# The history of single and multiple quadrupole mass spectrometers at Riber, Ribermag, Nermag, Delsi-Nermag Gérard Devant, Claude Beaugrand, O. David Sparkman, Christian Rolando, Christian Soulier, Patrick Arpino\*

## Early days



Alain Varon, Michel Desforges, François Jalenques



12 rue Jean Edeline, Rueil-Malmaison, previously a 19th century laundry factory



**1964**: Alain Varon (1928-2006), Michel Desforges (1928-2000), François Jalenques (1928-2002) founded Riber with an initial mission to provide high vacuum equipment.

The first factory was set up in several old buildings in the center of Rueil-Malmaison, France, one of which was a former 19th-century laundry. From there, Riber developed and commercialized a series of quadrupole mass filters and their associated power supplies that differed in size and performance. Small quadrupoles of the QS series were the heart of residual gas analyzers. Model QHD was a hydrogen leak detector for monitoring nuclear power plants. Larger models were used by physicists who fitted them into customdeveloped instruments, Auger electron spectroscopy and secondary ion mass spectrometry (SIMS).

**1975**: The QMM-17 guadrupole with four 6.35-mm diameter round rods was integrated into the QSM-17 GC/MS nstrument, in which the mass filter was coupled to an Intersmat GC via a glass jet separator. The mass range was limited to m/z 300, and ion signals were displayed on a strip-chart recorder. It was soon replaced by a new GC/MS that took advantage of the higher-performing SQ156 quadrupole analyzer.

1976: Riber became a division of Instrument SA, which was itself a bsidiary of the French engineering conglomerate Creusot-Loire. The Riber subdivision in charge of the GC/MS development program was Ribermag.

1978: Ribermag became an independent GC/MS manufacturer, changed its name to Nermag, and moved to a new location on Quai du Halage, along the Seine river

**1982:** Nermag joined the Giravions Dorand Industries, a company with a division already manufacturing Delsi GCs. From this union Delsi-Nermag was created.





**1978** Nermag - The company moves to new premises in Rueil-Malmaison Quai du Halage

## The R 10-10 story



SQ156 quadrupole within its field protection shield



Size comparison between QM-17 and SQ156

GC/MS R 10-10 C Interfaced to a Carlo Erba GC,

DEC 11/23 computer and SIDAR 111B Data system

Compact GC/MS R 10-10 T equipped with turbomolecular

vacuum pumping and IBM PC based data system

Quadrupole filter model SQ156, with its associated power supply, consisted of four large round rods, each with a diameter of 15.6 mm, making it one of the largest dimension quadrupoles ever commercialized. It was the heart of all subsequently produced Ribermag and Nermag GC/MS systems, optimizing the quadrupole length and the power supply RF amplitude to increase the initial instrument mass range of m/z 750, to m/z 2000, and later to 4000.

**1976:** The first R 10-10 GC/MS system was installed in CERN, Ispra, Italy. Two oil diffusion vacuum pumps (250 L/ s and 50 L/s respectively) permitted to couple either a conventional packed, or an open-bore capillary column, directly to the ion source, without a carrier-gas separator. The unique ion source could be operated either under electron impact (EI) or chemical ionization mode (CI) without any geometric modification. Switching from EI to CI required only the addition of a suitable CI reagent gas. The initial conventional electron multiplier detector was later replaced by an ion-photon conversion detector.



The model R 10-10 GC/MS series was manufactured 1978 to 1992, As improvements to performance were made, models designated with were different suffixes (-B, -C, -T, and -H). Quadrupole length was increased from 250 mm to 350 mm. The m/z upper limit was increased successively from 600, to 1500, and then to 4000 with a resolution of 6000. About 200 instruments of the marketed. series were mainly the R 10-10-C model.

chemical ionization

1982: Fast Atom Bombardment accessory (probe and gun)



**1982** Delsi-Nermag

000

NERMAG R 10.10 T

**1988** New premises in Argenteuil. Ceselsa takes control of Delsi-Nermag



Automass System 1

### Three quadrupoles in series, and more



**1983:** Nermag introduced the R 30-10 model, which combined three tandem quadrupoles (QqQ MS/MS device), including two 350 mm long analytical quadrupoles and a smaller intermediate collision chamber. The vacuum system included two 1000 L/s (He) oil diffusion pumps. In 1986, the upper Q<sub>1</sub> mass range was extended from m/z 2000 to m/z 4000. This device is particularly powerful for basic research and for quantitative analyses at very low detection thresholds.

Prototype triple quadrupole R 30-10 under development in Rueil-Malmaison factory



R 30-10 triple quadrupole QqQ assembly compared to the size of a cigarette pack



Only about twenty R 30-10 instru ments were produced in Rueil-Malmaison. They were sold mainly in the United States to laboratories in the pharmaceutical industry,. They also acquired by some were prestigious university laboratories, including those of Carl Djerassi at Stanford and of John B. Fenn at Virginia Commonwealth University.

Professor John B. Fenn, Nobel prize 2002, in front of his Nermag R 30-10 at Virginia Commonwealth University. Reproduced with permission, credit to Allen Jones / VCU University Relations.





**1995** Bought by Thermo Electron Finnigan Automass System 3



Nermag pentaquadrupole prototype for MS/MS/MS experiments, 1482 mm long from source to detector, assembled at the Ecole Normale Supérieure (Paris). Claude Beaugrand, Daniel Jaouen, Christian Rolando, and Nicole Morin (standing on a pedestal).

Delsi-Nermag undertook several collaborative projects with university teams in France, in particular at the Paris University of Jussieu (Richard Cole, Jean-Claude Tabet et al.) for the development of a device combining quadrupoles four interfaced to a Surface Induced Dissociation ion source; and at the École Normale Supérieure (Christian Rolando et al.) for the development of a device combining five quadrupoles, for MS/MS/MS analyses. The latter provided one of the first experiments of ion trapping in a linear quadrupole.

However, neither of these instruments was ever commercialized, leaving only the prototypes in the university laboratories where they had been developed.

### The Automass program

1988: Delsi-Nermag, now under the control of the Spanish engineering company Ceselsa, launched the Automass, a compact, entirely automated GC/MS instrument built around Nermag's iconic large rod -15.6-mm diameter -, quadrupole filter. The patented bright ion source was mounted on a ball bearing guide and was electrically motorized, providing precise positioning, easy access and minimum maintenance. The instrument included, two turbomolecular vacuum pumps, an ion-photon conversion detector coupled to a photomultiplier, an IBM PC computer system, and proprietary Lucy software for data acquisition and processing.

1992:The initial 1988 Automass System 1 was updated to System 2 by the company's new owner, ATI Unicam.

1995: System 2 was updated to System 3, (mainly with changes to electronics and substitution of a different GC) by Finnigan Corporation, yet another new owner.

At the beginning of the Automass program, Delsi-Nermag established a partnership contract with JEOL for OEM sales in Asia Pacific and Japan that resulted in the sale of ca. 900 units between 1988 and 2002. The remainder of the production, ca. 400 units, was sold mainly in Europe by the successive Delsi-Nermag owners.



