K3 and K3 Base User Manual

Models 1025 and 1024

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1 Regulatory compliance and safety instructions

IMPORTANT

Before installing and operating this product, and to avoid the risk of injury and potential hazards, read and review the regulatory pamphlet and follow all safety instructions.

2 Introduction

The K3® direct detection camera is a successor to the innovative K2® direct detection camera. The camera contains a direct detection transmission complementary metal-oxide-semiconductor (CMOS) detector, which gives the highest resolution images as compared to any other electron-imaging sensor available today. The camera runs in a mode constantly collecting images at 1500 frames per second. These frames are then transferred at full speed through a high-bandwidth link into dedicated high-throughput hardware designed for the express purpose of processing these images in real-time. By collecting and processing full-frame images so quickly, the detector can identify and record individual electron events (counting) as they reach the sensor. By counting every single electron event, the camera can eliminate the background noise typically seen in devices that simply read out the charge deposited by an electron striking a piece of silicon. By removing this source of noise, the camera can offer higher image quality and sensitivity than previously available in an electron-imaging device.

To help provide a fully anti-aliased camera, this device is also capable of operating in Counted mode. A feature available on the K3 camera (but not K3 Base), the sensor is able to localize the electron event with sub-pixel accuracy, effectively doubling the number of pixels available for imaging (from 4,092 x 5,760 to 11,520 x 8,184). Again, the processing is all done on full frames in real-time as the images are collected. In addition, the camera continues to employ a pixel design giving radiation hardness 10x greater than any other direct-detection sensor available (pixel lifetime of >5 billion electrons). The K3 camera also allows Linear read mode for high-dose applications.

2.1 Configurations

The K3 direct detection camera system includes the dedicated hardware to enable the electron-counting operation.

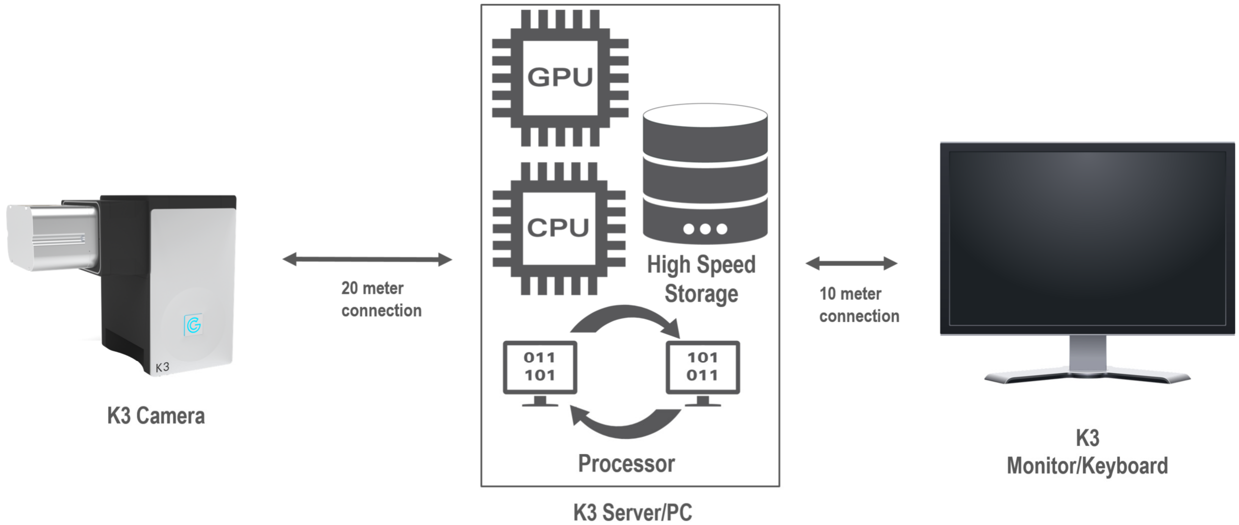

Figure 1: Overview of the K3 and K3 Base system.

The K3 direct detection camera systems include the camera and PC (K3 server). The K3 systems have been designed from the ground up to remove bottlenecks in the data acquisition process. One example of this optimization is to move the hardware responsible for electron counting from a standalone processor unit, found in the K2, to hardware integrated as a part of the K3 PC. These and other improvements help remove bottlenecks associated with collecting large volumes of data.

2.2 Counted mode description and overview of performance benefits

The K3 sensor was carefully designed, such that the point-spread function (PSF) is slightly larger than the 5 µm physical pixel size. As a result, each incoming electron deposits signal in a small cluster of pixels. The high-speed K3 electronics are able to recognize each electron event (at 1502 frames per second)

The first effect/benefit is the accurate localization of each electron event. With high-speed electron counting, the individual pixel can be recognized where the electron has passed through the sensor (electron counting).

The second effect/benefit is electron counting with sub-pixel precision (Super-Resolution mode). Due to the advanced electron counting algorithm and the carefully designed pixels, the accuracy of electron localization on each pixel is improved to one-quarter of a pixel. This results in a quadrupling of the effective number of pixels (pushing beyond the Nyquist information limit to even higher resolution), as well as a further improvement of the detective quantum efficiency (DQE) and modulation transfer function (MTF). Practically, this means that the field of view can be increased for the same end resolution allowing the researcher to capture much more data per image.

2.2.1 Counted (1x binned)

- Individual primary electrons are counted in-line in the K3 electronics on a pixel-by-pixel and frame-by-frame basis

- The electron-counted mode of K3 camera replaces the analog signal from each primary electron with a discrete count
- The benefit of counting is that it completely rejects the read noise and dramatically boosts the DQE of the detector across all spatial frequencies

2.2.2 Counted (0.5x binned)

- This mode is only available in the K3 version but no in the K3 Base version of the product
- Each primary electron's signal cloud is analyzed in the K3 processor to determine the electron's landing coordinates with sub-pixel accuracy; this technique extends the resolution beyond the number of pixels in the sensor
- The K3 camera's 0.5x binned Counted mode (formerly known as super-resolution) takes counting further and surpasses the theoretical information limit defined by the physical pixel size (information beyond Nq frequency)
- The K3 sensor was carefully designed such that the PSF is slightly larger than the 5 µm physical pixel size
- As a result, each incoming electron deposits signal in a small cluster of pixels
- The high-speed K3 electronics are able to recognize each electron event (at 1500 frames per second) and find the center of that event with sub-pixel precision
- The net effect is a quadrupling of the effective number of pixels (pushing beyond the Nyquist information limit to even higher resolution), as well as a further improvement of the DQE (and MTF)
- Practically, this means that the field of view can be increased for the same end resolution allowing the researcher to capture much more data per image

2.3 Linear accumulation setup mode

Linear mode is the traditional energy-integrating readout mode that captures the total integrated signal level in each pixel, just like a charge-coupled device (CCD) camera does. Individual frames can be summed for an effectively unlimited dynamic range. This mode is primarily used for diagnostic purposes and is available from the camera palette only in Power User and Service mode.

In Linear mode, the charge is collected, integrated during the exposure, and read out to provide the image. No electron counting is performed in this mode. The sensor electron charge proportional to the total energy deposited by the incoming primary electron is accumulated. This mode benefits from direct detection's improved DQE arising from the transmission detector and inherent higher conversion efficiency. When not counting, there is no requirement to keep charges separated. This mode is primarily for setup for diagnostic purposes and allows for dose rates much higher than in Counted mode. Of course, if higher doses are used, the user must remain aware of the total dose capability of the camera and avoid unnecessary beam/electron exposure to the camera.

