THz Technology in Application to Space Radar Systems

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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, it will be possible to have valuable information on resonances that 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, in our opinion, the use of active, broadband THz technology should greatly benefit the radar systems and specially the Space Radar Systems. The use of broadband THz technology would result in following advantages:

- Transmitted signals would be below the detectable noise levels assumed by other services and thus it could share frequency bands allocated to other services,
- Signal propagation is free from Raleigh-type fading, as they are transmitted over a very wide bandwidth,
- The bands above 100 GHz are at present mainly free from other transmission,
- The time resolution of broadband technology could be used to eliminate the time errors associated with moving transmitters/receivers and targets,
- The THz technology, with the ability to provide information on materials, may allow easier elimination of decoys and identification of even stealth targets.

The presentation will address broadband radar system for space applications capable of operating in different frequency bands extending up to 10 THz**.** Our analysis was based on very extensive modeling done using the FDTD Code on the super computer.

The broadband radar systems, built using 1” x 1” antenna, are capable of operating above the height of 3 miles over the Earth, with an angular resolution of 10^{-3} radian (0.06 deg.), corresponding to angular resolution of 50 feet at a distance of 10 miles. Such systems can be used to detect targets, even as small as few inches in size, and even if they are covered with variety of stealth absorbers. The impact of different obscurants on the limit of detection distance and the probability of detection will also be addressed.