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IceMole

Development of a Novel Subsurface Ice Probe and Testing of the First Prototype on the Morteratsch Glacier

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IceMole

Who we are

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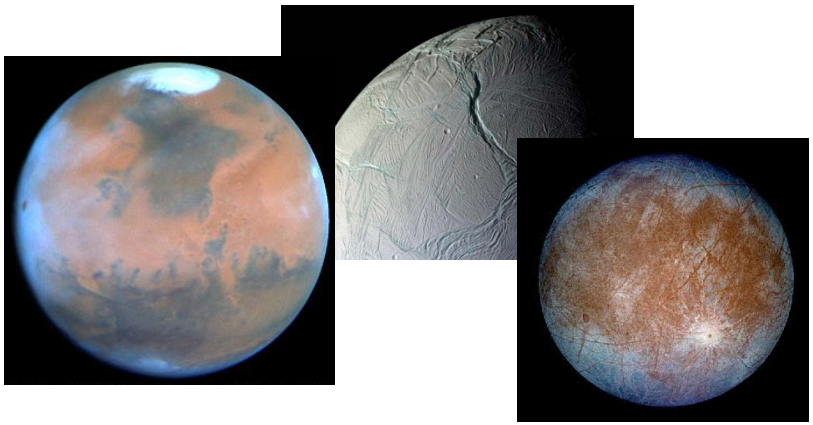
The space related concept

- Diploma thesis of Dipl.-Ing. Changsheng Xu

  „Preliminary design of an ice mole for the in situ exploration of ice layers“

- Extraterrestrial applications:
  polar caps of a planet or icy moons

Moon & Mars



Saturn`s moon Enceladus

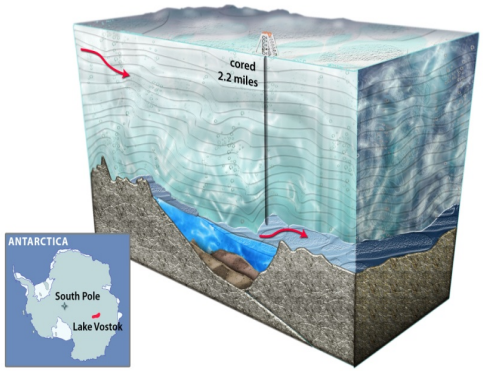
Jupiter`s moon Europa

The concept verification

- equally applicable to terrestrial scenarios

- research of glacier and ice sheets

- autonoumous research in Antarctica‘s ice and subglacial lakes



Classical melting probes

- first applications with melting probes in the early 1960‘s
- controlling the probe is a big problem
- movement in one direction, along gravitation vector

DLR: Stephan Ulamec, Jens Biele, Oliver Funke and Marc Engelhardt: „Access to glacial and subglacial environments in the Solar System by melting probe technology, in Life Extreme Environments“, Springer 2007

Classical ice core drilling

- first drilling with bore rods ~ 1930
- open bore hole leads to a high contamination

