Optical Scattering-Induced Noise in RF-Photonic Systems

by

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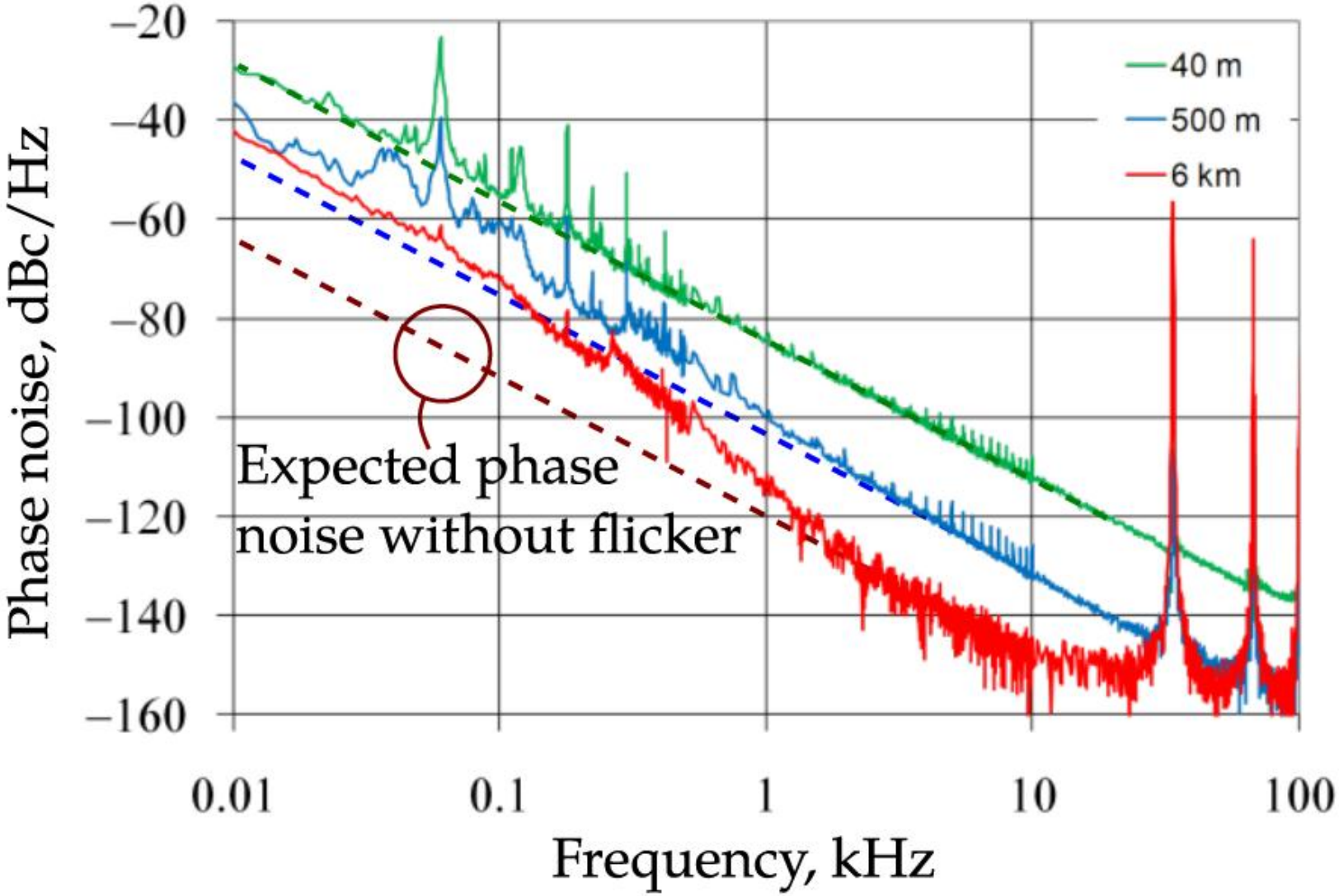
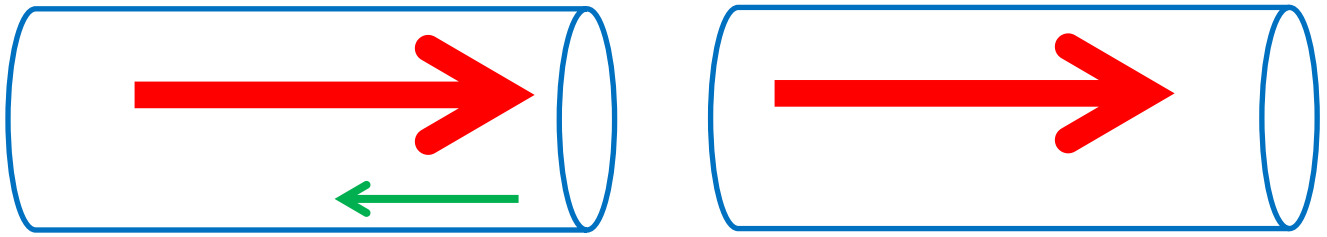
Fiber-Length Dependent Noise



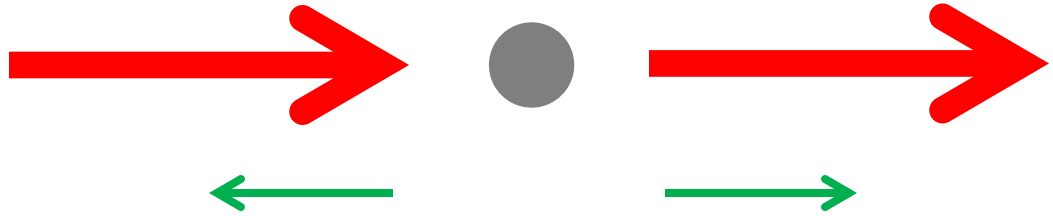
Optical Fiber Induced Noise

- Multiple phenomena induce noise in fiber
- We will focus on optical scattering
- **The dominant phenomenon depends on the system**

