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The 9th WaterLoss Asia 2022

08-10 NOV 2022
Virtual Event
Conference • Workshop



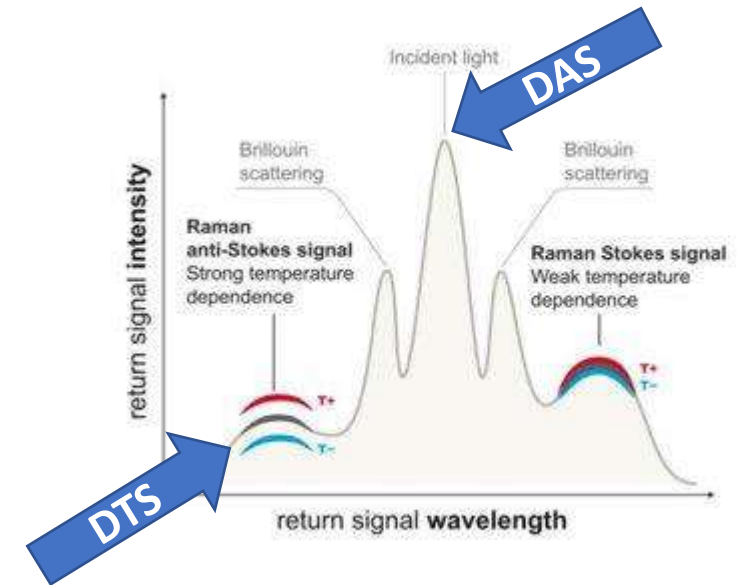
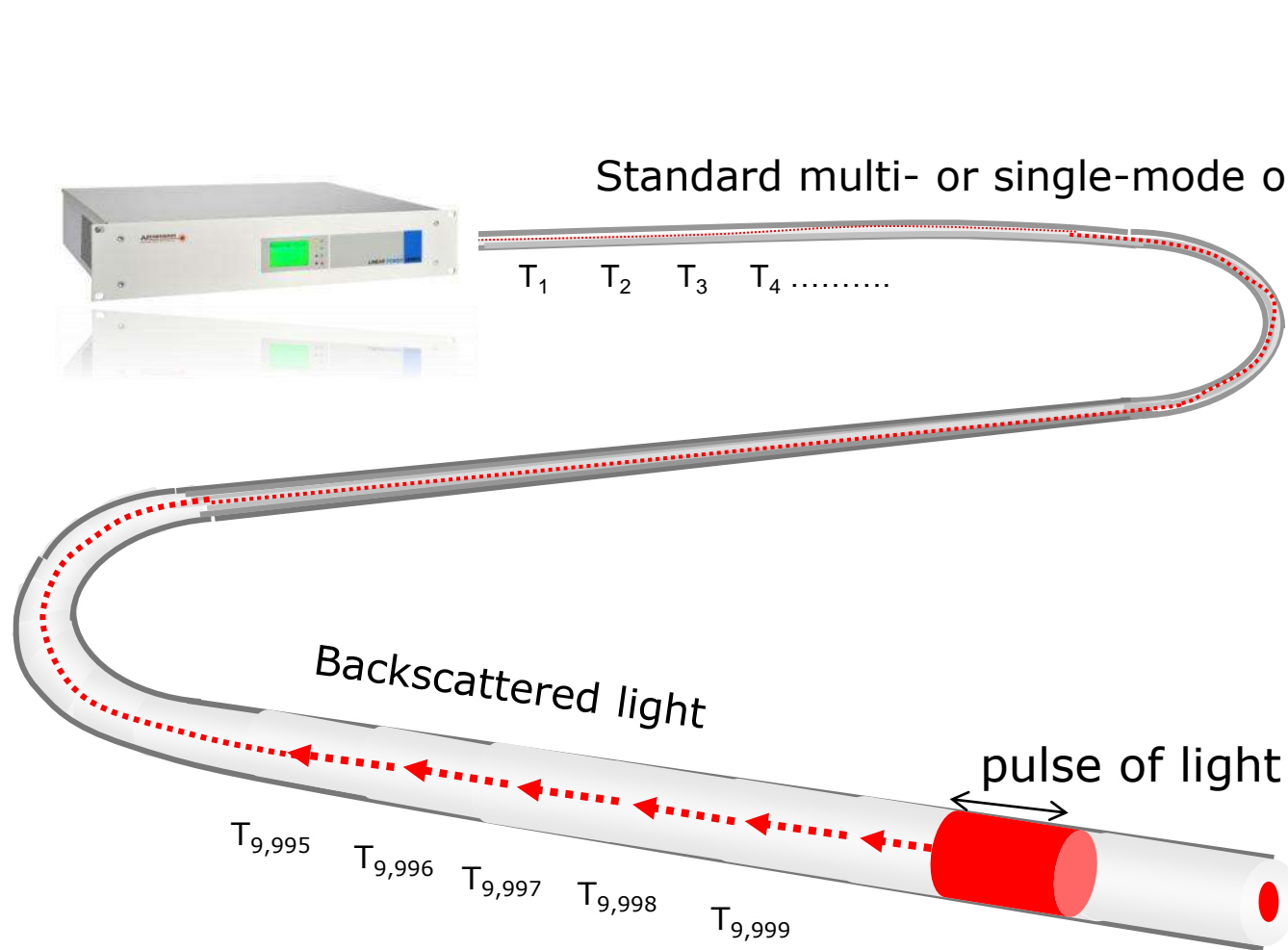
Controlling
Non-Revenue Water
through Digital Technology
& Artificial Intelligence

