

# SYSTEM AUV-5000 (V2)

HIGH RESOLUTION DYNAMICALLY FOCUSED MULTI-BEAM SIDE SCAN SONAR FOR AUV'S



AUV 5000 V2 System Components

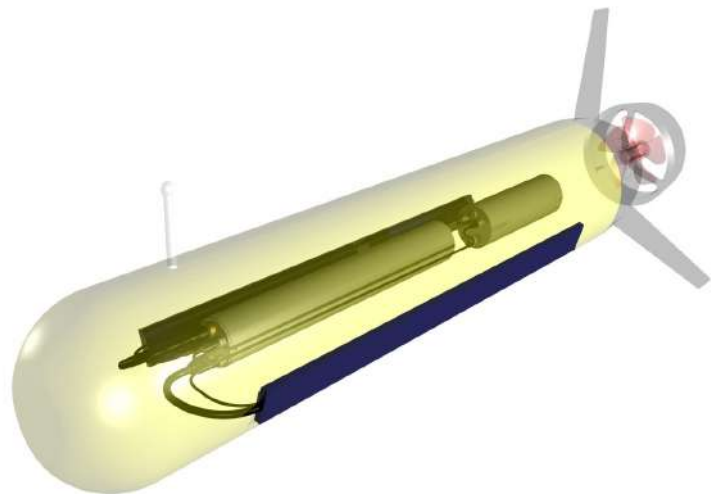
In keeping with Klein's reputation of providing the best high resolution Side Scan Sonar imaging systems in the world, we are proud to introduce the AUV 5000 V2 designed specifically as a dual purpose Side Scan and Bathymetry sonar payload for Autonomous Underwater Vehicles (AUV).

The Klein System AUV 5000 V2 simultaneously generates eight adjacent parallel sonar beams on each side of the AUV while employing advanced beam steering and dynamic focusing for unmatched Along Track resolution that is not possible using single beam or multi-pulse side scan technologies.

With the addition of Swath Bathymetry Sonar, the AUV 5000 V2 employs advanced Interferometric signal processing to produce simultaneous estimates of the seabed topography out to the full swath extent of the sonar, typically 10 to 12 times the overall altitude of the AUV. This added seabed topographic measurement is post processed and co-registered with the side scan backscatter imagery to more accurately position seabed targets. Sonar beam forming is done by the AUV 5000 V2 electronics thus allowing for integration with onboard CAD/CAC software.

## Key Features:

- Multi-Beam, Dynamically Focused Technology
  - Constant Along Track High Resolution Imagery
  - Enhanced Small Object Detection
- On-Board Processing (AUV)
  - Allows for direct integration with CAD/CAC processing Systems
- 100% Bottom Coverage at High Speed
  - Shorter Survey Time
- Advanced Noise Rejection Circuitry
  - Better performance & easy AUV integration
- Wideband FM (CHIRP)
  - Enhanced Range Performance under adverse conditions
- Bathymetry
  - Coincident Bottom Topography
  - More accurately positioned seabed targets
- SAS Compatible Hardware



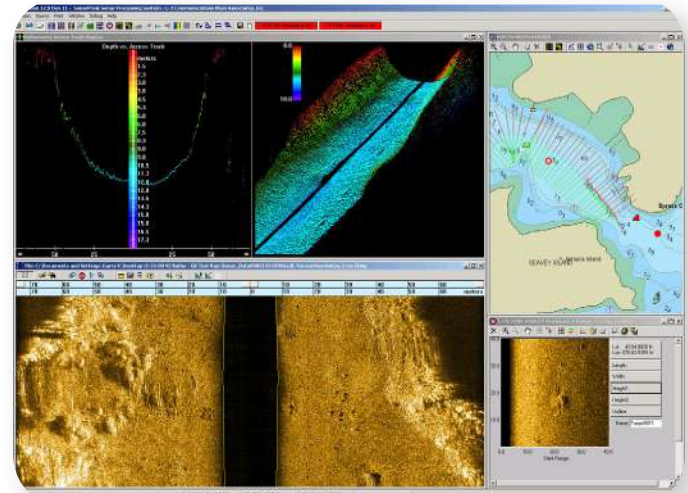
## *The Difference Is In The Image*

# SYSTEM AUV-5000 (V2)



HIGH RESOLUTION DYNAMICALLY FOCUSED MULTI-BEAM SIDE SCAN SONAR FOR AUV'S

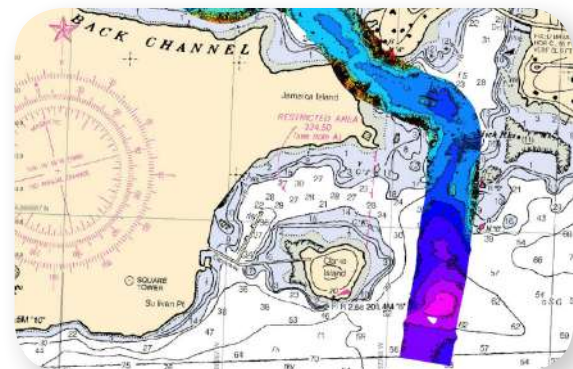
System Specifications	
<b>Number of Beams</b>	8 Port and 8 Starboard
<b>Frequency</b>	455 kHz
<b>Pulse Type (CW/FM)</b>	50 $\mu$ sec CW, 4, 8, 16 msec CHIRP
<b>Resolution (along track) constant of</b>	10 cm to 38 m Increasing at 0.14° to: 20 cm at 75 m 36 cm at 150 m 50 cm at 250 m
<b>Resolution (across track)</b>	3.75 cm at all pulse lengths
<b>Maximum Operating Range</b>	250 m (500 m swath) in Reconnaissance Mode
<b>Sensors</b>	Roll, Pitch & Heading (Standard)
<b>Depth Rating</b>	500 m
<b>Power</b>	85W (nominal 150m range with an 8 msec CHIRP) to 110W (150m range with a 16 msec CHIRP)
<b>Data Output</b>	100 BaseT Ethernet LAN
Interferometric Bathymetric Specifications (Optional)	
<b>Frequency</b>	455 kHz
<b>Number of Beams</b>	Single Beam (one per side)
<b>Along Track Resolution</b>	0.4°
<b>Pulse Type (CW/FM)</b>	FM maximum 16 msec CHIRP
<b>Maximum Range</b>	125 m nominal
<b>Data Output</b>	Generic Sensor Format (GSF)
Arrays	
<b>Size</b>	120 cm (47.2 in)
<b>Weight</b>	5.26 Kg (11.6 lbs in air) 2.27 Kg (5.0 lbs in water)
Sonar Processing Unit (SPU)	
<b>Size</b>	12.7 cm (5 in) (O.D.) x 40.6 cm (16 in) (length)
<b>Weight (Stainless Steel)</b>	12.7 Kg (28 lbs) in air 7.26 Kg (16 lbs) in water
<b>Input Voltage</b>	18-36 V DC (24 V DC nominal)
Sonar Electronics Unit (SEU)	
<b>Size</b>	11.4 cm (4.5 in) (O.D.) x 91.4 cm (36 in) (length)
<b>Weight</b>	43 lbs in air, 24 lbs in water
<b>Cables</b>	One set of Interconnecting Cabling for AUV Installation includes all necessary connectors and jumpers



## DIGITAL SIGNAL PROCESSING

The AUV-5000 (V2) departs from previous multi-beam systems in that the swath forming process is implemented digitally using digital signal processing (DSP), rather than analog delay lines, phase shifters, or multipliers and adders. The primary advantage of this technique is a reduction in the size and weight of the payload. This affords a concomitant reduction in the size of the required AUV/ROV and ancillary handling equipment. Other advantages include more flexibility in the swath processing, allowing software control of operating parameters.

The Series 5000 AUV V2 sonar system equipment consists of the Sonar Electronics (SE), the Sonar Processor (SP), a pair of sonar transducers, a deck cable and power supply (for topside, standalone operation); and various interconnect cables.



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# SYSTEM D3500TF DIGITAL SIDE SCAN SONAR

HIGH-DEFINITION SIDE SCAN SONAR FOR DEEP WATER SURVEYS

The Klein System D3500TF is a digital CHIRP/CW Side Scan Sonar designed for deep water surveys to 3000 m depth. The high fidelity, high definition imaging abilities make the D3500TF system an ideal and versatile tool for various deep water survey applications.

The D3500TF employs both a user selectable CW pulse and CHIRP transmission modes. Klein's advanced broadband CHIRP signal processing technology coupled with Klein's proprietary display algorithms, provides extraordinary long range, and high resolution seafloor acoustic imagery.

Dual simultaneous frequency (100/400 kHz) operation is standard in the D3500TF. 100 kHz provides long range, 600 m per side, search capability while 400 kHz provides higher resolution imagery for target classification to 200 m range per side.

The System features the new Smart Telemetry which measures the electrical parameters of the tow cable (including slip ring and deck cable) and selects data rate and filter settings that maximize data throughput. This results in continuous, high quality imaging over a broad variety of cable types and cable lengths, in excess of 6,000 meters of 0.68" equivalent cable. This feature is designed to support surveyors and rental companies who frequently switch equipment to different winches and different cables.

The D3500TF operates from 110/230, 50/60 kHz power sources. The standard system configuration is supplied complete with a rugged stainless steel towfish (with heading, pitch, roll & depth sensors installed), a 19" rackmount transceiver processor unit (TPU), a workstation with Windows and SonarPro® software installed, and a 100 m lightweight Kevlar test/tow cable. Available options include; laptop, a depressor wing, a responder interface, a magnetometer interface a motion reference unit, altimeter, and fiber optic tow cable interfaces.



## Applications:

- Geology / Geophysical
- Geo Hazard Mapping
- Cable and Pipeline Routing & Inspection
- Archaeological Surveys
- Search and Recovery (SAR)
- Submarine Rescue
- Oceanographic Surveys
- Minerals & Mining
- Benthic Habitat Mapping

## Key Features:

- Dual, Simultaneous Frequencies (100/400 kHz)
- CHIRP and CW Modes of Operation
- Depth Rated to 3000 m
- Hydrodynamic Stainless Steel Tow Fish
- Optional Magnetometer and Responder Interface Units
- Automatic Variable Rate Bandwidth Telemetry
- Easy Operation

*The Difference Is In The Image*

**KLEIN MARINE SYSTEMS, INC.** - Salem, NH



# SYSTEM D3500TF



## HIGH-DEFINITION SIDE SCAN SONAR FOR DEEP WATER SURVEYS

### Specifications:

System D3500TF Towfish	
<b>Construction</b>	316 Stainless Steel
<b>Body Length</b>	1.94 m (76.4 in)
<b>Outer Diameter</b>	15.2 cm (6.0 in)
<b>Weight (in air / in water)</b>	70 kg (154 lbs) in air 47.7 kg (105 lbs) in water
<b>Maximum Depth Rating</b>	3000 m
<b>Standard Towfish Sensors</b>	Compass: Heading +/- 0.5° RMS Roll and Pitch Sensor Depth Pressure Sensor
<b>Optional Tow Accessories</b>	K Wing II Depressor Wing Responder Interface Magnetometer Interface
<b>Topside Assemblies</b>	
<b>Tranceiver Processing Unit (TPU)</b>	19" rack mount
<b>Workstation PC Windows 7 and SonarPro® Installed</b>	19" rack mount, 21.5" LCD display, keyboard and mouse
<b>System Power Requirements</b>	
<b>Input Voltage</b>	110/230 VAC (50/60 kHz)
<b>Power Consumption</b>	120 w

Side Scan Sonar Specifications	
<b>Technology</b>	Single Beam
<b>Frequency</b>	100 kHz/400 kHz Dual Simultaneous
<b>Pulse Type</b>	FM CHIRP and CW
<b>Horizontal Beamwidth</b>	0.7° @ 100 kHz / 0.3° @ 400 kHz
<b>Vertical Beamwidth</b>	50°
<b>Across Track Resolution</b>	9.6 cm @ 100 kHz, 2.4 cm @ 400 kHz
<b>Maximum Operating Range (per side)</b>	600 m @ 100 kHz, 200 m @ 400 kHz
<b>Vertical Beam Center</b>	Tilted down 20° from horizontal
<b>Output Data Format</b>	SDF (Sonar Data Format), or XTF (Extended Triton Format or both - selectable)



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## ***KLEIN REDEFINES MODERN SIDE SCAN SONAR, AGAIN.***

Klein introduces the industry's first integrated single beam side scan and gap filler sonar.

