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Integrating sensors for dissolved gas concentrations (CO_2 and CH_4) into modern measuring platforms

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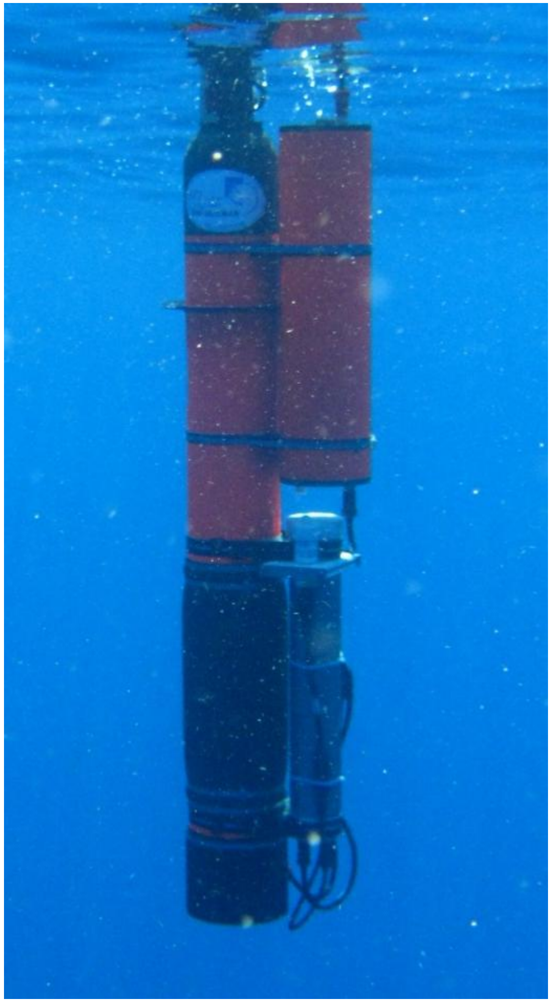
EGO2011, Las Palmas, 16.03.2011

Outline

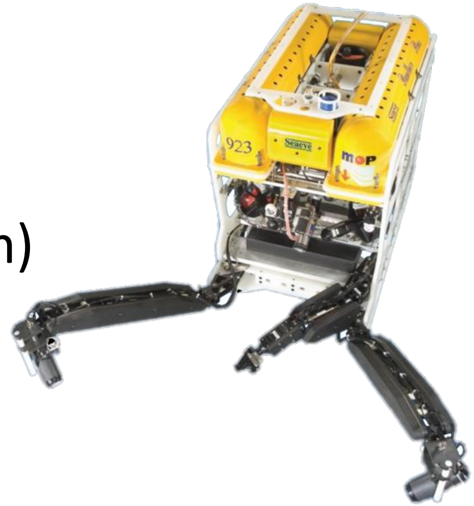
- Motivation for dissolved gas measurements
- Connection between platforms and sensors:

  Platforms & Sensor integration
- Sensor design & Measuring principle
- The HydroC familiy
- Example data & integrations
- Outlook & Summary

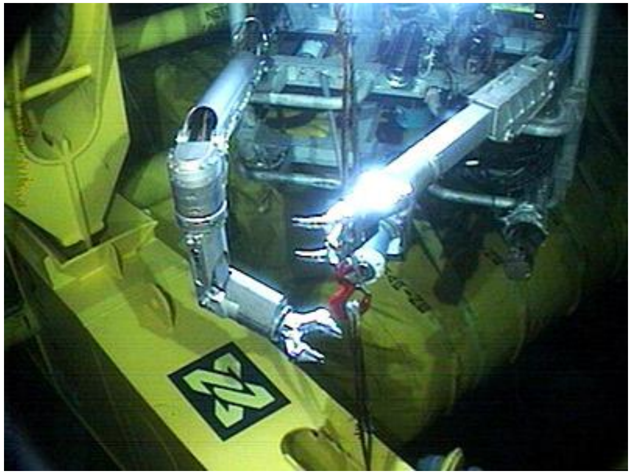


Courtesy of Björn Fiedler, IFM-GEOMAR

Pipeline- and Structure Inspection



Source: MTS ROV Committee



- ROV gets relatively close

  → visual inspection (~1 m)
- Maintenance intervals
- Pipelines often buried
- Usage of AUVs

  → larger distance

Source: Kongsberg

Source: IOW, Cruise Report RV Sonne, SO196

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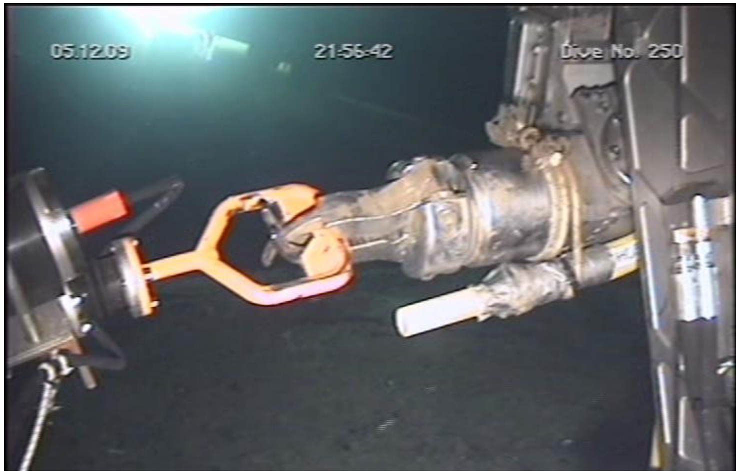
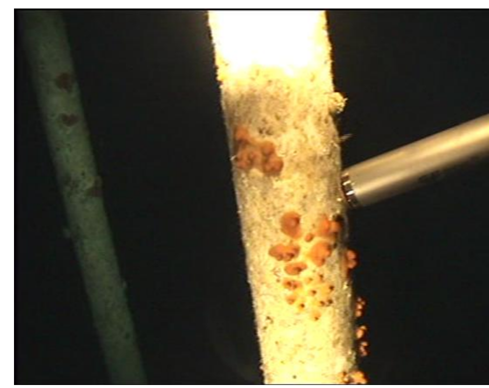
Pipeline- and Structure Inspection





