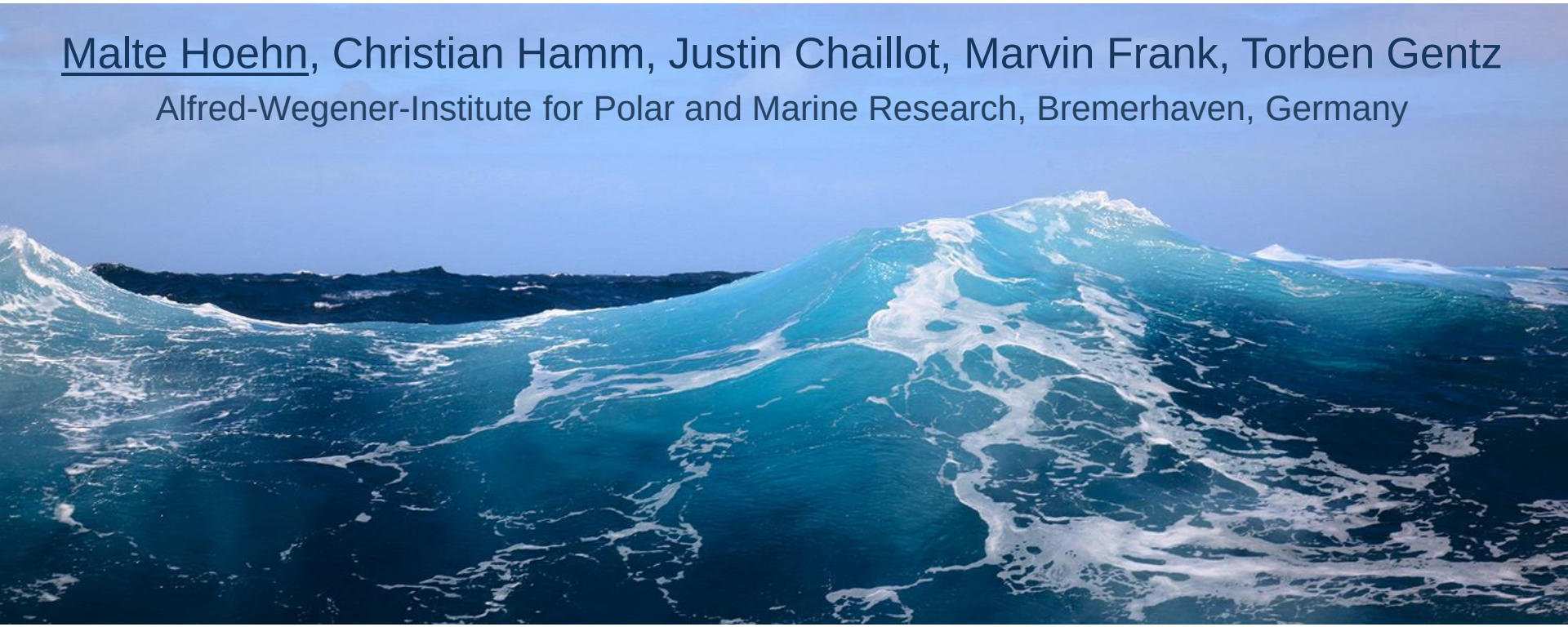
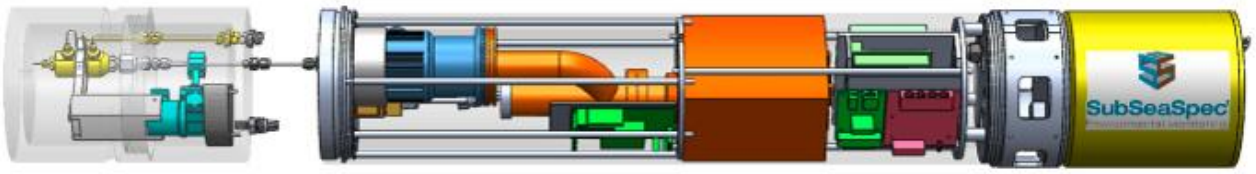
AN OPTIMIZED MEMBRANE INLET SYSTEM (MIS) FOR UNDER WATER MASS SPECTROMETRY (UWMS)

Malte Hoehn, Christian Hamm, Justin Chaillot, Marvin Frank, Torben Gentz

Alfred-Wegener-Institute for Polar and Marine Research, Bremerhaven, Germany





Bremen Der Senator für Umwelt, Bau und Verkehr

AWI ALFRED-WEGENER-INSTITUT HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Bremerhavener Gesellschaft für Investitionsförderung und Stadtentwicklung mbH bis

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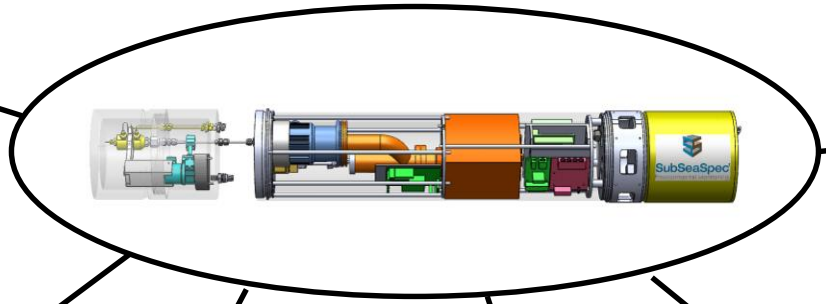
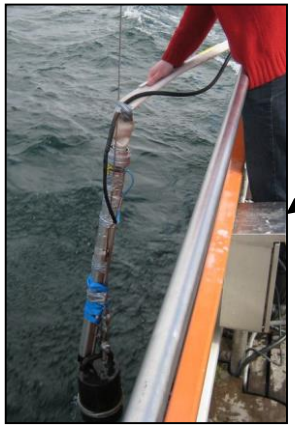
UNDER WATER MASS SPECTROMETRY: HARSH ENVIRONMENT?