**MA-X VIEW 600 side scan sonar** delivers unprecedented focused 600kHz imagery at an optimum range of 50 meters per side with capability of reaching 120 meters per side.

**MA-X Technology** (Patent Pending) provides imaging of the nadir zone (gap) with the same interpretive characteristics of side scan sonar improving survey times by approximately 40%. This means 40% less survey time at sea, 40% less fuel consumption and a higher probability to complete the survey in a window of good weather!

**Superior image quality combined with an increase in efficiency provide an unmatched value proposition.**

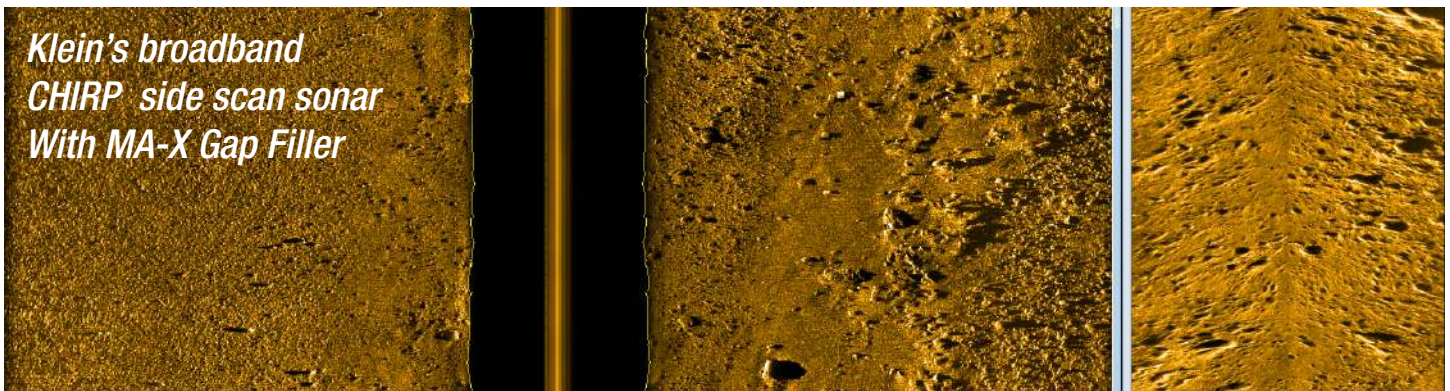


### Key Features:

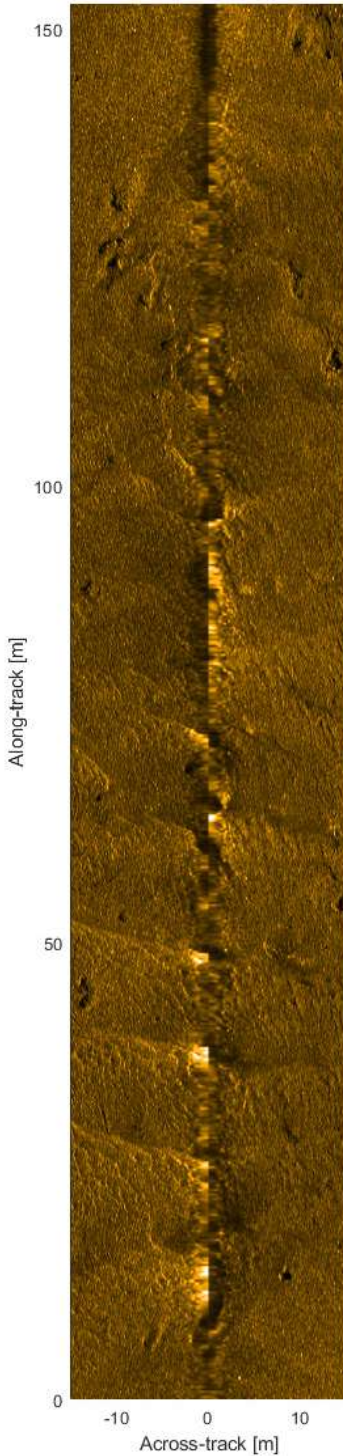
- Complete Nadir Coverage
- 40% increase in survey efficiency
- 600kHz Side Scan/850 kHz Nadir
- Broadband CHIRP
- Klein **BLUE TECHNOLOGY** for superior imaging performance
- Depth Rated to 300 m
- Ergonomic design and one-man deployable
- Smart Telemetry
- Operates on AC or DC Power

### What MA-X VIEW 600 can do for you:

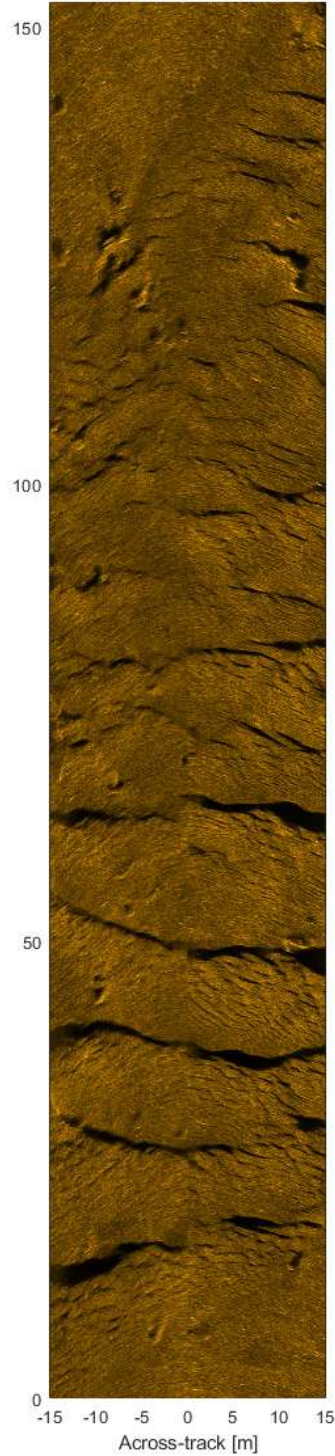
- **Construction/UXO:** Great reduction in shipboard costs.
- **First Responders, Search and Recovery and Harbor Security:** When time is of the essence, greatly reduces search time.
- **Hydrographers & Surveyors:** Maximum survey efficiency.



Traditional  
Side Scan Sonar with  
Slant Range Correction



Actual  
Nadir MA-X



## THE NADIR ZONE (GAP)

The nadir zone is the area directly below the towfish, just to the left and to the right of the towfish making up approximately 5% of the range scale. In this area the pings from side scan sonar produce very little shadow due to geometry. MA-X technology is a cost-effective solution to filling the nadir gap that is characteristic of traditional side scan sonar. By seamlessly covering the nadir region, MA-X based products eliminate the need for overlapping survey lines, resulting in an estimated 40% increase in efficiency. To perform any measurement in this area with side scan sonar, the surveyor needs to make a second pass to properly ensonify the nadir zone of the previous pass.

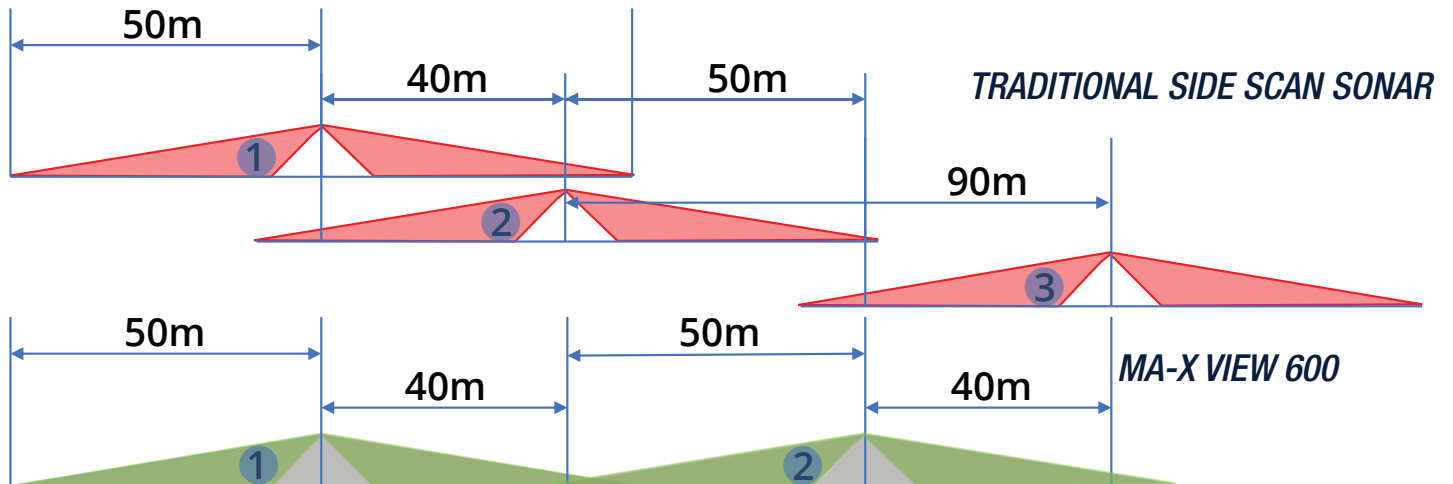
The **MA-X** technology of the **MA-X VIEW 600** generates acoustic shadows in the nadir area with the tail transducers and displays them in the **MA-X** window of SonarPro™.



Klein **BLUE** TECHNOLOGY represents innovations in transducer, signal conditioning and processing design which produces unmatched image quality and range performance.

Klein **BLUE** TECHNOLOGY design optimization achieves a new level of acoustic performance.

## MA-X VIEW 600 : RAISING THE BAR FOR SURVEY EFFICIENCY



### Gap filler is the “Holy Grail” of seafloor imaging -

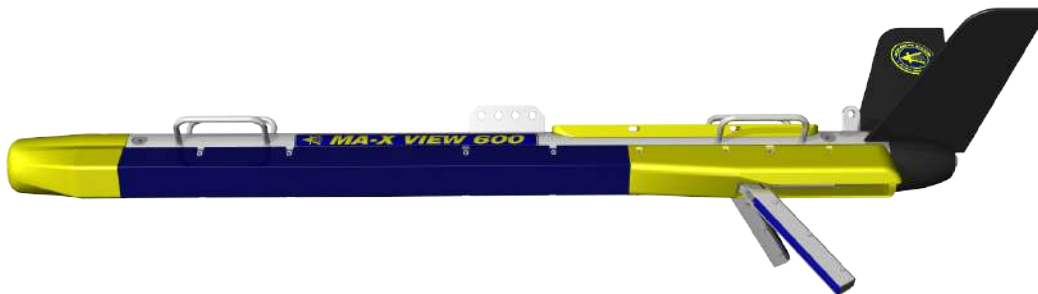
In just two passes with **MA-X VIEW 600** the surveyor achieves the same coverage previously achieved in three. No need to go over the nadir zone twice! The savings over time of shipboard costs makes the return on investment shorter than ever before.

### A note for rental companies -

**MA-X VIEW 600** incorporates Smart Telemetry - adopted across all of Klein’s modern systems (Klein 4900, 4000 and D3500TF). Smart Telemetry provides continuous, high quality imaging over a broad variety of cable types and cable lengths in excess of 5,000 meters. This feature is designed to support rental companies which frequently switch equipment to different winches with different cable lengths.