Peer Fietzek, *p.fietzek@contros.eu,* Las Palmas, 16.03.2011

General demands / aims

- Small & fast
- Reliable & robust
- Long-term stability & low power consumption
- Autonomous
- Sufficiently accurate

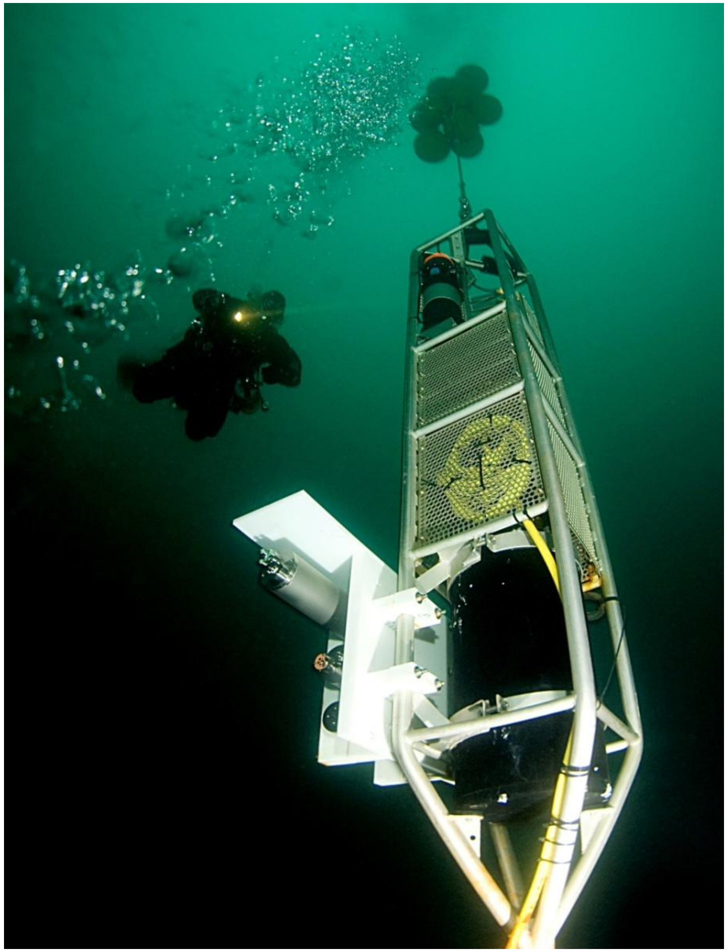
→ Increase number of data points / spatial & temporal coverage

→ Save time & money

→ Exploit more platforms

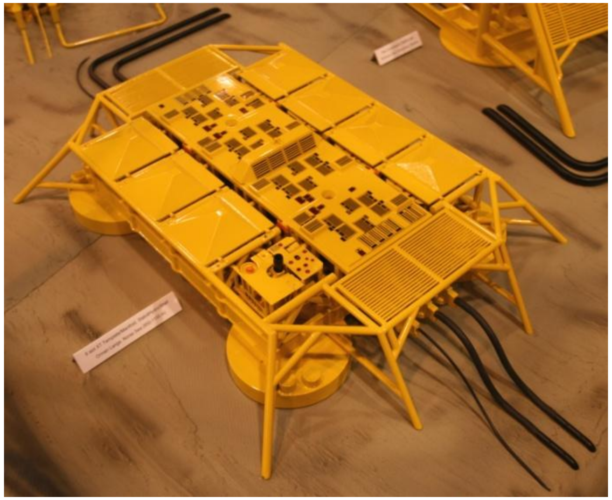
Application and platform specifiy the weighting of the stated demands

