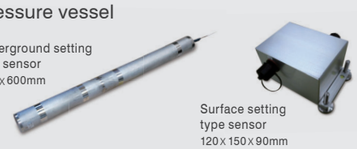
Performance specifications

Optical sensor seismic monitoring system

Accelerometer

Pressure vessel

Underground setting type sensor
60ϕ x 600mm



Surface setting type sensor
120 x 150 x 90mm

Accelerometer	
Sensor type	Optical interference accelerometer
Detection direction	2 horizontal directions, 1 vertical direction
Sensor characteristics	Resonance frequency 100Hz±4Hz, 30Hz±3Hz
Damping coefficient	0.7±0.2, 0.7±0.2
Measurement range	More than ±8G, More than ±2G
Operating temperature	Standard 85°C For high temperature 150°C
Operating pressure	Depends on the individual housing design

Optical transmitter / receiver	
A laser wavelength	1550nm
Measurement time	15ns or 30ns / sample
Measurement cycle	1uS±0.01uS
Laser output level	More than +7dBm
Number of connectable sensors	Up to 20 sets for a 3-component sensors, 60 for individual sensors
Sampling frequency	100Hz or 200Hz
Resolution	0.12mGal (100Hz sensor) 0.011mGal (30Hz sensor)
Time synchronization method	GPS or NTP
Recording method	Continuous recording / Triggered recording
Measurement Output	Maximum acceleration, instrumental seismic intensity, SI value
Data format	win format
Recoding media	2TB HDD Constitution

Fiber optic cable	
Optical fiber	Single mode fiber
Operating Temperature	Standard 85°C For high temperature 200°C

* Specification and design specified in this catalogue are subjected to change without notice.
* The content of this catalogue is as of April, 2023.

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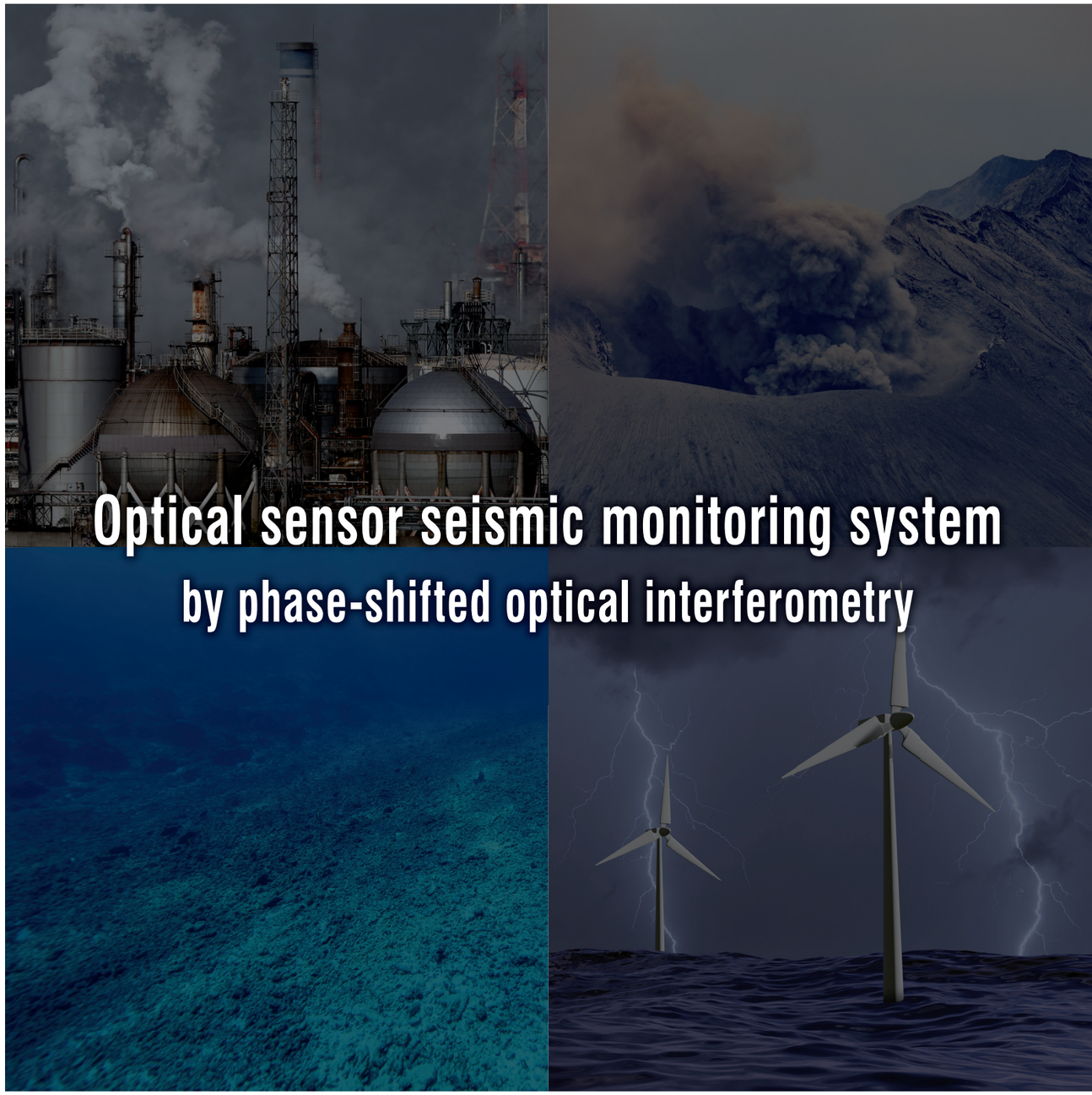
TEPCO

