

WYROWSKI

VirtualLab FUSION

OPTICAL DESIGN SOFTWARE



RAY TRACING

Start to investigate the performance of your optical system using 3D ray distributions, dot diagrams of ray positions and directions, and optical path length.



GEOMETRIC FIELD TRACING

Switch from conventional to smart rays and you quickly receive additional information about phase, polarization, coherence, and interference.



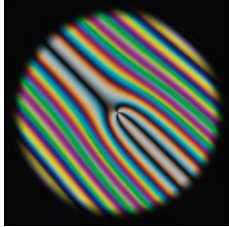
UNIFIED FIELD TRACING

Combine geometric with numerous diffractive modeling techniques to include more wave-optical effects in your simulation.

VirtualLab Fusion combines the best of different optical modeling approaches. Build up your optical system only once and all three co-operating engines are at your service!

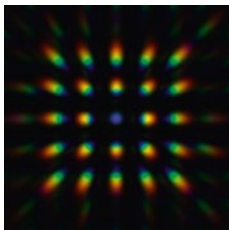
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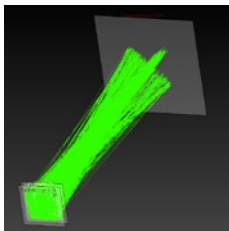
Laser Systems Design Package

The optical design and simulation of laser systems for single- as well as multimode, continuous wave (cw) and pulsed laser sources is enabled by this package. Laser systems can be designed including lenses, mirrors, diffractive optical elements, gratings and holograms. VirtualLab Fusion provides fast and accurate field and ray tracing engines in one software with an intuitive user interface.



Diffractive Optics Design Package

VirtualLab Fusion enables the design and simulation of diffractive optical elements, micro optical elements, gratings, freeform elements and holograms for shaping, splitting, diffusing and homogenization of both, laser and LED light. Fast physical optics simulation and optimization algorithms enable the design of these elements and take into account diffraction, interference, polarization and degree of coherence.



Illumination Systems Design Package

Optical elements for shaping, splitting, diffusing and homogenization of both, laser and LED light can be designed with this package. The emphasis is on the usage of lens arrays, diffractive optical elements and cells arrays consisting of gratings, mirrors and prisms. For the designed components, fabrication data can be exported in several formats including STL and GDSII.



Laser Resonators Design Package

VirtualLab Fusion enables the calculation of transversal eigenmodes of stable, unstable and ring laser resonators including beam delivery systems for optical pumping. The influence of plane and aspherical resonator end mirrors as well as plenty of intra-cavity components like sharp apertures, lenses, diffractive optical elements and freeform surfaces on the resonator mode can be investigated.

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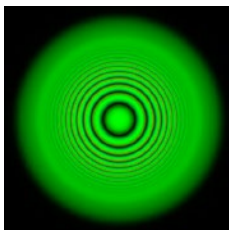
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Kahlaische Straße 4, 07745 Jena, Germany
Phone +49.3641.53129-50, service@lighttrans.com

Optical Design Software

Laser Systems Design Package



Y-component of the electric field in the focal region of a high-NA lens



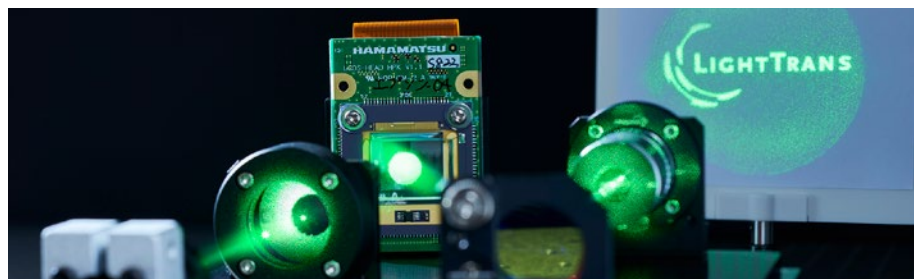
Interference fringes of Mach-Zender interferometer for a temporal partially coherent light source