Platforms



Courtesy of Biota Guard AS

Source: neptune canada;
jacobs university - Bremen



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3 types of integration

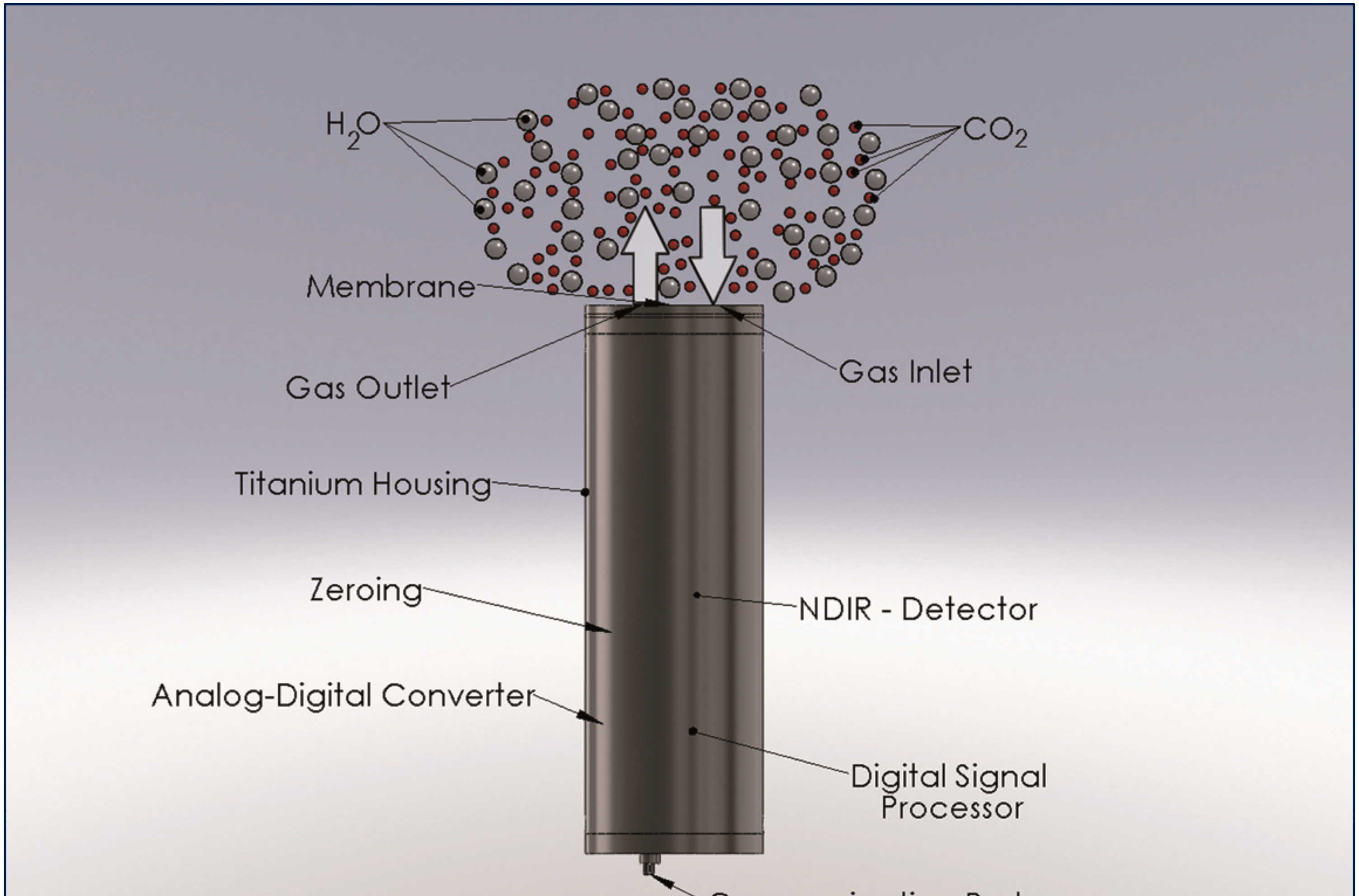
1. **Installation** refers to the straight forward mounting of an autonomous sensor on any platform; e.g. bouy

2. **Integration** additionally includes the realization of data transmission; e.g. ROV, wave glider, float

3. **Adaptation** demands for further changes to the sensors such as size reduction; e.g. (Hugin) AUV, LWD, *glider*

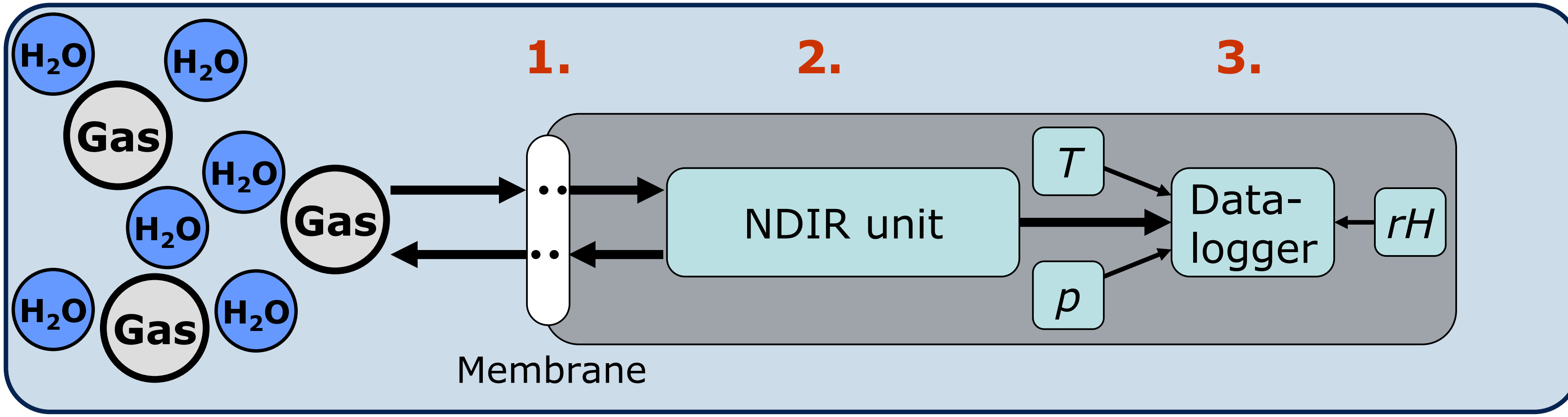
- The challenge & complexity of the task increase from 1.-3.
- Improve sensors such that **Adaptations** become **Integrations** without losing the versatility of the instrument → seek discussion / listen to demands

Measuring Principle - HydroC



Source: CONTROS GmbH

Measuring Principle - HydroC



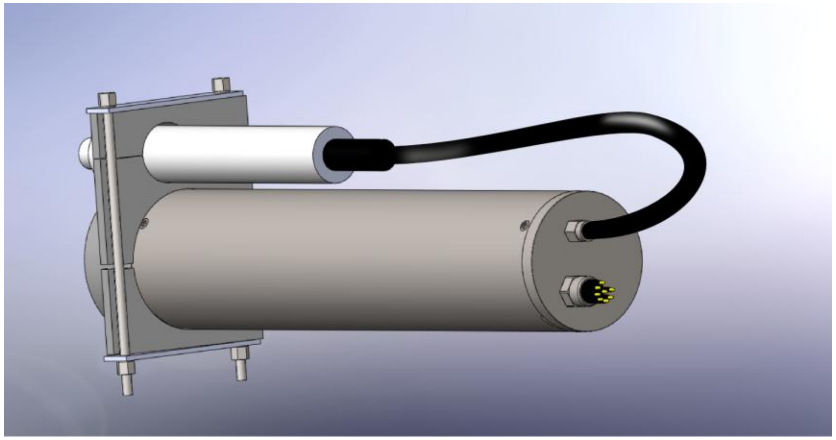
1. Dissolved gasses and water vapor pass hydrophobic membrane

