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Real-time FPGA-based control architecture for high-dynamic mechatronic systems at SIRIUS

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A 4th-generation synchrotron light source demands high-performance mechatronic systems to meet stringent requirements for optical focusing, energy filtering, beam stability, sample positioning, and scanning. SIRIUS, the facility the Brazilian Synchrotron Light Laboratory (LNLS), has achieved exceptional beam quality, supporting advanced scientific experiments through the continuous development of state-of-the-art mechatronic systems* at its beamlines. A flexible, scalable, and high-performance FPGA-based real-time control architecture has been developed to meet the demanding requirements. It is capable of handling high-dynamic systems with control bandwidth on the order of hundreds of hertz, as well as stable motions at the sub-nanometer scale. This work focuses on the embedded code architecture and implementation, reviewing the hardware topology and its seamless integration enabling the full mechanical capabilities. The design principles, implementation strategies, and performance evaluations demonstrate its effectiveness and potential applicability to advanced control applications. The scalable design has also led to significant improvements in beamline development and deployment throughput, enabling harmonious integration and customization towards a reliable system.

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Footnotes

*<https://accelconf.web.cern.ch/ipac2014/papers/mopro048.pdf>

- *T. R. S. Soares, J. P. S. Furtado, G. S. de Albuquerque, M. Saveri Silva, R. R. Geraldés, “Dynamical modelling validation and control development for the new High-Dynamic Double-Crystal Monochromator (HD-DCM-Lite) for Sirius/LNLS”, In: 19th Int. Conf. on Acc. and Large Exp. Phys. Control Systems (ICALEPCS’23)’

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