UNDER WATER MASS SPECTROMETRY

Saab Saabertooth AUV

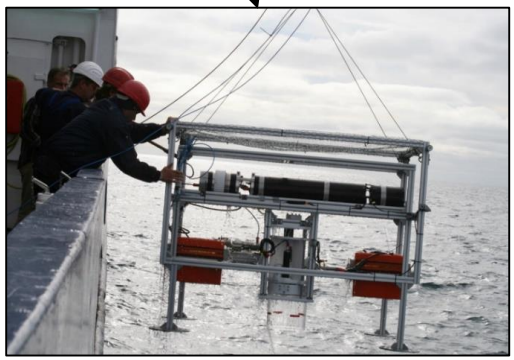


Laboratory measurements



Ex situ

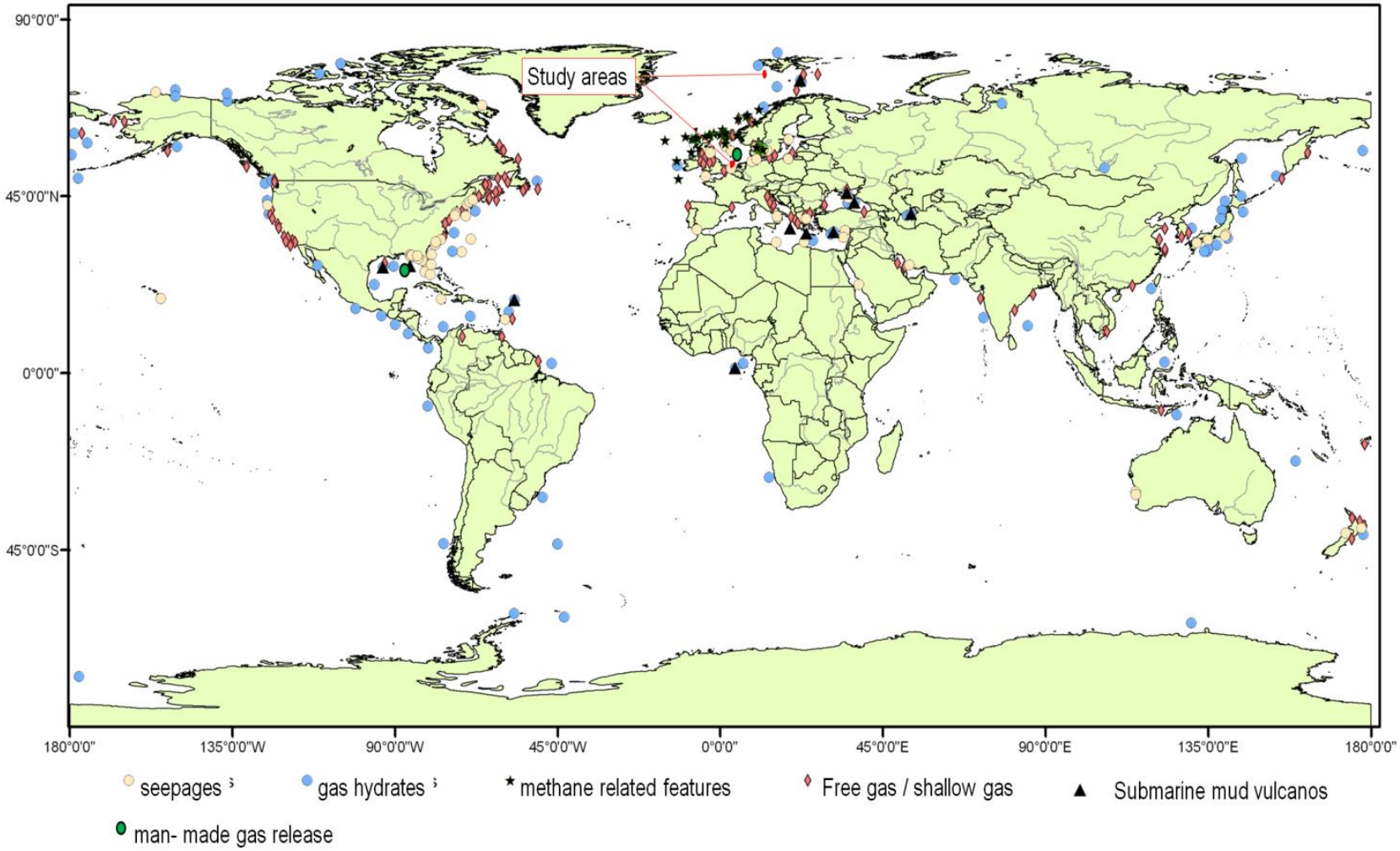
AUV



In situ in a frame
including benthic chamber

In situ at sediment-
water-transition-zone

GLOBAL RELEVANCE OF METHANE IN AQUATIC SYSTEMS



Worldwide distribution of submarine mud volcanos (Milkov 2000), gas hydrates (Kvenvolden et al. 2001), free gas occurrence (Fleischer et al. 2001), and pockmarks (Hovland et al. 2002).

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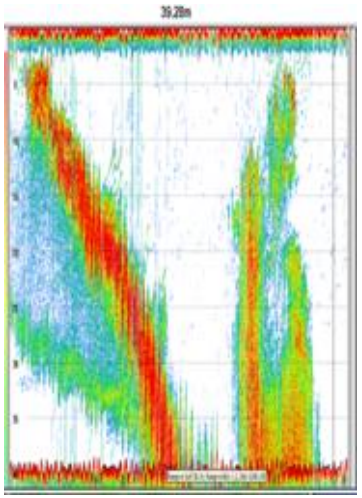
STATE OF THE ART

Water column sampling

Headspace technique for analysis of discrete samples

Gas analysis by gas chromatography

Phase separation: gas phase from aqueous phase



Acoustic “image” of gas bubble plumes in the water column.

RV Heincke

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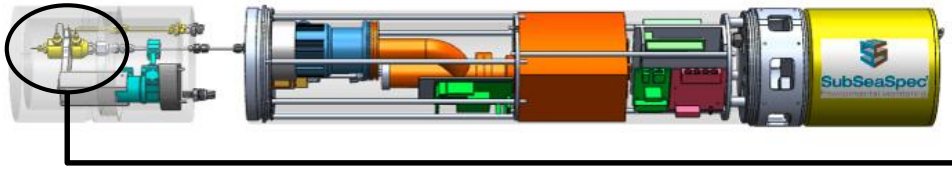
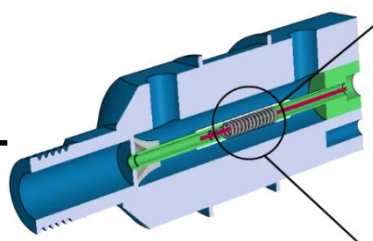
THE PRESSURE

THE MEMBRANE INLET SYSTEM (MIS)

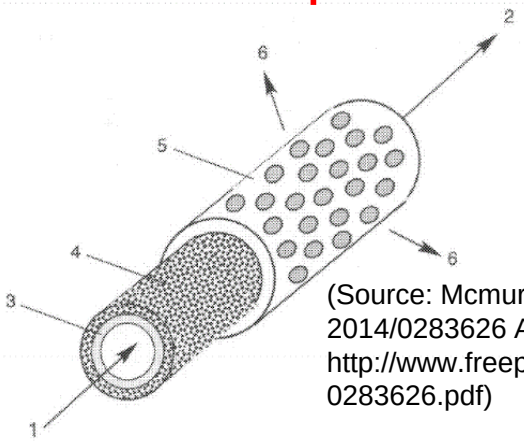




Supporting structure

Sintered material:

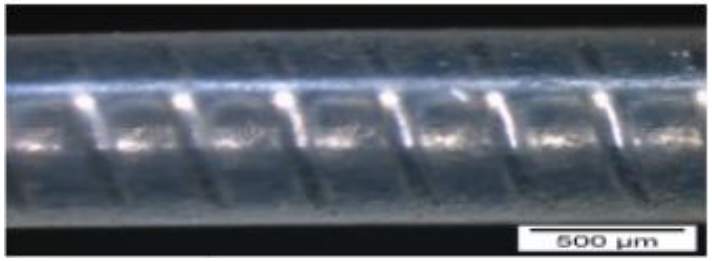
- Low porosity
- ✓ High pressure stability
- Bad reproducibility



