Measurement of UCN with a New Detector ◇

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A solid state detector for ultra cold neutrons(UCN) using the ^{6}Li(n,α)t reaction, where the reflectivity R was reduced and, thus, the efficiency ϵ increased by multilayers containing nuclei with negative(Ti(nat)) and positive scattering length(^{6}Li), respectively, was built by Kawai et al. [1]. Due to TiO_2 formation, R, which was measured with cold neutrons(CN) at a small angle, was still rather large(R > 0.6 for a momentum transfer corresponding to a UCN energy T < 50 neV). Therefore, Si PIN diode UCN detectors with ^{62}Ni and ^{6}LiF multilayers were developed. R was measured with CN to be R < 0.1 for T > 160 neV [2]. The atomic concentrations in the 150 double layers consisting each of 30 Å ^{62}Ni and 60 Å ^{6}LiF were confirmed by an ERD measurement at the MLL tandem with Au ions(fig.1).

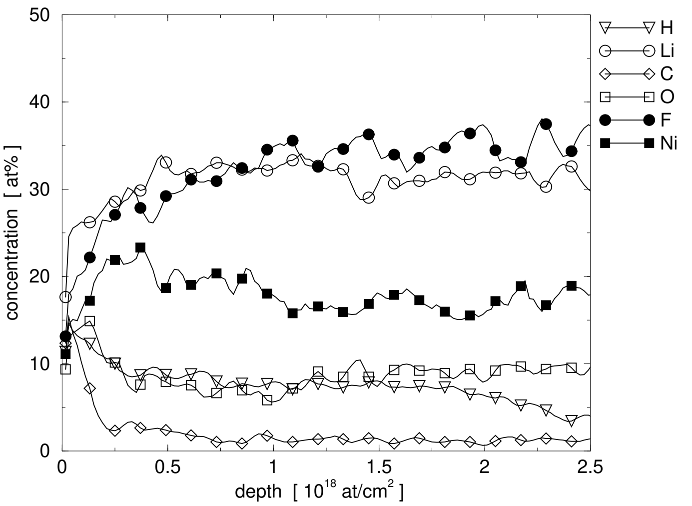

Fig. 1: Ni and LiF concentrations and some impurities(H, C, O) vs depth of the Si PIN diode UCN detector

The Si PIN diode UCN detectors were tested with UCN in a short February 2000 running time at the ILL PF2 beam line. Fig. 2 shows the measured spectrum with the 2.06 MeV α particle and the 2.73 MeV t.

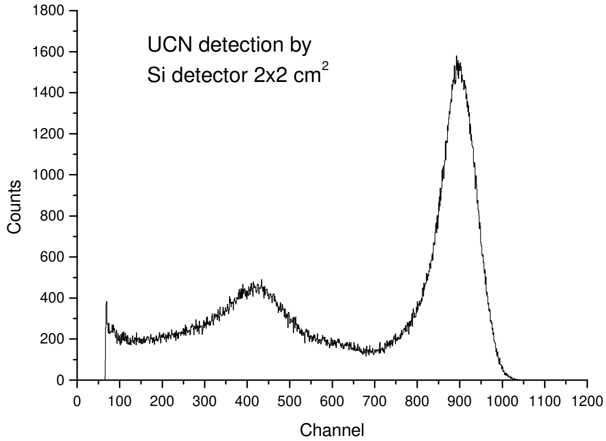

Fig. 2: Spectrum of α and t after the ^{6}Li(n,α)t reaction

According to calculations taking the energy loss in the multilayer and the 880 Å ^{58}Ni reflector into account, the energy of the α) and t deposited in the Si should be 1.38 MeV and 2.55 MeV, respectively, yielding the correct peak positions. ϵ of different T ranges was measured with the spectrometer shown in fig. 3. It consists of a cylindrical storage cell connectable to a UCN inlet and a vertically mounted detector tube each made from stainless steel. After 40 s storage cell filling time UCN are stored for 40 s and energy selected(T=0−38 neV) by an adjustable absorber. Finally, the UCN are exposed to the detector mounted in the detector tube at height L, thus, shifting the selected T range, and the measurement is started(t=0).

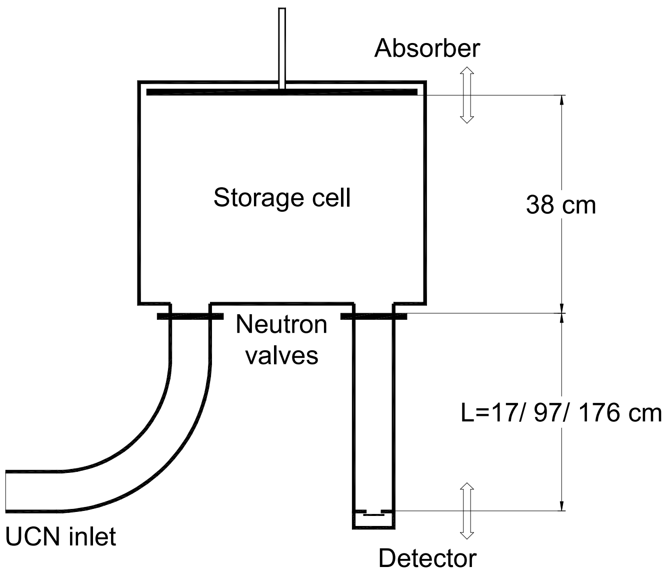

Fig. 3: Richardson spectrometer at ILL. The detectors are mounted in the detector tube(6.7 cm diameter) at three different heights L

Fig. 4 shows the measured decay rate $\dot{N}(t)$.

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