UT TWO

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PIPELINES
TRENCHERS
RENEWABLES

REAL APERTURE SONAR

vs Synthetic Aperture Sonar

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The Yankee 406ft steam powered cruiser shipwreck in Buzzards Bay, MA

SONAR

Since its first development in the 1950s, all Side Scan Sonars have been Real Aperture Sonar (RAS) Systems. These RAS systems still makeup the majority of commercial systems manufactured and in use today.

The newer Synthetic Aperture Sonars (SAS) are often presented as being a technique that offers improved resolution over conventional RAS. Their technical advantage is often quoted as having an improved along-track resolution compared to RAS systems. In this way, SAS is promoted as being 'Revolutionary'.

But is it really?

SSS IMAGE RESOLUTION

The resolution of a sonar image is comprised of three components:

1. Across-track resolution
2. Along-track resolution
3. Acoustic Shadow clarity

Across-track resolution is dependent on the pulse length or bandwidth of the transmitted acoustic pulse. Both SAS and RAS sonars transmit very similar acoustic pulses, resulting in both system types having 1-3 cm of Across-track resolution.

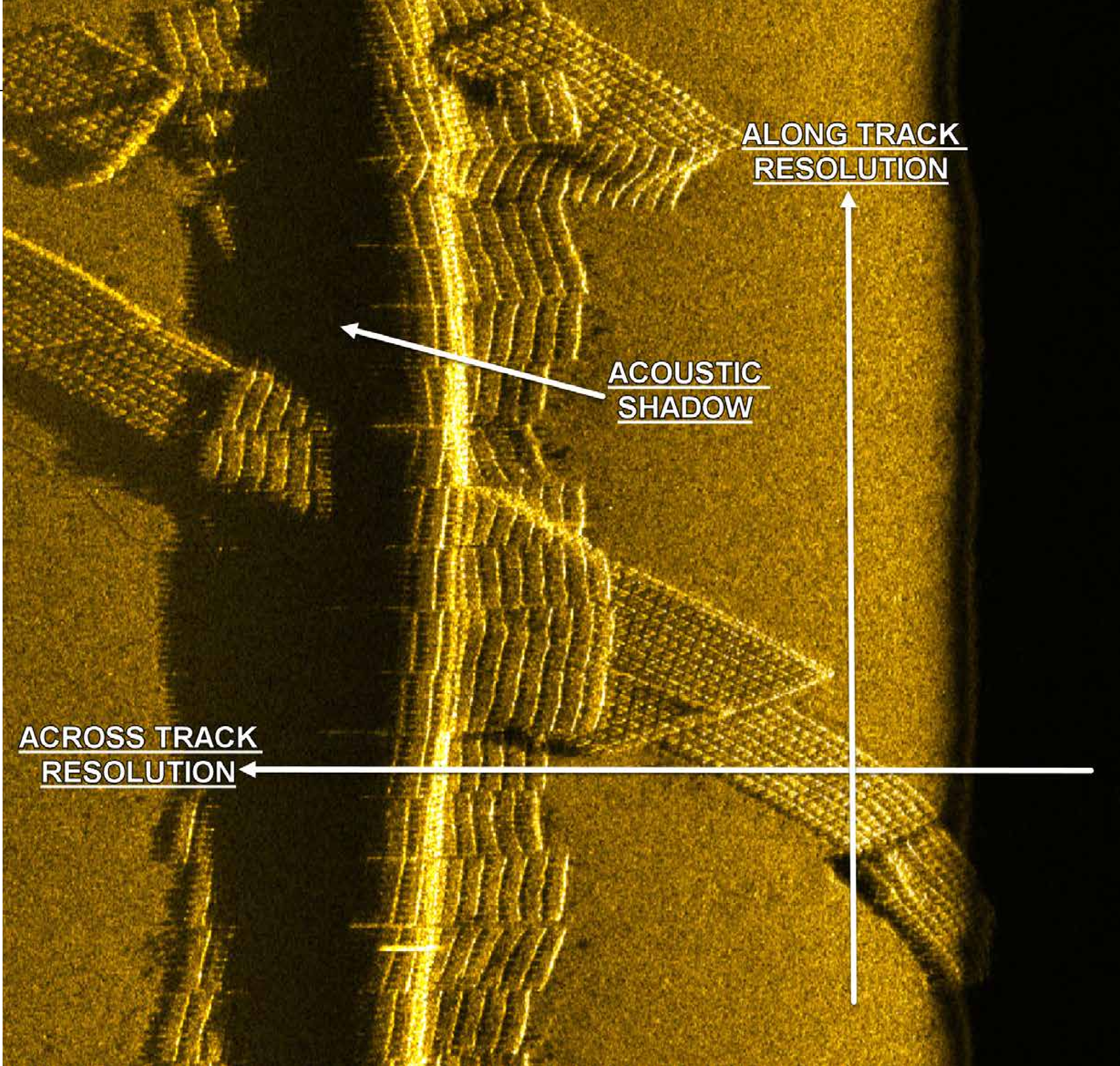
Along-track resolution is a function of array length whether real or synthetic. The along-track resolution of RAS systems is on the order of 10-20 cm whereas the SAS systems claim a theoretical 2-3 cm.

