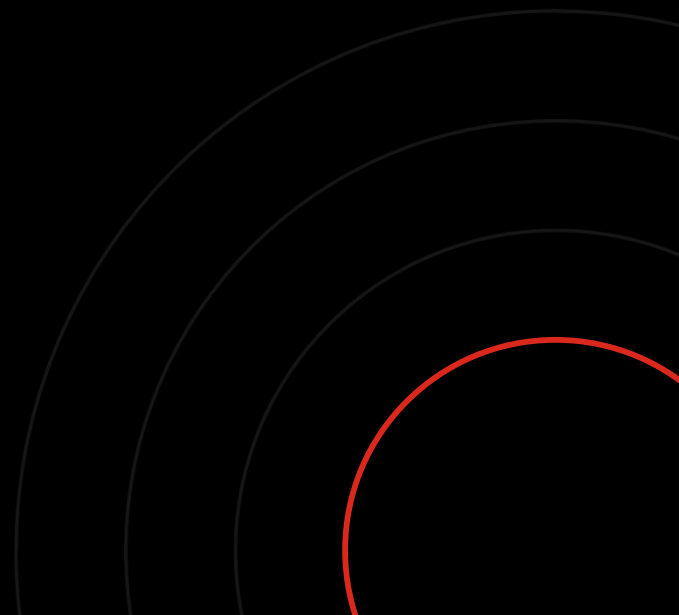


A QUALISYS WHITE PAPER

Ground Truth, Above and Below the Waterline

The marine engineer's guide to optical motion capture for hydrodynamic testing, AUV validation, and underwater structure tracking.

QUALISYS



ABOUT QUALISYS

Quality in Motion – for Three Decades in the Water

Qualisys has supplied precision motion capture and 3D tracking systems for more than 30 years, and marine testing has been part of that story since the early 1990s. **SINTEF Ocean – one of the world's most respected hydrodynamics institutes and a key contributor to IMO standards – has run on Qualisys since 1995.**

“Our marine solutions are shaped by the people who use them. We develop them in close collaboration with the world's leading experts, around the requirements of real tests.

— **MAGNUS BERLANDER, CTO, QUALISYS**

30+

Years supplying marine motion capture systems

<1 mm

Sub-millimeter position accuracy in scale-model vessel tracking

40 m

Rated underwater camera depth

1995

SINTEF Ocean running Qualisys for IMO testing

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CHAPTER 01

Testing Without a Second Take

CHAPTER ONE – THE MARINE TESTING CHALLENGE

When the Water Doesn't Give You a Second Chance

Every marine test – a towing-tank run, a basin trial, an open-water AUV mission – is expensive to set up and hard to repeat. The instrumentation recording it needs to be trusted the first time.



GPS Doesn't Work Underwater

Satellite positioning is unusable below the surface, leaving a blind spot exactly where hull and appendage behavior matters most.



DVL and INS Drift Over Time

Doppler velocity logs and inertial navigation accumulate error the longer a run lasts – fine for navigation, not for a scientific reference.



Wired Sensors Disturb Small Models

Tethered instrumentation adds mass, drag, and restraint to scale models, corrupting the very motion you're trying to measure.



Salt, Splash, and Humidity

Standard lab electronics weren't built for a wet, corrosive, high-humidity tank environment running for hours at a time.



CHAPTER 02

How Optical Motion Capture Works

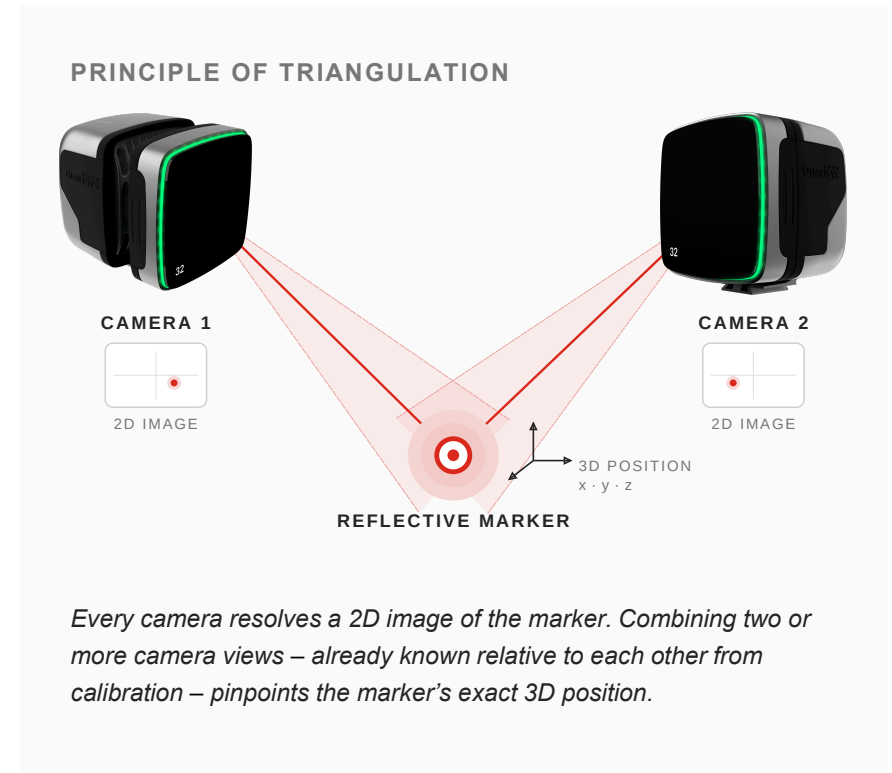
CHAPTER TWO – THE UNDERLYING TECHNOLOGY

Triangulation, Not Estimation

An optical motion capture system uses multiple synchronized cameras to measure the position of reflective or active markers in 3D space through triangulation. Markers attach directly to the model, vehicle, or structure, letting the system track position and orientation over time – with no cables and no drift.

