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Absolute Point Diffraction Interferometer

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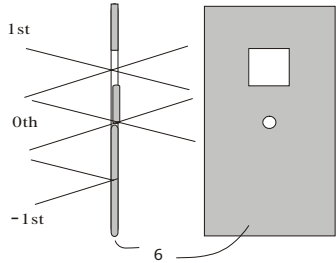
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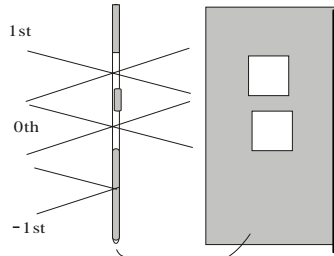
Measurement principle of Absolute PDI for calibration

PDI



$$W_1 = W_{R0} + W_{T1} + W_{G1} + W_S$$

CAL



$$W_2 = W_{T0} + W_{T1} + W_{G1} + W_S$$



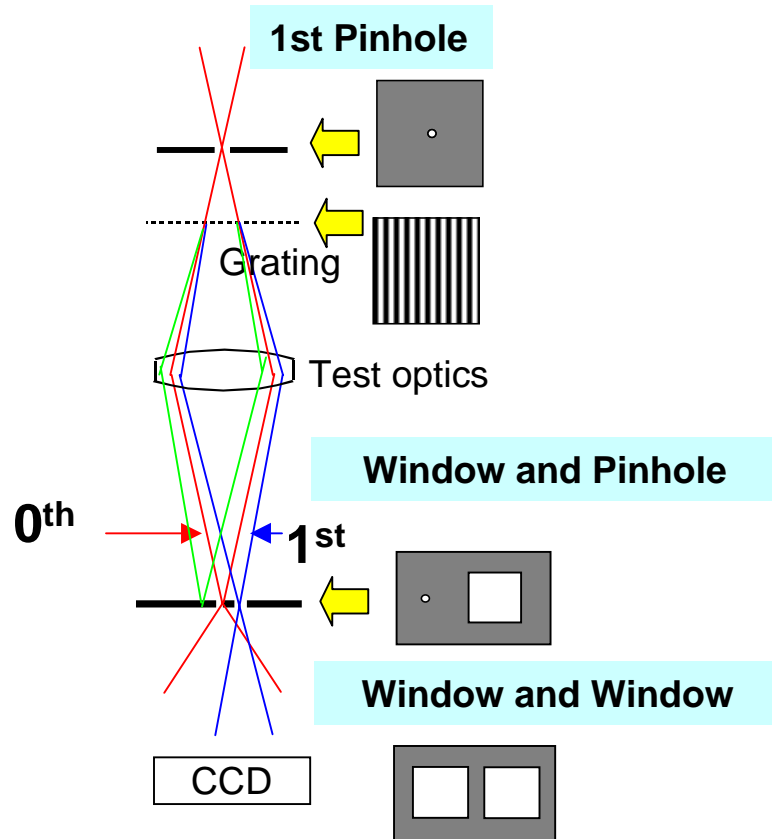
W_i: **i**th order Wavefront
R: Reference
T: Tested
G: Grating errors
S: Systematic errors
1: 1st order
0: 0th order
-1: -1st order

$$W_2 - W_1 = W_{T0} - W_{R0} = W_T$$

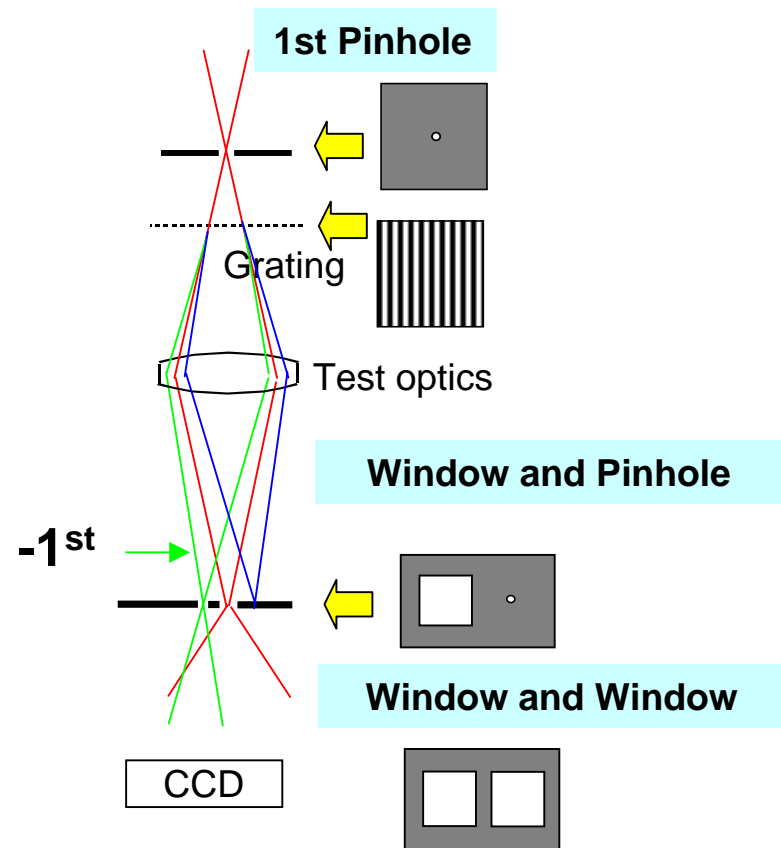
Systematic errors are removed !

