Modeling of High Power Broadband THz Antennas

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The term THz is currently applied to electromagnetic spectrum contained between 100 GHz and 10 THz. This region of electromagnetic spectrum remains virtually unused, despite many advantages that it could provide in the area of imaging and communication. During the last 25 years the only usage of the THz spectrum was attributed to narrow-band molecular spectroscopy for Earth, planetary and space sciences. What hampered the developments in the THz area was the lack of commercially available instrumentation.

The uniqueness of the THz technology is related to the fact that, as well as providing the information on structural images of objects it could also be used for spectroscopy—to provide information on materials. At the molecular level, the biologists will have a valuable new tool as the rotations and vibrations of the DNA molecules lie in the THz range.

Current developments of THz technology fall into two categories: active and passive. Active THz technology involves firing THz-rays at an object and analyzing the radiation transmitted and reflected back. However, all objects at normal temperatures are constantly emitting relatively low levels of THz-rays, which can be detected with sensitive instruments. Because of the low level of the detected signals, the passive THz systems have to be narrowband, but the active THz systems do not need to be restricted to the narrowband. Therefore, we can expect that the future system might be active and passive, and they can be narrowband as well as broadband.

Anticipating that by extending the frequency range into the THz region the substantial losses can occur in the antenna, which is generally the longest part of the broadband generating system, we decided to concentrate the effort on modeling the antenna using the FDTD code. Although the plan is to reach 10 THz, the first broadband antenna was designed to operate in the 100 GHz to 1 THz frequency range only. The antenna was designed to ensure gain of 50 dB and output peak power level of 0.1 MW. The design of the antenna was based on a TEM-Horn Antenna that operated successfully up to 100 GHz.

Our estimate indicates that the FDTD modeling of BGF antennas operating in the 100 GHz to 1 THz, will require approximately $10,000 \times 500 \times 400$ cells and as such it could only be done using super-computers. To allow easy implementation of the antenna model into the FDTD Code, while using super-computer, four different versions of a 3-D model of the broadband antenna were prepared and considered.

The publication will present the results of this very extensive modeling effort.