## Specifications NBX-7000

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| General Function | Separation of strain and temperature measured in single fiber, PPP-BOTDA / BOTDR / TW-COTDR / COTDR | | | | | | | |
| Function | PPP-BOTDA | | | | | TW-COTDR | | |
| Laser Wavelength | 1550 ±2 nm | | | | | 1530 nm ~ 1560 nm | | |
| Distance Range | 50m, 100m, 250m, 500m, 1km, 2.5km, 5km, 10km, 25 km | | | | | | | |
| Measurement Frequency Range | 9~13 GHz | | | | | 192300~196000 GHz | | |
| Range of Strain Measurements | -30,000 to +40,000 $\mu\varepsilon$ (-3% to +4%) | | | | | -15,000 to +20,000 $\mu\varepsilon$ (-1.5% to +2%) | | |
| Measurement Frequency Scan Step | 1, 2, 5, 10, 20, 50 MHz | | | | | 100, 200, 250, 500 MHz | | |
| Readout Resolution | 5 cm (default), 1 cm (minimum) | | | | | | | |
| Sampling Points | 600,000 (default), 3,000,000 (maximum) | | | | | | | |
| Hardware Average Count Settings | $2^5$ ~ $2^{16}$ times | | | | | | | |
| Average Count Settings | $2^5$ ~ $2^{23}$ times | | | | | | | |
| Pulse Width | 0.5 ns | 1 ns | 2 ns | 5 ns | 10 ns | 0.5 ns | 1 ns | 2 ns |
| Spatial Resolution | 5 cm | 10 cm | 20 cm | 50 cm | 100 cm | 5 cm | 10 cm | 20 cm |
| Dynamic Range(1) | 1 dB | 1.5 dB | 3 dB | 3 dB | 6 dB | 1 dB | 3 dB | 6 dB |
| Max. Measurement Distance(2) | 1 km | 2 km | 5 km | 10 km | 20 km | 1 km | 10 km | 20 km |
| Optical Budget(1)(8) | 2 dB | 5 dB | 7 dB | 8 dB | 10 dB | 2 dB | 5 dB | 7 dB |
| Measurement Accuracy (σ)(3)(4) | 15 με / 0.75ºC | 7.5 $\mu\varepsilon$ / 0.35 ºC | | | | 0.5 $\mu\varepsilon$ / 0.05 ºC | | |
| Repeatability (σ)(3)(4)(5) | 10 με / 0.5 ºC | 5 $\mu\varepsilon$ / 0.25 ºC | | | | 0.2 $\mu\varepsilon$ / 0.01 ºC | | |
| Measurement time (6)(7) | 5 seconds (minimum) | | | | | 60 seconds (minimum) | | |
| Measurement Accuracy for Hybrid mode(9) | 10 $\mu\varepsilon$ / 0.5 ºC | | | | | | | |
| Measurement Repeatability for Hybrid mode(9) | 5 $\mu\varepsilon$ / 0.25 ºC | | | | | | | |
| Input-output Fiber | Single mode optical fiber | | | | | | | |
| Fiber connector | FC-APC / SC-APC (factory option) | | | | | | | |
| Suitable Fiber | Single mode optical fiber | | | | | | | |
| Power Supply | AC100~240V 50/60Hz 250VA | | | | | | | |
| Laser Class | Class 1 (IEC60825-1: 2001) | | | | | | | |
| Dimensions / Weight | approx. 456 (W) × 485 (D) × 286 (H) mm / 30 kg | | | | | | | |
| Operating Temperature | 10~40 ºC, Humidity below 85% (no dew condensation) | | | | | | | |
| Storage Temperature | 0~50 ºC | | | | | | | |
| Place of Production | Japan | | | | | | | |

(1) Based on $2^{15}$ avarage cycles (TW-COTDR) / Based on $2^{15}$ avarage cycles in progressive measurement mode (PPP-BOTDA) .
(2) Based on avarage fiber loss of 0.3 dB/km using single mode fiber (UV-coated).
(3) Based on the measurement of strain free, UV coated fiber.
(4) Based on the measurement of strain free, UV coated fiber and in constant temperature environment.
(5) The maximum standard deviation of measurement value in 5 consecutive measurements for 100 consecutive points.
(6) The settings of 50 m distance range, $2^{14}$ count settings, 41 scanning steps excluding the time for Pulse Adjustment.
(7) The settings of 50 m distance range, $2^{14}$ count settings, 401 scanning steps excluding the time for Pulse Adjustment.
(8) Within the allowable range adjusted by the optical power excluding the case of nonlinear phenomena.
(9) The measurement mode of PPP-BOTDA and TW-COTDR used with conditions of (1)-(8) applied.
(1)-(5) are all based on a frequency scan step of 5 MHz for PPP-BOTDA and with Pulse Adjustment and Auto Frequency Adjustment on .
(1)-(5) are all based on a frequency scan step of 250 MHz for TW-COTDR and with Pulse Adjustment on .

