

Development of a “probability” approach to determine water and colloidal pollutant flow behavior in urban heterogeneous soils

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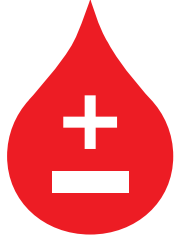
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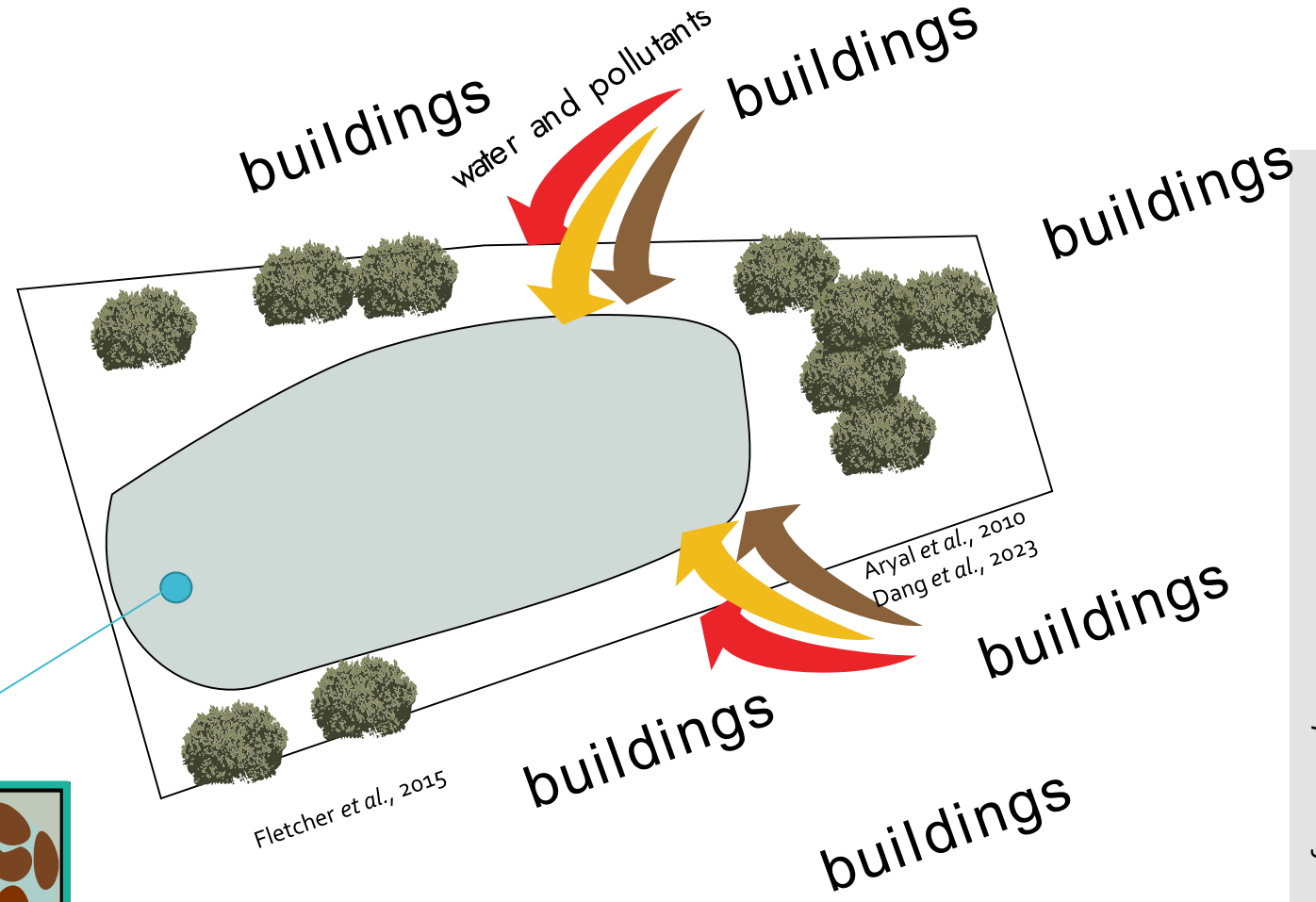
(d) Univ Lyon Université Claude Bernard Lyon 1, CNRS, Institut Lumière Matière, LYON, France



