Fusor V neutron detector assembly

By Richard Hull

Having studied, over a long period, the requirements for neutron moderation, I have decided on a new moderator assembly for my existing long 3He neutron detector tube.

The old moderator was excellent and in use constantly from 2003 until 2020. Pictured below.

The detection system utilized a water moderator in a section of 6-inch PVC pipe and contained a centrally located 22-inch long Reuter and Stokes, P-4, helium 3 standard thermal neutron detector. To help reduce noise, a Princeton Gamma Tech charge sensitive pre-amp was connected directly to the tube, avoiding the need for a connecting cable.

The above system was connected to a NIM bin where the high voltage, the final amplification, and windowing took place to rule out any gamma or x-ray detection. The neutron detection pulses were fed to a digital counter to display the count over a preset time-period.

As with all such assembled neutron detection systems, calibration was necessary. Once calibrated, all such systems must never be moved or re-arranged in any manner! This is the only way to maintain calibration. As such, the system was left in place from 2004 until 2020.

Calibration was achieved via "transfer calibration" from carefully "binned" bubble fast neutron dosimeters purchased from BTI over two years using data taken during many runs with two separate purchases of a bubble dosimeters during that period. The ensuing mathematics and averaging over time led to a total isotropic emission rate (TIER) in neutrons per second, yielding a "constant of calibration" for the digital count per minute display at the end of a timed period.

While the system was great and the acceptance of the inability to move the system about was a given, the water required constant attention in that it evaporated, and to maintain calibration, new water had to be added. The lab was unheated and the fear of freezing during the winter and crushing the valuable helium 3 detector tube, forced me to add automobile anti-freeze to the water. This proved to be highly satisfactory.

That advent of fusor V

Building the next fusor, I had learned a lot from more and constant reading related to neutron moderation. Almost all books recommended high density polyethylene for the moderator. I had built a "neutron oven" for activation purposes back in 2009 out of HDPE. I like the fact that such an assembly was portable and like a set of toy blocks and could be arranged in any number of useful ways for many thermalizing purposes.

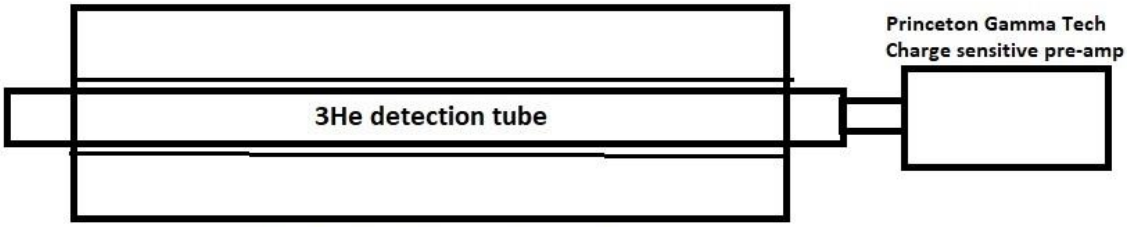
The "magic", minimal enclosure for thermalizing fusion neutrons in HDPE was 2.5 inches with 3 inches being ideal. Much over this for detection purposes was just "gravy", while for activation purposes, the more HDPE or moderator material, the better. This assumes total enclosure of the source and that which is to be activated. So many people buy a 6" diameter cylinder of HDPE, have a machine shop bore a 1" hole and drop in their tube. This is fine but locks the tube to the system and modifications are not there as with "toy blocks".

I did some figuring on what kind of "toy blocks" I might need to assemble a good new moderator of superior quality that would be versatile over a long period of time, even in other projects. I attach the results in a drawing along with photographs following the written text.

At the present time, (late July 2020), the system is working far beyond my expectations and can even be slightly altered-in-place for activation. I will purchase more HDPE soon to augment the versatility of this system moderator.

Calibration for fusor data reduction use remains to be done, however, but I can rely on quantitative count increases to tell me of improved operation, etc., for the time being. Naturally a 20% increase in count is a 20% increase in TIER, regardless.

6 x 6-inch high density built-up polyethylene moderator using P4 Reuters and Stokes helium 3 neutron detection tube 22- inch long with 19-inch sensitive volume. Preamp mounted to tube.



