Simplified configuration of fiber-optic Brillouin observation using tunable reflectivity mirror

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1. Background and purpose

Optical fiber sensors

Increasing demand for “health monitoring” of civil infrastructures for human safety

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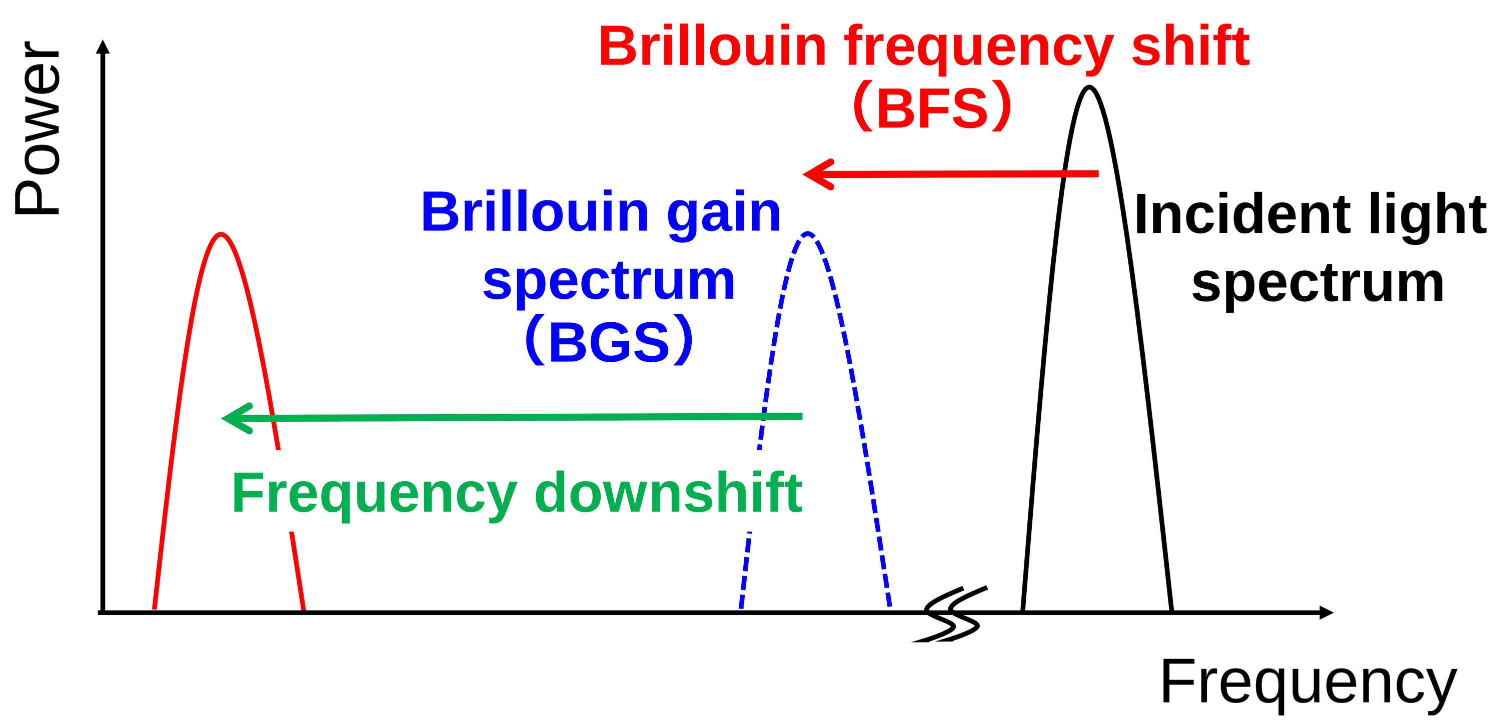
Features of optical fibers, such as small diameter, light weight, high flexibility, and resistance to electromagnetic interference

