ALBA NEWSLETTER

Number 3, September 2007

INTRODUCTION

This third issue of the ALBA Newsletter briefly describes the progress of the project (Civil Engineering, Accelerator, Experiments and Support Groups) and also includes brief reports of two recent scientific meetings that might be of interest to some future users.

This year 2007 is being very active in terms of contracting equipment. From January to the beginning of September, 53 contracts have, or are in the process of, being placed. To mention some: equipment for the Radio Frequency Laboratory, pulsed magnets and power supplies, girders for the booster, front ends for all the Phase I beamlines, helical undulators, superconducting and conventional wigglers, in vacuum undulators, five monochromators (3 hard x-ray and two soft) , 12 mirrors, vacuum and control equipment and two interferometers for optical metrology. This activity will continue in the next few months. As today, 73 % of the total budget of the project is already committed; most of the remaining one is distributed between Accelerator and Experiments Divisions.

The staff working within the project consists in 119 persons distributed in divisions as indicated in figure 1. Essentially staff is relatively young, as 55 % are below 35 years old. The distribution per nationalities is shown in figure 2. Apart from the main nationalities shown in the figure, there is staff from Belgium, China, Slovenia, Iran, Jordania, Letonia, Portugal, Sweden and Switzerland

Fig. 1

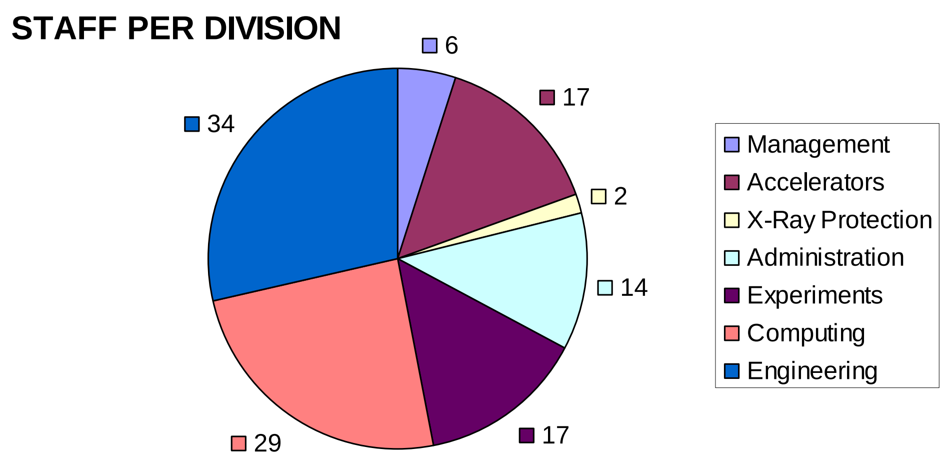
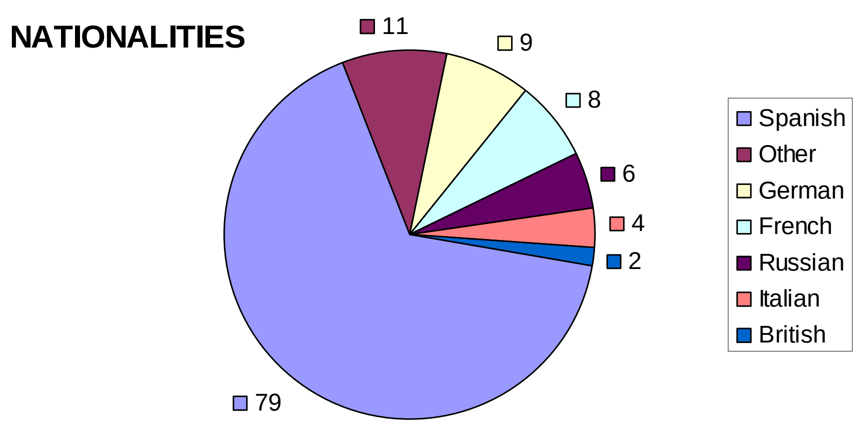


Fig. 2



CIVIL ENGINEERING

CELLS site occupies an area of 6 ha. between Cerdanyola del Vallès and Sant Cugat del Vallès, about 20 km from Barcelona, at 106 m above the sea level. The building complex will have a total useful surface of 28000 m^2, from which approximately 18.000 m^2 corresponds to Scientific Areas, 4.500 m^2 to Offices and 5.500 m^2 to Technical Services.

During the last year has been approved an execution of a storage building on the south part of the site, this new building will permit an additional 2.000 m^2 that could be used for pre-assembly of ALBA machine, temporary laboratories and storage area. This new building is foreseen to be available for CELLS by the end of 2007.

The civil works at the ALBA building started on June 2006 and now, a little bit more than one year later, there are several companies present on site and the construction schedule is running its way with no significant delays for the time being. By the end of October 2007, the Linac bunker will be finished completely and the first accelerator of the ALBA complex will be assembled on site as it was foreseen.

From the beginning of the civil works, more than 150.000 m^3 of soil were removed, the service gallery which connects technical and main building was built before the concrete slab of the critical area (dimensions of this slab are 120 m outer diameter, 60 m inner diameter and 1 m thickness). The whole critical slab was divided into 20 sectors, and produced one by one in such a way that the corresponding concrete volume was poured in one day, and the corresponding work properly executed. More than 10.000 m^3 of concrete have been poured during its execution.

During all the process of construction of the slab, the Survey & Alignment Group took advantage of the availability of lines of sight from the external pillars to install and measure more than 80 ground reference marks spread on the Linac bunker, tunnel and experimental hall. In collaboration with a workshop team, the final network will include around 300 references to be ready to align the first components of the machine before the end of the year.

Fig.3 Concrete being poured in a slab sector

Fig.4 The 1m thick concrete slab

In parallel the ALBA tunnel walls were erected and part of them are made by heavy concrete, a barite mix with a minimum density of 3.2 Tm/m^3. The walls allow achieving a monolithic behaviour, as ribs for the concrete slab since this provides a good behaviour of the critical slab where the accelerator and beamlines will be installed against the possible movements of the soil underneath.

Fig.5 View of the slab and the walls of the tunnel.

