

BEAMER

Advancing the Standard

Electron- and Laser-Beam Lithography Software

Optimum productivity, quality
and innovation by advanced data
preparation for electron- and
laser-beam lithography systems

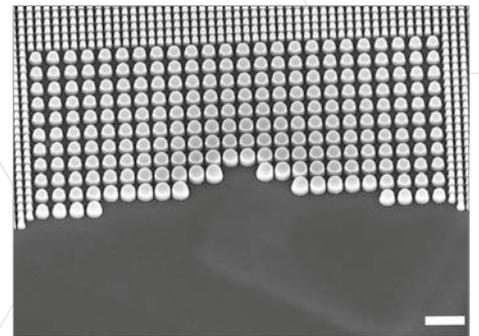


Electron- and Laser-beam Lithography Software

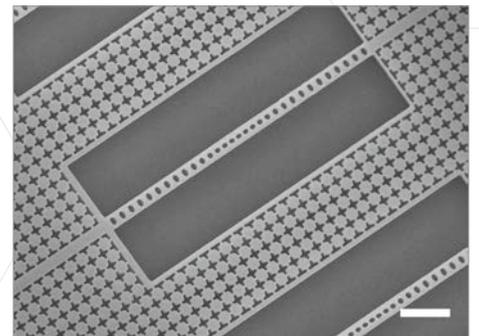
High-resolution and high-throughput electron-beam lithography is severely impacted by process effects, electron scattering effects, and tool artifacts resulting in non-ideal pattern transfer. Although the electron-beam tool is a highly sophisticated and expensive printer, the pattern-data needs to be optimized to significantly reduce the effects of various error sources such as beam positioning between shapes, filling shapes with "shots" on a discrete grid, field position dependent aberrations, stitching between fields, the spread of energy by electron scattering (proximity) and process effects.

BEAMER is the most comprehensive lithography software for optimum electron- and laser-beam exposure:

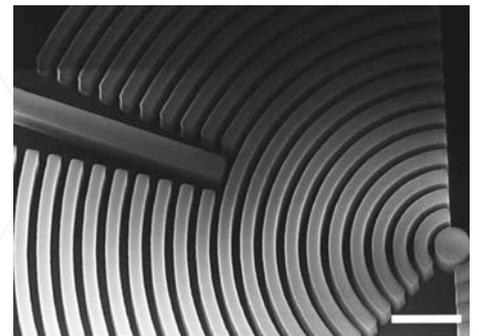
- Support for all major electron- and laser-beam exposure systems
- Superior machine specific fracturing of complex curved layouts
- Optimized field and shot placement
- Writing order control and advanced writing strategies
- Library of comprehensive layout processing functions
- Support for all major layout formats
- Integrated layout editor
- Build-in Viewer for immediate inspection, verification, and measurement of patterns
- Powerful proximity and process effect correction technology
- Electron-beam simulation of absorbed energy and resist contours



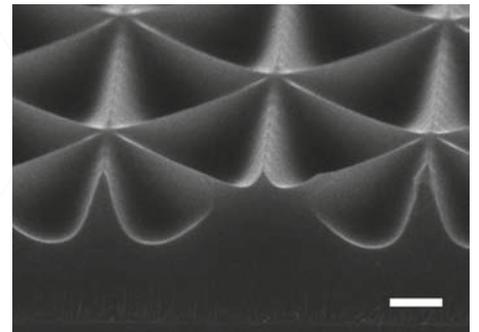
Georgia Institute of Technology – USA
(Scale bar corresponds to 500 nm)



Center for Nanoscale Science and Technology – USA
(Scale bar corresponds to 2 μm)



AMO GmbH – Germany
(Scale bar corresponds to 1 μm)



Heidelberg Instruments Mikrotechnik GmbH – Germany
(Scale bar corresponds to 6 μm)

