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Monte Carlo simulation of NSE at reactor and spallation sources

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Abstract

A MC computation study of NSE has been performed by means of VITESS investigating the classic and TOF-NSE options at spallation sources. The use of white beams in TOF-NSE makes the flipper efficiency in function of the neutron wavelength an important issue. The emphasis was put on exact evaluation of flipper efficiencies for wide wavelength-band instruments.

1. Introduction

A comprehensive Monte Carlo simulation study of NSE, of neutron instruments using polarized neutrons and the development of a general and flexible software for this purpose are next objectives in the VITESS project [1] at the HMI Berlin. MC computations lead to information on properties not easily accessible for experimental observation e.g. the exact λ dependence of flipping efficiency, details on correlations in the whole instrument and on action of stray fields. In this paper we show first results on the wavelength dependence

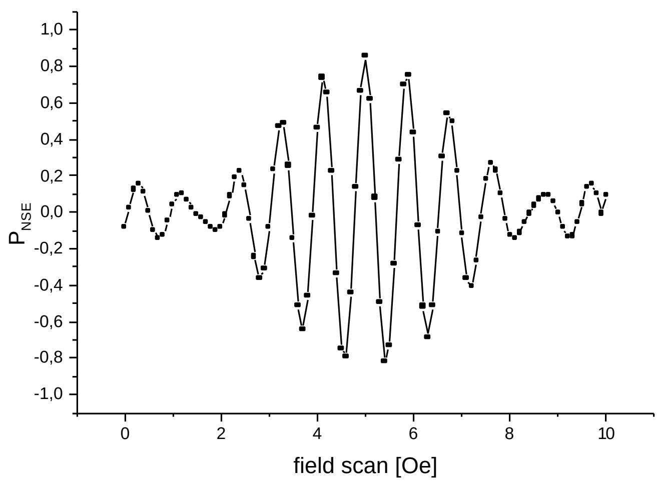

Fig.1: IN11 – MC simulated NSE group (asymmetric scan) at 6 Å, $\Delta\lambda/\lambda$ = 3.3%, first precession field 50 Oe.

of flipper efficiency and its influence on the final P_{NSE} signal in the case of a IN11-type spectrometer and of a TOF-NSE setup.

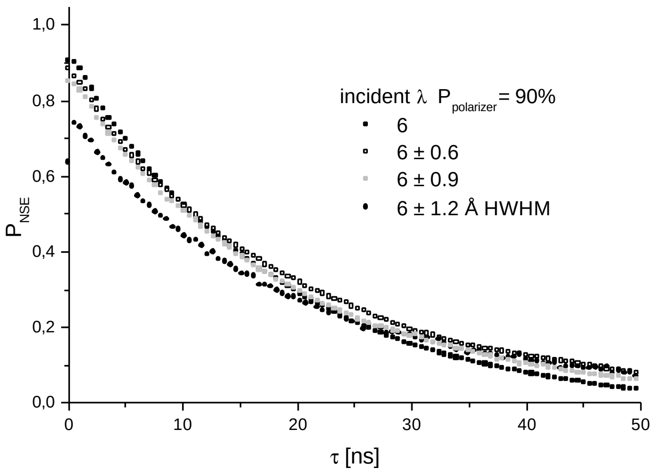

Fig.2: IN11 – Effect of wavelength band on flipper efficiency as obtained in the MC simulation; π and π/2 flippers set for 6 Å, polarizer efficiency was 90%.

