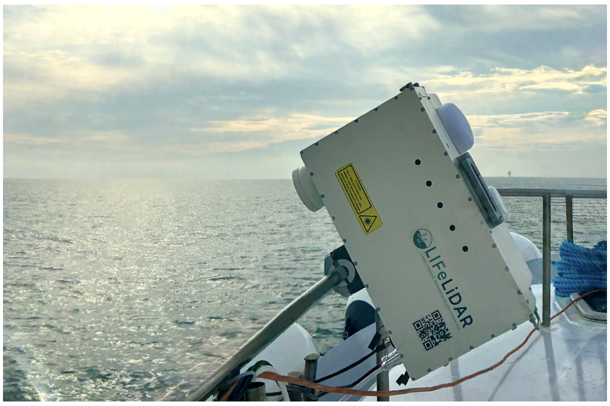
MULTI-WAVELENGTH FLUORESCENCE LIDAR

LIFL.11

Measuring the upper water layer

Measures water quality along a vessel track, by day and by night.



RAIL-MOUNTED, UNDERWAY

LIFL.11 sends laser pulses into the water and measures the fluorescence and scattered light that return. These signals provide information about phytoplankton pigments, dissolved organic matter, suspended matter and oil. **Measurements continue as the vessel moves**, showing how water quality changes along the survey route, during the day and at night.

2 per unit	48	10 Hz	21 kg	IP68
LASER WAVELENGTHS 266 / 355 / 532 NM	SPECTRAL BANDS 250 TO 800 NM	ALONG-TRACK RATE	MASS	MARINE-GRADE

WHY MEASURE ALONG A ROUTE?

Blooms, sediment plumes and oil slicks can vary over short distances. Samples collected at separate stations may miss the changes between them. Measurements along a vessel's route help locate these features and describe their extent.

LiDAR surveys add detail within a satellite pixel. At around ten knots, LIFL.11 can record about twenty measurements along the ten-metre width of a Sentinel-2 pixel. These observations help researchers assess local variability when comparing field and satellite data.

MEASURED PARAMETERS

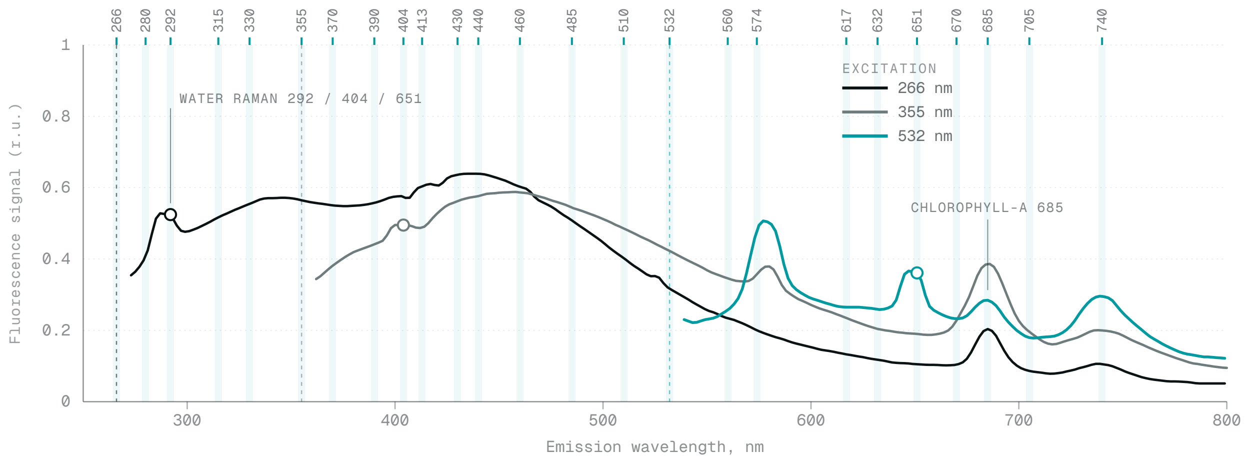
Chlorophyll-a	CDOM	TSS	Oil-in-water
0.01 to 1000 $mg \cdot m^{-3}$	a_{440} 0.001 to 0.15 m^{-1}	0.1 to 1000 $g \cdot m^{-3}$	Films, emulsions, film thickness

Phycoerythrin · Phycocyanin · Pigment ratios for bloom type · Organic matter type · TOC 0.1 to 100 $g \cdot m^{-3}$

Tryptophan · Phenolics · Crude and light oil · Floating-litter fluorescence

MEASUREMENT PRINCIPLE

A laser pulse produces fluorescence from substances in the water, alongside elastic and Raman scattering. LIFL.11 records these signals in **48 spectral bands between 250 and 800 nm**. Their spectral features help distinguish pigments, organic matter and other constituents. The water Raman signal provides an internal reference for normalizing fluorescence. Site-specific calibration then relates these normalized signals to water-quality parameters.



