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Challenges for Laser Optics

EPIC Online Technology Meeting

Dr. Gintarė Batavičiūtė

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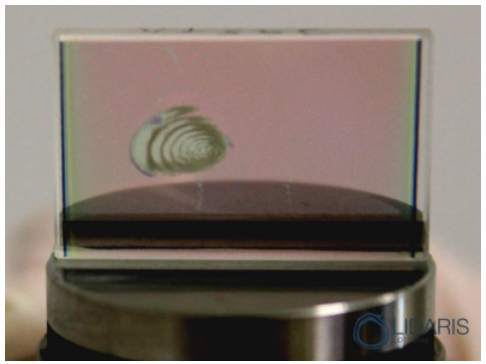
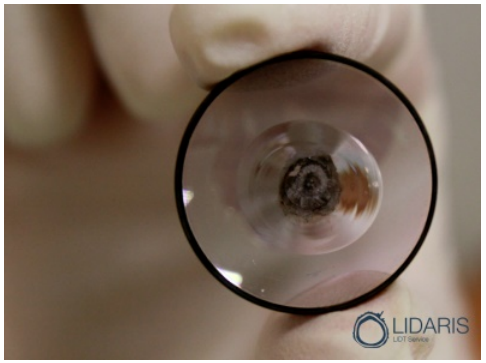
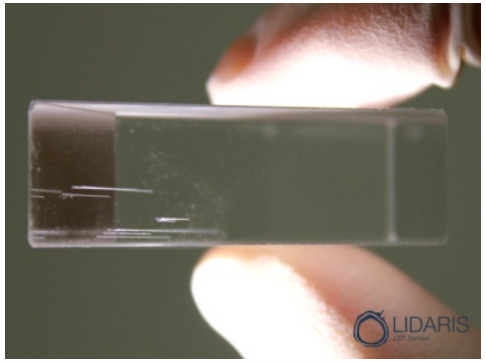
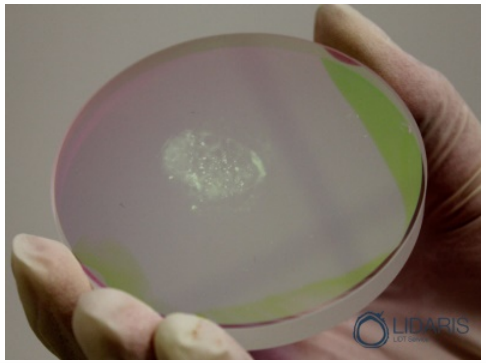
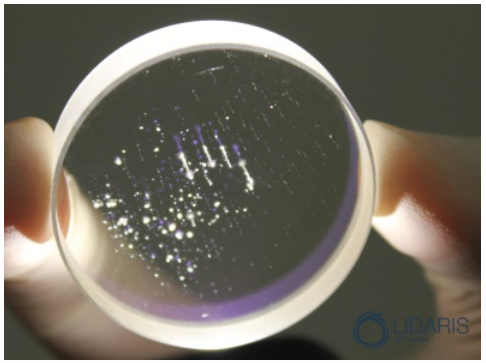
Laser – Induced Damage – a challenge for each high power optical element!

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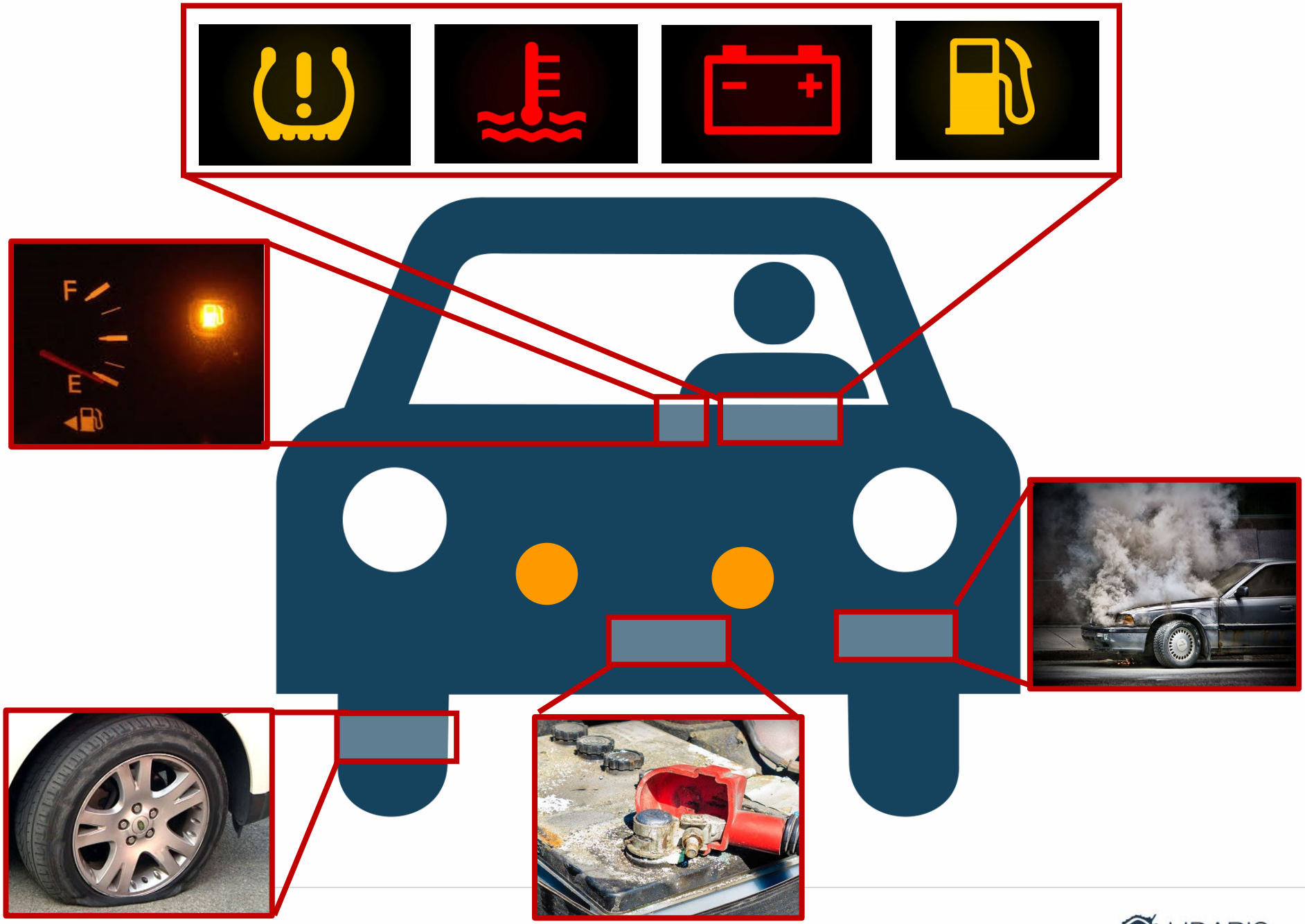
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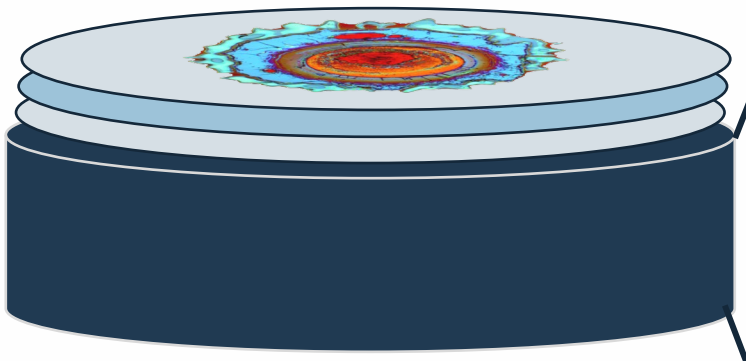
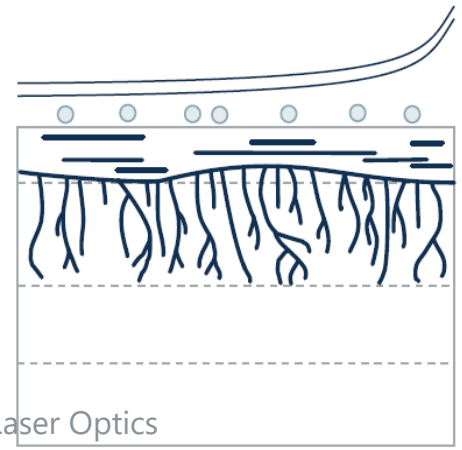
„LASER DAMAGE“ -
IS A SINGLE NAME
FOR VERY DIFFERENT PROBLEMS

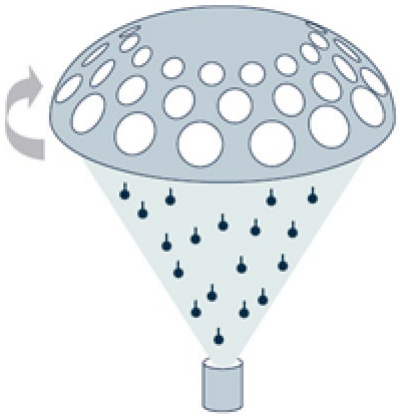


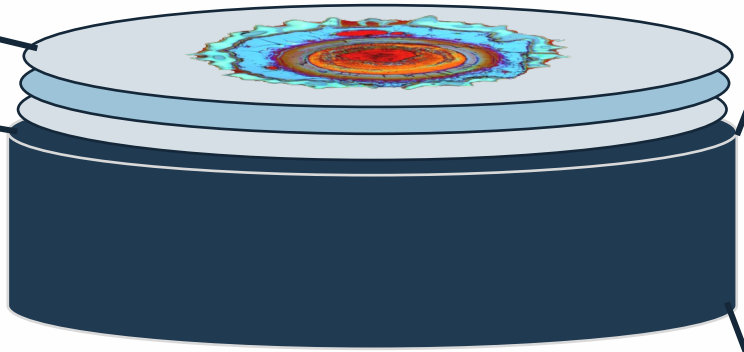
MATERIALS &
SUBSTRATE PROBLEMS



„LASER DAMAGE“ - IS A SINGLE NAME FOR VERY DIFFERENT PROBLEMS

COATING TECHNOLOGY NOT OPTIMIZED





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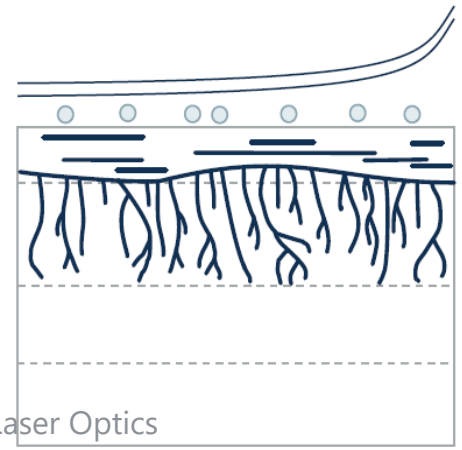

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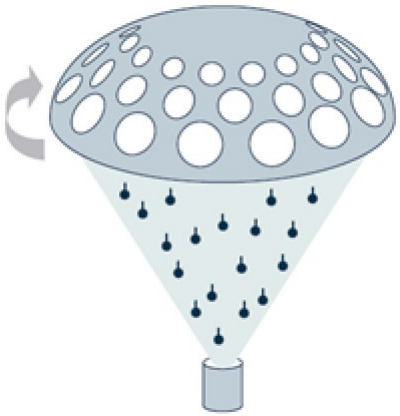
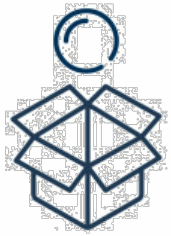
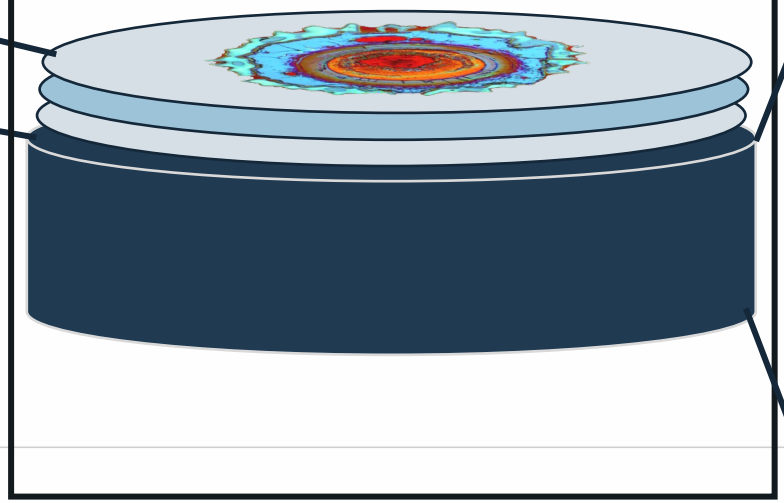


POOR HANDLING AND PACKING





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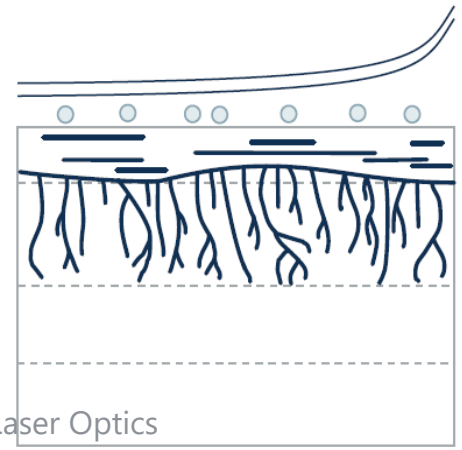

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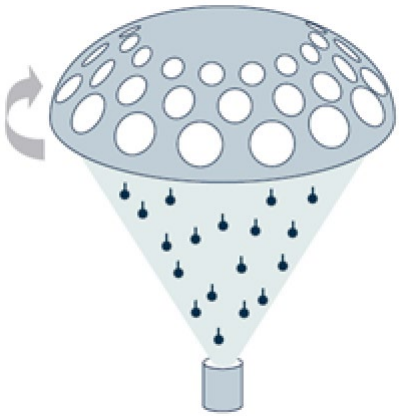

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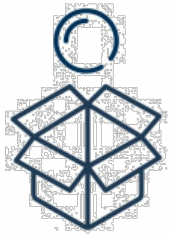
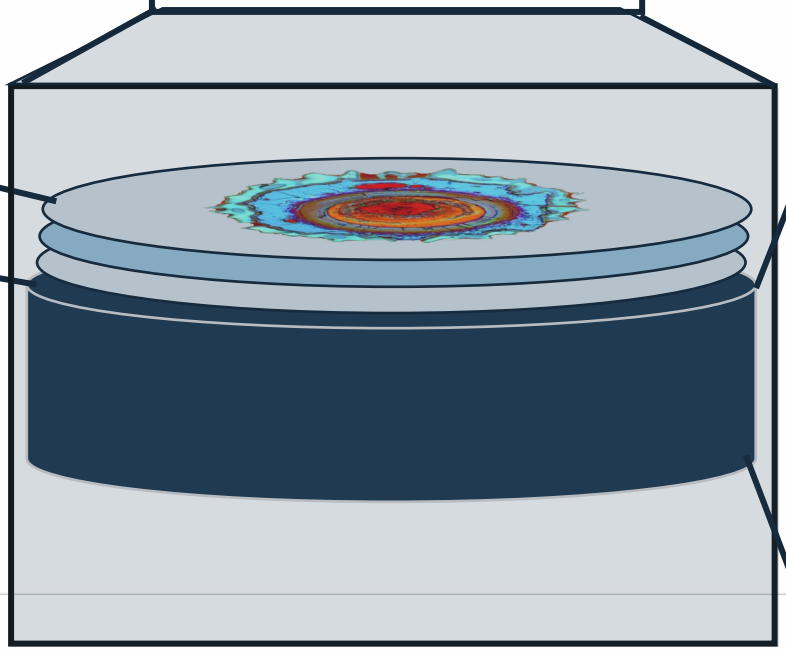


AMBIENT OPTICS OPERATE IN



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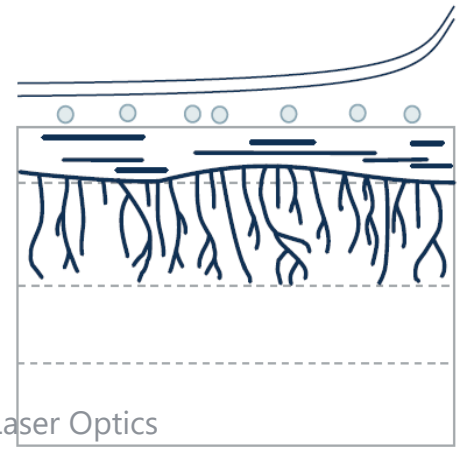
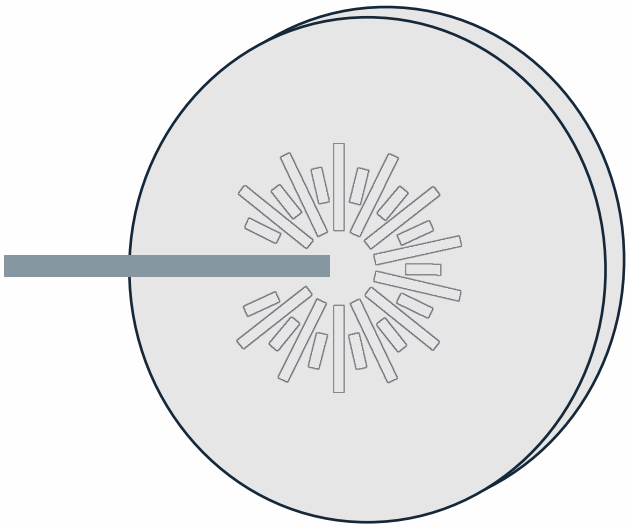


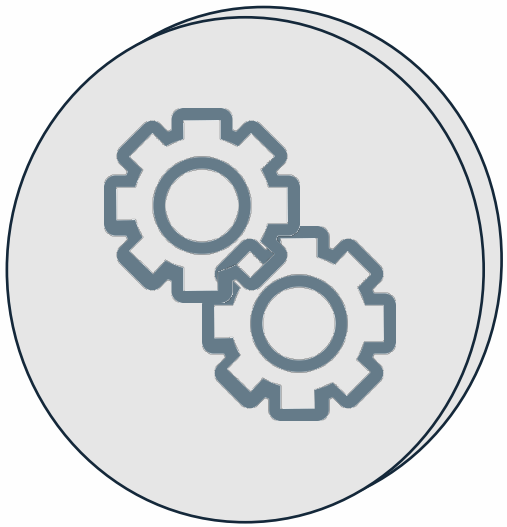
How this information could be used to overcome the challenge of laser damage?

Gain knowledge where to look!

Trial → Error + Feedback

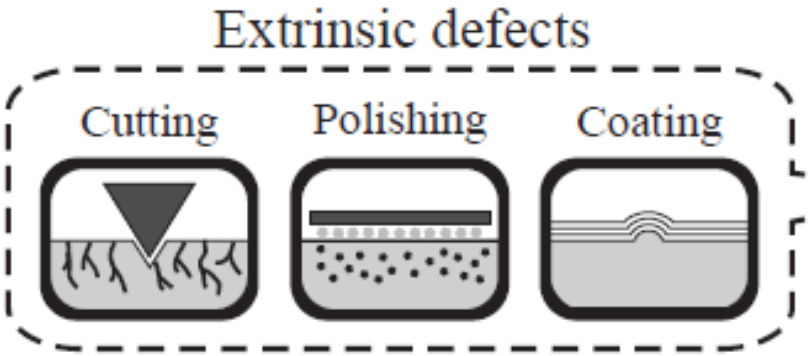


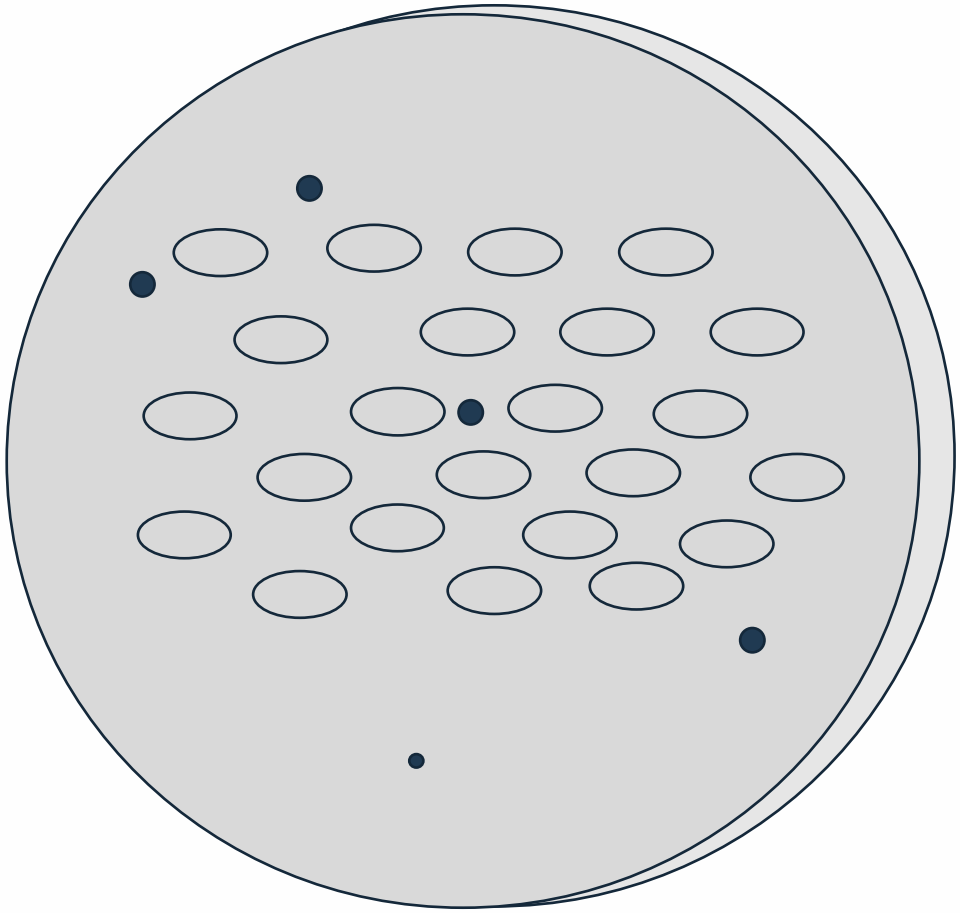
Testing: quality feedback



Parameters optimization

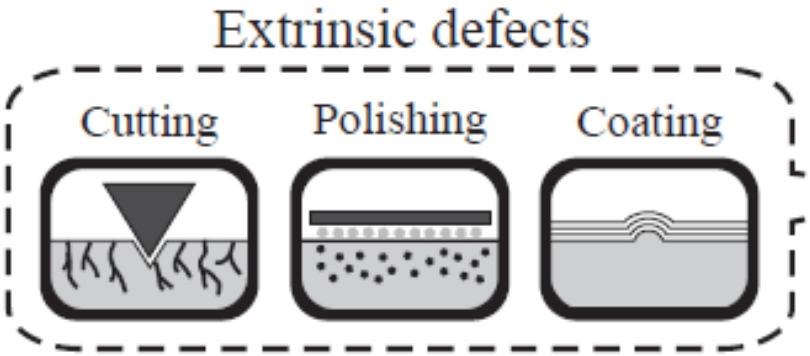
RARE DEFECT DRIVEN DAMAGE

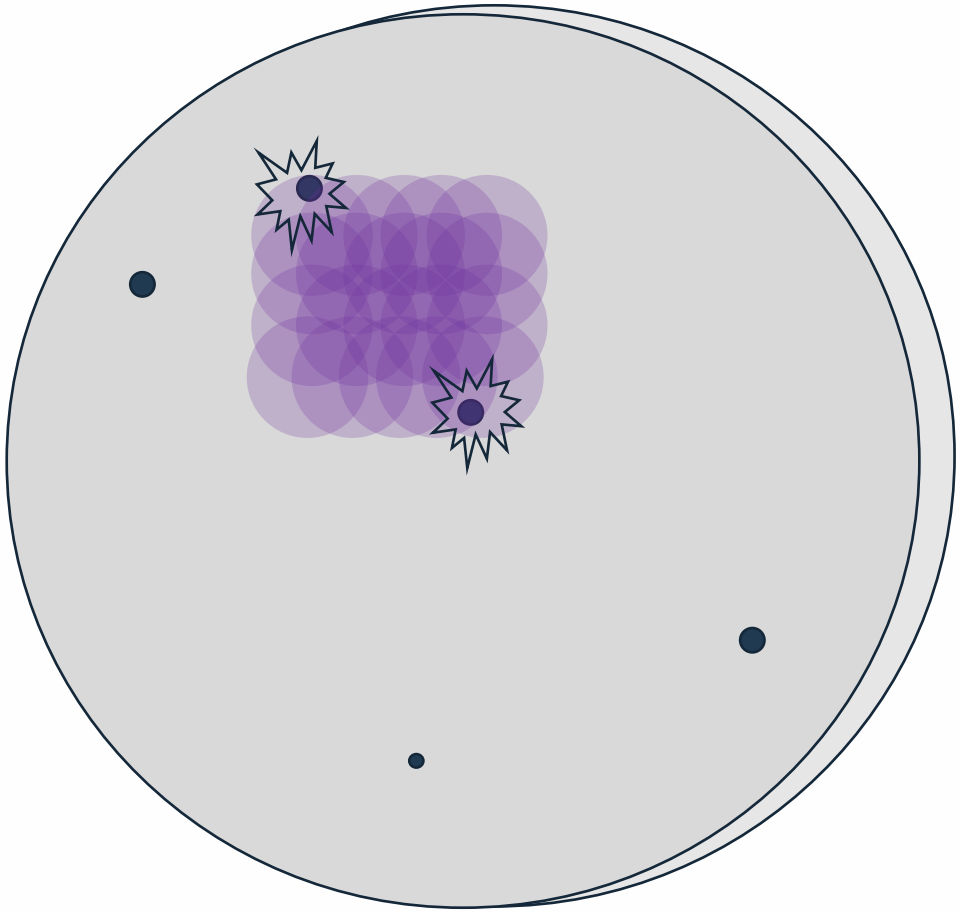




Standard statistical testing methods might not always be repeatable

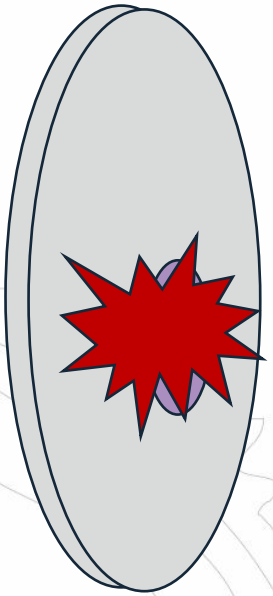
RARE DEFECT DRIVEN DAMAGE

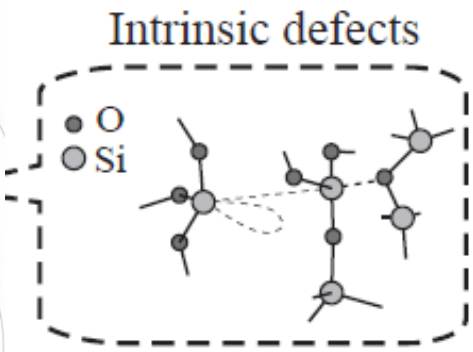


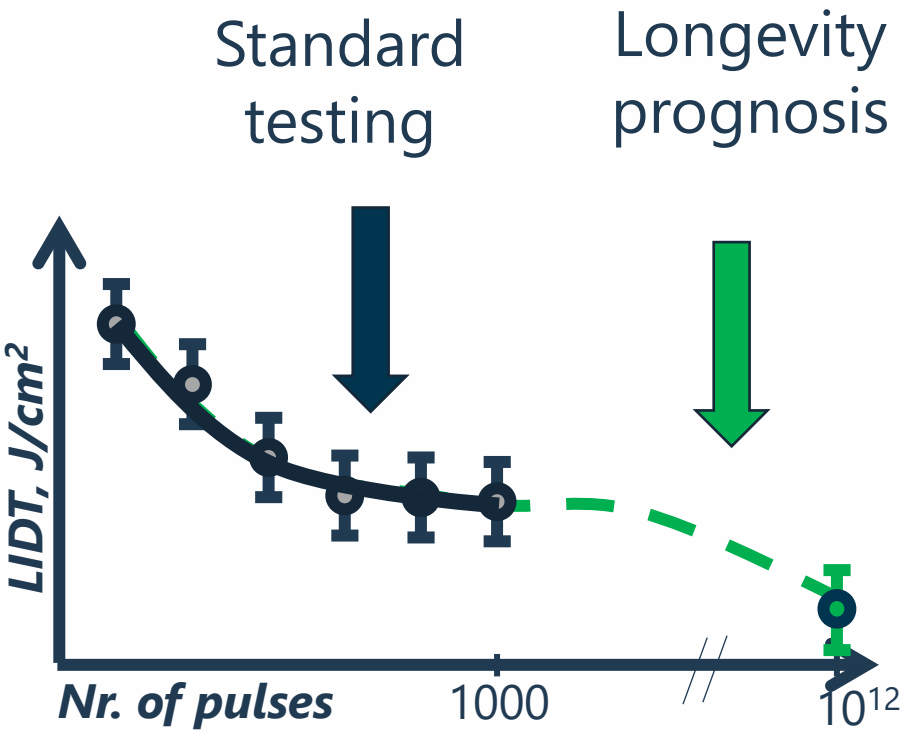


Other testing procedures such as raster scan should be applied.