Failed analysis points: Due to nature of Rayleigh scattering, the correlation of optical spectrums between two measurements may be lost at some locations. As a consequence, at those points, data analysis fails. This reflects the current limitations of the technology. Neubrex offers tools for recovering failed points data, however, their correctness cannot be ensured.

High speed measurements: The high speed capabilities are available for Brillouin type measurements only.

*Specifications are subject to change without notice


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***Give you a feel*®**
***When every point of the optical fiber is a sensor***

*Neural Optical Fiber Scope*

# *NEUBRESCOPE NBX-7000*

NEW

Pulse- PrePump Technology in BOTDA and Tunable Wavelength Technology in COTDR to measure and separate strain and temperature

Now operated from laptop computer for easy in-field use


**Measure & separate strain and temperature**

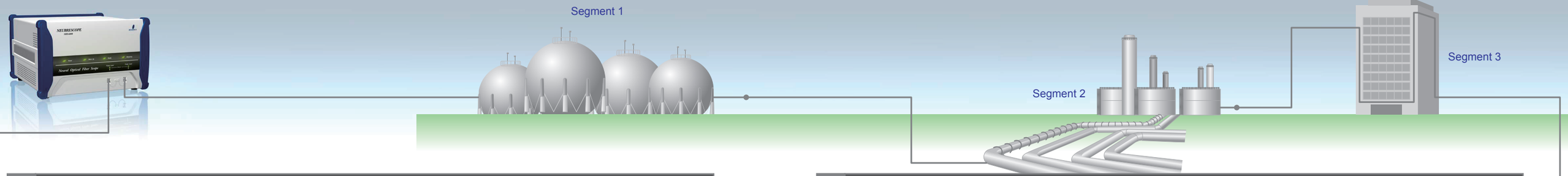
Measurement mode: **PPP-BOTDA / TW-COTDR**

Spatial resolution: **5 cm** / Sampling resolution: **1 cm**

Repeatability of strain measurement: **5 με** (Hybrid mode)

Repeatability of temperature measurement: **0.25 °C** (Hybrid mode)

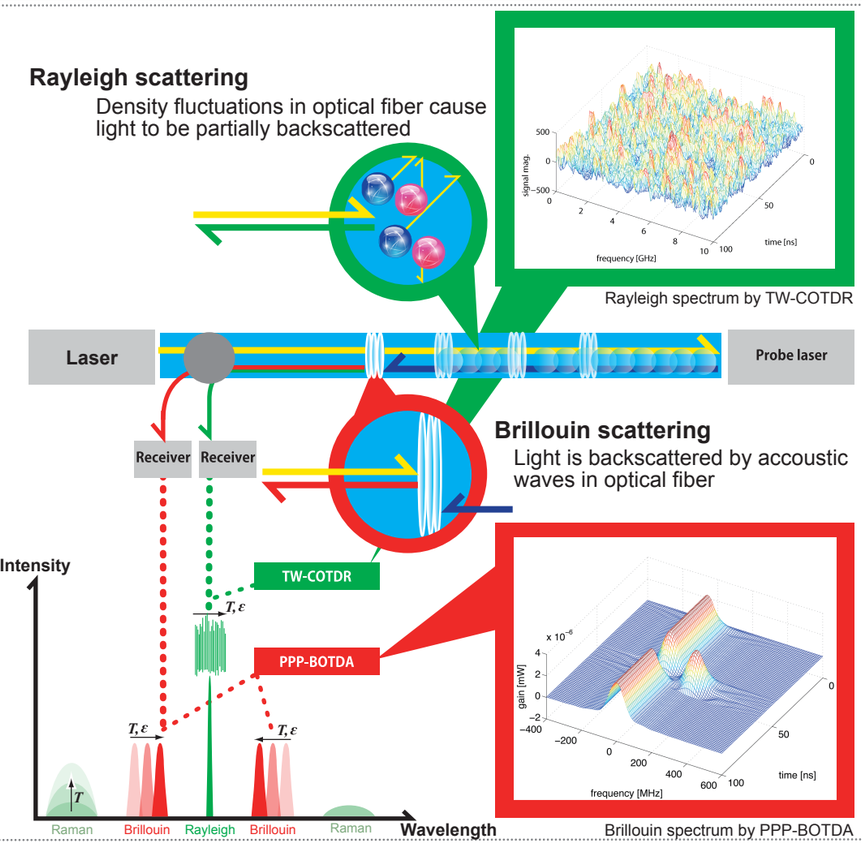
NEUBREX®




## Key features

- First ever, hybrid technology combining Brillouin and Rayleigh backscatterings in single system
- Measurement of strain and temperature at each point in any single mode optical fiber
- Identification and separation of strain and temperature changes

