実験報告書様式（一般利用課題・成果公開利用）

（ ※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 2014/3/25 承認者 Approver Kaoru Shibata 提出日 Date of Report 2014/3/24
課題番号 Project No. 2013B0064 実験課題名 Title of experiment Slow localized mode in the polar cluster of relaxor ferroelectrics 実験責任者名 Name of principal investigator Masato Matsuura 所属 Affiliation CROSS Tokai	装置責任者 Name of Instrument scientist Kaoru Shibata 装置名 Name of Instrument/（BL No.） DNA/BL02 実施日 Date of Experiment 2014/2/28〜3/5

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.

Yellowish transparent single crystal of 0.63($Pb(Mg_{1/3}Nb_{2/3})O_3$)-0.37($PbTiO_3$) with dimensions of 10 x 10 x $10mm^3$.

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.

Relaxor ferroelectrics have gained much scientific and industrial attention due to their extremely high piezoelectric and dielectric responses in a wide temperature range [1]. These materials also exhibit a remarkable dielectric frequency dispersion that extends over 10 orders of magnitude in frequency. These characteristic features have been attributed to randomly-oriented polar nanoregions (PNRs), which are local regions of ferroelectric order that are roughly several tens of nanometers in size. Diffuse scattering is commonly observed in lead-based relaxors below the temperature at which these PNRs form [2].

The thermal variation of the diffuse scattering roughly agrees with the dielectric susceptibility $\varepsilon'(T)$, suggesting one-to-one correspondence between diffuse scattering and PNRs. To understand the microscopic mechanism of PNRs, information on correlation of PNRs is indispensable. For this purpose, neutron scattering is the most powerful tool because it gives correlation function with tuning Q to the anisotropic diffuse scattering.

INS experiments were carried out by using the TOF type Si crystal analyzer near backscattering spectrometer "DNA" installed at BL02 of Materials and Life Science Experimental Facility in the J-PARC. The

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

300 kW at the experiment. We mounted the single crystal to access the (*hk0*) scattering plane in the pseudocubic notation. We measured the thermal variations of the quasi-elastic diffuse scattering near (100) Bragg points.

Figures 1 shows Q dependence of quasi-elastic neutron scattering (QENS) near (100) measured at *T*=300K. At *q*=0, we observed QENS with half-width-at-half-maximum (HWHM) of ~0.2meV as shown in Fig.1(a). In addition, narrow QENS component with HWHM of a few tens μeV coexists as shown in Fig.1 (b). With increasing q, QENS becomes broader, but still have narrow components. These QENS with wide distribution of HWHM are consistent with a remarkable dielectric frequency dispersion in relaxor ferroelectrics extending over 10 orders of magnitude in frequency. Recently, mode-distribution analysis of QENS has been developed by Kikuchi et al. [3] We are analysing these wide variation of QENS in relaxor ferroelectrics by this method. Inelastic neutron scattering gives Q-dependence of dynamics which can not be obtained by other technique especially at low energies. From the Q-dependence of the distribution function B(Q,Γ) and thier thermal variations, we believe we can how PNRs fluctuate and give rise to giant dielectric and piezoelectric responses.

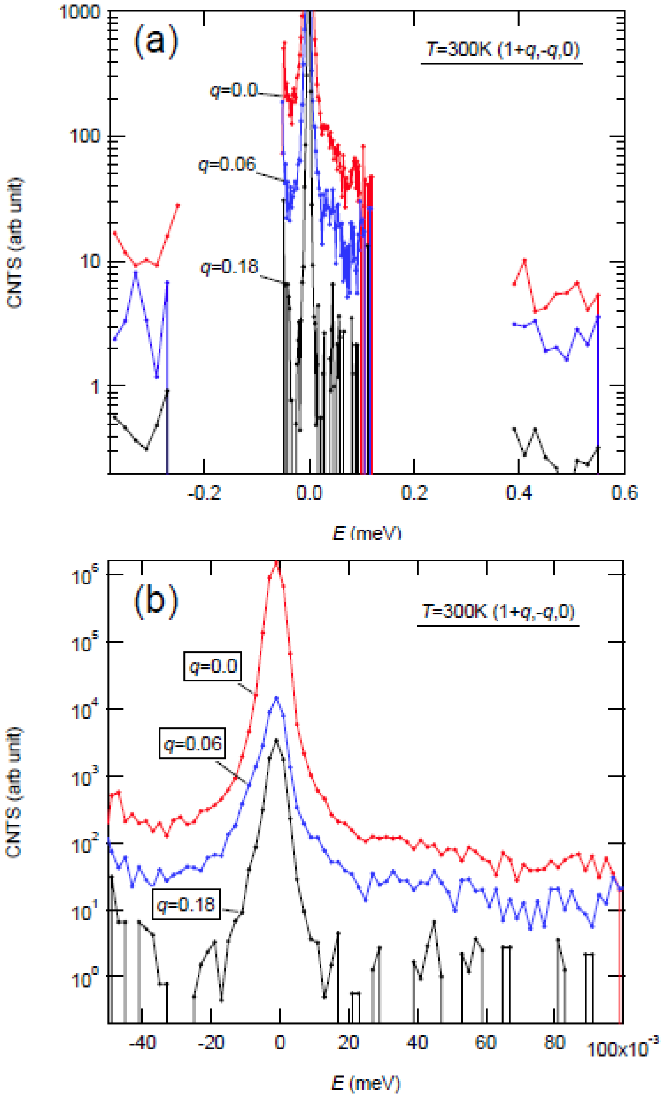

Fig.1 Q dependence of quasi-elastic neutron scattering at *T*=300K (a) in wide energy range and (b) in enlarged view near *E*=0.

References

[1] S.-E. Park and T. R. Shrout: J. Appl. Phys. 82 (1997) 1804.

[2] G. Xu et al., Phys. Rev. B 70 (2004) 174109.

[3] T. Kikuchi et al. Phys. Rev. E 87 (2013) 062134.