Mechanical, Vacuum and Optical designs status of ALBA Infrared Beam Line, MIRAS

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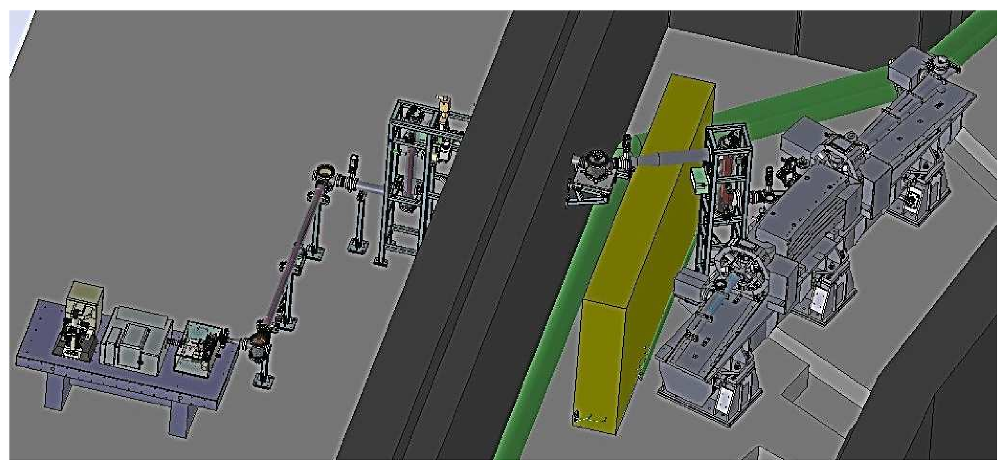
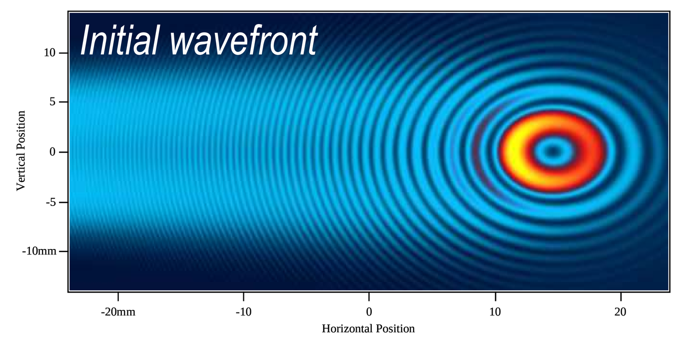
Abstract

The ALBA synchrotron light facility is a 3GeV storage ring able to work in top up mode which delivers X-Ray beams to seven beamlines, already in operation. ALBA is currently facing the second phase with construction of two new beamlines. One of them, called MIRAS, is dedicated to Infrared microscopy and spectroscopy. The beamline is now in design phase, although some construction works have already started, like the installation of the vacuum chamber for inserting the beam extraction mirror. The detailed design of the extraction mirror system is well advanced, and we expect to achieve 0.1 µm resolution, 1µm accuracy, and no resonances below than 80 Hz for proper stability. The extraction mirror mechanism has been designed and validated by means analytical and FEA analysis of its dynamic behavior. Also the thermo-mechanical behavior of the mirror has been validated, considering the radiation in working conditions. Also the layout and vacuum system of the optical elements inside the ALBA tunnel are in detailed design phase. The vacuum profile has been calculated by means MolFlow+ and SynRad+. With these tools the vacuum system has been optimized in terms of vacuum pumping capacity and position of all its elements and assuring vacuum pressure rise at extraction position interconnection at 10^{-10}mbar level. All the mechanics has been designed following the specifications requested by the optical design which have been simulated using in-house ray-tracing codes for modeling the requested beam steering capabilities for the beamline and the impact of the misalignments of the different elements of the beamline. In this article, we present these developments together with a detailed description of the beam line construction status

Precedents





SOLEIL & CELLS-ALBA collaboration:

- *Optical preliminary design*
- *Definition of the main lay-out*
- *Mechanical preliminary design*
- *Vacuum preliminary design*

