

Nikon's Approach to EUV projection optics

Yutaka Ichihara and Kazuya Ota
Nikon

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NIKON's Strategy

Cooperate with ASET
(Started 1998)

Step by Step Development

Accuracy

The accuracy of the figure of aspherical mirror

≡ Accuracy of the measurement
+Resettability of the measurement
+manufacturing error

≡ Accuracy of the measurement
+1.5x(Resettability of the measurement)

(Manufacturer believes the measured value to be true)

In case of aspherical mirror, accuracy depends on an accuracy of the null lens or null element (such as CGH) or some reference.

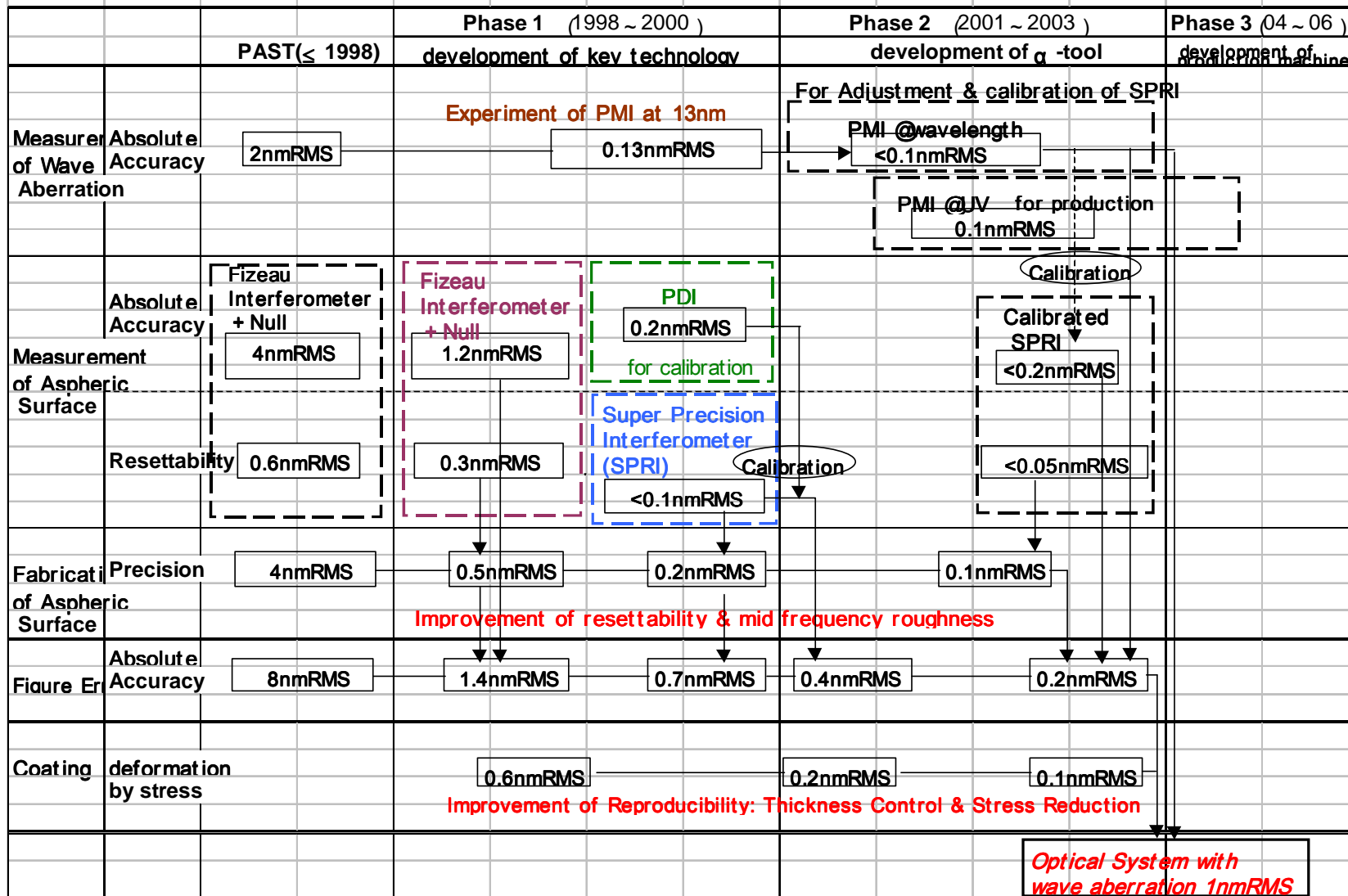
Resettability depends on the holding, environment(vibration, air turbulence etc) electric noise,etc

