Update

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Electrical Housing

- Size dependent on components
- Waterproofing through FDM and polyurethane combination

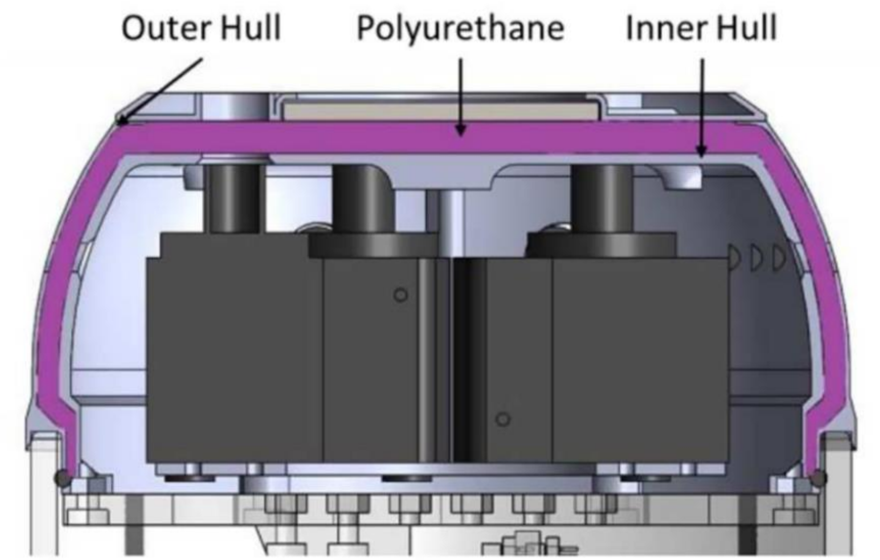
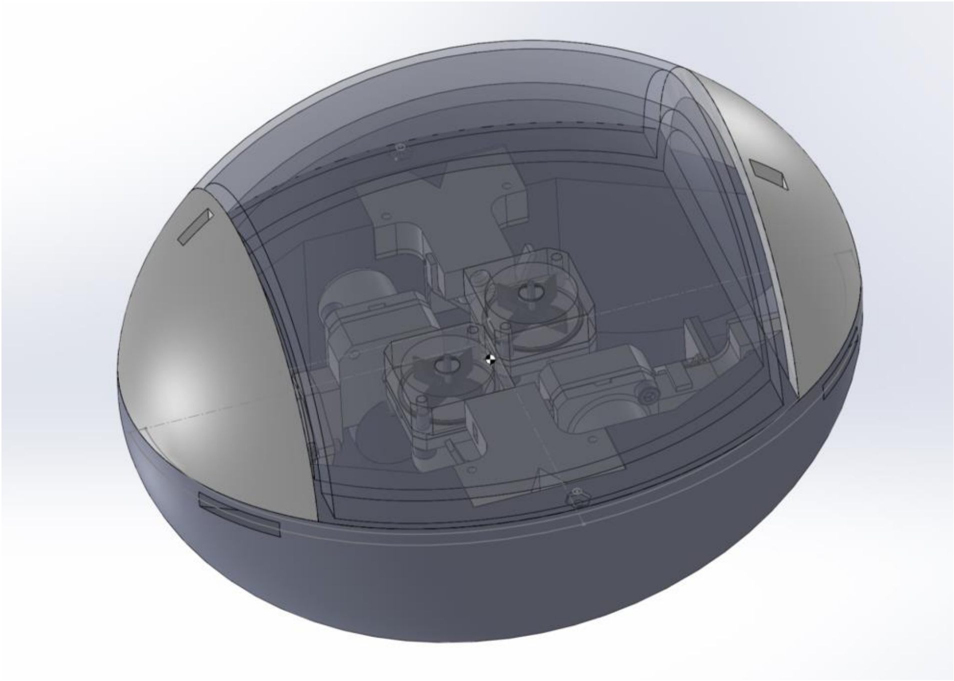


Fig. 4. Triple Hull Design End Cap.



