FEA Simulations of the Aluminium Vacuum Chamber for LOREA Insertion Device at ALBA Synchrotron Light Source

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Abstract

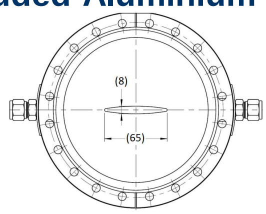
For LOREA, the new beamline at ALBA, the Insertion Device Apple-II helical out-vacuum undulator requires the installation of a suitable narrow – gap aluminium chamber.

The chamber design is based on the standard ALBA aluminium chamber which has an internal elliptical cross section, where NEG coating is deposited and bending magnet (BM) radiation from the upstream dipole is dissipated on the chamber walls. For the standard chamber the upstream distributed absorber cannot protect the entire chamber from direct BM radiation because there is a limitation for its design: the beam impedance of the machine.

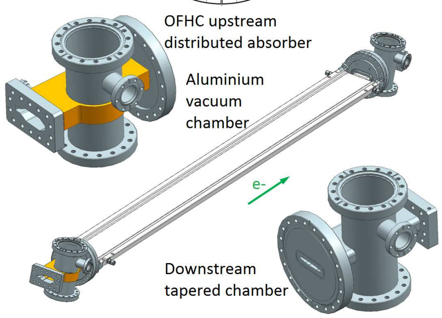
Based on new studies of collective effects it has been concluded that it's possible to implement modifications on the upstream distributed absorber and protect the chamber from lateral collision of BM radiation keeping the beam impedance of the machine inside of a safe range. In spite of that still there is a contribution of the tails of BM radiation.

In this paper we describe the behavior of the new aluminium vacuum chamber for different thermal load conditions using water and air for refrigeration. Also we present the design of the modified OFHC upstream distributed absorber.

The ALBA Narrow-Gap, NEG-Coated, Extruded-Aluminium Vacuum Chamber

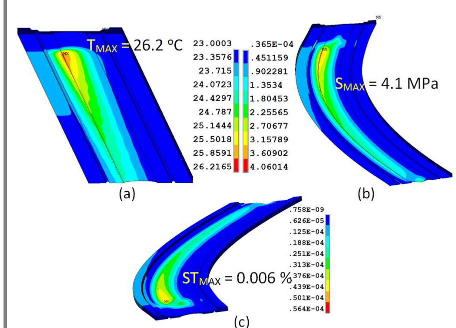


Internal elliptical cross section of 65 mm by 8 mm.



ALBA 3D model of the aluminium vacuum chamber, the OFHC upstream distributed absorber and the downstream tapered chamber.

FEA Results for BM Lateral Collision on the Wall of the Chamber

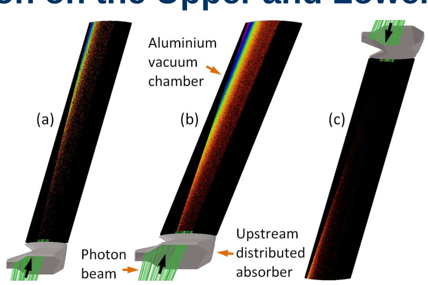


FEA results for the aluminium vacuum chamber for lateral collision of BM radiation. (a) Temperature map, (b) Stress map, and (c) Strain map.

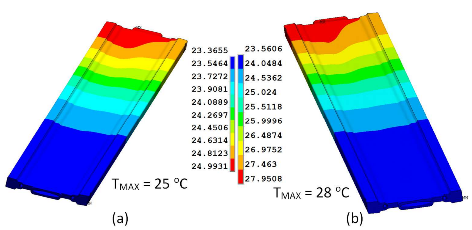
Table 1: Main parameters for ALBA Storage Ring

Parameter	Magnitude
Beam energy, E	3 GeV
Design current, I	400 mA
Dipole magnetic field, B	1.42 T

Collision on the Upper and Lower Walls

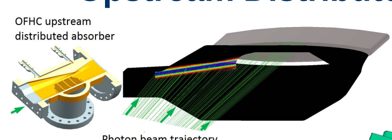


Footprint of the tails of BM radiation on the upper and lower walls of the aluminium vacuum chamber. (a) Nominal trajectory of the beam, (b) Radiation on the upper wall under vertical misalignment effect, and (c) Radiation on the lower wall under vertical misalignment effect.

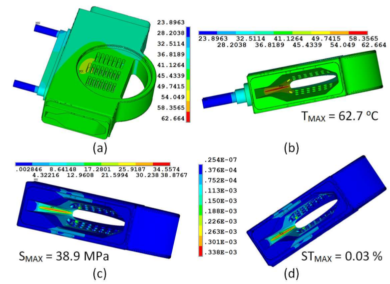


Thermal results for the aluminium vacuum chamber. The BM radiation is deposited on the upper and lower walls. (a) Temperature map for nominal trajectory of the beam. (b) Temperature map for trajectory of the beam under vertical misalignment effect

Upstream Distributed Absorber



Representation of the surface power density distribution using the SynRad+ computer code



FEA results of the OFHC upstream distributed absorber: (a), (b) Temperature map, (c) Stress map, and (d) Strain map

Conclusions

When the BM radiation hits the lateral wall of the chamber, water cooling is needed to dissipate the power; this is the current scenario for the aluminium vacuum chambers installed at ALBA. When the BM radiation hits only the upper and lower walls of the chamber, that is the power load is because of the tails of the Gaussian profile of the BM radiation, the power can be dissipated only by air natural convection.

The simulation of the new OFHC upstream distributed absorber has been made and the thermal structural results obtained are inside of the design criteria.