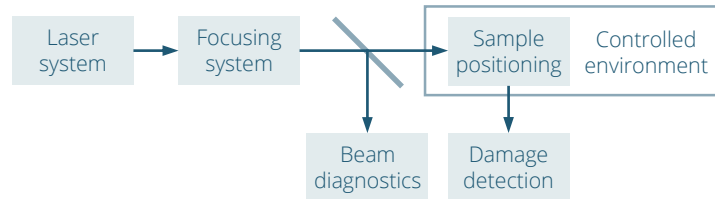


TEST EQUIPMENT

Test setup

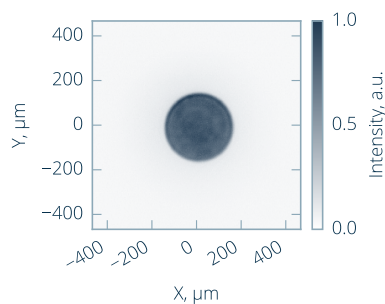


Laser and its parameters

Type	Continuous wave Yb: fiber laser
Manufacturer	IPG
Model	YLS6000-U
Central wavelength	1070.0 nm
Angle of incidence	12.0 deg
Polarization state	Random
Spatial beam profile in target plane	Near flat-top
Beam diameter in target plane (effective)	$(301.7 \pm 6.9) \mu\text{m}$
Longitudinal pulse profile	CW
Power stability	0.2 %

Energy/power meter

Manufacturer	Ophir
Model	10K-W-BB-45-V3
Calibration due date	2022-03



(a) Beam profile

Figure 1. Laser parameters used for measurements.

TEST SPECIFICATION

Definitions and test description

Laser-induced damage (LID) is defined as any permanent laser radiation induced change in the characteristics of the surface/bulk of the specimen which can be observed by an inspection technique and at a sensitivity related to the intended operation of the product concerned. ¹ LIDARIS' RASTER SCAN test procedure involves exposure of pre-defined surface region with spatially overlapping test sites so that 90% of onset peak irradiance coverage is guaranteed. For every new scan, the irradiance is ramped up until damage criteria or maximum available peak irradiance of the test system is reached. Laser-induced damage threshold (LIDT) is defined as the average irradiance of lowest observed damaged level and first undamaged level below.

Test specification

Area tested per scan level (1/e ² beam intens. level)	1.01 cm ²
Area tested per scan level relative to clear aperture	19.84 %
Scan speed in x-direction	15.92 mm/s
Beam overlap in y-direction	8 % of effective beam diameter
First irradiance level	0.0240 MW/cm ²
Irradiance level step	20 % increase for every subsequent level
Irradiance levels	16
Irradiance level scan duration	34 s

Analysis information

Online detection	Scattered light diode
Offline detection	Nomarski microscope
Software version	9585ef1

Test environment

Environment	Air
Cleanroom class (ISO 14644-1)	ISO7
Pressure	1 bar
Temperature	22.9 - 24.7 C
Humidity	22.3 - 23.8 %

Sample preparation

Storage before test	Normal laboratory conditions
Dust blow-off	Compressed air
Cleaning	None

¹ISO 21254-1:2011: Lasers and laser-related equipment - Test methods for laser-induced damage threshold - Part 1: Definitions and general principles, International Organization for Standardization, Geneva, Switzerland (2011)

LIDT TEST RESULTS

LIDT VALUE

	Irradiance	Linear power density
Lidaris' Raster Scan	$0.376^{+0.109}_{-0.096}$ MW/cm ²	$8.9^{+2.6}_{-2.3}$ kW/cm

Table 1: Evaluated Lidaris' Raster scan LIDT for sample M0001948 - LOT0080312.

