The Ultimate Choice in Confocal Technology.
LiveScan™ Swept Field Confocal Technology

Life presents an endless series of possibilities, and Nikon is committed to finding new and innovative ways to explore them. Now Nikon has taken confocal microscopy to the next level, allowing researchers to choose the optimum combination of speed and resolution for every application through the use of a new technology called LiveScan Swept Field Confocal Microscopy.
A Revolution in Confocal Technology.

With the advent of technologies allowing researchers to visualize processes in living organisms, the demand for precision instrumentation to document live cell studies continues to be very high.

Traditional point scanning systems utilize intense laser light with undesirable side effects such as phototoxicity, inefficient detectors and inflexible designs. Field scanning systems overcome some of these limitations on imaging living cells, but still require specific inflexible configurations that continue to limit the scope of experimental design.

Now, Nikon introduces the LiveScan Swept Field confocal scanner – thoughtfully designed to meet the needs and the growing demand for a flexible, adaptable confocal system.

Nikon LiveScan utilizes “cell friendly” technologies, providing unprecedented flexibility in selecting the combination of speed and resolution that will produce the clearest images of living specimens.

Embedded in a compact scanner, the Swept Field technology enables researchers to enjoy the benefits of high spatial resolution point scanners and high temporal resolution field scanners. LiveScan’s unique optical design maintains high efficiency and delivers less excitation energy to the specimen. Plus, the high quantum efficiency detector furthers the capabilities for low energy excitation and high temporal resolution applications.
LiveScan SFC
Live Cell Confocal Microscope System
A new approach to confocal:
LiveScan Technology Defined.

The principle requirement of confocal imaging is maintaining excellent axial resolution. With traditional field scanning confocals, this meant limitations on the microscope hardware that could be utilized, especially on the type and magnification of the objective lens. Typically, these systems offer limited choices of detectors and fixed illumination efficiencies, limiting researchers in the scope of their experimental designs.

These issues have been overcome by the Nikon LiveScan Swept Field System. At the core of the LiveScan is a multiple confocal aperture plate featuring seven different aperture sizes and shapes, allowing a user to choose from a larger selection of objective lenses on the microscope and still maintain high axial resolution and improved sensitivity.

For illumination, the LiveScan uses a novel tandem scanning approach to rapidly scan illumination through the confocal aperture onto the specimen. Rapid scanning speed coupled with extremely efficient light transmission allows the user to illuminate specimens with less light and for very short durations. The result is a more live cell friendly scanner.

With the flexibility of seven confocal apertures, the LiveScan further allows the user to designate the confocal aperture best suited not only for the microscope’s objective lens, but also for the experiment. Three selectable pinhole array apertures and an additional four slit apertures allow the user to choose the best combination of magnification, axial resolution, fluorescence sensitivity and temporal resolution for each experiment.

The compact modular design of the LiveScan Swept Field confocal microscope makes it simple to use and easy to maintain. In addition, it can be easily and economically upgraded as technologies and the user’s needs evolve.

LiveScan Technology Means Speed.

The LiveScan Swept Field features a scanner capable of supravideo (>30 fps) data acquisition. A unique scanner design rapidly scans an array of illumination light across the specimen, while keeping the confocal aperture stationary.

This design results in scanning speeds limited only by the speed of the camera hardware, while simultaneously illuminating points on the specimen only for very short time intervals.

The scanner controller and CCD detector are perfectly synchronized, so the illumination can be controlled to ensure that when the camera is not actively acquiring a frame, the illumination is off.

In addition, synchronization allows the user to control the duration of exposure by modulating the camera exposure, by changing the mirror scanning speed, or by doing both.
LiveScan Technology is Cell Friendly.

The LiveScan allows cell biologists and neuroscientists to monitor and record rapidly occurring events in millisecond time resolution within living cells without compromising spatial resolution. It does this while simultaneously controlling high frequency, low intensity illumination, which substantially reduces photobleaching and prolongs cell viability. Nikon's NIS-Elements imaging software even allows the user to modify the illumination time to meet the requirements of the experimental design.

Take a New Path.

The light path of the LiveScan Swept Field confocal microscope has been carefully designed so that the path of the excitation illumination never overlaps the path of the emission illumination.

The Swept Field's aperture is specifically designed to reduce crosstalk. By designing the confocal aperture in a linear array, crosstalk between confocal pinholes is minimized. Further, by utilizing separate confocal apertures for excitation and emission light, there is no over-illumination of the specimen.

Finally, because the light path of the LiveScan makes use of both sides of a scanning galvanometer mirror, any offsets in the speed or movement of the scanning mirror on excitation are symmetrically compensated for on the emission, eliminating the possibility of image artifacts caused by asynchrony of scanning mirrors.
Precision Control Through Nikon NIS-Elements Imaging Software.