2.4 Radiation hardness and expected lifetime

Minimize exposing the CMOS sensor to the electron beam when the camera is not in use. Based on the results to date, the life of the K3 detector is estimated at 5 billion e^-/pixel. Considering exposure rates of 100 e^-/pixel/s, if the sensor were exposed continuously for 24 hours a day every day, the expected lifetime would be well over one year. The camera employs a pixel design that is 10x more resistant to incident electron damage as compared with other direct-detection sensors. The extremely short exposure time, coupled with the event discrimination of Counted mode, confers an additional approximately 10x immunity to radiation.

The sensor can be damaged and marked by a bright beam. Use caution with intense beams and bright spots. Do not leave the sensor exposed to the beam when changing magnification levels or spot sizes. These can create brief, intense spots. Annealing may be able to reduce or remove minor beam spots.

Direct detection cameras receive the incoming electrons directly to the imaging sensor, and in the case of the K3 sensor, can detect them in several modes. This direct detection eliminates the need for scintillators and fiber optics or lenses and greatly reduces the PSF. Furthermore, in Gatan's Counted mode, noise can be essentially eliminated, particularly because with Gatan's transmission sensor, there are no scattered electrons re-entering the detector from below.

3 Getting started

3.1 Power-on sequence

To start from the power off:

1. Close **DigitalMicrograph**® (DM) software if it is open (or power on the PC if it is off).
2. Turn on power to the **K3 power supply**.
3. Wait at least **3 min** for the K3 camera to fully power on.
4. Turn on the **power switch** on the K3 PC.
5. Launch **DM** software.

3.2 Power-off sequence

Under normal circumstances, you can leave the K3 camera running. If necessary, you can power down the K3 camera completely.

To completely power down the K3 camera:

1. Shutdown **DM** software.
2. Power off the **TEC**.
3. Turn off the **PC**, if desired.

3.3 Setting temperature

1 In the **Camera** menu, select **Temperature…** and enter the setpoint value. The typical operating temperature is -20 °C.

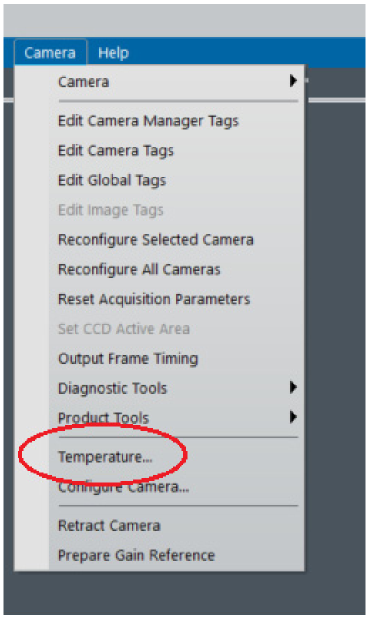

Figure 2: Camera menu.

2 If the camera chamber needs to be vented, set this to +20 °C, then wait for the warm-up to complete before venting.

The camera temperature is displayed in the **Camera Monitor** palette.

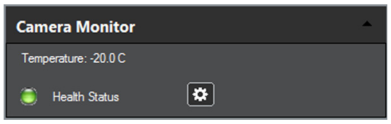

Figure 3: K3 sensor temperature.

3.4 Anneal cycle

Regular annealing (heating to +50 °C) of the sensor helps maintain the top performance of the sensor by reducing background levels and levels of surface contamination. Annealing can also help to repair some radiation damage. We recommend that an anneal cycle be performed each time the microscope does a cryo-cycle. This can be done as often as every evening or less frequently (say once a week) during extended periods of data collection.

To perform the annealing cycle:

1 In the **Camera** menu, select **Temperature.**

2 Select a set point of **+50 °C** and click **OK**.

3 Use the **Options** button to select a duration other than the current settings. Usually, an annealing cycle that lasts overnight is enough.

4 Click the **Start** button to begin the cycle. The camera cools down after completed annealing to whatever the setpoint was when the anneal cycle was started. If that was -20 °C, then after the annealing cycle is complete, it cools back down to -20 °C.

3.5 Imaging modes

In Power user or service mode, when the K3 camera is booted up, the two modes available from the **K3 Camera** palette are **Linear** and **Counted**.

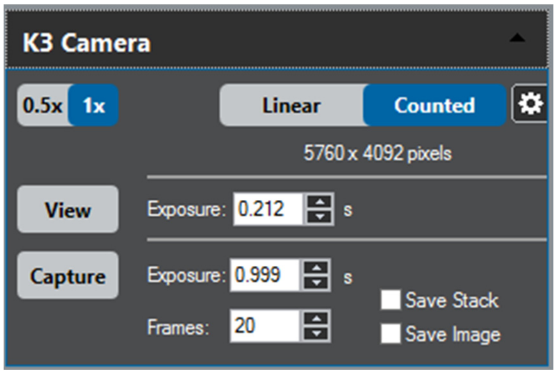

Figure 4: K3 Camera palette.

Linear mode is the way that the K3 camera operates in charge integration mode, while the Counted mode is a highly-processed mode where individual electrons are detected.

In the **View** and **Acquire** menus (in DM software), you can select two K3 imaging modes:

- **Linear:** In this mode, electron counting is disabled, and the electron charge is collected directly to form an image. Linear mode is only available to power users and is primarily for diagnostic purposes.
- **Counted:** Each electron event results in one count in the image.

  The raw images are dark subtracted, gain-normalized, and processed in hardware to detect individual electrons. The resulting summed electron counts are displayed as an image. In this mode, keep the beam at low levels (4 – 40 e^-/pixel/s) to avoid coincidence loss. This mode can be used with binning levels of 0.5x and 1. Binning 0.5x corresponds to the Super-Resolution mode found in the K2 camera.

Unique to the K3 and K3 Base cameras is the ability to run the camera in Standard mode or correlated double sampling (CDS) mode. The CDS option changes how the sensor is read out and takes about 10 s to switch from standard to CDS mode. The CDS mode offers a higher signal-to-noise ratio (SNR) with enhanced DQE due to reduced environmental fluctuations. To switch into the CDS mode, click the settings wheel in the **TEM Imaging** panel of the DM software, then the **CDS Mode** checkbox in the **K3 Setup** palette.

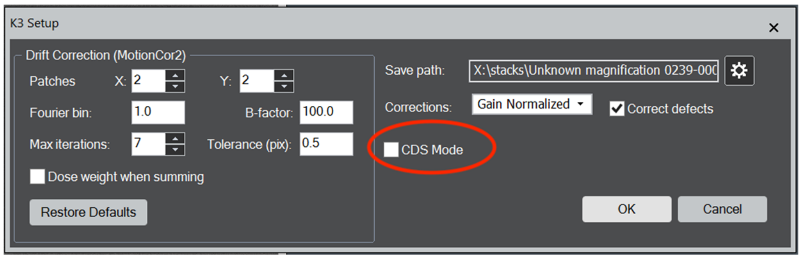

Figure 5: Switching into the CDS mode of DM software.

3.5.1 Standard vs. CDS mode

In Standard mode, each pixel is read out once and offers 1500 frames per second output from the K3 camera that translates to an accumulation of a minimum of 20 frames on PCIe cards and a maximum of 75 frames per second to the K3 PC for the K3 Camera and 25 frames per second for the K3 Base camera.

On the other hand, CDS mode involves reading each sensor pixel twice; the first signal read then reset to the empty pixel followed by another reading that serves as a reference. The double pixel-by-pixel sampling results in an output of 750 frames per second with a minimum of 10 frames accumulated on PCIe cards and a maximum of 75 frames to the K3 PC. The CDS mode reduces noise, resulting in a significantly higher DQE across all spatial frequencies. CDS mode reads each pixel twice, and therefore, the effective dose rate should be half of the dose rate used in the Standard mode.

