



Welcome

WIND ASSURING CONFIDENCE
THROUGH COMPETENCE

A new Testing Tool for MIC: What Problems Will It Solve For Operators?

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Dipl.-Biol. Mario Hörnig

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Short profile of Fraunhofer IWES North-West

Managing Director:

Prof. Dr.-Ing. Andreas Reuter

Research spectrum:

Wind energy from material development to grid connection

Operational budget 2014:

around 13,2 million €

Staff:

150 employees

Previous investments in the establishment of the institute:

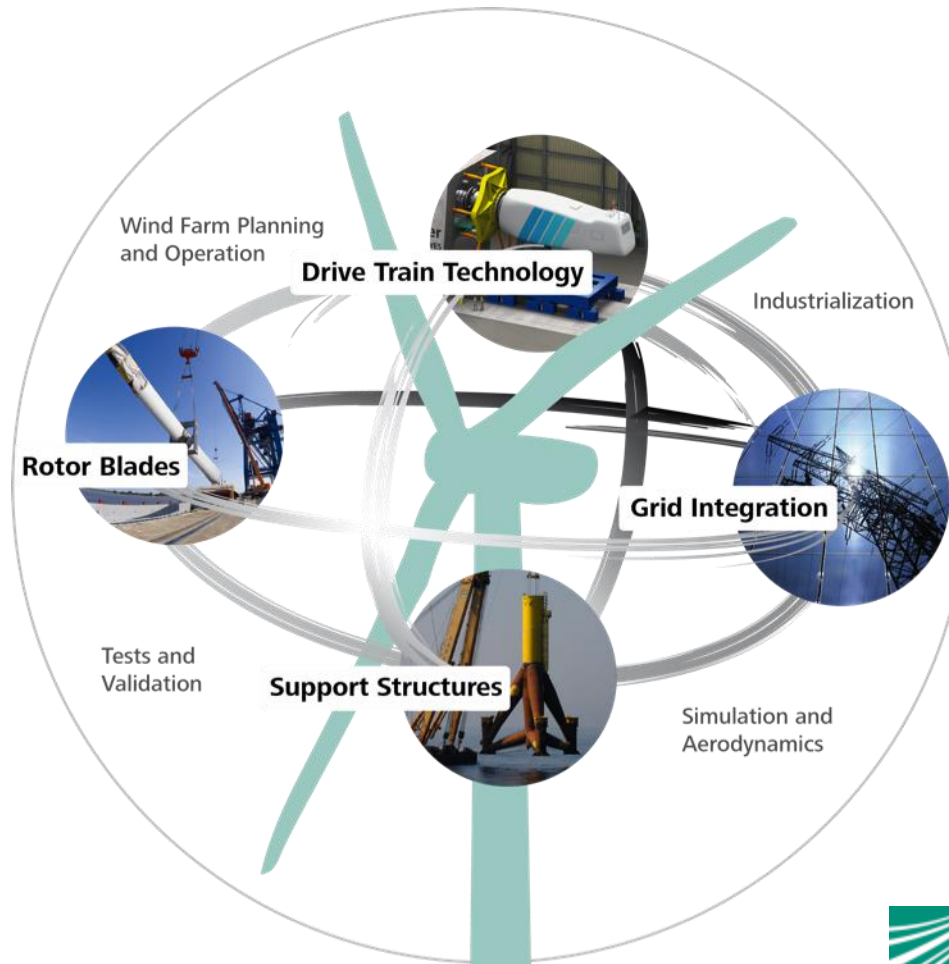
60 million €



Strategic Association with ForWind and the German Aerospace Center (DLR)



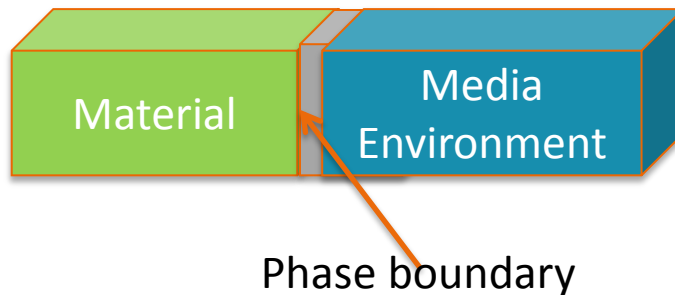
Research spectrum: Wind turbine as the sum of dynamically interacting subsystems



Corrosion definition

DIN 50900 Part 1 and ISO 8044

- Reaction of a metallic material with its environment which causes a measurable change in the material and may lead to an impairment of the function of a metallic component or system.



Microbiological Induced Corrosion

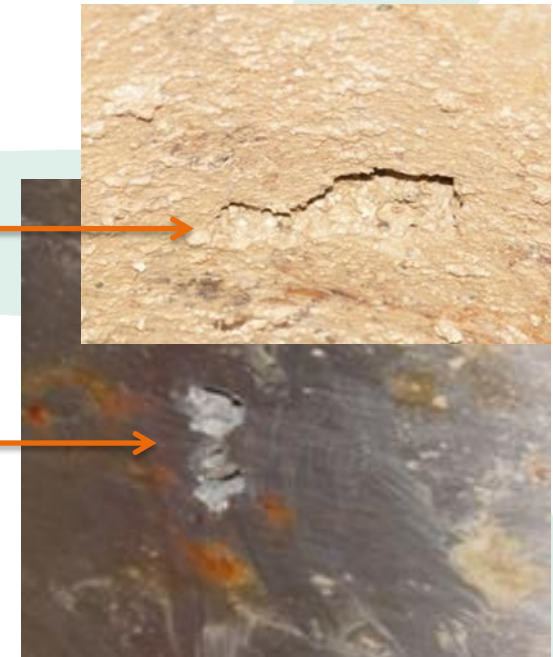
High cost for maintenance and replacement

Known issues among others at:

- Watergates
- Harbor facility
- Pipelines
- Oil tank,
- Industrial water systems
- High-alloy steel
-
- Waste water sewers
(concrete corrosion)

