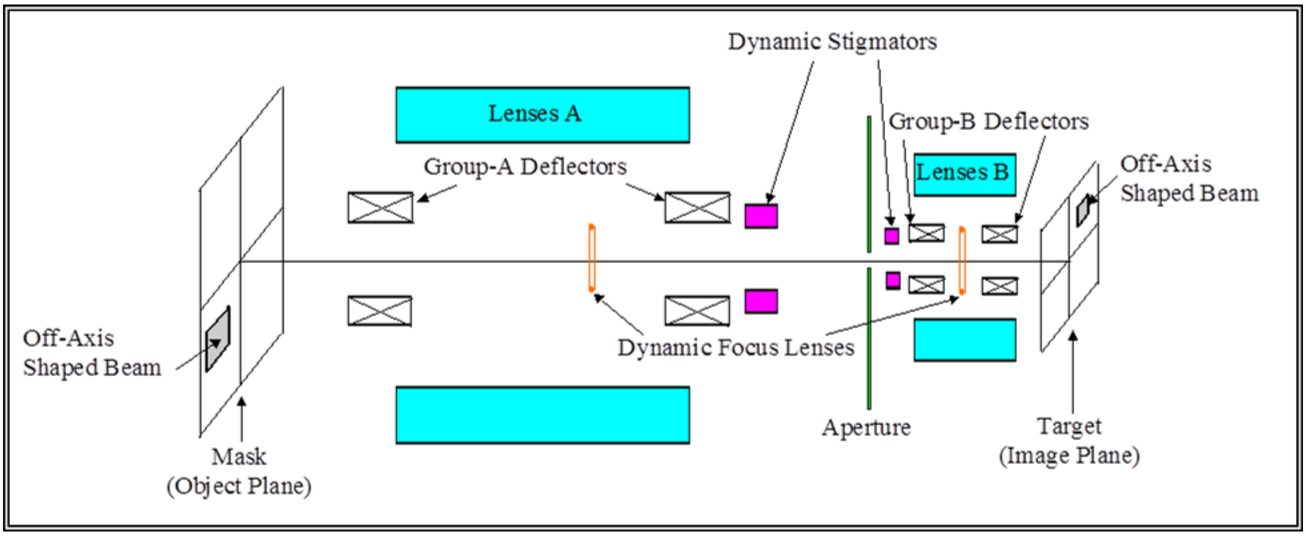
PROJECTION

Projection Optics

The PROJECTION software package is used for the simulation of electron beam projection systems including dynamic corrections and optimisation up to 5th – order aberrations. PROJECTION is a stand alone package.

The type of column that can be designed with the software is shown below.



Schematic structure of an electron or ion beam projection system, with an off-axis shaped beam. The two groups of deflectors (Group-A and Group-B) act as aberration-reduction elements

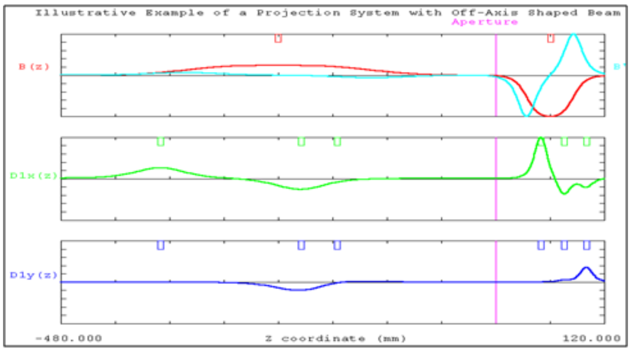
An electron or ion beam passes through a rectangular region of a mask (located at the "object plane"), forming a rectangular shaped beam. This shaped beam may be centered either on or off the optical axis. The general off-axis case is illustrated above. A system of magnetic or electrostatic projection lenses (Lenses A and Lenses B) is then used to form a demagnified image of this rectangular shaped beam at a target plane (located at the "image plane"). The lenses can be magnetic, electrostatic or both. An aperture is generally placed between the two sets of lenses.

Two groups of deflectors, which can be either magnetic or electrostatic, can also be located on each side of the aperture. The deflectors on the object side are called "Group-A Deflectors", and those on the image side are called "Group-B Deflectors". If the shaped beam is centered off-axis, the deflectors can steer the beam though the lenses along a modified path to reduce the aberrations, and thereby act mainly as aberration-reduction elements, rather than as conventional deflectors.