Roadmap of the measurement & fabrication of EUVL optics

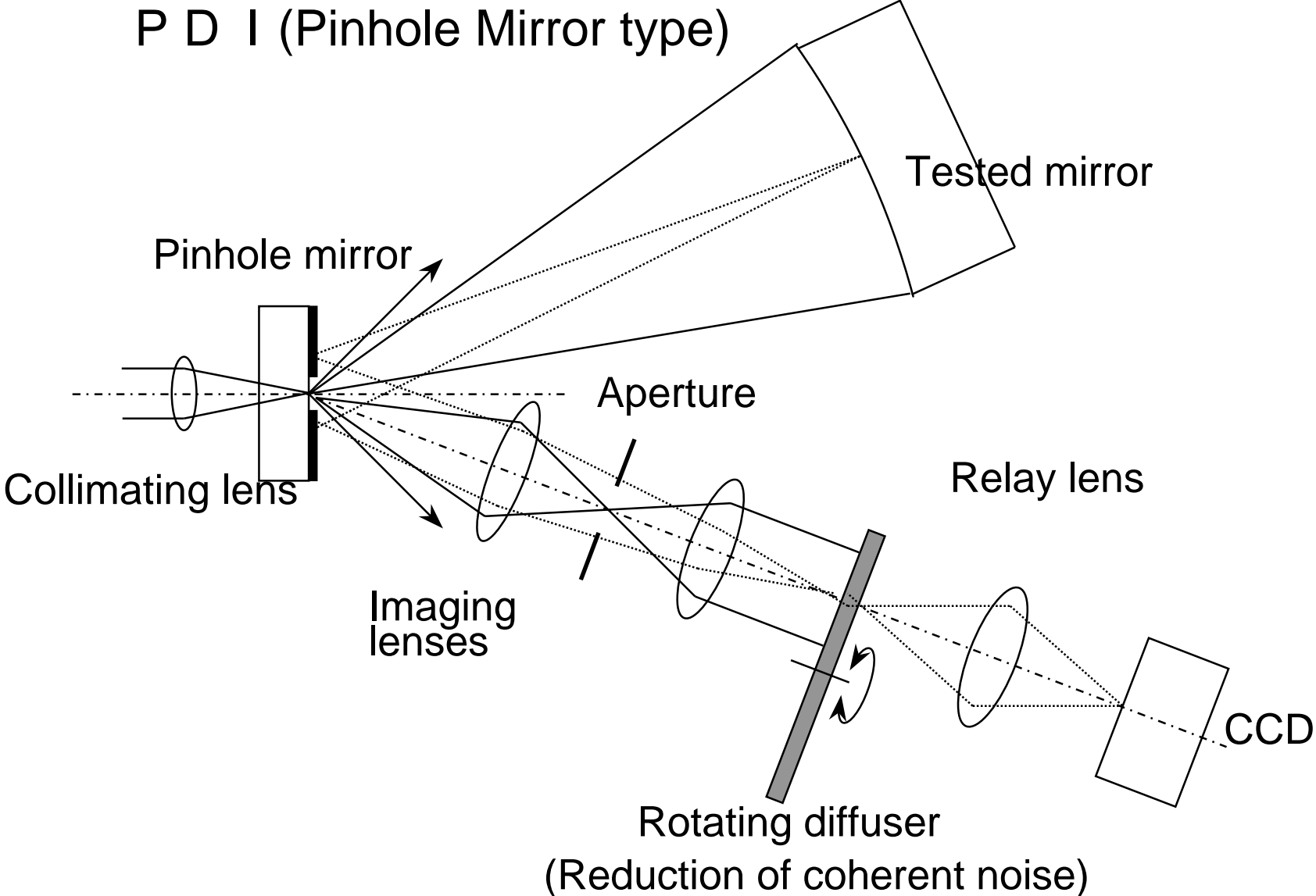
1999.10.12 NIKON

TARGET

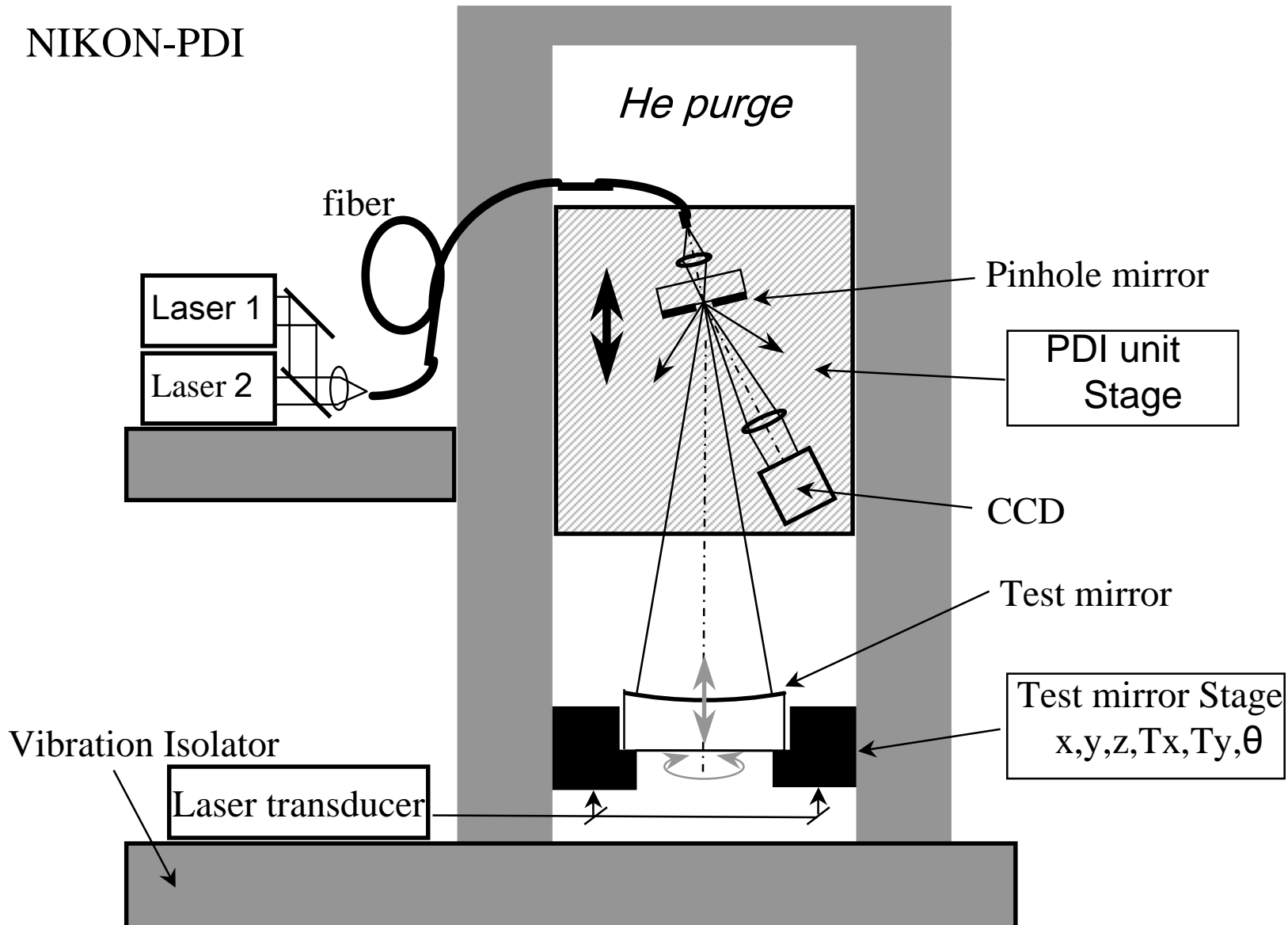
Wave Aberration: 1nmRMS
Accuracy of Mirrors: 0.23nmRMS