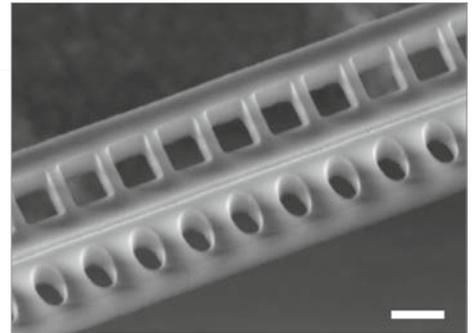
Productivity, Quality & Innovation

BEAMER provides reliable and highly powerful processing of large and complex layout data. It gives the user a large array of functions for extracting, combining and modifying the layout for an optimum exposure. Interfaces for all major electron- and laser-beam exposure tools are developed in close cooperation with machine vendors and are continuously optimized for the best exposure results, thereby extending the limits of these systems by advanced data preparation. Examples include: optimized fracturing for a significant reduction in shot placement artifacts, automated floating field to avoid/reduce field placement and stitching issues, user controlled field placement, and enhanced multi pass strategies. The user can instantly visualize and quickly optimize the exposure process, including field and shot position. Applying techniques such as “bulk & sleeve” or “coarse & fine” combined with proximity effect correction (PEC) to easily and effectively achieve high resolution, smooth edges at increased throughput.

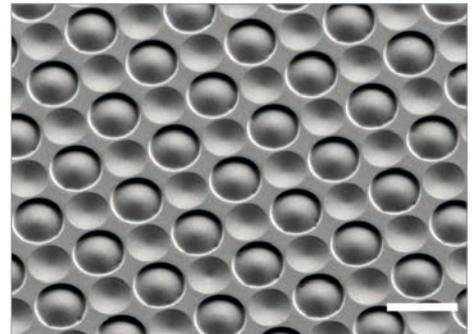
PEC is essential for improving the exposure quality by automatically adjusting exposure doses for optimum CD (critical dimension) uniformity and contrast. Additionally PEC eliminates the need to experimentally adjust the exposure dose for each layout thereby increasing productivity and process reproducibility. Performing traditional “Trial & Error” optimizations is very expensive and time consuming.

Advanced techniques available include: “model-based underdose-overdose” enabling ultra-high resolution in difficult scenarios, 3D PEC for three dimensional resist profiles in single and multi-layer resists, and full process calibration with simulation for quick development of new innovative solutions.

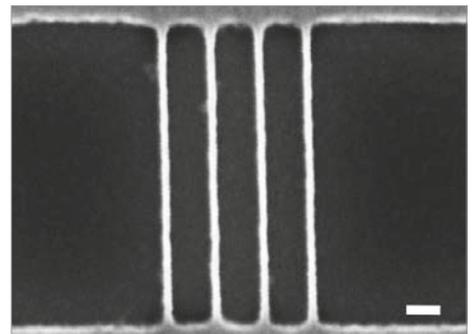
Strong collaboration with leading nanofabrication centers worldwide drives rapid enhancements and allows us to provide the most advanced capabilities to our users, improving their efficiency and effectiveness. **BEAMER** is designed for the industrial user focused on productivity, as well as universities and R & D centers interested in flexibility and high resolution lithography.



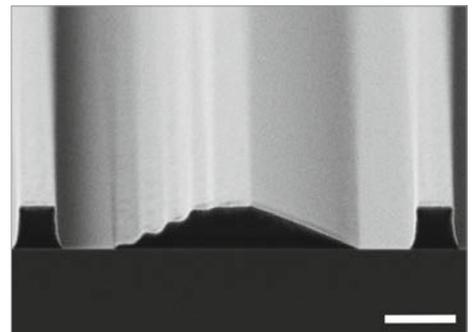
Center for Nanoscale Science and Technology (NIST) – USA
(Scale bar corresponds to 200 nm)