Vacuum simulation & optimization

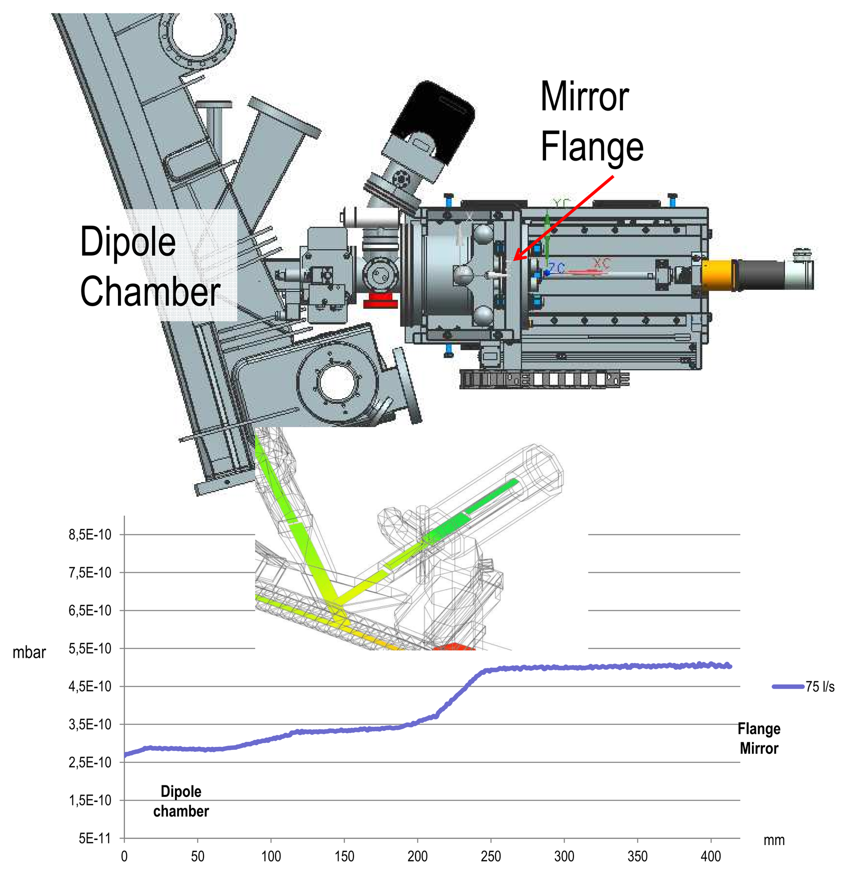
Vacuum Design

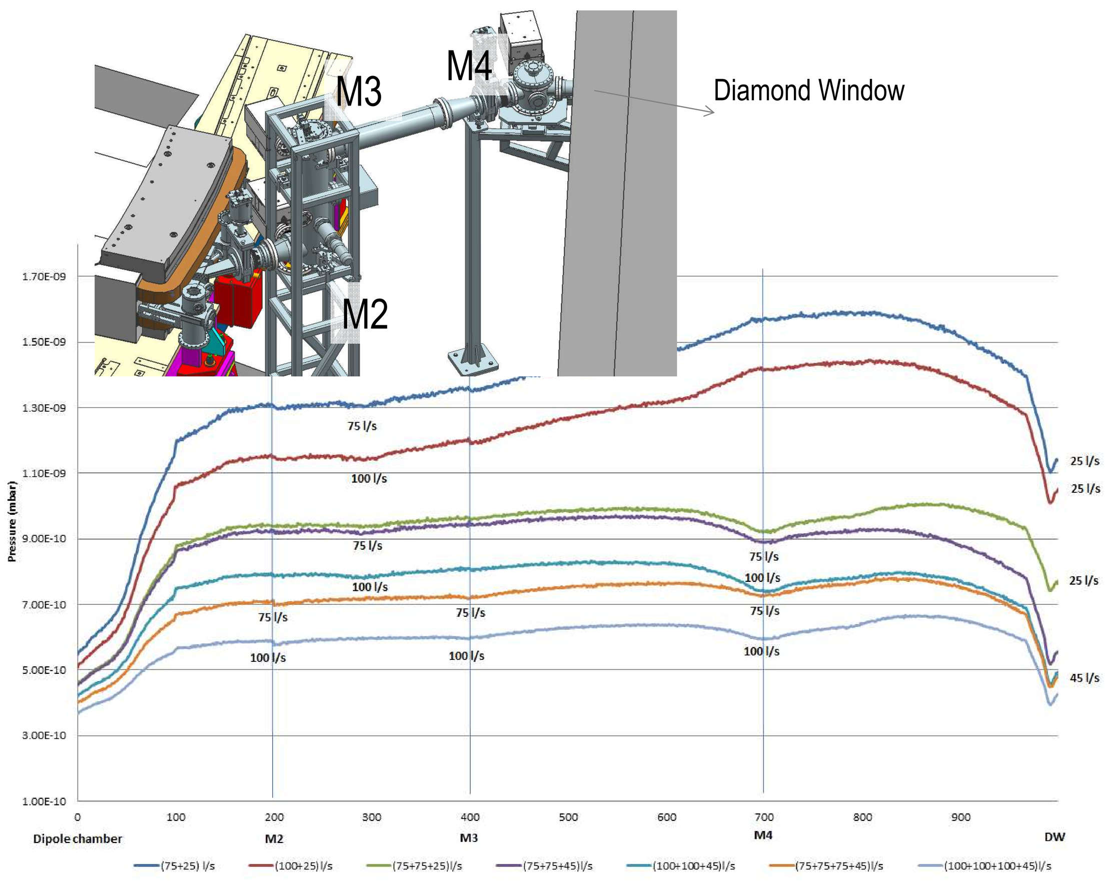
It is separated in two main systems

- *Inside Tunnel*
- *Outside Tunnel*

The vacuum design inside tunnel is finished

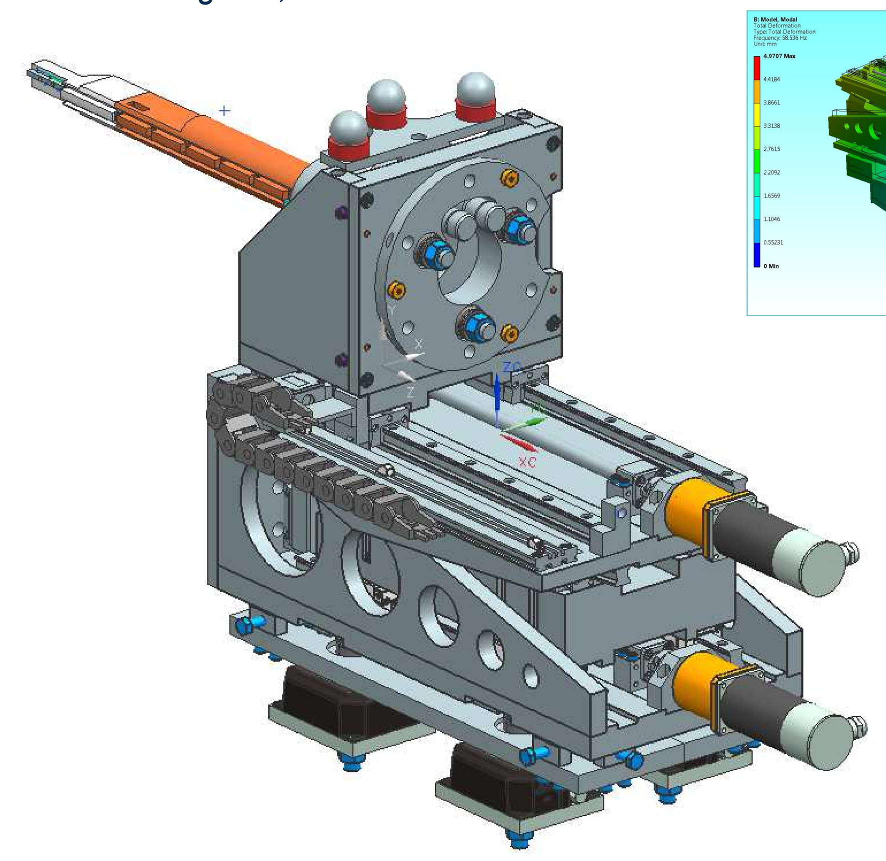
- *The vacuum level has been ensured ensuring no disturbance for the accelerator at extraction position:*
- *The position and capacity of the pumps has been optimized*
- *The position of the gauges also optimized where it is more sensible to changes*
- *The optimization has been done by means MolFlow+ and SynRad+*

