Accelerator Development in Spain

Fernando Toral
CIEMAT- Madrid

CERN Accelerator School, Granada, Nov. 2nd, 2012

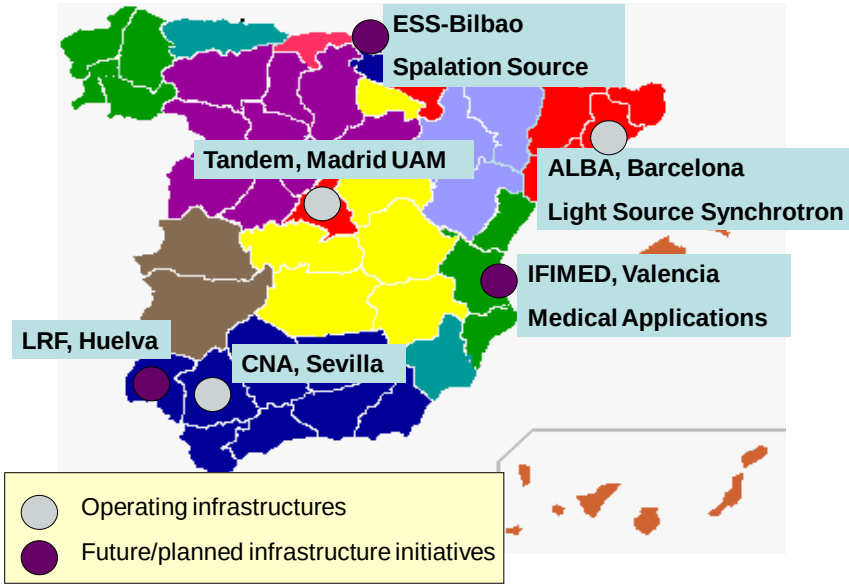
Many thanks to:

J. Bermejo, A. Faus-Golfe,
J. Fuster, L. García-Tabarés, J. Gómez-Camacho,
I. Martel, A. Muñoz, F. Pérez

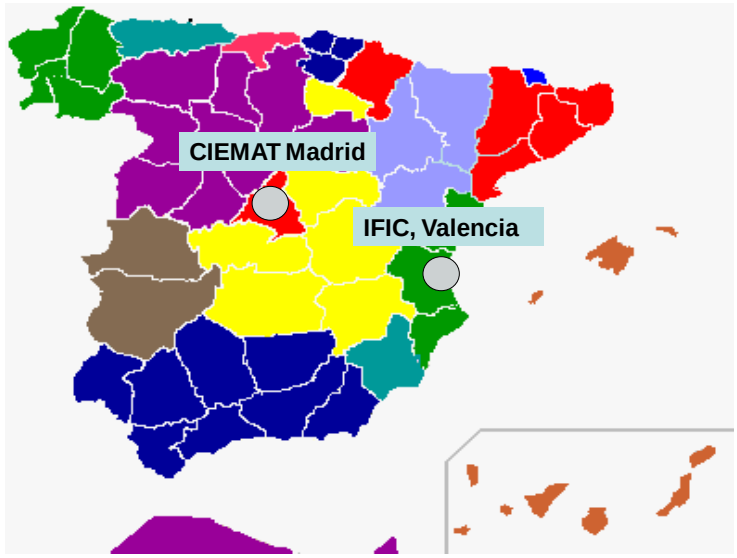
Outline

- **Spanish accelerator infrastructures:**
  - Infrastructures in operation:
    - ALBA (Barcelona)
    - CMAM (Madrid)
    - CNA (Sevilla)
  - Infrastructures in construction:
    - ESS-Bilbao
  - Infrastructures in consideration or preparatory phase:
    - LRF-Huelva
    - IFIMED (Valencia)
- **R&D accelerator activities**
  - CIEMAT (Madrid)
  - IFIC (Valencia)

Accelerator Infrastructures



Institutes/labs with R&D accelerator groups



The ALBA Synchrotron Light Facility

"A long and winding road"

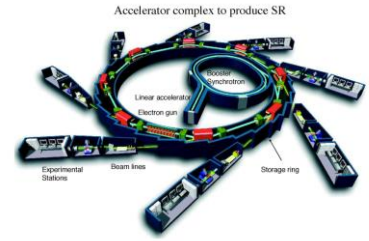
First proposal in 1992

…….

Inaugurated in 2009

2012, present

in successful operation



The ALBA Synchrotron Light Facility

Main characteristics of SL

Continuous Spectrum, from infrared to X-rays, with

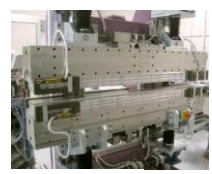
E_{crit} (keV) = 0.665 E^2 (GeV) B(T)

Intense, as a narrow beam

ϑ(rad) = 0.51/E (MeV)

Polarized in the orbital plane

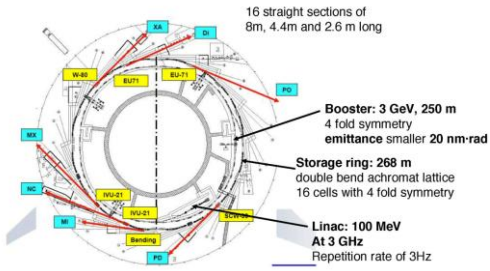
With **temporal structure**

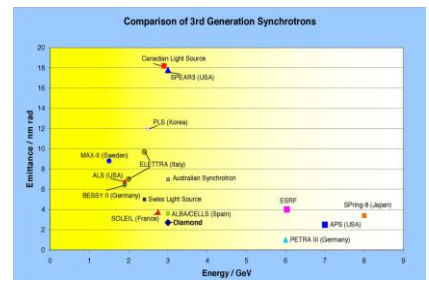


electrons

photons

3rd generation sources:
wiglers and ondulators





ALBA Synchrotron Light Source

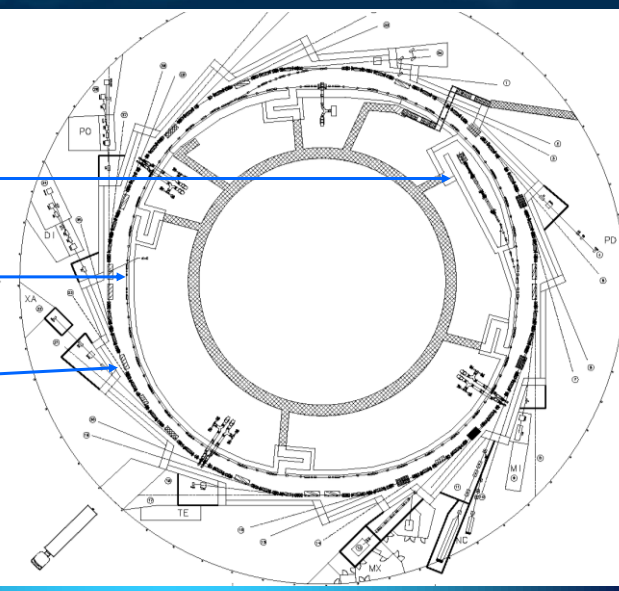
- ✓ 3 GeV electron Storage Ring
- ✓ 31 beamlines (7 on day one)
- ✓ Funding is 50% Spanish – 50% Catalan Governments
- ✓ Designed for sub-micron stability and top-up operation

