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Moderne havbunnseismikk med Noder

Innsamlingsmetodikk, effektivitet og arealbehov

Eivind Frømyr, Sjefsgeofysiker

Trondheim 24. April 2019

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18 December, 2018

Per Christian Grytnes, CEO Magseis ASA and Tony Dowd ,CEO Fairfield-Maxwell

We are delighted to announce completion of the acquisition of Fairfield Seismic Technologies and welcome the new combined company — Magseis Fairfield — to the market.

This transaction combines two complementary businesses to create a leading provider of marine seismic solutions, including Ocean Bottom Seismic (OBS), and positions Magseis Fairfield for accelerated growth in the expanding marine seismic industry.

Outline

- Introduction
- OBN - Why
- OBN - How
  - Operational Models
  - Reservoir Seismic
  - Impact
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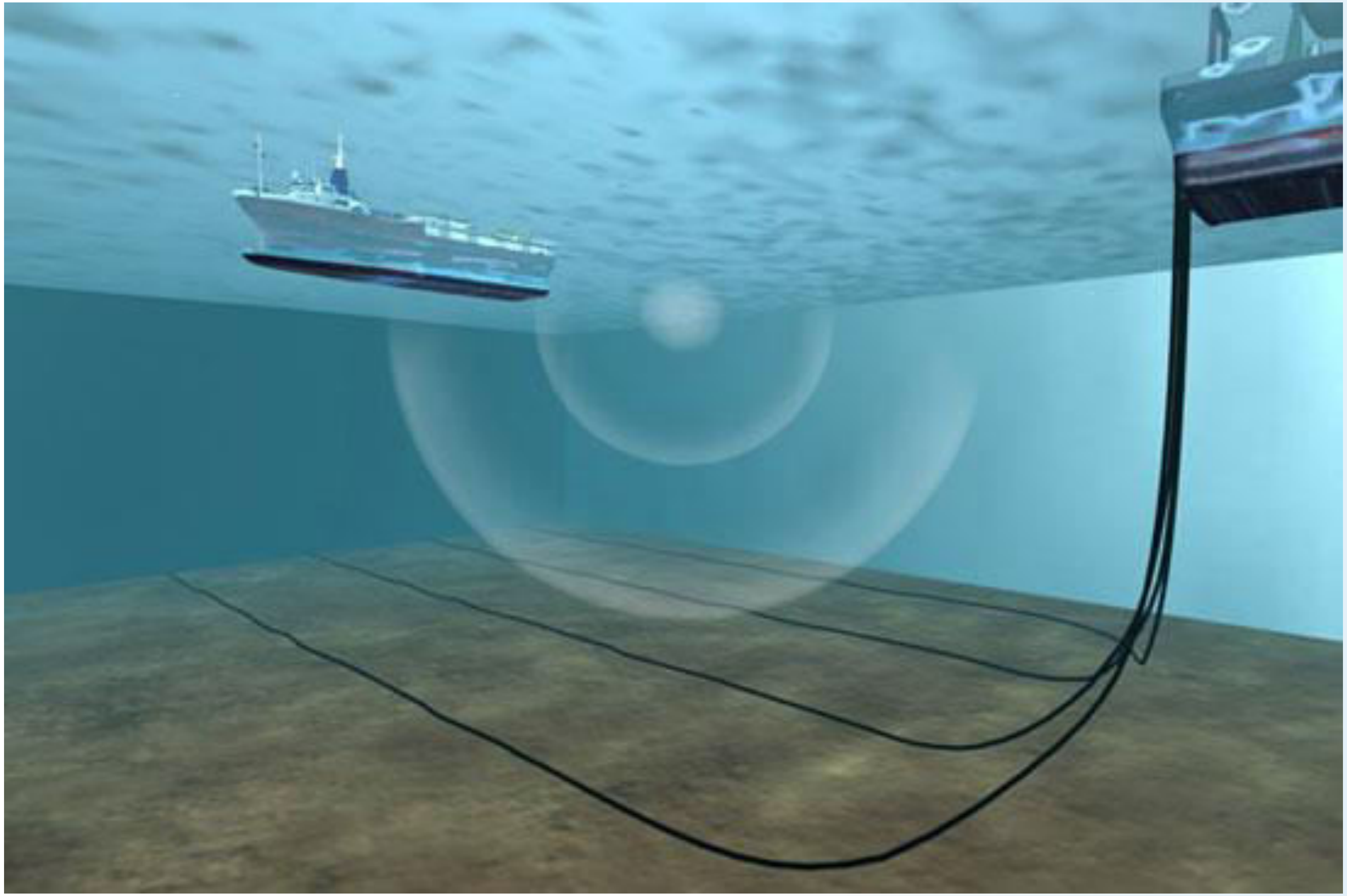
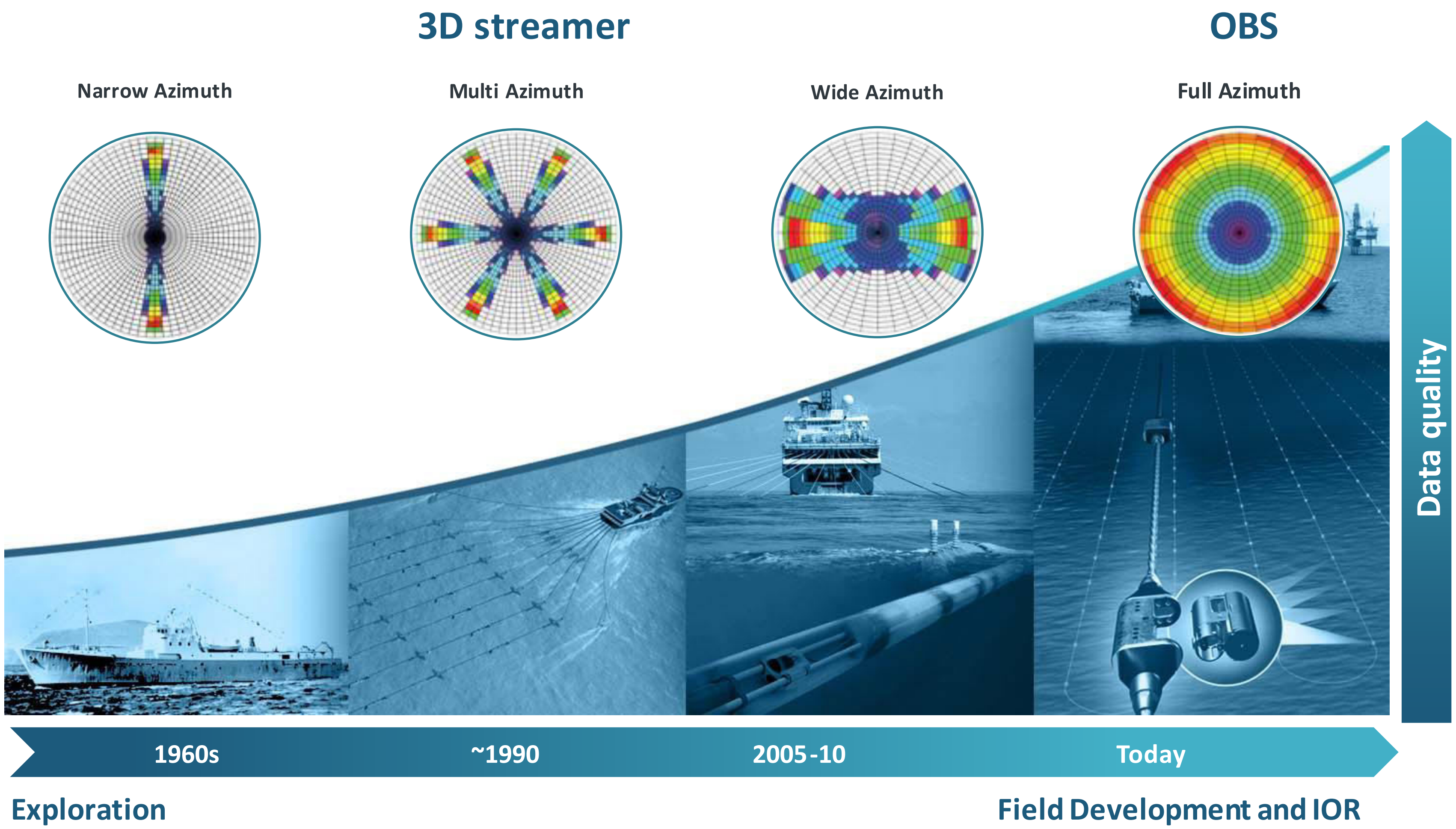
Traditional Ocean Bottom Seismic



MAGSEIS FAIRFIELD OBN NODE RANGE

MAGSEIS FAIRFIELD´S PORTFOLIO OF PROPRIETARY OBN SYSTEM

From Narrow Azimuth Streamer data to Full Azimuth OBN



OBS industry drivers

- ✓ IOR focus
- ✓ Complex geology
- ✓ Technology development
- ✓ Customer confidence and adoption