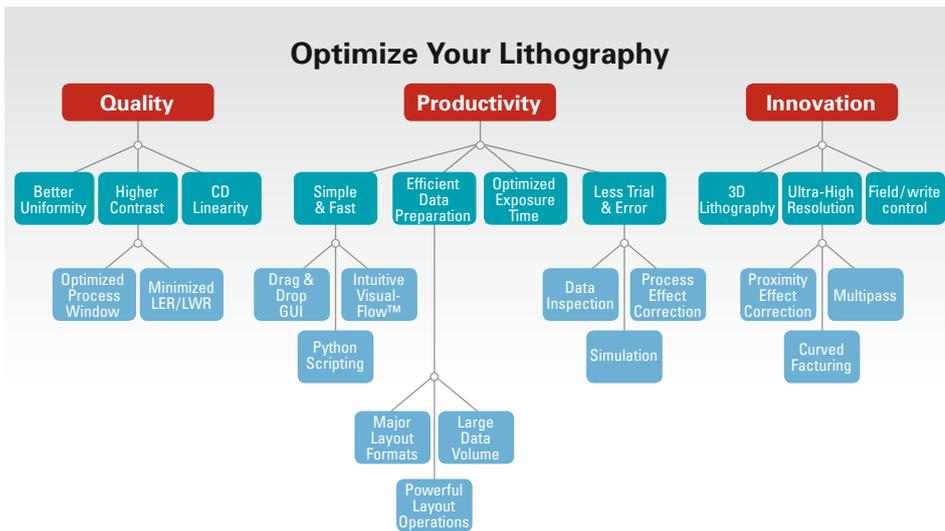
Paul Scherer Institute – Switzerland
(Scale bar corresponds to 10 µm)

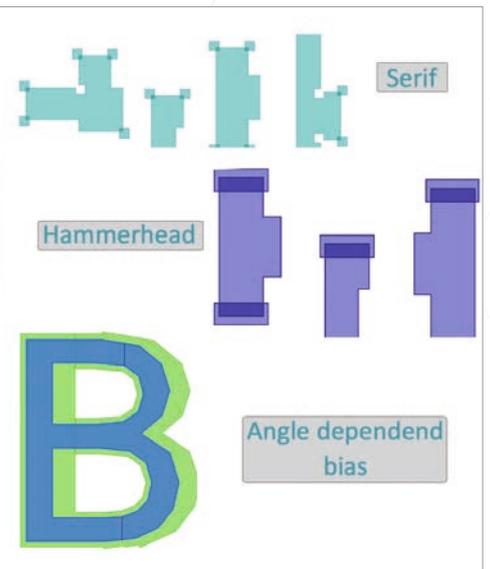
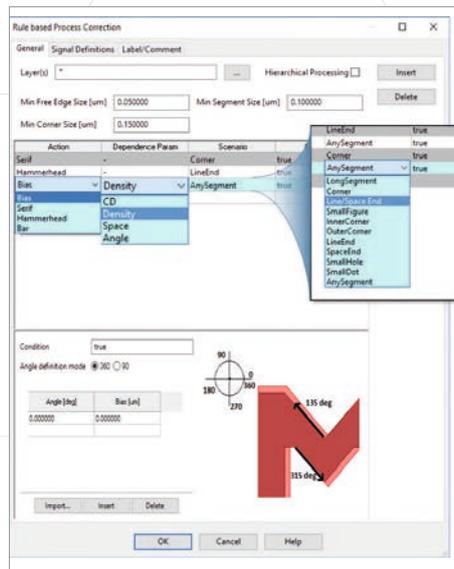
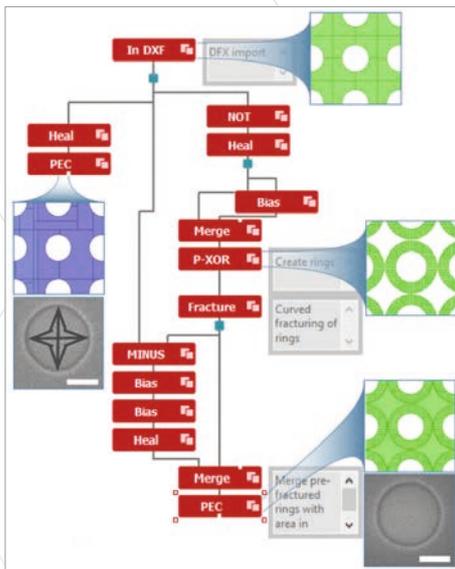


