ERATO Meeting Oct.9.2015

High-precision 3-D surface measurement using multi-wavelength digital holography referenced by optical frequency comb

By

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Objective: large depth measurement with multi-wavelength DH referenced by OFC

Merits:

1- High-precision (referenced to the FC of the fiber laser which is stabilized to the Rb atomic clock of 10^{-12} uncertainty)

2- Large stepped structures (by varying the repetition rate of femtosecond pulses)

3- Does not need phase unwrapping

Demerits:

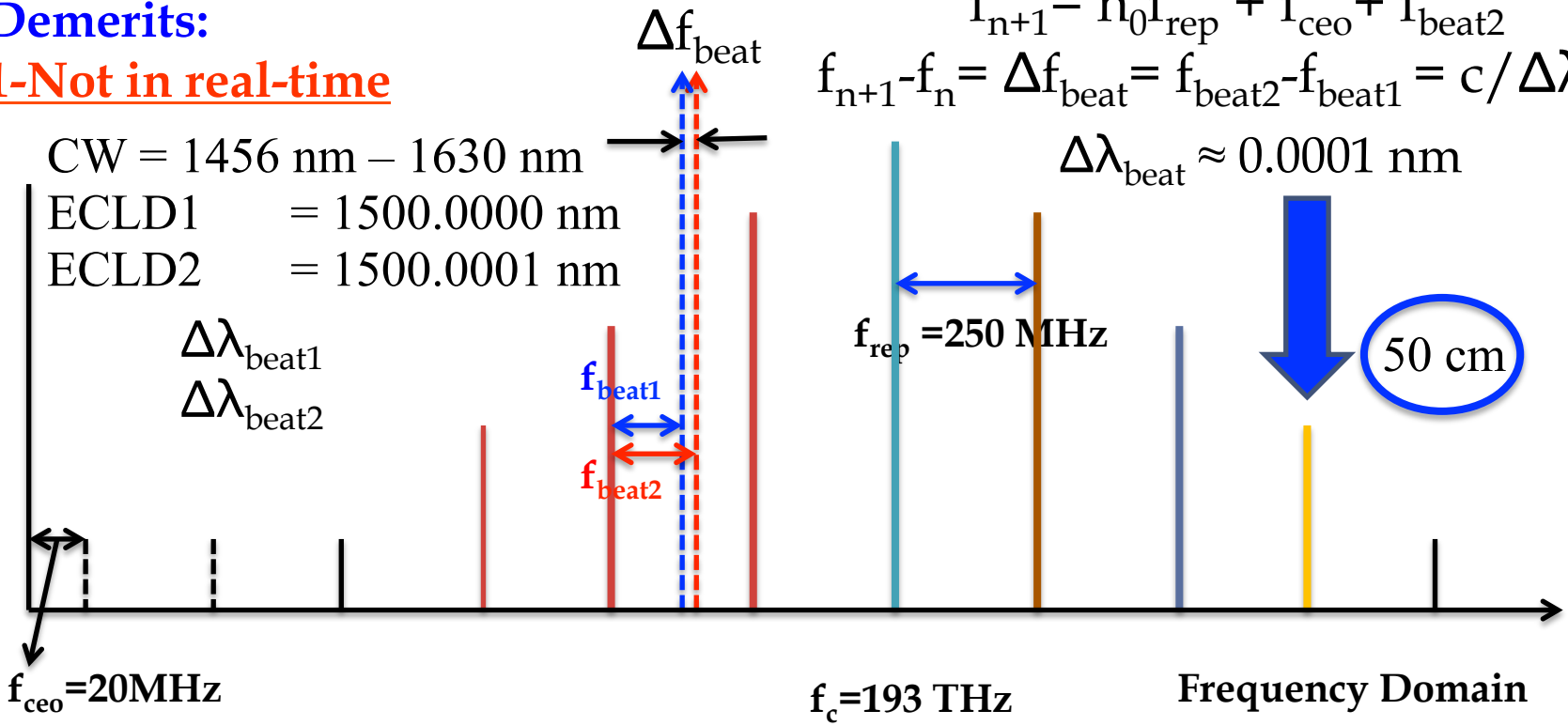
1-Not in real-time

$$f_n = n_0 f_{rep} + f_{ceo} + f_{beat1}$$

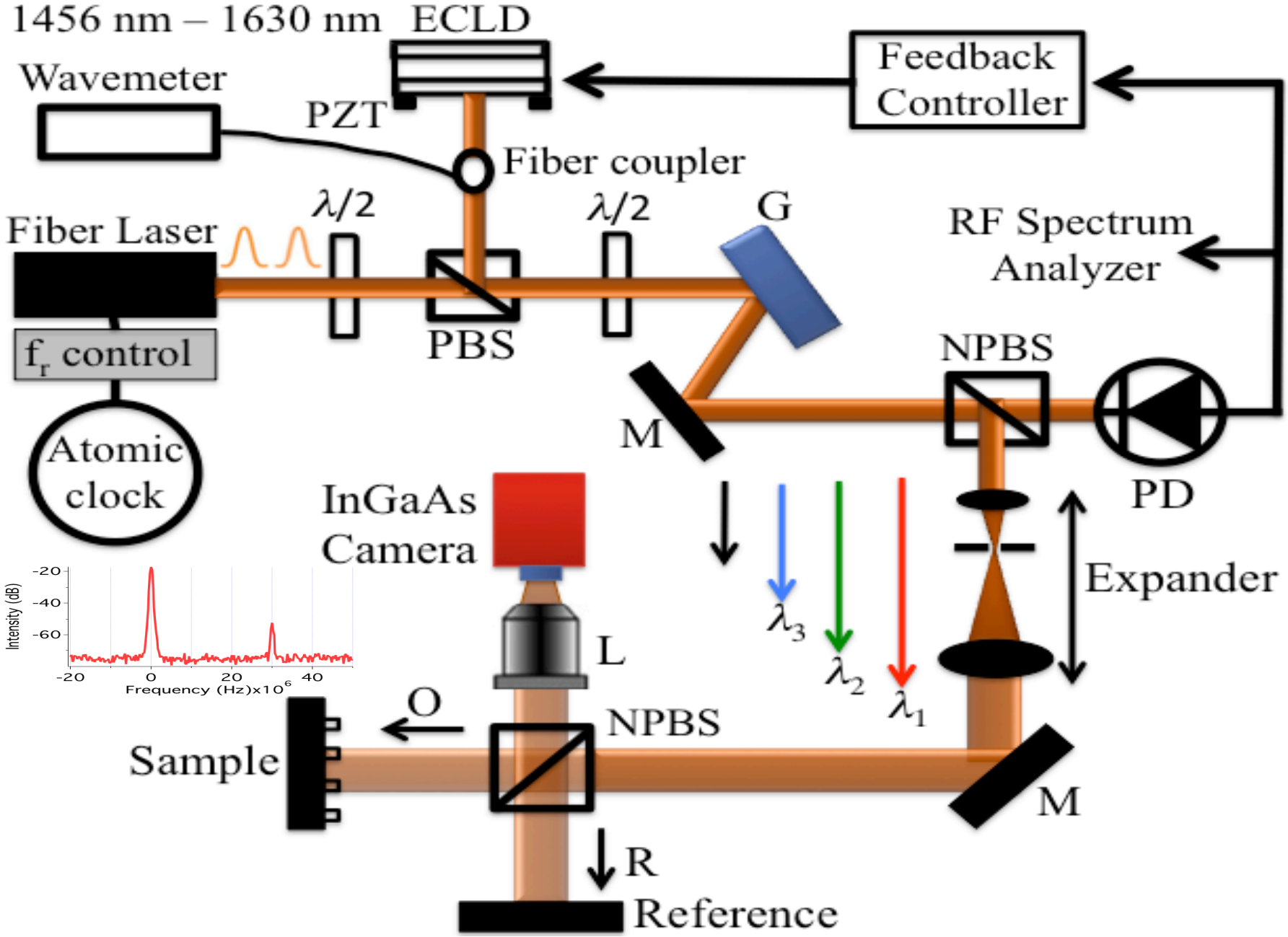
$$f_{n+1} = n_0 f_{rep} + f_{ceo} + f_{beat2}$$

$$f_{n+1} - f_n = \Delta f_{beat} = f_{beat2} - f_{beat1} = c/\Delta\lambda_{beat}$$