Distributed strain and temperature sensing based on Brillouin scattering

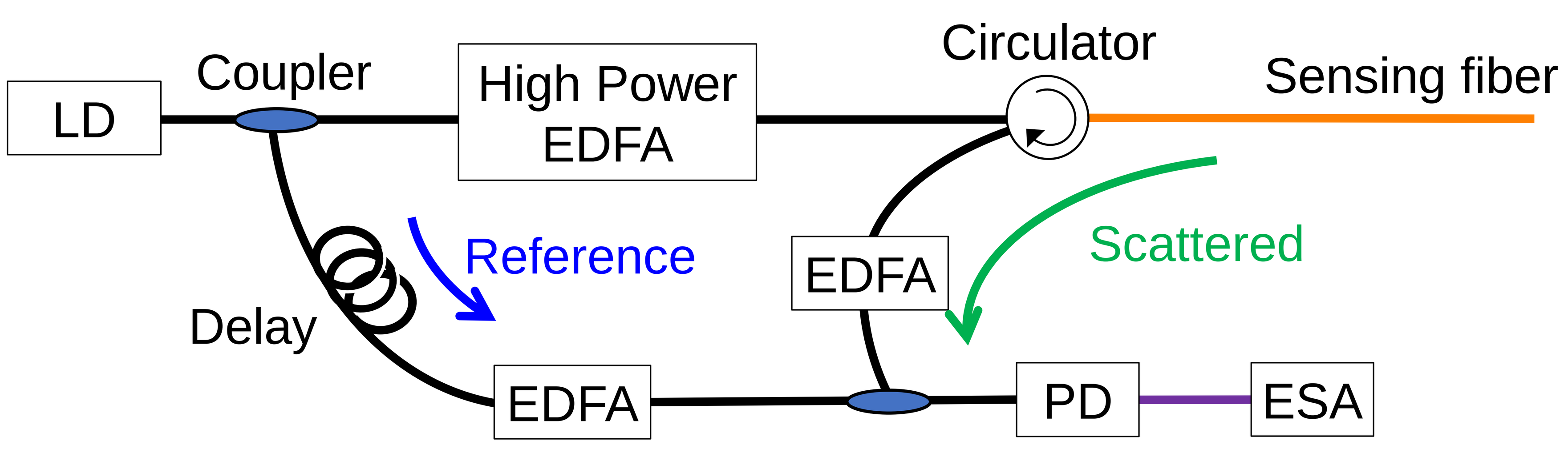
Ability to measure **magnitude** and **position** of strain and/or temperature change along sensing fiber



BFS linearly depends on applied strain and temperature

G. P. Agrawal, Nonlinear Fiber Optics (Academic Press, California, 1995).

BOCDR



LD: laser diode, **EDFA**: erbium-doped fiber amplifier,
PD: photo detector, **ESA**: electrical spectrum analyzer

Above is a widely used experimental setup for spontaneous Brillouin scattering observation. The Fresnel reflection at the open end of the FUT is suppressed, and **independent reference optical path is used for self-heterodyne detection**.

Efforts have been made to simplify and reduce the cost of this spontaneous Brillouin observation system.

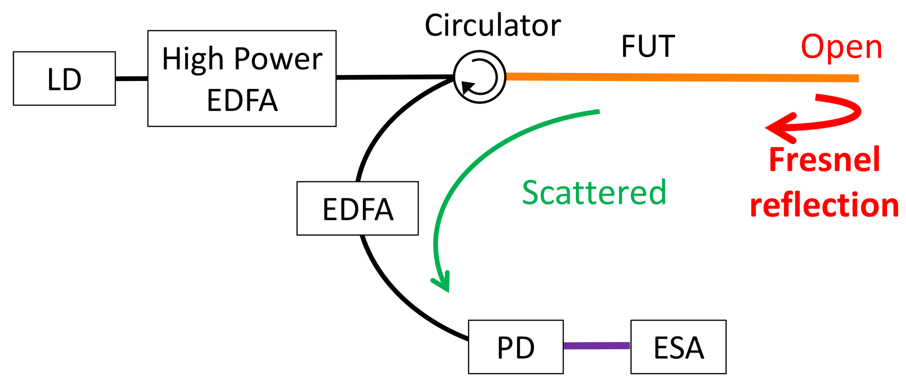
Purpose

Development of Brillouin observation system that **eliminates the independent reference light path** and **installs a TRM** at the open end of the sensing fiber to control the power of the Fresnel reflected light, and thus maximize the SNR of the BGS.

