# National Association of Regulatory Utility Commissioners (NARUC)

**Washington, D.C. Feb 28th, 2001**

## LEOS Leak Detection and Location System

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# Basic principles of LEOS

## Task

- Detection, localization of leaks and assessment of leak rate in pipelines, tanks and waste deposits

## Physical basis

- Transportation of leaking material according to diffusion process

## Measuring technique

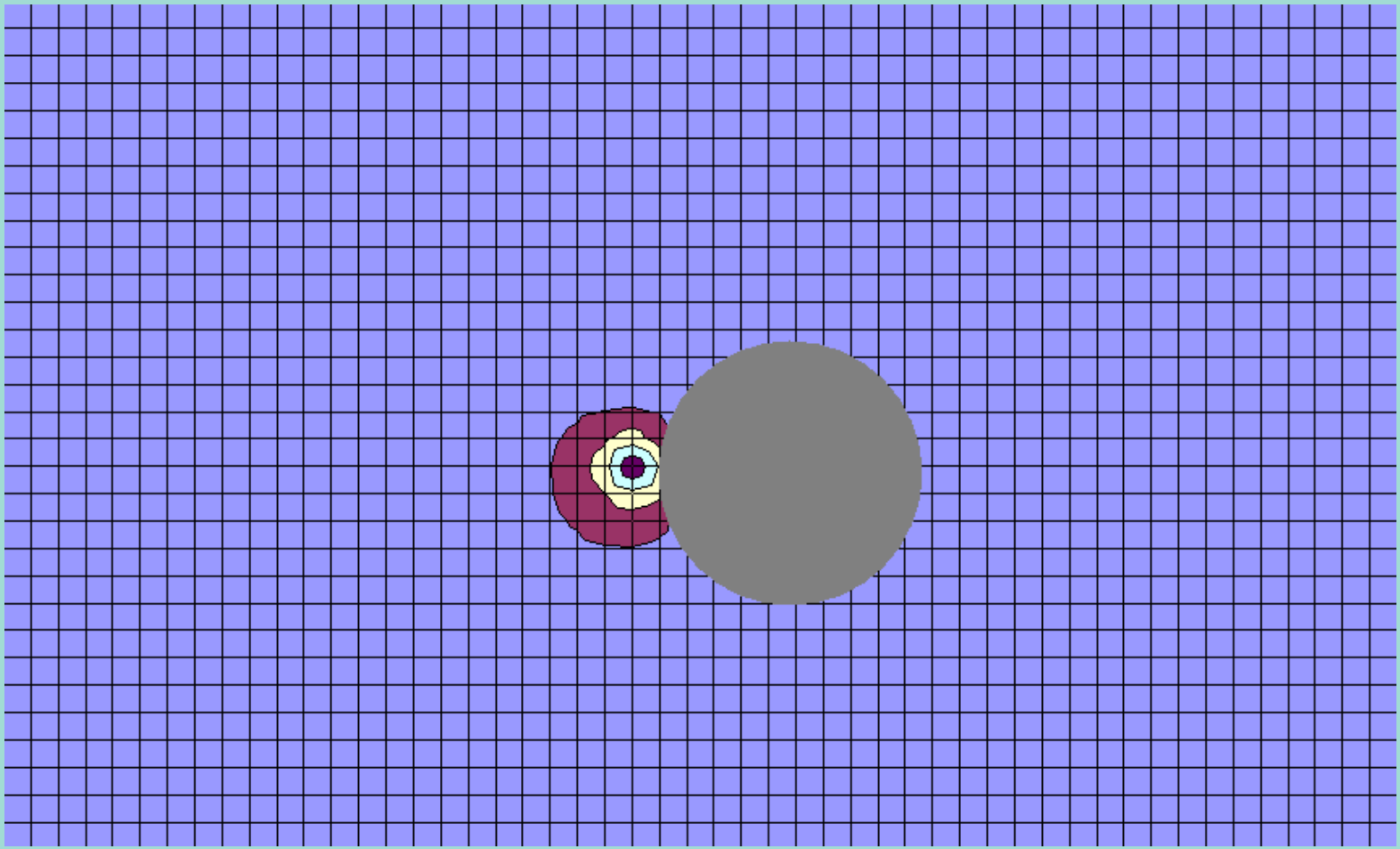
- Permeable and pressure - tight sensor tube along the component to monitored
- Central measuring system including a pump and sniffering gas detectors

## Evaluation parameters

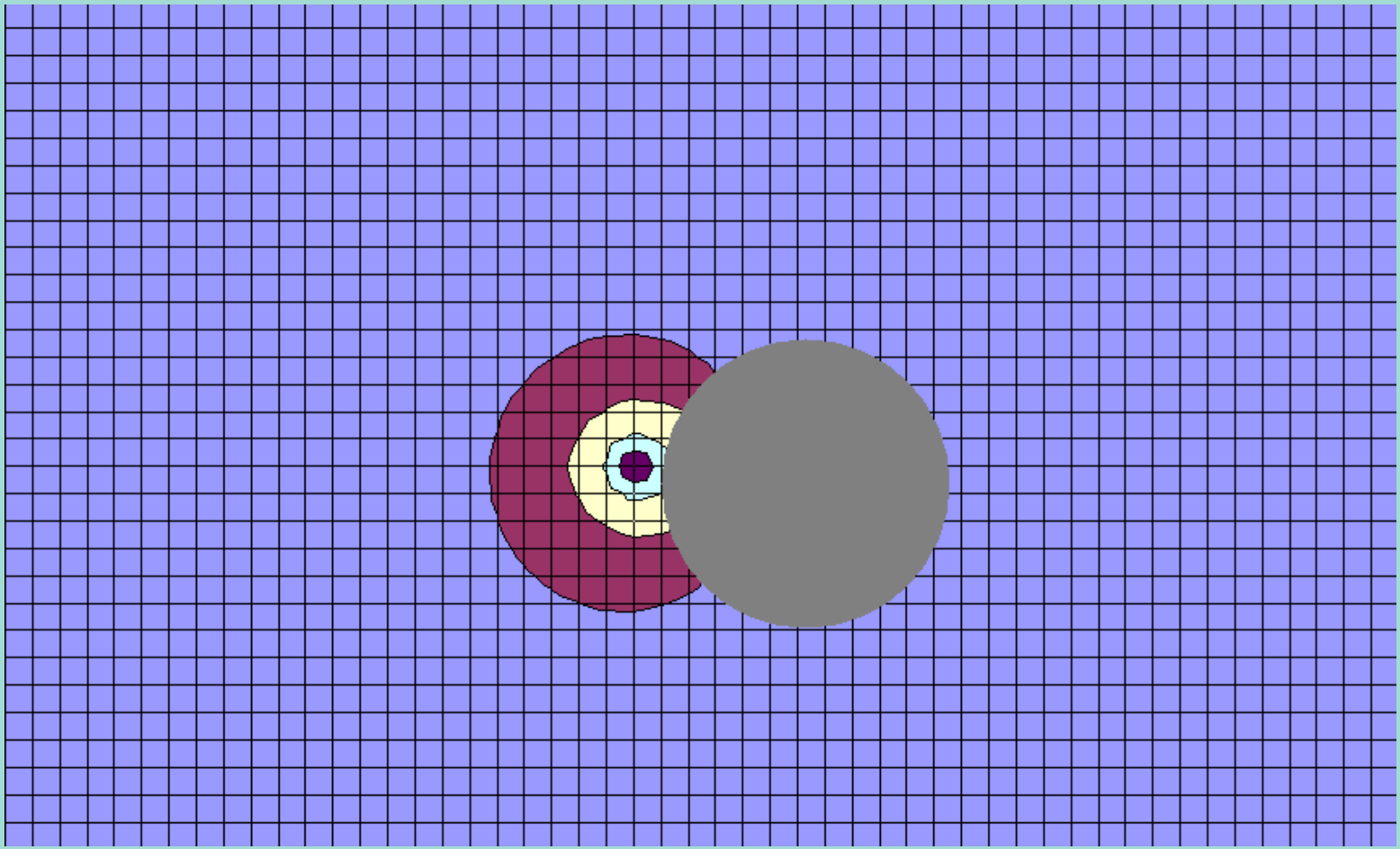
- Measuring of the gas concentration collected in the sensor tube as a function of the pumping time
- **Leak detection:** crossing of gas concentration above a threshold ( detection time )
- **Leak location:** detection time multiplied by the measured gas flow velocity
- **Analysis:** gas probe analysis, pattern recognition methods by neural networks using up to 7 sensors



