

# MONOLITHICALLY INTEGRATED ABSOLUTE FREQUENCY COMB LASER SYSTEM

US Pat. No.: 9,391,420

Technology Readiness Level: 3-4

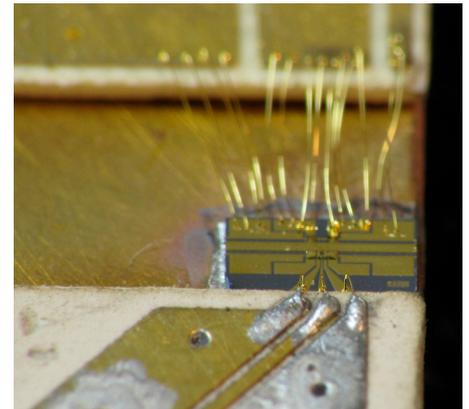
*Basic technological components are integrated to establish that the pieces will work together.*

Laser combs are increasingly used to provide precision measurements. Typical frequency comb systems use non-linear elements, distinct from the laser gain media, to create a set of emission lines with equally spaced frequencies. Separate detectors and/or frequency mixing elements are needed to lock the comb and determine the absolute frequencies of the emission lines. As a result, these systems can be extremely large and expensive.

Sandia's apparatus concept combines all the essential components for generating and locking a THz frequency comb: a multimoded laser, a non-linear mixer for generating mixed frequencies and a high frequency detector on a single mm size chip. A simple quantum cascade laser emits many modes equally spaced. A diode is embedded in the laser, creating harmonics, and the different frequencies can be used to lock the emission line frequencies while also serving as a possible detector if needed. The diode also has the ability to simultaneously mix these products against the original lines, eliminating various optical components, alignment issues, and feedback issues associated with conventional systems. With the decrease in size, weight, and system complexity, the application potential increases.



Frequency comb laser mounted on testing heatsink with current supply leads and microwave leads



Close up image of the frequency comb laser system on a chip

## TECHNICAL BENEFITS

- Compact, simplified system
- Higher power, resulting in improved efficiency
- Directly generates a THz frequency comb

## INDUSTRIES & APPLICATIONS

- Precision timing and clocking
- High-resolution broadband spectroscopy
- Remote sensing
- Astrophysics