Source: Magseis Fairfield

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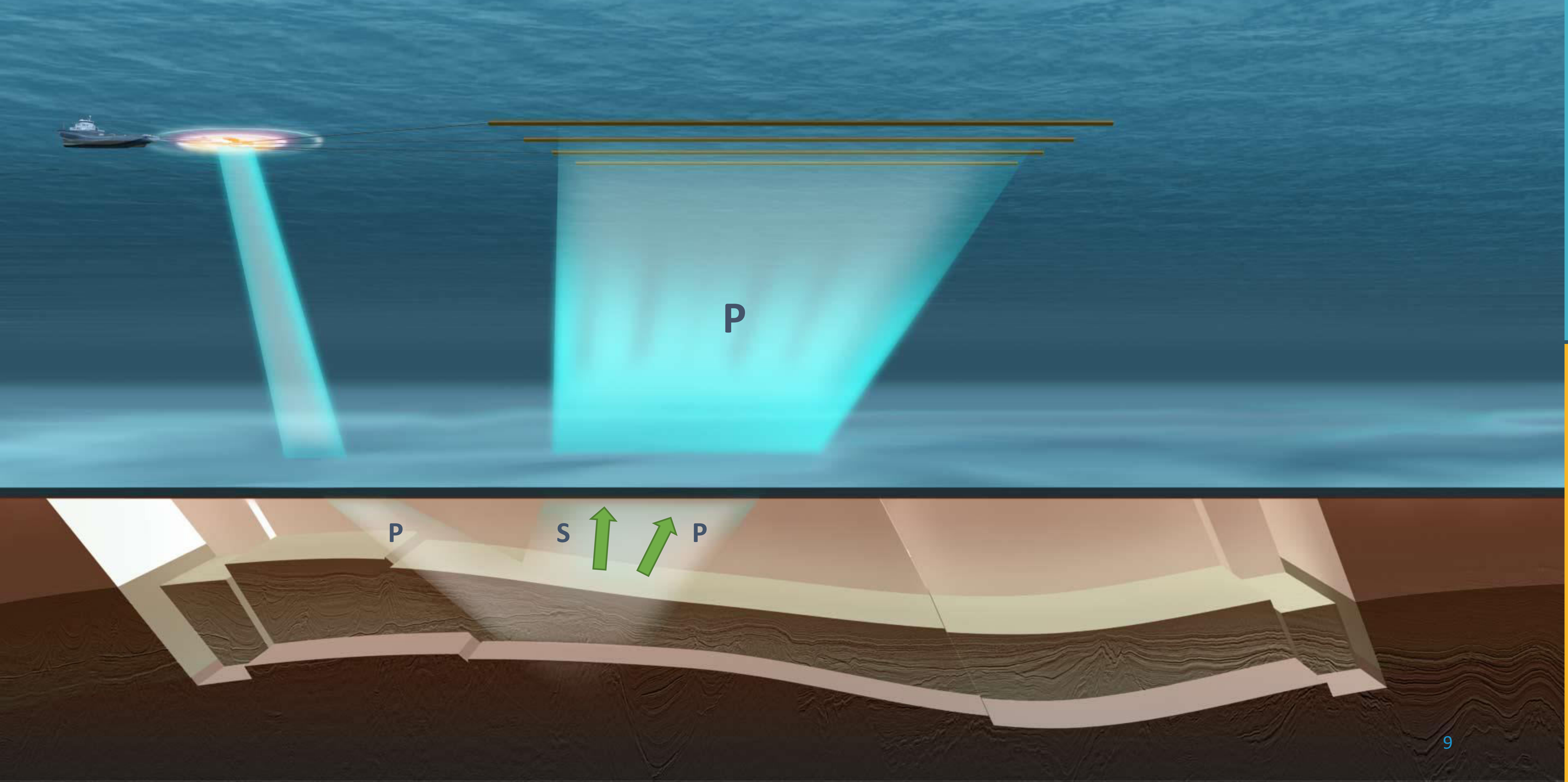
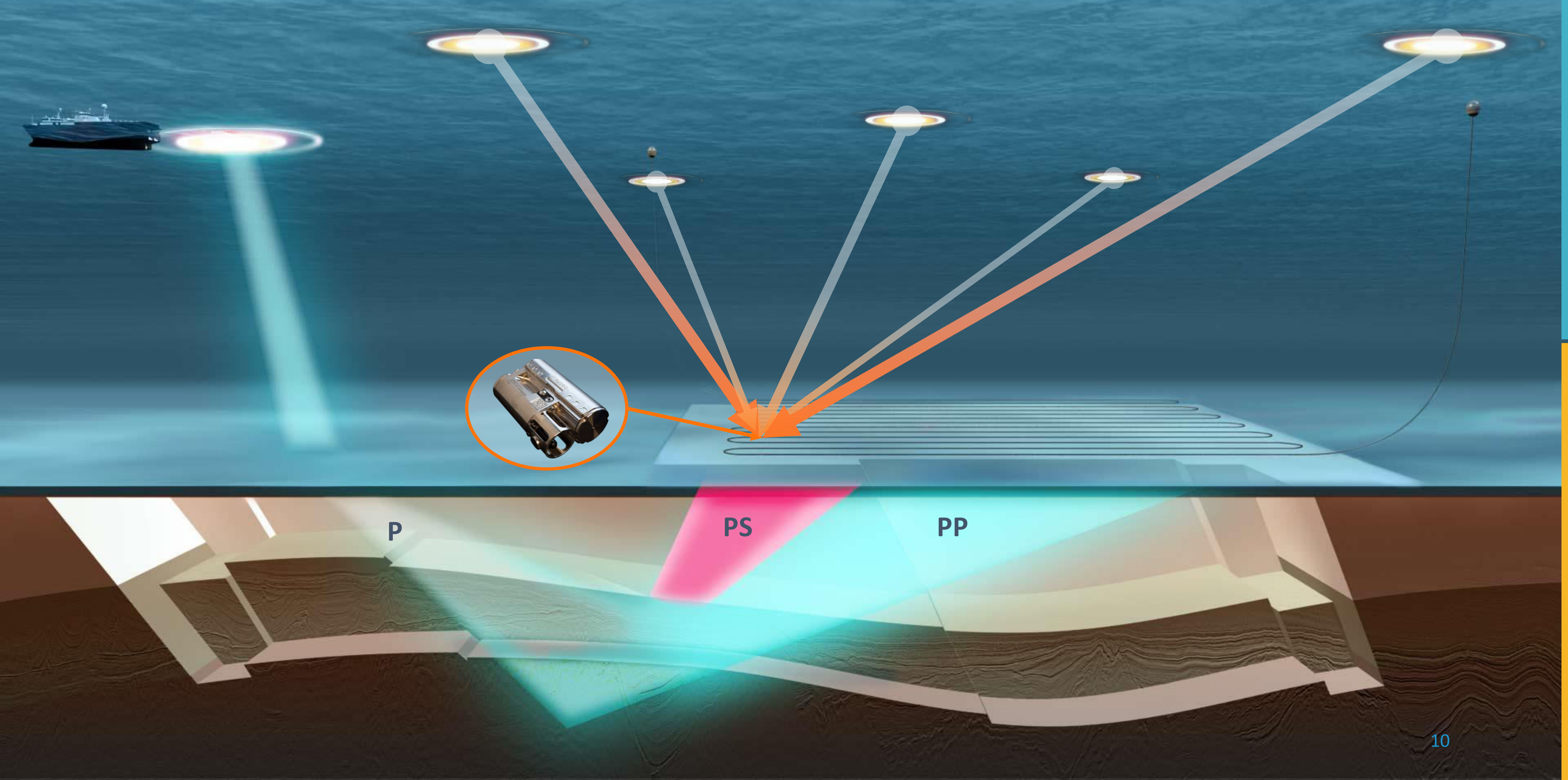
Towed Streamer Seismic Acquisition



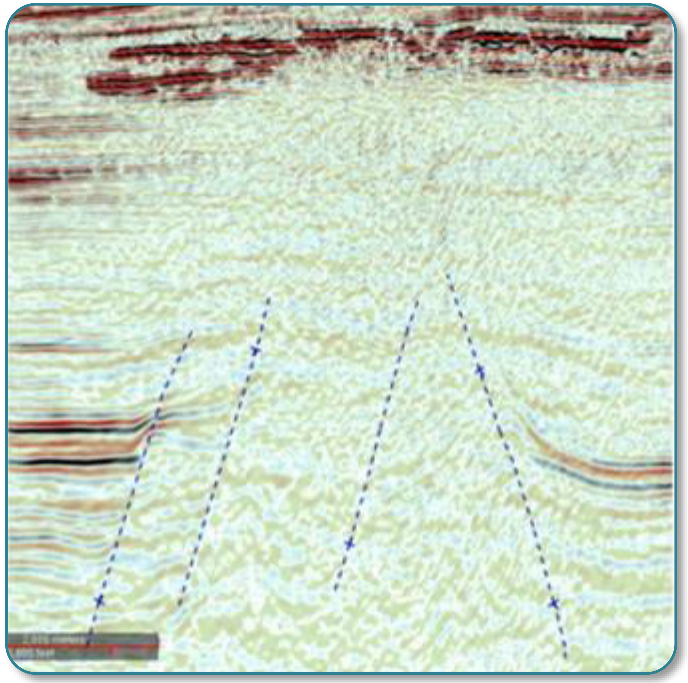
Seabed Seismic Acquisition



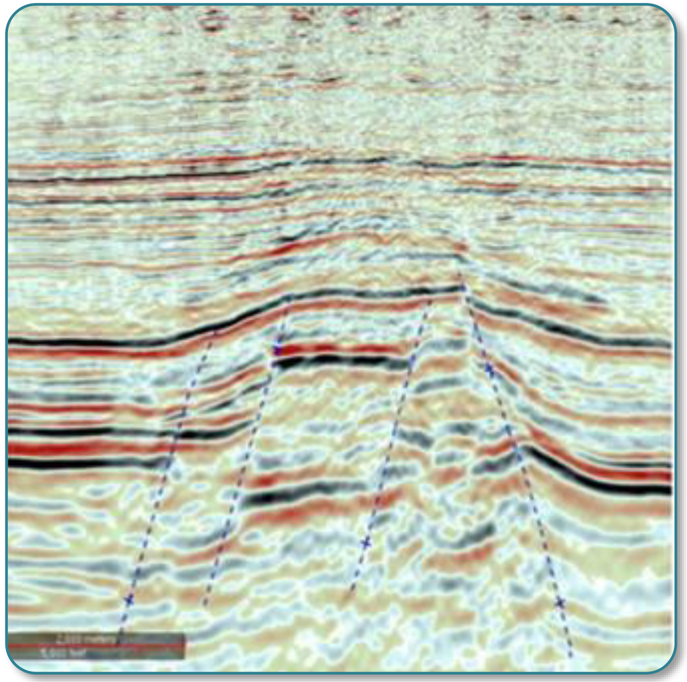
OBS seismic provides a step change in data quality

