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HARPIA: High Resolution Powder X-ray Diffraction beamline at Sirius

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Sirius is a fourth-generation synchrotron light source built at the CNPEM and is forecast to begin operations in 2020. Brazil is transitioning from a second-generation synchrotron source (UVX) to a leading position in the design and operation of the brightest 4th-generation machine in its energy class. This multidisciplinary research infrastructure will bring an advanced facility to the structural characterization of polycrystalline samples – HARPIA beamline. The synchrotron source of HARPIA will be an undulator with an 18 mm period length and importantly, without an energy gap. The beamline will be installed in a low-β straight section of the storage ring to increase the beam size in the horizontal direction. HARPIA's optical design aims to be simple, yet highly effective to provide high photon flux at the sample position, ≈2.21012 ph/s/100 mA at 20 keV, about 1000 times higher than that of the LNLS at 8 keV. Energy selection will be obtained by the Bruker double-crystal-monochromator. The two sets of Si crystals, (111) and (333), will allow an energy range from 5 to 30 keV. The beam size at the sample position is calculated to be around 0.85 mm (v) x 1.2 mm (h) with a divergence of 25 μrad (v) x 34 μrad (h) at 20 keV. HARPIA's experimental hutch (Fig. 1) will provide high-resolution X-ray diffraction data with a multi-analyser crystal from FMB Oxford having at least 8 modules of Si(111) crystals and NaBr2 scintillators detectors. Moreover, it will allow dynamic experiments using a linear fast detector developed in-house covering 90° in 2theta range to provide second scale temporal resolution.

The 3 co-axial circle heavy-duty diffractometer from the current XRD1 beamline at LNLS will be transferred to the HARPIA experimental hutch. X-ray diffraction measurements will be conducted in Debye-Scherrer geometry (capillary geometry). The diffractometer uses high precision rotary stages (Θ, 2Θ and d axes) and is designed to support heavy detector arrays, such as the two sets of detectors in the aforementioned paragraph.

A storage magazine for samples placed into capillaries allows hundreds of samples to be loaded and measured via the use of a robotic arm which serves as a sample exchanger. The robotic arm allows for the beamline to be programmed and, if necessary, operated remotely providing high levels of efficiency and maximization of the provided beamtime. HARPIA beamline will provide an efficient and user-friendly facility to the structural characterization of polycrystals in a variety of sample environments as well as fast and high-resolution mode detection to Sirius users.

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