TEMPO

ID-04320TEMPO Event-based Modulation System (2 ch)
ID-04340TEMPO Event-based Modulation System (4 ch)

Tempo (Trigger-event Modulated Probability Observation) improves the amount of information obtained for a given electron dose, the information efficiency, of STEM experiments. The concept is simple: There is a large diminishing return on information as more electrons are detected from each point in a STEM scan, so for each dwell period, quickly turn off the electron beam after a given number of electrons are counted (typically 1 – 25) and turn it back on at the start of the next dwell period. In this new imaging paradigm, TEMPO, pixel intensity is defined by the time taken to detect a fixed number of electrons, as opposed to the number of electrons detected in a fixed time. While this distinction may seem small the implications for minimizing specimen damage are substantial. TEMPO is an optional item for either EDM Basic or EDM Synchrony. Please make sure to include either EDM Basic or EDM Synchrony in the configuration. If EDM Basic or EDM Synchrony is already configured in the delivered TEM, TEMPO can be retrofitted.

Features

- Compatible with existing analog STEM detectors and TTL driven beam blankers.
- Maximum information efficiency extracted from a minimum delivered electron dose.
- Flexibly balance dose vs. precision across the full duty cycle range by specifying the count threshold for blanking.

Specifications

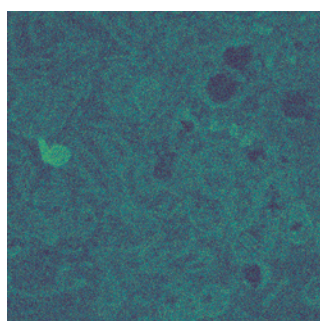|	2 Channel	4 Channel
Pulse channels	2 in, 2 out	4 in, 4 out
Tempo outputs	2 (from single input)	
Tempo voltage	3.3 V or 5 V	
Tempo resolution	8 ns	
Pixel clock input	3.3 V CMOS - 5 V TTL compatible	
Blank signal output	3.3 V CMOS, 5 V TTL	
Connections	BNC	
Signal range	Max. ±10 V	
Signal resolution	14-bit	
Input impedance	50 Ω	
Sample rate	125 Msps (per channel)	
Pulse voltage	3.3 V CMOS, 5 V TTL	
Pulse frequency	Max. 62.5 MHz	
Power	100-240 V AC	
Control interface	RJ45 ethernet	

Applicable model: JEM-ARM300F2, JEM-ARM200F (CFEG), JEM-F200 (CFEG), JEM-3300
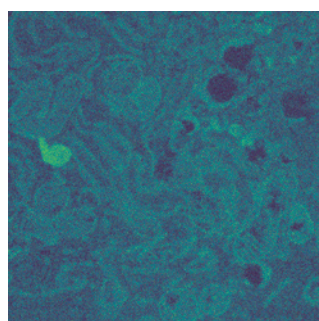Please contact JEOL regarding models other than those mentioned above.
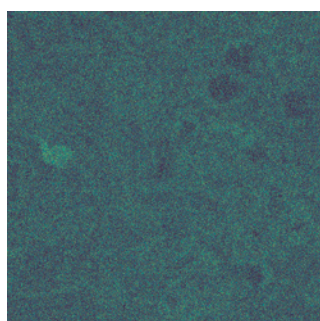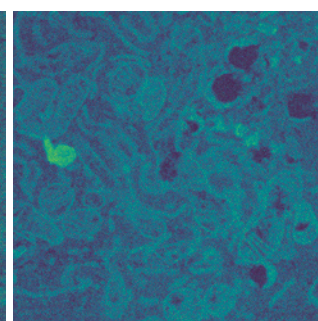
| 1 event per pixel | 3 events per pixel | 7 events per pixel | 14 events per pixel |