Acoustic shadows are generally sharper with RAS sonar images compared to SAS sonar images. This is due to SAS bleed around of the acoustic transmit energy from the wide horizontal transmit beam width that is required for SAS systems to work.

Thus, a sonar image is more than just 'Along-Track Resolution'. All three resolution components must be considered when determining how good a feature on the seafloor will look when imaged by the sonar.

SAS, THEORY VS EXPERIMENT

In theory, synthetic aperture processing should increase along-track resolution. In practice, they do produce high resolution images, but it is impossible



to measure the real resolution with any sort of accuracy.

What is lacking is a 'ground truth' test, where a resolution target is placed on the seafloor and then a SAS system is used to collect data at the maximum operational range.

The target needs small spherical reflectors spaced in a pattern at various relative angles where the spacing pattern is varied from 2cm to 20 cm. The processed data needs to show that the theoretical resolution can be verified by the experimental data and that reflectors spaced 2 or 4cm apart can be resolved.

In the past, Sonar resolution targets have been used for 'proof' of capability.

To date, most, if not all SAS systems have not performed a resolution verified experiment to demonstrate real world resolution improvements.

In fact, a resolution experiment should also include the collection of a RAS sonar data set of the same test target for comparative purpose and conclusions. It would be beneficial if SAS provided the along-track resolution improvement that is supported by the theoretical calculations.

