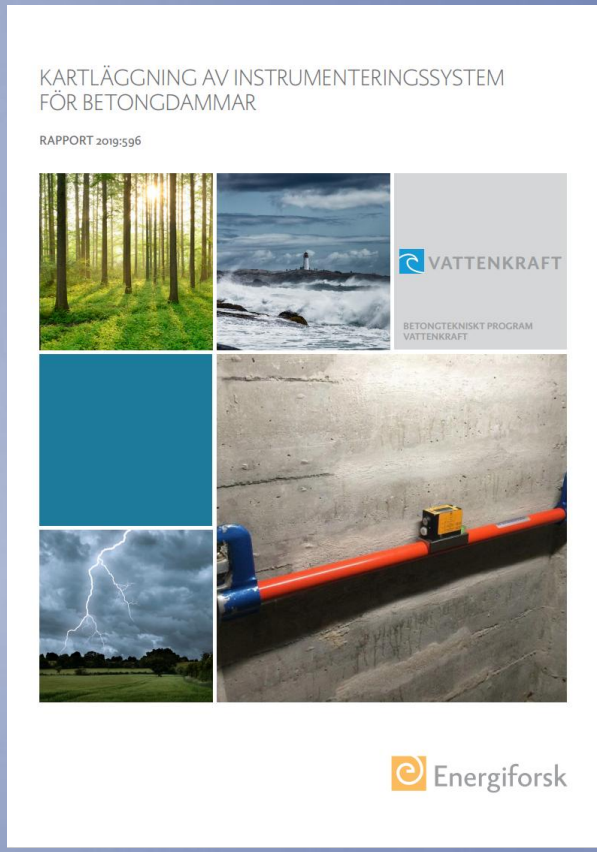
Swedcold 2025 - Nordic Dam Safety Seminar Oct 14
Benny Mohlin, Sweco Sverige AB

Benny Mohlin, Sweco specialist instrumentation with 37 years of experience in geotechnical investigations as well as instrumentation of embankment dams and concrete dams. Author or co-author of:

Energiforskrapport ”Erfarenheter av damminstrumentering (Experiences with dam instrumentation)”
(rapport 2019:577)

Energiforskrapport ”Kartläggning av instrumenteringssystem för betongdammar(Mapping of instrumentation systems for concrete dams)”
(rapport 2019:596)



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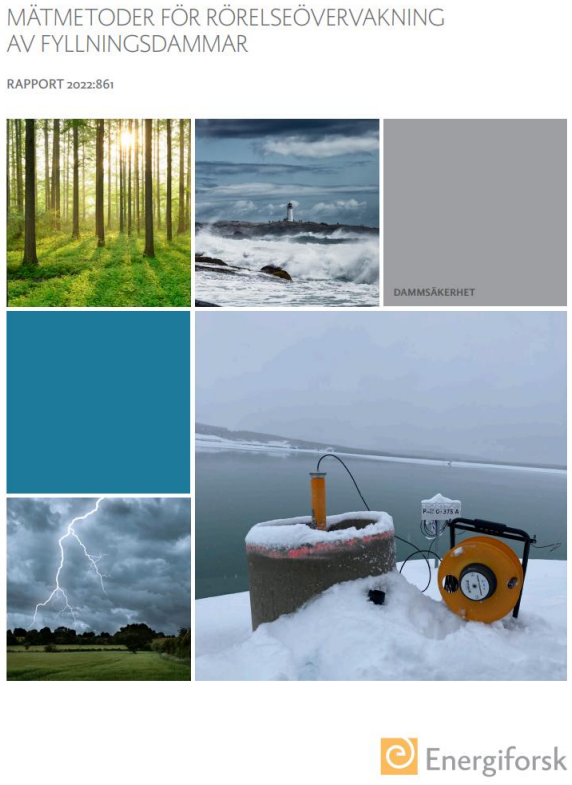
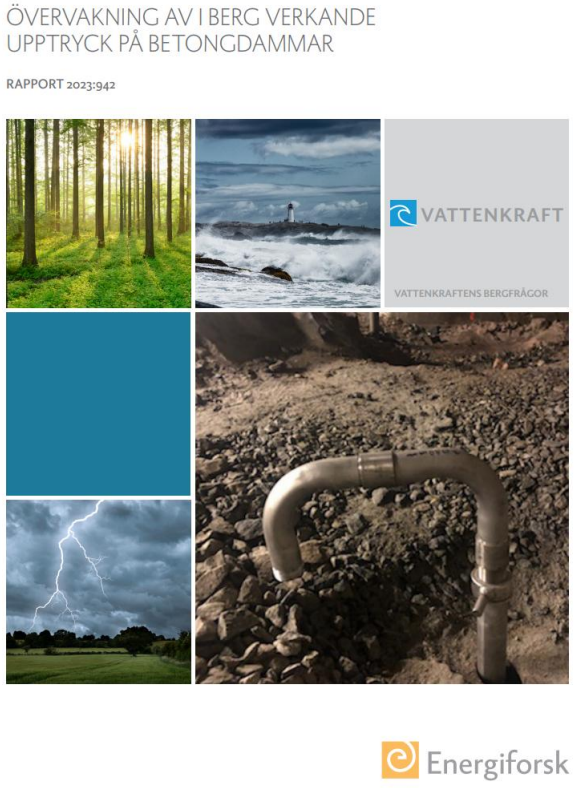
Energiforskrapport ”Mätmetoder för övervakning av fyllningsdammar (Measurement methods for monitoring embankment dams) (rapport 2022:861)