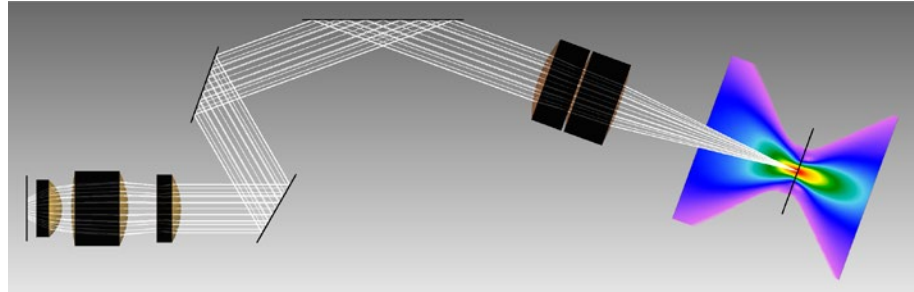
Laser beam shaping system with a SLM: the entire system can be designed with VirtualLab Fusion

VirtualLab Fusion enables the optical design and simulation of laser systems for single- as well as multimode, continuous wave (cw) and pulsed laser sources. Laser systems can be designed including lenses, mirrors, diffractive optical elements, gratings and holograms. VirtualLab provides fast and accurate field and ray tracing engines in one software with an intuitive user interface.

Applications

- ▶ **Beam delivery systems** · collimation, focusing, beam expander
- ▶ **Laser scanners** · f-theta lenses, scan mirrors, beam shaping
- ▶ **Fiber systems** · fiber coupling
- ▶ **Beam shaping and homogenization** · diffractive and refractive beam shapers
- ▶ **Analysis and control of ultra-short pulses** · compressors, stretchers, spatial and spectral filters, pulse shaping
- ▶ **Measurement systems** · interferometers, spectrometers, surface measurement
- ▶ **Surface and holographic gratings** · beam splitters, polarizers, photonics crystals, moth-eye structures
- ▶ **Hybrid and diffractive lens optics** · diffractive and refractive elements, hybrid lenses, diffractive lenses
- ▶ **Spatial light modulators** · real time control of laser beams, displays
- ▶ **Pattern generation** · light marks, logos, laser shows
- ▶ **Diffractive optical elements, holograms, phase plates** · shaping, splitting, diffusing light





Model of a beam delivery system for the focusing of a single mode diode laser beam and the electric field in the focal region

Applications and toolboxes of VirtualLab Fusion Laser Systems Design Package

Applications and required VirtualLab Toolboxes	Starter Toolbox	Grating Toolbox	Diffractive Optics Toolbox
Beam delivery systems, laser scanner, fiber systems	✓		
Beam shaping and homogenization	✓		✓
Analysis and control of ultra-short pulses	✓	✓	✓
Measurement systems	✓	✓	✓
Surface and holographic gratings	✓	✓	
Hybrid and diffractive lens optics	✓		
Spatial light modulators	✓		✓
Pattern generation	✓		✓
Diffractive optical elements, holograms, phase plates	✓	✓	✓

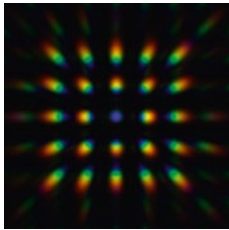
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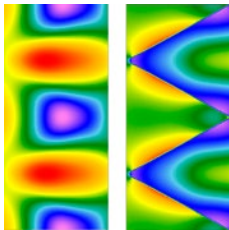
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Optical Design Software

Diffraction Optics Design Package



Far field of a diffractive beam splitter illuminated by polychromatic laser light



The electric field inside of a triangular grating: Ey and Ex for TE- and TM-illumination

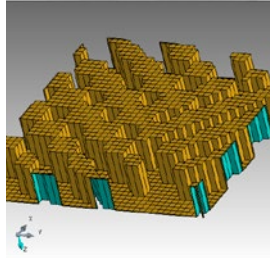
Holographic screen for headup display applications designed with VirtualLab Fusion

VirtualLab Fusion enables the design and simulation of diffractive optical elements, micro optical elements, gratings, freeform elements and holograms for shaping, splitting, diffusing and homogenization of both, laser and LED light. Fast physical optics simulation and optimization algorithms enable the design of these elements and take into account diffraction, interference, polarization and degree of coherence.

