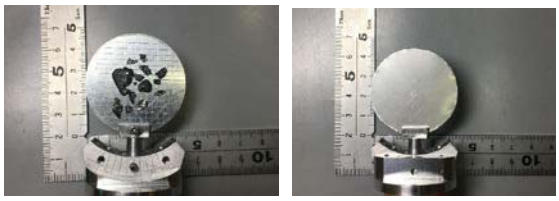
（ ※本報告書は英語で記述してください。ただし、産業利用課題として採択されている方は日本語で記述していただいても結構です。 ）

CROSS TOKAI **Experimental Report** J-PARC	承認日 Date of Approval 2017/9/28 承認者 Approver Ryoichi Kajimoto 提出日 Date of Report 2017/9/27
課題番号 Project No. 2017A0151 実験課題名 Title of experiment Neutron scattering study on CaKFe4As4 single crystals-a new class of Fe-based superconductor 実験責任者名 Name of principal investigator WEN Jinsheng 所属 Affiliation Department of Physics, Nanjing University	装置責任者 Name of Instrument scientist Mitsutaka, Nakamura Kazuya, Kamazawa 装置名 Name of Instrument/(BL No.) BL01 4SEASONS 実施日 Date of Experiment May 22nd to 31st, 2017

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.

Samples: 1 gram of $CaKFe_4As_4$ single crystals co-aligned on an Al plate. To subtract the background from Al, we also measure another similar Al plate. Both of them are shown below:



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 interplay between magnetism and superconductivity has been one of the central issues in the study of Fe-based superconductors (SCs). By substituting on different atom sites, hole, electron and isovalent doping have been realized in different classes of Fe-based SCs. Recently, a new series of Fe-based superconductors, namely the $AeAFe_4As_4$ (Ae=Ca, Sr, Ba; A=Na, K, Rb, Cs, 1114) systems have been reported. Distinct from the $(Ae_{1-x}A_x)Fe_2As_2$ (122) case that has a space group of I4/mmm, the 1144 structure is consisted of Ae and A layers alternatively stacked between the Fe_2As_2 layers, which belongs to the P4/mmm space group. It has a high Tc of ~36 K, close to the optimally-doped $Ba_{2-x}K_xFe_2As_2$ sample.

Inspired by its interesting properties, we carried out time-of-flight neutron scattering experiment on BL01 4SEASONS spectrometer. Our measurements were taken at high temperature (40 K, above Tc) and base temperature (5 K) with 4 days for each of them. One day left was spent on background measurement of Al plate. The series Ei of 27, 46, 95 and 300 meV were applied in the multi-Ei mode.

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

Because of a large background from Al plate, the main results are shown with subtracted data. The data along L direction has always been integrated for a better intensity in HK0 plane.

As shown in figure 1, spin excitation has been found located at (0.5 0.5). The raw data in the left panel shows that the Al plate contaminates a lot near the resonance peak, after subtracting background of Al, the resonances become clear in the middle panel. The right panel is energy cut by integrating qk in [0.4, 0.6], the resonance starts around 10 meV and ended around 17 meV, the signal over 18 meV might come from residual intensity after subtraction.

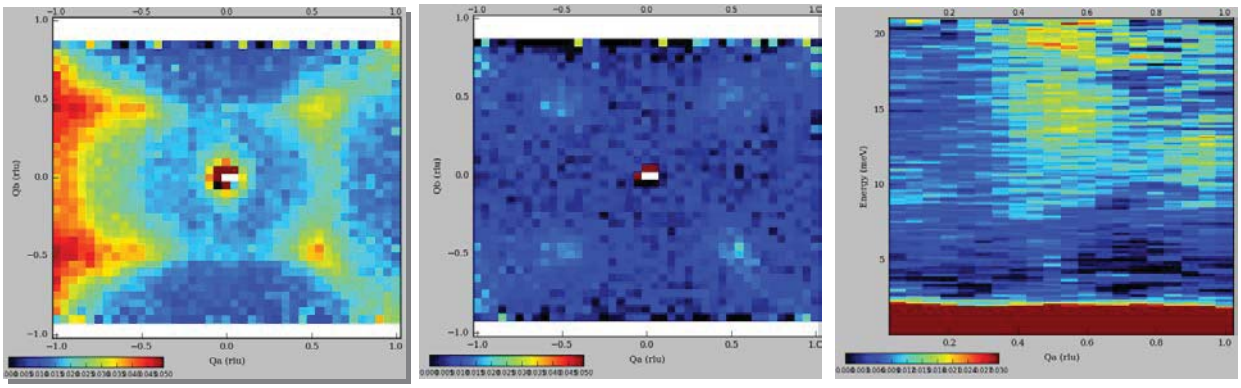


Figure 1. Spin excitation at (0.5 0.5 L) and energy range of 10~18 meV, measured at 5K, Ei=27 meV
From left to the right: Raw data plot in HK0 plane; Data subtracted by Al background; Energy vs Q

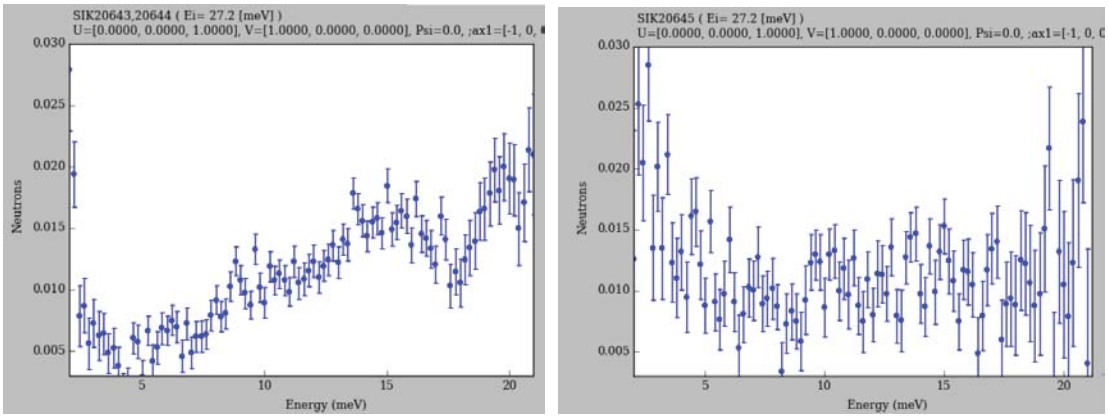


Figure 2. Energy cut at base temperature (left) and high temperature (right)

If we further look into the energy scans and plot the cut with qh in [0.4,0.6]. It is obvious that below Tc, the spin resonance and superconducting gap occurs around 15 meV and below 8 meV, respectively.

However, there are still some puzzles waiting for more efforts: the resonance energy is different when we check it with Ei=46 meV data, resonance is absent at L=2, and low energy background is higher with Ei=27 meV, with which we could have a better resolution.

To conclude, we have measured the spin excitations in 1144 Fe-based superconductor $CaKFe_4As_4$ and observed the spin resonance around 15 meV coresponding to the superconducting gap. The new structure of SC shows expected properties similar to the others in the Fe-based SC family. However, further work is needed such as to check what the role magnetism plays in this material. We would like to thank Mitsukata san and Kazuya san for their work during our stay, the experiment would not be performed without their help.