Energiforskrapport ”övervakning av i berg verkande upptryck på betongdammar (monitoring of in-situ stress acting on concrete dams) (rapport 2023:942)



Energiforskrapport (not released yet) “Status assessment of injection curtains”

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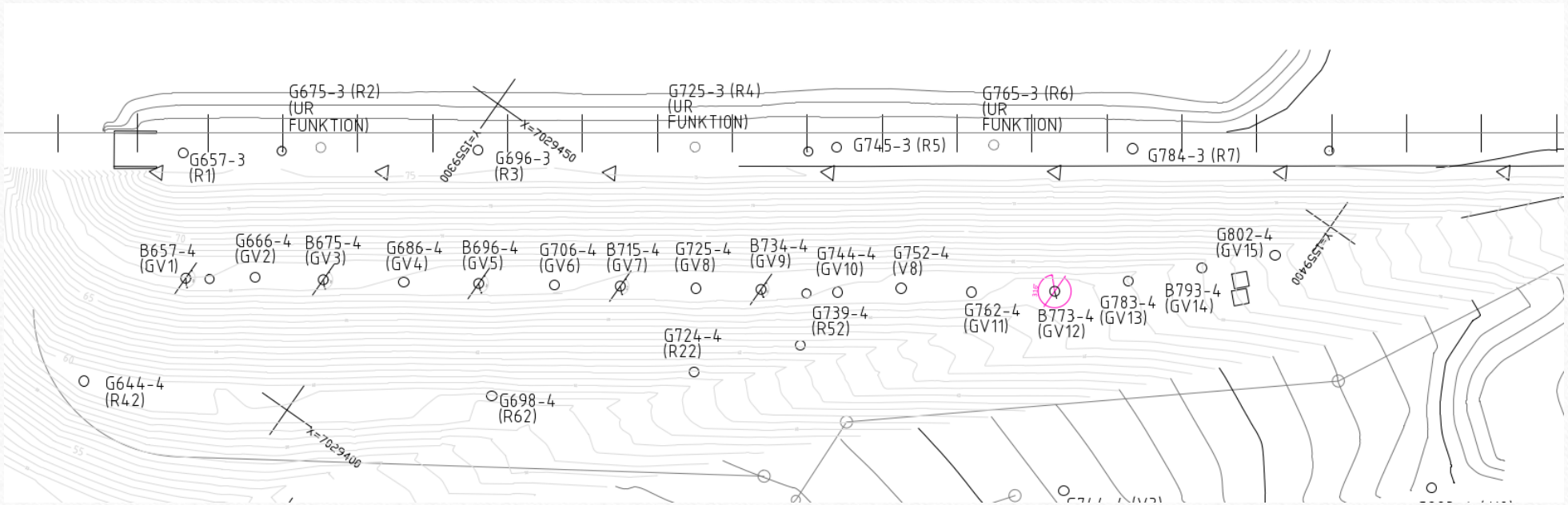
SAA (ShapeArray) - New tool for measuring movements in existing standpipes