Types of Scattering



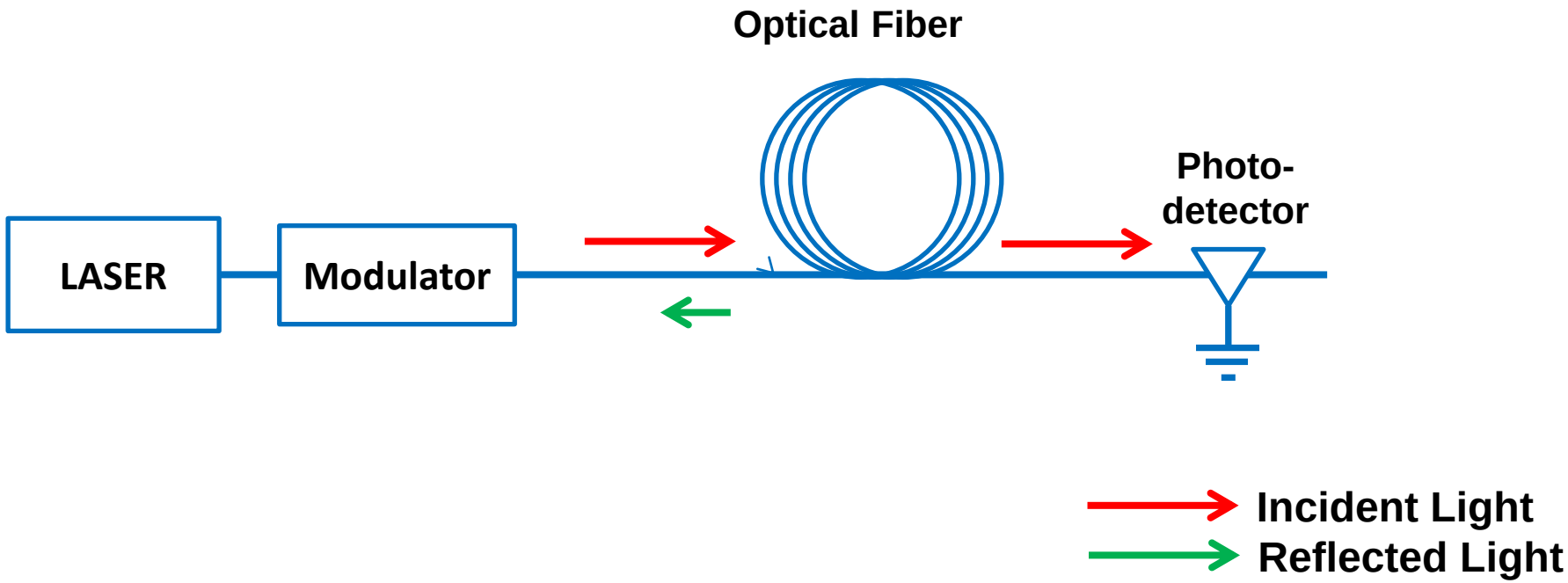
Fixed Point Scattering



Rayleigh Scattering

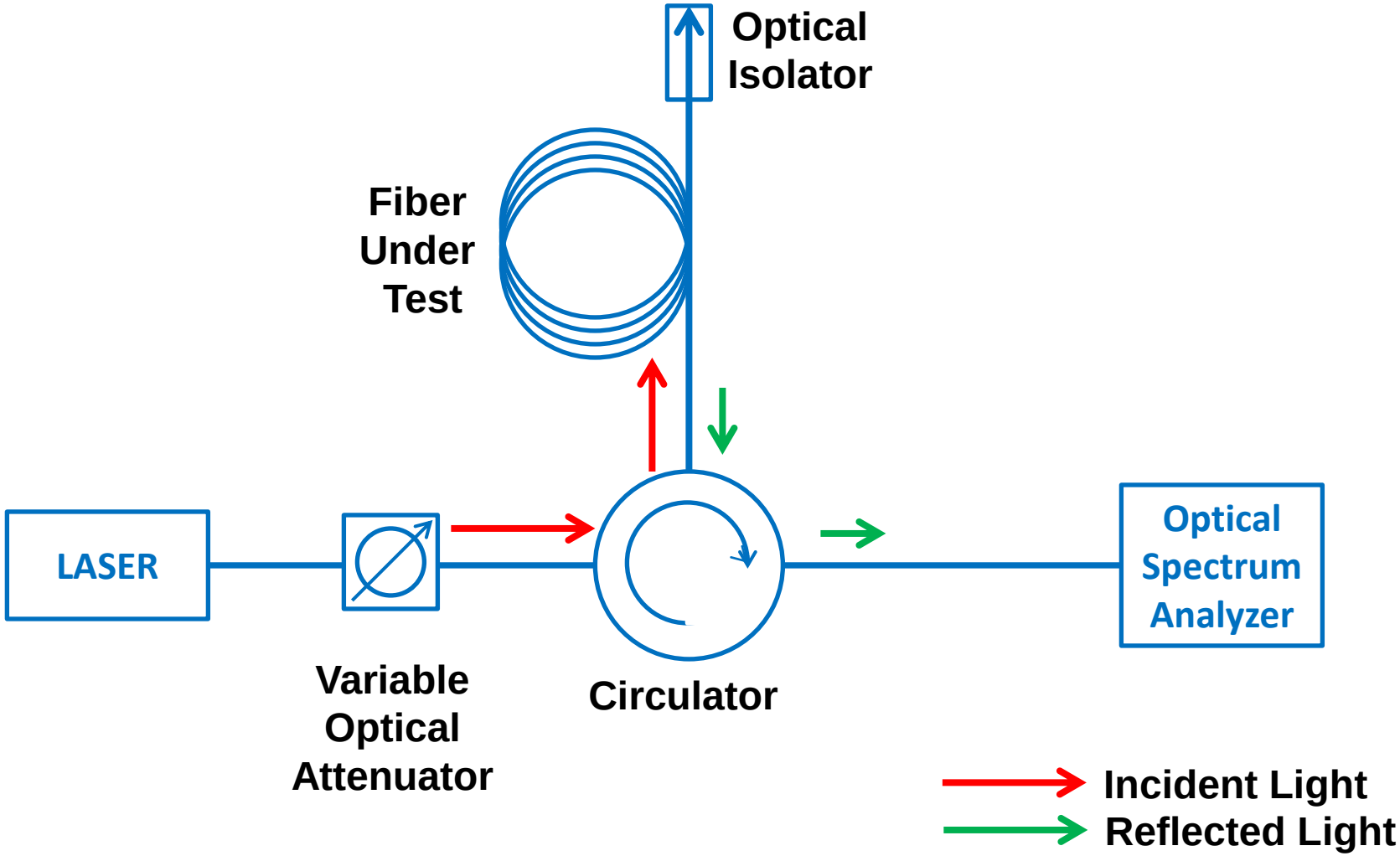
Brillouin Scattering

Transmission vs. Reflection

