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DISMANTLE, ASSEMBLY AND INSTALLATION PLANS FOR THE ALBA II UPGRADE

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Abstract

The 3.0 GeV ALBA Synchrotron Light Source, in operation with users since 2012, is looking forward an upgrade aimed at enhancing the brightness and coherence fraction of the delivered X-ray beam. The Storage Ring (SR) will be completely renewed but we plan on keeping the same orbit length and the position of the Insertion Devices (ID) source points. The energy of the electrons will be preserved and the same injector will be used. Major part of the ID and Front Ends (FE) will be kept; new ones will feed additional long Beamlines (BL) (230m-275m), included on the project.

The "dark period" is foreseen for 2030-2031. This paper presents the strategic plans being developed to test and assemble the new SR components, the dismantling of the present SR and the seamless installation of the upgraded SR. Emphasizing a cost-effective and time-efficient approach, we have started the planning by focusing on optimizing spaces and equipment movements necessary for the upgrade process.

INTRODUCTION

The ALBA Synchrotron Light Source started operation with users in 2012 and has produced more than three thousand publications since then. Nowadays the facility is providing synchrotron light from infrared to hard X-rays for ten BLs; three more are in commissioning, and one in construction.

In 2021 an upgrade project was officially launched and the White Paper was published in 2023 [1]. The core part of this project is the complete renewal of the SR aiming to transform ALBA into a diffraction limited facility, which implies the reduction of the emittance by at least a factor of twenty [2]. The construction of two new long BLs (230m-275m) is also part of the upgrade.

Different decisions have been taken to be cost effective. Firstly, no major modifications of the shielding tunnel-wall will be done. Secondly, the requirement of maintaining the IDs as close as possible to their present position will preserve them operative for ALBA II and will imply minor modifications to the BLs. Finally, the present injector will be kept; the Booster (BO) is sharing the same tunnel as the SR and its small emittance (9 nm·rad) is compatible with a good injection for the future SR. With these premises, the new accelerator maintains its 3GeV energy, 269m orbit length and the sixteen-cell geometry.

Upgrade considerations

This paper focuses on the current plans for the removal and installation of the SR; including the previous assembly phase. These are the main points to be considered:

- Upgrade the SR Magnets (MA), Girders (GI), Vacuum (VC), Diagnostics (DI) and Pulsed Magnets (PM).
- Keep the IDs, Radiofrequency (RF) and Front Ends.
- Add four active 3rd order harmonic cavities (3HC) [3].
- Maintain the existing ID source points.
- Change the location of RF cavities along the SR orbit.
- Maintain Tunnel, injector and services; cooling water and electric supply distribution.
- Test and mount the SR MA on girders in advance.
- Test, mount and activate the sixteen VC SR sectors in advance.

Regarding the removal and installation of equipment, the Tunnel is accessible from the roof, made by slabs. Two 12 tones orbital cranes cover the Experimental Hall, Tunnel and Service Area (SA). Four labyrinth doors, or some front walls can be used for personnel access and small equipment ground movement.

ALBA II PRE-ASSEMBLY SPACES

With the objective of minimizing the down time of the ALBA user program, we are planning to maximize the amount of integration work done before the "dark period". For this, we have to acquire, test and mount the SR MA, GI, VC, power supplies (PS), DI, RF 3HC and PM before 2030.

In fact, the required equipment for the upgrade that can be tested in advance in ALBA is already designed and being acquired; these are the RF 3HCs and the double dipole kicker, a new concept of pulsed magnet able to inject both, on and off axis [4].

One of the first steps going towards a pre-assembly strategy has been to study the required spaces for storage, test and assembly.

Table 1: Estimated space requirements. Girders storage includes plinths and mechanics

	MA	GI	VC	PS
Storage	300m^2	900m^2	60m^2	300m^2
Test & assembly	65m^2	200m^2	220m^2	150m^2
Storage assembled	800m^2		50m^2	300m^2

We have studied which of the actual spaces in our warehouse, experimental hall and laboratories could be used for this purpose. Half of the warehouse could be used for storing & testing the PS and testing & assembly GI and MA. In this existing building, some enclosures will have to be prepared for testing with proper temperature stability the different components.

An additional space of 1000m2 is required for storing MA and girders before and after assembly. Moreover, 400m2 are required to store the present ALBA SR after

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removal. For both, the procurement of a temporary warehouse is being considered using part of our plot.