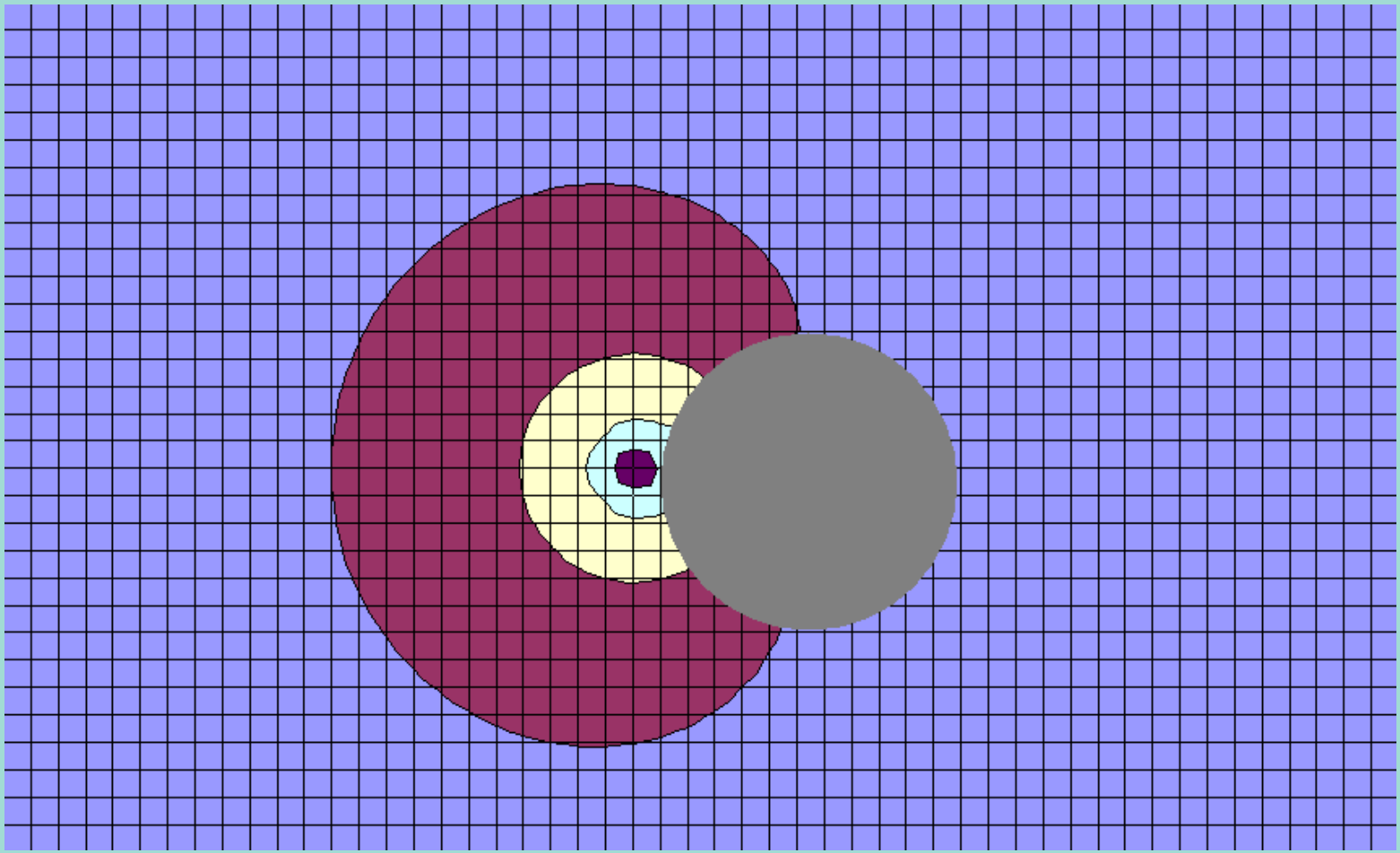
# Diffusion around the Pipe - Phase 1



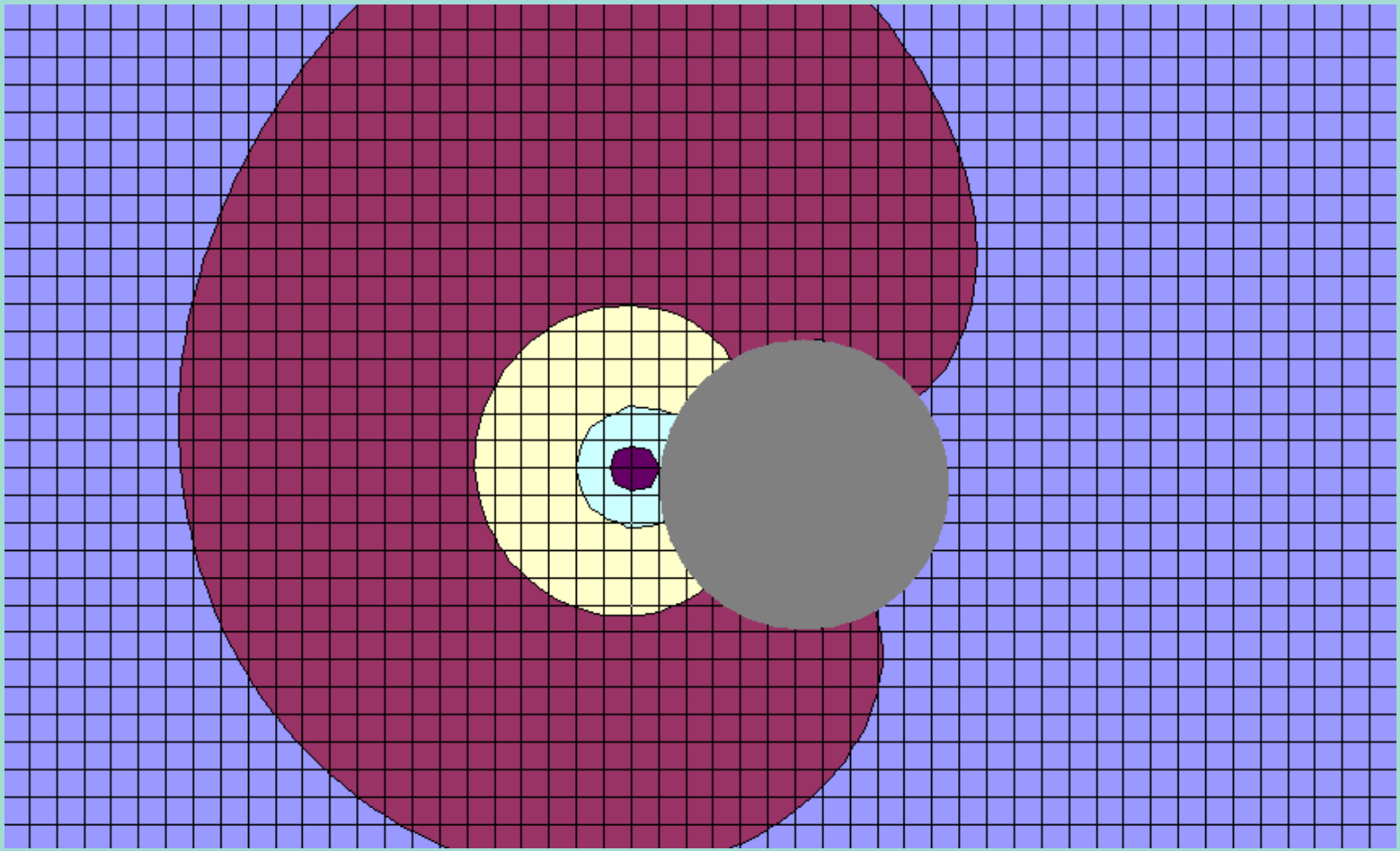
# Diffusion around the Pipe - Phase 2



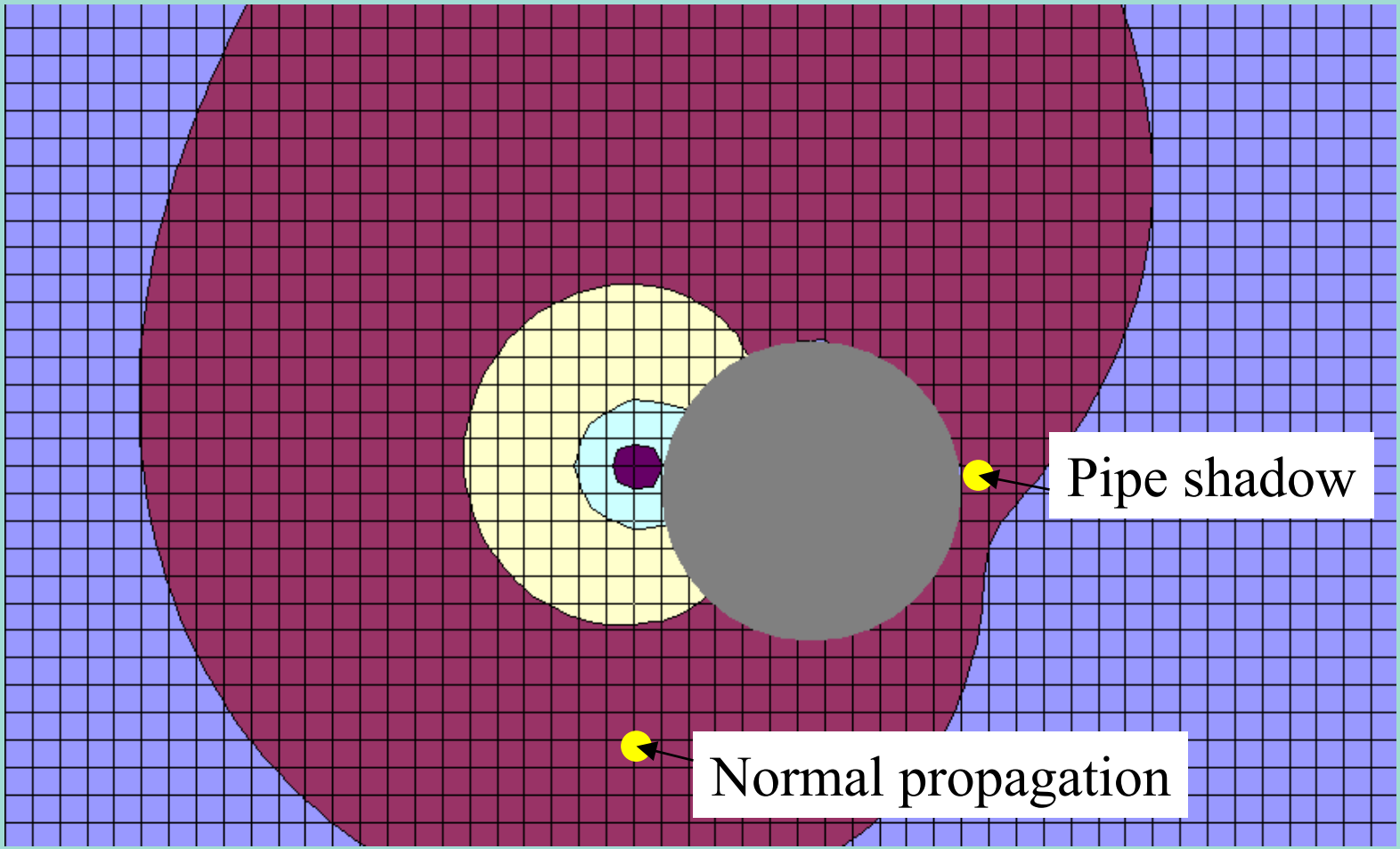
# Diffusion around the Pipe - Phase 3



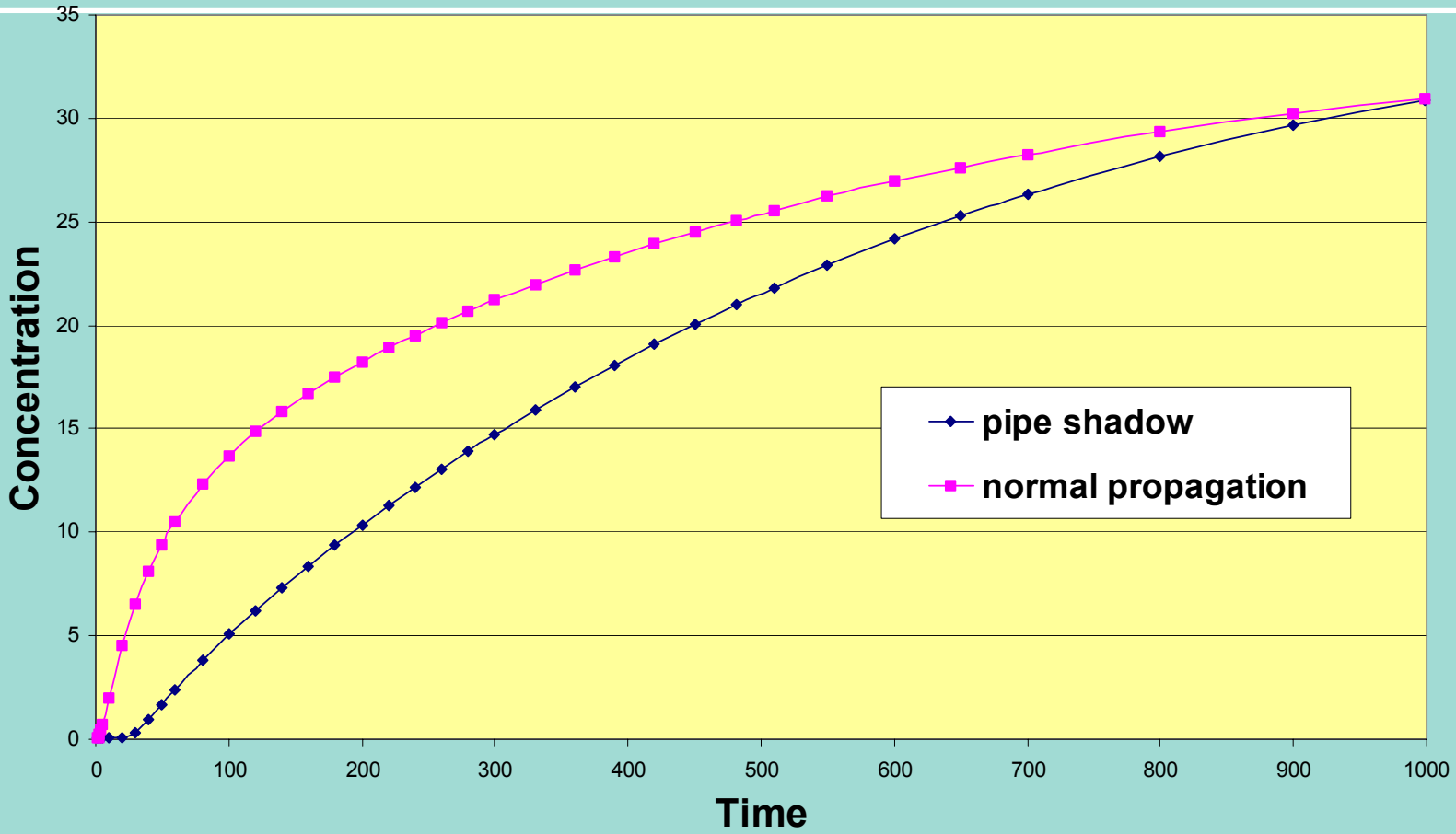