ALBA Accelerators

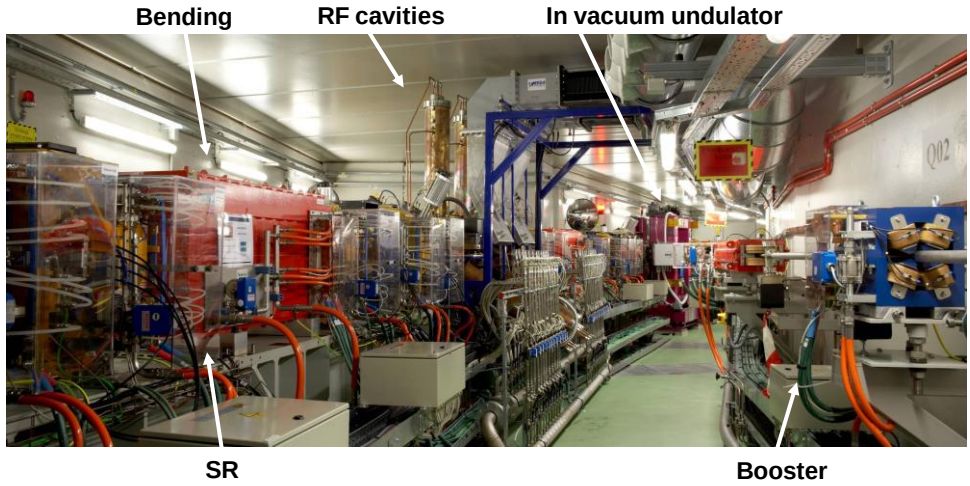
LINAC
100 Mev

BOOSTER
100 MeV – 3 GeV

STORAGE RING
3 GeV



SR and BOOSTER sharing the tunnel



STORAGE RING

	Nominal	Achieved
Energy	3 GeV	3 GeV
Max. Current	400 mA	200 mA
Tunes	18.18, 8.37	18.15, 8.37
Emittance	4.3 nm·rad	4.4 ± 0.4 nm·rad
Energy spread	$1.05 \cdot 10^{-3}$	$1.00 \cdot 10^{-3}$
Coupling	< 1 %	0.5 %
Lifetime @ 100 mA	>10 h	10 h
Ah accumulated		>100

ALBA BEAMLINES

Phase 1:

7 Beamlines in operation

6 ID's and 1 bending magnet port

In addition, *2 bending magnet* ports for Electron Beam Diagnostic

Phase 2:

8 proposals have been evaluated

2 new beamlines are approved but pending financial budget

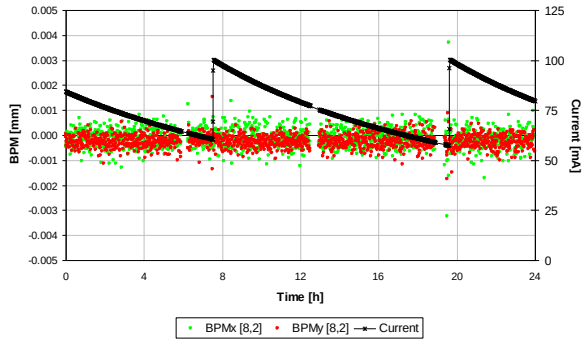
In total:

Capability for *17 ID* beamlines

And *14 bending magnet* beamlines

ORBIT STABILITY

Beam Stability over 24 h



RMS-Values:

σ_x = 0.5 µm

σ_y = 0.2 µm

SOFB (Slow Orbit FeedBack)

- Running every 3 s
- With RF frequency included on SOFB

The ALBA Synchrotron Light Facility

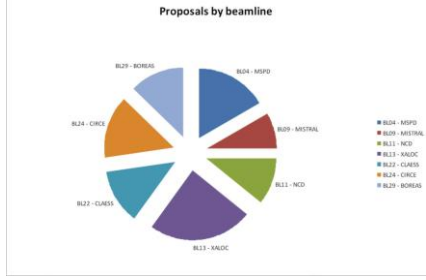
First phase of beamlines

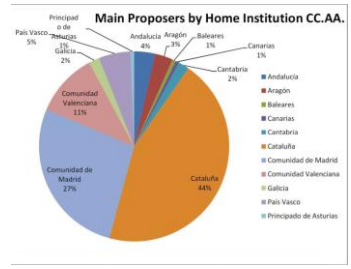
Port	Beam-line	Experimental techniques	Scientific applications
4	**MSPD** (SCW-30)	Materials Science and Powder Diffraction	Structure of Materials, Time resolved diffraction
9	**MISTRAL** (BM)	X-ray microscopy.	Cryogenic tomography of biological objects. Spatially resolved spectroscopy
11	**NCD** (IVU-21)	Non-Crystalline Diffraction	Structure and phase transformations of biological fibers, polymers, solutions. Time resolved X-ray studies
13	**XALOC** (IVU-21)	Macromolecular Crystallography	Protein crystallography, with particular emphasis on large unit cell crystals
22	**CLÆSS** (MPW-80)	Core Level Absorption & Emission Spectroscopies	Material Science, Chemistry, Time resolved studies
24	**CIRCE** (EU-62)	Photoemission Spectroscopy and Microscopy Photoemission microscopy (PEEM) Near atmospheric pres. Photoem. (NAPP)	Nano-science and magnetic domain imaging (PEEM). Surface chemistry (NAPP)
29	**BOREAS** (EU-71)	Resonant Absorption and Scattering	Magnetism, surface magnetism and magnetic structure

Results of the first call for users

- **200 proposals received**
- **636 registered researchers**
- **All the BLs (x7) have a high numeber of proposals**

- **82% are Spanish proposals**
- **16% are EU proposals**
- **3 are no UE proposals**

