Current informatics and communication technologies aim at using the last not used frequency band - the terahertz band (THz). This is the range of the electromagnetic spectrum where the field of a wave changes about 1012 times per second, and their wave length is equal to about 0.1 mm.

The THz band borders two other bands - microwaves (at lower frequency) and optics (at higher frequency). Electronics and optoelectronics of these two bands is very well developed which is justified by thousads of applications which are our companions at every day life. One of the reasons is that eficcient emitters and sensitive detectors are extremly well performant at visible and microwave radiation. The situation is quite different in the case of THz radiation - there are practicaly no small, cheap and eficcient sources and sensitive detectors. Partially, it is casued by the fact that a THz badn is experimentally diffcult because all signals with that frequency can be easily hidden in the noise generated by the environement - just, the energy of photons related to this noise, which is called a thermal excitaions energy - is much more higher then the energy carried by THz photons.

THz technolgies would stay long totally unnoticed if it was not shown that THz radaition can be extremly useful in areas which are crucial for the society. THz radiation passes through such materials as plastic, paper, wood, which offers applications in security systems or nondestructive quality testing. Many explosives can be detected and cognized with THz spectroscopy because their absorption spectra show characteristic spectral features. Besides, a THz radiation can be used in a medical diagnosism e.g., to determine cancer tissues, mainly of the skin. These facts indicate important social benefits which one can get from development of THz radiation, which means construction of sources, detectors, filtere, phase shofters, modulators, frequency multipliers and other elements which - connected in an appropriate way - can be united in a device with new possibilities. A post-office scaner is such a device which, using a THz beam, verifies if the letter of a parcel contain a dangerous material or not. Yet another aspect of THz technology is a run for a quicker then today information handling which is related to a problem of construction of very fast transistors.

A totally differerent subject concerns so called metamaterials. They are artificial materials with unusual optical properties, like a negative index of refraction. Metamaterial is a structure built of periodically positioned fundamental blocks which - depending on the frequency band we are interested in - can be of a very strange shape and can be fabricated of different materials. Metamaterials are totally artificial construction which means that we can model their properties according to our requirements. We are interested in THz metamaterials. Their form is a periodic lattice of metallic rings , sometimes with very complicated shape, with micrometer slits. These rings, which are called spli-ring resonators, are of a dimension of a few tens of micrometers and are fabricated on a surface of a semiconductor structure which contains a two-dimensional electron plasma. The resonators are, in essence, RLC circuits for THz frequency, with distributed elements which means that when the are subject (illuminated with) to THz radiation of an appropriate frequency, they will resonate. As in the case of any resonance, this means a strong increase of the amplitude of oscillating currents, which results in an increase of THz field in resonator's slit in comparison with the electric field of the incident wave. This strong electric field will lead, in turn, to specific effects, called nonlinear effects, in which a reaction of the medium to THz radiaiton is not proportional to the intensity of the incdent wave (this would be so called linear response) but stronger - in a nonlinear way.

Existence of nonlinear effects is crucial for electronics. One can say, that electronics could not exists without nonlinear components. Thus, one of the main goals of the project is to study properties of THz metamaterials fabricated on semiconductor structures with two-dimensional electron plasma as nonlinear elements, and also as detectors and filters.

A response of metamaterials to THz radiation will be investigated with a few experiemental techniques: we will study how THz radiation influences the current passing thoruhg a metamtaterial, how the radiation passes through the metamaterial. We will verify how the magnetic field and additional illumination with a visible light will modify properties of the metamtaterial. We will also use a very advanced technique of optical studies - and analysis of the light (i.e., its spectrum and the stae of polarization) emitted just from a slit of resonator at conditions of a resonant excitation with THz radiation. We expect that due to specific properties of metamaterials we shell prove that they can be used as THz detectors, filters and nonlinear elements.