# Diffusion around the Pipe - Phase 4



# Diffusion around the Pipe - Phase 5

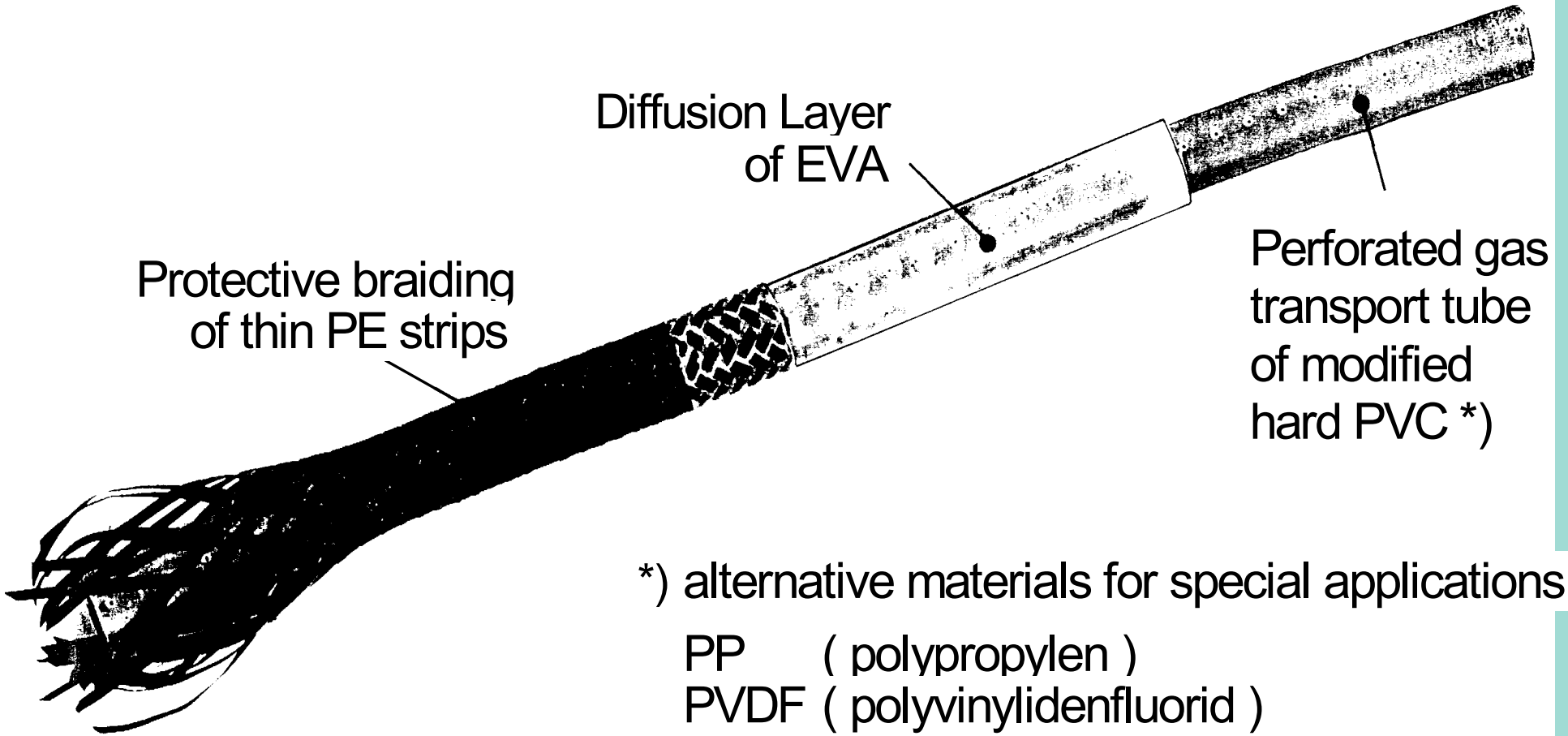


## Diffusion around a pipe (2-dimensional Model)




**LEOS (Leak- and Location System)**

## Structure of Sensor Tube




*) alternative materials for special applications:

PP ( polypropylen )
PVDF ( polyvinylidenfluorid )