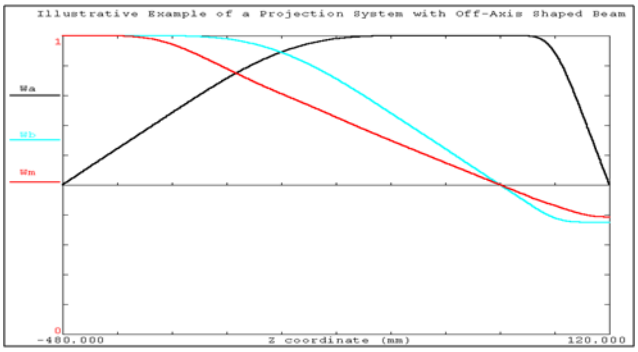
MEBS ELECTRON BEAM SOFTWARE

A conventional projection system, in which the projected area of the mask is centered on the optical axis, is simply a special case of the system shown above, with the shaped beam centered on the axis, and the deflectors either switched off or omitted. For the case where the shaped beam is located off-axis and there are two sets of deflectors, PROJECTION can handle the so-called "*balanced case*", in which the Group-A and Group-B deflections exactly cancel each other out. PROJECTION can also handle the general "*unbalanced case*", in which the two deflections do not cancel, but some residual net deflection remains. The unbalanced case is often required when the mask contains "grillage bars" between adjacent shot areas in the mask plane, since in this case the beam must be shifted so as not to leave gaps between adjacent projected shots on the wafer.

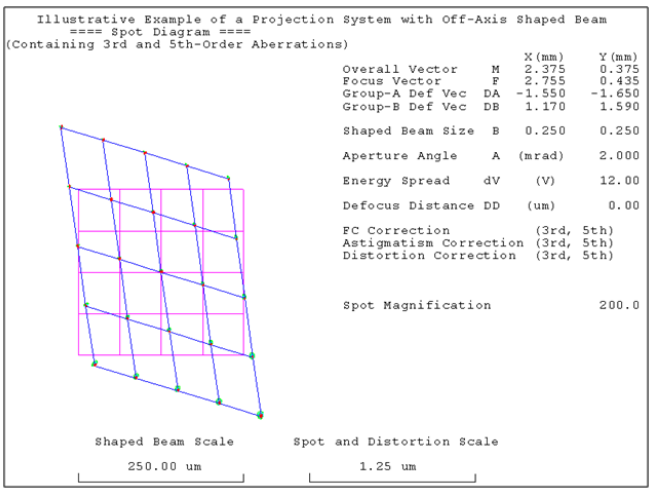
PROJECTION computes the optical properties of such systems, including the geometrical aberrations of 3rd-order and 5th-order and chromatic aberrations of up to 4th rank. The software can also refine the design to optimise the optical performance. The properties of dynamic correction elements (i.e. stigmators and dynamic focus lenses) can be computed. Several graphical post-processing facilities are included in PROJECTION for plotting the principal paraxial rays, the lens and deflector axial field functions, aberration spot diagrams in the image plane and current density contours in the final spot.



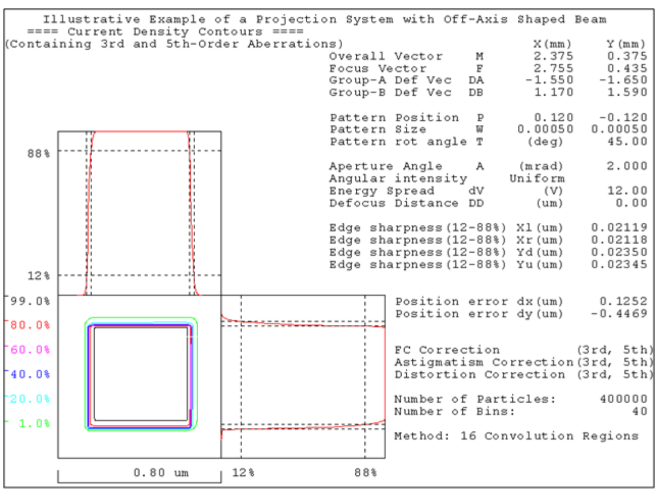
Lens and deflection axial field distributions



The three principal paraxial rays used to compute the optical properties.



Aberration spot diagram



Beam current density contour