New ideas in Synchrotron Mössbauer Source: iron borate crystals, collimating lenses

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The Synchrotron Mössbauer Source (SMS) at the Nuclear Resonance beamline ID18 at the ESRF operates with the (111) reflection of iron borate $^{57}FeBO_3$ crystal and the double-crystal Si(422)-Si(531) angular deflector (Fig.1). The advantage of this scheme is the practically horizontal beam from the SMS, adjusted in-line with the direct beam after the high-heat-load monochromator.

The compound refractive lens (CRL) is used in order to “squeeze” an incident radiation with the vertical divergence of ~12 μrad into the angular acceptance of the deflector (~3 μrad). In past, we used CRLs made of the O-30-H beryllium grade. With this CRL, the spectra were contaminated by contributions of Fe impurities in Be by about 2%. Therefore, in studies of non-enriched and thin samples, many users preferred to remove the CRL from the beam, even at the expense of about 40% loss of intensity.

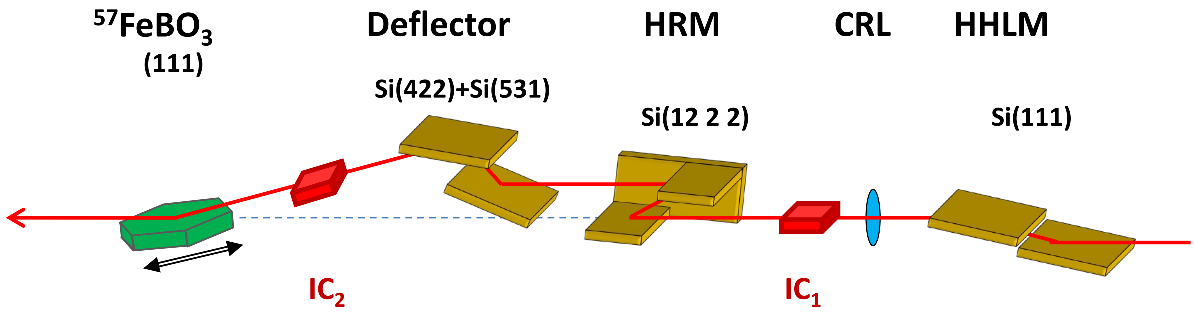

Figure 1. Synchrotron Mössbauer Source at ESRF. HHLM – high-heat-load monochromator with two Si(111) crystals; CRL – compound refractive lenses; HRM – high-resolution monochromator with two Si(12 2 2) reflections of a single channel-cut crystal, Deflector – double-crystal Si(422)-Si(531) angular deflector.

In 2020, ID18 tested new collimating parabolic CRLs (RXOPTICS) made from IF-5 and I70-H beryllium with ultra-low iron content. The contamination of spectra by contribution from iron impurities in Be decreased from 2% to 0.6%, where it is already dominated by a contribution from Be window (0.5%). Furthermore, high quality of CRLs allowed us to increase the flux by ~20% and, in addition, to gain further ~40% by slight detuning of the undulators from “best brilliance” to “best flux” magnetic gaps. Altogether, the obtained gain of intensity is ~1.7 for enriched or thick samples, and ~3 for non-enriched thin sample.

We also will discuss options to obtain enriched iron borate $^{57}FeBO_3$ crystal with better quality.