Power System

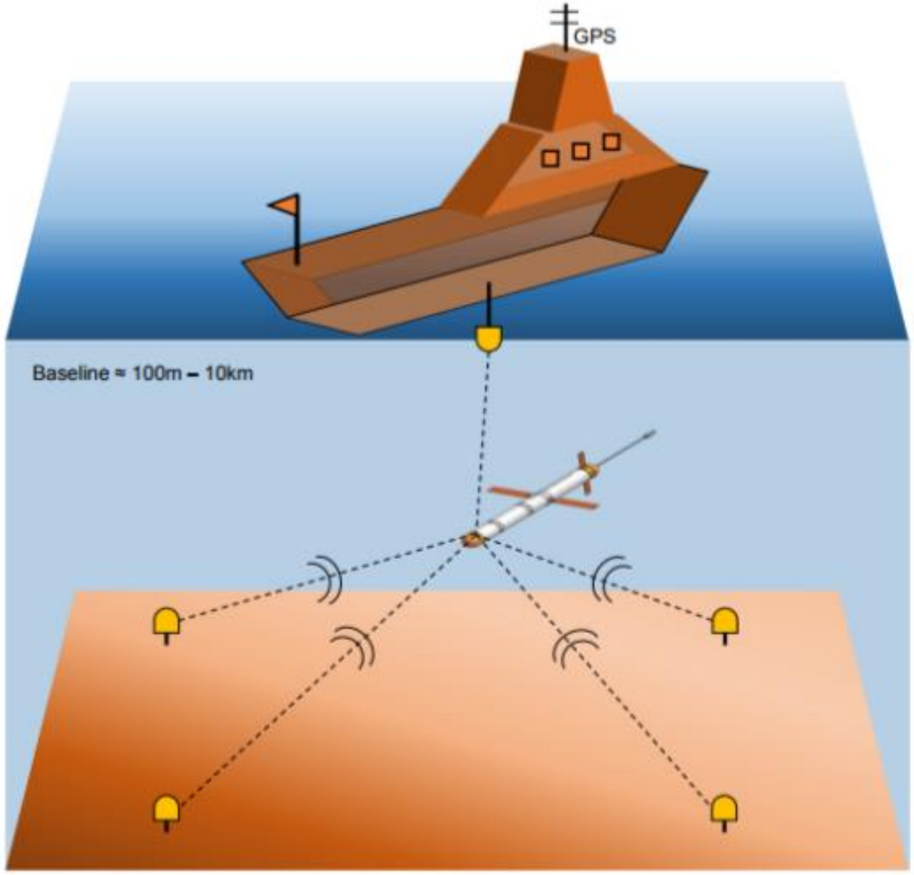
- Two independent system to minimize interference
  - Motor system (12V)
  - Sensor system
- Over-current protection circuit
- Voltage regulation
- Kill switch

Acoustic Positioning

- Classical long baseline
  - An AUV transducer interrogates each of the transducers in the array individually
- Accuracy of the system depends on significantly on baseline length and interrogation frequency

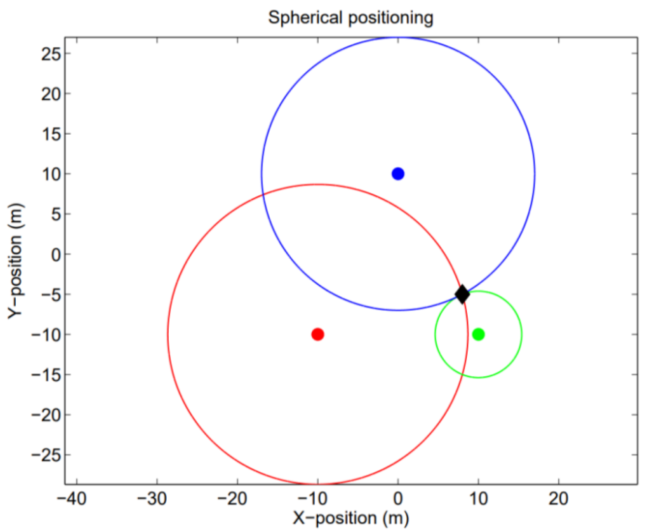
	Frequency Range	Maximum range	Typical relative, static accuracy*
Low frequency (LF)	8kHz to 16kHz	∽ 10km	2m to 5m
Medium frequency (MF)	18kHz to 36kHz	2km to 3.5km	0.25m to 1m
High frequency (HF)	30kHz to 60kHz	1,500m	0.15m to 0.25m
Extra high frequency (EHF)	50kHz to 110kHz	< 1,000m	< 0.05m
Very high frequency (VHF)	200kHz to 300kHz	< 100m	< 0.01m

