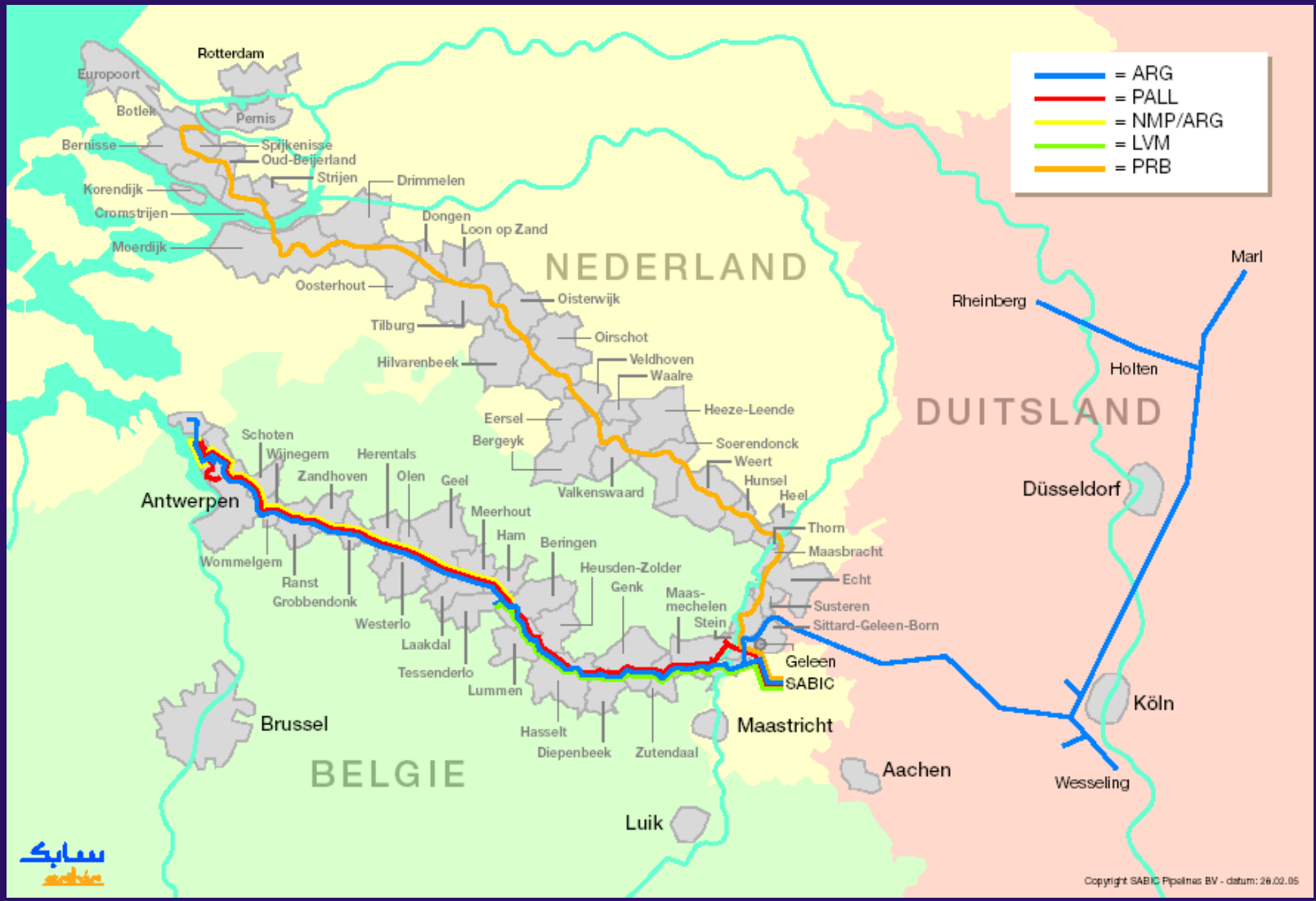
Leak Detection Systems

Workshop UNECE / Berlin

Ted Smorenburg
SABIC Pipelines
Netherlands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- **Pipeline incident Bellingham (US)**
- **Threats to pipelines**
- **Leakdetection systems**

City of Bellingham

Washington (US)

- **Incident on gasoline pipeline Olympic Pipeline company 1999**

Olympic Pipeline

Figure 2. Olympic Pipe Line Company system.

- 600 km metal pipeline
- 16” / 14” / 20”
- Transports gasoline
- 1965 constructed
- 100 Bar system
- Cherry point ->Renton / Seatle ->Portland
- Controlled from Renton

What happened?

- Production change from Renton to Seattle
- Problems with SCADA system / starting boosterpumps
- High pressure section 1 (15 -> 100 Bar) <- Pipeline collapsed
- Automatic stop pipeline to safe position

- Operator resumes transport and restarts
- After 15 minutes LDS alerts
- Operator starts extra pump

- Telephone call: smell of gasoline -> operator stops transport
  Alarm / emergency procedures started

1 hour passed since Rupture!!

After 1 ½ hour the spill ignited 2 km from leak-location

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N
Water line
tee connection
Pipeline rupture
Approximate orientation
of Olympic pipeline

Analysis

TPI

- **Pipeline was hit at excavations 5 years earlier**
- **Too little supervision by pipeline operator**

Technical

- **Inspections (pigging) insufficient analysed and actions taken**
- **Insufficient testing on safety-valves equipment before start-up.**

