Video LIDT detection & damage analysis technique “in-situ”

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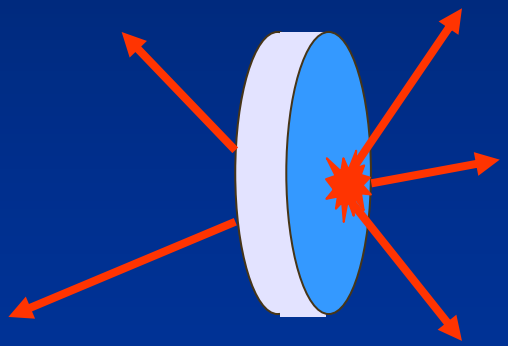
Responsible person: Marco Jupé
Head of department: Detlev Ristau

Hannover
2003

LZH

For understanding ☺

SPECIMEN



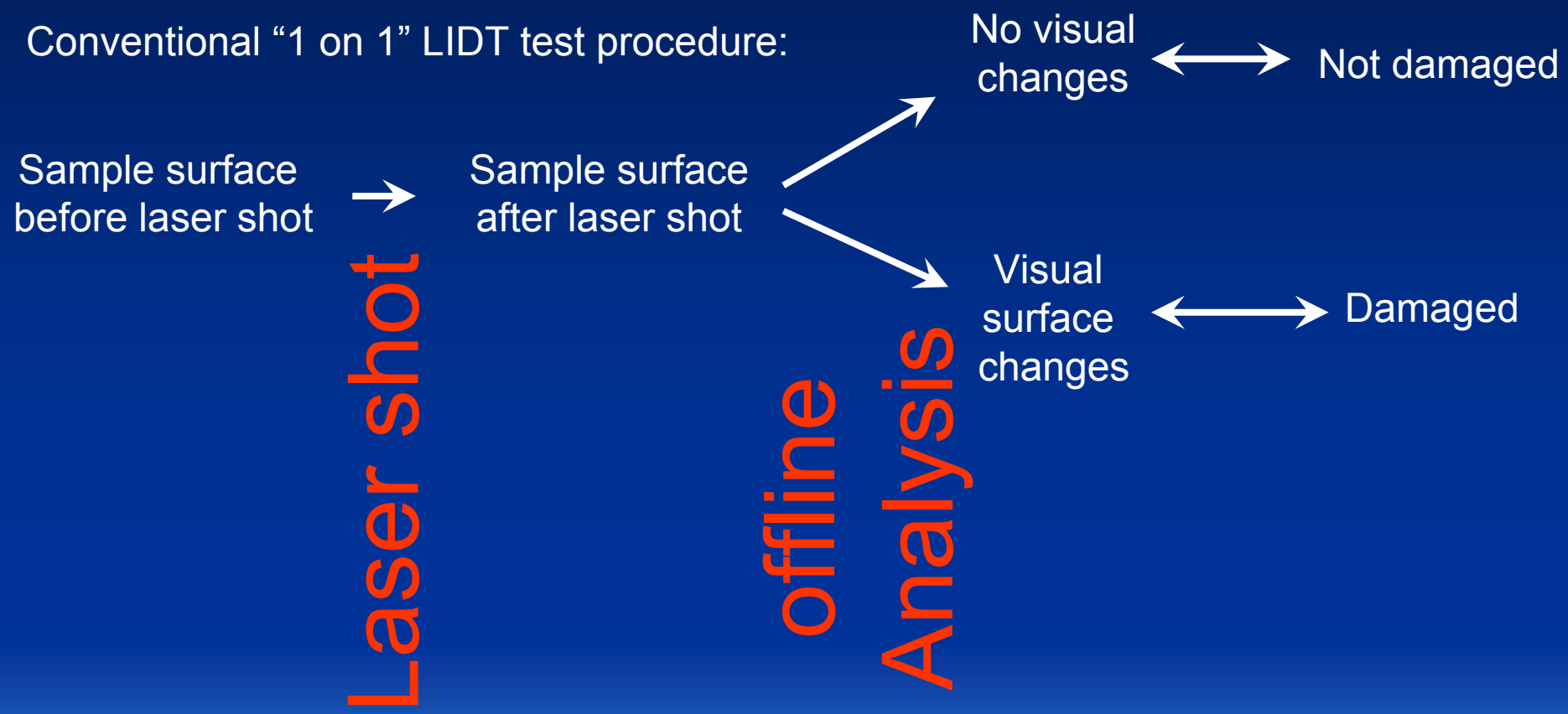
LASER

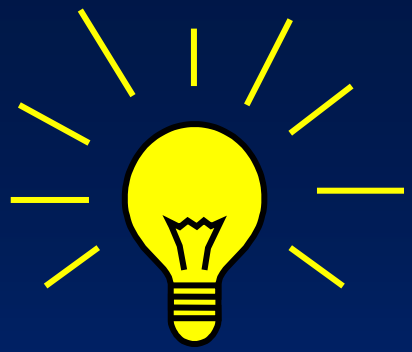
Purpose of the work

In-situ video detection and analysis
set-up for “1 on 1” and “S on 1”
LIDT-measurements
at low repetition rates

The procedure

Conventional “1 on 1” LIDT test procedure:

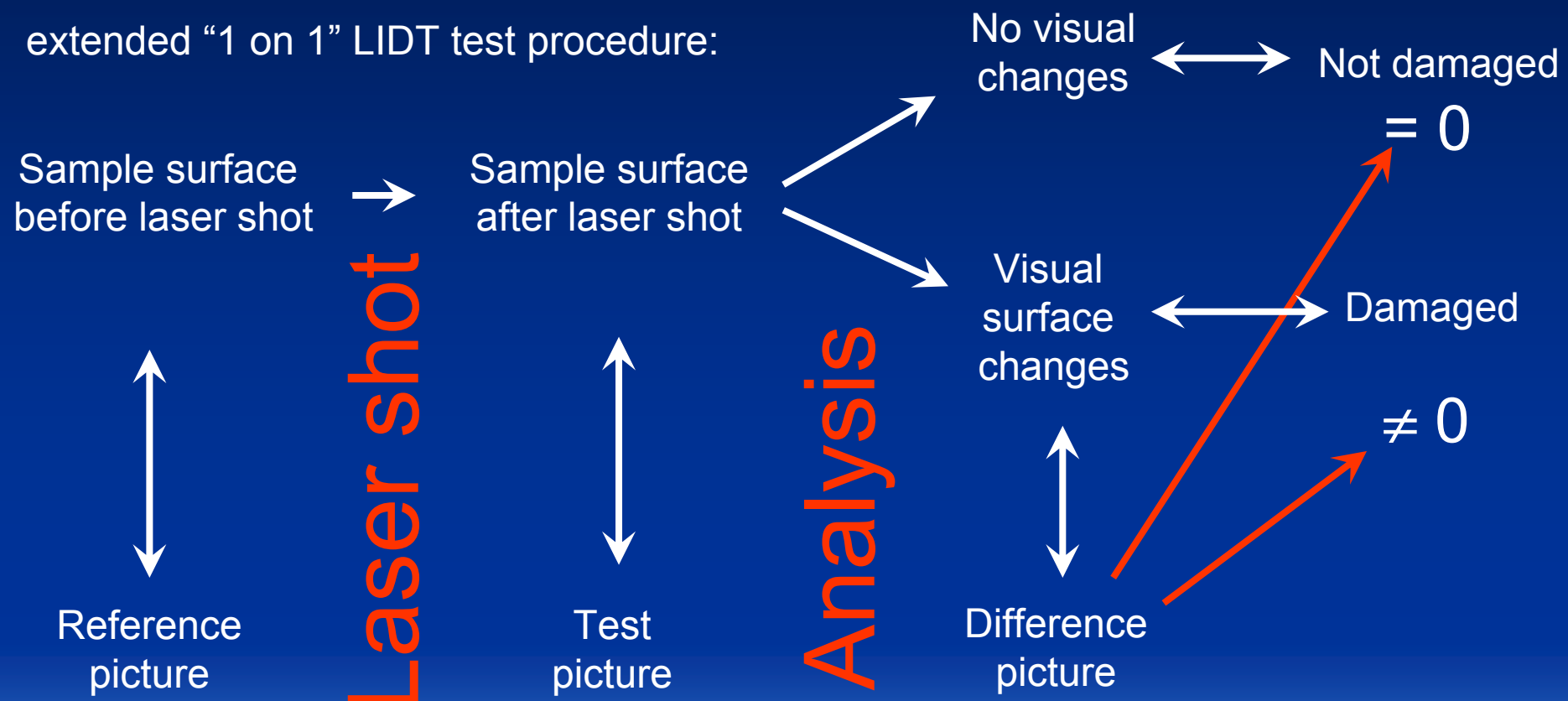




The main idea

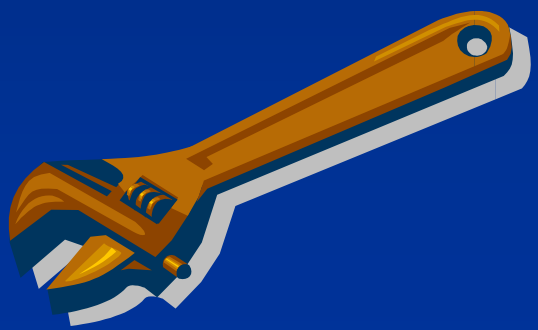
Picture of the specimen surface before laser shot	“–”	Picture of the specimen surface after laser shot	“=”	?

