ENOS DOWNHOLE GROUNDWATER MONITORING

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Innovative monitoring tools

For deployment in boreholes in potable aquifers

Tools have selected to fill gaps currently available tools for CO_2 site monitoring.

- BGS optical fibre tool for dissolved CO_2 by detection of changes in pH
- BRGM-IDIL optical fibre tool, for detecting gaseous CO_2
- Uniroma1 pCO_2 probes - Cost-effective tools, improving the response time of the pCO_2 tool.

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BGS - Optical fibre pH tool

- An optical fibre tool for dissolved CO_2 detection through changes in pH.
- The aim is to develop a low cost, ‘disposable’ monitoring technique that can be deployed in many boreholes.

- Use pH-sensitive indicators to monitor colour changes when CO_2 is present in aqueous fluids
- Independent of the concentration of the indicator
- The probes transmit light through the fluid and back via a protected reflector.
- The transmitted light is carried back to a spectrometer, located at surface

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01  amp=0.0468    it=15 av=10 s=10 bpblue atmospheric0013.abs  M- bpblue pH 2.28
02  amp=0.0597    it=15 av=10 s=10 bpblue atmospheric0012.abs  M- bpblue pH 2.42
03  amp=0.108     it=15 av=10 s=10 bpblue atmospheric0011.abs  M- bpblue pH 2.65
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05  amp=0.448     it=15 av=10 s=10 bpblue atmospheric0008.abs  M- bpblue pH 3.37
06  amp=0.731     it=15 av=10 s=10 bpblue atmospheric0007.abs  M- bpblue pH 3.58
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08  amp=1.11      it=15 av=10 s=10 bpblue atmospheric0005.abs  M- bpblue pH 4.08
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10  amp=1.82      it=15 av=10 s=10 bpblue atmospheric0003.abs  M- bpblue pH 4.65
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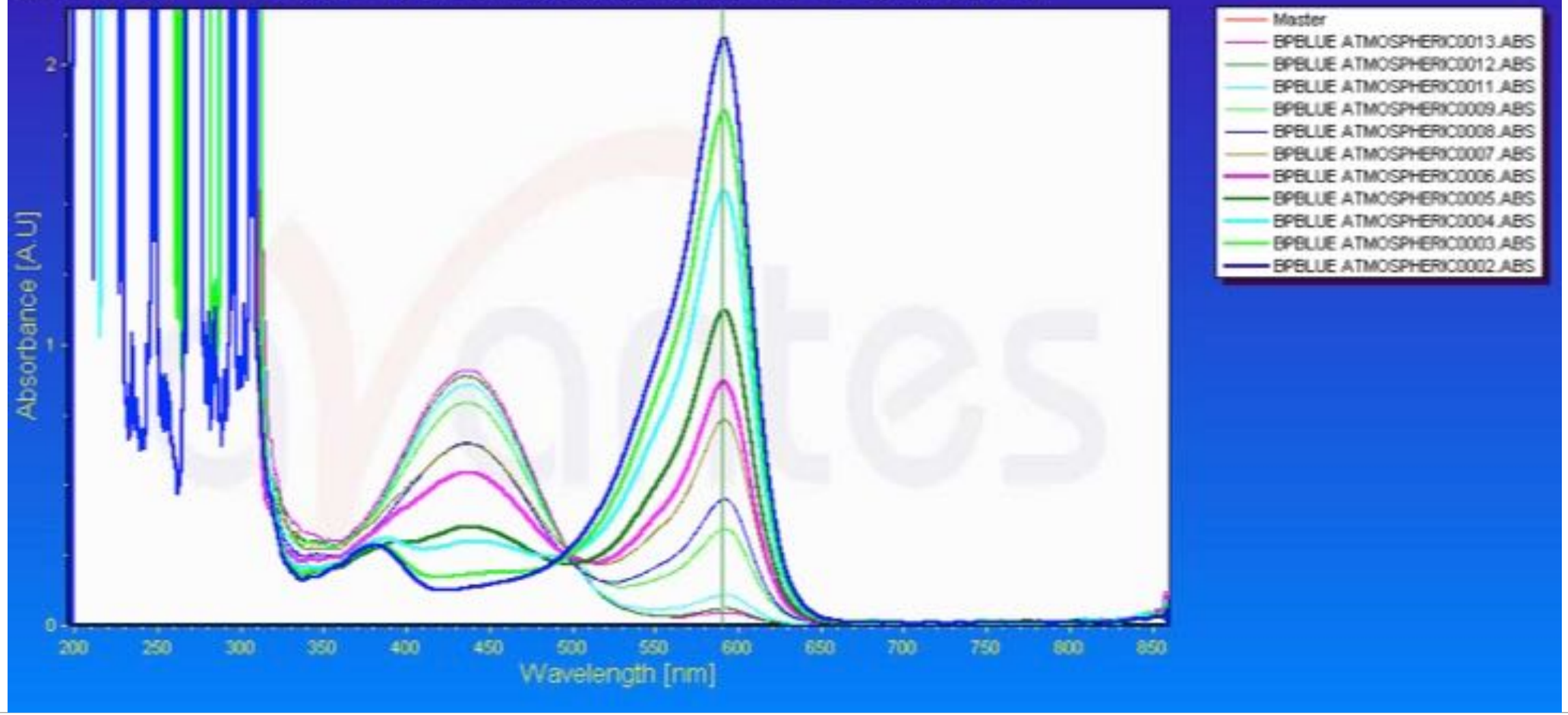
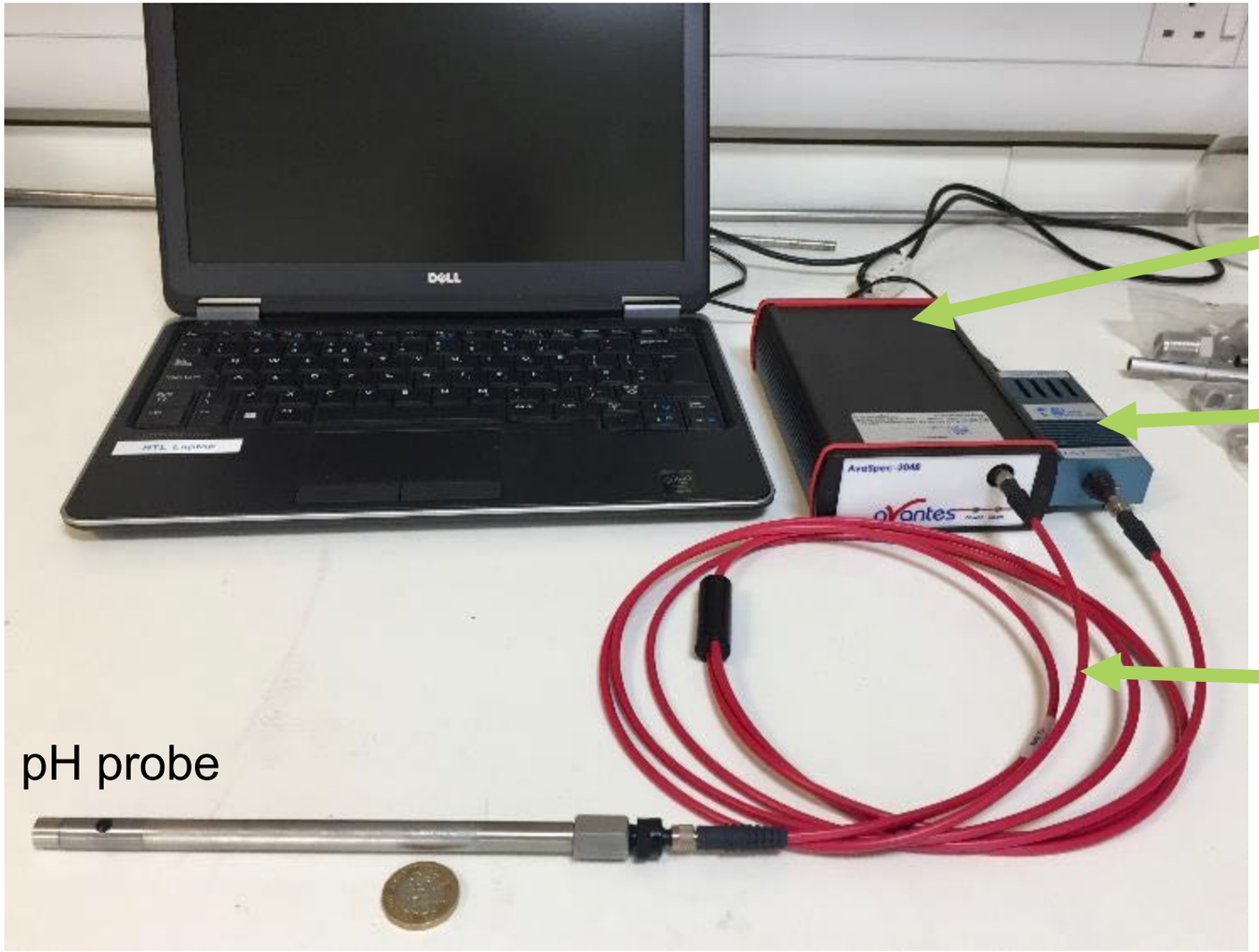


