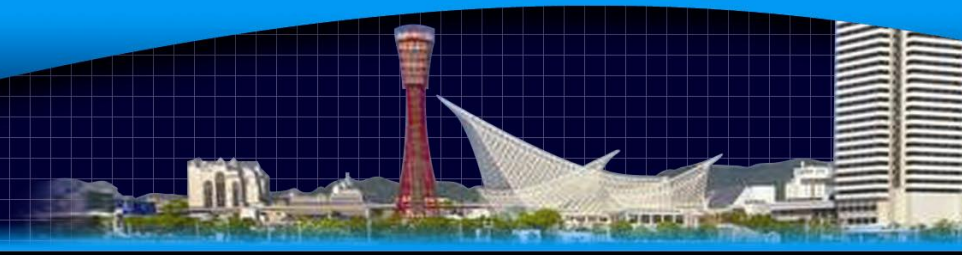
Dr. KINZO KISHIDA



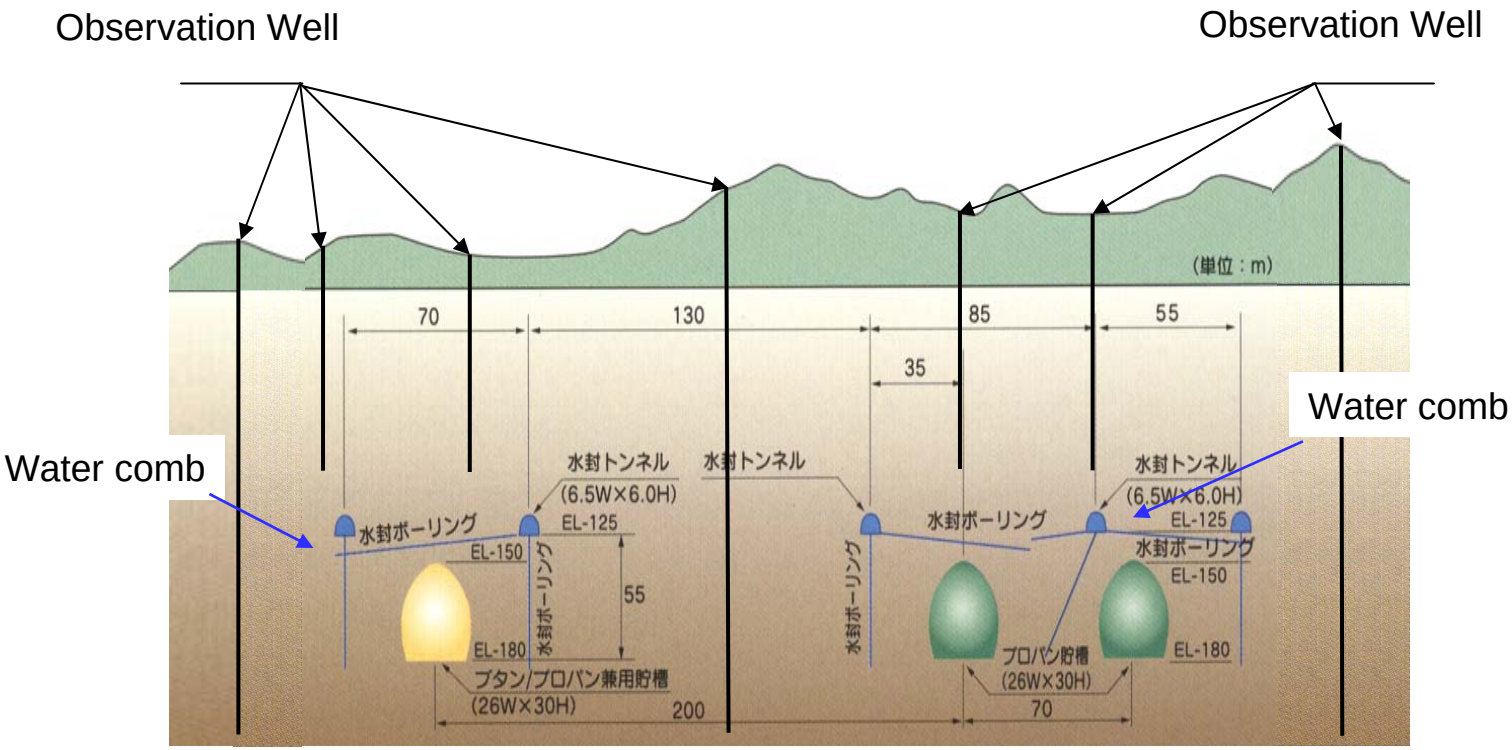
Neubrex Co., Ltd Kobe , Japan

Distributed Pressure System (DPS) Based on High Precision Brillouin Sensing Technology

- *High resolution is absolutely necessary for high precision*
- *Temperature and Strain*
- *Totally SM fiber scheme leads to economic, stable, long distance solution*
- *Fiber cable is the system – it is the sensor, is the communication line, is all you need*

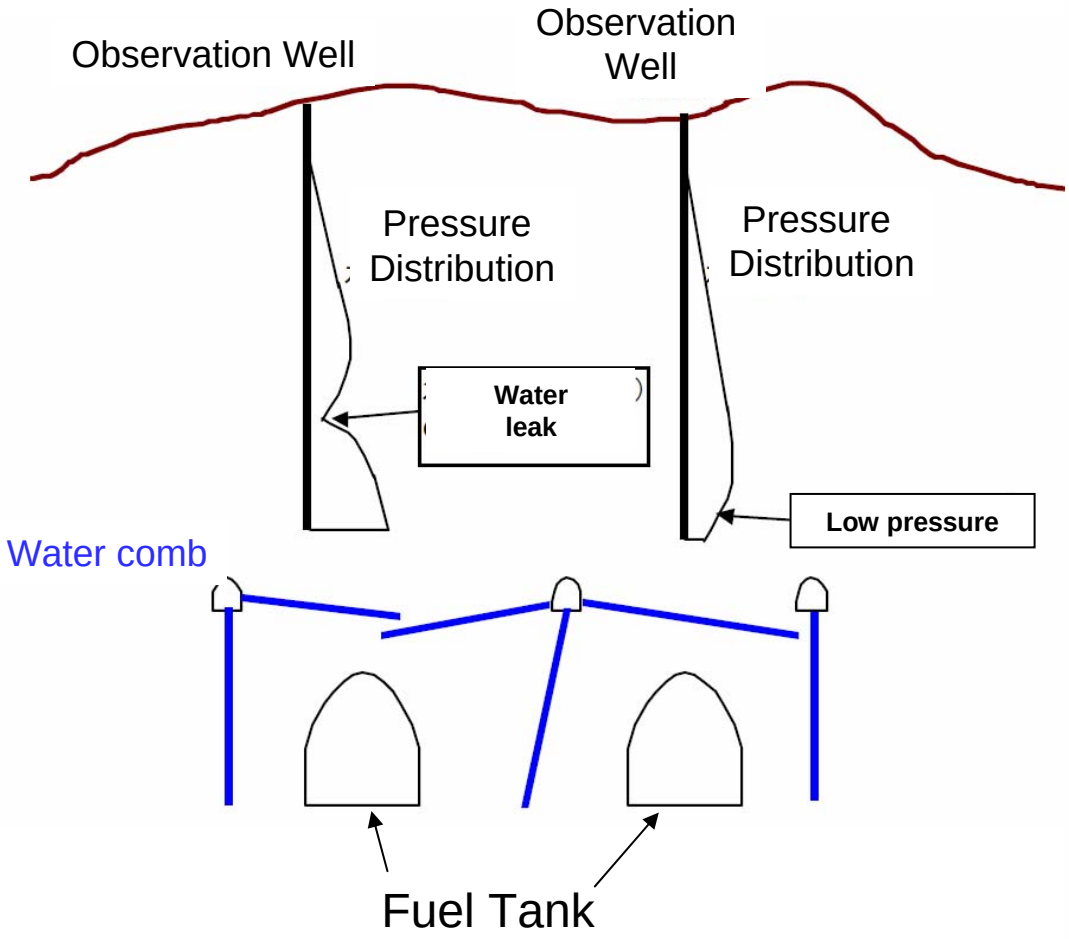
NEUBREX

Underground Fuel Storage Sealed by Water

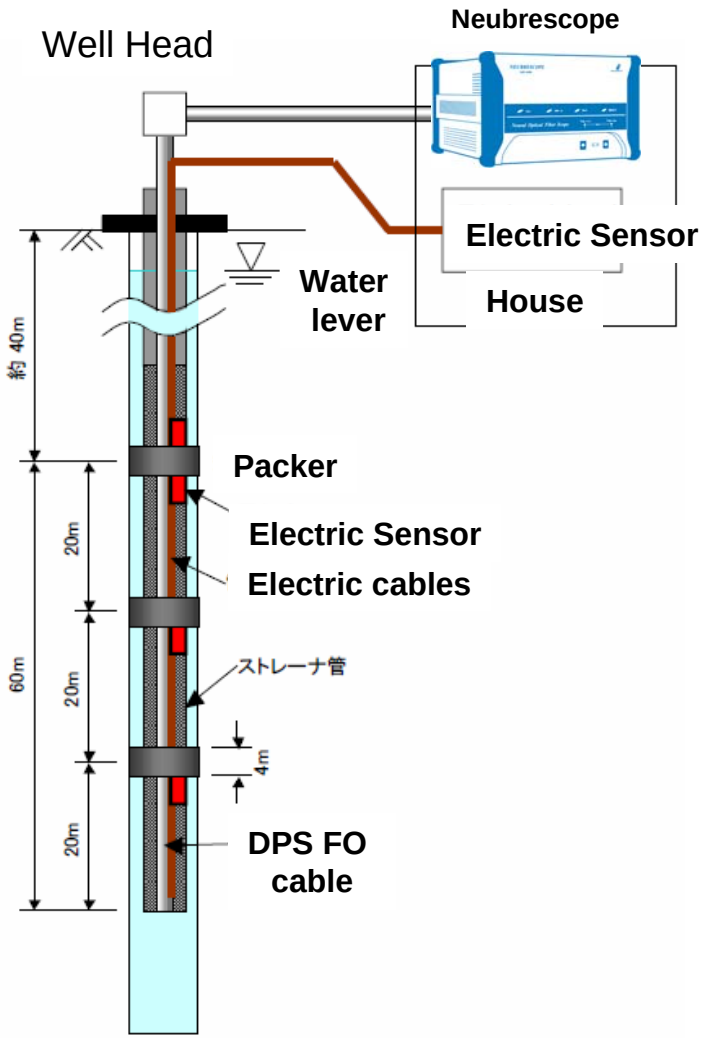


Pressure of underground water will seal the fuel in liquid phase for long time.
As long as the water is exist, The storage is safe

