The Bluefin Spray Glider

Recent Activity

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- and -

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EGO 2011

Agenda

- Bluefin Background
- Spray Overview
- Recent Improvements

About Bluefin

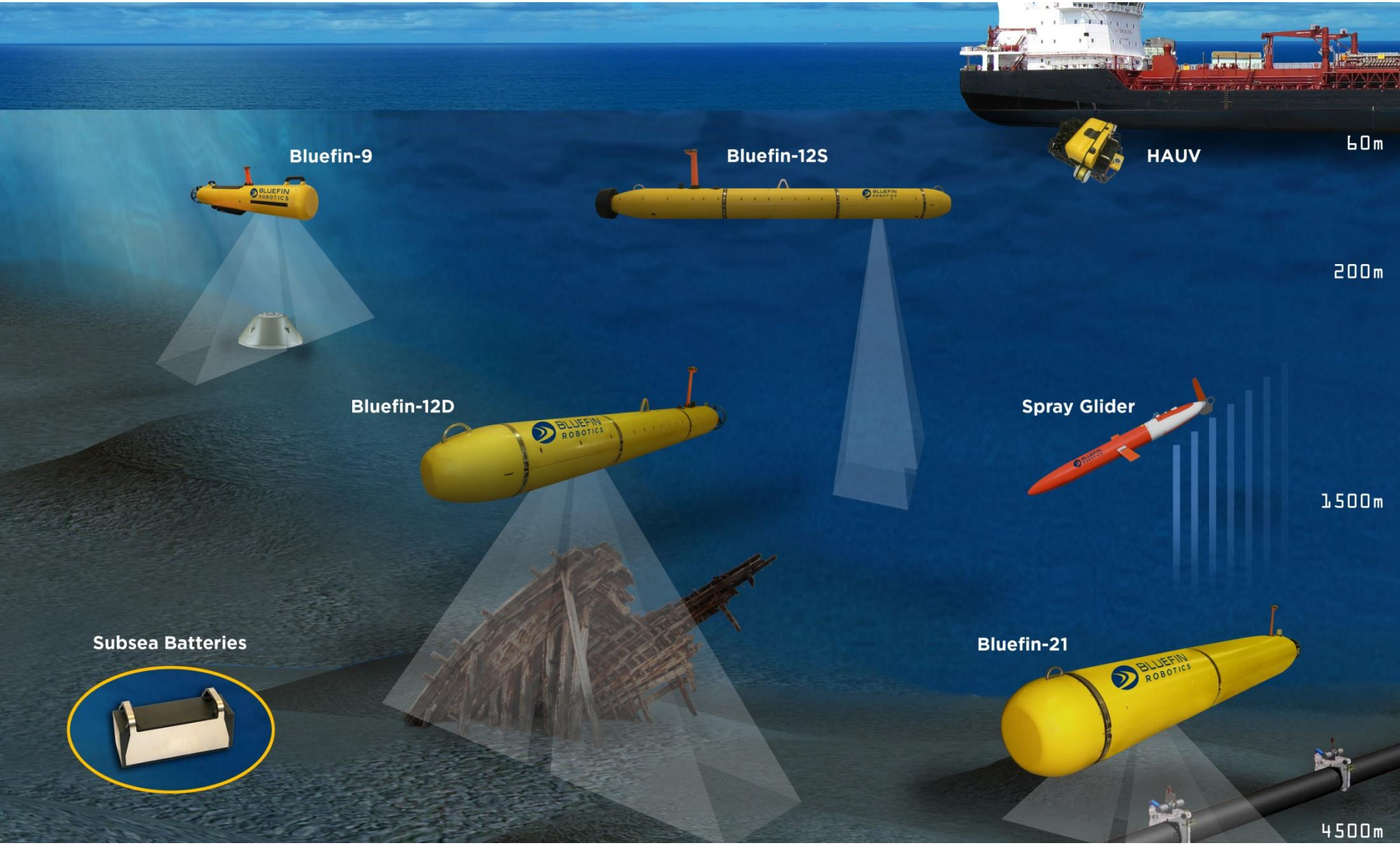
Full-service Autonomous Underwater Vehicle (AUV) provider located in Cambridge, MA

Spun-out from MIT AUV Lab in 1997

Acquired by Battelle in 2005

80+ person firm leveraging strengths of 20 years of experience in ocean engineering and robotics

One of Many AUVs in the Bluefin Fleet



Bluefin AUVs

BF Series

Bluefin-9

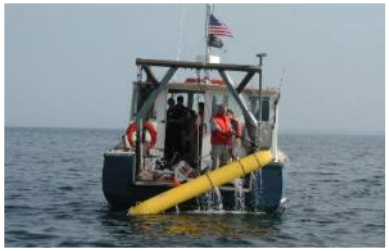
Diameter **9in** Length **69in** Weight **133lb**
D.Rating **200m** Endurance **12hr**

Bluefin-12S, Bluefin-12D

Diameter **12.75in** Length **150-170in**
Weight **250-525lb**
D.Rating **200m, 1500m**
Endurance **up to 26hr**

Bluefin-21

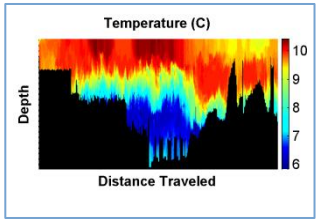
Diameter **21in** Length **195in**
Weight **1650lb**
D.Rating
200m, 4500m
Endurance
up to 25hr



Free-flooded & Modular | Rapid Turnaround | Multi-Payload

Spray Glider

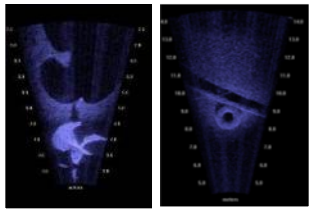
Diameter **8in** Length **84in**
Weight **115lb**
D.Rating **1500m**
Endurance **up to 6 months**



