（ ※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 2016/12/19 承認者 Approver Takenao Shinohara 提出日 Date of Report 2016/12/19
課題番号 Project No. 2016A0032 実験課題名 Title of experiment Bragg-Edge Strain Tomography for In Situ Loadings 実験責任者名 Name of principal investigator A/Prof. Chris Wensrich 所属 Affiliation The University of Newcastle	装置責任者 Name of Instrument scientist Dr Takenao Shinohara 装置名 Name of Instrument/(BL No.) RADEN (BL22) 実施日 Date of Experiment 2016/11/25 – 2016/11/29

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. C-shaped steel (EN26) sample (Sample 1)
2. Steel bearing rollers (Sample 2)

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.

This experiment was focused on providing a proof-of-concept demonstration of Bragg-edge strain tomography for in situ applied loads using an approach based on the reconstruction of boundary displacement. This proof-of-concept was based on 2 two-dimensional systems; a solid C-shaped steel sample subject to point loads (Sample 1), and a system of cylindrical steel rollers as a model of a granular system (Sample 2). The experiment consisted of measuring many in-plane Bragg-edge strain projections using the MCP/TimePix detector as supplied by Dr Anton Tremsin, from which our algorithm can reconstruct internal strain fields [1].

The experiment proceeded as expected, beginning with a number of preliminary measurements such as axial and d_0 projections for each of the two samples and an open beam image. The sample time to provide the required accuracy in strain measurements was determined during this process. Tomographic measurements then commenced and continued up until the final morning of the experiment. A golden angle increment was used to evenly distribute projections over 360^0, regardless of the time available.

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

Overall, we were able to measure a total of 86 projections of both samples; a number well in excess of what we had hoped for. This was due to a number of factors;

- The two samples were able to be stacked in such a way that both could be observed in the same image. This meant that only one set of projections was necessary to cover both samples.
- The source was very stable over the 4 days of our experiment; only experiencing a few brief outages.
- Acceptable errors in strain measurements (i.e. less than $1x10^{-4}$) were achievable with less than 1 hour of measurement time per projection.

Data for sample 1 was processed as it became available. This involved re-binning of pixels from the image stacks into columns 2-pixels wide and covering the full length of the sample. Bragg-edges of the form described by Santisteban [2] were fitted and the corresponding strain profiles were calculated as the relative shift of the edge position as a function of position in the sample. The sample position and centre of rotation were determined by matching the known geometry of the sample with the observed sinogram.

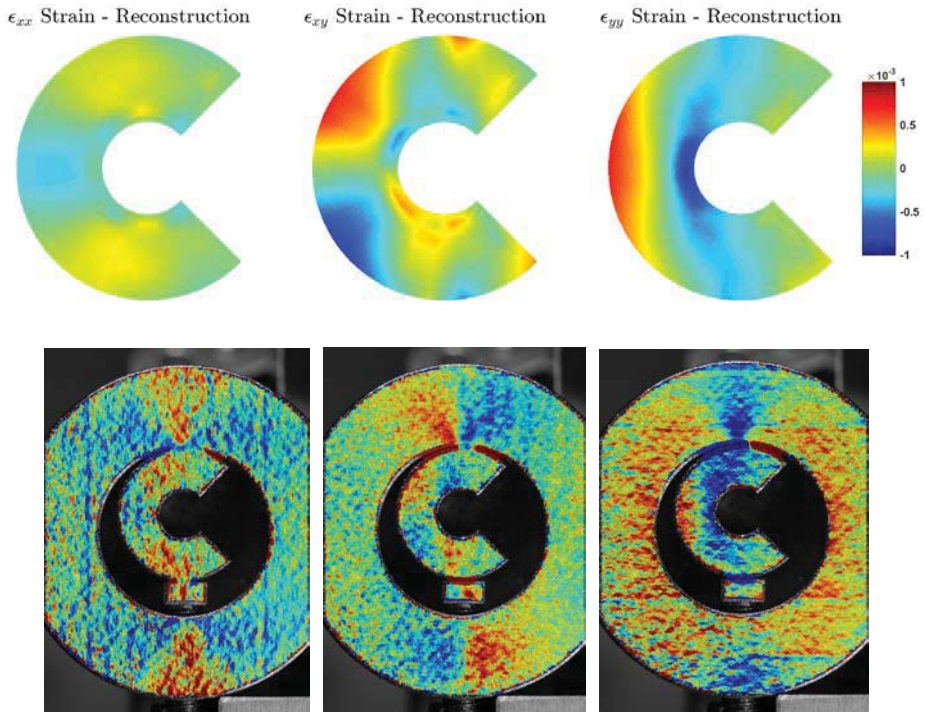

Figure 1: (Top) The final reconstruction of the three components of the strain field within Sample 1. (Bottom) DIC results for Sample 1. Note the same colour-scale is used in both sets of results.

Our reconstruction algorithm was applied to the resulting set of projections to produce the reconstruction shown in Figure 1. This is a significant result and represents the first ever practical demonstration of strain tomography for a non-axisymmetric system. A letter to be submitted to Physical Review Letters is currently in preparation. Results from sample 2 will be analysed in the near future.

[1] Wensrich et al. *Nucl. Inst. & Meth. In Phys. Res. B*, v383 52-58 (2016)

[2] Santisteban et al. *Appl. Phys. A*, v74 s1433-s1436 (2002).