Seismic monitoring system for harsh environment
(No semiconductor devices in sensors)



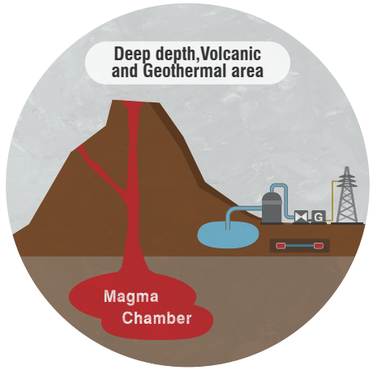
Tokyo Power Technology

HAKUSAN

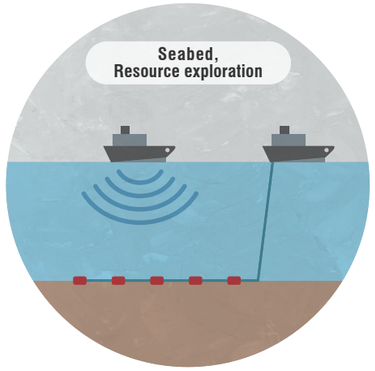
Seismic observation in harsh environments

High-precision seismic observation is possible under the harsh environment, places where power cannot be supplied, high temperature where electronic devices do not operate and oil and gas field where explosion proof devices are required.

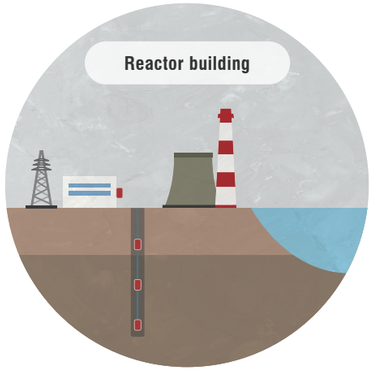
Seismometer — Fiber optic cable



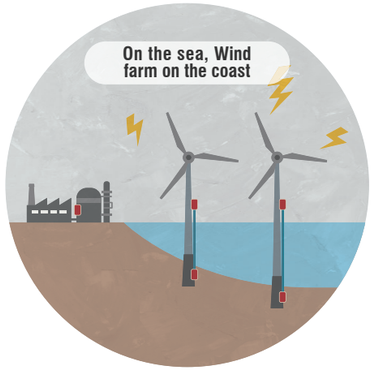
Under high temperature environment



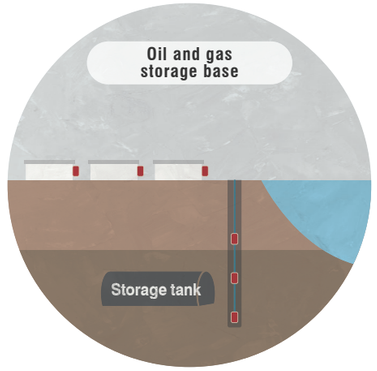
Difficult to supply power



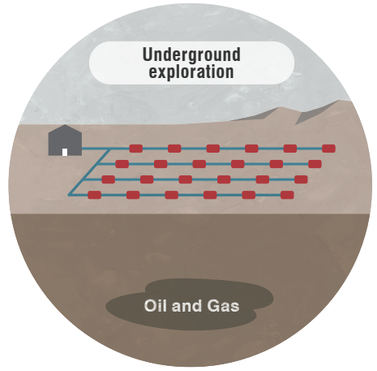
Under high radiation dose, Under high temperature environment



