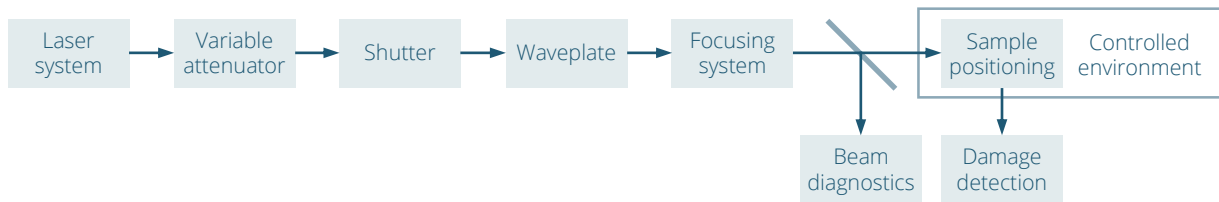


TEST EQUIPMENT

Test setup



Laser and its parameters

Type	Q-switched, seeded Nd:YAG
Manufacturer	InnoLas Laser
Model	SpitLight Hybrid
Central wavelength	1064.0 nm
Angle of incidence	45.0 deg
Polarization state	Linear P
Pulse repetition frequency	20 Hz
Spatial beam profile in target plane	TEM00
Beam diameter in target plane (1/e ²)	(240.1 ± 1.9) μm
Longitudinal pulse profile	Single longitudinal mode
Pulse duration (FWHM)	(10.1 ± 0.3) ns
Pulse to pulse energy stability (SD)	1.1 %

Energy/power meter

Manufacturer	Ophir
Model	PE50-DIF-C
Calibration due date	2021-06-01

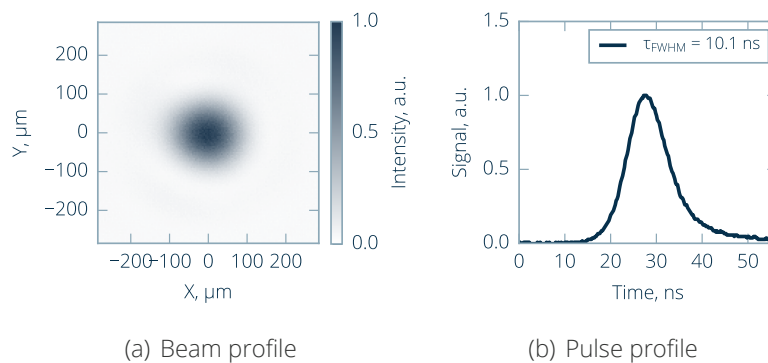


Figure 1. Laser parameters used for measurements.

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. Laser-induced damage threshold (LIDT) is defined as the highest quantity of laser radiation incident upon the optical component for which the extrapolated probability of damage is zero. ¹

LID of the sample is investigated by performing a standardized S-on-1 test procedure.² LIDT value is determined by fitting experimental damage probability data with a model derived for a Poisson damage process assuming degenerate defect ensemble. ³

Test sites

Number of sites	419
Arrangement of sites	Hexagonal
Minimum distance between sites	750 µm
Maximum pulses per site	1000

Analysis information

Online detection	Scattered light diode
Offline detection	Nomarski microscope
Software version	73ed106 - 858a298

Test environment

Environment	Air
Cleanroom class (ISO 14644-1)	ISO7
Pressure	1 bar
Temperature	22 C
Humidity	68 %

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)

²ISO 21254-2:2011: Lasers and laser-related equipment - Test methods for laser-induced damage threshold - Part 2: Threshold determination, International Organization for Standardization, Geneva, Switzerland (2011)

³J. Porteus and S. Seitel, Absolute onset of optical surface damage using distributed defect ensembles, Applied Optics, 23(21), 3796-3805 (1984)

LIDT TEST RESULTS

LIDT VALUE

10³-on-1

46.8 $^{+2.8}_{-6.8}$ J/cm²

CHARACTERISTIC DAMAGE CURVE

Table 1: Estimated LIDTs from fitting model for sample M0077239 LOT0063669.