The NIS-Elements platform is a key component of the LiveScan Swept Field confocal system. The software contains a host of device control features for the confocal scanner and camera, as well as a variety of additional peripherals. It is designed to maximize the workflow and the flexibility of image acquisition and analysis.

The LiveScan's software option incorporates a simple user interface with the powerful features associated with the confocal microscope. It allows the user to intuitively manipulate the focus, XY position, excitation wavelength, and confocal parameters, all without touching the microscope. The LiveScan interface also allows setup of direct hardware triggering for the fastest data acquisition rates possible.

Image Acquisition
NIS-Elements image acquisition can be as simple as drag-and-drop from a live image window, yet also provides access to more complex 6-dimensional experimental protocols utilizing multiple wavelengths, stage movements, Z-sections, and time-lapse intervals. Users will find a simple, yet sophisticated user interface to select parameters for acquiring data. User settings can be saved, archived, and reloaded for new experiments. Through enhanced file handling, data can be saved directly to disk without delay due to computer overhead, or the user can choose RAM Capture, allowing information that was seen before the capture button was pressed to still be recalled and saved.

Image Analysis
Image analysis functions in NIS-Elements can not only be performed post-acquisition, but often during acquisition itself. These functions include various intensity measurement routines, morphological feature measurements, and a large selection of image processing and enhancement tools to aid in extracting data from images. Several deconvolution options are available, including 2D real-time deconvolution as well as more robust 3D constrained-iterative blind deconvolution methods.

Image Display
NIS-Elements incorporates 6-dimensional, multi-channel imaging and display into its core design. Entire experiment data sets can be saved, displayed, and manipulated as single data files, simplifying file handling of potentially complex data sets. A robust multi-dimensional viewer allows the viewing of 3D volumes in multi-channel fluorescence over time. Data output options include the extremely flexible multi-dimensional format, high bit-depth, TIFF, movie formats, or even simple RGB files for generating quick presentations.
LiveScan Offers a Wide Array of Choices.

Flexible Laser Options
Illumination in an array of excitation wavelengths is available using cutting-edge diode lasers or proven gas laser designs.

More Detectors for More Applications
The LiveScan Swept Field supports several different detector types, including back-illuminated, frame transfer EMCCDs (including the all new Nikon DQC-FW) and high resolution interline CCDs.

Greater Choice of Objectives
With seven selectable aperture sizes, the LiveScan interfaces with more microscope objectives, including Nikon’s innovative APO 60x and 100x 1.49 NA objective lenses.

Rapid Scanning Rates
LiveScan supports a variety of detectors, including specialized detectors for ultra-high speed data acquisition (>500 fps).

LiveScan can be mounted on the Nikon Eclipse TE2000 inverted microscope (pictured above) or a Nikon Eclipse FN1 upright microscope.
Stage Hardware
Motorized stage control maximizes precision and accuracy of data throughput in time-lapse experiments. Piezoelectric Z focus drives offer 3D imaging with high precision, accuracy, and speed.

Filters
Customized filters and mirrors fit specific experimental needs. Automated emission filter wheels and shutters accurately control transmitted light for expanded multi-dimensional data acquisitions.

Laser Accessories
Nikon’s Total Internal Reflection Fluorescence (TIRF) illuminator can be used with the standard dual output emission of the LiveScan laser launch for expanded applications. Additional fiber is optional.

LiveScan Accessories
The LiveScan Swept Field Confocal is compatible with a wide variety of accessories for enhanced scanning and illumination that can be added to the microscope to expand the number of applications for which it can be used.

The Perfect Focus System
For long term time-lapse experiments, the Nikon Perfect Focus System (PFS) is the ideal accessory for stabilizing the imaging environment.

Deconvolution
Optional NIS-Elements software modules allow 2D real-time deconvolution and 3D blind deconvolution algorithms for LiveScan SFC image data.
The Nikon Confocal Family

With the addition of the LiveScan Swept Field, Nikon now has a confocal product to suit virtually every research need.

The LiveScan Swept Field Confocal Microscope is the newest member of the Nikon Family of Confocal Microscopes, designed to allow the user to choose the optimum combination of speed and resolution.

The Nikon C1 Plus is a modular confocal system designed for basic research that gives you the highest quality digital imaging with an ultra-compact and lightweight design. It holds up to four different lasers, allowing you to use a variety of fluorescent probes.

The C1 Plus is the ideal instrument for FRAP, a useful tool for measuring the speed of molecular diffusion and movement. It can precisely target the laser exposure to the region of interest, is compatible with TIRF, and features a new optional component, CLEM, which uses ultra-fast electronics to reduce specimen photobleaching and phototoxicity while expanding the confocal unit’s signal dynamic range.