Absolute Point Diffraction Interferometer Set-up

ABSPDI - L

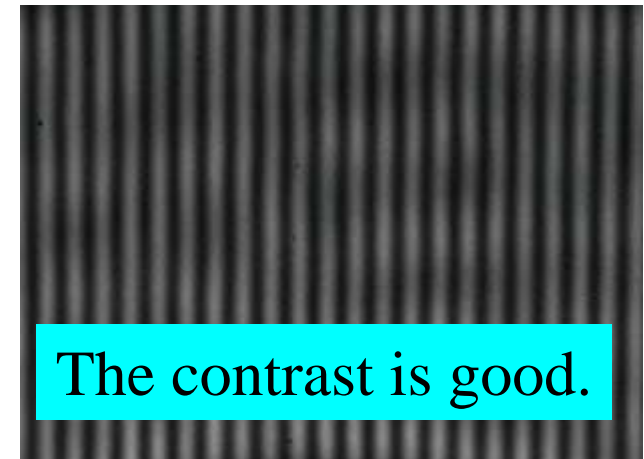
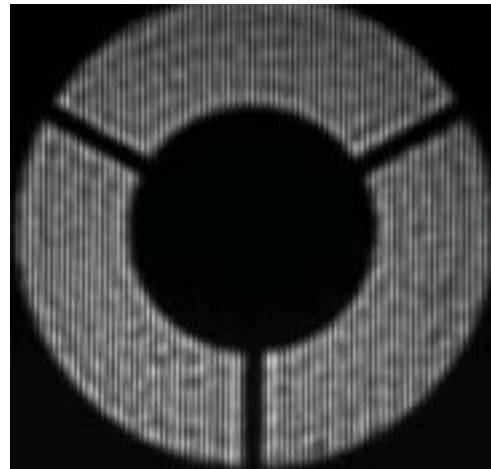
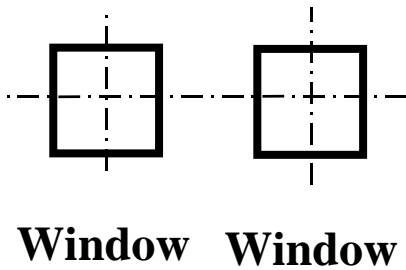
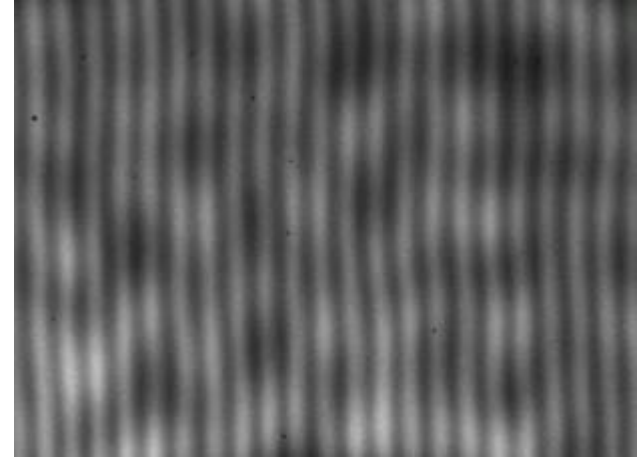
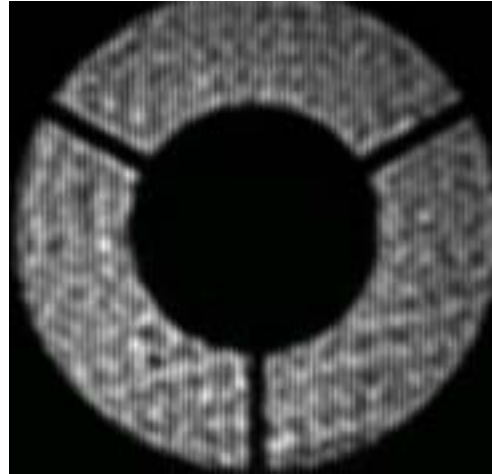
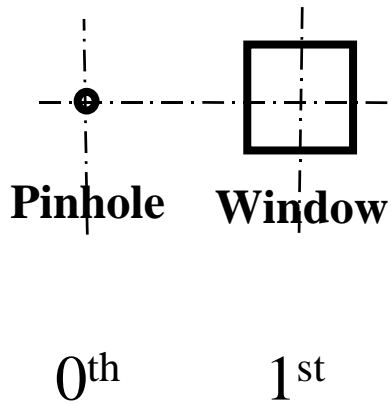


