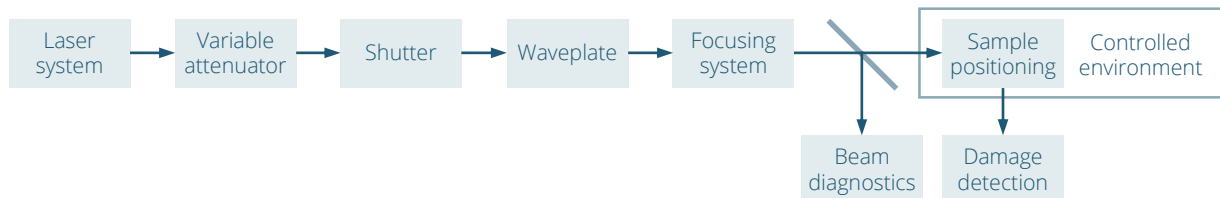


# TEST EQUIPMENT

## Test setup



## Laser and its parameters

Type	Q-switched, seeded Nd:YAG
Manufacturer	InnoLas Laser II
Model	SpitLight Hybrid
Central wavelength	532.0 nm
Angle of incidence	0.0 deg
Polarization state	Linear
Pulse repetition frequency	100 Hz
Spatial beam profile in target plane	TEM00
Beam diameter in target plane (1/e <sup>2</sup> )	(234.9 ± 3.1) μm
Longitudinal pulse profile	Single longitudinal mode
Pulse duration (FWHM)	(5.9 ± 0.3) ns
Pulse to pulse energy stability (SD)	1.1 %

## Energy/power meter

Manufacturer	Ophir
Model	PE50-DIF-C
Calibration due date	2022-05-01

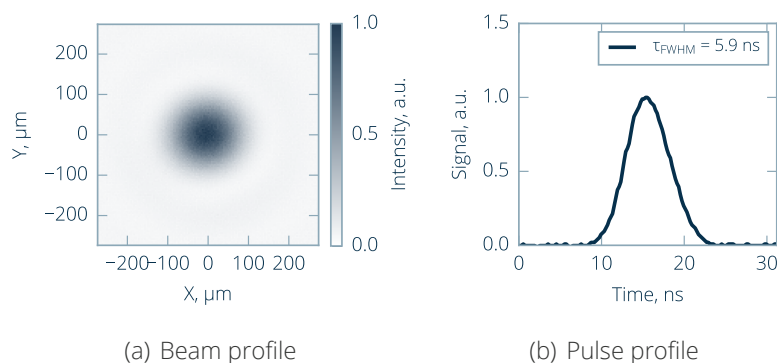


Figure 1. Laser parameters used for measurements.

# 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.<sup>1</sup>

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

## Test sites

Number of sites	420
Arrangement of sites	Hexagonal
Minimum distance between sites	900 µm
Maximum pulses per site	1000

## Analysis information

Online detection	Scattered light diode
Offline detection	Nomarski microscope
Software version	c8936f8 - 3d19ffc

## Test environment

Environment	Air
Cleanroom class (ISO 14644-1)	ISO7
Pressure	1 bar
Temperature	22.9 - 23.3 C
Humidity	22.6 - 26.7 %

## Sample preparation

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

<sup>1</sup>ISO 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)

<sup>2</sup>ISO 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)

# LIDT TEST RESULTS

## LIDT VALUE

10<sup>3</sup>-on-1

17.963  $\pm 0.052$   $\pm 0.226$  J/cm<sup>2</sup>

23.336  $\pm 0.068$   $\pm 0.293$  J/cm<sup>2</sup> (scaled to 10.0 ns)

## CHARACTERISTIC DAMAGE CURVE

Table 1: Estimated LIDTs from fitting model for sample M0082146 LOT0079750 etched.

