How to use Holo/Or's MATLAB simulation tool for Top-Hat beam shaper

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Thank you for downloading our free code for simulating Diffractive Top Hat elements using MATLAB™.

This tool has been developed as a part of our efforts to make diffractive elements easy to understand, and also accessible for integration in your optical designs.

We have published several documents that explain how to model and simulate diffractive elements in optical design programs such as ZEMAX™ and VirtualLab™. For several product categories, we have prepared ready-to-use models that can be downloaded directly from our website.

In this publication, we present the new Top Hat beam shaper simulation for MATLAB™. The purpose of the tool is to allow customers to better understand the typical performance of the Top-Hat element. For design requests, please contact us at mailto:holoor@holoor.co.il and we will find you a suitable solution.

You can find several links for other products at the end of this document.

Top Hat beam shaper - General information

Extended information about the Top Hat Beam-Shaper can be found in HOLO/OR's application notes:

http://holoor.co.il/Diffractive_optics_Applications/Application_Notes_BeamShapers.htm

Downloading and opening the files

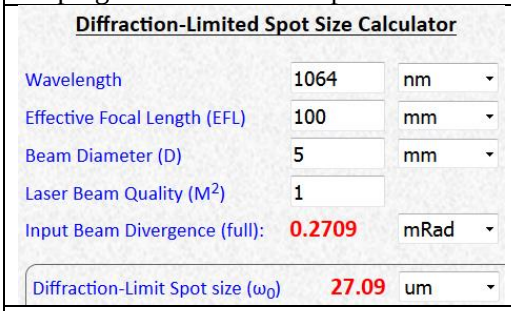
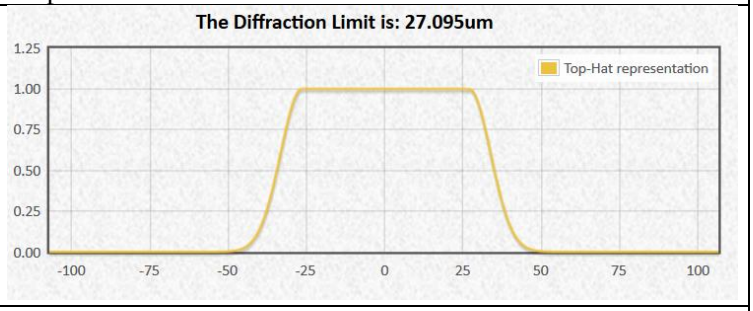
- After opening the ZIP file you will find two files – TopHatSim.m and TopHatSim.p type. The m. file displays 'help' information and the .p file includes the encrypted MATLAB code. You can read more about the p-code concept here: https://www.mathworks.com/help/matlab/ref/pcode.html
- Place both files in the relevant folder before running your simulations scripts

Input and output parameters - General recommendations

- For achieving the best performance, keep the relation between the clear aperture and the beam size values to be larger than 2.2.
- For efficient beam shaping, the recommended relation between the Top Hat size and the Diffraction limited spot size should be larger than 3.
- A typical defocus range for Top Hat element is similar to the Top Hat size.

For feasibility testing, we recommend to use HOLO/OR's interactive optical calculators in our website, see example below.

Estimation for target size and shape

In the below example we can see that effective shaping is available for Top Hat size ~> 80 um	It can also be useful to get a visual estimation for the Top Hat shape
	
http://holoor.co.il/Diffractive_Optics_Products/Calculators.php?PN=DL	http://holoor.co.il/Diffractive_Optics_Products/Calculators.php?PN=TH

Top Hat simulations – nominal performance run

Scripts examples.

**Detailed information can be found in help section: type *help TopHatSim* in MATLAB's Command Window

Round Shape	**Square Shape**	**Line Shape**

nominalStruct.CA = 12.5;
nominalStruct.beamDia = 5;
nominalStruct.f = 100;
nominalStruct.lambda = 1.064e-3;
nominalStruct.shape = '**round**';
nominalStruct.THSize = 0.08;
toleranceStruct.tolvariable_string = '';
TopHatSim(nominalStruct,toleranceStruct);
	nominalStruct.CA = 12.5;
	nominalStruct.beamDia = 5;
	nominalStruct.f = 100;
	nominalStruct.lambda = 1.064e-3;
	nominalStruct.shape = '**square**';
	nominalStruct.THSize = 0.08;
	toleranceStruct.tolvariable_string = '';
	TopHatSim(nominalStruct,toleranceStruct);
		nominalStruct.CA = 12.5;
		nominalStruct.beamDia = 5;
		nominalStruct.f = 100;
		nominalStruct.lambda = 1.064e-3;
		nominalStruct.shape = '**line**';
		nominalStruct.THSize = 0.08;
		toleranceStruct.tolvariable_string = '';
		TopHatSim(nominalStruct,toleranceStruct);

The main file's name is TopHatSim, which includes two structure-type variables: the first structure defines the optical parameters for the nominal simulation and the second structure defines the basic parameters to be simulated with tolerances.