$$\Delta\lambda_{beat} \approx 0.0001 \text{ nm}$$

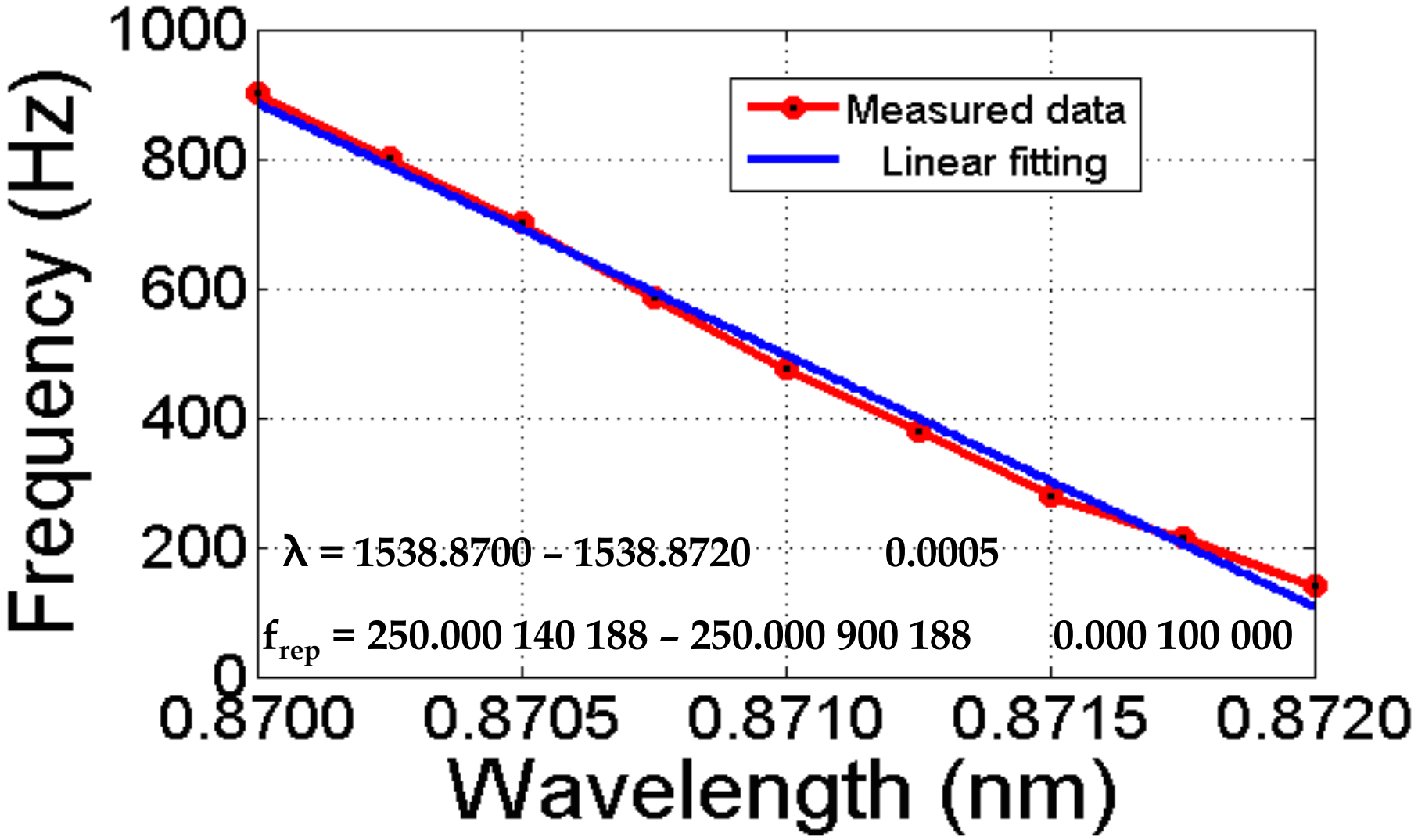


Optical Setup (generation of multi-beat)



Results: calibration, wavelength against f_{rep}

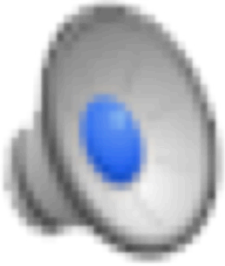
$\Delta\lambda \approx 0.0001$ nm → $\Delta f_{rep} \approx 15\text{-}20$ Hz



