Synthetic Aperture Sonar Nadir Gap Coverage with Centimetric Resolution

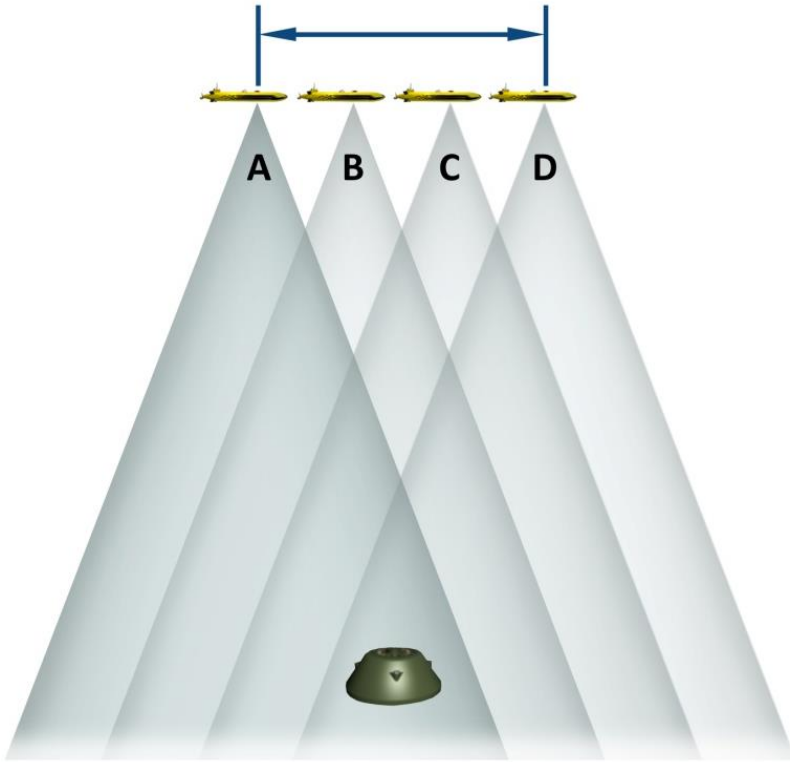
Jeremy Dillon

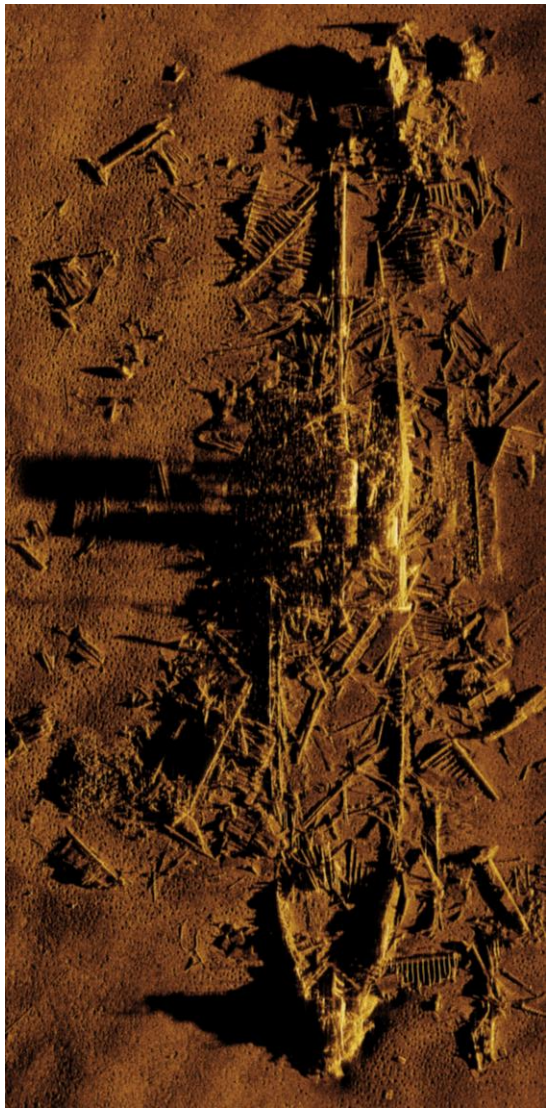
OCEANS 2020

KRAKEN

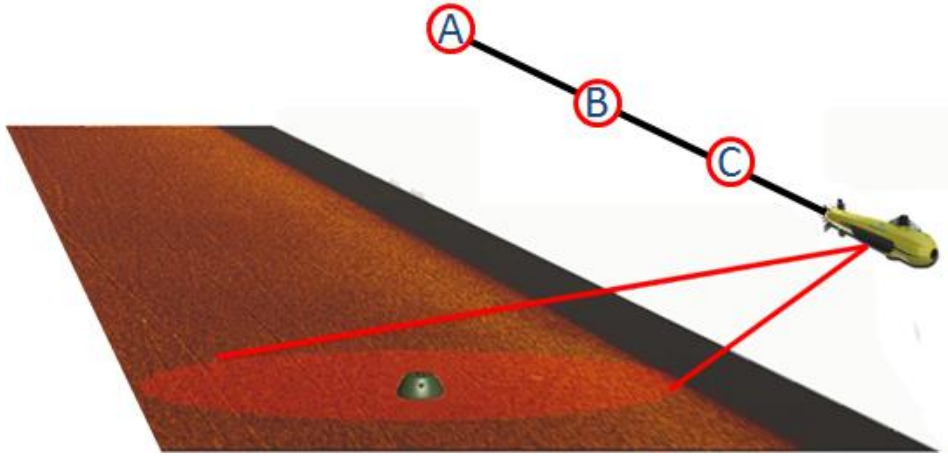
Synthetic Aperture Sonar Technology

Produces a synthetic aperture equal to the platform distance traveled.

