Terahertz optical MIMO system – generation algorithms and functioning of diffractive and hybrid compact structures.

Fast-speed wireless data transfer is the transcendent goal that is constantly moving away. People fight for requirements defined in Wi-Fi 6 specification aiming at extending capabilities of nowadays used systems to transfer data at short distances. Since few years, intense work on such technologies is in progress also in the terahertz (1 THz = 10^{12} Hz) band of radiation, which falls between far infrared and microwave bands. Two years ago, the telecommunication standard was officially announced for part of the THz range which is associated with high hopes for being able to offer link capacities similar to wire connections.

One of approaches, investigated in this project, is application of multiple-inputs multiple-outputs (MIMO) technologies, known from Wi-Fi systems, to the terahertz band in the optical form. The development of new optical elements is driving progress in nearly all devices related to emission and detection of radiation. For example, research studies on new generations of thin and lightweight optical elements has been critical especially in telecommunication and space industries. Such elements are called diffractive optical elements (DOEs) and their design is governed not by geometrical optics but according to the wave phenomena. Optical structures for THz radiation are very often thick, which means a large waste of energy due to attenuation of material. Moreover, their minimization with classic methods stops to be possible in some particular THz setups.

In this context, the technology of designing efficient optical structures is of particular interest. We propose using diffractive elements and hybrid structures (which consist of some parts generated with different design methods). THz signals will be redirected from multiple emission points to the single optical path and then from the single optical path to multiple detectors, which is illustrated in Fig. 1.

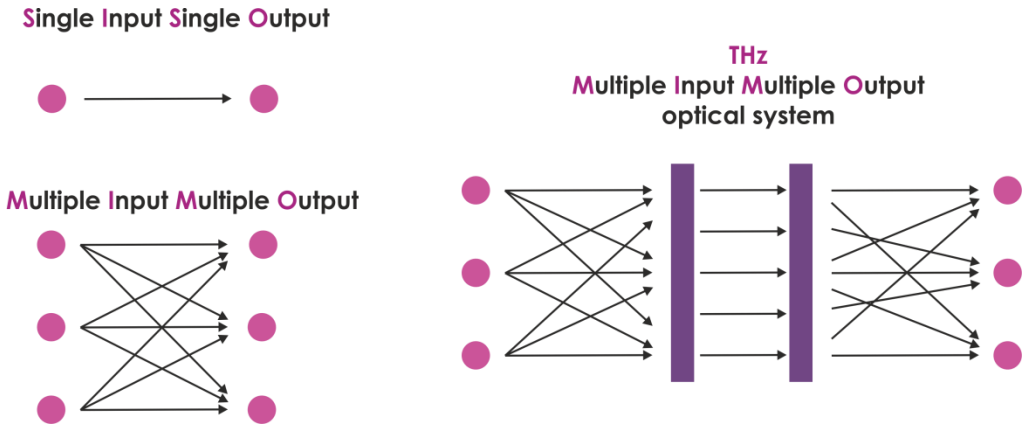

Fig. 1. The main scheme of MIMO system functioning.

New design algorithms will be used to generate MIMO structures. It is planned to create new software, enabling designing and propagation simulations for non-planar structures with real thickness. Designing complex real-shape structures, using the diffraction phenomena is very innovative approach. Moreover, it is planned to develop an additional algorithm, allowing iterative designing process.

It is worth highlighting that many optical setups for THz radiation require working distances in the range of centimeters (sometimes up to dozens of centimeters) to assure beam collimation and redirecting or focusing. Such setup geometry results in extremely small amount of information coded in designed element in relation to the THz wavelength (for example in comparison with visible light). The whole structure has the size of only dozens/hundreds of the wavelength.