The full Short-Stroke and Rotary Stages retrofit for the High-Dynamics Double Crystal Monochromator (HD-DCM) at nano crystallography Manacá beamline in Sirius/LNLS*

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Abstract

The first unit of the High-Dynamics Double Crystal Monochromator (HD-DCM) is operating at Manacá Beamline (Micro **Ma**cromolecular and **Na**no **C**rysta**l**lography) since 2020 at Sirius/LNLS. Figure 1 shows the HD-DCM present in the optical hutch at Manacá Beamline. This 4th generation beamline is dedicated to the determination of macromolecular biological structures using X-Ray crystallography.

After the successful development of the new monochromators (HD-DCM-Lite), the new embedded architecture was deployed to the HD-DCM. Retrofitting the HD-DCM shows that the new concepts are reliable and flexible, as it improved the usability of the monochromator by the beamline staff, which also includes the robustness to deal with disturbances.

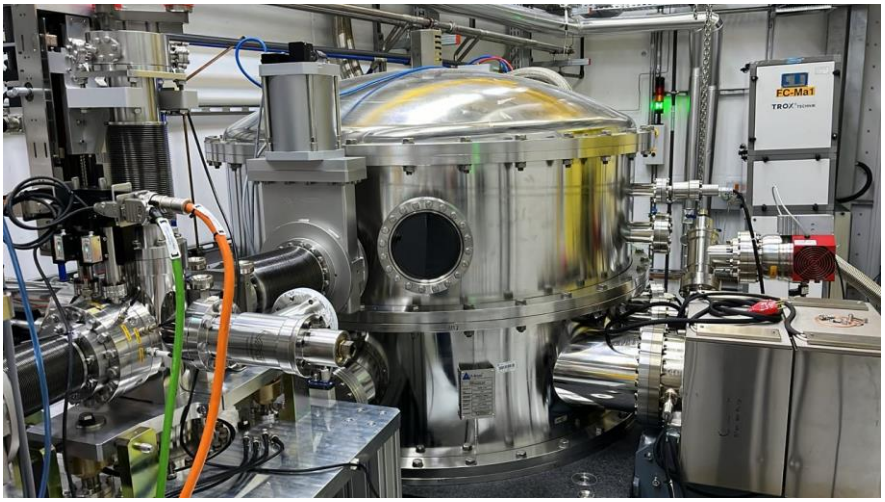

Figure 1: HD-DCM present in the optical hutch at Manacá Beamline

This work aims to show the complete diagnosis of all subsystems responsible for the motion of the monochromator using systems identification techniques based on frequency responses. Also, it will be compared with the results obtained during the prototyping of the HD-DCM, when it was

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being assembled in the metrology room in the years before the beamline inauguration. It is important to emphasize that the prototyping was done using the SpeedGoat rack and the development of the new 2nd generation monochromators (HD-DCM-Lite) has brought a new approach to the system identification, as it is currently being done using the same hardware (including cabling specifications and infrastructure) of the final application: the compactRIO 9049. Thus, improving traceability as the tests can be done periodically due to the unnecessary exchange to an external rack, and reliability as the hardware of the diagnosis is the same as the operation.

This work also aims to show the results for stability and motion of all subsystems present in this HD-DCM, after the design of new controllers using the re-identified systems. As well as the embedded code developed for the new HD-DCM-Lite, the new architectures allow the increase of controllers' complexity, improving the algorithm based on frequency domain determinism to deal with external disturbances, such as vibration from cryocooler and the gate valves of the hutch. For the high dynamics Short-Stroke and the 3-phase brushless Rotary Stage, the system identification after four years of operation will be presented, such as the new developed controllers using loop-shaping techniques to reach in-position stabilities of less than 2 nm (RMS) for the gap and less than 8 nrad (RMS) for the pitch. For the Long-Stroke, a stepper motor, the switching architecture will be discussed, such as the optimized reference curve that allowed the efforts minimization of the Short-Stroke. Finally, this work also aims to compare the stability results to the ones observed in the past four years of operation, including prospects for the re-commissioning.