RAS TO SAS COMPARATIVE IMAGES

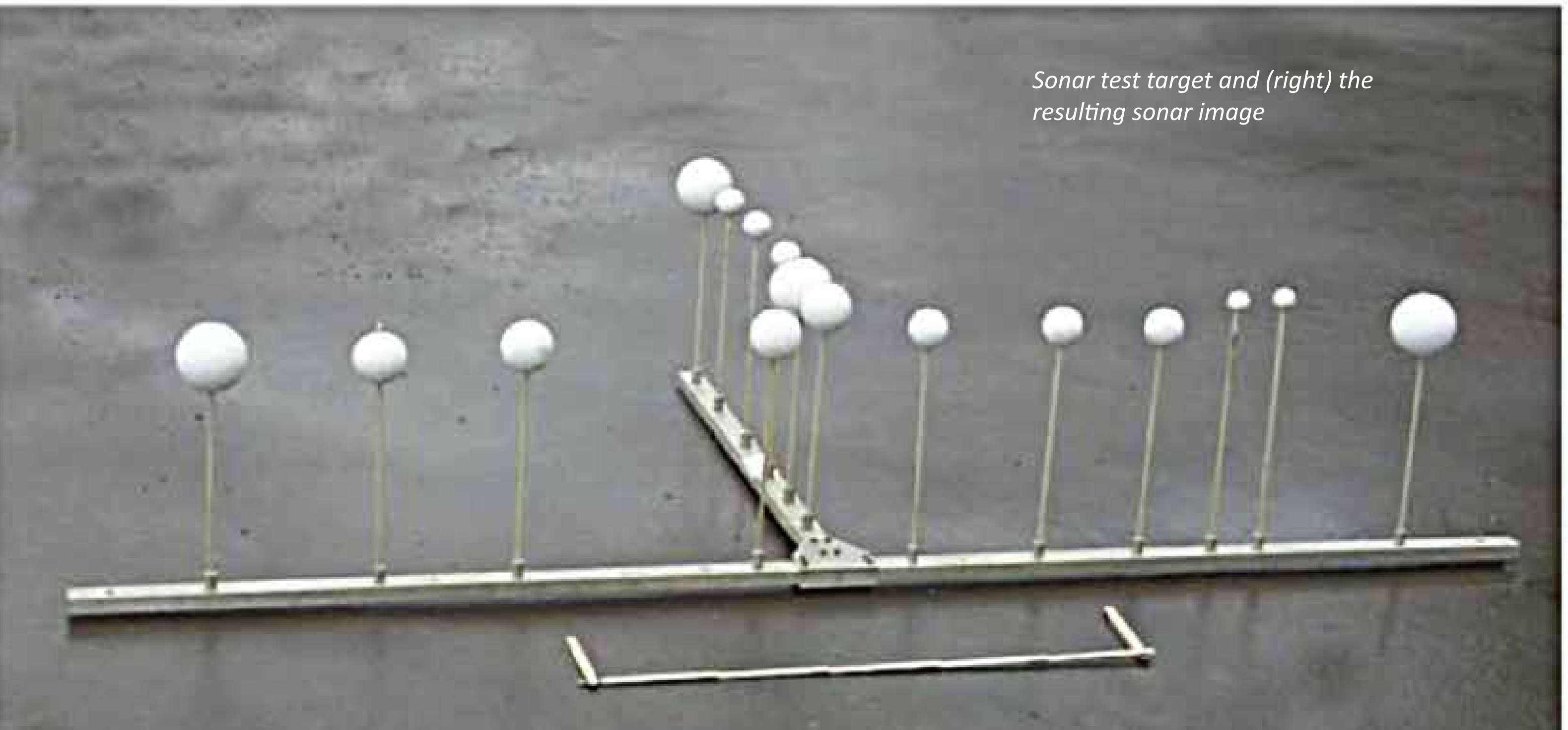
Since SAS manufacturers do not provide experimental test data sets to illustrate the claimed resolution improvements, the best that can be done is to compare similar sonar imagery of RAS vs SAS.

One such RAS sonar image was taken of the of the "Yankee" shipwreck in Buzzards Bay MA. The Yankee, a 406ft steam powered cruiser, was used as a US Navy training ship. In 1908, while on a training manoeuvre the ***Yankee*** ran aground 5 miles south of Bedford MA. It has since become a dive site as well as a target used for sonar testing.