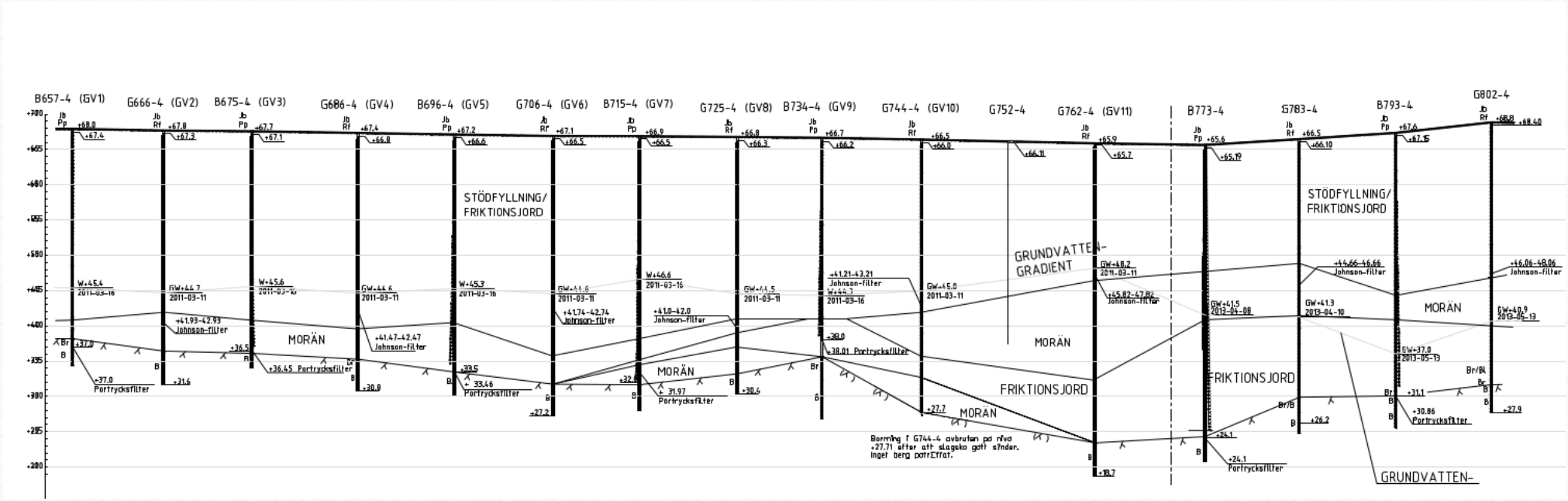
- Technology project aimed at being able to utilize existing standpipes for movement measurement through the soil profile, not just to measure water level and temperature
- Allows comprehensive monitoring of movements through the dam without drilling for inclinometers
- Provides a similar function to inclinometers, but with less accuracy – potentially sufficient for our needs?
- Enables assessment of actual installation versus theoretical plans
- Includes bonus temperature measurement along the pipe during movement assessment

SAA - Movement monitoring through the soil profile along the entire dam in existing pipes?



SWECO

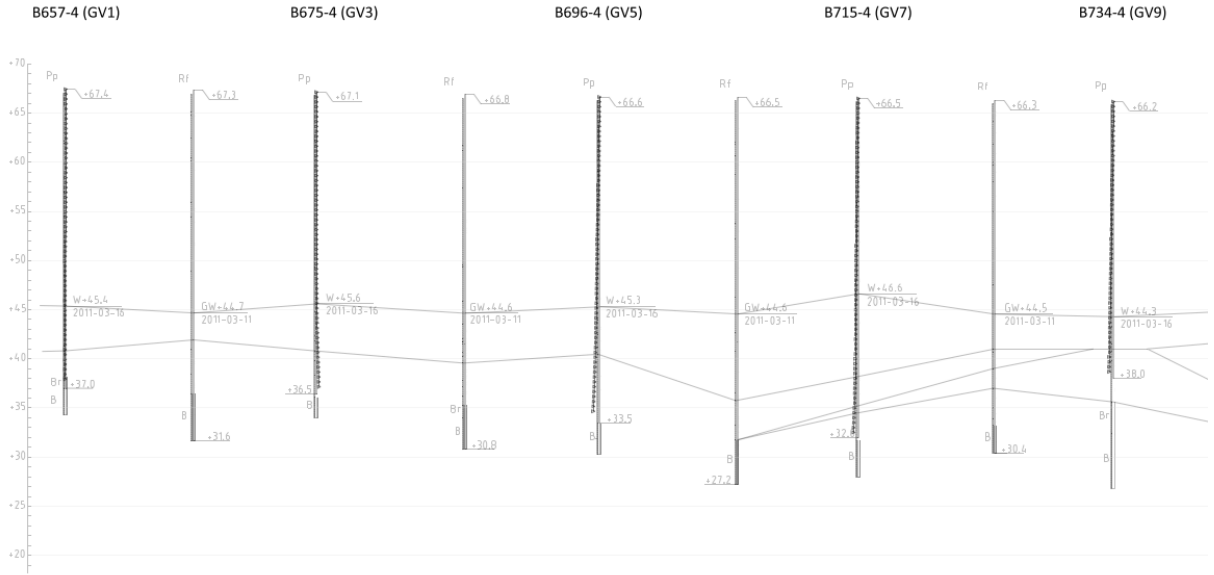
SAA - Movement monitoring through the soil profile along the entire dam in existing pipes?

