 MLF Experimental Report	提出日 Date of Report 2016 Jan.04
課題番号 Project No. 2014B0278 実験課題名 Title of experiment Feasibility study of boron imaging by detecting 478 keV gamma ray following the $^{10}\text{B}(n, \alpha)^7\text{Li}^*$ reaction aimed at steel and plant study 実験責任者名 Name of principal investigator Kino Koichi 所属 Affiliation Hokkaido University	装置責任者 Name of responsible person Toh Yosuke 装置名 Name of Instrument/(BL No.) ANNRI/(BL 04) 実施日 Date of Experiment 2015/11/08~11

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. Iron sample: 6 sets (boron 0, 5, 10, 50, 100, 500 ppm) Each sample is composed of 20mm × 20mm × 1mm 5 Fe plates and 4 papers that includes boric acid. 2. Water sample: 6 sets (boron 0, 5, 10, 50, 100, 500 ppm) Each sample is 20mm × 15mm × 1mm water that includes boric acid in the aluminum vessel.

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. We used the ANNRI and its Ge spectrometer to detect 478-keV gamma-rays followed by the $^{10}\text{B}(n, \alpha)^7\text{Li}^*$ reaction for the iron and water samples that contains a tiny amount of boron. The pulsed neutron beam was bombarded on the sample under the condition that the X-collimator was 27mm and the rotary collimator was 7 mm in diameter at the JSNS power of 499kW. The gamma rays from the neutron source were cut by the 37.5-mm thick lead filter. We obtained the data of Au foil, NaCl and B-10 samples, and Eu-152, Co-60, Cs-137, Na-22, Ba-133 sources for the energy calibration, TOF calibration, and TOF spectrum of the neutron beam. The measurement times for the iron and water samples were about 12 and 23 hours, respectively. Fig. 1 shows the energy spectra of gamma rays around the 478-keV gamma ray for the iron and water samples, in which boron is included at the concentration of 0, 5, 10, 50, 100, and 500 ppm. For the iron sample, excess of the 478-keV gamma ray above the 0 ppm sample are seen. On the other hand, for the water sample, the excess was not observed on the 5 and 10-ppm samples. The intensity of the background below the 478-keV gamma ray is low compared to that of the 0-ppm sample. The reason is attributed to the leakage of water from the aluminum vessel since the intensity of the 2.2-MeV gamma ray that is due to the coupling of

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

proton in water molecules is much weak for the 5 and 10–ppm samples. However, the samples were packed in two layers of FEP film. Therefore, there was no leakage of water outside.

Figure 2 shows the relation of the concentration of boron and the count rate of the 478–keV gamma ray for the iron and boron samples. The data was obtained by subtracting the 0–ppm sample spectrum from the others. For the iron sample, the 500–ppm sample did not contain the intended amount of boron. Therefore, the figure does not have the data point of the 500–ppm sample. The relation is almost proportional. However, the intercept of the fitting curve (linear function) was not zero. The reason has not been understood yet. For the water sample, the data points of the 5 and 10–ppm samples are not plotted due to the reason mentioned above. The linearity of the relation is quite good.

In conclusion, we succeeded in observing ppm level boron in the iron and water samples. The intensity of the gamma rays originating from boron was almost proportional to the concentration of boron. This result indicates that we can microanalyses boron in iron and water. In the future, we will conduct quantitative imaging experiments of boron by scanning the samples using ANNRI.

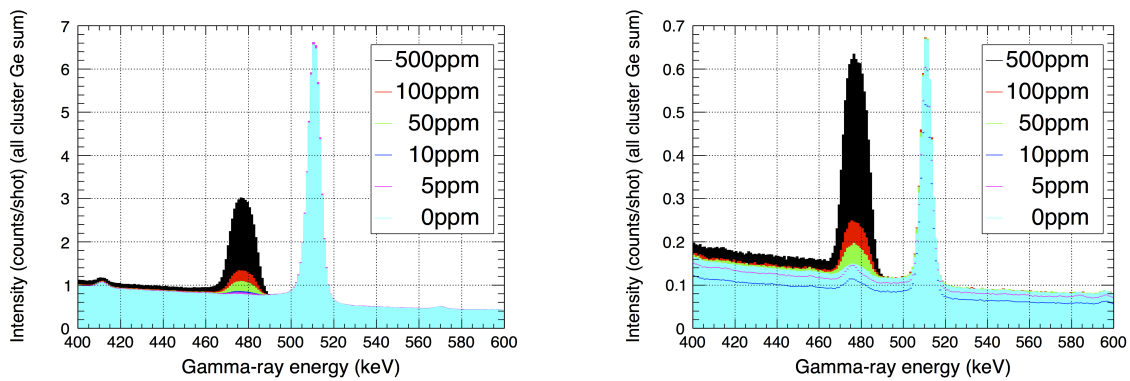


Figure 1 Energy spectra of gamma rays around the 478-keV gamma ray. The left and right figures are the iron and water samples, respectively.

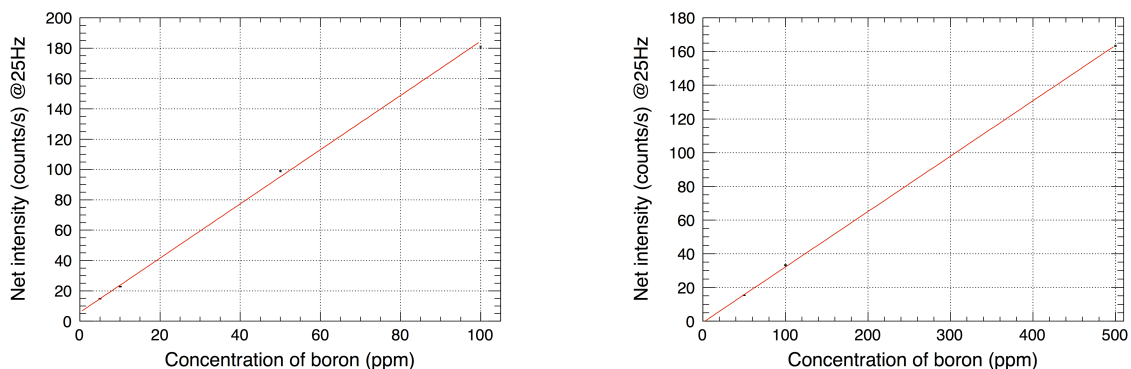


Figure 2 Relation of the count rate of 478-keV gamma ray and the concentration of boron in the samples. The left and right figures are the iron and water samples, respectively. The red curve is the fit by a linear function to the data points.