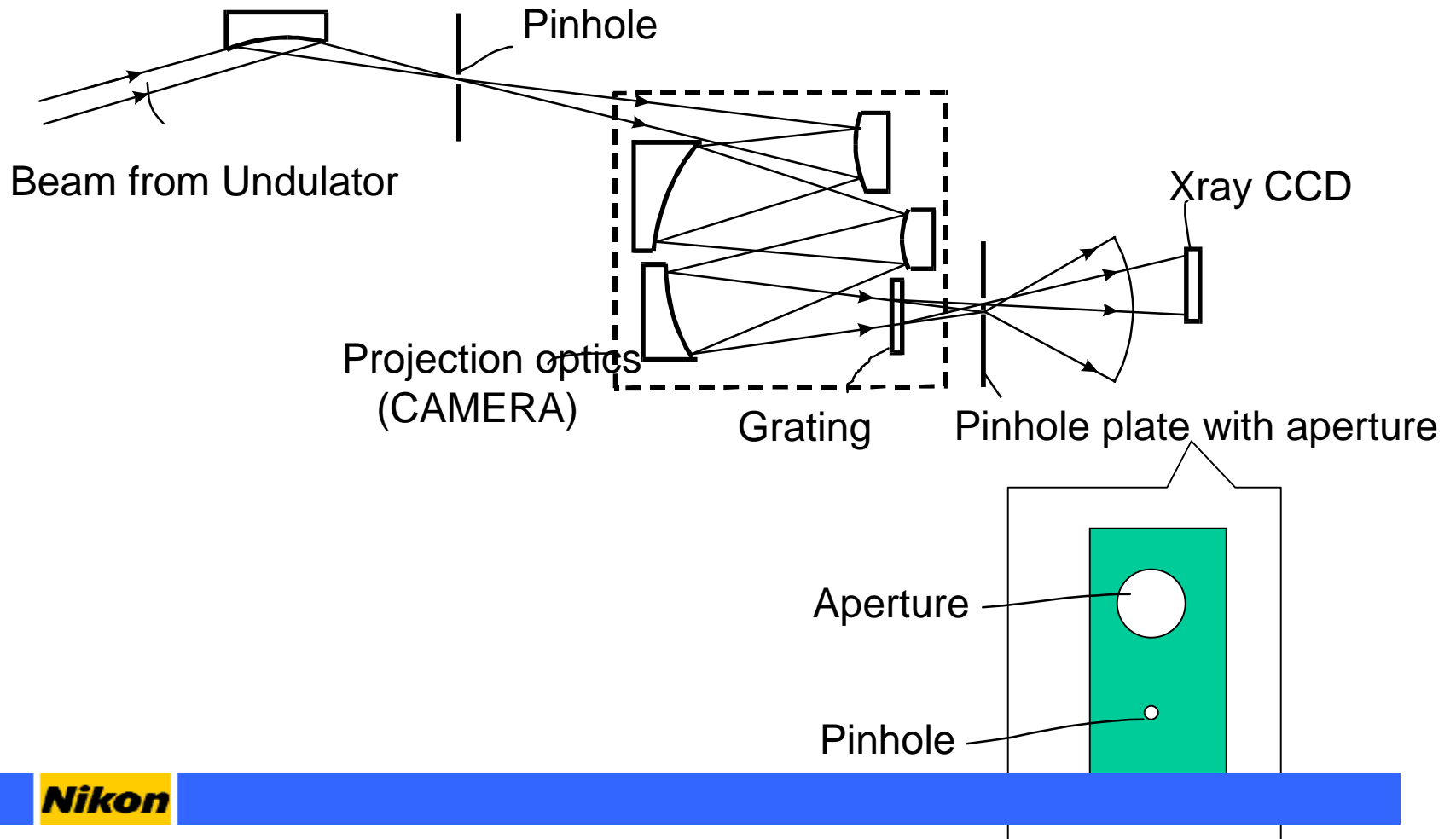
P D I (Pinhole Mirror type)



