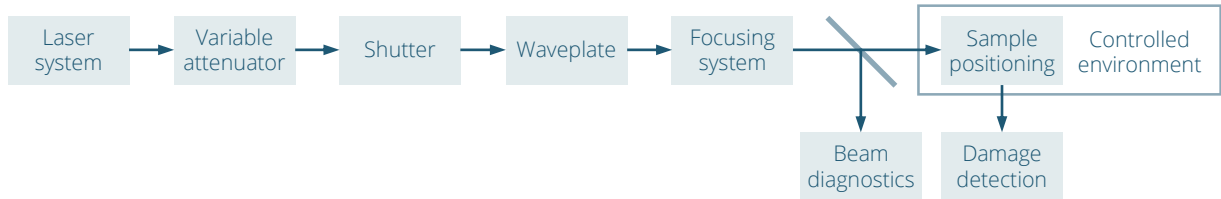


TEST EQUIPMENT

Test setup



Laser and its parameters

Type	Q-switched, seeded Nd:YAG
Manufacturer	Ekspla
Model	NL940-100
Central wavelength	2090.0 nm
Angle of incidence	0.0 deg
Polarization state	Linear
Pulse repetition frequency	100 Hz
Spatial beam profile in target plane	Near Gaussian
Beam diameter in target plane ($1/e^2$)	$(101.3 \pm 1.3) \mu\text{m}$
Longitudinal pulse profile	Single longitudinal mode
Pulse duration (FWHM)	$(3.7 \pm 0.3) \text{ ns}$
Pulse to pulse energy stability (SD)	2.8 %

Energy/power meter

Manufacturer	Ophir
Model	PE50-DIF-C
Calibration due date	2023-04-01

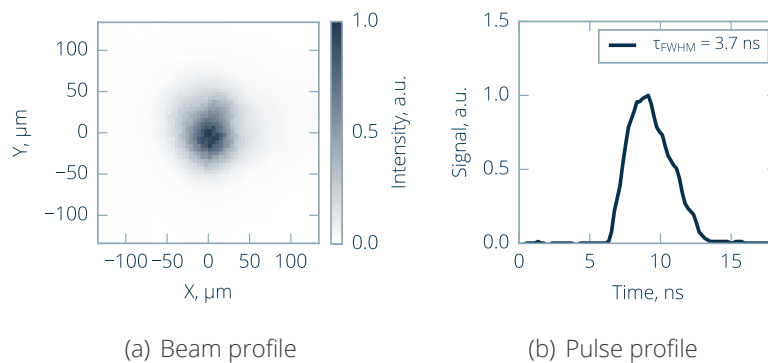


Figure 1. Laser parameters used for measurements.

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	483
Arrangement of sites	Hexagonal
Minimum distance between sites	650 µm
Maximum pulses per site	1000

Analysis information

Online detection	None
Offline detection	Nomarski microscope
Software version	8c85ab1

Test environment

Environment	Air
Cleanroom class (ISO 14644-1)	ISO7
Pressure	1 bar
Temperature	21.5 - 22.0 C
Humidity	39.5 - 44.5 %

Sample preparation

Storage before test	Normal laboratory conditions
Dust blow-off	Canned air
Cleaning	Isopropanol

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

10 ³ -on-1	9.7 $^{+3.1}_{-5.5}$ J/cm ²	31.9 $^{+10.1}_{-18.0}$ J/cm ² (scaled to 40.0 ns)
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CHARACTERISTIC DAMAGE CURVE

Table 1: Estimated LIDTs from fitting model for sample M0001948 LOT0088065 ID 78463.

Test mode	Threshold (Offline detection - microscopy)	Threshold (Offline detection - microscopy) scaled to 40.0 ns	Threshold (Online detection - scattering)	Threshold (Online detection - scattering) scaled to 40.0 ns
1-on-1	9.7 $^{+5.6}_{-5.5}$ J/cm ²	31.9 $^{+18.3}_{-18.0}$ J/cm ²	9.7 $^{+5.5}_{-5.5}$ J/cm ²	31.9 $^{+18.0}_{-18.2}$ J/cm ²
10-on-1	-	-	9.7 $^{+5.4}_{-5.5}$ J/cm ²	31.9 $^{+17.7}_{-18.2}$ J/cm ²
10 ² -on-1	-	-	9.7 $^{+5.4}_{-5.8}$ J/cm ²	31.9 $^{+17.7}_{-19.0}$ J/cm ²
10 ³ -on-1	9.7 $^{+3.1}_{-5.5}$ J/cm ²	31.9 $^{+10.1}_{-18.0}$ J/cm ²	9.7 $^{+3.0}_{-5.8}$ J/cm ²	31.9 $^{+9.8}_{-19.0}$ J/cm ²