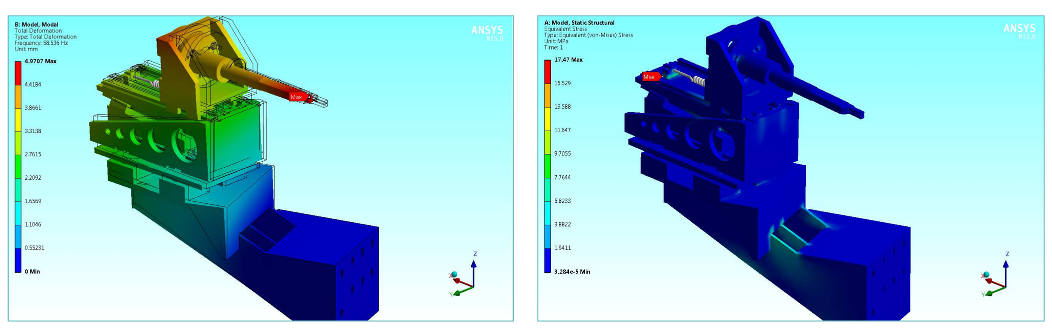




Extraction Mirror mechanics

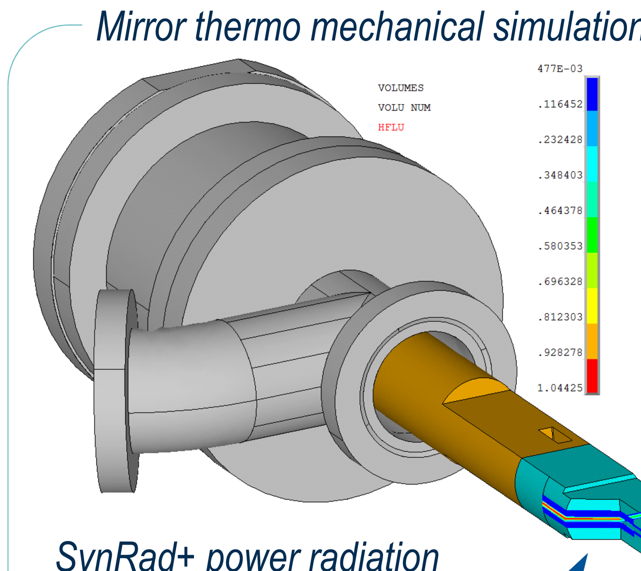
Movable stages Y,Z



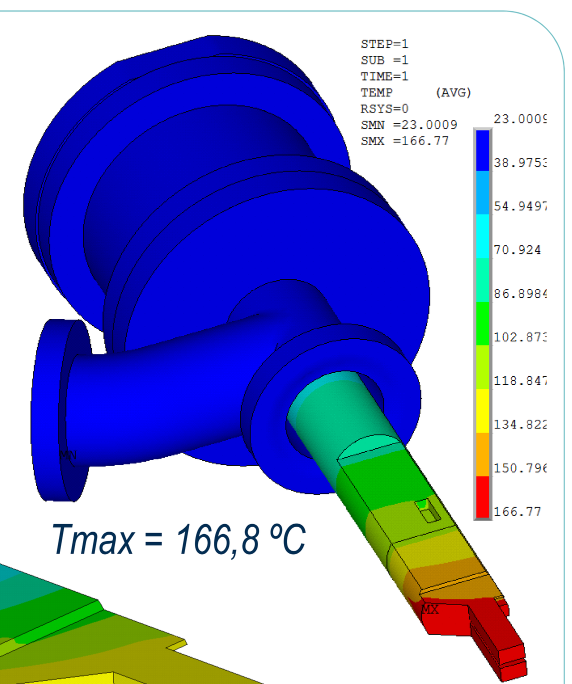


- *First Resonance mode: 58 Hz,*
- *Max tension: 17,5MPa*
- *Max total deformation: 0,21 mm*
- *Longitudinal movement:*
  - *Range: 300 mm*
  - *Extraction time: 4,5 min.*
  - *Resolution: 0,5 µm*
- *Vertical movement:*
  - *Range: 3mm*
  - *Resolution: 0,1 µm*

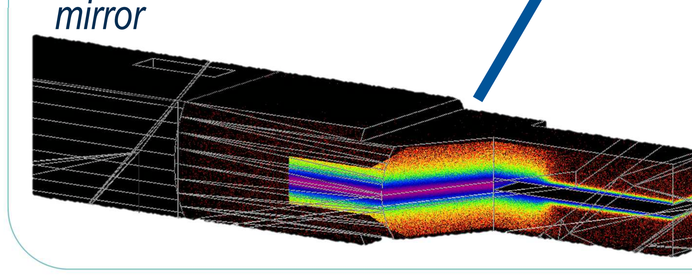
Mirror thermo mechanical simulations



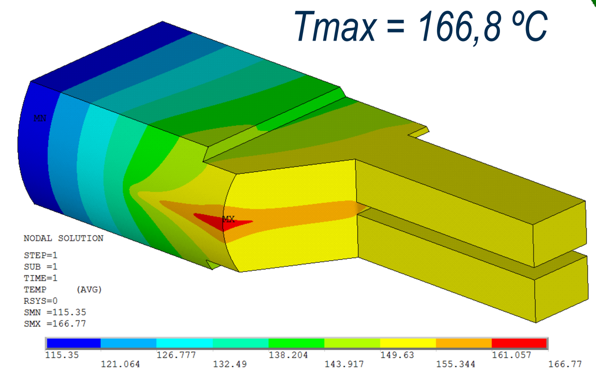
Using SynRad+, the beam trajectory of the upstream bending magnet is calculated; SR photons are generated and traced through the geometry until their absorption.