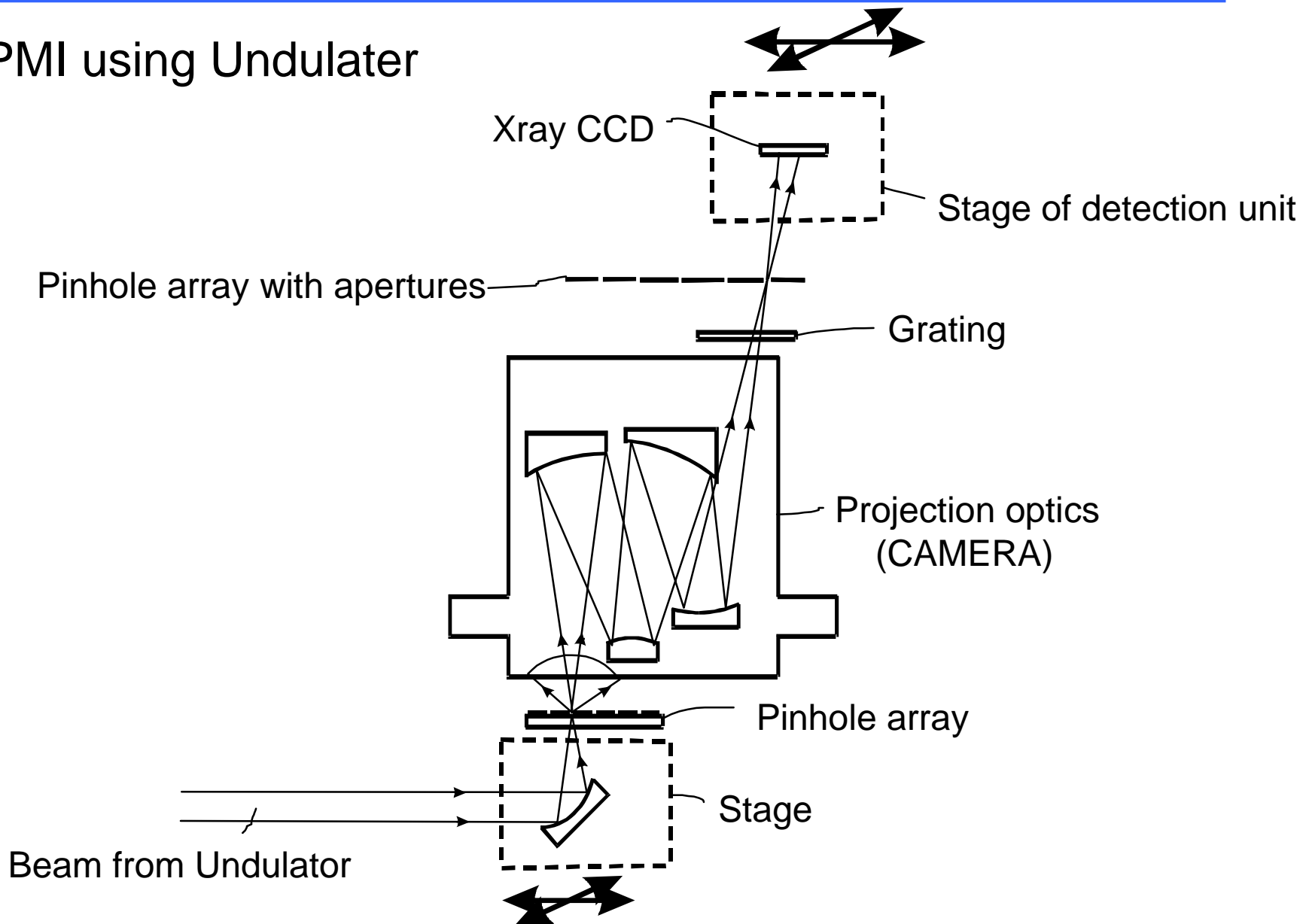
NIKON-PDI

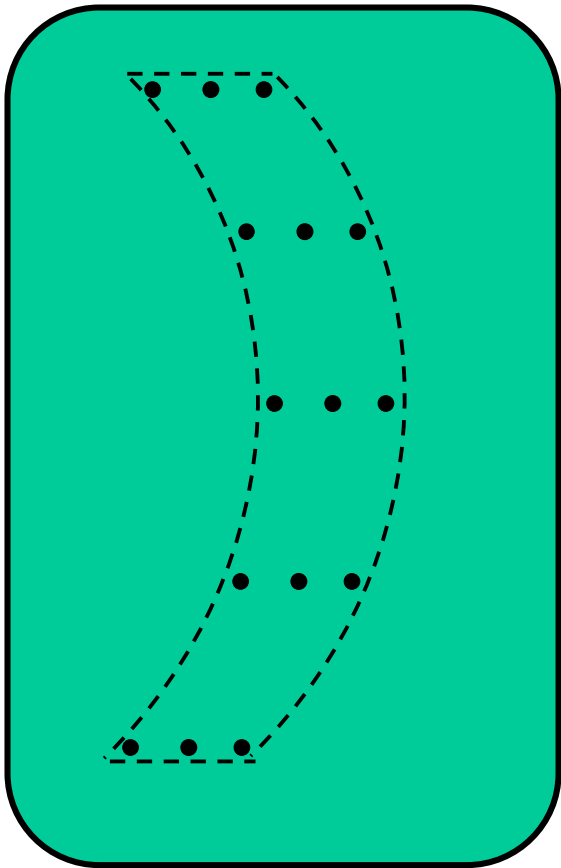


PMI@wavelength

