

Issue 3 - January 2026

THE **WST** *CHRONICLE*

Pushing the Boundaries of Spectroscopic Surveys



MOS Positioners

**Interviews with
R. Ellis & A. Puglisi**

**Exoplanets, stars,
and the Milky Way**

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Cover image: JWST's image scene of star birth in Pismis 24, a young star cluster (Credit: Image: NASA, ESA, CSA, STScI; Image Processing: Alyssa Pagan—STScI). The WST will play a transformational role in the study of star formation.

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International Day of Women and Girls in Science

February 11 marks the International Day of Women and Girls in Science (womeninscienceday.org), a global celebration of women's contributions to science and an opportunity to reflect on inclusion and representation. On this day, several WST members will take part in outreach activities aimed primarily at elementary and middle school students. Organised by local and national institutions, these activities span both in-person and online formats.

Our WST colleagues will share experiences from their own careers, highlight the technological and scientific advances that keep them motivated and in awe of our Universe, and showcase hands-on demonstrations of emerging technologies being developed for future facilities such as the WST. Reaching the next generation through a diversity of role models is a crucial step toward greater inclusion in science, but retention remains a major challenge, and this day also offers space to reflect on how to address it.

The broader WST community is warmly invited to share information about the activities they will be participating in via this short anonymous form: tinyurl.com/5ynhn2kw

COORDINATOR MESSAGE

As this third issue of the *Chronicle* is also the first of 2026, it offers a perfect opportunity to look back at 2025 and consider what lies ahead. The past year has indeed been very fruitful across all aspects of the project—science, technology, as well as organisation and communication. What began a few years ago as an idea, even a dream, has now blossomed into a project with international recognition. Several indicators illustrate this progress: the science team has now grown to more than 800 members; external institutes from ESO member states outside the EU collaboration are ready to engage in the project if it is approved by ESO; and several non-member states—in addition to Australia, already an active consortium member—have expressed strong interest and are developing plans to potentially join as partners and contribute additional expertise and funding (Canada, Chile, India).

The science team has undertaken a significant reshaping of the science cases initially presented in the first version of the white paper¹. By incorporating new ideas and emphasising what will be truly transformational in the 2040s, a revised science case is now emerging. This work will be the subject of future publications and will form the basis of our ESO proposal in 2027. Our response to the ESO call for short white papers was particularly impressive, resulting in 65 proposals spanning almost all fields of astrophysics and submitted to the ESO senior committee. This breadth clearly demonstrates both the richness of the WST science case and its potential impact on astrophysics in the 2040s. In 2026, we will continue this effort by producing source catalogues and using the soon-to-be-released Exposure Time Calculator and Survey Simulator to obtain quantitative predictions and develop a first global survey plan.

Following last year's key milestone—the selection of the reference optical design for the telescope—we will carry out similar trade-offs for the instrument designs and select reference designs for further development. A first iteration with industry will allow us to assess both cost and feasibility, in particular for the



manufacturing of series of complex opto-mechanical systems such as spectrographs and detectors.

The year 2026 will also be marked by several major milestones: site pre-selection; a decision on the implementation of ground-layer adaptive optics for the IFS; the launch of a new website; the submission of a letter of intent in response to the ESO call; the development of the facility operating model and science data flow; and an assessment of sustainability and innovative solutions to reduce WST's environmental impact. A few initiatives from the Equity, Diversity, and Inclusion (EDI) group are also planned.

2026 will undoubtedly be a busy year. The busy week planned in June will provide a unique opportunity for a large fraction of the consortium to meet and exchange, and further meetings with the broader community are planned at both national and international levels, including workshops for the French and UK communities and conferences such as EAS and SPIE. We look forward to seeing many of you at these major events.

Finally, I would like to sincerely thank all science team and consortium members for their enthusiastic and unflinching commitment to the project, carried out within a constructive and inclusive environment. I wish you and your loved ones a very successful and happy 2026!

Roland Bacon

¹ Mainieri, V. et al., 2024, arXiv:2403.05398

THE WST' SCIENTIFIC SYNERGIES

The case for a 10-m-class telescope dedicated to spectroscopic surveys is now firmly established and shared worldwide in the astronomical community. A facility like the WST will indeed fill a critical gap in the global astronomical infrastructure of the 2040s. The WST will deliver major scientific breakthroughs on its own, but its transformative power will rely also on strong synergies with other major astronomical facilities.

By delivering unprecedented spectroscopic mapping of the Universe, the WST will fundamentally reshape the scientific landscape and unlock entirely new discovery space for both current and future ground- and space-based observatories. Its surveys will not only maximise the scientific return of major facilities such as the ELT, Rubin/LSST, *Gaia*, *Euclid*, *Roman*, and SKAO, but will also enable science that is simply inaccessible without the WST. Below, we highlight several key examples of these powerful and far-reaching synergies (Fig. 1).

Understanding the assembly and accretion history of the Milky Way (MW) is a remarkable challenge, with major implications for the comprehension of galaxy formation and evolution in general. The ESA *Gaia* mission has been a game-changer, providing positions, distances, motions, and photometry of nearly two billion stars with unprecedented precision. The final *Gaia* data release is expected by the beginning of the next decade; however, even in the 2040s a major fraction of the stars with exquisite astrometry from *Gaia* will still miss the fundamental spectroscopic information providing detailed elemental abundances and radial velocities. Ongoing and upcoming imaging surveys with *Euclid*, Rubin/LSST, and *Roman* will extend the coverage of the Milky Way's stars beyond the *Gaia* faint limit. Spectroscopy with appropriate spectral resolution will remain fundamental in the 2040s to unlock the full scientific potential of these photometric and astrometric datasets. For example, the MW's stellar halo has been profoundly shaped by hierarchical formation, as ■■■

