# Molecular sensor-based monitoring of toxic algae

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## Introduction

Planktonic algae are the most abundant photosynthetic organisms on earth and the basis of the marine food web. **Harmful algal blooms (HAB)** are blooms of planktonic algal species that have negative impacts on humans and aquatic environments. One subset of HAB is able to produce **phycotoxins** that can pass through the food chain and poison co-occuring organisms. Several climate and environmental drivers influence timing and frequency of these algal blooms. There is some evidence that the occurrence of HAB might become more intense, widespread, frequent and unexpected in future decades due to climate variability (1). For prediction and adequate management of harmful and toxic algae, precise and rapide **monitoring** of these species is required.
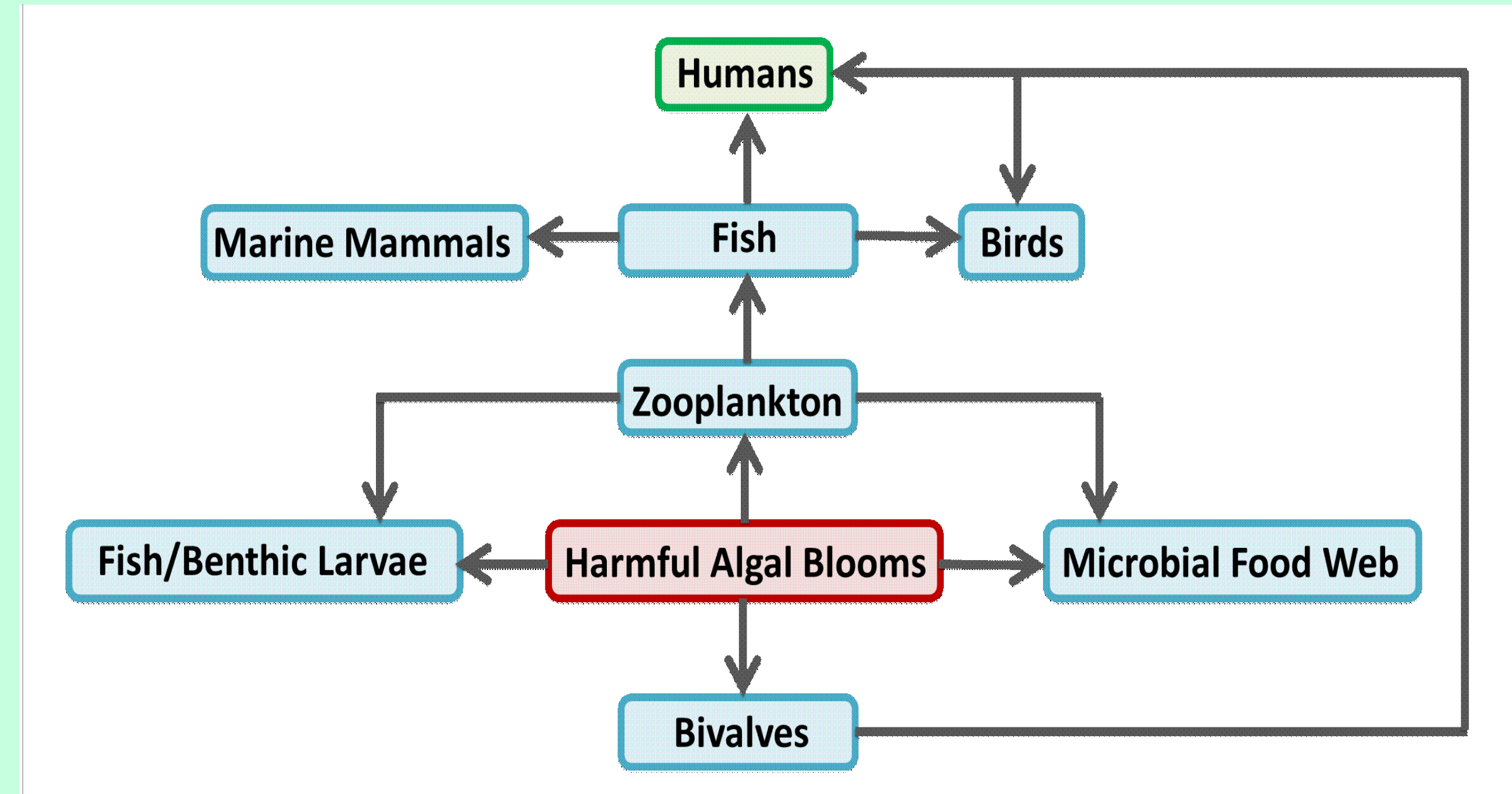


**Fig.1: Simplified illustration of food-web toxin routing.** Main trophic linkages between harmful algal blooms, primary grazers and upper-trophic-level consumers (modified from 2).