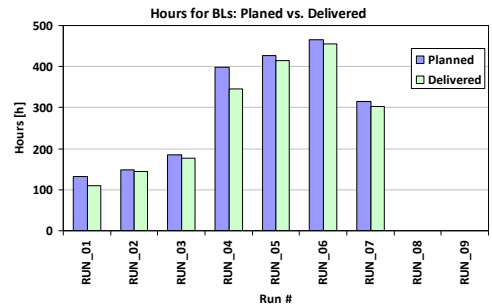


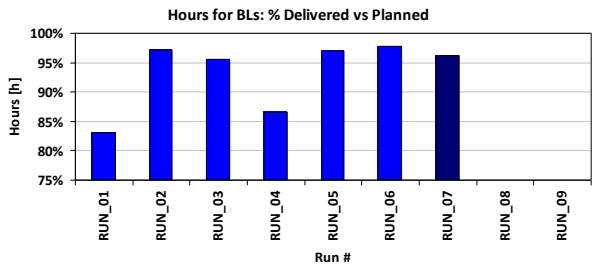


OPERATION 2012

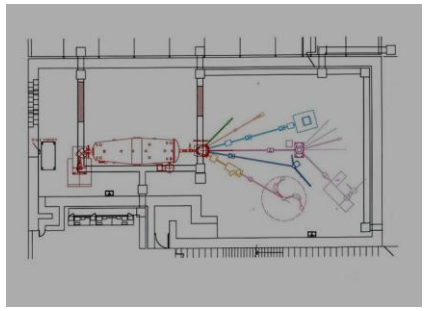
Statistics Jan-Sept 2012

- **Beamline operation:**
  - **2073 planned**
  - **1950 delivered**
- **94 % beam availability:**





CMAM: Centre for Micro-Analysis of Materials



- **Centro de Micro-Análisis de Materiales is a research laboratory with an electrostatic accelerator for ions at UAM.**
- **A 5 MV parallel fed Cockcroft-Walton.**
- **It is in operation since 2002 covering:**
  - Analysis of materials using ion beam analysis (IBA) technics applied in different fields of knowledge.
  - Applications based on the modifications of the properties of materials by ion irradiation and implantation
  - Basic studies on ion matter interaction
  - Provides service to external users managed by the Parque Científico de Madrid

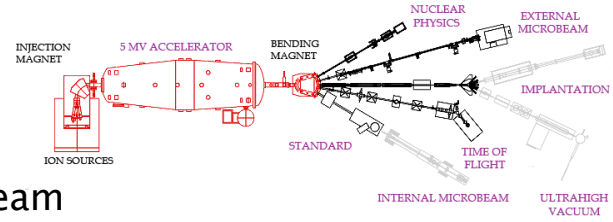
CMAM: Centre for Micro-Analysis of Materials

Staff

A staff of 23:

- 10 scientists,
- 3 PhD students,
- 8 technicians,
- 2 administrative

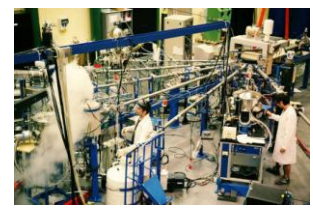
Beamlines

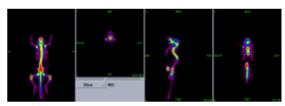


- Standard
- External μ–beam
- ERDA–ToF
- Nuclear Physics
- Internal μ–beam

- Under commissioning
  - Implantation,
  - UHV–line,

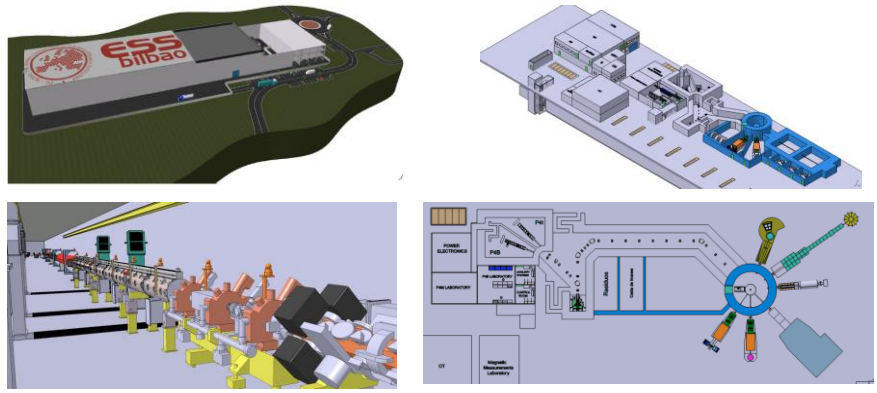
CNA: Centro Nacional de Aceleradores





- **Centro Nacional de Aceleradores (US, JA, CSIC). It includes:**
  - 3 MV Van de Graf tandem
  - 1 MV Cockcroft-Walton tandem.
  - 18 MeV Cyclotron
- **Main activities:**
  - Material science
  - Applications to environmental science
  - Basic science: instrumentation, nuclear physics
  - Dating using ^{14}C technique
  - Radio pharmacy
  - Bio-medical research

EES-Bilbao: European Spallation Source Bilbao



The ESS-Bilbao (ESSB) light ion linear accelerator has been conceived as a multi-purpose machine, useful as the core of a new standalone accelerator facility in southern Europe giving support to local beam users and accelerator physicists, as well as fulfilling specifications so as to serve as a driving injector for the European Spallation Source (ESS) once this latter project gets off the ground.

EES-Bilbao: Some figures of merit

Work groups

Beam Physics (4 Ph D´s)
Electromagnetic Design (3 Ph D´s, 2 Eng.)
RF- Systems – (2 Ph D´s 2 Eng.)
Beam Diagnostics – (3 Ph D´s 4 Eng.)
Control & Synchronization (4 Ph D 1 Eng.)
Power Electronics (1 Ph D, 2 Eng)
Ion Sources (3 Ph D´s)
Nuclear Engineering and Fluid Dynamics (2 Ph D´s, 6 Eng.)
Mechanical and Thermal Engineering design (1 Ph D, 6 Eng)
Advanced Welding Facility (4 Eng.)
Conventional Facilities & Plant Engineering (2 Eng.)

Components and subsystems built so far

2 Ion Sources (H+ ECR and H- surface Penning)
1 Low Energy Beam Transport section
1 352 MHz 4 vane Radiofrequency quadrupole: 1 m Cold Model finished; main structure, RF coupler, tuners and pickups under manufacture
1 Low level RF control system: first prototype already built and fully tested
1 RF Test Bench for conditioning of 352 MHz structures and subsystems
2 High Power (3 MW peak) converter/modulators
1 Medium Energy Beam Transport System under prototyping
4 Sets of beam diagnostics: button + stripline BPM, double SEM grid, Allison scanner, beam spectrometer

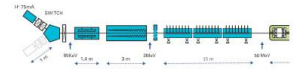
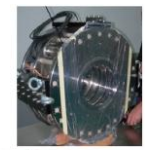
EES-Bilbao machine parameters

