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Authors:	Uwe Filges, Paul Scherrer Institut

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Abstract

Simulating complex spallation source setups related to background is time-consuming and it is connected with uncertainties. That's why neutron spectra measurements are very important for the optimisation of neutron scattering instruments. In addition high gamma fields effect the quality of neutron spectra measurements by producing noise in the neutron detectors. The goal of this task was to evaluated existing measurement techniques/detector systems in respect of the needed specification.

1. Neutron detector systems

The evaluated detector systems are shown in table 1. Of course the number of available neutron spectroscopy detectors is larger as the 4 different solutions from table 4. But the four discussed detector systems are representing already a preselection. The preselection was done by the following criteria:

- covering a wide energy range
- low gamma sensitivity
- energy resolution
- simple measurement technique

Type	**Energy range**	**Energy resolution**	**Comments**
Recoil proportional counter	0.05 – 5 MeV	10 %	limited energy range high complexity for the detector system high gamma ray sensitivity pulse height analysis
Organic scintillator	2-150 MeV	4 %	limited energy range high gamma ray sensitivity pulse height analysis
Multisphere system (BSS)	10^{-8} – 20 MeV	> 10 %	wide energy range extendable mobil & easy to use unfolding procedure

Foil radioactivation	0.2 – 20 MeV	> 20 %	high neutron flux needed limited energy range low gamma response unfolding procedure

Table 1: Evaluated detector systems

The result of the evaluation was that the preferred technique is the Multisphere system known as Bonner Sphere Spectrometer (BSS). The only limitation is that the upper energy response is around 20 MeV for a standard system. Nevertheless we decided to built such a system with additional goal to work on the energy extension.

The following tasks has been done for the BSS system:

- The neutron detector was selected. It is a He-3 proportional counter from Centronic type **SP9**/152/Kr/0916-21 (B).
- The detector efficiency has been measured.
- A fast preamplifier was evaluated. Analog pulse width of the counter and preAmp have been measured for the dead time estimation.
- The data acquisition unit was evaluated. We have chosen the MPA unit from „FAST ComTech“. Here we have the option to measure also the time-dependent neutron background.
- The neutron/gamma discrimination in the BSS system was optimized in field measurements at SINQ (PSI).
- Background caused by electronics and cosmic rays was investigated.
- Response function were measured for the polyethylene spheres of the BSS system.
- The needed lead sphere (for the extension of the BSS system) are produced and characterised.

Finally we can conclude that we have an operational system for measuring neutron spectra at different facilities.

2. Gamma detector system

As described in the previous chapter the measured neutron spectra can be effected by gamma rays. For that reason we have evaluated two gamma detector systems. The first system is a NaI detector (see figure 1a) which is very robust in high gamma field environments. The main purpose of this detector is to check the level of the gamma field.

The second system is sensitive gamma spectrometer (see figure 1b), which has a Ge-Detector, where we can observe the energies of the gamma rays. That is very important because the neutron/gamma discrimination depends from the energy of the gamma rays.

Figure 1a: NaI detector used in the neutron field

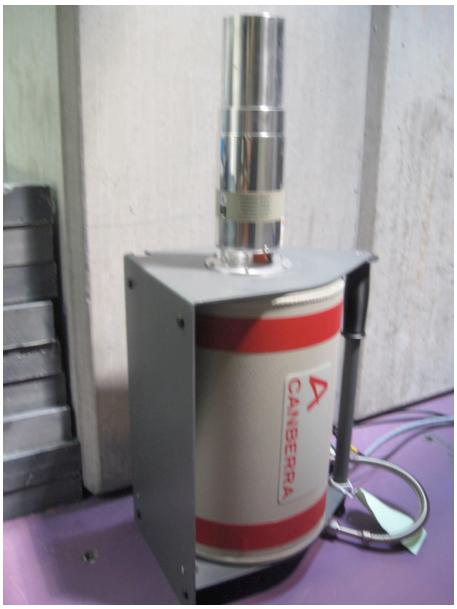

Figure 1b: Ge-Detector of the gamma spectrometer

Both systems were already used successfully for BSS calibration measurements at SINQ (PSI).

3. Summary

The evaluation of the fast neutron detector system is finished and we started already to use the Bonner Sphere Spectrometer at SINQ (PSI).