Imaging below gas

Top reservoir Albatross NW

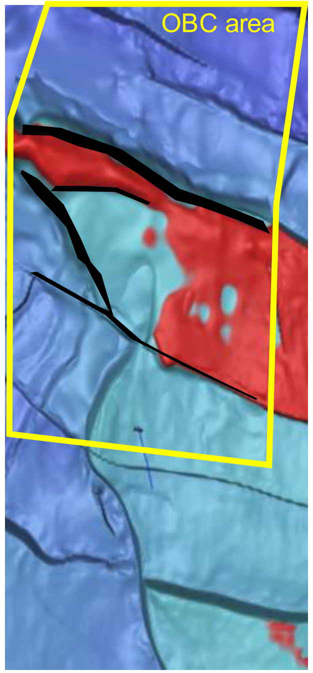


Streamer data



OBC PS

Streamer interpretation

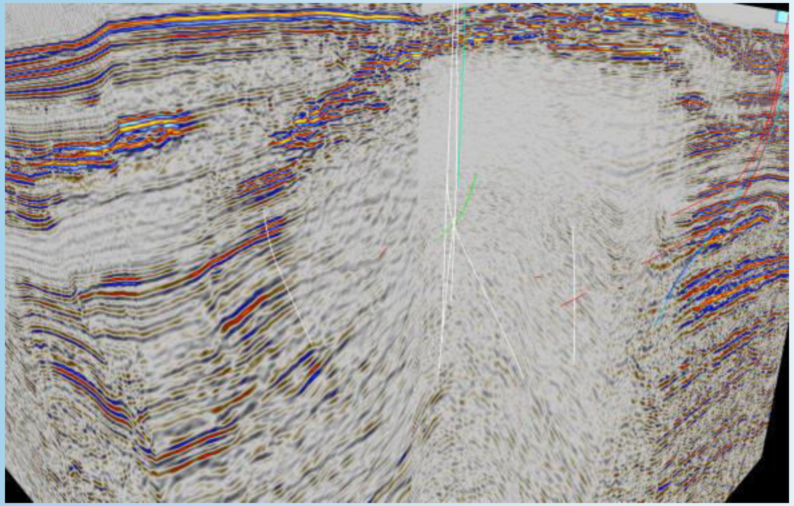


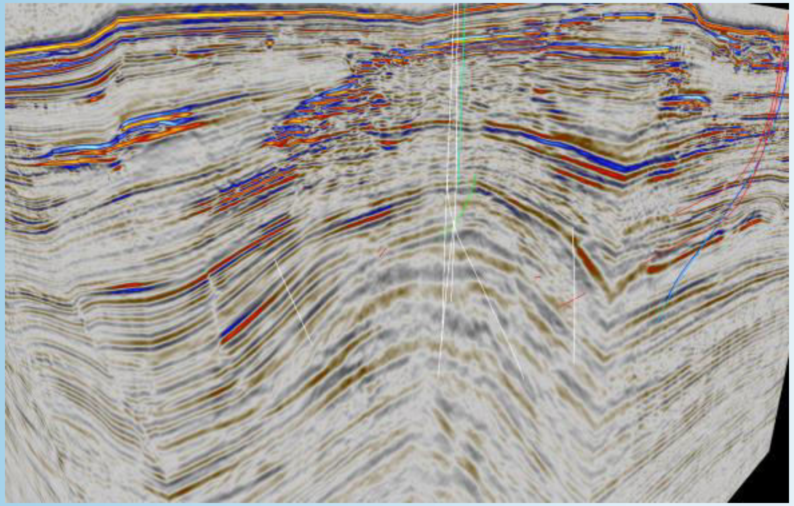
OBS interpretation

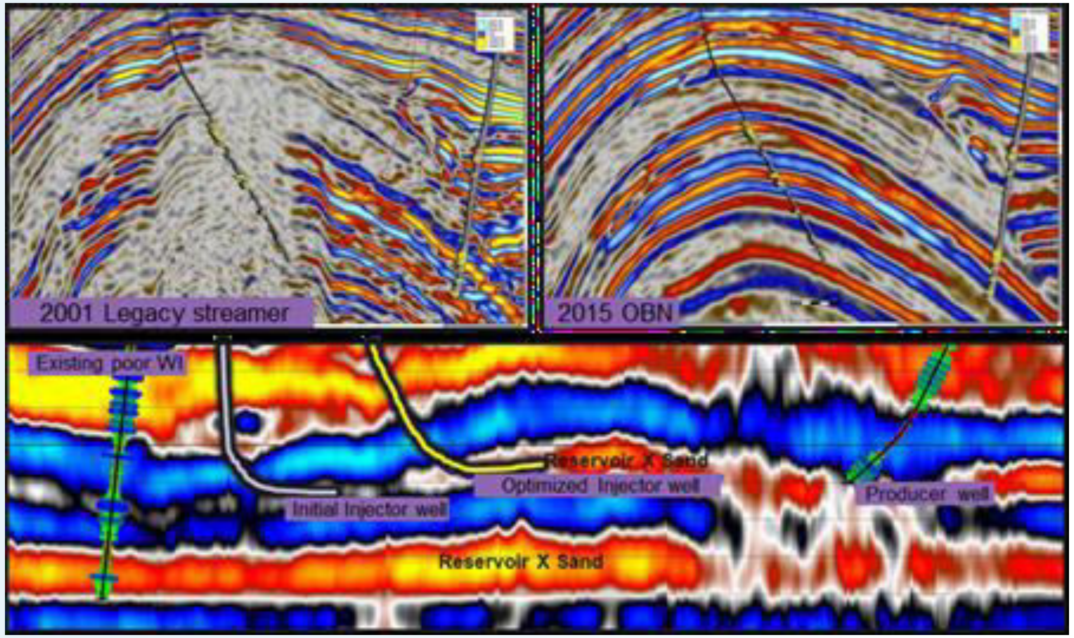
OBS data acquired by Magseis

Source: Equinor

Full Azimuth – PP Streamer OBN comparison





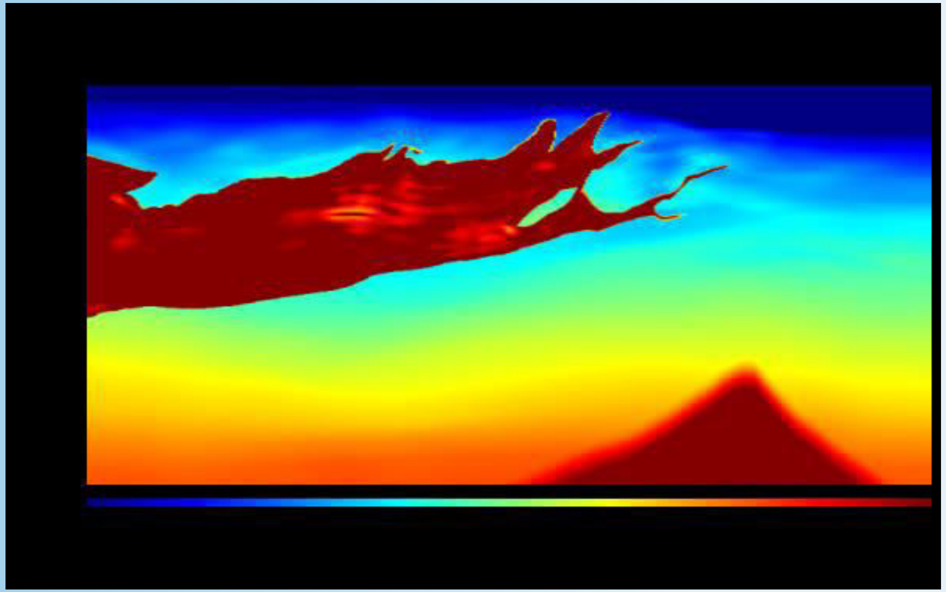


Uncovering the missing data in the gas cloud with P-P wave imaging: the first deep-water OBN survey from Southeast Asia

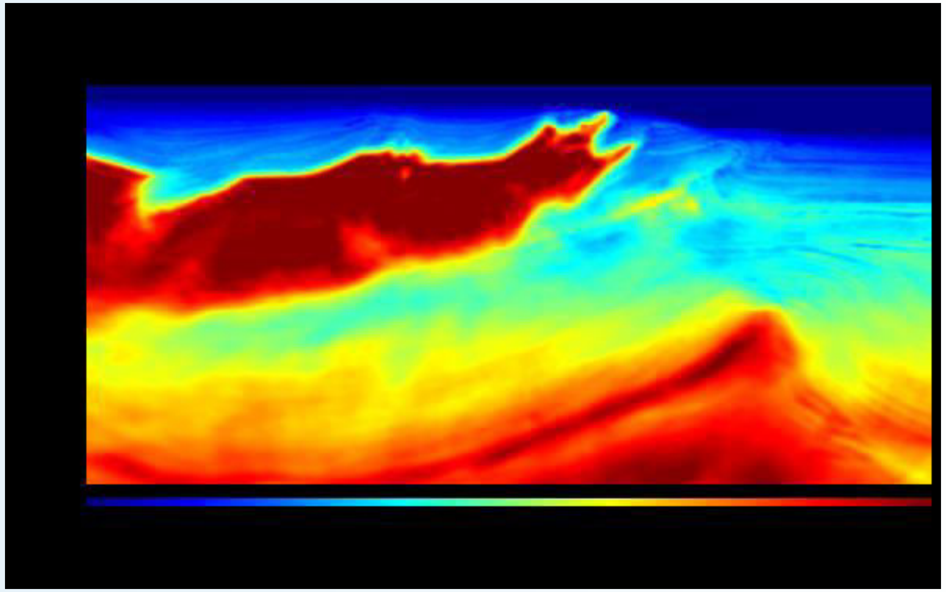
Gavin Menzel-Jones[1], Michelle Tham[1], Artem Sazykin[1], Wai Leng Cheah[1], Paal Kristiansen[1], Vanessa Goh[2], Herman Van Voorst Vader [2], Prasanta Nayak[2], Sijmen Gerritsen[2]*

[1]WesternGeco, [2]Shell

Atlantis – Long Offsets (20km +)



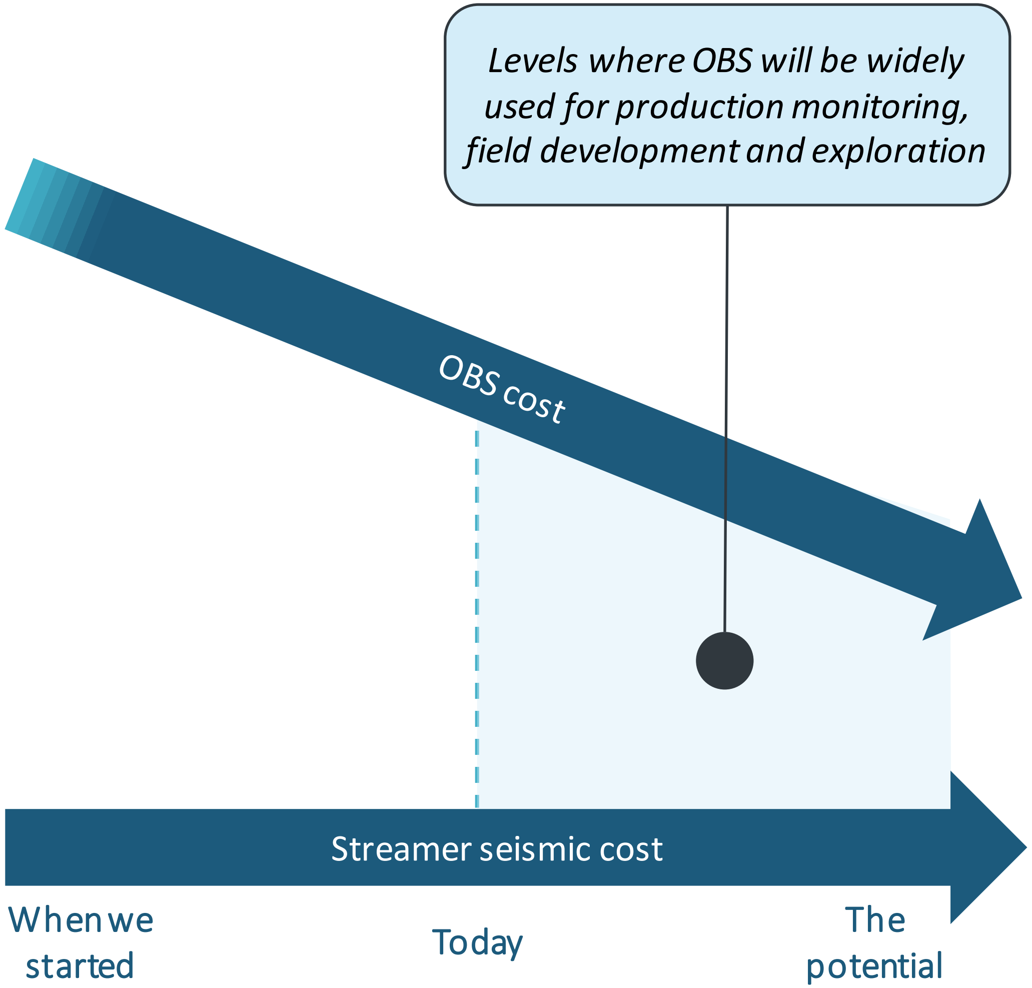
Legacy Velocity Model

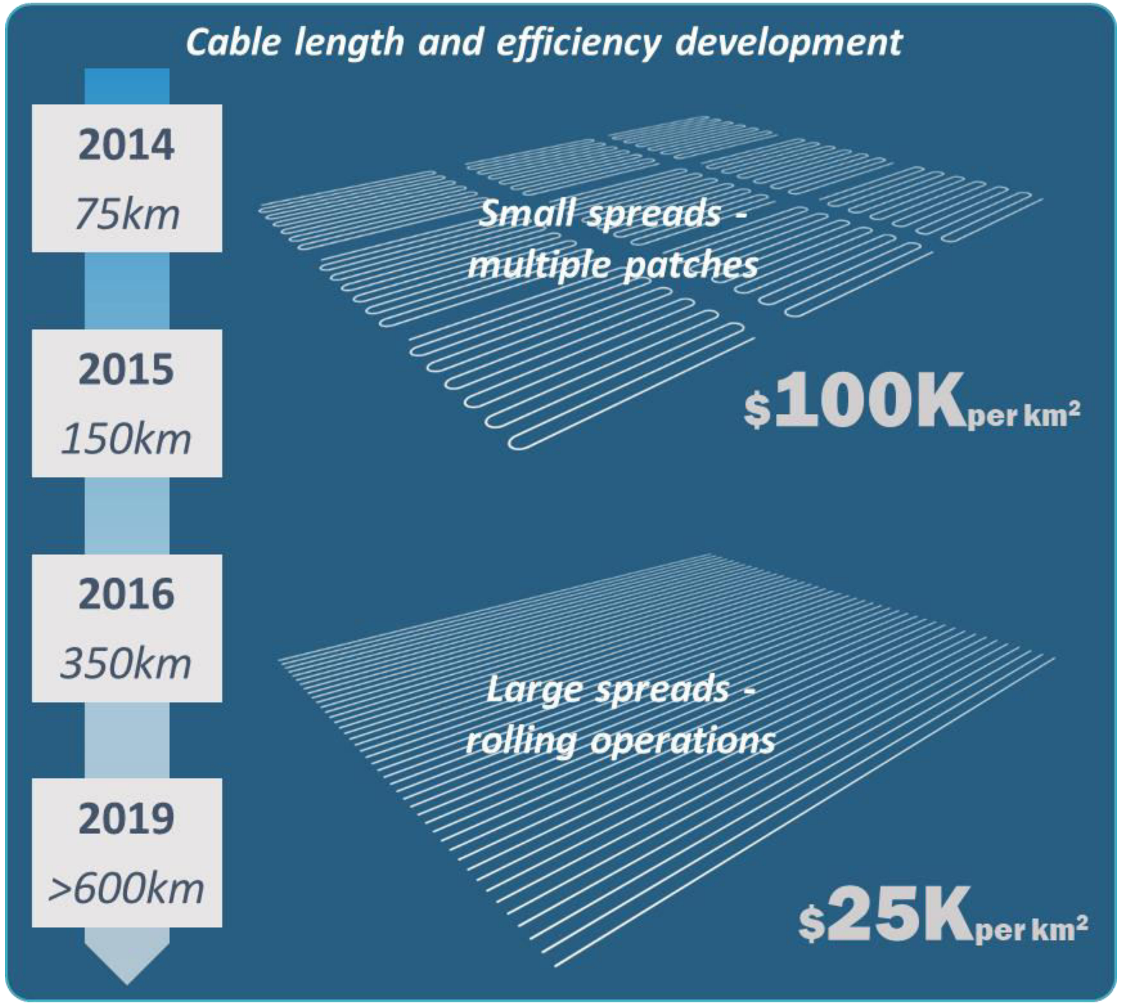


Velocity Model after FWI update

Salt model building at Atlantis with Full Waveform Inversion
Xukai Shen, Imtiaz Ahmed, Andrew Brenders, Joe Dellinger, John Etgen and Scott Michell , BP America Inc., Houston*

