

## Project Results – Part 2

# Source identification module

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# Source Identification:

## PROBLEM DESCRIPTION

### Objective:

Find the location of contaminant intrusion based on sensor alarms

### Challenges:

- Inverse Problem:
  - difficult to solve
  - no unique solution
- Real-time

### Solution approaches:

- Particle backtracking
- Adjoint method

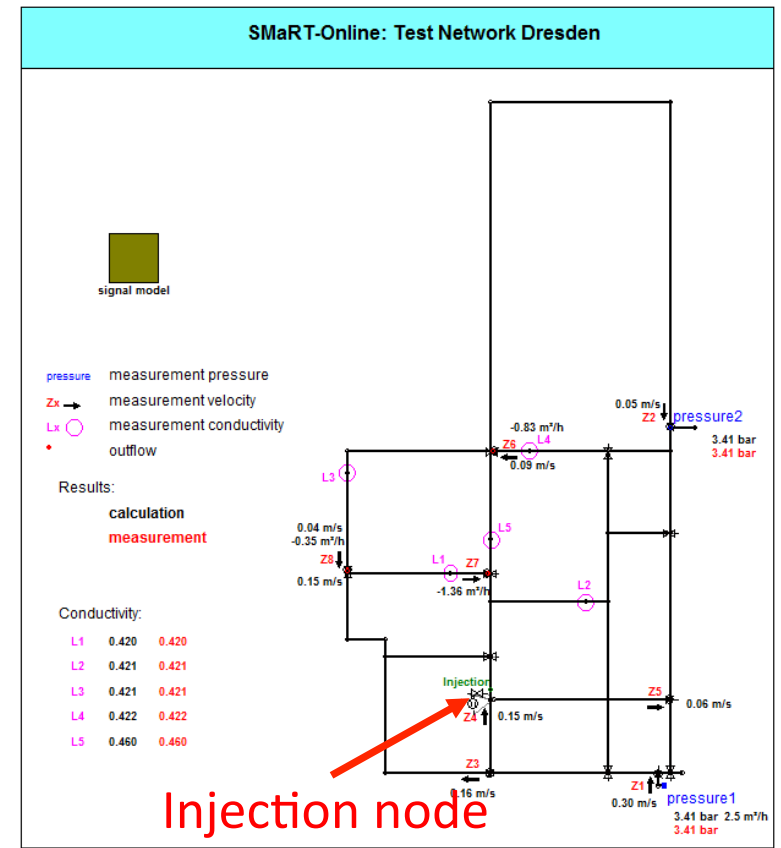


# Contamination event and source identification

## SCENARIO DESCRIPTION

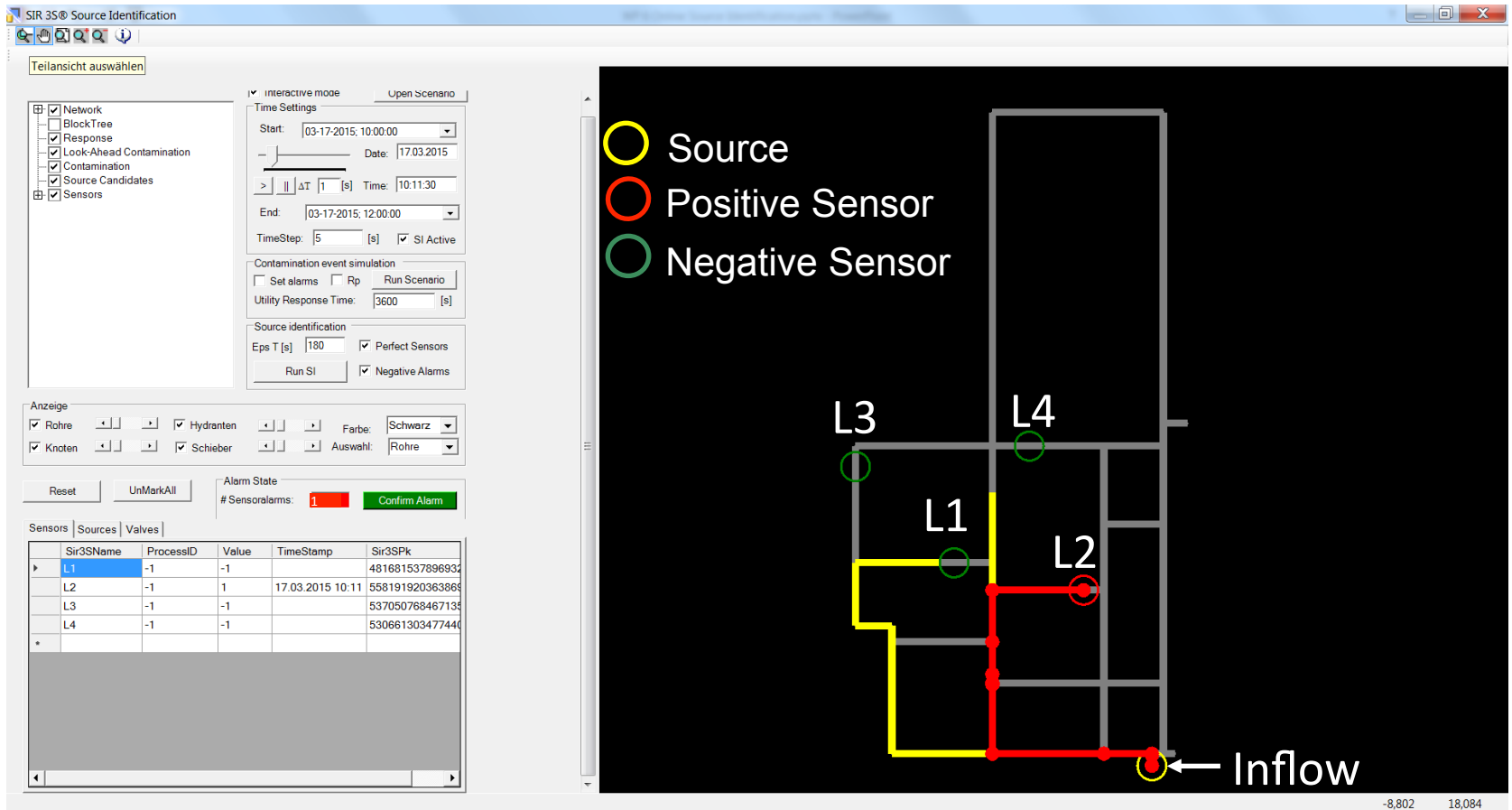
### Contamination Scenario

- Injection node: „Injection“
- Start Time: 10:10
- End Time: 10:20
- Four Sensors L1, L2, L3, L4.