Test mode	Threshold (Offline detection - microscopy)	Threshold (Online detection - scattering)
1-on-1	46.8 $^{+2.8}_{-5.4}$ J/cm ²	47.1 $^{+2.8}_{-5.3}$ J/cm ²
10-on-1	-	47.1 $^{+2.8}_{-6.6}$ J/cm ²
10 ² -on-1	-	46.9 $^{+2.8}_{-6.6}$ J/cm ²
10 ³ -on-1	46.8 $^{+2.8}_{-6.8}$ J/cm ²	46.8 $^{+2.8}_{-7.0}$ J/cm ²

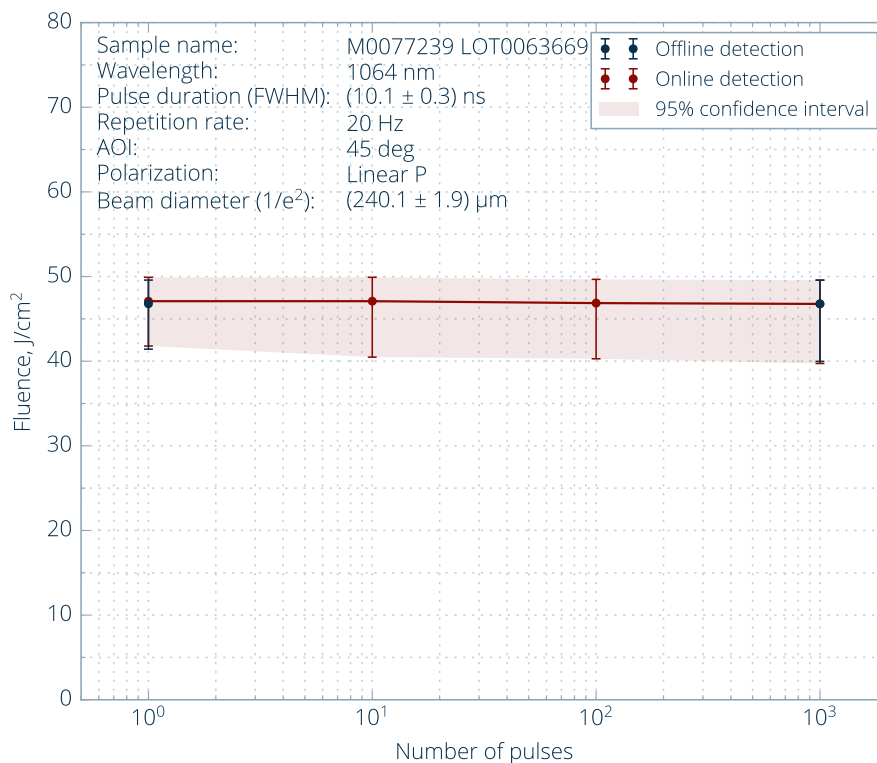
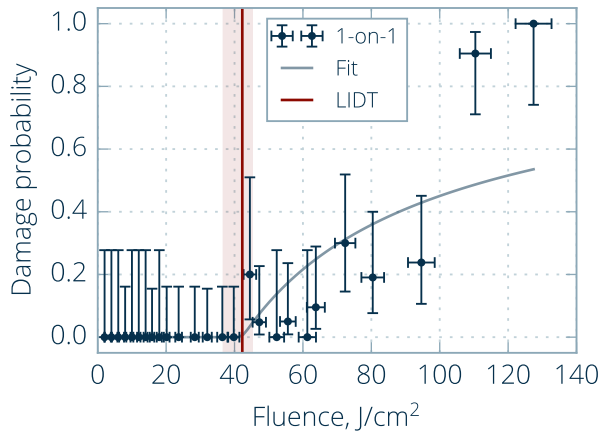
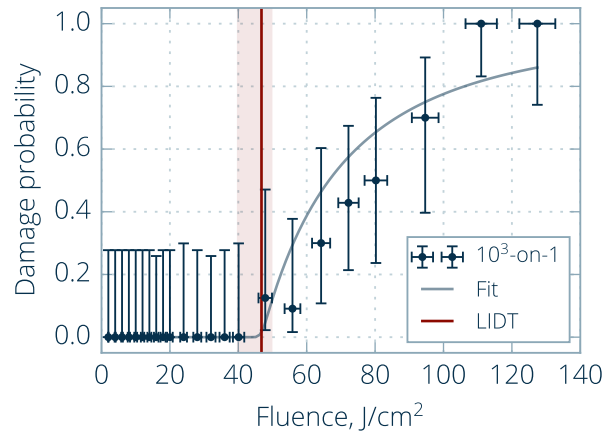


Figure 2. Characteristic damage curve.