	Raw sensor frame rate	Counted frame saved to disk per second (K3 Camera)	Counted frame saved to disk per second (K3 Base Camera)
Standard	1502	75	25
CDS	751	75	25

3.5.2 Linear reference images

First, collect a Linear mode high-beam level gain reference used for Linear mode and hardware gain correction in Counted mode.

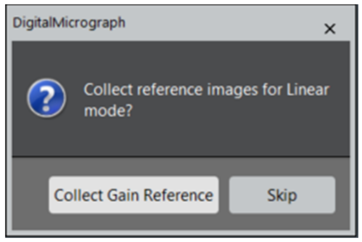

Figure 6: Option to skip gain reference collection.

Note: Linear mode gain reference acquisition must be performed even if Counted mode imaging is used for data collection. You can skip parts of this procedure if you already have a good reference and don't want to update it, or if you wish to leave the procedure partway through and come back later. For instance, at this step, you could skip gathering a new linear reference if you already have one and proceed with the later steps.

You may be asked if it's OK to insert the camera or switch from another mode if the camera is currently running a live view. Click **Yes**. A dark reference is automatically acquired and saved to the processors

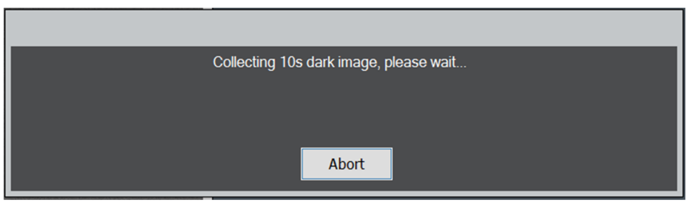

Figure 7: Automated dark reference acquisition.

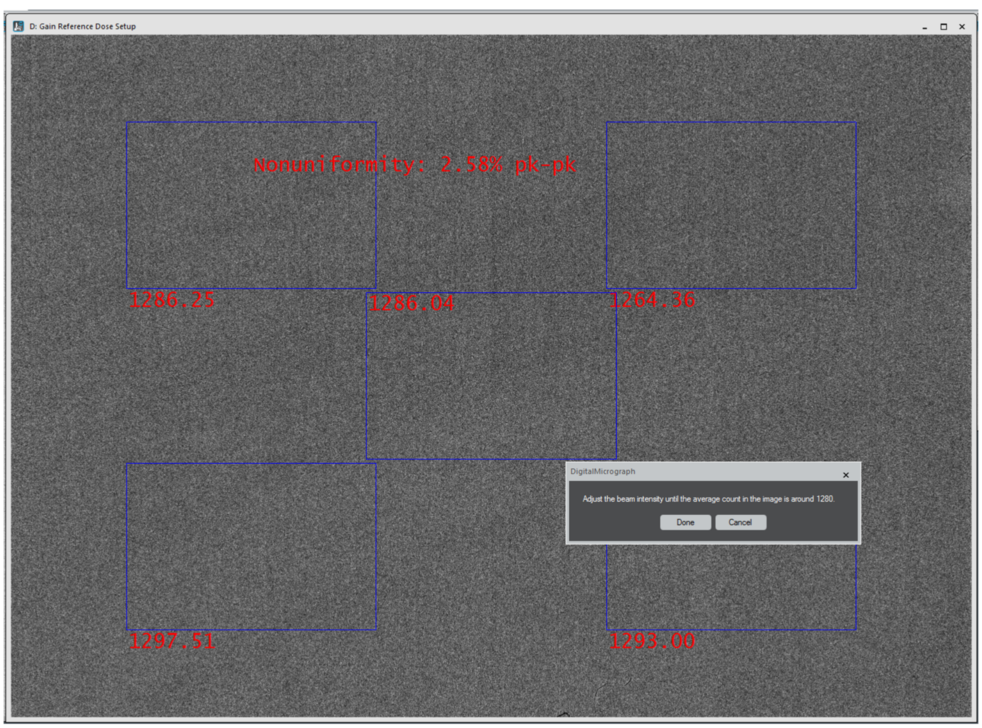

Figure 8: Beam intensity recommendation.

You are now asked to adjust the beam to the selected dose rate (1280 average counts). Because short exposures are used, the requested dose (1280 average counts) is a fraction of the desired dose rate (6000 counts/second above).

Note: Default Linear mode gain reference beam level is more than 10x brighter than the typical Counted mode level. If you have been operating in those modes, you have to brighten the beam considerably.

DM software collects and saves the necessary images and calculates any needed corrections and pixel mask.

3.5.3 Counted

After acquiring Linear mode gain references, you are asked if you want to collect the counted references (which are also used for counted images). Preparing a gain reference for K3 counted mode is optional if it was completed recently. A gain reference can last for a week at a time.

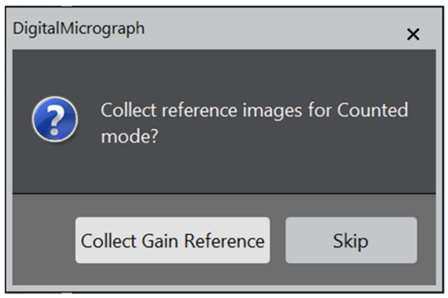

Figure 9: Gain reference collection option.

The first step is the automated acquisition of a dark reference to the processors.

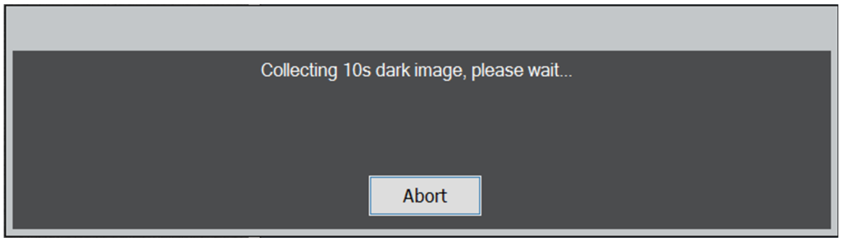

Figure 10: Automated dark reference acquisition.

Next, the linear gain reference is automatically uploaded. These references are used for correcting the images in the processors before electron detection and counting.

In the next step, you have the option to choose counted gain reference collection parameters. The **Gain Reference Exposure Setup** window opens. If you click the **Expert Mode** box, you have the option to restore default values or select and save your values for the Counted mode gain reference collection.

Note: In Counted mode, the dose rate is much more tightly constrained—too high of a dose rate and electrons are undercounted. Think carefully before using a dose rate other than the default value.

In the following figures showing dialog boxes, the default values are given for Counted mode. The dose rates in the dialog box correspond to the per-pixel recommended dose rate for reference images. Notably, the dose rate for Counted mode gain acquisition is 15 e-/pixel/s, and therefore, 20 s per gain frames will be acquired.