Reaction of DPS in water pressure monitoring

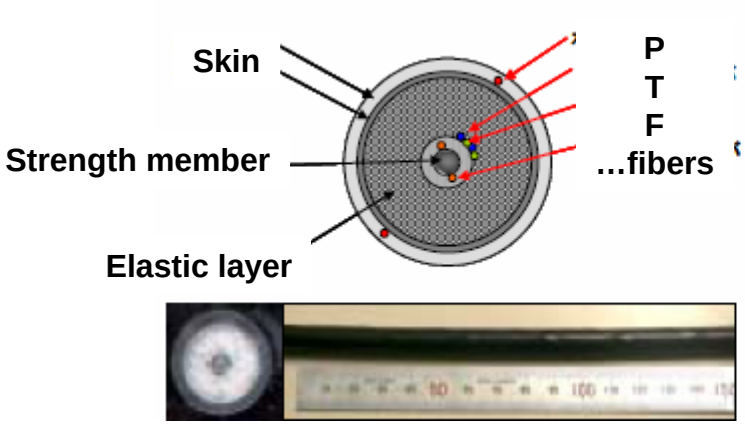


Principle

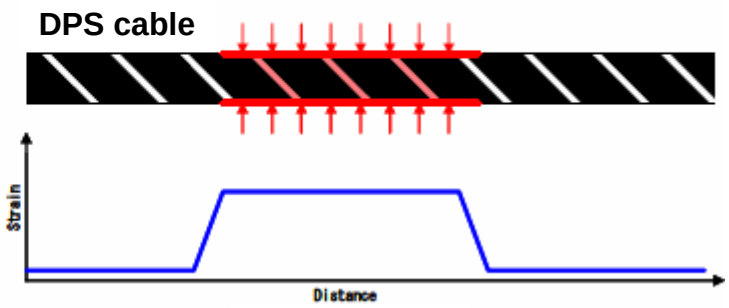


Field Test Plan

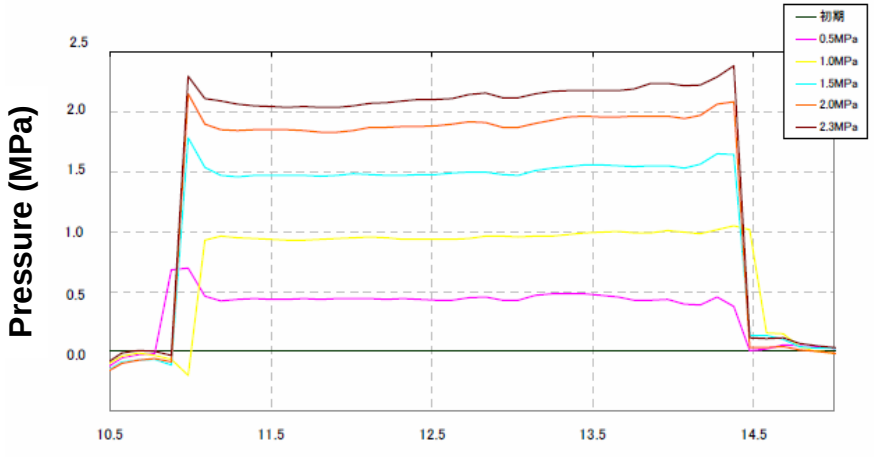
DPS design and lab calibration



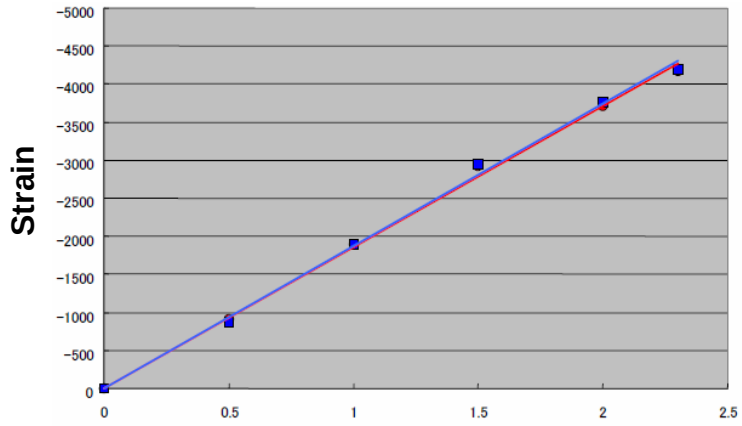
Size



Action image

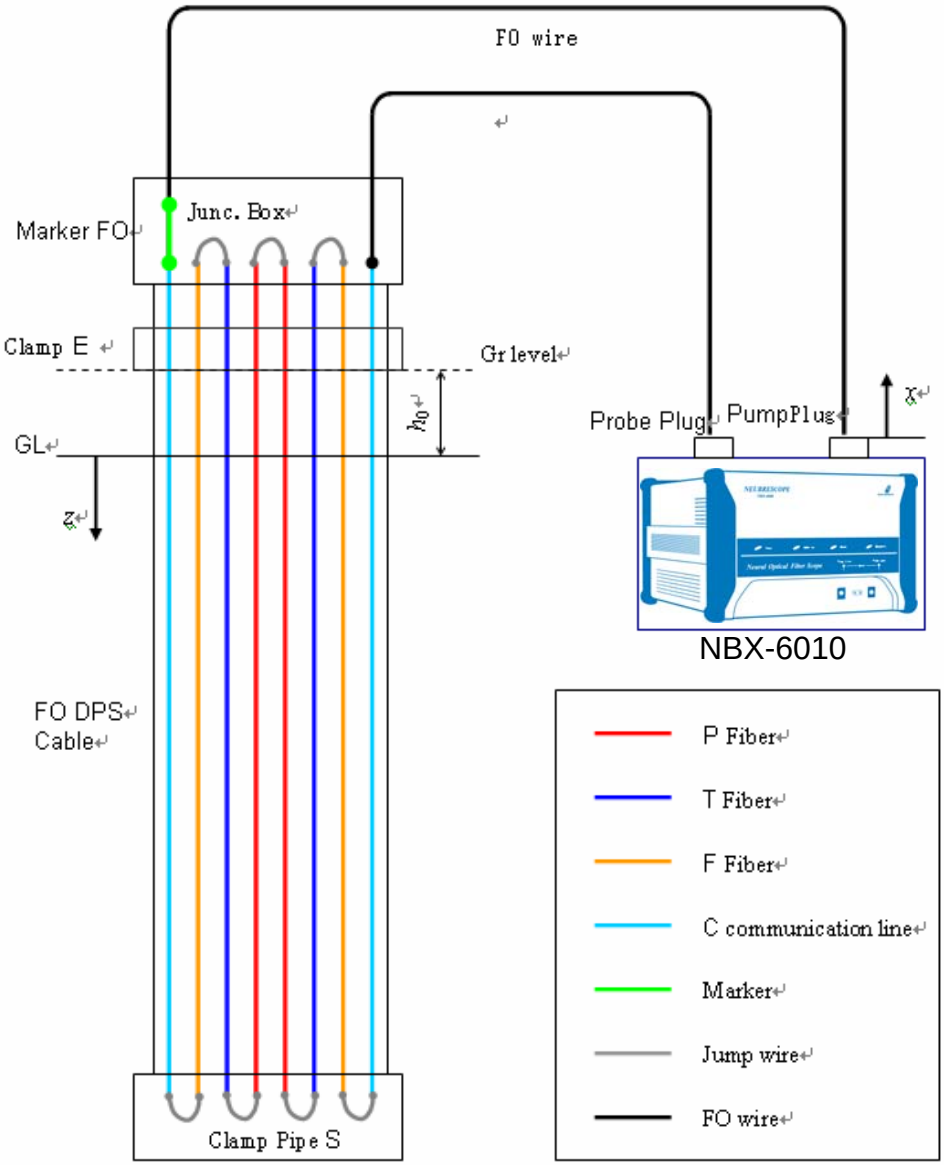


Position

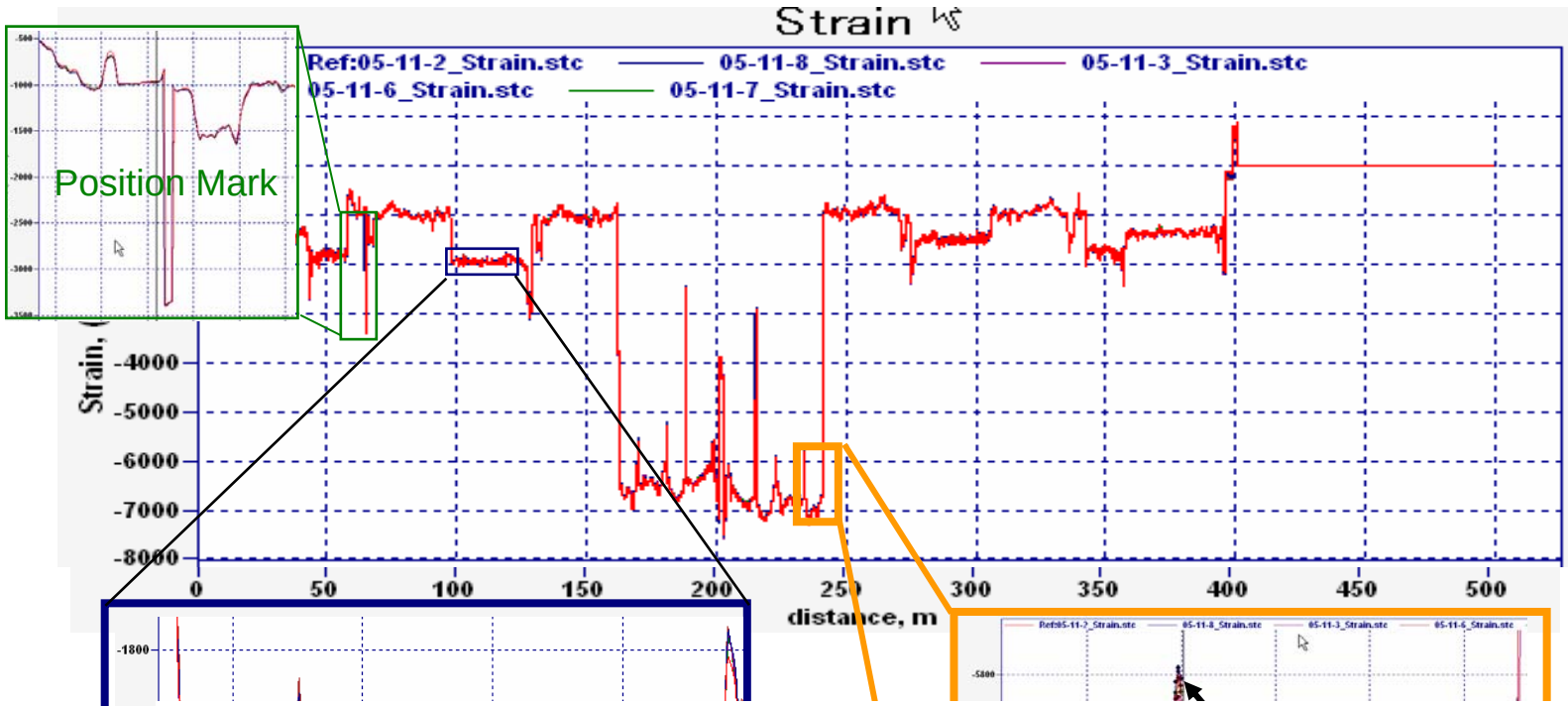


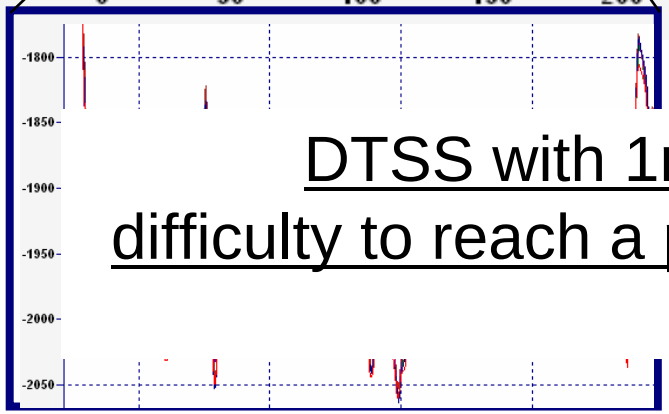
Pressure (MPa)

Whole SM Fiber Optical Scheme

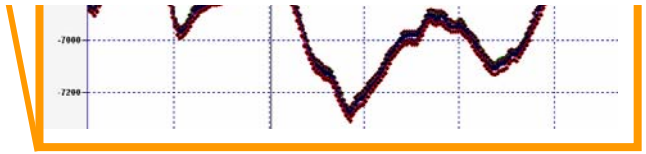