DAMAGE PROBABILITY (OFFLINE DETECTION)



(a) 1-on-1



(b) 10³-on-1

Figure 3. Damage probability plots.

TYPICAL DAMAGE MORPHOLOGY (OFFLINE DETECTION)



Figure 4. Typical damage morphology: fluence 47.3 J/cm², damage after 1 pulse(s).

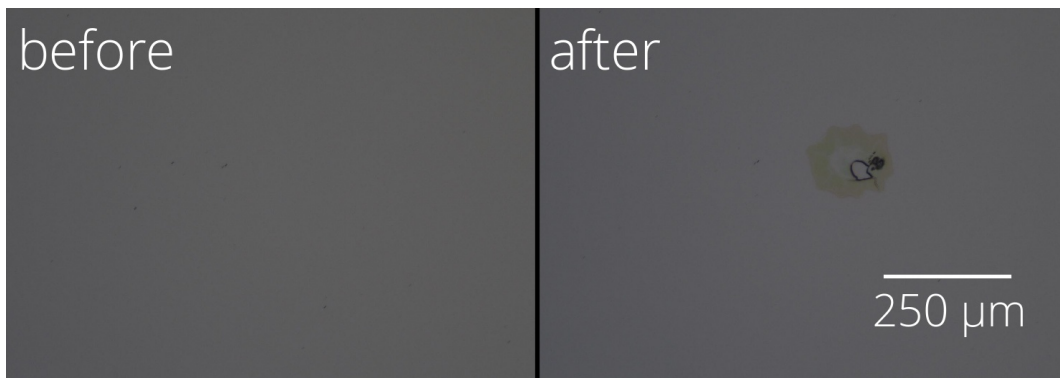
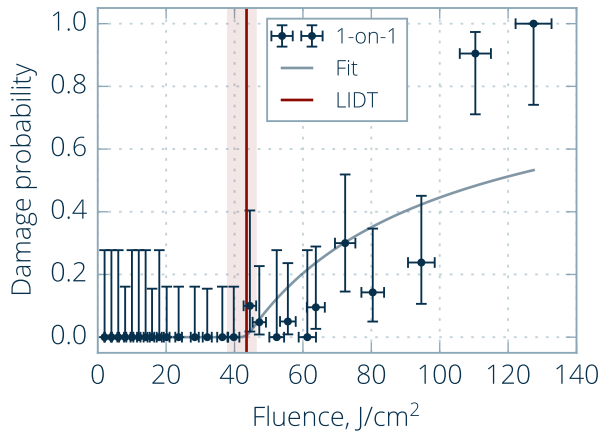
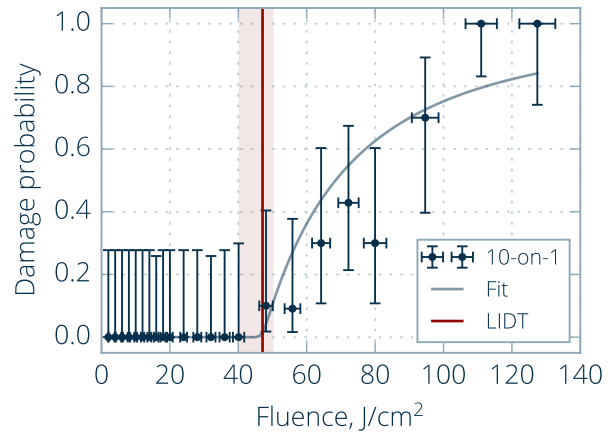


Figure 5. Typical damage morphology: fluence 112 J/cm², damage after 1 pulse(s).

