Calibration of Fourier domain short coherence interferometer for absolute distance measurements

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We present the calibration of a Fourier domain short coherence interferometer (FDSCI) operated in laboratory conditions. We compared the optical thickness of five individual thickness standards determined with the FDSCI (Fig. 1) to the certified geometric thickness. Using this calibration data we derived a calibration function $C = (0.017r - 0.1) \mu m$ with a 95% confidence interval system uncertainty of $(6.3 \times 10^{-3} r + 2.4) \mu m$, where $r$ is the optical distance in $\mu m$, across the 240 $\mu m$ optical measurement range (Fig. 2). The confidence limit includes contributions from uncertainties in the optical thickness, refractive index, and geometric thickness measurements as well as uncertainties arising from cosine errors and thermal expansion. The results show feasibility for non-contacting absolute distance characterization with micron level accuracy. This instrument is intended for verifying the alignment of the discs of an accelerating structure (Fig. 1, dashed box) in the possible future Compact Linear Collider [1].

![Figure 1. Schematics of the FDSCI setup. Dashed box: fiber-optic setup to characterize the internal alignment of an accelerating structure (AS). Abbreviations: L–lens, BS–beam splitter, r–optical distance, h–optical thickness.](image1)

![Figure 2. Measurement bias ($e$) of the FDSCI setup for five calibration samples. Abbreviations: $h_M$–measured optical thickness, $h_C$–calibrated optical thickness, $r$–optical distance, $C$–linear calibration function. Inset: Measured $h$ versus calibrated $h$. The error bars represent the 2$\sigma$ uncertainties.](image2)