Significant efficiency and cost gains but more to come





Source: Magseis Fairfield

Global presence supports our client base and secures good node utilisation

Global footprint through local presence enables enhanced node utilisation

Magseis Fairfield historical operations

Source: Magseis Fairfield

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Leading Edge Sensor Electronics

- Small size
- Ultra compact electronics
- Ultra low power consumption
- 32 bit ADC resolution
- Atomic clock
- 64 – 128 GB Flash Memory
- Recording time up to 65-150 days
- Low Power options
- Fully programmable CPU
- Depth rated to 3000m

- Self test – electronics and sensors

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The Artemis Athene

Combined cable handler and source vessel

MASS – Marine Autonomous Seismic System

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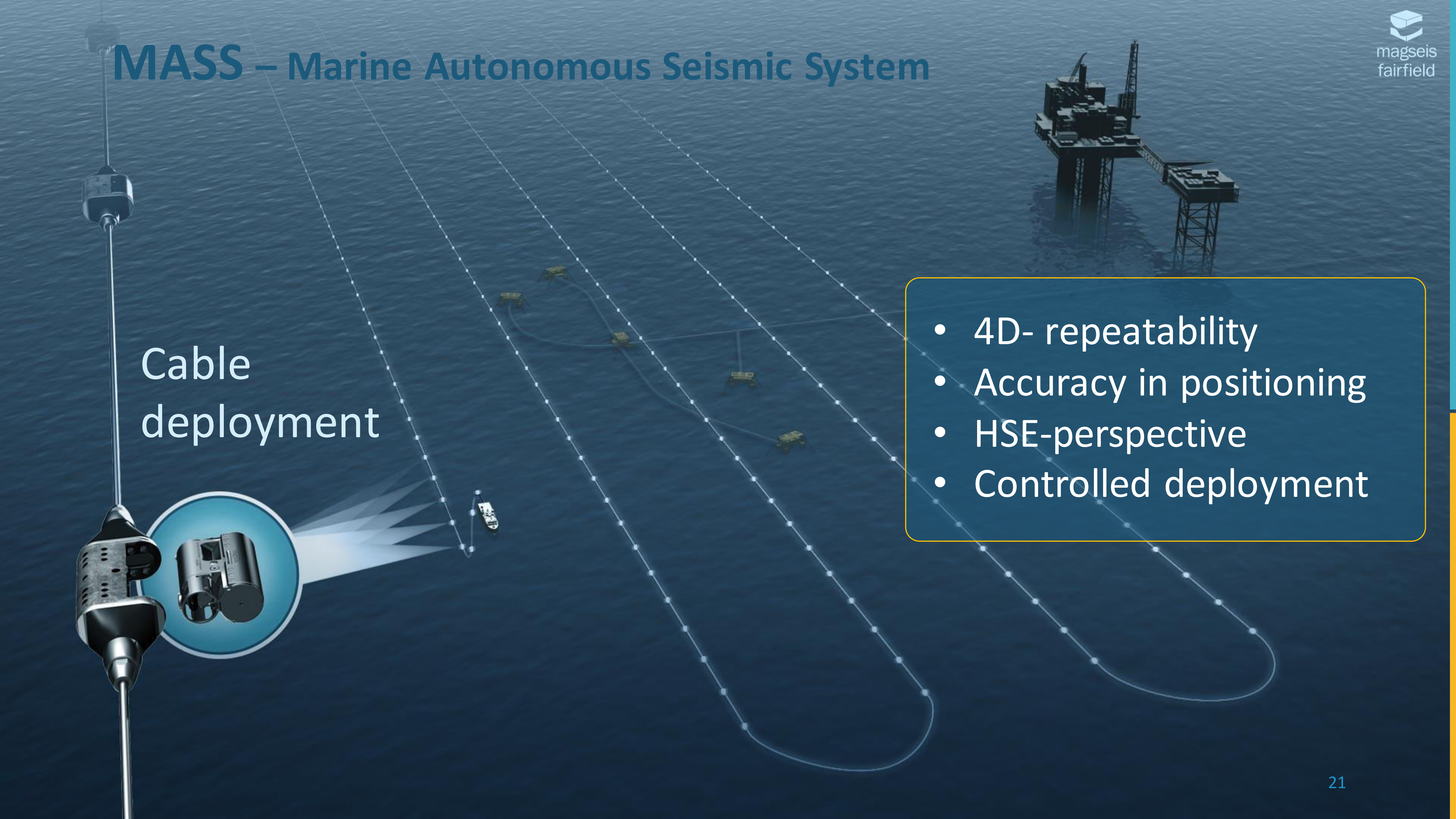
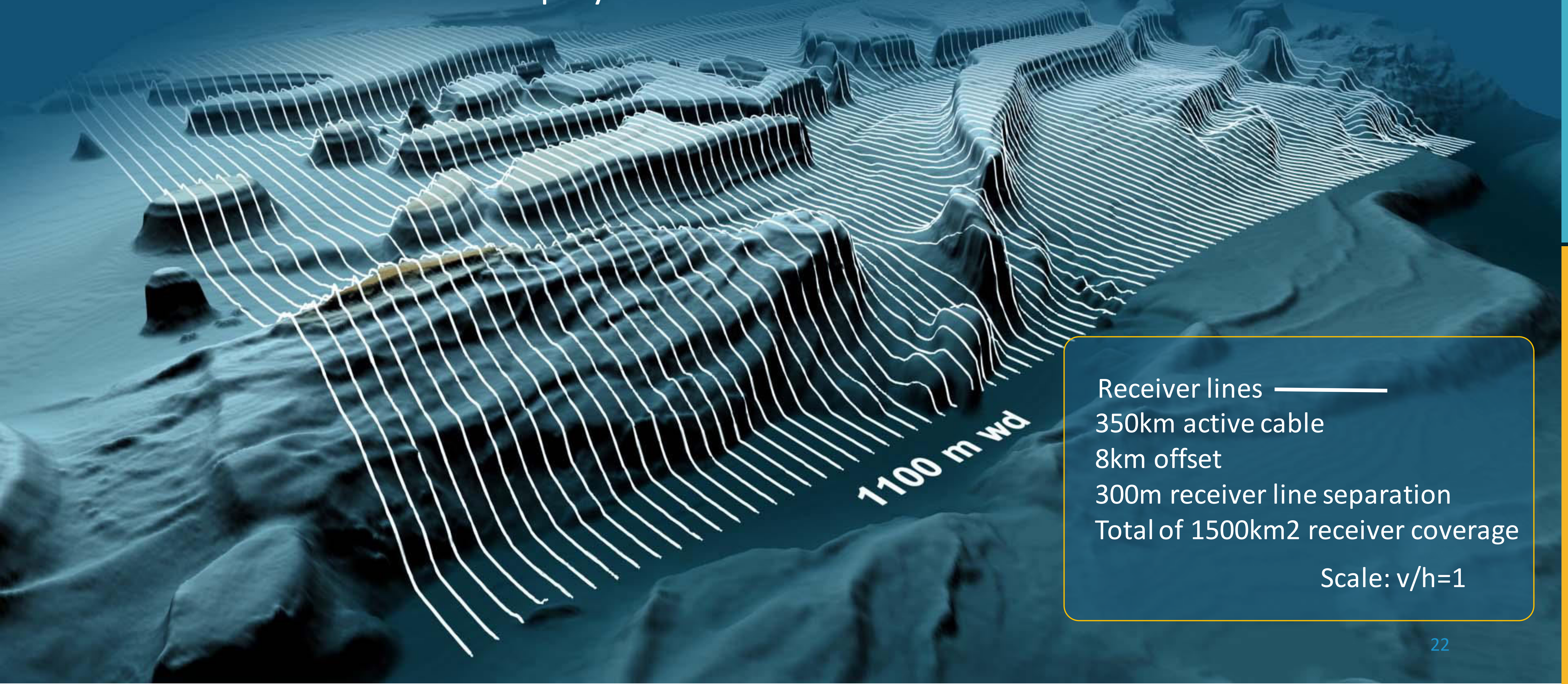


Cable deployment

- 4D- repeatability
- Accuracy in positioning
- HSE-perspective
- Controlled deployment

Red Sea survey

Receiver line layout and seabed topography
Combined cable and TZ deployment of 4C sensors

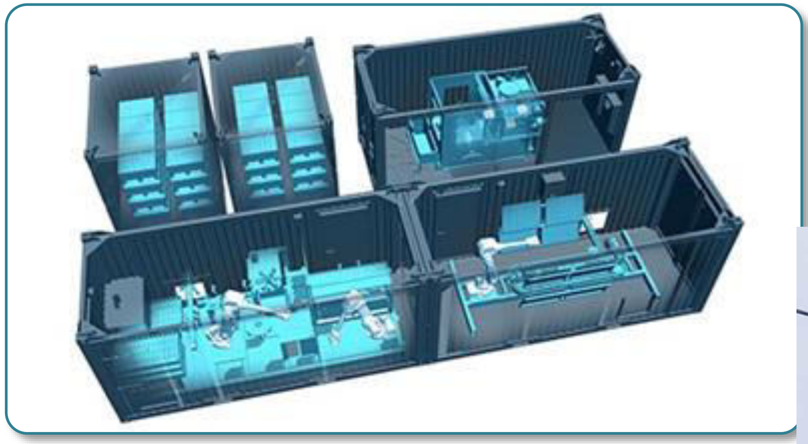


Receiver lines
350km active cable
8km offset
300m receiver line separation
Total of 1500km2 receiver coverage

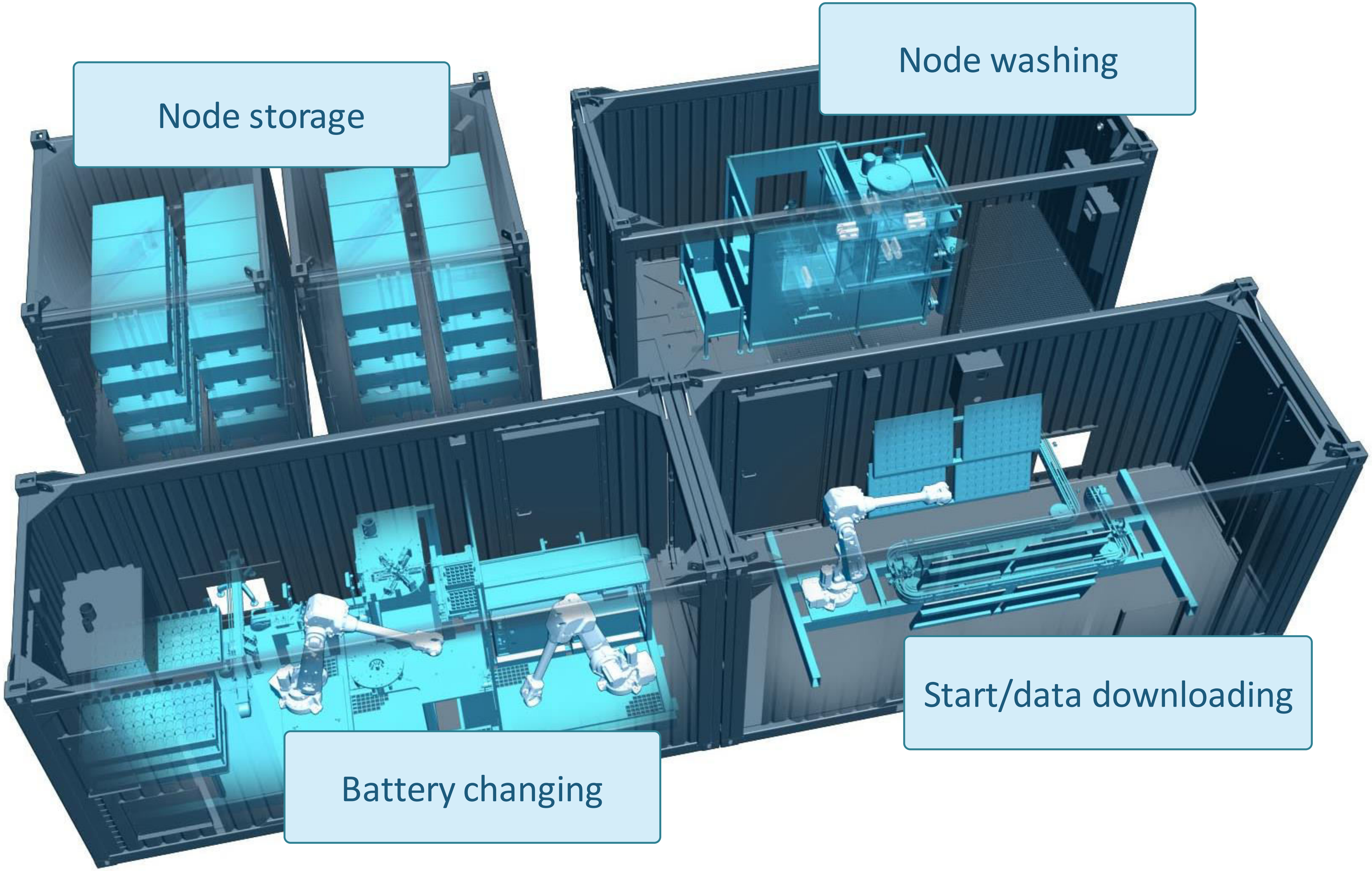
Scale: v/h=1

MASS Modular

- Fully containerized system
- Fully automated node handling system
- Unlimited number of nodes
- Hybrid onshore/offshore solution with respect to start-up, download and QC
- Mobilisation in < 1 wk
    - On vessel of opportunity
    - Onshore
- Efficiency comparable with high-end cable-based deployment platforms



