



FUSION

A Step Change in Military Autonomous Technology

Introduction

Commercial vs Military AUV operations

Typical Military Operation (Man-Portable
Class)

Fusion System Components

User Interface (HMI)

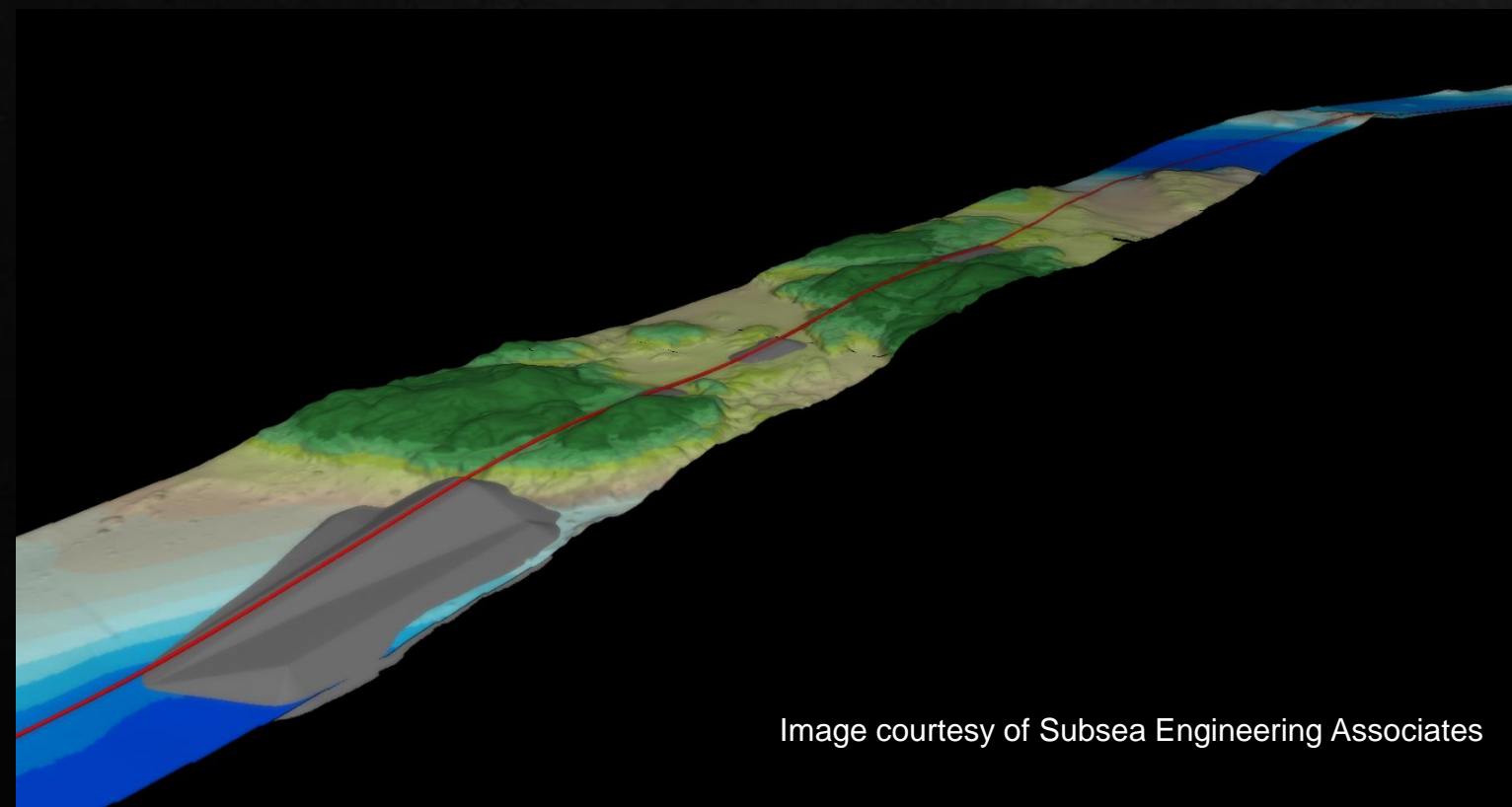
Modes of Operation



Typical Commercial vs Military AUV (UUV) operations (generalisation)

Commercial

- Long distance eg pipeline routes, pipeline surveys
- Large areas eg seabed surveys / bathy
- Large amount of data collected for post-mission analysis
- Predominantly torpedo shaped, require motion to manoeuvre
- Errors or delays cost money



Military

- Intelligence gathering, area survey, reconnaissance, battlespace preparation
- Mine countermeasures (MCM), ASW, threat / UXO location and identification
- Less data, desire for in-mission target recognition and mission adjustment
- Desire for “hover” ability but often use COTS AUV or adaptations for specific tasks, including hull inspection, payload deployment, sacrificial vehicle
- Errors or delays increase risk
- Typical categories: **man-portable**, lightweight, heavy weight & large vehicle



Typical Current Military Operation (Man-Portable Class) Cost

- Survey areas of interest using AUV & identify targets of interest:
- Deploy ROV to perform detailed survey of identified targets:
- Deploy divers to deal with targets:

Assets

AUV & Operating Team

ROV & Operating Team

Dive Team with Nav Aids &
Diver Propulsion

Equipment

USD 250k to USD millions

USD 200k to USD 450k

USD 25k – USD 100ks

3 teams, 3 sets of equipment
= opportunity for cost reduction



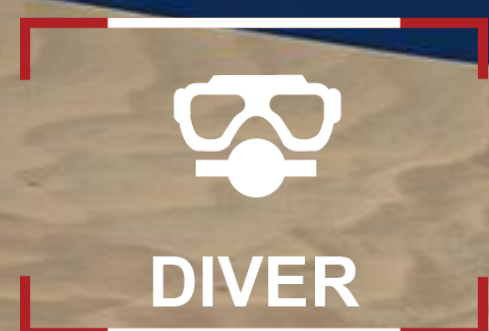
Hybrid System, Target Market : Man-Portable Class Rapid Response



Autonomous underwater vehicle capable of complex manoeuvres, hover, stationkeep and comprehensive sensor data acquisition and in-mission decision-making



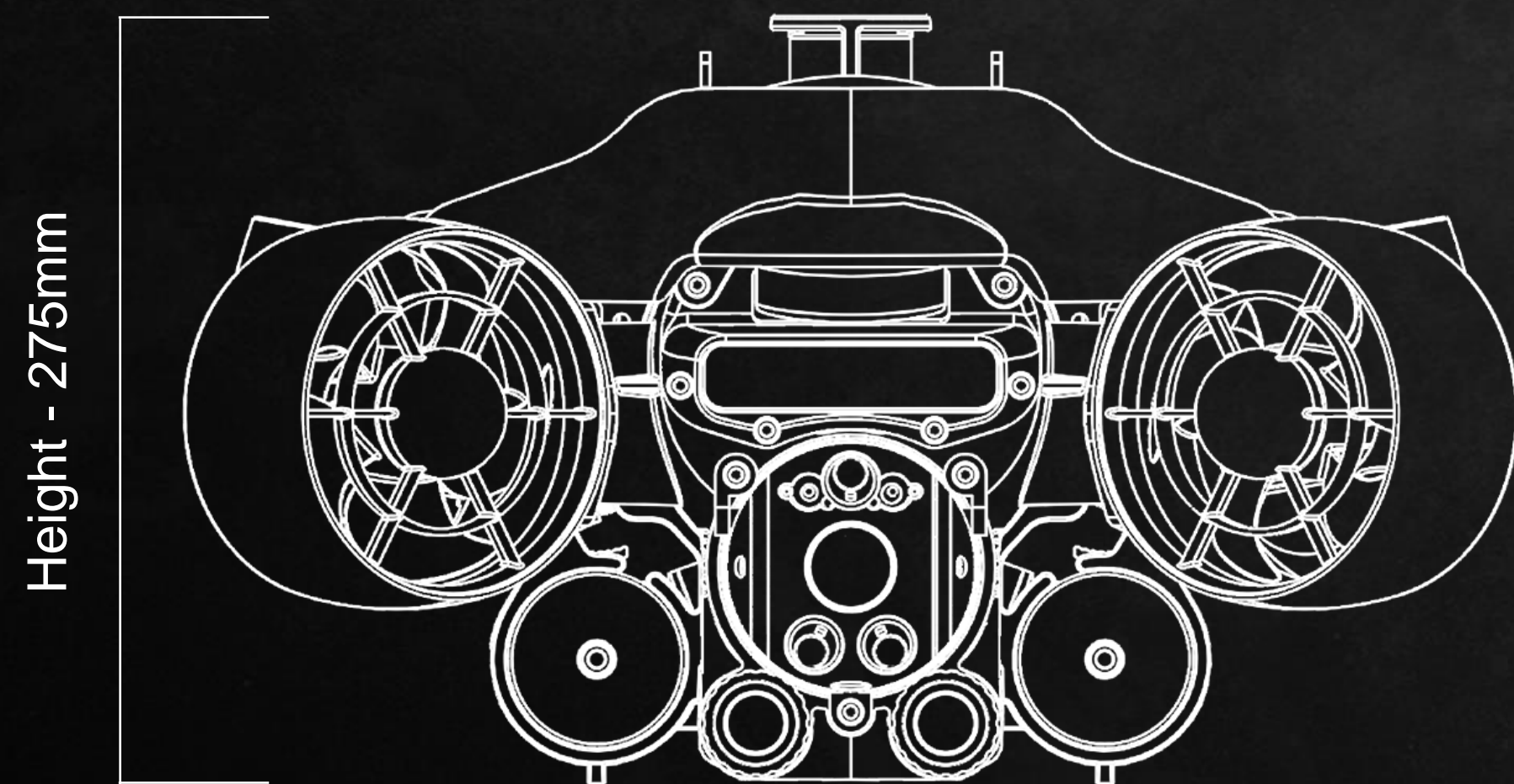
High performance extended excursion fully automated remotely controlled vehicle, with stationkeep functionality



