An optoelectronic oscillator (OEO) is a hybrid oscillator that uses photonic and electrical components to generate low noise and high frequency oscillations.

1. Motivation
Increasing market demand for high frequency oscillators to:
- Extend the capacity and speed of next-generation radar and communication systems.
- Overcome performance deficiencies of prevailing electrical oscillators at high frequencies.

2. Project Aims
To develop a novel OEO that employs an optical filter to generate oscillations with:
- Low noise
- High spectral purity
- Fine tunability
- High frequency and wideband operation

3. Design Principle
The OEO design utilises a microwave photonic filter (MPF) as a frequency selective element in the oscillator feedback loop.
- Multiple discrete modes are sustained at frequencies where the total phase change along the circulating path $L$ is a multiple of $2\pi$.
- The single passband MPF isolates one discrete mode to realise single-tone oscillation at the filter centre frequency.
- An amplifier provides gain compensation.
- Continuous tunability of the OEO is achieved by adjusting the filter centre frequency to capture different modes.

4. Oscillator Schematic

4.1. Generic Oscillator Topology

4.2. Optoelectronic Oscillator Topology

5. Experimental Results
- The initial filter design [1] with a 3-dB bandwidth of 94 MHz provided oscillations in the range of 0-3 GHz.
- An alternative wideband filter [2] enabled high-frequency oscillations within the range of 0 to 14 GHz for a filter 3-dB bandwidth of 0.18 GHz.

6. Conclusion
Integration of a single passband MPF in the OEO feedback loop as a frequency selective element produced continuously tunable oscillations up to 14 GHz.

7. Applications
- Wireline and Wireless Communications
- Medical Imaging and Diagnostics
- Defence Systems
- Radar Technology
- High-Precision Clock Signals
- Testing Instruments
- High-Speed Microprocessors
- Radio Astronomy

8. References and Related Papers