ABSPDI - R

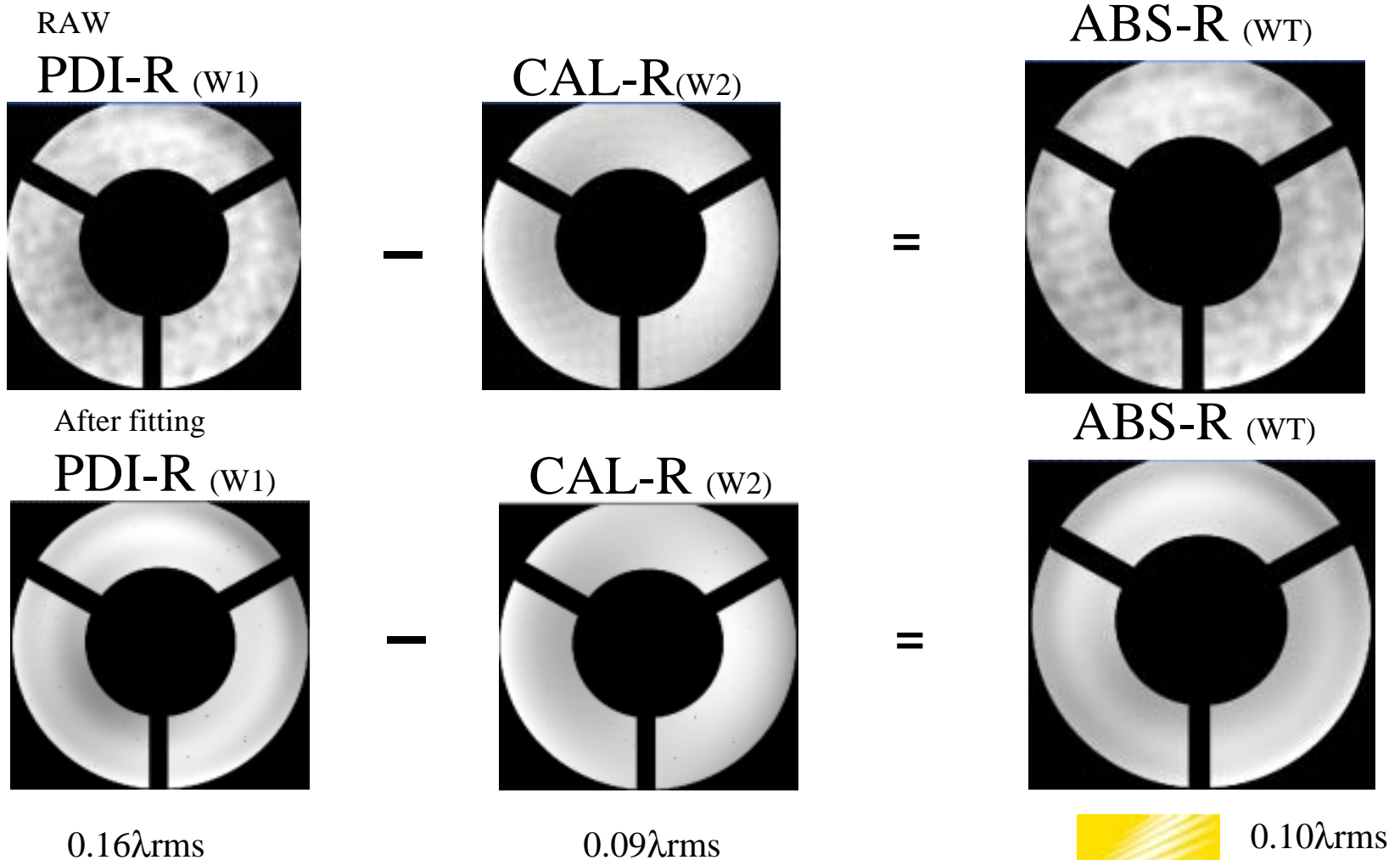


- ABSPDI-L and ABSPDI-R are used to verify the absolute measurement accuracy.

