Tube Lens Selection for Widefield Calcium Imaging

Mursel Karadas

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Based on your sensor specifications and desired field of view (FOV), here is the calculation for tube lens selection.

System Parameters

Parameter	Value
Camera	Allied Vision GT2750 (Sony ICX694)
Sensor size	12.5 mm × 10.0 mm
Pixel size	4.54 µm
Objective	Nikon Nikkor 50mm f/1.2
Objective focal length (f_{obj})	50 mm
Target FOV	~4 mm (horizontal)

> **i** Note
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> In widefield calcium imaging setups (e.g. the COSMOS macroscope), camera lenses like the Nikkor 50mm f/1.2 are frequently repurposed as objectives by mounting them in reverse or utilizing their infinity space.

Calculation

The magnification of an infinity-corrected system is determined by the ratio of the tube lens focal length (f_{tube}) to the objective focal length (f_{obj}):

$$M = \frac{f_{tube}}{f_{obj}}$$

The field of view is given by the sensor size divided by the magnification:

$$\text{FOV} = \frac{\text{Sensor Size}}{M} = \frac{\text{Sensor Size} \times f_{obj}}{f_{tube}}$$

Rearranging to solve for the required tube lens focal length:

$$f_{tube} = \frac{\text{Sensor Size} \times f_{obj}}{\text{FOV}}$$

Plugging in values (horizontal sensor dimension = 12.5 mm, target FOV = 4 mm):

$$f_{tube} = \frac{12.5\text{ mm} \times 50\text{ mm}}{4\text{ mm}} = \frac{625}{4} = \mathbf{156.25\text{ mm}}$$

Recommended Tube Lens

You need a tube lens with a focal length of approximately **150–160 mm**.

Tube lens	Magnification	Horizontal FOV
150 mm	$150/50 = 3\times$	$12.5/3 \approx$ **4.17 mm** ✓
160 mm	$160/50 = 3.2\times$	$12.5/3.2 \approx$ **3.91 mm** ✓
200 mm (Thorlabs/Olympus standard)	$4\times$	≈ 3.1 mm — too small

> Recommendation
>
> A **150 mm** achromatic doublet gives ~4.17 mm FOV — closest to the 4 mm target and the mathematically direct solution.

Implementation Notes

Lens selection

Look for an achromatic doublet with $f = 150$ mm or 160 mm and a clear aperture of at least 25–30 mm to avoid vignetting at f/1.2. Suitable sources: Thorlabs, Edmund Optics, or surplus telephoto lenses (135 mm, 180 mm) adapted to your mount.

Infinity space

Since the Nikkor 50mm acts as an infinity-corrected objective, ensure sufficient distance between the back of the Nikkor and the tube lens to accommodate excitation/emission filters and a dichroic mirror in the collimated beam path.

Working distance

The Nikkor 50mm f/1.2 in this reversed configuration typically gives a working distance of ~15–20 mm — suitable for mouse cortex imaging through a cranial window with standard widefield GCaMP setups.

Conclusion

Select a **150 mm** tube lens for a ~4.2 mm FOV, or a **160 mm** lens for ~3.9 mm FOV. Both satisfy the 4 mm target; the 150 mm is the closer match.