The roof of the ALBA tunnel will be 1 m thick of concrete prefabricated elements. The front walls and the removable roof will be cast in a factory and then transported and assembled at the site. All front walls are made of heavy concrete. The execution of all these prefabricated elements will finalise in October 2007.

In April 2007 the erection of the steel structure pillars started and in summer the first part of the roof has already been assembled.

During the next months until the end of the civil works, several specialised firms will execute all conventional installations, it means electrical, cooling, HVAC (High Voltage Alternate Current) of all ALBA facilities, finalizing by mid 2008.

Electrical Power

During standard operation, ALBA will consume about 9 MW of electrical power. In order to deal with peaks of consumption and future expansions a total of 12 MW will be installed. From the 9 MW of consumed power, about 4 MW will feed the accelerator and beamlines, 4MW will be devoted to cooling and HVAC and the remaining 1MW to offices, workshops and laboratories.
In due course power will be achieved by individually connecting ALBA to a 220 kV line via a transformer or to a co-generation plant.

During the installation phase power will be obtained from a provisional power line on the 25 kV bar.

In case of a brief power failure, the critical equipments of the accelerator and beamlines will be feed by four dynamic UPS (Uninterruptible Power Supply) equipped with a flywheel that will provide filtered power for 12 s. For longer failures, static UPS together with a Diesel engine will guarantee the supply. For very long failures the installation will have two sets of generators equipped with Diesel engines to ensure the supply of the critical components.

Fig.6 View of the site (18/07/07)

COMPUTING AND CONTROL

The Computing and Control division takes care of covering the computer needs of the employees and also of preparing for the control of the synchrotron accelerators and beamlines. The building with its scientific installations will need the support of computing in all its components. The division was therefore involved in most call for tender procedures and standardizations. Many demands have been analyzed and centralized to be able to carry out this standardization for better functionality and easier maintenance. This has put an enormous stress on the people doing this work but has leaded in addition to the points mentioned above lead to significant budget savings. One could mention here the computers, PLCs (Programmable Logic Controller) and motor controllers on one side but also the racks and the cabling. Also in this phase of the project general procedures are being defined (budget management, holidays, overtimes...) which require the active support of the division. But let's now look into the different areas now with more details.

Computing Infrastructure

The network at Alba installation keeps growing rapidly most notably in the workshop. In August more than 430 devices were connected.

As more and more users are now working at the construction site all necessary IT (Information Technology) service have to be supplied also at the site. At the moment, the connection is provided by an encrypted ADSL-VPN tunnel making the remote subnet a part of CELLS network in a transparent manner. A dedicated microwave connection between the UAB C5 building and the site is foreseen to be installed as soon as possible.

The most important services will be provided by local servers at the site which will be synchronized with our existing ones. These "local servers" will run on the same hardware using the so called virtualization of operating systems. This helps keeping the hardware at a minimum as there is no real server room at the site.

The renovation of our mail system has been finished successfully. All users have been migrated to the new server where they can enjoy a lot more space. And for the constantly growing number of users many existing services had to be upgraded: the storage area, more printers, more Citrix users, etc.

Fig. 7 View of the electronics lab.

Installation

Installation of the Radiofrequency laboratory (RF lab) is in process. The control system for the RF Plant is ready for commissioning. A complete tango installation is set up for the lab, including a control system for the Vacuum, with synoptics, trend charts and archiving facilities, PLCs for the interlocks and temperatures readout, stepper motor control for plungers and integration of Low level regulation control for Radio Frequency. The PSS (Personnel Safety System) for the RF plant is installed and ready to be commissioned.

Fig.8 Prototype of the PLC B&R for interlocks.

Hardware for Computing and Control

Contracts for supplying the hardware components for the timing system, equipment protection system for magnets, vacuum, insertion devices, front-ends and beamlines are signed. Offers for network infrastructure and switches, racks, crates and Industrial PCs have been received and are currently under evaluation. Technical specifications for the call for tenders for CCD (Charge Coupled Device) cameras for fluorescence screens will be ready in September 2007.

Personnel Safety System (PSS)

A contract with Pilz has been signed for the delivery, installation, commissioning and validation of the PSS for the RF laboratory, Linac , Booster and Storage ring . A call for tender for the turn-key PSS for 7 beamlines has been published in August, and the contract signature is foreseen in October 2007.

The PSS for the RF laboratory has been already installed and it is ready for commissioning. PSS for Linac and Tunnel is under construction.

Motion Control

A contract has been signed with Duhamel to manufacture the number of Icepap motor controllers required by Alba. Two deliveries are scheduled. The first one, in November 2007, includes 35 racks, 35 master modules, 35 slave modules and 280 driver modules. Later, in February 2008, Alba will receive 40 racks, 40 master modules, 40 slave modules and 220 driver modules.

Consequently, needs for motor control of accelerators and beamlines are fulfilled.

Electronics Laboratory

The electronics laboratory is fully operational, managing a pool of dozens of devices available on loan. The lab is multipurpose. Most projects have tasks to be performed in the lab, i.e. PLC prototypes, electronics developments, software development for various cards, etc.

Electronics Devices

The computing division has developed some electronics for the different projects. IPAP drive is an interface for the Middex BCD 140 driver with the Icepap motor controller, which is housed in a slot of the Icepap chassis.

PLocum is a junction box for the Locum XBPM (X ray Beam Position Monitor) that will be installed in the front ends with the data acquisition boards, and with the timing system.

PBLM is another junction box to interface the Beam-loss Signal Conditioner from Cosylab with the ALBA control system.

Management Information Systems (MIS)

After evaluating different ERP (Enterprise Research Planning) solutions, The MIS section recommended SAP Business One as the next ERP to run all the different areas of CELLS administration (Finance, Purchasing, Inventory, Fix-Assets, Projects, HHRR).

The implementation of SAP B1 will give CELLS a single system that covers all the administrative processes. This will enable to reduce time spent on administrative tasks, better control of data for internal accounting purposes, generate real time reports to inform management and more.

The implementation of SAP B1 will start in September and is expected to last 4 months including training and in-house development of necessary add-on packages. Once the system has been implemented our current Intranet will be integrated with the new system.