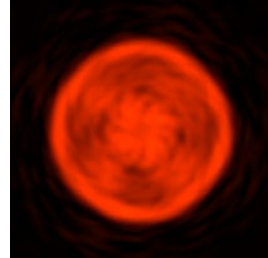
Applications

- ▶ **Homogenization and shaping of LED light** · micro lens arrays, diffractive diffusers, cells arrays of gratings, micro prisms and micro mirrors
- ▶ **Diffractive optical elements, holograms, phase plates** · shaping, splitting, diffusing light
- ▶ **Pattern generation** · light marks and logos for laser and LED light
- ▶ **Surface and holographic gratings** · beam splitters, polarizers, photonics crystals, moth-eye structures
- ▶ **Deterministic scattering** · surface scattering, volume scattering, real surfaces and index modulations
- ▶ **Spatial light modulators** · real time control of laser beams, displays

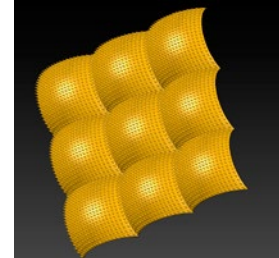




Surface profile of a diffractive beam splitting element



Effect of surface scattering on the intensity in the target plane of a laser beam beam shaping system



Micro lens arrays with an AR nano structure

Applications and toolboxes of VirtualLab Fusion Diffractive Optics Design Package

Applications and required VirtualLab Toolboxes	Starter Toolbox	Grating Toolbox	Diffractive	
			Optics Toolbox	Lighting Toolbox
Homogenization and shaping of LED light	✓	✓	✓	✓
Diffractive optical elements, holograms, phase plates	✓	✓	✓	
Pattern generation	✓	✓	✓	✓
Surface and holographic gratings	✓	✓		
Deterministic scattering	✓	✓		
Spatial light modulators	✓		✓	

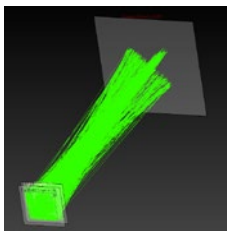
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Optical Design Software

Illumination Systems Design Package



Ray tracing simulation of an illumination system containing a grating cells array

VirtualLab Fusion enables the design and the simulation of illumination systems for shaping, splitting, diffusing and homogenization of both, laser and LED light. The emphasis of the software package is on the usage of lens arrays, diffractive optical elements and cells arrays consisting of gratings, mirrors and prisms. For the designed components, fabrication data can be exported in several formats including STL and GDSII. Fast physical optics simulation and optimization algorithms enable the design of these optical elements. The modeling takes into account diffraction, interference, polarization and degree of coherence.

