

FOCUS ON

A storage ring

fit to operate two long beamlines simultaneously

It required the work of more than a dozen SOLEIL groups to enable the respective undulators of ANATOMIX and NANOSCOPIUM to provide a beam simultaneously to both of these long beamlines.

Each long SOLEIL beamline, ANATOMIX and NANOSCOPIUM, takes a photon beam from an in-vacuum undulator with a minimum gap width of ± 2.5 mm, installed in a long straight section of the storage ring. The linear optics of the machine have been specially optimized to ensure a minimum vertical size at the center of each insertion device; this has been made possible by the introduction of a focusing quadrupole triplet at the center of the section and also a magnetic chicane. By November 2011, the first beam tests had been carried out, while simultaneously closing both undulators at their minimal gap. Unfortunately, vertical instabilities and strong out-gazing were quickly observed upstream of the second undulator. After removing the downstream undulator during the technical shutdown in January 2012, the reason for this instability was investigated and clearly identified: the photon beam from the upstream undulator had overheated the copper and nickel (Cu/Ni) protective sheet covering the undulator magnets, deforming it and eventually piercing it several times. A project group was created to analyze the reasons for this incident and find a perennial solution for simultaneously closing both undulators at their minimal gap values.

The solution: a beam absorber and finer local monitoring of the electron beam

It became clear that the characteristics unique to SOLEIL (lever arm linked at a large distance

between the two undulators, magnetic gaps of 5.5 mm) significantly increased the risk of damaging the undulator for any large enough accidental vertical displacement of the incident beam. The solution was to insert a dedicated absorber at the entrance of the downstream undulator, as well as introducing finer monitoring of the position and angle of the electron beam going through the upstream undulator.

Optimizing the altimetry of the magnets inserted downstream, and therefore the Cu/Ni sheet covering them, was another major factor to minimize any local defects in the surface. Any “bump” would concentrate the power deposited locally, which would then be multiplied by a factor of 40. This complex project took into account the constraints of operating or constructing ANATOMIX and NANOSCOPIUM beamlines, but also the ability to intervene only during sufficiently long shutdown periods.

By June 2015, an interim solution without the absorber had been introduced (a gap of 8 mm instead of 5.5 mm for upstream insertion) to allow the two long beamlines to function simultaneously. This was also accompanied by increased position monitoring by adding, for the first time, control of the vertical angle of the electron beam within the upstream undulator. The system is fast as it interrupts the beam in 2 milliseconds when there is a faulty angle.

The final solution consisted of a new type of local high-speed interlock system (position and angle in both

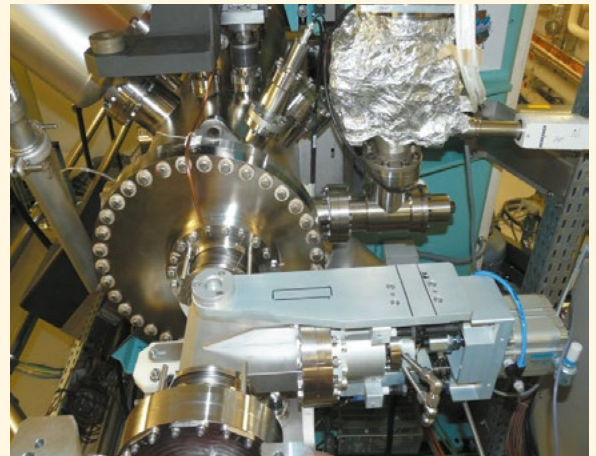


Figure 1: Dedicated absorber, installed just before the downstream insertion in section 13.

transverse planes) as well as a dedicated photon absorber. This absorber's main purpose was to prevent photons from reaching the upper or lower jaws of the downstream undulator, but also to protect the double XBPM* installed downstream on the beamline front end during technical shutdown in January 2016. The setting up of the absorber and machine interlocks, as well as checking the absence of deleterious effects on the beam, were followed by a series of radioprotection tests that were completed in late May 2016. This multidisciplinary project involved many groups: magnetism and insertion devices, accelerator physics, electronics and data acquisition, control, mechanical engineering, machine operation, diagnostics and synchronization, alignment and metrology, ultra-vacuum, security, building and infrastructure, as well as the personnel of the ANATOMIX and NANOSCOPIUM beamlines.

* XBPM:
X beam
position monitor

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