Cable Database

The computing division has developed a cable database, now accessible from our Intranet to anyone with a login. This database will store data of all cables, connectors, equipments and racks of the entire synchrotron. The cable database will be a great tool that will help us with the cable routing, cable tender documentation and installation. The system will also be the central point of documentation for all the divisions. We are now in the process of entering data but there are already 282 racks and thousands of equipments and cables. You can have a look at all this information, reports and documentation at: http://www.cells.es/Intranet/MISApps/ccdb

Overtime Management System

The computing division has developed a web application to manage the overtime. The application is based on the new collective agreement. It includes an approval workflow and integrates perfectly with our current absence/holidays application. Users will be able to ask time off "recuperation overtime" directly from the absence/holiday application. The system will also inform administration of all overtime that needs to be paid. Currently the system is being tested but in the next few weeks it will be in our Intranet ready to use.

ACCELERATOR DIVISION

The accelerators of ALBA are now entering a critical phase. The design of almost all components is finished, testing of the prototypes of the main components has been performed or is under way, series production is starting and at the end of the year we will enter into the next phase with the installation and commissioning of the LINAC.

Beam Dynamics

A detailed lifetime calculation, including the effects of the absorbers, has been carried up. For a coupling of 0.3%, a beam current of 400 mA and a minimum gap of 5.5 mm in the insertion devices the obtained lifetime is around 7 h.

The ALBA booster and storage ring are extremely sensitive to the integrated quadrupolar component on the combined magnets. Different models have shown discrepancies of few percent on the tune values. To obtain reliable results, a realistic modeling of combined functions bending magnets has been developed. To this end, a slicing procedure has been developed in Matlab to generate the input file for MAD/AT/Tracy from a field/gradient map. A procedure using transport matrices confirms the results found during slicing.

The fast orbit feedback system concept has been designed in collaboration with the Computing Division. It uses the same correctors foreseen for the slow correction system, and the communication scheme will be similar to that used at Diamond. The system will have at least 18 bit resolution full range, provides 40 mrad of correction at 100 Hz and 0 dB point close to 200 Hz

Finally, the planning for commissioning of the accelerators has started.

Beam Instabilities

The global impedance budget of the storage ring is almost finished. It is obtained by adding the individual contribution of each one of the vacuum components. One of the latest analyses has been to determine the space within two flanges of the vacuum chamber. The impedance and instability analysis has shown the need to reduce this distance from 0.4 mm to 0.2 mm. Also, the dimensions of the vacuum slits for the vacuum ports have been designed minimizing its influence in the beam stability.

From the impedance budget, the broadband model is obtained. The model for the transverse and longitudinal planes has been obtained. They are used to model the instabilities in the storage ring. Longitudinal instabilities are not foreseen, but transversally the onset of instabilities can occur at currents well below the design current. Also, the damping of the RW-instabilities with betatron tune spread generated by octupoles has been addressed, but without success. All these results confirm the need of the transverse feedback system for the storage ring.

Finally, in order to find an alternative solution to the cavity TE011 HOM induced instability at 400 mA, a computation of Landau damping by partial ring filling has been addressed. We found that with 2/3-filling, the onset of the instability can be shifted up to 476mA, which confirms the feasibility of ALBA design.

Injector

LINAC: the first accelerating section and the 1st klystron have passed the Factory Acceptance Test. Also the subhamonic prebuncher and the prebuncher have been finished, as well as the electron gun and the timer board. The meetings to plan the installation started on July 2007 and the installation at ALBA site will start in November 2007, as scheduled. Tests are foreseen between February and March next year, and tuning and commissioning is expected to take place in April of 2008.

Booster: From the point of view of beam dynamics, the closed orbit correction scheme has been confirmed; the aperture requirements and the dipole modeling have been finished, so the operation mode has been fixed. The current work is centered in the development of tools to be used during the commissioning period.

Injection: From the point of view of beam dynamics, the injection/extraction schemes have been fixed. The different hardware components have already been contracted and we are now in the design phase.

Magnets & Power Supplies

In what concerns the Storage Ring, the pre-series of quadrupoles and sextupoles have been received and approved. Magnetic measurements were performed at the manufacturer as well as at SOLEIL with comparable results. Now the series production has been started and the first batch is expected to be delivered at CELLS in November of 2007. Five more deliveries will follow. Also the combined function magnet pre-series has been received at the end of July and magnetic measurements have been done during August. These are being analyzed and will be used to determine the end chamfer to be used in the series production. The end chamfer has been designed to adjust the final focusing strength.

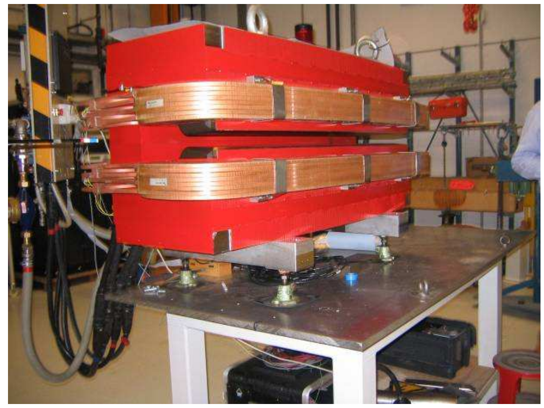


Fig.9 Storage ring combined function magnet pre-series

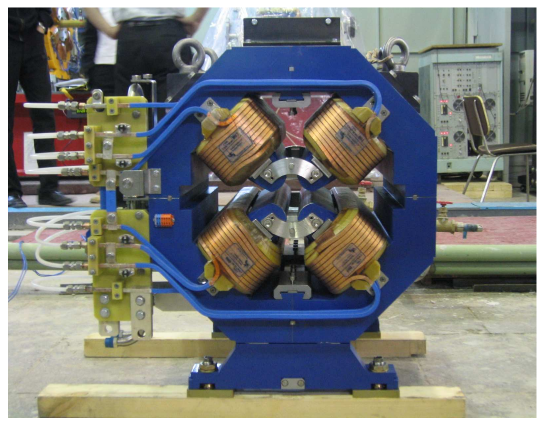


Fig. 10 Quadrupole magnet for the storage ring and series of sextupoles being built at BINP in Novosibirsk

Regarding the booster, the prototype of the dipole has been measured at Sigmaphi during August. Once measurements have been discussed and accepted, the series production will start. With respect to quadrupoles, the laminations have been accepted and three prototypes are under production. Their delivery is expected at the end of September. Finally, regarding sextupoles and steerers, the prototypes have been received and measured at CELLS. They have been accepted and series production is ongoing.