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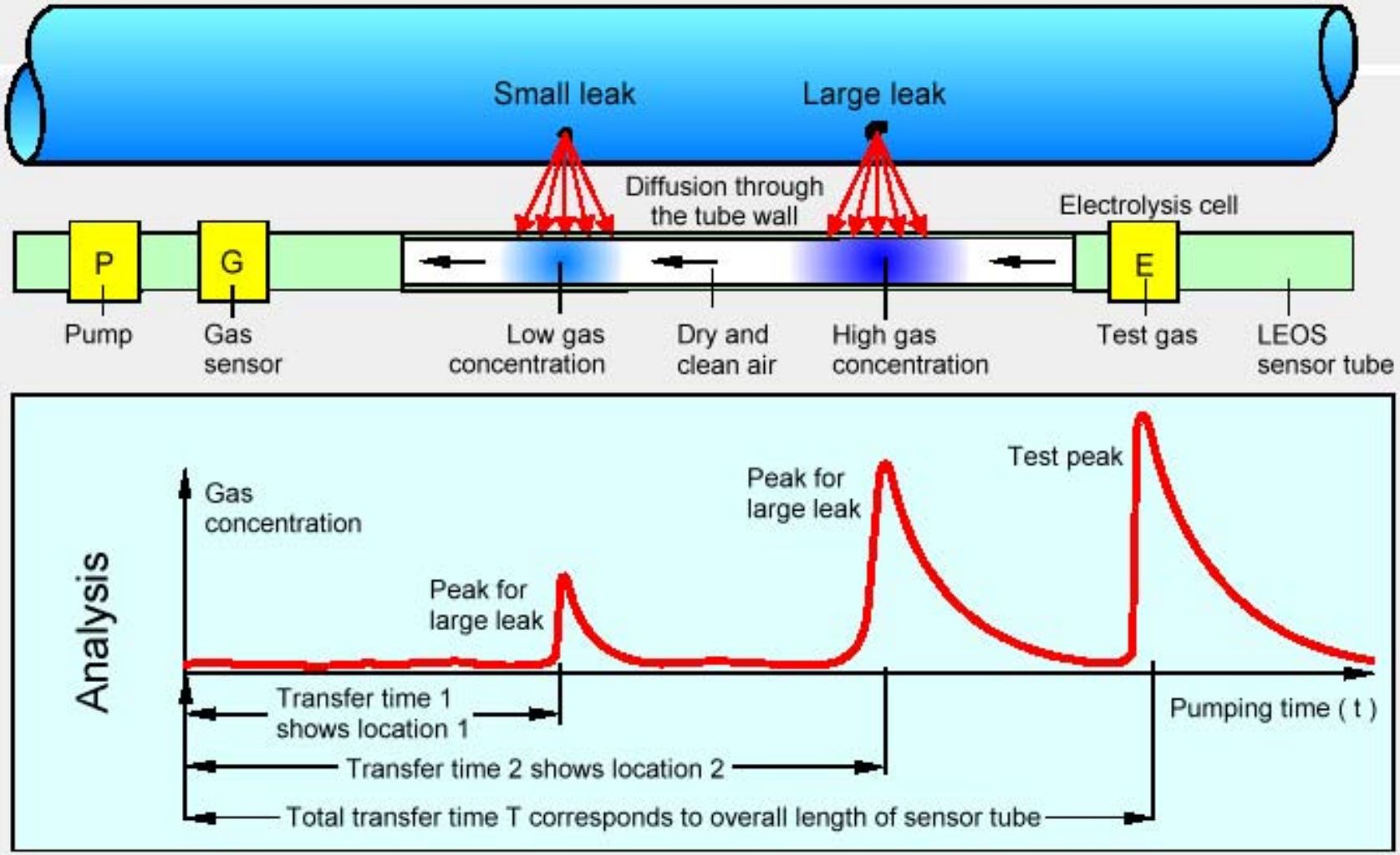
# Mode of Operation




LEOS ( Leak Detection and Location System )

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# LEOS capabilities

## Detectable materials

- All types of carbonats such as propan, crude oil, petrol, halogenized hydrocarbons, alcohols, ester, ether, ketones
- Anorganic gases ( hydrogen, ammonia )

## Detection limits

- Sensor tube: ≤ 10 µl / l for fluids
  ≤ 5 ml / l for gases
- Leaking material: ≤ 1 l / h for fluids
  < 0,1 $m^3$ / h for gases

## Monitoring length / - area

- For each measuring system: pipeline: 15 km ( up to 50 km for methan )
  waste deposits: < 100 ha ( ≲ 35 km )

## Location accuracy:

- better than ± 25 m for 5 km ( ≙ 0,5 % )

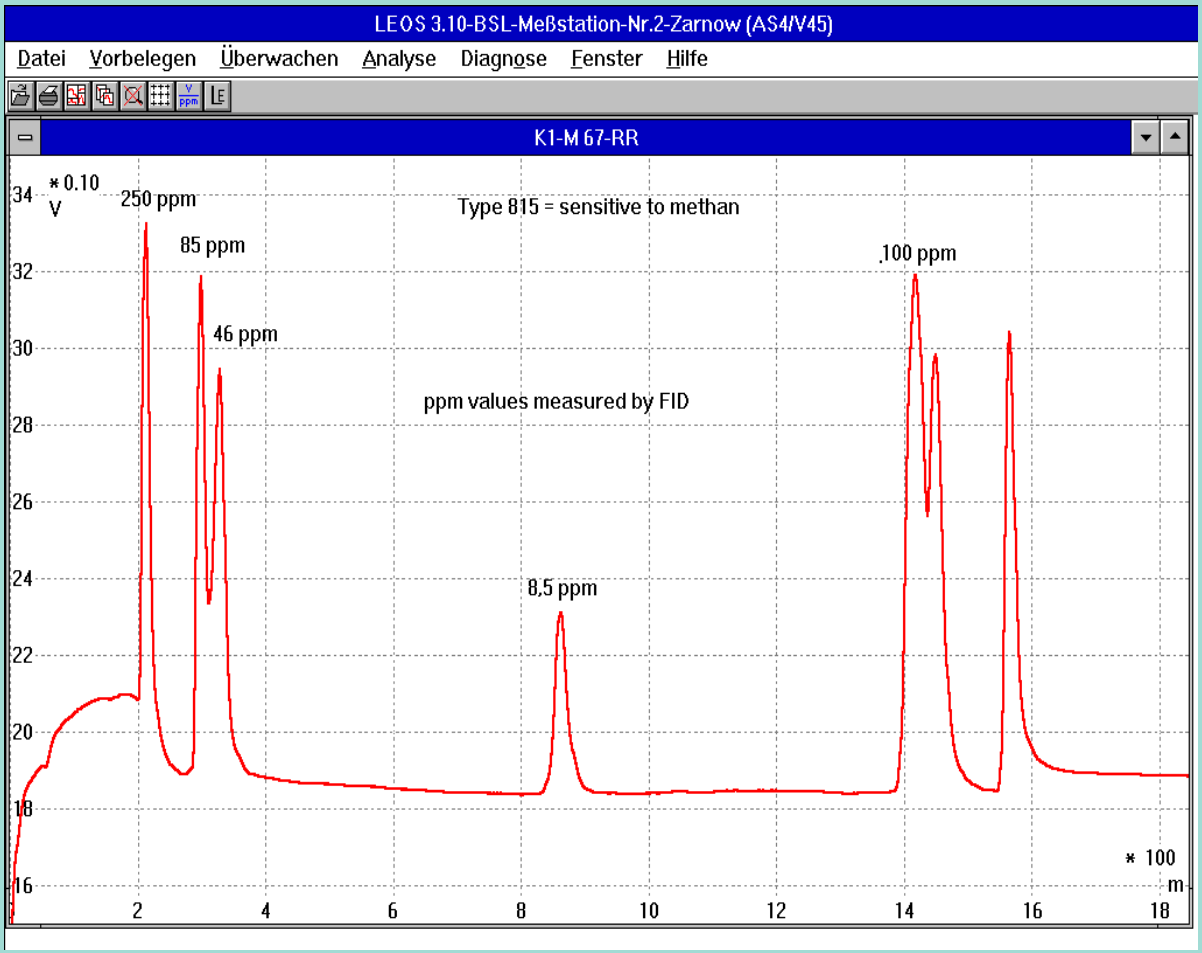
## Response time:

- normal application: 24h
  special gas application: ≥ 0,5h (for short distances )

