Frequency-agile THz wireless communication with Kerr frequency comb in microresonator

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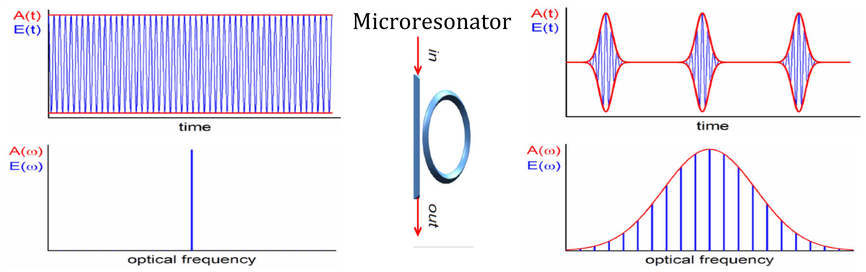
Background

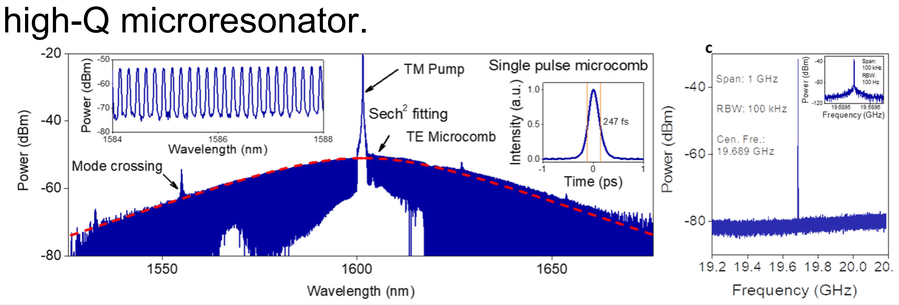
Maroconi pursues the idea of building a wireless communication link using Hertzian waves which is considered as the first demonstration of wireless communication system. The wireless data rates have been increasing two-fold every 18 months so that the higher and higher carrier frequencies need to be exploring to enhance channel capacity. In recent years, Terahertz band communications have been attracted considerable attentions to meet the ever-increasing demand for the speed of wireless communications. In this poster, we present a THz wireless communication system based on chip-scale Kerr frequency comb and broadband THz photomixer. The spectral shaping Kerr comb injects into the broadband THz photomixer for generating multiple THz carrier. The power of the generated THz can be tuned by controlling the input power of the THz mixer. Finally, the optical modulated data signal is moved into the baseband by two stages heterodyne mixing.

