
S·A·L·T
20
YEARS
AFRICA'S GIANT EYE ON THE SKY
CELEBRATES 20 YEARS
ANNIVERSARY

SALT AT 20

The Southern African Large Telescope, called SALT, celebrates two decades of cutting-edge astronomy and human collaboration. Inaugurated in November 2005 as "*Africa's Giant Eye on the Sky*," SALT has since grown into a flagship facility for South African science and a valued global observatory. This brochure reflects on SALT's 20-year journey — from bold vision to construction, early challenges to scientific triumphs — and looks ahead to its future. Each section offers a snapshot of SALT's story, enriched with facts from the latest reports and highlights from recent years.

We also acknowledge the many partners, people, and communities that have made SALT a success. Enjoy this look back at SALT's first 20 years and view towards the future.

ABOUT
SALT

SALT is the largest single optical telescope in the southern hemisphere and amongst the largest in the world. It has a hexagonal primary mirror array 11 metres in diameter, consisting of 91 individual 1-m hexagonal mirrors. Its design was based on the Hobby–Eberly Telescope (HET) located at McDonald Observatory in West Texas (USA). The light gathered by SALT's huge primary mirror is fed into a suite of instruments (an imager and three spectrographs) from which astronomers infer the properties of planets, stars and galaxies, as well as the structure of the Universe itself.

SALT is owned by the SALT Foundation, a private company registered in South Africa. The shareholders of this company include universities, institutions and science funding agencies from Africa, India, Europe and North America. The South African National Research Foundation (NRF) is the major shareholder, owning approximately one third of the shares. Just over half of the operating costs are currently covered by the NRF, ensuring that significant observing time is available to the South African community. Other large shareholders are Rutgers University, the Nicolaus Copernicus Astronomical Centre (NCAC) of the Polish Academy of Sciences, Dartmouth College, the University of Wisconsin–Madison, and the Inter–University Centre for Astronomy and Astrophysics in India (IUCAA). Smaller shareholders include the American Museum of Natural History (AMNH) and the UK SALT Consortium, with the latter currently representing Armagh Observatory & Planetarium. The size of the shareholding of each partner determines the access to the telescope that they enjoy.

SALT is located at the observing site of the South African Astronomical Observatory (SAAO), near the small Karoo town of Sutherland, about 370 km northeast of Cape Town. This site has been host to a number of other smaller telescopes since the early 1970s, and benefits from its location in a semi-desert region with clear, dark skies. The quality of this site for optical astronomy is preserved by South African legislation.

SALT is, first and foremost, a spectroscopic telescope. Due to its operating mode and design, it is most efficient when employed as a survey telescope, with a wide range of targets available in the observing queue. The telescope's large collecting area and Sutherland's dark skies mean that highly competitive results can be obtained for diffuse, low-surface-brightness objects. Brighter targets – where most of the light is above the sky background, regardless of the seeing – can be observed very efficiently. There are several spectroscopic options available, including multi-object, fast and polarimetric modes, some of which are rare on large telescopes. Operationally, SALT is capable of rapidly changing modes and instruments on-the-fly, and can most efficiently respond to transient events and time-sensitive requests (e.g., targets of opportunity) during the course of a night.

SALT's design with the primary mirror and the payload in the prime focus marked. The low construction costs are partly due to its unconventional design with a fixed elevation angle.-- Credit: Rutgers University.

MESSAGE FROM

THE CHAIR OF THE SALT BOARD

Welcome to this celebration of the 20th anniversary of the Southern African Large Telescope, which we call SALT. Its birthday is 10 November 2005 when President Mbeki officially inaugurated SALT. This was a historic day, as SALT became the largest single optical telescope in the southern hemisphere. In the 20 years since, SALT has become an extremely productive telescope making highly significant discoveries.

In the mid to late 1990's, optical astronomy was changing dramatically, as a number of 8 to 10 meter class telescopes were being constructed around the world. Astronomers at the South African Astronomical Observatory (SAAO), led by Bob Stobie, David Buckley, and Darragh O'Donoghue, realized that if SAAO wished to be a world class observatory, a new large telescope would need to be built in Sutherland. They did not want South Africa to simply host a large telescope, which has been done in other countries, they wanted South Africa to take the lead in the financing, construction and operation of a large telescope. Motivated by an ambitious science white paper from the new government, they developed a plan for South Africa to build and operate the largest single optical telescope in the southern hemisphere. This was a courageous decision on many levels since previous optical telescopes in South Africa had all been built outside the country and SALT would be the first South African built optical telescope.

Although South Africa would take the lead, the new telescope was planned as an international collaboration, and intentionally named the Southern African Large Telescope, and not the South Africa Large Telescope. With support from the National Research Foundation and the Department of Science and Technology, the SAAO astronomers developed an international partnership which would assist with funding, telescope design, and building the instrumentation for SALT.

SALT is an international collaboration, set up as a private company in South Africa. There are currently eight SALT shareholders, based in five different countries. The partners bring their own background, expertise, and knowledge to SALT, and this collective expertise is a strength for the organization. SALT is governed by a board of directors, and each shareholder has at least one representative on the board. Their diverse perspectives ensure that SALT has a robust governance structure. As with any long-term collaboration, there can be the occasional disagreement among partners. However, we all share the same vision for SALT to be a world class observatory. As a result, the partnership is remarkably collegial and productive. The international nature of SALT has fostered a number of student exchange visits and training of PhD students over the years among the different partners. We look forward to continued close collaboration among the partners going forward.

