Iceland Liechtenstein Norway grants

Norway grants

Optimization of Shallow Geothermal Energy Resources for Green Transition OptiSGE

DTS Examples

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06.06.2024

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How

- An optical fibrecable is installed in the borehole(s)
- The ends of the fibres are coupled to a measurement instrument and logger
- The measurement instrument sends laser pulses through the fibre and registers the backscattered light
- Light is converted to temperature by a formula with 3 parameters
- Calibration consists in adjusting offset/parameters

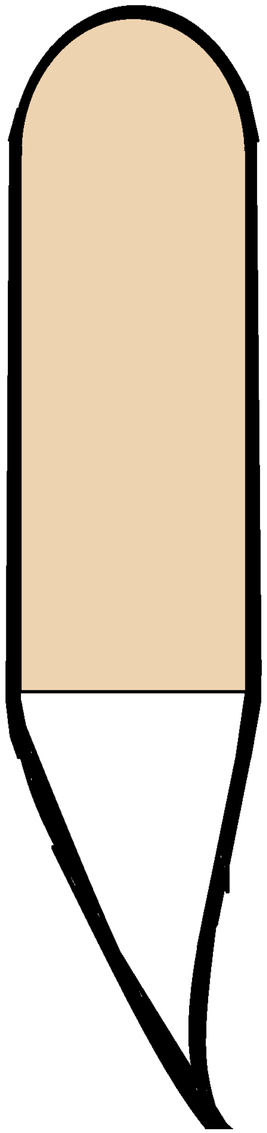
Avoid!

- Avoid bending sharply/breaking the fibres
- Avoid end at the end - End signal is bad

