STATUS OF ALBA

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Abstract

The construction of ALBA, the 3 GeV Synchrotron Light Source near Barcelona (Spain) is proceeding according to schedule. The works for the building started in June 2006 and access to the building for installation of the 100 MeV Linac is expected at the end of 2007.

Most of the machine components are already under construction and several have already been delivered. This report will concentrate on recent design developments, component choices and current status. Also the results on the first prototypes will be discussed. Other papers at this conference deal with accelerator physics issues and vacuum design.

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. The light source should be operational in 2010, including the operation of seven Beam-lines among which six are based on Insertion Devices (IDs), covering a wide spectral range extending from UV to hard X-rays.

BEAM DYNAMICS

The beam dynamics studies have been focused on the study of a realistic model of the bending magnet, the conceptual design of the fast orbit feedback, study of the Touschek effect with a realistic model of the vacuum chamber, and injection into the storage ring. The study of the modelling of the bending magnet is described in detail elsewhere in these proceedings [1].

The conceptual design of the fast orbit feedback is finished, and is based in a global orbit correction system, capable of compensating motion of the beam up to frequencies of 100 Hz for perturbations creating orbit distortion up to 50 µm. 88 Libera BPM electronics and 88 correctors in each plane (integrated in the sextupoles as extra coils) are used to correct the orbit, and the data is being distributed using the protocol developed at Diamond [2]. Details about the implementation of the correction algorithm are under study.

The effect of the horizontal aperture limitation due to the absorbers [3], the septum, and the vertical limitations due to the in-vacuum undulators in the lifetime have been evaluated. Also the effects of the high order multipole components on the magnets have been included. For the most restrictive cases (machine operating with a chromaticity of (+5,+5), orbit correction, coupling of 0.3%, in-vacuum undulator gap 5.5 mm), the energy acceptance of the lattice is in the range of 2.5 %, with a Touschek contribution to the lifetime of 9.5 hours for 400 mA of current with 90% filling pattern, and considering normal vacuum conditions the total lifetime is of 7.4 h. For the most relaxed case of (+1,+1) chromaticity, the Touschek lifetime is 24 h, and the total is 14 h. Both cases are good values for top-up operation.

Preparations for the commissioning have started. We have chosen to use the so called Matlab MiddleLayer developed at Spear-III and ALS [4] and widely used now in several synchrotron light sources. An implementation of LOCO [5] for ALBA is also being developed.

MAGNETS AND POWER SUPPLIES

All the magnets of ALBA, over 480, have already been ordered. For the storage ring the quadrupoles and sextupoles prototypes have been received and measured with a rotating coil system at BINP, the manufacturer. The magnets have successfully passed the tests. The rotating coil system is also used to minimise the difference between the magnetic center and the mechanical center of the magnets. Shims on the lateral side of the magnets and washers under the magnets are individually determined in such a way that the mechanical center and the magnetic center are always within 30 µm one from the other one. Also the tilt is adjusted to be within 0.2 mrad. The acceptance of the series magnets will be done based on the contents of high order harmonics and magnet identity.

Figure 1: SR Quadrupole with a side opening to let a beamline pass through.

The storage ring combined magnets are built as C magnets split in the middle by Danfysik. In this case the vacuum chamber is easier installed. The tight tolerances on the pole profile, ±15 µm are guaranteed through the precise machining of the poles on a 3D CMM machine. The combined magnets will be measured using a Hall probe system set up at ALBA.

Power supplies for the dipole, the quadrupoles and the sextupoles have already been ordered and prototypes are

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under production. Regulation is digital and a stability of ±10 ppm has been specified.

VACUUM SYSTEM

The 316LN stainless steel vacuum chambers for the storage ring are under production; the prototypes have been manufacturer and under testing (see figure 2). The crotch absorbers design is finished; it is based in the ANKA/SLS design [6]; the tender for the crotch absorbers has been issued, as well as that for the UHV pumps. The design of all the straight sections of the storage ring (i.e. the injection straight, the diagnostic straights, the RF cavity straights and phase one ID straights) is done. The chambers for the narrow gaps IDs will be extruded aluminium with NEG coating.

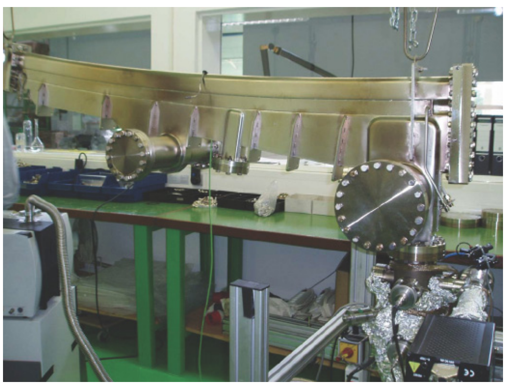

Figure 2: Prototype of the Bending vacuum chamber in the test stand.

RF

The first units of the RF system for the storage ring are now finished or under the last testing procedures. The complete transmitter, including HVPS and IOT will be undergoing the Factory Acceptance Test at the end of June. The test of the IOT with a new output cavity, see figure 3, having a 6 1/8" coaxial output, has been already tested for 24 h.

Figure 3: IOT under test.

The HOM damped RF cavity has been tuned to the final frequency and is now in our test bench for the final checking of their characteristics, mainly the impedance of the HOM Both, cavity and transmitter will be tested up to 80 kW in the new High Power RF Lab built at ALBA, where the installation of the waveguide components and low level electronics is under way.

SR GIRDERS

A prototype of the storage ring girder has been built and tested at CELLS by the Spanish company Nortemecanica. The flatness of the girder has been measured to be within 30 μm, in agreement with the specifications.

Figure 4: SR girder prototype with dummy magnets.

