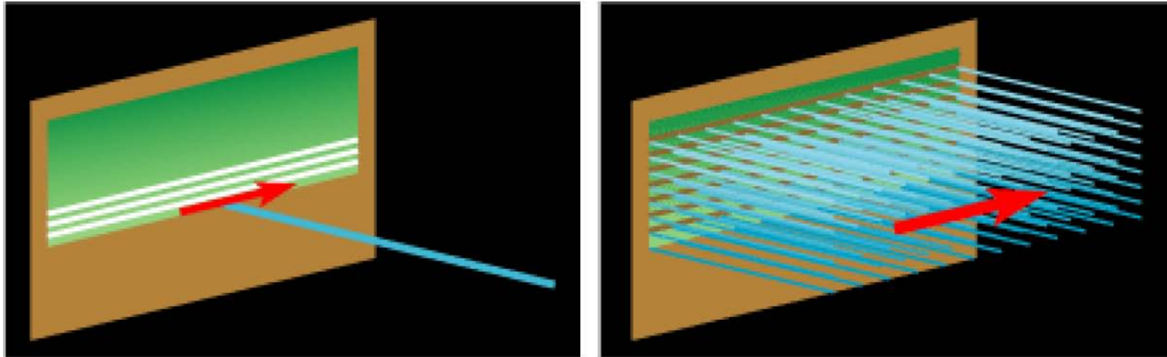
Principles

Principles of the Microlens-enhanced Nipkow Disk Scanning Technology

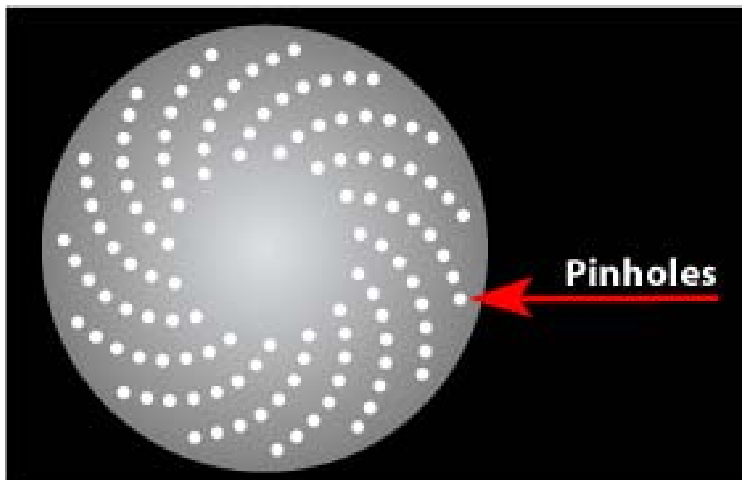
The most common conventional confocal microscopes use a single laser beam to scan a specimen, while the CSU models scan the field of view with approximately 1,000 laser beams, by using microlens-enhanced Nipkow disk scanning: in short, the CSU models can scan 1,000 times faster.



Conventional single beam scanner   Multi-point scanning with the CSU

The Nipkow disk is a spinning disk with a spiral pattern of holes arranged to raster scan the specimen with the light source – either laser or white light – illuminating through the holes; numerous small points of light scan the specimen simultaneously when the disk is spinning.