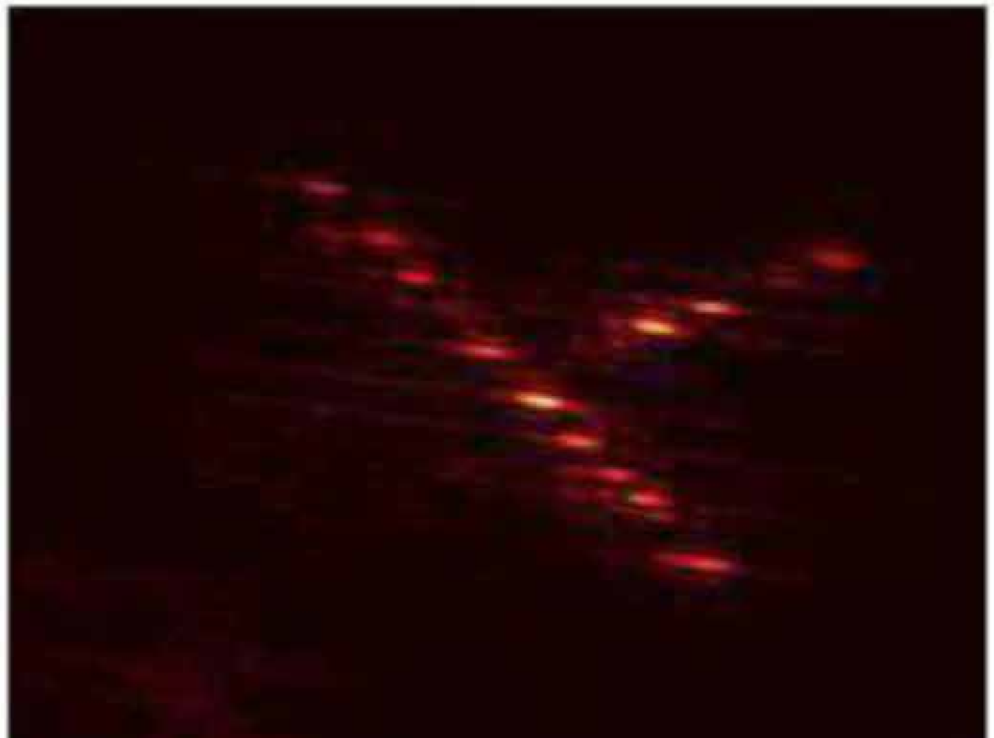
It is possible to compare the news archive images taken by SAS image as a comparison with the RAS sonar image. The resolution differences between SAS and RAS are subjective but there is no clear Along-Track resolution difference.

