

– Fish ‘n’ Chips –

FischFit-Monitoring – a project for the application of electronic microsystems in the water sector

Financially promoted by the ProFIT - programme of the IBB

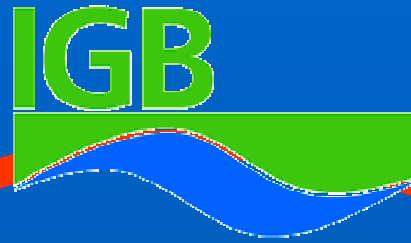
Dr. Daniela Baganz, Dr. Georg Staaks

Prof. Hans-Ullrich Balzer

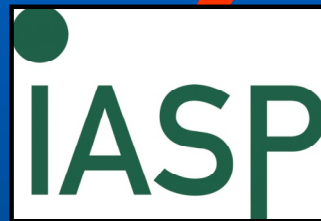
Dr. Volker Großer

Dipl.-Ing. Thomas Sichtung

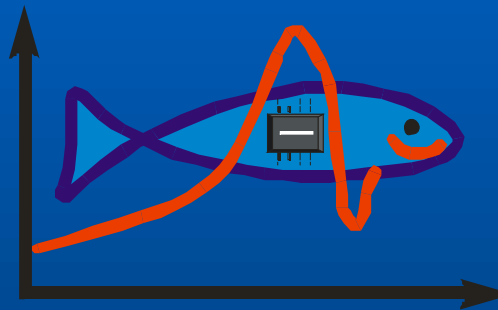
Project Partners



Institute of Freshwater Ecology
and Inland Fisheries (IGB)



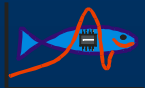
Institute of Agricultural and
Urban Ecological Projects (IASP)



Fraunhofer Institute of
Reliability and Mikrosystem
Integration (IZM)



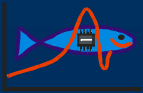
Electronic Components GmbH
(ELBAU)



Project Objectives



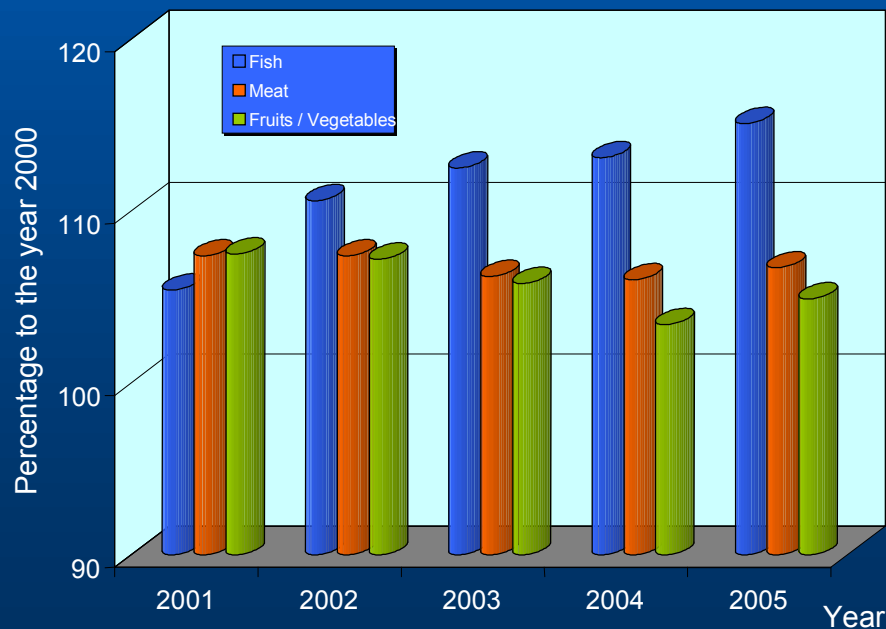
- Development of an innovative measurement and diagnostic system for the early and detailed analysis of fish health and fitness in an aquacultural production process
- Recording and telemetric transmission of physiologic data of monitor fishes by autonomous, injectable microsensor systems
- Automated long-term monitoring and control of fish stocks
- Reliable and cost-effective diagnostic evaluation of physiologic alterations and / or behavioural irregularities in fishes
- Optimisation of fish production methods and quality assurance of aquacultural products



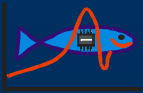
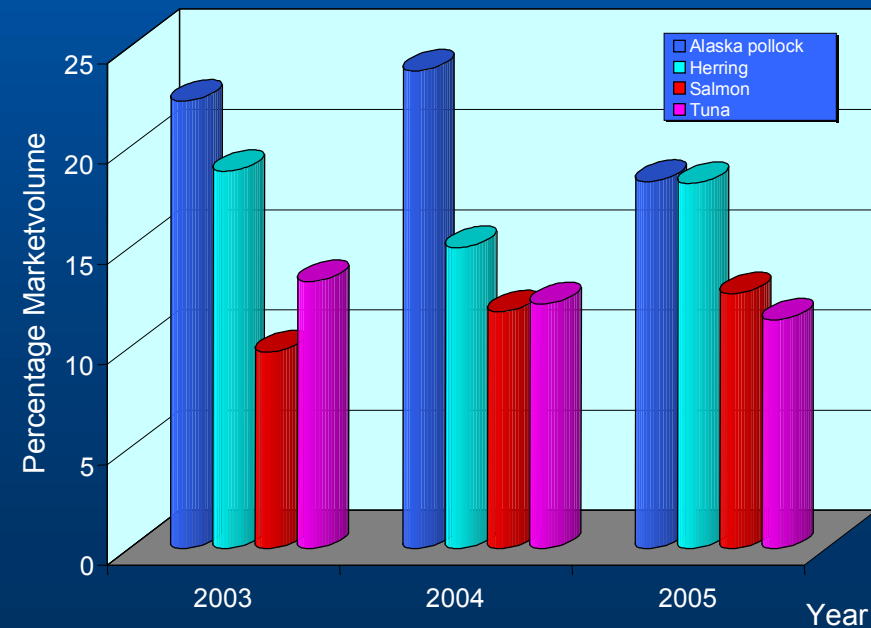
Potential Development of the Market (1)

- Aquaculture is growing and gaining more importance in the light of the rapid breakdown of natural fish resources, especially in the marine sector
- The European Commission forecasts for the aquaculture development area a growth rate of 4% per year and 10,000 additional jobs
- Growth potential on a global as well as local scale

Development of retail prices



Most important fish species in Germany



Potential Development of the Market (2)

Per capita consumption of fish in Germany

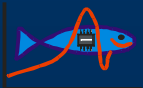
Year ¹	2000	2001	2002	2003	2004 ²	2005 ³	2006 ³
per capita cons. [kg]	13.7	15.3	14.0	14.3	13.8	14.8	15.6

¹ Data from 2004 on not comparable to previous data related to the EU-enlargement.

² Corrected.

³ Provisional.

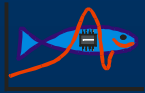
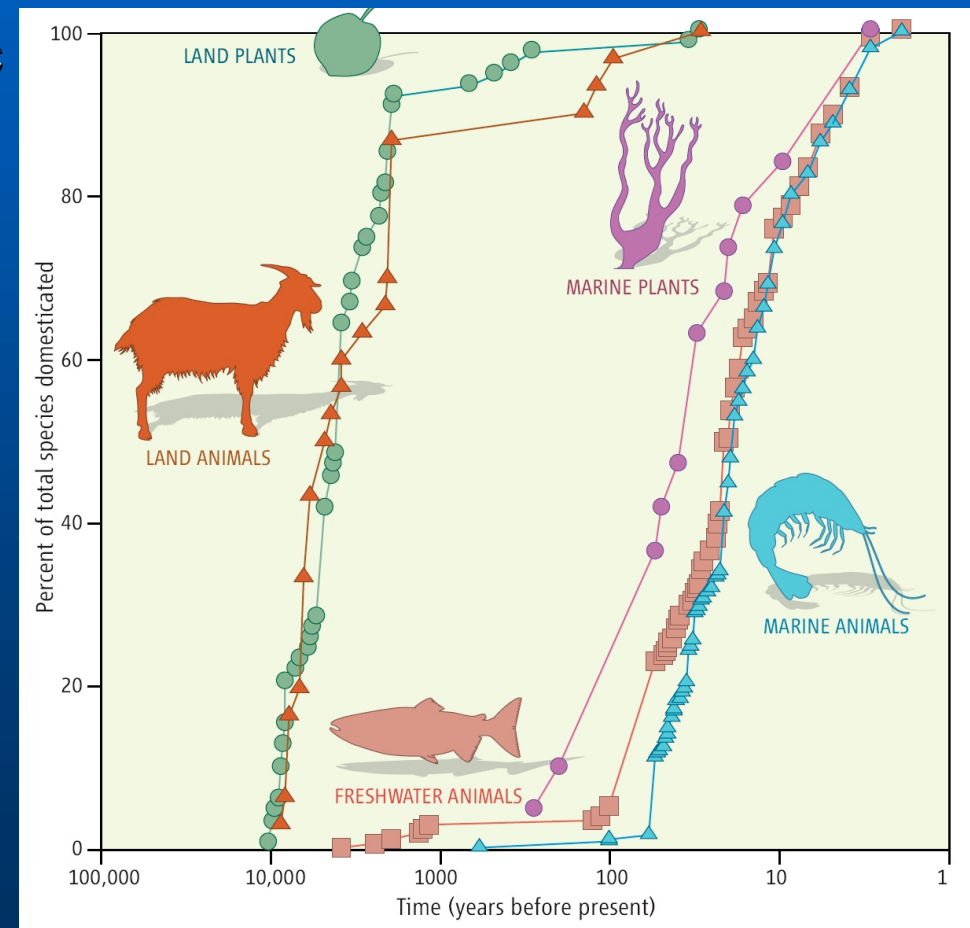
www.fischinfo.de



Applicability in Aquaculture



- Aquaculture as an innovative branch of animal production
- Acceptance for innovations promoted by high qualification level
- Relatively young and dynamic branch of production
- High risk of losses
- Poor observation and monitoring conditions



