HELMHOLTZ
GEMEINSCHAFT

ROBEX Allianz

HGF-Alliance ROBEX
Robotic Exploration of Extreme Environments

„Lab on a Chip“ promising technology for space- and oceanographic missions

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UNIVERSITY OF Southampton

12th IPPW Cologne June 2015

ROBEX

ROBEX – marriage between space- and marine sciences

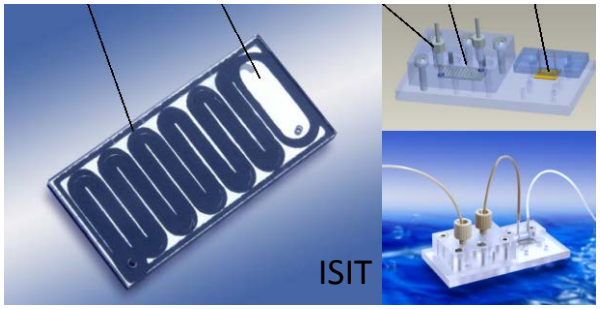
16 partners in Germany

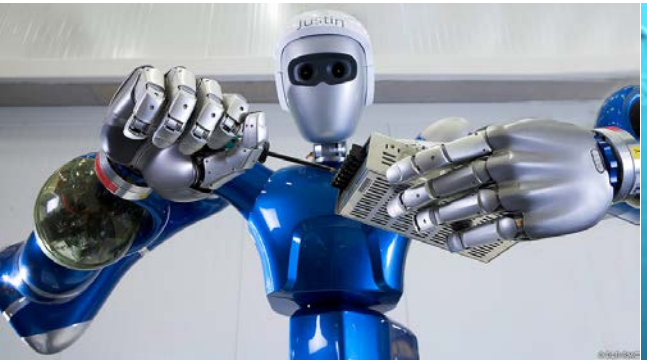
GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel
DLR
Deutsches Forschungszentrum für Künstliche Intelligenz GmbH
marum
JACOBS UNIVERSITY
AWI ALFRED-WEGENER-INSTITUT HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG
AIRBUS DEFENCE & SPACE
Universität Bremen
Technische Universität Berlin
Julius-Maximilians-UNIVERSITÄT WÜRZBURG
TECHNISCHE UNIVERSITÄT KAISERSLAUTERN
TECHNISCHE UNIVERSITÄT DRESDEN

Aim of ROBEX

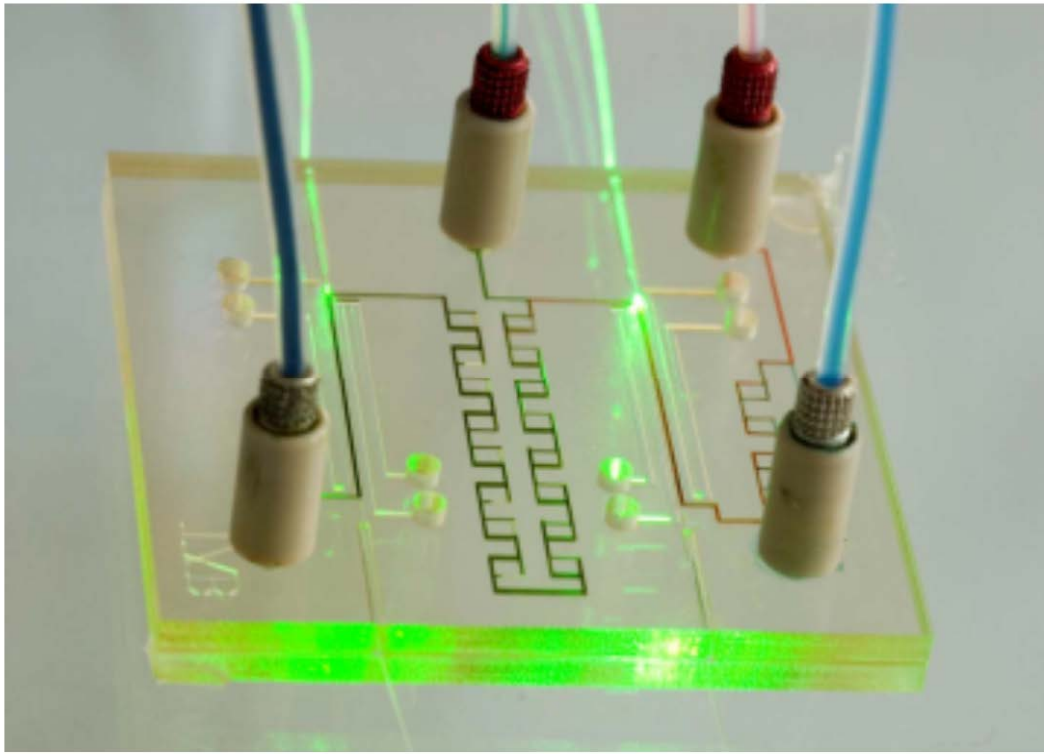
Bridging these scientific disciplines → novel technologies and approaches for the autonomous exploration of marine and space environments