Deep-rated | Pumped Sensors | Extended Deployments

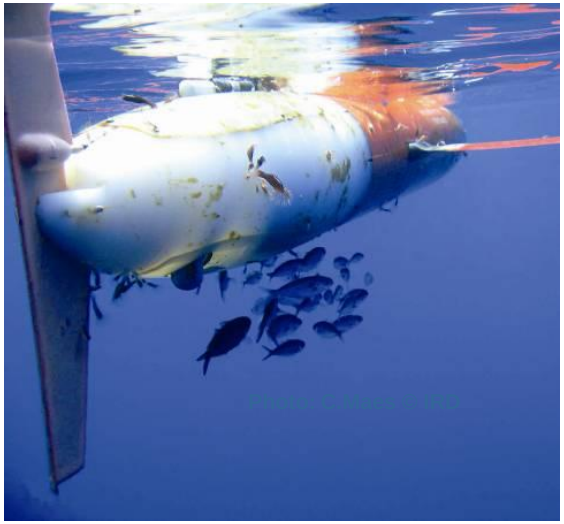
Hovering AUV

Diameter **42 x 39.5 x 16 in**
Weight **174lb**
D.Rating **30m, 60m**
Endurance **up to 3.5hr**



Hi-Res Imagery | Precise Control | Real-time Comms

Applications



ACADEMIC

Oceanography
Fishery Assessment
Archaeology
Research & Development Platform

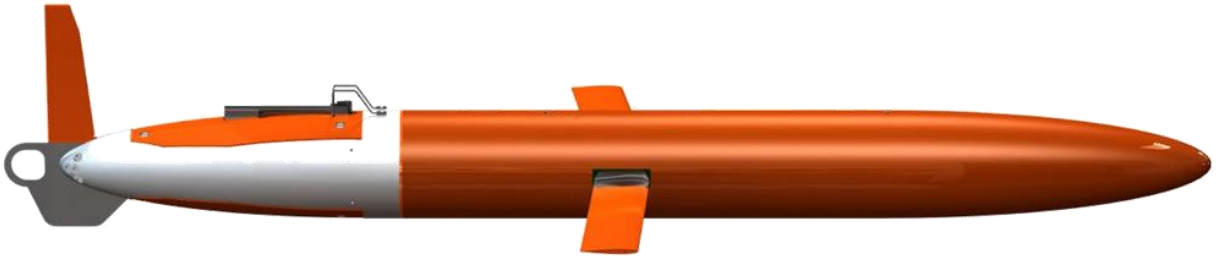
COMMERCIAL

Deep Water Survey
Pipeline & Engineering Survey
Ocean Floor Mapping
Environmental Monitoring

SECURITY

Mine Countermeasures (MCM)
Intelligence, Surveillance & Reconnaissance (ISR)
Port and Harbor Security
Rapid Environmental Assessment
Ship Hull Inspection

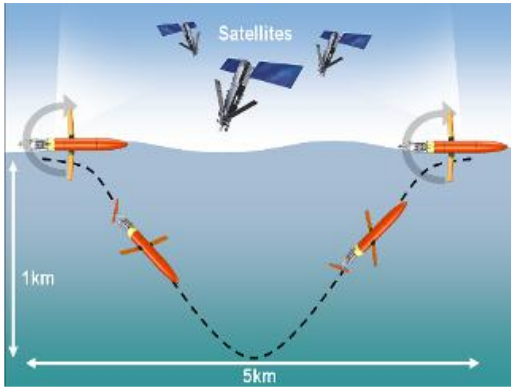
Spray Glider

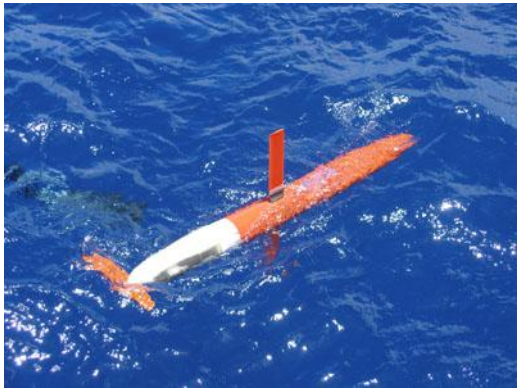


DEEP DIVER
Rated to 1500 meters

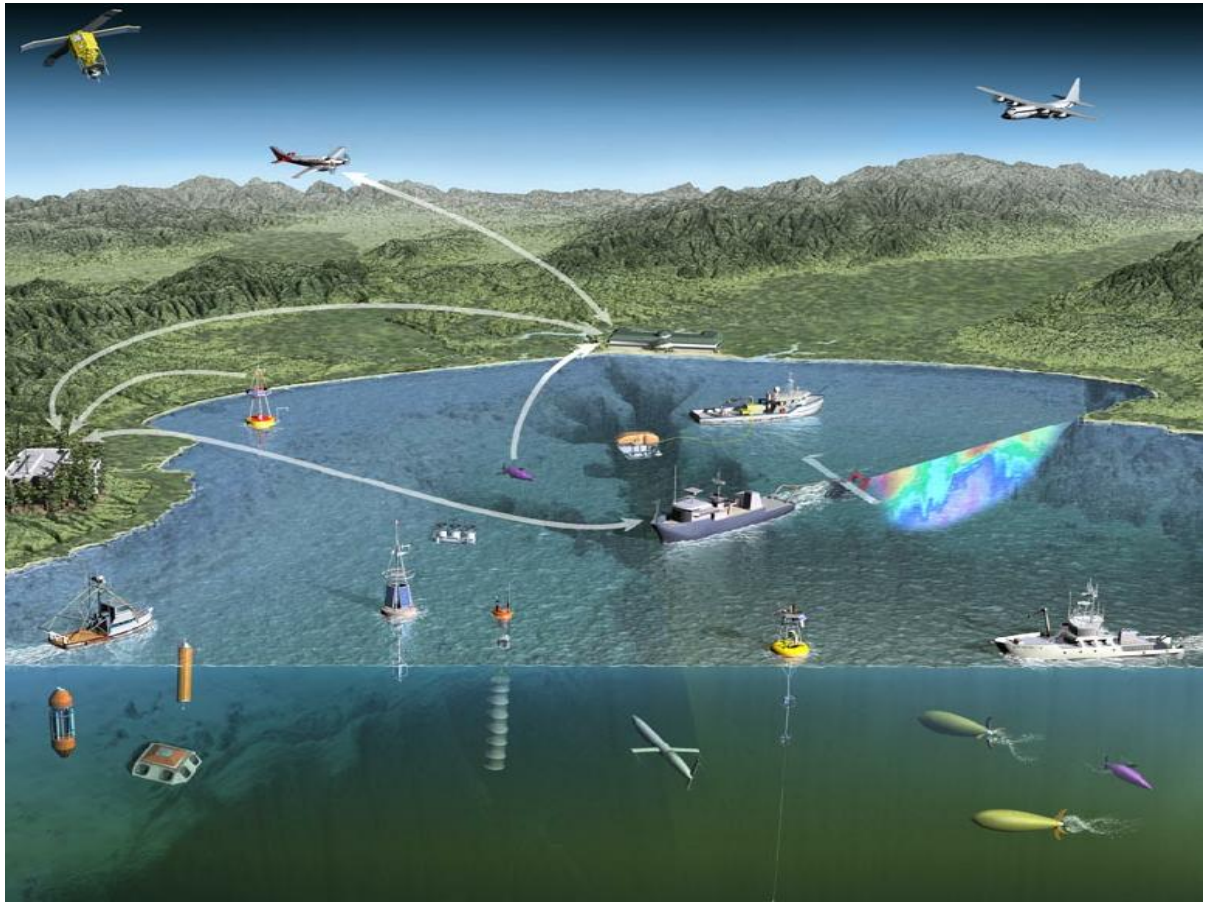
FIRST TO USE A PUMPED CTD
Combats against biofouling, a typical problem in warm water environments and especially crucial for long deployments

