Pulse System for STEM

The Pulse system is a modular and retrofittable upgrade to improve the speed and precision of scanning transmission electron microscopy signals. At its core, it streams the analog signal from an electron detector, including those using scintillator based technology, identifies individual electron events and returns a fully digital output.[1] The result is images with calibrated units of individual electrons with a true zero background level and pure Poission noise.

Advantages

- Connects to any acquisition system accepting TTL digital inputs.
- Produces quantifiable images with true zero dark level and pure Poisson noise.
- Acts alongside existing detectors for simultaneous acquisition of images, including spectroscopy.
- Features two channels for electron counting on two separate detectors.

Specifications

	2 Channel	4 Channel
No. channels	2 in, 2 out	4 in, 4 out
Connections	BNC	
Input range	Max. ±10 V	
Input resolution	14-bit	
Input impedence	50 Ω	
Sample rate	125 Msps (per channel)	
Output voltage	3.3 V CMOS, 5 V TTL	
Output frequency	Max. 62.5 MHz	
Power	5 V (USB-C or barrel jack)	
Control interface	RJ45 ethernet	

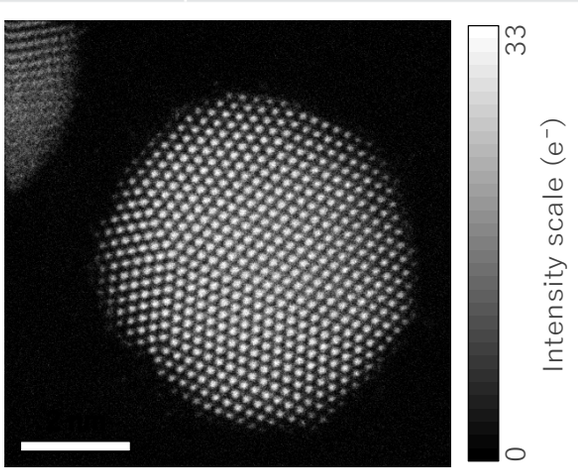

Figure 1 Electron counted image of a gold nanoparticle. Image was acquired on a Nion UltraSTEM 200 with a Pulse readout interfacing with a Gatan Digiscan II.[1]

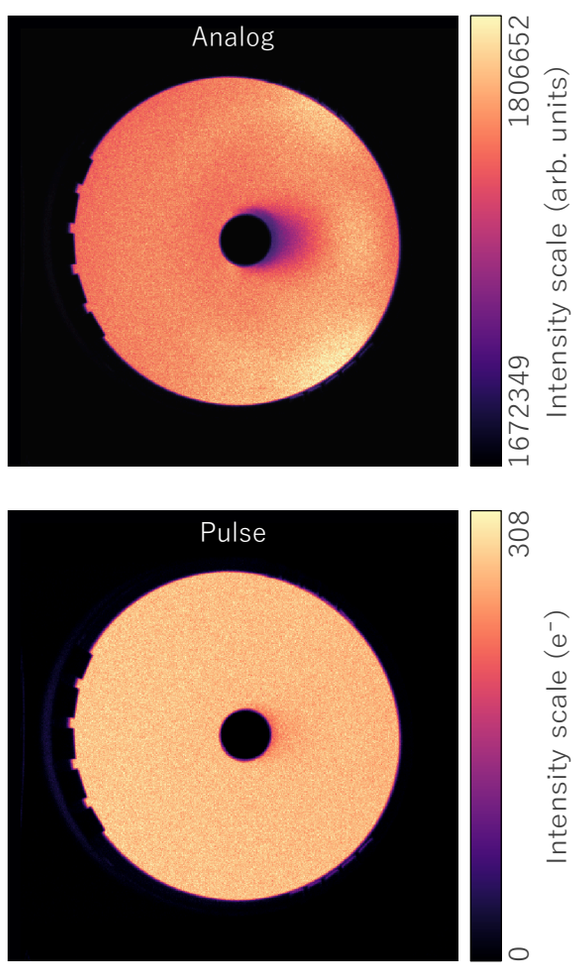

Figure 2 Annular dark field detector maps comparing the raw analog signal (top) and Pulse (bottom). Acquired from a Titan G2 300kV system and point electronic REVOLON scan controller.