- **Autonomous operation and manipulation**
- **System configurability, modularity**
- **Mobility and navigation**
- **Instrumentation** (e.g. Lab on the the chip technology)





Lab on the Chip Technology (LOC) – Microfluidic devices



Courtesy Legiret et al. NOC UK

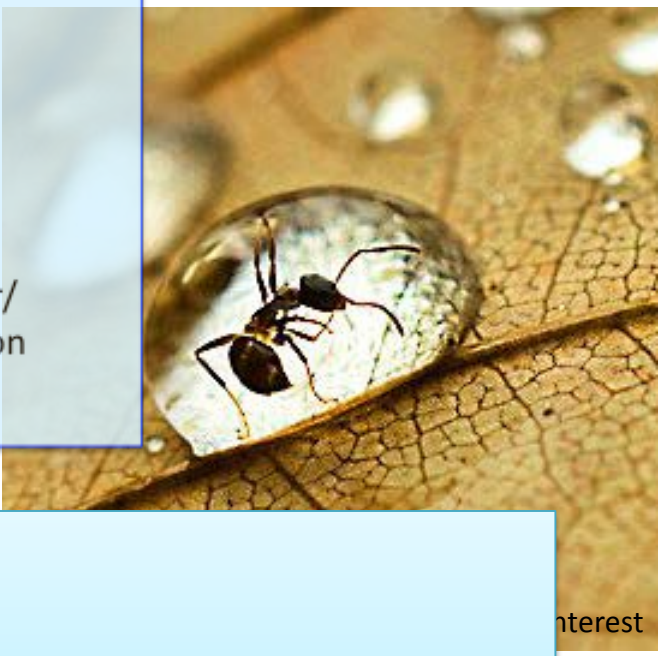
Sample handling
- Preparation e.g. extraction
- Mixers
- Pumps
- Valves

Reactors (small reaction volumina)
Separation
Detectors

Lab on the Chip Technology – from a macro- to a microworld

it's not only to make things smaller – the physics changes

macro		micro
inertial forces, turbulence	**Reynolds** $\rho uL/\eta$	viscous shear, laminar flow
convection	**Péclet** uL/D	diffusion
viscous shear/ surface tension	**Capillary** $\eta u/\gamma$	viscous shear/ surface tension



LOC advantages:

- small ⇨ fast analysis times, ⇨ low reagents (waste),
- low weight
- controlled fluid handling under low gravity
- low cost (depending on complexity)
- low power consumption,
- potential mass fabrication allows establishment of **sensor networks, redundancy**

nterest

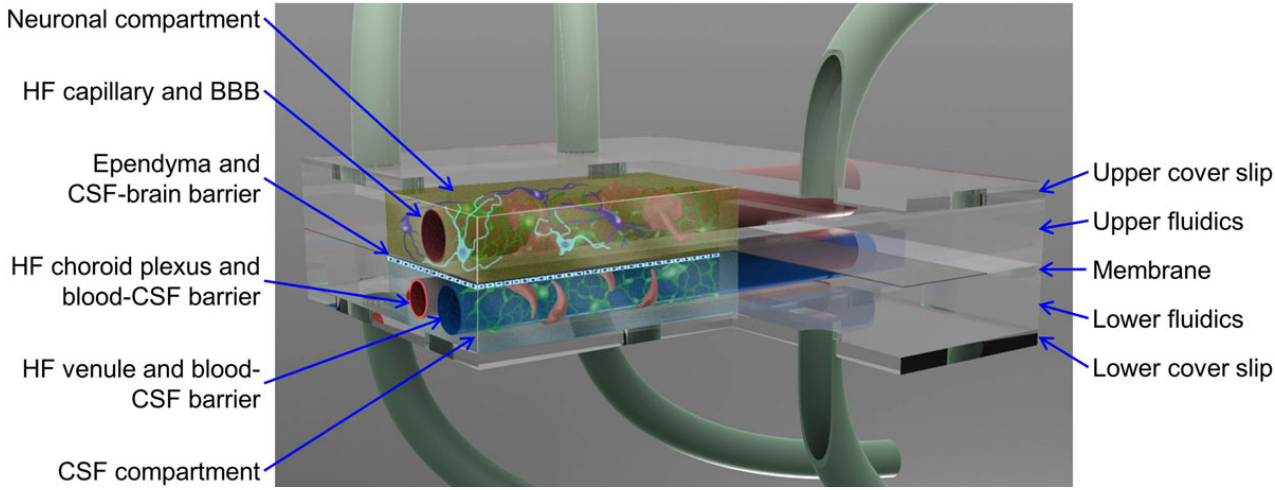
Wide range of applications of LOC Technology