Kerr Frequency Comb

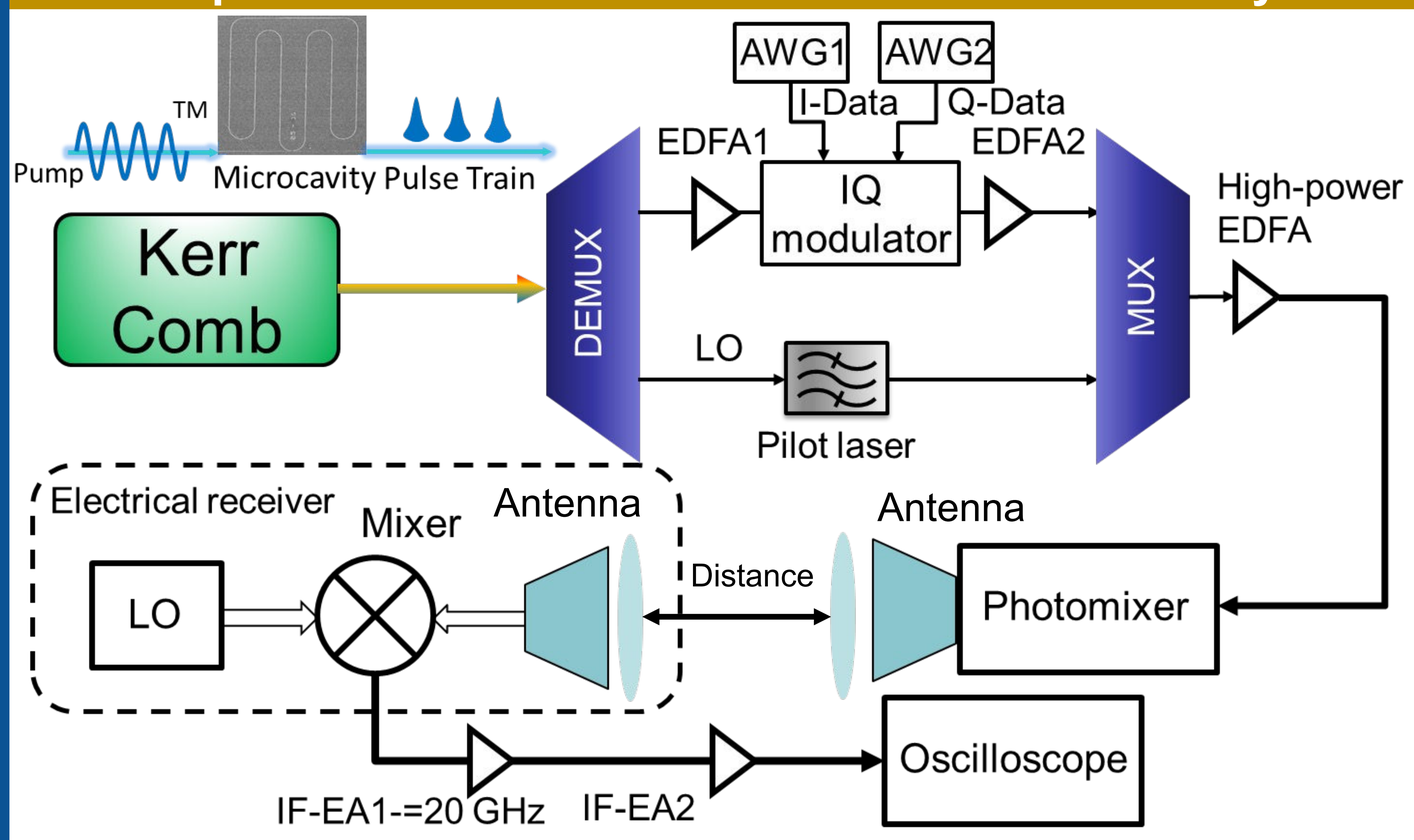
Optical frequency combs is unique light sources that coherently link optical frequencies with microwave frequency signals. In time domain, it is an optical pulse train and it contains multiple frequency components in frequency domain with a certain frequency separation.



Kerr frequency comb is generated by optical pumping a high-Q microresonator.