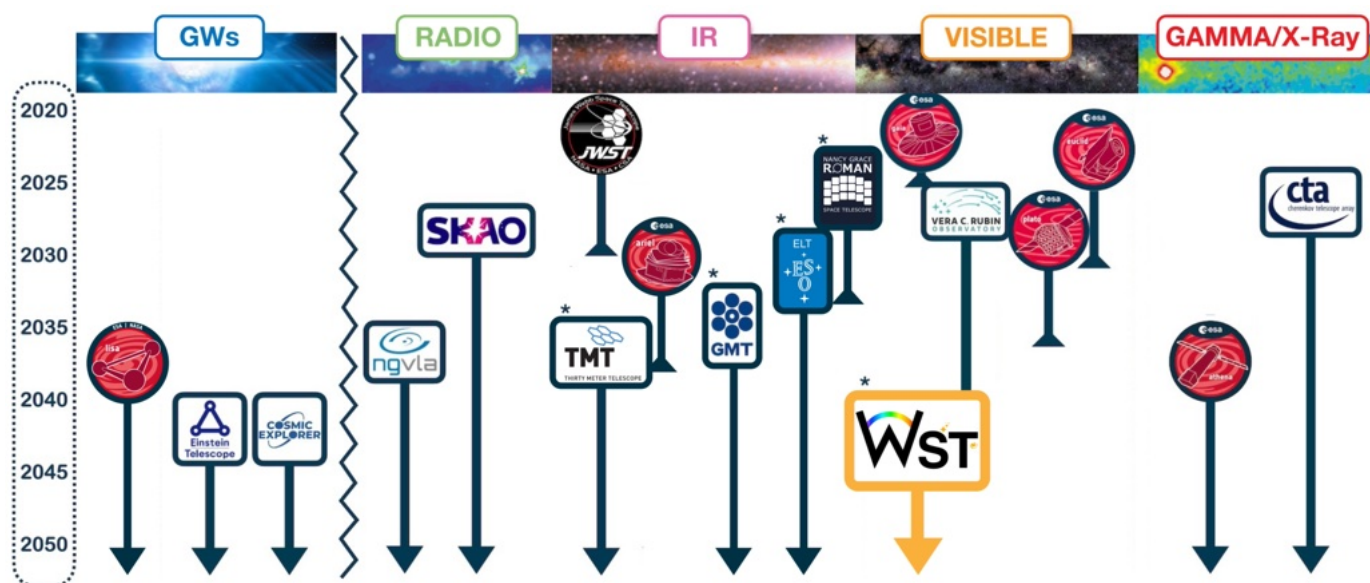


Figure 1. Graphical representation of the current and upcoming major astronomical facilities. For visual purposes, the facilities marked with an asterisk (e.g., ELT, TMT, GMT) have been listed in the spectral range they cover the most, although they also partly cover other bands. The duration of space missions reflects the publicly available nominal values. The WST will have strong synergies with many of those, filling in a gap in the current landscape. Credit background images: ESO/L. Calçada/M. Kornmesser; NASA Godard SFC.

■ ■ ■ revealed by the growing number of known accretion events uncovered over the past decades—many of them thanks to *Gaia*.

The WST's unique combination of $R=40,000$ spectral resolution, high-multiplexing, and large collecting area will enable chemodynamical identification of past accretion events. Distinguishing stars formed in situ and those formed in progenitor galaxies will unlock the MW's full formation history and, in turn, sharpen our understanding of how galaxies evolve.

Multi-messenger astronomy will be mainstream in the WST era, and entire facilities will be dedicated to rapidly evolving phenomena, spanning energy ranges from TeV (CTE) through μeV (SKAO). Next-generation gravitational wave observatories such as the Einstein Telescope, *Cosmic Explorer*, and ESA's LISA mission, along with astro-particle detectors like *IceCube* or *Antares*, will deliver real time, full-sky multi-messenger alerts. The WST's unmatched capability for time-resolved optical spectroscopy of many faint sources will render this facility truly irreplaceable. The third generation of Gravitational Wave (GW) detectors will provide unprecedented sensitivities to detect the signal from the final state of mergers in binary systems of neutron stars or black holes. The unique combination of field of view, sensitivity, and multiplexing of the WST will be crucial to detect and characterise the electromagnetic counterparts of such events (e.g., Bisero et al. 2025, *arXiv:2507.02055*). In addition, the WST spectroscopic surveys will reach significantly deeper in redshift and completeness than any facilities likely available in the 2040s, providing a key resource to exploit the GW events as dark sirens and put independent constraints on H_0 (e.g., ET Blue Book, *arXiv:2503.12263*).

The WST will have remarkable synergies with new radio facilities in the 2040s, such as the SKAO and the Next Generation Very Large Array (ngVLA). The two arrays of the SKAO will be in the southern hemisphere and will operate on a wide range of frequencies (50 MHz-15 GHz). The planned northern hemisphere ngVLA will additionally provide sensitive continuum and spectral imaging capabilities at

$\sim 1\text{--}116$ GHz down to equatorial and somewhat sub-equatorial fields also covered by the WST. The multi-object spectrograph (MOS) of the WST will be uniquely placed to understand the spectral properties and redshift distribution of the new population of sources that will be discovered with the SKAO and the ngVLA, therefore providing valuable information about large-scale structure formation, galaxy evolution, and the origin of the large-scale coherent magnetic fields in galaxies over cosmic time. Moreover, by cross-correlating the fluctuating 21-cm signal (as traced with the SKAO) at $z\sim 5\text{--}7$ with the large-scale distribution of galaxies in the same cosmic volumes (as traced with the WST-MOS), will it be possible to infer the role of different types of galaxies in the cosmic reionisation of the Universe, understanding the relative impact of the rare luminous or abundant sub-luminous sources, as well as active galactic nuclei.

The integral-field spectrograph (IFS) of the WST will provide the ionised gas phase kinematics of the interstellar medium of galaxies, complementing the neutral hydrogen component traced by SKAO. We will be able to obtain spatially resolved, multi-phase gas kinematics of a wide range of galaxies at various redshifts. This will be crucial to understand how gas flows into galaxies, is consumed by star formation and regulated by nuclear activity via feedback mechanisms, then further recycled into new stars, gaining in passing knowledge on how all these processes depend on galaxy properties and their environments.

Future X-ray missions, such as *NewAthena*, will characterise the hot circumgalactic medium surrounding galaxies in a wide redshift range. The IFS of the WST will be uniquely suited to complement the mapping of the ionised gas on similar scales, therefore providing the panoramic multi-phase view of the gas that is a key element to understand how baryons flow in and out galaxies—the so-called baryon cycle. ■

Come and meet us at the following meetings

French WST workshop	25-27 March 2026	Nice, France
EAS 2026	29 June - 3 July 2026	Lausanne, Switzerland
SPIE 2026	5-10 July 2026	Copenhagen, Denmark
UK WST workshop	14-16 December 2026	Cambridge, UK

Florentin Millour captured this breathtaking wide-field image of comet C/2024 G3 (3I/ATLAS) on January 21, 2025, from ESO's Paranal Observatory in Chile. The Very Large Telescope sits atop Cerro Paranal to the left, while the comet sets in the western horizon right after sunset.



Credit: F. Millour/ESO

“THE WST WILL BECOME THE ULTIMATE SPECTROSCOPIC MACHINE”

An interview with Richard Ellis

Tell us a little about you

I am a professor at University College London where I started my astronomical career as an undergraduate quite a while ago. However, in addition to working at three other UK universities, I spent sixteen years at Caltech in the USA and two at ESO in Germany. Much of my career has involved proposing and overseeing the construction and exploitation of faint object spectrographs for cosmology and studies of galaxy evolution.

What first drew you to astronomy, and how did that lead to WST?

I decided to become an observational astronomer when I was six. I built my own telescope and was lucky to become a young postdoctoral researcher at a time when the UK was greatly expanding its investment in ground-based telescopes. I used the Anglo-Australian Telescope (AAT) extensively in the 1980s and 1990s and, with colleagues, developed and exploited multi-fibre and multi-slit instruments to undertake faint galaxy redshift surveys to explore the evolution of galaxies to redshift one. This culminated in a proposal I made for the AAT 2-degree field facility, which led to a new prime focus corrector and a 400-fibre optic robotic system that charted the distribution of 250,000 galaxies and discovered the baryonic acoustic oscillation feature—now a major probe of dark energy. When I left Caltech and arrived at ESO as a senior scientist, I was asked to chair an international panel to consider the future potential of

multi-object spectroscopy in the era of the ELT. Our panel report proposed a dedicated 12 metre class optical telescope which, in due course, has become the WST.

What is your role in the WST project?