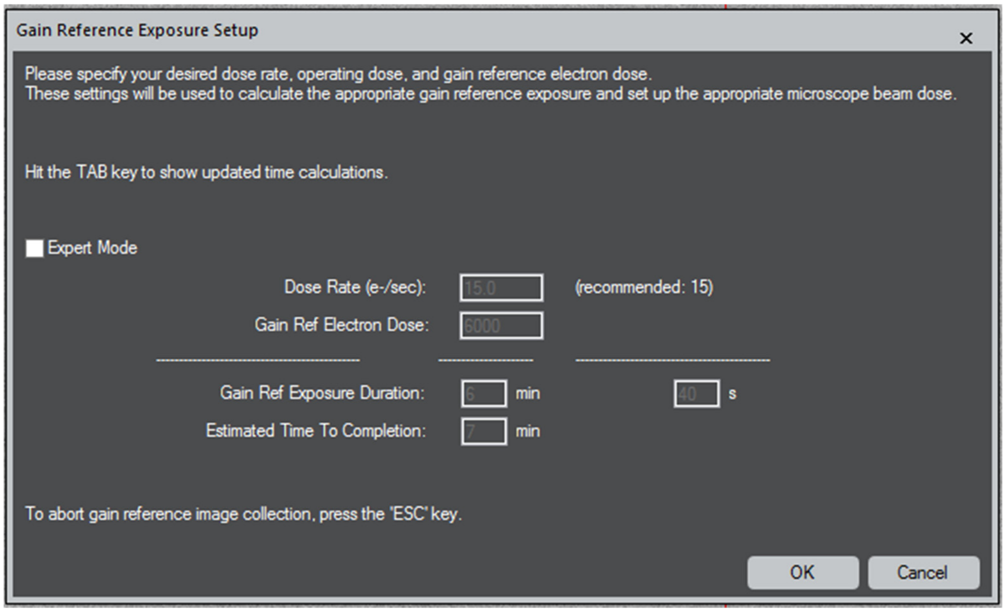

Figure 11: Settings for K3 Counted mode gain reference.

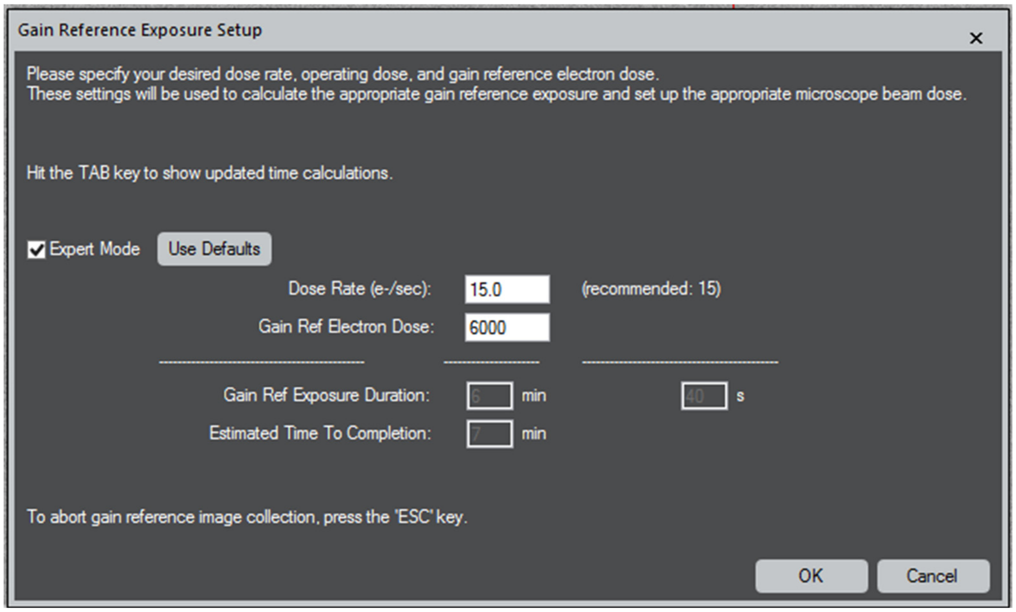

Figure 7: Expert Mode settings.

As a reminder, for default values, the beam needs to be dimmed by at least a factor of 10 from the previous step. When changing the beam intensity, please check to ensure that fringes from the edge of the beam are not visible in the image during gain reference data collection. We proceed to the dose setup. Counted mode is more sensitive than the Linear mode to dose rate; you should try to get the beam very close to the recommended level—within 10 – 20%. Typically, we don't recommend making changes to the default settings during the Counted mode gain reference collection.

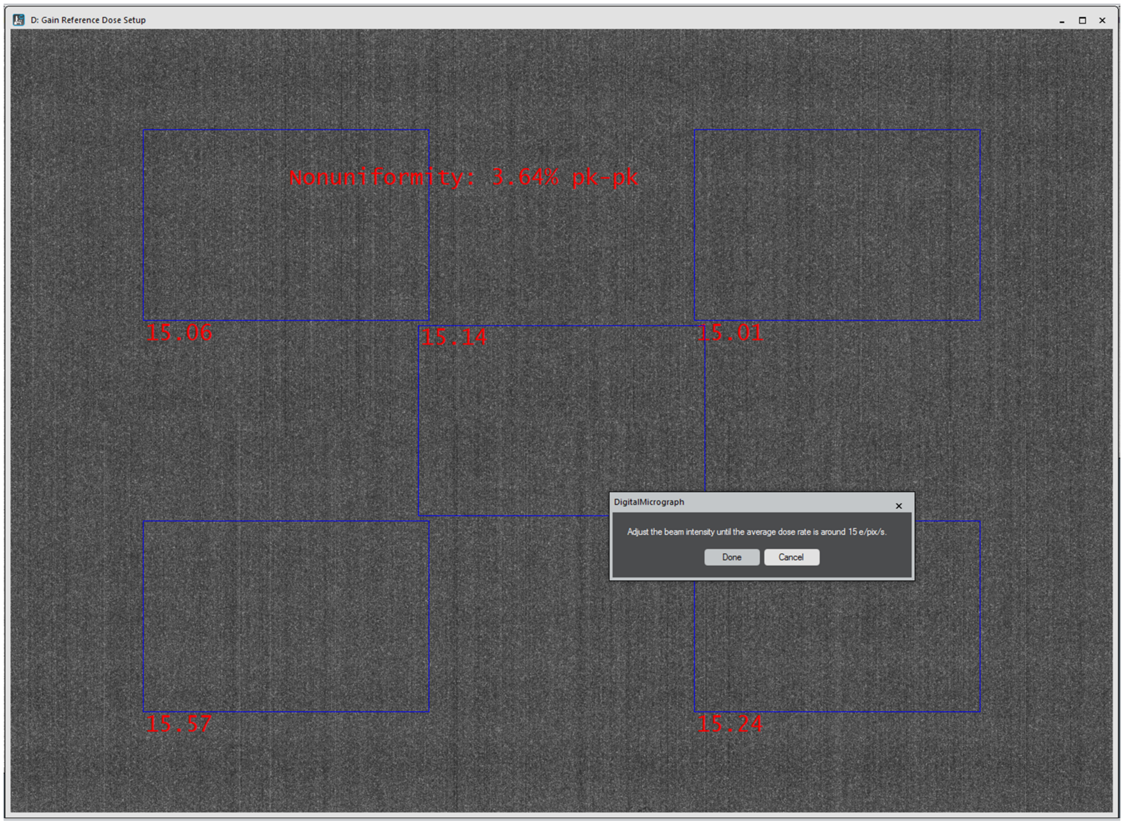

Figure 8: Beam intensity recommendation for Counted mode.

When operating at the Counted mode dose rate, this gain reference takes longer to collect than the linear reference. When it is done, the references are saved.

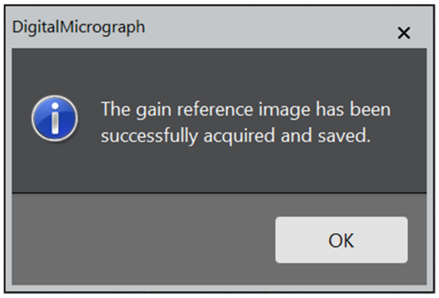

Figure 9: Counted mode gain reference success message.

3.5.4 CDS

If working with CDS mode, you will have to acquire CDS-Linear and CDS-Counted mode gain references before data collection. The reference acquisition process is very similar to the Standard mode with a few exceptions.