The procedure

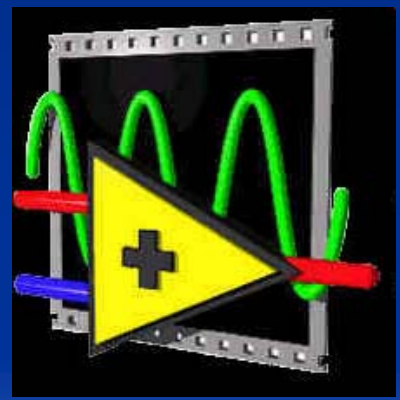


Know how ☺

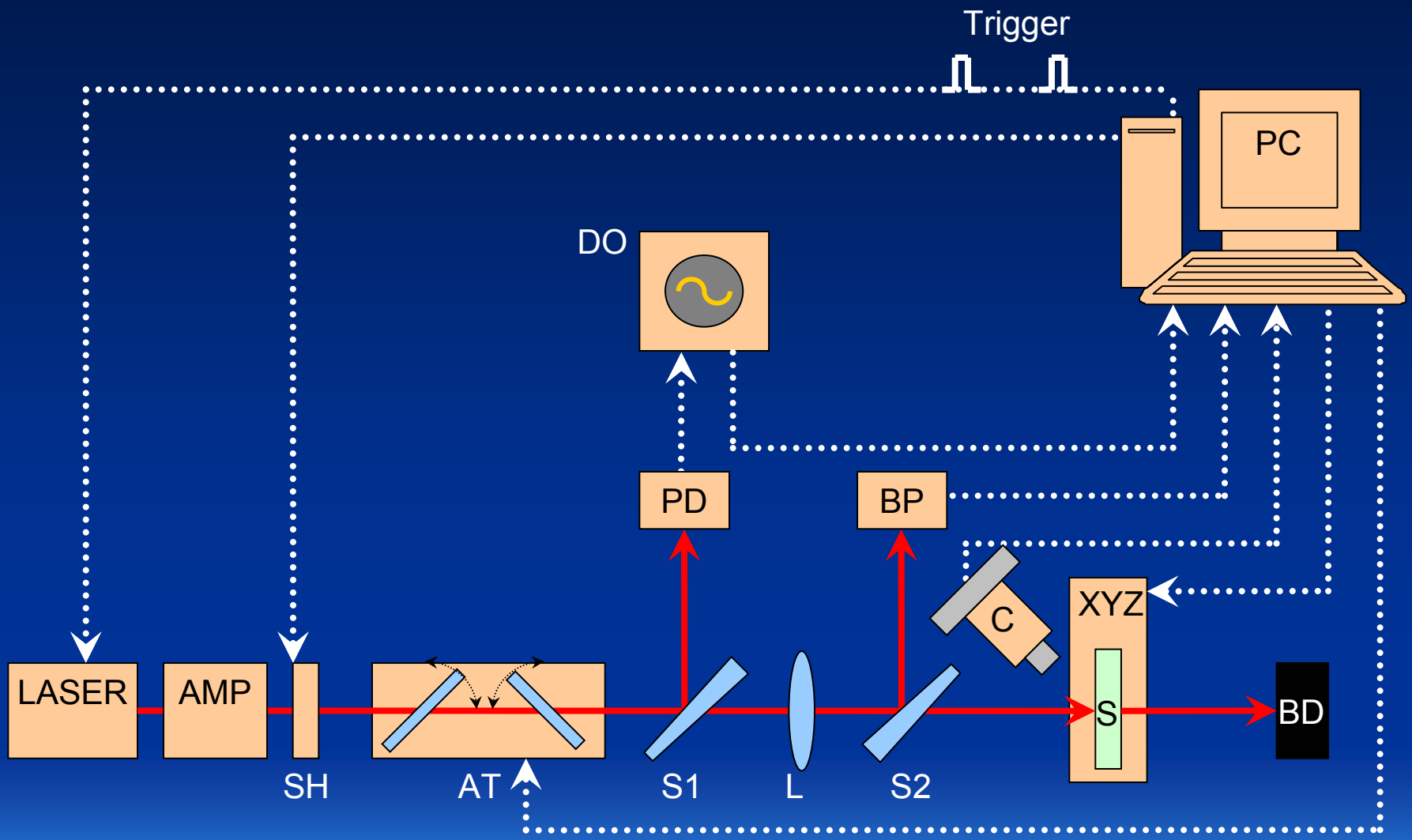
“Hardware”



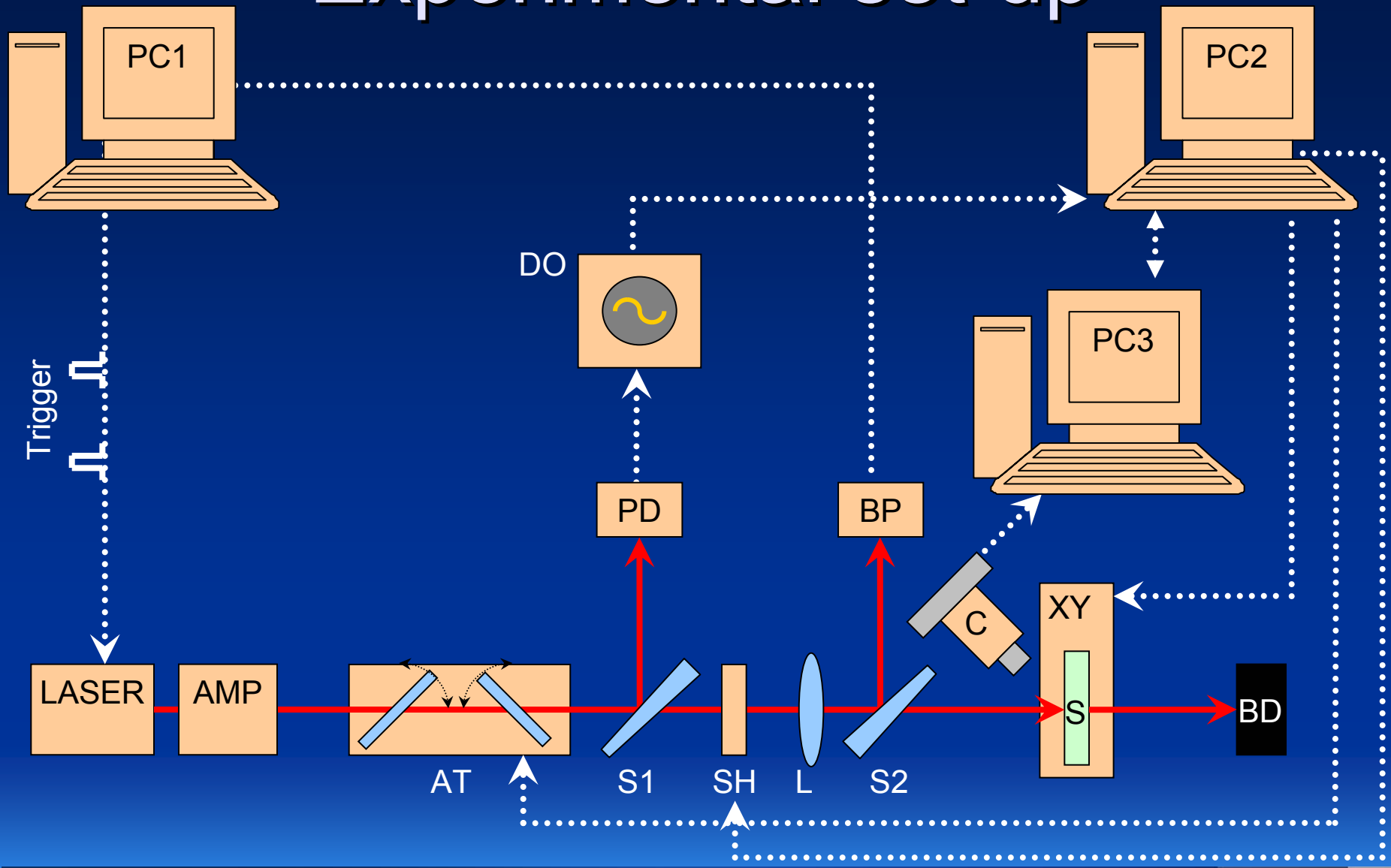
“Software”