(Source: Mcmurtry Patentnumber: US 2014/0283626 A1; http://www.freepatentsonline.com/20140283626.pdf)

Steel Spring:

- ✓ High porosity
- Low pressure stability
- ✓ Great reproducibility

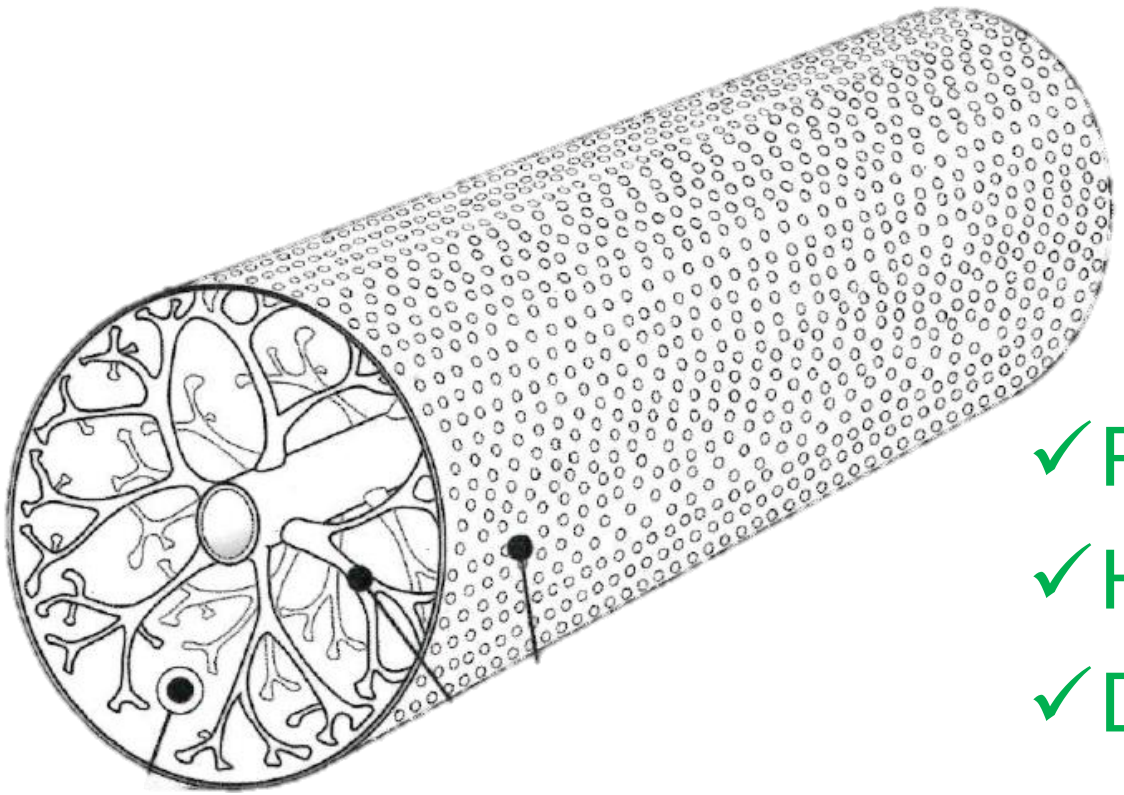


(Source: Gentz and Schlueter)

→ Combine the best properties?!

THE STRUCTURE

- „Tree“-stabilisation inside
- Holes in the surface
- Tube in the structure for additional heating management



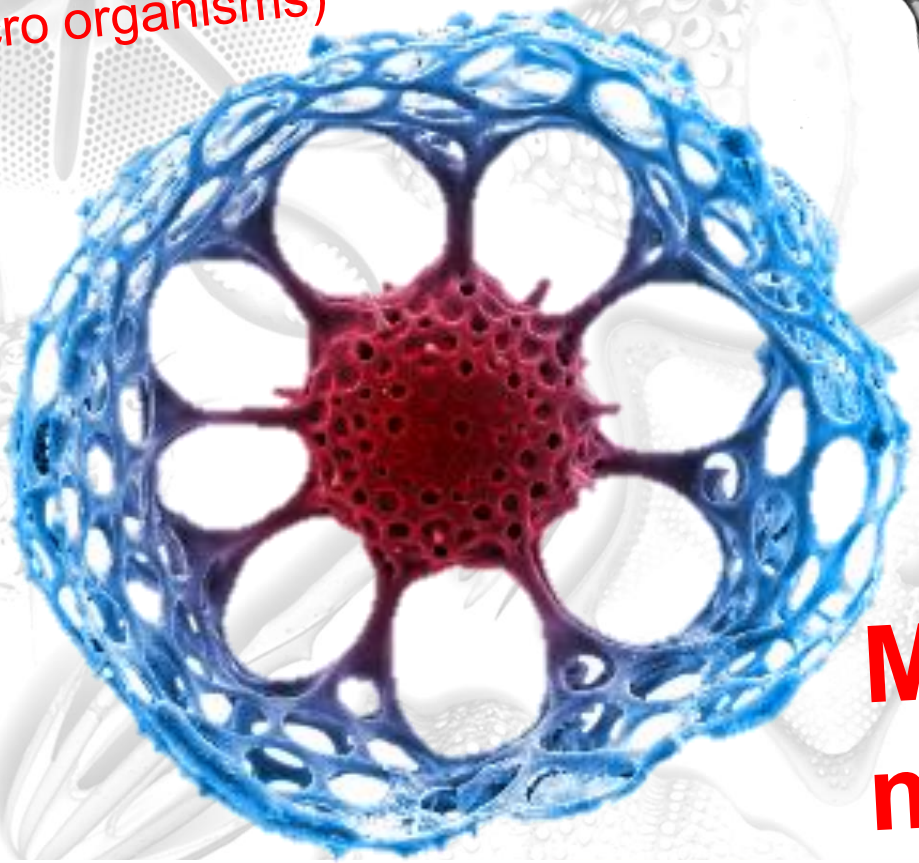
✓Reproducibility

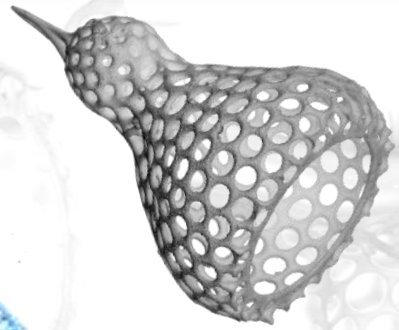
✓High porosity

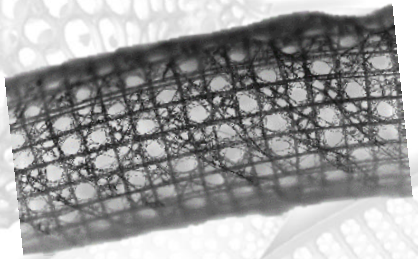
✓Depth up to 4000 m

EliSE – BIONIC LIGHT WEIGHT

Diatoms
(micro organisms)





