

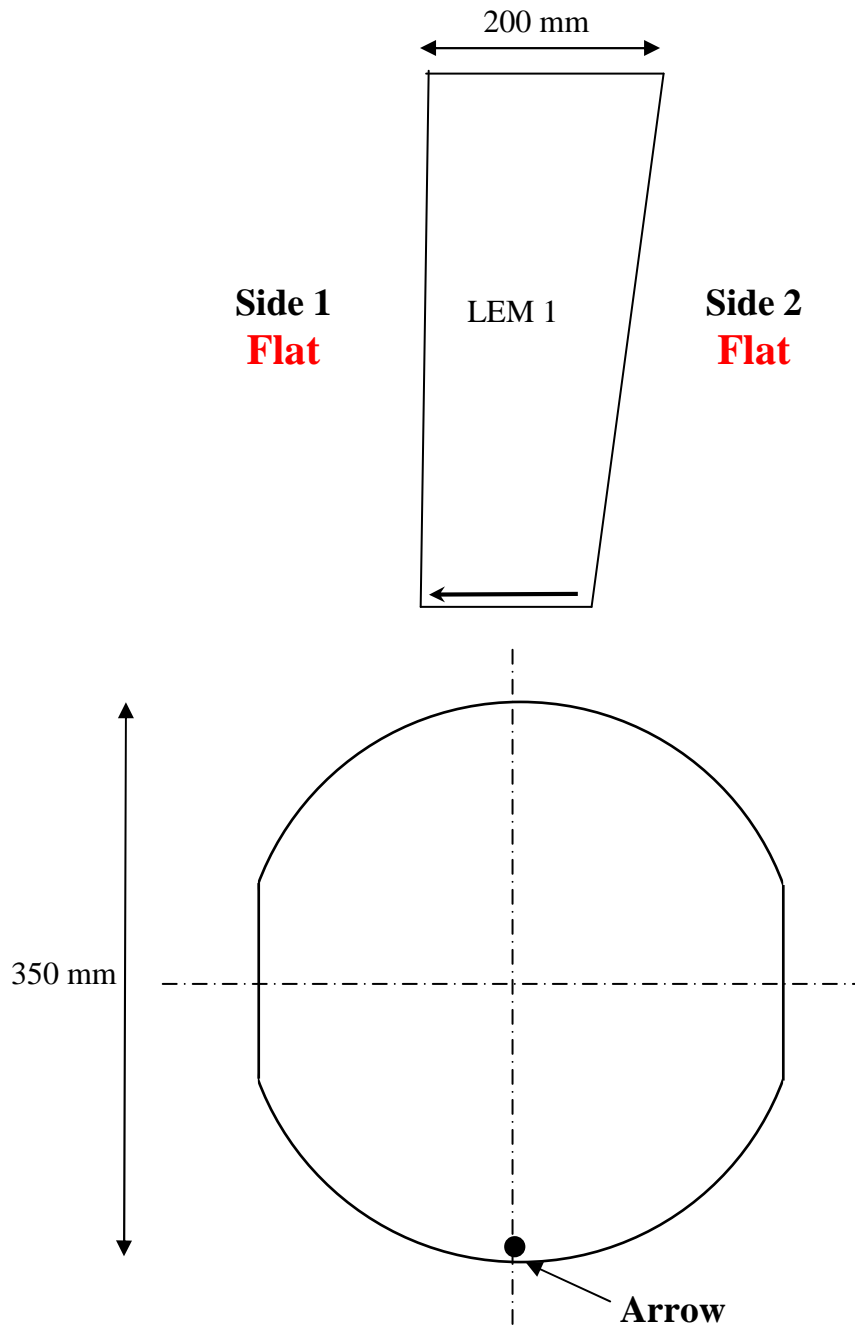


LASTI End Test Mass Characterization

**Reference : C07039 + C07040
on substrate LEM 1**

LMA-SPE- 2007-01

LASTI End Test mass Drawings



Signification of the ARROW etched on the edge of the substrate:

- It shows **SIDE 1** where the HR coating is deposited
- It shows where the optical part has its minimum thickness.

SUBSTRATE CHARACTERIZATION



LEM 01 substrate Characterization Before coating

Dimensions: diameter 350 mm, thickness 200 mm

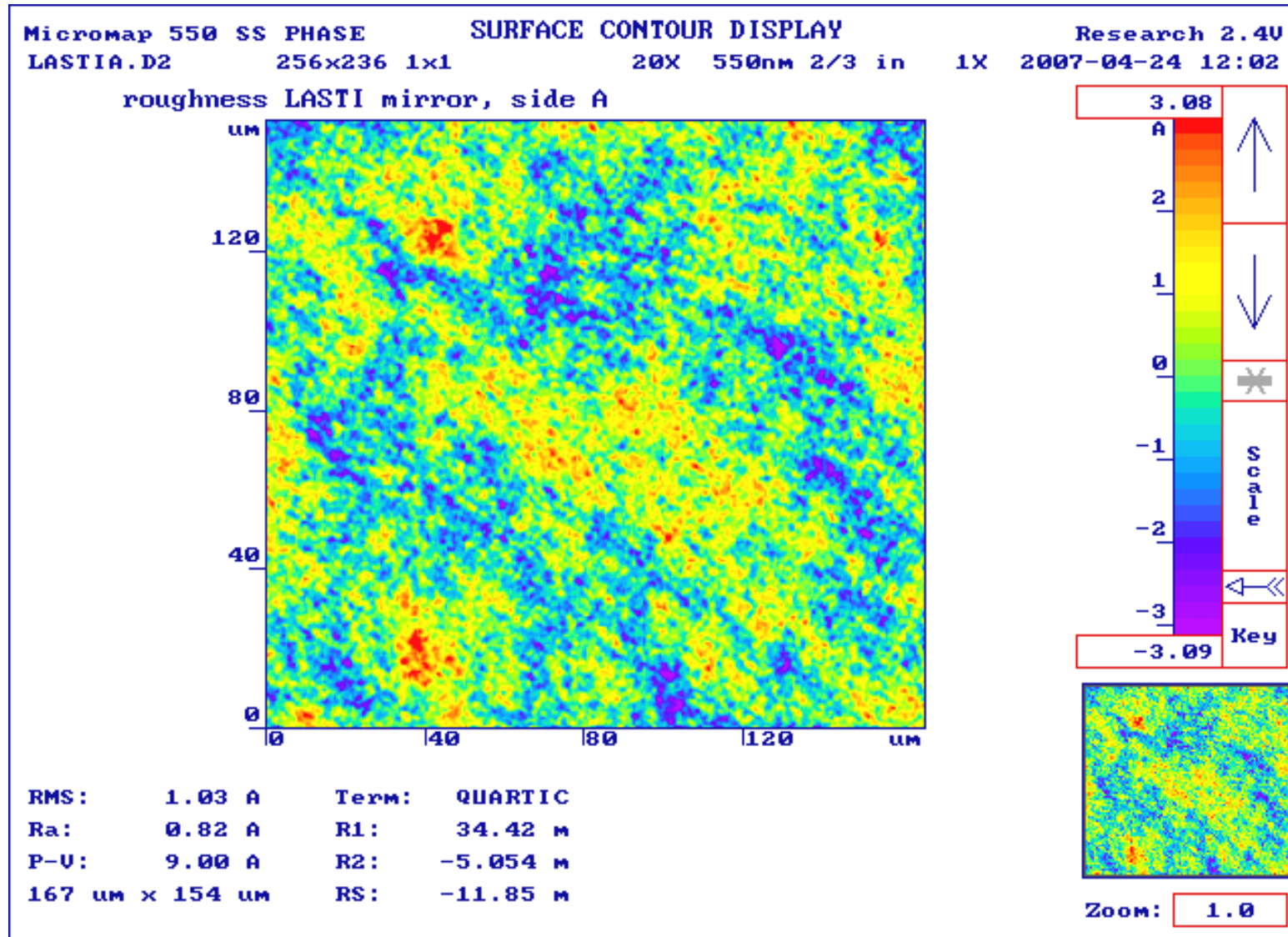
	LIGO Requirements	LMA Measurements
Roughness side 1	< 2 Å rms Over Central 120 mm diameter	1.03 +/- 0.1 Å rms (average value of 5 measurements)
Roughness side 2	Not specified	5.3 +/- 0.5 Å rms (average value of 5 measurements)
Wavefront side 1	< 63 nm PV Over Central 120 mm diameter	277 nm PV – 74 nm RMS Over Ø 120 mm 63 nm PV Over Ø 50 mm 19 nm PV – 3.8 nm RMS Over Ø 25 mm
Defect Detection Side 1	-	99 points (defect < 1µm) 74 areas (defects >1µm) 44 lines (scratches) Over 100 mm diameter

Comments:

The side 2 was really dirty. Gloves marks were found everywhere and we have a lot of trouble to clean them. Also, what was strange, we found on large areas on this surface some marks which looks like water which has dried on the surface. The problem is that we did not succeed in removing these marks with our cleaning technique before coating.

