（ ※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。 ）

TOKAI CROSS Experimental Report J-PARC	提出日 Date of Report 25/09/2012
課題番号 Project No. 2012A0104 実験課題名 Title of experiment Observation of entire spin excitation spectrum in the T'-structured Pr1.9Ca0.1CuO4 実験責任者名 Name of principal investigator Masaki Fujita 所属 Affiliation Institute for Materials Research, Tohoku University	装置責任者 Name of responsible person Masaki Fujita 装置名 Name of Instrument/（BL No.） 4SEASONS(BL01) 実施日時 Date and time of Experiment 14/06/2012, 10am. -20/06/2012, 9am.

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.

As-grown PLCO, $Pr_{1.4}La_{0.6}CuO_{4+\delta}$, δ=0

Ar-annealed PLCO, $Pr_{1.4}La_{0.6}CuO_{4+\delta}$, δ=-0.05

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.

High-energy inelastic neutron scattering measurements on the as-grown and the Ar-annealed $Pr_{1.40}La_{0.60}CuO_4$ were carried out, to clarify the magnetic excitation spectrum in the T'-structured system. Using the newly developed multi-Ei method on 4SEASONS, we successfully determined the dispersion relation of spin excitations from T'-structured system in a wide momentum and energy spaces for the first time. Figure 1 shows the intensity contour at four energies obtained for (b)-(e) as-grown and (f)-(i) annealed systems. The overall dispersion relation is depicted in Fig. 1(a). The ling-shaped intensity distribution around (0.5, 0.5) reciprocal position gradually spreads with increasing the energy transfer. This spread is consistent with the expected energy-evolution of spectrum from the conventional spin-wave excitation. The peak-position in the constant-energy spectra below 250 meV is almost same for the two systems, suggesting the negligible annealing effect on the dispersion relation, namely the nearest neighbor exchange coupling. However, the absolute intensity was found to be much weaker in the annealed system, as is seen in Fig. 1.

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

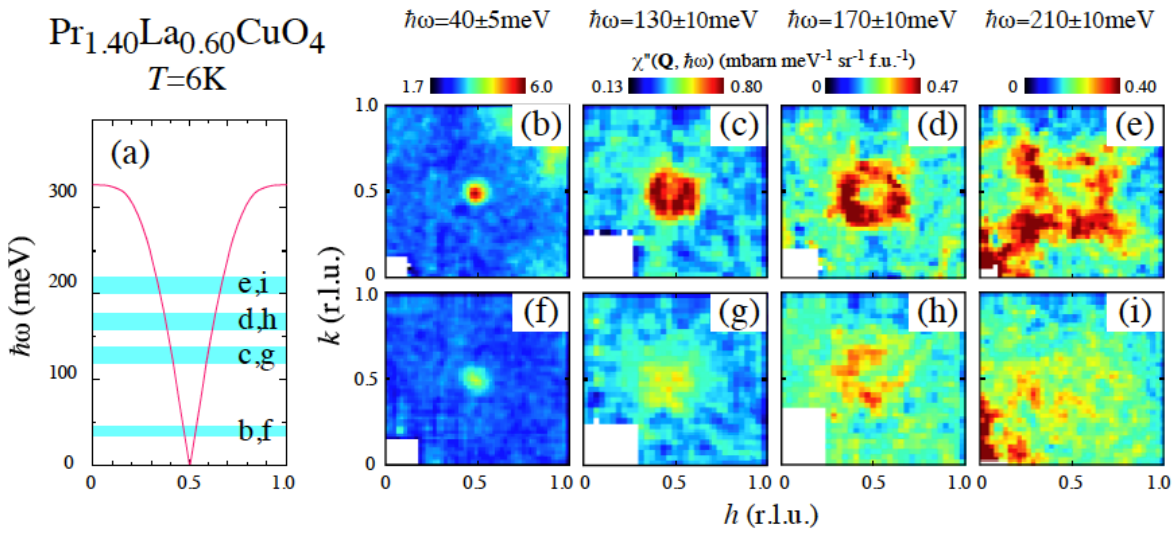

Fig. 1. (a) The dispersion relation of excitation spectrum. Constant energy slices of dynamical spin susceptibility for (b)-(e) as grown and (f)-(i) $Pr_{1.40}La_{0.60}CuO_{4+\delta}$. Measurement on the two systems were done under the identical experimental set-ups.

The local spin susceptibility χ" as a function of energy transfer is plotted in Fig. 2. In the all measured energy range below 250meV, χ" is smaller in the annealed system, and the total χ" integrated over energy transfer between 6meV and 250meV in the annealed system is only 40% of that in the as-grown system. This intensity-reduction without changing the dispersion is difficult to understand within the simple localized spin picture. One may think that the reason for the intensity-reduction is attributed to the electron-doping effect introduced by the oxygen removal. However, the weight-loss is far beyond the expected value from the decrease of number of spins, meaning a break-down of sum rule. One possibility for the anomalous suppression of intensity is a change of magnetic form factor F(Q). If the cloud of charge density ρ(r) expands by annealing, the F(Q), which is the Fourier transform of ρ(r), at higher Q is suppressed, resulting into the loss of scattering intensity. Direct measurement of F(Q) in the two systems would be important to test the anneal-induced change of charge density.

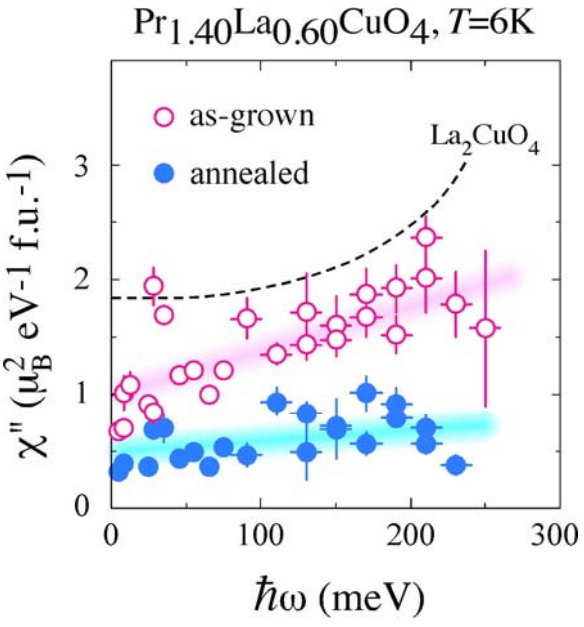

Fig. 2. Energy dependence of local spin susceptibility for as-grown (open circles) and annealed (closed circles) $Pr_{1.40}La_{0.60}CuO_{4+\delta}$.