Generation of Short Microwave Pulses with a Compact Reverberation Cavity using Time-Reversal

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Microwave pulse compression is a technique for converting a long-duration, lower amplitude pulse into a short, higher power pulse. The benefit of pulse compression is that it allows for significantly higher peak power to be generated from existing sources whose output peak power is otherwise limited. For this reason, pulse compression has been of interest for applications such as particle accelerators and directed energy.

There is interest in generating ultrashort, sub-nanosecond pulses that can be utilized in various applications such as high resolution radar, wireless power transfer, directed energy and biomedical applications. Conventional pulse compression techniques employing high Q cavities or dispersive waveguide structures are typically limited from generating sub-nanosecond pulses due to their physical design constraints that limit the bandwidth.

In this paper, we present a passive pulse compressor capable of generating sub-nanosecond high power pulses using a compact reverberation cavity. By utilizing one-bit time-reversal, a long duration, flat amplitude input pulse is generated. As a result of wave focusing at the cavity output due to time-reversal, a compressed short pulse with peak power significantly higher than the input pulse is generated. Since the cavity supports closely spaced eigenmodes over an ultra-wide bandwidth, a sub-nanosecond pulse can be generated as long as the input pulse contains energy over the corresponding bandwidth. The time-reversal process essentially removes phase distortion between modes, thereby compressing the waveform in time to form a short pulse.

To demonstrate such a pulse compressor, we have built a compact reverberation cavity (0.015 m^3). The experimental results show that a 130 ps short pulse can be generated with the peak gain of 19dB from an input waveform of 300 ns duration.