SynRad+ power radiation deposition on extraction mirror



Tmax = 166,8 ºC

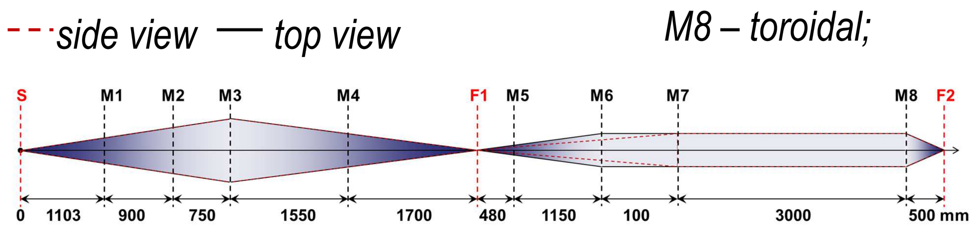


Specifications, in-house ray tracing codes

Optical layout

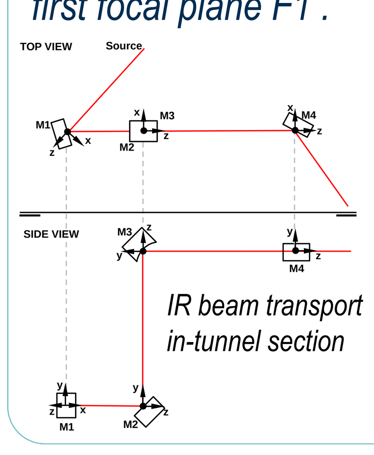
IR wave-front propagation has been simulated using SRW and SpotX codes as well as in-house developed ART raytracing code.

Mirrors:
- *M1 – flat, slotted;*
- *M2 – flat;*
- *M3 – toroidal;*
- *M4 – flat;*
- *M5 – flat;*
- *M6 – cylindrical;*
- *M7 – cylindrical;*
- *M8 – toroidal;*



Beam transport mirror motion simulations

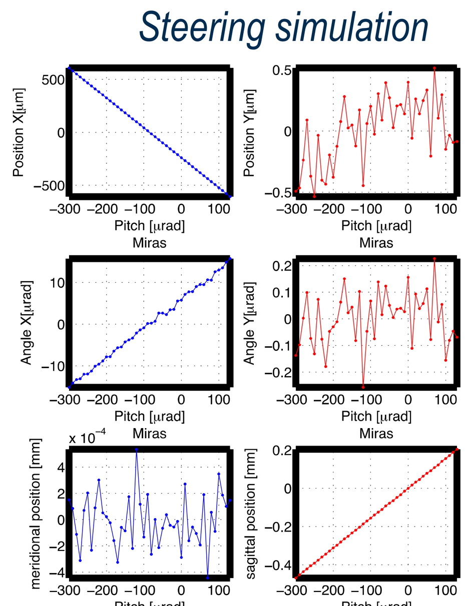
Simulation has been used to establish and minimize required mirror motions, their resolution and repeatability in order to control optical parameters (size, lateral and angular position) of the IR beam at the first focal plane F1 .



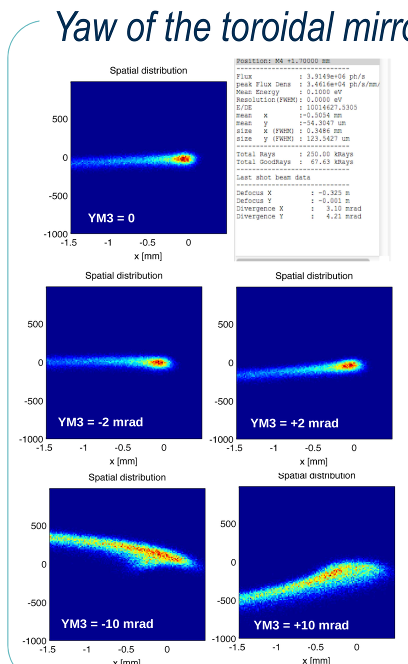
IR beam transport in-tunnel section

Example (right) of simulation of the effect of steering a physical axis on the optical parameters of interest :

- *dependence of the optical parameters as a function of the pitch rotation of M1*
- *the dependence is quite linear, indicating the appropriateness of the approximation*



Yaw of the toroidal mirror



Effect of the yaw misalignment on the image of the source at plane F1, for several positive and negative values

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