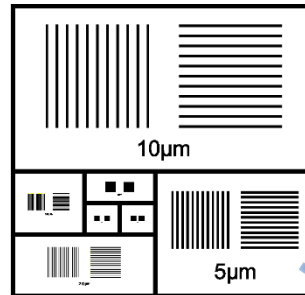
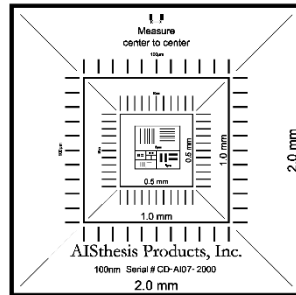


AISthesis Products

Advanced Imaging Products for Nanotechnology,
Engineering and Life Sciences
PO Box 1950, Clyde NC 28721



Certificate of Calibration for Pelcotec™ Critical Dimension Magnification Standard



Product Number: Pelcotec™ 697-1 CDMS-XY-1C-ISO

Product Description: 2.5x2.5mm, Pelcotec™ 2mm-1µm
Critical Dimension Magnification Standard.

Product Serial Number: CD-AI07-1234

As Received Condition: New

As Returned Condition: N/A

Date of Receipt: N/A

Customer name and contact information:



P.O. Box 492477

Redding, CA 96049-2477

Tel: 530.243.2200

www.tedpella.com

The accuracy of this product with Serial Number CD-AI07-1234 was determined using a Field Emission Scanning Electron Microscope (FE-SEM) by reference comparison to working standards traceable to the National Institute of Standards and Technology (NIST), using methods in CP 01 FE-SEM Imaging of Critical Dimension Magnification Standards (CDMS) and CP 02 Certification of Critical Dimension Magnification Standards. The data applies only to the CDMS identified in this report. All results are "as-is". Repair and/or adjustments are not possible.

Below are the ISO 17025:2017 compliant Certified 10 µm Pitch Measurements unique to Serial Number CD-AI07-1234 and traceable to NIST Certified Standard CD-PG01-0211.

X-Direction

Line	ISO 17025:2017 Compliant Certified Pitch	Position of Measurement
0-10 µm	9.993 µm	± 7.5 µm from center
10-20 µm	9.980 µm	± 7.5 µm from center
20-30 µm	9.980 µm	± 7.5 µm from center
30-40 µm	9.999 µm	± 7.5 µm from center
40-50 µm	10.007 µm	± 7.5 µm from center
50-60 µm	10.014 µm	± 7.5 µm from center
60-70 µm	9.999 µm	± 7.5 µm from center
70-80 µm	9.999 µm	± 7.5 µm from center

80-90 μm	9.999 μm	$\pm 7.5 \mu\text{m}$ from center
90-100 μm	9.999 μm	$\pm 7.5 \mu\text{m}$ from center
<i>Sum</i>	<i>99.969 μm</i>	
Average	9.9969 μm	
2-Sigma *	0.0042 μm	

* Corrected for sample size using the appropriate Student t-factor.

Y-Direction

Line	ISO 17025:2017 Compliant Certified Pitch	Position of Measurement
0-10 μm	9.993 μm	$\pm 7.5 \mu\text{m}$ from center
10-20 μm	9.980 μm	$\pm 7.5 \mu\text{m}$ from center
20-30 μm	9.980 μm	$\pm 7.5 \mu\text{m}$ from center
30-40 μm	9.999 μm	$\pm 7.5 \mu\text{m}$ from center
40-50 μm	10.007 μm	$\pm 7.5 \mu\text{m}$ from center
50-60 μm	10.014 μm	$\pm 7.5 \mu\text{m}$ from center
60-70 μm	9.999 μm	$\pm 7.5 \mu\text{m}$ from center
70-80 μm	9.999 μm	$\pm 7.5 \mu\text{m}$ from center
80-90 μm	9.999 μm	$\pm 7.5 \mu\text{m}$ from center
90-100 μm	9.999 μm	$\pm 7.5 \mu\text{m}$ from center
<i>Sum</i>	<i>99.969 μm</i>	
Average	9.9969 μm	
2-Sigma *	0.0042 μm	

* Corrected for sample size using the appropriate Student t-factor.

Measurements are reported with an uncertainty ($k=2$)** of $\pm 0.012 \mu\text{m}$. Statements of Conformity are not provided in this report. Review the results and verify that they meet the requirements for the intended use. Physical damage to or contamination of the CDMS occurring after calibration may invalidate the reported measurements. Use this product at $25^\circ\text{C} \pm 5^\circ\text{C}$ and at less than 80% RH.

** Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of $k = 2$. The reported expanded measurement uncertainty is stated as the standard measurement uncertainty multiplied by the coverage factor K such that the coverage probability corresponds to approximately 95%.

X-Direction

Line	Number of Lines	Position of Measurement	Non-ISO 17025:2017 Compliant Measured Distance (first to last line)	Average Pitch
2.0mm	2	$\pm 1.00\text{mm}$ from center	2.000 mm	2.000 mm
1.0mm	2	$\pm 0.5\text{mm}$ from center	1.000 mm	1.000 mm
0.5mm	2	$\pm 0.25\text{mm}$ from center	0.500 mm	0.500 mm
0.1mm	11	$\pm 50 \mu\text{m}$ from center	1.000mm	100.038 μm
50 μm	11	$\pm 50 \mu\text{m}$ from center	0.500 mm	50.031 μm
5 μm	12	$\pm 20 \mu\text{m}$ from center	55.057 μm	5.005 μm
2 μm	16	$\pm 10 \mu\text{m}$ from center	30.051 μm	2.003 μm
1 μm	17	$\pm 5 \mu\text{m}$ from center	16.033 μm	1.002 μm

Y-Direction

Line	Number of Lines	Position of Measurement	Non-ISO 17025:2017 Compliant Measured Distance (first to last line)	Average Pitch
2.0mm	2	± 1.00mm from center	2.000 mm	2.000 mm
1.0mm	2	± 0.5mm from center	1.000 mm	1.000 mm
0.5mm	2	± 0.25mm from center	0.500 mm	0.500 mm
0.1mm	11	± 50 µm from center	1.000mm	100.038 µm
50µm	11	± 50 µm from center	0.500 mm	50.031 µm
5µm	12	± 20 µm from center	55.057 µm	5.005 µm
2µm	16	± 10 µm from center	30.051 µm	2.003 µm
1µm	17	± 5 µm from center	16.033 µm	1.002 µm

The average pitch is derived from the stated length that was determined using measurements (taken center-to-center) over the stated number of lines (i.e., length divided by the number of lines minus one).

Date of Analysis: January 29th, 2023

Equipment used:

Instrument	Model	Serial #	Resolution	Repeatability	Temperature	Humidity	Ref.
FE-SEM	FEI Verios 460L	9922551	0.9nm	0.030%	23.3 ± 0.3 °C	42.5 ± 1.5%	CD-PG01-0211

Location: Analytical Instrumentation Facility, NC State University, Raleigh NC 27695-7531.

Notes:

D.S. Finch
Certified by

Signature

H. Haehlen
Authorized by

Signature

January 29th, 2023
Date report issued.

This certificate shall not be reproduced without the permission of AIStHesis Products, Inc.
P.O. Box 1950, Clyde, North Carolina 28721 Tel: 828.627.6555 E-mail: CDMS@aisthesisproducts.com