BGS - Optical fibre pH tool

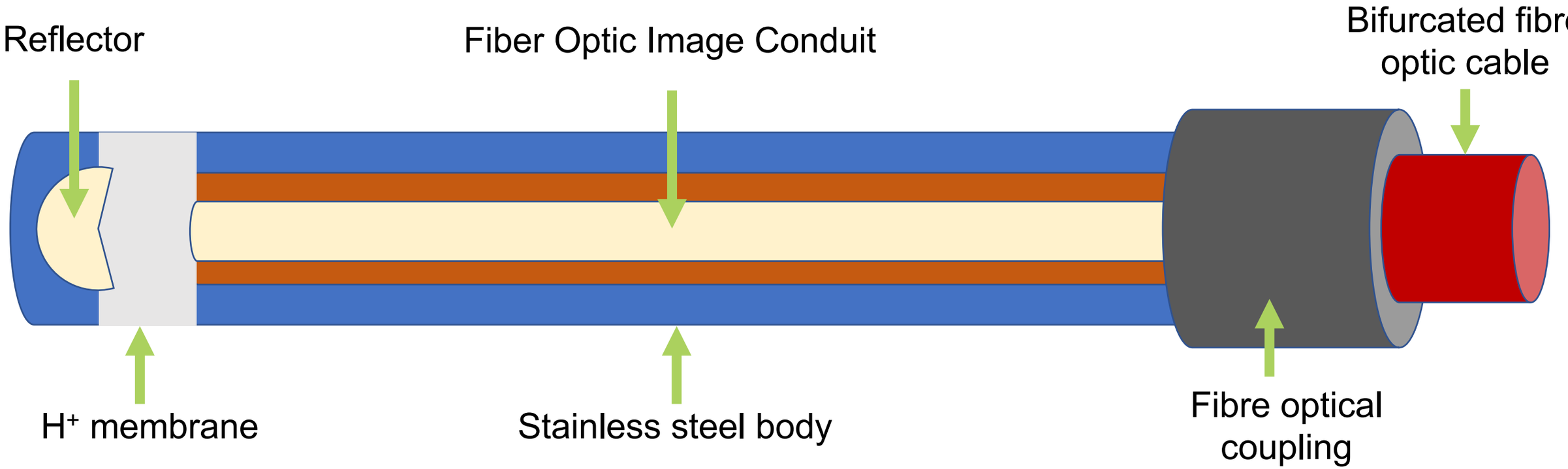


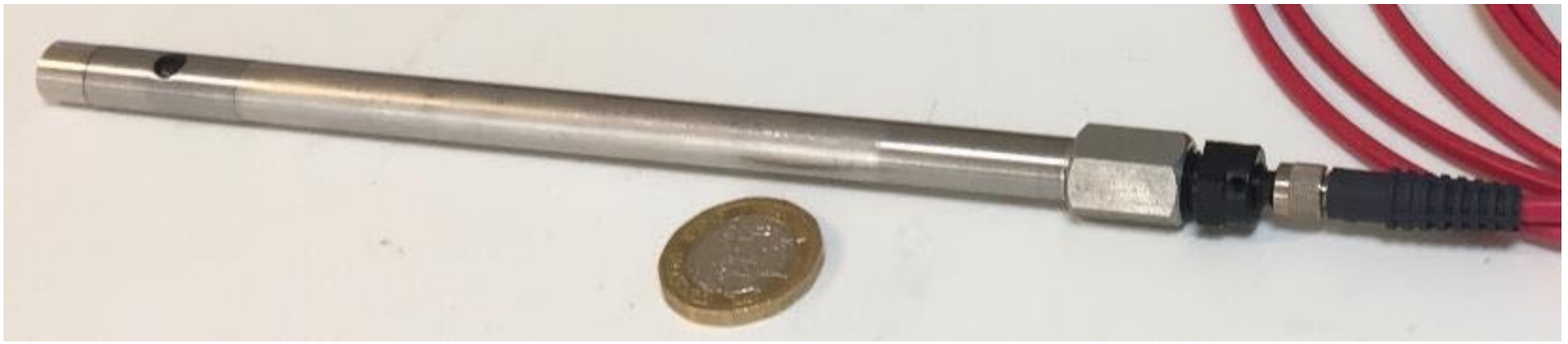
UV-vis spectrophotometer

Light source

Bifurcated fibre optic cable

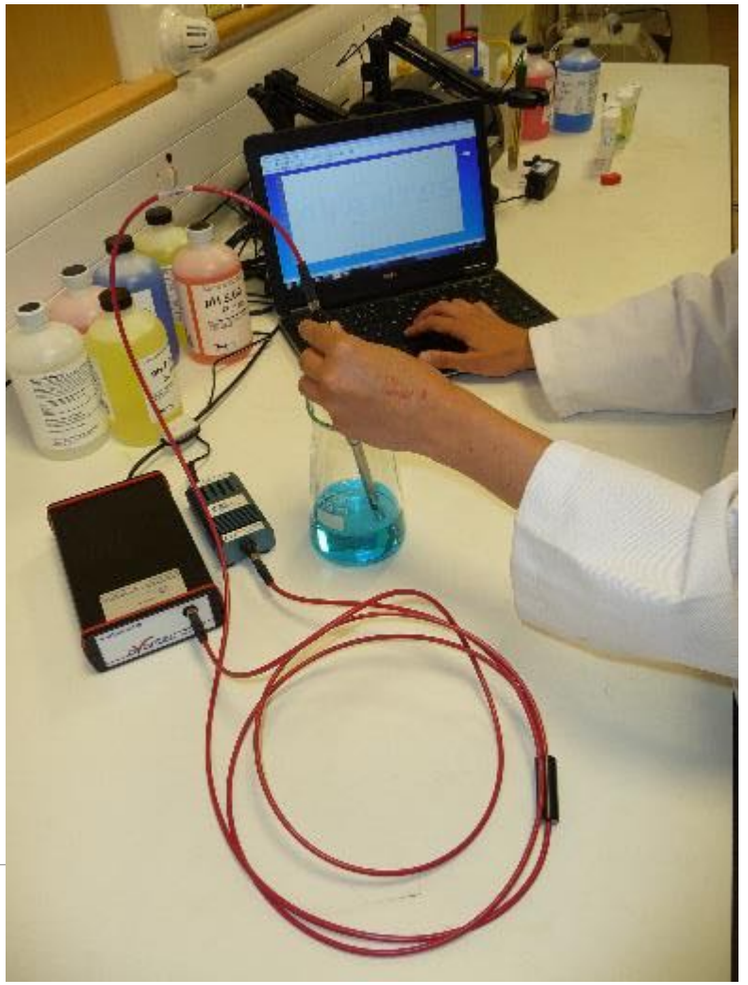
BGS - Optical fibre pH tool





BGS - Optical fibre pH tool, progress

- Principle of pH determination by colourimetric means, proven at P and T
- Probe modifications made to improve light transmission
- Next step to fit H^+ membrane



