

Design, fabrication and testing of a micro total analysis system for monitoring of spilled oil in coastal water system

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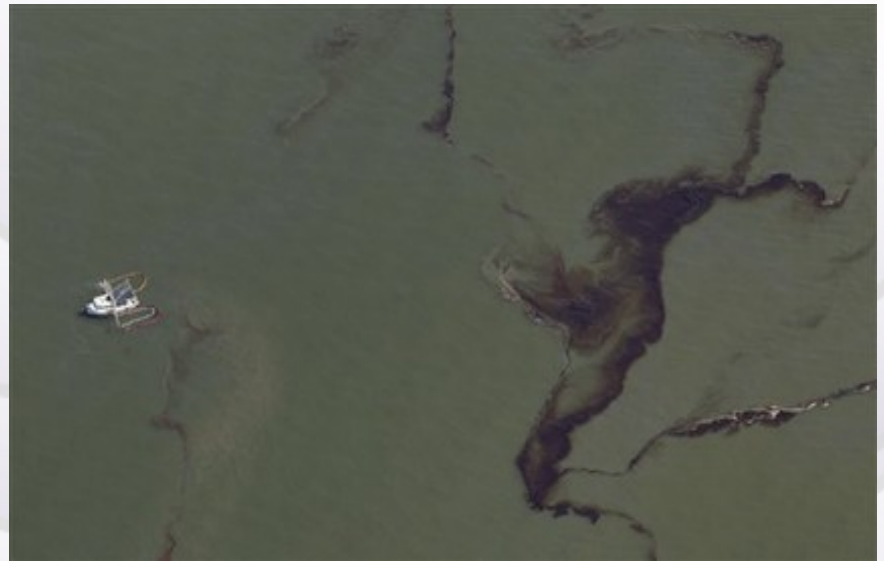
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Outline

- Introduction
 - Motivation
 - The principle of fluorescence detection for crude oil
 - Drawbacks of current detection devices
 - Our design goals
- Design of an integrated detection system
 - Liquid-liquid extraction components
 - Optical detection component
 - Microfabrication
 - Field testing setup
- Summary

Motivation

- On April 20th 2010, the largest offshore oil spill in U.S. history happened in the Gulf of Mexico (more than 4.9 million barrels)
- Large amount of dispersants was used (more than 1.8 million gallons)



Dispersed oil invaded the coastal and inland water system due to tides, winds and waves.



It is very important to keep monitoring the leaked oil in the coastal water system

Fluorescence detection principle

- Crude oil typically absorbs light of wavelength between 200 nm and 400nm, and emits light in the range from 300 nm to 650 nm
- The intensity of the emitting light is proportional to the concentration of the crude oil when exposed to constant excitation light

Drawbacks of current devices

- Bulky for carry-on on-site monitoring applications (Turner 10AU field fluorometer), requires many accessories
- Portable but requires pre-concentration otherwise the accuracy will be greatly reduced (TD-500D, Turner Designs Hydrocarbon Instruments, Inc.)