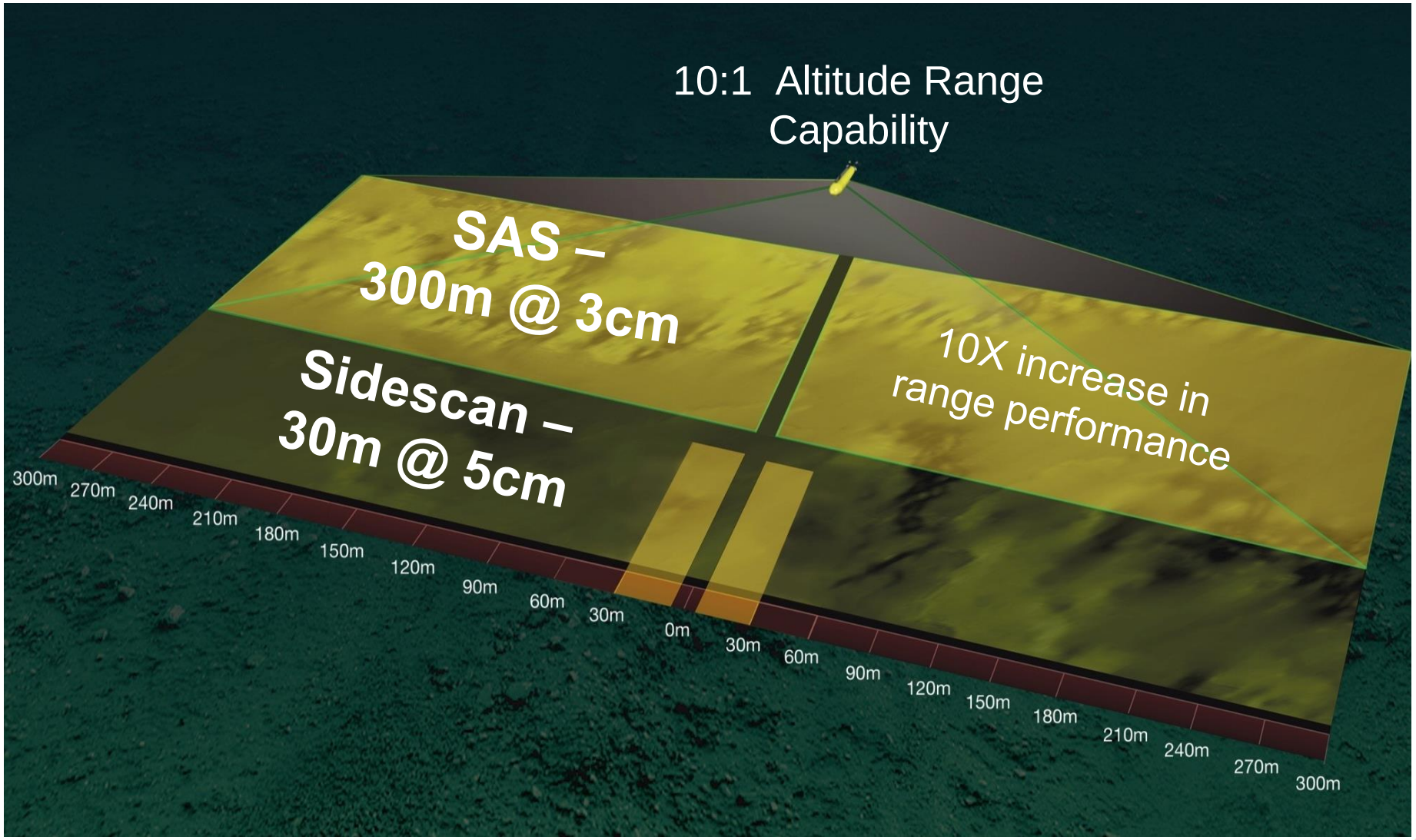




SAS coherently combines acoustic pings to create ultra-high resolution images.

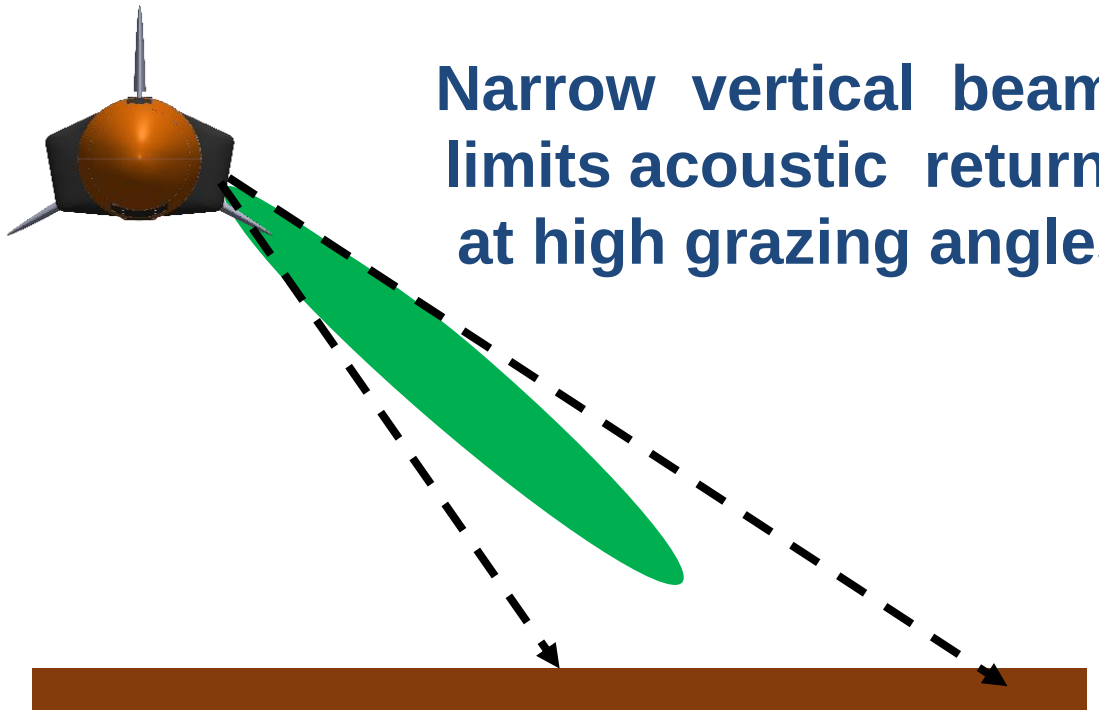


Synthetic Aperture Sonar (SAS) Advantage



Side looking geometry maximizes range performance but causes a gap in coverage at NADIR

SAS NADIR Gap



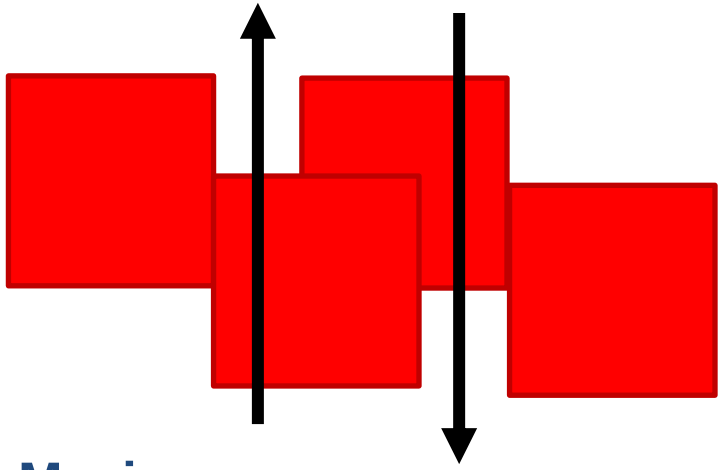
Narrow vertical beams limits acoustic returns at high grazing angles

Near-range imagery begins at depression angles of 45°, leaving a nadir gap of at least 2X altitude

