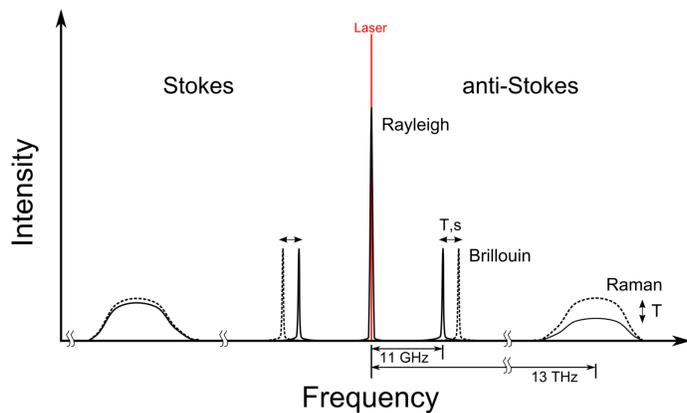
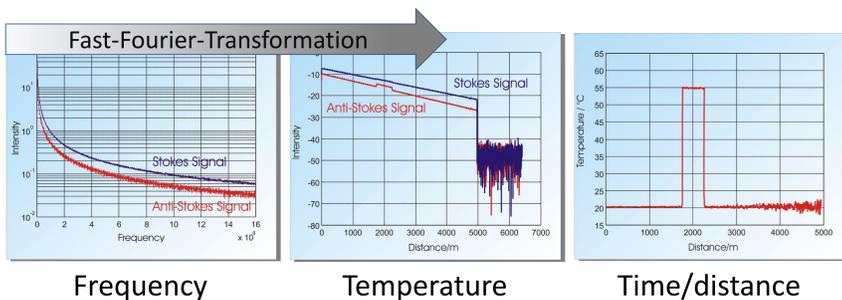


## Measurement Method

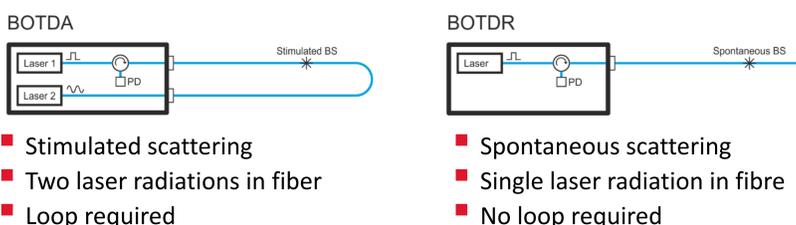
Linear optical sensing is based on backscattering of laser light launched into an optical fibre. Raman and Brillouin backscattering signals are used for measuring temperature and strain:



**Raman-OFDR:** The anti-Stokes / Stokes intensity ratio is analysed for measuring temperatures. LIOS uses the Optical Frequency Domain Reflectometry (OFDR) with a continuous wave laser. The backscattering signal is processed using the inverse fast-Fourier transformation for analysing the spatially resolved temperature profile.



**Brillouin-OTDR:** LIOS uses the B-OTDR scheme for analysing the Brillouin frequency shift for measuring temperature and strain. In comparison to BOTDA, the LIOS system needs only a single fibre and no fibre loop setup.



## DTS and DSM Specifications:

Distance range	Up to 70km
No. of channels	1 to 16
Spatial resolution	1m to 5m
Temperature accuracy	0.1°C to 1°C
Strain resolution	2µε to 20µε
Temperature range	-170°C to +450°C



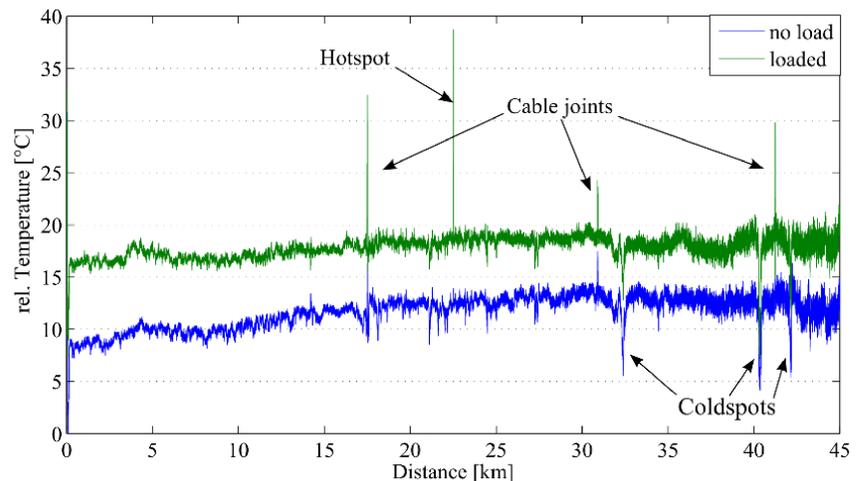
Brillouin-DTS system

### Typical Applications of LIOS DTS Systems

- Fire detection (tunnels, Elbphilharmonie, etc.)
- Powercable monitoring (Offshore windfarms, underground cable)
- Industrial applications (e.g. reactor skin monitoring)
- Oil and gas downhole and pipeline applications

## Temperature Profiles

Typical DTS curves are shown below. Data is taken from a measurement of an export cable of an offshore windfarm in Germany at low and high power load:

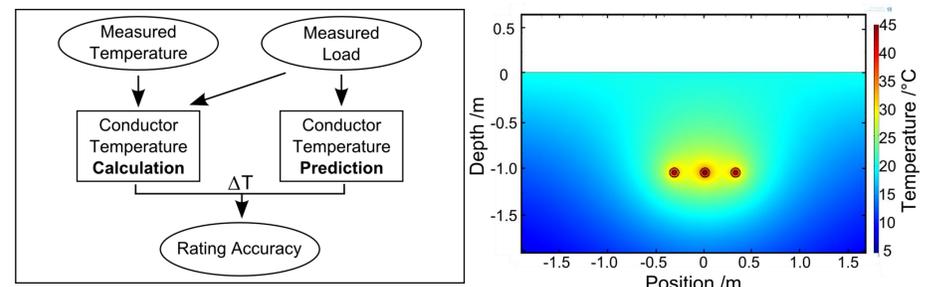


## Case Studies

### Power Cable Monitoring:

For permanent monitoring of power cables, LIOS developed the EN.SURE Real Time Thermal Rating (RTTR) software. EN.SURE RTTR enables the safe operation of power cable installations by calculating conductor temperature profiles along the entire length of a cable and by emergency calculations (predictions) in real-time.

Thermal models are verified by comparison with FEM calculations.



### Reactor Skin Monitoring

LIOS has gained deeper understanding in monitoring reactor skins in high temperature applications. The fibre-optic cable is laid in meanders to cover the whole reactor skin. With this monitoring strategy, the plant operator gets the temperature distribution on the reactor skin and is able to observe any defects or degradation in refractories as well as critical temperatures of the reactor surface.

LIOS developed an easy fibre installation method, based on high-temperature magnets and/or brackets. The magnet installation is shown in the pictures below.