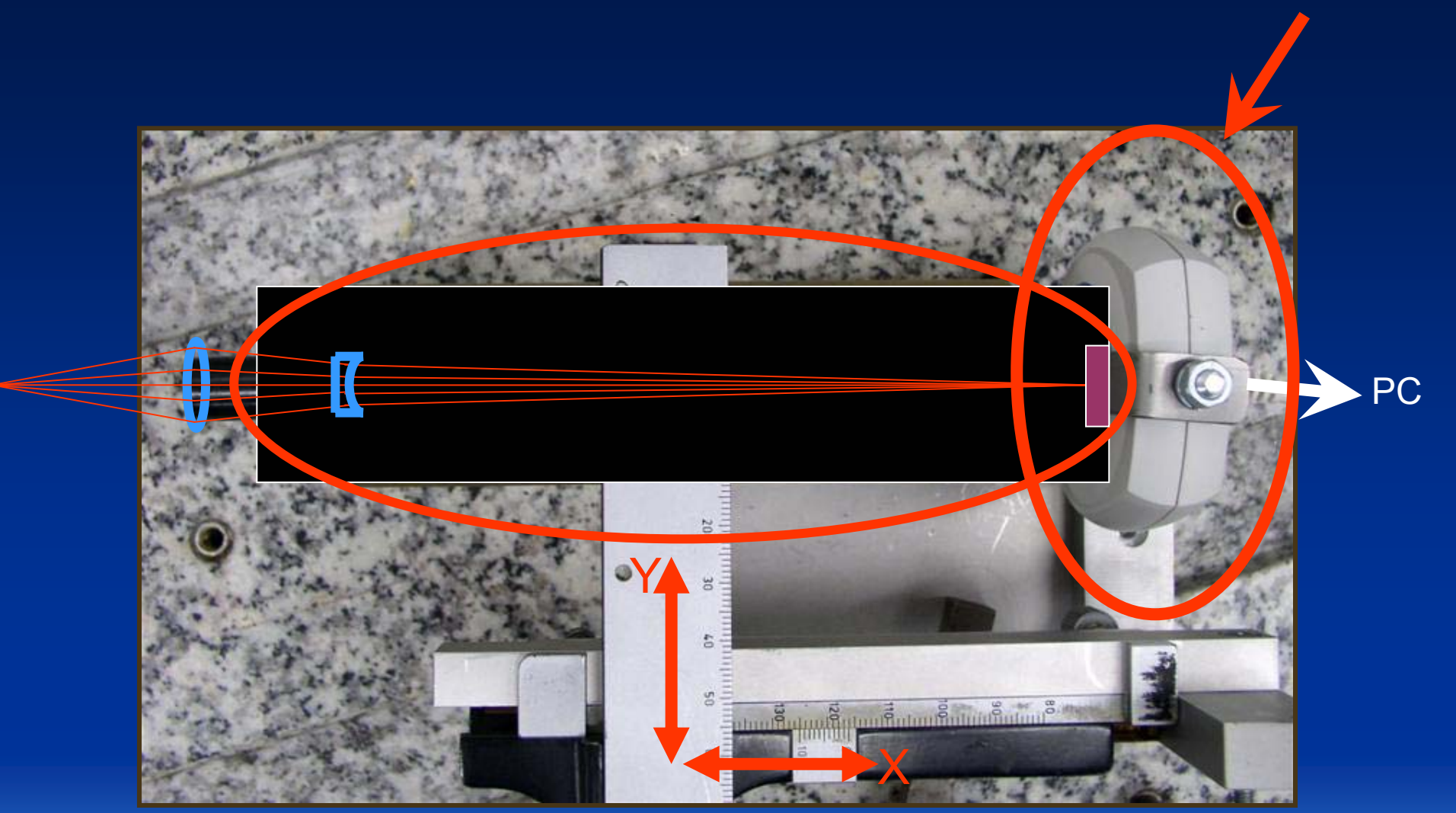
Experimental set-up



Experimental set-up

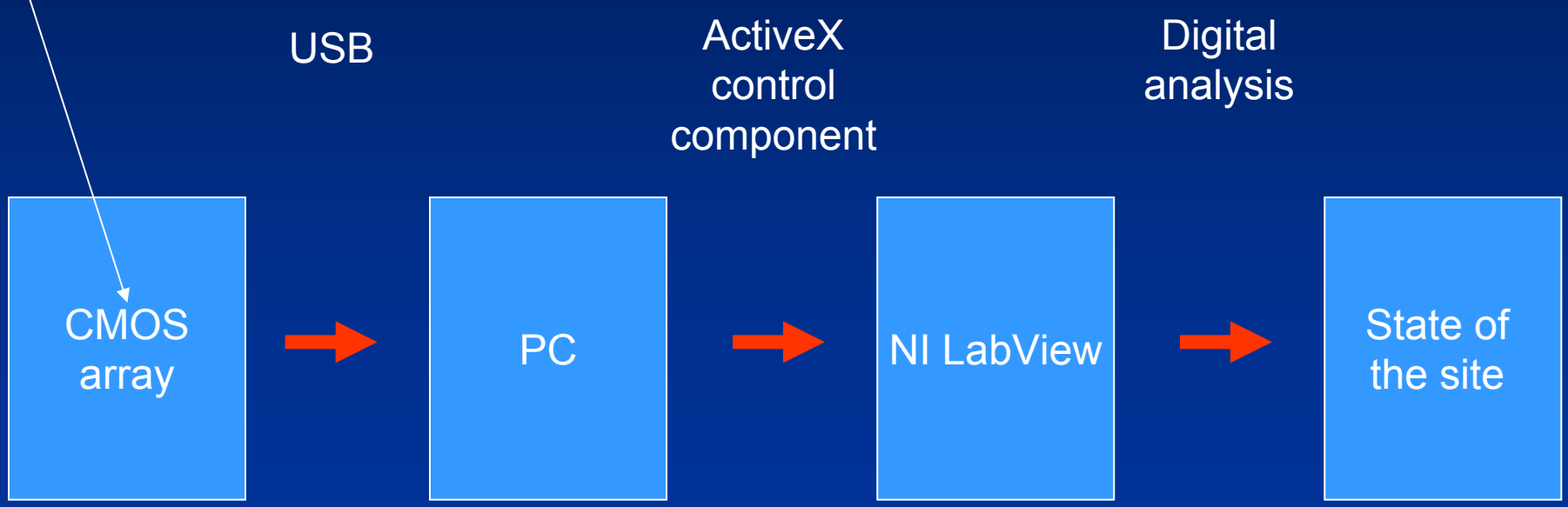


Detection module

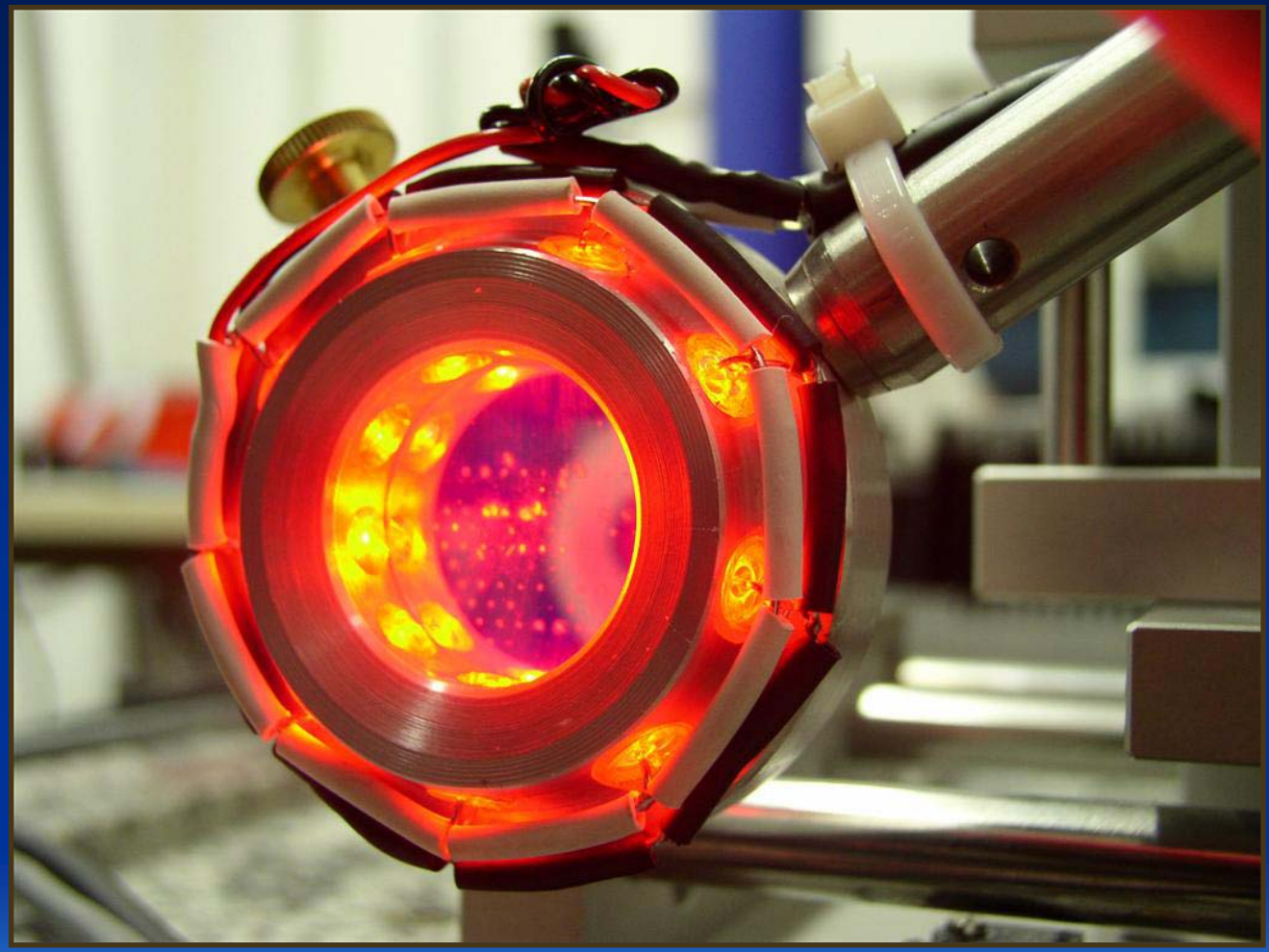


Communication interface

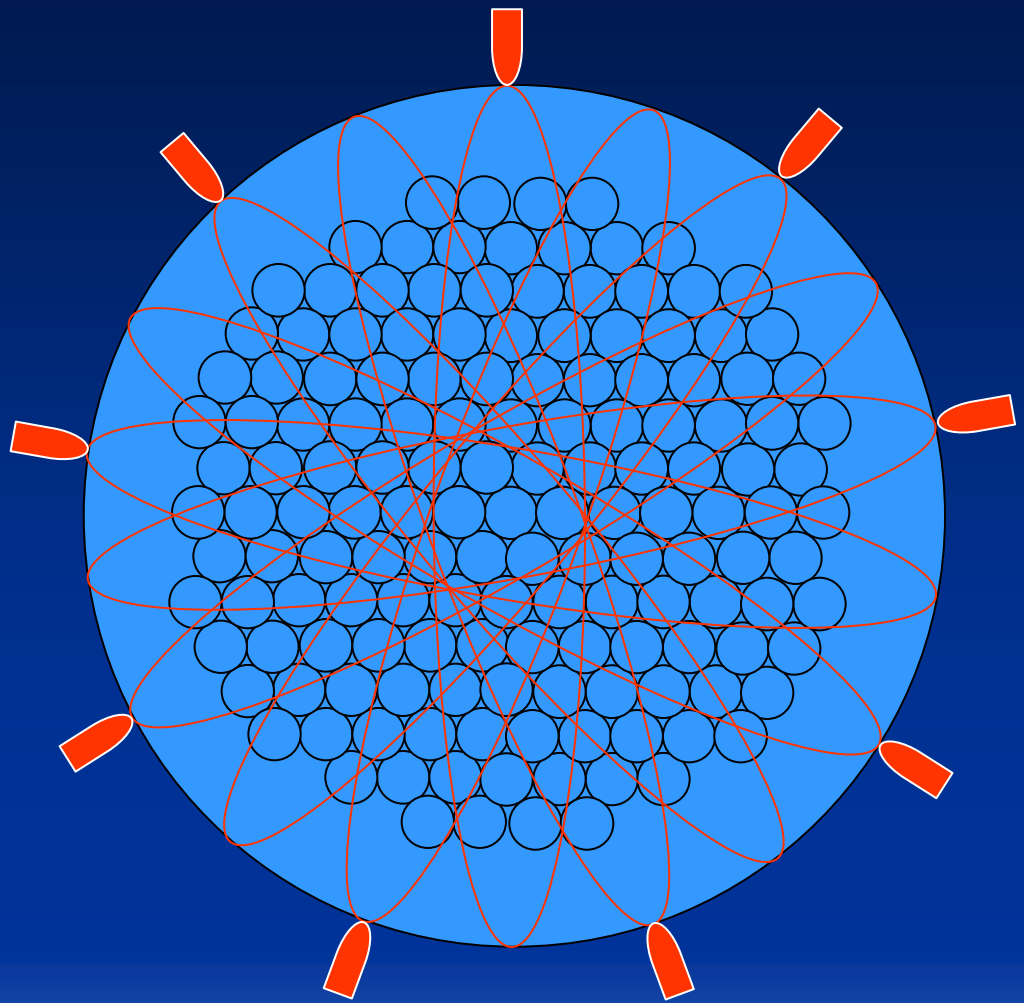
Complementary Metal Oxide Semiconductor



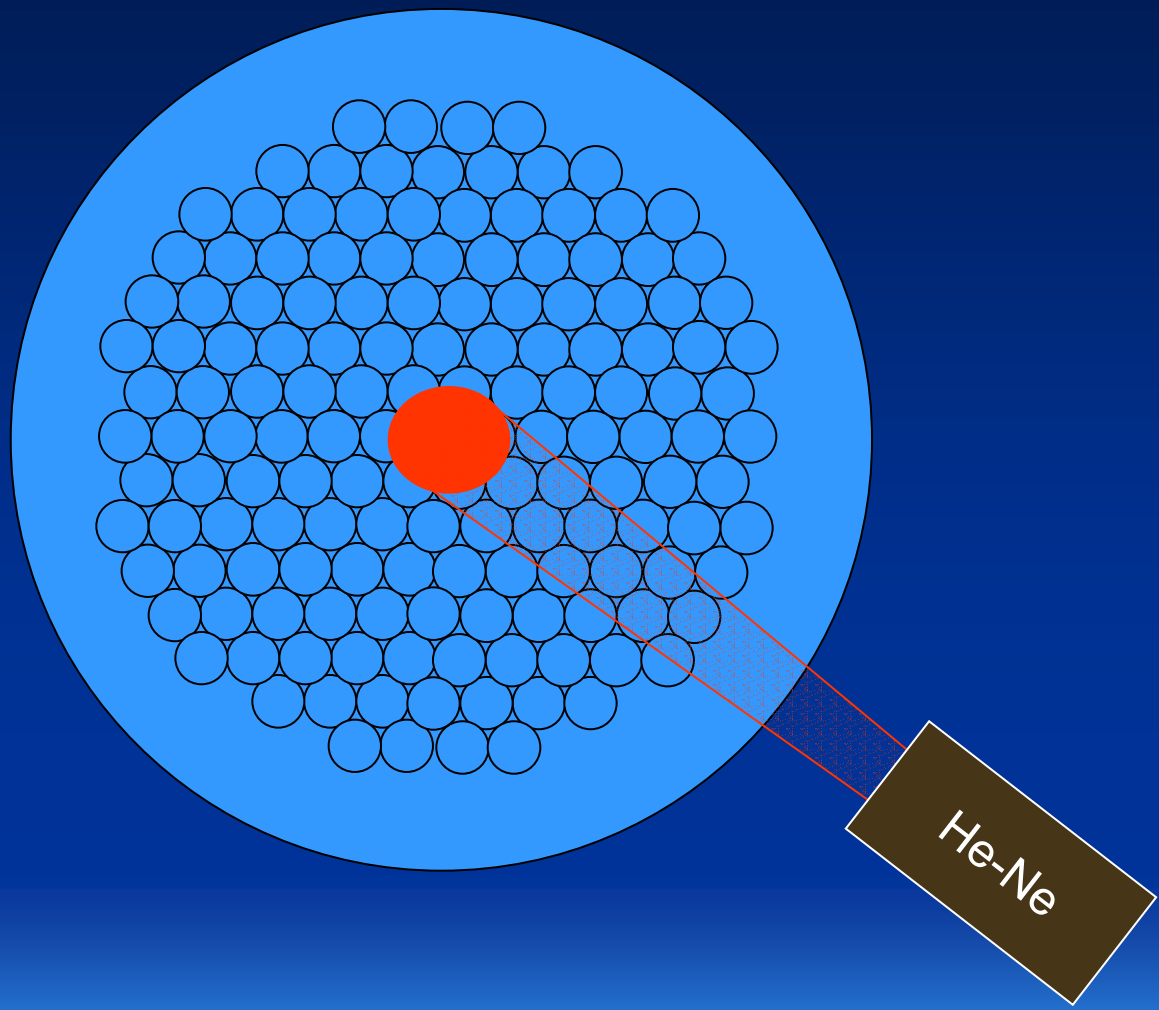
Sample holder



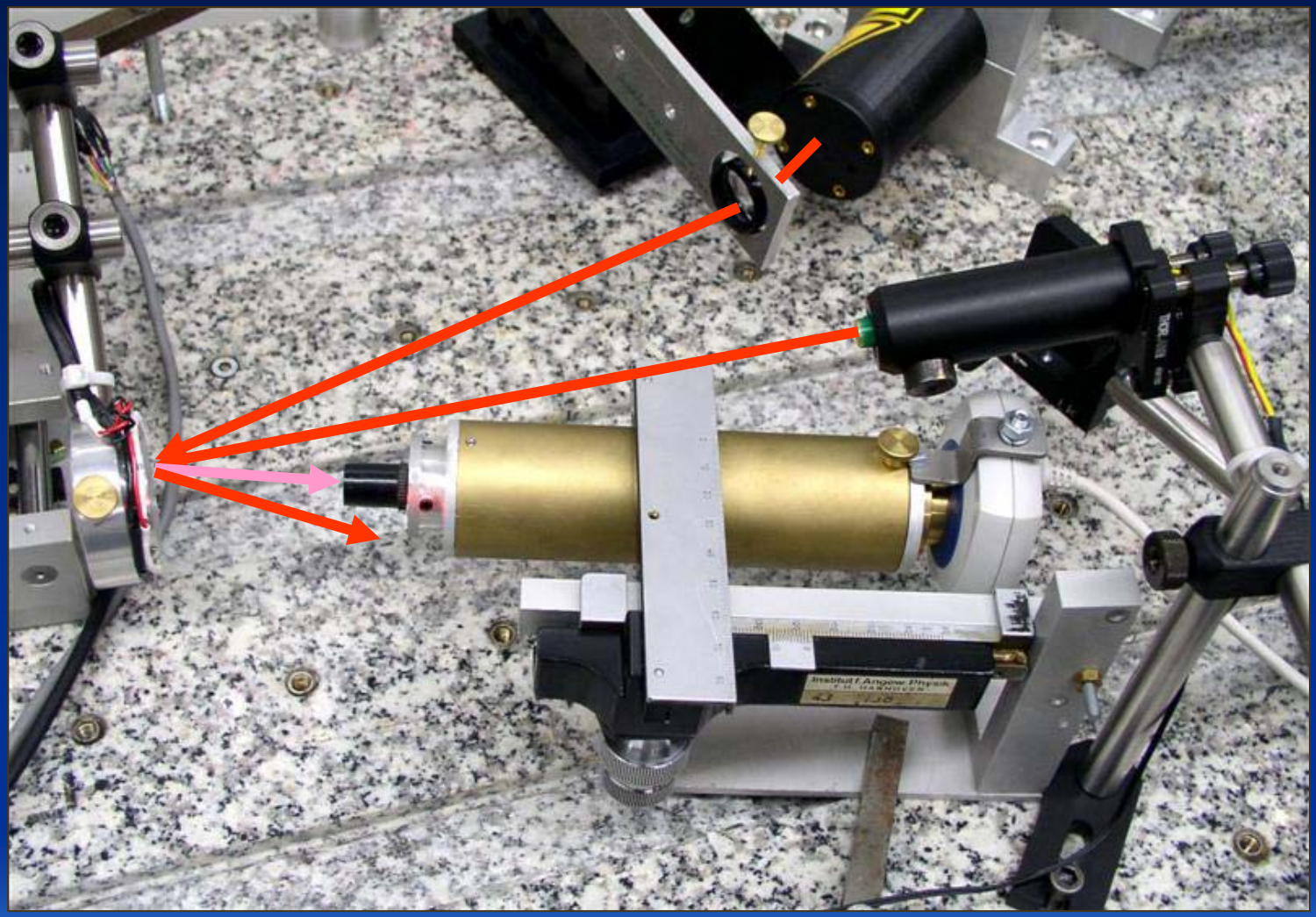
Diode lighted sample



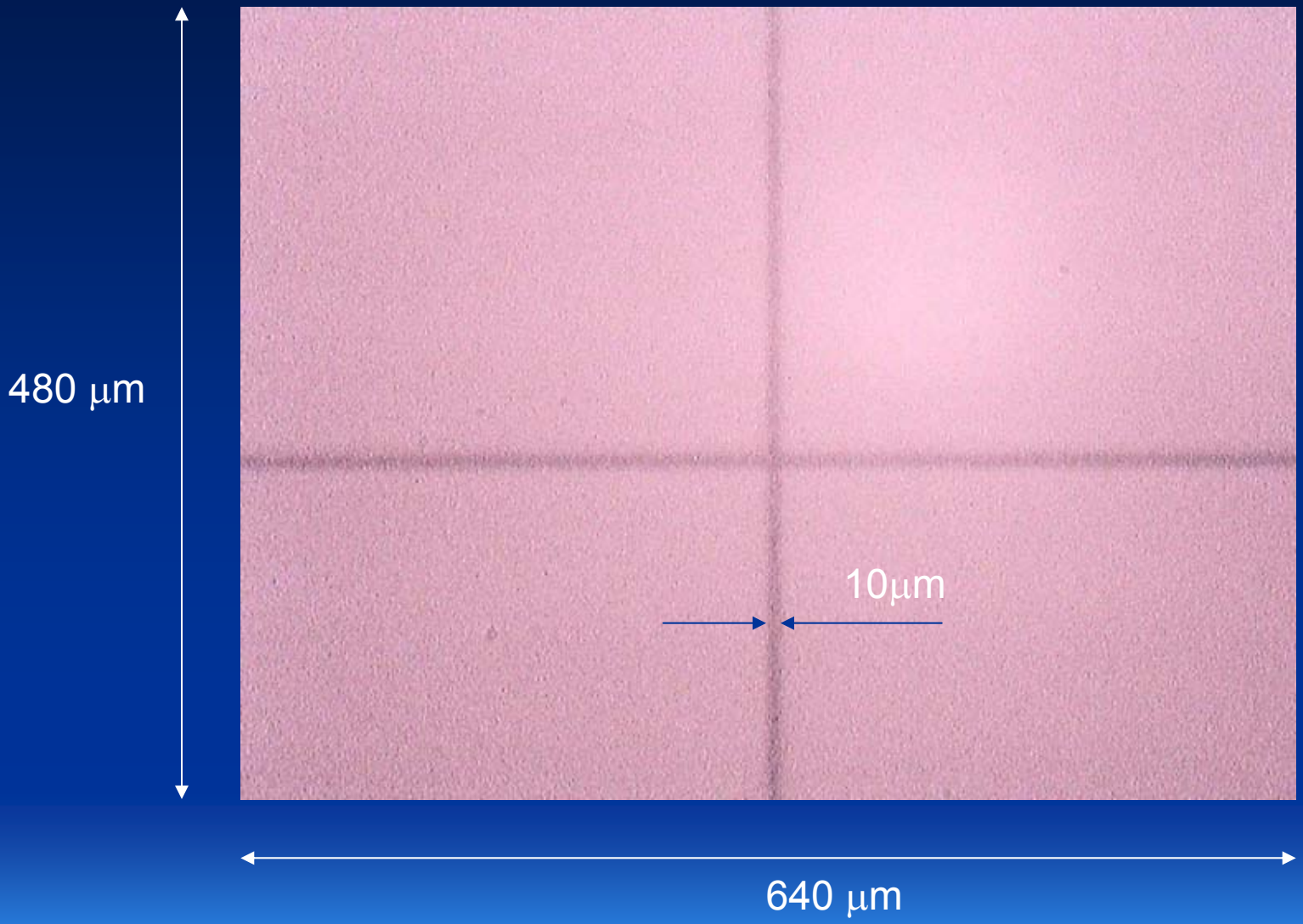
He-Ne lighted sample

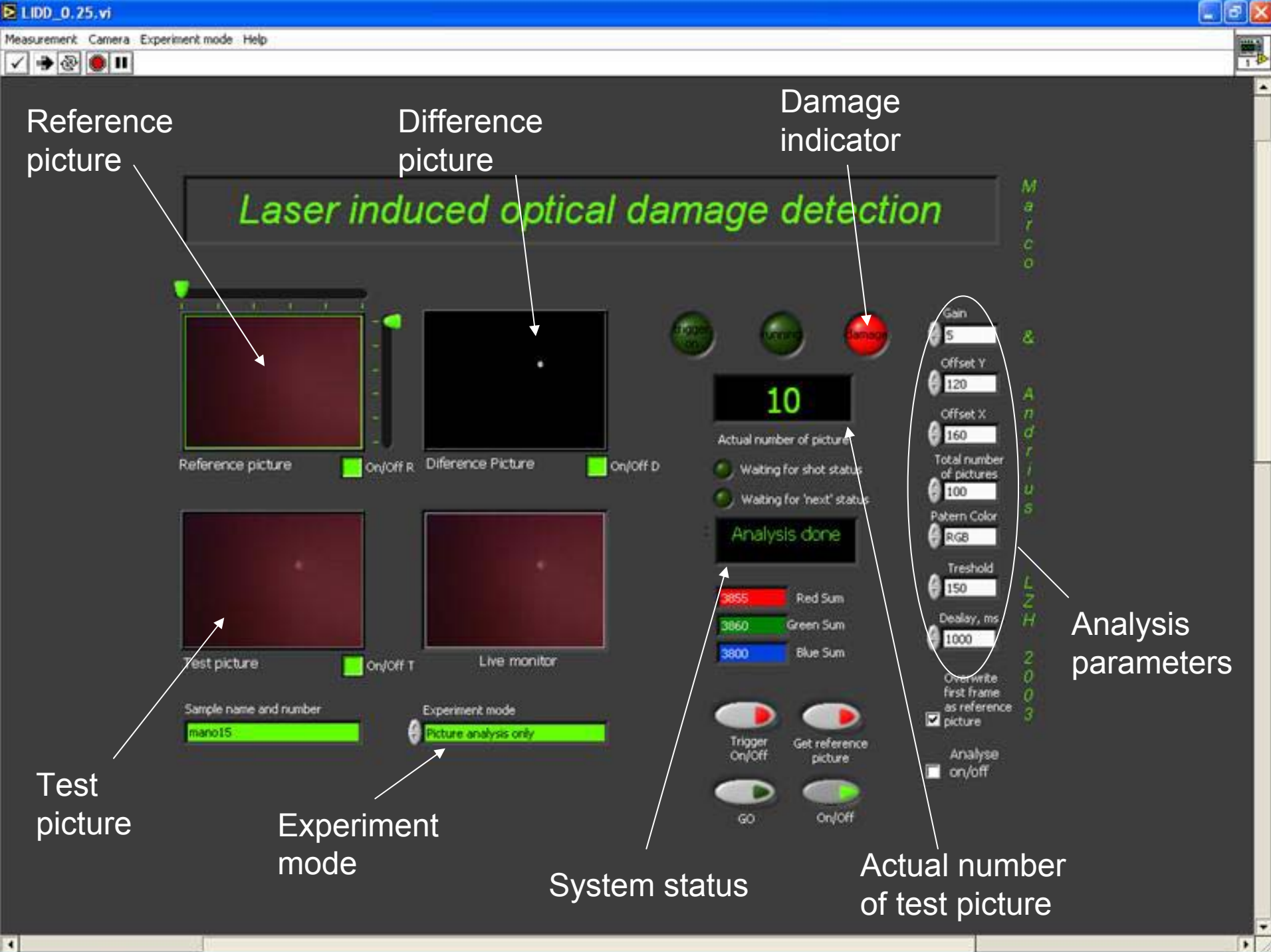


Set-up in real life



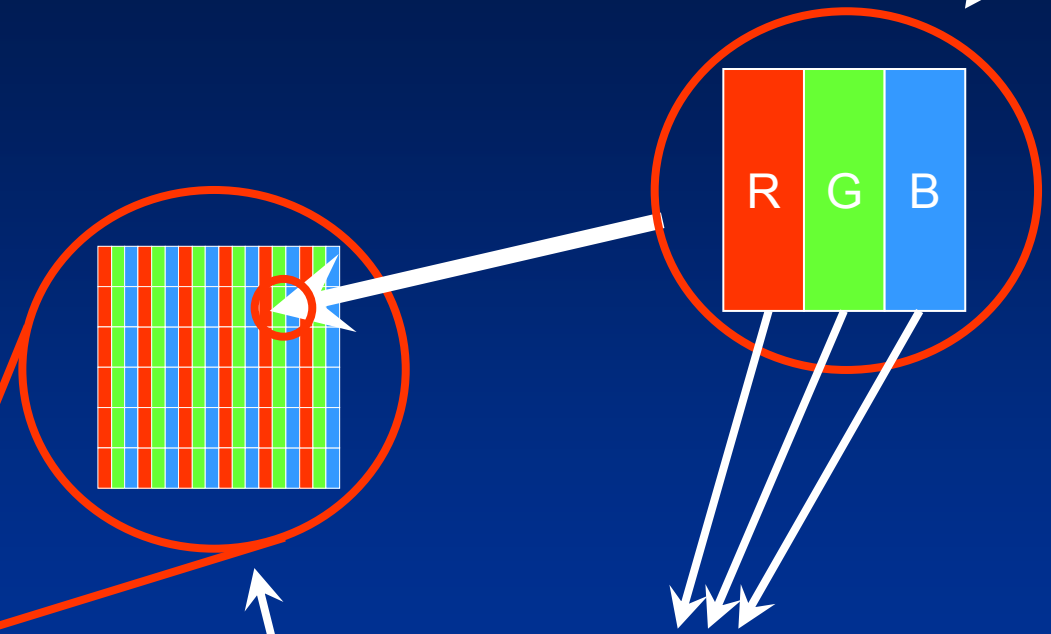
Magnification




LIDD_0.25.vi
Measurement Camera Experiment mode Help
Laser induced optical damage detection
Marco & Andrius LZH 2003
Reference picture
