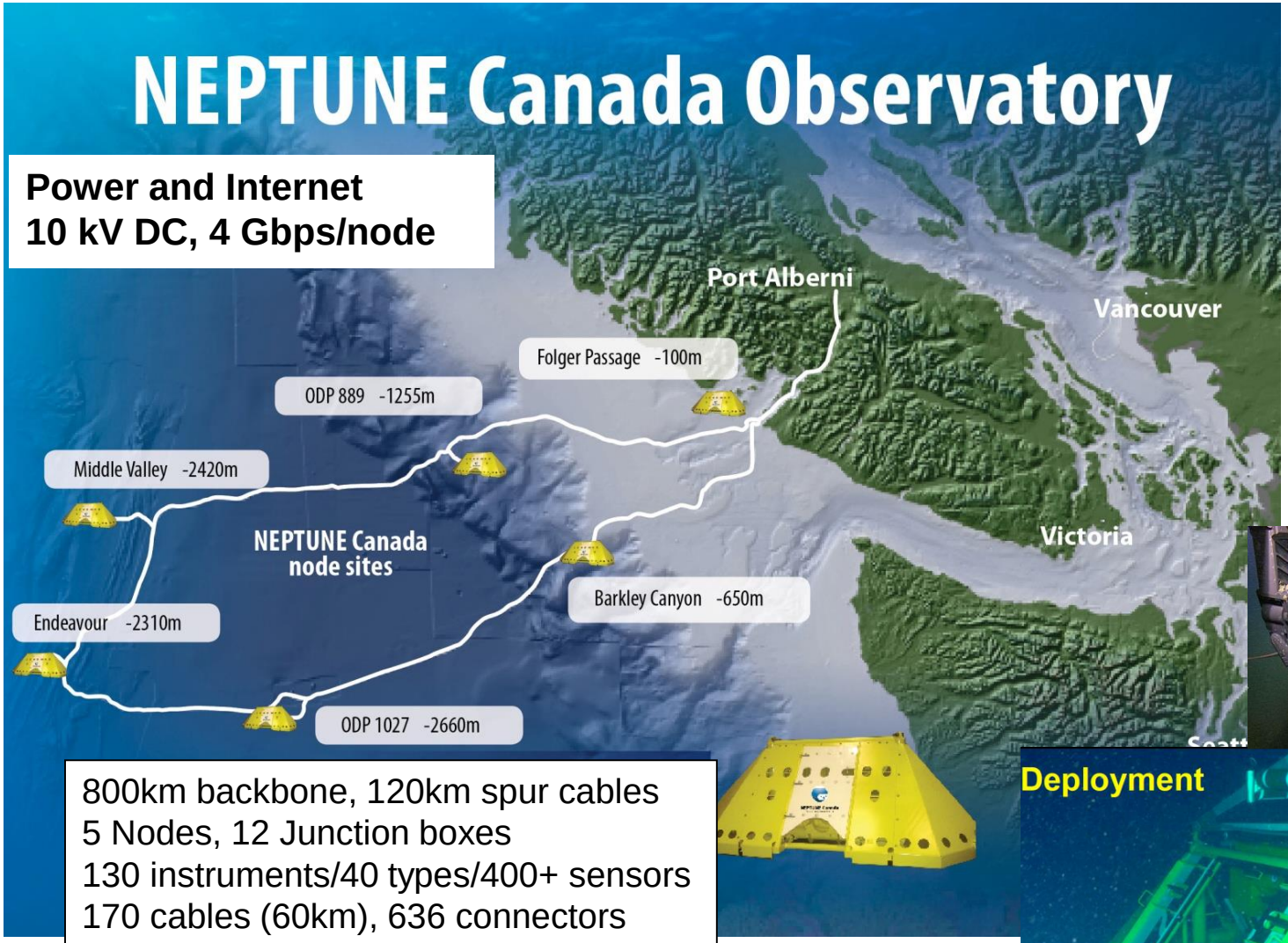
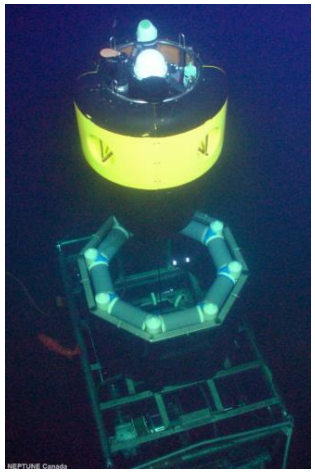
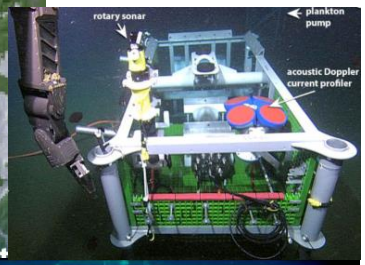
Optical Fiber Sensors

