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Numerical study of the polarization effect of GPR systems on the detection of buried objects

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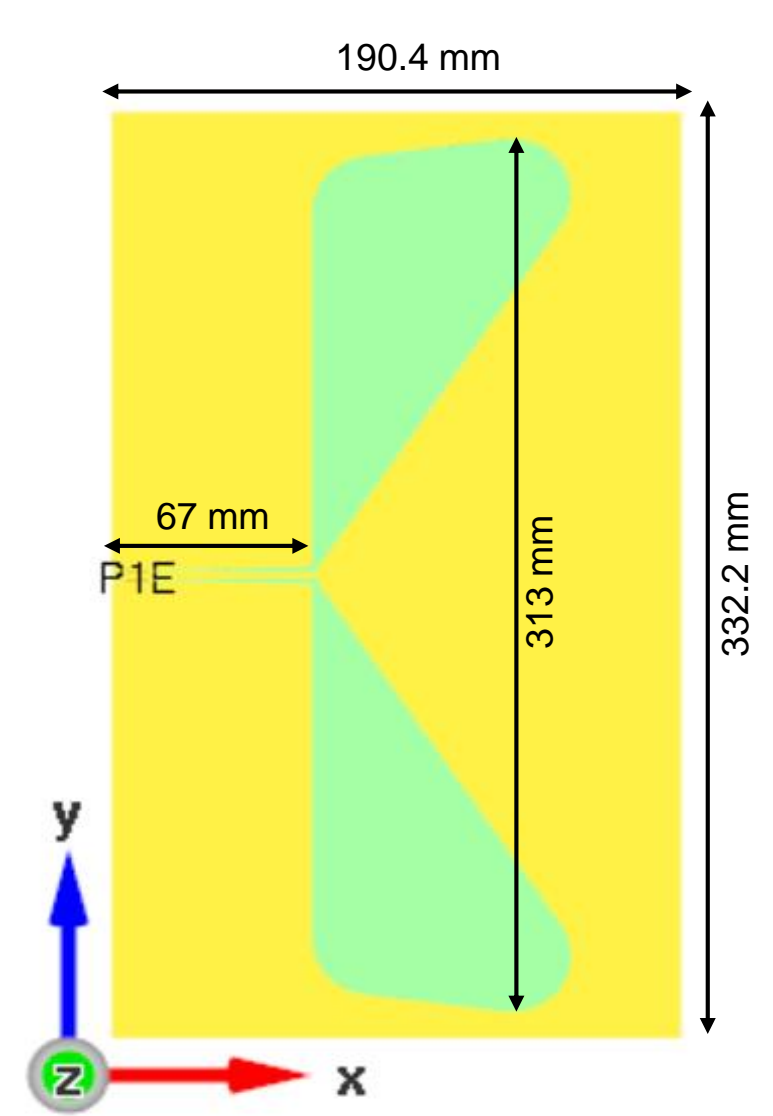
florence.sagnard@ifsttar.fr

Context

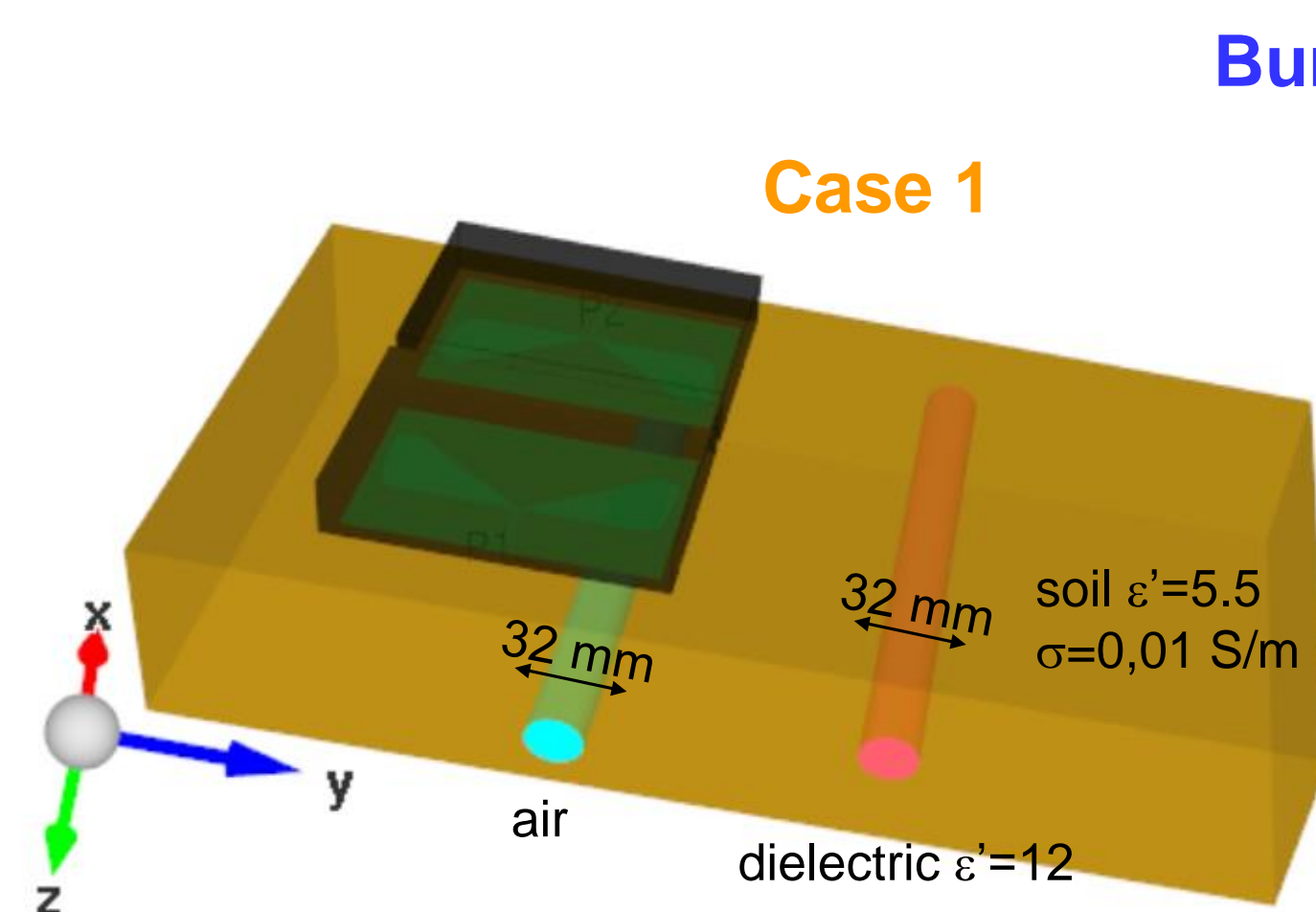
- Polarization is a fundamental property of propagation of electromagnetic waves that provides a unique opportunity for producing improved images of buried objects. It helps to discriminate different classes of objects and to estimate parameters such as the size, shape, orientation, and electrical properties of buried objects
- The definition of the GPR system and particularly the antenna geometry and the frequency band (UWB) contribute to provide images where information appears more accessible before applying pre-treatments
- Numerical simulations (FDTD and FIT) appear essential to study the polarization effects by means of a parametric study