**Aim:** Develop a sensor system for automated surveillance of marine microalgae

Subtasks:
- Calibrate species-specific probes for molecular detection of selected harmful algal species in the North sea.
- Evaluate the ultrasound module for cell lysis and the optimal sensorchip-design for molecular detection.

## Material and Methods



**Fig.2: Sampling regions in the North Atlantic.** Water samples will be collected during different ship cruises within selected regions (★).
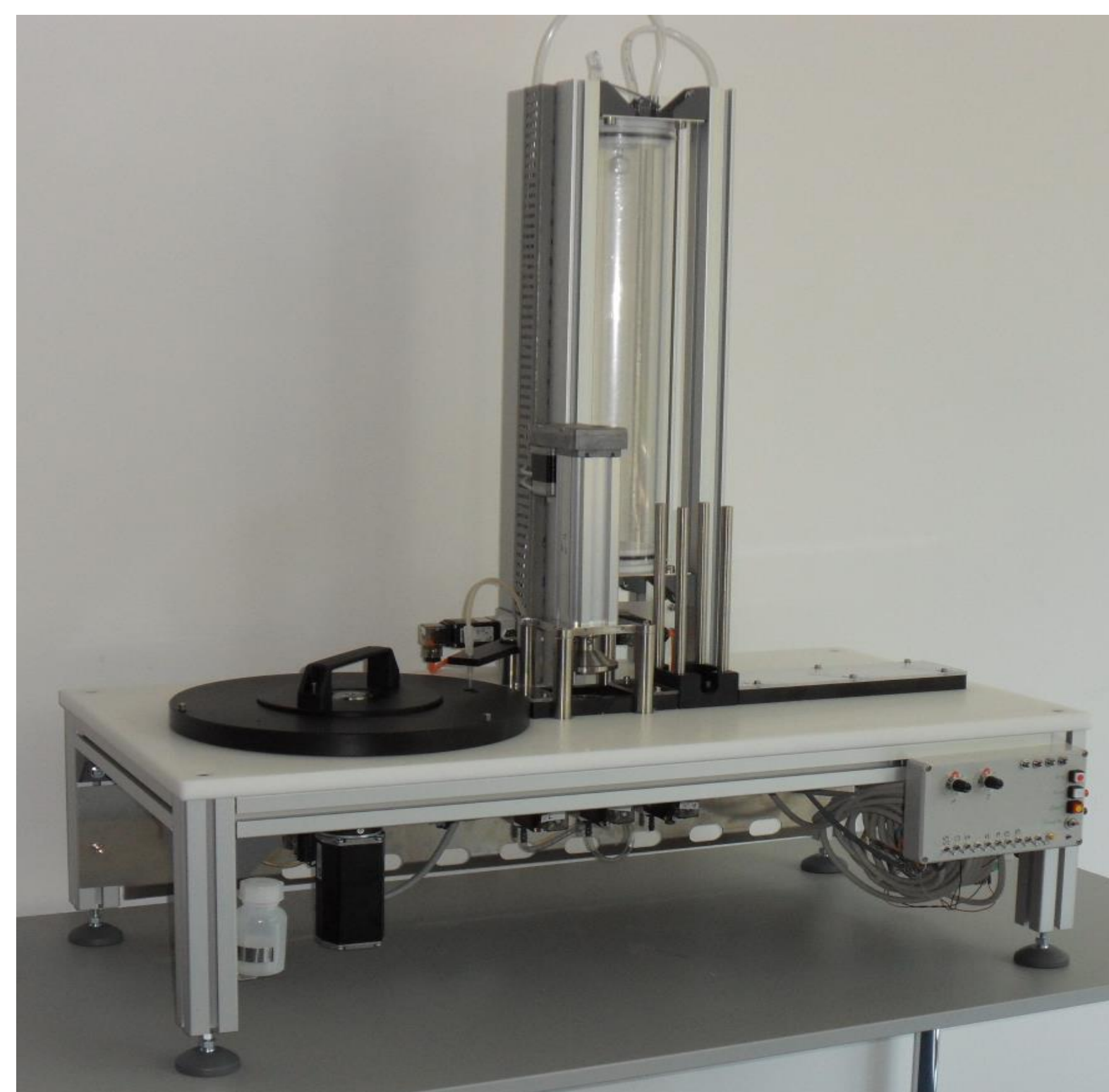


**Fig.3: Automatic Filtration Module Auto-FiM.** Auto-Fim combines different units for autonomous sampling, filtration and an ultrasound-unit for cell lysis.

