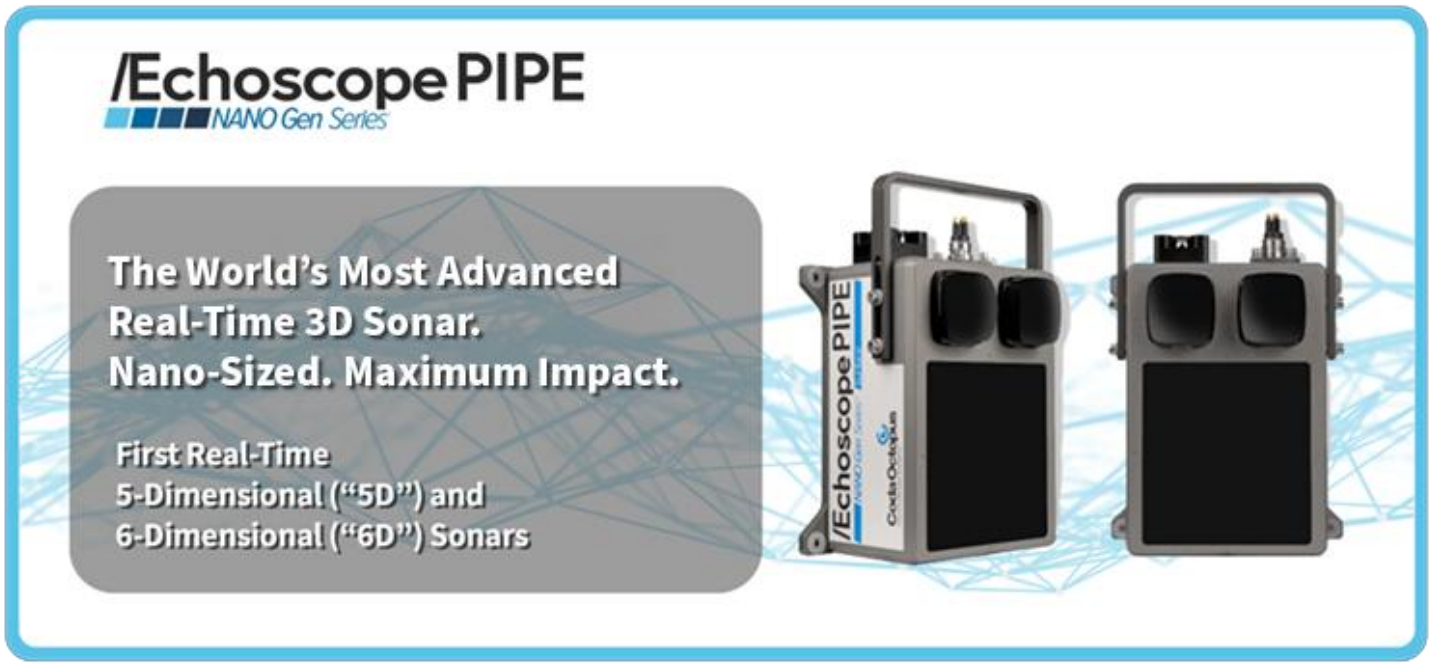
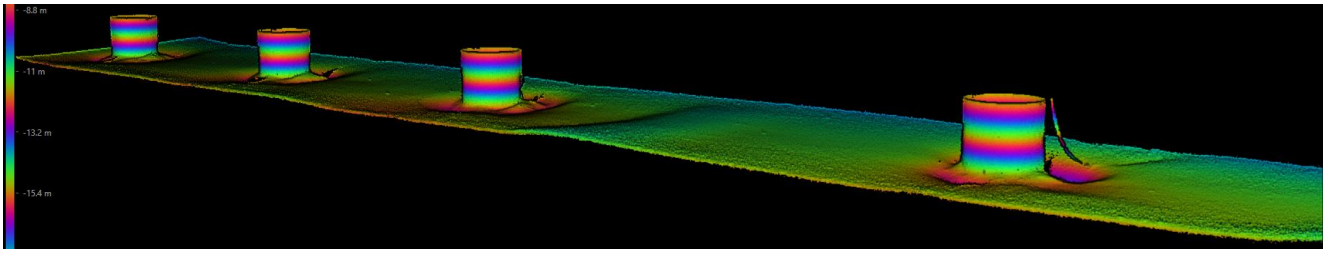


