The Focusing Compensated Asymmetric Laue Spectrometer

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A new kind of x-ray spectrometer [1], set up in the **FO**cussing **C**ompensated **A**symmetric **L**aue (**FOCAL**) geometry (figure 1), will aid in achieving an accurate determination of binding energies of heavy hydrogen-like ions in the ESR storage ring. The spectrometer serves in measuring small wavelength differences between the fast moving x-ray source, represented by the circulating ions in the ESR, and a stationary calibration source. It is designed for energies between 50 and 100 keV or wavelengths between 25 and 12 pm leading to Bragg angles of less than 4° for a Si(220) crystal.

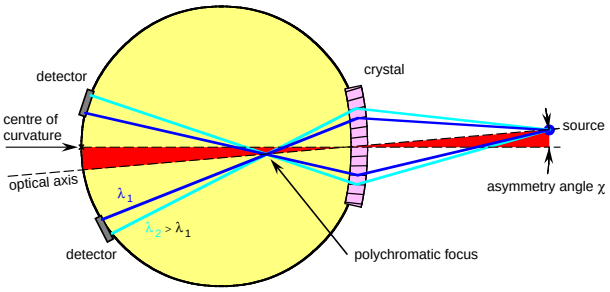

Figure 1: Principle of the compensated asymmetric curved Laue geometry. The source is placed on an axis intersecting the crystal at its apex there pointing in the direction of the tilted crystal plane [1].

With this optimized solution (i) a boost of the integrated reflectivity by a factor of 20 relative to the symmetric Laue case is achieved while (ii) preserving a high systematic wavelength accuracy for both fast moving and stationary x-ray sources. A prototype of such an instrument was built and first tests have been performed with a mechanical scanner and a conventional Ge(i) detector replacing position-sensitive x-ray detectors which presently are under development. The results, summarized in figure 2 and in table 1, were gained with a ^{169}Yb source which emits the Tm-Kα-doublet. All the data measurable in that test, are in agreement with the estimates based on ray-tracing calculations performed with `MacRay` [1]. The observed line width (FWHM) of 60 eV is consistent with the 41 eV width of the crystal reflection when the natural width of the lines and the finite slit width used are taken into account. A more detailed mapping of the crystal will be performed by changing the distance between source and detector.

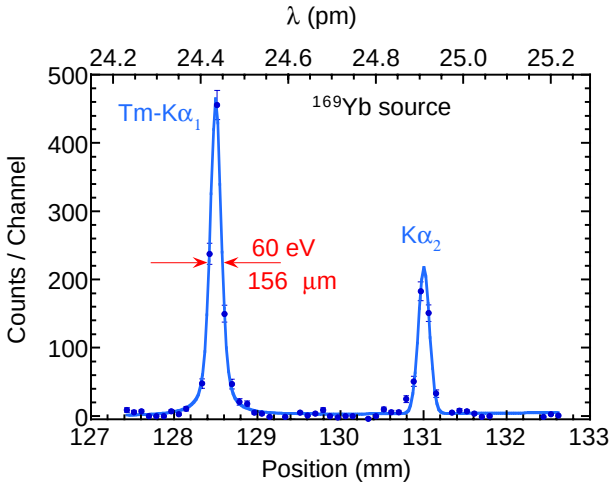

Figure 2: First x-ray spectrum recorded with the FOCAL spectrometer in scanning mode.

Table 1: Parameters of the **FOCAL** crystal spectrometer.

Test energy E_x	50 keV (Tm-Kα)	
Crystal	Si 220: $40 \times 80 \times 1.25$ mm^3	
Asymmetry angle χ	2°	
Bending radius R	2 m	
ΔE_x(FWHM)	estimated	measured
	30 eV (Γ_K)	
	41 eV (crystal)	
	38 eV (slit)	
	63 eV (total)	60 eV
Line splitting Δx	2.497 mm	2.492 mm
Crystal efficiency[1]	$2 \times 6 \times 10^{-8}$	$2 \times 10 \times 10^{-8}$

[1]for two reflections each 100 mm wide at the detector

References

[1] H.F. Beyer, Nucl. Instrum. Methods. A **400** (1997) 137, and references cited therein.