STATUS OF THE ALBA PROJECT

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Abstract

The Storage Ring ALBA is a 3 GeV third generation synchrotron light source under construction in Barcelona (Spain). ALBA is optimized for high photon flux density with a beam emittance of 4.5 nm.rad and a large number of straight sections for Insertion Devices (3× 8 m, 12× 4.2 m and 2× 2.6 m) in a relatively small circumference of 268.8 m. Top-up operation is foreseen from the start. The injector complex will consist of a 100 MeV Linac and a full energy Booster with a rather small emittance 9nm.rad. The design of the lattice and of the major components of the accelerator complex (Linac and Booster, Magnets, RF system, Vacuum system) has been completed and the procurement procedure has started for the large majority of them. The construction of the building is planned to start in the first half of 2006 and the commissioning of the storage ring is foreseen for the end of 2008. This report gives an overview of the status of the project.

INTRODUCTION

ALBA is the synchrotron facility constructed and operated by CELLS, the Consortium for the Exploitation of the Synchrotron Light Laboratory and is co-financed by the Spanish and the Catalan governments. Since the beginning of 2004, the team for CELLS is being constituted, the final design of the light source has been produced and several call for tenders have been launched. The light source should be operational in 2010, including the operation of seven Beam-lines among which six are based on Insertion Devices (IDs). The emission of these undulators will cover a wide spectral range extending from UV to hard X-rays.

INJECTOR

The injector for ALBA consists of a 100 MeV Linac, a 3 GeV Booster synchrotron and the corresponding two transfer lines [1]. The Linac will be provided as a turn-key system by Thales Communications, the design is based upon the SOLEIL Linac. During the design phase, the emittance has been reduced to 30 πmm × mrad and the transmission has been increased to 75% because of the introduction of a 3 GHz pre-bencher. The manufacturing of the Linac should be finished in the middle of 2007. The ALBA Booster has a circumference of 249.6 m and will be located in the same tunnel as the Storage Ring. A TME lattice has been used in order to minimize the emittance up to 9 π nmrad. Figures 1 and 2 show the unit cell and the optical functions for the ALBA Booster. It will include 40 combined function magnets (vertical focussing), 60 quadrupoles (horizontal focussing), and 16 sextupoles. The magnets have been designed and the call for tender has been started. The vacuum chamber will have two different cross sections, an elliptical one at the dipoles (46 mm x 17.6 mm) and a round one with an internal diameter of 29 mm in the rest. The vacuum chamber will be 1 mm thick. The diagnostics of the Booster comprises 44 BPM's with first turn capabilities, 4 fluorescent screens, 3 synchrotron radiation monitors, 2 current transformers and also a set of two striplines which will be installed to perform tune measurements at very low currents from day one.

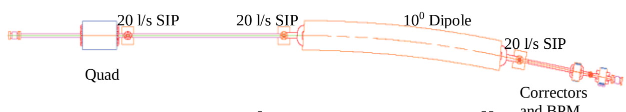

Figure 1: The ALBA Booster cell.

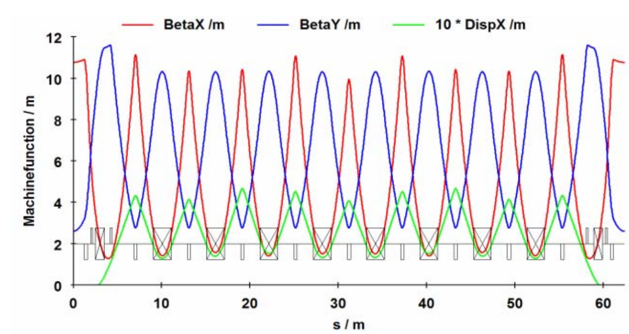

Figure 2: Lattice functions within the ALBA Booster.

STORAGE RING

During 2005, the ALBA Storage Ring has seen the completion of its design and the start of the ordering of its main components (quadrupoles, sextupoles and RF cavities). The optimization of the lattice has been extensively discussed in previous publications (see ref [2]). Table 1 and figure 3 show the main characteristics of the ring and the optical functions within one super-period.

