A 1+

Confocal Microscope
Smart Tools for Superior Results

Nikon’s modular A1+/A1R+ confocal laser scanning microscope system can meet the most demanding imaging requirements with hardware and capabilities that are continuously updated to achieve both high-quality images for spatial information and high speed images of fast-moving events.

Optimized sensitivity
It starts with Nikon’s optical design and quality, coupled with intelligent electrical design to maximize signal throughput, mechanical improvements to gather more emitted photons, and improved detectors for high sensitivity, even at extremely high speed acquisition.

Maximizing resolution
The high resolution galvanometer scanner (A1+/A1R+), and the high frequency resonant scanner (A1R+), together with Nikon’s unique image correction technologies, ensure the highest spatial and temporal resolutions. The high definition resonant scanner provides imaging of 1024 x 1024 pixels (15 fps).

Designed for high speed imaging
Imaging beyond the normal video rate (up to 420 fps) means capturing fast moving events while simultaneously illuminating for a shorter time, maintaining more live-sample friendly imaging.

Spectral sensitivity
A variety of spectral detection options allow simultaneous acquisition of 32 channels of emission, or user-defined emission bandwidths. High-sensitivity detector options allow tunable emission spectral imaging with resonant scanning.
The A1R+ is a hybrid scan head that incorporates both a high-resolution galvano (non-resonant) scanner and an ultrahigh-speed resonant scanner. Hybrid scan heads allow imaging and photoactivation at the ultrafast speeds necessary for revealing cell dynamics and interaction. The A1+ is equipped with a galvano scanner for high-resolution imaging.

**A1R+ hybrid scan head**

- 3 detection ports
- 2 laser introduction ports
- Continuously variable hexagonal pinhole
- Low-angle incidence dichroic mirror
- Galvano mirror scanner
- Resonant mirror scanner

**Continuously variable hexagonal pinhole**

- Square pinhole: 64% of the area of a circle
- Hexagonal pinhole: 83% of the area of a circle

**Low-angle incidence dichroic mirror**

- Conventional 45° incidence angle method
- Low-angle incidence method

**High resolution imaging with A1+ and A1R+**

Both A1+ and A1R+ are equipped with a galvano scanner enabling high resolution imaging of up to 4096 x 4096 pixels. This scanner can capture images at up to 10 fps (512 x 512 pixels).

**Ultrafast imaging with A1R+**

The A1R+ scan head is equipped with a resonant scanner enabling frame rates of up to 420 fps (512 x 32 pixels), or resolutions of up to 1024 x 1024 pixels (15 fps).

**Hybrid scanning**

Imaging and photostimulation can be carried out simultaneously by utilizing both resonant and galvano scanners in the A1R+.

<table>
<thead>
<tr>
<th>Scanner Type</th>
<th>1D scanning</th>
<th>2D scanning</th>
<th>Full frame scanning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galvano</td>
<td>5,200 fps</td>
<td>130 fps</td>
<td>10 fps</td>
</tr>
<tr>
<td>Resonant</td>
<td>15,600 fps</td>
<td>420 fps</td>
<td>60 fps</td>
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<td></td>
<td>(512 x 32 pixels)</td>
<td>(512 x 32 pixels)</td>
<td>(512 x 512 pixels)</td>
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<td>(512 x 512 pixels)</td>
<td>(256 x 256 pixels)</td>
<td>(1024 x 1024 pixels)</td>
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</table>
Nikon’s new resonant scanner mounted in the A1R+ scan head supports both high speed and high resolution imaging. The wide dynamic range and reduced noise level raises the bar for image quality in resonant scanners.

**High resolution**
A new resonant scanner achieves finely detailed images with a maximum resolution of 1024 x 1024 pixels (15 fps). A newly developed sampling method produces sharper images with any configuration even at lower resolution settings. When combined with Nikon’s high NA objective lenses, the A1R+ can achieve absolute optical precision.

**Large field of view**
With both 1024 x 1024 pixel resolution and a large field of view (FOV18), the new resonant scanner delivers higher throughput in various imaging applications.