Distributed Fiber Optic Sensing



FAST
GROUPE CLAIRE

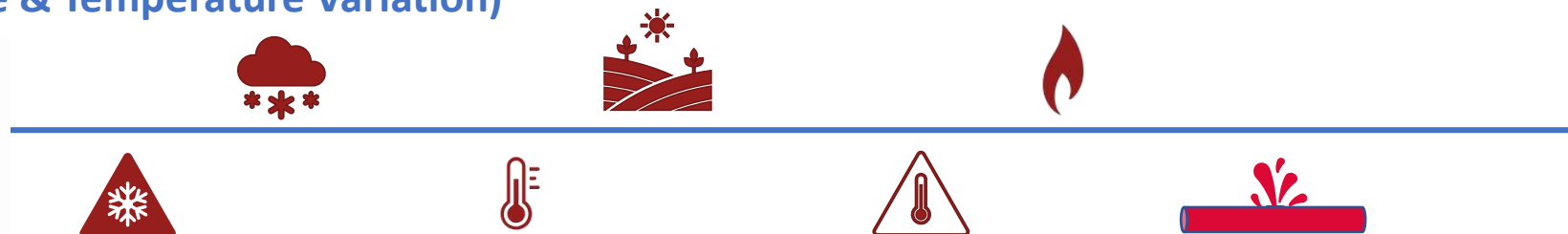
AP SENSING
advanced photonic



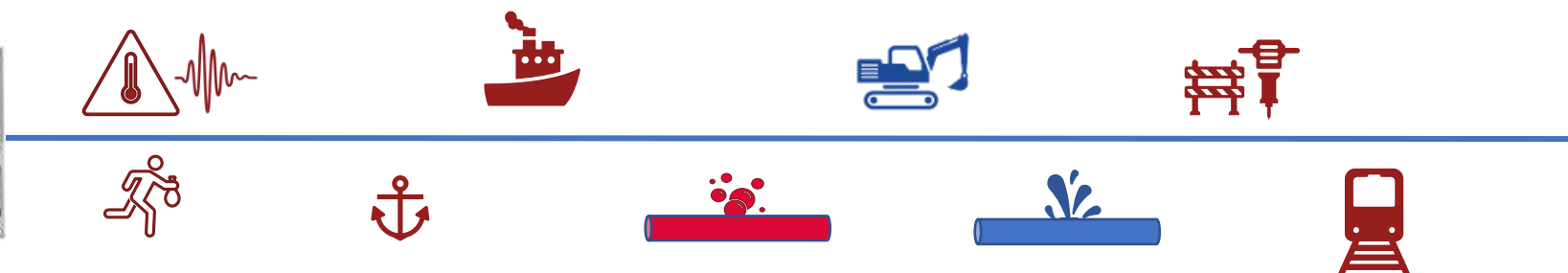
DAS and DTS Interrogators

DAS and DTS pipeline applications

DTS (Measurement of Temperature & Temperature Variation)



DAS (Monitoring of Acoustic Events & Temperature Variation)