### Special Applications -

Klein **MA-X VIEW 600** is designed to provide portability, submergence and optimal stability at all depths to a maximum of 300m. For specialized applications, keel weights and K-Wing options are available.



The retractable arrays are easily opened with one finger and can retract in case of a direct hit from an obstacle in the water (or on deck). At the same time they are very robust and can withstand up to 12 knots of current. At the end of the survey, the operator can snap them into the closed position for ease of storing.



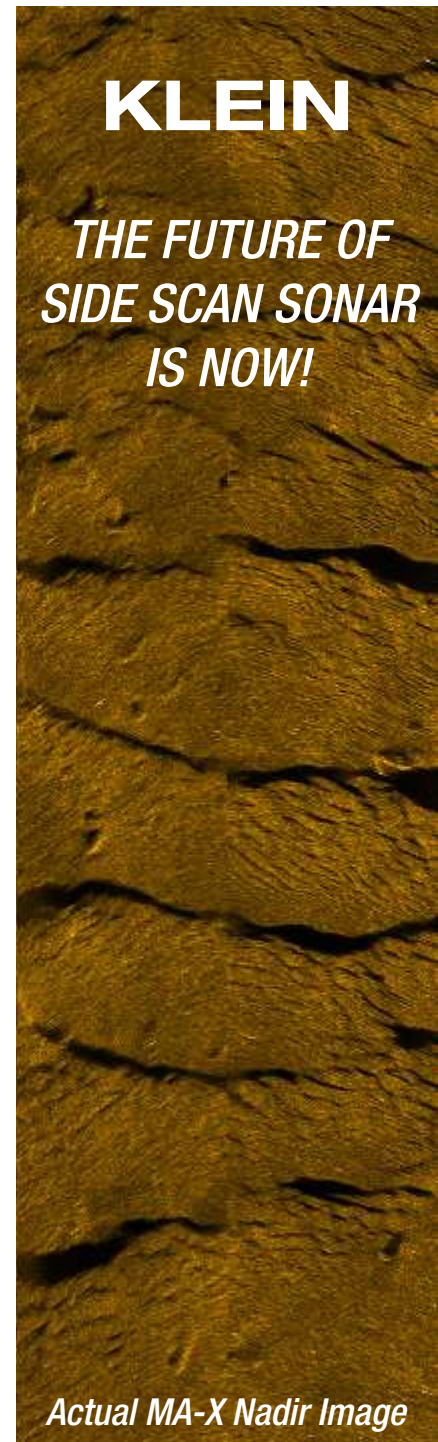
## Specifications:

MA-X VIEW 600 Sonar Specifications	
Technology	Single Beam
Frequency	600kHz (SSS) 850 kHz (Nadir MA-X)
Pulse Type	FM CHIRP
Horizontal Beamwidth	0.23° (SSS)
Vertical Beamwidth	40° (SSS)
Across Track Resolution	2.4 cm (SSS)
Max Range (Per Side)	120 m (SSS)
Vertical Beam Center	Tilted down 25° from Horizontal (SSS)
Output Data Format	SDF or XTF or both – selectable
Input Voltage	12 VDC or 110/220 VAC (50-60 Hz)
Power Consumption	75 W

MA-X VIEW 600 General Specifications	
Construction	Electro-Polished 316 Stainless Steel
Body Length	1.42 m (56 in)
Outer Diameter	8.9 cm (3.5 in)
Weight	30.4 kg (67 lb) (in air) 16.8 kg (37 lb) (in water)
Depth Rating	300 m
Standard Accessories	<ul style="list-style-type: none"> <li>• Heading, Roll and Pitch Sensor</li> <li>• Depth (Pressure) Sensor: 0-300 m</li> <li>• Water Temp. Sensor: 0-35° C</li> <li>• Safety Cable</li> <li>• Reusable Carrying Case, Towfish</li> <li>• Laptop with SonarPro installed</li> </ul>
Optional Accessories	<ul style="list-style-type: none"> <li>• K Wing I</li> <li>• Keel Weight</li> <li>• Ruggedized Laptop</li> <li>• Pole Mount Bracket</li> <li>• Magnetometer interface</li> <li>• Responder Interface</li> </ul>

Specifications subject to change

*MIND Technology is deeply committed to customer support. We are currently servicing valued customers in 80 countries, and relying on a network of competent International Representative to meet and exceed the service needs of our customers around the world. We provide 24 hour / 7 day a week support.*



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Klein's **next generation** Single Beam Side Scan Sonar is purpose built to meet the demanding requirements for long range's, deep-water operations and optimized shallow water performance. Condensing our 50 years of design knowledge into a system that combines Klein's iconic imaging with unprecedented towing options and range performance for unsurpassed search and survey efficiency.

Klein **BLUE TECHNOLOGY™** represents innovations in transducer, signal conditioning and processing design producing unmatched image quality and range performance. These enhancements also allow for motion tolerant performance in heavy sea states where vessel motion impacts tow fish stability. Klein **BLUE** design optimization achieves a new level of acoustic performance for our workhorse Klein 4000 System.



**What the system 4000 can do for you.**

**Salvage/Wreck hunters:** Whether you work in deep sea salvage or are looking for a historical wreck the System 4000 is without equal at long ranges minimizing your search effort.

**Rental Companies:** Unknown customer capabilities of cables and winches are a thing of the past with Klein's Smart Telemetry technologies' ability to adapt to any limitations and to still provide a system that works. Both keel weight and depressor wing options are available.

**Surveyors:** For pipeline and communication cable site survey or in support of a hydrographic survey the versatility of the 4000 system shines through.

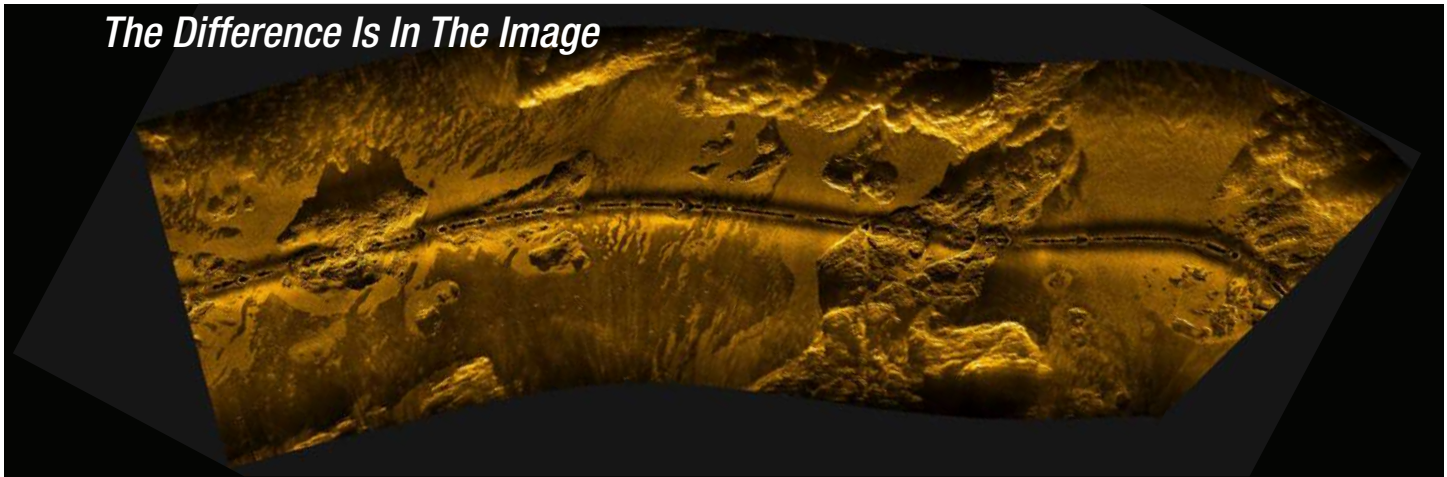
Key Features	
<b>Dual Simultaneous Frequency</b>	Frequencies of 100 kHz and 400 kHz were chosen to provide the most versatility of range capability and resolution
<b>Variable Transmit Power</b>	The system's ability to automatically adjust transmit power improve both frequency separation and short range performance
<b>CHIRP and CW</b>	Advanced Broadband CHIRP processing combined with our propriety algorithms provide both industry leading long-range capability as well as Klein's iconic seafloor images
<b>Smart Telemetry</b>	Automatically Adapts to the electrical properties of cable, winch and slip ring to provide a working system in cases of degraded cables and connections where a fixed telemetry system would not work at all.
<b>Depth Performance</b>	Depth rated to 2000 meters with options for both keel weights and depressor wings to reach your needed depth
<b>Hydrodynamic Design</b>	Designed for reliability and tow stability to achieve exceptional image performance out to a full range of 600 meters
<b>Easy Operation</b>	Klein's SonarPro® software provides all the advanced functionality needed while still providing the easiest to use interface on the market
<b>Ergonomic Design</b>	Four handles make the System 4000 the easiest sonar to handle, without sacrificing the performance you need. The system is easily set on deck with no fear of rolling away or damage without a cradle

# KLEIN SYSTEM 4000



*SIMULTANEOUS - DUAL FREQUENCY - MULTI-PURPOSE - SHALLOW OR DEEP WATER*

*The Difference Is In The Image*



## Specifications:

Side Scan Sonar Specifications		Towfish Construction	
<b>Technology</b>	Single Beam	<b>Towfish</b>	Electro-Polished 316 Stainless Steel
<b>Frequency</b>	100 kHz/400 kHz (Dual Simultaneous)	<b>Body Length</b>	1.42 m (56 in)
<b>Pulse Type</b>	FM CHIRP and Selectable CW	<b>Outer Diameter</b>	8.9 cm (3.5 in)
<b>Horizontal Beam Width</b>	1° @ 100 kHz 0.3° @ 400 kHz	<b>Weight (in air/in water)</b>	32 kg (70 lbs) / 16.8 kg (37 lbs)
<b>Vertical Beam Width</b>	50°	<b>Maximum Depth Rating</b>	2000 m
<b>Across Track Resolution</b>	9.6 cm @ 100 kHz 2.4 cm @ 400 kHz	<b>Standard Towfish Sensors &amp; Accessories</b>	Heading, Roll and Pitch Sensor Depth (Pressure) Sensor, 0-2000 m Water Temperature Sensor: 0-35° C Safety Cable
<b>Maximum Operating Range (Per Side)</b>	600 m @ 100 kHz 200 m @ 400 kHz	<b>Towfish Options</b>	<ul style="list-style-type: none"> <li>• Multiple Keel Weights</li> <li>• K-Wing I</li> <li>• K-Wing II</li> <li>• Responder Interface</li> <li>• Magnetometer Interface</li> <li>• Power Fail Emergency Pinger Interface</li> </ul>
<b>Vertical Beam Center</b>	Tilted down 25° from horizontal		
<b>Output Data Format</b>	Klein SDF (Sonar Data Format) XTF (Extended Triton Format) Both or Selectable		

	4000-SP	4000-RM
<b>Transceiver Processing Unit (TPU)</b>	Splash Proof (IP-65) 50.8 cm (20 in) x 40.6 cm (16 in) x 19.05 cm (7.5 in)	19 in rack mount, 2U
<b>Input Voltage</b>	12 Vdc or 110/220 Vac (50-60Hz)	110/220 Vac (50/60 Hz)
<b>Workstation PC</b>	Laptop Computer with SonarPro® installed (Ruggedized options available)	19 in rack mount PC, 21.5 in LCD monitor, keyboard and mouse with SonarPro® installed

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## KLEIN - A MIND Technology Business

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mind-technology.com



The Klein System 4900 is a versatile Side Scan Sonar that can be used for many different survey, search and recovery applications. The high fidelity, high-definition imaging abilities and the portability of the System 4900 make it an ideal tool for Search and Recovery (SAR) missions while its rugged construction, selectable frequencies and 300 m operational depth rating provide superb capabilities for the coastal survey and security communities.

