

Lenses, Mounts, and Other Bolognese Visions

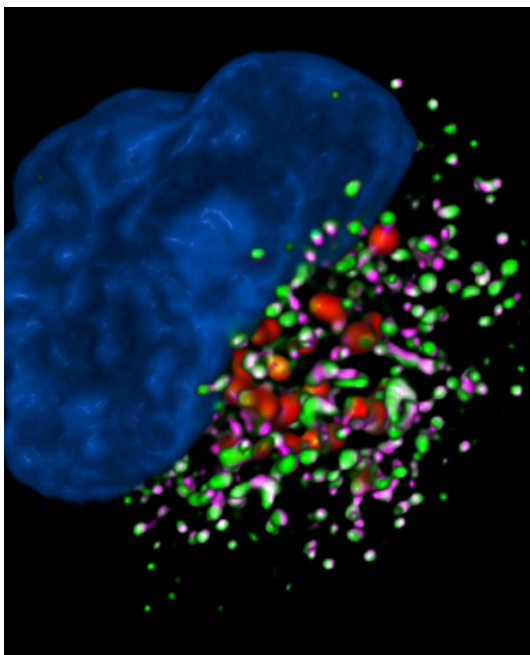
Spartaco Santi
May 2025

1

There is a silent revolution that starts from the mirror. Or rather, from its disappearance. In the world of photography, the new mirrorless cameras have eliminated the mirror that for decades defined SLRs. It's not just a mechanical issue: removing the mirror means seeing more directly, with fewer constraints, more light, more design freedom. A philosophy. An optical ideology. Meanwhile, something was also changing in microscopy labs. Finite objectives (those designed for a 160 mm tube length) have been replaced by infinity optics: designed for an open optical space, capable of accommodating intermediate lenses, filters, fluorescence modules, polarizers. More freedom, more versatility, more correction. Here too, fewer constraints. Here too, a revolution.

At first glance, photography and microscopy seem like distant worlds. But both have felt the need for a new kind of coupling: wider, smarter, more open. Nikon, Canon, Leica have redesigned mounts to accommodate lenses that were previously impossible (58mm f/0.95? Please, come in). Microscopes have also abandoned the historic 20 mm RMS thread to move toward M25, M27, ICS mounts. 20x objectives with 0.80 numerical aperture? Once upon a time, that was science fiction.

And Bologna? Bologna watches. Or rather: Bologna is made to be observed. With a mirrorless camera under the Voltone del Podestà, with an infinity objective in a lab at the Rizzoli Orthopaedic Institute. But also with the curious gaze of someone who knows that optics is not just a matter of lenses, but of viewpoints. In the end, the city itself is a continuous coupling: between old and new, between DIC (Differential Interference Contrast, which increases contrast in bright-field microscopy) and DPCM (ministerial decrees that regulate the world outside the lab), between precision microscopy and Italian bureaucracy, between technical culture and tavern poetry. Remove the mirror, look inside. There is more light than you thought. But let's proceed step by step.



*Confocal microscope + deconvolution
PlanApo TIRF 100x 1.49NA objective*



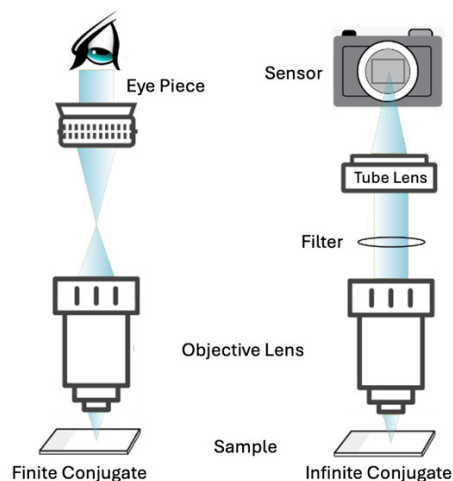
*Hasselblad X2D
90mm f/2.5 objective*

In microscopy

The change in how objectives are mounted in microscopes with the introduction of infinity optics began in the 1980s, with a significant acceleration in the 1990s, when infinity-corrected optical systems became the standard among major microscope manufacturers (such as Nikon, Olympus, Leica, and Zeiss). Traditionally, microscopes used a finite optical system, in which the distance between the objective and the optical tube (tube length) was fixed and specified (typically 160 mm, as in the German DIN standard — Deutsches Institut für Normung). In these systems, each objective was designed for that exact distance.

With the introduction of infinity optics:

- Objectives no longer form a real image directly, but instead collimate light into parallel rays, as if the focal point were at infinity.
- The real image is then formed by a tube lens located within the microscope body.
- This allows intermediate optical elements (such as beam splitters, filters, fluorescence modules, or DIC devices) to be inserted without affecting focus or introducing additional aberrations.



