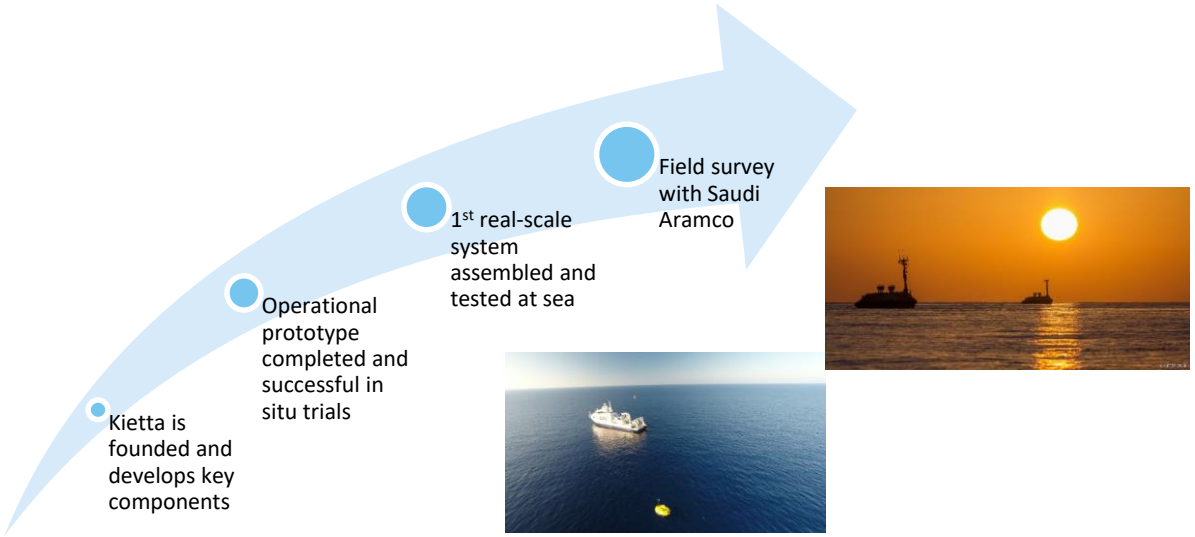
FreeCable™: Autonomous Seismic Acquisition

April-19

Company background

- **Kietta is a technology company that designs, develops and operates an unmanned & autonomous marine seismic acquisition system**
  - Private company, registered and headquartered in France
  - R&D, testing, initial commercialization phases complete → expansion is next
  - Unique combination of cutting edge technology and seismic expertise
- **FreeCable™ : a game-changing technology**
  - Kietta replaces the traditional vessels of seismic industry with autonomous vessels
  - The result is superior data quality at very competitive prices

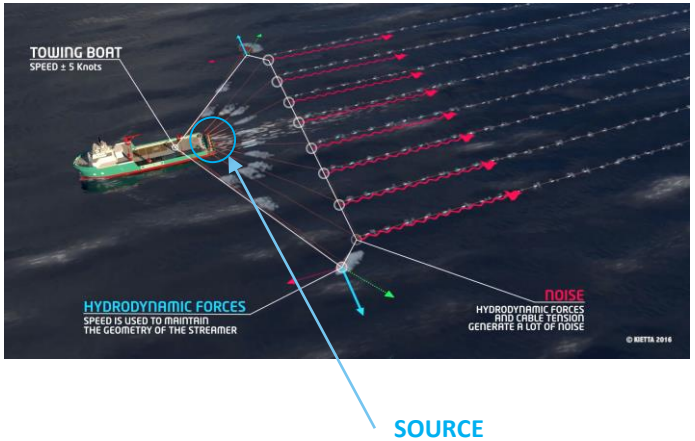


Outline

- **Limitations of Marine Seismic today**
- The FreeCable™ Method
- Technology Comparison
- Conclusions

What are your choices today?

Towed streamer acquisition

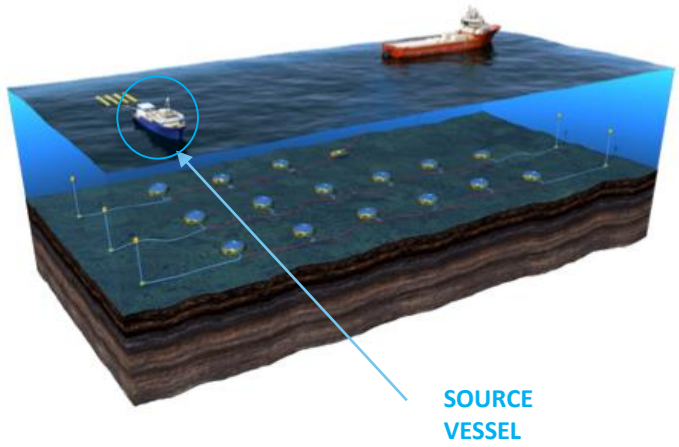


- High productivity

- Number of towed streamers stalling
- Azimuth perfectible only at high cost
- Broadband affected by noise

- Can't operate inside oil fields
- Can't access shallow waters
- High fuel consumption

Sea-bottom acquisition (OBC/OBN)



