Hes·so VALAIS WALLIS
School of Engineering

SCCER SoE
SWISS COMPETENCE CENTER for ENERGY RESEARCH
SUPPLY of ELECTRICITY

Harsh Environment Sensors for geo-energy and water reservoir monitoring

Joseph Moerschell, Charles Praplan, Christian Cachelin, Grégory Emery, Alexandre Ganchinho

In cooperation with the CTI

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Commission for Technology and Innovation CTI

September 15th, 2017

WP3.1 Innovative technologies

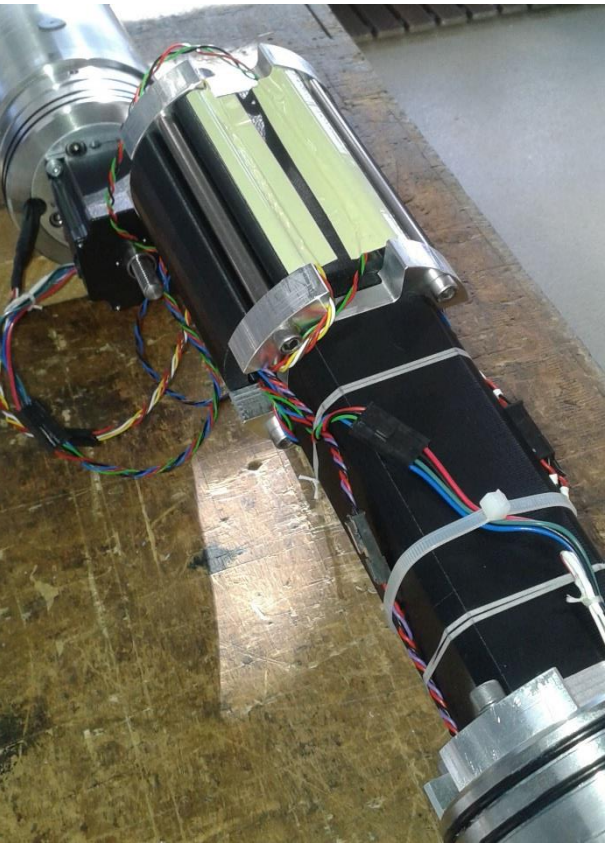
E. Harsh Environment Sensors

E1: **Deep well monitoring of seismicity**
E2: **3D extensometer measurements**
E3: **Continuous electric impedance monitoring**
E4: **Continuous 3D-surface monitoring**

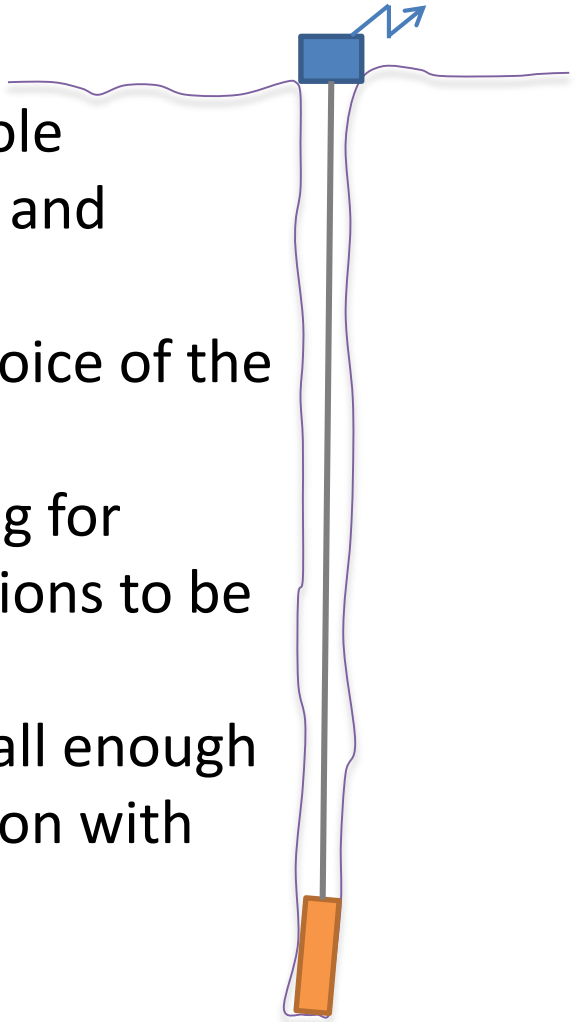
Borehole Seismometer

Distinctive features of the instrument:

- Sensing acquisition electronics inside the borehole instrument, only power supply and data storage and communication above ground



- More freedom in the choice of the sensing elements
- Modular design, allowing for additional sensing functions to be integrated
- Power consumption small enough for autonomous operation with solar supply



Partners: Alpgéo S.A., Streckeisen GmbH

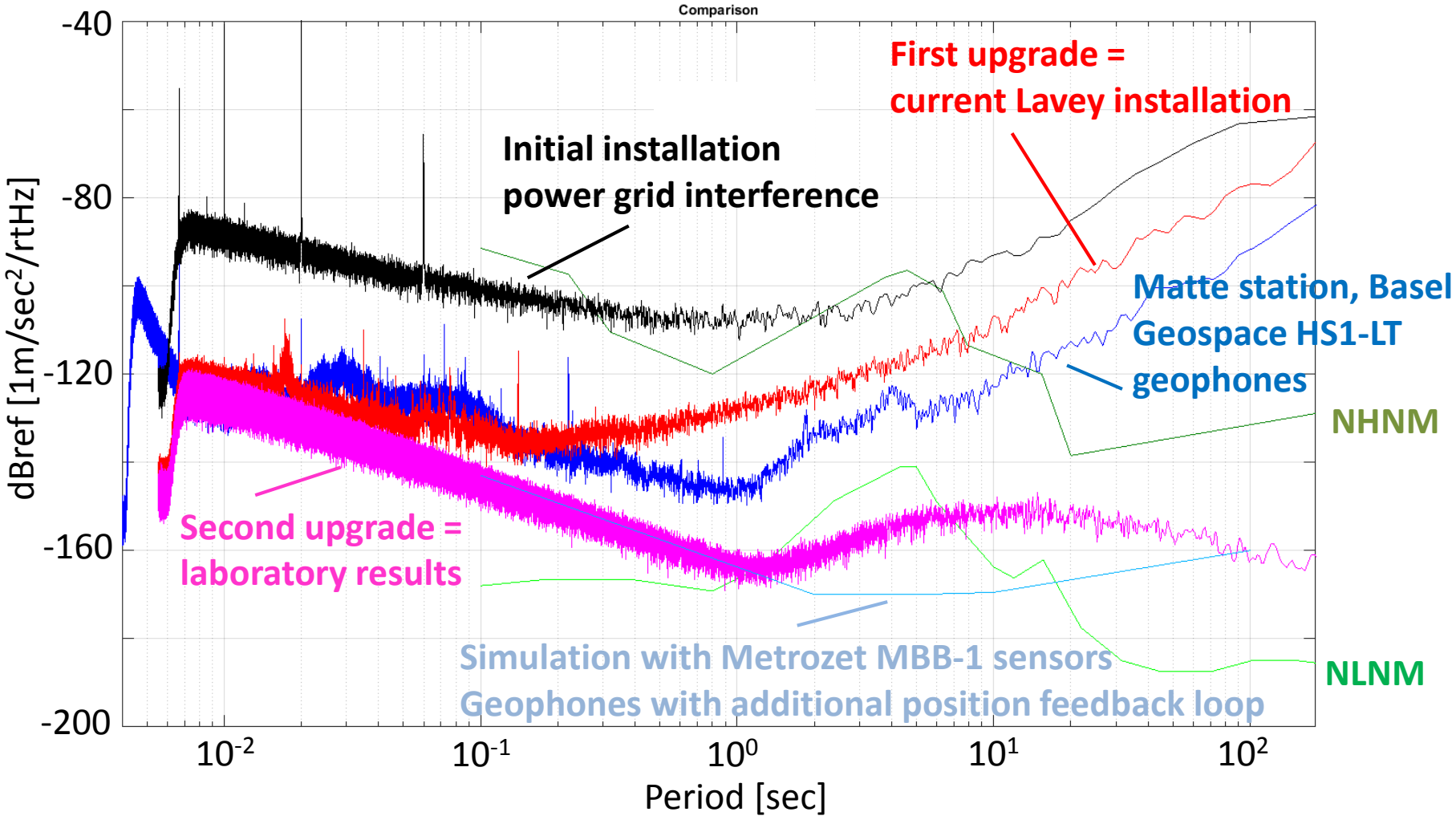
State of the borehole seismometer project

