



ACCELERATOR CONTROL COMPONENTS

National Electrostatics Corp.

Single Stage Accelerator Mass Spectrometry (SSAMS)

Experience

NEC began building AMS systems over 30 years ago and is one of the premier manufacturers of AMS systems in the world. Of the more than 55 AMS systems provided to customers, over half are dedicated to radiocarbon measurements in the fields of Archaeology, Geology, Groundwater analysis, Metabolite profiling, Microdosing, Atmospheric sciences, Oceanography, Nuclear waste management, Toxicology, Cosmogenic study, Astrophysics, Pharmacokinetics, and many more.

The NEC Single Stage Accelerator Mass Spectrometer (SSAMS) is based around a 250 kV high voltage deck for beam energies around 285 keV. The system is optimized for world-class precision, superb throughput, and low background of radioisotope samples. The NEC SSAMS is a complete system with all necessary hardware and software for both on-line and off-line radiocarbon isotope measurements.

Design

Once a sample has been appropriately processed and inserted into the ion source (either as graphite or CO₂), the sample is converted to negative ions and is accelerated through the first bending magnet. This first mass spectrometer has a biased chamber to allow sequential injection of the negative ions of interest, allowing low energy ¹²C⁻ and ¹³C⁻ to be measured in offset Faraday cups. As the negative ions exit the magnet, they accelerate to higher potential energy (around 285 keV) into a gas stripper that breaks up negative molecules and converts the resulting single nuclei ions to positive ions. In this way,

such ions as ¹²CH⁻, ¹²CH₂⁻, ¹³CH⁻, and others are converted to single nuclei ions, ¹²C⁺, ¹³C⁺, and ¹⁴C⁺. This eliminates interferences that might be caused by molecular ions when counting ¹⁴C⁺ ions later in the system. The higher energy ions pass through the second spectrometer, resulting in an improved mass separation, allowing the abundant isotopes ¹²C⁺ and ¹³C⁺ to be measured with high precision current integrators. The rare isotope ¹⁴C⁺ continues through a 90° electrostatic spherical analyzer (ESA) which removes any outstanding interferences and the beam is measured in a solid state particle detector. NEC AMS systems include full computer control with AMS analysis software to provide chronological ages, carbon content in dpm/gm, or pMC (percent modern carbon) values.

NEC AMS systems can support several configurations from a single, 40 sample source, to dual 134 sample sources for a maximum throughput of 2,000 samples to 2% precision per week. Sample wheel loading takes less than 30 minutes with full 40 sample wheels typically measured to precision within about 24 hours. NEC ion sources have no noticeable memory effects and are extremely reliable. NEC has provided more than 125 MC-SNICS sources around the world.

The system proceeds automatically to switch from sample to sample as the required precisions, time constraints, or other criteria are met. The system can be monitored remotely and is fully interlocked in case of power, water, or air failure to protect personnel and precious samples.

Single Stage Accelerator Mass Spectrometry (SSAMS)

Specifications

HV Deck

Voltage Range:	to 250 kV @ 1mA
Single Charged Energy Range:	to 285 keV
Voltage Stability:	0.01% per hour after 1/2 hour warmup

Primary Components

Beamline Height:	1.4 m (40 MC-SNICS) or 1.5 m (134 MC-SNICS)
Pumps:	Turbo molecular pumps, rough backing pumps
Vacuum System Base:	$5e^{-7}$ Torr, or better (without beam)
Ion Source(s)/Injector:	Injection voltage, ~30-40 keV 40 or 134 MC-SNICS (carbon)

Acceptance Test Values

Carbon, Terminal Potential:	250 kV
^{12}C - (Pulsed Beam):	Current > 40 μA
Beam Transmission:	> 40%

AMS Ratios

$^{14}\text{C}/^{12}\text{C}$ (abundant ratio $1e^{-12}$)	Precision < 0.2%	$^{14}\text{C}/^{12}\text{C}$ (CO_2 abundant)	Precision < 0.8%
$^{13}\text{C}/^{12}\text{C}$ (abundant)	Precision < 0.2%	$^{14}\text{C}/^{12}\text{C}$ (CO_2 background)	Ratio < $8e^{-15}$
$^{14}\text{C}/^{12}\text{C}$ (background)	Ratio < $1e^{-15}$		

NEC will provide Alfa Aesar unprocessed graphite for carbon machine background tests. All acceptance tests are verified using a minimum of three samples.

Facility Requirements:

Compressed air: 80 psig

Electrical Power: 7 kVA

Cooling water: 2.0 gpm (7.5 l/min)

(Approximate values based on a single source configuration)

1. 40 sample or 134 sample cesium sputter source
2. 90° injector magnet with insulated chamber for sequential 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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