

## Dissertation Abstract

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Dissertation title	<p style="text-align: center;"><b>Evaluation of short-term growth dynamics of plant under the influence of growth hormones using optical interferometry</b></p> <p style="text-align: center;">(干渉法を用いた植物成長ホルモン影響下の植物の極短時間成長動態の評価)</p>		
<p>Statistical interferometric technique (SIT) is a highly sensitive, high speed non-contact, and non-destructive optical technique developed by our group capable of measuring instantaneous sub-nanometer displacements. SIT applied to plant leaf elongation revealed nanometric intrinsic fluctuations (NIF) that are robust and sensitive to variations in the environment making NIF as a measure of healthiness of the plants. In this study, exogenous plant hormones, auxin (2,4-dichlorophenoxyacetic acid- 2,4-D), and gibberellic acid (GA<sub>3</sub>), along with an auxin transport inhibitor 2,3,5-triiodobenzoic acid-TIBA, that affect plant growth were used to investigate their effects on NIF. Rice (<i>Oriza sativa</i>) seedlings were used, and their roots were exposed to 1, 2, and 4 μM 2,4-D, and the auxin transport inhibitor, TIBA, of 10, and 20 μM for 22 hours and GA<sub>3</sub> solution of different concentrations of 10, 40, and 100 μM for 5 hours. Results showed significant increment in NIF for 1μM and reduction for 4 μM 2,4-D while application of both 10, and 20 μM TIBA led to reduction in NIF. On the other hand, significant increment in NIF for 40 μM, and a significant reduction at a higher concentration of 100 μM for five hours of GA<sub>3</sub> were also observed in comparison to those of control. Our results indicate that NIF as revealed by SIT could show both the positive and negative effects depending on the concentration of exogenous hormones, and transport inhibitors. Results suggest that SIT could be a valuable tool being sensitive enough to speedily assess the effects of plant growth hormones.</p> <p>Optical coherence tomography (OCT) as a label free imaging modality has been extensively used in conducting microstructural analysis in biomedicine. However, its application in the study of plant physiology has thus far been limited. In this study, we demonstrate the potential of applying speckles obtained as noise in OCT images to monitor short term activity changes during foliar application of phytohormones to plant leaves. Chinese chives were used as the sample. Plant growth hormone gibberellic acid (GA<sub>3</sub>) was sprayed onto the leaf and OCT images were recorded at 10 fps over a period of 60 sec. Biospeckle OCT (bOCT) images were calculated with OCT images to characterize the changes due to the application of GA<sub>3</sub>. Different concentrations of GA<sub>3</sub>, namely 0, 40, and 100 μM were used. While 40 μM application of GA<sub>3</sub> failing to produce differences in OCT structural images, bOCT speckle contrast images could show clear difference in internal layer structures, thus, making bOCT as a viable technique to investigate the immediate effects of exogenous agents onto plants. Further, quantitative analyses across the selected mesophyll layer showed significant reduction in speckle contrast suggesting for local adaptation to agent at faster time scales of within an hour. Demonstration of OCT utilizing the speckles could become a promising tool in monitoring of environment or chemically induced structural organizations as well as the functional characteristics in plant botany and plant physiology.</p>			