

## A Compact High Solid Angle EDX Detector System for SEM and TEM

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Modern electron microscopy frequently generates new challenges for Energy Dispersive X-ray spectroscopy (EDX) detectors. In an increasing number of applications, low primary beam energies and currents are required for nondestructive analysis of sensitive samples or examination of regions close to the sample surface. For such applications, the fluorescence yield and therefore the signal to be detected by the EDX detector is very low. Combined with the demand for short measurement times, it is vital to collect as much of the available signal as possible. This sets the requirement for large area detectors in close proximity to the sample in order to achieve large solid angles.

The “Rococo2” Silicon Drift Detector (SDD) has an advanced geometry allowing positioning close to the sample while having a large detector area. It consists of four 15 mm<sup>2</sup> SDDs arranged evenly around a center hole, all combined on one monolithic chip. The detector can be positioned right below the pole piece (Figure 1) while the electron beam is guided through the center hole. This arrangement enables a very close proximity to the sample resulting in a solid angle of up to 1.4 sr [1]. In comparison to a common 10 mm<sup>2</sup> SDD with a typical solid angle of about 0.01 sr, the Rococo 2 can deliver a hundred times higher signal intensity and therefore reduces the measurement time significantly. This is shown in Figure 2 where two EDX mappings of a duplex brass sample were recorded using a round 10 mm<sup>2</sup> SDD and the Rococo2 detector at the same conditions and acquisition time. The four individual SDD cells enable high count rate spectroscopy with a cutting edge energy resolution down to 124 eV FWHM @ Mn-K $\alpha$  & -20 °C. Backscattered electrons are stopped within thin filter foils. By choosing the right filter materials light element performance with high energy resolution can be realized.

The next generation of the “Rococo 2” SDD pushes the boundaries even further. The chip has four 19 mm<sup>2</sup> SDDs also arranged evenly around a center hole. Due to a further optimized geometry, the solid angle reached by the system is now up to 2.4 sr. Despite the large area, this detector still has an optimum energy resolution of 124 eV FWHM @ Mn-K $\alpha$  & -20 °C.

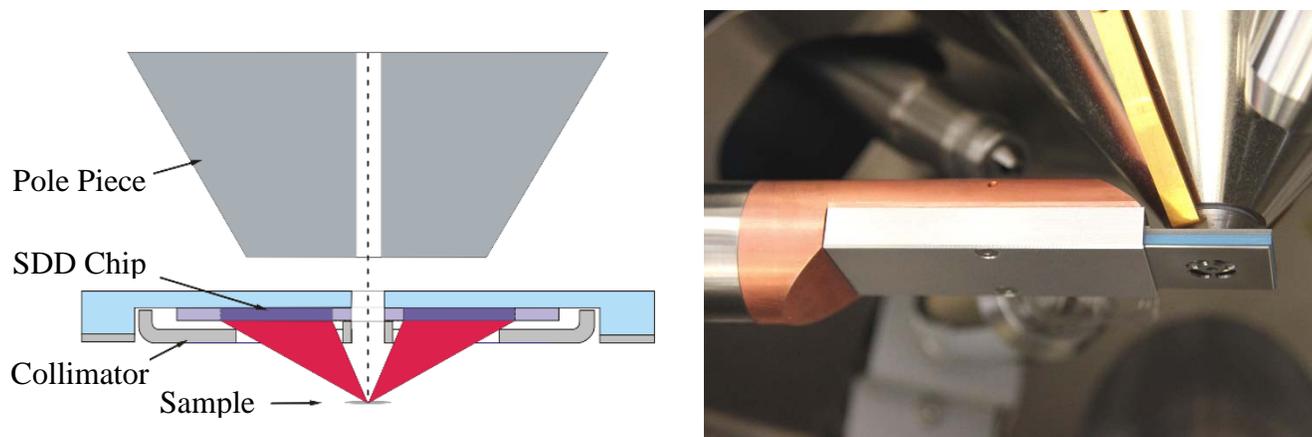
To simplify the integration of the Rococo 2 Detector System, we have developed a very compact detector system, which features a four-channel preamplifier subsequent to the detector chip. With the readout electronic close to the SDD, parasitic influences are negligible, guaranteeing the best possible energy resolution. The whole system, including a water cooling system, fits into a 26 mm tube and is therefore adaptable to all vacuum ports commonly used in electron microscopes or similar systems. A drawing of the new Rococo 2 Detector System is shown in Figure 3.