I co-chair the Extragalactic Science Working Group alongside Mark Sargent and Francesco Belfiore. This is the largest working group in the overall WST science team, as we cover a broad range of scientific projects—from charting the cosmic web through cosmic time in both emission and absorption to examining the resolved properties of baryonic material in and around nearby galaxies. A particularly exciting prospect is how the WST might be used to address future topics, such as coordinating spectroscopic observations of distant star-forming galaxies with 21cm measurements of cold gas from the Square Kilometre Array to better understand how galaxies reionised the intergalactic medium.

When did you start working on the WST?

After my panel published its report in 2016, ESO was preoccupied with the ELT and so reluctant to start moving forward with a new telescope. However, thanks to Luca Pasquini and Bernard Delabre, good progress was made towards an optical design. With Roland Bacon, Vincenzo Mainieri and Sofia Randich at the helm, a strong international team of scientists and technical experts from Europe ■■■



Welshman by birth, Richard Ellis was educated at University College London (UCL) and Oxford University. He served as a professor at Durham and Cambridge Universities before emigrating in 1999 to Caltech where he served as Director of Caltech Optical Observatories. In 2017, he returned to UCL. His research focuses on observational cosmology through studies of supernovae, weak gravitational lensing, and searching for the most distant galaxies, all with Keck, VLT, HST, and, now, JWST.

He was awarded the Gold Medal of the Royal Astronomical Society and the Gruber Cosmology Prize. He is a Fellow of the Royal Society and an international member of both the Australian and US Academies of Science.

■ ■ ■ and Australia was assembled and we eventually succeeded in getting design study funds in 2024 from the EU's Horizon Infrastructure Fund.

Do you have a story or moment from the project that stands out?

I was naturally disappointed that my panel's 2016 report effectively lay dormant for many years. I was impatient given how long it takes to design, develop the scientific case, raise funds and build any new ground-based telescope. We also failed with our first request for EU's Horizon Infrastructure funding. Yet more disappointment! However, a memorable moment was in Padua at the time of the European Astronomical Society's meeting in July 2024. I'll never forget meeting Roland at the morning coffee break where he told me that our second attempt at EU funding was not only successful, but our proposal had received top marks in each category! This was fantastic news and a welcome reward for all our hard work. At the EAS conference dinner that evening we had a great celebration!

What do you think makes the WST unique?

In some sense, the WST represents the ultimate end point of the revolution of multi-object spectroscopy. The MOS offers 30,000 fibres—an order of magnitude improvement in multiplex gain over the AAT 2-degree field facility. Likewise, the 3 x 3 arcmin field IFS provides an order of magnitude increase in the field of view over MUSE, the VLT's most popular and successful instrument. Remarkably, uniquely with the WST one will be able to observe simultaneously with IFS and MOS, offering astronomical insight from

both targeted and serendipitously found sources and probing a huge range of physical scales in a single pointing.

The WST is a project for the future, with the participation of many young scientists. As a more senior member of the team, do you have a message for the younger generation?

"Prediction is very difficult, especially if it's about the future," claimed Niels Bohr. It takes courage to join a team and plan a facility that's over 10–15 years ahead and may not end up looking quite like what you imagined! Having worked for many years on the 2-degree field and Subaru Prime Focus spectrographs, I know that it can be frustrating when there are setbacks. However, overall, there are many satisfying moments. You learn a lot in the adventure and become a better scientist. In a large team with a single goal, there's a wonderful camaraderie and you make friends for life.

What's one thing about the project you wish more people knew?

The WST is the new adventure in exploring the Universe. There's room for everyone to contribute and shape the future. Contemplate joining our project, wherever you are!

How would you describe the WST in one sentence to a non-astronomer?

To understand the contents of our remarkable Universe we need much more than pictures, we need spectra of billions of stars and galaxies; WST will become the ultimate spectroscopic machine. ■



Credit: ESA/Euclid/Euclid Consortium/NASA, image processing by J.-C. Cuillandre, E. Bertin, G. Anselmi

EXOPLANETS, STARS, AND THE MILKY WAY WITH THE WST

Driven by extensive astrometric, photometric, and spectroscopic surveys, our understanding of exoplanets, stars, and galactic astronomy has recently made giant strides. *Gaia* has been a game-changer, mapping the positions, distances, and motions of nearly two billion stars with unprecedented precision. Spectroscopy is known to amplify the power of these surveys: it uniquely provides detailed chemical abundances and radial velocities—essential for reconstructing 3D stellar motions—and reveals key stellar properties such as mass, age, and evolutionary stage. Together, these data unlock a detailed view of Galactic evolution.

Gaia has spurred numerous major spectroscopic surveys, yet its two billion stars cover only about 1% of the Galaxy. Furthermore, by the 2040s, spectra will exist for no more than 1–2% of *Gaia* sources. Meanwhile, astrometric samples will grow with *Gaia*'s final data release at the end of the decade and upcoming imaging surveys like *Euclid*, *LSST*, and *Roman*, will extend coverage beyond *Gaia*'s faint limit ($G > 20$ – 21 mag). Spectroscopy remains fundamental to unlock the full scientific potential of these photometric and astrometric datasets through the 2040s.

In the next twenty years, a few hundred million stars will have been subjected to spectroscopic observations, mostly at a resolving power (R) of the order of 10,000 or lower—just enough to provide radial velocities and some limited chemical information from strong spectral lines. About 10% of these will have been observed at $R \sim 20,000$, allowing greater radial velocity precision and detailed chemical abundances. Abundance determinations of good quality will only be available for stars with $G \sim 14$ – 16 mag. Finally, solely 1% of the stars observed with spectroscopy by the 2040s will have been observed at $R > 30,000$, which is essential for detecting weak spectral lines and enabling high-precision chemical analyses of a broad range of chemical elements.

This is where the WST will be decisive (Fig. 1). There

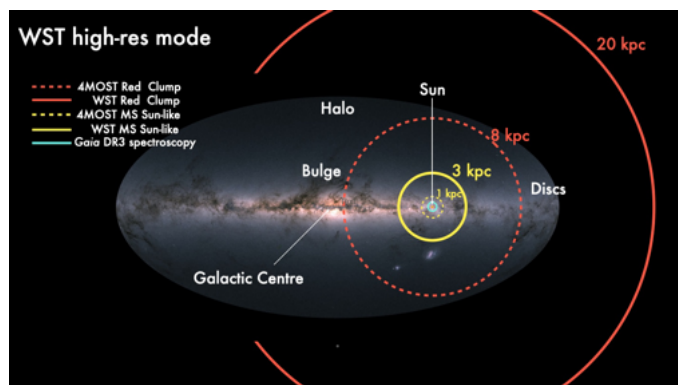


Figure 1: The WST will probe a much larger volume of the Galaxy than possible with 4MOST, enabling transformative science. Credit: Laura Magrini

are three main avenues for the WST to open new parameter spaces in stellar studies in comparison to what on-going and planned surveys in 4-m class telescopes can do: i) large scale high-precision analyses of high-resolution stellar spectra; ii) expansion of the chemical inventory down to the faintest stars in the *Gaia* catalogue; and iii) increasing the availability of radial velocities and metallicities to fainter magnitudes. In the landscape up to the 2040s, no fully dedicated 8–10 m spectroscopic survey telescopes will exist, and such surveys will only be done on 4m-class telescopes. The extremely large telescopes will also be a reality in the 2040s, but they will have tiny fields of view and will not operate in survey mode.