Backside of a 25 mm
stainless steel coupon

Frontside of
the same coupon



Biofilm

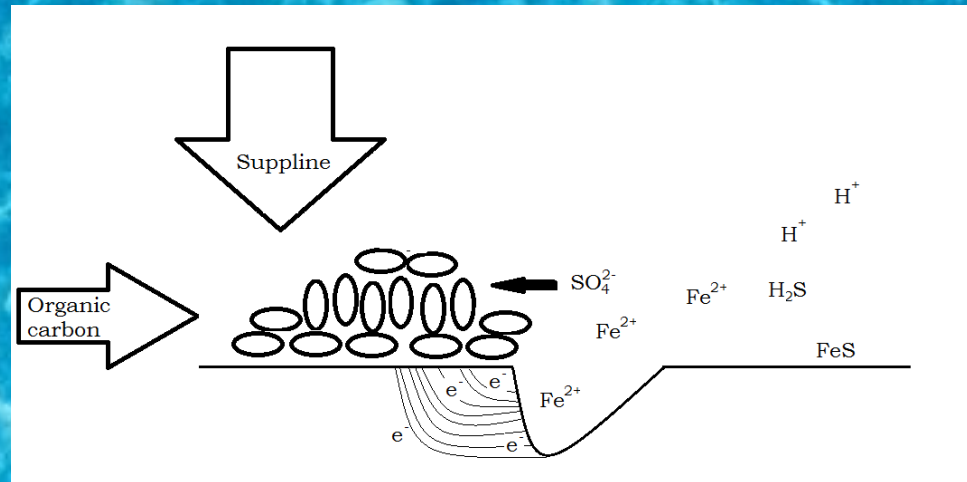


MIC

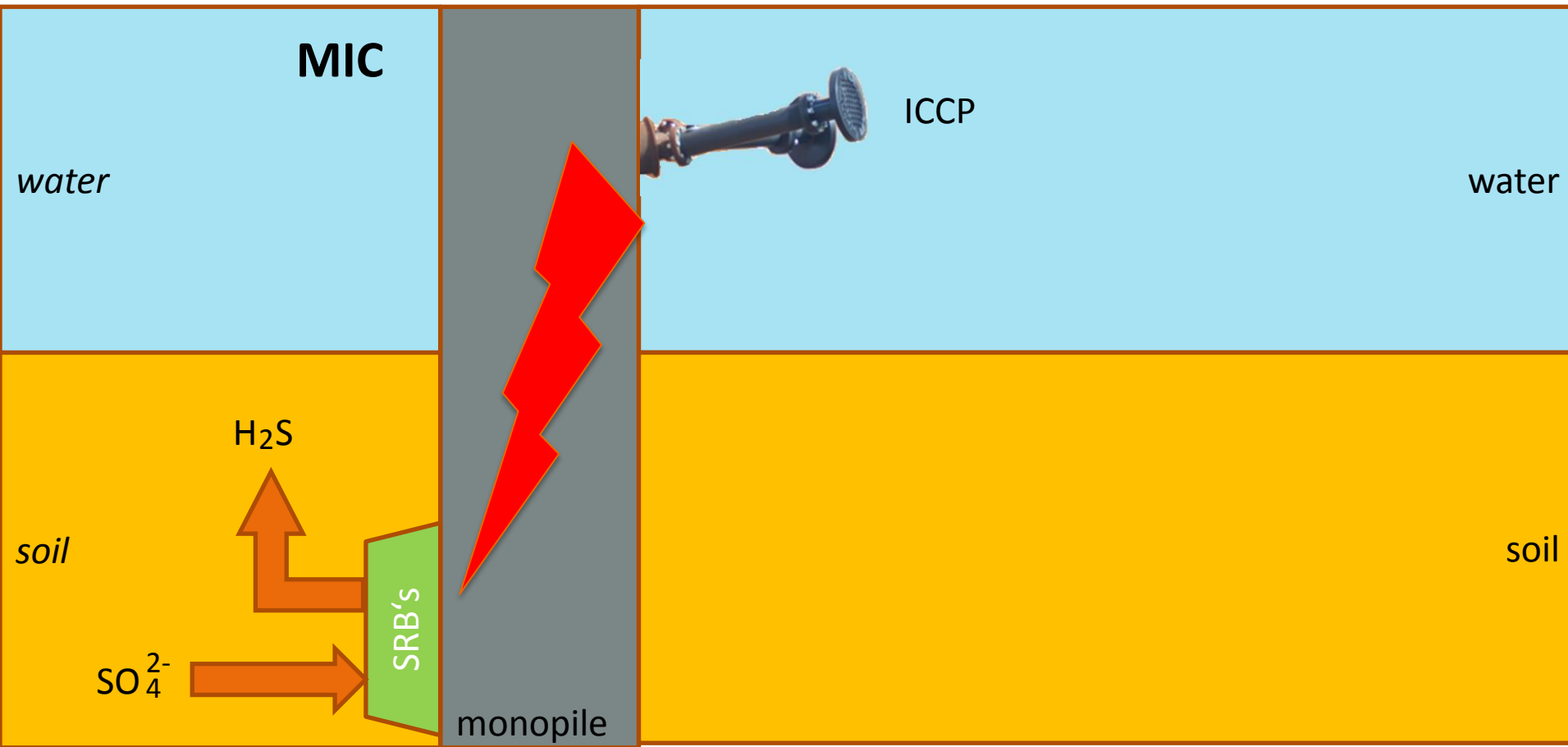
Fouling



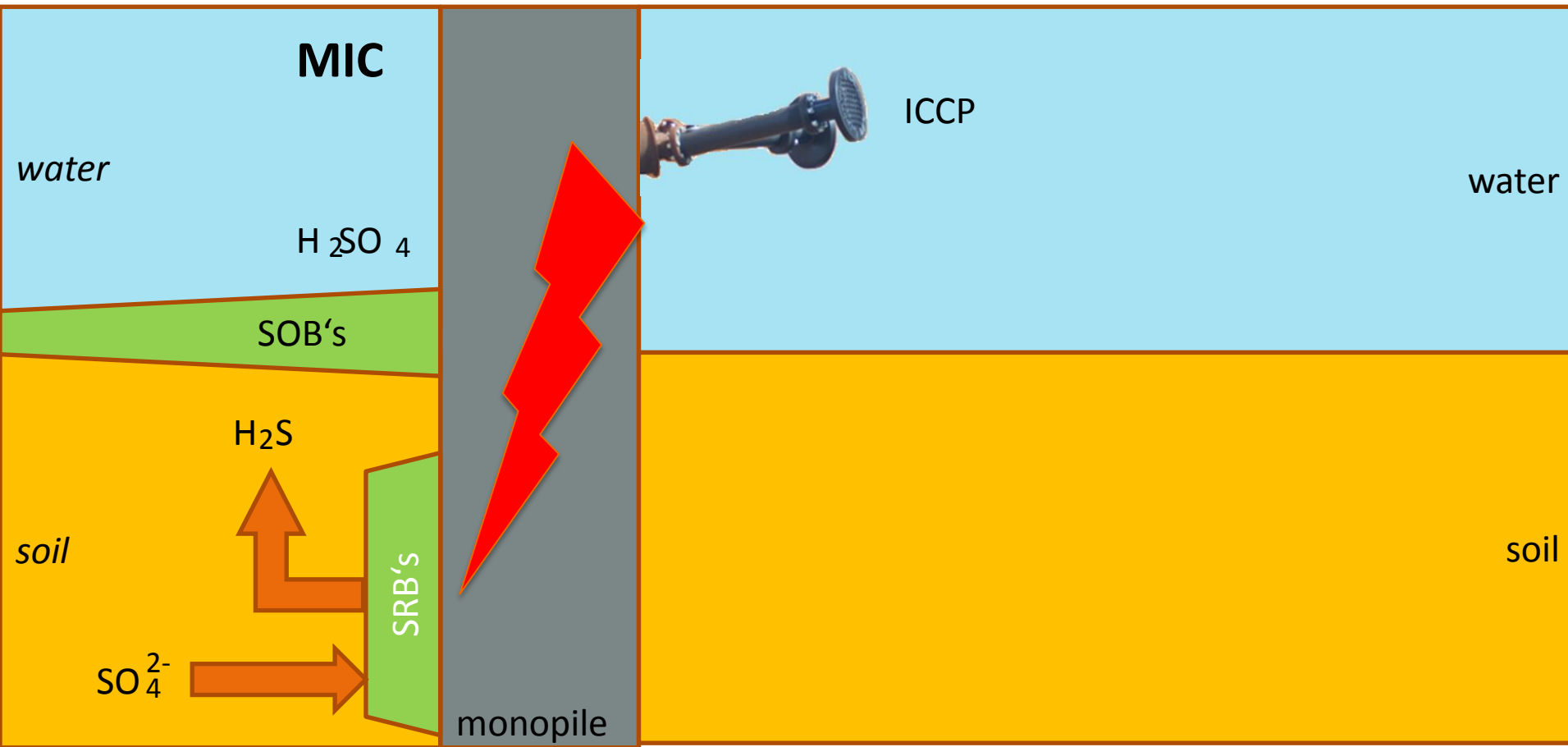