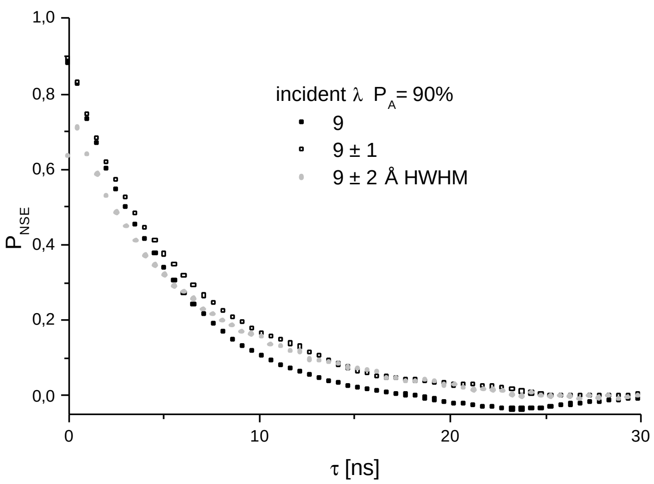

Fig.3: IN11 – Effect of wavelength band on flipper efficiency; π and π/2 flippers set for 9 Å, polarizer efficiency was 90%.

2. Results

The general layout of the classical (first) NSE spectrometer IN11 at ILL, is described in [2] and that of the simulated TOF-NSE in [3,4]. In Fig.1 the NSE group (asymmetric scan) simulated for IN11 is shown for 3.3 % FWHM wavelength distribution. In Figs. 2. and 3. the NSE signals can be seen as calculated for the average wavelength values 6 and 9 Å and various $\Delta\lambda/\lambda$ as determined by the velocity selector.
A typical MC simulated P_{NSE} signal for time-of-flight NSE is illustrated in Fig.4. The Fourier time scale was obtained by converting the TOF spectra. As known, the basic idea is to obtain

a NSE scan by using the white beam – instead of changing the precession field –, the wavelength being strongly correlated with the TOF because the long flight path along the spectrometer (15m). In all spectra presented here an isotropic quasielastic sample was simulated and consequently we only had energy dependence. A comparison of the synchronized and tuned flipper cases leads to conclusions on the wavelength window which still gives a good approximation to the Fourier transform of the Lorentzian i.e. $\exp(-\Gamma\tau)$.

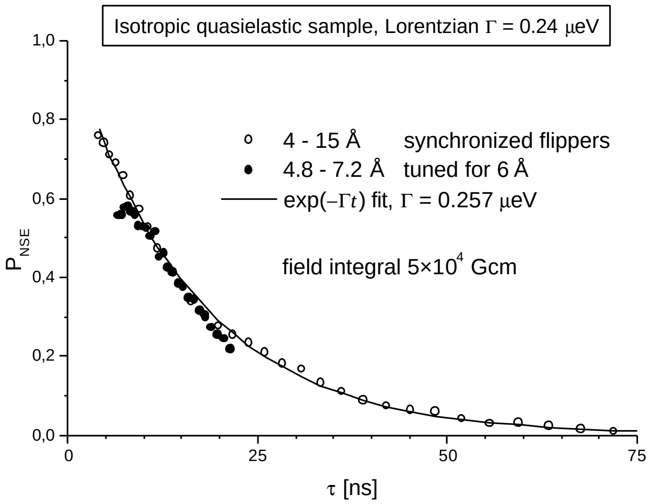

Fig.4: Pulsed NSE – The simulated polarization spectrum for an isotropic Lorentzian quasielastic sample. The TOF was converted to Fourier time.

3. VITESS for polarized neutrons

The finished downloadable version VITESS 1.0 is available for all users since end of 1999 with small current changes for operating systems Windows, Unix (SunOS: versions from 5.6, OSF1 V4.0) and Linux (versions from 2.0.35). It consists of executable Codes for instrument modules for a linear construction of the scattering process.

In the beginning of year 2001 Version 2.0 will be released. New modules for the simulation of *polarized neutrons* will be available (supermirror, crystal, multipole, ^{3}He, polarizers/analysers; $\pi/2$ and π coil spin flippers; homogenous and inhomogeneous precession magnetic field codes) and existing modules will be upgraded with a spin-option (source, guide, samples).

The existing graphical user interface (GUI) will be improved and expanded in version 2.0. In principal VITESS 2.0 will serve as a flexible simulation engine: the fixed executable modules can be completed by the user by self-defined codes.

References

[1] VITESS website: http://www.hmi.de/projects/ess/vitess

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[4] B. Faragó, G. Ehlers , G. Káli and A. Wischnewski, ILL Annual Report 1999, p. 79