# Submillimetric High Resolution Passive Imaging System using Synthesis Aperture Technique

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***Abstract*— This paper presents a G-band [140-220 GHz] high resolution passive imaging system for personal security applications. The spatial resolution depends on the size of the antenna. Since a spatial resolution of 1 cm, at a distance of 5 m requires a very large aperture antenna equal to 1 m at 140 GHZ, so it is difficult to achieve a compact system. The synthesis aperture technique allows to reduce the size of the system,while keeping a good spatial resolution. To apply this technique, the studied system is a Y-shaped radiometric interferometer. One of the advantages of such a system, is that there are no moving part, and the size of the synthesized aperture is easily expandable to meet more uses. The system design, simulated performances, and realized monolithic microwave integrated circuits results are presented.**

## I. Introduction

In the microwave range, passive imaging remote sensing has a great interest for personal security applications, mainly for safety.

Based on Planck's blackbody radiation law, radiometric remote sensing of concealed objects is possible due to the spectral brightness of materials in G-band, and since the atmospheric absorption at 140 GHz is low. The low dependence of atmospheric shapes (rain and fog) offers advantage compared to optic imaging systems [1].

Generaly, a high spatial resolution system needs a large aperture antenna, which implies a great system size. In addition, a high imaging resolution needs an array with many receivers, to provid the necessary number of pixels. To overcome these constraints, one solution is to use the technique developed for radioastronomy applications, as SMOS (Soil Moisture and Ocean Salinity) and GeoSTAR (Geostationary Synthetic Thinned Aperture Radiometer) satellites [2],[3]. These systems are Y-shaped interferometers, using the synthesis aperture technique. The Y-shaped radiometric interferometer is composed of many elementary receivers. Operating at higher frequencies, the wavelength (2.14 mm at 140 GHz) allows the miniaturization the elementary receivers, and to use such a system for short range applications.

This paper presents the Y-shaped imaging system design, the first simulations of the system performances according to element imperfections, and the measurement results of the first fabricated Monolithic Microwave Integrated Circuits (MMIC).

## II. Passive Imaging Interferometer

### A. *Y-shaped interferometer topology*

The interferometer is based on a two-dimensional array of heterodyne radiometers (elementary receivers) to synthesize a large aperture. Applying the Synthetic Aperture (SA) technique, the radiometric array achieves a high spatial resolution, while relaxing the size constraints on the antenna [4], to reduce the size of the final system. The geometry of this array is a Y shape, where three densely packed linear arrays are offset 120° from each other. The elementary receivers have been arranged on the Y-shaped as follows : one central noise-adding radiometer and an equal number (N) of heterodyne radiometers on the three arms, as shown in figure 1. Thus, Na = 1+3N receivers are used. On each arm, heterodyne radiometers are equidistant from each other.

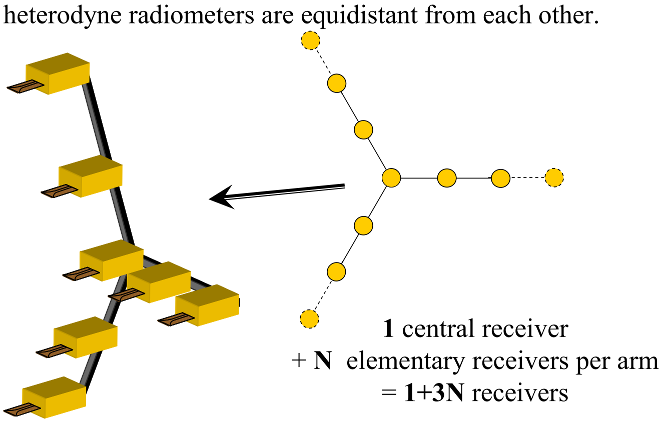


Fig 1. Y-shaped interferometer using elementary receivers

All antennas are illuminating in the same direction. The number of elementary receivers defines the restored image resolution. For example, with a 9 receivers Y-shaped interferometer, the size of the reconstructed image is equal to 16 x 16 pixels. The arm size determines the spatial resolution, respecting the condition of the recovery of the field of view (FOV). Indeed, the distance between the arm end defines the aperture of the synthetised antenna. So, to achieve a spatial resolution of 5 mm at a 1 m range, the aperture of the