LONG RANGE and ENDURANCE
4800 km, 25 cm/s at 19˚glide angle to 1000 m
(calculated on power budget and full battery capacity)
Up to 6 months



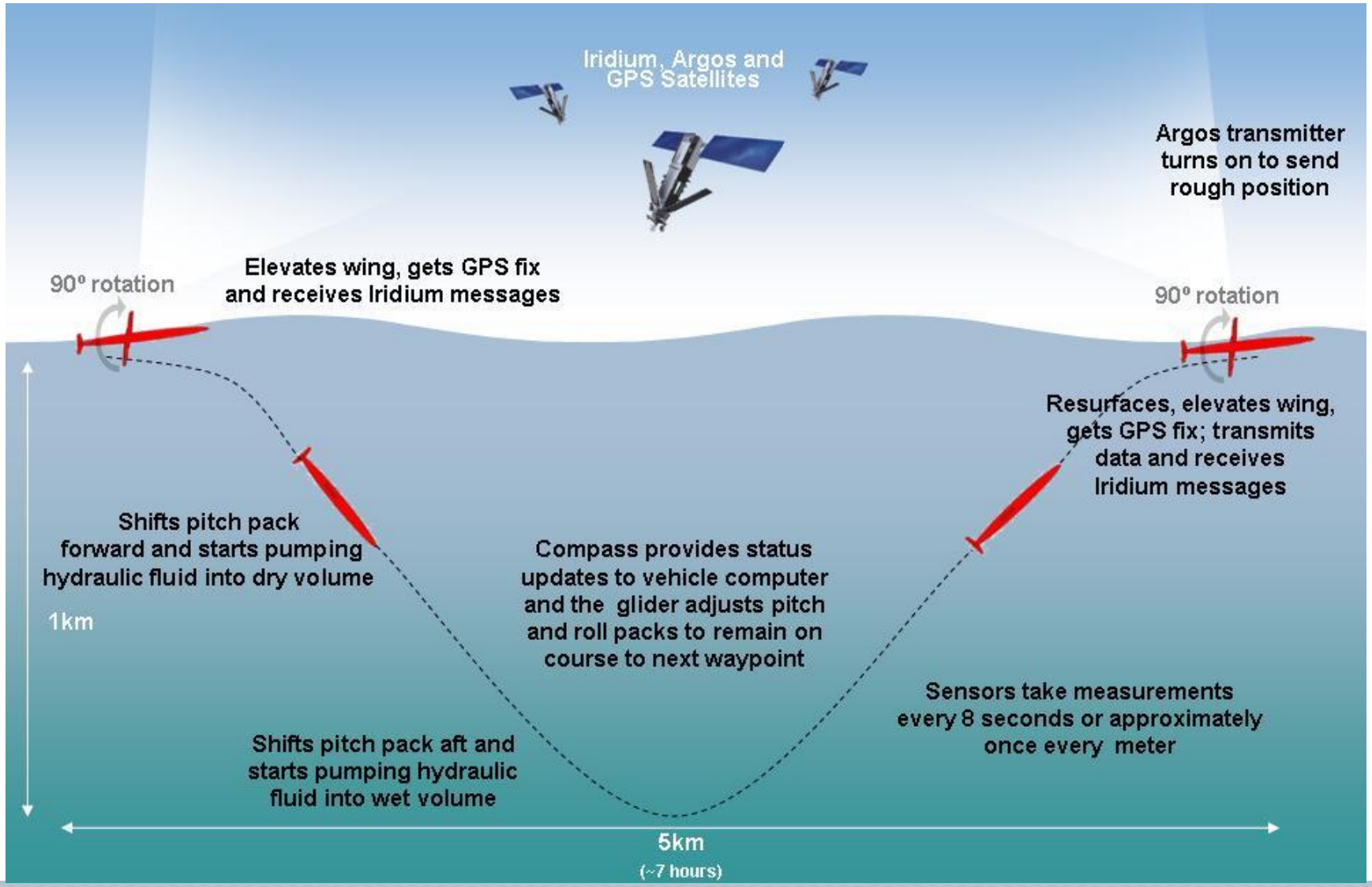


Spray History



- Glider development funded by ONR as part of AOSN (Autonomous Oceanographic Sampling Network) program from 1995-2000
- Three gliders developed through AOSN
- One of the gliders was Spray glider, developed by Scripps under Russ Davis
- Bluefin licensed to manufacture Spray Glider in 2004