Simulation scenarios (50 MHz-4 GHz)

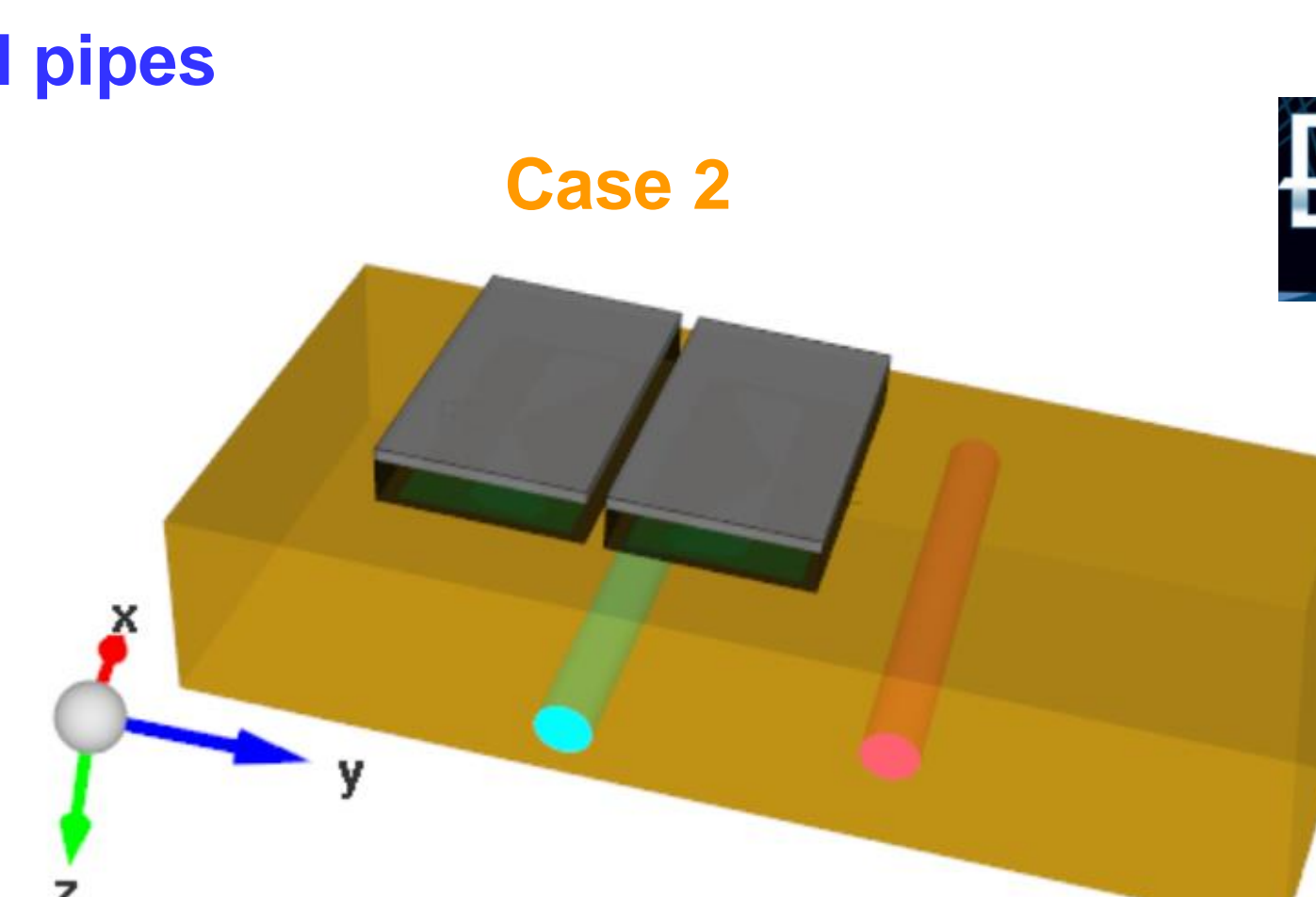
Bowtie slot antenna



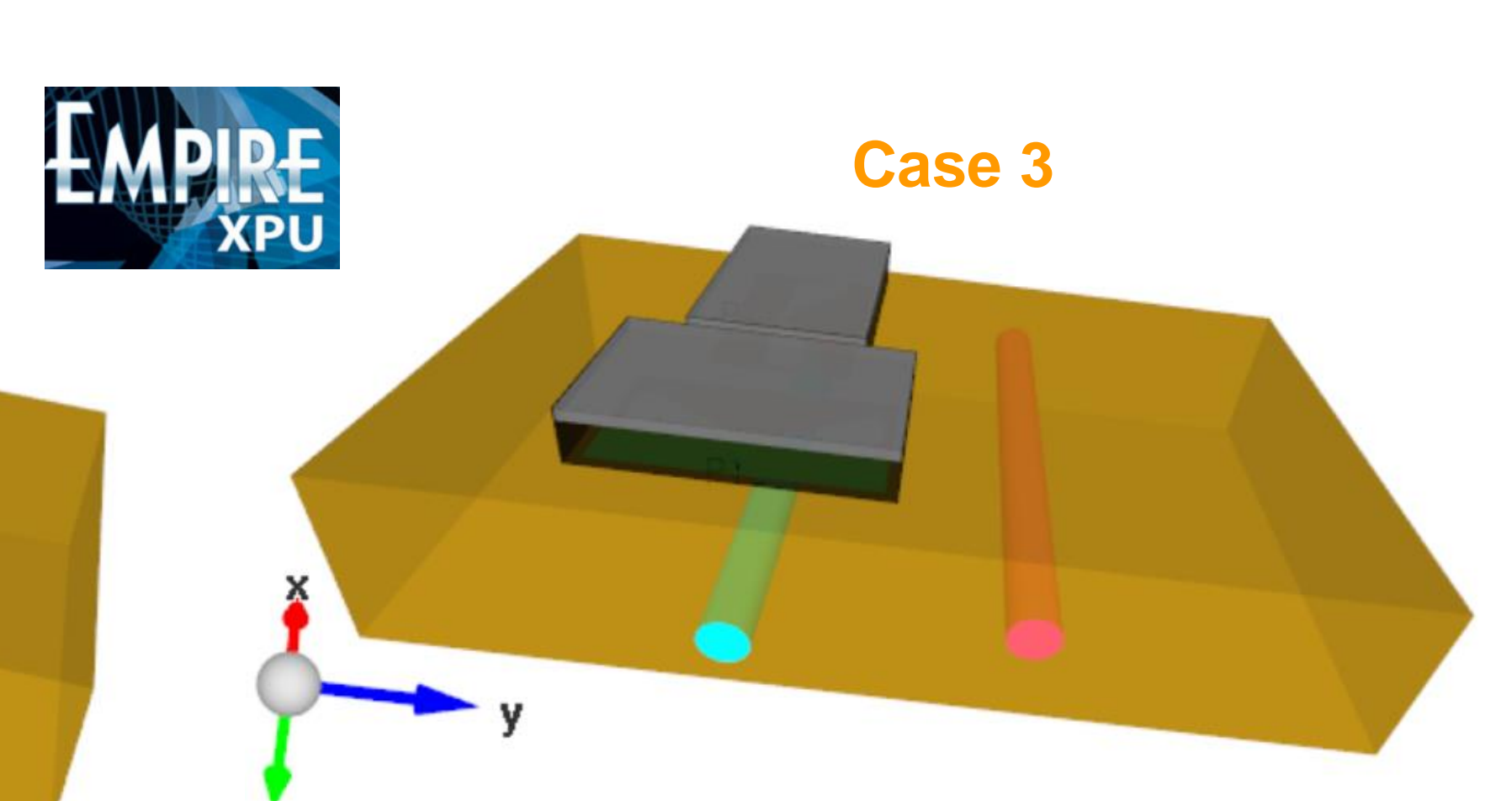
TM polarization