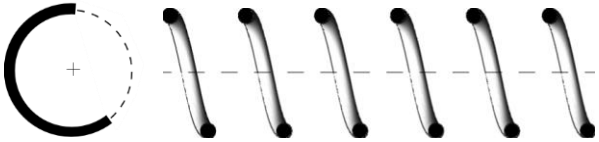
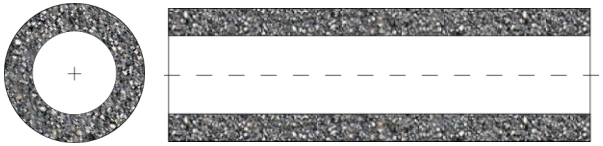
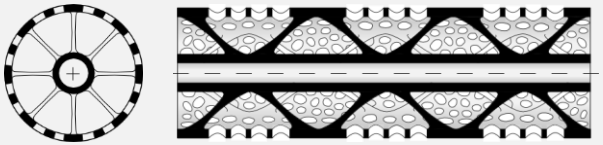


Manufactured by micro-printing

Adapt structures from micro organisms out of harsh environmental surroundings

THE STRUCTURE

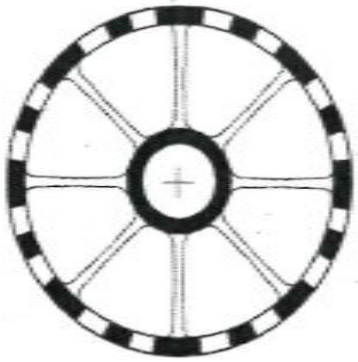
Advantages / disadvantages

Supporting structure		Pressure stability	Permeability	Reproducibility	Heating
Steel spring		↯	✓	✓	↯
Sintered		✓	↯	↯	✓
Developed		✓	✓	✓	opt.

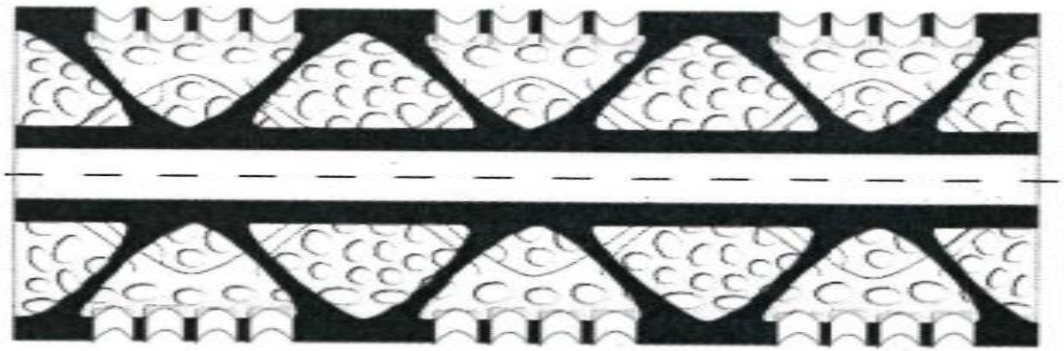
THE STRUCTURE

- Additive 3D-microprinting of steel
  - Precision up to 50 µm
  - Complex structures possible
- Membrane material is limiting the porosity

