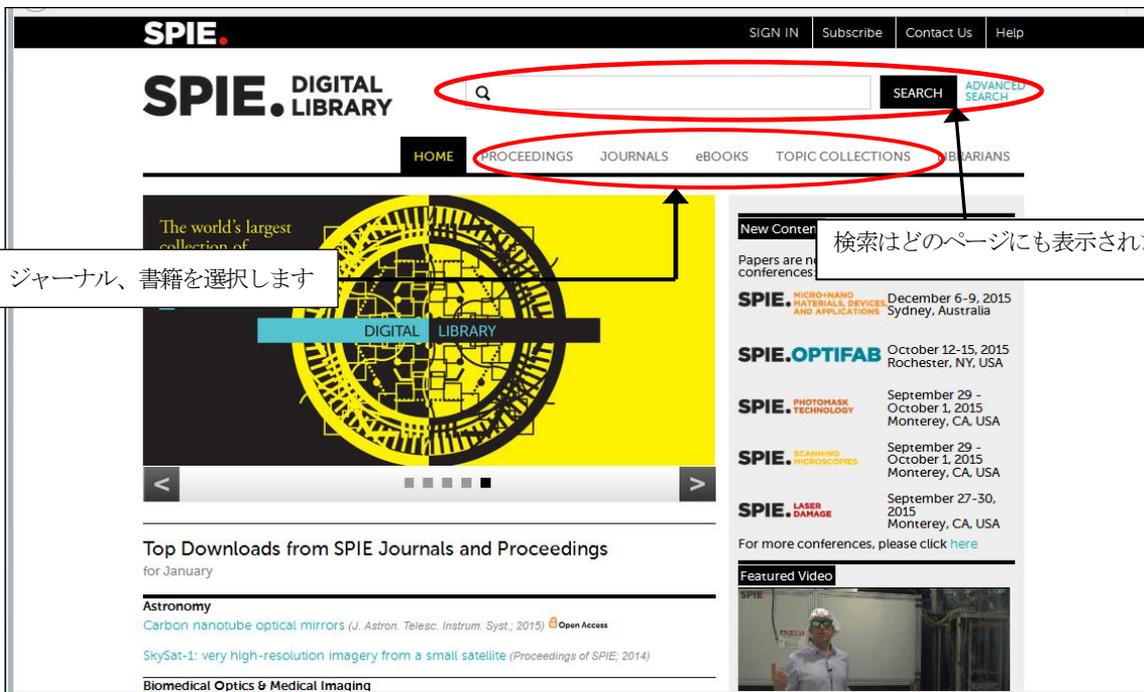


## SPIE Digital Library クイックガイド

### 1. アクセス

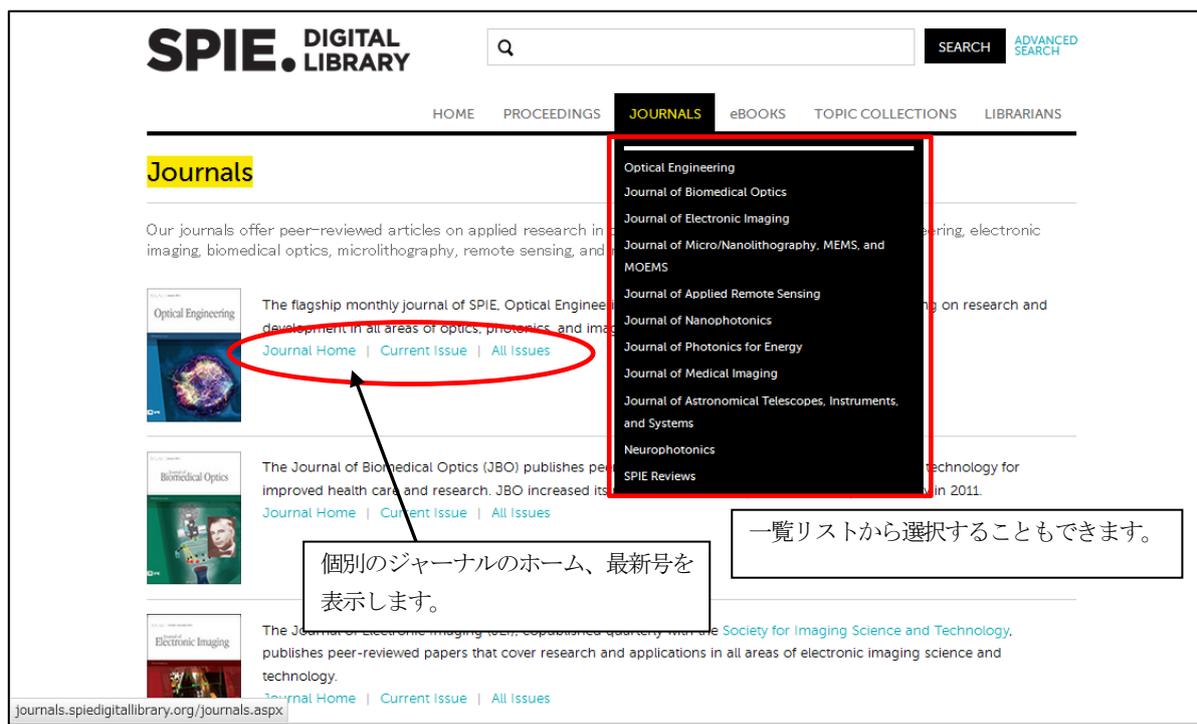
<http://spiedigitallibrary.org/>



Digital Library ホーム

### 2. ジャーナルコンテンツへのアクセス

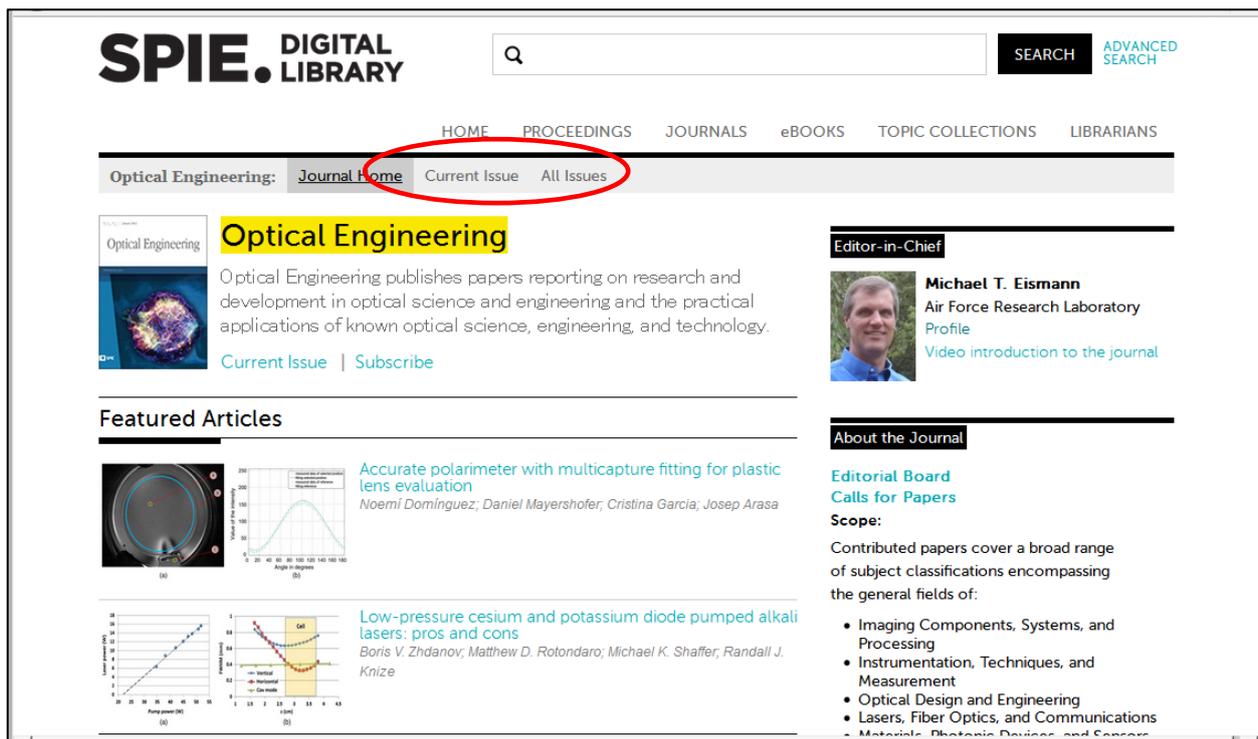
ホームのジャーナルをクリックすると、ジャーナル一覧を表示します。



Journal 一覧ページ

★ジャーナル個別のホームページ

特定のジャーナルタイトルをクリックすると、ジャーナルのホームページを表示します。



Optical Engineering ホーム

★目次 (Table of Contents) の表示

Current Issue を選択すると、最新号の目次を表示します。



★記事の表示 (HTML & PDF 全文)

