SATLAB® GEOSOLUTIONS

Case Study

# Singlebeam vs. Multibeam:

## Advancing Underwater Surveying Efficiency

### Project Overview

As inland waterway shipping grows rapidly, precise hydrographic surveys are essential for safe and efficient navigation. The Shiqiao Waterway, a key canal connecting major shipping routes, plays a crucial role in regional commerce and transportation, necessitating frequent and accurate assessments of underwater topography to ensure safe navigation and efficient operations.


Traditionally, these surveys were conducted using the ***HydroBoat 1200 USV, equipped with a single-beam echosounder***. However, as shipping traffic increased, the demand for higher precision also grew. To meet this need, the shipping department introduced the ***HydroBoat 1500 USV with the HydroBeam M4 multibeam system***, enabling more detailed and comprehensive bathymetric mapping.

This project compares singlebeam and multibeam technology in terms of efficiency, cost, and data quality, providing insights for future hydrographic initiatives.

## *Singlebeam Survey: A Traditional Approach*

### 1. Equipment and Setup

The HydroBoat 1200 USV features a compact design with an integrated 200 kHz singlebeam echosounder, eliminating the need for additional installation. Once deployed, it begins data collection immediately.

### 2. Route Planning

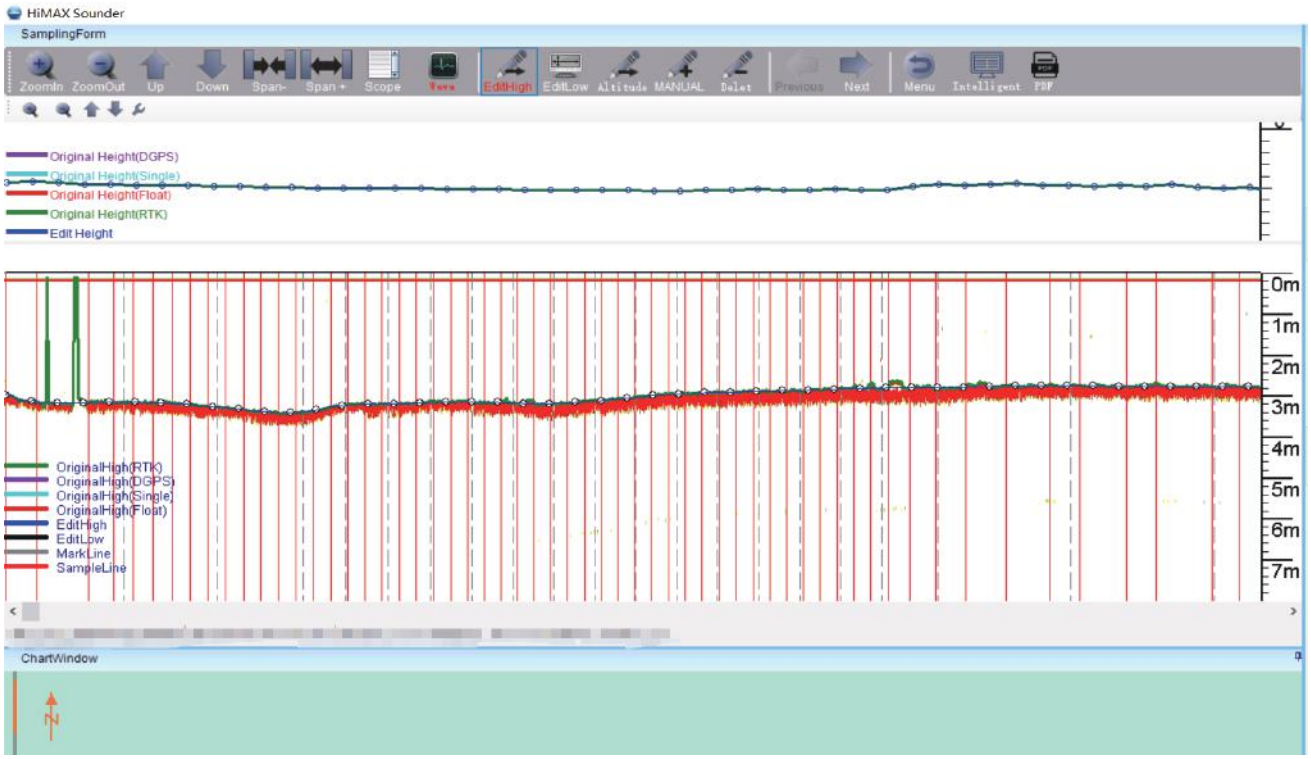
After selecting the survey area on the Android controller, the *SLHydro USV software* automatically generates survey lines spaced 5 m apart.