10cm may be the essential request for DTSS





Ripple of period about90cm, 150$\mu\varepsilon$



DTSS with 1m spatial resolution is difficulty to reach a precision of 100$\mu\varepsilon$ (*i.e. 5℃*)

GUI DEMO

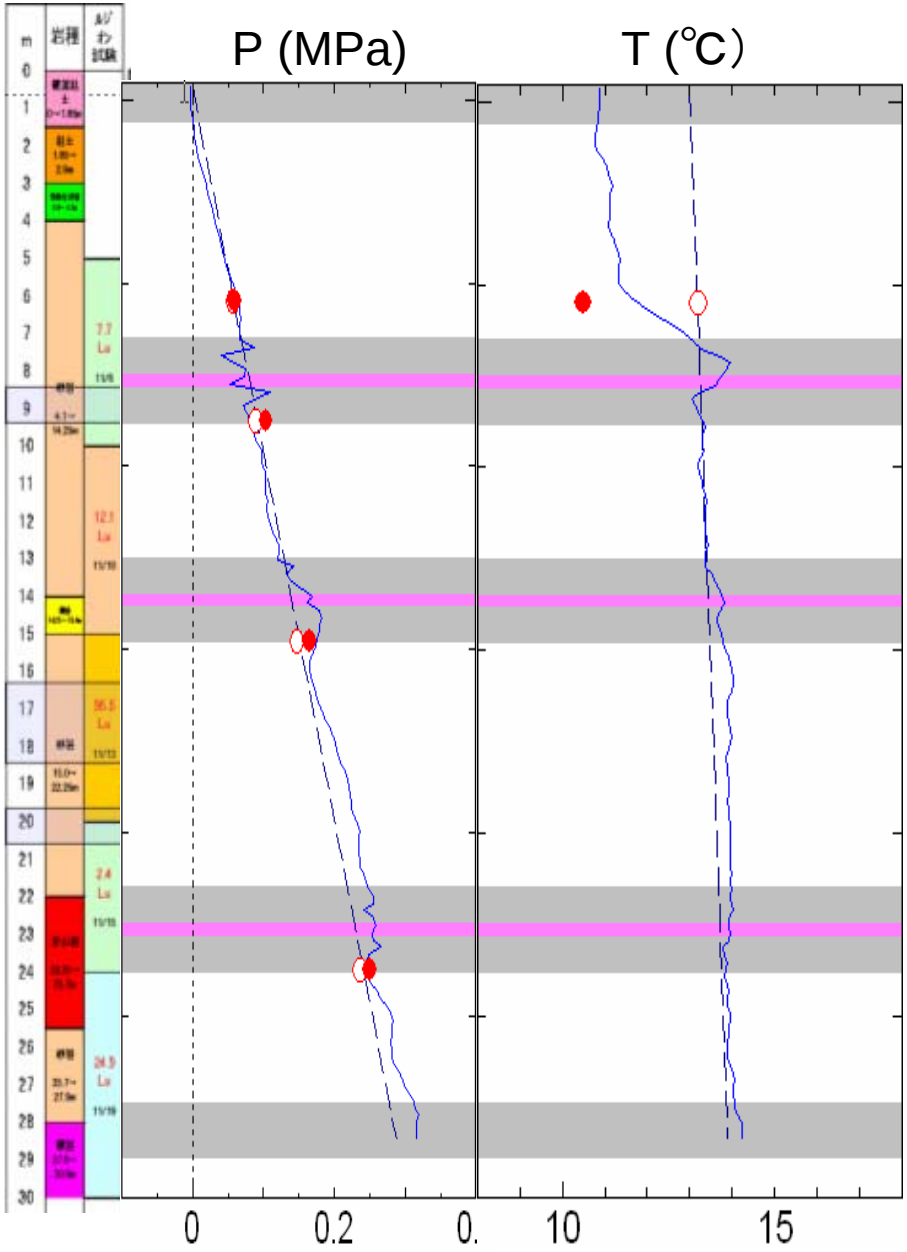
Field Test

DPS Cable Bobbin

Installation

Extend to building

Field Test Results



DPDT＝

Distributed Pressure and Distributed Temperature System

Spec:

Max. Pressure Range: 2MPa (200m)

Max. temperature : 45 (℃)

Pressure precision : ±0.01MPa (1m)

Application:

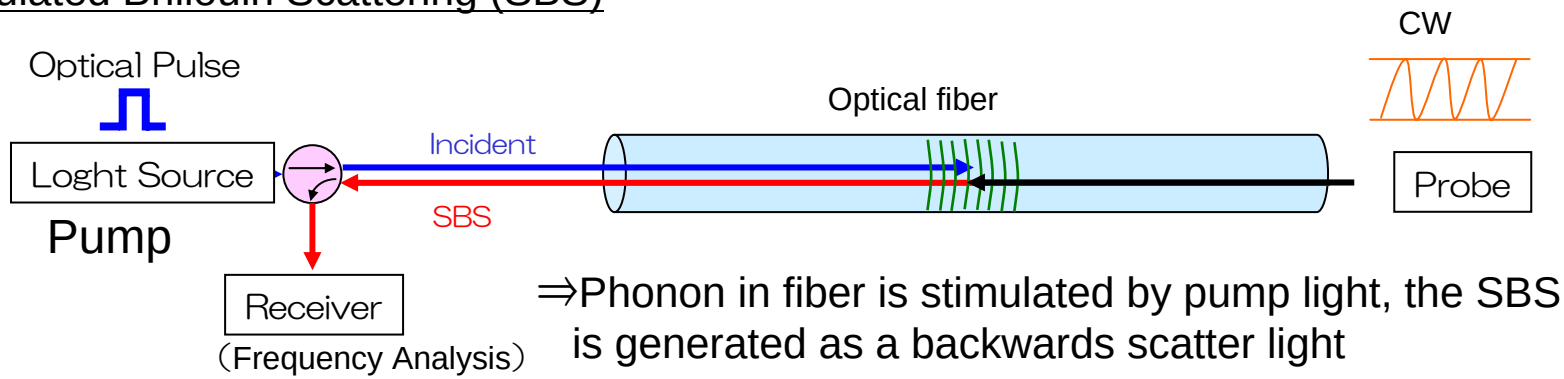
Underground Storage of fuel

EPS

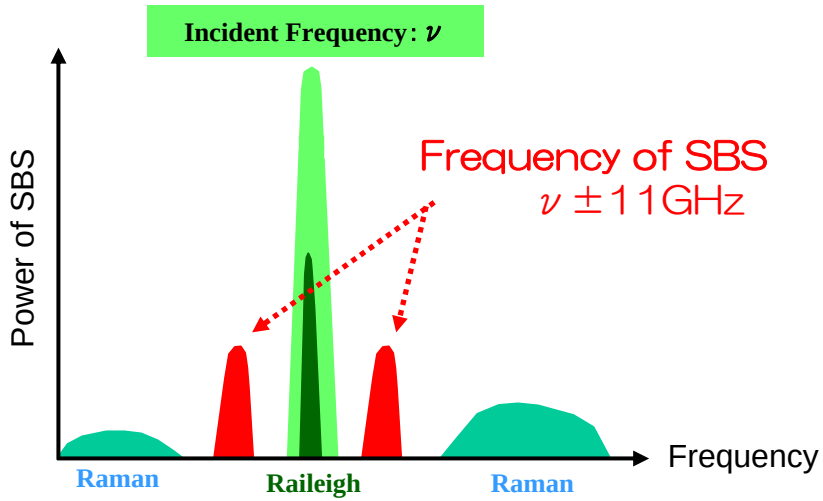
Dam

Principle

■ Stimulated Brillouin Scattering (SBS)

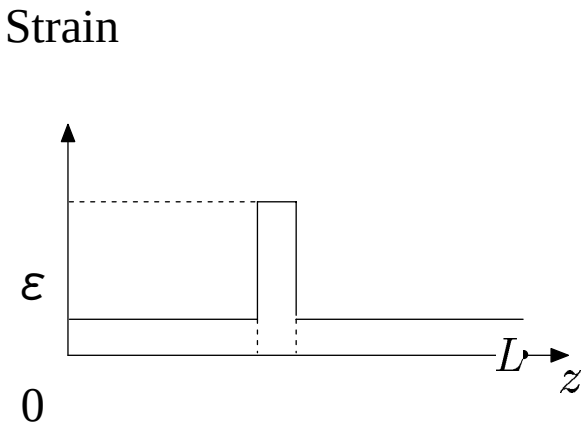


⇒Phonon in fiber is stimulated by pump light, the SBS is generated as a backwards scatter light

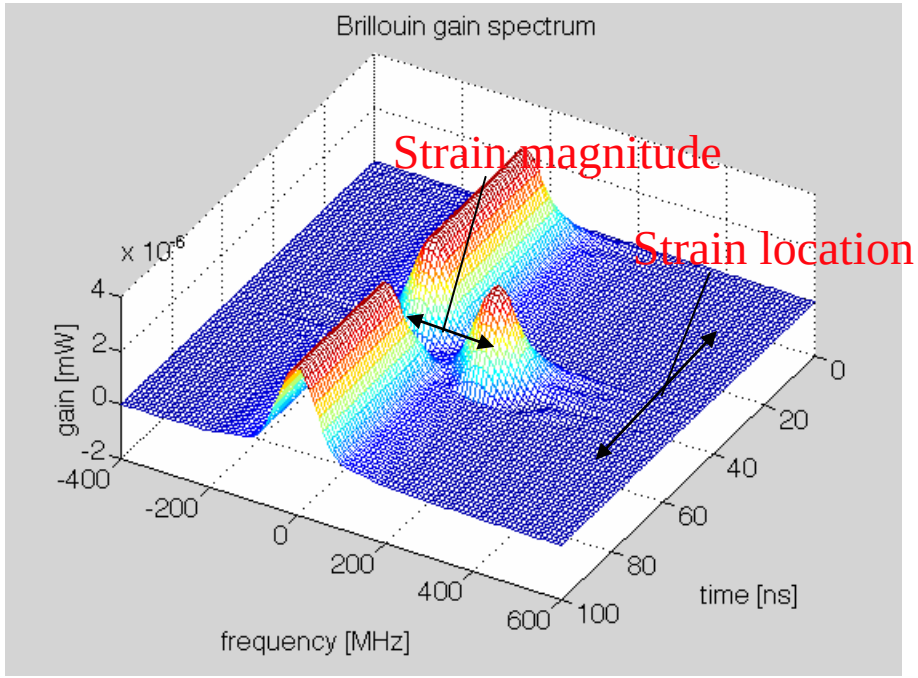


Contents of back scattering

Peak of local frequency represent the magnitude of strain (temperature)



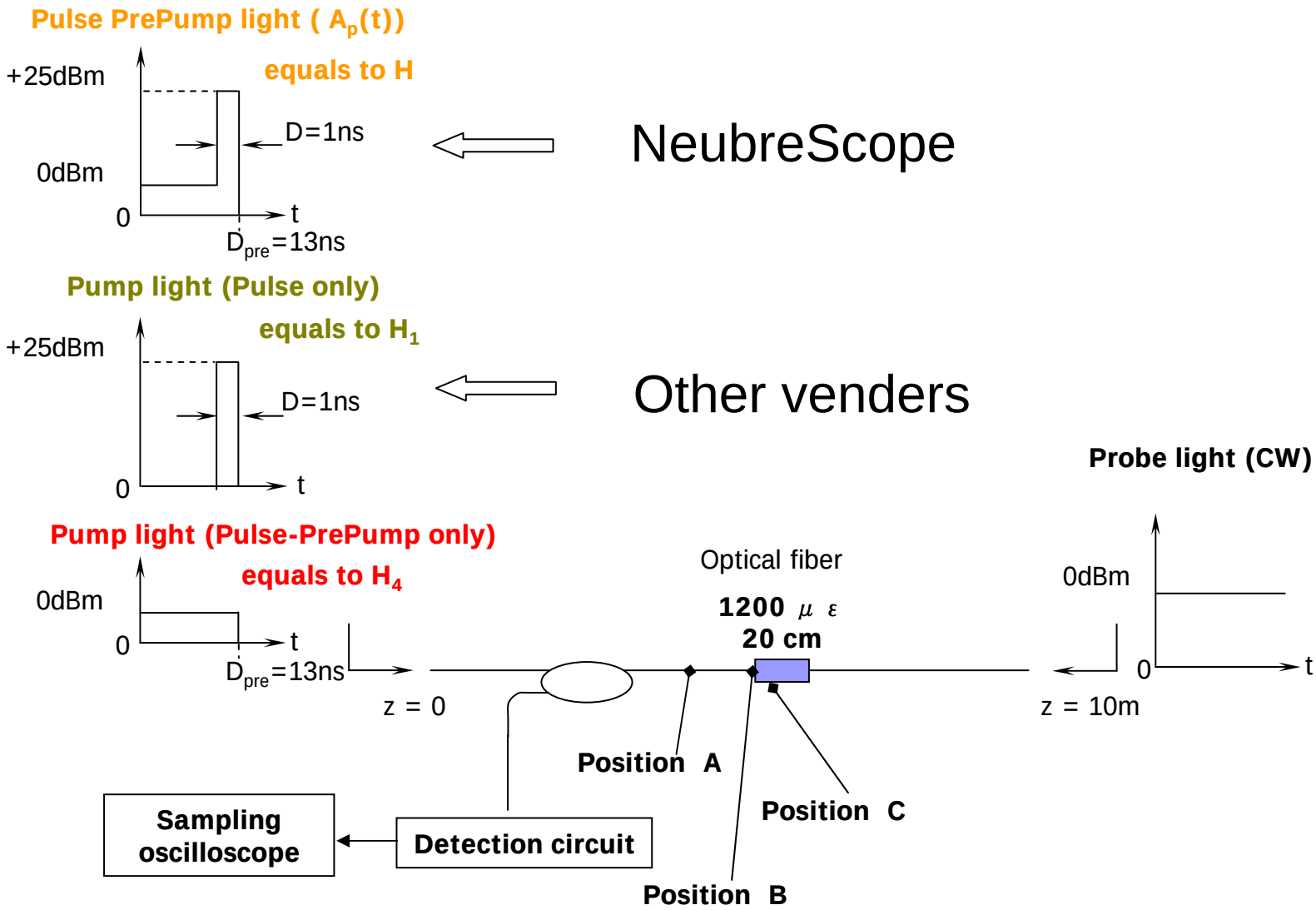
Strain Distribution



Brillouin Gain Spectrum (BGS)