## Evaluation:

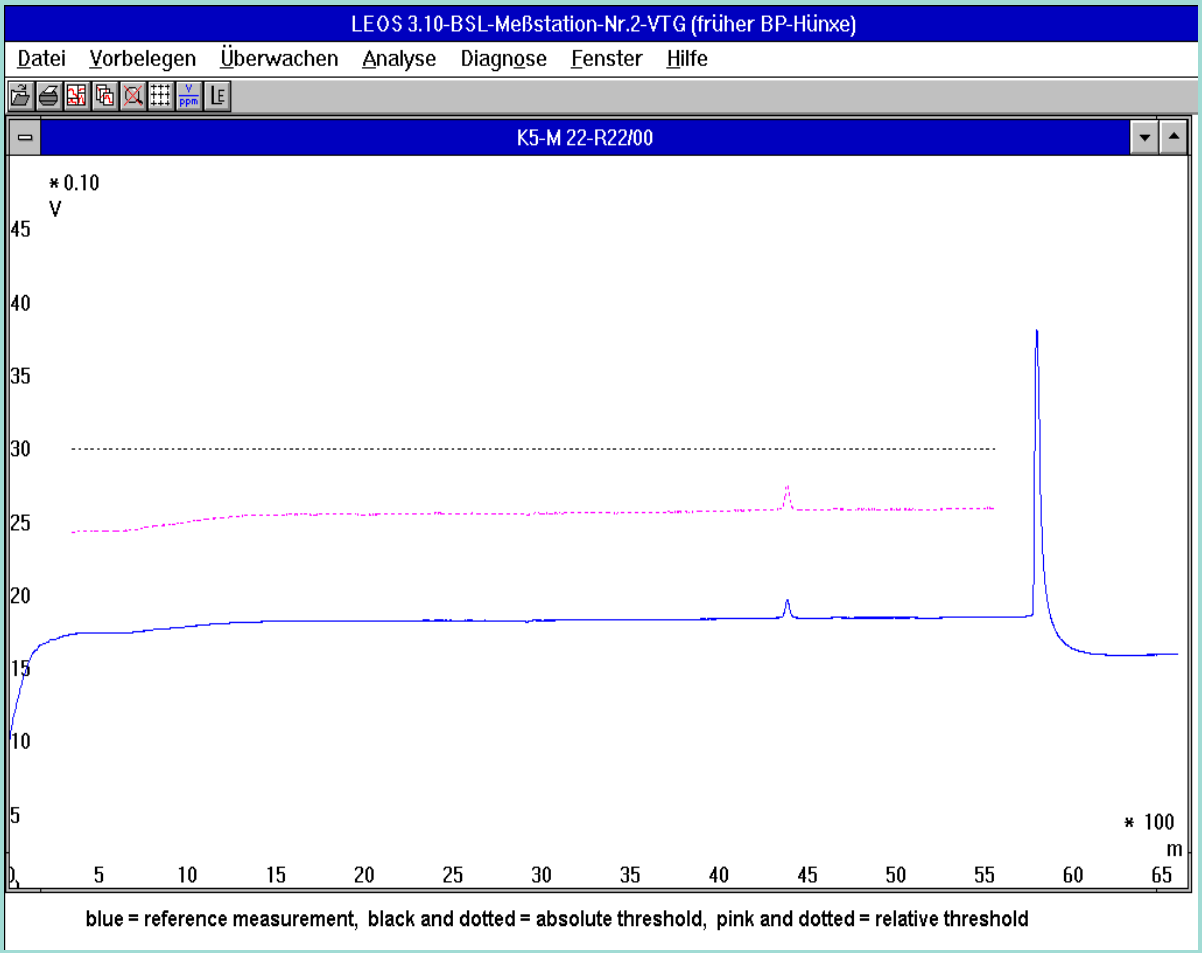
- automatic leak alarm
- trending of leak indication
- identification of leaking material

# LEOS Reference Location Plot
# High Background of Methane at Selected Positions

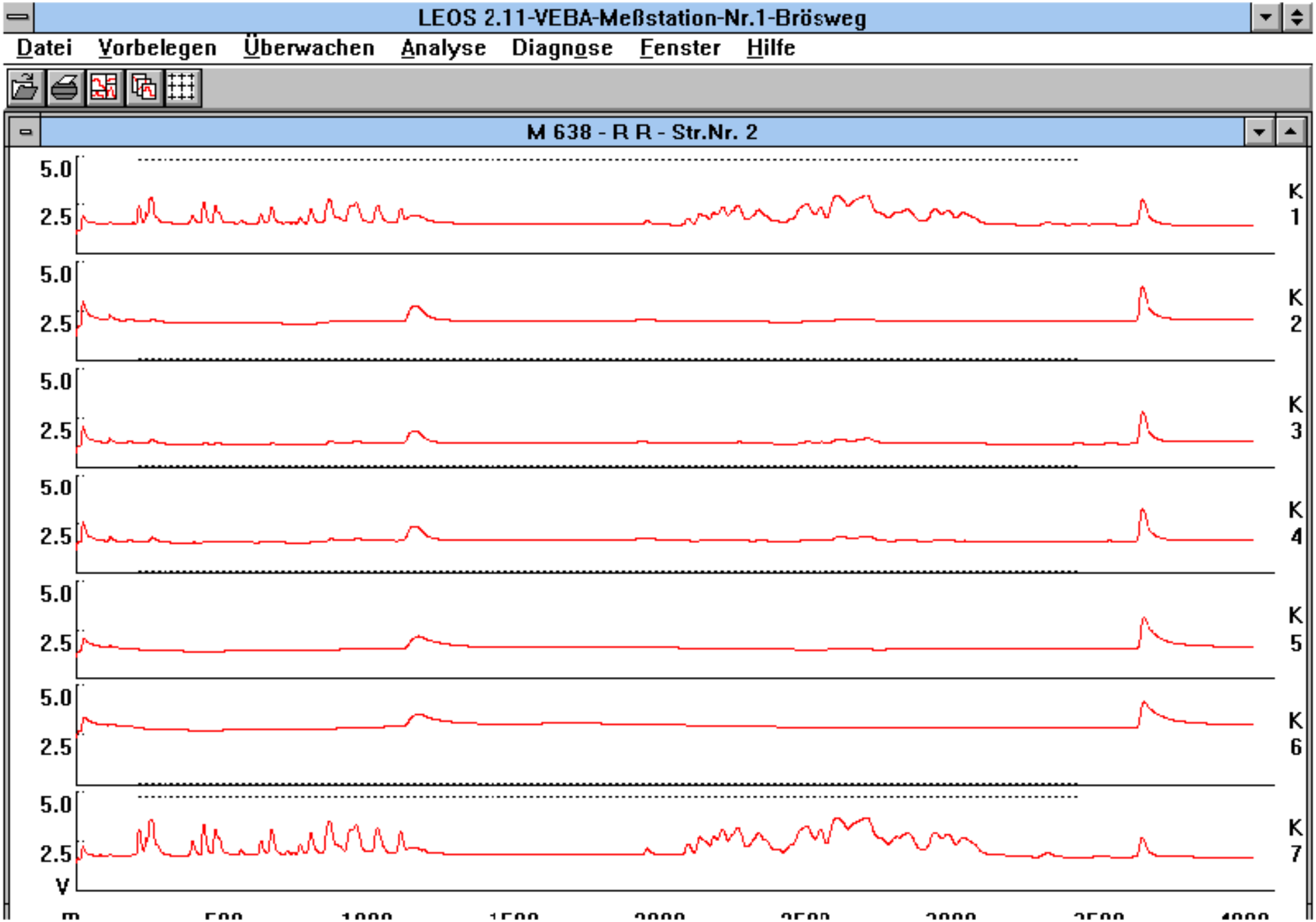


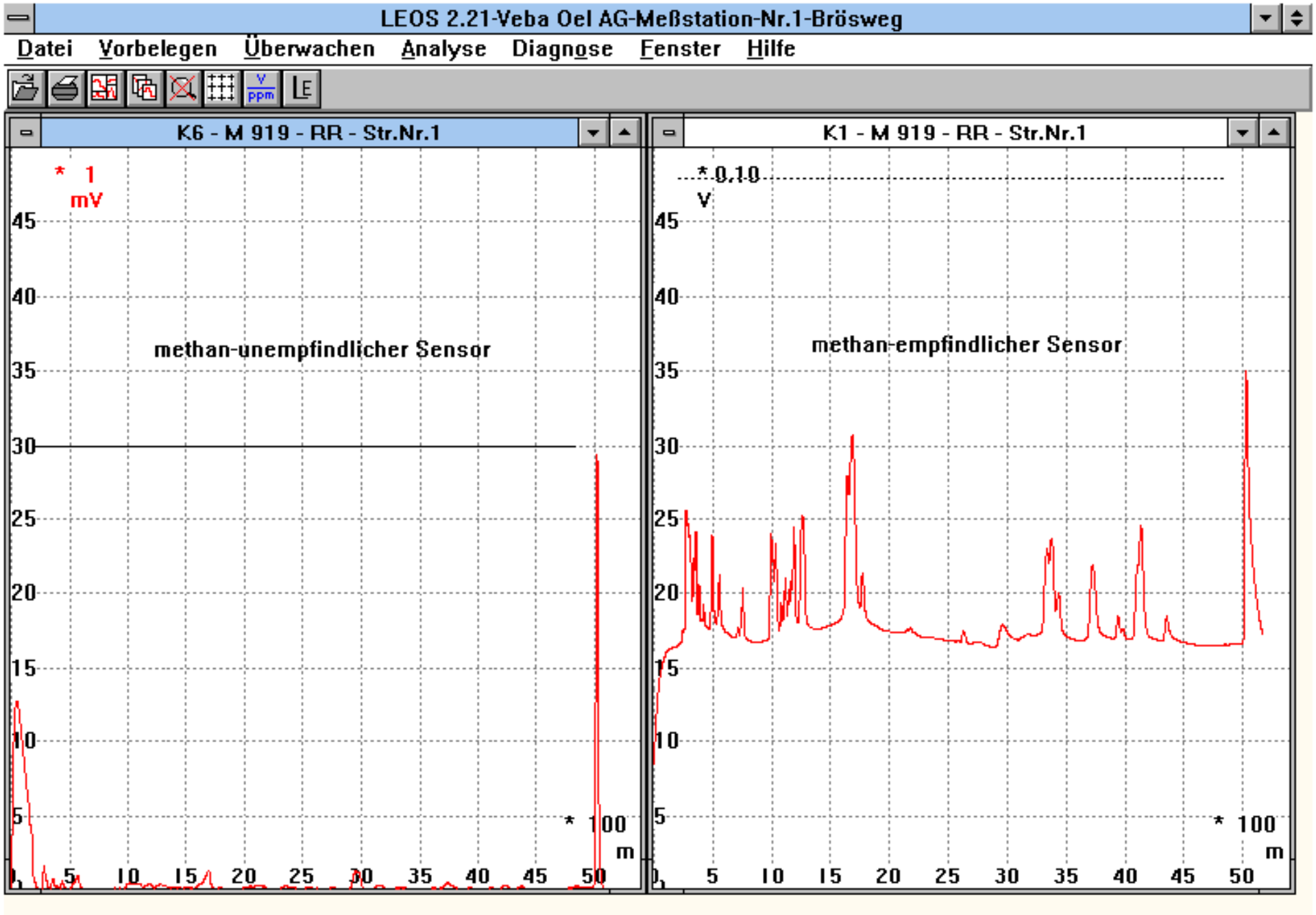

LEOS (Leak- and Location System)