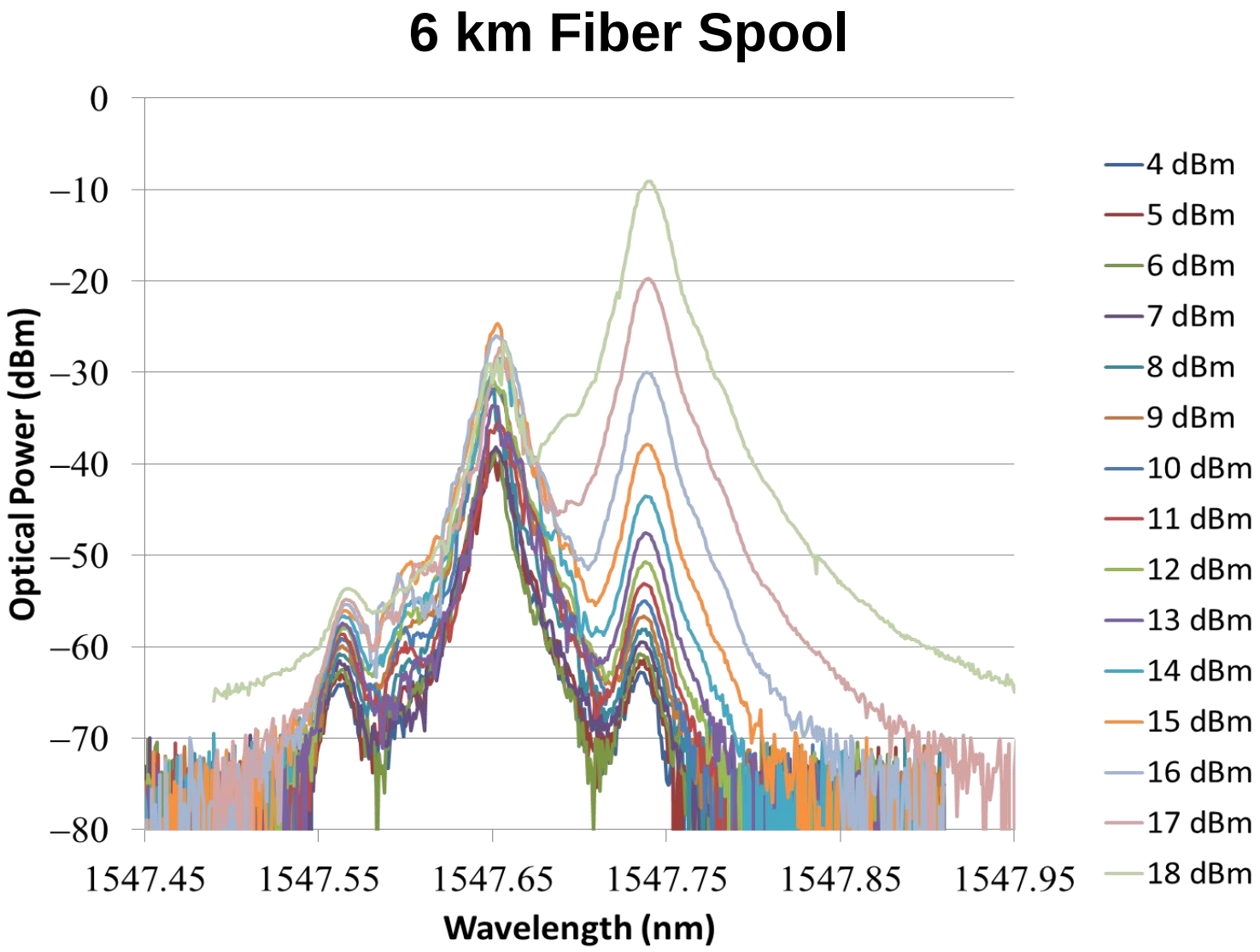


Reflected light used to characterize scattering effects

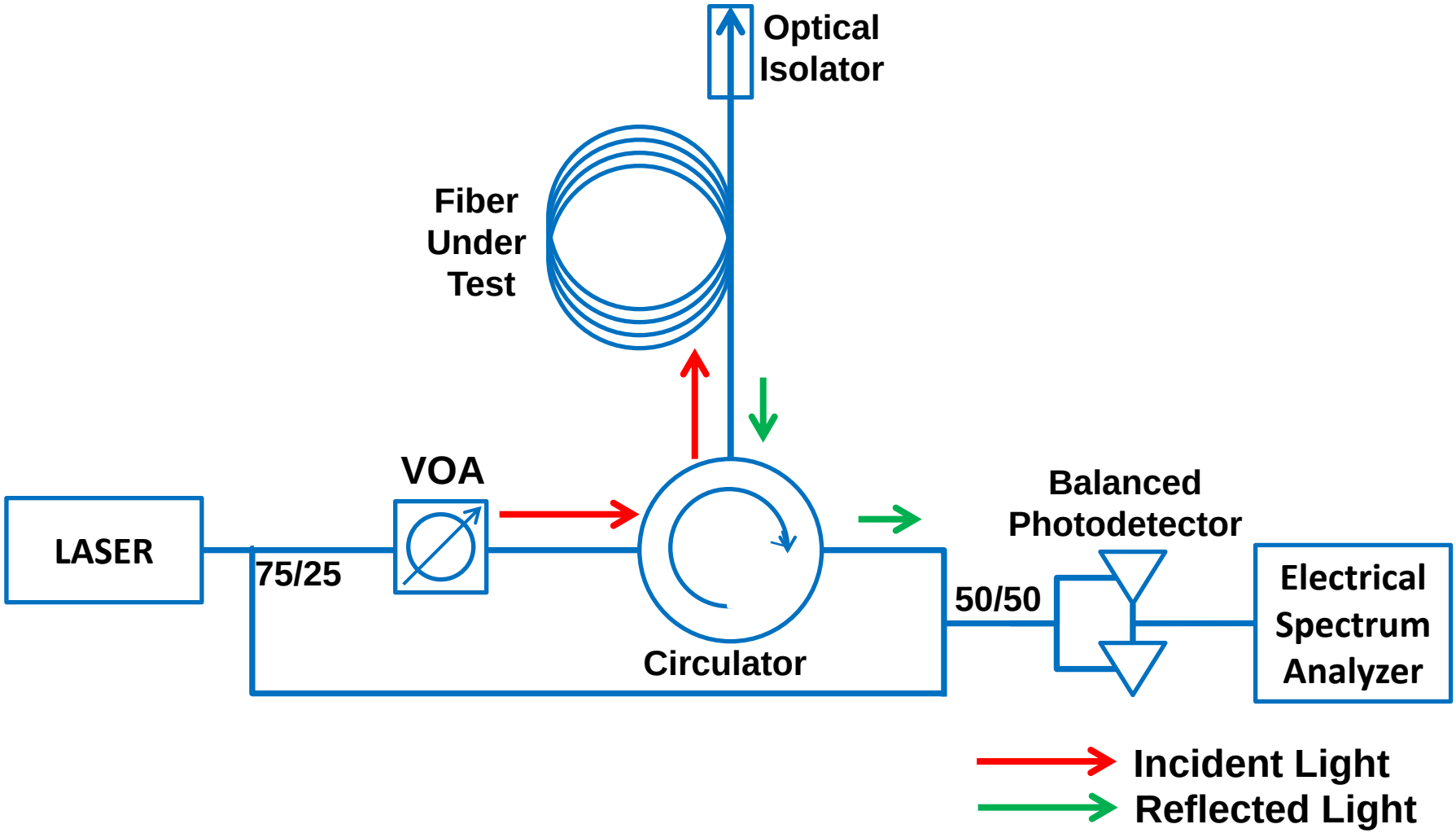
Optical Measurements: Experimental Setup