Difference picture
Damage indicator
Reference picture
On/Off R
Difference Picture
On/Off D
Test picture
On/Off T
Live monitor
Sample name and number
mano15
Experiment mode
Picture analysis only
10
Actual number of pictures
Waiting for shot status
Waiting for 'next' status
Analysis done
3855
Red Sum
3860
Green Sum
3800
Blue Sum
Trigger On/Off
Get reference picture
GO
On/Off
Gain
5
Offset Y
120
Offset X
160
Total number of pictures
100
Patern Color
RGB
Treshold
150
Dealay, ms
1000
Overwrite first frame as reference picture
Analyse on/off
Analysis parameters
Test picture
Experiment mode
System status
Actual number of test picture

Digital image structure

1 pixel



Digital photo:

pixel
array

8 bits = 2^8 = 256
different states:

0 … 255

Digital Signal Processing

Σ(RGB)

Before shot:

1	1	1	1	1	1	0	0	0
1	1	1	1	1	1	1	0	0
2	2	1	1	1	1	1	0	0
2	2	1	1	1	1	1	0	0
1	1	1	1	1	1	0	0	0

Reference picture

“_”

After shot:

1	1	1	1	2	2	0	0	0
1	1	1	2	9	8	2	0	0
2	2	1	2	7	9	2	0	0
2	2	1	1	2	2	1	0	0
1	1	1	1	1	1	0	0	0

Test picture

“=”

Difference:

0	0	0	0	1	1	0	0	0
0	0	0	1	8	7	1	0	0
0	0	0	1	6	8	1	0	0
0	0	0	0	1	1	0	0	0
0	0	0	0	0	0	0	0	0

Difference picture

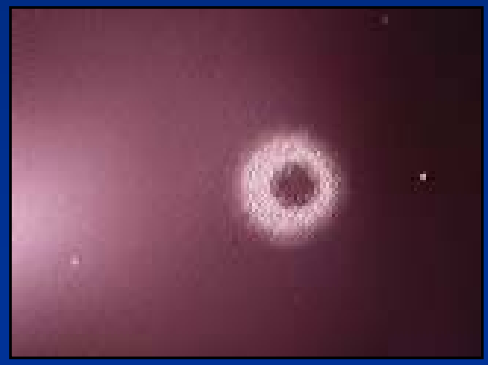
Digital Signal Processing (1 on 1)

Before shot:

Reference picture

“−”

After shot:



Test picture

“=”

Difference:

Difference picture

Digital Signal Processing (1 on 1)

Before shot:

Reference picture

“−”

After shot:

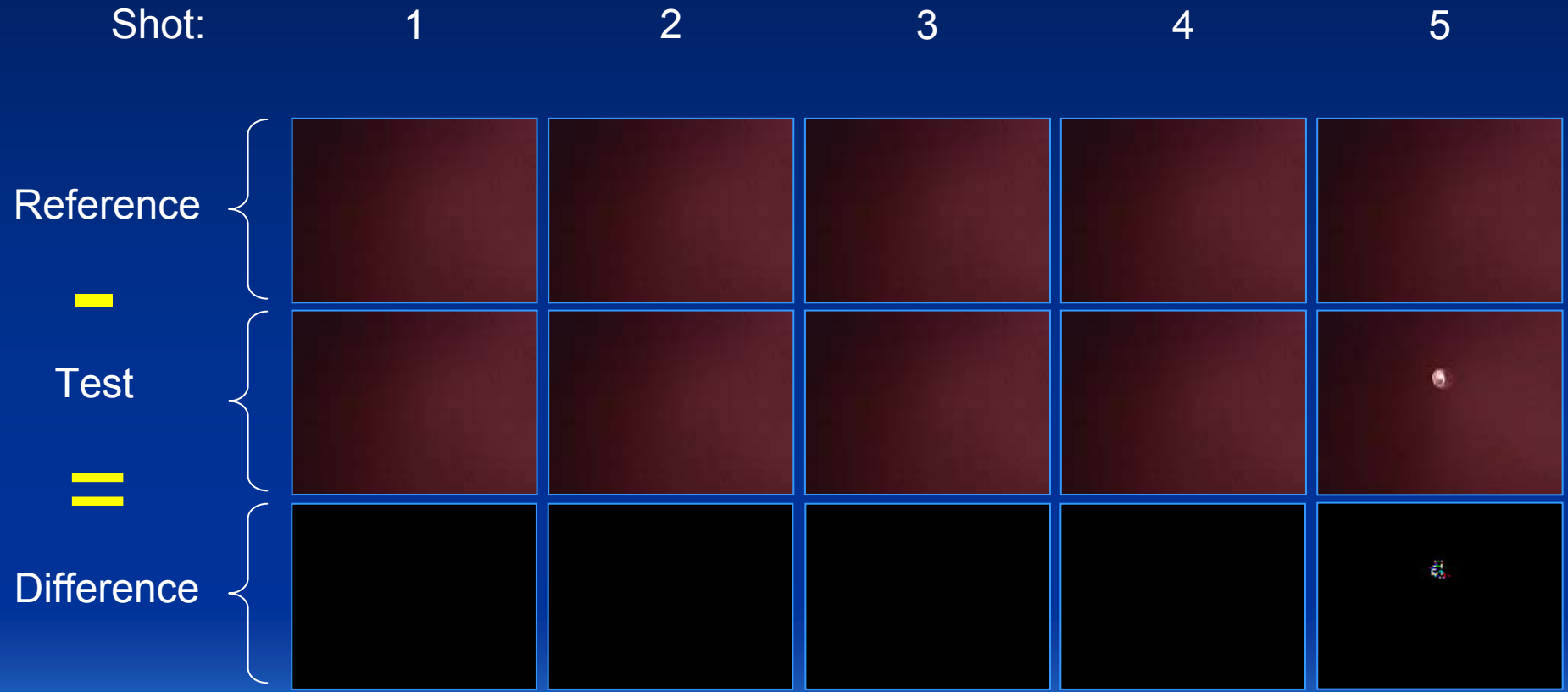
Test picture

“=”