Test mode	Threshold (Offline detection - microscopy)	Threshold (Offline detection - microscopy) scaled to 10.0 ns	Threshold (Online detection - scattering)	Threshold (Online detection - scattering) scaled to 10.0 ns
1-on-1	19.948 $\pm 0.097$ $\pm 0.439$ J/cm <sup>2</sup>	25.916 $\pm 0.126$ $\pm 0.570$ J/cm <sup>2</sup>	21.943 $\pm 0.077$ $\pm 0.349$ J/cm <sup>2</sup>	28.507 $\pm 0.101$ $\pm 0.453$ J/cm <sup>2</sup>
10-on-1	-	-	17.962 $\pm 0.057$ $\pm 0.199$ J/cm <sup>2</sup>	23.336 $\pm 0.074$ $\pm 0.259$ J/cm <sup>2</sup>
10 <sup>2</sup> -on-1	-	-	17.962 $\pm 0.055$ $\pm 0.199$ J/cm <sup>2</sup>	23.336 $\pm 0.071$ $\pm 0.259$ J/cm <sup>2</sup>
10 <sup>3</sup> -on-1	17.963 $\pm 0.052$ $\pm 0.226$ J/cm <sup>2</sup>	23.336 $\pm 0.068$ $\pm 0.293$ J/cm <sup>2</sup>	17.962 $\pm 0.054$ $\pm 0.199$ J/cm <sup>2</sup>	23.336 $\pm 0.071$ $\pm 0.259$ J/cm <sup>2</sup>

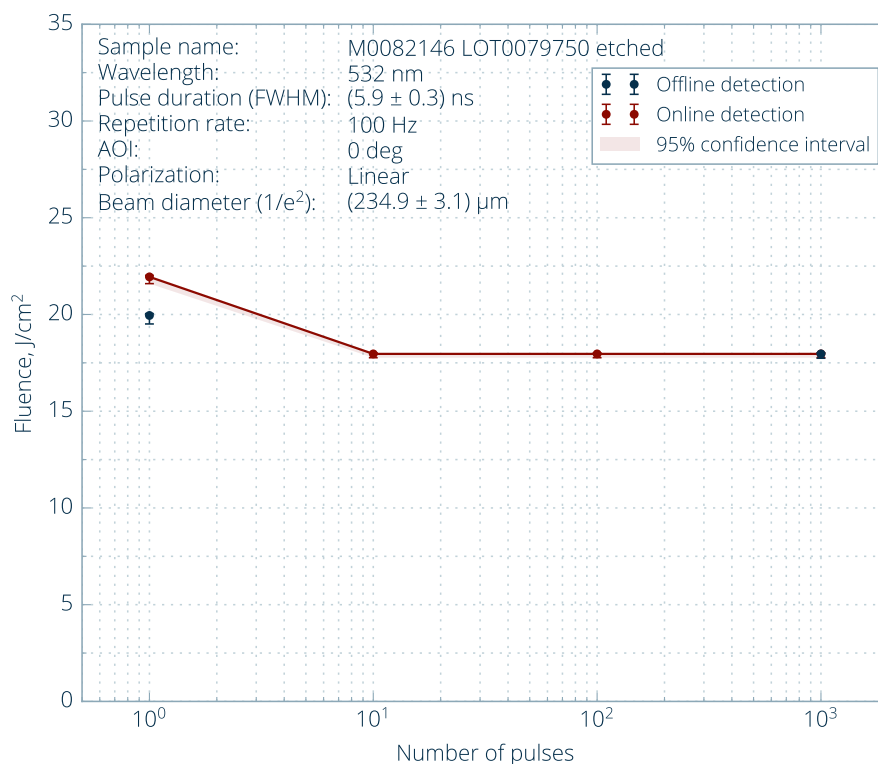
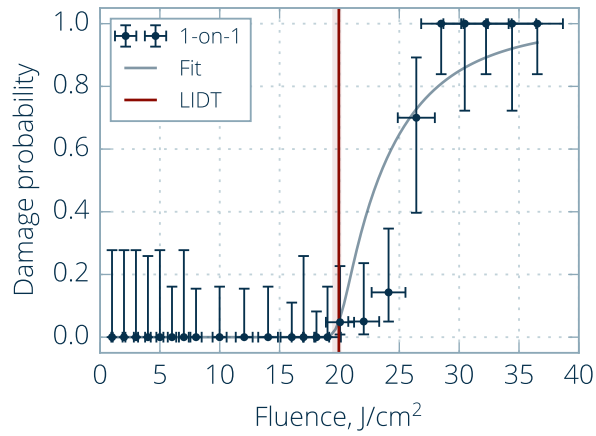
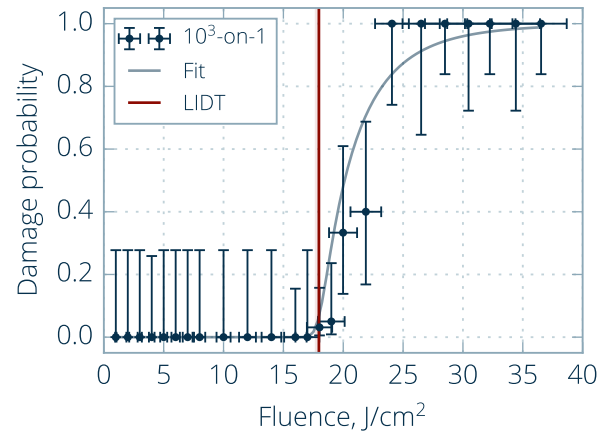


