



## **Living sensors in precision mariculture and ecological monitoring**

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IoT Week Belgrade  
May 31<sup>st</sup>–June 2<sup>nd</sup> 2016

[www.bio-ict.ac.me](http://www.bio-ict.ac.me)



## □ Facts

- Area: 13 812 km<sup>2</sup>
- Population: 620 000
- Capital: Podgorica, 187 000, administrative and economic centre
- Cetinje, historic and cultural centre
- Sea shore: 293.5 km
- Length of beaches: 73km
- Five national parks

## □ Diversity

- Geographical
- Climate
- Cultural
- Modern vs. rural









## □ Agriculture and mariculture

- **South** region (olive, citrus, pomegranate)
- **Central** region (grapevine, peach, strawberry, vegetables, kiwi, fig, cherry)
- **North** region (potato, apple, plum, pear, raspberry)
- Livestock farms
- Fish and mussels farms
- Organic food production

## □ Tourism

- Sea coast, mountains
- Historic markers
- Traditional and modern gastronomy



- ❑ **Electrical Engineering**
  - Recognized scientific contributions
  - Strong theoretical background
  - International collaboration
- ❑ **Biotechnical Sciences**
  - Ten research departments
  - Great test facilities
  - Hands on experience
- ❑ **Marine Biology**
  - Conservation of environment
  - Aquaculture
  - Fundamental research, several projects of practical nature
- ❑ **Institute for Public Health**
  - Not part of the UoM, but research base of the university
  - Referent institution for public health, food safety and quality



## ❑ **First Centre of Excellence in Montenegro**

- Established on **June 01, 2014**.
- Funded by Ministry of Science of Montenegro through the World Bank loan
- Coordinated by **Faculty of Electrical Engineering, University of Montenegro**
- Project budget: **3.418.000,00 €**
- Project duration: **3 years**

## ❑ **Partners**

- 4 leading research institutions from Montenegro
- 2 international research institutions
- 2 successful SMEs from Montenegro.

## ❑ **Mission**

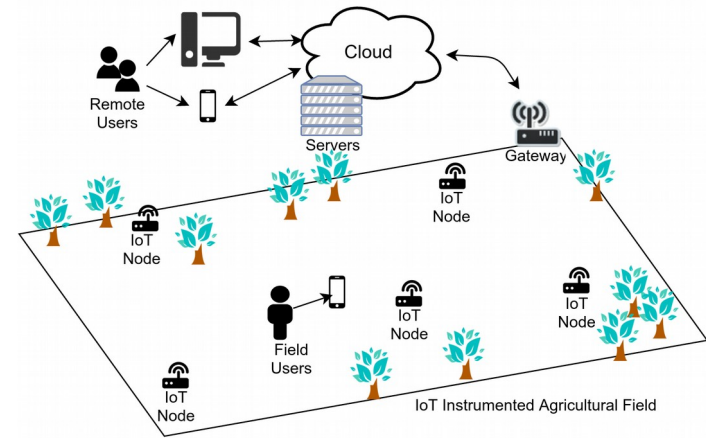
- Development of a state-of-the-art R&D platform in the areas of **precision agriculture, food production, ecological monitoring**, and improvement in the **public health** area.





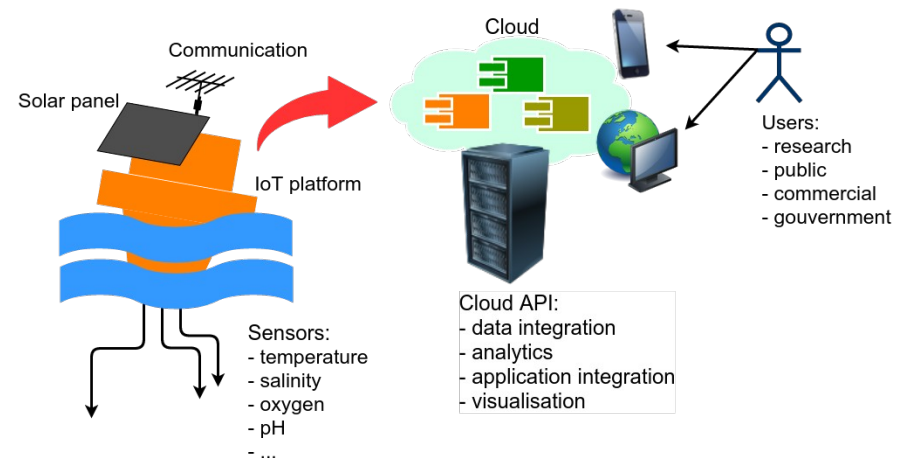
## □ Precision Agriculture

- Smart spraying
- Smart irrigation
- Pest control
- Disease detection
- Weather station
- ...