- Result of phase I: prototype of 3-axis instrument
- First installation in Feb. 2017 in Lavey-les-Bains, 85m deep hole in crystalline rock
- First performance upgrade in spring ‘17, new installation 2 months ago
- Second performance upgrade in preparation, to be validated in Lavey borehole until end of Oct. ’17
- New version of the instrument in design and development
- New demonstrator test site (‘18): 900m, 25° inclined JAFE borehole in Saillon (Vs)

Performance comparison

Based on acceleration noise density spectra

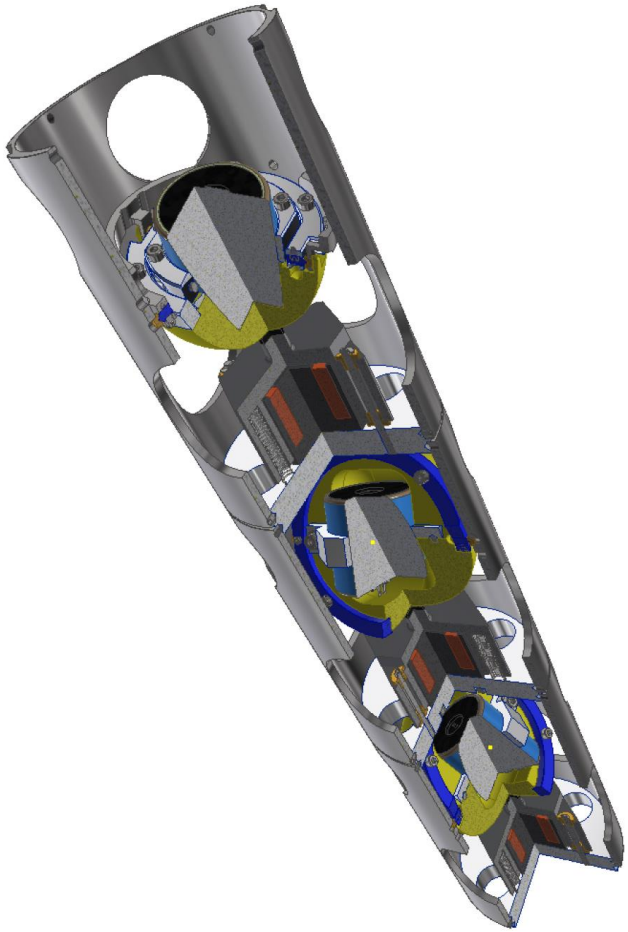
