INSTALLATION AND COMMISSIONING OF THE EXACTLY-CONSTRAINED X-RAY MIRROR SYSTEMS FOR SIRIUS/LNLS

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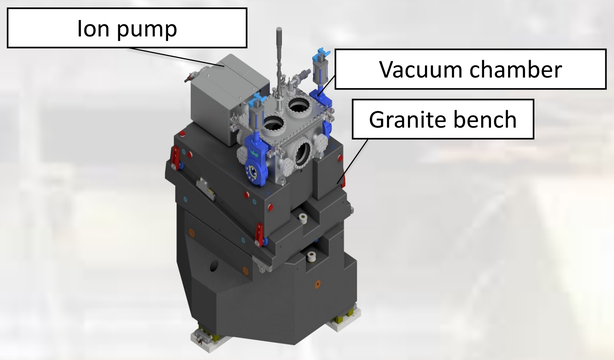
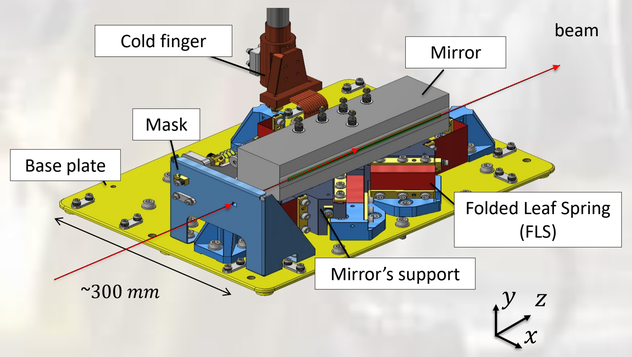
Abstract

Innovative exactly constrained thermo-mechanical designs for beamline X-ray mirrors have been developed since 2017 at the 4th-generation Sirius Light Source at the Brazilian Synchrotron Light Laboratory (LNLS)*. Due to the specific optical layouts of the beamlines, multiple systems cover a broad range of characteristics, including: power management from a few tens of mW to tens of W, via passive room-temperature operation, water cooling or indirect cryocooling using copper braids; mirror sizes ranging from 50 mm to more than 500 mm; mirrors with single or multiple optical stripes, with and without coatings; and internal mechanics with one or two degrees of freedom for optimized compromise between alignment features, with sub-100-nrad resolution, and high dynamic performance, with first resonances typically above 150 Hz. Currently, nearly a dozen of these in-house mirror systems is operational or in commissioning in 5 beamlines at Sirius: MANACÁ (MAN), CATERETÊ (CAT), CARNAÚBA (CAR), EMA and IPÊ whereas a few more are expected by the end of 2021 with the next set of the forthcoming beamlines. This work highlights some of the design variations and describes in detail the workflow and the lessons learned in the installation of these systems, including: modal and motion validations, as well as cleaning, assembling, transportation, metrology, fiducialization, alignment, baking and cooling. Finally, commissioning results are shown for dynamic and thermal stabilities, and for optical performances.

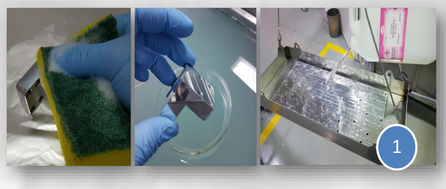
Beamline	Energy range	Source	Status
CARNAÚBA (CAR)	2.05–15 keV	ID	Commissioning
MANACÁ (MAN)	5–20 keV	ID	Commissioning
CATERETÊ (CAT)	5–20 keV	ID	Commissioning
IPÊ	100–2000 keV	ID	Installation
EMA	2.7-30 keV	ID	Assembling