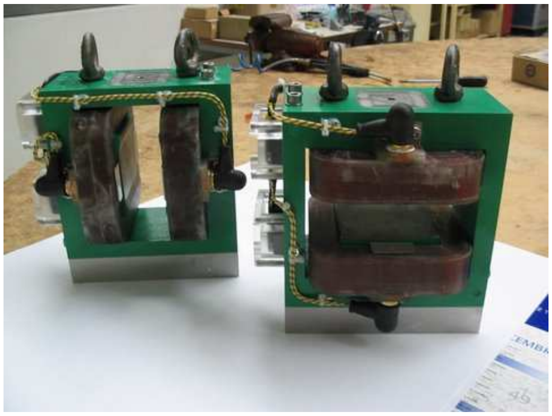


Fig.11 Booster steering prototypes. Booster sextupole prototype

With respect to power supplies, those for the Storage ring have been awarded to Hazemeyer, and their design has been completed. Pre-series of the quadrupoles and sextupoles power supplies are being built right now and will be tested before the end of the year. For the booster and the transfer lines, the power supplies have been awarded to Bruker, and their design is under final processing. Finally, for the closed orbit correction the power supplies for the corrector magnets are now under the tendering process.

Diagnostics

Regarding diagnostics, the first batch of electronic beam position monitors control units (Libera from I-Tech) have already arrived to CELLS and have been tested. Now, a new contract has been signed to upgrade them to Libera Brilliance which will improve the orbit control at the sub-micron level.

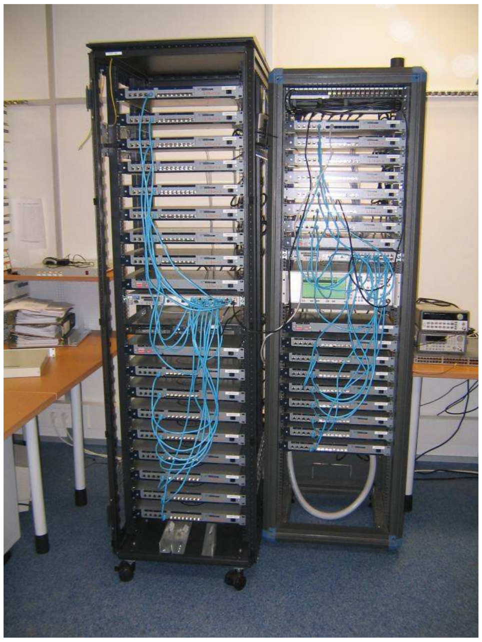


Fig. 12 Libera units installed in the electronics laboratory during testing

With respect to the BPM buttons (Beam Position Monitor), first series of buttons for the storage ring (FMB) and booster (Rial) have been delivered. All of them from the company Kyocera. The buttons are being tested at factory with excellent results. Sorting of the buttons by their electrical behavior is underway in order to minimize the electrical offset of each BPM block; this allows a better linearity and precision of the measurements of the beam orbit.

With respect the mechanics diagnostics system, the construction of all required components (DCCTs, FCTs, FS…) has been awarded to Cinel (May 2007). Construction drawings are being produced by Cinel and production will start in October. In this context, an optimisation of the electromagnetic transmission and reflection of the stripline feedthrough has been done.

Regarding electronics devices, a new call for tender is prepared for scopes, spectrum analyzers, streak camera, etc. Also the required hardware/software configuration to control Bergoz Beam Loss Monitors has been set, and a call for tender is expected before the end of this year.

In addition to that, a small optical laboratory will be built, to test the optical equipment required for the FS (Fluorescent Screen), SRM (Synchrotron Radiation Monitor), etc. An optical table has been bought as well as a remote control system with lenses, mirrors, focus and CCD cameras. The laboratory will be located at CELLS workshop.

Radio Frequency

The different components of a complete RF plant (cavity, transmitter, waveguide components, LLRF- Low Level RF, EPS- Equipment Protection System, and PSS- Personnel Safety System) have been already delivered, assembled and partially tested. In October a complete RF plant will be operational in the CELLS workshop for high power test, up to 80 kW.

For that purpose, a bunker inside CELLS workshop has been built and the construction, beside the CELLS workshop, of new cooling and power plants has been necessary. Authorization to operate the RF lab has been already given by legal authority, the “Consejo de Seguridad Nuclear”. The computing division has already installed and tested the PSS and EPS systems needed for high power operation.

The laboratory has been already used to test the performance of low level RF electronics, both digital and analog, including amplitude, phase and tuning loops. Both systems performing well and ready for the final test at high power.

Waveguides, circulator and loads have been installed and tested at low power, and also ready for high power test operation.

The pre-series SR Dampy cavity of the series have been tested at low power, resulting in good fundamental mode characteristics, but still showing one HOM (High Order Mode) impedance in the limit of the specifications (the E011 mode). Bake out and leak check of the cavity has been successfully performed together with the vacuum group. The cavity is ready for high power test. After the high power test, the production of the series will be re-started.

Fig.13 Waveguide and load installed over the bunker in the RF lab.

The first RF transmitter has been already installed and commissioning is under way.

Several call for tenders have been launched, regarding the cavity combiner (CaCo) and the arc detector electronics. Electronics equipment, like oscilloscopes, RF amplifiers and RF generators are included in the diagnostics tender.

Fig. 14 The prototype of the Dampy cavitiy and the Watrax for the storage ring.

Tenderings are in preparation for WATRAX and for the IOTs & Klystrons long term sales agreement.

Two collaboration agreements have been signed. One with DESY for the Booster Cavity and another with CIEMAT, where CELLS will provide the know-how for low level RF and waveguide design for the IFMIF project (within the framework of ITER).

Fig.15 Thomson and CELLS team during the transmitter installation in the RF lab.

Insertion Devices (IDs) and Front Ends

With respect to ID procurement, Apple-II undulators EU71, EU62 have been awarded to Elettra through a collaboration agreement, and contract is ready to be signed in September. Within this project, CELLS is developing the control system for a multi-axis ID, and a test bench is being built at CELLS workshop. Control system will use Tango tools and motors will be driven through Icepap motor controller.