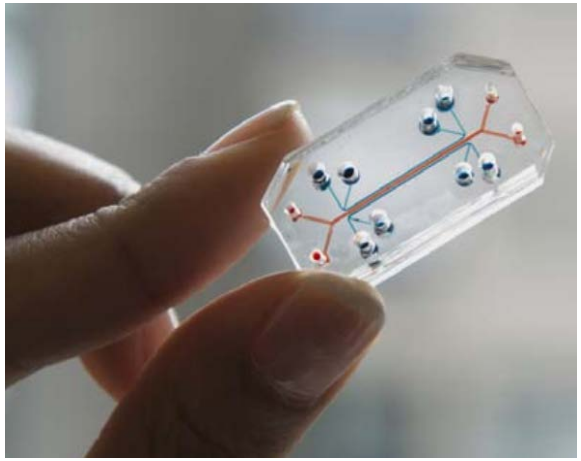
Experiments e.g. µ-physiological systems to model living organ tissues

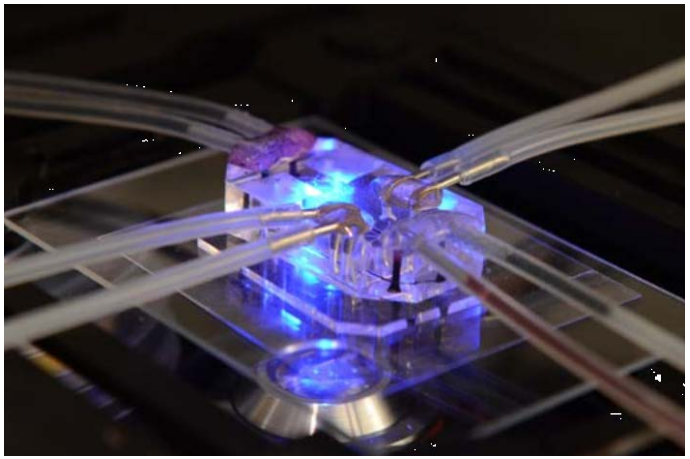
Interesting for applications on the ISS (e.g. life sciences) – require manual operation

Microbrain
to investigates how the brain metabolizes and receives drugs, pathogens, etc. crossing the blood-brain barrier

Alcendor et al. 2013



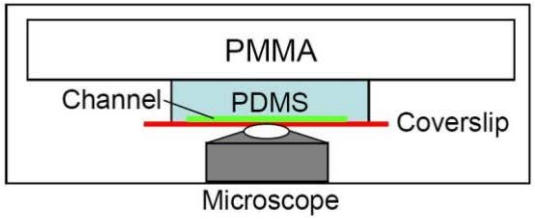




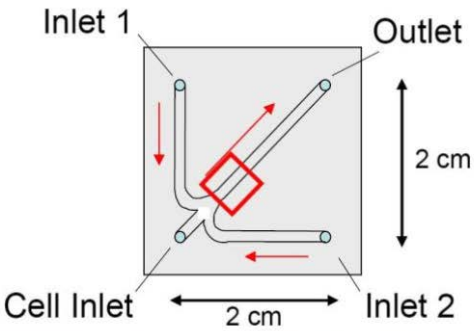
Lung tissue chip

Whyss Institute

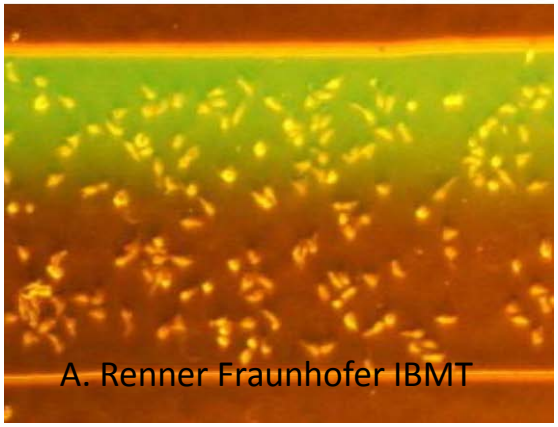
Sackmann et al. Nature Review March 2014



