# Error Analysis According to the Polarization Ratio on Measuring the Magnetic Domain of a Magnetic Material Measured by Polarized Neutrons

Hui-Chia Su,[1,*] Yu-Han Wu,[2] and Chih-Hao Lee[1,2]

[1]*National Synchrotron Radiation Research Center, 30076, Taiwan*
[2]*Department of Engineering and System Science, National Tsing Hua University, Hsinchu, 30013, Taiwan*

(Received June 20, 2011)

A statistic error occurred corresponding to the polarization ratio during analysing the measured data of a magnetic domain by using neutron depolarization is presented. The error bar calculated of a fitting curve is strongly related to the polarization ratio but the relevant reports are rare. Therefore, we tried to understand how the polarization ratio affects the error and find out the optimal polarization ratio for the polarized neutron experiments in order to avoid non-necessary efforts on updating the polarization ratio of a polarized neutron beamline, especially for a $^3$He polarizer. The accuracy of the data analysis is increased as the polarization ratio increases. However, it's still not necessary to increase the polarization ratio higher than 95% due to the statistical error is already acceptable to the experiments. The experimental result is still barely acceptable (within 5-10% error) after modifying the statistical error within 85% polarization ratio.

PACS numbers: 75.70.Kw, 77.22.Ej, 29.27.Hj

## I. INTRODUCTION

In polarized neutron experiments, such as polarized neutron reflectivity (PNR) or neutron depolarization (ND), the polarization ratio of the incoming neutron beam plays an important role on the data analysis of a sample [1–6]. Ideally, a neutron beam with 100% polarization ratio is preferred to avoid the error incurred during data correction. However, in most setup of polarized neutron beamlines, the goal to achieve a very high polarization ratio might not be easily due to the limitation of polarizer operated at non-optimal wavelengths, high harmonics contamination, defects of optical elements, and stray fields from the surrounding materials. To estimate the statistical error due to the insufficient polarized ratio of a beamline is important, especially, when a $^3$He polarizer is used. In the recent developed $^3$He polarizer, a polarization ratio of only 70-80% was achieved [7, 8]. For PNR and ND experiments, many previous works [9–11] discussed how to improve the polarization ratio of the incoming neutron beam in order to improve the precision of the physical parameters acquired. A polarization ratio of 99.98% has been achieved already [11]. Several reports also discussed about the importance of the corrections of polarization ratio in the PNR and ND experiments [12–14]. In this work, we will focus on the statistical error

*Electronic address: su.huichia@nsrrc.org.tw

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