Non-destructive measurements of Li distributions inside batteries are important for understanding their performance and degradation. Conventional X-ray fluorescence analysis is unsuitable for this purpose, because fluorescent X-rays from light elements such as Li have very low energies and are strongly absorbed within the battery. We therefore focus on muonic X-ray analysis. When a negative muon stops in matter, it is captured by an atom and undergoes cascade transitions to the 1s state. It emits muonic X-rays whose energies are characteristic of the element. Because the muon is about 207 times heavier than the electron, muonic X-rays are much more energetic than ordinary fluorescent X-rays and can escape from deep within a sample. The stopping depth can be tuned with the muon momentum. Muonic X-ray analysis is thus a non-destructive elemental analysis technique that provides depth-dependent information and is sensitive to light elements such as Li and C. It has been applied to cultural heritage and materials science, primarily using Ge detectors.

In this work, we used XRPIX8, a device in the XRPIX series of SOI pixel detectors originally developed for X-ray astronomy. XRPIX8 has a 94 × 94 array of 36 μm × 36 μm pixels and simultaneously provides energy and pixel-level position information over an energy range from a few keV to several tens of keV. At the D2 beamline of J-PARC MLF, we irradiated a sample consisting of 2 mm and 1 mm thick Li metal plates with a muon beam and observed the muonic X-ray line of Li at 18.7 keV, the primary target of this work, together with muonic X-rays from carbon (about 14 keV) and from silicon in the detector itself (about 12 and 27 keV). In the two-dimensional images, the Li and Si distributions were complementary, and more Si muonic X-rays were observed in the 1 mm-thick region. This indicates that muons passed through the Li and stopped in the silicon detector. We also investigated the depth dependence of the muonic X-ray intensity by varying the incident muon momentum. In this presentation, we report these results.