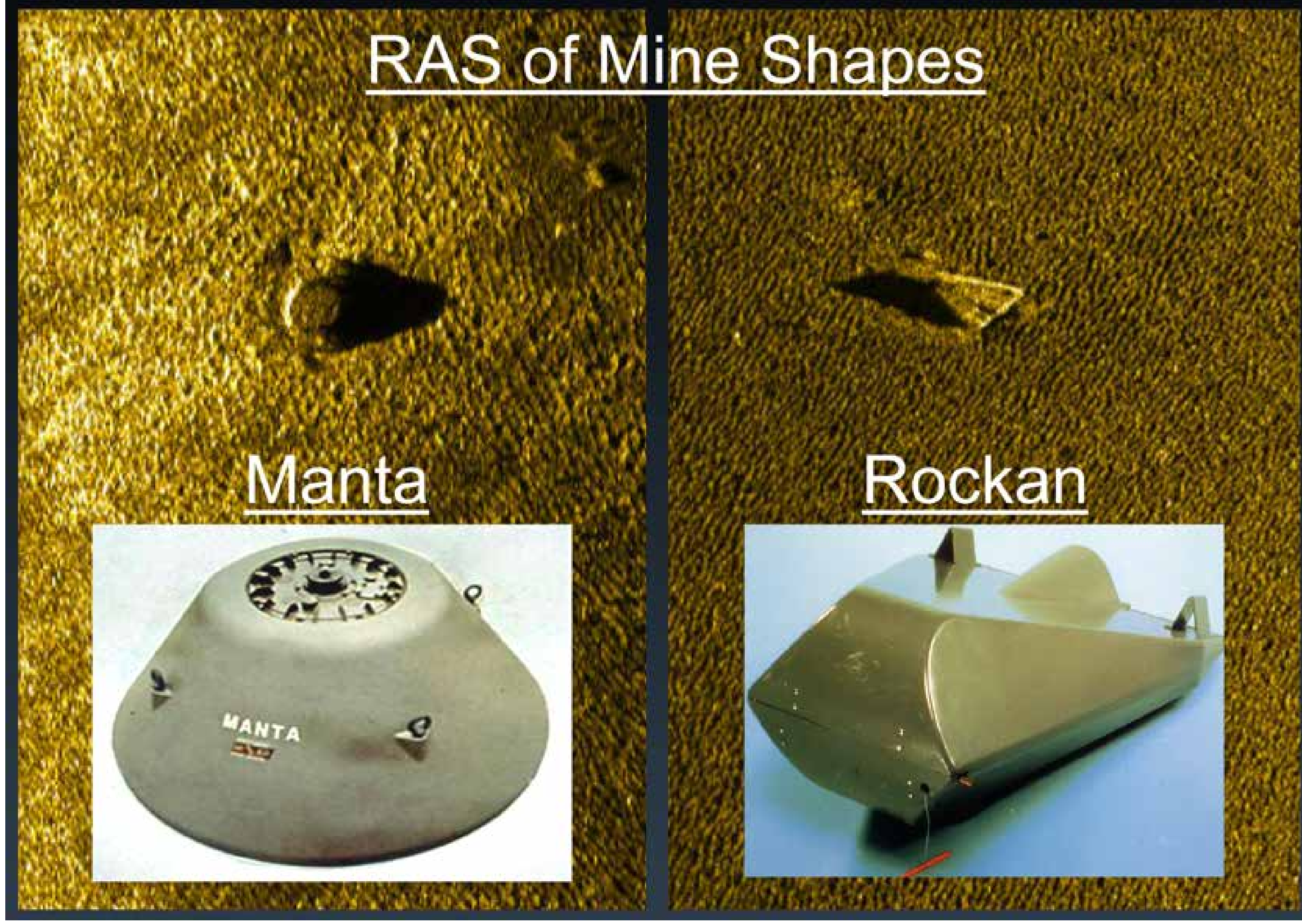
Navies around the world have important requirements for sonar systems to locate mines and mine-like objects. The dimensions of the objects are typically in the 1–3m in size range. High resolution is desired to aid in filtering out objects of interest from surrounding bottom clutter as well as aiding in their classification.

RAS side scan sonar systems have been used for decades for this going all the way back to the 1950s when the first Navy system, the C-Mk1 Shadowgraph was developed. SAS claims an advantage over RAS systems for mine-like objects, but this is not always supported out by reality.



Sonar test target and (right) the resulting sonar image





A similar common SAS image of chains illustrates again that when a comparison is made, any perceived resolution improvements of SAS is subjective with both displaying very high resolution.

The major advances in side scan sonar began in the 1980s and again in the 1990s when digital designs replaced the earlier analogue systems. Improvements in computers and software development lead to the next big jump with integrated positioning from GPS and the ability to process the raw sonar data for maximum sonar image fidelity and resolution.

The latest development of tri-frequency RAS systems offer surveyors a very flexible system that can handle diverse survey requirements from large area seafloor mapping or search needs to ultra-high resolution target and feature classification. These new systems are the standard for both towed as well as autonomous surface and underwater systems.

SAS is an interesting technique but many ask if the high cost and complexity of SAS provide a proportional improvement in the sonar product output. A recent conversation with a USA government official and very experienced RAS side scan sonar user provides perspective. Participating in a SAS technology demonstration, he came away with some interesting observations and comments.

"The technology undoubtably made nice high resolution images, but they did not appear much different than traditional RAS images," he said.