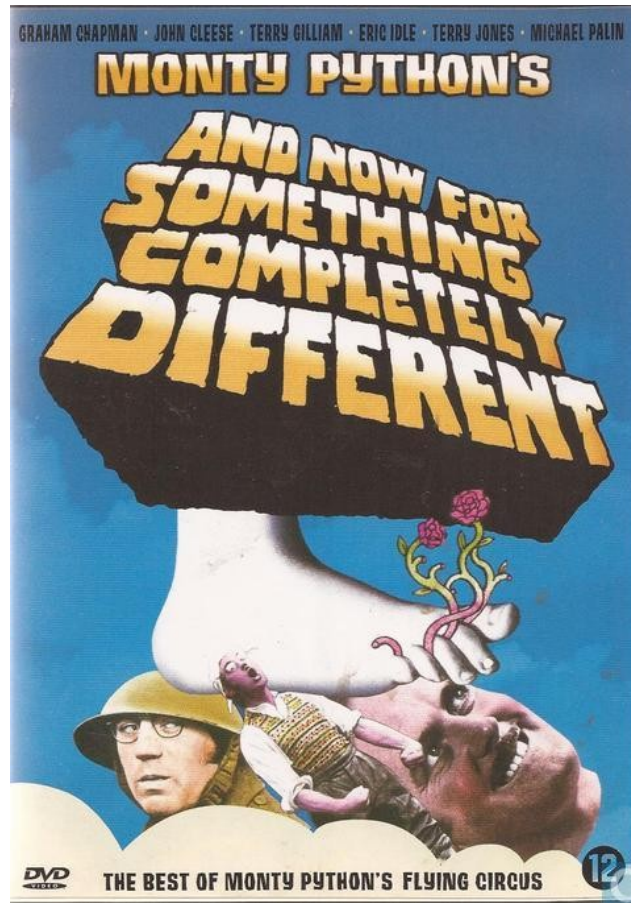


## □ Eco monitoring and mariculture

- Satellite monitoring and in-situ sampling (i.e. chlorophyll)
- Environmental monitoring (Smart buoy, water quality,...)
- ... but, there is **more...**



# And now something...





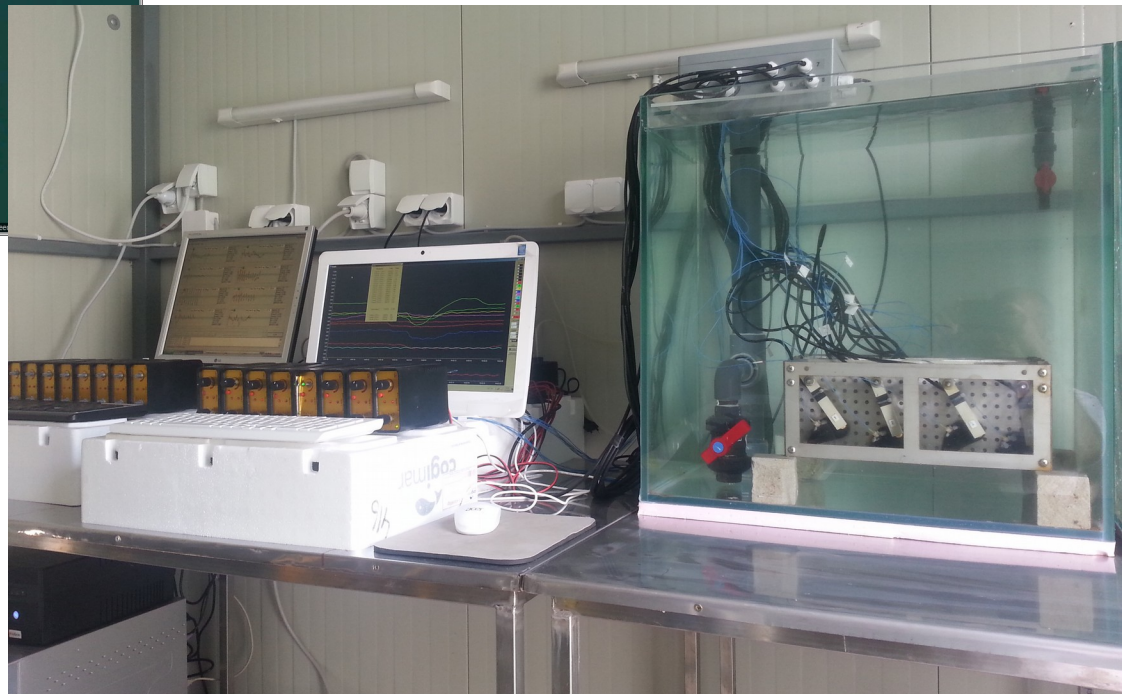
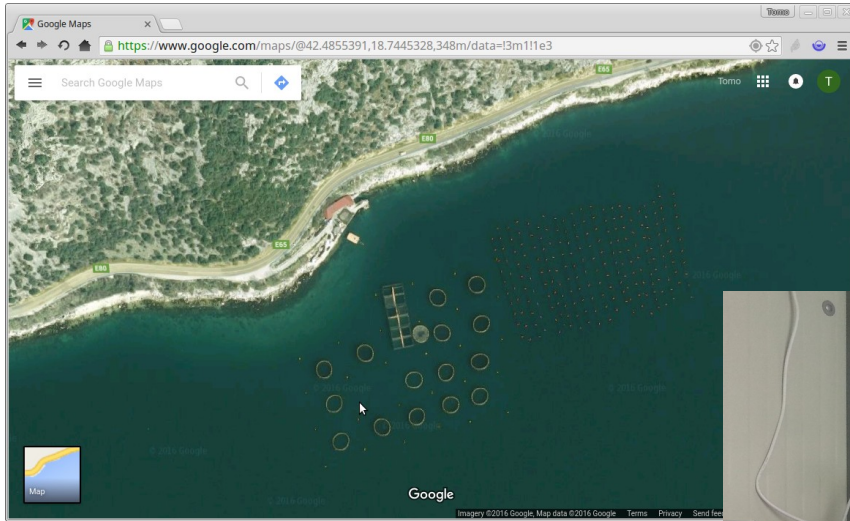
## ❑ I am a living sensor:

- I am a mollusk.
- I come from the family of *Mytilus galloprovincialis* L.
- I can filter 5-7 liters of water per hour.
- My heart rate changes when I am stressed.
- I can detect bio-toxins in water.
- I think I can defend myself by closing and opening my valves.
- I know my environment better than you do.
- After this project, I will still be alive, unharmed, and I will return to my natural habitat.