### 3. Data Collection

The HydroBoat 1200 USV autonomously follows predefined survey lines, efficiently capturing depth data with minimal operator intervention.

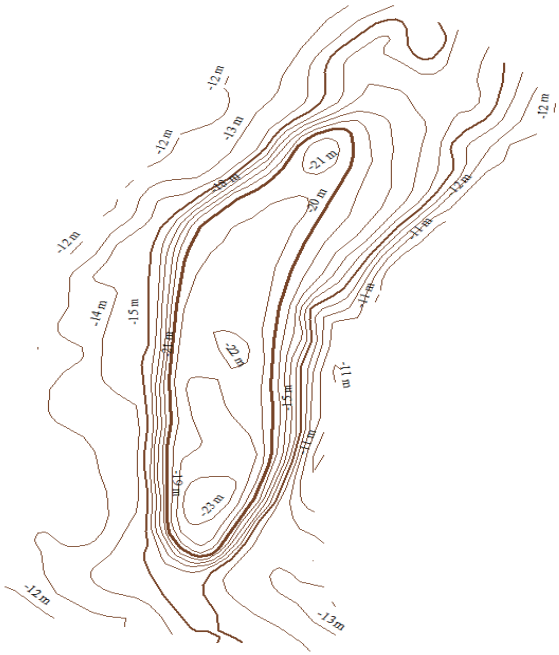

### 4. Data Processing

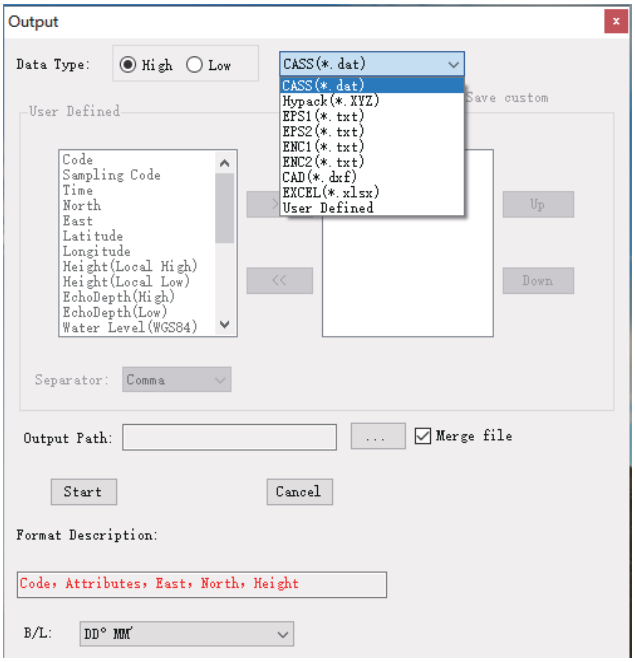
After the survey, the collected data undergoes basic filtering and is exported in multiple formats for further analysis using hydrographic software.



### 5. Performance and Limitations

Singlebeam technology works well for small-scale surveys but collects only one depth point per ping, making large-area surveys time-consuming. While it remains a cost-effective and user-friendly solution, its limited resolution may not be sufficient for detailed hydrographic studies.