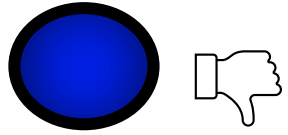


Why use Fiber Optic Distributed Sensing

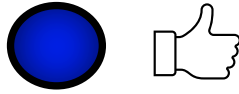
- **Acoustic Sensing through the pipe wall**
 - The **large diameter pipes** conduct sound very poorly, especially small leaks. This poses a problem for point acoustic sensors (acoustic loggers), as the access points are many hundreds of meters apart.
- **Insulated Pipes**
 - Chilled water and District Heating systems insulated pipes poses a challenge to point acoustic sensors



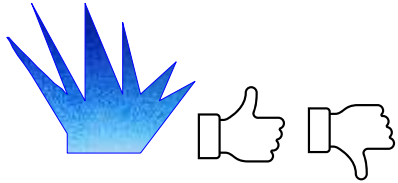
Excursion: sound propagation



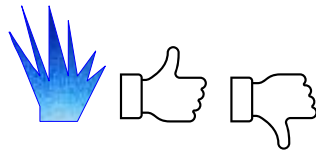
DN 600
Poor propagation



DN 50
Good propagation



Big leak
Low frequencies



Small leak
High frequencies

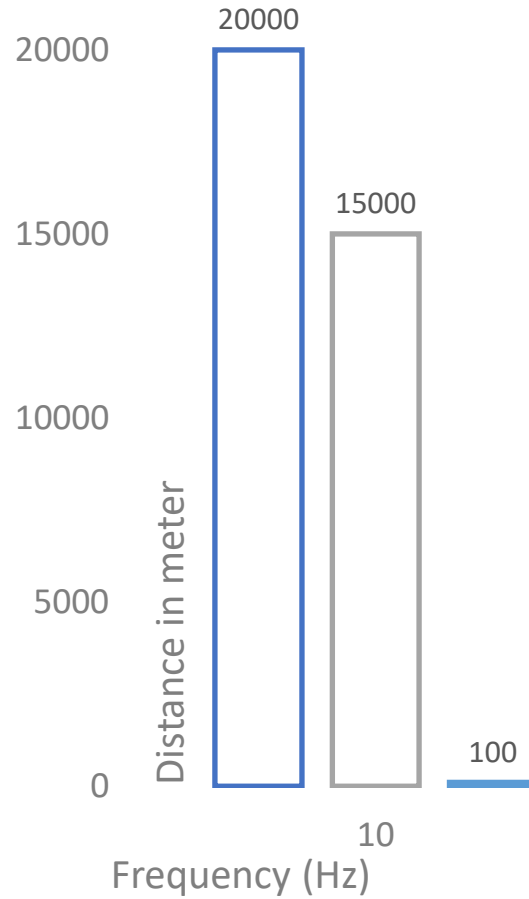


High pressure
Big noise level

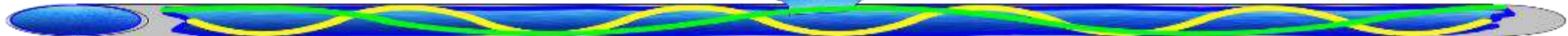
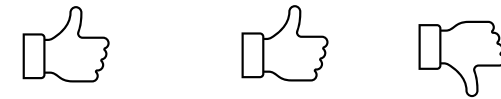


Low pressure
Small noise level

25000



Stahl Guß Pvc



Case study: DTS for District Cooling Pipes

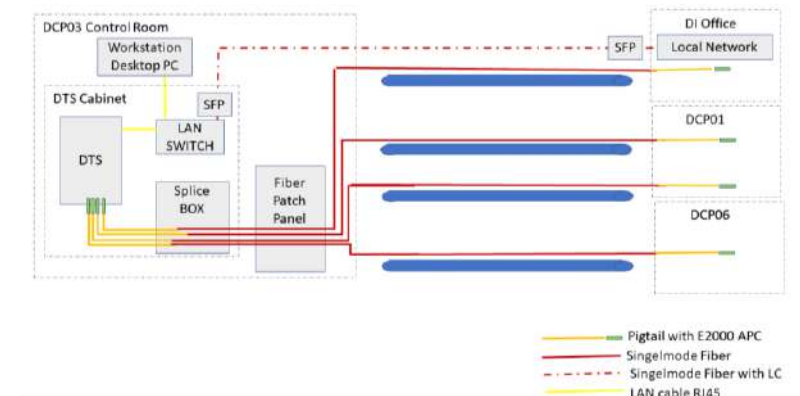
Challenges:

- Leak location is the main challenge.
- Leaks could remain unlocated for a long time, as much of the pipework is hidden in wall cavities or underground.
- Delay in finding leaks can cause damage to structures.
- Acoustic point sensors and other acoustic technologies are difficult to implement due to high background noise and insulation.