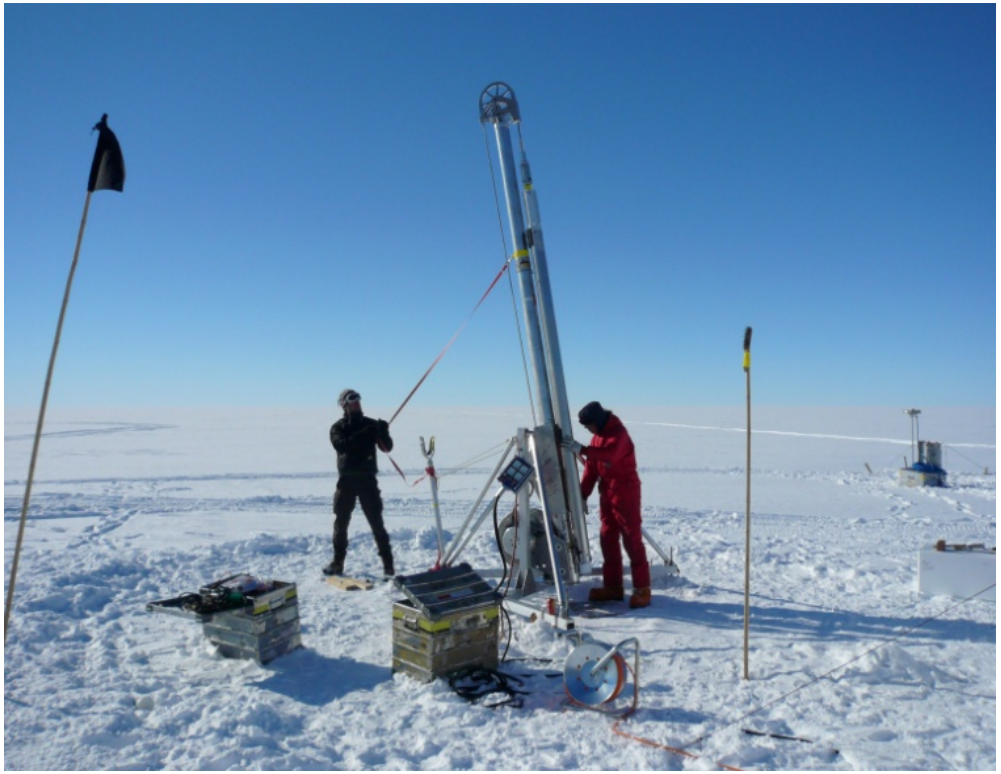
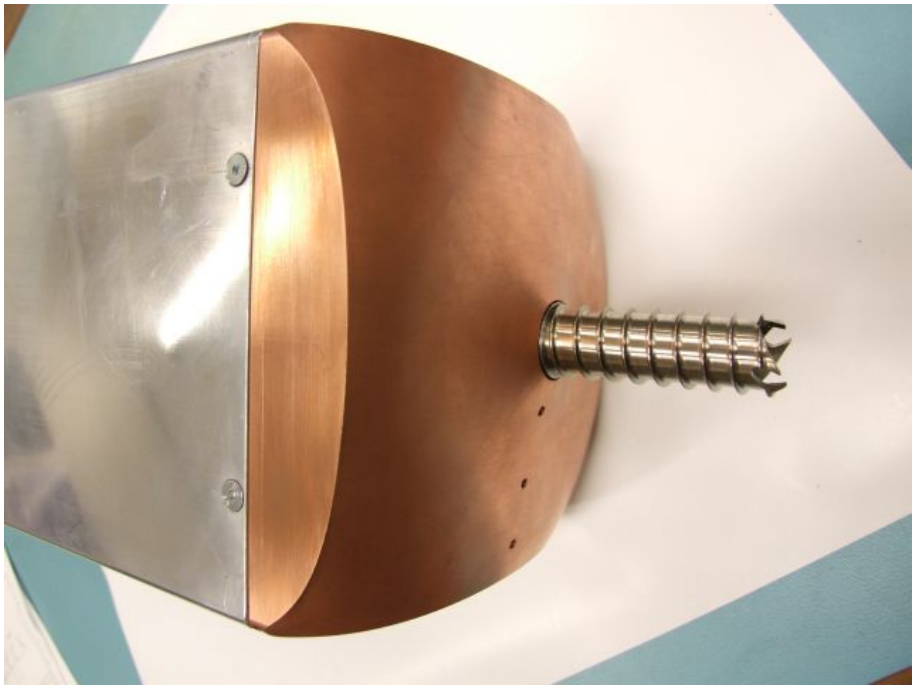


Bild: Jakob Schwander, Uni Bern
Eisbohrungen mit dem Bern-4-Zoll-Bohrer nahe der Neumayer-Station in der Antarktis

The advanced concept

- forward motion with combined melting head and ice screw
- large contact area to the ice
- robust mechanics

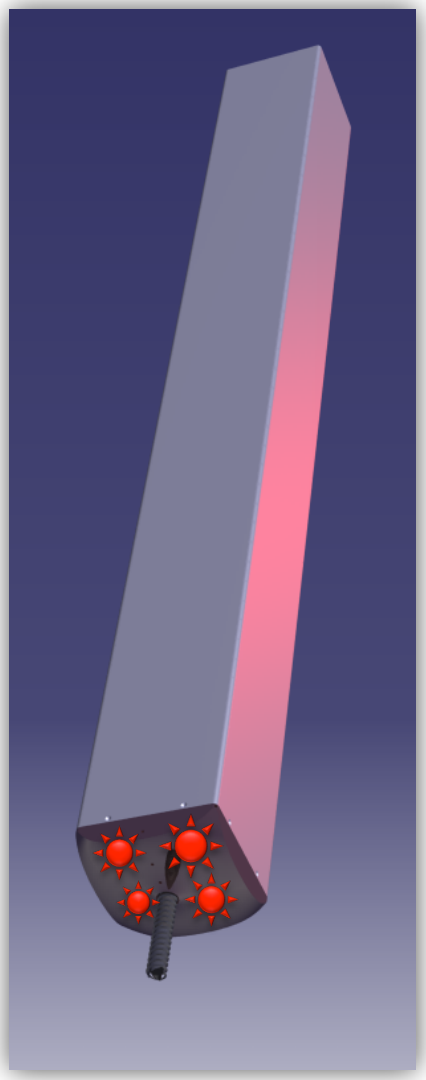


Advanced drive/melting concept

Manoeuvers made possible by:

- 4 heaters are separately controllable at the melting head
- Screw is important for horizontal movement and vertical up-melting against gravity

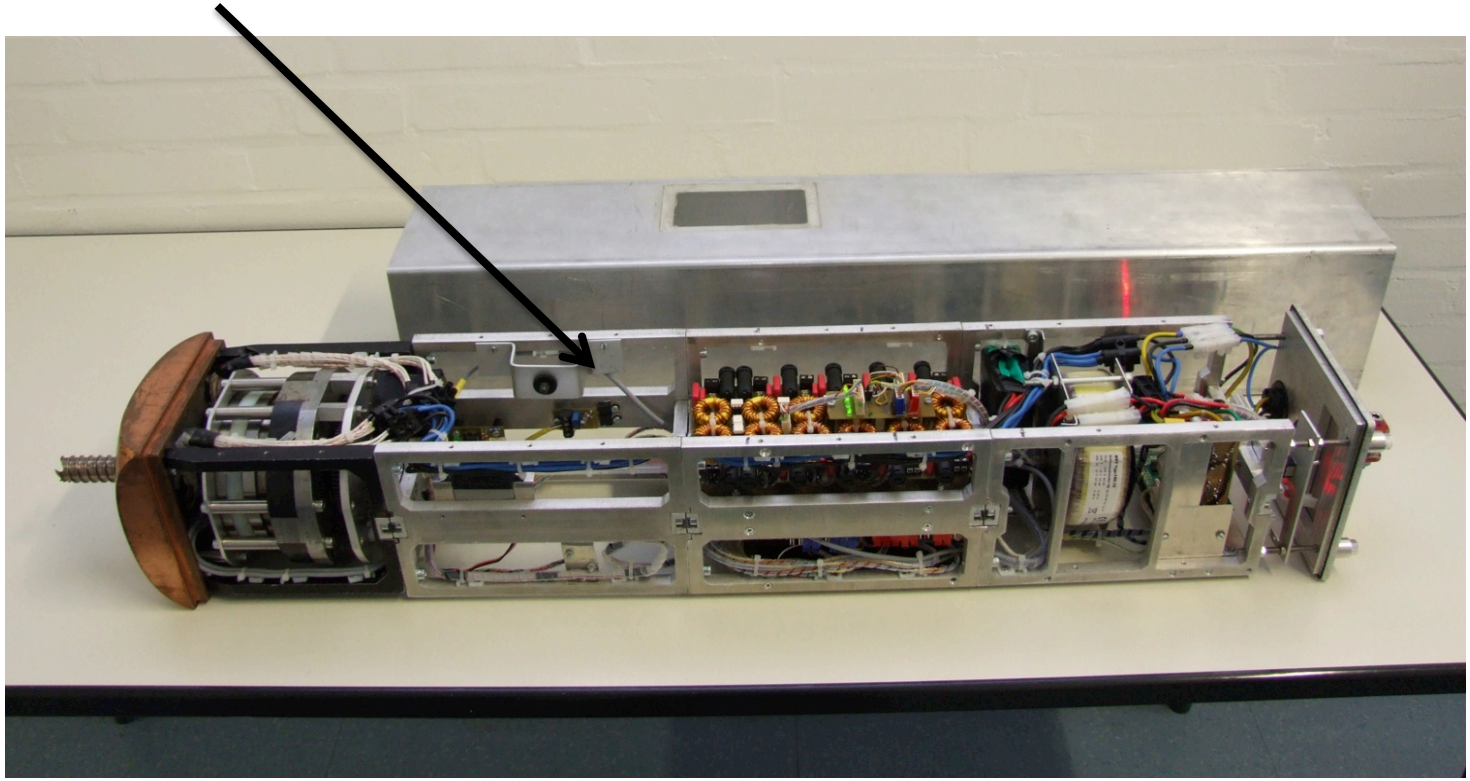
Film: 3D Animation



IceMole

Interior View

- Sampling of clean ice core for scientific analysis
- No biological contamination of sampled ice
- Variety of instrumentation options
  (square instrument bay, 140 mm × 140 mm × tbd mm)

