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An ion-source-plus-uranium target to study non-gaseous fission product activities in the IALE facility is described.

This paper is devoted to describing the ion source-plus-uranium target assembly recently made operational in the Buenos Aires ISOL facility (IALE project). As has been described elsewhere [1] the IALE Project was designed on the basis of Scandinavian-type isotope separator, an uranyl stearate target and the use of the thermal-neutron flux generated by an electrostatic accelerator. The very convenient target–ion source geometry, the high separator efficiency and the absence of the contaminations allowed us to work succesfully for several years with rare gas isotopes (Kr and Xe) [2]. In the interest of widening the field of nuclear spectroscopy studies, a new ion source plus uranium target has been designed, able to handle non gaseous fission products.

The idea was to take advantage of the fast diffusion rates of many elements in carbon at moderately high temperatures and shortening the "transit time" by incorporating the target in the ion source discharge chamber. This very convenient property of carbon is well known, but there are not many examples of systems with target and ionizer in the same active volume [3]. The uranium, as a fine grained powder of UO_2, was mixed with graphite powder and glued with "UCAR" (cement Grade C-34) [4] special high temperature adhesive to a cylindrical graphite cloth that fits the inside diameter of the discharge chamber.

Heated under vacuum, the UO_2 decomposes and becomes mainly UC, releasing CO. To ensure that the chemical reaction involves a high fraction of the UO_2 it is necessary to use a very fine powder (<50 μm) and that the C (as graphite powder) be in excess from the stoichiometric ratio. The total amount of ^{235}U (typically 2–5 g) is almost completely transformed into UC after running the ion source plus target for 6–8 h at 1500–1700°C. This is clearly noticeable because the discharge sustained by the released CO goes out.

The chemical process is easily reversible and much care should be taken to avoid air exposure of the target, specially during machine openings for maintenance. As fig. 1 shows, an external heater and a heat shield have been added to the original design. The external heater, fed with dc, also replaces the previous external coil for the ion source.

The maximum power allowed by water and oil cooling of the source and lens system is approximately 1600 W and temperatures as high as 2000°C have been reached (as shown by the unexpected melting of stainless steel parts).

Additionally, special care has been taken in redesigning the oil cooled extraction electrode, its position and the corresponding optimum ion-source exit-hole size and angles. Two coupled einzel lenses, complete the electrostatic optics. A typical beam shape computer calculations performed with the OPTIC II program [5] is shown in fig. 2.

In practice, this whole system has been able to handle Xe currents as high as 20 μA giving 1–2 mm diameter beam spots at the collector plate.

From the radioactive isotopes point of view, the interest has been focussed on the doubly magic ^{132}Sn region and many Sn, Sb, Te, etc., fission products have been seen, as shown in fig. 3, where typical Ge(Li) gamma-ray spectra are presented. No In activities have been observed, probably due to the low independent yield. No neighbouring mass contamination can be seen which means that "tails" and hydride molecule concentrations are small.

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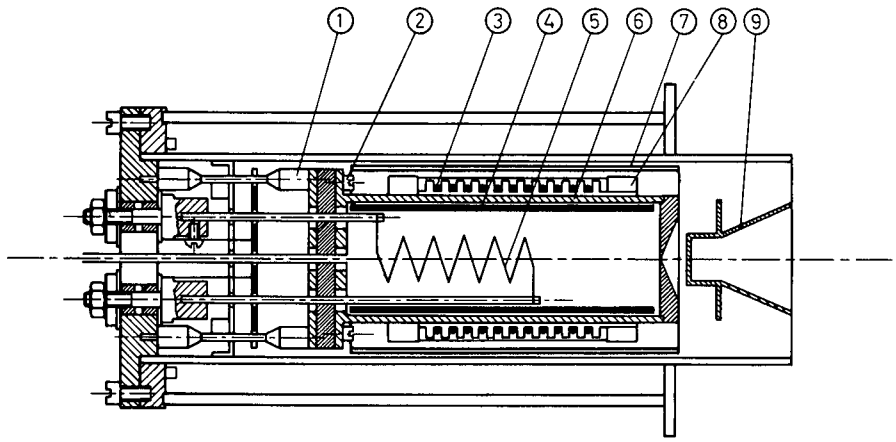

Fig. 1. Diagram of the IALE ion source–uranium target assembly. The numbers correspond to: (1) stainless steel; (2) TZM (tungsten, zirconium, molybdenum); (3) tungsten; (4) CU target; (5) filament; (6) discharge chamber; (7) thermal screen; (8) boron nitride; (9) extraction electrode.

