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EUROPSKI STRUKTURNI I INVESTICIJSKI FONDOVI

Operativni program KONKURENTNOST I KOHEZIJA

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STIM-REI

Project title: STIM-REI (Research, Education, Innovation)
K.K.01.1.1.01.0003

User: Sveučilište u Splitu

Duration: 15.10.2017.-15.10.2022.

Total amount: 37.999.788,07 kn

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STIM

This publication was produced with the financial support of the European Union.
Its contents are the sole responsibility of the University of Split and do not necessarily reflect the views of the European Union.

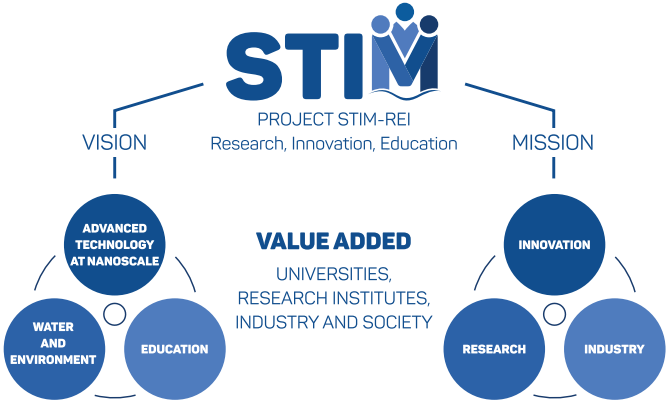
INTRODUCTION

STIM-REI, a project at the Center of Excellence for Science and Technology – Integration of Mediterranean Region (STIM), connects **research** (R), **innovation** (I) and **education** (E) through three project elements based on the international excellence of scientists and choice of research topics that are of critical importance for the needs of society

I. **ADVANCED TECHNOLOGY AT NANOSCALE** - focuses on advances in renewable energy and medical diagnostics by developing new materials for ***fuel*** and ***solar cells*** and by designing novel nanostructured materials for biosensing and biomedicine;
II. **WATER AND ENVIRONMENT** – includes ***research on pollution transport dynamics***, the ***monitoring*** and impact of ***climate change*** on coastal areas and marine life through the characterization of ***biologically active substances*** and ***biofilms***;
III. **EDUCATION** – the fundamental ***scientific education*** of young researchers and ***transfer of knowledge and technology*** through innovative connection of research results and their application with purpose of promoting the ***flexibility, creativity, and entrepreneurial mindset*** of young researchers

OUR MISSION focuses on the unique integration of the triangle **research** – **innovation** – **education**:

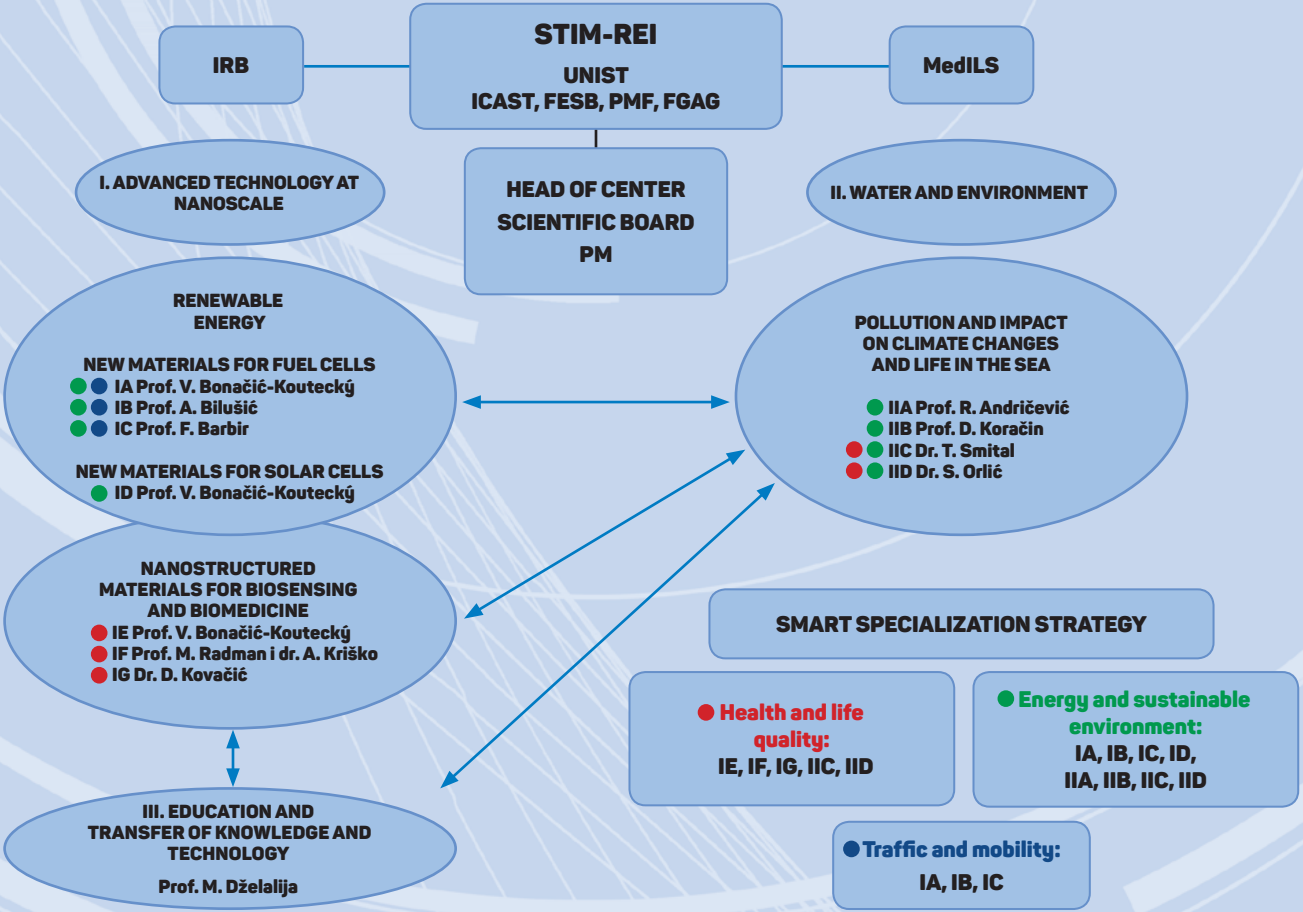
- Fundamental project roots remove boundaries between scientific disciplines and provide the basis for new interdisciplinary research through networking within and outside of Croatia!
- Our innovation system unifies all aspects of the project elements, including long-term collaboration between academic community and enterprises, providing unique opportunity to use research results in practice!



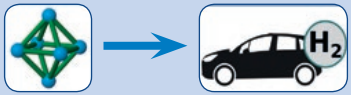
- The STIM-REI project provides modern equipment for conducting internationally competitive and innovative research!
- The results of newly employed young researchers in Croatia already opens the door for the international recognition and long-term success!
- Connecting education and innovation for the promotion of its own abilities, as well as participation of young foreign researchers from the very beginning makes the STIM Center very attractive and contributes to its long-term sustainability.

Join us in new projects today!

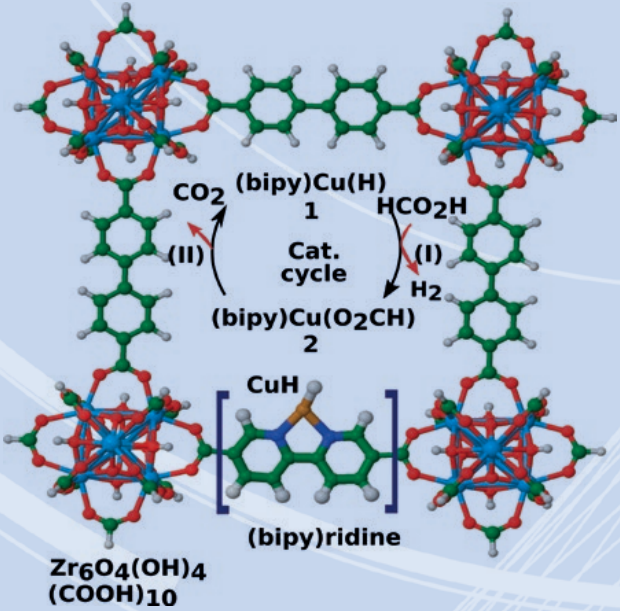
Head of STIM Center: Prof. Dr. Dr. h.c. Vlasta Bonačić-Koutecký