Geospace GS11-D geophones

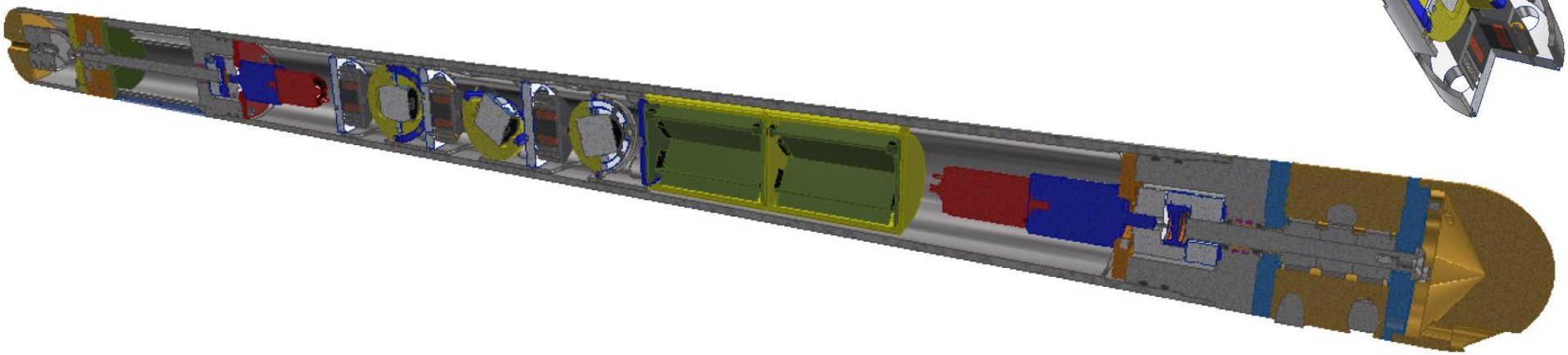


Next demonstrator model

New features:

- Gimballed sensor suspension, with magnetic locking devices
- Ability to install into inclined boreholes, ±90° rotation range
- Additional sensor package: temperature, turbidity, electrical conductivity, borehole camera, hydrophone, Radon radiation.
- Outer instrument diameter reduced to 88mm.





Next demonstrator test site

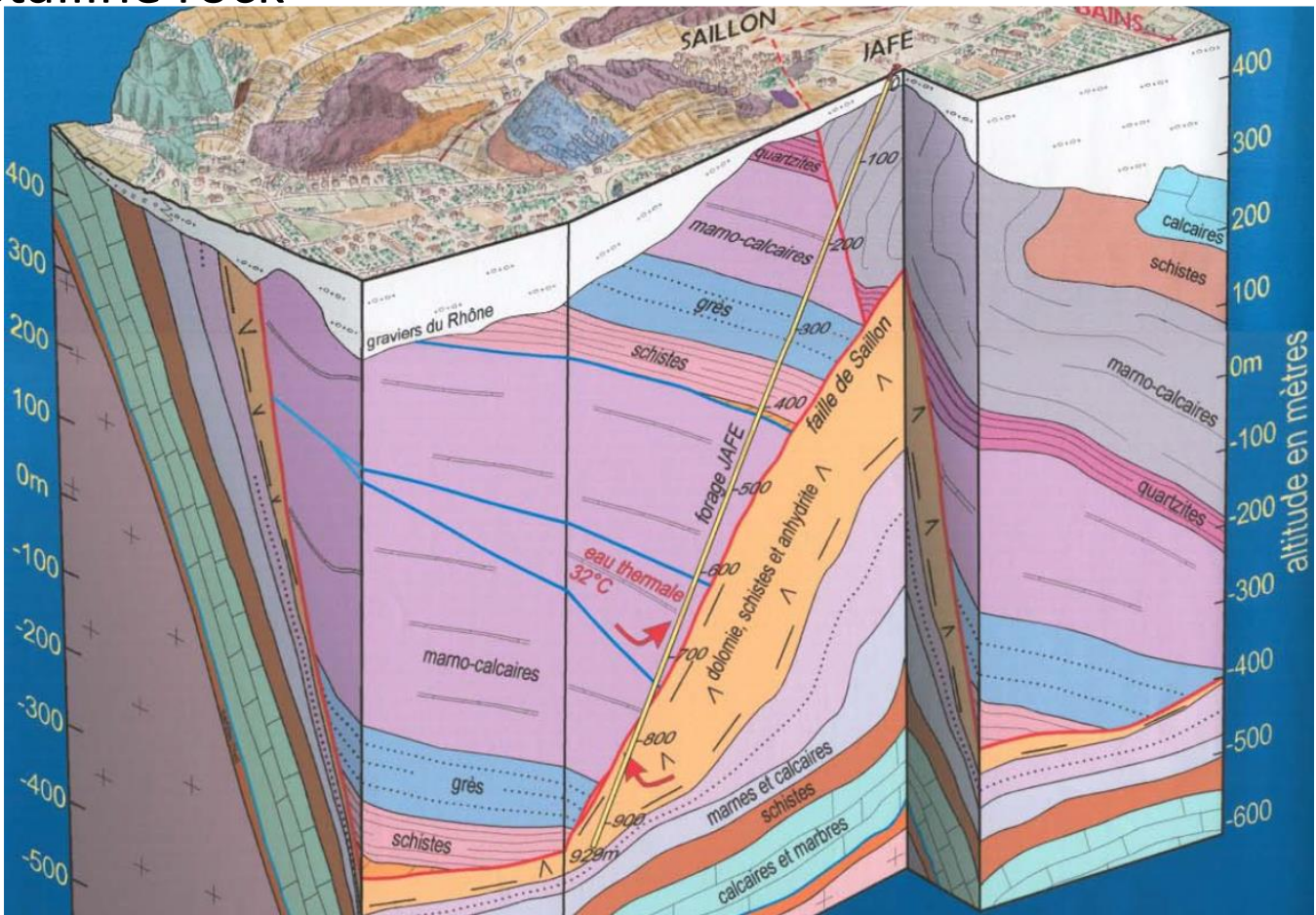
JAFE borehole in Saillon (Vs): drilled 1996 in search for hot water