After the CDS-Linear mode gain reference collection, which is similar to the standard Linear mode, you have the option to choose CDS-counted gain reference collection parameters. The **Gain Reference Exposure Setup** window opens. If you click the **Expert Mode** box, you have the option to restore default values or select and save your values for CDS-Counted mode gain reference collection. Notably, the dose rate for CDS-Counted mode gain acquisition is 4 e-/pixel/s, and therefore 75 x 20 s frames will be acquired.

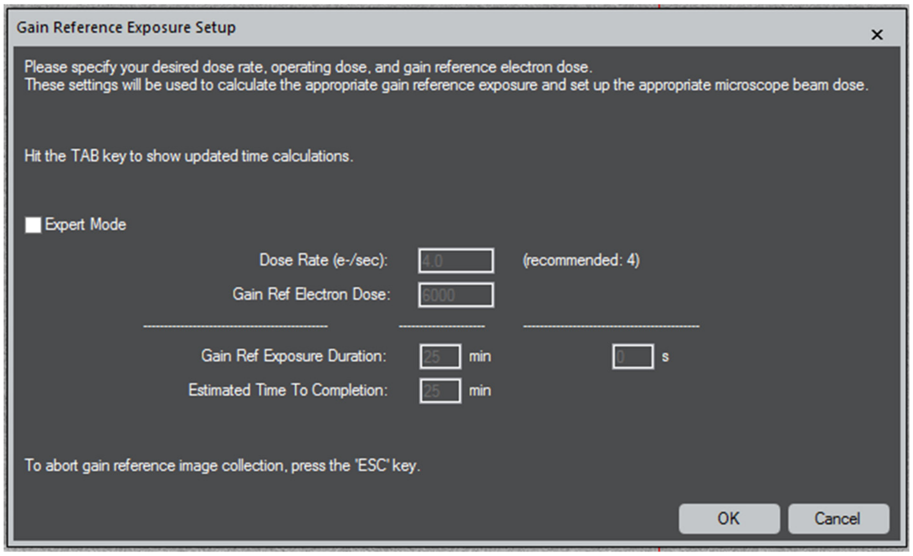

Figure 11: Settings for CDS-Counted mode gain reference.

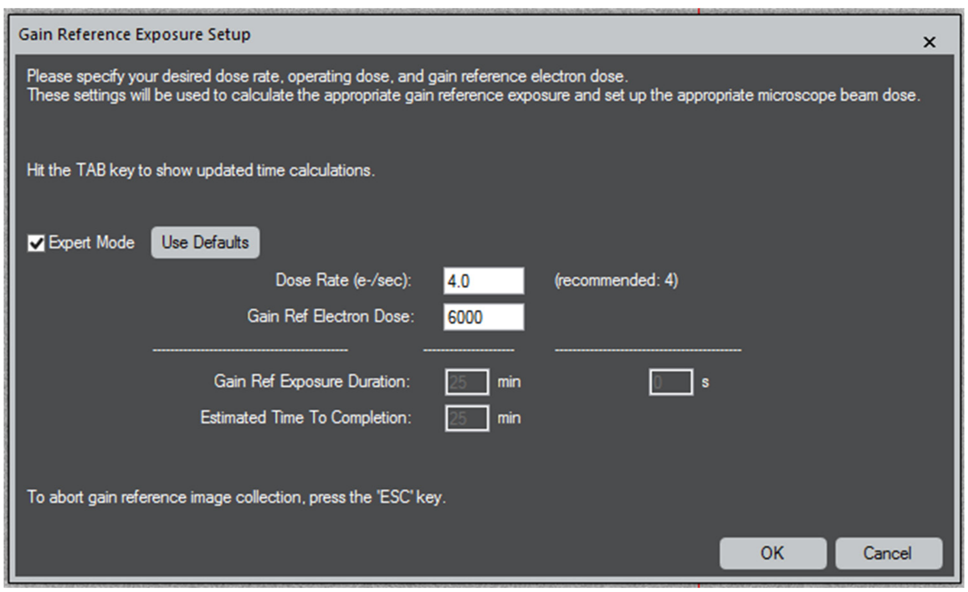

Figure 10: Expert Mode settings.

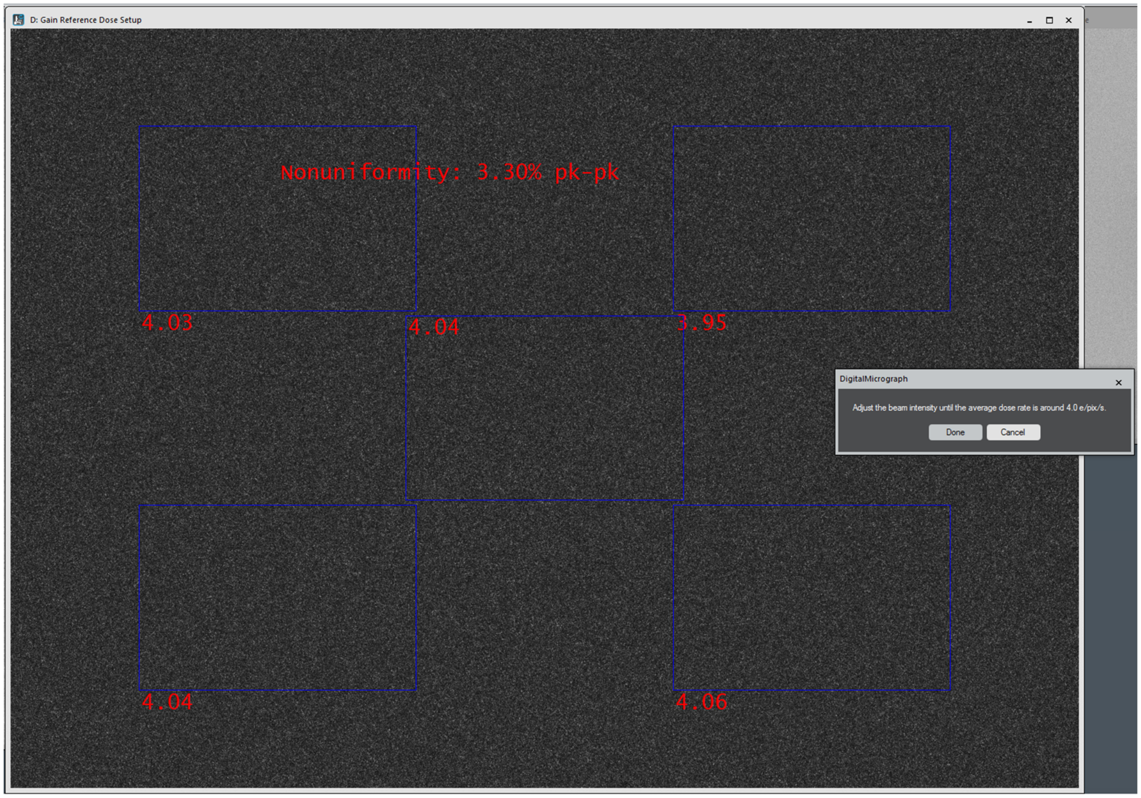

Figure 12: Beam intensity recommendation.

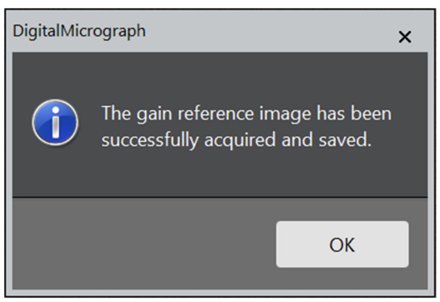

Figure 18: CDS-Counted mode gain reference success message.