Finite and infinity optical systems

The transition to the infinity system made it necessary to:

- New objectives compatible with infinity optics, not compatible with finite tube-length systems.
- Modification or replacement of the mechanical mount (often the 20.32 mm RMS standard is retained, but with different optical correction specifications).
- Integration of the tube lens into the microscope body, therefore leading to optical incompatibility between infinity and finite systems.



The different nomenclatures that can be found between finite (160) and infinity (∞) systems

After the first experiments with infinity systems (especially by Zeiss and Nikon) in the 1970s, starting in the 2000s infinity optics became the standard in almost all new compound microscopes. Of course, each manufacturer has a proprietary infinity system (e.g. Olympus UIS, Nikon CFI, Zeiss ICS), so infinity objectives are not always interchangeable between different brands. Moreover, mechanical compatibility does not mean optical compatibility: even if an objective can be screwed in, it may introduce aberrations or fail to focus properly.

It should be noted that each infinity system has its own tube lens focal length: Nikon CFI ~200 mm, Olympus UIS ~180 mm, Zeiss ICS ~165 mm, Leica HCX ~200 mm. Optical performance improves thanks to more advanced optical design (plan-achromatic and apochromatic correction, correction of spherical and chromatic aberrations) and high-performance optical glass, enabling an increase in the field of view.

Characteristic	Finite optics	Infinity-corrected optics
Tube length	Fixed (e.g. 160 mm)	Flexible (~165–200 mm)
Insertion of optical elements	Degrades the image	Image remains unchanged
Objective compatibility	Specifically calibrated objectives	Compatible only within the same system (e.g. Nikon CFI, Zeiss ICS, Olympus UIS)
Modern applications	Limited	Suitable for fluorescence, DIC, optical modules, and increased field of view

Summary of the advantages of infinity-corrected optics

Numerical Aperture

The introduction of low-magnification objectives (e.g. 10×, 20×) with high numerical aperture (NA) is one of the most significant innovations in modern microscopy, particularly with the establishment of infinity optical systems and new optical materials with high transparency and low dispersion. Numerical aperture is a measure of an objective's ability to gather light and its resolving power. It is calculated as:

$$AN = n \cdot \sin(\theta)$$

where:

- n = refractive index of the medium (air, oil, water, etc.)
- θ = half-angle of the light cone accepted by the objective

The higher the NA, the greater the resolution and the ability to observe fine and faint details (e.g. in fluorescence microscopy). Historically, low-magnification objectives (4×, 10×, 20×) had long focal lengths and wide fields of view, but modest NAs (typically 0.2–0.4). Optimization was achieved at the expense of resolution: the goal was to obtain field rather than detail, since finite microscopes did not have optical space for intermediate corrections. Today, 20× objectives with NA values up to 0.75–0.95 are available. Thanks to infinity optical systems that allow intermediate corrective modules and sub-micrometric manufacturing technologies, the compromise between field of view and resolution has been revolutionized. Previously, one had to choose: either detail (high NA) or field of view. Now both can be achieved thanks to advanced optics. This makes these objectives ideal for quantitative imaging, digital diagnostics, and modern fluorescence microscopy.

In photography

The introduction of new mounts in mirrorless cameras—such as Nikon Z, Canon RF, Leica L, Sony E (partially), Hasselblad X, etc.—represents one of the most important structural changes in modern digital photography. These new mounts are not just a mechanical matter: they were designed to overcome the physical and optical limitations imposed by older DSLR mounts (such as Nikon F, Canon EF, Pentax K), and to fully exploit the mirrorless format.

With the disappearance of the mirror and pentaprism in mirrorless cameras, manufacturers gained greater design freedom. This has allowed them to:

- Reduce the flange focal distance—the distance between the mount and the sensor.
- Widen the mount diameter.
- Add faster and more versatile electronic connections.
- Produce brighter, more compact, and better-corrected lenses.

The new mirrorless mounts have revolutionized lens design. The first obvious advantage is the ability to create brighter lenses with extreme apertures that are still optically well corrected. Lenses such as the Canon RF 50mm f/1.2, the Nikon Z 58mm f/0.95 Noct, or the Sigma 35mm f/1.2 for L-mount are concrete examples. These large apertures require wide light entry angles, which are only possible thanks to larger-diameter mounts.

Characteristic	DSRL (e.g. Canon EF, Nikon F)	Mirrorless (e.g. Z, RF, L)
Flange focal distance	Long (44–46.5 mm)	Short (16–20 mm)
Diameter	Limited (e.g. Nikon F: 44 mm)	Wide (e.g. Nikon Z: 55 mm)
Electronic contacts	8-10 pin	12-20 pin
Backward compatibility	High (especially Nikon F)	Variable, often with adapter
Optical optimization	Constrained by the mirror	Much more flexible
Support for new lenses (e.g. f/1.2, f/0.95)	Limited	Full support

Main differences between old and new mounts

Another advantage is improved correction of optical aberrations. The reduced flange focal distance—meaning the very short distance between the sensor and the rear lens element—allows for the design of more symmetrical optics, particularly for wide-angle lenses. This eliminates the need for complex retrofocus designs, resulting in better edge sharpness and reduced chromatic and lateral aberrations. This new design also enables a reduction in overall size. Shorter lenses, especially in standard and wide-angle focal lengths, make it possible to build more compact and lightweight cameras. Models such as the Canon R8 or Sony A7 offer professional performance in a smaller body.