STIM-REI
UNIST
ICAST, FESB, PMF, FGAG
IRB
MedILS
HEAD OF CENTER
SCIENTIFIC BOARD
PM
I. ADVANCED TECHNOLOGY AT NANOSCALE
II. WATER AND ENVIRONMENT
RENEWABLE ENERGY
NEW MATERIALS FOR FUEL CELLS
IA Prof. V. Bonačić-Koutecký
IB Prof. A. Bilušić
IC Prof. F. Barbir
NEW MATERIALS FOR SOLAR CELLS
ID Prof. V. Bonačić-Koutecký
POLLUTION AND IMPACT ON CLIMATE CHANGES AND LIFE IN THE SEA
IIA Prof. R. Andričević
IIB Prof. D. Koračin
IIC Dr. T. Smital
IID Dr. S. Orlić
NANOSTRUCTURED MATERIALS FOR BIOSENSING AND BIOMEDICINE
IE Prof. V. Bonačić-Koutecký
IF Prof. M. Radman i dr. A. Krško
IG Dr. D. Kovačić
III. EDUCATION AND TRANSFER OF KNOWLEDGE AND TECHNOLOGY
Prof. M. Dželalija
SMART SPECIALIZATION STRATEGY
Health and life quality:
IE, IF, IG, IIC, IID
Energy and sustainable environment:
IA, IB, IC, ID,
IIA, IIB, IIC, IID
Traffic and mobility:
IA, IB, IC

IA New catalyst for hydrogen storage based on metal-organic framework



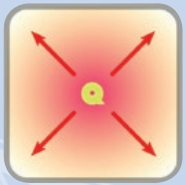
Model for MOF with CuH site for the selective decomposition of formic acid into H_2 and CO_2



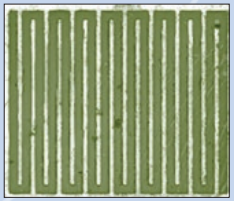
- The simulation of the two-step catalytic cycle (I) H_2 loss and (II) CO_2 removal from formic acid HCO_2H has been accomplished in order to propose synthesis of new materials.
- The reaction is energetically favorable.
- Our concept opens routes toward the use of new MOF materials as novel catalysts.
- The preparation and evaluation of the performance of such MOF catalysts is in progress.
- Experimental part: Prof. R. O'Hair (University of Melbourne, Australia)

IB Design of new catalytic materials for low temperature fuel cells

- Poor thermal conductivity of the catalyst layer is one key cause of the short lifecycle of today's hydrogen fuel cells.
- Experimental data with thermal conduction modelling will elucidate new approaches for improved design of the hydrogen fuel-cell catalyst layer.

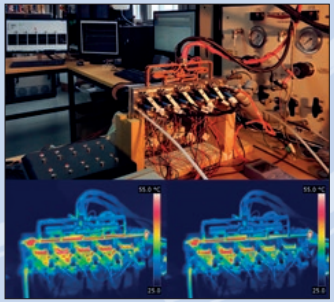


- Reliable energy sources are a basic building blocks of future low-power always-on sensor/ actuator systems.
- By implementation of optical lithography, we aim to develop an array of 2D micro-fuel cells that would power e.g. sensors in harsh conditions and biomedical implants as well.