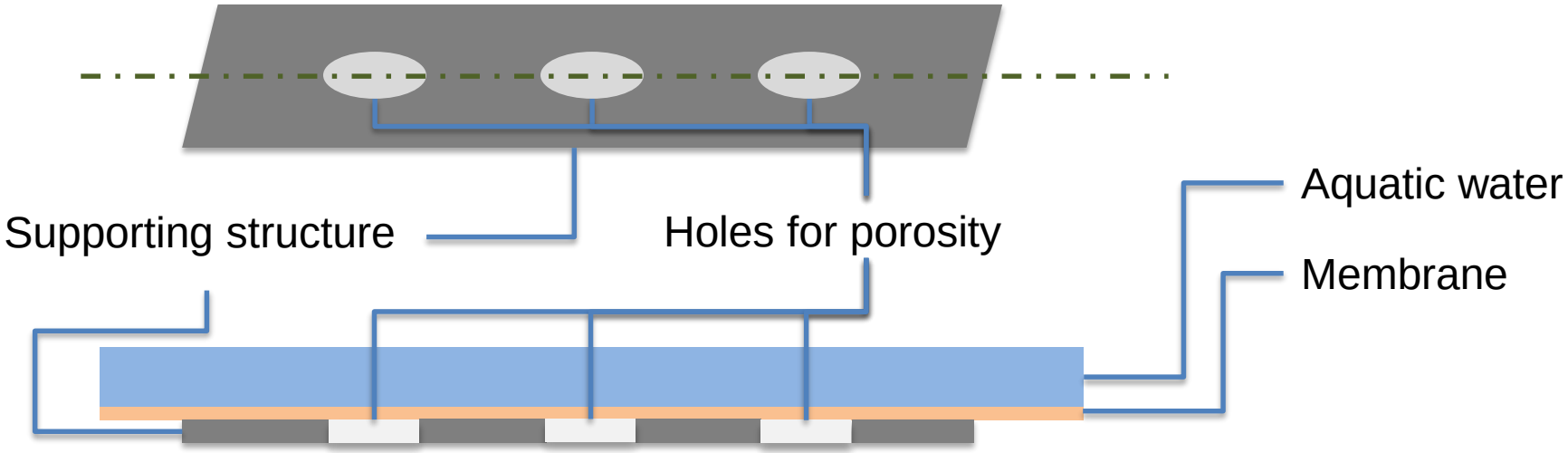
$\sim 1/8"\ (3mm)$



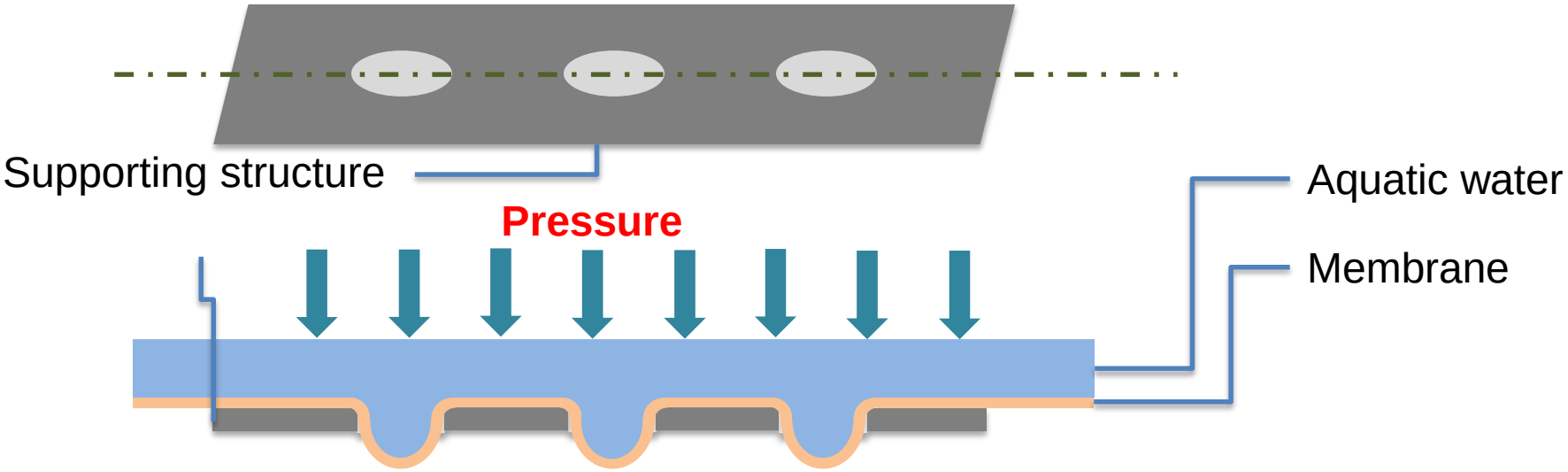
$\sim \frac{1}{2}"(13\text{mm})$



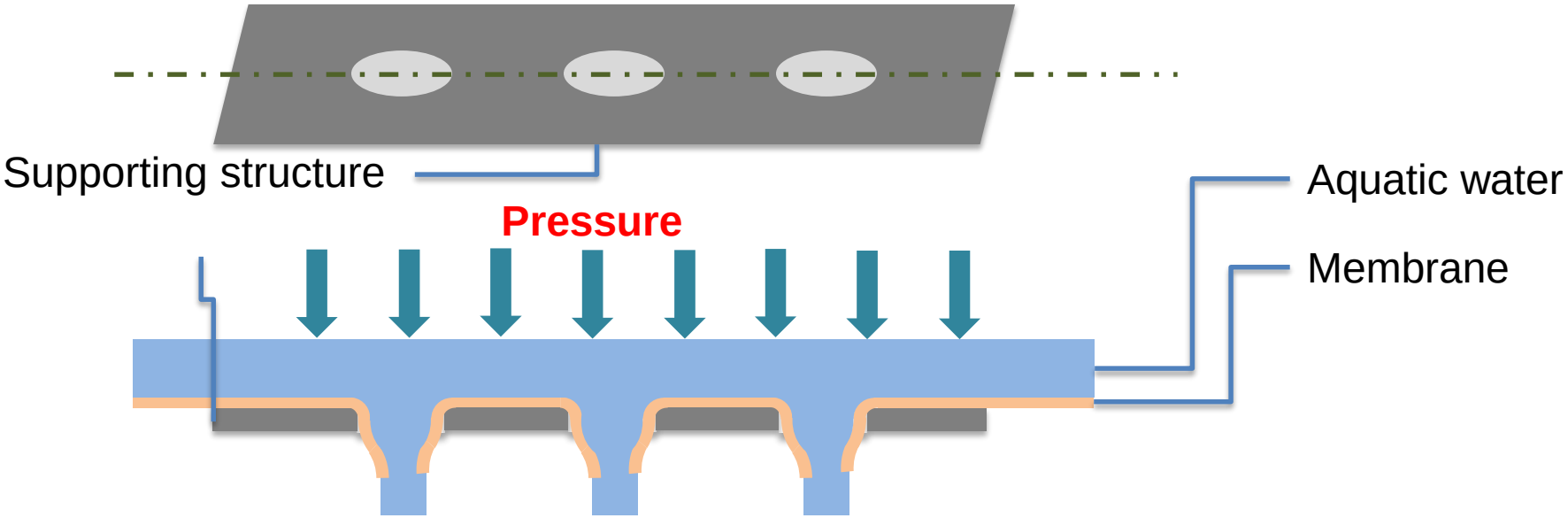
THE STRUCTURE



THE STRUCTURE

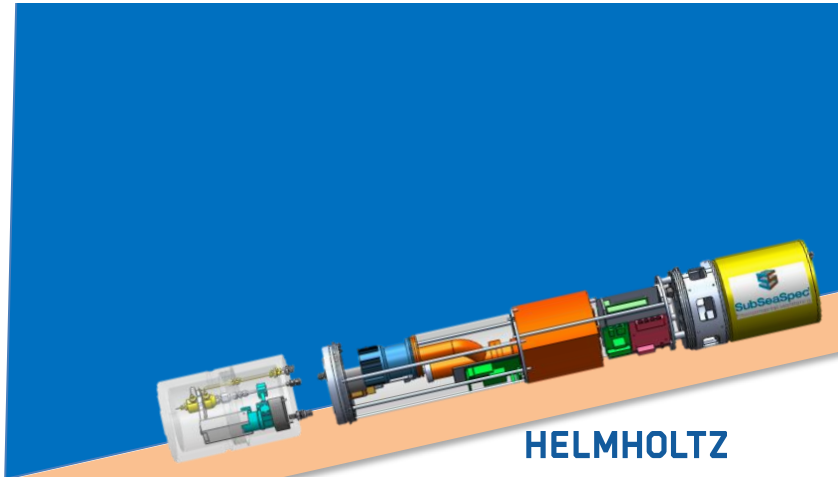


THE STRUCTURE



Too high pressure / oversized holes

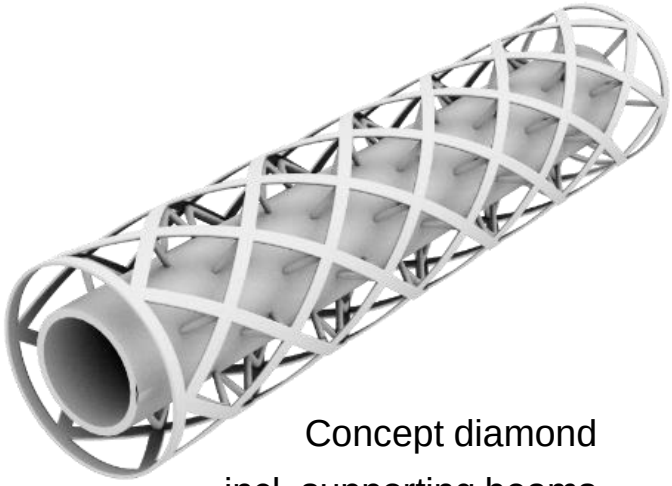
Damaged System - Cut rope and leave at the ground



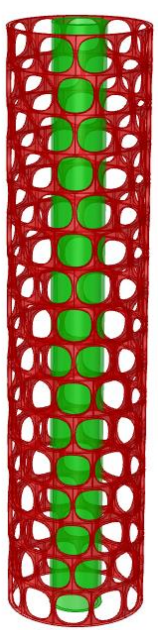
THE STRUCTURE

Design concepts

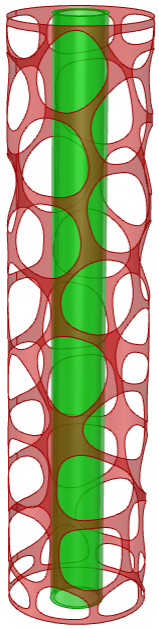
- Adapt functions
- Solve requirements
- Production-oriented design