Turner 10AU field fluorometer

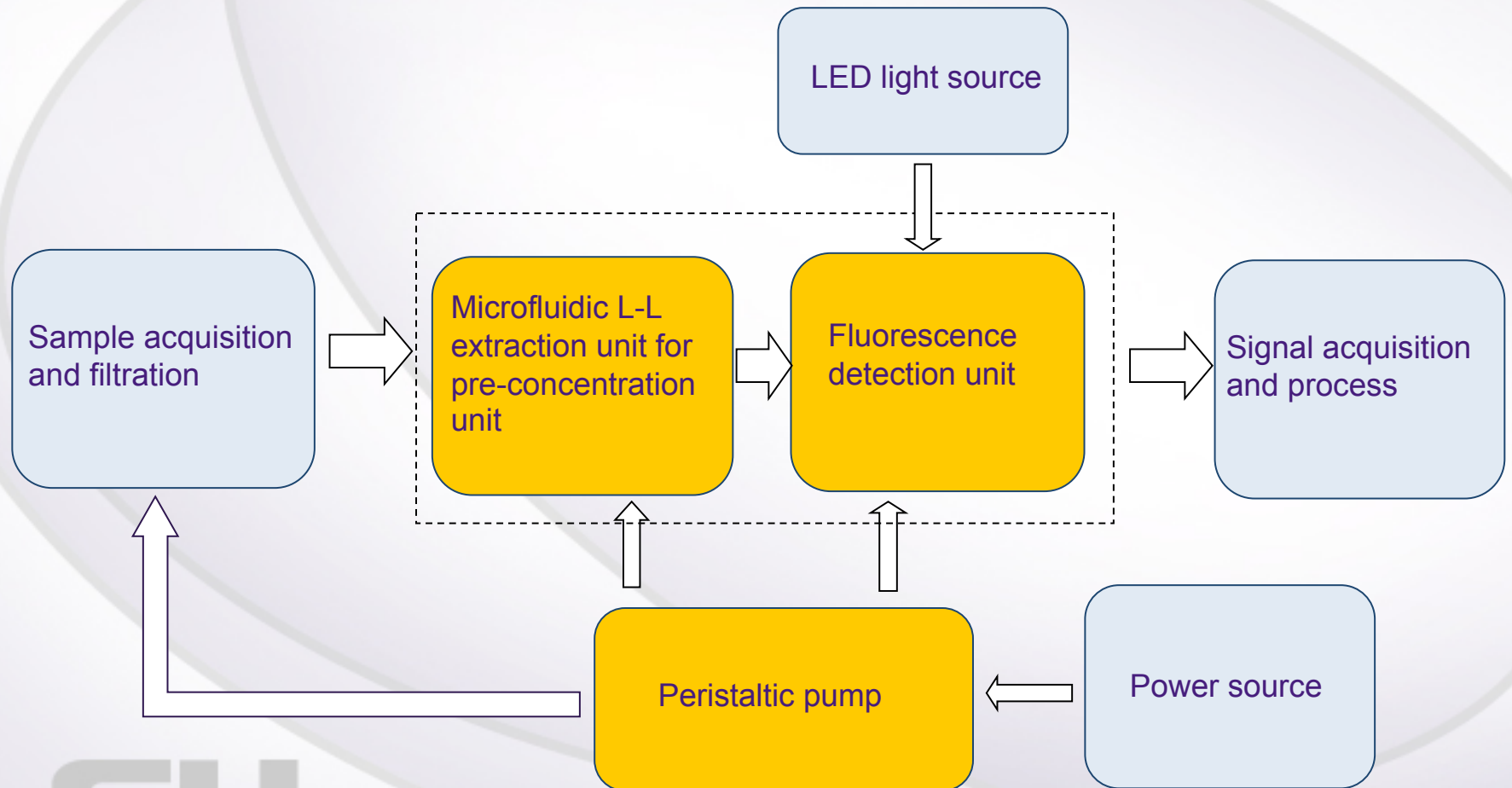


TD-500D

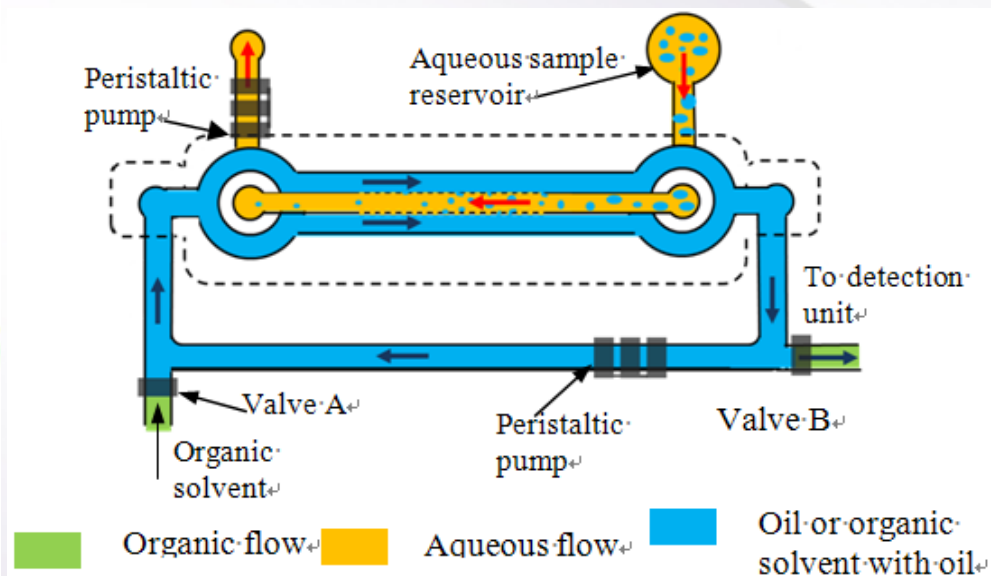
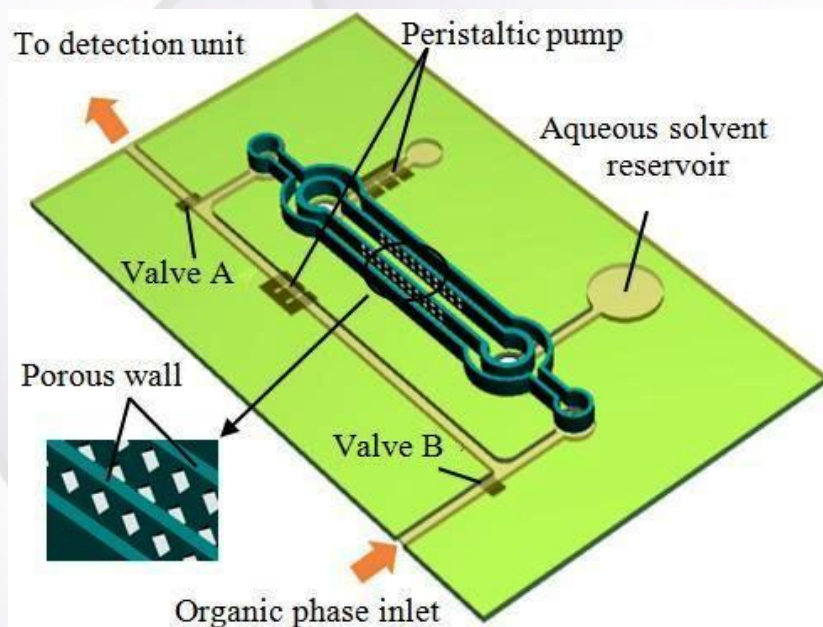
Our design goals

- Integration of extraction concentration unit and fluorescence detection unit into a single micro total analysis system (μ TAS)
- This μ TAS fabricated by disposable polymers is capable of on-site monitoring of spilled oil in coastal water system
- High accuracy, low cost, reliable and easy to operate