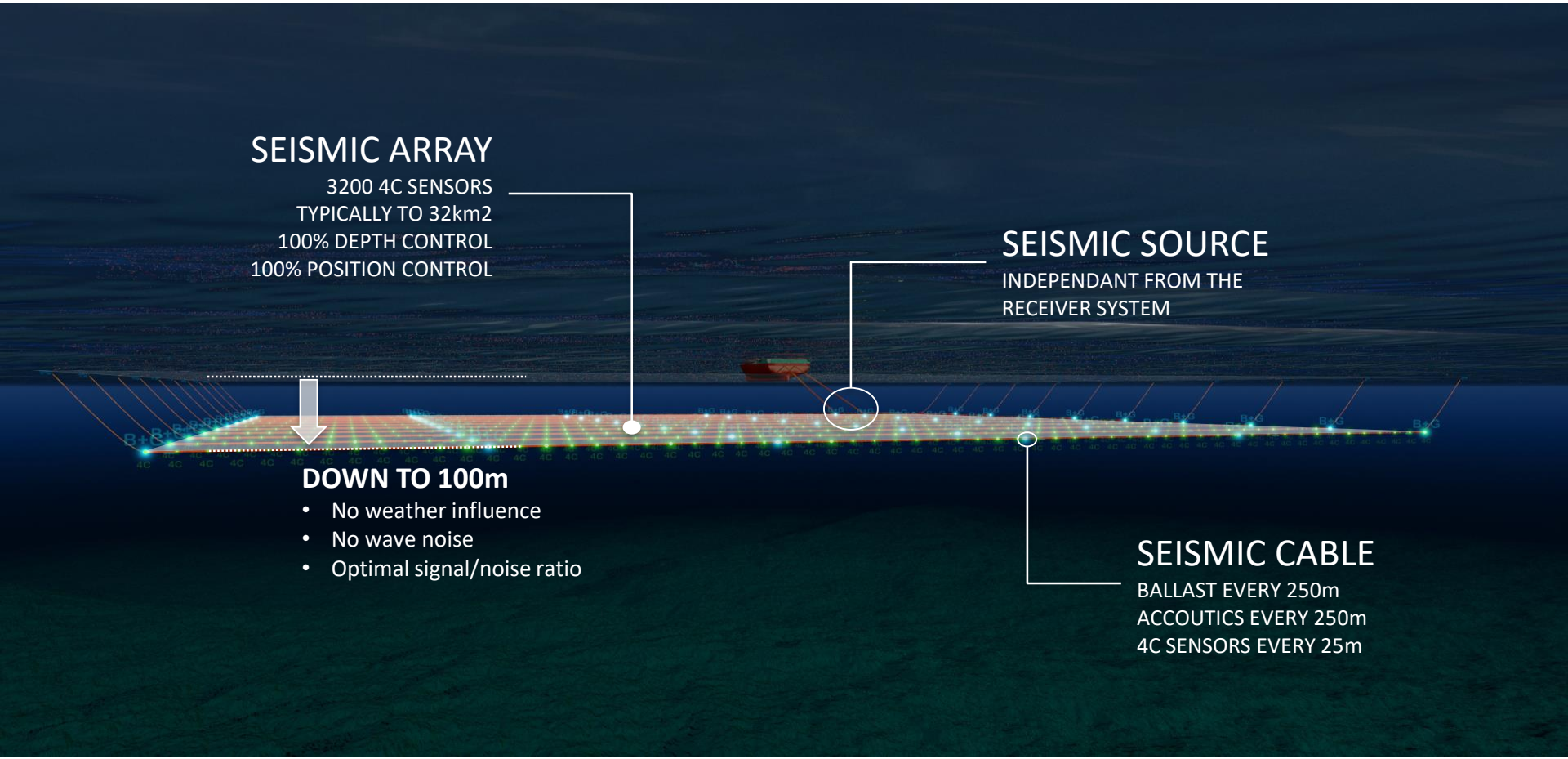
- High quality (azimuth, offsets, far from sea surface)
- Broadband

- Low productivity
- Seabed-related noise (Scholte wave, mud roll, shear noise)
- Strong velocity contrast
- Non-flat seabed requires complex elevation corrections
- Receiver response not isotropic, heterogeneous, not repeatable

- Complex to deploy (pinnacles, corals, infrastructures, hills)
- Incremental overheads in deep water
- Blind acquisition (OBN)

Think Different

Autonomous Mid-water Stationary Cable



It's not moving, no noise, very little tension

Very good, homogeneous, coupling for Hydro- & Geo-phones

4C sensors in quiet environment gives excellent S/N & Broadband data

Each cable is automated and independent from others ➔ any spacing

outline

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- **The FreeCable™ Method**
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FreeCable™ Principles

MASTER VESSEL

- Supply & deploy cables & drones
- Maintenance shop
- Scientific HQ for data storage
- Command & Control and real time data analysis

SOURCE BOAT

- Continuous shooting over the sensor grid
- Full offset shooting
- Full azimuth shooting

Independent cable network made of:

10 MSCs

(Midwater Stationary Cable)