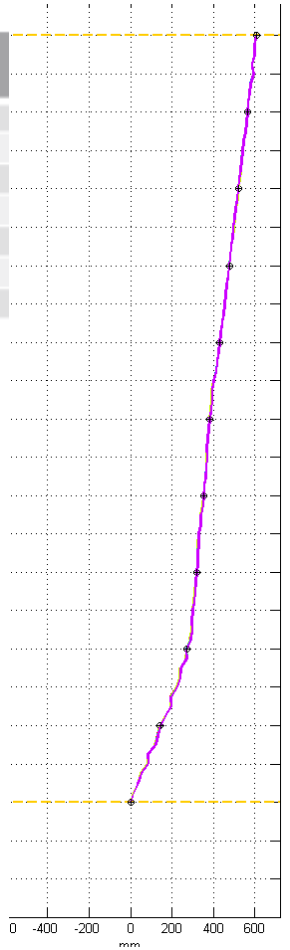


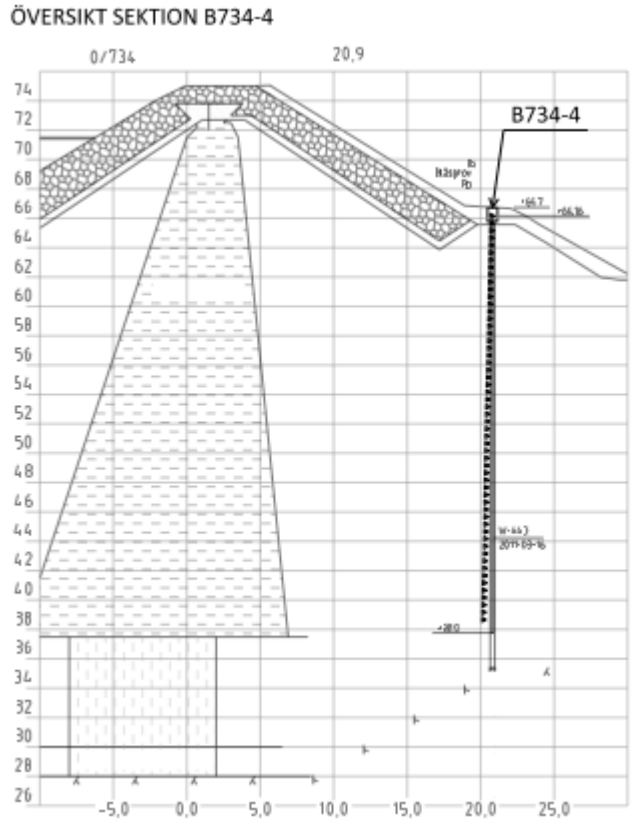
SWECO

SAA – Where is the bottom of the pipe?

Rör		Rördjup [m]	Avvikelse filterspets US-NS [mm]	Avvikelse filterspets profil [mm]	Mätnoggrannhet [mm]
B657-4	GV1	30.13	-157	-46.08	9.22
B675-4	GV3	30.56	-563	181.44	9.38
B696-4	GV5	32.37	334	-440.64	10.00
B715-4	GV7	34.37	-116	-346.32	10.63
B734-4	GV9	27.97	-583	-296.64	8.59
B773-4	GV12*	40.9	639	798.48	12.50
B793-4	GV14	35.9	253	1021.68	11.09