1 µm

Figure 1 TEMPO images of human macrophage cells recorded with the beam blanker triggering after various event numbers. Contrast represents scattering-rate values. Data credit: turboTEM.
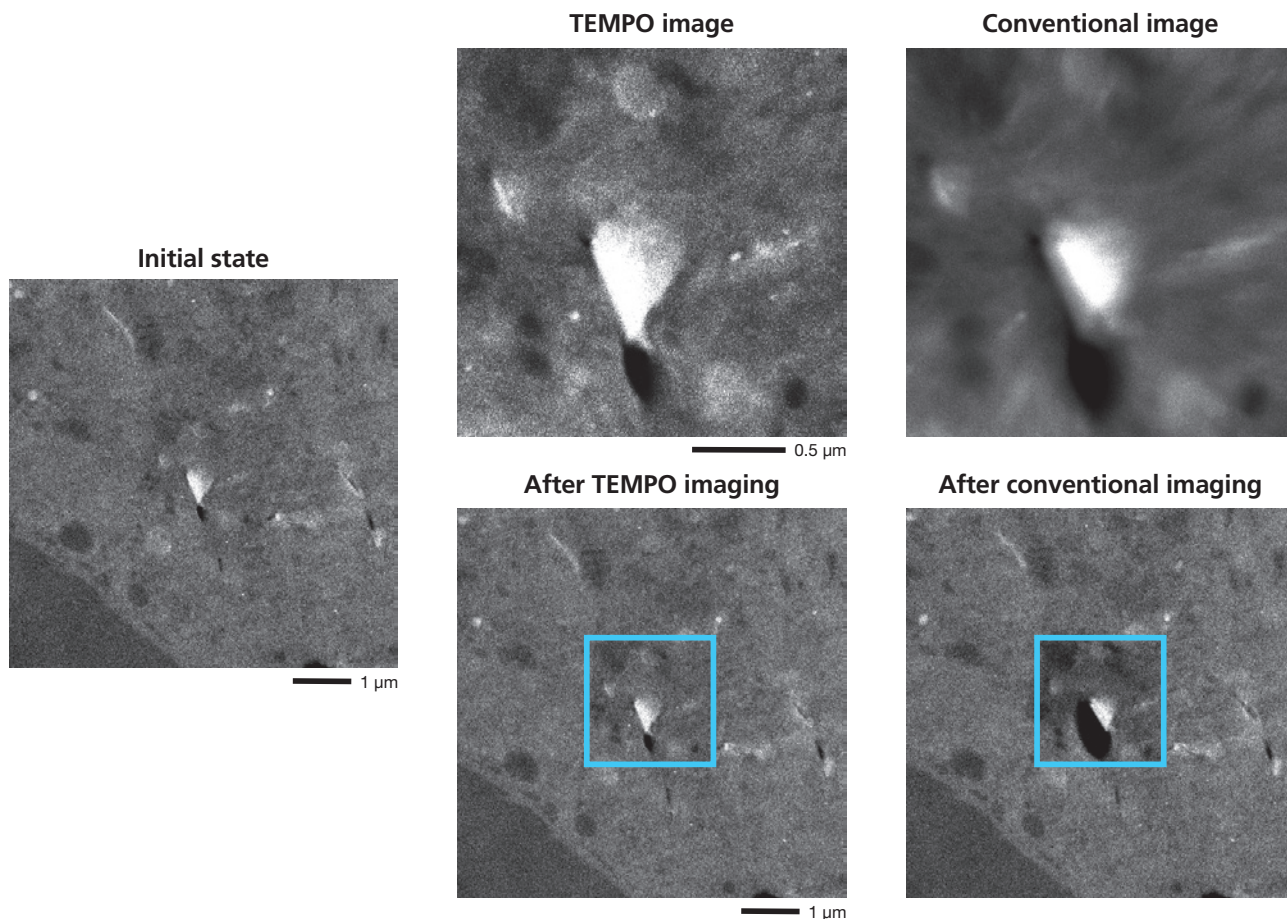
TEMPO image