AI07 1234

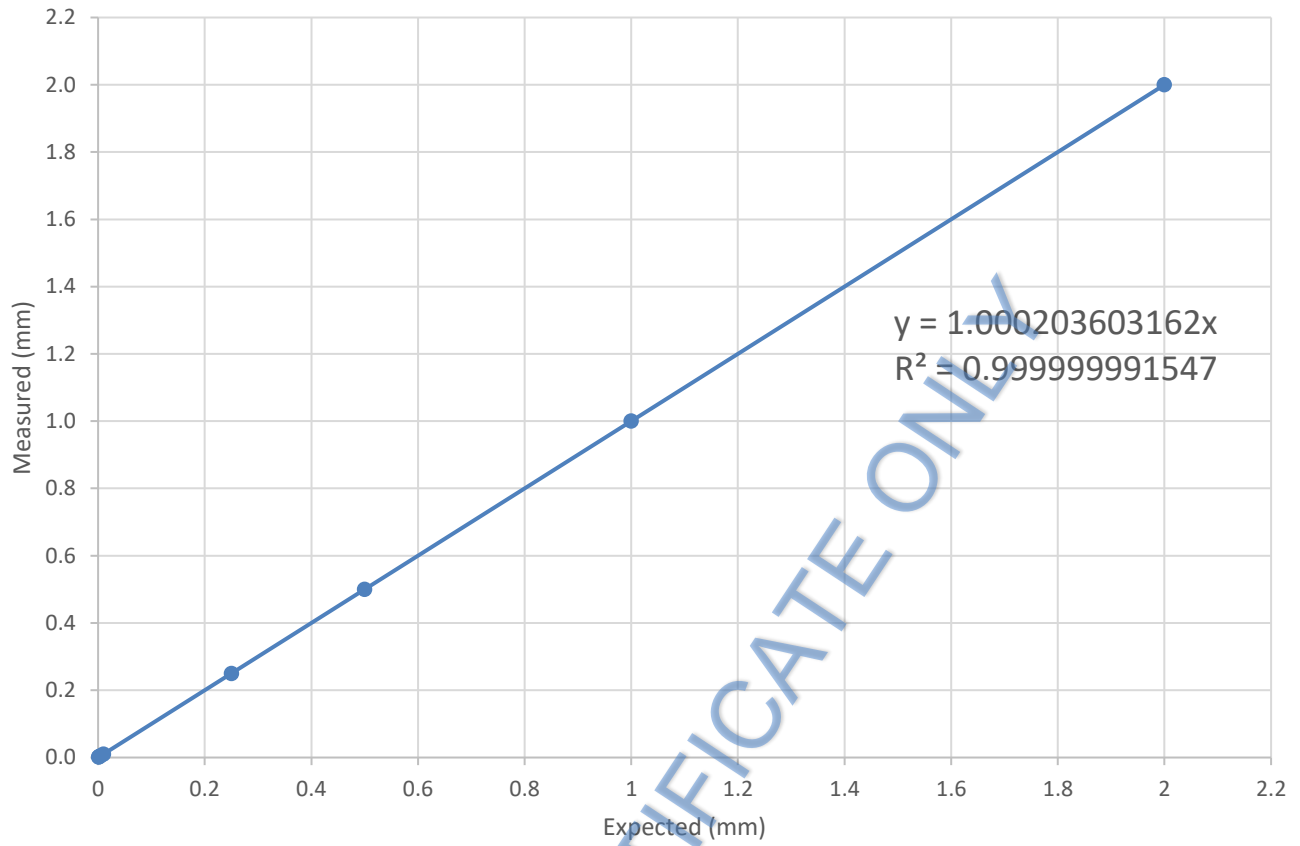


Figure 1. Expected versus actual measurements in the X direction including all lines with linear regression and R^2 values reported.