Multiple Parallel 4D Data Sets Simultaneously for Different Requirements of Underwater Operations in Real-Time

The Echoscope PIPE® *NANO Gen Series* forms part of our PIPE® Sonar Series and is our latest innovation of the PIPE® technology platform for real time 4D, 5D and 6D imaging (*NANO Gen Series*). Our latest *NANO Gen Series* takes another significant leap forward in this domain by dramatically reducing the form fact of the technology to be extremely compact (for illustration – a shade bigger than current smartphones in the market), without compromising on the unique and industry leading capabilities of the Echoscope® family of sonars which has served as a key consolidated sensor for multiple underwater applications.

Sitting at the heart of our PIPE® Sonar Series is our Parallel Intelligent Processing Engine ("PIPE") which is capable of capturing, processing and displaying in real time significantly higher data density with multiple parallel 4D data sets. In addition, the increased processing capability allows more advanced beamforming algorithms to be employed including phased-based processing (Enhanced Resolution Split Aperture processing ("ERSA")). The new *NANO Gen Series* can process up to 256 x256x 5,500 (360 million data points per ping) to generate 4D images with typically several hundred thousand 4D data points per ping (depending on the insonified scene). The powerful PIPE Processing Engine is designed to optimize the data acquisition process, through automation of the data acquisition parameters and delivering in real time "multiple and different" 4D data sets to serve the different users of the survey operations (through automatically setting up different and independent sequence of data captures by using different acoustic parameters such as, frequency, range, filters, pulse length, TVG, and processing methods (such as Advanced Beamforming Mode or ERSA (Enhanced Resolution Split Aperture Mode).



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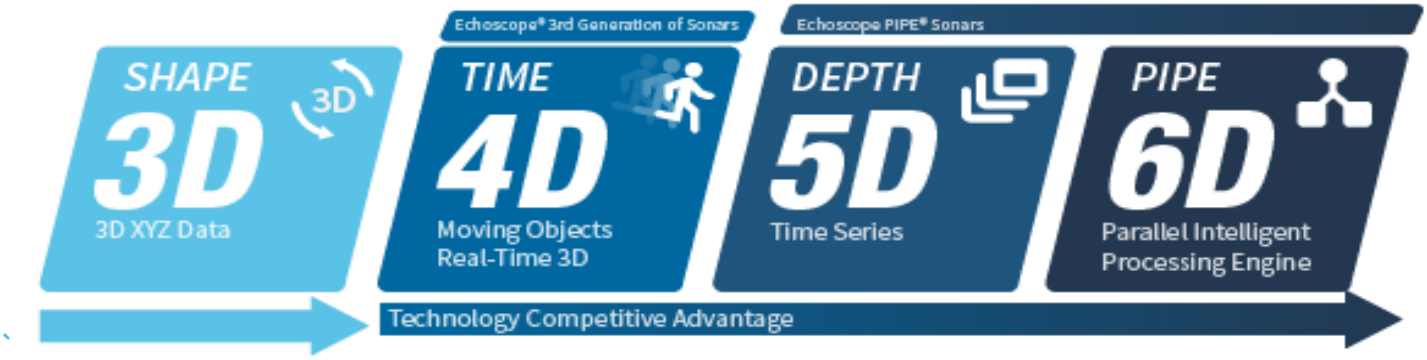
/Echoscope PIPE
NANO Gen Series

About the **Echoscope PIPE** *NANO Gen Series®*

The Echoscope PIPE *NANO Gen Series®* delivers real-time 3D/4D/5D/6D capabilities and is ideal for the new generation of underwater and surface vehicles – extremely compact but uncompromising on all the capabilities of the Echoscope PIPE® Sonar Series.

Evolution of 5D and 6D Sonar



3D imaging typically is the scanning of an object of a sequence of images to construct a 3D Shape. The limitation of this approach is the inability to see any moving objects and having a high dependency of a stable platform to perform the imaging.

