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ABSTRACT

Experiments with DT-filled glass microballoons positioned near the pinch region of a plasma focus have resulted in the production of neutrons which do not appear to be due to D-T reactions.

In early experiments at LLL, glass microballoons filled with DT were placed on the axis of the plasma focus machine at the position where the pinch is believed to occur. The fill gas was H_2 so that any neutron production was assumed to be due to gas in the balloon. In some of these experiments, there were indications that neutrons had been produced. Later experiments of this type with more complete neutron diagnostics failed to confirm the production of neutrons. In these experiments the microballoons were exposed directly to the plasma focus environment; they were supported in the pinch region by attachment to a fine glass fiber with no protection from possible precursors which might destroy the balloon before it could be affected by the main pinch.

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Since the experiments were performed with the plasma focus operating in the low-density mode in which electron and ion beam production is a dominant channel for dissipation of magnetic energy, it was speculated that the neutron production, erratic as it was, might have resulted from the interaction of a very concentrated electron beam with the glass balloon. Both because the balloon in the "direct exposure" position was unprotected from precursors and because the glass fiber mounting was known usually to quench the production of intense electron beams it was decided to try alternate experiments in which the microballoon was mounted inside a small (2 mm diameter) cavity in the apex of a conical copper tip attached to the center of the anode. Usually, the cavity was covered with a thin foil transparent to energetic electrons and the balloon was positioned 2-5 mm behind the foil. Thus, the balloon was exposed to the electron beam but protected from precursors and there was no mounting fiber to prevent the production of the beam. In all, there were twenty such experiments of which eight produced neutrons. The number of neutrons produced in the various shots ranged from 2×10^6 to 6×10^7. Any production less than about 1×10^6 would not have been identified due to the level of the background in the Ag activation detectors. O_2 activation detectors (threshold $\gtrsim$ 10 MeV) which had been installed to determine whether the neutrons were sufficiently energetic to have been made in D-T reactions, did not respond to any of the signals seen in the Ag detectors. The background level in the O_2 detectors was such that neutron production less than a few x 10^6*2 could not be seen but it is evident that, at least in the four shots for which the number of neutrons was $\gtrsim 10^7$, most were produced by reactions other than D-T.

Subsequent to this series of experiments it was found that occasionally neutrons were produced in the H_2-filled plasma focus even in the absence of a DT microballoon. The neutrons were never energetic enough to be detected in the O_2 detector. Neutron production was found to occur in only about 5% of the shots whereas with DT microballoons in the anode tip, neutrons were produced in 40% of the shots attempted. In both the experiments with microballoons and those without, it was found that neutrons were produced only in those shots for which there was substantial formation of energetic beams of electrons as evidenced by the production of hard bremsstrahlung, although there were many shots with intense electron beams and no neutrons.

The mechanism for production of neutrons in the H_2-filled focus remains unknown. If the rather sparse production statistics are relied upon it could be argued that, since the introduction of

*The exact number depending on the level of the background during any particular shot.

microballoons greatly enhances the probability of neutron production, the neutrons must be produced in those cases by interactions of accelerated deuterons or tritons though evidently not by D-T reactions.

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