PROFILING THE OCEAN FOR HEALTH: LOW-COST XCTD DEVELOPMENT FOR OCEANOGRAPHIC RESEARCH

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Expendable Conductivity-Temperature-Depth (XCTD) Devices

- Generate a depth profile of temperature and salinity
- Free-falling probe transmits data as it descends
- Designed for one-time use in rough sea conditions
- Commercial options are expensive (~ $2,000 per unit)

APL-UW Personnel deploying XCTD

Introducing: Ion-XCTD

Initial prototype deployment

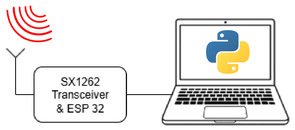
- Lower-cost platform preserving core XCTD functionality
- Reduces barrier to entry for small research groups
- Open-source design allows for reproducibility
- Integrates APL salinity sensor
- Minimizes environmental impact

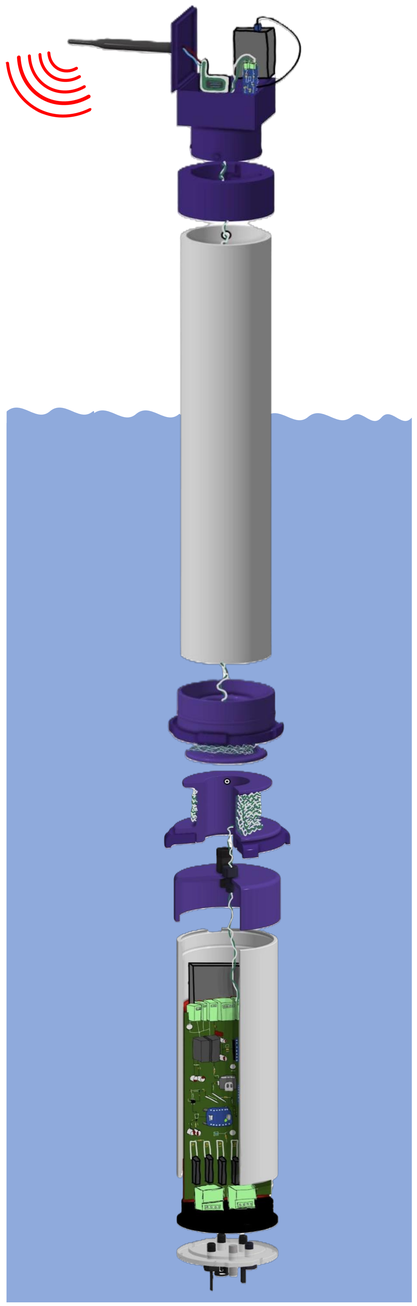
System Requirements

- ☑ Per unit cost less than $600
- ☑ Export CSV and generate plots
- ☑ Deployable from dock or boat
- ☑ Depth resolution of 10 cm/sample
- ☑ Use non-toxic materials
- ☑ Minimize size of all components
- ☑ Incorporate APL salinity sensor
- ☑ Device must self-scuttle
- ☑ Profile depths up to 15 m
- ☑ Wireless range up to 5 km

Shore Station

- Receives LoRa packets from buoy
- Logs incoming CTD data to CSV
- Generates plots for comparison





Buoy Expression

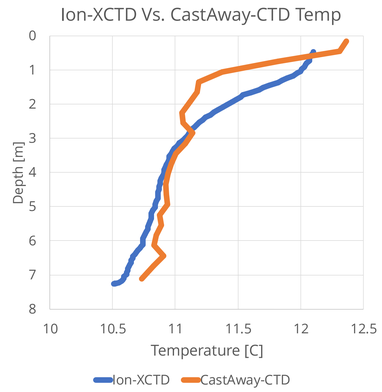
- 3D printed spool and electronics mount
- Water-soluble filament plug scuttles device after ~49 minutes
- Water-soluble twine gives sensors time to acclimate before release
- Receives sensor data over RS-485 twisted pair tether
- Forwards packets wirelessly with LoRa
- Buoyant PVC housing holds antenna above waterline

Sensor Package

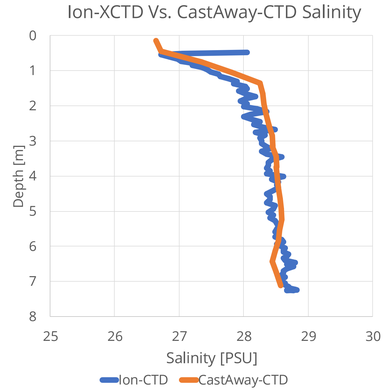
- Potentiometric sensor voltage measured between reference and sensing electrodes using custom analog capture circuitry
- Pressure and temperature sampled over I2C; depth is derived from pressure
- CTD samples packeted for transmission over RS-485 tether with timestamps
- Waterproof enclosure leak-tested by pulling vacuum before backfilling with nitrogen
- Magnetic reed switches enable remote activation after sealing
- BlueRobotics Bar30 Pressure Sensor gives ±2 cm relative depth accuracy
- BlueRobotics Temperature sensor gives ±0.1 °C accuracy, with a verified 1 second time constant

Performance and Comparisons

Comparison with industry standard CastAway-CTD device



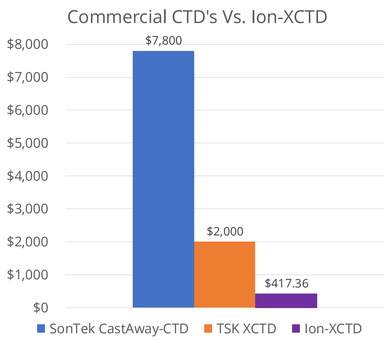
Ion-XCTD plots from Golden Gardens Pier



CastAway-CTD plots from Golden Gardens Pier

Golden Gardens Pier free-fall test:

- Depth Resolution of 6.8 cm/sample for GG-Pier deployment
- Sampling rate of 3.9 Hz
- Max verified deployment depth of 12.5 m at Edmonds Fishing Pier
- Electrode voltage fit to salinity concentration via Nernst equation



Future Work

- Reduce sensor package size, cost
- Biodegradable materials
- Wireless retransmission
- Aerial deployment support
- DPSK wire communications
- Saltwater battery

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