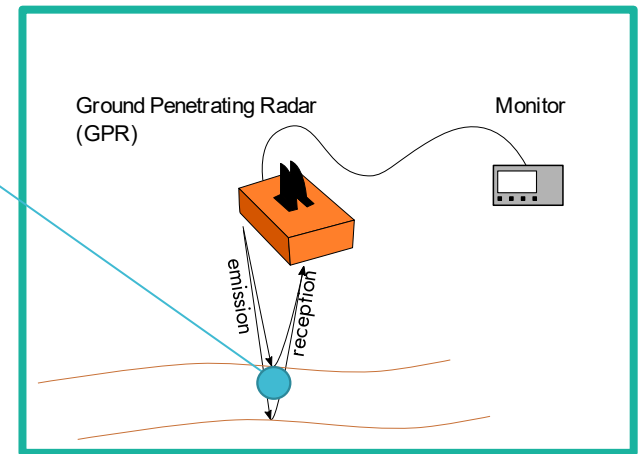
Context and introduction



Bressy *et al.*, 2014

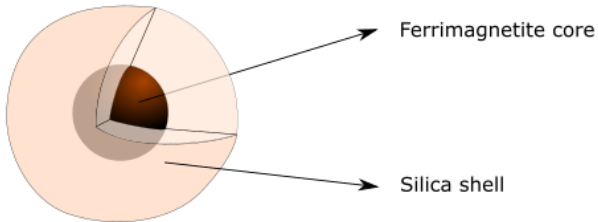
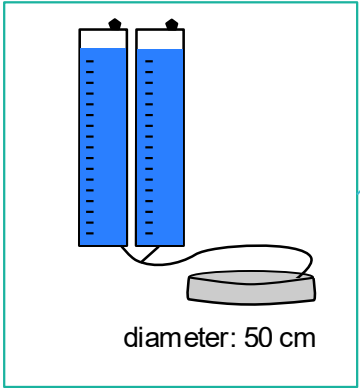
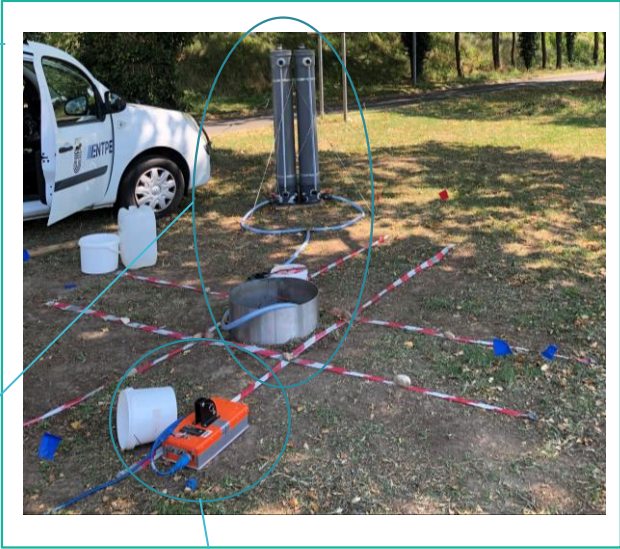
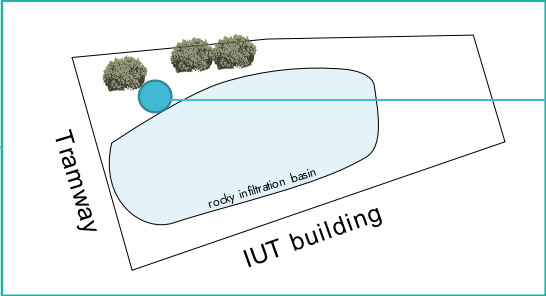