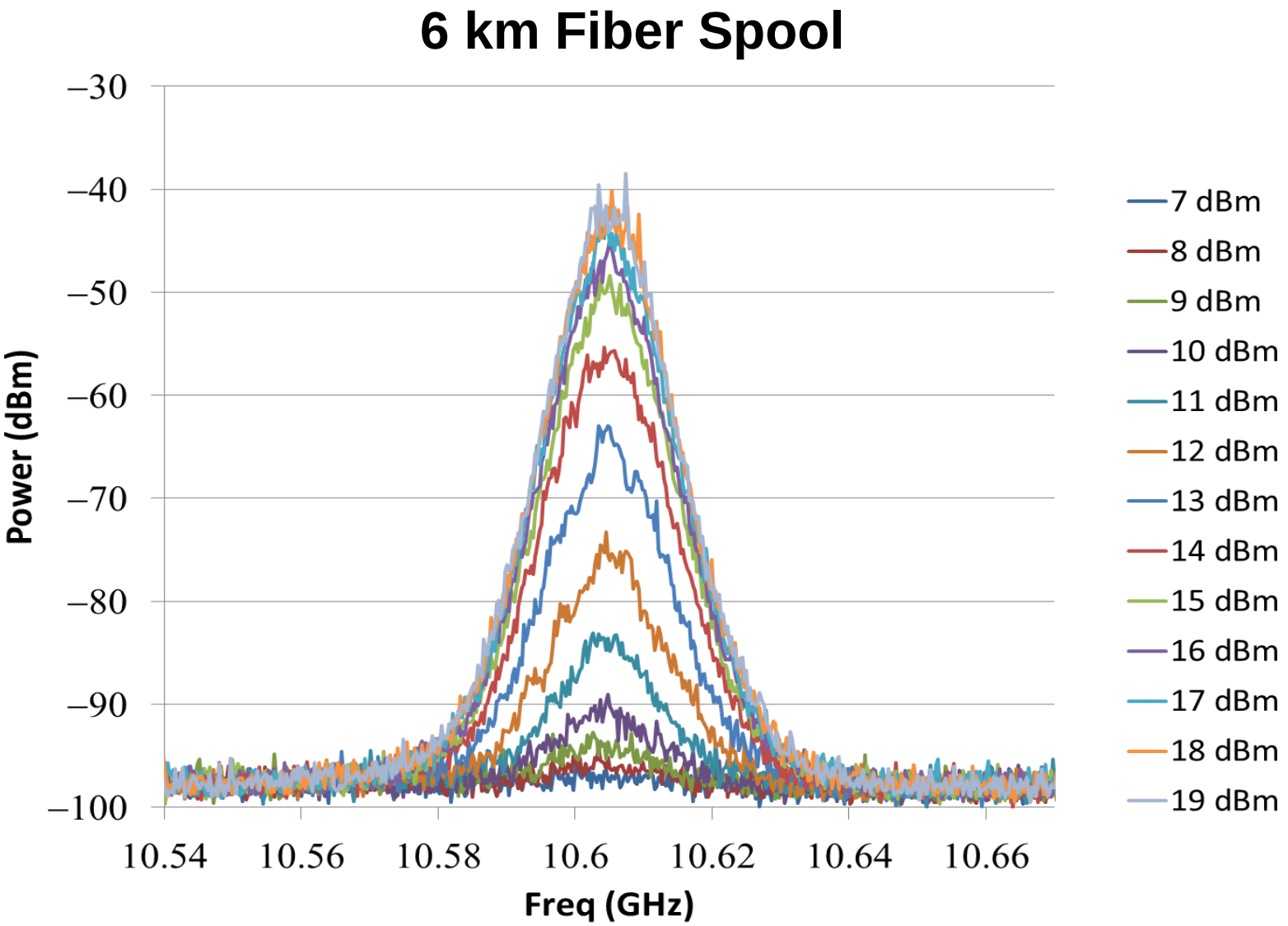
Stimulated Brillouin Scattering



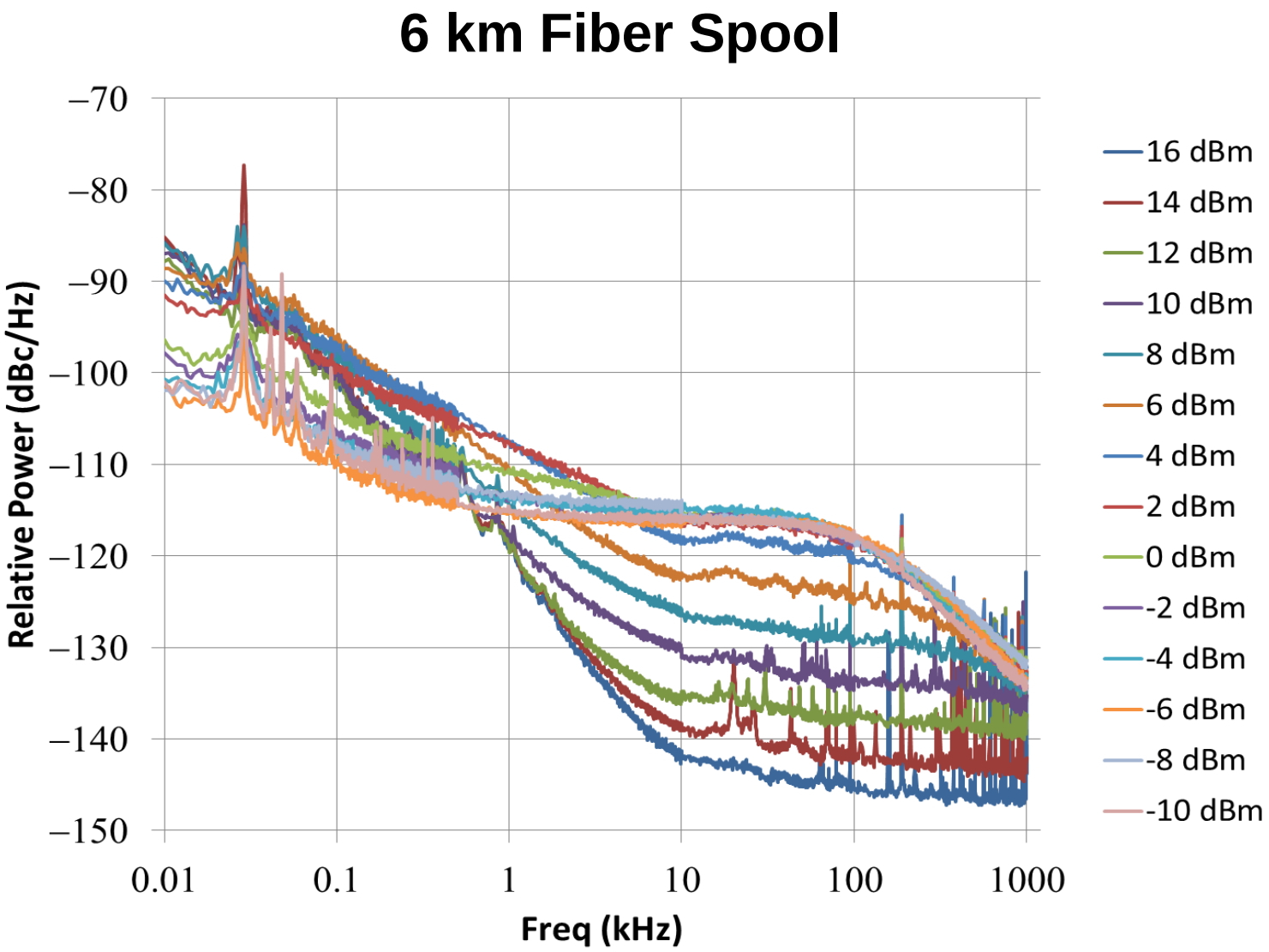
High-Resolution Coherent Measurements



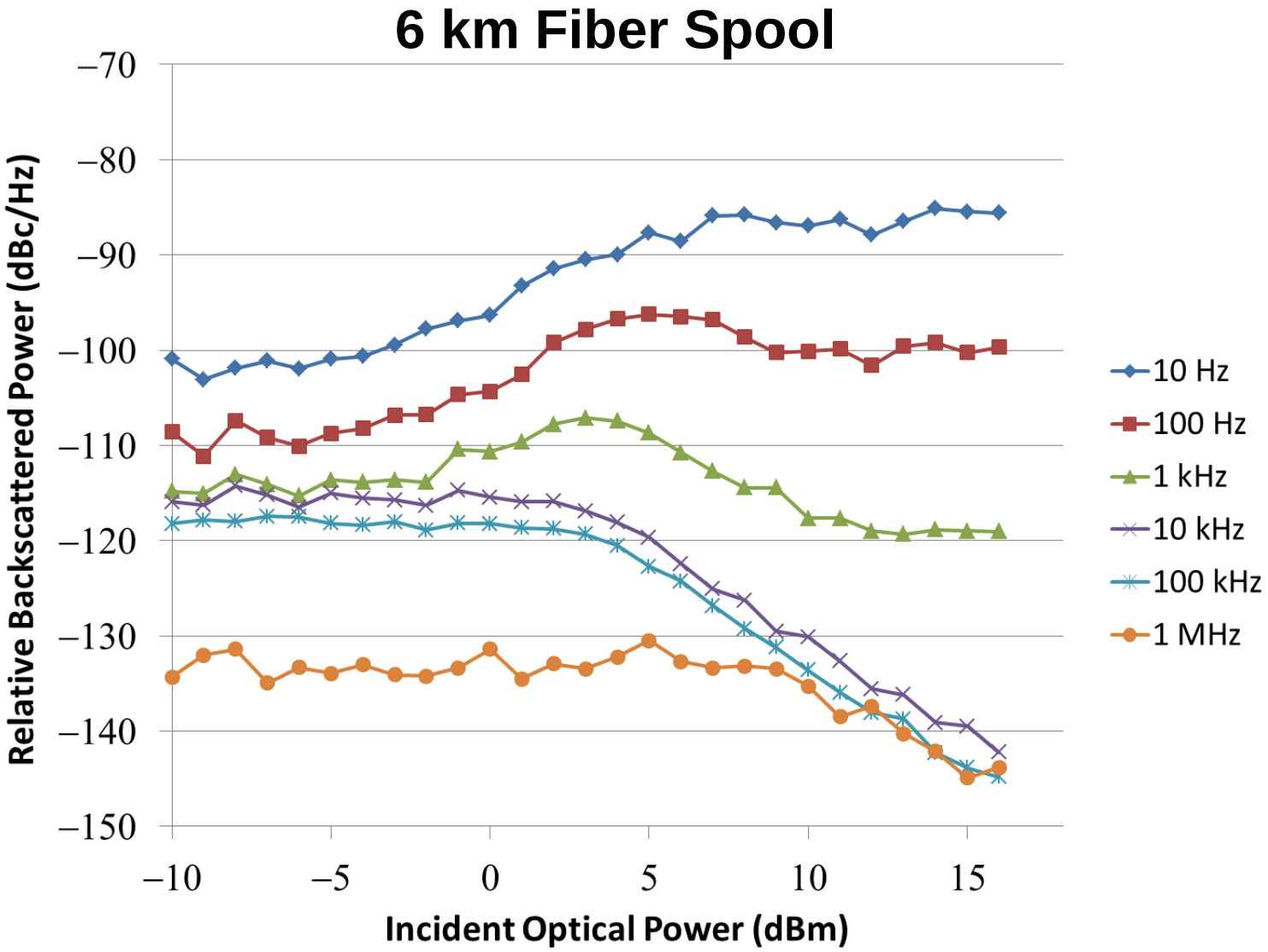
Brillouin Scattering Spectra



Rayleigh Scattering Spectra