+ Originally 929m deep, 25° slope, water filled

- Does not reach crystalline rock

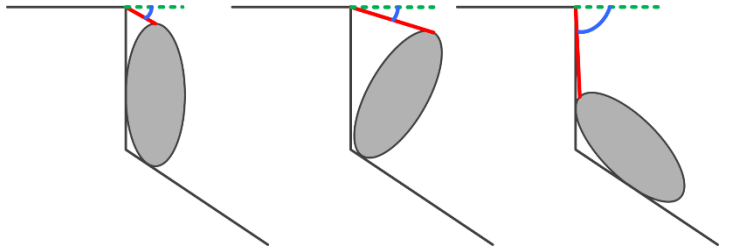
Diameter 6”
down to 858m,
then 5” internal,
tubed

- Negotiation with village authorities
- First check to be done



3D Rock slide extensometer

- Acquisition of all 6 dof of motion between two points of an instable rock slope
- Low power wireless data transmission out of the rock slope
- Prototype installation at Moosfluh rock slide



Partners:

Norbert S.A.

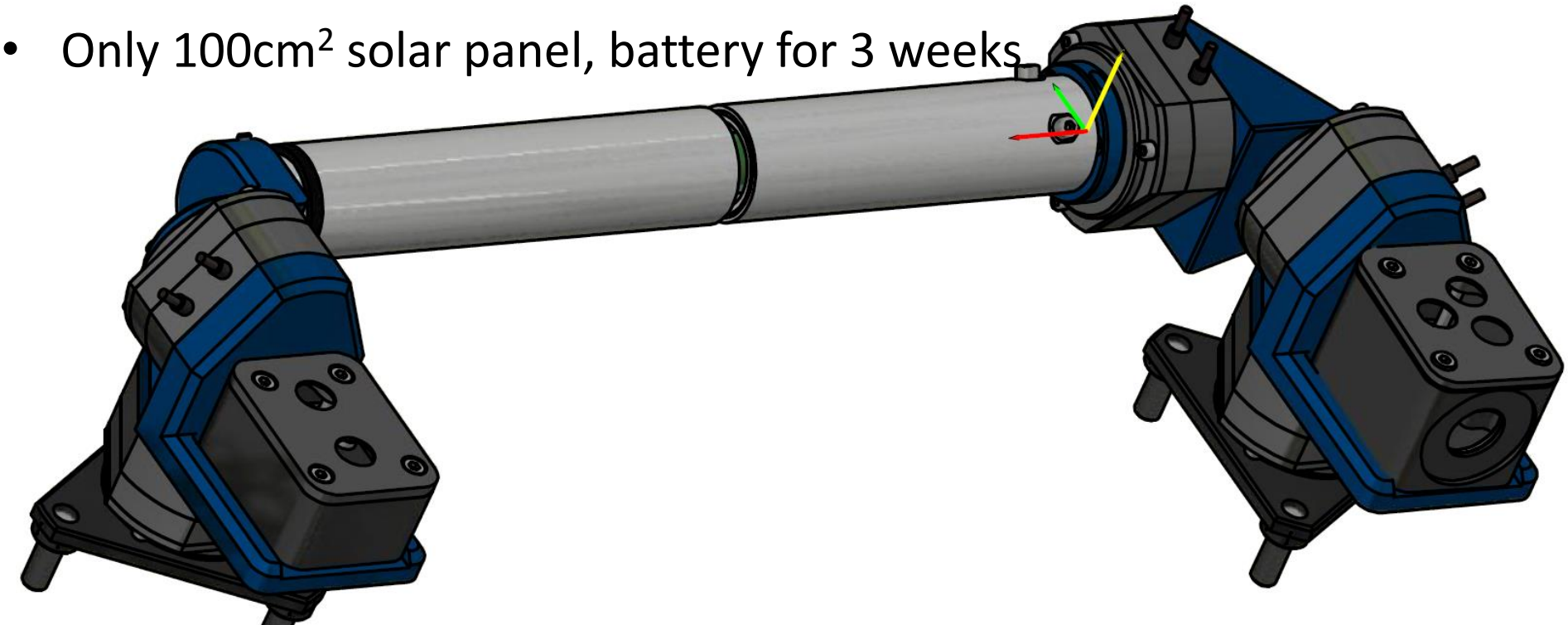
Canton of Valais

Regione Valle d'Aosta

CREALP

3D Rock slide extensometer

- 1 Eddy current linear and 5 magnetic angular sensors