Roughness Side 1

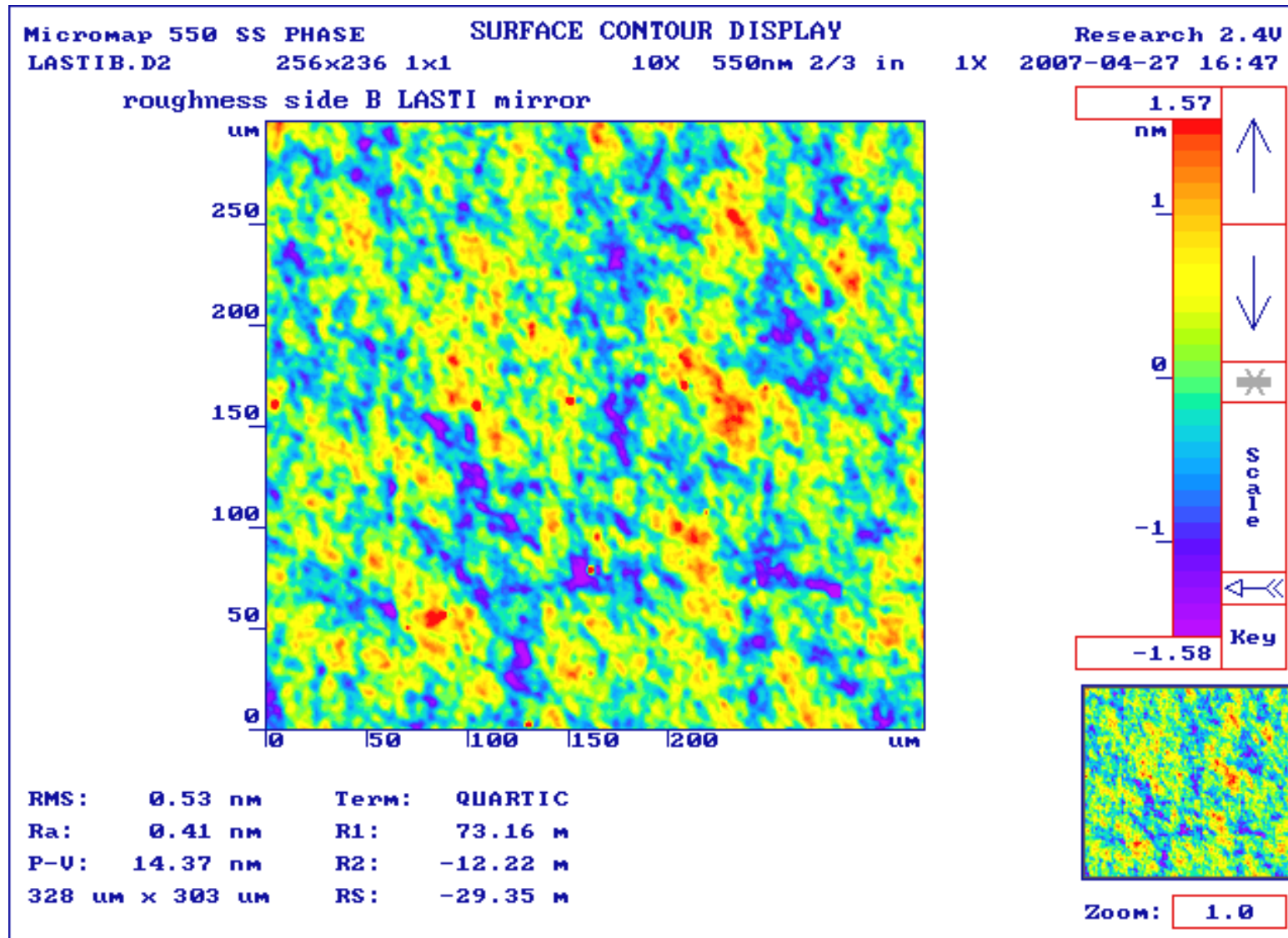
E070150-00



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Roughness Side 2

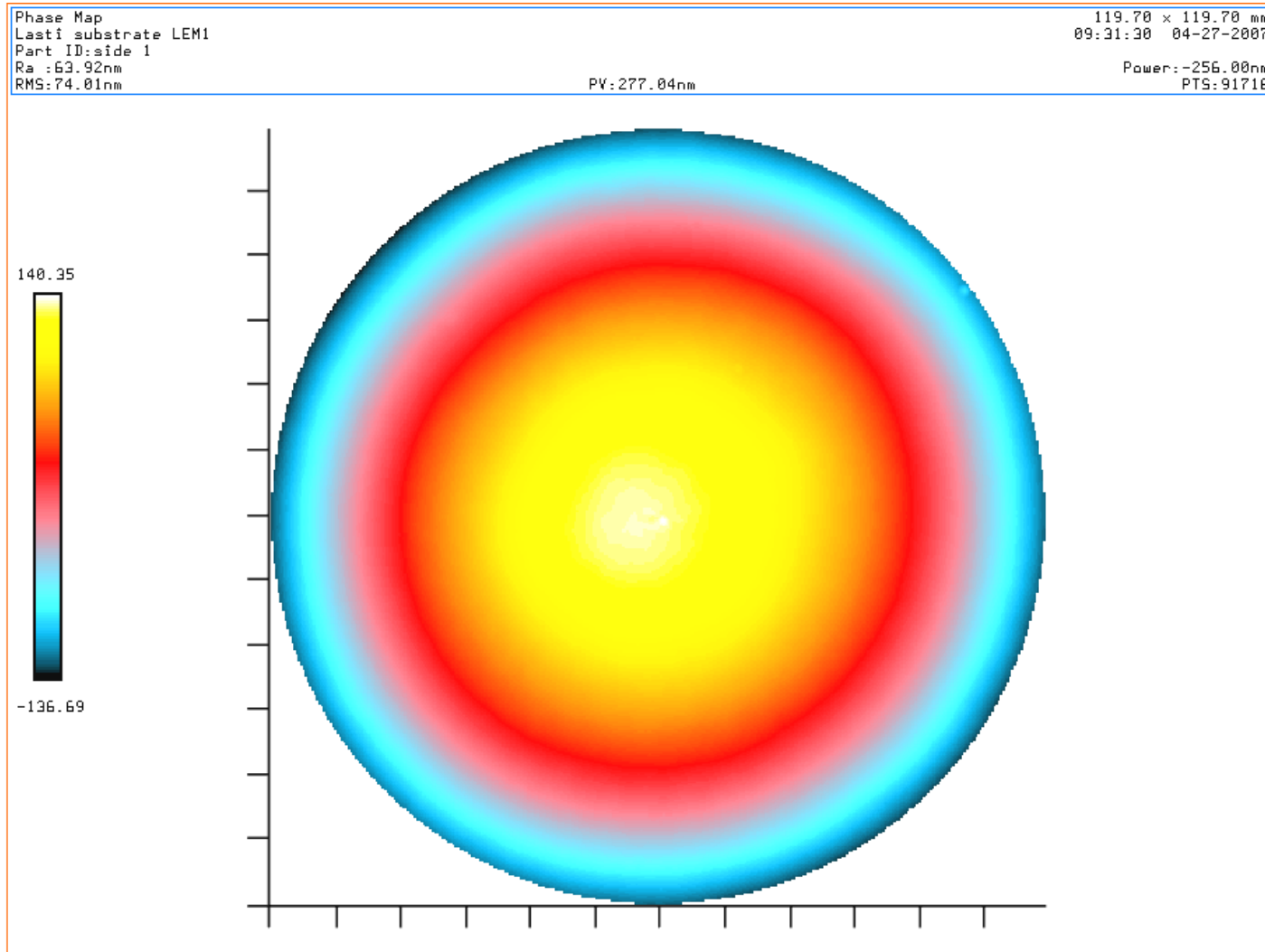
E070150-00



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Wavefront Side 1 (Ø 120 mm)

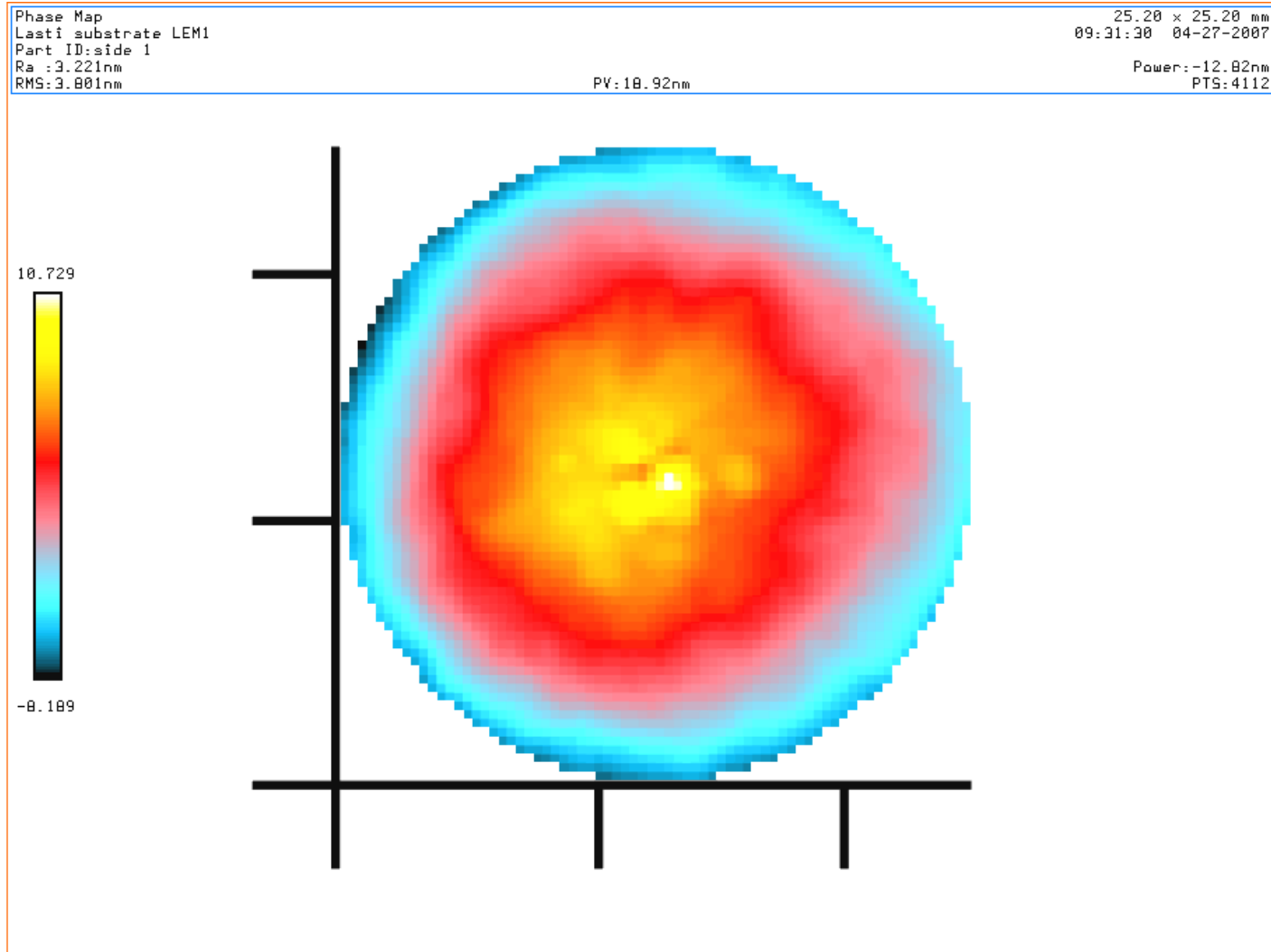
E070150-00



Title: Lasti substrate LEM1	L.M.A.	DATE: 04-27-2007 09:31:30
Part ID: side 1	ADE/PHASE SHIFT	Wedge: Surface
Customer: LIGO	OptiCode - Phase Analysis Software	Polarity: +
Operator:	Version 4.23 (c) 1995-2000	
Terms Subtracted: Tilt		

Wavefront Side 1 (Ø 25 mm)

E070150-00



Title: Lasti substrate LEM1	L.M.A.	DATE: 04-27-2007 09:31:30
Part ID: side 1	ADE/PHASE SHIFT	Wedge: Surface
Customer: LIGO	OptiCode - Phase Analysis Software	Polarity: +
Operator:	Version 4.23 (c) 1995-2000	
Terms Subtracted: Tilt		

Measurement
Area:
Circle
Diameter:
100.00 mm

Total Scans
31416

Frames: 20

Focus Map
Load Ref
Test Image
Start Scan
Resume Scan
Clear

Parameters
Threshold:
35 255
Pix/Point
15
Analyze

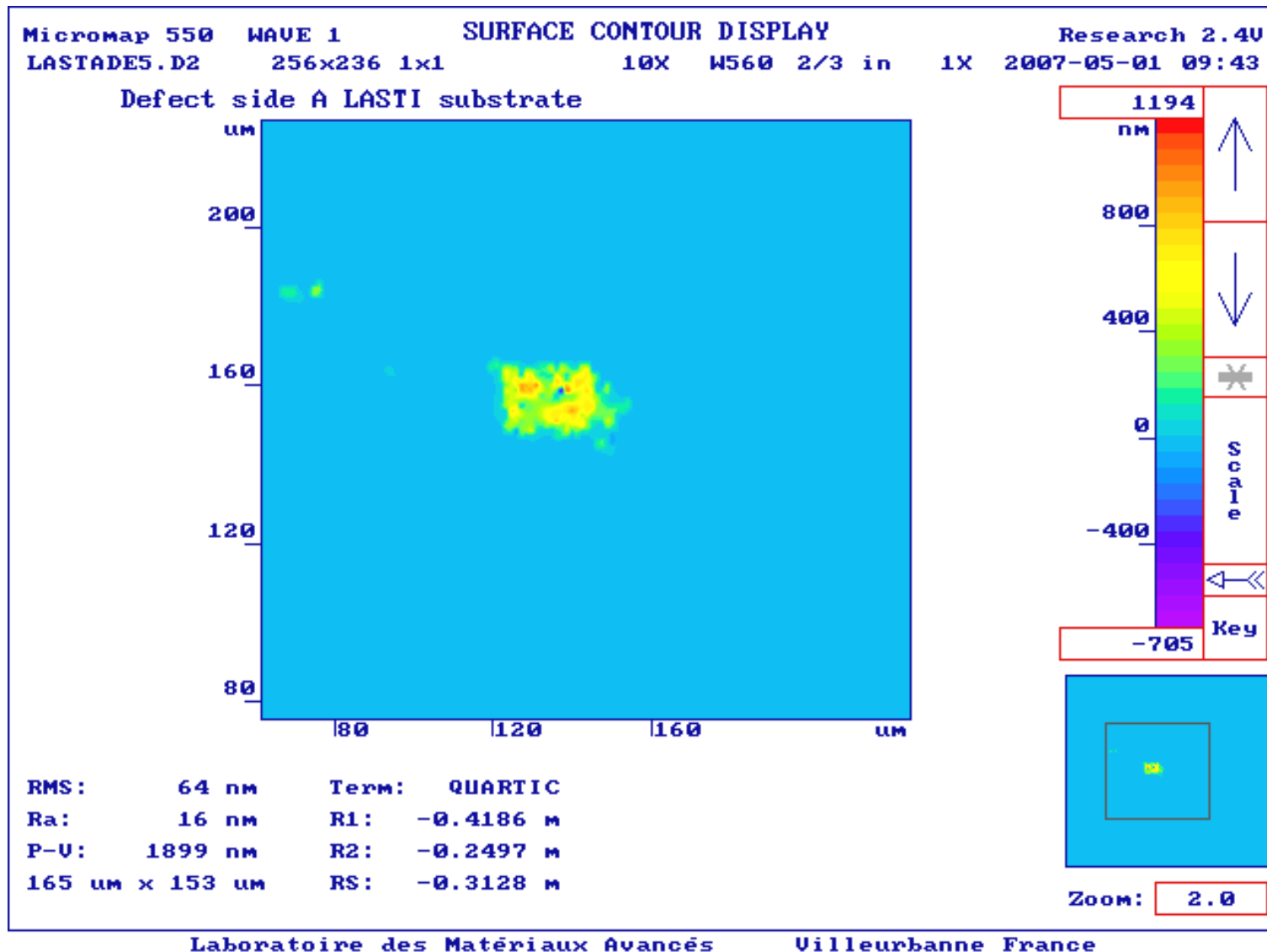
Scale
0.000000
0.000000
Key

Side 1 LASTI 17:16 2007-04-30
100.0 mm x 100. Point:99
Origin: Move To Line:44
Index Defect D:\DEFAUTS\2007\AU No Image Load Zoom: 1.0