Tabla 2.1: Parámetros básicos de la instalación

Máxima energía cinética del haz	60	MeV
Corriente máxima	75	mA
Frecuencia máxima de repetición	30	Hz
Frecuencia de paquetes (bunches)	352.2	MHz
Máxima duración del pulso	1.8	ms
Especies a inyectar	H^+ y	H^-
Longitud elementos de aceleración	29.5	m
Emitancia normalizada en extracción (T)	0.34 π mm mrad	(norm.)
Emitancia normalizada en extracción (L)	0.20 π ° MeV	
	0.50 π mm mrad	(norm.)
Número total de klystrons	4	2.8 MW en pico
Eficiencia de RF	0.85	
Errores tolerables		
En gradiente de cuadrupolos	±0.5 %	
En posición	±0.1 mm	
En alineamiento angular	± 0.5° (x,y)	0.3° (z)
En fase cavidades RF	± 1°	
En amplitud cavidades RF	±1 %	
Transporte a blancos		
Malla óptica	FODO	7 m
Número total de celdas	5	
Grad. max. cuadrupolo de trasporte de haz	2.08 T m^{-1}	
Disp. extracción	kicker	dipolo
Blanco de generación de neutrones		
Material	Be metálico	100 % ^{9}Be, 1.848 g cm^{-3}
Estructura	Disco rotatorio	92 cm O.D / 68 cm I.D.
Moderador primario	CH_4	12 cm × 4 cm × 12 cm
Flujo a 10 meV	[n/cm^2-eV-Se-MW]	8.09 × 10^{11}
Moderador intercambiable	$p - H_2$	12 cm × 12 cm × 14 cm
Flujo a 10 meV	[n/cm^2-eV-Se-MW]	1.63 × 10^{12}
Reflector	Be metálico	Cilindro 80 cm∅ × 120 cm

Tabla 2.2: Parámetros básicos de los elementos del acelerador

Elemento Unidad	Long. m	Energ. MeV	No. Cavs.	No. Gaps	Pot. RF MW	No.Klystrons
Fuente	1.5	0.075	-	-	-	-
LEBT	4					
RFQ	3.9	0.075 - 3.0	1	560	1.2	1
MEBT	3	3	2	-		
DTL	14.6	3 - 50	3	85	3.8	3
Spokes	3.5	50 - 60	2	4	0.8	1





EES-Bilbao: International cooperation

LRF-Huelva: Linac Research Facility

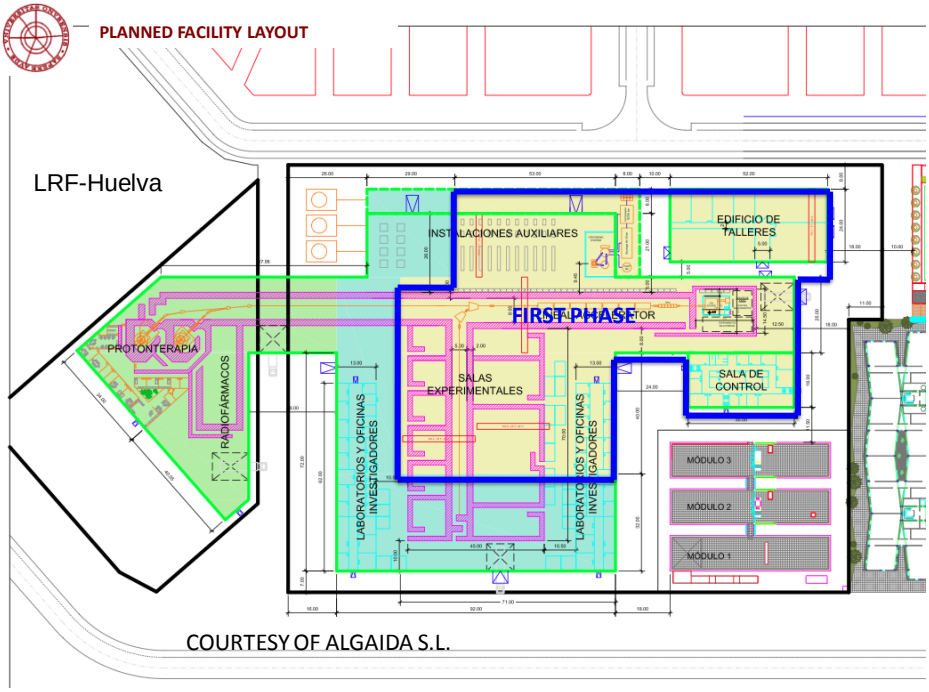
The **Linac Research Facility (LRF)** is foreseen to be a user oriented facility for producing intense HEAVY ION BEAMS for basic research on nuclear physics and applications.

HIGH INTENSITY SUPERCONDUCTING LINAC:

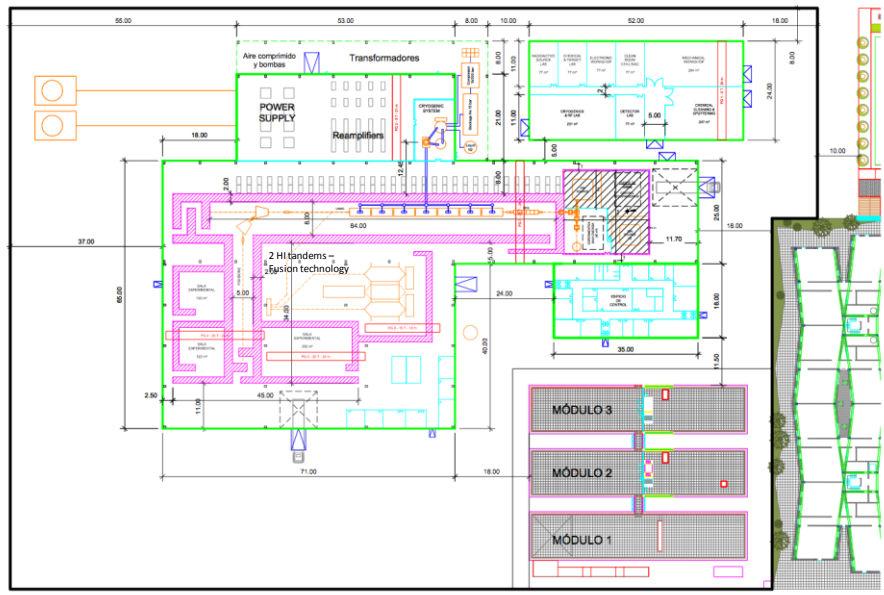
- Wide range of heavy ions
- Wide range of energies, from keV/u ~15 MeV/u
- Maximum intensity for HI (~100uA, ^{40}Ar)
- protons up to 30 MeV (~1 mA); up to 70 MeV (nA)

RESEARCH & APPLICATION PROGRAM
Basic nuclear physics: reactions & structure, astrophysics, superheavies; exotic isotopes(IGISOL)
Materials for Fusion and Fission energy
Aerospace
Medical applications: Radioisotopes & Proton therapy

