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Report on the ESO workshop

AO4ELT8: First Edition of AO4ELT in Chile

held at Viña del Mar, Chile, 27–31 October 2025

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Adaptive optics is one of the major challenges that the future extremely large telescopes face, and it's essential to reach their scientific goals in terms of accuracy and sensitivity. It's crucial for the entire scientific community working on the topic to gather and share ideas about the latest advances in this field. This is achieved through the Adaptive Optics for Extremely Large Telescopes (AO4ELT) conference, which has been held every two years since 2009. After the success of the seventh AO4ELT conference organised by the Optics Department of ONERA (the French aerospace lab) and the Marseille Astrophysics Laboratory, the Optoelectronics Laboratory (OPTOLAB) and Pontifical Catholic University of Valparaiso (PUCV) have joined the AO4ELT organisation to host the eighth conference in the series (AO4ELT8). The event was held in the city of Viña del Mar, Chile, between 27 and 31 October 2025.

The eighth Adaptive Optics for Extremely Large Telescopes (AO4ELT8)$_1$ conference brought together international experts in adaptive optics (AO) to share advances supporting the upcoming generation of extremely large telescopes (ELTs), including ESO's Extremely Large Telescope (ESO's ELT), the Giant Magellan Telescope and the Thirty Meter Telescope. Held over five days, the programme consisted of plenary lectures, focused technical sessions and extensive poster presentations, reflecting both the rapid evolution and the interdisciplinary expansion of AO technologies.

The conference began with a broad view of "The Adaptive Optics Renaissance", highlighting how AO has become essential not only for ground-based astronomy but also for fields such as optical communication and defence. Subsequent plenaries addressed new wavefront-correction frontiers, cross-domain synergies and AO technologies poised to shape the next decade. Parallel sessions explored the most active domains in AO research. Key topics included the design status of major AO systems for first-light instruments at ESO's ELT (the High Angular Resolution Monolithic Optical and Near-infrared Integral field spectrograph [HARMONI], the Multi-AO IMaging Camera for Deep Observations [MICADO], the Mid-infrared ELT Imager and Spectrograph [METIS], the Multiconjugate adaptive Optics Relay For ELT Observations [MORFEO], the ArmazoNes high Dispersion Echelle Spectrograph [ANDES]), wavefront sensing and reconstruction, vibration mitigation, turbulence characterisation, and AO system control. Special attention was given to machine learning, with sessions dedicated to deep neural networks for wavefront reconstruction, predictive control, point spread function modelling and real-time telemetry analysis.

Figure 1. Conference photo

A strong emphasis was placed on pathfinder systems and testbeds, demonstrating the maturity of AO concepts ahead of implementation on ELT-scale platforms. Contributions showcased progress from major observatories such as Keck, Subaru, Gemini, ESO’s Very Large Telescope, and the Large Binocular Telescope, including on-sky demonstrations, laboratory validation and real-time control developments.

The conference featured more than 150 poster presentations, covering a diverse array of topics, including laser guide star systems, wavefront sensor prototypes, AO control architectures, atmospheric turbulence studies, high-contrast imaging methods and applications outside astronomy such as satellite communication and space surveillance. The poster sessions provided a complementary venue for detailed technical exchange and interdisciplinary discussion.

Over the week, some common themes emerged: AO systems for ELTs are reaching final design reviews; AI-driven approaches are transforming wavefront sensing and control; and integrated simulations are enabling more reliable performance prediction. Together, these developments highlight both the maturity and expanding scope of AO research showcased throughout AO4ELT8. The contributions demonstrated significant progress in AO system design for ELT-class instruments, the growing influence of machine learning across all aspects of AO operation, and the emergence of AO as a critical enabling technology beyond classical astronomy. As the extremely large telescopes approach first light, the field is undergoing rapid evolution and entering a phase of unprecedented capability, poised to deliver transformative scientific, technological and interdisciplinary impact.

Demographics

Like many workshops, the Scientific Organising Committee (SOC) sought fair representation from the community. To this end, we voted on 14 invited speakers, and four plenary sessions, using the sole criterion of who would give the best review of each topic. The result was a 71:29 ratio of male to female.

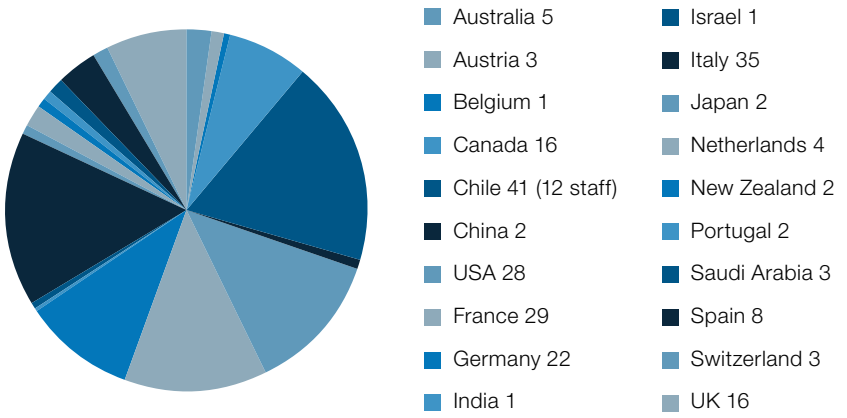

Figure 2. Number of participants per country.

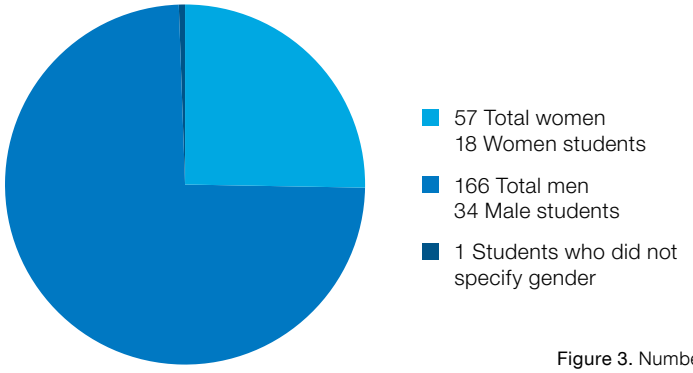

Figure 3. Number of participants by gender.

Attendees (Figure 1) came from five continents (all but Africa & Antarctica), the numbers as shown in Figure 2. The gender breakdown of participants is shown in Figure 2.

The talk selection was made blindly (one SOC member removed names and identifying information about the authors and then abstained from voting), so we conclude that the method likely worked to address gender biases. We also had a decent level of participation from young researchers, with around 24% of attendees being students. We also provided six student travel scholarships funded by OPTICA2.

The workshop had a high level of participation, with approximately 224 participants. We attribute this to both the compelling nature of the subject matter, which draws researchers at all career stages, and to the generous support that kept the cost of attendance relatively low.

Acknowledgements

We would like to express our sincere appreciation to all the sponsors whose support was essential to the realisation of this conference. Their generous contributions enabled the organisation of this event and facilitated the exchange of ideas and research within our community. We gratefully acknowledge their commitment and assistance.

Links

[1] Conference website: https://ao4elt8.pucv.cl/
[2] OPTICA website: https://www.optica.org/