Paper ID: 10669
student

SYMPOSIUM ON NEW TECHNOLOGIES FOR FUTURE SPACE ASTRONOMY MISSIONS (A7)
Technology Needs (2) (3)

Author: Ms. Patricia Voll
Stanford University, United States, pvoll@stanford.edu

Prof. Sami Tantawi
SLAC National Accelerator Laboratory, United States, tantawi@slac.stanford.edu
Prof. Mohammed El-Beltagy
Cairo University, Egypt, mohammed@computer.org

A SMOOTH-WALLED FEEDHORN ANTENNA DESIGN FOR ASTROPHYSICAL INSTRUMENTATION IN SPACE

Abstract

For many astrophysical instrument applications, an ideal feedhorn antenna would have good spatial response with very low far field side-lobes, large bandwidth, low cross polarization, and low cross talk between pixels. Corrugated feedhorn designs are commonly used to achieve these characteristics, but large arrays of these feeds are costly and time consuming to produce because of their complexity. We present two smooth-walled feedhorn designs that meet the necessary performance requirements and are also compact, light-weight, and easy to manufacture. The diameter of the feedhorn profiles decreases from the aperture, so they can be easily and inexpensively generated using a Computer Numerical Control (CNC) lathe. In addition, when the feedhorn designs are scaled for operation in a band around 90 GHz they are less than five centimeters long, so they use less material than corrugated feeds and weigh less, which is ideal for space-based instruments. The feedhorn designs were developed using a genetic algorithm that manages populations of designs through thousands of generations where variables that define the shape of the feedhorns are mixed and mutated like genetic code. A crucial step in the process is determining the fitness of each design in the population, so that the best designs can have the most influence on the next generation. This evaluation is provided by a computer program written in Mathematica and C++ that uses mode matching analysis between sections of different diameter to calculate the scattering matrix and the resulting field vector at the aperture for each design. The ideal field vector was determined by the specification of minimizing cross polarization, and the fitness of each design was evaluated by how well the field vector at the aperture of the feedhorn matched the ideal. Results from the mode matching code have been confirmed using Ansoft's High Frequency Structure Simulator (HFSS) software. Radiation patterns from computer modeling of the feedhorn design and physical tests of a prototype in an anechoic chamber are presented. In the future, these feedhorns can be used in a variety of astrophysical experiments, including measurements of the Cosmic Microwave Background (CMB), spectroscopy, and Earth sensing. The design method can also be applied to other applications where specific feedhorn antenna radiation patterns are required.