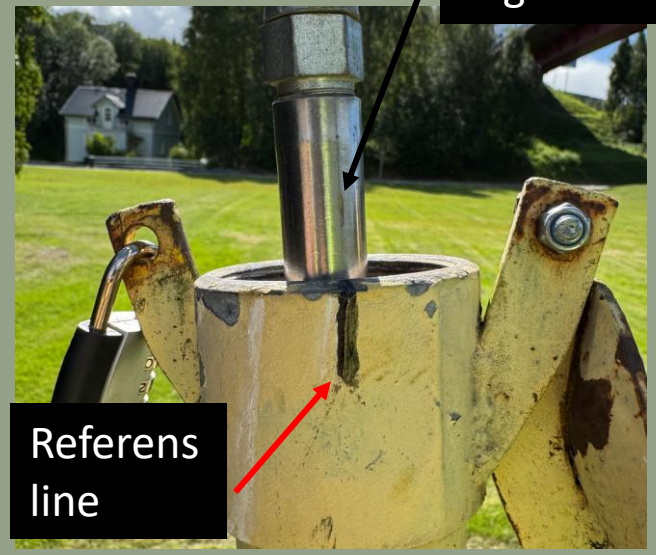




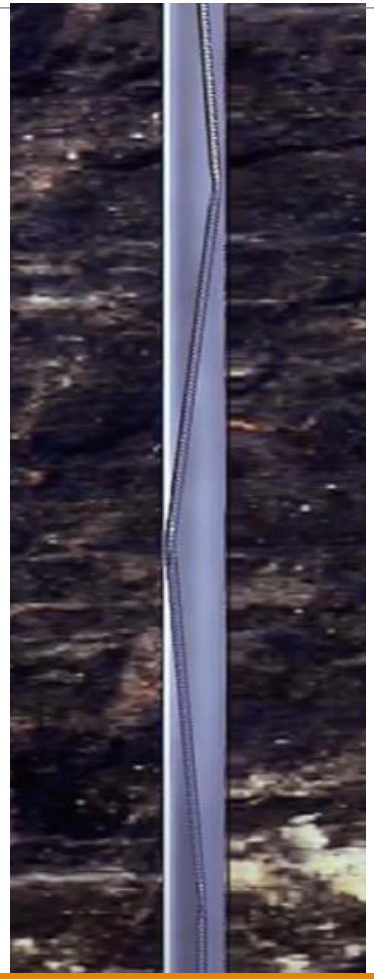
Inclinometer tubes and normal standpipes have different conditions, means that we cannot achieve the same control and accuracy

The inclinometer tube has grooves that guide the instrument to the bottom – measurement – accuracy 1-2 mm

Standpipes has no interior grooves



SAA- originally intended to measure in drilled rock holes – standing on the bottom



With spacers possible to measure in pipes? First attempt with hard distances - drilled through

The cable hangs 20 cm above the bottom of the pipe, centered using a cover and spacers in the pipe