We have determined that the position of the holes is extremely dependent on the temperature at which these are produced and measured. The frequency spectrum of the girder is now being determined.

INJECTOR

The injector for ALBA is composed of a 100 MeV linac, built by THALES Communication as a turn-key system and a 3 GeV booster synchrotron mounted in the same tunnel than the storage ring.

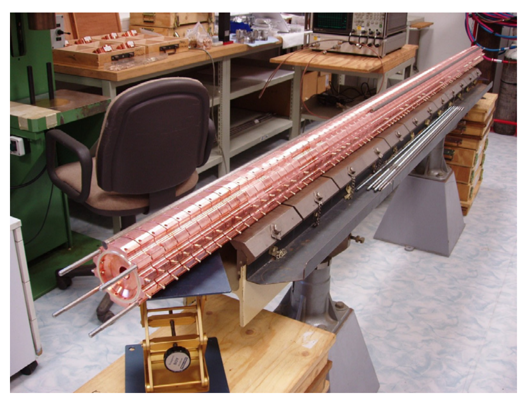

Figure 5: Accelerating structure before brazing.

The Linac production is well advanced. The modulators are ready and waiting for the pulsed klystrons. The first accelerating structure has been brazed and the measurements of the electrical field and resonant frequency are consistent with the simulated values.

For the booster, the magnets are all under production and prototypes are expected to be ready in July this year. The vacuum chamber is also under production and it is based on a 1 mm thick stainless steel tube, circular at the quadrupoles and elliptical at the bending magnets. The transition from one section to the other will be done with a single step. We have estimated that the change in impedance should have no effect on the booster dynamics. The power converters for the Booster are all of the 4Q topology to assure no remanent effects at injection, where the magnetic field is rather low (30 mT). There will be two power supplies for the combined function magnets. To ensure the same magnetic field on all the combined function magnets both power supplies will feed all the dipoles, one will feed the upper coils and the other the lower coils. Tracking between dipoles and quadrupoles has been specified to be better than 10^{-3}

INJECTION INTO STORAGE RING

The injection and extraction processes have already been specified. Injection into the booster is a single turn on axis injection using a septum and a fast kicker magnet right after the septum. Extraction from the booster is single turn and uses a kicker and a septum at 3 GeV.

The injection into the Storage Ring is performed in a 7 meter long straight section where four kickers and the septum are installed. The stored beam is bumped at -10 mm with four kickers with strength of 7 mrad and a half sine pulse length of 4-6 µs. The injected beam has an emittance of 9 nm rad, i.e. twice the emittance of the stored beam, and it is injected into the SR from the inner side of the machine through an out-of-vacuum septum magnet of 9°. The septum sheet at -16 mm allows an energy acceptance of 3% and its transverse position can be adjusted between -15 and 20 mm. Figure 6 shows the phase space of the injected beam in the first turns.

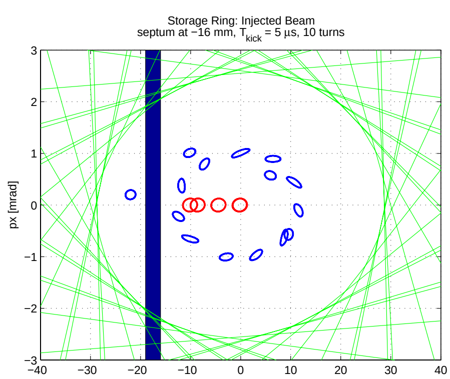

Figure 6: Injected (blue) and stored beam (red) in the horizontal transverse phase space at the injection point. The blue region corresponds to the septum location, the green lines give the physical aperture all along the ring.

Simulations to statistically estimate the injection efficiency are now being carried out taking into account magnets errors, high chromaticities and the physical apertures of the vacuum chamber. In particular the timing parameters and the alignment errors of the pulsed magnets will be determined and optimized.

The septa magnets will be out of vacuum, C shape laminated magnets which will use a thyristor as switching device. The Booster injection and extraction kickers, with rise/fall time of around 200 ns and a flat top of 400 ns will use thyristors as switching devices. These magnets will be in vacuum. Finally the storage ring kicker magnets will be out of vacuum, with ceramic chambers and the switching devices will be GCT's.

INSERTION DEVICES

Table 1 shows the main characteristics of IDs to be installed. There will be three identical in-vacuum undulators, two Apple-II undulators, a multipole wiggler and a superconducting wiggler.

ID	Period	Length	N	K_{max}
	mm	m		
SC-W31	31	1.8755	60.5	6.05
IVU-21	21.6	1.9649	92.25	1.6
MPW-80	80	1.0200	12.75	12.98
EU-62	62.76	1.7102	27.25	5.09 (K_H)
EU-71	71.36	1.5878	22.25	6.19 (K_H)

CONTROL SYSTEM

ALBA uses Tango as the toolkit for building the control system. Tango has been developed at the ESRF (Grenoble, France) and now is co-developed and maintained in a collaboration between four institutes: ESRF (Grenoble, France), SOLEIL (Paris, France), ELETTRA (Trieste, Italy) and ALBA.

The device servers controlling hardware run on Linux and are mainly written in C++ and Python. Clients are mostly developed in Java (using the ATK framework) and Python (using Qt application development framework), at the same time as other clients such as Matlab are integrated as well. On the hardware side, PLCs and distributed I/O are used for Equipment Protection and the Personnel Safety System (safety PLCs). Timing system is based on events transmitted by fiber optics. Many devices are controlled by Ethernet, like power converters, oscilloscopes, CCD cameras, etc.

CONCLUSION

The construction of ALBA is going according to schedule. The installation of the Linac is foreseen for November 2007 followed by installation of the Booster starting in April 2008

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