

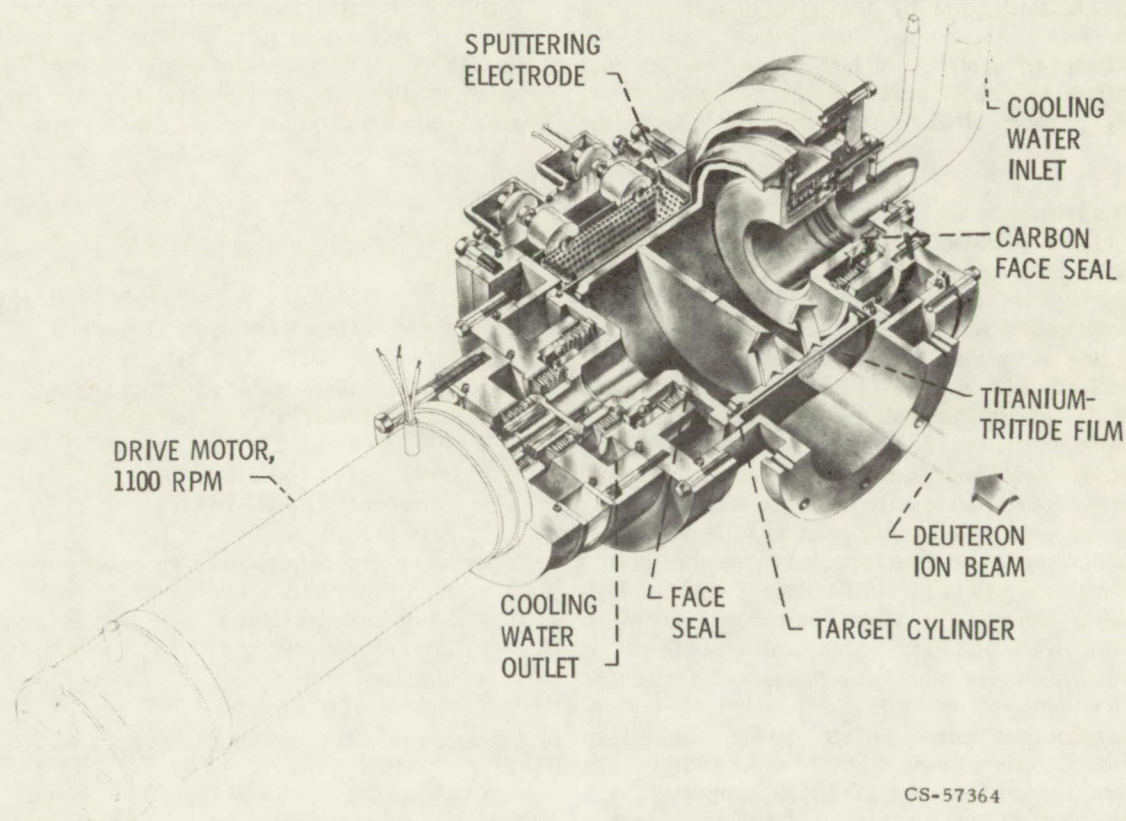
NASA TECH BRIEF

Lewis Research Center



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A High Yield Neutron Target



CS-57364

The Problem:

An intense source of high energy neutrons (14 MeV or better) in excess of 10^{12} neutrons/second is presently needed for cancer research, fusion reactor material research, fast neutron shielding studies, and for the production of radioisotopes for medical and industrial uses. These neutrons are produced by the $T(d,n) He^4$ reaction when a beam of 100 keV (or higher energy) deuterons is impinged upon a tritium-bearing material in the form of a thin titanium tritide film on a cooled copper substrate. Many commercially available deuteron accelerators are capable of producing the high deuteron beam currents required for the desired neutron production rate; but the

lifetime of present titanium tritide targets that could be used by these accelerators is too short to be of practical use for this purpose (less than 50 hours). The short lifetime of tritide targets is primarily due to the displacement of the tritium atoms by the implanted deuterons of the beam. However, an additional rapid loss of tritium can also occur if the target is not properly cooled and the decomposition temperature of the tritide is exceeded.

Present targets can only utilize a titanium tritide film that is of the same thickness as the depth of penetration (range) of the accelerated deuteron (about 3 micro meters for a 300 keV deuteron). The tritium is quickly displaced from the thin film. Increasing the titanium loading within

(continued overleaf)

the accelerator and providing better target cooling by fabricating the target in the form of a disc or cylinder that is rotated in front of the beam extends the target lifetime, but only by a few hours (10-50).

The Solution:

A target, the High Yield Neutron Target (HYNT), that is capable of producing neutron yields of greater than 10^{12} neutrons/second with a useable lifetime in excess of 600 hours.

The target is made in the form of a cylinder that rotates rapidly in front of the beam. A titanium tritide film is used that is much thicker than the range of the accelerated deuteron. A sputtering electrode permits full use of this thick film by removing tritium depleted titanium layers to expose fresh tritide beneath the depleted region. A stream of high-velocity coolant that flows across the back surface of the cylindrical target substrate provides efficient transfer of heat from the target.

How It's Done:

The HYNT is shown in the figure. A thick titanium tritide film is formed on the outer surface of a replaceable, hollow, copper target cylinder. The target cylinder slides over and is secured to an aluminum drum by a holding ring. A narrow coolant flow gap exists between the cylinder and drum with "O" ring seals on each end to separate the coolant and vacuum. The rotatable aluminum drum, with its hollow end shafts, has hardened stainless steel face seal seats secured to the aluminum by an epoxy adhesive. These seal seats mate with face seals to provide vacuum and water sealing of the rotating drum. The target high vacuum region, which is capable of a vacuum of 10^{-6} torr or higher, receives minimal leakage across the high vacuum seals from a differentially pumped region between the rotating water and high vacuum seals on each end of the drum. This region is held at a pressure of about 10^{-2} torr by a roughing pump.

The cylindrical target surface is wide enough to accommodate several target bands. In order to utilize the full cylindrical surface, the HYNT is supported by a mechanism (not shown) that provides lateral movement of the entire HYNT along the axis of the cylinder relative to the beam.

When the entire titanium tritide film surface has been depleted of tritium to the depth of penetration of the deuteron, the sputtering electrode is used to remove the tritium depleted titanium. An isolation valve in the beam tube is closed, the target region back-filled with argon gas, and high voltage is applied to the sputtering electrode. During sputtering, argon gas is leaked into the target housing at a low rate while the correct sputtering pressure is maintained by a small auxiliary vacuum pump that is connected to the HYNT.

During sputtering, the thickness of titanium tritide on the copper cylinder is periodically measured, in situ, by an x-ray thickness monitor that was specifically designed for this purpose (described in NASA Tech Brief 74-10065). When the depleted titanium film has been removed, as indicated by the monitor, the argon gas is pumped from the HYNT by the auxiliary pump and the beam tube isolation valve is opened. A fresh titanium tritide target surface now exists on the target cylinder.

Notes:

1. Further information is available in the following report:

NASA TM-X-68179 (N73-16067), A High Yield Neutron Target for Cancer Therapy

Copies may be obtained at cost from:

Aerospace Research Applications Center

Indiana University

400 East Seventh Street

Bloomington, Indiana 47401

Telephone: 812-337-7833

Reference: B74-10066

2. Specific technical questions may be directed to:

Technology Utilization Officer

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21000 Brookpark Road

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Reference: B74-10066

Patent Status:

NASA has decided not to apply for a patent.

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