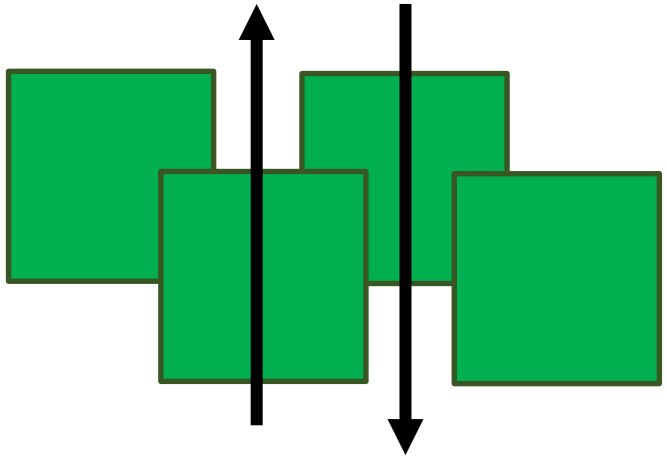
To obtain full coverage need to either:

- Overlap survey lines
  → decreases area coverage rate.
- Develop technology to cover the gap
  → challenging to match SAS altitude and resolution capabilities

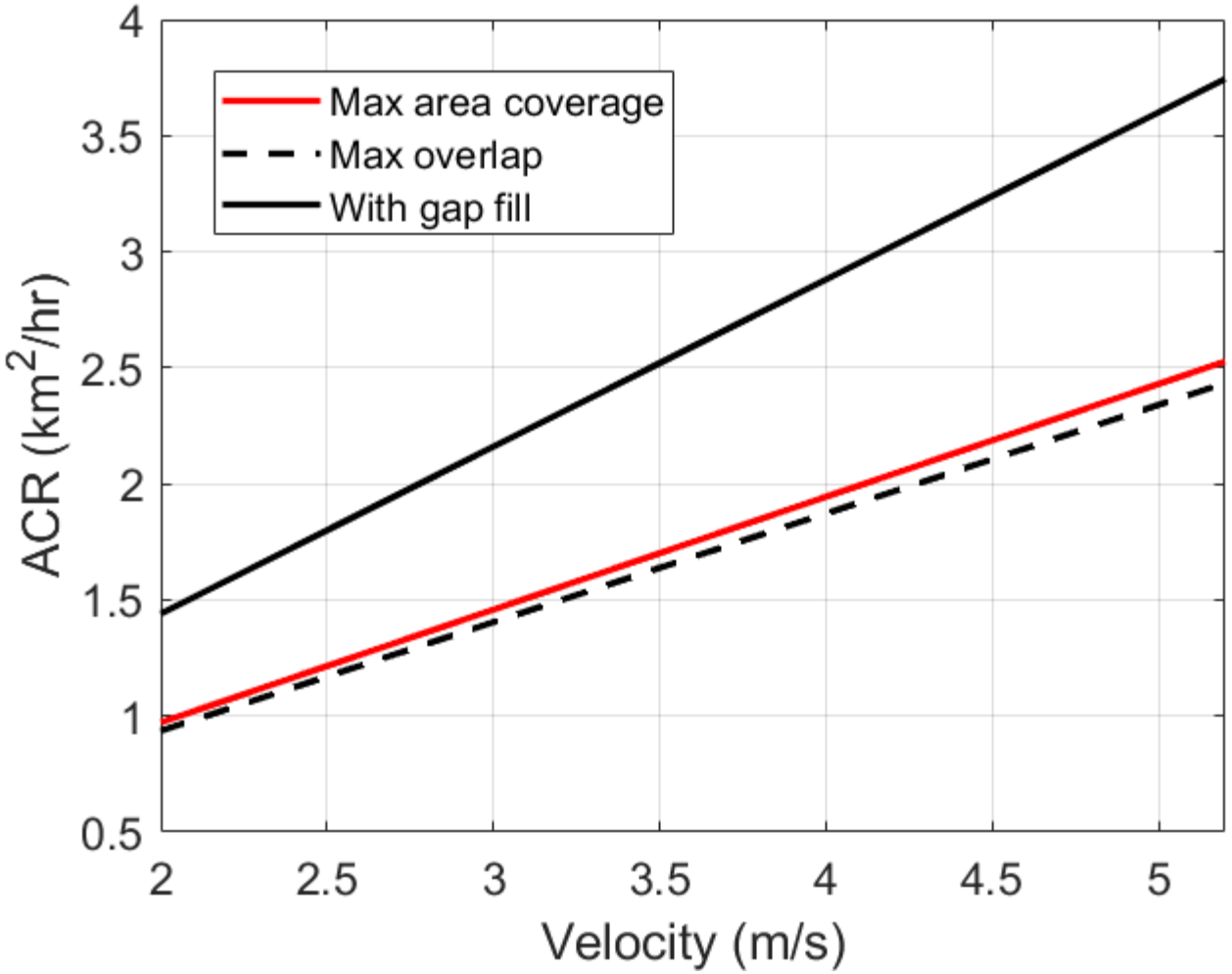
Area Coverage Rate



Maximum area coverage



Maximum overlap



The presence of a nadir gap causes a minimum 25% reduction in ACR.

KATFISH Actively Stabilized Towfish

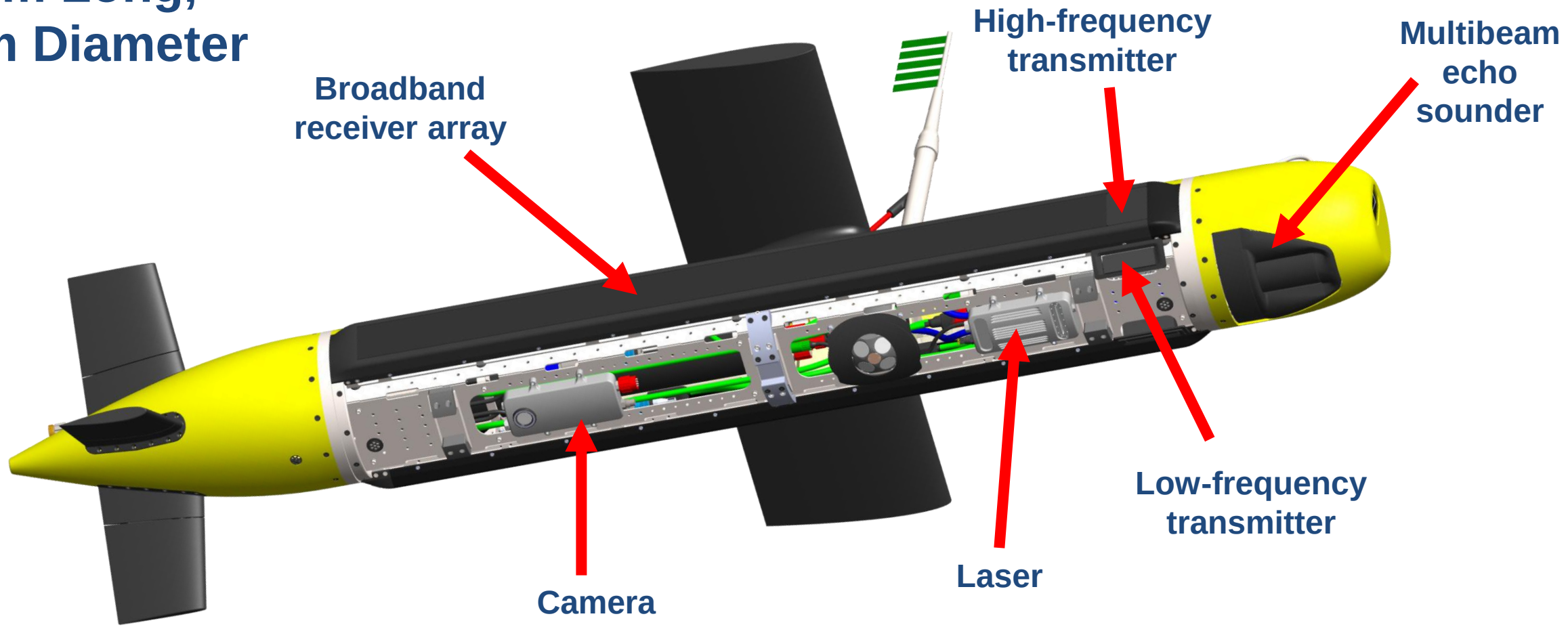
- **Equipped with AquaPix® Miniature Interferometric Synthetic Aperture Sonar**
- **Tow speeds: 3.0-10 kts (1.54-5.14 m/s)**