The unique power of the WST for resolved stellar studies resides in comprehensive surveys of stars of all types, including exoplanet hosts, throughout the Milky Way (MW) and in resolved galaxies in and just beyond the Local Group. The combination of a large field-of-view, large aperture, and large multiplex on a dedicated spectroscopic facility with three different modes operating simultaneously allows for diverse surveys. A five year survey with the WST can collect spectra for several million stars in high resolution (HR; $R=40,000$) to AB ~ 17 mag; tens of million stars in low resolution (LR; $R \sim 3000$ – 4000) to AB ~ 23 mag; and study numerous dense fields, such as the MW bulge, star forming regions, clusters, and nearby galaxies, using the integral field spectrograph (IFS) with $R \sim 3500$. Three main

- driving science cases have been identified that can be comprehensively addressed by WST surveys in the 2040s. They are described in what follows.

Origins of the elements

Understanding the origin of the elements requires tracing all the nucleosynthetic pathways (Fig. 2), while accurately characterising these pathways and the underlying physical processes will have major repercussions across numerous areas of astrophysics and nuclear physics. Some of the key science questions in this topic include: *Do the known nucleosynthesis processes explain all the elements in the Universe or are there still undiscovered processes? How well do we really understand the known processes in different environments?*

Answering these questions requires high-resolution, high signal-to-noise spectra to obtain precise and accurate abundances (that is, with errors below 0.05 dex) of different chemical elements in large, statistically significant samples. These new surveys will make it possible to accurately track the chemical evolution in all the Galactic components with distinct star formation histories (and therefore affected by different nucleosynthetic sources at different times).

Large samples also offer the best chances to detect and study rare objects, such as the most metal-poor stars—tracers of the earliest star formation in the Universe.

Thanks to its high-resolution mode (R~40,000), the WST will be able to disentangle the production of heavy elements produced by the different neutron capture processes (rapid, slow, and intermediate). The key chemical elements for this kind of study typically have spectral lines that are too weak or outside the wavelength range covered by current or planned large scale surveys. The WST’s high-resolution surveys in the blue will be transformative, being able to quantify the relative importance and timescale of the various sources of neutron-capture elements, such as evolved stars, kilonovae, and various types of supernovae.

The WST offers a unique opportunity to probe the nucleosynthesis of Type Ia supernovae (SNe Ia) in unprecedented detail. Precise measurements of elements produced by SNe Ia can be placed in the broader context of star formation and chemical enrichment across Galactic populations. This will enhance our ability to link abundance patterns to local star formation histories and to disentangle the ■■■

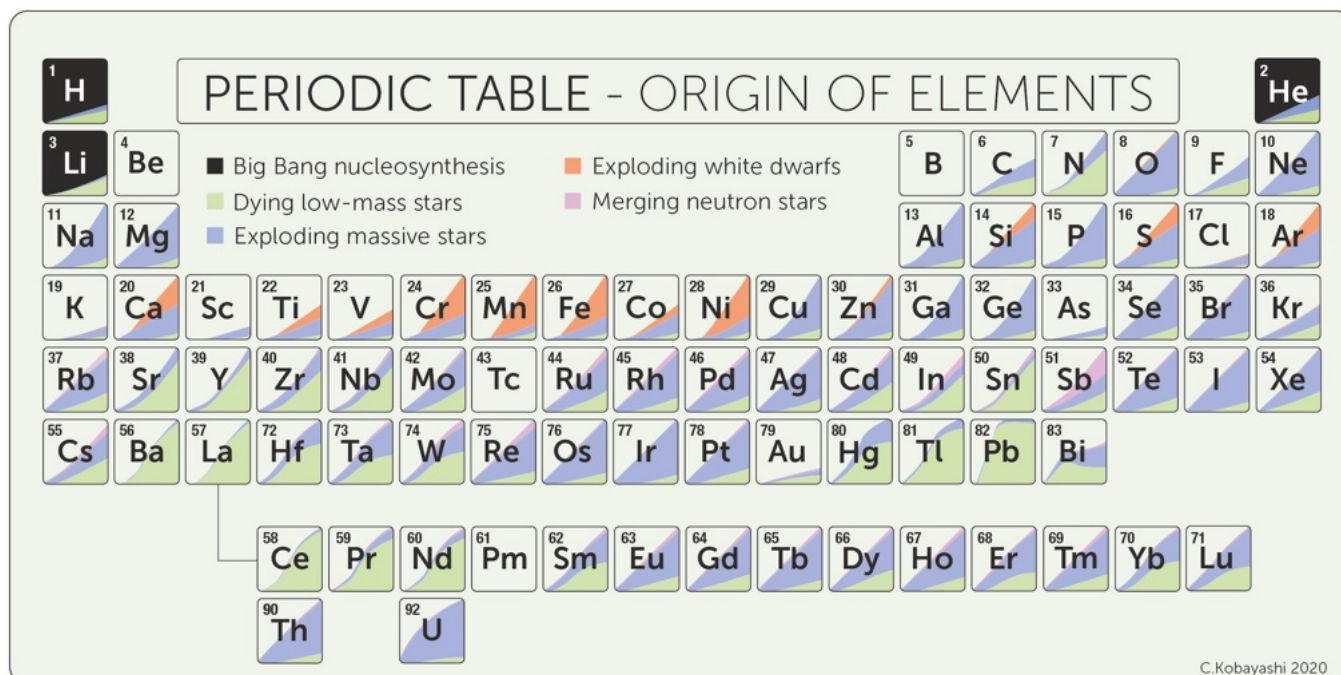


Figure 2: A periodic table mapping the astrophysical origins of Earth’s elements. Figure from Chiaki Kobayashi (see Kobayashi, Karakas & Lugaro 2020, ApJ, 900, 179).

- ■ ■ contributions of different SN Ia subtypes to a galaxy's chemical evolution.

The Detailed Origins of the Milky Way system

The Milky Way and its satellite galaxies are the environment in which the cosmological paradigms of galaxy formation can be put to the most stringent and detailed tests. A comprehensive chemical study of all the Milky Way stellar populations requires all-sky surveys of several millions of stars, extending from the inner bulge to the outer edges of the stellar disc and the halo. The key science questions are: *How do the diverse in situ and accreted stellar populations in the Milky Way and its surroundings compare to galaxy formation and evolution models? Can we uniquely determine the complete accretion history over time? Can we predict the gas properties with time? How did the bulge form? How old is the stellar disc?*

Our understanding of the Milky Way's assembly has advanced tremendously, especially thanks to *Gaia* and large spectroscopic surveys. Upcoming projects like the Vera Rubin/LSST will probe stars up to four magnitudes fainter than *Gaia*, enabling 3D kinematic studies in regions currently out of reach. A large-scale WST survey will fill gaps in our samples of stellar radial velocities and chemical abundances at the faint end of the *Gaia* and *Vera Rubin/LSST* catalogues, observing at greater depth than possible with surveys in 4-m class telescopes. Combining WST's LR and HR data will greatly expand our view of the Milky Way, offering a powerful, complementary perspective on galaxy evolution alongside high-redshift studies.