Noise effect

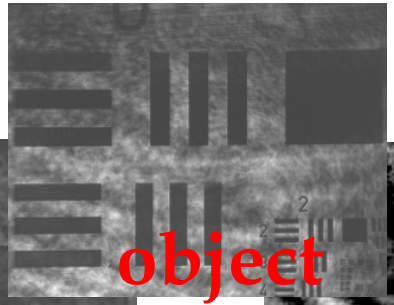
Unstable

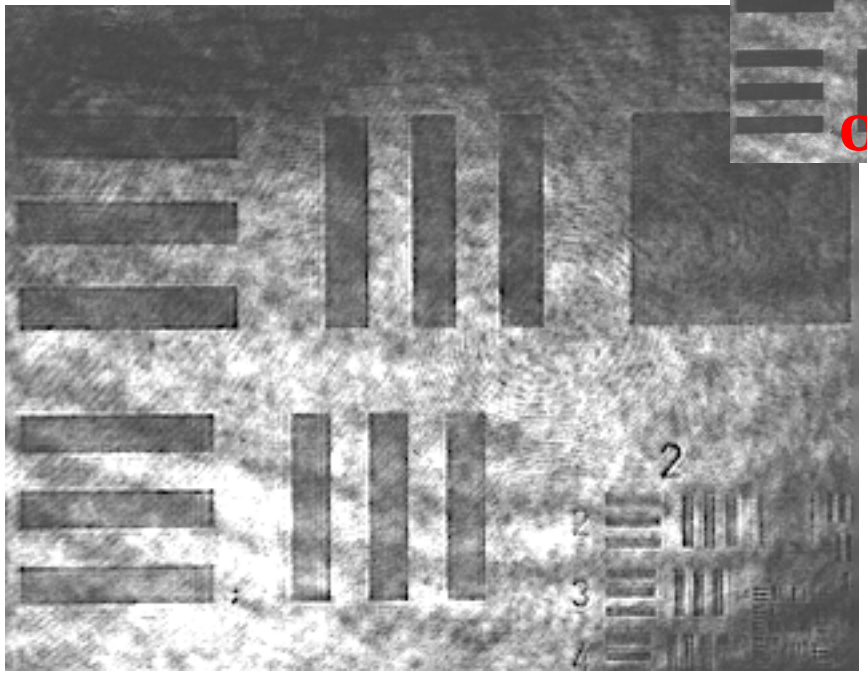
Stable

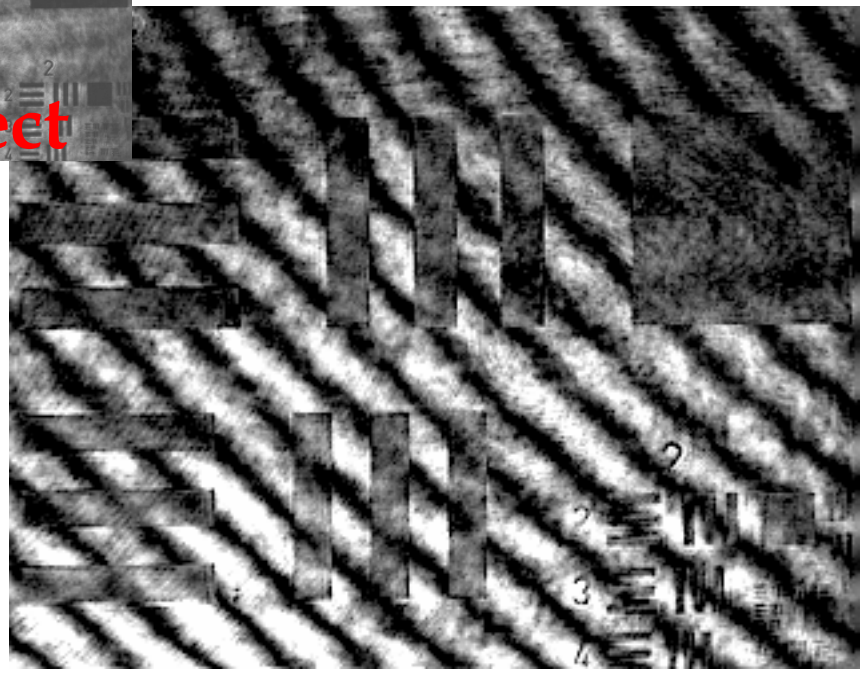


Inline hologram

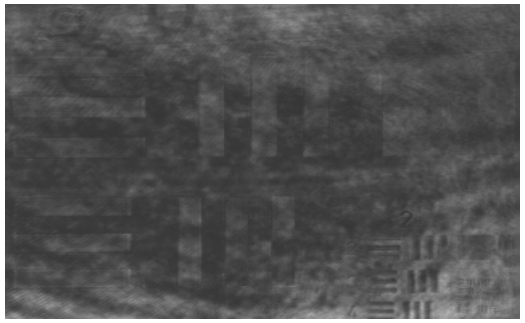
Off-axis hologram



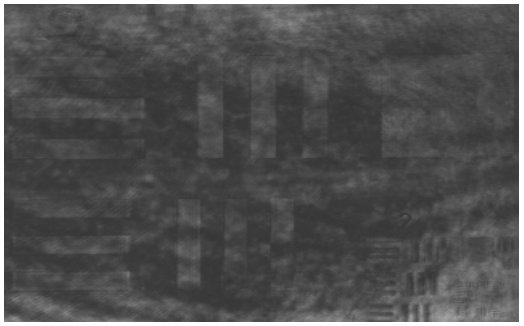




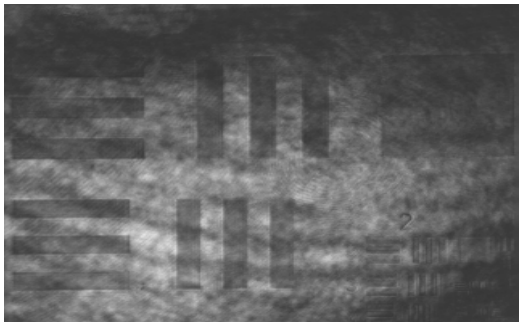
Results: holograms with 0.0005 nm difference