Two solutions for Gap coverage:

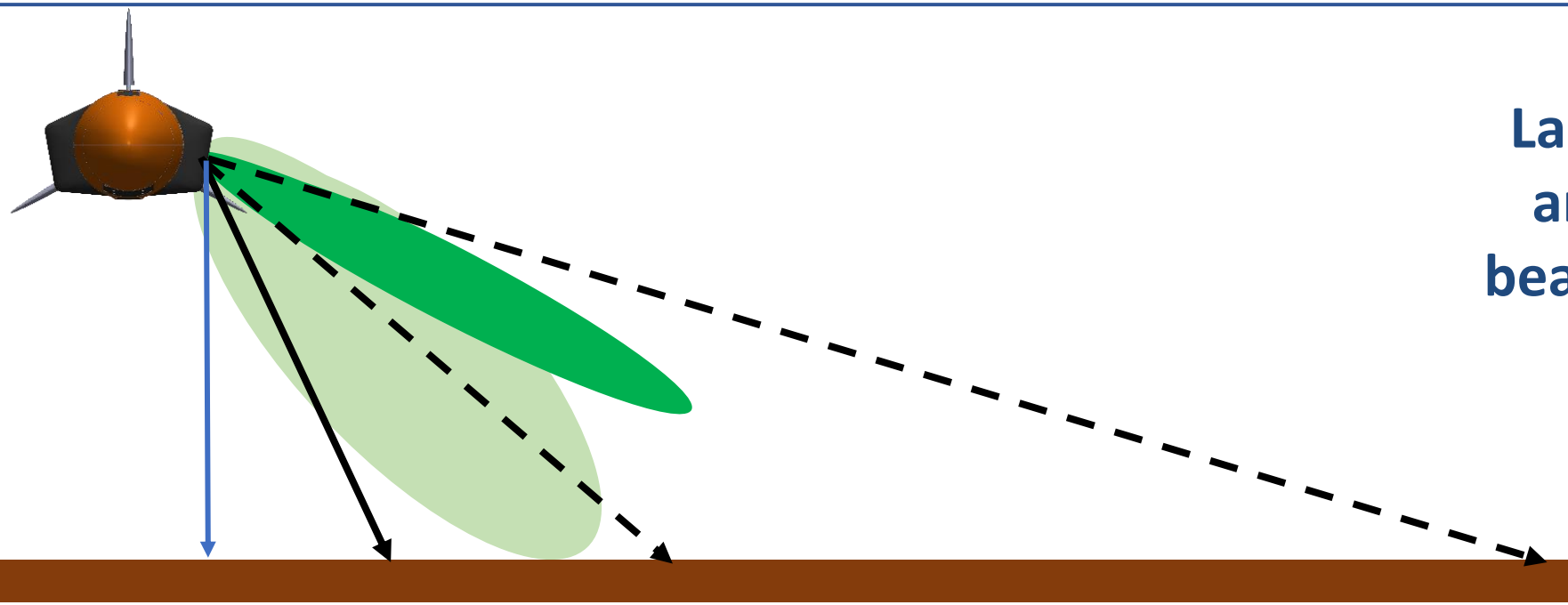
- **Short range (low frequency) SAS**
- **Auxiliary Sensors:**
  - **-Laser Profiler**
  - **-Multibeam**