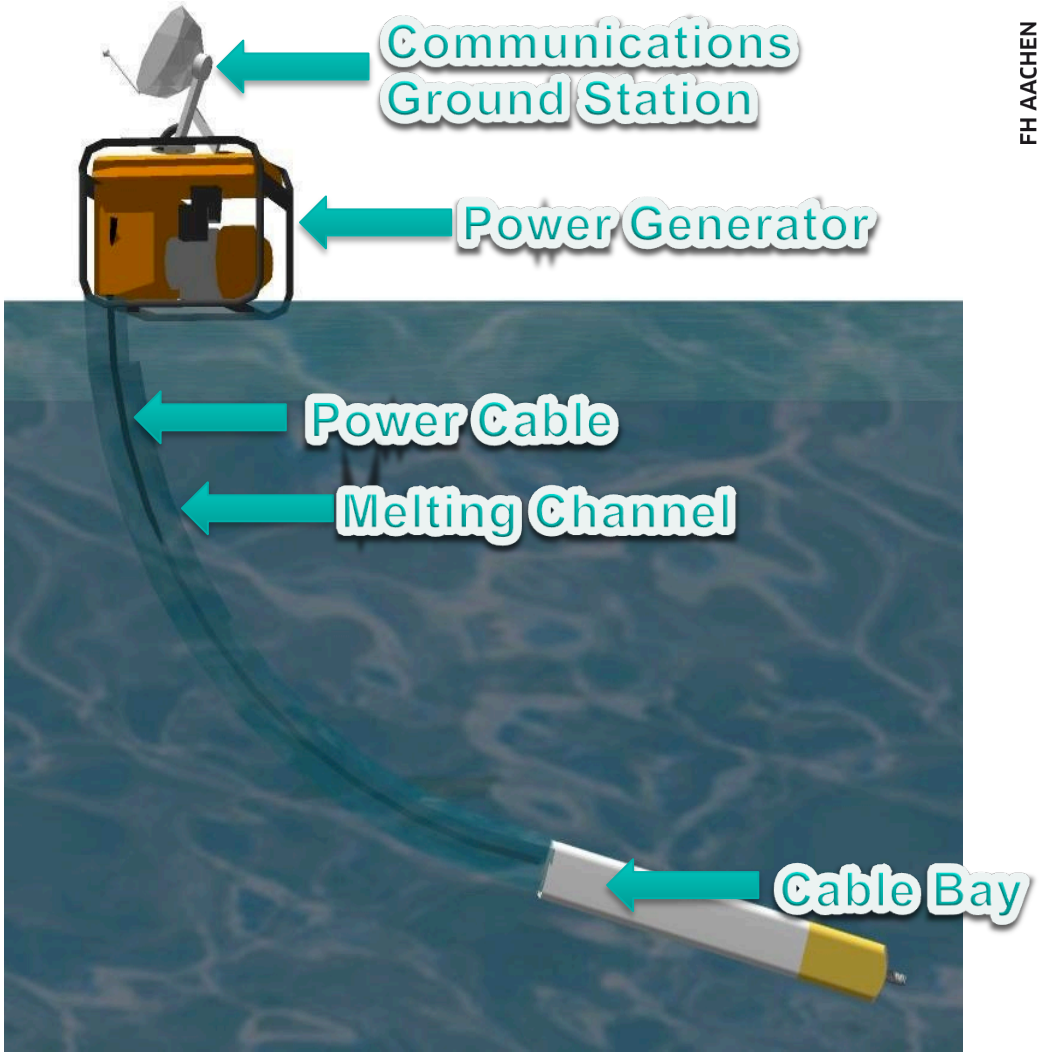


Technical data (Version I, 2010 tested)

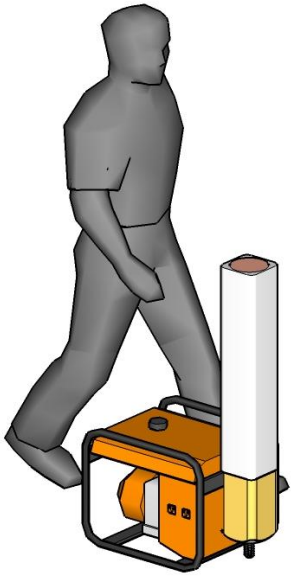
- up to 3,2 kW power at the melting head
- melting velocity 0,3 m/h
- screw length 60 mm
- possible tensile load of the screw > 2000 N
- dimension: 150mm x 150mm x 1000mm

Power and communications concept

- Power supply with generator
- Power cable is coiled up within the IceMole (it freezes behind the IceMole)
- Powerline-Modem transmits data between the IceMole and the ground station via the power cable