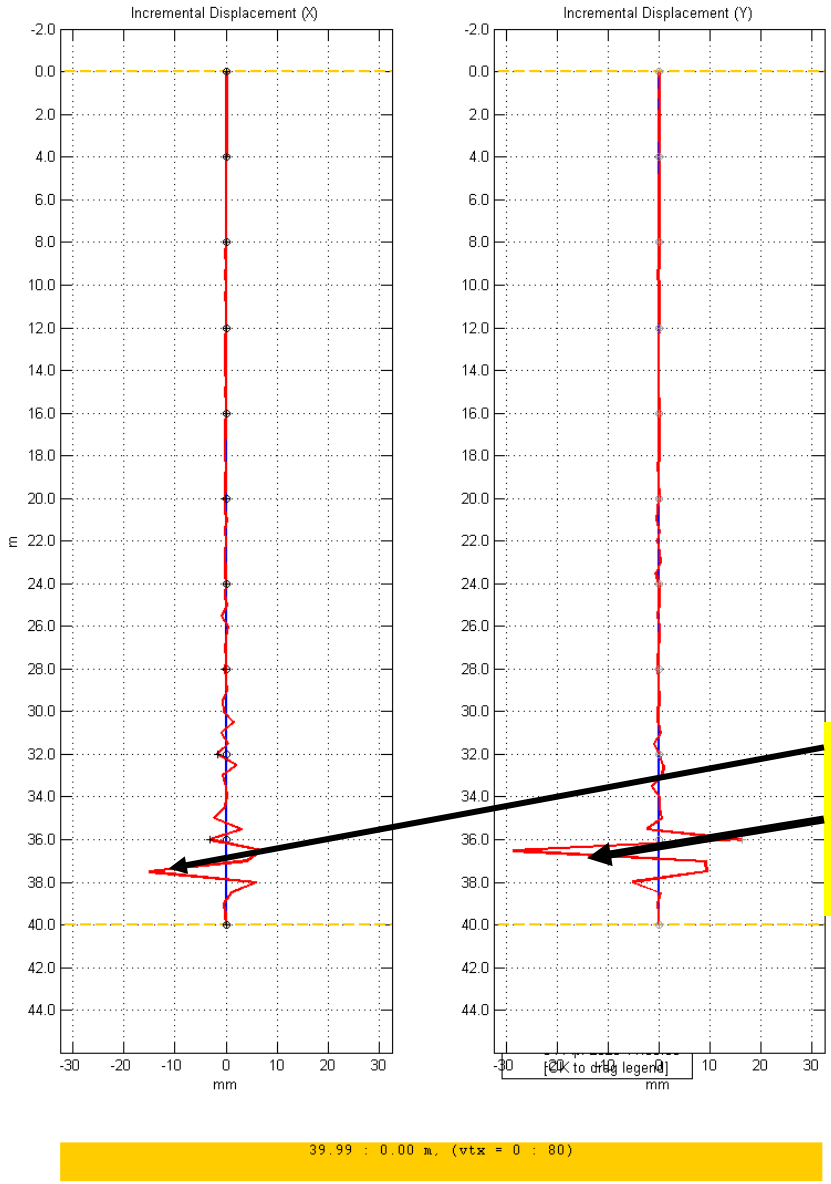
SAA – Check the pipes before measurment

Second attempt with slotted spacers that are pressed against the inner wall of the pipe

Second attempt with slotted spacers that are pressed against the inner wall of the pipe

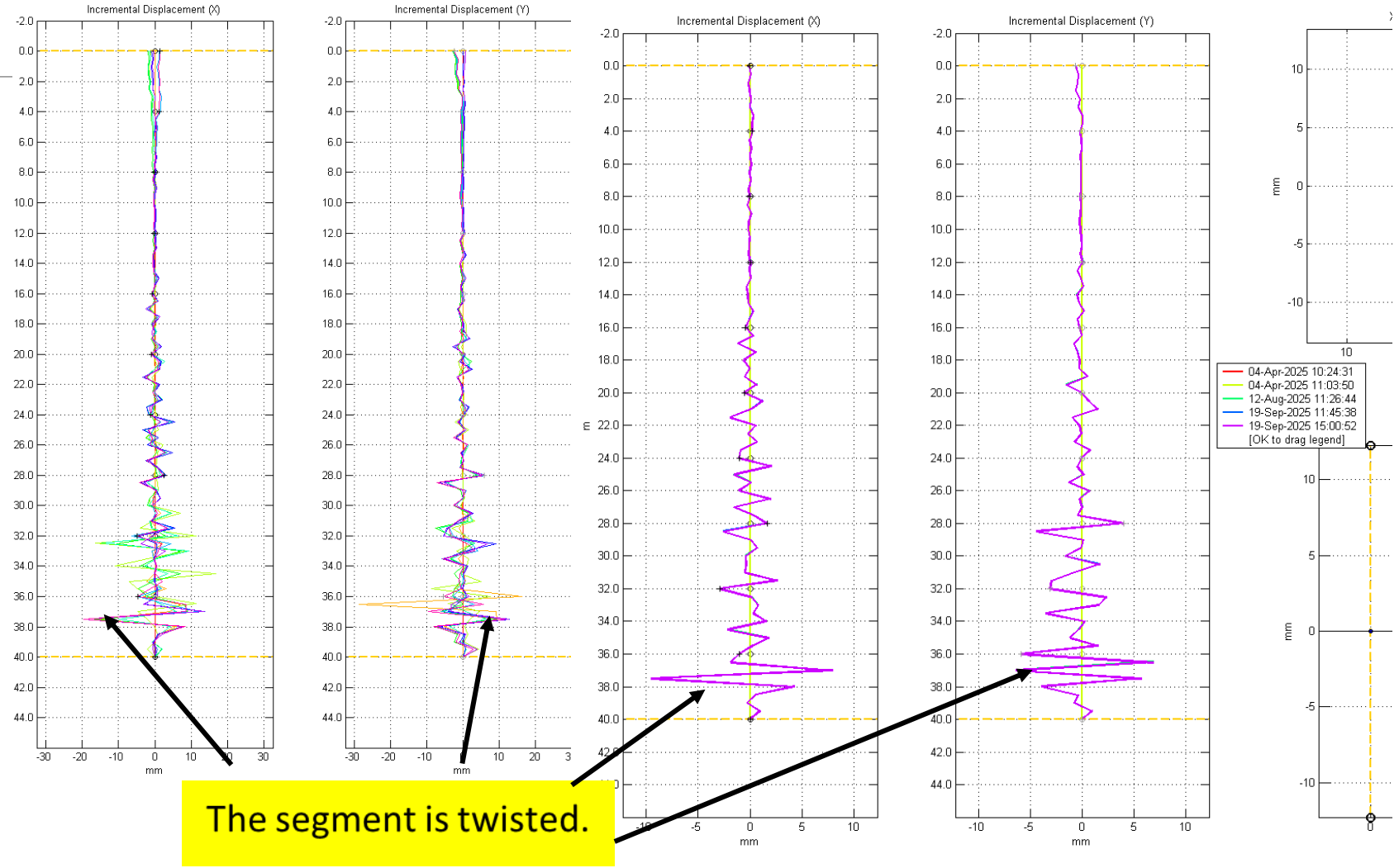
SAA- Accuracy

- The first two measurements without moving the instrument – just up and down again
- A few millimeters difference between the two measurements



