

# Active-DTS measurements conducted in Kerrien

Name of experiment: Active\_DTS\_Kerrien\_06042016

Date: April 6<sup>th</sup>, 2016

Objectives: Conducted active-DTS measurements in streambed sediments

Principle: A Fiber Optic (FO) cable is electrically heated through its steel armoring and the elevation in temperature, associated to the heat injection, is continuously monitored all along the heated section using the FO inside the cable.

## 1. Installation and experimental setup

Active-DTS measurements were conducted in April 2016 by deploying a FO cable in the streambed in the wetland of the Kerrien catchment (see Figure 1 for localization)

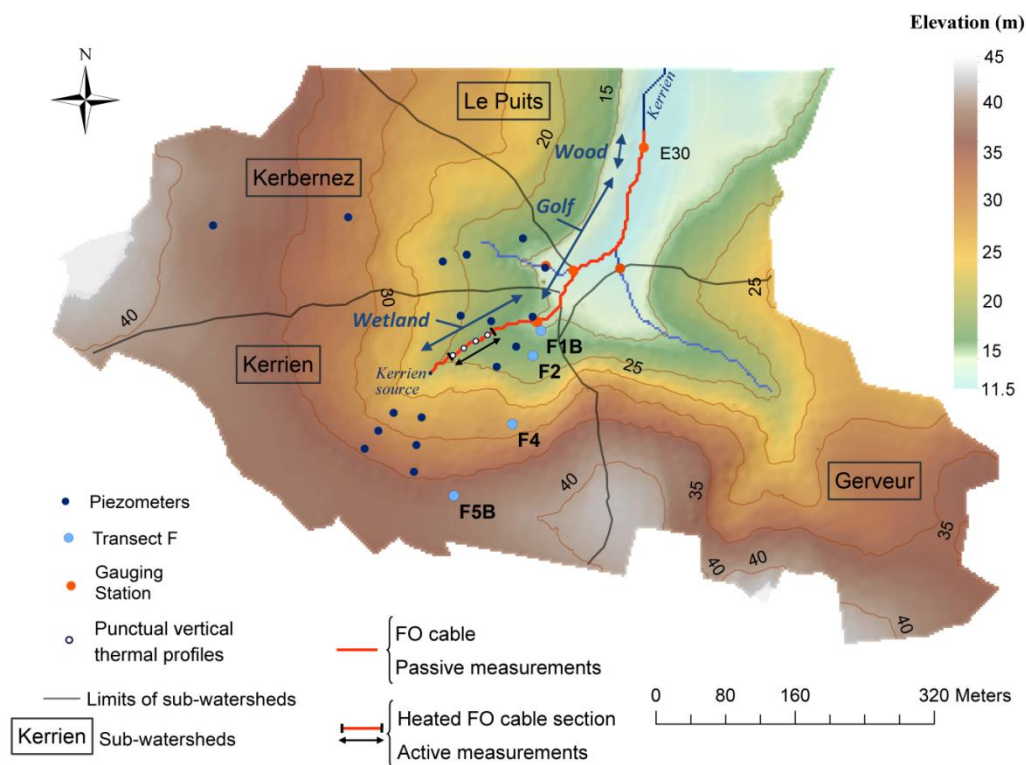


Figure 1: The active-DTS measurements were conducted in the stream located in the wetland area of the Kerrien catchment.

Figure 2 presents the experimental setup of the active-DTS experiment. A 150 m length of BruSens FO cable has been connected to a FO-DTS control unit, a **Silixa Ultima S instrument**. The unit was configured in double-ended configuration to collect data at **12.5 sampling cm and 60 seconds time interval**. The effective spatial resolution of DTS measurements with this unit was estimated varying between 66 and 90 cm. Two sections of 20 m of FO cable were installed inside calibration baths (a

cold calibration bath and a warm one) and RBR SoloT probes (0.002°C accuracy) were used to calibrate the data. Comparison between DTS measurements and RBR SoloT probes validated the temperature measurements, with a relative uncertainty of measurements estimated at 0.05°C and absolute uncertainty of measurement estimated at 0.2°C.