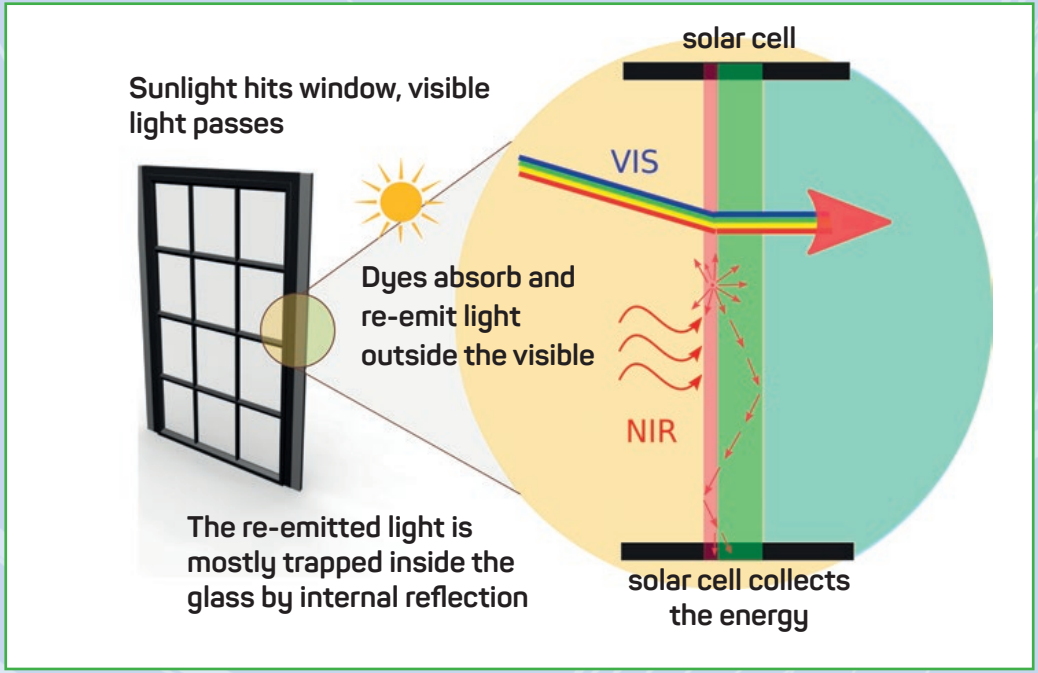


IC Research and Development of Fuel Cells and Electrolyzers

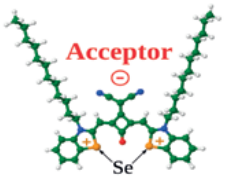
- Catalytic layer thermal conductivity effect on durability of PEM fuel cells
- Development of degradation diagnostics of polymer membrane fuel cells and electrolyzers
- Effect of operating conditions on durability of polymer membrane fuel cells and electrolyzers with the goal of developing new control algorithms that could result in increased durability
- Design of a fuel cell with temperature gradient along the cathode flow field – from a single cell to stack
- Collaboration with, and support of, other research teams on STIM-REI project



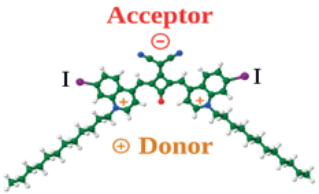
ID New materials for Transparent Luminescent Solar Concentrators



Organic dyes:
Acceptor - Substituted Squaraines



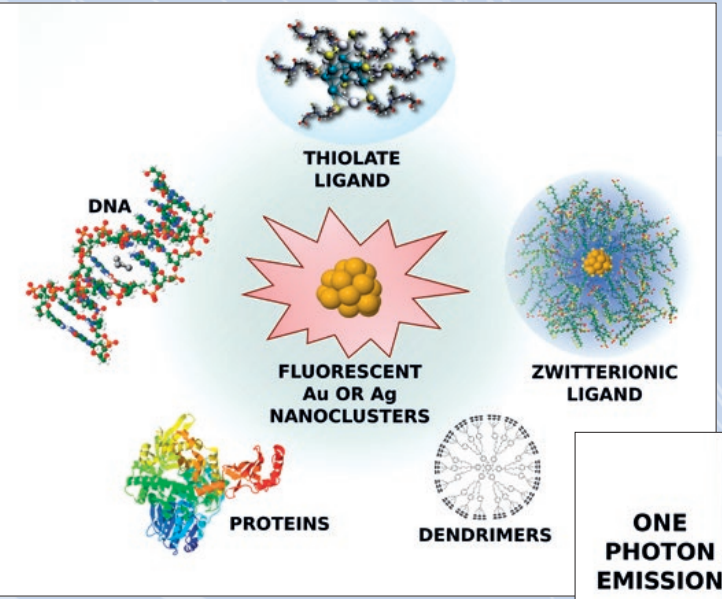
Experiment in solvent
QY: 93%, λ_{ab}: 719 nm



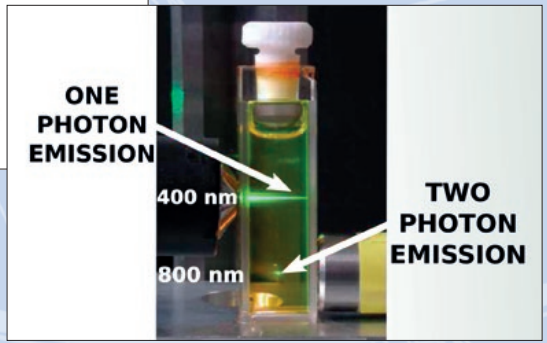
Experiment in solvent
QY: 17%, λ_{ab}: 900 nm