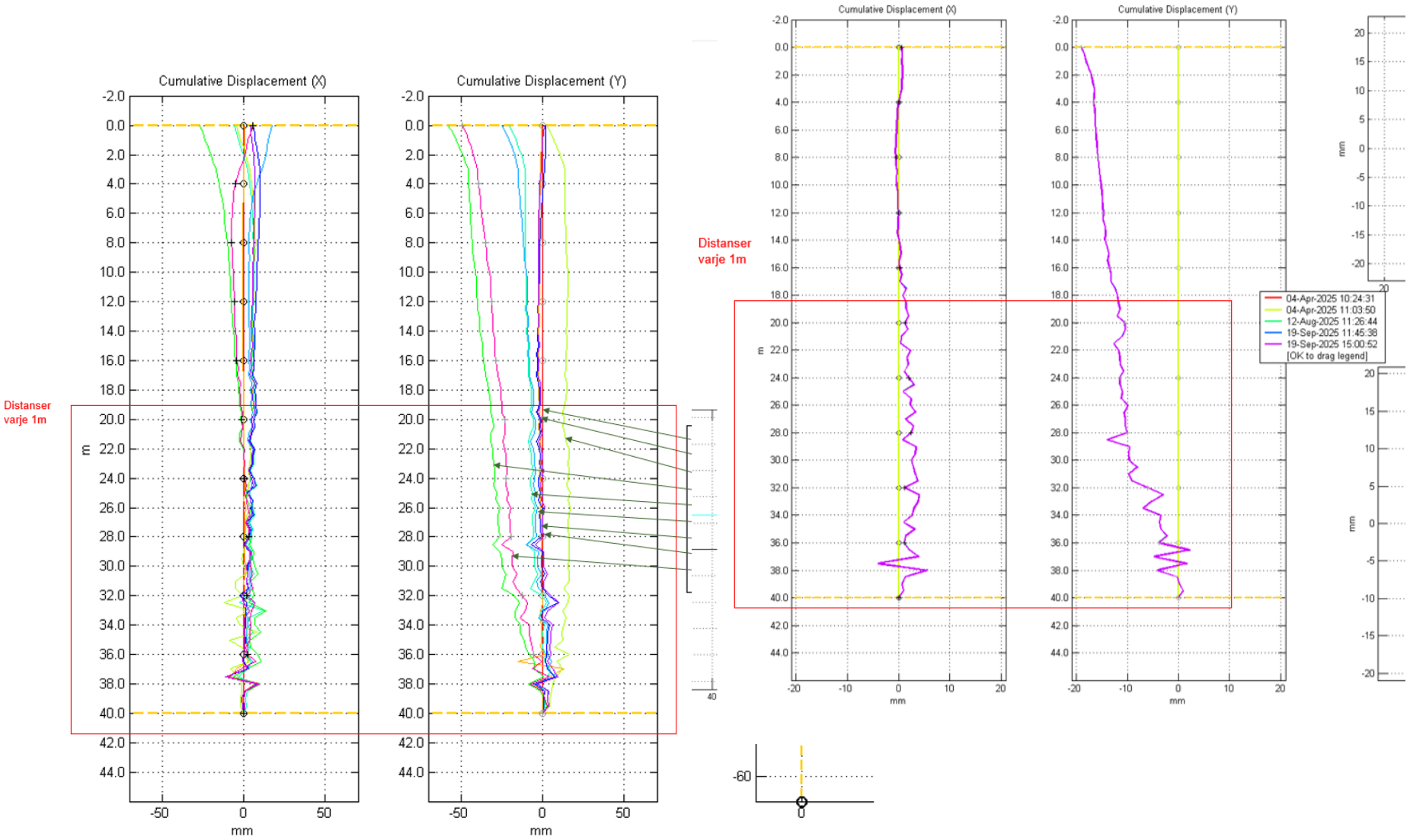
SAA- Accuracy

- After a total of 9 measurements where the instrument was moved between measurements
- The measurement accuracy is within 10-15 mm