System schematic diagram



Liquid-liquid extraction system

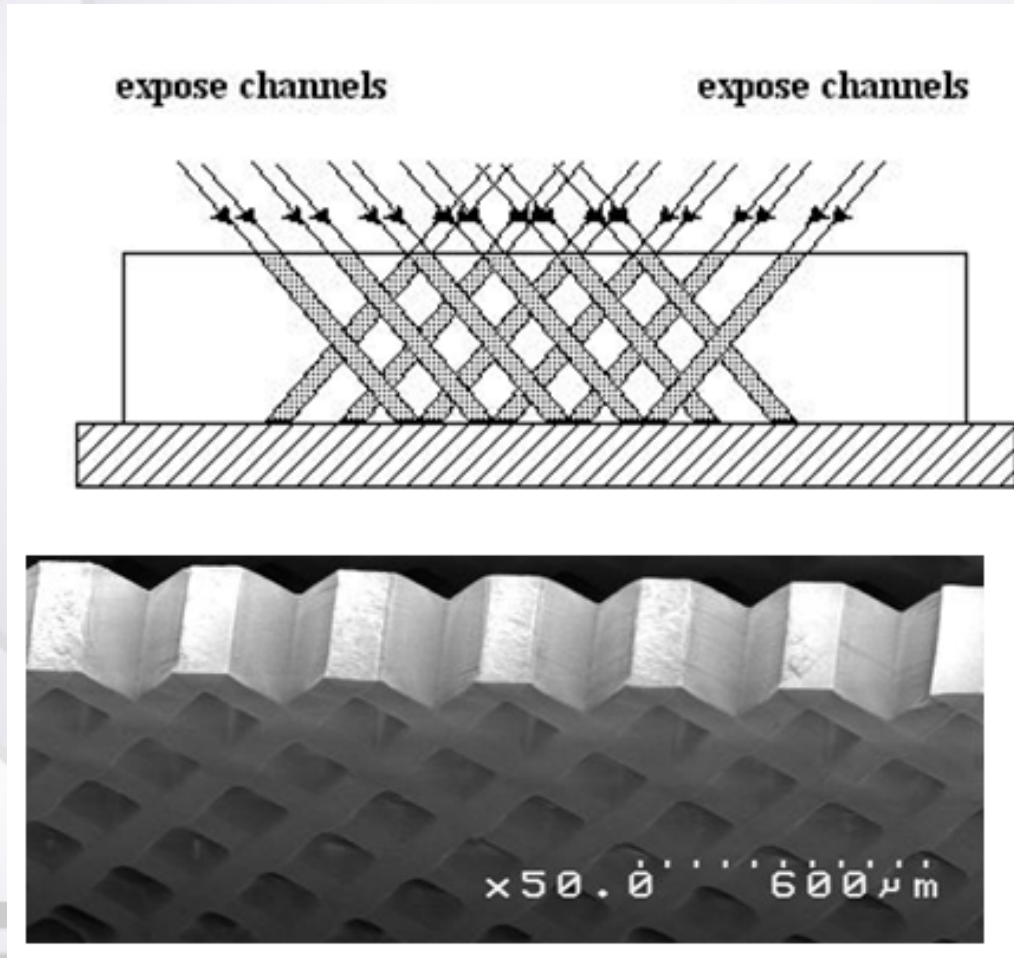


The immiscible aqueous sample and the organic solvent separated by the porous wall with micro-size holes

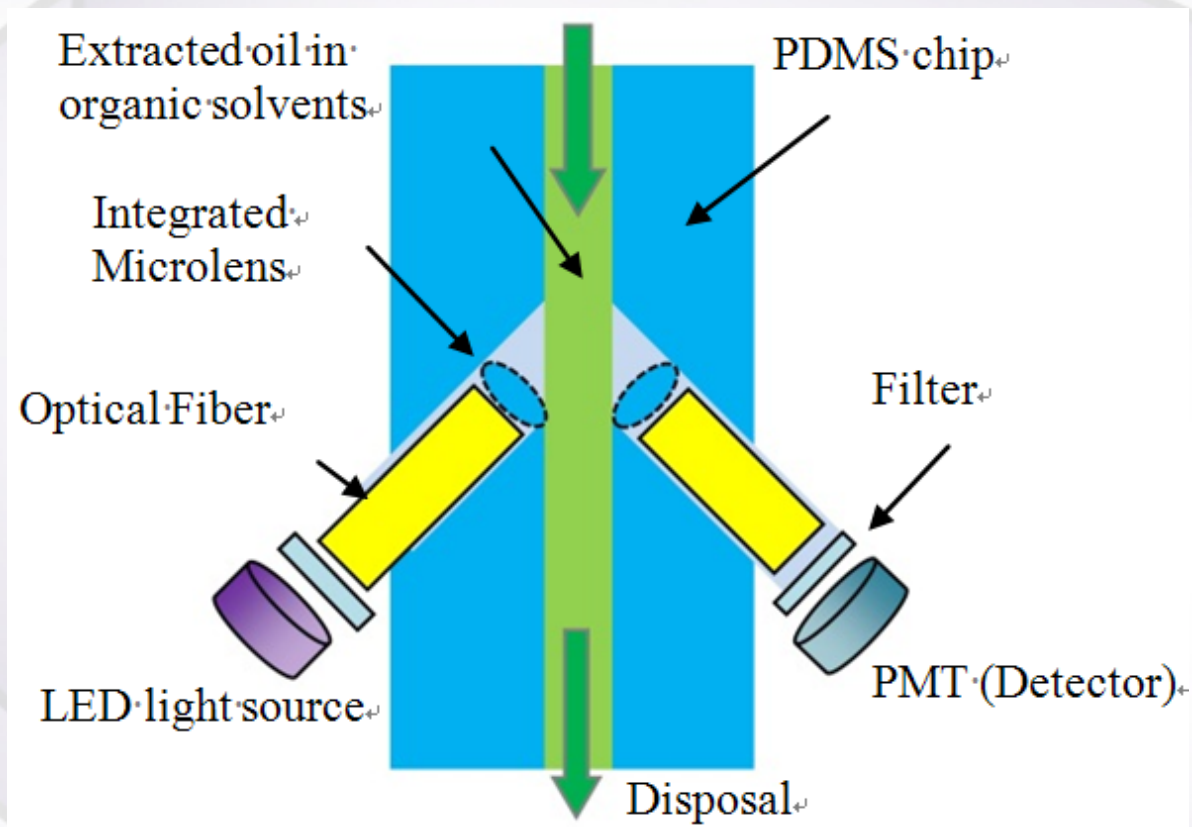
Organic solvent → circulating in the system