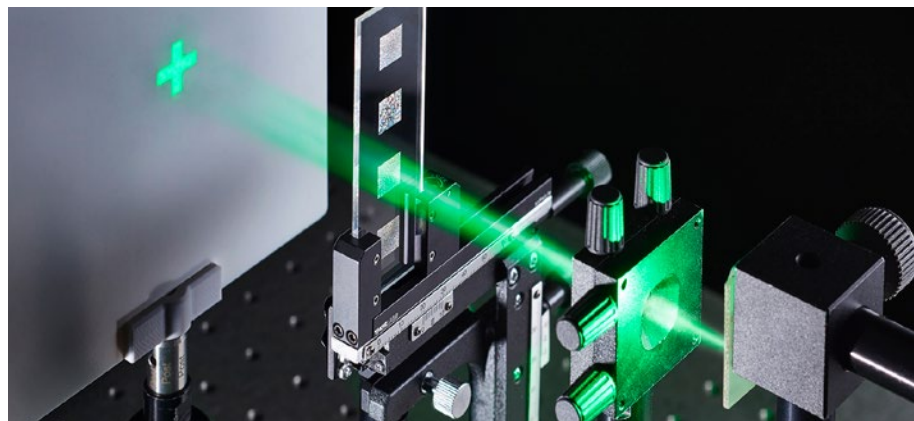


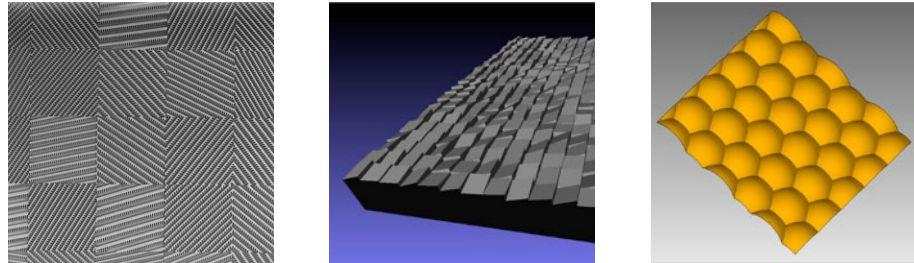
Skyline of Jena generated by a diffractive diffuser illuminated by a red LED

Applications

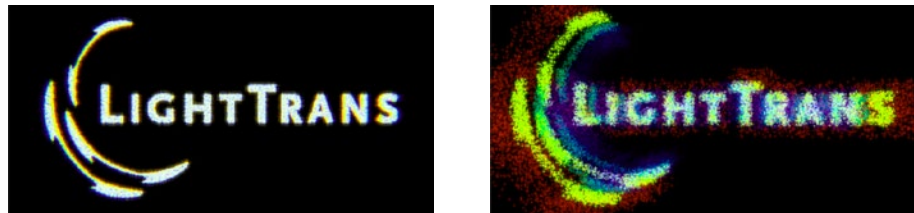
- ▶ **Homogenization and shaping of LED light** · micro lens arrays, diffractive diffusers, cells arrays of gratings, micro prisms and micro mirrors
- ▶ **Deterministic scattering** · surface scattering, volume scattering, real surfaces and index modulations
- ▶ **Pattern generation** · light marks and logos for laser and LED light

Compact light shaping for a LED: a grating cells array is used to transform the divergent light into a cross pattern





Structures for the shaping of LED light: image of a grating cells array (left), 3D surface of mirror cells array (middle) and hexagonal lens arrays (right).



The chromatic effects for an illumination with white LEDs strongly depend on the structure being used. The effects are much smaller for prism cells (left) than for grating cells (right).

Applications and toolboxes of VirtualLab Fusion Illumination Systems Design Package

Features and required VirtualLab Toolboxes	Starter Toolbox	Grating Toolbox	Diffractive	
			Optics Toolbox	Lighting Toolbox
Homogenization and shaping of LED light	✓	✓	✓	✓
Deterministic scattering	✓	✓		
Pattern generation	✓	✓	✓	✓

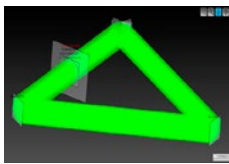
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Optical Design Software

Laser Resonators Design Package

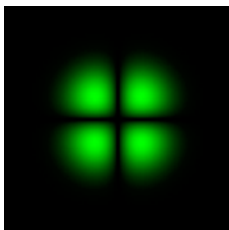


Mode analysis of a laser ring resonator

VirtualLab Fusion enables the calculation of transversal eigenmodes of complex laser resonators. The influence of plane and aspherical resonator end mirrors as well as plenty of intra-cavity components like sharp apertures, lenses, diffractive optical elements and freeform surfaces on the transversal resonator mode can be investigated. This enables the simulation of stable, unstable and ring resonator geometries and beam delivery systems for optical pumping. In addition the fully-vectorial Fox and Li algorithm enables the analysis of thermal lensing, stress-induced birefringence and nonlinear gain saturation for solid-state active media.