KATFISH Gap Coverage Technology

2.95 m Long,
0.3 m Diameter



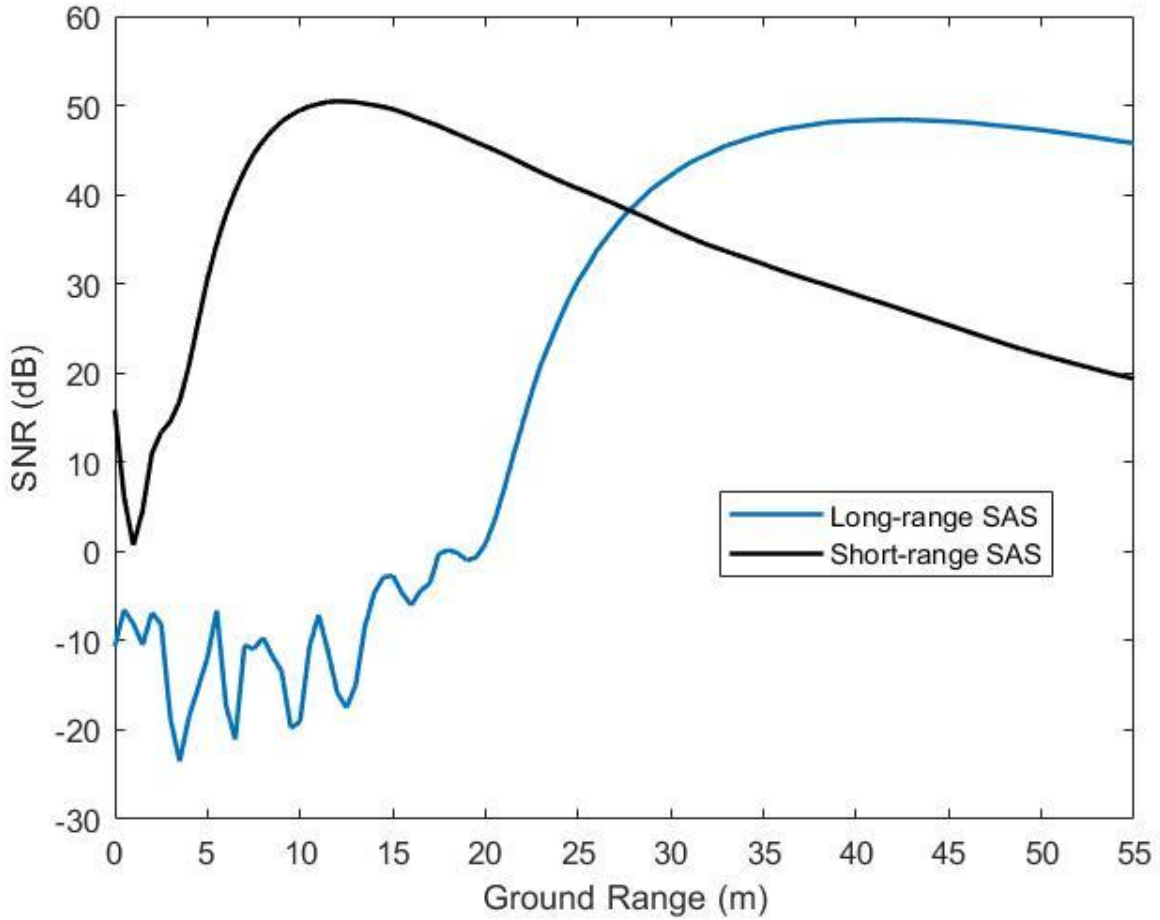
NADIR Gap Fill: Short range SAS



Larger depression angle and wider beam reduces nadir gap to 60°

Range Performance Modelling

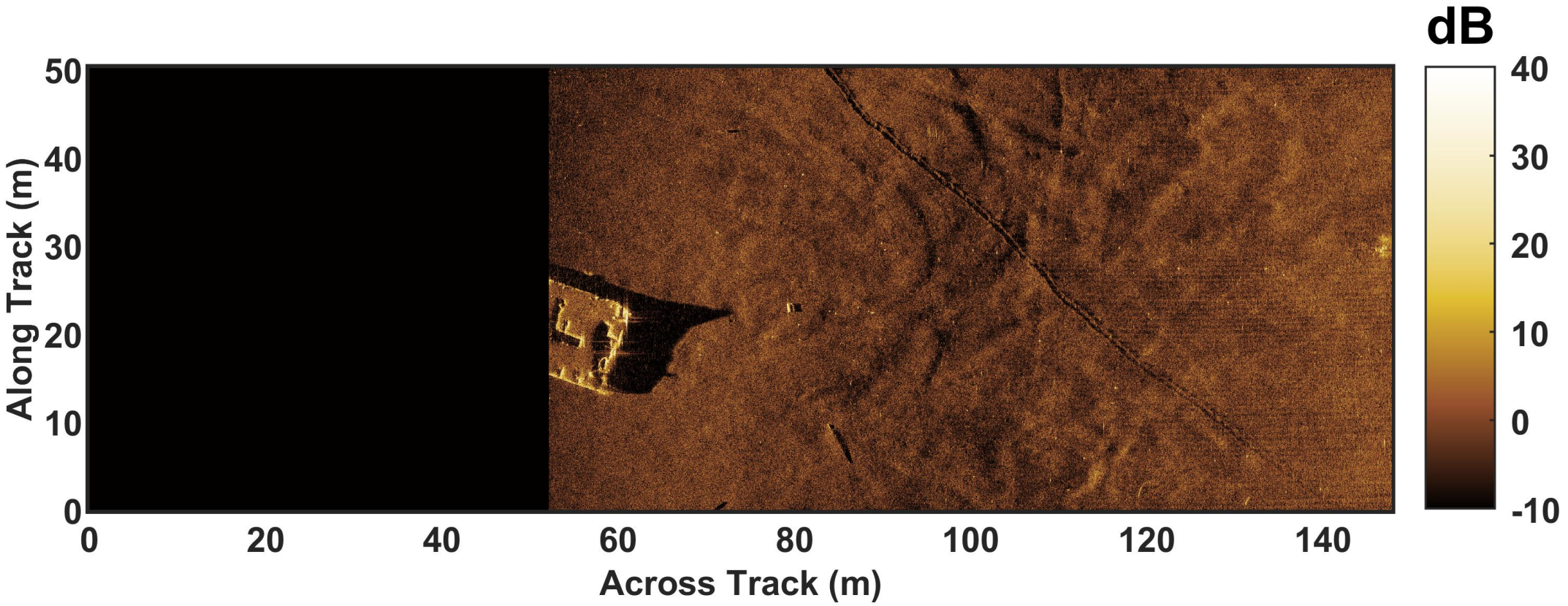
Predicted Gap Fill operation range: 0.6 -2.7x altitude



SONAR performance model parameters:

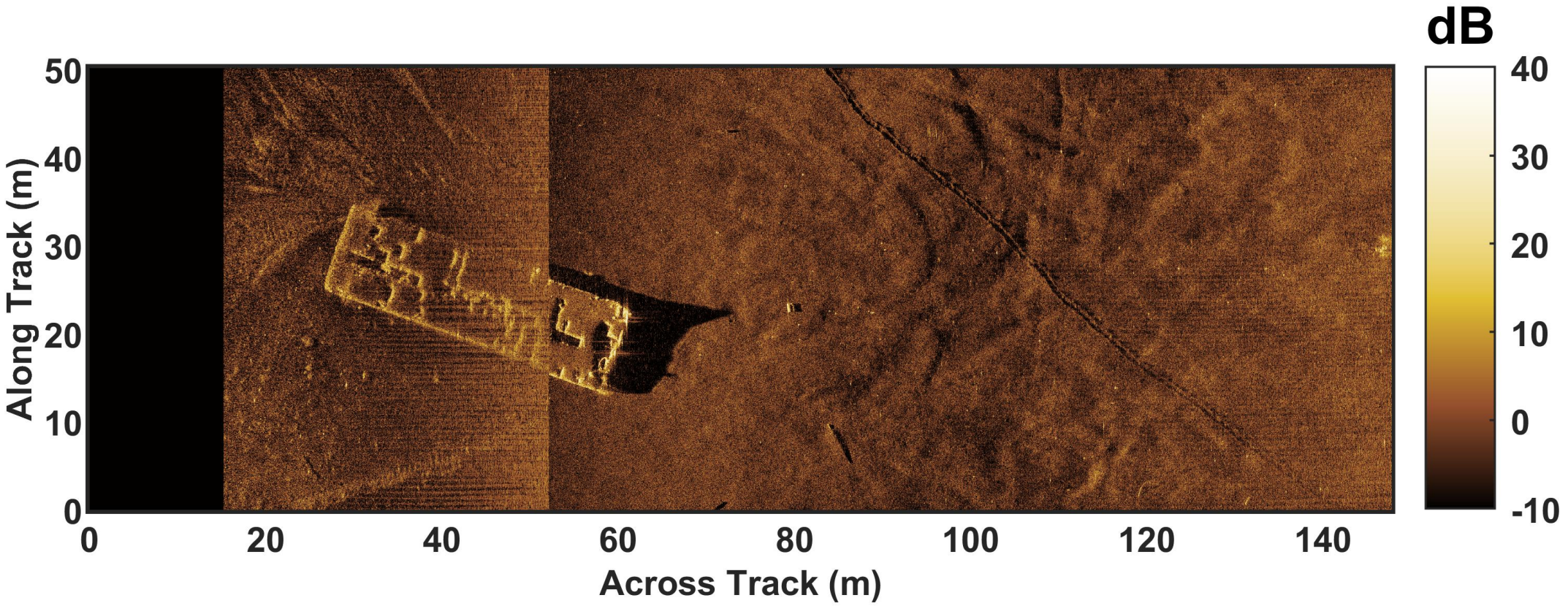
- **Deep water environment (70 m water depth)**
- **Platform flying at an altitude of 10 m above the seabed.**
- **Silt sediment**

