3RD INTERNATIONAL CONFERENCE ON
EXOTIC NUCLEI AND ATOMIC MASSES
July 2-7, 2001, Hämeenlinna, Finland

Direct evidence of beam emittance reduction using a gas-filled radiofrequency quadrupole ion guide

S. Henry, C. Bachelet, Z. Djouadi, C. Gaulard, M. de Saint Simon and D. Lunney
Centre de Spectrométrie Nucléaire et de Spectrométrie de Masse (IN2P3-CNRS)
Université de Paris Sud, F-91405 Orsay, France

The emittance is the all important characteristeric of an ion beam and has a decisive influence on the sensitivity of precision experiments using radioactive beams. Since Liouville's theorem tells us that beam emittance is conserved under the influence of electromagnetic beam optics, often the only way to increase sensitivity is to cool the beam, but while ensuring minimal loss in intensity. Beams of short-lived radionuclides impose the additional constraint of requiring the cooling process to be very fast.

A gas-filled radiofrequency quadrupole mass filter, first used in an MS-MS (molecular fragmentation) instrument [1] and later designed for use with accelerated isotopic beams [2] has now found its way into the mainstay of radioactive beam facilites: LISOL [3], ISOLDE [4], JYFL [5], and ANL [6], for example. All of these installations use a segmented quadrupole rod system [7] where the ion motion is damped by interaction with light, neutral gas molecules. A new system has been developed at Orsay that cools a continuous beam [8]. In parallel, we have developed a very compact emittance-meter especially designed for use with weak beams of relatively small emittance - such as those of our quest (the dream beam).

Recent results using a 5 keV test beam, slowed to about 50 eV and cooled in a 500 mm long quadrupole, show that excellent transmission is maintained while significantly reducing the beam emittance. These are the first results in which the transverse emittance is actually measured and as such, a direct proof of beam cooling using this technique.

We acknowledge the technical assistance of J.-F. Képinski, M. Jacotin, G. Conreur and D. Ferraz. We also thank the ISOLTRAP collaboration for the loan of segmented quadrupole pieces. This work supported by the IN2P3 (CNRS) of France and the European RTD Research Network EXOTRAPS (contract no. ERBFMGCET980099).

References

[1] D.J. Douglas and J.B. French, J. Am. Soc. Mass Spectrom. 3 (1992) 398
[2] M.D. Lunney and R.B. Moore, Int. J. Mass Spectrom. 190/191 (1999) 153
[3] P. Van den Bergh et al., Nucl. Inst. Meth. A333 (1996) 194
[4] F. Herfurth et al., Nucl. Inst. Meth. A (2001) in print
[5] A. Nieminen et al., (APAC99 Proceedings) Hyp. Int. 127 (2000) 507
[6] M. Maier et al., (APAC2000 Proceedings) Hyp. Int. (2001) in print
[7] A. Kellerbauer et al., Nucl. Inst. Meth. A (2001) in print
[8] S. Henry, Doctoral thesis, Université de Strasbourg - Louis Pasteur, 2001