Project Partner / Competence

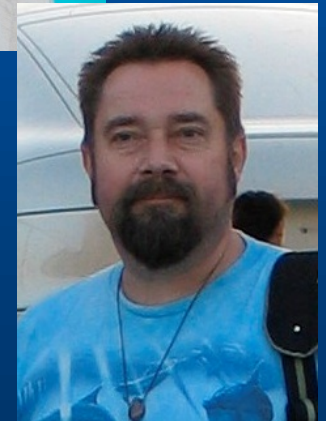
- IGB

Biology and Ecology of Fishes

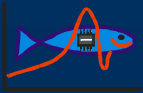


Dr. Daniela Baganz

Dr. Georg Staaks



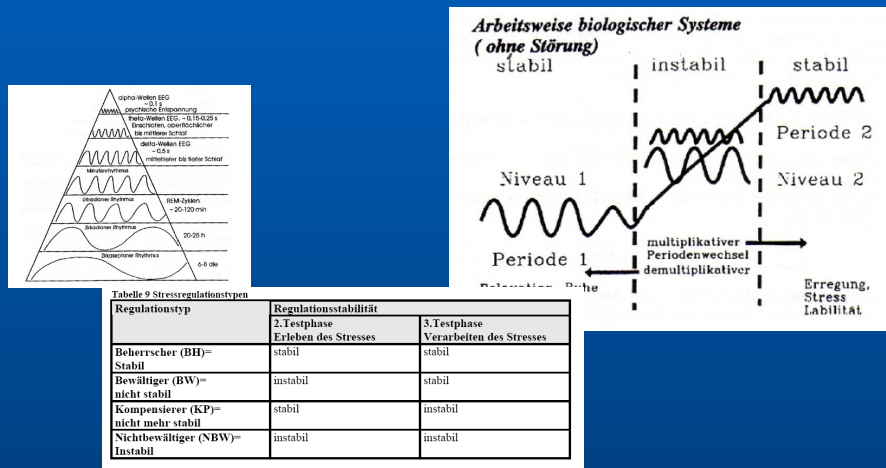
Long- and short-term behavioural changes in fishes
Chronobiology, swimming physiology, respiration and metabolism
Fish diseases
Aquaculture techniques and technology



- IASP

Prof. Hans-Ullrich Balzer

Chrono-psycho-biological regulatory diagnostics



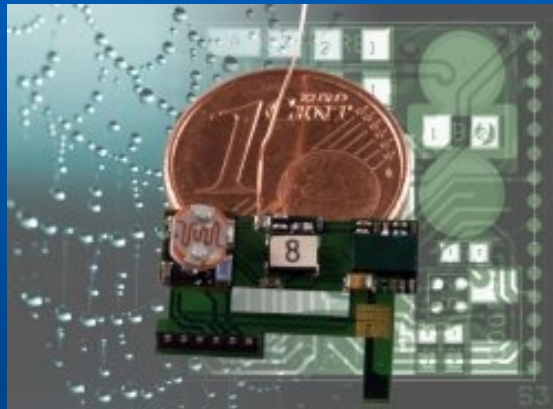
Signal analysis and differentiation of rhythmic components of overlapping signal datasets
 Analysis and evaluation of ECG, breathing rhythms and changes in the electric skin potential
 Combinatoric evaluation of biological rhythms

Project Partner / Competence

- Fraunhofer IZM

Dr. Volker Großer

System Design & Integration



Simulation electric, electromagnetic, thermic and mechanic characteristics of complex microelectronic wirings

Design and development of electronic microsystems

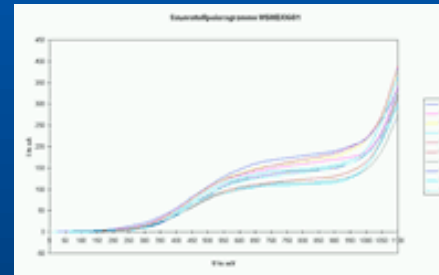
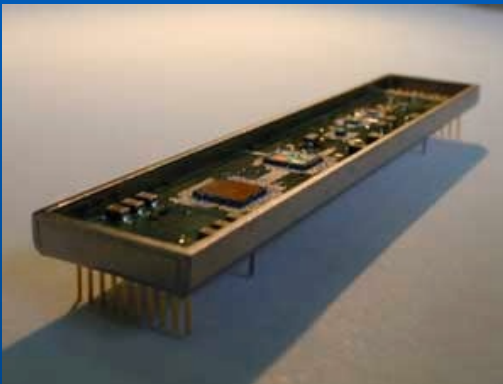
Functional demonstrator units of miniaturised sensor systems in cooperation with the technologically oriented IZM departments

Project Partner / Competence

- ELBAU GmbH

Dipl.-Ing. Thomas Sichtung

System development & integration of sensors

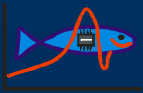


Service deliverer for:
microsystem technology, sensor technology, circuit boards or plates,
special electronic technologies

Main characteristics of ELBAU products are sensor-specific construction and connection technologies, application-specific integrated data acquisition and analysis, and the development up to a ready-to-go product design

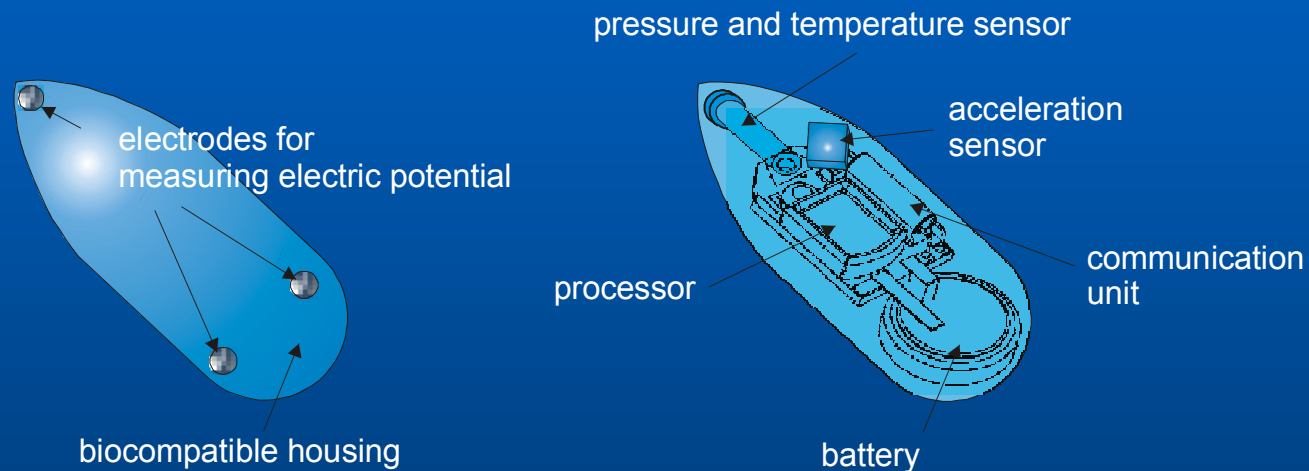
Main Research Topics

- Development of methods for long-term monitoring of physiologic parameters (breath frequency, heart rate, body temperature, electric skin potential) and behavioural parameters (swimming activity)
- Development of a procedure to elaborate diagnoses of the health and fitness status of fish automatically on the basis of the chronobiological regulatory diagnostics
- Development of an appropriate non-reactive application technology
- Development of an enhanced low-power sensor technology
- Development of intelligent autonomous telemetric communication modules

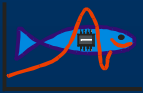


Planned Design of the Microsensor

- small 25 x 6 x 2.5 mm
- injectable
- long living - 1 year + rechargeability

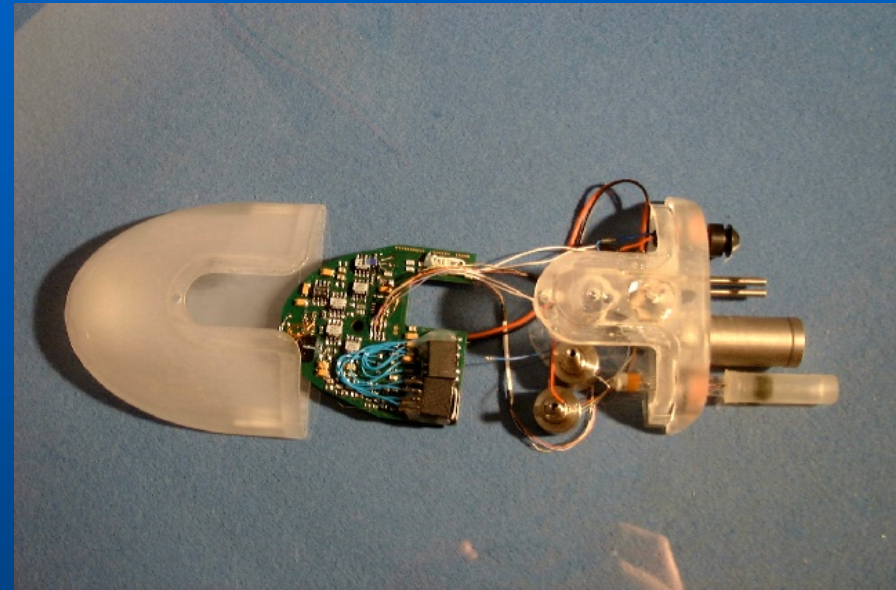
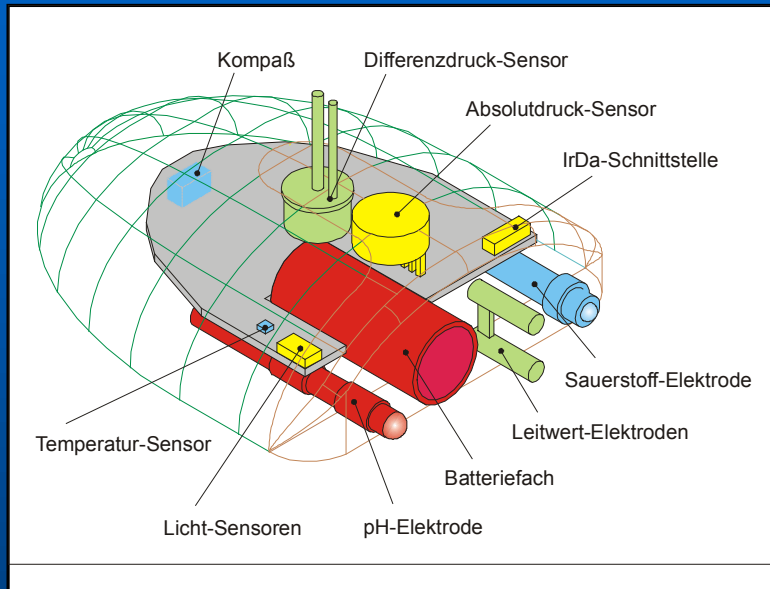