Diver navigation and propulsion vehicle with real-time sensor feedback and logging



Vehicle Stats

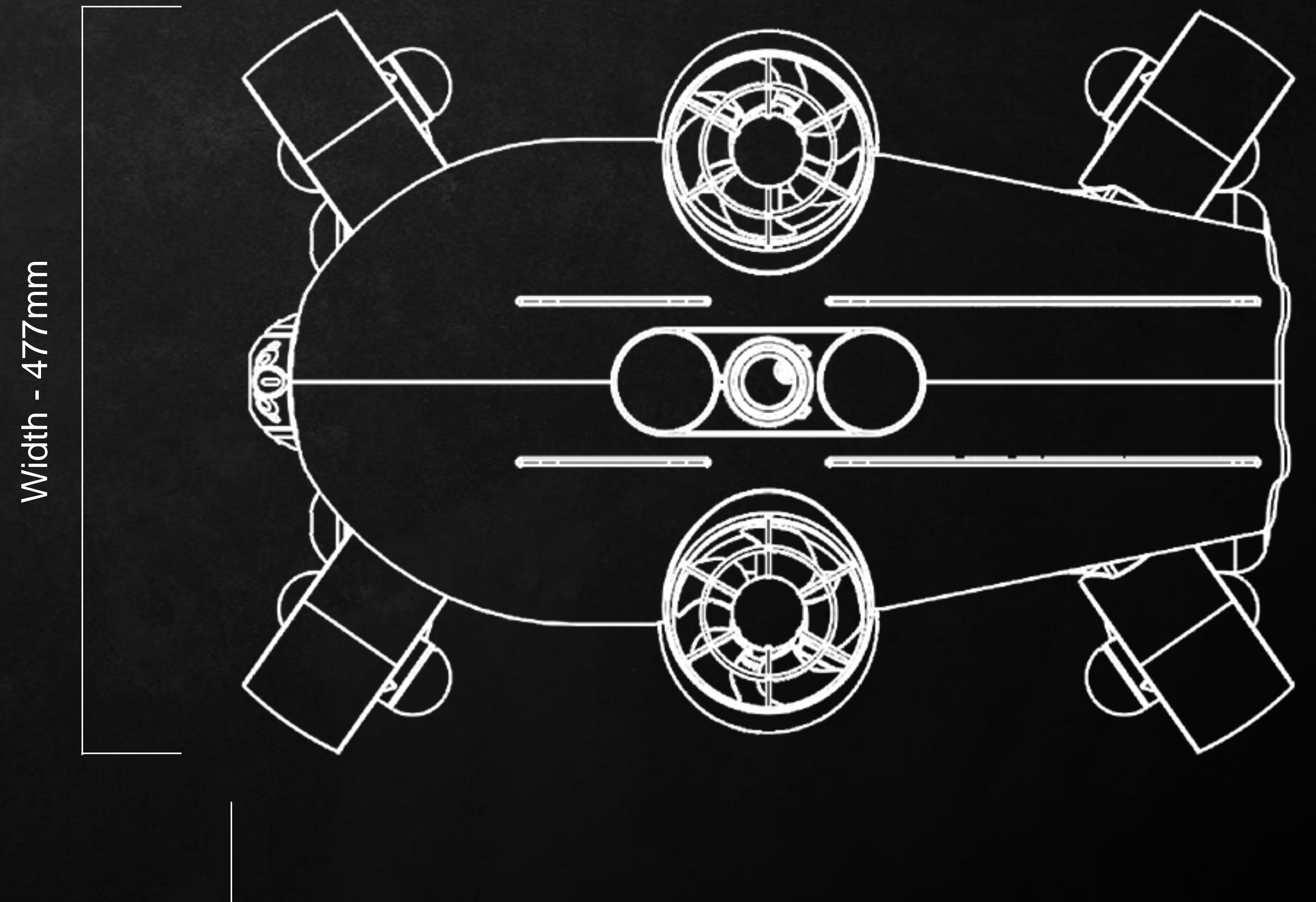


Height - 275mm

Vehicle Weight 27.5kg

Depth rating 300m

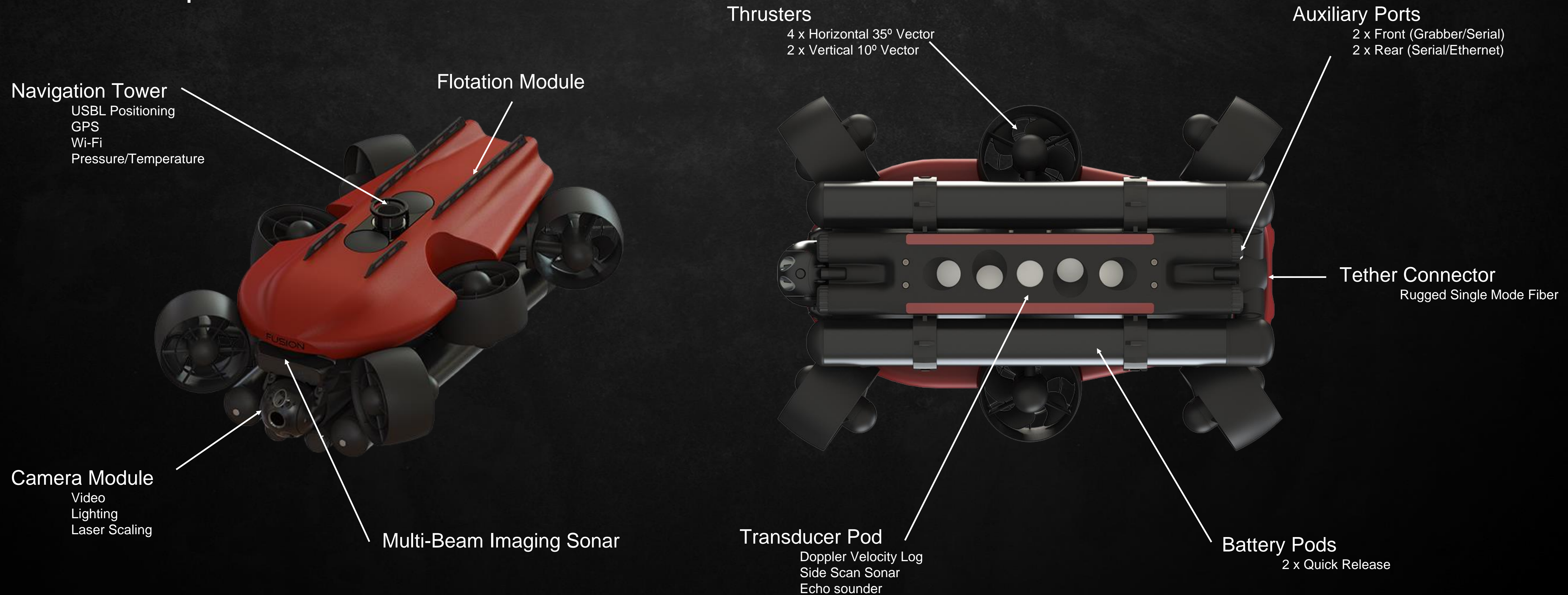
Forward speed 4+ knots (target 5 knots)



