

# Near-Field Phase Retrieval from Intensity-Only Measurements on a Cylindrical Helix <sup>1</sup>

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## Abstract

An amplitude-only measurement strategy is proposed to recover the near-field phase on a cylindrical helix. A recently designed probe, performing near-field intensity-only measurements, is used in conjunction with the helicoidal scanning to significantly reduce the data acquisition time and the complexity of the near-field equipment. Numerical simulations on a uniformly spaced array of dipoles are presented to validate the method.

## 1 Introduction

The increasing development of high performances radiating systems has demanded considerable efforts for developing more efficient antenna testing techniques. Near-Field/Far-Field (NF/FF) amplitude-only methods have been proposed to deal with the problem of unreliable direct phase measurement [1-2]. Recently, an integrated probe has been presented which collects near-field squared amplitude data to be subsequently used in the NF/FF transformation [3-5]. The original single-frequency design employed two patch antennas as probes to simultaneously scan a single near-field surface. Subsequently, the application has been extended to the entire X-band by substituting the patches with two rectangular waveguides [6]. In this paper, the application of the innovative probe to the helicoidal geometry is investigated. Numerical simulations on an uniformly spaced array of dipoles show the validity of the method, which significantly reduces the acquisition time while obtaining an accurate evaluation of the near-field phase.

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## 2 Formulation

The helicoidal scanning geometry (fig.1) is described by the parametric equations:

$$\begin{cases} x = R \cos \varphi \\ y = R \sin \varphi \\ z = \frac{p\varphi}{2\pi} \end{cases}$$

where  $\varphi$  is the angular parameter,  $R$  is the cylinder radius and  $p$  the helix step, i.e. the distance between two adjacent points along a generatrix.

The helicoidal scanning requires a linear movement ( $z$ -axis) of the probe and a rotation (along  $\varphi$ ) of the antenna under test. In order to satisfy Shannon's theorem, sampling criteria used in cylindrical scanning are considered, namely  $p = \lambda/2$  and  $\Delta\varphi = \lambda/(2R)$ .

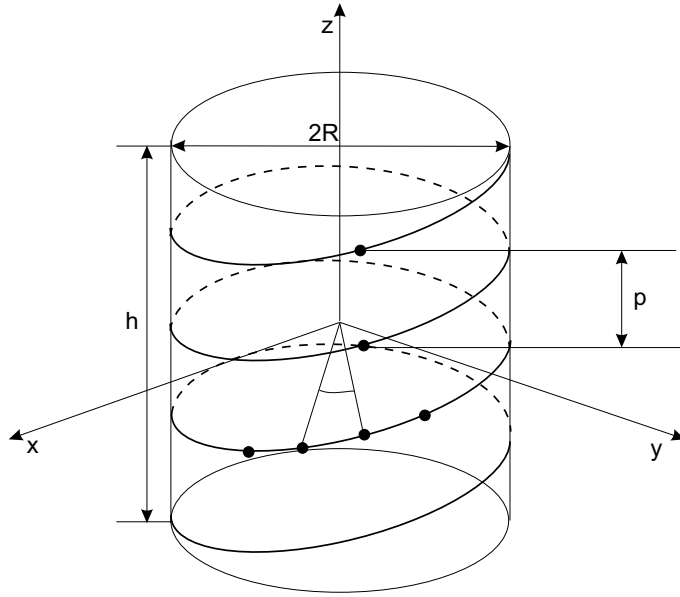


Figure 1: *Helicoidal scanning geometry*

Let us consider two adjacent points on the helix, at an angular step  $\Delta\varphi$ . Their distance is easily obtained as:

$$d = R\sqrt{2(1 - \cos(\Delta\varphi))}$$

The application of the probe to the helicoidal geometry has then required a separation  $d$  between the waveguides, whose height is also shifted by a quantity  $\Delta z = p\Delta\varphi/2\pi$  (fig.2). As described in [3-5], the integrated probe provides four squared amplitude data, which are subsequently processed to obtain two independent sets of complex near-field measurements on even and odd points, respectively. An interpolation algorithm is finally applied to retrieve the unknown phase-shift between the two sets.

The applied approach provides high precision results while employing a less expensive and simpler setup. When applied to the helicoidal scanning, a reduced number of samples is also needed with respect to the classical cylindrical technique. Moreover, only

one interpolation must be performed along the helix, which can be considered as a one-dimensional geometry. So, a much less computation time is required with respect to the standard planar and plane-polar scanning surfaces.

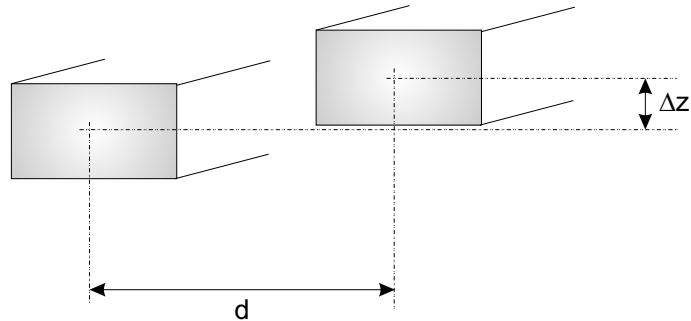


Figure 2: Waveguides mutual positions

### 3 Experimental Results

An array of 21 dipoles  $\lambda/2$  spaced each other along the y-axis is considered to numerically validate the method. Near-field amplitude-only measurements are simulated on a cylindrical helix  $5\lambda$  away from the test antenna, with  $R = 10\lambda$  and  $h = 30\lambda$ . The effectiveness of the phase retrieving algorithm is shown in fig.3, where the exact near-field phase along the generatrix  $\phi = 0^\circ$  is compared with that obtained from amplitude-only data.

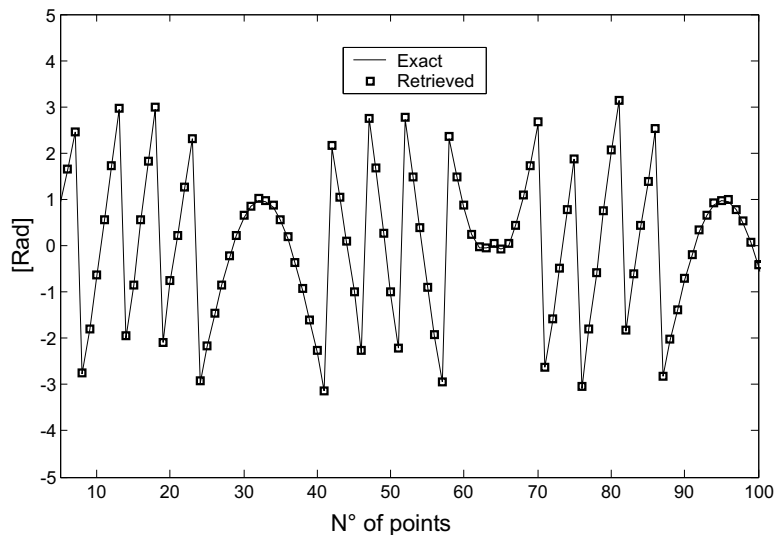


Figure 3: Retrieved phase compared to the exact phase along the generatrix  $\phi = 0^\circ$

## References

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