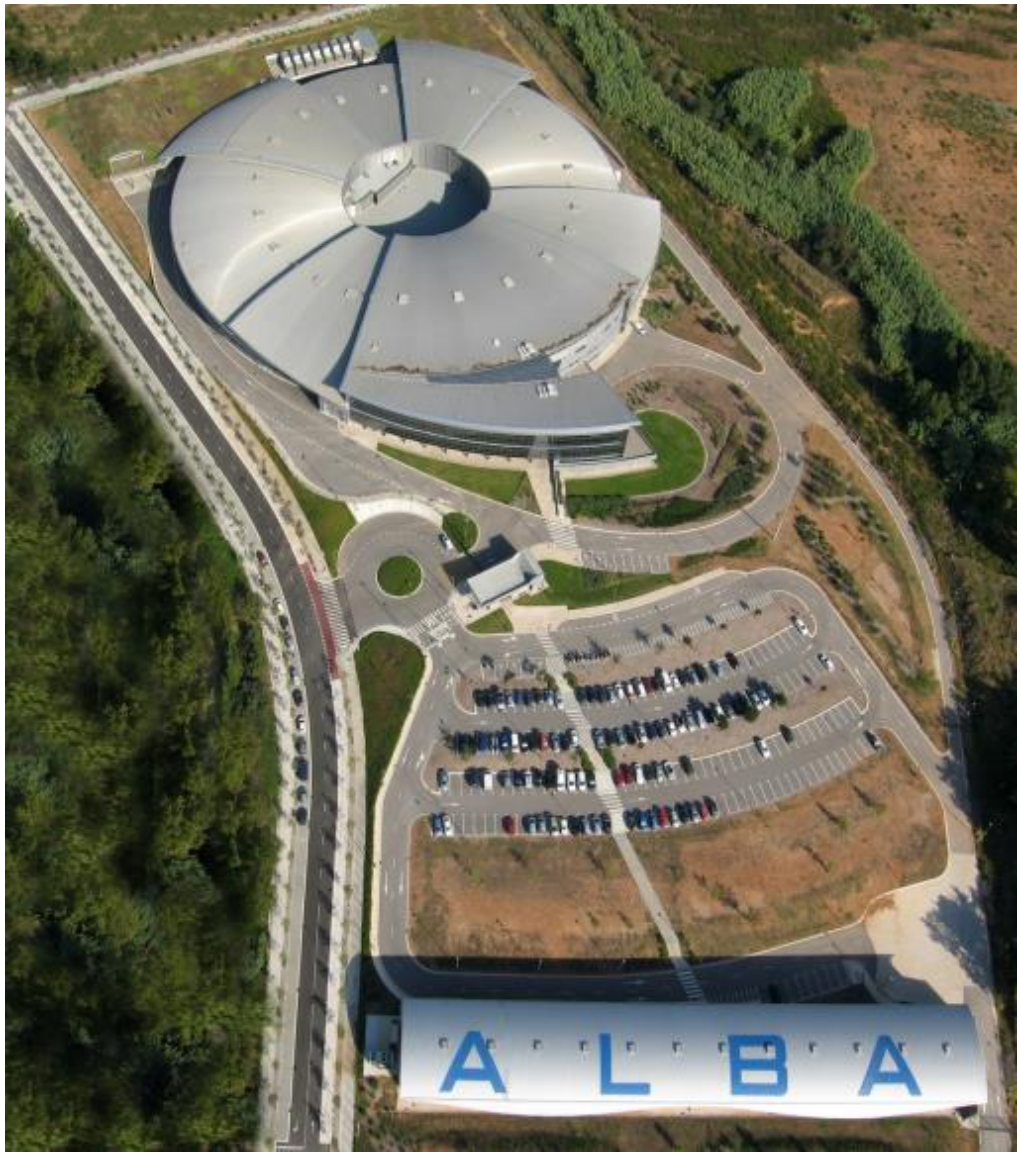
FF Loop for beam loading compensation

✓**Beam Loading measured with 1/3 filling pattern (60mA)**





- *Beam Phase modified by 5° due to beam loadign effect*
- *Future upgrade: Phase modulation (feed-forward loop) to compensate this effect*
- *Needed to prove feasibility of this approach for CLIC collaboration*