Width - 477mm

Length - 686mm

Main Components



Sensor Suite

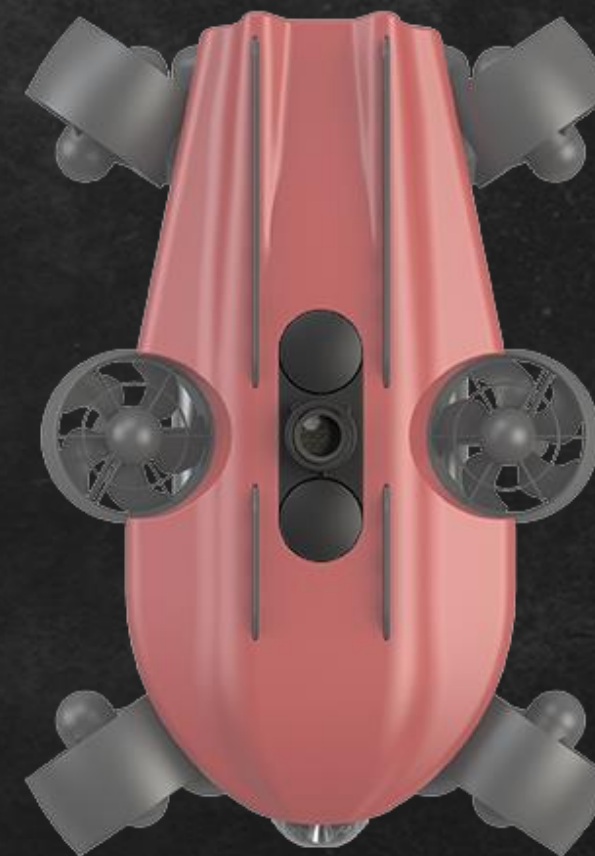
Camera Module

Resolution - 1080p30 HD
Lights - 3 x LED
Scaling - 2 x Red Laser Line
Tilt - 135°



Multi-Beam Imaging Sonar

Frequency - 750kHz / 1.2MHz
Horizontal Beam Width - 130°
Vertical Beam Width - 20° / 12.5°
Range (750kHz) - 0.1-100m
Range (1.2MHz) - 0.1-35m
1°/0.6° acoustic angular resolution
4mm/2.5mm range resolution
256 beams

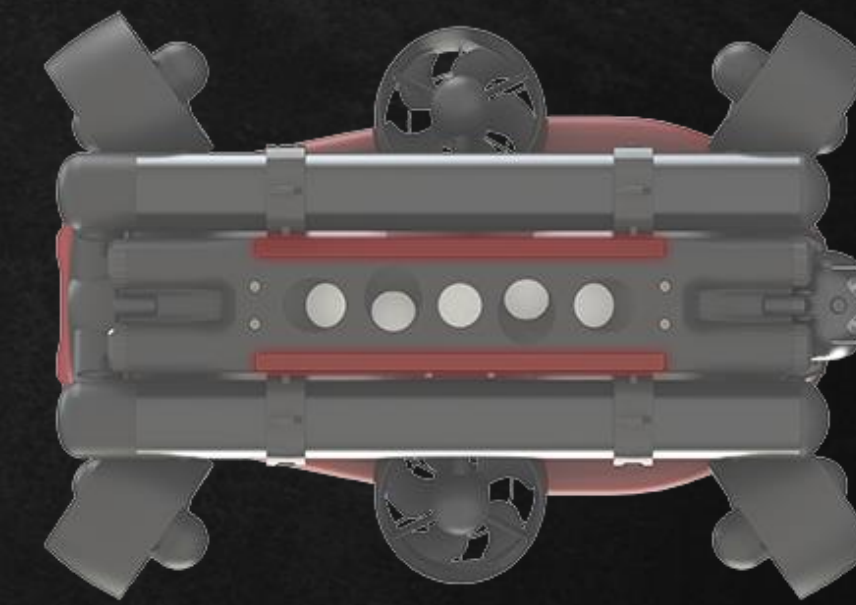


Navigation Tower

USBL Positioning
Range - 1+km
Resolution - $\pm 50\text{mm}$
Angular Resolution - $\pm 1^\circ$
GPS
Channels - 72
Accuracy - 2.5m
GNSS - GPS / GLONASS
Wi-Fi
Frequency - 2.4GHz
Pressure & Temperature
Accuracy - 0.01m

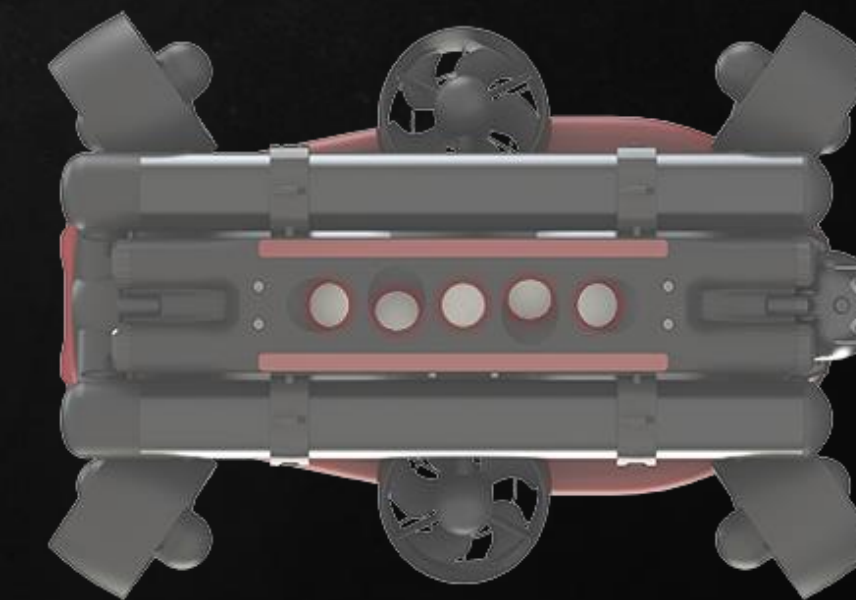
Internal Navigation

AHRS
Roll & Pitch Accuracy - 0.2°
Heading - 1°
Heave - 0.1m



Side Scan Sonar

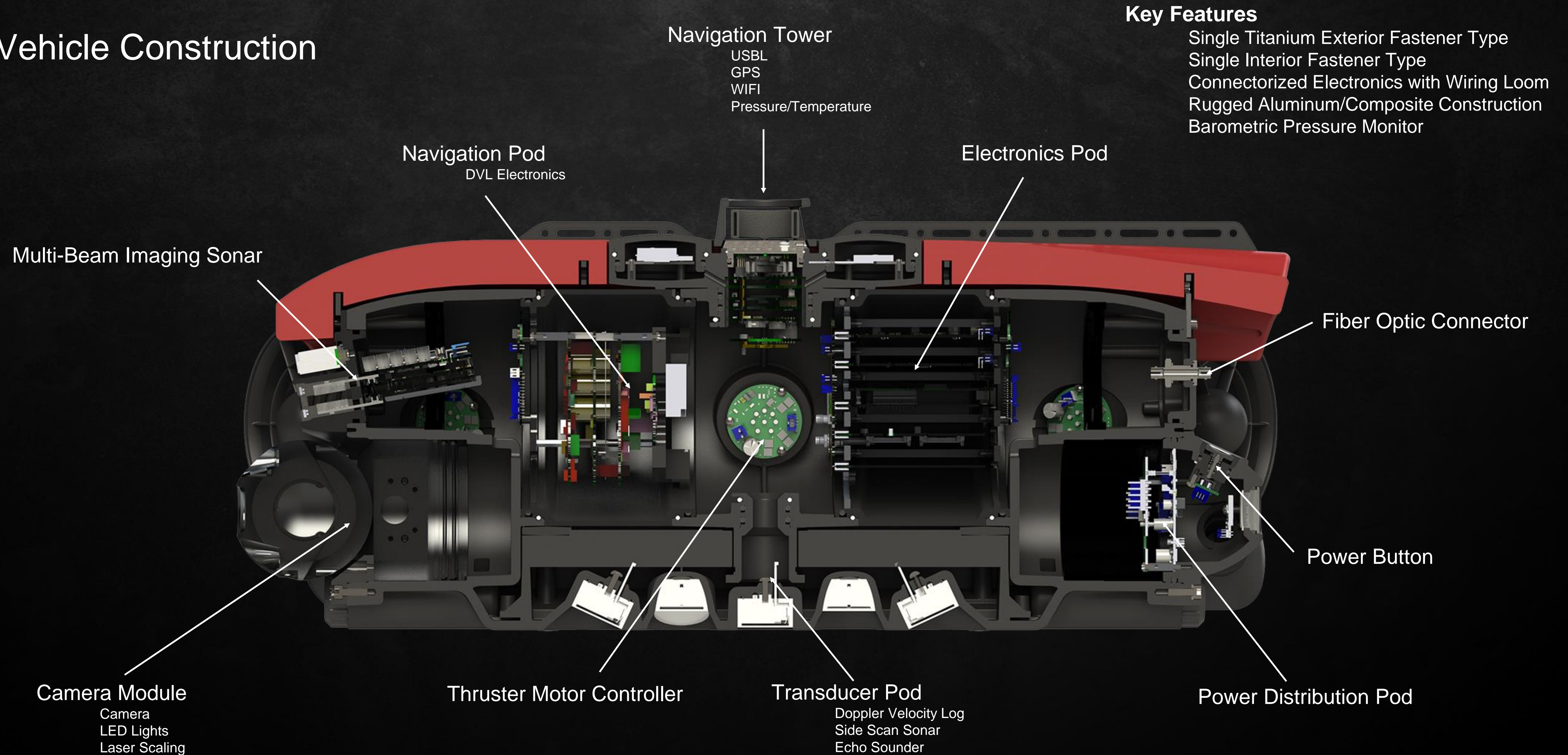
Frequency - 450kHz CHIRP
Horizontal Beam Width - 0.5°
Vertical Beam Width - 60°
Range - 100m / 328ft