Origins of stars and planets

Although still far from understood, star formation is critical at various levels. On large scales, star formation drives galaxy evolution through its rate and initial mass function, while locally it sets the stage for planetary system origins. Key science questions include: *What is the role of the environment (e.g., density and metallicity of molecular clouds) in defining the star formation process at both small and large scales? How do stellar properties shape the architecture of planetary systems? How is planet formation influenced by the Galactic environment?*

Optical and near-infrared spectroscopy is often the only way to confirm the youth of photometrically

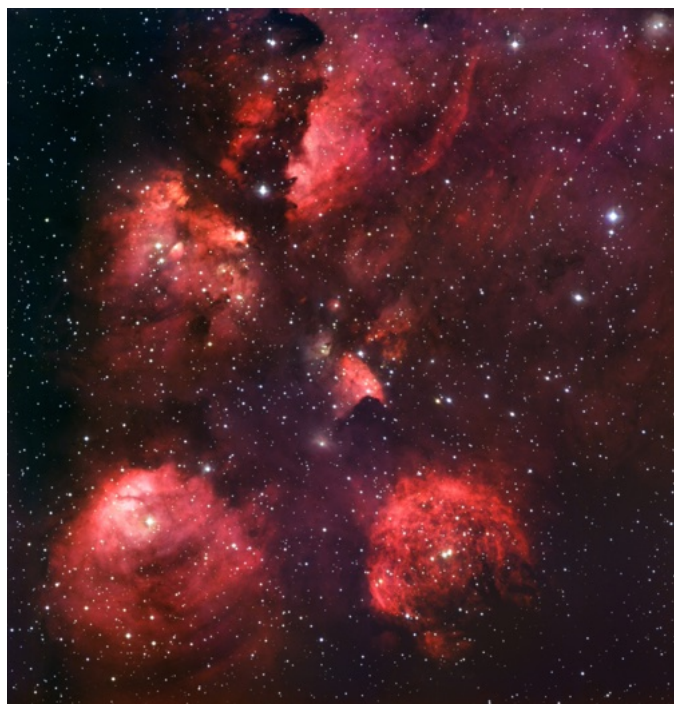


Figure 3: The WST will play a key role in the study of star-forming regions, such as the Cat's Paw Nebula. Image: ESO.

selected young stellar candidates and to measure radial velocities, which, combined with astrometry, reveal 3D stellar kinematics. Spectroscopic indicators also allow determination of stellar ages and masses and enable the study of star-disc systems through accretion and outflow diagnostics. The influence of metallicity on star formation will be investigated in detail by looking at star forming regions beyond the solar neighbourhood.

Thanks to its large collecting area and the combination of an IFS and a wide-field fibre-fed multi-object spectrograph (MOS), the WST will play a transformational role in studies of the origin of stars and planets. The IFS will allow us to probe with unprecedented detail star formation processes in massive, dense environments. The low-resolution MOS will be used to characterise dispersed populations, while the high-resolution MOS is ideal for measuring abundances and studying activity in large samples of planet-hosting stars across different stellar populations. The WST surveys will obtain spectra for tens of thousands planet-host candidates throughout the Galaxy, clarifying how Galactic environment influences the formation of planets with potential to host life. ■

THE WST IN CHILE

A WST workshop dedicated to the Chilean astronomical community took place on 15–16 December 2025 in Santiago de Chile. The event was hosted at the University Andrés Bello (UNAB) and organised by Matias Gomez, director of the UNAB Astrophysics Institute, along with Steffen Mieske (ESO). It was well attended, with 73 astronomers participating from across the country.

Following a presentation of the ESO Expanding Horizons initiative by Jarle Brinchmann (ESO), several general overviews of the project were given by members of the WST consortium. The rest of the day was dedicated to presentations by the community on science cases that would benefit from the WST's unique capabilities. Topics covered included time-domain and transient science, galaxy evolution, and AGN.

A lively discussion followed during a panel and plenary session, focusing on how to strengthen Chilean national involvement and on practical ways to participate in the next phases of the WST project, should it be selected by ESO.

On the second day, presentations from the Chilean community continued, with a focus on Galaxy Assembly and Chemical Evolution. The final session addressed New Tools and Methods for WST Science. The workshop concluded with a second panel session,



The first day panel meeting members, from left to right: Patricia Arevalo, Franz Bauer, Timo Anguita, Yara Jaffe, Bruno Dias (photo R. de Jong)

where the potential role of the Chilean community was once again discussed.

The workshop highlighted the strong scientific interest in the WST from the Chilean community, as well as its synergy with other ongoing facilities such as Rubin/LSST, where Chile plays a key role. A central topic of discussion was the desire to go beyond the 10% telescope-time share granted in exchange for the land concession, and to take an active part in the construction and future operations of the project. Concrete steps toward this goal will be explored in the coming year, including the submission of a letter of intent by the end of 2026. ■



The traditional group photo in the Aznar auditorium of the beautiful UNAB campus (photo R. de Jong)

A VISIT TO LA CHIRA

On Friday, December 19th, 2025, the team in charge of site selection—Steffen Mieske and Angel Otarola from ESO—visited the La Chira site, accompanied by the coordinator Roland Bacon and the facility scientist Roelof de Jong. La Chira, which can be translated as the “dry peak”, is one of the potential sites for the WST. It is a mountain peak at 2560 m altitude, located 18 km north of Paranal, within the Paranal-Armazones ESO concession area.

With no road access, they used two four-wheel-drive vehicles (for safety reasons) to cross the desert up to the La Chira summit. After 40 minutes of bumpy travel, they reached the top. There, ESO is planning to install site monitoring equipment as part of an ongoing ESO internal project. Data obtained during this monitoring are foreseen to be made publicly available and will, as a byproduct, allow a better characterisation of La Chira, which is of great interest for the WST.

From the summit, the vista of both the VLT and the ELT is stunning. Surrounded by the colourful and majestic landscape of the Atacama Desert, it is easy to imagine that, two decades from now, the WST could stand here—another giant gazing at the sky, joining the VLT and the ELT nearby in their quest to explore the Universe. ■



“WE AIM TO STRENGTHEN THE COMMUNITY AND MAKE ITS VULNERABLE MEMBERS FEEL LISTENED TO”

An interview with Anna Puglisi,
co-lead of the Equity, Diversity, and Inclusion (EDI) WP

When did the EDI group form, and what was the process that led to it?

The EDI group emerged from a bottom-up process that I led in 2023, following a series of community discussions, and was immediately warmly supported by management. Establishing it as a working group aimed to embed equity, diversity, and inclusion as a structural element of the WST at every level. The group officially began its activities in April 2025, after an open call for participation. We encouraged involvement from people with a wide range of backgrounds, both in terms of EDI experience and expertise in science and technology.

What is the composition of the group?

The group currently consists of members mostly coming from scientific fields. At present, the group is predominantly made of women, research-focused and largely based in European institutes. The membership spans a range of career stages, with representation from senior researchers, postdoctoral researchers, early-career staff, and PhD students. We strongly encourage people from the technological sector, men, and senior staff beyond Europe to join, as a diverse composition offers a much broader view, different perspectives, and inputs.

How did you become involved in EDI?

I have always been involved in community-related activities, from

coordinating the journal club to serving as a representative for postdocs and students, as well as co-organising weekly student talks. Building on this experience, I co-founded the IDEA (Inclusion, Diversity, Equity, and Accessibility) discussion group and mentored PhD students in their “Cakes for Good” initiative. Over time, my involvement broadened to LGBTQ+ inclusion, with activities such as organising a dedicated EAS session on travel-related challenges and safety considerations for LGBTQ+ researchers.