MASS Modular



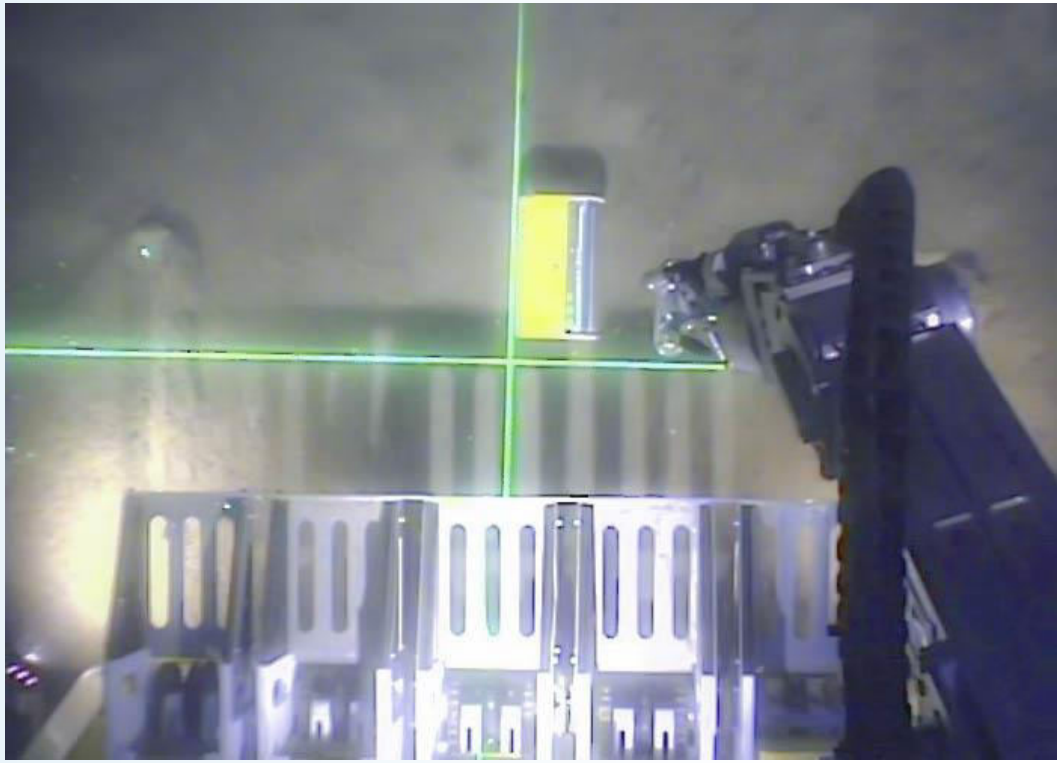
MASS Modular
ultra-compact & mobile

- High Capacity of nodes
- Modular handling system that can be mobilised quickly across the globe and with low fixed cost base
- Using vessels of opportunity / clients own vessels
- Enables cost-effective reservoir monitoring for smaller fields
- ConocoPhillips contract a key proof of concept

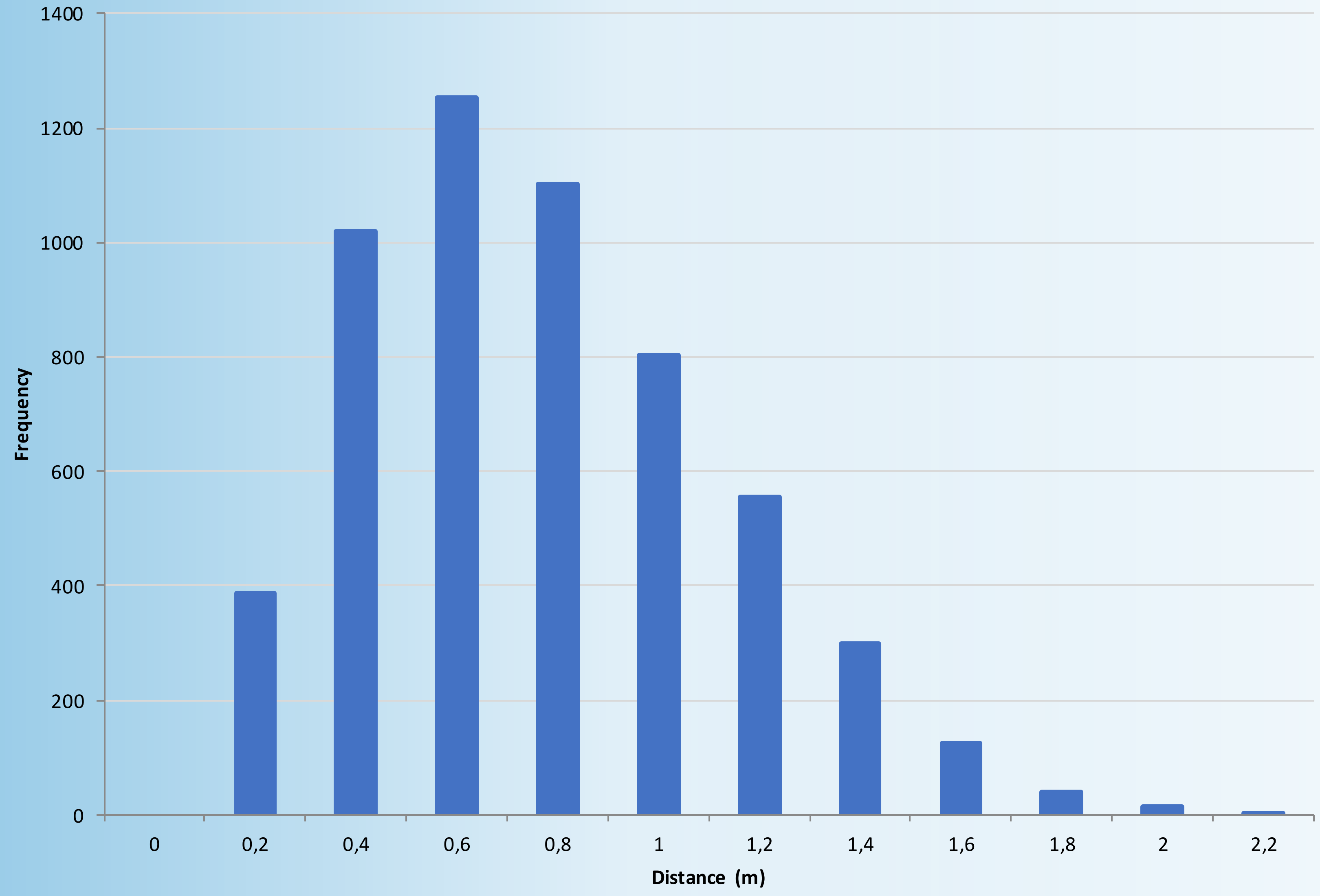
Easily transportable modular solution

4D: Positioning accuracy

- USBL with DVL-aided INS positioning on ROV for initial position
- Typical spec with calibrated USBL is 0,6% of water depth
- Time for fix on each node location tradeoff – accuracy vs efficiency
- Can be improved to about 0,3% of water depths using DVL-guided INS
- Verify node position with first-break picks



Distance Between Pre Plot and First Break Positions
Fast deployment – well within spec.



Difference in distance between pre planned location coordianates and coordinates confirmed by first break positioning.

During node deployment 15 nodes were unable to be placed on there pre plot positions due to platfrom obstructions or unsuitable seabed bottom type

95% Confidence interval = 0.68m ±0.01

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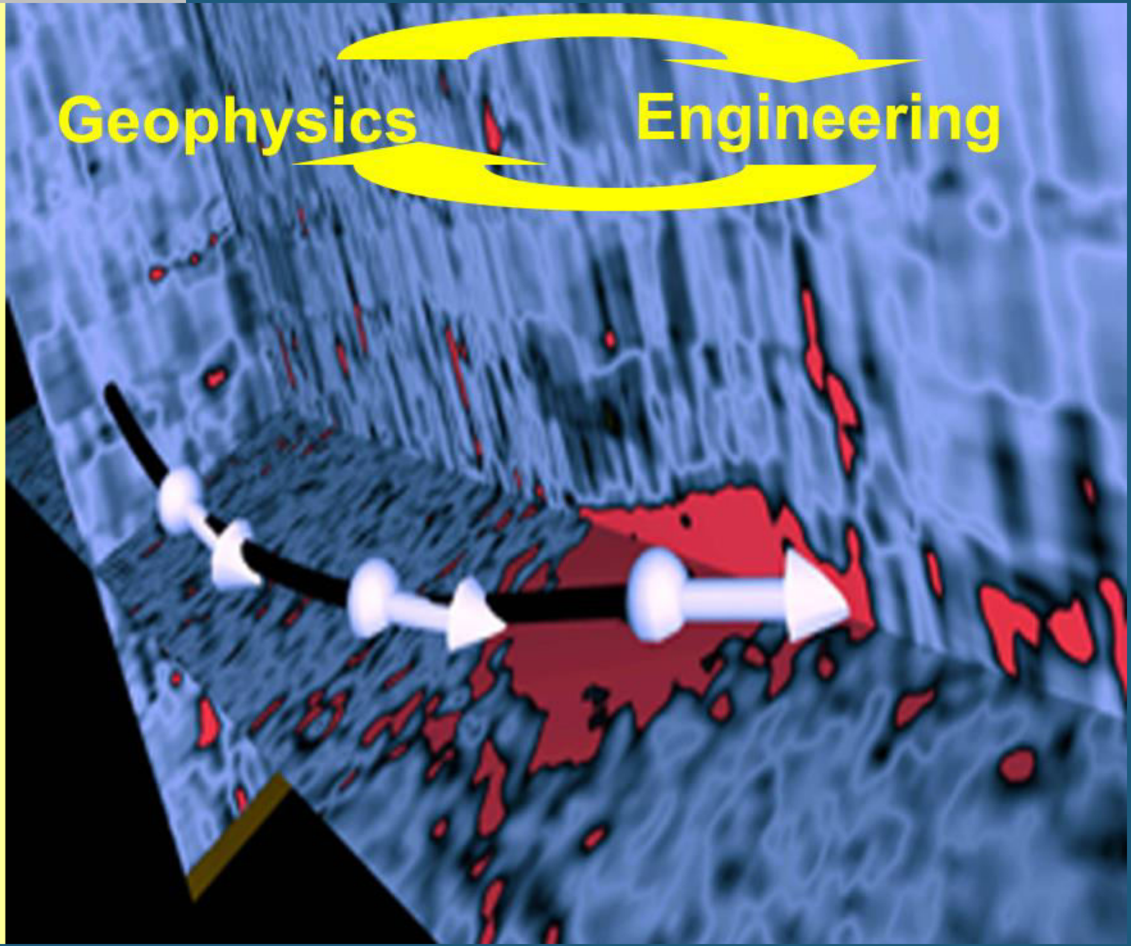
A new operational and commercial model for Seismic Reservoir Monitoring