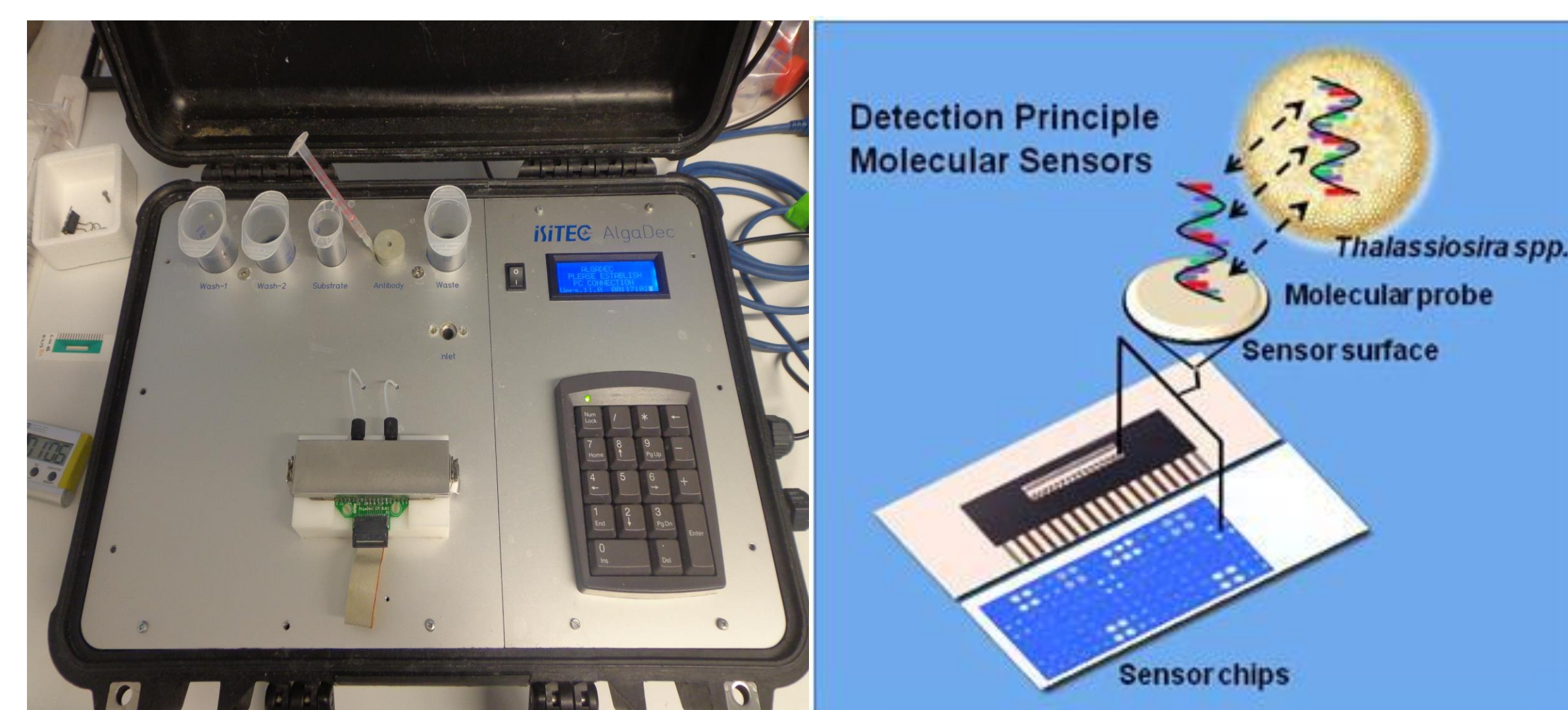Sampling → Filtration → Cell Lysis → 18S rRNA → **Molecular Detection**