Solution:

- High ΔT and insulation make a perfect case for DTS.



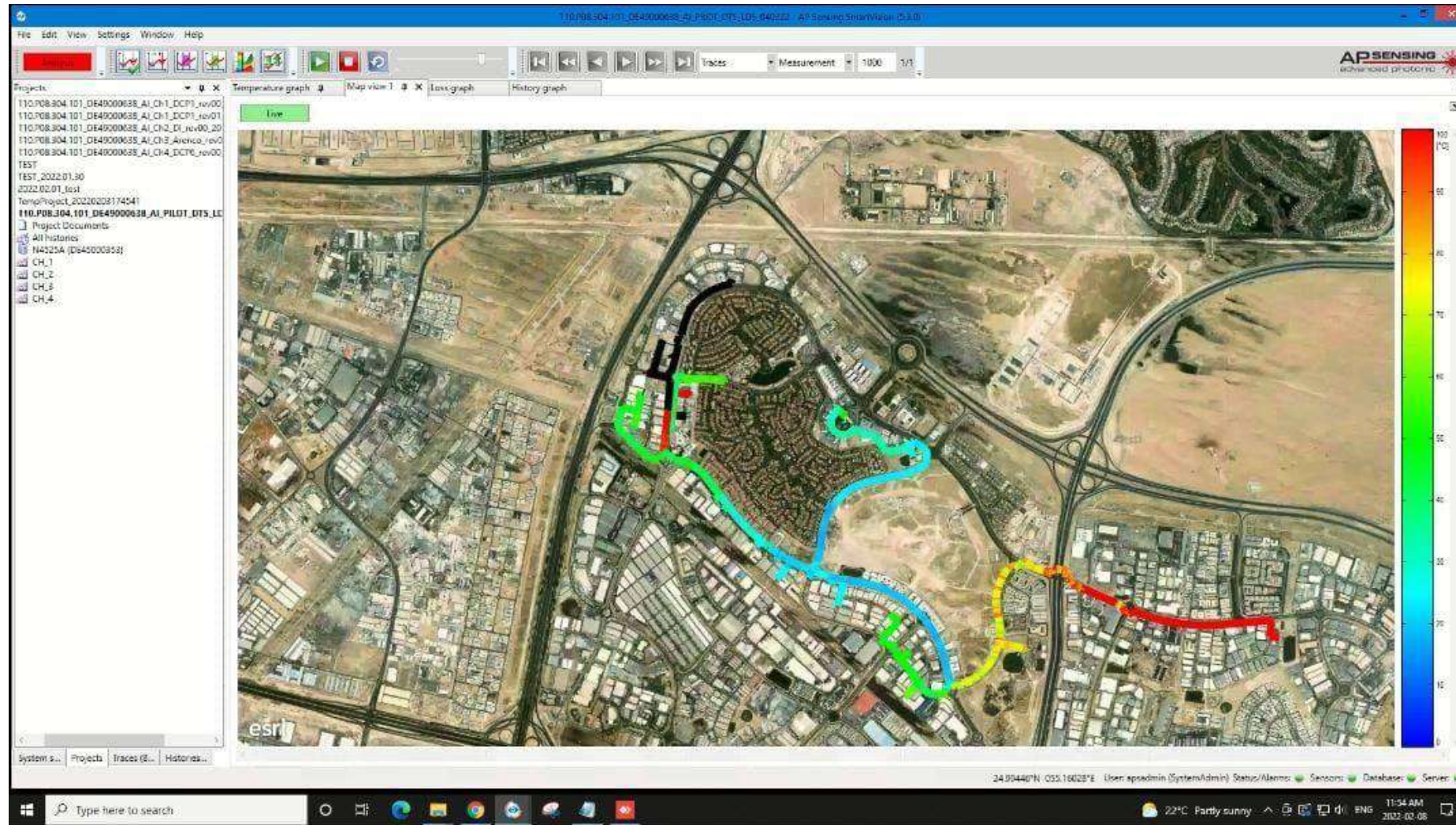
Case Study: Emicool DCP

Onsite photos of FOC along pipes



Case Study: Emicool DCP

Map View of AP Sensing DTS Software – Smart Vision



Internal leak monitoring using DAS

- DN80 PVC pipe, approx. 40m length

Pump
to obtain
pressure



Insertion Sleeve