Rayleigh Power Dependence

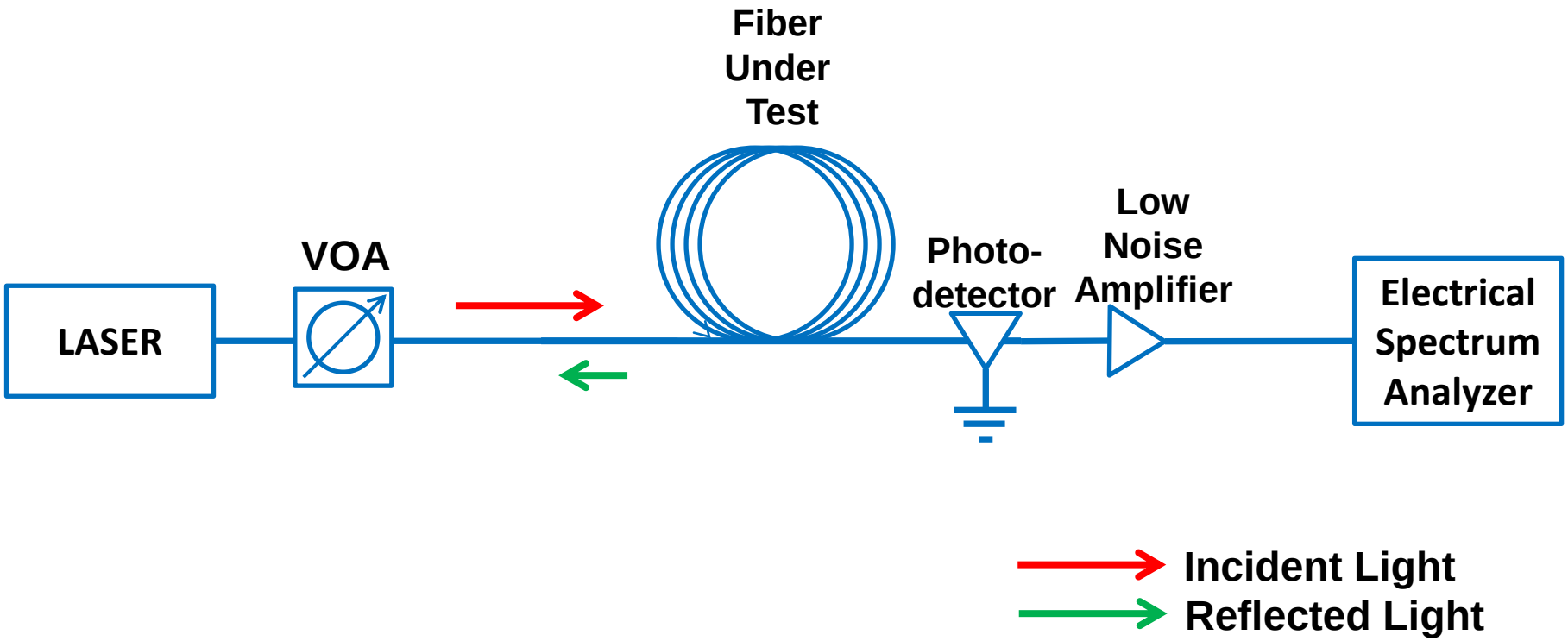


Effects on Transmitted Light

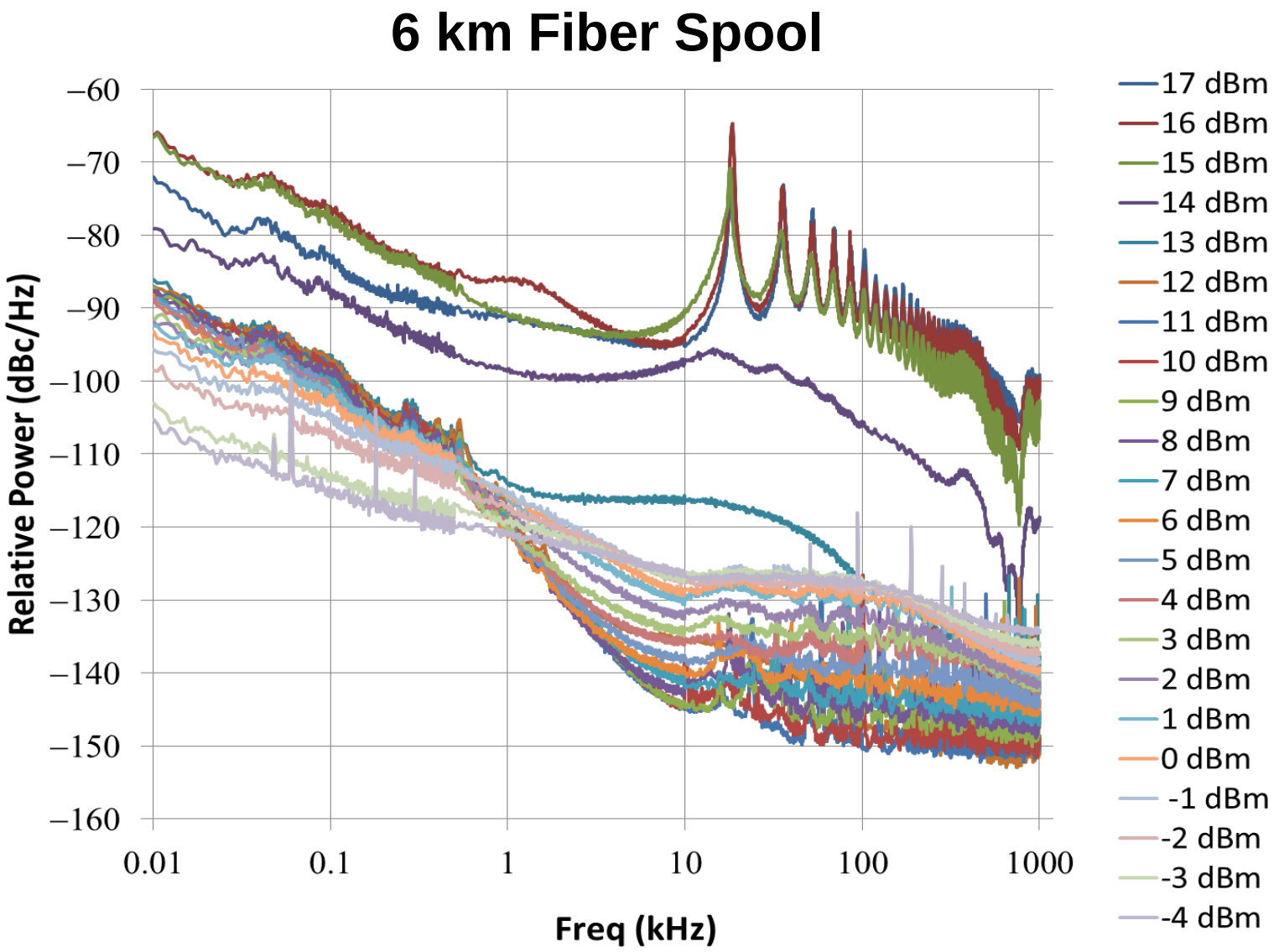
- Reflected spectrum shows :
  - Rayleigh at low power levels
  - Brillouin at high power levels