- Measurement of:
- Electric skin resp. tissue potential,
 - Body temperature,
 - 3D-acceleration,
 - Breath and heart frequency



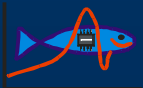
BioMAR – Experiences

Multi-sensor system for penguins and whales:



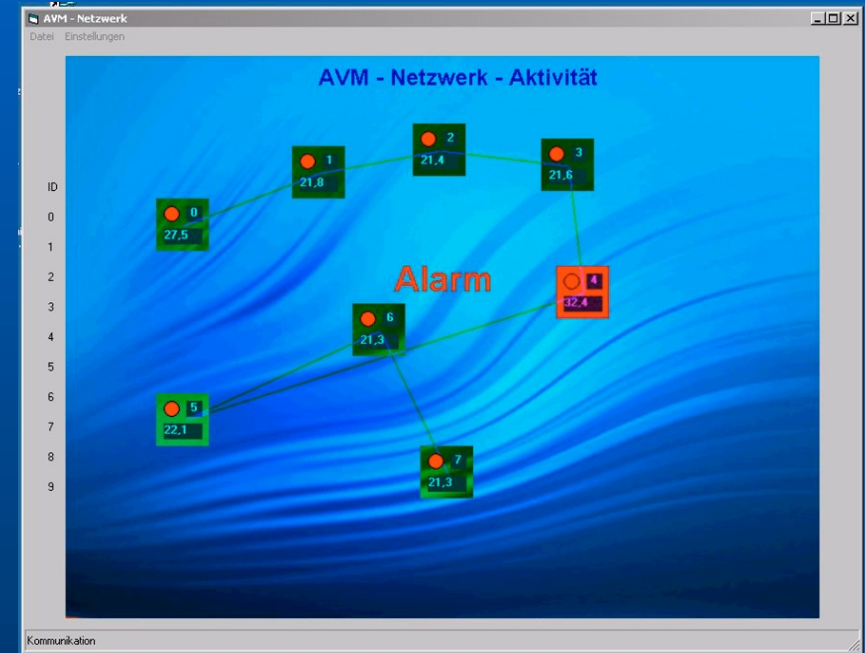
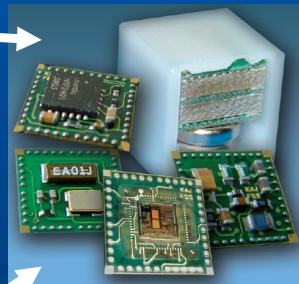
Experiences: - long-term reliability in (sea)water
- biocompatibility for the animal

Disadvantage: - too big and too heavy for fishes



Autonomously Communicating Sensor Networks

ASNs - new dimension of network functionality
e.g. by ad-hoc networking

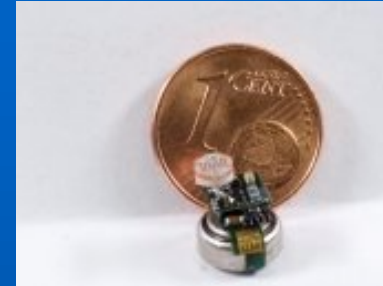


No network infrastructure required

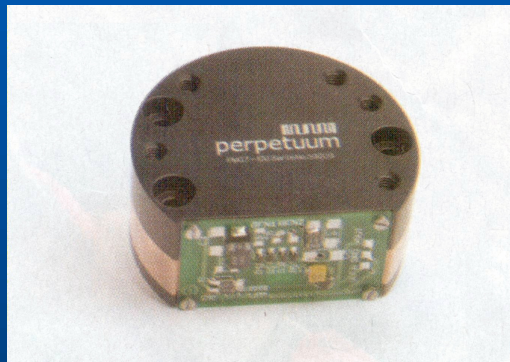
Autonomously Distributed Microsystems (AVM)

New dimension in miniaturisation by multi layer technology

Up to 2010 so called "eGrains" with a size of ca. 2 x 2 x 4 mm

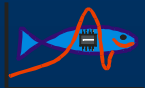


Wireless network enabled micro sensor at a flexible folded substrate with 6 mm edge length

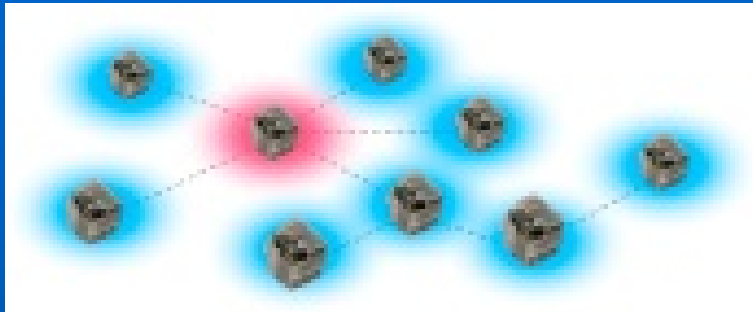


Power supply by „Goldcaps“ or micro generators

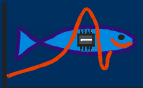
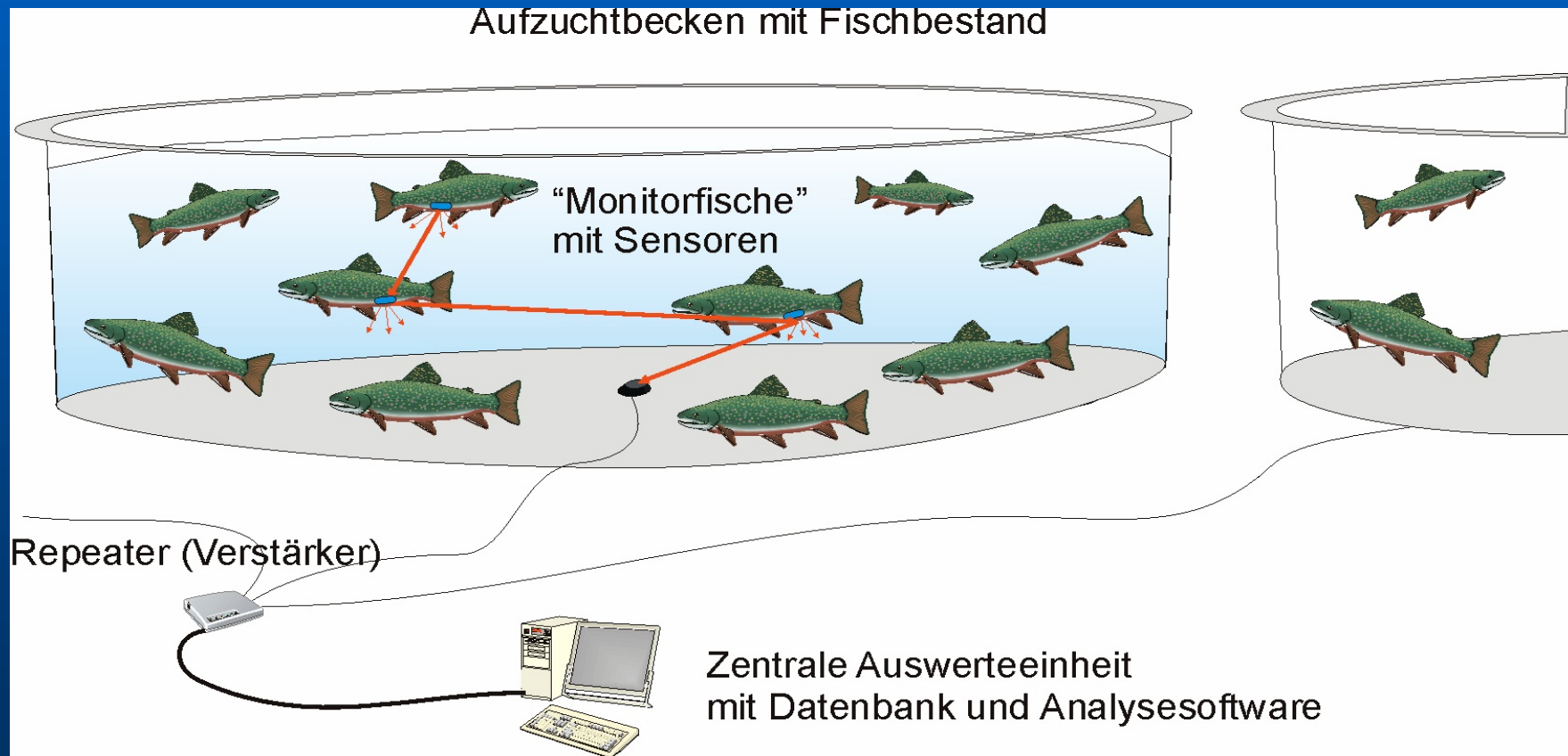
Integrated processor power, energy supply and communication module