FATIQUE DRIVEN DAMAGE







Lidaris – your RnD project partner

ESPRESSO

TRUST

STAR

UNIPULSE

esa

OPTOMAN

IBS HERO

Altechna

EKSPLA

Linas
Smalakys

PROJECT: UNIPULSE
1030 nm, 10kHz, 500fsm

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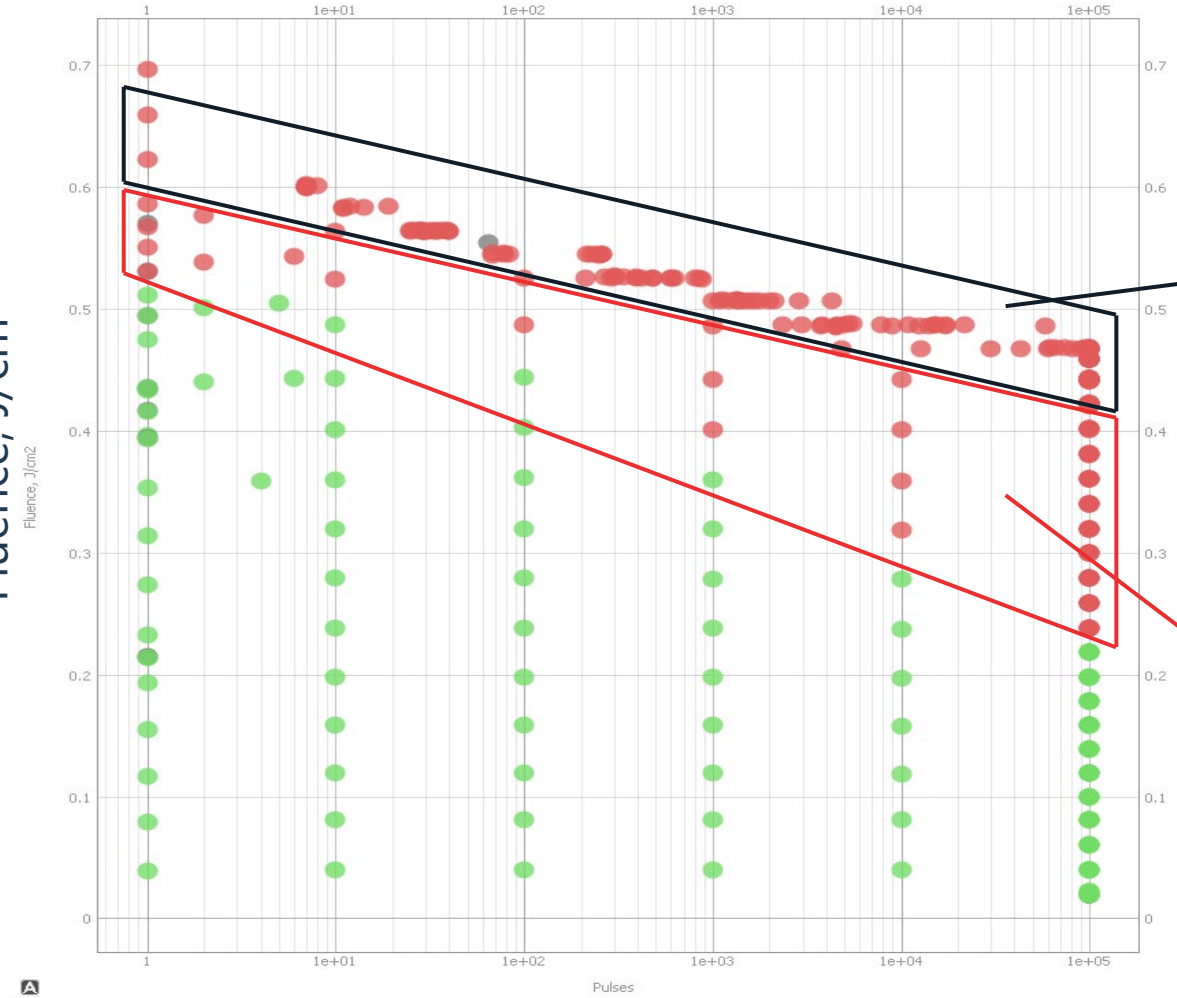
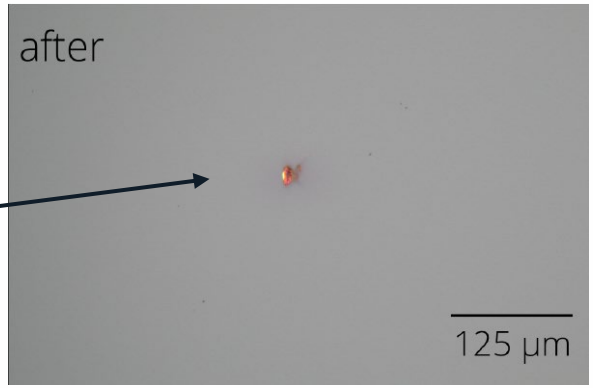
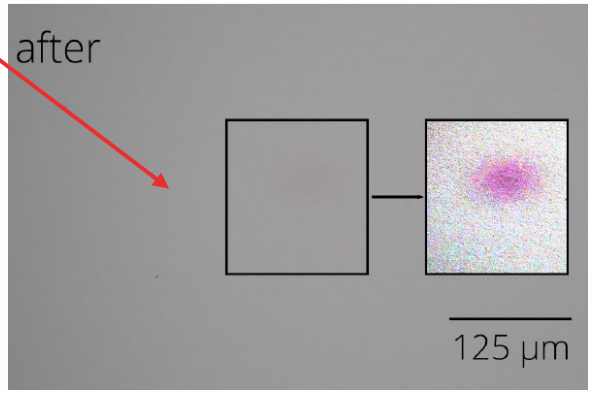
OPTOMAN
IBS HERO



Catastrophic mode



Color change mode



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Linas
Smalakys

PROJECT: UNIPULSE
1030 nm, 10kHz, 500fsm

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OPTOMAN
IBS HERO

Fitted lognormal distributions: mean ± 3 standard deviations

Catastrophic
Color change

Fluence, J/cm^2

0.0
0.1
0.2
0.3
0.4
0.5
0.6

10^2 10^3 10^4 10^5 10^6 10^7 10^8

Pulses

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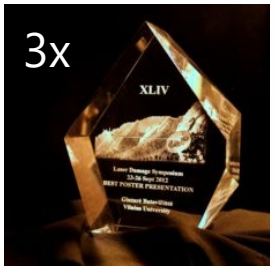
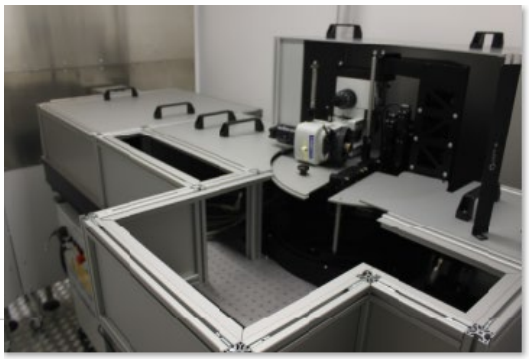
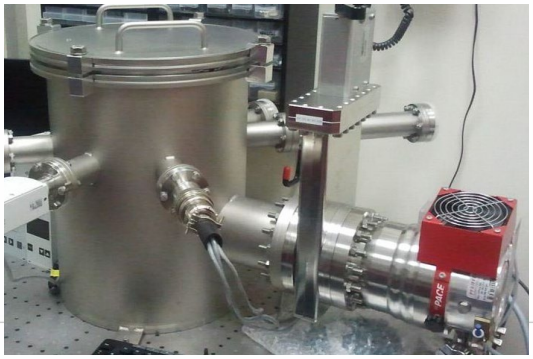
LASER DAMAGE TESTING SERVICE

serve over 130 optics companies



3x time awarded at SPIE





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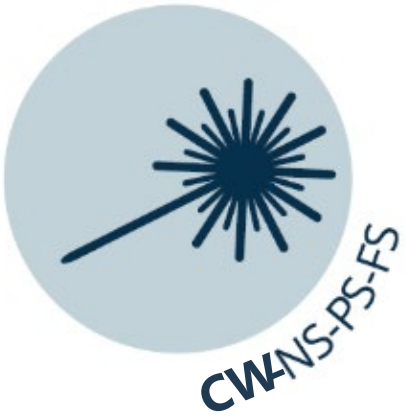
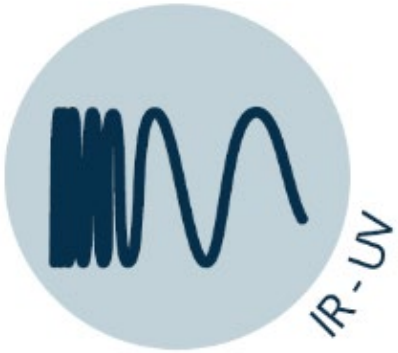
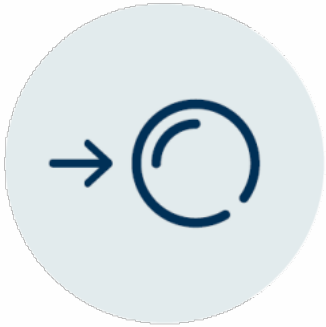
WHAT WE CAN DO AT LIDARIS

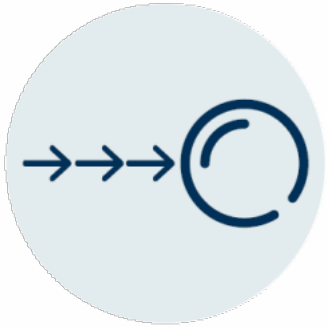
Wide assortment of LIDT testing condition

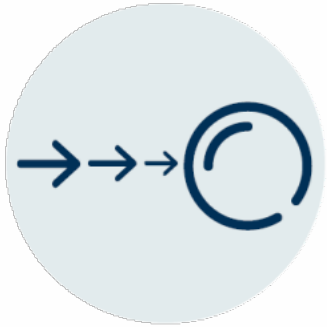


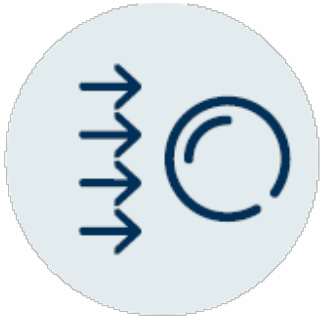


1-ON-1 **S-ON-1** **R-ON-1** **Certification** **Raster Scan**

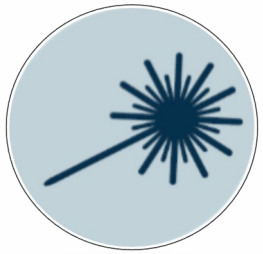




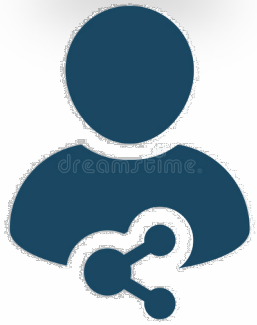




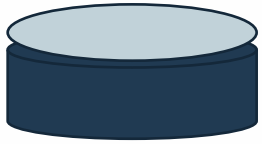
WHAT YOU CAN DO FOR US



Routine testing of the optical elements



Share your LIDT problems: DOE approach to optimize their optical elements, understanding specific cases, RnD possibilities



Stable lasers, quality optical elements

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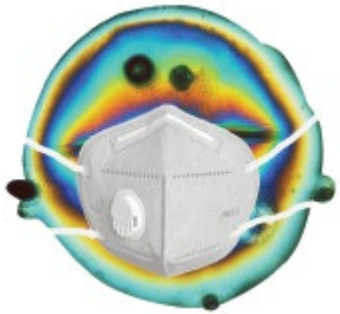
THANK YOU FOR YOUR ATTENTION!



CONTACT US
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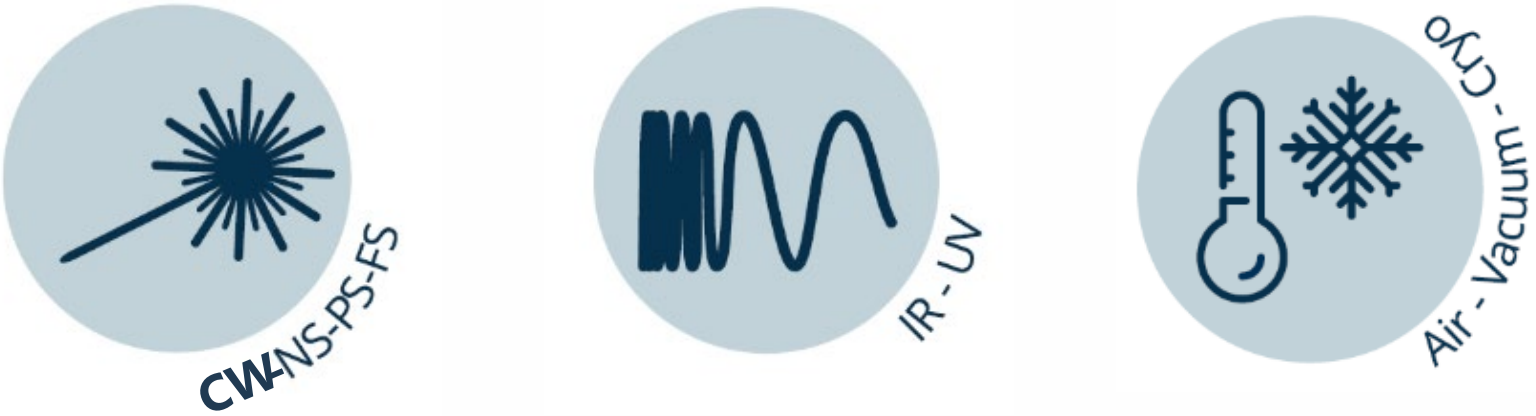
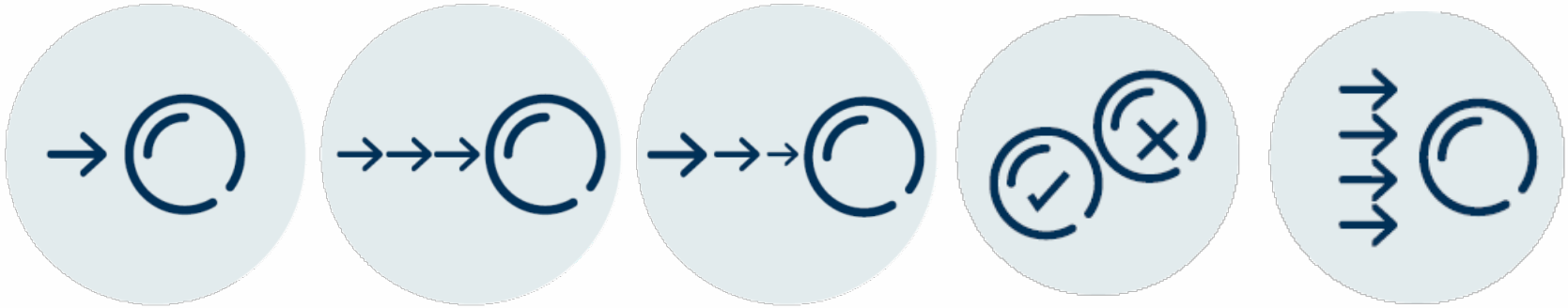
ALL TESTING AT ONE PLACE!



WIDE ASSORTMENT OF LIDT TEST CONDITIONS

ALL TESTING AT ONE PLACE!

1-ON-1 **_S_-ON-1** **_R_-ON-1** **Certification** **Raster Scan**



WIDE ASSORTMENT OF LIDT TEST PROCEDURES

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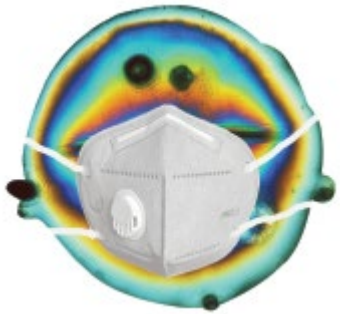
THANK YOU FOR YOUR ATTENTION!



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Vienas is challenge yra pazeidimas
Pazeidimas suprntamas per siautai: kaip vienas kaicius

Pazeidimas gali buti nulemtas defektu arba senejimo: degradavimo

Lidaris supranta tokias problemas ir gali padeti jums panaudoti tas zinias

Projketas su optoman del ilgalaiskiskumo

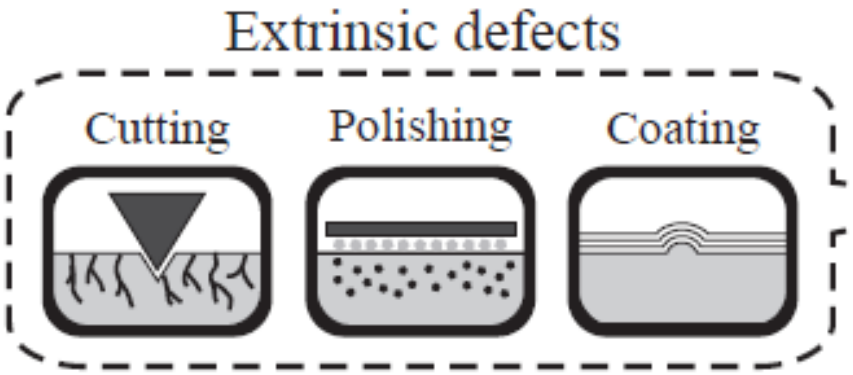
Ka galima daryti tokiais: atvejais?

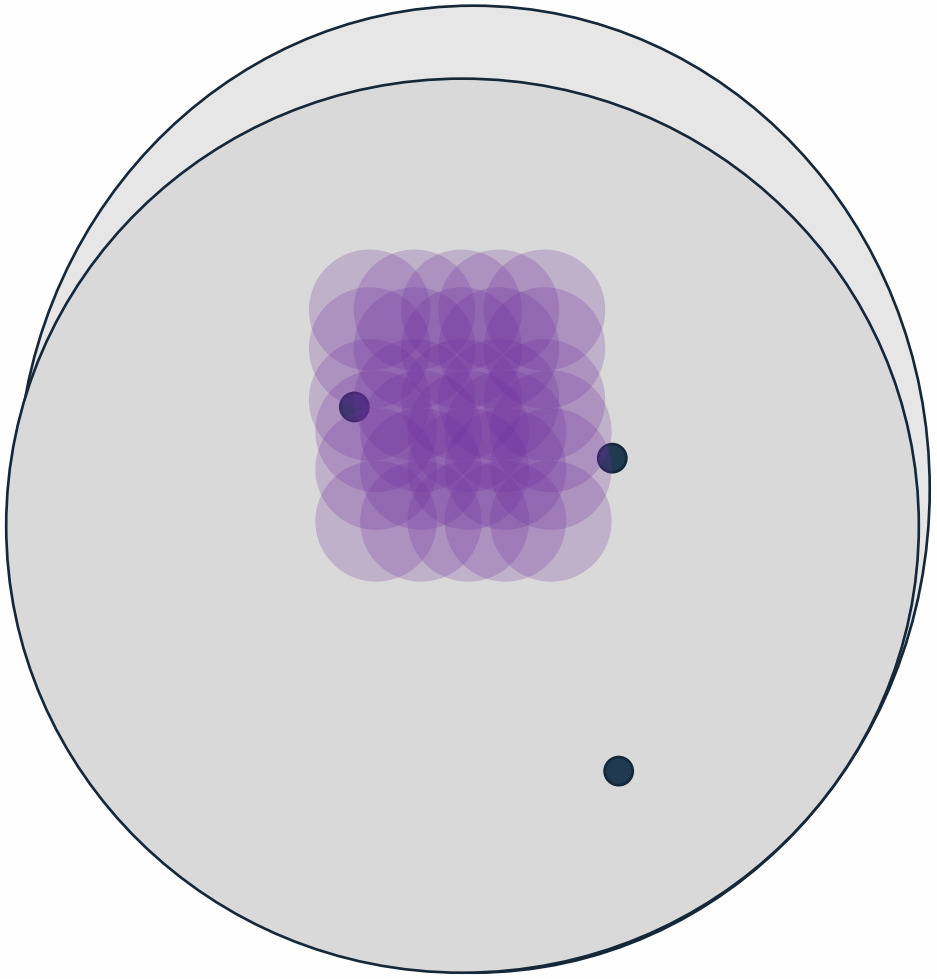
Galima gerintitevhnologijas, bet tam reikai gero griztamojo rysio

Jei svarbu sneejimas: tada prognozavimas

Jei dirbama su didesliu apreturu optika: defektu gaudymas (raster scan)

SPACE: defect driven damage





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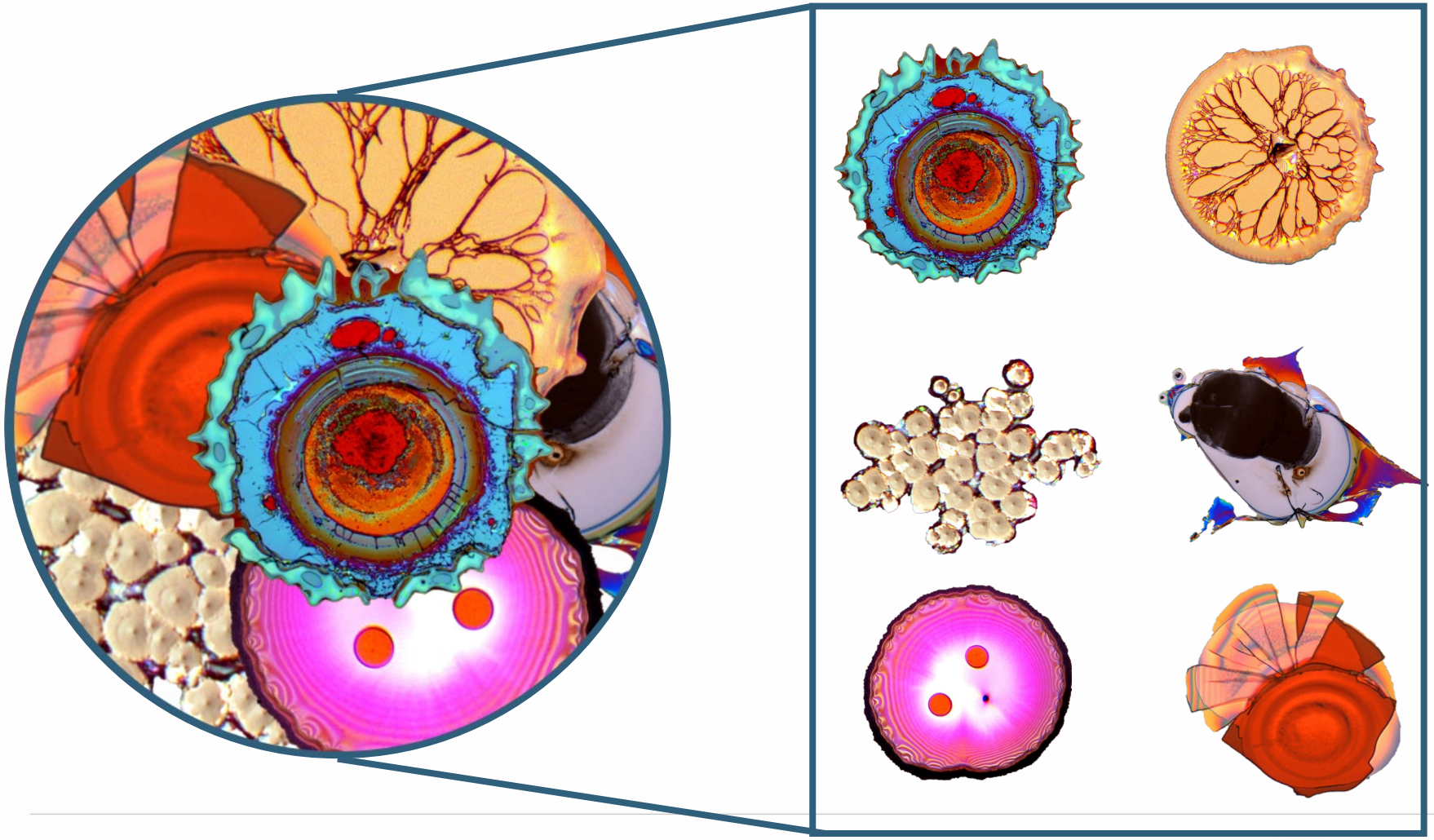
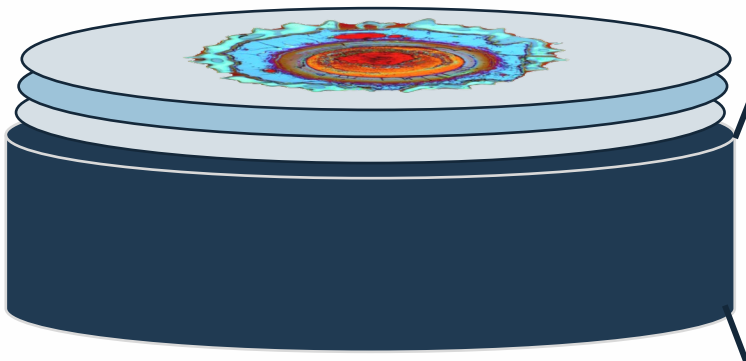
IS A SINGLE NAME
FOR VERY DIFFERENT PROBLEMS

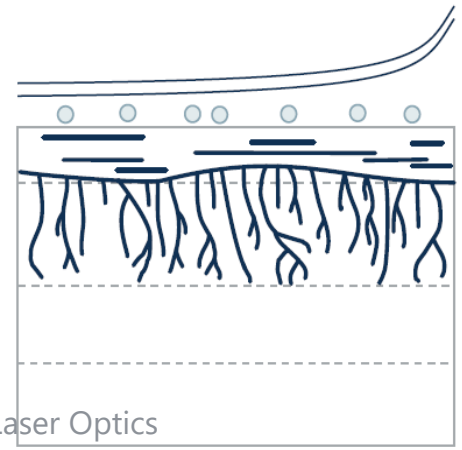


LIDARIS
LIDT Service

„LASER DAMAGE“ -
IS A SINGLE NAME
FOR VERY DIFFERENT PROBLEMS

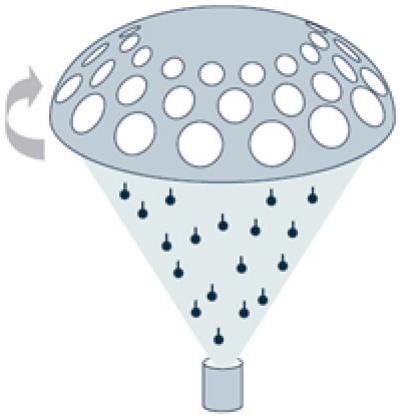


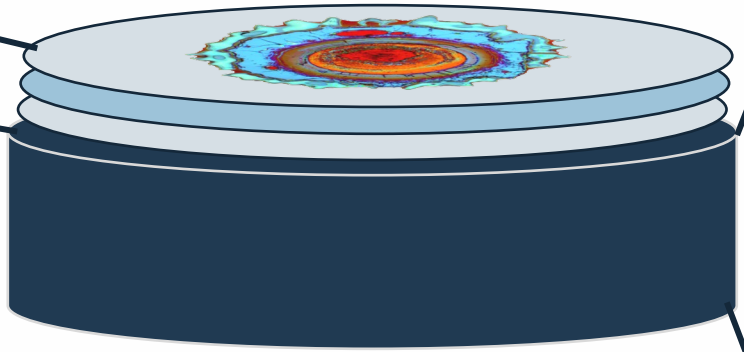
MATERIALS &
SUBSTRATE PROBLEMS



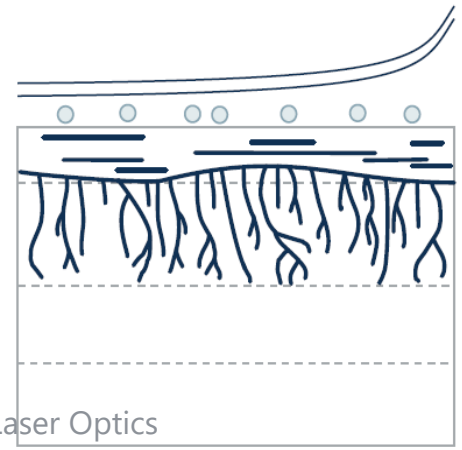
„LASER DAMAGE“ - IS A SINGLE NAME FOR VERY DIFFERENT PROBLEMS

COATING TECHNOLOGY NOT OPTIMIZED





MATERIALS & SUBSTRATE PROBLEMS



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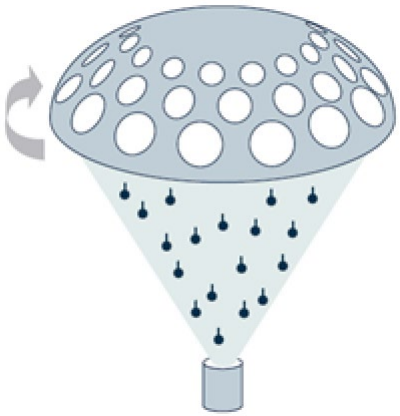
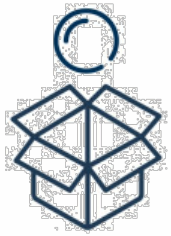
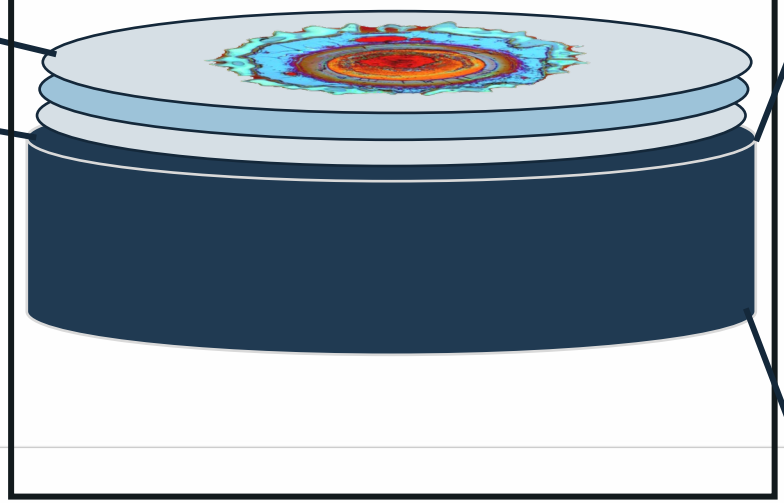
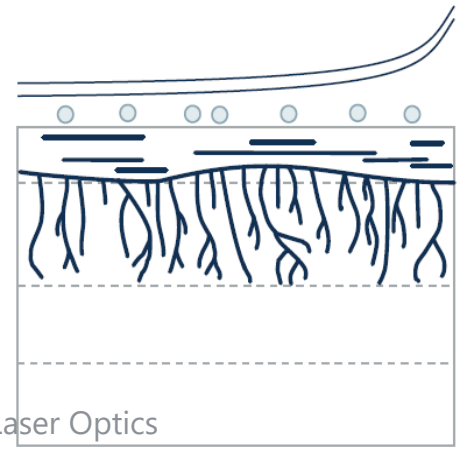