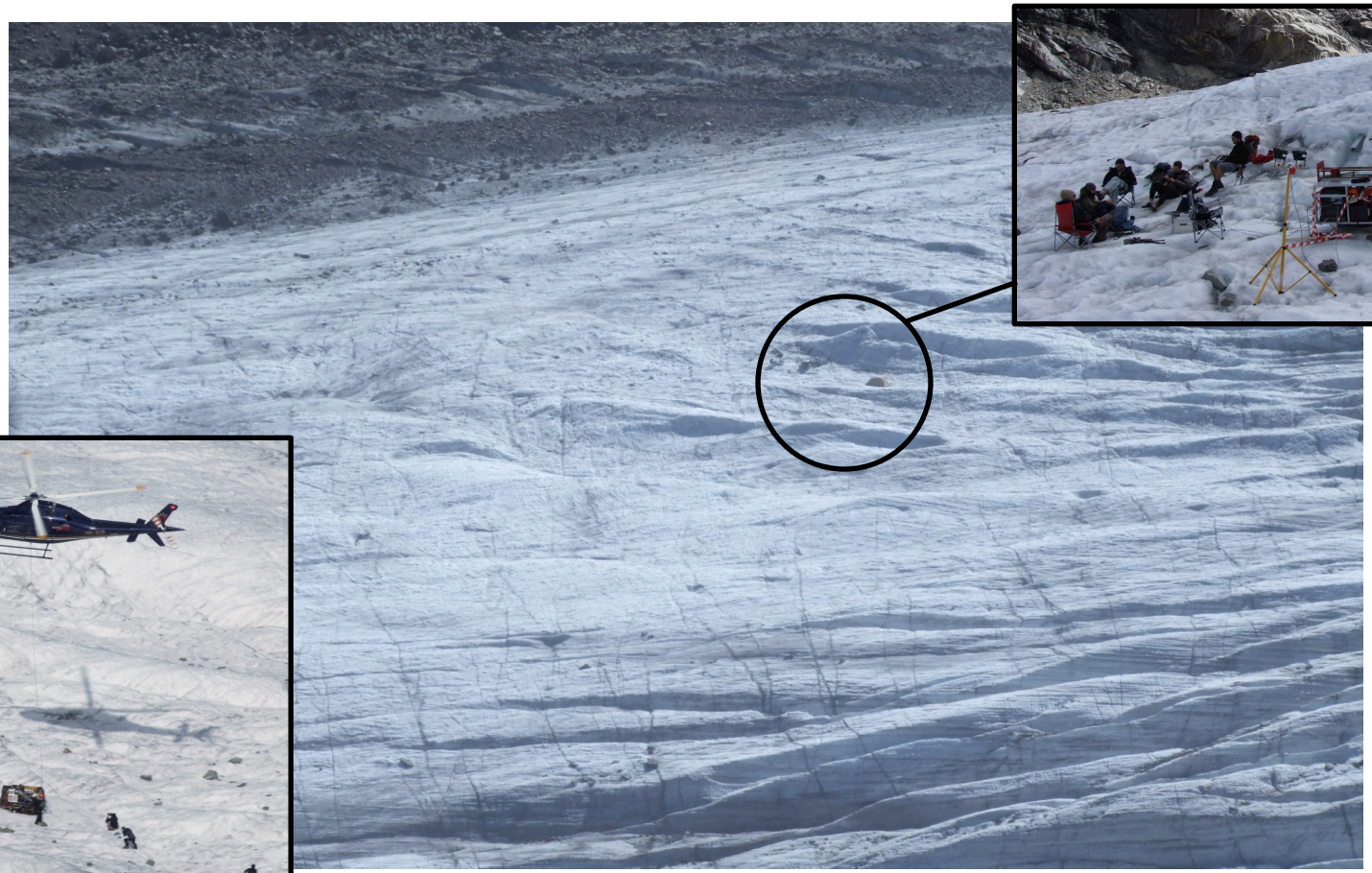
Operations scenario



- Compact
- Robust
- Mobile
- Autonomous
- Safe
- Environmentally friendly

Field Experiments (Sept. 2010)

- Morteratsch Glacier (Upper Engadin, Switzerland)