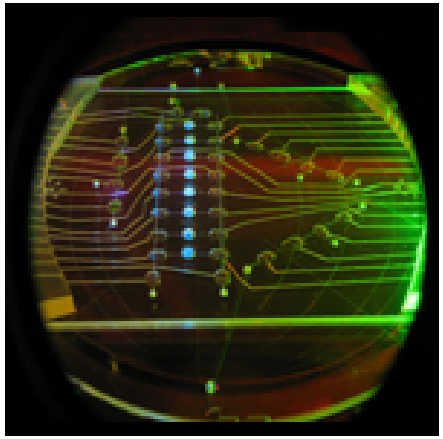
Microfluidic devices as bioreactors, cell cultures, cell manipulation

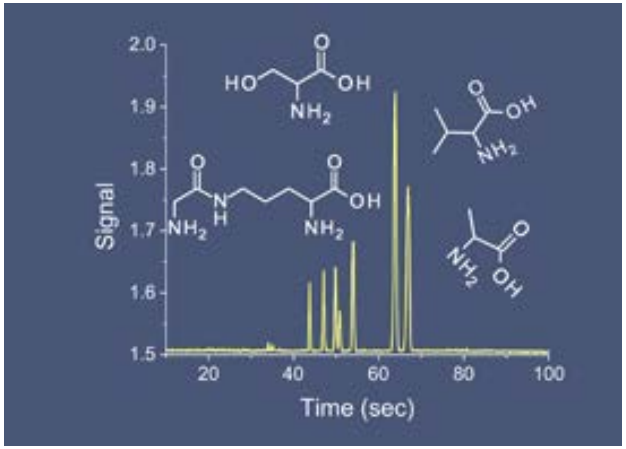


Microsystems offer:
better supply to single cells, inspection, experimental manipulation, handling e.g. smaller volumes