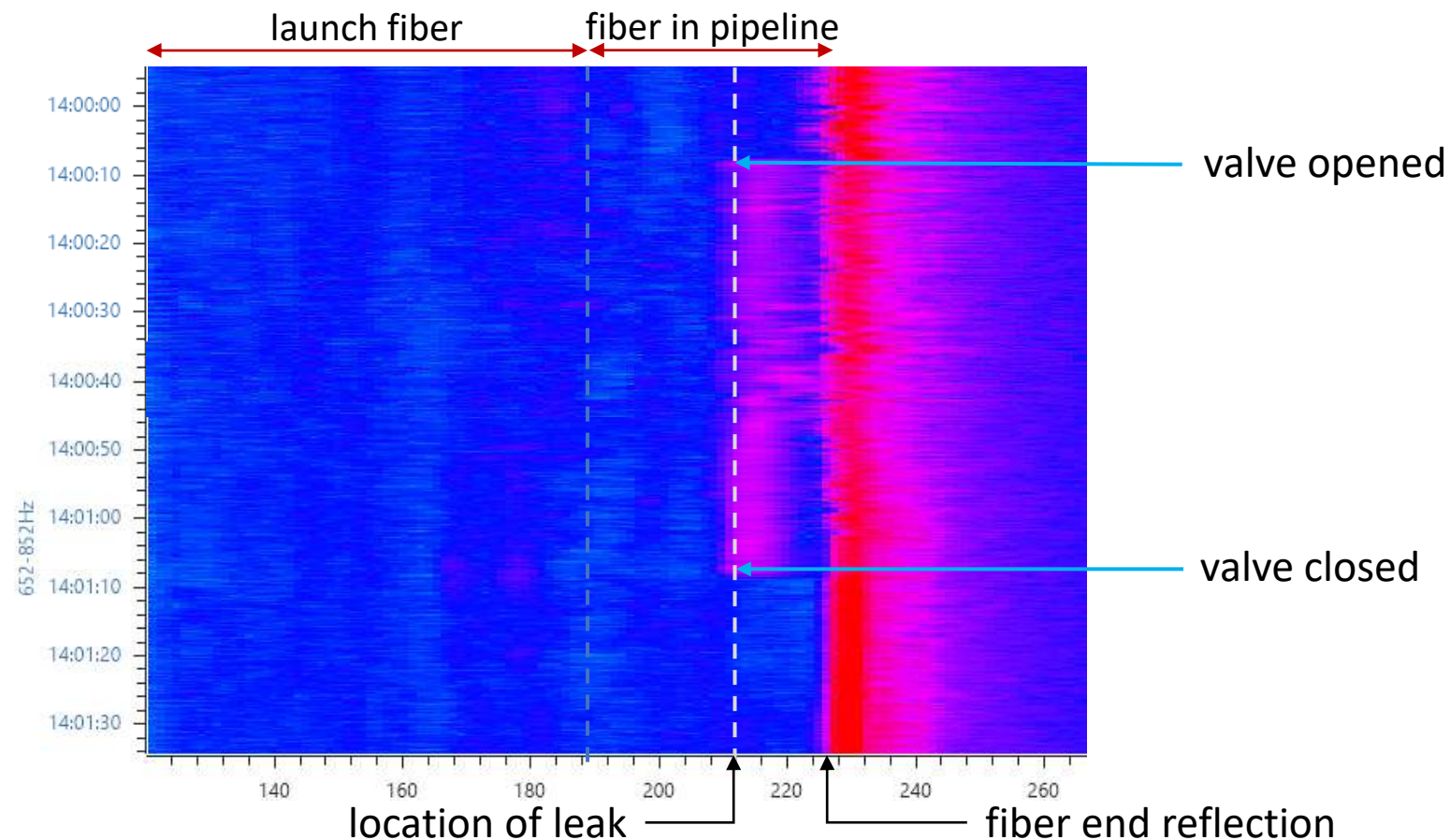
approx. 32m



Manual Valve
to simulate leakage

Waterfall Diagram DAS – Inline acoustic

- Waterfall diagram displays measured intensity (color coded) over fiber length and time
- Waterfall diagram clearly shows time and location of the leak
- Test was carried out on DN80 ductile iron pipeline at 2.0 bar