DVL / Altimeter

DVL Frequency - 1MHz
Altimeter Frequency - 500kHz
Altitude Range - 0.2m-50m
Velocity Range - $\pm 16\text{m/s}$
Velocity Resolution - 0.01mm/s

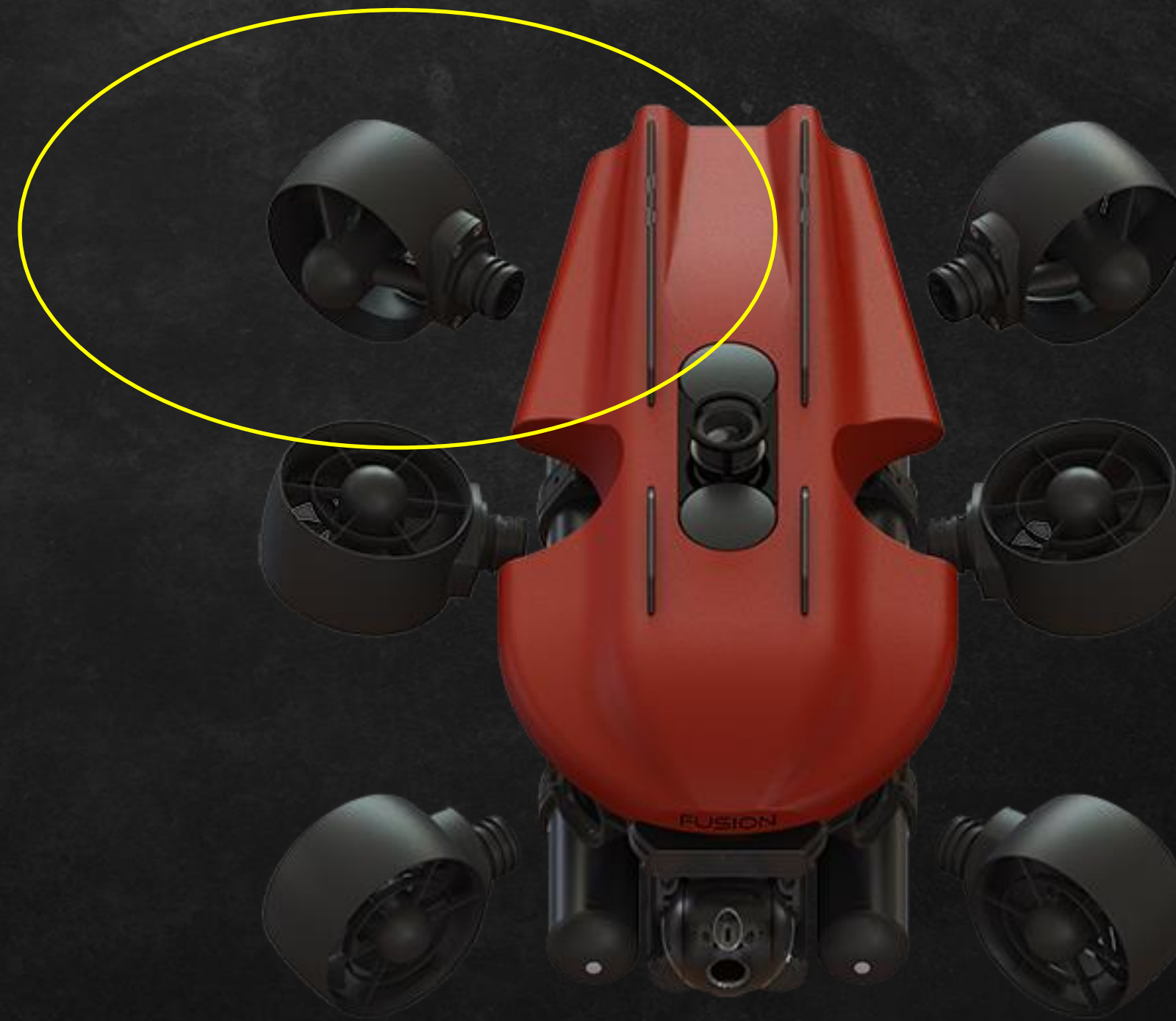
Vehicle Construction



Propulsion

Key Features

- 4 vectored horizontal thrusters
- 2 vectored vertical thrusters
- Low maintenance, flooded design
- Electronics inside vehicle
- Tool-less rapid thruster change
- Quick-detach guard



Battery Power

Key Features

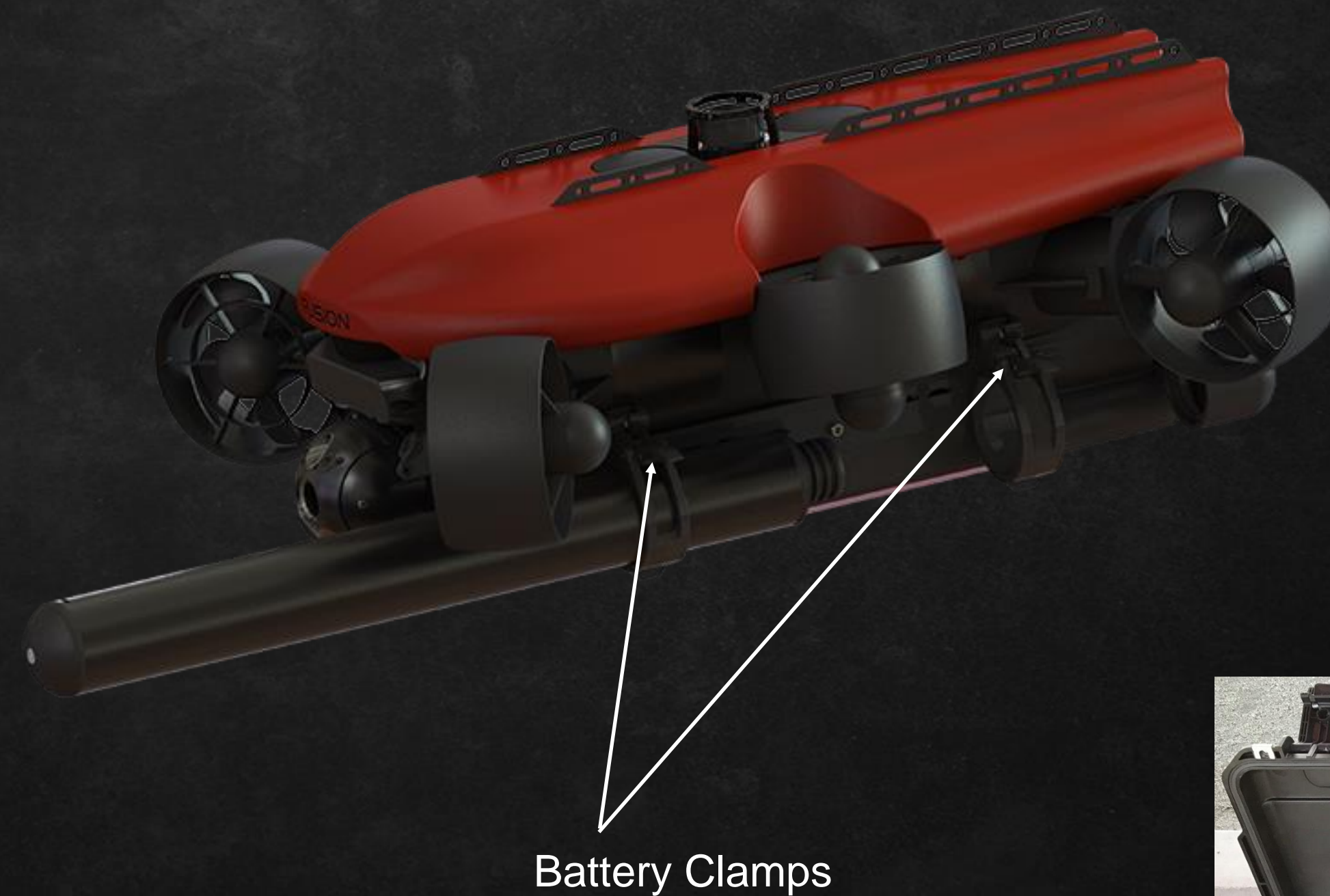
- Quick change mechanism
- Intelligent battery management
- 2 pairs included