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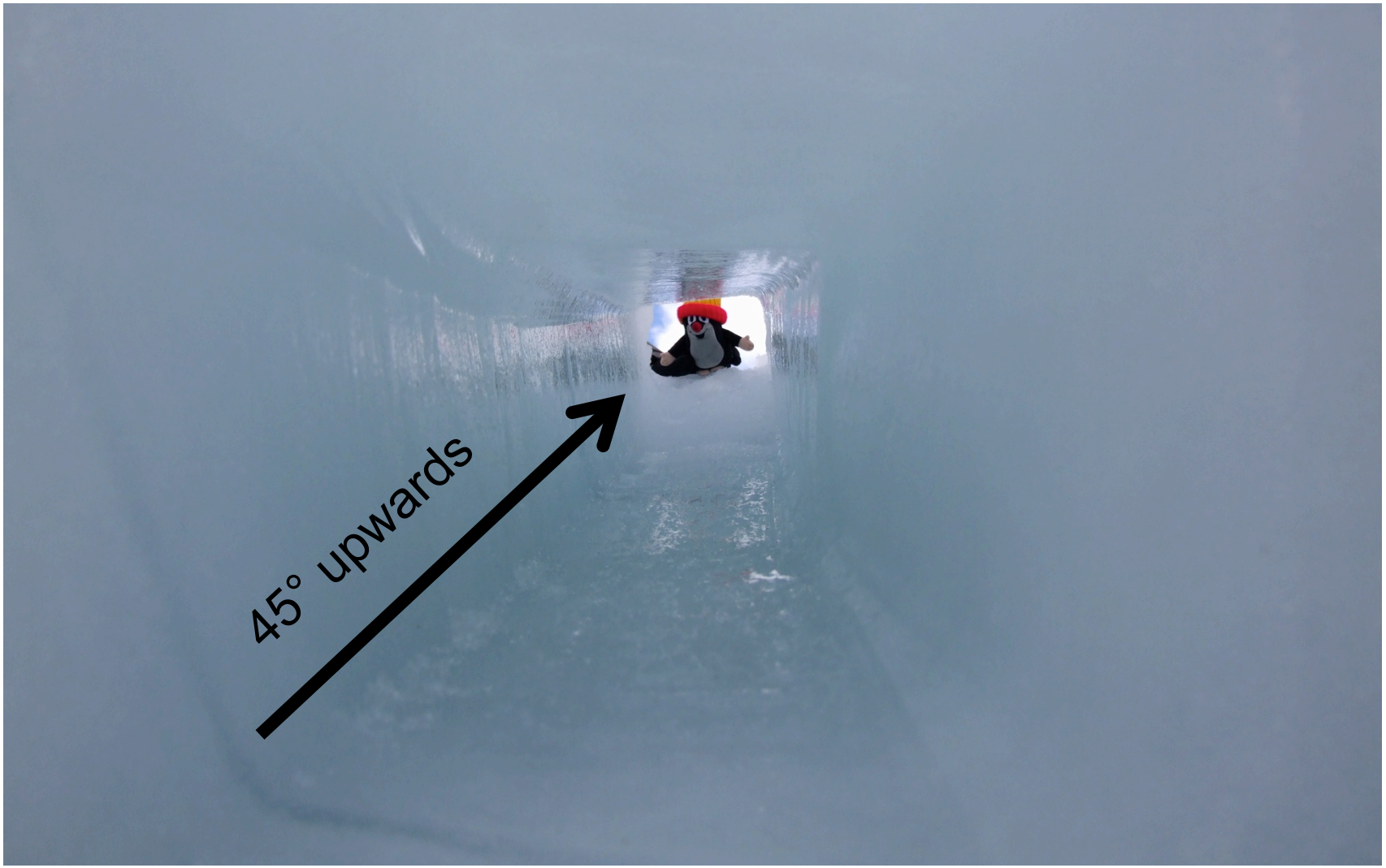
Field Experiments | Channel #1