目次から標題をクリックすると、その記事の HTML 形式で全文を表示します。

PDF をクリックすると、PDF での全文を表示します。Share は、Facebook などの SNS サービスでシェアします。Get Citation は、書誌情報を文献管理ツールに取り込みます。

Related Content は、この記事に関連のあるコンテンツを雑誌、会議録、電子書籍から検索して表示します。

本文のセクションにジャンプします。

HTML 表示画面

Optical Engineering 54(1), 013105 (January 2015)

## Artificial target detection with a hyperspectral LiDAR over 26-h measurement

Eetu Puttonen,<sup>1,2,3\*</sup> Teemu Hakala,<sup>2</sup> Olli Nevalainen,<sup>2</sup> Sanna Kaasalainen,<sup>2</sup> Anssi Krooks,<sup>2</sup> Mika Karjalainen,<sup>1,2</sup> and Kati Anttila<sup>1,2</sup>

<sup>1</sup>Finnish Geodetic Institute, Department of Remote Sensing and Photogrammetry, Geodeetinrinne 2, Masala FI-02431, Finland  
<sup>2</sup>Finnish Geodetic Institute, Centre of Excellence in Laser Scanning Research, Geodeetinrinne 2, Masala FI-02431, Finland  
<sup>3</sup>Finnish Meteorological Institute, Department of Meteorological Research, Erik Palménin aukio 1, Helsinki FI-00560, Finland

**Abstract.** Laser scanning systems that simultaneously measure multiple wavelength reflectances integrate the strengths of active spectral imaging and accurate range measuring. The Finnish Geodetic Institute hyperspectral lidar system is one of these. The system was tested in an outdoor experiment for detecting man-made targets from natural ones based on their spectral response. The targets were three camouflage nets with different structures and coloring. Their spectral responses were compared against those of a Silver birch (*Betula pendula*), Scots pine shoots (*Pinus sylvestris* L.), and a goat willow (*Salix caprea*). Responses from an aggregate clay block and a plastic chair were used as man-made comparison targets. The novelty component of the experiment was the 26-h-long measurement that covered both day and night times. The targets were classified with 80.9% overall accuracy in a dataset collected during dark. Reflectances of four wavelengths located around the 700 nm, the so-called red edge, were used as classification features. The addition of spatial aggregation within a 5-cm neighborhood improved the accuracy to 92.3%. Similar results were obtained using a set of four vegetation indices (78.9% and 91.0%, respectively). The temporal variation of vegetation classes was detected to differ from those in man-made classes. © The Authors. Published by SPIE under a Creative Commons Attribution 3.0 Unported License. Distribution or reproduction of this work in whole or in part requires full attribution of the original publication, including its DOI: [DOI: 10.1117/1.OE.54.1.013105]

Keywords: lidar; hyperspectral; spectroscopy; laser applications.  
 Paper 141348 received Aug. 27, 2014; accepted for publication Dec. 19, 2014; published online Jan. 23, 2015.

### 1 Introduction

#### 1.1 Background

Over the previous decade, new studies have begun to discuss the convergence of two popular and well-established remote sensing techniques, namely spectral imaging and light detection and ranging (LiDAR). Both techniques are being used in a wide range of different remote sensing applications. However, they both have limitations that prevent their effective use in all measurement settings. Spectral imaging systems use passive sensors that depend on external lighting sources, thus making a measurement setting sensitive to forest and land class recognition from airborne data.<sup>3-9</sup> The results of these studies have shown a clear trend in improving overall classification accuracies over single-sensor results.<sup>3,8,9</sup> Additionally, forest studies have moved from overall forest type mapping to tree species level. Classification can be carried out even for individual tree crowns in the most optimal cases.<sup>4</sup> Some data fusion studies have also been carried out at ground level.<sup>10</sup> In these studies, the viewing geometry causes extra complications with passive imaging sensors: abrupt changes in lighting and shadows make accurate radiometric calibration of spectral data challenging, if not outright impossible. However, even with

PDF 全文表示

★図 (Figure) の表示 (HTML 全文)

図をクリックすると、拡大表示できます。

vegetation indices (78.9% and 91.0%, respectively). The temporal variation of vegetation classes was detected to differ from those in man-made classes.