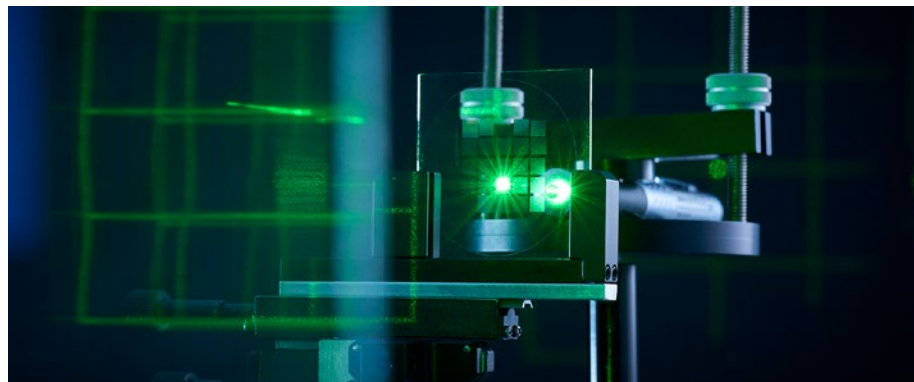
Applications

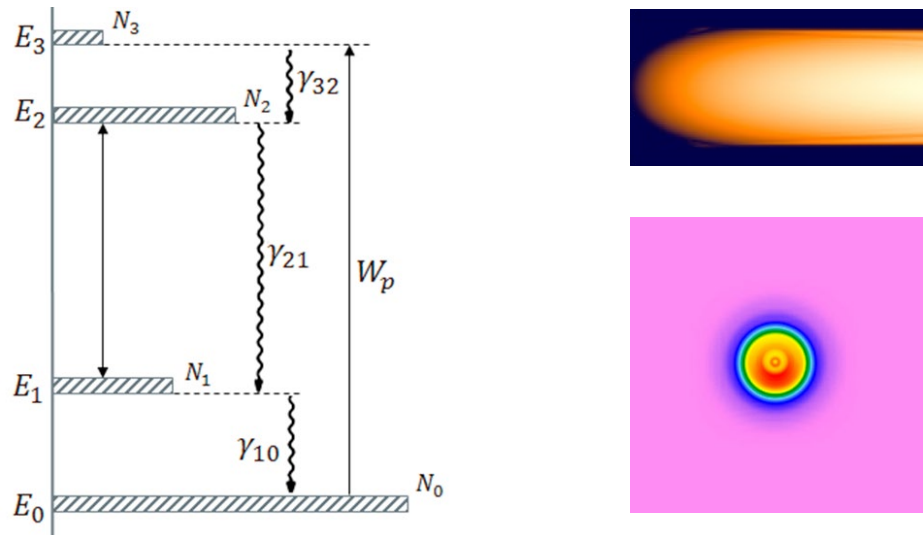
- ▶ **Solid-state laser resonators** · laser crystals, thermal lensing, birefringence, nonlinear gain saturation
- ▶ **Optical pumping** · diode pumped solid state (DPSS) lasers, design of optical pump systems, tolerancing
- ▶ **Unstable resonators** · non-Gaussian resonator modes, sharp intra-cavity apertures
- ▶ **Mode shaping** · intra- and extra-cavity mode shaping by diffractive and refractive optical elements



Transversal laser resonator mode calculation

Laser resonator mode shaping: a diffractive optical element is used to generate a customized laser beam profile.





Light amplification within solid-state laser crystal (upper right) and resulting non-Gaussian transversal resonator mode (lower right). The corresponding 4-level energy level diagram is shown on the left.