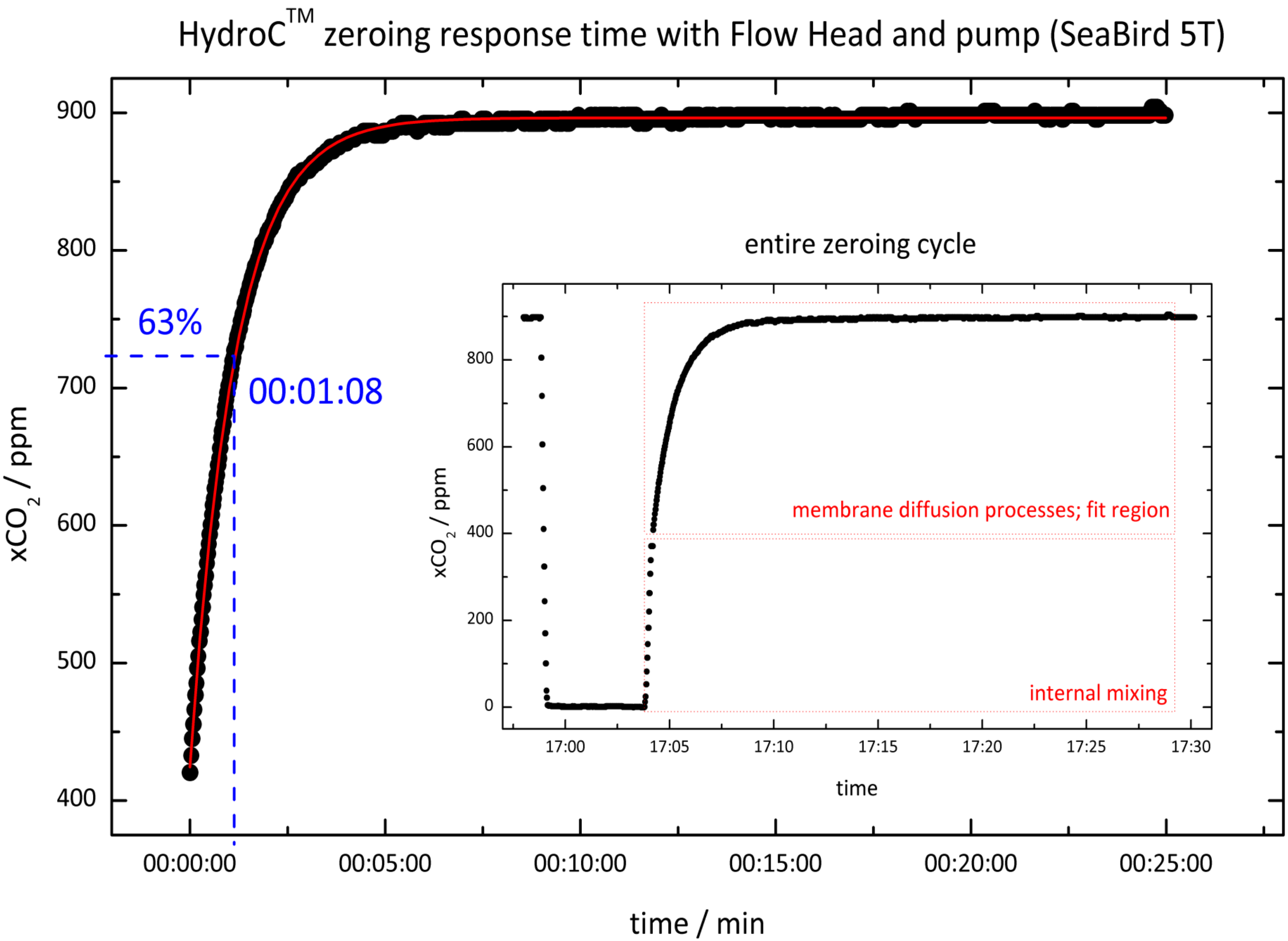
   → Equilibration

2. Gas concentration measured by non-dispersive infrared spectrometry (NDIR) within a gas circuit; Zeroing included (for CO_2)

3. Internal datalogger saves xCO_2 along with *T*, *p* and *RH* (microcontroller and AD-converter); RS 232 – serial connection