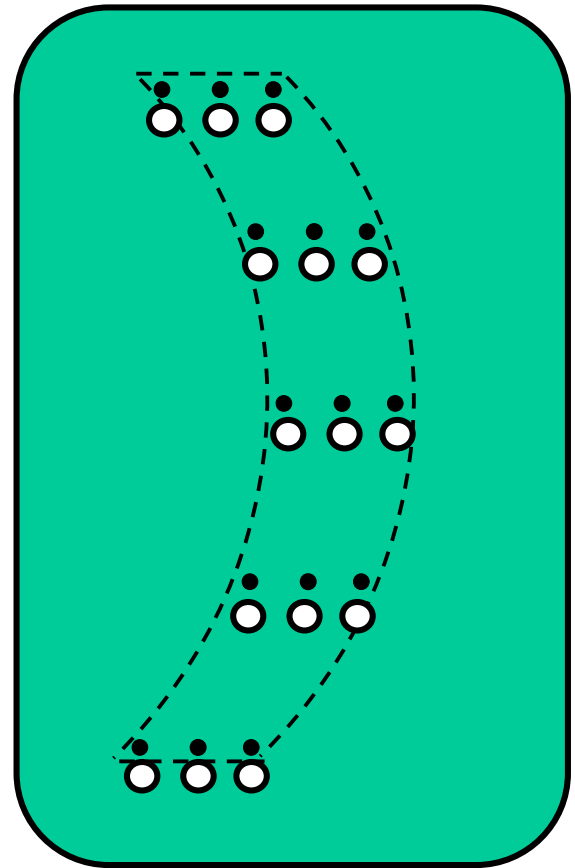


PMI using Undulator



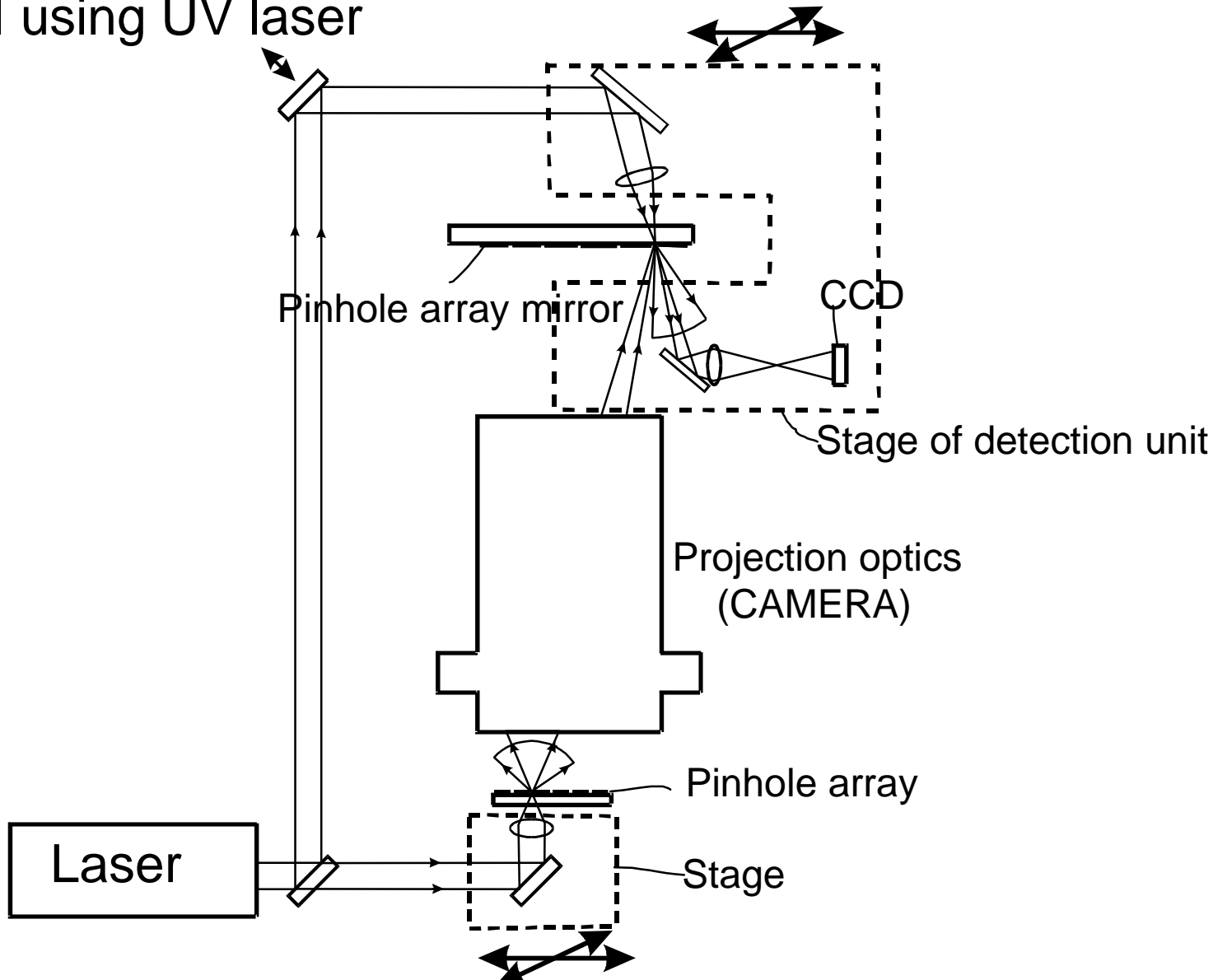


Pinhole Array
(Wafer)