Applications and toolboxes of VirtualLab Fusion Laser Resonators Design Package

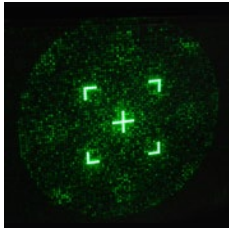
Applications and required VirtualLab Toolboxes	Starter Toolbox	Resonator Toolbox	Diffractive Optics Toolbox
Solid-state laser resonators	✓	✓	
Optical pumping	✓		
Unstable resonators	✓	✓	
Mode shaping	✓	✓	✓

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Optical Engineering and Fabrication Services



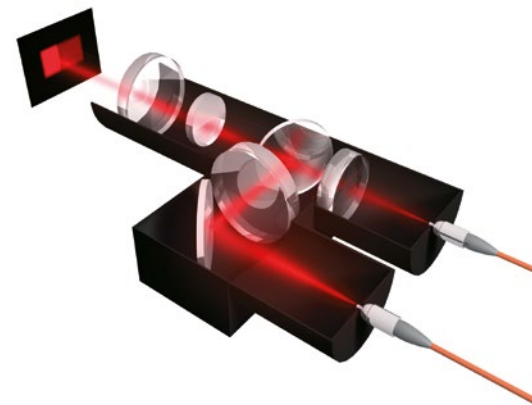
Light pattern generated by diffractive beam splitter

LightTrans offers optical design and engineering services for a variety of applications, in particular for laser and illumination systems. You can profit from our long term experience in the areas of physical and diffractive optics. We apply the unified optical design software VirtualLab Fusion in our engineering work.

Innovative optical system design frequently contains components which require novel optics fabrication techniques. LightTrans has arranged a powerful network of experienced fabrication partners to deliver high-end optical components.

Solutions

- ▶ **Optical design and engineering services**
Development and design of customized optical components and systems for laser and illumination applications
- ▶ **Fabrication of optical components**
Fabrication of micro-optical components with flexible lot size ranging from prototyping to mass replication phase



Applications

- ▶ **Laser beam shaping, splitting and diffusing**
Tailoring laser light by diffractive optical elements
- ▶ **LED light shaping & homogenization**
Design of compact illumination optics by micro cell and lens arrays
- ▶ **Holographic screens & displays**
Development of transparent screens and head-up displays
- ▶ **Computer generated holograms**
Design of transmission functions for spatial light modulators
- ▶ **Analysis tools for near-eye displays**
Simulation tools for physical optics based analysis of near-eye displays



Green LED light shaped into a cross pattern by a grating cells array

Your Benefits

- ▶ Entire optical development cycle from a feasibility study across the design process to mass fabrication by one supplier
- ▶ More than 15 years of experience in optical design
- ▶ Component fabrication by experienced external partners
- ▶ Unique design methods especially for micro-optical components
- ▶ Physical optics based simulation and design
- ▶ Problem-adapted extensions of VirtualLab Fusion for specific design tasks

Reference Projects



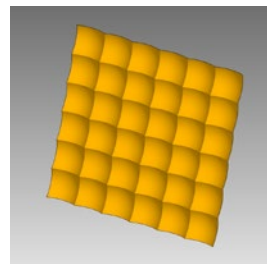
High-NA diffractive diffuser, field-of-view:
120 degrees



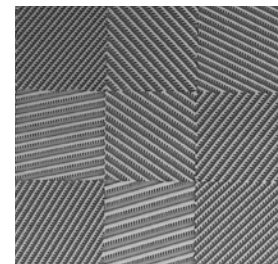
Holographic transparent screen,
transparency > 90°



Light shaping by a spatial light
modulator (SLM), diffraction
efficiency > 90°



Microlens array, array pitch:
200 μm



Grating cells array for LED
shaping, package volume of
optics < 15 mm^3



LightTrans offers solutions including software and training, engineering and fabrication. The software VirtualLab Fusion provides fast physical optics modeling and a variety of design algorithms. Choose your individual level of our customized services to solve your optical design projects very efficiently!