- **Advantages of probe**
- Cheap – current probe cost ≈ €1k
- Small – can be used in narrow observation wells
- Multiple probes can be deployed at once
- Spectrometer, and logging located at surface

IDIL-BRGM - Optic fibre gaseous CO_2 detector

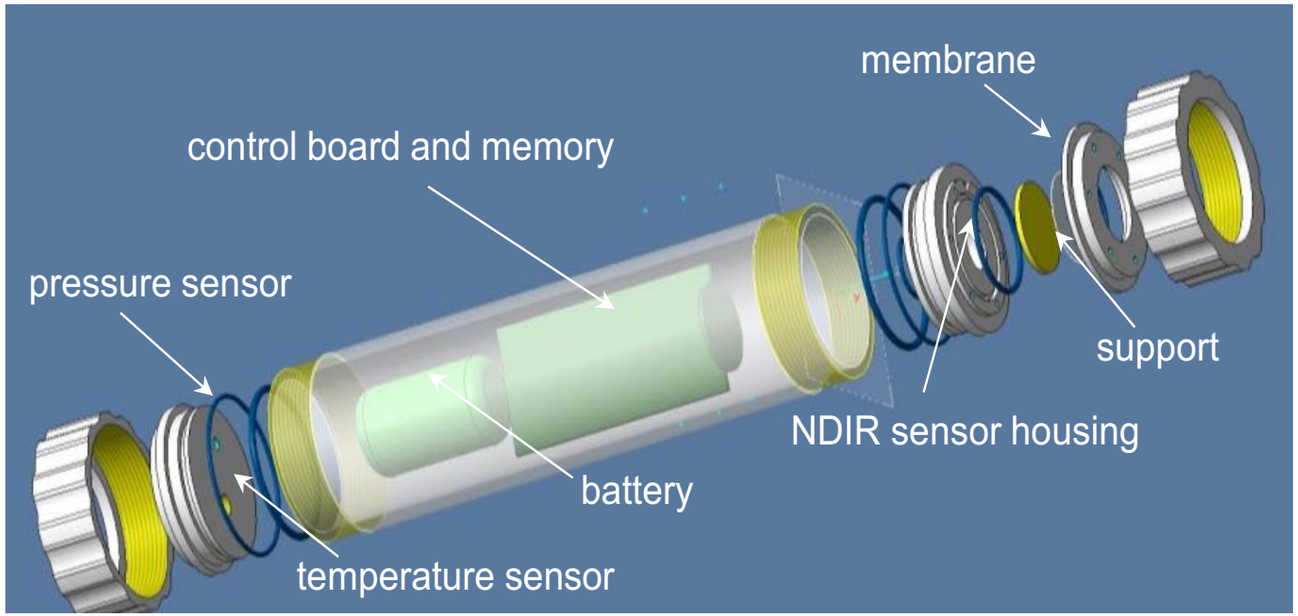
- Tool successfully tested at the low noise underground laboratory (LSBB) of Rustrel (Avignon, France)

- During this test, CO_2 was injected in the borehole and the optical fiber sensor gave a good response

- The objective is now to deploy the tool at one of the ENOS field laboratories

Testing the IDIL-BRGM optic fibre tool

UniRoma1 GasPro – design and function



- Non Dispersive InfraRed (NDIR) CO_2 sensor housed behind gas permeable Teflon membrane
- Measurement frequency - 1s, 1min, 1 hour, 1 day, 1 month
- Internal data logger or real-time data transfer

- Research on miniaturization and addition of other sensors (like pH, EC, REDOX)