## *Multibeam Survey: Advancing Precision and Efficiency*

### 1. Equipment and Setup

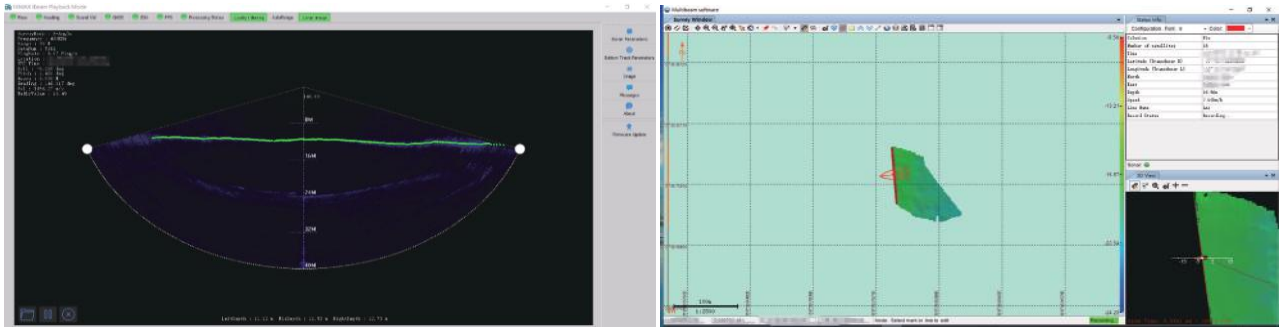
The HydroBoat 1500 USV is equipped with the HydroBeam M4 multibeam echosounder, offering full-swath coverage with 1,024 beams. This system is pre-integrated, requiring no setup, and is ready for high-density data acquisition upon deployment.

## 2. Route Planning

The SLHydro USV software automatically generates optimized survey lines based on the selected area.

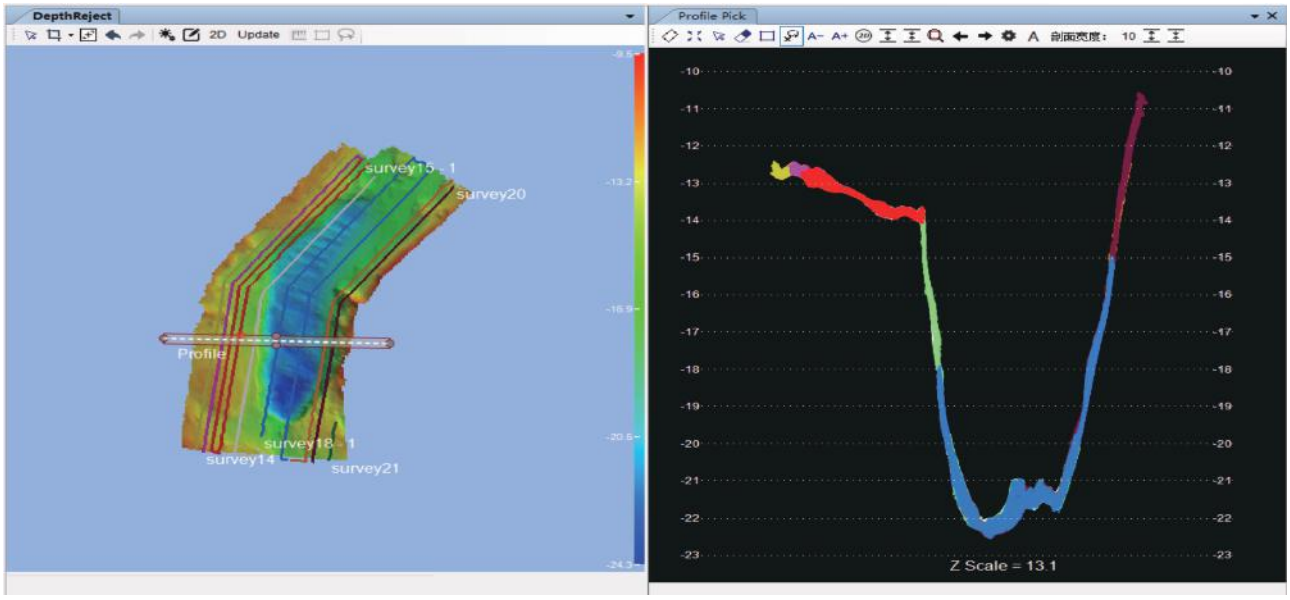
## 3. Data Collection

The HydroBoat 1500 USV autonomously follows predefined survey lines, efficiently capturing high-density depth data with minimal operator input. Its wide swath coverage reduces data collection time to 0.6 hours—three times faster than singlebeam for the same area. Operators use a laptop to remotely control the industrial computer built into the HydroBoat 1500 for multibeam data acquisition.