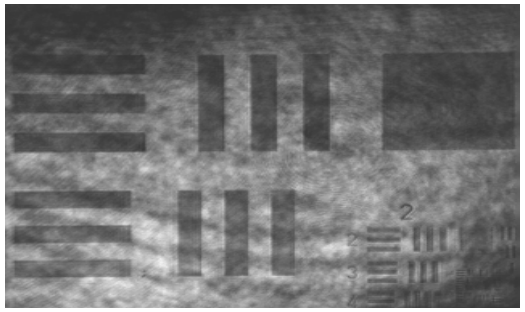
$\lambda_1 = 1538.8700$



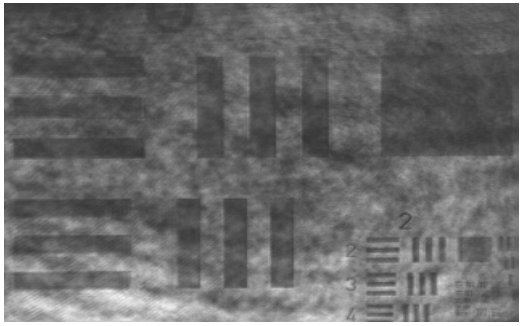
$\lambda_2 = 1538.8705$



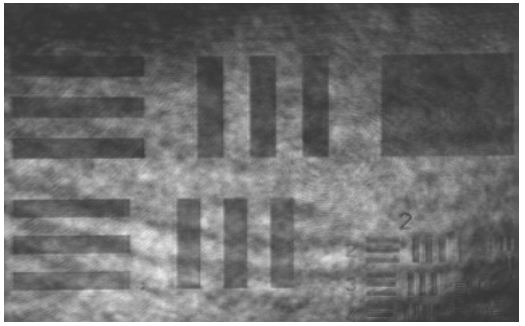
$\lambda_3 = 1538.8710$



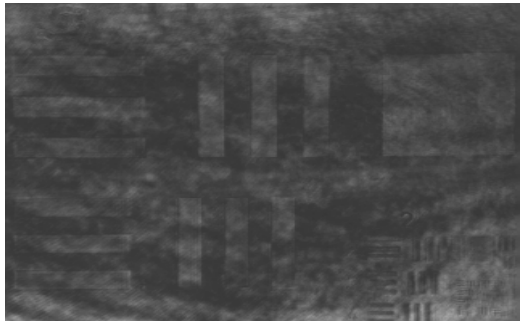
$\lambda_4 = 1538.8715$



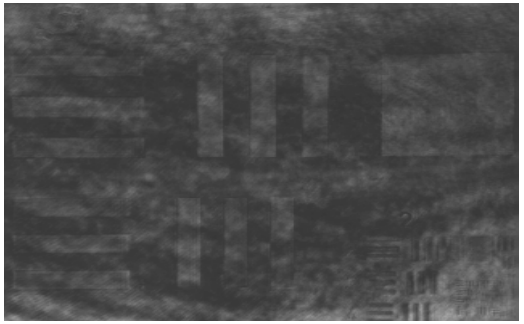
$\lambda_5 = 1538.8720$