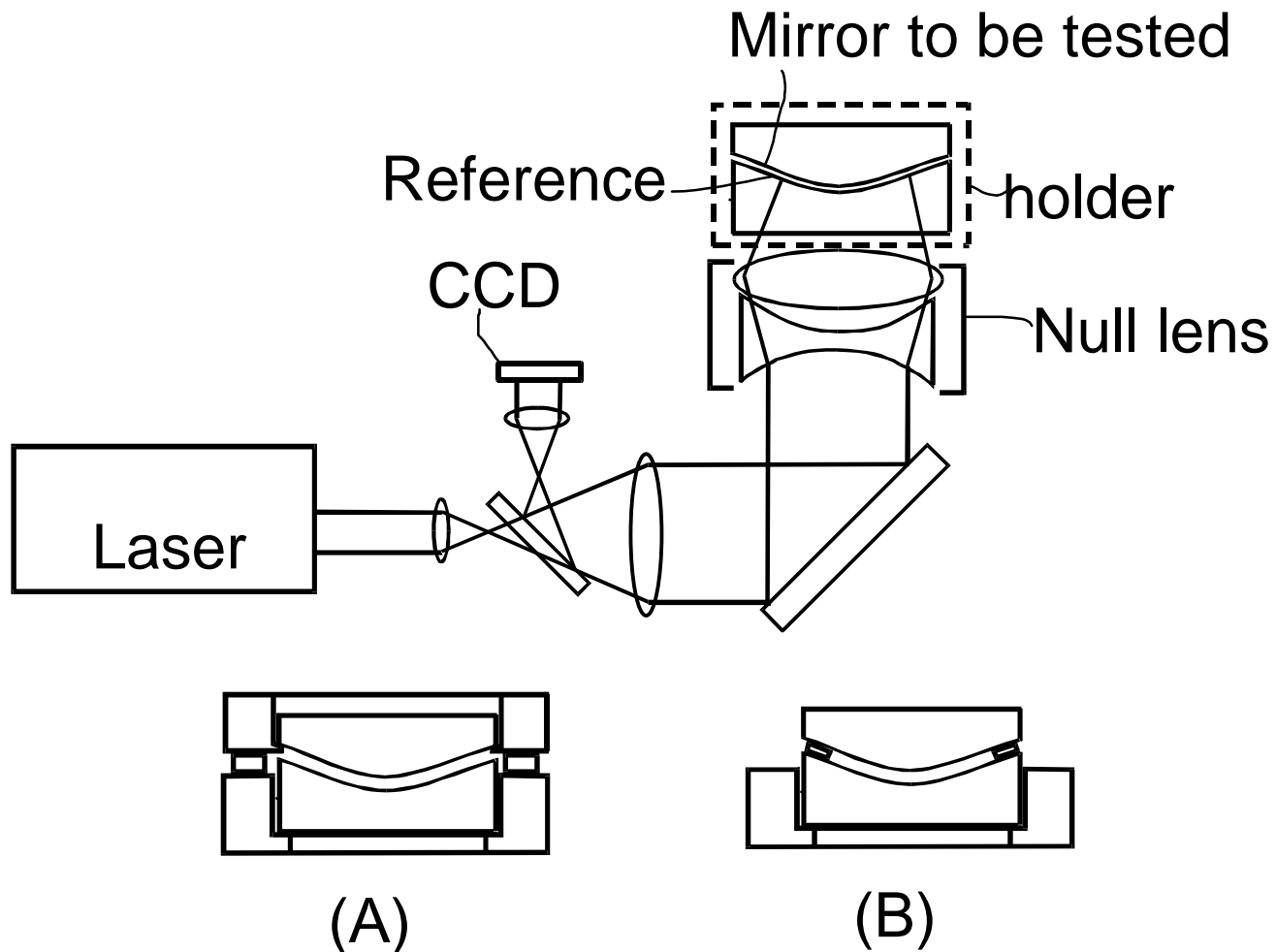


Pinhole Array with aperture
(Mask)

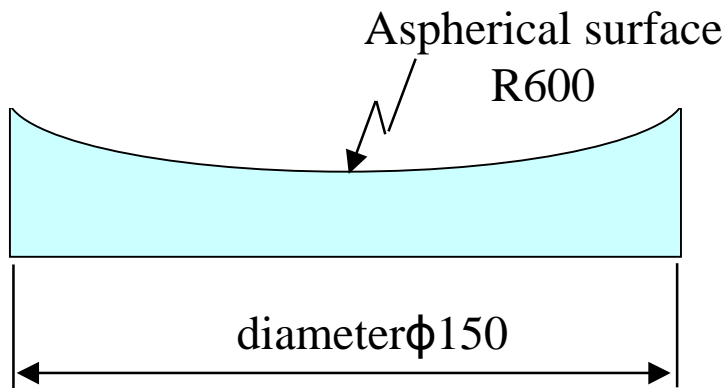
PMI using UV laser



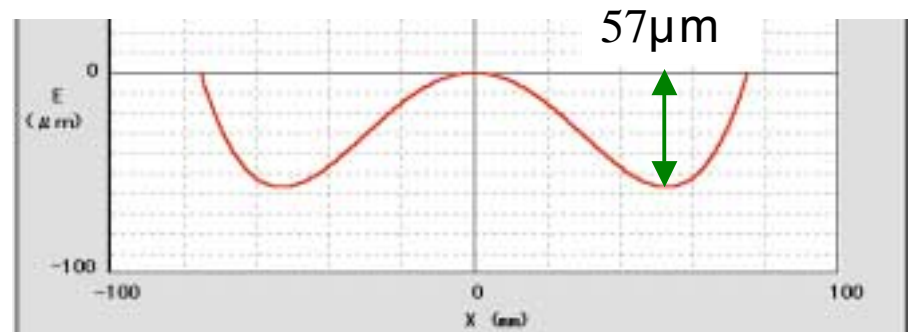
SPRI (Super Precision Interferometer)