On the electronic side, modern mounts allow much more advanced communication between lens and camera. The increased number of contacts enables faster and more precise autofocus, combined stabilization (IBIS + OIS), detailed EXIF data, and even firmware updates for lenses themselves. Finally, these mounts open the door to lenses that were previously unthinkable: such as the constant-aperture Canon RF 28–70mm f/2, compact super-telephoto lenses like the retractable Canon RF 600mm f/11, or extreme wide-angles like the Nikon Z 14–24mm f/2.8, which is more compact and better corrected than its F-mount equivalent. These are more than just “new mounts”: they represent an optical and mechanical paradigm shift that is bringing photography into a more fluid, lighter, and more powerful era.

The rangefinder: a class alternative without a mirror

Before the advent of mirrorless cameras, the rangefinder represented a different way of eliminating the reflex mirror. Cameras such as the Leica M—followed by Minolta, Nikon, and Canon with rangefinder models—used a separate optical-mechanical system for focusing, without the need for a mirror or pentaprism. This solution made it possible to build very compact camera bodies and extremely fast lenses, such as the remarkable Leica 50mm f/0.95, thanks to the design freedom provided by the absence of the reflex system.

Although the rangefinder had limitations in terms of through-the-lens composition, it paved the way for a new optical philosophy: fewer mechanical constraints for higher-performing optics. Modern mirrorless cameras, such as the latest Leica M versions, extend the principle of the absent mirror by offering focusing based on the real image in the electronic viewfinder, focus peaking, real-time exposure and depth-of-field preview, combined with full integration with digital sensors.



The rangefinder and viewing through the viewfinder

Photography and microscopy: two worlds, one optical revolution

Photography and microscopy are undergoing the same silent revolution: new mounts, freed optical spaces, increased diameters, and intelligent communication are transforming not only the instruments, but also the way we see the world—whether it is a street in Bologna or a cancer cell. In both cases, the central optical structure is freed from previous physical constraints (the mirror in DSLRs, the fixed tube in finite microscopes), enabling new optical solutions. Both fields leverage this evolution to create more compact, higher-performing, and more versatile systems, also adapting to digital needs (high-resolution sensors, quantitative scientific imaging).

Effect	Cameras	Microscopes
Previously impossible lenses	28–70 f/2, 58mm f/0.95, compact zooms	20x/0.90 Plan Apo, ultra-flat objectives for digital imaging
Better edge performance	Uniform sharpness on 60+ MP full-frame sensors	Flat field over 25–26.5 mm, advanced chromatic correction
Compactness	Shorter lenses with the same performance	Microscopes with improved optical performance

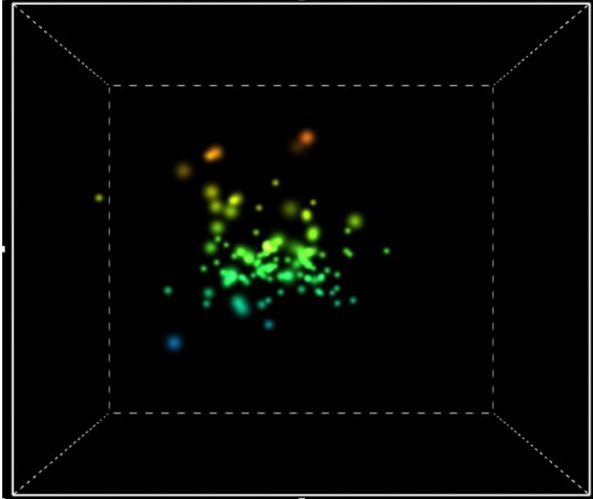
The effect of design freedom

So what?

So everything changes. And yet it remains the same.

Whether you are photographing the Arco del Meloncello at dawn or tracking a fluorescent extracellular vesicle in Via San Giacomo, it is always a matter of light, mounting, and perspective. The real revolution is not in the lens, but in the eye—in the idea of seeing better, deeper, without intermediate mirrors.

And Bologna, a city that lives on improbable couplings—between the thread of a Lambrusco bottle and mechanical laboratories, between old RMS mounts and new bayonet systems—has always known it: precision is science, but also poetry.



*STORM microscope
PlanApo TIRF 100x 1.49NA objective*



*Hasselblad X2D
28mm f/4.0 P objective*