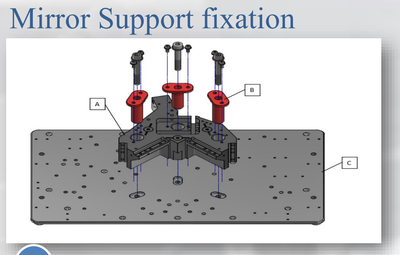


Assembly

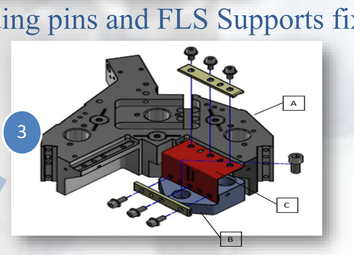
Cleaning



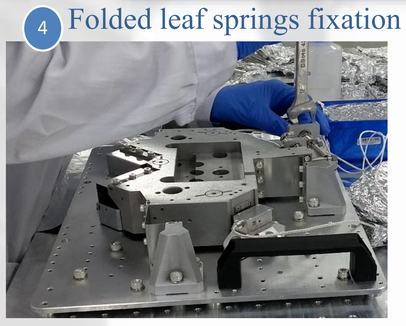
Mirror Support fixation



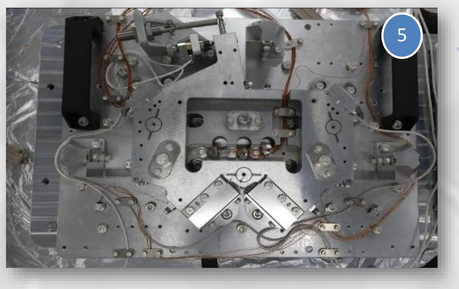
Guiding pins and FLS Supports fixation



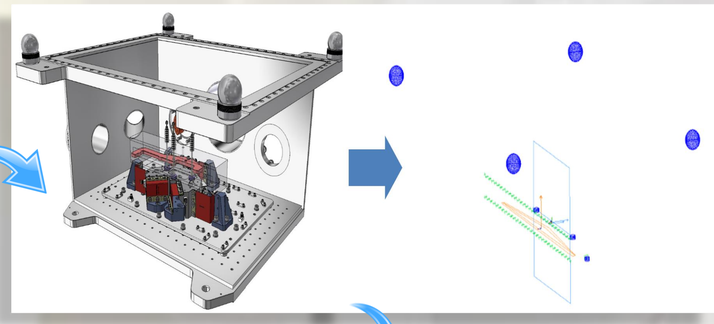
Folded leaf springs fixation



Sensors and actuators attachment



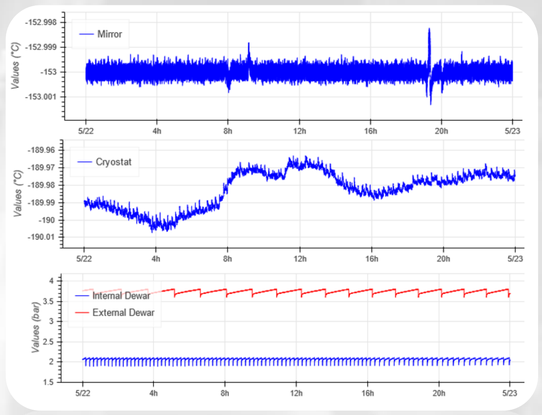
Installation



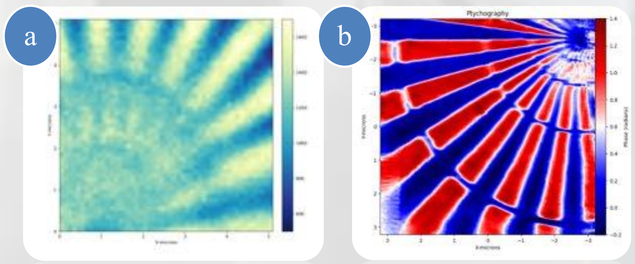
Installation main steps main steps:

- ❑ Portable cleanroom laminar flow cleaning and particle measurements;
- ❑ Internal mechanisms fixation and fiducialization;
- ❑ Copper braid attachment and mirror's fixation;
- ❑ Alignment and baking.

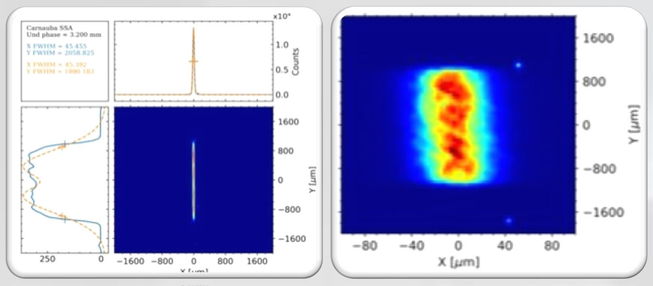
Commissioning results



CAT M1 thermal stability due to the control design ensures millikelvin maximum variations from setpoint.

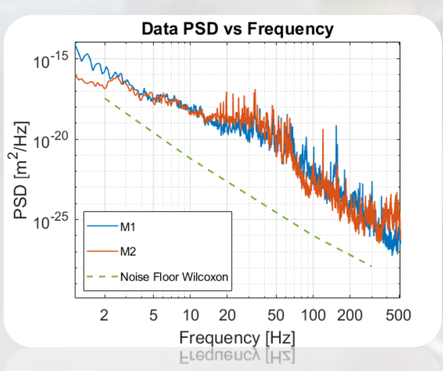


(a) Fluorescence and (b) Ptychography at Tarumã station.



Experimental image of the CARNAÚBA's beam focused on the horizontal plane, producing a vertical beam at the SSA position with FWHM of 45 µm .

Experimental eigenfrequencies	
M1	M2
42	42
56	46
64	51
78	64
91	70
148	104
170	130



Regarding modal results, measurements were performed on both Carnauba's mirrors, M1 and M2, have shown that the ionic pump uncouples at approximately 42 Hz for both mirrors. The mirrors internal mechanisms have high firsts eigenfrequencies, being 148Hz for M1 and 130Hz for M2. Stability on the benches and surrounding floor measurements have been done to complement the modal information [7].

Granite bench kinematic control characterization.
Measurements using the encoders of the feedback control system.

DoF	Step Size (nm - nrad)	Accuracy (nm - nrad)	Repeatability (nm - nrad)
Tx	500	0.52	529
Ty	500	0.81	53
Tz	500	0.86	145
Rx	1000	5.68	41
Ry	10000	8.65	708
Rz	1000	8.68	55

Acknowledgements

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