Operations

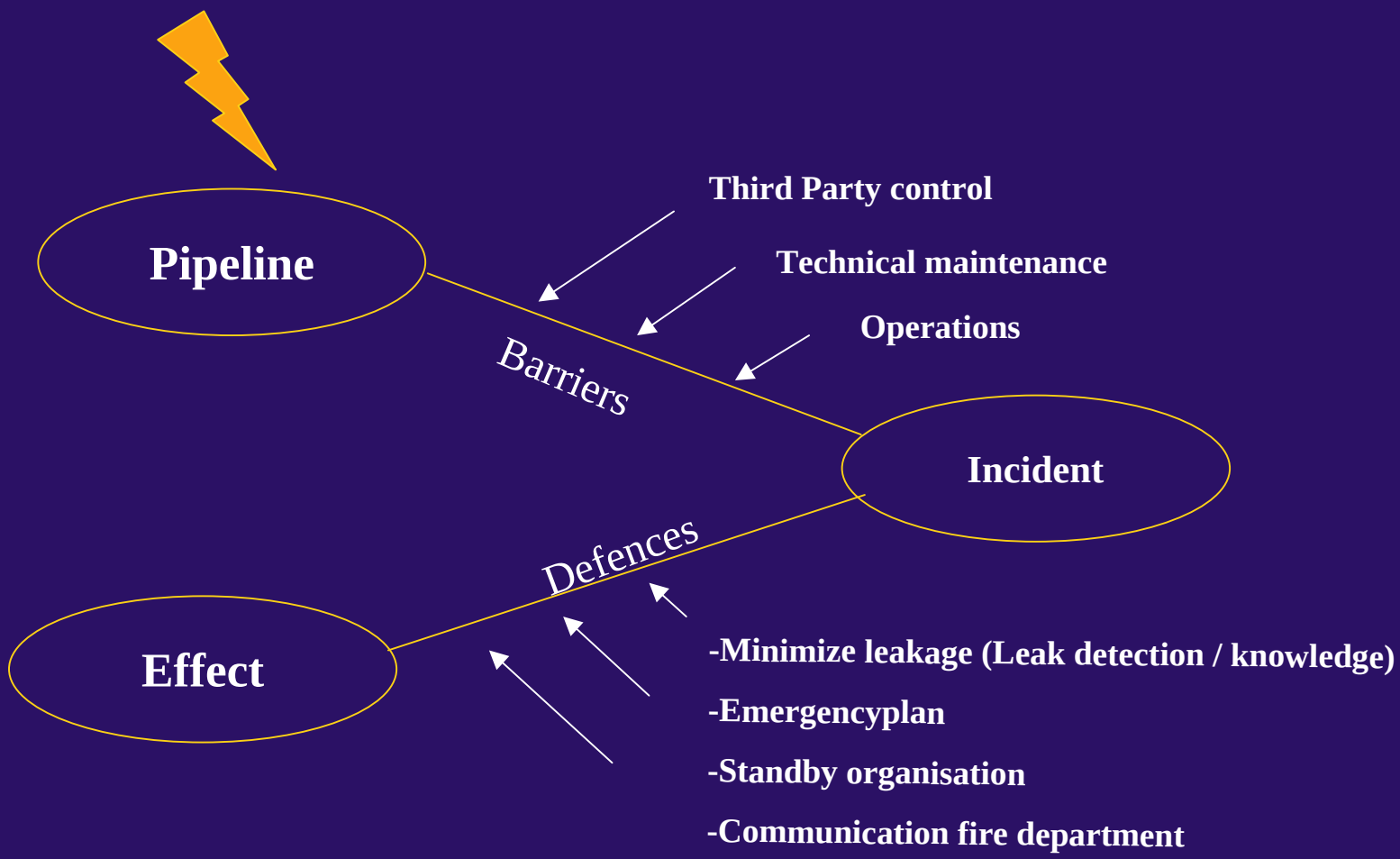
- **Process-upset was accepted after new connection at pipeline**
- **SCADA procedures insufficient, LDS inadequate during upsets**

Consequence:

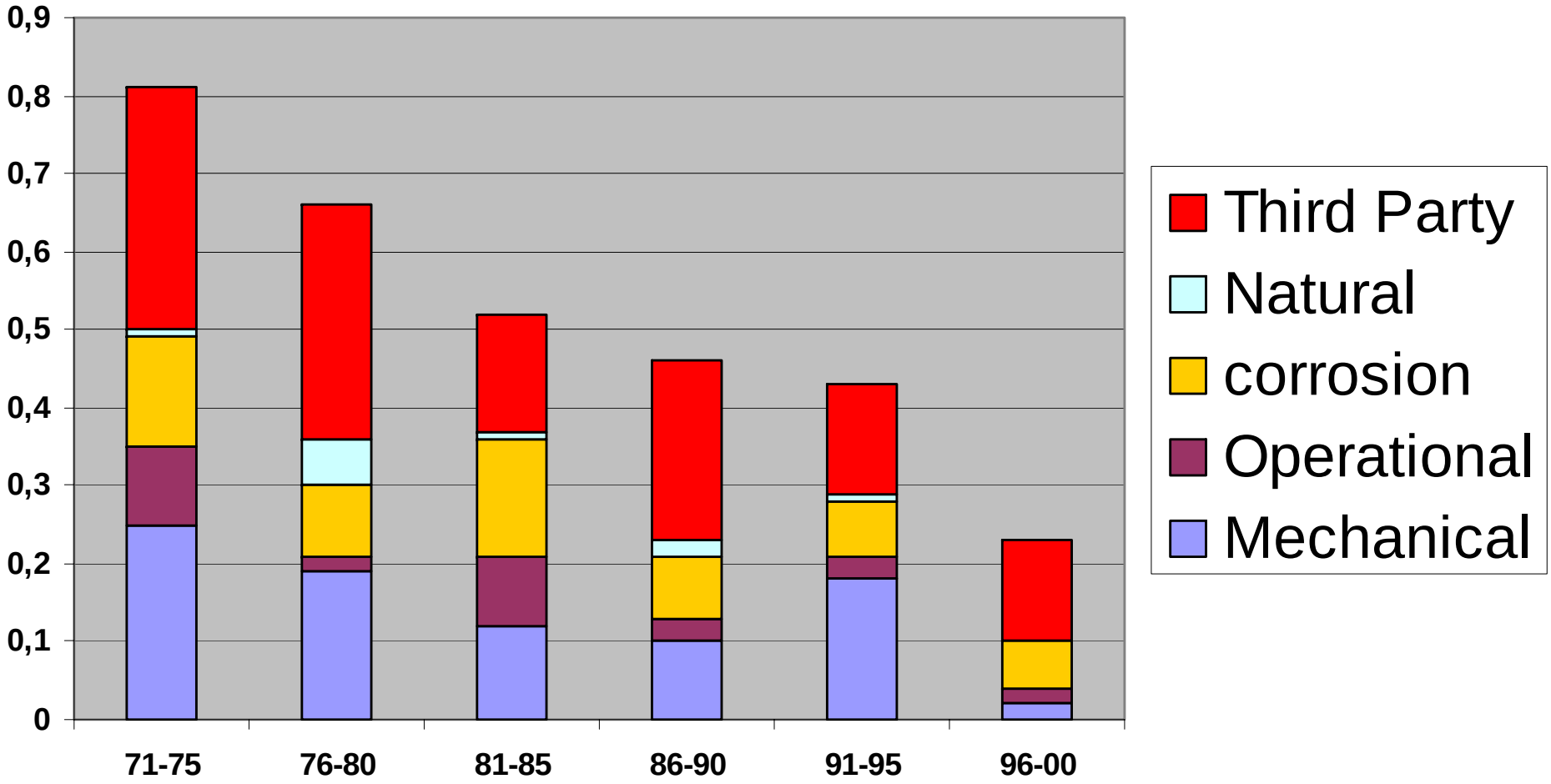
3 death

1000 m3 spill

€ 45.000.000 damage


Pipeline
Third Party control
Technical maintenance
Operations
Barriers
Incident
Defences
Effect
-Minimize leakage (Leak detection / knowledge)
-Emergencyplan
-Standby organisation
-Communication fire department

Spills per yr/1000km (Concawe)



