Poster THP118

A Femtosecond-Level Fiber-Optics Timing Distribution System Using Frequency Offset Interferometry

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Accelerators are getting big: kilometers of extent

Timing requirements getting tight: femtoseconds
Synchronize: cavities, lasers, photoinjectors, diagnostics

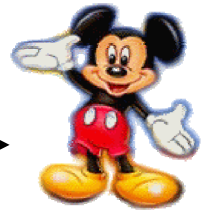
Stabilized single-mode optical fiber can give femtosecond synchronism performance over kilometers of fiber.

Demonstrations at LBNL and SLAC are providing femtosecond stability over 2 km fiber length in an ambient environment

This is equivalent to measuring the distance from LA to San Francisco to less than 1 centimeter

San Francisco

dz < 1 cm



LALA Land

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System uses a Michaelson interferometer with a twist:

The optical phase is downconverted to RF
1 degree RF phase at S-band is equivalent to 1 femtosecond at optical phase

The optical local oscillator for downconversion (heterodyning) is phase-coherently derived from the same laser that carries the information along the optical fiber.

The phase correction signal for the optical fiber is carried out in the RF domain (easy) and applied back to the optical fiber.

The phase length of the fiber is maintained by adding/subtracting optical cycles to the fiber with a solid-state acousto-optic modulator.

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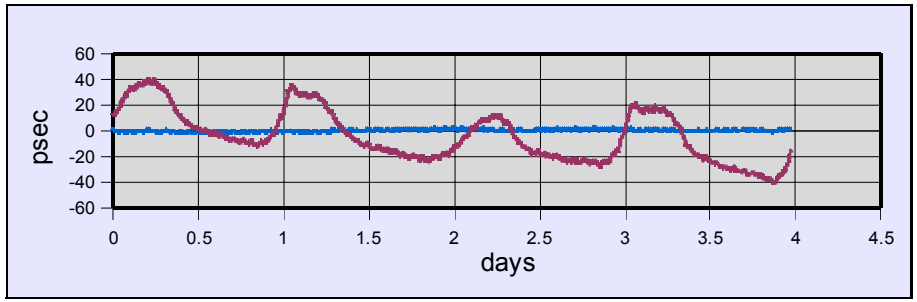
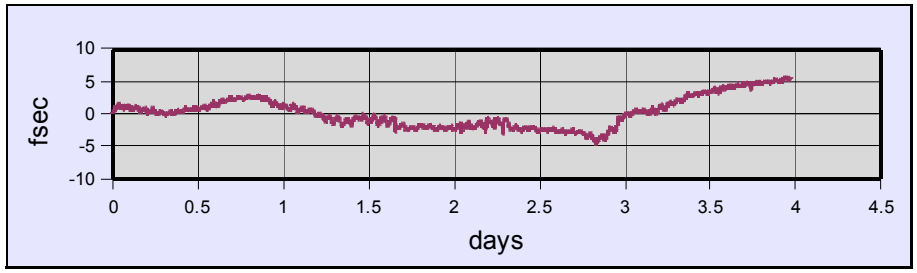
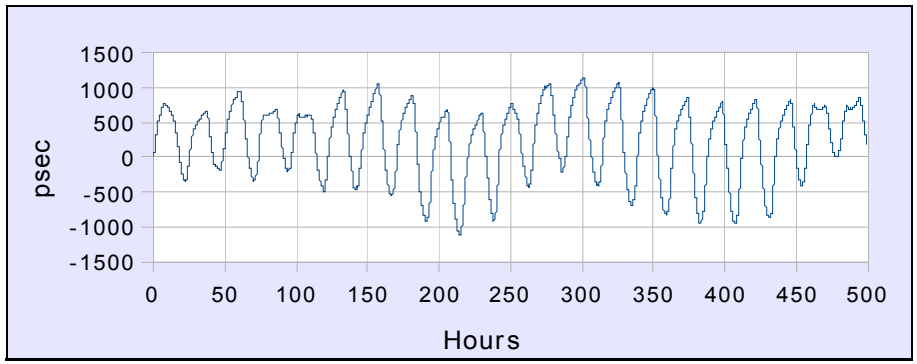
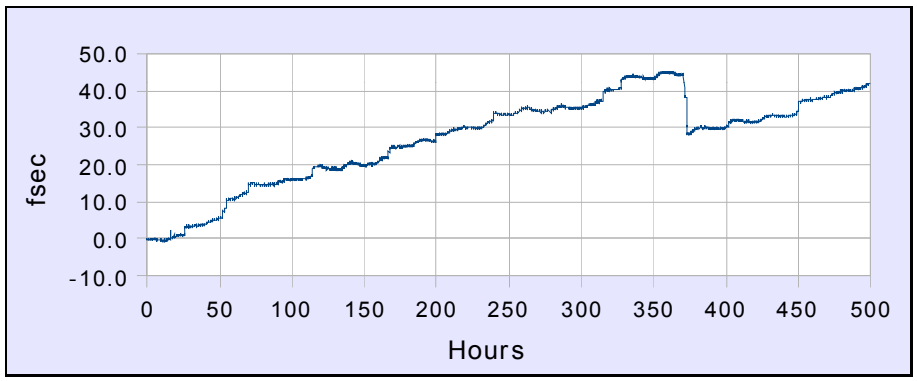
Results from LBNL and SLAC

LBNL: 80 psec day/night fiber phase variation over 4 days corrected to 9 femtoseconds variation in 2 km of fiber that runs through buildings and under roads.









SLAC: 2100 psec day/night in 2.8 km fiber in klystron gallery corrected to drift of 3.2 fsec/day, continuing over a month of data taking, with klystrons operating over first week of data.

Similar work going on at DESY, MIT, with a different approach.

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