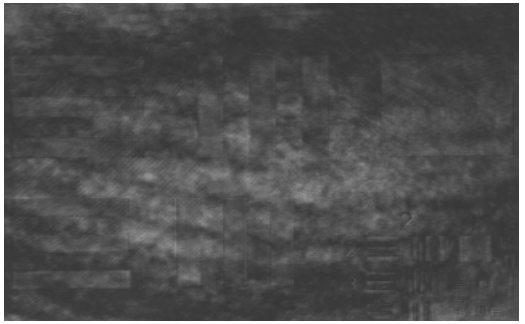
$\lambda_6 = 1538.8725$



$\lambda_7 = 1538.8730$

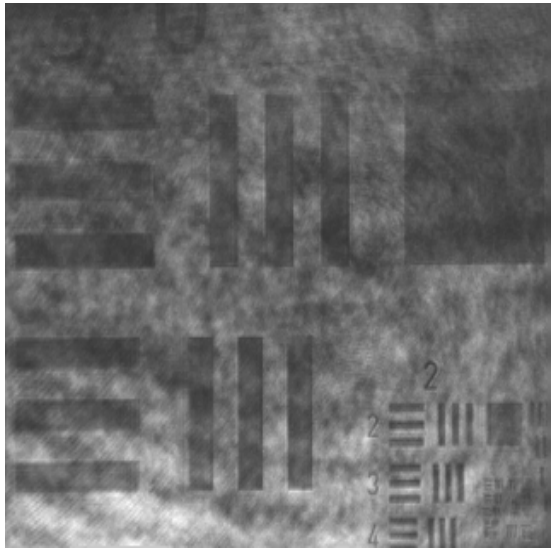


$\lambda_8 = 1538.8735$

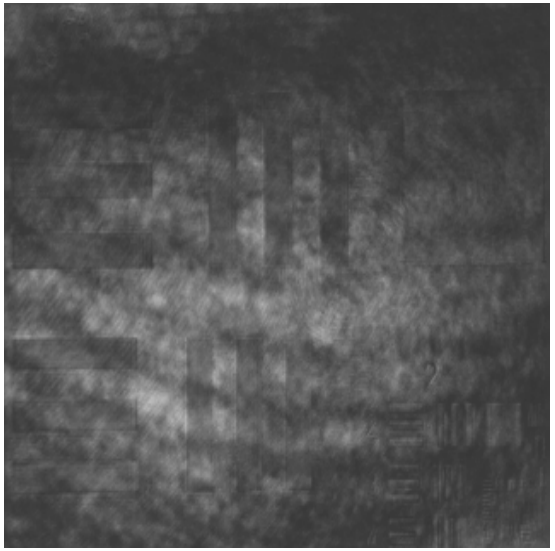


$\lambda_9 = 1538.8740$

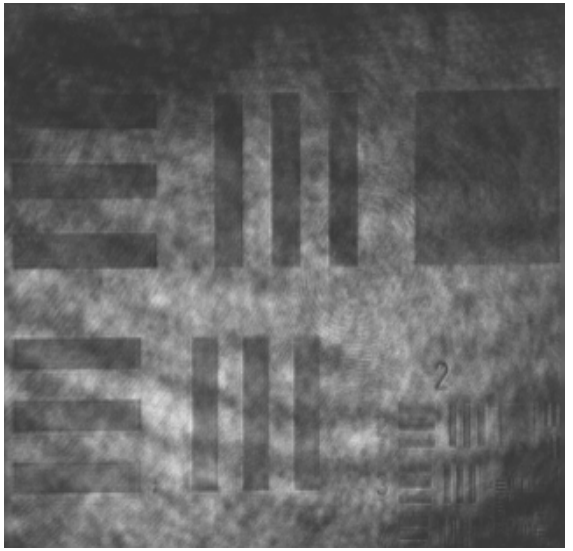
Results: holograms with 0.0001 nm difference