Concept diamond
incl. supporting beams



Concept ellipse



Concept comb

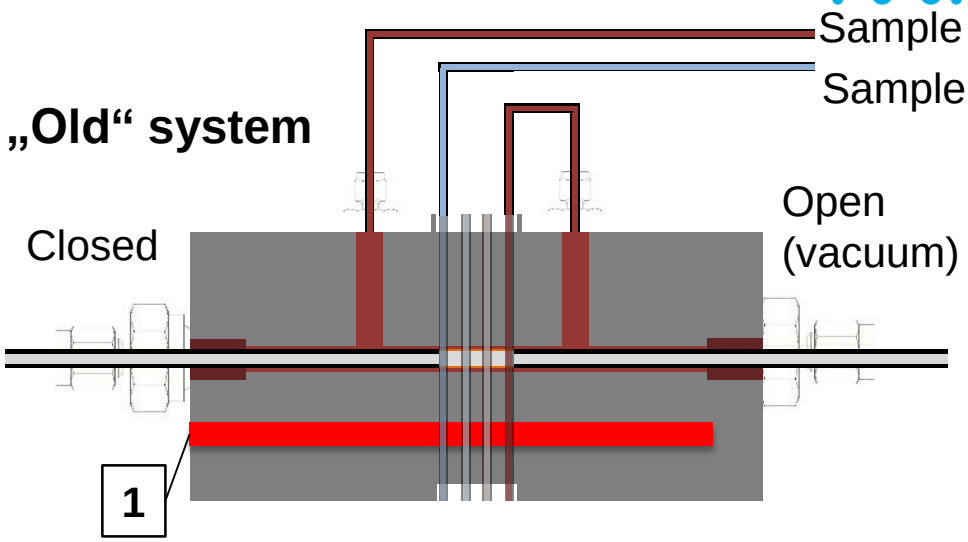
Concept diamond

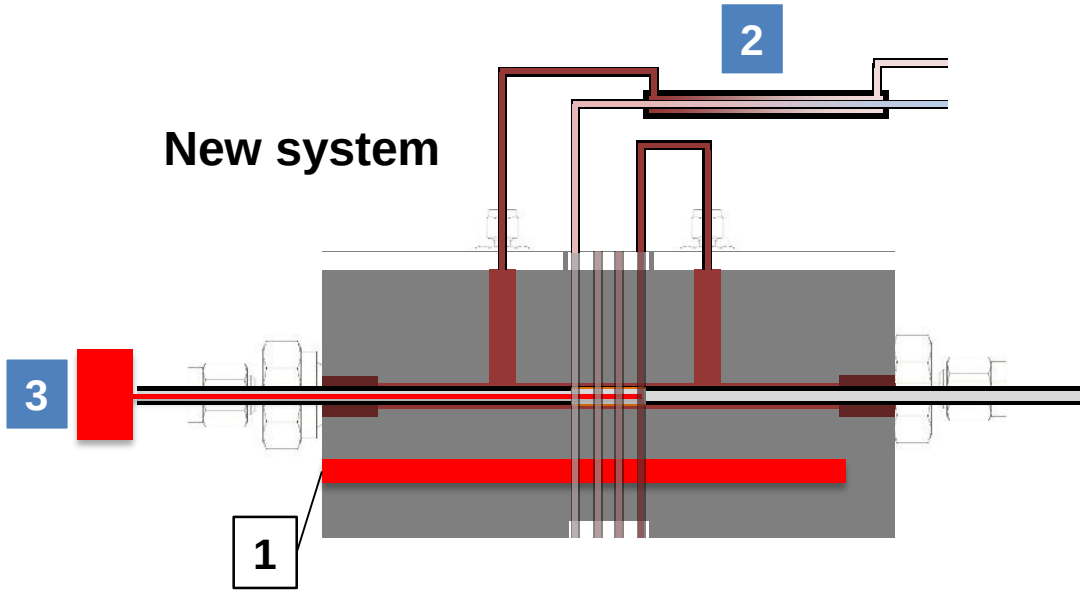
Not suitable for production

HEATING MANAGEMENT

Three integrated modules for the heating management:

1. Heating of the steal body with cartridge heaters
   - Heating of the twisted tubes
2. **Heat exchanger**
   - **from 1 heated water heats the inflowing**
3. **Internal membrane heating**





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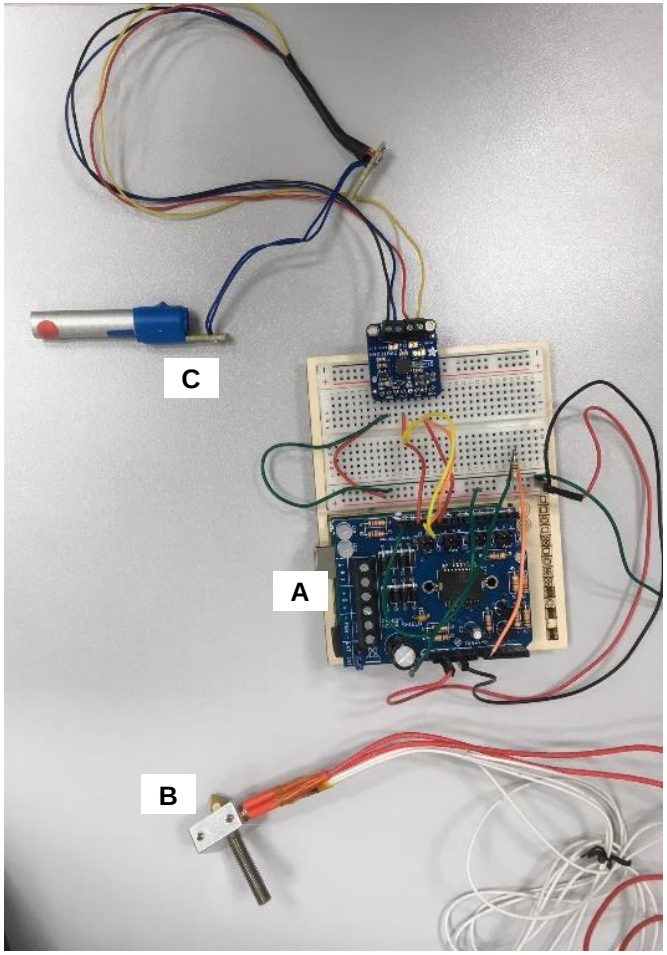
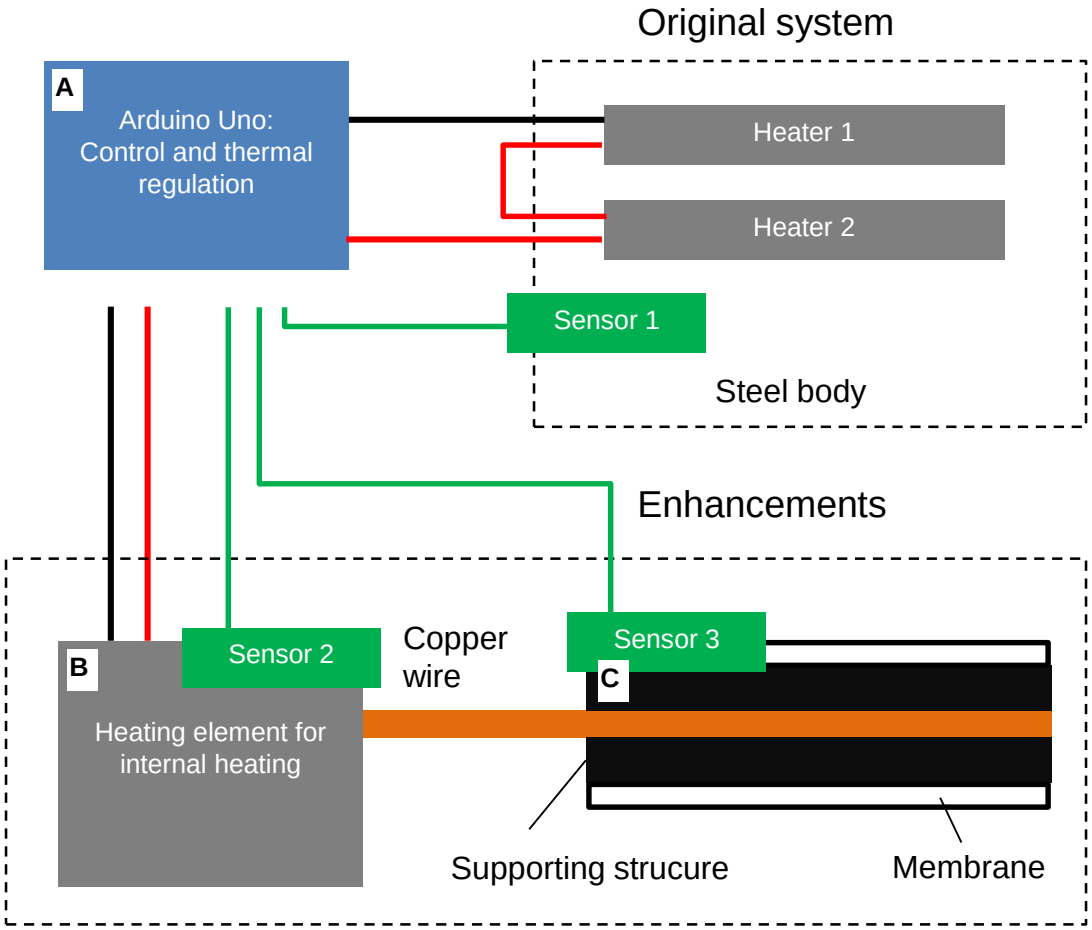
HEATING MANAGEMENT

