

APPLICATION NOTE

How to Select the Correct Coupler Magnification

A guide to selecting the correct coupler for your microscope camera



Selecting a suitable coupler to connect a camera to a microscope is an important step in the system configuration. Several factors must be considered in order to maximize the camera's field of view, without compromising image quality. This application note will explore the factors that will help you with the correct coupler selection, demonstrate the impact of various coupler magnifications, and speak to the effects of selecting a coupler magnification that is smaller than the recommended coupler size for your microscope and camera set up.

Another term for a coupler is a C mount adapter, and the terms are often used interchangeably.

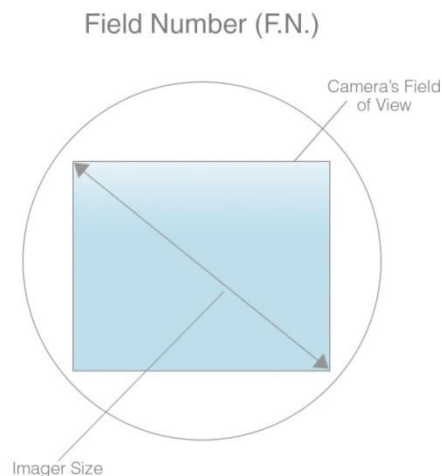
The field of view of a camera is dictated by three factors:

- Field number of the microscope
- Sensor format of the camera
- Magnification of the coupler

The field number (FN) is dictated by the microscope and is defined as the diameter, in millimetres, of the field of view when measured at the intermediate image plane, and typically varies from 20 to 26 mm.

The sensor format of the camera is another way of referring to the size of the image sensor. Common sensor formats for microscopy cameras are 1/3", 1/2", 2/3", and 1". By knowing the microscope's FN and the sensor format, it is possible to select a coupler magnification to maximize the field of view for the camera.

This can be done by calculating the ratio between the field number and the diagonal size of the imager, as illustrated in the following equation:



$$\text{Coupler Magnification} = \frac{\text{Field Number (FN)}}{\text{Imager Size}}$$

It is important to note that the sensor format is not what should be used for the above calculation. It's the measured diagonal of the sensor (in millimetres) that should be used, which can be found in the camera's datasheet under "Imager Size."

Selecting the Right Coupler Size:

The table below shows the general rule of thumb to ensure there is even illumination across the entire field of view of the camera:

Sensor Format	Coupler Magnification
1/3"	0.35x
1/2"	0.5x
2/3"	0.66x
1"	1x

If the selected coupler magnification is too small, an undesired effect called vignetting will occur.

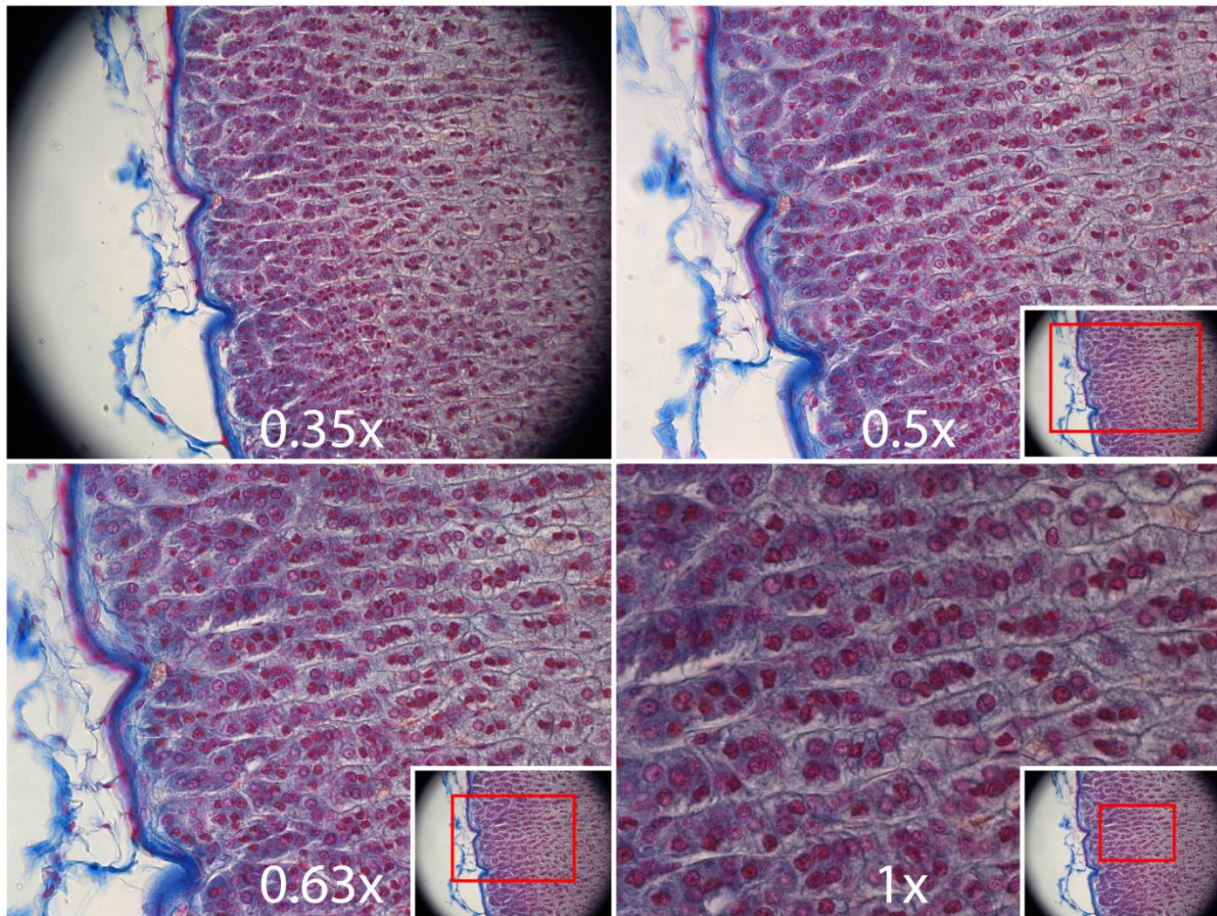
Vignetting occurs when the outer regions of the image, starting with the corners will start to have a drop in illumination.