# LEOS Reference Measurement
# Low Background at VTG (BP) Pipeline Bundle

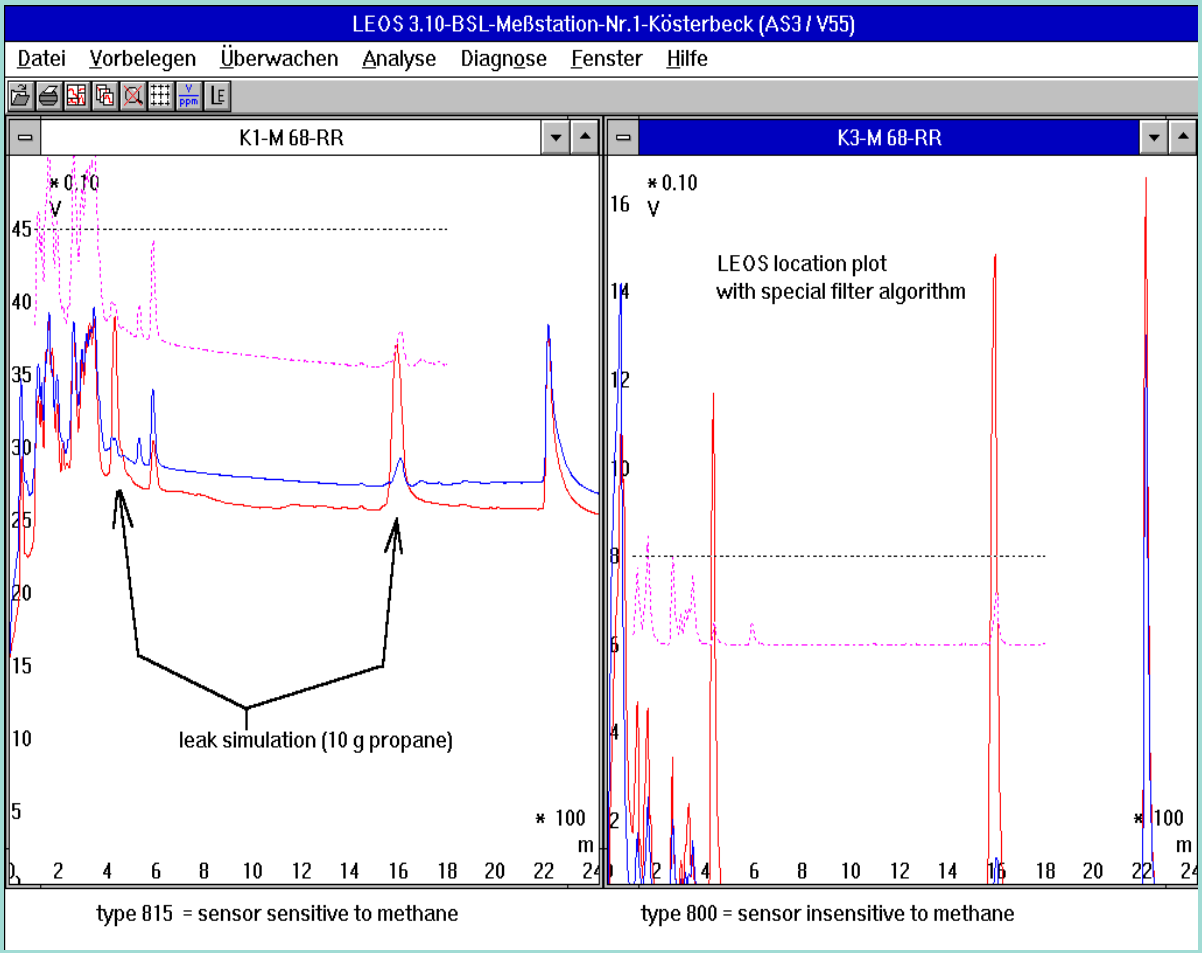



**LEOS (Leak- and Location System)**


LEOS 2.11-VEBA-Meßstation-Nr.1-Brösweg
Datei Vorbelegen Überwachen Analyse Diagnose Fenster Hilfe
M 638 - R R - Str.Nr. 2
5.0
2.5
K 1
K 2
K 3
K 4
K 5
K 6
K 7
V
m


LEOS 2.21-Veba Oel AG-Meßstation-Nr.1-Brösweg
Datei Vorbelegen Überwachen Analyse Diagnose Fenster Hilfe
K6 - M 919 - RR - Str.Nr.1
* 1
mV
methan-unempfindlicher Sensor
* 100
m
K1 - M 919 - RR - Str.Nr.1
* 0,10
V
methan-empfindlicher Sensor
* 100
m

# LEOS Location Plot
# Influence of Sensor Type and Filter Algorithm




**LEOS (Leak- and Location System)**

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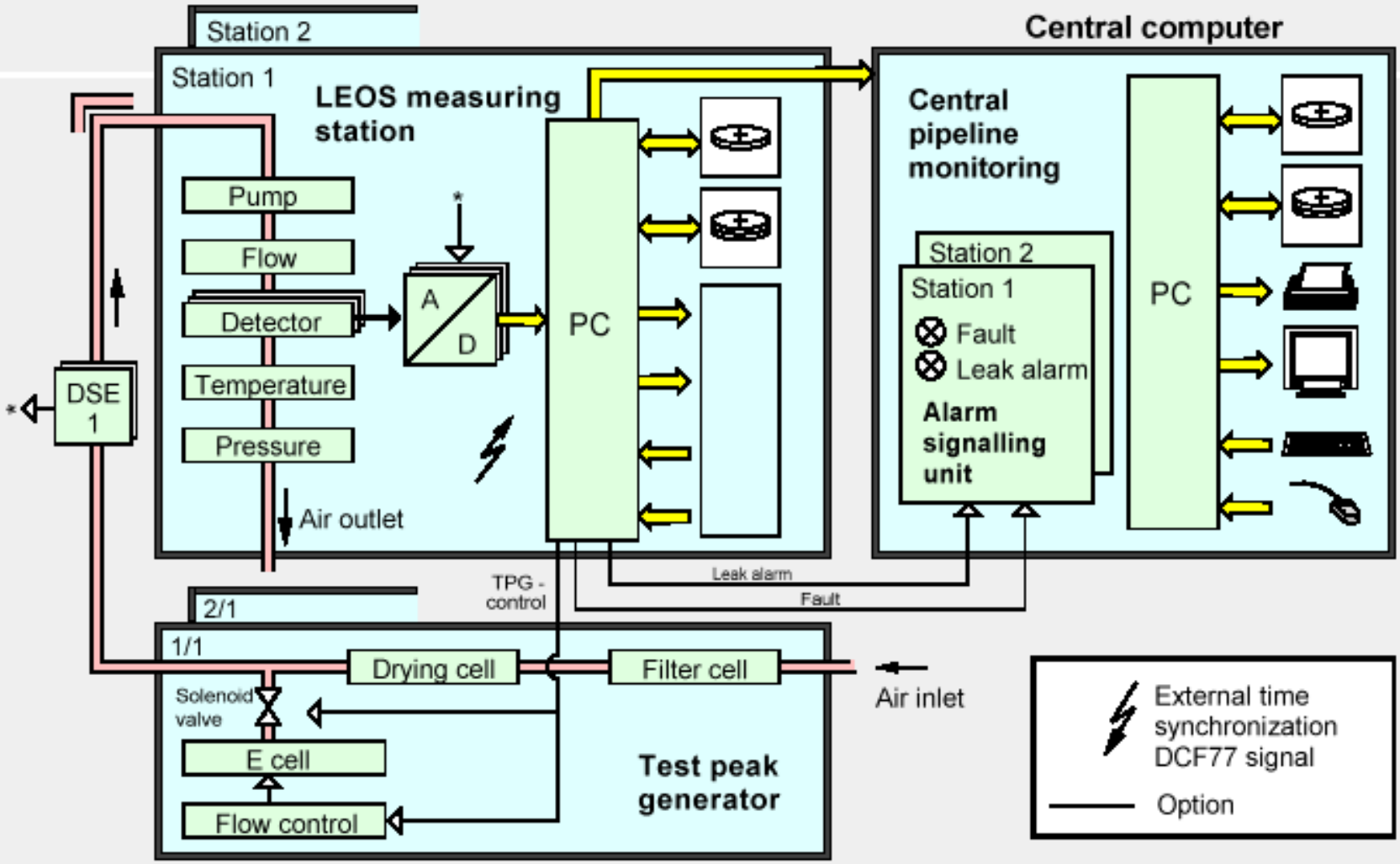
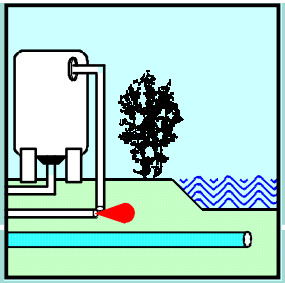
# Pipeline monitoring with central computer