MINSAS imaging gap



Long range SAS performance: 2.4-6.9x range

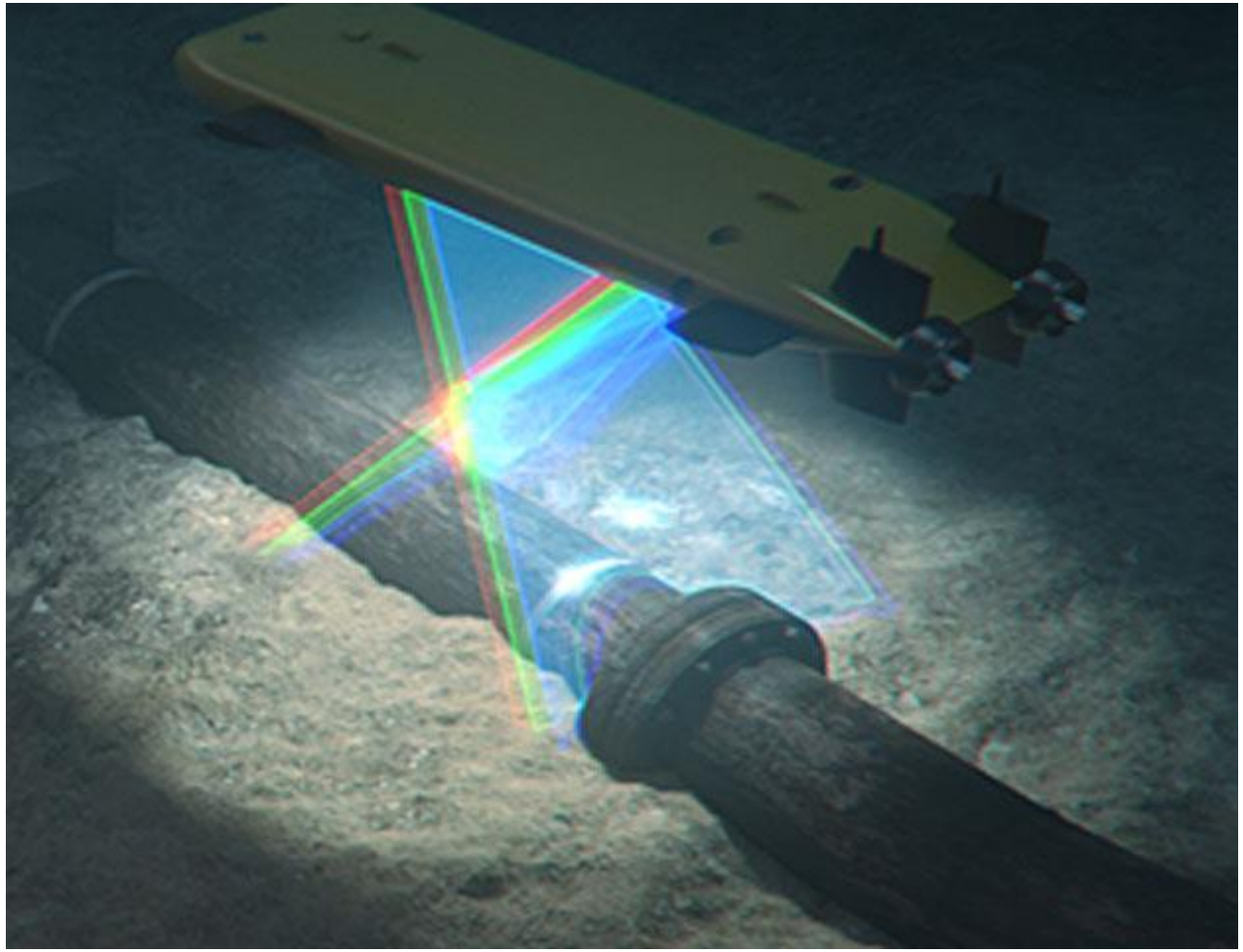
Gap reduction with low-frequency transmitter



Short range SAS performance: 0.6-2.4x range

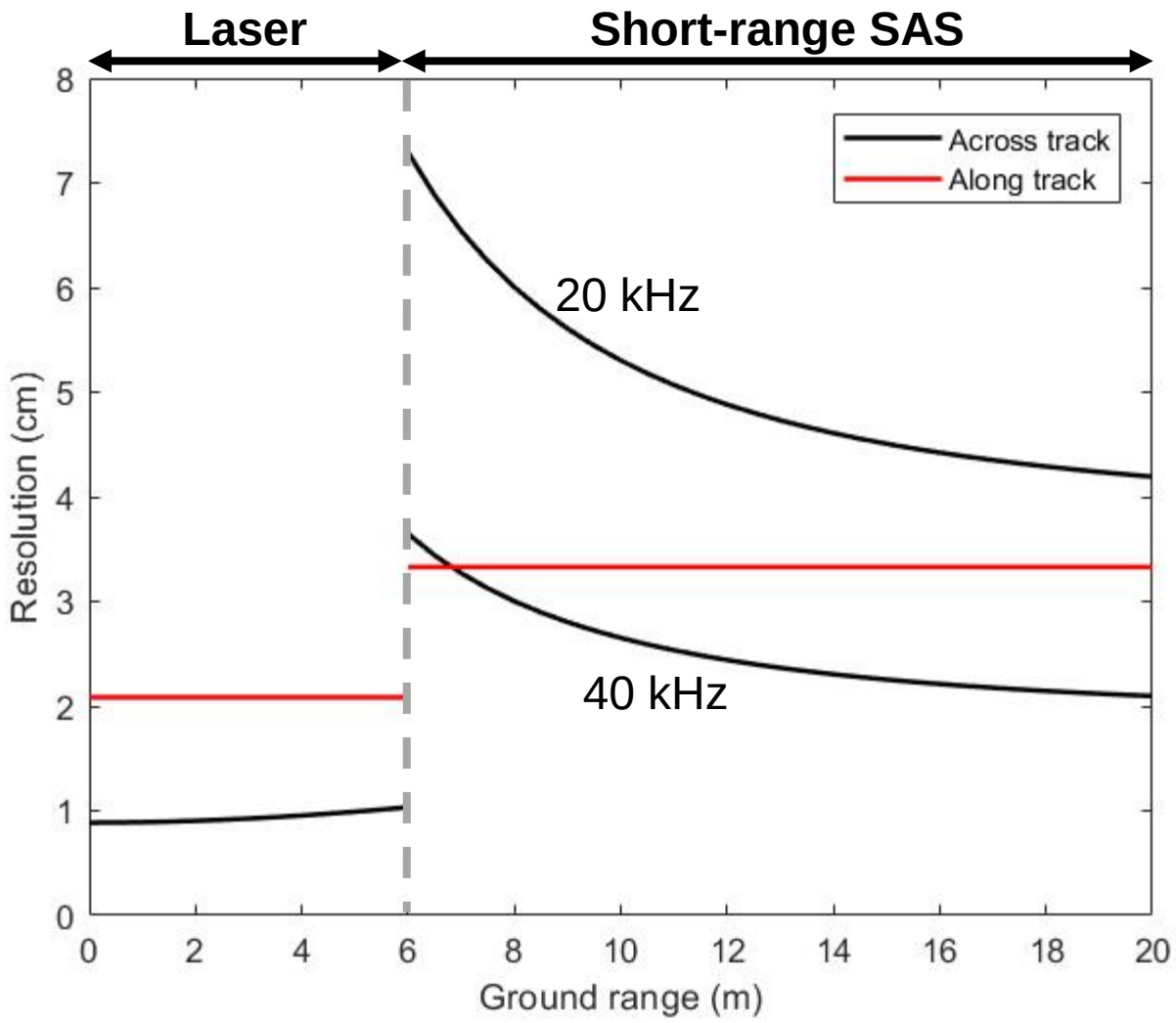
NADIR Gap Fill: SeaVision 3D Laser Profiler

