Fourier Transform Operating Mode for a 3D Quadrupole ion Trap : Fourier Transform Quadrupole Ion Trap Mass Spectrometer (FTQIT/MS)

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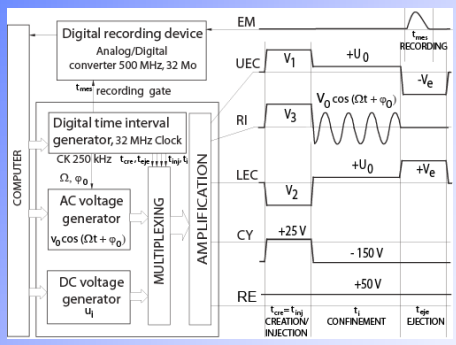
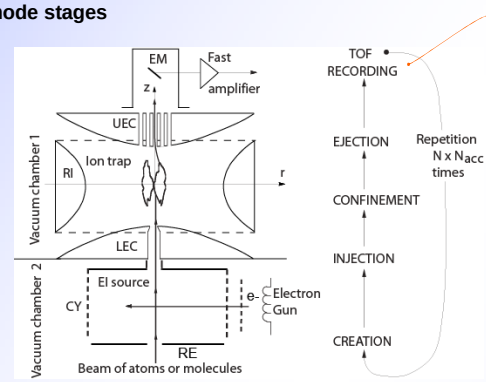
1 Experimental set-up & succession of the operating mode stages



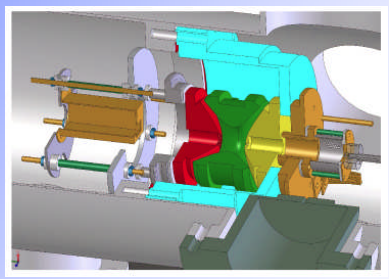
Control, measure and power supply unit

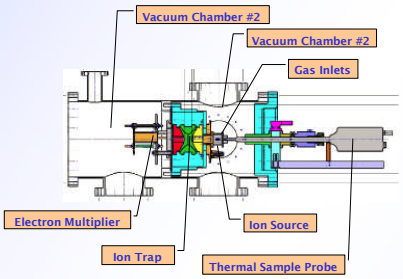
Potentials applied to the electrodes. EM signal



Ion source, ion trap and electron multiplier

Stages of one experiment. Succession of experiments for increasing confinement durations (t_i).





- ✓ Constant values of the confinement parameters: V_0 & Ω
- ✓ Secular axial frequency measurement => m/z
- ✓ As Te = T_Ω, only secular frequencies are detected
- ✓ No perturbation during confinement:
  - Vacuum inside the trap (~10^{-7} torr)
  - Pure quadrupole ion trap
  - Pure electric field: $U_0 + V_0 \cos \Omega t$
- ✓ Initial confinement conditions giving the optimal detection dynamic:
  - Distribution of off-centred positions In a small range (ca 1-2 mm) along axial direction, and zero-centred in radial plane
  - zero-centred distribution of velocities

3 Secular radial frequency measurement

by radial discrimination of the ejected ions

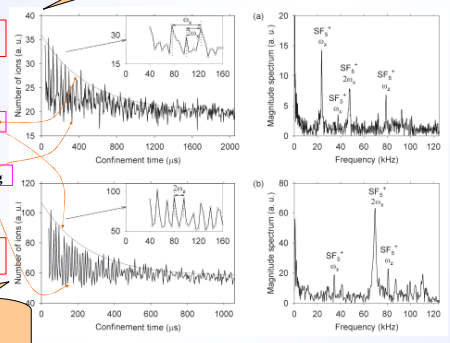
Detection of the number of confined ions with a reduced ejection flue / to the maximal extension of the ion cloud in the radial plane during confinement

Reduced and off-centred small ejection holes allow detection of ω_x and 2 ω_x

Decreasing of the maxima => ion loss

Constant minima values => no ion cooling

Reduced and centred small ejection holes allow detection of 2 ω_x

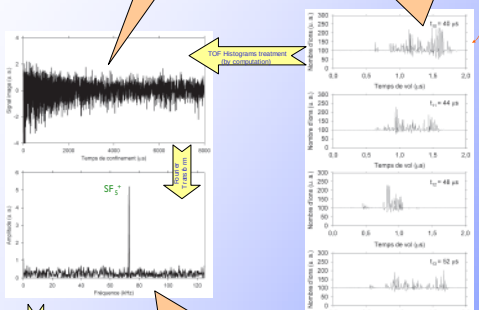


Studies of:
- ion loss & ion cooling processes
- Ion lifetime
- Secular radial frequency spectra

2 Secular axial frequency measurement

Image Signal

Measure : a set of N Time-Of-Flight histograms

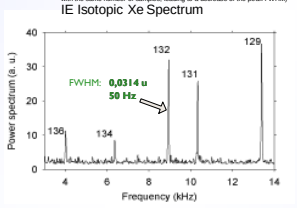


Frequency spectrum of the secular axial trajectories of the simultaneously confined ions

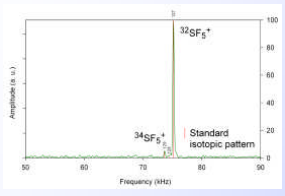
Secular Axial frequency => m/z ratio of the confined ion

4 Main experimental results

Optimal experimental Resolution
(with undersampling in order to increase the temporal window of observation with the same number of samples, leading to a decrease of the peak FWHM)
IE Isotopic Xe Spectrum



Sensitivity of detection of a low-amplitude peak near the main peak of the spectrum (at 100 %)
IE Isotopic SF_6 Spectrum



5 Applications

High sensitivity and high resolution in-line mass analysis

Currently:
In-line direct dioxin-trace analyser schedule
Coupling of an Adsorption device, a thermo desorption device and a mass spectrometer. The adsorption device employs a set of selective adsorption materials (zeolites).

In the offing:
Miniature mass spectrometry (Mass filter and Ion Trap) for nuclear fission products (Xe/Kr and H/He) measurement:
from the consumed fuel in laboratory,
and inline, in Material Testing Reactor,
in collaboration with Stephen Taylor, Department of Electrical Engineering and Electronics, Liverpool University, UK.

6 Bibliography

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