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Defects Side 1
Height 1.9 μm , width 40 μm

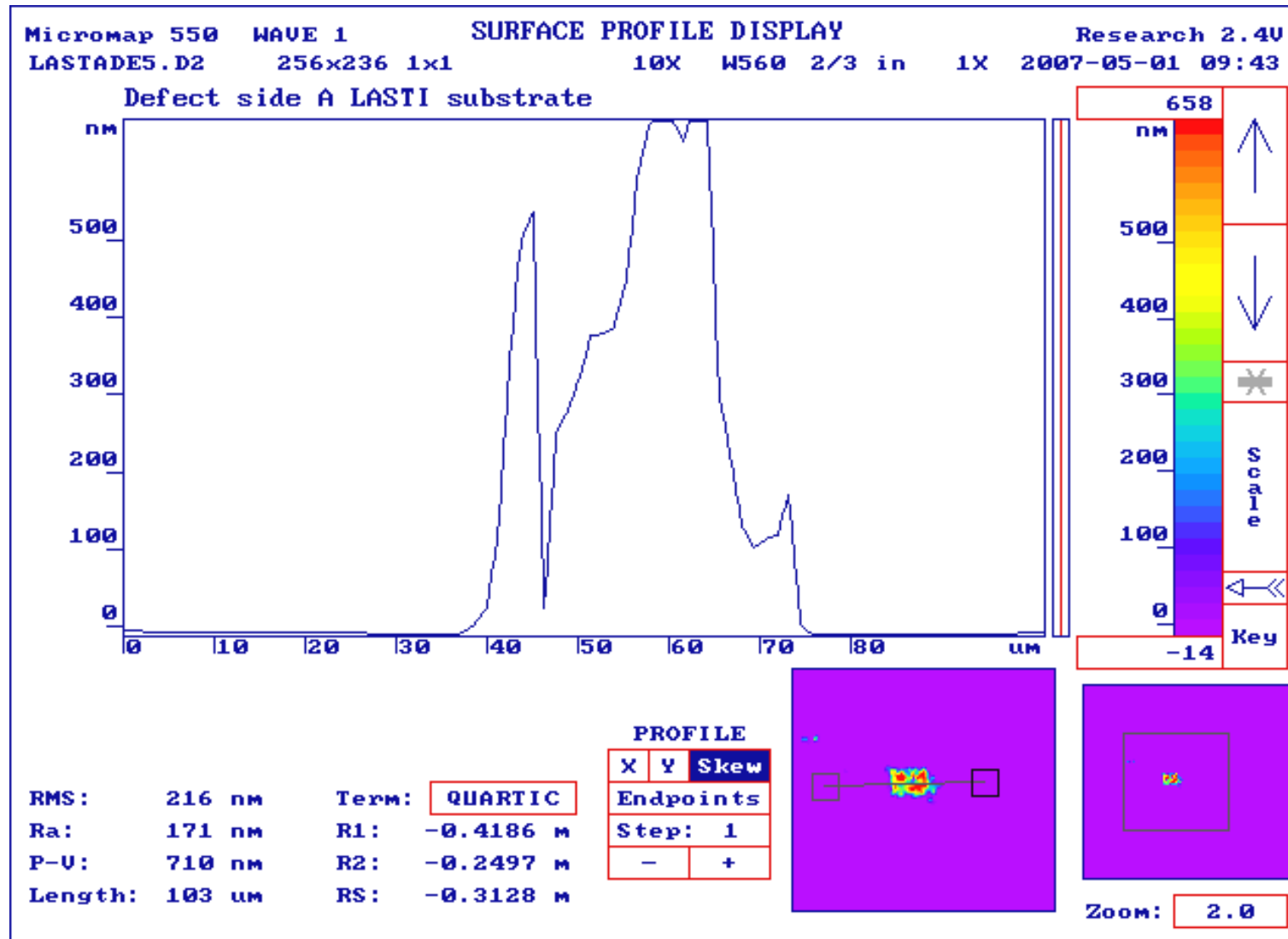
E070150-00



Defects Side 1

E070150-00

Height 1.9 μm , width 40 μm



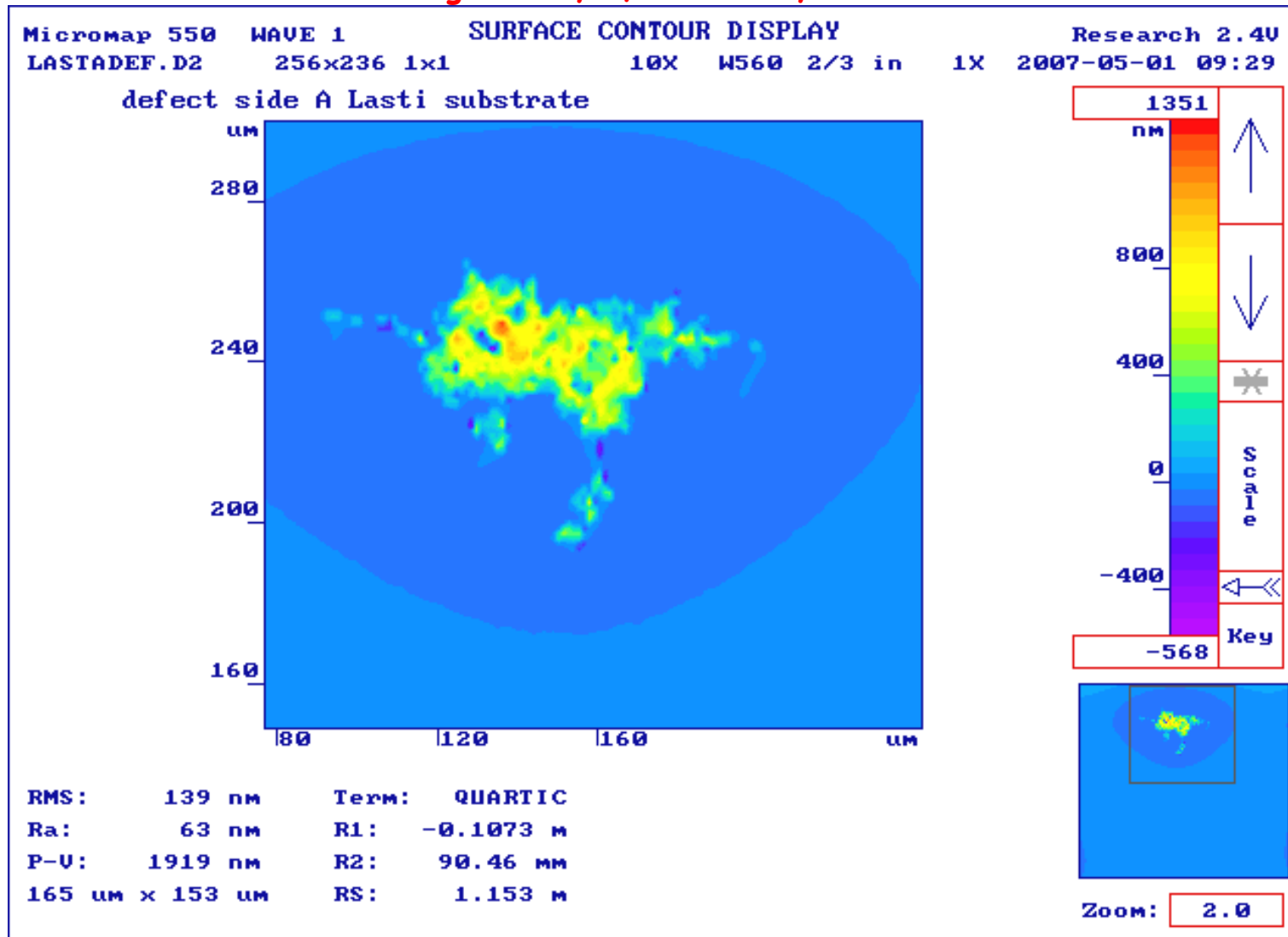
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Defects Side 1

