研究課題別事後評価結果

１．研究課題名：　高速量子波面モジュレーション・クライオ電顕

２．個人研究者名

Radostin Danev（東京大学大学院医学系研究科　教授）

３．事後評価結果 *Project Evaluation*

This project aims to transform the transmission electron microscope from a static and rigid instrument into a dynamic and flexible optical platform, which sets the stage for the invention of new imaging modalities in view of resolution and sensitivity for cryo-electron microscopy.

［どのような量子性をどのように扱ったのか］*Quantum View Points*

・A coherent quantum beam of electrons to observe the atomic structure of biological objects.
・Modulating the quantum wave in real-time to achieve better performance.

［達成状況とインパクト］*Research Outcomes & Impact*

Dr. Danev enabled real-time defocus modulation and successfully evaluated the practical performance of the system. Through his theoretical and numerical investigations of the proposed defocus modulator designs, he revealed practical challenges regarding the required electromagnetic field and overcame them through his new approach based on applying an electrostatic potential on the objective lens aperture. He also confirmed the system's performance and suitability for fast and accurate defocus modulation (FADE) and enabled the start of FADE experiments at the University of Tokyo. Regarding Cryo-EM experiments on the FADE system including the processing of non-standard FADE data, Dr. Danev succeeded in producing the first high-resolution 3D cryo-EM reconstructions in the world and achieved a new resolution record for this type of electron microscope. Moreover, he installed a new electrostatic dese modulator (EDM) on the development system and confirmed proper operation of the hardware and its added capability for beam intensity modulation. To summarize, his research outcomes are shown as follows:

- Evaluated the performance of two electromagnetic wave modulators.
- Invented a new modulator based on the interaction between chromatic aberration and electrostatic potential on the objective aperture.
- Quantified and validated the modulation frequency and linearity of the new modulator.
- Performed tests with biological cryo-samples, confirmed the usability, and optimized the practical implementation of the method.
- Invented a new nano-FADE modulation approach which can reduce systematic noise from the sample, the support, or the camera.
- Set a new resolution record with the nano-FADE method.

Dr. Danev now leads strong academic and industrial partners in this research field. Together with the above outcomes, this project was successful and highly commendable. Further EDM-based investigations are expected on the new microscope platform in the future.