AMO GmbH – Germany
(Scale bar corresponds to 30 nm)



Paul Scherer Institute – Switzerland
(Scale bar corresponds to 1 µm)





BEAMER Major Features

Layout Import/Export

- Layouts of all major formats, without size limitation (GDSII, CIF, DXF, LTXT, OASIS, BMP, DWG)
- Electron- and laser-beam machine formats (Raith, JEOL, Elionix, Crestec, ADVANTEST, MEBES, Vistec, Heidelberg)

Advanced Fracturing

- Support of all major machine formats
- Optimized for arbitrary shapes
- Curved fracturing
- Correction for shot positioning
- Beam Step Size (BSS) fracturing
- Field position control (tiled, floating, manual)
- Multi-pass exposure
- Writing order control

Integrated Layout Editor

- Create new layouts
- Edit layout within flow

VIEWER

- Integrated detachable global viewer
- Multi-view
- Feature Measurements
- Shot and field placement view
- Write order and field visualization
- Dose assignment

Layout and Boolean Operation

- Healing, Biasing, Sizing, Merge, Tone reversal (NOT)
- AND, OR, XOR, P-XOR, MINUS
- Extract layer, datatype, cell, region
- Scale, Shift, Rotation, Mirror

- Filter geometries by width, height, area, angle, and relative dose
- Grid adjustment
- Mapping layout layers and datatypes
- Pre-fracture
- Cell Replace
- Hierarchy Flatten or Build

Flow Control Modules

- Parametrized loops with IF, SELECT, and FILTER operations
- Script for starting command line application from flow
- Optimizer for parameter fitting

Proximity and Process Correction

2D Dose PEC

- Fast and robust edge equalization technique
- Excellent dimension control by optimized dose on feature edges
- Fracturing based on absorbed energy distribution
- Perfectly symmetrical and stable for arbitrary shapes
- Process correction (e.g. lateral development, loading)

Shape Correction

- Model based shape correction of short and mid-range effects
- Combination with long-range correction with dose modulation
- Model based contrast enhancement ("undersize – overdose")

3D PEC

- Correction for defined resist thickness at any layout position (resist profile) for single layer resist (e.g. 3D gratings, 3D holograms, angled sidewalls, lenses)
- Correction for critical dimensions (CD) for each layer for a multi layer resist (e.g. T-gate structures)
- Additional compensation for substrate topography or material variation

Laser-beam Lithography Correction

- 3D Gray Tone Lithography
- OPC for resolution and linearity enhancement

Corner PEC

- Corner sharpening correction
- Dose PEC combined with rule based correction for edges, inner and outer corners.

Flexible PSF and Process Modeling

- PSF from Monte Carlo simulation or experimental table
- Visualization and fit of PSF function
- Apply full PSF data or Gaussian approximation
- Process loading, shot size dependent blur, fogging effect

Electron-beam Modeling

- 2D intensity image, 2D resist contour at multiple thresholds
- 1D/2D image viewing and analysis
- Multi- and matrix-view for automated runs
- Metrology for automated measurement and comparison to experiment
- 3D resist simulation can be performed with the LAB software package