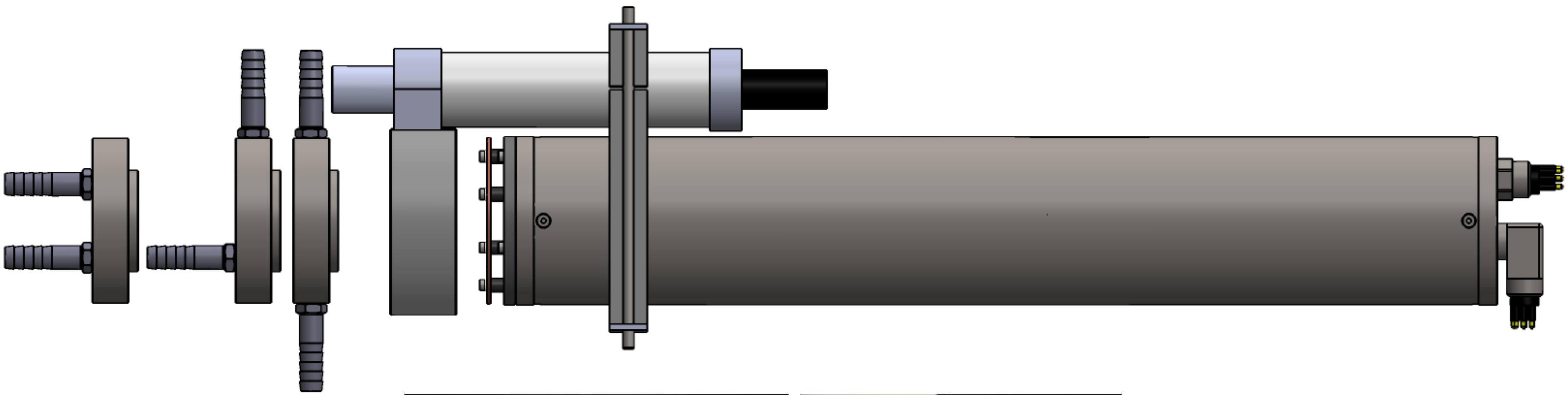
Response Time – Flow-Head

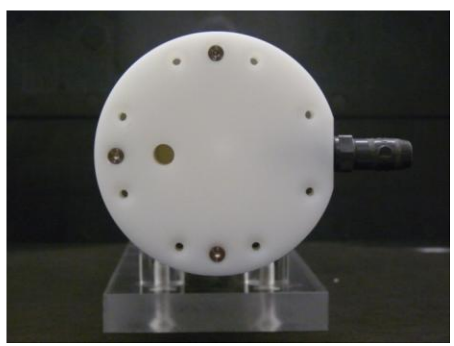


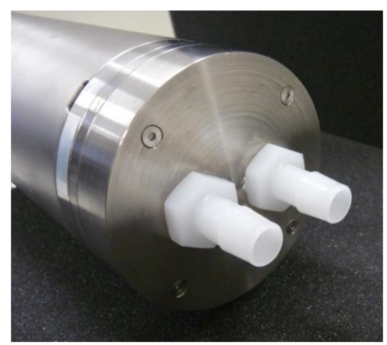

HydroC™ zeroing response time with Flow Head and pump (SeaBird 5T)
63%
00:01:08
entire zeroing cycle
membrane diffusion processes; fit region
internal mixing
xCO2 / ppm
time
time / min
900
800
700
600
500
400
00:00:00
00:05:00
00:10:00
00:15:00
00:20:00
00:25:00
17:00
17:05
17:10
17:15
17:20
17:25
17:30
0
200
400
600
800

Versatility

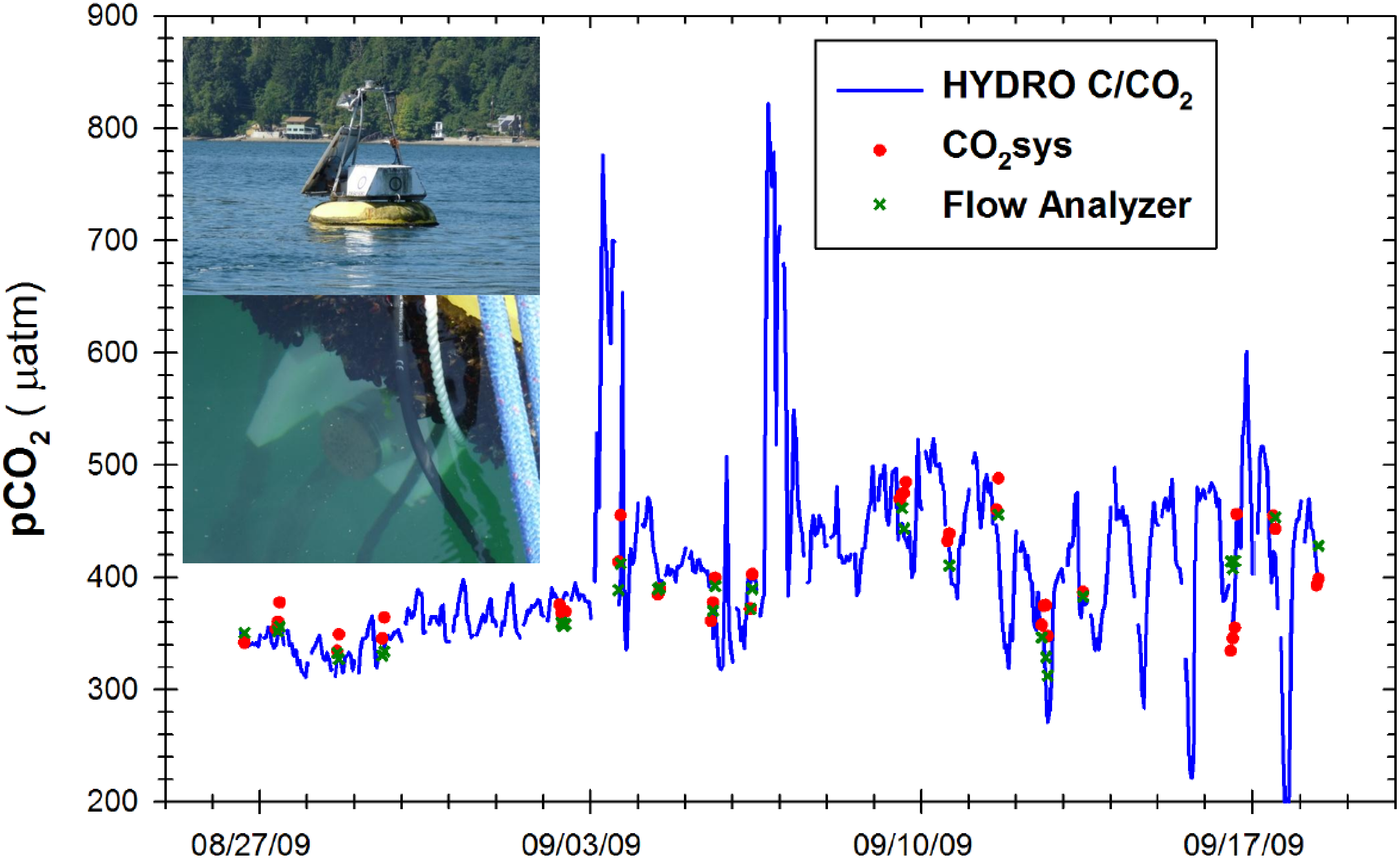
- Protection Cap
- Flow-Head
- Underwater - Flow-through