Conventional image

Initial state

0.5 µm

After TEMPO imaging

After conventional imaging

1 µm

1 µm

Figure 2 Example of reduced damage to a human macrophage sample when using TEMPO to image versus conventional STEM. After TEMPO imaging (using 3 electrons per pixel, 10 averaged frames) the initial state is preserved. During and after conventional imaging (10 averages frames) the sample displays significant damage and distortions. Data credit: turboTEM.
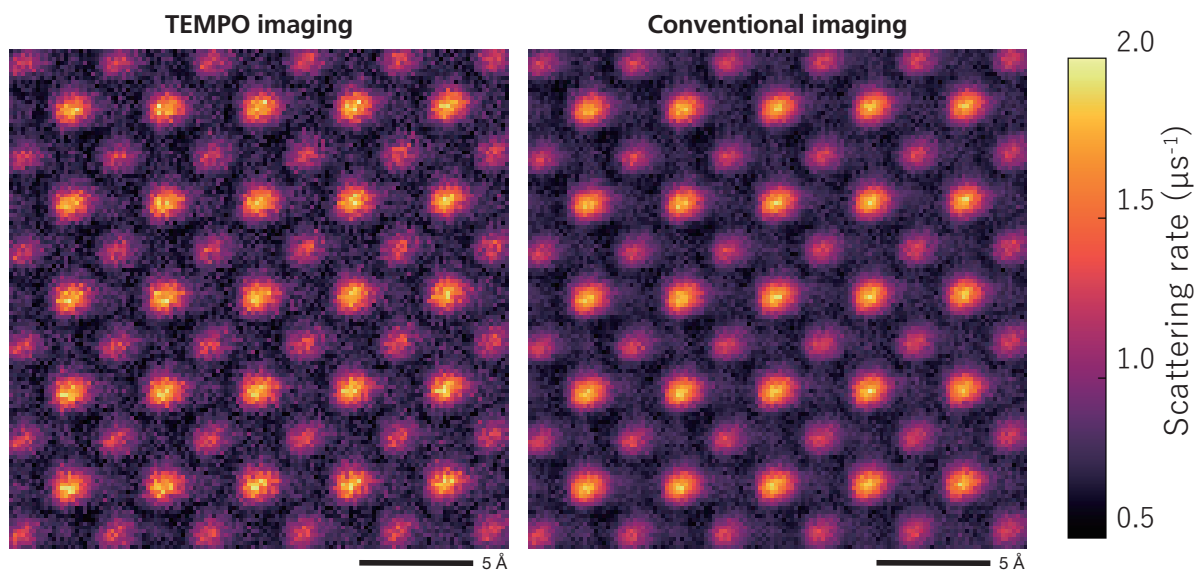
TEMPO imaging

Conventional imaging

Scattering rate (µs^{-1})

2.0

1.5

1.0

0.5

5 Å

5 Å

Figure 3 Comparison of the image contrast between TEMPO and conventional STEM imaging of $SrTiO_3$. Both images are shown in units of events per microsecond. The quantitative information offered by TEMPO is identical to conventional approaches. Both images used approximately the same total average dose, amounting to 210 detected electrons per pixel in the TEMPO image. Peters et al., Science **385**, 549 (2024)

JEOL | **JEOL Ltd.**

3-1-2 Musashino Akishima Tokyo 196-8558 Japan   Sales Division Tel. 81-3-6262-3561   Fax. 81-3-6262-3577
www.jeol.com   ISO 9001 · ISO 14001 Certified

▼ Local office

• AUSTRALIA & NEW ZEALAND • BELGIUM • BRAZIL • CANADA • CHINA • EGYPT • FRANCE • GERMANY • UNITED KINGDOM (UK) • INDIA • ITALY • KOREA • MALAYSIA • MEXICO • RUSSIA
• SWEDEN • SINGAPORE • TAIWAN • THAILAND • THE NETHERLANDS • UNITED ARAB EMIRATES (UAE) • UNITED STATES OF AMERICA (USA)