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RETRACTABLE ABSORBER (MASK) AND WHITE BEAM IMAGER DIAGNOSTIC FOR CANTED STRAIGHT SECTION

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Abstract

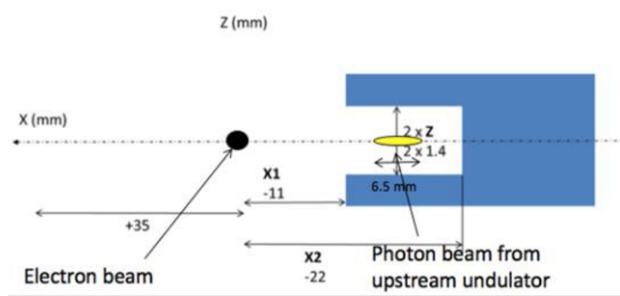
At the SOLEIL synchrotron, as in other accelerators, two canted sources can coexist on the same straight section for space and economic reasons. For its two long beamlines (ANATOMIX source upstream and NANOSCOPIUM source downstream) SOLEIL has made the choice to equip one of his long straight section with two canted insertion devices capable to operate simultaneously. That implies to take into account the degradation risk management of equipment, due to radiation. As the beam power deposition from the upstream undulator can seriously degrade the downstream one, or even other equipment. To handle these risks, Soleil first designed and installed in 2016 a retractable vertical absorber between both insertions to protect the downstream source from the upstream one. In 2017, Soleil then designed and installed a white beam imager, redundant an existing photon beam monitor (XBPM), to verify the correct positioning / alignment of equipment and beams relative to each other. For the vertical absorber as for the white beam imager SOLEIL had to meet some interesting technological and manufacturing aspects that we propose to present in a poster.

INTRODUCTION

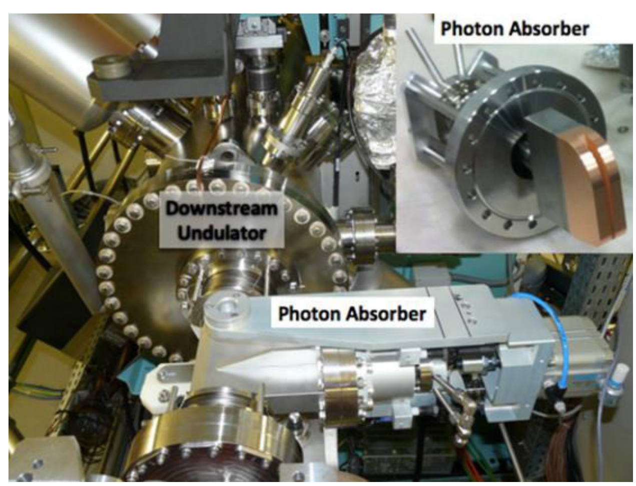
In one of the long straight sections of SOLEIL, SDL13, two canted insertion devices have been installed for X-rays delivery to the ANATOMIX (upstream) and NANOSCOPIUM (downstream) beamlines. For the insertion devices to be operated and used simulatneously by those two independent beamlines, they were canted in the horizontal plane. But the canting angle remains small, so that the upstream ID radiation passes through the downstream ID. To prevent any damage of the downstream ID magnets from the upstream ID radiation, it was first decided to install an absorber in between the two IDs, to shadow the downstream ID magnets. But the efficiency of this mask relies on an accurate relative alignment of the upstream ID, the mask itself and the downstream ID. Those diagnostics to do the survey are mandatory. An XBPM in the beamlines front-end is in operation since 2016. But to ensure a redundancy in the measurements, it was decided in 2017 to add nearby a white imager. This paper summarizes the design of both the absorber and the white imager.