Mechanically independent cables

Head and Tail Recording Autonomous Vessels maintain the cables stationary

A network of parallel straight cables

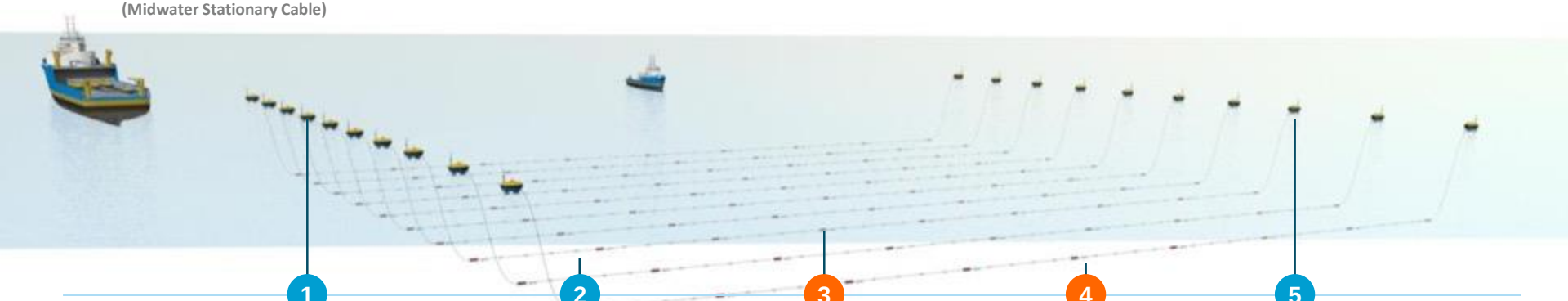
Command & Control system developed to pilot stationarity of the system within currents

Kietta Main Components

Independent cable network made of:

10 MSCs

(Midwater Stationary Cable)



- FLEET
- GEOMETRY
- ACQUISITION

1 HEAD RAV
RECORDING AUTONOMOUS VESSEL

- Real time positioning
- Tension to maintain linear geometry
- Cable extremity depth control
- Store and transfer data to master vessel
- Autonomy 41 days

2 BALLASTS
EVERY 250M

- Real time compensation of the cable depth
- Keep the cable horizontally stationary at constant depth

3 4C SENSORS
EVERY 25M

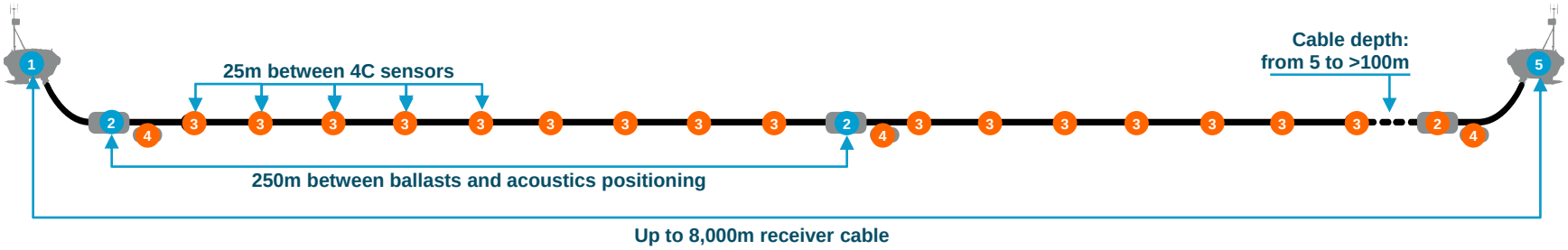
- x, y, z displacement
- Pressure variations

4 ACOUSTICS
EVERY 250M

- Real time recording of cable positioning

5 TAIL RAV

- Identical to head RAV
- Each RAV can be either head or tail



Kietta Recording Autonomous Vessel (RAV)

Telecom antennas to **transmit data** to master vessel while recording and **remote control** of the RAV

