



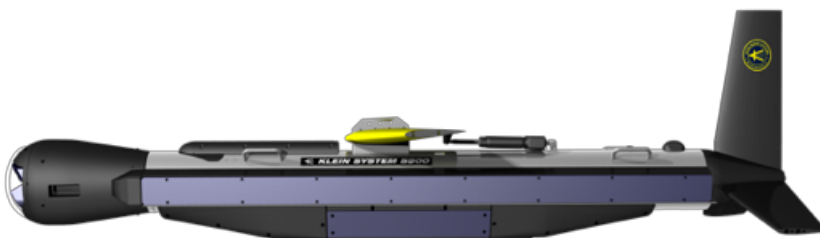
KLEIN
A MIND Technology Business

KLEIN SYSTEM 5900

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

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

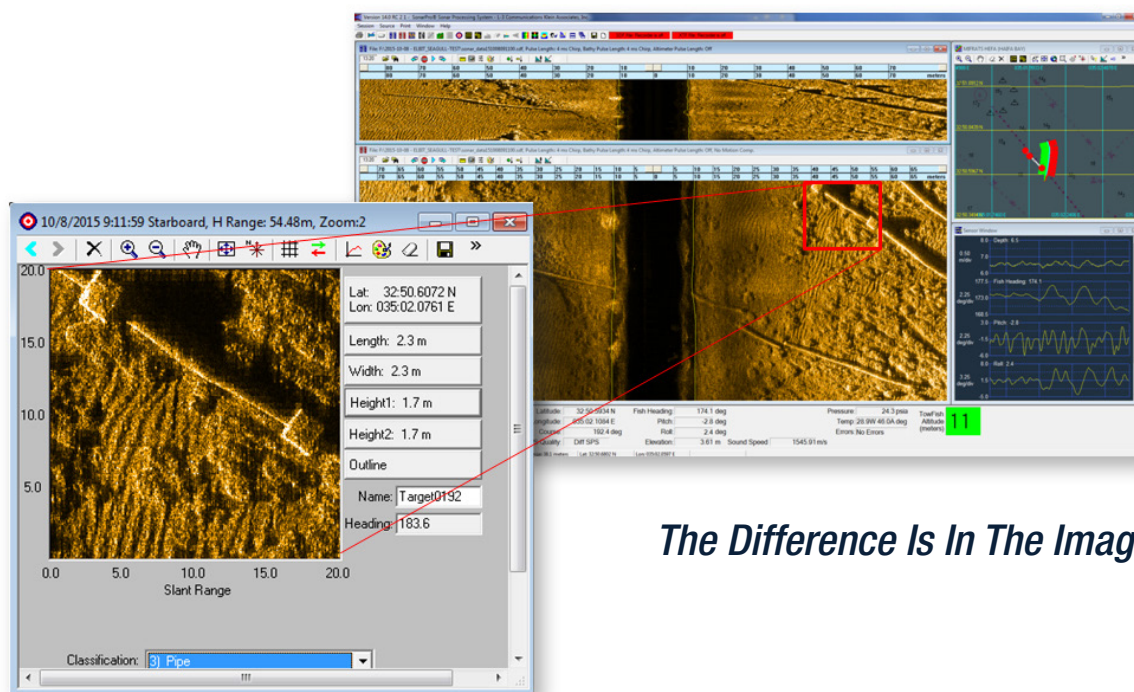
The Klein 5900 compares (or even outperforms) commercial and military SAS systems in the acoustic near field for manned and unmanned towed applications.

