MLF Experimental Report	提出日 Date of Report March 21, 2013
課題番号 Project No. 2012B0108 実験課題名 Title of experiment Thermal Strain Exerted on Superconductive Filaments in Practical Nb_3Sn and Nb_3Al Strands 実験責任者名 Name of principal investigator Kozo Osamura 所属 Affiliation Research Institute for Applied Sciences	装置責任者 Name of responsible person Kazuya Aizawa, Stefanus Harjo 装置名 Name of Instrument/（BL No.） BL19: TAKUMI 実施日 Date of Experiment 23 – 27 Dec, 2012

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.

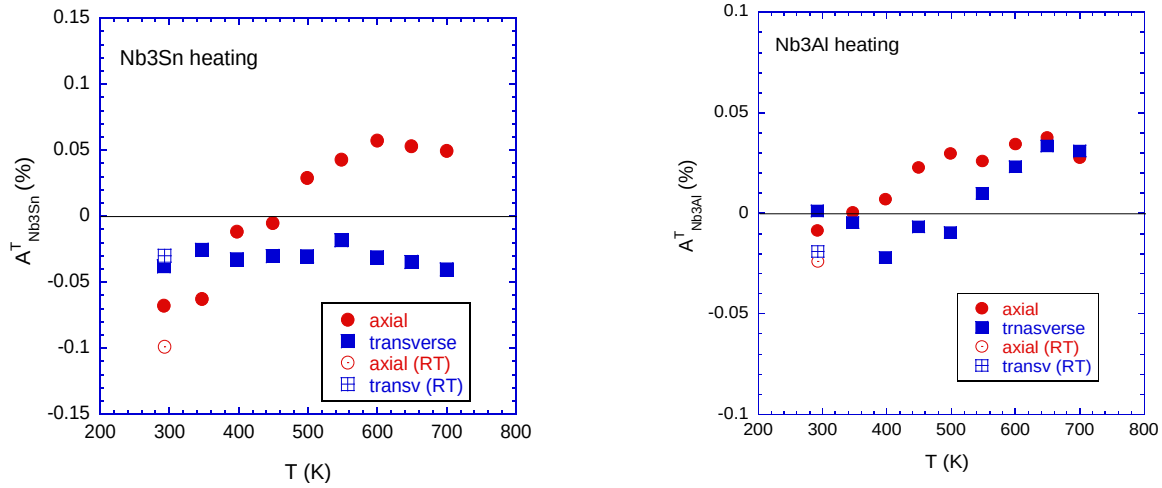
Two types of SC strands were examined. Nb_3Sn strand was fabricated by Hitachi cable for ITER project, in which 11,000 SC filaments were embedded in the bronze matrix and surrounded by Nb barrier and Cu stabilizer. The original composition of bronze was 15.5wt%Sn-0.3wt%Ti. According to the preliminary electron microscope analysis, the Sn concentration of Cu-Sn matrix was 0.9– 1.1wt% Sn after the fully reacted state. Nb_3Al strand was fabricated by Hitachi cable through Jerry Roll method, in which 90 SC filaments were embedded in Cu matrix.

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 diffraction measurements were carried out at TAKUMI of J-PARC, where the pulsed neutrons with wavelength region between 0.06 and 0.2 nm were utilized. The diffracted beams were detected by means of two detector banks consisting of ^3He detectors, which were equipped at two orthogonal positions to the incident beam. The south data bank accumulated the diffracted neutrons parallel to the strand axis, but another north one accumulated the diffracted ones transverse to the strand axis. In principle, each data bank was able to accumulate two dimensional data with respect to wavelength and diffraction angle. In order to measure the thermal strain at elevated temperatures, the bundle of short samples was put in the evacuated electric furnace, which was equipped at the center of goniometer. The simultaneous experiments of tensile test and diffraction were carried out at room temperature by using the specially designed load frame, which was equipped at the center of goniometer. The Nyilas type extensometer was attached to the sample to measure external strain.

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

By using the electric furnace, the temperature dependence of thermal stains exerted on SC filaments was measured along both axial and transverse directions as shown in Fig. 1. Here the room temperature data are added in the figures. The axial thermal strain near room temperature was negative, that means compressive strain. It decreased with increasing temperature and became zero. Then the sign of thermal strain turned to positive, it means tensile. It tended to saturate at high temperature. On the other hand, the transverse thermal strain was compressive in the whole temperature range and gradually decreased with increasing temperature for Nb_3Sn strand. In the case of Nb_3Al strand, the behavior of axial thermal strain was similar to the change for Nb_3Sn as shown in Fig.1(b). At room temperature, the axial strain was compressive. With increasing temperature, the thermal strain became tensile and saturated. The transverse thermal strains at room temperature were scattered, but their average was compressive. It increased and turned to tensile with increasing temperature.



(a) Nb3Sn (b) Nb3Al

Fig. 1 Change of thermal strain as a function of temperature for Nb_3Sn and Nb_3Al strands.

Their temperature dependence was numerically evaluated by means of iteration method. As a whole, it has been established that the temperature dependence of thermal strain can be well reproduced by the numerical calculation proposed here. It was pointed out that the thermal strain on SC filaments is affected by the creep phenomenon at high temperatures above a threshold temperature.