Investigation of Superluminescent Diodes for Smart Lighting Systems

From the Abstract:

High-speed low-power superconducting single flux quantum (SFQ) digital circuit technology offers significant advantages over the currently dominant CMOS digital technology (that consumes too much power) for a wide range of applications, ranging from digital radio frequency receivers to high performance computing. SFQ circuits can operate at frequencies over 100 GHz. Computers based on SFQ, however, have not been competitive due to lack of energy-efficient, high-bandwidth data links from cryogenic superconducting circuits to room-temperature semiconductor circuits. From the energy efficiency point of view, an optical data link would have an obvious advantage over all-electrical metal links in terms of much lower heat conductivity of optical fibers or windows (negligible heat leak) and low signal attenuation.

To maximize the optical data link energy efficiency, one needs to develop a low-power, high-speed electro-optic converter or modulator capable of working with a few mV signals (typical SFQ output signals are 1 ps pulses with an amplitude of ~1 mV, 10 - 50 Ω source impedance, and ideally > 100 GHz repetition rate). A key capability under development at UNM, directly pertinent to data egress in cryogenic computing systems, is the technology of strongly injection-locked whistle-geometry microring lasers. They offer unprecedented, ultrahigh values of modulation bandwidth, exceeding 100 GHz, that is achievable by direct current modulation without any multiplexing.

Based on excellent predicted high-speed performance of strongly injection-locked WRLs, under this project prototype photonic integrated circuits (PICs) will be developed, comprising a single-frequency master laser, an injecting waveguide, a strongly injection-locked WRL, a directional output coupler, and (optionally) a high-speed photodetector, all monolithically integrated on a single chip and therefore requiring no optical ingress or alignment. The WRL will be injection-locked by a stable single-frequency master laser monolithically integrated on the same chip. CW and ultrafast electrical and optical characterization of the PICs will be performed at UNM over a temperature range from 4 K to 350 K.

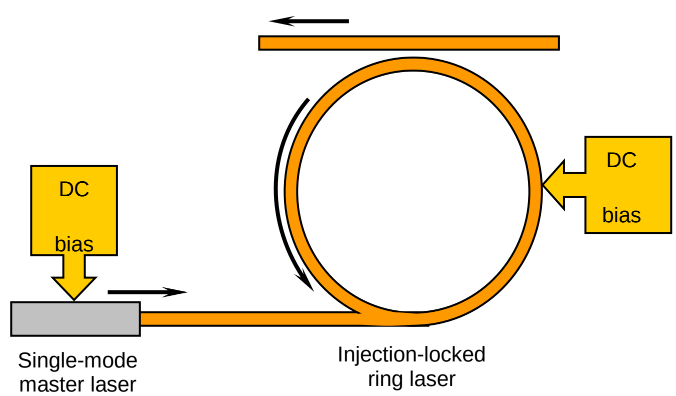

Fig. 1. Schematic layout of the proposed photonic integrated circuit.

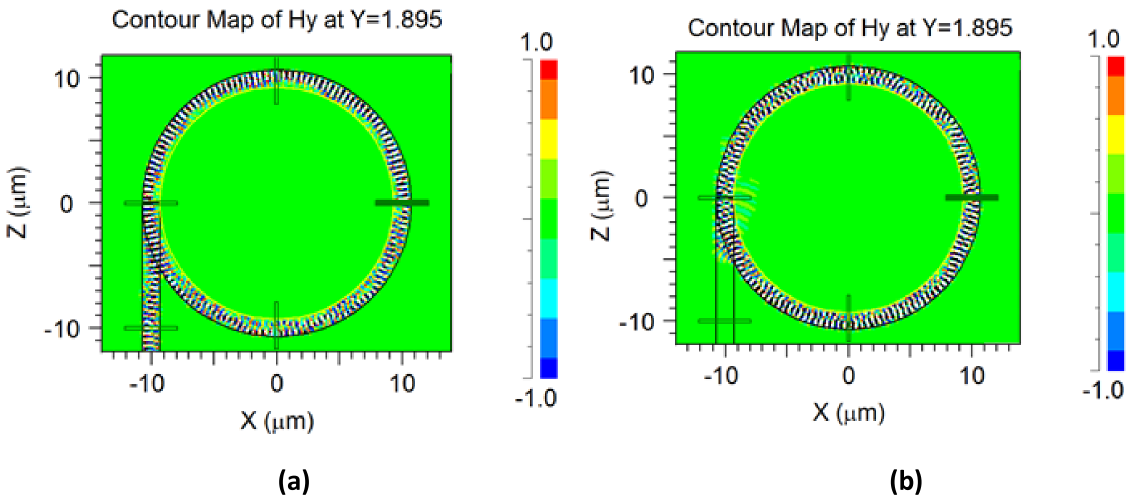

Fig. 2. Unidirectionality of whistle-geometry ring lasers. (a) Counterclockwise propagation. (b) clockwise propagation.

Sources / Related:

- http://www.chtm.unm.edu/osinski/ (Osiński Research Group)
- Laser Diode market projected to grow