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Penetration Depths Limits of In Vivo Confocal Reflectance Imaging

Smithpeter C, Dunn A, Welch A.J, Richards-Kortum R; Appl Opt. May 1998; 37(13): 2749-54.

ABSTRACT

We present experiments to predict the maximum penetration depth at which typical biological structures in amelanotic tissue can be detected with confocal microscopy. The detected signal is examined as the signal source strength (index of refraction mismatch), the source depth, and the medium scattering coefficient are varied. The detected background produced by scattering outside the focal volume is examined as the medium scattering coefficient, the depth in the medium, the dimensionless pinhole radius, $nu(p)$, and the shape of the scattering phase function are varied. When the system approaches ideal confocal performance ($nu(p) \gg 3$), the penetration depth is limited by the signal-to-noise ratio to approximately 3-4 optical depths (OD's) for a 0.05 index mismatch. As $nu(p)$ increases to 8, the penetration depth is limited by the signal-to-background ratio and is dependent on the scattering coefficient. At $\mu(s) = 100 \text{ cm}^{-1}$ ($l(s) = 100 \text{ }\mu\text{m}$) and an index mismatch of 0.05, the maximum penetration depth is approximately 2 OD.