

**“AURORA” PROJECT**  
**Ultra-Resolution Ocean Analysis for Advanced Tracking**

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# “AURORA” PROJECT

## Análisis de Ultra Resolución Oceánica para el Rastreo Avanzado

The AURORA Project aims to develop an ultra-precision bioenergetic telemetry system for monitoring large marine species, especially whale sharks, integrating advanced sensing, reliable transmission, and a hydrodynamic design that minimizes any impact on the animal.

The system is made up of two main units:

1. STL-ULTRA (Shark-Tag Live): Implantable sensor and processing unit.
2. HNR-ULTRA (Hydro-Net Relay): Temporary reference buoy and satellite transmission.

### STL-ULTRA (Shark-Tag Live)

The STL-ULTRA is the onboard telemetry unit, designed for edge processing, secure storage, and encrypted transmission to the HNR-ULTRA network.

#### Main components and functions

Component	Main function	Technical justification	Location / Estimated Duration	Energy
Titanium casing Ti-6Al-4V	Pressure resistance and biocompatibility	Robust and anti-corrosive material	Outer casing	N/A
Li-SOCl <sub>2</sub> battery + supercapacitor	Energy source	Autonomy 3–5 years	Central nucleus	Integrated
Pt1000 (internal)	Thermal drop detection → ingestion	High-precision sensor	Near body wall (>5 years)	STL
Micro-NIR	Chemical classification of dams	Reflection spectroscopy	Ventral to gastric cavity (>3 years)	STL

External thermistor (YSI)	Room temperature	Ultra-precision + anti-fouling	Posterior end (>5 years)	STL
GPS RTK antenna	Submetric geographic location	Antena patch / choke-loop	Dorsal area under the skin (>4 years with duty cycle)	STL
Acoustic Transducer (ATM-885)	Sending data underwater	High-speed short packets	Lateral/ventral (>4 years)	STL
Pressure sensor	Depth measurement	Anti-fouling protective membrane	Ventral (>5 years)	STL
Central electronics (BMS + sensors)	Energy control and monitoring	Intelligent battery management	Central nucleus	STL

Sending data to the HNR,eThe STL-ULTRA processes and transmits:

- Ingestion events and prey type (Pt1000 + Micro-NIR).
- Location and depth (GPS RTK + pressure sensor + acoustic TDOA).
- Room temperature (external thermistor).
- All data is encrypted, signed and sent to the HNR buoy.

## DESIGN AND SHAPE OF THE STL-ULTRA

### 1. General form

- Elongated and oval profile, torpedo/capsule type.
- Smooth, rounded edges to prevent turbulence.
- Slightly pointed front end and more tapered rear end to reduce wake.

### 2. Approximate dimensions

- Width: 15–20 cm.
- Maximum diameter: 4–6 cm.
- Compact to minimize resistance and drag.

### 3. Materials

- Housing: Grade 5 titanium (Ti-6Al-4V), pressure resistant and biocompatible.

- Anti-fouling and antibacterial polymer coating for smooth surfaces.

#### 4. Sensor location

- GPS/antenna: dorsal, almost flush with the skin.
- Acoustic transducer: lateral or ventral.
- External thermistor: rear end with anti-fouling grid.
- Micro-NIR: ventral towards gastric cavity.
- Pressure sensor: protected ventral membrane.

#### 5. Anchoring to the shark

- Dorsolateral semi-surgical implantation, 10–15 cm posterior to the dorsal fin.
- Titanium subdermal fins for stable fixation and alignment with water flow.

#### 6. Hydrodynamic considerations

- Minimum outstanding volume.
- Orientation parallel to the longitudinal axis of the shark.
- Smooth surface for drag reduction.

## HNR-ULTRA (Hydro-Net Relay)

The HNR-ULTRA buoy acts as a reference node and secure relay to remote servers.

Main components.

Component	Function	Technical justification	Duration
Floating structure (5083-H116)	Stability, thermal dissipation	Anti-corrosive marine alloy	>5 years
Solar panel + rechargeable battery	Energy source	Extended autonomy	>5 years
Rubidium oscillator	Ultra-precise time base	Submetric TDOA calculation	>5 years
Acoustic receiver (ATM-885 compatible)	Receiving packages	High communication rate	>5 years
VSAT Communications (Cobham Sailor 900)	Satellite data forwarding	Prioritization of ingestion and critical events	>5 years

## Reception and transmission process

1. Reception of encrypted acoustic packets every 5 minutes.
2. Security validation and digital signatures.
3. Sub-meter localization with TDOA.
4. Satellite transmission to central servers.

## EFFICIENT DESIGN AND OPERATION

- All sensors are optimized to not alter the shark's behavior.
- Guaranteed lifespan of 3–5 years with intelligent energy management.
- Prioritized transmission of critical data (ingestion, location, temperature).
- Temporary storage in the STL with automatic retransmission out of range.
- Antifouling design and strategic layout to minimize biointerference.

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