PLANNED FACILITY LAYOUT



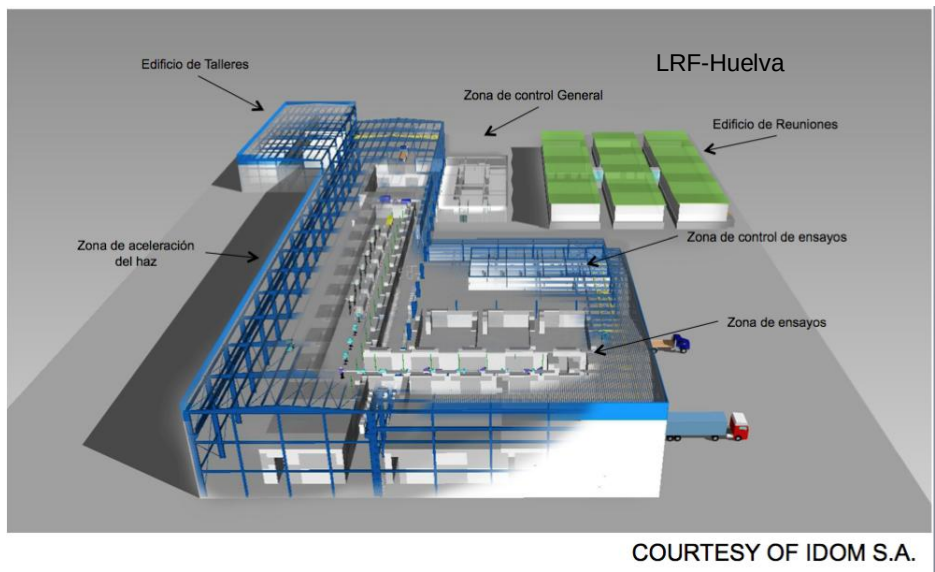
COURTESY OF ALGAIDA S.L.



COURTESY OF ALGAIDA S.L.

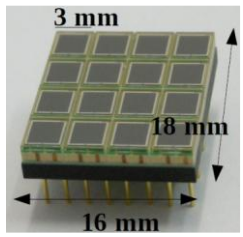
LRF-Huelva

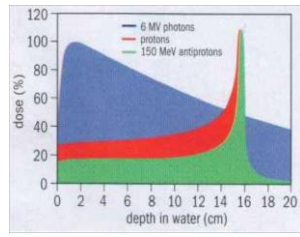
I. Martel, University of Huelva (Spain)

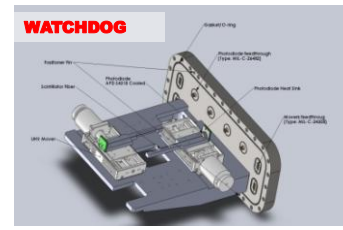


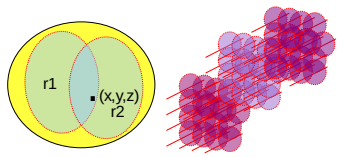
I. Martel, University of Huelva (Spain)

IFIMED: research in imaging and accelerators applied to medicine

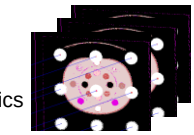








IFIMED is conceived to be the Spanish Reference Centre for Imaging and Particle Accelerators for Medical Physics. The activity of the groups is carried out on an international context: since 2007, IFIMED is a member of ENLIGHT European Platform



Motivation and research in:

- Accelerators for Medical Physics
- Radiation Detectors
- Image Science
- MonteCarlo Simulation in GRID

Accelerator R&D activities: CIEMAT

CIEMAT Accelerator Technology group

In the year 2008, CIEMAT created a Particle Accelerators Unit with 25 people up to now. It absorbs the former Applied Superconductivity Group and the facilities located at another Institute, CEDEX. Presently it is part of the Electrical Engineering Unit where other activities such as Energy Management, are also developed.

Capabilities

- **Calculations**: electromagnetic, thermal and mechanical and beam dynamics simulations
- **Engineering design**
- **Prototyping**: fabrication and assembly of magnets, RF structures and other accelerator devices
- **Tests**: two vertical cryostats, one cryocooler and low power RF measurements

Accelerator R&D activities: CIEMAT

Facilities

Main Offices (Moncloa)

CIEMAT Winding Machine

Energy & Superconductivity
(J. Camarillo)

Accelerators Components (J. Camarillo)

Accelerator R&D activities: CIEMAT

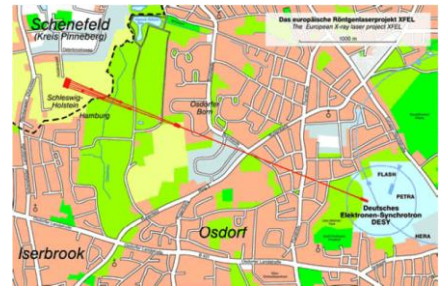
CIEMAT Accelerator Group Activities

Accelerators	Energy
Large Facilities ↓	***Storage*** ↓
XFEL	SA^2VE
FAIR	ACEBO
CLIC	TRAIN2CAR
SuperLHC	EERA
ILC (DANTE)	***Production*** ↓
IFMIF	SuperTURBINES
TIARA	SeaWEDGE
Small Accelerators ↓	UNDIGEN
MICROTRON	IISIS
CYCLOTRON (AMIT)	

CIEMAT Contribution to the E-XFEL Project

E-XFEL

The European X-ray Free Electron Laser Facility (E-XFEL) will be based on a 17.5 GeV electron Linac.
Its beam will be used in three undulator systems to obtain ultra-brilliant X-ray flashes from 0.1 to 6 nanometres for experimentation.



CIEMAT Contribution:

LINAC

UNDULATORS

- 103 Combined Superconducting Magnets
- Prototyping of Phase Shifters
- 91 Closed-Loop Quadrupole Movers
- 91 Intersection Control Racks

Accelerator R&D activities: CIEMAT

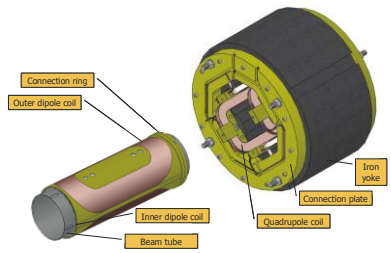
Combined Superconducting Magnets

E-XFEL

The cryomodules of the E-XFEL linac will be equipped with one combined superconducting magnet package per module, which consists of

- **One Superferric quadrupole** for focusing
- **Two dipoles** (horizontal and vertical) for steering the beam, glued around the beam tube

Both enclosed in a stainless steel vessel.



• Five prototypes have been fabricated and several designs have been implemented.

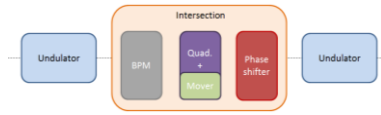
• Series production of 102 units is ongoing. Five of them have been already successfully cold tested.

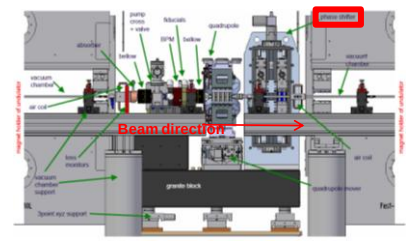
Accelerator R&D activities: CIEMAT

Phase Shifter

E-XFEL

The undulator systems in E-XFEL are formed by 5m long undulator segments and 1.1 m long intersections in between. They accommodate a quadrupole on top of a precision mover, a beam position monitor, two air coil correctors and a phase shifter.