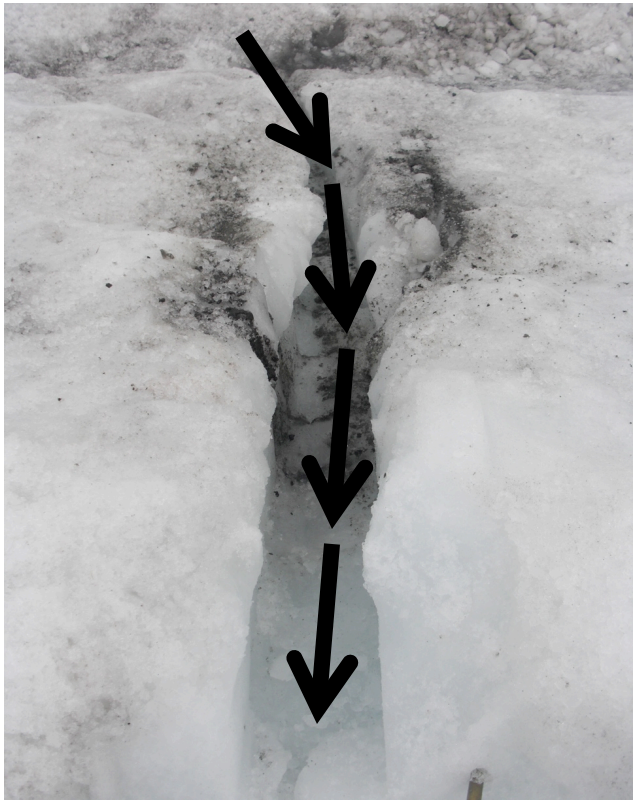


Field Experiments | Channel #2

Field Experiments | Channel #3

Penetration of ~ 4 cm of sediment layer

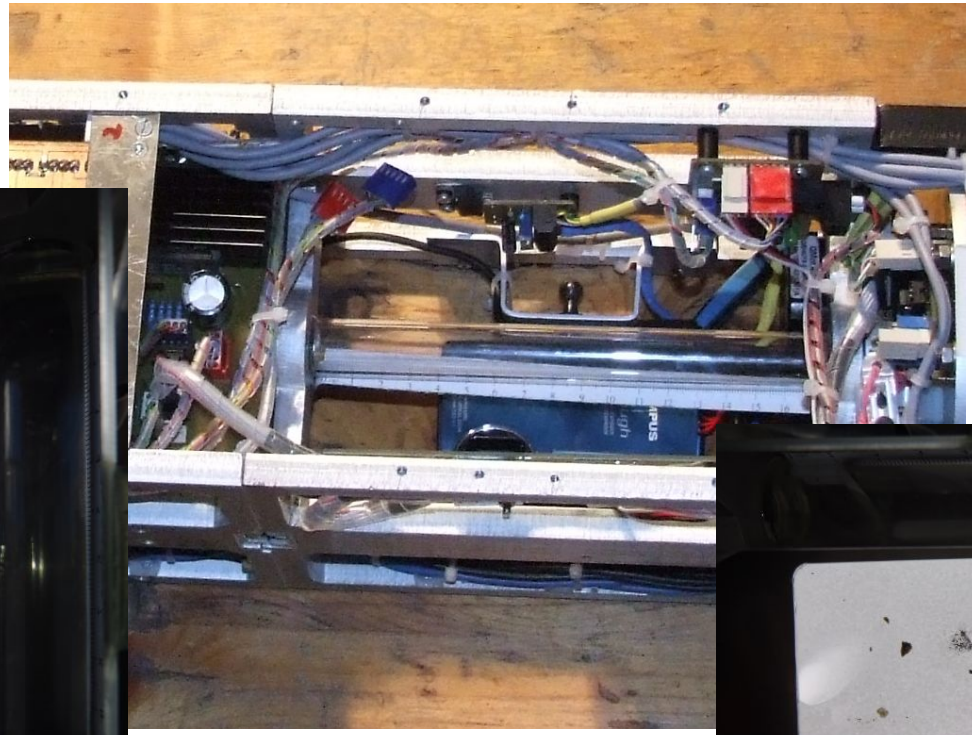
curvature radius ≈ 10m

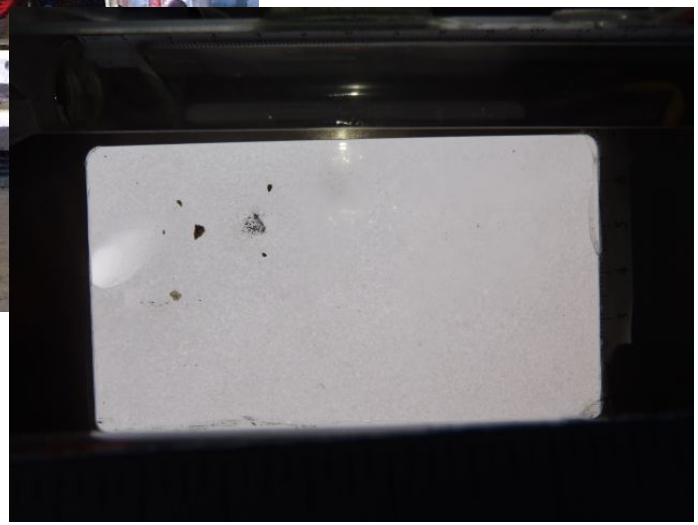


(Chanel was opened afterwards)

Field Experiments | Payload

- Payload module 2010: digital camera





Results and milestones of the field experiments

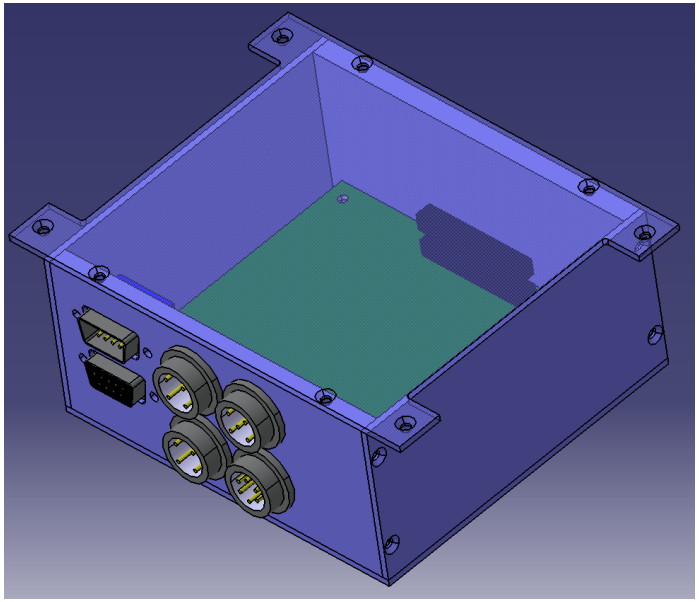
- the function of the drive concept is proven
- first probe which can move against gravity
- first maneuverable melting probe
- curvature radius is about 10 meters

film: time lapse

Internal Payload

Potential payload`s :