- Real time 3D processing
- Simultaneous laser and video
- External laser extends the range of the system to ~10 m

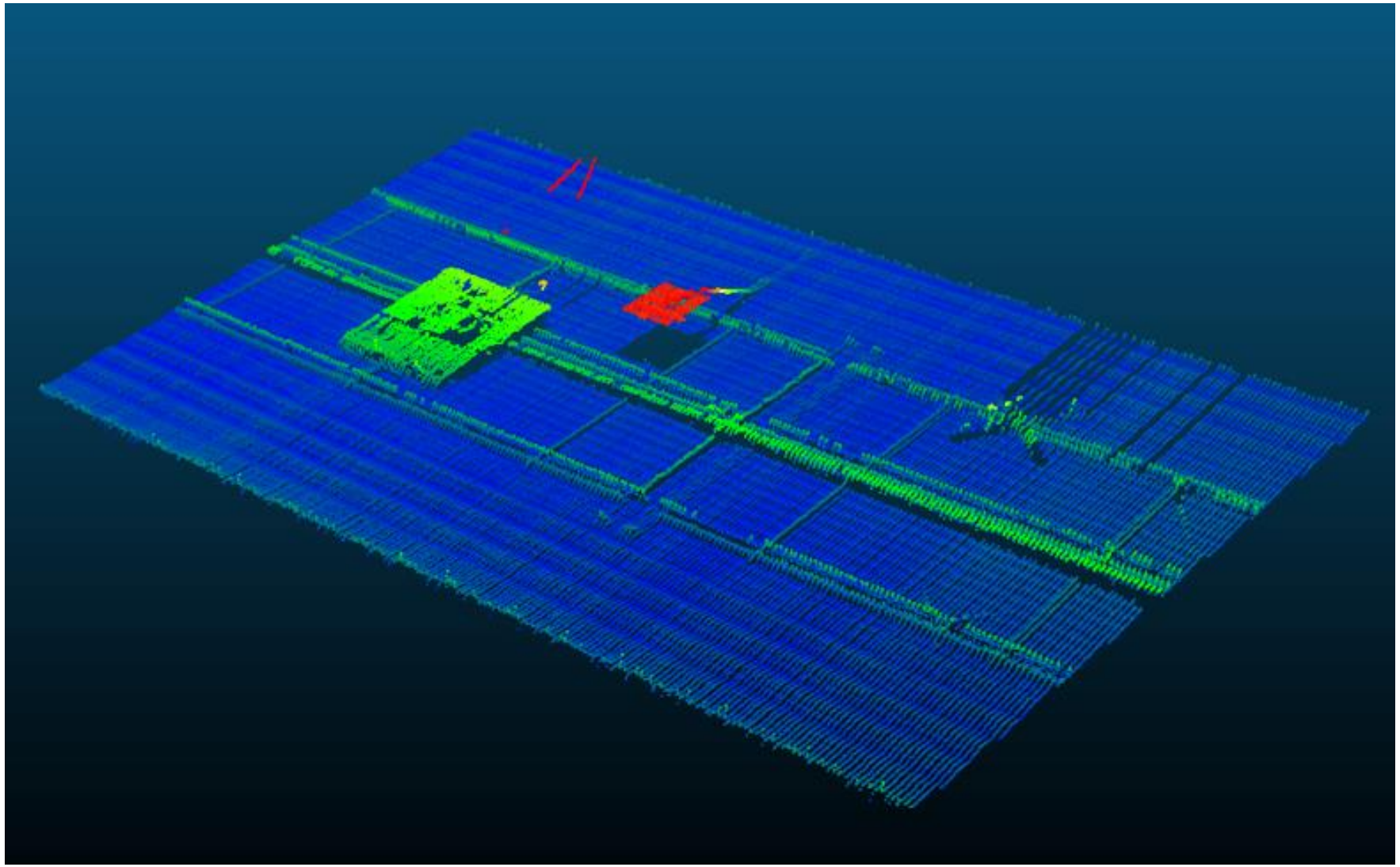


KATFISH Gap Fill Resolutions

- Laser exceeds SAS resolution
- Laser supports sub-centimeter mapping at low altitudes and reduced tow speeds
- Current short-range SAS across track resolution: 4-7 cm
- Future iterations will have higher bandwidth to ensure 3cm resolution obtained across entire swath