The System 4900 employs both a user selectable CW pulse transmission mode and advanced broadband CHIRP signal processing technology which, when coupled with Klein's proprietary despeckling algorithms, provide extraordinary long range, high resolution seafloor images.

Image quality is further improved by the System 4900 transducer design which is optimized to provide very narrow horizontal beam widths and thereby exceptional along-track resolution. The combined result of these discriminating features is a high quality image resolution at long ranges which is comparable to higher frequency systems. When sonar detail and range is important, look to Klein for the solution!

The System 4900 also features the new Smart Telemetry which measures the electrical parameters of the tow cable (including slip ring and deck cable) and selects data rate and filter settings that maximize data throughput. This results in continuous, high quality imaging over a broad variety of cable types and cable lengths, in excess of 7,500 meters of 0.68" equivalent cable. This feature is designed to support surveyors and rental companies who frequently switch equipment to different winches and different cables.

The 455/900 kHz provides long range detection, 200 m per side at 455 kHz, and high definition imagery for classification to 75 m per side at 900 kHz.

The System 4900 towfish does not require an optional keel weight for submergence; it has been designed to provide portability, submergence and optimal stability at all depths to a maximum of 300 m.

The System 4900 conveniently operates from AC or DC power sources. The standard system configuration is supplied complete with a robust stainless steel towfish (with heading, pitch, roll & depth sensors and optional magnetometer and responder interfaces installed for simple integration), and IP-65 rated splashproof transceiver processor unit (TPU), a laptop workstation with SonarPro<sup>®</sup> software installed, 50 m of lightweight Kevlar<sup>®</sup> tow cable, a safety cable and a portable towfish carrying case for easy transport.



## Applications:

- Survey, Search and Recovery
- Shallow/Inland Water Surveys
- UXO Surveys
- Port and Harbor Security
- Hydrographic Surveys
- Archaeological Surveys
- Treasure/Wreck Hunting
- Hull Surveys

## Key Features:

- 455/900 kHz (Simultaneous)
- Broadband CHIRP and CW Transmission Modes
- Smart Telemetry
- Operates on AC or DC Power
- Depth Rated to 300 m
- Hydrodynamic Stainless Steel Tow Fish with:
  - Heading, Pitch and Roll Sensors
  - Depth (Pressure) Sensor
- Easy Operation
- Ergonomic Design for one person launch and recovery

# KLEIN SYSTEM 4900 SIDE SCAN SONAR



*SIMULTANEOUS – DUAL FREQUENCY – SURVEY, SEARCH AND RECOVERY*

## Specifications:

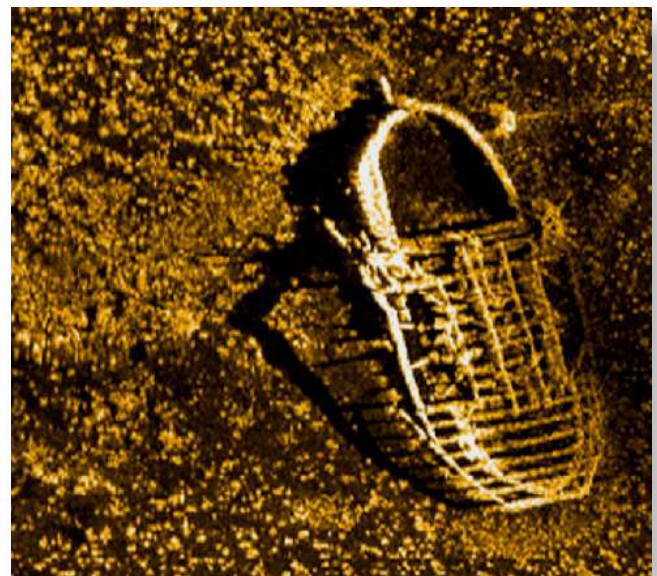
System 4900 Towfish	
<b>Construction</b>	Electro-Polished 316 Stainless Steel
<b>Body Length</b>	1.42 m (56 in)
<b>Outer Diameter</b>	8.9 cm (3.5 in)
<b>Weight (in air / in water)</b>	24.7 kg (54.5 lbs) 13.5 kg (29.7 lbs)
<b>Maximum Depth Rating</b>	300 m
<b>Standard Towfish Sensors &amp; Accessories</b>	Heading, Roll and Pitch Sensor Depth (Pressure) Sensor: 0-300 m Water Temperature Sensor: 0-35° C Safety Cable Reusable Carrying Case, Towfish

Topside Assemblies	
<b>Transceiver Processor Unit - Splashproof</b>	50.8 cm (20 in) x 40.6 cm (16 in) x 19.05 cm (7.5 in)
<b>Laptop</b>	15" Laptop with SonarPro® installed

System Power Requirements	
<b>Input Voltage</b>	12 VDC or 110/220 VAC (50-60 Hz)
<b>Power Consumption</b>	75 W

Optional Accessories	
<ul style="list-style-type: none"> <li>• K Wing I or II Depressor Wings</li> <li>• Ruggedized Laptop</li> <li>• Hull Scan Bracket</li> <li>• Pole Mount Bracket</li> <li>• Magnetometer - Option Ready</li> <li>• Responder - Option Ready</li> </ul>	

Side Scan Sonar Specifications	
<b>Technology</b>	Single Beam
<b>Frequency</b>	455 kHz / 900 kHz, Dual Frequency
<b>Pulse Type</b>	FM CHIRP and CW
<b>Horizontal Beamwidth</b>	0.3° @ 455 kHz 0.3° @ 900 kHz
<b>Vertical Beamwidth</b>	50°
<b>Across Track Resolution</b>	2.4 cm @ 455 kHz 1.2 cm @ 900 kHz
<b>Maximum Operating Range (Per Side)</b>	200 m @ 455 kHz 75 m @ 900 kHz
<b>Vertical Beam Center</b>	Tilted down 20° from Horizontal
<b>Output Data Format</b>	SDF (Sonar Data Format), or XTF (Extended Triton Format) or both - selectable



*MIND Technology is deeply committed to customer support. We are currently servicing valued customers in 80 countries, and relying on a network of competent International Representative to meet and exceed the service needs of our customers around the world. We provide 24 hour / 7 day a week support.*

In the image above: The Burlington Horse Ferry, in Lake Champlain, VT. Image taken with Klein 4900 at 900Khz, 60m swath, 4knots, captured on the port side. Software: Klein SonarPro®.

Note: (a) Crisp definition, highlighted by strong contrast in shadows (b) Fine detail of the wreck's wooden beams and decaying paddlewheel spokes (c) Clearly defined rudder at the top of the image (d) Clusters of invasive zebra mussels (*Dreissena polymorpha*) are exposed by the wide band signal processing inherent in the 4900.

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**KLEIN - A MIND Technology Business**  
 11 Klein Drive • Salem, New Hampshire 03079  
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 mind-technology.com



The Klein 5000 was the first commercial sonar system to employ cutting-edge multi-beam, side scan technology. In the years since it was first introduced, we've been continuously working to make improvements in all aspects of its technology. In keeping with our long, undisputed record of providing the best high-resolution imaging in the industry, we're proud to offer the Klein 5000 V2.

The 5000 V2 simultaneously generates five adjacent, parallel sonar beams on each side of a towfish or AUV while employing advanced beam steering and dynamic focusing techniques. This produces extremely sharp along-track resolution at high tow speeds, with 100% bottom coverage. No single-beam side scan sonar system can match this performance.



The wreck of the Bungsberg  
Range: 150 meters  
Depth: approximately 36 meters  
Speed: 5 knots

*The Difference Is In The Image*

#### Applications:

- Surface Mine Counter Measures (SMCM) and Q-route surveys
- Port and harbor security
- Hydrographic surveys
- Geophysical surveys
- Pipeline and offshore survey
- AUV version available

#### Key Features:

- Long-range reconnaissance mode up to 250 meters
- High-speed with 100% bottom coverage
- Highest resolution, multi-beam technology of any commercial side scan sonar
- Phase differencing swath bathymetry
- Rugged stainless steel construction - built like a tank... not a toy
- 500 meter depth rating (200 m with bathymetry option)

## ONLY KLEIN CAN DELIVER THIS DEPTH OF SONAR IMAGE QUALITY!

You've come to expect the very best from Klein, and the 5000 V2 has everything you would expect from a top-of-the-line side scan sonar (SSS). With peaked performance and extended range capability, no single beam SSS comes close. Our Reconnaissance Mode provides extended or long-range coverage to 250 m\* per side while maintaining along-track resolution of 36-61 cm at ranges from 150 m to 250 m.

The Reconnaissance Mode employs 16 msec frequency modulated Chirp technology coupled with beam steering and dynamic focusing techniques to provide the new extended-range capability. A further advantage to this technique is a significant reduction to the system noise level resulting in much better image quality.

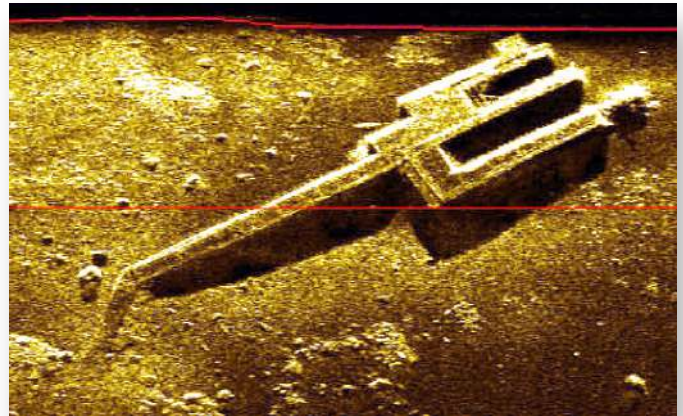
The 5000 V2 overlaps sonar beams and displays only integral, non-overlapped beams. Regardless of the number of beams displayed, all new data can be stored on the PC hard drive for future processing, as desired.

Conventional side scan sonar systems use a single sonar beam per side to generate an image of the seafloor. The physics of this type of sonar results in the degradation of image resolution as range increases. Additionally, operating speeds of 5 knots or less are required to ensure 100% bottom coverage. Sometimes, low-cost multi-pulse and dynamically focused transducer technologies are used to slightly enhance the performance of single-beam systems. However, the result is nowhere near the high quality achieved by Klein's multi-beam technology. This methodology is still lacking, and is not capable of providing the along-track resolution and image quality of a multi-beam system.

Klein sonar, using frequency modulated Chirp, yields consistent cross track resolution at all range settings and speeds. Multi-Ping, without Klein technology, sacrifices cross-track resolution. Each additional pulse effectively decreases cross-track resolution by a factor equal to the number of multi-pulses.