Sketch of Sensor Communication Functionality



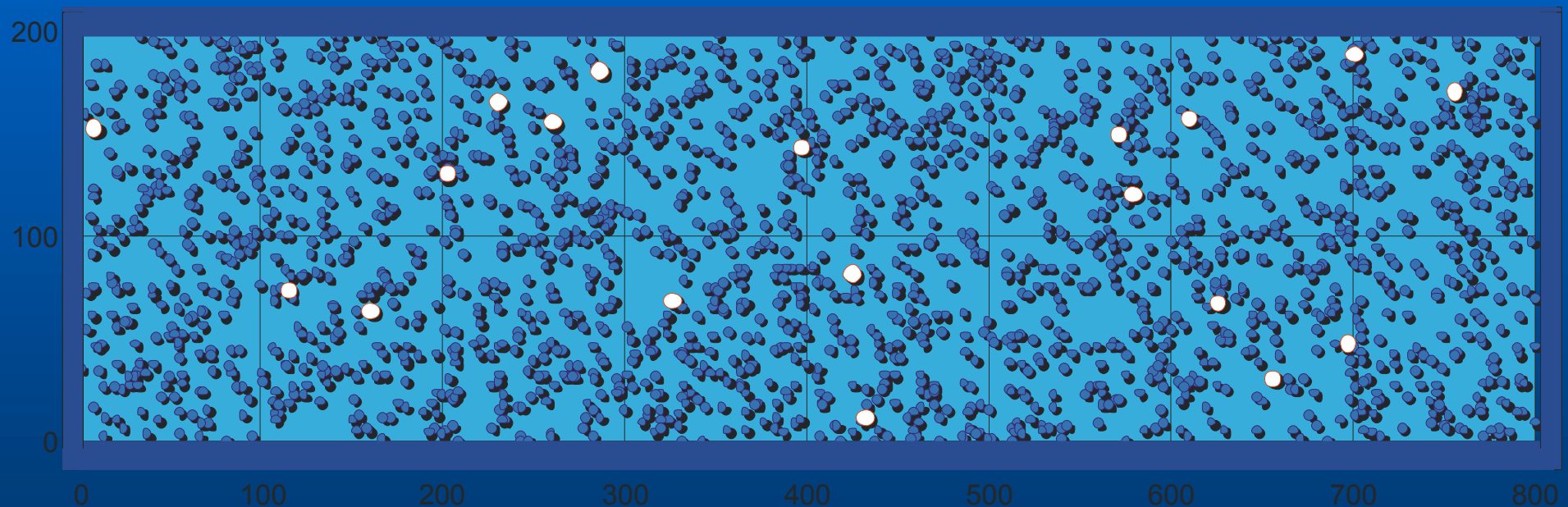
Integrated transmission and receiver units
Integrated microprocessor
Self-organising networks



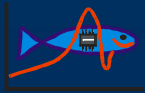
Fish Distribution and Distances of Single Sensors

Theoretical distribution of tagged and untagged fish
in a raising basin

Number of monitor fish (between 1-5 % of the stock)

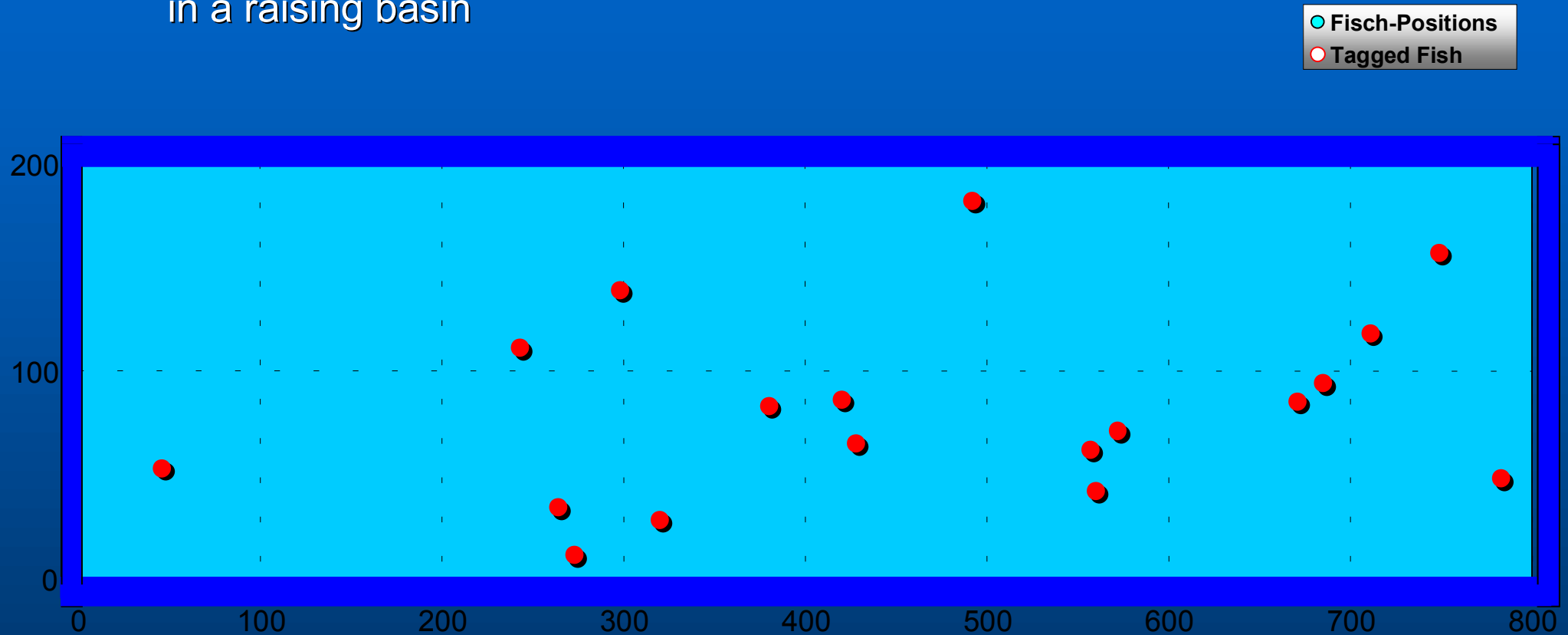


Basin size	8x2x1 m	Body mass kg/fish	0,4
Basin volume	20 m ³	Fish / m ³	125
Stocking density	50 kg/m ³	Number of fish	2000

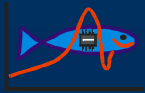


Fish Distribution and Distances of Single Sensors

Theoretical distribution of tagged and untagged fish in a raising basin

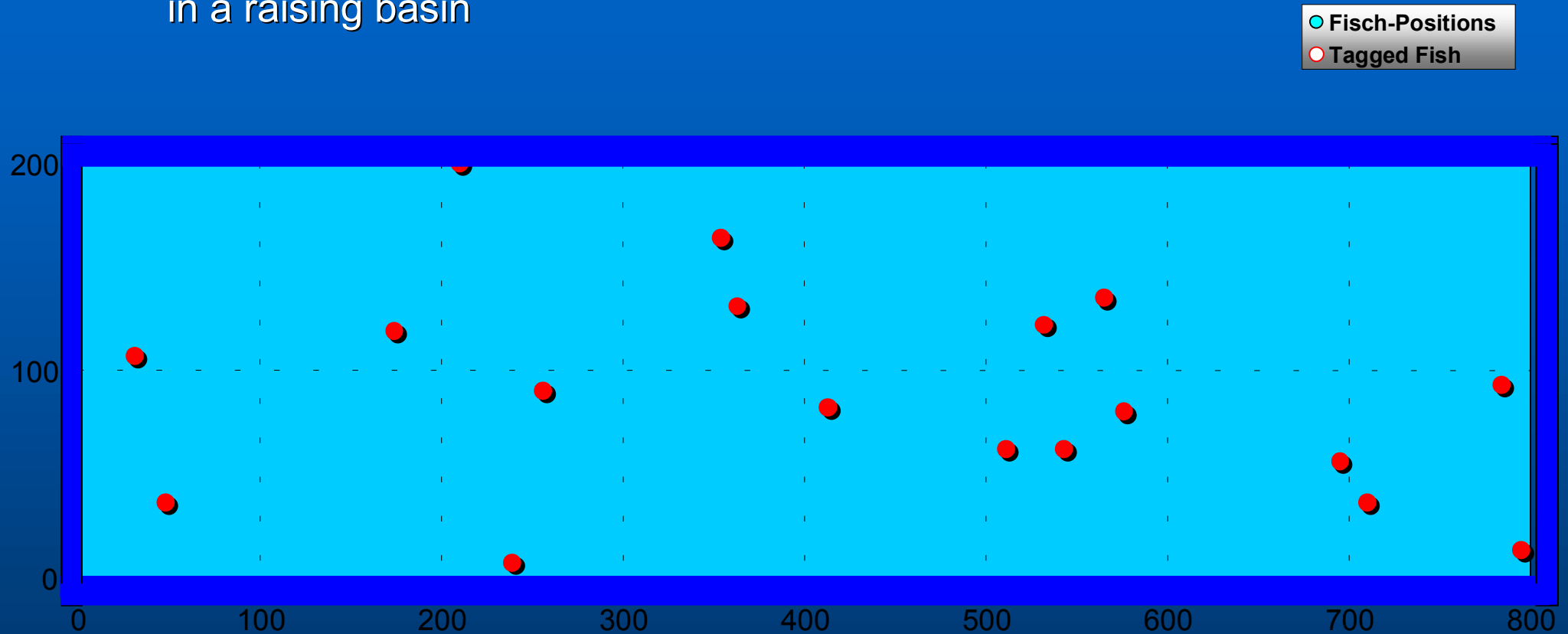


Basin size	8x2x1 m	Body mass kg/fish	0,4
Basin volume	20 m ³	Fish / m ³	125
Stocking density	50 kg/m ³	Number of fish	2000