Phase shifter

The phase shifter developed by CIEMAT is a permanent magnet device and it will be located at the end of the undulator system intersection.

Goal: To adjust the phase of the electron beam with respect to that of the radiation field when the wavelength is changed by tuning the gap

- Three prototypes have been fabricated by CIEMAT.
- Magnetic acceptance tests have being performed at CELLS.
- Call for tenders for series production is made by E-XFEL.

Accelerator R&D activities: CIEMAT

Quadrupole mover

E-XFEL

The quadrupole mover with submicron repeatability will be used in the intersections of the Undulator Systems of the E-XFEL. The main specifications include submicron repeatability for a 70 kg quadrupole magnet within compact dimensions and a ±1.5 mm stroke in the vertical and horizontal direction.

MAIN FUNCTIONS

1.-Quadrupole positioning

2.-Off-centring corrections

3.-Quadupole/Intersection tolerances relaxing.

PROJECT STATUS

- Two prototypes have been fabricated by CIEMAT
- Acceptance tests have been successfully performed
- Pre-series of three units successfully delivered (Sept. 2012)
- Series production of 89 units after green light.

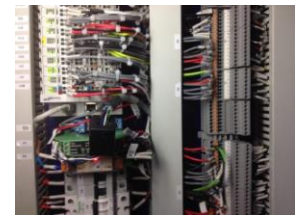
Accelerator R&D activities: CIEMAT

Intersection control rack

E-XFEL

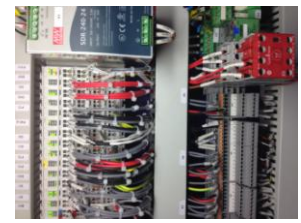
The electronics for the mover and phase shifter local control system are embedded in a common rack.

MAIN FUNCTION: Local control system of mover and phase shifter.



PROJECT STATUS

- The first prototype has just been sent for approval to E-XFEL.
- Three pre-series units will be fabricated after green light.
- Then a series production of 88 units is necessary.

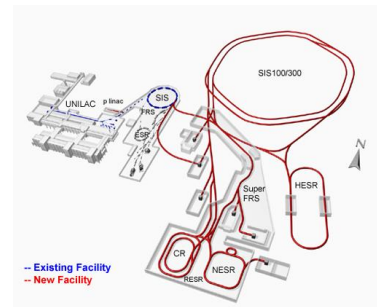


Accelerator R&D activities: CIEMAT

CIEMAT Contribution to the FAIR project

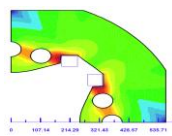
FAIR

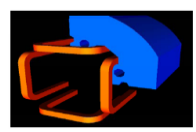
FAIR (Facility for Antiproton and Ion Research) which will be located at GSI, Darmstadt, consists of 8 circular accelerators, 2 linear accelerators and 3500 m. of beam transport.



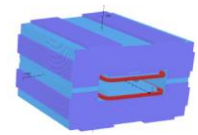
- Since 2004, CIEMAT has been collaborating in FAIR
- The final CIEMAT contribution is not well defined yet
- Two possible alternatives are:
  - ✓ Multiplets for the SFRS
  - ✓ Superferric dipoles for the SFRS

CIEMAT performed a design for the SFRS Multiplets Quadrupoles which was finally selected among other candidates.





Presently, it is likely that CIEMAT contributes with the fabrication of 8 superferric superconducting dipoles for the SFRS. The first prototype has been developed in China.



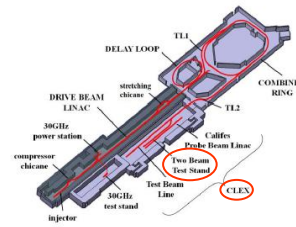
Accelerator R&D activities: CIEMAT

CLIC

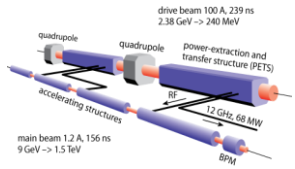
CLIC: PETS

CIEMAT collaborates with the CLIC Test Facility 3 (CTF3) since 2004, which main aim is to demonstrate the feasibility of the two beam scheme of the e-e+ linear collider CLIC

Orbit correctors, stripline kickers, septa magnets and quadrupole movers have been already delivered. CIEMAT has been working in PETS for CTF3 since 2007 and still keeping the effort.



PETS



CLIC module. Source www.clic-study.web.cern.ch

- PETS (power extraction and transfer structures) are part of the accelerating modules for CLIC.
- Their function is to extract power from the drive beam and transfer it to the main beam.

- The particles interact with the corrugated structure, converting the beam energy into electromagnetic energy.
- The RF power flows through the structure and is collected at the end by a power extractor and then carried through rectangular waveguides to the accelerating structures.

Accelerator R&D activities: CIEMAT

CLIC

CIEMAT contribution to PETS

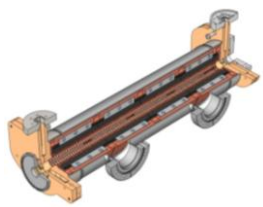
Test Beam Line in CTF3:

Study and validation of the drive beam stability during deceleration.

Scheduled 16 PETS (TBL with 12 PETS in 2012)

- First prototype:
  - Engineering design.
  - Fabrication and assembly
  - Low power RF Test.
- Series production:
  - Implementation of modifications.
  - Assembly of 3 PETS.
  - Low power RF test.
  - Fabrication of several parts for 8 tanks + 4 more tanks

CIEMAT Contribution to the Double Length CLIC PETS



PETS designed by CERN to generate RF power in **CLEX MODULE.**

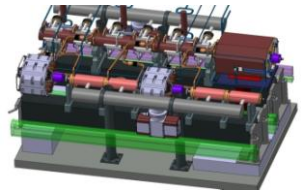
- Engineering design.
- Fabrication and assembly.
- Low power RF Tests.

Accelerator R&D activities: CIEMAT

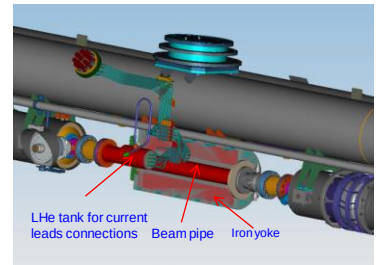
CIEMAT Contribution to the DANTE project

DANTE

CIEMAT & IFIC collaborate in the development of new technologies for future linear colliders (the DANTE project)



CLIC Module



Superconducting magnet fot ILC (courtesy of V. Kashikhin, Fermilab)

CIEMAT Tasks:

- **ILC:** Conceptual design of a superconducting magnet combined with indirect cooling
- **CLIC:** Engineering and fabrication of a second prototype of PETS for the First CLIC module.

Accelerator R&D activities: CIEMAT

CIEMAT Contribution to the SLHC-PP

SuperLHC

• CIEMAT has collaborated in the Super LHC Preparatory Phase Project (2008-2011).

