

## **MUSIC imaging method for low-high frequency inspection of composite multi-layers**

Giacomo RODEGHIERO<sup>1\*</sup>, Ping-Ping DING<sup>1</sup>, Yu ZHONG<sup>2</sup>, Marc LAMBERT<sup>1</sup>, and  
Dominique LESSELIER<sup>1</sup>

<sup>1</sup> Département de Recherche en Electromagnétisme – Laboratoire des Signaux et Systèmes  
UMR8506 CNRS-SUPELEC-Univ. Paris Sud, 3 rue Joliot-Curie, 91192 Gif-sur-Yvette, France

<sup>2</sup> A\*STAR, Institute of High Performance Computing, 138632 Singapore

### **Abstract**

THIS PAPER IS SUBMITTED AS STUDENT POSTER.

Non-destructive Testing-Evaluation (NdT-E) of damaged multi-layer structures like fiber-made composite materials involved in aeronautic and automotive industries is a topic of great interest to solve problems of viability and security.

From eddy currents to test graphite-based materials to microwaves and beyond to test glass-based composite structures, one aims to obtain images of the possibly damaged parts with robust, fast inversion algorithms. In this contribution, such algorithms are tailored to detect small (compared to the local wavelength in propagative regime or skin depth in diffusive regime) inclusions affecting the structures mentioned above. These inclusions may be voids, fluid-filled cavities (i.e., isotropic) or even uniaxial ones. Yet this requires proper models of the layerings to compute their response due to electromagnetic sources, notably electric dipoles or magnetic coils.

Based on [1-2], it is proposed herein a method to compute in an effective fashion the dyadic Green's functions (DGF) for such structures within the framework of contrast-source integral equations. Special care is taken when the sources are far away from the origin, yielding an oscillating spectrum of the DGF. The Multiple Signal Classification (MUSIC) imaging method [3], which uses such DGF, is applied to find the position of small defects. Possible application of MUSIC for structure delaminations is treated also.

### **References**

- [1] Y. Zhong *et al.*, “Electromagnetic response of anisotropic laminates to distributed sources”, *IEEE Trans. Antennas Propag.*, **62** (2014), pp. 247-2560.
- [2] G. Rodeghiero *et al.*, “An efficient interpolation for calculation of the response of composite layered material and its implementation in MUSIC imaging”, *COMPUMAG 2013 Conf.*, Budapest, June.
- [3] H. Ammari *et al.*, “MUSIC-type electromagnetic imaging of a collection of small three-dimensional inclusions”, *SIAM Journal of Scientific Computing* **29** (2007), pp. 674–709.

---

\* Corresponding author. E-mail address: giacomo.rodeghiero@lss.supelec.fr