MIC (microbiological induced corrosion)



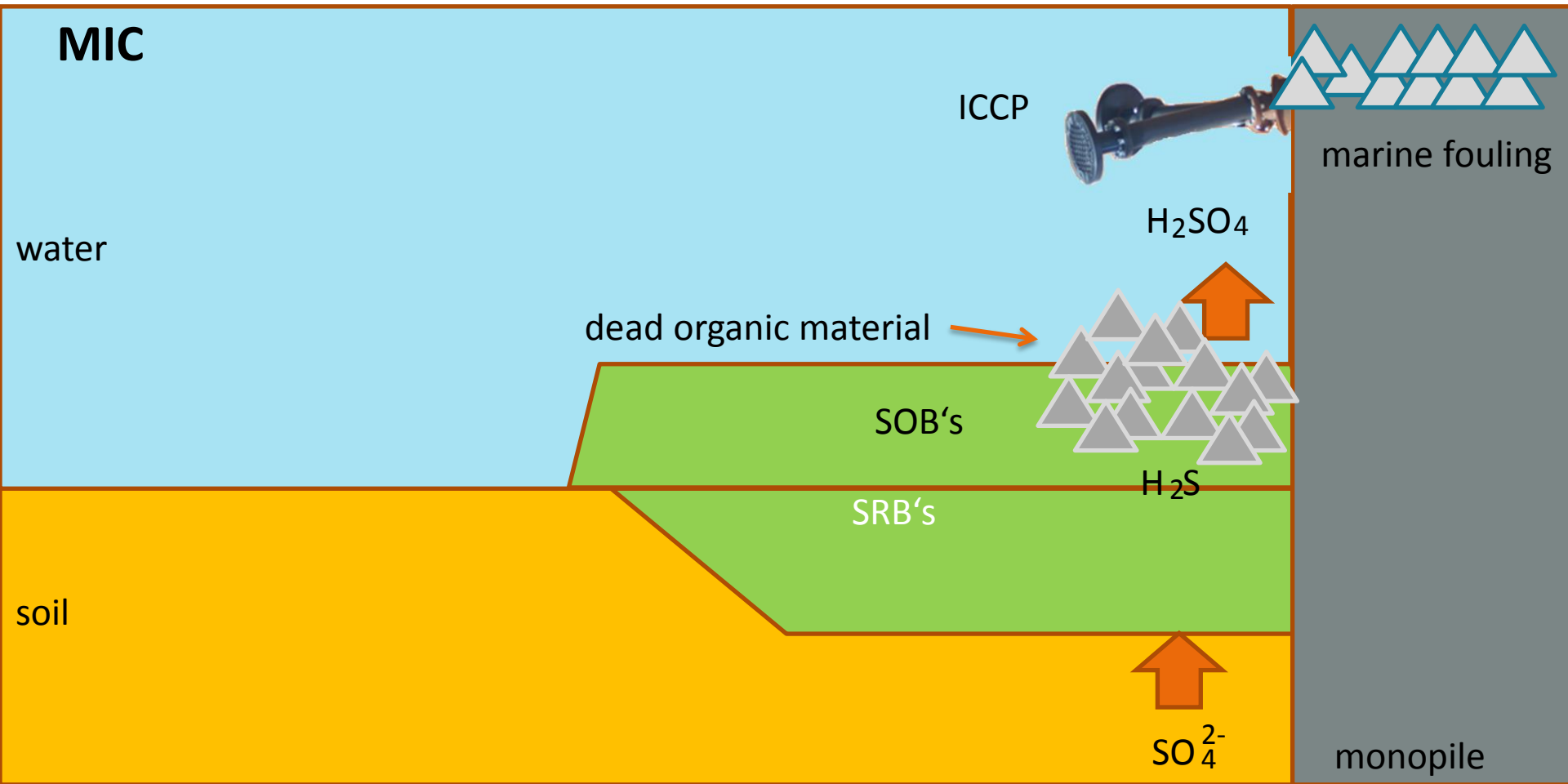
Protective current might increase the risk of acid corrosion by biogen produced acid and may lead to a faster colonization bei SRB's (Sulfat reducing bacteria)



