Contribution ID: **164** Type: **Poster not shown**

Development of a monitoring system for the Ultra-Cold Neutron (UCN) source at PSI

At the Paul Scherrer Institute (PSI) in Villigen, Switzerland, commissioning of the high intensity ultra-cold neutron source has started. It uses a 1.3 MW proton beam for the production of neutrons in a spallation target. After moderation in D2O and further downscattering by means of a 5K cold frozen-D2 converter into the so-called ultra-cold regime (Ekin < 7neV) the neutrons are trapped inside a ˜2 m3 storage volume inside a biological shield. From there they can be transported to the experiments via UCN guides.
A detection system is being developed to monitor the UCN density inside the storage volume. The system will have to withstand a very high neutron and gamma radiation level of up to 13 MGy/y (neutronfluency 10ˆ18n/cmˆ2 in 20 Years). The detector will have to operate in a clean vacuum and at a temperature of ˜60 K. Furthermore, the detection system has to be small in order not to decrease the UCN storage properties of the storage volume substantially. The detector is based on a 1-2 mm2 6Li-glass scintillator which is read out by a Geiger-Mode APD at the end of a 5 m long quartz light guide.
An overview of results from performance tests, development work and final installation will be presented.

Summary (Additional text describing your work. Can be pasted here or give an URL to a PDF document):

At the Paul Scherrer Institute in Villigen, Switzerland, the construction of a new ultra-cold neutron (UCN) source is nearing its completion. We expect to exceed the current best UCN source at ILL in Grenoble by one or two orders of magnitude; therefore, it is of great interest to monitor the UCN density in situ. The neutrons are produced in a spallation process, which creates a significant amount of radiation. The UCN will be stored in a volume about 2 m above the spallation target, i.e. in a strong radiation field before being directed to the experiments via ˜8 m long UCN guides, which traverse the biological shield surrounding the storage volume. The first possibility to measure the UCN is at the end of the mentioned guides. Our aim is to monitor the density of UCN inside the volume without altering its storage properties. A detector is being developed to meet the stringent requirements of radiation-hardness, vacuum compatibility and a small size.

UCNs can be detected via different channels, all of them relying on a nuclear conversion.
The most common materials are 3He, 6Li and 10B. Unfortunately apart other problems, the aging of the detector gas would necessitate a He3 supply line into a container placed in the vacuum of the source. It should also be noted, that the He3 market has great difficulties to meet the demands, which favors the decision for alternative detector concepts where ever possible.
R&D was concentrated on the development of a detector based on the GS10 Li glass scintillator. The pulse shape and height of this scintillator allows for a good discrimination between neutrons and gammas. However, the light yield of the glass scintillator is only 20-30% relative to anthracene.

The readout of the low amounts of light was achieved with a semiconductor, namely a Geiger-mode avalanche photodiode. We chose to use avalanche photodiodes because of their vacuum compatibility and their small size. However, the downside of using semiconductor devices is the limited lifetime under irradiation. Simulations have shown the neutron fluency at the detector position to be in the order of 10ˆ18 n/cmˆ2 over a time of 20 years. The APD failed after irradiation with a fluency of less than 10ˆ15 n/cmˆ2. Thus, the positioning of the APD dominated the design.

An overview of the R&D work on radiation hardness, light collection and testing with UCN will be presented.

Author: GÖLTL, Leonard (Paul Scherrer Institut)

Co-author: UCN PHYSICS GROUP, PSI (Paul Scherrer Institute)

Presenter: GÖLTL, Leonard (Paul Scherrer Institut)