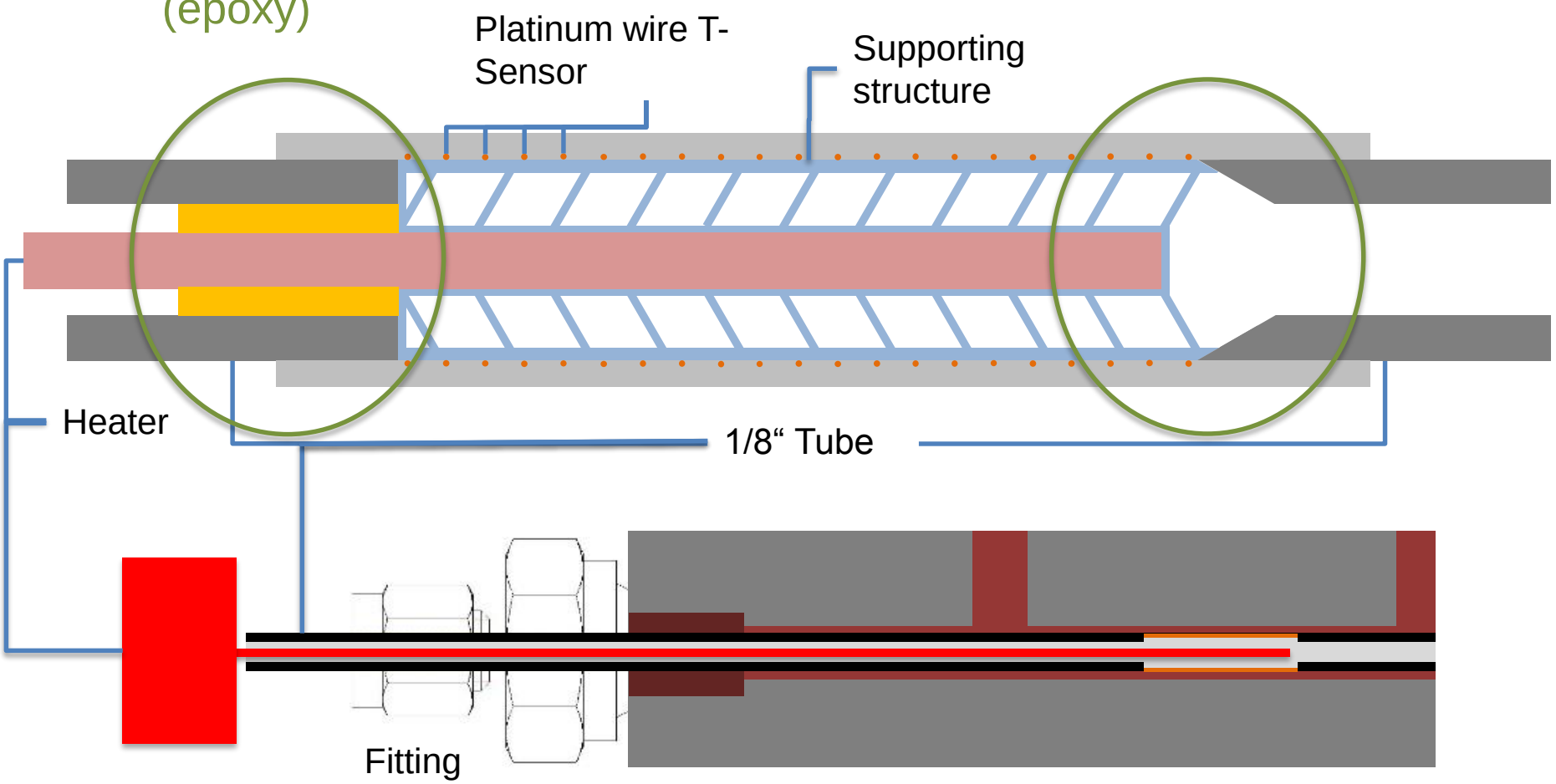




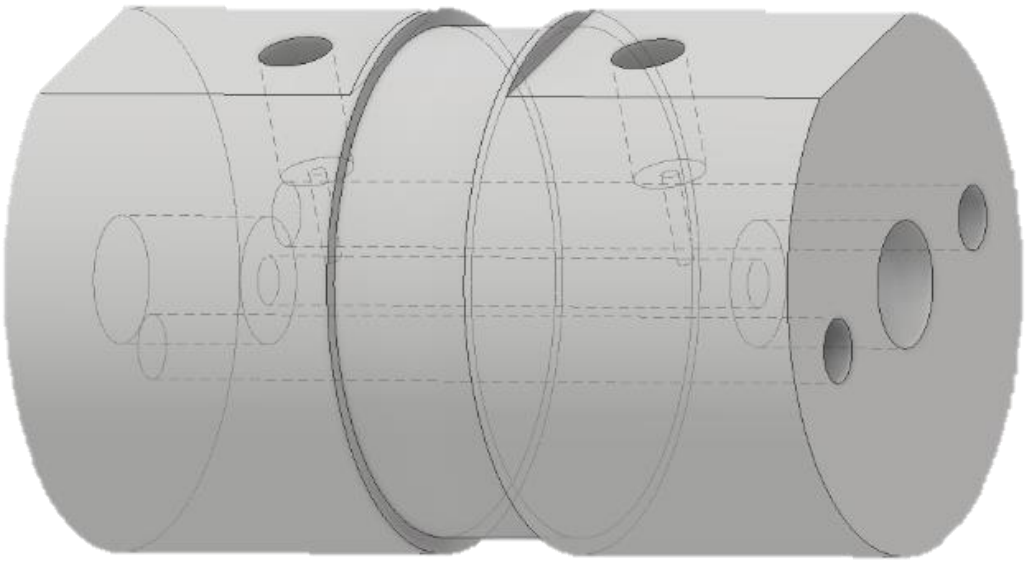
HEATING MANAGEMENT

External heating of a thermal element

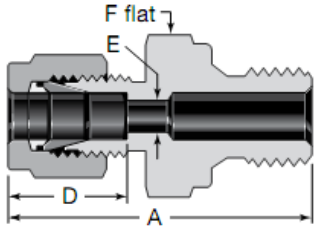
Centering with conus and heating element (epoxy)



OTHER DEVICES & COMPONENTS



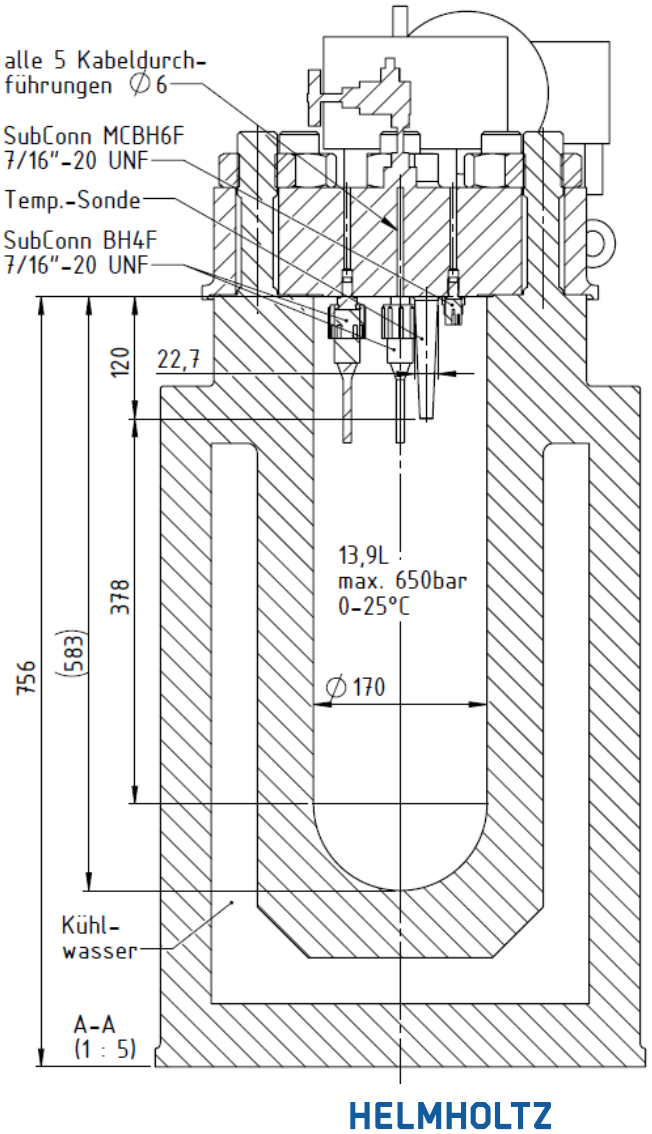
- More stable steel body
  - 5cm diameter
  - New design
- Fittings
  - Other seals
  - Other fixation of the tubes



(Source: swagelok.com)

