BASSCAM-500: Bathyal Area Scouting Subsea Camera 500 m

Program Inovasi – Skema Akselerasi Inovasi Multidisiplin

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Abstract

BASSCAM-500 (Bathyal Area Scouting Subsea Camera for 500 m depth) is the second-generation development of an affordable underwater visual observation system at ITB. It aims to extend the first-generation BASSCAM towards a target depth of 500 m, while improving reliability, modularity, and integration. Development involved multidisciplinary teams from ITB and PT Robomarine Indonesia. PT Pageo Utama was designated as the user partner to support the technology's application and field evaluation. Individual components were successfully pressure-tested up to approximately 30 bar. However, an October 2026 field trial in the Kepulauan Seribu identified leakage at 40 m, leaving full-system validation incomplete. The final self-assessment placed the technology at Technology Readiness Level (TRL) 5. Further testing is required to validate its intended performance. Next steps include pressure testing the fully integrated system up to 50 bar, followed by a full-system field trial in the Kepulauan Seribu, planned for November 2026, and in a real-world operational setting by PT. Pageo Utama to evaluate its operational performance in various environment.

Keyword: deep-sea technology, underwater observation, subsea inspection

Introduction

Underwater visual observation is essential for exploring natural seafloor features and inspecting submerged infrastructure. Applications range from marine scientific research and habitat observation to the inspection of ship hulls, offshore platforms, and other underwater structures. However, deep-water observation systems often require sophisticated equipment, substantial infrastructure, and considerable operational costs, highlighting the need for more accessible technological solutions.

To address this need, BASSCAM was developed through a multidisciplinary research programme in 2025. The initial system was designed for visual observation at depths of up to 200 m. It underwent controlled pressure testing at up to 25 bar and field testing in the Kepulauan Seribu, where it operated successfully to 72 m. Additional testing by PT Pageo Utama in the PT Pertamina Hulu Energi Offshore Southeast Sumatra (PHE OSES) area demonstrated its potential for underwater structural inspection. These trials also identified limitations related to stability in currents, thermal management, and operational integration.

Building on these findings, BASSCAM-500 was initiated in 2026 to improve system reliability and extend the intended operating depth to 500 m. The project focuses on integrating mechanical, electrical, and tether management subsystems into a remotely monitored and controlled underwater observation platform.

Research Method

The development of BASSCAM-500 followed a staged engineering approach, beginning with the definition of design requirements and objectives (DR&O), followed by conceptual and detailed design, manufacturing, subsystem testing, and system integration. The design requirements included a target pressure resistance equivalent to 500 m water depth (approximately 50 bar), depth and temperature measurement, visual recording with adequate illumination, directional information relative to magnetic north, vertical stability in currents of up to 0.5 knots, and modular construction for transportation and deployment.



Picture 1. Leakage testing for an integrated camera tube (left) and master tube (right)

The system architecture consists of two primary pressure housings: a master tube containing the electrical, computing, power, and sensor components, and a camera tube accommodating the imaging and illumination equipment. These are connected to the surface through a tether management system (TMS), comprising an underwater cable, tether reel, slip ring, underwater connectors, and media converters. A Raspberry Pi-based control system and human-machine interface (HMI) provide surface-level monitoring and control.

Testing included component-level laboratory assessments, leak testing, pressure-chamber experiments, functional testing, and field trials. Performance was evaluated against the DR&O, with particular attention to pressure resistance, watertight integrity, subsystem functionality, and system integration.



Picture 2. BASSCAM-500 field test at Kepulauan Seribu, October 2026

Discussion & Result

The project achieved substantial progress across its three principal subsystems. By the final reporting stage, mechanical and electrical development had each reached 85%, while the TMS reached 95%. Nevertheless, system-level validation remains a major challenge. Although individual housings passed leak testing after design and manufacturing improvements, the October 2026 field trial in the Kepulauan Seribu identified leakage at 40 m associated the cable connection between the master tube and camera tube. Consequently, the complete mechanical and electrical configuration has not yet been demonstrated successfully underwater. Pressure-chamber testing was also limited to approximately 20-30 bar at component level, despite simulations being conducted up to 50 bar.

The final self-assessment established TRL 5, with 92.5% fulfilment of TRL 4 indicators and 80% of TRL 5 indicators. TRL 6 remained unfulfilled at 56.7%, reflecting the need for further integrated testing and field demonstration.

Conclusion

The BASSCAM-500 development has advanced the first-generation underwater observation system towards an integrated platform for deep-water exploration and underwater inspection. Through collaboration between ITB and PT Robomarine Indonesia, substantial progress was achieved in the mechanical, electrical, and tether management subsystems. Integrating pressure housings, imaging equipment, sensors, surface monitoring, and cable management strengthens Indonesia's capacity to develop its own underwater observation technology.

However, subsystem completion does not necessarily translate into successful system-level performance. Leakage identified during the October 2026 field trial, alongside limited pressure-chamber testing, means the intended 500 m operating capability remains unvalidated. The final self-assessment therefore places BASSCAM-500 at TRL 5, below the initially targeted level. Consequently, the planned collaboration with PT Pageo Utama could not proceed, as the system was not yet fieldwork-ready.

Further development should prioritise improving inter-housing seals, completing full-system pressure testing towards 50 bar, and verifying the integrated configuration under controlled underwater conditions. Subsequent field demonstrations at progressively greater depths will establish operational reliability. Planned applications in marine research and underwater infrastructure inspection offer potential pathways for utilisation. Ultimately, successful validation, supported by operational procedures, maintenance arrangements, and user evaluation, will determine readiness for broader deployment and further development.