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From ripples in space-time to innovation in seismic imaging

Attract NL, 12 January 2018

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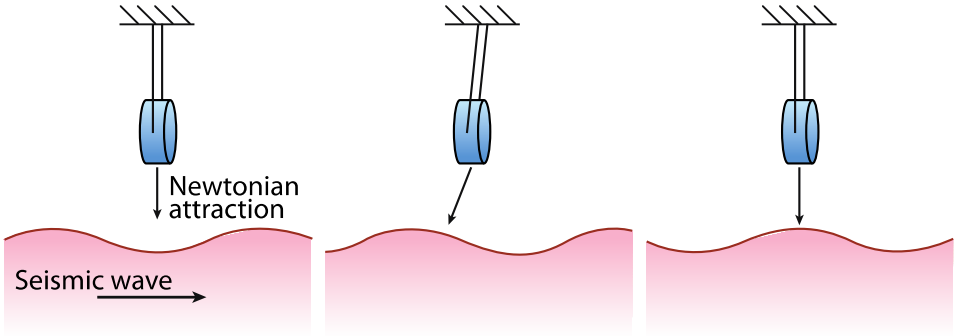
Valorization opportunity - from Gravitational Physics to Geophysical surveys



Measure seismic noise to improve gravitational wave detector

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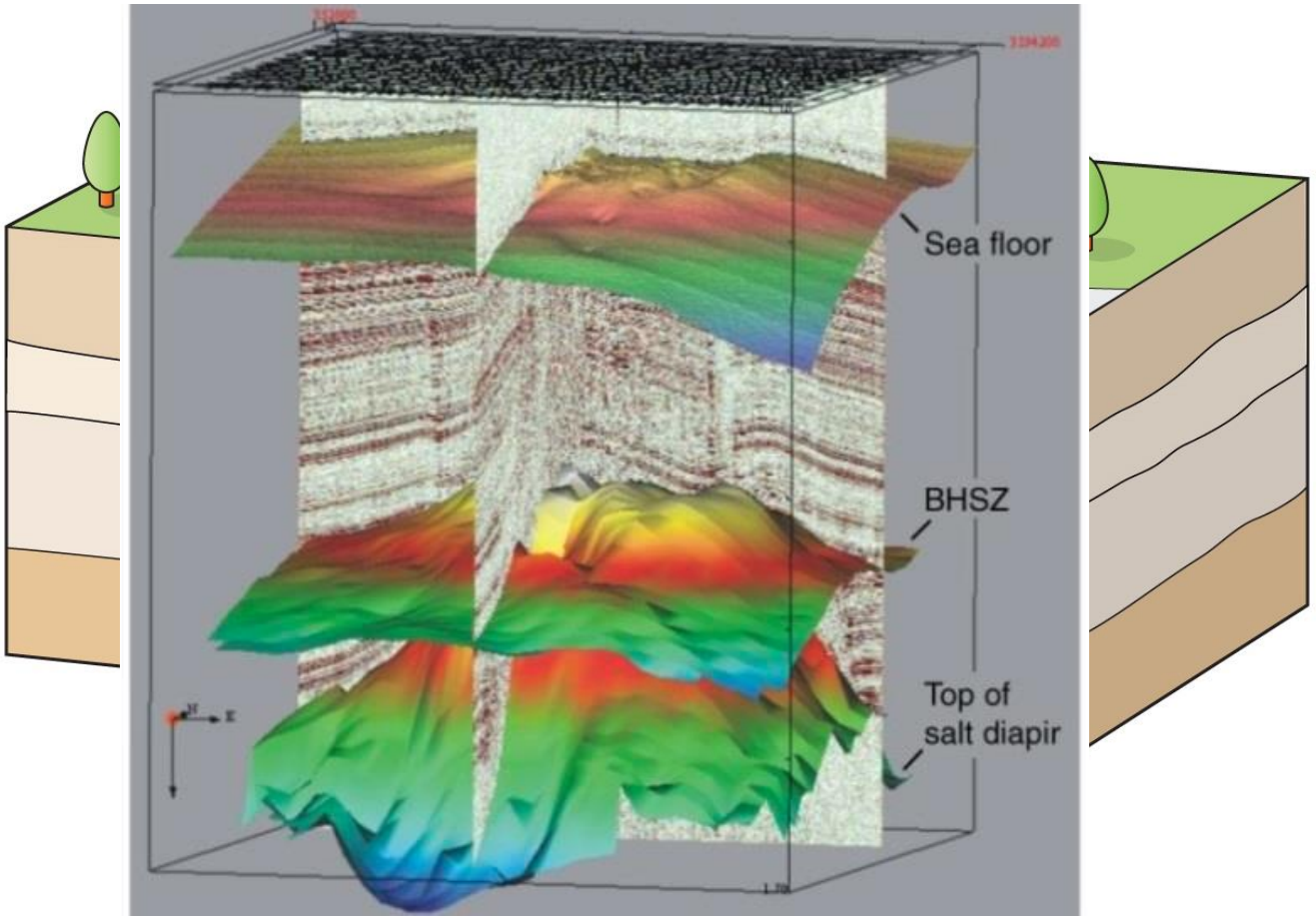
Seismic imaging

Natural gas production can be safer, more responsible and done more cost effectively when high resolution images of the subsurface can be made



