0. Remarks on the Thermal Power in a Cold-Neutron Source at the Proposed SIN Spallation Source, W. E. Fischer, SIN

In a reactor, the γ-rays from a multiplying core give a considerable contribution to the heating of a cold source. This implies that such a source is normally placed a certain distance from the reactor core, that is, in a region where the flux is not maximal. In a spallation reaction, the energy of the γ-rays produced per neutron is ~10 times smaller. If the ratio of target-to-beam diameter is large enough and the chamber of a Pb-Bi target is 10 cm (as considered for the SIN source) these γ-rays will be absorbed in the target itself. We therefore assume a cold neutron source near to the target in the region of maximum thermal neutron flux. The main contributions to the heating come from:

- cascade neutrons (we assume the cascade protons also to be absorbed in the heavy metal target)
- gammas from neutron capture in the material of the source and its surrounding.

Let us assume a spherical cold source with a volume of 30ℓ, in the region of maximum thermal neutron flux (see Fig. II-0.1). The containment consists of two spherical shells of 4-mm Al or Zircalloy each, with the space between the two shells being evacuated. The inner shells shall be filled with liquid D_2 at a temperature of 20 °K. This source corresponds roughly in its material composition to the cold source of the ILL reactor in Grenoble.[1]

1. Contribution from Cascade Neutrons

We assume an angular distribution and an energy spectrum of cascade neutrons from Monte Carlo calculations, as given in Ref. 2. Knowing the material composition of the source, we calculate the energy deposition by fast neutrons in the inner shell of the containment and in the liquid D_2. For a primary proton current of 1 mA, we obtain a heat deposition of 280 W by fast neutrons.

2. Contribution from Capture Gammas

This power is proportional to the thermal flux in the region of the source. Since the material composition is similar to the one at the ILL source, we take the results of the ILL calculations[1] and scale them down to our thermal neutron flux. For the thermal neutron flux, which corresponds to a 1 mA primary proton current, we obtain 620 W of heating by capture γ-rays.

Therefore, the total power dissipated in this cold source adds up to 900 W per 1 mA proton current, with 50% being deposited in the inner containment shell and 50% in the liquid D_2. Such a cold source could be operated with an external power of approximately 250 kW. We hope that a primary proton current of 2-3 mA (600 MeV) could provide us with a cold-neutron source which is competitive with the strongest sources available today.

References

1. P. Ageron, R. Ewald, H. D. Harig, T. Verdier, Energie Nucleaire, 13, 15 (1971).

2. R. R. Fullwood, J. D. Cramer, R. A. Haarman, R. P. Forrest, R. G. Schrandt, Los Alamos Scientific Laboratory report LA-4789 (January 1972).

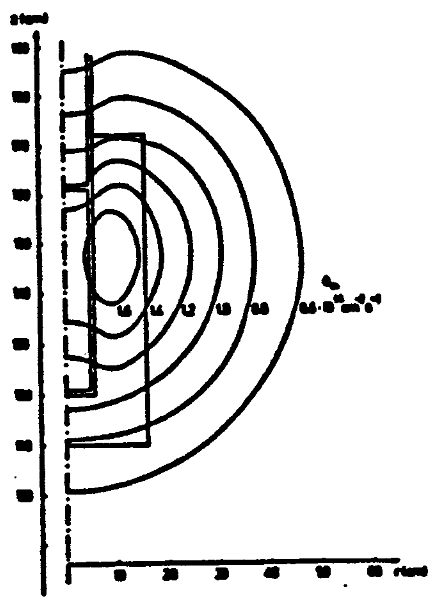

Fig. II-0.1. Flux lines for constant thermal neutron flux.