BL43LXU
(RIKEN Quantum NanoDynamics)

In FY2018, BL43LXU was dedicated mostly to user experiments [1]. However, some time was allocated to the installation and commissioning of new equipment (see below). The present report emphasizes both the changes and the problems at the beamline in an effort to provide an accurate record of progress and useful information to others

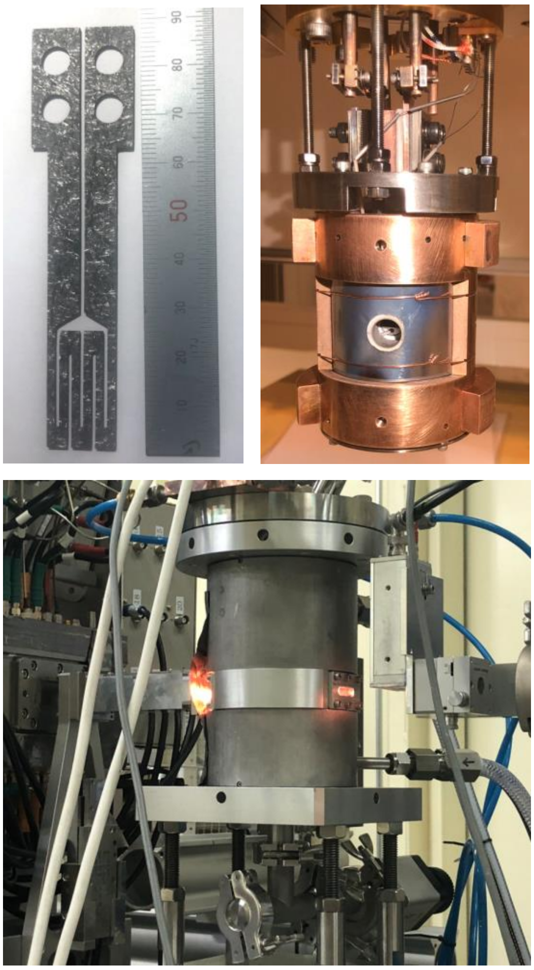

Fig. 1. High-temperature vacuum furnace. Upper left is one of the carbon composite heaters. Upper right is the sample unit before installation in the vacuum chamber. Lower panel shows the furnace in use at BL43LXU.

working on developing Synchrotron Radiation (SR) instrumentation.

Work at the experimental stations was largely performed by members of the Materials Dynamics Laboratory with the assistance of members of JASRI and RIKEN as well as members of the RIKEN beamline support group for some projects. Help from part-timers included more general beamline tasks (Hattori) and work on technical drawings (Taguchi). Additionally, full-time members of the engineering team (Nagare and Umezawa) focused on specific BL43 tasks, including the standard start-up of the LN_2 cooling for the mirror and monochromator, beam size measurements, and setup of sample refrigerators. This is an ongoing process, which is complicated by the multiple setups at BL43LXU.

The upstream BL components (electron orbit, IDs, and mirrors) were stable during FY2018. The orbit-correction protocol operated smoothly without ID issues. The high-heat-load mirror (M1) operated without changes and was reasonably stable when used. The BPMs (SiC quadrant) is now well integrated into standard operations.

1. KB for 21.747 keV

Mirror substrates for an elliptical KB pair were delivered from J-Tec and then coated. The initial coating (by Incoatec) failed to meet the required specifications. (Part of the issue was an intermediary company was not transparent with communications.) However, recoating by Osmic/Rigaku solved this issue. Osmic is thought to be more capable of precise d-spacing control. The mirror reflectivity and uniformity were verified and found to be reasonable. The first focusing tests are slated for fall of 2019.

2. 1600 °C Furnace

After repeated failures and a significant loss of beamtime because a user furnace was unable to sustain high temperatures, a new furnace was designed by A. Baron with help from M. Inui (Hiroshima University) and K. Matsuda (Kyoto University). The new furnace uses carbon composite heaters instead of tungsten or molybdenum wire heaters, fundamentally changing the entire internal structure and concept of the furnace. This new setup performed well. It stably held temperatures in excess of 1560 °C achieved in a vacuum over ~48 h period. Additionally, the heaters are suitable for repeated use (for four cycles per day).

This is a dramatic improvement over the previous furnace. The new furnace allows good data collection for liquid Fe and Co using both 0.8- and 1.3-meV resolutions. It is noteworthy that there was one occasion where the feedback failed and a Mo part (perhaps ~10 g of Mo) was melted and pooled on the lower ceramic insulator, indicating the temperature exceeded 2600 °C before the heaters failed. On another occasion, operations at 1900 °C were possible but only for a few hours before the heater failed. Thus, 1560 °C is thought to be reliable, but higher temperatures will require some work because all the heaters should be capable of achieving > 2500 °C.

3. Cryomagnet

We continued to commission the 7-T cryomagnet. This was originally a project of a post-doc who left suddenly to take a permanent job in his home country. The initial tests with the beam at BL43LXU in FY2015 failed because Oxford Instruments had set the heat-switch current too conservatively (35 mA vs. a typical value of 72 mA), and they were not able to help until the experiment ended. We planned another experiment in June 2019 with D. Bessas, who was visiting from ESRF. During this time, the system controller failed (it had to be taken to Oxford Instruments in Tokyo to be fixed), a window developed a leak, and the Temperature control was slow, suggesting a blocked needle valve. These issues were addressed during the summer of 2019, and partly included re-designing the window with the intermittent leak.

Fig. 2. 7-T cryomagnet installed on the high-resolution spectrometer.

The system performed well during testing (T was controlled from 2 K to 300 K, and H < 1 T) in September 2019. Many small auxiliary pieces were then ordered. More work is planned for December 2019. Our hope is that the Oxford system will not develop any new failure modes.

4. Medium-resolution spectrometer

This spectrometer operated during January and February 2019. Reasonable datasets were collected for several samples, including liquid hydrogen in a DAC.

5. High-resolution spectrometer

This spectrometer operated reasonably for most of the year, except for issues with the granite becoming scratched, presumably due to drift in the alignment/floor stability. In FY2018, with help from the Engineering Team, the airflow to the airpads was significantly enhanced, and the float heights of most pads increased to 20–30 microns. These improvements should make the system less sensitive to slight alignment drifts. We have also contacted Huber Diffraktiontechnik about re-polishing the granite. Hopefully, they will respond in a timely fashion. Additionally, a Pilatus CdTe 300M was purchased by SPring-8. It can be used to measure diffuse scattering and powder diffraction on the high-resolution spectrometer. Work continued with the sub-meV setup because this is thought to be interesting to the broader community.

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Reference:

[1] A. Q. R. Baron, SPring-8 Inf. Newsl. 15, 14 (2010). and A. Q. R. Baron, in Synchrotron Light Sources Free. Lasers Accel. Physics, Instrum. Sci., edited by E. Jaeschke, et al. (Springer, Cham, 2016), p. 1643–1757. See also arXiv 1504.01098.