実験報告書様式（一般利用課題・成果公開利用）

MLF Experimental Report	提出日 Date of Report 2011/08/21
課題番号 Project No. 2010A0004 実験課題名 Title of experiment Evolution of magnetic excitations with Se substitution in Fe1.01SexTe1-x near the quantum critical point 実験責任者名 Name of principal investigator Jooseop Lee 所属 Affiliation University of Virginia	装置責任者 Name of responsible person 梶本亮一 装置名 Name of Instrument/(BL No.) 4SEASON (BL01) 実施日 Date of Experiment 11/22/2011-11/29/2011

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.

Name: Iron Telluride with Selenium doping

Formula: $Fe_{1.01}Te_{0.7}Se_{0.3}$

Sample type: Single crystal

A 5.3g of nonsuperconducting sample of $FeTe_{0.7}Se_{0.3}$ was grown using Bridgman method at Institute of Solid State Physics, University of Tokyo. The magnetic and electrical properties of the $Fe_{1+y}Te_{1-x}Se_x$ system depend on the excessive iron amount, y, of the sample. With y almost being zero, when measured by SQUID, the magnetic susceptibility data showed nonsuperconductivity and spin glass magnetic behavior.

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.

To investigate the evolution of spin excitation in this sample, we performed neutron diffraction experiment at the time-of-flight chopper spectrometer, 4SEASON, JPARC. Using multiple incident energy technique, we were able to use 257, 87, 43, 26, 17meV incident energies at the same time, which enables us to investigate several energy windows all at once. To study the spin excitation in HK plane, the sample was aligned with the incident wave vector parallel to the c-axis within 2 degree, and was cooled down to 8K, as the transition temperature to spin glass phase is known to be 23K. Here, we will define momentum transfer (q_x, q_y, q_z) in reciprocal lattice unit, (H, K, L)=($q_x a/2\pi$, $q_y b/2\pi$, $q_z c/2\pi$) of tetragonal crystallographic unit cell, not Fe-square lattice magnetic unit cell.

As depicted in Fig. 1, the cigar-shape spin excitation which is thought to be formed by overlapped spin excitation quartet is observed around (1/2 0) position below about 10meV. Furthermore, it seems there are no peaks around (1/2 1/2) position in our case. This is in contrast with previous report done using filamentary superconducting sample with same Se concentration.

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

In the previous study, It was reported that (1/2 0) peak coexist with (1/2 1/2) peak at filamentary superconducting sample, and suppressed in bulk superconducting sample. At that time was thought to be related with excessive iron in that sample, which can play a role in superconductivity breaking. The (1/2 0) peak, however, could be observed even though there is no excessive iron with y being almost 0 in our sample. Therefore, the plausible explanation is that the 45 degree rotated peak is intrinsic in this system, and it seems to suppress the development of superconductivity, while (1/2 1/2) peak is necessary. The peak position is slightly incommensurate (~0.4) as expected.

When the energy transfer increases, the intensity of cigar-shape peaks around (1/2 0) smears out gradually toward 45 degree rotated direction, (1/2 1/2), and finally form quartet around (1 0) at 20meV as shown in Fig. 2. The enhanced intensity around (1.5 0.5) is contamination from aluminum phonon. The formation quartet is consistent with the previous report. As the energy increases, this quartet shrinks to (1 0) forming a ring, and finally evolve into spot at (1 0). The similar evolution of spin excitation of both superconducting and nonsuperconducting sample at high energy could suggest the significance of low energy excitation in superconductivity.

Furthermore, we could observe another interesting spin dispersion behavior which was not revealed in the former study. Even though it is true that the spin excitation, in general, shrinks from the quartet, ring, and into spot, the distance of peaks from (1 0) does not simply decrease. It is shown that there is hourglass-like dispersion around (1 0) position in the low energy region, which is reminiscent of cuprate. The quartet is far away from (1 0) position, and move close together as the energy increase, which becomes closest around 20meV, and then separates away again. These peaks eventually meet together becoming a spot at much higher energy. Recent study on the 11 system also showed similar hourglass like dispersion in its normal state. This behavior was interpreted within Fermi surface nesting picture, and could be related with hole-pocket excitation in multiband system like metal Chromium with help of strong electron-electron interaction and spin-orbital coupling. Very recently, another group also discovered similar phenomena like our data at lower concentration of Se, 5%, and they tried to explain the spin fluctuation based on spin wave. The fit of the data, however, is rather poor and do not seem to capture the salient feature of this phenomena. Further comparative study between superconducting and nonsuperconducting and among different family of iron based superconductor is desired.

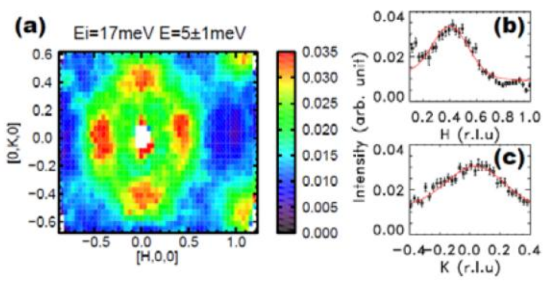

Figure 1. HK plane image of magnetic excitation at T=9K

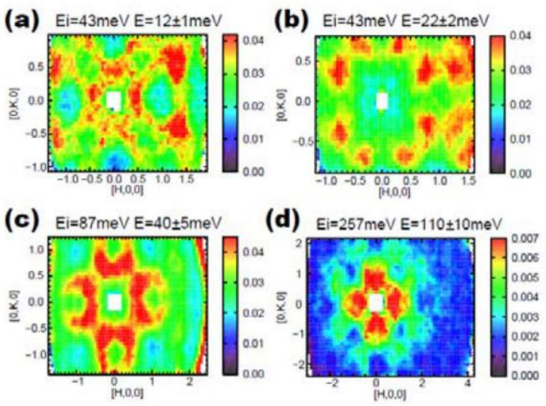

Figure 2. Evolution of magnetic excitation in HK plane