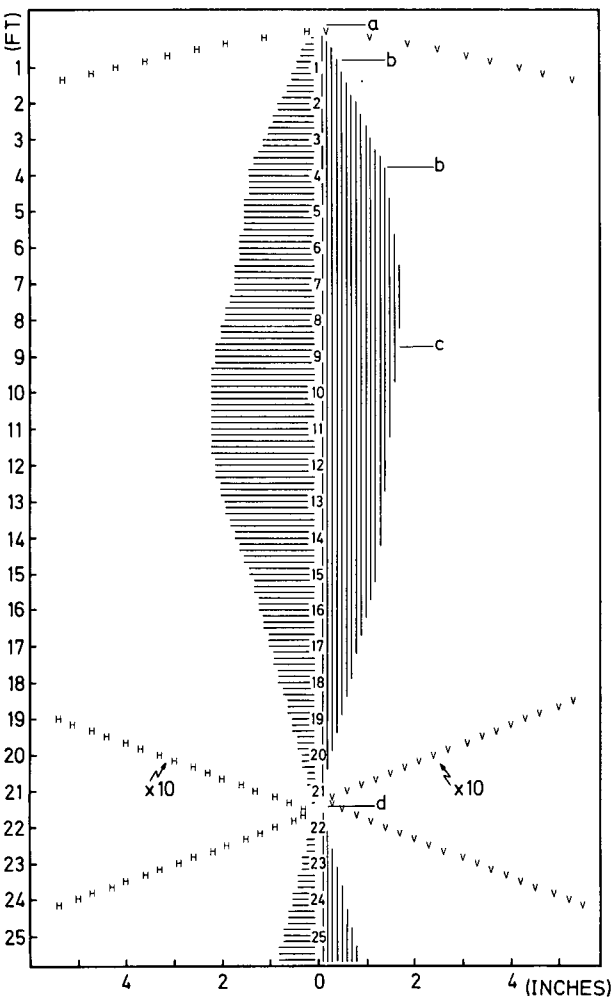

Fig. 2. Beam shape calculated with the OPTIC II code where: (a) corresponds to the position of the ions source, (b) to that of the einzel lens, (c) to that of the isotope spectrometer, (d) to that of the collector.

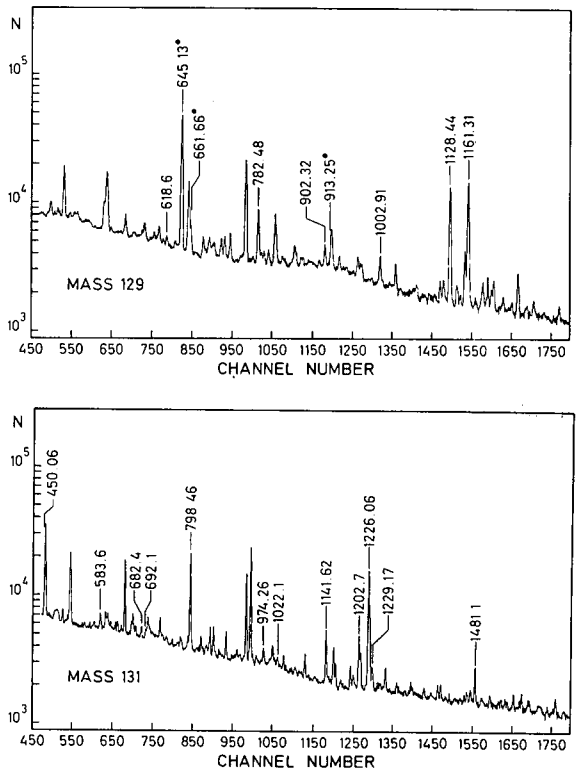

Fig. 3. Typical spectra of masses 129 and 131, where the most important gamma rays of the decay of Sn are shown with their energies in keV. In the case of mass 129 the dots correspond to the decay of 2.23 m ^{129}Sn and the rest to the 7.5 m decay of ^{129}Sn.

The overall efficiency can be calculated knowing the neutron flux, the amount of uranium, and measuring the saturation activity for one particular isotope for which the level scheme and the independent yields of the mass chain are known. In our case, it turns out to be ~1–2% for short-lived (~1 min) Sn isotopes and as large as 5–7% for long-lived (~1 h) Te isotopes.

In spite of the low thermal neutron flux (10^8 n/cm^2 s) the activity is high enough to perform gamma–gamma coincidences with semiconductors detectors, as has been done in the ^{131}Sn and ^{129}Sn decays presently under study.

References

[1] E. Achterberg et al. Nucl. Instr. and Meth. 101 (1972) 555.

[2] E. Achterberg, F.C. Iglesias, A.E. Jech, J.A. Moragues, D. Otero, M.L. Pérez, A.N. Proto, J.J. Rossi and W. Scheuer, Phys. Rev. C10 (1974) 2526 and Phys. Rev. C9 (1974) 299.

[3] R. Klapisch, Ann. Rev. Nucl. Sci. 19 (1969) 33; S. Borg, I. Bergström, G.B. Holm, B. Rydberg, L.E. De Geer, G. Rudstam, B. Grapengiesser, E. Lund and L. Westgaard, Nucl. Instr. and Meth. 91 (1971) 109; L.C. Carraz, I.R. Halderson, H.L. Ravn, M. Skarestad and L. Westgaard, Nucl. Instr. and Meth. 148 (1978) 217; L.C. Carraz, S. Sundell, H.L. Ravn, M. Skarestad and L. Westgaard, Nucl. Instr. and Meth. 158 (1979) 69.

[4] UCAR trade mark of Union Carbide Corporation, U.S.A.

[5] J.D. Larson, OPTIC II, a beam transport program, version B32 (private communication).