National Electrostatics Corp.
7540 Graber Rd., P.O. Box 620310, Middleton, WI 53562-0310 USA

Single Stage Accelerator Mass Spectrometry (SSAMS)

DESIGN

The Single Stage Accelerator is based on an air insulated 250kV deck. This accelerator is the basis of a complete Accelerator Mass Spectrometry (AMS) System specially constructed to measure the amount of ^{14}C in small graphite samples to a precision of 0.3% or better. This system employs the fast, 10 Hz, sequential energy pulsing technique first used in the early 1980's by the group at Eidgenössische Technische Hochschule, ETH, Zurich. In this system a beam of C^- ions is produced by bombarding the cool cesiated surface of a graphite sample with about 5 keV Cs^+ ions. The C^- beam produced by the sputtering of the sample by the Cs^+ beam is accelerated, focused, and mass analyzed into mass 14, 13, and 12 amu beams. These beams are then accelerated to about 275 keV in sequence by successively changing their energy as they pass through the mass analyzer so that they are on the correct trajectory for transmission into the Single Stage accelerator. The energy changing sequencer is adjusted about 10 times per second so that about 1 part in 10^5 of the mass 12 beam, 1 part in 10^3 of the mass 13 beam, and 99.8% of the mass 14 beam passes into the accelerator keeping average accelerated and beam loading currents very low and X-rays produced directly or indirectly by high energy ions also very low. The beam of negative ions is 275 keV in energy when it reaches a region of relatively high gas pressure, the molecular ion dissociator canal, located on the high voltage deck. The fast moving negative ions lose electrons and become predominantly C^+ ions when passing through the canal. Also critical to the AMS process, negative molecular ions such as CH^- and CH^{-2} are broken into C^{+n} and H^+ ions by the dissociator gas. This eliminates interferences that might be caused by molecular ions when counting $^{14}C^+$ ions later in the system.

The singly charged ions are magnetically deflected and focused at 90° by the analyzing magnet so that the pulses of $^{12}C^+$ and $^{13}C^+$ can be separated from the $^{14}C^+$ and measured in Faraday cages. The $^{14}C^+$ ions and a small number of $^{12}C^+$ or $^{13}C^+$ ions from the molecular breakup in the terminal that have exactly the right energy to be transmitted around the 90° magnet then pass into a 90° electrostatic spherical analyzer (ESA) which deflects the faster $^{12}C^+$ and $^{13}C^+$ ions away from the $^{14}C^+$ ion beam path. The ESA also provides a final focusing so that the $^{14}C^+$ ions are transmitted to a solid state detector where they are counted. By recording the ^{12}C and ^{13}C currents and ^{14}C counts as known and unknown samples are sputtered, the amount of ^{14}C present in a sample is determined to high accuracy.

With appropriate corrections for how the ^{14}C came to be in the sample, the years of radioactive decay and a chronological age can then be found.

[SSAMS]

SSAMS

SPECIFICATIONS

Insulating Column Voltage:	250 kilovolts
Voltage Stability:	Better than 0.01% per hour after 1/2 hour warmup
Voltage Ripple:	0.03% rms
Single Charged Ion Energy Range:	to 275 keV
High Voltage Power Supply Current Rating:	1 milliamp

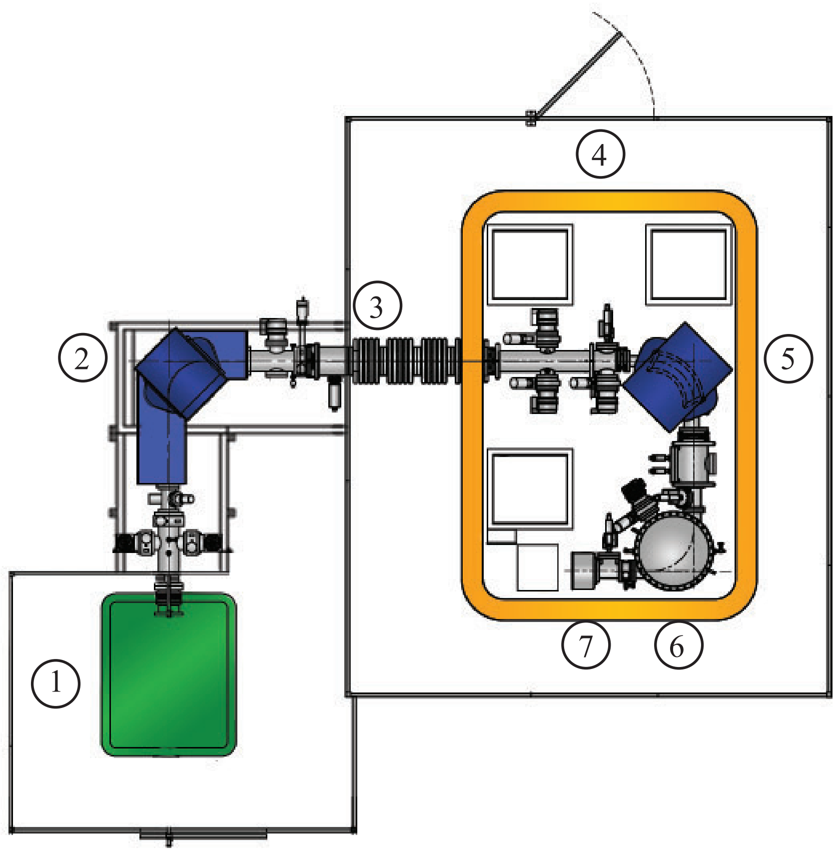
Acceptance Test Values

C^- Pulsed	50μA

Ratio of $^{14}C/^{12}C$ from measurements of three (3) “modern” graphite carbon samples with a precision of 0.3% or better, using known solid samples of unlimited size provided by the buyer.

Ratio of $^{13}C/^{12}C$ currents from three (3) solid graphite samples of unlimited size 0.3% or better.

Ratio of $^{14}C/^{12}C$ for three (3) dead graphite samples 2.5×10^{-15} or lower, using Alfa Aesar graphite supplied by NEC.



1. 40 sample or 134 sample cesium sputter source
2. 90° injector magnet with insulated chamber for sequencial injection
3. 250kV acceleration tube
4. 250kV insulated deck
5. 90° analysis magnet with wide exit pole for abundant isotope measurement
6. 90° electrostatic spherical analyzer
7. solid state particle detector for measuring ^{14}C events

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