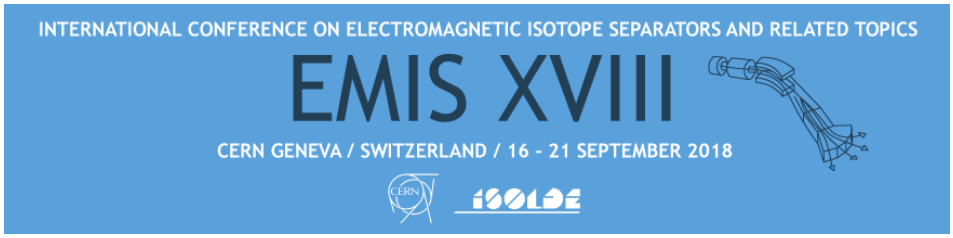

Contribution ID: **135** Type: **Poster**

TOF/FFT Hybrid Mass Analysers

Monday, 17 September 2018 18:06 (1 minute)

As it is well known isochronous periodic structures (electric or magnetic) are used for mass measurements either as Time of Flight (TOF) mass analysers (MA) or Fast Fourier Transform (FFT) mass analysers with image charge detection. In this study we demonstrate that both the operational modes can be implemented in a single and compact hybrid mass analyser. Such an instrument can be run in one of the two complimentary modes - multi-pass TOF with lower m/dm, but faster mass analysis, or FFT mode with higher m/dm and slower analysis. Two examples are presented: (i) a multi-reflection coaxial mirror analyser, and (ii) a rotationally symmetric multi-turn sector field analyser.

Analysers of the 1st type are widely used in nuclear physic experiments as MR-TOF instruments [1-5]. Many authors have also used similar systems as electrostatic ion traps with image charge detection and FFT analysis [6-9]. In this work we describe a 400 mm long MR-TOF, which can work in two complimentary modes - as a MR-TOF instrument with m/dm˜100 k (fwhm), or an electrostatic ion trap with m/dm>600 k (fwhm).

Analysers of the 2nd type [10] comprise a pair of polar-toroidal sectors S1 and S3, a toroidal sector S2 located at the mid-plane of the system, lens electrodes for longitudinal and lateral focusing, each set of the electrodes being mirror symmetric with respect to the mid-plane. In the multi-turn TOF operational mode drift focusing segments are additionally used to provide focusing in the drift direction. It was demonstrated earlier that in the multi-turn TOF mode the analyser achieves at least ˜200 k (fwhm) of m/dm [11]. In this work we present three similar analysers - with 500 mm, 250 mm and 120 mm diameter of the external electrode. The largest of the three is the most appropriate for the use in the multi-turn TOF mode. Its simulated m/dm for 5 keV 400 Th ions is~ 400 k (fwhm) at typical flight times of about 2.2 ms. The large size, however, makes it rather slow for running in the FFT mode. On the contrary, the smallest analyser is the fastest of the three and the most appropriate for the use in the FFT only mode. The 5th harmonic of the FFT signal provides m/dm of~ 800 k (fwhm) after ˜1 sec of measurement time. In the multi-turn TOF mode its estimated m/dm is only ˜15-20 k. The intermediate size (hybrid) analyser demonstrates m/dm~ 100k (fwhm) in the multi-turn TOF mode and m/dm of~ 800 k (fwhm) after~ 2.1 s measurement time. It can be used in one of the two complimentary modes - multi-turn TOF or FFT.

Keywords: TOF mass spectrometry, FFT mass spectrometry, Mass spectrometers, Ion optics, Aberrations

References:

[1] H. Wollnik and M. Przewloka. Int. J Mass Spectrom. Ion Process. 96 (1990) 267-74.

[2] W. R. Plaß, T. Dickel and C. Scheidenberger. Int. J. Mass Spectr. Ion Process. 349 (2013) 134-44.

[3] P. Schury, K. Okada, S. Shchepunov, T. Sonoda, A. Takamine, M. Wada, H. Wollnik and Y. Yamazaki. Eur. Phys. J. A 42 (2009) 343-349.

[4] R. N. Wolf, M. Errit, G. Marx and L. Schweikhard. Hyperfine Interact. 199 (2011) 115-22.

[5] A. Piechaczek, V. Shchepunov, H. K. Carter, J. C. Batchelder, E. F. Zganjar, S. N. Liddick, H. Wollnik, Y. Hu and B.O. Griffith. Nucl. Instr. and Meth. B 266 (2008) 4510-4514.

[6] W.H. Benner. Patent US005880466, 2 June 1997.

[7] C.D. Hanson. Patent US006013913, 6 February 1998.

[8] D. Zajfman, O. Heber, H. Pedersen, Y. Rudich, I. Sagi and M. Rappaport. Patent US2002190200 (A1), 18 June 2001.

[9] D. Zajfman, O. Heber, L. Vejby-Christensen, I. Ben-Itzhak, M. Rappaport, R. Fishman and M. Dahan. Phys. Rev. A 55 (1997) R1577.

[10] V. Shchepunov and R. Giles. Patent GB201118279A, 21 October 2011.

[11] V. Shchepunov, M. Rignall, R. Giles and H. Nakanishi. Shimadzu Review Vol. 72, No. 3・4（2015) 141.

Primary authors: Dr SHCHEPUNOV, Vyacheslav (Shimadzu Research Laboratory (Europe) Ltd); Dr RIGNALL, Michael (Shimadzu Research Laboratory (Europe) Ltd.); Dr GILES, Roger (Shimadzu Research Laboratory (Europe) Ltd.); Dr FUJITA, Ryo (Shimadzu Research Laboratory (Europe) Ltd.); Dr NAKANISHI, Hiroaki (Wharfside, Trafford Wharf Road, Manchester, M17 1GP, United Kingdom); Dr WAKI, Hiroaki (Shimadzu Research Laboratory (Europe) Ltd.)

Presenter: Dr SHCHEPUNOV, Vyacheslav (Shimadzu Research Laboratory (Europe) Ltd)

Session Classification: Poster Session 1

Track Classification: Ion optics and spectrometers