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# CETA-F: Scintillator camera for Entry level 100kV Single Particle Analysis

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Single-Particle cryo-electron microscopy is a well-established technique which provides information about high-resolution details of biological structures. Over the last 10 years direct electron detectors (DED) became the leading technology for low-dose imaging of radiation sensitive samples [1]; however, the technology remains out of reach for most institutions as it is rather costly. Recently, we at Thermo Scientific™ introduced the Tundra, a new entry level Cryo-EM that is dedicated to SPA and operates at 100kV. Our mission with the Tundra is to enable adoption of Cryo-EM SPA by the broader life sciences community, including biochemistry laboratories and inexperienced users. The Tundra creates a "revolution" in effectivity by providing a cost-optimized solution that offers biologically-relevant performance.

Here, we demonstrate that a significantly more affordable scintillator-based camera with good sensitivity can substitute for expensive DED cameras at 100kV. Tundra introduces the 4kx4k CETA-F camera with four times improved sensitivity at 100kV compared to the standard CETA 16M product. Importantly, at 100kV the higher sensitivity and increased photon yield density within the CETA-F scintillator layer significantly improves low dose DQE [2] as demonstrated in Figure 1. It shows DQE curves, where spatial frequency is normalized to the camera field of view (FOV). Figure 2 illustrates the remarkable improvement in the CETA-F DQE at 100kV relative to the DQEs of DEDs and hybrid detectors at 100kV [3]. Thus, the CETA-F is a viable and inexpensive 100kV detector alternative to the more expensive DED. Moreover, it does not suffer from the low FOV and radiation hardness challenges typically associated with hybrid and DED technology. Our latest benchmarking experiment with Apoferritin (440kDa) achieved high SNR and a 3D reconstruction at sub-3Å resolution. This demonstrates that the CETA-F camera is sufficient for SPA data acquisitions and for optical alignment of the instrument. The camera operates in linear mode using correlated double sampling with a frame rate of 14fps. It is also equipped with dose-fractionation mode that enables reconstruction of detailed protein structures.

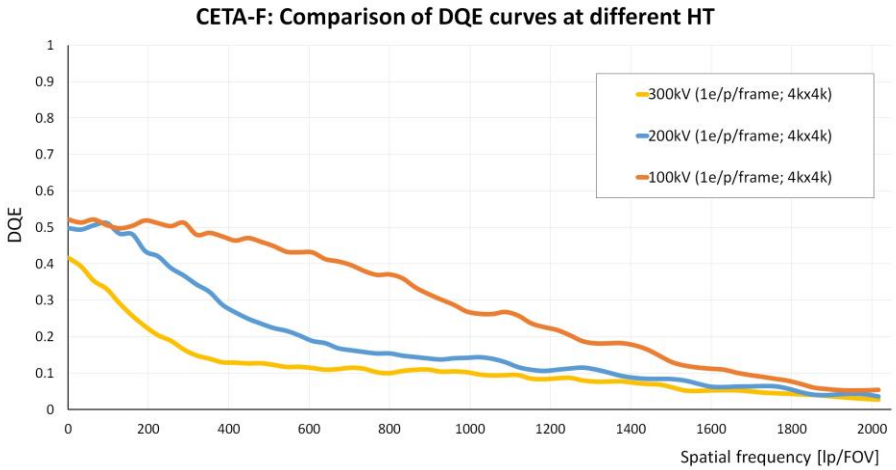


**Figure 1.** DQE of CETA-F at different HT

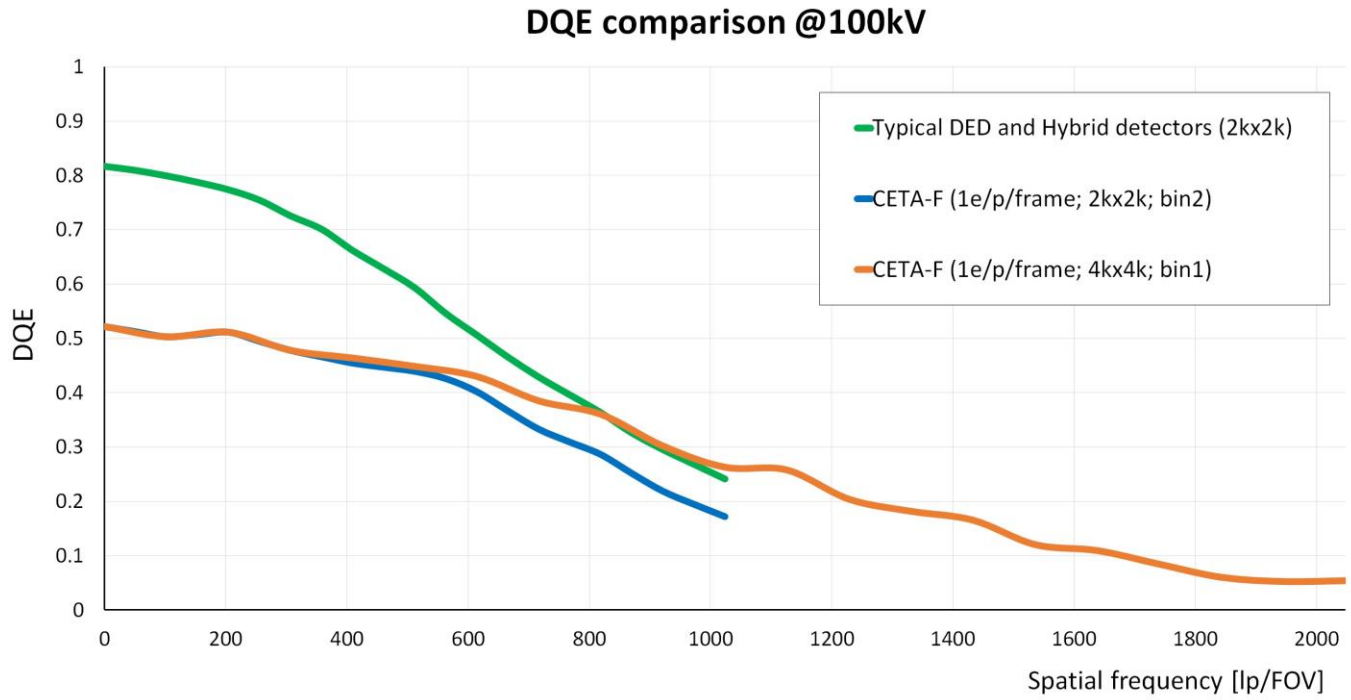


**Figure 2.** DQE comparison of CETA-F and typical hybrid / direct electron detector at 100kV.

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