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

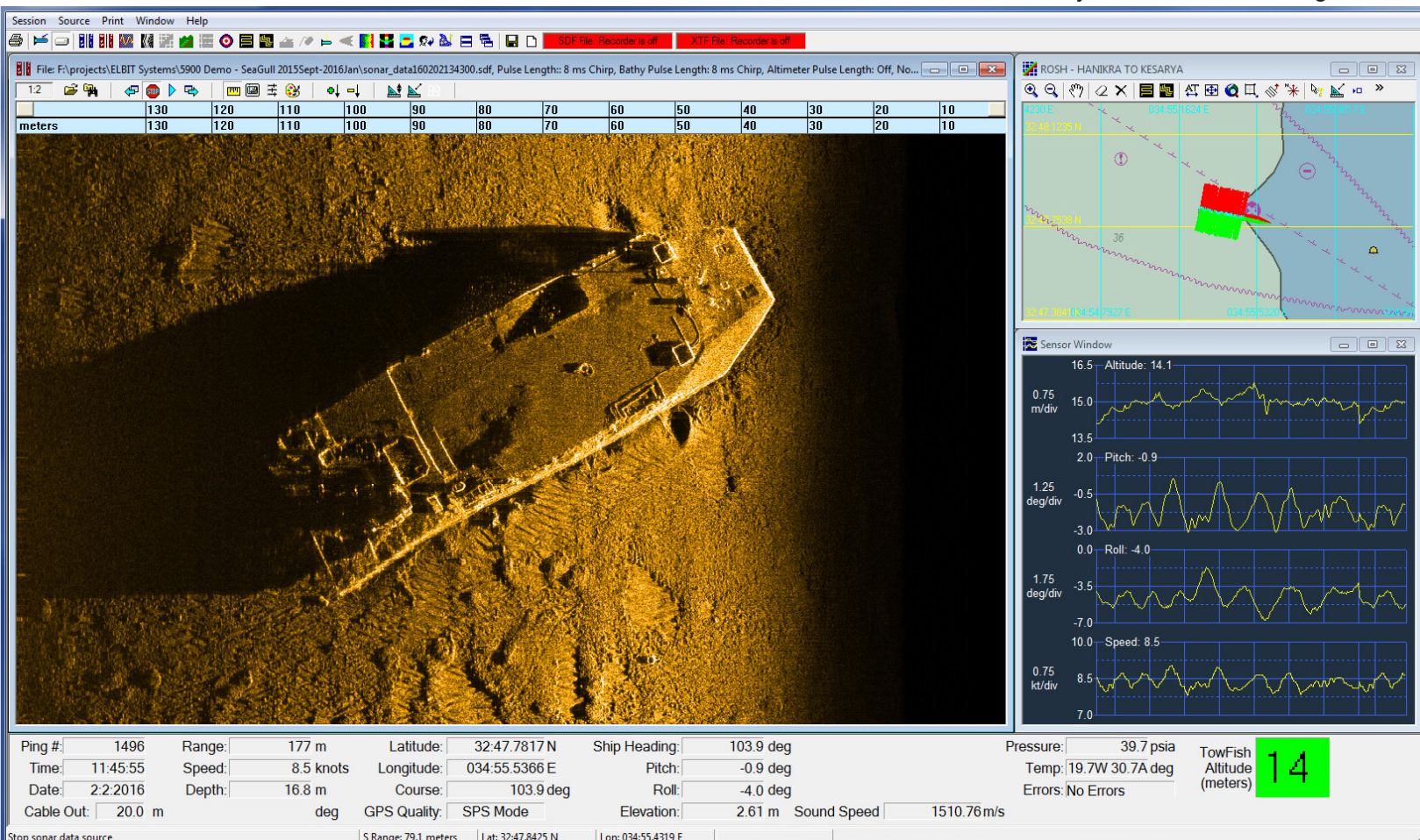
When towing at 12 Knots in unknown waters, the high risk of damaging or even losing valuable equipment when operating in unknown waters is another consideration behind the Klein 5900 design. The sound processing architecture allows Klein Marine Systems to eliminate expensive and sometimes fragile components (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

