# Lithium stearate - a new absorber material for ultracold neutrons

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**Abstract**

UCN are free neutrons with kinetic energies on the neV-scale and with velocities smaller than 10 m/s. This corresponds to a temperatures of some mK. Hence they are called ultracold. The need to develop suitable materials for UCN storage as well as for efficient absorption of UCN has grown in the past. Comparative experimental studies have been carried out in a UCN storage experiment on four absorber materials : Polyethylene (PE), titanium (Ti), boron-10 (B) and lithium stearate (LiSt). The latter material features the highest absorption property.

**Introduction:** Polyethylene and titanium are widely used as absorber materials to remove UCN from a storage volume by absorption or inelastic up-scattering. Due to its high absorption cross section, 10-boron is also a promising absorber material. It has never been investigated before. Lithium stearate should have an even higher absorbing characteristic. Its chemical composition is ($C_{18}H_{35}LiO_2$). The compound has an atomic mass of 290.41 g mol$^{-1}$ and melting point of 220°C.

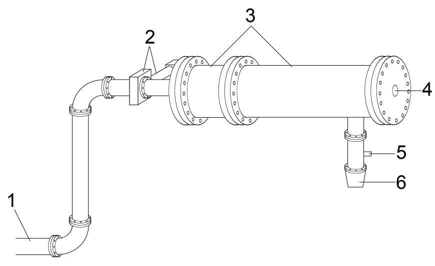


Figure 1: Draft of the experimental setup installed at the Institut Laue-Langevin in Grenoble, France.

**Experimental:** A draft of the experimental setup is shown in Fig. 1. The neutrons are guided (1) into a storage chamber (3) made from stainless steel. A shutter (2) was installed at the entrance of the chamber. An absorber plate (4) of diameter 4 cm could be installed onto one flange of the chamber. The detector was installed below the chamber. Pumps are connected at (5). Figure 2 shows the count-rate at the detector during the experiment. At $t = 0$ the shutter is opened. The count-rate reaches a saturation value $N_0$. The shutter is closed. The subsequent decrease of the count-rate from $N_0$ is called empty process. It is governed by neutron beta-decay, by absorption at the chamber walls, at the absorber plate, and by detection of UCN. The according time constant $\tau_{empty}$ is fitted with a model explained in more detail in [1]. The derived emptying times and $N_0$ for different absorbers installed in the chamber are summarizes in the table below.

**Discussion:** The main differences between the four absorber materials can be seen already in Fig. 2.

| | Ti | PE | B | LiSt |
|---|---|---|---|---|
| $\tau_{empty}$/[s] | 15.8(0.4) | 14.2(0.5) | 10.8(0.4) | 10.2(0.4) |
| $N_0$/[s$^{-1}$] | 167.7(0.2) | 171.8(0.2) | 146.7(0.2) | 153.7(0.2) |

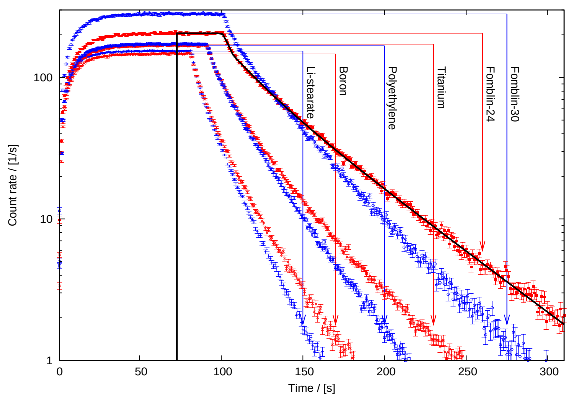


Figure 2: The measured count-rate at the detector for different absorbers installed in the chamber.

The saturation count rate $N_0$ for lithium stearate and boron-10 is comparatively low in contrast to polyethylene and titanium. Further, lithium stearate produces the smallest time constant $\tau_{empty}$. Therefore, lithium stearate shows the highest probability for UCN absorption.

Boron-10 and lithium stearate are both commercially available. The latter material is sold at a very low price compared to boron-10. Due to its low melting point lithium stearate can easily be evaporated on wide surfaces. The material can also be melted to small discs of some centimeter diameter. Such discs were used in our experiment. Lithium stearate can be regarded as a prospective new absorber material for present and future experiments with ultracold neutrons.

[1] *Absorber materials for low-energy neutrons - Theoretical and experimental studies*, NIM A 664 (2012) 353357

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