Title
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Compact Neutron Generators for Environmental Recovery Applications*

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Compact neutron generators based on the D-D or D-T fusion reactions are being developed at the Lawrence Berkeley National Laboratory for explosive and mine detection, nuclear and non-nuclear waste characterization, neutron radiography and boron neutron capture therapy. The neutron generators will be composed of an ion source, from which a 1.5 A deuterium beam will be extracted and accelerated to about 150 keV onto a target loaded with deuterium. Based on the D-D nuclear reaction, the neutron generator will yield approximately 10^{12} n/s (10^{14} n/s. for D-T reaction). With this neutron output, thermal and cold neutron fluxes of 10^7 n/s. cm^2 and 6 x 10^6 n/s. cm^2 have been estimated using neutron moderators designed by the neutron transport simulation code MCNP.

The cold neutrons generated can be used for environmental recovery purposes by using the neutron induced prompt gamma activation analysis (PGAA). PGAA is a non-destructive, self-calibrating radio-analytical method capable of simultaneously identifying nearly the entire periodic table. The method has been applied to material science, chemistry, geology, mining, archaeology environment, food analysis, medicine and other areas. Advancements in cold neutron technology make it possible to analyze materials in a low background environment by increasing PGAA sensitivity compare to thermal beams. PGAA has been limited mainly to reactor facilities. Development of a cold neutron beam on a portable neutron generator would expand PGAA capabilities to many areas.

New steps are being taken to produce higher neutron flux with smaller neutron generators. Currently, simulations are being run on geometries such as the one shown in Figure 1. In this case, the neutron generator is a small cylindrical tube target and a single cylindrical multi-slit plasma electrode. The nature of the geometry allows the ion trajectories to expand naturally (Figure 2). The equipotential lines curve with the shape of the two electrodes. The design is simpler – in that it does not require as many electrodes, and produces a higher current at the target. This as well as other geometries are being studied and may be tested in the near future.

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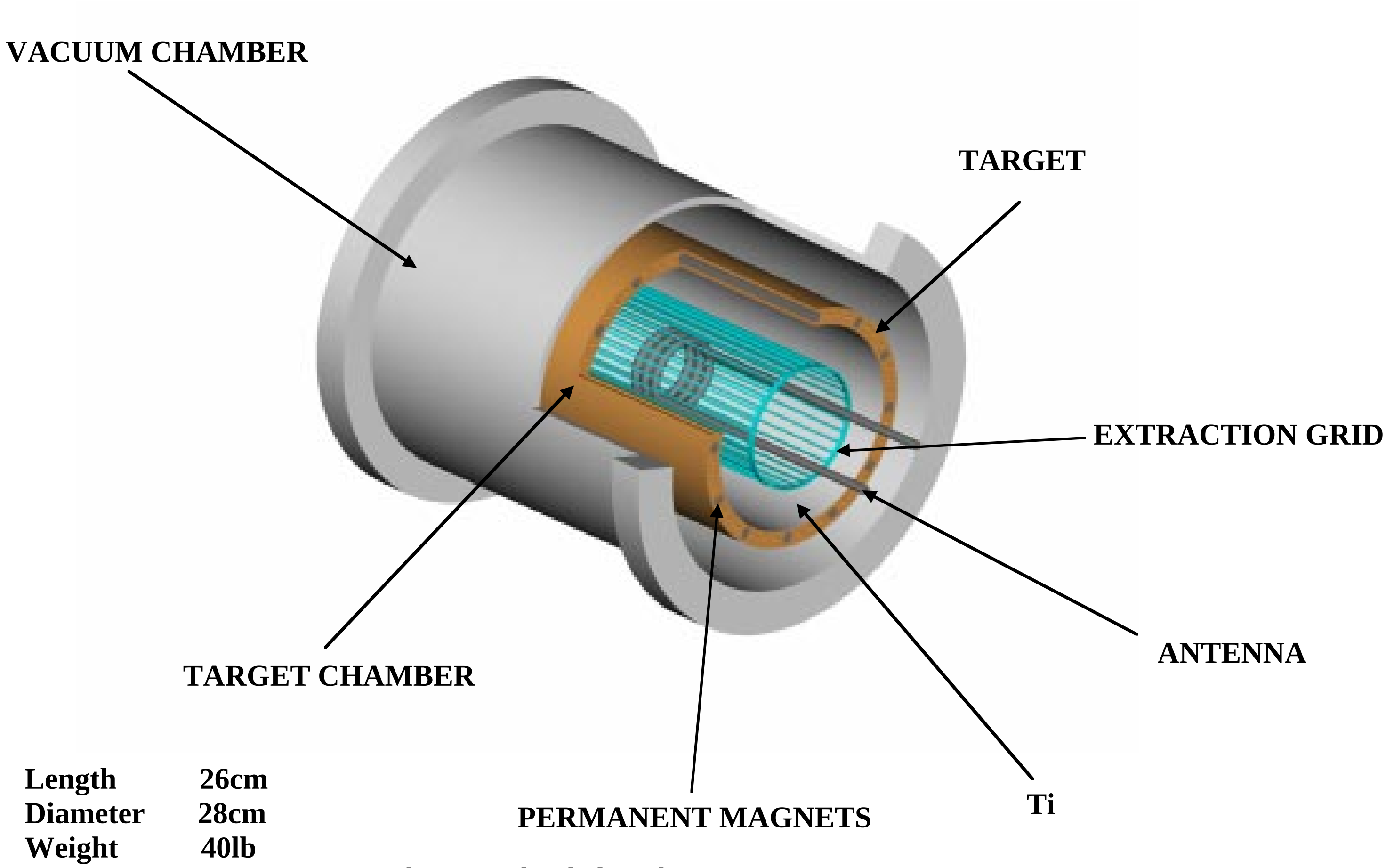

