【Grant-in-Aid for Scientific Research(S)】
Biological Sciences (Biology)

Title of Project：Construction of novel detector system for structural biology using ultrafast fine pixel detector

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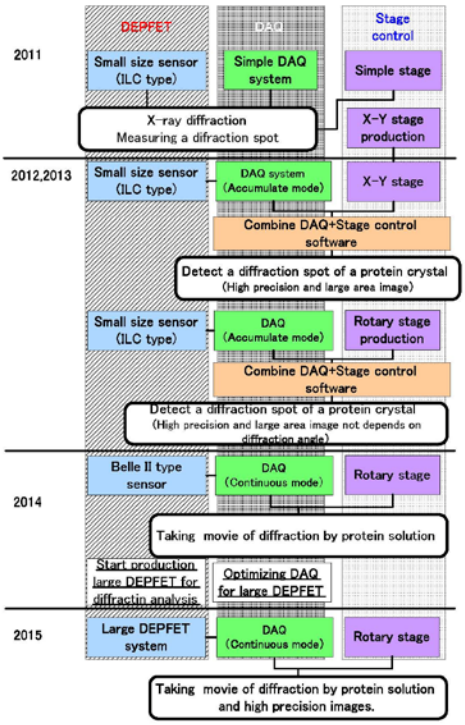
Research Area：Structural biochemistry
Keyword：X-ray crystallographic analysis, novel detector

【Purpose and Background of the Research】

Highly accurate measurements of X-ray diffraction and scattering data are essential to obtain detailed structural information in protein structural analyses. Therefore the position resolution of X-ray detector is crucial in achieving fine structure analysis. In recent years, attention has been drawn to pixel detectors that measure positions with high accuracy and that can also record moving images by retrieving hit information at high speed. In this study, we will focus on the latest pixel detector (Depleted P-channel Field Effect Transistor [DEPFET]) developed for elementary particle physics experiments and will create new DEPFET detector system optimized for structural analysis of proteins. Our target in this study is creating an ultrafine, fast-readout, large-area (8 million pixels) detector that is far superior to conventional detectors, to give breakthrough on very difficult structural analysis and structural dynamics research of proteins.

【Research Methods】



The above figure illustrates a summary of our research plan. A DEPFET Sensor Team will develop and fabricate a sensor and check operations at KEK. A Data Acquisition (DAQ) Team will construct the DAQ system while addressing two readout modes and increased sensor output data bandwidth. A Stage Team will create an x-y and rotation stages necessary for a large area. A Structural Analysis Team will be responsible for conduction of X-ray experiments, and analyses, as shown in the white rectangles in the figure. In 2015, we will perform very difficult crystal structure analyses of proteins using the completed new DEPFET detector.

【Expected Research Achievements and Scientific Significance】

This is an interdisciplinary study in which researchers in the structural biology field will apply their expertise on particle detection cultivated through elementary particle physics experiments to the synchrotron radiation field. We can reduce the initial cost for developing sensors significantly, as the development of DEPFET detectors and readout electronics was already established in the process of aiming for the Belle II experiment. The DEPFET detector and broadband data collection mechanism developed in this study will define the detector in the future for difficult crystal structure analyses of protein complexes, and for protein structural dynamics research with much higher time resolution (20 μs).

【Publications Relevant to the Project】

[1] “PILATUS: A single photon counting pixel detector for X-ray applications”, B. Henrich et al., Nucl. Instrum. Meth. A, vol **607**, p 247 (2009).
[2] “The DEPFET active pixel sensor for vertexing at ILC and Super KEKB”, Stefan Rummel et al., Nucl. Instrum. Meth. A, vol **623**, p189 (2010).

【Term of Project】 FY2011-2015
【Budget Allocation】 161,400 Thousand Yen

【Homepage Address and Other Contact Information】

http://twiki.hll.mpg.de/twiki/bin/view/DEPFET/WebHome