Leakdetection systems

Goal

- **Limiting the quantity of the spill**
- **Location of the spill**

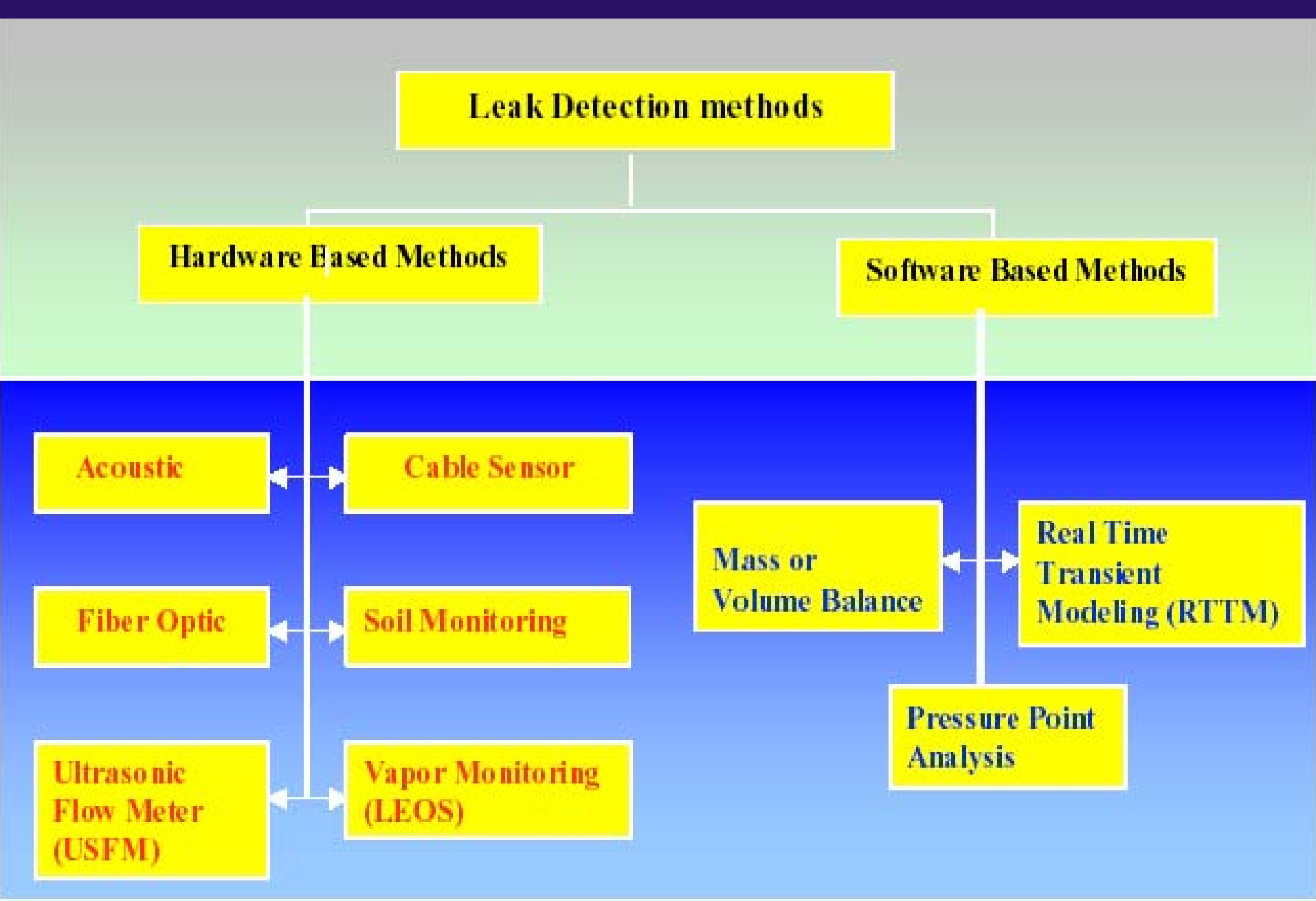
No prevention!!

Definitions (API 1155)

- **Sensitivity: Leak size and time to detect**
- **Accuracy: exactness of calculated leak size and location**
- **Robustness: availability of the functionality under transient conditions:**
  Starting / stopping of pumps, large transport changes
- **Reliability: ability to make the correct decision**

- **Overview Technologies**

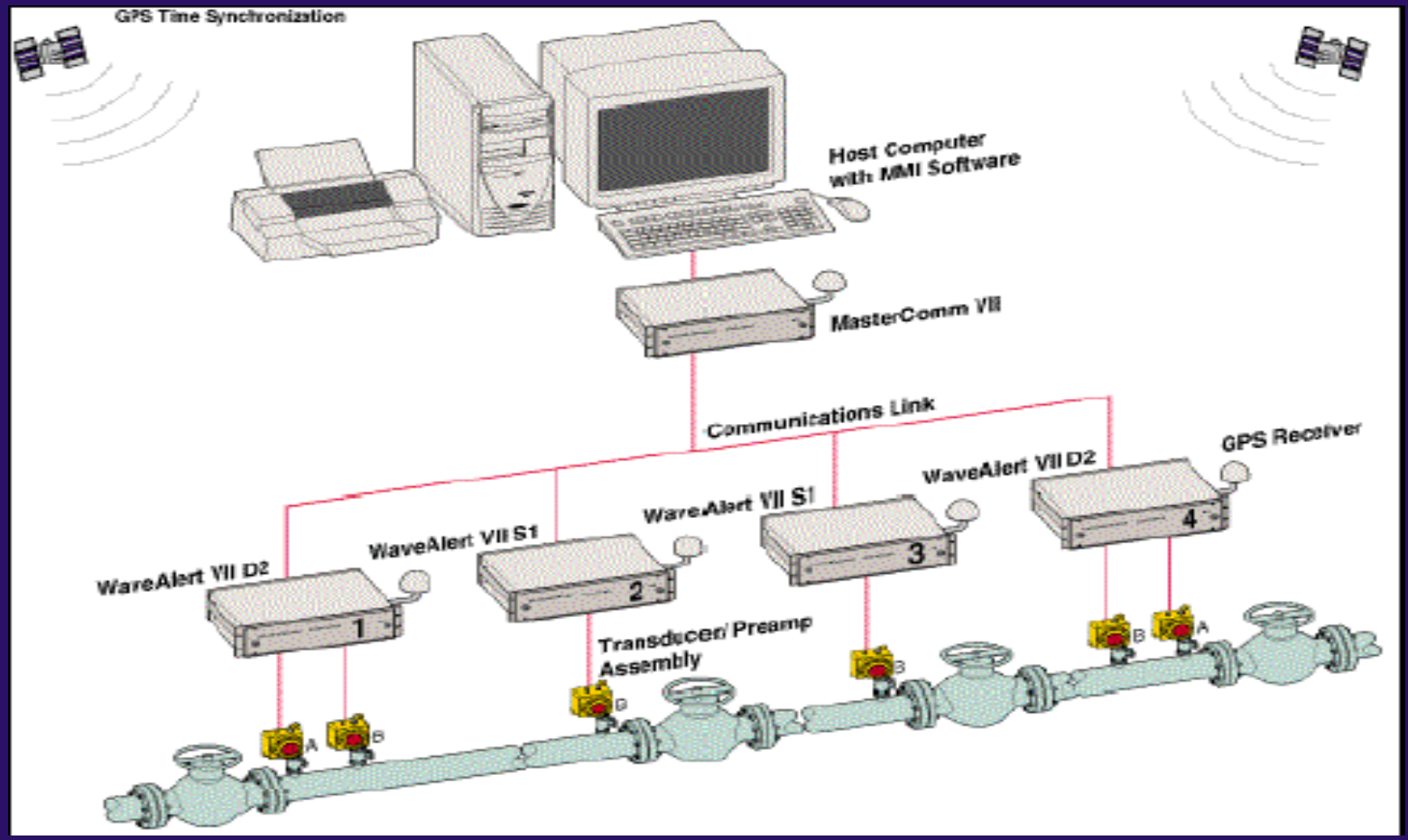
(ref: Worldwide assessment of Industry Leak detection capabilities, University Texas, 2003)