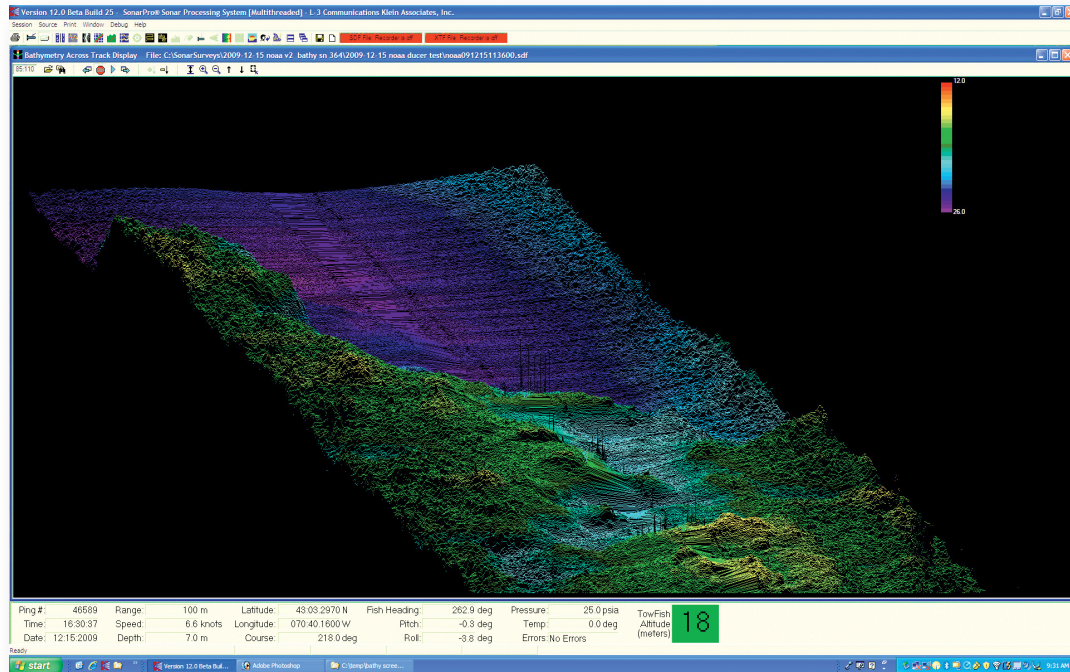
Klein System 5900 at 150 m range.



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.



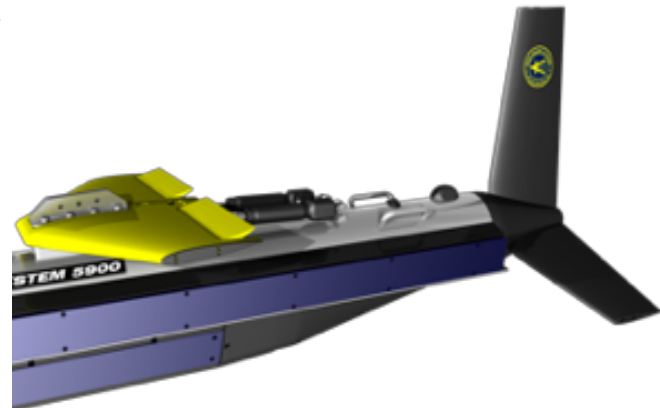
Bathymetry data @ 455 kHz.

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

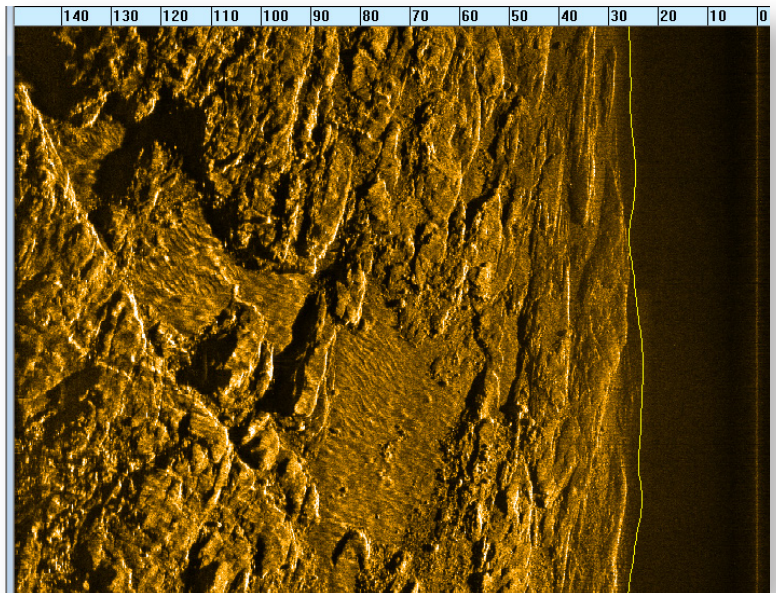
Real time targeting is made possible on the mother ship when a drone is towing the Klein 5900 through Klein's proprietary SP-Link compression scheme. This allows full resolution transmission of compressed data images delivering a 10:1 reduction in bandwidth requirements.