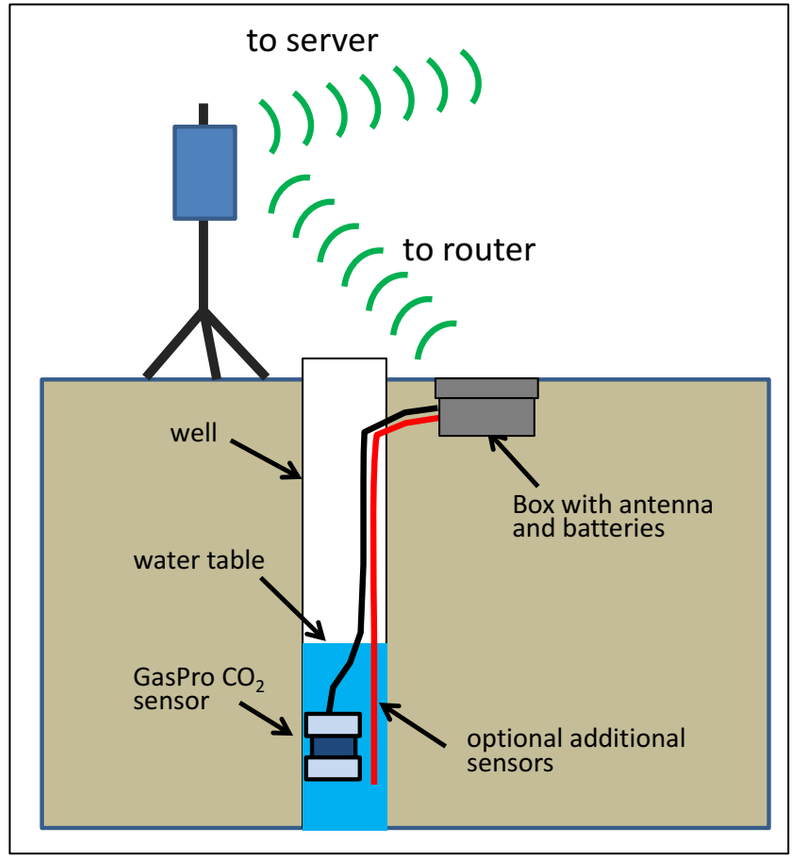
UniRoma1 GasPro – deployment options

Data logger version.

- With measurement every hour batteries last about 4 months
- memory non-limiting

Data transfer version

- Batteries, memory and antenna on surface
- CO_2 and other sensors down-hole
- Hourly link to server



What has been achieved with the UniRoma1 GasPro?