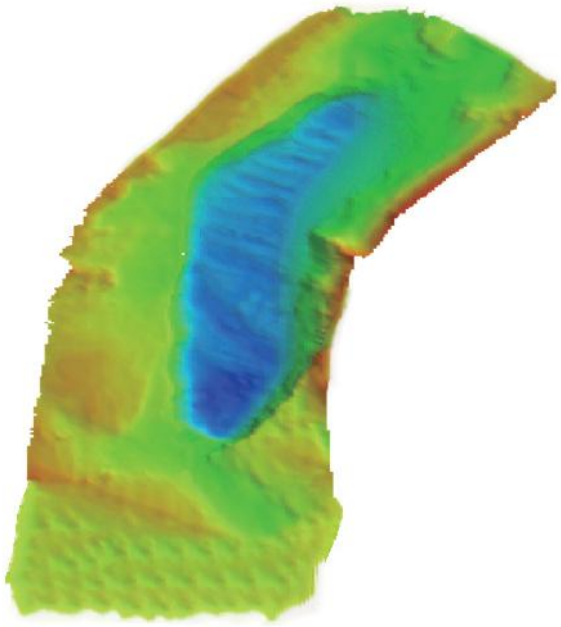
## 4. Data Processing

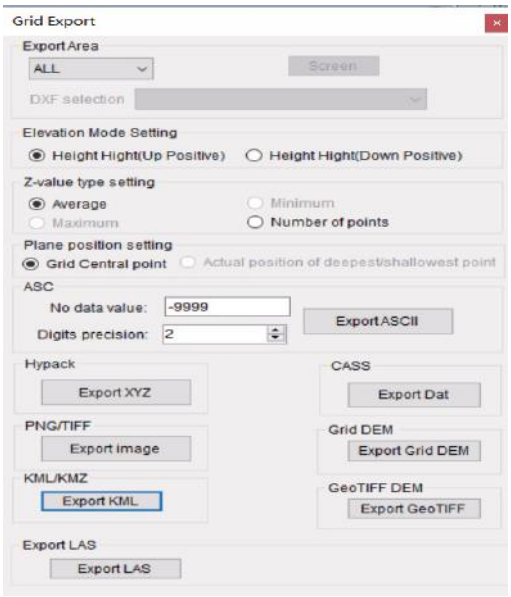
After the survey, the data undergoes advanced filtering—sound velocity and tide corrections, noise removal, and data stitching—before export for further analysis.



**5. Performance and Benefits**

Multibeam technology enhances survey efficiency by covering larger areas in less time. Unlike single-beam, which captures one depth point per ping, the HydroBeam M4 records up to 1,024 beams per swath, significantly improving resolution and accuracy. Ideal for mapping complex underwater terrains, it provides detailed 3D models of the seafloor, making multibeam the preferred choice for large-scale hydrographic projects.






## *Comparative Analysis: Efficiency, Cost, and Precision*

| *Feature* | *Singlebeam Echosounder* | *Multibeam Echosounder* |
|---|---|---|
| ***Number of Beams*** | 1 (vertical) | 1,024 (140° swath) |
| ***Coverage Width*** | Single point per ping | Up to 7 times the depth |
| ***Data Density*** | 1 point per 5 m | ≥180 points/m² (5 m depth) |
| ***Survey Time*** | 2 hours | 0.6 hours |
| ***Data Processing*** | Basic filtering | Advanced corrections |

While both methods support hydrographic mapping, the multibeam system's ability to capture denser data in less time makes it the optimal choice for large-scale, high-precision projects. Additionally, real-time data validation enhances quality control and accelerates project timelines.

