（ ※本報告書は英語で記述してください。ただし、産業利用課題として採択されている方は日本語で記述していただいても結構です。 ）

CROSS TOKAI Experimental Report J-PARC	承認日Date of Approval 2015/11/09 承認者Approver TAKEDA Masayasu 提出日Date of Report 2015/11/08
課題番号 Project No. 2014A0136 実験課題名 Title of experiment Investigation of the depth profile of the distribution of magnetic moments in (GaMn)As thin layer. 実験責任者名 Name of principal investigator TAKEDA Masayasu 所属 Affiliation Japan Atomic Energy Agency	装置責任者 Name of responsible person TAKEDA Masayasu 装置名 Name of Instrument/（BL No.） SHARAKU(BL17) 実施日 Date of Experiment 2014/5/27 10:00 ～ 2014/5/30 10:00 2014/5/30 22:00 ～ 2014/6/1 10:00

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

$Ga_{0.935}Mn_{0.065}As$ on a GaAs substrate

2. 実験方法及び結果（実験がうまくいかなかった場合、その理由を記述してください。）
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

The Mn-doped GaAs thin films are the most advanced semiconducting materials so that many fine tuning experiments have been carried out by using well controlled film. In our research, we focused on the following issue to be solved; macroscopic measurements suggested that the reduction or depletion of the bulk magnetization by applying an external voltage as well as the decrease of the Curie temperature would be originated by the superparamagnetism of Mn atoms, which should be experimentally proved from the microscopic experiments detecting the local behaviors of spins.

The polarized neutron reflectometry (PNR) is certainly the best experimental method to measure the local magnetic density distribution in the film by analyzing not only the depth profile of the specular reflection but the off-specular reflection where magnetic diffuse scattering is picked up. These measurements should be certainly performed by applying the voltage across the film for Mn doped GaAs thin films. Prior to this ambitious measurement, we performed the specular PNR measurement at zero electric field at low temperatures.

2. 実験方法及び結果（つづき） Experimental method and results (continued)

The PNR measurements of the $Ga_{0.935}Mn_{0.065}As$ single layer with thickness of 50 nm on a GaAs substrate were performed using SHARAKU without a spin-analyzer after the sample. The sample was set in a cryocooler and cooled down to 2.3 K. Figure 1 (a) indicates the polarized neutron reflectivity after the zero-field cooling process above *T*c. The red curve indicates the reflectivity when the neutron spin is parallel to an external magnetic field at the sample position, and the blue one anti-parallel. The difference between these two curves indicates an existence of the net magnetization in the sample. We successfully measured the reflectivity down to 10^{-7}, and observed a distinct magnetic signal after the zero-field cooling from 170 K under an external field of 10 kOe. On the contrary to this, the magnetic signal was not observed above *T*c (Fig. 1 (b)). This is a clear evidence of existence of the induced ferromagnetic moments in the sample. However, we feel difficulty to find out the structural parameters to reproduce the whole reflectivity curves. We suspect that something was wrong with the measurements although we think we carefully performed the experiments.

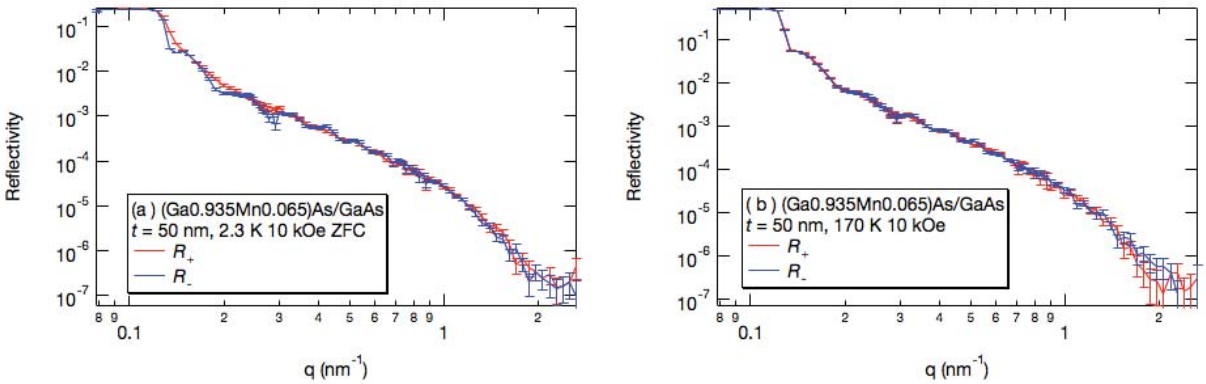

Fig. 1 Polarized neutron reflectivity profiles of $Ga_{0.935}Mn_{0.065}As$ single layer (50 nm) on a GaAs substrate under a magnetic field of 10 kOe (a) at 2.7K after ZFC from ambient temperature, and (b) at 170 K above T_c.