

PHOTONICS spectra

WHITE PAPERS & APPLICATION NOTES



1. In vivo imaging in the NIR-II range

In vivo molecular imaging in pre-clinical animal models is key to a better understanding of physiological mechanisms. Over the past decades, fluorescence in the 1st biological window (NIR-I) range, 700-900 nm, has been widely used to this purpose. NIR-I fluorescence penetration is larger than that of visible light thanks to reduced absorption and scattering [1, 2] (Figure 1A). However, in this range of wavelengths the image resolution and sensitivity are poor for signals deeper than a few millimeters. This is partly due to the poor penetration of the fluorescence excitation wavelength (typically 500 nm).

Imaging further into the infrared, in the second biological window, has several advantages [1]:

1. NIR-II excitation can be excited with NIR-I wavelengths which have optimal penetration (Figure 1B).
2. Scattering and absorption is low in the second biological window (Figure 1A).
3. Tissue autofluorescence is low which enables improved signal to background ratios.

As a result, NIR-II imaging (1000-1700 nm) yields better spatial resolution, penetration depth and contrast than visible or NIR-I fluorescence. It is becoming a key player in pre-clinical [3] and clinical research [4].

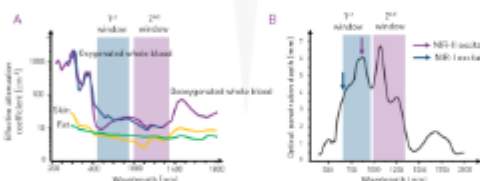


Figure 1. (A) Optical windows in biological tissues. (B) 1st and second infrared windows. The absorption and scattering from blood and tissues are minimized, hence enabling light to penetrate more easily. (C) Absorption spectra for imaging in the first and second windows, arrows point to the wavelengths typically used for excitation.

It has been shown that some of the contrast agents used in NIR-I imaging have an emission tail in the NIR-II range which can be exploited (Figure 2B). In the case of Indocyanine Green (ICG), a biocompatible and FDA approved contrast agent, commonly used for both NIR-I and NIR-II fluorescence imaging [5].

In vivo NIR-II Small Animal Imaging with C-RED 2 InGaAs Camera

C-RED 2 is a highly sensitive InGaAs camera which can be cooled down to -40°C for optimal performances, making it a great choice for fluorescence imaging in the NIR-II range. An experiment in a pre-clinical imaging context was performed to dynamically map the in vivo biodistribution of Indocyanine Green (ICG) in a nude mouse. High quality dynamic imaging of physiological processes was enabled by the high sensitivity of the camera.

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