Standard Towfish Accessories:

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

Options:

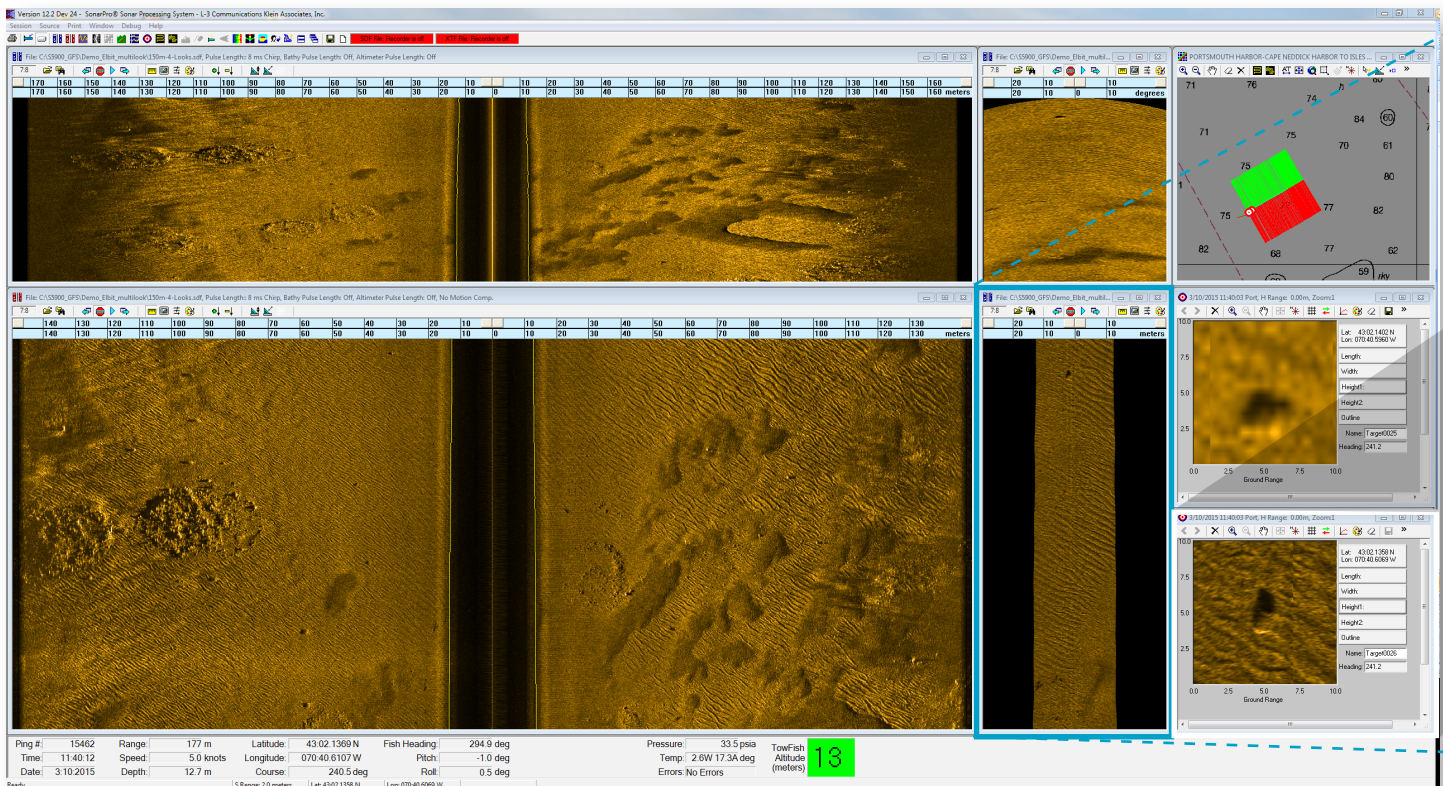
- Gap Filler Sonar - Nadir coverage
- Interferometric Swath Bathymetry Sonar
- Terrain following module
- Augmented INS (with DVL and INS sub-system) for high precision positioning
- K-Wing™ II or K-Wing™ IV - Dynamically Controlled