Analysed Threshold type	Threshold (Irradiance)	Threshold (Linear power density)
Catastrophic failure	$0.376^{+0.109}_{-0.096}$ MW/cm ²	$8.9^{+2.6}_{-2.3}$ kW/cm

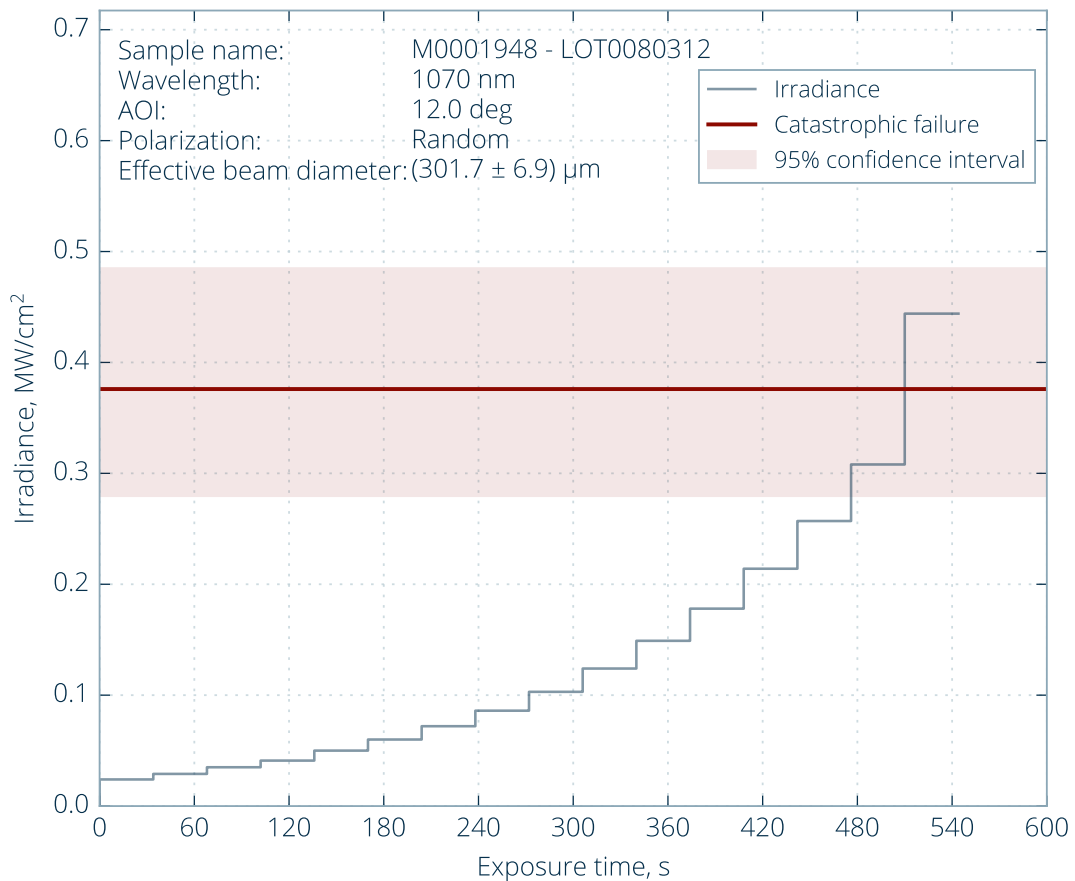


Figure 2. Raster scan test results.

IRRADIANCE LEVELS

Table 2: Lidaris' Raster scan irradiance levels for sample M0001948 - LOT0080312.