Functionality



Original Spray Architecture

DESIGN

Buoyancy-driven design
- Hydraulic system
- Roll/pitch battery packs

ENERGY

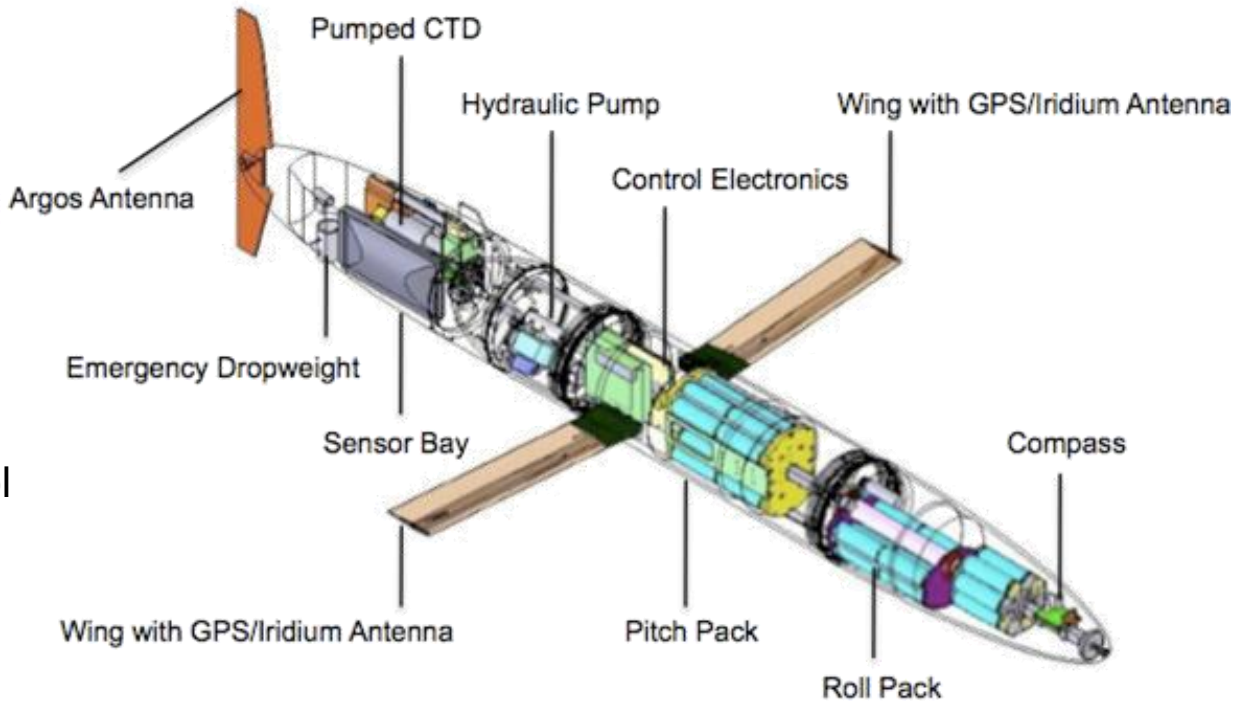
17 MJ Lithium ion Primary Batteries (52 cells)

CONTROL

Wings provide passive control surface and satellite communication

PAYLOAD

Flooded tail section houses payload sensors



Spray Training

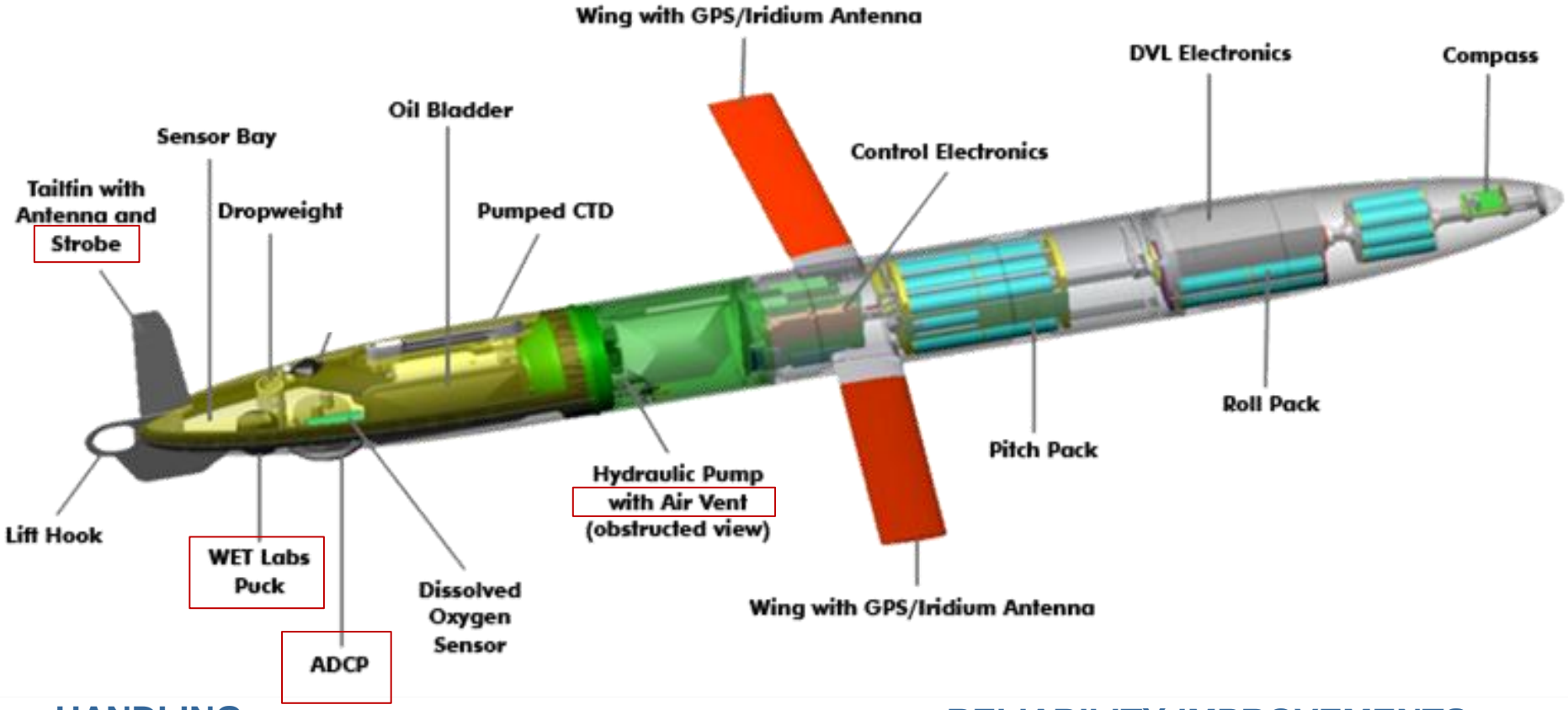
- Three day training course
- For up to three people
- At Bluefin's factory and operational facility
- Consists of classroom training and hands-on vehicle training in tank and at-sea training
- On-site training can be provided

