

## Three-dimensional mass spectrometry imaging system (3D MSI)

Mass spectrometry imaging (MSI) has become an essential tool for surface analysis of objects of natural and synthetic origin. MSI methods has achieved high sensitivity and spatial resolution in the identification of elements in metals, polymers and semiconductors. The elemental specificity of MSI has also motivated studies in medicine, biology and material sciences. In biochemistry and medicine, molecular MSI is used, for example, in studies of metabolic exchange in microorganisms, localization of drugs, metabolites in tissue, biomarker research etc. MS imaging nowadays is performed almost exclusively in two-dimensional (surface only, 2D) mode.

At the moment, there is no commercially available system capable of direct or real 3D MSI. It is extremely challenging for mass spectral imaging to map molecular composition in three dimensions.

Project objectives are: building of 3D LARESI system that is suitable for real/direct 3D mass spectrometry imaging, tests of this system and analyses of biological samples in 3D. Planned system will have two ion sources. Optical setup will consist of infrared pulsed laser with novel optical design. Proposed setup will be capable of precisely controlling of removal of chosen layers of studied material which is crucial for 3D analysis. Additionally, optics will provide very high resolution of analysis. It is planned that in this project 3D system configuration of LARESI will be made and after preliminary tests it will be used for first real 3D MSI of biological tissue. Objects that will be analyzed are plant tissues, animal tissues and also human cancer and normal kidney and bladder tissues. Results will be compared with other methods such as MALDI and with our own nanoparticle-based methods.

Selected application fields of new 3D MSI system:

- Analysis of 3D distribution of primary and secondary metabolites in plant and animal tissues
- Biomarker research - analysis of composition of cancer tissue, precise discrimination between normal and cancer tissue
- Analysis of transfer of chemicals through skin – especially important for cosmetic chemistry, analysis of metabolites of cosmetic products and their distribution
- Analysis of composition of synthetic and natural materials – polymers, composites, composition and thickness of layers etc.
- Analysis of biofilms and their interactions with materials (including biofilms on metals)
- Analysis of whole organisms
- Analysis of human skin for pathological changes in their early stages
- Analysis of mineral materials
- Analysis of wide range of materials in forensic sciences
- 3D MSI of hair for disease markers and also for drugs