Absolute PDI fringe at EUV wavelength

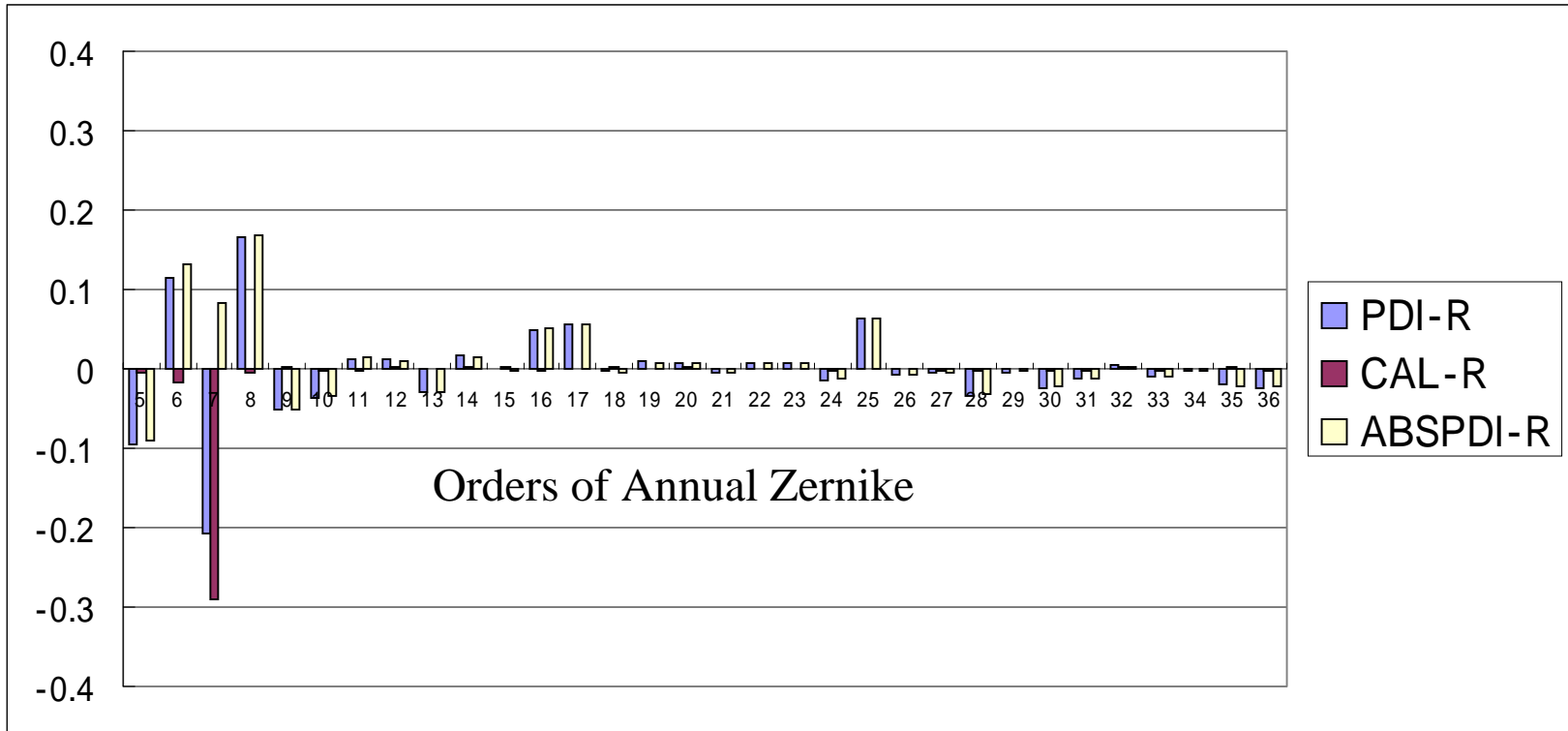


Experimental results by ABS-PDI-R(0th and 1st)

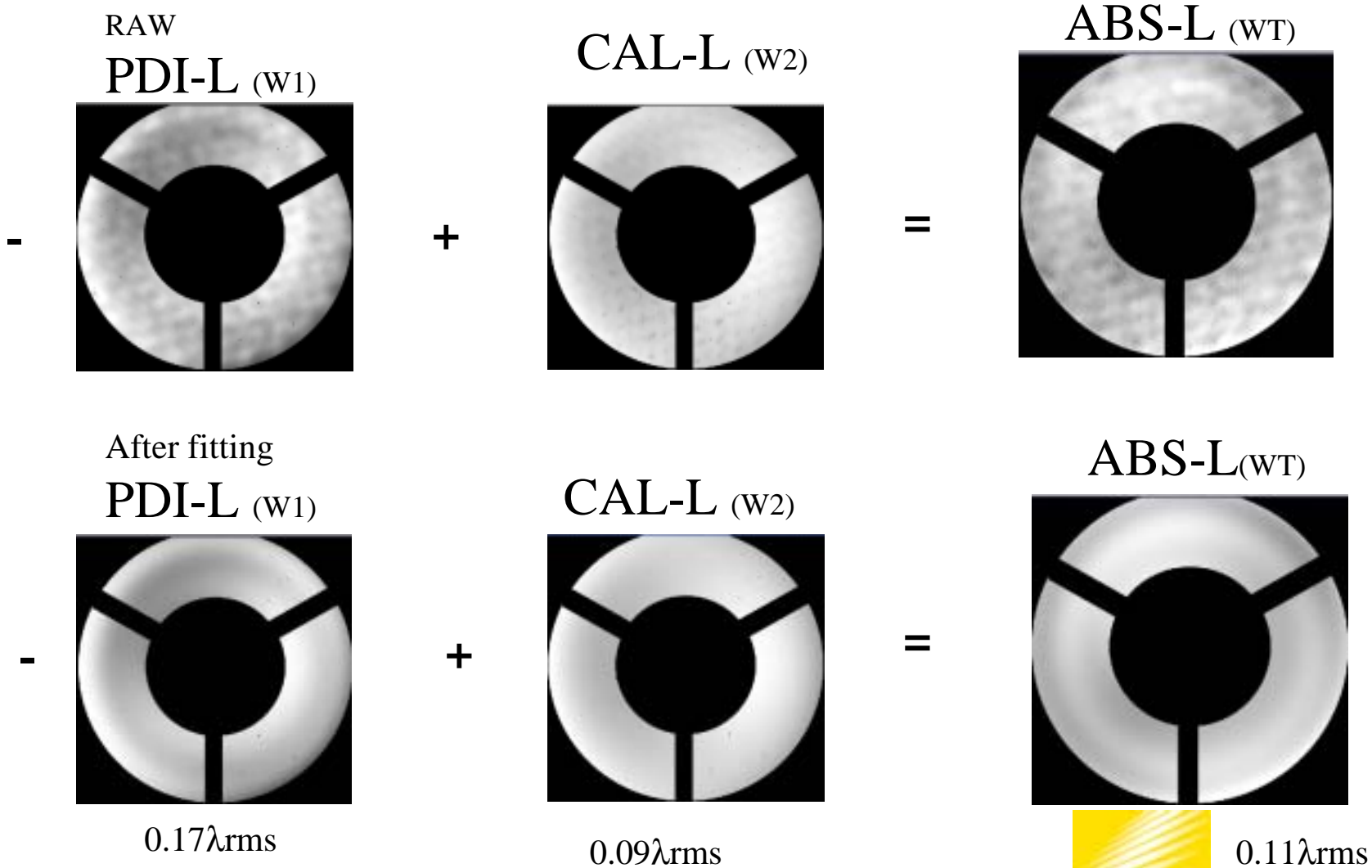


Right-configuration

ANZ Coefficient (λ)

