EFTMS2026.org 27-30 April 2026 - Rouen, France
European Fourier Transform Mass Spectrometry Workshop

HIGH RESOLUTION MASS SPECTROMETRY IN A SPATIAL CONTEXT

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High resolution mass spectrometry (HRMS) is employed to unravel the composition of complex samples. The unique capabilities of FTMS have proven itself in a wide variety of applications. In the last decade FTMS has gained traction in the application of spatially aware analysis. Particularly in the life sciences it has been applied to the study of cellular metabolism, single cell proteomics and lipid isomer imaging through the use of dedicated fragmentation techniques. In this contribution recent innovations in FTMS based spatially aware analytical strategies are discussed ranging from fundamental image oriented structural analysis strategies, high spatial resolution source developments as well as innovative applications of FTMS as a structural analysis tool that combines native mass spectrometry with Cryo-Electron microscopy based imaging. A key objective in all of these developments is to unravel the complexity of molecules and surfaces through spatial analysis. These developments play a key role in the current spatial biology revolution where multimodal imaging is employed understand cellular signaling networks. Integration with spatial transcriptomics, image-guided LC-MS based proteomics and direct imaging metabolomics demonstrate to be able to resolve single cell details that pave the way for novel diagnostics and associated therapies. The high mass accuracy and resolving power of HRMS instruments help distinguish molecules with similar masses, enabling more confident identification and structural analysis of both single molecules as well as single pixel generated complex mixtures.
Overall, spatially aware HRMS-based bridges the gap between molecular profiling and complex molecular histology of cells and tissues. As instrumentation and computational analysis continue to improve, high-resolution mass spectrometry is expected to play an increasingly important role in the construction of detailed molecular atlases of cellular systems, complex organs and advance precision medicine.

Keywords
MALDI-MSI, imaging mass spectrometry, spatial biology, structural analysis