**Fig.4: Nucleic acid biosensor device ALGADEC and the reaction principle of the molecular detection.** The target organism is identified by binding of two species-specific molecular probes to the ribosomal RNA. One of the probes is immobilised on the surface of the sensorchip, the other is coupled to digoxigenin, which binds to an antibody enzyme complex. The enzymes catalyse a redoxreation that can be measured as an electrochemical signal (3).
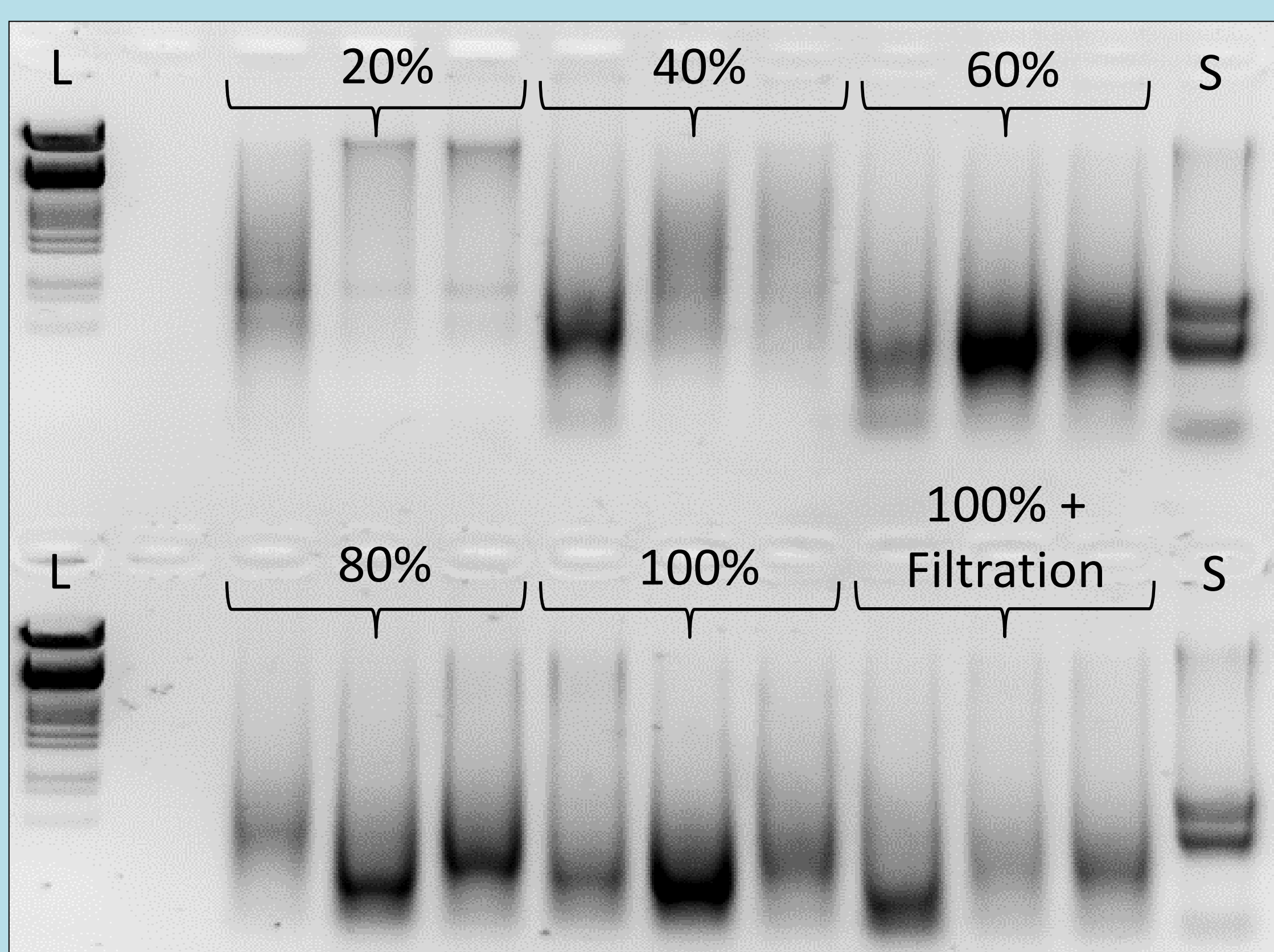
## First Results

