J-PARC **MLF Experimental Report**	提出日 Date of Report 9 May 2013
課題番号 Project No. 2012B0017 実験課題名 Title of experiment Investigation of degradation mechanism in large-scale superconductor for fusion reactors 実験責任者名 Name of principal investigator Tsutomu Hemmi 所属 Affiliation JAEA	装置責任者 Name of responsible person Aizawa Kazuya 装置名 Name of Instrument/（BL No.） BL No. 19 実施日 Date of Experiment 24 Nov. 2013 – 28 Nov. 2013 4 Dec. 2013 – 8 Dec. 2013

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.

1) ITER CS conductor sample (solid): Nb_3Sn, Nb, Cu, CuSn, Stainless steel (JK2LB), Cr
2) Nb_3Sn Filaments (solid): Nb_3Sn
3) Nb_3Sn Strand (solid): Nb_3Sn, Nb, Cu, CuSn, Cr
4) Bent Nb_3Sn Strand (solid): Nb_3Sn, Nb, Cu, CuSn, Ti6Al4V

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.

As shown in Figure 1, an incident beam is diffracted at a selected position of the conductor sample. The TOF diffracted beam is collected by a pair of detector, which is located at 90 degree angles from the incident beam, in order to determine internal strains for axial and lateral directions simultaneously. The measured gauge volume of 7 x 2 x 16 mm^3 in the conductor sample was determined by the incident slit to specify the measured position of 7 mm in height and 16 mm in width, and a pair of radial collimator to specify the measured position of 2 mm in thickness. The sample conductor was turned over to measure for the lower loading side (LLS) and the higher loading side (HLS) to have same path of the neutron beam.

To evaluate internal strains in conductor sample, neutron diffraction measurements were performed at room temperature after the SULTAN testing. Figure 2 shows the neutron diffraction profiles for Nb_3Sn (211) at the LLS and the HLS of the field center and 1150 mm from the field center of the CSJA01 L before cutting. There is difference in neutron diffraction peak profile of Nb_3Sn (211) between the LLS and the HLS of the field center. ΔHWHM is the difference between the HWHMs of the sample and the Nb_3Sn strands to show the broadening of the neutron diffraction profile. The bending of the Nb_3Sn was found at the LLS of the field center since the broadening of the neutron diffraction peak profile of the LLS of the field center was observed.

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

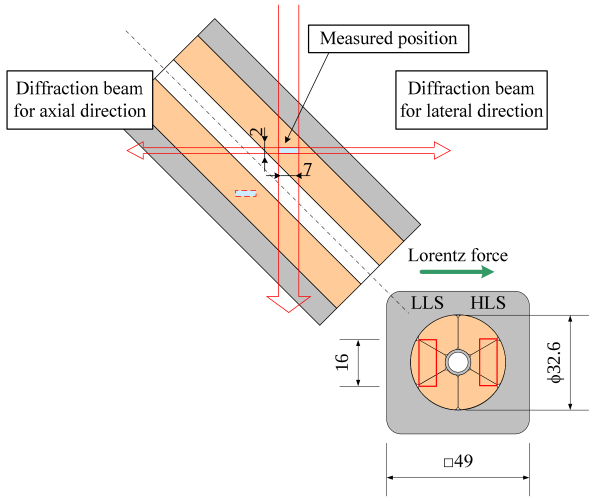


Figure 1 Schematic diagrams of measurement

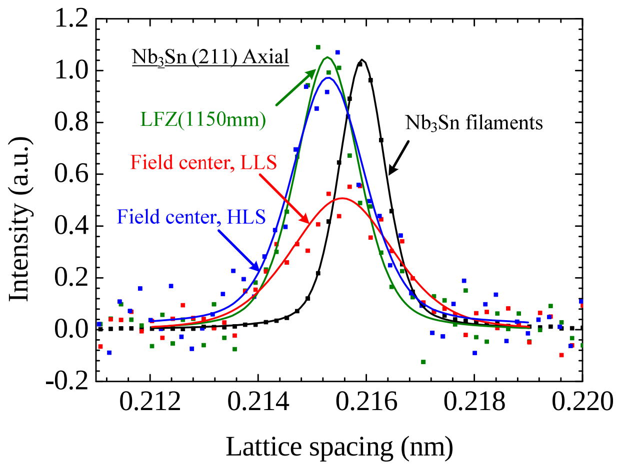
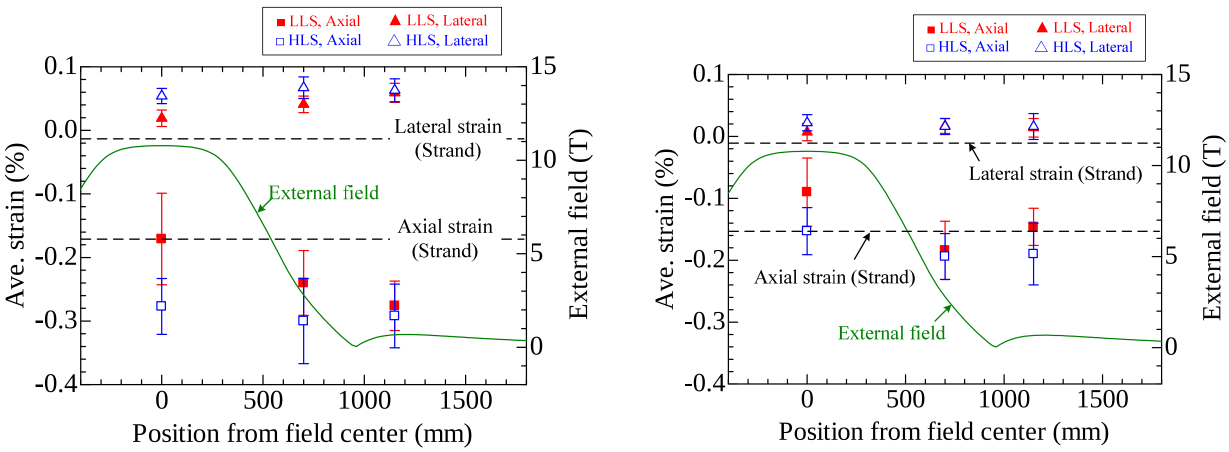


Figure 2 Differences in neutron diffraction profile.

Figure 3 shows the internal strain evaluated from the diffraction planes of Nb_3Sn (210), (211), (320) and (321) as averages weighted by the integral intensities of each diffraction peak profile before/after cutting of the conductor sample. The internal strain of Nb_3Sn was changed to the tensile side and broadened by the cyclic testing at the LLS of the HFZ. The internal strain was released by cutting since the thermally induced residual strain generated by the difference in thermal contraction between the cable and the jacket was changed.



(a) before cutting (b) after cutting

Figure 3 Results of internal strain for Nb_3Sn before/after cutting.

The neutron diffraction measurements of the conductor sample before/after cutting were performed to investigate the T_{cs} degradation of the conductor sample. As a result of the neutron diffraction measurement, the large bending at the LLS of the HFZ was observed. Therefore, it is concluded that the T_{cs} degraded position of the conductor sample due to the cyclic loading was the LLS of the HFZ in the conductor sample. The large bending was considered as an origin of the strand buckling due to the large void generated by the transverse electromagnetic loading and the thermally induced residual strain generated by the difference in the thermal contraction between the cable and the jacket.