Battery Pack Specifications

- Chemistry – Lithium Ion
- Capacity - 457w-hr (ea)
- Voltage range 21- 29VDC
- Certification - UN38.3
- Cycle Life - Est. 750+

Charge times

- 0-100% - 4 hrs (pair)
- 0-90% - 2 hrs (pair)

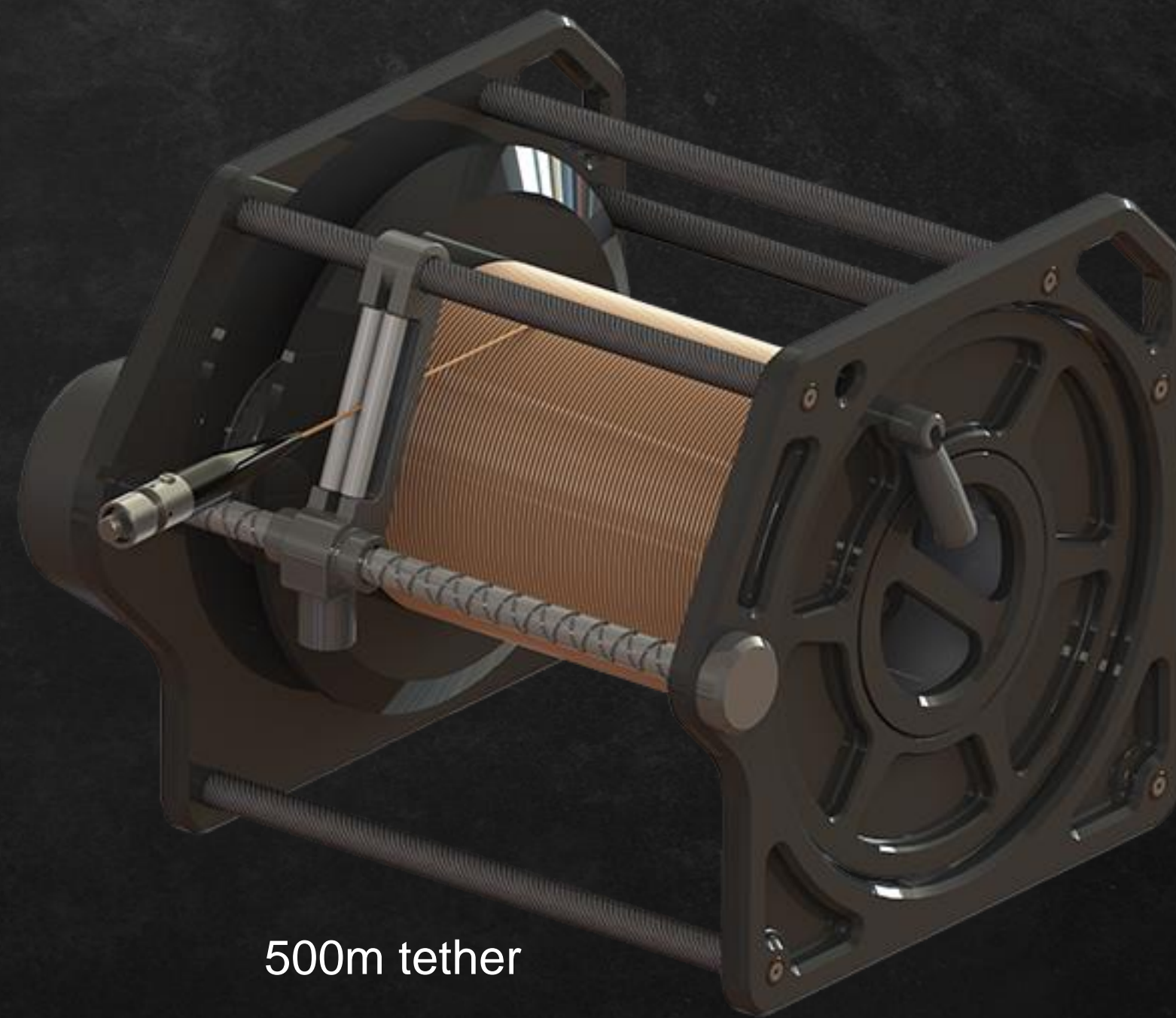


Battery storage (2 sets), charger and vacuum pump

Reel

Key Features

- Quick change spool
- 2,000m capacity
- Level wind
- Electrical slip-ring
- Compact & lightweight

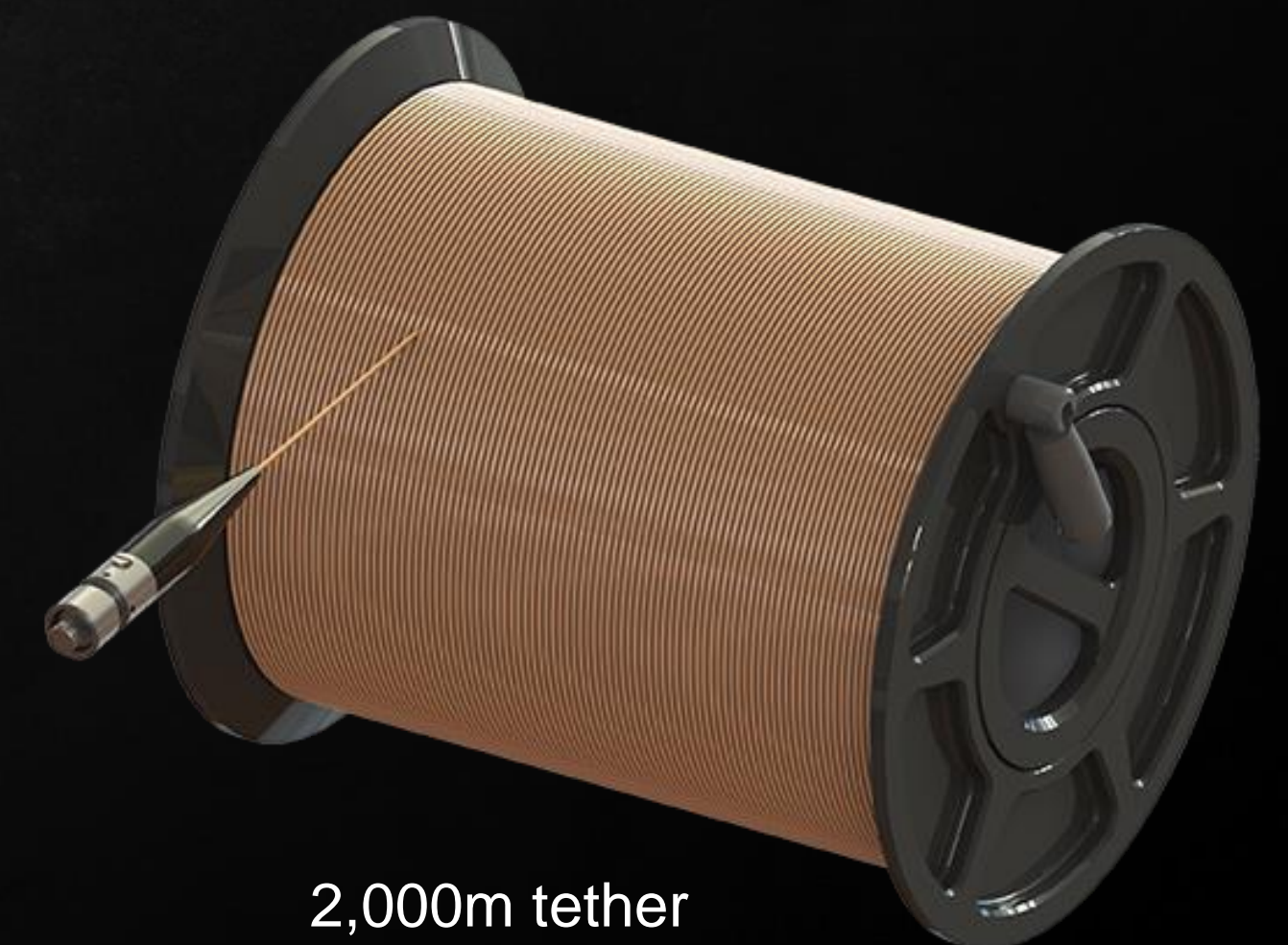


500m tether

Tether

Key Features

- 2.4mm diameter (nominal)
- 500m length (standard)
- 2,000m length (optional)
- 110kgf strength
- Gigabit / 1000baseT Ethernet
- Single Mode optical fiber
- Rugged / kink free design
- Neutral in fresh water