On this subject, one of the actions proposed by the Code of Conduct is to pay attention to the choice of conference and meeting venues/countries. Can you explain?

It’s a broad issue, rooted in the reality that not all countries are safe for LGBTQ+ people. The impact extends far beyond conferences and meetings: it affects the workplace, influencing where someone feels comfortable in applying for a position, a postdoc, and so on. Being LGBTQ+ can close doors: not by policy, but because individuals may not feel safe working in certain places, resulting in a real reduction of opportunities. With regard to conferences, our proposal is, in the first place, to raise awareness of the issue, but also to encourage the use of hybrid formats and meaningful remote engagement when events are held in locations that may be unsafe. However, the most important first step is to talk about it openly and make the community more conscious of the challenges



involved. Another valuable tool, especially when travelling to countries that are hostile toward the LGBTQ+ community, is the creation of short guides that indicate safe places, such as bars and other supportive venues, to help make the experience as secure and comfortable as possible, and design local point of contact for practical support.

Has any training been provided, or is any planned on the EDI?

We would very much like to do so, but at the moment we are limited by a lack of resources. As a result, we are unable to bring in external experts, such as sociologists, to provide proper training. This is a widespread challenge in EDI work and affects many organisations beyond our own. Nevertheless, we are actively seeking funding to be able to offer this type of support in the future and, in the meantime, we are planning to draw on the experience of members of the EDI group (e.g., in gender-related ■■■

- ■ ■ topics, LGBTQ+ issues, visual impairment) to raise awareness across the WST community.

Are there any forms of academic recognition or career credit for the time invested in this type of contribution/service?

Much of this work is carried out on a personal basis, and it can have an impact on one's career. It takes time away from other academic responsibilities. To do it well—and to be genuinely supportive—you also need proper training, which is itself very time-consuming. What typically motivates people is a personal interest, an internal drive, a sense of purpose. Recognition is not guaranteed, but this is one of the areas where the group is working within the WST. In some consortia, for instance, EDI members are given a “builder status,” which acknowledges their structural contribution and allows them to sign papers. As with any cross-cutting area, designing appropriate recognition mechanisms requires careful balance, but such approaches can play an important role in supporting long-term engagement with EDI work.

The EDI WG does not have a specific task to aim for, but rather a horizontal action aimed at ensuring that the human and professional climate is fair, inclusive, equitable, and respectful of diversity. How do you choose your long- and short-term goals?

For now, we have had to work in a somewhat emergency mode because there were deliverables to be completed within very tight deadlines (code of conduct and identification of ombudspersons). Now that we can finally do some planning, the next steps will be: preparing community surveys, organising a leadership course and EDI information and exchange seminars, and drafting a priority-

setting and activity-report paper. EDI has an output that is difficult to quantify, and in this sense, this document also serves to guide future activities, while the community survey will allow providing a structure and cyclical planning of activities based on the data. One of the central objectives is to create constant contact with the community, give presentations, and increase visibility, from which we can build trust: strengthen the community and make its vulnerable members feel listened to.

Are there metrics to assess the impact of your actions?

There are quantitative indicators that can be used in EDI work, but there are no simple metrics that can, on their own, capture the impact of EDI actions. This is why we want to implement community surveys, especially periodic ones, as they allow us to track trends and identify areas that require attention, while seeking support from EDI experts in the design and interpretation of these surveys. In parallel, we want to promote active and continuous community

engagement and support. In this context, it is important to clarify that EDI is not just conflict resolution, although this remains an important component of community support. A central question is how much a person feels part of the community, both scientifically and on a human level.

Do you have any data available on the actual inclusiveness of the WST community?

One of the objectives of the surveys will also be to understand how diverse the community at large is and how this is reflected in leadership positions. However, this requires a long time scale. The community survey is necessary and should be carried out periodically to track trends and inform future actions.

How can someone get involved with the EDI group, or contact you in case of need?

We're always keen to hear feedback and welcome input from the community. If you'd like to get involved or need to reach us for any reason, please don't hesitate to send us an email. ■

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THE WST MOS POSITIONERS: A TECHNOLOGICAL CHALLENGE AT INDUSTRIAL SCALE

Imagine coordinating 32,000 robotic arms, each smaller than a pencil, to simultaneously point at different stars across a patch of sky 15 times the size of the full moon—all with sub-micrometre precision. This is the challenge facing the Wide-field Spectroscopic Telescope (WST) fibre positioning system, representing a sixfold increase in complexity over any existing instrument.

The WST emerges at a pivotal moment in astronomy. While *Gaia* maps stellar positions, *Euclid* traces dark matter influence, and Vera Rubin Observatory's *LSST* survey finds transient sources. These surveys share a common limitation: they observe without spectroscopy. WST's 12-metre aperture and 3.1 deg² field of view are designed to provide the missing spectroscopic dimension, in particular with its Multi-Object Spectrograph (MOS).

The enabling technology behind this is the fibre

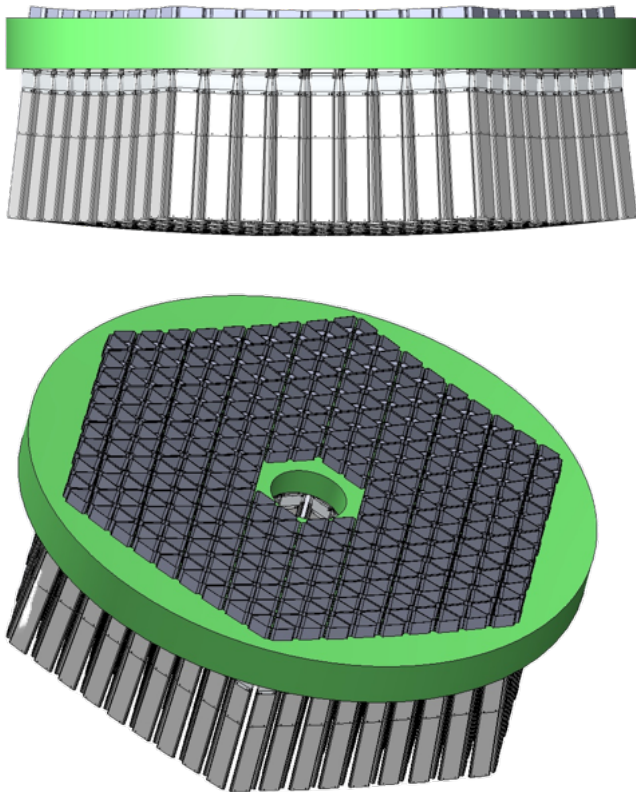


Figure 1: Focal plane diagram with triangular positioner modules

positioner system, a marvel of precision engineering that must operate reliably, reconfigure rapidly, and scale to industrial production levels. Four distinct positioner concepts are currently being developed and tested by international teams, each offering different solutions to this unprecedented technical challenge.

The Crucial Role of Positioners

Fibre positioners are the critical interface between the telescope's focal plane and its spectrographs. Each positioner is a miniature robotic system responsible for precisely positioning an optical fibre tip onto a designated astronomical target. As the telescope tracks across the sky, these thousands of robots must work in concert, moving their fibres to new positions for each observation field, creating what is essentially a dynamically reconfigurable multi-object spectrograph.