TRAINING TOPICS
System Components
Buoyancy Engine
Behavioral Aspects
Navigational Concepts
Comms Interface/Mission Planning
Ballast/Trim Procedure
Glider Deployment
Shore Commands
Recovery, Data Retrieval, Turnaround
Customer Proficiency Demonstration

Production

- Over 60 Sprays fielded to-date
- Dedicated production resources and tools
- 1-2 Sprays in-house at any time
  - On-the-shelf unit for demonstrations
  - In-house R&D asset for development work
- 99% of manufacturing vendors sourced local to Bluefin
- Revamped manufacturing process
  - 5S, Kaizens to optimize assembly and checkout
  - Improved quality control

Improved Spray Glider Design



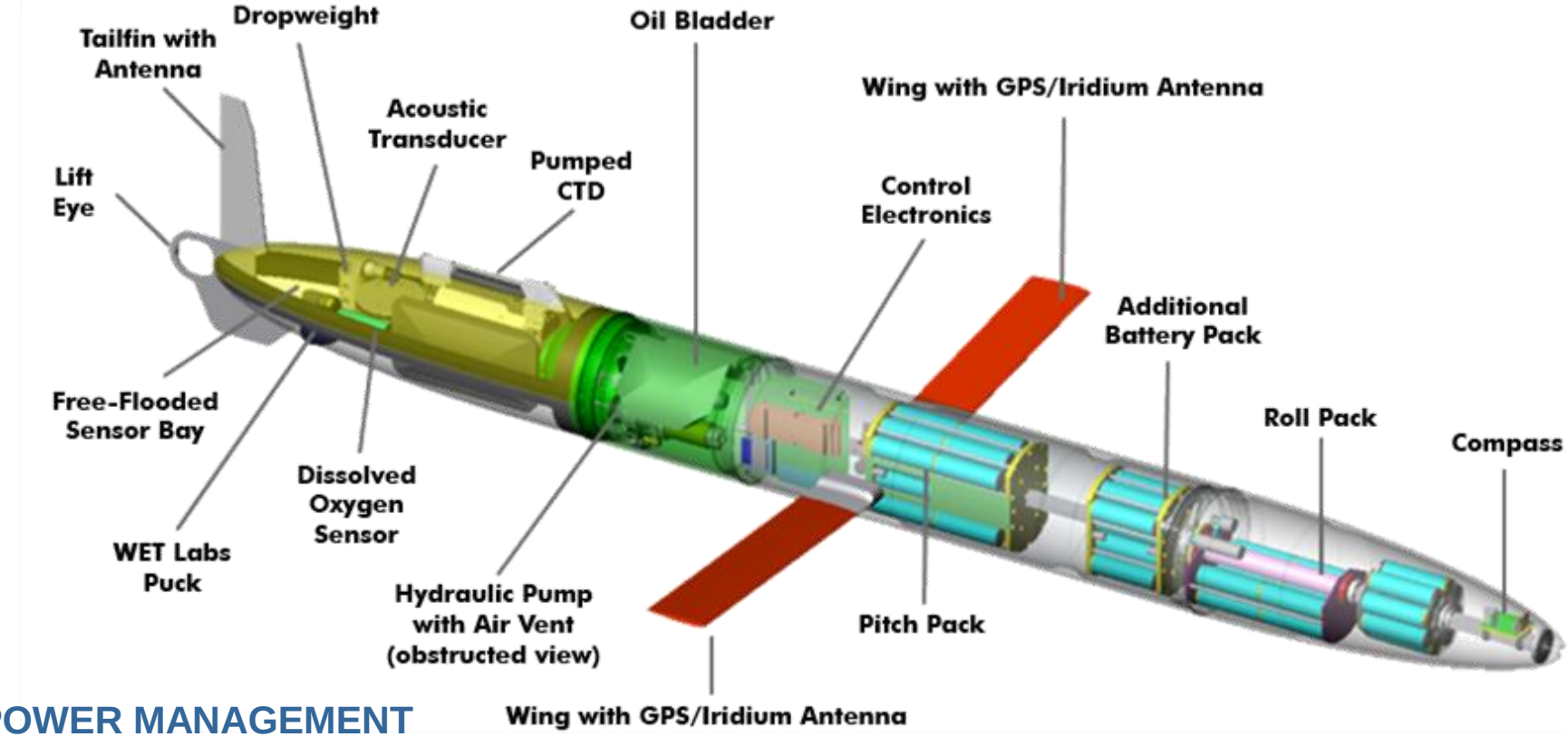
HANDLING
Lift hook to aid recovery

ADDITIONAL SENSORS
DVL, PAR, DO, etc

RELIABILITY IMPROVEMENTS
Improved roll pack design

TAIL ATTACHMENT
Robust Ortman ring groove instead of tab clamps

Long Range Spray



POWER MANAGEMENT

Improved electronics and redesigned power bus

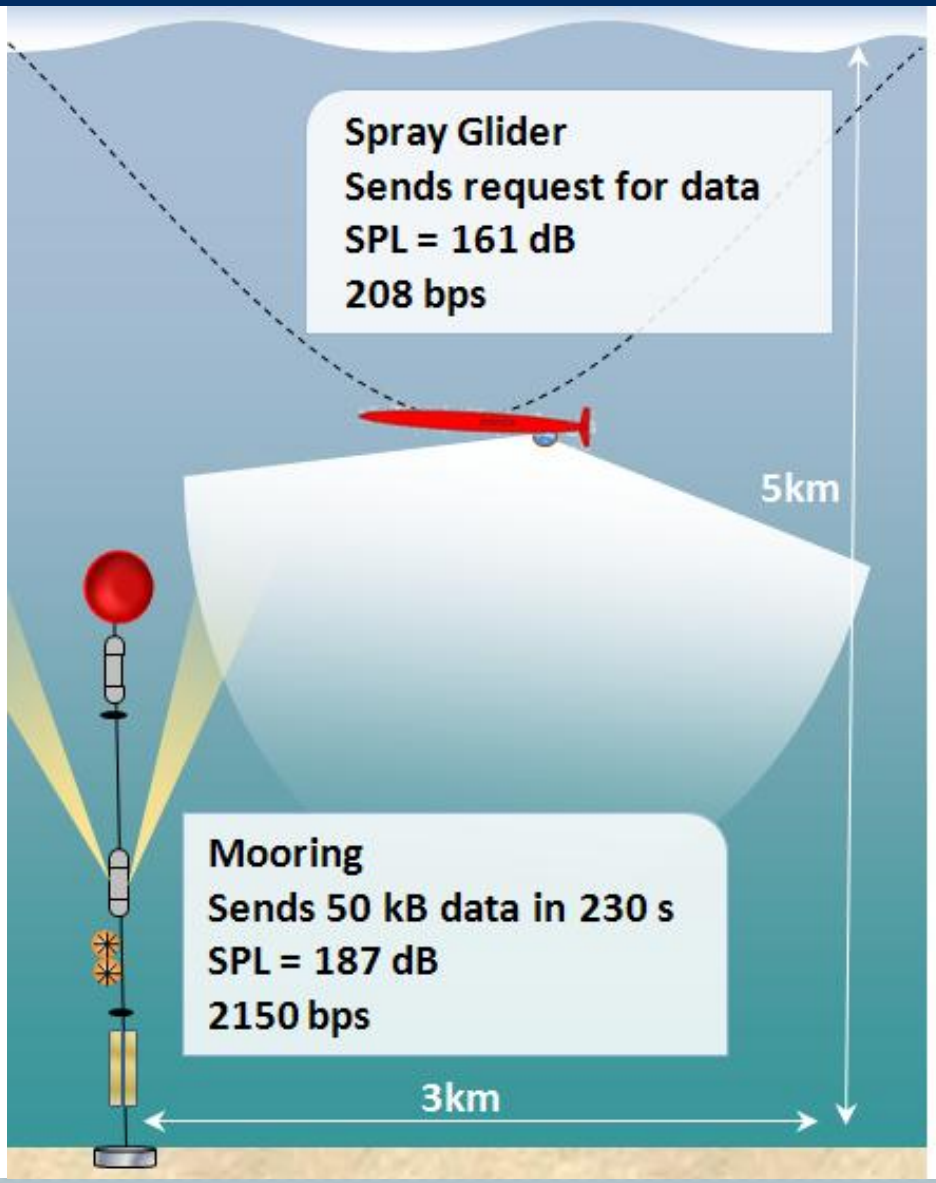
ADDITIONAL BATTERY PACK

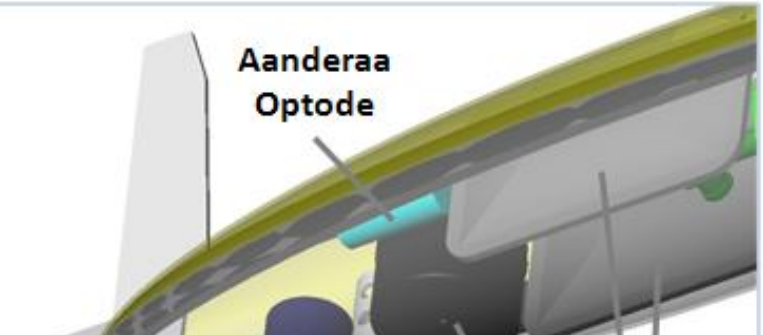
Increased power to 22 MJ

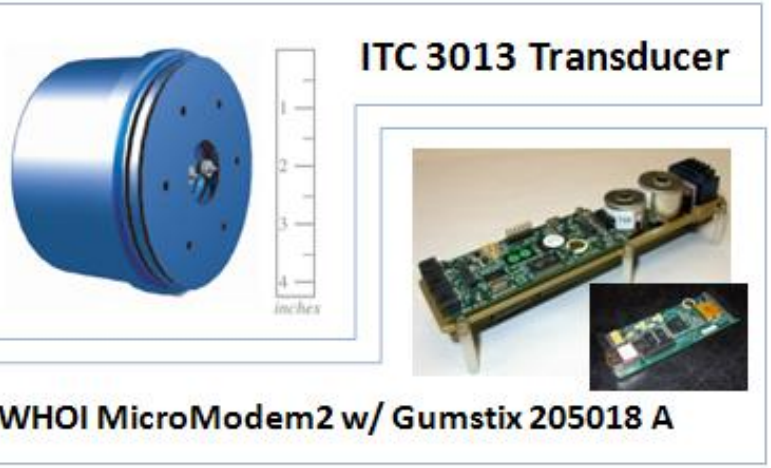