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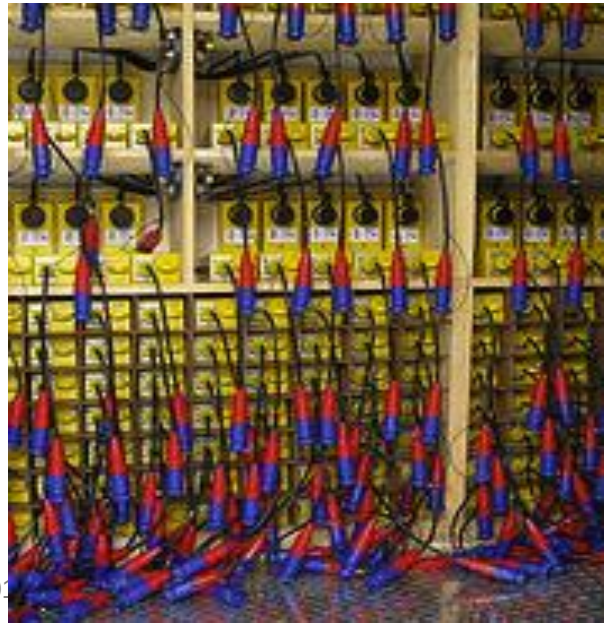
The problem

Land seismic acquisition is limited in scalability due to expensive and inefficient recording systems



Solution: Low-power, light-weight seismic sensors

The industry's lightest seismic sensor which allows cost-effective faster onshore seismic imaging for higher resolution images of the earth's sub-surface

Ultra-low power
50+ days operating life
continuous recording

GPS
GNSS/GLONAS/Galileo
Timing precision ±10 µs

Bluetooth Low Energy
Quality control
Configuration and proximity

High dynamic range
up-to 130 dB

Highly visible LED
Health status feedback

Connectors
High-speed USB interface
Battery charging

Internal batteries
Rechargeable Li-ion
Charge time 3 hours

Robust enclosure
Watertight IP68

High sensitivity geophone
10 or 5 Hz
optional external connector

Internal calibration
System and sensor check

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Shell – The Netherlands, Eastern Europe and Oman
Both passive and active surveys

Field trials

- 100 nodes deployed in the north east of the Netherlands
  - High data taking efficiency, robust nodes, no water or environmental damage
  - Varying weather conditions including snowfall and temperatures below -10 ^{o}C
  - Results published in leading industry journal
- Exploring opportunities in Earthquake monitoring

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Acceptance generated through series of field trials with industry leaders
First major sales mid-2017, followed by further sales

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Patented MEMS will allow cost reduction and improved performance in a smaller and lighter form factor

Microelectromechanical systems (MEMS) – “Geophone on a chip”

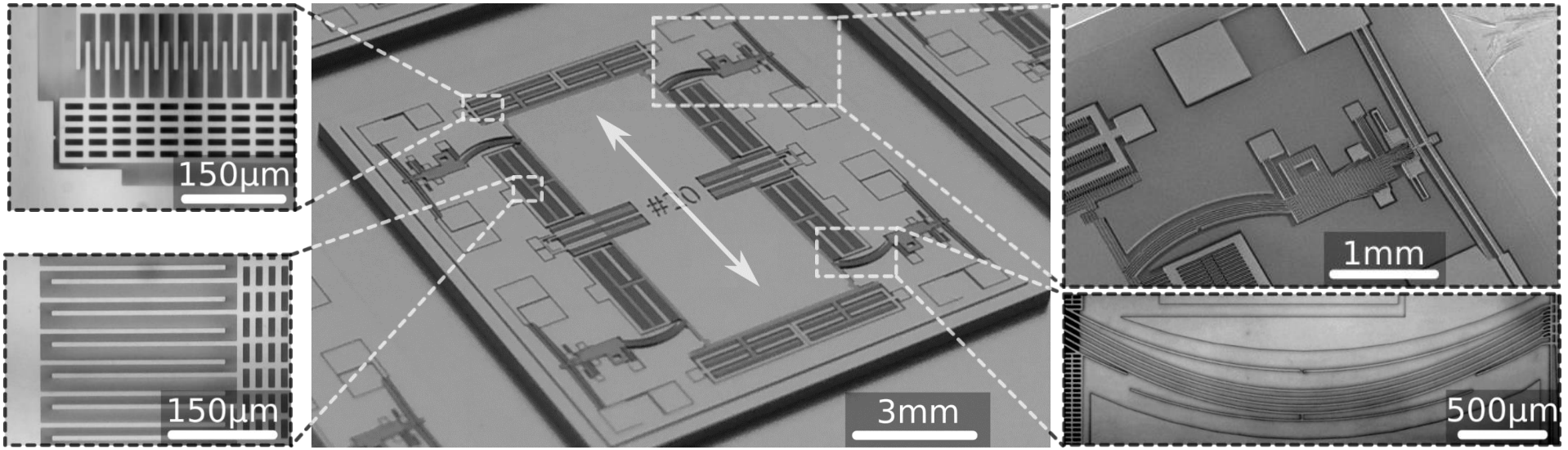
Unique features

- We have demonstrated a world record sensitivity: 1 ng/$\sqrt{\text{Hz}}$ around a few Hz
- Process allows mass production at lowest cost
- Low power consumption and no noise injection – Patented technology
- Excellent low frequency performance (e.g. for earthquake monitoring)
- Release date targeted at Q4 2018

Actuation Caps

Overview

Compression System



Sensing Caps

Suspension Springs

MEMS will see many applications in areas within and outside of the oil and gas industry

Microelectromechanical systems (MEMS) – “Geophone on a chip”

Inertial Navigation

- Aerospace
- Military
- Naval
- Railway
- Automobile

Vibration detection

- Industrial application
- Preventative maintenance
- Machine learning

Stability and motion detection

- Mobile phones/tablets
- Cameras

Automobiles

- Airbags
- Roll detection
- Theft detection
- Head light stabilization.

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