- **Both forms of scattering affect transmitted spectrum**

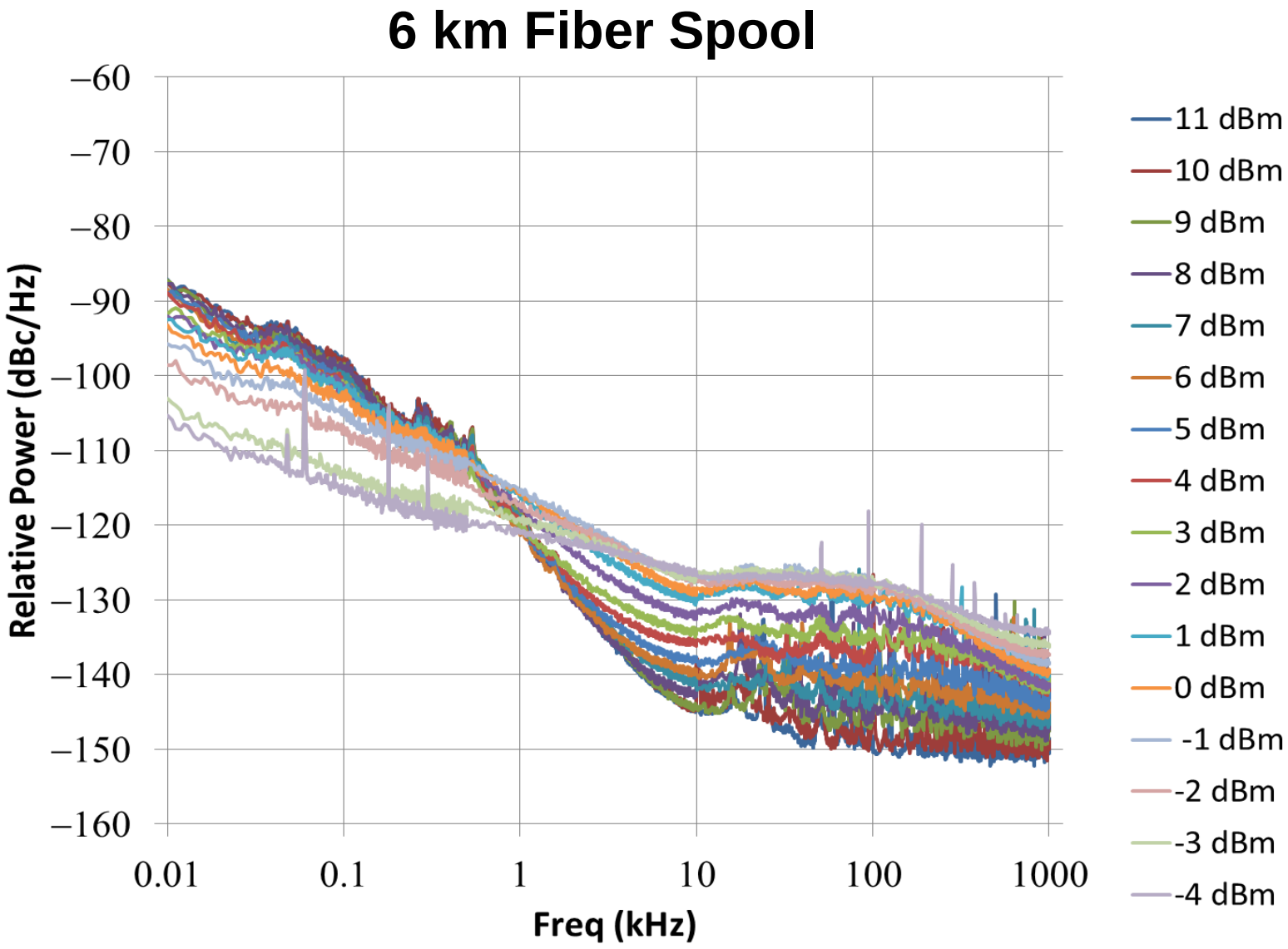
Transmission Measurements



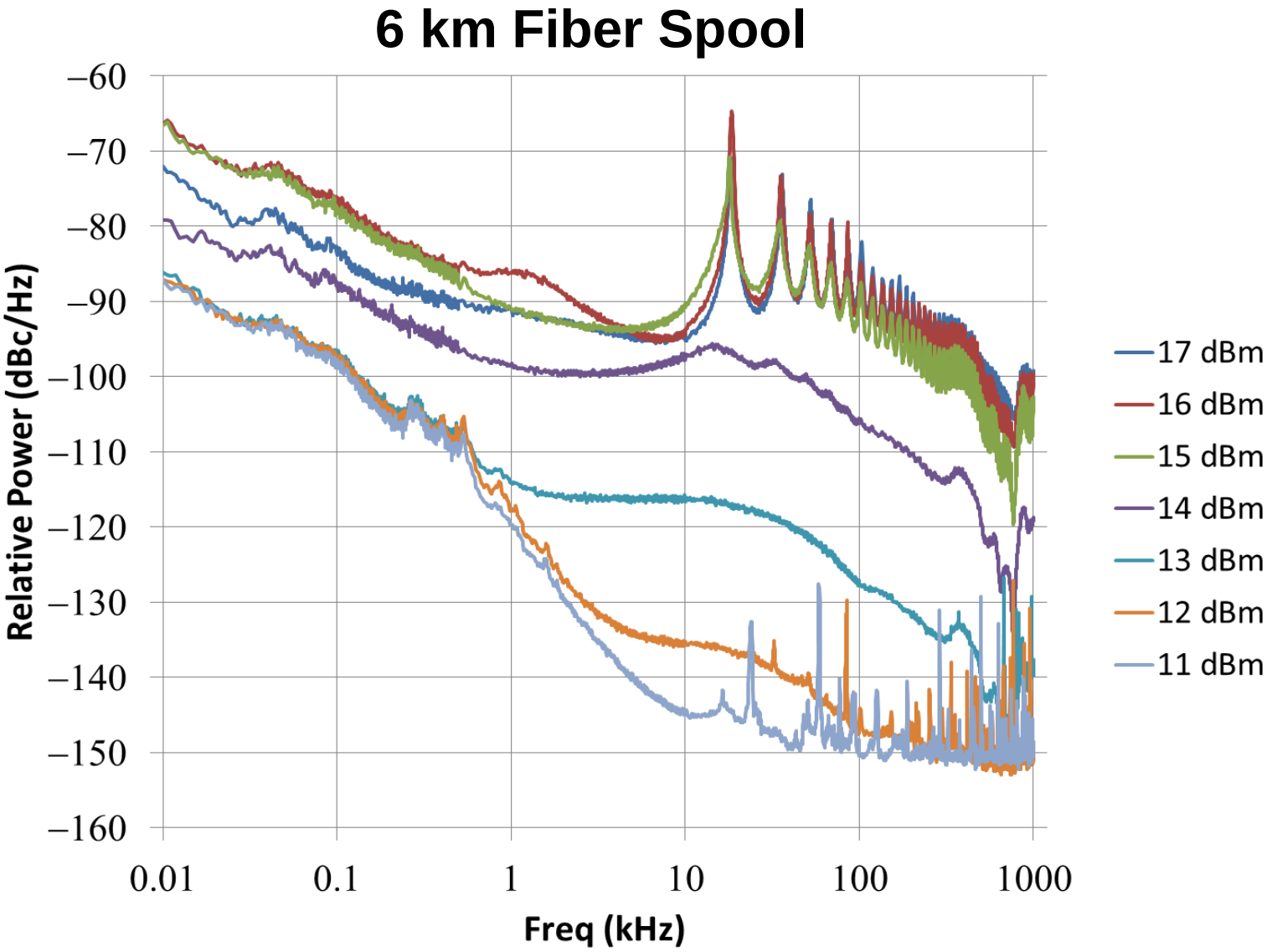
Transmitted Spectra



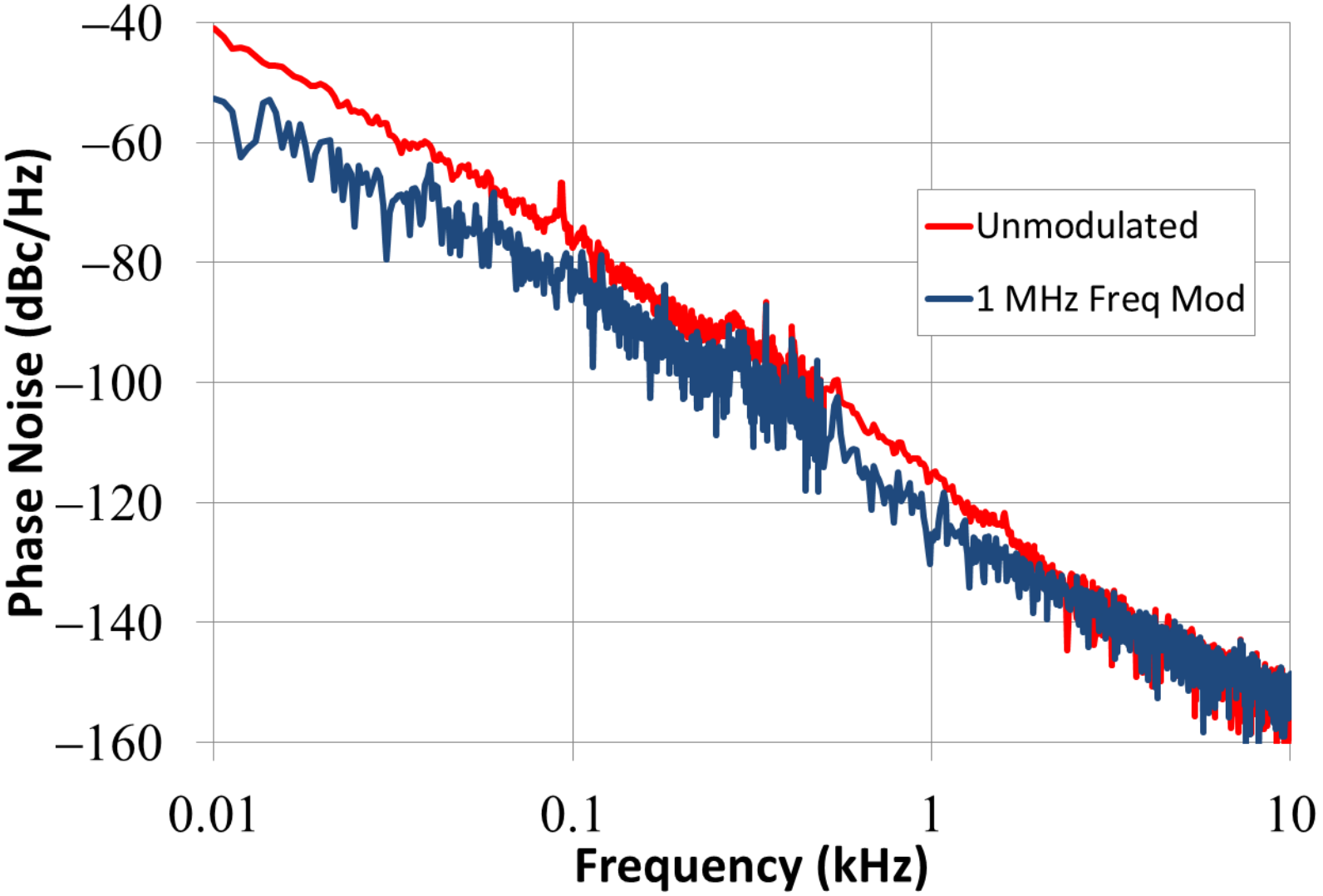
Rayleigh Regime



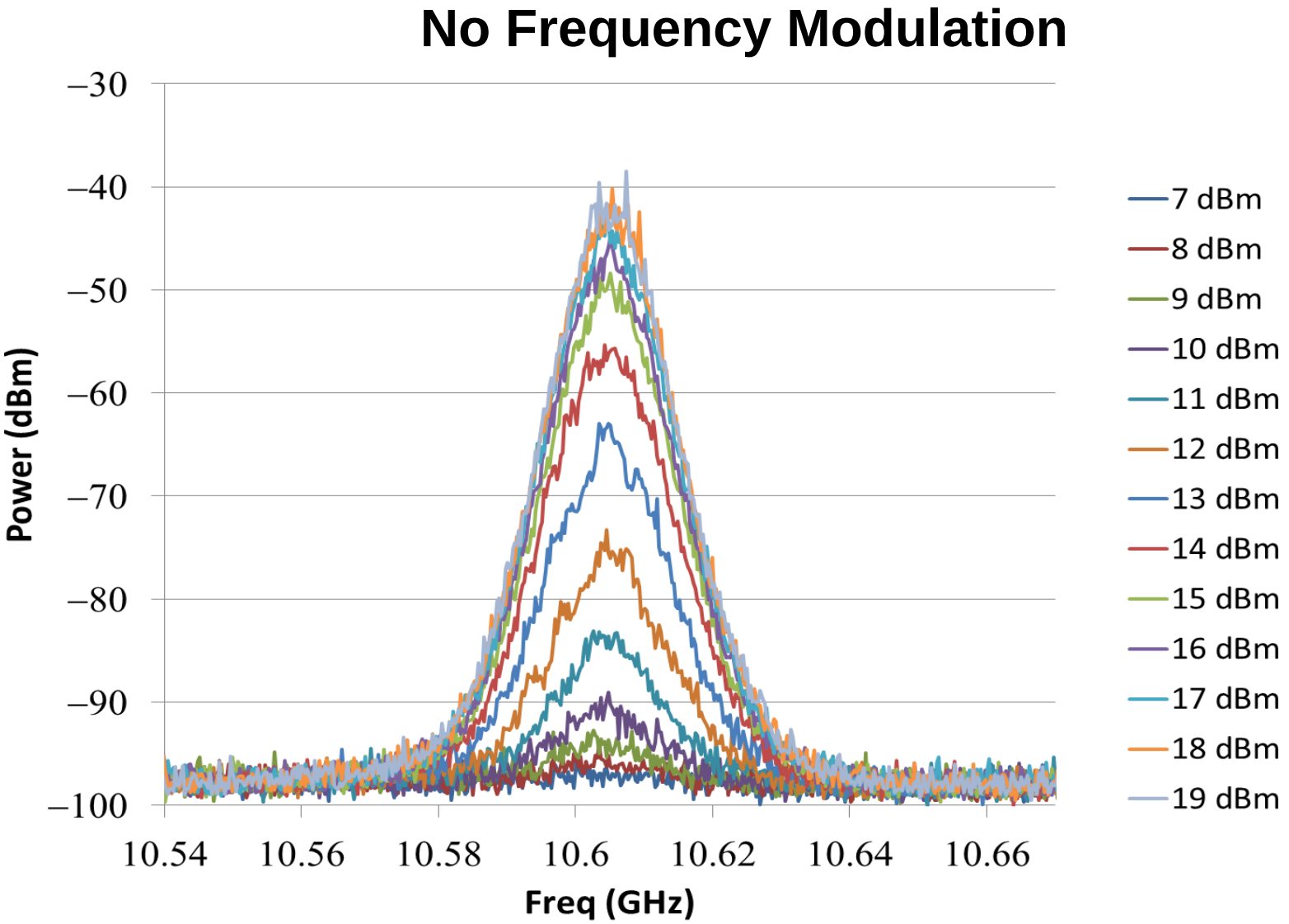
