# DESIGN OF LOW ENERGY SEM WITH ELECTOSTATIC OPTICS AND MATRIX DETECTOR

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*INTRODUCTION*

The detectors usually used for the collection of signal electrons in scanning electron microscopes (SEM) give little or no information on their angular or energy distribution. If such an information is needed, another type of detector, a matrix CCD detector, has to be applied. Our paper describes the design of a SEM [(1)] using this type of detector. The experimental apparatus designed at ISI Brno is an ultra high vacuum (UHV) low energy SEM (LESEM) with a cathode lens [(2)].

*SYSTEM OVERVIEW*

The scheme of the optical system is shown in the Figure. The primary electron beam with energy 5 keV passes two condenser lenses (CL1, CL2), a Wien filter (WF), a two-stage scanning system (SS) and an objective (OL). The electric field between the objective lens and the specimen, a cathode lens (CL), retards primary electrons to appropriate impact energy.

The signal (back-scattered and secondary) electrons are accelerated to the energy close to the energy of primary electrons by the cathode lens field. The beam of signal electrons passes the optical system in direction opposite to the primary beam. In the Wien filter, the signal electrons are deflected about 15° away from the optical axis. A transport lens (TL) focuses this beam to a directly electron-bombarded CCD detector [(3)] (ED). The Wien filter can deflect signal beam in an arbitrary direction, so that more than one detector is possible. The orientation of the filter field can be easily changed by switching of its electrical supplies.

The electrostatic optics was preferred in the design because of its small and compact construction and advantages for application in UHV.

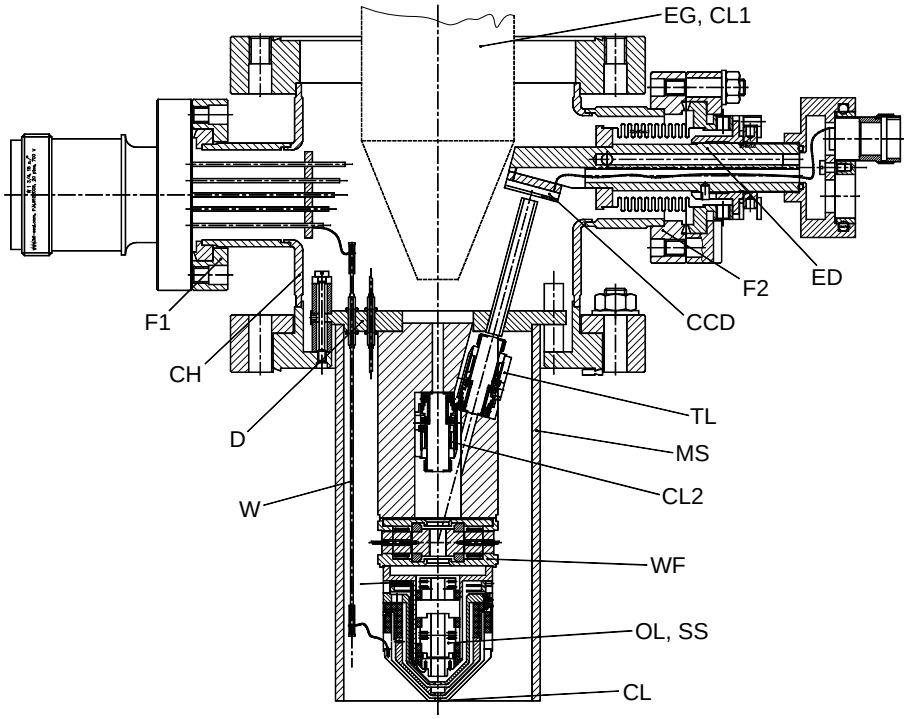
*THE ELECTRON OPTICAL COLUMN CONSTRUCTION*

The electron gun (EG) with Schottky cathode and the condenser lens (CL1), drawn in dash lines in the Figure, are parts of a commercial microscope. The other parts were designed specifically for this experimental apparatus.

The three-electrode electrostatic objective lens is joined to the two-stage electrostatic scanning system. The electrodes of the objective lens have the form of truncated cones with apical angle of 90°. The electrodes are made of titanium, soldered to ceramic insulators and bored simultaneously by spark erosion to achieve the highest possible accuracy.

The Wien filter [(4)] is used for separation of signal electrons from the primary beam. Its electrodes, made of magnetic material, produce both the electric and magnetic fields. The coils, which excite magnetic field, are placed in vacuum and have to be made UHV compatible. The condenser and the transport lenses, both about 20 mm in diameter, contain an electrostatic two-stage centering system joined to their entrance side.

All components mentioned above are assembled to a single unit mounted on an insulated metal disk (D), provided with electrical wires (W) and magnetic shielding (MS). The disk is placed at the bottom of an UHV chamber (CH) with six flanges. One of them (F1) is provided with an electrical feedthrough, resistant to bake-up temperature. The CCD detector chip is attached to another flange (F2), its position in vacuum can be accurately adjusted from outside. This flange is kept cold when the apparatus is outgassed by baking.

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