This gain reference takes significantly longer to collect than the standard Counted mode reference. When it is done, the references are saved. The CDS mode gain references can last for one day.

3.6 Key points to ensure optimum operation

Counted mode dose rates: Unlike older cameras, for the K3 camera, the dose rate (instead of total dose) becomes the first concern in getting good images. For the three K3 modes, the preferred dose rates are shown in the table below.

	Standard dose (counts per physical pixel/s)	Approximate dose rate (e^-/pixel/s)	Approximate beam intensity	Conversion between counts and incident electrons (counts/e^-)
Counted (standard)	8 – 32	8 – 40	**Dim**	1
Counted (with CDS)	4 – 16	4 – 20	**Very dim**	1

Table 1: ***Preferred dose rates***

In Counted mode, counting efficiency starts to sharply decrease above the suggested dose.

3.7 Other recommendations

It is best to avoid saving data to the desktop. The solid-state system drive is fast but small and can fill quickly. We recommend saving the data to the 10 TB solid-state drive, which provides the fastest HD write times on this system.

Do not quit and immediately restart DM software. DM software requires a few seconds to save data when closed.

4 Imaging operation

4.1 Defect correction

Defect pixel mapping and removal are performed automatically as part of the reference acquisition process and do not require specific attention. Regular updating of references allows continued high performance of the camera as the sensor ages.

Defect correction removes poorly performing pixels, which contribute to fixed pattern noise such as hot, dark, or noisy pixels.

There are a couple of ways to perform the K3 camera defect correction:

1 Pixel defect map: Generated during both Standard and CDS gain reference acquisition.

Mode	Saved as
Standard Linear	Pixel defect map.m0
Standard Counted	Pixel defect map.m1
CDS-Linear	Pixel defect map.m2
CDS-Counted	Pixel defect map.m3

2 User-defined pixel defect map: User-generated defect map. The input conventions are identical to Gatan K2 camera.

4.2 Binning

The K3 detector includes two types of counted modes: 1x and 0.5x binned, while the K3 Base offers the 1x binned mode. The 1x binned uses the same processing algorithm as the 0.5x binned, but bins pixels 2 x 2 in the camera to support faster live viewing speeds and a more compact data format. Choose the mode to use based on user criteria and experiments on an application-by-application basis. This is the reason why a single counted (0.5x binned) acquisition is all that is needed to produce software gain references for both counted modes.

Binning is performed post-acquisition, which means that it doesn’t increase readout speed by itself in the way that binning does on a CCD. However, it does allow a large increase in dynamic range in exchange for the associated loss in spatial resolution. Because of the very low read noise of the camera, the noise floor remains low. Perhaps the biggest benefit, however, is the possibility of imaging in Counted mode with large signal levels. As an example, counting mode binned by 1x allows 40 e^-/pixel/s instead of the binned 0.5x level of 20 e^-/pixel/s. This is very useful for microscope alignment and stigmation with live diffractograms.

4.3 Unprocessed vs. gain corrected images

K2 camera users frequently requested that Gatan minimize the size of files saved. For K3 camera, the gain correction process has been adjusted to try to help minimize file size.

Traditionally, gain correction involves the conversion of raw counted images (integers) to gain corrected images (floating point), which correct for small (typically 1 – 3%) variation seen in the pixel response. Conversion of an 8-bit integer to a 32-bit floating-point image results in an increase in file size by a factor of 4x.

With the K3 cameras, gain correction no longer requires conversion of the file types from an 8-bit integer to a 32-bit floating-point. During gain correction, each count is scaled by 32x on average while keeping the file type the same.

The unprocessed defected corrected image can be saved without gain correction. Gain correction can either be applied pre-processing or post-processing. Gain correction involves a 32x scaling factor.

4.4 Save Stack

Save Stack mode provides straight-to-disk capture at 75 fps. Save Stack Dose Fractionation mode is accessed as an alternative to the standard Record mode available in the camera palette. Selecting **Save Stack** in the camera palette switches the system from acquiring single images to acquire a series of images. Save Stack mode splits the total electron dose that would normally be used to acquire a single image into several separate frames. For instance, a 20 e^-/pixel dose in 1 s can be distributed over twenty 50 ms images, each with 1 e^-/pixel.

These frames can be viewed independently and used for different options such as frame alignment and drift correction or, in some cases, advanced usages such as local drift correction within regions of a single frame.

4.4.1 Setup

When **Save Stack** is selected for imaging in the **K3 Camera** palette, the exposure time for the entire series is set by the exposure time.

To configure **Save Stack** mode (formerly called dose fractionation with the K2), click on the **Save Stack** checkbox in the **K3 Camera** palette.

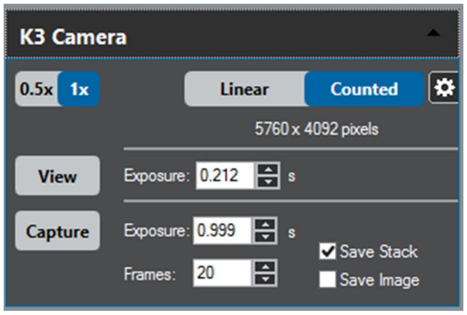

Figure 13: Switching to the Save Stack mode.

For best performance, the **Save Stack** mode should use the dedicated solid-state raid array to store data. Use the **Setup** dialog to configure the location that this mode will save the data.

4.5 Shutter configuration

The standard K3 camera requires one shutter or beam blanker for low-dose work that uses the transmission electron microscope (TEM) shutter before the specimen.

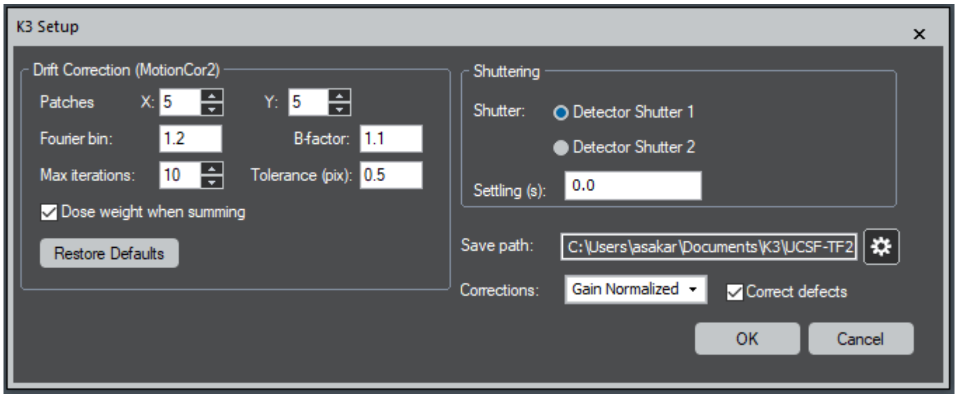

Figure 20: Shutter configuration of the K3 system.

4.6 Temperature

Typical operating temperature is -20 °C. Monitor the temperature; the **Camera Monitor** palette indicates the camera temperature.

WARNING
Never operate the camera above +22 °C, or with a vacuum above $1.5E^{-5}$ Torr.

Check the flow of cooling water periodically. If the flow rate of the cooling water deviates significantly from the value initially set (~15 L/h), make sure the lines are not obstructed and adjust the pressure regulator to bring the flow back to the original level. If the water flow stops while the Peltier cooler is on, damage to the camera may result.

WARNING
Ensure there are no airflow restrictions around the PC, K3 power supply, and monitor.

4.6.1 Anneal cycle

Regular annealing (heating to +50 °C) of the sensor extends the useful life of the sensor and minimizes contamination of the detector. If the camera is used a lot without warming, the electron beam can harden any contaminants, making the CMOS detector difficult to clean. We recommend that an annealing cycle is performed each time the microscope undergoes a cryo-cycle.