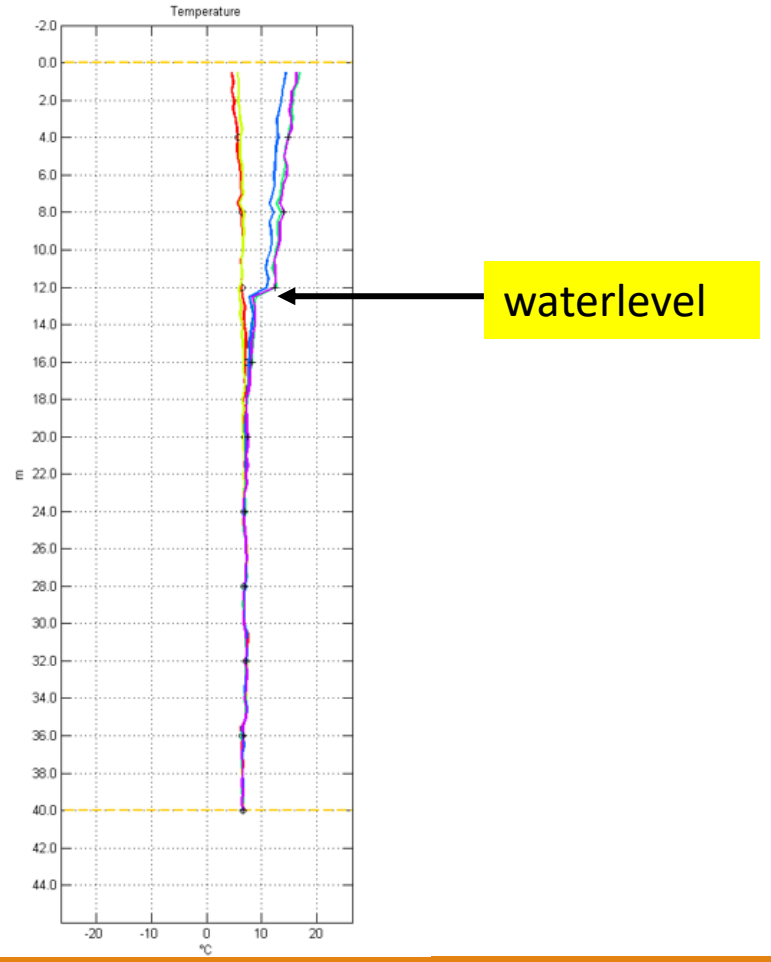
SAA- Results from the test

- A 40 m long pipe, spacers on the bottom 20 m that center the instrument
- Variation between the measurements accumulated; raw data – about 50 mm along a 40 m long pipe
- Variation between measurements – corrected data approximately 15-20 mm along a 40 m long pipe



SAA – Temperature measurement along the pipe is obtained as a bonus during measurement

- Temperature measurement is used as calibration for the instrument but is also obtained as a graph that can be used for evaluation.
- The measurement accuracy of the temperature is 1 degree Celsius



Ability of a standpipe tube to bend during ground movement?

- A metal pipe is relatively stiff, but joints and the length of the pipes should mean that the pipes bend during ongoing ground movement.
- However, a plastic pipe bends more easily and would be preferable for future installations.

SAA - Simplify work in the field

- <u>The equipment is heavy, therefore it was rebuilt to facilitate the measurements:</u>
- Electric winder powered by a generator (can handle 20 meters of water head)
- Widened the measuring drum to make room for the spacers
- The frame has been redesigned to make it easier to operate the instrument
- The next step is adaptation so that the entire instrument can be lifted with a wheel loader, which may be required at high standpipe above the ground surface.

SAA -Summary

- Is it possible to use SAA to measure movements through the dam in existing standpipes with sufficient accuracy?

Yes, the tests show that we can detect a movement greater than 10-20 mm on a 40 m long pipe, which should be sufficient?

4 measurements in the same pipe are recommended to obtain an average

Depending on availability, one can get through 4 - 8 pipes per day, which means comprehensive movement measurement through the dam at low cost

An initial reference measurement, the next measurement the following year, and thereafter every 3 years?

- The measurement provides an accurate picture of how the pipes are installed compared to the theoretical installation.
- Temperature measurement along the length of the pipe is obtained as a bonus during the measurement
- If you are planning new standpipes and intend to measure movement in them, choose plastic pipes

Do you want to know more?

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