**High speed**
The fast acquisition speed of the resonant scanner is able to capture images with a very short dwell time, minimizing excitation time and light energy exposure of the samples.

**Multicolor**
Up to 5 channel (four-channel episcopic detector plus diascopic detector) simultaneous imaging is possible.
Fast volumetric time-lapse imaging
Resonant scanning coupled with fast piezoelectric Z drivers allows capture of fast 4D volumes. Multiple Z stacks can be acquired each second, allowing the acquisition of not just 2D, but rapid succession 3D datasets versus time.

Calcium waves in isolated cardiomyocytes imaged at 120 Hz; representative frames showing wave propagation in live cells.

High speed imaging with resonant scanners
Ultra-fast scanning with the resonant scanner allows low excitation dosages and captures fast physiological processes. The Nikon original optical pixel clock generation method realizes high image quality even at the highest speeds.

The high resolution galvano scanner enables acquisition of images of up to 4096 x 4096 pixels in up to 5 channels (four-channel fluorescence plus diascopic DIC) by using the A1-DU4-2/DUG-2 or A1-DUVB-2 detector.
The unique hybrid scanning layout of the A1R+ allows simultaneous imaging and photostimulation. This enables instantaneous imaging of the results of or recovery from photostimulation. NIS-Elements C imaging software performs all types of photostimulation experiments in guided workflows, including photoactivation, photoconversion, FRAP, FLIP, and caged-compounds.

In the A1R+ system, the resonant scanner acquires images while the galvano scanner is used to direct the photostimulation laser. Imaging with the resonant scanner ensures the fastest acquisition possible.
Implementation of high-sensitivity gallium arsenide phosphide (GaAsP) detectors have created a new standard in image quality. GaAsP PMT cathodes achieve much higher quantum efficiency than conventional detectors, resulting in brighter imaging with minimal noise, even while imaging at high-speed. The combination of low light dosage, high sensitivity, and rapid imaging makes resonant scanning a very effective tool for acquisition of living specimens or to increase speed and efficiency in high-throughput workflows.

Hybrid GaAsP detector

A1-DVG-2 is a 4-channel detector utilizing both GaAsP and Multi-Alkali PMTs, assigning the detector based on sensitivity at the emission wavelength of fluorescence for the maximum sensitivity.

DUVB GaAsP detector

A1-DUVB-2 is a tunable bandwidth emission GaAsP detector unit that allows custom-defined emission bandwidths for imaging in up to 5 channels.

Sensitivity comparison of GaAsP PMT and Multi-Alkali PMT

[Graph showing sensitivity comparison]

GaAsP PMT realizes higher sensitivity than Multi-Alkali PMT, thus offering high quantum efficiency up to 45%. *Quantum efficiency indicates logarithm.
Filter-less intensity adjustment is possible with V-filtering function

Up to four desired spectral ranges can be selected from 32 channels and combined to perform a filtering function that matches the spectrum of the fluorescence probe being used. By specifying the most appropriate wavelength range, image acquisition is possible at the optimal intensity of each probe in FRET and co-localization. The sensitivity of each range can be individually adjusted.

A1-DUVB-2 GaAsP detector unit

High-sensitivity spectral image acquisition

With a GaAsP PMT, the A1-DUVB-2 tunable emission detector delivers flexible detection of fluorescent signals with higher sensitivity.

Variable acquisition wavelength range

The A1-DUVB-2 is a compact fully tunable emission detector unit capable of spectral imaging with user defined emission bandwidths as small as 10 nm, in both galvano and resonant imaging modalities, eliminating the need for fixed bandwidth emission filters. Spectral images of multi-labeled specimens can be acquired by capturing a series of spectral images while changing detection wavelengths.

Optional second channel detector

An optional second GaAsP PMT allows simultaneous two-channel imaging such as FRET and ratio imaging. Users can divert selected wavelengths to the second fixed bandwidth emission channel by inserting a dichroic mirror, while simultaneously utilizing the user-definable emission band on the first channel.