POOR HANDLING AND PACKING





MATERIALS & SUBSTRATE PROBLEMS



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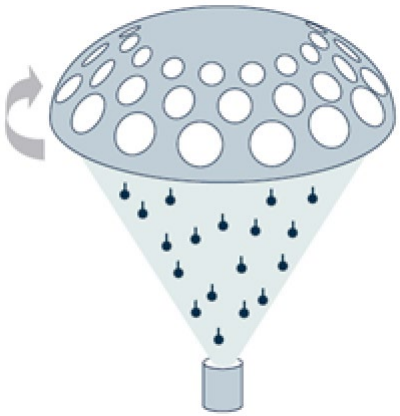
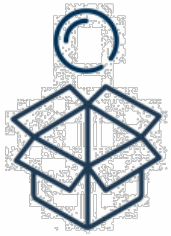
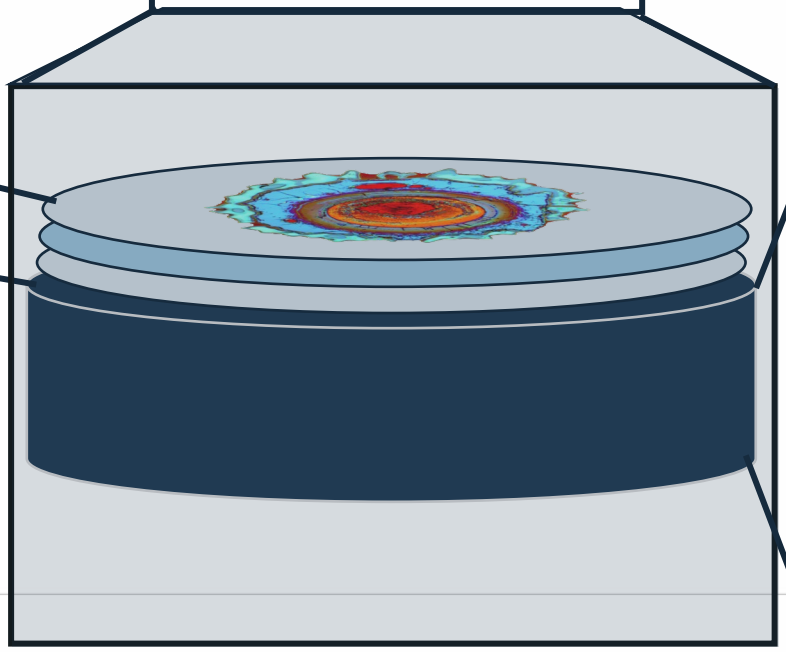


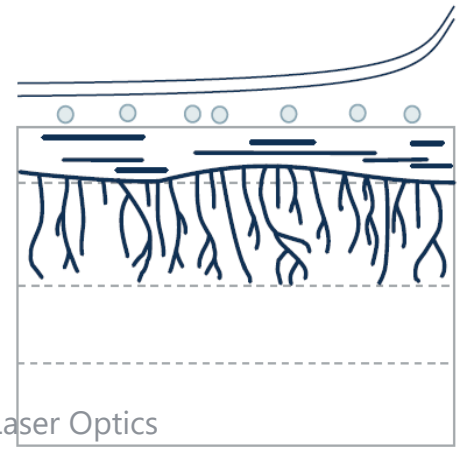
POOR HANDLING AND PACKING



AMBIENT OPTICS OPERATE IN



MATERIALS & SUBSTRATE PROBLEMS



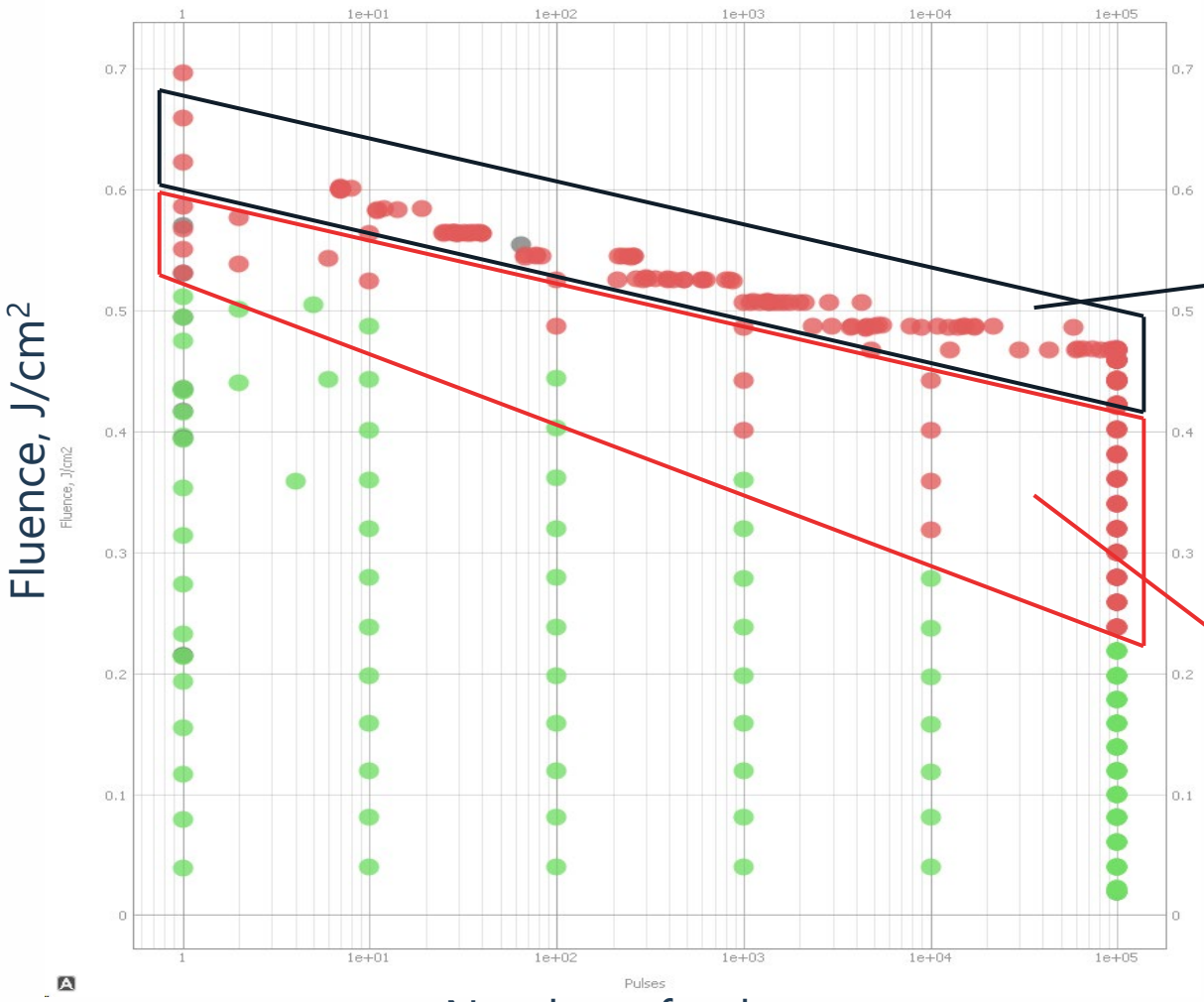
How does this affect LIDT testing?

OPTOMAN

IBS HERO

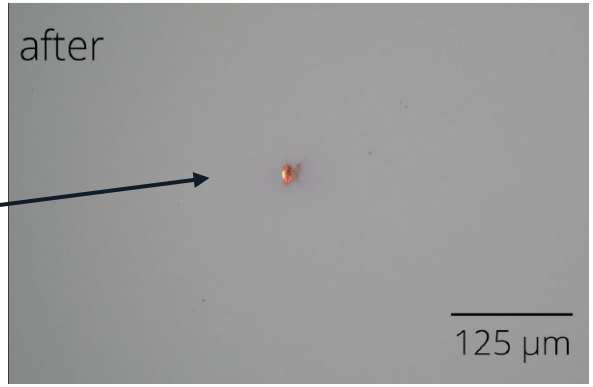
PROJECT: UNIPULSE
1030 nm, 10kHz, 500fsm

Linas Smalakys

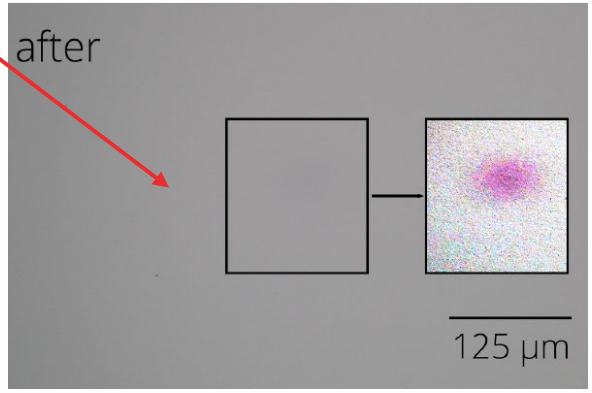


Number of pulses

Catastrophic mode



Color change mode



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IBS HERO

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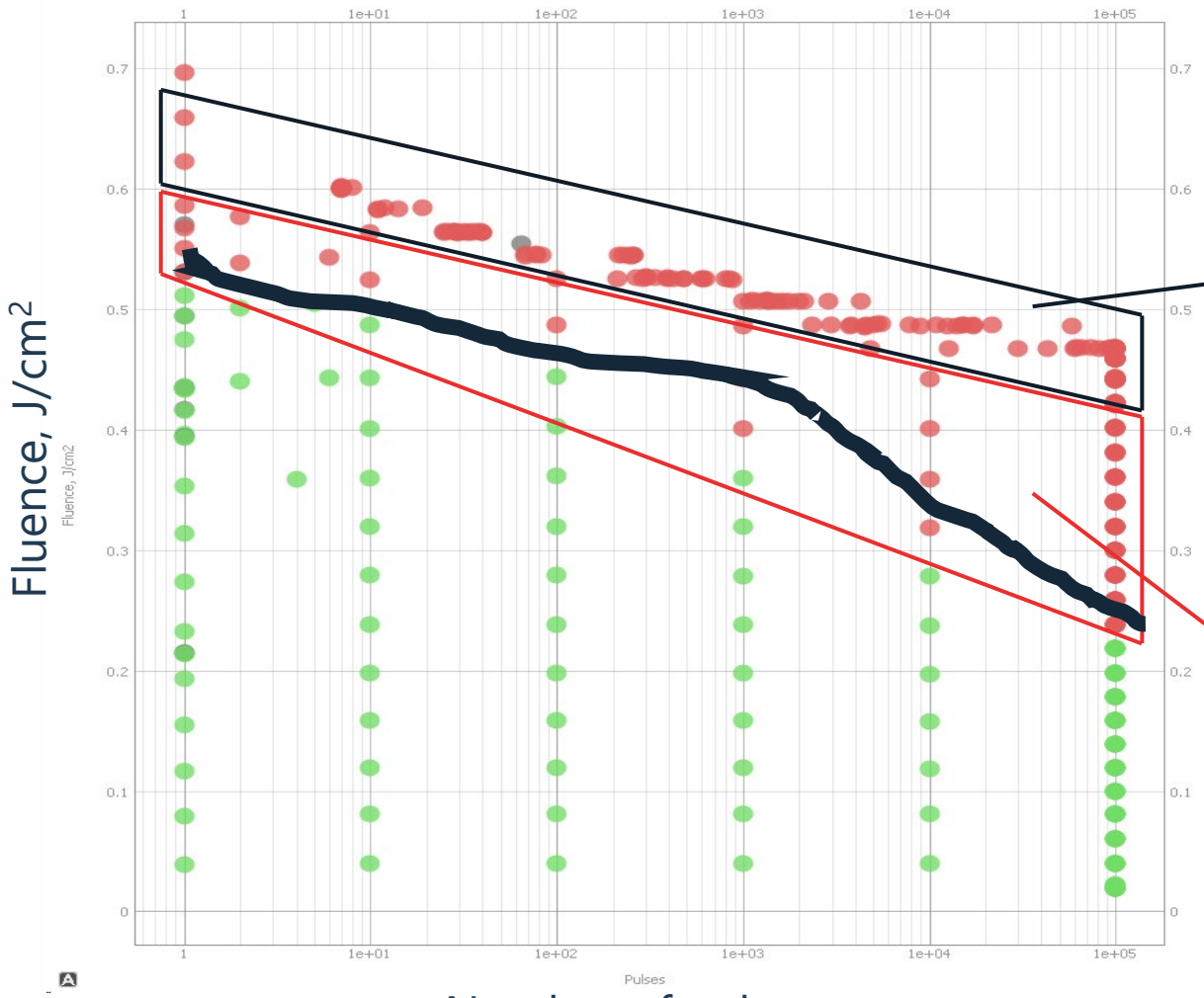
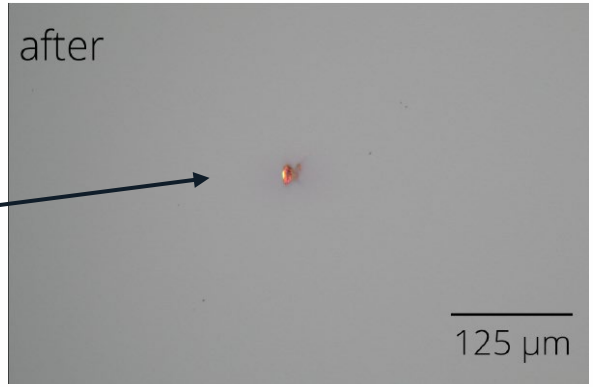
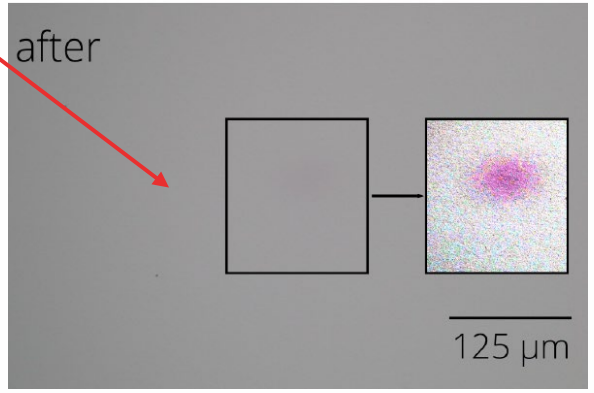
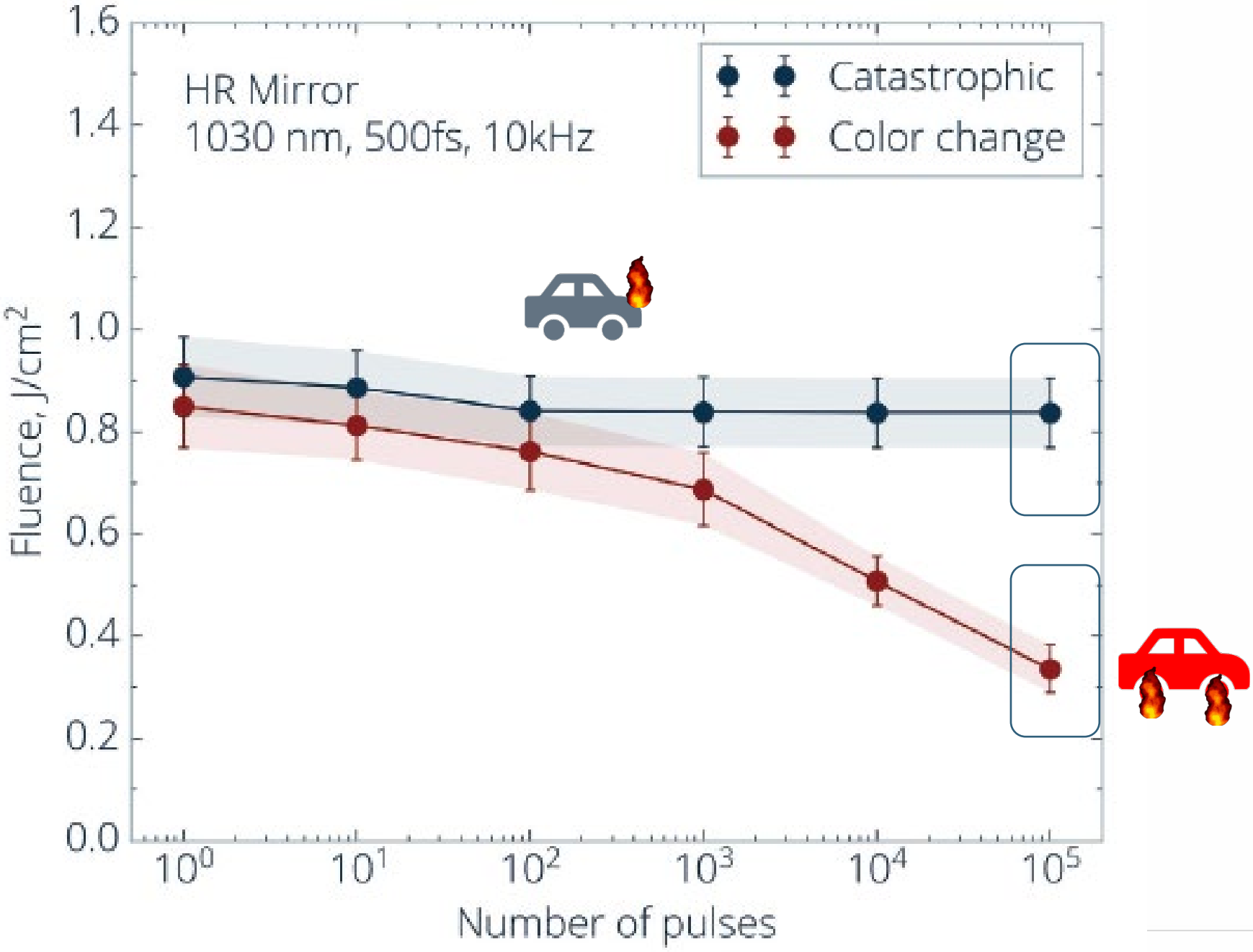