The acid corrosion risk will increase, if the process closely interact with each other combined SOB's especially in the pothole area.



Marine fouling will increase the risk further on



Cathodic delamination by using protective current (ICCP)

- ✧ The damage in the coating might lead to almost similar conditions like the behavior mentioned (Eder-dam)
- ✧ Equale damages and corrosion rates might be possible like occurred at Eder-dam.



Goal of the presentation

- **What are the current possible methods for monitoring and testing for MIC or MIC risk?**
- The research, development and testing that has gone into our new MIC testing solution
- How does the testing equipment work on a practical level and how accurate are the results?
- What are the remedial activities that can be taken for MIC once it has been diagnosed at a site?

What are the current possible methods for monitoring and testing for MIC or MIC risk?

- Pyrosequencing of the whole DNA in the sample
Information of the diversity of the sample.
MIC activity not proofed! Even if SRBs are present.
- Analytic of minerals formed indicating microbial activity Thiosulfat, Sulfur, Sulfids, Jarosite
is not a proof that MIC occurs actually
- Cultivation under specific conditions to isolate SRB's
is not a proof, that a local MIC process is running!
- Further genetic methods like PCR with specific primers for SRB's genes in the sample, DGGE
and analyses of mRNA
are not a proof, that a local MIC process is running!

What are the current possible methods for monitoring and testing for MIC or MIC risk?

The use of monitoring data, as a first indicator for a increasing risk

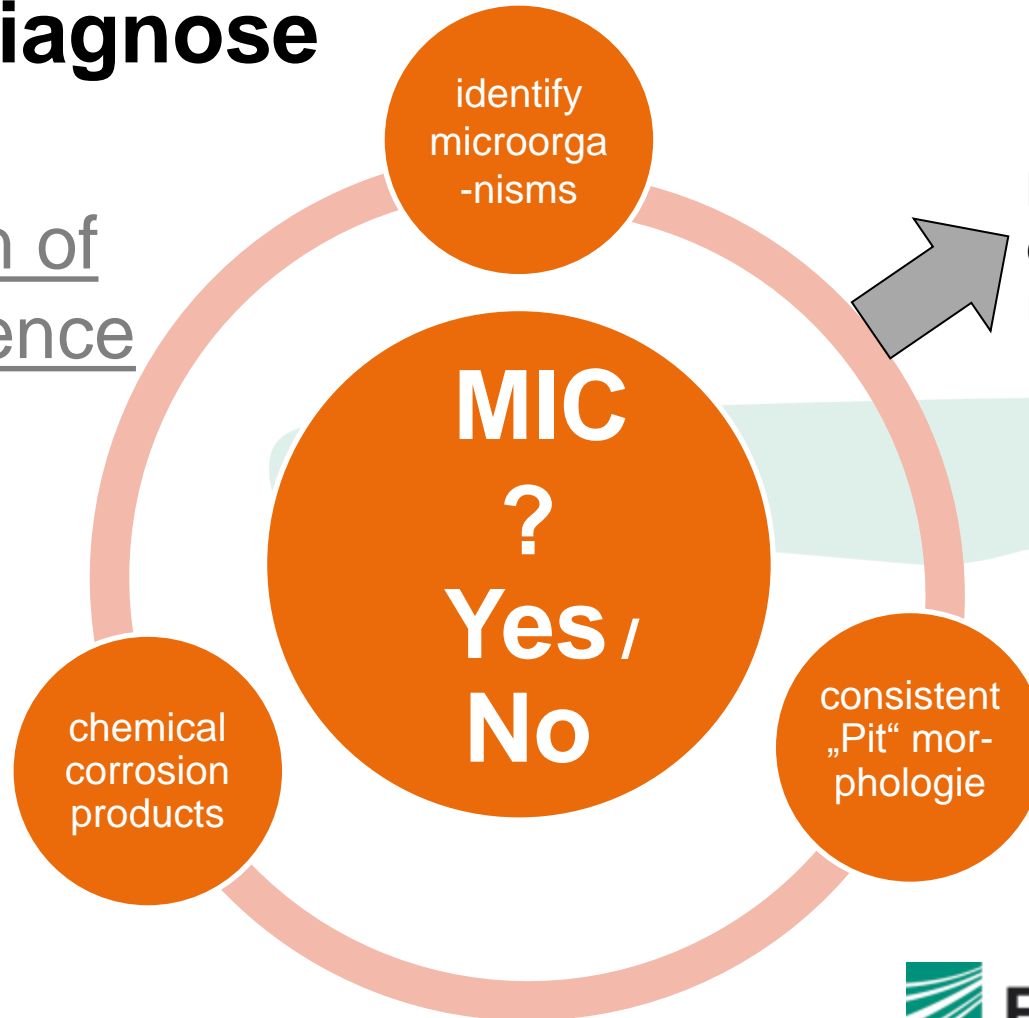
- Increased corrosion progress in the mud zone as an possible indicator for microbial activity measured by a free iron sample and a capsuled reference iron sample
- Coupons mostly fixed inside of monopiles. Weight loss of the coupon and apperance
- Measurement of oxygen, pH, conductivity
- Visual inspection