NEPTUNE Canada Observatory

Power and Internet
10 kV DC, 4 Gbps/node





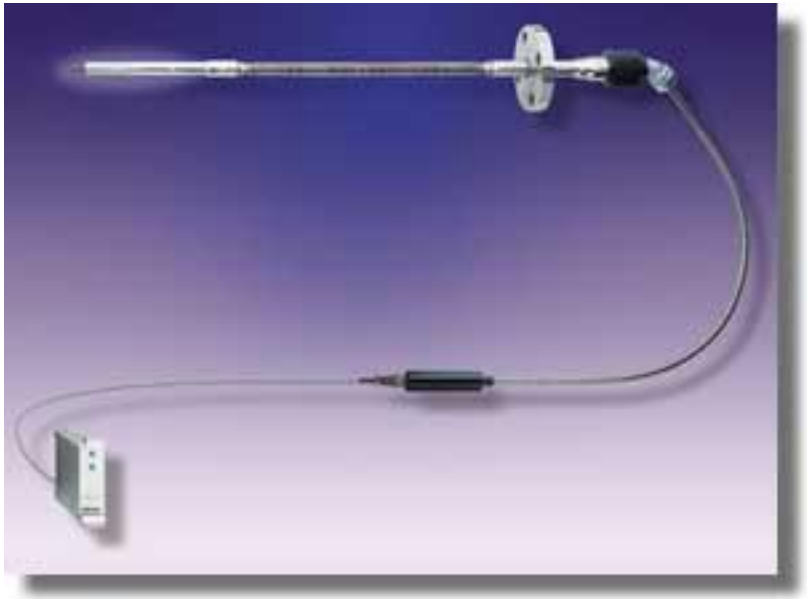


800km backbone, 120km spur cables
5 Nodes, 12 Junction boxes
130 instruments/40 types/400+ sensors
170 cables (60km), 636 connectors

Purpose built - NEPTUNE > US$140M

How they work

- Fiber optic sensors measure properties of their environment.
- They can measure anything which changes the way light travels through the fiber, or alters the light's properties.



What can they measure?

- Temperature
- Pressure
- Strain
- Displacement
- Acceleration
- Flow rate
- Vibration
- Chemical concentrations
- Electrical and Magnetic Fields
- Rotation rate

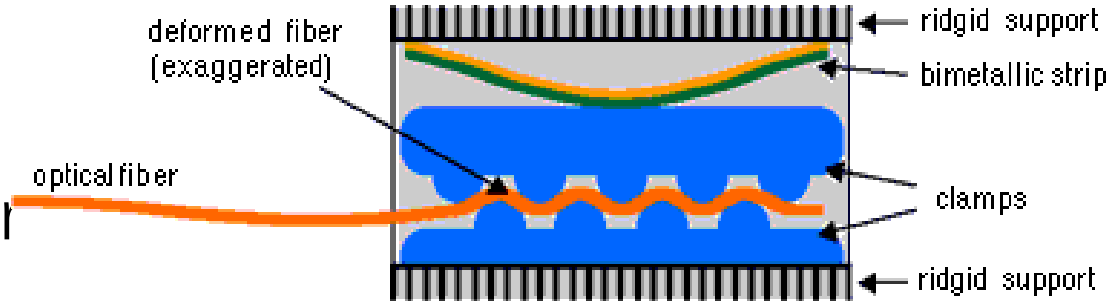
Methods of Measurement

- Amplitude- and Intensity-Based Sensors
- Frequency- and Wavelength-Varying Sensors
- Polarization and Phase-Modulating Fiber-Optic Sensing

$$E = Ae^{i(kr-\omega t+\phi)}$$

Intensity-Based Sensors

- Detect changes in light intensity, correlate change to change in pressure, or temperature, etc.