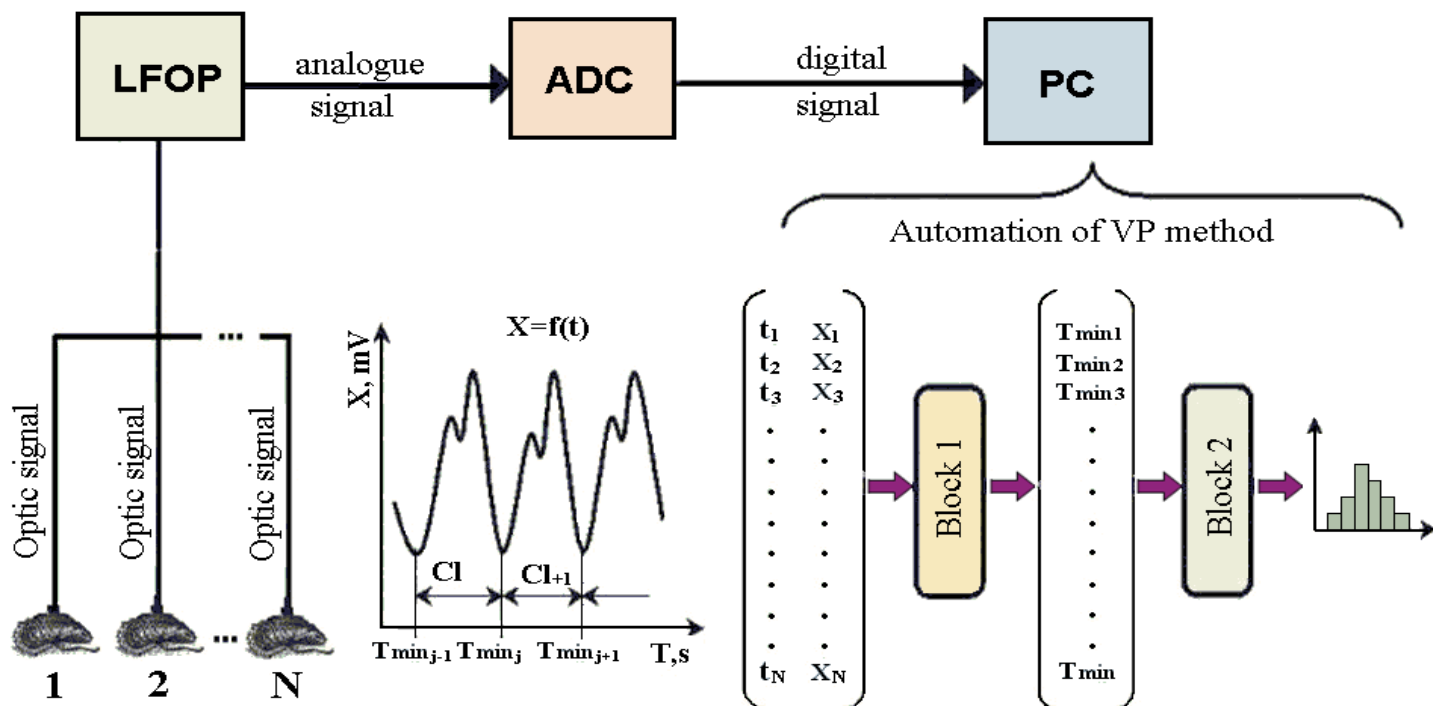


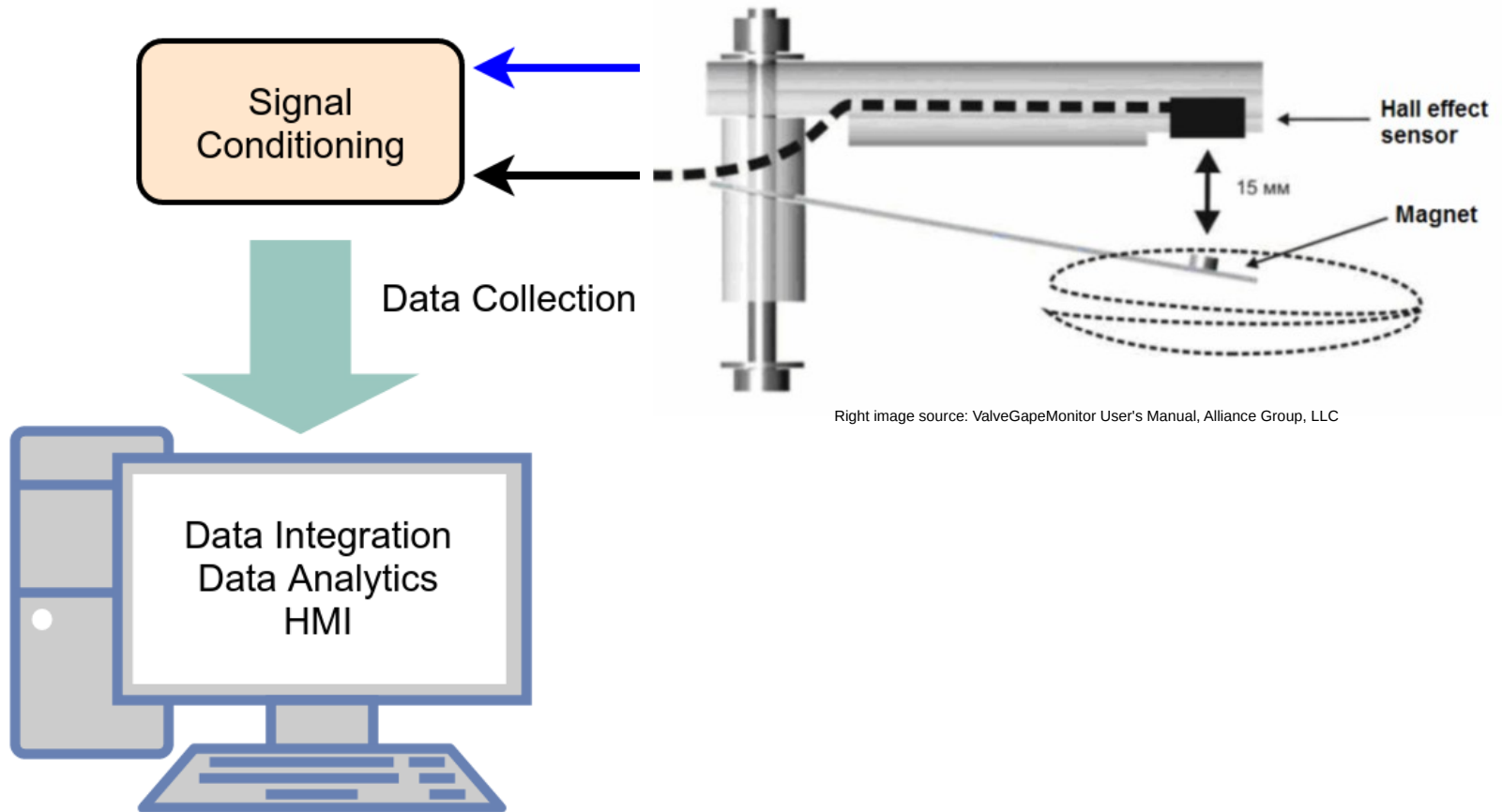
- ❑ **Real-time in-situ monitoring of water ecosystems using bio-sensors**
  - **Physiological** response: continuous monitoring of heart rate (HR) for a whole year
  - **Behavioral** response: continuous monitoring of valve movement (VM) for a whole year
  - **Comparison of** HR and VM biomarkers
  
- ❑ **Joint Effort under BIO-ICT Centre**
  - Faculty of Electrical Engineering, UoM
  - Institute for Marine Biology, UoM
  - St. Petersburg Scientific Research Center for Ecological Safety





