

## OPTIMISING THE BEAM TRANSFER IN ESEM

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Optimising the beam transfer is a primary consideration in the design and operation of ESEM. It is counterproductive to attempt improvements of the signal gain at the detection stage alone, when the primary probe, due to unnecessary electron losses, has introduced unacceptable noise on the image. Experimental, theoretical and computational studies on beam transfer from high-vacuum to high-pressure gas in the specimen chamber have been reported during the last 30 or more years, while new works are being announced. However, implementation of an optimum design electron optics system that embodies the best possibilities of an optimum gas dynamics configuration has not yet been implemented on commercial microscopes. ElectroScan accomplished the first leap towards this goal in the late 1980s, but later generations of instruments have significantly departed from this, whilst they have incorporated the latest electron optics and electronics advances. This departure seems to be caused by the choice of technological strategy: The gas dynamics modifications were adapted, not at best, around existing electron optics designs instead of the reverse, namely, the design of an optimum electron optics system that accommodates the best gas dynamics requirements. The great gains of field emission guns have been wastefully employed with the result that signal-to-noise-ratio has not improved over the oldest experimental prototype ESEM based on optics of vintage late 1960s. This raises the question whether there is a fundamental physical limitation in matching modern electron microscope capabilities with the requirements of a best possible ESEM. If so, are we then limited only to a reproduction of old electron optics to retain an optimum ESEM design and operation, or a decision by the manufacturers to adopt the best available technologies is simply well overdue? This depends to a large extent on the users (clients) and experts to come up with a definite verdict that may propel further progress in ESEM technology, instead of users alone attempting only to make the best from what is on offer.