A Modified Negative Ion Sputter Source for AMS and its Efficiency for Plutonium

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Negative ion sources of the Middleton type [1] are rather common. A modified and improved ion source of this type with a spherical ionizer [2,3,4] was in use at our Tandem for all AMS measurements throughout the following years. Although having a lot of advantages over the ion source used before, some improvements could be realized in a new version of this ion source. Some development was driven in the context of the RadBioMat–Project [5,6,7]. The major changes are:

- Ionizer surface:
  In the old design, the ionizer, where the Cesium vapor gets ionized at temperatures of about 1 000°C, was built from a coaxial tantalum wire coiled in a spherical shape. It was positioned inside a stainless steal housing. The housing was thermally contacted through three distance wires made of 1 mm tantalum. The new design of the housing is made out of tantalum. Thus the surface is much smoother, also the temperature range of the ionizer is increased.
- Ionizer heating:
  The coaxial tantalum wire acted not only as surface for ionization, it was also used for heating. Since the performance as an AMS negative ion source demands regular cleaning, the very expensive wire has to be replaced frequently. With the new design the ionization surface and the heating functions are decoupled. For the heating we now use a tantalum wire insulated by ceramics disks. The ionizer surface can be cleaned at low cost with usual sandblasting. The other parts are not expensive, thus can be replaced by new parts.
- Mechanical stability:
  The old negative ion source had the concept of minimal usage of material at cost of reduced mechanical stability. Especially the insulator after the plug valve is exchanged by a standard insulator. This provides a better adjustment as well as an easier exchange when broken.

Figure 1 shows the negative ion source mounted at the AMS platform. It is now routinely used for AMS runs. An important parameter for the ion source is the efficiency for negative ion formation, which influences strongly the total efficiency of the AMS system, namely the fraction of atoms in the sample holder which is detected in the final detector. This was tested by a sample target with a spike of ^{236}Pu ($T_{1/2}$= 2.86 a). The sample holder used had an activity of 0.35 Bq corresponding to 4.6×10^7 atoms of ^{236}Pu. This activity was still measurable by counting with the liquid scintillation technique. The graphite sample holder has been prepared in the same way as described in [8], but had a smaller hole of 1 mm depth and diameter. In total 640 counts have been detected, corresponding to an efficiency of 1.4×10^{-5} or one count for 70 000 Pu-atoms in the sample holder. Further tests with real samples, which were fabricated by a simple and thus more easily practicable pressing technique, were used for the detection of ^{244}Pu. This yielded to even better efficiencies of $3 - 10 \times 10^{-5}$ [9]. The count rate for ^{236}Pu grew for the first hours and after a plateau fell after about seven hours. These samples lasted for at least 12 hours during the search for primordial ^{244}Pu [9].

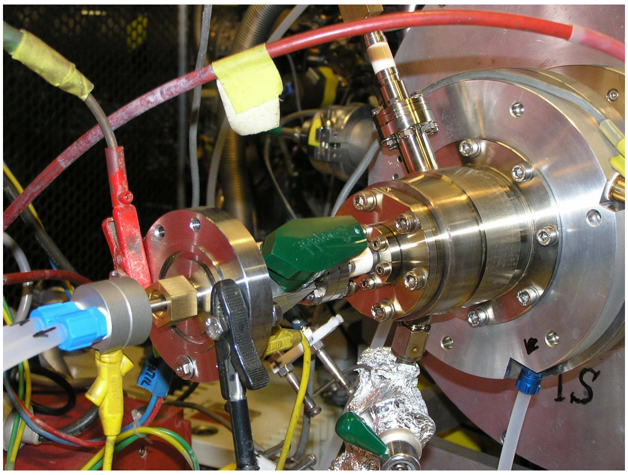

Fig. 1: Picture of the new negative ion source at the AMS injector plattform.

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