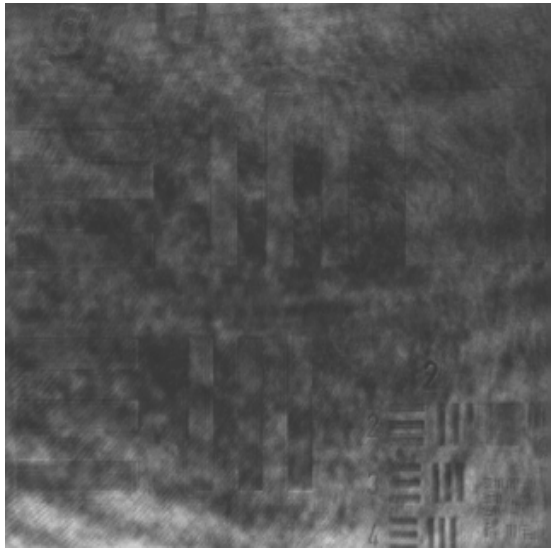
$\lambda_1 = 1538.8735$



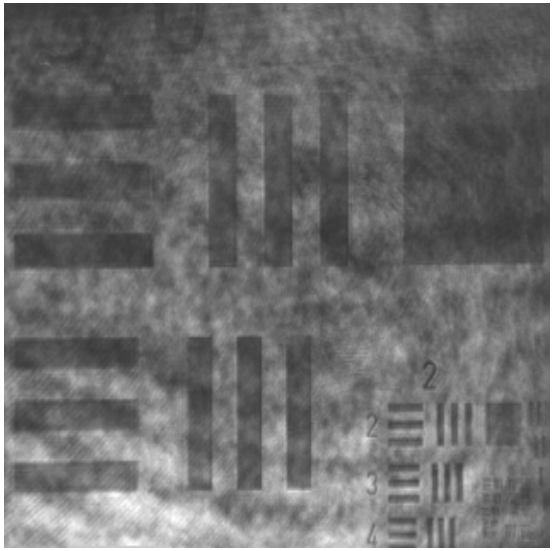
$\lambda_2 = 1538.8736$



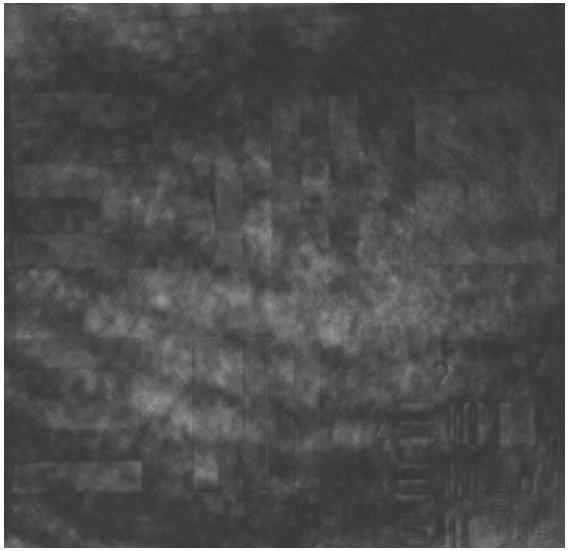
$\lambda_3 = 1538.8737$



$\lambda_4 = 1538.8738$