Leak Detection methods
Hardware Based Methods
Software Based Methods
Acoustic
Cable Sensor
Fiber Optic
Soil Monitoring
Ultrasonic Flow Meter (USFM)
Vapor Monitoring (LEOS)
Mass or Volume Balance
Real Time Transient Modeling (RTTM)
Pressure Point Analysis

Acoustic

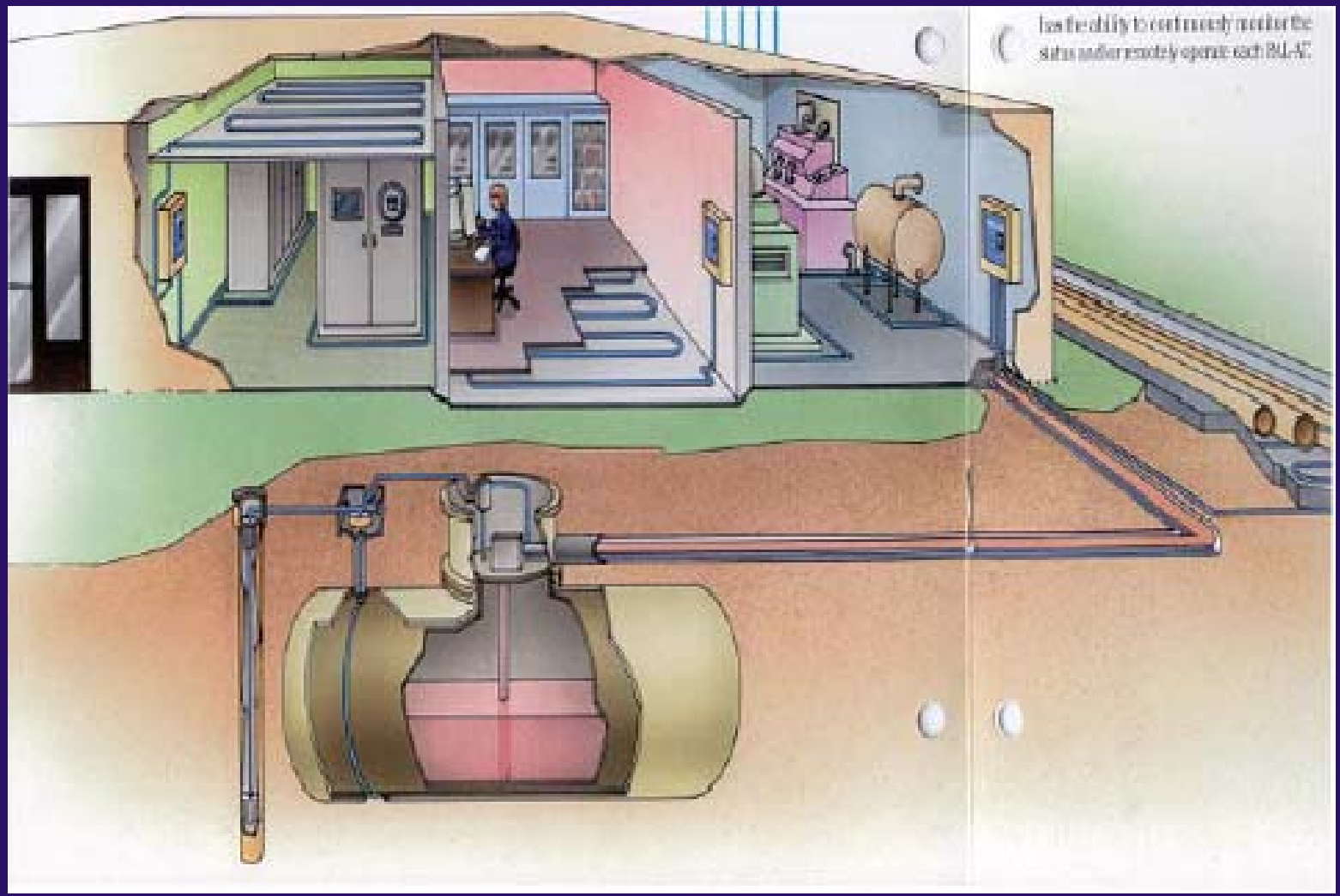
Reacts on sudden pressure drop

- only low flow rates & little noise
- limited sensitivity at transients



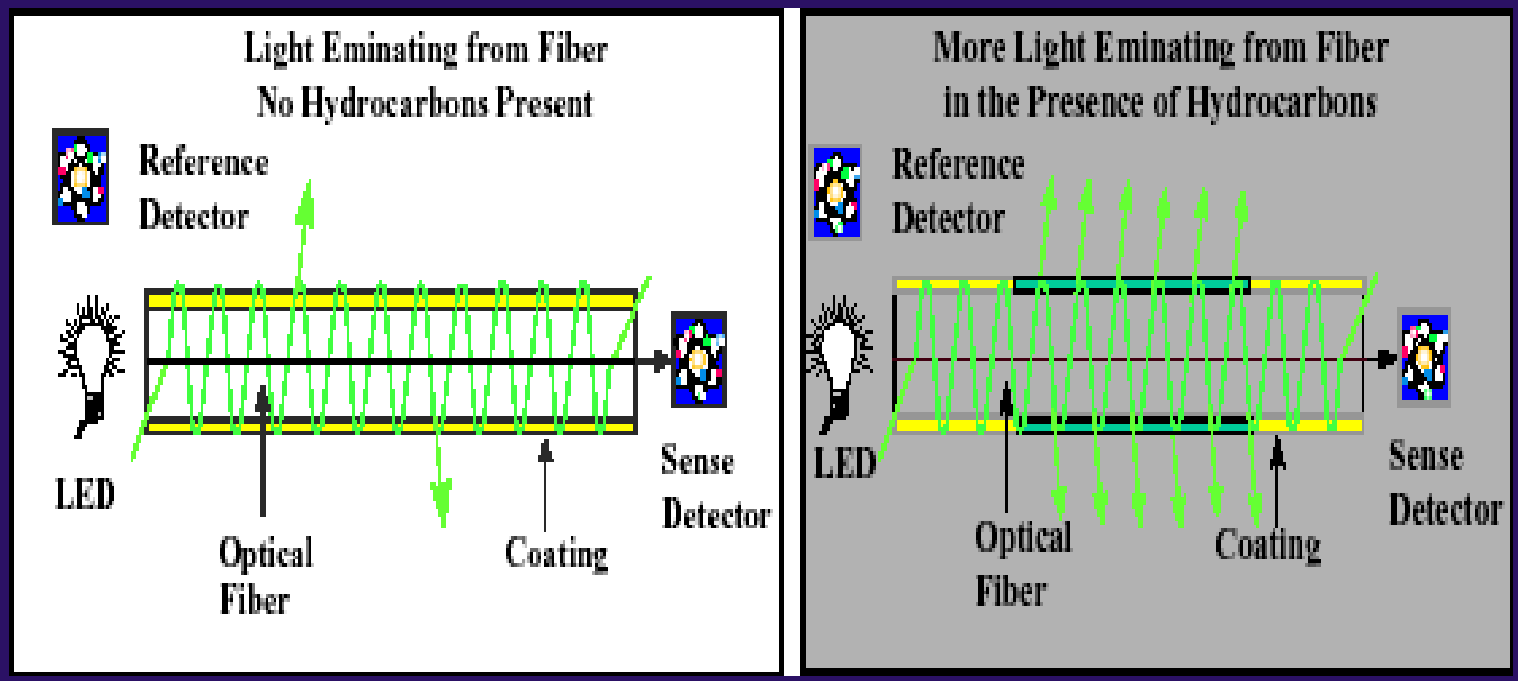
Cable sensor Change in Electrical properties