Ben Slimene *et al.*, 2017

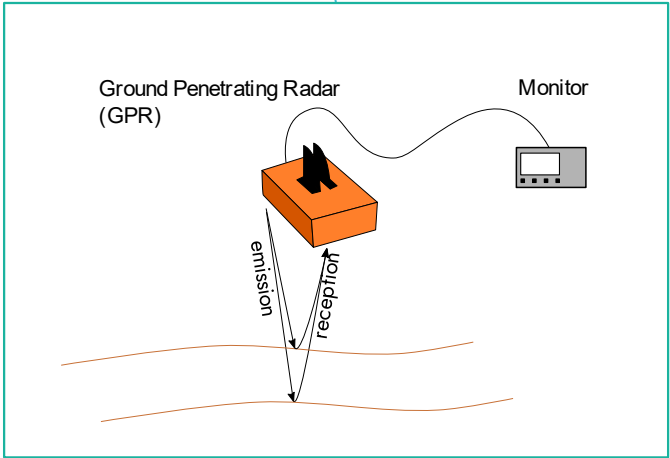


Di Prima *et al.*, 2020
Truss *et al.*, 2007
Allroggen and Tronicke, 2015

Material

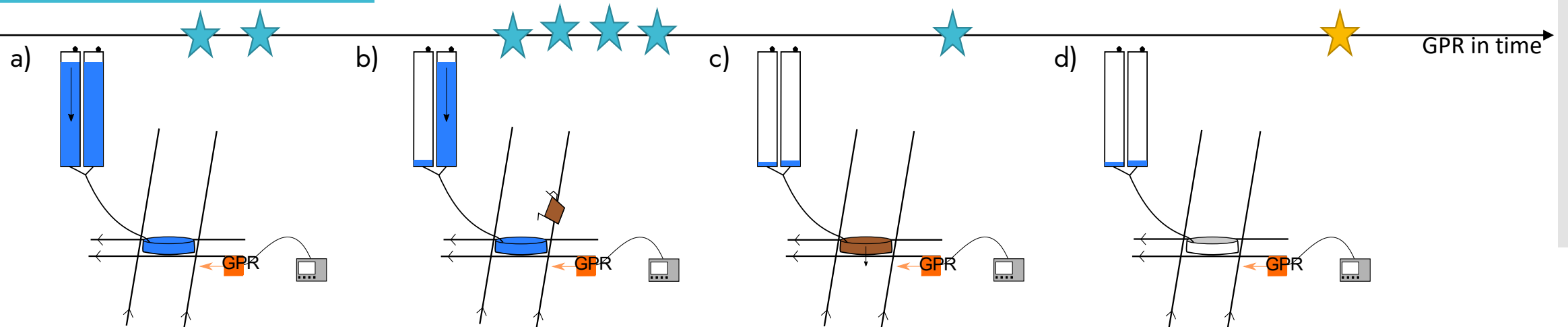


SPIONs
Superparamagnetic Iron Oxide Nanoparticles
Diameter: 20-80 nm



Methods on the field

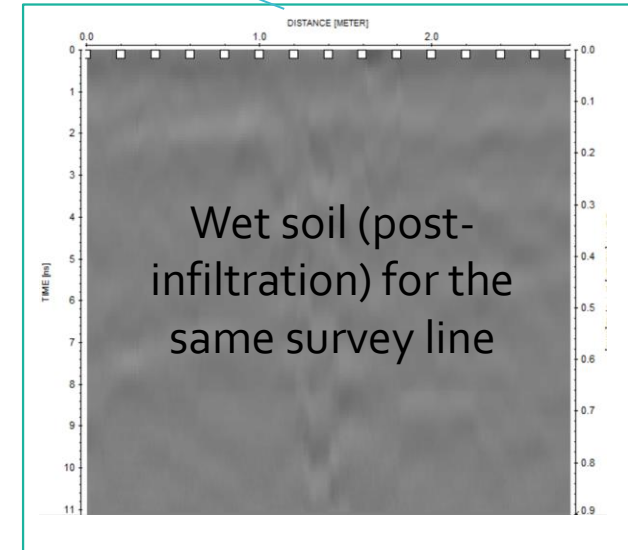
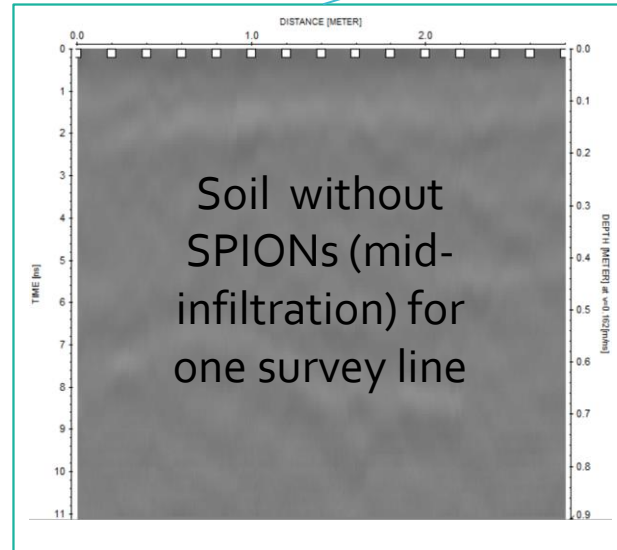
1. Put plastic inside the ring to avoid infiltration
2. Fill the reservoirs and ring with water
3. Follow the survey lines with the GPR, then start infiltration (a)
4. Open the second reservoir and begin to pour the SPIONs (b)
5. Wait for ring infiltration (c)
6. Follow again the survey lines with the GPR again (d)



Treatment methods

1. Filters: normalization, gains, reducing noises

Software: ReflexW



Method 1: structural similarity (Allroggen et Tronicke 2015)

- Function applied following a moving window

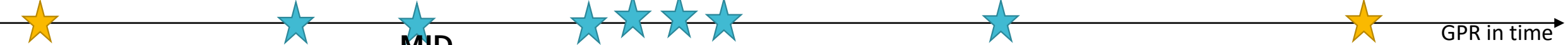
$$SS(x, y) = \frac{c_{xy} + a}{\sigma_x \sigma_y + a}$$

$$\text{with } c_{xy} = \frac{1}{N-1} \sum_{i=1}^N (x_i - \mu_x)(y_i - \mu_y)$$

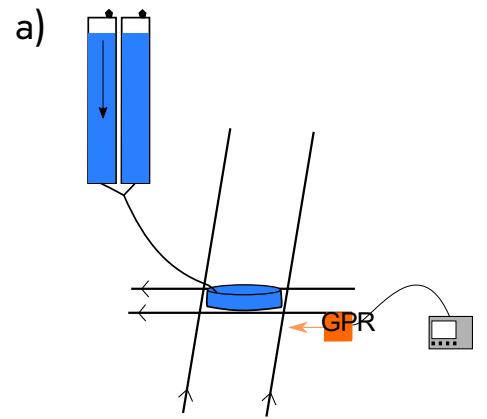
Method 2: standard deviation (Di Prima *et al.*, 2015)

- Difference between two radargrams
- Threshold chosen to visualize preferential flowpaths: 1.5*standard deviation (Di Prima *et al.*, 2015; Guo *et al.*, 2014)