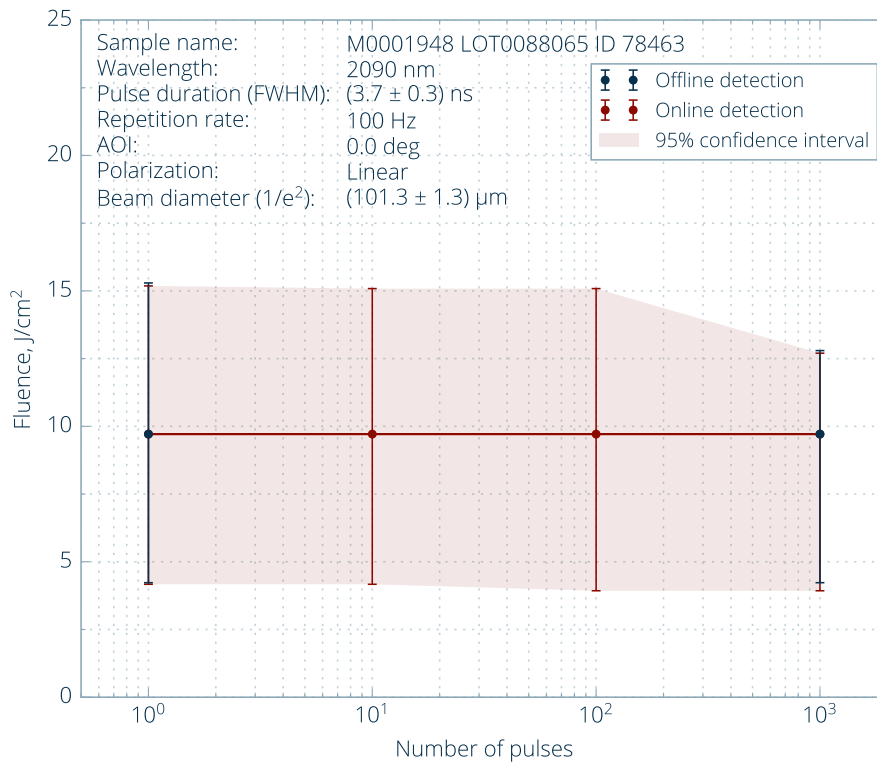


Figure 2. Characteristic damage curve.

DAMAGE PROBABILITY (OFFLINE DETECTION)

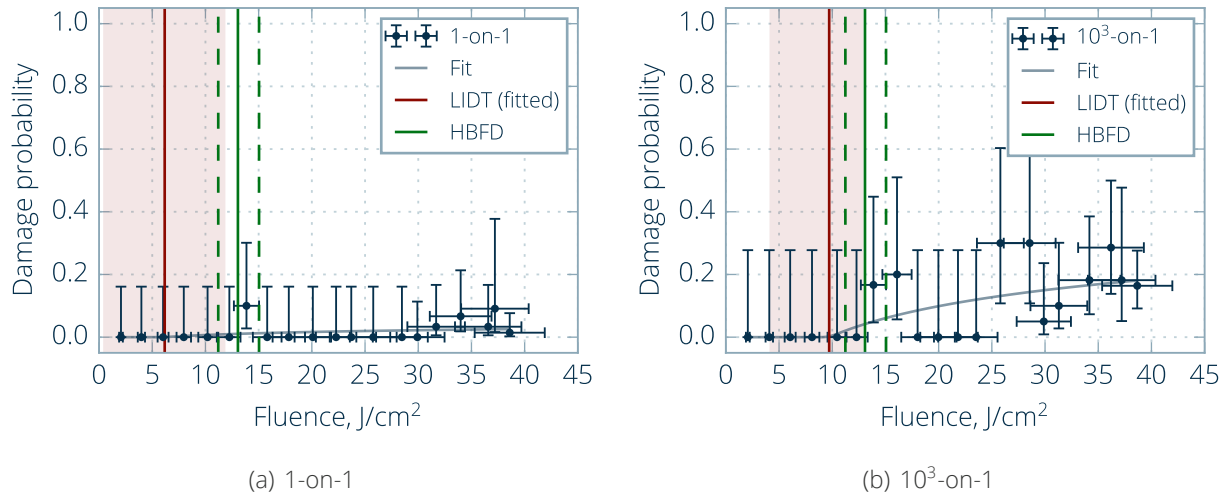


Figure 3. Damage probability plots. ⁴

⁴Read Technical Note 1

TYPICAL DAMAGE MORPHOLOGY (OFFLINE DETECTION)

