Development of a miniaturized Fourier transform time-of-flight mass spectrometer

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Mass spectrometry is a powerful tool to detect and analyze chemical and biological compounds. Typically mass spectrometers are either bulky and come at very high costs or lack mass resolving power and require special trained and qualified personnel. These circumstances are not suitable for establishing the mass spectrometer in further markets such as point-of-care diagnostics. Therefore, our goal is to develop a demonstrator of a cost-efficient and very compact mass spectrometer providing high mass resolution. Potential applications are metabolic profiling, monitoring of volatile organic compounds, identification of toxins in the environment, Earth observation in low Earth orbit, or gas analysis on deep space missions.
Our mass spectrometer is a miniaturized Fourier transform time-of-flight type mass spectrometer. The neutral measurement gas is ionized in the ion source by electron impact ionization. In this ion source, the created ions are accelerated and injected into the ion trap resonator. Such a resonator, as introduced by Zaifman, et al. [1], uses two opposite facing isochronous ion mirrors to trap the ions. The mass separation in such a mass spectrometer is achieved in frequency domain, since the ion velocity is characteristic for each compound and therefore also the oscillation frequency of the trapped ions will be characteristic. The big advantage of such a mass spectrometer is its ability to measure ions over the full mass range simultaneously without the need of scanning instrument parameters.
Our achievement is a miniaturized version of the described ion optical system. The miniaturization calls also for the development of a miniaturized ion detection system, which is used to measure the oscillation frequency of the ions in the resonator without influencing the path of these ions.
References:
[1] D. Zajfman, et al., Electrostatic bottle for long-time storage of fast ion beams, Phys. Rev. A, Vol. 55, No. 3, R1577–R1580, March 1997.