E070150-00

Height 1.9 μm , width 80 μm

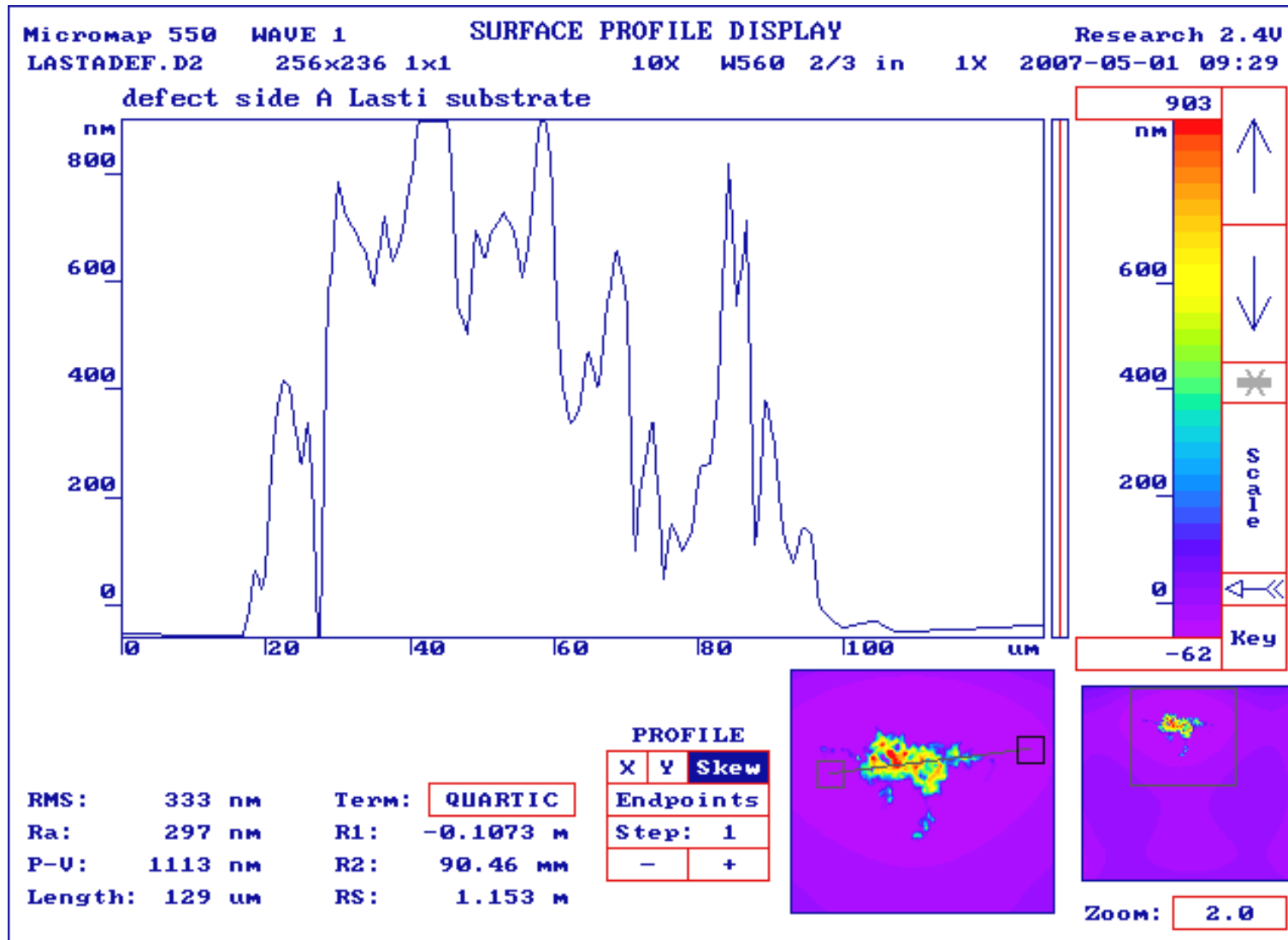


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Defects Side 1

E070150-00

Height 1.9 μm , width 80 μm

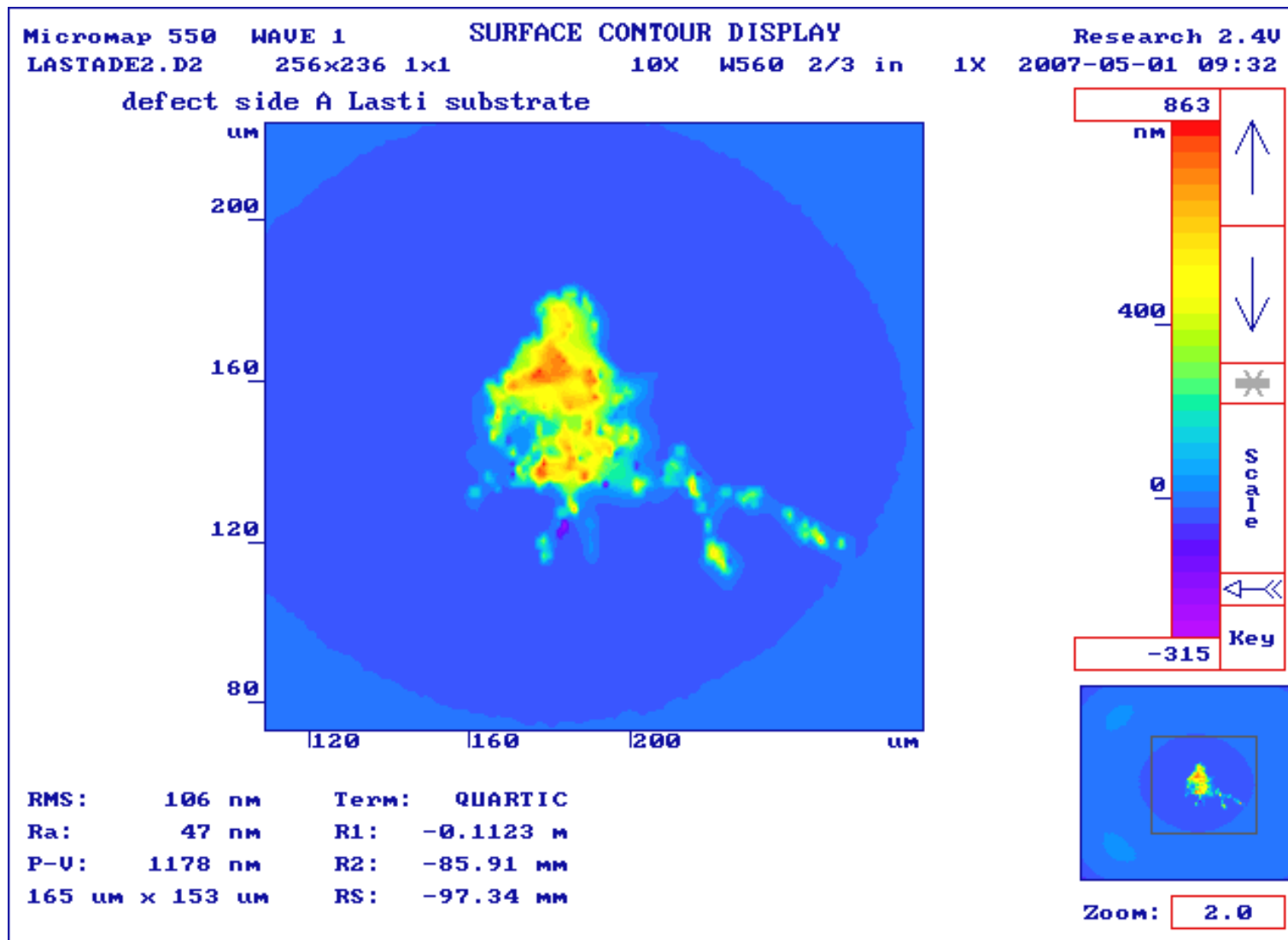


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Defects Side 1
Height 1.2 μm , width 100 μm

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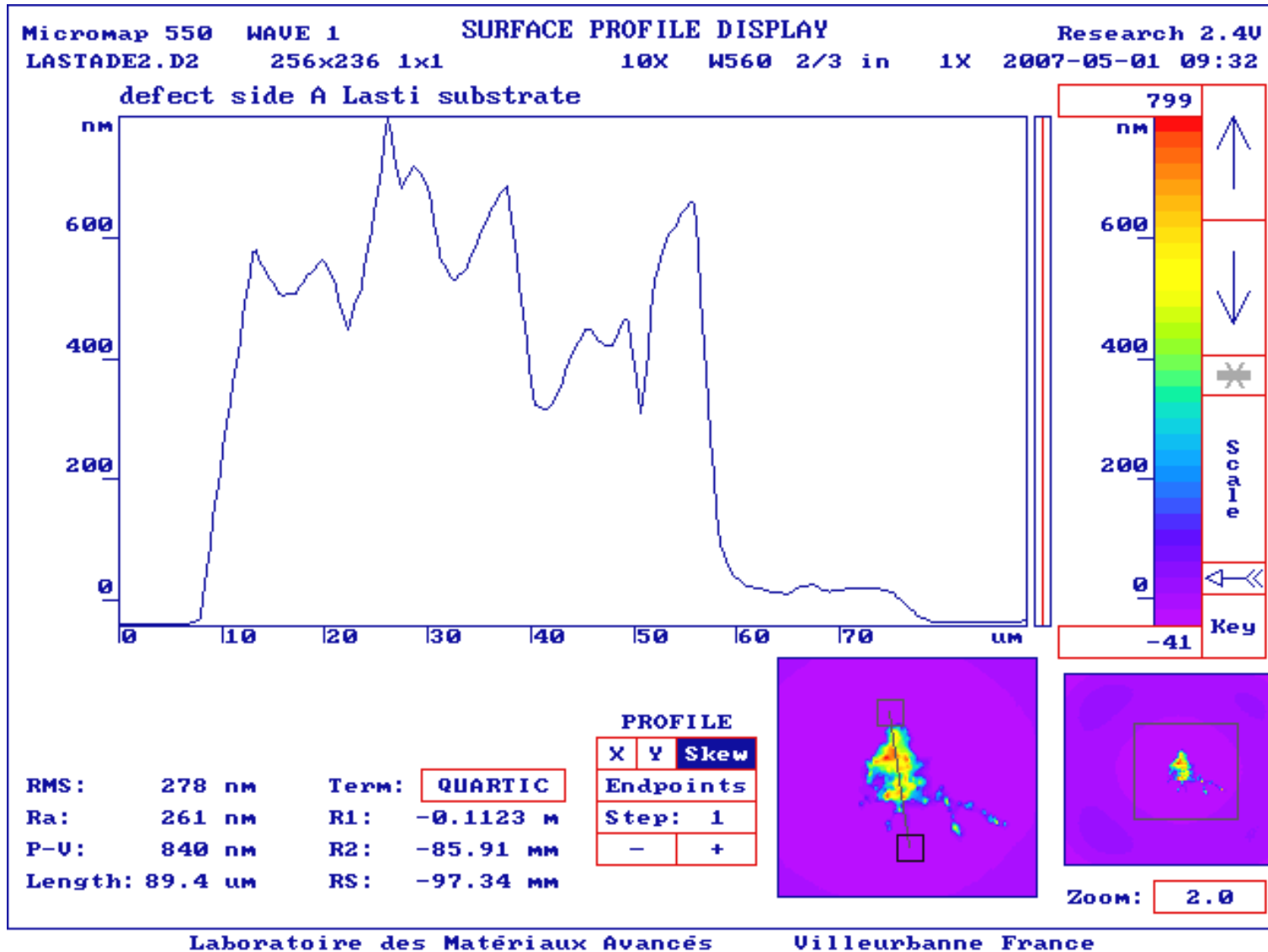