Catastrophic mode

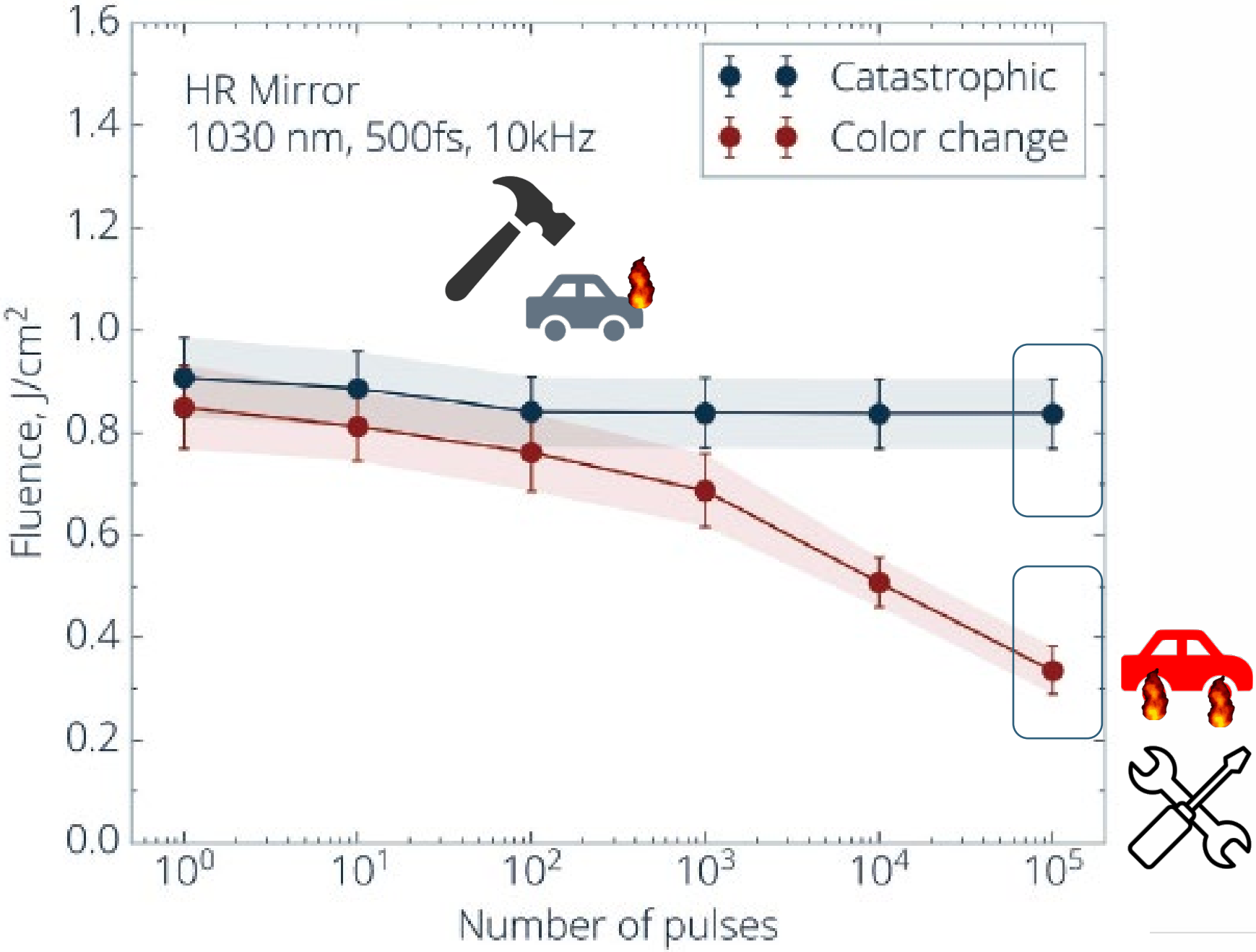


Color change mode

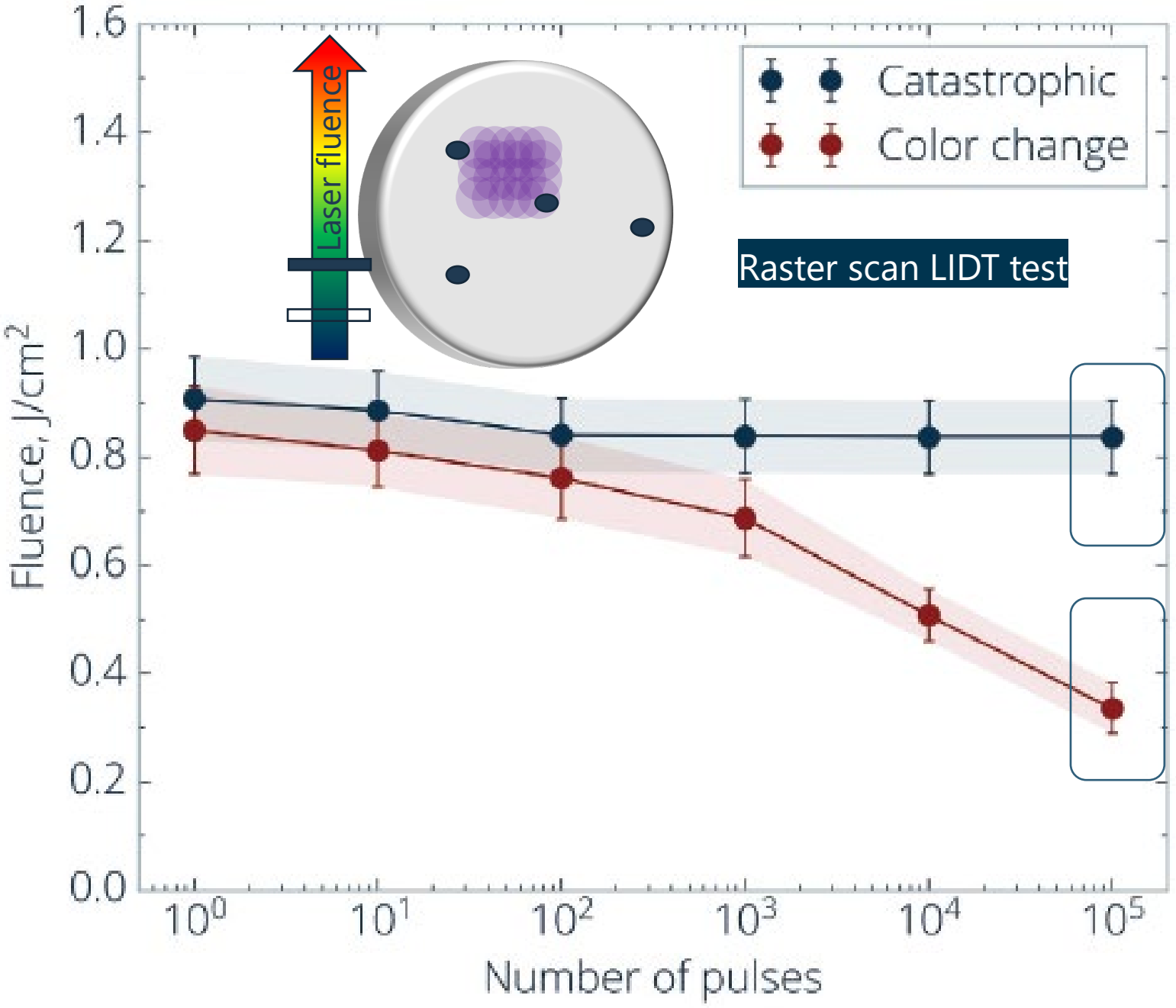




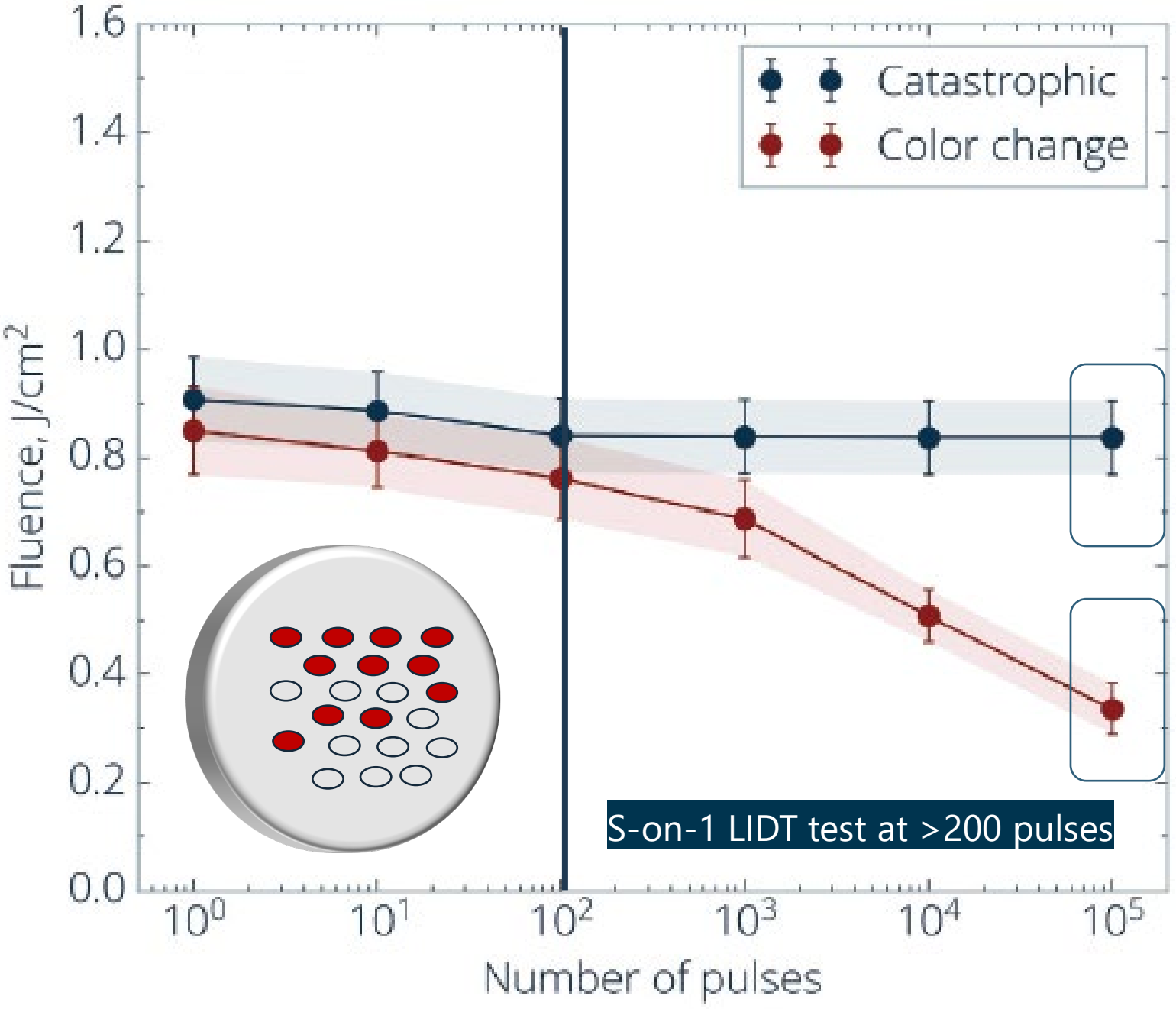
LIDARIS
LIDT Service



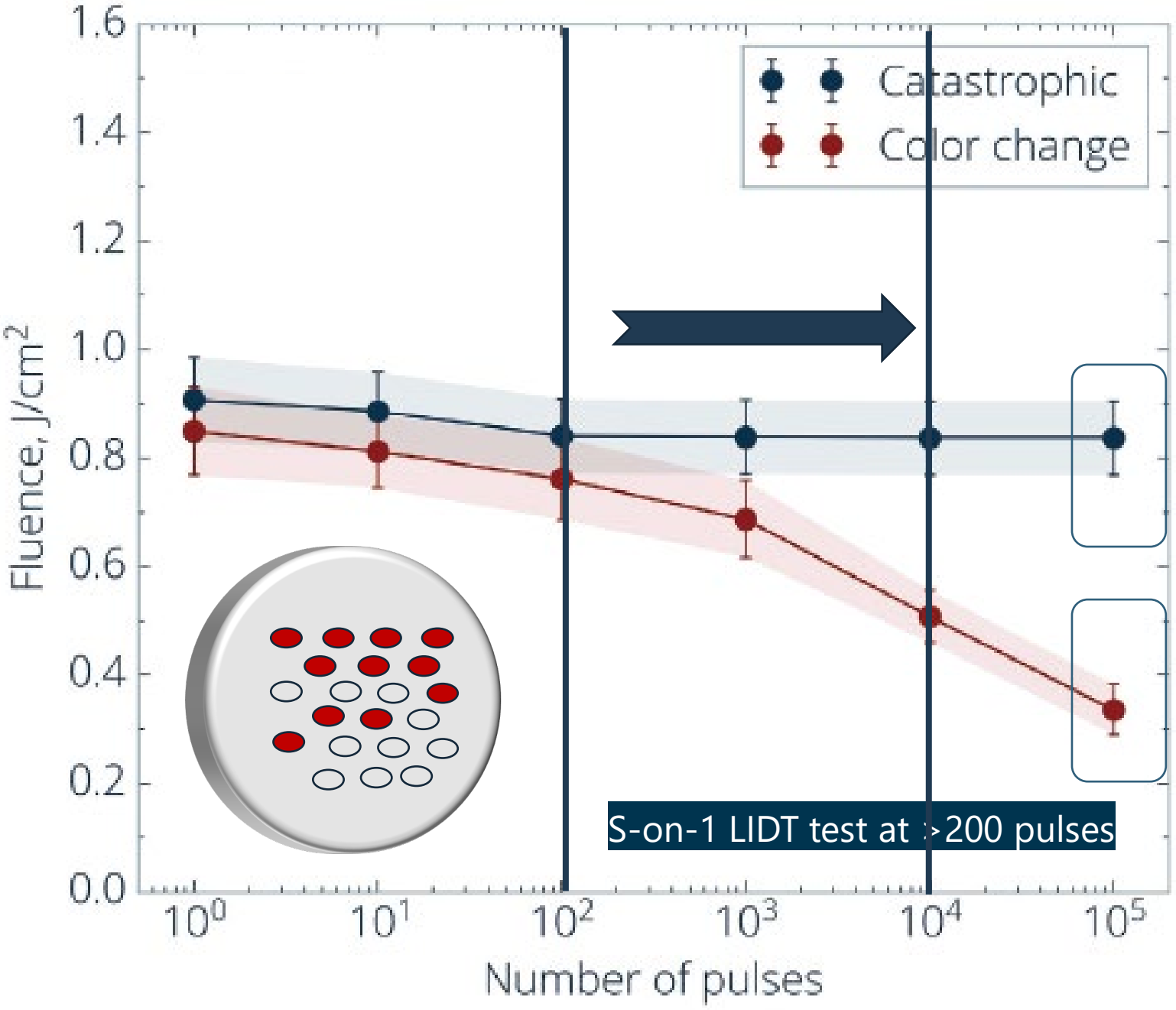
LIDARIS
LIDT Service



LIDARIS
LIDT Service

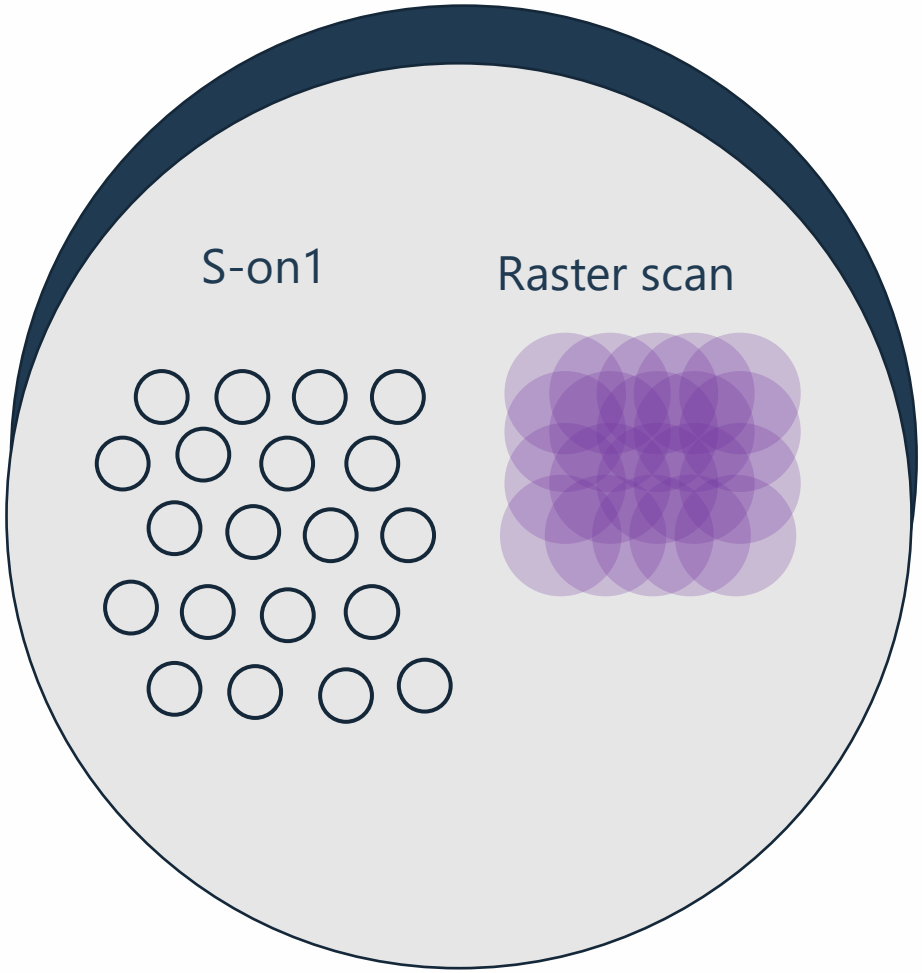


LIDARIS
LIDT Service



LIDARIS
LIDT Service

Messages to take home

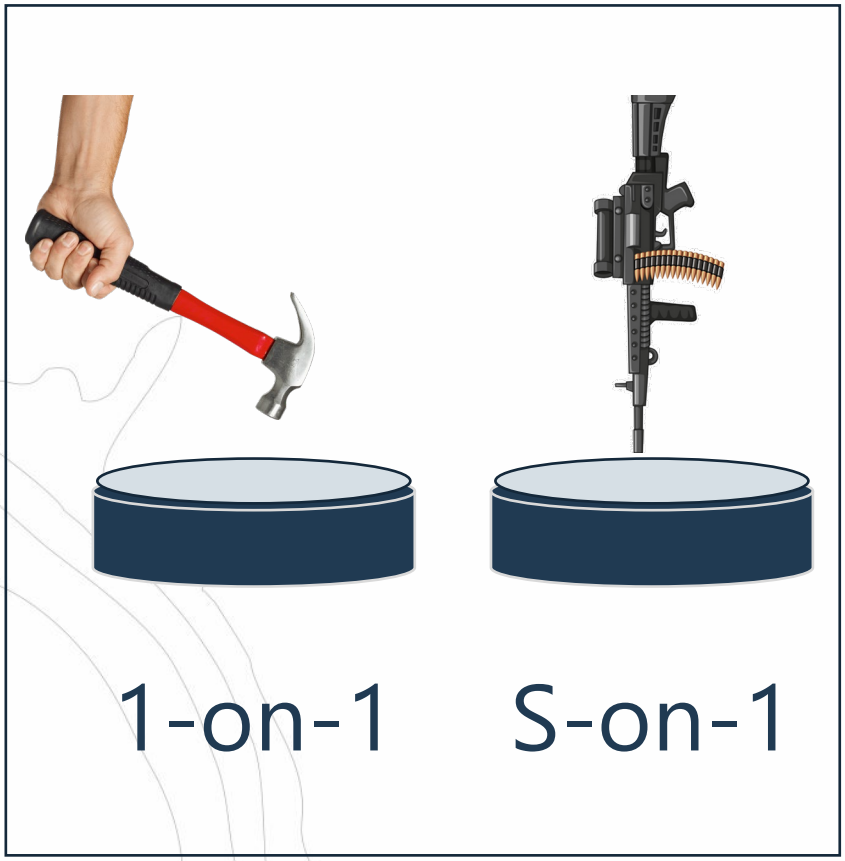


1 Combined laser damage testing

Find a trusted partner so solve laser damage issue

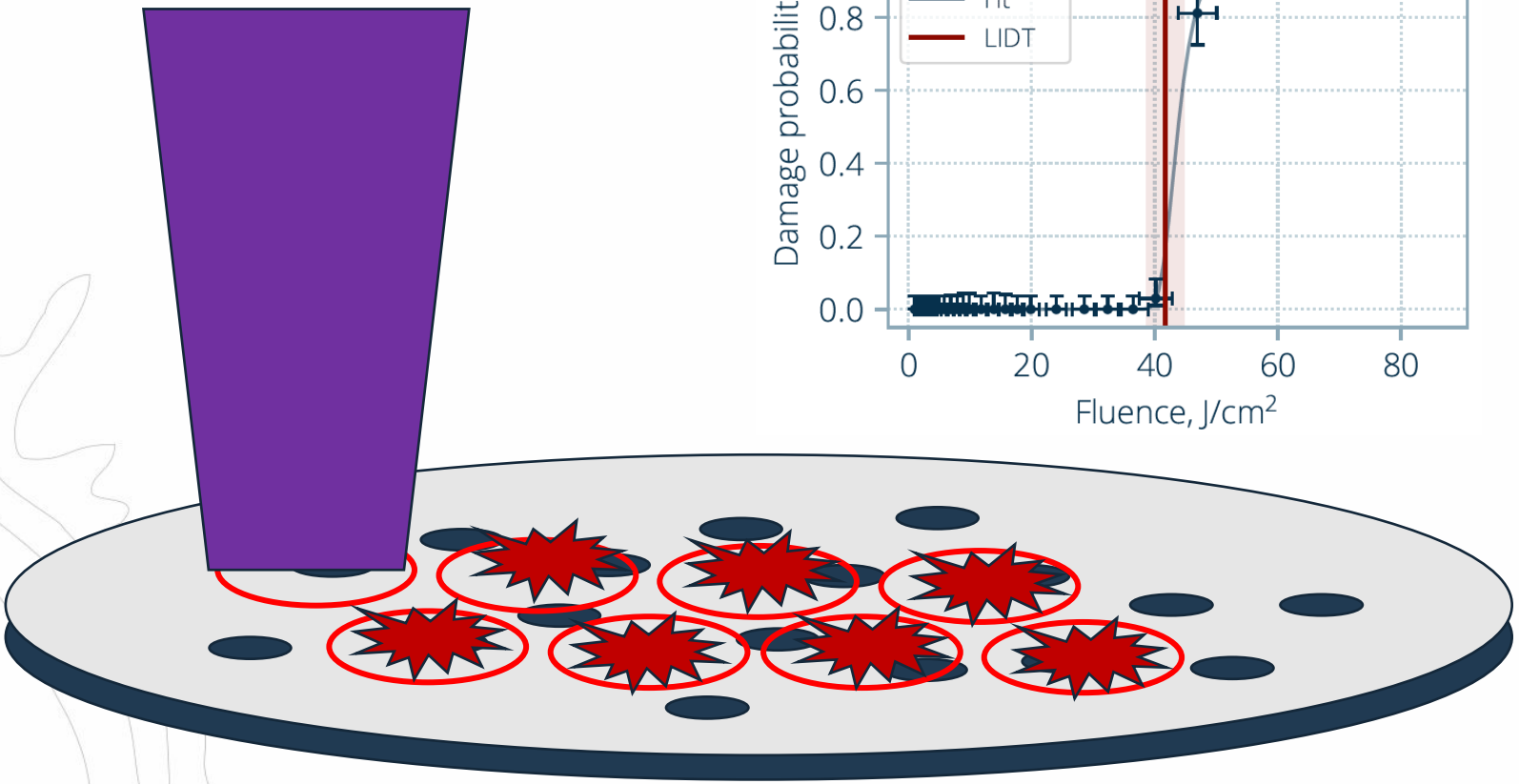
LIDARIS
LIDT Service

THERE ARE DIFFERENT WAYS HOW TO BREAK OPTICAL ELEMENT



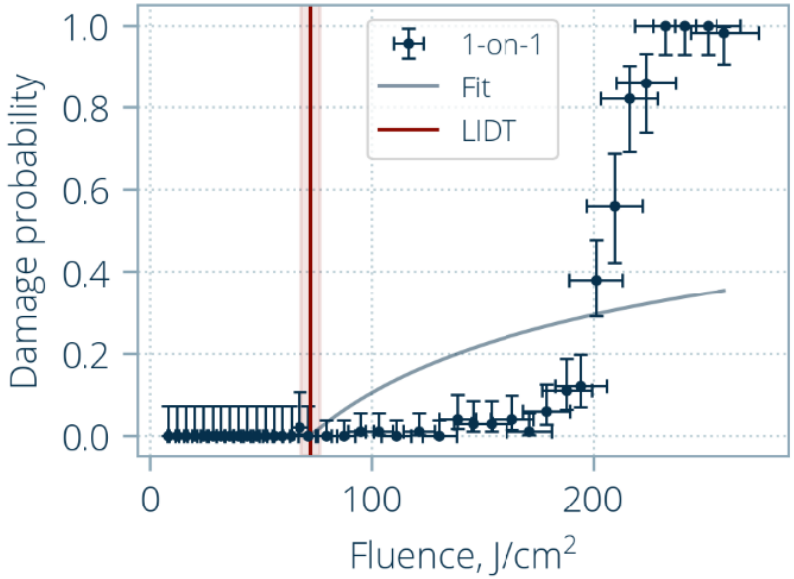
LIDARIS
LIDT Service

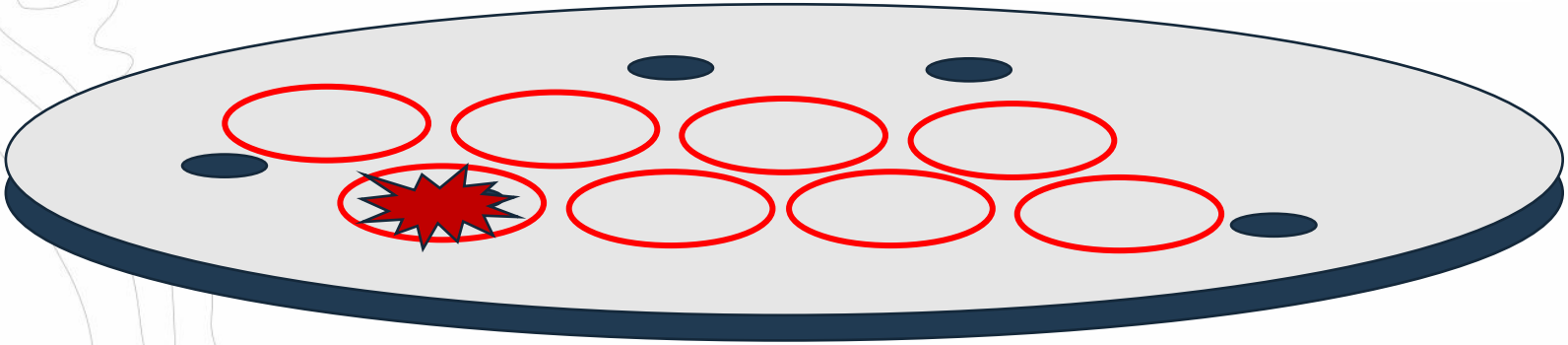
Laser damage characterization



LIDARIS
LIDT Service

Laser damage characterization





LIDARIS
LIDT Service

THERE ARE DIFFERENT WAYS HOW TO BREAK OPTICAL ELEMENT

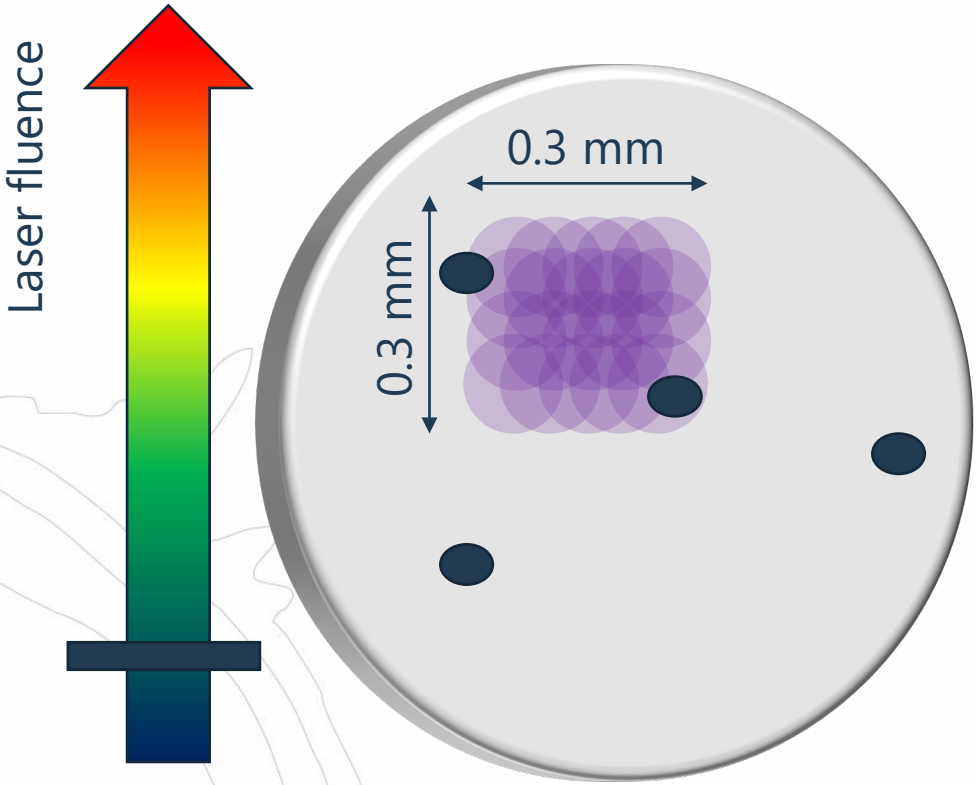
1-on-1

S-on-1

R-on-1

Raster scan

Laser damage characterization

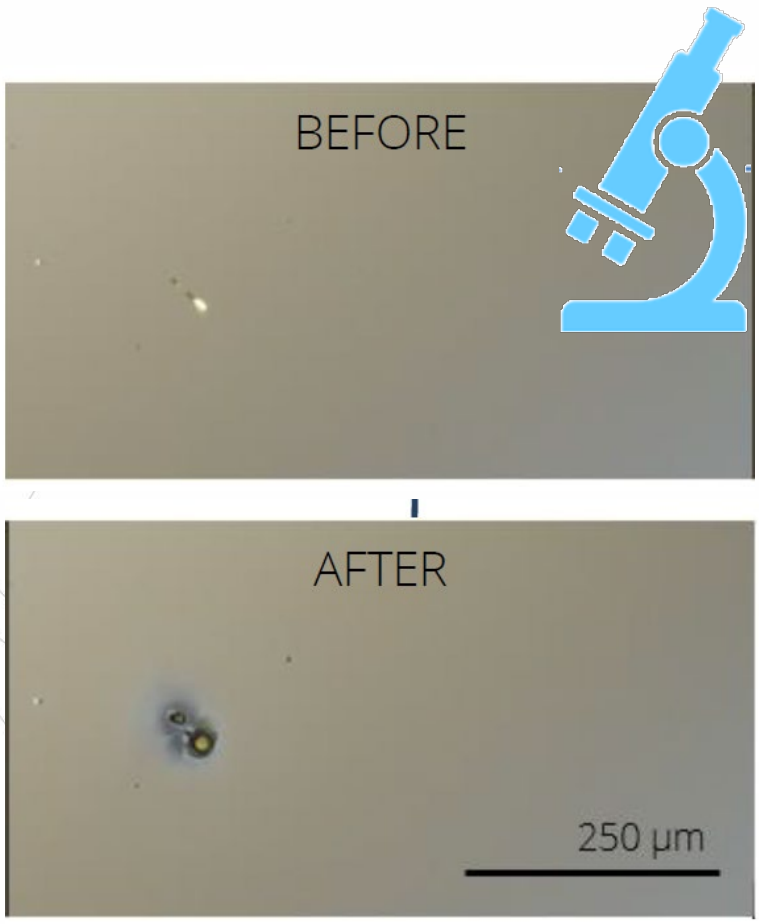


RASTER SCAN PROCEDURE

1. A fresh unexposed area of 0,9 cm^2 was selected
2. Fluence value is preset
3. Area raster scanned with 90% overlapping beam at $1/e^2$ intensity level

LIDARIS
LIDT Service

Laser damage characterization

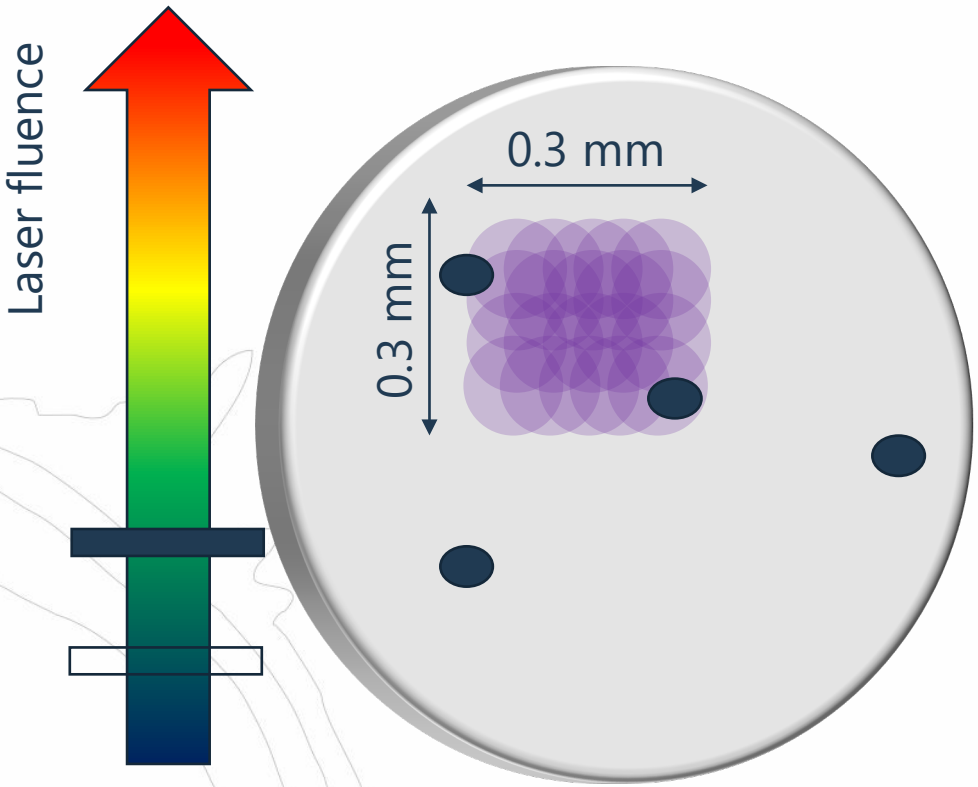


RASTER SCAN PROCEDURE

1. A fresh unexposed area of 0,9 cm^2 was selected
2. Fluence value is preset
3. Area raster scanned with 90% overlapping beam at $1/e^2$ intensity level
4. Surface of the sample is inspected under Nomarki microscope.

Damage was found to be initiated by defects (nodular or other type defects) located on the sample surface

Laser damage characterization



RASTER SCAN PROCEDURE

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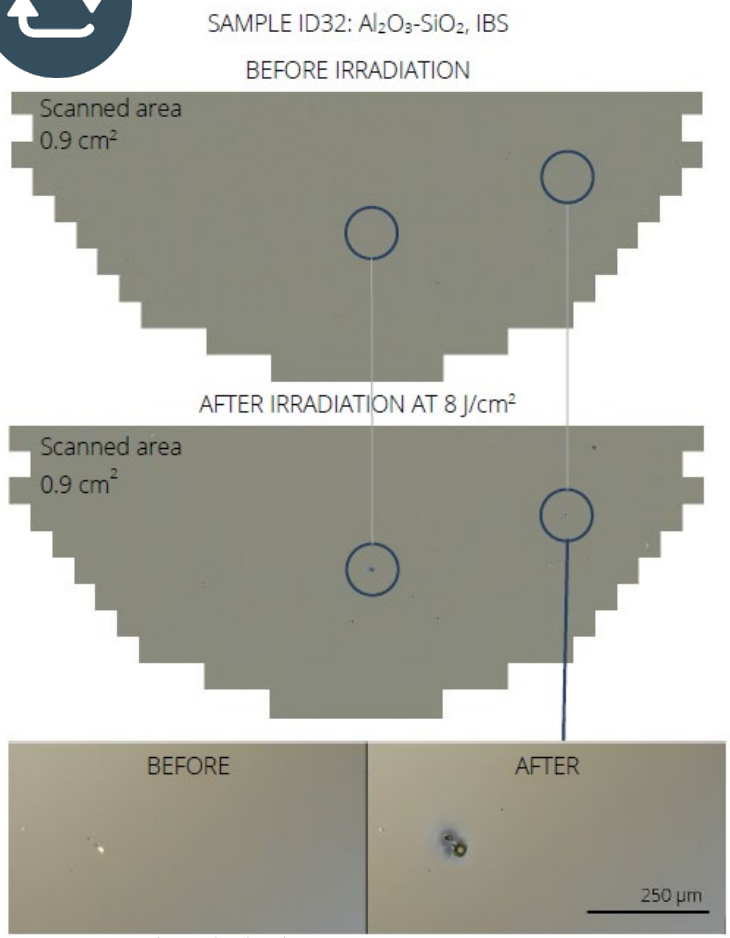
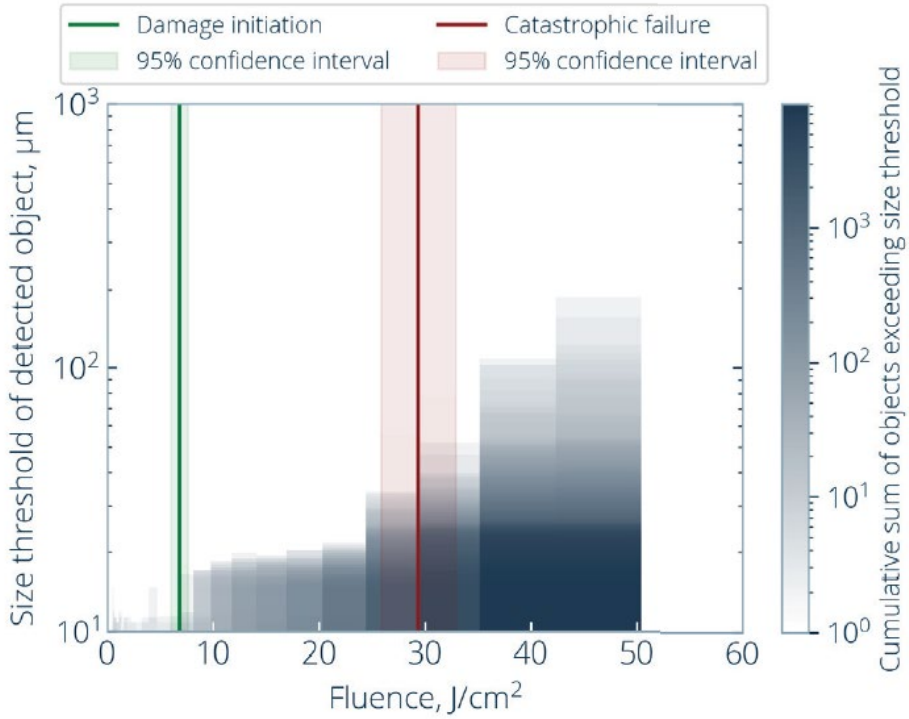
2. Fluence value is preset
3. Area raster scanned with 90% overlapping beam at $1/e^2$ intensity level
4. Surface of the sample is inspected under Nomarki microscope
5. Fluence is increased and the same procedure is repeated again.