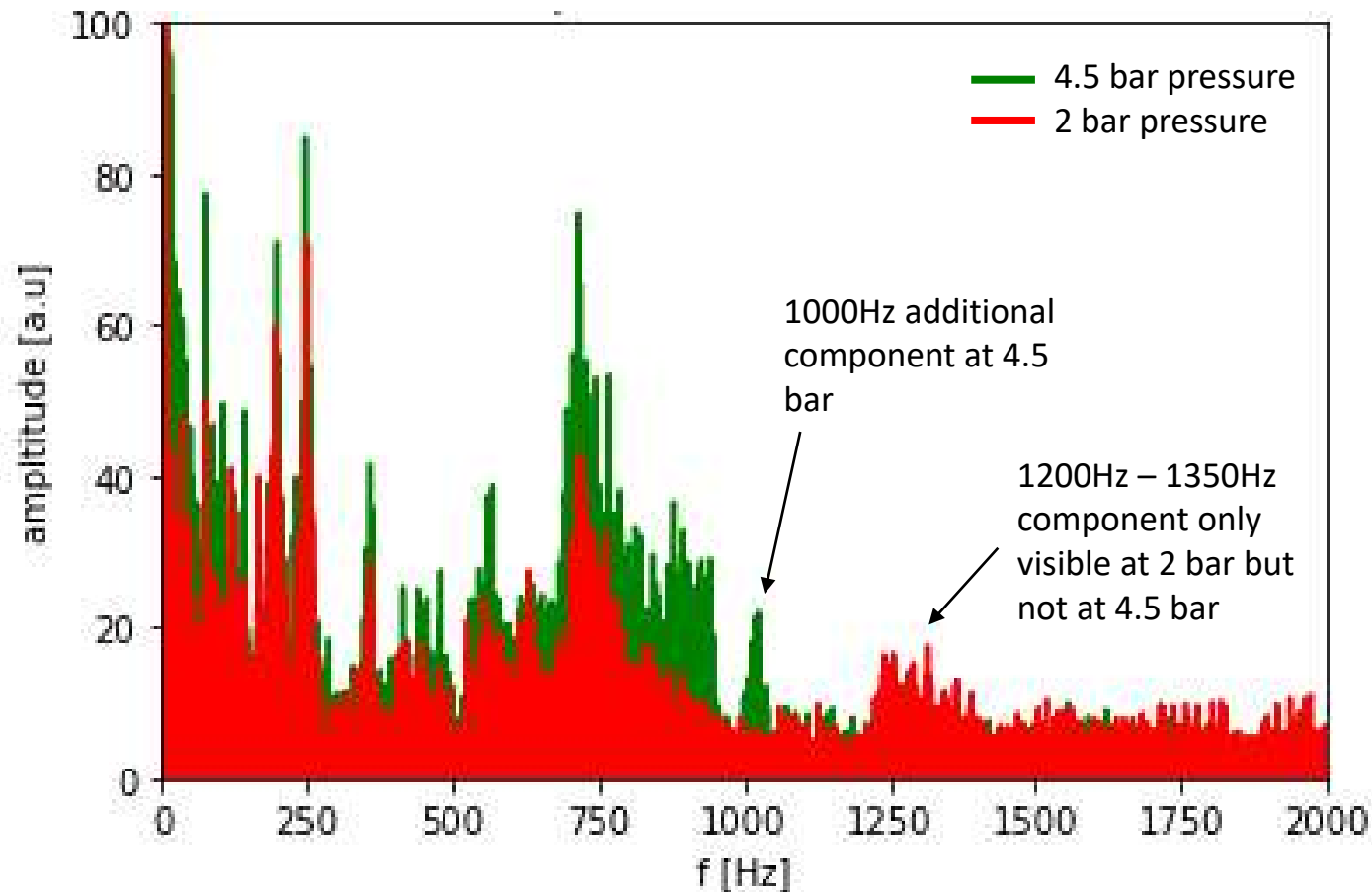
- Valve opened for 70s (13:59:56 – 14:01:06)
- Valve operation and leak are clearly visible