Note: It is not necessary to interrupt extended data-taking to perform the anneal cycle; however, it is recommended to anneal the sensor about every 7 days.

To perform the annealing cycle:

1. Select **Camera** / **Temperature**.
2. Select a set point of **+50 °C**; click **OK**.
3. Click the **Options** button to select a duration other than 24 hours. Usually, an annealing cycle of overnight is sufficient.
4. Click the **Start** button to begin the cycle.

The camera cools down to the original set temperature after the annealing cycle is complete.

WARNING
DigitalMicrograph software MUST CONTINUE RUNNING during the anneal cycle.

4.6.2 Auto retraction

Delay setup (must be longer than longest intended image)

The camera may unexpectedly retract if you are taking several long exposures (typically 30 s or longer). This is related to a safety feature which retracts the camera if it is not in use. Set the retraction time to 600 s.

4.7 Insertion indicators

The Gatan logo on the camera lights up when the camera is inserted, and the **Camera Inserted** box is checked in the **Camera View** palette.

5 Software

Install the Gatan Microscopy Suite® (GMS) license using the Gatan license USB. Installation instructions are included with the USB. Then install the GMS application software using the GMS installer USB. Installation instructions are included with the USB. Make sure K3 direct detection camera is selected in Camera Hardware and TEM.

WARNING

- *Do not add any additional PCI cards to PC.*
- *Do not modify PC configuration.*

IMPORTANT

- *For optimal performance, do not run anti-virus applications during operation of the camera.*
- *For optimal performance, do not load third-party applications other than those recommended or verified by Gatan.*

5.1 Overview: Control of K3 camera within DM software

The PC requires approximately 5 min to boot and may display a blank screen for much of this time. Please allow it the necessary time to boot and don't force a power cycle. This may cause disk corruption essentially with the SSD RAID.

5.1.1 Screenshot of DM display for the K3 camera

This is a typical representation of how DM software should be set up, with respect to the palettes.

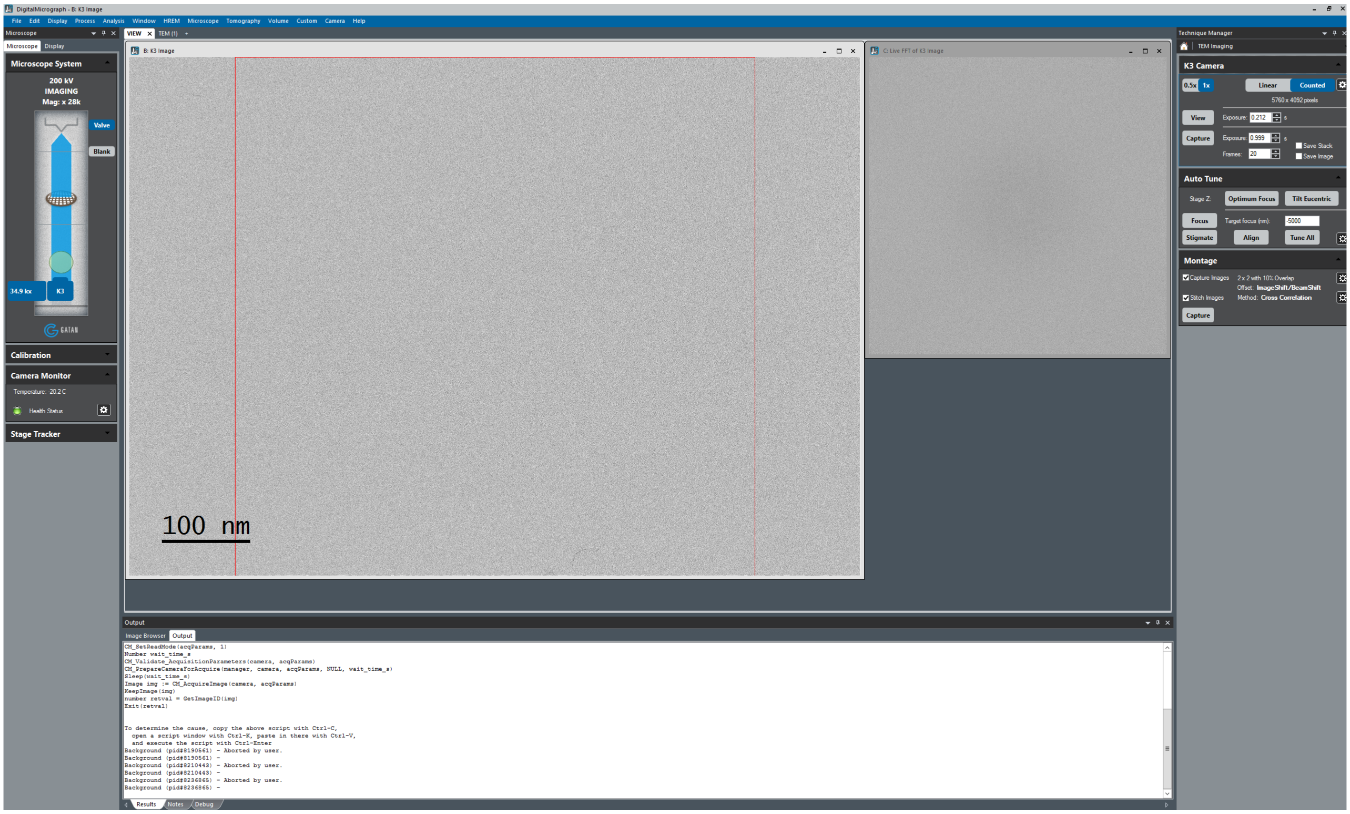

Figure 21: Screenshot of DM display for the K3 camera.

To configure/choose your palettes, go to **Window** / **Floating Windows**. Then select the windows/palettes you would like to display. The checked items are displayed in the DM configuration.

5.2 Magnification correction/calibration

The displayed nominal magnification on TEM is for either the viewing screen or for photographic film and has an accuracy of 5 – 10%. The K3 camera is located on a different plane (height-wise) respect to the film camera. Consequently, the magnification must be calibrated. The calibration is done using reference calibration samples.

At low magnifications:

- Use a cross grating sample or any sample with known spacing

At high magnifications:

- Use graphite or any crystalline samples with known lattice spacing
- Use the **Calibrate Image from Diffractogram** method

It is essential to make sure that the DM software correctly reads the TEM magnification. If the communication between the computer and the TEM is established, the magnification is read automatically. Otherwise, make sure DM is set to prompt the user to enter a value for TEM magnification every time an image is to be acquired. This can be set by choosing the **Global Microscope Info** window under the **Microscope** menu.

5.3 Low magnification

Record an image of a cross grating replica.

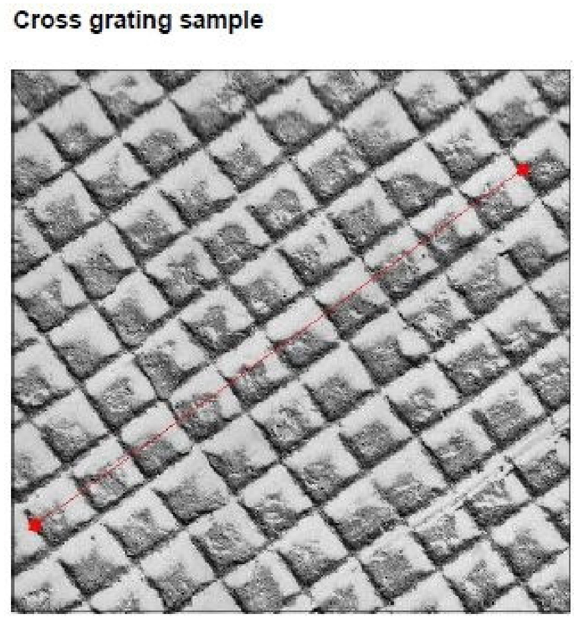

Figure 14: Example of marking a known distance during magnification calibration.