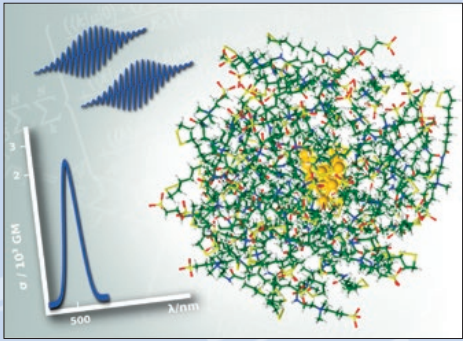
- Design of new dyes with NIR emission and efficient fluorescence (high QY) for synthesis and integration into windows is in progress
- Cooperation with University of Würzburg, Germany (Prof. F. Würthner and Prof. R. Mitrić)

IE Design of novel nanostructured biosensing materials and their application in medical diagnostics



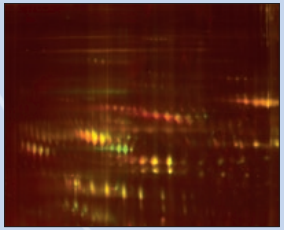
- Interaction between light and biological matter
- Biosensorics with superior detection is based on metallic nanoclusters stabilized by biomolecules (new class of non-linear fluorophores) which allow deep tissue penetration and direct imaging of living cells for early medical diagnostics
- Experimental part: Dr. Rodolphe Antoine and Dr. Philippe Dugourd (Université Claude Bernard Lyon 1, CNRS, Lyon, France)





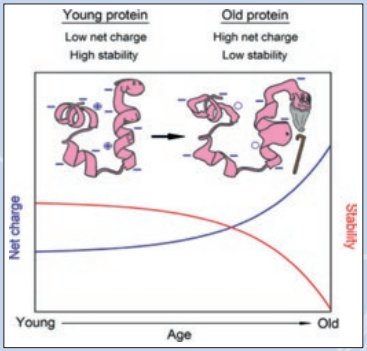
Theoretical design and experimental confirmation

IF Application of new nanostructured materials in medical diagnostics



2D-oxyDIGE gelo of human plasma proteom

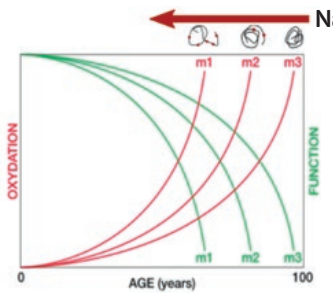
Protein carbonylation is detected and quantified with 2D-oxyDIGE, a novel proteomic approach using specific fluorescent cyanine dyes coupled with hydrazide probes which will react with protein carbonyls.



SOD-1 protein, an antioxidant protein, will be used to measure carbonylation. A panel of different mutations of the SOD-1 protein involved in ALS disease (amyotrophic lateral sclerosis) will be studied and assessed for their susceptibility to carbonylation and to form aggregates.

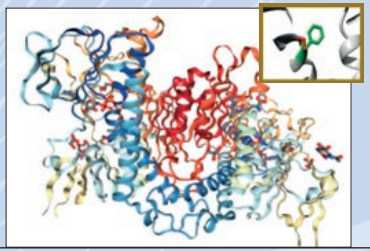
In order to improve the specificity and the sensitivity of the technique, nanocluster probes are under development to replace theses cy-hydrazide dyes.

Protein oxidation is one of the best markers of biological aging and inflammatory diseases



Protein oxidation is reversely proportional to its function and a good predictor of cellular biological age

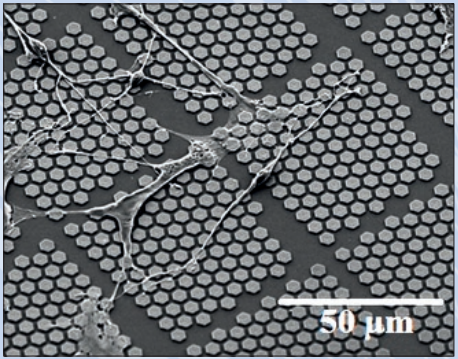
Metal nanoclusters: The novel detectors of protein carbonylation



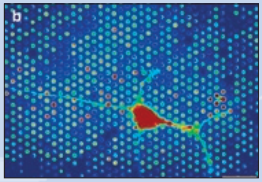
Glutathion reductase, a model protein used to develop **metal cluster-based protein carbonylation detection**

To apply metal nanoclusters to detect and quantify protein carbonylation *in vitro* and *in vivo*
Cooperation with Prof. Vlasta Bonačić-Koutecky and Dr. Rodolphe Antoine (Université Claude Bernard Lyon 1, CNRS, Lyon, France)

