























The corresponding pulse repetition rates,  $f_{o1}$  and  $f_{o2}$ , are related to the interferometer imbalance  $\Delta T_0$  through the simple relation  $\Delta T_0 = 1 / (f_{o2} - f_{o1})$ . Since the length of the short arm is precisely known, the length of the long arm can be derived. We have measured the difference between  $f_{o1}$  and  $f_{o2}$  to be 148.64 kHz. This is translated to a 2.02-km free-space distance or, in our case, 1376 m in fiber and 0.546 m in free space, from the laser.

In conclusion, we have presented here an in-depth study of OSCAT. Theoretically, a dynamic model of OSCAT has been formulated to describe the temporal dependence of the relative pulse delay on the pulse repetition rate modulation. It shows that a long interferometer imbalance (e.g., > km) can substantially magnify the effect of a small intracavity tuning to produce a large delay scan. The model also reveals a close relation between the scan rate and the scan depth when a highly imbalanced interferometer is used. Such a relation is absent in the previous static model. Experimentally, we have demonstrated remote tracking of target motions based on dynamic OSCAT. Target vibration has been successfully detected at an equivalent free-space distance of more than 2 km, with line-of-sight oscillations as small as 15  $\mu\text{m}$  peak-to-peak and as fast as 50 Hz faithfully detected. Scan rates up to 1 kHz have been experimentally demonstrated with our current OSCAT system. However, much higher scan rates are in principle feasible with wide-bandwidth PZT actuators and GHz femtosecond lasers. The technique offers a ready solution for lidar as the large interferometer imbalance is naturally supplied by the long target distance and the rapid delay scan enables fast motion tracking.

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