

# FIELD CURVATURE COMPENSATION FOR THREE-DIMENSIONAL RECONSTRUCTION OF CHROMATIC CONFOCAL MICROSCOPY IMAGES

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## 1. ABSTRACT

The chromatic confocal microscopy has a capability of parallel depth scanning by focusing different wavelengths of the incident broadband light source to different axial position through intentionally generated axial chromatic aberration and by spectrum analysis of light reflected from the sample. It is thought of as a promising technique to improve the measurement speed of confocal scanning microscopy because axial depth scanning is realized without mechanical translation [1][2]. As the raster point beam scanning popularly used for lateral scanning of confocal microscopy is accompanied with the change of light incident angle to the objective lens, the field curvature effect caused by this scanning angle should be considered and compensated to correctly reconstruct three-dimensional images. In conventional confocal laser scanning microscopy, consideration of the field curvature effect in only one focal plane is generally sufficient because plane-by-plane images are stacked for three-dimensional reconstruction which is done by translating the objective lens or the sample itself. However, when the point beam scanning is combined with the chromatic depth scanning to achieve three-dimensional measurement, the field curvature effect should be considered at successive planes which are axially distributed as a function of wavelength. In this research, the field curvature effect and the compensation of it in beam scanning chromatic confocal microscopy is investigated both theoretically and experimentally.

## 2. RESULTS

The chromatic confocal microscopy with the lateral point beam scanning is constructed for three-dimensional surface measurement. The chromatic depth scanning range and the depth resolution is characterized to specify the performance of this imaging system. To investigate the field curvature effect, the relationship between wavelength and its correspondent depth at different lateral scanning angles is numerically estimated and experimentally verified. The method to compensate this field curvature effect is proposed, and three-dimensionally reconstructed images are compared before and after the field curvature compensation. The results show that the field curvature effect is more serious in the beam scanning chromatic confocal microscopy especially for imaging large field of view or depth range, and the compensation of it is essential to reconstruct the correct three-dimensional surface images. The three-dimensional images acquired by the beam scanning chromatic confocal microscopy and those by a commercial laser scanning confocal microscope are also compared to demonstrate the imaging capability.

[1] A. K. Ruprecht, T. F. Wiesendanger, and H. J. Tiziani, "Chromatic confocal microscopy with a finite pinhole size," *Optics Letters*, **29**, 2130-2132 (2004).

[2] K. Shi, P. Li, S. Yin, and Z. Liu, "Chromatic confocal microscopy using supercontinuum light," *Optics Express*, **12**, 2096-2101 (2004).