+ short fuel lines / sensitive area's.
- interference with CP-system



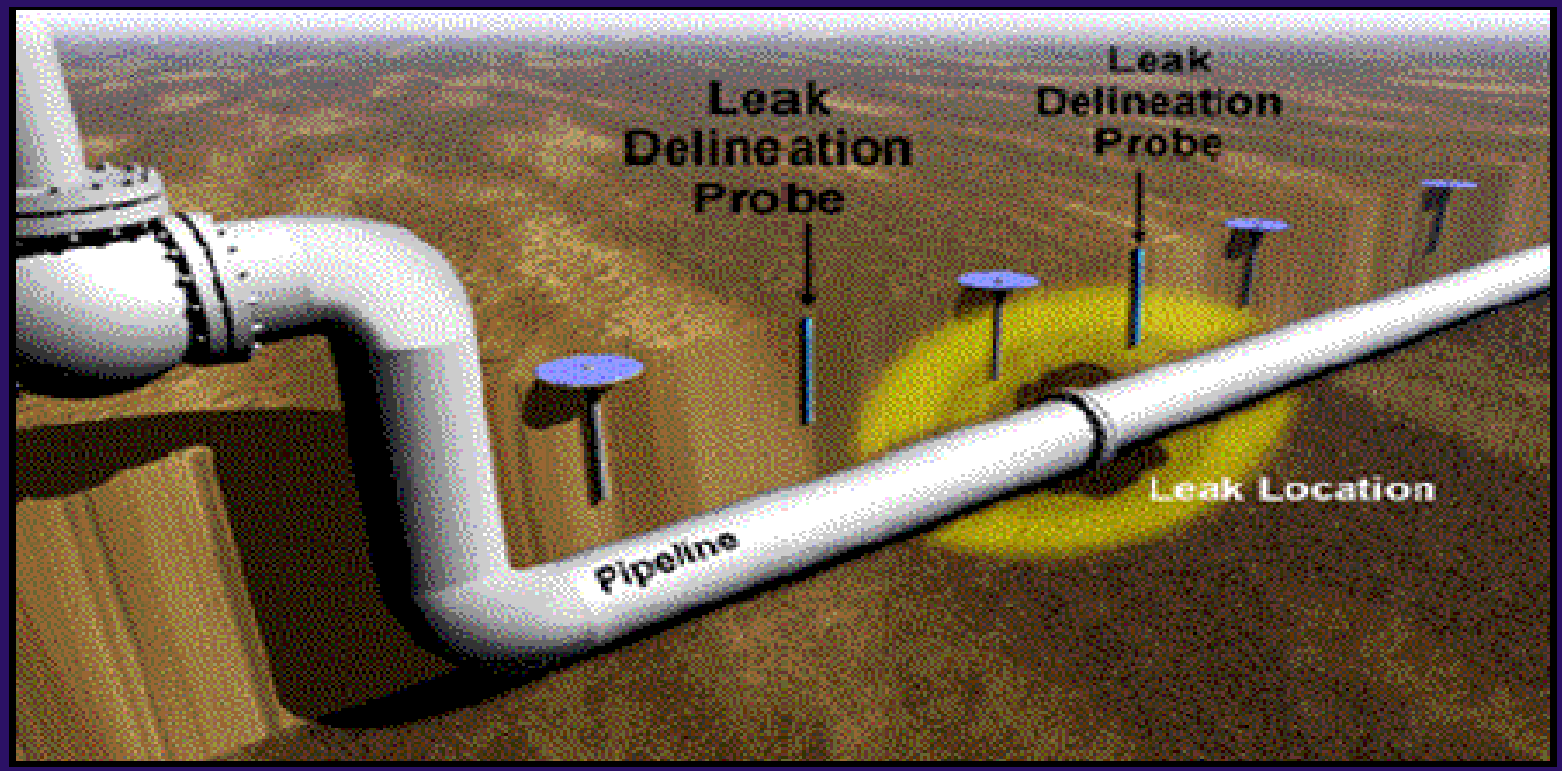
Fiber optic detect on temperature change / micro bends / chemicals