Natural-water fluorescence measured with LIFL.11 under each available laser wavelength. Teal ticks show 25 of the 48 detection bands. Band centres and widths are specified for each instrument. Elastic returns are off-scale and omitted. Circles mark water Raman signals at 292, 404 and 651 nm; the 685 nm peak is chlorophyll-a. Intensity is shown in arbitrary units.

Along-track survey

MAPPING, UP TO 10 HZ

Records four selected bands at up to ten measurements per second while the vessel moves. At about ten knots, this gives **roughly twenty measurements across a ten-metre pixel**. Use this mode to map changes in blooms, oil slicks, plumes and floating litter.

Fixed-point measurement

FULL SPECTRUM, ABOUT 15 S

Records all 48 bands at one location in about fifteen seconds. The fuller spectrum helps characterise the water at a sampling station and select bands for an along-track survey.

MODEL VARIANTS

LIFL.11a

355 + 532 NM

For studies of pigments and organic matter. The 355 nm laser supports measurements of chlorophyll-a and CDOM. Typical uses include aquatic research, satellite validation and water-quality surveys.

LIFL.11b

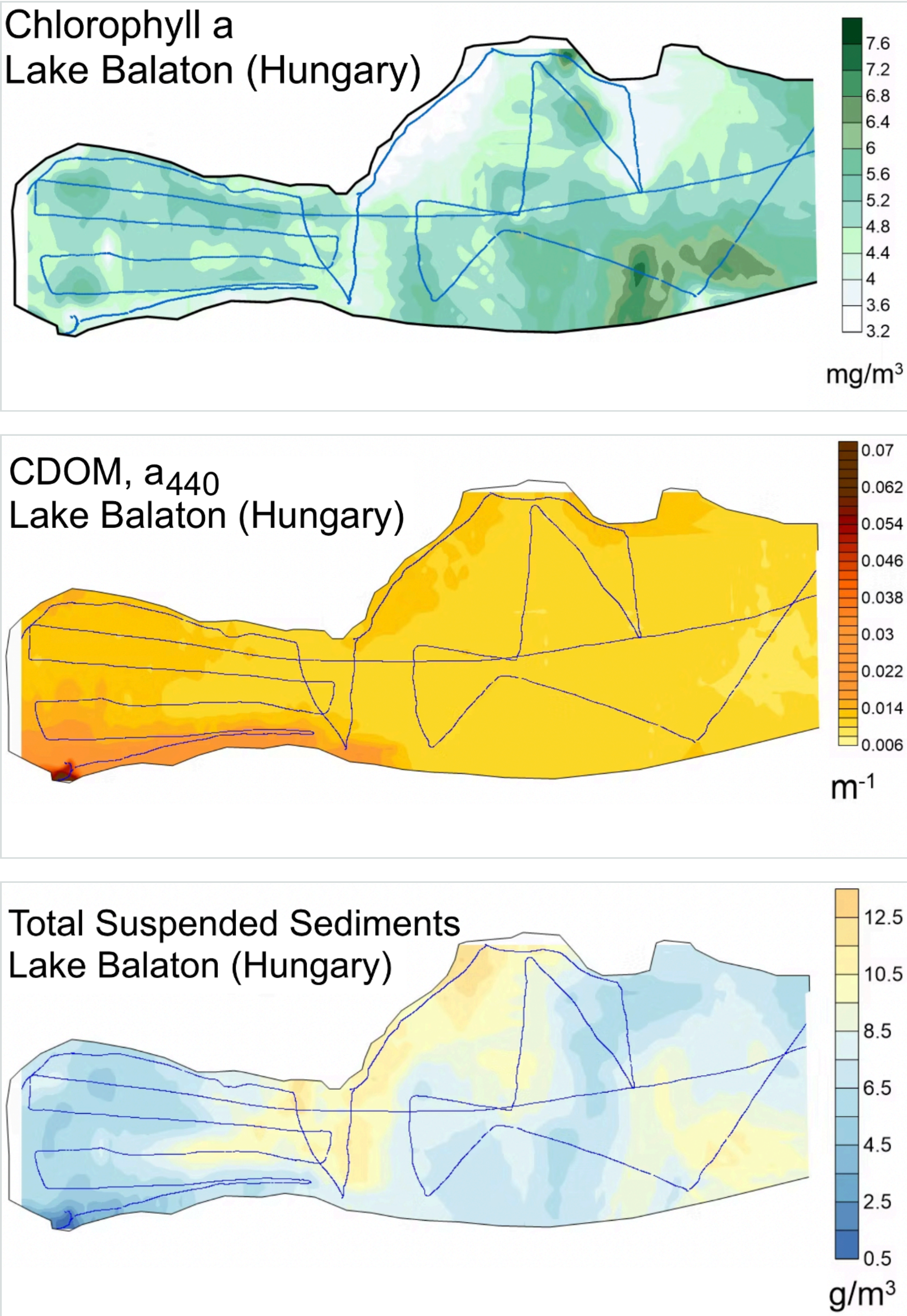
266 + 532 NM

For pollution surveys. The 266 nm laser excites aromatic compounds, including oil components, tryptophan and phenolics. Typical uses include port monitoring, discharge assessment and spill response.