**A 60-meters section of the 150 m FO cable has been buried in the streambed** and the burial depth was measured in situ and estimated to be around 8 to 10 cm. This 60-m section has been electrically isolated and heated using a power controller (provided by CTEMP, <https://ctemps.org/>) supplying a constant and uniform heating rate power of 35 W/m along the heated FO cable. The heated cable has been energized continuously during 4 hours and the recovery was also monitored for an additional 3 hours after turning off the power controller.

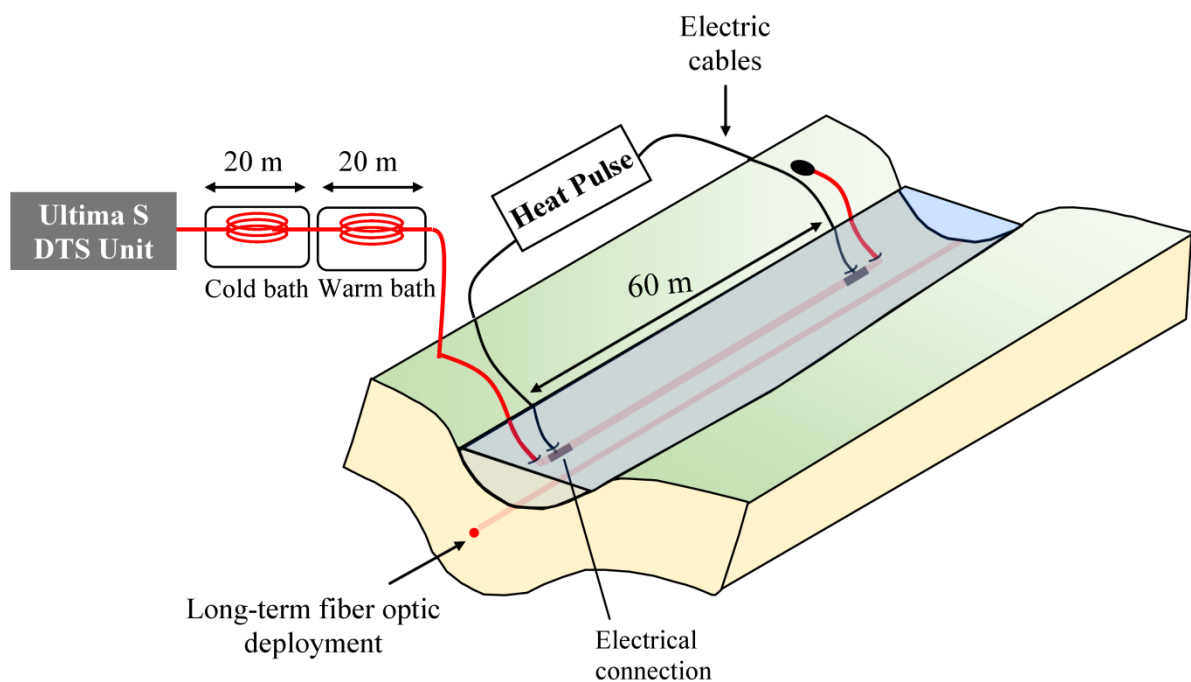


Figure 2. Experimental setup of the active experiment: a 60 meter-section of heatable cable has been electrically isolated, buried in the sediments and then heated by connecting to a power controller.