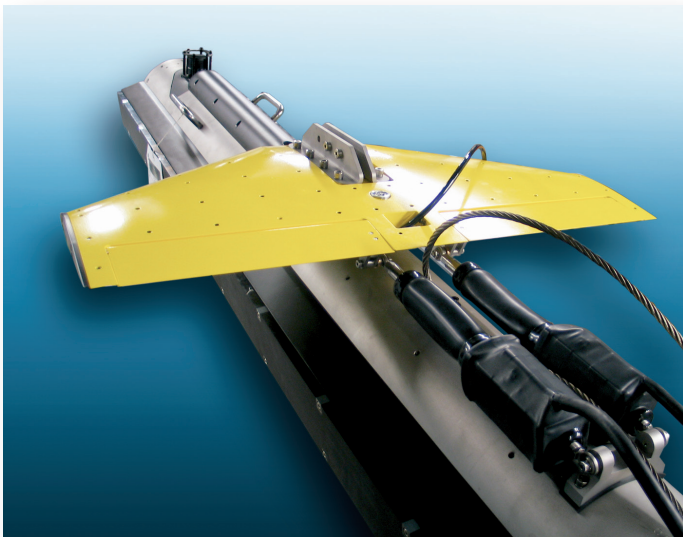
Klein 5900 at 150 m range without optional Gap Filler

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)

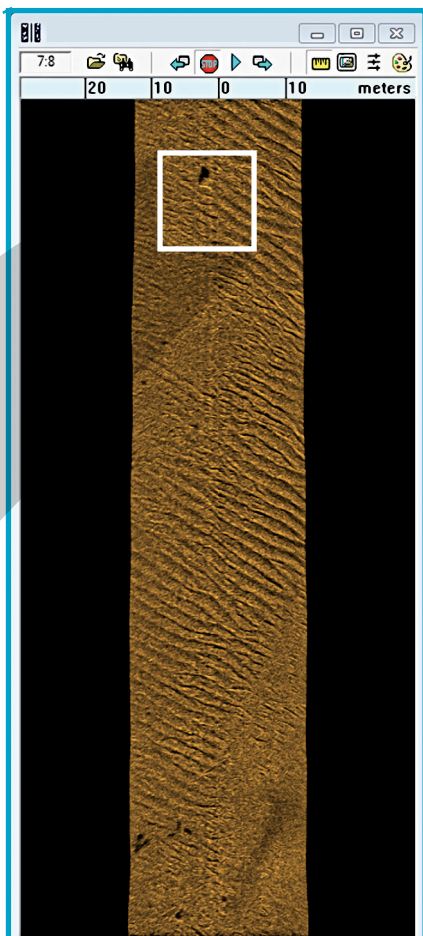
| | |
|---------------------|--|
| Construction | Aluminum |
| Dimensions | 30.5 in x 15.625 in x 2.5 in |
| Weight | In air: 38 kg (84 lb) In water: 12 kg (27 lb) |

Swath Bathymetry Sonar (Optional)

