PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 8336

, "Front Matter: Volume 8336," Proc. SPIE 8336, Integrated Modeling of Complex Optomechanical Systems, 833601 (7 December 2011); doi: 10.1117/12.920466

SPIE.

Event: Integrated Modeling of Complex Optomechanical Systems, 2011, Kiruna, Sweden

PROCEEDINGS OF SPIE

Integrated Modeling of Complex Optomechanical Systems

Torben Andersen

Anita Enmark

Editors

15–17 August 2011

Kiruna, Sweden

Organized by

SRT, Division of Space Technology, Luleå University of Technology (Sweden)

Lund Observatory, Lund University (Sweden)

Published by

SPIE

Volume 8336

Proceedings of SPIE, 0277-786X, v. 8336

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

The papers included in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. The papers published in these proceedings reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from this book:

Author(s), "Title of Paper," in *Integrated Modeling of Complex Optomechanical Systems*, edited by Torben Andersen, Anita Enmark, Proceedings of SPIE Vol. 8336 (SPIE, Bellingham, WA, 2011) Article CID Number.

ISSN 0277-786X
ISBN 9780819489937

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA
Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445
SPIE.org

Copyright © 2011, Society of Photo-Optical Instrumentation Engineers

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/11/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.

SPIE
Digital Library

SPIDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc.

The CID number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

Contents

vii	<i>Conference Committee</i>
ix	<i>Introduction</i>
xi	<i>Conference Photo</i>

SESSION 1 INTRODUCTION

- 8336 02 **A perspective on modeling and simulation of complex dynamical systems** [8336-30]
K. J. Åström, Lund Univ. (Sweden)

SESSION 2 LARGE TELESCOPE PROJECTS: MODELING STATUS I

- 8336 03 **Systems modeling in the design and verification of the James Webb Space Telescope** [8336-14]
D. M. Muheim, M. T. Menzel, NASA Goddard Space Flight Ctr. (United States)
- 8336 04 **Opto-mechanical modeling of the Herschel Space Telescope at ESA/ESTEC** [8336-19]
S. Fransen, D. Doyle, European Space Agency (Netherlands); B. Catanzaro, CFE Services (United States)

SESSION 3 LARGE TELESCOPE PROJECTS: MODELING STATUS II

- 8336 05 **Integrated modeling and systems engineering for the Thirty Meter Telescope** [8336-37]
G. Z. Angeli, K. Vogiatzis, Thirty Meter Telescope Observatory (United States);
D. MacMynowski, California Institute of Technology (United States); B.-J. Seo, C. Nissly,
M. Troy, Jet Propulsion Lab. (United States); M. Cho, National Optical Astronomy
Observatory (United States)
- 8336 06 **E-ELT modeling and simulation toolkits: philosophy and progress status** [8336-09]
B. Sedghi, M. Müller, H. Bonnet, M. Esselborn, M. Le Louarn, R. Clare, F. Koch, European
Southern Observatory (Germany)

SESSION 4 LARGE TELESCOPE PROJECTS: MODELING STATUS III

- 8336 07 **Modeling and analysis of ring telescope** [8336-16]
Y. Dai, J. Lin, Yunnan Astronomical Observatory (China)

- 8336 08 **Pointing stability and image quality of the SOFIA Airborne Telescope during initial science missions** [8336-21]
U. Lampater, Univ. of Stuttgart (Germany) and NASA Dryden Flight Research Ctr. (United States); P. Keas, Moog CSA Engineering (United States); R. Brewster, NASA Ames Research Ctr. (United States); T. Herter, Cornell Univ. (United States); J. Wolf, E. Pfüller, M. Wiedemann, Univ. of Stuttgart (Germany) and NASA Ames Research Ctr. (United States); S. Teufel, Univ. of Stuttgart (Germany) and NASA Dryden Flight Research Ctr. (United States); F. Harms, Kayser-Threde GmbH (Germany); H. Jakob, Univ. of Stuttgart (Germany) and NASA Dryden Flight Research Ctr. (United States); H.-P. Röser, Univ. of Stuttgart (Germany)
- 8336 09 **Simulation of Chinese Giant Solar Telescope** [8336-24]
Z. Liu, Z. Jin, Yunnan Astronomical Observatory (China)