2,000m tether

User Interface (HMI)

Key Features

- Single interface for all modes
- Shared data between modes
- Intuitive / simplistic display
- Built in support manuals/videos
- Maintenance prompts and automation
- User configurable

Based on commercial drone interface



Key Features

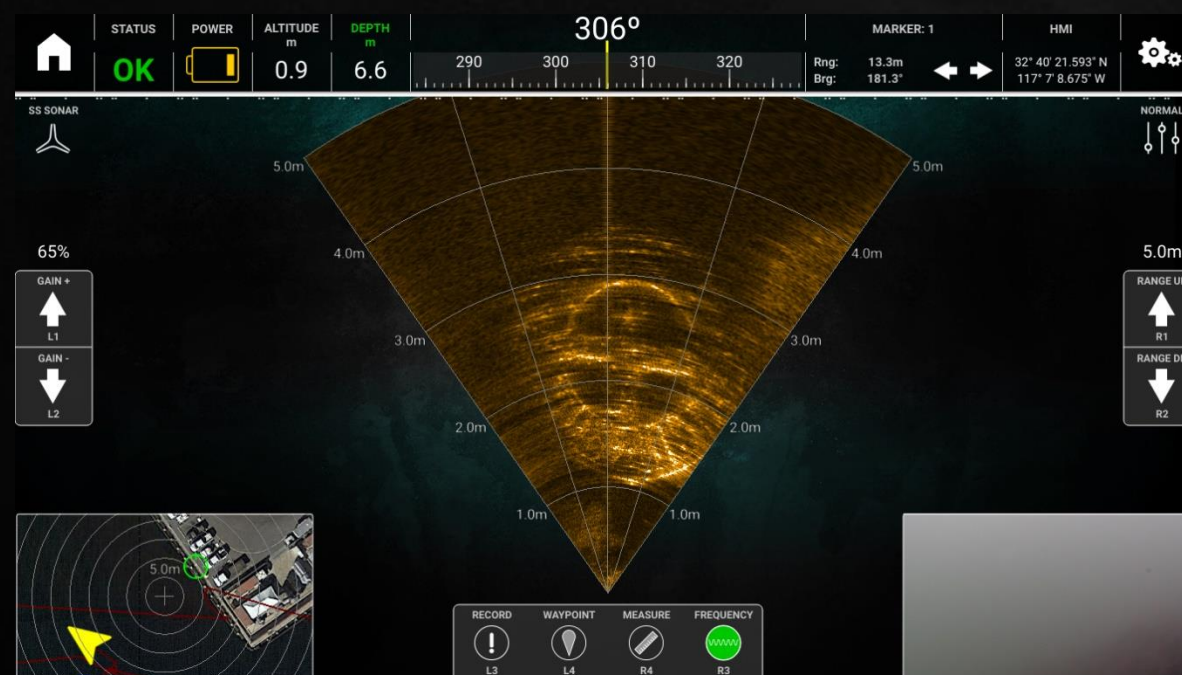
Quick change between windows

- Sonar dominant
- Video dominant
- Navigation dominant

All key data displayed

Touchscreen functions

Buttons change to match mode

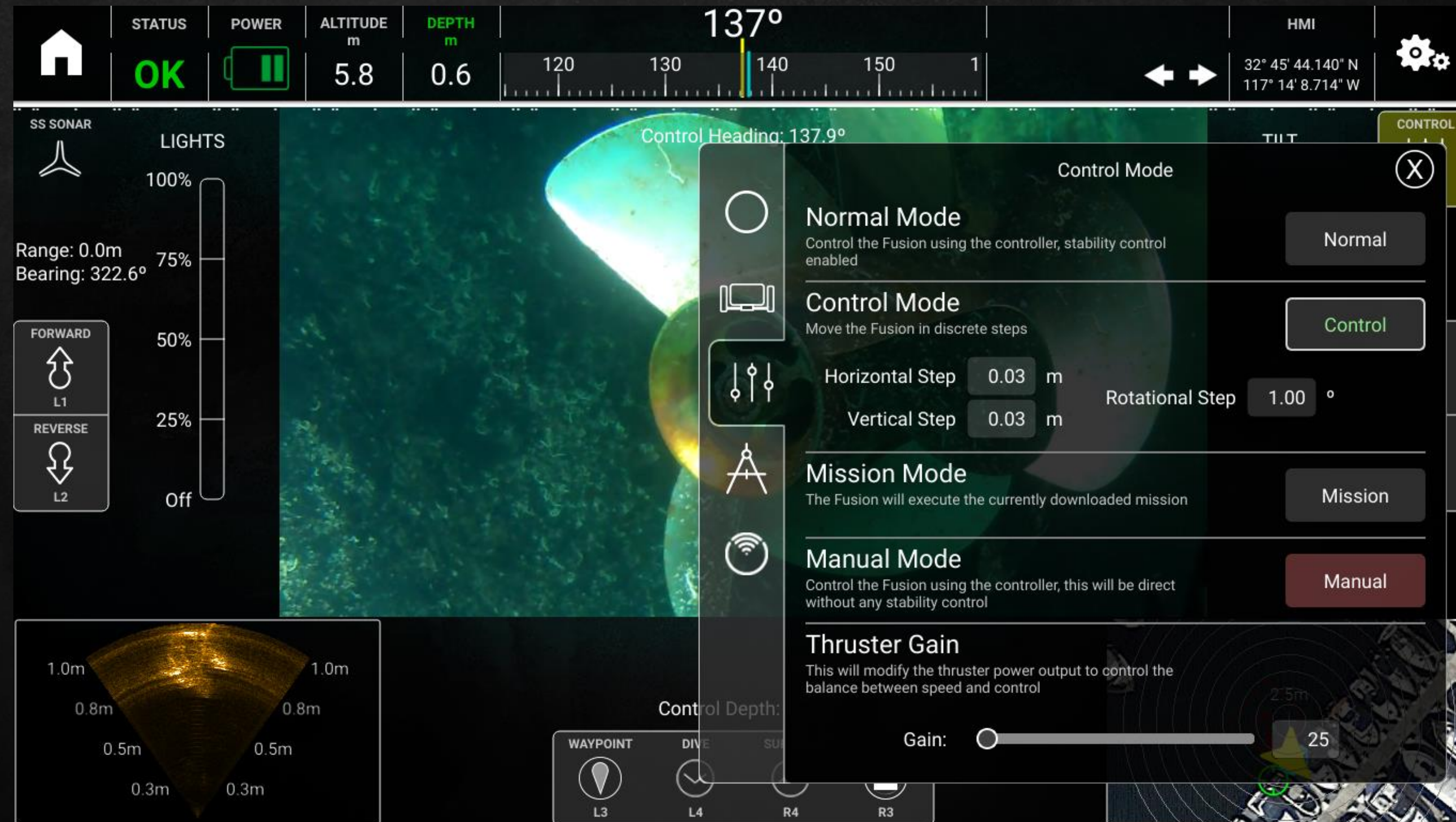




Tethered Functionality

Modes of Operation:

Normal
Control
Mission
Manual



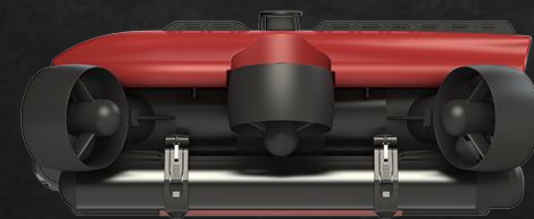


AUV

Untethered Functionality

- Enhanced maneuverability
- 300 meter operational depth
- 4+ hour mission capability
- Extensive sensor data
 - Side scan
 - Multi-beam imaging sonar
 - HD video
 - Laser scaling
- Intuitive mission planning