Leading winch to control the **cable head depth**

2 power engine for **propulsion and ballasts power supply (100% redundancy)**

Fuel tanks for **41 days of autonomy** between idle time bunkering

360 rotating propulsion to ensure **positioning** in every directions

Leading to **maintain cable at specified depth**

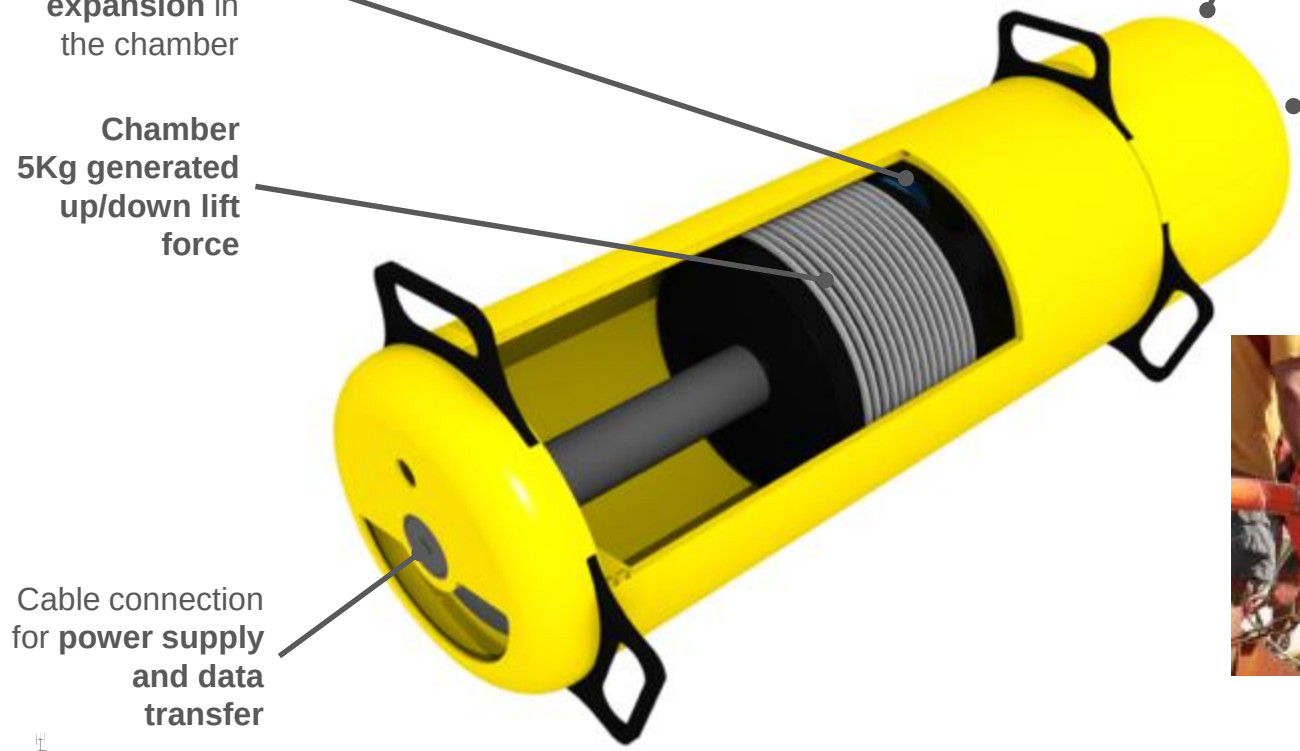
Kietta Ballasts

each ballast has its own code and can be **directed independently of others**

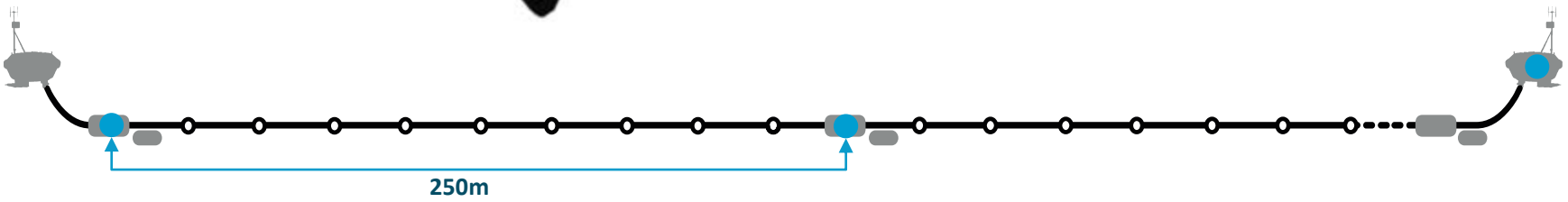
Micro pump creating a **volumetric expansion** in the chamber