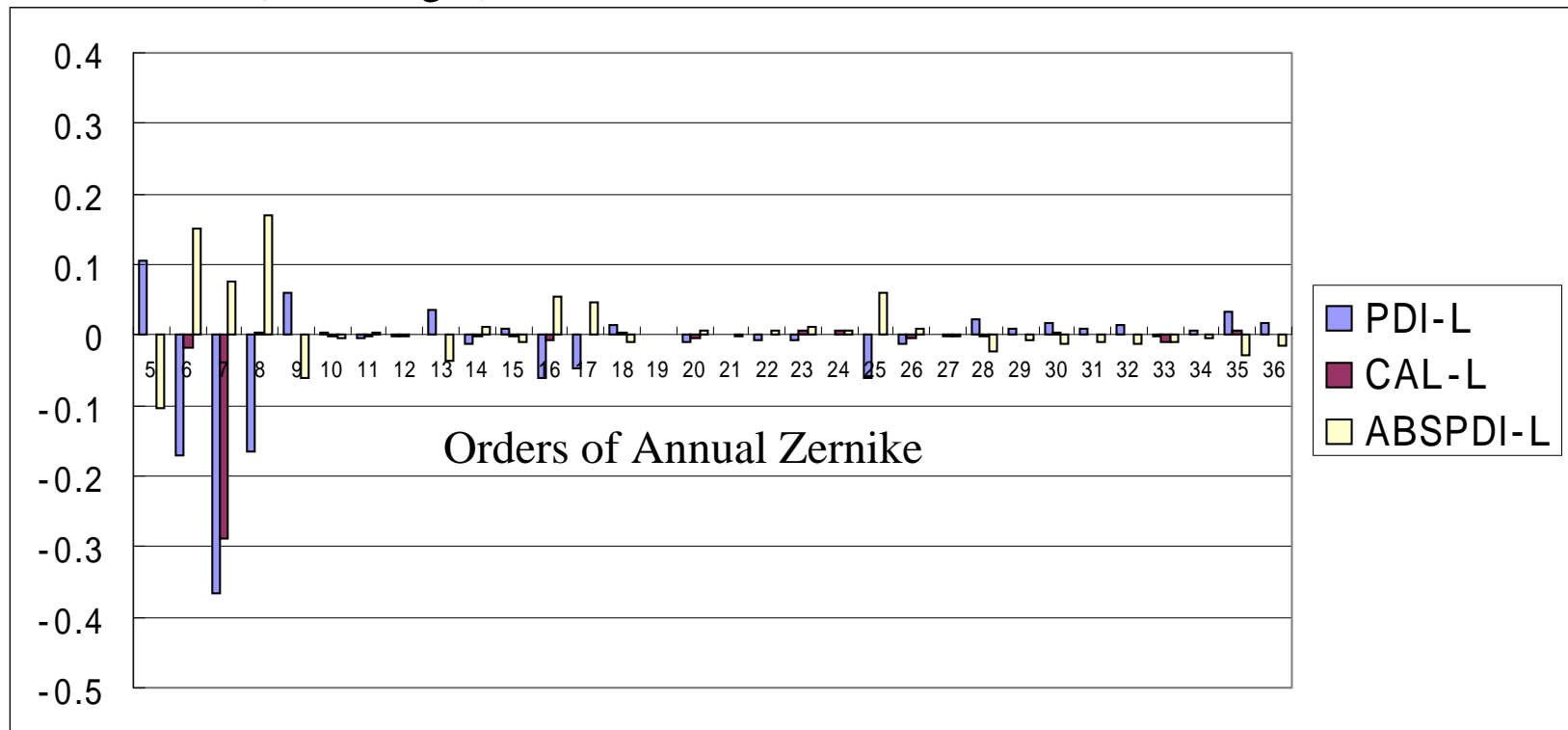


Experimental results by ABS-PDI-R(0th and -1st)