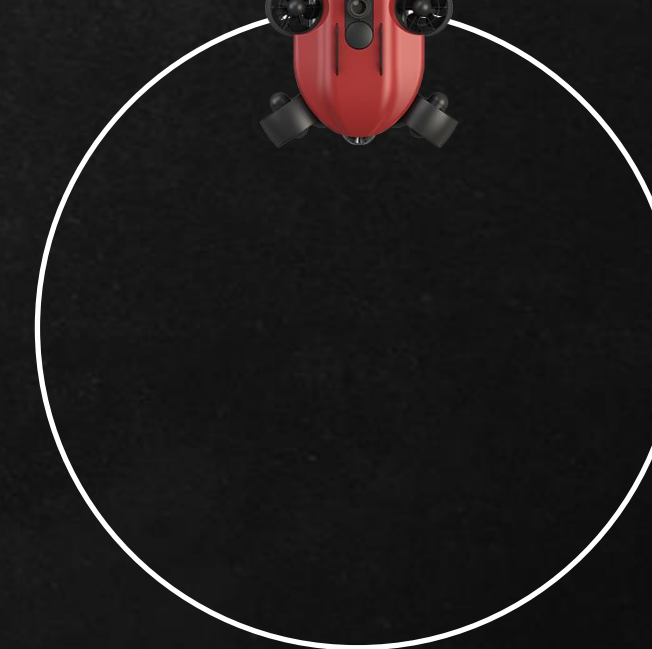
Vertical Dive / Surface



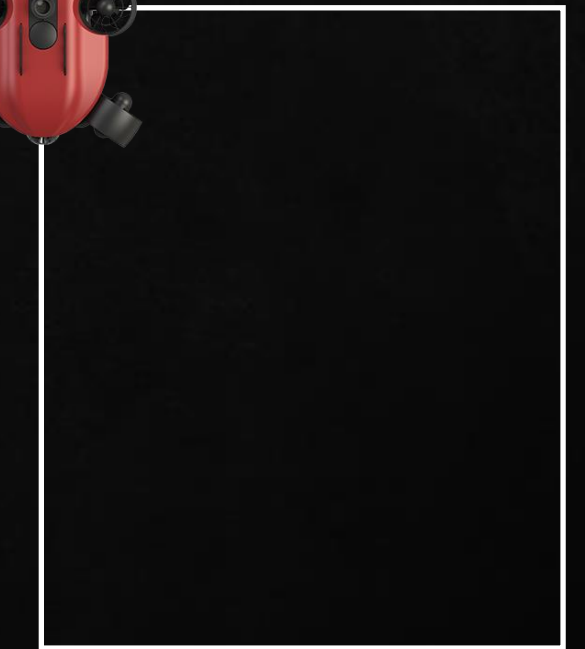
Complex Maneuvres



Orbit



Lateral Movement





AUV

Untethered Functionality

Traditional AUV mission patterns

“Orbit” pattern

User-defined patterns

Shallow turn radius due to thruster configuration

No surfacing requirement

Vehicle communications during mission

Reduced mission durations

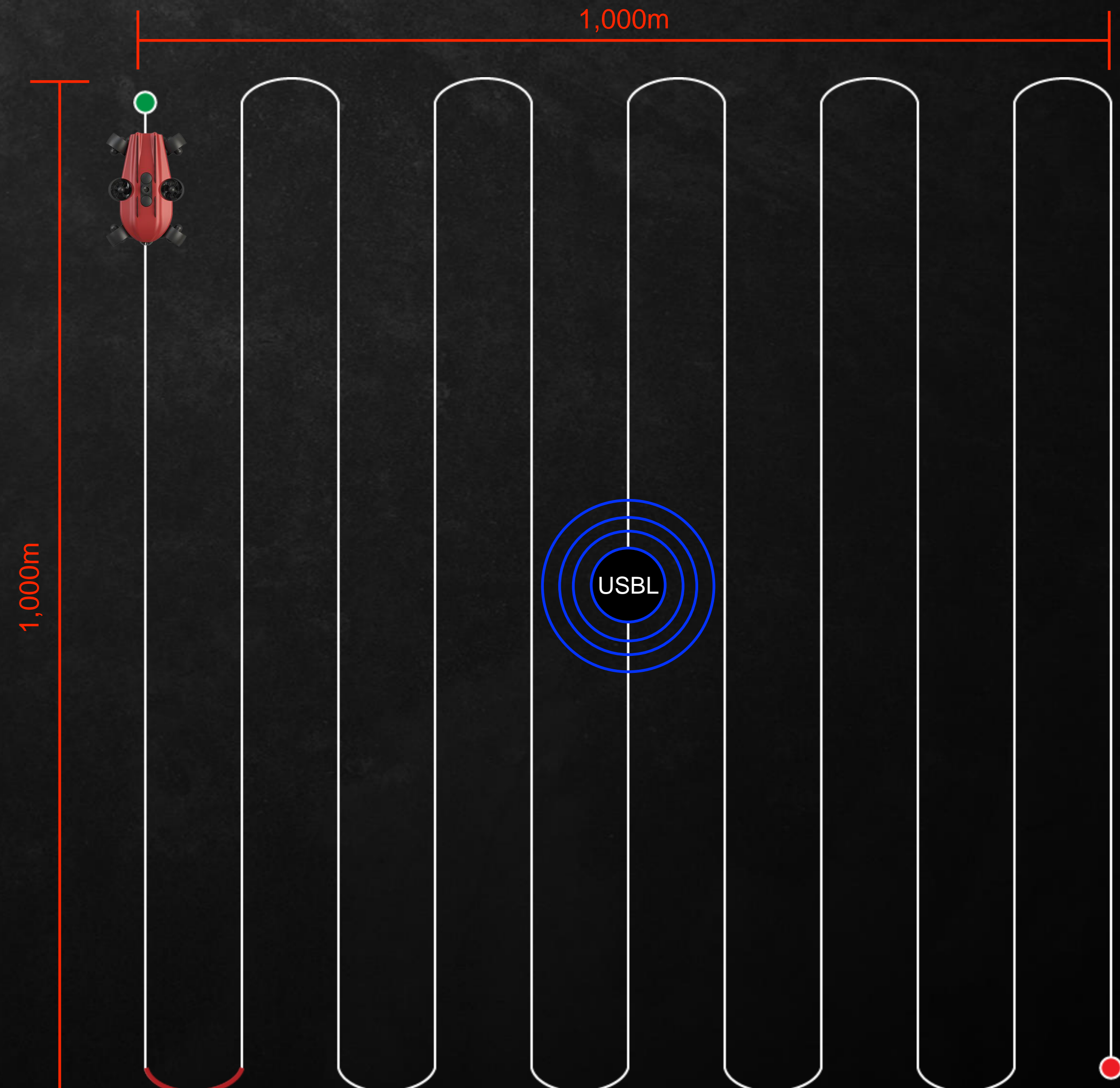
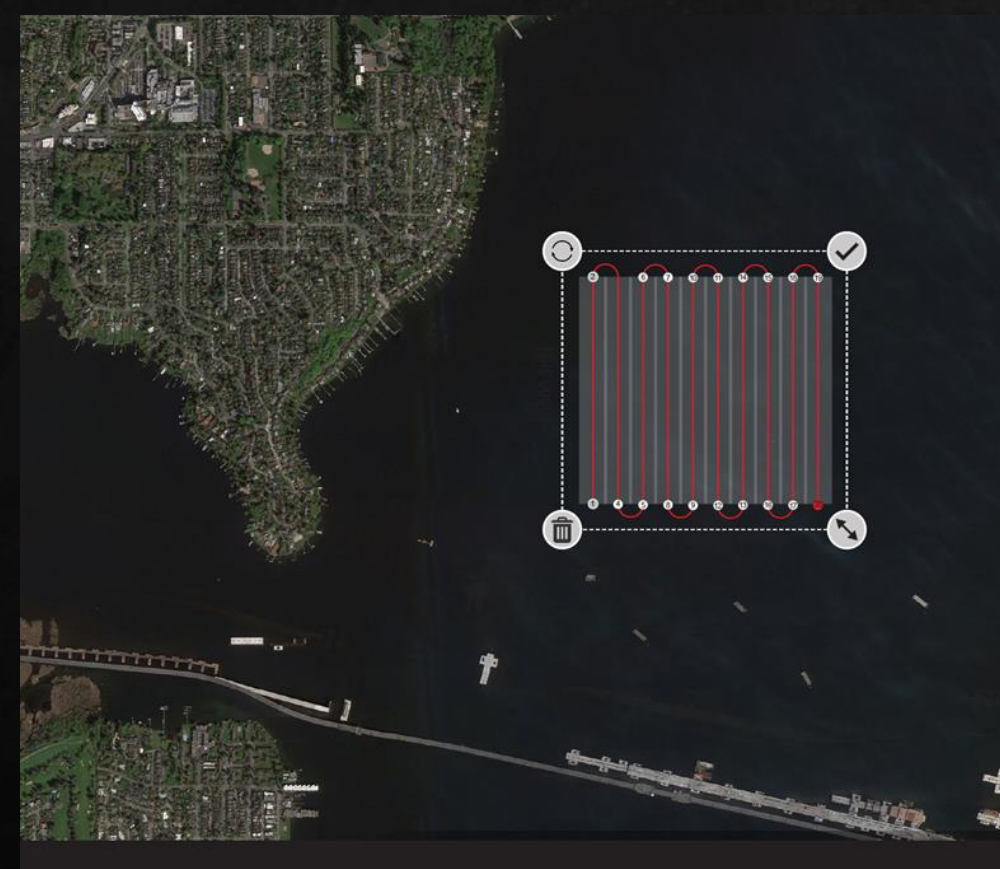
2 hours, 42 minutes

