Genetic material of human cells suffers various types of damage, including breaks of one or both complementary DNA strands. These lesions are repaired by various specialised repair enzymes. It has been demonstrated that during a process of repair of double-strand DNA breaks chromatin, a complex of proteins and DNA contained in the cell nucleus, undergoes dramatic structural reorganisation. Tightly packed chromatin fibres move away from each other and thus facilitate access of repair factors to the damaged DNA. Little is known, however, about the mechanisms controlling this phenomenon, and its role in various repair processes. Development of new laboratory methods, including optical super-resolution microscopy, methods of inducing and detecting DNA damage in predetermined site in the cell nucleus and in a selected base sequence of DNA, and methods of investigating dynamics and mobility of macromolecules in live cells opens new opportunities in investigations into the mechanisms and the role of global and local chromatin reorganisation in response to various types of DNA damage. The goal of this research is to improve super-resolution optical microscopy and apply it, as well as other new techniques, in studies of the mechanisms that govern the processes of chromatin reorganisation during repair of the most dangerous DNA lesions – double strand breaks.

The results of this research will enrich our knowledge about the principal mechanism involved in maintaining genome stability, structural reorganisation of DNA-protein complexes, and the influence of this phenomenon on the efficiency of repair processes. It is anticipated that this knowledge will become useful in understanding the mechanisms of genetic diseases and in searching for methods of preventing and treating cancer.