Also available: Klein 5000 AUV V2 Payload, for integrating 5000 V2 capabilities into the user's AUV



Seafloor Structure

### SONARPRO® VISUALIZATION SOFTWARE

Klein's SonarPro® software has long been recognized in the industry as the benchmark for visualization software. Feature sets not found in competitive systems include:

- Full control of sonar system set-up operation
- Data acquisition and recording
- Ability to launch multiple software applications on the same workstation
- Fully integrated viewer, navigation and target analysis
- Import raster and/or vector charts to navigation window
- Save targets as true GEO-TIFF with associated World file
- Survey grid setup
- Survey route setup
- User-friendly Graphical User Interface (GUI)
- Real-time transmission of target position information over network in UDP protocol

### DISTRIBUTED PROCESSING TECHNIQUE

The 5000 V2 uses SonarPro® to connect the topside Transceiver Processor Unit (TPU) to the PC or workstation. This system is very flexible, permitting multiple clients to operate simultaneously from the server, conducting such functions as:

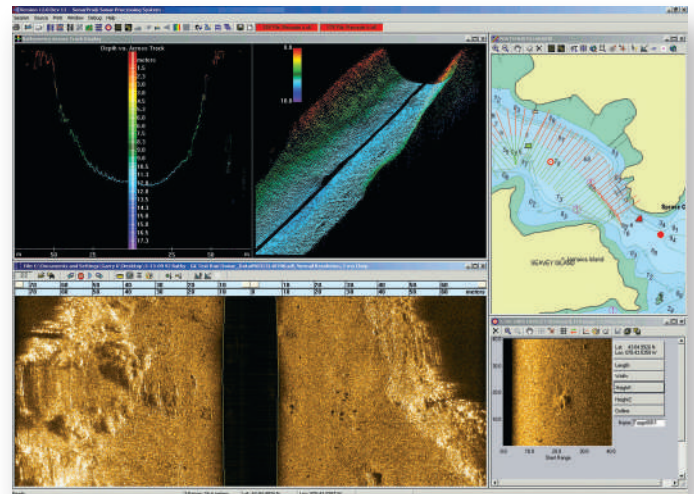
- Raw data storage for archival purposes
- Real-time viewing and processing of data by multiple operators
- Transmission of real-time data to remote workstations
- Post-processing of data while monitoring real-time data in a screen window
- Review of data without impact on collection of real-time data

\* in typical Northeastern USA seas, conditions permitting

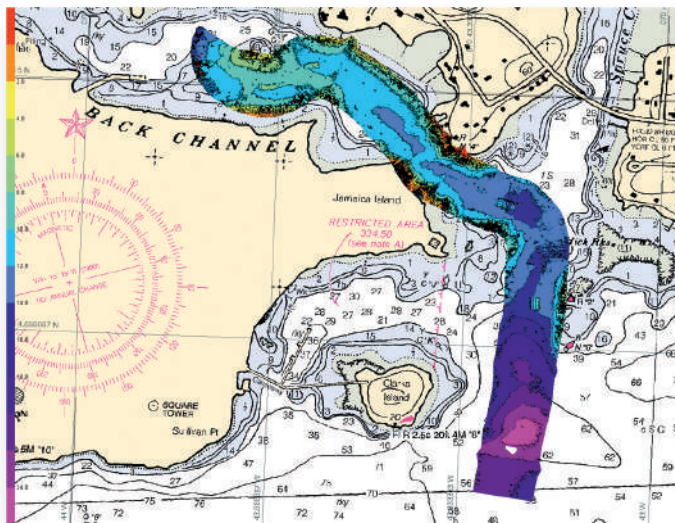
## SWATH BATHYMETRIC SONAR

The 5000 V2 can be configured with an optional Swath Bathymetric Sonar (SBS). This sonar uses advanced phase differencing signal processing to produce simultaneous estimates of the seabed topography out to the full-swath extent of the sonar, typically 10–12 times the overall altitude of the tow fish. This data is co-registered with the resulting side scan backscatter imagery and can be used to more accurately position seabed targets.

Side-looking sonars that do not have the ability to perform bathymetric measurements must assume a locally flat bottom when measuring the location of seabed targets. This can result in target position errors on the order of meters when surveying over sloped bottoms. This added seabed topographic measurement capability is extremely advantageous when performing missions involving shallow water, rapid area assessment.



SonarPro® Real-Time Display



Swath Bathymetry Data Overlay

## STANDARD SCOPE OF SUPPLY

- Model 5250 V2 Towfish (500 m depth rating)
- Model 5105 V2 Transceiver Processor Unit (TPU)
  - Ethernet LAN hub (100 BaseT)
  - SonarPro Visualization software license
- Armored fully terminated 0.68 coaxial cable – 250 m
- 5000 V2 Workstation with:
  - Windows operating system software installed
  - SonarPro software installed
  - 17" flat panel LCD display
  - Keyboard and mouse
- Instruction manual on CD

## Options/Accessories:

### Swath Bathymetry

- Consisting of:
  - Bathymetry transducers and electronics
  - Klein high-accuracy Attitude Sensor
  - SonarPro® Bathymetry Software

### Pressure Sensor

- 500 meter towfish depth rating

### Responder/Transponder

- Acoustic responder kit including transducer and electronics
- Responder/transponder interface kit for customer-supplied USBL beacon

### Depressor Wings

K-Wings Depressors I and II are available for use with the 5000 V2 system. Depressor wings are used to develop hydrodynamic force to drive the towfish and cable down which allows for greater depth placement of the towfish with less cable required for deployment.

### Tow Cables

- Tow cable types and lengths:
  - Lightweight coaxial (0.45 in) nominal diameter (250 m max length)
  - Armored coaxial (0.40 in) nominal diameter (400 m max length)
  - Armored coaxial (0.68 in) nominal diameter (900 m max length)
  - Armored stainless steel (0.525 in) nominal diameter (400 m max length)

### Other Options

- Sealed slip ring assemblies (deck cable from slip ring to TPU)
- 5000 V2 on-board spare parts kits

# KLEIN SYSTEM 5000 V2



HIGH-RESOLUTION, DYNAMICALLY FOCUSED, MULTI-BEAM SIDE SCAN SONAR

Specifications:

General Specifications	
<b>Array Length</b>	120 cm (47.2 in)
<b>Body Length</b>	194 cm (76.4 in)
<b>Body Diameter</b>	15.2 cm (6 in)
<b>Weight (in air)</b>	70 kg (155 lbs)
<b>Depth Rating</b>	500 m standard, 200 m with Bathymetry option

Multi-Beam Side Scan Sonar Specifications	
<b>Number of Beams</b>	5 port & 5 starboard
<b>Frequency</b>	455 kHz
<b>Pulse Type (CW/FM)</b>	50 µsec CW, 4, 8, 16 msec Chirp
<b>Resolution (along track)</b>	10 cm @ 38 m 20 cm @ 75 m, increasing to 36 cm @ 150 m and 61 cm @ 250 (in the Reconnaissance Mode)
<b>Resolution (across track)</b>	3.75 cm at all pulse lengths
<b>Operating Speed Envelope</b>	2 to 10 knots at 150 m
<b>Maximum Operating Range</b>	250 m (500 m swath) in Reconnaissance Mode
<b>Towfish Sensors:</b>	
<b>Heading</b>	Standard
<b>Pitch and Roll</b>	Standard
<b>Pressure</b>	Standard
<b>Altimeter</b>	Standard

Phase Differencing Bathymetric Specifications	
<b>Frequency</b>	455 kHz
<b>Number of Beams</b>	Single Beam (one per side)
<b>Along Track Resolution</b>	0.4°
<b>Pulse Type (CW/FM)</b>	FM Maximum 16 msec Chirp
<b>Maximum Range</b>	125 m nominal
<b>Data Output</b>	Generic Sensor Format (GSF) XYZ Format

Transceiver Processing Unit (TPU)	
<b>Width</b>	Standard 19 in rack-mount
<b>Height</b>	13.2 cm (5.2 in)
<b>Depth</b>	54.6 cm (21.5 in)
<b>Weight</b>	12.7 kg (28 lbs)
<b>Input Voltage</b>	115/240 VAC, 50/60 Hz
<b>Power</b>	120 W
<b>Data Output</b>	100 BaseT Ethernet LAN

Workstation PC	
<b>Workstation PC</b>	Optional, with SonarPro® software installed
<b>SonarPro® Installed</b>	
<b>Windows OS Installed</b>	

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Image:  
S5000 V2 - Range: 150 m

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Klein Marine System's 5900 sonar is the flagship in our exclusive family of multi-beam side scan sonar systems.

The system is a highly configurable multi-functional platform that allows high-speed surveys up to 12 knots with 100% bottom coverage. Its non-magnetic tow body is hydro-dynamically designed to provide a stable towing for increased acoustic performance, natural depression capabilities and overall robustness.



Shown with optional High Resolution Gap Filler

The Klein 5900 high-resolution side scan sonar doubles the already legendary resolution of the Klein 5000 for mine countermeasure (MCM) grade images. The 5900 uses more than twice the number of acoustic channels available on its predecessors. This coupled with a carefully selected center frequency of 600 kHz and an acoustic aperture of 182cm produces high-resolution images of superior quality.

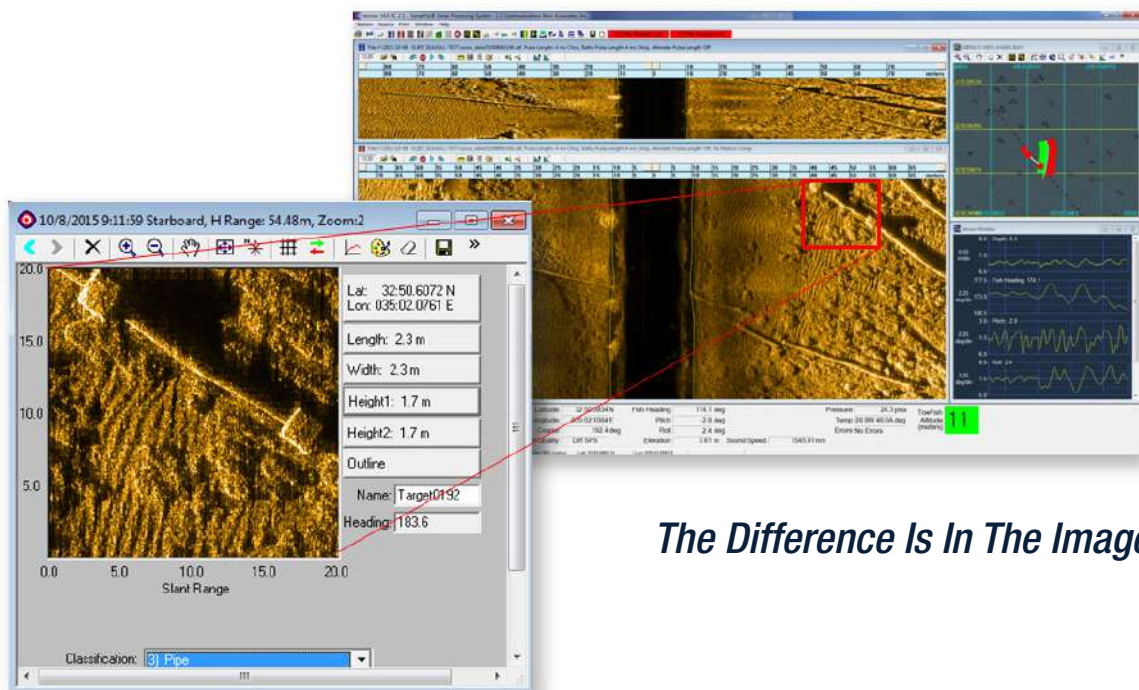
### MODERN AND PRACTICAL APPROACH TO MINE COUNTERMEASURE

The Klein 5900 compares (or even outperforms) commercial and military SAS systems in the acoustic near field for manned and unmanned towed applications.

### Mine Countermeasures in Littoral Waters

Littoral waters present the frequent challenge of wave-induced motion on the towing vessel causing motion on the towed body. This situation is a major problem for conventional SAS systems inhibiting them from producing a synthetic image due to excessive heave variations. The architecture of the 5900 system relies instead on the known length of its segmented arrays to compute its synthetic beams.

Careful transducer design and narrow vertical beam-widths ensure delivery of outstanding shallow water performance by minimizing surface reflections typical of high sea state conditions of littoral waters. MCM with any weather



*The Difference Is In The Image*

MCM operations need to be conducted with high efficiency and high coverage rate in all sensible weather conditions. SAS systems compel the MCM Commander to limit operations to windows of good weather or low sea states. The 5900 dramatically expands the window of operations due to its inherent motion tolerance. This shortens the MCM campaign by weeks in some occasions. You go to sea you get images.