## Principles of PPP-BOTDA and TW-COTDR




The NBX-7000 hybrid sensing system combines advantages of both Brillouin and Rayleigh backscattering phenomena. The Brillouin sub-system employs the breakthrough technology of Pulse Pre-Pump Brillouin Optical Time Domain Analysis (PPP-BOTDA) while the Tunable Wavelength Coherent Optical Time Domain Reflectometry (TW-COTDR) is used in Rayleigh sub-system. For standard, single-mode fiber the hybrid system provides frequency shifts for Brillouin and Rayleigh scatterings. As both shifts are function of strain and temperature, their separation is required. It removes the influence of temperature on strain, and vice versa, and allows one to obtain pure strain and temperature values.

## Strain and temperature separation equations

$$\Delta\varepsilon = D_{11}\,\Delta\nu_B + D_{12}\,\Delta\nu_R$$

$$\Delta T = D_{21}\,\Delta\nu_B + D_{22}\,\Delta\nu_R$$

where
$\Delta\varepsilon$ : strain change
$\Delta T$ : temperature change
$\Delta\nu_B$ : frequency shifts for Brillouin scattering
$\Delta\nu_R$ : frequency shifts for Rayleigh scattering
$D_{11}/D_{12}$ : strain-frequency coefficients for Brillouin and Rayleigh scattering
$D_{21}/D_{22}$ : temperature-frequency coefficients for Brillouin and Rayleigh scattering

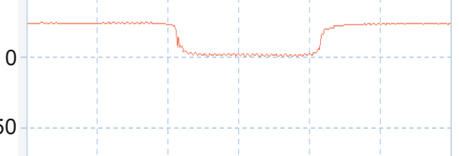
## Software

NeubreScope NBX-7000 is equipped with specialized software, for performing measurements (NeubreScope GUI) and advanced data analysis (Neubrex Advanced Data Analysis Studio). Main features include:

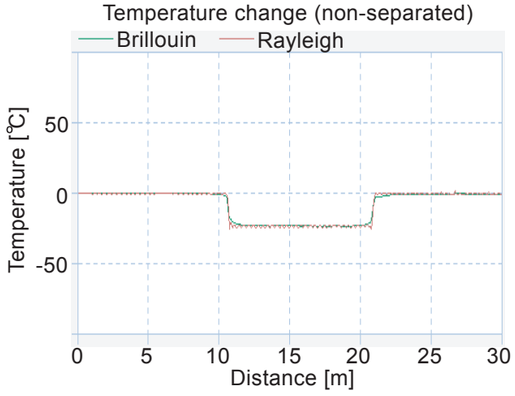
- Position and lengths adjustments of the fiber for valid comparison and trend analyses
- Filtering, offset removal, and regions mapping functionality
- Open Architecture (OA), allows user to customize, automate, and extend the standard capabilities of the software

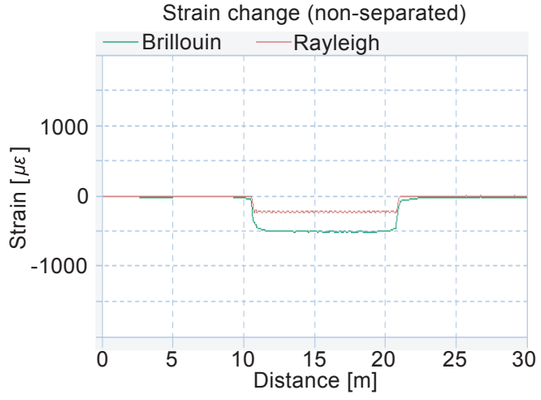
## Measure and separate strain and temperature

Application example




Experiment setup
(1) Temperature inside chamber: 0℃
(2) Temperature outside: 26℃
(3) No strain changes applied.




Using Brillouin or Rayleigh scattering only, it is impossible to determine whether measured frequency shift is due to change in strain and/or temperature (upper figures). The NBX-7000 provides clear and definite answer by separating their influence on frequency shift (lower figures).