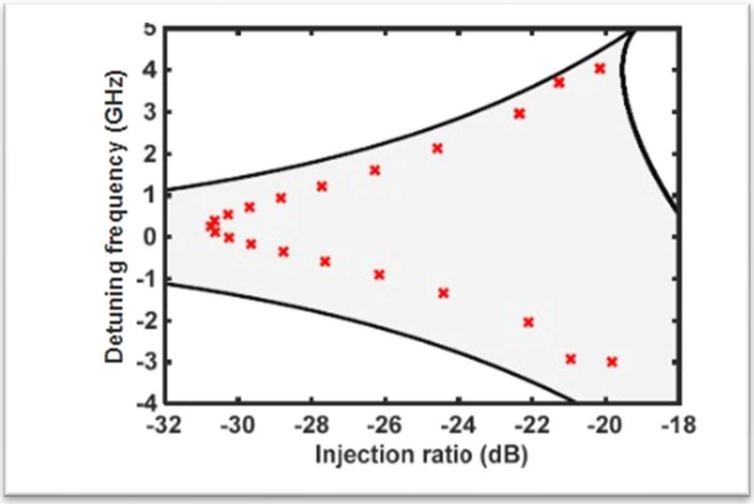
The method uses OIL semiconductor lasers, where the phase and amplitude of the laser output are controlled by adjusting injection-locking parameters.

Inputs:

- Injection-locking parameters: These control the phase and amplitude of the laser output by modulating the injected light from a master laser. This includes parameters like injection ratio (power ratio of master to slave laser), detuning frequency (difference in center frequencies), and modulation signals for phase and amplitude control.
- OPA element layout: The arrangement and spacing of the OIL lasers within the OPA influence the emitted beam pattern. This might involve specific configurations or tailored phase shifters for beam steering.
- Taylor window function profile: This function defines the desired intensity distribution across the OPA elements to minimize side lobes. It acts as a reference for modulating the injection-locking parameters.

Outputs:

- Optical beam pattern: The main output is the emitted light beam from the OPA, characterized by its directionality, intensity profile, and side-lobe levels. The goal is to achieve a narrow main beam with minimal side lobes for efficient and targeted light delivery.
- Phase and amplitude data: In the process of optimizing the OIL modulation, measurements of the laser phase and amplitude at each OPA element might be considered outputs. These values can be compared to the Taylor window function profile for control feedback and fine-tuning.
- Beam steering angles: If the system incorporates OPA element control for beam steering, the angles or directions in which the main beam points would be additional outputs. These can be adjusted by dynamically changing the injection-locking parameters and element configurations.



➢ Afffecting Parameters

❖ Input power:

- Injection ratio: This refers to the power ratio between the master and slave lasers in the OIL scheme. Higher injection ratios generally lead to a wider locking range and stronger injection, potentially allowing for wider phase and amplitude modulation and thereby better side-lobe reduction. However, excessive power can introduce detrimental effects like nonlinear instabilities and reduced efficiency.
- Master laser power: Increasing the master laser power generally strengthens the injection signal and leads to more stable locking, enabling better control over the slave lasers and side-lobe suppression. However, high power levels can also increase optical noise and introduce thermal management challenges.

❖ Laser characteristics:

- Linewidth: Narrower linewidth lasers in both the master and slave roles contribute to a cleaner and more stable output beam pattern, potentially enabling lower side-lobe levels. Wider linewidths can introduce spectral broadening and instability, impacting beam quality and side-lobe suppression.
- Gain and saturation characteristics: These govern the laser's response to the injected light and affect the locking range and achievable modulation depth. Lasers with appropriate gain and saturation properties allow for efficient control over the phase and amplitude, leading to better side-lobe reduction.
- Mode structure: Single-mode lasers offer better coherence and beam quality compared to multi-mode lasers, resulting in cleaner output patterns and

potentially lower side lobes. However, multi-mode lasers might offer certain advantages in specific applications depending on the desired beam shape and flexibility.

- Temperature

Impact on lasers:

- Changes in refractive index: As temperature increases, the refractive index of the laser cavity materials changes. This can lead to shifts in the laser wavelength and mode structure, potentially affecting the locking range and beam quality. Excessive temperature variations can destabilize the locking operation and introduce fluctuations in the emitted beam pattern, ultimately impacting side-lobe levels.
- Thermal lensing: Temperature variations within the laser cavity can induce thermal lensing effects. This alters the beam collimation and introduces additional wavefront distortions, potentially degrading the beam quality and contributing to higher side lobes.
- Gain and saturation characteristics: Temperature changes can influence the gain and saturation properties of the laser material. This can affect the laser's responsiveness to the injected light and impact the achievable modulation depth and side-lobe suppression.

Impact on other components:

- Optical components: Temperature fluctuations can cause thermal expansion and contraction in optical elements within the OPA system, such as lenses, fibers, and phase shifters. This can lead to misalignment and introduce unwanted phase errors, affecting the beam directivity and side-lobe formation.
- Electronic control systems: The electronic control circuitry used for modulating the injection-locking parameters can be sensitive to temperature variations. This can introduce noise and affect the accuracy and stability of the control signals, potentially impacting the side-lobe suppression performance.