### MCM in unfriendly or unknown Waters

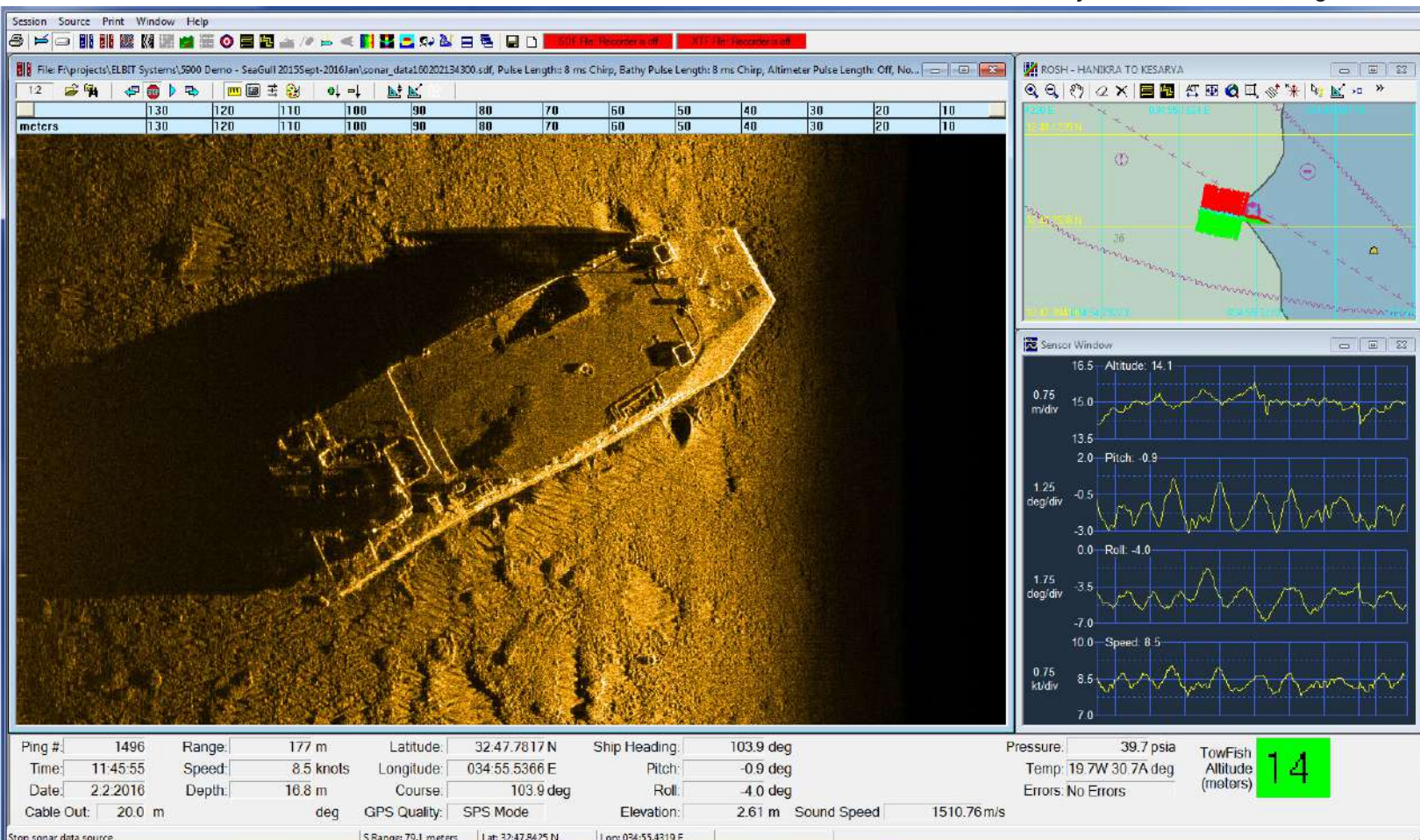
When towing at 12 Knots in unknown waters, the high risk of damaging or even losing valuable equipment when operating in unknown waters is another consideration behind the Klein 5900 design. The sound processing architecture allows Klein Marine Systems to eliminate expensive and sometimes fragile components (high-end motion sensors and stabilization appendices). Furthermore, with the use of MIL-COTS components, the Klein can deliver high resolution systems at commercial prices. The total cost of ownership when including the operational risks of equipment damage or loss, is therefore minimized.

Klein's design philosophy is to avoid the complications, costs and ITAR restrictions of a full SAS implementation, focusing instead on shallow coastal waters and relatively short range MCM operations.

### Key Features:

- Variable multi-beam (up to 20 beams per side, per ping) for high-speed, high-resolution coverage
- 1.8 m long array, 600 kHz operating frequency, provides twice the resolution of the System 5000
- INS for dynamic digital beam stabilization
- FM-Chirp transmit coding, extremely low-noise acquisition and 28-bit analog-to-digital converter contribute to a very wide dynamic-range sonar system
- Dynamic focusing, high-pixel density imagery provides enhanced contrast for target/shadow definition
- Arrays optimized for multi-path and surface reverberation suppression
- Built-in system test capabilities

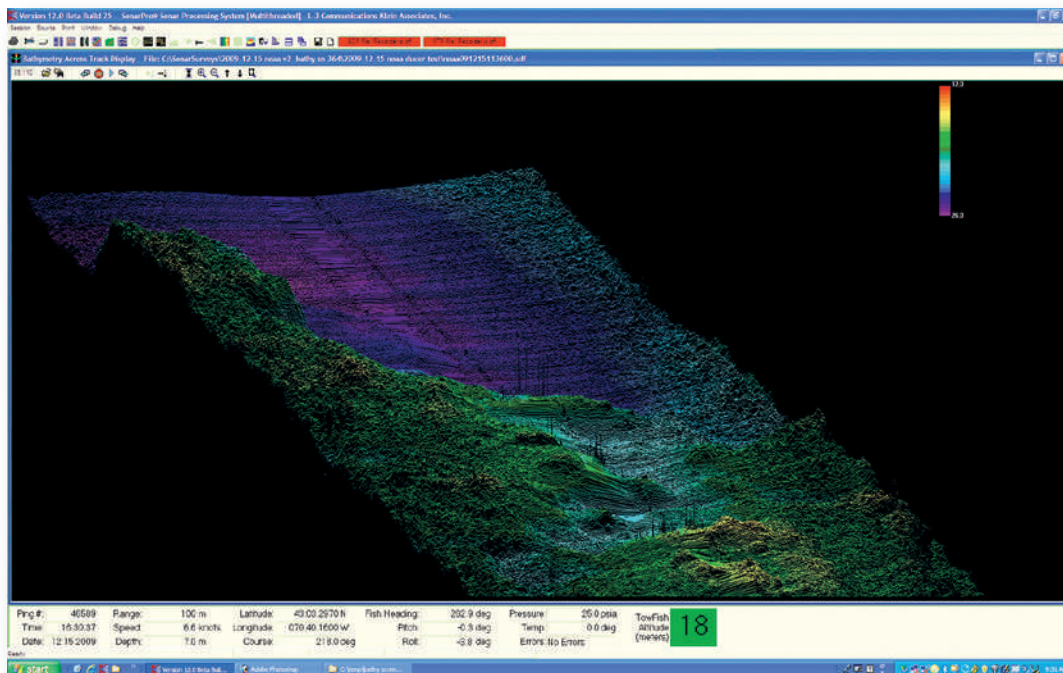
Klein System 5900 at 150 m range.



## Beyond Bathymetry: Klein Q-Factor for Unmanned MCM

The Interferometric Swath Bathymetry Sonar option provides a co-registered “third dimension” - or topographic information- in addition to the side scan data. Bathymetric data acquired by the KLEIN 5900 is seamlessly processed by the Klein Sonarpro™ and by the major hydrographic software producers.

However, Klein 5900 bathymetry system can do much more. It is co-registered with the side scan sonar, providing a very important quality factor for the performance of the side scan sonar. In an unmanned scenario, the quality factor, which indicates presence of second returns and other anomalies, can be used to make real-time decisions (even in an automated fashion) which can dramatically increase the productivity of the survey.



Bathymetry data @ 455 kHz.

### High accuracy positioning options (DVL, USBL, INS)

The 5900 can be supplied with a fully integrated inertial navigation and sensor fusion package – including sensors such as APS/USBL, DVL (for velocity) reported position, IMU - 3-axis linear acceleration and 3-axis gyro rotation. When the information is fused with the vessel GPS, the software reports a high accuracy position necessary for MCM targeting operations.

### Terrain Following Capability

High speed modern unmanned MCM demands terrain following. Klein 5900's K-Wing IV depressor includes two control surfaces, enabling depression and lift, while a closed loop control provides an autopilot function that enables Automatic Depth and controls the Bottom Following function via three hydrodynamic surfaces located in the tail. All mobile appendices are carefully studied to be away from where they could be damaged during launch and recovery, particularly in an unmanned scenario.



### SP-LINK real time full resolution image transmission for real time targeting

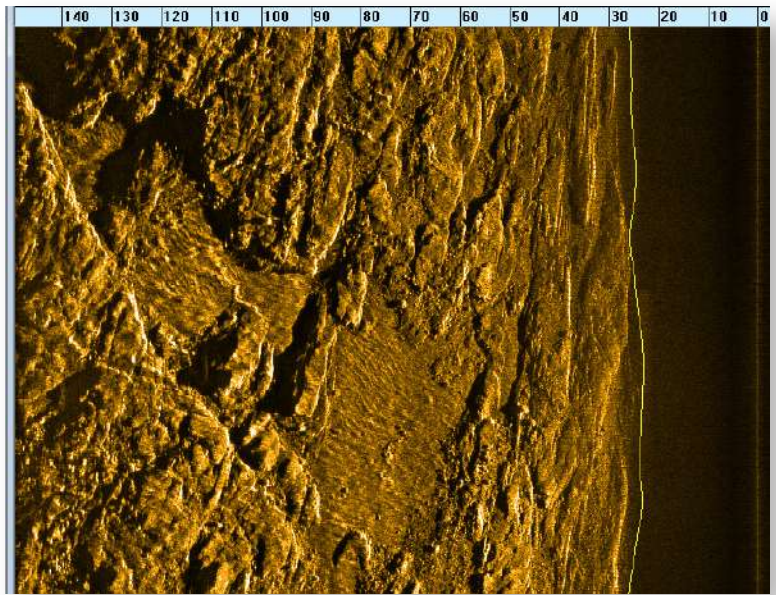
Real time targeting is made possible on the mother ship when a drone is towing the Klein 5900 through Klein's proprietary SP-Link compression scheme. This allows full resolution transmission of compressed data images delivering a 10:1 reduction in bandwidth requirements.