Figure 2. Characteristic damage curve.

## DAMAGE PROBABILITY (OFFLINE DETECTION)



(a) 1-on-1



(b) 10<sup>3</sup>-on-1

Figure 3. Damage probability plots.

## TYPICAL DAMAGE MORPHOLOGY (OFFLINE DETECTION)

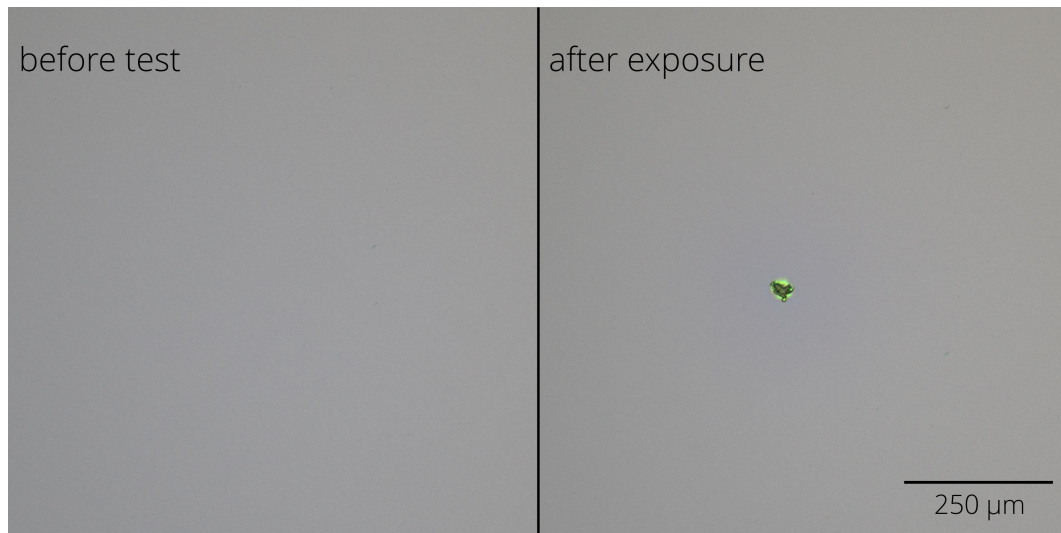
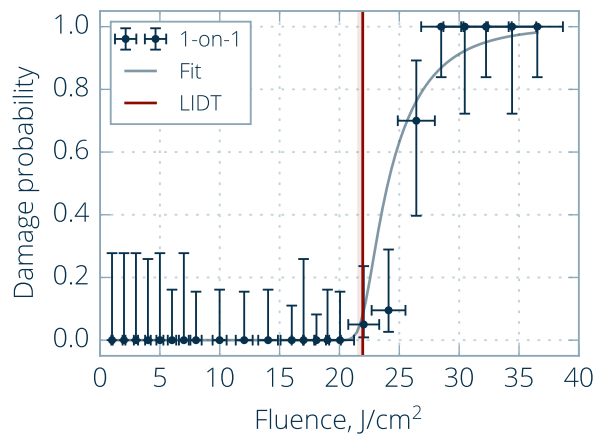