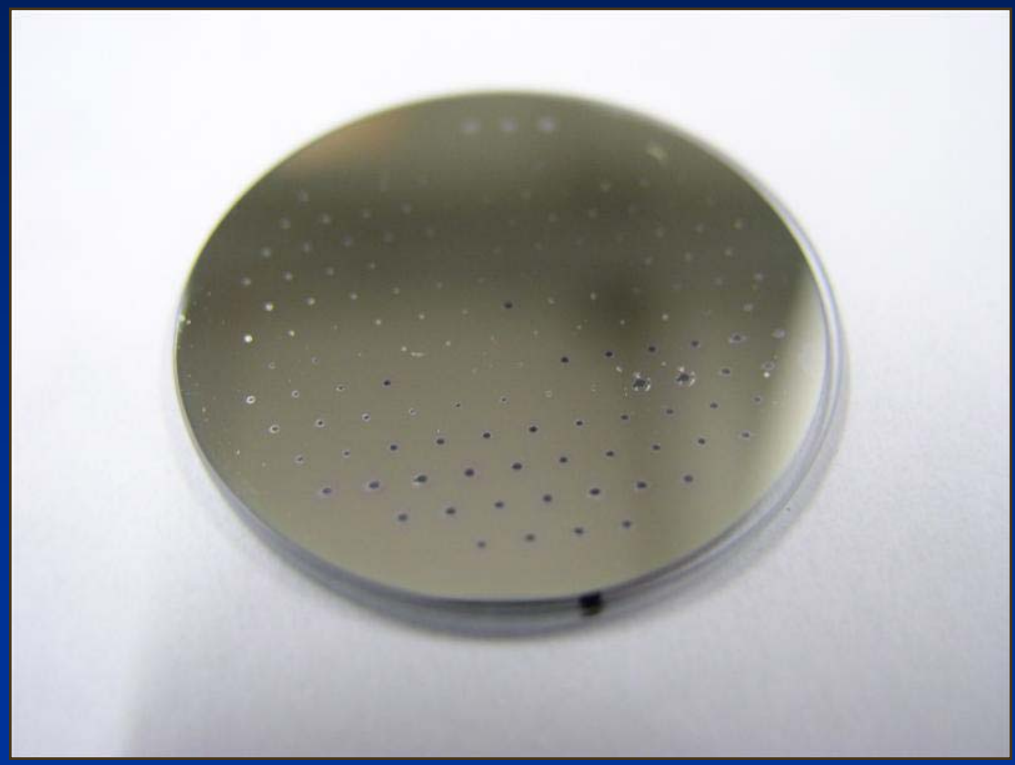
Difference:

Difference picture

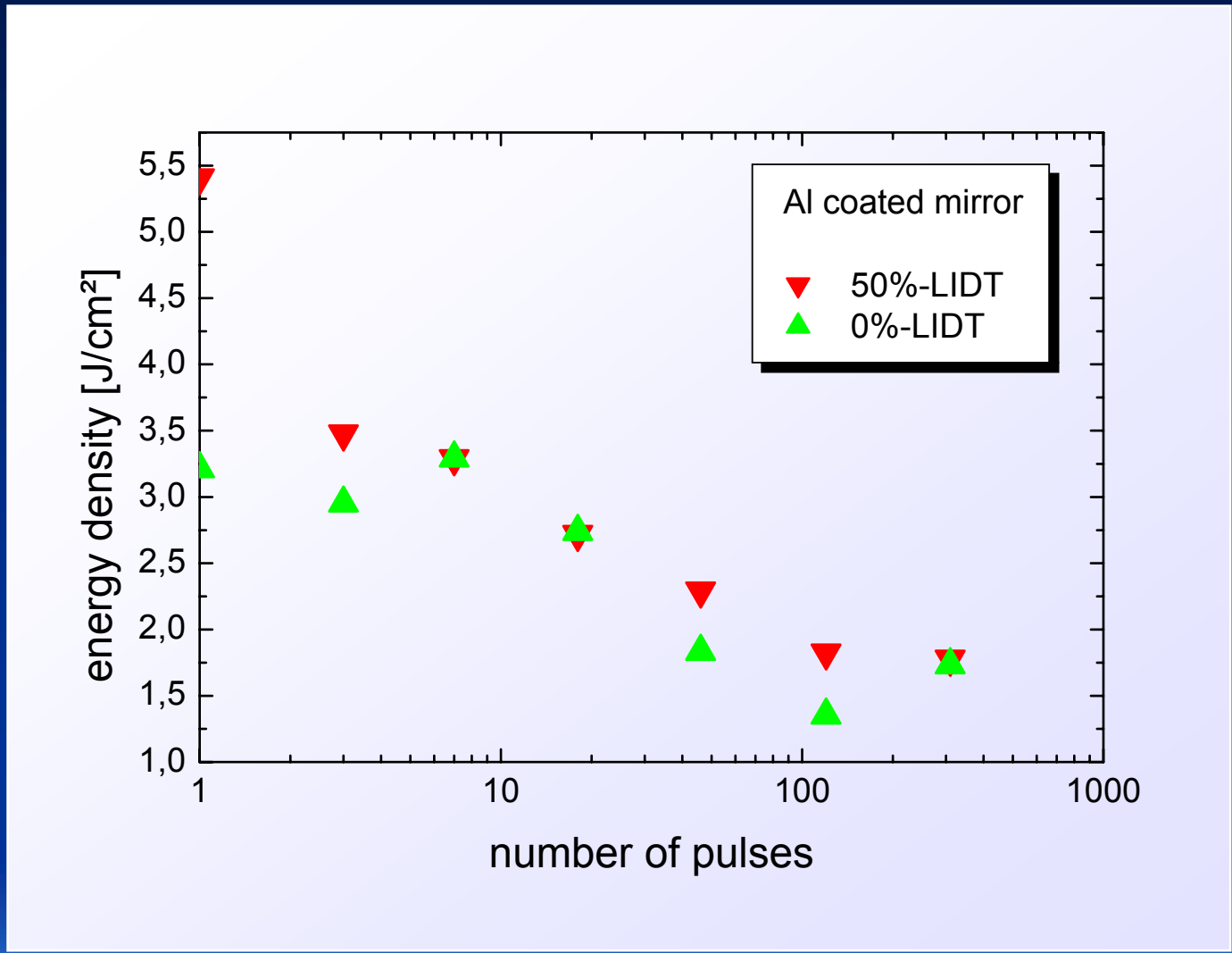
Digital Signal Processing (S on 1)