SESSION 5 INTEGRATED MODELS I

- 8336 0A **NRCIM integrated opto-mechanical analysis toolset for the Thirty Meter Telescope** [8336-01]
S. Roberts, National Research Council Canada (Canada)
- 8336 0B **High fidelity optical modeling for the TMT** [8336-36]
C. Nissly, B.-J. Seo, M. Troy, Jet Propulsion Lab. (United States) and California Institute of Technology (United States); G. Angeli, Thirty Meter Telescope Observatory (United States); M. Cho, National Optical Astronomy Observatory (United States); B. Ellerbroek, Thirty Meter Telescope Observatory (United States); P. Piatrou, Univ. of California, Irvine (United States); L. C. Roberts, Jr., J. C. Shelton, Jet Propulsion Lab. (United States) and California Institute of Technology (United States); L. Wang, Thirty Meter Telescope Observatory (United States)
- 8336 0C **Aero-thermal modeling framework for TMT** [8336-10]
K. Vogiatzis, Thirty Meter Telescope Observatory Corp. (United States)
- 8336 0D **Dynamical simulation of E-ELT segmented primary mirror** [8336-07]
B. Sedghi, M. Müller, B. Bauvir, European Southern Observatory (Germany)

SESSION 6 INTEGRATED MODELS II

- 8336 0E **Optical integrated modeling activities for the James Webb Space Telescope (JWST)** [8336-33]
J. M. Howard, NASA Goddard Space Flight Ctr. (United States)
- 8336 0F **Modeling and verification of the diffraction-limited visible light telescope aboard the solar observing satellite HINODE** [8336-35]
Y. Katsukawa, Y. Suematsu, S. Tsuneta, National Astronomical Observatory of Japan (Japan); K. Ichimoto, Kwasan and Hida Observatory (Japan); T. Shimizu, ISAS/JAXA (Japan)
- 8336 0G **Performance simulations for the conceptual design of the European Solar Telescope (EST)** [8336-06]
L. Cavaller, GRANTECAN S.A. (Spain); M. Collados, Instituto de Astrofísica de Canarias (Spain); J. Castro, GRANTECAN S.A. (Spain)

- 8336 OH **The optimization of the opto-mechanical performance of the mirror segments for the E-ELT** [8336-28]
J. Nijenhuis, R. Hamelinck, TNO (Netherlands)
- 8336 OI **The simulation of the local seeing in segments active alignment** [8336-17]
S. Yuan, J. Lin, Yunnan Astronomical Observatory (China)

SESSION 7 INTEGRATED MODELS III

- 8336 OJ **Integrated model of the Carina Telescope** [8336-40]
A. Enmark, Luleå Univ. of Technology (Sweden); T. Andersen, M. Owner-Petersen, Lund Observatory (Sweden); R. Chakraborty, A. Labeyrie, Collège de France (France)
- 8336 OK **ATST enclosure mechanical and thermal models** [8336-12]
G. Murga, AEC IDOM (United States); H. Marshall, L. Phelps, AURA (United States); A. Hervás, I. Larracochea, AEC IDOM (United States)
- 8336 OL **Integrated modeling analysis of a novel hexapod and its application in active surface** [8336-26]
D. Yang, Nanjing Institute of Astronomical Optics & Technology (China); L. Zago, Univ. of Applied Sciences of Western Switzerland (Switzerland); H. Li, Nanjing Institute of Astronomical Optics & Technology (China) and Graduate Univ. of Chinese Academy of Science (China); G. Lambert, Univ. of Applied Sciences of Western Switzerland (Switzerland); G. Zhou, G. Li, Nanjing Institute of Astronomical Optics & Technology (China)
- 8336 OM **Track creep: experience, modeling efforts, and consequences of work done at the 100 meter Green Bank Telescope** [8336-04]
D. Egan, National Radio Astronomy Observatory (United States)