• The main goal of the project is to increase the luminosity of the LHC (Hi-Lumi LHC).

• It is foreseen to change the magnets close to the intersection points, with higher aperture and radiation resistant magnets.

• CIEMAT has successfully developed two superconducting corrector magnets:

- One **superferric sextupole**
- One radiation resistance **superferric octupole**.

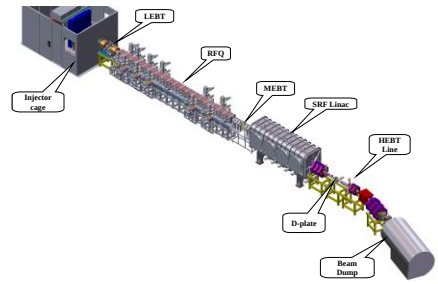
CIEMAT Contribution to the IFMIF Project

IFMIF

CIEMAT is collaborating in the International Fusion Materials Irradiation Facility (IFMIF), in the EVEDA Phase.

CIEMAT contribution to LIPAC accelerator is: 175 MHz RF systems, SRF magnet package, transport lines, 1.2 MW beam dump, beam dynamics, local control systems and beam instrumentation

Most of these packages are being developed by the Fusion group.



Accelerator R&D activities: CIEMAT

CIEMAT Contribution to the IFMIF Project

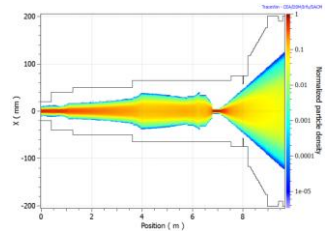
IFMIF

Beam diagnostics: BPMs , emittance & energy spread measurements, ...

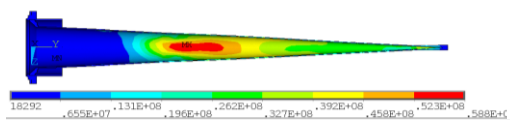
Superconducting coils for SRF linac

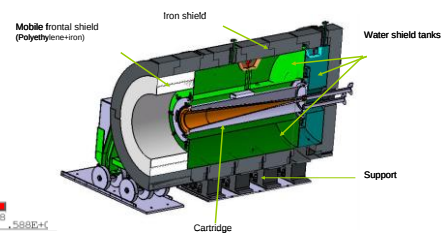
Prototype BPM

BEAM DYNAMICS



BEAM DUMP

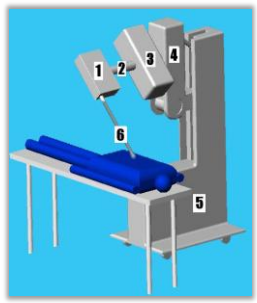


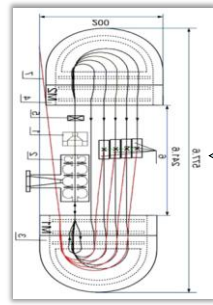


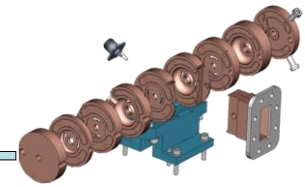
Microtron R&D Activities.

MICROTRON

A compact race-track microtron (RTM) was developed in collaboration with UPC and SINP







The CIEMAT contribution was the radiofrequency (RF) design of the 2 MeV C-Band Linac, the mechanical design and thermo mechanical calculations and to follow-up the machining procedure.

The LINAC was successfully finished.
The project is currently in the integration step.

Accelerator R&D activities: CIEMAT

The AMIT Project

AMIT

AIM OF THE **AMIT** PROJECT: Development of the core technology for molecular imaging in Medicine and Biomedicine. It is divided in 4 WP: 1) Efficient radioisotopes production 2) New techniques for radiopharmatheutical synthesis 3) New instrumentation techniques for image acquisition and 4) quantitative data processing.

WP1: Development of a Compact Superconducting Cyclotron for ^{11}C (100mCi) and ^{18}F(40mCi) production.

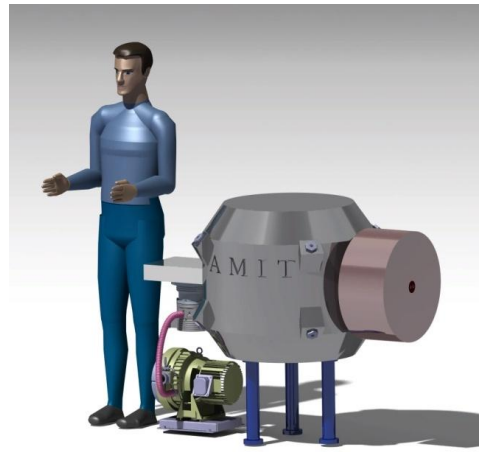
CYCLOTRON SPECIFICATIONS

PARAMETER	VALUE	UNITS
Energy	> 8.5	MeV
Current	>10	µA
Ions	H-	
Magnet	Superconducting (LTc)	
Central Magnetic Field	4	T
Extraction radius	105.3	mm
Weight (exc. shielding)	< 2000	kg

Accelerator R&D activities: CIEMAT

Cyclotron General Layout

AMIT



The aim of the AMIT project is to develop the smallest possible cyclotron able to achieve the required energy. Presently, the proposed machine will weight around 1500 kg with an external diameter of about 800 mm.

Accelerator R&D activities: GAP at IFIC

RESEARCH ACTIVITIES

- Collimation systems studies for Circular Colliders (LHC) and Future Linear Colliders (CLIC).
- Optics studies for the Luminosity upgrade of LHC
- Optics Design and Beam Instrumentation studies for the Beam Delivery System of Future Linear Colliders (ILC and CLIC).
- Beam Dynamics studies for the EXT line of ATF-ATF2.
- Design and Construction of Beam Instrumentation:
  - Inductive Beam Position Monitors for CTF3;
  - Optical Transition Radiation Monitors for ATF-ATF2;
  - Beam Position Tunning for Hadrontherapy Facilities;
  - Stripline Kickers for CLIC Damping and Pre-Damping Rings;
- Cyclinacs for hadrontherapy applications.