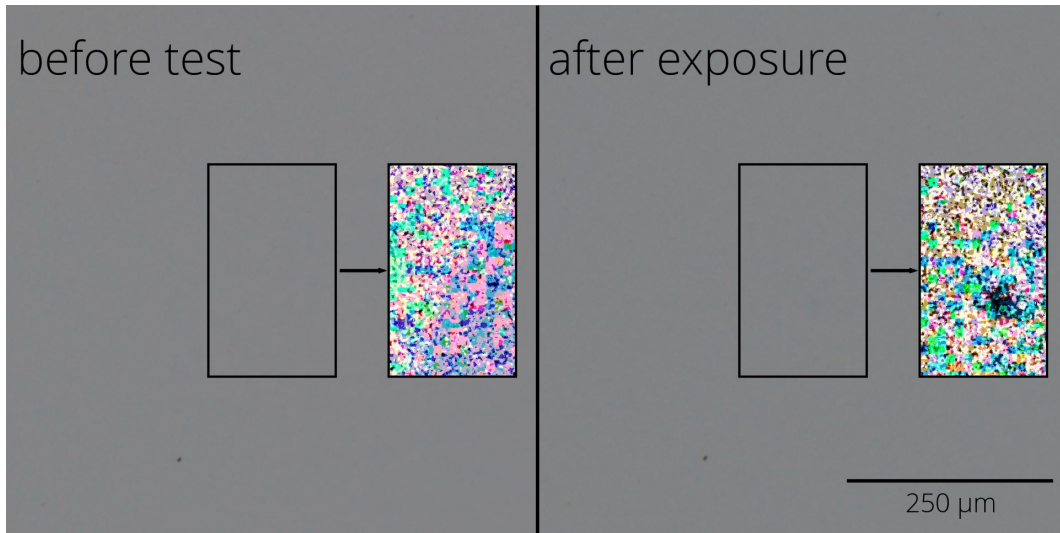


Figure 4. Typical damage morphology: fluence 13.2 J/cm², damage after 1 pulse(s). High contrast image.

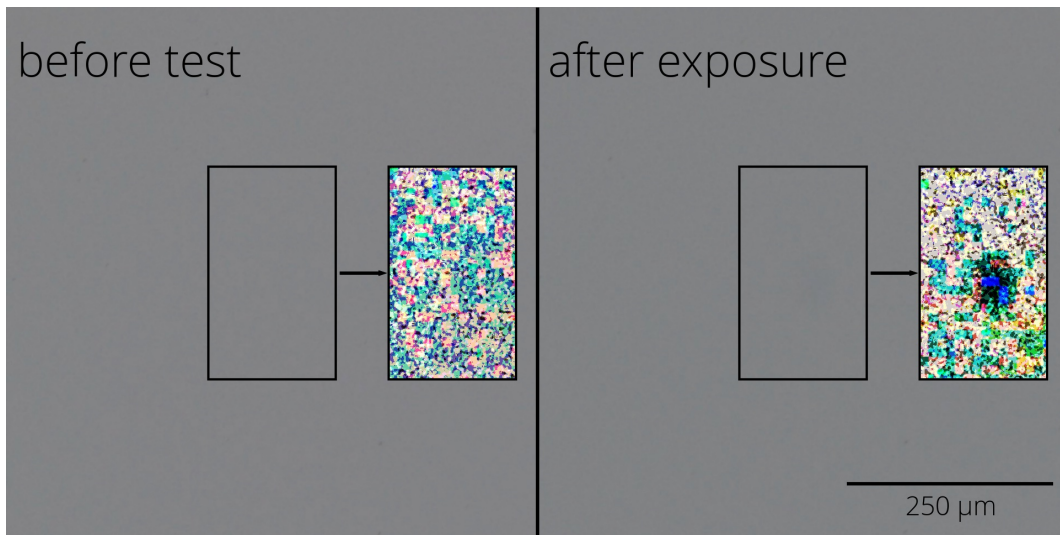


Figure 5. Typical damage morphology: fluence 38.0 J/cm², damage after 1000 pulse(s). High contrast image.