Increased complexity Astrobiology

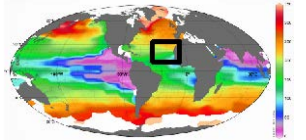


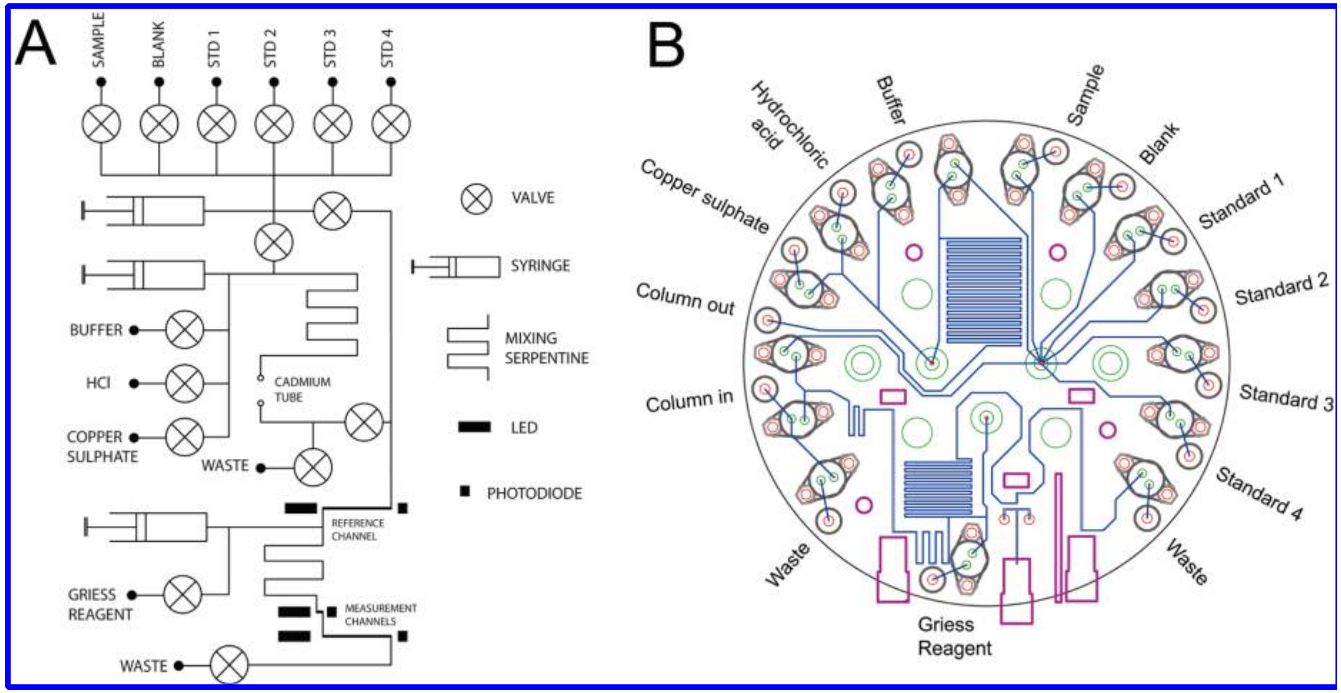


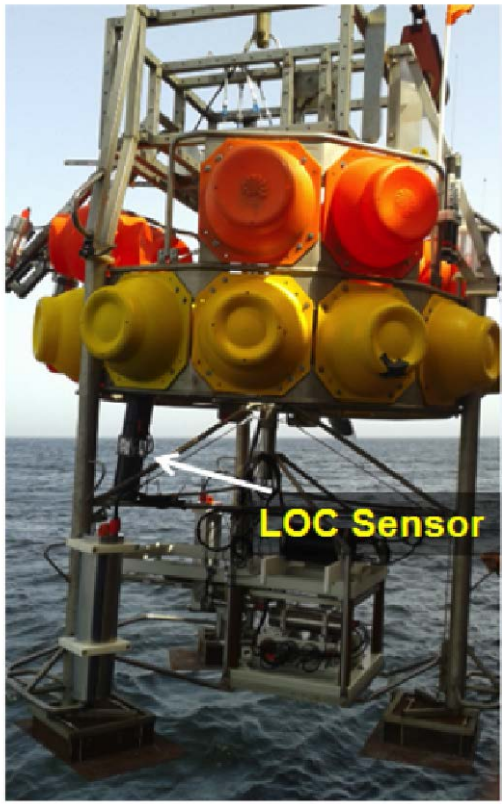
on-chip capillary electrophoresis, Skelley et al. 2005

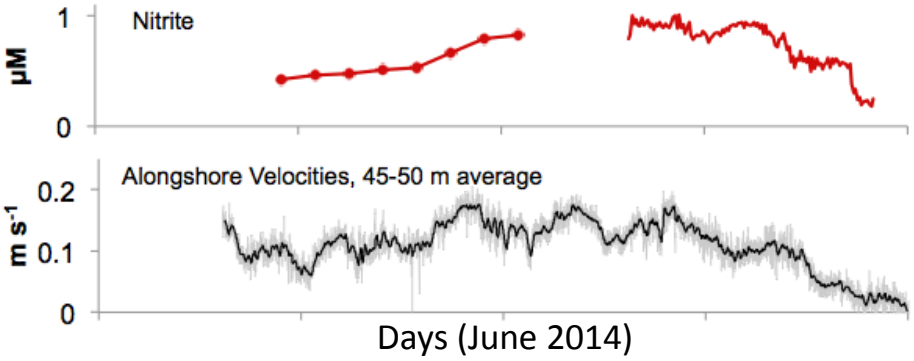
Autonomously operating complex measurement system