Reservoir Management

4D Goals

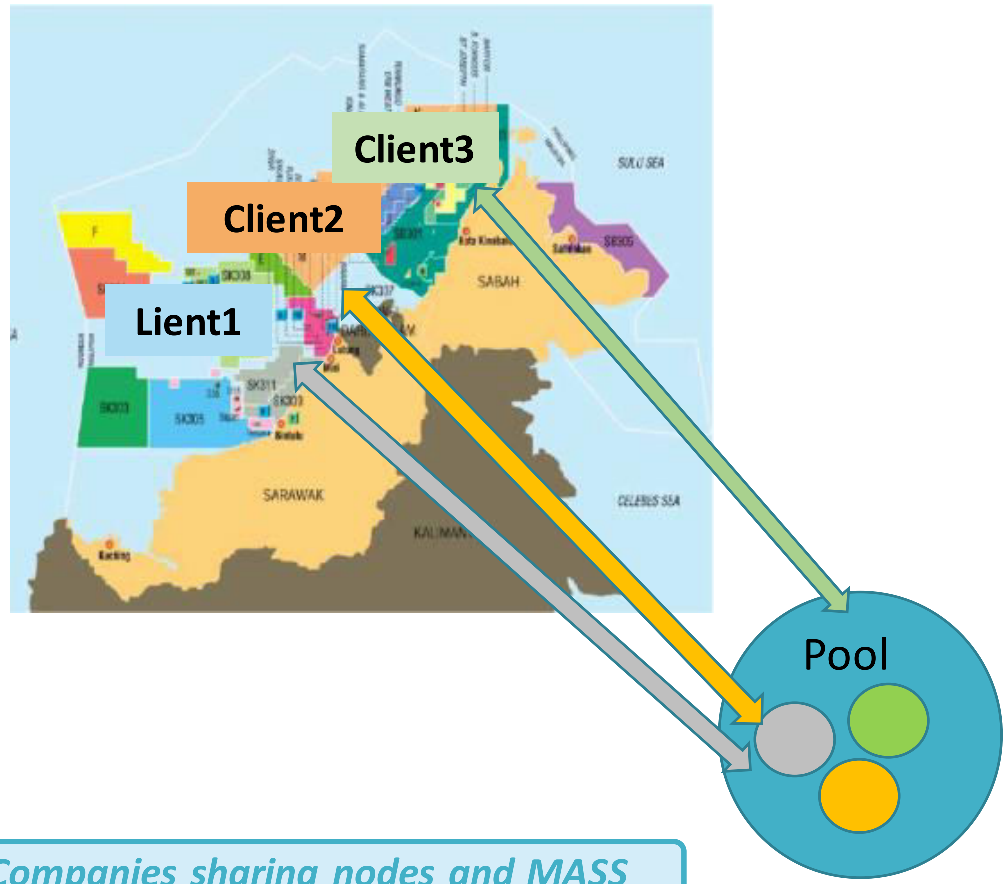
- To detect the changes in the reservoir (pressure, fluid saturation, movement of fluid contacts, temperature, …) due to production effects
- To minimise differences in 4D seismic data due to non-repeatable changes in data acquisition and processing
- To produce a clear image of the reservoir changes

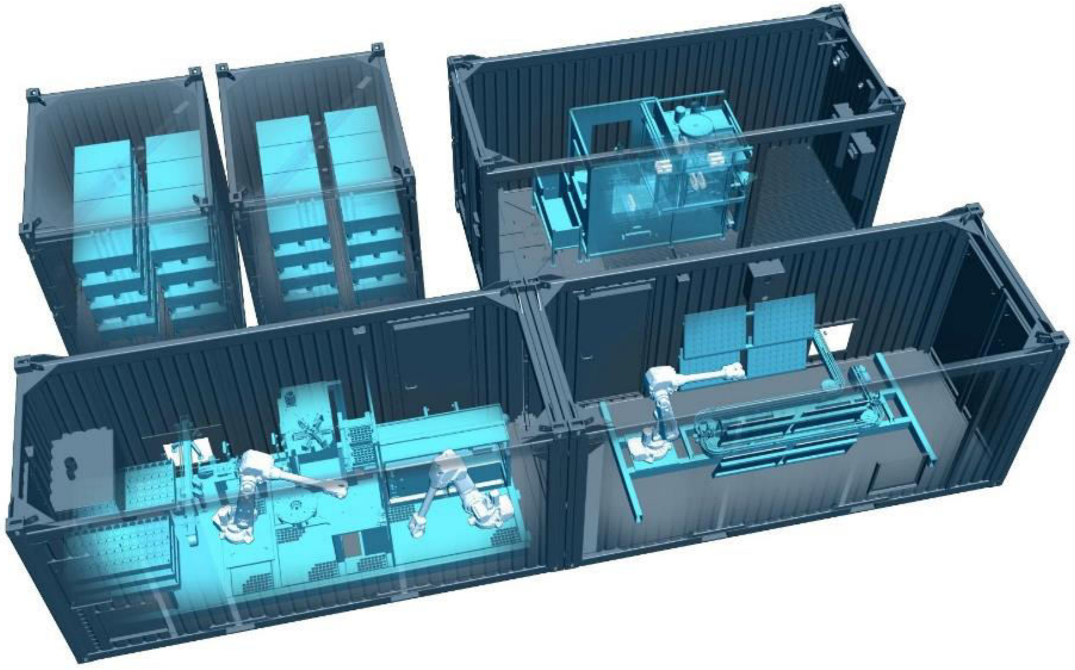


To Optimize Reservoir Management => Seismic On Demand

Ongoing AP Bundled Operation

Cost efficient operation by surveys sharing one handling system

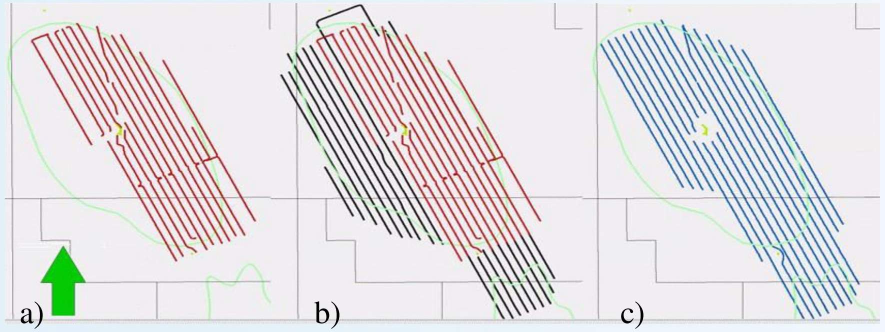




3 Companies sharing nodes and MASS Modular System for a back to back acquisition

Reduced mobilisation cost and continuous operation

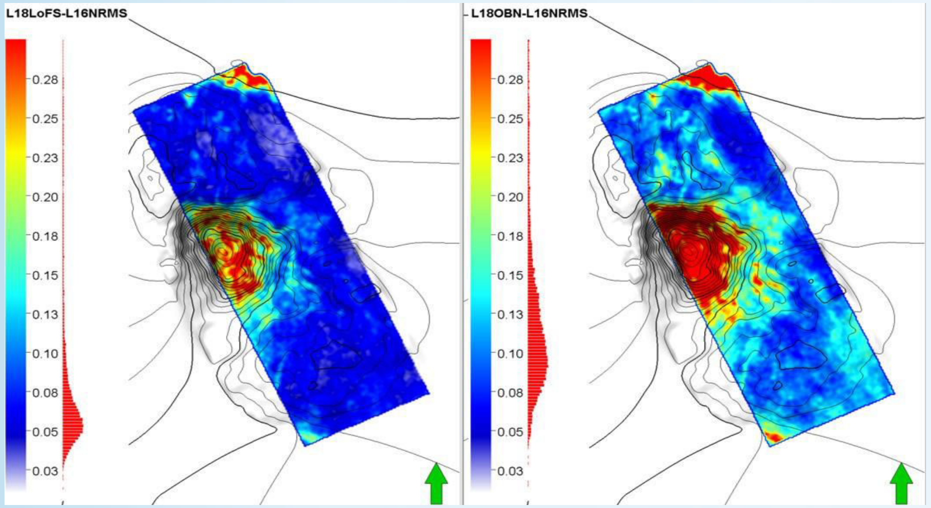
Valhall PRM&Nodes – 2003 trough 2018

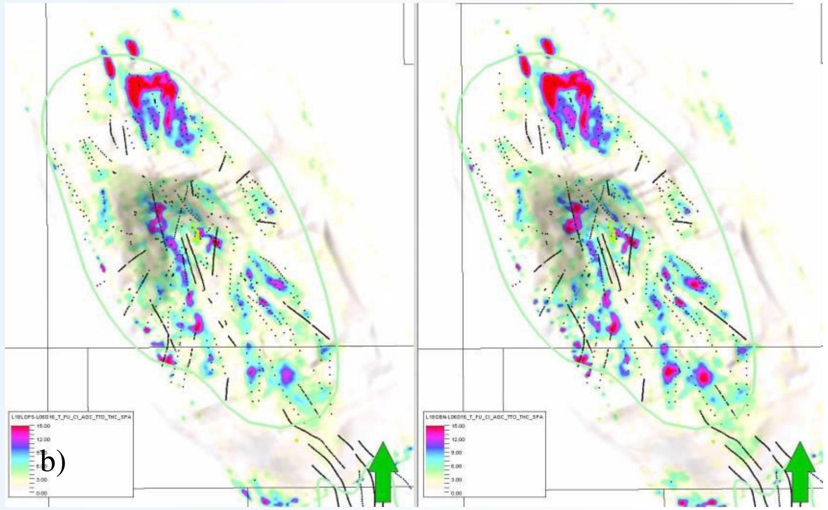


Survey #15 #17 #18

Variation in Monitor(s) Focus and Extent 2015 through 20017

The modal NRMS value for the LoFS vs LoFS version is approximately 6%, whilst the OBN vs LoFS is over 9%.





The Evolution of 4D Monitoring at the Valhall Field, from Permanent Cables to Retrievable Nodes