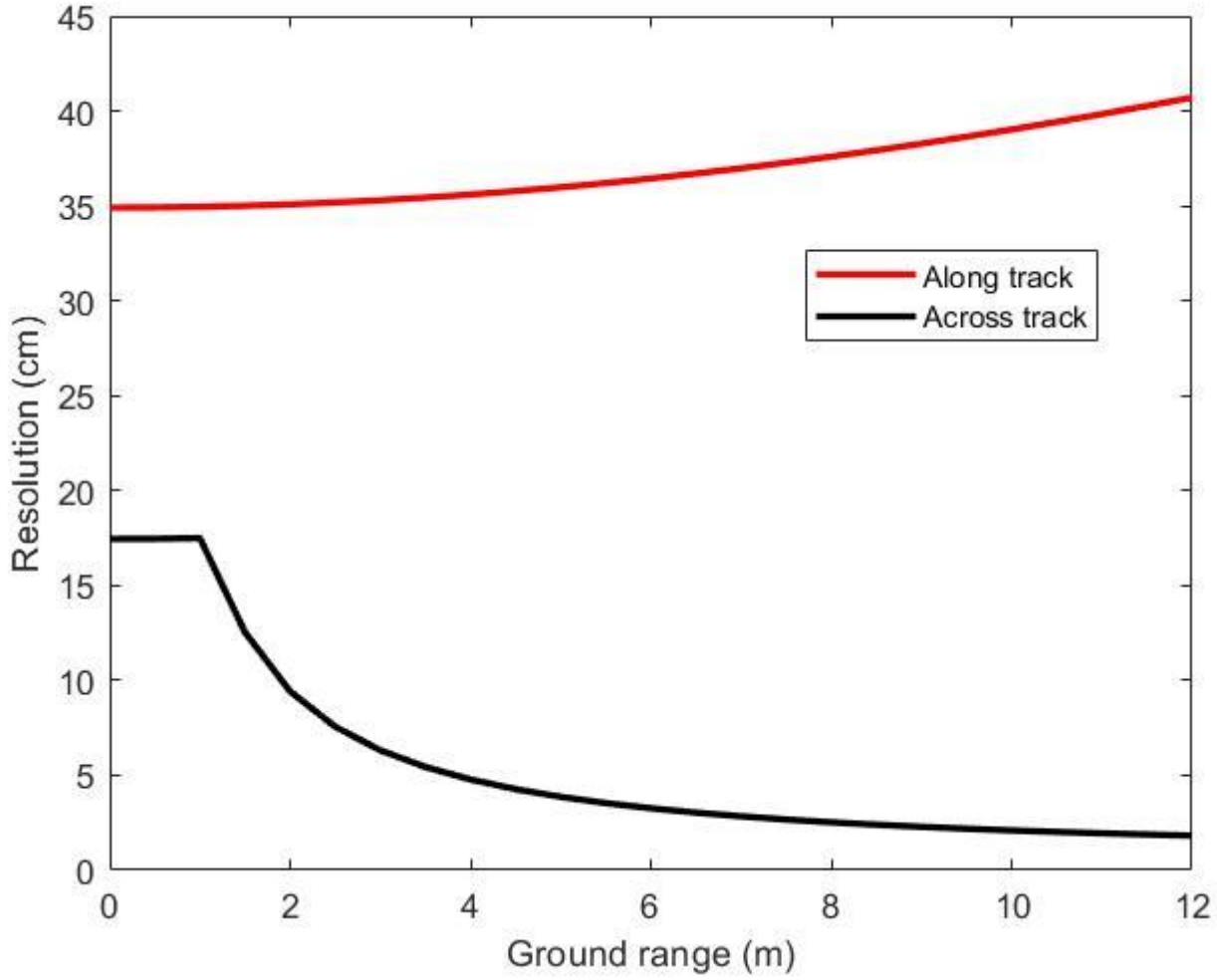


Laser Profiler Performance at High Speed



- Multiple tests conducted in a 200 m long, 7 m deep, and 12 m wide towing tank
- Maintained resolutions of less than 3.5 cm while towing at max speed (5 m/s)

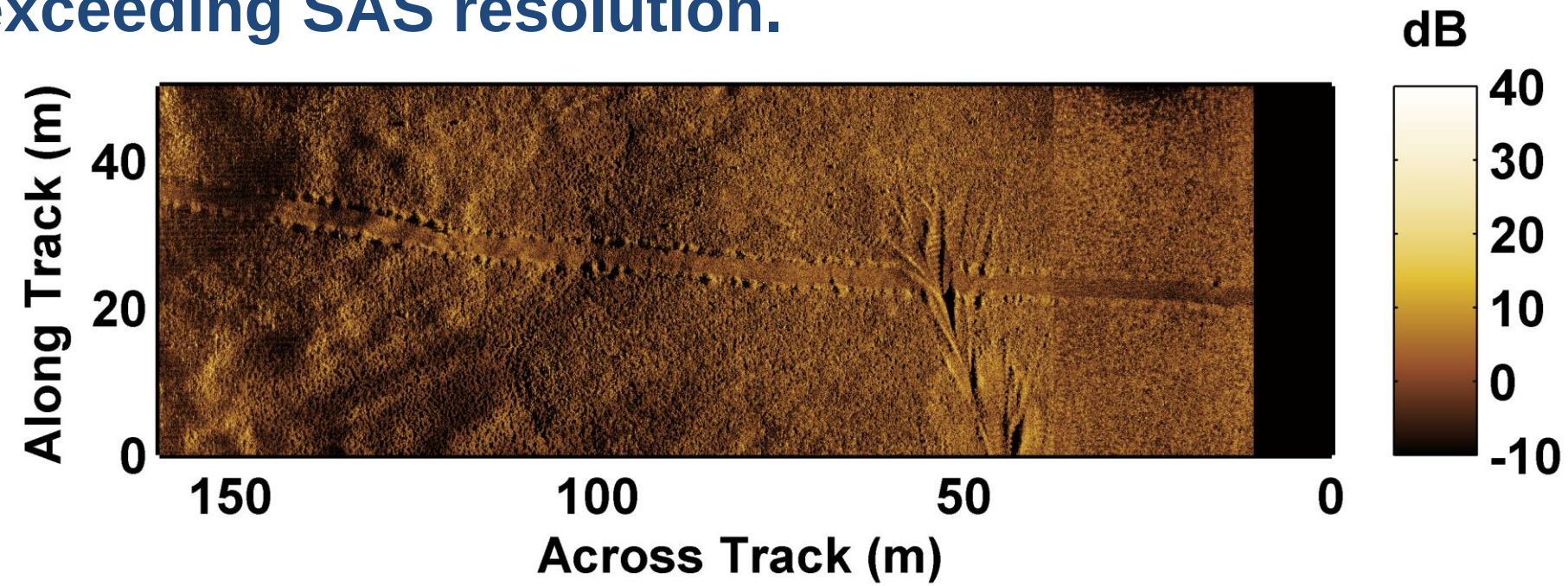
High Altitude Gap Fill Solution: Multibeam



- Laser generally limited to altitudes less than 10 m.
- For higher altitude surveys multibeam can be used.
- Multibeam has significantly reduced resolution in the along track direction.

Summary

- Gap fill technology increases ACR and simplifies mission planning.
- Short-range SAS maintains centimetric resolution across the entire swath and maximizes the ACR with minimal additional hardware.
- The SeaVision Laser profiler can fill the remainder of the gap while exceeding SAS resolution.



Questions?

Jeremy Dillon
Chief Scientist

Kraken Robotic Systems Inc.

189 Glencoe Drive
Mount Pearl, NL
A1N 4P6, Canada

1.709.757.5757

jdillon@krakenrobotics.com

To learn more about

Kraken Robotic Systems Inc.,

please visit www.krakenrobotics.com.