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Advanced Optical and Mechanical Technologies in Telescopes and Instrumentation

Eli Atad-Ettedgui
Dietrich Lemke
Editors

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Introduction

This conference, hosted in sunny and hot Marseille, gave an opportunity and a forum for opto-mechanical engineers and scientists to present and discuss the state-of-the-art technologies in astronomical telescopes and instrumentation. The topics covered were: optical fabrication, materials, segment mirror technologies, test and metrology, atmospheric compensation and adaptive optics, telescope structure and active instruments, cryogenic space and ground-based instrumentation, innovations in spectroscopy, optical fibers, and coatings and filters. The good response to the call for papers (205 papers) resulted in oral presentations from Monday morning until Saturday evening, and in a large number of poster presentations (about 40% of all papers).

In optical fabrication, we are looking at a revolution in technologies used in polishing and testing lightweight mirrors with extreme aspheric surfaces (up to 14-mm asphericity). Computer generated holograms (CGH) and laser trackers are currently used to test those challenging components. A 4-m F/1 Zerodur aspherical mirror (1-mm asphericity) was manufactured with a 25nm rms WFE across the full clear aperture. The optical design of the new generation of survey and giant telescopes such as the E-ELT, the TMT or the GMT require very large and very fast mirrors. Moreover, the making of these telescopes relies on mastering major design and technological challenges, one of which is the production of giant primary mirrors (with up to thousands of large segmented mirrors of 1- to 2-m size) which need to be reliably pipeline manufactured and tested over several years. The primary blank for a large telescope of today can now only serve as a secondary to these future giants.

In materials, we are also looking at a mini revolution with the introduction of novel materials (Al-Be) and the improvement of existing materials (Zerodur, SiC) for mirrors. Although Zerodur was considered to be outdated already at past conferences, its superior qualities in polishing, transparent testing, and CTE still give it a future. New are optical materials with a high degree of homogeneity for very large lenses (N-BK7/LLF1...) used in field correctors and atmospheric dispersion correction.

The situation is similarly challenging for space-based astronomy. Due to the limited transportation volume and mass, large space telescopes need highly reliable deployment mechanisms combined with sensors and actuators for their figuring, all to be operated in the space cryo-vacuum as well as under laboratory conditions. Space focal plane instruments combine many observing modes in a very limited volume and therefore require a diversity of precise optical cryo-mechanisms to be operated with a minimum of power and to be rigid enough to survive the harsh rocket launch.

As we embarked on developing the structures and mechanisms for these sophisticated and ever more complex telescopes and their instrumentation, we examined the state-of-the-art, the lessons learned, the new tools available, and explore what may lie ahead for the future of this ever-growing area. Several of these talks were presented in a very exciting and entertaining style; in particular, the commissioning of the 11 m SALT telescope sounds like a detective story.

Innovations in spectroscopy are now almost ready to be implemented: massively replicated MEMS spectrograph, very large image slicers, introduction of volume phase holographic components at cryogenic temperatures, and multi-object spectroscopy using micromirror arrays. These techniques will be used in future large survey telescopes and instruments.

We extend special thanks to the program committee and presenters for their contributions and look forward to see you again in San Diego in 2010.

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Dietrich Lemke