Figure 4. Typical damage morphology: fluence 18.5 J/cm<sup>2</sup>, damage after 5 pulse(s).

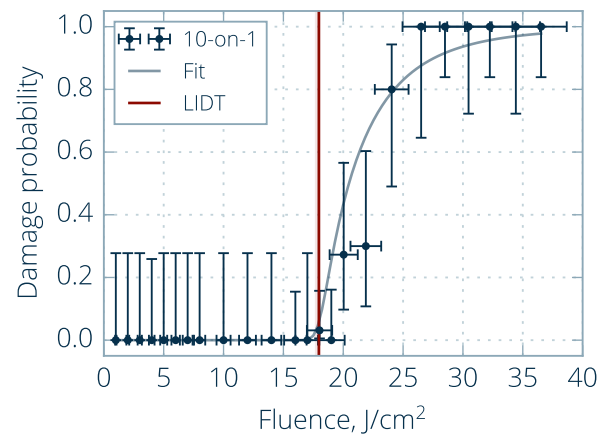


Figure 5. Typical damage morphology: fluence 19.9 J/cm<sup>2</sup>, damage after 15 pulse(s).

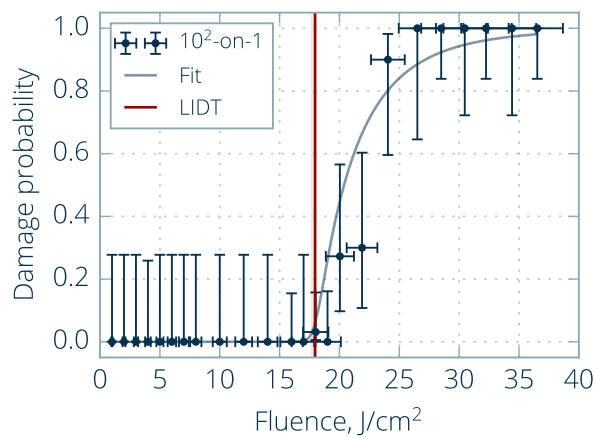
## DAMAGE PROBABILITY (ONLINE DETECTION)



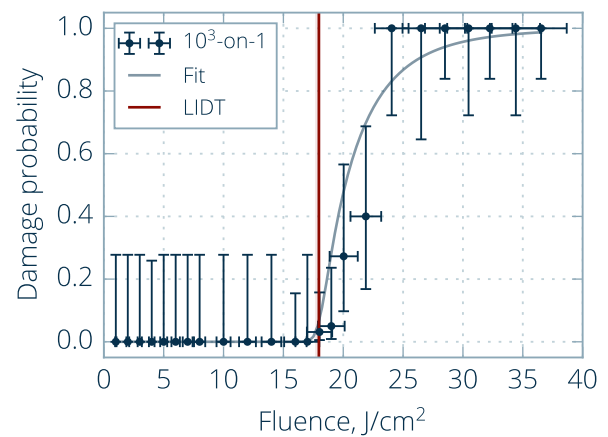
(a) 1-on-1



(b) 10-on-1



(c) 10<sup>2</sup>-on-1



(d) 10<sup>3</sup>-on-1

Figure 6. Damage probability plots.

# TECHNICAL NOTES

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## TECHNICAL NOTE 1: Back surface damage

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Back surface damage was observed exposing with more than  $22 \text{ J/cm}^2$  fluence laser radiation.