The use of metamaterials: millimeter components for astrophysical applications.

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Designed for astrophysical applications, the devices such as coupler or filters must be as small as possible to be integrated in a low temperature superconducting detection chain. By using metamaterials, dimensions can be reduced and performances enhanced compared to a conventional devices. The novelty of the work presented in this paper is a coupler and a filter that operate at millimeter waves (W band – 75 to 110 GHz) and cryogenic temperatures (4K) for astrophysics applications and more precisely for the detection of the CMB (Cosmological Microwave Background) radiation. Indeed, the metamaterials are periodic structures which periodicity is around a wavelength divided by 10. These metamaterials can exhibit effective parameters (permittivity and permeability) values ranging from very positive to negative. In our case, their use explains the reduction of the size of components, useful for embedded planar polarimeter. In this paper, two millimeter components are presented. In the one hand, the metamaterial-based coupler will be presented. It consists on the presence of Complementary Split Ring Resonators (CSRRs) on the ground plane. This allows adjusting the phase of the lines and so reducing their length. Usually, this length depends on the working wavelength. In the other hand, SRRs are added on each side of the transmission line to create a compact cut-band filter. By changing progressively the size of the SRR along the transmission line, the bandwidth of the filter increases. Finally, a study of the influence of different parameters such as the height of the substrate, the error of regularity in the fabrication of the arrays of SRRs or the size of the metal deposit on the substrate was made to understand the critical parameters to respect during the fabrication in clean rooms.