ALBA R&D labs

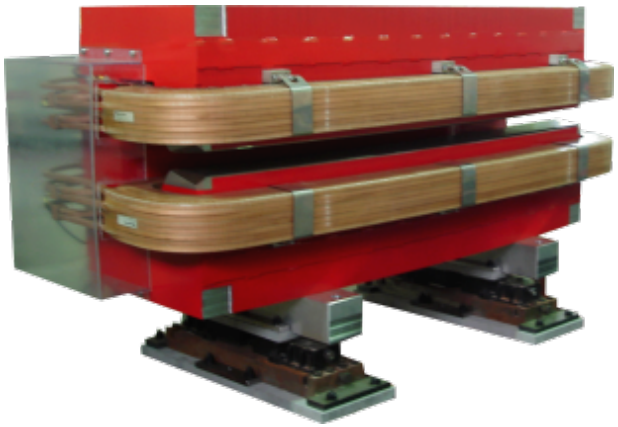
- Magnetic lab
- RF lab
- Vacuum lab

Magnetic Measurements Laboratory

- Specialized in accurate measurements of big magnetic structures

Mission of the laboratory:

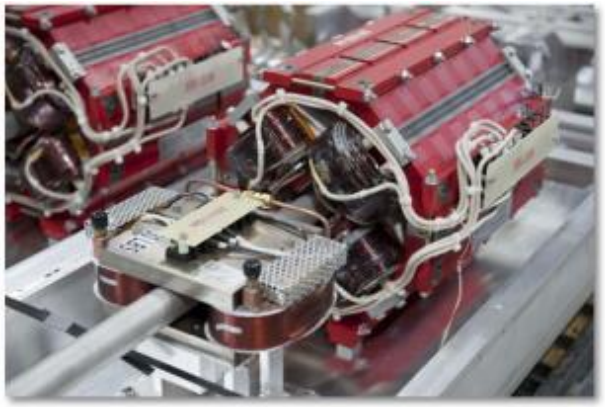
1. Measurement of Accelerators Magnets
2. Construction and measurement of IDs



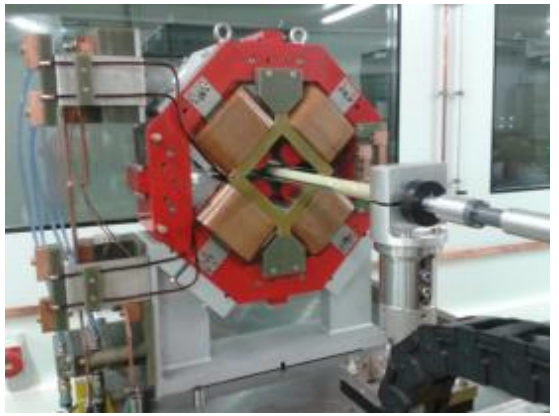
Magnetic Measurements Laboratory

Magnetic Measurements Laboratory

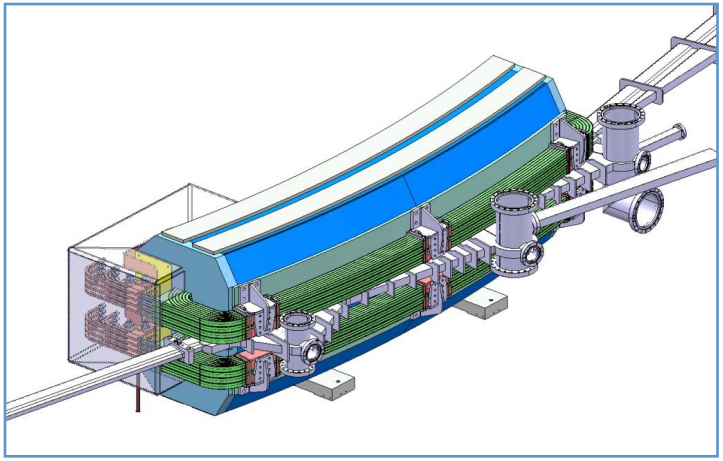
Collaboration with other research centers