Thunder spots, Difficult to maintain



Explosion-proof location

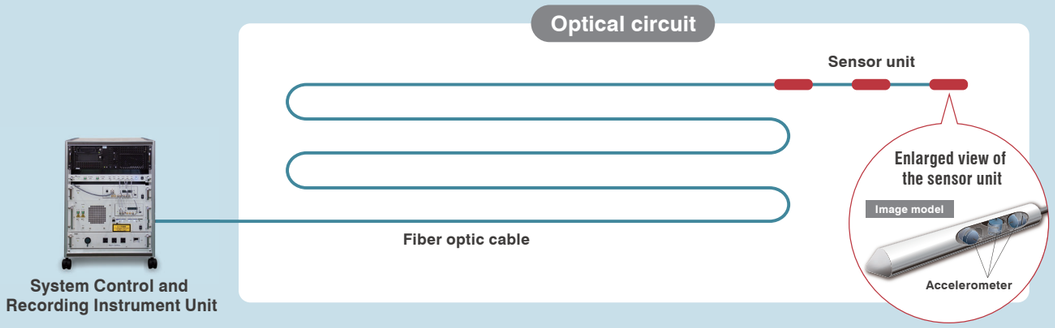


Long distance, Wide area

Features

The phase-shifted optical interferometry enables highly accurate* seismic observation without power supply to the sensor.

- No power supply or electronic components required (from the fiber optic cable to the sensor)
- High temperature resistance, high pressure resistance, lightning resistance, explosion proof, radiation resistance
- Long-distance / wide-range observation
- Long-term stable operation in the field
- Shortening the construction period and reducing costs

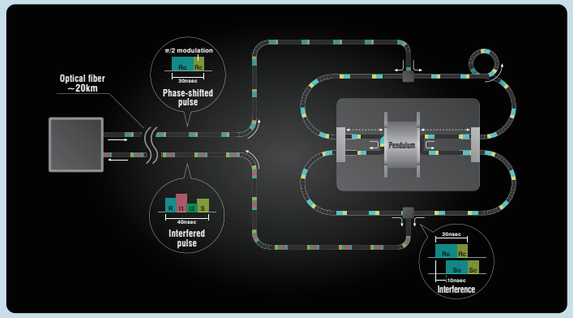


*In a comparison of microtremor observation conducted in a quiet place, the same high sensitivity and low noise as the electric broadband seismometer were confirmed.

Phase-shifted optical interferometry

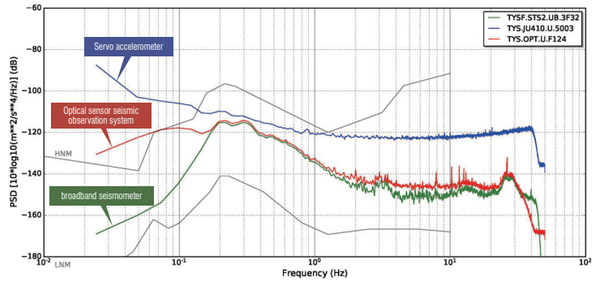
Optical interferometer can measure a very small distance change. However usual interferometer has only a half (1/2) wavelength of measurement range. Our patented phase shifted optical interferometer extends the range of up to thousands of wavelengths.

【Related Patents】
Patent number 5118004: Optical fiber sensor
Patent number 5118246(U.S. patent number 9273948): Optical fiber sensor
Patent number 5702623: Optical fiber sensor
(The phase of the reference light is shifted by π / 2.)
Patent number 6002329: Optical interference sensor and observation system



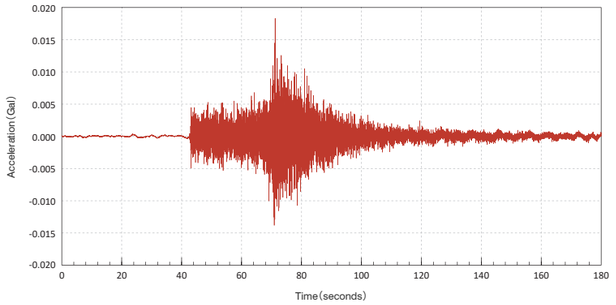
Observation results

Noise level comparison between optical interference sensor, broadband seismometer and servo accelerometer.



Noise spectra of an optical sensor seismic observation system, a servo accelerometer, and a broadband seismometer observed at the Tono Yamazaki Observatory of Tohoku University in Japan.
As the broadband seismometer is a velocity seismometer, the record of the broadband seismometer is differentiated and converted to acceleration. The optical sensor seismic observation system observes the ground motion of the observation tunnel from 0.1Hz to 30Hz, similar to the broadband seismograph. The noise level of the servo accelerometer is higher than that of the optical sensor seismic observation system and the broadband seismometer.

Observation example of a small earthquake



Waveform of the vertical component of the earthquake observed by the optical sensor system at the Tono Yamazaki Observation Tunnel of Tohoku University around 0:16 am on December 18, 2019.
The waveform with the maximum amplitude of 0.02 Gal is clearly captured.