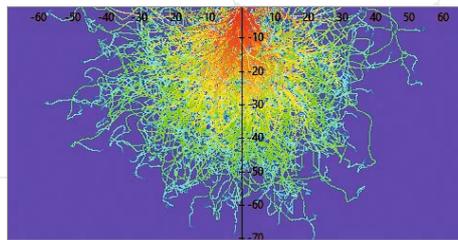
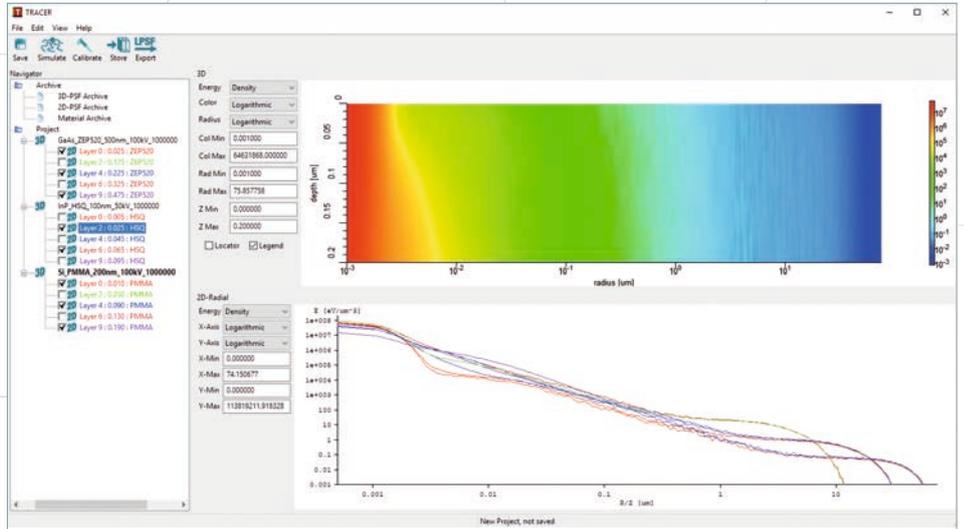


Fast, Easy and Accurate PSF Simulation and Visualization

Manage, Maintain and Archive all PSFs with an Interface to BEAMER & LAB

A Point Spread Function (PSF) is the essential input for any type of Proximity/Process Effect Correction (PEC) or electron-beam simulation. A PSF describes the deposited energy as a function of the distance from the incident beam. In other words, a PSF can be described as the convolution of the electron scattering beam size (or beam blur) and process effects, which can include collateral effects from resist development and pattern transfer. The quality of a process effect correction (PEC) depends entirely on the knowledge of the PSF and process correction parameters such as base dose and process bias. As such, a necessary starting point is a Monte Carlo (MC) simulation of not only electrons back-scattered from the substrate, but also fast secondary electrons from both the primary exposure and backscattering events.

TRACER offers an easy-to-use interface for defining the required parameters (material data, stack parameters, acceleration voltage), running the MC simulation, visualizing the 2D r-z simulation results (energy spread at different resist thicknesses), and extracting the 1D PSF which can then be used for PEC.