Cable connection for **power supply and data transfer**

Chamber 5Kg generated up/down lift force

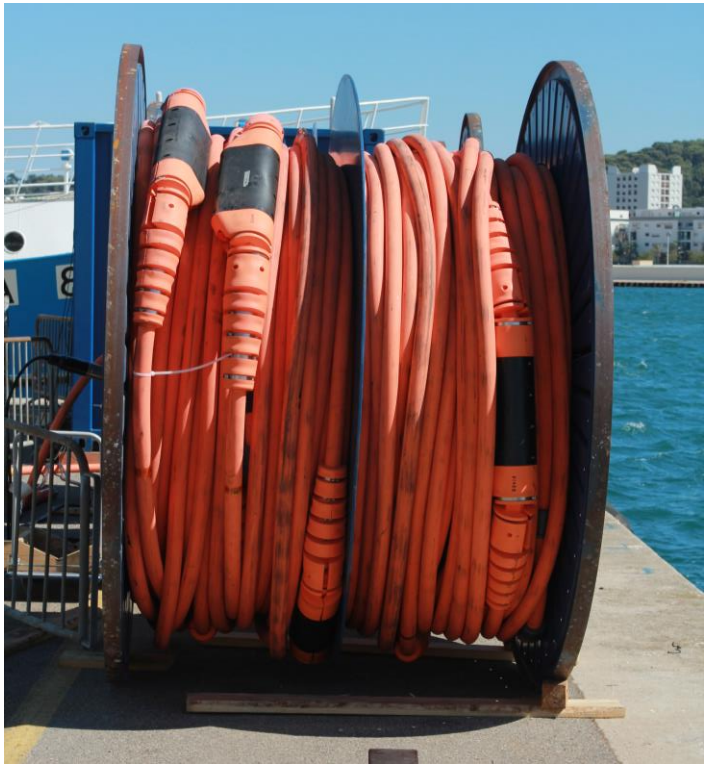


Cable connection for **power supply and data transfer**



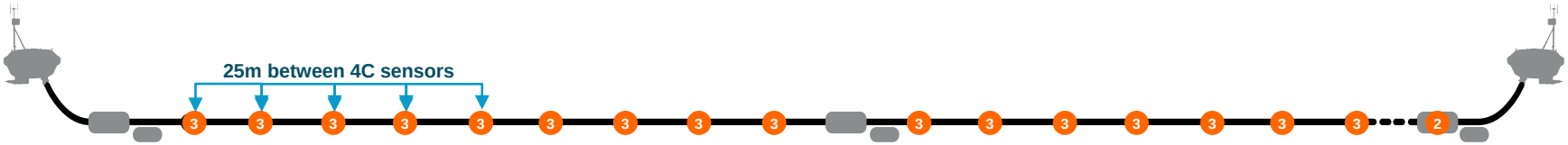
Up to 8,000m

FreeCable™ Geospace Cable



Adapted from proven sensor cables

- Neutrally buoyant cable
- Integrated power line for the ballasting system
- Optimization of the housing of the 4 component (4C) sensors modules



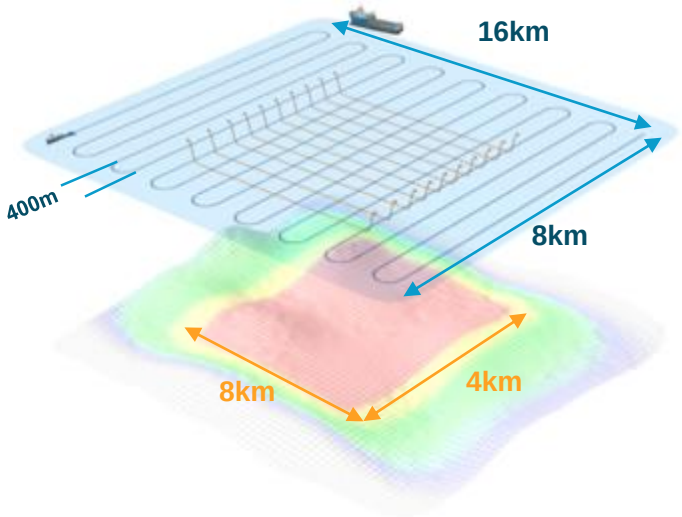
How does the Kietta Technology Work?

Two main acquisition methods with high productivity and superior data quality for both Production & Exploration projects

1 Patch Shooting

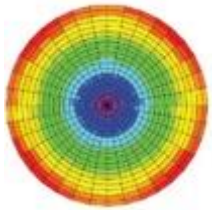
Stationary Autonomous Vessels

- A set of cables is maintained in position in mid water. Each cable is maintained by 2 RAVs, constituting a MSC. Each MSC is independent, making the complete system fully scalable
- A source vessel shoots seismic waves orthogonally to the direction of the cables, generating high density, full azimuth, and long offset data



Data Quality

Full Azimuth Coverage

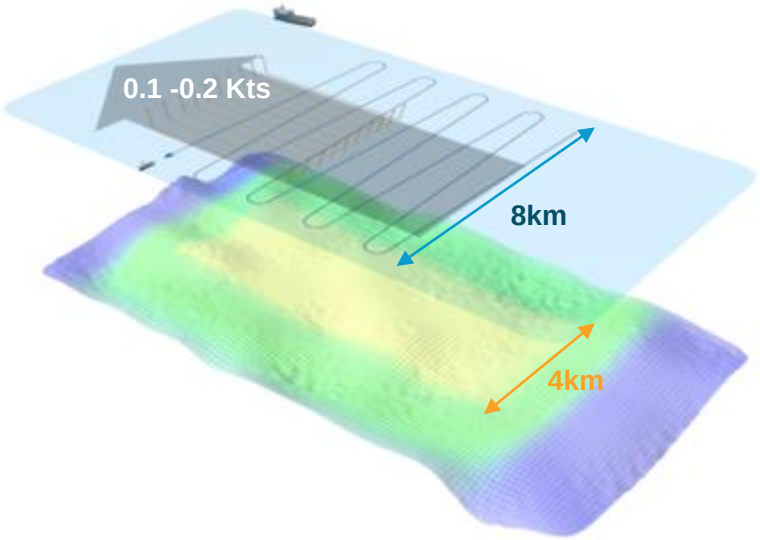


★★★★★

2 Progressive Shooting

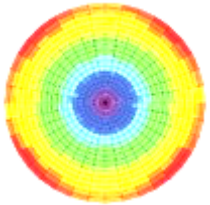
Moving Autonomous Vessels

- Same disposition as for Patch Shooting mode, but all the cables (MSCs) are moving at a slow pace (less than 1 knots) to increase productivity
- Similar richness of data as in Patch shooting but with a lower density – still significantly higher than what can be acquired with any type of towed streamers