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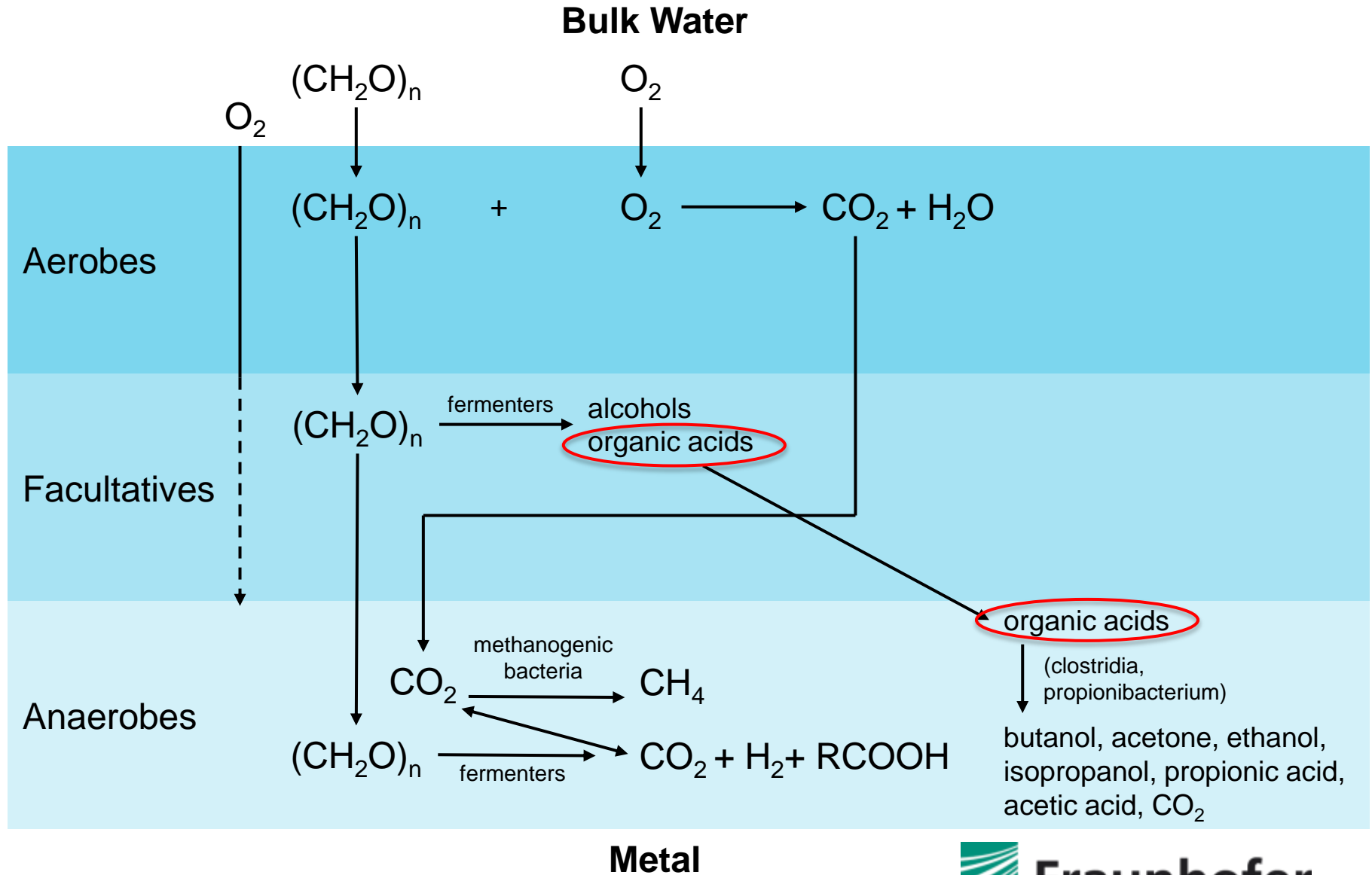
Microbiological influenced corrosion (MIC) diagnose

chain of
evidence



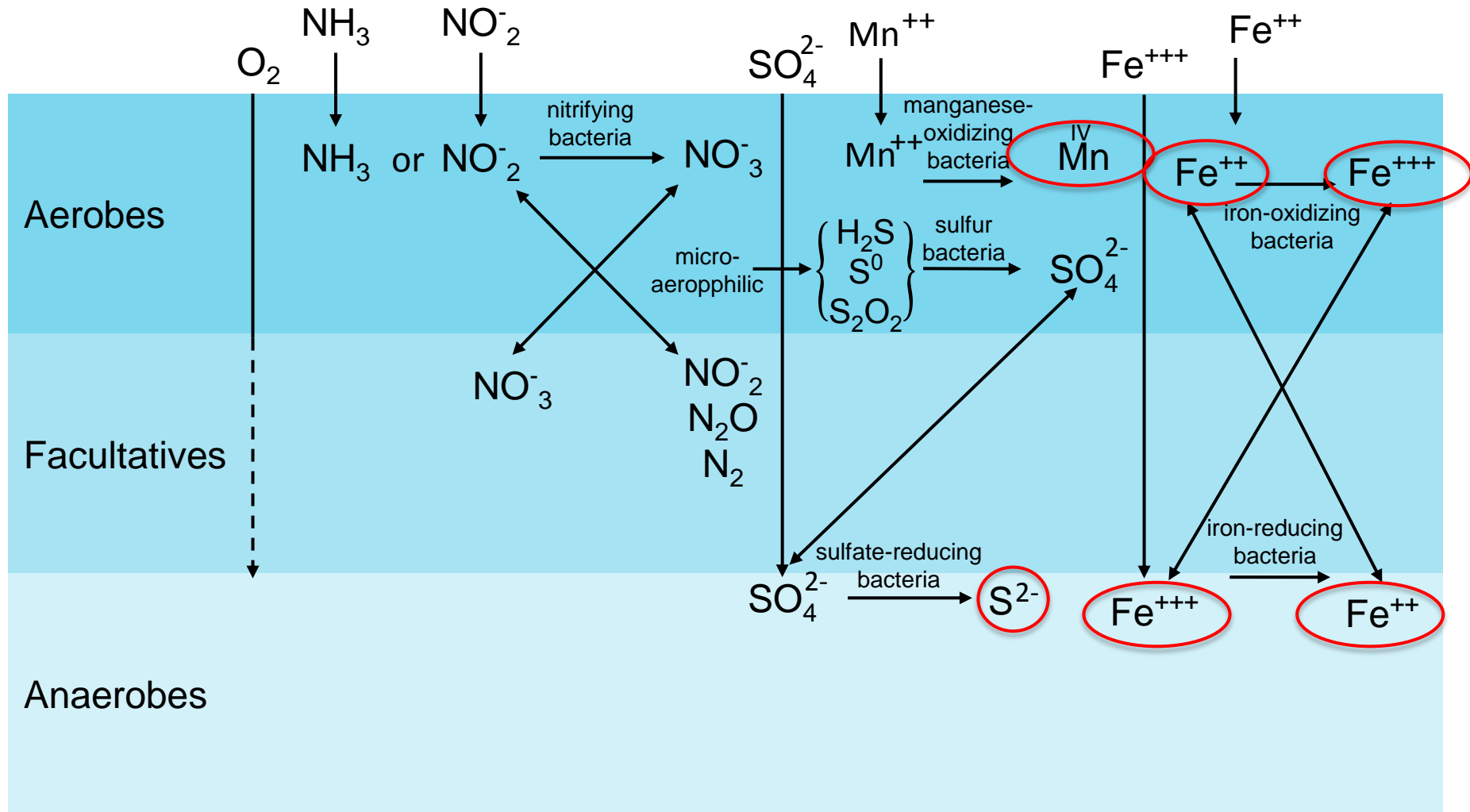
**industrial
biochemical-
quick assay for a
reliable proof**