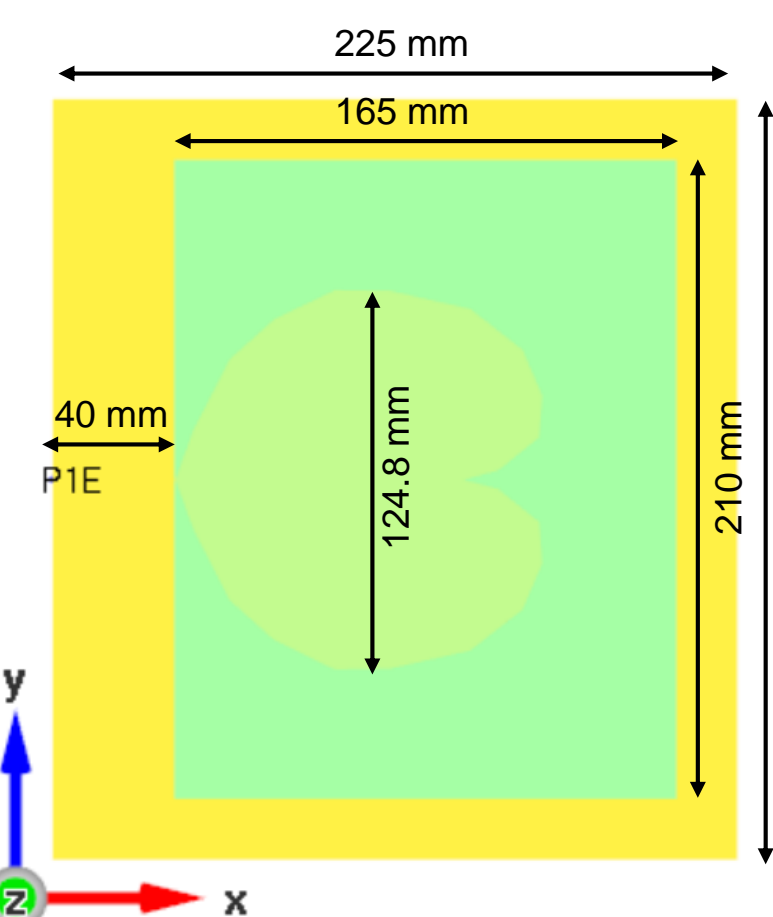
TE polarization



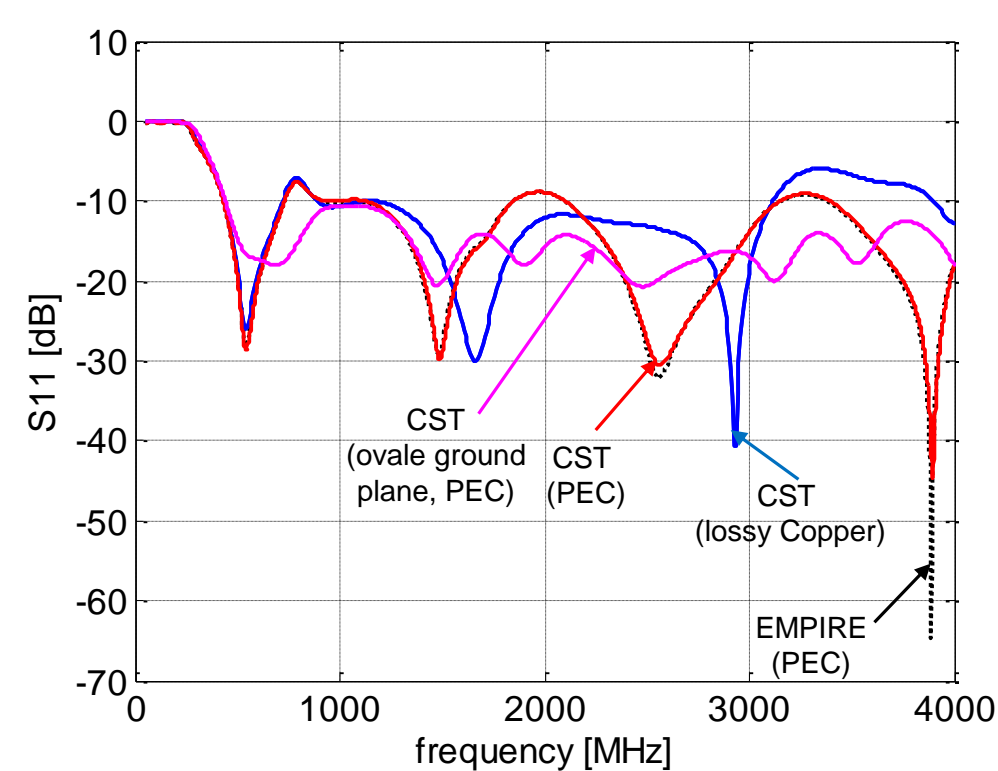
Cross polarization



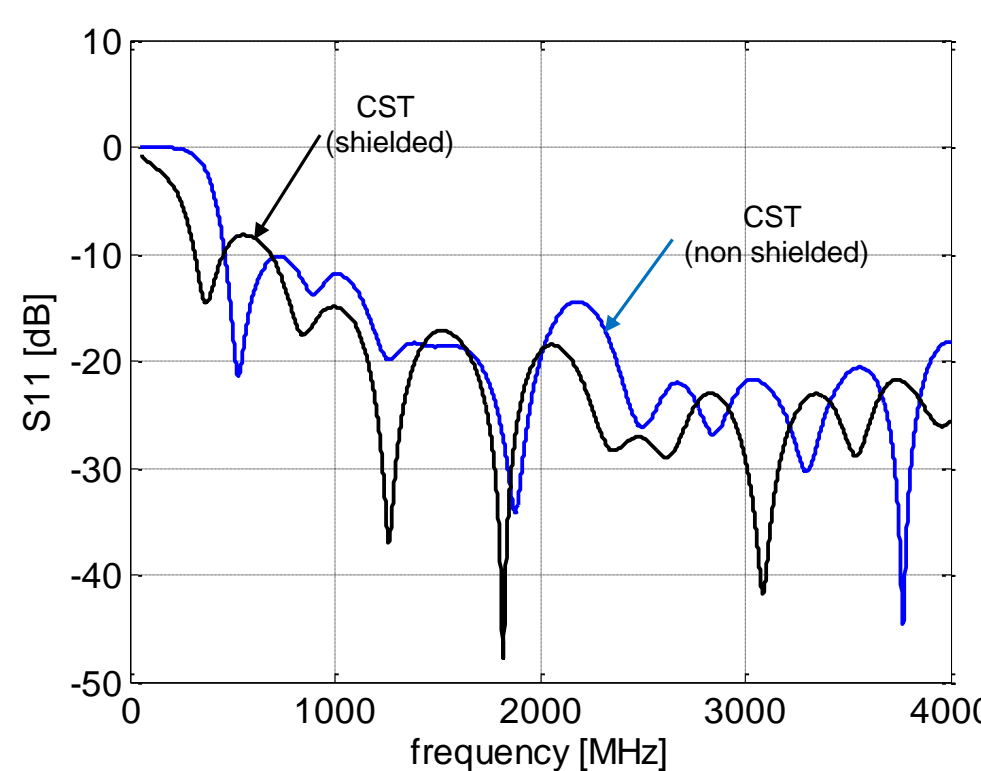