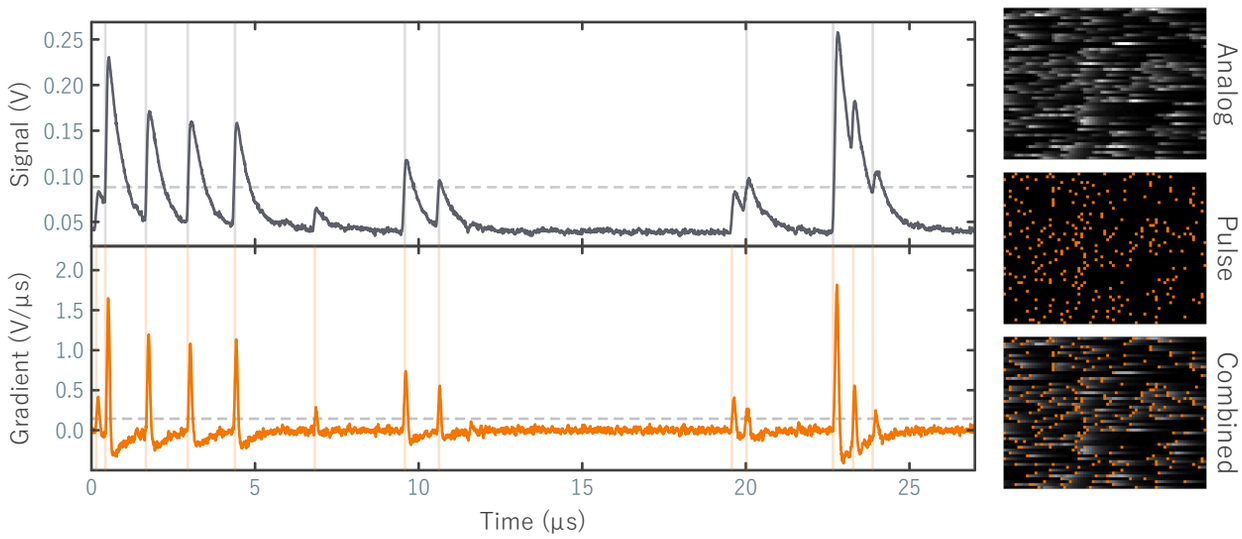

Figure 3 Raw data stream from a scintillator detector (top) and differentiated signal (bottom). Horizontal dashed line shows an example threshold with vertical lines showing detected electrons. Right shows high-speed, low-dose images from analog and Pulse detection, showing improved temporal response when using Pulse.

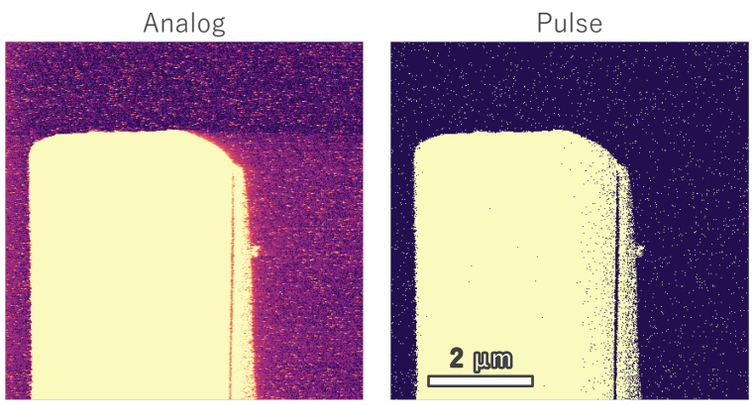

Figure 4 Low magnification image of a FIB lamella acquired using the analog (left) and Pulse (right) signals. Slow streaking into the vacuum can be observed in the analog signal.

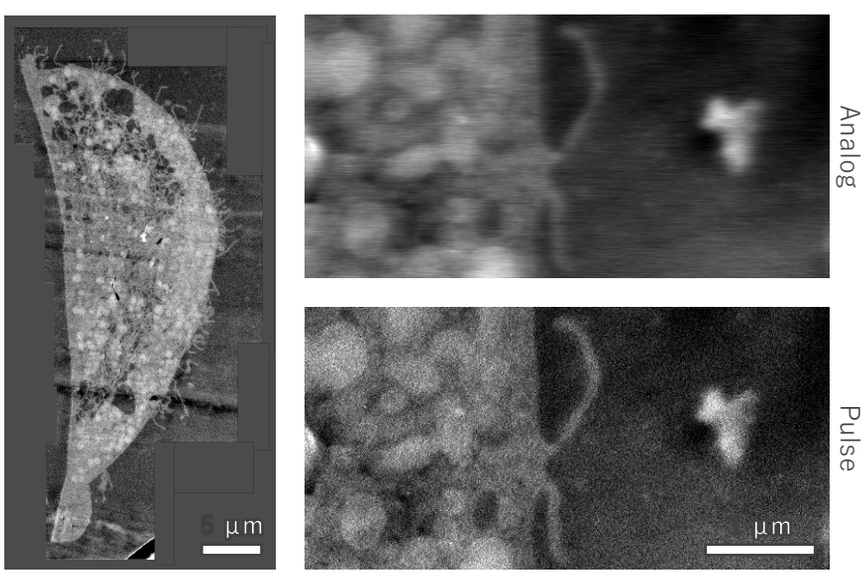

Figure 5 Montage image of a human macrophage (left). Right shows higher magnification analog and Pulse images showing streaking in the analog image from detector afterglow whilst the Pulse image remains sharp. Images acquired simultaneously at 50 ns per pixel using a Titan G2 300kV system and point electronic REVOLON scan controller. Sample credit: Alexandra Porter (UCL) and Karin Muller (U.

[1] T. Mullarkey, C. Downing, L. Jones, Development of a Practicable Digital Pulse Read-Out for Dark-Field STEM, Microsc. Microanal. **27** (2021) 99–108