（ ※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 2017/05/17 承認者 Approver Kaoru Shibata 提出日 Date of Report 2017/05/11
課題番号 Project No. 2016B0075 実験課題名 Title of experiment Investigation of the domain wall dynamics in ferroelectric $BaTiO_3$ 実験責任者名 Name of principal investigator Knji OHWADA 所属 Affiliation National Institutes for Quantum and Radiological Science and Technology	装置責任者 Name of Instrument scientist Kaoru SHIBATA 装置名 Name of Instrument/（BL No.） BL-02 (DNA) 実施日 Date of Experiment 3/24 9:00 – 3/27 9:00

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.

Barium titanate

$BaTiO_3$

single crystal

10x10x3 mm^3

2 pieces (001 cut, 111 cut)

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.

In this proposal, we focused upon understanding the dynamics of the domain walls considered to be contributing to the large susceptibility in the ferroelectrics. We have constructed a suitable experimental system for studying the dynamics of the domain walls in the typical and well known ferroelectrics $BaTiO_3$, where $BaTiO_3$ has no chemical heterogeneity and allows us to construct an ideal experimental system. Concretely speaking, we have prepared two samples with *single domain* and *engineered domain* by the electric field application and search for the domain-wall dynamics by the inelastic neutron scattering expected to appear in the quasielastic (micro-eV) region by comparing the two samples.

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

Two single crystals of $BaTiO_3$ with the dimension of 10 x 10 x 3 (x, y, z) mm^3 were prepared. One is <111> cut and the other is <001> cut perpendicular to the z-axis of the sample. The former case, the application of the electric field of 10 kV/cm resulted in the *engineered domain* configuration with a few micro meter domain size, while the latter case, the application of the electric field resulted in the almost *single domain*.

The sample was set in the Cryo-furnace installed at BL02/MLF and the temperature was controlled from room temperature (tetragonal and ferroelectric phase) to 420 K (cubic and paraelectric phase). The quasielastic scattering was measured near the 010 Bragg position. We compared the quasi-elastic scattering spectra from *single-domain* $BaTiO_3$ and *engineered-domain* $BaTiO_3$, and found a dynamics considered to be from the domain walls. Figure 1 shows the spectrum of the quasielastic scattering measured at (0.03, 1, 0) (red filled circle) as well as resolution (green line). In the spectrum, two components can be observed; one is nearly resolution limit (~3.5 micro eV) and the other (tail of the scattering) is broader than the resolution.

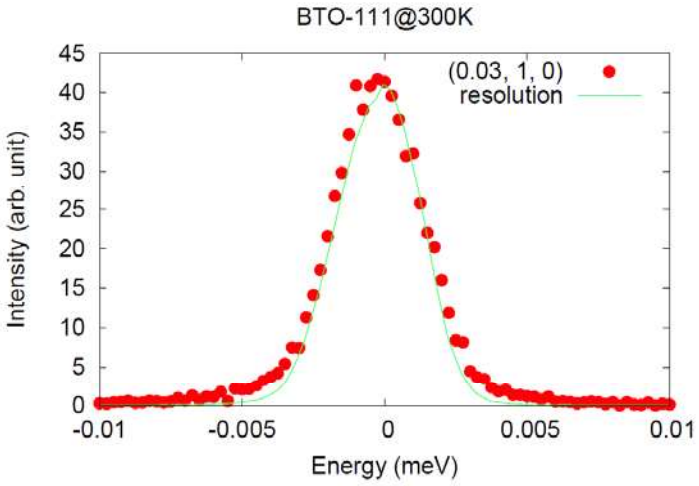

Fig. 1 Observed quasielastic scattering spectrum (red filled circle) from 111-cut $BaTiO_3$ measured at (0.03, 1, 0). The observed resolution function (green) is also shown.

As previously reported [1], there are two dynamics related to the domain wall; low-frequency (~0.1 GHz) dispersion is related to the domain wall vibrations, while the high-frequency (~10 GHz) dispersion is attributed to the flip of individual dipoles. The observed dynamics nearly resolution limit is considered to be the domain wall vibrations, while the dynamics broader than the resolution is considered to be the flip of individual dipoles. These peaks almost disappeared at 420 K indicating that the spectrum was originated from the ferroelectric phase. More detailed analysis is now under processing.

[1] P. Chu *et al.*, Scientific Report 05007 (2014).