# Contamination event and source identification

## FIRST ALARM AT SENSOR L2

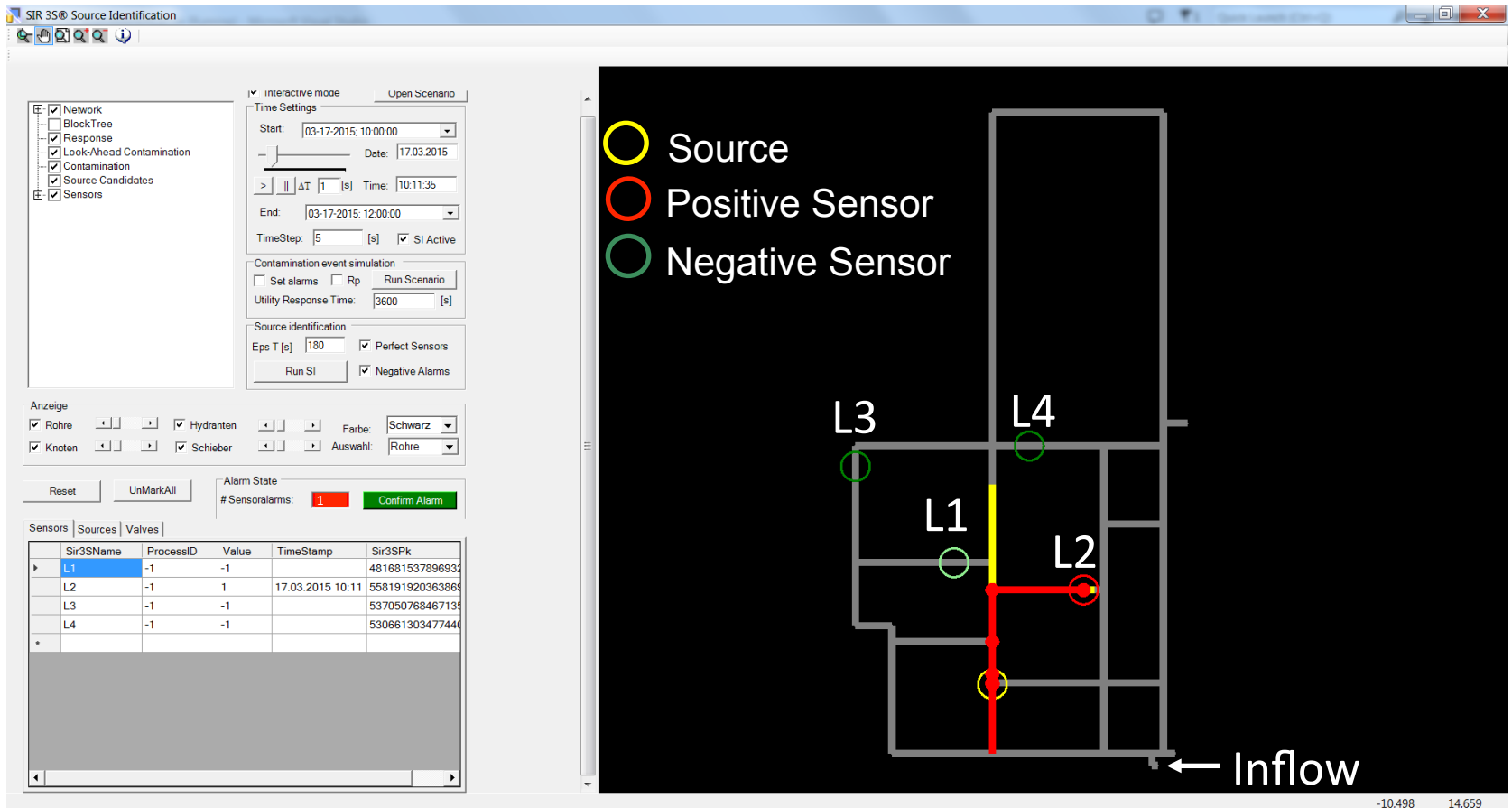


source candidates

spread of contamination based on assumed source location

# Contamination event and source identification

## NEGATIVE ALARM AT SENSOR L1

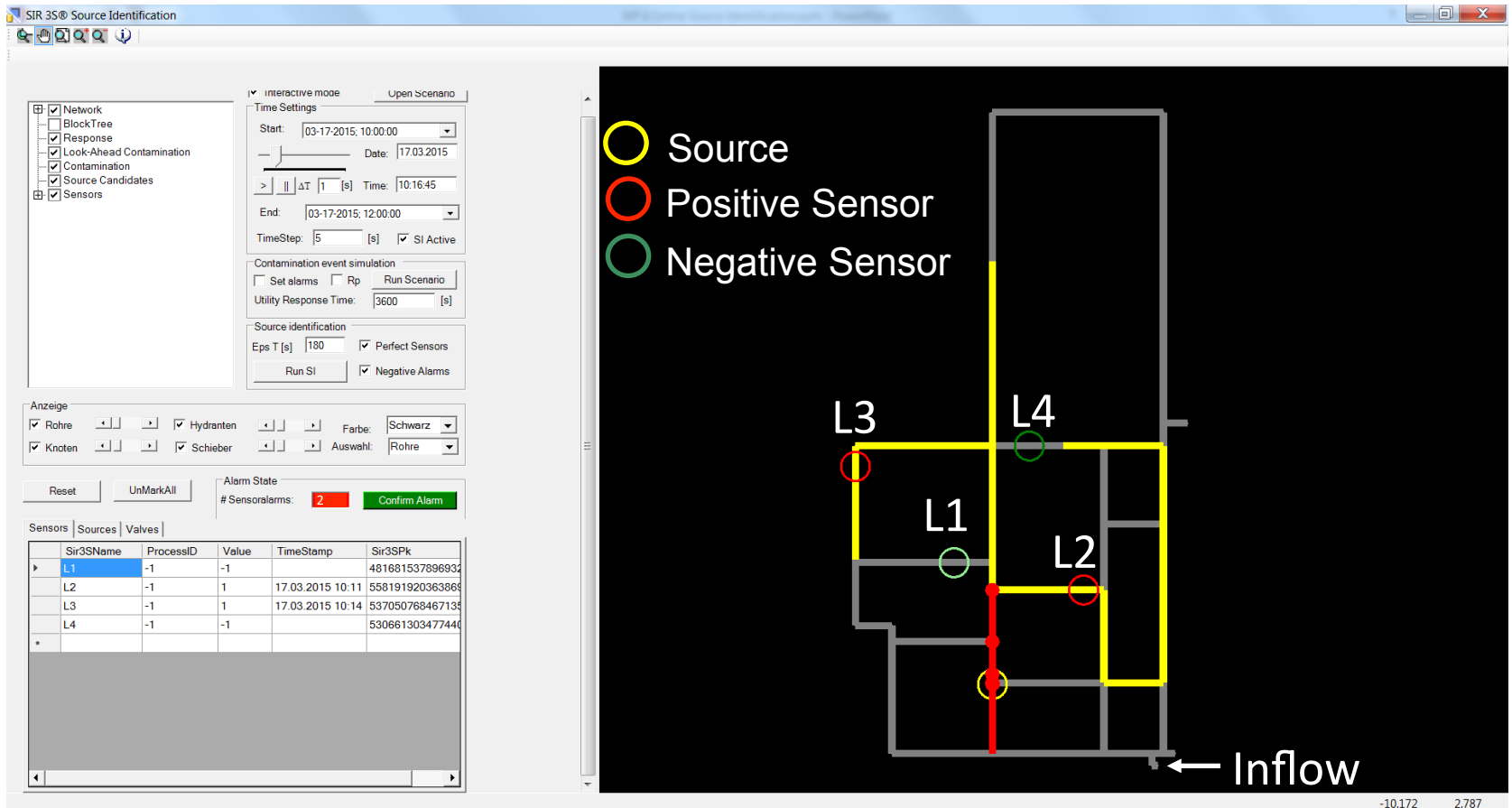


source candidates

spread of contamination based on assumed source location