TEST OF THE DEVELOPED SYSTEM

- AWI pressure tank for tests
  - Up to 650 bar
  - Component groups
    - Supporting structure & membrane
    - Fittings & tubes
    - MIS steel body
- HPLC-pump
- Final expedition



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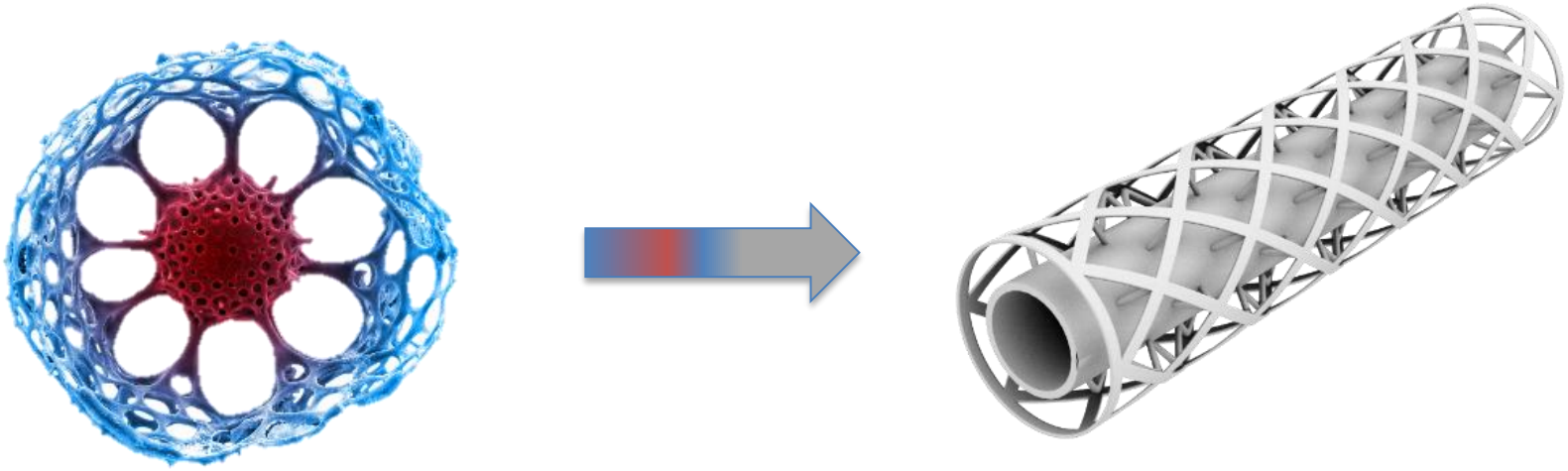

- ✓ High porosity
- ✓ High pressure stability
- ✓ High reproducibility

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Malte.Hoehn@awi.de