Continuous geochemical measurements in the marine environment

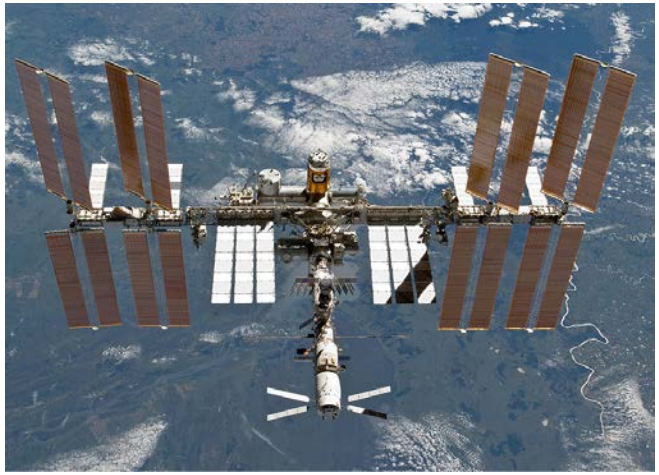
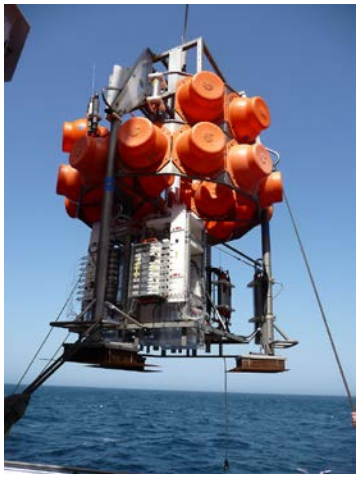
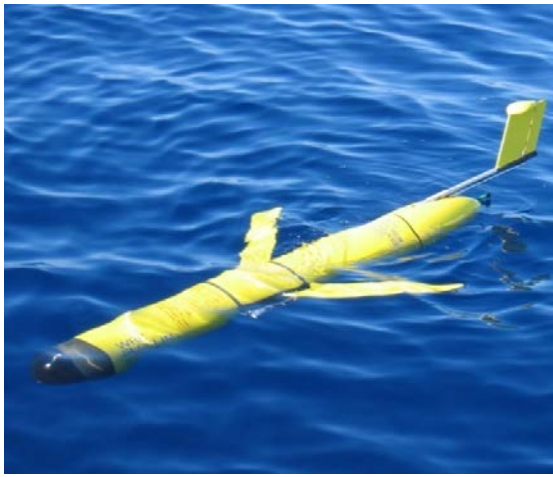






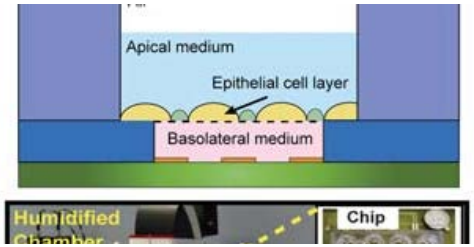


Prototypes - Vision: in situ measurements - autonomous LOC systems to be deployed on (robotic) platforms

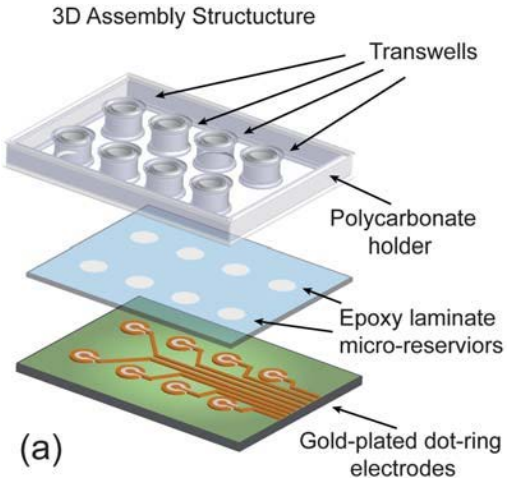




- **Periphery (pumps, valves, etc.) – size, reliability, robustness, longterm stab.**
- **Experiments linked to sensors on one platform**

  lungepethelia function
  ESA ILSRA 2014
  D. Davis et al.