Data Quality

Full Azimuth Coverage



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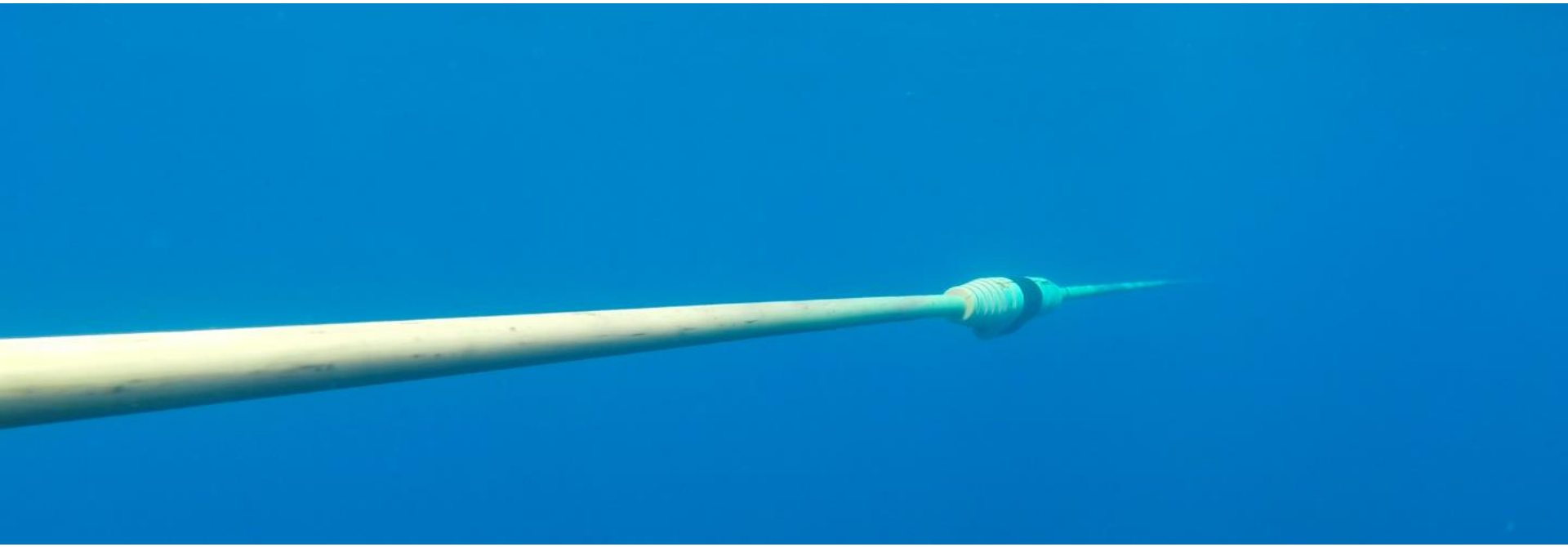
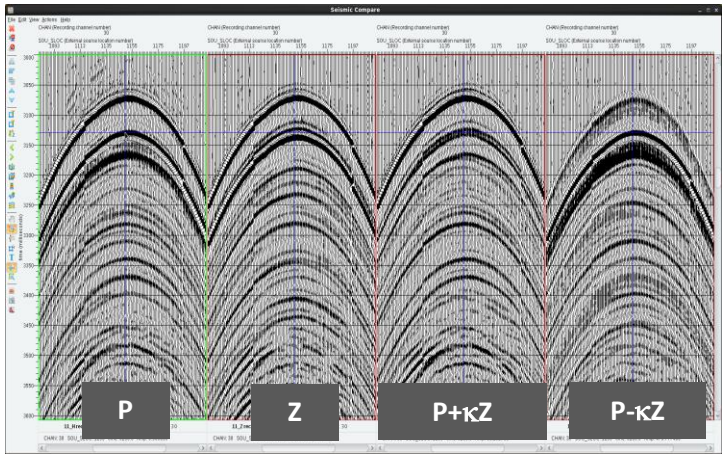
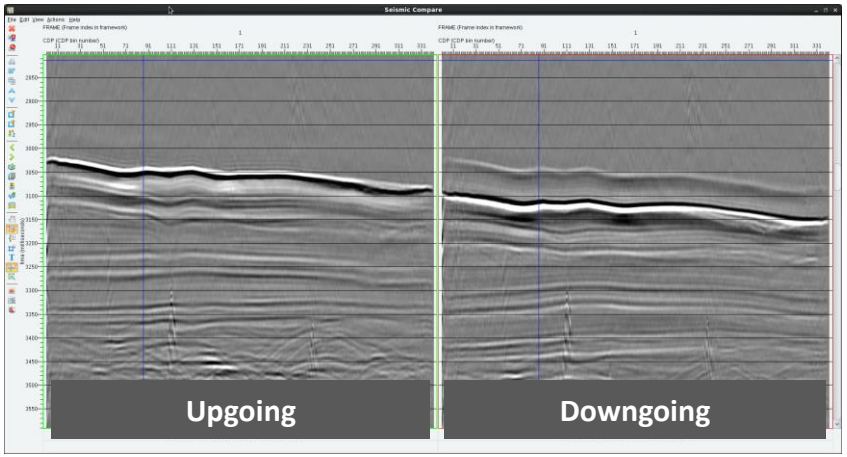
Outline



- Limitations of Marine Seismic today
- The FreeCableTM Method
- **Technology Advantages**
- Conclusions

Advantages: Low Noise and True 4C





Low acquisition noise

- Low speed
  => **no flow noise**
- Higher cable depth
  => **no swell noise**
- Lower tension
  => **no tug noise/strumming noise**