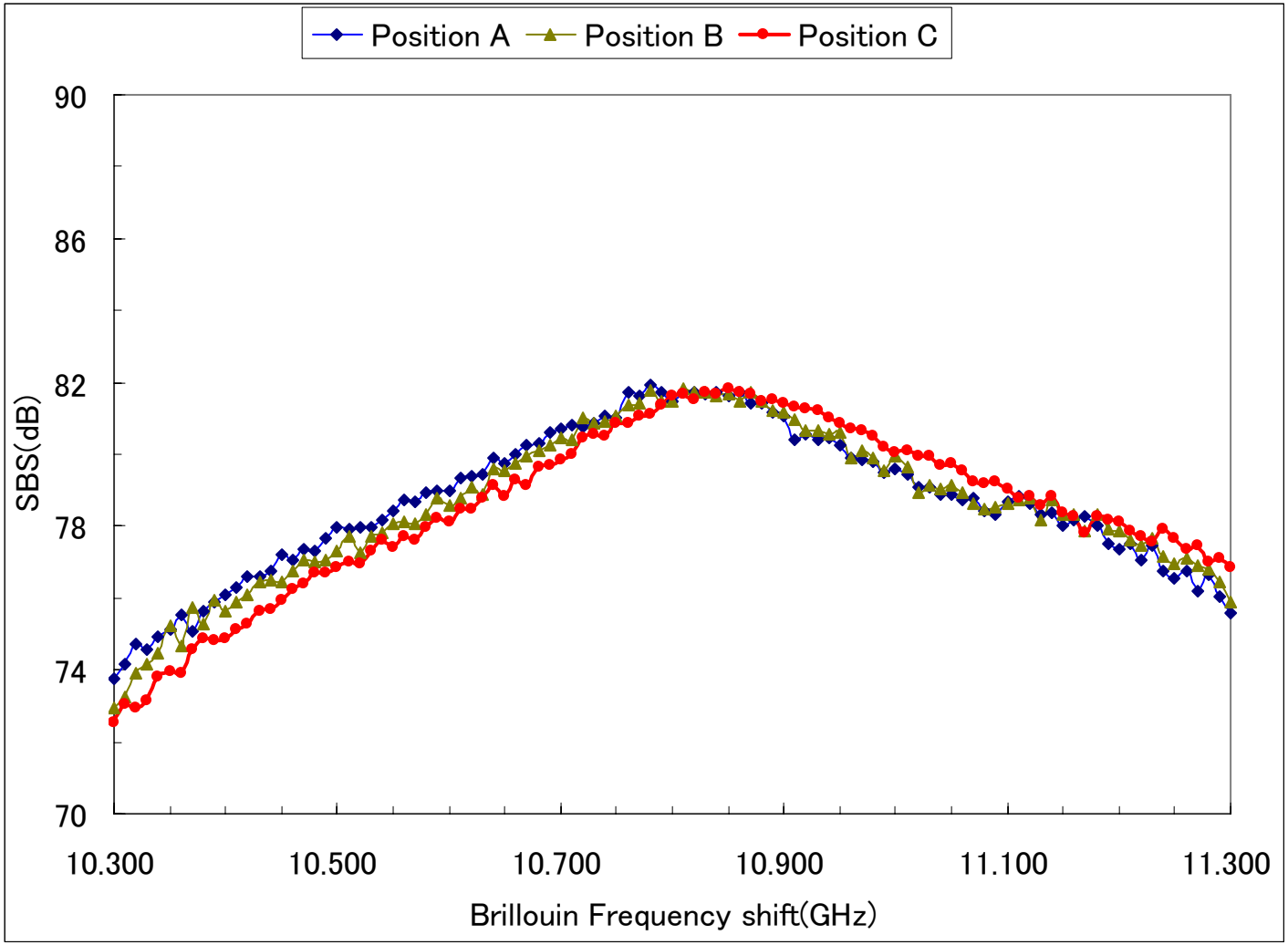
Spatial Resolution (SP) is decided by the length of pump pulse

NeubreScope Based on PPP technology



Spectrum by Simple Pulse Pump

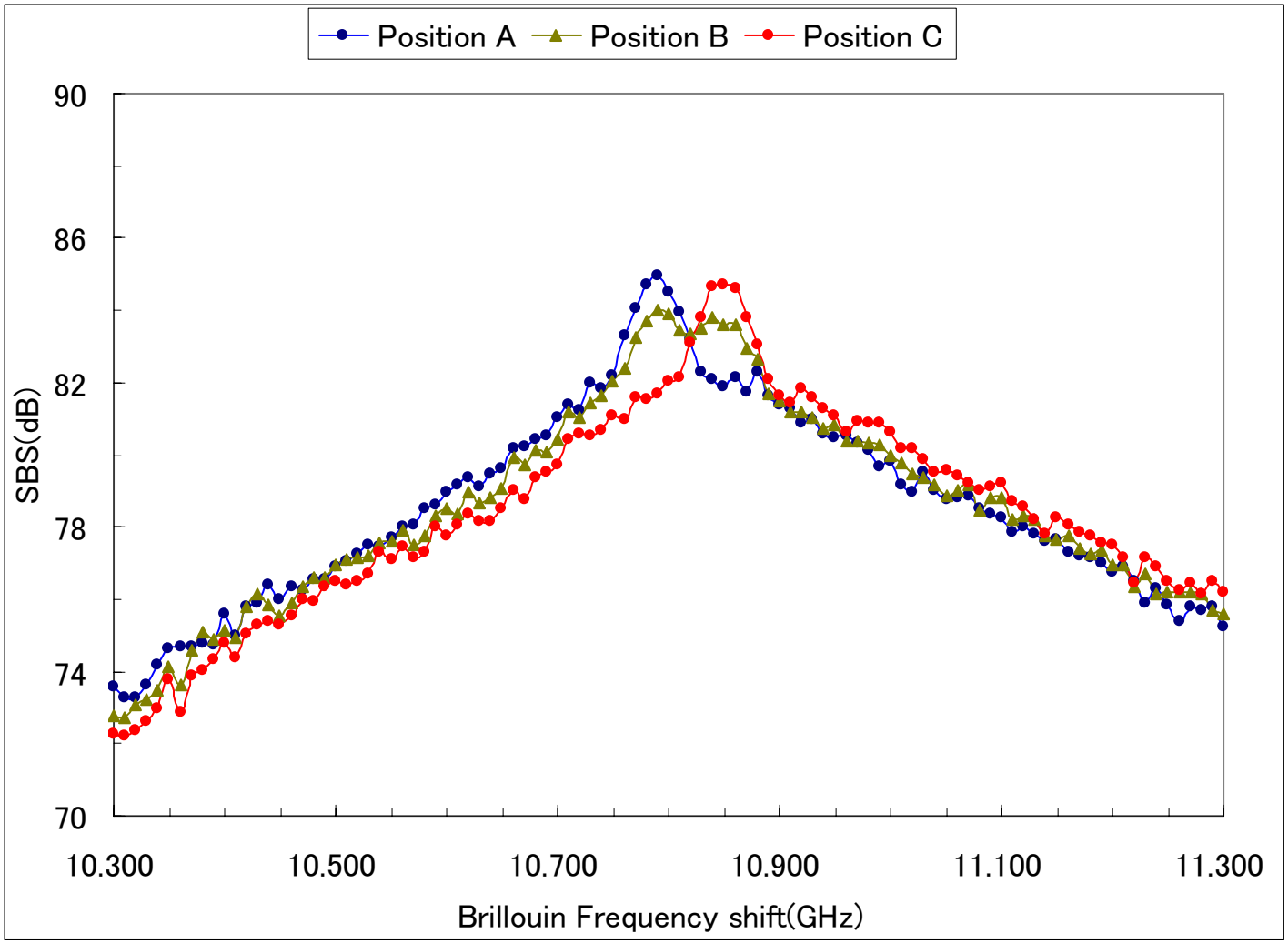
Sampling interval: 10 MHz



Spectrums at all positions (pulse light only)