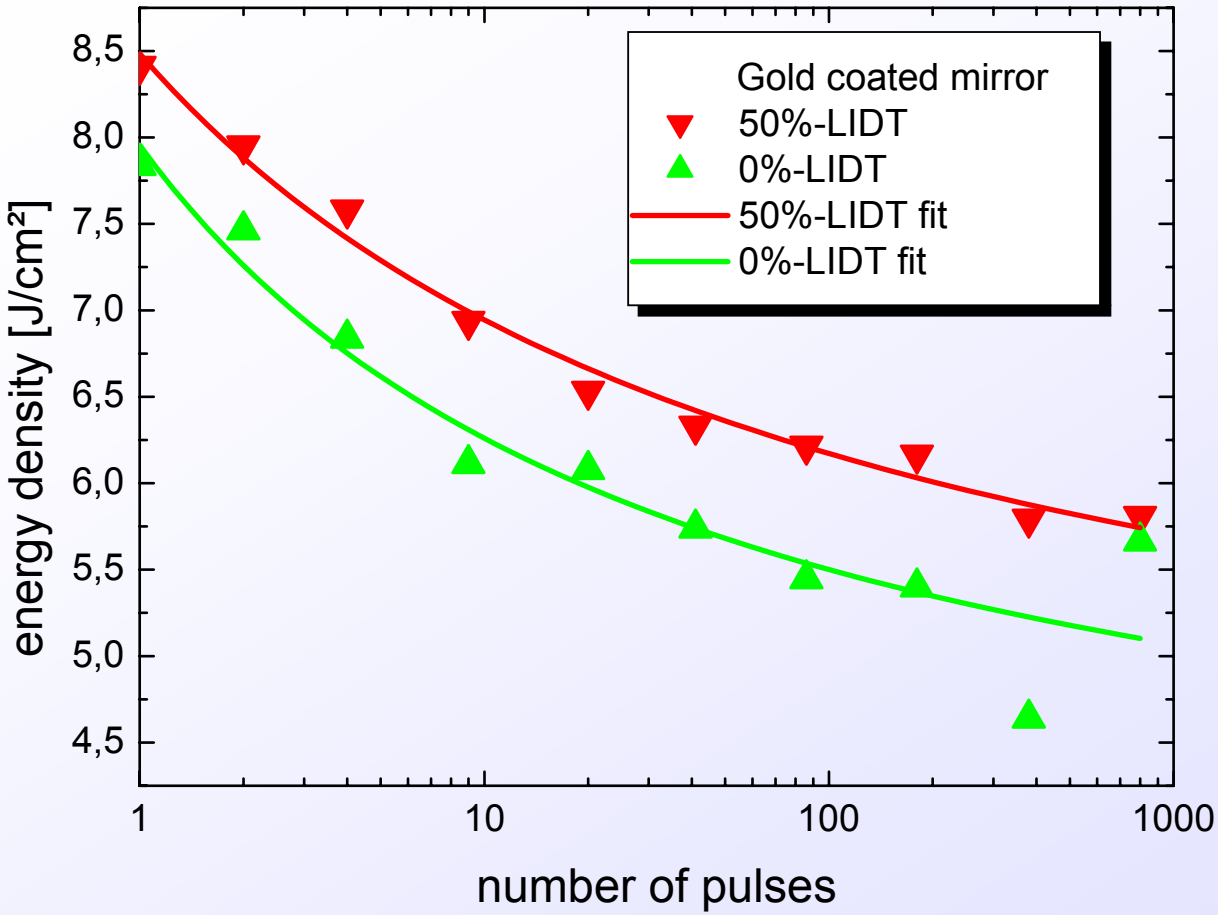
Results



Characteristic damage curve



Characteristic damage curve



Probe: SON11707030

LIDT 50% ▼ fit

χ^2 = 0.01344
R^2 = 0.9876

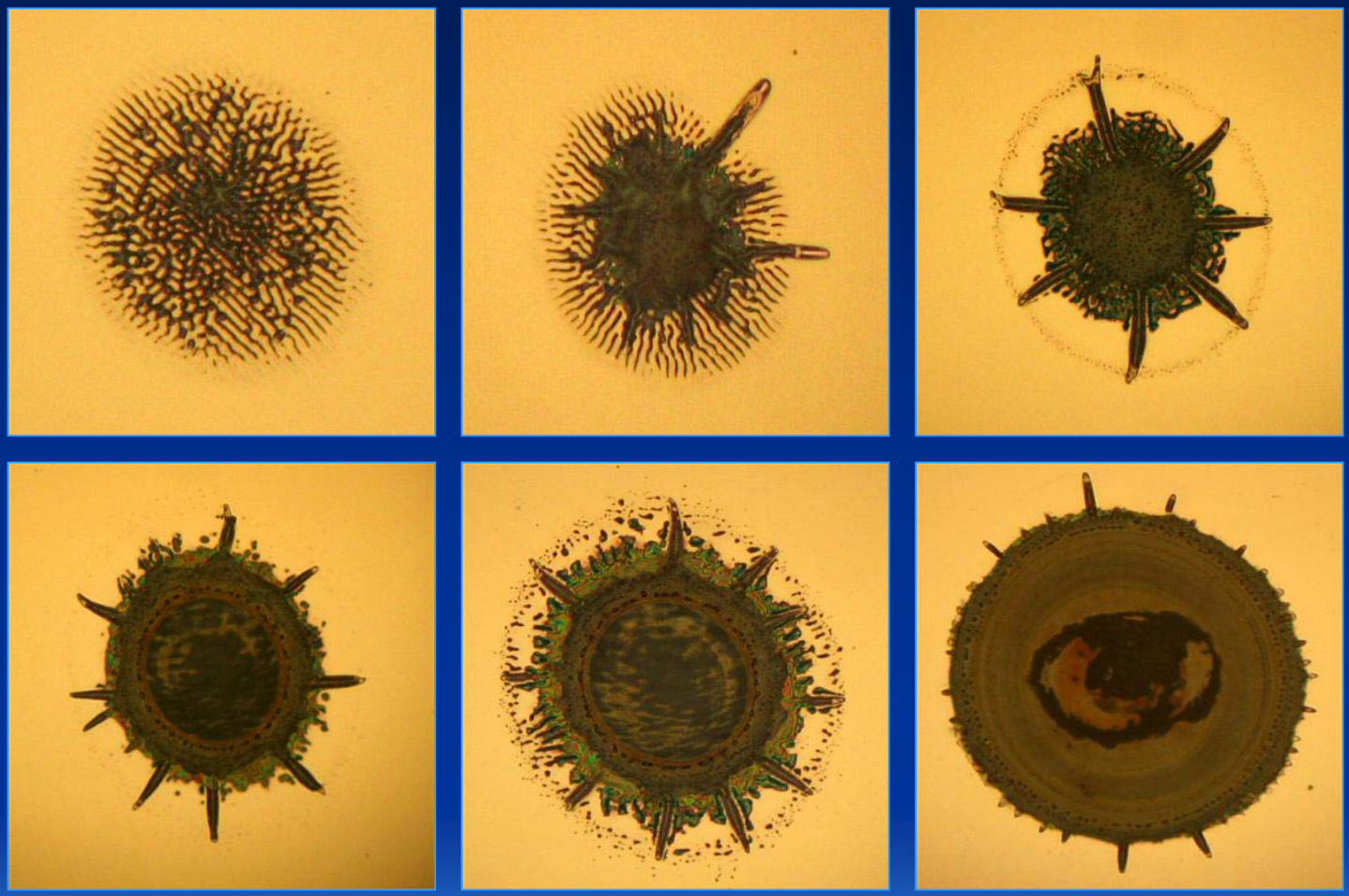
$LIDT_{infinity}$ 3.83362 ± 0.54062
$LIDT_{1on1}$ 8.48459 ± 0.1051
Δ 2.02085 ± 0.5179

LIDT 0% ▲ fit

χ^2 = 0.11139
R^2 = 0.91125

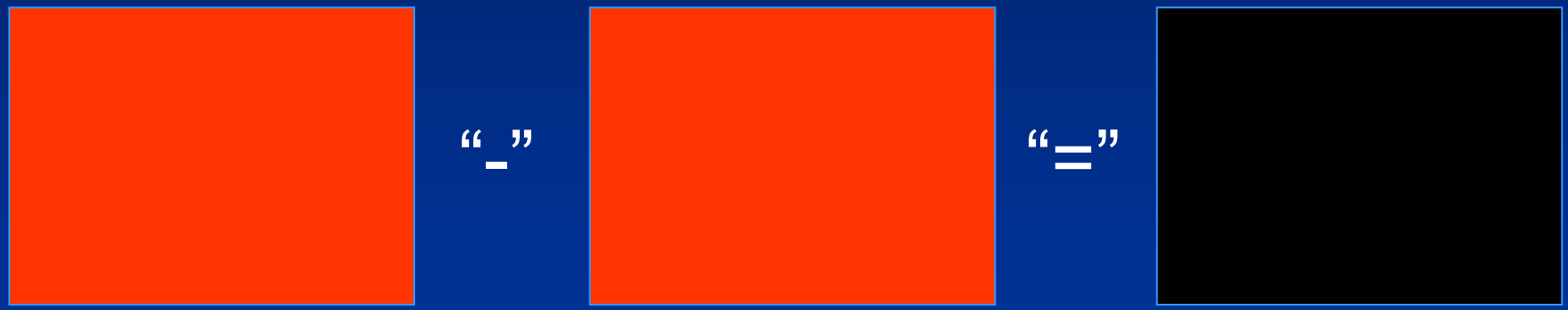
$LIDT_{infinity}$ 3.50601 ± 1.18916
$LIDT_{1on1}$ 7.95502 ± 0.308
Δ 1.62508 ± 1.06014

Typical damages (Al)