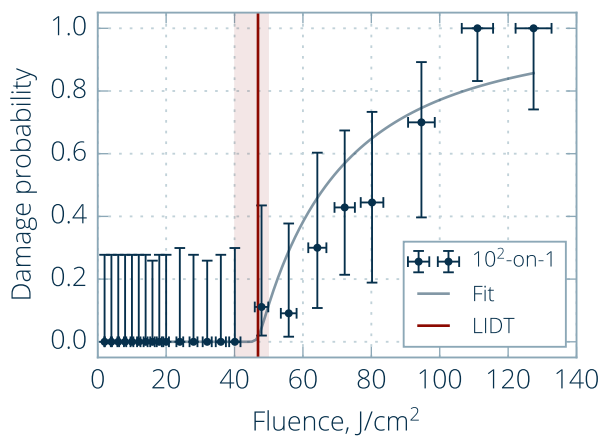
DAMAGE PROBABILITY (ONLINE DETECTION)



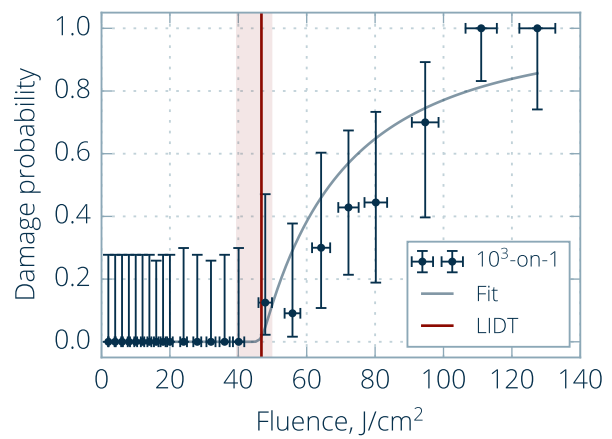
(a) 1-on-1



(b) 10-on-1



(c) 10²-on-1



(d) 10³-on-1

Figure 6. Damage probability plots.

TECHNICAL NOTES

TECHNICAL NOTE 1: 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 fluence at different angles of incidence (Figure 7).

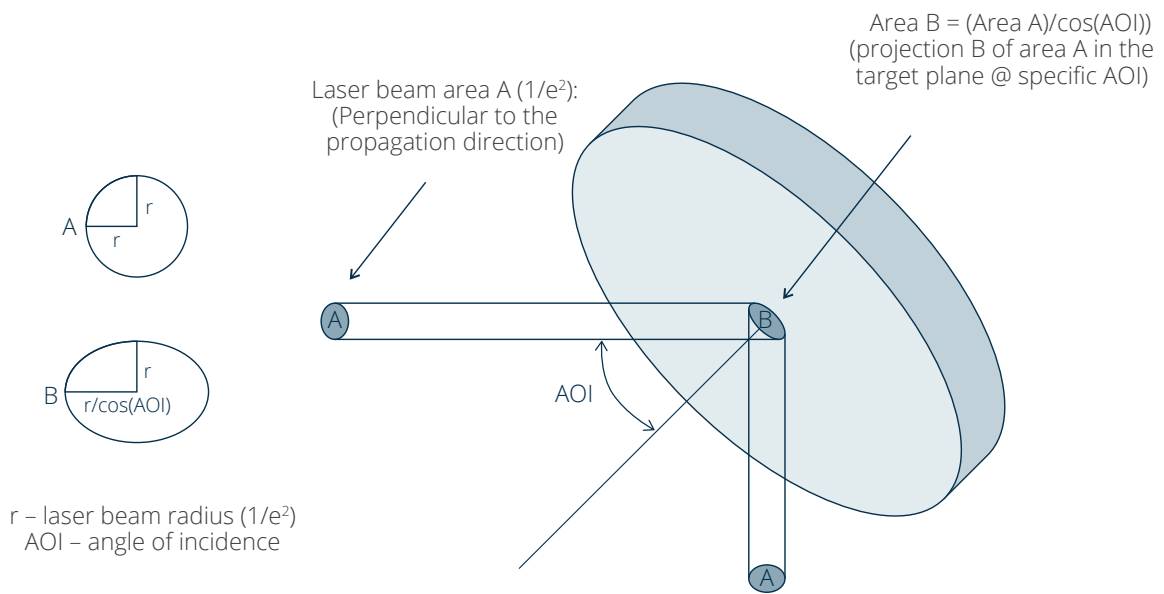


Figure 7. Oblique incidence.