Characterization of dispersive elements of focusing X-ray spectrometers [[1]](#footnote-1)\*)

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X-ray spectroscopy is a powerful tool to study parameters of hot and dense plasma. Relative intensities of specific pairs of x-ray lines and their shapes provide information on plasma electron temperature, density, electromagnetic fields, etc. Registration of x-ray spectra with high resolution is typically realized with focusing spectrometers for example Johann type. Their dispersive element is Bragg crystal (quartz, germanium, silicon, mica, etc) bent along cylindrical, spherical, toroidal, etc substrates. The best spectral resolution is achieved with the crystals on optical contact, where the crystal and substrate are kept by van der Waals forces. The lack of glue layer of uncertain thickness with unavoidable dust particles and mechanical stresses are the advantages of optical contact. Spectral resolution of x-ray spectrometers is measured by optical and diffraction quality of the dispersive element. Characterization of dispersive elements is important to estimate optimal spectral resolution which can be achieved with bent crystal. This report describes the results of characterization of spherically bent quartz crystal (cut 11-20), size 40X100 mm, on optical contact, bending radius R = 3930 mm. The goal of characterization is to analyze Δθ - angular resolution of the crystal, where Δθ = Δλ/λ/cosθ, θ is Bragg angle. Optical quality of crystal is studied in experiment and calculated numerically. The resulting optical component of angular resolution is estimated as Δθopt = 2.5⋅10-4 rad. Diffraction quality is studied by two crystal diffractometer, where rocking curve is measured step by step along the crystal surface and also taken from the entire crystal area. Numerical code is created to calculate rocking curve of bent crystals using Takagi-Taupin approach. Both experimental and numerical approaches have shown that rocking curve is wider compared to that one taken for flat sample. The diffraction component of resolution is estimated as Δθdif=7⋅10-5 rad. Finally optimal spectral resolution of studied element (R3930 mm, quartz 11-20, size 40X100 mm) is Δθ = 3.2⋅10-4 rad. To achieve optimal resolution crystal and detector should be in their exact positions on Rowland circle. In this sense an important step is to check the radius of atomic planes (RAP) of the crystal which is usually assumed to be equal to the radius of substrate (RS). Simple optical scheme is proposed and used to study RAP. It was found that RAP (R=3930 mm) differs from RS (3827 mm). The reasons are discussed which might explain this effect.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/It/ru/DU-Baronova.docx) [↑](#footnote-ref-1)