CROSS TOKAI **Experimental Report** J-PARC	承認日 Date of Approval 2017/5/22 承認者 Approver Ryoichi Kajimoto 提出日 Date of Report 2017/5/22

実験装置名／BL番号 Name of Instrument/BL
4SEASONS/BL01 2015I0001
実験装置責任者 Name of the person responsible for the instrument:
Ryoichi Kajimoto
所属 Affiliation: Materials and Life Science Division, J-PARC Center, Japan Atomic Energy Agency

1. 研究成果概要 （a）装置グループ内の成果、（b）ユーザー課題実装時における特筆すべきサポート、（c）ユーザー課題の執行状況について、まとめてください。A4 サイズ用紙使用のこと。

Outline of your activities. Following results at your instrument should be reported in A4 size papers: (a) results of your instrument group, (b) significant user support works, and (c) statistical summary of user experiments.

(a) Results of the instrument group

The experiments performed in the 2015 term are classified into the following three categories: (1) Calibrations of devices for stable operation of the instrument, (2) Performance evaluations of the instrument and devices, and (3) Preliminary measurements for new scientific themes and short supplementary measurements for users.

For the category (1), we performed position calibration of the ^{3}He detectors and phase calibration of the choppers. These are regular calibrations of the instrument performed after long-term shutdowns.

For the category (2), we performed performance evaluation measurements of the radial collimator. The radial collimator used on 4SEASONS can be oscillated to suppress shadows by the collimator blades [M. Nakamura *et al.*, JPS Conf. Proc. **8**, 036011 (2015)]. The speed of oscillation and the number of oscillations are important parameters for the performance of the collimator. Then, we measured spatial profiles of incoherent scattering of a vanadium sample with various oscillating speeds of the radial collimator. Figure 1(a) compares the spatial profiles when the radial collimator was oscillated at two different speeds. At the higher oscillating speed, non-uniform intensity distribution due to the shadows of the blades is smoothed. Figure 1(b) shows the spatial profiles for four different numbers of oscillations. As the number of oscillation n increases, the spatial profile becomes more uniform, and becomes unchanged for n > 10. The difference in the profiles in Fig. 1(b) should be attributed to the difference in the number of oscillations. When the measurement time is short, we need to increase the speed to obtain enough number of oscillations. The present results give us an important guide for the operation of the radial collimator.

In addition, for the category (2), we also performed measurements of magnetic excitations in a 140-mg single crystal of $CuCrO_2$. This material is a triangular-lattice antiferromagnet with S=3/2 and shows spin-wave excitations at low energies. The spin-wave excitations in this crystal was already measured using the cold-neutron spectrometer AMATERAS [R. Kajimoto *et al.*, J. Phys. Soc. Jpn. **84**, 074708 (2015)]. Although 4SEASONS is classified as a thermal neutron spectrometer, even low E_i's

1．研究成果概要（つづき） Outline of experimental results (continued).

less than 10 meV, which are usually utilized at AMATERAS, are obtained thanks to the multi-E_i feature. To evaluate the performance of 4SEASONS with such low E_i's, we measured the spin-wave excitations of the same crystal as used at AMATERAS. Figure 2 shows the excitation spectrum measured at 5 K by using E_i = 4.5 meV. A clear dispersion relation of the spin-waves was observed. Although the observed intensity is inferior to that obtained at AMATERAS, it is practically sufficient for measurements of such a small crystal. The energy resolution is comparable to that of the high-flux operation mode of AMATERAS. The present result shows that 4SEASONS provides enough performance for cold neutrons, and extends the possibilities of the multi-E_i measurements. On the other hand, in Fig. 2, we observed a funny background at $\hbar\omega$ ~ 0.4 meV. This background probably comes from neutrons scattered by the sample environment, but the exact cause remains to be clarified.

Finally, as for the category (3), we performed test measurements of phonon DOS of $SrTiO_3$, magnetic excitations in the triangular-lattice antiferromagnet $Li_2InMo_3O_8$, magnetic excitations in the iron-based superconductors $BaFe_{0.91}Cr_{0.09}As_2$ and $Ba_{0.75}K_{0.25}Fe_2As_2$, to promote scientific activities of the instrument group. They were lead to respective general proposals. In addition, supplementary measurements for users were performed. They are a supplementary experiment of catalysts and a background evaluation measurement of a ^3He cryostat

(b) User support works

User programs were performed by technical and scientific supports by the instrument group staffs of 4SEASONS, R. Kajimoto (JAEA), M. Nakamura (JAEA), K. Ikeuchi (CROSS), K. Iida (CROSS), and K. Kamazawa (CROSS). Data acquisition and analysis were particularly supported by Y. Inamura. One technical staff from CROSS (M. Ishikado) provided technical support. In addition, the user program was supported by many other technical staffs in MLF such as R. Takahashi (JAEA) (sample environment), N. Kubo (JAEA) (electric work), and W. Kambara (JAEA), K. Aoyama (JAEA) (machine design).

