The analytical instrumentation, in which sample solutions are introduced *via* the pneumatic nebulization while the analytes are determined by using bulky atomization cells (flame burners, heated quartz tubes) or excitation sources (flame burners, inductively coupled plasma or microwave induced plasma burners) combined with atomic spectrometers for the radiation detection, is certainly the Achilles' heel of modern analytical atomic spectrometry. This is because the transport efficiency of the analytes into these devices is very low (just several %), hence their analytical performance for some environmentally relevant elements (for example germanium, lead, tin) is quite pour, while the measurements cannot be carried out in the field or on the sampling site. At the same time, these obvious drawbacks contribute to the development of quite new analytical devices, which would be characterized by the increased transport efficiencies of the analytes as well as smaller sizes, the possibility of using in the on-site measurements in the field and much lower costs associated with the operation of such devices.

The low-temperature and low-power plasmas, such as dielectric barrier discharge and atmospheric pressure glow discharge, are nowadays two thrillingly new radiation sources that can profitably replace the commercial atomization cells and excitation sources in order to miniaturize the analytical instrumentation and make it portable and less expensive, particularly in the case of the determination of the volatile species forming elements (100% transport efficiency) that are difficult to be measured using the pneumatic nebulization approach, i.e., germanium, lead, tin.

The aim of this project, being a joint scientific venture between two research teams from the Czech Republic and one from Poland, is the exploration of the miniaturized devices based on dielectric barrier and atmospheric pressure glow discharges as the new atomization cells for the reliable measurements of (ultra)trace elements that can be introduced into the atomic spectrometer detectors by the volatile species generation. Both miniaturized types of discharges will be investigated in reference to their feasibility to efficiently atomize and eventually excite the volatile species of elements introduced *via* chemical (e.g., germanium, lead and tin as hydrides but also copper and silver as nanoparticles) and photochemical (e.g., molybdenum, nickel and ruthenium as hydrogenated, methylated or carbonylated species) vapor generation reactions. This will require the construction of the new atomizers based on the both types of discharges, followed by their comprehensive characterization due to the selected spectroscopic properties (temperatures and concentrations of reactive species) and the course of the atomization processes (and eventually the excitation processes) and the atomization/excitation mechanism. The analytical performance of such novel atomizers will be assessed and they will be combined with atomic absorption and atomic fluorescence spectrometers (and the optical emission spectrometrs when considering their excitation potential) for the trace element analysis of samples of different matrices. To improve the detectability and the sensitivity of the measured elements offered by this new analytical instrumentation, the time resolved measurements will be carried out.

The expected result of the project will be the new analytical instrumentation with novel, miniaturized plasma based atomizers that will reduce the costs of the trace element analysis, related to the operation of the devices. In addition, the quality of measurements of several elements, commonly difficult to be measured using the commercially available approach by means of the pneumatic nebulization, will be improved. Finally, the construction of the miniaturized, plasma-based atomizers and the understanding of the atomization/excitation processes taking place in them will be particularly useful in the future for the development of the fully portable analytical instrumentation.