Fresh aqueous sample → continuously pumped into the system

Microfabrication of the porous channel wall for L-L extraction



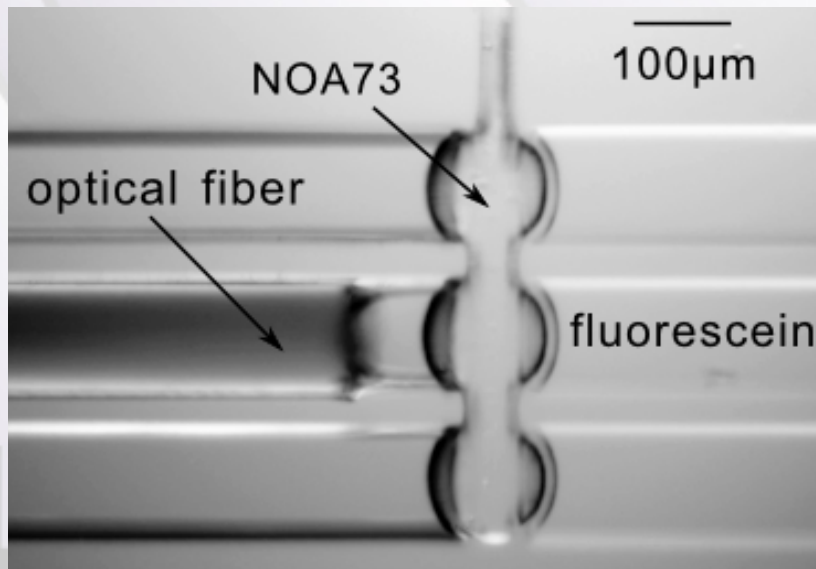
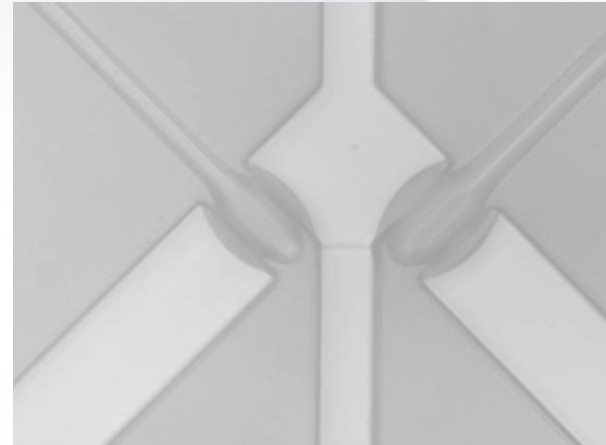
Fluorescence detection system



Concentrated oil dissolved in organic solvent passing through microfluidic channel → excited by LED light source → emitting fluorescence light → detected by sensor.