Spectrums during Leakage

5s averaged spectrum of leakage without “background noise floor”

- pressure increase from 2.0 bar to 4.5 bar results in higher amplitudes
- Additional peak at 1,000 Hz due to pressure increase



Installation of FOC inside the pipeline



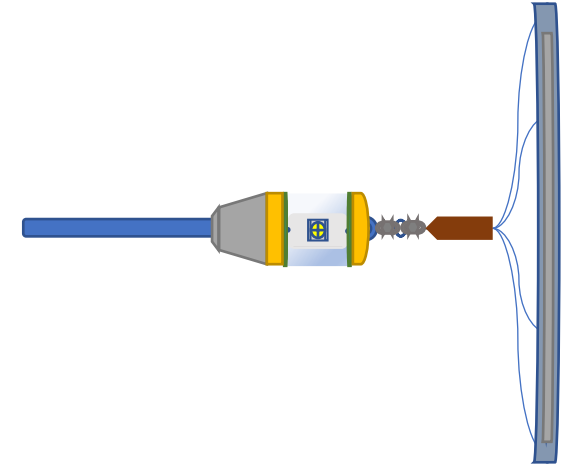
Parachute system with acoustic and optical (camera) sensor

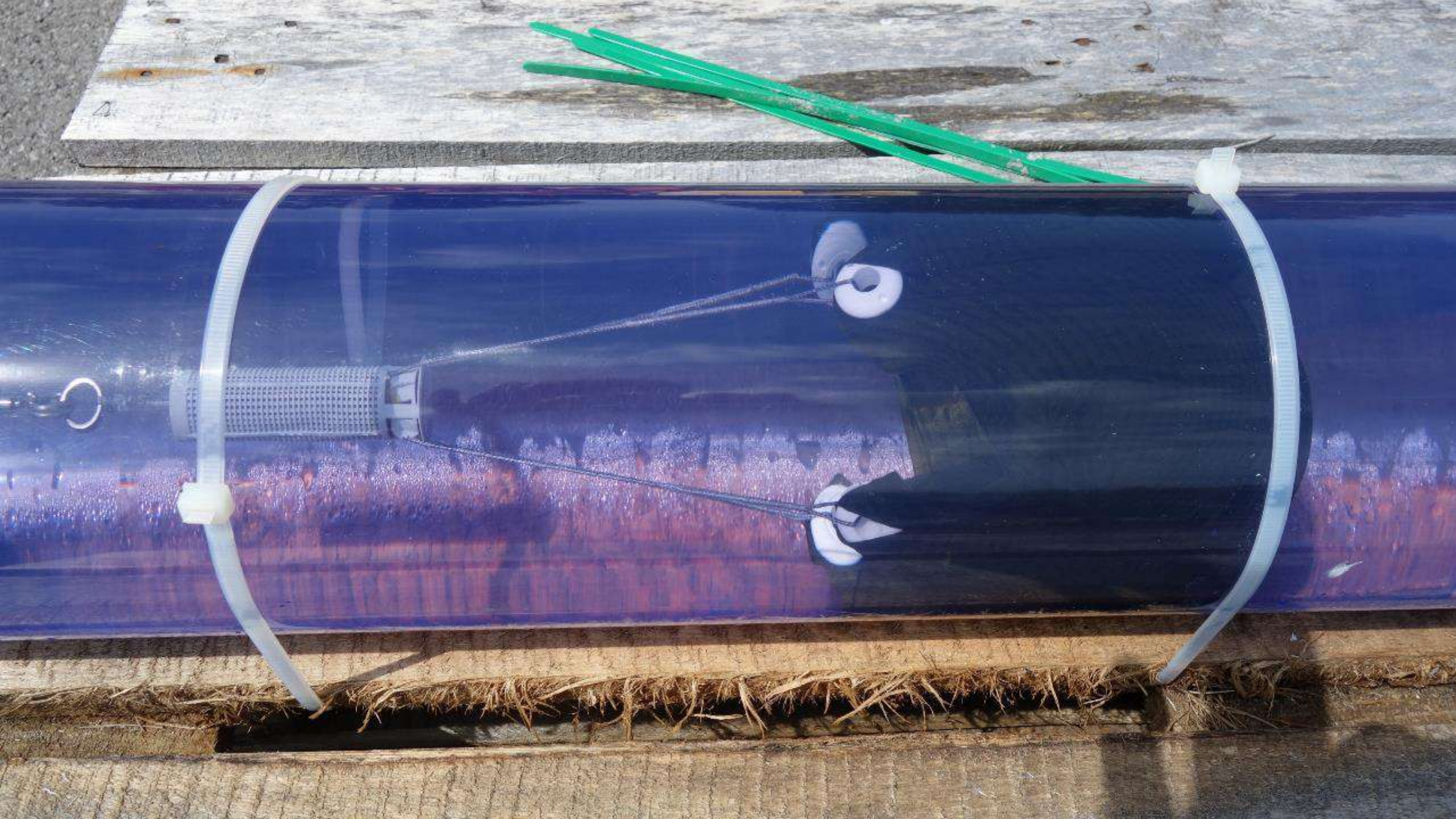


Flow velocity check



folding mechanism of the parachute

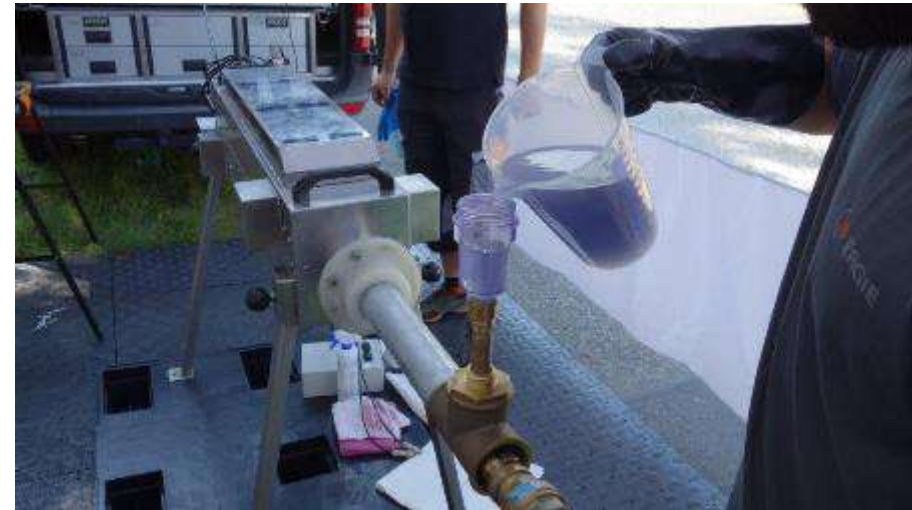




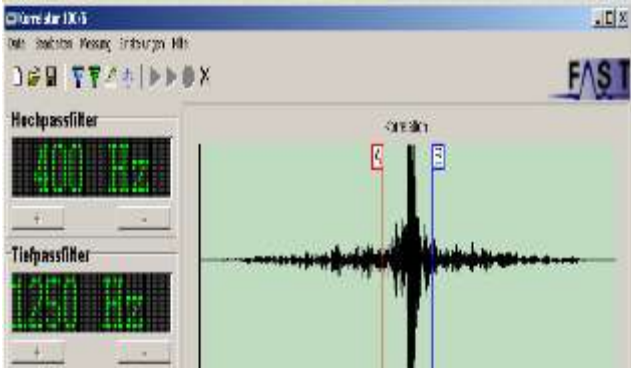
Parachute system applied in Nürnberg



Installation on a DN400 ductile pipe through „free-flow“ hydrant including disinfection methodology



Parachute – insertion and disinfection





Conclusions

- **DTS and DAS complement the existing set of point-based leak detection and location tools for challenging applications.**
- **Distributed Sensing allows close proximity to the leak location and high sensitivity**
- **Internal and External cable installation create flexibility for the cost-effective installation of new and existing pipes.**
- **The sensing of Acoustic and Thermal leak signatures enables the selection of effective detection and location sensor (DAS or DTS).**
- **Internal distributed sensing cable addresses the main challenge for large diameter pipes, as they conduct sound very poorly, and their access points are many hundreds of meters apart.**