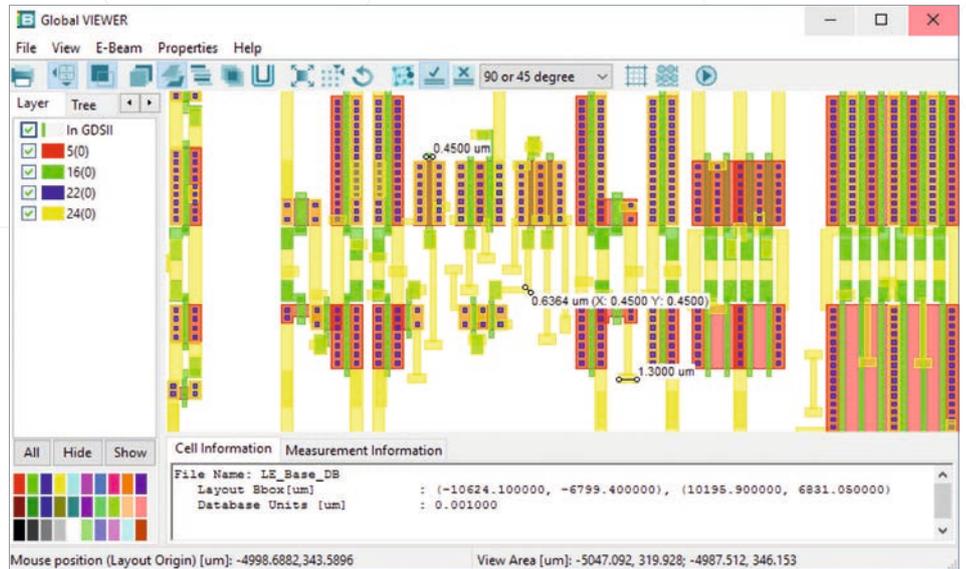
The comprehensive material database includes all standard materials and can easily be expanded with custom materials by defining the new material's stoichiometry and mass density. Functionalities such as fitting to Gaussian functions, averaging, convolution of PSFs, determination of base dose factors between PSFs and powerful visualization enable the user to analyze, compare and optimize PSFs.

In addition tool and process effects such as spot size, lateral development, resist diffusion and loading effects need to be quantified and corrected. **TRACER** has an easy-to-use *Calibration* feature which determines and corrects these effects using measured CD data (typically CD as a function of dose and layout density) obtained after processing of a calibration pattern. Process parameters such as base dose, process blur and process bias are rapidly computed and the display of calibration versus measured data allows the user to immediately verify the fit quality.

TRACER Major Features

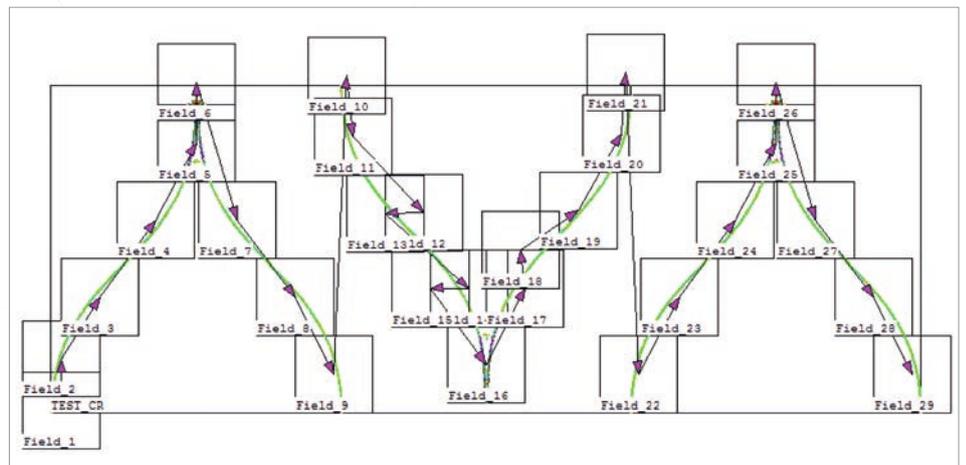
- Monte Carlo simulator that computes the electron-solid interaction for optimal electron-beam exposures, including beam blur
- Process calibration using experimental data
- Archive to maintain and manage all PSFs
- Visualization tool for PSF inspection
- Faciliator to combine electron-PSF and process-PSF into a single-effective-PSF, or to separate out the process-contribution-PSF from an experimental-PSF
- Dose factor calculator between two PSF's
- Electron trajectory visualization (results can be exported for post-processing)