THE ABSORBER

The absorber first aim was to shadow the downstream ID magnets from the upstream ID radiation. Installed in between the two IDs, this gave a vertical aperture of 2.8 mm. Detailed studies were then carried out to define its geometry in order not to jeopardize the performance of the storage ring in terms of collective effect induced instabilities, beam losses, injection efficiency and beam time. The absorber is a piece of copper with an asymmetric 90 degree U-shape (see Figure 1). It encloses the photon beam produced upstream while the electron beam is located at -11 mm from the U-border of the absorber (see inset in Figure 1 b).



(a) Schematic



(b) Pictures before (inset) and after installation

Figure 1: Schematic and pictures of the absorber.

The absorber is maintained inserted in between the IDs using a spring based system. For security reason, the stage is by default inserted. It can be retracted when needed, thanks to a remote controlled jack (see Figure 4).

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THE WHITE IMAGER

The white imager first aim is to check the relative alignment of the upstream ID, the absorber and the downstream ID. Its principle is the following: a diamond disk is inserted on the upstream ID photon beam path after passing through the downstream ID. The photon beam hits diamond imperfections (Nitrogen) causing scintillation of the diamond in the visible range. This scintillating pattern is then imaged on a CCD. It is then checked on this image that the upstream radiation is correctly "clipped" by the absorber, meaning that the downstream ID magnets are protected.

The Diamond

Given the upstream ID radiation pattern dimensions together with the absorber shadow geometry in the imager plane, the diamond disk had to reach a minimum diameter of 26 mm: a clear aperture of 28 mm was chosen. To ensure sufficient light collection but also to limit the expected temperature elevation to +40°C, the diamond thickness was chosen to be 0.3 mm. Because the incident power on the diamond is of the order of 10 W/mA, it can only be inserted at low (<10 mA) currents. To enable the water cooling of the diamond, it was brazed on a copper ring (see Figure 2). A 30 µm silver coating was deposited on the diamond surface to increase its thermal conductivity. The whole system (diamond + ring) was realized by Diamond Materials.

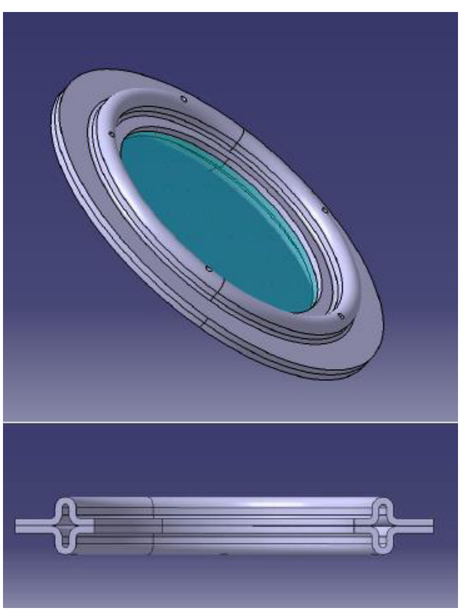

Figure 2: Schematic of the diamond disk brazed on its cooling copper ring.

The Diamond Holder and Cooling System

The diamond is mounted on a holder which ensures both the diamond supporting and cooling (see Figure 3). The diamond copper ring is hold by a refined pressuring system using Belleville rings to ensure a homogeneous stress on the ring. To evacuate the heat load on the diamond, water flows through the holder in and out around the copper ring with a limited speed to prevent vibrations.

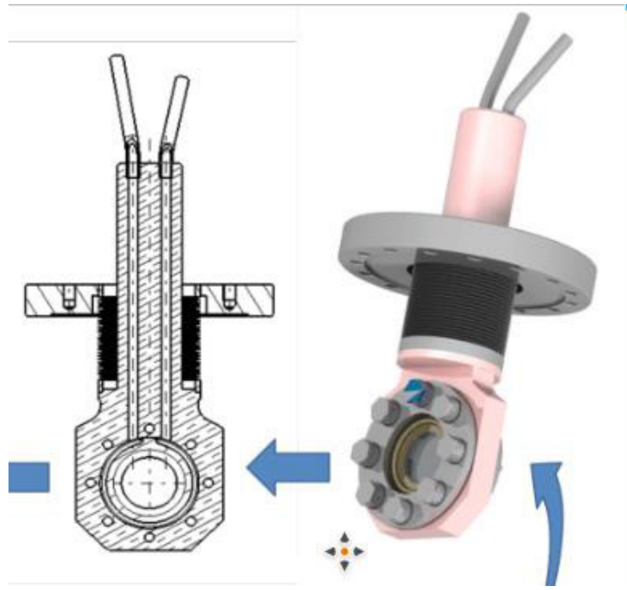

Figure 3: Diamond holder and cooling system.