Save Figure | Download Slide (.ppt) | Print

Top view of the scan area

LECA block  
Birch, stem  
Birch, canopy  
Pine shoots  
Willow stems  
Camo 1  
Chair  
Camo 2  
Camo 3

(a) (b)

本文中の図や表は、拡大表示できます。 PowerPoint のファイルとしてダウンロードも可能です。

★レファレンスリンク

HTML もしくは PDF 形式での全文記事の参考文献 (References) リストからその電子ジャーナルの記事にリンクできます。 CrossRef の表示があれば他の出版社の記事へリンクして表示します (全文表示には別途アクセス権が必要な場合があります)。

References

Abstract | Introduction | Equipment | 24-h Experiment Setting | Data Processing | Results | Discussion | Conclusions | Acknowledgments | Reference

例: 1 件目の CrossRef をクリックすると、その電子ジャーナル (Remote Sensing) の記事を表示します。

- 1 Kaasalainen S. et al., "Radiometric calibration of terrestrial laser scanners with external reference targets," Remote Sens., 1, (3), 144 –158 (2009). 2072-4292 **CrossRef**
- 2 Ahokas E., "Aspects of radiometric calibration related to the Finnish Geodetic Institute's laser scanning data," Geosci. Remote Sens. Lett., 10, (2), 103-106 (2013).
- 3 Dalponte M., Bruzzone L., "Remote sensing data fusion for forest classification," Geosci. Remote Sens. Lett., 10, (2), 103-106 (2013).
- 4 Alonzo M., Bookchin N., "Hyperspectral and lidar data fusion for forest classification," Geosci. Remote Sens. Lett., 10, (2), 103-106 (2013).
- 5 Anderson J. E. et al., "Assessing the impact of disturbance and climate change on the temperate mixed hardwood forest," Remote Sens. Environ., 115, (12), 2853-2863 (2011).

Remote Sensing

Remote Sens. 2009, 1(3), 144-158; doi:10.3390/rs1030144

Article

**Radiometric Calibration of Terrestrial Laser Scanners with External Reference Targets**

Sanna Kaasalainen \*✉, Anssi Krooks ✉, Antero Kukko ✉ and Harri Kaartinen ✉

Department of Remote Sensing and Photogrammetry, Finnish Geodetic Institute, Geodeetinrinne 2, 02431 Masala, Finland

\* Author to whom correspondence should be addressed.

Received: 2 June 2009 / Revised: 29 June 2009 / Accepted: 3 July 2009 / Published: 3 July 2009

View Full-Text | Download PDF [481 KB, uploaded 19 June 2014] | Browse Figures

**Abstract**

The intensity data produced by terrestrial laser scanners has become a topic of increasing interest in the remote sensing community. We present a case study of radiometric calibration for two phase-shift continuous wave (CW) terrestrial scanners and discuss some major issues in correcting and applying the intensity data, and a practical calibration scheme based on external reference targets. There are differences in the operation of detectors of different (although similar type) instruments, and the detector effects must be known in order to calibrate the intensity data into values representing the target reflectance. It is, therefore, important that the effects of distance and target reflectance on the recorded intensity are carefully studied before using the intensity data from any terrestrial laser scanner.

