

LLRF Topical Workshop - Timing, Synchronization, Measurements and Calibration



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Optical technologies for generating microwaves, time and frequency distribution and synchronization

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With the invention of the frequency comb two decades ago it became possible to easily (and phase coherently) switch between radio and microwave frequencies in the GHz to 10s of GHz range and optical frequencies in the range of several 100 THz.

The much faster oscillations of optical frequencies give us a few orders of magnitude advantage whenever it comes to interferometric stabilization.

Frequency combs also enable the use of optical references in the GHz domain by optical down conversion, i.e. dividing the very stable output of optical cavities with relative stabilities in the 10^{-15} or even 10^{-16} range into the GHz range. With this technique we have generated a world record breaking 10 GHz signal with -173 dBc at 10 kHz from the carrier.

By using the phase information of an optical wave we have transmitted a frequency reference with better than 10^{-19} relative accuracy over a distance of 1920km. Using the same technique of optical carrier phase comparison, it is possible to synchronize two lasers to attosecond precision even over large distances.

By combining these techniques one can envision an optical control system of large accelerator and free electron laser facilities far superior to any RF only system.

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