Enhanced spectral detectors

A1-DUS spectral detector unit

Fast 32-channel imaging at 24 fps

Spectral imaging over a 320 nm wavelength range is possible with a single scan. Acquisition of 512 x 512 pixels in 0.6 second and 512 x 32 pixels at 24 fps can be achieved.

Accurate spectral unmixing

High wavelength resolution of at least 2.5 nm enables accurate separation of closely overlapping fluorescence spectra and the elimination of autofluorescence. In addition, probes with adjacent spectra such as GFP and YFP can be unmixed in real time during image acquisition. This is convenient for FRET analysis.

Wide band spectral imaging

Simultaneous excitation with four lasers, selected from a maximum of eight lasers of different wavelengths, is possible.

Before unmix

After unmix

A1-DUS system for higher diffraction efficiency

256 detector with 3 mobile shields, allowing simultaneous excitation by up to four lasers.

Optical fiber

32-channel detector unit

Spectral and unmixed images of five-color fluorescence-labeled HeLa cells

Specimen courtesy of: Dr. Tadashi Karashima, Department of Dermatology, Kurume University School of Medicine

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A unified acquisition and analysis software platform

NIS-Elements C, Nikon’s unified software platform, provides intuitive workflow for confocal imaging. Combined with the graphical programming tools such as JOBS and illumination sequence, the comprehensive operational environment can be fully customized for any level of application needs.

NIS-Elements C
Detailed operability based on analysis of confocal microscope operation patterns provides an intuitive interface and operation. Complicated experiment sequences such as photoactivation can be carried out with easy-to-use settings.

NIS-Elements C-ER*
Higher resolution images can be generated with a single click. The software assesses the captured image and automatically determines processing parameters to achieve increased resolution. The unique image processing technology increases image resolution beyond that of a conventional confocal image (resolution can be improved 1.5 times (XY), 1.7 times (Z)).

Device Control
Multidimensional Imaging
Optical configuration settings can be combined in the ND acquisition GUI to create experiments combining multichannel, multi-stage position, z-stacking, and timelapse imaging. Photostimulation and photobleaching can also be flexibly combined.

Display & Processing

Denoising
Efficient tools for removing noise or graininess from images, improving image quality in low light imaging. This greatly improves the output quality of the image for analysis and presentation.

Deconvolution
Automatic/manual, robust algorithms are provided to actualize theoretical resolutions. Both 3D and 2D deconvolution are available.

Image analysis
Automatic measurement
Segmentation tools, morphology functions, classifiers, and an extensive list of measurement tools for 2D, 3D and timelapse datasets.

2D and 3D object tracking
Identifying and tracking 2D and 3D objects. Measurements include velocity, acceleration, distance, and direction.

Real-time measurement
Time measurements can be carried out in real-time and visualized during acquisition.

* NIS-Elements C-ER not sold in all areas. ER functionality is available as an add-on module for NIS-Elements C in the Americas.
Highest performance optics for confocal imaging

A selection of high numerical aperture (NA) objectives are available, which provide chromatic aberration correction for UV to near-infrared.

- **CFI SR HP Plan Apochromat Lambda S 100XC Sil**
  - By using silicone oil that has a refractive index closely matching that of live cells as its immersion liquid, this lens allows high resolution imaging of thick samples and is suitable for long term time-lapse imaging.
  - Numerical aperture: 1.35
  - Chromatic aberration correction: from visible to UV
  - Nano Crystal Coat applied.

- **CFI Plan Apochromat VC 60XC WI**
  - This lens' chromatic aberration correction up to the UV range enables accurate multicolor confocal imaging.
  - Chromatic aberration correction: the full visible wavelength range over 405 nm
  - Superior image flatness

- **CFI Apochromat TIRF 60XC Oil**
  - This lens has the industry's highest NA, providing unparalleled resolution and efficient acquisition of fluorescent signals in confocal imaging.
  - Numerical aperture: 1.49
  - Chromatic aberration correction: from UV through to near IR

Nikon's exclusive Nano Crystal Coat is an anti-reflective coating consisting of ultra-fine crystalline particles. This forms a coarse structure that enables the passage of light through the lens rather than reflecting it, thus providing superior light transmission.
Laser units with great flexibility and efficiency

**LU-NV series**
- Supports up to eight wavelengths and switching between seven different scanners.
- Lasers available for this series are: 405 nm, 445 nm, 458 nm, 488 nm, 514 nm, 532 nm, 561 nm, 640 nm, and 647 nm.
- High-power lasers for the N-SIM/N-STORM super resolution system.

