Mass Spectrometer Modernization
Or
Teaching an Old Dog New Tricks

NBS 12-90 Upgrade
At Los Alamos National Laboratory

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ABSTRACT

THERMAL IONIZATION MASS SPECTROMETRY

The solution is electroplated onto a rhenium filament, which is inserted into the ion source of the mass spectrometer. A current is passed through the filament, which causes the plutonium isotopes in the sample to ionize. The ions are accelerated through a magnetic field, resulting in separation of the ions by mass, with heavier ions having more momentum. An electron multiplier allows the number of ions of each isotope to be counted. The amount of Pu-239 in the original sample is calculated by comparing the number of those ions to those resulting from a known amount of Pu-242 spike. The Pu-242 tracer was added to the sample prior to electroplating. These operations are conducted in a Clean Room environment, and there are two mass spectrometers available for sample analysis. The nominal detection limit for this analytical method is 0.5 fCi/l. Approximately 300 samples, plus QCs, are analyzed per year for the LANL Bioassay Project.

The Machine

The Mass Spectrometer consists of three major parts, a vacuum flight tube with a Source at the front, a 90-degree bend with dipole bending magnet in the middle and a Detector at the end. The modern electronics are as follows.

The Source

The Source has the sample filament and source lenses for drawing the ionized particles into flight. The source lenses operate ~10Kv and are powered by eight 15Kv Bertan high Voltage Power supplies. The filament supply is a Agilent precision 5Vdc, 20 A supply that floats at the 10Kv or so operating voltage. The High Voltage supplies can be controlled with GPIB or by means of a DAC. The DC filament supply may only be controlled by GPIB through a fiber optic extender set in order to isolate the high voltage.

Bending Magnet

Once the Ion stream is focused and traveling the flight tube, the gaussian field on the magnet is set to a value known to be able to deflect the desired particles toward the detector. The magnet should not bend particles that are unwanted. The bending magnet is a high impedance iron core dipole being of a 1960's design, requires a high voltage low current power supply. The power supply will only be controlled by its remote DAC input via the PXI chassis. A LakeShore 450 gauss meter/ controller measures the Gaussian field and is the controlling feedback to the PXI chassis using GPIB.

The Detector

The detector is an Electron Multiplier Tube, which is powered by a 5Kv power supply, is AC coupled to a low noise amplifier, fed to a peak counting discriminator, and counted by the frequency counters. We also have an air actuated Faraday Cup which can be inserted and counted by a precision pico-ammeter.

Support

All is to be controlled by a National Instruments PXI 8156B. The vacuum pumps, the ion gage, the ion pump, the door interlocks, the pyrometer that measures the filament/sample ionization temperature. High Voltage "Run Permit" will depend on the system seeing all functions in a Go condition. Control software will be a combination of LabVIEW, Component Works, and Visual Basic. All Data is to be downloaded into Excel files which are then analyzed by the Nuclear Chemists. The Source will be automated with stepper motors so that five samples can be rotated into place and increase our productivity.