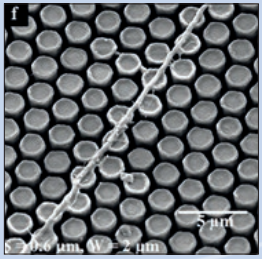
IG The design and application of new nanostructured materials in neuro-electronic interfaces for biomedical application



Neurite length



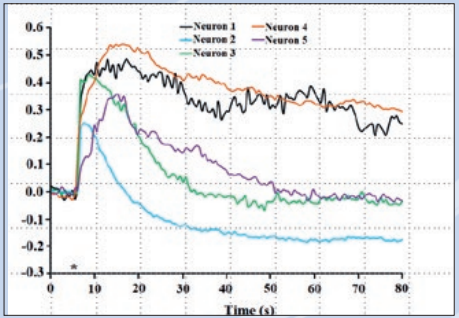
Electrical stimulation



Localized stimulation by biphasic electrical stimulation

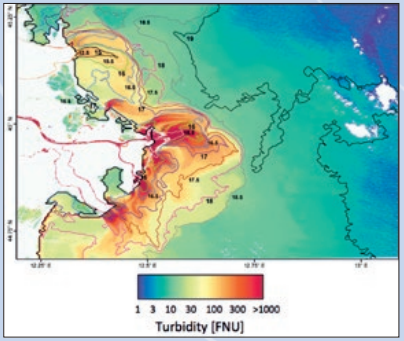
Neurite alignment and guidance FFT

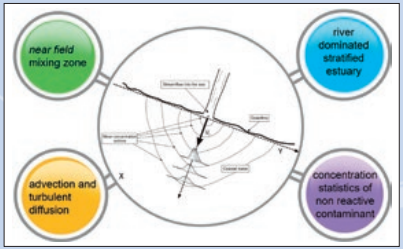
Neurite interaction with glial cells

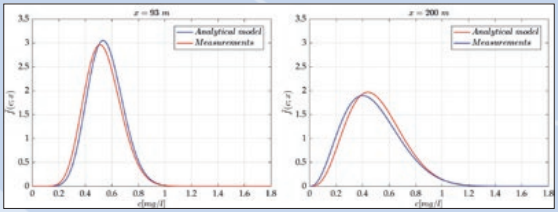


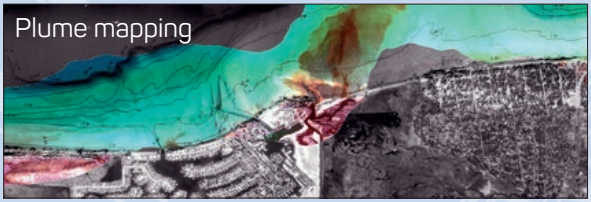
- **Research on new graphene-based nanostructured materials to improve neuroelectronic interfaces for stimulation of auditory neurons in collaboration with the National Center for Graphene at the National University of Singapore (NUS)**

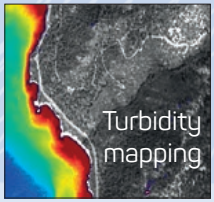
IIA Flow and transport processes and monitoring in rivers and coastal waters







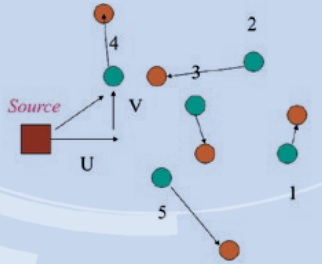




- Under stratified conditions, most mixing processes are restricted to the surface layer, which is receiving a pollutant supply from river plumes
- The spatially integrated statistics of passive contaminant provides a methodology to deliver a description of key dilution processes in river dominated estuaries
- The use of salinity measurements of sea water dilution (during stable stratified condition) as an inverse process of a pollutant transport by river discharge in the near field
- Introducing the expected mass fraction (EMF) and its extension to EVF, provide a new dilution measure for analyzing contaminant plumes in estuaries
- Coastal water can be classified with hyper spectral imagers for overall clarity and presence of sediments, hydrocarbons, certain nutrients and sub-aquatic vegetation that may pose problems from riverine discharges

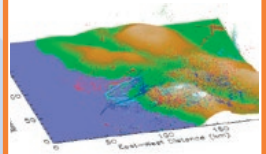
IIB Climate change effects in coastal regions