4D Volumetric Images represent a true volume of spatial data collected and processed at the same instant. Sequential 4D Volumetric images represent a time sequence of the scene showing moving objects within the volumetric image.

5D Images are 4D represented with multiple slices of depth data - similar to a medical CT Scan. The 5D images contain more depth information, detail and resolution of each target and sequential 5D images over time show higher resolution moving targets.

6D PIPE allows multiple parallel 5D images to be generated with different imaging and sonar parameters. This allows different processing to be performed on the RAW sonar data in parallel and extracts more specific results without compromise.

PIPE® Features

Some of the new and innovative PIPE® features available are:

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Improved Beam Detection through phase-based processing (split-aperture), greater dynamic range and incorporating full floating- point processing resolution
Improved Image Processing with greater control and capability over image processing, greater selection of noise suppression, user selected sidelobe rejection filter and extensive array shading
Increased Beam Density up to 256x256 compared to 128x128 (in our previous generation of sonars)
Advanced Beamforming Mode allows users to change beamforming methods. Field of View (FoV) Focusing and Beam Density (number of beams applied to an underwater target to maximize the resolution and image definition on the fly)
Enhanced Resolution Split Aperture ("ERSA") Beamforming on the fly This method enhances the accuracy of the Split Aperture mode through applying direction of arrival discrimination based on beam spacing and can support higher ping rates.
Live Real-Time XYZ data point output using Coda Octopus top end software. Live Real-Time XYZ data point output also available direct from sonar with new OEM Option
Ability to swap configuration sets instantly ping-to-ping to achieve dynamic frequency, field of view and other capture and processing functions
Multiple real-time 4D images with different capture and process parameters which can be accessed and displayed in independent views of the survey operations in real-time
Parallel Processing and Display of Real-Time Images
Availability of Full Time Series 3D Backscatter Range and Intensity Data comprising millions of data points per ping

Echoscope PIPE® Features available with 4G USE® software:

Core	**PIPE: Core Module** This module is common to all Echoscope PIPE® sonar systems and provides the core functionality including enhanced dynamic range, improved image processing and advanced beamforming with dynamic frequency and beam density adjustment in real-time.
Sequencer	**PIPE: SEQUENCER Module*** This module allows users to create a sequence of up to 10 different parameter sets for multiple parallel acoustic 4D – data set capture and processing including different frequencies allowing hands free multi-application data collection from a single deployed sonar system.
Full Time Series	**PIPE: FULL TIME SERIES Module (5D Capability) *** This module provides the ability to capture and record raw 3D Full Time Series Data up to 81 million data points per acoustic ping. This FTS capability is highly beneficial for seabed coverage surveying and volumetric analysis of water column data.
Raw	**Multiple 4D and 5D Images and RAW Data (6D Capability) *** This module offers the ability to log RAW acoustic data and process multiple 4D images and 5D images with different imaging and acoustic parameters offline. With RAW data processing the user is in control of reprocessing any recorded data to extract required results and is highly beneficial on autonomous platforms with no human in the loop for QC and data visualization in real-time.