The details of the closed orbit correction scheme and the effects of IDs on the beam dynamics are currently being examined. Frequency map analysis and 6D Touschek

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Table 1: Parameters of the Storage Ring

Emittance	4.5 nm. rad
Energy	3 GeV
Circumference	268.8 m
Beam current	400 mA
Betatron tunes (ν_x, ν_z)	(18.18, 8.37)
Natural chromaticities (ξ_x, ξ_z)	(-39, 27)
Beam size σ_x/ σ_z Middle of 4 m straight Middle of dipole	 132/ 74 μm 49/ 32 μm

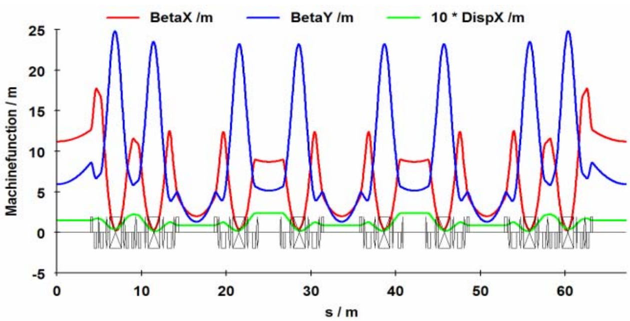

Figure 3: Betatron functions along one super-period.

lifetime computations have been performed for a helical device EU71 (in all possible polarization modes) and an in-vacuum undulator U21. The first results showed no significant effect except for moving slightly the horizontal tune to ν_x= 18.19 in order to avoid the 3rd order systematic resonance $2\nu_x$-ν_z=28 and improve the injection efficiency. Figure 4 shows the on-momentum dynamic aperture obtained in the case of the EU71 operated in the vertical polarization mode when compared to the nominal case. The Touschek lifetime is 41h and the total lifetime is 14h when considering the elastic and non elastic scatterings.

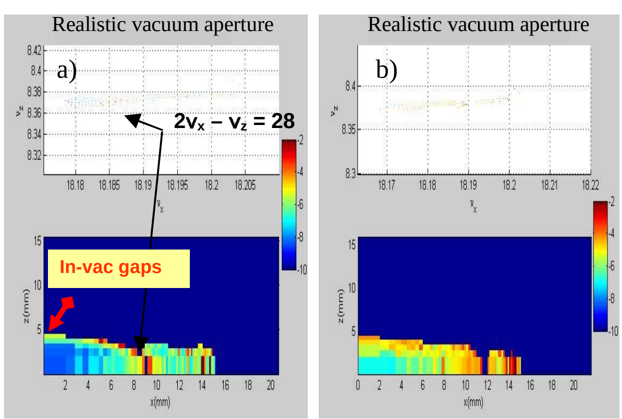

Figure 4: On-momentum dynamic aperture for a) the bare lattice and b) the lattice including an EU71 in the vertical mode where the linear tunes are not yet compensated (18.17, 8.379) and the beta beating is 12%.

MAGNETS

The ALBA Storage Ring is composed of 32 combined function magnets, 112 quadrupoles and 120 sextupoles. The combined magnets have a central field of 1.42 T, a gradient of 5.65 T/m and a central gap of 36 mm. The combined function magnet will also be equipped with trim coils in order to correct each magnet for the right integrated field and gradient. The quadrupoles and sextupoles have been optimised in order to have a large gradient and not decrease the vacuum conductance so much. Each quadrupole will have an independent power supply while the sextupoles will be powered in families. Overall, the lattice has 9 families of sextupoles. The magnets have already been ordered and the prototypes shall be ready for testing in December 2006. The sextupole magnets will be equipped with additional coils for correction. Each pole will have two additional windings that will be used for vertical and horizontal dipolar correction as well as to introduce a skew quadrupole component.