Leaf antenna : a novel compact antenna geometry



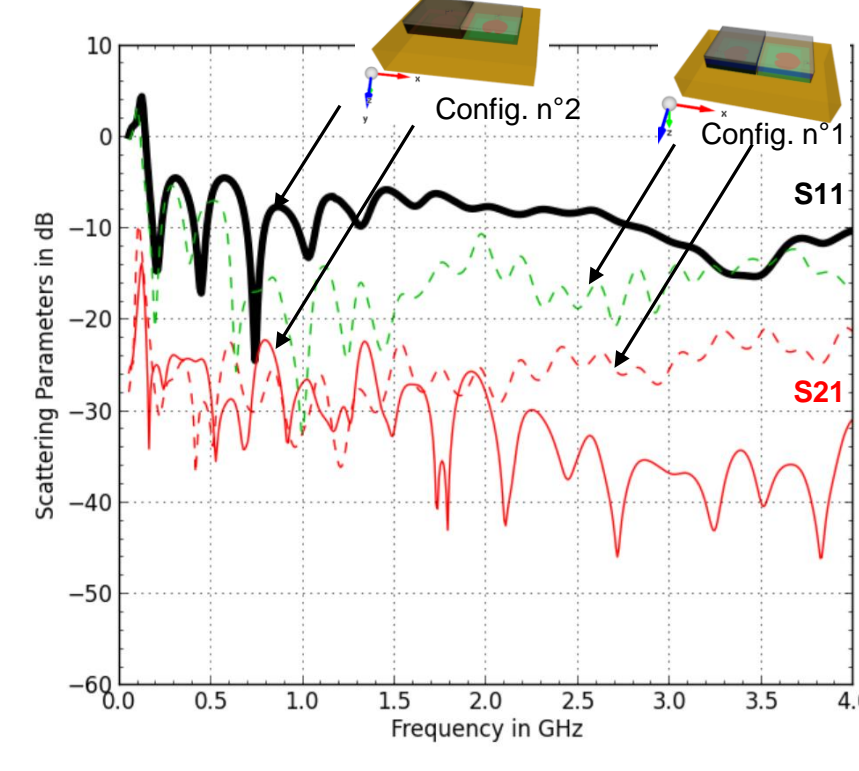
S11 in air (non shielded)



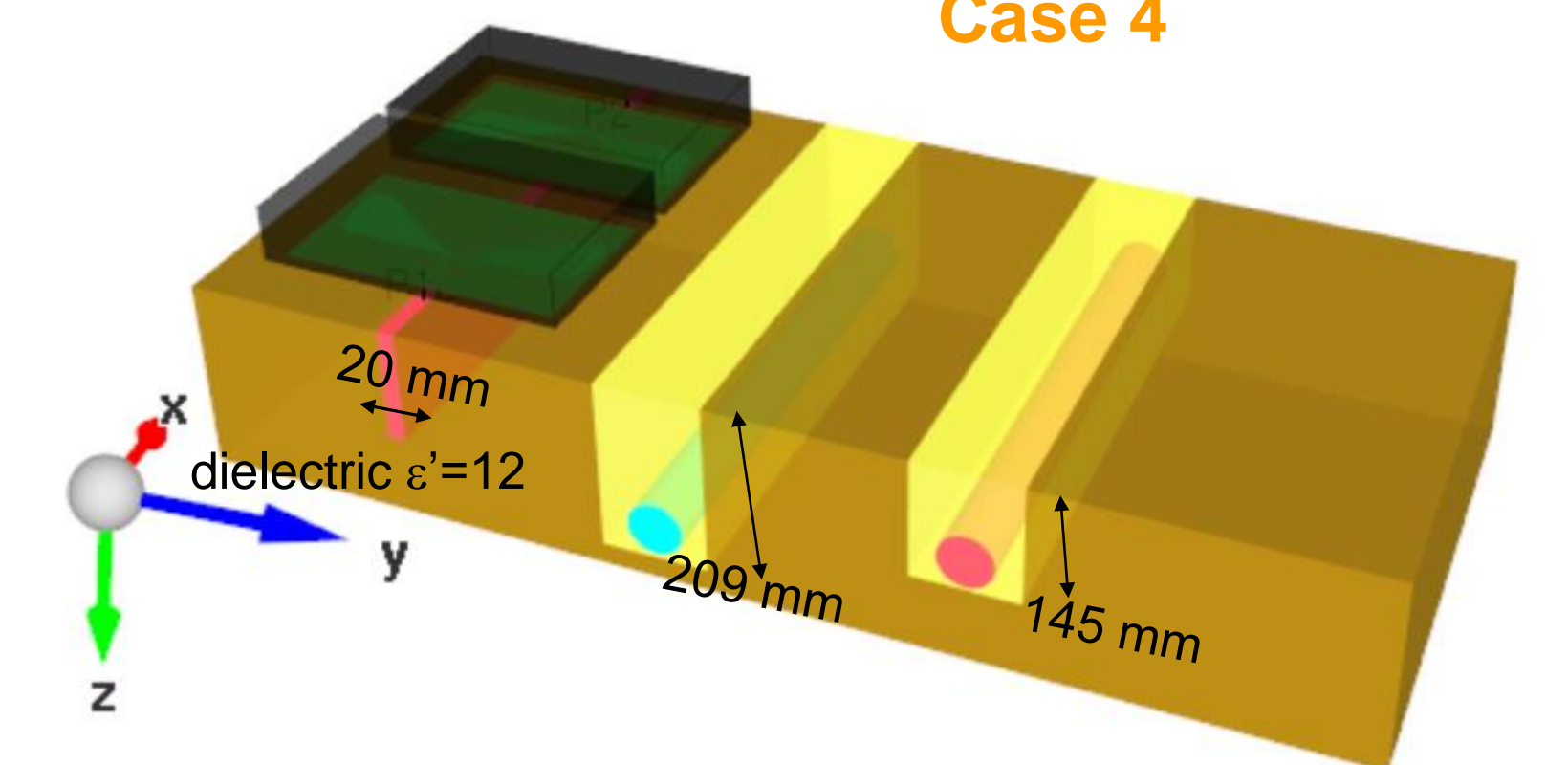
S11 in air (bowtie-slot)