DAMAGE PROBABILITY (ONLINE DETECTION)

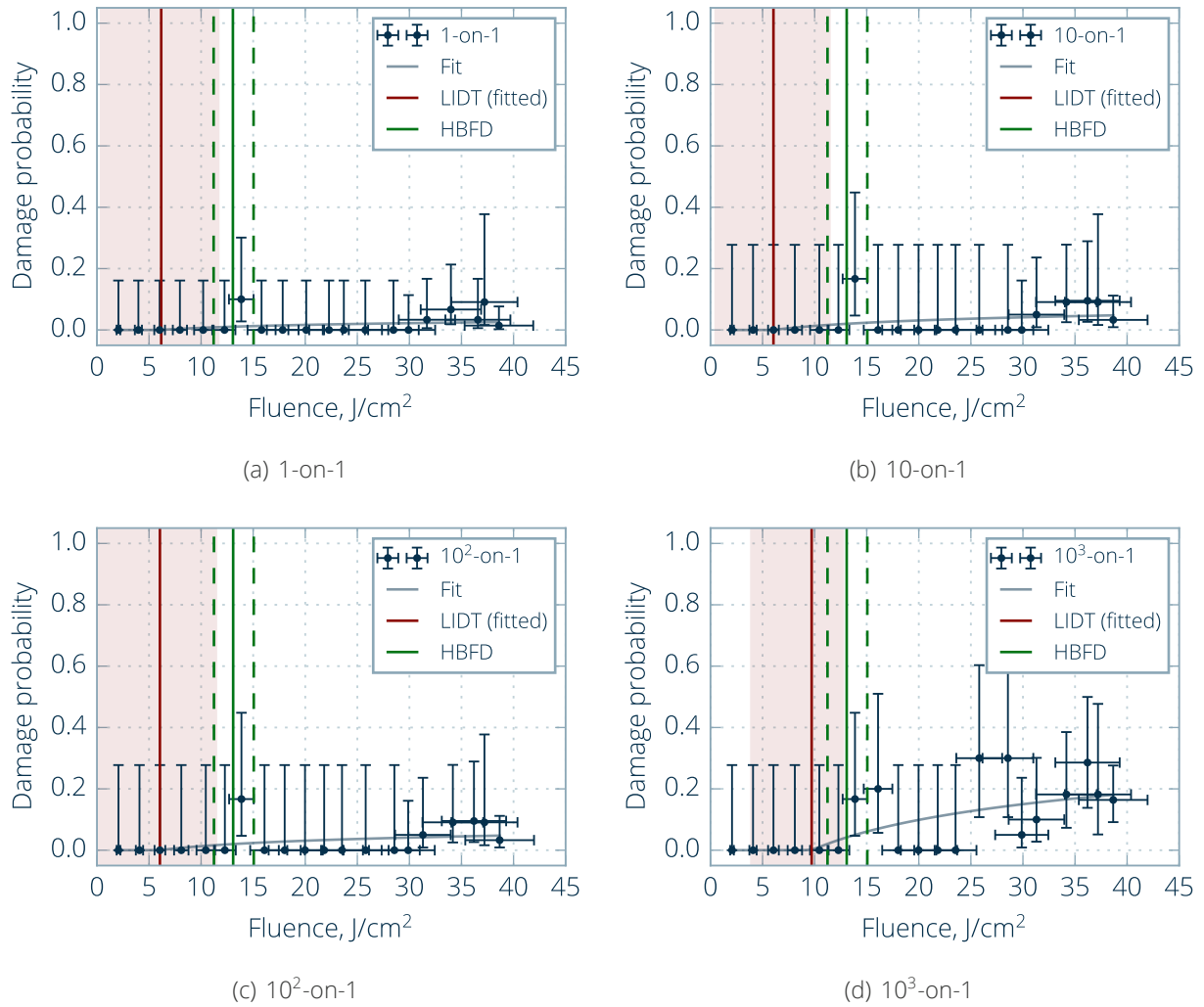


Figure 6. Damage probability plots. ⁵

⁵Read Technical Note 1

HIGHEST THRESHOLD BEFORE FIRST DAMAGE CURVE (NOT ISO STANDARD)

Table 2: Estimated thresholds as HBFD for sample M0001948 LOT0088065 ID 78463.