Each instrument has two laser wavelengths: 532 nm paired with either 355 or 266 nm. Both variants measure chlorophyll-a, CDOM, suspended matter and oil.

FIELD RESULTS: ONE SURVEY, THREE PARAMETERS

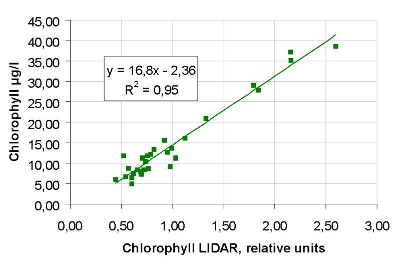
Chlorophyll-a, CDOM and suspended matter were estimated from measurements collected during **one survey**. Recording several spectral bands together allows these parameters to be mapped without separate vessel passes. The maps show measurements along the route and estimated values between tracks.



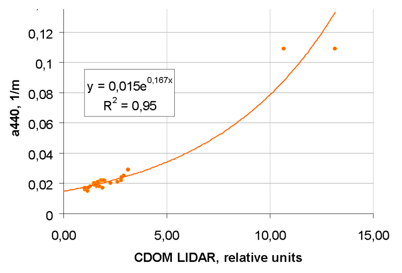
Lake Balaton, Hungary. One survey, 27 160 measurement points. Blue lines mark the vessel track; the fields between them are interpolated from it.

VALIDATION AGAINST LABORATORY SAMPLES

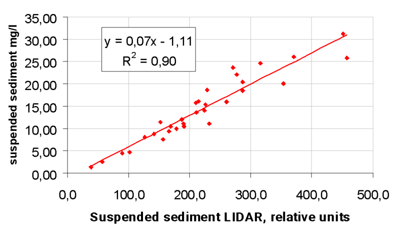
Water samples collected during field campaigns were analysed in the laboratory and compared with LiDAR signals from the same locations. **The plots show the relationship between the two measurements.** This comparison is used to determine site-specific calibration coefficients. The reported R-squared values describe the fits, not the full measurement uncertainty.



CHLOROPHYLL-A R^2 0.95



CDOM A_{440} R^2 0.95



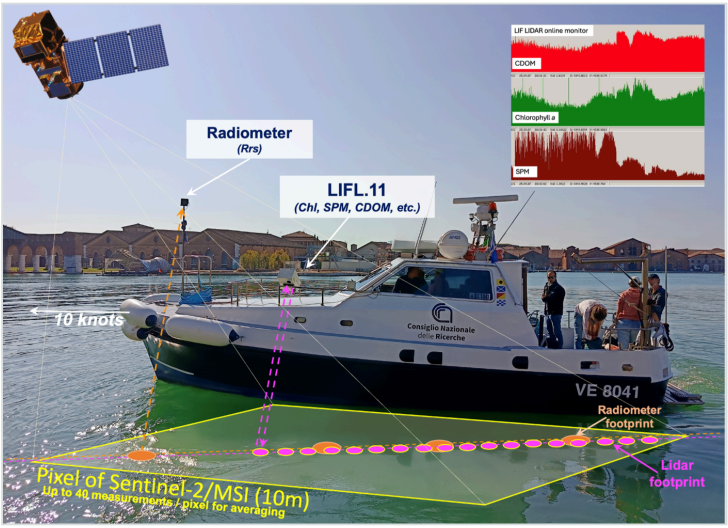
SUSPENDED SEDIMENT R^2 0.90

Laboratory analysis of water samples on the vertical axis, LiDAR signal on the horizontal. Chlorophyll-a and suspended sediment are linear; CDOM absorbance follows an exponential fit.