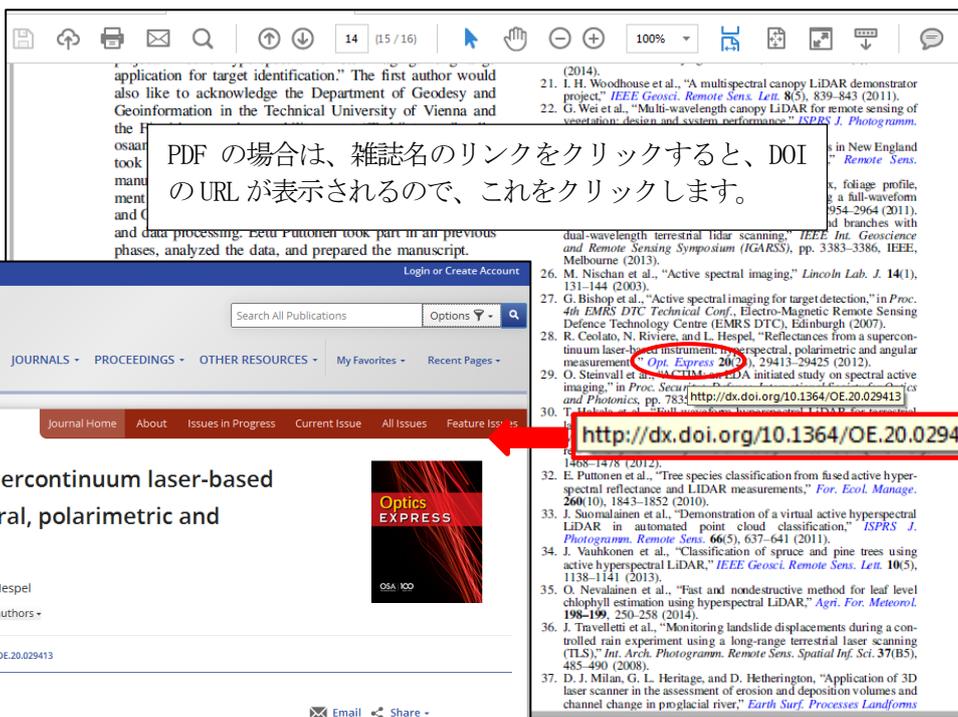
Special Issue

New Sensors, Multi-Sensor Integration, Large Volumes: New Opportunities and Challenges in Forest Fire Research

Guest Editors  
Prof. Diófantos Hadjimitsis  
Prof. Ioannis Gitas  
Prof. Luigi Boschetti  
Dr. Kyriacos Themistoclous

