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IT-1-P-2688 Energy analyzer for point electron sources

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We have built an energy analyzer for characterization of parameters of various types of point emitters, electron guns, and illumination blocks of electron columns. It can be also used for characterization of electron monochromators, and for studying the influence of electron – electron interaction on the beam energy spread.
The concept of the analyzer is very simple and physically straight, based on dispersion characteristics of magnetic prism: It is configured for measuring energetic spread of emitters with the virtual source size between 1 nm and 50 nm independently of the electron source distance, it means any design or type of electron gun can be measured.
The theoretic resolution of the analyzer is:

- < 15 mV for the virtual source size of 50 nm,
- < 3 mV for the virtual source size of 15 nm.

The image of virtual source is focused only in the dispersion direction (see Fig. 2). The dispersion of the magnetic prism in this plane is about 3 μm/V at the output edge of the prism. The optical set guarantees the resolution of electron spectrometer on the level of 10 mV or better, the use of slit aperture provides the capability of statistical evaluation of 2048 spectra (pixel columns).
Although the dispersion itself is relatively small (units of μm/V), the analysis is possible at the level of units of mV, because the source image size in the spectral plane is in units of nm. The dispersion plane can be enlarged electron-optically so that it is projected onto a screen with the size accessible for imaging by high-quality light optics (the dispersion and source image are magnified in the same proportion).
The significant input parameters that determine the resulting energy resolution are the virtual source size and used aperture angle. We illustrate on the chart that the effect of the virtual source size for cold field emission and Schottky cathode is in a significant range of aperture size under the resolution of a light objective lens with NA as high as 0.95 in this arrangement.
The high energy resolution of the electron-optical part can be used for very effective monochromatization of en electron beam.
Reference: V. Kolařík, M. Maňkoš, L. H. Veneklasen, Close packed prism arrays for electron microscopy, Optik 87, No.1(1991)

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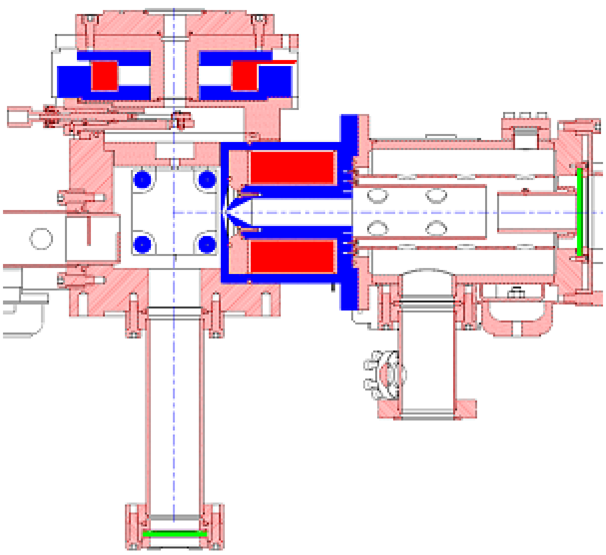

Fig. 1: Section along the optical axes

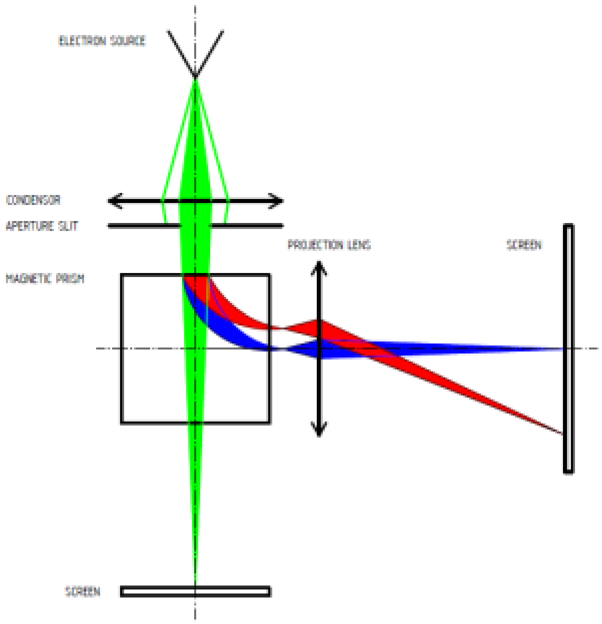

Fig. 2: Optical scheme

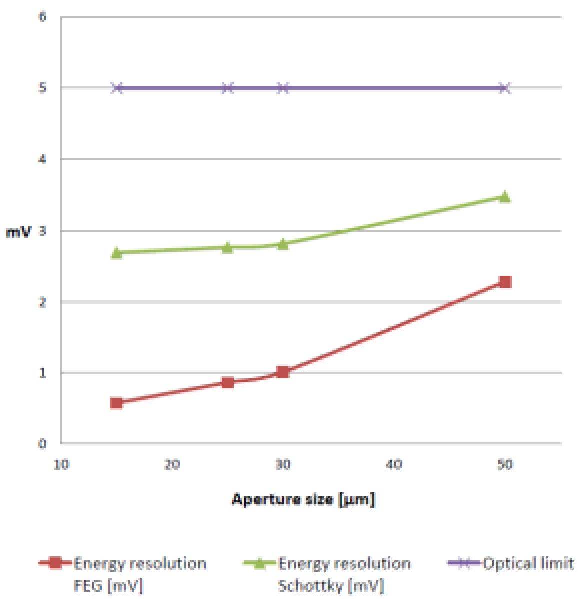

Fig. 3: The influence of the aperture on the energy resolution for CFE and Schottky emitter at dispersion of 2.8 µm/V in relation to the optical limit (at NA = 0.95, M=40×, pixel size = 7.4 µm)

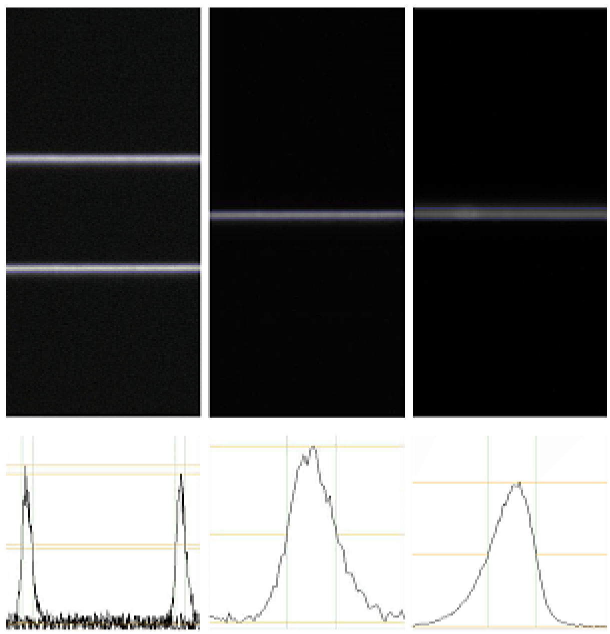

Fig. 4: Examples: calibration of measurement, profiles - CFE energy spread – 0.34 eV, Schottky emitter energy spread – 0.58 eV