Absolute distance measurement by two-color heterodyne pulse-to-pulse interferometry of optical frequency combs

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ABSTRACT

Optical frequency comb has led to revolutionary progress in absolute distance measurement. In our previous study, we have reported a synthetic-wavelength interferometry of optical frequency combs to improve the accuracy of pulse-to-pulse alignment [1]. However, the system that requires second harmonic generation and two acousto-optic modulators is complicated for practical applications. In the present study, we developed a compact heterodyne pulse-to-pulse interferometer for absolute distance measurement.
Figure 1 illustrates the system layout configured for our measurements. The approach utilizes an optical frequency comb of Er-doped mode-locked fiber laser as the light source. The system is based on an unbalanced Michaelson interferometer. We use two band-pass filters to select two close wavelengths (λ_a=1550 nm and λ_b=1560 nm) to generate a synthetic wavelength of 240 μm. Long fiber is used to expand the dynamic range of distance measurement. With this system we made a step-by-step distance measurement up to 0.5m to confirm the measurement dynamic range expansion and evaluate the ranging accuracy. By using synthetic wavelength as a bridge between the interference intensity peak-finding method and the heterodyne interferometric phase measurement, we can achieve distance measurement in nanometer level.

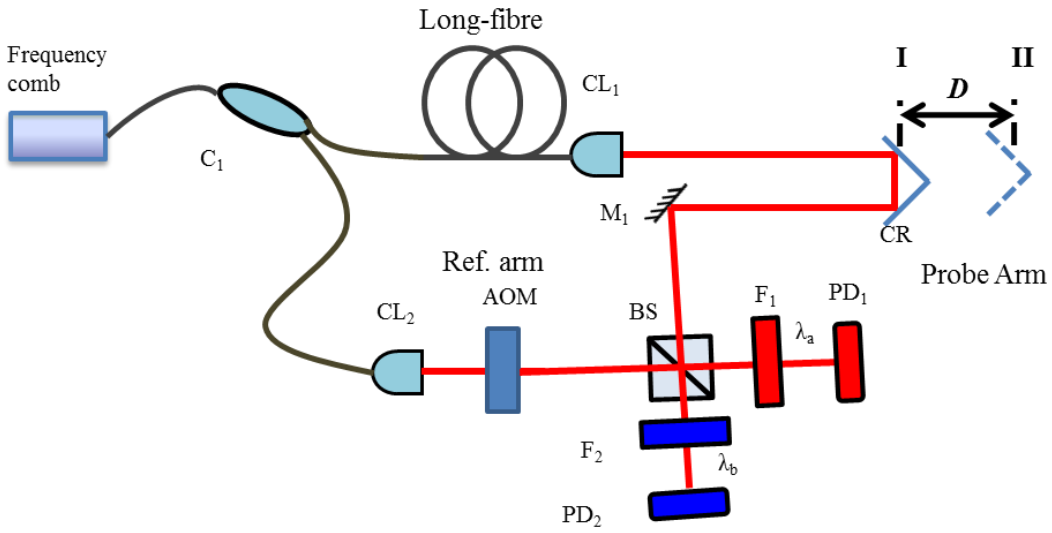

Fig. 1 Heterdyne pulse-to-pulse interferometer with wide dynamic range of measurement .C: coupler, CL: collimation lens, CR: corner reflector, M: mirror, AOM: acousto-optic modulator, BS: beam splitter, F: band-pass filter, PD: photodetector

REFERENCES

[1] G. Wu, M. Takahashi, H. Inaba, K. Minoshima. "Pulse-to-pulse alignment technique based on synthetic-wavelength interferometry of optical frequency combs for distance measurement," Opt. Letters 38(12), 2140-2143 (2013).

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