- *Prof. Konstantin Lukin*

- **Lecture :**

MIMO Noise Radars with Orthogonal and Temporal Divisions
Of signals in Tx/Rx channels

Radar vision systems are dynamically developed as they may provide widely required imaging of various objects. Key points for such system elaboration are electromagnetic compatibility, device reliability and cost. The method of SAR imaging provides lower microwave hardware complexity comparable to multi-channel SIMO, MISO and phased array-based coherent systems with digital signal processing. The lower complexity improves dimensions, reliability and cost of the end-user item. Besides, these systems based upon Noise Radar Technology have such advantages as electromagnetic compatibility, i.e. ability to share one frequency band by several microwave devices. Application of wideband non periodical sounding signals provides desirable distance estimation features such as high resolution and absence of range ambiguity. The coherence of SAR images enables to apply differential interferometry technique to detect small displacements with high accuracy.

In many applications, such as: intrusion detection, concealed weapons detection, monitoring of large objects: bridges, buildings, towers, etc. 3D microwave or millimeter wave imaging of partially transparent objects may be implemented via generation of a series of 2D images as cross-range slices at different range gates which is possible when applying a high resolution radar. Actually this technique is a realization of 2D aperture synthesis at each range bin of a wideband radar having high enough range resolution. Hereinafter, this technique will be called as Radar Tomography which is in agreement with general definition of the tomography.

The lecture is devoted to investigation and implementation of novel approach to millimeter wave tomography which consists in combining of Multiple-Input-Multiple-Output (MIMO) and Synthetic Aperture Radar (SAR) principles. Unlike any earlier work, in the lecture the millimeter wave tomography is implemented with the help of millimeter wave noise signals and millimeter

wave antennas of a new type: Antenna with Pattern Synthesizing. To demonstrate implementation of millimeter wave tomography with the help of Ka-band Ground Noise SAR we have carried out indoor and outdoor experiments aimed on obtaining of 3D tomographic images. Another approach to MIMO Noise Radar design is based on the orthogonality of the received/transmitted signals which enables their division in the receive/transmit channels, provided proper time delays in the antenna systems..

The approaches suggested open up a new directions in microwave tomography which may be applied for design of millimeter wave tomographic systems for content inspection of closed boxes, hidden monitoring of closed room, etc.

Application of ***radiometric*** principle enables to discard generation and radiation of sounding signals, since radiometric system receives noise waveform signals of objects thermal radiation. In particular we may implement indoor imaging in spite of multipath influence. Moreover the radiometric system compete noise waveform radar in such features as probability of interception, covertness and electromagnetic compatibility because it has no sounding. Radiometric imaging of distant objects using their thermal radiation may be realized in several different ways. In microwave and millimeter-wave bands, the ***radiometric*** imaging is usually based upon application of multi-channel receivers of thermal radiation in combination with their mechanical motion or, otherwise, with frequency scanning of multi beam antenna. We present original results related to investigation of radiometric imaging and justification of novel concept for range-azimuth *coherent* radiometric imaging using antennas with pattern synthesizing. Experimental investigations have been carried out using a ground based Ka-band interferometric radiometer based upon equipment of ground based noise waveform SAR developed earlier in the LNDES IRE NASU. In addition, some results of 2D and 3D imaging in S, X and Ka band imaging with noise waveform SAR as well as some results of application of Ka-band Ground NW SAR for precise monitoring of Bell towers of Cathedrals and SAR imaging of ground vehicles and aircrafts will be presented.