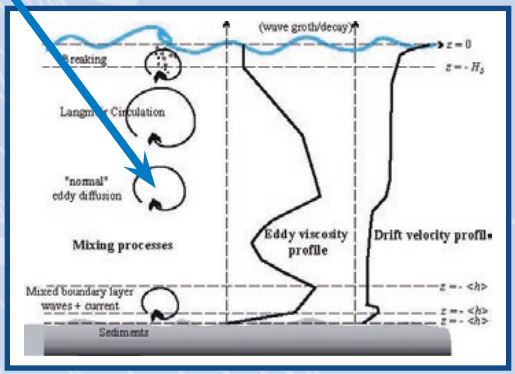
Dynamics and dispersion in the sea



Dynamics and dispersion in the atmosphere

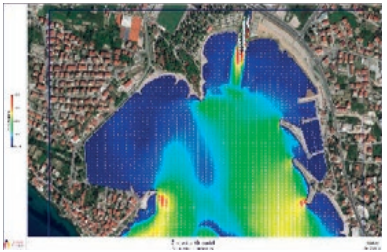
Atmospheric and ocean modeling





Climate change

"Expected Mass Fraction"

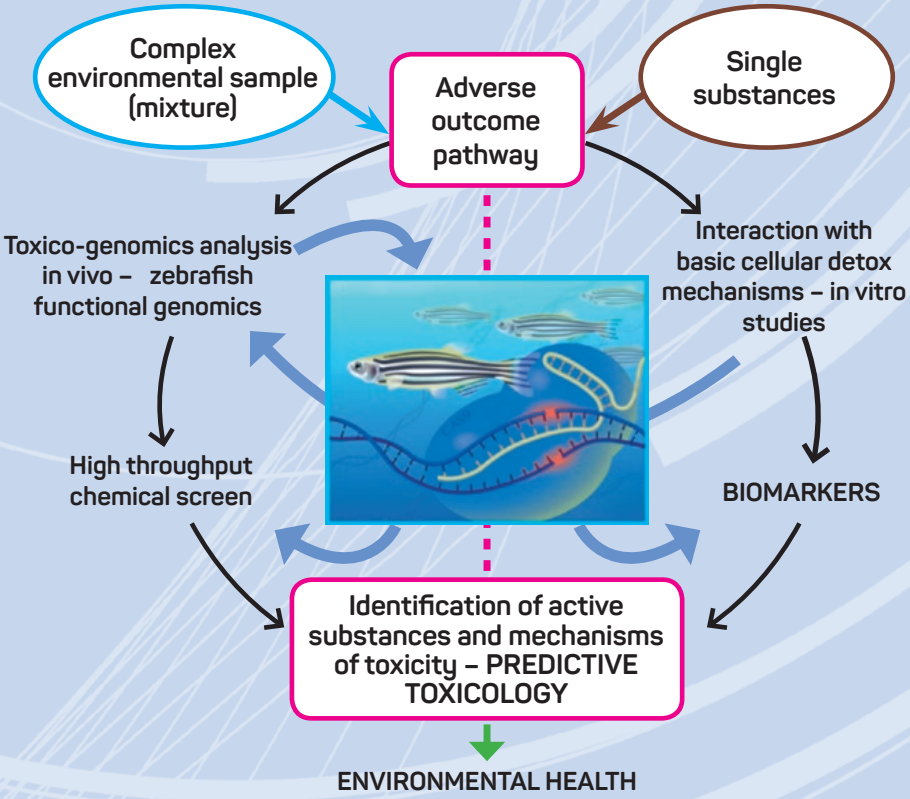


Forecasts of coastal waters quality in current and future climate

3D Lagrangian dispersion
Pollutant concentrations

IIC Ecotoxicological characterization of biologically active substances and complex samples from marine environment

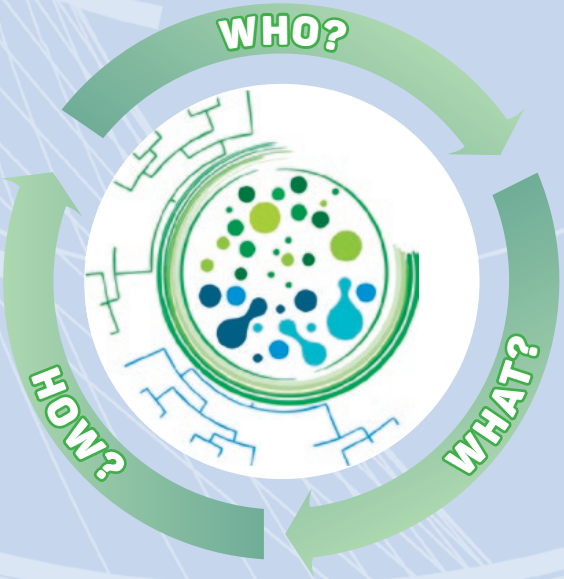
- Understanding the interaction of environmental substances with basic cellular detoxification and defense mechanisms in aquatic organisms;
- Identification and characterization of biologically active substances from marine environment.