With its modular design, the C1 Plus can be easily upgraded to Nikon’s C1si Spectral Confocal Microscope System.

The Nikon C1si offers the same basic capabilities as the C1 Plus with innovative technology providing real, true wideband spectral detection and superior resolution. It provides brighter images at higher spectral resolution and rapid data acquisition times for time sensitive imaging.

With its one-shot acquisition ability, exclusive Diffraction Efficiency Enhancement system, and new FRAP and FRET macros, the C1si eliminates the need for cumbersome custom filter sets.

For more information, visit www.nikonconfocal.com
Specifications (LiveScan SFC Hardware)

Microscope
- TE2000 series inverted microscopes
- Upright FN1 series physiological microscopes

Scanner
Compact multipinhole array and variable slit scanner utilizing high speed galvanometer.

Frame Rates
- Up to 100Hz in pinhole array modes*
- Up to 1200Hz in slit mode*
  *solely dependent on maximum frame rate of detector

Confocal Apertures
Software-selectable 30, 45, 60µm pinhole arrays. Software-selectable 22, 35, 50 and 70µm slits. Apertures match a variety of microscope objective lenses for confocal imaging.

Detector
Standard detector: Nikon DQC-FW 512x512 back-illuminated frame transfer electron-multiplication gain (EM) CCD. Several other detector types are optional and easily interchangeable.

Lasers
- Solid-state diode options: 440nm (50mW), 488nm (50mW), 561nm (50mW), 638nm (35mW)
- Gas laser options: Argon 488nm/514nm, Argon/Krypton 588nm/647nm

Laser Modulation
Acusto-optical tunable filter (switch time < 10⁻⁶ sec)

Scan Speeds
Variable speed galvanometer scanner (software selectable) allowing users to modify laser dwell time on the specimen.

Controller
Macro scripting directly to LiveScan hardware is possible (also via software interface) for user-defined experiment routines. In/Out trigger ports allow synchronization with electrophysiological equipment.

Synchronization
Detector, confocal, and focus drive are synchronized through direct connections for fastest acquisition.

Environmental Conditions

Working Environment
Temperature: 5°C to 35°C
Difference of temperature during setup and usage should be within 5°C (recommended)
Humidity: Less than 70%RH (no condensing)

Storing Environment
Temperature: 5°C to 35°C
Difference of temperature during setup and usage should be within 5°C (recommended)
Humidity: Less than 97%RH (no condensing)

Installation Conditions
Installation on an anti-vibration table is recommended.

Power Supply
100 to 240 VAC, 50-60 Hz

Camera Specifications

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Nikon DQC-FW</th>
<th>Interline CCD</th>
<th>Ultra-fast Frame Transfer EM-CCD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E2V CCD97 back-illuminated frame transfer CCD with &gt;90% peak quantum efficiency</td>
<td>Sony ID205 interleaved CCD with &gt;65% peak quantum efficiency</td>
<td>E2V CCD90 back-illuminated frame &gt;90% peak quantum efficiency</td>
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<td>1280x1040, 12µm pixels</td>
<td>1296x1296, 24µm pixels</td>
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<td>CCD Type</td>
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<td>Low noise interline CCD</td>
<td>Electron multiplication gain (EMCCD)</td>
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<td>Linear Full Well</td>
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<td>16,000 e⁻</td>
<td>250 keV (non-EM), 750 keV (EM)</td>
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<td>up to 1000x</td>
<td></td>
</tr>
<tr>
<td>CCD Temp.</td>
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<td>-30°C ambient (regulated)</td>
<td>-30°C ambient (regulated)</td>
</tr>
<tr>
<td>Dark Current</td>
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<td>0.001 e⁻/p/s</td>
<td>&lt;1 e⁻/s</td>
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<tr>
<td>Read Noise</td>
<td>&lt;60e⁻ rms (non-EM), &lt;1 e⁻ rms effective (EM)</td>
<td>5.5 e⁻ rms @ 20MHz</td>
<td>&lt;65 e⁻ rms (non-EM), &lt;1 e⁻ rms effective (EM)</td>
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<tr>
<td>Digitizer</td>
<td>16 bits @ 10MHz, no binning</td>
<td>14 bits @ 20MHz, 15 bits @ 12MHz</td>
<td>16 bits @ 12MHz</td>
</tr>
<tr>
<td>Frame Rate full frame, no binning</td>
<td>31 fps</td>
<td>15 fps</td>
<td>510 fps</td>
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<td>Digitizer Speeds</td>
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<td>20MHz, 10MHz, 12MHz</td>
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</tbody>
</table>

Software Specifications

System Configuration
Graphic user interface to modulate laser power and usage, set confocal aperture position, access all camera control functions as well as configure and run experiments.