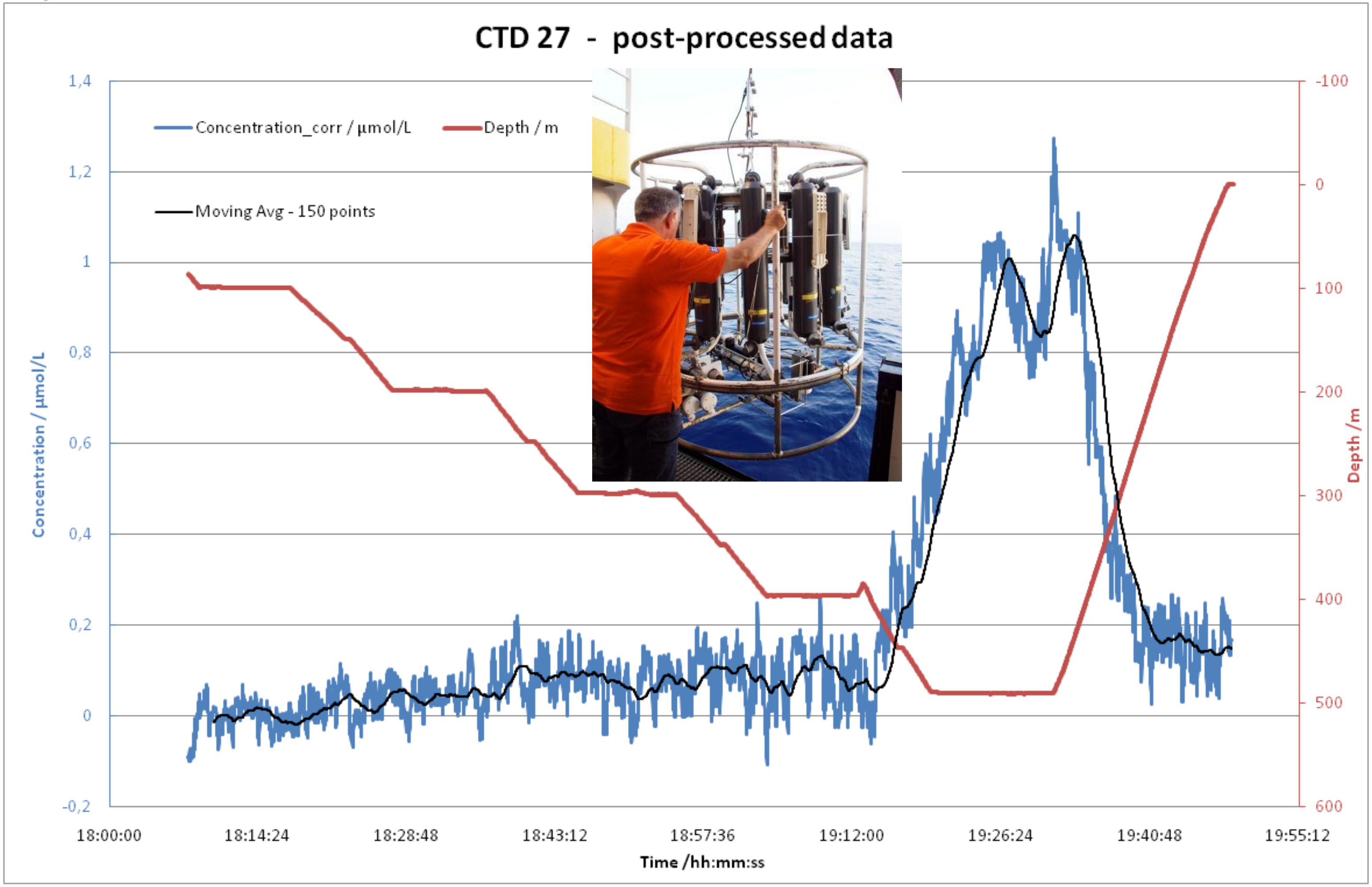


Example data – ACT-Test Seattle



Source: Alliance for Coastal Technology, Performance Demonstration Statement – CONTROS HydroC™/CO_2, www.act-us.info