Spectrum by Pulse PrePump

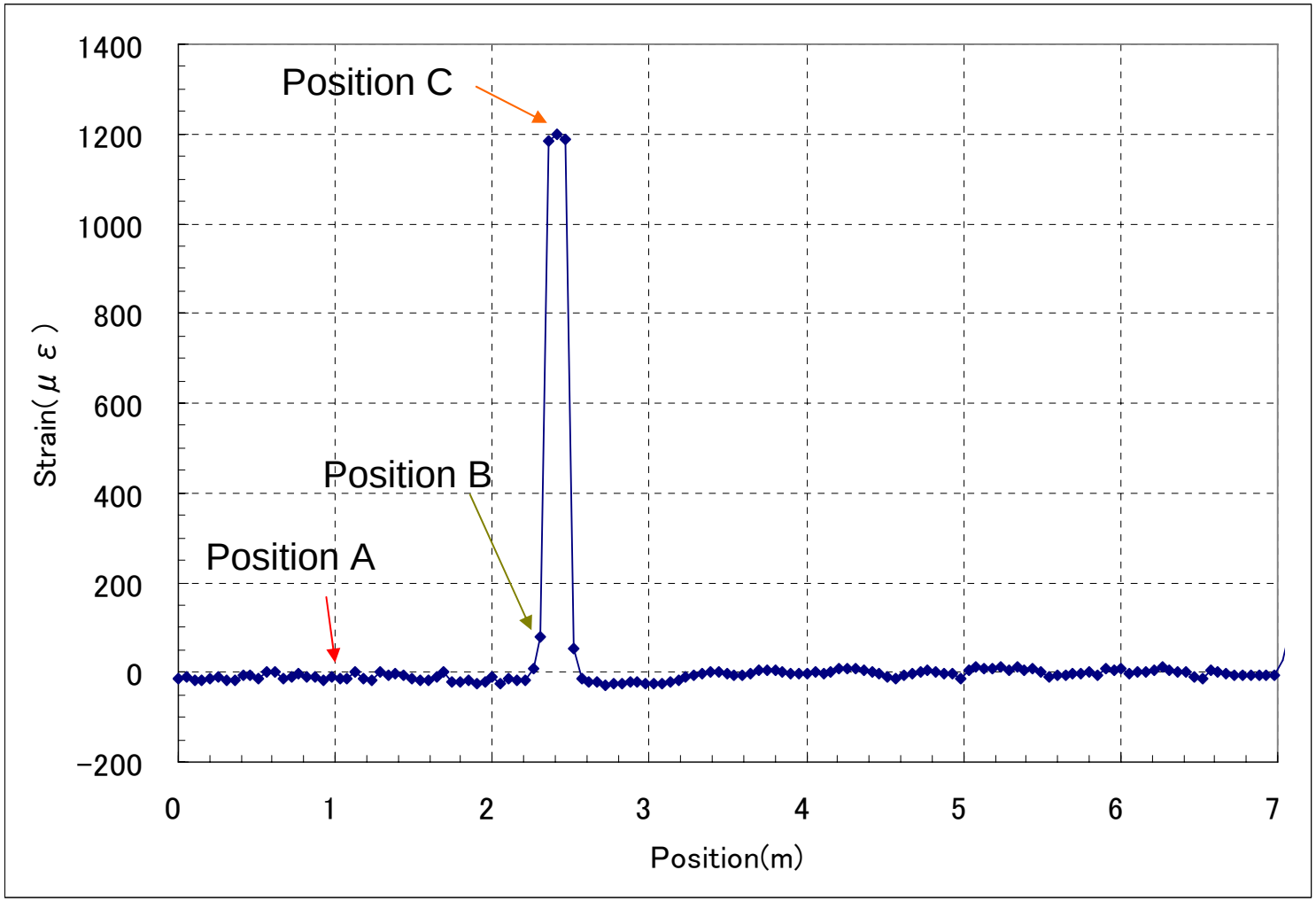
Sampling interval: 10 MHz



Spectrums at all positions (step pulse light)

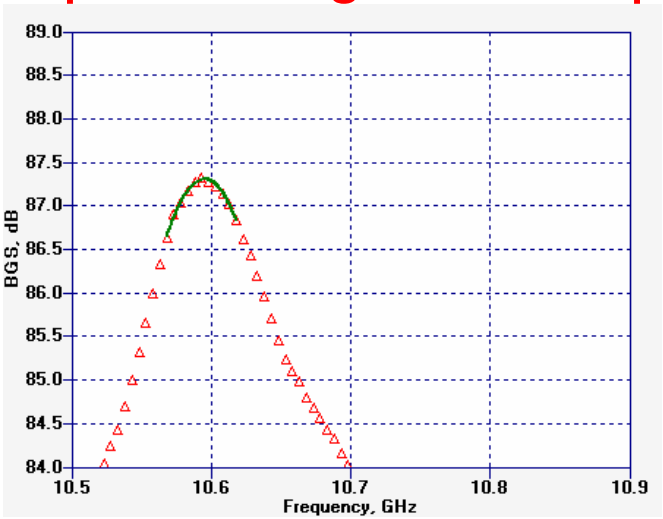
Strain distribution obtained by PPP

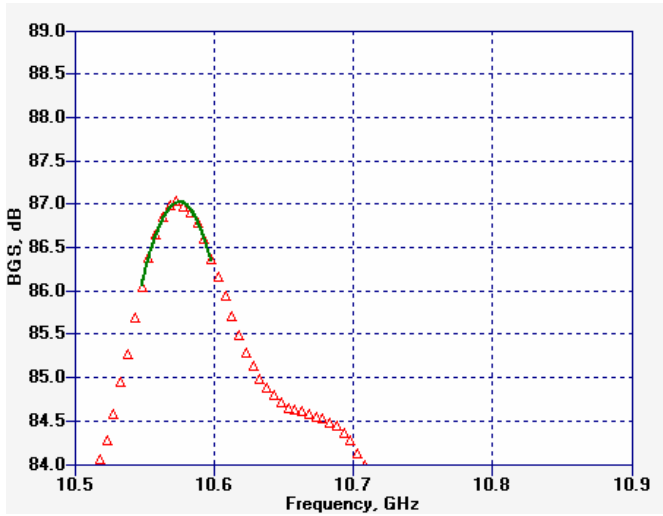
Sampling interval: 5 cm



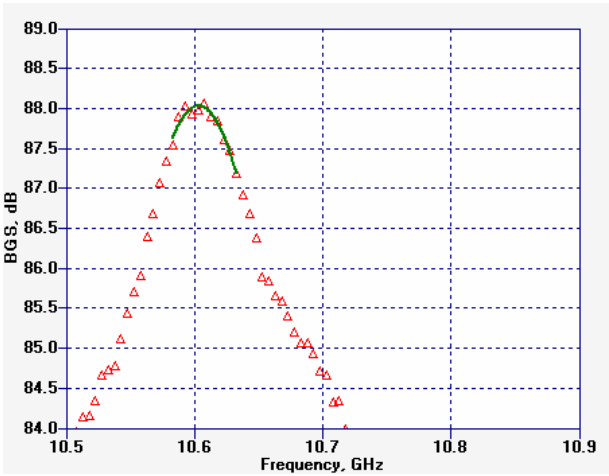
Calculated strain values (from BGS spectrum)

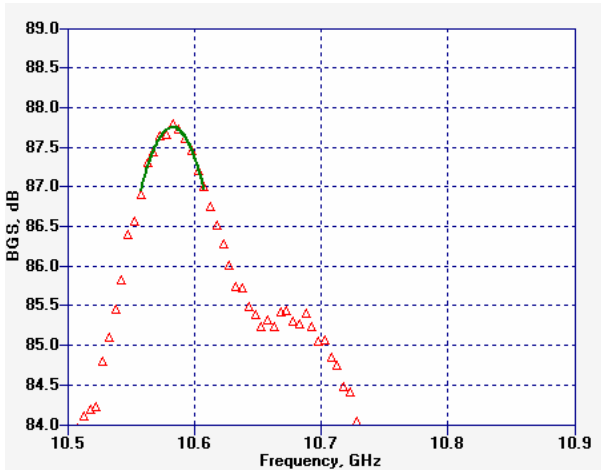
To Achieve request of DPS, High quality signal processing is developed