- 0.1mm linear and 0.1° angular resolution
- 400mm linear range, 360° angular range in all 5 rotary joints
- Possibility to install with extension rods of various lengths
- Less than 5kg, including controller, rapid installation
- Only 100cm^2 solar panel, battery for 3 weeks



From measurement campaigns to continuous monitoring – a shift in paradigm

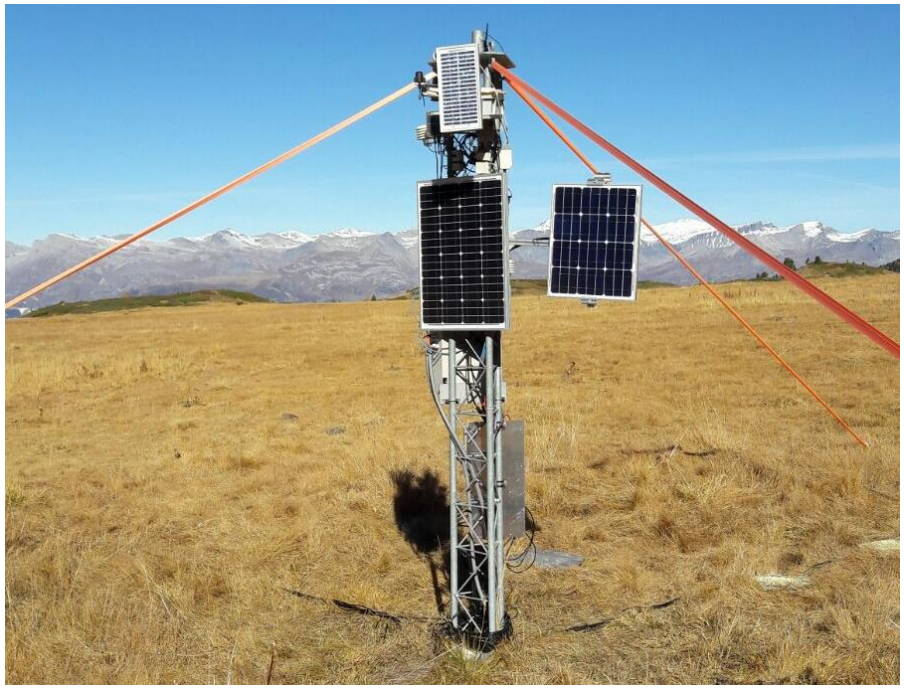
- Advent of low cost sensors, e.g. for automotive applications
- Improvement of low power wireless communication links
- Adaptation of known measurement methods to low power operation
- Development of integrated database and visualization environments