Mechanisms of Microbial influenced Corrosion



Mechanisms of Microbial influenced Corrosion

Bulk Water



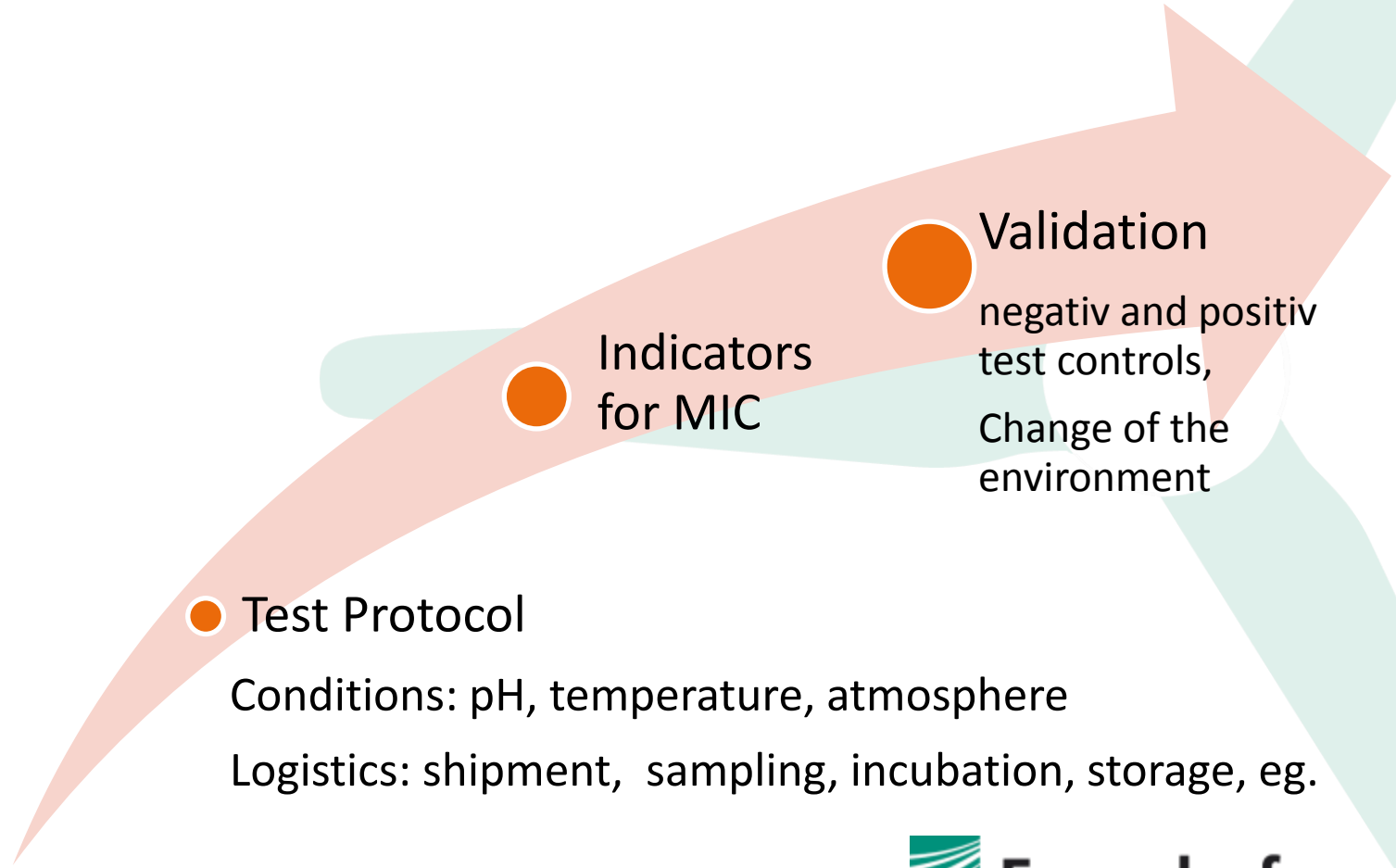
Metal

Limitations of current detection methods

Limitations

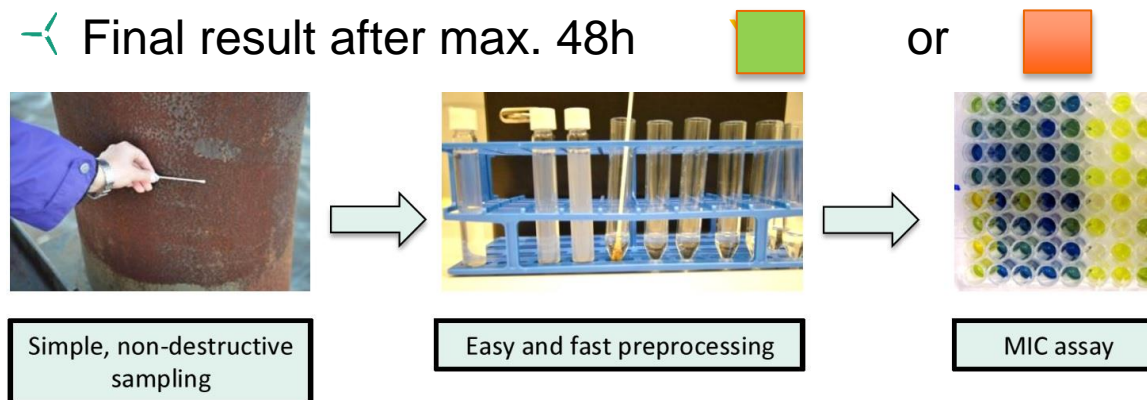
- Culture techniques underestimate the organisms in natural populations
- Complexity of a natural environment cannot be reproduced exactly
- Incubation temperature selective
- Detection or demonstration of bacteria associated with corrosion is not diagnostic for MIC
- Microorganisms ubiquitous, so there is no relationship between the presence, type or levels of planktonic or sessile bacteria and the occurrence of pits
- ...

Development process

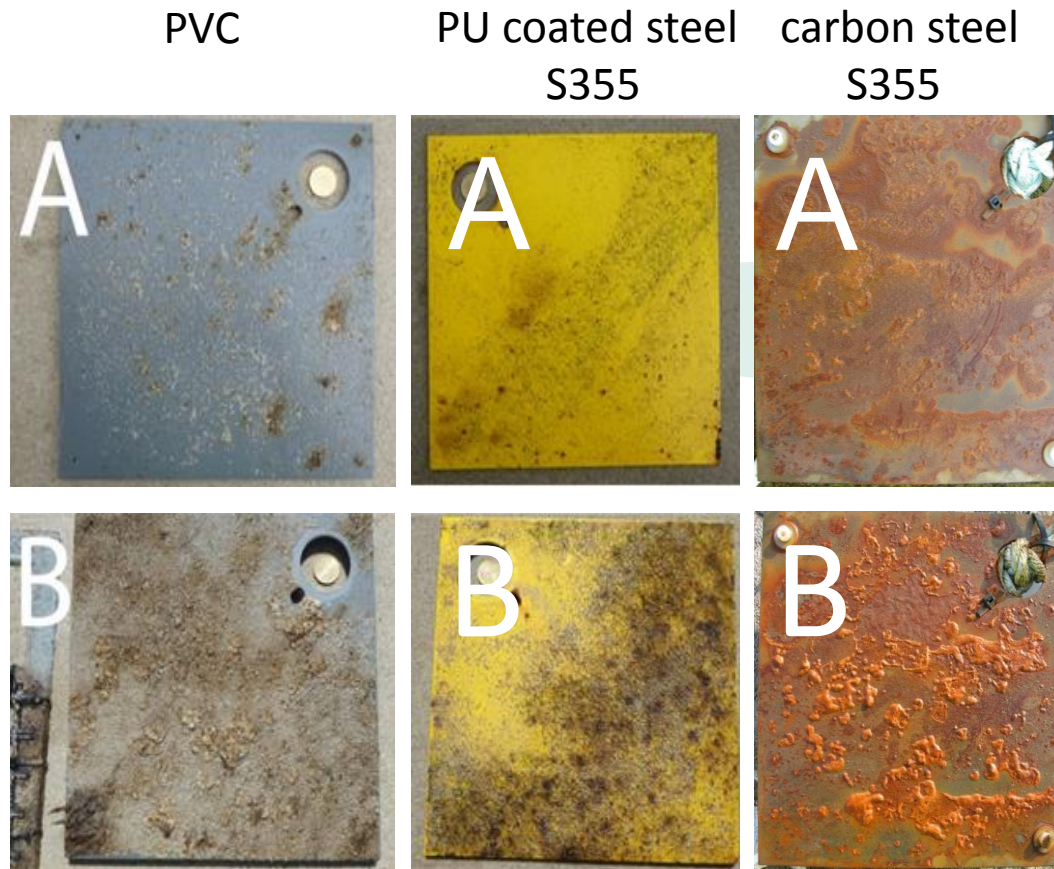