Concave Aspherical Mirror

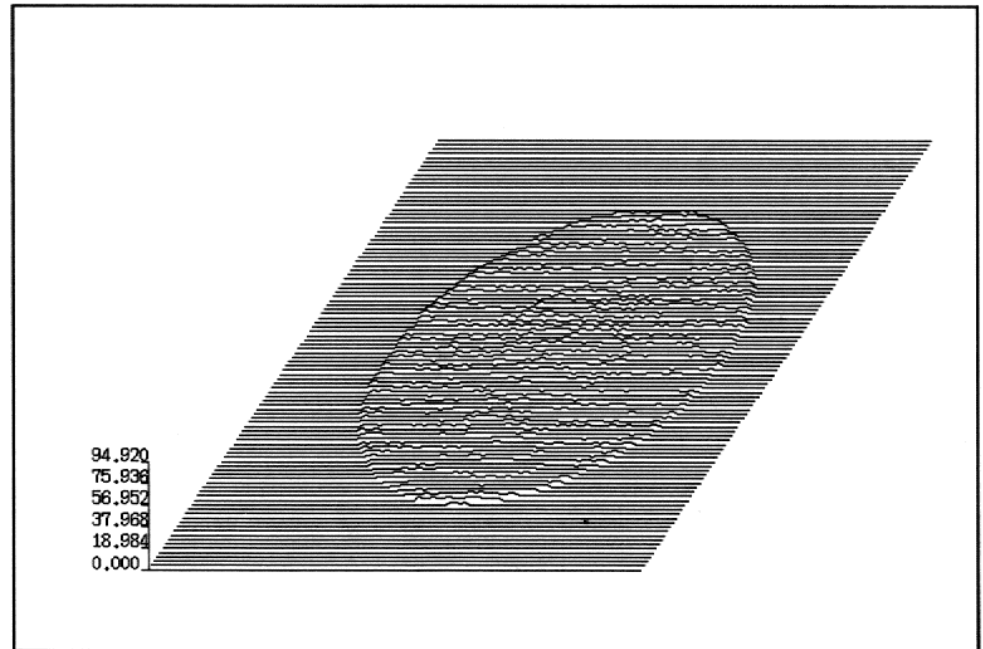


Deviation from the best fitting sphere



Form Data of Concave Aspherical Mirror

RMS	0.48052 nm
PK-PK	3.69974 nm
DZ	137.142 nm
X-TILT	1.062 urad
Y-TILT	0.226 urad
X-SHIFT	-640.441 nm
Y-SHIFT	-138.897 nm
PITCH	6.32800 nm



Data of Mid Frequency roughness (measured field size $\phi 1.5\text{mm}$)



Mag: 2.5 X

Mode: PSI

Date: 08/16/99

Time: 14:10:11

Surface Data

Surface Statistics:

Ra: 0.32 nm

Rq: 0.41 nm

Rz: 1.91 nm

Rt: 2.31 nm

Set-up Parameters:

Size: 184 X 118

Sampling: 13.60 μm

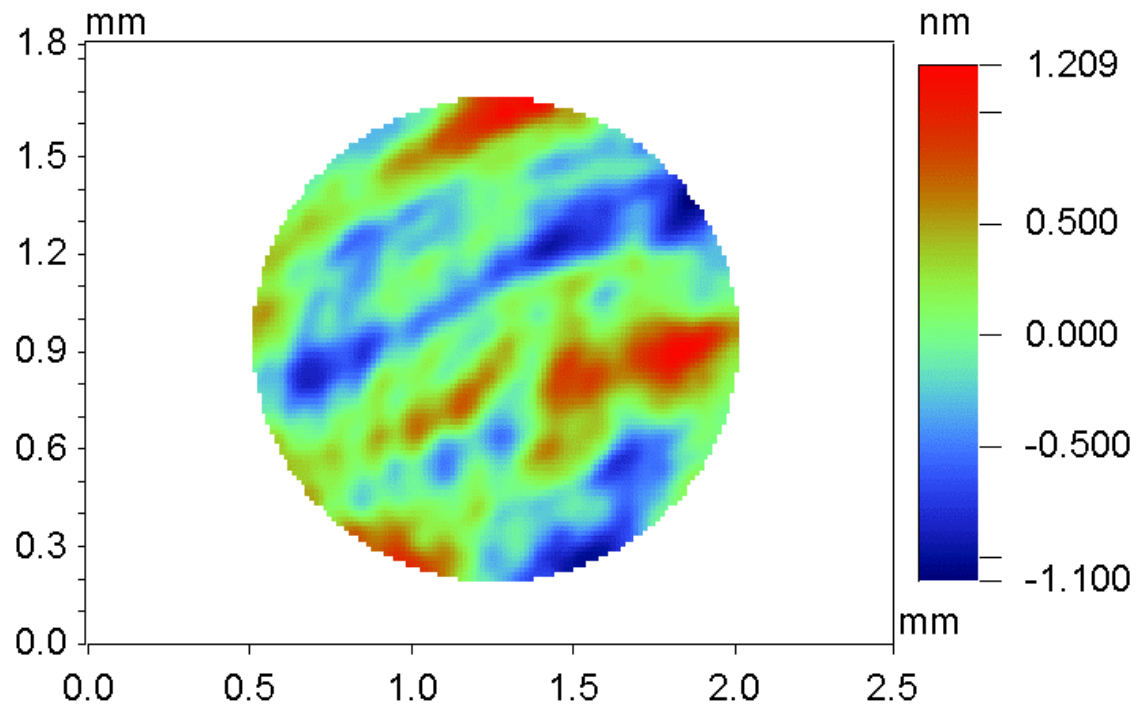
Processed Options:

Terms Removed:

Cylinder & Tilt

Filtering:

Low Pass



Title:

Note:

Mid Frequency Roughness (120×89μm)



Mag: 51.9 X
Mode: PSI

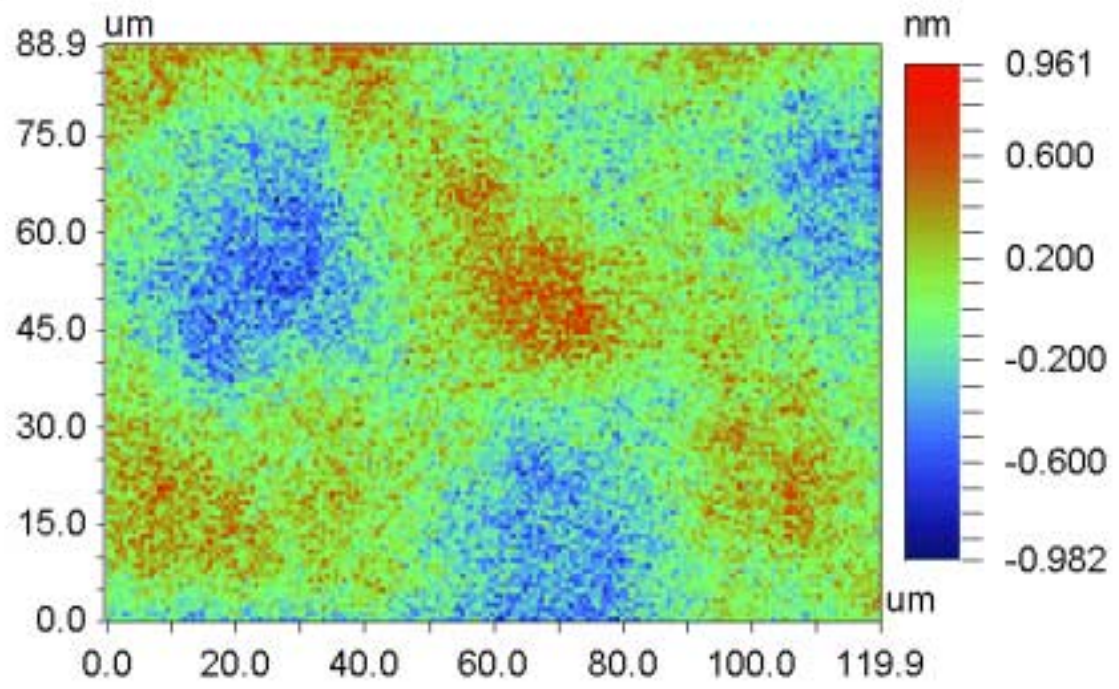
Surface Data

Date: 08/24/99
Time: 10:09:05

Surface Statistics:
Ra: 0.21 nm
Rq: 0.27 nm
Rz: 1.71 nm
Rt: 1.94 nm

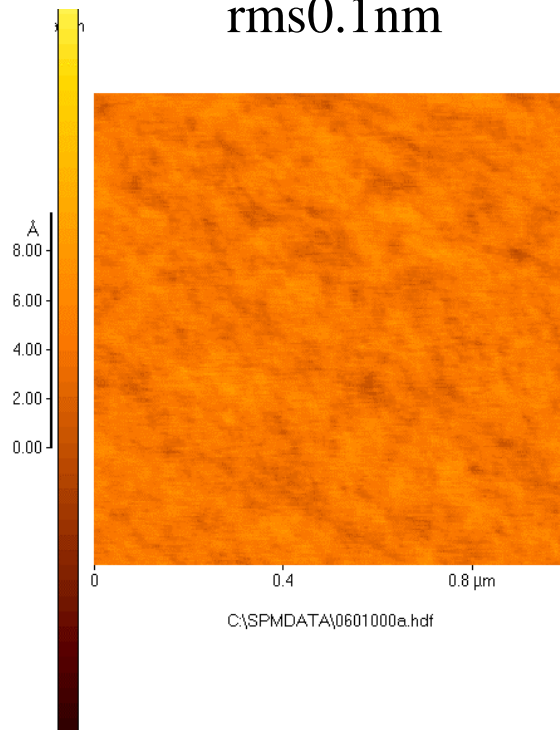
Set-up Parameters:
Size: 184 X 118
Sampling: 655.32 nm

Processed Options:
Terms Removed:
Tilt
Filtering:
None



Title:
Note:

AFM IMAGE ($1\mu\text{m}^2$)
rms0.1nm



AFM IMAGE ($5\mu\text{m}^2$)
rms0.12nm