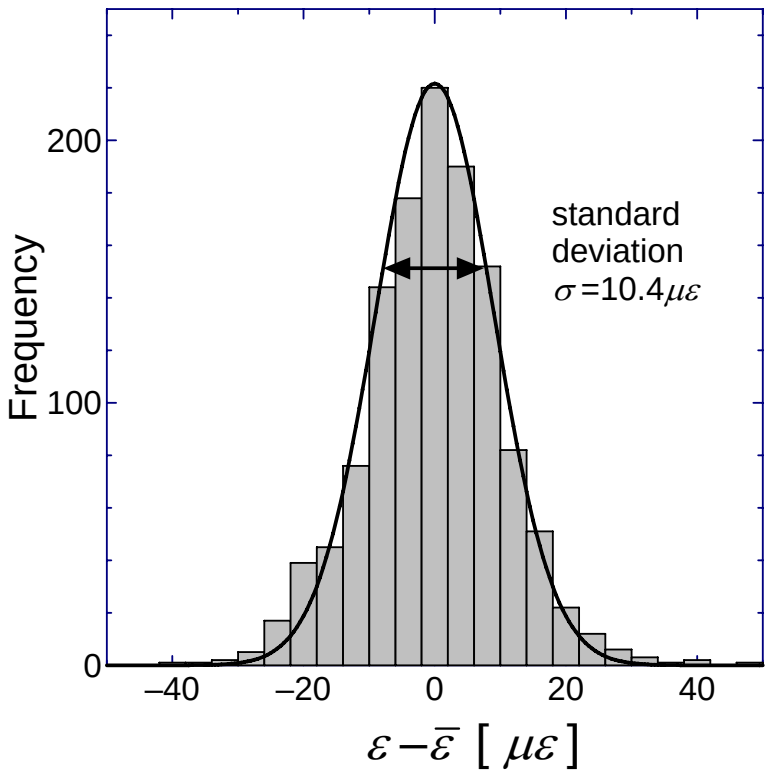
High quality signals examples



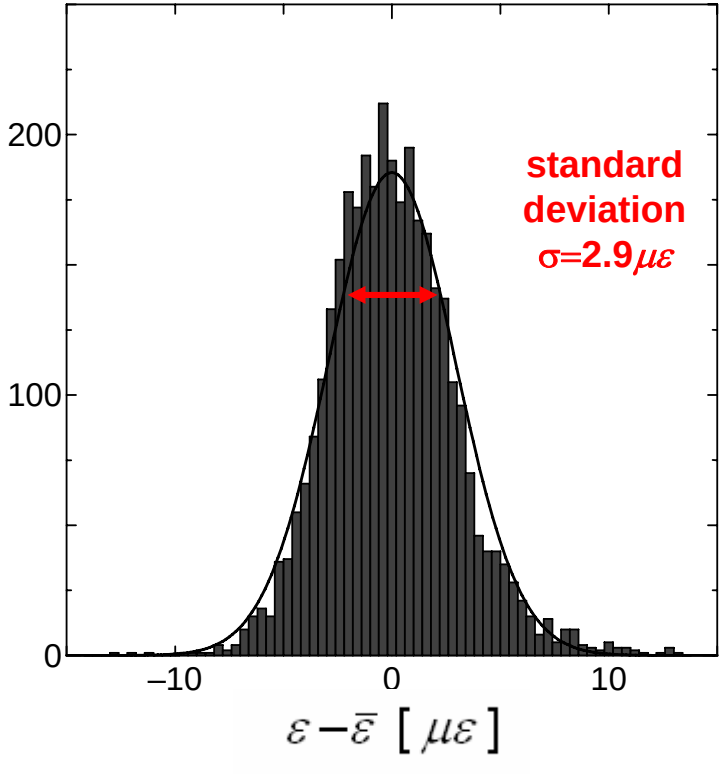


Previous quality signals by NBX-6000

Progress Measured by Repeatability



NBX-6000

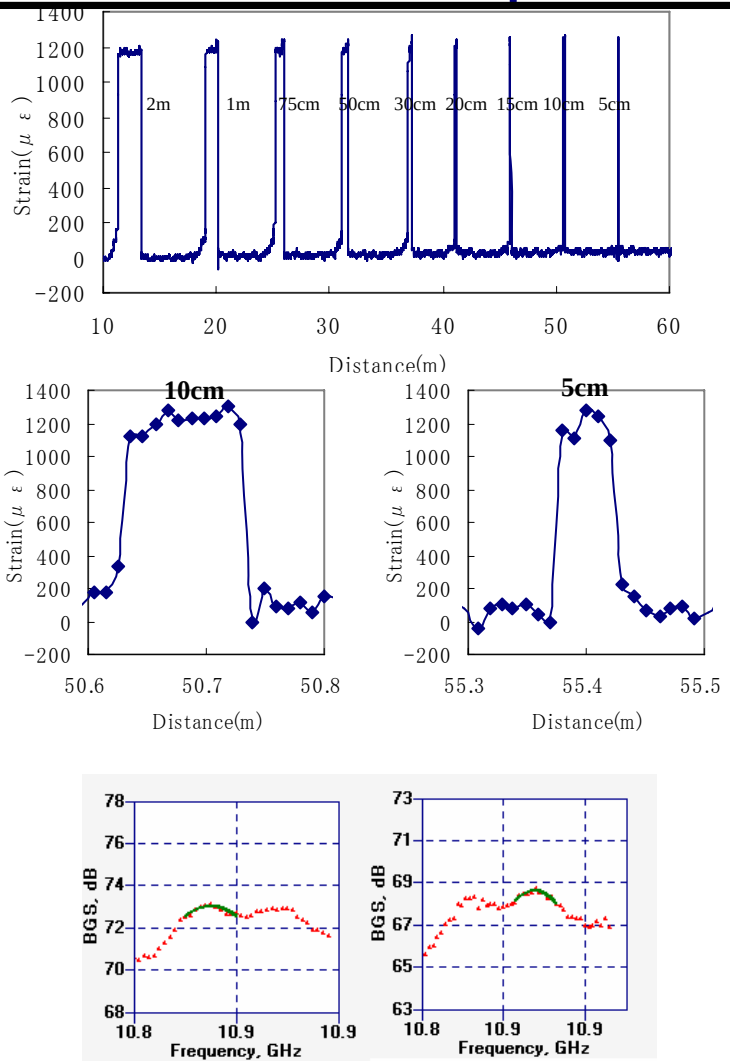


NBX-6010

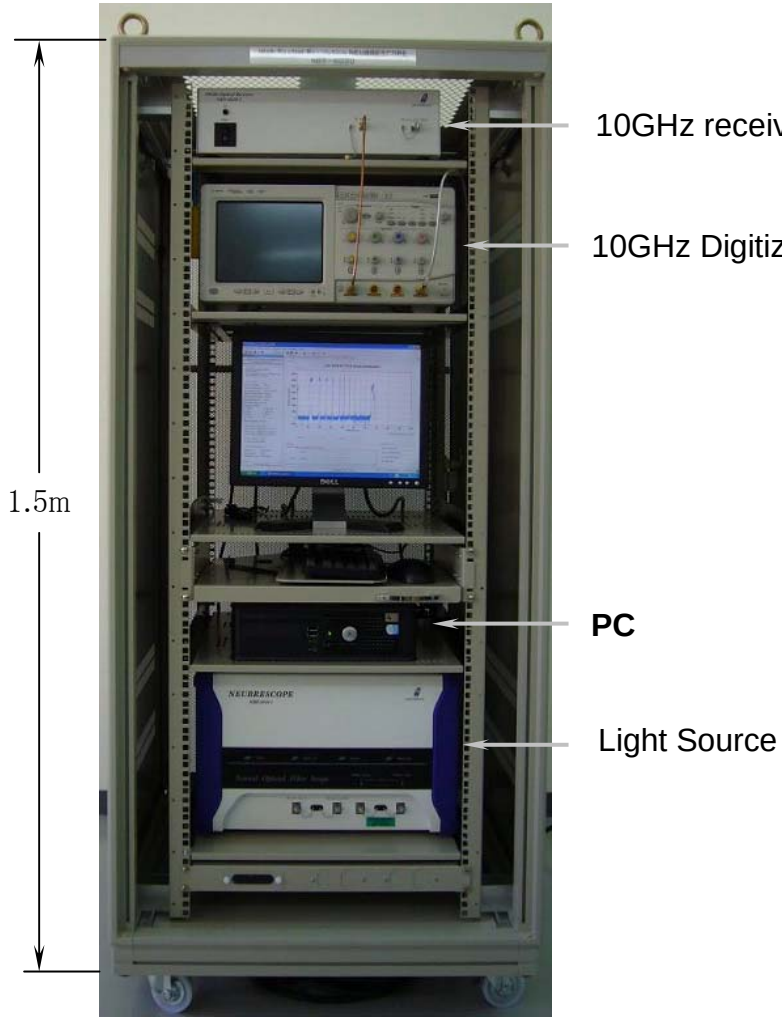
NEUBRESCOPE NBX-6000

Spatial Resolution:	less than **10cm**
Strain Precision :	±**25** $\mu\varepsilon$ (±0.0025%)
Repeatability:	±1**5** $\mu\varepsilon$ (±0.0015%)

Cut edge Technology of PPP-BOTDA NBX-6020: 2cm Spatial Resolution



Brillouin Spectrums of 1cm space



Neubrescope NBX-6020

The only one commercialized high precision DTSS

Technical details and comparison

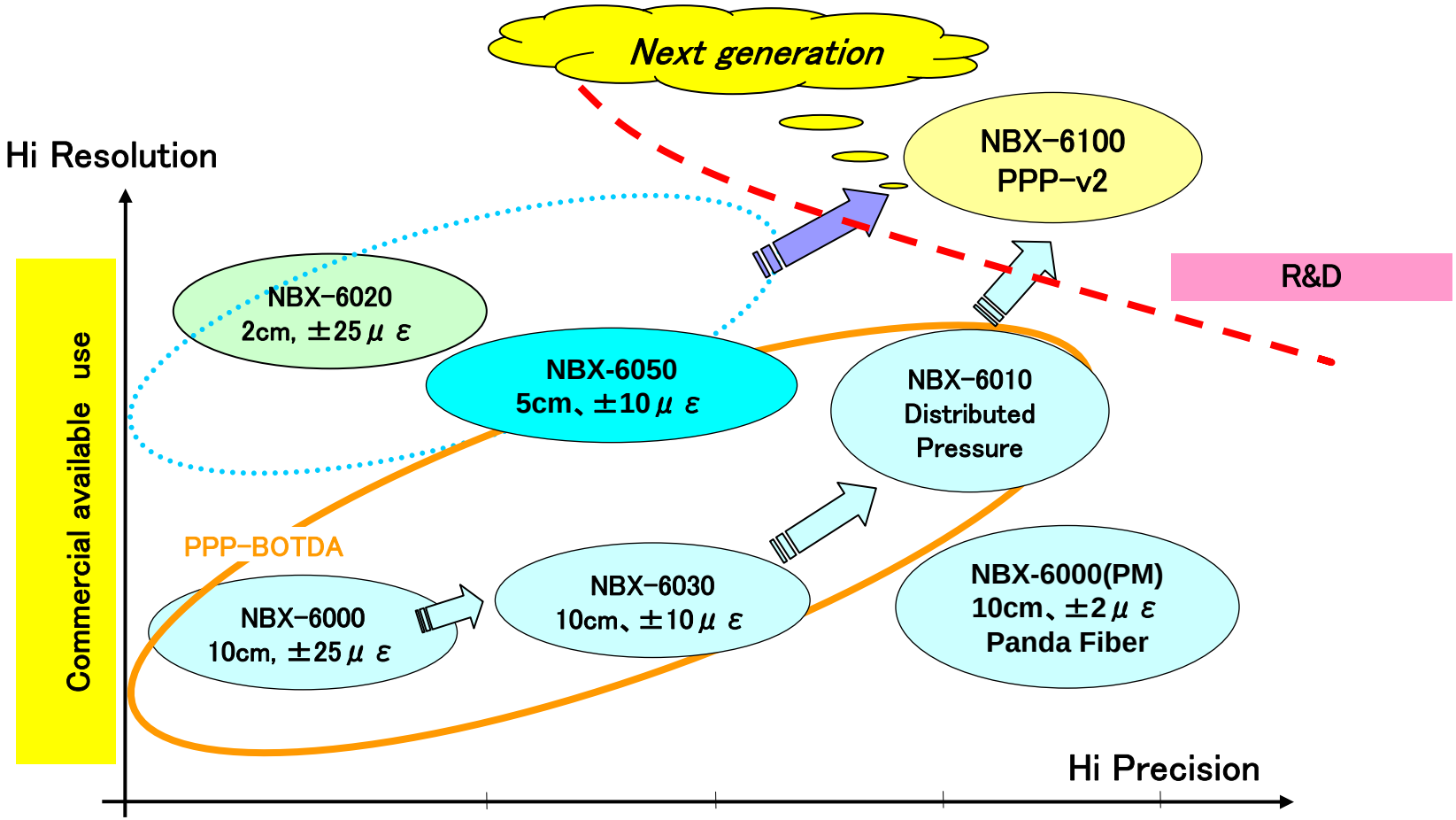
Feature		PPP-BOTDA	conventional
Spatial resolution		10cm	1m
Max. available measurement distance	10cm resolution	1km	×
	1m resolution	30km	10km
Strain accuracy		25 $\mu\varepsilon$	Approx. 100 $\mu\varepsilon$
Temperature accuracy		0.6℃	1℃
Measurement time		3min	2min
Repeatability		10 $\mu\varepsilon$	50 $\mu\varepsilon$?