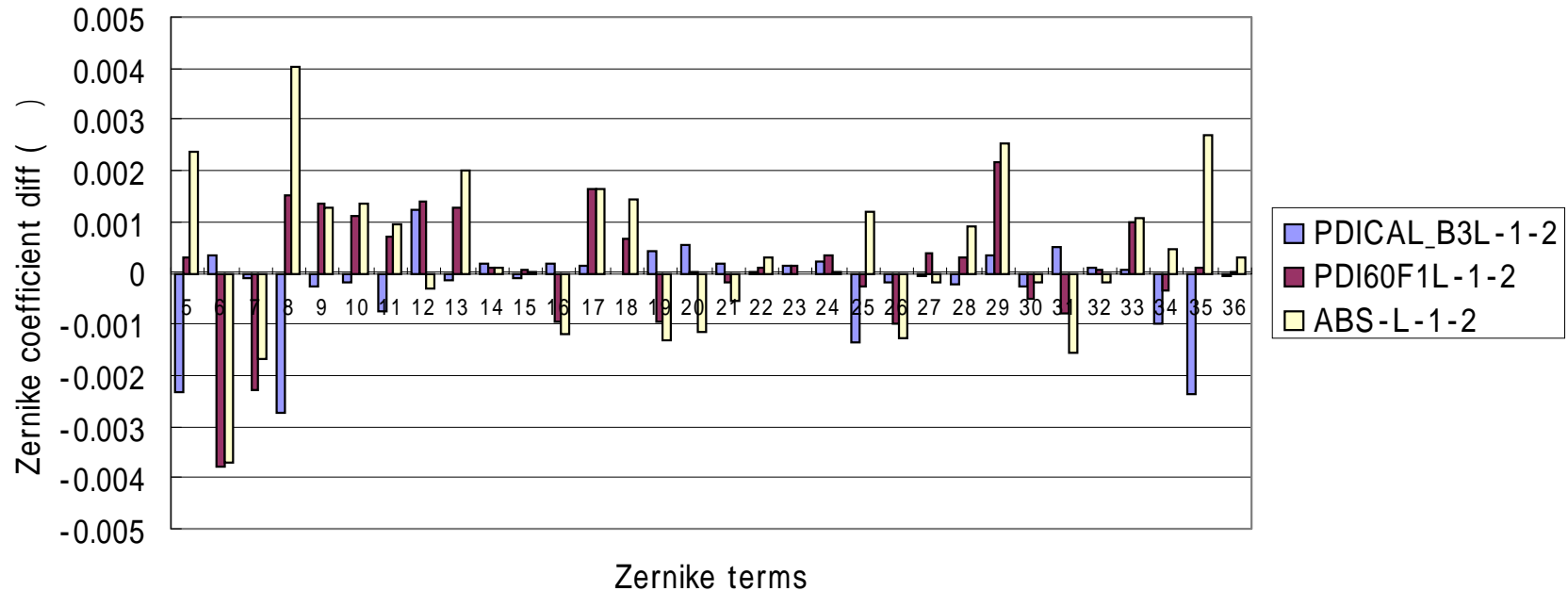


Left configuration

ANZ Coefficient (wavelength)

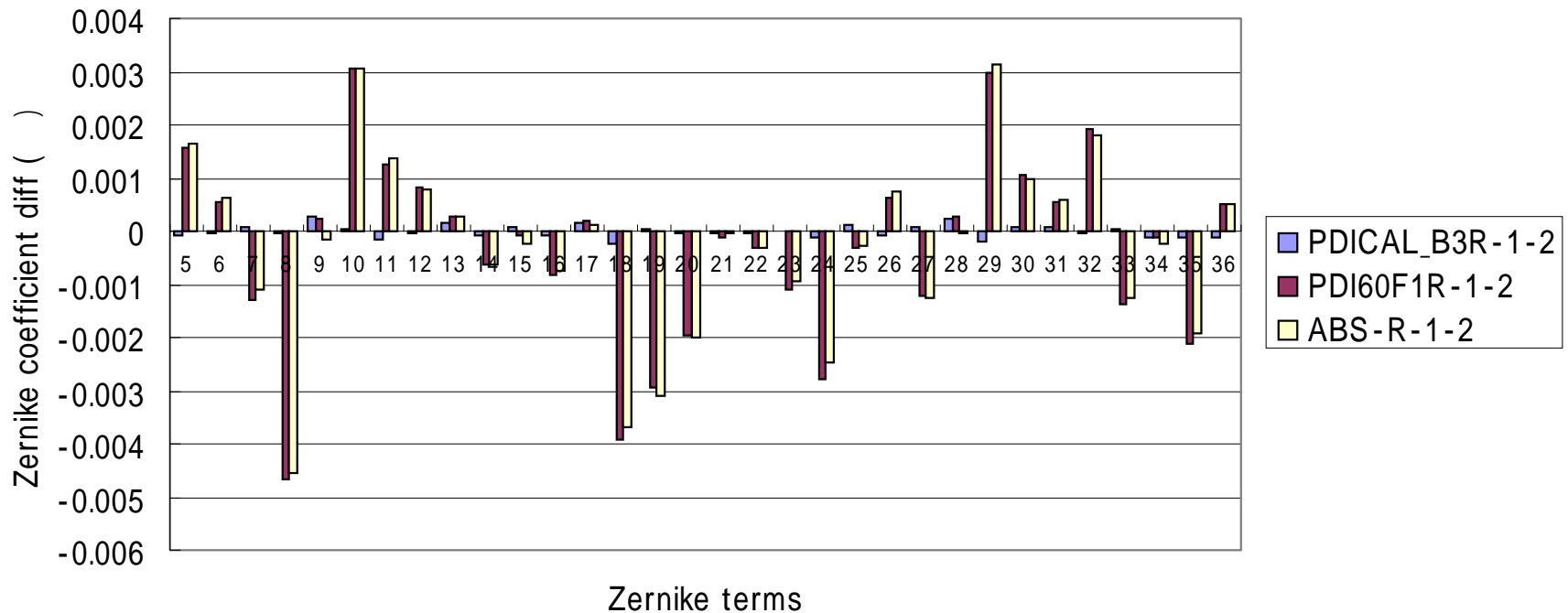


Repeatability of ABSPDI-L



The total RMS value of the differences of two measurements on ABSPDI-L is within $3m\lambda$ (0.04nm at 13.5 wavelength) after fitting.