The Nipkow Disk



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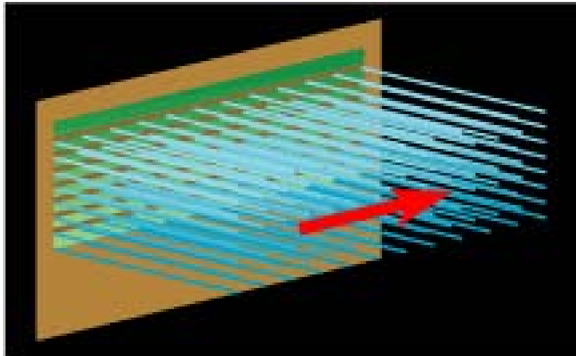
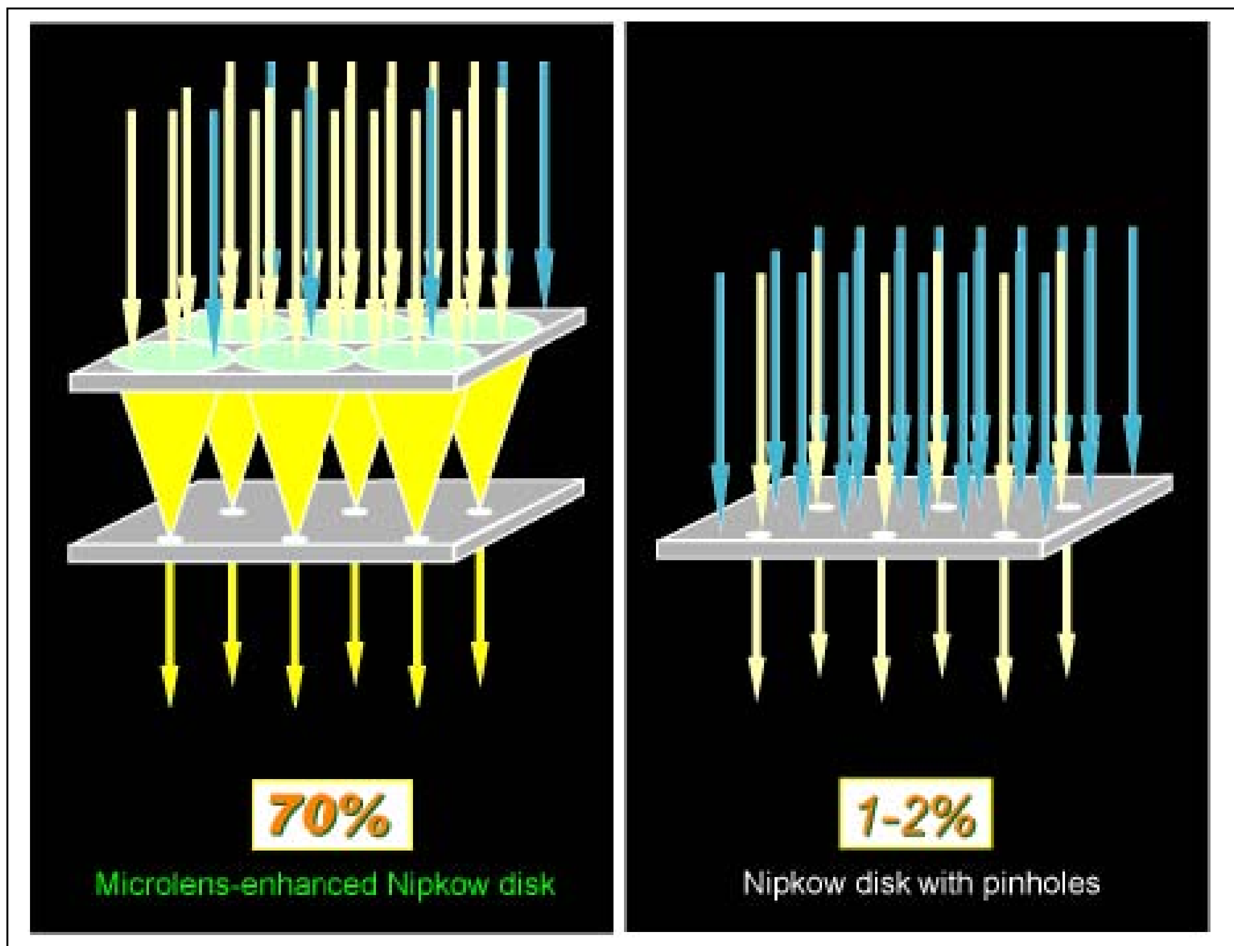
The First Proposed Method of Scanning

Invented by Paul Nipkow in 1884, it was used for very early stage of television. Although capable of high-speed scanning, conventional Nipkow disks failed to provide enough light to clearly image fluorescence from live cells.

Multi-point scanner



Advantages: Fast, real time confocal
Disadvantages: Historically poor light efficiency through the disk



