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Report on the ESO workshop

# ExoELT-2025 Community Workshop: Planetary Formation & Exoplanets in the ELT Era

held at Headquarters, Garching, Germany, 17–21 November 2025

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**The ExoELT-2025 community workshop, held at ESO's headquarters in Garching, Germany, in November 2025, brought together more than 170 participants to review the scientific readiness of ESO's Extremely Large Telescope (ELT) for studies of planet formation and exoplanets ahead of its first light by the end of this decade. The workshop presented the status and performance of the ELT and its instruments and discussed key science cases, ranging from planet-forming discs and protoplanets to exoplanet demographics and atmospheric characterisation. The unique capabilities of the ELT as regards spatial resolution, sensitivity and instrument versatility were highlighted, together with strong synergies with existing and future ground- and space-based facilities. The workshop fostered community coordination, promoted early-career researchers and identified priorities and challenges for maximisng the scientific return of the ELT.**

## Motivations

Understanding how giant and rocky planets form and evolve, their internal structure and that of their atmosphere, represents one of the major challenges of modern astronomy, directly linked to the ultimate search for life by 2040. In 2029, ESO's Extremely Large Telescope (ELT) will collect its first light from the sky. The high angular resolution and the huge collecting capacity combined with the extreme sensitivity of the instruments will allow unprecedented observations of regions of planet formation and exoplanetary systems. In light of this, the ESO community has developed a key expertise in the study of the initial conditions of planet formation, the search for exoplanets, the atmospheric characterisation of giant and rocky exoplanets and the search for biomarkers. This community includes various international laboratories and scientists who are also heavily involved at a technical and scientific level in the construction, scientific preparation and operation of instruments for the ELT and who have the opportunity to play a key role in ensuring a global return and shared success in the exploitation of the ELT.

In this context, the ExoELT-2025 community workshop[1] "Planetary Formation and Exoplanets in the ELT era" was held at ESO's headquarters in Garching, Germany, from 17 to 21 November 2025. The workshop attracted about 170 participants (Figure 1) with three main objectives:

– informing the ESO community about the status, schedule, modes and performances of the ELT and its suite of instruments (the Multiconjugate adaptive Optics Relay For ELT Observations [MORFEO], the Multi-AO Imaging Camera for Deep Observations [MICADO], the High Angular Resolution Monolithic Optical and Near-infrared Integral field spectrograph [HARMONI], the Mid-infrared ELT Imager and Spectrograph [METIS], the ArmazoNes high Dispersion Echelle Spectrograph [ANDES] and the planetary camera and spectrograph [PCS]) with specific interests in this science theme,
– presenting and revisiting together the science that will be addressed by the ELT, the scientific cases, samples, strategies of observation, calibration, data analysis and interpretation tools of the programmes dedicated to the study of planet formation and exoplanets,
– fostering collaboration and synergy within the community to harmonise our efforts, tools and strategies for the preparatory work on the ELT programmes dedicated to this topic within the framework of the guaranteed time and the open time. This includes in particular work on source selection, simulation and data analysis tools and calibrations, preparatory observations involving different observational techniques and also synergies between our programmes and those of of ground-based observatories and space missions (the Atacama Large Millimeter/submillimeter Array [ALMA], Gaia, the Very Large Telescope Interferometer [VLT/I-2030], JWST, the PLAnetary Transits and Oscillations of stars [PLATO] spacecraft, the Atmospheric Remote-sensing Infrared Exoplanet Large survey [ARIEL] spacecraft, the Nancy Grace Roman Space Telescope [Roman], the Square Kilometre Array, etc.). The key is to optimise the scientific return for our community and our observation programmes in guaranteed and open time on the ELT.

## Demographics and remote access

The workshop aimed to attract young students while actively promoting gender equity and enhancing the visibility of junior researchers through opportunities such as contributed and review talks. Particular emphasis was placed on fostering scientific exchange by encouraging questions and answers, stimulating open discussions and creating meaningful social interactions throughout the event. To ensure broad participation and accessibility, remote attendance was made possible via MS Teams, with Slido enabling interactive Q&A sessions and Slack supporting continuous communication and collaboration among participants. These objectives are clearly reflected in the distribution of registered participants, as shown in Figure 2, as well as in the overall structure of the workshop programme, and represent a significant success for the organisers.

## Summaries of sessions

The first session of the workshop was dedicated to presenting the current status of the ELT project, including updates on the construction site, the dome and telescope assembly, and the procurement and delivery of key opto-mechanical components. An overview of the current schedule leading to the ELT's first light in 2029 was also provided. This was followed by a presentation on the implementation of the new operational scheme at ESO and Paranal, aimed at fully integrating the ELT into observatory operations in the coming years. The session continued with status updates and key science drivers presented by the instrument consortia focused on planet formation and exoplanet science. These presentations covered the full suite of ELT instruments, beginning with MICADO and METIS, followed by HARMONI, MORFEO, and ANDES, and concluding with PCS. The second session concluded with a series of synergy talks highlighting the

Figure 1. ExoELT-2025 community workshop participants.

complementarity between the ELT science drivers and existing and future facilities, including the VLT/VLTI, ALMA, and space missions such as Gaia and JWST, as well as upcoming missions like PLATO, ARIEL, and the coronagraph instrument on Roman.

The third and fourth scientific sessions addressed key astrophysical questions related to planet formation. They began with studies of the evolution and chemistry of planet-forming discs, progressed to the physical processes driving planet formation and then focused on disc substructures and the detection and characterisation of protoplanets. The unique capabilities of the ELT, particularly its unprecedented spatial resolution that will enable access to planet-forming regions within 10 au, its high sensitivity and the versatility of its instrumentation in terms of wavelength coverage, spectral resolution, and observing modes, were highlighted as transformative. These capabilities will enable detailed exploration of the links between circumstellar discs and their environments, extend our understanding of the demographics of disc substructures across different star-forming regions and down to lower stellar masses and allowing the physics of accretion and the formation of young planets to be probed while they are still embedded in their natal environments.