Level	Irradiance, MW/cm ²	Linear power density, kW/cm	Status ²
1	0.0240	0.569	Passed
2	0.0290	0.687	Passed
3	0.0350	0.829	Passed
4	0.0410	0.972	Passed
5	0.0500	1.18	Passed
6	0.0600	1.42	Passed
7	0.0720	1.71	Passed
8	0.0860	2.04	Passed
9	0.103	2.44	Passed
10	0.124	2.94	Passed
11	0.149	3.53	Passed
12	0.178	4.22	Passed
13	0.214	5.07	Passed
14	0.257	6.09	Passed
15	0.308	7.30	Passed
16	0.444	10.5	Catastrophic failure

²Read Technical Note 1

SCANNED SAMPLE AREA

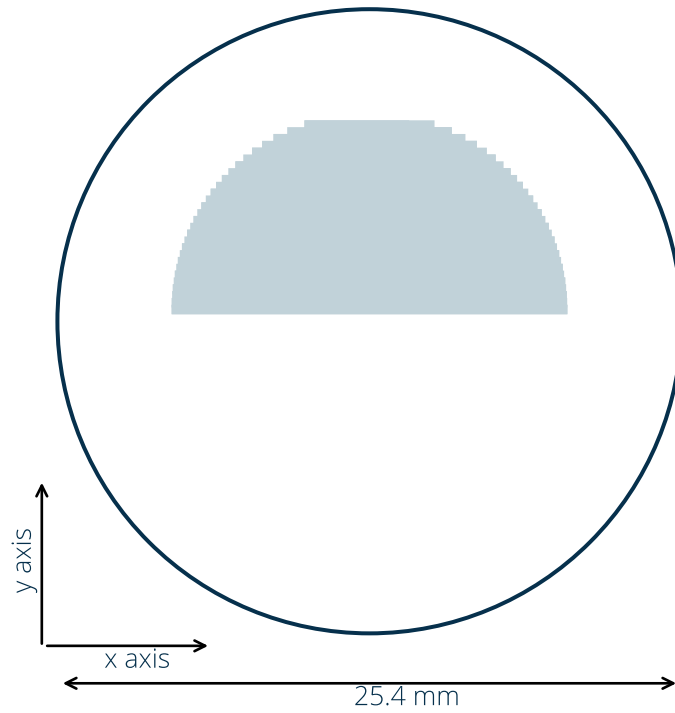


Figure 3. Scanned sample area.

TYPICAL DAMAGE MORPHOLOGY (CATASTROPHIC)

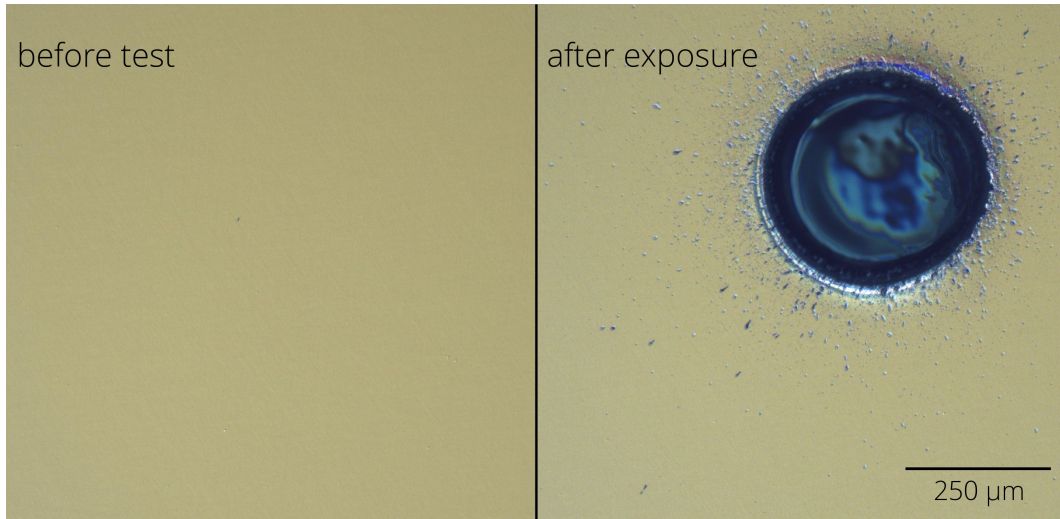


Figure 4. Typical damage morphology: irradiance 0.444 MW/cm².