Fish Distribution and Distances of Single Sensors

Theoretical distribution of tagged and untagged fish in a raising basin



Basin size 8x2x1 m

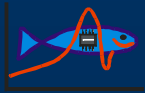
Basin volume 20 m³

Stocking density 50 kg/m³

Body mass kg/fish 0,4

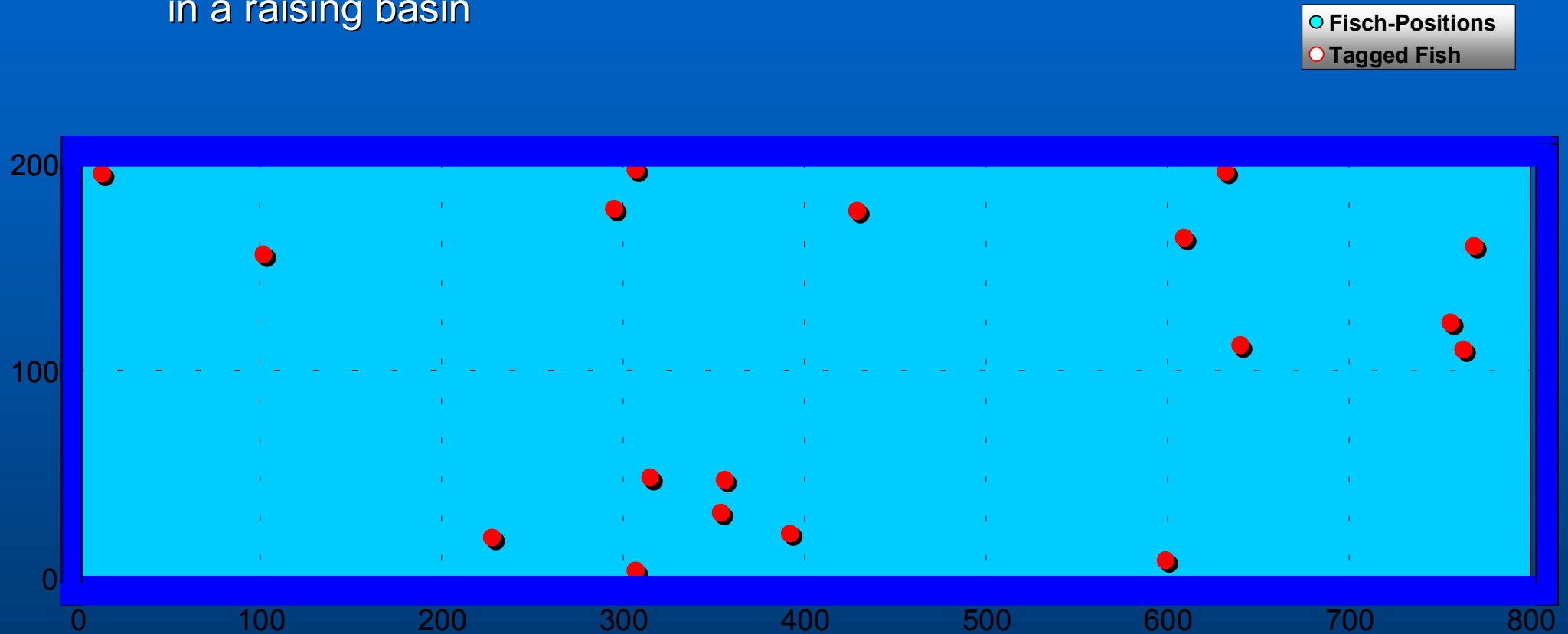
Fish / m³ 125

Number of fish 2000

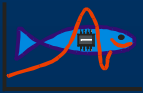


Fish Distribution and Distances of Single Sensors

Theoretical distribution of tagged and untagged fish in a raising basin

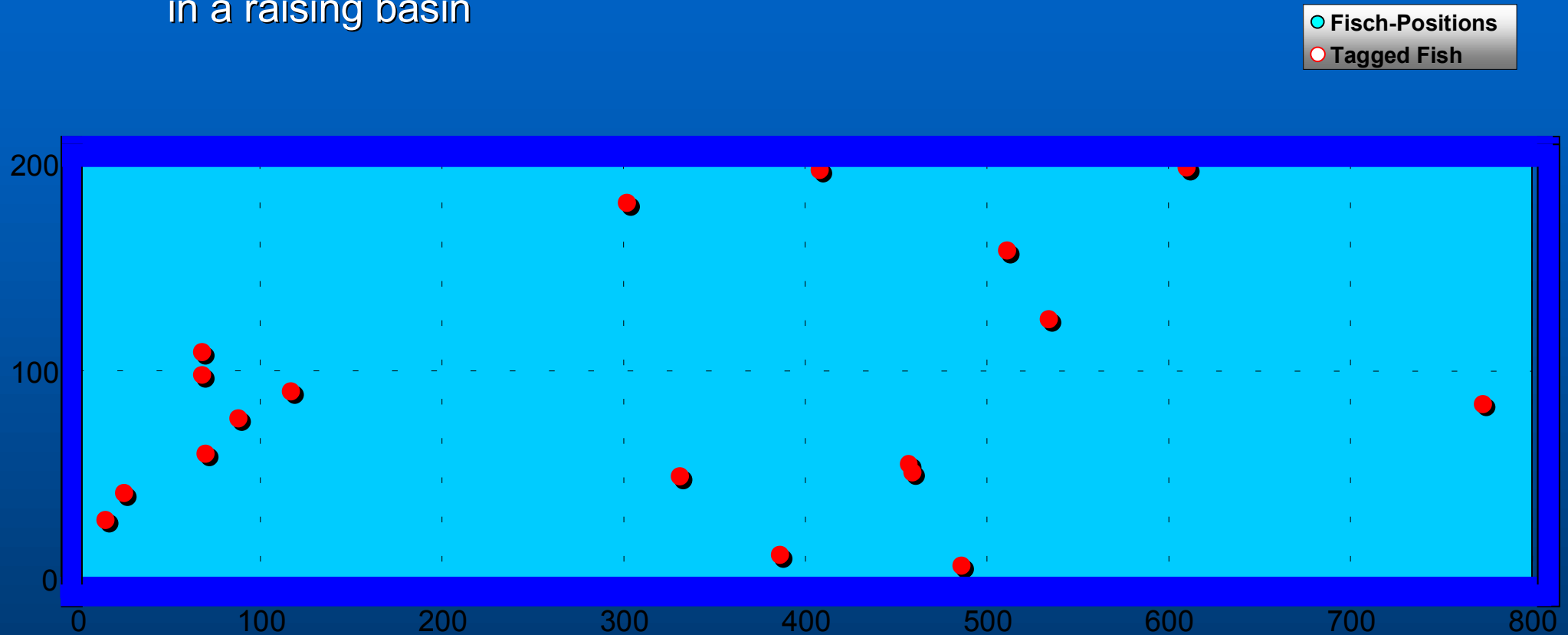


Basin size	8x2x1 m	Body mass kg/fish	0,4
Basin volume	20 m ³	Fish / m ³	125
Stocking density	50 kg/m ³	Number of fish	2000

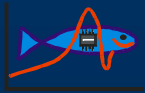


Fish Distribution and Distances of Single Sensors

Theoretical distribution of tagged and untagged fish in a raising basin

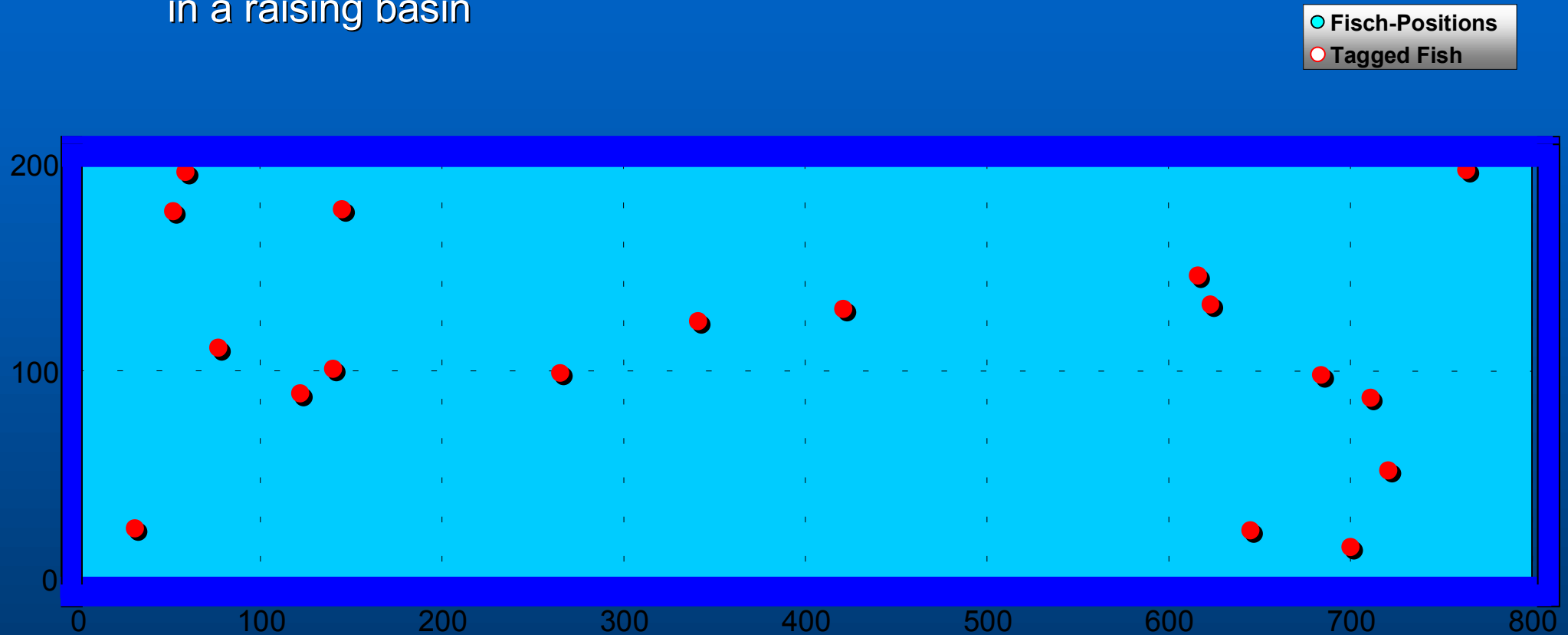


Basin size	8x2x1 m	Body mass kg/fish	0,4
Basin volume	20 m ³	Fish / m ³	125
Stocking density	50 kg/m ³	Number of fish	2000



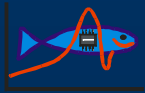
Fish Distribution and Distances of Single Sensors

Theoretical distribution of tagged and untagged fish in a raising basin



Basin size 8x2x1 m
Basin volume 20 m³
Stocking density 50 kg/m³

Body mass kg/fish 0,4
Fish / m³ 125
Number of Fish 2000



Fish Species

- Species with a longer raising time, an individually high body mass and economic value



