（ ※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。 ）

MLF Experimental Report	提出日 Date of Report 2016/6/29
課題番号 Project No. 2015P0401 実験課題名 Title of experiment Experimental and numerical study on stress states of structural discontinuities 実験責任者名 Name of principal investigator Koichi Akita 所属 Affiliation Japan Atomic Energy Agency	装置責任者 Name of responsible person Kazuya Aizawa 装置名 Name of Instrument/（BL No.） TAKUMI (BL19) 実施日 Date of Experiment 2016/3/31-4/3 & 2016/4/21-24

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) Sample name: Invar alloy-stainless steel friction welding joint (FW joint)
   Dimensions: ϕ25 × L130 mm
   Number of samples: 1
   Materials: Invar alloy (Fe, Ni, Mn, C), Stainless steel JIS SUS316L (Fe, C, Si, Mn, P, S, Ni, Cr, Mo)
2) Sample name: Stainless steel welded pipe (Welded pipe)
   Dimensions: Outer diameter ϕ164.5 × L195 × t12 mm
   Number of samples: 3 (As weld, Shot peened, Thermal treated)
   Materials: Stainless steel JIS SUS316L (Fe, C, Si, Mn, P, S, Ni, Cr, Mo), Stainless weld metal JIS Y316L (C, P, S, Cr, Nb, Ta, Ti)

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.

<Experimental method>

Neutron diffraction strain mapping experiments were performed using BL19 TAKUMI at J-PARC MLF. Fig. 1 shows the sample setup. The gage volume was 2 x 2 x 2 mm^3 and was defined by an incident slit and a pair of radial collimators with 2 mm width. Measured diffraction data were analyzed using the Rietveld analysis software for J-PARC, Z-Rietveld.

(a) FW joint. (b) Welded pipe.

Fig. 1 Sample setup at BL19 TAKUMI.

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

<Results>

1) FW joint

Strain mapping was performed on the longitudinal section area of the sample as shown in Fig. 2 schematically. The stress free lattice parameter (d-zero) which is needed for calculating strains is not yet measured. Therefore, the tentative d-zero of each material was determined at a far position from the joint interface.

Measured strain maps are shown in Fig. 3. Tensile strains are observed at the SUS316L side near the interface, while the compressive strains are observed in the invar side. The most likely explanation is that the difference of the linear expansion coefficients between both materials caused thermal stresses. The linear expansion coefficient of the invar alloy is about 1.5×10^{-6}/ºC that is one-tenth of that of SUS316L. Therefore, the tensile strains were generated in the SUS316L side by deformation restraint during cooling from the fabrication temperature for the friction welding.

After this experiment, this sample will be mechanically machined to the pipe shape which simulates the shape of an actual pipe joint component. And, the sample core cut out from the sample will be machined to some d-zero samples. Strain mapping in the sectional area of the pipe wall and d-zero measurements will be performed in the next experiment round to discuss the effects of the initial residual stress on the structural integrity of the joint.

2) Welded pipe

Strain maps near the weld bead of the three pipe joints were successfully obtained. Some results are shown in Fig. 4. Typical strain distributions can be seen in the figure. We will analyze the data in detail later.

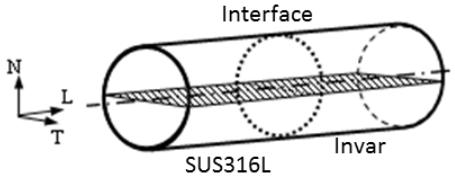

Fig. 2 FW joint sample. Strain mapping was performed on the hatched area of the figure.

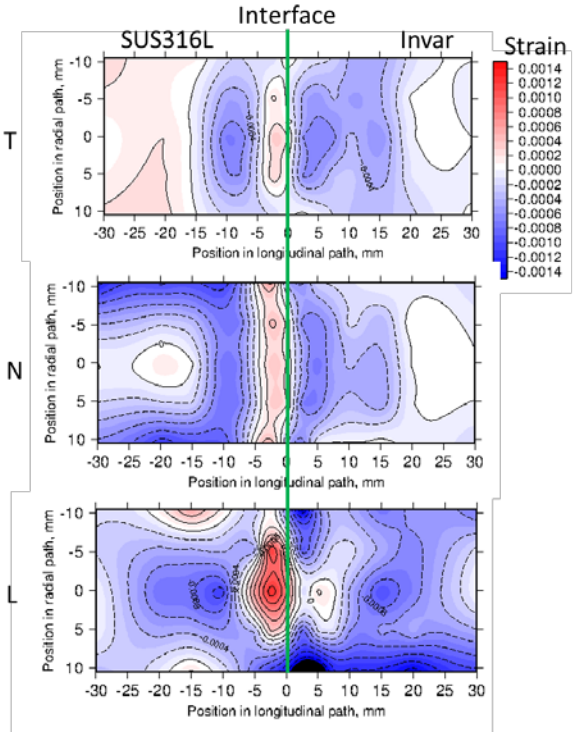

Fig. 3 Strain maps of the FW joint sample.

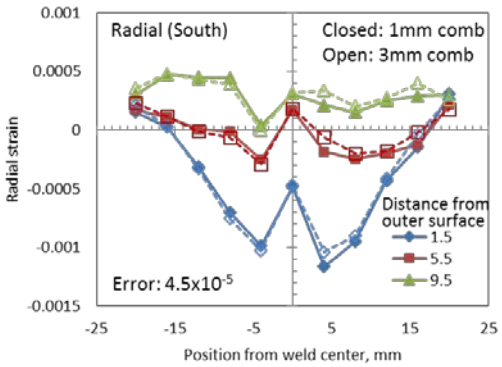

Fig. 4 Examples of residual strains in the welded pipe.