On the development of a quasi-optical system for short and long range standoff imagers

E. Gandini*, J. Svedin†, T. Bryllert‡, and N. Llombart*
*TeraHertz sensing group, Delft University of Technology, Delft, Netherlands Email: E.Gandini, N.Llombart@tudelft.nl
†Swedish Defence Research Agency, FOI, Linköping, Sweden
‡Chalmers University of Technology, Göteborg, Sweden

***Abstract*—The European Defense Agency project TIPPSI aims to produce a phenomenology study to evaluate the performance of standoff imagers for security applications at submillimeter frequencies. In this context, a modular optical architecture is being developed. It is composed by a compact Dragonian system to image at short ranges coupled to a confocal system that operates at a larger focusing distance. The performance of the two solutions is described in this contribution.**

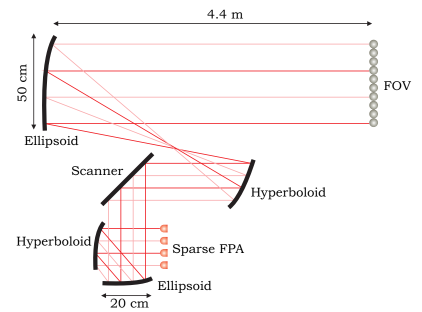
I. Introduction and Background

THE design of the opto-mechanical system for standoff security imagers, [1]- [2], is driven by different constraints depending on the chosen frequency and imaging distance. THz frequencies are often chosen because they can penetrate the cloths and the size of the optic system is smaller compared to lower frequency solutions. A given linear field of view (FOV) corresponds to a relatively small angular FOV for large ranges and a large angular FOV for short ranges. Since large apertures are required to achieve a satisfactory resolution in long range systems, a scanner is typically placed before the main reflector and a large optical magnification is necessary. This implies additional scan loss due to the scanner rotation. In a short range system, good resolution can be achieved with a relatively small primary aperture, and the scanner can be placed after the main reflector, without introducing additional beam aberrations. In both short and long range systems, the use of a focal plane array (FPA) can drastically improve the frame rate if compared to single pixel solutions. The issue is to illuminate the optics with low scan loss for off-focus feeds.

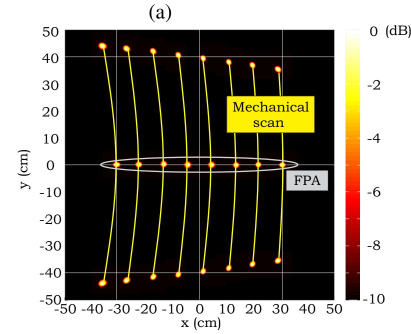
In this contribution, an optical system that can operate at both short and long ranges is presented. The proposed architecture is shown in Fig. 1(a). The short range system is based on a Dragonian dual-reflector architecture and the scanner is placed after the main aperture. A linear sparse FPA of 8 active transceivers is used to feed the reflectors. The same Dragonian system is used to illuminate a confocal dual-reflector architecture. The latter has a larger main aperture allowing good resolution at a larger focal distance.

II. Results

The system was designed at the central frequency 220 GHz and a prototype fabrication is on-going. The focusing distance and two-way resolution of the short range system are 3.5 m and 2 cm, respectively. The FOV, in this case, is 55×60 cm^2 with less than 3 dB scan loss. The radiation patterns of the long range focusing system are shown in Fig. 1(b). The focusing distance is 4.4 m and the nominal two-way resolution is 1 cm. The simulated FOV is 70 cm $\times$ 80 cm. The resolution is narrower than 1.2 cm over the entire FOV. This small variation is expected to allow very similar image quality over the FOV. If a longer range was chosen, a larger FOV could be achieved. In this case, a larger main reflector is required to keep the same resolution.



(a)



(b)

Fig. 1. Dragonian dual-reflector illuminating a confocal dual reflector system: (a) reflector architecture and (b) radiation patterns.

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References

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