LIDARIS LIDT Service

Laser damage characterization

For each fluence

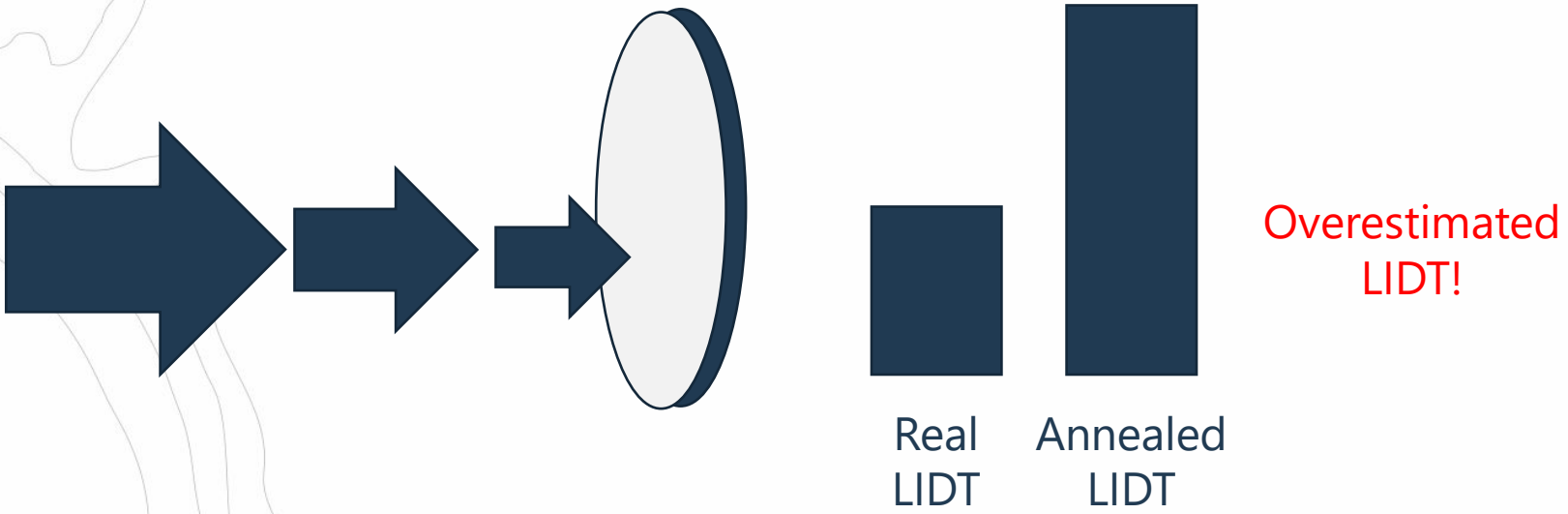




LIDARIS
LIDT Service

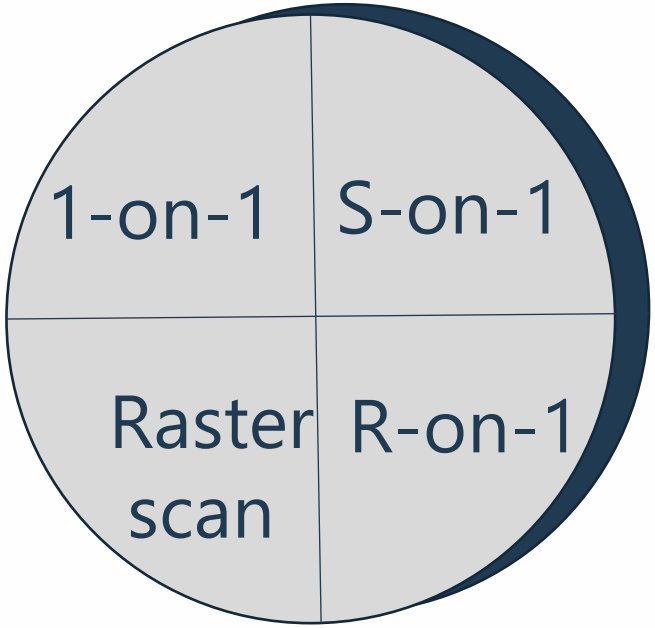
2
myths

Most of the other LIDT tests will not work, because of annealing effect

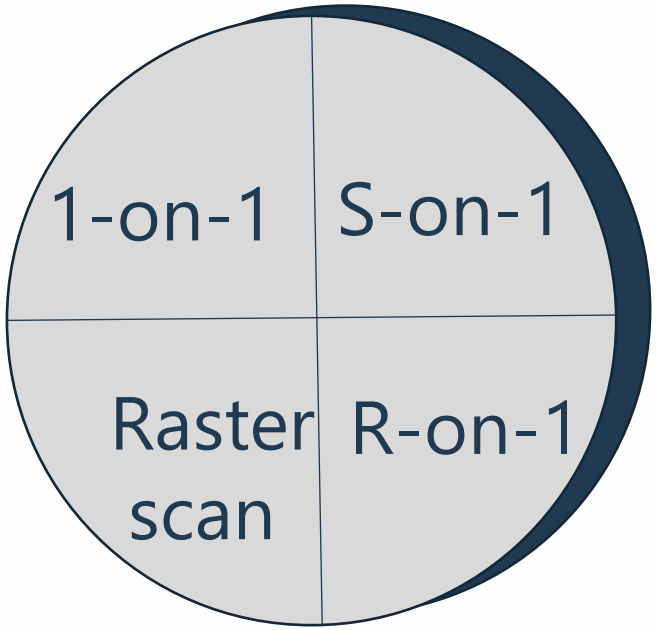


Rūta Pakalnytė *et al „Direct comparison of laser-induced damage threshold testing protocols on dielectric mirrors: effect of nanosecond laser pulse shape at NIR and UV wavelengths"* Proc. of SPIE, Laser-induced Damage in Optical Materials 2019, 1117318 (17 December 2019)

HR, ~10ns, AOI: 0 deg.

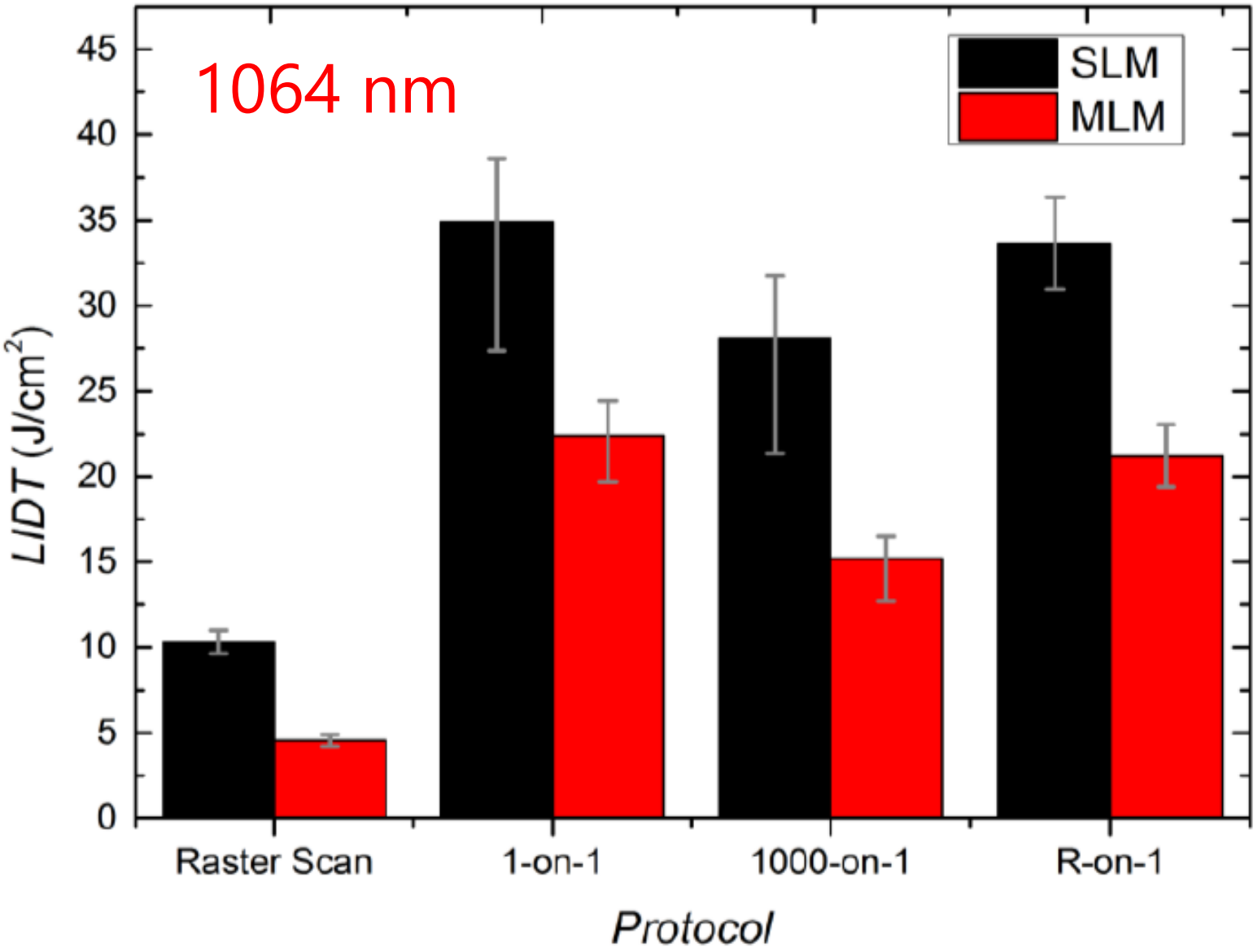


1064 nm
MLM+SLM



355nm
MLM+SML

LIDARIS
LIDT Service



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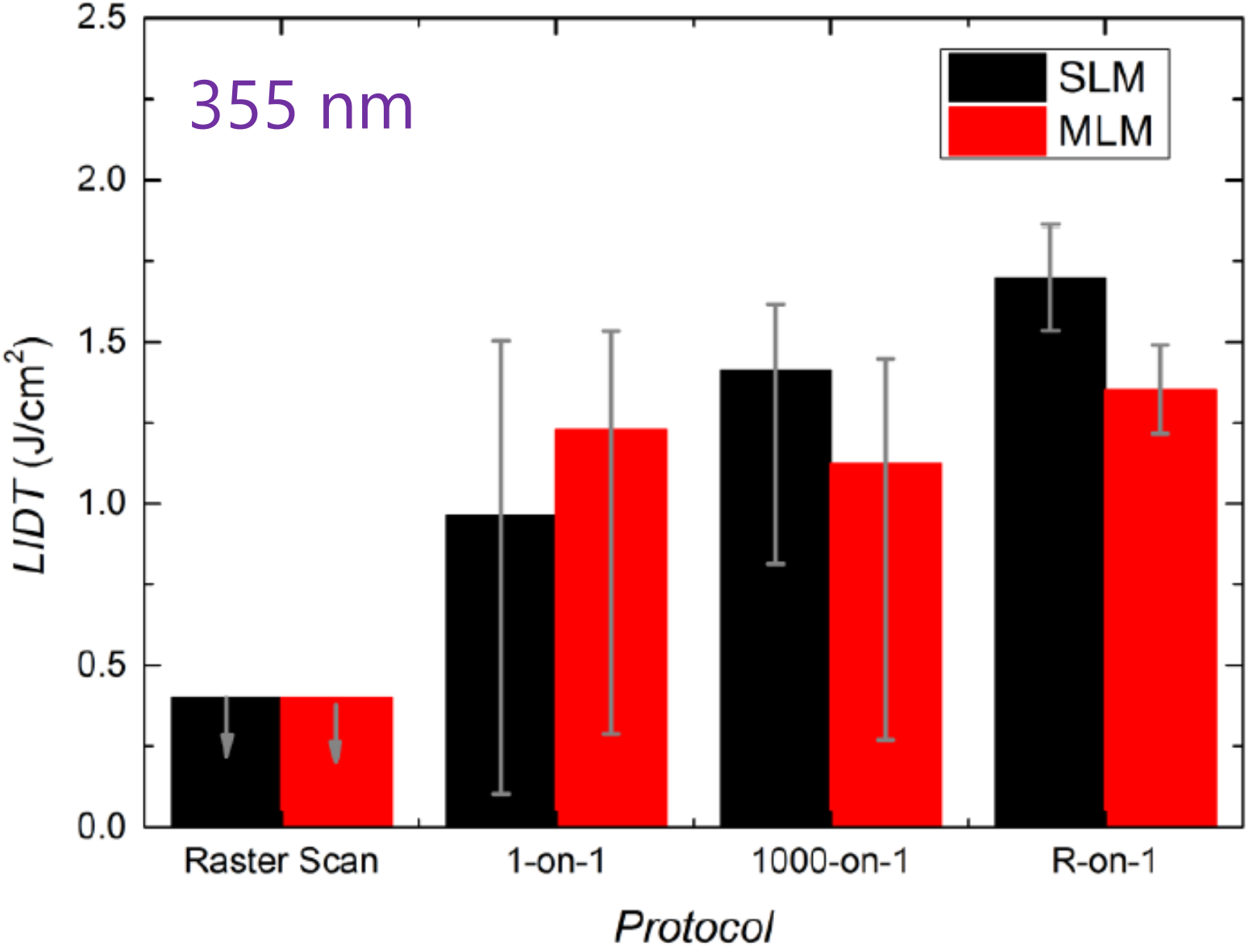

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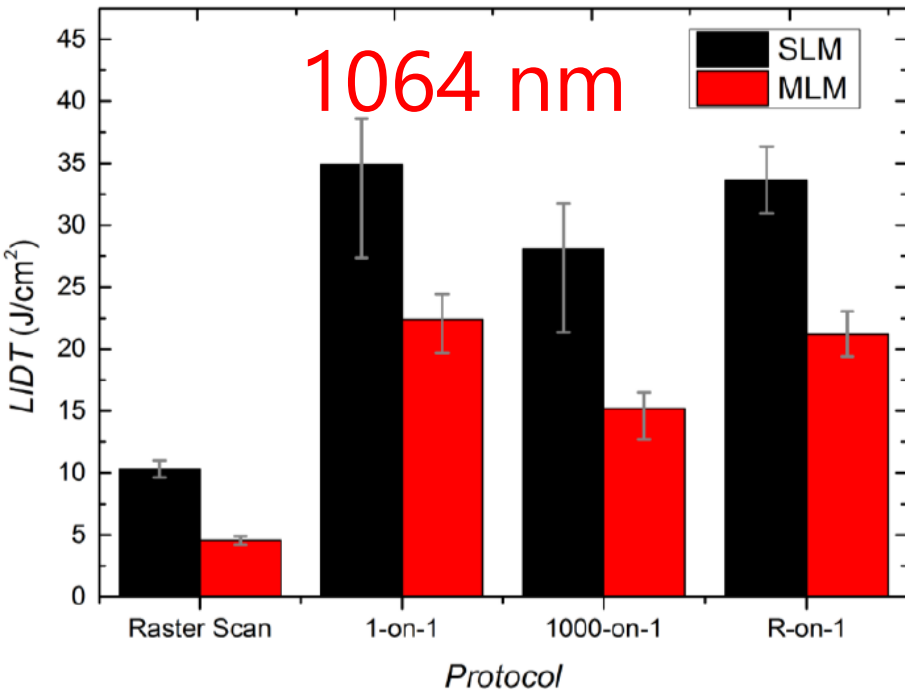
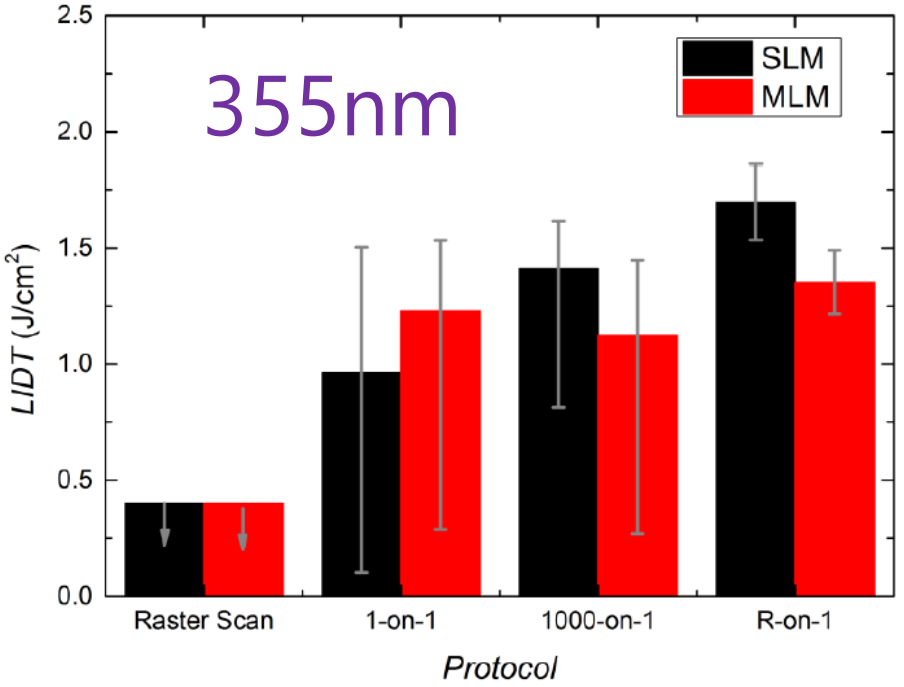
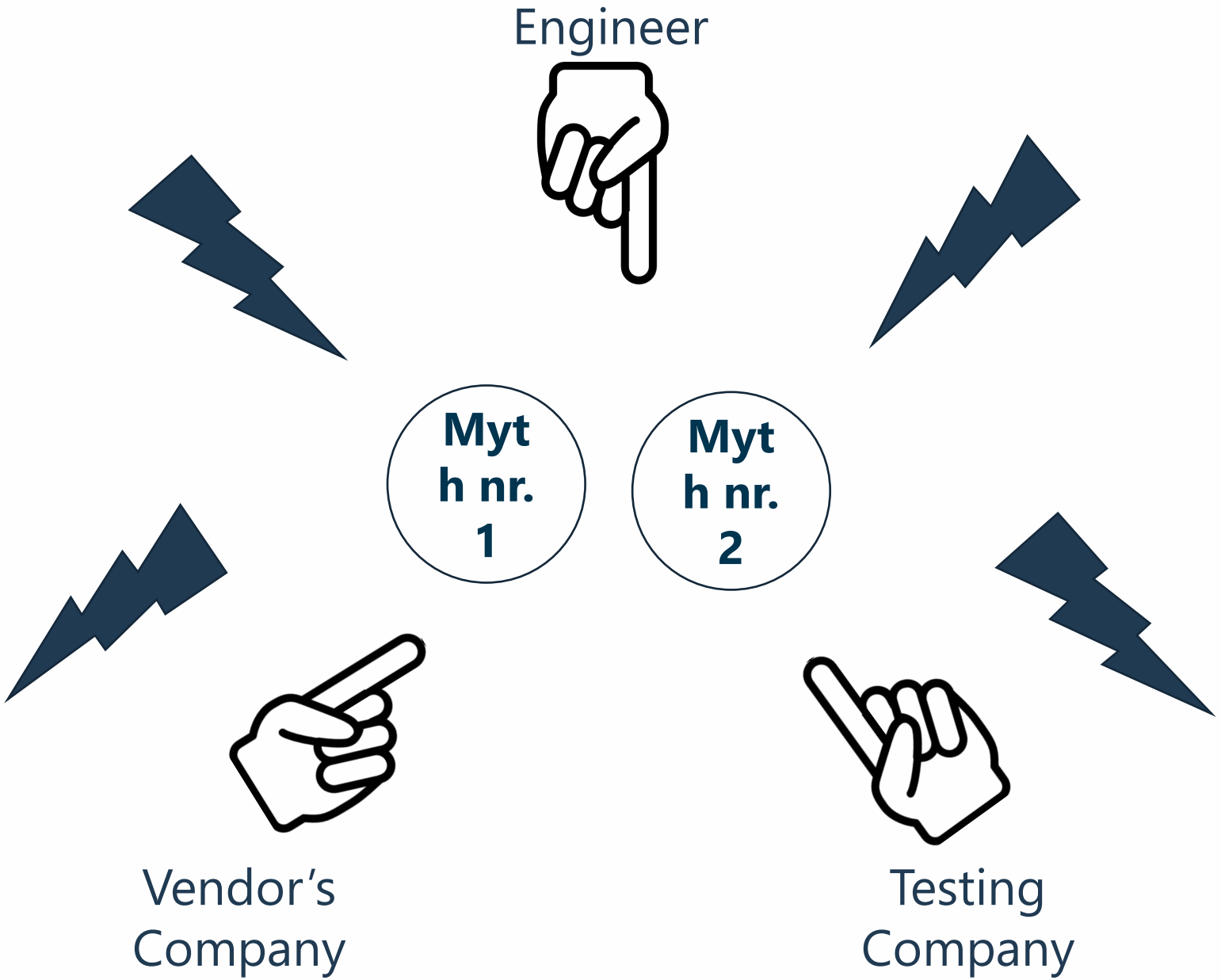




1] R. Pakalnyte et al *"Direct comparison of laser-induced damage threshold testing protocols on dielectric mirrors: effect of nanosecond laser pulse shape at NIR and UV wavelengths"*, Proc. of SPIE, Laser-induced Damage in Optical Materials 2019, 1117318 (17 December 2019)

LIDARIS
LIDT Service


Engineer
Myth nr. 1
Myth nr. 2
Vendor's Company
Testing Company

Engineer

LIDT*

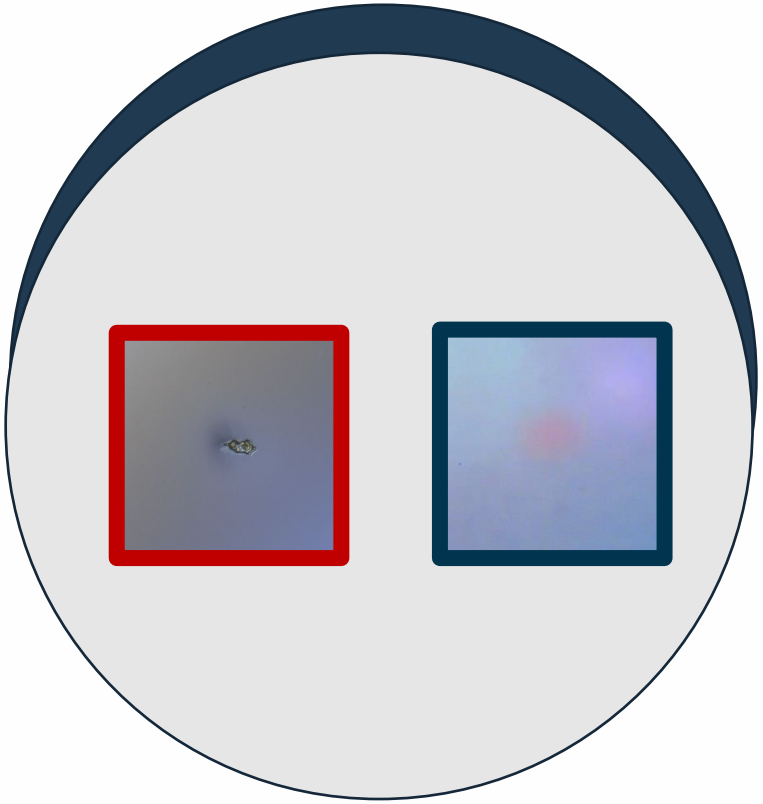
Vendor's Company

Testing Company

Messages to take home

1

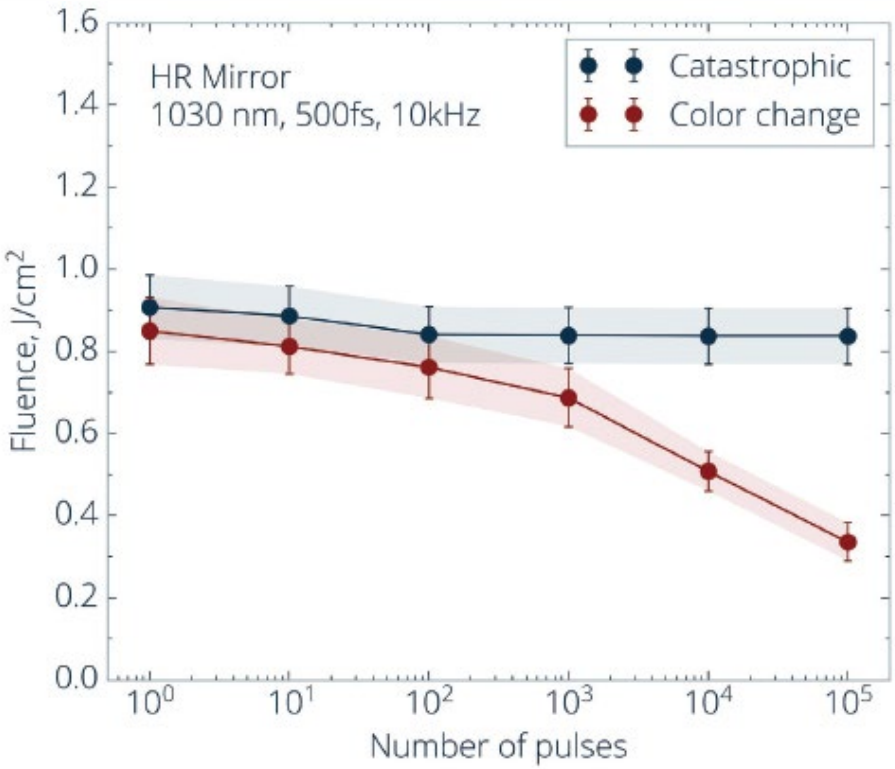
Laser damage failure modes exist (coexist)



Messages to take home

1. Laser damage failure modes exist (coexist)

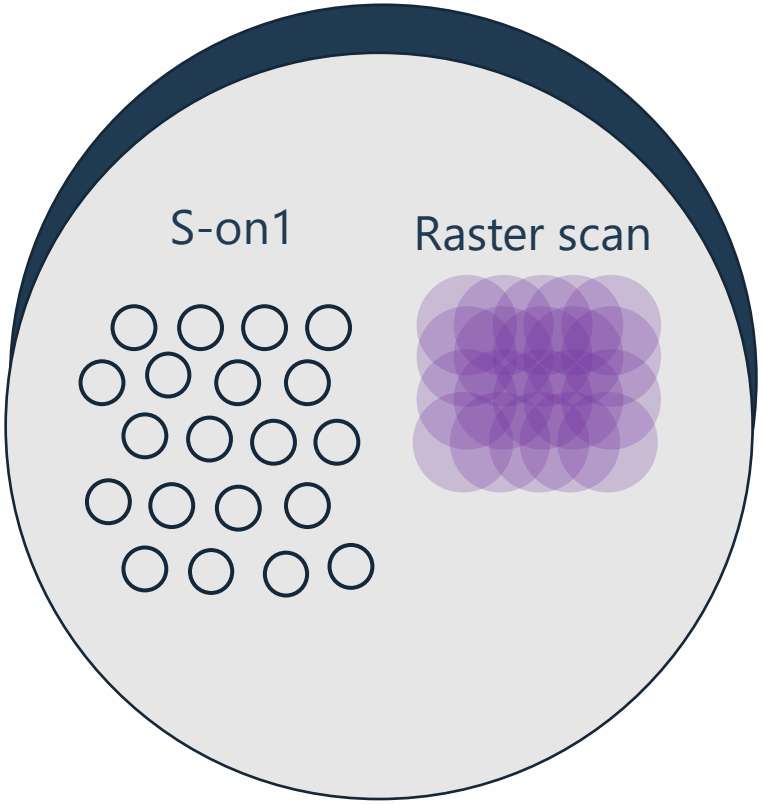
2. Laser damage in space and time should be separated



LIDARIS
LIDT Service

Messages to take home

1. Laser damage failure modes
2. Laser damage in space and time
3. Combined laser damage testing

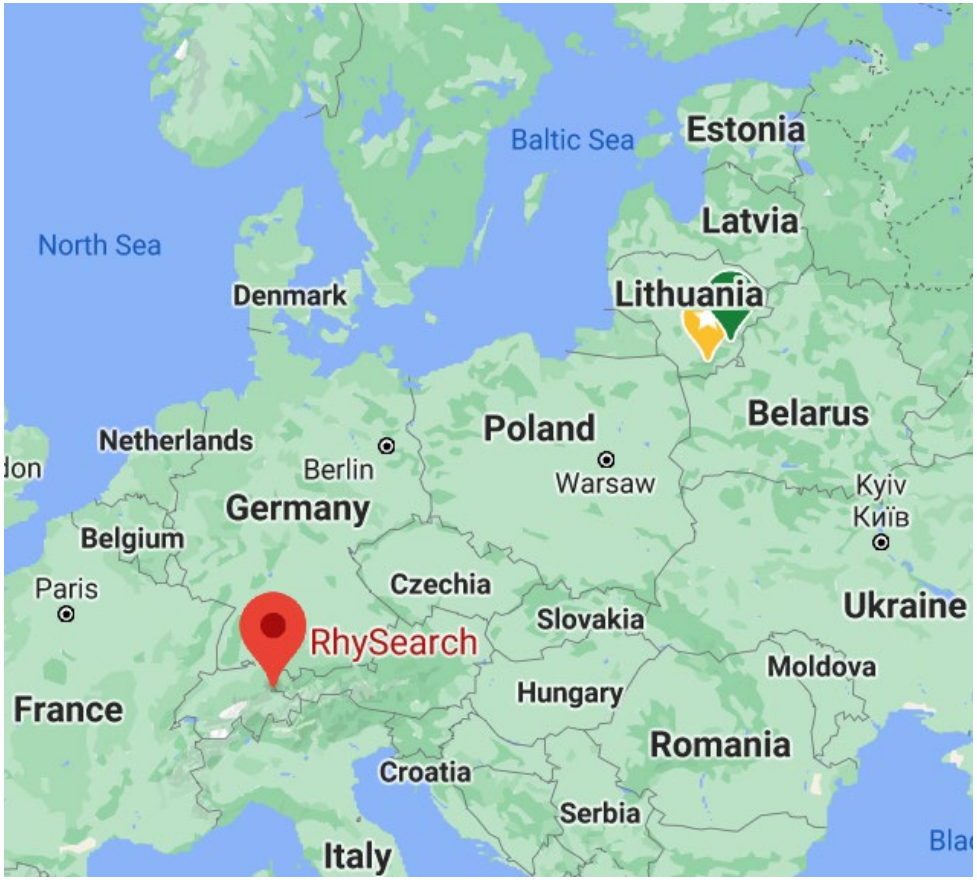


Messages to take home

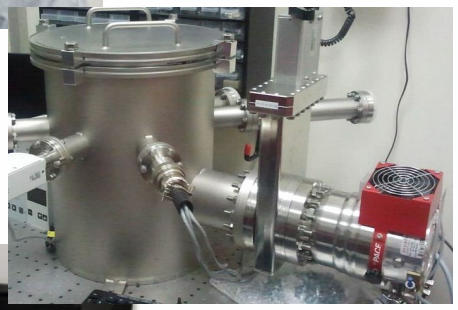
1. Laser damage failure modes
2. Laser damage in space and time
3. Combined laser damage testing