EXTENDED ENDURANCE AND RANGE

12 months and 9000+ km with 20% margin

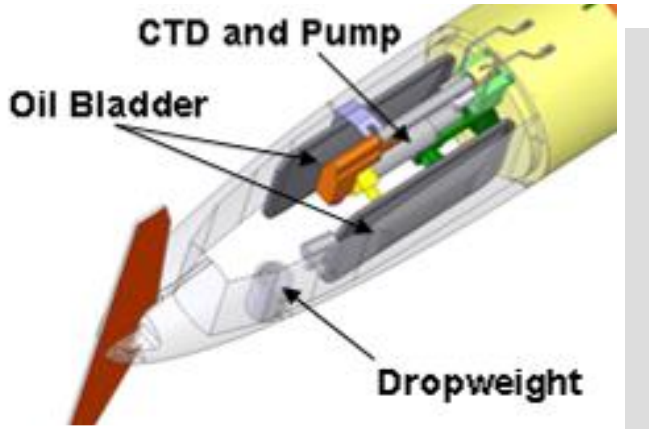
Acoustic Modem Upgrade







Sensors



STANDARD CTD

- Pumped to combat bio-fouling
- Critical for long and/or warm water missions

EXPANDED PAYLOAD BAY

- Payload bay and electronics expanded to accommodate additional sensors

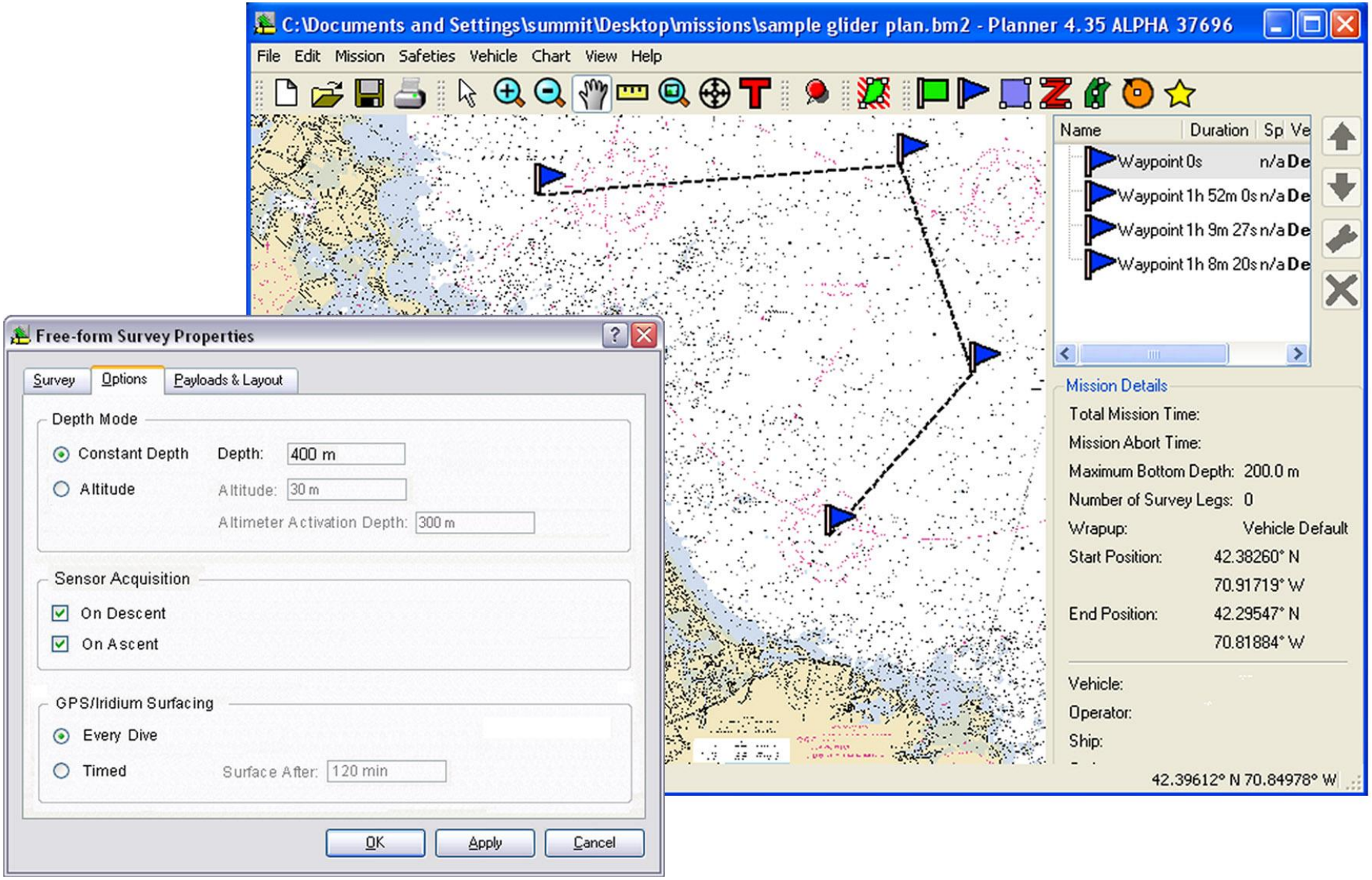
OPTIONAL SENSORS

- Turbidity
- Dissolved oxygen
  - SeaBird pumped
  - Aanderaa optode*
- Fluorometer
  - Seapoint
  - WetLabs ECO CDOM*
- PAR*
- ADCP
  - RDI*
  - NorTek*
- Altimeter