(c) Statistical Summary of user experiments

The user program in this fiscal year was severely affected by troubles of the neutron target. 10 General Use proposals, 1 Urgent Use proposal, 1 Trial Use proposal, 2 Element Strategy Initiative Use proposals, and 2 Project Use proposals were approved for BL01 in JFY2015. Since the 2015B call for proposals was canceled, the number of approved proposals is smaller than usual. Moreover, many of the approved proposals in 2015A were postponed to JFY2016, and the beamtimes of the Instrument Use and the Project Use were reduced. One General Use proposal was canceled on request from the user due to the delay of the operation schedule.

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1．研究成果概要（つづき） Outline of experimental results (continued).

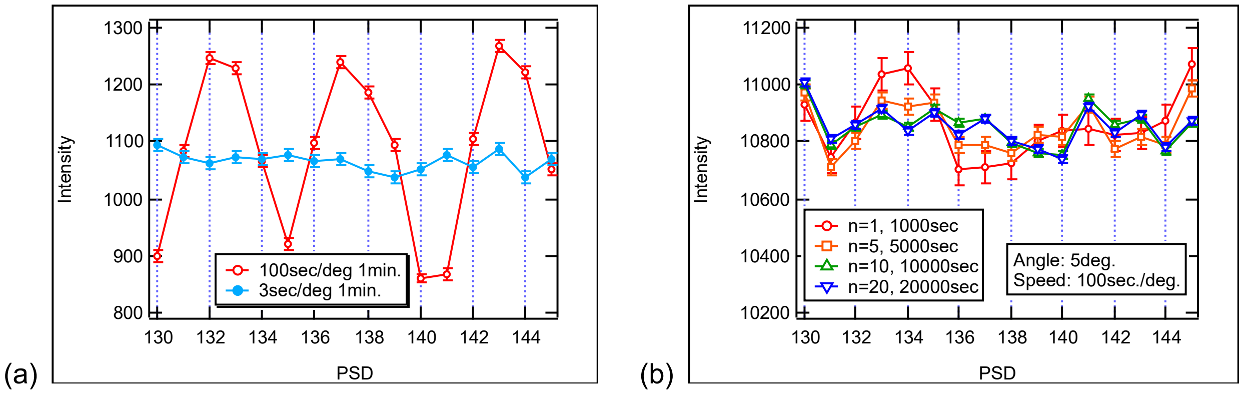

Fig. 1. Spatial distributions of scattering intensity from a vanadium sample with the oscillating radial collimator. (a) Open and closed circles show the data with a low-speed oscillation (100 s/°) and a high-speed oscillation (3 s/°), respectively. Each measurement time was 1 min. (b) Circles, squares, upward triangles, and downward triangles show the data after the radial collimator oscillated back and forth 1, 5, 10, and 20 times, respectively. The oscillating speed was 100 s/°.

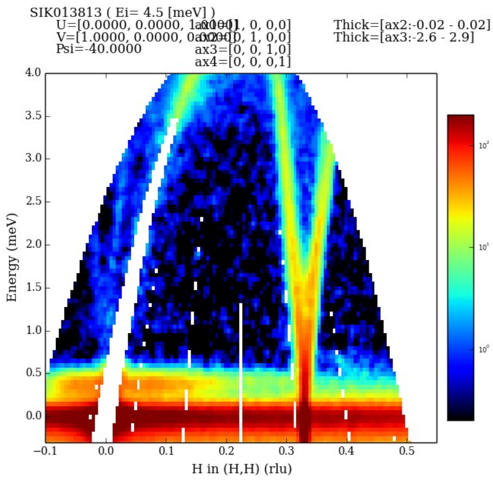

Fig. 2. *Q-ħω* map of the excitation spectrum of the 140-mg single crystal of $CuCrO_2$ measured at 5 K. The spectrum is cut along the [1,1] direction in the two-dimensional reciprocal lattice.

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