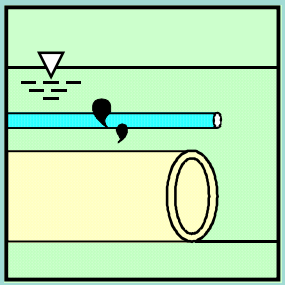

LEOS ( leak detection and location system )



## Groundwater Protection Area 1978 BASF AG, Ludwigshafen

**Medium transported:** *Ethylene $C_2 H_4$* **Piping length:** *4km*

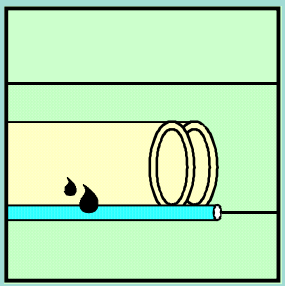
**Configuration:** *above groundwater level, sensor tube lies beside pipe*



## Rhine River Crossing /Foreshore 1978 BASF AG, Ludwigshafen

**Medium transported:** *Ethylene $C_2 H_4$* **Piping length:** 2 x 1,5 k*m*

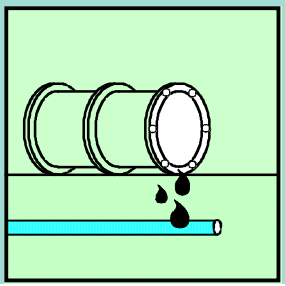
**Configuration:** *sensor tube at 12 o‘ clock in Rhine River bed, in a depth of 24 m from the maximum water level*



## Piping Bundle in Rhine Foreshore 1983 Wintershall AG, Mannheim

**Medium transported:** *Pentane and nonane cut, benzene, aviation fuel,* **Piping length:** 2 x 1,5 k*m*

**Configuration:** *sensor tube at 12 o‘ clock in Rhine River bed, in a depth of 24 m from the maximum water level*



## Chemical Storage Facility 1987 Cable Factory, Coburg

**Medium stored:** *Ketone, mixed solvents, oil etc* **monitored area:** 225 m $^3$

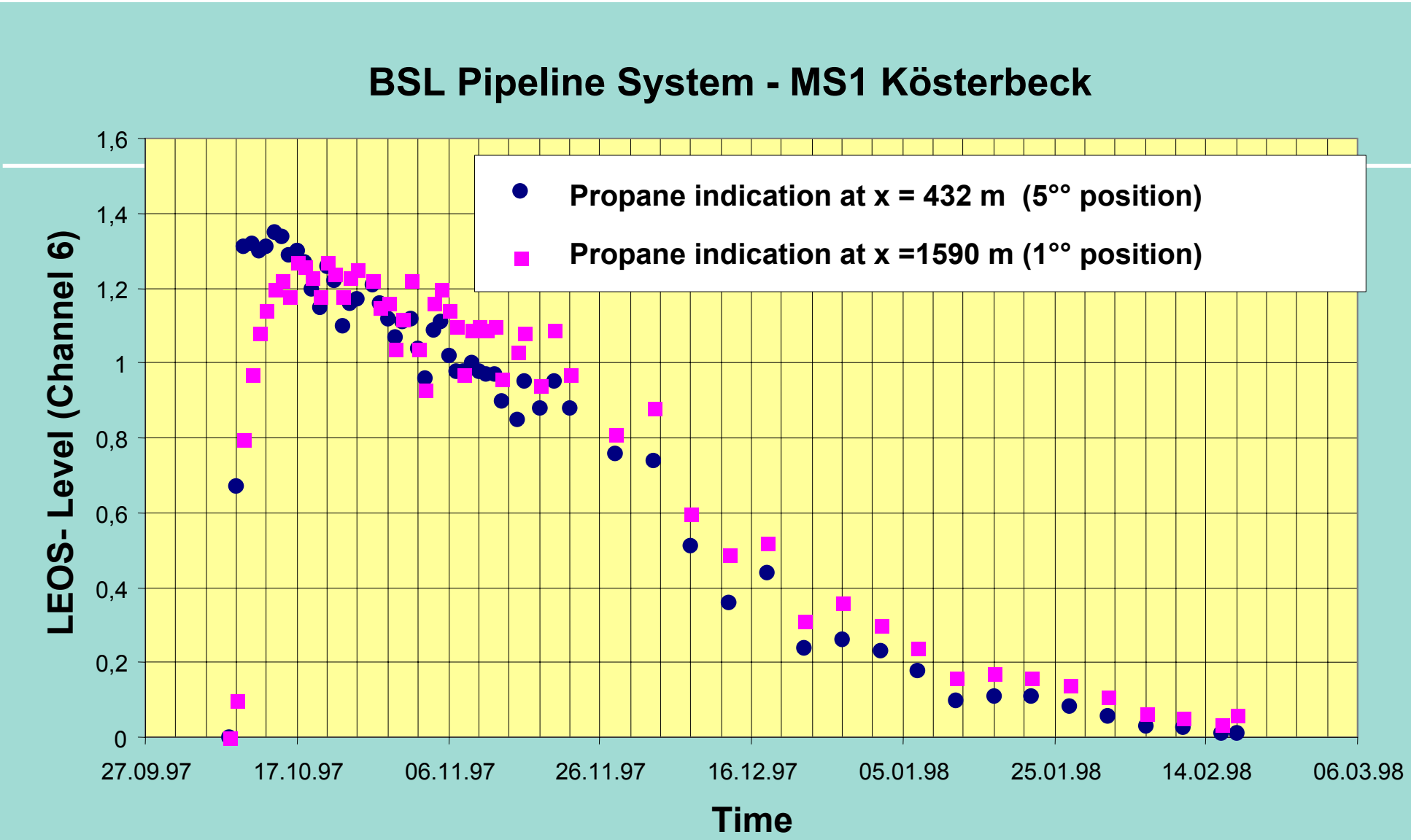
**Configuration:** *sensor tube laid in ducts below building*

**LEOS (Leak- and Location System)**

## Track Report on Monitoring Function / Field Experience

- LEOS in operation ***since 1978***
- ***Small leaks*** at valves during pipeline operation
- ***No leak undetected*** including field tests
- ***Approved system for water protection*** in Germany
- ***Methane emissions*** from natural organic processes
- Other background emissions from ***industrial pollutants***

**LEOS (Leak- and Location System)**




**LEOS (Leak- and Location System)**

## System Experience

- ***100 % reliability*** of installed sensor tube buried in soil or water
- Highly reliable ***electronic components***
- ***Automatic*** monitoring with specified capabilities
- Low equipment ***maintenance***
- ***Measurement Module*** allows simple system adaptation to monitor loop or radial systems, (up to 8 monitoring lines for each module)

## BPXA Northstar Project

**Stipulation of U.S. Army Corps of Engineers:**

"oil spill leak detection system"

**Design Basis:** 15 years , plus

6 miles subsea oil pipeline

water depth 0 to 39 ft, burial depth 5 to 11 ft

60 °F operating temperature

ambient air temperature during construction : - 50°F

high salinity

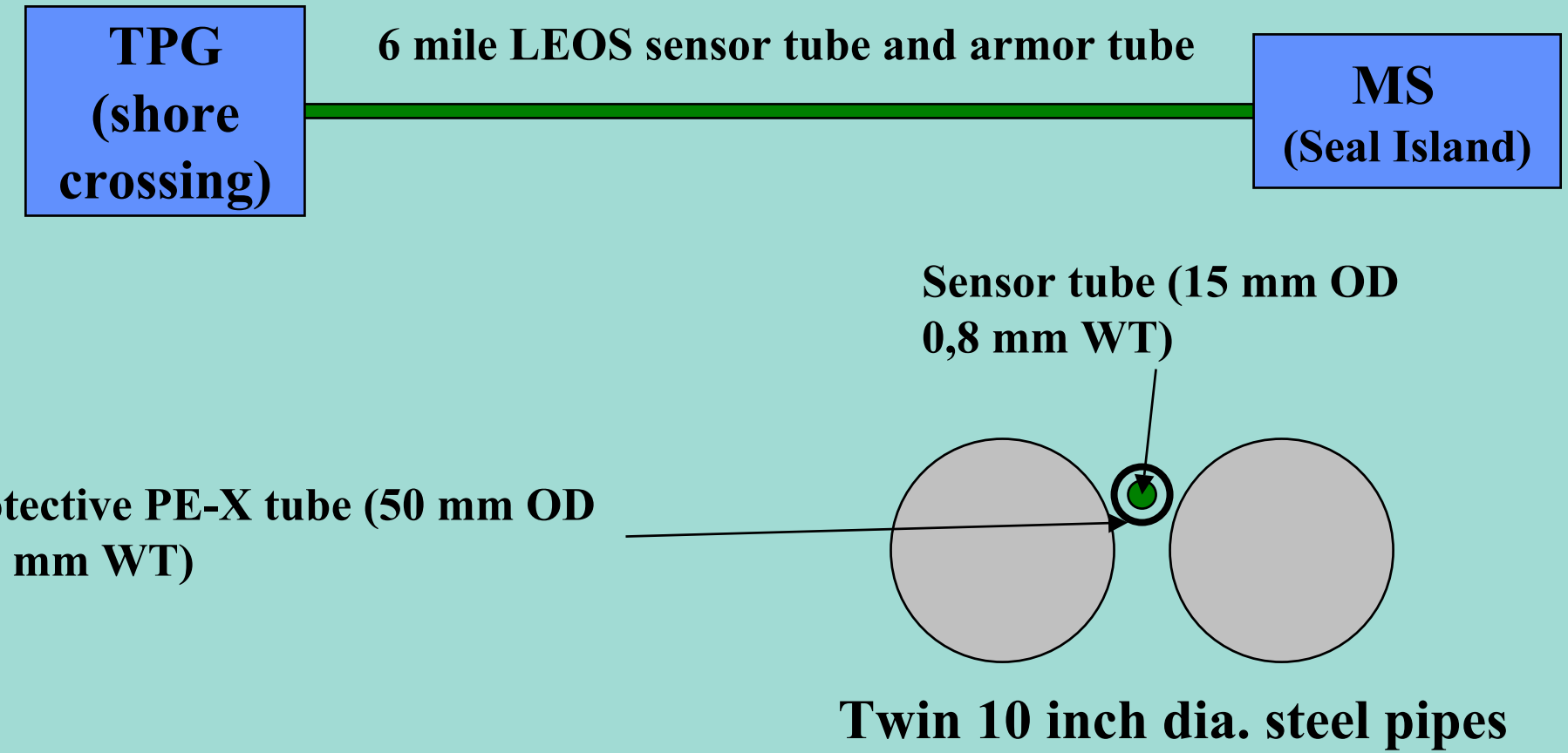
**Sensitivity:** < 1 bbl/day (32.5 bbl/day requested)