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Defects Side 1

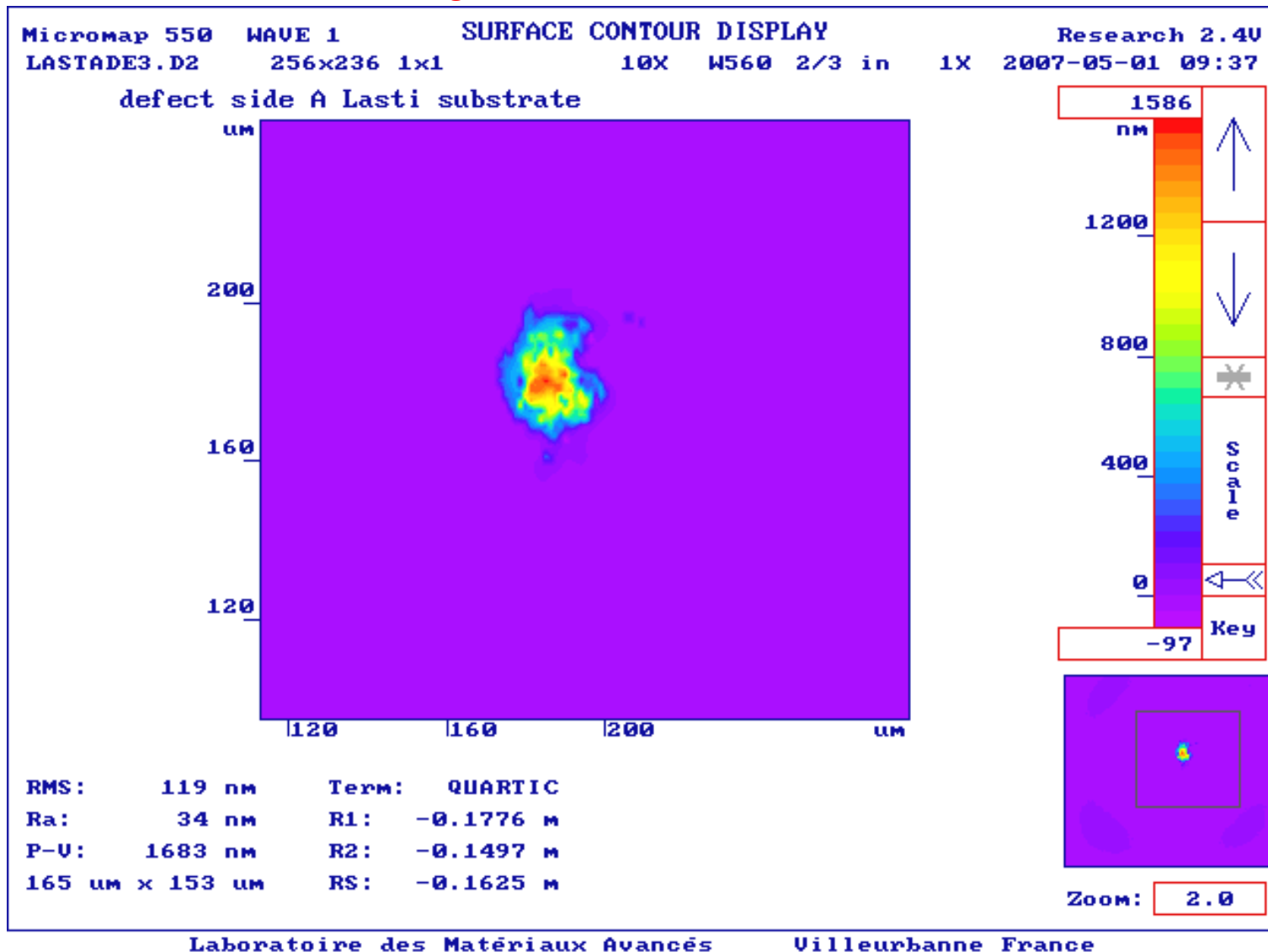
E070150-00

Height 1.2 μm , width 100 μm



Defects Side 1
Height 1.6 μm , width 50 μm

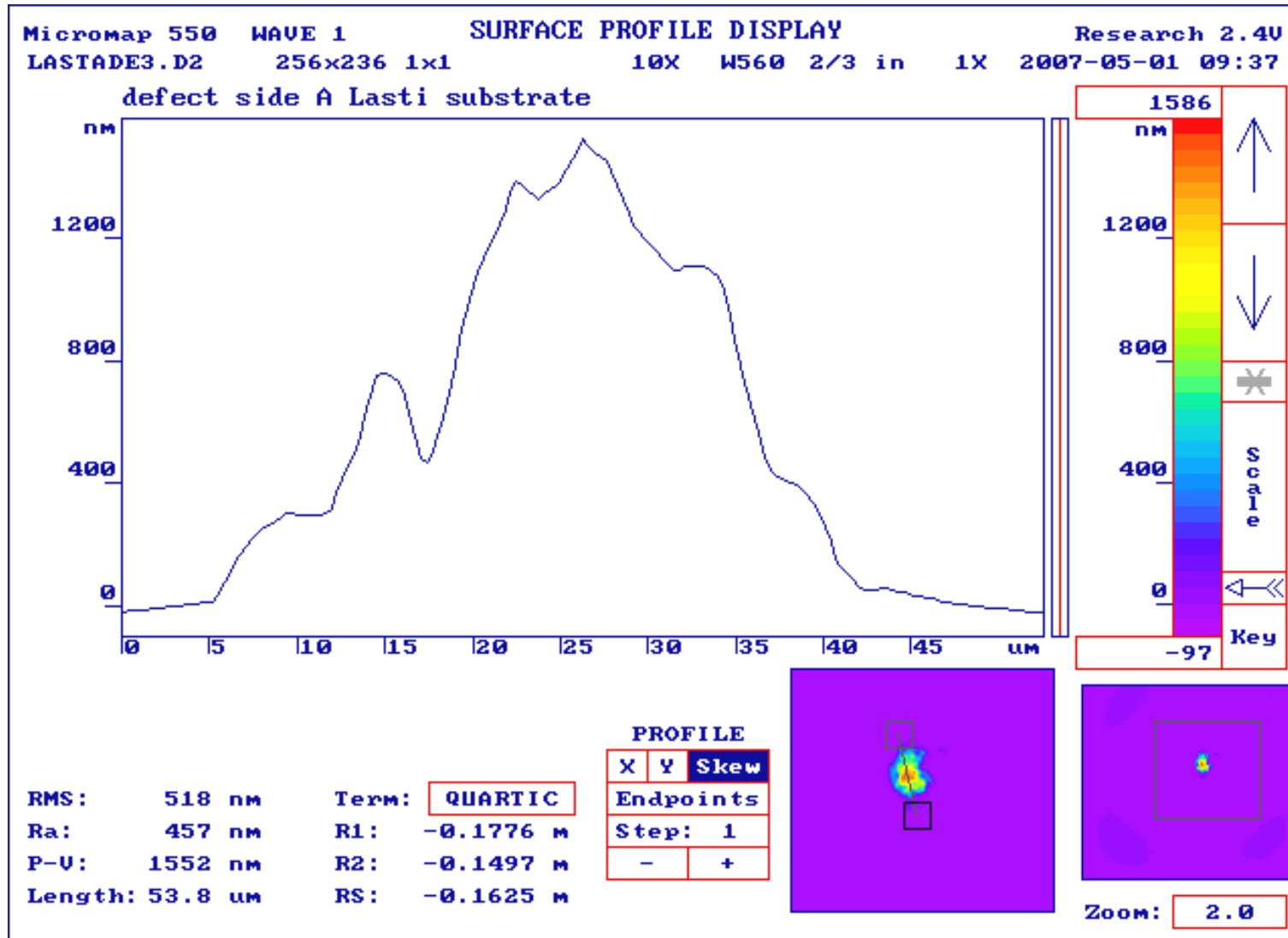
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Defects Side 1

E070150-00

Height 1.6 μm , width 50 μm

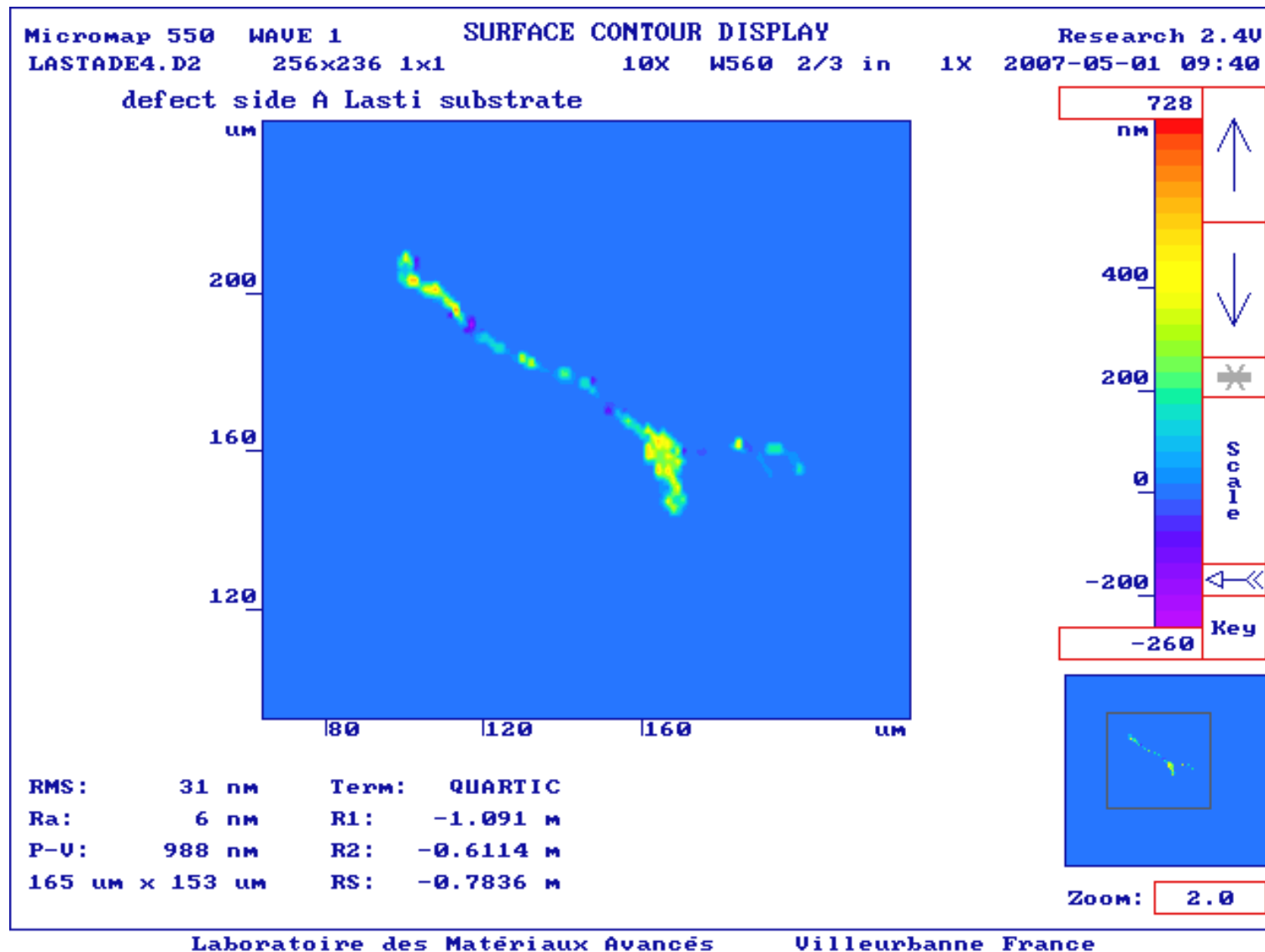


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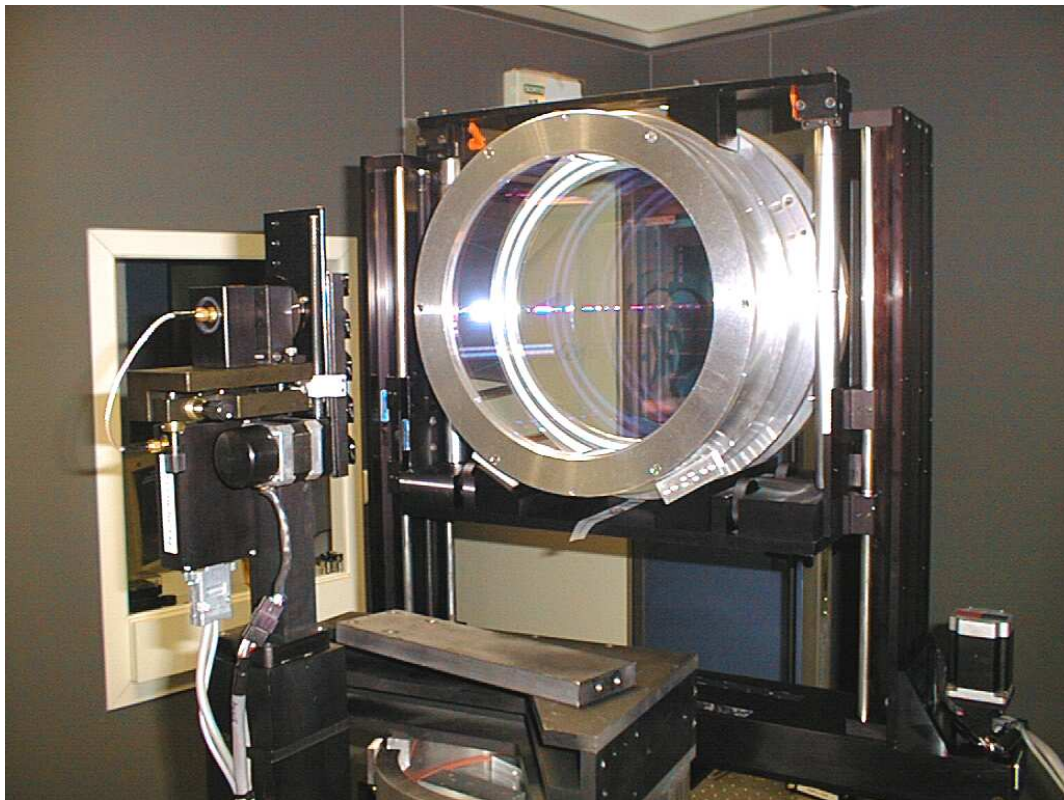
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Defects Side 1 Example of scratch

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COATINGS CHARACTERIZATION



Coating Characterization

Ref. C07039 + C07040

	LIGO Requirements	LMA Measurements
Coating Nature Side 1	High Reflective Coating Transmission < 20 ppm 0° incidence	High index layer : Ti doped Ta ₂ O ₅ – Formula 5**-
Coating Nature Side 2	Antireflective Coating Reflection < 300 ppm 0° incidence	High index layer : Ti doped Ta ₂ O ₅ – Formula 5**-
Transmission (ppm)	T < 20 ppm	10.7 +/- 0.05 ppm Ø 112 mm
Reflection Side 2 (AR)	R < 300 ppm	R = 211 +/- 10 ppm
Wavefront Side 1 (HR)	< 63 nm PV Over Central 120 mm diameter	282 nm PV – 75 nm RMS Over Ø 120 mm 64 nm PV – 14.3 nm RMS Over Ø 50 mm 19 nm PV – 4 nm RMS Over Ø 25 mm
Absorption Side 1 (HR)	A < 1 ppm Ø 120 mm	0.26 +/- 0.05 ppm (*)
Scattering Side 1 (HR)	< 15 ppm Ø 120 mm	24 ppm over Ø 112 mm (**) 14 ppm over Ø 40 mm 8 ppm over Ø 20 mm
HR Reflectivity at 670 nm	> 5%	R # 20-25 %
AR Reflectivity at 670 nm	> 5%	R # 6-8%

(*) The corner (variation of 0.05 ppm max) visible on the absorption map due to the small scale (0.1 ppm -0.3 ppm) is linked to the wedge of the substrate that can not completely compensate on large scale maps (120 mm).