+ promising new technolgy
+ exact locations
- limited experience



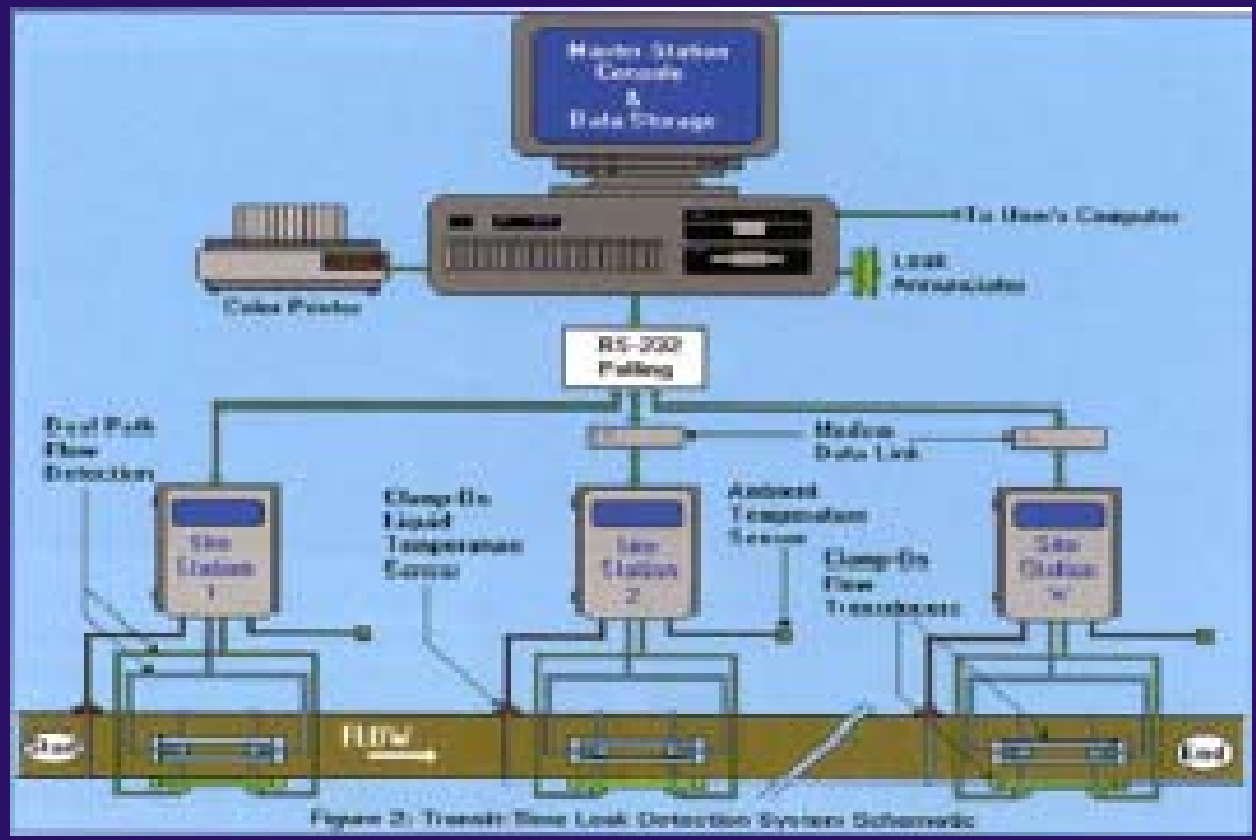
Soil monitoring addition of tracer in product

- high cost
- short pipelines
+ independent from flow

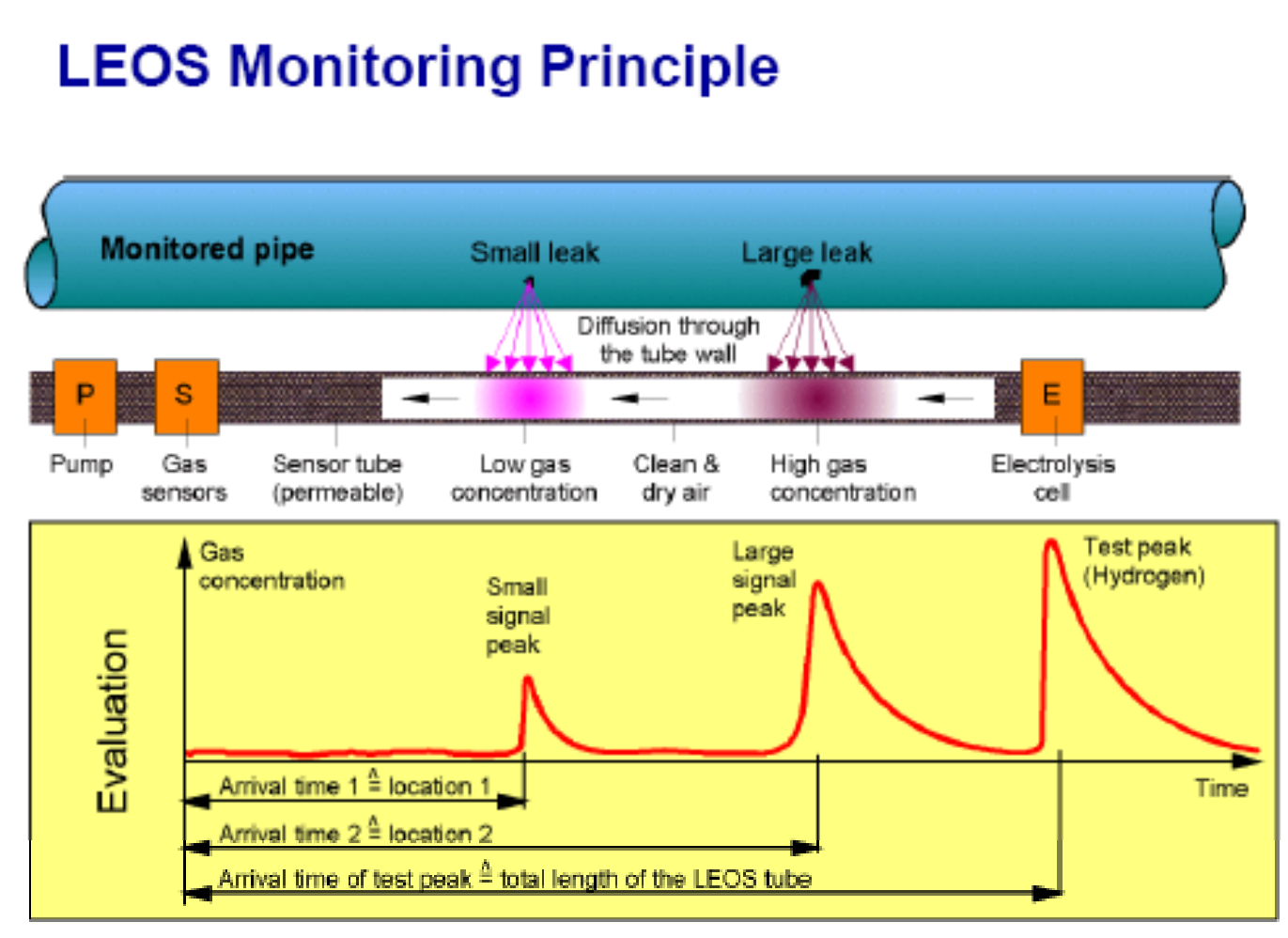


Ultrasonic flow meters clamp on. Overall volume balancing.