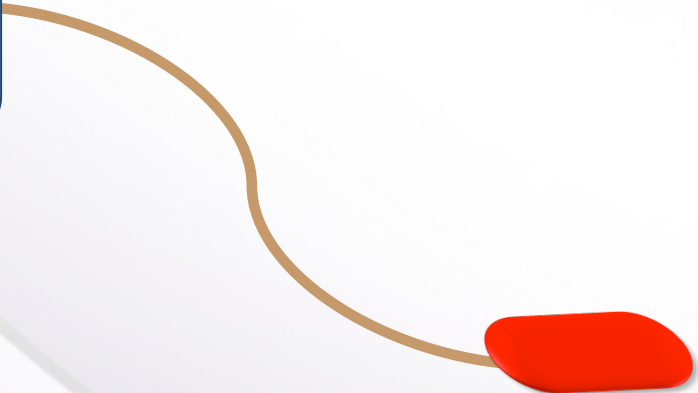
Pneumatic out-of-plane lens

- Key component for fiber-based optical detection systems
- Improve capability and sensitivity
- Easy to integrated
- Controllable lens profile



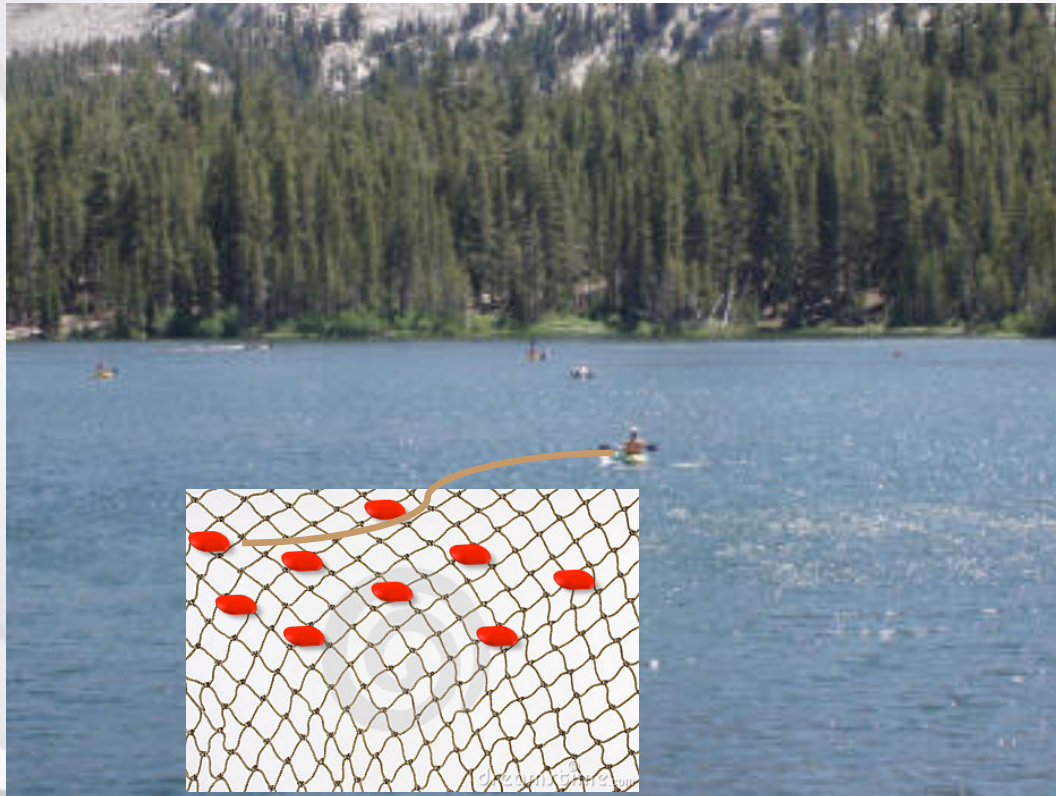
Field testing setup

Interface and power
source (handheld size)

A curved brown line representing a cable or wire connects the handheld interface box to the probe chip. The line starts from the bottom of the box and curves downwards and to the right, ending at the red chip.

Probe(integrated chip)
1inchx3inch size of a slide

Potential application (network sensor)
– capable of detecting different area
simultaneously



Summary

- We are fabricating and testing a micro total analysis system based on fluorescence detection for monitoring of the spilled oil in coastal water system
- Integration of extraction and fluorescence units onto a single micro chip
- Low price, quick response, high accuracy and portable

Acknowledgement

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Question



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