() This scattering level over 120 mm diameter can be explained by the number (# 100) of large defects (width 40-60 μm , height 1-2 μm) and scratches detected before coating on the LEM 1 substrate which create high scattering points.**

HR Transmission (\varnothing 112 mm)

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TC07039.10R

Wavelength
= 1.0640 μm

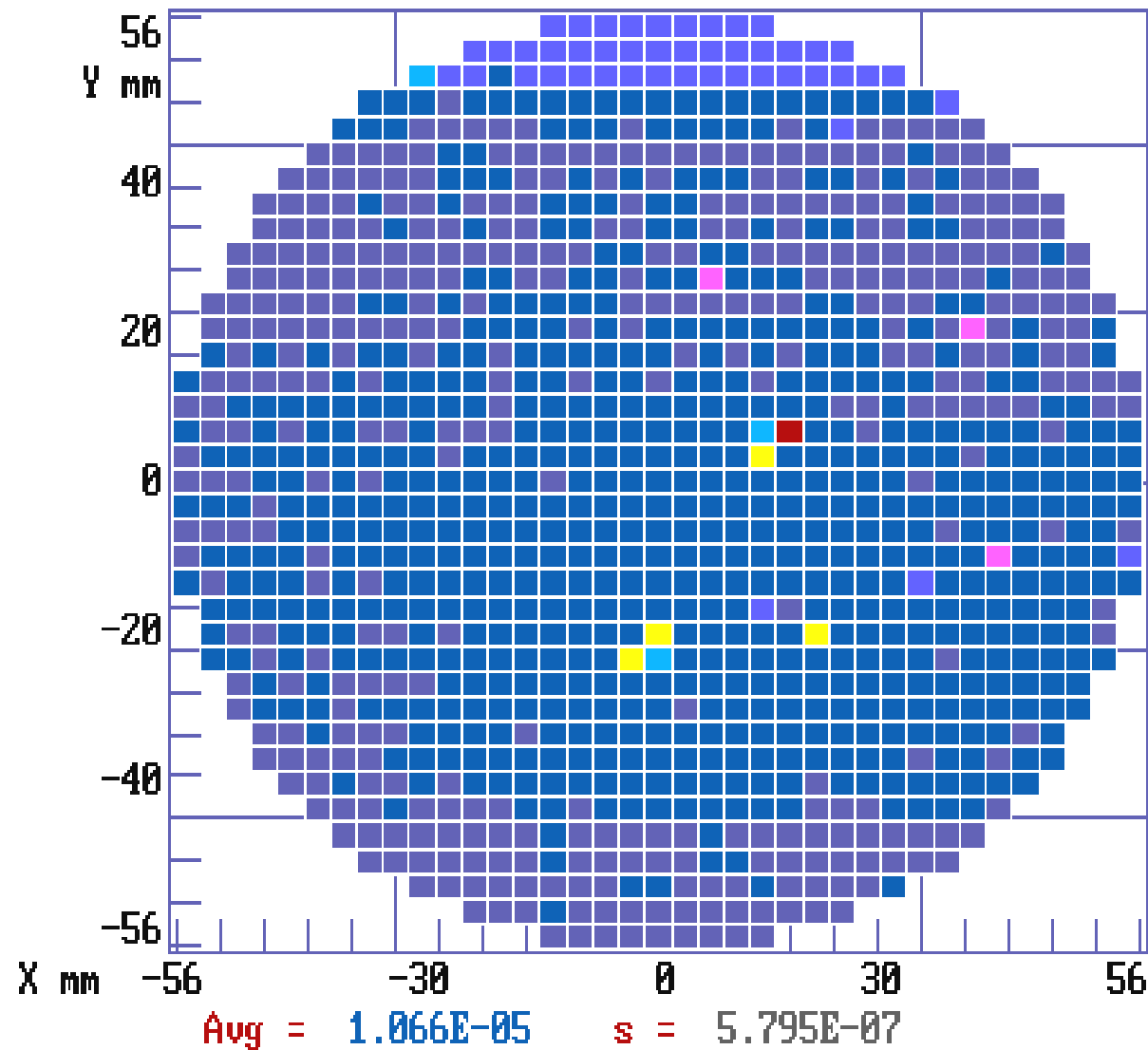
Reflectance
R = 0.1E-04

Angles:
 $\theta_i = 1.00^\circ$
 $\theta_s = 1.00^\circ$
 $\alpha = 0.00^\circ$

Spot Dia., mm
= 1.000

Step Size, mm
= 3.000

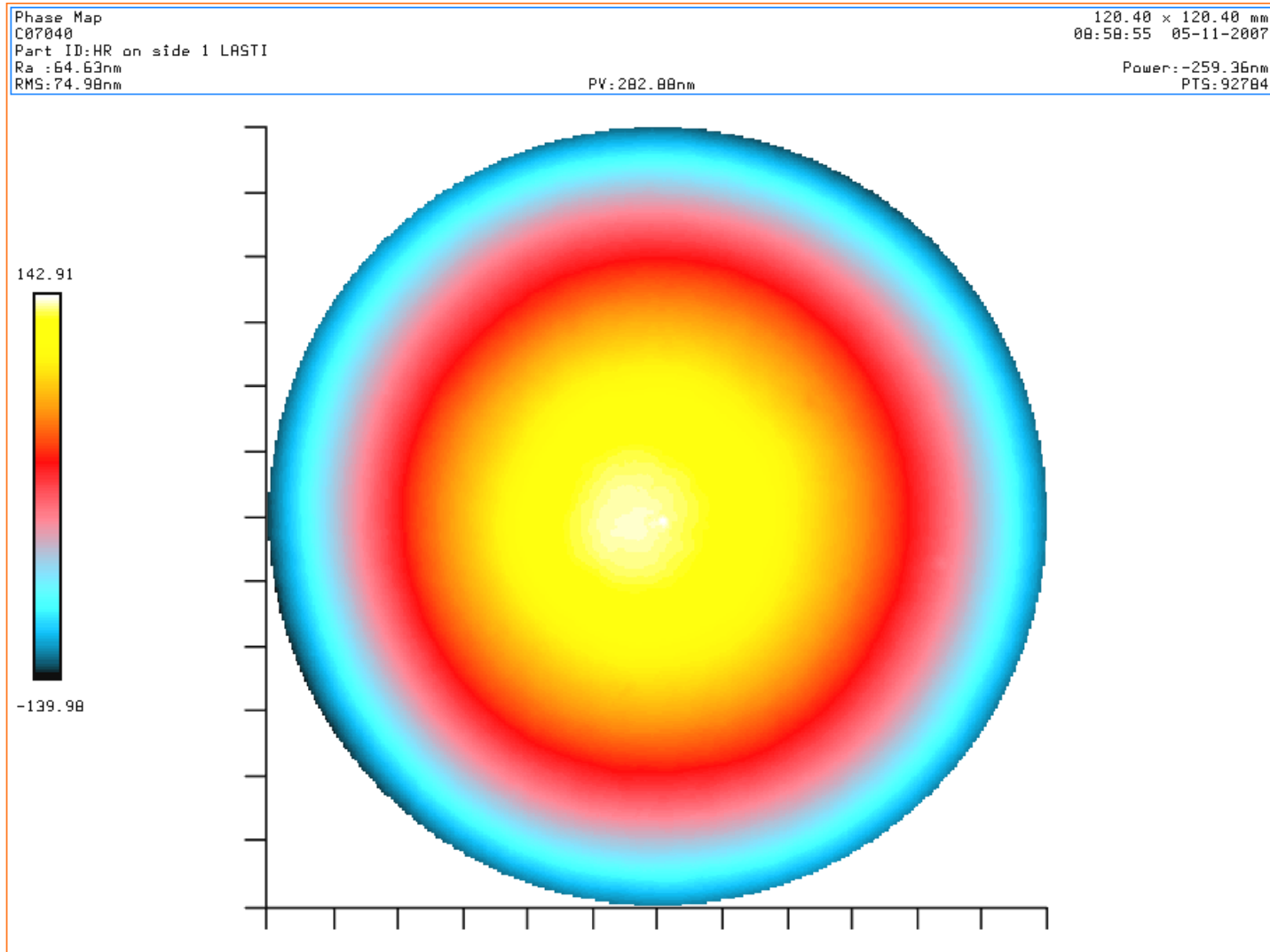
Scan Ctr., mm
X = 0.000
Y = 0.000



Ref 1
LOG
1.192E-05
1.177E-05
1.162E-05
1.147E-05
1.132E-05
1.117E-05
1.103E-05
1.089E-05
1.075E-05
1.061E-05
1.047E-05
Sub Scale

Wavefront Side 1 (HR) (Ø 120 mm)

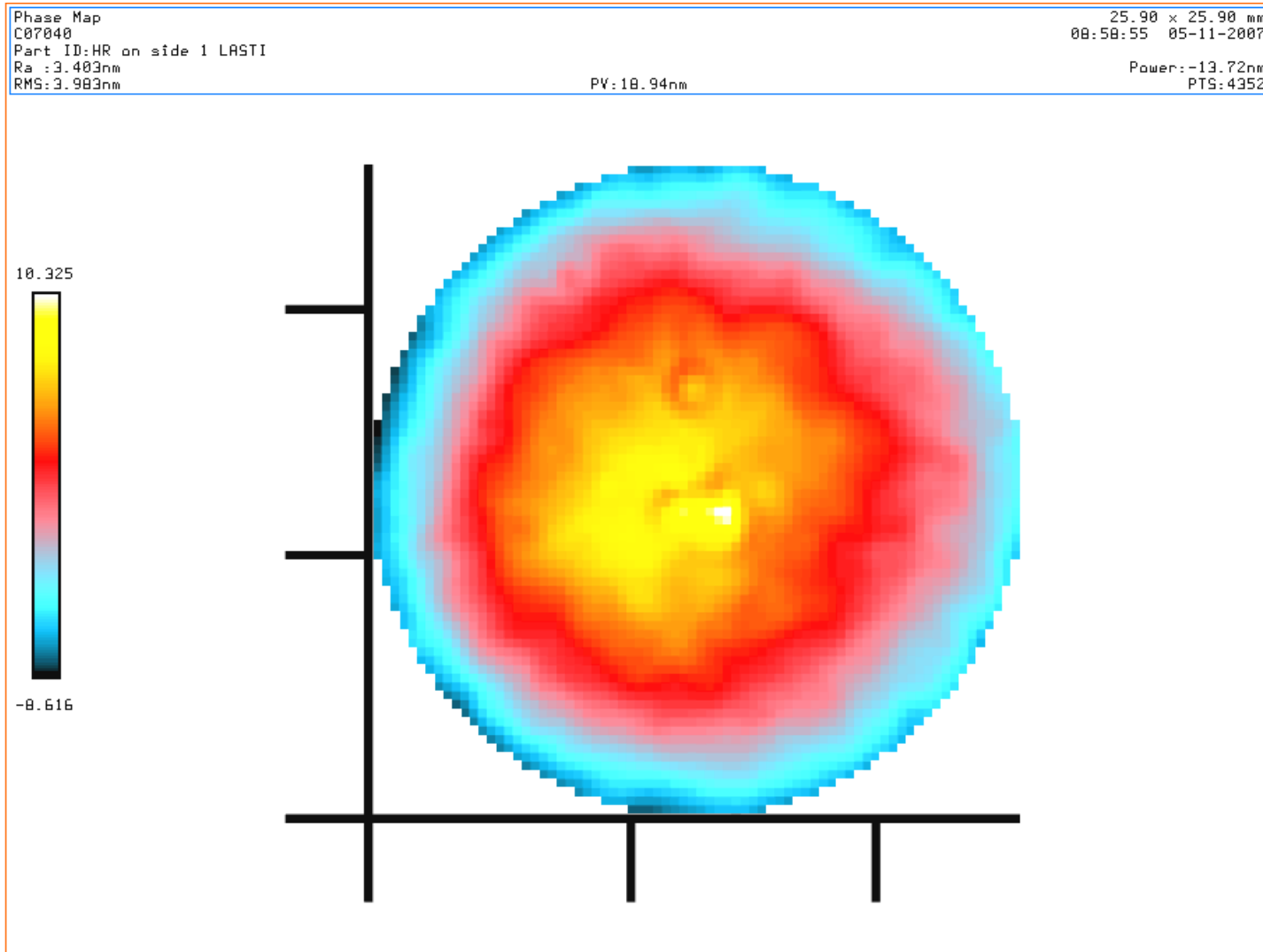
E070150-00



Title: C07040	L.M.A.	DATE: 05-11-2007 08:58:55
Part ID: HR on side 1 LASTI	ADE/PHASE SHIFT	Wedge: Surface
Customer: LIGO	OptiCode - Phase Analysis Software	Polarity: +
Operator:	Version 4.23 (c) 1995-2000	
Terms Subtracted: Tilt		