R. Milne* (Aker BP), J. Kommedal (Aker BP), E. Kjos (Aker BP), M. Porter (WesternGeco)

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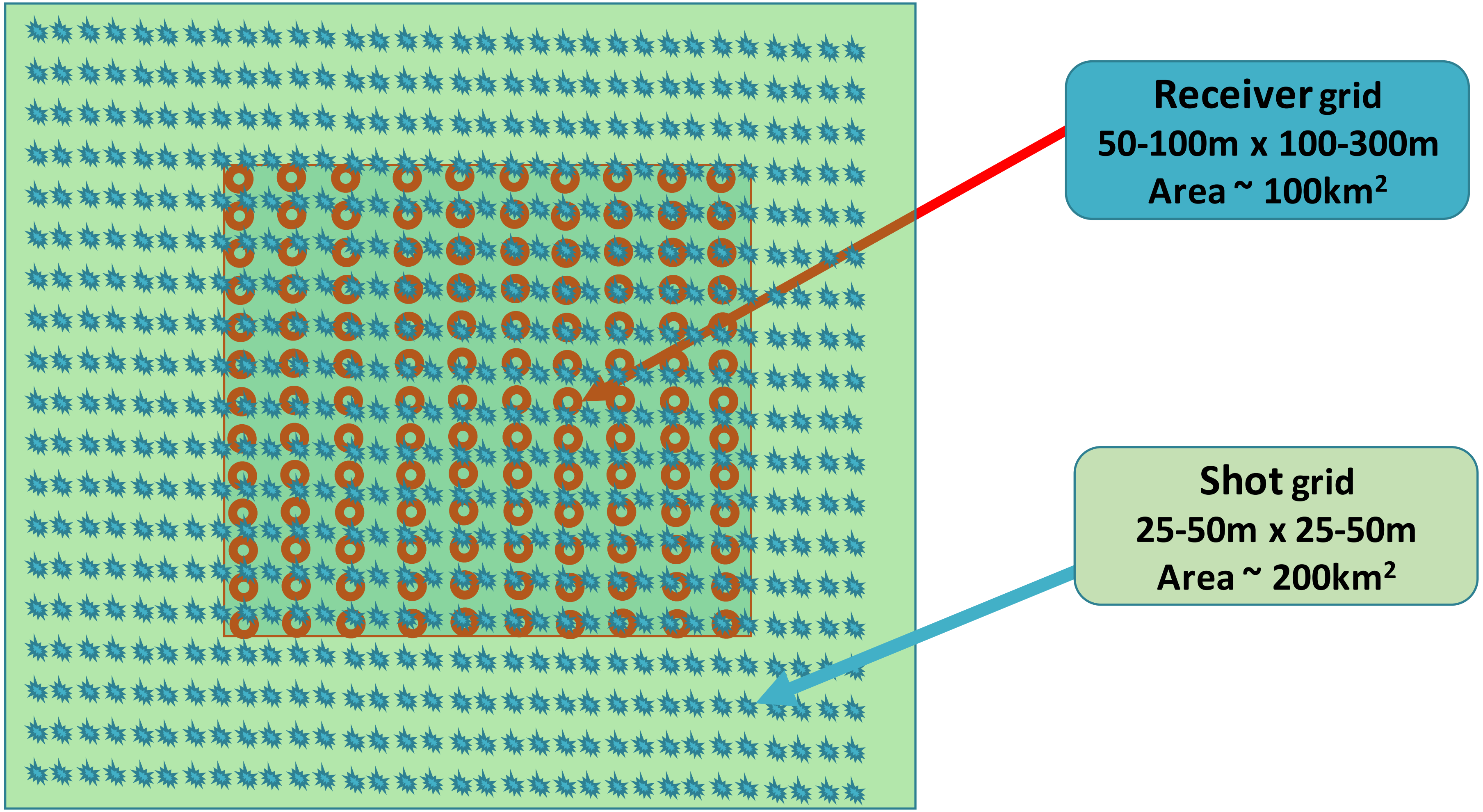
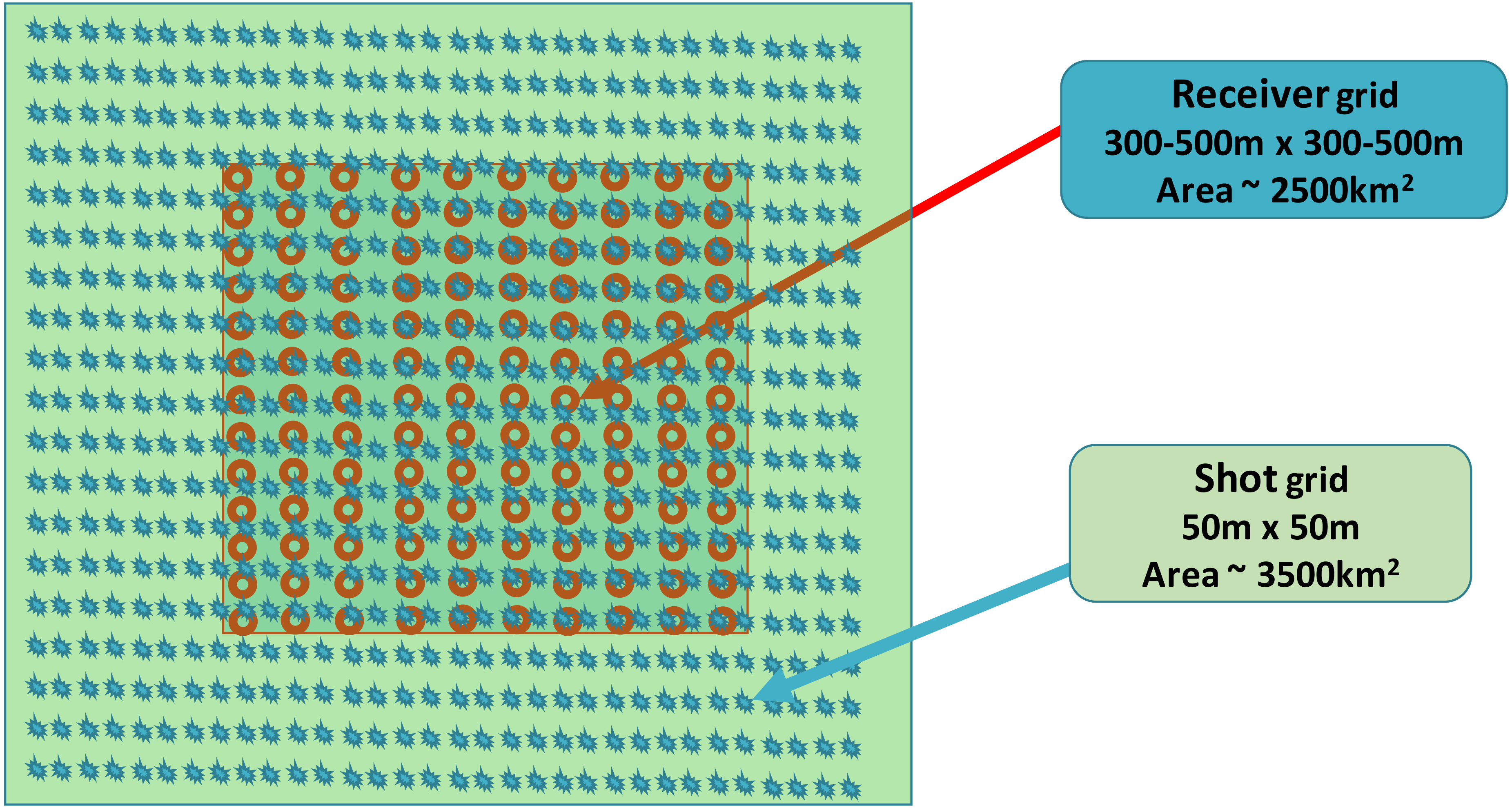
Shot and Receiver grid I



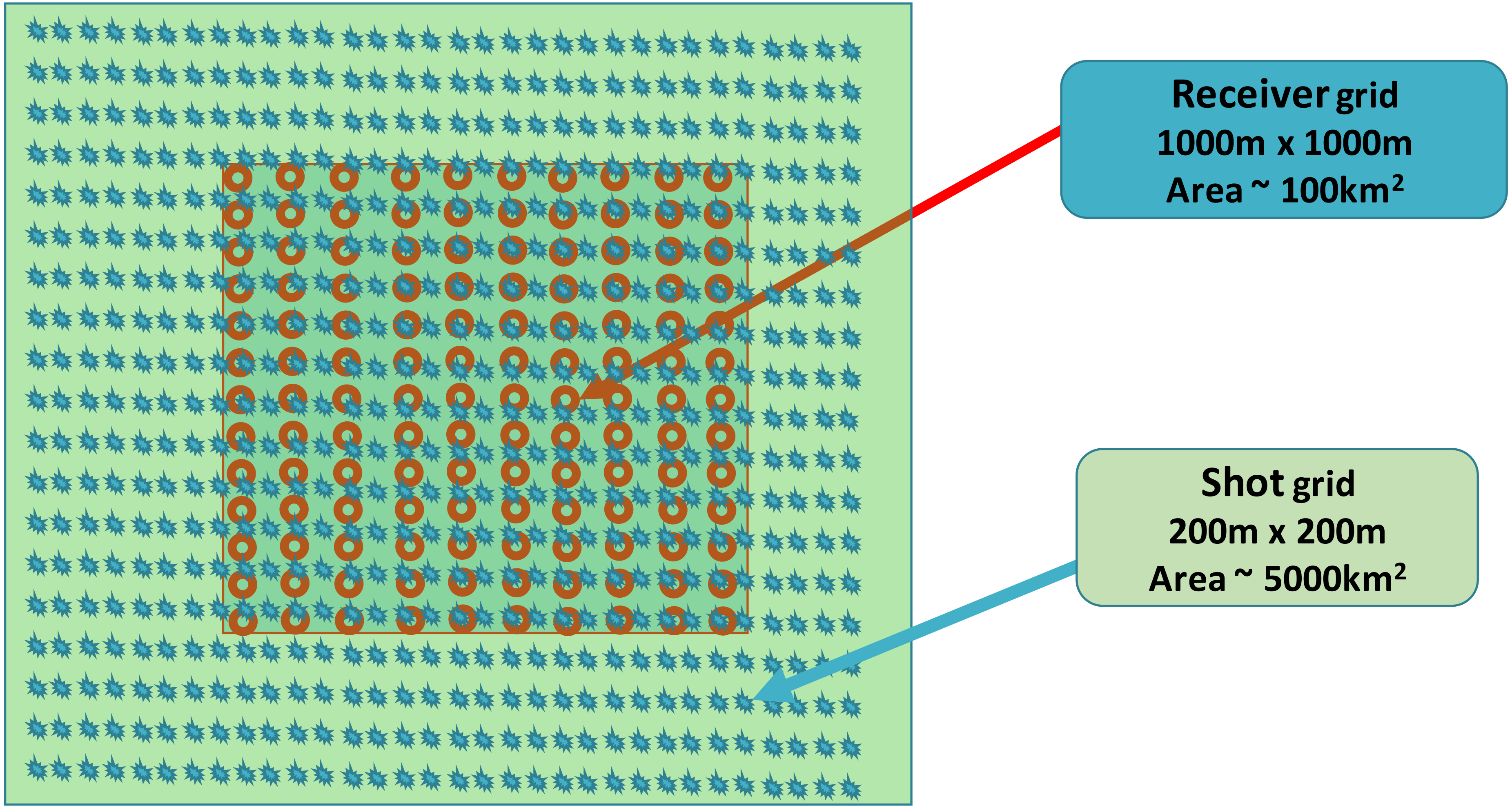
A typical 4D Configuration

Shot and Receiver grid II



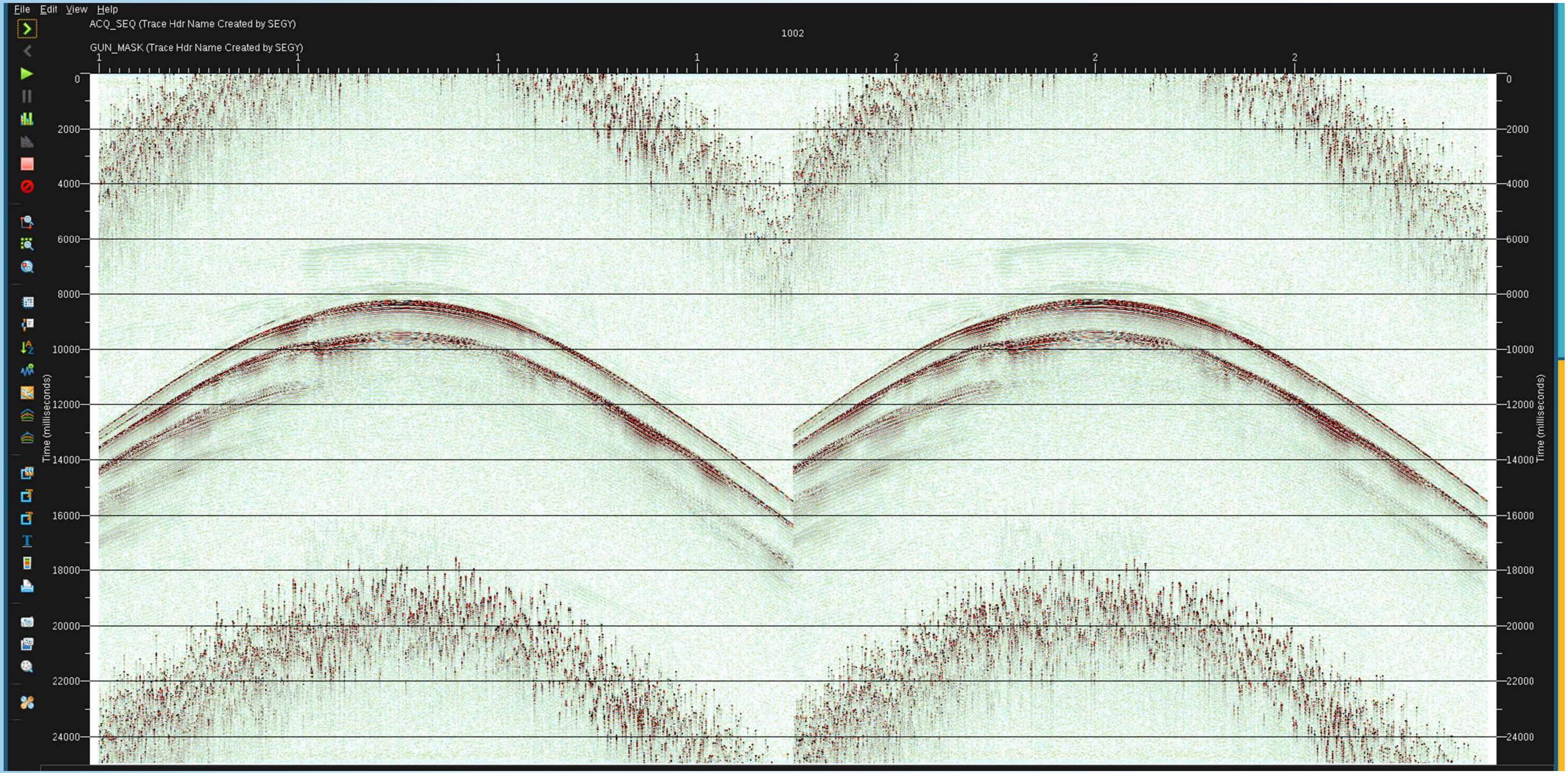
A typical Exploration Configuration

Shot and Receiver grid III



A typical Velocity Profile Configuration (GOM)