In boreholes

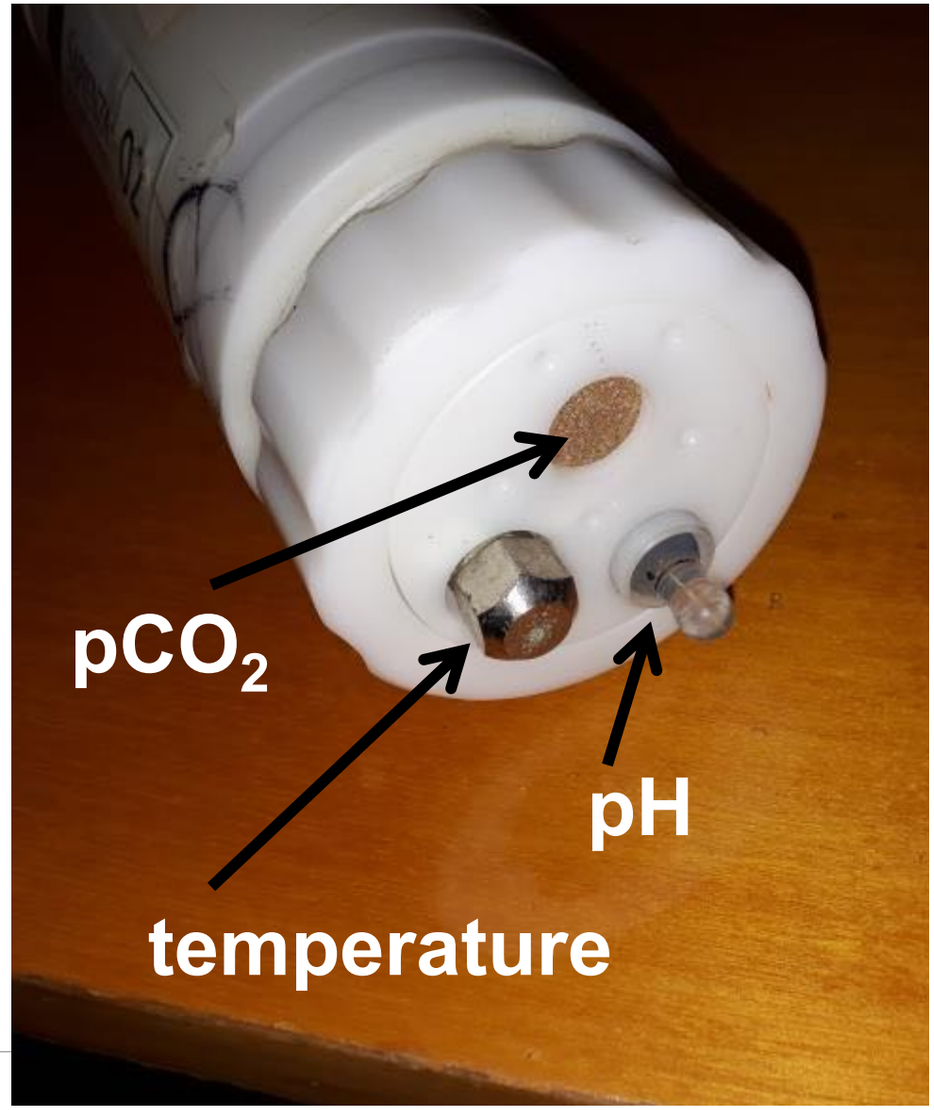
- In Sulcis area (for Sotacarbo) for baseline CCS monitoring. 10 wells monitored for 1-2 years.
- Reproducible seasonality in shallow surface well, influenced by climate and in-well biological processes.

In surface water

- Numerous deployments (from days to months) in surface waters from 5 to 50 m depth (Adriatic and Tyrrhenian seas)

What are the potential benefits of the UniRoma1 GasPro?

- Simple, robust, low maintenance, no moving parts
- Low power consumption
- Low cost allows for deployment of many units.
- In situ measurement
- Pressure tested to 300 m
- Teflon membrane is resistant to bio-fouling
- Next version will integrate pH, EC, REDOX sensors. First prototype with pH already constructed



Summary

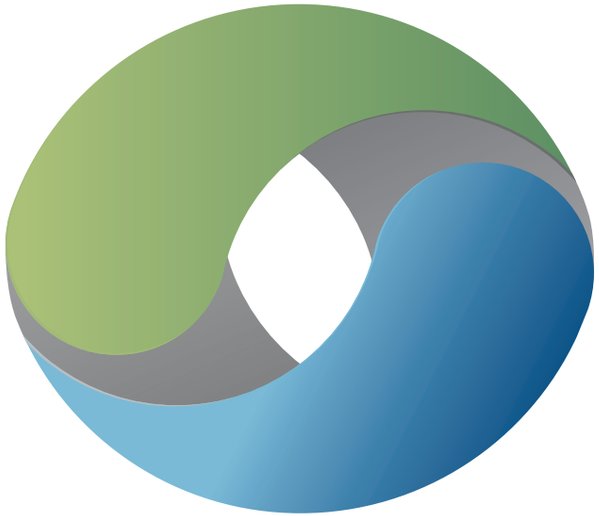
ENOS can offer a range of

- **Innovative**
- **Complementary**
- **Robust**
- **Low maintenance**

monitoring tools

For deployment in boreholes in potable aquifers

Tools fill gaps in current tools for CO_2 site monitoring.



ENOS

Enabling Onshore CO_2 Storage

www.enos-project.eu

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