Test mode	Threshold (Offline detection - microscopy)	Threshold (Offline detection - microscopy) scaled to 40.0 ns	Threshold (Online detection - scattering)	Threshold (Online detection - scattering) scaled to 40.0 ns
1-on-1	13.1 $^{+2.0}_{-1.8}$ J/cm ²	42.9 $^{+6.5}_{-6.1}$ J/cm ²	13.1 $^{+2.0}_{-1.8}$ J/cm ²	42.9 $^{+6.5}_{-6.1}$ J/cm ²
10-on-1	-	-	13.1 $^{+2.0}_{-1.8}$ J/cm ²	43.0 $^{+6.5}_{-6.1}$ J/cm ²
10 ² -on-1	-	-	13.1 $^{+2.0}_{-1.8}$ J/cm ²	43.0 $^{+6.5}_{-6.1}$ J/cm ²
10 ³ -on-1	13.1 $^{+2.0}_{-1.8}$ J/cm ²	43.0 $^{+6.5}_{-6.1}$ J/cm ²	13.1 $^{+2.0}_{-1.8}$ J/cm ²	43.0 $^{+6.5}_{-6.1}$ J/cm ²

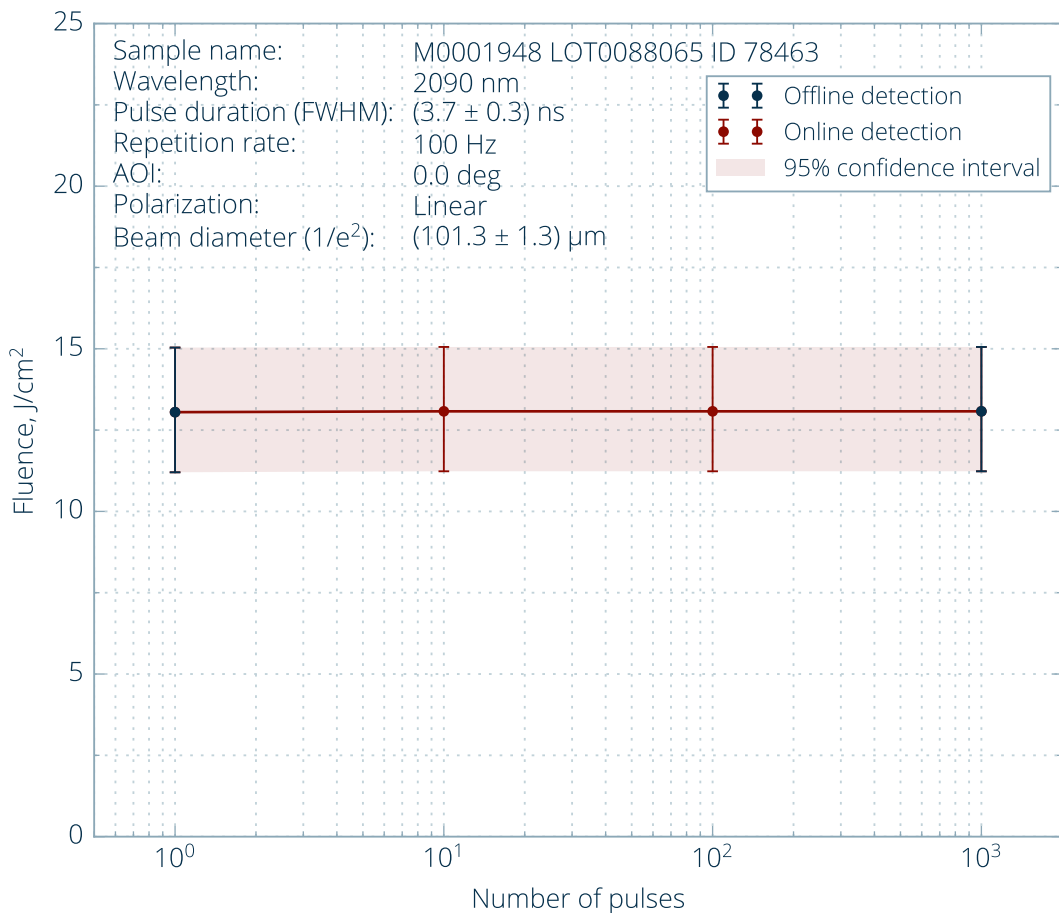


Figure 7. Highest threshold before first damage curve. ⁶

⁶Read Technical Note 1

TECHNICAL NOTES

TECHNICAL NOTE 1: Non standard HBFD threshold estimation

HBFD (Highest Before First Damage) values represent threshold values determined by taking the average of the highest fluence value before which no damage was observed and the lowest fluence value at which damage was first observed. This value is not ISO standard threshold and it should be considered as complimentary information. It was included in the report because error of the highest pulse class LIDT value exceeded 30%.