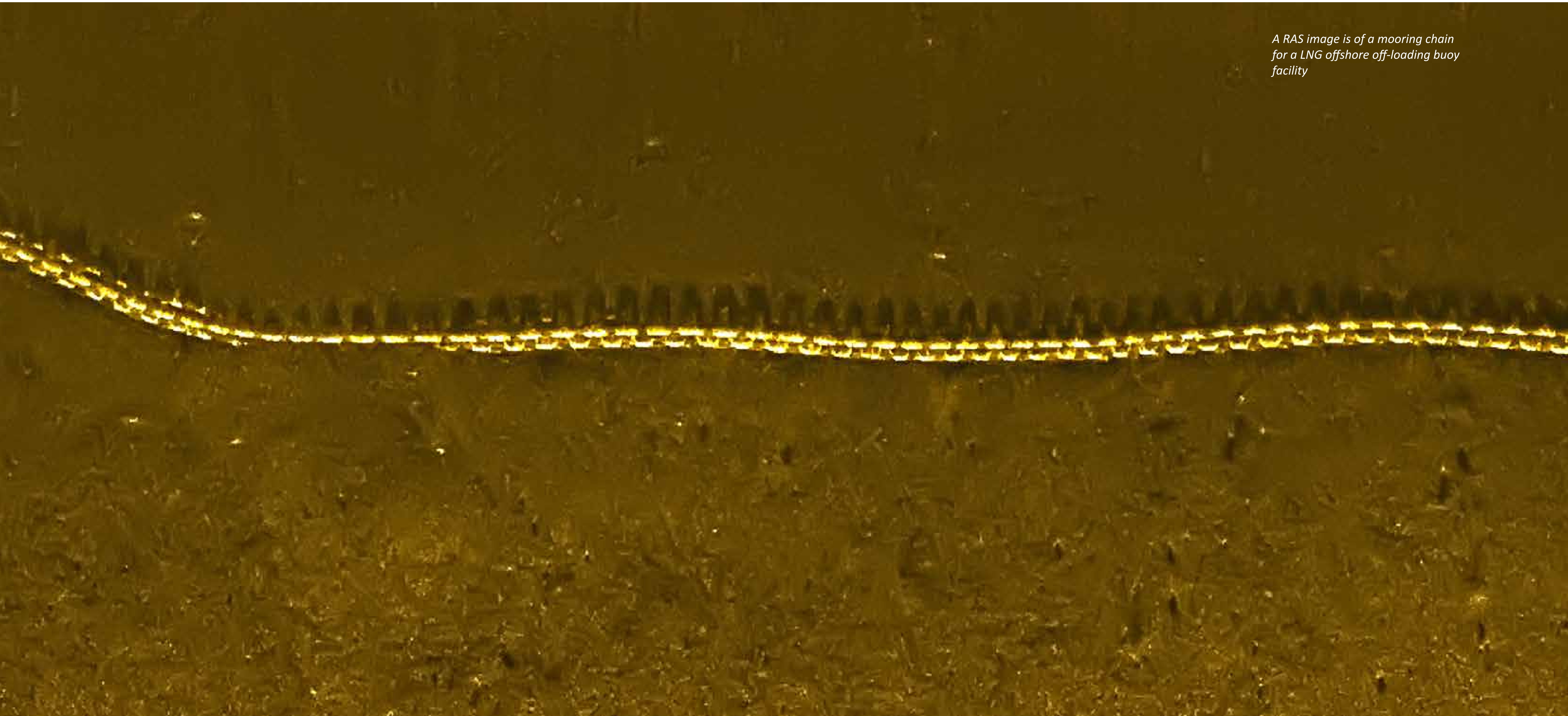
"The product output is in the form of geo-referenced Tile images which are not a form that is ideal for the mosaic production. The image Tiles vary in intensity and gamma as well as positional misalignment when a mosaic is created.

"The volumes of data created in acquisition were significantly large, particularly compared to RAS systems.

"The processing overhead was high because of the large data volume size and though it is claimed that the data is 'near real time', it is in fact not real time because of the SAS processing time.

"With SAS systems costing 5 to 10+ times the cost of field proven RAS systems. *I don't really need a new tool in search of a job*".

RAS systems will remain the main stream workhorse for the foreseeable future with SAS being for those willing to invest in an exotic expensive solution.



A RAS image is of a mooring chain for a LNG offshore off-loading buoy facility