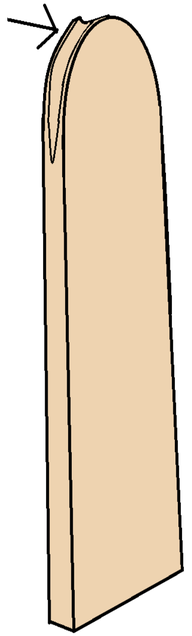
Site I: Ørlandet

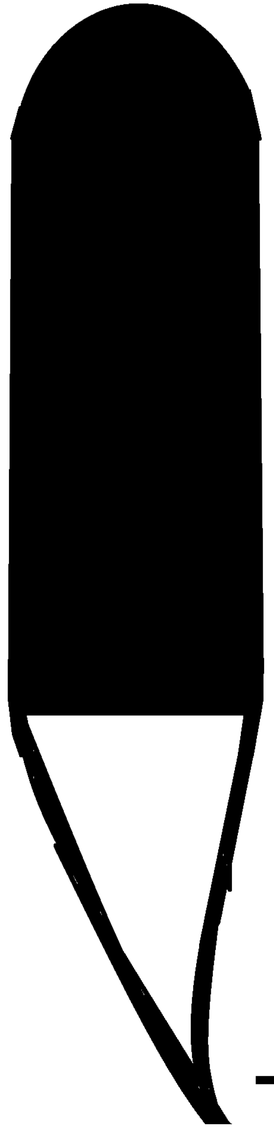
First fibre

Track



Taped fibre

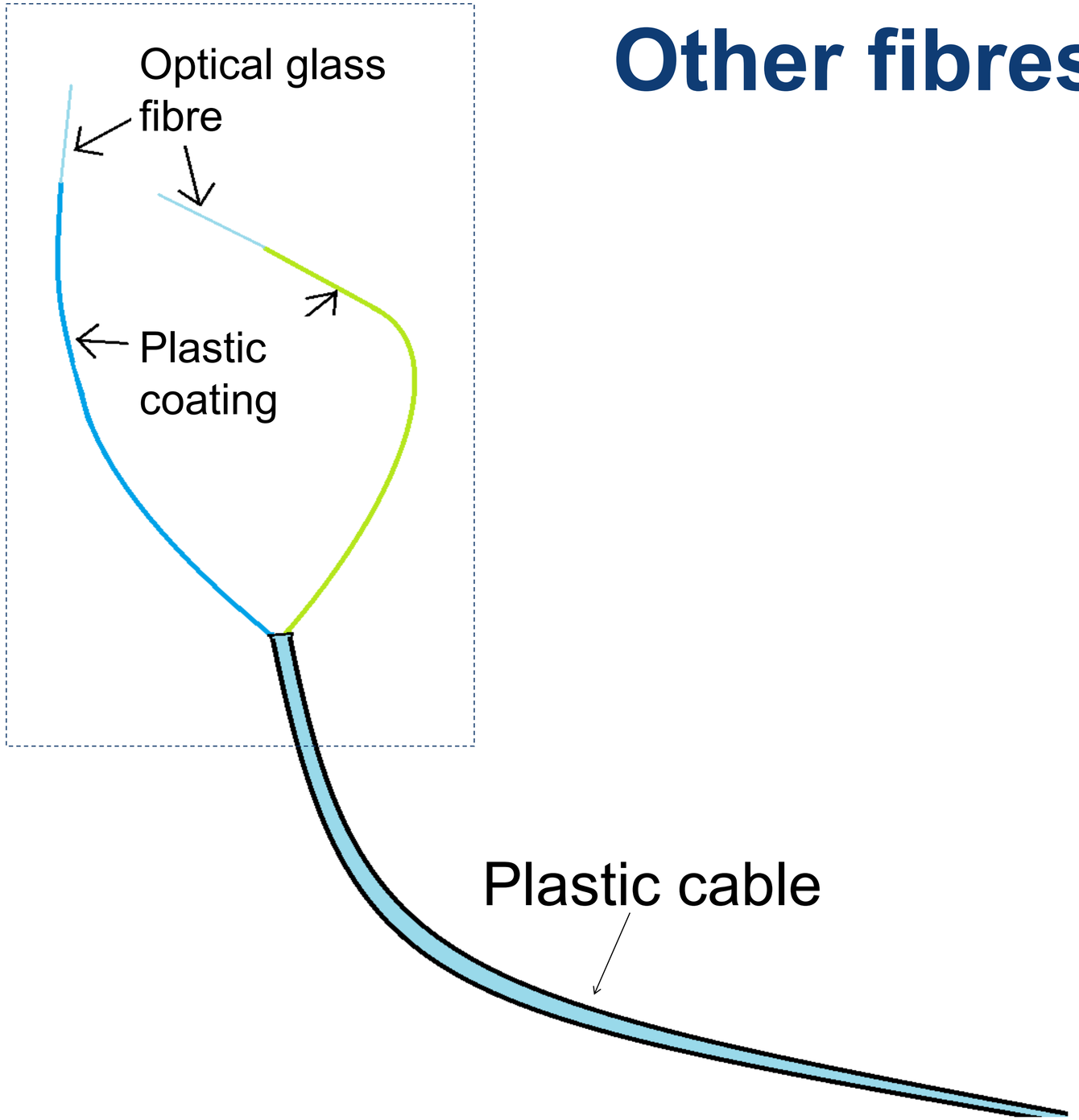


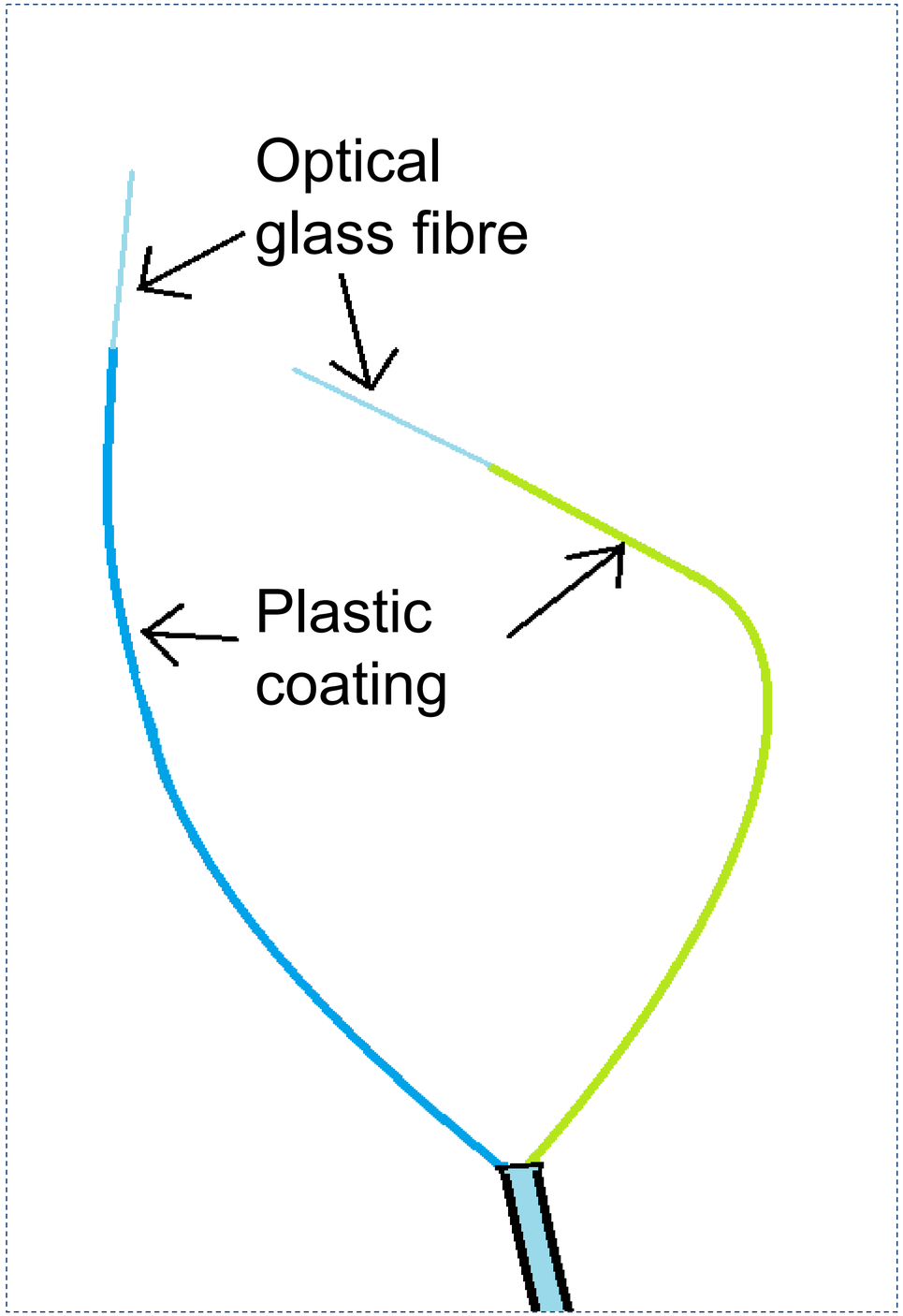