Magnets built by industry



CIEMAT magnets for IFMIF



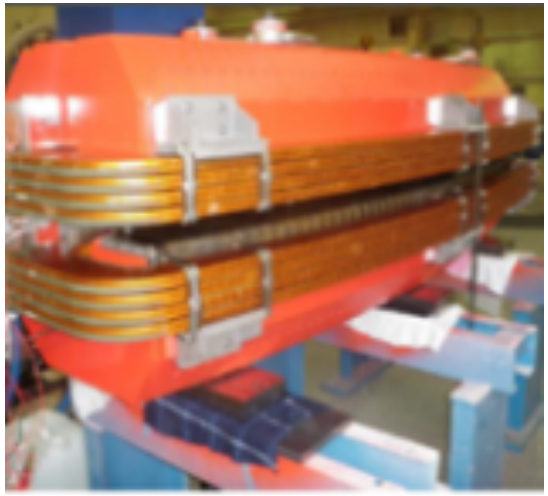
SESAME dipoles –
CERN agreement

CIEMAT phase
shifter for E-XFEL

Magnetic Measurements Laboratory

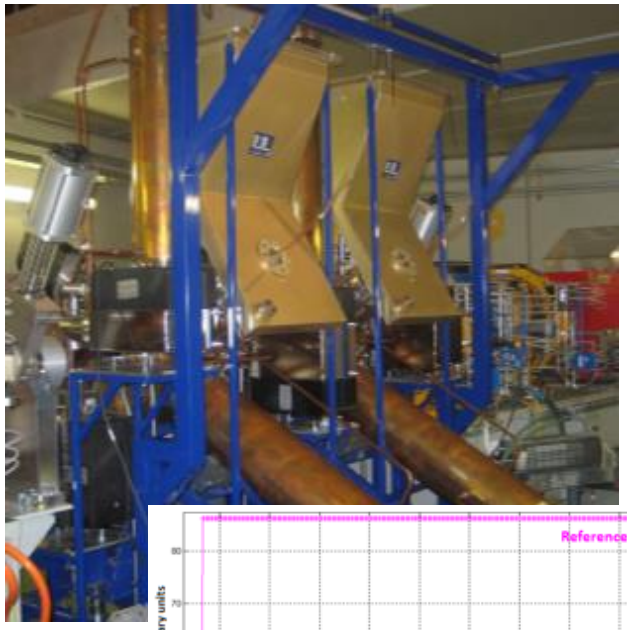
Collaborations/Contracts

- Magnetic Lab
  - SESAME Dipoles, done
  - IFMIF Quads, done
  - Elytt/LEHIPA permanent magnets quads, on going
  - CIEMAT cyclotron magnet (new magnetic bench, 2016)
  - ThomX magnets (2016)
  - ANTEC - CNAO
  - Other collaborations under discussion



High Power RF Laboratory

- Specialized in low and high RF power measurements and cavity conditioning



In order to build the accelerators, ALBA did set up a complete high power RF laboratory for prototype testing and cavity conditioning:

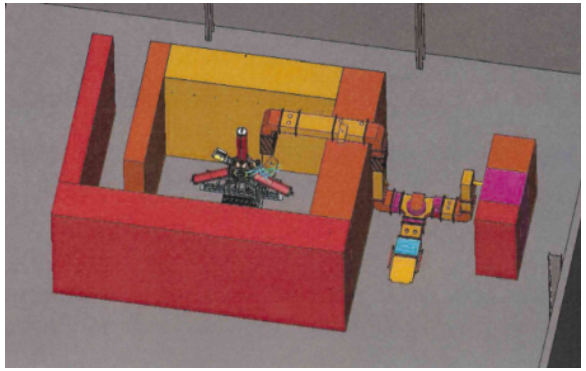
1. LLRF tests
2. Controls tests
3. 80 kW amplifier IOTs tests
4. High power RF conditioning of:
   - Cavities
   - Input power couplers