Mud Volcanoes in the Nile River Delta
CH_4 Profiling on a Water Sampling Rosette



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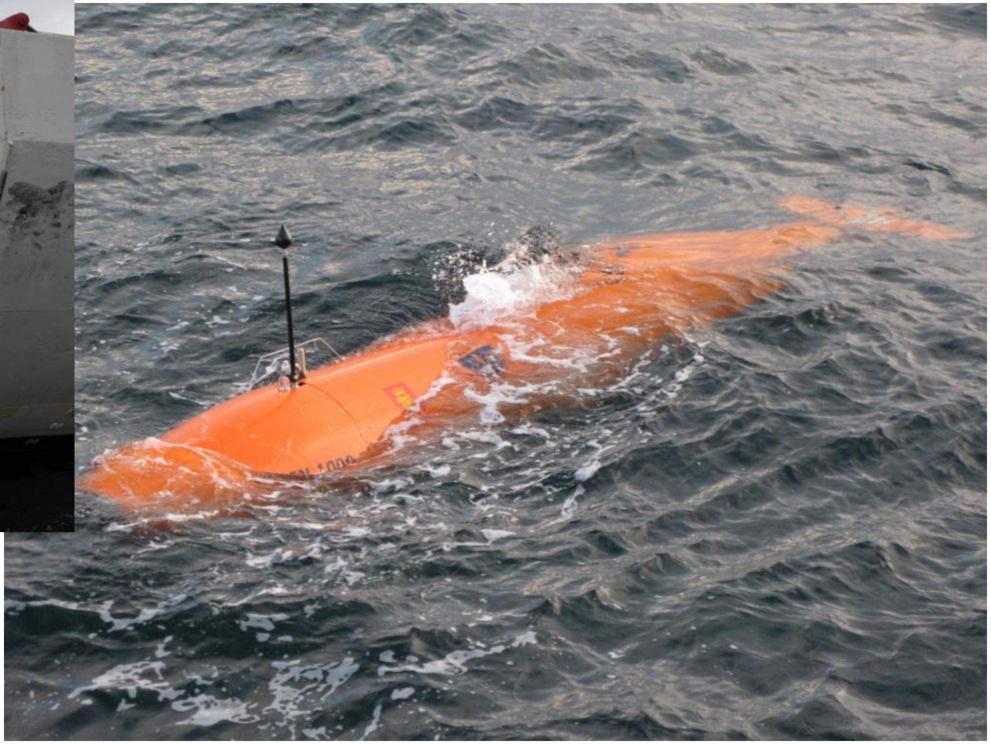
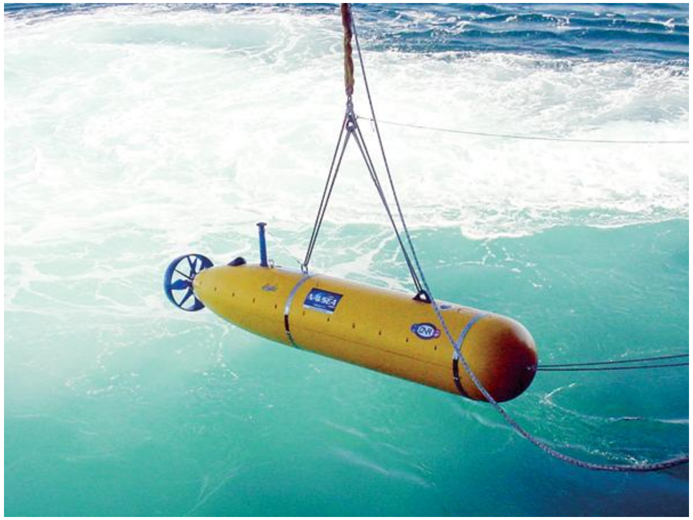
Adaptation- Hugin AUV



Courtesy of Stig Solem – Kongsberg Maritime

Integration - BlueFin AUV

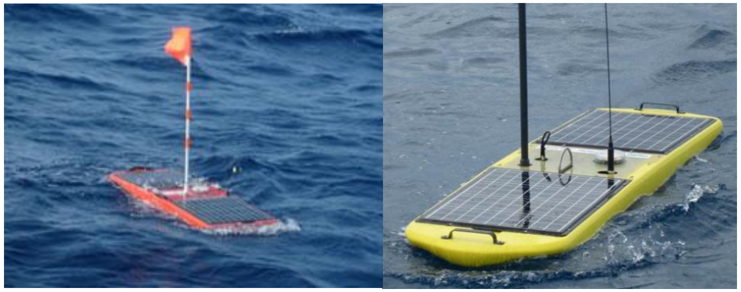
- Diameter 21“(53cm)
- Scientific payload section



Source: www.bluefinrobotics.com

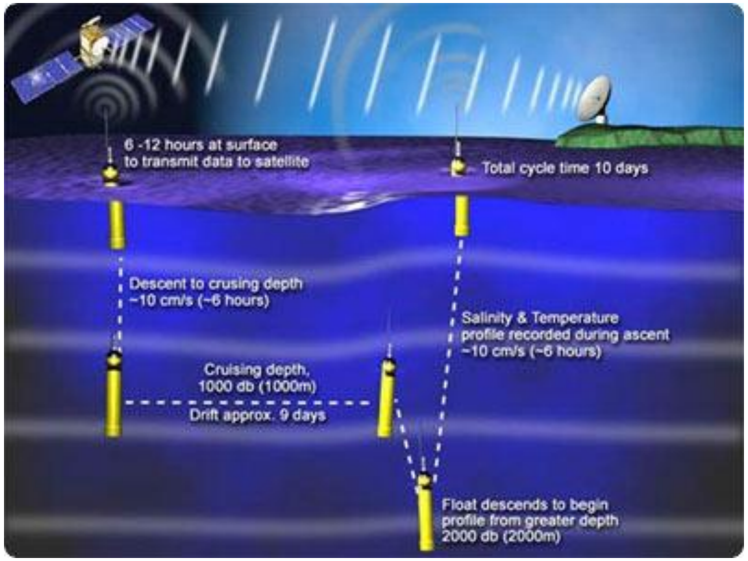
Integration – Liquid Robotics WaveGlider

- HydroC-FT in customized and dry payload enclosure
- Realtime geo-referenceing via GPS
- Real “surface” data