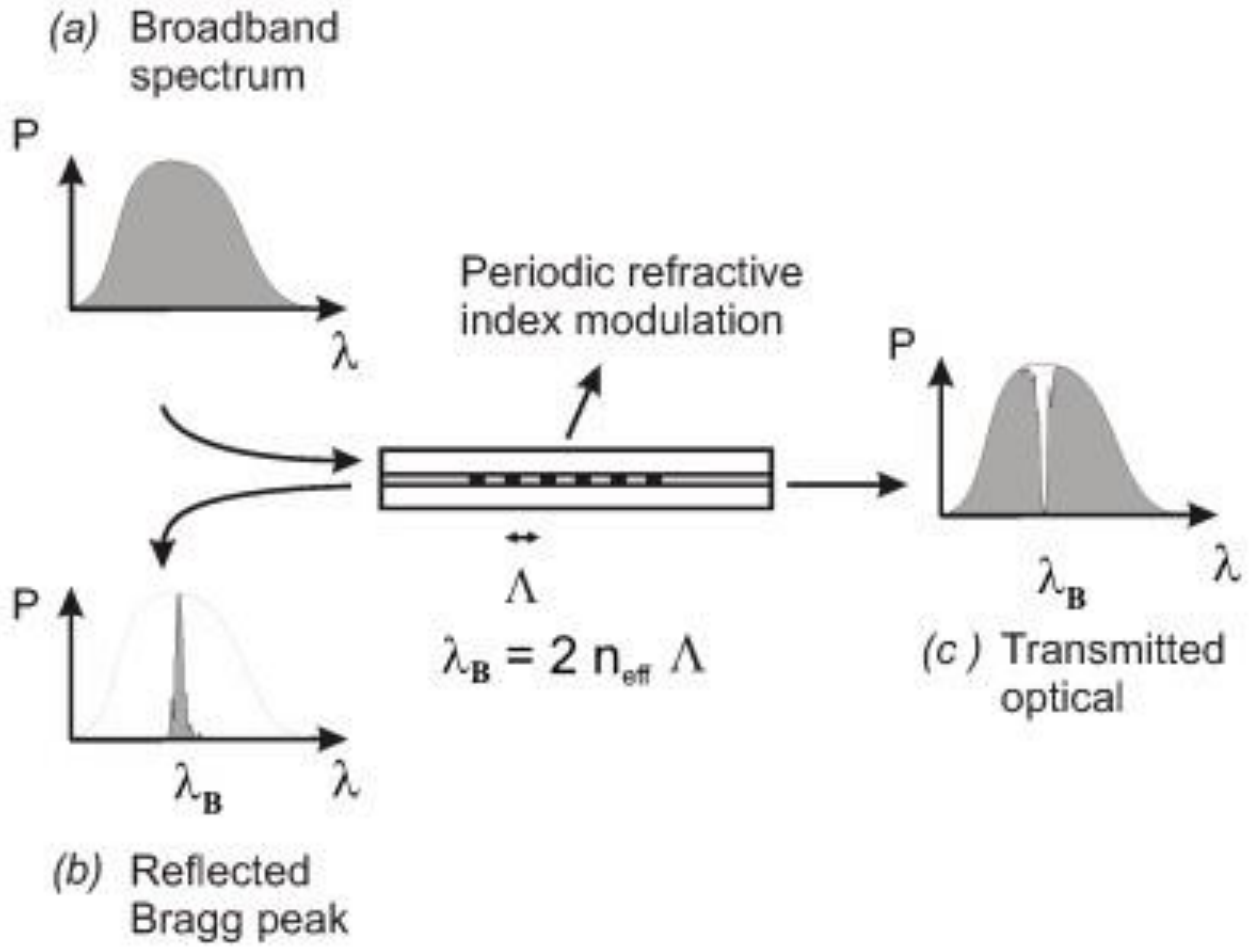


Fiber Optic Temperature Sensor Using Fiber Deformation

- These systems have a poor ability to screen noise, leading to lower precision, but are simple and inexpensive systems.

Wavelength-Varying Sensors…

- Fiber Bragg Grating: most common type.
  - Characteristic reflected light wavelength dependent on grating spacing. Stress applied to fiber changes spacing.



Advantages of Fiber Sensors

Many sensing applications could use mechanical or electronic sensors, but fiber sensors have advantages for some applications.

- Explosive environments- no electricity to start fires
  - (ie. pressure sensors in rocket fuel tanks).
- Corrosive environments- silica fiber is chemically resistant, unlike copper.
- Hot environments- many of these sensors work above 750 F. (400 ℃) The sensor can be cast into aluminum metal.
- Remote sensing- signal detection/processing can be done miles from active part of fiber sensor.
- Small size! 125μm

Industrial Use: Oil Wells

- Oil well temperature monitoring: measures temperature at 1 meter intervals along 10 km deep well pipes, with 0.1 ℃ accuracy. With just a single fiber!