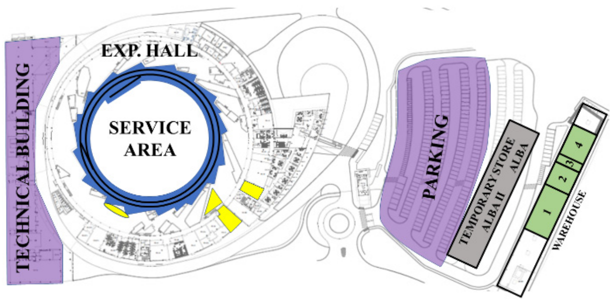

Figure 1: ALBA synchrotron plot with the proposed spaces needed for the upgrade. The temporary storage building for ALBA and ALBA II components is shown in grey. In the warehouse, four spaces (in green) are reserved for: (1) PS racks storage, (2) PS tests, (3) MA measurements and (4) GI and MA assembly area. The VC assembly and storage areas are indicated in yellow in the main building.

Just before starting the dark period, we plan to have all the SR GI with MA mounted stored in the temporary store, and the sixteen vacuum arcs mounted and stored in the Experimental Hall. Still under consideration is the possibility of designing the cable trays and secondary water-cooling piping in a way that can also be pre-assembled and tested to minimize installation times.

GI and MA assembly

We are considering that we can test two girders and their mechanics and mount the magnets on the two girders in one week. All components will be precision aligned to each other greatly reducing the assembly and alignment time in the Tunnel. With our actual design of five girders per cell, 40 weeks would be needed to mount the sixteen SR cells.

The weekly period is very convenient since we can use Fridays to move the mounted girders to the storage zone and bring the new equipment to the assembly zone. The weekend would be used to thermalize the equipment before testing, mounting and aligning; from Monday to Thursday.

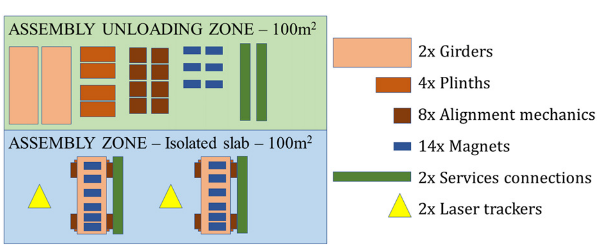

Figure 2: Preliminary view of the SR girders and magnets assembly area. The laser trackers will have some predefined pedestals to make the alignment of MA on GI.

SR sector vacuum assembly, store and transport

Initial considerations adopt a minimum magnet aperture of 20 mm. With a 1 mm vacuum pipe thickness and 1 mm clearance to magnets, an effective inner diameter of 16 mm is assumed. The resulting low conductance requires the use of distributed pumping along the chambers with non-evaporable getter films, NEG coatings. An ex-situ activation method has been chosen.

Additionally, the restrictions imposed by the short distance between magnets and the girders distribution (GI + MA has to weigh less than 12 tones), made us prefer a full cell vacuum assembly outside the Tunnel. A special tool will be designed to mount a complete SR vacuum sector, bake it out, store it and, finally, move it into the Tunnel.

REMOVAL AND INSTALLATION PLAN

We are considering a two years dark period; the first year dedicated to removal and installation of the new SR equipment and the second year to commission both, the accelerator and beamlines. All the actions to be done during the removal and installation period are being merged in one plan considering working teams, logistic resources and dependencies.

From the beginning, it has been clear that the two cranes will be a bottleneck. In order to optimize their usage, a full removal of the two thousand roof slabs is assumed to be done just before the removal and installation period. Besides a reduction of cranes workload, this also gives us more flexibility regarding unexpected changes due for example to delivery delays.

Another important consideration is that the booster shares the same tunnel as the SR. We are planning to install a protection for the booster to minimise risks during loads movement and leave it inside the tunnel during removal and installation.

ALBA equipment for ALBA II

An important aspect of the whole process is the equipment that has to be reinstalled from ALBA to ALBA II; IDs, FEs and RF cavities. In order to protect this equipment and free tunnel space during the SR installation, we are considering to remove this equipment from the tunnel and install it back afterwards. Available space in the Experimental Hall is the preferred option to store it.

