

## THE EVOLUTION OF THE MULTICollectOR IN ISOTOPE RATIO MASS SPECTROMETRY

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Multicollection of ion beams with flat topped peaks is one of the unifying principles of isotope ratio mass spectrometry. Mass spectrometers used for measurement of isotope ratios are classified by either their ion source or by applications, and multicollection is now used in a wide variety of mass spectrometers, including IRMS, noble gas (both EI), TIMS, ICPMS, SIMS, and SSMS. Because it is necessary to measure more than one ion beam in order to form a ratio, and because the users have always demanded improved measurement precision, it is the performance differential between single collectors and multicollectors that has driven the evolution of collector arrays. Current isotope ratio mass spectrometers all evolved from single collector instruments. There is considerable diversity in the practice and design of multicollectors and it is instructive to look at the evolution of multicollection in the light of the mechanisms of biological evolution:

### **Biological evolution**

Cambrian explosion  
Evolutionary hot spots  
Unicellular organisms at the base  
Elaboration of existing designs  
Repetition of somatic elements  
Enhancement by novel designs  
  
Alternative designs  
Symbiotic incorporation  
Increase in complexity  
Hybridization  
New use for existing technology:  
Gene exchange between taxa

### **counterpart in multicollector ICPMS**

Manhattan project  
Bremen, Germany; Manchester, UK  
Single Faraday collector EI MS at the base  
Faraday cups become shielded, deeper, lined  
Development of n-Faraday arrays (n<13)  
Moveable platforms, retardation and zoom lenses  
SEM, Daly knobs, photoplates  
Addition of SEM to collector array  
Arrays with variable mass resolution  
ICPMS + TIMS = MC-ICPMS  
use Faraday cups as capacitors  
retardation lenses from TIMS to IRMS and ICPMS

Even with " 2,500 multicollector instruments in operation, the pace of evolution has not slowed down. The hyphenation of the ICP with TIMS multicollection has led to an evolutionary "arms race" not unlike that pursued by dinosaurs, where a wide variety of original designs have been developed within an overall trend towards giantism. The current multicollector array of the MC-ICPMS from Finnigan MAT can measure either positive or negative ions simultaneously in 9 out of 19 possible collectors, and includes 8 moveable platforms each of which can hold a Faraday cup and an ion counting electron multipliers, variable slits to enable multicollection with flat top peaks at high mass resolution for interference free measurements, a retardation lens to reduce tailing and reflected ions. Aspects of evolution for analogues in multicollection can be sought include endemism, simplification through loss of function, and extinction.

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