AI07 1234

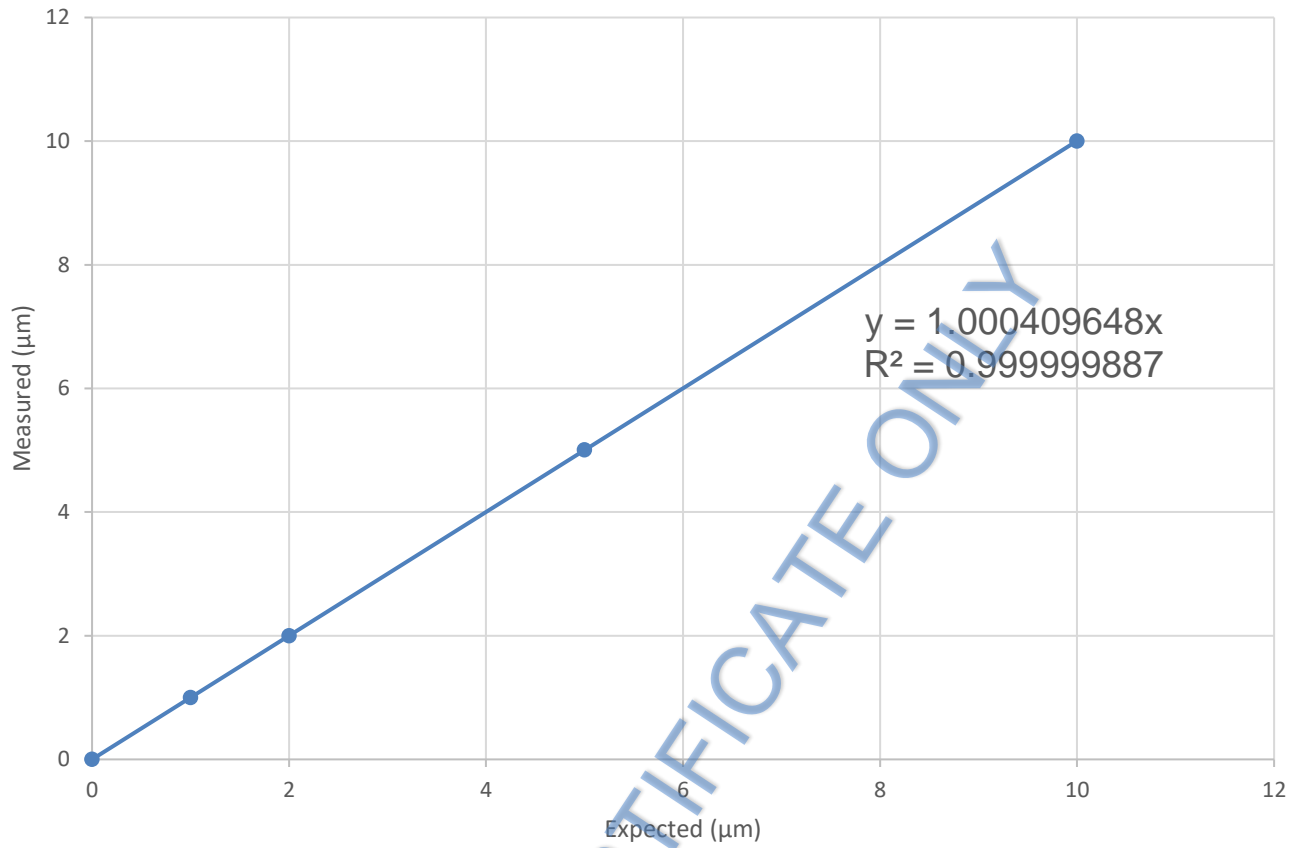


Figure 2. Expected versus actual measurements for the X-direction 10µm, 5µm, 2µm, and 1µm pitch lines with linear regression and R² values reported.