+ fast detection of large leaks
- little field experience



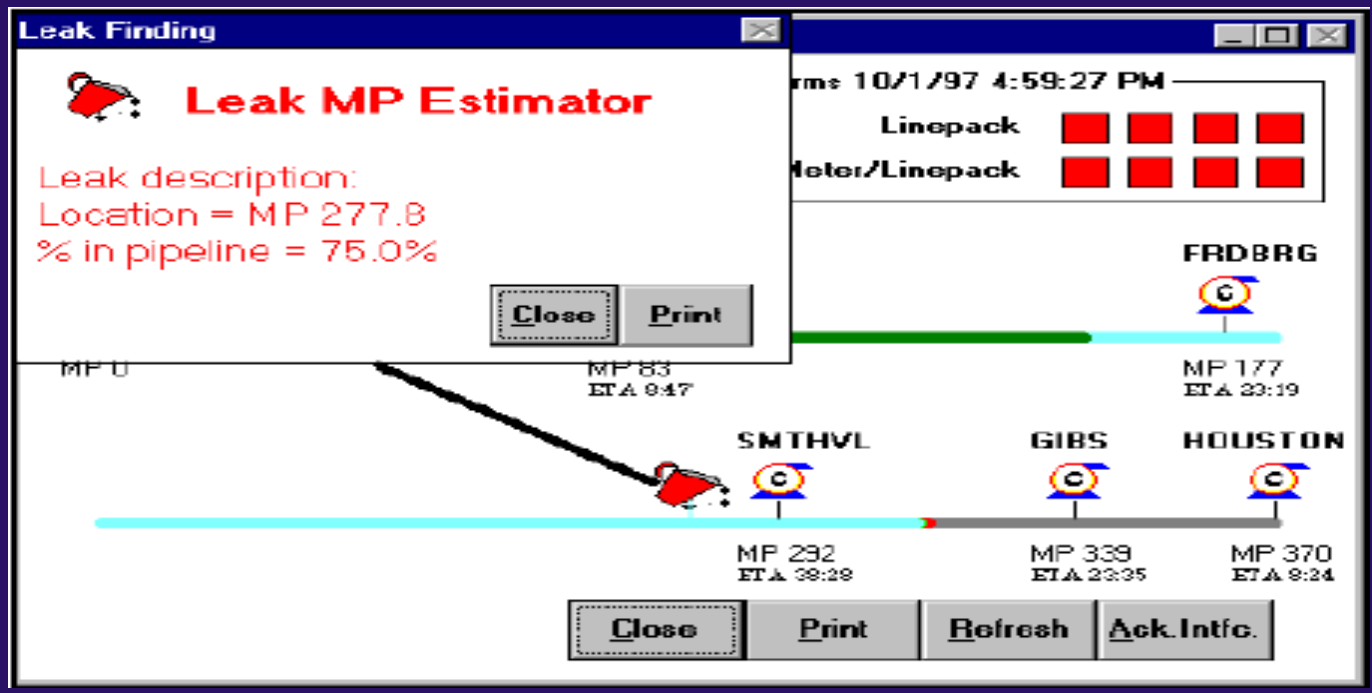
Vapor Monitoring gasdetection via reference gas (H2) and analysers



+ high sensitive
- slow detection
- high costs (short lines)

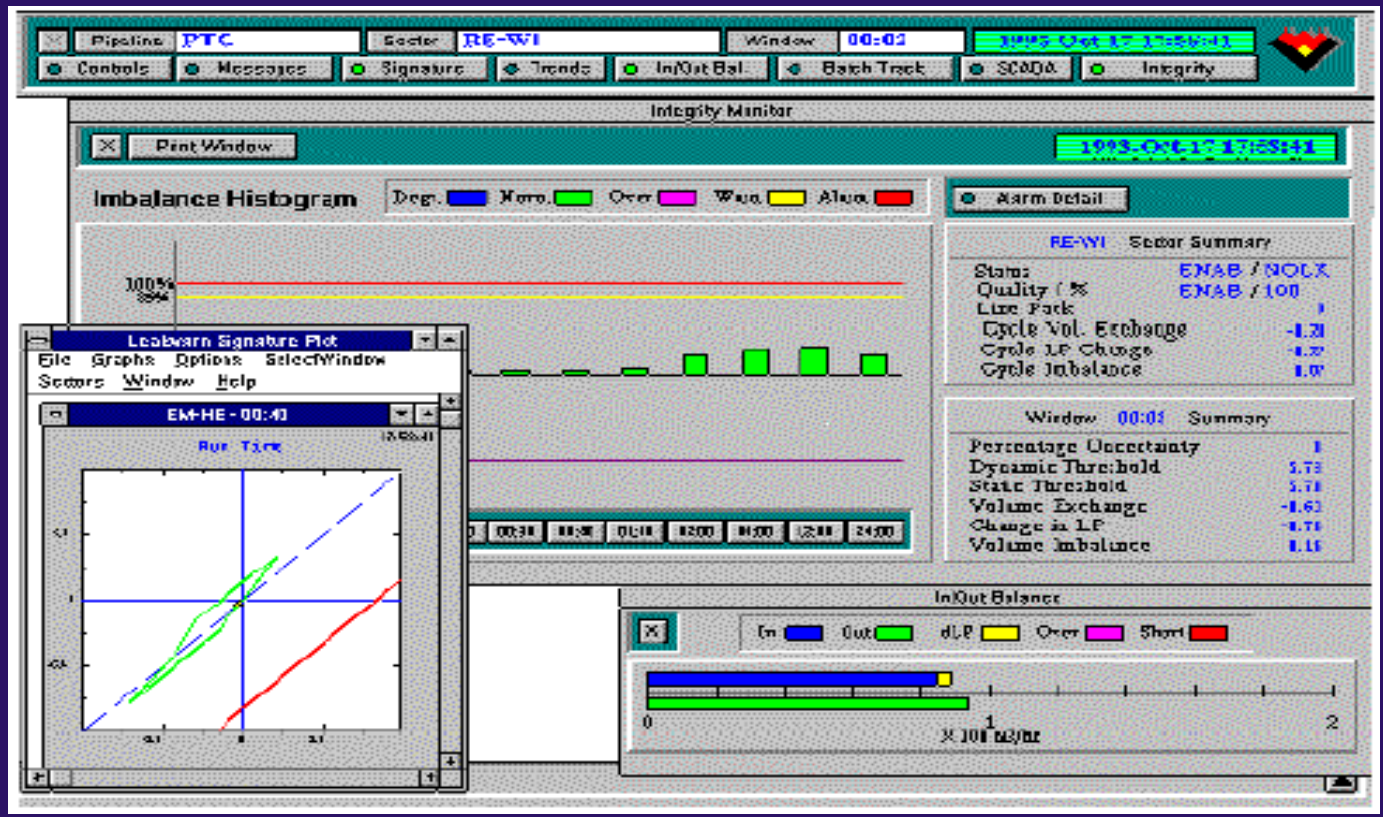
Mass balance $(M_{in} - M_{out})/M_{in}$ or $(F_{in} - F_{out})/F_{in}$

+ generally accepted
+ simple
+ no extra hardware
- not sensitive during transients
- requires accurate flow sensors
- no leak location



Real Time Model Mass, momentum, energy and equation of state. Calculation is compared with measured values.