1 square kilometer

@ 2.5 knots

with 50 meter side scan range

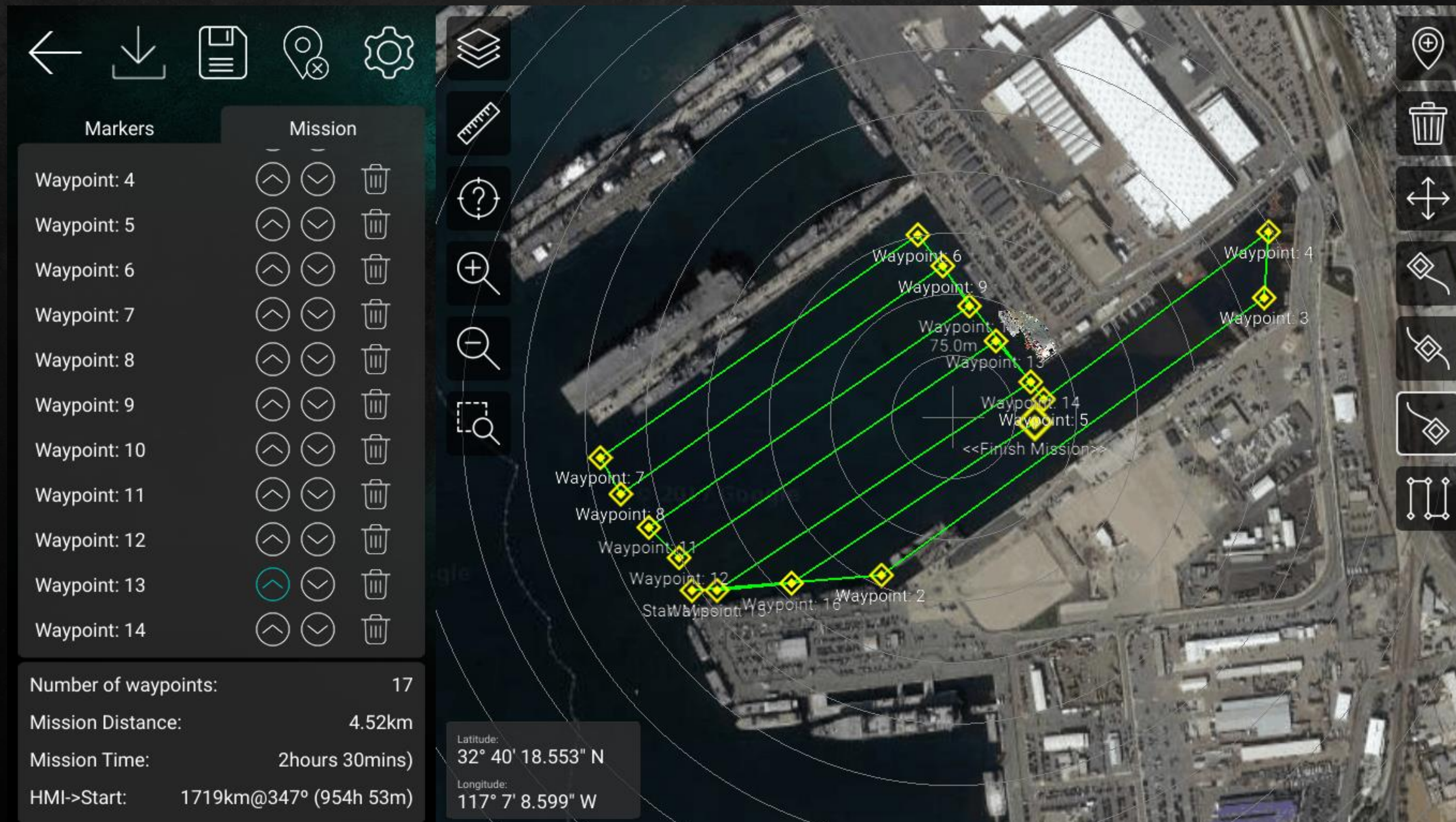
@ 100 meter depth





AUV

Untethered Functionality





DIVER

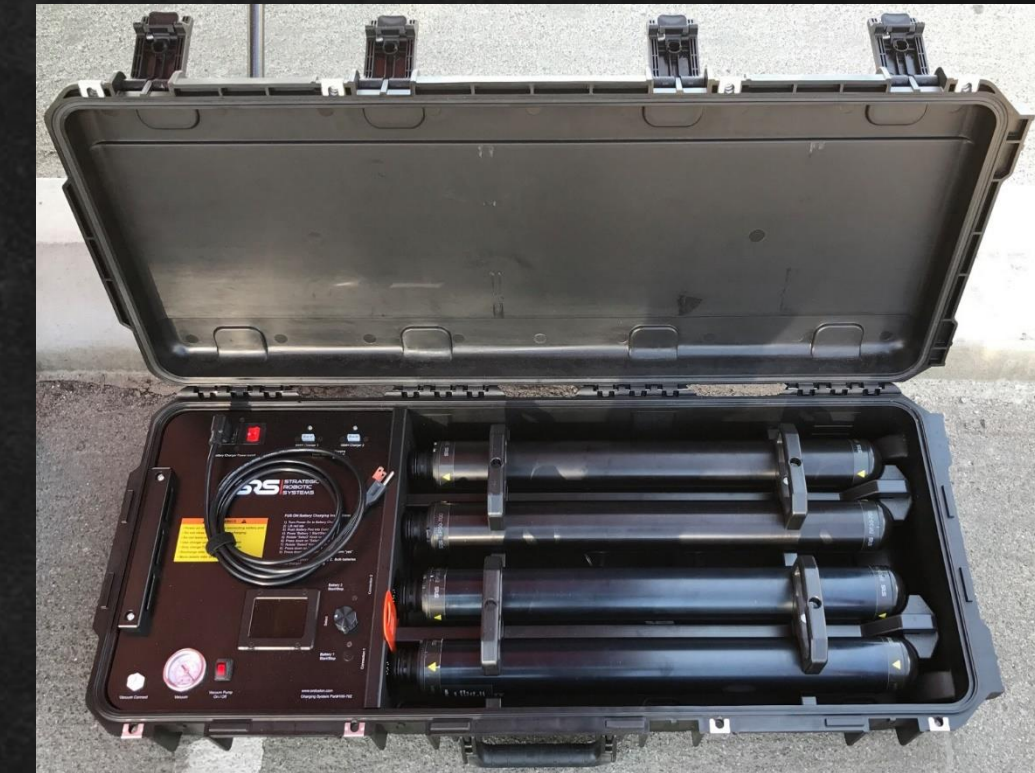
DIVER Mode

- Quick attach diver module
 - Nav & propulsion controls
 - 178mm screen
- Sonar and navigation
- Propulsion
- Virtual anchor when not in use
- Video recording
- 1.5 knot forward velocity (est)
- 60-90 minute duration (est)



CURRENT STATUS:

- Production of stationkeep ROV version has commenced
- Mission planning is in testing, nearing completion
- Obstacle avoidance under development



ONGOING AND FUTURE DEVELOPMENT:

- Target recognition / identification
- Integrated Fusion / RIB / dive package
- Remote deployment (helicopter drop / remote surface vessel)
- Test Correlation Velocity Log (CVL) vs DVL
- Ability to “swarm”



QUESTIONS

