# Time Resolved Blind Experimental Data for a Globally Convergent Inverse Algorithm

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**Abstract**

In the past several years a globally convergent numerical method for Coefficient Inverse Problems for the equation

$$\varepsilon(x)\, u_{tt} = \Delta u, x \in \mathbb{R}^3, t \in (0, \infty),$$

$$u(x, 0) = 0, u_t(x, 0) = \delta(x - x_0)$$

with a single source position was developed starting from the work [1]. The phylosophy of this approach is presented in [2]. Here $\varepsilon(x)$ is the spatially distributed dielectric constant. The full global convergence theory was completed and a lot of numerical experiments were conducted. Results were summarized in the book [3] and in the paper [4], see Theorem 2.9.4 in [3] and Theorem 5.1 in [4] for global convergence results. In particular, in [2] and in Chapter 5 of [3] accurate reconstruction results for *transmitted* experimental data were presented, also, see [5,6].

Based on these developments, an experimental apparatus was built in University of North Carolina at Charlotte, which was sponsored by US Army Research Laboratory and US Army Research Office. This device emits electric pulses of 300 picosecond duration and measures *backscattering* time resolved signals (voltages) at a number of detectors. The goal is to use this information to reconstruct dielectric constants of scattering targets. The target application is in detection and identification of explosives. Only a single location $x_0$ of the source is used. This shceme of data collection is both the most economical and most suitable one for this application.

The main difficulty is a *huge mismatch* between the real data and ones obtained in computational simulations. Thus, the data pre-processing is necessary. The pre-processed data are used as input for the above globally convergent method. Initially we have imaged targets located in the air [7]. Next, we have imaged the most challenging case: when targets are buried in a sandbox [8]. In this case the signal from the target is mixed with the signal from the sand. Many results for the case of blind data (the answer was unknown in advance) were successfully treated in both cases. Targets are both homogeneous and heterogeneous ones. Results of [7,8] will be presented.

**Acknowledgments**

This research was supported by US Army Research Laboratory and US Army Research Office grants W911NF-11-1-0325 and W911NF-11-1-0399, the Swedish Research Council, the Swedish Foundation for Strategic Research (SSF) through the Gothenburg Mathematical Modelling Centre (GMMC) and by the Swedish Institute, Visby Program.

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