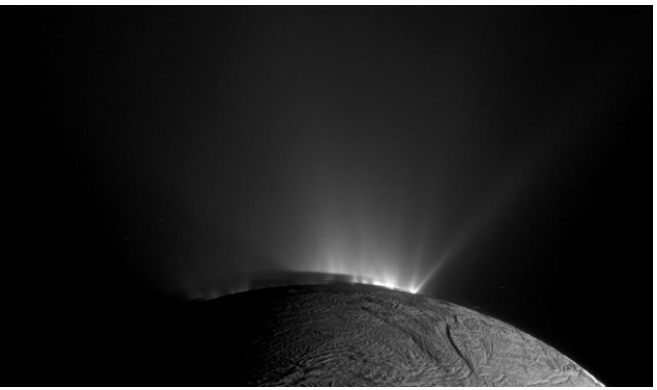


- **Embedding of different sensor systems e.g. LOC-Raman**

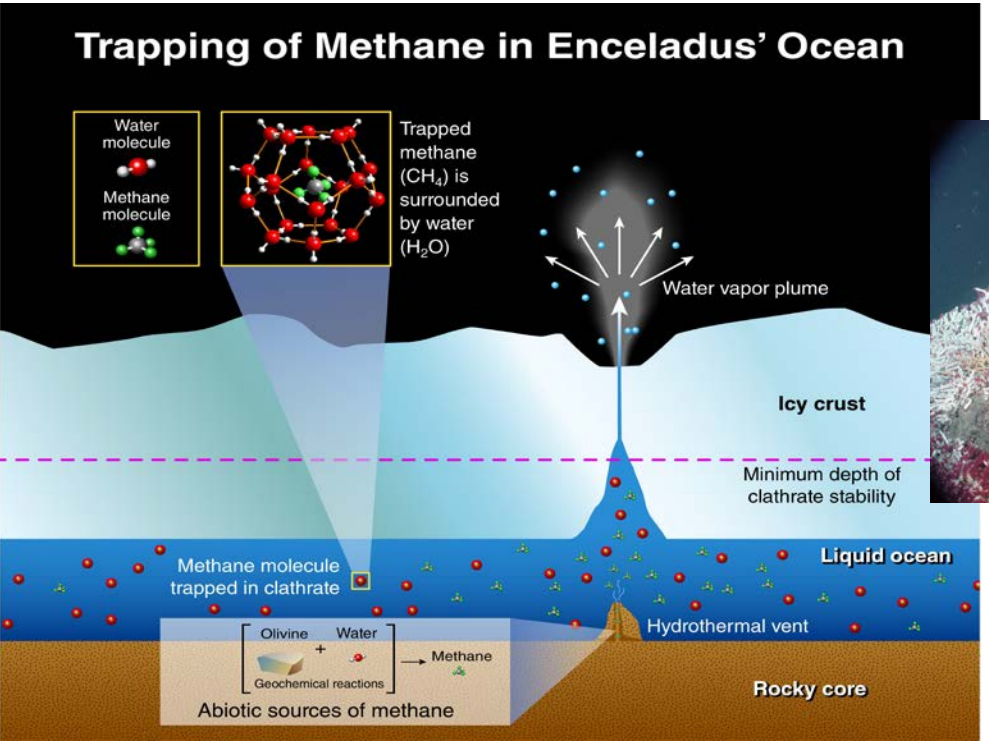


Sun et al. 2010

Ocean research in our solar system

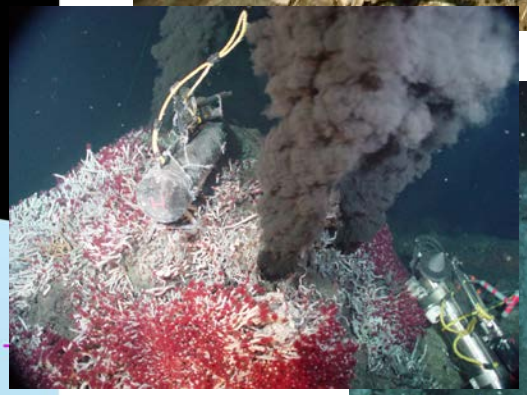


NASA/JPL/
Space Science
