Problems of sub-THz astronomy, radars and telecommunications: development of equipment and methods

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Abstract. Some original results of development methods and equipment for subterahertz astronomy, radars and telecommunications are presented in this paper. There are problems of extremely low sensitivity of receivers, high power transmitters, atmosphere propagation and development of key solid state components for this band: detectors arrays, cooling systems, antennas and so on.

1. Introduction
In recent years, there has been a boom in the development of the terahertz range. To be more precise we are talking about its long-wave part from 0.1 to 1.0 THz called sub - THz waves. Sub - THz astronomy, radar and telecommunications have been widely developed last decade [1]. The talk presents the main approaches to solving the most critical problems of sub-THz waves: influence of the atmosphere and low signal / noise ratio in majority of sub-THz applications.

2. Results
Among problems of sub-THz waveband development, a key place is occupied by the significant atmospheric absorption of these waves and the study of atmospheric absorption or microwave astroclimate [2-4], as well as the selection of adequate sites for the placement of radio telescopes and antennas for deep space communications, as well as radars effective for diagnosing of space debris using very high power gyrotrons and low noise receivers [5]. Some of the results of astroclimate research, as well as specially developed equipment and methods, are presented: solid state components for sub - THz band including superconducting detectors arrays, cryogenically cooling systems and interfaces, components of Sub THz antennas and so on.

The main task here was solution of critical problems listened above for relatively large antennas (13-70 m) assumed to be fabricated for Suffa observatory [2]. Suffa project now is multipurpose observatory with astronomy, telecon and radar applications. The development of extremely low noise receivers and high power transmitters is presented, cooled to deep cryogenic temperatures including subK levels, is presented in the talk [6]. Some technical approaches how to solve a problem of phase manipulation for sub-THz communications are also presented.

3. Conclusion
As a result of studies based on direct 2 and 3 mm measurements, as well as comparisons with the results of GPS and optical measurements, we’ve selected most promising sites for Suffa antennas and
came to the conclusion that it is necessary to fabricate the receiver for direct measurements of the astroclimate at wavelengths of 1.3 and 0.8 mm and the total futility of subsequent transparency windows of 0.55 mm and further tasks of ground astronomy and radars. There is certain perspective for short-range communication (mobile 7G) with a distance between cell elements up to hundreds of meters up to 700 GHz waves. Methods for parrying a high level of absorption of sub-THz waves for communication, radar and astronomy problems through the use of powerful generators and superconducting receivers are proposed and investigated. A prototype of a 3 mm receiver based on commercial LNA from Farran was demonstrated, and a comparison was made with a two-frequency cooled receiver of 13 and 8 mm range. The development of microwave technologies has pushed the frontier of the promising application of cryogenic receivers to the sub-THz wave boundary. At lower frequencies, ground-based radar, communications and astronomy systems are dominated by the atmosphere and there is no point in deep cryogenic cooling. Despite the fact that the atmosphere at sub THz waves is less transparent than at long mm waves, cryogenic cooling of the equipment gives a more significant effect due to a priori higher noises of the less perfect uncooled receiving equipment of sub THz waves, which are still far from the quantum limits. The level of the quantum limit here is higher.

4. Acknowledgements

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