The long way towards SALVE

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The talk will start with the Darmstadt corrector project [1], which was abandoned in 1983 and follow the meandering way full of obstacles which finally lead to the SALVE project [2]. Explanations will be given, why the ambitious goals (a spatial resolution of 1 angstrom at 60kV) could not be reached by the Darmstadt corrector. The main reasons were missing automated aberration measurement, computer controlled electronics, too large manufacturing tolerances and missing knowledge about electrical alignment strategies.

All these problems had been solved within the Volkswagenstiftung project, which lead to the prototype TEM hexapole corrector for Jülich [3, 4]. However, within this project the focus spread coming from the finite energy width of the electron source in combination with the chromatic aberration had not been reduced.

This step was first overcome with the incorporation of the gun monochromators e.g. within the SATEM project. There, the first time sub-angstrom (SA-) point resolution was achieved, but still not in a low voltage environment (-LVE). With the first commercial Cc-correctors (CCOR: TEAM project, PICO microscope) for the first time sub-angstrom resolution could be demonstrated for accelerating voltages below 100kV.

The SALVE corrector was especially designed for the low voltage applications from 20kV to 80kV. In comparison to the CCOR the residual aberrations in fifth-order could be reduced significantly. Contrary to the CCOR design, the fifth-order spherical aberration C5 is positive and can slightly be tuned. A positive C5 combined with a suitable small negative spherical aberration of third order and positive defocus is beneficial for phase contrast imaging. Then the linear and non-linear contributions to the contrast in most cases add up.
As the last known obstacle it turned out that electron optical devices with high and long ray paths suffer from image spread. Methods had to be developed to distinguish between focus and image spread even in an uncorrected electron microscope [5]. The nature of the image spread could finally be uncovered as Johnson Nyquist noise coming from the conducting surrounding close to the image forming electrons (surprisingly inclusive magnetic materials) [6, 7]. This discovery transferred the last obstacle from a mystery into a solvable technological challenge.
Before the change of the 'platform', the SALVE corrector met the electron optical expectations. The measured image spread limit agreed within measuring accuracy with the theoretical prediction. An update of the state of the project will be given.

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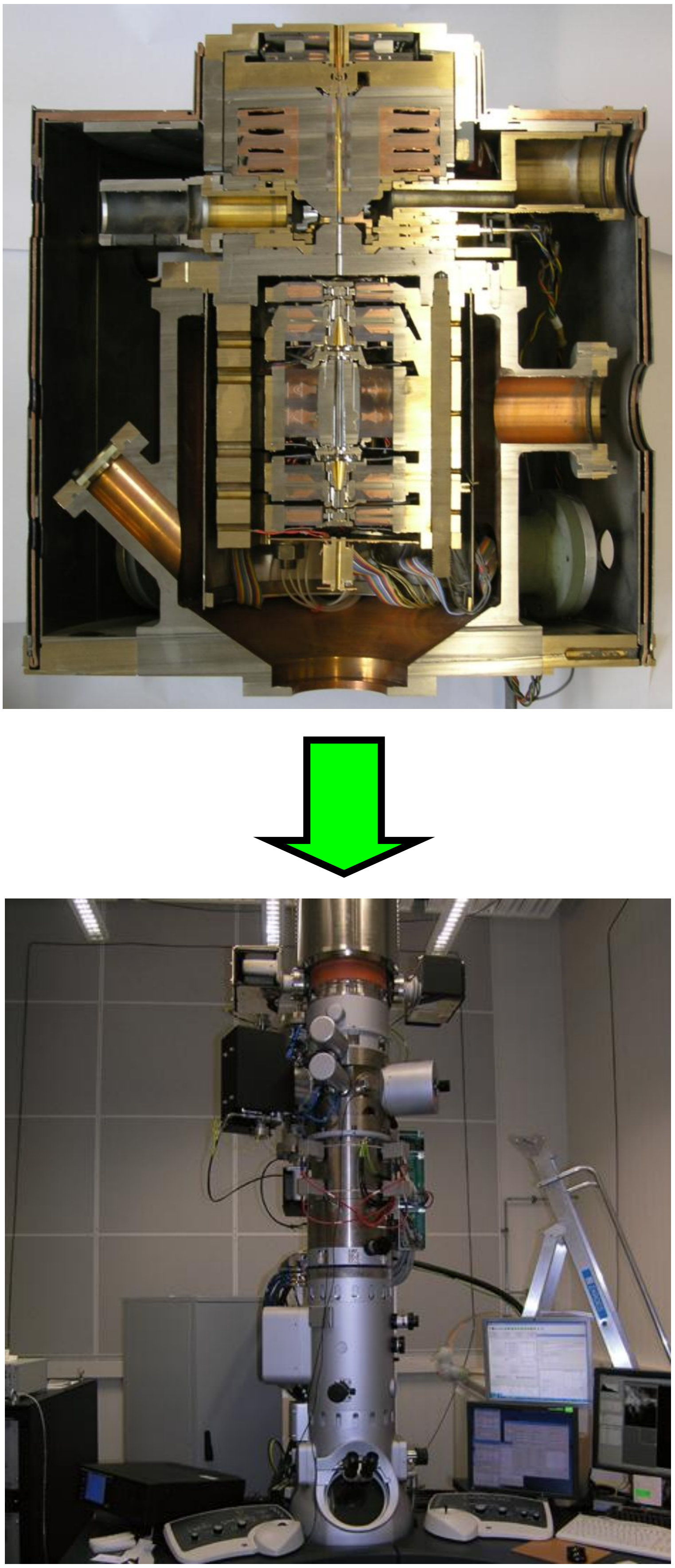

Fig. 1. The upper picture shows one half of the Darmstadt corrector as it can be visited at CEOS now. Below the whole SALVE corrector can be seen while mounted in the SALVE II microscope before the microscope was returned to ZEISS.