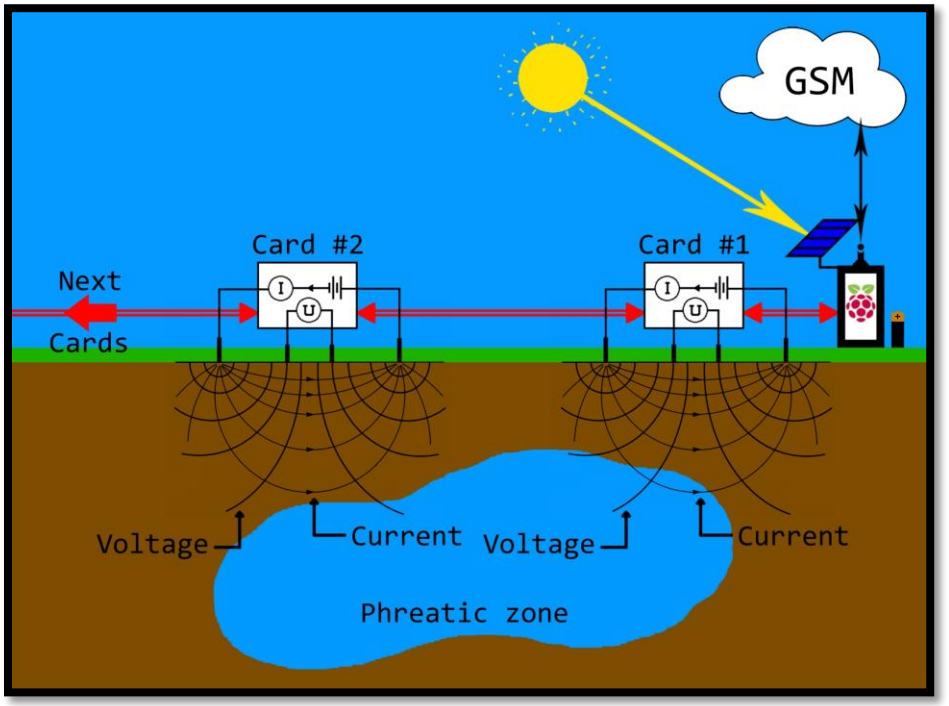
Lead to a shift from measurement campaigns to continuously operating monitoring equipment, which can be afforded by small public authorities

- Monitoring of natural dangers
- Monitoring of water basins for hydro-electric power
- Monitoring of underground water reservoirs for geothermal energy harvesting

Electric monitoring of water reservoirs

- First prototype installation at Ar du Tsan (Vs), wetland at 2200m alt.
- 6 + 10 electrodes, 50 impedance spectra recorded every 30 minutes
- Second protoype in work for up to 1km line, with up to 256 electrodes
- Additional acquisition of electric spontaneous potentials