Normal	Name	Mass Density (g/cm³)	Excitation Energy (eV)	Stoichiometry	Optional
1	Air	1.205000	470.000000		
2	Al	2.698000	186.000000		
3	Alkx	3.700000	281.729400	Al 1 - Au 1	Co 5 - Di 10.1
4	AlkxAlTi	3.990000	233.647700	Al 15 - Ga 85 - Au 100	Co 5 - Di 11
5	AlkxAlSi	4.070000	295.879300	Al 80 - Ga 20 - Au 100	Co 5 - Di 11
6	AlSi	3.230000	129.689000	Al 1 - Ni 1	Co 7 - Di 8.3
7	Alumina	3.970000	140.200000	Al 2 - O 3	Co 5 - Di 10 - Ep 20.8718 - La 3.7482
8	Au	19.300000	790.000000		Au 1 - Co 73 - Di 6.5 - Ep 48.2985 - La 1.04
9	Cu	7.980000	247.800000		Co 5 - Di 10 - Ep 20.8718 - La 3.7482
10	CaF2	3.200000			
11	Cu	8.960000			
12	Fe	7.874000			
13	GaAs	5.910000			
14	GeSiO4	5.000000			
15	GaSi	6.750000			
16	Si	2.330000			
17	HEBS_glass	2.700000			
18	Inde	3.480000			
19	SiF4	4.784000			
20	SiF6O3	4.640000			
21	SiF6O2	7.450000			
22	SiF6	10.200000			
23	Ni	8.800000			
24	Fe	21.450000			
25	SiF2	7.300000			
26	Quartz_Glass	2.200000			
27	AgpHre	3.870000			
28	Si	2.330000			
29	SiO2	3.800000			
30	SiC	3.210000			
31	SiO2	2.650000			



VIEWER is an ideal, ultrafast tool to inspect and compare layouts, that is included in **BEAMER**. On the input side, all major layouts (GDSII, OASIS, CIF, DXF) plus electron- and laser-beam machine formats are supported. Multiple layout files can be loaded to visualize them overlaid. The user has a multitude of viewing options and capabilities. **VIEWER** is also available as a stand-alone software package.

- Extensive color management (user defined palette, transparency and overlay colors, and mapping of colors to layers /datatypes, doses, cells, layouts)
- Hierarchy support (view of the hierarchy tree, selection of cells/ layers to be displayed, drawing of features down to a user specified hierarchy depth)
- Metrology support (measure, pick, various snapping options such as snap to edge, snap to corner, snap orthogonal)
- Script generation for automation of metrology equipment and visualization of metrology results added into the layout
- For electron-beam machine formats view deflection fields, beam shots, writing order, and stage traversal order



GenISys products share highly dedicated support, have flexible licensing and are available on various platforms operating systems.

Flexible licensing and platform support

- USB license key for dongle and network
- Flexible on off-the-shelf PCs (> 4 GB RAM recommended)
- Windows 7/8/10 64bit, Linux64 Red Hat 5.4+, Ubuntu 14.04+
- Multithreading

Maintenance and Support

- Technical Support Hotline (e-mail, Skype, phone)
- Frequent updates with enhancements, new functions, performance tuning and bug fixes
- Regional trainings, technical workshops, user meetings
- 12 month maintenance service included in license price
- User feature requests are a high priority for implementation in future updates

BEAMER

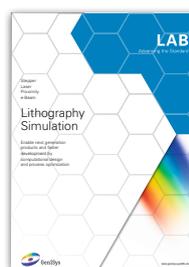


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Based in Munich (Germany), with offices in Tokyo (Japan), and California (USA), **GenISys** develops, markets and supports flexible, high-performance software solutions for the optimization of micro- and nano-fabrication processes. Addressing the market for lithography and inspection, **GenISys** combines deep technical expertise in layout data processing, process modeling, correction and optimization with high caliber software engineering and a focus on ease of use.

GenISys products give researchers, manufacturers, and system suppliers unparalleled efficiency, ease of use and optimal value in research, development, and production of future nano-patterning technologies.

As a company focused on customer service, **GenISys** delivers fast, highly dedicated support for the application and development of the functionality needed to meet demanding customer requirements.