- ✓ Full 6DOF: surge, sway, heave, roll, pitch, and yaw
- ✓ Sub-millimeter to millimeter position accuracy, 0.1° on rotation*
- ✓ Multiple objects tracked simultaneously, contact-free
- ✓ Synchronized video overlaid directly on 3D data

* Achieved accuracy depends on capture volume size, camera setup and calibration quality, among other factors.





CHAPTER 03

One System, Two Worlds

CHAPTER THREE – THE TWIN SYSTEM

One Capture, Above and Below the Surface

Most motion capture stops at the waterline. Qualisys doesn't. Synchronized above-water and underwater cameras run on one clock and one coordinate frame, delivering continuous 6DOF data across both environments — no stitching, no manual alignment, no compromise.



ABOVE THE WATERLINE

- IP67-rated Arqus cameras, built for splash and humidity
- Coverage up to 100 m × 100 m or more
- Fixed calibration via total-station survey for global positional validity
- Active long-range markers trackable beyond 100 m



BELOW THE WATERLINE

- IP68-rated underwater cameras, pressure-tested to 40 m depth
- Coverage up to 100 m × 60 m
- Corrosion-protected housings for saltwater and chlorinated tanks
- Seamless transition between underwater and above-water volumes

Result: outputs align seamlessly with DVL, INS, sonar, and hydrophones — giving every other sensor on the test a common, trustworthy reference.



CHAPTER 04

Typical Applications

CHAPTER FOUR – WHERE IT'S USED

From Basin Trials to Open-Water AUV Missions



Ocean Basins & Maneuvering Basins

Fixed, total-station calibration with long-range active markers tracks large-scale models across 30–50 m basins at millimeter accuracy. Ideal for seakeeping and maneuvering trials.



Towing Tanks

4–8 cameras ride the carriage with the model, using standard wand calibration – tracking is maintained across the full length of the tank as it moves.



Underwater Structures & Vehicles

AUVs, ROVs, mooring lines, pipelines, trawl doors, and windmill structures tracked with passive or active underwater markers, wand or fixed calibration.



Ice, Wave & Flume Tanks

The same camera and marker technology extends beyond standard basins to icebreaking tests, wave tanks, and flume-tank current studies.



CHAPTER 05

Proven Where Standards Are Written

CHAPTER FIVE – REAL-WORLD VALIDATION

Built Around the Demands of Real Marine Testing

IMO standards aren't optional – and neither is the data behind them. Turning ability, stopping distance, course-keeping, and zig-zag maneuvers all demand precise, repeatable measurement that holds up to scrutiny.

SINTEF Ocean – one of the world's most respected hydrodynamics institutes and a key contributor to IMO standards – has run Qualisys motion capture since 1995. The system was built around the demands of real marine testing, in the environment where those very standards were being written.

DST in Duisburg, Germany, is another important Qualisys ambassador, focusing on inland and coastal navigation.



IMO-grade testing criteria this data supports:

- Turning ability
- Stopping distance
- Course-keeping
- Zig-zag maneuvers

CHAPTER SIX – A PRACTICAL DECISION GUIDE

Choosing the Right Setup

Calibration method and camera choice both hinge on facility size and how the test will run. Use this as a starting point — Qualisys engineers can size a system to your exact basin, tank, or test plan.

FACILITY	TYPICAL SIZE	RECOMMENDED CALIBRATION	MARKER TYPE
Large ocean basin	30–100+ m × 30–100+ m	Fixed (total-station survey)	Long-range active markers
Small–medium ocean basin	10–30 m × 10–30 m	Dynamic wand calibration	Passive markers, 20–50 mm
Towing tank	3–10 m capture area (mobile)	Wand calibration on carriage	Passive or long-range active
Underwater — standard	~10–15 m × 10–15 m	Wand (underwater kit)	Passive underwater markers
Underwater — large basin	50–100 m × 30–60 m	Fixed (drained-basin survey)	Active underwater tracking markers



Fixed calibration is strongly recommended for open ocean basins. Wand calibration can become challenging there because of reflections off the water surface — addressed with camera masks and marker-size filtering when wand calibration is required.

SUMMARY

Ground Truth You Can Build On

- Marine testing gives you one shot: GPS fails underwater, DVL and INS drift, and wired sensors disturb the very model you're measuring.
- Optical motion capture solves this with contactless triangulation – millimeter accuracy in large volumes, full 6DOF, no cables, multiple objects at once.
- The Qualisys Twin System is the only optical solution that synchronizes above- and underwater cameras into one continuous, single-clock measurement.
- From ocean basins to open-water AUV trials, Qualisys hardware is purpose-built for the marine environment – not adapted from a lab.
- SINTEF Ocean has trusted Qualisys since 1995 for IMO-grade testing – proof this system holds up where the standards themselves are written.



Quality in Motion

Ready to bring ground-truth accuracy to your next marine test program?

CONTACT US TODAY

www.qualisys.com/engineering/marine-tracking

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