# Contamination event and source identification

## SECOND POSITIVE ALARM AT SENSOR L3

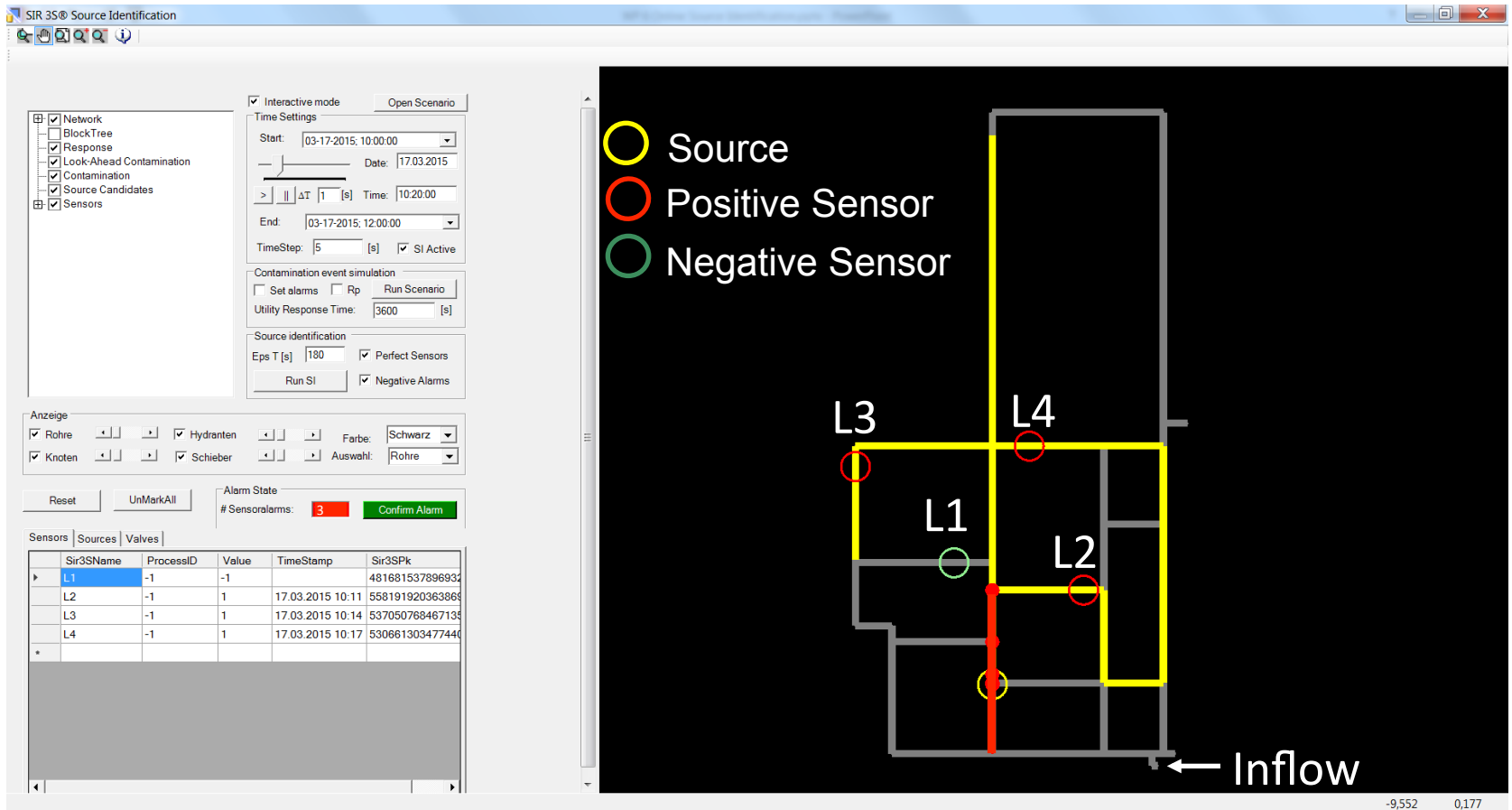


source candidates

spread of contamination based on assumed source location

# Contamination event and source identification

## END OF CONTAMINATION

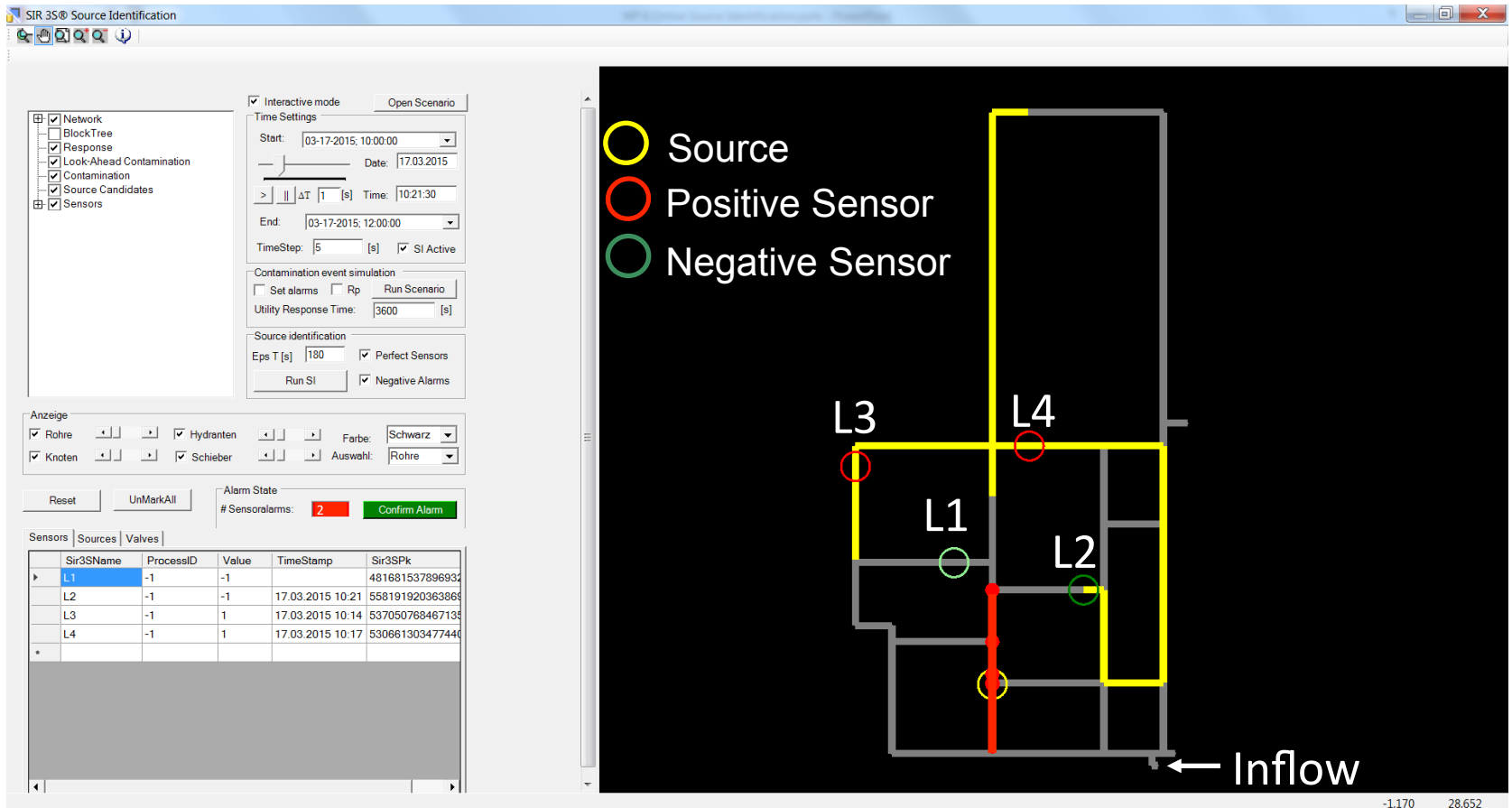


source candidates

spread of contamination based on assumed source location

# Contamination event and source identification

CLEAN WATER FRONT REACHED SENSOR L2