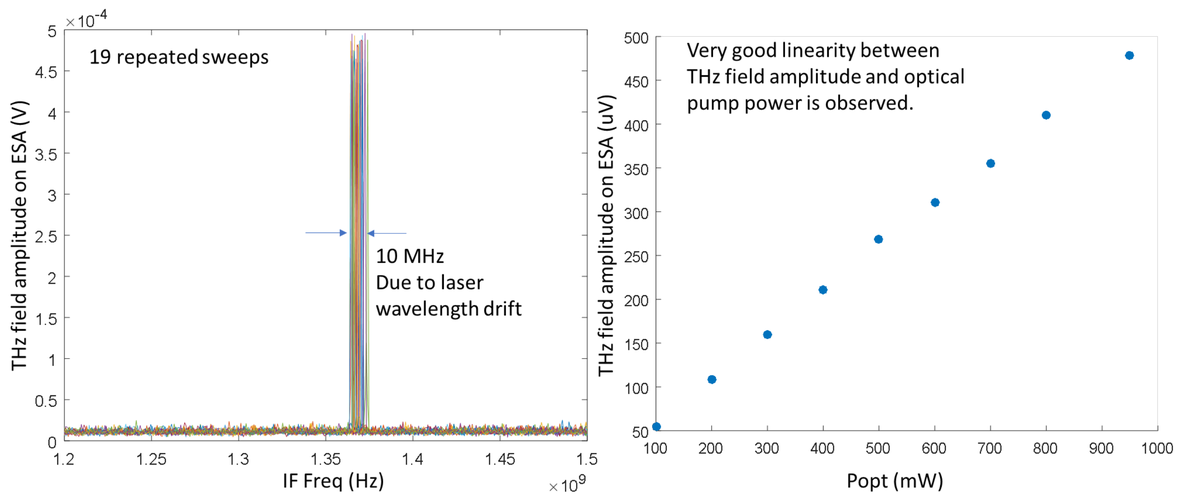


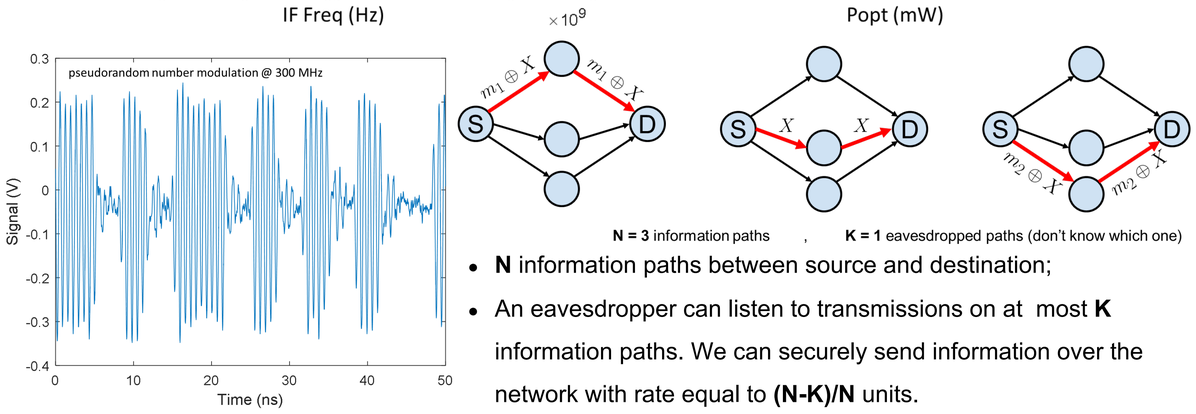
Multiple carrier Tbit THz wireless communication system



AWG: Arbitrary waveform generator; EDFA: Erbium-doped fiber amplifier; MUX: Multiplexer; DEMUX: Demultiplexer; LO: Local oscillator, EA: Electrical amplifier.

Experimental Results





N = 3 information paths , **K = 1** eavesdropped paths (don't know which one)

- **N** information paths between source and destination;
- An eavesdropper can listen to transmissions on at most **K** information paths. We can securely send information over the network with rate equal to **(N-K)/N** units.

Conclusion and discussion

- Demonstrated the broadband THz signal generation with grating structure photomixer. The generated THz signal power depends on the optical pump power quadratically. The frequency of the generated THz can span from 300 GHz to 3 THz which can cover all atmospheric transparent windows of THz wireless communication.
- Demonstrated OOK modulation with 300 MHz baudrate, THz transmission, frequency downconversion from 330 GHz to 1.3 GHz with a help of heterodyne THz mixer. The detected IF signal has more than 20 dB SNR which can support high-order advanced modulation format.
- Since the Kerr frequency comb can provide multiple THz carrier, Tbit communication can be feasible. Moreover, secure wireless communication can be achieved with the diamond-path or frequency hopping scheme.

References

[1] S. Koenig, et al. Wireless sub-THz communication system with high data rate. *Nat. Photon* **7**, 977–981 (2013).

[2] T. Nagatsuma, et al. Advances in terahertz communications accelerated by photonics. *Nat. Photon* **10**, 371–379 (2016).

[3] S.-W. Huang, et al. Globally stable microresonator Turing pattern formation for coherent high-power THz radiation on-chip. *Phys. Rev. X* **7**, 041002 (2017).

[4] Gaurav Kumar Agarwal, et al. Secure communication over 1-2-1 networks. *IEEE ISIT* 196-200 (2018).

[5] D. Turan, et al. 0.4 mW Terahertz Power Generation through Bias-Free, Telecommunication-Compatible, Photoconductive Nano-Antennas," 2019 IRMMW-THz, Paris, France, 2019, pp. 1-2.