AI07 1234

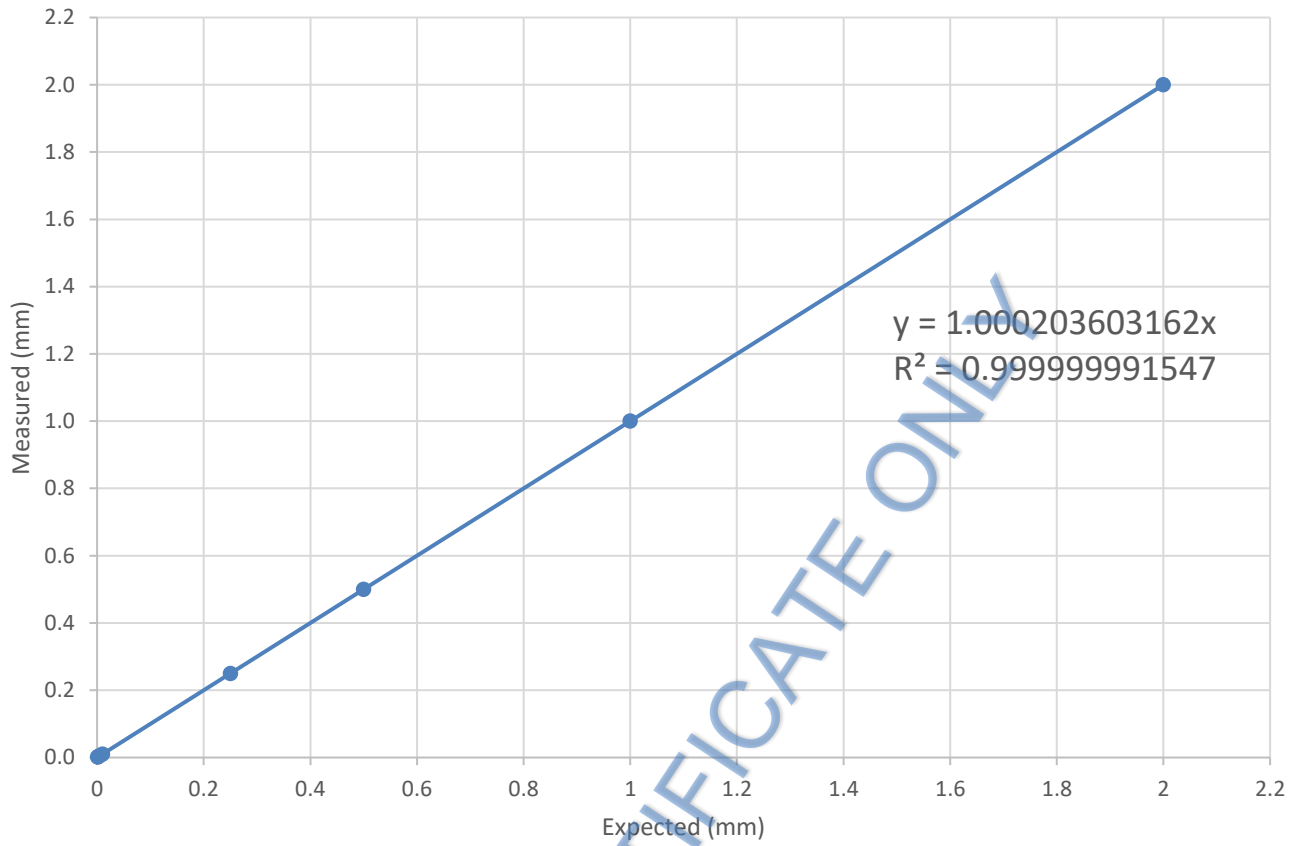


Figure 3. Expected versus actual measurements in the Y-direction including all lines with linear regression and R² values reported.

AI07 1234

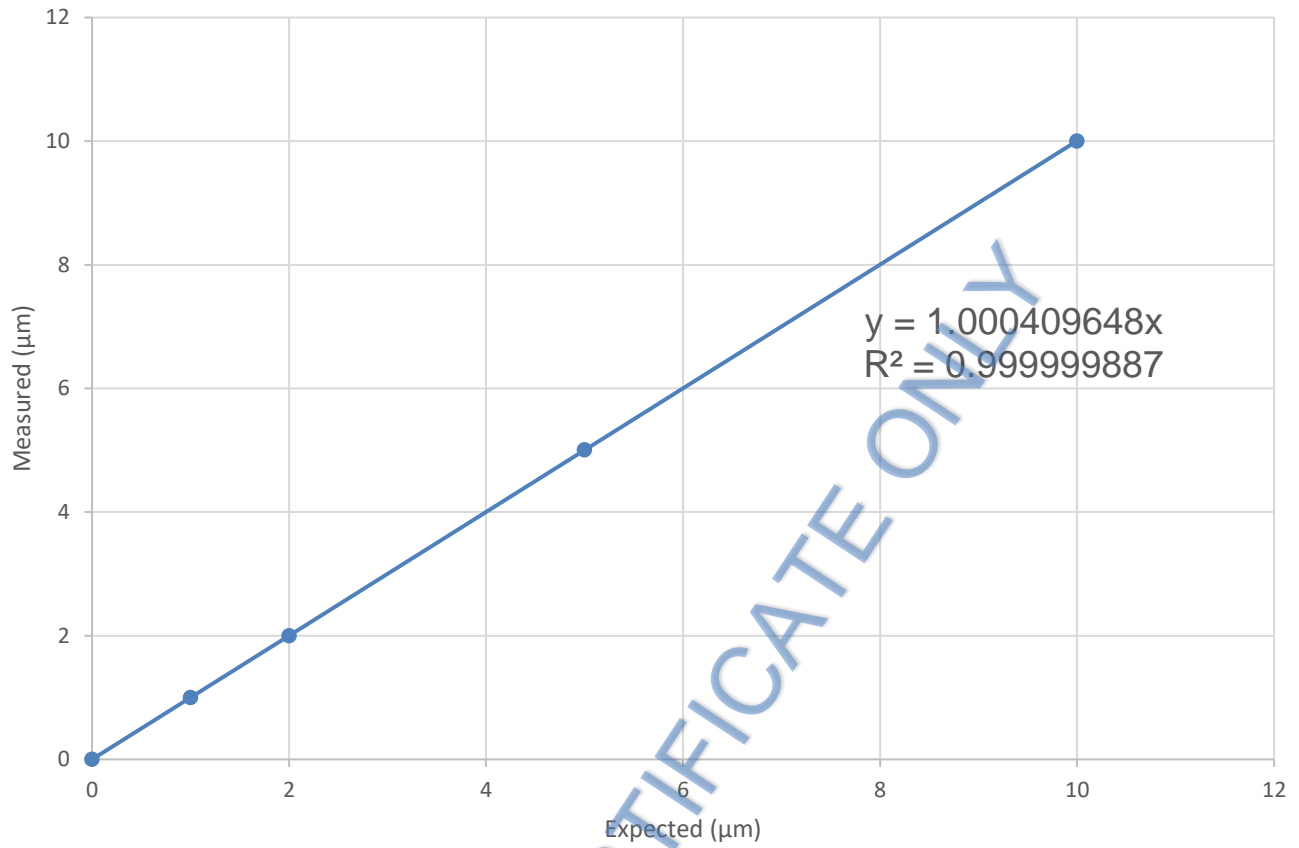


Figure 4. Expected versus actual measurements for the Y-direction 10µm, 5µm, 2µm, and 1µm pitch lines with linear regression and R² values reported.

