

## Antennas: numerical methods and systems

**Keywords :** Integral equations; Beamforming systems; Metamaterials.

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**Abstract – UCL’s Antenna Group is active in the field of fast integral-equation methods for the analysis of antenna arrays and metamaterials. The Groups also realized a number of demonstrators centered on multiple-antenna systems, devoted to direction-finding and near-field imaging.**

The Antenna Group at UCL/ICTEAM conducts research in the fields of numerical analysis and design of multiple-antenna systems.

From the analysis point of view, the methods under development are relying on an integral-equation approach, for which the unknowns are limited to interfaces. This is made possible thanks to the exploitation of a vast set of analytical results. For array problems, including metamaterials<sup>1</sup>, accelerations by several orders of magnitude have been made possible through the use of “Macro basis functions”, FFT-based convolutions, multipole decompositions, complex-plane analysis, Green’s function compression, etc.

From the system of point of view, a number of demonstrators have been developed for direction-finding and near-field imaging, in close collaboration from industry. Those systems also include the micro-wave front-ends and base-band conversion, and in some cases, the array signal processing.

The applications currently under study are the following:

- Chipless passive RFID (with Profs. Aguii and Rmili)
- Analysis of particle’s accelerators (with SCK-CEN and Prof. Remacle)
- Ground penetrating radar (with Prof. Lambot)
- Reflect-arrays and frequency-selective surfaces
- Centimeter-wave radar (with Profs. Vanhoenacker and Vandendorpe, and Dr. Razavi Ghods)
- Arrays devoted to radio-astronomy (with Dr. de Lera Acedo and Dr. Razavi Ghods)
- Metamaterials for THz sensing (with Prof. Withington)
- Beamforming with transponder on Mars (with Prof. Dehant)
- Ultra-wideband positioning (with Profs. Vandendorpe and Flandre)
- Real-time polarimetric RFID tracking
- High-gain metamaterial antennas
- Urban propagation (with Prof. Oestges)
- Acoustic brain stimulation (with Prof. Moureaux)
- Beam-scanning antennas (with Prof. Huynen)
- UWB near-field imaging (with Prof. Rmili)
- Scattering by moving objects (with Prof. Oestges)
- Small antennas for wireless maintenance
- Phased arrays for 5G communications.

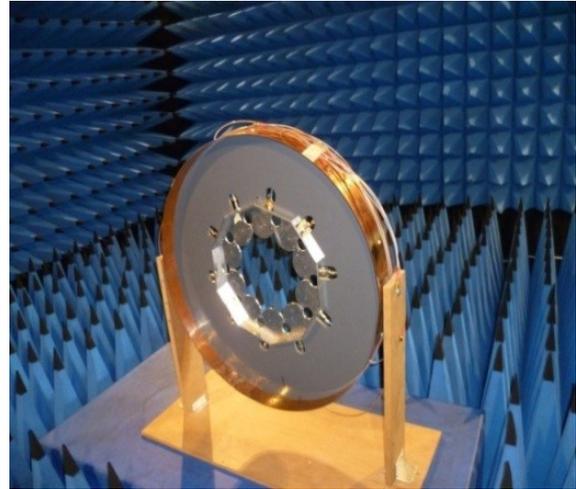


Figure 1: The Wheel-of-Time comprising 10 connected UWB antennas devoted to near-field imaging in the 1-to-5 GHz frequency range.

### References

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<sup>1</sup>Metamaterials are periodically structured material engineered to exhibit unusual electromagnetic properties.