source candidates

spread of contamination based on assumed source location





# Real world application example

BWB LARGE NETWORK

## Injection on main pipe

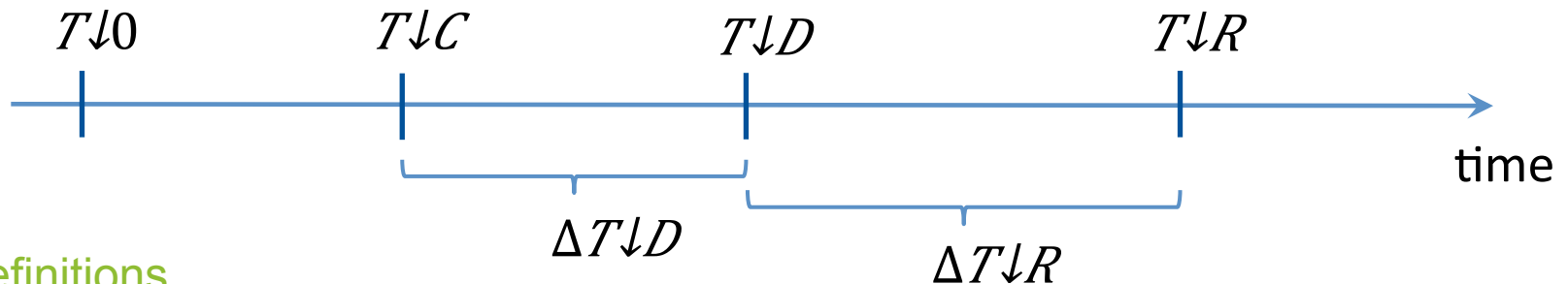
- 24 hours duration
- 1.800 km pipe length
- 36.000 pipes in model
- 22.500 valves

# Response to contamination event

## TIMING

### Time bar in case of an event

#### a) Definition of different points in time of an event



#### Definitions

- $T\downarrow 0$  : scenario start time (begin of observation)
- $T\downarrow C$  : start time of contamination (unknown)
- $T\downarrow D$  : detection time (time of evidence of contamination)
- $T\downarrow R$  : time of reaction (utility is ready to react)
- $\Delta T\downarrow D$  : time to detection (dependent on sensor network)
- $\Delta T\downarrow R$  : response time (time interval that utility needs to react)

