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## Four-Bounce Crystal Monochromators for the Sirius/LNLS beamlines

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#### Abstract

This contribution presents the design and performance of four-bounce silicon-crystal monochromators for the Sirius beamlines, which is basically composed of two channel-cut crystals mounted on two goniometers that counter-rotate synchronously. The mechanical design ascertained the demands for the nano-probe and coherent scattering beamlines - namely, CARNAÚBA and CATERETÊ - focusing on solutions to minimize misalignments among the parts, to grant high stiffness and to ensure that the thermal performance would not impair beam characteristics. Hence, all parts were carefully simulated, machined, and measured before being assembled. The present work introduces mechanical, thermal, diagnostics, and dynamic aspects of the instruments, from the design phase to their installation and initial commissioning at the beamlines.



#### Mechanical Design



Parameter	CARNAÚBA	CATERETÉ
Crystal Set	Si (111)	
Angular Range (°)	7-75	4.5-50
Encoder Resolution (nrad)	27	
Crystal Size (mm <sup>3</sup> )	62x90x50	50x98x62
Channel-Cut gap (mm)	8.0	6.2
Beam Size (mm <sup>2</sup> )	1.5x2.6	0.99 x 0.5
Heat Load from Beam (W)	7	17.4
Base Pressure	<5E-8 mbar	





 Commercial cryostat as cold source
Design based on Copper Braids, Flexible elements, gold coating, and indium as thermal interface material
Lumped Mass Modelling
Crystals Setpoints: 125 K
Rotary Stages Setpoints: 22°C
Pt-2k sensors; 12V Flexible heaters

#### Positioning Control

In-position error @ home

Axes synchronism error

### Alignment

#### □ Granite benches with 5 DoFs

Si(111) planes aligned to the rotation axes using shims and X-Ray Diffraction
Ray-tracing analysis of beam displacement amplitude downstream the 4CM-CATERETÊ for its entire range as a function of aligning tolerances:





#### Preliminary Characterization





Rx, Ry, and Rz (Bench to Lab)  $\pm 500 \mu$ rad

Rx', Ry', and Rz' (Rotary Stages to Bench)  $\pm 500 \,\mu$ rad

Rx", Ry", and Rz" (Crystal to Rotary Stages)  $\pm$  100  $\mu$ rad



□ Offset calibrations by matching reflections and by maximizing the beam

intensity on the diagnostics between and downstream the crystals.

Main References

[1] H. C. N. Tolentino, et al. "Innovative instruments based on cryogenically cooled silicon crystals for the CARNAÚBA beamline at Sirius-LNLS". AIP Conference Proceedings 2054, 060026. 2019.

[2] F. Meneau et al., "Cateretê, the Coherent Scattering Beamline at Sirius, 4th Generation Brazilian Synchrotron Facility", in Coherence at ESRF-EBS, Grenoble, France, 2019.

[3] M. Saveri Silva. "Thermal modeling for the development of a four-bounces crystal monochromator for the Sirius project". University of Campinas. 2019

[4] L. Martins dos Santos et al. "The Control System of the Four-Bounce Crystal Monochromators for Sirius/LNLS Beamlines". Submitted to 18th International Conference on Accelerator and Large Experimental Physics Control Systems. Shanghai. 2021.

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0,4

0,3

0,2

0,1

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Intensity