IID Biofilm research – blue biotechnology

BIOFILMS

- Eukaryotic and prokaryotic microbial communities determined
- Environmental stress protection

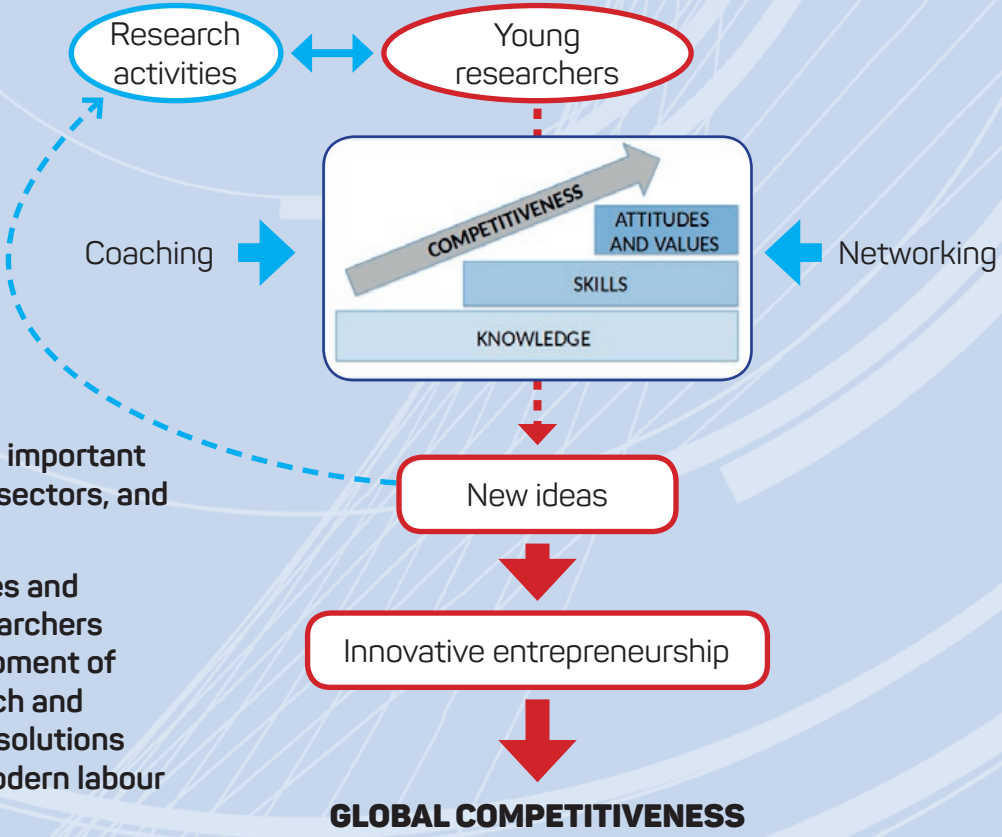


Understanding the structure and function of microbial communities using the cutting-edge molecular methods (next generation sequencing methods, microscopy, bioinformatics)

- Determination of mechanisms causing interactions and functions between and inside communities

Environmental biotechnology in support of sustainable development

- Defined microbial communities' function



- **Learning is fundamentally important for all students, business sectors, and society as a whole.**
- **Available modern machines and equipment for young researchers enable the further development of ideas for scientific research and adaptation of conceptual solutions for the development of modern labour markets.**

GROUP LEADERS
ADVANCED TECHNOLOGY AT NANOSCALE

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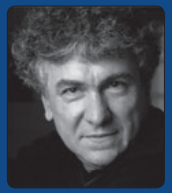
FESB

ANTE BILUŠIĆ
Prof. dr. sc.
PMFST



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IRB

EDUCATION

MILE DŽELALIJA
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PMFST

STIM-REI

SVEUČILIŠTE U SPLITU
UNIVERSITAS STUDIORUM SPALATENSIS