Carrier heating effects on Relative Intensity Noise (RIN)

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Outline

- Physical originations
- Simulations
- Experiment
Originations

- Spontaneous emission
- Carrier generation-recombination process
- Carrier heating
Simulations (I)

Total RIN

\[ RIN = \frac{\langle \delta P(t)^2 \rangle}{P_0^2} = \frac{S_{\delta P}(\omega_0) \ast 2f}{P_0^2} \]

Laser RIN

\[ RIN_L = \frac{RIN}{f} = \frac{2S_{\delta P}(\omega_0)}{P_0^2} \]
Simulations (II)

\[ \langle F_N F_N \rangle \langle F_N F_P \rangle \langle F_P F_P \rangle \langle F_P F_o \rangle \langle F_o F_o \rangle \]

\[ S_p(\omega) \]

\[ S_{\delta p}(\omega) \]

\[ RIN \]

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Simulation (III)

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Experiment (I)

Driver board

Laser

O/E

RSA

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Experiment (II)

\[ RIN = RIN_M - \frac{N_{th}}{R_L (r P_{AVG(opt)})^2} - \frac{N_q}{R_L (r P_{AVG(opt)})^2} \]

\( N_q (f) \)  \( N_{th} \)  \( r \)  \( R_L \)  \( P_{AVG(opt)} \)

- Thermal noise power per Hz
- Photonic shot noise power per Hz
- Responsivity of photo-detector
- Load resistor of the spectrum analyzer input
- Average power of the photocurrent.

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Experiment (III)

**Graph**

- X-axis: Frequency (GHz)
- Y-axis: RIN (dB/Hz)
- Data points for various currents (25mA, 40mA, 60mA, 100mA)

**Legend**
- 25mA
- 40mA
- 60mA
- 100mA

**Footer**

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Conclusion

- Carrier heating reduces the peak position of the RIN spectrum especially at high injection levels.
- Carrier heating may contribute to the RIN in low frequency ranges.