# Indoor 3D Spherical Near Field RCS Measurement Facility: localization of scatterers

Pierre Massaloux[1], Pierre Minvielle[1], Jean-François Giovannelli[2],
[1]CEA, DAM, CESTA, F-33114 Le Barp, France
[2]Univ. Bordeaux, IMS, UMR 5218, F-33400 Talence, France

***Abstract*—This paper details a RCS measurement technique and the numerical post processing of raw RCS data in order to analyze the localization of the scatterers of the target under test. A specific 3D radar imaging method is developed and applied from the fast 3D spherical near field scans.**

***Index Terms*—RCS, 3D radar imaging, near field, measurement, inverse problem, regularization, penalization.**

## I. Introduction

Indoor Radar Cross Section (RCS) measurement facilities are usually dedicated to the characterization of only one azimuth cut and one elevation cut of the full spherical RCS target pattern. In order to perform more complete characterizations, a spherical experimental layout was developed in 2006 at CEA for indoor near field monostatic RCS assessment [1]. This experimental layout is based on a motorized rotating arch (horizontal axis) holding the measurement antennas. From 2011, a new study has been conducted in order to achieve a more accurate positioning of the measurement antenna. To cope with the accuracy requirements of the mechanical positioning systems, advanced alignment techniques have been implemented, including a laser tracker to assess the map of residual alignment errors [2].

The present paper describes the RCS measurement technique applied to this layout and the numerical post processing of raw RCS data. On the one hand, calibrated RCS results of a canonical target is presented and compared with simulation data, and on the other hand, different methods of signal processing has been described in order to quantify and locate the scatterers on the target (3 dimensions). A specific 3D radar imaging method is developed and applied from the fast 3D spherical near field scans.

## II. The near-field 3D RCS facility

The experimental layout is dedicated to the RCS characterization of small targets (typically $< 1$ ft). It was composed of a 4 meters radius motorized rotating arch (horizontal axis) holding the measurement antennas while the target was located on a polystyrene mast mounted on a rotating positioning system (vertical axis). The combination of the two rotation capabilities allows full 3D near field monostatic RCS characterization.

Two bipolarization monostatic RF transmitting and receiving antennas are driven by a fast network analyzer:

- an optimized phased array antenna for frequencies from 800 MHz to 1.8 GHz. This phased array antenna has been optimized to reduce spurious signals coming to and from the arch metallic structure.
- a wideband standard gain horn for frequencies from 2 GHz to 12 GHz (see figure 1).

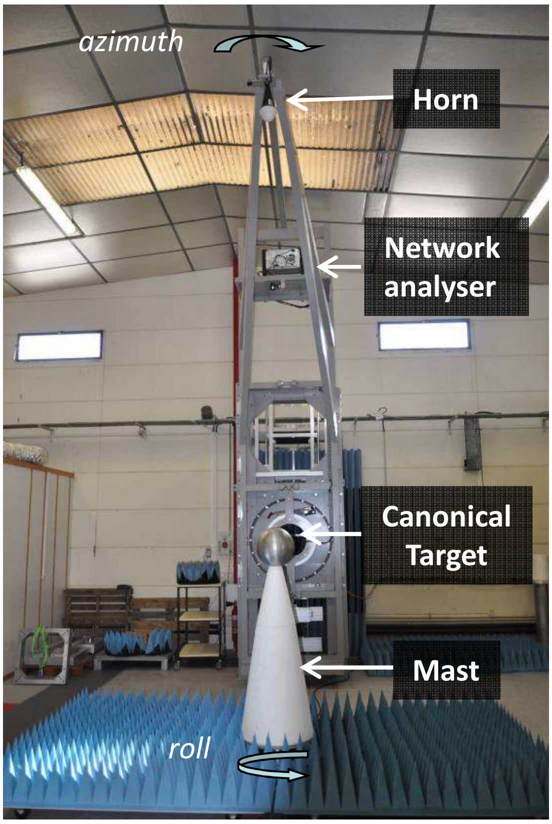


Fig. 1. Near-field 3D RCS measurement facility

The target under test is located vertically on a polystyrene mast below the measurement antenna. The target rotation with respect to a vertical axis corresponds to its roll angle. The arch rotation with respect to an horizontal axis corresponds to the azimuth angle. A full set of data is therefore composed of three different sweeps: frequency, azimuth, and roll.

### *Arch Positioner ($\theta$)*

This arch is built of aluminum, weights about 200 kg, measures approximately 5m $\times$ 3m, and is designed to minimize