Real-Time Imaging Sonar Systems Comparison

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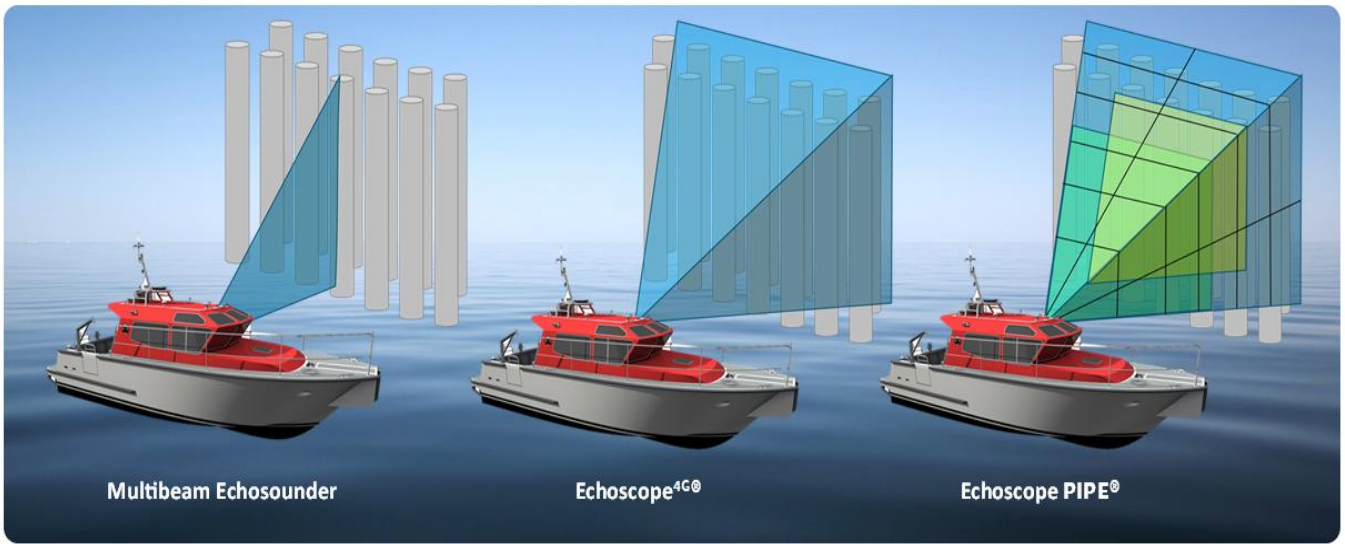

Size Comparison

Size Comparison between the Echoscope PIPE *NANO Gen Series®* and a standard smartphone

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NANO Gen Series® Product Specifications

Performance (by Model) Depth Rating	**250m** (820ft)	**600m** (1,968ft)	**3,000m** (9,843ft)
Acoustic Projectors	Mid-Frequency (500kHz) High-Frequency (840kHz)		
Adaptive Frequency Band	Mid-Frequency Range (420kHz-550kHz) High- Frequency Range (700kHz-920kHz)		
Number of beams (Density)	Up to 256 x 256 x 5,500		
Number of Values Per Beam	Up to 5,500		
Maximum range*	50m (164ft) at 840kHz 75m (246ft) at 500kHz		
Minimum range*	0.5m (1.64ft)		
Range resolution	2cm (0.7”)		
Update rate (ping rate) *Range Dependent*	Up to 50Hz		
Rx Angular Beamwidth	Up to 0.8° x 0.8°		
Tx Angular Coverage	420kHz - 550kHz: 54°x54° - 46°x46° 700kHz - 920kHz: 33°x33° - 23° x 23°		
Software Compatibility	4G USE® 4G USE® OEM		
*The actual working range will depend on the target’s size, reflectivity, and the level of detail required for the application.			
Physical			
Dimensions (h x w x d)	~ 247.5 x 182 x 148.9 mm (9.74 x 7.16 x 5.86”)		
Weight in Air	~ 7.15kg (15.7 lbs)		
Weight in Water	~ 4.68kg (10.3 lbs)		
Power and Power Consumption	24 – 48VDC 2A at 48VDC		