The contract for superconducting wiggler SC-W31 has been awarded to BINP through a collaboration agreement, and the contract is ready to be signed in September. Final design review is foreseen in November / December 2007, including prototype tests.

Regarding conventional wiggler MPW80 and in-vacuum undulators IVU21, there is a tendering in process. First discussions with companies took place on August and the awarding of the contracts is expected by 1st of October.

In addition to that, integration of IDs into the ring has been addressed, both from the control point of view (cabling, racks, and control system) as well as the installation.

In what concerns Front Ends, the contract has been awarded on August to FMB.

Status of Other Components

- Vacuum: Vacuum chambers are under production. Three prototypes of the Storage Ring vacuum chambers have been received and tested at the CELLS workshop.

- Girders: A prototype of the girder for the Storage Ring has been received and measured, with special interest in the identification of the resonant frequencies. In order to make realistic tests, a complete set up of girder, magnets and vacuum chamber has been installed, as shown in the enclosed picture. This test has also been used to cross check the fiducialization and alignment system of the elements.

Fig.16 At the workshop after mounting magnets on a girder.

EXPERIMENTS DIVISION

Beamlines

All the designs of the optical components of the phase I beamlines have already been finalized and the corresponding technical documents are already written and published in Cells web site. Some beamlines are in the process of discussing and/or verifying preliminary designs which afterwards will evolve to the detailed designs for manufacturing. Others are in the process of discussing with companies in order to do an adequate choice. The time lag between the most and less advanced beamlines is only of few months and efforts are done to build all the beamlines in parallel as far as possible.

What we design as beamline optics consist of the focusing and collimating mirrors, the monochromators, precision slits, all the associated vacuum parts and supports, and in some cases beam diagnostic components. Usually, the tendering process starts with publishing the technical specifications, and then a negotiation with companies follows in order to select the most suitable ones and later the construction contracts are defined and signed.

The table below summarizes the status of the optics of the beamlines in September 27th.

PORT	Beamline	Published	Negotiation	Contract
4	Powder Diffraction (PD)	yes	In process	
9	Microscopy (Mistral)	yes		
11	Non Crystalline Diffraction (NCD)	yes	In process	
13	Macromol. Crystallog. (Xaloc)	yes	Finished	Signed
22	X ray Absorption Spectr. (XAS)	yes	In process	
24	Photoemission (CIRCE)	yes	Finished	Signed
29	Circular Dichroism (XMCD)	yes	In process	

The end stations of the beamlines are in the phase of design. In about 3 months most of them will be completed. An exception is **CIRCE** since the PEEM instrument (Photoemission Microscope) is already in

the tendering process. The microscope will be based on a Photo Emission Electron.

Microscope with energy filtering and an electron source and beam splitter for LEEM/LEED capabilities. The system will be fully UHV and permit fast introduction of samples from air as well as installation of ancillary equipment such as evaporators, laser sources, gas inlets, etc. The microscope is specified to 10 nm lateral resolution and 0.2 eV energy resolutions.

Fig. 17 Beamline scientists checking the positioning of the sample location (28/06/2007)

Energy filtered full-field imaging will enable accurate chemical mapping down to the core level shift detail. Small spot mode shall enable choosing a submicron spot in order to perform spectroscopy or imaging of the reciprocal space (photoelectron diffraction, band mapping). The combination with the tunable polarization of the beamline, giving access to dichroic contrast, and the availability of Low Energy Electron Microscopy and Diffraction, highly sensitive to the surface structure, permits a comprehensive approach to many problems, with fast switching between complementary experimental techniques. The applications range from surfaces, interfaces and thin film science to nanoscale materials, micromagnetism, and any kind of heterogeneous system or process, as well as the interplay of structure, electronic, magnetic and chemical properties. In summary, the microscope will be a high-performance multi-technique instrument able to fulfill the experimental requirements of a wide variety of scientific users.

The conceptual layout of the **NCD** of the end station is completed and the detailed design engineering is currently being carried out. Attention to slit locations, slit assembly,

component stability and versatility has been paid to allow easy use of the beam line in SAXS/WAXS mode and micro-focus mode.
An X-ray flight tube is being designed, manufactured and assembled in the workshop of Alba.

The **XALOC** beamline has made good progress has been made during the last months on the design of the different elements namely, the safety enclosures, the optics, and the end-station.

The safety enclosures are now designed and their tendering will be open soon.

The optics, which consists of a diamond filter, a monochromator, and two focusing mirrors, is the more advanced part of the beamline. After careful calculations, extensive studies and meetings with the manufacturing companies in July and August 2007, the preliminary design report of the main optical elements of the beamline has been approved.

Special care has been taken to minimize vibrations in all the critical optical elements of the beamline. In particular, the vibration modes of the monochromator and the mirror holders have been thoroughly modeled using finite element analyses. The cooling of the monochromator is also being optimized to minimize vibrations by considering special holders for the pipes and a laminar flow of the liquid nitrogen in the cooling circuit. Moreover, the use of accelerometers in all these elements, to monitor vibrations in real time, is also under study. Minimizing vibrations has led to the use of massive granite blocks in supports, and the strengthening of all weak links of the holding structures and positioning stages.

Finally, the end-station is intended to be out for tender in the next few months. It will be equipped with up-to-date instrumentation to guarantee its wide-range applicability by the scientific community. Both the beam conditioning elements (attenuators, fast shutter, slits, and diagnostics) and the detector (having large area and fast readout) will be placed onto two granite blocks to ensure stability. The diffractometer will be designed to perform demanding x-ray macromolecular crystallography experiments and allow the implementation of a control interface suitable for automated operation in cryogenic conditions.
At the **XAS** beamline, intense activity has been concentrated in the design of the fluorescence analyzer set up. This is a x-ray emission spectrometer which will feature: (i) large energy range: 2–30 keV; (ii) energy resolution better than the natural widths of K alpha lines for elements S trough Ru; (iii) ample space for the insertion of large sample setups, up to Ø600 mm; (iv) energy dispersive images exempt from necessity of doing theta/2theta scans; the energy dispersion will be possible in two scales: (a) over a single fluorescence line and (b) over several hundreds eV when several fluorescence lines are of interest; (v) compact design which will allow the integration of a small vacuum tank (<0.2 m^3) into the common beamline vacuum system, so that the complete x-ray path source-optics-sample-crystal-detector would fully windowless.