TECHNICAL NOTES

TECHNICAL NOTE 1: Lidaris' Raster scan statuses

Performing Lidaris' Raster scan test scanned area is imaged with Nomarski microscope (10x) after each irradiance level. Using additional image analysis tools each irradiance level is labeled with one of the following statuses:

Passed – no apparent change in morphology was observed.

Laser cleaning – dust or other artificial object was cleaned with laser radiation and, as a result, sample surface might be affected by plasma scalding. It is assumed that sample survived specific irradiance radiation.

Damage initiation – minor damages (small pin-points, smooth color changes, etc.) occurred. In general, they might not affect spatial properties of laser beam that irradiates the optical element but these damages can grow into further upon laser exposure.

Catastrophic failure – clearly observed damage that is bigger than 100 μm or the damage that experienced exponential or asymmetric growth after scanning the surface with higher irradiances.

TECHNICAL NOTE 2: Oblique incidence

According to the ISO 21254-2:2011 standard, for spatial beam profiling perpendicular to the direction of beam propagation and angles of incidence differing from 0 degrees, the cosine of the angle of incidence is included in the calculation of the effective area, which leads to correct evaluation of laser irradiance at different angles of incidence (Figure 5).

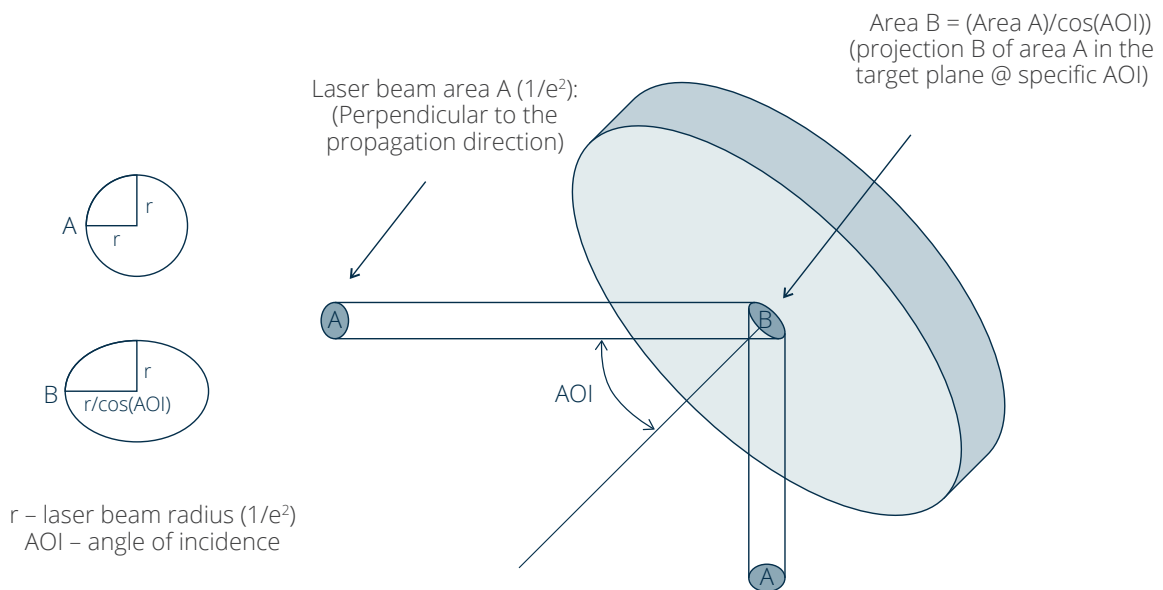


Figure 5. Oblique incidence.

TECHNICAL NOTE 3: Damage initiation threshold could not be evaluated

Due to technical issues sample surface images after each scan level were not created. Raster scan analysis was performed using only Online detection signal. Therefore, damage initiation threshold could not be evaluated and New objects distribution histogram is not available for this test. Only catastrophic damage threshold is provided.