Features of the Test

- ↘ Direct, non-destructive sampling of the biofilm of a steel surface.
(Sample can be taken by a customer, by using the testkit)
- ↘ The test kit procedure is adopted to easy and efficient sampling
- ↘ Microbial growth is not necessary for the biochemical assay
- ↘ Standardised photometrical measurement (High sampling speed)
- ↘ Computer based data analysis
- ↘ Final result after max. 48h



Marine field-tests as a tool for validation



2 weeks

6 weeks

Controlled laboratory conditions used as tool for validation

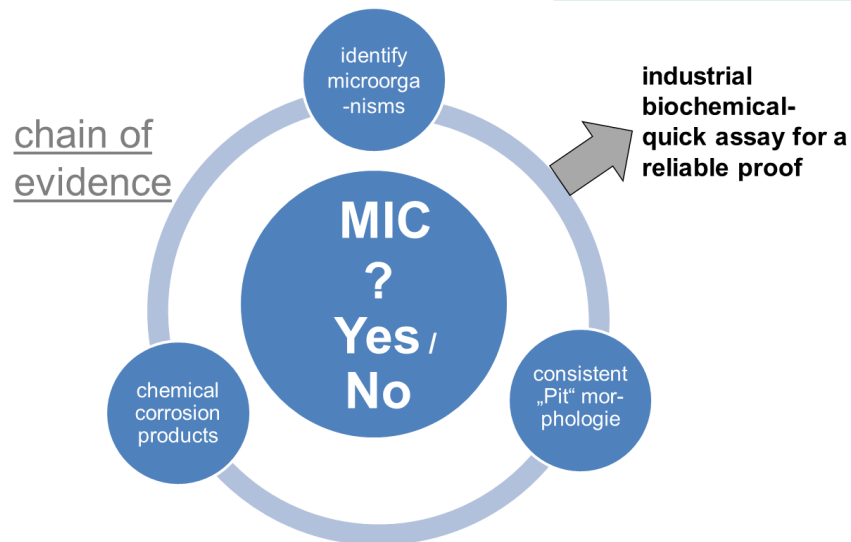


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How does the testing equipment work on a practical level and how accurate are the results?