Wavefront Side 1 (HR) (Ø 25 mm)

E070150-00

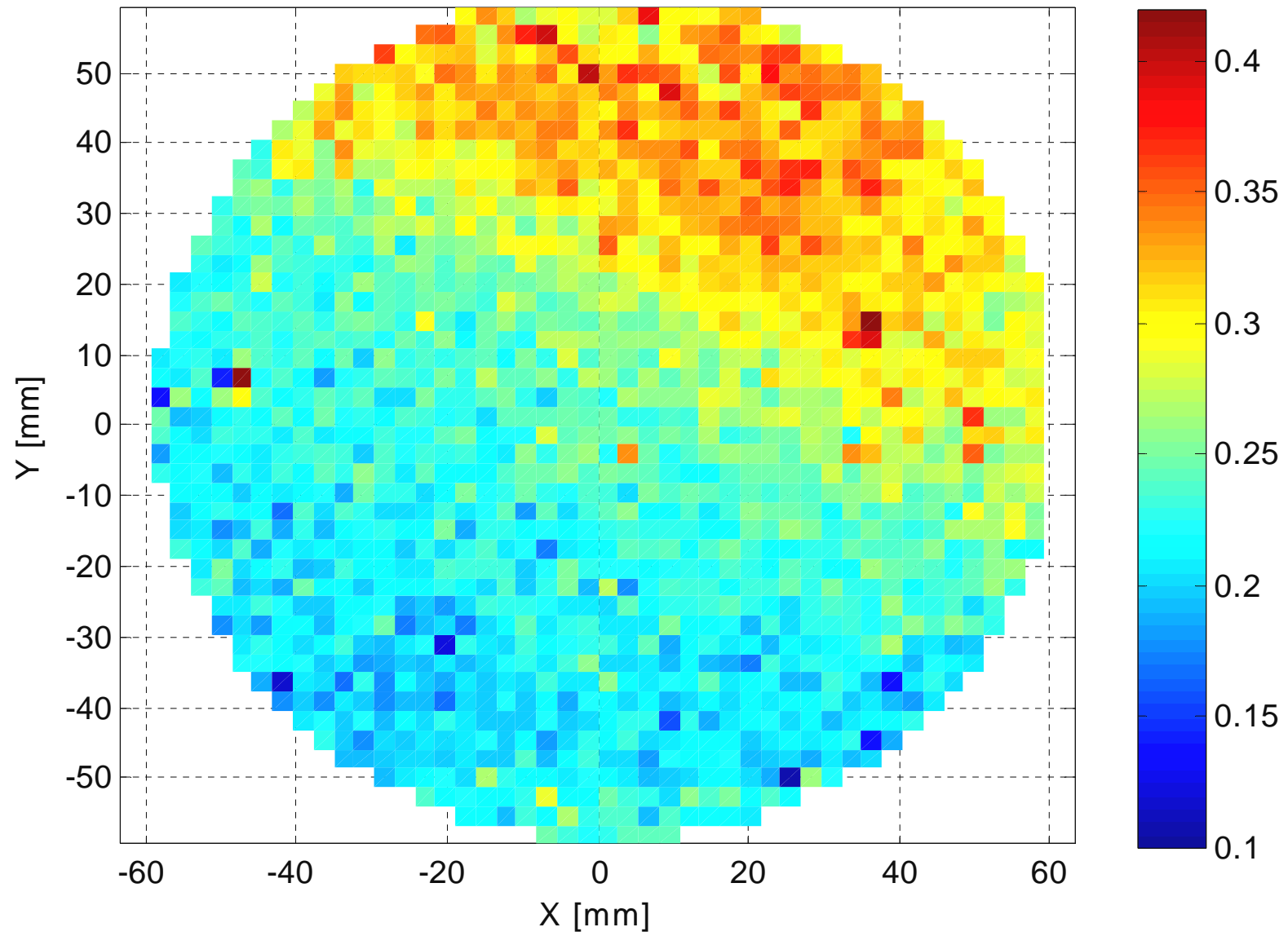


Title: C07040	L.M.A.	DATE: 05-11-2007 08:58:55
Part ID: HR on side 1 LASTI	ADE/PHASE SHIFT	Wedge: Surface
Customer: LIGO	OptiCode - Phase Analysis Software	Polarity: +
Operator:	Version 4.23 (c) 1995-2000	
Terms Subtracted: Tilt		

HR Absorption (\varnothing 120 mm)

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Absorption [ppm], échantillon :C07040a01



HR scattering (\varnothing 112 mm)

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C07039.10R

Wavelength
= 1.0640 μm

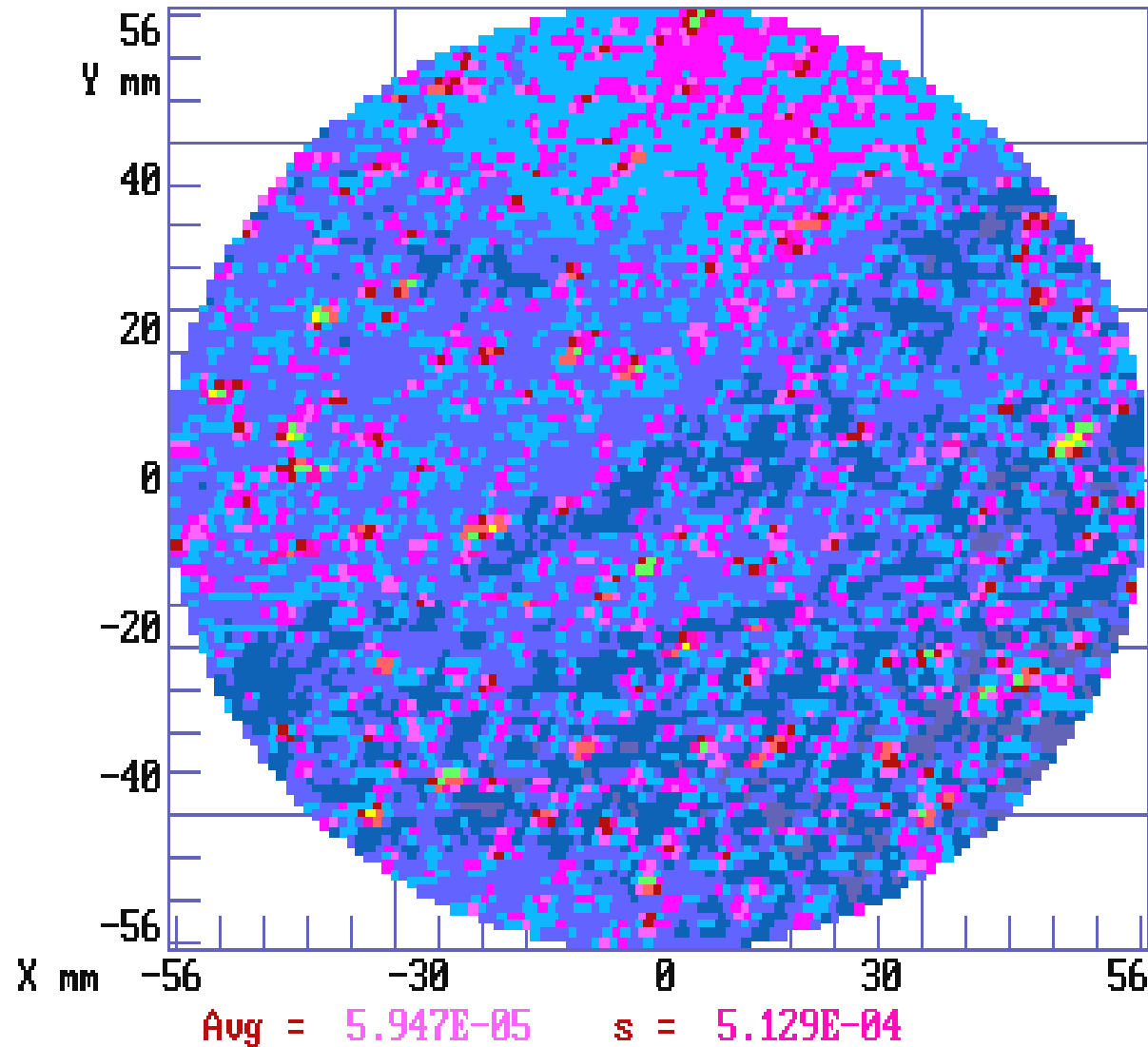
Reflectance
R = 0.9785

Angles:
 $\theta_i = 3.00^\circ$
 $\theta_s = 13.00^\circ$
 $\alpha = 0.00^\circ$

Spot Dia., mm
= 1.000

Step Size, mm
= 1.000

Scan Ctr., mm
X = 0.000
Y = 0.000



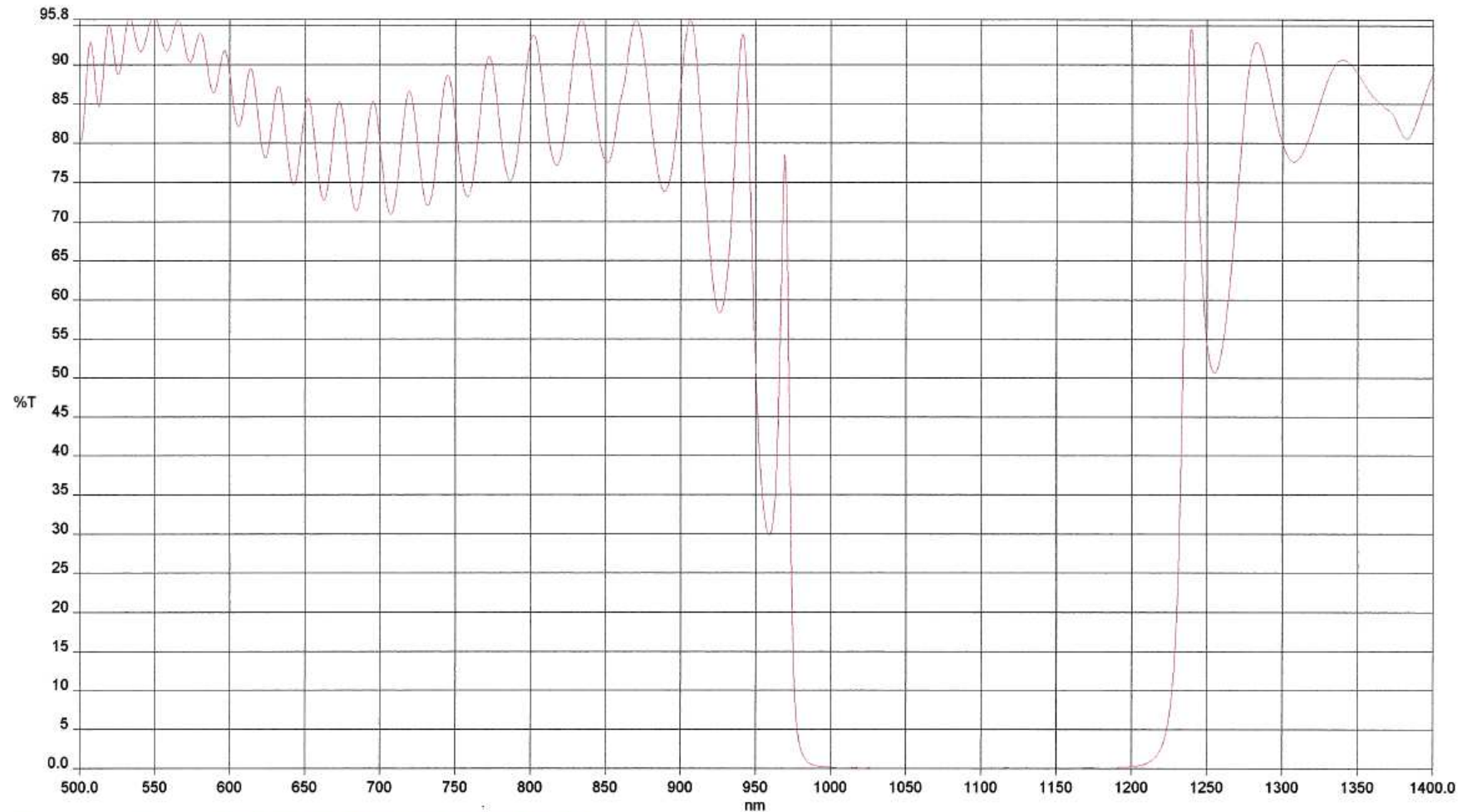
HR Transmission Spectrum on witness sample C07036