S11/S21 on soil (epsilon' = 5,5)

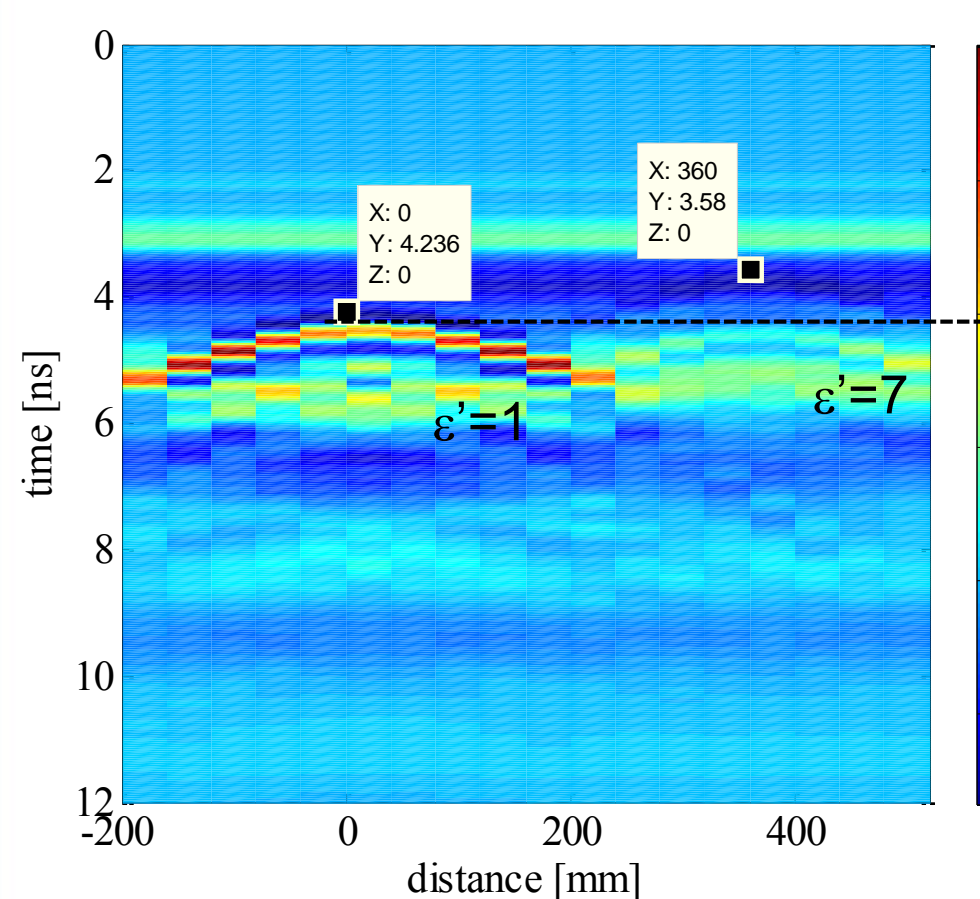


Buried pipes in trenches Case 4

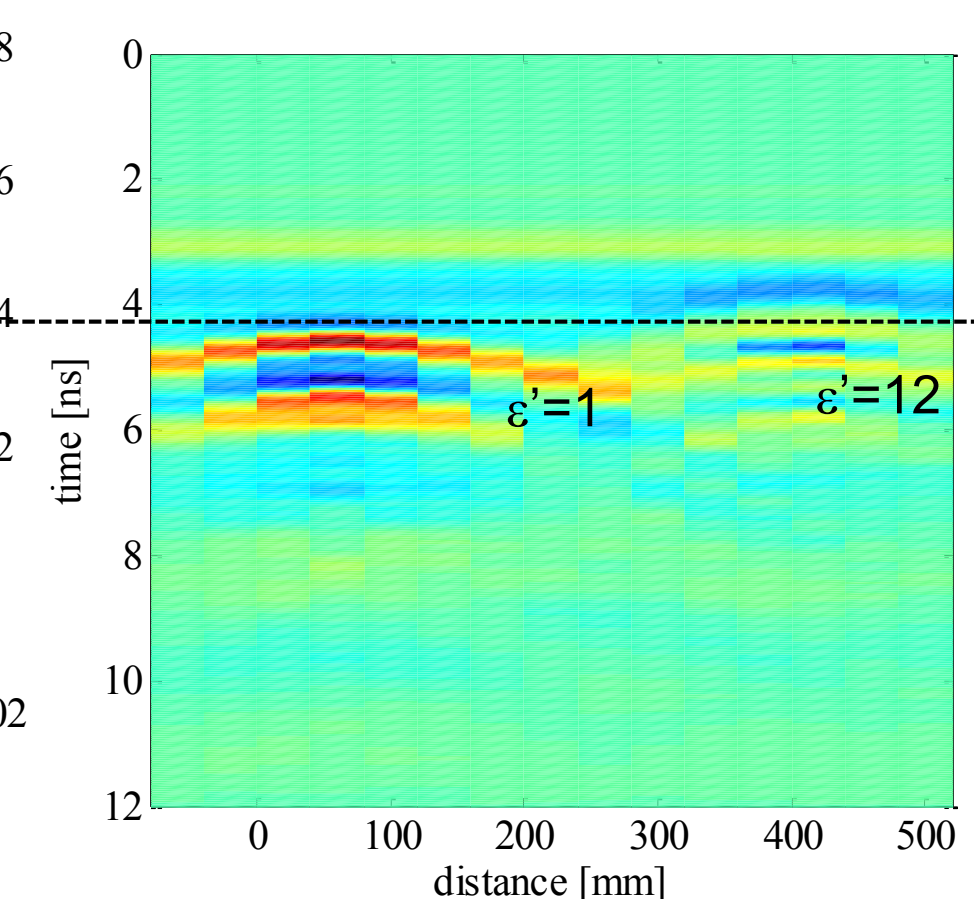


