The miniaturization of analytical instruments, like mass spectrometers (MS), has been an issue concerning many scientific groups for years. The biggest driving force here is the possibility of carrying out on-site measurements. It is especially important in space exploration, where reduction of size and weight brings dramatic decrease of cost. Miniaturization gives also new possibilities – if the instruments are small, or even chip-scaled, it is possible to think about the use of several or several dozen independent instruments to conduct research on a large area.

During last decades, a lot has been achieved in this area, suitcase versions of mass spectrometers have been developed, MEMS (micro-electro-mechanical system) technology has been applied for miniaturization of at least some of the components of MS. However, miniaturization often comes with a cost - for mass spectrometry in a form of reduction of the resolution, sensitivity or mass range of the analysis. Thus, the utilization of the compact instruments has so far been limited. Further development is possible when the parameters of the miniature version of the spectrometer were more similar to the standard one. At the same time the complexity of the whole instrument in terms of both core components and electronics necessary for its operation should not be increased, so that the instrument can be relatively cheap in mass production, and mechanically resistant. The currently applied approaches to miniaturization seemed to reach their limits. The aim of this project is to cross those limits, while maintaining sufficiently good instrument parameters, by the use of non-standard methods of internal ionization of gas samples and alternative analytical techniques.

In conventional instruments ions are introduced into the quadrupole filter from some kind of external ion source (based on field-emission, glow-discharge, thermo-emission, etc.). It is hard to limit their energy below several eV, and this is required to reduce the operating frequency. In the approach proposed in this project it is believed, that it can be accomplished by utilization of so-called internal ionization, in which ions are created directly inside the quadrupole filter. In that case the transversal energies of ions are extremely low, because they are induced almost only by space-charge forces created by charged particles themselves. Such solution, known form some ion traps, has not been applied in quadrupole mass analyzers so far. It gives opportunity to reduce the length of the filter (miniaturization of core component) and utilization lower trapping frequencies, which leads to decreasing of required signal amplitudes (miniaturization of electronics). The result of this project will lead to emergence of new type of mass analyzers, which will be hybrid between Quadrupole Mass Analyzers and Ion Traps, taking the best of each. And will result in further miniaturization of mass spectrometers developed for new, emerging applications.

The goal of the project is extremely interesting and successful realization can lead to breakthrough in miniaturization of analytical measurements.