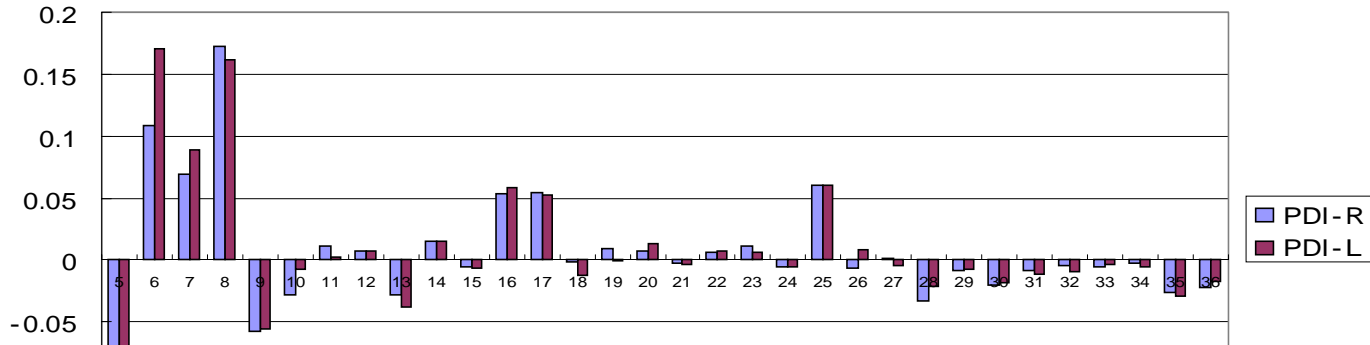
Repeatability of ABSPDI-R



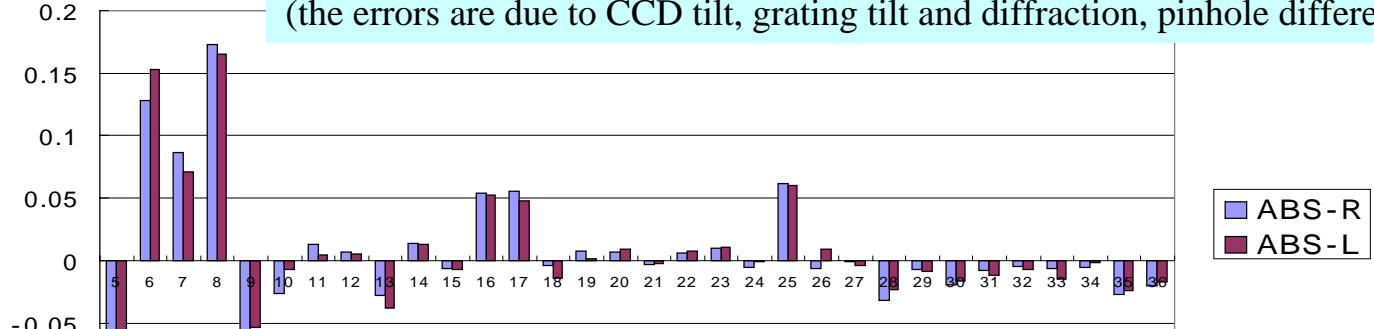
The repeatability of ABSPDI-R is also within $3m\lambda$ RMS after fitting.

Experimental confirm of the absolute PDI

ANZ Coefficient (wavelength)

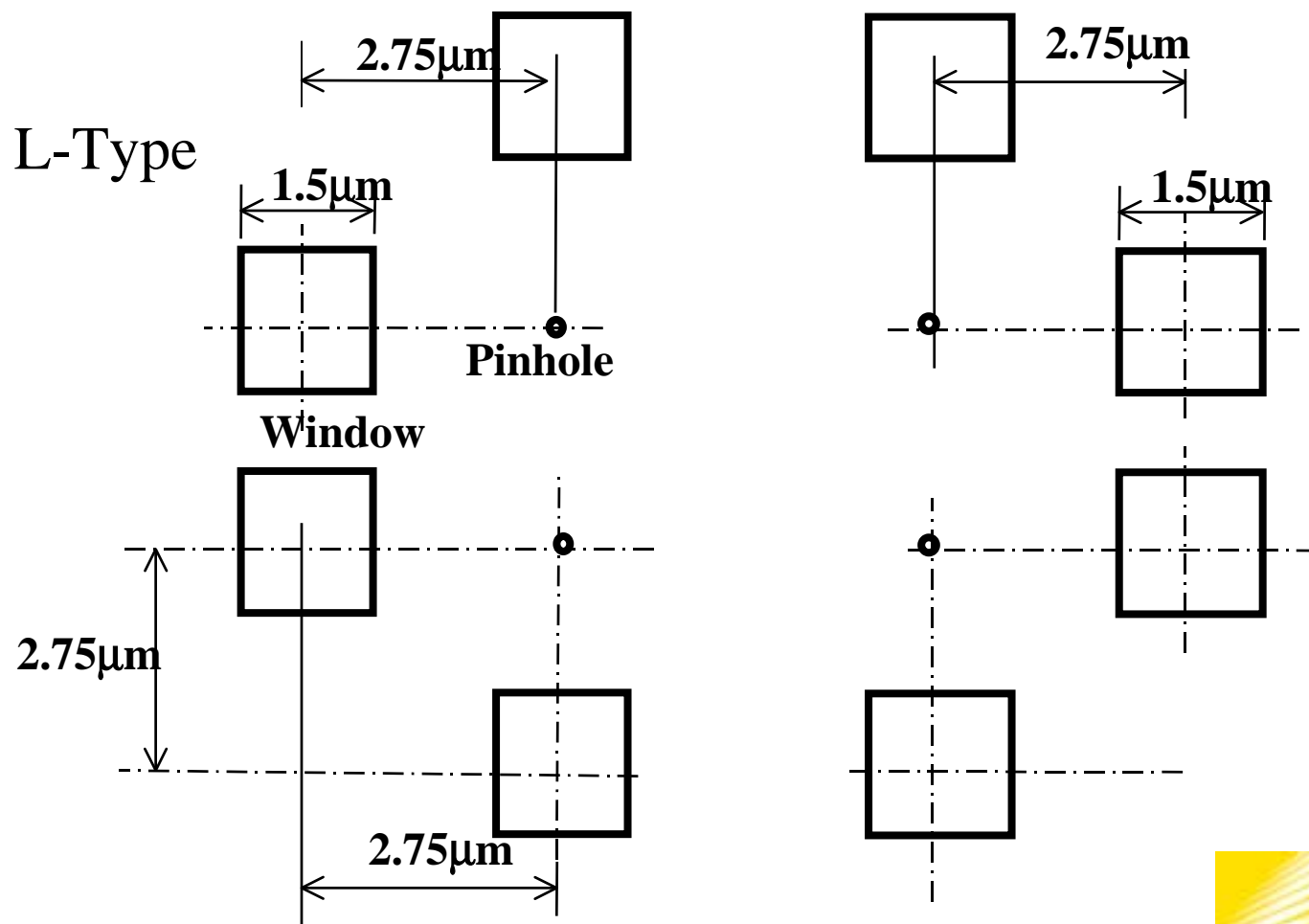


Hyperbolic error has been taken out
 The repeatability of both PDI-and ,PDI-Rare within $3 m \lambda$ RMS after fitting.
 The difference between PDI-L and PDI-R is within **0.033λ RMS**.
 (the errors are due to CCD tilt, grating tilt and diffraction, pinhole difference.)