### Ultrasound Unit



**Fig.5: Isolated RNA of *Pseudonitzschia seriata*** after 30 sec treatment with ultrasound of different intensities [%]. Cycle 0.5 sec. L: Ladder, S: Standardisolation. Image: K. Oetjen (AWI).
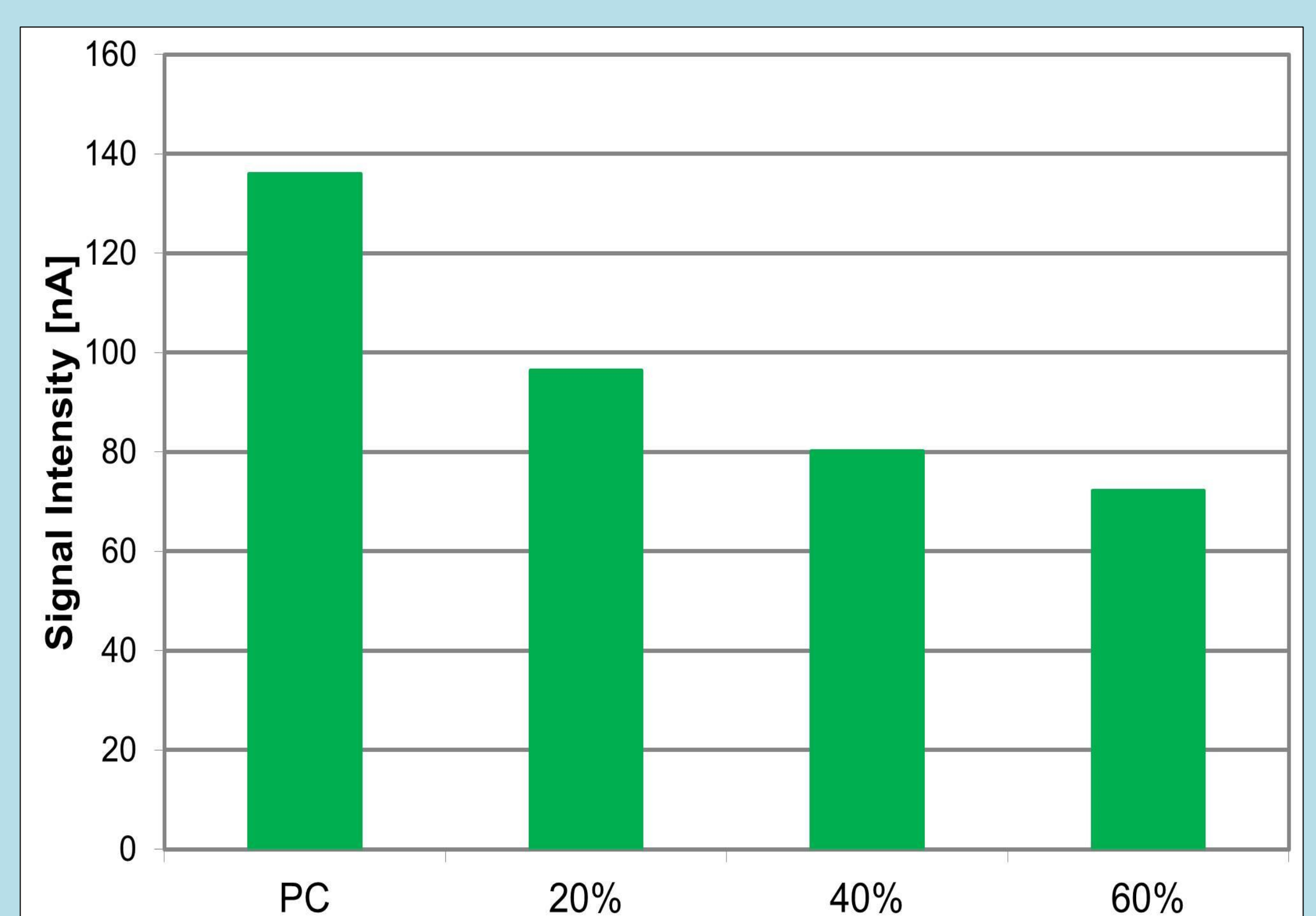


**Fig.6 : Mean signal intensities [nanoampere, nA] of RNA samples from *Pseudonitzschia seriata*** after cell lysis with different ultrasound intensities [%]. Signals measured with the ALGADEC-device. Negative controls used for value correction. PC = Positive control.

→ Successful cell lysis via ultrasound
→ Decreasing quality of RNA and signal intensity with increasing ultrasound intensity

## Outlook

- Combine filtration module Auto-FiM and detection unit ALGADEC to an autonomous working sensor system.
- Determine the biogeographic distribution and dispersal of selected harmful/toxic algal species in the North Atlantic.
- Can biosensors serve as early warning systems for human health policies and marine food resources?

**References:**
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(3) Diercks-Horn, S. , Metfies, K. , Jäckel, S. and Medlin, L. (2011): The ALGADEC-device: A semi-automated rRNA biosensor for th detection of toxic algae , Harmful Algae 10:, pp. 395-401

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