Software: R

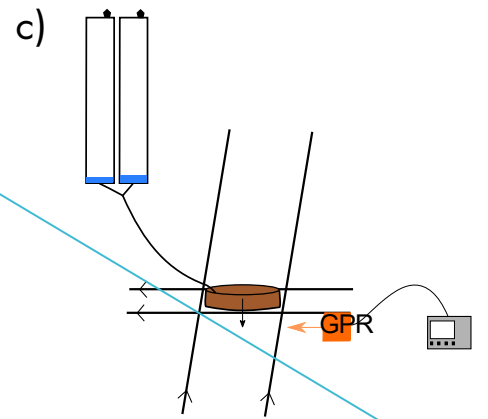
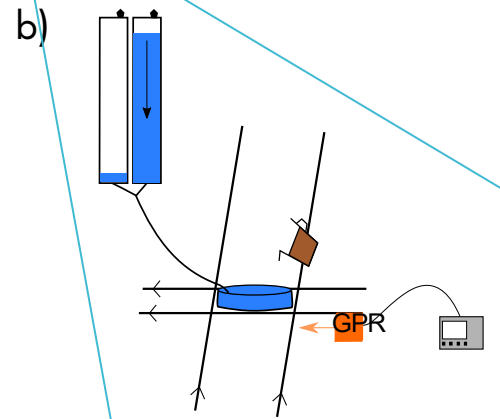


