Laser devices has been fabricated for many years now. One of characteristic features of laser light is its ability to propagate in one, well defined direction as a beam which stay narrow over great distance. For many application it is highly desirable that the power distribution along beam cross-section could be described by bell-curve, that is it has the highest value in the center of the beam and smoothly decreased towards the edges. Unfortunately, this is not the case in many cases.

Often the power distribution in emitted beam can be distorted because of not uniform distribution of the temperature of the active region. This problem was solved when the laser active region was form as a disk. Such disk of few millimeter in diameter and fraction of millimeter in thickness can be mounted directly on a heatsink. Large surface and small thickness permit for efficient heat extraction from the disk. Because the heat can flow uniformly towards the heatsink the temperature distribution is uniform, as well. In consequence the laser has axial symmetry so the emitted beam. Such laser emits the beam of excellent optical quality; beam stay narrow over great distance and the power distribution along the beam cross section can be well described by bell-curve. The power for emission of the disk laser is provided by high power electrically driven semiconductor laser diodes.

The laser diodes have great advantage that they can be excited directly by a electric current, in addition they can emit light with high power and very high efficiency. The only drawback is that at high power the beam is highly divergent and the power distribution is highly nonuniform. In consequence in all application where the high quality beam at high power is needed the laser diode emission is not used directly but after conversion by, for instance disk laser. The axially symmetric disc laser absorbs the radiation from laser diodes and re-emits its in a beam of excellent optical quality. The disk itself can be fabricated from semiconductor, as well. Such laser we would like to develop in our project.

The disk shaped active region of the laser will allow us to maintain the excellent beam quality whereas the semiconductor material employed for its fabrication will permit us to make use of the unique flexibility of the modern semiconductor materials.

The modern semiconductor technologies permit to fabricate the laser disks which consists of many layers of different chemical composition and thicknesses. In solid state laser the material from which the disk is made predetermine the emission wavelength. Not all wavelength can be emitted. In contrast for semiconductor disk the emission wavelength only slightly depends on the chemical composition. The emitted wavelength depends on the internal structures of the disk: the number of layers and on the layer thickness. The thickness of same layers can be as low as 10nm what corresponds to only 20 atomic layers. Such small spatial dimensions are comparable with the de Broglie wavelength of the electrons in the semiconductor. This make the quantum effects dominant. The quantum effects not only defines the emission wavelength, but also enhance emission efficiency.

Being capable to deposit such thin layers we are able to play with nature and fabricate the laser emitting at any wavelength in very broad range, in infrared. This is a unique feature of semiconductors. In our research we will concentrate for emission at the wavelength at 1750 nm. For this purpose we will have to deposit a number of layers from alloys consisting of aluminum gallium and indium arsenide. We will have to control with atomic precision both the layer thicknesses and the composition of any individual layer. The X-ray technique will be applied for the control of the atom position within the layers. Wrong position of too large number of atoms can result in dislocation formation, what would greatly deteriorate the emission efficiency.

Along the disk fabrication we will concentrate on the heat management of the disk. We plan to enclose the semiconductor disk in-between two transparent diamond plates. The diamond has the highest among known material thermal conductivity. It will allow for the highly efficient heat extraction from the disk. The good optical parameters of diamond its high transparency will not deteriorate the laser optical features. If we succeed in our efforts we will be able to demonstrate emission at 1750nm moreover this wavelength will be tunable in broad range to adjust to actual needs. The semiconductor disk laser emitting at this wavelength has not bean demonstrated so far.

The 1750nm is a mid infrared radiation. For this wavelength the strong absorption by water molecules take place. When operated at low power this makes our laser suitable for example for surgery. The good beam quality will allow to focus the beam to the spatial extension as small as a single cell. At he same time the strong absorption by water present in the tissues will prevent deep penetration and limiting the side effects of the medical treatment.

Another possible application of the laser will be pumping of the solid state laser made from chromium doped zinc selenide. The chromium doped zinc selenide laser is highly desired since it is capable for the emission in a very broad spectral range in mid infrared. Unfortunately, there is no suitable pump laser for excitation. we believe that our laser will be especially suitable for this purpose.