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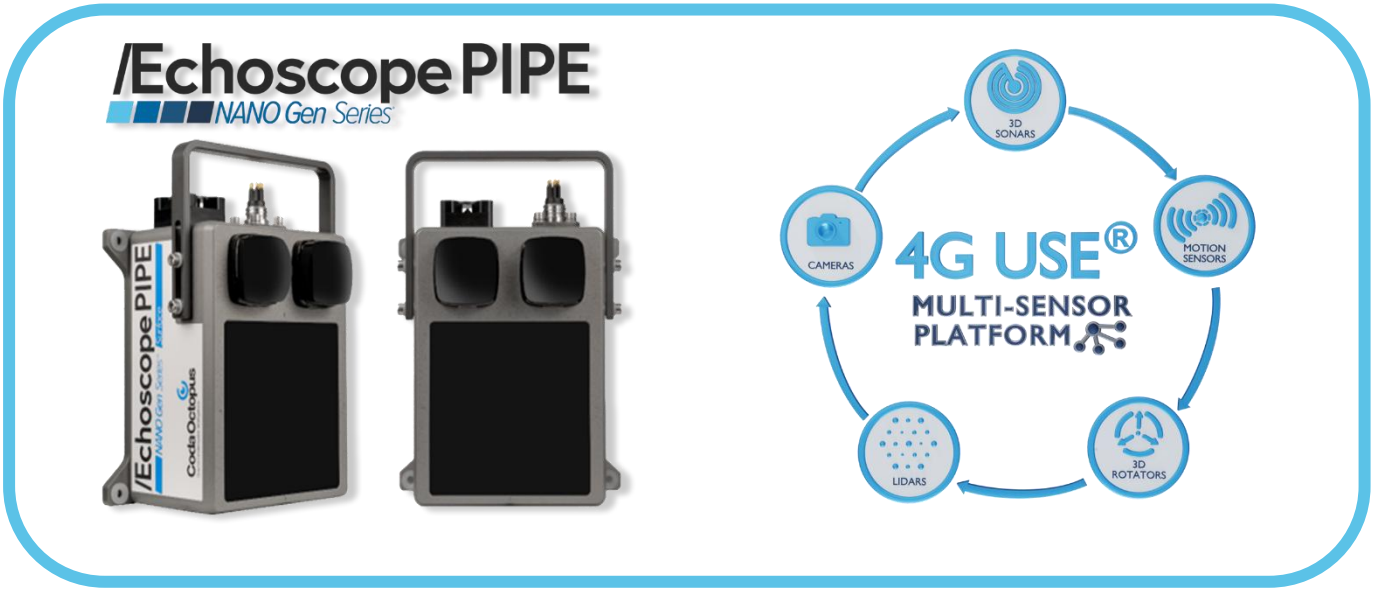
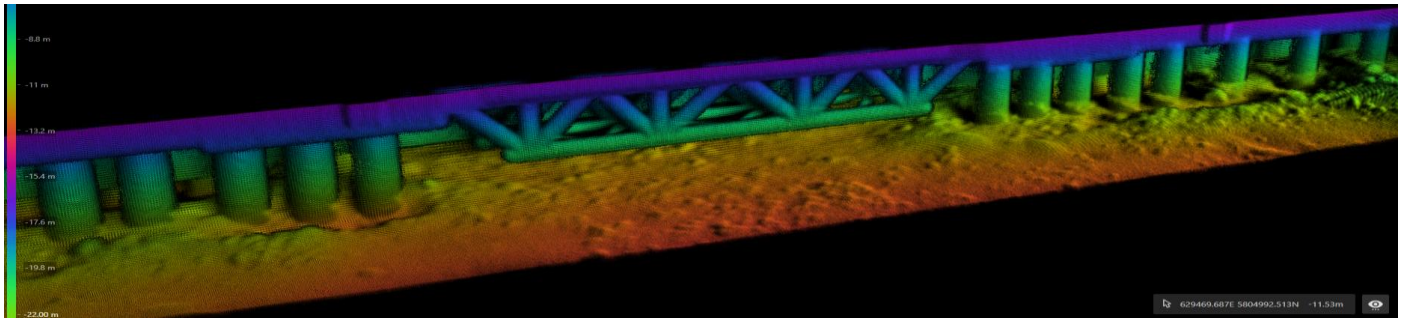
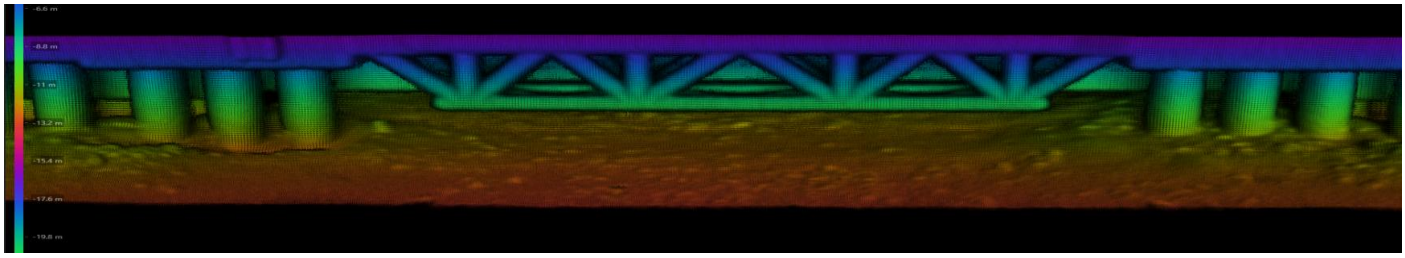