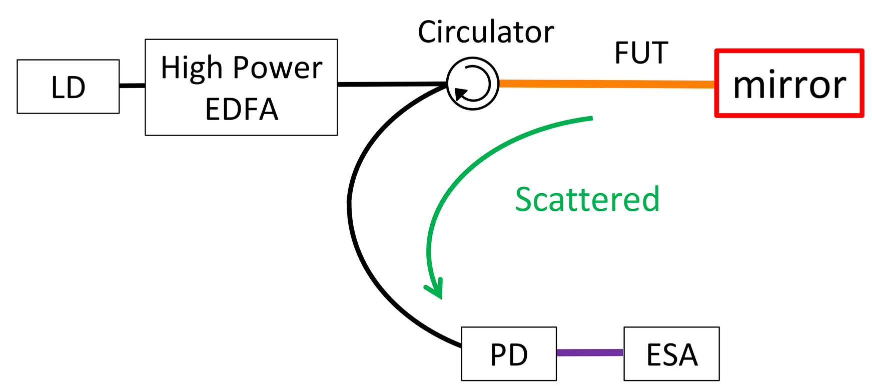
2. Experiments

Experimental setup for observing BGS

Standard setup



Simplified setup with TRM



Length of sensing fiber : ~ 5 m

Injected optical power： ~ 20 dBm

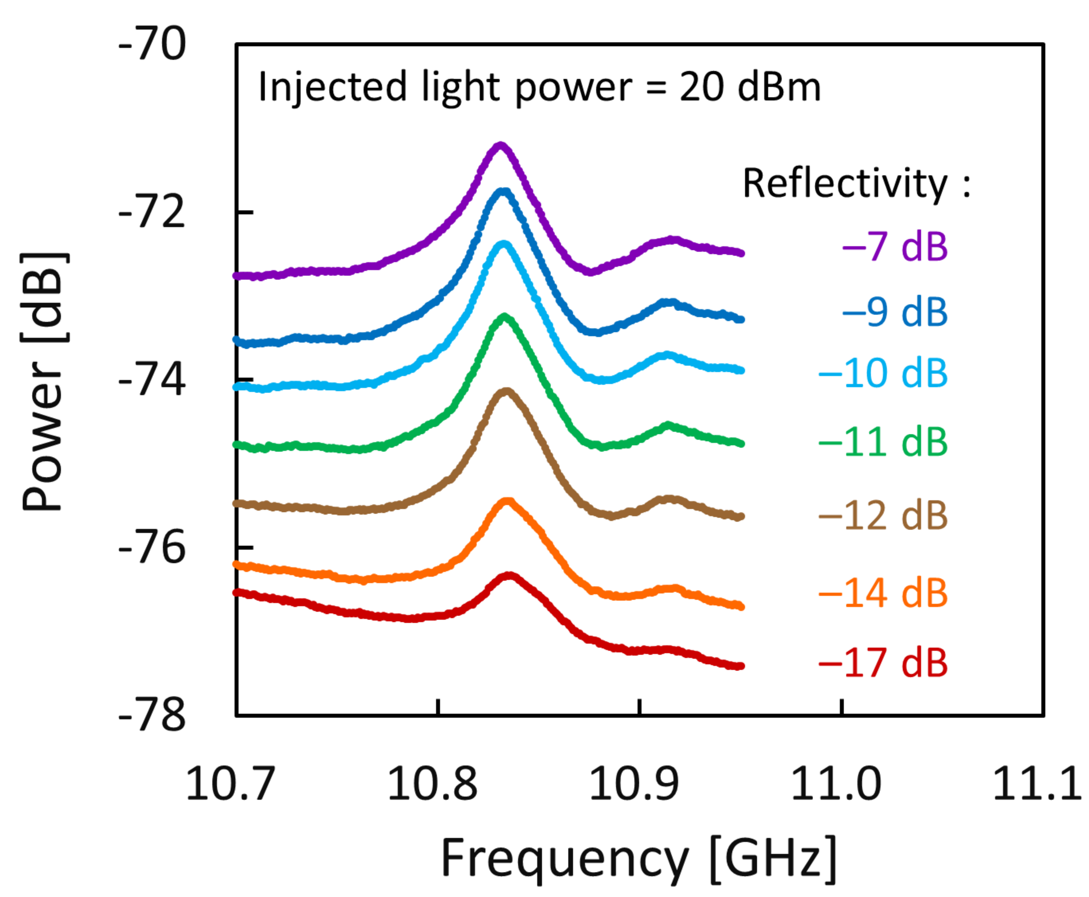
Conditions：

① Observation of BGS when the reflectivity is between –7 dB to –17 dB.