Multi-dimensional Experiments
Configure and run multi-dimensional experiments (up to 6 dimensions*). Time, wavelength, Z, stage position XY, and transmitted light illumination. Preview experiments during acquisition. Re-load experiment parameters easily.
  *with appropriate motorized hardware

Acquisition Modes
Pinhole array and slit scanning modes with two galvanometer drive modes.
Ultra-fast hardware triggered acquisition mode.
RAM capture mode.

Laser Control
Power, wavelength, illumination order, and shuttering. Integrated laser control with LiveScan SFC and independent laser control for other applications (e.g., TIRF).

continued on next page
Device Control
All Nikon motorized microscope hardware components. Numerous motorized XY stages, focus motors, and piezoelectric focus drives, wavelength switching devices, and numerous CCD detectors.

Visualization
Included multi-dimensional viewer (time, wavelength, volume, stage position) with output to Windows AVI format.

Deconvolution
Optional 2D real-time deconvolution and 3D blind deconvolution modules.

Image Analysis
Intensity, ratio, region-of-interest versus time, 3D volume, Object counting, Ratiometric calculation and display.

Image Arithmetic
Image and image stack background and shading correction, arithmetic, and Boolean functions.

Safety

Laser Safety
IEC60825-1 Class 3B
FDA Class III
CE marking
Low Voltage Directive: EN61010-1, EN60825-1
EMC Directive: EN61326 (EN55011 Group 1 Class B EN61000-4-2/4-3/4-4/4-5/4-6/4-8/4-11), EN61000-3-2/3-3

Complies with FCC Part 15B Class A

This equipment has been tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the FCC Rules.

These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with this instrument's instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which the user will be required to correct the interference at the user's own expense.

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la Classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

LiveScan configured with Nikon Eclipse TE2000 inverted microscope.

LiveScan configured with Nikon Eclipse FN1 Upright microscope.
Fold-out Insert

Choose Galvanometer Movement
Select the time of excitation the specimen receives via a software-selectable galvanometer mirror control. For maximum frame rates, use ultra-high speed sinusoidal galvanometer movements.

Normal drive mode

Sinusoidal drive mode

Choose Device Control
The LiveScan enables the use of triggered device control for high speed imaging in multiple wavelengths and through Z. By direct communication between the LiveScan and the hardware devices, the highest speed synchronized movement of hardware can be achieved.

Normal device control: PC communicates separately with each communication device.

PC → Z Drive
Excitation λ
LiveScan SFC → CCD

Triggered device control: PC sends instructions directly to the LiveScan, which orchestrates fast, synchronized hardware control.

PC → LiveScan SFC → Excitation λ → Z Drive

LiveScan™ Swept Field
Confocal Microscope System

A Matter of Choice.

Choose the Experiment
The unprecedented versatility of the LiveScan makes it ideal for a wide variety of live cell applications and experiments.

- Physiology
- Cell Biology
- Long-term Time-lapse
- Immunofluorescence
- Ultra-High Speed

The Eyes of Science

www.nikoninstruments.com

Speed comparison - 10 Z steps (100 nm range, 1 µm step) in 2 colors with 100 ms exposure times:
- Normal device control: 15.5 seconds to acquire
- Triggered device control: 2.5 seconds to acquire
The choice is yours with the Nikon LiveScan Swept Field Confocal.

Choose an Objective
The LiveScan's variable aperture design allows the use of several microscope objective types while still maintaining high axial resolution. In addition, both pinhole and slit aperture options are selectable for maximum flexibility in experimental design.

*60μm pinholes
*50μm slit

*30μm pinholes
*35μm slit

*22μm slit

Choose the Confocal Aperture
The LiveScan gives you the choice between highest axial resolution and highest speed. After selecting the objective lens, the aperture selection can be made based on desired frame rate, sensitivity and axial resolution.

Pinhole image

Maximum intensity projection of pinhole versus slit image

Slit Image

Volume pinhole image

Volume slit image

Pinhole mode frame rate: up to 100Hz*
Slit mode frame rate: up to 1200Hz*

Choose the Detector
Various detectors can be used with LiveScan based on experimental needs - high speed and high sensitivity, or high sensitivity and spatial resolution.

Interline CCD

Maximum intensity projection of interline versus EMCCD

Quantum efficiency of interline versus frame transfer CCD

EMCCD

Interline speed: 10 frames per second†
FT speed: 30 frames per second†

Interline pixel size: 6.45μm
FT pixel size: 16μm

*Frame rate depends on camera settings (exposure, ROI, binning, ADC speed)
†Full frame, no binning, no ROI