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Ultrahigh Resolution 2D-RIXS at NanoTerasu BL02U

Thursday, 20 November 2025 12:00 (1h 30m)

NanoTerasu is Japan's newest 3GeV synchrotron radiation facility, which commenced user operations in 2024. NanoTerasu hosts a suite of advanced beamlines, including BL02U dedicated to ultrahigh-resolution Resonant Inelastic X-ray Scattering (RIXS). RIXS is a powerful, photon-in/photon-out spectroscopic technique that allows us to observe very low-energy excitations in materials. These excitations, arising from charge, spin, orbital, and lattice degrees of freedom, govern the fundamental physical properties and functions of materials, such as quantum materials and functional devices.

Achieving higher energy resolution in RIXS has been a long-standing challenge, since it traditionally comes at the cost of significantly lower measurement efficiency (throughput). To overcome this trade-off, we developed a state-of-the-art "2D-RIXS" spectrometer at BL02U. This spectrometer uses energy-dispersed incident X-rays, rather than monochromatic X-rays, allowing it to acquire multiple RIXS spectra simultaneously. This sophisticated design successfully circumvents the efficiency limitations of conventional spectrometers.

Through dedicated development and commissioning, the BL02U beamline has successfully achieved the ultrahigh energy resolution in the soft X-ray region. Our results have demonstrated a combined resolving power (E/ΔE) exceeding 58,000, corresponding to an energy resolution of 16.1 meV at the Cu L-edge (930 eV).

This presentation will provide an overview of the NanoTerasu facility and the general principles of RIXS. We will then detail the performance realized by the BL02U beamline and 2D-RIXS spectrometer. We will also touch upon the initial scientific results, showcasing the new opportunities available for investigating complex material properties.

[1] J. Miyawaki et al., J. Phys. Conf. Ser. **2380**, 012030 (2022).
[2] K. Yamamoto et al., J. Phys. Conf. Ser. **3010**, 012115 (2025).
[3] J. Miyawaki et al., Synchrotron Radiation News **38**, 4 (2025).

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