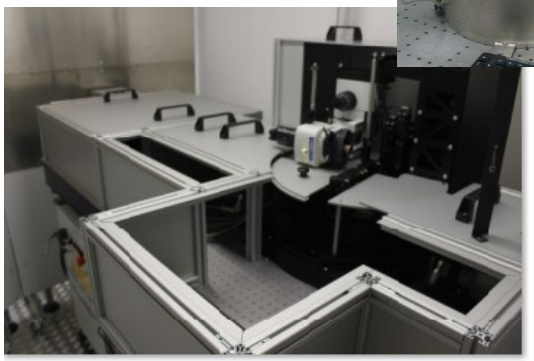
Find a trusted partner so solve laser damage issue

LASER DAMAGE TESTING SERVICE



esa





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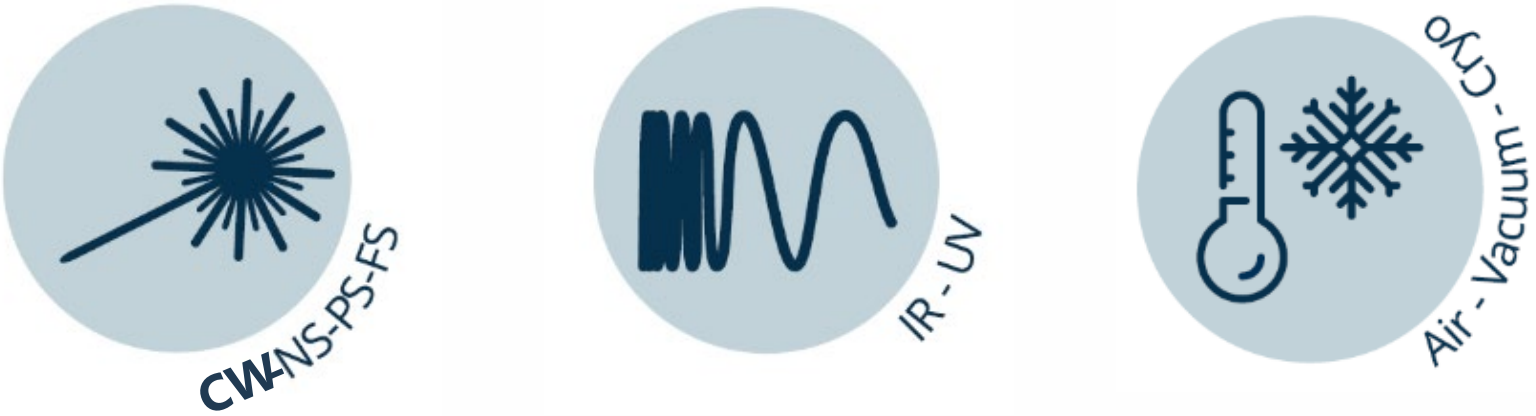
LIDT Service

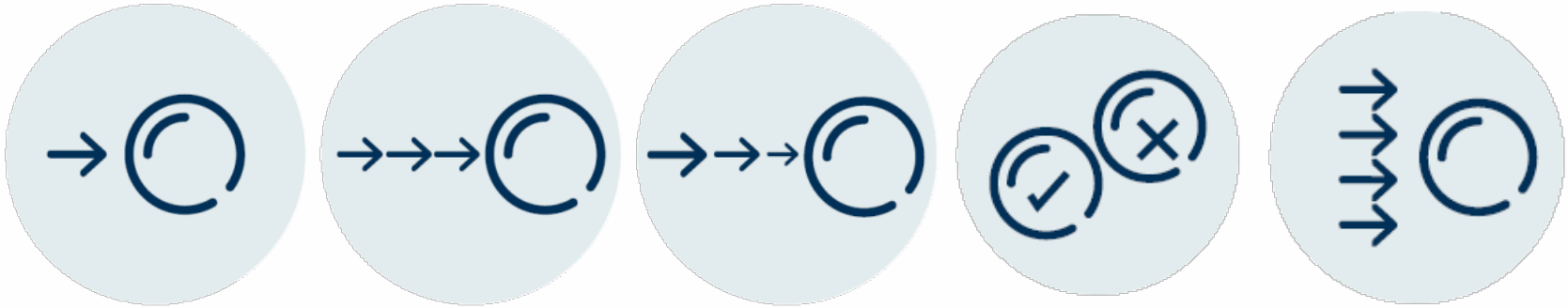
ALL TESTING AT ONE PLACE!



WIDE ASSORTMENT OF LIDT TEST CONDITIONS

ALL TESTING AT ONE PLACE!

1-ON-1 **_S_-ON-1** **_R_-ON-1** **Certification** **Raster Scan**



WIDE ASSORTMENT OF LIDT TEST PROCEDURES

SPIE. LASER DAMAGE

LIDARIS sponsored Laser Damage Competition 2020 (@532nm, ns)

LIDARIS LIDT Service

MEET LIDARIS TEAM

CEO

Dr. Andrius Melninkaitis

Marketing

Dr. Gintarė Batavičiūtė

Sales

Giedrė Šareikaitė

Vaida Žusinaitė-Nekriošienė

Petras Dominykas Tadaras

Analytics

Dr. Justinas Galinis

Administration

Jūratė Burbulienė

Metrology group

Egidijus Pupka

Dr. Lina Vigricaitė

Edvinas Zaharovas

Marijus Mickus

Urtė Kimbaraitė

Rūta Pakalnytė

R&D

Mindaugas Ščiuka

Linas Smalakys

Dr. Tomyslav Sledevič

STARTED IN 2012

5 PhD'S

>18 YEARS OF EXPERIENCE

>70 PUBLISHED RESEARCH ARTICLES
3x AWARD WINNERS OF SPIE LASER DAMAGE

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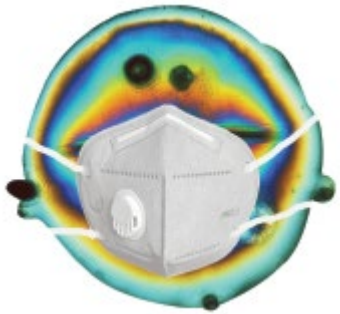
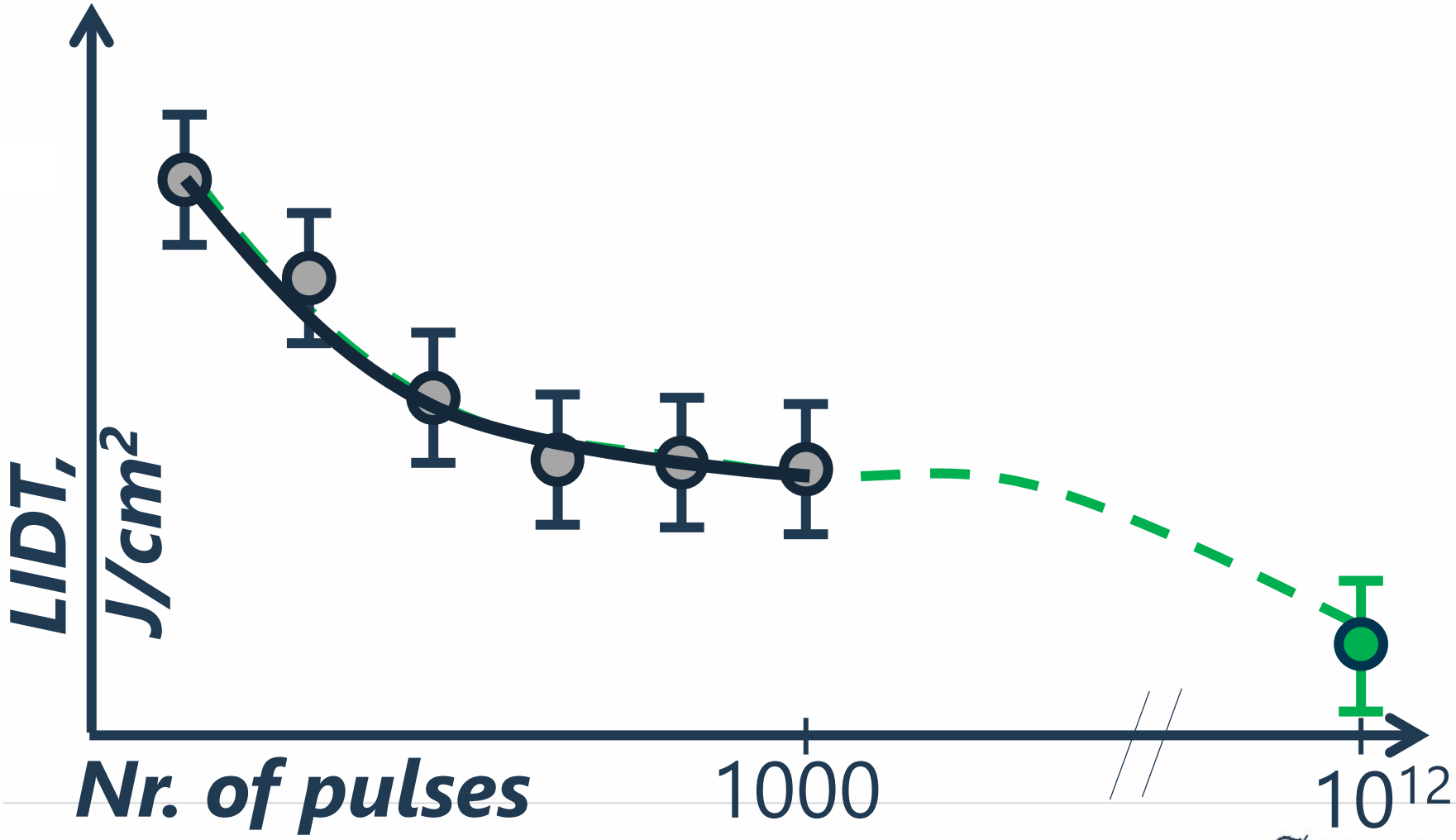
THANK YOU FOR YOUR ATTENTION!



CONTACT US
LET'S MAKE A DIFFERENCE!

www.lidaris.com info@lidaris.com +370 609 09233 Lidt_service

PROJECT ESPRESSO: ESsential PREparation Steps for Qualification Longevity of Space Optics



PROJECT ESPRESSO: ESsential PREparation Steps for Qualification Longevity of Space Optics

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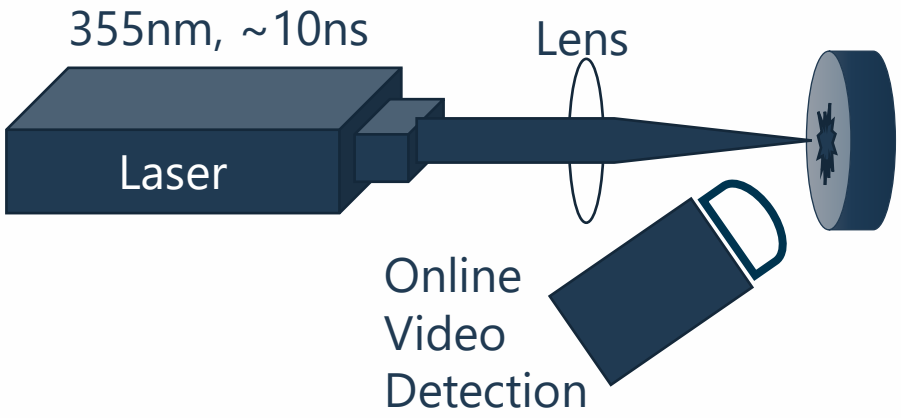
esa European Space Agency



Images by video detection

55 PULSES
30 PULSES
1 PULSE

Exposure:

up 100.000 pulses if not damaged

Photo inspection:

- 24 pictures for each site if it is not-damaged;
- Ability to see track damage evolution;
- Ability to evaluate exposed area before testing (identify defects)

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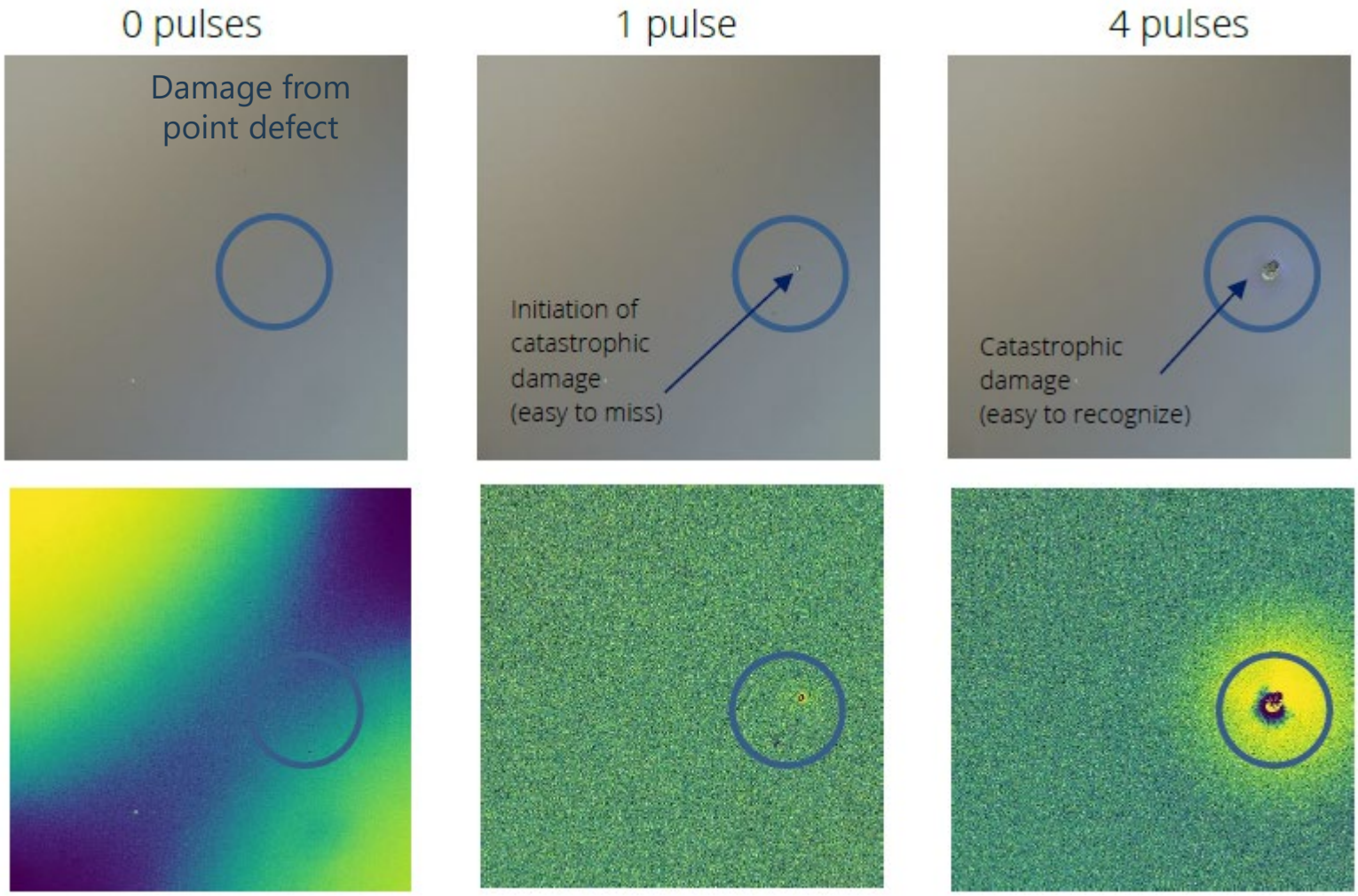
DAMAGE MODES

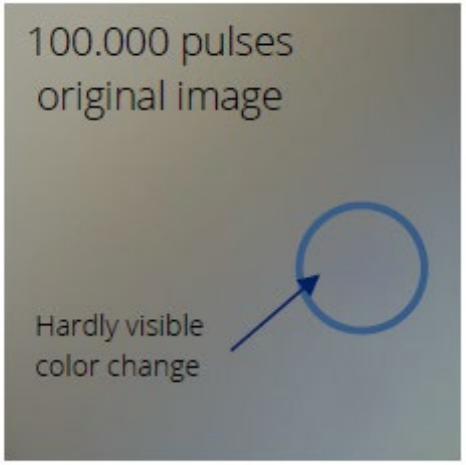
esa
European Space Agency

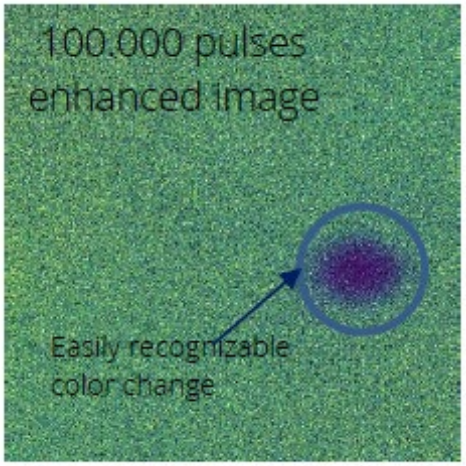
Defect driven damage mode



DAMAGE MODES

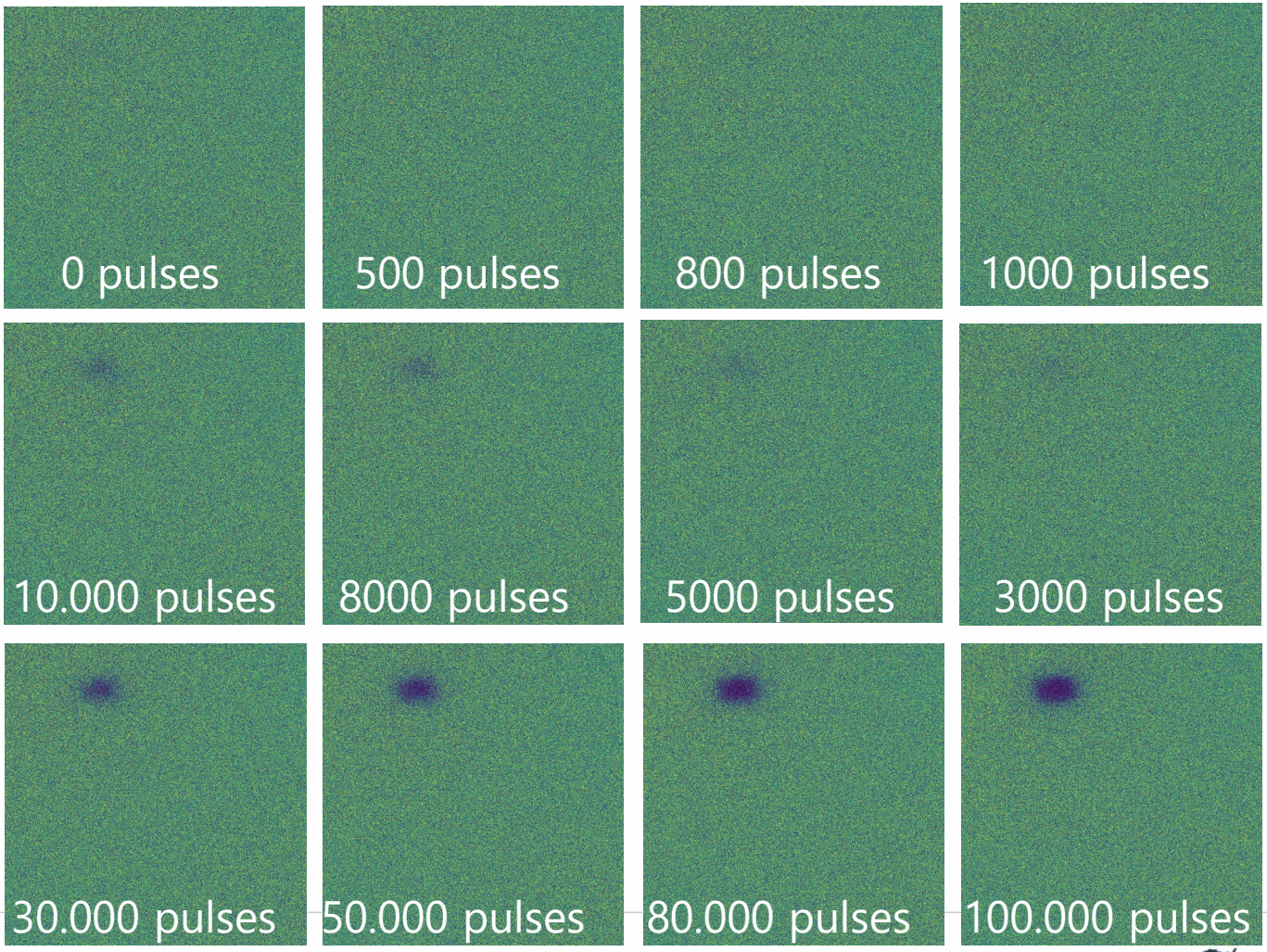
Colour change

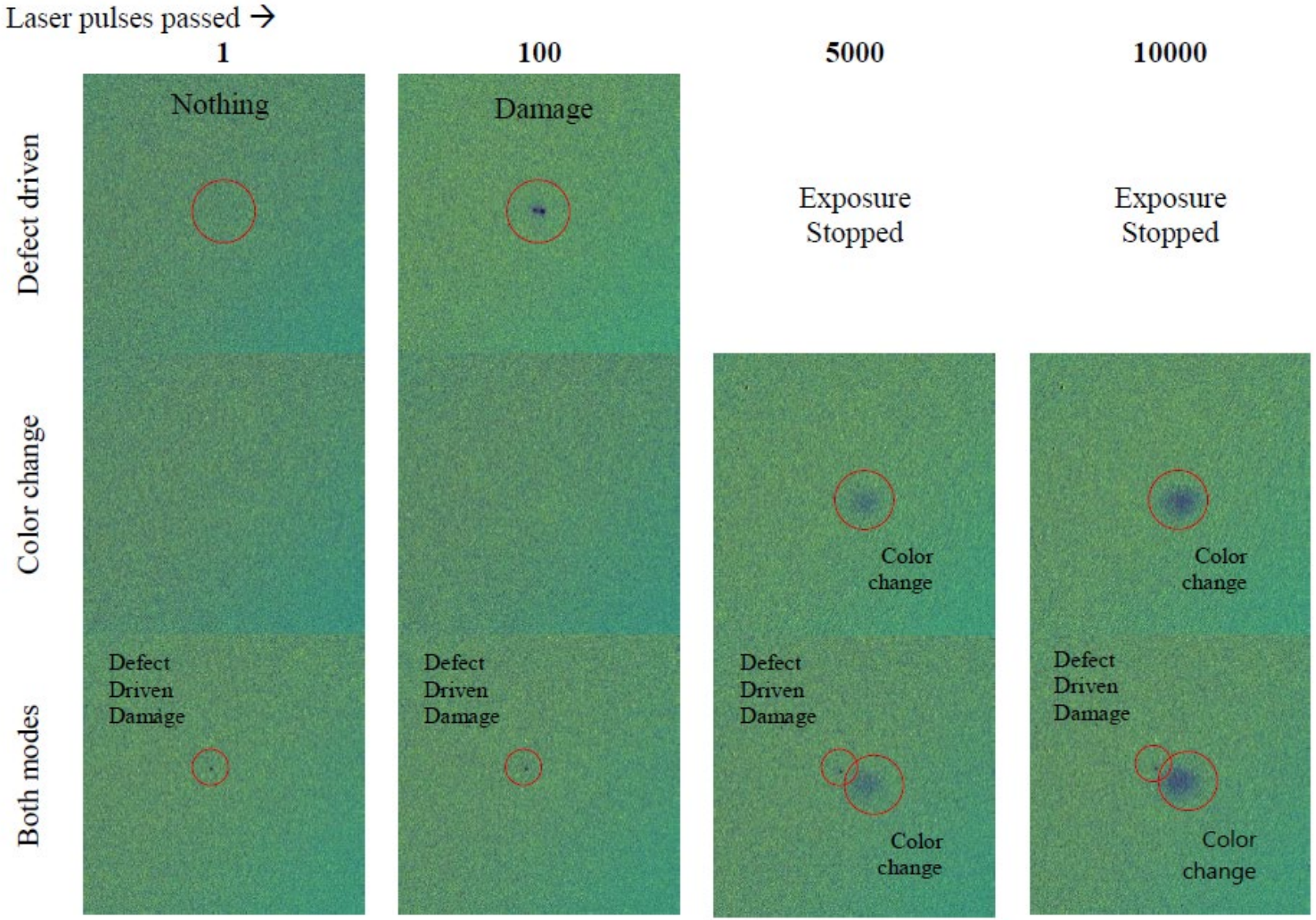




DAMAGE MODES

Colour change





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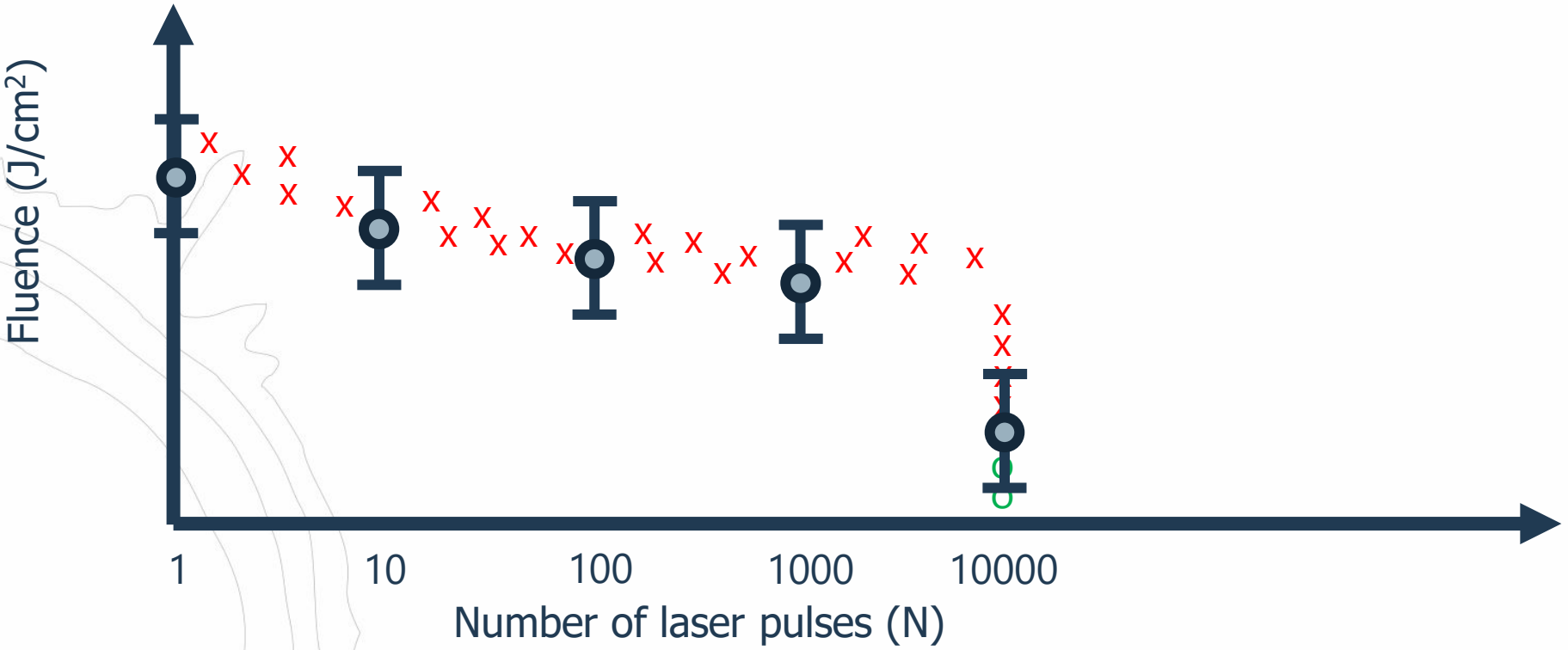
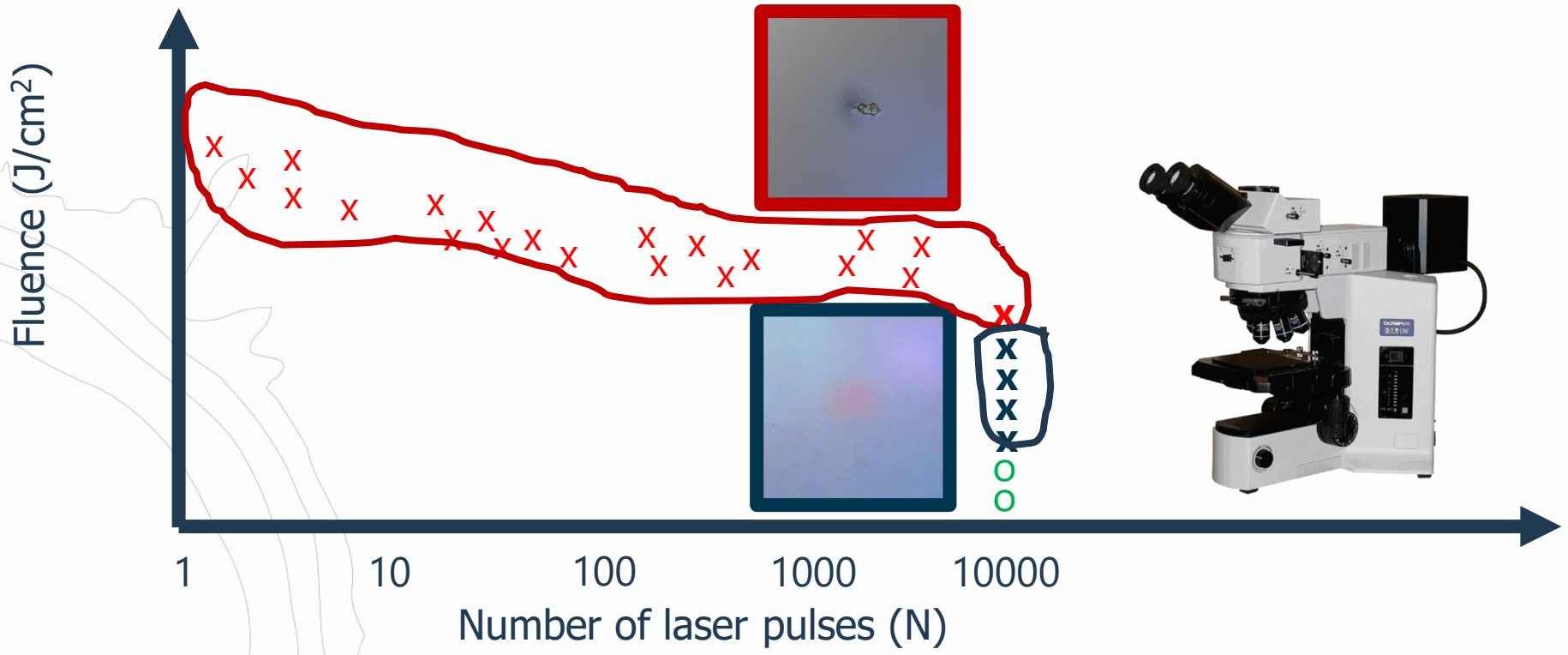
DAMAGE MODES