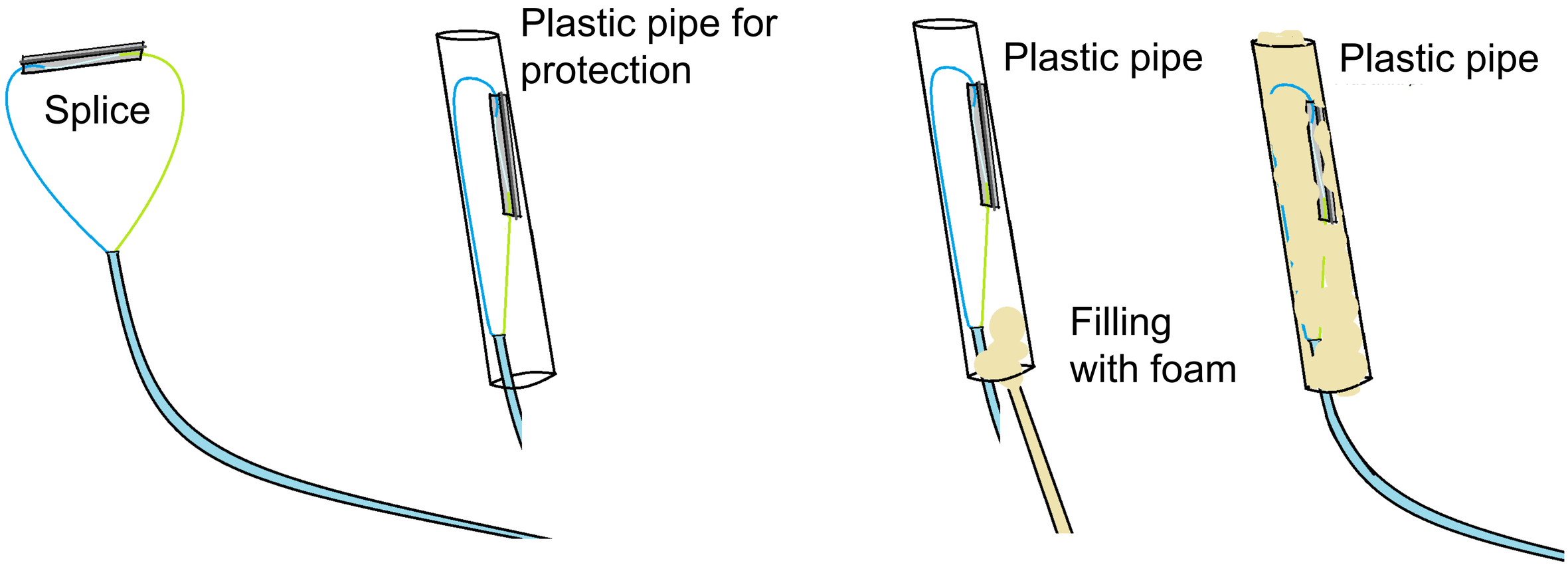
Tape d fibre

Tape

Other fibres

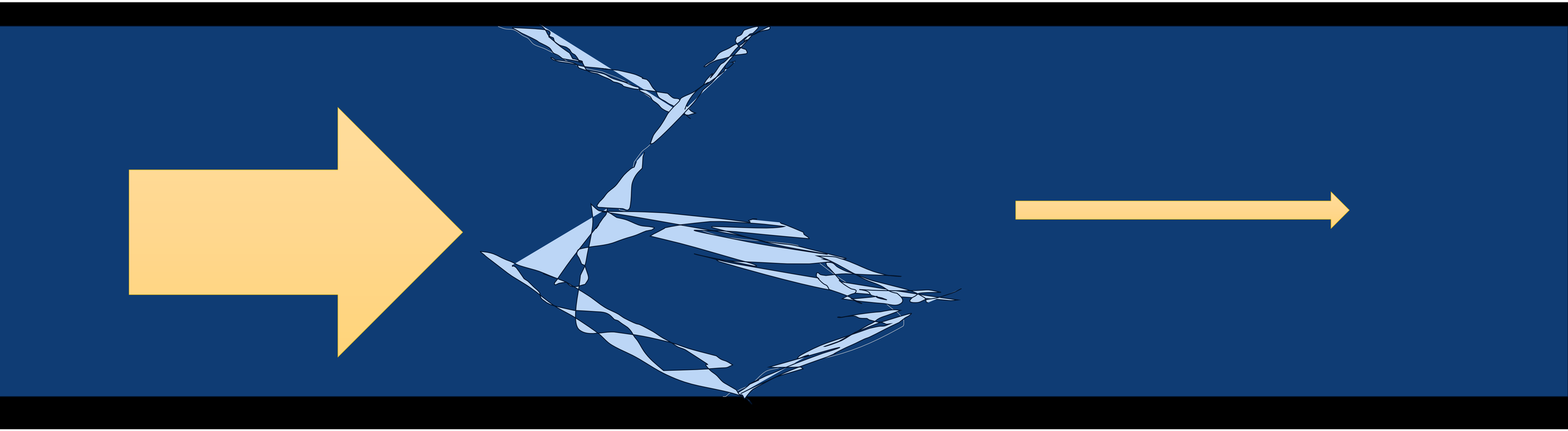






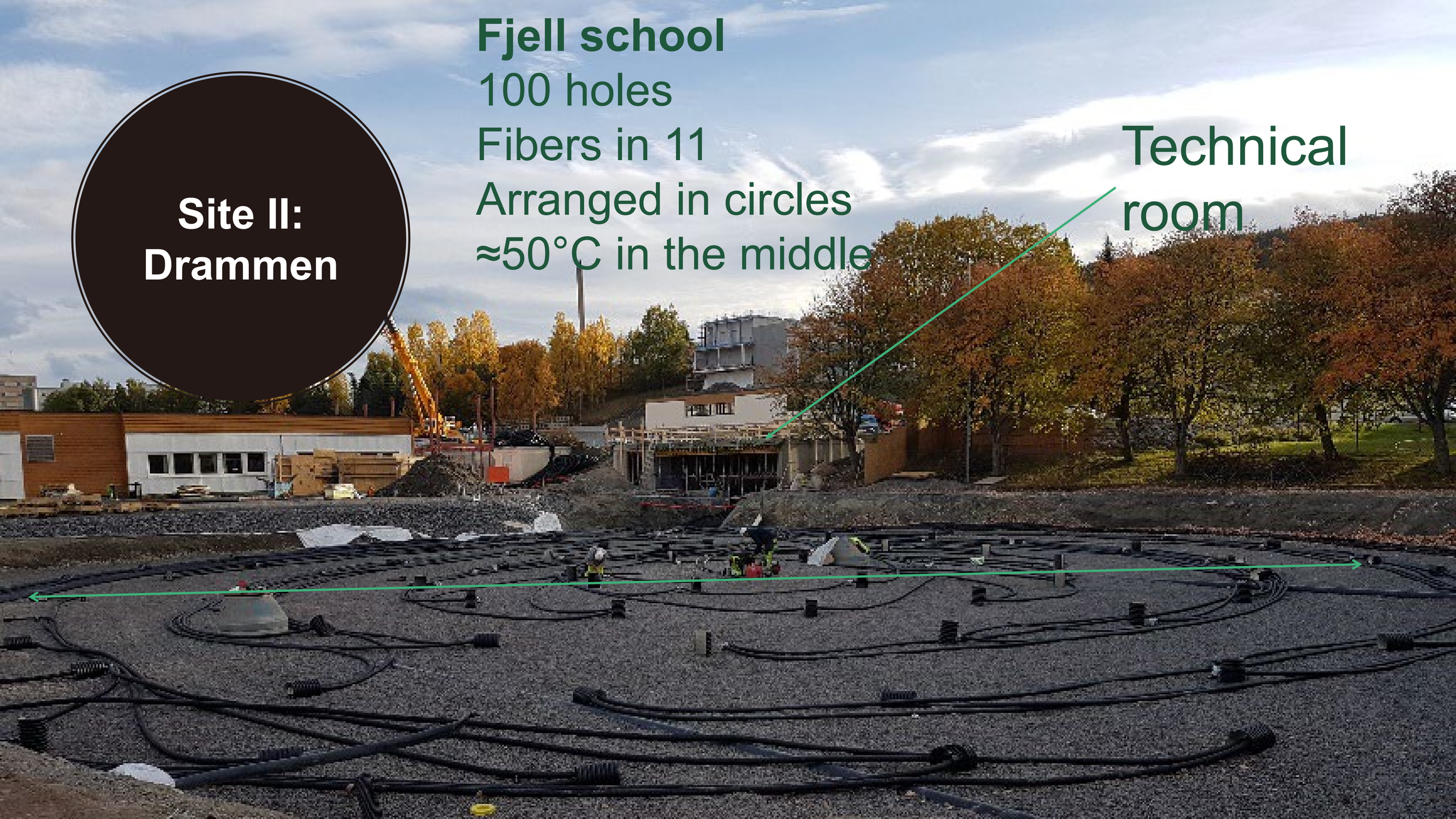
Spliced ends – requires practiced hands

Plastic cable with glass fibre:



Measurement setup:

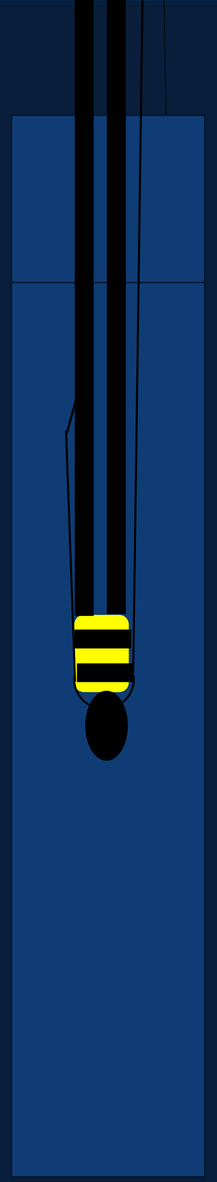
- How high resolution do you need?
- Length: long enough, bit no longer! Time for loading data!
- Longer averageing times – lower errors


Site II:
Drammen
Fjell school
100 holes
Fibers in 11
Arranged in circles
≈50°C in the middle
Technical
room

Taped end of fiber


To technical room
Fiber taped to the collectors at the
10 m taped to the collectors

Fiber and collectoras are lowered into the hole



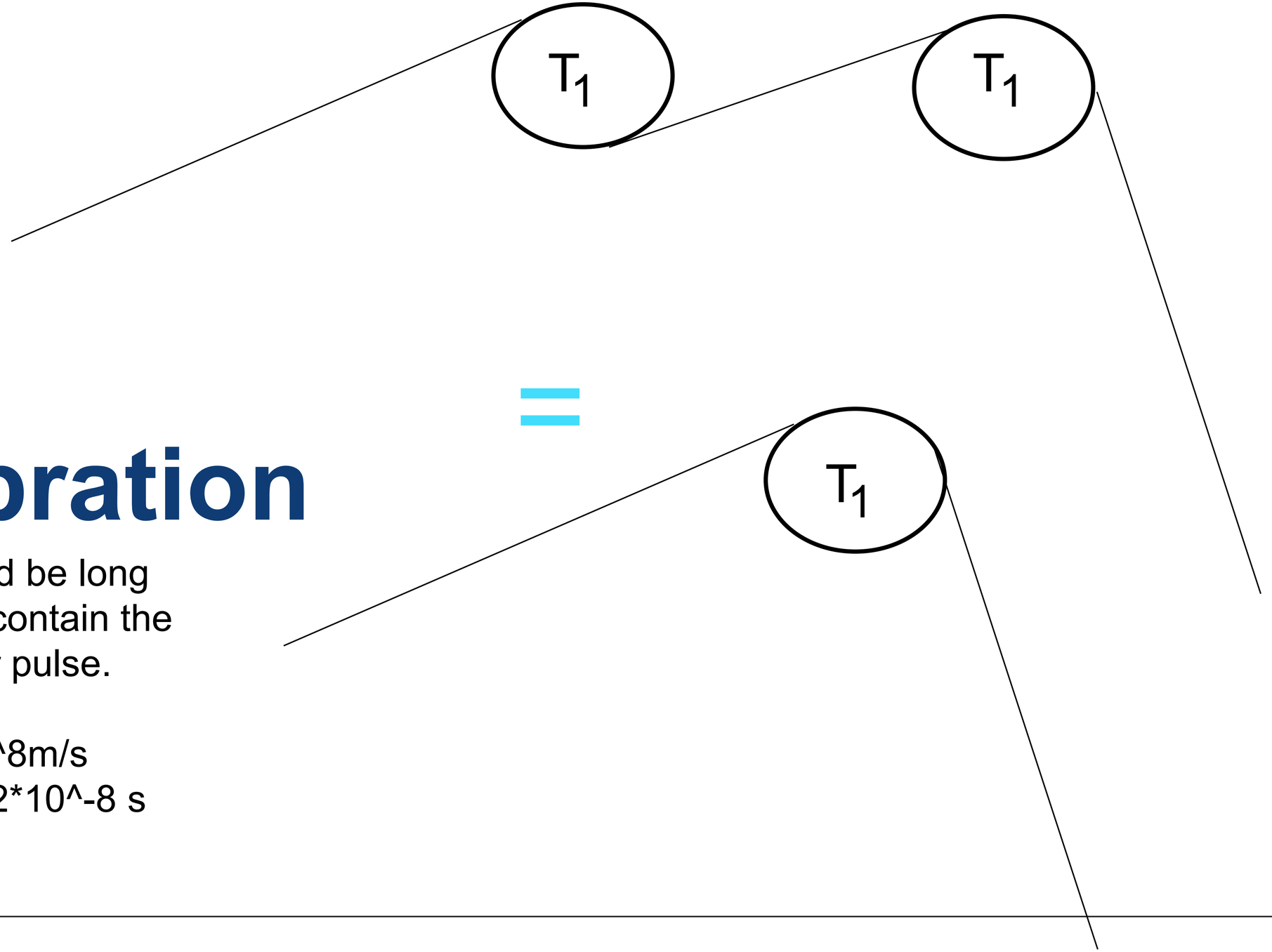
Done!

Technical room

Calibration

Coils should be long enough to contain the whole laser pulse.
V=200 000 km/s=2*10^8m/s
dt=20 ns =2*10^-8 s
x=4 m

