Upgrade of the Nuclear Resonance beamline at ESRF

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In 2024 the Nuclear Resonance beamline at the ESRF will be upgraded and it will change location from the ID18 to the ID14 straight section. The aims of the upgrade are to pursue *(i)* spectroscopies with extreme spatial resolution and *(ii)* studies of atomic dynamics with extreme energy resolution, and eventually *(iii)* allow one to use all advantages of the Extremely Brilliant Source of the ESRF.

For studies with extreme spatial (~150 nm) and extreme energy (~50 μeV) resolution, the beamline will be equipped with two new instruments, Nanoscope and Spectrograph, respectively. In both cases, the improvement in resolution will be achieved without essential losses of flux; i.e., keeping nearly the same count rate. Details of both instruments are discussed in two separate contributions to this workshop.

In order to assure stable operation with extreme spatial and energy resolution, the second optics hutch (containing optics of high-resolution monochromators, synchrotron Mössbauer source, and Spectrograph) and a new fourth experimental hutch (hosting Nanoscope) will be equipped with thermal isolation, and with high-quality heating, ventilation, and air conditioning (HVAC) system providing temperature stability of about 0.1°C.

The radiation source is expected to be upgraded to cryogenically-cooled permanent magnet undulators (CPMU), providing an increase of intensity by a factor of 1.4 for 14.4 keV (^{57}Fe), by a factor of 3-7 for 20-40 keV (^{151}Eu, ^{149}Sm, ^{119}Sn, ^{161}Dy, ^{125}Te, ^{121}Sb, ^{129}Xe), and by a factor of 15-20 for 60-90 keV (^{61}Ni, ^{99}Ru).

The high-heat-load monochromator (HHLM) will be upgraded by switching from vertical to horizontal scattering plane. This will allow for preserving best quality of the beam after HHLM in vertical plane for downstream high-resolution optics (working in the vertical plane of scattering). Simulations [1] show, that under these conditions the angular deteriorations of the beam after the HHLM due to heat-load effects are smaller than the angular size of the beam source (as seen from the HHLM position), i.e., that this instrument is free of the heat-load effects in the vertical plane. Similar to the improvement of spatial and energy resolutions, this will be achieved without noticeable (~3% percent only) decrease of intensity.

The Nanoscope and Spectrograph instruments are expected to be delivered to users by end of 2021, still at ID18, and moved to ID14 in 2023. ID18 is planned to be operational till second half of 2023, and user service at ID14 is expected to start from beginning of 2024.

References:

1. P. Brumund, *et al*, Design simulations of a horizontally-deflecting high-heat-load monochromator, Journal of Synchrotron Radiation, 2020, accepted for publication.