8 €/kg



9 €/kg

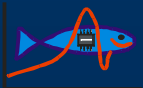


15 €/kg



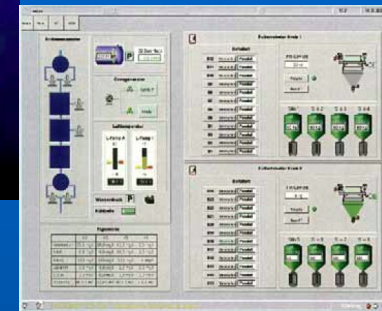
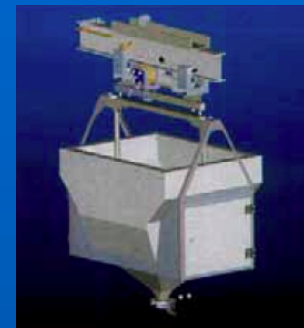
6-8 €/kg

400-2000 €/kg

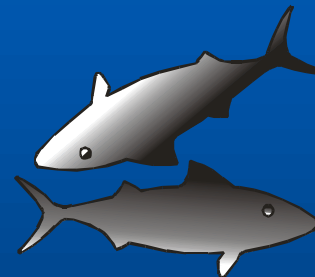


Economic Effects

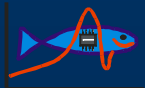
- Minimisation of required food amounts



- Avoidance or minimisation of losses



- Enhancement of product quality of fish



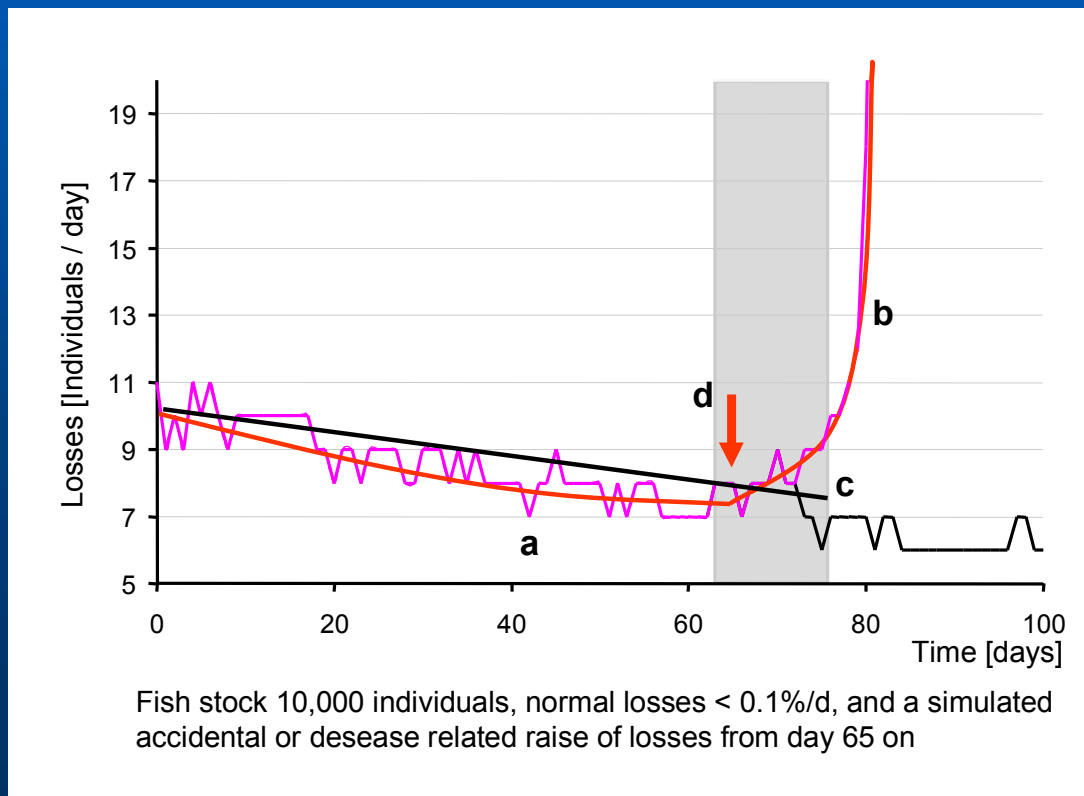
Possibility of Loss Prevention (1)

Normal losses in aquaculture account up to 0.1% per day

Stochastic processes lead to a certain daily variability

Objective:

Early diagnosis of disease outbreaks with a circaseptane time advancement

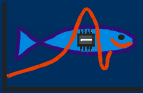


a – real daily losses

b – loss curve calculated by chronobiological methods

c – alarm point by traditional methods (means)

d – alarm point by chronobiol. methods



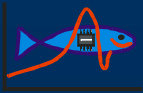
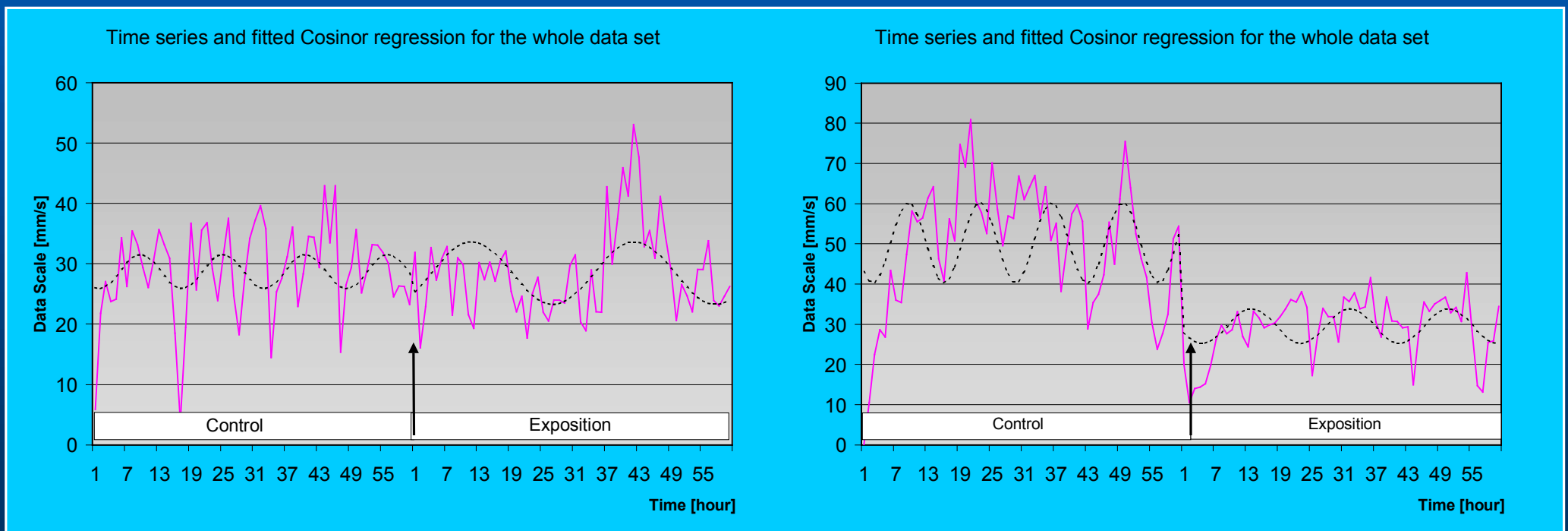
Possibility of Loss Prevention (2)

Diagnosis of disturbances or impairments in periods of hours
Made possible by an analysis of shifts in the biological rhythms of an organism

Expl. Toxic influence of cadmium and phenol on medakas

a) Cd 1 mg/l

b) Phenol 10 mg/l

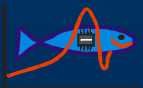


Potential End-Users and Manufacturers

- Fischerei Müritz-Plau GmbH
- CAVIAR CREATOR Manufaktur GmbH
- Peitzer Edelfisch Handelsgesellschaft mbH
- automation & software Günther Tausch GmbH
- SWISSBIT GERMANY AG, Berlin
- HEIDENHAIN-MICROPRINT GmbH, Berlin



Advisory council for research project

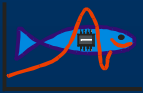


Long-Term Possibilities for Application

- Optimisation of fish aquaculture, integration in aquacultural management systems
- Monitoring of the health status of aquatic animals in larger scale ponds
- Physiologic telemetry in the field (rivers, lakes, oceans) to monitor waters and fish stocks



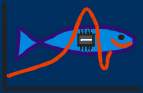
-
- Health monitoring and disease prophylaxis in larger farmed or wild animals
 - Application in human medical monitoring



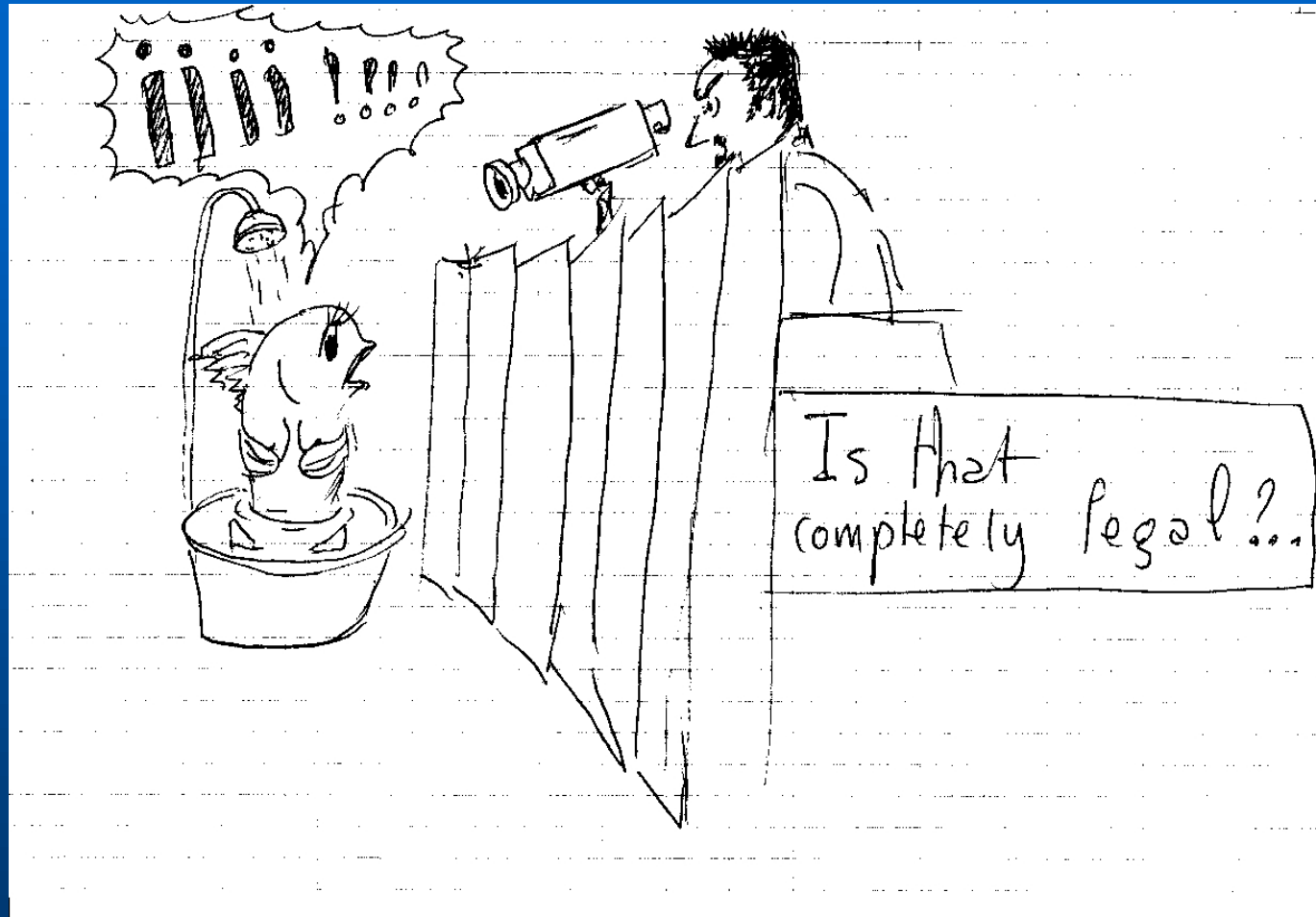
Possibilities for Application in the Water Sector