## Standard Towfish Accessories:

- Compass - Heading
- Motion Reference Unit
- Dedicated Acoustic Altimeter - 170 kHz
- Depth Pressure Sensor
- Water Temperature Sensor
- Responder Interface
- Magnetometer Interface

## Options:

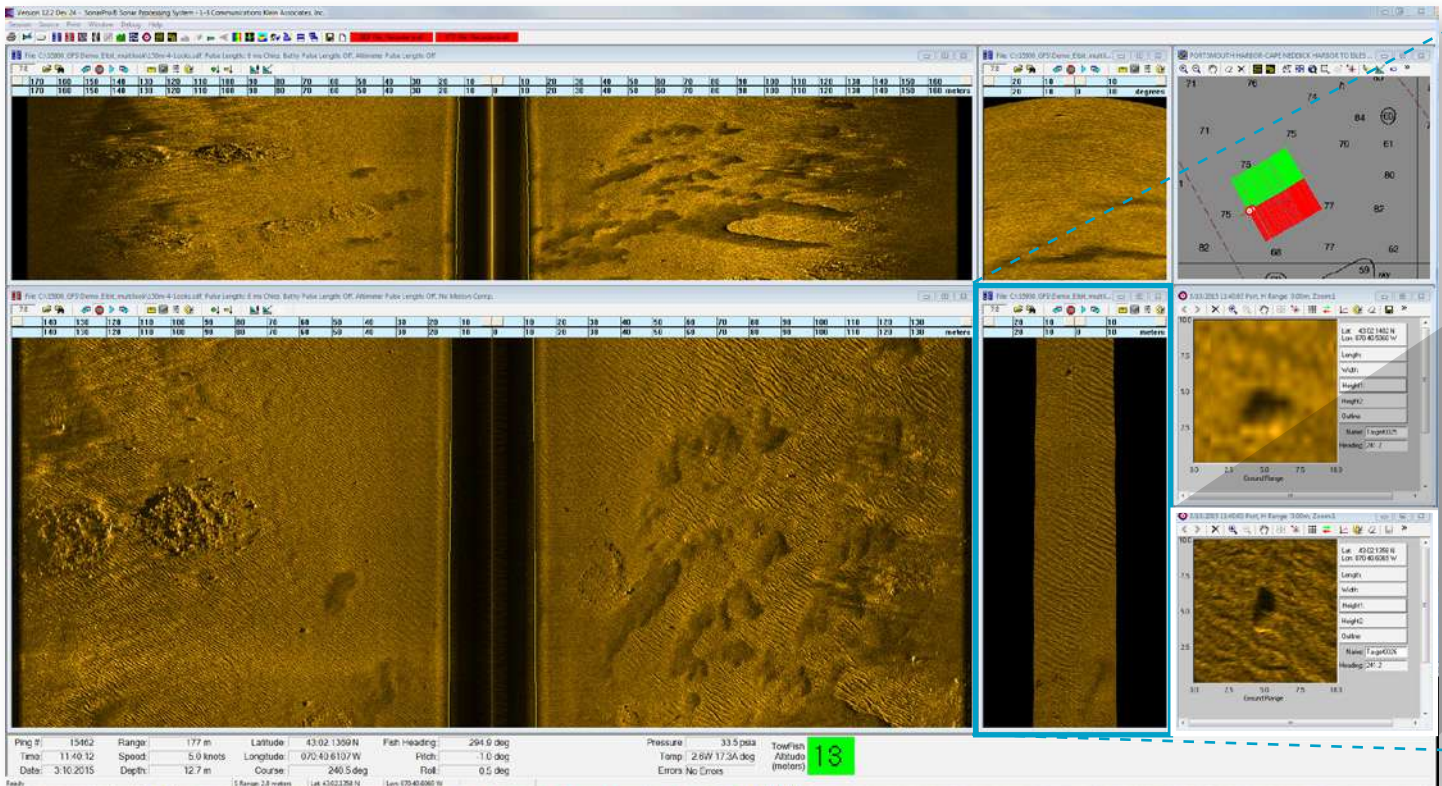
- Gap Filler Sonar - Nadir coverage
- Interferometric Swath Bathymetry Sonar
- Terrain following module
- Augmented INS (with DVL and INS sub-system) for high precision positioning
- K-Wing™ II or K-Wing™ IV - Dynamically Controlled



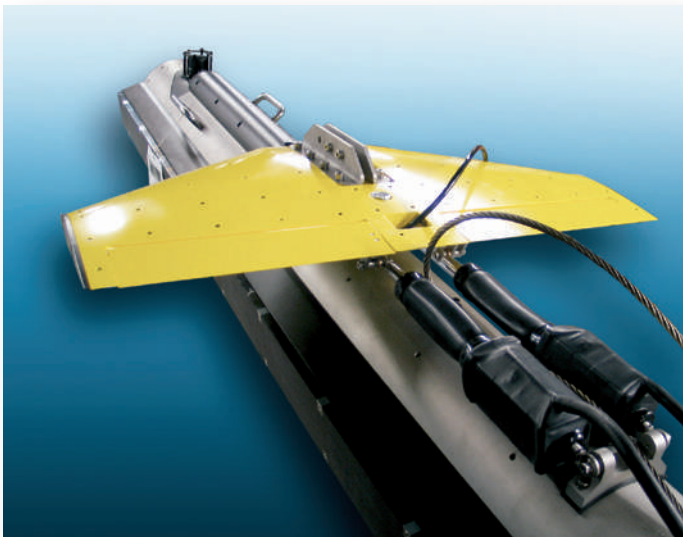
Klein 5900 at 150 m range without optional Gap Filler

**ONLY KLEIN CAN DELIVER THIS DEPTH OF SONAR IMAGE QUALITY!**

Klein System 5900 with optional Gap Filler Sonar (quality control and processed beam displays) at 150 m range.



**HIGH-RESOLUTION, DYNAMICALLY FOCUSED, MULTI-BEAM SIDE SCAN SONAR**



The K-Wing IV uses hydrodynamic forces to depress and steady the towfish while underwater. Dual ailerons are integrated and adjustable in the Klein SonarPro® software or via SDK to compensate for roll bias, slight adjustments in altitude and fast-rise capability.

#### K-Wing IV (Optional)

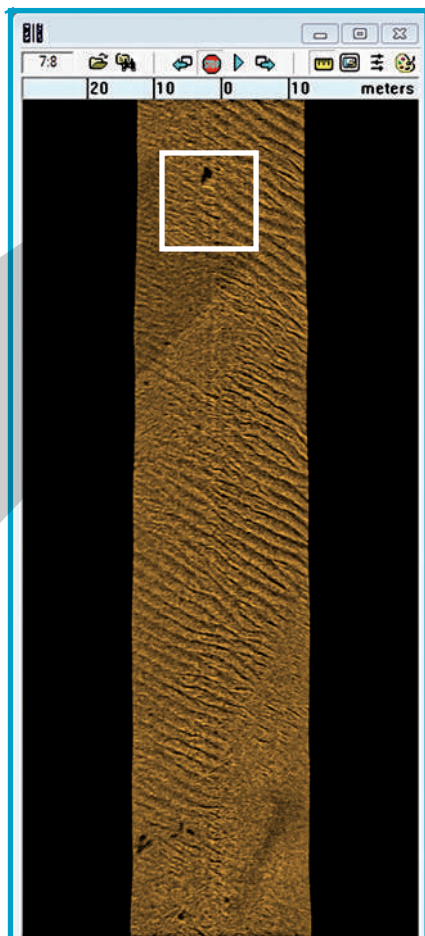
<b>Construction</b>	Aluminum
<b>Dimensions</b>	30.5 in x 15.625 in x 2.5 in
<b>Weight</b>	In air: 38 kg (84 lb) In water: 12 kg (27 lb)

#### Swath Bathymetry Sonar (Optional)

<b>Frequency</b>	455 kHz
<b>Transmit Pulse</b>	CW, FM-Chirp
<b>Along-Track Resolution</b>	0.4° [single swath per ping]
<b>Swath Coverage</b>	10 to 12 times altitude

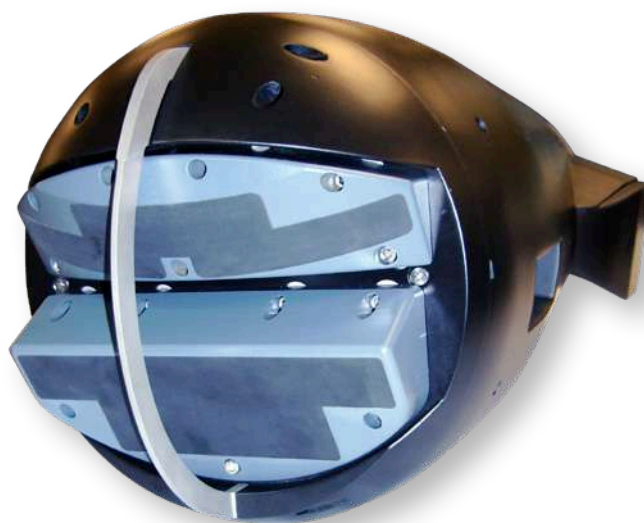
#### Gap Filler Sonar (Optional)

<b>Frequency</b>	750 kHz
<b>Transmit Pulse</b>	CW, FM-Chirp
<b>Along-Track Resolution</b>	4.8 cm
<b>Across-Track Resolution</b>	< 0.5°
<b>Gap Coverage</b>	To 45° each side
<b>Declination</b>	Tilted down 30° from horizontal



#### Optional High Resolution Gap Filler:

The optional Gap Filler increases the rate of coverage by 40%, providing a full swath with gap-less coverage.

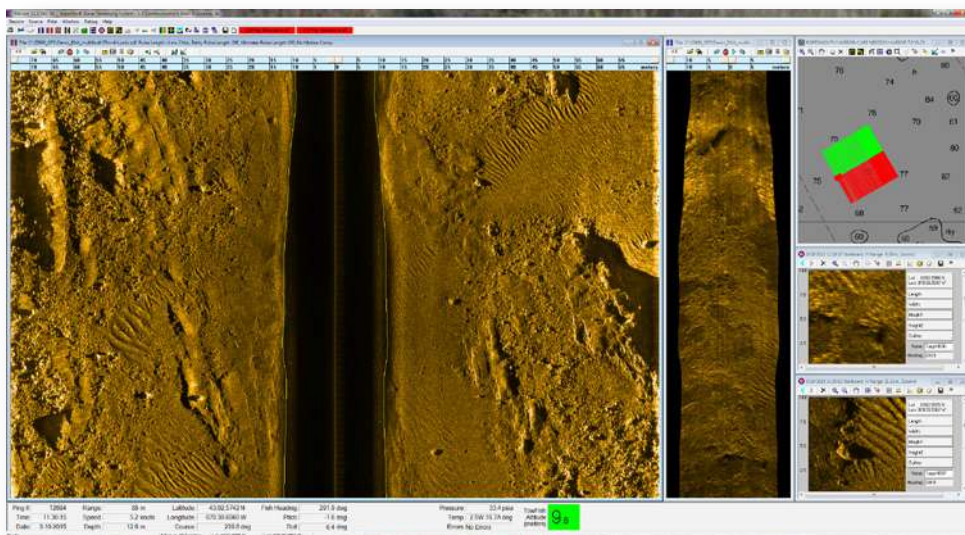


### Specifications:

Tow Fish General Specifications	
<b>Construction</b>	316 Stainless Steel
<b>Length Without Gap Filler Sonar (GFS)</b>	2.36 m (93 in)
<b>Length With Gap Filler Sonar (GFS)</b>	2.73 m (107 in)
<b>Outer Diameter</b>	20 cm (8 in)
<b>Weight</b>	In air: 238 kg (525 lb with Bathy) In water: 179 kg (394 lb) nominal
<b>Maximum Depth Rating</b>	750 m
<b>Operating Speed Envelope</b>	2 to 14 knots (with 100% bottom coverage)

Topside Assembly Dimensions / Weight	
<b>Towfish Interface Unit (TIU)</b>	2U 19-in rack-mount chassis
<b>Sonar Processing Unit (SPU)</b>	2U 19-in rack-mount chassis
<b>High-Voltage Power Supply (HVPS)</b>	1U 19-in rack-mount chassis
<b>Workstation PC</b>	2U 19 in rack mount chassis, 27 in monitor, with SonarPro® and Windows installed
<b>System Power Requirements</b>	100-125 or 200-250 VAC, 50/60 Hz at 1,000 W nominal

Multi-Beam Side Scan Sonar Specifications	
<b>Technology</b>	Multi-Beam Sonar with dynamic focus and dynamic aperture (maintains 100% bottom coverage, up to 20 beams per side)
<b>Frequency</b>	600 kHz
<b>Along Track Resolution</b>	6.2 cm at 50 m range setting (constant) 9.3 cm at 75 m range scale 15.5 cm at 125 m range scale [0.07° beamwidth]
<b>Across Track</b>	3.75 cm
<b>Transmit Pulse</b>	CW, FM-Chirp
<b>Maximum Operating Range</b>	150 m (nominal)/side
<b>Array Length</b>	1.8 m
<b>Vertical Beamwidth</b>	Optimized for shallow water operations
<b>Background to Shadow Contrast Ratio (CR)</b>	> 10 dB - at detection range of 150 m > 15 dB - at classification range of 75 m
<b>Output Data Format</b>	SDF (Sonar Data Format), XTF (Extended Triton Format) or both, - selectable -also supported via SDK
<b>Tow Cable</b>	750 m coaxial; > 3,000 m fiber-optic cable



**Left:**  
Klein System 5900  
Optional Gap Filler Sonar  
(processed beam displays  
with targets)  
at 75 m range.

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For over 50 years, Klein has “set the bar” for commercial side scan sonar performance. The newly developed UUV-3500 product line leverages a powerful, wholly FPGA-implemented, multi-channel processing engine. The sonar engine simultaneously optimizes two different and concurrent output data streams for:

- Photo-quality side scan imagery
- High-accuracy, co-registered swath bathymetry

The UUV-3500 operates exclusively with Klein’s proprietary wide-band technology providing unmatched side scan range and resolution performance in a low-power, compact and lightweight payload. The swath bathymetry option allows for wide swath performance which is typically 10 to 12 times the overall altitude of the UUV and thereby significantly greater coverage than can be achieved by a multi-beam echo-sounder.