The spectrometer is based on the Rowland circle geometry with three crystals Si(111), Si(220) and Ge(400) which have dynamical sagittal bending. The crystals are diced with facets of an optimum size of 2×2 mm^2.

The PD beamline team has also concentrated in preparing a Conceptual Design Report CDR for both end stations (High Pressure and Powder Diffraction) to get a basis for a discussion with the user community and to subsequently extract the corresponding tendering. Concerning the PD station the most serious decision is about the number of rotary circles and, therewith, if and how a 1 or 2D Position Sensitive Detector (PSD) will be included. At the moment a 2-circle diffractometer with a stand-alone solution for a PSD downstream the Diffractometer is preferred. The tendering will most likely include both possibilities and commercial aspects might also play a role in the final purchase order.

Related to the diffractometer design is the layout of the multi-crystal detector stage MD, which will be the main detector system for the PD station. From the point of technical feasibility a MD system with 11 independent channels and an angular spacing of about 1.5 deg seems feasible and is momentarily under closer investigation. The final mechanical design and manufacturing will be done in cooperation with an external engineering company. The technical features of this detector allow scan repetition rates below 1 minute and make the use of a PSD system dispensable in many cases.

Both the tendering for Diffractometer and MD shall be launched in November 2007. Staggered in time by about 2 month a similar procedure will be started for the High Pressure station.

The call-for-tender of the **XMCD** beamline optical components is running since early July. One of the next steps will be the design and construction (call for tender) of the experimental end-stations. Among the two projected end-stations, the design of the XMCD absorption chamber for high field/low temperature is given priority as it is expected that it will attract most of the users in the early stage of the ALBA users operation, starting in 2010.

At the time, the main characteristics of the chamber are being defined. The originally projected lower limit of the temperature range at 2 K might be optionally shifted down to 0.3 K, if the expected research projects require this. A maximum magnetic field of about 7 T appears to be a good tradeoff between cost and magnetic field strength. Other important issues are, e.g., the geometry of the sample transfer, the required degrees of freedom for the sample movement, the detectors, and eventually the compatibility of the sample holders with other experimental stations at ALBA.

It is now planned to organize a meeting with experienced research groups, in order to discuss all these issues and establish cooperation between them and ALBA, for the design, construction and funding of this experimental chamber.

Safety Hutch for the Non Crystalline Diffraction Beamline

The NCD beamline has been chosen to define the "reference hutch design" that will be later on be used in the other beamlines. The figure below shows a 3D view of the optics and experiments hutch.

At present, four offers from different companies are being evaluated to decide the most suitable one.

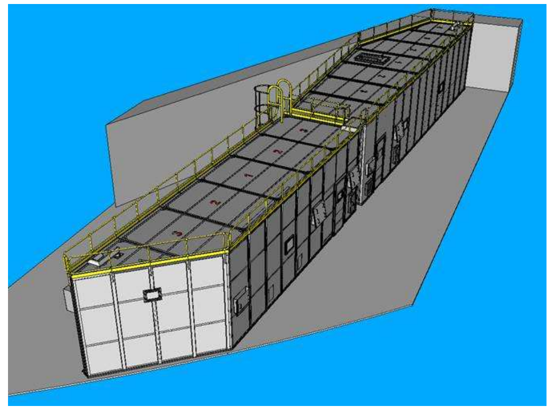


Fig.18 Personnel Safety Hutches for the NCD beamline. The optics and experiment hutches share the wall normal to the beam axis.

X-ray Microscopy: New Optical Design

In the past issue of the Newsletter a layout of the optics of the Microscopy beamline (MISTRAL = MIcroscopy, Spectroscopy, Tomography) was described. The design was based in a horizontally dispersing constant Length Speherical Grating Monochromator.

A few months after the publication of the previous Newsletter, on April 07, a technical meeting with several specialist in optics form other synchrotron sources (Soleil, Elettra, Bessy..) and ALBA staff was celebrated to critically review the design. After several discussions it was concluded that the choice of the monochromator was not optimum when the photon energy had to be changed. Also, the horizontally dispersing geometry was not fully justified. As a result a new design was developed in the forthcoming months. In the present design which has been launched to tendering, the monochromator is a stationary PGM (Plane Grating) which will provide a constant output beam at all energies. Special care has been taken to have a beam as round as possible at the entrance of the capillary condenser. This design allows keeping the sample fixed at all energies. In addition, the microscope will also have the possibility to perform spectroscopic imaging and thus do chemical-state mapping.

A brief description of the optical design follows. More details may be found at the CELLS website.
The optical layout is based on a Varied Line Spacing Plane Grating Monochromator (VLS

PGM) that will deliver monochromatic light to a single-reflection elliptical glass capillary (the "condenser"), which will, in turn, focus the light on to the sample. The transmitted signal will be collected by an objective Fresnel zone plate and a magnified image will be delivered to a CCD.

To fill the condenser with light, a homogeneous beam of maximum possible flux is required at the capillary entrance for any energy in the range (275-2600 eV). A maximum FWHM fan of radiation of 1.5 mrad (H) × 1.2 mrad (V) will be used by the beamline. The vertical angle is chosen to collect the vertical FWHM at the lowest energies while, at the highest energies, the needed collection angle diminishes to approximately 0.5 mrad. The collected fan from the bending magnet will pass through the beamline front end and the shield wall into a small optics hutch containing two mirrors in Kirkpatrick-Baez (KB) geometry ("KB system"). The first mirror M1 of this KB pair will reflect in the vertical plane and will focus light from the source on to the monochromator entrance slit S1. The second mirror M2 will reflect in the horizontal plane and will focus light from the source on to the monochromator exit slit S2. Both M1 & M2 have been chosen to have a magnification equal to 1/3.

A vertically dispersive VLS (Variable Line Spacing) PGM, comprising a plane mirror M3, two VLS gratings (or one VLS Variable Groove Depth grating), an elliptical cylinder mirror M4 and, entrance and exit slits, will provide monochromatic light to the capillary condenser. A constant slit-to-slit magnification in the dispersion plane of $1/c_{ff}$ with c_{ff} = 2.25 will be used in positive diffraction order. Imaging requires only a moderate resolving power of 500-1000 which corresponds to the typical number of zones of an objective Fresnel zone plate. For standard operation, the vertically defining exit slit S2 will have an opening of 15 µm; the entrance one S1 will be set at 30 µm. Figure 1 shows the beamline optical layout up to the experimental hutch.