Calibration



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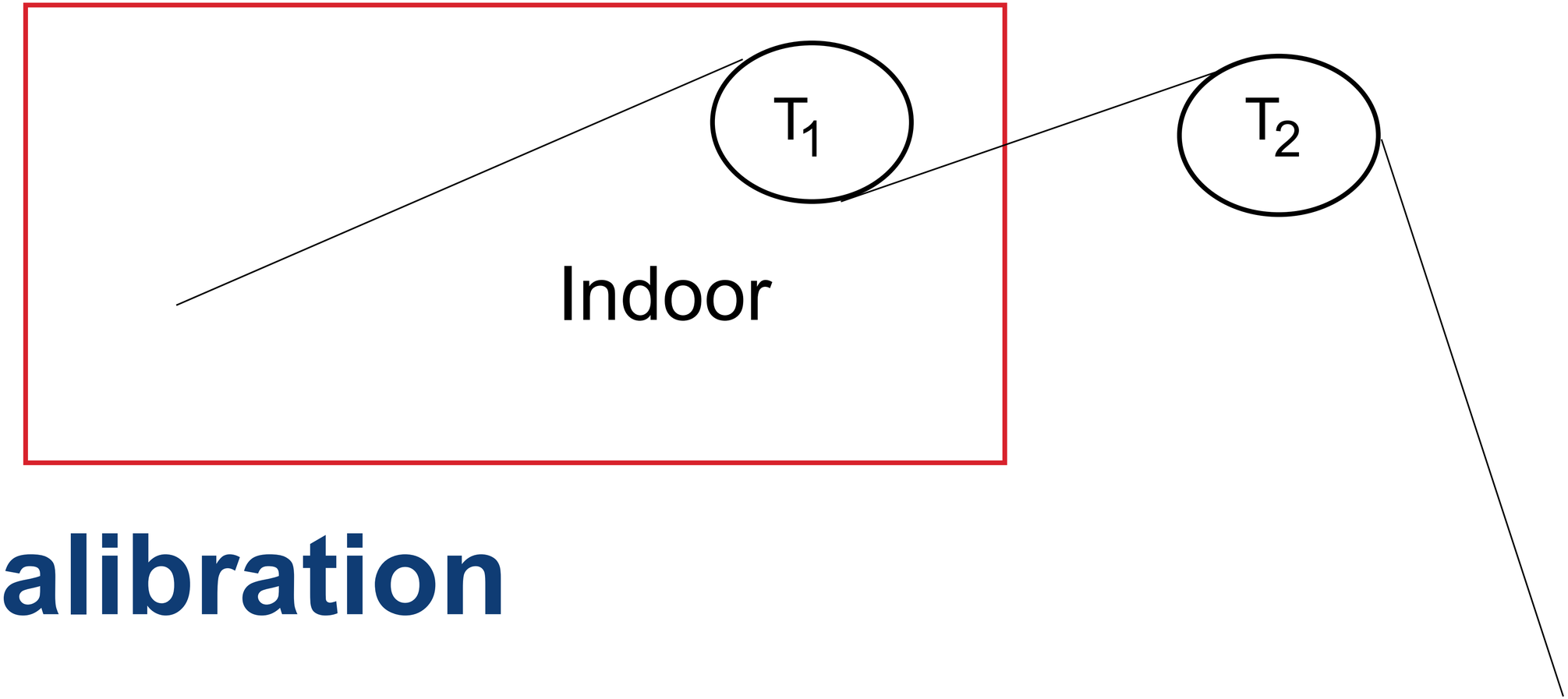
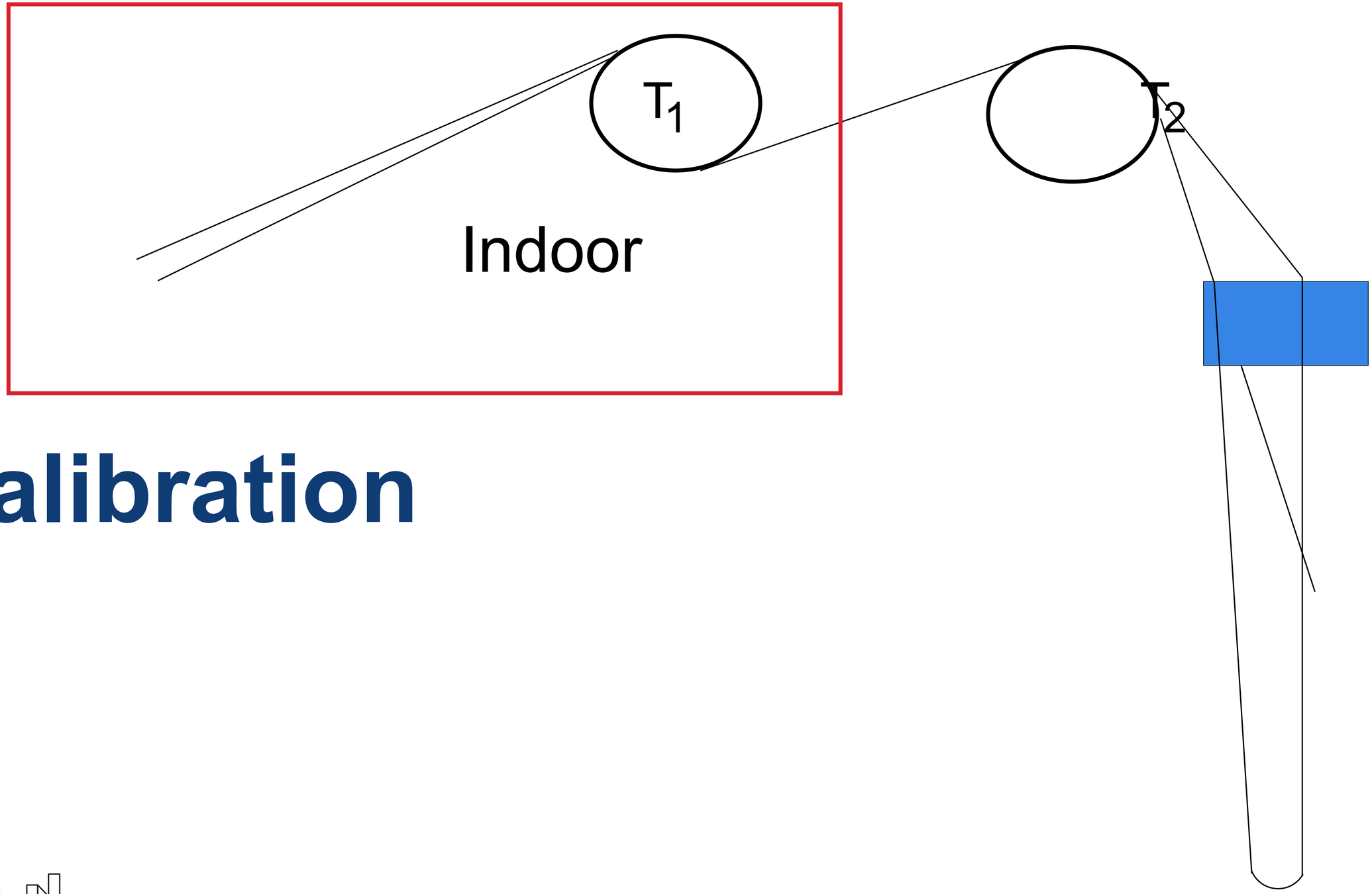
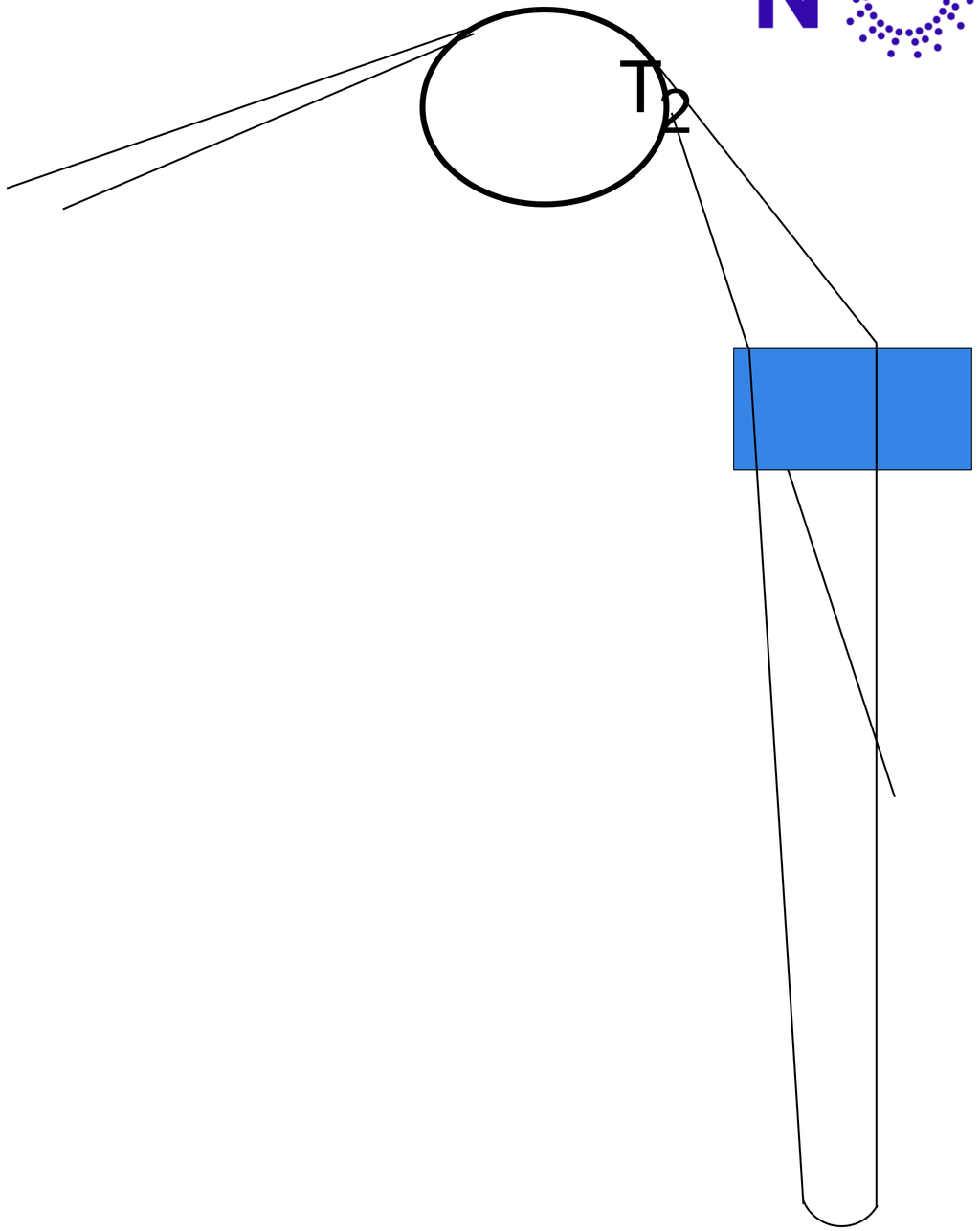