COLLABORATORS

- **Doug McCormick**
- **Glen White**
- **Gabriel Montoro**
- **Fernando Toral**
- **Álvaro Lara**
- **Iván Podadera**
- **ATF2 team**
- **Yannis Papaphilippou**
- **Mike Barnes**
- **Maurice Haguenauer**
- **Patrick Poilleux**

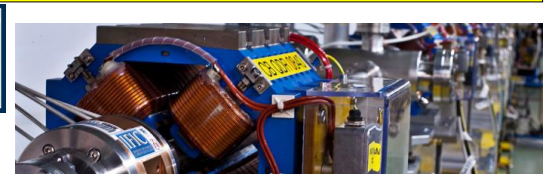
PEOPLE

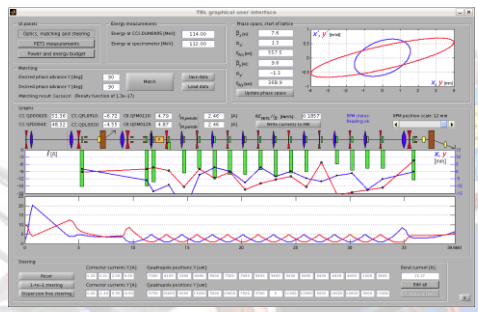
- **Dr. Angeles Faus-Golfe** (CSIC researcher)
- **Juan José García Garrigós** (Electronical engineering)
- **César Blanch Gutiérrez** (Mechanical engineering)
- **Dr. Javier Resta López** (Postdoc Juan de la Cierva)
- **Dr. Luisella Lari** (Postdoc EUCARD)
- **Silvia Verdú Andrés** (PhD PARTNER)
- **Javier Alabau Gonzalvo** (PhD Bancaja)
- **Carolina Belver Aguilar** (PhD FPI)
- **Alfonso Benot Morell (**PhD Especialización Infraestructuras Científicas y Organismos Internacionales)
- **Núria Fuster Martínez** (PhD Student UV)

Accelerator R&D activities: GAP at IFIC

RESEARCH ACTIVITIES:
DESIGN AND CONSTRUCTION OF BEAM INSTRUMENTATION

1) Inductive Beam Position Monitors for CTF3





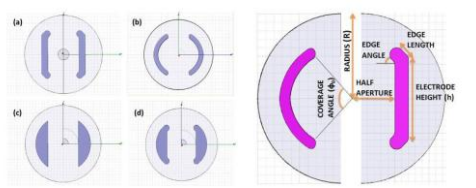
MEASUREMENT OF THE POSITION WITH THE BPS's IN THE TBL OF CTF3-CLIC

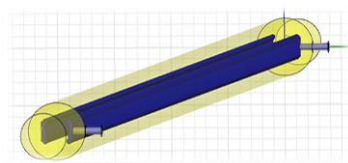
Accelerator R&D activities: GAP at IFIC

RESEARCH ACTIVITIES:
DESIGN AND CONSTRUCTION OF BEAM INSTRUMENTATION

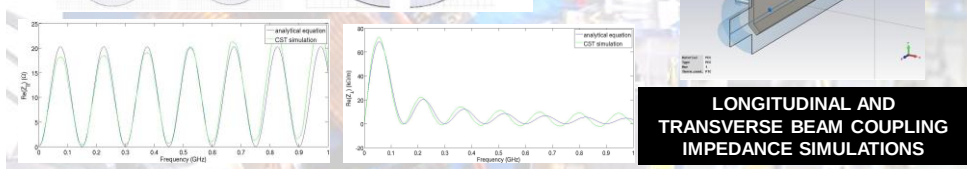
4) Stripline kickers for CLIC Damping and Pre-Damping Rings

CROSS SECTION OPTIMIZATION





STRIPLINE ELECTRODES

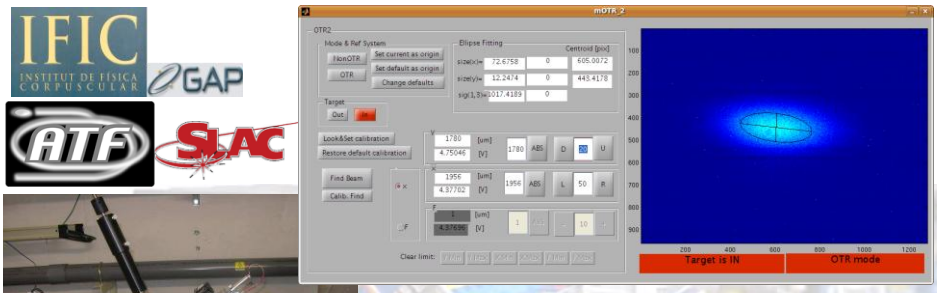


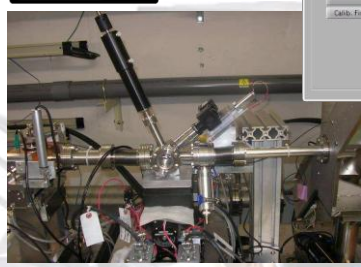
LONGITUDINAL AND TRANSVERSE BEAM COUPLING IMPEDANCE SIMULATIONS

Accelerator R&D activities: GAP at IFIC

RESEARCH ACTIVITIES:
DESIGN AND CONSTRUCTION OF BEAM INSTRUMENTATION

2) Optical Transition Radiation Monitors for ATF-ATF2





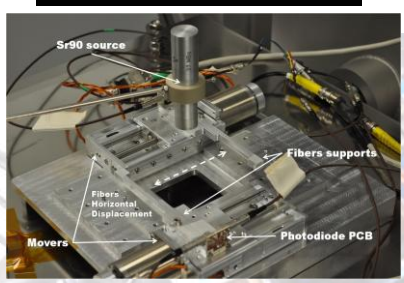
MEASUREMENT OF THE EMITTANCE AND BEAM SIZE IN ATF2 KEK WITH THE MULTIO-OTR SYSTEM

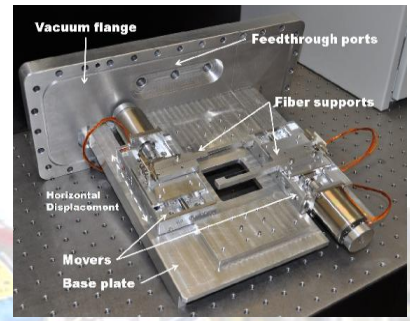
Accelerator R&D activities: GAP at IFIC

RESEARCH ACTIVITIES:
DESIGN AND CONSTRUCTION OF BEAM INSTRUMENTATION

3) Beam Position Tunning for Hadrontherapy Facilities

FIRST CALIBRATION TESTS





WATCHDOG PROTOTYPE

Summary

- **Spanish accelerator Infrastructures:**
  - **ALBA (Synchrotron Light Source, Barcelona)** A major technological achievement in Spain**.** A huge and successful effort which has started its exploitation.
  - **CMAM (Madrid) and CAN (Sevilla)** very useful centers providing *mainly* a national support to science (material, nuclear, etc..) and applications (radio-pharmacy, etc..).
  - **ESS-Bilbao,** new infrastructure in construction.
  - **LRF-Huelva, IFIMED (Valencia)**, infrastructures in preparatory phase or consideration.
- **R&D activities and groups:**
  - **CIEMAT (Madrid):** a consolidated and experienced group with many international collaborations. Important contributions to many projects with novel accelerator techniques.
  - **IFIC (Valencia):** a young, active and very motivated group which has interesting and visible contributions to some of the most challenging projects of the field.
  - **CIEMAT and IFIC** have an essential role for training young accelerator physicists and engineers. A good cooperation between the two groups is observed and needs to continue being supported.