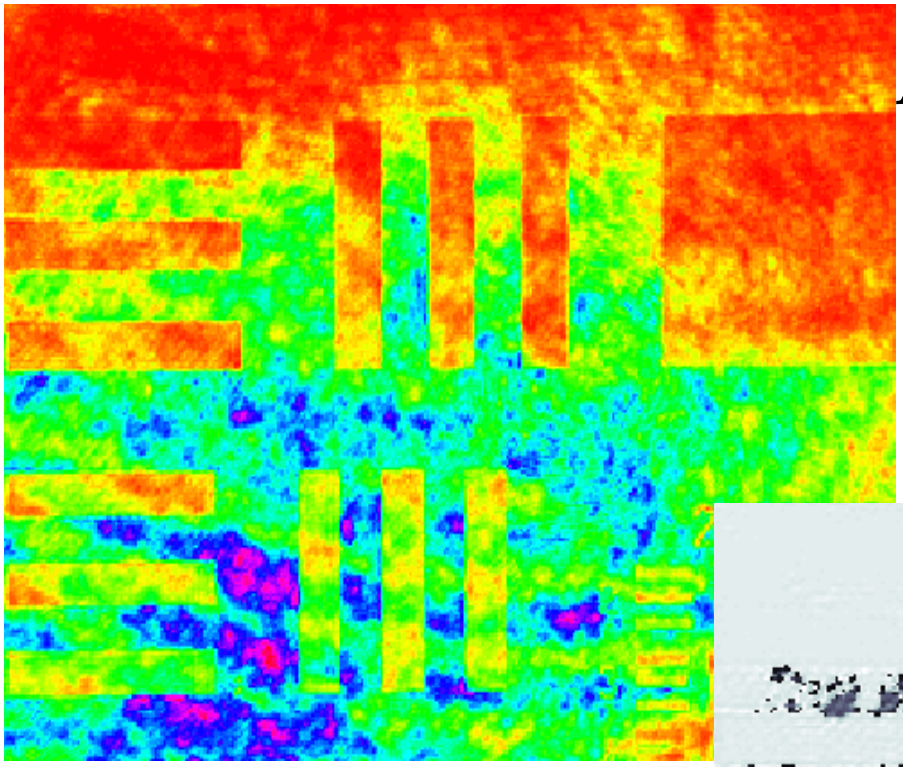


$\lambda_5 = 1538.8739$

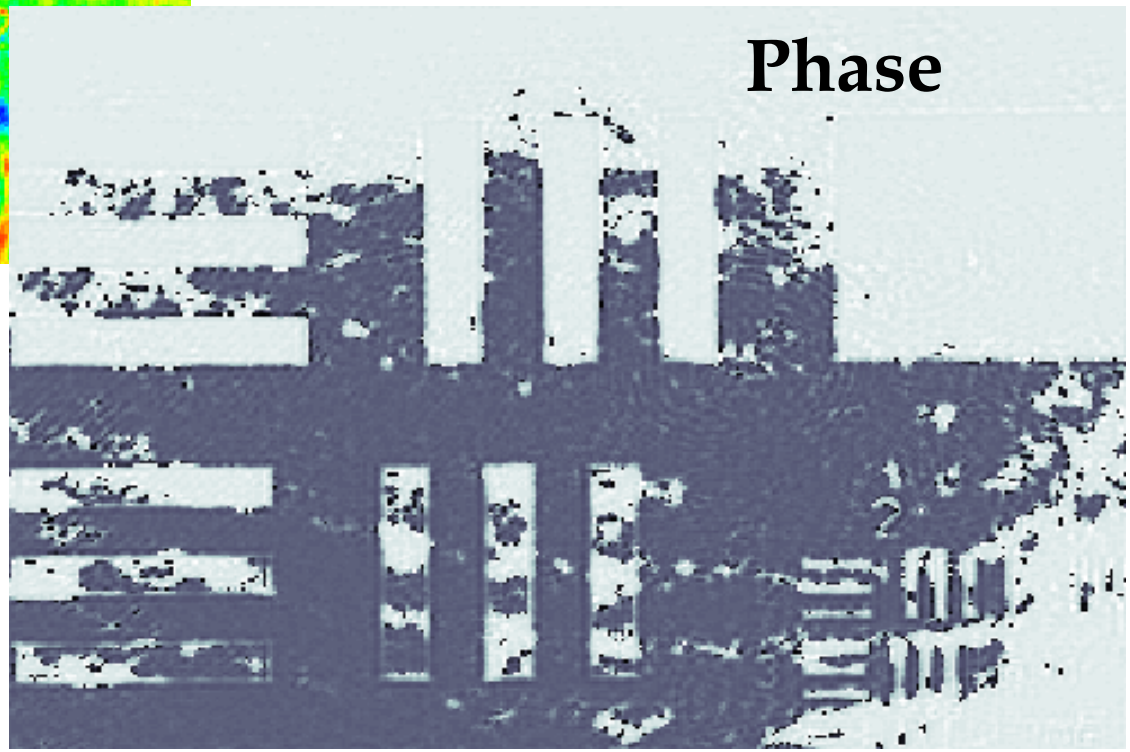


$\lambda_6 = 1538.8740$

Reconstruction at single wavelength (1538.8735)



Amplitude



Phase

Thank you for listening.
Any questions or suggestions?