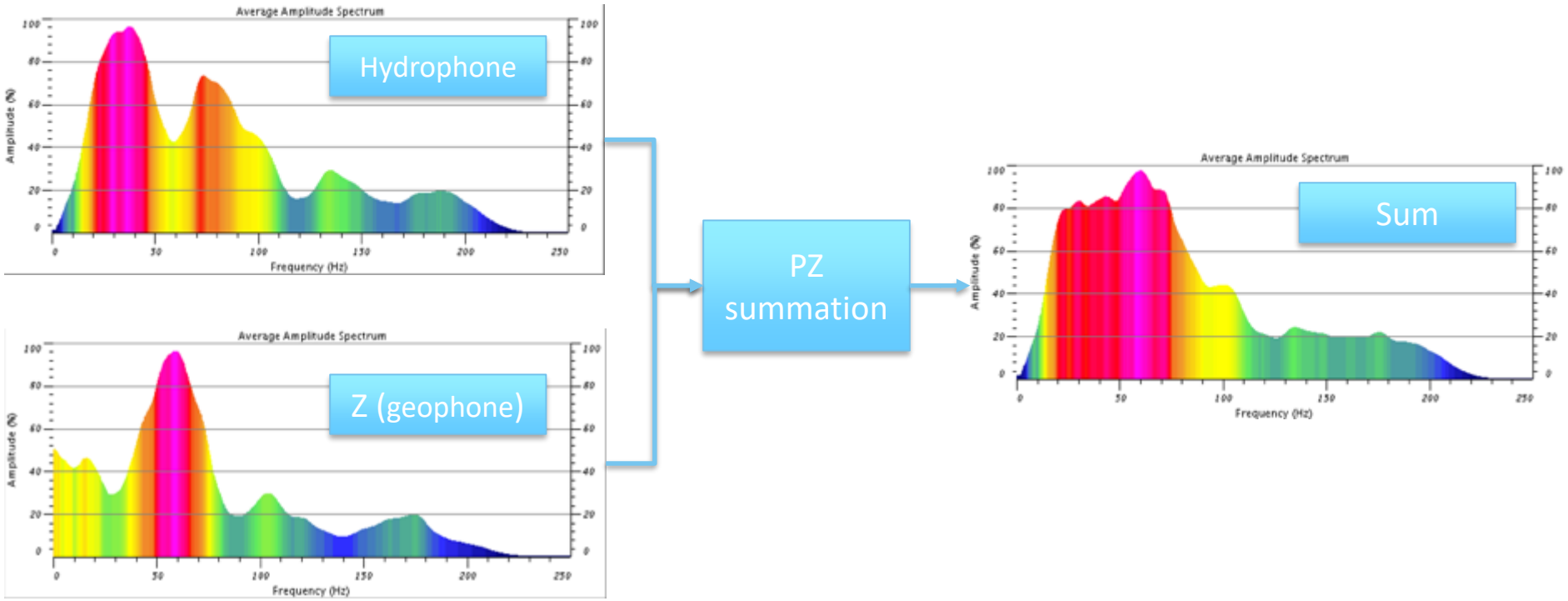
Full 4C recording

- Straightforward and easy deghosting through simple PZ sum (κ simple constant scalar value (water velocity impedance)
- H, X, Y1, Y2 and orientation (inclinometer)
- All geophones record useful signal and low frequencies
- Separation of downgoing and upgoing waves

Advantages: Full Bandwidth

Full bandwidth over seismic band

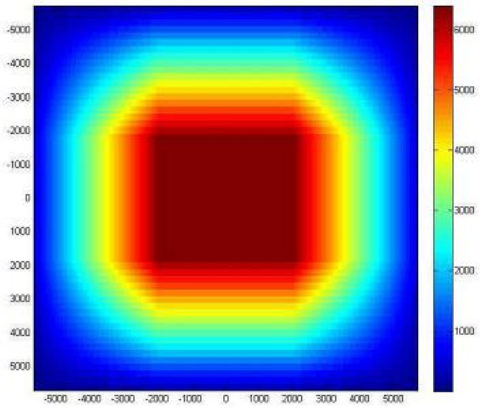
- Receiver ghost notch cancelled out through PZ sum



Advantages: Full offset, Full azimuth

Very high fold

- 400 fold in natural bin of 12,5m x 12,5m
- Very high S/N ratio: low acquisition noise, post-stack SNR improved by 26dB
- Can be increased with dense shooting