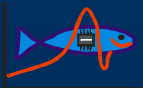
- Integration in “Drifters”, following water currents or movements
 - Detection of pollution point sources by bringing out sensors in the area of interest or under observation
 - Monitoring ship or boat movements
-
- Follow shoals of fish moving in open waters (fresh water or marine in the long-term in combination with Robofish data acquisition stations)



What are the fish thinking about it?

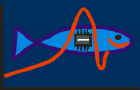
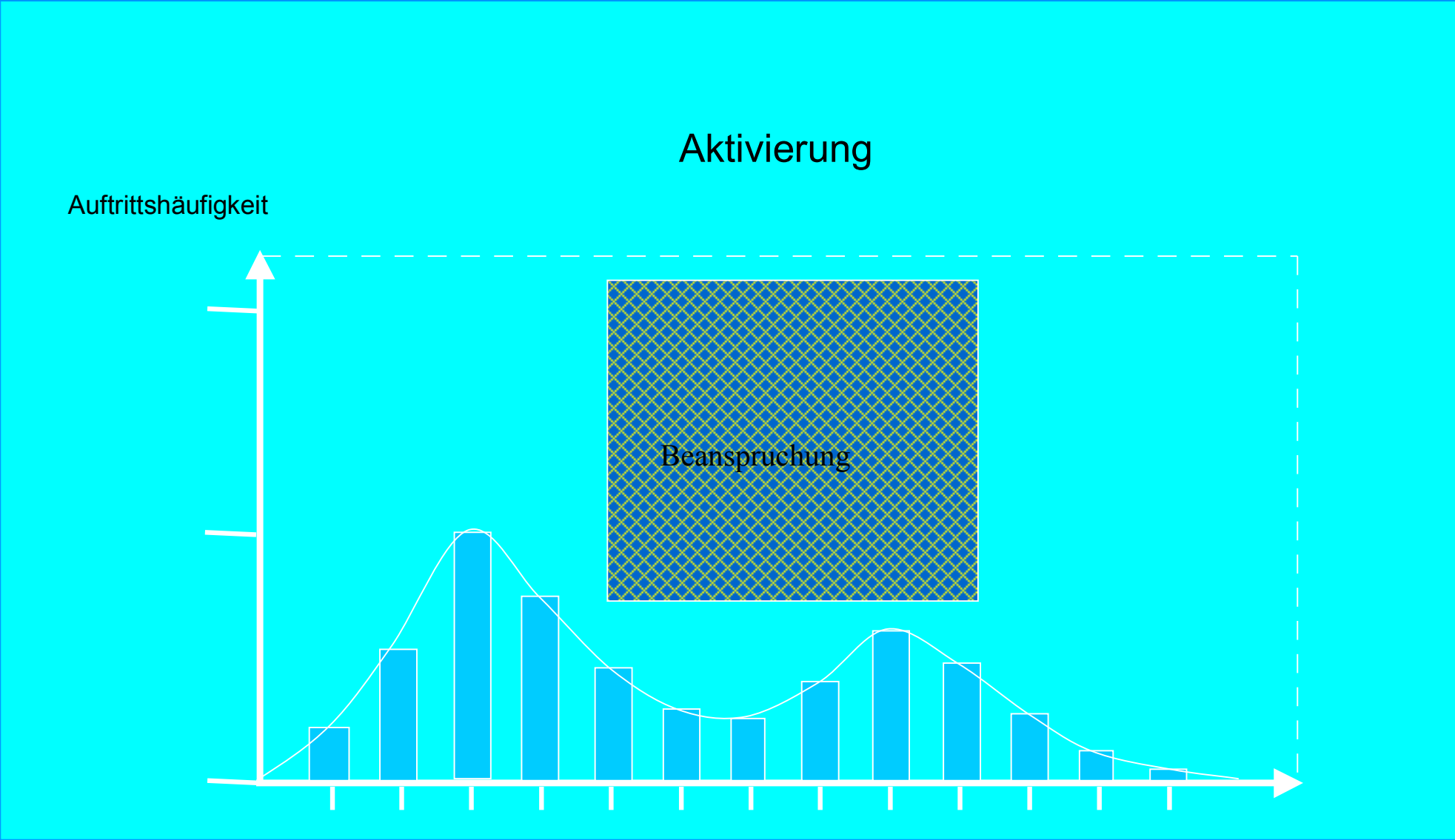


Thank You !

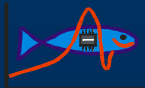
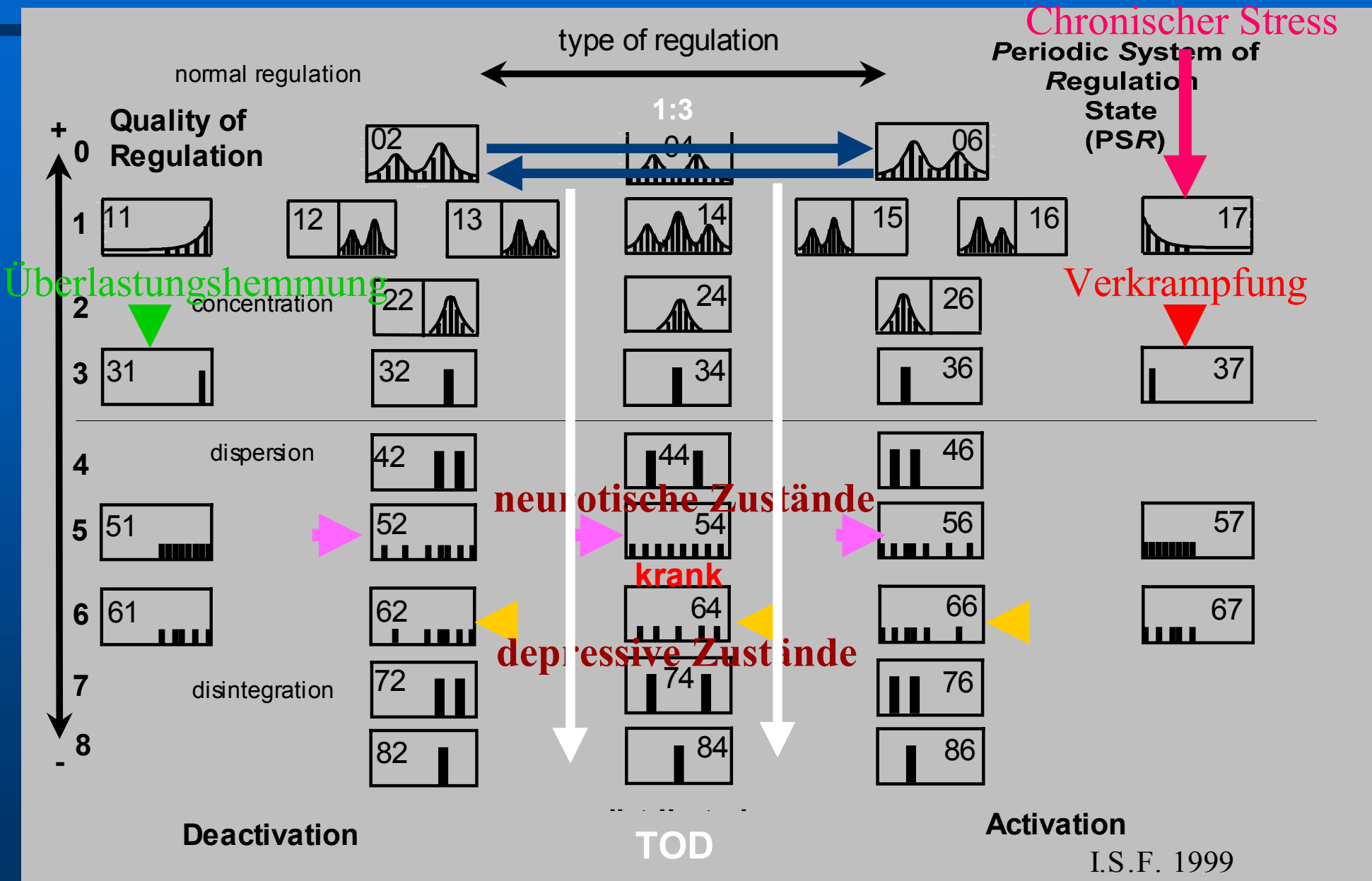