Deadline  
31 July 2016

Reference 一覧画面



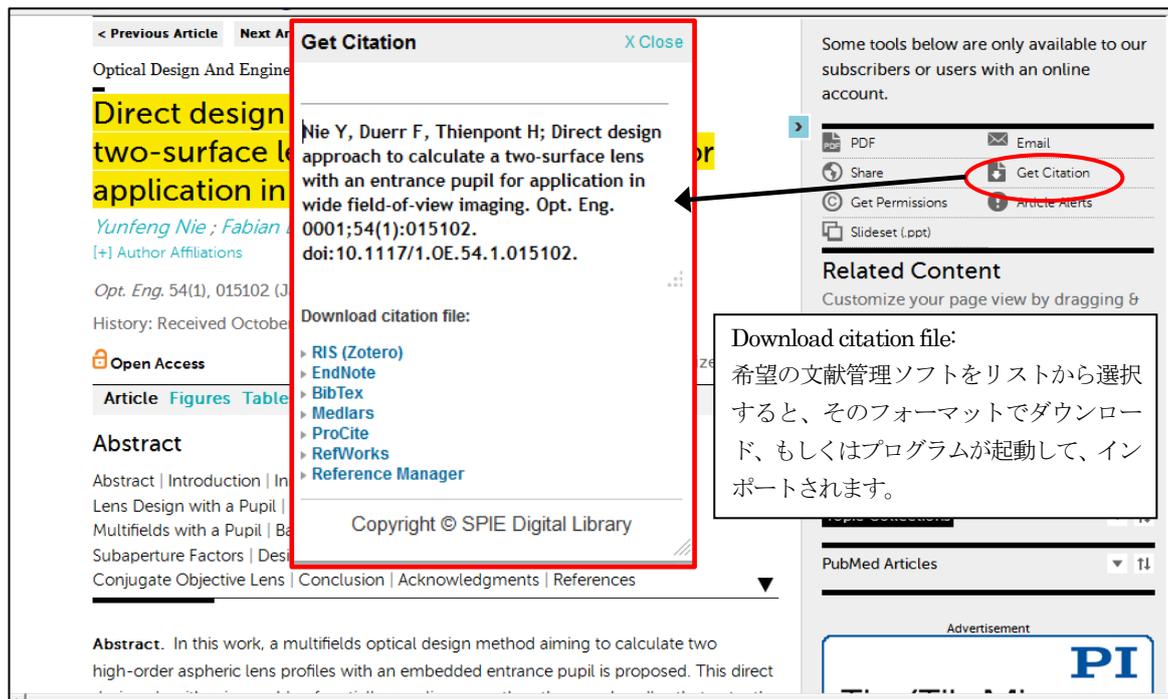
★バックナンバーへのアクセス

バックナンバーは、All Issues のリンクをクリックします。刊行済みの巻号が一覧表示されます。



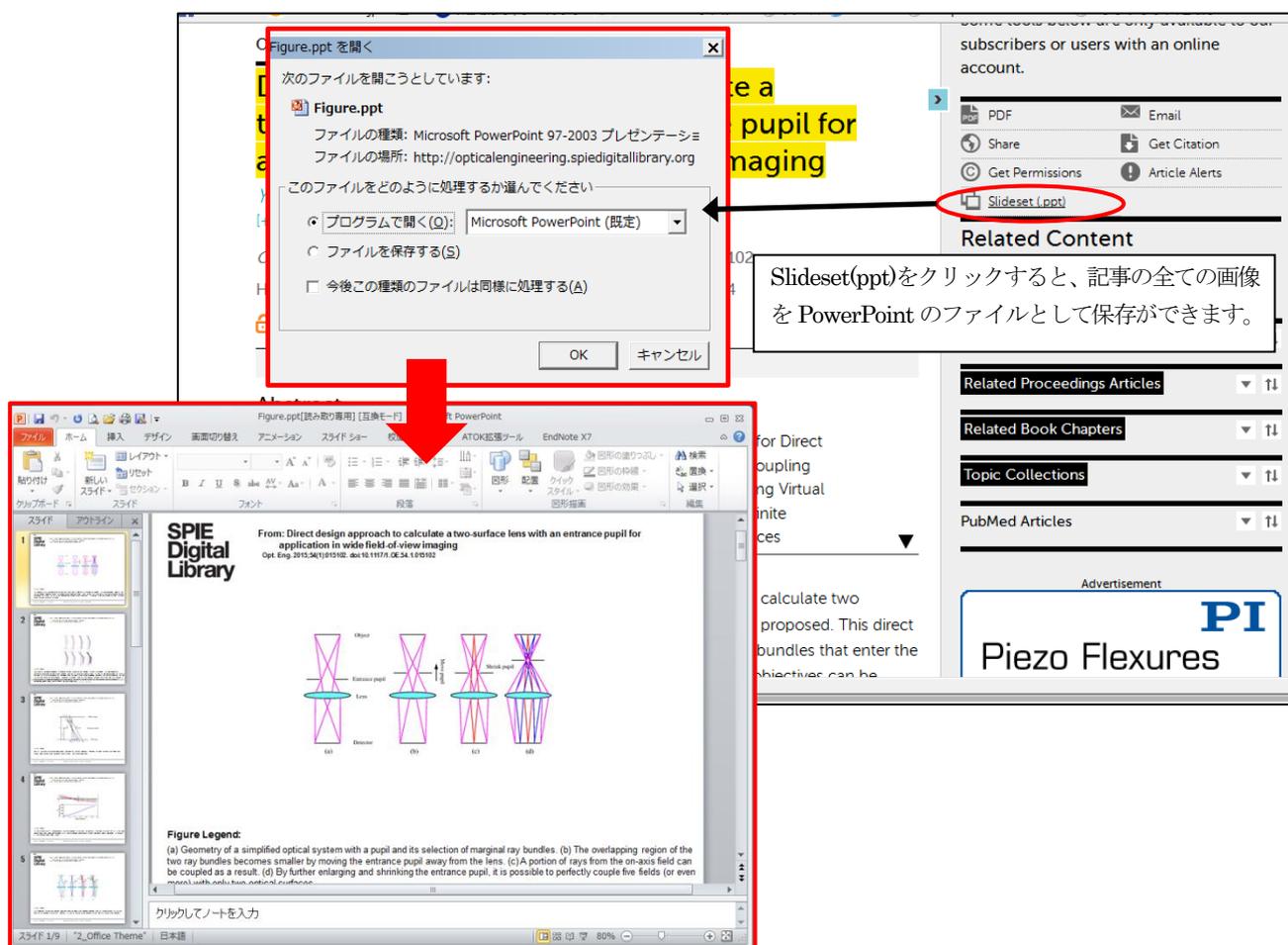
### ★文献管理ソフト (EndNote など) への取り込み

記事の書誌情報を文献管理ソフト (EndNote など) に取り込むことができます。HTML 全文ページから、右側にある Get Citation をクリックすると、ポップアップウィンドウで選択した記事とダウンロードするフォーマット (文献管理ソフト名) の選択画面になります。