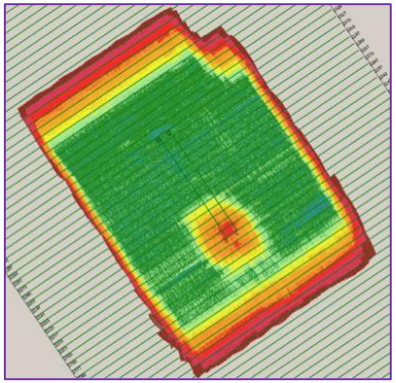
6000 fold with 50x50m dense shooting

360° azimuth

- Illuminate sub-salt targets
- Quantify anisotropy

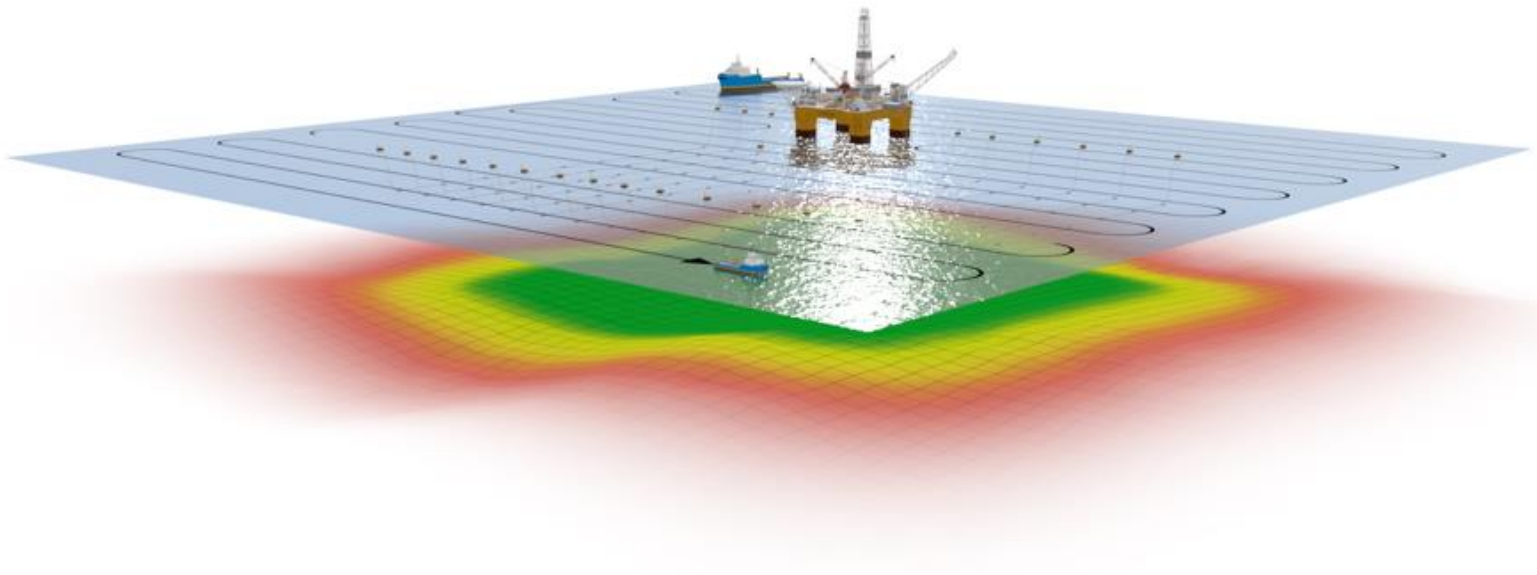
Offset 0 to 16 km

- Detailed velocity model
- Illuminate salt diaphir flanks
- Quantitative AVO / AVA at greater depths



Coverage map, no infill shooting

Advantages: Productivity & HSE



Production

- Close-to-platform operations
- Operate in any water depth
- x10 km^2 / day full fold (allowing for infill and standby)
- Less weather downtime
- Multi-vessel, simultaneous source linear productionincrease

HSE

- Reduced staff headcount at sea
- Small footprint operation
- Very low fuel consumption
- Low-power source possible wrt marine fauna
- No impact on sea bottom (reefs, production facilities)

Competitive Survey in the Red Sea

Context and objectives

- First commercial survey for the system
- Pilot test: competition between 4 technologies
- High-end 3D seismic data: wide azimuth, long offset
- Complex environment: islands, shallow water, platforms

Main Conclusions

- 1. FreeCable **extremely well suited** to this type of environment
- 2. **Very good data quality** (low noise, 4C recording, long offset)
- 3. **Excellent control** of the system (unmanned and autonomous)
- 4. **Excellent productivity**
- 5. **Kietta Best-in-class**:
  - **Only Kietta** completed two areas in 2 weeks
  - 1 competitor did ½ in 4 weeks
  - 2 failed providing results

FreeCable™ Special Applications

Landlocked seas and lakes
System is easily road transportable and can be deployed anywhere

 # Inaccessible to streamers

Shallow Waters
Draft of our RAVs is small and the cable depth may be adapted for very shallow waters

 # Ideal for 4D patch

Obstructed areas
Knowledge of sea currents & maneuverability of the system allows proximity to obstacles

 # Ideal for 4D patch

Broadband, full azimuths, long offsets
The path geometry offers high fold, full azimuths and offsets as long as required

 # Sub salt imaging

Ice infected areas
Could operate in areas where the sea is covered by up to 80 % of floating ice (floes)

 # Inaccessible to Streamers

Outline

- Limitations of Marine Seismic today
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Automated and Safer Acquisition

Geophysical Data Quality

- High signal-to-noise
- Pressure and 3C motion recording
- Real full azimuth acquisition geometry
- Full broadband with easy notch cancellation
- Full offset from zero to maximum, evenly spread
- Real-time monitoring for QC and pre-processing

Productivity and Operability

- Wrap up data acquisition in weeks, not months
- Get your results quicker, time is of essence!
- Minimal disruption around producing fields
- Daily coverage and data quality reports, real-time data
- HSE exposure reduced

Kietta

Thank you!