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The UE49 SGM RICXS beamline at BESSY II

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Abstract: Beamline UE49-SGM is a dedicated high-flux soft x-ray beamline, spanning the energy range of 95 eV to 1400 eV. Its micrometer focus makes it ideally suitable for investigation of small or inhomogeneous samples both with spectroscopic methods and coherent scattering as well as imaging techniques with full polarization control.

1 Introduction

The UE49SGM RICXS beamline is a dedicated high-flux-density beamline, which accomodates two permanent experimental set-ups for x-ray scattering: the Resonant Inelastic X-ray Scattering (μmRIXS) and the Coherent X-ray Scattering (CXS) end-stations. The µmRIXS experiment is designed for resonant X-ray Raman studies of solid samples under ultra-high vacuum conditions and in the temperature range from liquid He to room temperature. It is equipped with a confocal plane grating spectrometer, which allows optimizing the operation mode between high signal-transmission and high energy-resolution. The CXS set-up allows the use of coherent X-rays in scattering, imaging and spectroscopy applications. In particular, the transverse and longitudinal coherence length can be optimized for the particular experiment to maximize the coherent photon flux on the sample. A large part of reciprocal space can be covered by a moveable 2048 x 2048 pixel soft X-ray CCD detector (moveable in situ by $\pm 45^{\circ}$ horizontally and vertically with adjustable pixel oversampling ratio). A 3D magnetic vector field of up to 1 T is available as sample environment. The characteristics of the RICXS beamline were designed to meet the high demands of the two techniques, which are high (coherent) photon flux, a µm-size beam focus and full polarization control (linear and circular). It can be operated in the energy range 95 – 1400 eV, covering the resonant transitions of many relevant elements, such as silicon and phosphor L-

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edges, lanthanide $N_{4,5}$-edges, carbon, nitrogen and oxygen K-edges and transition metal $L_{2,3}$-edges. The beamline is realized as a spherical grating monochromator (SGM) with a Kirkpatrick Baez refocusing stage. It is optimized for high transmission by minimizing the number of reflections, with the liquid nitrogen cooled grating being the first optical element to directly accept the undulator radiation. The monochromator accommodates three laminar gratings: 180 l/mm (operation range: 95 – 270 eV, best energy resolving power E/ΔE = 6500 at 95 eV), 410 l/mm (180 – 650 eV, E/ΔE = 10000 at 210 eV), 900 l/mm (400 – 1400 eV, E/ΔE = 12000 at 450 eV).

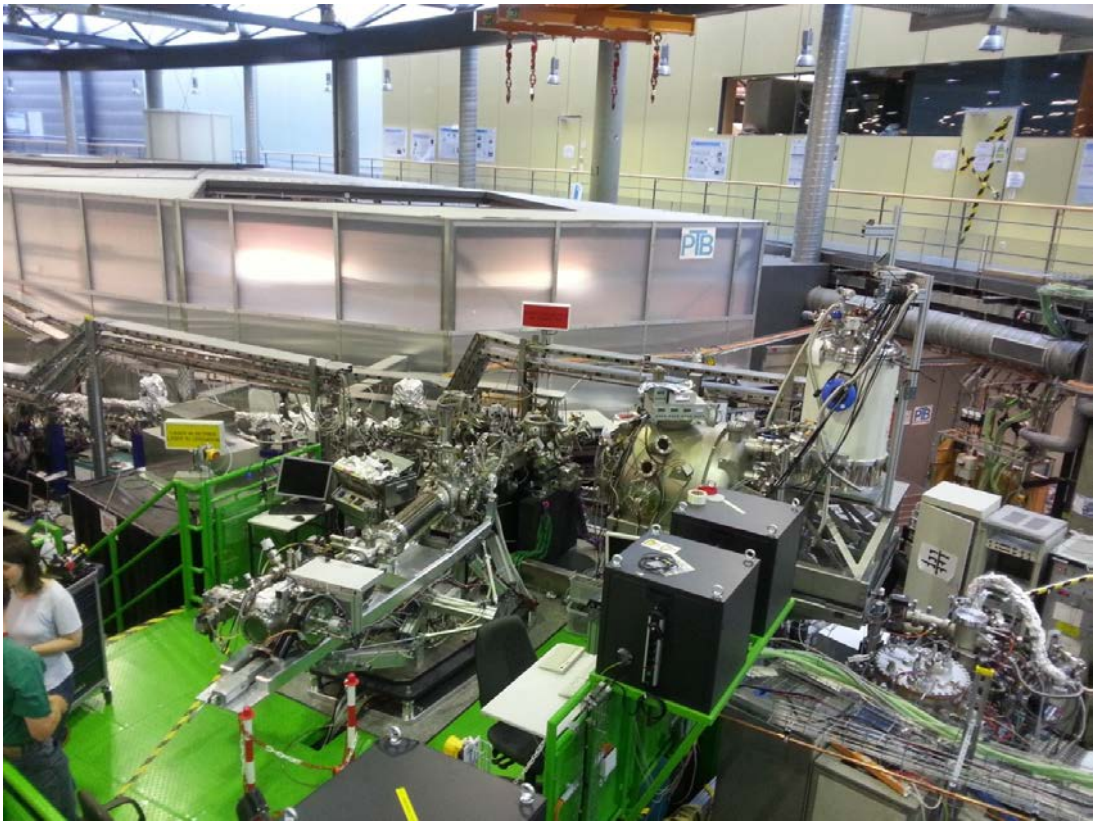

Figure 1: Top-view of beamline UE49 SGM | RICXS.