The Diamond Insertion Stage

The insertion of the diamond in its holder on the photon beam path is enabled by a pneumatic jack. For machine and diamond security reasons, the diamond has to be by default extracted: this was ensured using two strong springs that have to be compressed by the jack for diamond insertion.

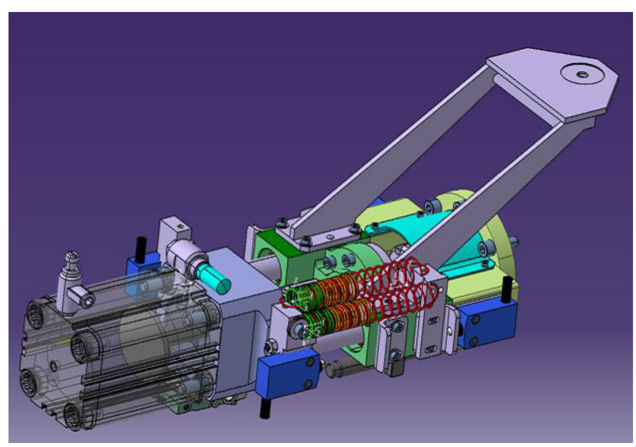

Figure 4: The diamond insertion stage.

The Imaging System

In order to image the scintillation pattern on the diamond disk, an imaging system is mounted behind an UHV window on the top of the diamond vacuum chamber (see Figure 5). This imaging system simply consists in an objective with extender and of a CMOS camera. The photon pattern is demagnified by about a factor 0.55 which allows a spatial resolution better than 10 µm.

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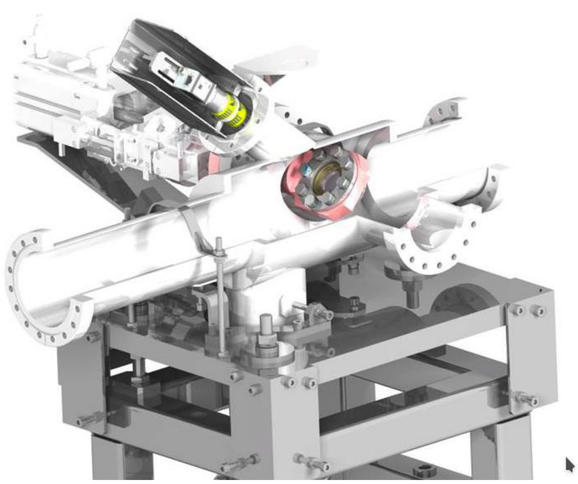

Figure 5: White imager general view.

ABSORBER AND IMAGER OPERATION

The absorber was successfully installed and commissioned in 2016. In users operation, it is systematically inserted to allow the simultaneous operation of the SDL13 beamlines. It is only extracted during specific machine studies.

The white imager was successfully installed and commissioned in 2017. It was found out that using a current of 6 mA is already sufficient in terms of photon flux to operate the diagnostics. The white imager is used after each machine shutdown and after each extraction/insertion of the absorber. It gives complementary information to the XBPM measurements and even revealed more straight forward and easy to use.

CONCLUSION

The absorber and the white imager were designed at SOLEIL to secure the operation of two canted IDs. Both rely on simple thus robust mechanical concepts which rend their commissioning easy and straight forward. They are now successfully used to operate routinely ANATOMIX and NANOSCOPIUM beamlines simultaneously.

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