Holo/Or LeanLine™ system for laser material processing

Various modern production processes require high intensity laser lines at 355-1064nm. These applications include laser lift off, flat display production, solar cell processing and polymer welding, among others.

Laser intensities of more than 50mJ/cm^2 at 10-20ns pulses are often required for such processes, over lines of 100mm or more. Single mode laser systems cannot provide high enough pulse energies when the pulse is spread over such long lines, while multi-mode lasers have higher intensities but cannot by focused to a narrow enough line due to their high M^2.

The solution is M^2 transformation- a system that takes an axis-symmetrical high M^2 (multimode) beam and outputs lower M^2 in one axis and higher M^2 in the other axis. Afterward the output is shaped into a line in the axis with high M^2 and is focused into a narrow Gaussian profile in the axis with low M^2. This way the Intensity in the line is increased to the required process threshold, as the line can be focused using a cylindrical lens to much narrower widths.

Such M^2 transformations are commonly done by micro-refractive methods (cylindrical lens arrays) or by fiber-optic methods (input coupling and then splitting to multiple fibers arrayed in a line). These methods are complicated, require multiple optical components and have many sensitive degrees of freedom that must be tuned within tight tolerances, and often tailored to the specific parameters of each costumer's laser system.

Holo/Or has developed LeanLine™, a robust 2-module system that preforms M^2 transformation on a round input beam and converts it into a narrow line at focus. LeanLine™ uses an invocative diffractive approach to M^2 transformation that reduces the number of elements required in the system and relaxes the required tolerances.

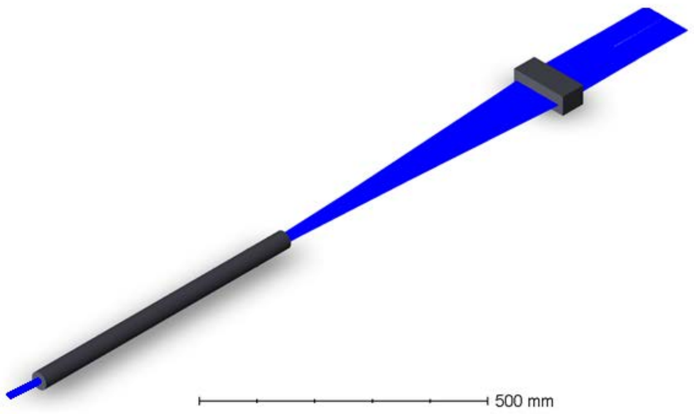

Fig 1: LeanLine100™ system drawing

The entire system includes two modules:

- The first module is used for M^2 transformation and line beam shaping
- The second module is used for line length-control and focusing in the narrow axis

This modular system construction allows flexibility – the same basic setup can generate different line widths by switching the output module.

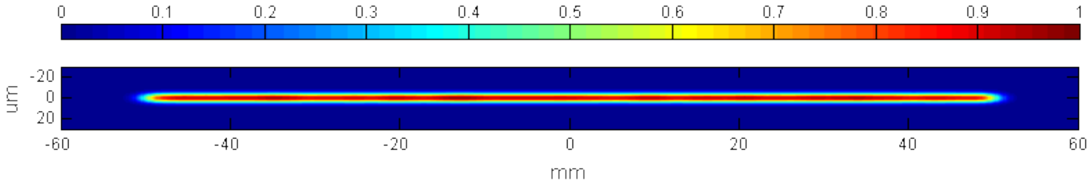

Fig 2: Simulated intensity at LeanLine™ 100mm system output (focal plane) for M^2 = 25 round input beam.

Diffractive solution advantages

1. Easy alignment and installation
2. Extremely high precision for M^2 transformation quality, achieved by the lithography production process
3. A fully transmissive (non-reflective), on-axis system
4. Aberration free
5. Can be easily modified to produce different line lengths and widths
6. No internal focus points
7. Available in a wide spectral range from DUV to NIR.

Applications:

Laser annealing to improve process quality in a variety of industries:

- Flat panel display production
- Semiconductor devices
- Thin-film solar cell production
- Sensor production

Processing of a broad range of materials, including:
- Silicon
- Silicon on glass
- Polymers
- ITO on glass