1 Choose **Microscope** / **Calibrate Image**.

2 Follow the instructions on the screen.

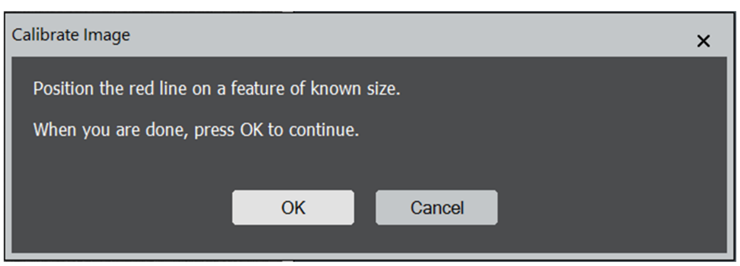

Figure 15: Magnification calibration instructions.

A red line appears on the image.

3 Position it on a feature of known size.

4 Press **OK** on the **Calibrate Image** window.

5 Enter the correct distance for the selected feature (e.g., 10 line pairs of cross-grating sample where the distance = 10 x 0.463 µm) in the **Calibration** window and select the units. Select the distance marked in the previous figure to perform the magnification calibration.

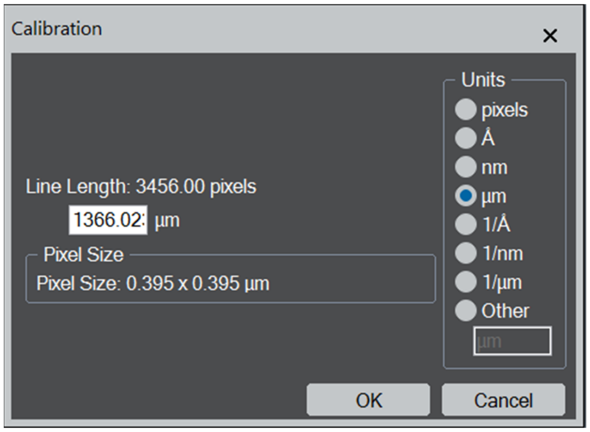

Figure 16: Calibration settings.

6 Press **OK**.

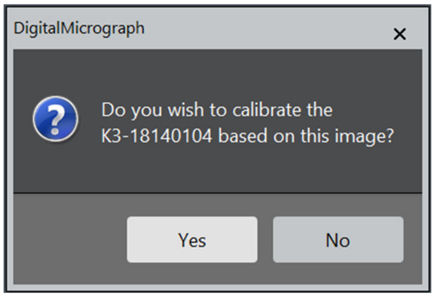

Figure 17: Calibration confirmation.

7 Click **Yes** to complete the calibration.

8 The calibration can be checked on the calibration table containing pairs of value, the nominal microscope magnification, and the calibrated value.

9 To view the magnification table, select **Microscope** / **Calibrations**.

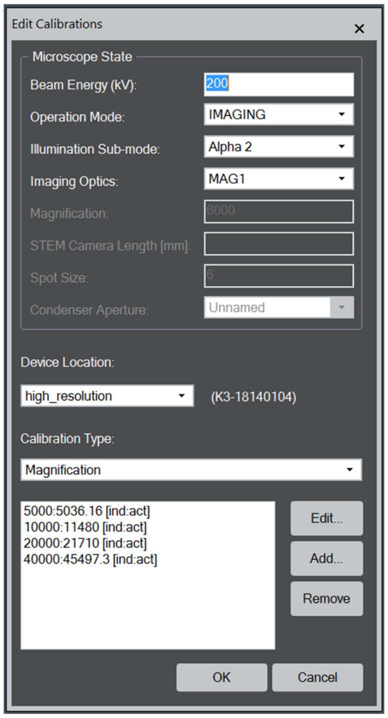

Figure 186: Microscope Edit Calibrations dialog.

The microscope calibration dialog shows the table of magnification calibrations stored for the current imaging device and microscope operating condition.

5.4 High magnification

Record a lattice image of the crystalline sample.

High-resolution image of a crystalline sample

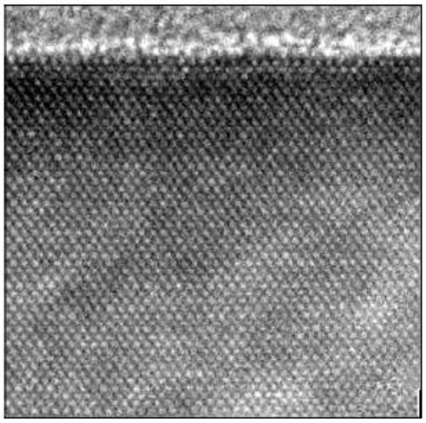

Figure 19: High-resolution image of sample to be used in the magnification calibration.

1 Select **Microscope** / **Calibrate Image** from Diffractogram.

Diffractogram

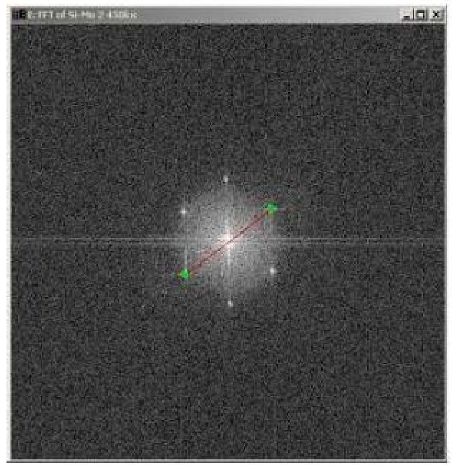

Figure 20: Distance between peaks in the calculated diffractogram.

2 To calculate the diffractogram, follow the on-screen instructions.

3 A red line appears on the diffractogram, indicating the distance between peaks.

4 Position the endpoints of the red line on two symmetrical diffraction peaks.

5 Press **OK** to specify the reciprocal unit and the d-spacing (in the corresponding real units) in the next window.

6 Read the calibration instructions and click **OK**., then enter the known spacing between peaks in the magnification calibration in the **Calibration Settings** window.

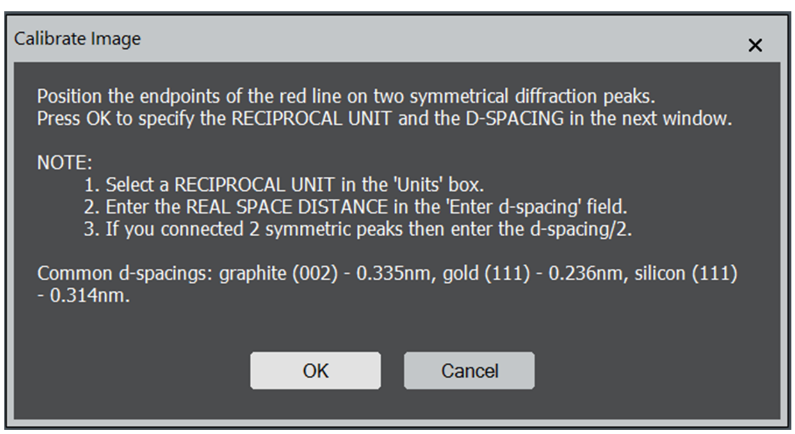

Figure 29: Calibration instructions.