Calibration

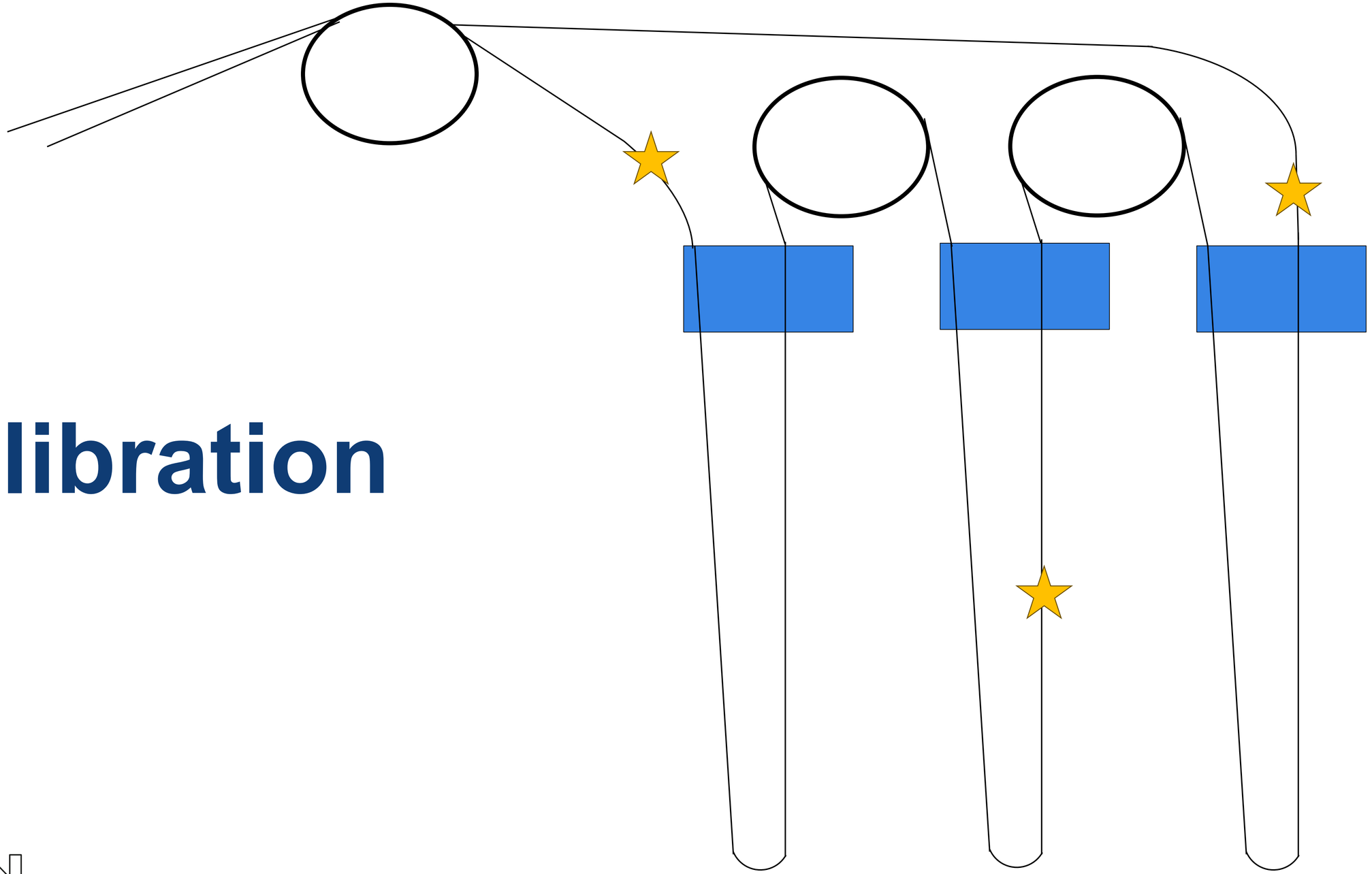


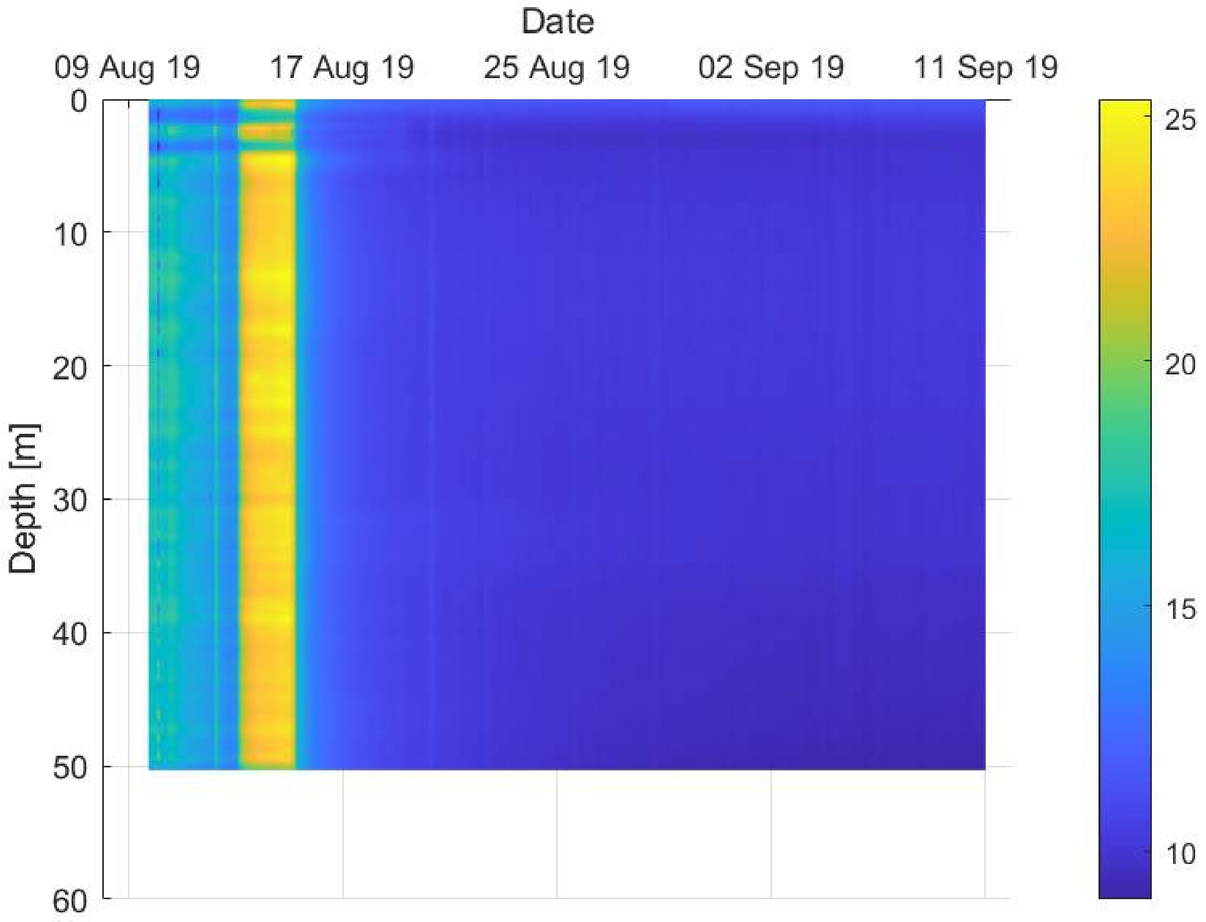
Calibration

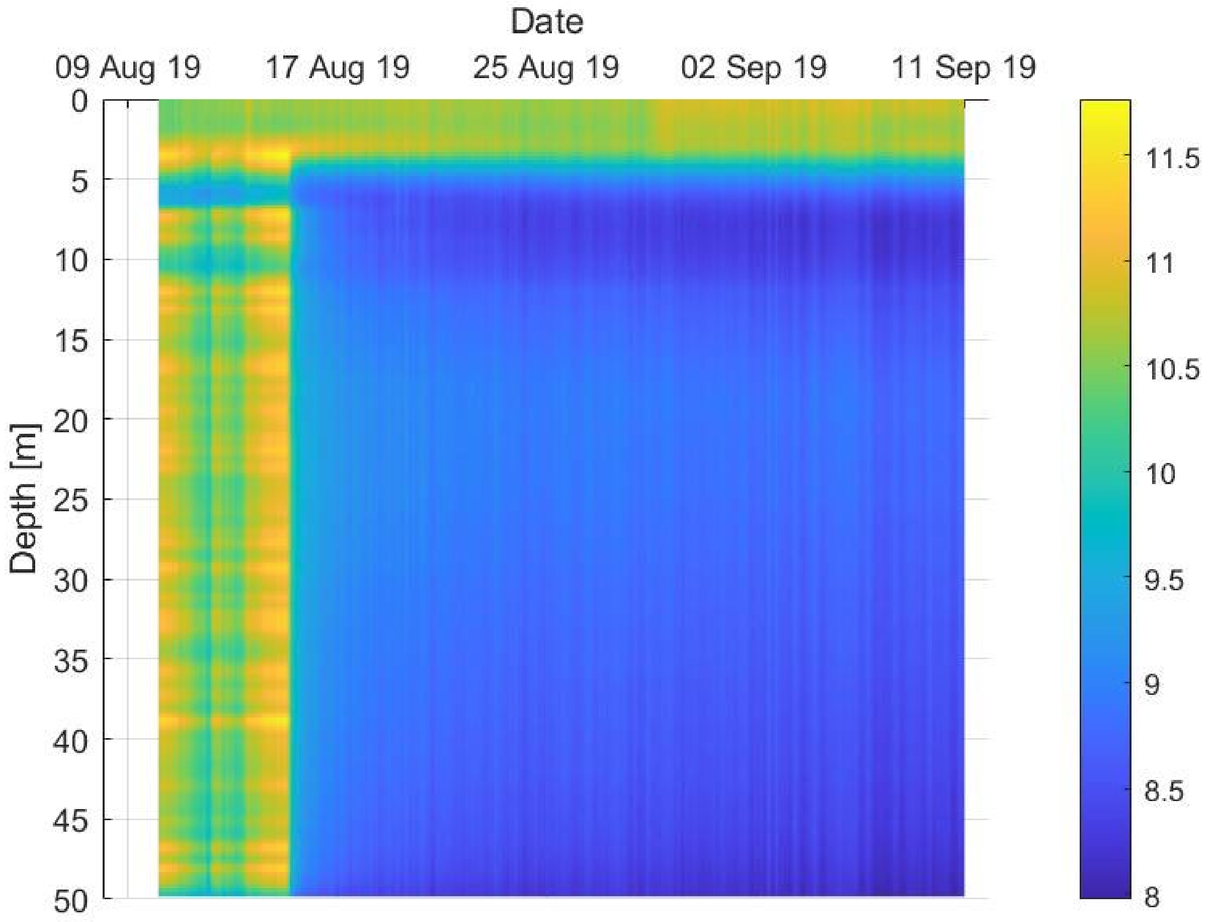
Calibration



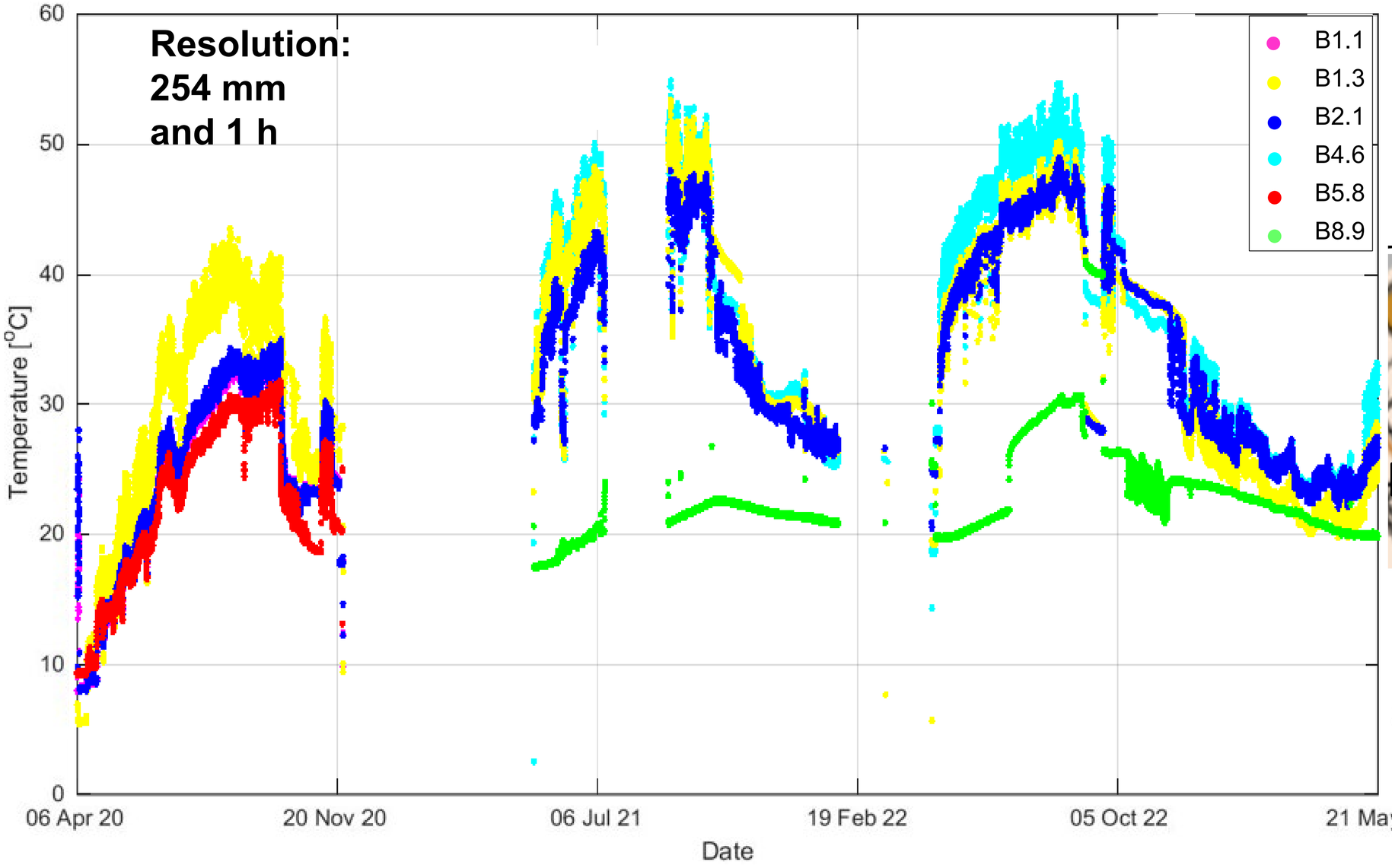
Calibration

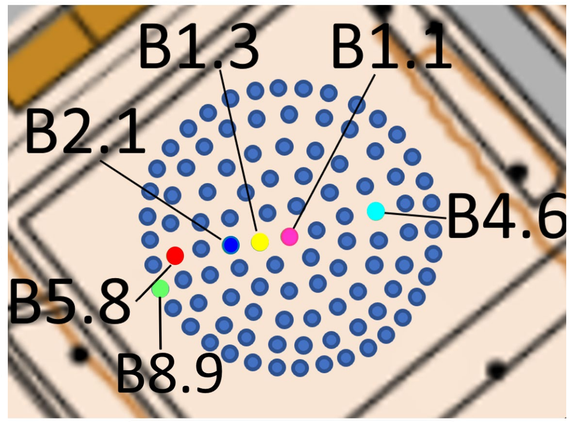



Date
09 Aug 19
17 Aug 19
25 Aug 19
02 Sep 19
11 Sep 19
Depth [m]
0
10
20
30
40
50
60
25
20
15
10


Date
09 Aug 19
17 Aug 19
25 Aug 19
02 Sep 19
11 Sep 19
Depth [m]
0
5
10
15
20
25
30
35
40
45
50
11.5
11
10.5
10
9.5
9
8.5
8