Measurement distance *vs.* resolution

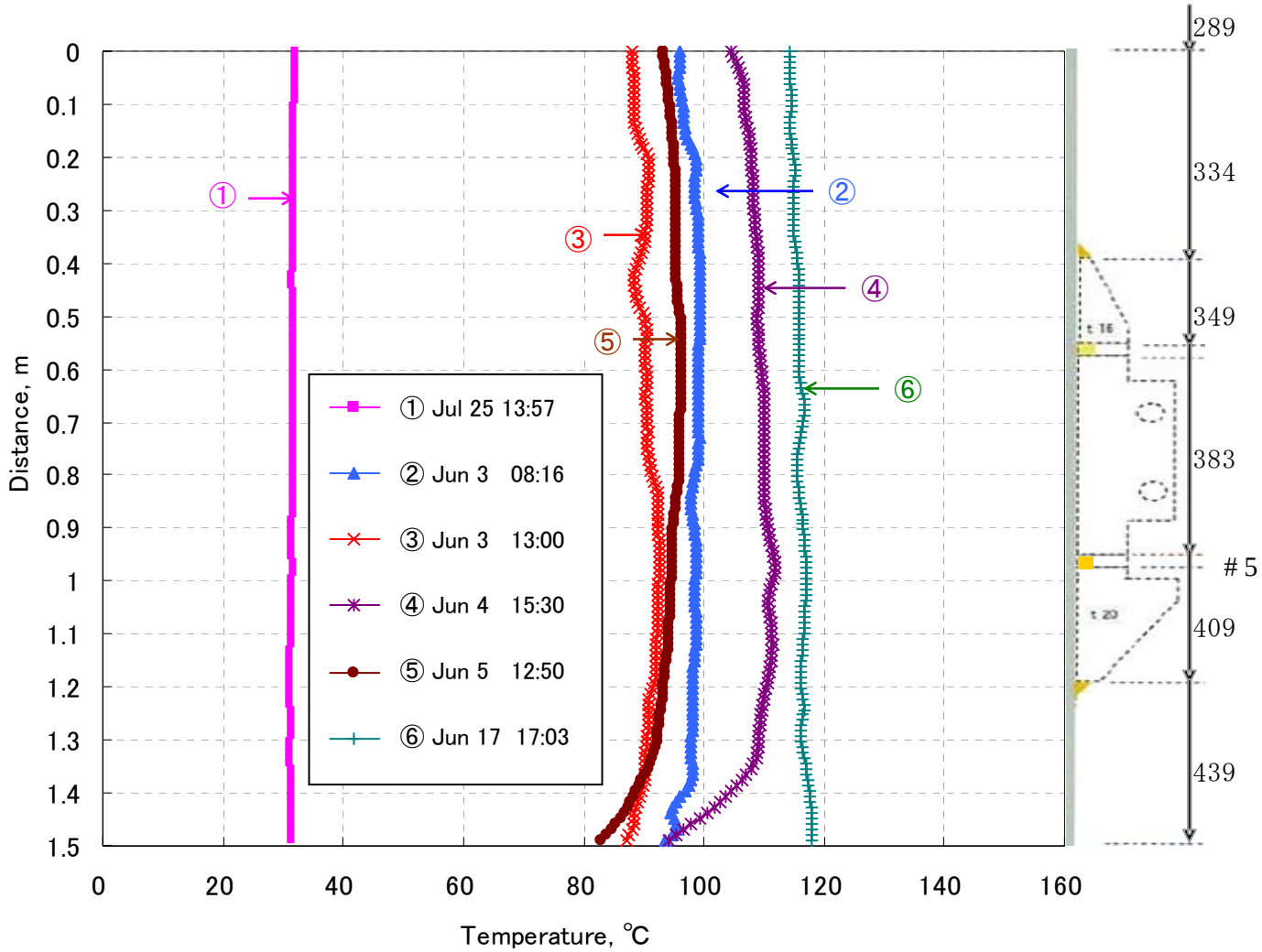
Resolution (cm)	10	20	30	50	100
Pulse time (ns)	1	2	3	5	10
measurement distance (km)	1	5	10	20	30

NeubreScope NBX-6000 Series

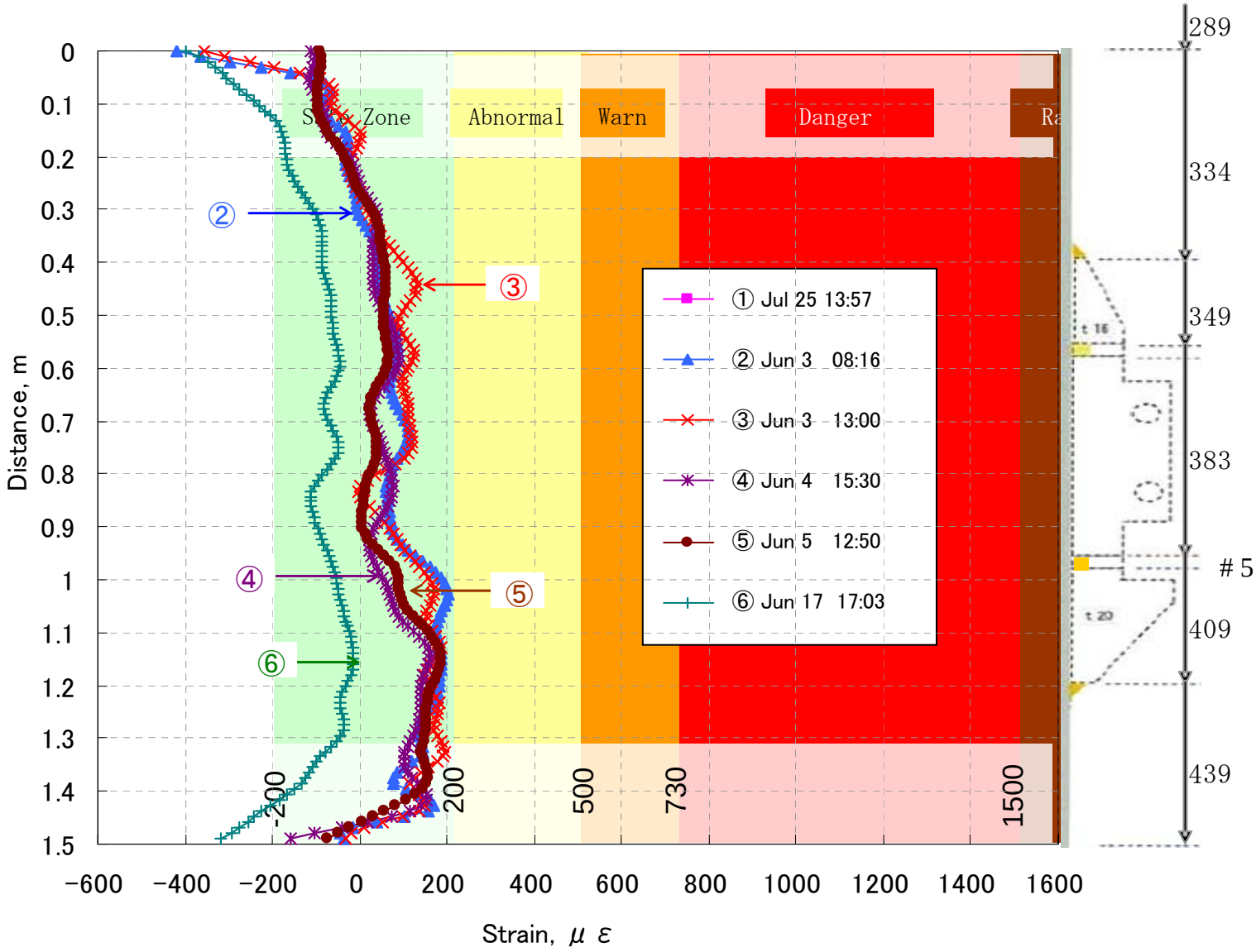
=> High resolution and High accuracy and High Speed
=> Strain／Temperature／Pressure　combine



Temperature changes during operation



Mechanical strain changes during operation without thermal effect



Neubrex Solution

A full SM FO system for smart structure

Submarine cable

Horiguchi et al, NTT（1989）

First Generation

- SP～100m
- Desktop System

Application to Civil engineering

Ando Co., Ltd NTT（1992 ～2002）

Second Generation

- SP～1m
- Portable
- Strain Precision 100με

Application to metal structures

2ns for 5km

NEUBRESCOPE
NEUBRESTATION
NEUBREGATE

- SP<10cm
- Strain Precision<10με
- Structural Health Monitoring system

Third Generation