Brillouin Regime



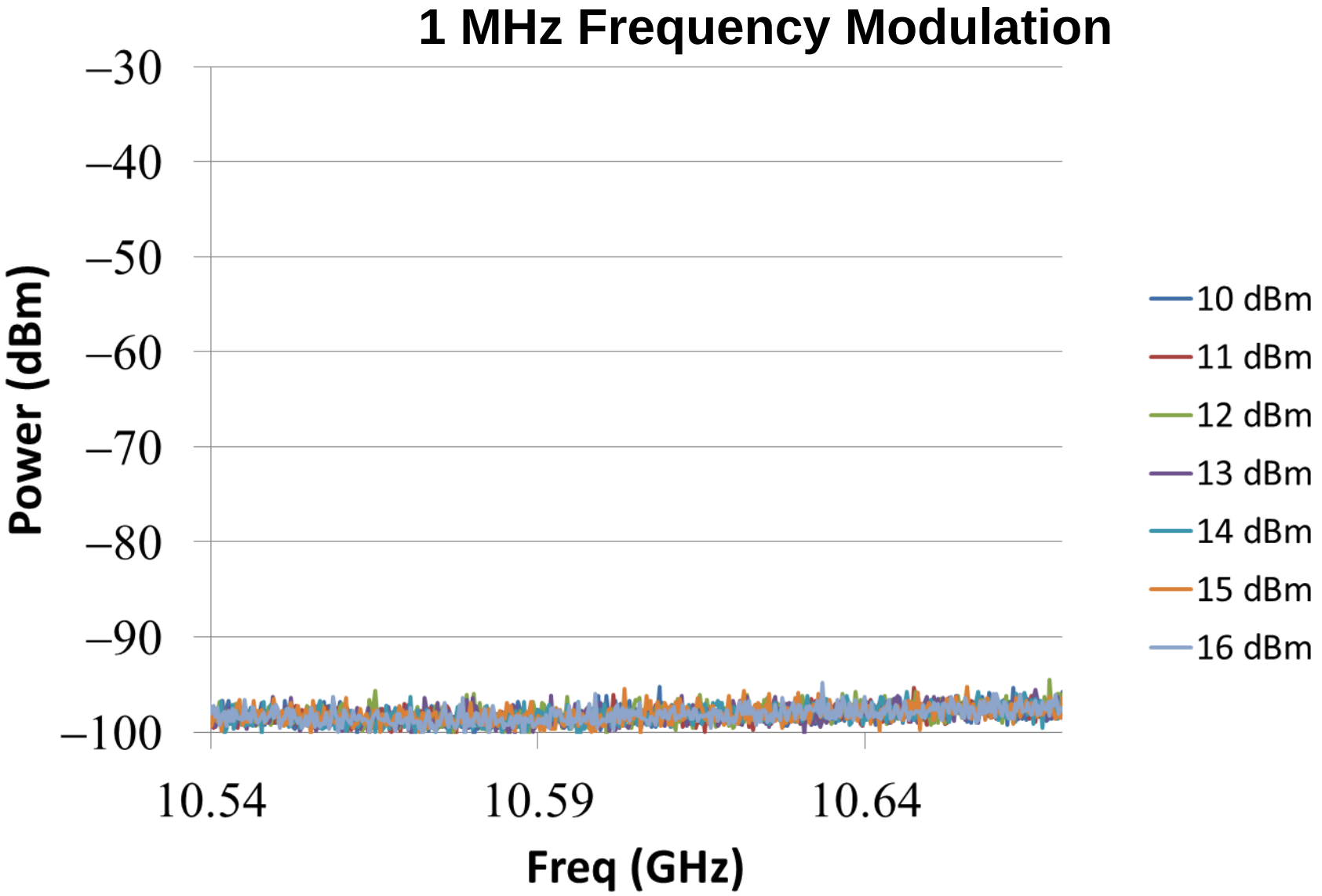
OEO Phase Noise



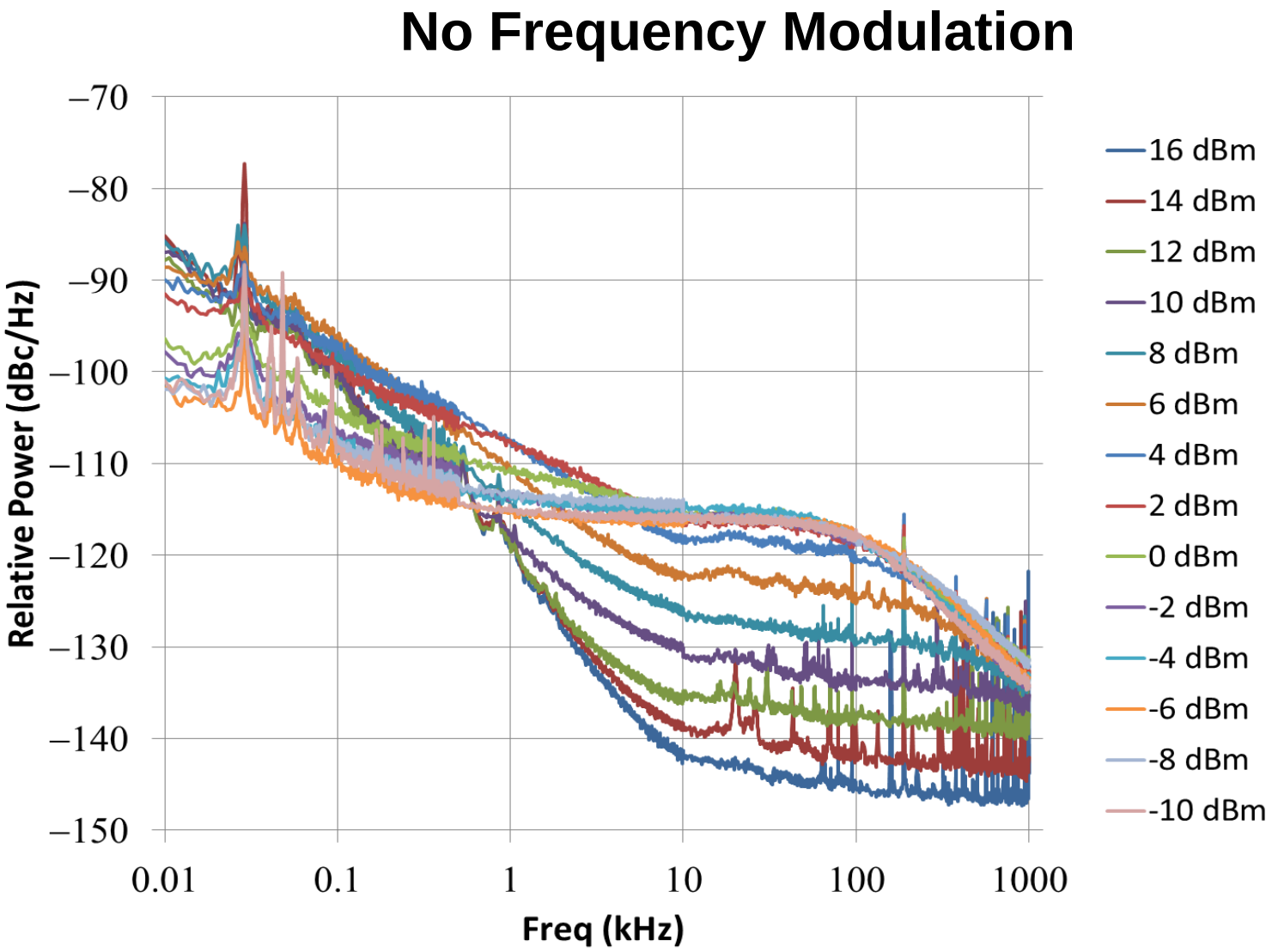
Brillouin Scattering Spectra



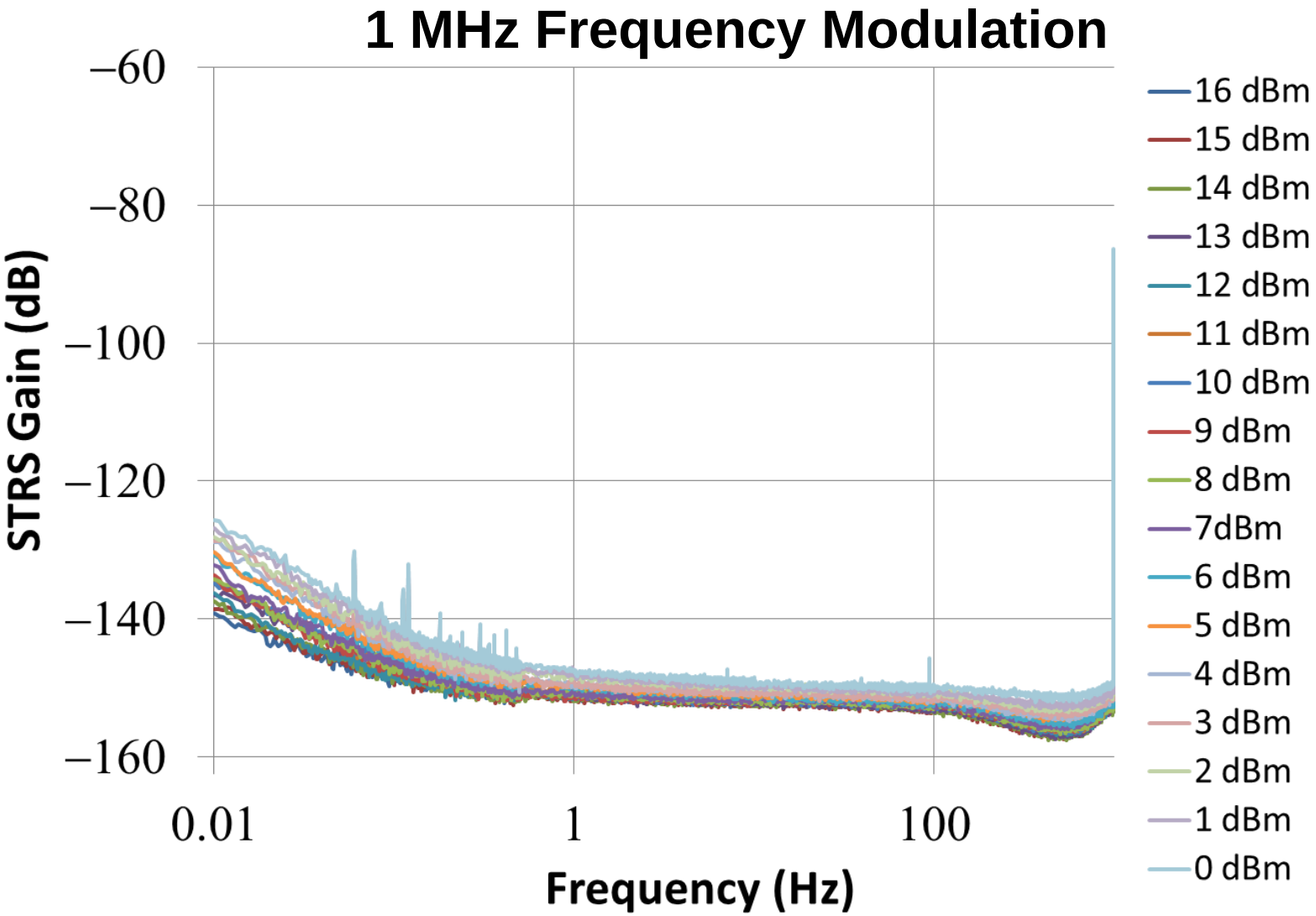
Brillouin Scattering Spectra



Rayleigh Scattering Spectra



Rayleigh Scattering Spectra



Conclusions

- At low power levels, close-in noise is dominated by Rayleigh scattering
- At high power levels, Brillouin scattering dominates
- Double-Brillouin scattering leads to increased noise above 13 dBm
- **This noise converts to RF frequencies after photodetection**