The system electronics will easily integrate into all small UUV platforms currently on the market and is also available in a watertight pressure case configuration. Klein’s newly designed, ruggedized transducers are built to last and perform in the most demanding environmental conditions.

Post-survey analysis of the data can be accomplished using Klein’s SonarPro® software. Alternately, we offer a Software Development Kit (SDK) which allows UUV manufacturers and third party software developers the ability to control the sonar directly, as well as display data using our proprietary image display engine.

### *The Difference Is In The Image*



#### Applications:

- Hydrographic/Geophysical survey
- Cable/Pipeline survey
- Environmental survey
- Small object detection
- Mine Countermeasures (MCM)/Intelligence, Surveillance, and Reconnaissance (ISR) surveys

#### Key Features:

- Superior low-frequency resolution
- Unsurpassed high-frequency range performance
- True dual-frequency operation to maximize along track resolution
- On-board processing allows for direct integration with CAD/CAC systems
- Low-power, compact and lightweight
- Easily integrates into all man-portable UUV's
- Side Scan and Bathymetry for Autonomous Underwater Vehicles (AUV's), Remotely Operated Vehicles (ROV's) and UUV's
- Excellent cost-to-performance value

## HIGH-RESOLUTION SIDE SCAN SONAR FOR UUV's

### Specifications:

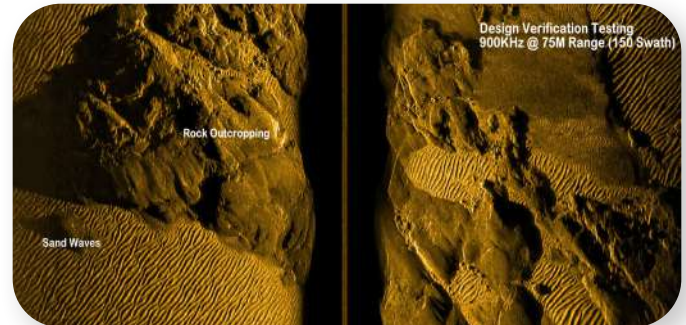
UUV-3500 General Specifications	
<b>Total Electronics Volume</b>	3"L x 4"H x 15"D (Note 1) (76.2 x 101.6 x 381 mm) 1.8 lb / 1.0 lb (0.82 kg / 0.45 kg) dry/wet
<b>Transducers</b>	22"L x 1.75"H x 1"D (Note 1) (559 x 44.45 x 25.4 mm)
<b>Transducer Weight</b>	1.8 lb / 1.0 lb (0.82 kg / 0.45 kg) dry/wet
<b>Transducers With Bathy</b>	22.75"L x 3.89"H x 1.14"D (Note 1) (577.85 x 98.8 x 28.95 mm)
<b>Transducer Weight (Bathy)</b>	7.5 lb/ 4.0 lb (3.40 kg / 1.81 kg) dry/wet
<b>Power</b>	24 VDC (nominal), 18-30 W RMS, including optional bathymetry
<b>Depth Rating</b>	600 m (deeper depth rating options available)

Side Scan Specifications	
<b>Frequencies</b>	455 kHz, 900 kHz
<b>Pulse Technology</b>	Wide-band FM Chirp (1, 2, 4, 8 msec)
<b>Across Track Resolution</b>	2.4 cm
<b>Beam Width</b>	Horizontal: 0.34°, Vertical: 45°
<b>Range (typical)</b>	150 m @ 455 kHz 75 m @ 900 kHz
<b>Side Scan Data Output</b>	SDF

Swath Bathymetry Specifications	
<b>Frequency</b>	455 kHz
<b>Along Track Resolution</b>	0.48°
<b>Across Track Sampling</b>	4.8 cm
<b>Pulse Technology</b>	FM Chirp
<b>Range</b>	125 m nominal / side (typically 10 to 12 times altitude)
<b>Bathymetric Data Outputs</b>	SDF, GSF, & XYZ

Note 1: System electronics and transducers can be modified to support specific requirements of the UUV

Note 2: Transducers available in either a pigtail or penetrator cable configuration



### Flexible System Architecture:

- System supports local data storage to solid-state hard disk or remote data logging to the UUV host over ethernet using network file system (NFS) protocol
- System supports UUV host via ethernet LAN or over a dedicated RS232 link
- Flexible configurations can support both wet and dry vehicle types
- System supports external triggering of its active acoustic devices which mitigates the impact of acoustic interference by allowing the UUV to coordinate acoustic emissions
- 1 PPS timing support

### Standard System:

- Sonar Electronics
  - » Control data interface
  - » Receiver
  - » Transceiver
  - » PC-104 CPU
  - » Power filter
  - » Receiver transition
- Port / Starboard transducer (Note 2)
- SonarPro® software and documentation

### System Options:

- Pressure housing with end cap
- Bathymetry
- Solid-state hard drive
- Mounting bracket
- Transducer pressure test & certification

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From the experience of over 50 years of sea exploration, Klein offers a line of products rated to 3000 m or 6000 m depth based on its widely successful UUV-3500 side scan sonar payload.

The line is composed of:

- The Mid-Depth (3000 m) UUV-3500 high resolution, low power consuming, dual-frequency side scan sonar for unmanned underwater vehicles, including AUVs and ROVs. The system is designed to interface easily with a remote AUV host controller or a telemetry interface for an ROV.
- The Deep (6000 m) UUV-3500 high-resolution, high power, dual-frequency side scan sonar for unmanned underwater vehicles, including AUVs and ROVs. The system is designed to interface easily with a remote AUV host controller or a telemetry interface for an ROV.
- The Deep tow sled, a highly configurable vehicle, is designed for seafloor mapping and deep water surveys, search and recovery, habitat, geology & mineral resource mapping, engineering and scientific studies, as well as cable and pipeline route surveys.
- Klein's provides full support, from concept and planning to integration design, factory-based and sea acceptance testing (FAT/SAT) and on-site integration, harbor and sea acceptance testing (HAT/SAT), as well as factory-based and local on-site maintenance and applications training.

The 6000 m rated UUV-3500 leverages a powerful, wholly FPGA-implemented, multi-channel processing engine. The sonar engine simultaneously optimizes two different and concurrent output data streams for:

- Photo-quality high-resolution side scan imagery
- True dual-frequency simultaneous operation
- Exceptional range performance
- Flexible and robust electronics payload



The UUV-3500 DEEP operates exclusively with Klein's proprietary wide-band technology providing unmatched side scan range and resolution performance in a low-power, compact and lightweight payload.

The system's electronics easily integrate into medium to large size AUV platforms and are also available in a watertight pressure housing configuration for ROV, submarine, and tow sled installations. Klein's ruggedized transducers are designed and built to last and perform in the most demanding environmental conditions.

Real-time control and survey data logging, as well as post-survey analysis of the data, can be accomplished using Klein's SonarPro<sup>®</sup> software. Alternately, Klein offers a Software Development Kit (SDK) which allows UUV manufacturers and third party software developers the ability to control the sonar directly, record data, as well as display the sonar data using Klein's proprietary image display engine.



Klein custom designed control room in ISO container

# KLEIN UUV-3500 DEEP (3,000 m and 6,000 m)



## HIGH-RESOLUTION SIDE SCAN SONAR FOR UUV's

### Specifications:

UUV-3500 Mid and Deep Depth Payloads - General Specifications		
	Side Scan Payload - Mid	Side Scan Payload - Deep
<b>Total Electronics Dimensions</b>	18.25 x 4.5 in (114 x 464 mm)	35.6 x 9.1 in (905 x 231 mm)
<b>Total Electronics Weight</b>	28/17 lb (12.7/ 7.7 kg), dry/wet	90/22 lb (40.9/10 kg), dry/wet
<b>Transducer Dimensions</b>	37.1 x 2 x 1.1 in (942 x 51 x 28 mm)	40.5 x 7.2 x 2.5 in (1028 x 182 x 63 mm) – 100/400 kHz 40.4 x 8.6 x 3.1 in (1028 x 214 x 79 mm) – 75/400 kHz
<b>Transducer Weight</b>	8/5 lb (3.6/2.3 kg) dry/wet	89/62.5 lb (40.6/28.4 kg), dry/wet – 100/400 kHz 126.5/88.5 lb (57.5/40.2 kg), dry/wet – 75/400 kHz
<b>Power</b>	20-32 VDC (24V nominal), 18-30 W RMS	215-325 VDC (300V nominal), 150 W RMS
<b>Depth Rating</b>	3000 m	6000 m

Note 1: System electronics and transducers can be modified to support specific requirements of the UUV

Side Scan Performance Specifications		
	Side Scan Payload - Mid	Side Scan Payload - Deep
<b>Frequencies</b>	100 & 400 kHz	75 & 400 kHz or 100 & 400 kHz
<b>Pulse Technology</b>	Wide-band Chirp, or CW	Wide-band Chirp, Narrow-band Chirp, or CW
<b>Across Track Resolution</b>	9.6 cm @ 100 kHz, 2.4 cm @ 400 kHz	2.4 cm @ 75 kHz, 2.4 cm @ 100 kHz, 1.2 cm @ 400 kHz
<b>Beam Width</b>	0.76° @ 100 kHz, 0.32° @ 400 kHz	1.0° @ 75 kHz, 0.76° @ 100 kHz, 0.32° @ 400 kHz
<b>Range (typical)</b>	600 m @ 100 kHz, 200 m @ 400 kHz	1500 m @ 75 kHz, 750 m @ 100 kHz, 200 m @ 400 kHz
<b>Side Scan Data Output</b>	SDF and/or XTF	SDF and/or XTF

### Flexible System Architecture:

- System supports local data storage to solid-state hard disk, remote data logging to the UUV host over Ethernet using network file system (NFS) protocol, and real-time interface with SonarPro® or various third party survey data acquisition software, utilizing Klein's SDK.
- System supports UUV host via Ethernet LAN or over a dedicated RS232 link
- System supports external triggering of its active acoustic devices which mitigates the impact of acoustic interference by allowing the UUV to coordinate acoustic emissions
- 1 PPS timing support

### Standard System:

- Sonar Electronics Housed in Pressure Vessel
- Port & Starboard transducers
- Port & Starboard Pre-Amplifiers (in pressure vessels)
- Interconnect Cables for Transducers, Electronics Pressure Vessel, and Pre-Amplifiers
- SonarPro® software and documentation

### System Options:

- Solid-State Hard Drive
- Software Development Kit (SDK)
- Klein Direct Support with System Integration
- Towsled System Configuration
  - Depressor
  - Fiber Optic tow cable
  - Winch/Controls
  - Survey Operation and Control Lab
  - Third Party software for survey data acquisition and mapping
  - Interface for Doppler Velocity Logger (DVL)
  - Interface for Sub-Bottom Profiler (SBP)
  - Interface for Multi-Beam Echo Sounder (MBES)
  - Interface for Magnetometer
  - Interface for Responder/ Ultra-Short Base Line (USBL) Acoustic Tracking System

*The Difference Is In The Image*

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