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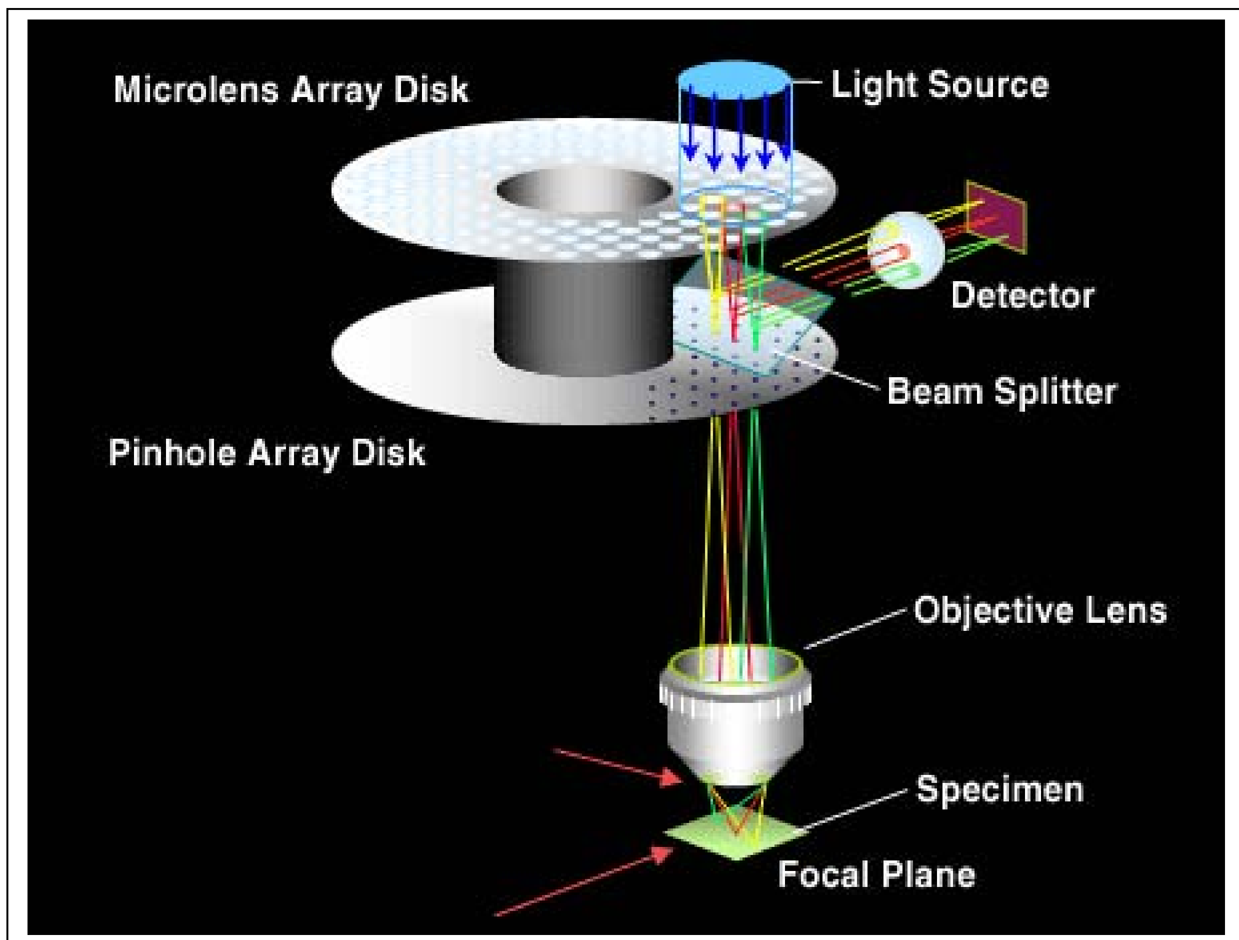
By using a disk containing microlens arrays in combination with the Nipkow disk, we have succeeded in dramatically improving the light efficiency and thus successfully made real-time confocal imaging of live cells possible.

The expanded and collimated laser beam illuminates the upper disk containing about 20,000 microlenses (microlens array disk). Each microlens focuses the laser beam onto its corresponding pinhole, thus, effectively increasing laser intensity through pinholes placed in the pinhole array disk (Nipkow disk).

With the microlens, backscattering of laser light at the surface of the pinhole disk can be significantly reduced, thus, dramatically increasing the signal to noise ratio (S/N) of confocal images.



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About 1,000 laser beams passing through each of the pinholes fill the aperture of the objective lens, and are then focused on the focal plane. Fluorescence generated from the specimen is captured by the objective lens and focused back onto the pinhole disk, transmitted through the same holes to eliminate out-of-focus signals, deflected by the dichroic mirror located between microlens array disk and the Nipkow disk to split fluorescence signal from reflected laser, passed through emission filter and then focused into the image plane in the eyepiece or camera.

The microlens array disk and the Nipkow disk are physically fixed to each other and are rotated to scan the entire field of view at high speeds, thus, making it possible to view confocal fluorescent images in real-time through the eyepiece of the CSU head.

As compared to conventional single point scanning, multi beam scanning by the CSU requires a significantly low level of light intensity per unit area, which results in significantly reduced photo bleaching and photo toxicity in live cells.

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