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

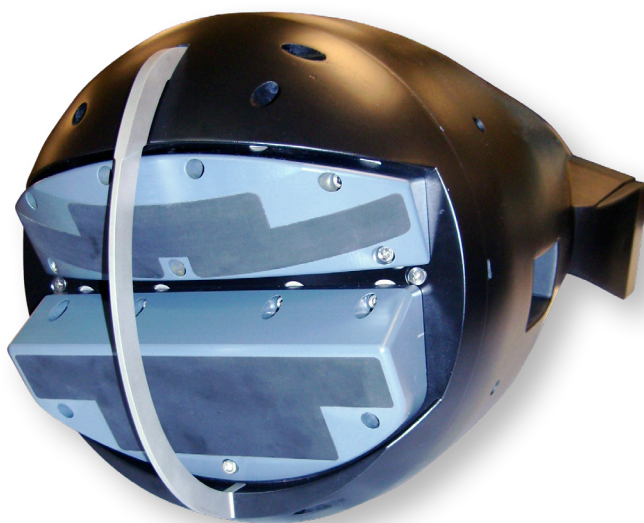
Gap Filler Sonar (Optional)

| | |
|--------------------------------|---------------------------------|
| Frequency | 750 kHz |
| Transmit Pulse | CW, FM-Chirp |
| Along-Track Resolution | 4.8 cm |
| Across-Track Resolution | < 0.5° |
| Gap Coverage | To 45° each side |
| Declination | 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.



KLEIN SYSTEM 5900



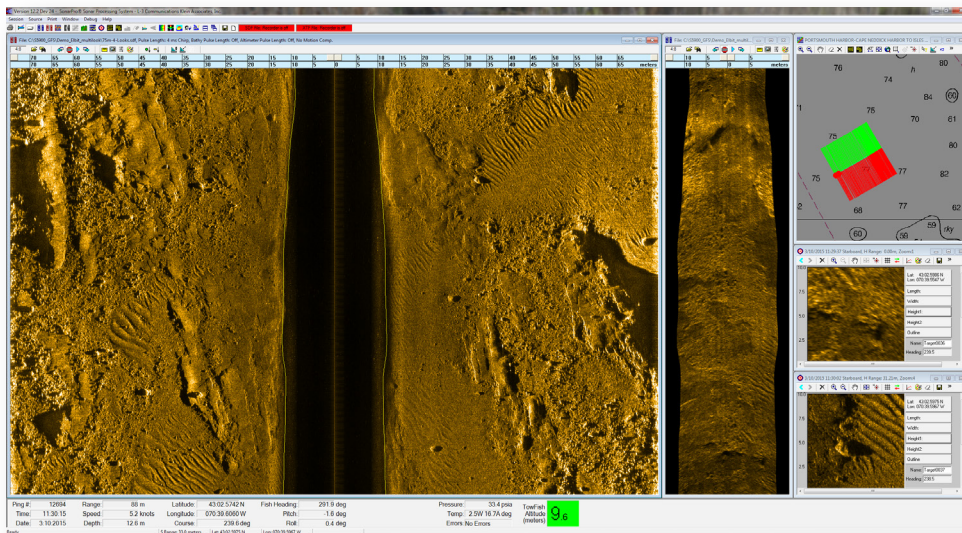
HIGH RESOLUTION, DYNAMICALLY FOCUSED, MULTI-BEAM SIDE SCAN SONAR

Specifications:

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

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

| Multi-Beam Side Scan Sonar Specifications | |
|---|--|
| Technology | Multi-Beam Sonar with dynamic focus and dynamic aperture (maintains 100% bottom coverage, up to 20 beams per side) |
| Frequency | 600 kHz |
| Along Track Resolution | 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] |
| Across Track | 3.75 cm |
| Transmit Pulse | CW, FM-Chirp |
| Maximum Operating Range | 150 m (nominal)/side |
| Array Length | 1.8 m |
| Vertical Beamwidth | Optimized for shallow water operations |
| Background to Shadow Contrast Ratio (CR) | > 10 dB - at detection range of 150 m > 15 dB - at classification range of 75 m |
| Output Data Format | SDF (Sonar Data Format), XTF (Extended Triton Format) or both, - selectable -also supported via SDK |
| Tow Cable | 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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