COMPARING FIELD AND SATELLITE MEASUREMENTS

A ten-metre Sentinel-2 pixel combines the signal from an area where water quality may vary. At 10 Hz and about ten knots, LIFL.11 records **about twenty measurements across that distance**. These help assess how well a field measurement represents the pixel.

Such surveys also support models linking optical signals to water quality for MSI, OLCI, MODIS and PACE. Adding **mHR.2** on the same vessel provides reflectance data for comparison with satellite retrievals.



Co-located acquisition within one Sentinel-2 / MSI pixel: lidar footprint (magenta) and radiometer footprint (orange) along the same track at about ten knots, with chlorophyll-a, CDOM and suspended matter displayed in real time. ESA PHY2FLEX, Venice, October 2025, aboard a CNR vessel. The annotation in the figure dates from the 20 Hz prototype; at 10 Hz the count is about 20 per pixel.

PRACTICE

20+ years of LIF LiDAR work across 50+ water bodies

FIELD RECORD

ESA PHY2FLEX, Venice, October 2025

LITERATURE

Peer-reviewed Sentinel-2 and -3 cal / val, coastal plumes, turbid water

SUPPORTED BY

FRANCE DEEPTECH Quand la science entreprend
FRANCE 2030
LA FRENCH TECH CÔTE D'AZUR RÉGION SUD
Telecom Valley Animateur Azuréen Numérique
PÔLE MER MÉDITERRANÉE

SPECIFICATION

EXCITATION	266 or 355 nm, with 532 nm
PULSE ENERGY	10 mJ at 266 12 mJ at 355 and at 532
PULSE DURATION	4 ns
REPETITION RATE	Up to 10 Hz
RECEIVER	4-channel splitter, 12 narrowband filters each, 48 bands
SPECTRAL RANGE	250 to 800 nm
FULL SPECTRUM	48 bands in about 15 s
TELESCOPE	76 mm Newton, 1 to 50 m
SURFACE LAYER	0.5 to 5 m at 355 nm 1 to 10 m at 532 nm
PROFILING	Up to 50 m at 532 nm About 0.5 m resolution across profiling wavelengths
GEOREFERENCING	GNSS and IMU at 10 Hz, context camera
CONTROL	Wi-Fi, 5G, LAN, RS485, from a laptop or a phone
POWER	100 to 230 V AC or 24 V DC under 80 W, after warm-up
OPERATING TEMP.	0 to +30 °C
STORAGE TEMP.	-20 to +70 °C
SIZE	44 × 33 × 28 cm
MASS	21 kg, IP68 marine-grade
OPTIONS	2-axis scanning gimbal Hyperspectral receiver, 380 to 750 nm, under 10 nm

APPLICATIONS

1. **Water-quality baselines and satellite calibration and validation**
   RESEARCH INSTITUTES, ENVIRONMENTAL AGENCIES, WATER AUTHORITIES
2. **Bloom mapping and harmful-algal-bloom early warning**
   COASTAL AND INLAND WATER QUALITY, AQUACULTURE, RESERVOIRS
3. **Oil spills and oil-in-water emulsion**
   PORTS, TERMINALS, DISCHARGE COMPLIANCE, SPILL RESPONSE, COASTGUARD
4. **Wastewater plume and dissolved organic matter tracking**
   ESTUARY AND OUTFALL MONITORING, INDUSTRIAL DISCHARGE OVERSIGHT
5. **Floating litter and plastics surveys**
   MARINE-LITTER MAPPING, CLEAN-UP PLANNING

6 to 12 months

BUILD TIME

Each instrument is configured for the intended survey. The water body and target parameters guide the choice of laser wavelengths and detection bands.

COMPLEMENTARY INSTRUMENTS

Use **LIFL.11** for mobile surveys and **mHR.2** on the same vessel for reflectance measurements that can be compared with satellite data. Fixed **mFL.12** sensors on buoys and piers monitor conditions between surveys. Each instrument works independently; additional instruments can be added as monitoring needs grow.

LIFeLiDAR SAS
1 Place Sophie Laffitte, 06560 Valbonne
Sophia Antipolis, France
info@lifelidar.com +33 7 80 72 60 72
www.lifelidar.com