The fifth session of the workshop took a complementary perspective by exploring instrumental solutions, performance improvements and synergies aimed at maximising the scientific exploitation of the ELT. Topics ranged from recent developments at the VLTI, including the GRAVITY+ project, to the latest performance assessments of the high-contrast imaging modes of the METIS and MICADO first-light instruments. The session also covered emerging technologies such as photonic lanterns and interferometric nullers, which could pave the way for future observing modes and instruments on the ELT. This session concluded with a hands-on tutorial attended by more than 50 participants, during which ELT observations were simulated using the Python-based ScopeSim[2] tool.

The sixth session reviewed the current state of the art in exoplanet demographics, drawing on population studies based on transit and radial-velocity surveys at short orbital separations, complemented by direct-imaging surveys probing separations beyond 10 au. These results highlighted a critical gap in parameter space between 1 and 10 au, a region where the ELT is expected to provide a decisive breakthrough and substantially advance our understanding of planetary system architectures. In particular, the ELT will be uniquely suited to explore planet–disc and planet–planet interactions, as well as the morphology and mineralogy of debris discs in the near- and mid-infrared, a strong synergy with ALMA observations.

The seventh and eighth sessions focused on the transformative impact the ELT is expected to deliver even at first light with MICADO, METIS, and HARMONI to study the physics of exoplantary atmospheres. These instruments will enable detailed studies of the composition and dynamics of the atmospheres of close-in hot Jupiters, as well as temperate and cooler giant and sub-Jovian planets beyond the snow line, providing key insights into the processes governing exoplanet formation and evolution. Beyond the first generation of instruments, ANDES and PCS are expected to detect and characterise temperate terrestrial planets and to offer the first clues regarding the presence of conditions favourable for the emergence of life. The challenges associated with defining the most suitable target samples, optimising observing strategies and advancing theoretical and interpretative models were discussed in detail. Particular emphasis was placed on the importance of strong synergies with future space missions such as the Habitable Worlds Observatory (HWO) and the Large Interferometer for Exoplanets (LIFE), highlight-

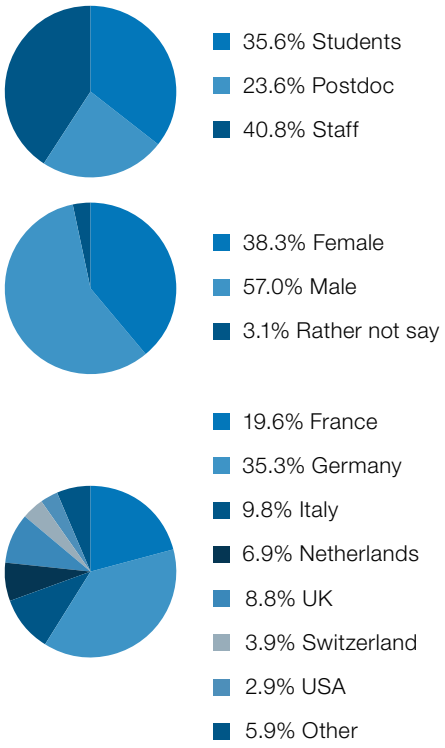


**Figure 2.** ExoELT 2025 Workshop participant demographics in terms of career, gender and nationality.

ing how coordinated ground- and space-based observations will be essential to fully exploit the scientific potential of the ELT and to achieve a comprehensive characterisation of exoplanetary systems.

## Conclusions & perspectives

The ExoELT-2025 community workshop provided an excellent opportunity to bring together the community interested in the study of planet formation and exoplanets and to take stock of the current status of the ELT and its suite of instruments while placing them within a broader context of synergies with existing and forthcoming ground-based facilities and space missions. The workshop offered a comprehensive overview of key scientific themes and outstanding questions in the field, and helped identify the major challenges and priorities for the coming years. All presentations have been made available to the community[3]. In addition, the workshop played an important role in raising awareness among a large fraction of early-career participants of the future challenges and opportunities that the ELT will offer for exoplanet and planet-formation studies. Feedback collected through a short post-workshop survey was overwhelmingly positive, as regards both the scientific content and the overall organisation of the event. Participants expressed a strong interest in repeating this type of community workshop every three to four years, and suggested that future workshops include more hands-on and applied sessions focused on the preparation of observing programmes and proposal strategies in anticipation of the ELT's first light in 2029.

### Acknowledgements

We would like to thank all participants for their active participation in the conference, which was crucial to making it such a success. We would further like to thank the members of our Scientific Organising Committee and Local Organising Committee for their fundamental and invaluable effort. We also thank ESO for funding the conference. A special thanks goes to Denisa Tako for her support with the organisational aspects of the conference.

### Links

[1] ExoELT-2025 webpage: https://www.eso.org/sci/meetings/2025/exo-elt.html
[2] Link to ScopeSim tool: https://scopesim.readthedocs.io/en/stable/
[3] Link to all presetnations on Zenodo: https://zenodo.org/communities/exoelt2025/

ESO/G. Vecchia

This drone image, taken in April 2026, shows a stunning view above the dome of ESO's Extremely Large Telescope (ELT), under construction atop Cerro Armazones, a mountain in Chile's Atacama Desert. The sliding doors are partially open, showing the top of the telescope's main structure inside. The catwalks running along the edges of the sliding doors convey the sheer size of the 80-m high dome.