**Performance requirements:**

no false alarms

robust to survive installation and long-term operation

# Main LEOS Components of Northstar Project




LEOS (Leak- and Location System)

# Construction - Protection during Installation

*Impact and abrasion resistance*

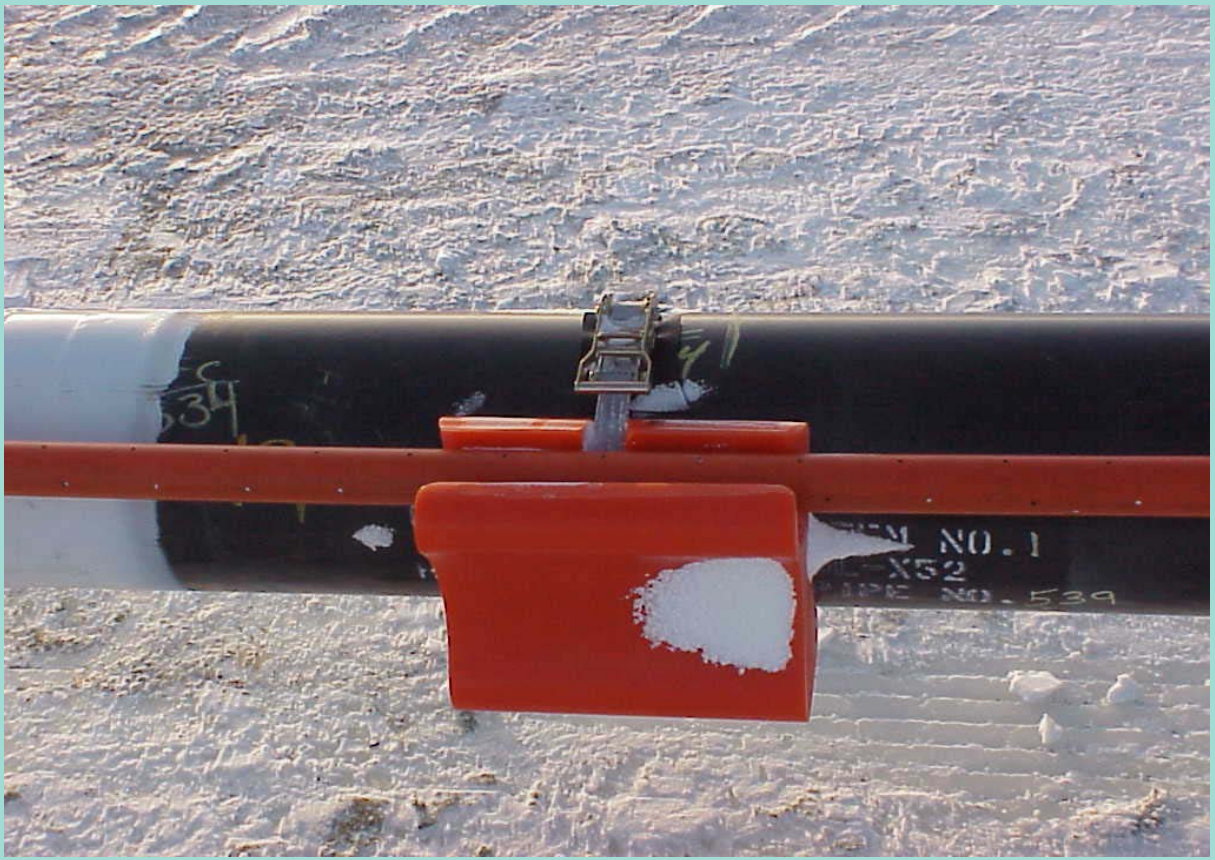
- Sensor hose installed in a protective PE-X perforated tube
- Sensor hose and PE-X assembly delivered in 300 m (1,000-ft) coils
- Splice and repair can be made in the field

*Low ambient temperature application*

- Modified inner sensor tube made from PVDF

*Installation QAQC*

- Pressure tests of the sensor hose after each relevant step
- Final pressure test of the complete monitoring line

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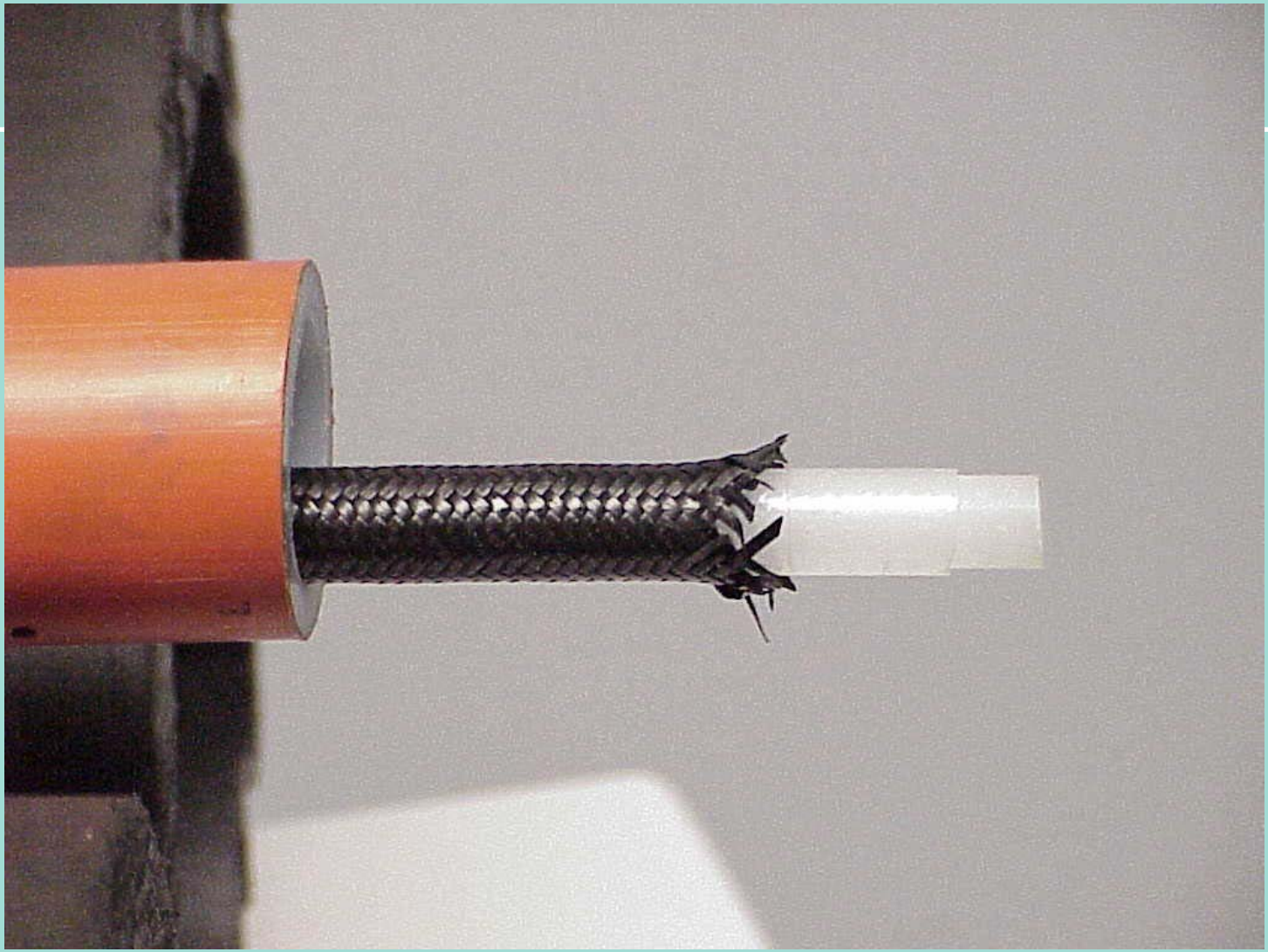

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