Radargrams

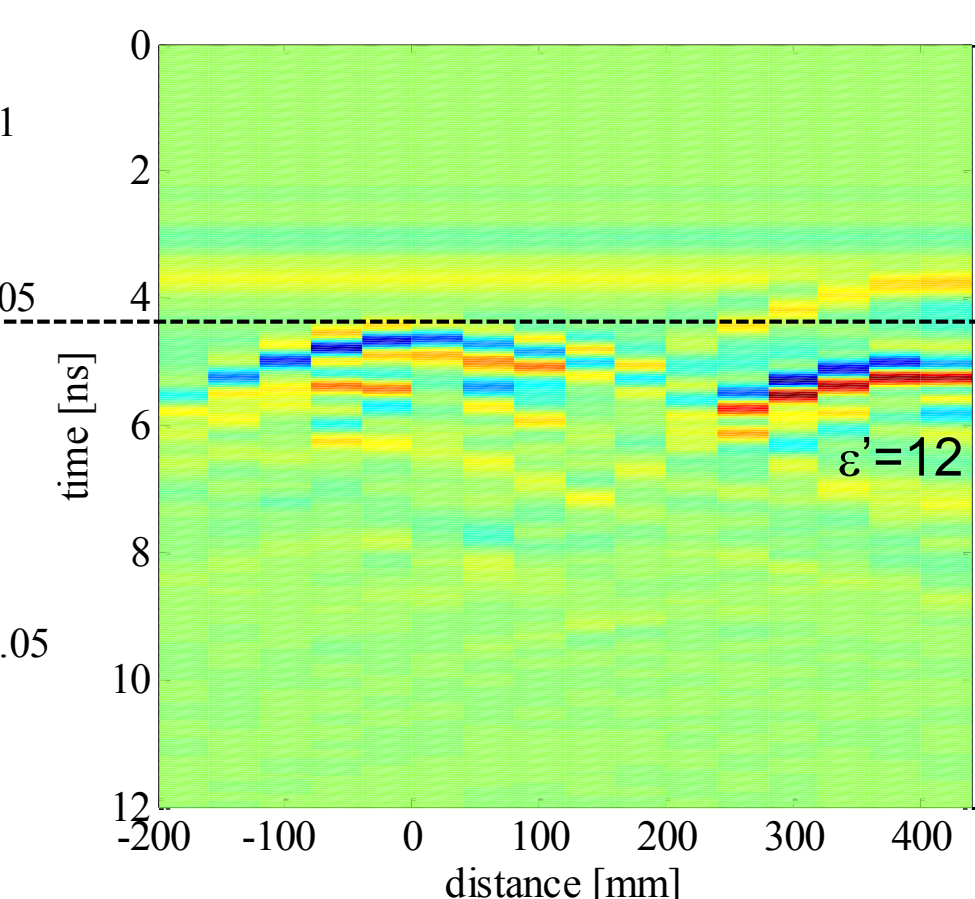
Case 1 (TM)



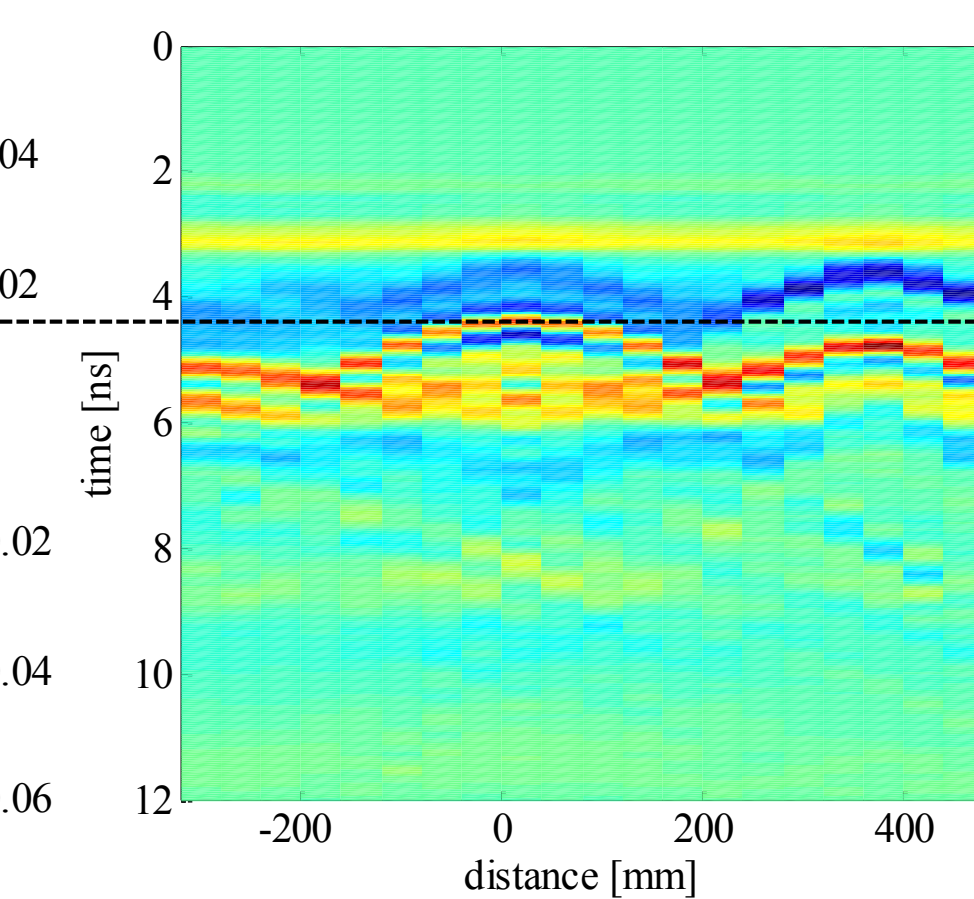
Case 2 (TE)