Bestimmung von Regulationszuständen

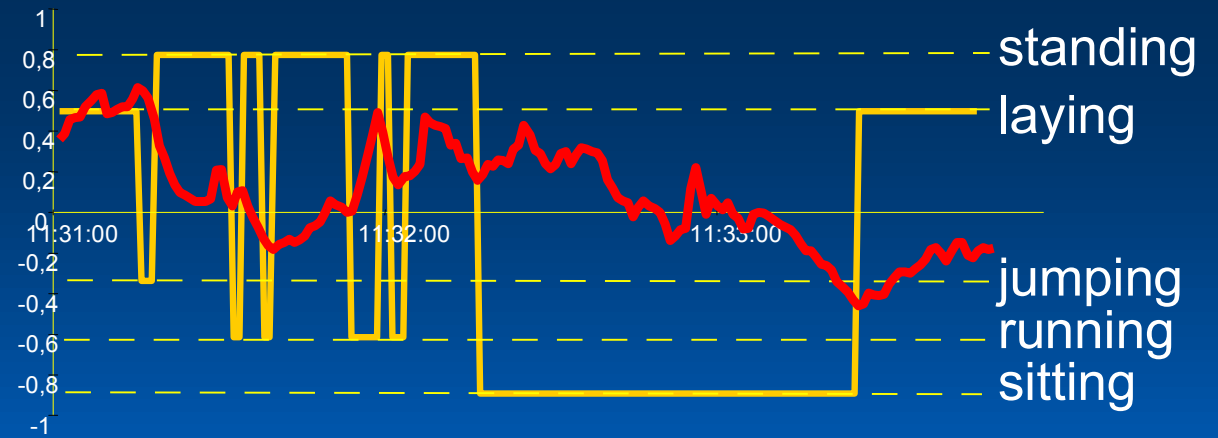
➤ Arbeitsweise biologischer Systeme



Periodisches System von Regulationszuständen



dog: MK






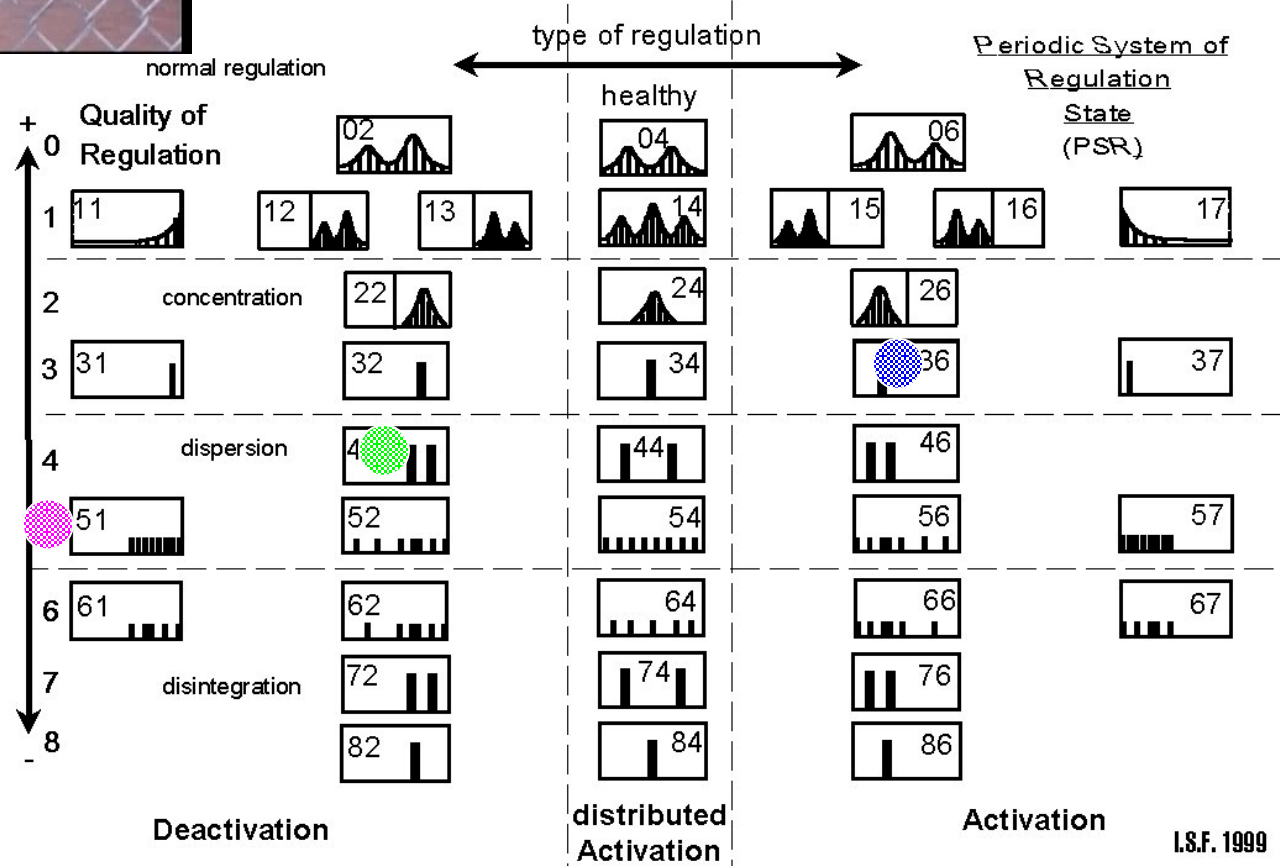
Synchronisation of body functions

Ethogram

Stop: 11:34:00 Uhr

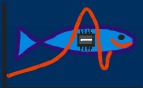
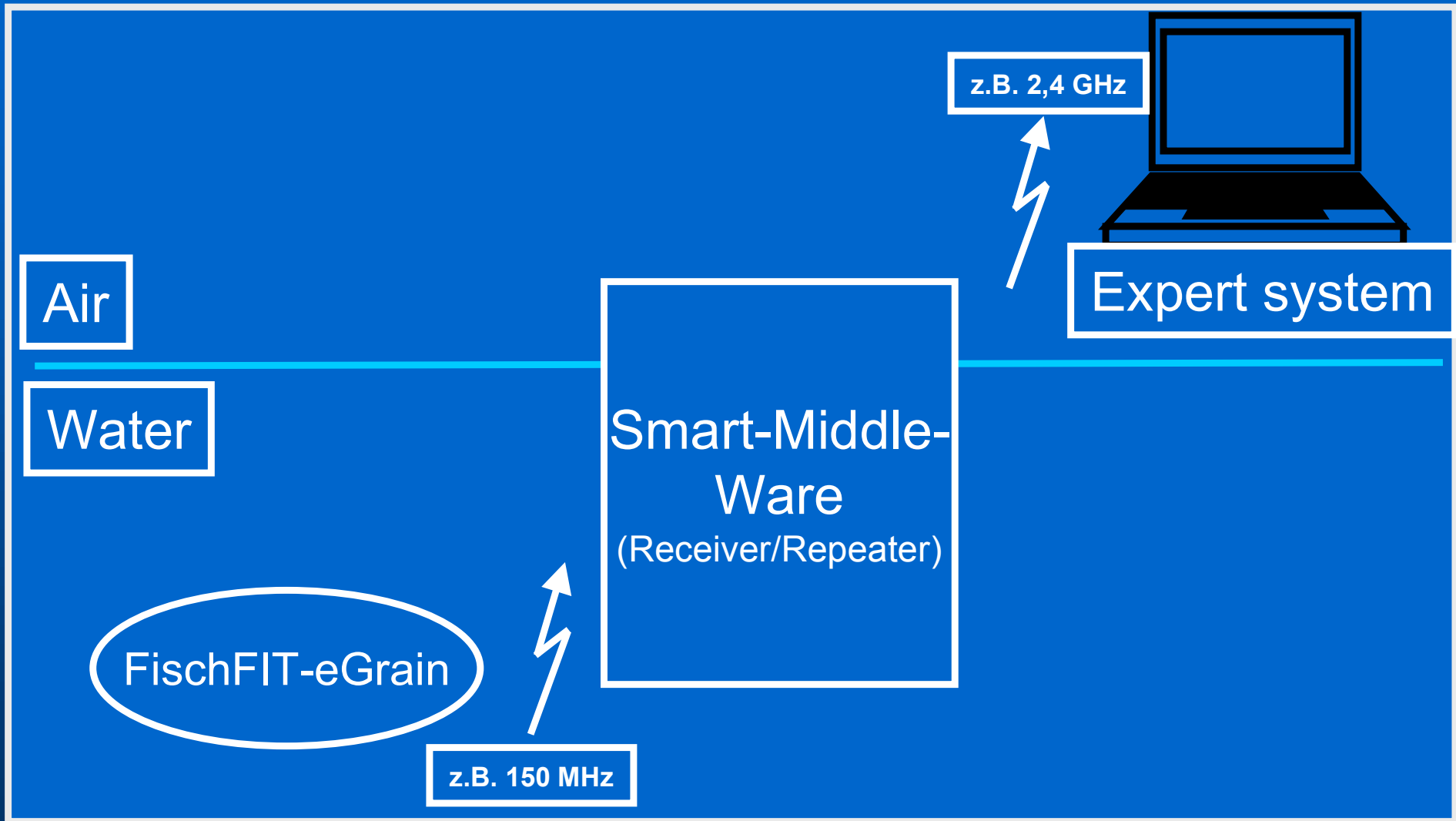
Parameter

-  emotional reaction / SYM
-  neural reaction / SP
-  muscular reaction / EMG



I.S.F. 1999

Psychophysiological Behaviour



Integration in das ProFit-Förderprogramm

„FischFit-Monitor“

- Innovatives Berliner FuE-Projekt
- Interdisziplinäre Kooperation zwischen Ingenieurwissenschaften, Biowissenschaften / Veterinärmedizin und Fischereitechnologie
- Bündelung regionaler Kompetenzen vorrangig aus dem Raum Berlin / Brandenburg
- Stärkung der Berliner Forschungslandschaft
- Technologietransfer von den beteiligten Forschungseinrichtungen in produzierende Berliner und Brandenburger Unternehmen
- Wirtschaftliche Verwertung von FuE-Ergebnissen vorrangig in Berlin möglich