Two VLS gratings (or one VLS VGD grating) as well as two capillaries will cover the energy range:

Low Energy : 275 – 800 eV,
High Energy : 800 -2600 eV.

From a magnification point of view, the two ranges are equivalent. To ensure the best spatial resolution, each capillary will match the numerical aperture of the corresponding objective Fresnel zone plate. Objective zone plates of outermost-zone width between 25 nm and 50 nm will be used. A practical spatial resolution of about 30 nm is expected. The working distances (condenser-exit-to-sample distance) will vary with the energy ranges from 42 mm (maximum energy) to 6.5 mm (minimum energy). The predicted (ray trace) FWHM focus size at the sample position given by an ideal elliptical glass capillary will vary from 2.9 × 2.9 µm^2 for higher energies to 1 × 1 µm^2 for the lower ones. Therefore, the capillary will be wobbled to fill the sample with light: at least 10 µm of field of view is needed. This procedure is commonly used at modern synchrotrons where the emitted phase-space area is often smaller than the phase-space acceptance of the microscope.

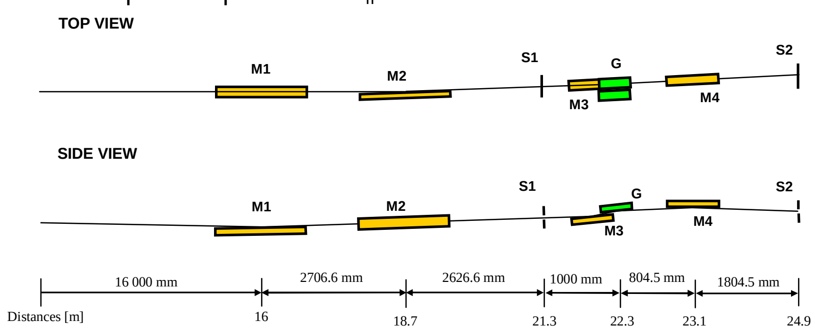


Fig. 19 MISTRAL Beamline sketch showing the KB pair M1 & M2, the VLS PGM constituted by a plane mirror M3, two VLS plane gratings G (only shown in the top view) and an elliptically bent mirror M4. The PGM works at constant magnification. The entrance (S1) and exit (S2) slits are kept fixed. The deflection angle is 2.4º for M1, M2 & M4.

Metrology and Detectors

An optical metrology laboratory is in the process of being put together in the workshop space at the campus of the UAB. The existing instruments are a linear interferometer, an autocollimator and a Fizeau interferometer. The last one will be used to qualify the quality of the x ray mirrors by obtaining the figure errors from two dimensional interference patterns. The sensitivity that is aimed to achieve is below 1 microrad over mirrors with a length up to one meter. The instrument will also be used to test mirrors equipped with benders in order to quantify the mechanical stress induced by the mounting. In addition, to improve the precision on the determination of the slope errors a project to develop advanced numerical analysis computer packages based on lateral shearing function reconstruction algorithms is being carried out. This project is the subject of a PhD thesis in collaboration with the Optics Department of the UAB. In addition to the equipment already existing, a long trace profiler is being built up, and is foreseen to be in available by fall 2008.

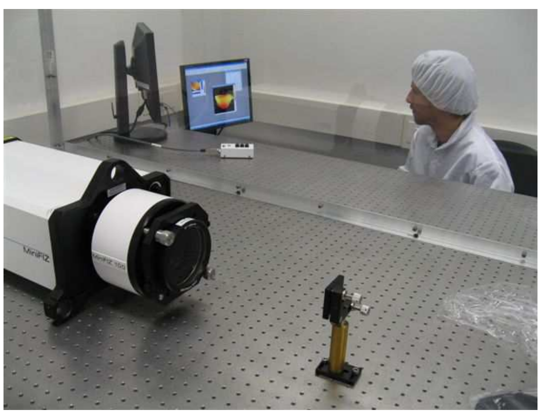


Fig. 19 Fizeau interferometer for measuring figure errors of x ray mirrors being installed

A project to develop a 2D gas filled detector has been going on for several years and it is almost mature for applications (for details see: NIM A **570**, 511 (2007), **573**, 41 (2007), and IEEE Trans. **53**, 544 (2006)). Today, a 20 cm x 20 cm active area unit is performing satisfactorily: very good linearity compared to similar detectors and a local counting rate of 2xE(4) s-1 mm^{-2} which is better than anticipated. The spatial resolution (~1mm) may still be improved by optimizing the preamplifiers and delay lines. The last aspect is carried out in collaboration with the Engineering Department of UAB.

External Collaborations

As mentioned above, in the next few months the conceptual design of the end stations of the beamlines will be finalized. The end stations are the closest equipments to the users of the entire ALBA project and their design determines in a appreciable extent the nature and limits of the experiments that will be performed. Due to this, a close interaction with future users is extremely important. In addition, future users might help in defining and financing ancillary equipments of the end stations that are not within the budget of the beamlines. A step in this direction has already been taken since a collaboration project with the Centro de Investigacion de Nanociencia y Nanotecnologia de Barcelona (CIN2) has been defined and presented for funding. It consists in designing and building a preparation chamber equipped with a STM microscope to feed samples into the two end stations of the XMCD beamline. The success of this project would upgrade the scientific possibilities of the beamline noticeably. Today, there is only one station worldwide, at the ESRF, offering this possibility.

Users are encouraged to undertake analogous initiatives to increase the scientific potential of ALBA. A series of meetings with selected users to discuss these issues are already planned.

Workshops and Meetings

In what follows a brief report on two scientific meetings is presented. The first one concerns High Pressure Science in Spain and the second one on Coherent Diffraction.

REPORT ON THE THIRD HIGH PRESSURE SCHOOL (Inma Peral, ALBA Scientist)

The “Centre Especial de Recerca Planta de Tecnología dels Aliments” linked to the “Universitat Autònoma de Barcelona (UAB)” held the Third Spanish School on High Pressure focused on the applications of high pressure tehcnology on material science, food science and geological sciences on July 2-6, 2007. The school was attended by 50 participants from Spain and consisted in five days of lectures and of hands-on practical sessions.