The WST's innovative design incorporates two complementary spectrographic systems served by different positioner populations. The bulk of the system—30,000 low-resolution positioners—enables wide-field surveys and efficient target screening. An additional 2000 high-resolution positioners provide detailed spectroscopic diagnostics for selected targets. This dual approach maximises scientific flexibility, allowing the WST to simultaneously conduct large statistical surveys and obtaining high-quality spectra of key objects. The combined system of 32,000 positioners represents a more than sixfold increase over DESI's ~5,000 positioners, the current record holder.

Each positioner must achieve a positioning accuracy of approximately five micrometres—roughly one-tenth the diameter of a human hair—to ensure optimal light coupling into the fibre. This precision must be maintained across a densely packed focal plane where positioners are separated by several millimetres, creating a complex choreography problem where neighbouring units must avoid collisions as they reach their targets.

Beyond positioning accuracy, the system must meet stringent operational criteria. Reconfiguration time ■■■

- ■ ■ between fields must be minimised—typically a few minutes to reposition all 32,000 fibres. The positioners must operate reliably over the telescope's operational lifetime, potentially executing millions of moves in varying environmental conditions, including temperature fluctuations and potential dust exposure. Any failure of individual positioners must be detectable and manageable without compromising overall system performance.

The positioners are organised into modular units containing several positioners, allowing for systematic integration, testing, and potential maintenance or replacement. Two different modular grouping solutions are developed, the triangular concept (Fig. 1) and the inline concept (Fig. 2).

This modular approach, inherited from lessons learned from MOONS, 4MOST, SDSS-V, DESI, and other instruments, provides both manufacturing efficiency and operational flexibility. The modules tile together to cover the telescope's curved focal plane, with each module managed by dedicated control electronics.

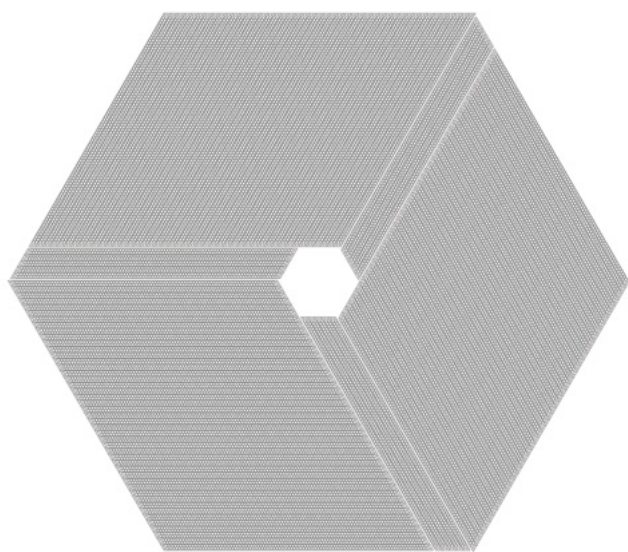


Figure 2: Focal plane diagram with the inline concept

Major Technical Challenges

While the above established WST's ambitious scope, the path from concept to reality involves formidable engineering obstacles. The transition from DESI's proven 5000-unit system to 32,000 positioners is not merely additive, but requires fundamental advances in manufacturing, integration, and control methodologies.

Industrial-scale production poses the first major hurdle. Moving beyond prototype fabrication means establishing supply chains capable of delivering tens of thousands of precision components with consistent tolerances. Cost control becomes paramount: achieving affordable unit pricing without compromising micrometre-level accuracy requires optimisation strategies drawn from industries. Each of the modules must undergo rigorous validation before integration, creating a testing bottleneck that demands parallel processing capabilities.

The operational environment introduces challenges absent in smaller systems. Managing collision avoidance for 32,000 simultaneously moving arms requires sophisticated algorithms that scale beyond current implementations. Communication architecture must handle the data throughput of commanding and monitoring all units without creating bottlenecks. Thermal loads from thousands of motors, though individually modest, accumulate to create heat dissipation challenges across the focal plane that could affect positioning stability. The control system must implement fault tolerance strategies, allowing continued operation even as individual positioners fail over the instrument's lifetime.

Economic realities compound technical difficulties. Budget constraints demand careful trade-offs between performance specifications and manufacturing complexity. Production timelines must synchronise with the overall project schedule, requiring early commitment to specific technologies before full maturation. Risk mitigation strategies include qualifying multiple suppliers for critical components and maintaining design flexibility to accommodate evolving manufacturing capabilities. ■ ■ ■

■ ■ ■ The Four Concepts Under Development

Given the unprecedented scale of 32,000 positioners and the associated risks, the WST project is pursuing a multi-concept development strategy (Fig. 3). Four different positioner architectures are being developed and tested in parallel, allowing the project to evaluate performance, cost, manufacturability, and reliability before committing to a final design. This approach provides both technological redundancy and the opportunity to select the optimal solution based on actual prototype performance.

All four concepts are being prototyped and tested with a pitch around 6 mm. Performance metrics including positioning accuracy, repeatability, speed, collision avoidance, and reliability are being systematically compared. By 2027, the project will down-select two concepts for production based on this comprehensive evaluation.

Teams Involved

Developing a system of 32,000 precision fibre positioners requires a truly international collaborative effort, bringing together expertise from academic institutions, national laboratories, and industrial partners across multiple continents. The main institutions involved are EPFL (École Polytechnique Fédérale de Lausanne), Switzerland, AIP (Leibniz Institute for Astrophysics Potsdam), Germany, UKATC (United Kingdom Astronomy Technology Centre), Scotland, and the AAO (Australian Astronomical Optics), Australia. The project operates through regular coordination meetings, shared testing

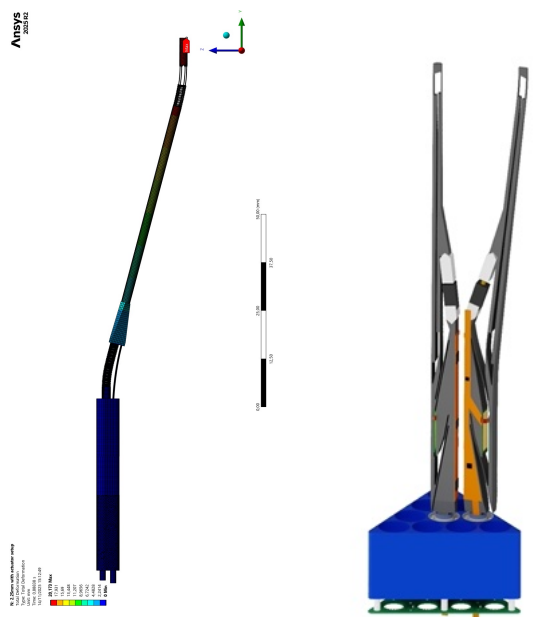


Figure 3: Visual comparison of different positioner concepts (AIP and UKATC concept)

protocols, and open exchange of results. This collaborative approach ensures that best practices are shared across concepts, while maintaining healthy competition to drive innovation.

Current Status and Outlook

Significant progress has been made with all types of prototype positioners.

Near-term milestones (2024-2025):

- Testing of larger prototype modules
- Comprehensive performance comparison across all four concepts
- Collision avoidance algorithm validation at module scale
- Thermal and environmental testing
- Initial cost modelling for mass production of 32,000+ units.