2 Instrument application

Typical applications for μmRIXS are:

- study of low-energy excitations in solids (study of magnetic, orbital, nuclear and charge degrees of freedom and their interplay)
- study of the electronic structure of solids (the size of band-gaps and band-widths)
- study of materials showing phase separation with µm-real-space resolution

Typical applications for CXS are:

- studies of nanomagnetic phenomena via x-ray magnetic circular or linear dichroism
- x-ray holography, coherent diffraction imaging and ptychography
- coherent resonant x-ray scattering in transmission and reflection geometry

3 Source

The insertion device is the elliptical undulator UE49 with the following parameters:

Type	APPLE2
Location	L108 (low beta section)
Periode length	49 mm
Periods/Pols	64
Minimal Energy at 1.7 GeV	91.2 eV
Minimal Gap	16 mm
Polarisation	linear variable 0° ... +90° elliptical, circular

Table 1: Parameters of insertion device UE49.

4 Optical Design

To ensure maximum flux, the optical beamline design consists of only three optical elements: a spherical VLS grating with a vertical deflection angle of 175° and a Kirkpatrick Baez refocusing stage.

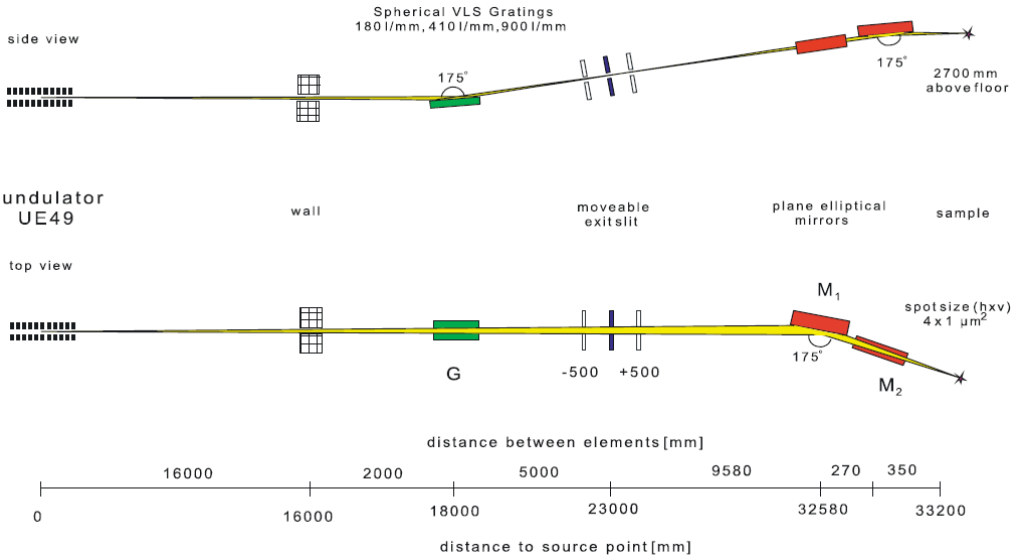

Figure 2: Optical layout of beamline UE49 SGM | RIXCS.

5 Technical Data

Location	10.1
Source	UE49
Monochromator	Spherical VLS grating monochromator
Energyrange	90 - 1400 eV
Energyresolution	4000 - 12000
Flux	Up to $7{\cdot}10^{14}$ photons / s / 0.1 A / 0.1 % BW
Polarisation	Full polarization control
Focus size (hor. x vert.)	4 μm x 1 μm (hor. x vert.)
Height Focus/floor level	1100 mm
Free photon beam available	No
Fixed end station	Yes

Table 2: Technical data of Beamline UE49 SGM | RIXCS.

References

Helmholtz-Zentrum Berlin für Materialien und Energie. (2016a). CXS: Coherent X-ray Scattering at the UE49-SGM at BESSY II. *Journal of large-scale research facilities*, *2*, A56. http://dx.doi.org/10.17815/jlsrf-2-81

Helmholtz-Zentrum Berlin für Materialien und Energie. (2016b). The μmRIXS spectrometer at BESSY II. *Journal of large-scale research facilities*, *2*, A55. http://dx.doi.org/10.17815/jlsrf-2-80

Könnecke, R., Follath, R., Pontius, N., Schlappa, J., Eggenstein, F., Zeschke, T., … Föhlisch, A. (2013). The confocal plane grating spectrometer at BESSY II. *Journal of Electron Spectroscopy and Related Phenomena*, *188*, 133 - 139. http://dx.doi.org/10.1016/j.elspec.2012.11.003