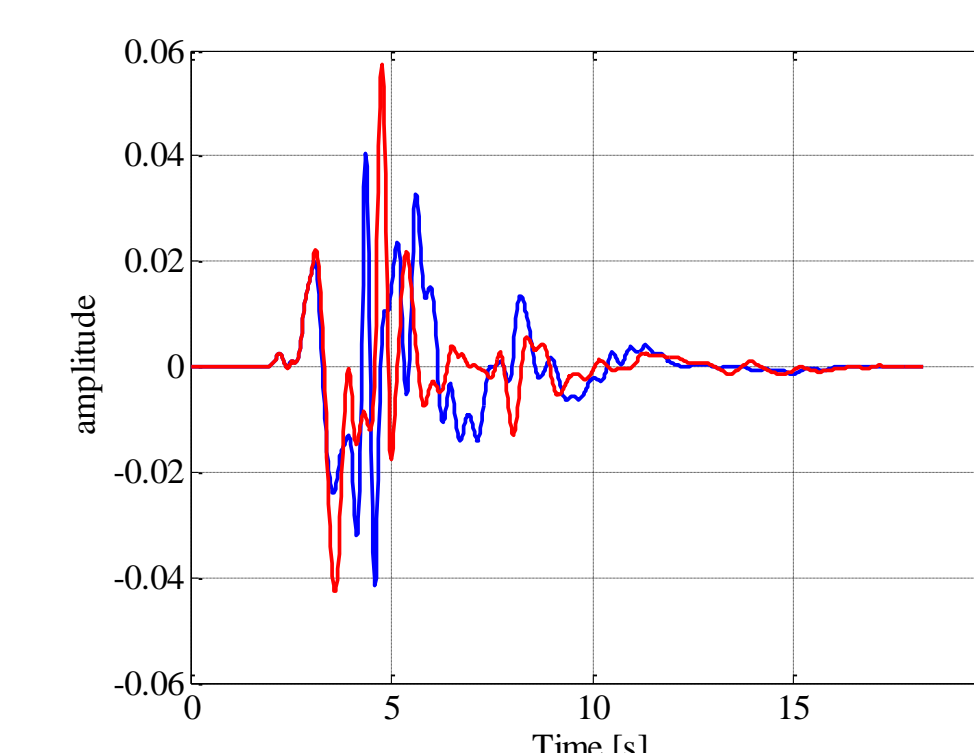
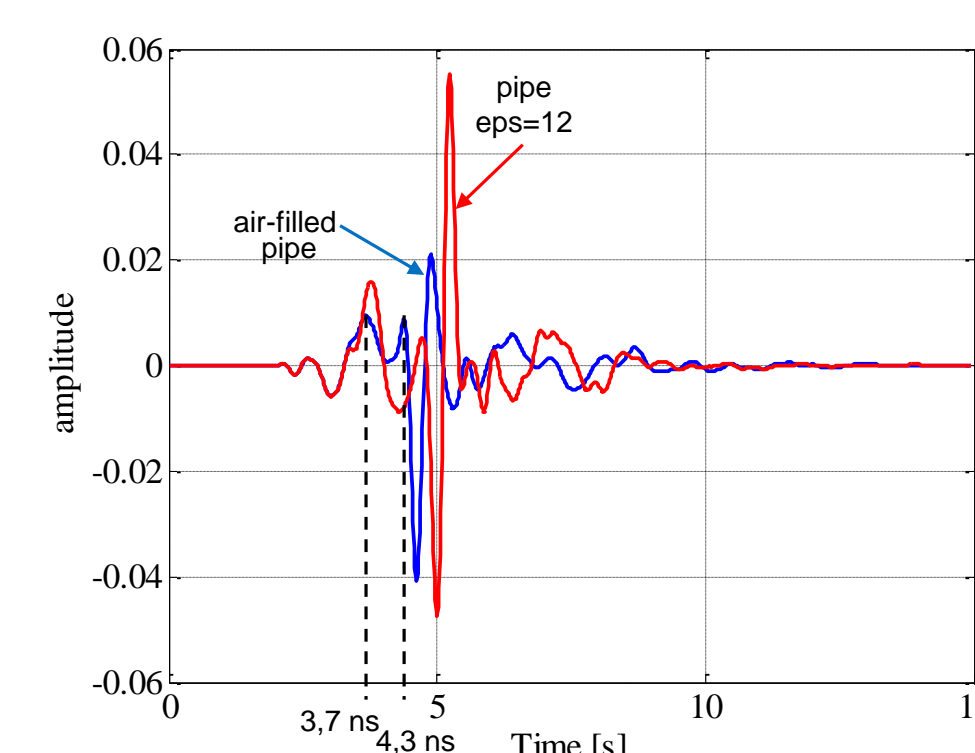
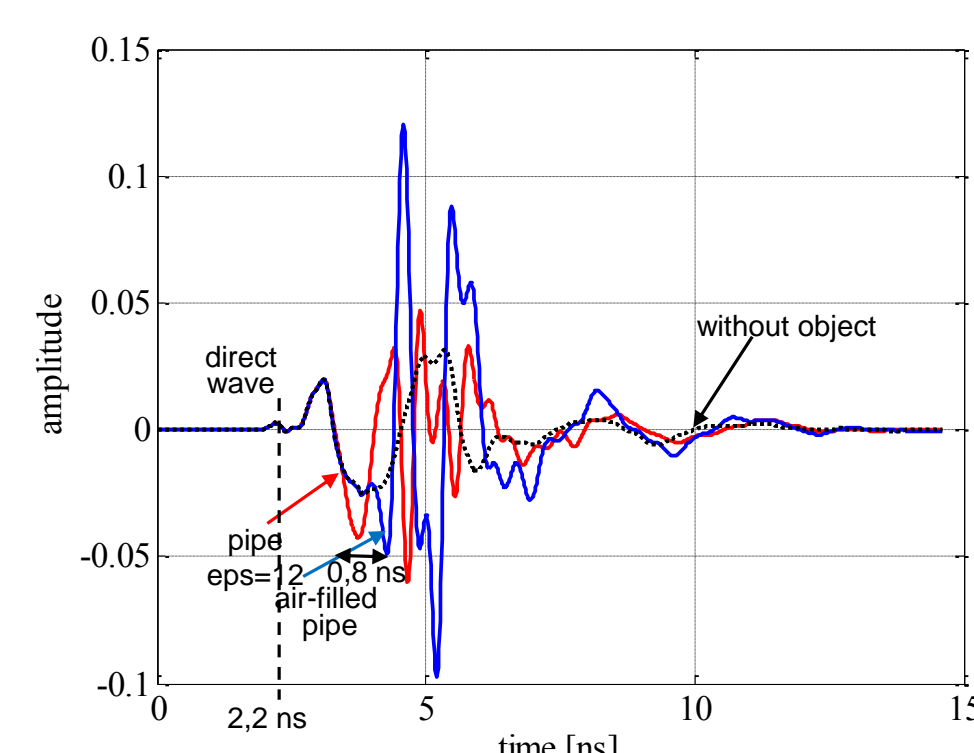
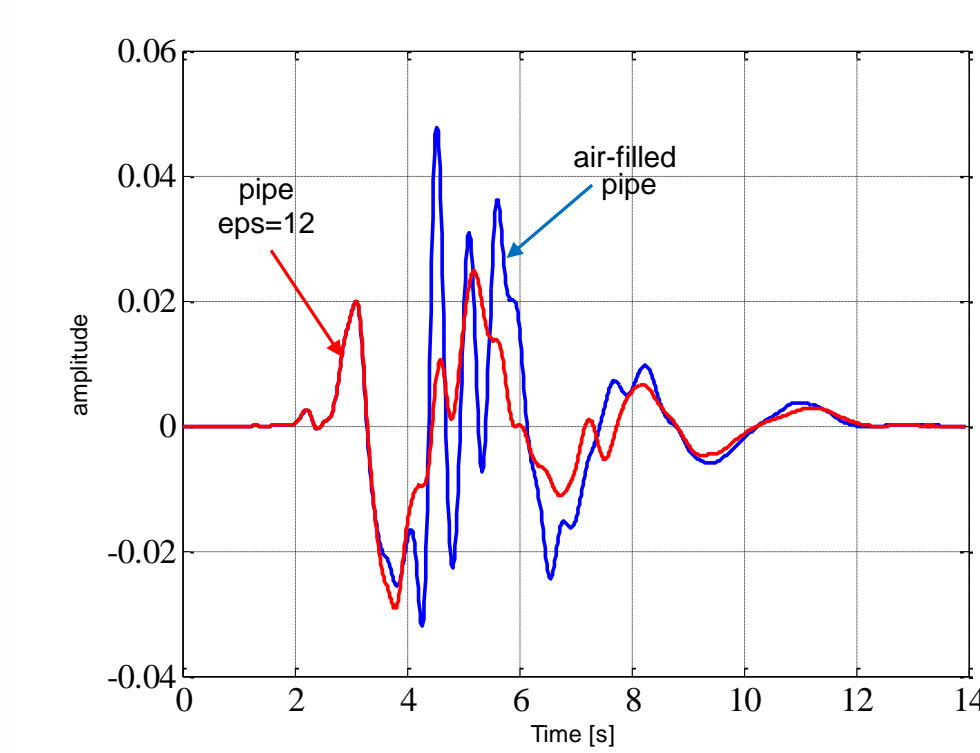
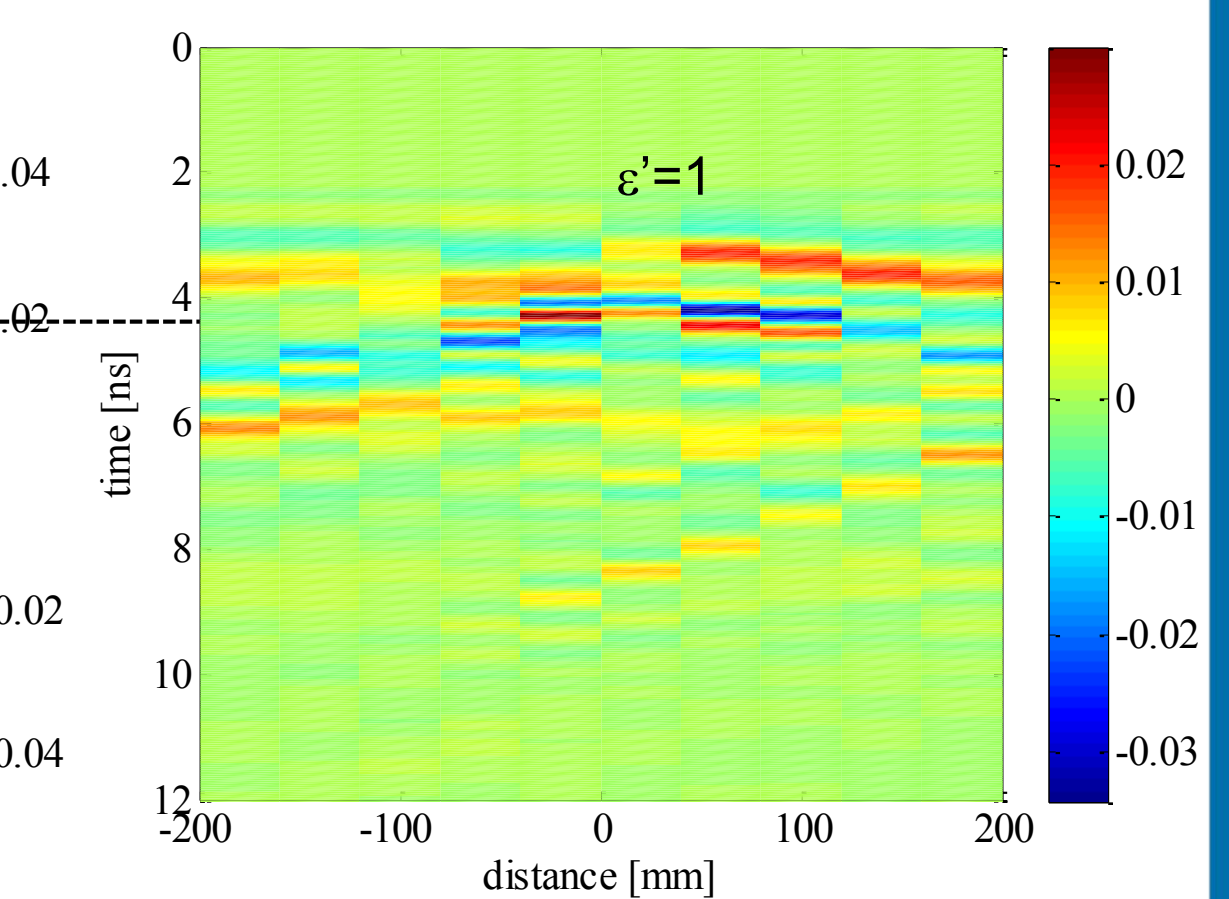
Case 3 (TM-TE)



Case 4 (TM)



Case 4 (TM-TE)



- Disymetry observed for cross-polarized antennas
- Object responses depending on the polarization to be superimposed and compared
- Effect of the antenna geometry on the direct coupling in the several polarization configurations

Conclusion

A parameter study to consider :

- Influence of the antenna geometry on polarization
- Contribution of the polarization to reduce the direct coupling and to improve the detection of shallow objects
- Pre-processing techniques to benefit from several components of polarization
- Quantify dielectric characteristics of buried objects