Medium-term roadmap (2025-2027): The HORIZON Europe-funded conceptual study phase will focus on

- Down-selection to one or two positioner concepts
- Detailed production planning for 32,000+ units
- Supply chain development and risk mitigation
- Integration strategy for 520+ lines or modules
- Final cost-to-completion estimates.

The development of 32,000 fibre positioners for WST represents far more than an incremental advance; it is a technological leap that will enable a new era of spectroscopic astronomy. By pursuing multiple innovative concepts in parallel, the international WST collaboration is mitigating risk, yet still pushing the boundaries of what is achievable in precision mechanisms, control systems, and mass production of astronomical instrumentation.

The positioners are truly the enabling technology for WST's ambitious science goals. Success requires not only solving unprecedented technical challenges but also establishing new paradigms for international collaboration and industrial-scale production in astronomy. The progress achieved so far, with prototype positioners almost exceeding specifications, provides confidence that these challenges can be met. As the WST moves from concept to reality over the coming decade, the lessons learned from developing this massive positioner system will benefit future astronomical facilities and establish new standards for large-scale precision instrumentation. The 32,000 fibre positioners of the WST will be the robotic workforce that unlocks the spectroscopic secrets of billions of celestial objects, transforming our understanding of the Universe. ■

OPERATIONS FACE-TO-FACE MEETING

On November 18–19, the first face-to-face Operations meeting took place in Milan, Italy, at INAF-IASF. The two-day sessions focused on assessing the status of the Operations work-package, accelerating progress, defining key requirements—particularly those leading to the M6 Horizon milestone—and reviewing the Facility Simulator design.

The meeting opened with updates on the project, the telescope and the instruments. These highlighted the establishment of a robust optical design and the planned instrument trade-off activities scheduled for February, remarking that, while technical development is progressing well, one of the main challenges remains achieving operational readiness.

Technical discussions addressed several core topics, including the need for a fast acquisition sequence and the importance of rapidly evaluating fibre positioner efficiency using the Facility Simulator. Data reduction workflows were also a central focus, particularly those supporting time-critical processing and sky subtraction across the WST large field of view.

Sustainability has been also addressed, with discussions focusing on minimising the environmental impact of data centres and promoting renewable energy solutions for large-scale data processing.

Science and survey planning were further explored, with time-domain astrophysics—including alert handling and the integration of IFS and MOS observations—identified as a key driver of operational requirements.

The Facility Simulator design, intended to prototype the WST survey planning process, has been presented and discussed in detail, also highlighting the importance of fibre-level Target of Opportunity observations and a robust alert system for transient events.



The meeting concluded with a session dedicated to Equity, Diversity and Inclusion, emphasising a collaborative culture grounded in trust, professionalism and mutual respect, as outlined in the adopted Code of Conduct.

In summary, the Milan meeting successfully set the stage for focused operational planning, emphasising efficiency, scientific readiness, sustainability, and inclusion as the WST progresses toward the first Operations Horizon milestone and beyond.

GROUND-LAYER ADAPTIVE OPTICS BRAINSTORM MEETING

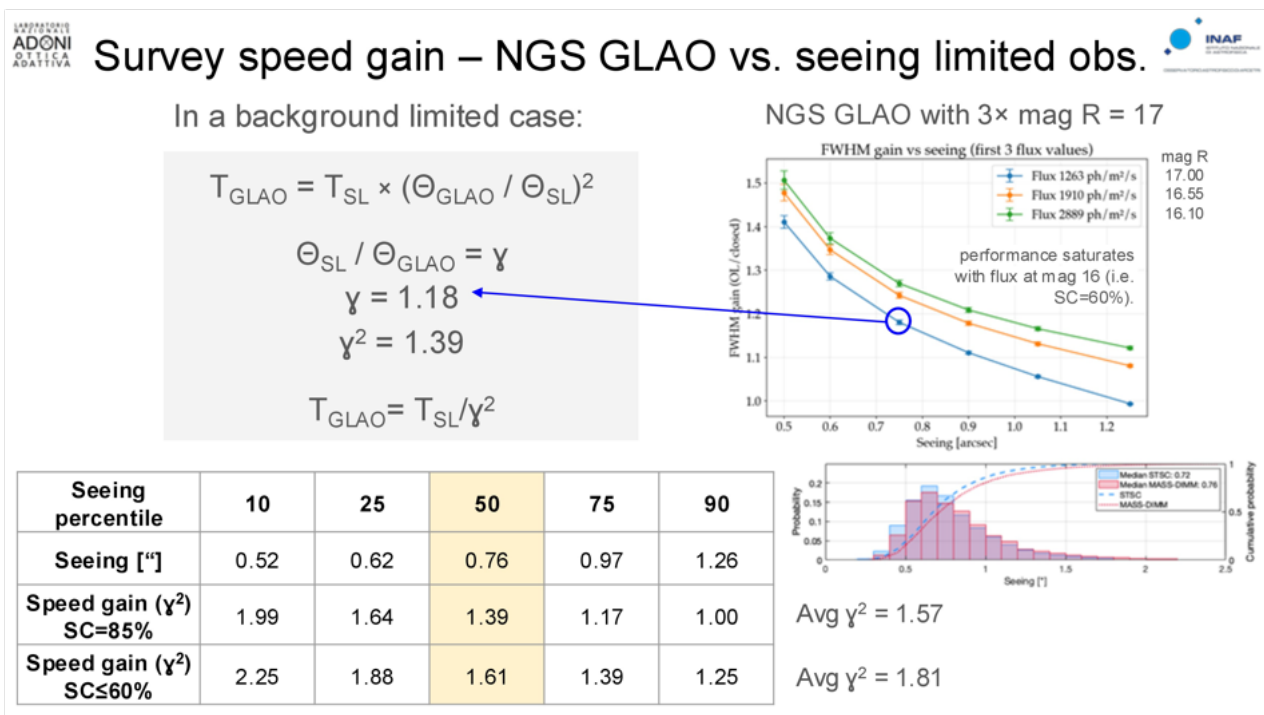
On November 20, 2025, a meeting organised by S. Randich was held in Firenze, Italy, at the INAF Arcetri Observatory, to discuss and assess the feasibility of developing a ground-layer adaptive optics (GLAO) system for the WST Integral Field Spectrograph (IFS). Such system stabilises the image quality by correcting for the low-altitude, variable turbulence and would generally enhance image quality over a large field of view, positively impacting the IFS science and increasing the survey's efficiency. The meeting brought together a group of scientists from INAF, CRAL, and ESO, including several adaptive optics experts.



The INAF Arcetri Observatory in Florence resides in a beautiful setting surrounded by olive trees, not far from Galileo's former house. It provided a great and inspiring environment for this brainstorming session.

The WST project, telescope and IFS design concepts, and site selection were presented. The brainstorming session proved very productive, with many ideas exchanged and dynamic discussions on expected performance, based on preliminary simulations. It was concluded that no major obstacles are identified, and that a GLAO system relying on natural guide stars could significantly improve image quality, while offering good sky coverage.

Based on these findings, it was decided to continue simulations and to schedule a follow-up meeting in March 2026, aiming at determining whether GLAO can be adopted as the facility baseline. ■



Slide from Guido Agapito's presentation, predicting a 40%-60% increase in survey speed when GLAO is used.