Focal-πShaper in Photovoltaics

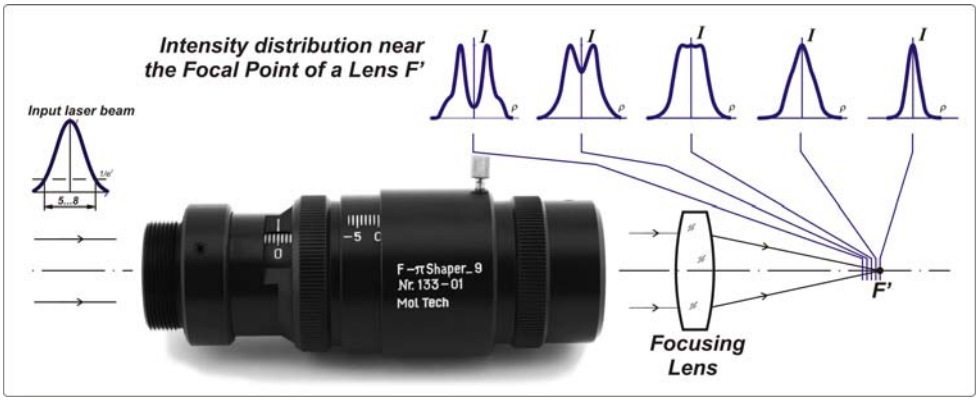
Lasers become more and more popular in production of various solar cells finding application in such technologies like:

- Edge Isolation,
- Vias Drilling,
- Patterning in Thin-Film cells (P1, P2 and P3 structuring),
- Edge Delete in Thin-Film cells,
- Marking,

and bringing increasing the productivity, quality and other features in production process.

Performance of above mentioned laser technologies can be seriously improved by applying the Laser Beam Shaping technique, for example, transformation of a beam intensity profile from Gaussian to so called flattop (uniform) distribution. This optical transformation helps to improve a trench profile in sense of steeper walls and reaching flat bottom, reduce drastically the HAZ (heat affected zone) and increase the productivity of material processing due to more efficient usage of the laser energy (see the details at **http://www.pishaper.com/shaping_system.php**).

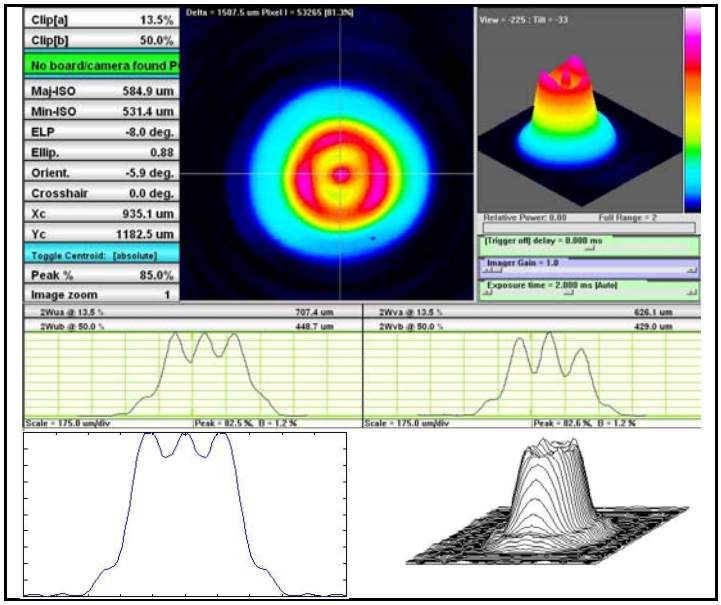
Just this transformation is realized by the refractive beam shapers ***Focal-πShaper*** (or ***F-πShaper***) - intended to work with lasers of different wavelengths and create flattop, donut and other intensity distributions for beams focused by a diffraction limited lens to spots below 100-200 micron.



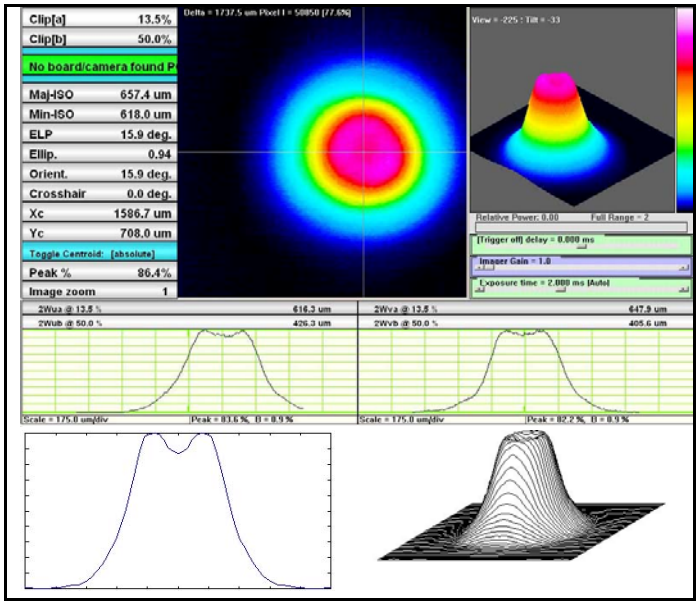
The series of ***F-πShaper*** models is a part of a family of refractive beam shapers realizing so called field mapping optical approach and having the trade name ***πShaper***.