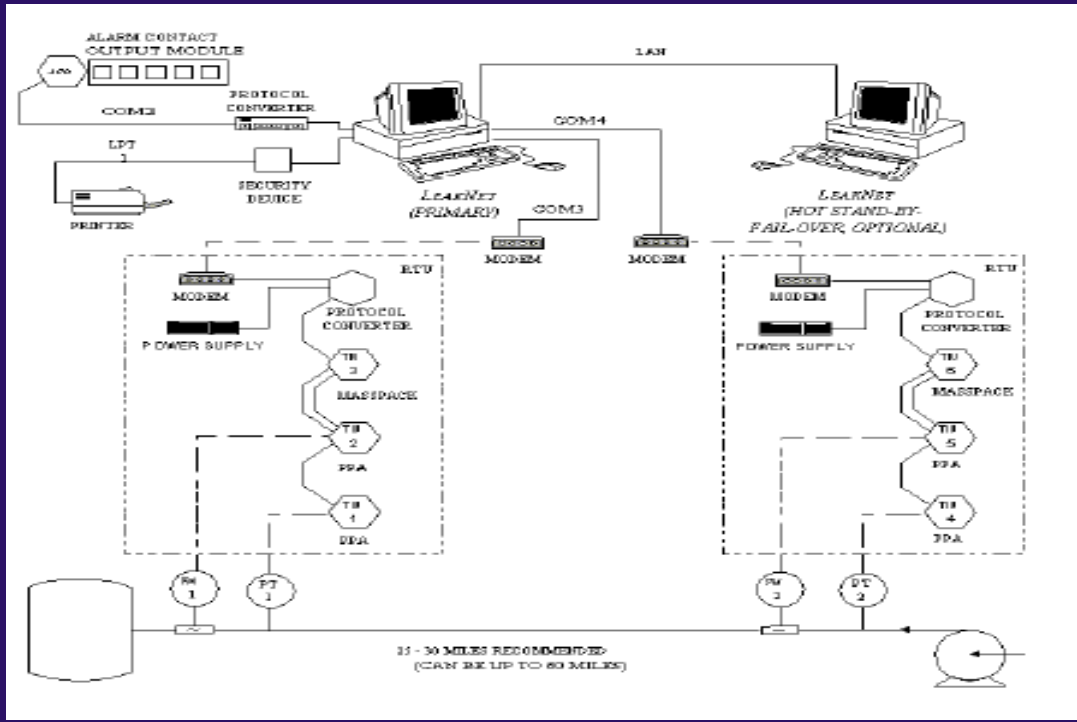
+ compensates for linepacking
+ false alarm suppression
+ detects leaks < 1%
- very expensive (HW, SW, Tuning)
- high complexity, trained users!



Pressure point analyses

Statistical interpretation of pressure and flow conditions
Network / blocked sections

- **+ Accepted technology**
- **+ less tuning / modelling than RTM**
- **+ existing instrumentation**
- **- limitations in transient / batch conditions**
- **- accuracy instrumentation**



Other and new developments

- **Pressure-wave detection with local pressure sensors**
  (fast, large leaks, exact location, limited experience)

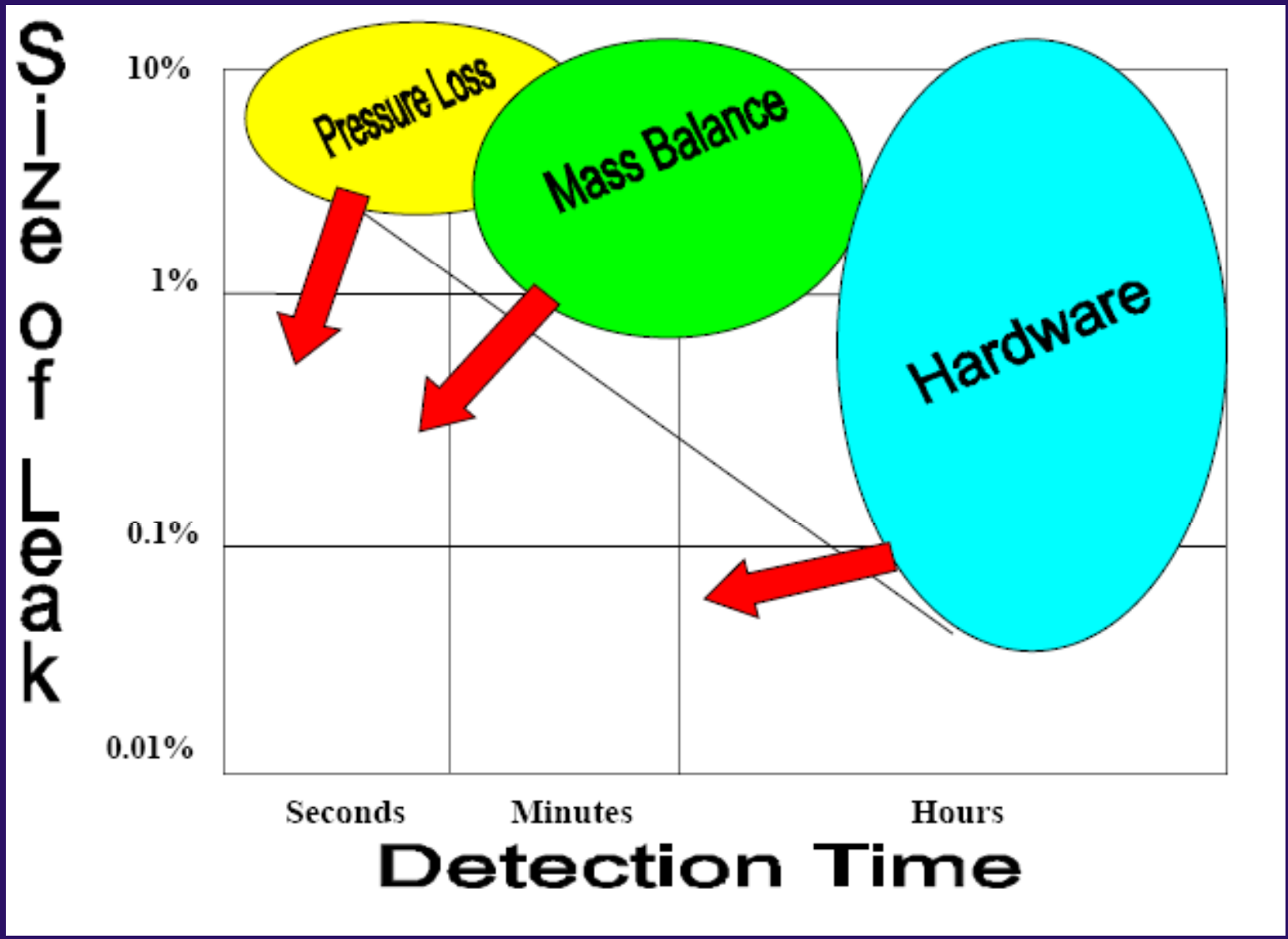
- **Ultrasonic Pig**
  Accurate on small leaks , batchwise

- **Sniffer dogs**
  Little experience (Belgium)

- **Air surveillance**
  - **Airborne Radar, Ultra violet, Infrared, high Resolution reconnaissance photography. Proven technology**

- **Satellite High Res photography**
  - **Not proven, whether dependent**

- **Artificial Neural Networks**
  - **New. Handles transients. Promising.**


Size of Leak
10%
1%
0.1%
0.01%
Pressure Loss
Mass Balance
Hardware
Seconds
Minutes
Hours
Detection Time

Limitations on Leak detection systems

- Complexity of the pipeline operation (single flow, single product, multi flow, multi product, reverse operation)
- Availability and accuracy of measurements (flow, pressure, product)
- Product / pipeline changes
- Acceptance by operators

BETTER TO PREVENT LEAKS

then

LEAKS to DETECT !!