This is due to the fact that the optics in the microscope produce a circular image and the image sensor is rectangular in shape. When the magnification of the coupler projects the circular field of view onto the sensor that is smaller than the entire area of the image sensor, the corners are darkened, creating the vignetting effect.

The below images were taken using Lumenera's INFINITY3-3URC, with a 2/3" sensor with different coupler sizes to demonstrate vignetting – as the coupler magnification is increased, the field of view decreases. With a 0.35x magnification coupler, the vignetting appears in the corners of the image.

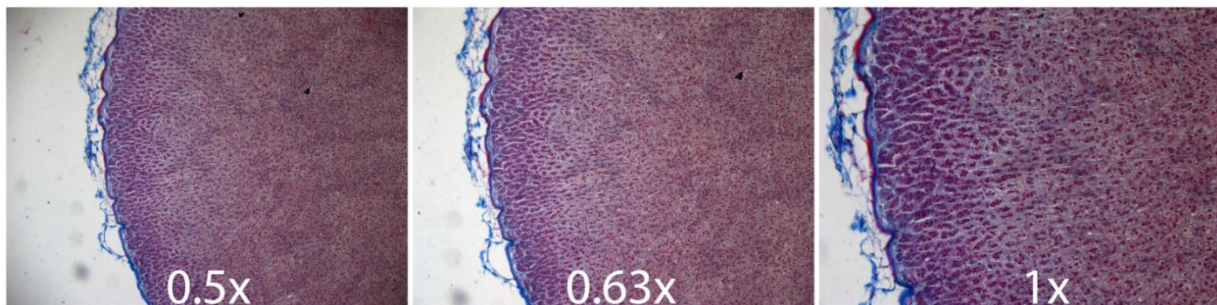
As noted in the image below, due to the 40x magnification of the objective, when a 0.5x coupler is used, there is very little noticeable vignetting. However, when a 10x objective is used, the vignetting in the corners becomes more apparent with a 0.5x coupler. This can be seen in the below image.

(Continue to next page for image.)



Variation of Coupler Magnification with 40x Objective and INFINITY3-3URC Camera with 2/3" Sensor

These images demonstrate how the rule of thumb is applied to a 2/3" image sensor. It is clear that a 0.63x magnification gives the largest field of view without vignetting. Consideration of the application and most used objective(s) should dictate coupler selection as wider fields of view may be possible with couplers having lower magnification, generating slight or acceptable levels of vignetting.



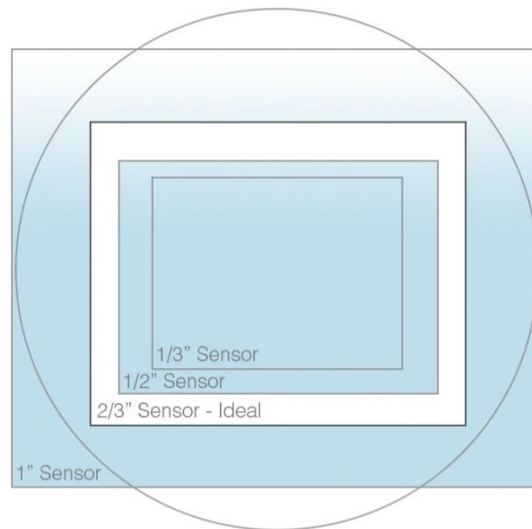
Variation of Coupler Magnification with 40x Objective and INFINITY3-3URC Camera

As indicated on the back page of Lumenera's [INFINITY product brochure](#), Lumenera recommends a coupler for each of our cameras. This recommendation is a guideline based on the general rule of thumb mentioned above and will help to ensure proper illumination across the entire field of view. You may need more specific advice based on your application, in which case, we recommend using the formula above or speaking to your microscope vendor.

If vignetting isn't an issue for your application, and you desire a field of view that is as large as possible, you can achieve this by reducing the magnification of your coupler from what is recommended for your camera.

Additionally, higher-end microscopes with larger field numbers can accommodate couplers with lower magnification than the general rule of thumb or the recommended coupler magnification.

0.67X Coupler



Every scenario is unique, and this article is meant to provide a general understanding of the relationship between the field numbers (FN), the sensor format, and the coupler's magnification. If you are still unsure on which coupler size you need, we encourage you to direct any questions to your microscope vendor or to the Lumenera Technical Assistance Center (TAC) team for further assistance with selecting a coupler for your INFINITY Camera.

Additional Third Party Resources: [Nikon's MicroscopyU Interactive Simulator](#)