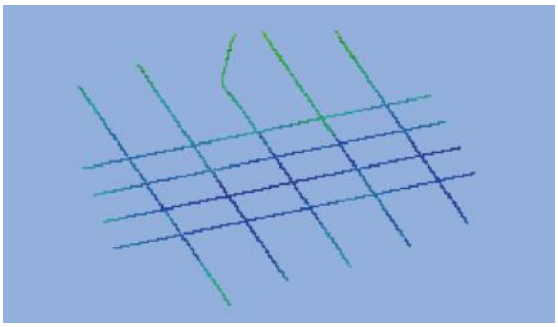
## *Data Quality and Accuracy: Ensuring Reliable Results*

### 1. Accuracy & Compliance

Both technologies maintain a 95% confidence level, ensuring reliable hydrographic data:

- *Singlebeam:*

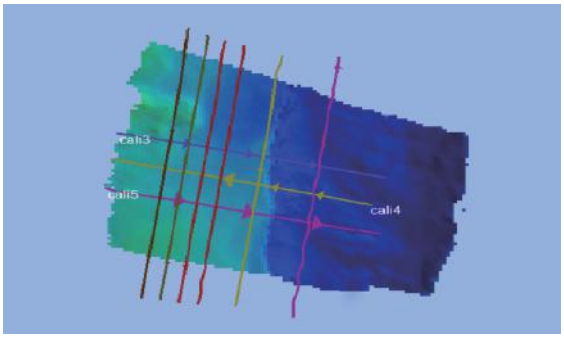
95.35% of data falls within the confidence interval—suitable for basic depth measurements.



| | |
|---|---|
| Generation time | [redacted] |
| Measurement class | SpecialOrder |
| Total number of points in the grid | 3539 |
| Above IHO model error points | 82(2.28%) |
| Below IHO model error points | 3457(97.72%) |
| **IHO Error Model** | **SpecialOrder(a=0.25m, b=0.0075m)** |

- *Multibeam:*

97.72% meets the confidence interval—ensuring superior precision and reliability.

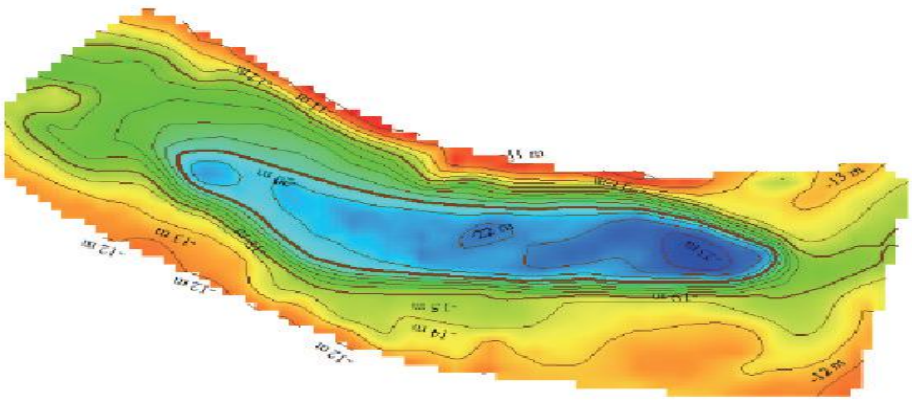



| | |
|---|---|
| Generation time | [redacted] |
| Measurement class | SpecialOrder |
| Total number of points in the grid | 43 |
| Above IHO model error points | 2(4.65%) |
| Below IHO model error points | 41(95.35%) |
| **IHO Error Model** | **SpecialOrder(a=0.25m, b=0.0075m)** |