### **Summary of equipments:**

- Fiber optic cable : 3.8-mm-diameter fiber optic cable (BruSens cable; reference LLK-BSTE 85°C) containing 4 multimode 50/125- $\mu\text{m}$  fibers
- Calibration : double-ended calibration ; 2 paired-fibers (red – blue and yellow and green) spliced and connected at the end of the cable
- Measurements:
  - Silixa Ultima S DTS unit reporting temperature every 12.5 cm at a-60 seconds sampling interval (30 sec per channel).
- Calibration:
  - 20 m of cable placed in a warm calibration bath and 20 m in a cold calibration bath (box filled with wetted ice)
  - RBR SoloT probes (0.002°C accuracy) recorded the temperature in each bath
  - Air pumps set to homogenize temperature

- Spatial resolution: experimentally estimated during heating periods between 51 and 67 cm [further details : Simon, N., Bour, O., Lavenant, N., Porel, G., Nauleau, B., Pouladi, B., & Longuevergne, L. (2020). A Comparison of Different Methods to Estimate the Effective Spatial Resolution of FO-DTS Measurements Achieved during Sandbox Experiments. *Sensors*, 20(2). <https://doi.org/10.3390/s20020570>]
- Heated section: A 60 meter-section of heated cable electrically isolated and connected to electrical cable (connections C<sub>1</sub> and C<sub>2</sub>) allowing the injection of electricity by connecting to a Silixa's Heat Pulse Control System, delivering a well-controlled and constant power intensity

## 2. Data available in the database

- **FO data**

Name of the file : **FO\_Active\_DTS\_measurements**

Contents : 3 data files (format .txt)

- **'Distance'** - Localization of measurement points along the FO cable (Distance from the DTS unit, located in 0) – 4240 points, each separated of around 12.5 cm
- **'Time'** – Time of the temperature record – 472 points
- **'Temperature'** – Temperature measured for each measurement point located along the FO cable and at each moment of the experiment – 4240 x 472 points

- **Temperature recorded in the calibration baths with RBR Solo T** (see Figure 2)

Name of the file : **RBR\_data**

Contents : 4 data files (format .txt)

- **'Temperature\_RBR380\_CB'** - Temperature recorded with the RBR SoloT n°380, installed in the cold calibration bath
- **'Time\_RBR380\_CB'** - Time of the temperature record (corresponding to the RBR SoloT n°380 installed in the cold calibration bath)
- **'Temperature\_RBR381\_WB'** - Temperature recorded with the RBR SoloT n°381, installed in the warm calibration bath
- **'Time\_RBR381\_WB'** - Time of the temperature record (corresponding to the RBR SoloT n°381 installed in the warm calibration bath)

## 3. About the FO data

### Concerning the 'Distance':

- The data corresponding to the temperature recorded in the **cold calibration bath** are located between **55.8 and 71.36 m** along the FO cable (index 442 and 565 respectively)
- The data corresponding to the temperature recorded in the **warm calibration bath** are located between **35.31 and 52.51 m** along the FO cable (index 280 and 416 respectively)

- The data corresponding to the temperature recorded along the **heated section** are located between **101.6 and 161.2 m** along the FO cable (index 804 and 1275 respectively)
- The data recorded between 0 and 35.31 m (index 1 and 280 respectively), between 71.36 and 101.6 m (index 565 and 804 respectively) and between 161.2 and 252.1 m (index 804 and 1994 respectively) correspond to temperature measurement outside (not buried in the streambed) or in the streambed in non-heated sections.
- FO were **spliced and connected** at the end of the cable: **252.1 m** (index: 1994). Data recorded for  $d > 252.1$  m correspond to the “mirror” signal induced by the double-ended calibration.

**Concerning the ‘Time’:**

- The temperature recorded **between t=1 (08:21:05 AM) and t=66 (09:30:17 AM)** correspond to the **initial state (before the heating period)**. The very first data correspond to the DTS unit calibration (should not be interpret)
- The temperature recorded between **t=67 (09:31:18 AM) and t=268 (12:58:57 PM)** correspond to the **heating period (Power controller ON)**. The electricity injection started between t=66 and t=67.
- The temperature recorded between **t= 269 (12:59:59 PM) and t= end (04:29:34 PM)** correspond to the **recovery period (after the heating period, Power controller OFF)**. The electricity injection stopped between t=268 and t=269.
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