VACUUM SYSTEM

The storage ring will be divided into 16 vacuum sections by ultra high vacuum (UHV) gate valves. The vacuum chamber will be made of stainless steel with an internal vertical aperture of 28 mm and 72 mm width and will be connected to an antechamber with a slot of 15 mm height and 20 mm width. The antechamber will have discrete absorbers, which will absorb the unwanted synchrotron radiation. The pumping will be by sputter ion - (SIP) and NEG pumps, with an overall pumping speed from SIP of 57400 l/s. This will maintain an average dynamic pressure of around 1.0E-9 mbar to achieve a beam lifetime >15 hours at the design current. No in-situ bake out is foreseen, as the vacuum section will be conditioned ex-situ and installed under vacuum to the Storage Ring. The tendering process of the Storage Ring vacuum system has already started.

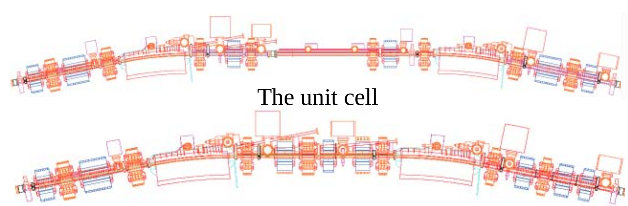

Figure 5: The ALBA vacuum chamber design.

GIRDERS

The criteria's for the design of the girder systems are: a) to get a stiff system and b.) high eigenfrequencies. In order to compensate for the effects of reverse focusing magnets, these should be mounted on just one girder. Mounting the dipole and its surrounding quadrupoles on the same girder gives a length of ~6 m for the ALBA girder. To get eigenfrequencies above 40 Hz with such a girder, 3 pedestals per girder are necessary with overall 6 feet. We represent in Figure 6, the ALBA Storage Ring's girder prototype with the location of the magnets.

RF SYSTEM

The 500 MHz Storage Ring RF system serves to restore the energy lost due to synchrotron radiation (1300 MeV/turn) and to provide the energy acceptance for the

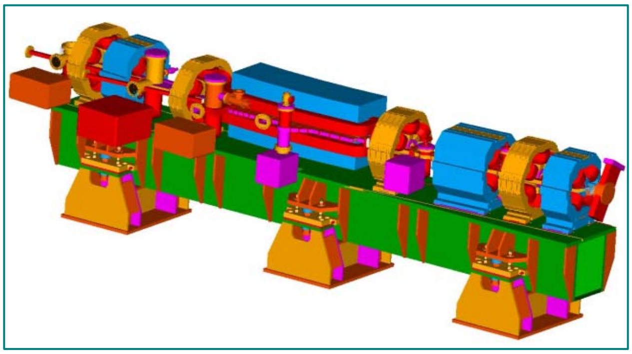

Figure 6: The ALBA girder system design.

required beam lifetime (3% RF acceptance with 3.6 MV). The RF system is composed of six 160 kW cw plants. Each plant exits of two 80 kW RF transmitters, combined through a Cavity Combiner (CaCo) to feed an individual single cell resonant cavity through the RF Waveguide System [3] (see Figure 7). The main cavity is a normal conducting HOM damped type, designed by BESSY. The system was designed such as to not induce couple bunch instabilities (Longitudinal and Transverse HOM impedances <5MOhm.MHz and <50KOhm/m respect.) and had to fit in a Short straight section.

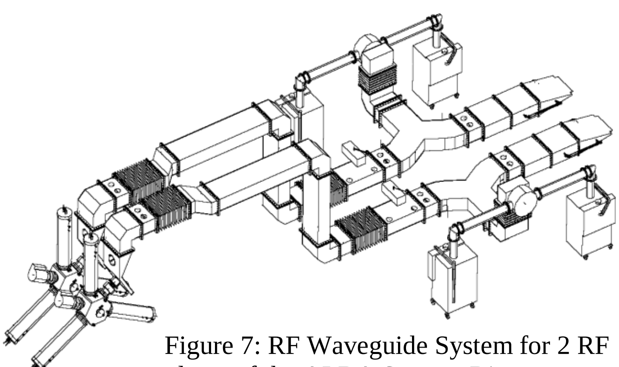

Figure 7: RF Waveguide System for 2 RF plants of the ALBA Storage Ring.