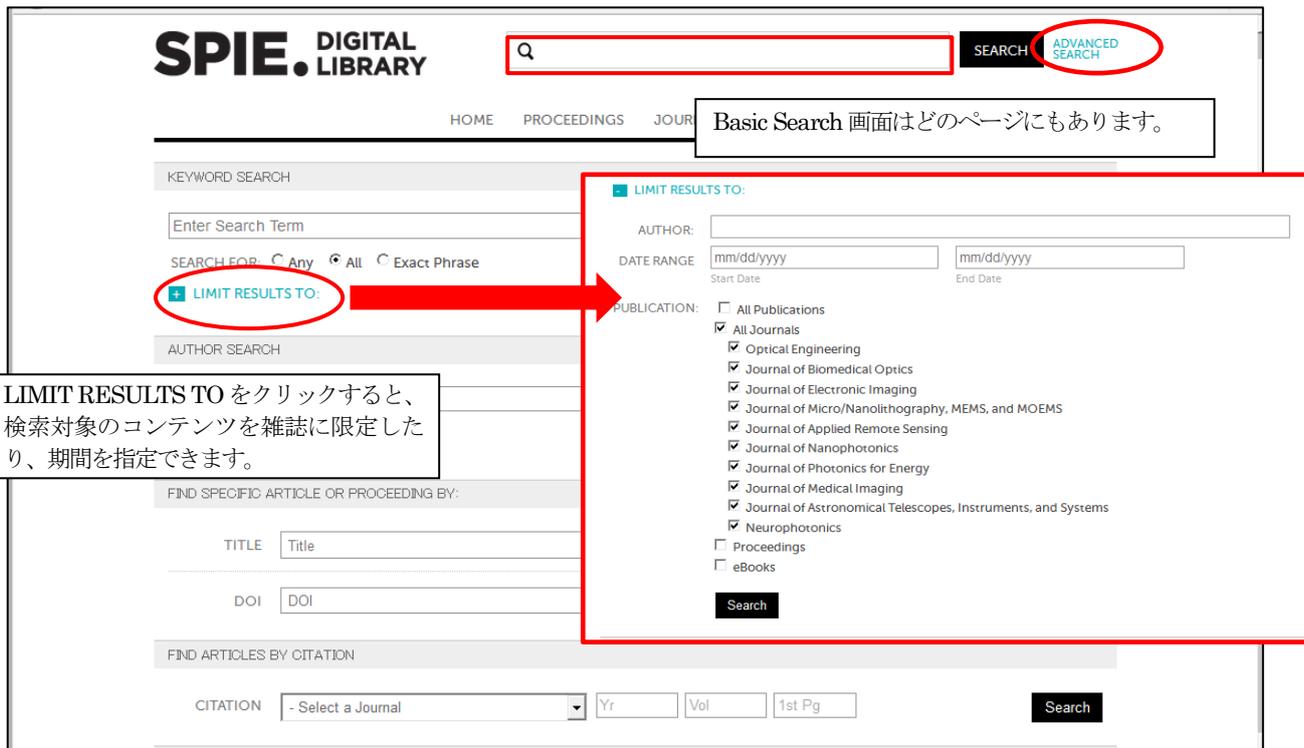
### ★図・表・写真などの PowerPoint スライド一括保存

記事中の図・表や画像情報を PowerPoint のスライドとして一括保存ができます。



### 3. 記事の検索

検索画面は、どのページにも表示されます。Advanced Search のリンクをクリックすると、Advanced Search 画面を表示します。



Advanced Search 検索画面



検索結果一覧表示画面 (検索例 : solid state laser)