Intensity profiles of focused beams under various *F-πShaper* settings

(Courtesy of Altechna, Lithuania)



Input beam diameter 6 mm



Input beam diameter 4.2 mm

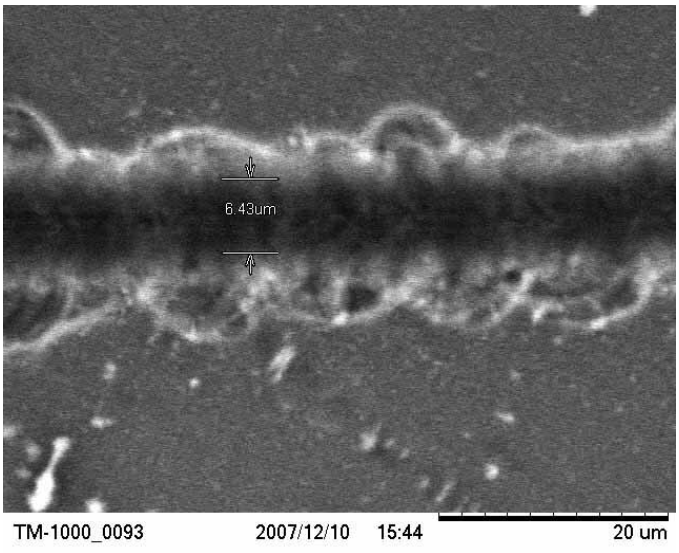
The operational principle presumes applying of a focusing lens after the ***F-πShaper***.
There can be a lens of any type: an F-theta lens, any kind of telecentric lens or focusing lens. The most important feature of the lens is that it has to be diffraction limited one, in other words, it shouldn't implement any wave aberration over whole working field. This is an essential condition for proper operation of the ***F-πShaper***.

Detailed description of the ***F-πShaper*** models is presented at **http://www.pishaper.com/f_shaper.php**.

Effect of applying the ***F-πShaper*** in scribing laser technologies is illustrated on below pictures showing results of scribing of glass with a femtosecond laser, wavelength 1064 nm, M^2 about 1.2.

Laser scribing with a shortpulse laser

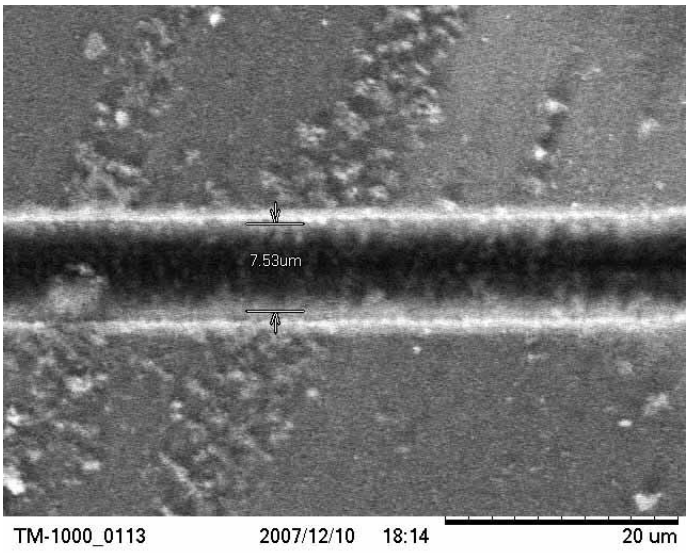
(Courtesy of Altechna, Lithuania)



with Gaussian beam

Features:

- irregular trench edges,
- wide HAZ.



with F-πShaper 9_1064

Features:

- even trench edges,
- steep walls,
- almost without HAZ.

Other features of the scribing of thin-film solar cells with using beam shaping optics on the base of the ***F-πShaper 9_1064*** are discussed in details in the paper:

Alexander Laskin, Vadim Laskin (2010)
Refractive field mapping beam shaping optics: important features for a right choice (M1301)
ICALEO 2010, September 27 – 30, 2010, Anaheim, CA, USA.