SESSION 8 INTEGRATED MODELS IV

- 8336 ON **Integrated modeling of a laboratory setup for a large deformable mirror** [8336-11]
R. Heimsten, T. Andersen, M. Owner-Petersen, Lund Observatory, Lund Univ. (Sweden); D. G. MacMynowski, California Institute of Technology (United States)
- 8336 OO **Local effects on E-ELT global performance: two examples for requirement verification** [8336-08]
B. Sedghi, M. Müller, F. Koch, L. Pettazzi, European Southern Observatory (Germany)
- 8336 OP **E-ELT active optics system modeling and performance evaluation** [8336-20]
H. Bonnet, M. Esselborn, M. Müller, B. Sedghi, F. Koch, European Southern Observatory (Germany)

SESSION 9 CONTROL SYSTEM RELATED MODELING

- 8336 OQ **Model-based wavefront control for CCAT** [8336-31]
D. Redding, J. Z. Lou, A. Kissil, M. Bradford, Jet Propulsion Lab. (United States); S. Padin, D. Woody, California Institute of Technology (United States)

- 8336 OR **Control system modeling for the Thirty Meter Telescope primary mirror** [8336-02]
D. G. MacMynowski, California Institute of Technology (United States); P. M. Thompson, Systems Technology, Inc (United States); J. C. Shelton, L. C. Roberts, Jr., M. M. Colavita, Jet Propulsion Lab. (United States); M. J. Sirota, Thirty Meter Telescope Project (United States)
- 8336 OS **Modeling of the SOFIA secondary mirror controller** [8336-15]
A. Reinacher, Univ. of Stuttgart (Germany) and NASA Dryden Flight Research Ctr. (United States); H.-P. Roeser, Univ. of Stuttgart (Germany)
- 8336 OT **Alignment estimation and control of the James Webb Space Telescope mirrors using decomposition of an influence matrix** [8336-32]
S. Shiri, J. M. Howard, D. L. Aronstein, NASA Goddard Space Flight Ctr. (United States)

SESSION 10 THERMAL MODELING

- 8336 OU **A dynamic thermal model for design and control of an 800-element open-air radio telescope** [8336-13]
M. Bremer, A. Greve, IRAM-Domaine Univ. de Grenoble (France)
- 8336 OV **Thermal modeling of the TMT Telescope** [8336-18]
M. Cho, National Optical Astronomy Observatory (United States); A. Corredor, Univ. of Arizona (United States); K. Vogiatzis, G. Angeli, California Institute of Technology (United States)
- 8336 OW **Integration of a thermo-structural analysis with an optical model for PEPSI polarimeter** [8336-03]
I. Di Varano, K. G. Strassmeier, I. Ilyin, M. Woche, Leibniz Institut für Astrophysik Potsdam (Germany); H. J. Kaercher, MT Mechatronics (Germany)
- 8336 OX **Athermal design of the optical tube assemblies for the ESO VLT Four Laser Guidestar Facility** [8336-27]
R. Henselmans, D. Nijkerk, M. Lemmen, F. Kamphues, TNO (Netherlands)

SESSION 11 SIMULATION TECHNIQUES

- 8336 OY **Parallel-computing architecture for JWST wavefront-sensing and integrated modeling** [8336-38]
J. S. Smith, B. H. Dean, A. Rilee, T. P. Zielinski, NASA Goddard Space Flight Ctr. (United States)
- 8336 OZ **The experience of GPU calculations at Lunarc** [8336-23]
A. Sjöström, J. Lindemann, Lund Univ. (Sweden); R. Church, Lund Observatory, Lund Univ. (Sweden)
- 8336 IO **Transitioning a message passing interface wavefront sensor model to a graphics processor environment** [8336-25]
M. T. Browne, R. Miceli, National Univ. of Ireland, Galway (Ireland)