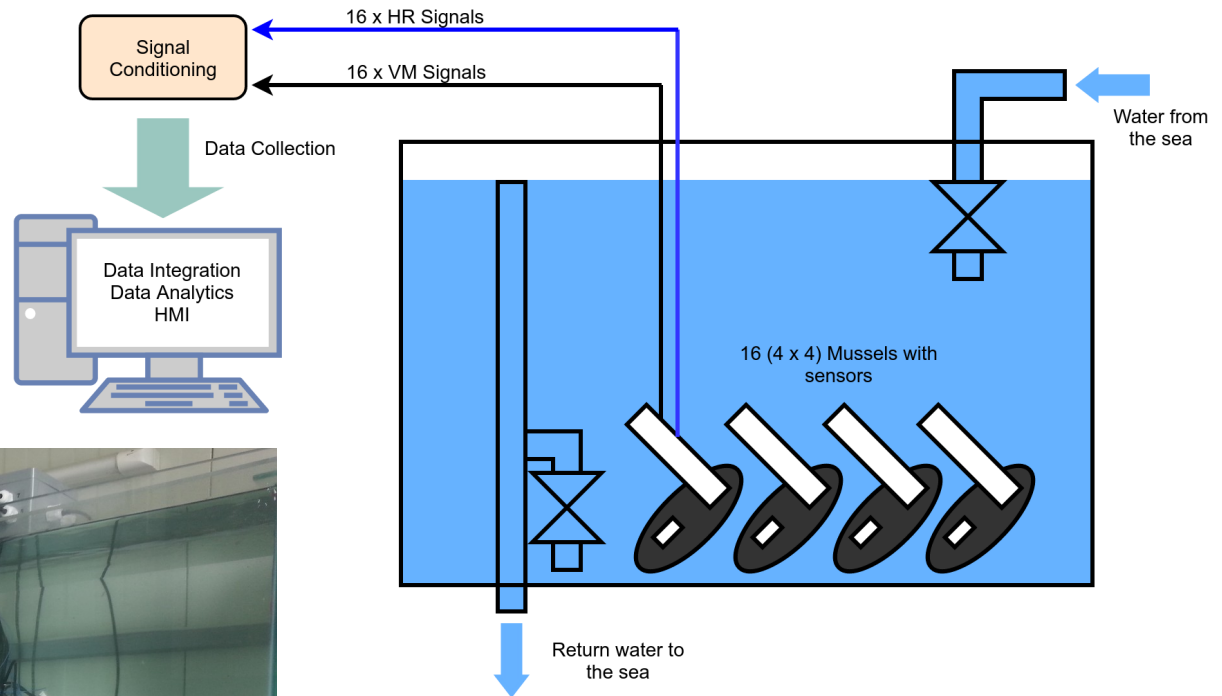
## Laser optic photoplethysmograph





Right image source: ValveGapeMonitor User's Manual, Alliance Group, LLC

