The History of Quadrupole Mass Spectrometry at VG - Micromass - Waters

Mike Morris, Steve Bajic, Kate Whyatt, Keith Worrall, Dave Gordon, Mark Roberts, Richard Moulds, Lance Nicolayes, Nicholas Ellor, Viki Brooks, Amir Farooq

COMPANY BACKGROUND
VG Instruments was formed in 1962 (Vacuum Generators Limited) to provide ultra-high vacuum components and systems. In 1975, VG Micromass was formed to specialise in mass spectrometry and in 1976 was fragmented into four VG brands: VG-Optima, VG Micromass, VG Inorganic and VG Isotopes. In 2000, VG-Micromass was acquired by Waters Corporation, along with VG Systems. The rationale behind the reorganization of small companies was Bernard Eastwood’s Christmas card principle: most people send Christmas cards to between 50 and 100 people, and this represents a natural maximum number of people with whom to collaborate.

SINGLE QUADRUPOLES
The first quadrupole mass filters from the VG stable were introduced in 1971 by VG Quadrupoles, with the Q (m/z range 120) and Q1000 (m/z range 10,000), and were available either as a stand-alone system or as part of a complete analytical system, in either a triple or quadrupole configuration. Dual ionisation capability (for example electron impact/EI; chemical ionisation/CI) and API gas analyses (RIA applications) were introduced. The instruments were equipped with 1.5, 2.4 and 3.0m long columns. This was the first instrument to be launched with the Windows-based MassLynx data system. Other capabilities that were introduced with the Platform software were Accessory selection and analysis for synthetic chemistry, and the MassLynx deconvolution software for use in the analysis of complex mixtures. These were available as software modules to deliver accurate mass measurement (M+Ht to m/z 500) in a routine environment using (A4-bit Digital) Fast Fourier transforms (FFT).

In 2000, a pair of instruments based on the same architecture was released – the Waters ZQ single quadrupole and the Quattro micro triple-quadrupole. Both of these instruments were designed to be part of an LC-MS system. The integration with liquid chromatography was a step further in 2003 with the delivery of the single and tandem quadrupole instruments designed to work with the ACQUITY UPLC system. Capabilities included the SGI and TGD, facilitating method development with the introduction of on-board UltraTag and new software functionalities.

The second generation of the TRIO-1 in 1988, the TRIO 1000, saw the introduction of the PC-based data system and LabBase instrument control and data processing. The TRIO-2 was a research-targeted multi-int (GC/LC-MS) single quadrupole instrument with an increased mass range vs the TRIO-1. The Quattro I was introduced in 1993, the last EI/CI/Atmospheric Pressure Ionisation switchable dedicated for vacuum or quadrupole was the Quattro LC, introduced in 1996, which depending on the target applications. This was the first Micromass instrument to use RF-transfer lenses between the embedded transputer and as well as the facility for using packed GC columns with a jet separator. In addition, direct sample introduction (heated filament and solids) probes were available.

The current state-of-the-art single quadrupole, the QDa, was launched in late 2013, and specifically designed as a detector for use with liquid chromatography. The QDa was the first mass detector fully configured within the LC stack, with the intention of bringing the benefits of mass spectrometry to the chromatographer, and incorporated built-in calibration and operation with broad tuning parameters.

TANDEM QUADRUPOLES
The first tandem quadrupole instrument from VG Micromass in 1984 was the TRIO-3 with dual optical detectors and controlled with a PDP 11/73 data system. The dual detectors permitted switching between MS and MS/MS modes in 50ms, and allowed mixed mode scanning experiments as well as data-dependent analyses.

The first dedicated atmospheric pressure ionisation triple quadrupole was introduced in 1991 at the VG BioQ with electrospray ionisation. The BioQ was marketed primarily for infusion analysis of proteins. In combination with MassLynx, the BioQ was also the last quadrupole instrument that used infusion vacuum pumps.

In 1989, the Quattro I was followed by the Quattro II which was a multi-int tandem quadrupole instrument and was the last EI/CI Atmospheric Pressure Ionisation switchable tandem quadrupole, with all tandem quadrupole benefits from being indicated for vacuum or atmospheric based collision altes.

The first benchtop triple quadrupole was the Quattro LC, introduced in 1996, with a mass range of 10,000 on the target applications. This was the first Micromass instrument to use RF-transfer lenses between the embedded transputer control system to embedded PC control, as well as the introduction of the dual orthogonal ESI-applied ion source, internally referred to as the 'goldfish bowl'. The introduction of the multiplex (MUX) interface in 1999 allowed for the introduction of 4 or 8 parallel LC streams simultaneously into the ESI ion source and the analyser. The Quattro LC also saw a move away from the vacuum pumps.

In 1994, the Quattro II was followed by the Quattro II which was a multi-int tandem quadrupole instrument and was the last EI/CI Atmospheric Pressure Ionisation switchable tandem quadrupole, with all tandem quadrupole benefits from being indicated for vacuum or atmospheric based collision altes.

The BioQ was followed in 2000 by the Quattro Ultima Pt, which saw enhancements in usability with the introduction of the Universal Ion Source that would allow for a full range of ionisation techniques to be used from ESI/ESI/APC/TOF to APC. The Quattro Ultima Pt also saw enhancements in usability with the introduction of the Universal Ion Source that would allow for a full range of ionisation techniques to be used from ESI/ESI/APC/TOF to APC. The Quattro Ultima Pt also saw enhancements in usability with the introduction of the Universal Ion Source that would allow for a full range of ionisation techniques to be used from ESI/ESI/APC/TOF to APC. The Quattro Ultima Pt also saw enhancements in usability with the introduction of the Universal Ion Source that would allow for a full range of ionisation techniques to be used from ESI/ESI/APC/TOF to APC. The Quattro Ultima Pt also saw enhancements in usability with the introduction of the Universal Ion Source that would allow for a full range of ionisation techniques to be used from ESI/ESI/APC/TOF to APC. The Quattro Ultima Pt also saw enhancements in usability with the introduction of the Universal Ion Source that would allow for a full range of ionisation techniques to be used from ESI/ESI/APC/TOF to APC.