**LU-N4/NAS 4-laser unit**
- LU-N4/NAS is equipped with four lasers (405 nm, 488 nm, 514 nm, and 561 nm), while the LU-N3 has three lasers (405 nm, 488 nm, and 561 nm). The LU-N4/NAS is compatible with spectral imaging.

**LU-N3 3-laser unit**
- LU-N3 laser unit
- LU-N4/NAS 4-laser unit
- LU-NV series laser unit

**Specifications**

### Laser
- **LU-N4/NAS 4-laser unit**
  - 405 nm, 488 nm, 514 nm, 561 nm lasers are installed, built-in AOTF
  - LU-NV series laser unit
    - Compatibilities: 405 nm, 445 nm, 458 nm, 488 nm, 514 nm, 532 nm, 561 nm, 594 nm, 640 nm, 647 nm, built-in AOTF

### Standard fluorescence detector
- **LU-NV** series laser unit
- **LU-N3** 3-laser unit
- **LU-N4/NAS 4-laser unit**

### Diapositive detector (optional)
- **LU-N4/NAS 4-laser unit**
- **LU-NV series laser unit**

### Detector
- **A1-DUG-2 GaAsP Multi Detector Unit**
- **A1-DU4-2 Detector Unit**

### Software
- **A1-DUT Diascopic Detector Unit**

### System diagram

**Laser unit**
- LU-N4/NAS Laser Unit 405/488/514/647**
- LU-N4 Laser Unit 405/488/561/640
- LU-N3 Laser Unit 405/488/561

**LASER SERIES Laser Unit**
- Laser unit

**Controller**
- Remote Controller

**Detector unit**
- Detector unit
- Scan Head and Controller

**Microscope**
- Automatic XY stage
- High-speed Z stage
- High-speed piezo objective-positioning system

**Software**
- A1-DUT Diascopic Detector Unit

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1. FCS/FCCS/FLIM is possible in combination with third-party systems.
2. A fusion mode is compatible with seven or eight filters and scanning modes: XY, X-Y, X-Z, X-Z rotation.
3. *LU-N4 cannot be used with A1-DUS spectral detector*
Diverse peripherals and systems for pursuit of live cell imaging

A1+ with N-SIM, A1+ with N-STORM and A1+ with TIRF

A1+ can be equipped with the TIRF system and super resolution microscope systems N-SIM, N-STORM on a single inverted microscope and all controlled from Nikon’s integrated software. This meets the demands of multi-perspective cellular analysis. N-SIM provides super resolution of approximately double that of conventional microscopes, while N-STORM provides approximately 10 times higher super resolution. TIRF enables visualization of ultra-thin optical specimen sections of approximately 100 nm, enabling the observation of single molecules.

Confocal microscope with Perfect Focus System

With the inverted microscopes Ti2-E, an automatic focus maintenance mechanism—Perfect Focus System (PFS) can be used. It continuously corrects focus drift during long time-lapse observation and when reagents are added.

Water Immersion Dispenser

The Water Immersion Dispenser increases the stability of long-term imaging using PFS, by automatically applying the appropriate amount of water to the tip of a water immersion objective, preventing the immersion liquid from drying out or overflowing during experiments.
Specifications and equipment are subject to change without any notice or obligation on the part of the manufacturer. August 2017 ©2010-17 NIKON CORPORATION

WARNING
TO ENSURE CORRECT USAGE, READ THE CORRESPONDING MANUALS CAREFULLY BEFORE USING YOUR EQUIPMENT.

Monitor images are simulated.

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*Products: Hardware and its technical information (including software)

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