Fig. 1 The coaxial radial ion beam extraction neutron generator.

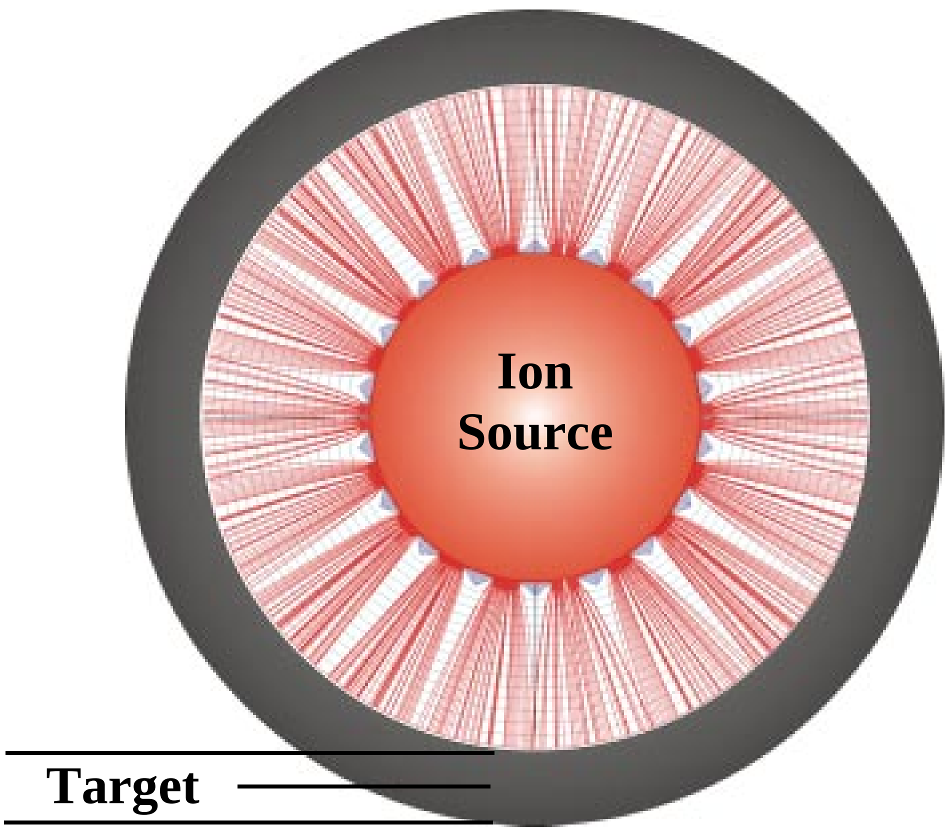

Fig. 2 Cross-sectional view of the coaxial neutron generator with ion beam trajectories computed by using the IGUN simulation code.