Institute

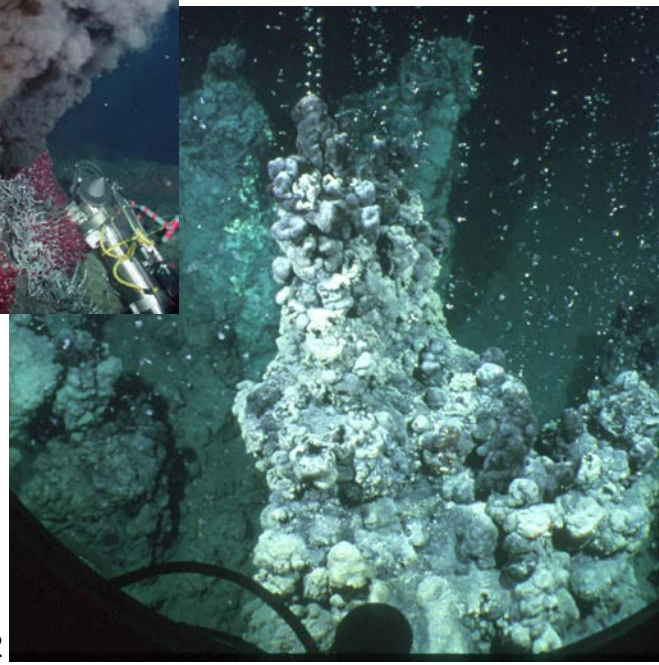


NASA/JPL

S. Joye

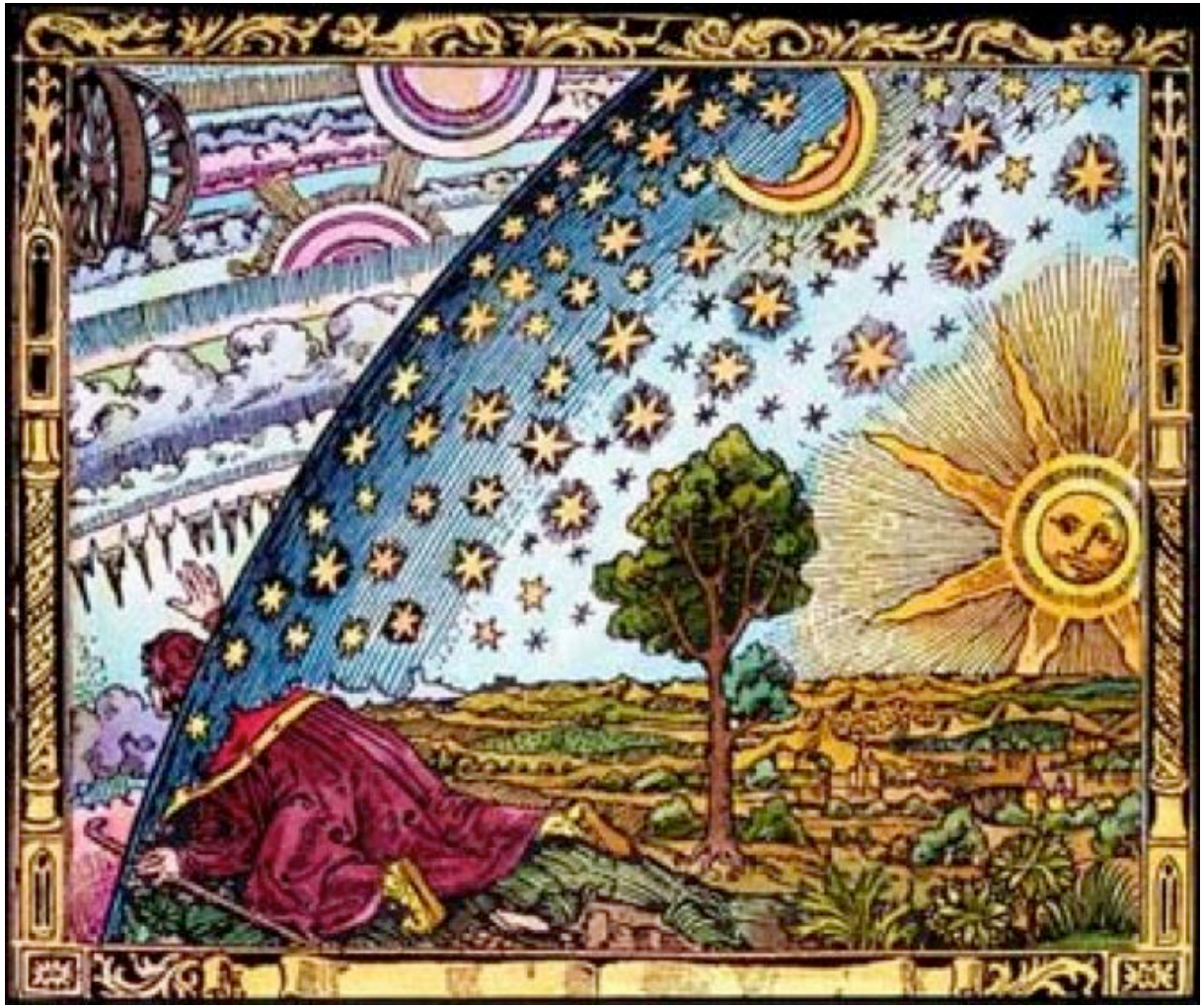


NOAA PMEL



Michaelis et al. 2002

thank you



ROBEX LOC workshop end of 2015 at GEOMAR, Kiel, Germany

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