Image Gallery





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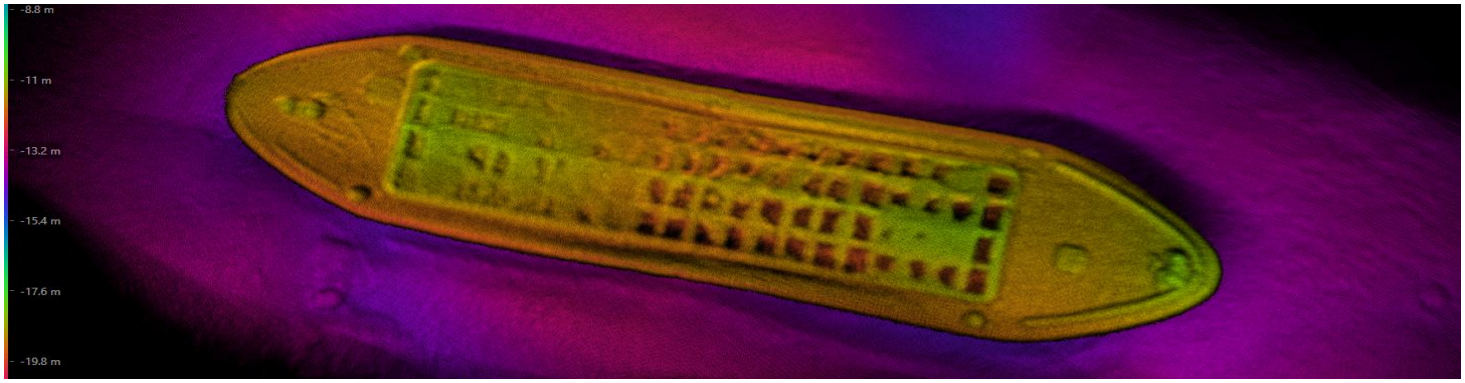

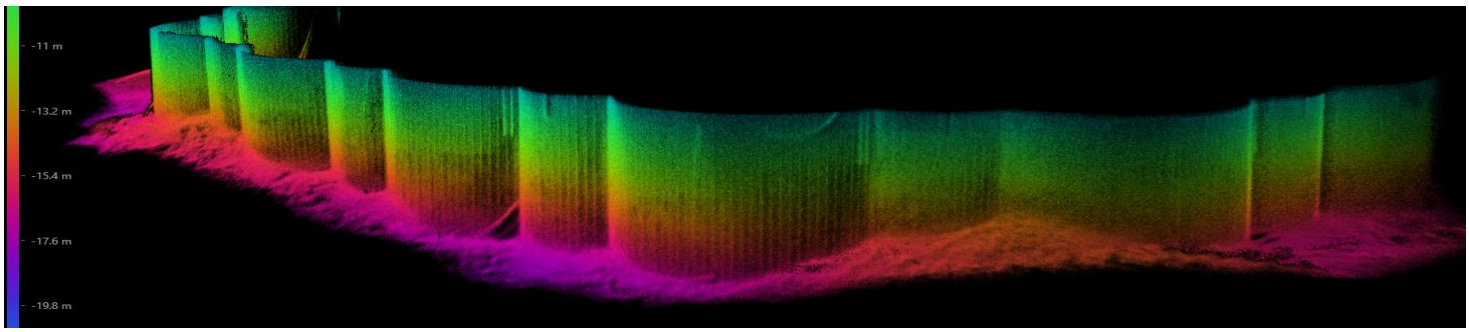

Common small vehicles used with the *NANO Gen Series®*

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"Extremely compact form-factor suitable for deployment on small vehicles"

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