Typical S-on-1 data



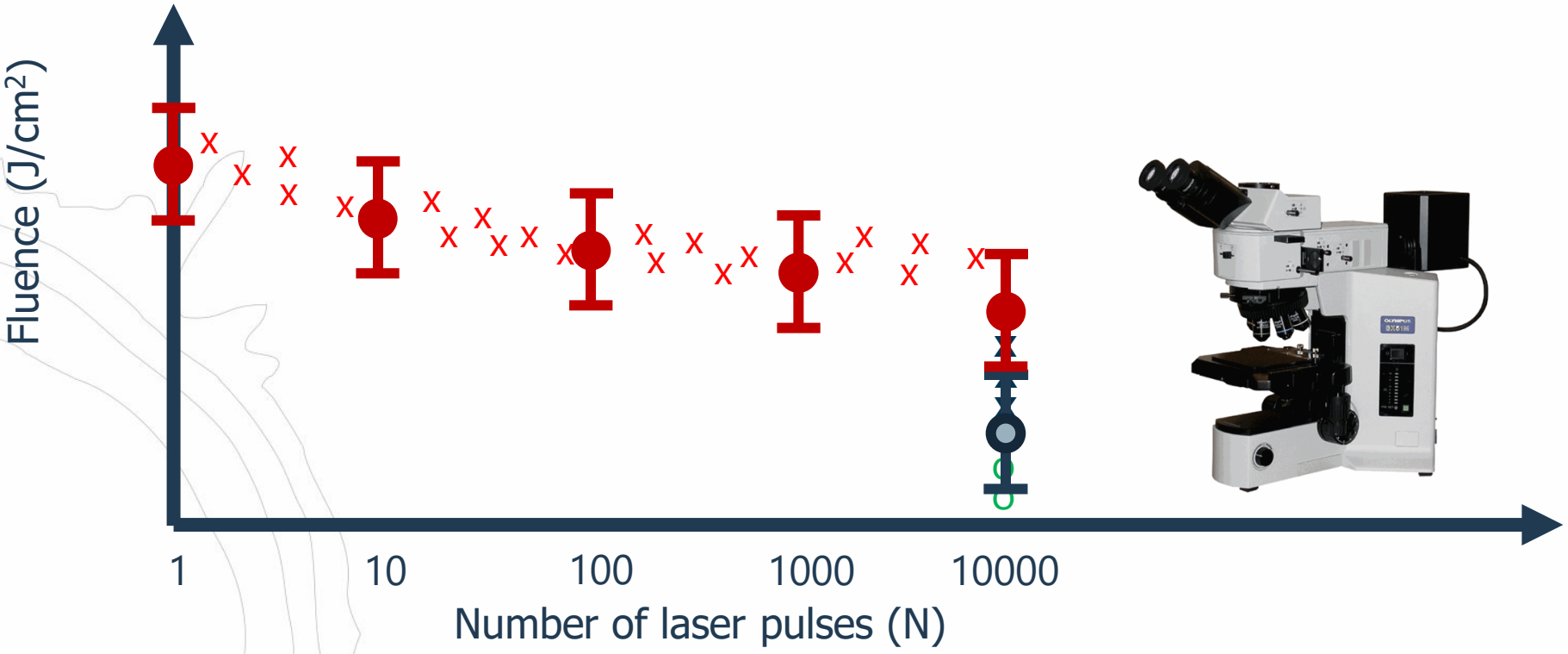
DAMAGE MODES

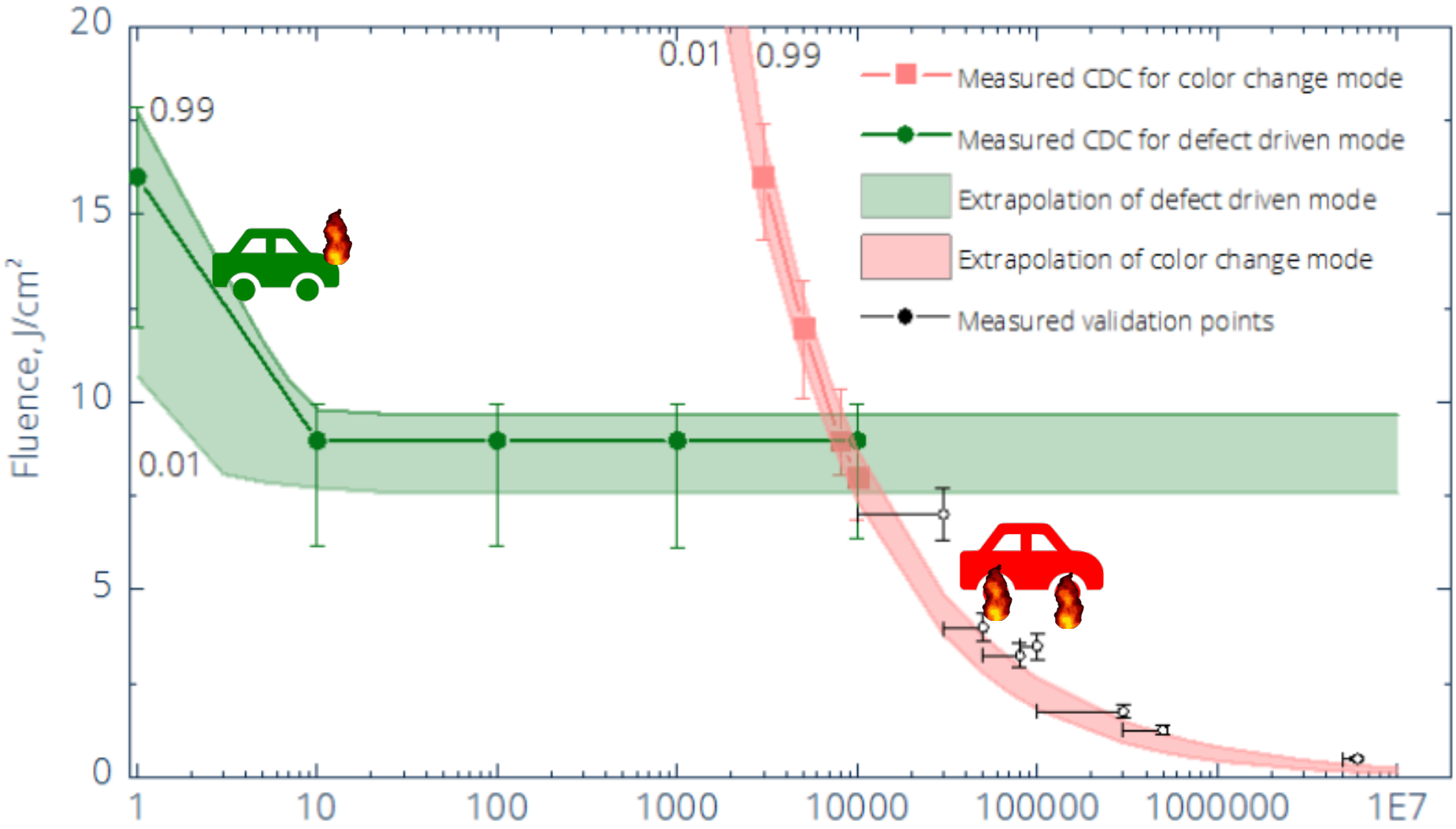
What our S-on-1 data consist of?



DAMAGE MODES

Better way to interpret S-on-1 data





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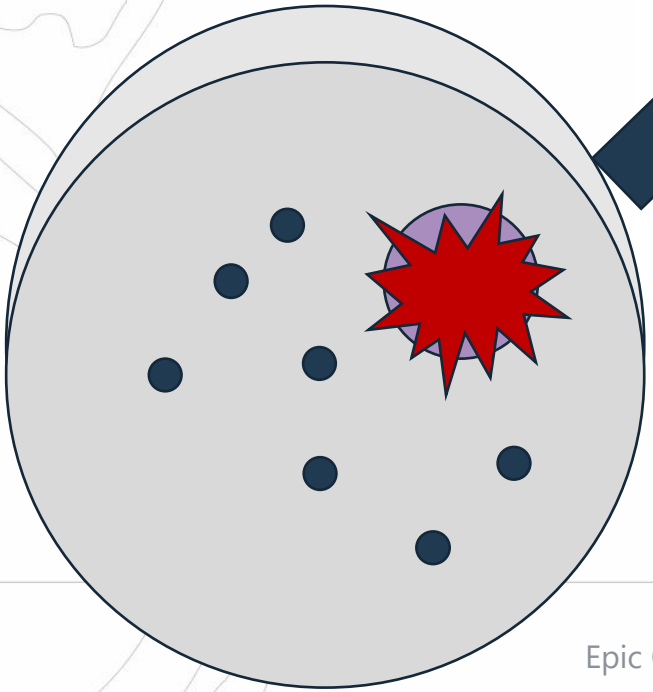
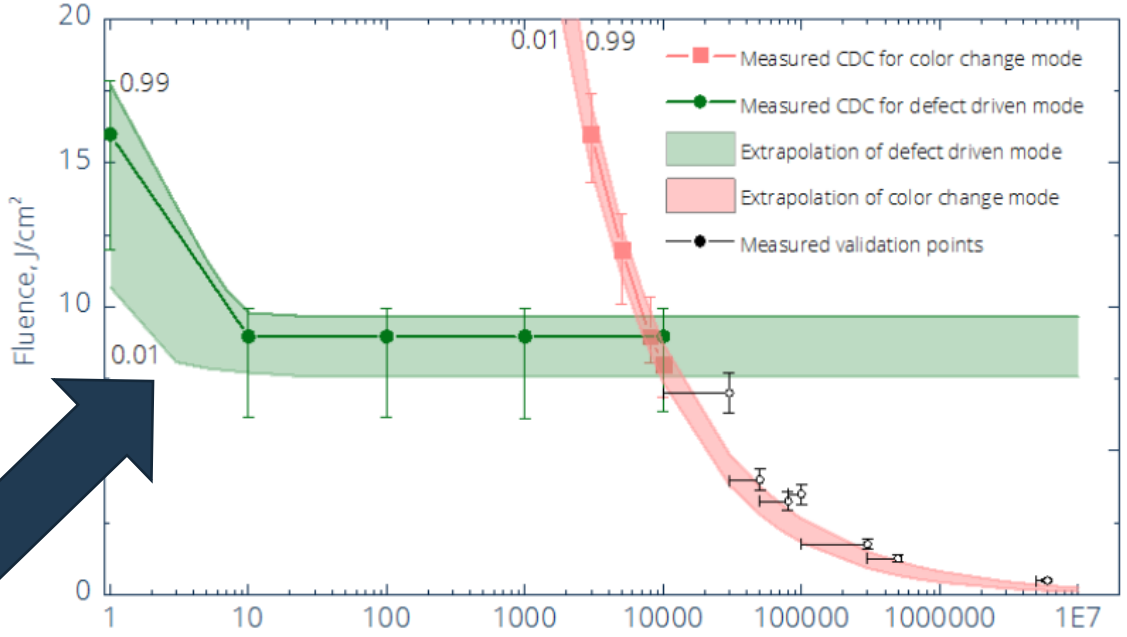
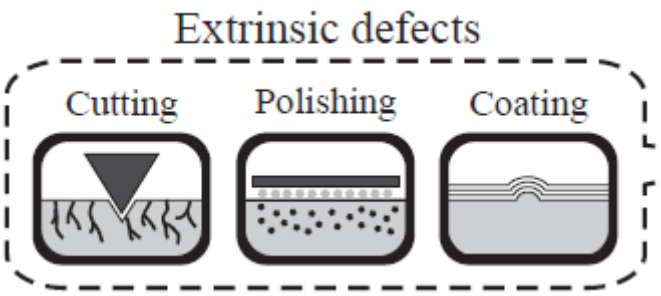
A new way to look at laser damage

1 SPACE







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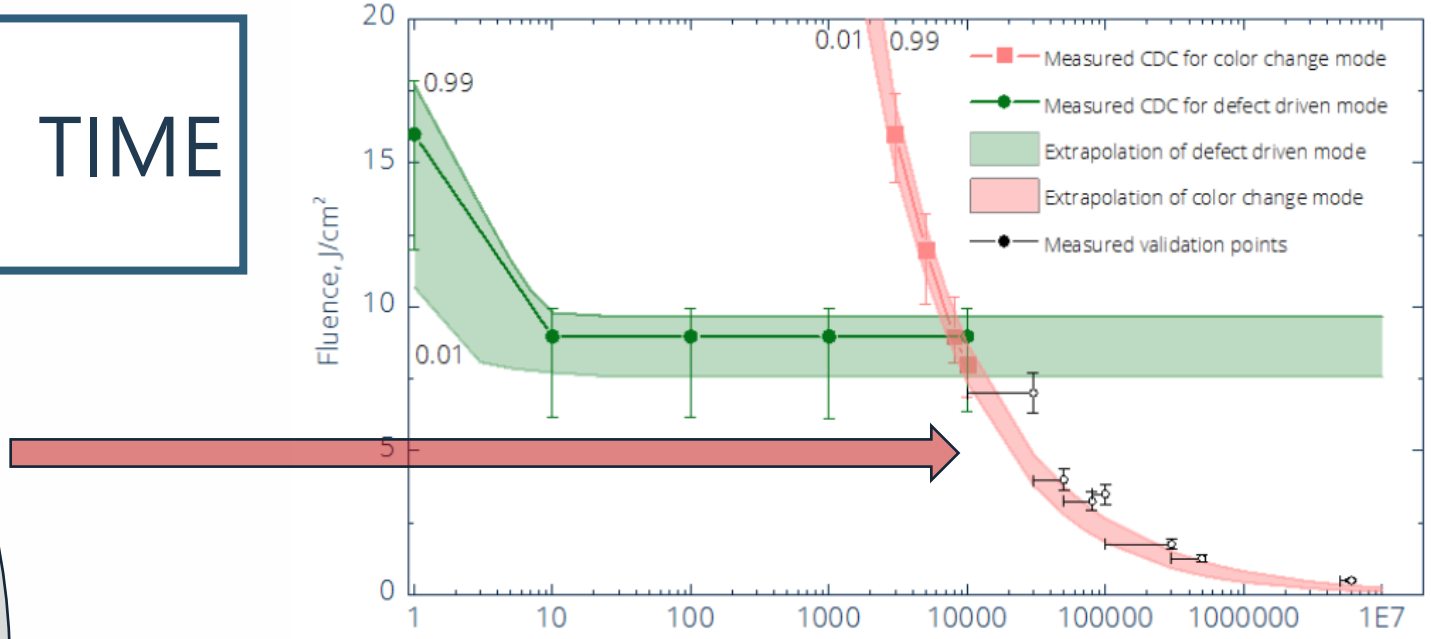
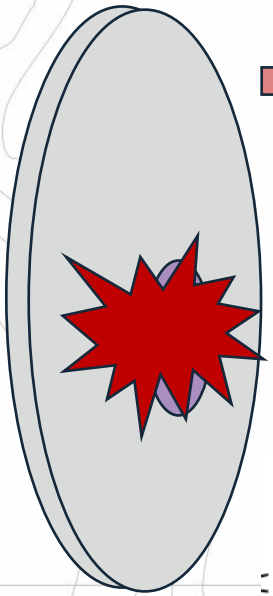
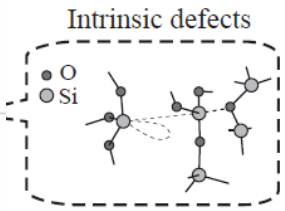
A new way to look at laser damage

1 TIME







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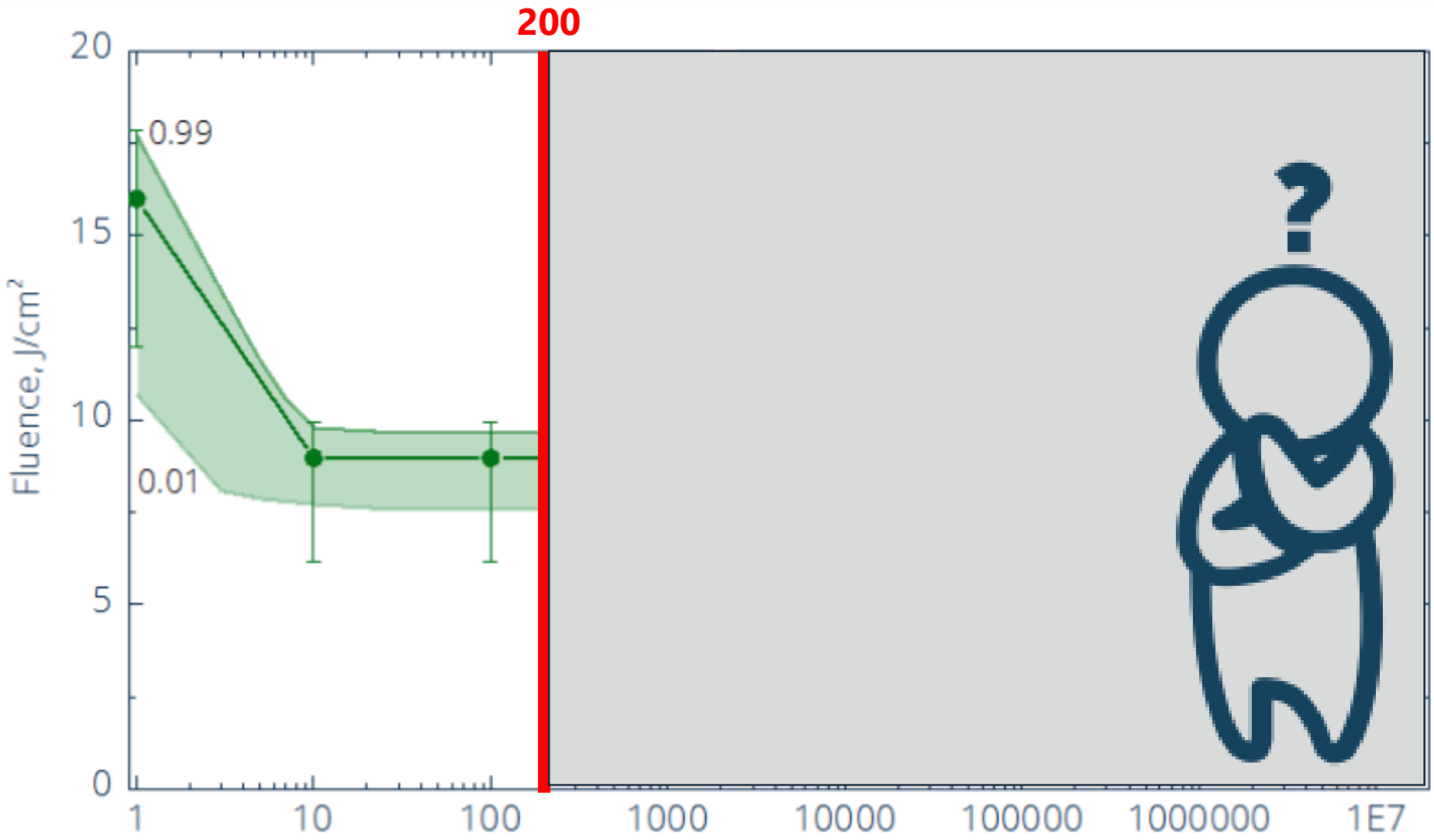
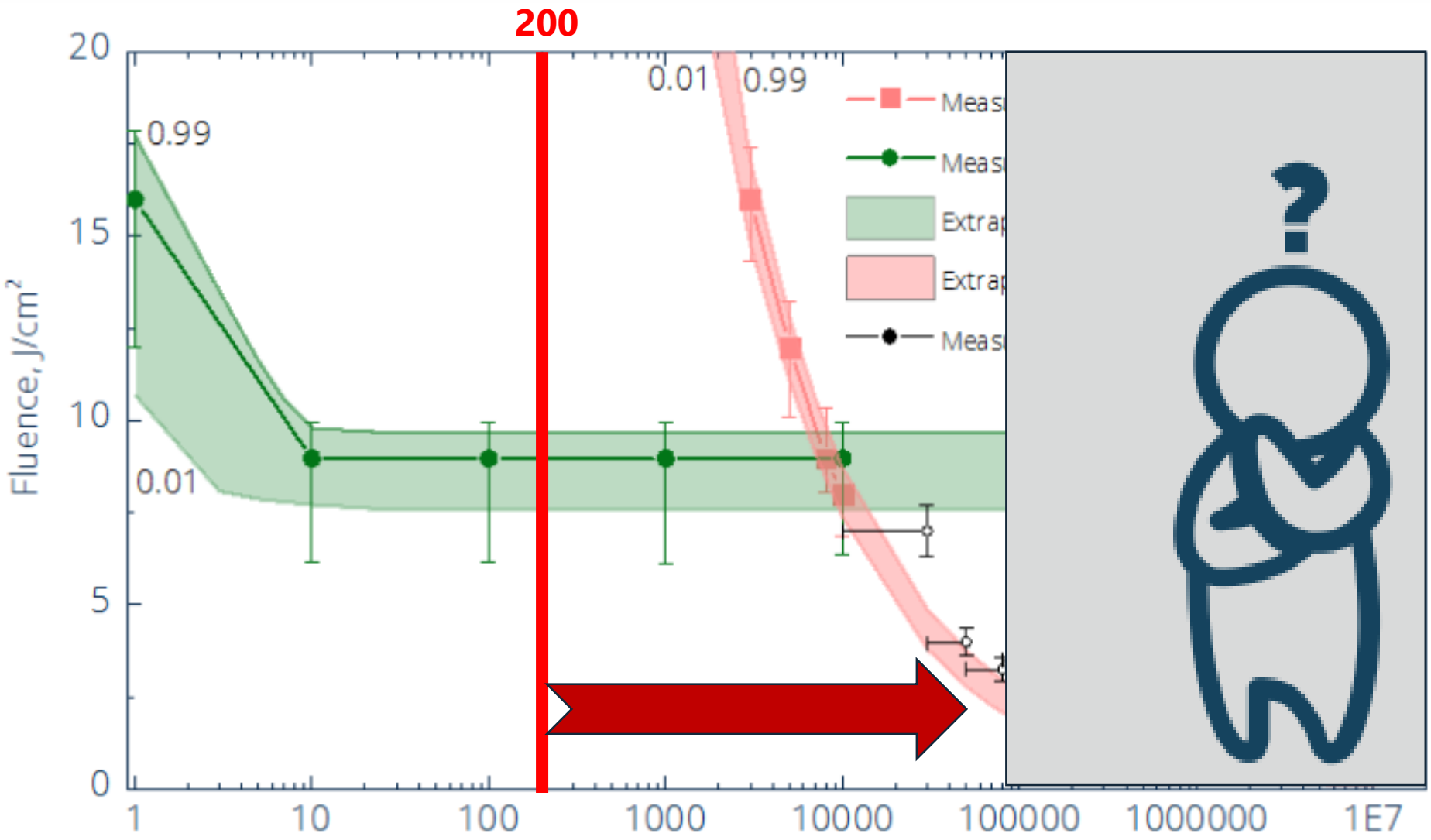

200
20
15
10
5
0
Fluence, J/cm²
0.99
0.01
1
10
100
1000
10000
100000
1000000
1E7
?



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Irrational problem: why it got damaged?

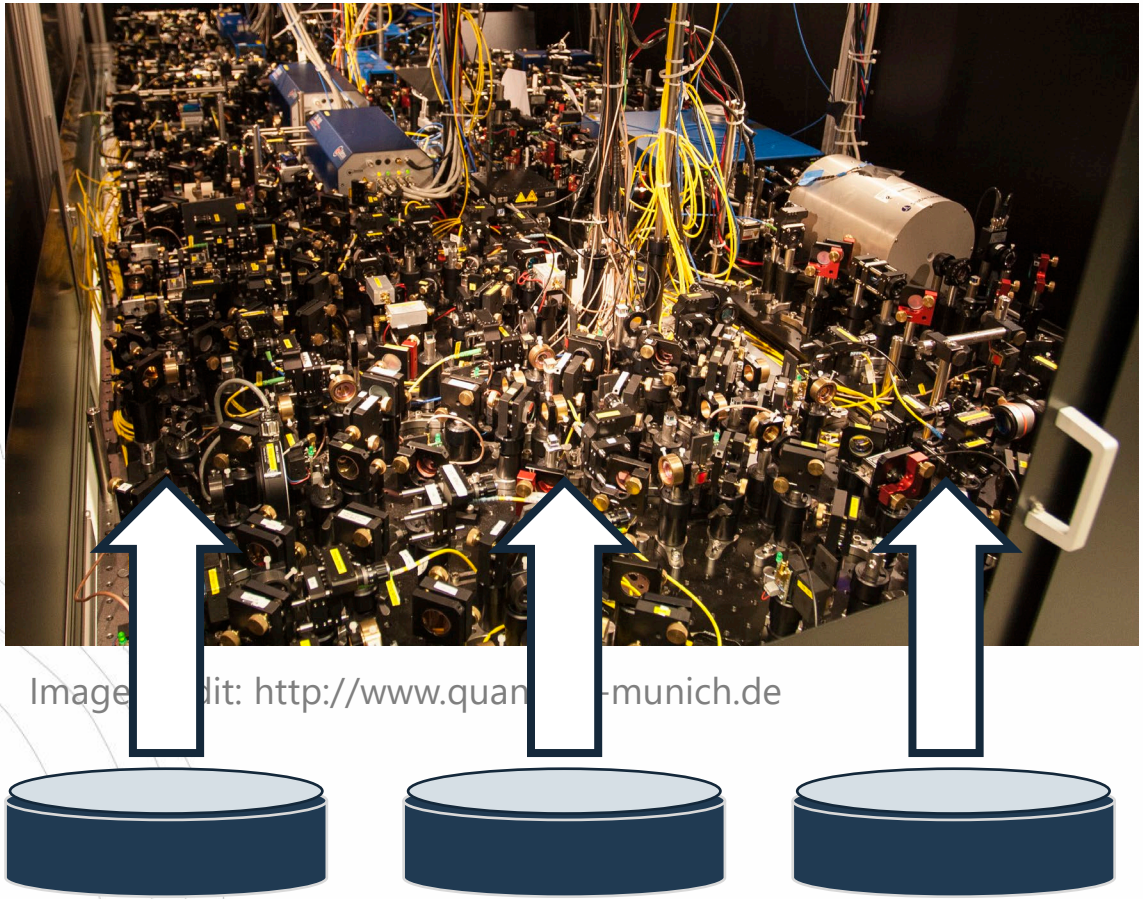

Image credit: http://www.quan[illegible]-munich.de

LIDT

10 J/cm2
@
1064nm,
10ns,
10Hz

Let's work with 8 J/cm^2

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Irrational problem: why it got damaged?

