National
Electrostatics
Corp.

Single Stage Accelerator Mass Spectrometry (SSAMS)

单极加速器质谱

DESIGN 设计

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.

单极加速器基于 250KV 的空气绝缘板。这个在完整加速器质谱系统基础上，特制用于测量小石墨样品中的 14C，精度可以达到 0.3%或更好。

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.
本系统采用的快速，10Hz，连续能量脉冲技术（首次应用在 1980 年代初由集团在 eidgenössische 工业学院，ETH，苏黎世）。

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.

在这个系统中，C-离子束是用大概 5 keV Cs^+离子来轰击石墨样品的铯表面而产生。

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.

C-离子的产生通过 Cs^+离子束溅射样品，C-离子被加速，聚焦，然后质谱分析器分离成 14， 13， 12 质量数。

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.

这些离子束然后通过 275KeV 加速，然后当他们通过质量分析器时改变能量，以使得他们以正确的轨迹传输到单级加速器。

The energy changing sequencer is adjusted about 10 times per second so that about 1 part in 105 of the mass 12 beam, 1 part in 103 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.
能量变化的时序器调整大约每秒 10 次，以至于质量数 12 的离子束 $1/10^5$，质量数 13 的离子束的 $1/10^3$， 以及 98%的离子束通过加速器并保证了平均的加速，并且离子束载入电流非常小，并且由于高能量离子束直接或间接产生的 X 射线会很小。

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.
负离子束在能量是 275keV，当达到相对高气体压力，分子离解通道，安装在高电压板。快速移动的负离子失去电子，变成主要的 C+离子当通过通道时。

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.

对于 AMS 同样重要的是：负分子离子束比如 CH- 和 CH_2^- 将转变成 C^+_n 和 H+离子，当通过铯气体时。可能由分子离子产生的干扰的消除会在系统后。

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.

单电荷离子的磁偏转和聚焦在 90°通过磁铁，C12+离子和 C13+离子将会从 C14+离子中分开，并由法拉第杯检测。

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.
14C 离子和少量的 12C +或 13C +离子从分子的分裂在终端有正确的能量被传输的 90°磁铁周围然后进入 90°静电分析仪（ESA）将更快的 12C +和 13C 离子远离 14C 离子光路。

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.
ESA 也提供一个最终的聚焦，以使得 C14+离子可以被传输到一个固定的检测器中（被离子计数）。通过记录 C12 和 C13 电流，C14 计数（已知样品和未知样品飞溅出），样品 C14 数量测量保持了高的准确性。

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.
随着对样品中 C14 适当的更正，放射性衰变的年和年龄都可以发现。

National
Electrostatics
Corp.

SSAMS

SPECIFICATIONS 技术指标

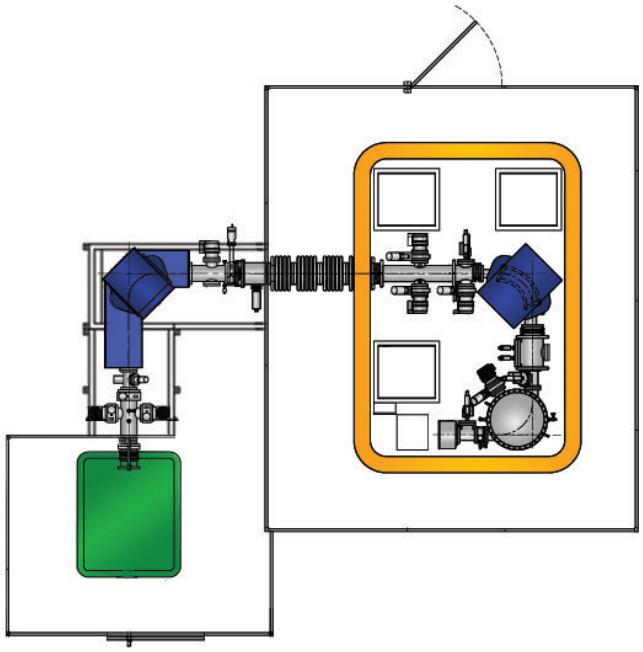
项目	参数
Insulating Column Voltage 绝缘柱电压	250 kilovolts
Voltage Stability: 电压稳定性	Better than 0.01% per hour after 1/2 hour warmup
Voltage Ripple 电压波动	0.03% rms
Single Charged Ion Energy Range 单电荷离子能量范围	to 275 keV
High Voltage Power Supply Current Rating 高压电源额定电流	1 milliamp
Acceptance Test Values C- Pulsed 验收测试值 C 脉冲	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.
使用由客户提供的已知不限制大小的样品，三次测量“现代”石墨碳的样品，C14/C12 精度可达 0.3%或者更好。

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

对于固体石墨样品，不限制尺寸三次测量 13C/12C 比值不超过 0.3%。

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 samplecesium sputter source

   40 样品或 134 样品铯溅射源

2. 90° injector magnet with insulated chamber for sequencial injection

90°注射磁铁与顺序注射隔离室

3. 250kV acceleration tube

250kV 加速管

4. 250kV insulated deck　250KV 绝缘甲板

5. 90° analysis magnet with wide exit pole for abundant isotope measurement

90° 分析磁铁，包括为大量测量的宽出口极

6. 90° electrostatic spherical analyzer

90° 静电球形分析器

7. solid state particle detector for measuring ^{14}C events

测量 C14 固体粒子探测器