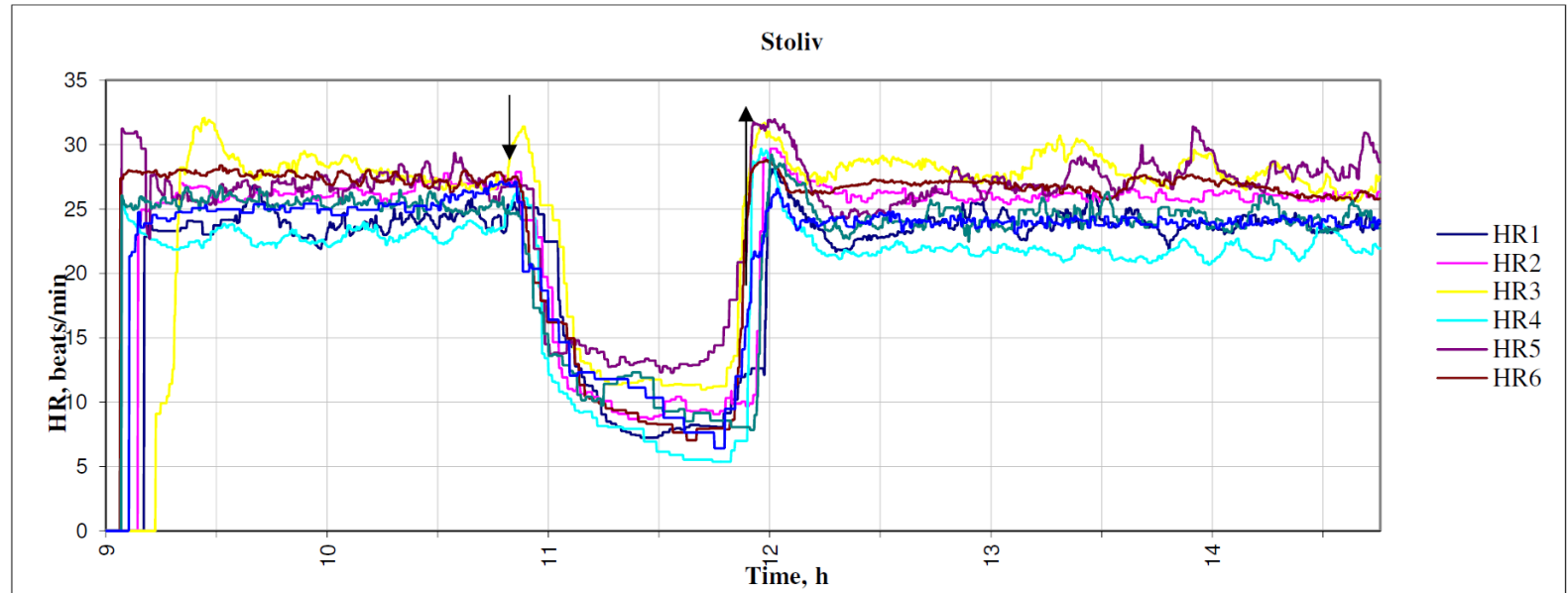








# Ex. 1 Salinity stress (HR)

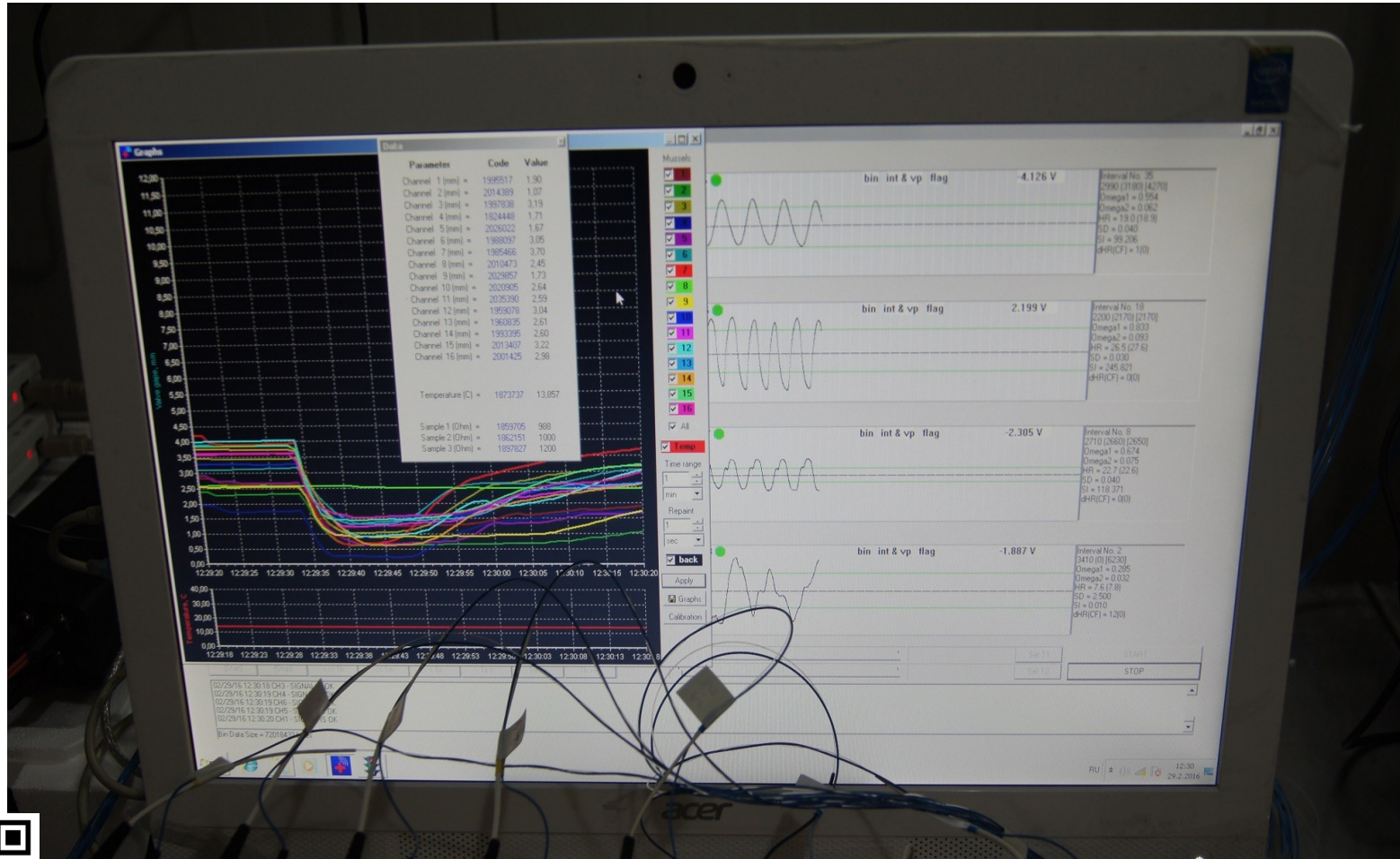


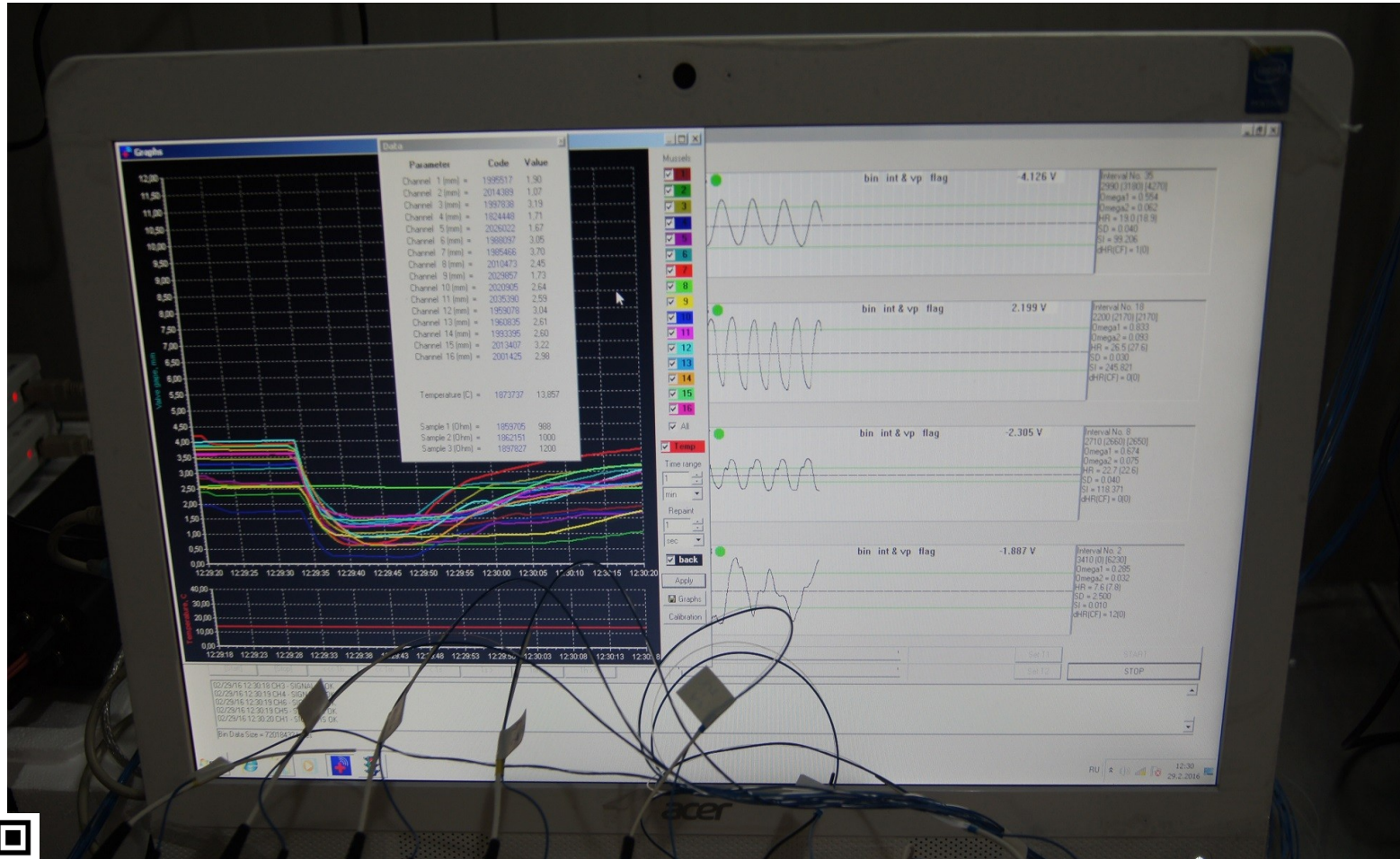
Salinity drop of 50% by adding distilled water to the basin;  
returning the mussels to the natural sea water;  
Ponto 375, Stoliv