5 µm Line X-direction	Pitch
0-5µm	5.005 µm
5-10µm	5.005 µm
10-15µm	5.005 µm
15-20µm	5.010 µm
20-25µm	5.010 µm
25-30µm	5.005 µm
30-35µm	5.005 µm
35-40µm	5.003 µm
40-45µm	5.000 µm
45-50µm	5.008 µm
50-55µm	5.000 µm
<i>Sum</i>	<i>55.057 µm</i>
Average	5.0051 µm
2-Sigma *	0.0079 µm

2 µm Line X-direction	Pitch
0-2µm	2.031 µm
2-4µm	2.003 µm
4-6µm	2.001 µm
6-8µm	2.003 µm
8-10µm	2.001 µm
10-12µm	2.001 µm
12-14µm	2.003 µm
14-16µm	1.998 µm
16-18µm	2.003 µm
18-20µm	2.001 µm
20-22µm	2.001 µm
22-24µm	2.001 µm
24-26µm	2.003 µm
26-28µm	2.001 µm
28-30µm	2.003 µm
<i>Sum</i>	<i>30.051 µm</i>
Average	2.0034 µm
2-Sigma *	0.0173 µm

Excluding 1 st and last lines	
Average	2.0013 µm
2-Sigma *	0.0036 µm

1 µm Line X-direction	Pitch
0-1µm	1.005 µm
1-2µm	1.001 µm
2-3µm	1.002 µm
3-4µm	1.002 µm
4-5µm	1.001 µm
5-6µm	1.002 µm

6-7µm	1.001 µm
7-8µm	1.001 µm
8-9µm	1.004 µm
9-10µm	1.001 µm
10-11µm	1.000 µm
11-12µm	1.002 µm
12-13µm	1.001 µm
13-14µm	1.001 µm
14-15µm	1.004 µm
15-16µm	1.004 µm
<i>Sum</i>	<i>16.033 µm</i>
Average	1.0021 µm
2-Sigma *	0.0032 µm

Excluding 1 st and last lines	
Average	1.0017 µm
2-Sigma *	0.0026 µm

5 µm Line Y-direction	Pitch
0-5µm	5.005 µm
5-10µm	5.005 µm
10-15µm	5.005 µm
15-20µm	5.010 µm
20-25µm	5.010 µm
25-30µm	5.005 µm
30-35µm	5.005 µm
35-40µm	5.003 µm
40-45µm	5.000 µm
45-50µm	5.008 µm
50-55µm	5.000 µm
<i>Sum</i>	<i>55.057 µm</i>
Average	5.0051 µm
2-Sigma *	0.0079 µm

2 µm Line Y-direction	Pitch
0-2µm	2.031 µm
2-4µm	2.003 µm
4-6µm	2.001 µm
6-8µm	2.003 µm
8-10µm	2.001 µm
10-12µm	2.001 µm
12-14µm	2.003 µm
14-16µm	1.998 µm
16-18µm	2.003 µm
18-20µm	2.001 µm
20-22µm	2.001 µm
22-24µm	2.001 µm
24-26µm	2.003 µm

26-28µm	2.001 µm
28-30µm	2.003 µm
<i>Sum</i>	<i>30.051 µm</i>
Average	2.0034 µm
2-Sigma *	0.0173 µm

Excluding 1 st and last lines	
Average	2.0013 µm
2-Sigma *	0.0036 µm

1 µm Line Y-direction	Pitch
0-1µm	1.005 µm
1-2µm	1.001 µm
2-3µm	1.002 µm
3-4µm	1.002 µm
4-5µm	1.001 µm
5-6µm	1.002 µm
6-7µm	1.001 µm
7-8µm	1.001 µm
8-9µm	1.004 µm
9-10µm	1.001 µm
10-11µm	1.000 µm
11-12µm	1.002 µm
12-13µm	1.001 µm
13-14µm	1.001 µm
14-15µm	1.004 µm
15-16µm	1.004 µm
<i>Sum</i>	<i>16.033 µm</i>
Average	1.0021 µm
2-Sigma *	0.0032 µm

Excluding 1 st and last lines	
Average	1.0017 µm
2-Sigma *	0.0026 µm

End of report.