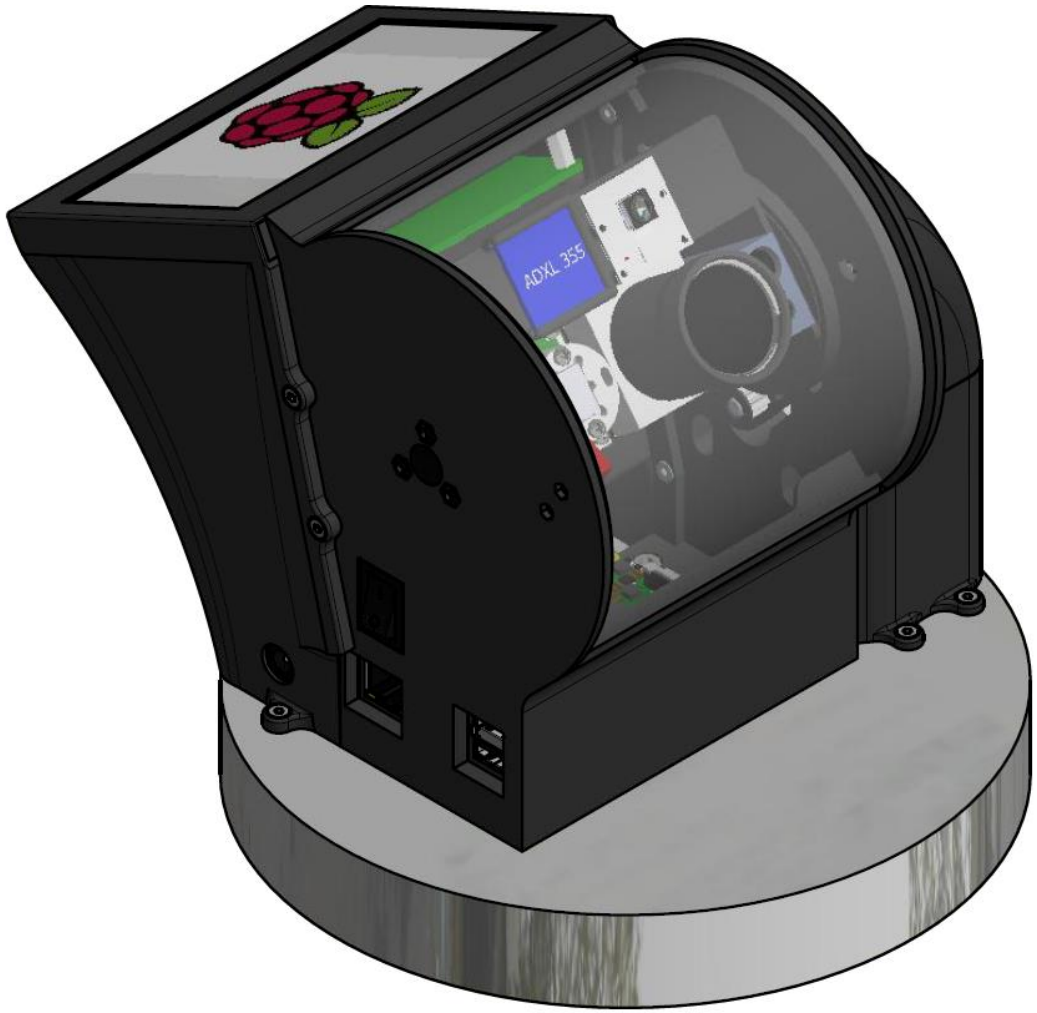




Partners: CREALP, Norbert S.A., Geo2X S.A.

LIDAR scanner

- Low-power automotive solid state LIDAR system, very compact
- For small range applications, e.g. tunnel scanning, 3D mapping by quadricopters
- cm resolution, 5cm precision
- Shall be adapted to permanent outdoor use
- Future transition to Geiger mode LIDAR with detector matrix
- GSM link can be added



Partner: in-Terra Sàrl