18-inches long for sensitive volume

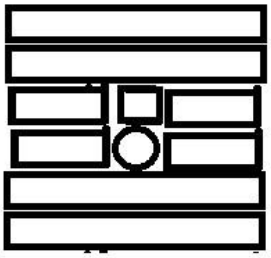
Side view

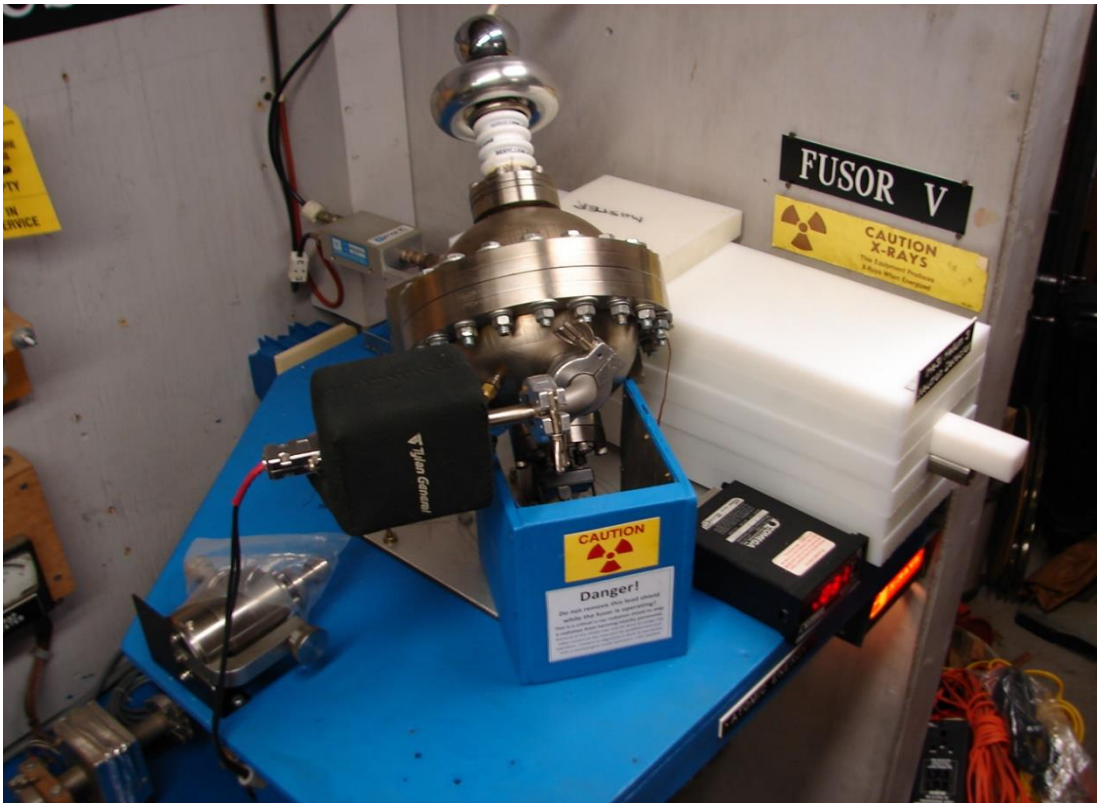
Bill of materials:

(4) 1 - inch thick 6 X 18 HDPE sheet stock
(4) 1 - inch thick 2.5 X 18 HDPE sheet stock
(1) 1 X 1 - inch HDPE sheet stock

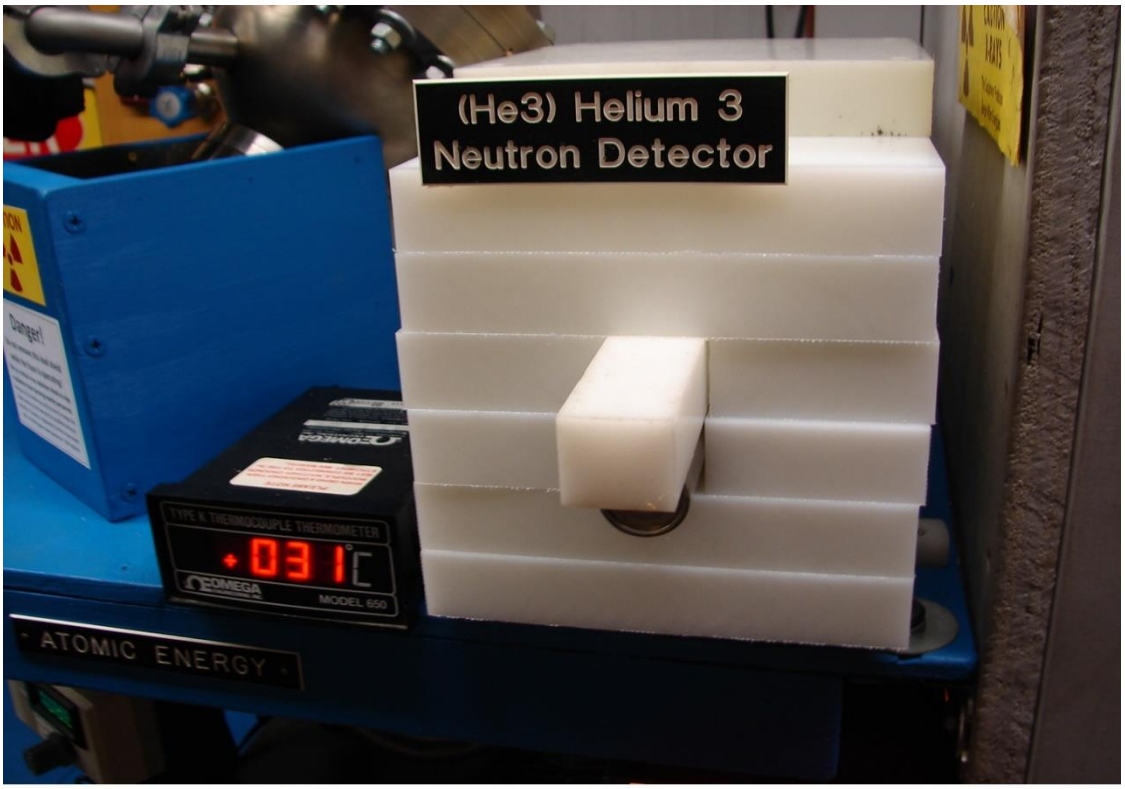
Cost with cutting and tax delivered as above $97.00 purchased from local Piedmont Plastics, Inc.

Front view





Fusor V with new HDPE moderator in-place. It is a lot more flexible than the water moderator



7/14/20 Closeup of assembled HDPE 1-ich slab built moderator. Tested an performs very well. HDPE cost $100

7/14/20 Charge sensitive preamp mounted to Reuter and Stokes 4 atm, 22-inch long 3He detector tube