In summary it can be said, that the Rococo 2 Detector System can cover a large solid angle while providing an excellent energy resolution. The new compact system with integrated preamplifier makes it easy to adapt it to various electron microscopes and benefit from higher count rates at very low beam currents resulting in shorter measurement times.

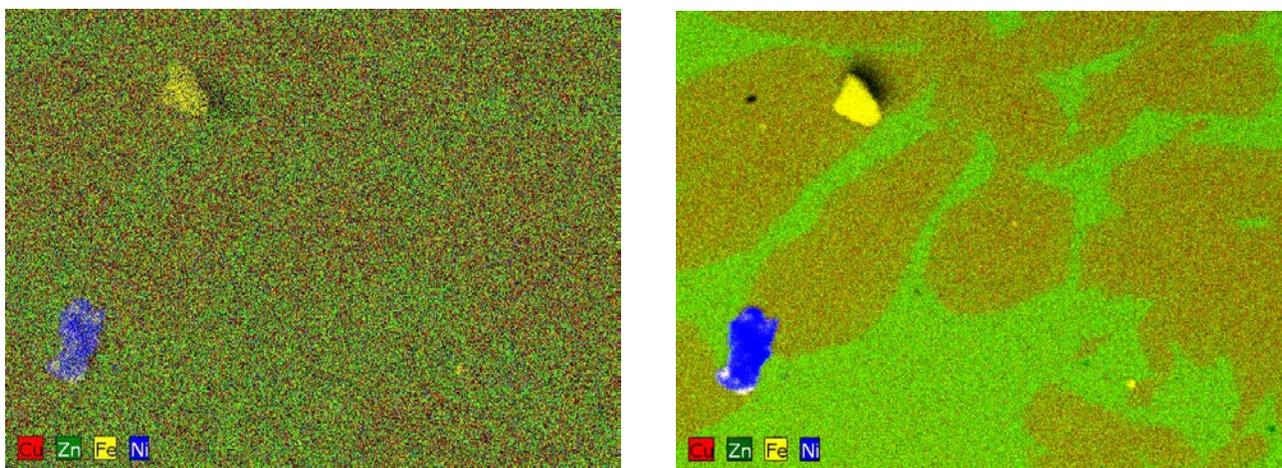
We will present further results with the compact Rococo2 detector system demonstrating the large solid angle and its advantages in electron microscopy.

References:

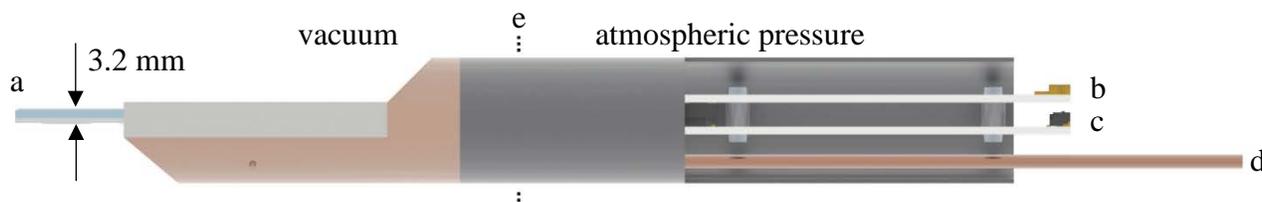
[1] A Niculae et al, Microscopy & Microanalysis, vol. 18 S2 (2012) p. 1202-1203



**Figure 1.** Schematic drawing of the Rococo EDX detector positioned below the pole piece (left). A picture of the detector system inside a SEM (right).



**Figure 2.** EDX Mapping of a duplex brass sample showing  $\alpha$  and  $\beta$  phases with different concentrations of copper and zinc. The left image was obtained with a conventional 10 mm<sup>2</sup> SDD with approximately 0.01 sr solid angle, the right one with the Rococo 2 detector with a solid angle of more than 1 sr at the same conditions and acquisition time. Images are shown without any post-editing.



**Figure 3.** Schematic of the Rococo 2 Detector System (scale 1:1.5): a) SDD on substrate, b) preamplifier signal output, c) supply voltages, d) water cooling connection, e) vacuum interface.