SSAMS

Single Stage Accelerator Mass Spectrometry

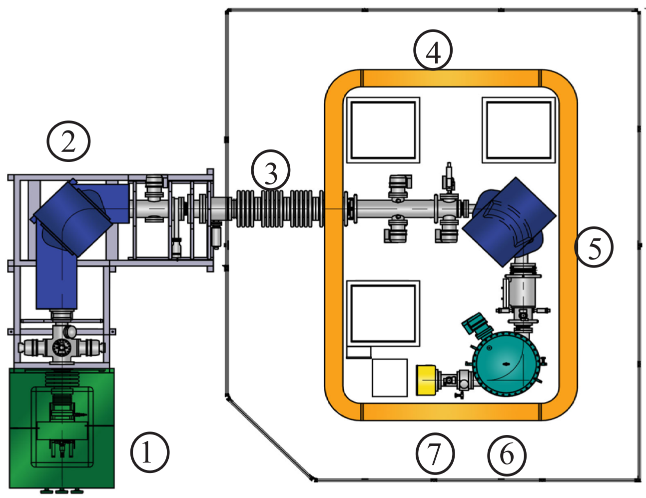
The Single Stage Accelerator Mass Spectrometer (SSAMS) is a tandem mass spectrometer consisting of a low-energy mass spectrometer that sorts the three carbon masses and sends them in a precisely controlled sequence through a single stage of acceleration to an air-insulated 250 kV deck.

Design

On the deck, the ions pass through a gas stripper that breaks up molecules and changes the ion charge states. The ions then pass through a second mass spectrometer, in tandem, which separates the three carbon isotopes. The SSAMS can measure ^{14}C and the stable isotopes of carbon with the same high precision and low background as other AMS systems without the need for a vacuum insulated pressure vessel, SF_6 or other insulating gas, or troublesome high-voltage cables or feedthroughs.

The SSAMS employs the same 40-sample and 134-sample NEC MC-SNICS ion sources as other NEC AMS systems. Configurations are available for one or two sources and sources are available for use of graphite samples or direct CO_2 samples. The MC-SNICS is the most widely used AMS source in the world due to its ruggedness, reliability, and easy maintenance. The SSAMS shares the NEC sequential injection system used on all NEC AMS systems, based on concepts pioneered by Eidgenossische Technische Hochscule, ETH, Zurich, though completely modernized by NEC over the past 25 years.

As in all other AMS systems, the ion source produces negative carbon beams by cesium sputtering. A 90^{O} injection magnet separates the ion masses. Masses 12, 13, and 14 are switched rapidly by altering their energies as they pass through the magnet. An off-axis Faraday cup measures mass 12 during the mass 13 injection, and mass 13 during mass 14 injection. Injected masses pass through an acceleration tube to the air-insulated deck, reaching an energy of about 275 keV.



1. 40 sample or 134 sample cesium sputter source
2. 90° air cooled injector magnet with insulated chamber for sequential injection
3. 250kV acceleration tube
4. 250kV insulated deck
5. 90° air cooled 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

On the deck, all masses pass through a dual turbomolecular pumped gas stripper (molecular dissociator), which both converts the negative ions to positive ions and destroys the various CH and CH_2 molecules. This essential process eliminates molecular ions, critically of mass 14, that would pose as ^{14}C counts.

Design

A second 90^O magnetic analyzer deflects and focuses the singly charged ions, sending the pulses of $^{12}C^+$ and $^{13}C^+$ to off-axis Faraday cups. The $^{14}C^+$ ions and a few ions of other masses that manage to pass through the 90^O magnet are filtered by a 90^O Electrostatic Spherical Analyzer (ESA).

After the ESA, a solid-state detector counts the ^{14}C ions. By recording the ^{12}C and ^{13}C current via patented NEC high-precision integrators and ^{14}C counts for each sample, the software calculates the $^{14}C/^{12}C$, $^{13}C/^{12}C$, and $^{14}C/^{13}C$ ratios.

These ratios can then be processed to produce the radiocarbon (RC) age, and the age uncertainty for each sample. The chronological age can then be determined from international calibration data.

SSAMS Performance

Fast isotope cycling - Typically, the system measures all three masses about ten times per second.

Flexible injection timing - The ^{14}C is measured about 99% of the time. This maximizes ^{14}C counting efficiency and reduces the load on the acceleration tube.

Complete recording of all stable isotope currents and of all the rare isotope counts and detector signals - This allows for on-line analysis, data archiving, and re-analysis at any time. Complete data sets can be instrumental in detecting and solving sample preparation or operation problems.

Specifications and Facility Requirements

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

Standard Values

$^{12}C^-$ (low energy)	125 μA
$^{12}C^+$ (high energy)	50 μA
Beam Transmission	> 40%

Ratio of $^{14}C/^{12}C$ from measurements of three (3) “modern” graphite carbon samples with a precision of 0.2% 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 0.2% or better.

Ratio of $^{14}C/^{12}C$ for three (3) dead graphite samples 1e^{-15} or lower, using Alfa Aesar graphite supplied by NEC.

Facility Requirements

Compressed Air:	80 psig
Electrical Power:	2.5 kVA
Cooling Water:	Not Needed

(Approximate values based on a single source configuration)