Author Index

Conference Committee

Conference Chairs

Torben Andersen, Lund University (Sweden)

Anita Enmark, Luleå University of Technology (Sweden)

Program Committee

George Angeli, Thirty Meter Telescope Project (United States)

Thomas Gustafsson, Luleå University of Technology (Sweden)

Mike Lieber, Ball Aerospace & Technologies Corporation (United States)

Danniella Muheim, NASA (United States)

David Redding, Jet Propulsion Laboratory (United States)

Babak Sedghi, European Southern Observatory (Germany)

Session Chairs

- 1 Introduction
Anita Enmark, Luleå University of Technology (Sweden)
- 2 Large Telescope Projects: Modeling Status I
David Redding, Jet Propulsion Laboratory (United States)
- 3 Large Telescope Projects: Modeling Status II
Scott Roberts, National Research Council (Canada)
- 4 Large Telescope Projects: Modeling Status III
George Angeli, Thirty Meter Telescope Observatory (United States)
- 5 Integrated Models I
Danniella Muheim, NASA (United States)
- 6 Integrated Models II
Matt Johns, Giant Magellan Telescope Organization (United States)
- 7 Integrated Models III
Sebastiaan Fransen, European Space Agency (Netherlands)
- 8 Integrated Models IV
Torben Andersen, Lund University (Sweden)

- 9 Control System Related Modeling
Babak Sedghi, European Southern Observatory (Germany)
- 10 Thermal Modeling
Doug MacMynowski, Thirty Meter Telescope Observatory (United States)
- 11 Simulation Techniques
Zhong Liu, Yunnan Astronomical Observatory (China)

Introduction

Mathematical modeling and performance simulation are playing an increasing role in large, high-technology projects. There are two reasons; first, projects are now larger than they were before, and the high cost calls for detailed performance prediction before construction. Second, in particular for space-related designs, it is often difficult to test systems under realistic conditions beforehand, and mathematical modeling is then needed to verify in advance that a system will work as planned.

Computers have become much more powerful, permitting calculations that were not possible before. At the same time mathematical tools have been further developed and found acceptance in the community. Particular progress has been made in the fields of structural mechanics, optics and control engineering, where new methods have gained importance over the last few decades. Also, methods for combining optical, structural and control system models into global models have found widespread use. Such combined models are usually called *integrated models* and were the subject of this symposium.

The objective was to bring together people working in the fields of ground-based optical telescopes, ground-based radio telescopes, and space telescopes. We succeeded in doing so and had 39 interesting presentations and many fruitful discussions during coffee and lunch breaks and social arrangements. We are grateful that so many top ranked specialists found their way to Kiruna and we believe that these proceedings will prove valuable during much future work.

Torben Andersen
Anita Enmark

1. Joseph Howard	23. Carl Nissly	43. Claude Aime
2. Zhang Liu	24. Douglas MacMynowski	44. Babak Sedghi
3. Dennis Egan	25. David Redding	45. Michael Esselborn
4. Andreas Reinacher	26. Jean-Tristan Buey	46. Teodora A. Viera Curbelo
5. Michael Browne	27. Heather Marshall	47. Hilton Lewis
6. Mark Sheehan	28. Danniella Muheim	48. Konstantinos Vogiatzis
7. Ibon Larracoechea Zuluaga	29. Igon Di Varano	49. Mark Sirota
8. Sara Powell	30. Jan Nijenhuis	50. Byoung-Joon Seo
9. Young-Soo Kim	31. George Angeli	51. Mette Owner-Petersen
10. Gaizka Murga Llano	32. Jens Bormann	52. Javier Castro López-Tarruella
11. Mikael Helgesson		
	33. Ulrich Lampater	
	34. Dehua Yang	
	35. Behrouz Afzalifar	
	36. Zhenyu Jin	
	37. Rens Henselmans	
	38. Yukio Katsukawa	
	39. Scott Roberts	
	40. Yichun Dai	
	41. Arne Ardeberg	
	42. Michael Bremer	