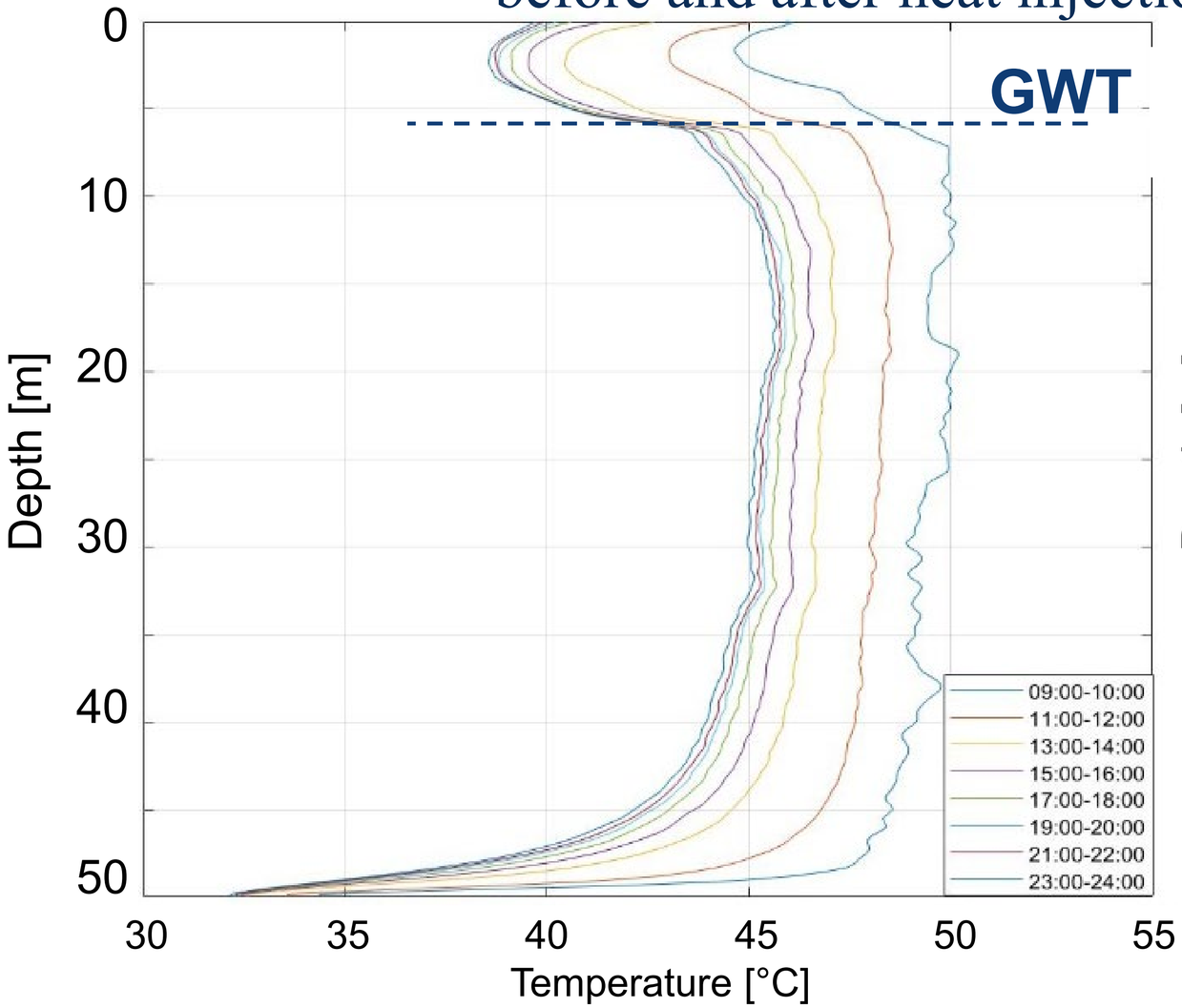
Measured mid-temperatures

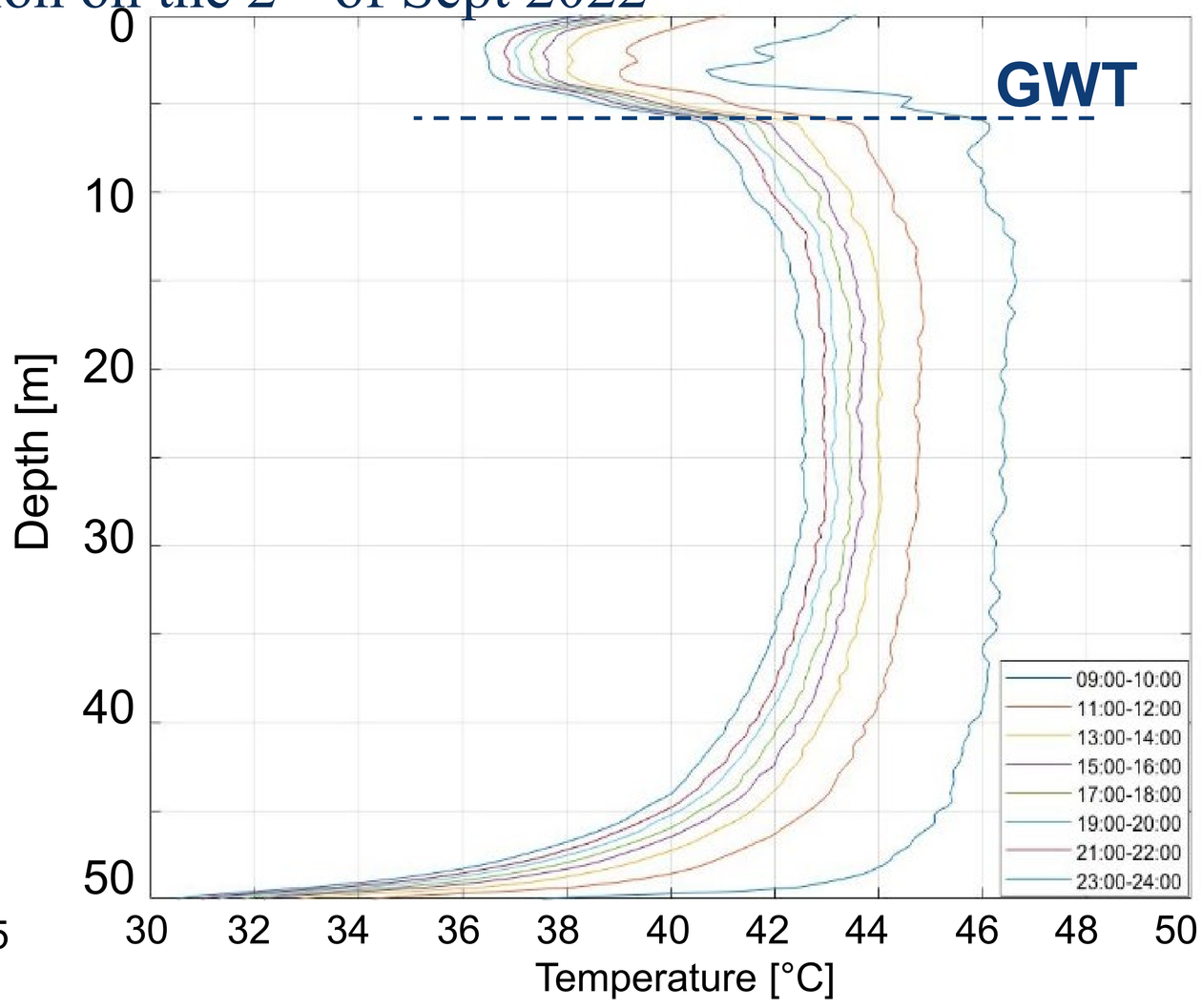




From: Kvalsvik et al., 2024.

Temperature profiles in B4.6 (left) and B2.1 (right) before and after heat injection on the 2nd of Sept 2022





