**DETECTING RADIOACTIVE MATERIALS USING HIGH-POWER, TERAHERTZ GYROTRONS***

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Researchers at the Russian Academy of Science (RAS) have reported achieving unique advances in the capabilities of gyrotrons. In 1983, by employing pulsed magnets with fields up to 27 Tesla, they achieved gyrotron output power ~100 kW in 80 ms pulses at several fixed frequencies in the range 375-650 GHz; at 500 GHz the gyrotron efficiency was 8% [1]. More recently, in 2008, using a pulsed magnet with fields up to 40 Tesla, they achieved gyrotron operation at 1.01 THz [2]. At the University of Maryland, we have begun a theory and experimental program aimed at enhancing these capabilities and adapting them to important applications, for example in such areas as shipping container security.

Based on a 27 Tesla pulsed magnet, we are designing a fixed frequency gyrotron with 100 kW output power at a frequency chosen at a relative minimum for absorption in air (e.g. 670 GHz). One aim of the design is to achieve gyrotron efficiency of ~20%. Some details of the design are presented in [3]. Such a gyrotron may be useful for detecting the presence of concealed radioactive materials using a scheme described below.

Focusing the output power from a 100 kW, 0.67 THz source in air at 1 atmosphere will allow the electric field to exceed the threshold for avalanche breakdown. However, the critical volume in which the threshold field is exceeded will be on the order of a cubic millimeter, whereas ambient electron density is on the order of one per cubic centimeter. Thus, there will be a statistical lag time between the application of a breakdown field and the start of the avalanche (i.e. the time for an electron to appear in the critical volume). For ambient electron density, we estimate the statistical lag time to be ~10 ms which may be compared with the time for forming the breakdown avalanche of only 30 ns. In general, the statistical lag time will depend on the level of background electron density. A significant shortening of the statistical lag time would then indicate an elevated value of background electron density perhaps due to the presence of radioactive material. We are initiating studies of the effect of various radioactive materials and geometries on background electron density.

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