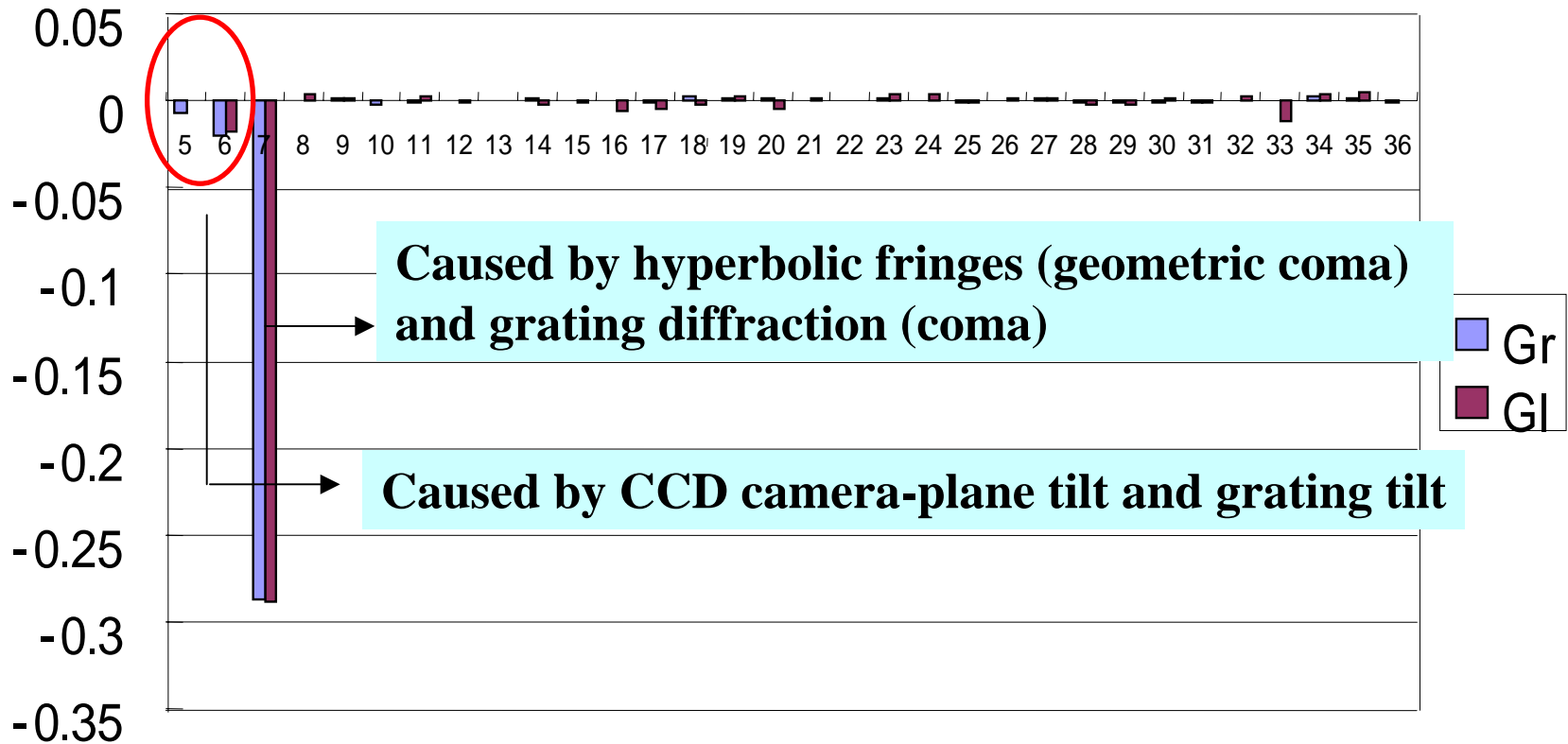
No need to consider the hyperbolic fringe effect. Systematic errors are removed. Currently obtained difference between ABSPDI-L and ABSPDI-R is within **0.019λ RMS** (the main error source is considered due to the pinhole difference.)

Modification of masks by using the same pinhole to identify the effect from different pinholes at the absolute PDI



Systematic errors at PDI-R($Gr = PDI-R - ABS-R$)

Systematic errors at PDI-L($Gl = PDI-R - ABS-R$)



These data can be saved as future references for the further measurements and the calibration can be done by subtracting them.

Summary

Calibrations are essential for high accuracy. The good thing about the absolute PDI is that all the systematic errors, including geometric coma, CCD camera plane tilt, grating tilt and grating coma can be simply calibrated all at once by subtracting two measurements.

There are two ways to apply it. One is to carry out twice measurements, the other way is to save the difference between the regular PDI and ABS-PDI as reference and subtract it in the further measurements.

Acknowledgments

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