Table 2: RF parameters

RF Voltage	3600 kV
Beam current	400 mA
Losses (inc. IDs)	1300 keV/turn
Beam power	520 kW
CAVITY	
Insertion Length	~500 mm
Number	6
Frequency	500 MHz
Shunt Impedance	>3.1 Mohm
Voltage/cavity	600 kV
Input power coupler	160
Cooling capacity	>80
TRANSMITTER	
Tube type	IOT
Number	2 × 6
Total Power	960 kW

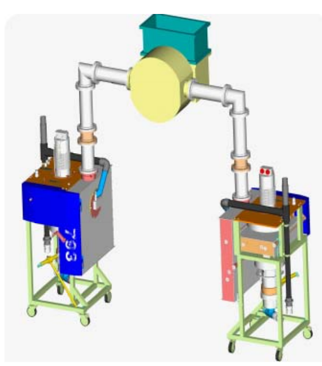

Figure 8: CaCo prototype.

At this stage, the technical specifications have been completed and the contract for building the cavities has been awarded to ACCEL. The call for tender for the transmitters is under way. The WATRAX prototype (**Wa**veguide **Tr**ansition to Co**ax**ial) has been ordered from ATF and the CaCo prototype (Figure 8), built by Thales, has already been tested up to 150 kW. ALBA is also currently developing two Low Level RF (LLRF) prototypes. One is analogue and the other is based on digital FPGA processing. Both prototypes are based on the IQ modulation/demodulation technique.

INSERTION DEVICES

Seven beam-lines will be built together with the storage ring in the first phase. Six of them are based on IDs which characteristics are shown in Table 3 together with the anticipated spectral output for the designed lattice and phase 1 IDs in Figure 9. The magnetic conceptual design has been completed for all phase 1 IDs except for the conventional wiggler which is not yet specified. For the superconducting wiggler, it is foreseen to launch the call for tender for a turn-key device during this summer. The in-vacuum and APPLE II devices will be built in collaboration with other laboratories

Table 3: Characteristics of the "Day 1" Insertion Devices. The IVU-21 will be built twice

ID	Field	Period	Min.-gap	Length
SC-W-32	2.1 T	32 mm	11 mm	1.95 m
IVU-21	0.87 T	21 mm	5.5 mm	2.0 m
EU 62	0.88 T	62 mm	15.5 mm	1.5 m
EU 71	0.93 T	71 mm	15.5 mm	1.675 m
W 65	1.55 T	65 mm	11.5 mm	2.0 m

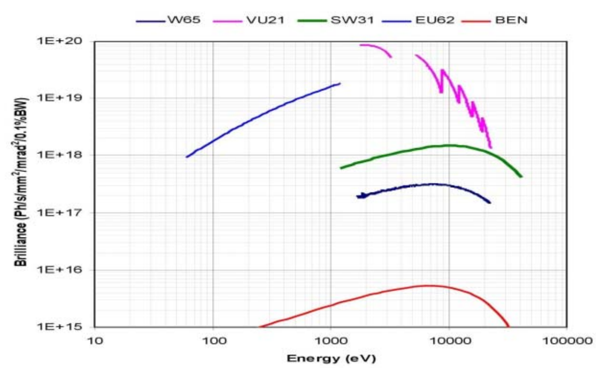

Figure 9: Typical Brilliance for ALBA.

SITE AND BUILDING

The design of the building including the technical infrastructure (water, electricity, HVAC,…etc) has been finished and the call for tenders for the different parts of the building are under way. The soil movement and the slabs contracts have been awarded and the work will start in June 2006.

REFERENCES

[1] D. Einfeld et al., "Progress with the Synchrotron Light Source ALBA", PAC'05, May 2005, p. 4203.

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[3] F. Perez et al. "New Developments for the RF System of the ALBA Storage Ring", to be published, EPAC'06, May 2006.