### 2. Resolution & Detail

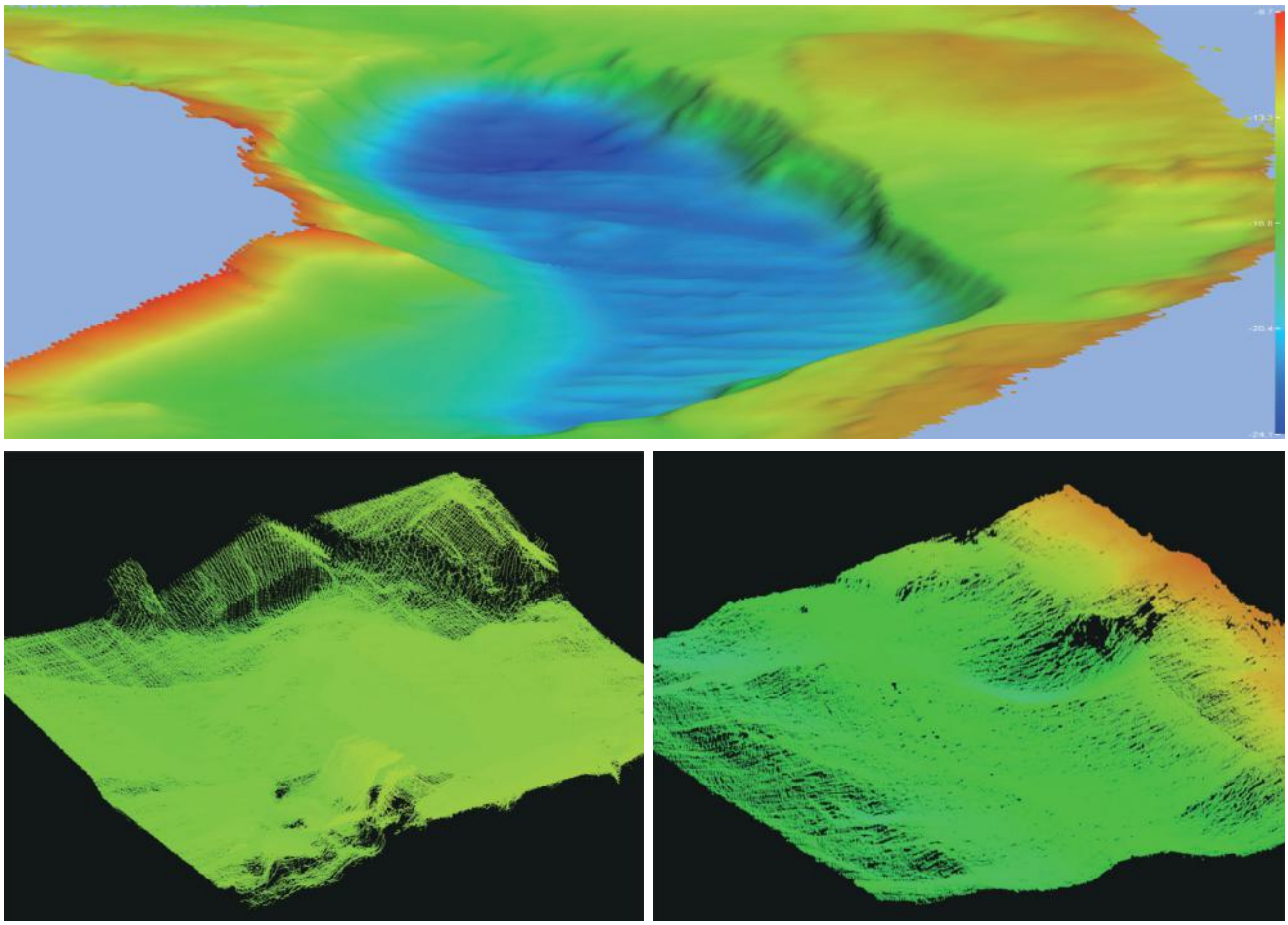
- *Singlebeam:*

Generates discrete depth points, effective for basic contour mapping but limited in detecting smaller underwater features.



- *Multibeam:*

Produces high-density point clouds, enabling detailed 3D modeling and precise identification of submerged features like sand waves, reefs, and obstructions.



## *Conclusion: Choosing the Right Technology*

This case study demonstrates that ***while singlebeam surveys remain viable for small-scale applications, multibeam technology provides significant advantages for large and high-precision hydrographic projects***. The ability to capture more data in less time, combined with superior resolution and accuracy, makes multibeam the preferred choice for complex underwater surveys.

Ultimately, the choice depends on project needs, balancing cost, complexity, and required detail. As demand for high-quality hydrographic data rises, multibeam technology is set to play a crucial role in improving waterway safety, environmental monitoring, and efficient navigation management.