E070150-00

Date: 16/05/7

Time: 13:54:51

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Spectrum Name: C:\DATA\GC2007\C07036R.SP

Description: (HB)170.57H2.47B apres rec LASTI

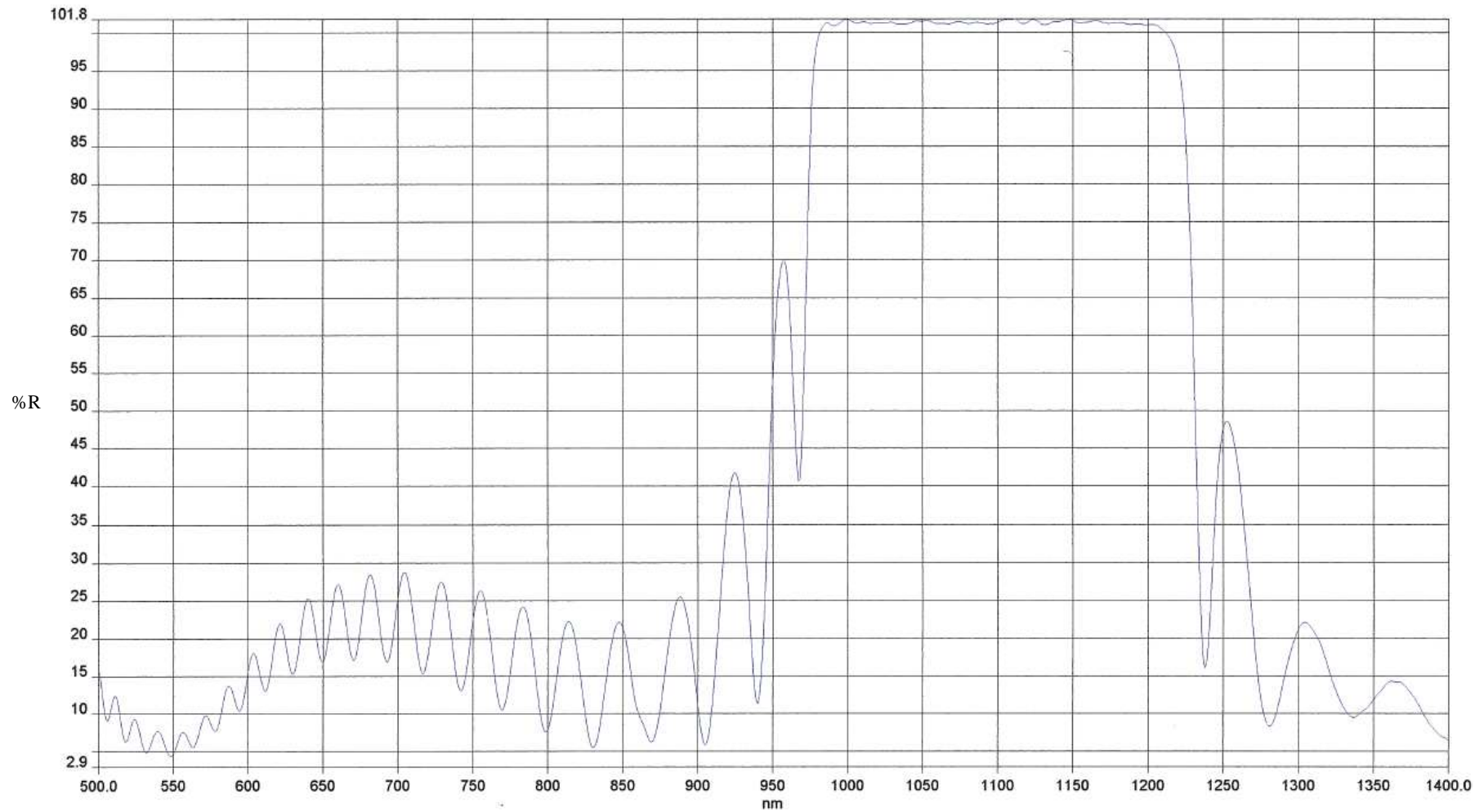
HR Reflection Spectrum on witness sample C07036

E070150-00

Date: 16/05/7

Time: 14:52:39

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Spectrum Name: C:\DATA\GC2007\RC07036R.SP

Description: réflexion C07036

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69622 – Villeurbanne Cedex FRANCE

May 2007

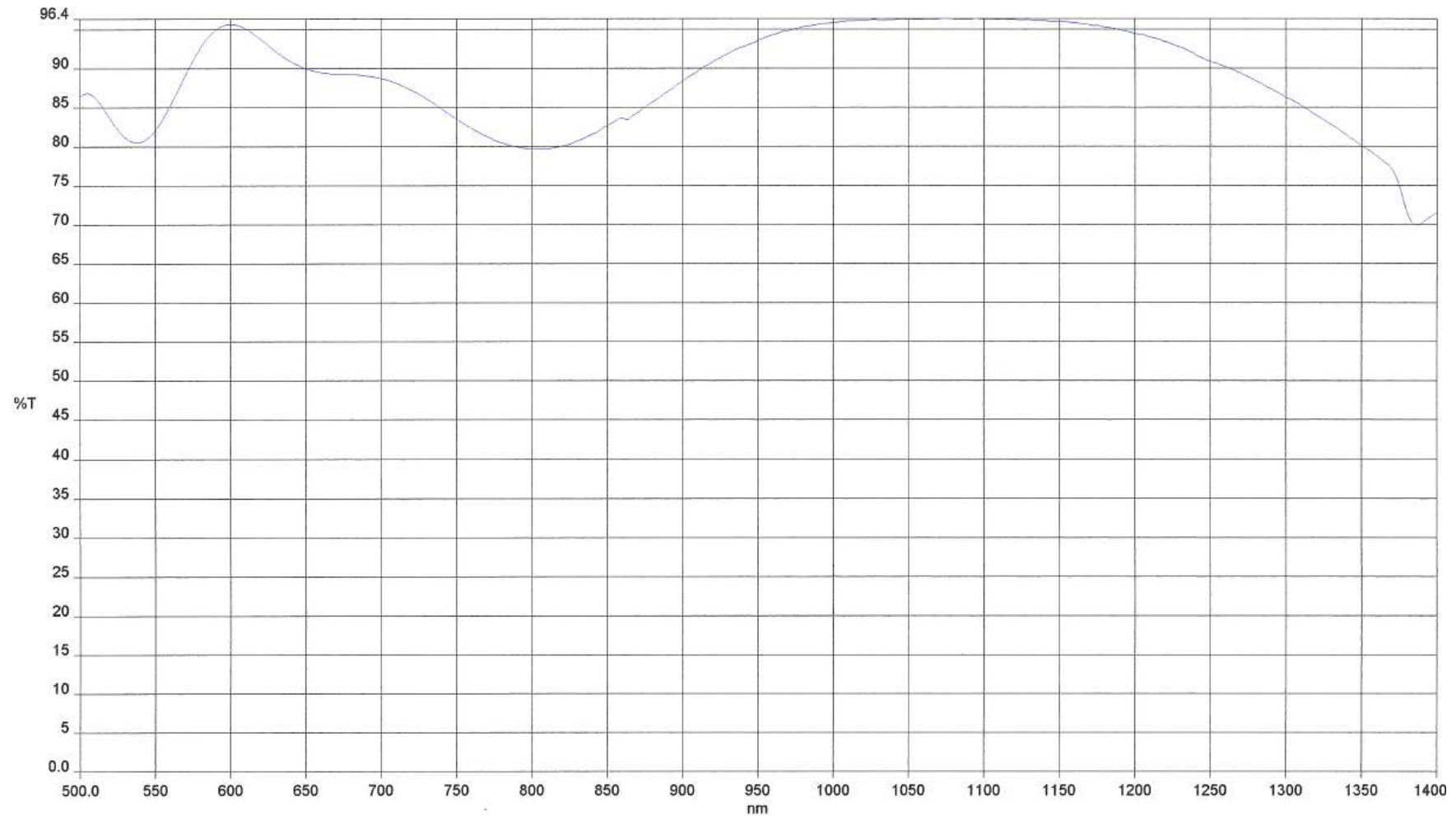
AR Transmission Spectrum on witness sample C07038

E070150-00

Date: 16/05/7

Time: 14:49:05

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Spectrum Name: C:\DATA\GC2007\C07038R.SP

Description: AR @ 1064 nm sur μ GO apres recuit

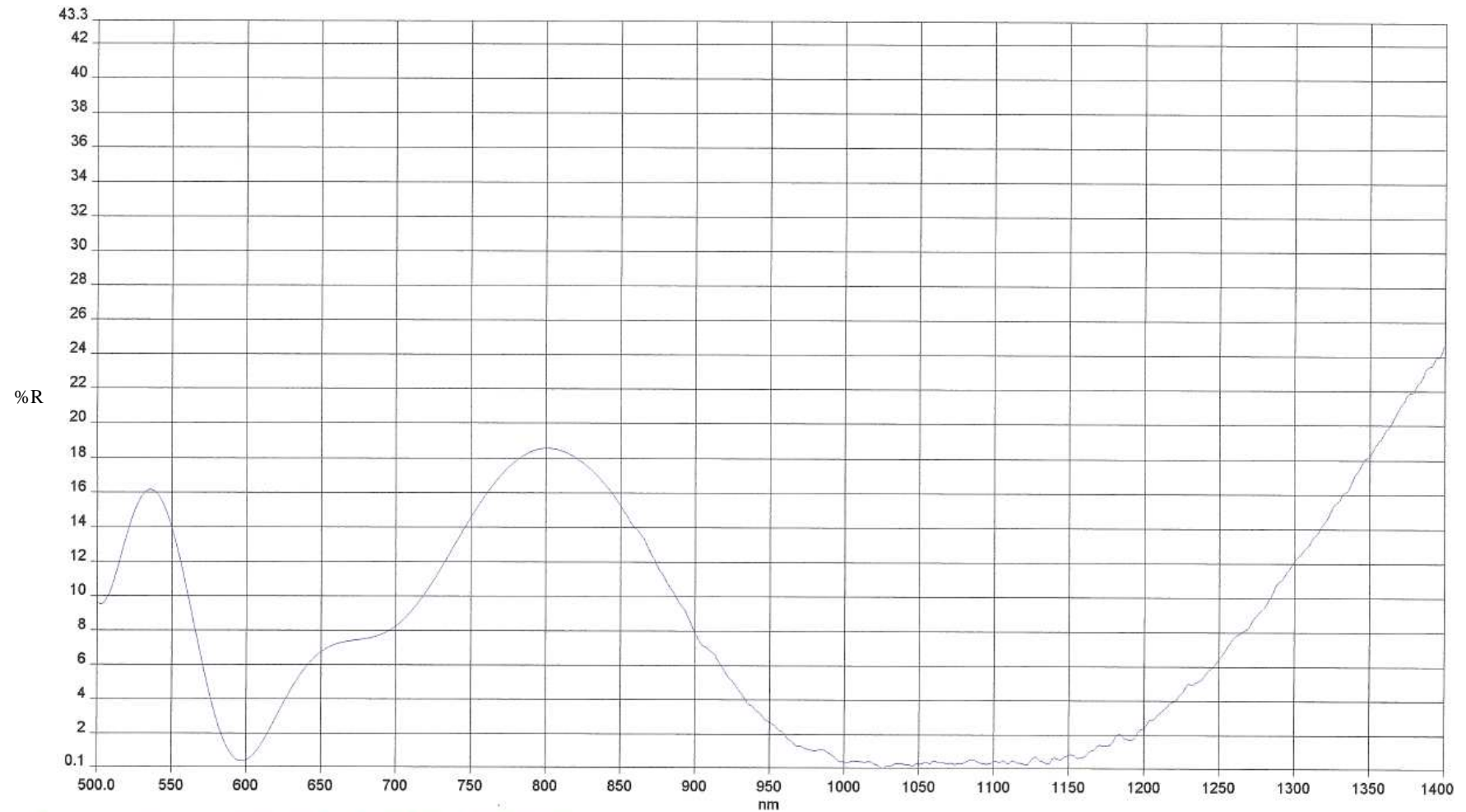
AR Reflection Spectrum on witness sample C07038

E070150-00

Date: 16/05/7

Time: 14:56:05

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Spectrum Name: C:\DATA\GC2007\RC07038R.SP

Description: reflexion C07038