Detailed information about the fields of each structure:

NominalStruct structure fields:

nominalStruct.CA	clear aperture size in mm
nominalStruct.beamDia	Gaussian beam diameter at exp(-2) in mm
nominalStruct.f	Effective Focal Length (EFL) of the system in mm
nominalStruct.lambda	laser wavelength in mm (i.e, 500nm=0.5e-3)
nominalStruct.shape	shape string: 'square', 'round' or 'line'
nominalStruct.THSize	Top Hat size in mm

toleranceStruct structure fields:

toleranceStruct.tolvariable_string	variable for tolerances. Options: ' ', 'defocus', 'wavelength', 'beamSizeChange', 'decenter'
toleranceStruct.tolvar_values	values for tolerances in mm

Possible tolerances options:

- defocus - distance from nominal plane in mm
- wavelength - deviation from nominal wavelength in mm
- beamSizeChange - deviation from nominal beam size in mm
- decenter - misalignment between the incident beam and Top Hat element. Only positive values are possible in mm

* It is possible to run several tolerance values in each run using []

Examples for tolerances run

Defocus	**Wavelength**

nominalStruct.CA = 12.5;
nominalStruct.beamDia = 5;
nominalStruct.f = 100;
nominalStruct.lambda = 1.064e-3;
nominalStruct.shape = 'square';
nominalStruct.THSize = 0.08;
toleranceStruct.tolvariable_string = '**defocus**';
toleranceStruct.tolvar_values = [-0.1 -0.05 0.05 0.1];
TopHatSim(nominalStruct,toleranceStruct);
	nominalStruct.CA = 12.5;
	nominalStruct.beamDia = 5;
	nominalStruct.f = 100;
	nominalStruct.lambda = 1.064e-3;
	nominalStruct.shape = 'square';
	nominalStruct.THSize = 0.08;
	toleranceStruct.tolvariable_string = '**wavelength**';
	toleranceStruct.tolvar_values =1.064e-3*[-0.1 0.1];
	TopHatSim(nominalStruct,toleranceStruct);

beamSizeChange	**decenter**

nominalStruct.CA = 12.5;
nominalStruct.beamDia = 5;
nominalStruct.f = 100;
nominalStruct.lambda = 1.064e-3;
nominalStruct.shape = 'square';
nominalStruct.THSize = 0.08;
toleranceStruct.tolvariable_string = '**beamSizeChange**';
toleranceStruct.tolvar_values = [-1 -0.5 0.5 1];
TopHatSim(nominalStruct,toleranceStruct);
	nominalStruct.CA = 12.5;
	nominalStruct.beamDia = 5;
	nominalStruct.f = 100;
	nominalStruct.lambda = 1.064e-3;
	nominalStruct.shape = 'square';
	nominalStruct.THSize = 0.08;
	toleranceStruct.tolvariable_string = '**decenter**';
	toleranceStruct.tolvar_values = [0.25];
	TopHatSim(nominalStruct,toleranceStruct);

Links for more simulation tools:

1. VirtualLab BlackBox
   http://holoor.co.il/Diffractive_Optics_Publications/InstructionUsingBlackBox_VirtualLab.pdf
2. ZEMAX BlackBox for TopHats
   http://holoor.co.il/Diffractive_Optics_Products/Diffractive_Beam_Shapers/Using%20BlackBox%20file%20of%20TH.pdf
3. Diffractive Homogenizers presented by BSDF files in ZEMAX
   http://www.holoor.co.il/Diffractive_Optics_Products/Diffractive_Beam_Homogenizers/BSDF/BSDF_MANUAL.pdf
4. Simulation of MultiSpots (Beam Splitters) in ZEMAX
   http://holoor.co.il/Diffractive_Optics_Publications/Tutorials/Beam%20splitter%20tutorial%20for%20Zemax.pdf