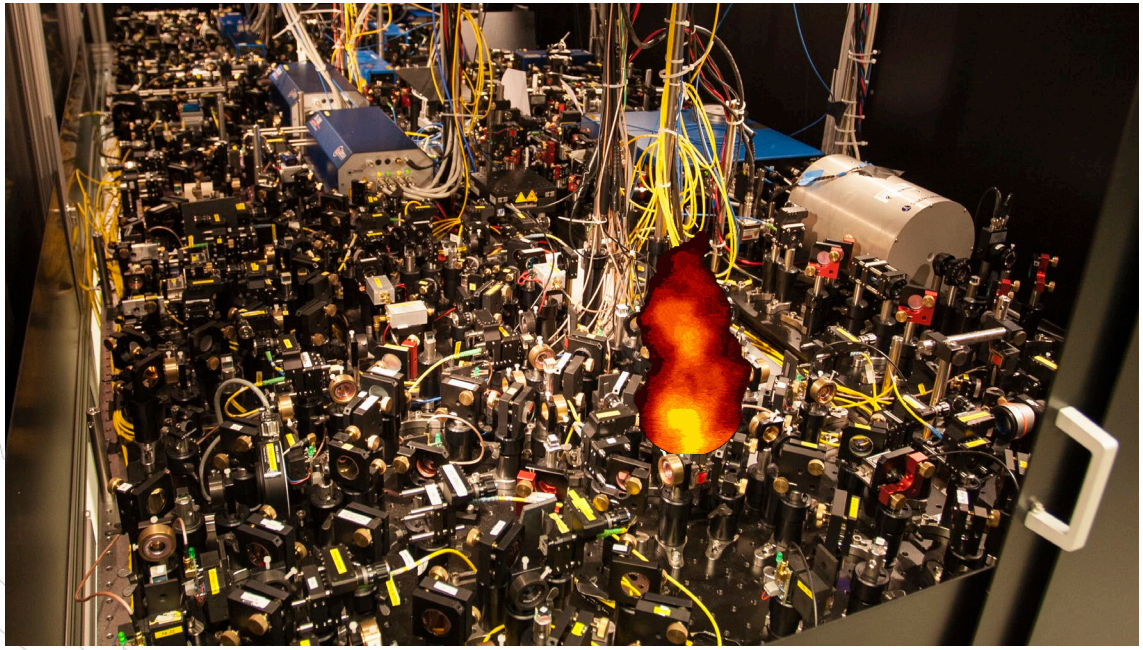
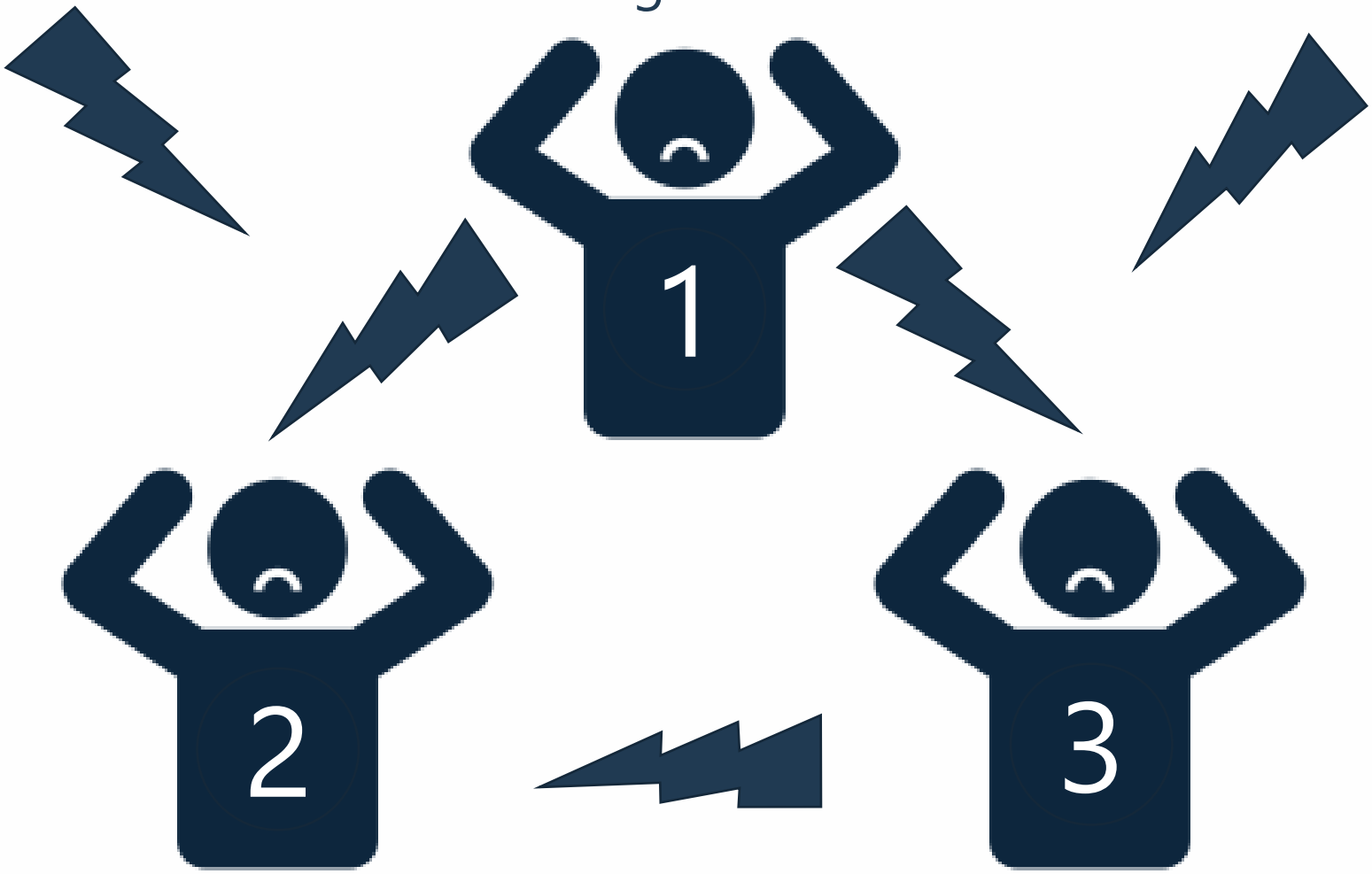


Image credit: http://www.quantum-munich.de

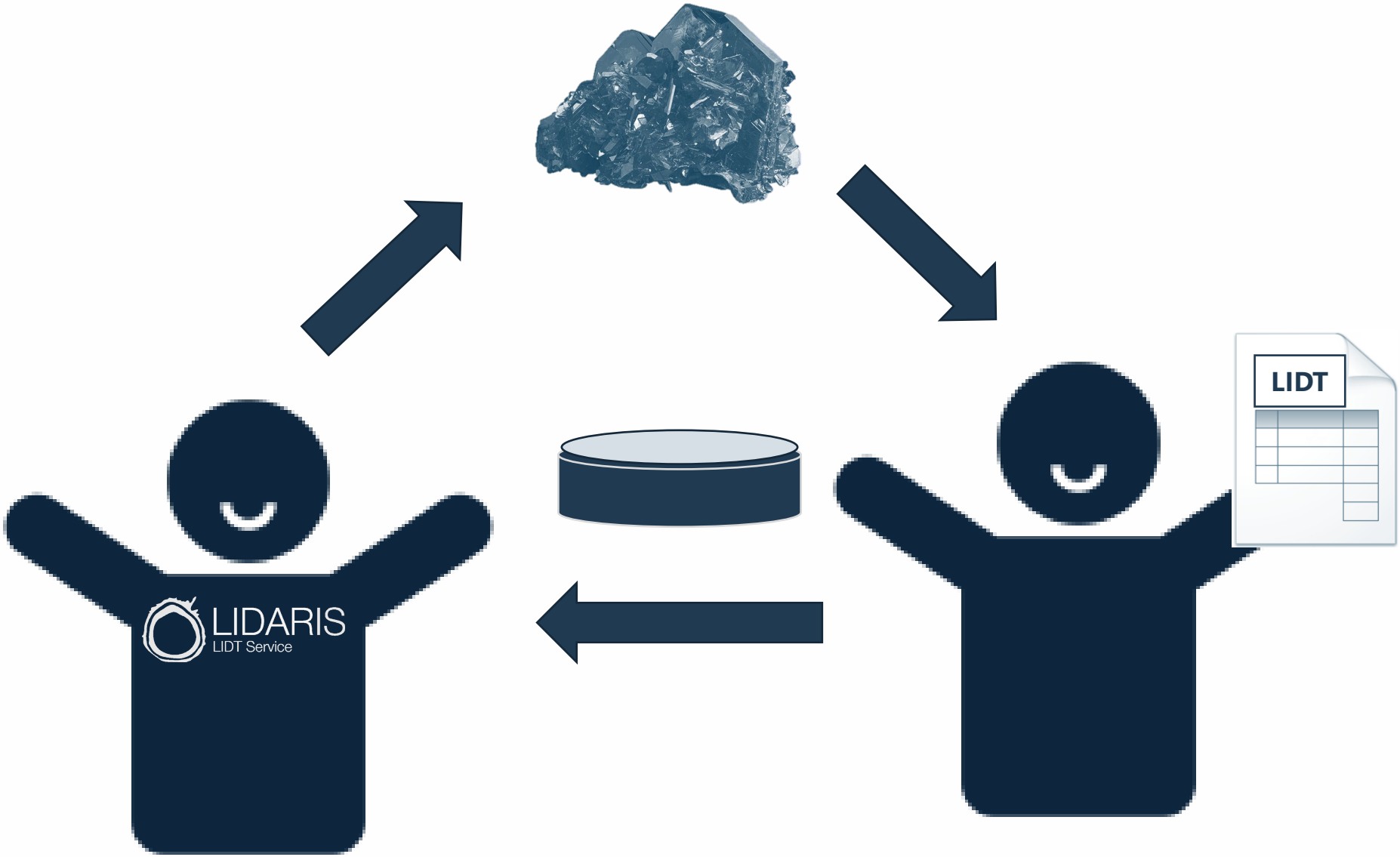

Engineer
1
2
3
Vendor's Company
Testing Company

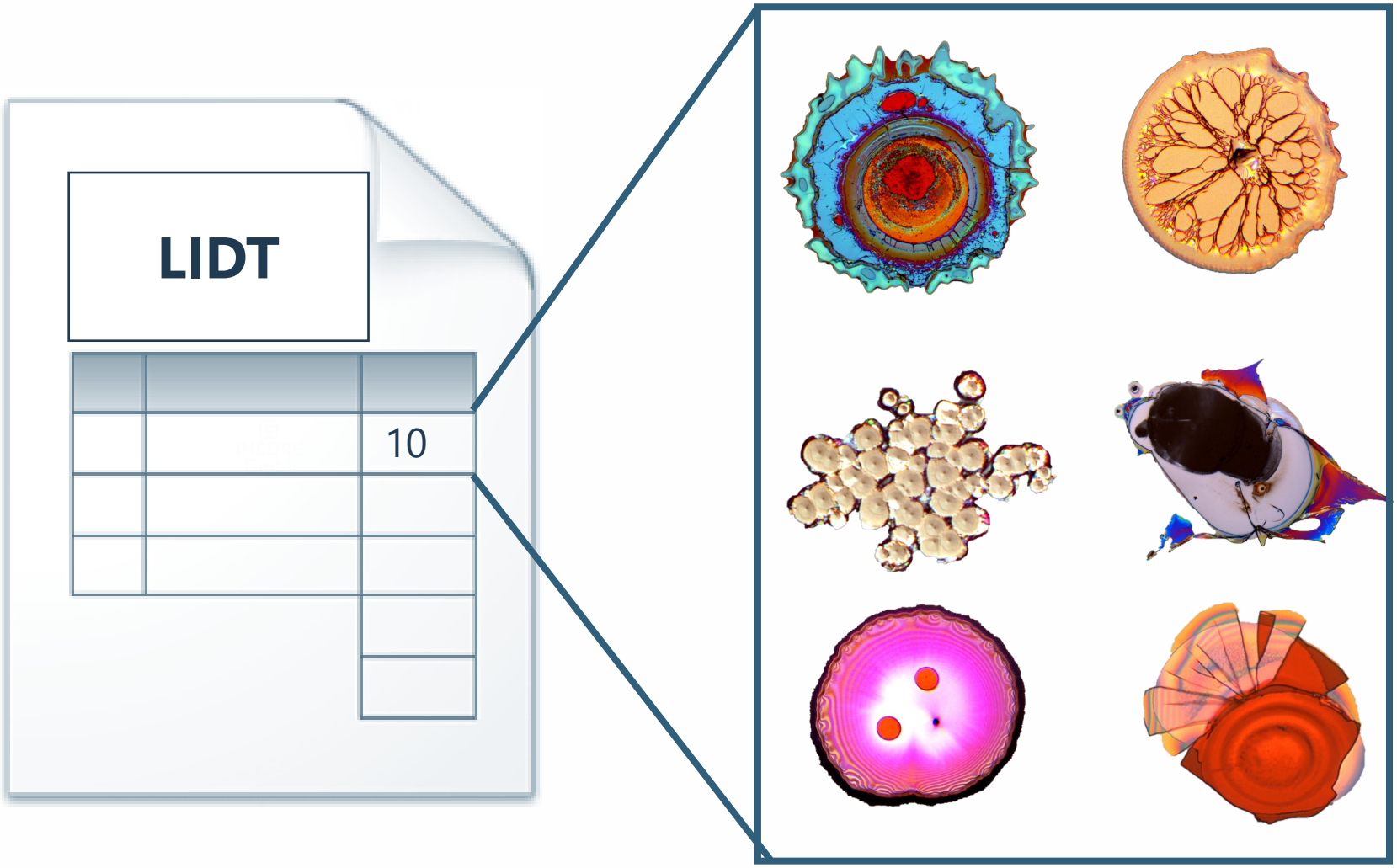
Engineer
1
2
3
Vendor's Company
Testing Company

Engineer
1
2
3
Vendor's Company
Testing Company

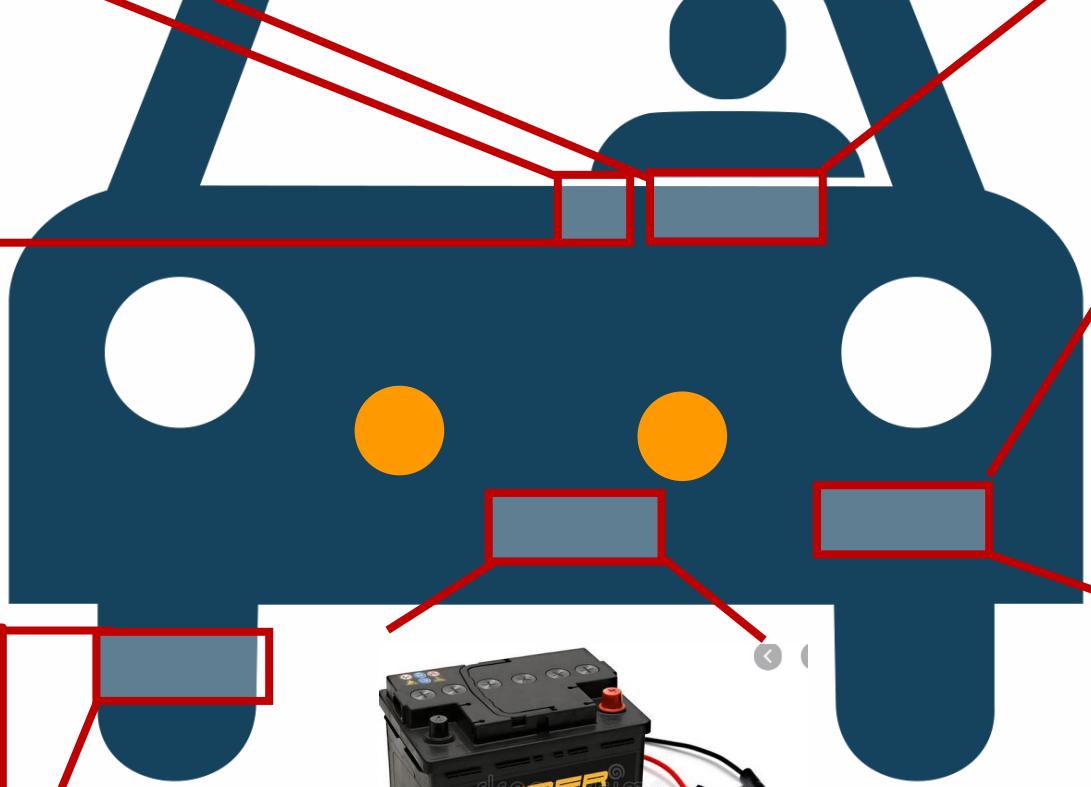
Engineer
1
2
3
Vendor's Company
Testing Company

Then, why optics still get damaged?


LIDT
LIDARIS
LIDT Service


LIDT
10

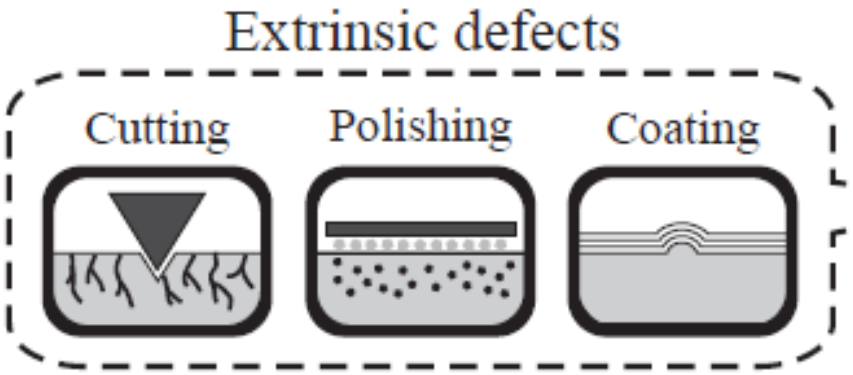
CAR REPAIR SERVICE

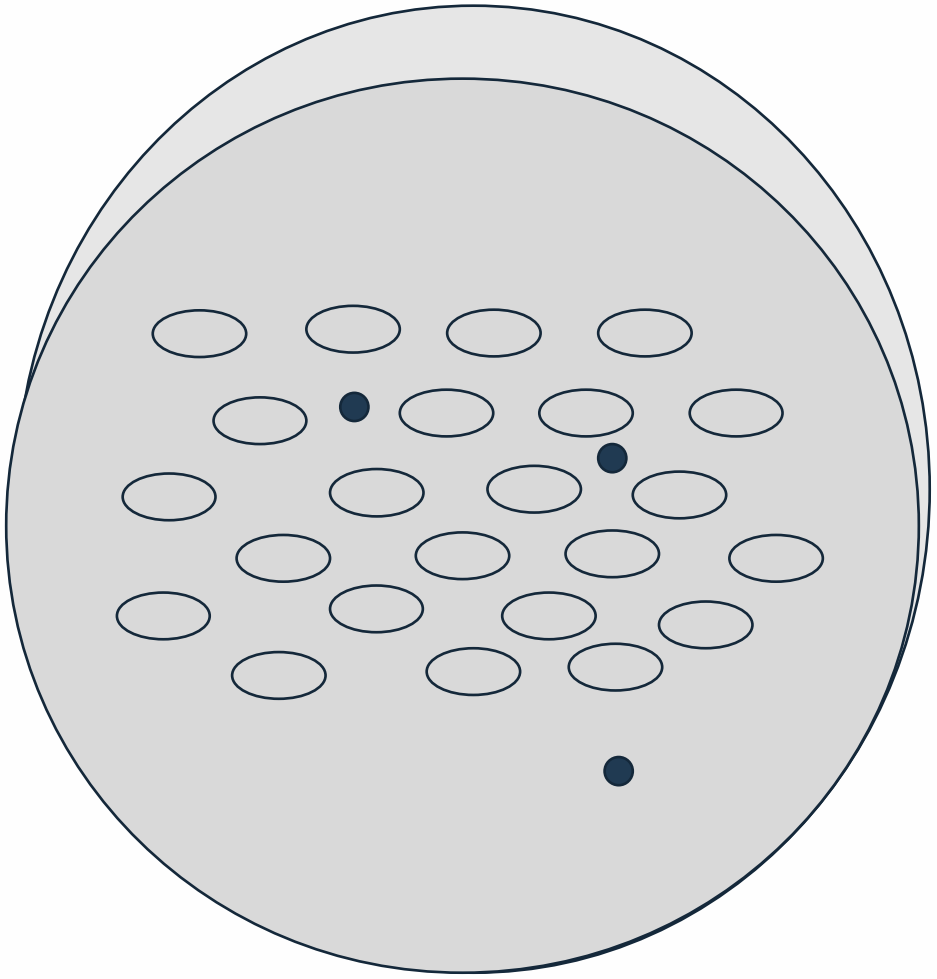


SUPER
CHARGE

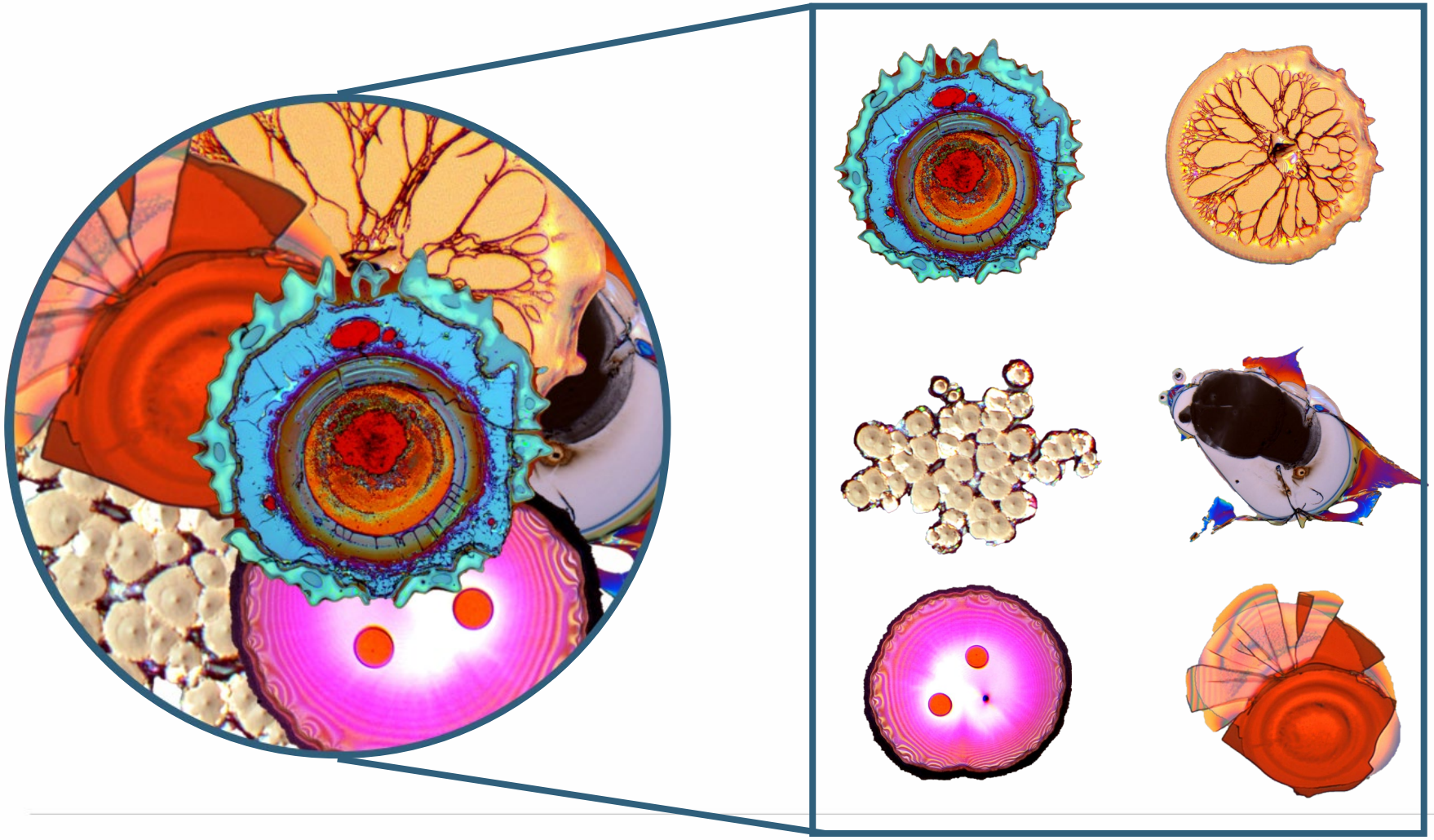
A new way to look at laser damage

SPACE: defect driven damage





„LASER DAMAGE“ -
IS A SINGLE NAME
FOR VERY DIFFERENT PROBLEMS



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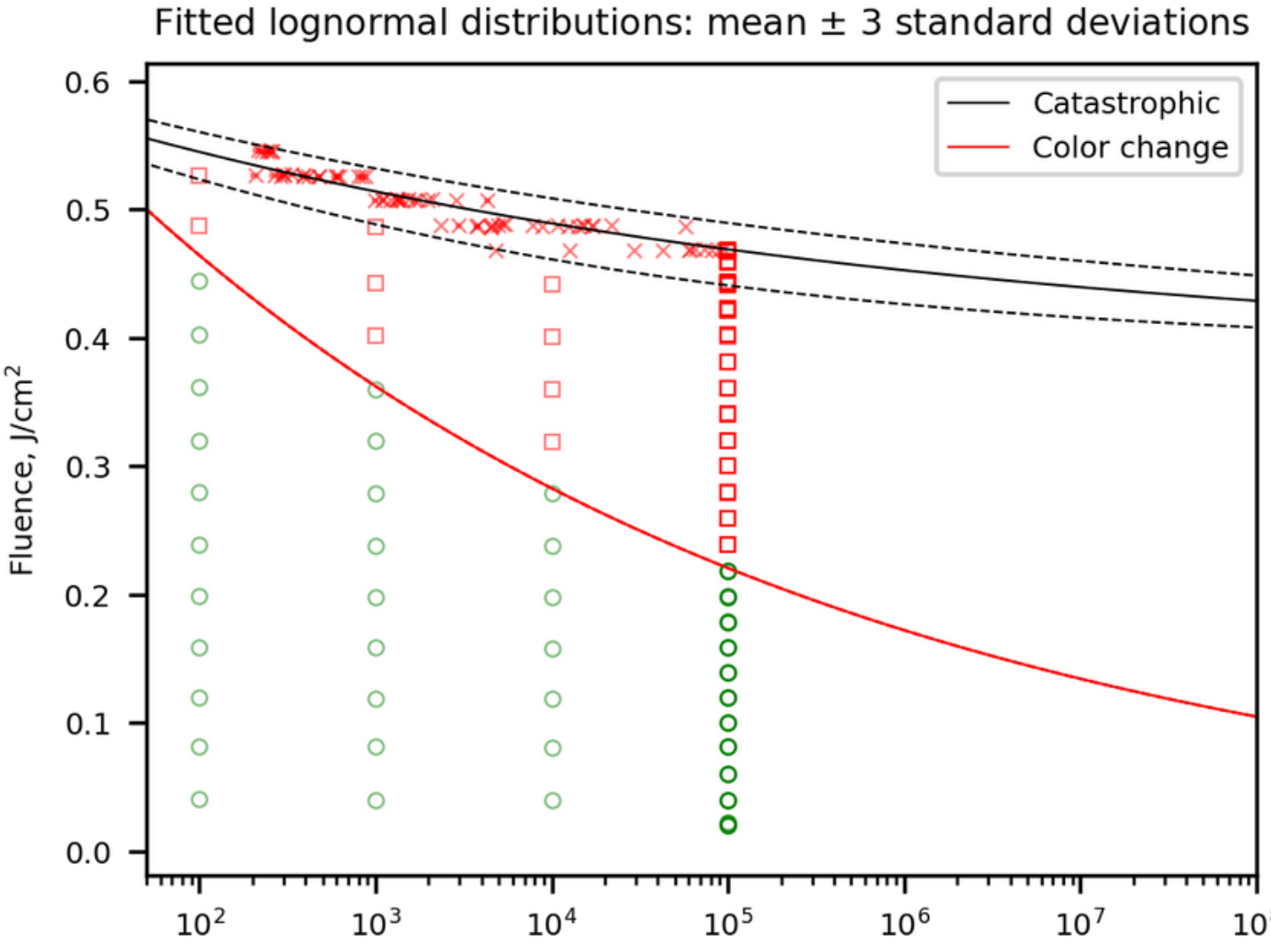
OPTOMAN

IBS HERO

PROJECT: UNIPULSE
1030 nm, 10kHz, 500fsm

Linas Smalakys



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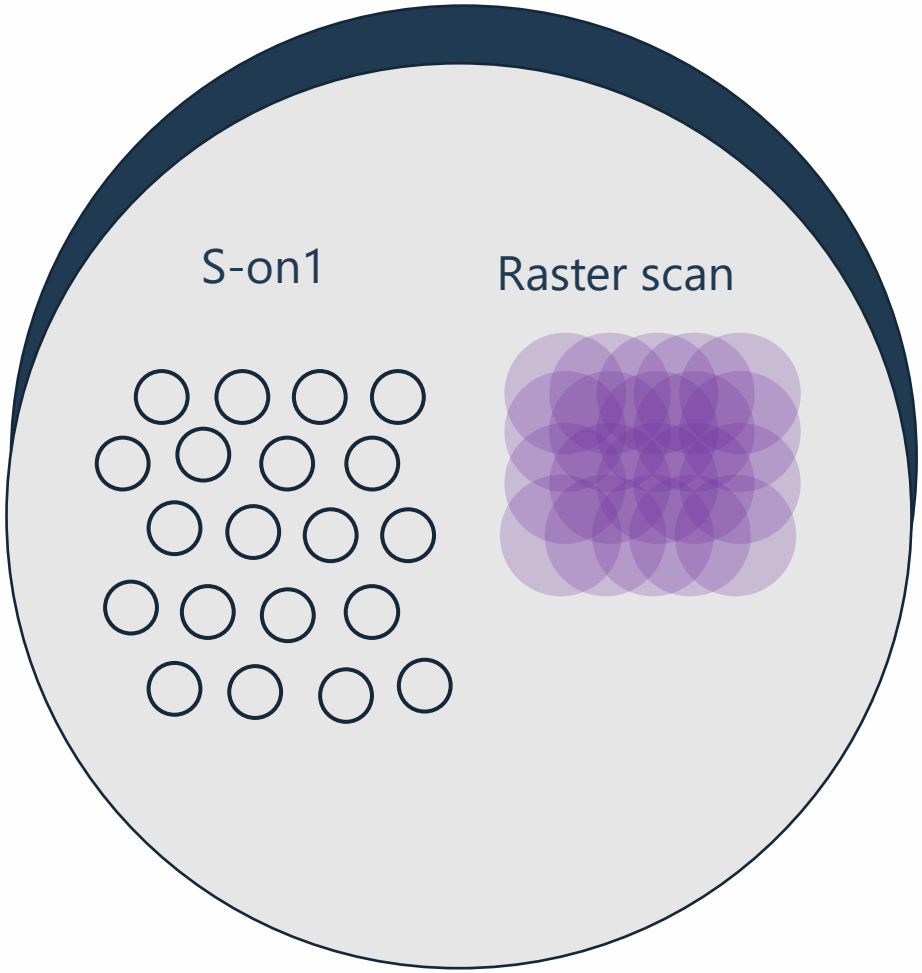
Messages to take home



1. Laser damage is a complex issue

2. Use of the correct testing procedure is a way to benefit from LIDT testing

Find a trusted partner so solve laser damage issue