Little problem 1 ☺

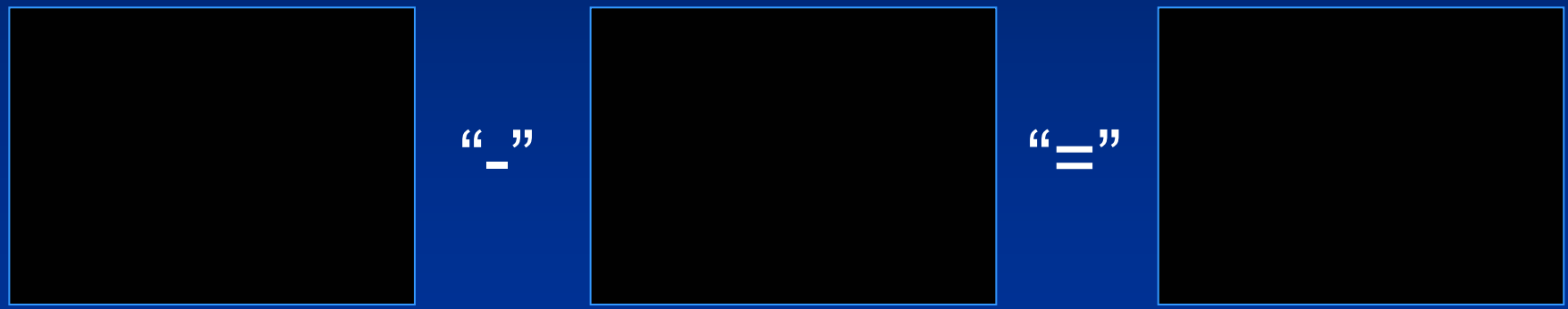
Saturation: too much light



255 - 255 = 0

Little problem 2 ☺

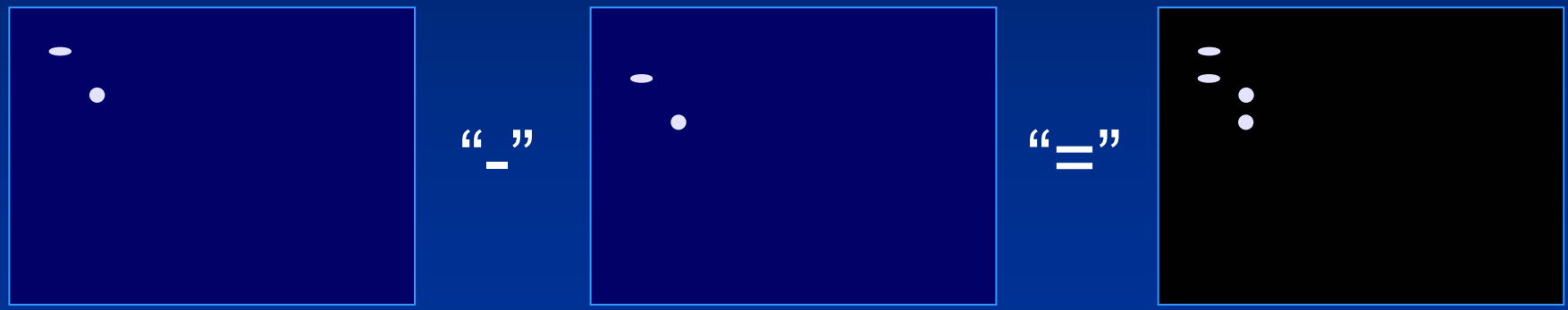
Not enough light



0 - 0 = 0

Little problem 3 ☺

Impurities and vibrations



10 - 10 ≠ 10 + 10

Little problem 4 ☺

Problem of 100 Euro

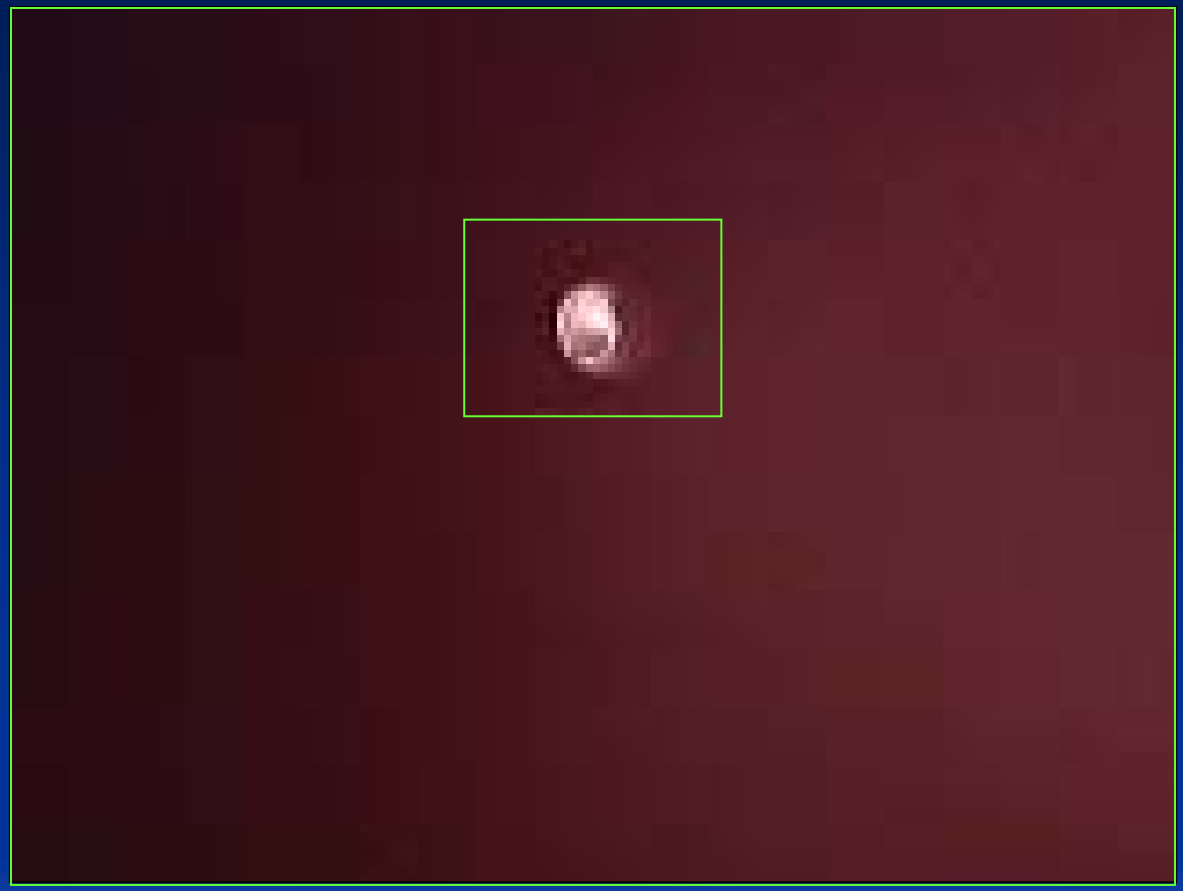
Little problem 5 ☺

(Problem of ~1500 Euro)

Fast PC recommended:

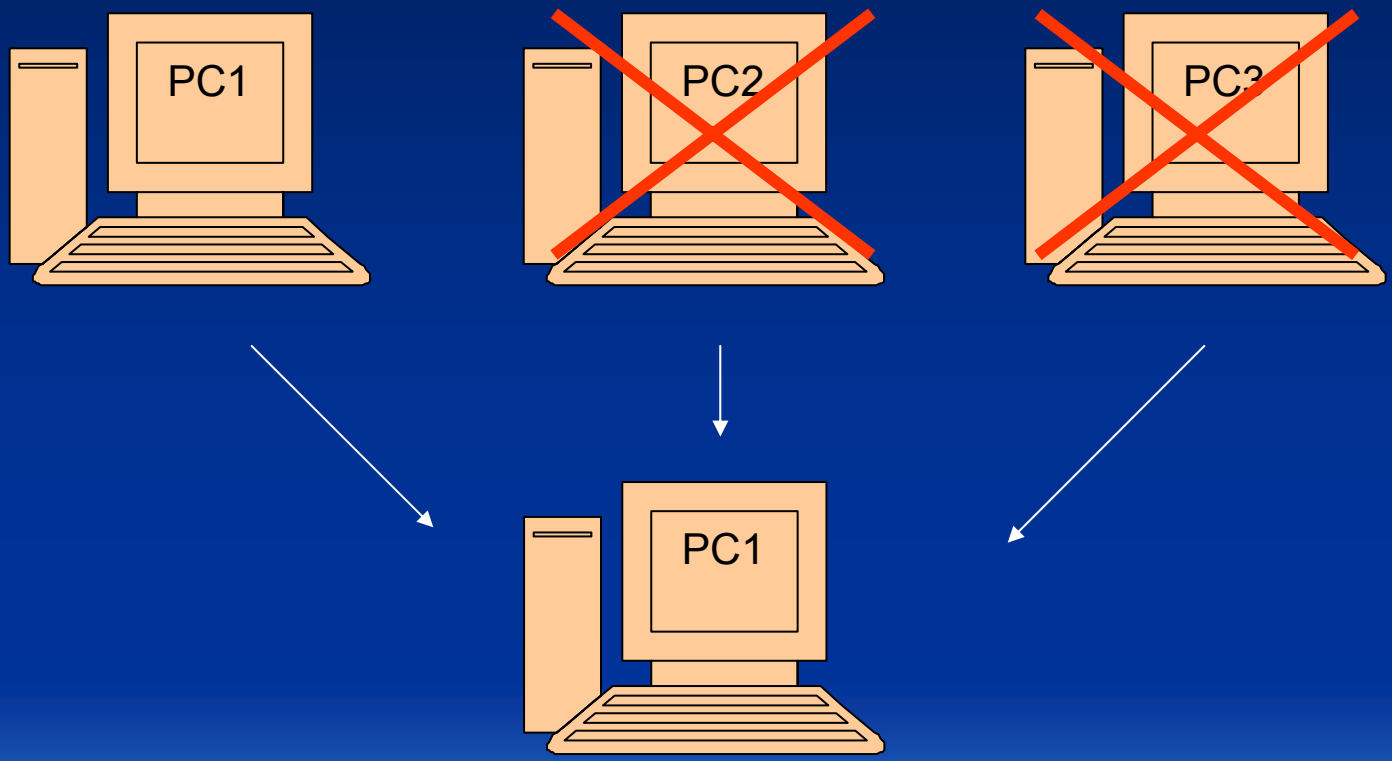
1. Intel Pentium4 (3 GHz) or higher
2. Faster Web Cam
3. Faster ActiveX control drivers

Partial solution of problem 5 ☺



Little problem 6 ☺

3 computer problem:



“+” & “-”

“+”

1. Real time detection “In situ” (in principle: inspection to)
2. Ability to check result after measurement
3. Analysis based on the Differences of the site

“-”

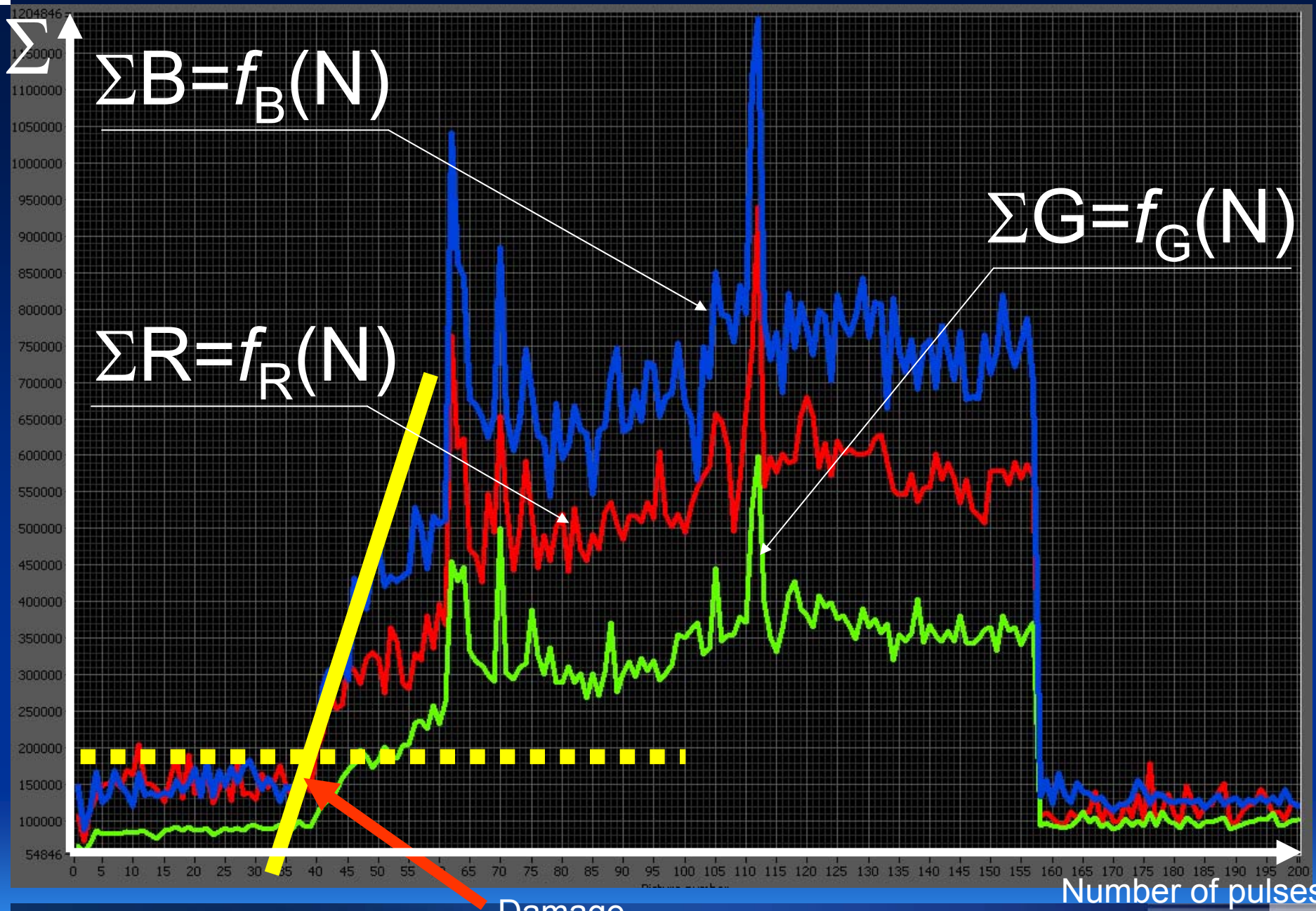
1. Relative low repetition rate of the analysis module (up to 40 Hz)
   - Camera
   - Drivers
   - Computer
2. Vibration isolation
3. Resolution of the microscope system

Possible applications in future:

1. Real time damage “dynamics” observation

2. LIDT detection for high repetition mode

Movie


Σ
ΣB=f_B(N)
ΣG=f_G(N)
ΣR=f_R(N)
Damage
Number of pulses

Conclusions

Experimental set-up for “1 on 1” and “S on 1” assembled

Microscopic video sensor based detection module was developed

The system tested:
(Measured LIDT for several mirrors)