before

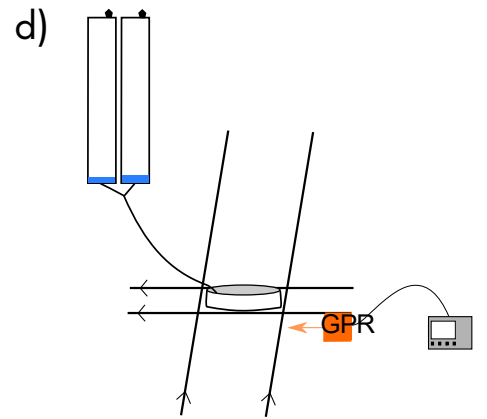


« MID-before » GPR data for water

after

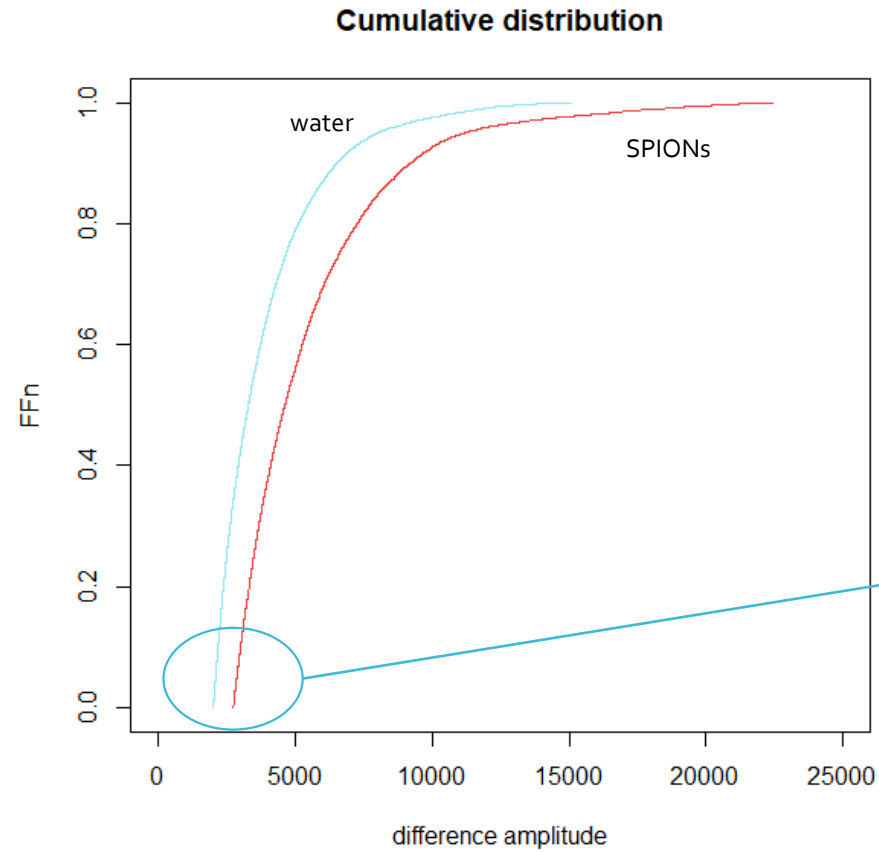


« after-MID » GPR data for SPIONs



Method 2: standard deviation (Di Prima *et al.*, 2015)
- Difference between two radargrams