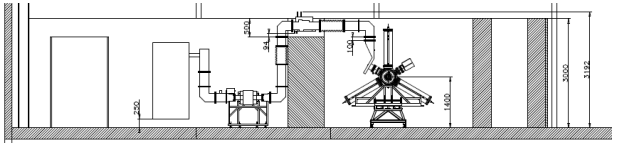
High Power RF Laboratory

RF transmitter

LLRF and Controls racks

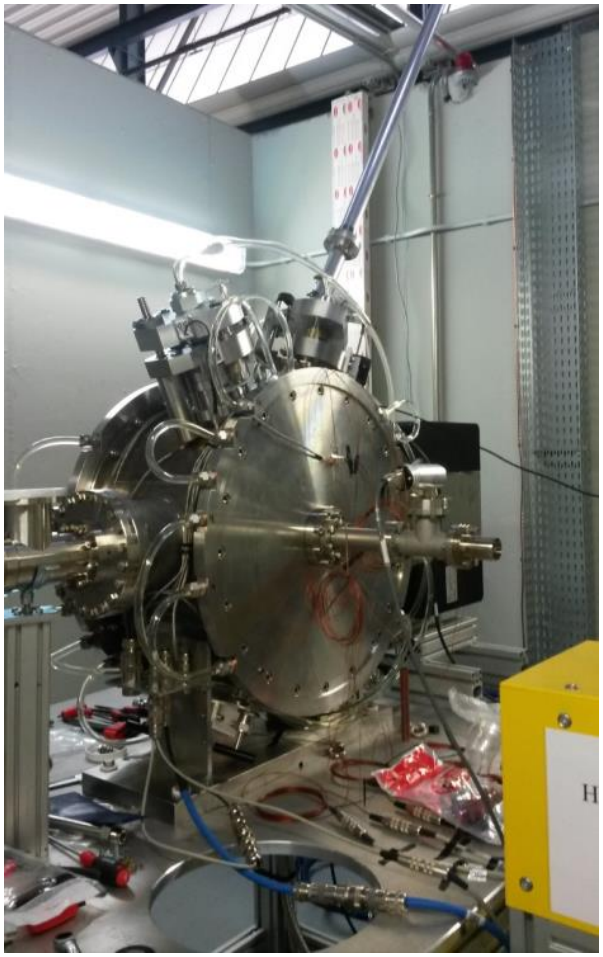
Cavity inside the Bunker

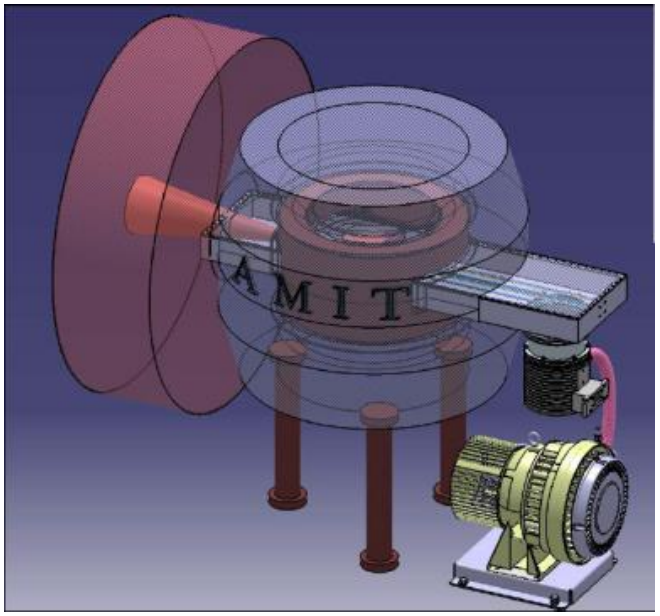




High Power RF Laboratory

Collaboration with other research centers





CIEMAT - Cyclotron Cavity (2016)

CIEMAT
IFMIF Buncher cavity
at *ALBA RF lab* for High Power Conditioning
(2014 & 2015)

Vacuum Laboratory

- Specialized in Ultra High Vacuum: design, construction and tests.

Vacuum Laboratory

Installation and Material :

Clean room class 100000 (ISO 8)

Bake out oven (length 14m,height 1m,width 2m)

12 roughing station

7 leak detectors

Material for bake out (controllers, heaters …)

Ion pumps

Residual gas analyser

Vacuum measurement gauges

Traveling crane (1T)

Design and Calculation

Nx (Siemens) Cad system

Ansys for calculation

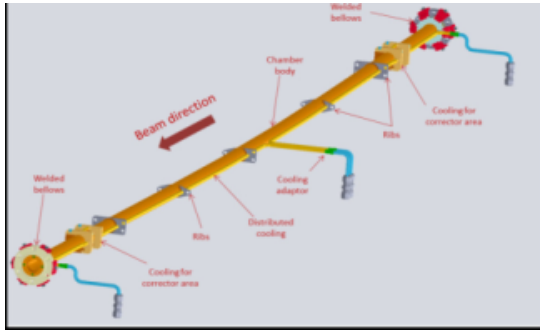
Molflow for vacuum calculation

Vacuum Laboratory

Collaboration with other research centers

MAXLAB (Sweden):

- Design of vacuum chambers for the 3Gev and 1,5Gev MaxIV Storage Rings
- Thermal, mechanical and vacuum calculation
- Technical specifications & CFT process



Salamanca University (Spain)