The talks presented were aimed at the interdisciplinary audience and were provoking and entertaining. Most of the presentations focused on the role and impact of high pressure research on particular disciplines: food science, material science and geological science. The rest of the talks were devoted to the role, status and scientific opportunities on high pressure research of both theory (ab initio calculations) and experimental techniques (light spectroscopy, neutron experiments and synchrotron light experiments). One of the speakers showed the status of ALBA and the design concept for the experimental station devoted to high pressure diffraction. The experimental station proposal was prepared and presented in 2004 by part of the community that organizes the school.

The last day of the school there was a talk presenting the CONSOLIDER funding that has been awarded this year to the high pressure research community. The 5 million euros funding is called MALTA (an acronym from the Spanish title project) and will be spent in the next five years. The principal investigator stressed that the main goal of MALTA is to establish a strong and competitive high pressure community in Spain. The plans for the near future were presented, among them: organize schools and masters dedicated to high pressure, create a web tool with information about high pressure and MALTA, construct and equip a workshop to build and design diamond anvil cells and other high pressure devices, buy a high pressure x-ray diffractometer, setup three top-level spectroscopic techniques and a novel large-volume facility for biological applications, and setup a super-computing center to give support for massive *ab initio* calculations. A technician and a postdoctoral fellow will be appointed for each facility involved in MALTA.

The practical sessions included hands-on mounting and loading of diamond anvil cells and measurements with laser beams of luminescence on diamond anvil cells. This allowed participants to learn more about optimal sample conditions and the importance of well focused beams and accurate alignment procedures. There was also a whole morning of modeling of the thermo physical properties and of investigating transitions paths between crystalline states induced by pressure (utilizing the Bilbao Crystallographic server http://cryst.ehu.es)

Both the lectures and practical sessions were enthusiastically received by the participants. The cozy allocation, as well as the delightful half hour break between sessions provoked relaxed atmosphere and interesting discussions. Among the best questions:

- How is possible to measure the change in taste of cheese after applying pressure?
- What is the highest pressure that can be achieved with a DAC?
- How is possible that the same experiment performed by different groups and even *ab initio* calculations performed by different research groups give different results?

REPORT ON THE COHERENCE 2007 CONFERENCE (Malcolm R. Howells, ALBA Consultant)

Introduction

The Coherence 2007 meeting was held at the conference center at Asilomar USA, a beautiful coastal location near the Californian city of Monterey, June 25-28. The conference was the fourth in a biennial series of highly successful conferences previously held at Berkeley USA, Cairns Australia and Porquerolle Island, France The initial conferences were addressed to coherent x-ray diffraction imaging and I will concentrate on that area. This is a lensless imaging method in which the object is illuminated by a coherent x-ray beam, usually from a synchrotron providing a diffraction pattern which gives the wave amplitudes. The phases are not provided directly by this measurement but they can be calculated from the measured data using a phase-retrieval algorithm allowing the image to be recovered by Fourier transformation. A variant of the scheme can use a tilt series of measured patterns to reconstruct three-dimensional images.

This form of imaging is considered important because, like other forms of x-ray microscopy, it provides a unique capability to image objects that are too big for the electron microscope and that have interesting features that are too small for the visible light microscope. In addition, being lensless, it overcomes the limitations of zone-plate manufacturing technology and, under suitable conditions, is already able to make 3D images at 10 nm resolution.

I will now give a short account of five papers from the imaging part of the conference which particularly appealed to me

Ultrafast Coherent Diffractive Imaging with X-ray Free-Electron Lasers

(Henry N. Chapman)

This was an account of a program that seeks to use fast pulse XFEL's to overcome the radiation damage limit in determining protein atomic structure. Single randomly oriented molecules are to be irradiated (and destroyed) by the fast x-ray pulse but the information-containing wavefield will be launched before destruction. This is understood to be very hard but some important technical and theoretical developments have been generated. Specifically, (1) Images have been obtained at the FLASH XFEL facility in Hamburg using destructive single pulses that were identical to the images reconstructed from a summation of 3000 diffraction patterns representing the same total dose. (2) Time-resolved FEL imaging experiments have been done that provide evidence that pulses as long as 50 fs may produce images at 3 Å resolution. (3) Single-pulse diffraction images have been produced of particles injected into vacuum from solution traveling across the beam at 200 m/s.

Crystallography without Crystals: Structure from Diffraction Patterns of Randomly Oriented Molecules

(V. L. Shneerson, et al.)

The above scheme for protein structure determination is similar to an electron microscope method dealing with *images* of randomly oriented molecules. The XFEL will provide diffraction patterns instead of images and the theoretical implications of that were addressed in this exquisitely articulated presentation by Saldin. He first described a method for aligning the diffraction patterns based on a variant of the common-line method used for electron images. His most daring proposal was to present the data to an appropriate algorithm without determining the angles at all but rather in the form of a set of correlation functions expanded in a series of spherical harmonics. The point of this is that the number of independent coefficients in the expansion can be very much reduced by use of the constraints that all the patterns were produced by the same object and all the angles are equally probable. This greatly reduces the needed x-ray exposure offering the possibility to do the experiment on a regular storage ring!

X-Ray Coherent Diffraction Microscopy of Extended Objects

(F. Pfeiffer, et al.)

This new technique, which is a form of ptychography, has been developed conceptually over the last few years by the Rodenburg group and implemented via collaboration with the Swiss Light Source group. It is a brilliant new idea that was the main talk of the conference and many people are thinking of getting into it (Rodenburg PRL **98**, 03481 (2007)). Essentially one scans the sample in 2D with a small coherent patch of x-ray illumination taking a few hundred diffraction patterns. An algorithm is then used to reconstruct the image. It overcomes most of the inconveniences of "standard" diffraction imaging and can be used to search and home in on regions of interest like a visible light microscope. However I think there are reasons to hesitate. It took about a shift of exposure time at the SLS microXAS undulator beam line to get a 2D, 1k$\times$1k image (50 nm resolution). To get a tilt series and thus a 3D image by the present method, it appears that one will need reconstructible-quality data at every view, which would be prohibitively time-consuming and dose intensive.

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FRONT COVER: Aerial view of the Alba site on 1st September 2007

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