- ↘ Validation tests in laboratory (microcosms) as well as in the field led to reproducible results
- ↘ Specific enzymes, pitted and typical corrosion products were detected.
- ↘ Sequencing data showed indicator bacteria (SOBs, SRBs, IRBs etc.)
- ↘ Negative controls and statistics were used to ensure that the data is high quality



You are interested to apply the new method to your project?

We had already started with the next step and analyse samples that are taken from specific locations like windfarms.

If you are interested send an e-mail to:

oliver.kranz@iwes.fraunhofer.de

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What are the remedial activities that can be taken for MIC once it has been diagnosed at a site?

- Involve an expert in further investigations
- Determine the size and area of the MIC-damage
- Check which mechanisms drive the MIC-process
- Evaluate the possible countermeasure opportunity

?

Acknowledgements

Fraunhofer IWES is funded by the:

Federal State of Bremen

- Senator für Umwelt, Bau, Verkehr und Europa
- Senator für Wirtschaft und Häfen
- Senatorin für Bildung und Wissenschaft
- Bremerhavener Gesellschaft für Investitions-Förderung und Stadtentwicklung GmbH

Federal State of Lower Saxony

Federal Republic of Germany

Federal Ministry for Economic Affairs and Energy (BMWi)

with support of the European Regional Development Fund (ERDF)



Lower Saxony

Supported by:



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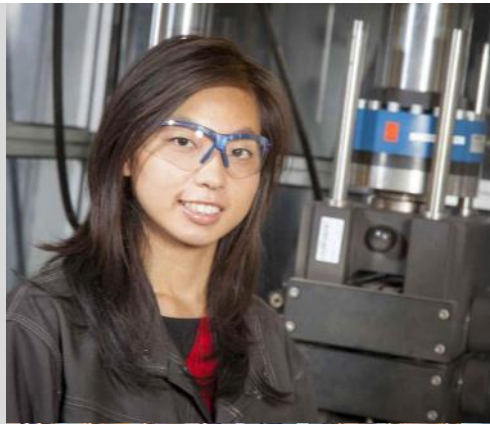
Fraunhofer
IWES

Our employees are all

innovation accelerators

efficiency boosters

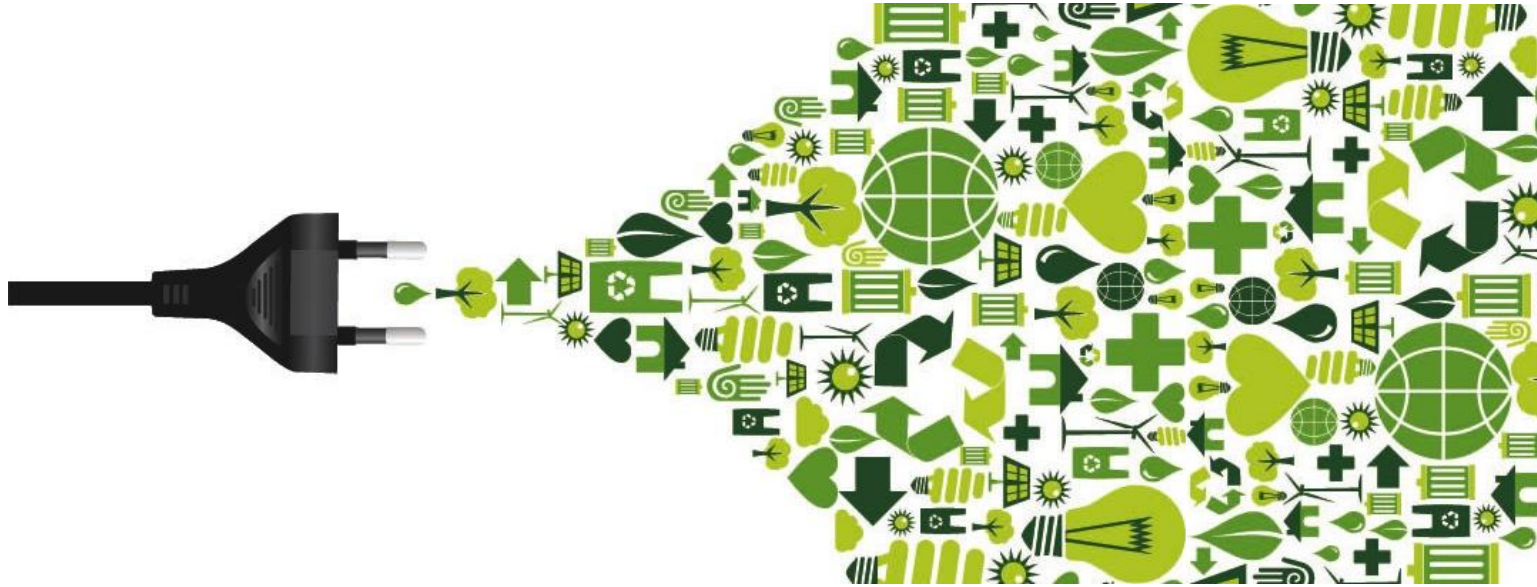
competence linkers



concept expanders

knowledge intensifiers

planing securers



THANK YOU FOR YOUR ATTENTION

Any questions?

oliver.kranz@iwes.fraunhofer.de (Oliver Kranz)