THE GIRDER SYSTEM PROTOTYPE FOR ALBA II STORAGE RING

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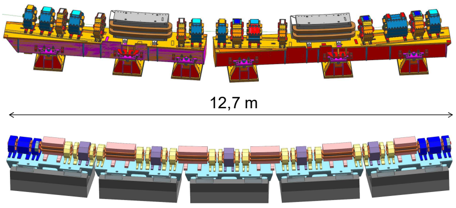
ABSTRACT

The main goal of the upgrade of ALBA into ALBA II is the transformation of the current accelerator into a diffraction limited storage ring, which implies the reduction of the emittance by at least a factor of twenty. Positioning tolerance requested for one magnet with respect to another one located in an adjacent girder is 50 µm.

Besides the girders must enable to reposition the magnets against the overall deformation of the site while ensuring the vibrational stability of the components on top. A dedicated project was awarded to build prototypes for ALBA II machine, Two girder prototypes are planned to be built next year in order to check its full functionality, and to be tested during 2025.

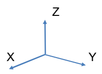
From ALBA to ALBA II

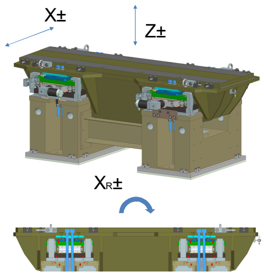


Dimension	ALBA	ALBA II
Compactness grade	49%	80%
Vacuum chamber size	28x56 mm	18 mm
Dynamic aperture	50 mm	6 mm
Beam Size	60 µm	5 µm

ALBA current storage ring is composed by 264 magnets, which are distributed in 16 cells in an array of 2 girders of 6 meters for each cell. ALBA II proposed layout is composed by 592 magnets, in the same arc length as ALBA storage ring, meaning that the compactness ratio has increased by a factor of 2.

Request for a new girder

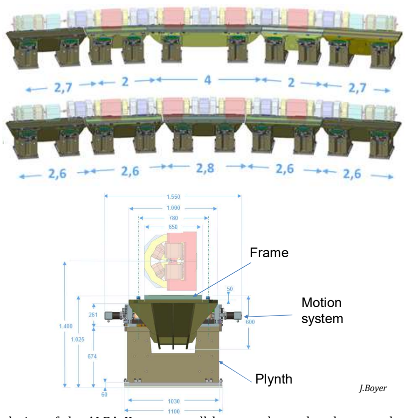




Specification	Value	Comments
Length	2.6 m /4 m	Extreme possible lengths.
eBeam height	1400 mm	Girder interface height about 1 m, defined by magnet design.
Eigenmodes	>50 Hz	By design.
XY adjustment Resolution	20 µm	Manual.
Z range manual	+/-5 mm	Manual.
Z range motorized	+/- 1 mm	Value determinate by the final assembly architecture.
Z resolution	5 µm	Motorized axis.
Assembly weight	<12 Tn	Considering magnet assembly.
Magnet positioning tolerance	50 µm	Considering magnets of consecutive girders.

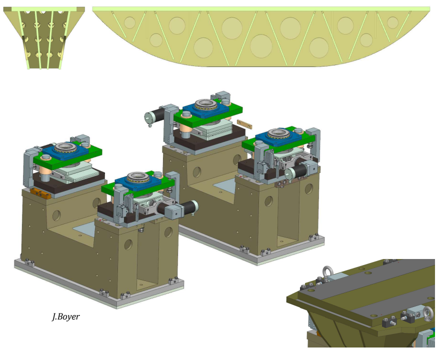
A new girder design is requested to cover the needs of dynamic positioning of the magnetic elements. Motorization for vertical positioning is considered as a demand to be able to automatically compensate the small incremental vertical deviations and maintain electron beam stable in dynamic aperture.

Prototyping the new design



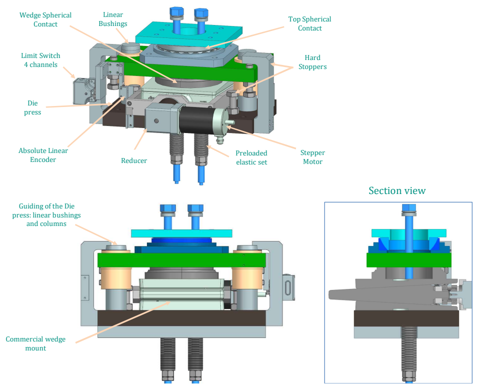
design of the ALBA II vacuum cell have not been closed yet, as the strategy for choosing in situ or ex situ vacuum conditioning is still open. that's the main reason of prototyping of 2 girder length. The girder it is composed by three main components: Plynth, motion system and frame.

Design of the structural parts



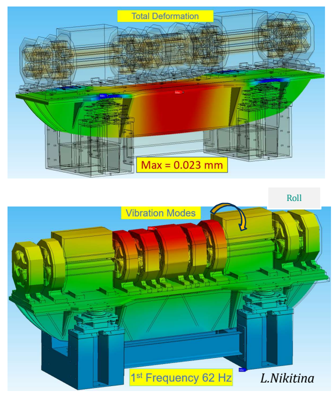
The plinth is designed to be screwed to a grinded steel plate which is epoxy-glued to the floor. This plinth will support the Z positioning system, together with the electrical interfaces. It is conceived to be manufactured with steel welded plates but a solid block of granite is also considered as a possibility. The frame will be manufactured by continuous welded steel and it has been optimized in shape and weight in order to minimize deformations and maximize vibrational stability. The most optimal geometry has been found, based on welded plates distributed in a triangular shape. The horizontal alignment is foreseen to be implemented by a plate that will be adjusted in XY position on top of the frame by means of a push pull system with fine thread screws. Apart from that, it is foreseen a control of the relative position between girders by means of LVDT absolute encoders and limit switches.

Architecture of the motorized positioner



The motion system consists mainly on four actuators composed by motorized commercial wedge mounts to performs a precise vertical positioning. The wedge mount alone is unguided and this would generate uncertainty in the horizontal position when it is actuated. The system proposed is foreseen to be guided with a die press like system, where the top plate of the wedge are guided with respect to the bottom one with two linear bushings. Each actuator, composed by the motorized wedge and the guiding system includes an absolute encoder and limit switches to control and limit its range. A set of preloaded elastic elements are implemented to ensure full contact during operation. It is assumed a maximum reaction force of 40 kN for each actuator. Considering this value as first assumption, the stepper motor and the reducer are sized.

FEA calculations of girder with magnets



First eigenmodes and static deformation have been calculated by FEA, with the following boundary conditions: a fixation on the 4-frame supports and the inclusion of a model of the magnets as masses. When the frame shape was optimized, the full girder model with all the parts included in the model were simulated.

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CONCLUSIONS

The objectives of developing this prototype are to evaluate the performance of the positioning system and the stability of an entire girder module, measuring ground vibration and vibrations induced by external excitation.

As a first step, it is foreseen to characterize the positioning system as a single unit, to check the proper dimensioning of the motion elements and the rigidity of the overall assembly. The conclusions taken for this preliminary test are needed to finalize the design.

The prototype has a modular architecture to be able to interchange spherical contacts, leave sliding surfaces or impose mechanical restrictions between the plinths and the motion system, with the objective of evaluate the best performance of it.

Assembly feasibility and easiness of transportation is also a request from the girder design, as the upgrade machine time has to be minimized.

Before manufacturing the prototype, further optimization analysis are being carried out to gain vibration stability and mechanical reliability.