We are considering to completely re-cable this equipment. After eighteen years of operation, it is a good policy to install new cables that have to last the lifetime of the upgraded SR. Moreover, the cables that connect this equipment with the electronics at SA share the same cable trays as the rest of SR. It is easier to complete remove all the cables, rather than identify, carefully un-install and install back afterwards.

The RF cavities will change location for ALBA II. Nowadays, the RF cavities are located inside the ALBA SR arc of sectors 6, 10 and 14. This is not possible in ALBA II, where the arcs have much more magnets and less space between them. The RF cavities will be relocated in two straight sections between arcs (sectors 8-9 & 12-13).

Removal and disposal of the ALBA SR

Once the IDs, FEs and RF cavities are removed from the tunnel, the rest of SR can be dismantled considering only safety and quickness. The SR MA, GI, VC, cables, cable trays and secondary piping will be disassembled and moved to a disposal zone outside the main building, within

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our plot. There, proper activation measurements, classification and recycling of the different materials will take place.

The maximum weight the two orbital cranes can handle is 12 tones. This exceeds the weight of the SR GI plus MA and VC devices. Thus, some equipment will have to be disassembled and removed before taking the girder with the cranes.

Even though the two cranes are the easiest way of removing most parts, some will have to be disassembled in smaller parts and removed through ground transportation (labyrinth doors or front walls) due to the crane availability. The cable trays with cables or the water-cooling secondary pipes are good candidates for this strategy.

Floor preparation

The ALBA SR has two girders per sector and the upgraded SR has five girders per sector. This is due to the higher number of magnets of the new lattice as well as the longer length of its arc.

The plates where the GI are nowadays fixed to the floor cannot be used for ALBA II. They will have to be teared off, the floor repaired and new plates set up before starting the ALBA II installation. Different options to make this process time effective will have to be studied.

Installation of the SR MA, VC, RF, IDs & FE

As described, the SR MA will be tested and assembled on girders prior the dark period; as well as each of the sixteen vacuum arcs. An optimized sequence of equipment installation has to be done together with the installation of cable trays, cables, and secondary water-cooling piping.

In this plan, we are prioritizing the safety of the vacuum arc; a very fragile structure that will be entered into the tunnel, the latter, the better.

Like the removal phase, two cranes will be available and will work in parallel and in opposite sectors at the same time. Similarly, two truck entrances are available to bring the equipment from the warehouse (PS racks) and temporary warehouse (SR GI).

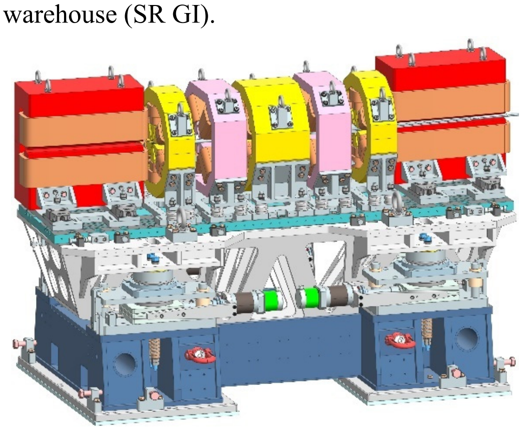

Figure 3: Model of a girder with magnets mounted.

Once the sector is installed in the tunnel, the magnets will be opened to install the vacuum arc. As described before, a special tool to mount and transport the fragile vacuum structure of 16 m has to be designed. We plan to have one of these structures for each of the sixteen sectors.

SERVICE AREA

ALBA II will require more equipment and therefore, more racks. We have estimated the number of racks per subsystem (see Table2). An increase of 50% in number of racks is foreseen for ALBA II. Furthermore, the change of location of the RF cavities imposes a relocation of the RF power production plants in the SA. Therefore, a reorganization of the Service Area is being planned, which will also include new electrical distribution within the SA.

Table 2: Number of racks for ALBA and ALBA II. The estimated number of FE racks for ALBA II consider not only the new BL, but a full occupation of the ports

	ALBA	**ALBA II**
Injector & others	155	187
SR PC	58	128
SR VC	34	34
SR RF	19	50
FE	20	36

CONCLUSION

The design of the removal, assembly and installation for the ALBA II upgrade is ongoing. The spaces required for the whole process are being considered as well as the reorganization of the Service Area. This will be the basis of a detailed plan, with many issues still to be considered.

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