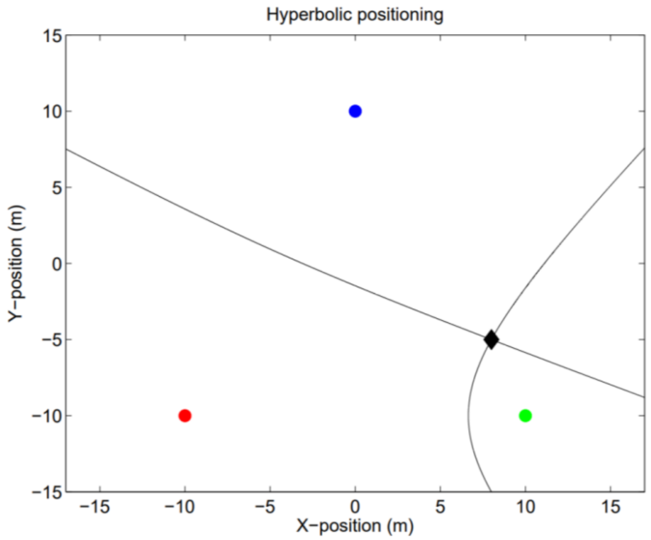
Table 2.2: LBL positioning accuracy versus frequency



(a) Classical LBL

Spherical and Hyperbolic Positioning





- Spherical
  - Based on the time of arrival (TOA) of signals from each transducers
  - These are converted to a ranges using a sound-velocity profile
  - The AUV position is at the intersection of the range spheres
- Hyperbolic
  - Uses the time difference of arrival (TDOA) between two different transducer
  - These time differences are converted into a hyperboloid on which the receiver can lie
- Spherical can be more accurate as you can have redundancy

Spherical Localization Techniques

- Static localization methods
  - Least squares estimate
    - Minimizes the weighted sum of the squared range errors
- Dynamic position estimation
  - Kalman filter
    - Uses a vehicle model to add in its dynamics
  - Extended Kalman filter
    - Similar to Kalman filter but doesn’t linearize the model
- Smoothing
  - Uses information from measurements taken over a time interval to allow for more accurate linearization

Acoustic Hardware

- Transducer
  - Sends an interrogation signal at one frequency and receives a response at another frequency
- Transponder
  - When it receives a signal at a certain frequency it will send a response at another frequency
- Beacon/Pinger
  - Continuously sends out signal at particular frequency
- Hydrophone
  - Listening device which receives response from transponder/beacon
- Responder
  - Is able to produce a signal which externally signaled

Hardware Systems

- Classical LBL
  - Requires a transducer on the vehicle and transponders which will return the signal
- One way travel time
  - Responders send out signals to hydrophones on the vehicle
  - Requires all nodes to carry synchronized clock hardware

Input/Output System

- Connects sensors and actuators to the computer
- Sensors without direct USB connection have their own microcontroller
- Motor system
  - Each motor requires an electronic speed controller (ESC) which allow PWM control
- Hydrophone system
  - Depends on hardware

Depth Sensor

- MS5803-14BA
- 1.8 to 3.6 V
- High resolution
- Data transferred to a microcontroller via I2C protocol then transferred to the computer

TECHNICAL DATA

Sensor Performances (V_{DD} = 3 V)				
Pressure	**Min**	**Typ**	**Max**	**Unit**
Range	0		14	bar
ADC		24		bit
Resolution (1)		1 / 0.6 / 0.4 / 0.3 / 0.2		mbar
Accuracy 0°C to +40°C, 0 to 6 bar (2)	-20		+20	mbar
Accuracy -40°C to + 85°C 0 to 6 bar (2)	-40		+40	mbar
Response time		0.5 / 1.1 / 2.1 / 4.1 / 8.22		ms
Long term stability		-20		mbar/yr
Temperature	**Min**	**Typ**	**Max**	**Unit**
Range	-40		+85	°C
Resolution		<0.01		°C
Accuracy	-0.8		+0.8	°C

Notes: (1) Oversampling Ratio: 256 / 512 / 1024 / 2048 / 4096
(2) With autozero at one pressure point

Next Steps

- Acoustic hardware
- IMU
- Microcontrollers
- Computer
- Look into scattering/interference issues