② Investigation of reflectivity dependence of BGS height when reflectivity is between –2 dB to –20 dB.

Experimental result

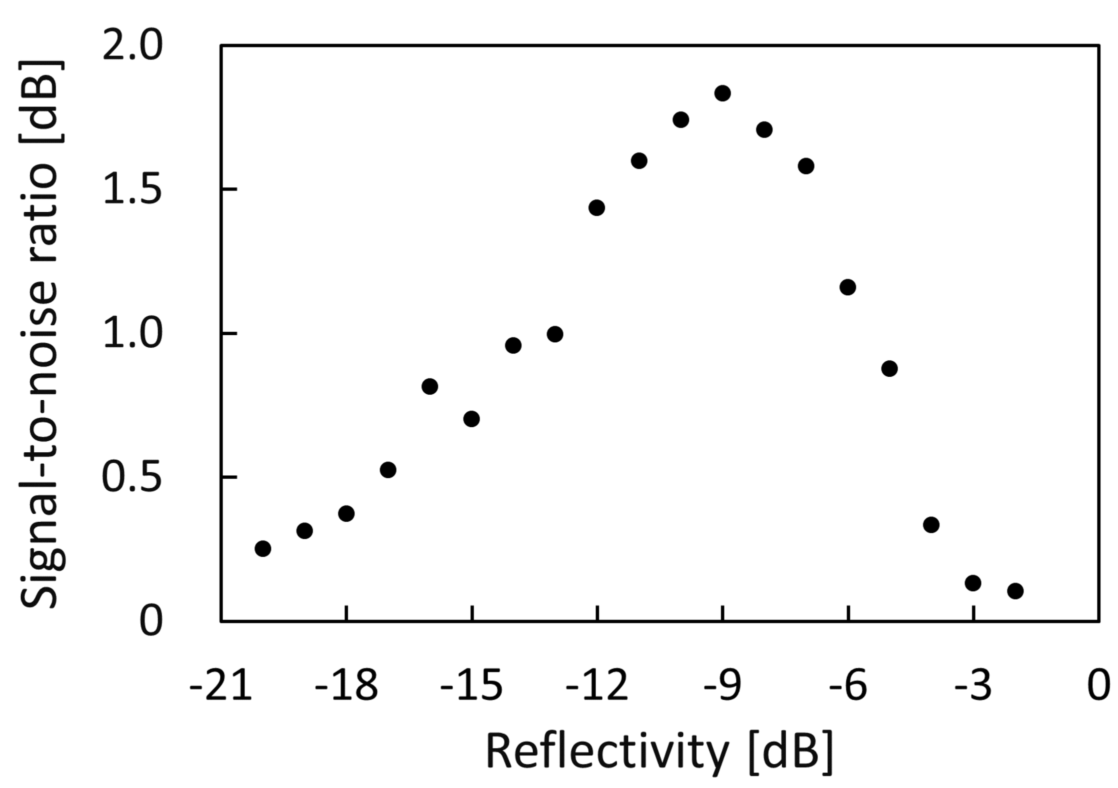
① Observed BGS dependence on mirror reflectivity



Reflectivity is defined as power difference between incident and reflected light on sensing fiber

BGS around 10.83 GHz clearly changed depending on reflectivity

② Height of BGS change in varying the reflectivity



SNR reached maximum of 1.8 dB when reflectivity was -9 dB

Fresnel reflection at open end of silica SMF is about -14 dBm, and SNR at this time is about ~ 1.0 dB

3. Conclusion

We developed a simplified Brillouin observation system that eliminates the need for an independent reference path by incorporating a tunable reflectivity mirror at the open end of the sensing fiber.

At a reflectivity of -9 dBm the SNR was approximately double that of the -14 dB Fresnel reflection.