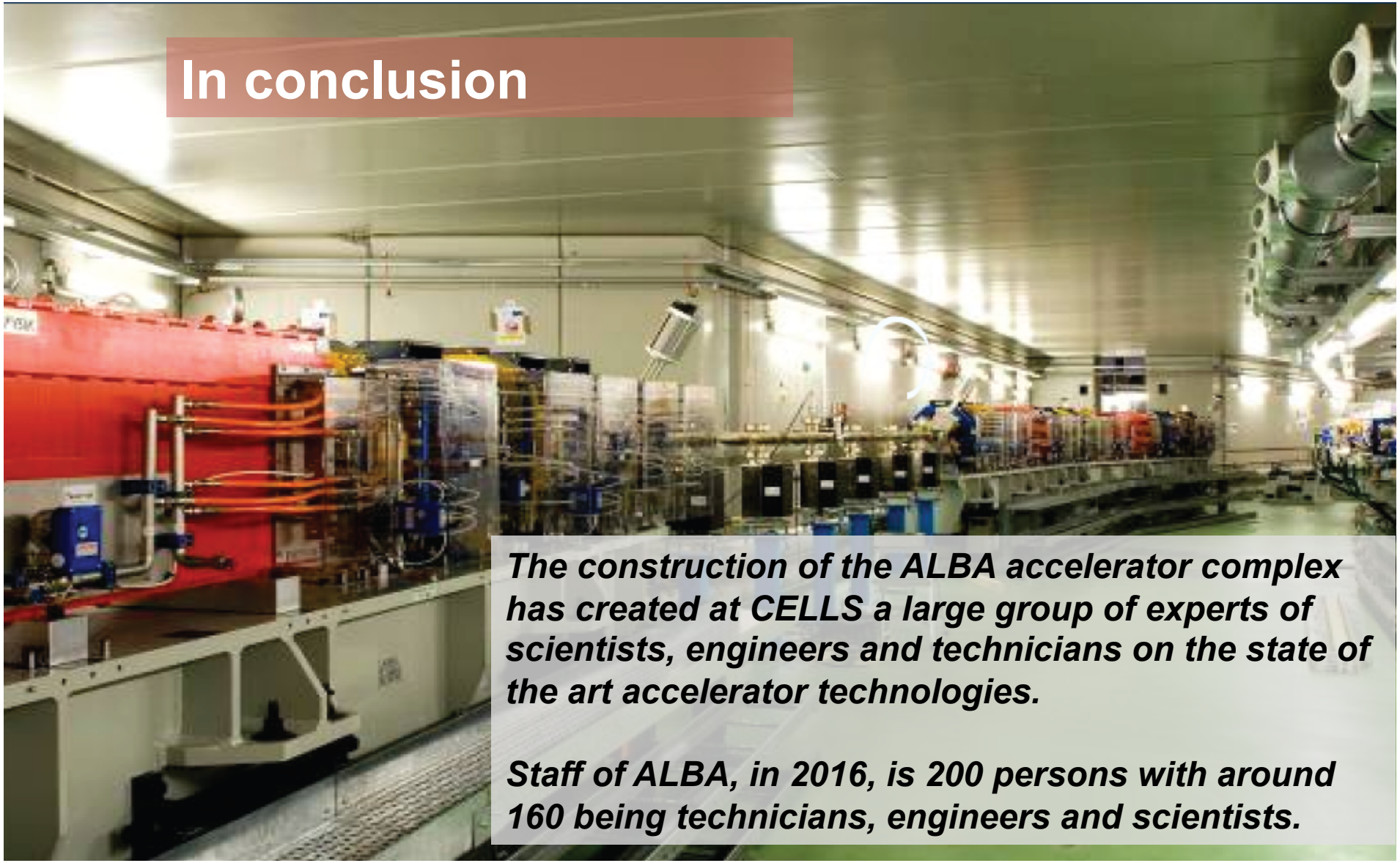
- Design and calculation of a vacuum chamber for a 200TW laser compressor optical devices
- Technical specifications & CFT process
- Fabrication follow-up
- Installation and vacuum tests

EuroCirCol – H2020 for FCC (CERN)

EuroCirCol

Horizon 2020
H2020-INFRADEV-1-2014-1
RIA action, proposal number 654305

In conclusion



The construction of the ALBA accelerator complex has created at CELLS a large group of experts of scientists, engineers and technicians on the state of the art accelerator technologies.

Staff of ALBA, in 2016, is 200 persons with around 160 being technicians, engineers and scientists.