BL43LXU
RIKEN Quantum Nano Dynamics

1. Introduction

The majority of the beamtime at BL43LXU [1] in 2019 was for user experiments. However, there was also some installation and commissioning of new equipment (see below). The present report will, as usual, emphasize both the changes and the problems at the beamline, in an effort to provide a record of progress and useful information to others working to develop SR instrumentation. One notes that the COVID-19 outbreak did impact running, with user experiments mostly cancelled from mid-April through June of 2020. However, some remote work was carried out, and also some useful beamline tests and R&D. There was significant effort to use the beamtime effectively even without users.

2. Recent activities

Work at the experimental stations has largely been done by members of the Materials Dynamics Laboratory, with assistance on some projects by members of JASRI, and RIKEN, and, occasionally, members of the RIKEN beamline support group. Help from part timers included some for more general beamline tasks (Hattori), some work on technical drawings (Taguchi). BL43 also had some help from full-time members of the engineering team (Nagare) on specific tasks including standard start-up of the LN_2 cooling for the mirror and mono, and, sometimes, beam size measurement and setup of sample refrigerators. This is an ongoing process, complicated by the sophistication of many of the setups at BL43LXU.

2-1.Optics hutch and upstream components

The upstream components - electron orbit, IDs, mirrors, and high-heat-load (HHL) mono -were stable during FY2019. The orbit-correction protocol operated smoothly, and there were no issues with the IDs. The HHL mirror (M1) operated without changes, and was stable when used. The BPM (SiC quadrant), placed just before the sample, is now well integrated into standard operation. The encoder for th1 of the high-heat-load mono became unreproducible in April of 2020: based on present investigation (September 2020) this looks to be an issue with external (cable interface) electronics in the Renishaw encoder. We had feared the in-vacuum read-head had died (multiple read-heads died early in beamline running) however, it seems the 1mm W shielding that was added after the early failures has been effective.

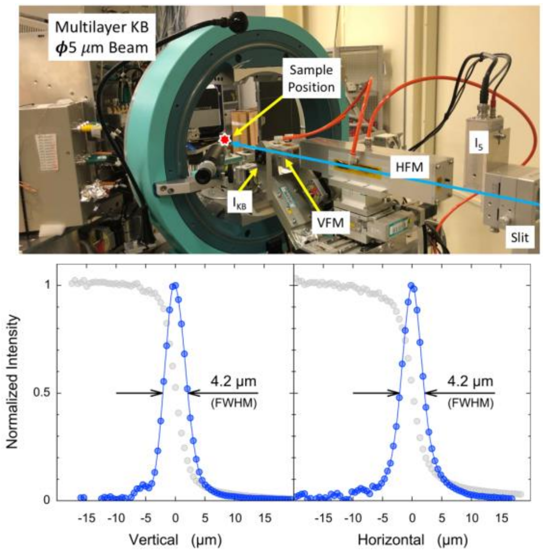

Fig. 1. Multilayer KB for focusing the 1 mm × 3 mm beam at 21.747 keV.

2-2. KB focus at 21.747 keV

In FY2018, substrates for an elliptical Kirkpatrick-Baez (KB) pair (JTEC) and subsequent coating (Osmic/Rigaku) for high precision (0.2%) d-spacing control were delivered. The new mirrors were used to focus the beam in 2019 and performed well with >45% throughput for an incident beam size of 1 mm × 3 mm and a sub-5-micron beam size in the 1.3-meV resolution Si (11 11 11) setup (Fig. 1).

2-3. Cryomagnet

The cryomagnet system was used in a first user experiment in December of 2019 - this followed extensive off-line work to improve the system in 2018. In general, the magnet performed reasonably. However, some care with sample mounting is needed: on two occasions a sample of superconductor flew off its mount when the temperature was reduced below Tc, despite large amounts of epoxy being used the second time. There were also some issues with the sample positioner not rotating properly. That system was re-greased. Hopefully the system will now be stable: next experiments using the magnet are planned for November/December of 2020. At that time we will begin to teach engineering team how to set up the magnet.

2-4. Medium-Resolution Spectrometer

This was not operated in FY2019 due to efforts devoted toward realizing measurements with a sub-meV resolution at sub-nm^{-1} momentum transfers in the high-resolution setup.

2-5. High-Resolution Spectrometer

This operated reasonably during most of 2019. In the summer of 2019, six of the noisier chips/channels of the CZT IXS detector were replaced by Hamamatsu. This upgrade removed the noise from these channels. In March of 2020, Huber came and re-polished both the granite field and the surface of airpads. Hopefully, with the airpad flight height increase in FY2018, the granite will survive longer without being scratched. Two motherboards for the VME crates were replaced in the summer of 2019. The large window on the analyzer chamber was also replaced late in 2019, and, during the summer of 2020, changes were made to the readout software for the analyzer T-control to accommodate a revised version of some hardware. An additional column of analyzers was installed for regular work, increasing the analyzer array from 24 (4 × 6) to 28 (4 × 7) channels.

2-6. Soller Slits and Soller Screens

After increased experience and generally favorable results with the Soller screen and the Soller slits (see [2] for more details), new models were designed and installed, including a Soller slit for general operation with a 4 × 8 analyzer array and a revised Soller screen for high-pressure work. In addition, a different screen design was fabricated for use with laser heating. The new Soller slit allows an 80-mm downstream clearance after the sample. The Soller screen allowed for the collection of extremely clear data on iron acoustic modes at pressures well in excess of 200 GPa (in collaboration with Ohtani-lab of Tohoku University)

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References:

[1] A. Q. R. Baron, SPring-8 Inf. Newsl. **15**, 14 (2010) http://user.spring8.or.jp/sp8info/?p=3138 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 http://arxiv.org/abs/1504.01098

[2] A. Q. R. Baron, D. Ishikawa, H. Fukui, and Y. Nakajima, AIP Conf. Proc. **2054**, 20002 (2019) https://aip.scitation.org/doi/abs/10.1063 /1.5084562.
See also https://arxiv.org/abs/1807.03620