Aktiwave's beam shapers: highly versatile transmission control for your applications

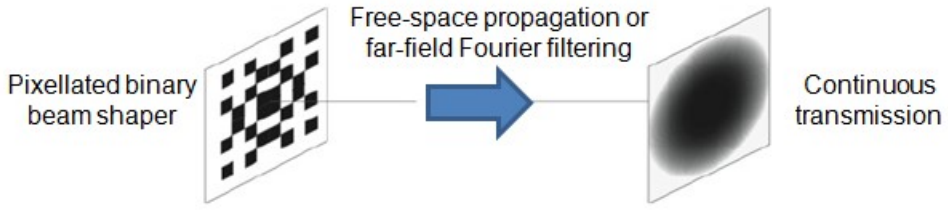
The need for optical elements with spatially varying transmission

Elements with spatially varying transmission are useful in applications such as laser engineering, imaging, microscopy, and astronomy. Typical examples of applications include:

- Apodization of an optical source by a soft aperture to avoid sharp edge diffraction in an optical setup.
- Precompensation of the spatially varying gain of an optical amplifier by applying a filter having a transmission corresponding to the inverse of the gain profile.
- Transformation of a Gaussian beam from a laser cavity into a flat-top beam using a Gaussian compensating filter to obtain a better fill factor in a laser amplifier or more efficient laser material processing.
- Optimization of the point-spread-function of a telescope by modifying the pupil transmission in order to observe an exoplanet orbiting around a bright star.
- Spatial modulation of an illumination system to improve uniformity or avoid deleterious diffraction effects.
- Calibration of a detection system using elements with known reference transmission.

Principle of Aktiwave's beam shapers

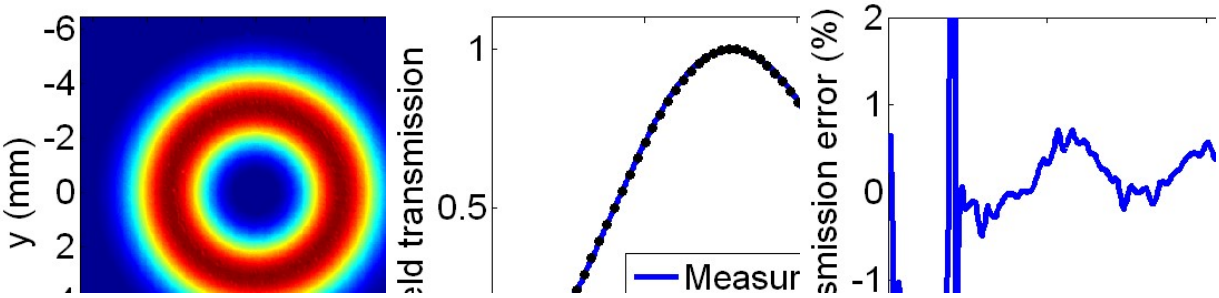
Aktiwave can design elements with spatially varying transmission following a quasi-arbitrary specification. These elements are fabricated by contact lithography of a metal layer deposited on a substrate. Distributions of small pixels, either opaque or transparent, are used to generate a continuous transmission after diffraction or far-field filtering. Proper design and manufacturing ensures good accuracy and reproducibility.



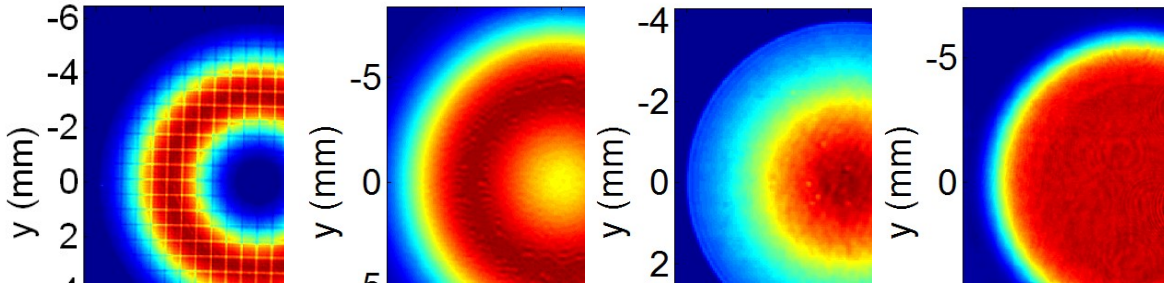
Principle of the realization of a continuous transmission from an element with binary pixels.

Examples of fabricated beam shapers

The examples shown here highlight some of the features of Aktiwave's beam shapers. Very good control of the spatial transmission is obtained thanks to optimized design, precompensation of inherent fabrication-related effects, and careful fabrication. Arbitrary transmission profile without symmetry requirements can be generated. Features such as alignment fiducials or calibration grids can be added.



Measured spatially resolved transmission of a coronagraph (left), comparison between specified field transmission and measured transmission (center), and transmission error, i.e. difference between measured and specific transmission (right).



Measured spatially resolved transmission of a coronagraph with a grid pattern and three other patterns that could be used for example to shape a Gaussian beam into a flat-top beam, shape a flat-top beam into a Gaussian beam, and apodize an optical source (from left to right).

Test plate with transmission varying from 0 % to 100% discretely (left) and continuously (right).

Advantages of Aktiwave's beam shapers

- **Excellent control of the spatial transmission**. Beam shapers have been manufactured for various applications, with control of the transmission between 0% and 100% and good spatial resolution. Accuracy of the order of a few percents is typically obtained. There is no requirement for circular symmetry.
- **Achromaticity**. Pixellated beam shapers are achromatic, leading to the same spatial transmission over a large wavelength range. They can therefore be used with broadband sources.
- **Absence of spatial phase distortion**. The pixellated beam shapers do not modify the phase of the transmitted beam. They can therefore simply be inserted in an imaging system or optical layout with little impact on the alignment, or beam shapers corresponding to different transmission function can be used alternatively in a setup.
- **Choice of substrates adapted to application and wavelength range**. Standard and custom substrates can be coated with a metal opaque at the wavelength of use. Typical choices for the substrate include BK7, fused silica, and Infrasil. Typical choices for the metal include Chrome and Aluminum.
- **Compatibility with conventional AR coating**. Dielectric and sol-gel AR coatings can be applied to a beam shaper after fabrication to decrease Fresnel losses.
- **High versatility**. Beam shapers can be manufactured on any plane surface. For example, a beam shaper could be fabricated on the plane surface of a plano-convex lens, on a beamsplitter, or on a prism.
- **Good reproducibility**. Fabrication with contact lithography from a master mask ensures good reproducibility of fabricated parts.
- **Possibility to add features such as grid patterns and centering fiducials**.