BL19LXU
RIKEN SR Physics

1. Introduction

BL19LXU is a hard X-ray beamline equipped with a 27 m in-vacuum undulator in one of the four long straight sections of the SPring-8 storage ring. Experimental hutches (EHs) 1, 2, and 3 have been in operation since FY2000, and EH4 was constructed in FY2001.

The beamline has been continuously updated as follows. Major updates in the optics hutch include the installation of a transport-channel (TC) mirror to reject higher harmonic radiation (FY2004), the installation of precision four-jaw slits (FY2010), the renewal of the stages (FY2013), the installation of the cooling pipes in the double-crystal monochromator (DCM) for enhanced stability (FY2015), the installation of an in-line beam monitor made of a diamond thin film (FY2015), and the replacement of the vacuum system from turbomolecular pumps to an ion pump (FY2017) to keep the surfaces of the monochromator crystals and the mirrors clean. In FY2017, the minimum photon energy was lowered from 7.270 keV to 7.092 keV, which is below the iron K edge at 7.112 keV, by changing the minimum gap size of the undulator.

For micro- and nano-focusing, Kirkpatrick–Baez (KB) mirror systems were permanently installed in EH3 (FY2014) and EH4 (FY2010). The outdated Ti:sapphire laser system was updated (FY2016), and the repetition rate was increased from 1 kHz to 10 kHz, which improved efficiency in time-resolved experiments. In accordance with the 10-kHz system, the X-ray chopper was also upgraded to select a single bunch at 9.49 kHz (FY2016). To improve the experimental environment, the lighting in the hutches was changed from fluorescent tubes to LEDs (FY2015), the precision air-conditioning systems in EH1 and EH3 were upgraded (FY2016), and the doors of EH1 and EH3 were motorized (FY2017). The PLC system was upgraded to allow users to select the active hutch and to operate in a remote mode at all times for users' convenience (FY2018). The regles of the doors of EH1 and EH3 were backfilled to seamlessly join the floors inside and outside the hutch, which makes it much easier for users to carry heavy apparatuses into the hutch (FY2019). A heavy-load Z stage was installed in EH2. The Z stage mounts the X-ray chopper, a 4-jaw slit, and the diamond thin-film beam monitor, and can easily adjust these components to the beam axis.

2. Recent activities

Synchrotron Mossbauer experiments, which are one of the major research activities at BL19LXU, require high flux because the nuclear-resonance efficiency is very low. To deliver higher X-ray flux, the front-end slits are opened up to the limit imposed by the cooling power of DCM.

The liquid-nitrogen cooling system of DCM responded very slowly after a sudden increase in the heat load. When the heat load was near the limit, the cooling system could not handle it properly and stopped abnormally in the worst case. To prevent such failure, the front-end slits must be opened gradually while monitoring the status of the cooling system, i.e., the temperature of the circulating liquid nitrogen (Fig. 1). This procedure was delicate and

complicated for nonexpert users, who had to do it by themselves when the storage ring was recovered from abort during their beamtime.

In FY2023, the cooling system was optimized to make the operation easy under high-flux conditions. A proportional-integral-derivative (PID) algorithm governs the response. The PID was tuned so that the same parameters could be used for two typical high-heat-load setups and the standard one. The improved response is shown in Fig. 2. Now, the system can properly handle the sudden increase in the heat load after the refill of the storage ring, which enables users to restart their experiment without the need to perform a complex procedure.

Various user experiments, which require brilliant X-rays, and R&D programs for X-ray free-electron laser experiments are performed at each experimental hutch. In FY2023, experiments performed in EH1 included a fundamental study on X-ray parametric down-conversion and nuclear resonance vibrational spectroscopy to study hydrogenase. Most of the experiments, such as research on the X-ray pumping of the thorium-229m isomeric state, high-energy X-ray diffraction for the stress–strain analysis of iron materials, linear dichroism in HAXPES, and time-resolved X-ray diffraction experiments with the synchronized Ti:sapphire laser system, were performed in EH3. X-ray magnetic scattering experiments were performed in EH4 using a superconducting magnet.

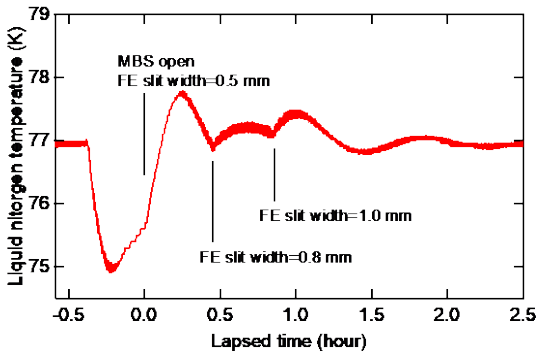

Fig. 1. Trend of the liquid nitrogen temperature during a front-end slit opening operation. The width was gradually increased to keep the temperature below 78 K.

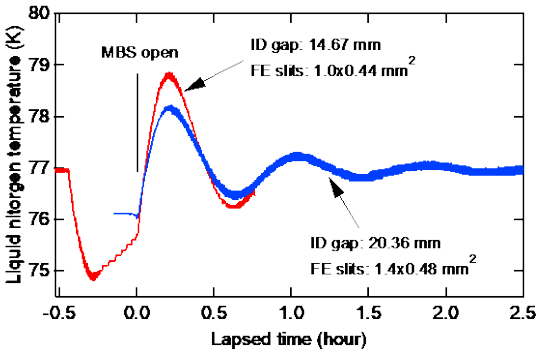

Fig. 2. Trend of the liquid nitrogen temperature for two typical high-heat-load conditions after the PID optimization.

TAMASAKU Kenji

Physical and Chemical Research Infrastructure Group, Advanced Photon Technology Division, RIKEN SPring-8 Center