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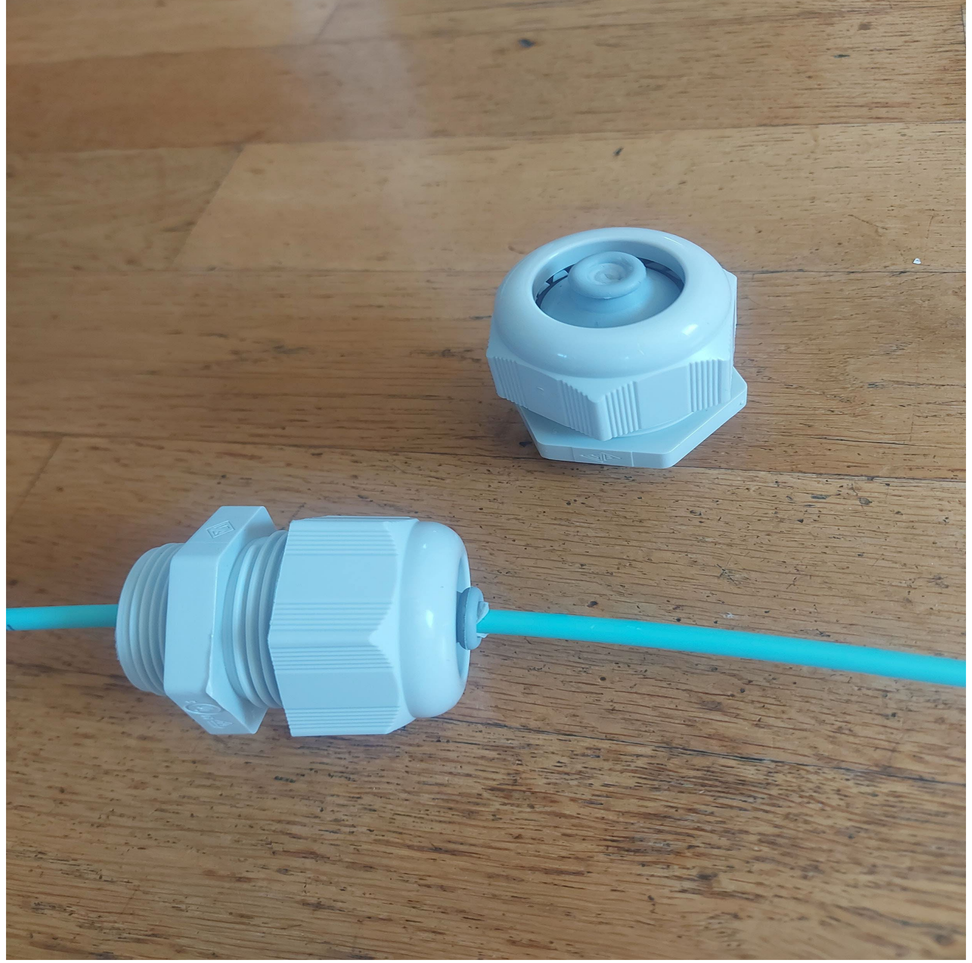
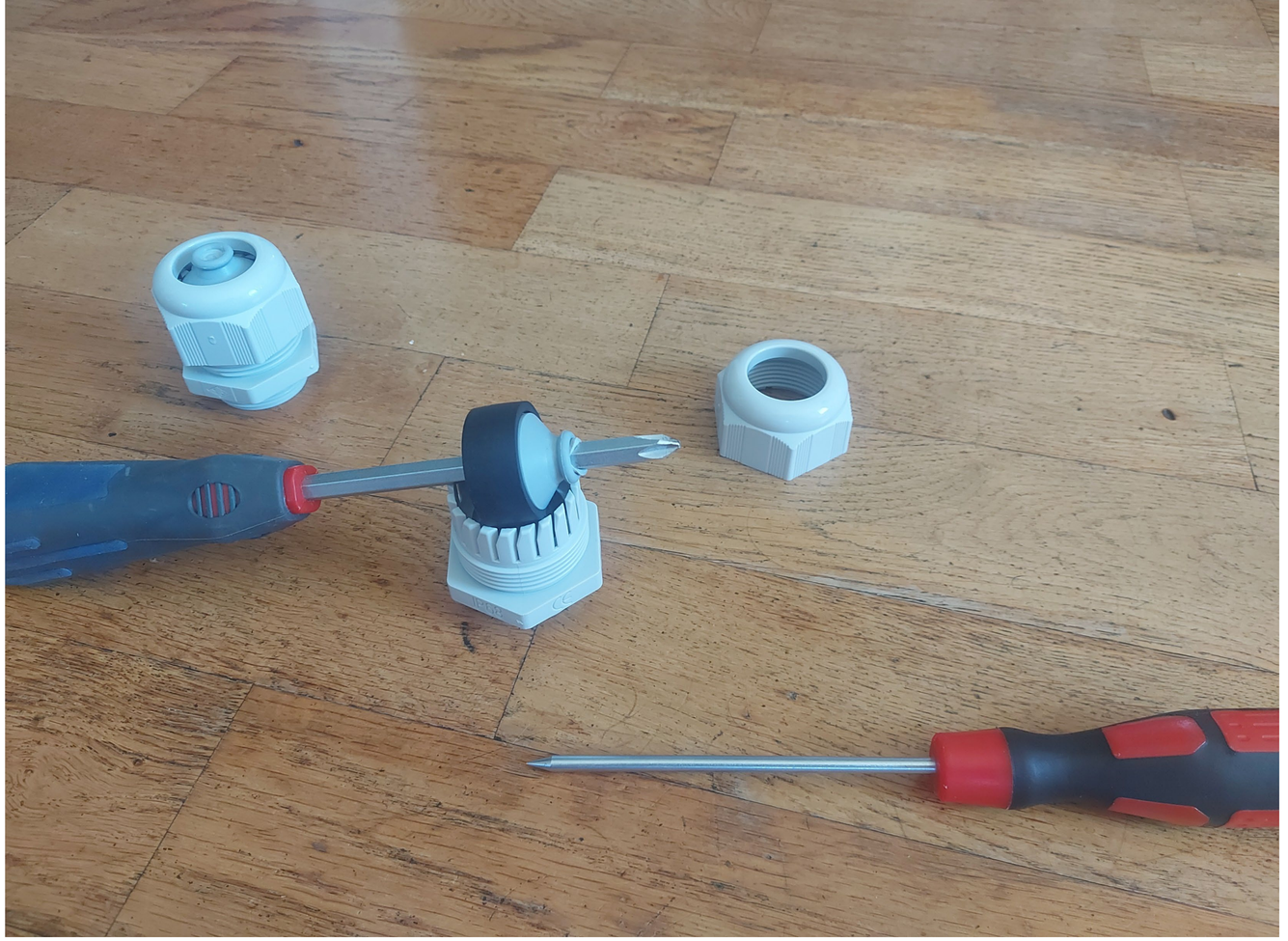
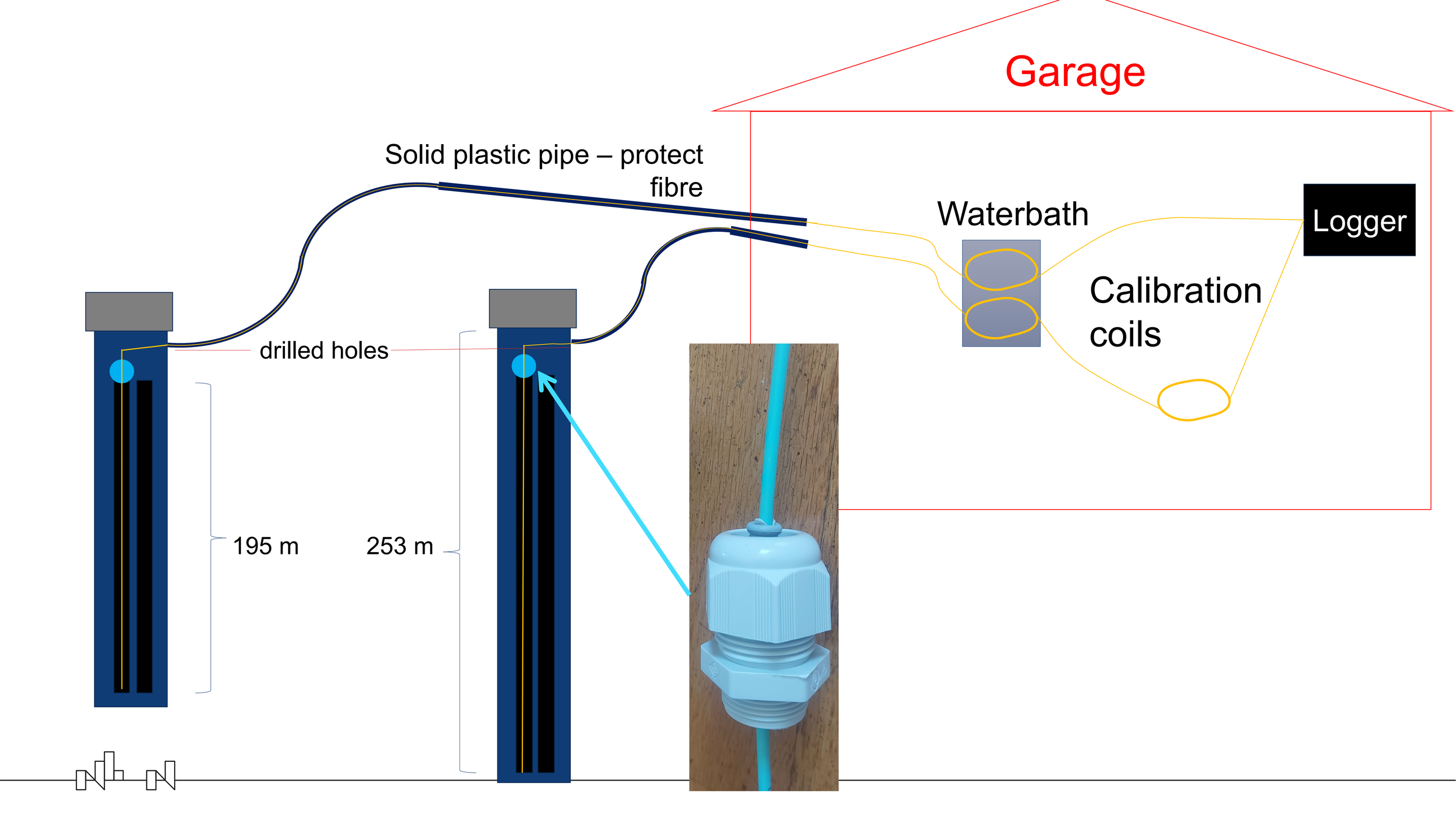


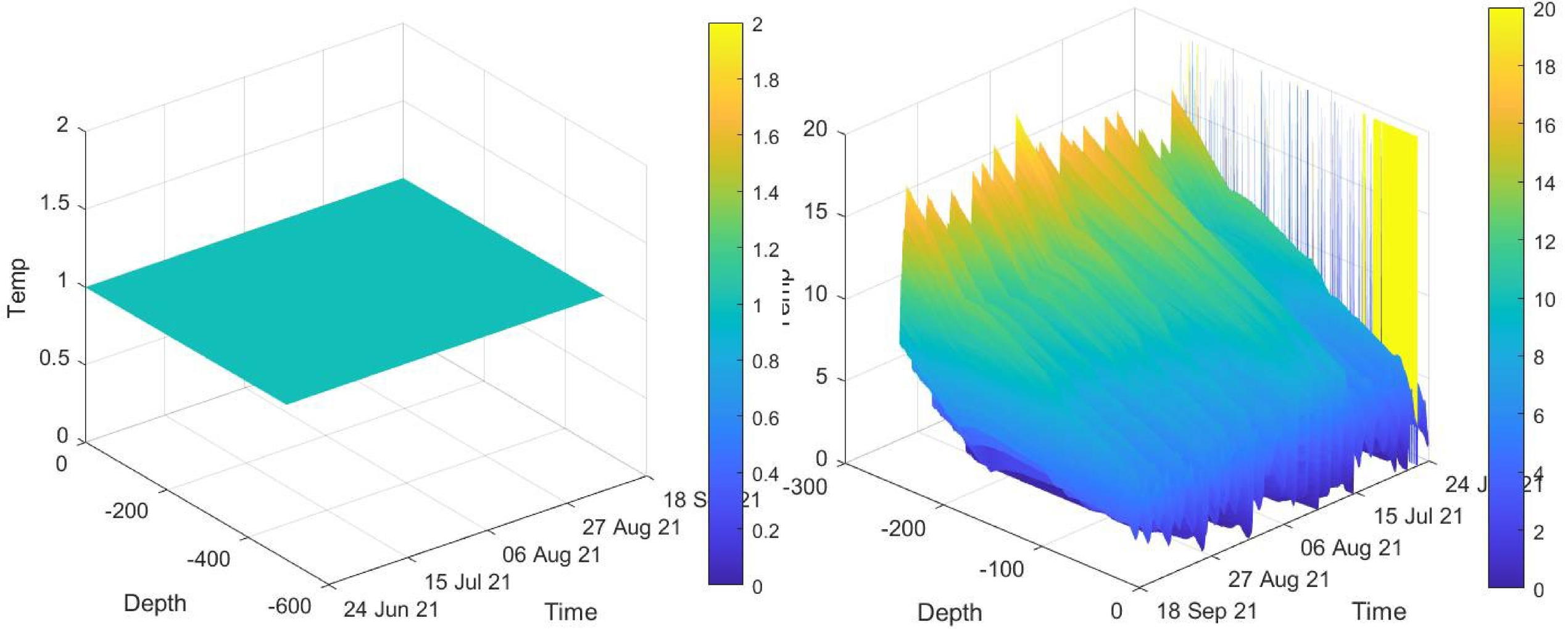


Site III:

Vensmoen


Garage
Solid plastic pipe – protect fibre
Waterbath
Logger
Calibration coils
drilled holes
195 m
253 m

Results from Vensmoen – broken fibre in one well



Sources

- Kvalsvik, K.H., Ramstad, R. K., Holmberg, H. and Kocbach, J. M (2024). “Quantification of losses from borehole thermal energy storage through distributed temperature sensing and numerical modelling”. Proceedings of IGSHPA2024, Montréal, Canada.
- A. T. Leaf, D. J. Hart, and J. M. Bahr (2012): Active thermal tracer tests for improved hydrostratigraphic characterization. Groundwater, (50), no. 5, pages 726–735

Thank you!

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