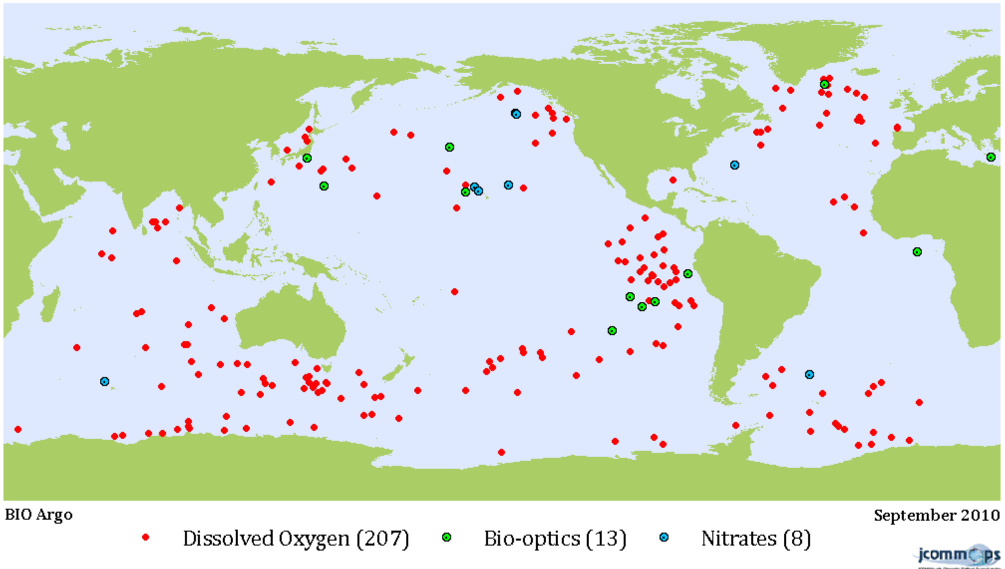


Courtesy of LiquidRobotics

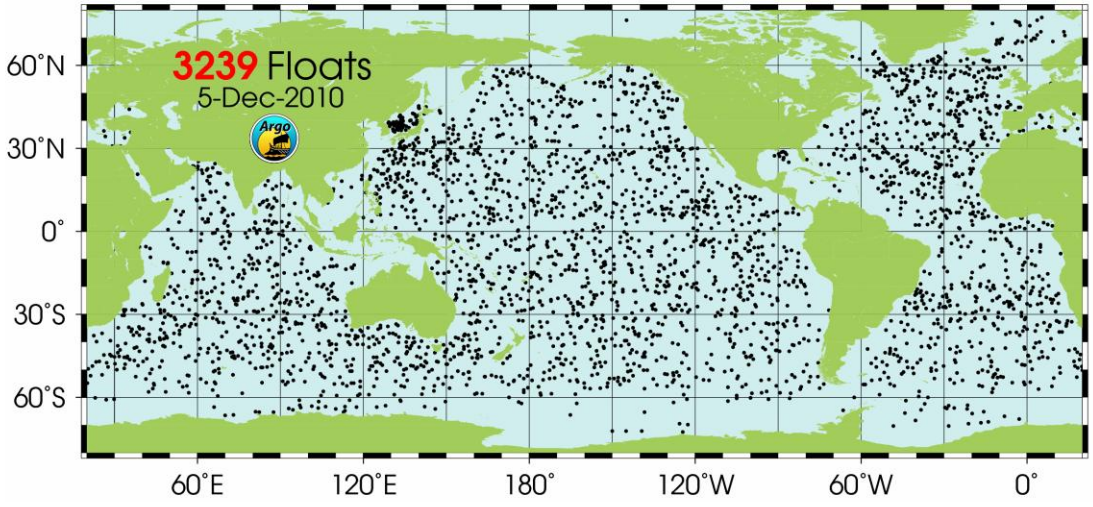
Argo floats (with additional sensors)



Source: www.metoffice.gov.uk



Source: http://wo.jcommops.org



Source: www.argo.ucsd.edu

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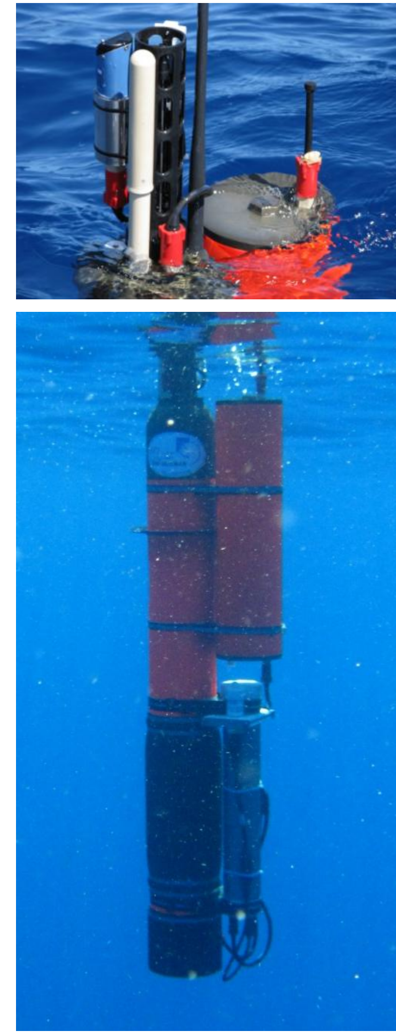
Integration – Optimare Nemo-float

Courtesy of Timo Witte, Optimare

- Deployment near Capverdes Island November 2010
- ~8 weeks (9.11.-5.1., 57days) and 44 collected profiles in upper 200 m
- Sensor runtime is ~ 3 hours every 30 hours
- Total runtime of the sensor was ~88 hrs; (+22 hrs the sensor kept running in the lab); battery capacity was 52 Ah
- Redundant data storage system on float and sensor (→ high resolution)
- Datafiles sent via satellite after each profile (5 dbar steps); two-way satellite communication



Courtesy of Björn Fiedler, IFM-GEOMAR

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Near-future Goals

- Reduction of **power requirements**:

  integrated sleep-mode (→ only record profiles) i.a.

- Several changes that increase the **user friendlyness**:

  pump control, software i.a.

- Further reduce **response time** (→ pump is necessary for fast platforms)
- Introduce a zeroing for the CH_4 sensor → **Drift correction**, in situ response time

- **Weight reduction** by introducing a POM shallow water version

- **Length reduction**

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Summary and outlook

- *p*CO_2 and dissolved CH_4 are parameters of increasing relevance
- HydroC: Reliability proven during many missions and on various platforms
- HydroC: Individually calibrated, fast and includes drift correction
- Sensor adaptation is a process that we are heavily involved in and that we want to discuss with you.

- A weeks to month lasting deployment on a glider is a realistic milestone; especially if a pump is already installed.

Thank you!

Any questions?

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