Simultaneous Shooting can reduce the project time



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4D Experience 2005 to 2019

In Excess of
5500 km^2 Receiver Coverage
120 000 Node Locations

4D Experience 2005 to 2019

Field Name	Date Start/End	Company Name	Geographic Location	Deployment Method	Rcv sqkm	SRC sqkm	No. of Nodes	Total no.Shots	Duratior Days	Water Depth
Gulfaks	Nov 11 - Mar 12	Statoil	North Sea	NodesOnRope	59	112.7	4,824	38,896	150	120m
Gulfaks 2	May 12 - Jul 12	Statoil	North Sea	NodesOnRope	23	44	3,106	35,144	90	120m
Beryl	Jul 12 - Aug 12	Apache	North Sea	NodesOnRope	39.2	86	2,529	68,820	25	110m
Njord OBS	June 14 - July 14	Statoil	North Sea	NodesOnRope	147	156.8	14,868	100,350	30	300-340m
Laggan	Sept 14 - Oct 14	Total	North Sea	NodesOnRope			2,592	22,724	35	600m
East J Ridge	Oct 14 - Feb 15	CoP	North Sea	NodesOnRope	260.3	528.5	17,952	238,050	120	120m
Golden Eagle	March 15 - June 15	Nexen	North Sea	NodesOnRope	74	228	5,154	364,826	65	95m
Valhall	June 15 - July 15	BP	North Sea	NodesOnRope	54	63.3	3,580	63,285	35	100m
Valhall/ HOD	Mar 17 - May 17	BP	North Sea	NodesOnRope	92	265	6,160	103,219	48	70m
Clair Ridge	May 17 - Aug	BP	North Sea	NodesOnRope	66	125	13,244	222,036	110	130-190m
Kinnoull	Aug 17 - Sept 17	BP	North Sea	NodesOnRope	60	128	6,120	51,630	37	100-130m
NOC Al-Shahee	Dec 18 -nSep 19	NOC	Qatar	NodesOnRope					274	15-75 m
Atlantis	Oct 05 - May 06	BP	GoM	ROV	247	760	1,628	458,098	168	2200
Deimios	Jul 07 - Nov 07	Shell	GoM	ROV	125	450	802	185,180	99	850
Mars	Apr 10 - Jul 10	Shell	GoM	ROV	175	650	1,097	266,427	78	900
Ursa	Oct 10 - Dec 10	Shell	GoM	ROV	145	720	937	290,117	78	1200
Perdido	May 12 - Jul 12	Shell	GoM	ROV	24	95	153	37,279	42	2400
URSA -1	Sep 12 - Oct 12	Shell	GoM	ROV	21	80	134	32,030	42	1000
URSA-2	Aug 12 - Sep 12	Shell	GoM	ROV	21	80	132	32,000	45	1160
Mars I4D	Nov 12 - Jan 13	Shell	GoM	ROV	22	82	140	33,000	47	900
Perdido	May 13 - Sept 13	Shell	GoM	ROV	240	790	1,550	315,877	41	220-0-2400
Atlantis	Nov 14 - Apr 15	BP	GoM	ROV	303	1,150	1,896	453,750	151	700-2700
Thunderhorse	Apr 15 - Oct 15	BP	GoM	ROV	320	1,125	2,006	484,758	138	160-0-2000
Mars/ URSA	Oct 15 - Mar 16	Shell	GoM	ROV	396	1,160	2,385	494,070	146	800-1200
Great White	Mar 16 - May 16	Shell	GoM	ROV	962		962	158,293	67	220-0-2600
Libra	Oct 17-Nov 18	Petrobras	Brazil	ROV	734	1,193	3,576	478,434	408	2,000
Mad Dog	Oct 17 - Mar 18	BP	GoM	ROV	583	1933	3061	787394	146	2000
Oseberg	May14 - Sep 14	Statoil	North Sea	Cable						
Gullfaks	Jun14 - Jul14	Statoil	North Sea	Cable						
South Arne	Sep14 - Nov14	Hess	North Sea	Cable						
Captain	Apr15 - Aug15	ChevronUK	North Sea	Cable						
Bokor	Dec15 - May16	Petronas	Malaysia	Cable						
Eldfisk	Jun17 - Sept18	CoP	North Sea	ROV						
Balder Ringhor	May18 - Jun 17	Point R.	North Sea	ROV						

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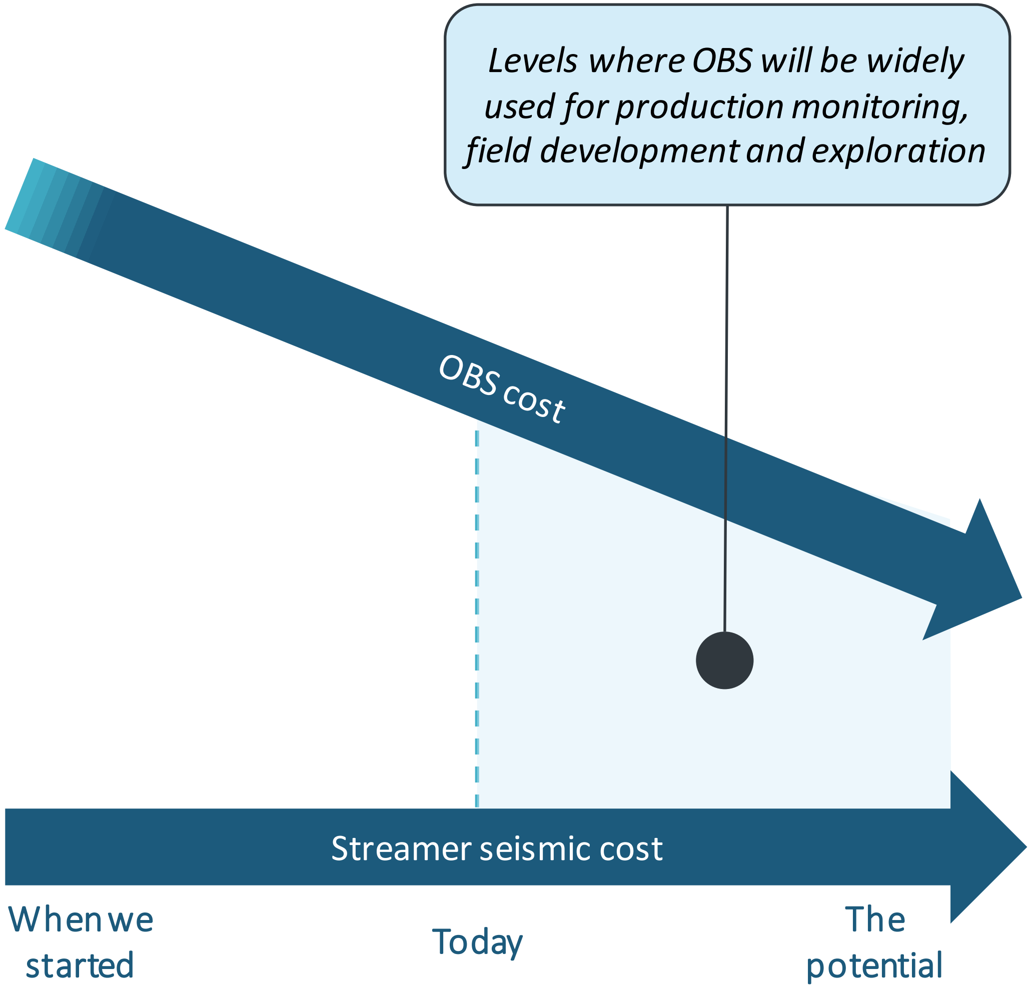
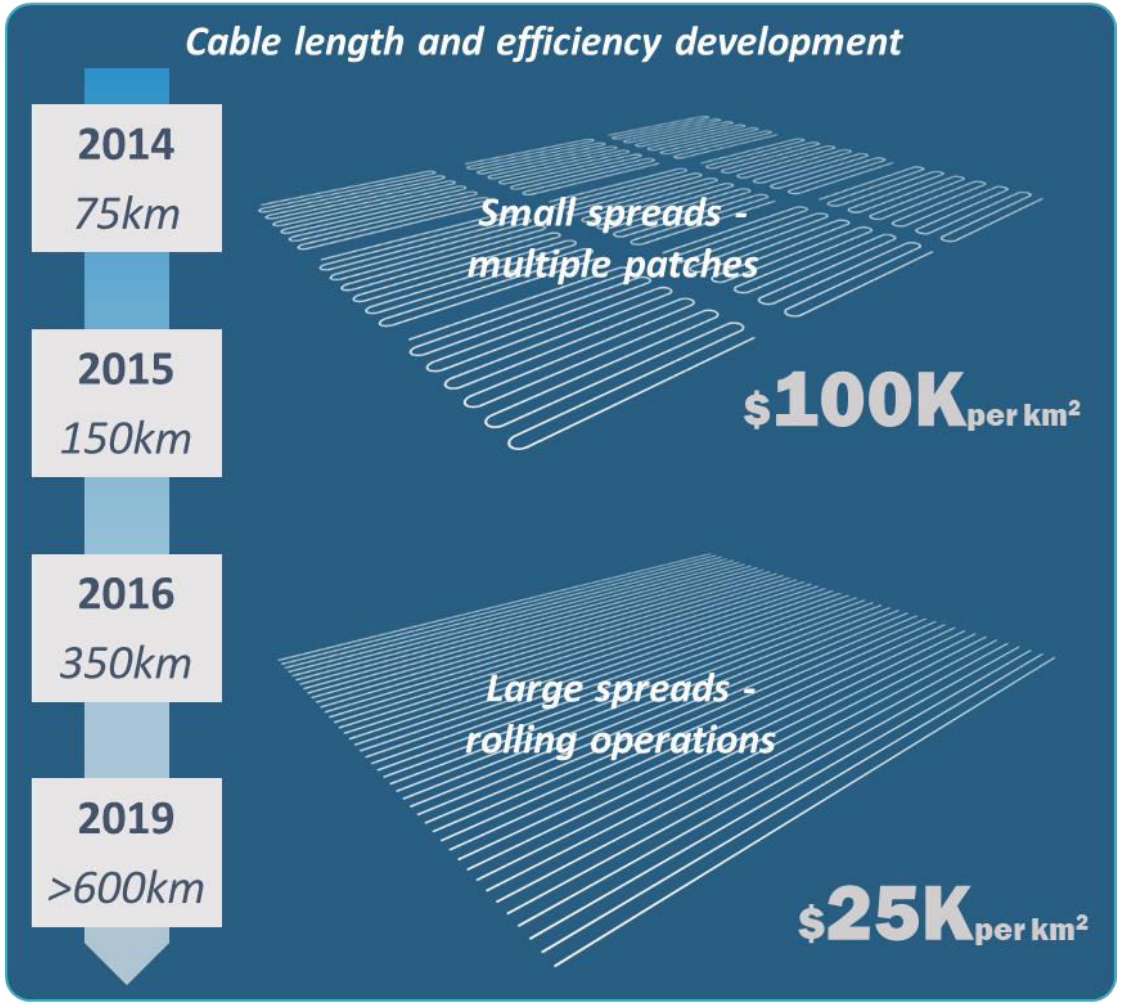
Significant efficiency and cost gains but more to come





Source: Magseis Fairfield

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Thank You!