- Threshold chosen to visualize preferential flowpaths: 1.5*standard deviation (Di Prima *et al.*, 2015; Guo *et al.*, 2014)
Software: R

Difference between water and SPIONs



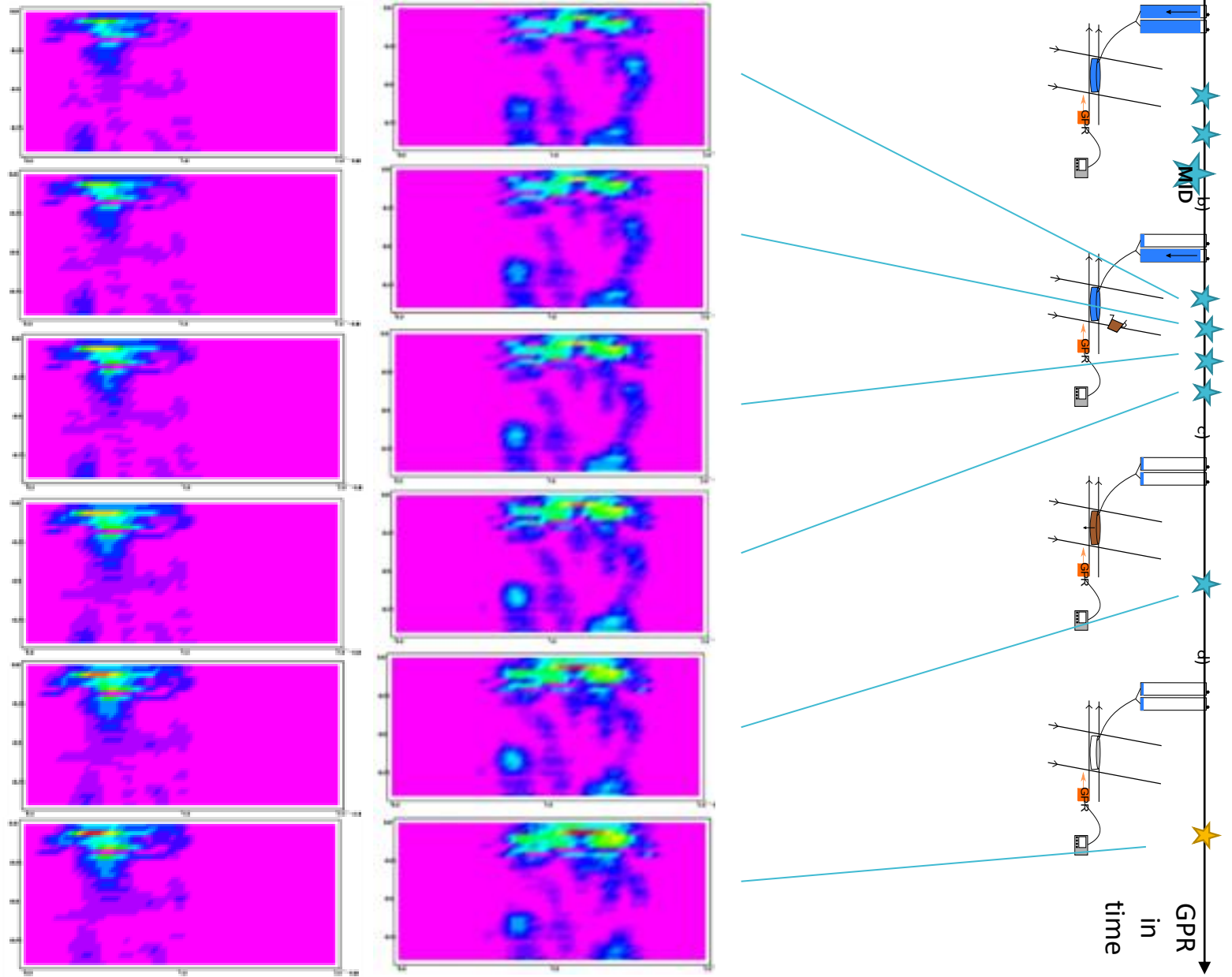
Signal higher for SPIONs: median significantly different (Kruskall $p < < 0.05$)