- optical sensors
- dielectric properties of ice cores

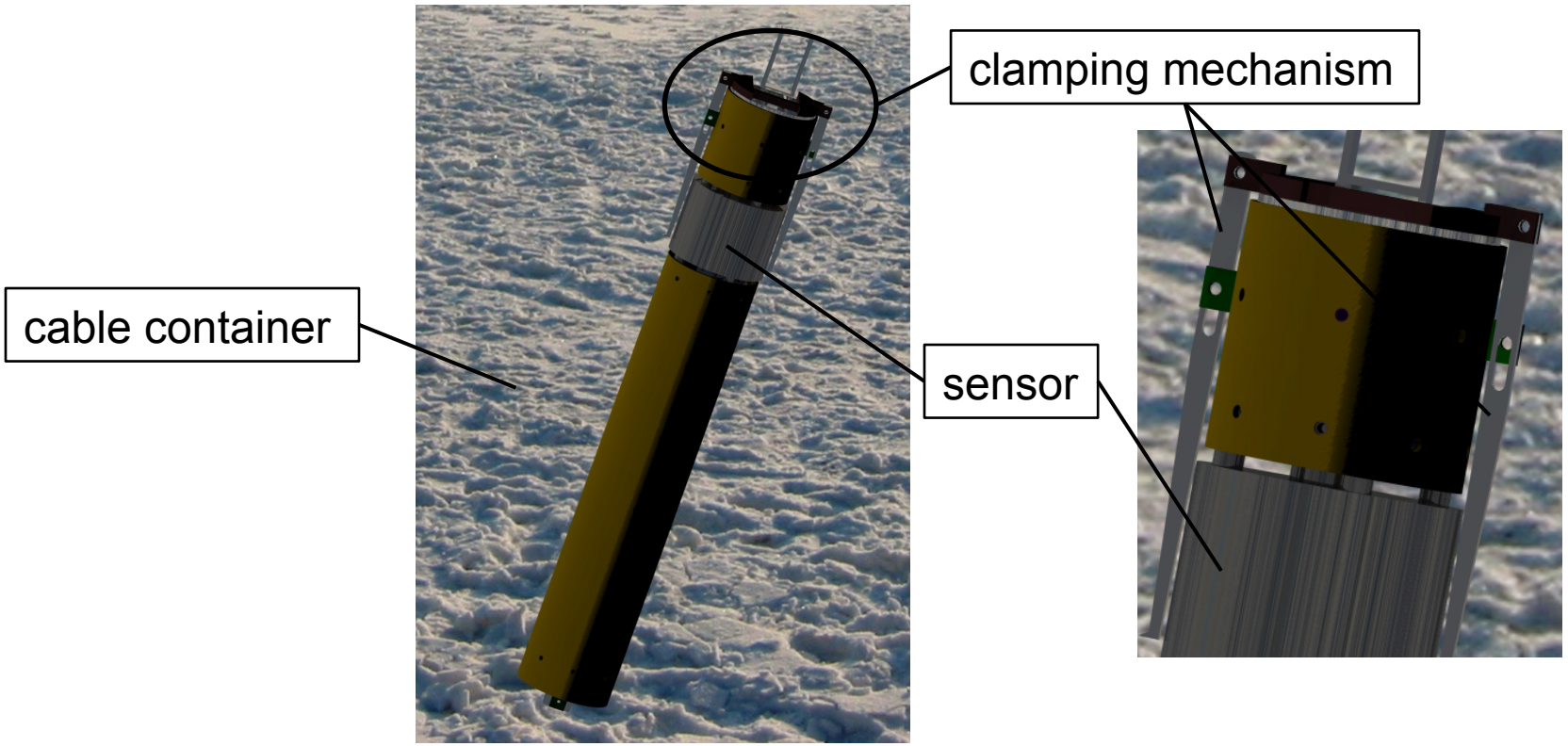


Payload compartment:

- Payload dimensions: 110mm x 50mm x L mm
- Internal power supply: 24 Volt DC
- Data link: CAN-Bus

External Payload

Deploying sensors on cable containers



Future technical challenges

- Transmission of several kW of power over large distances / depths
- Communications over the power line
- Navigation in the ice
- Optimization of ice screw and drive mechanism
- Optimization of manouverability
- Autonomous and robust control

Co-operation Partners, Sponsors and Supporters

Thanks for your attention !

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Subsurface Icecraft