*** - Improvements**

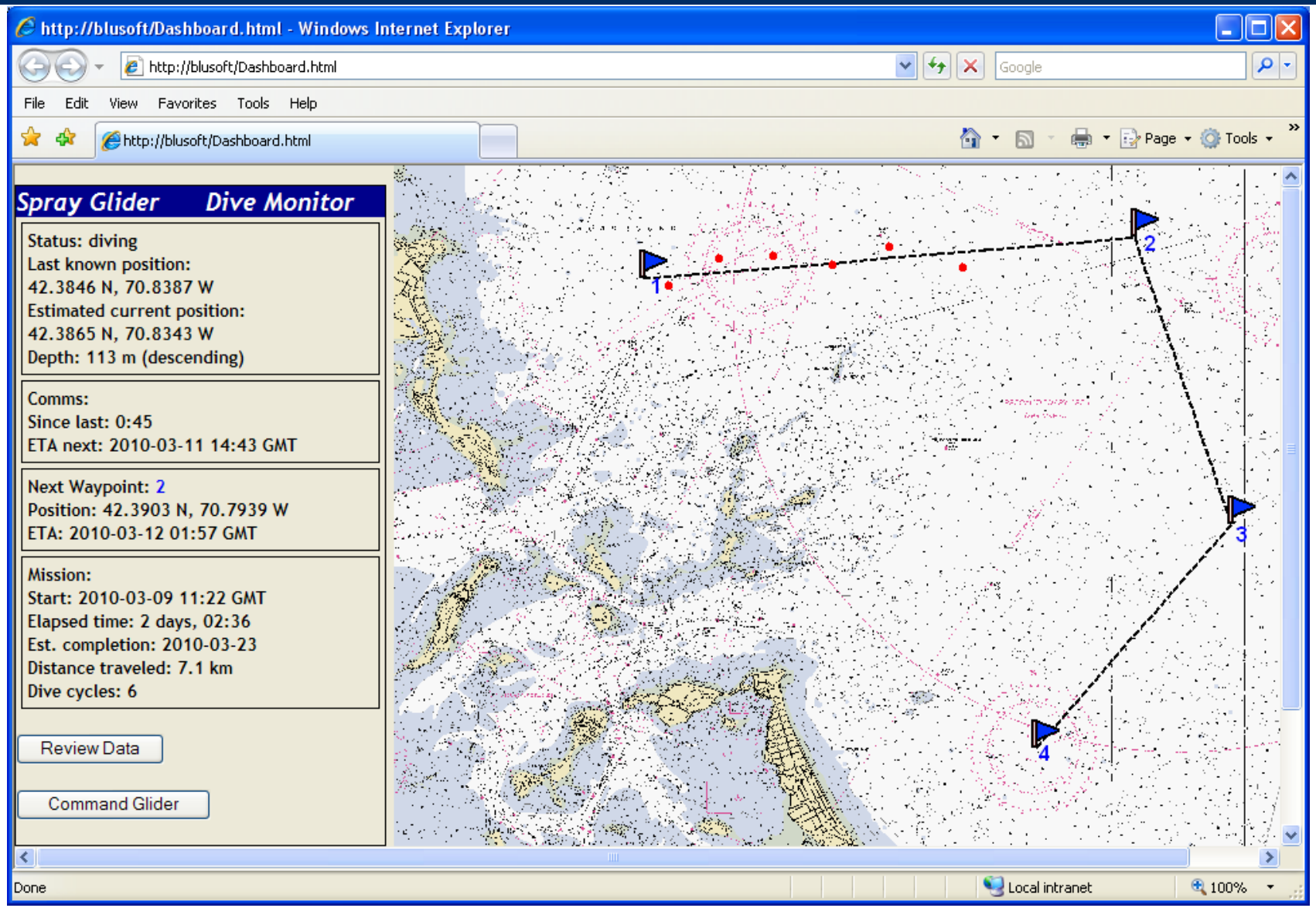
Spray Planner

Completely Configurable Tool for Mission Planning



Spray Dashboard

Web-Based Tool for Mission Monitoring



Glider Research & Operations Center (GROC)

- Collaborative effort with Bluefin Robotics and the Harbor Branch Oceanographic Institute (HBOI)

- Seed funding from Battelle Memorial Institute

- Advance glider-based marine science, technology, and education
  - New payload development and integration
  - Novel data synthesis approaches
  - Research vertical distribution of turbulent layers
  - Collaborate with Bluefin in new glider designs
    - 3000m-rated glider

- Deploy (2) new SPRAY gliders to measure petroleum presence in the Gulf of Mexico, Brazilian Basin and offshore Angola
  - Assess environment post-Deepwater Horizon spill
  - Brazil operations in collaboration with HBOI partner Grupo Cepemar

- Initial deployment Spring 2011

Quick Facts about Harbor Branch Oceanographic Institute

- Founded in 1971 by J. Seward Johnson & Edwin A. Link
- Located on 125 acres on Indian River Lagoon, 5 miles north of Fort Pierce.
- Acquired by Florida Atlantic University (FAU) on December 31, 2007.
- Functions as a research institute of FAU.
- 152 employees
- 23 Principal Investigators
- 30 graduate students
- Recent hires have been made in engineering and biomedical research

Wrap Up

- Bluefin has recently invested in significant upgrades to the Spray glider that expand capability and dataset
- The SPRAY glider integrates well with our existing fleet of AUV solutions
- Partnership with Harbor Branch Oceanographic Institute will extend presence in the science community and foster innovative payload approaches

Deep Down, You Want Bluefin.





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HARBOR BRANCH
FLORIDA ATLANTIC UNIVERSITY

Backups

Changes from the Original Scripps Design

- 99% of parts are locally sourced versus Scripps parts
- Reduced production time to delivery
- Additional payloads available
- Shortened tail with lift hook
- Cleaner, more user-friendly ballasting
- Reduced drag on wing joints and payload bay covers
- Making software improvements on a continuous basis
- New roll pack design for increased reliability
- Robust Ortman ring groove instead of tab clamps

Communications

GLOBAL POSITIONING SYSTEM (GPS)

Standard L1 GPS

< 6 meter accuracy (50%), < 9 meter (90%)

IRIDIUM

Shore Commands allow the user to change mission parameters on the vehicle using the Shore-Burst-Data (SBD) Iridium Service

Information is sent to email address

Customer account with a SIM card

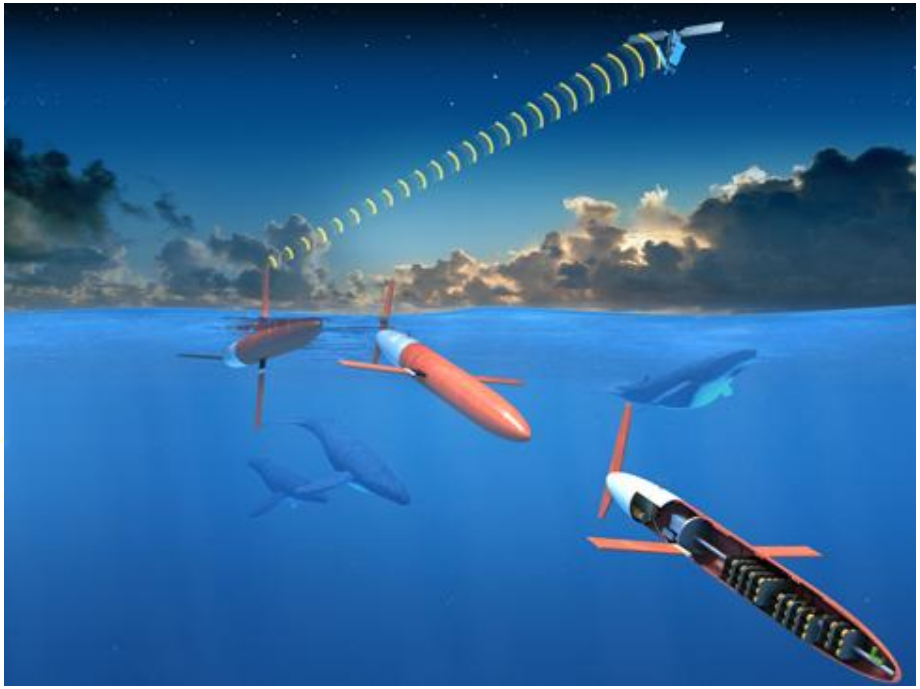
Equates to cost saving for user

IMPROVEMENTS

RUDICS Iridium for high data rate communications

RF link for testing and deployment

Acoustic modem



Emergency Systems

DROPWEIGHT

- Vehicle is slightly positively buoyant
- When released vehicle resurfaces

ARGOS SYSTEM

- Standard configuration includes ARGOS transmitter
- Range is within one mile radius
- Dual purpose:
  - Provides a RDF signal with which to locate the glider
  - Reports the surface location via ARGOS Satellite System

IMPROVEMENT

- Strobe light to aid in recovery

Improved Spray Functional Diagram