# Identification of Isolation Valves

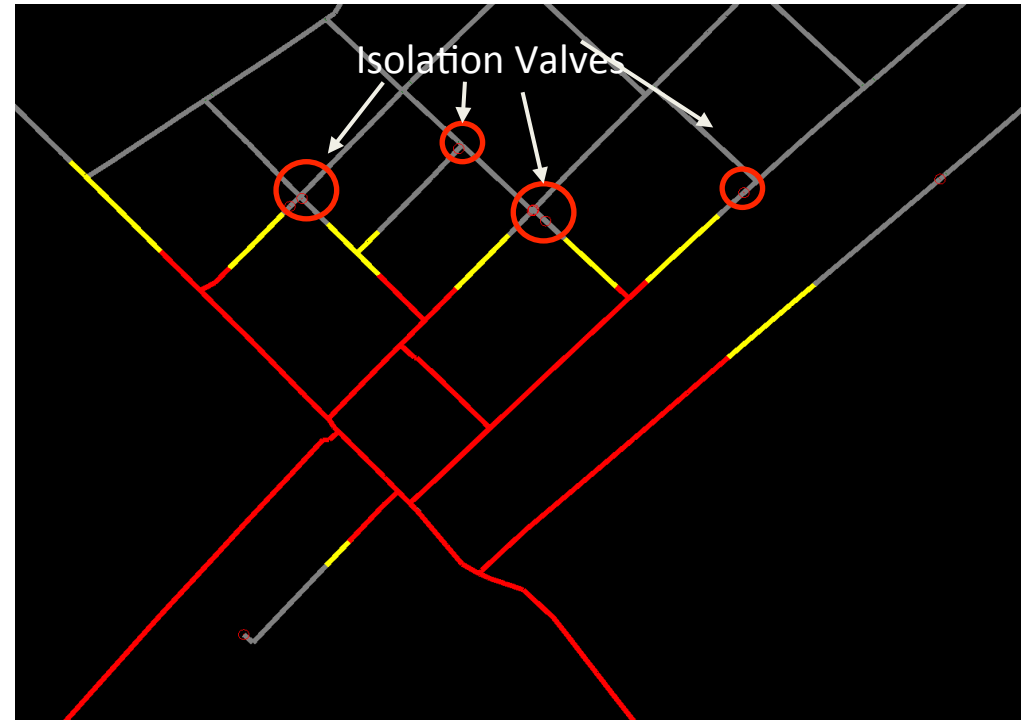
## RESULTS OUTPUT

At every time step, a look ahead calculation of the spread of contaminant at the earliest response time is carried out.

### Output:

List of valves (sorted by contamination time):

Sensors	Sources	Valves				
	StreetName	ArrivalTime	X-Coor	Y-Coor	Sir3SPk	
▶	Lindenberger Weg	09.07.2010 08:49	31671,42	33850,09	521235025	
	Hörstenweg	09.07.2010 08:51	31240,62	35169,92	497010552	
	Wilbergstrasse	09.07.2010 08:51	31285,19	34184,42	490226075	
	Robert-Rössle-Strasse	09.07.2010 08:55	31392,68	33455,57	487452726	
	Karower Chaussee	09.07.2010 08:55	31377,63	33494,48	570642949	
	Robert-Rössle-Strasse	09.07.2010 08:58	31383,38	33490,12	501715409	
	Schwanebecker Chaussee	09.07.2010 09:02	31947,74	34293,98	484988172	
	Bruno-Apitz-Strasse	09.07.2010 09:02	31052,53	33470,09	461330728	
	Viereckweg	09.07.2010 09:04	31669,56	35183,59	566847343	
	Uhlenweg	09.07.2010 09:05	31482,04	35155,45	486642387	
	Wolfgang-Heinz-Strasse	09.07.2010 09:07	31127,15	33619,74	541170506	



Contamination at current time  
Contamination at response time  
(look ahead)



## Summary and Conclusions

- Real-time source identification method has been developed and implemented.
- It is integrated in the SIR OPC 9 online framework.
- Look-ahead simulation of contaminant transport from identified source shows affected area.
- For supporting response actions and mitigation the valves to close are identified.
- In case of no alarm the application shows the current monitoring state of the network.



Thank you for your attention  
Any questions?

<http://SMaRT-OnlineWDN.eu>