Different thresholds for water and SPIONs

2D SPIONs transfer visualization

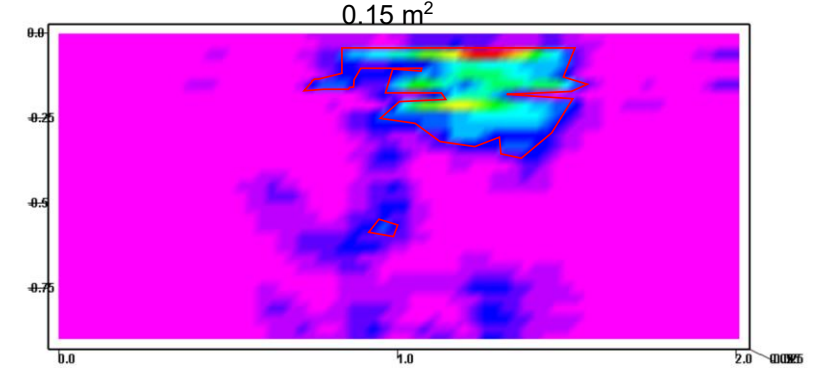
« *after-MID* » GPR data for SPIONs

2D visualization (one column represents one survey line during the same field test)

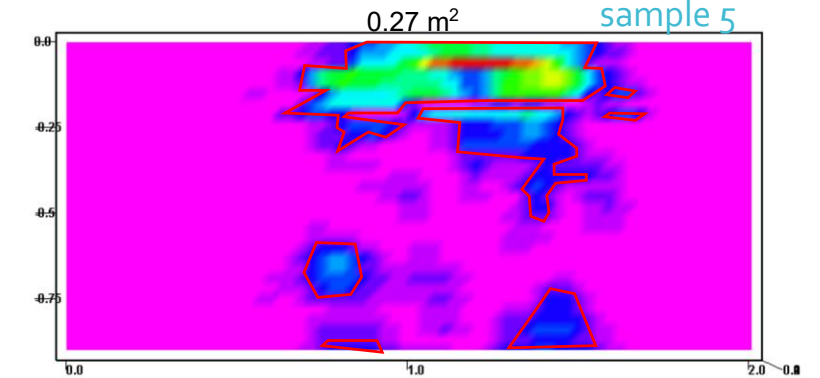


Samples	1	2	3	4	5
NTs occupation degree on X transect (%)	10.5	32.4	11.2	28	12.2
NTs occupation degree on Y transect (%)	17.9	18	19.1	13.7	15
Surface NTs/surface water for X transect	0.53	1.97	0.74	7.29	1.16
Surface NTs/surface water for Y transect	2.27	1.89	1.42	2.50	1.80

Table with indicators for nanotracers (NTs) characterization



2D visualization of water on one X survey line – sample 5



2D visualization of SPIONs on the same X survey line – sample 5

Development of indicators for flow and nano-pollutant transfer

First conclusions and further studies

Conclusions:

- Water & nanotracers visualization in time and space with GPR
- First versions of indicators for the assessment of infiltration and filtration functions

Further studies:

- Need to improve reproducibility for GPR
- Optimization of SPIONs concentration



Thank you!

Don't hesitate to
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