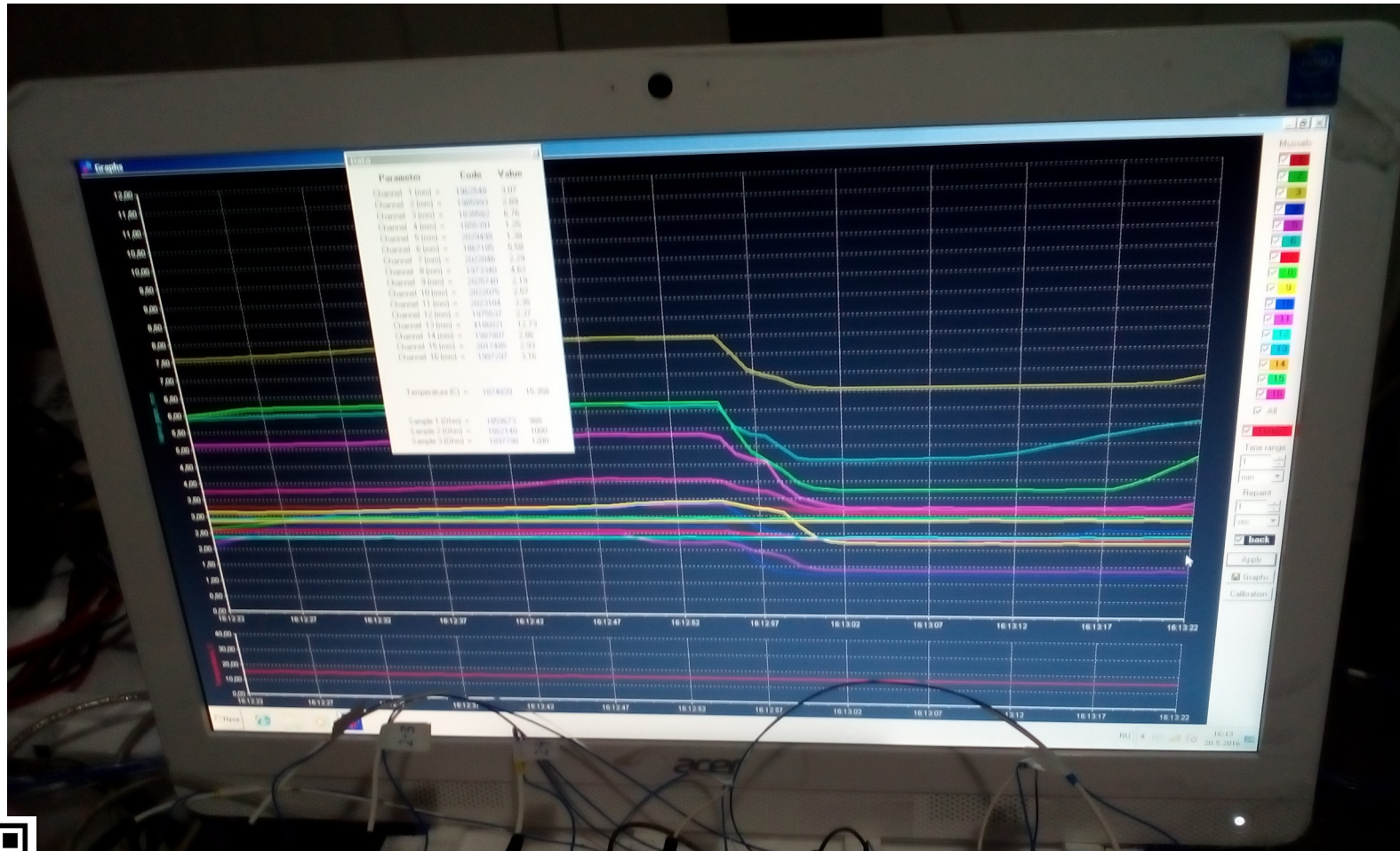


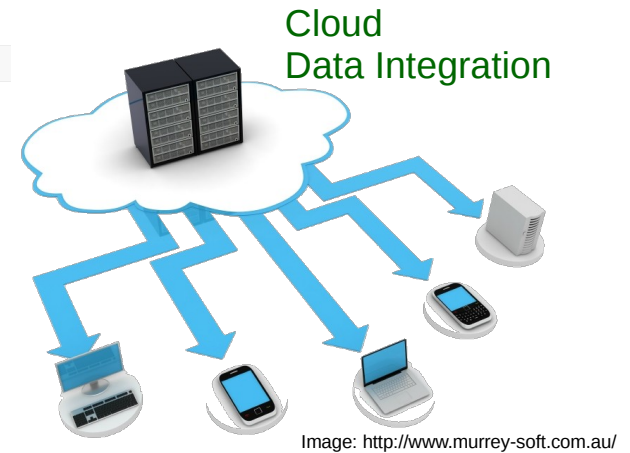
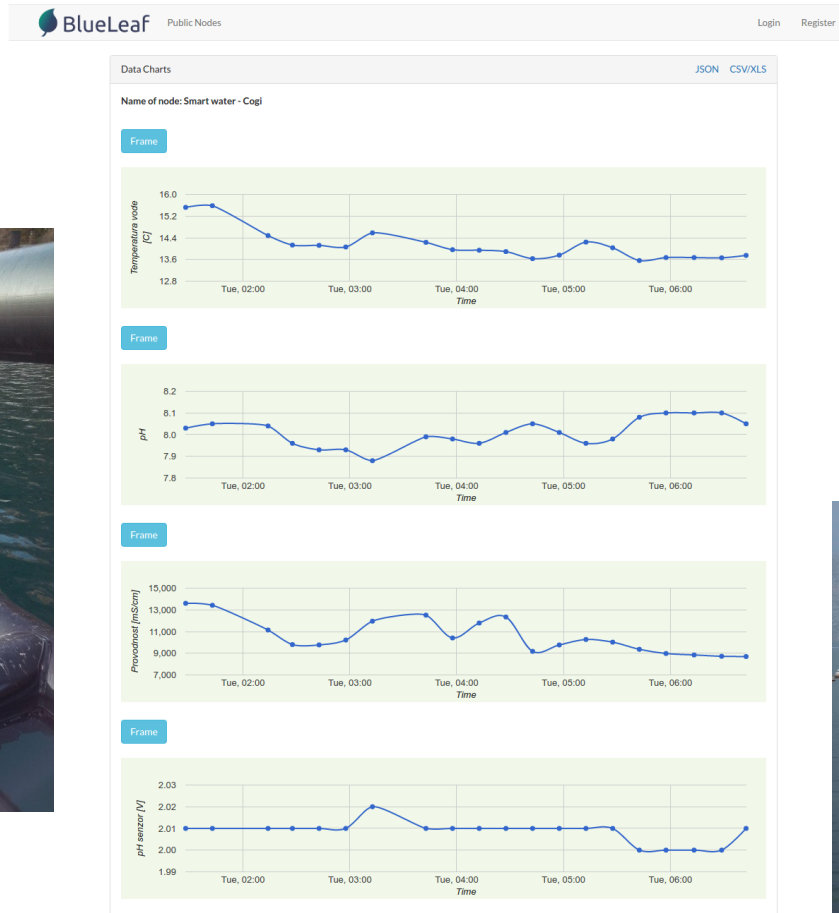
# Ex 2. Salinity stress (HR)











- ❑ **Ecological monitoring**
- ❑ **Aquacultures**
- ❑ **Water supply stations**
- ❑ **Waste water management**
- ❑ **Industry facilities**
- ❑ **Anti-terrorism**



## □ **Internet of Living Things**

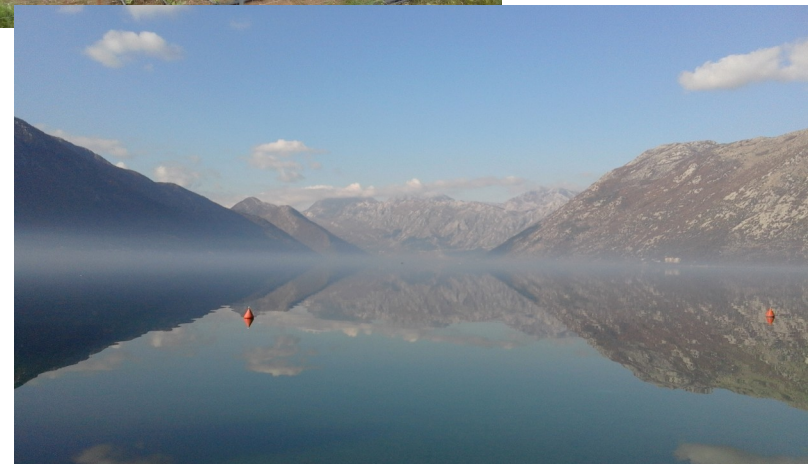
- Great potential
- Lots of interesting research ahead of us
- Respecting the environment

## □ **University of Montenegro**

- Great diversity in a small place
- BIO-ICT as a framework for interdisciplinary work
- Open for collaboration

## □ **Partnership for H2020 calls**

- Strong team of multidisciplinary scientists
- Unique testing facilities
- Teaming call



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