A key part of SALT's initial vision was positively leveraging astronomy for domestic development. The team wanted to ensure that there would be strong collateral benefits associated with building and operating a large telescope in South Africa. This vision remains today, and SALT is still very committed to ensuring that the telescope benefits more than just astronomers. For example, SALT assisted in setting up a community center in Sutherland that it continues to run today. SALT is also funding a maths teacher in the local schools.

Twenty years on, SALT has become a very successful and productive telescope, enabling world class science. There have been over 600 publications based upon SALT data, with a record over 80 publications in 2024. One of the many science highlights was SALT obtaining one of the first optical spectra associated with a gravitational wave detected on 17 August 2017. This gravitational wave was produced by the merging of two neutron stars, leading to an enormous explosion, and it is the light from this explosion that was observed by SALT. The SALT spectrum, along with other spectra collected around the world, demonstrated that the merging neutron stars had created a significant number of new heavy elements. This discovery highlights the multi-messenger nature of modern astronomy to which South African remains committed.

The ongoing success of SALT has been made possible by a remarkable set of dedicated individuals and leaders over the years. The initial construction team, led by Kobus Meiring and Mike Lomberg, did an outstanding job of keeping the project on budget and completed in a timely manner. When early commissioning observations discovered optical quality issues, Darrah O'Donoghue worked tirelessly to correct the problem. A succession of managing directors of SAAO, Phil Charles, Patricia Whitelock, Ted Williams, Petri Väisänen, and now Ros Skelton, provided, and continue to provide, a strong commitment to SALT, which has been critical to its success. SALT has been very fortunate to have a large number of talented and engaged individuals who are focused on ensuring SALT is a productive telescope. Although I don't have time to name everyone, I speak on behalf of the SALT board when I say that we are deeply grateful for all of the hard work by our exceptional group of employees, who have contributed so much to SALT's success.

As we celebrate 20 years, we must acknowledge that SALT has some aging infrastructure, most notably its spherical aberration corrector, which will require significant new investment. Although it will not be easy, all partners are committed to improving SALT, and we have agreed in principle to go forward with the replacement of the spherical aberration corrector. This commitment, along with new instruments that are or will soon be available for observations, will ensure that SALT will remain a world class observatory going forward. We are looking forward to the first observations with the new high precision mode for the HRS spectrograph, which will allow SALT to discover and characterize planets that orbit other stars. SALT is currently commissioning infrared and optical spectrographs, which will enable SALT to simultaneously obtain a few hundred spectra to explore the structure and dynamics of galaxies. We are eagerly looking ahead to the next decades of exploration with SALT.

Lastly, both my professional and personal life have been enriched by my strong and rewarding connection to this beautiful country. I've been coming to South Africa for over 20 years now, and I'm continually impressed with your dynamic, diverse country. I'm very grateful to be a part of this wonderful endeavor. Thank you.

Brian Chaboyer, Chairperson of the SALT Board

MESSAGE FROM

THE DIRECTOR OF THE HOST INSTITUTION, SAAO

Twenty years ago, a bold idea took shape beneath the pristine skies of Sutherland: to build the largest optical telescope in the southern hemisphere. Today, as we celebrate two decades of the Southern African Large Telescope (SALT), we honour the extraordinary achievements of South Africa and its international partners in building, operating, and continually advancing this world-class facility.

SALT is a flagship of South African science — a beacon of excellence that has catalysed the growth of our astronomical community and elevated our global standing in big science. Its success was instrumental in securing South Africa's role as host of the SKA-Mid telescope, ensuring our continued leadership in the global astronomical enterprise for decades to come.

At the South African Astronomical Observatory (SAAO), our mission extends far beyond infrastructure. As the national facility for optical and near-infrared astronomy, we serve as a hub for coordination, collaboration, and capacity-building — across South Africa, the African continent, and the world. The growth of African astronomy is evident in milestones such as hosting the International Astronomical Union's General Assembly in Cape Town last year — a historic first for Africa.

Through initiatives like the National Astrophysics and Space Science Programme (NASSP), SAAO has helped unify universities and research institutions, nurturing generations of scientists and engineers. Many of SALT's researchers and staff trace their roots to this programme, supported by the Department of Science, Technology and Innovation (DSTI) and the National Research Foundation (NRF). By training the next generation, we ensure the long-term advancement of science for the benefit of society.

Innovation remains at the heart of SALT. The newly developed fibre-fed Slitmask Integral Field Unit — the first of its kind in Africa — enables spatially resolved spectroscopy. Meanwhile, cutting-edge exoplanet research is being advanced through the installation of a Laser Frequency Comb calibration system, thanks to collaboration with Heriot-Watt University.

SALT inspires curiosity, pride, and possibility. Through the SALT Collateral Benefits Programme (SCBP), SAAO has engaged thousands of learners, educators, and members of the broader public across South Africa, using astronomy as a gateway to science education and opportunity. This work has been especially meaningful in Sutherland, where SALT's presence has supported community development and helped grow astro-tourism, fostering a lasting connection between science and society.

SALT's journey has been powered by the dedication, passion, and expertise of countless individuals — from the visionaries who first imagined it, to the teams who keep it running every day. To all who have contributed: thank you. SALT has become a cornerstone of South African science and a symbol of Africa's growing presence in global astronomy. With this strong foundation, we are poised to embrace the next chapter — advancing discovery, inspiring new generations, and shaping our understanding of the universe beneath the beautiful African skies.

Rosalind Skelton, Managing Director, NRF-SAAO

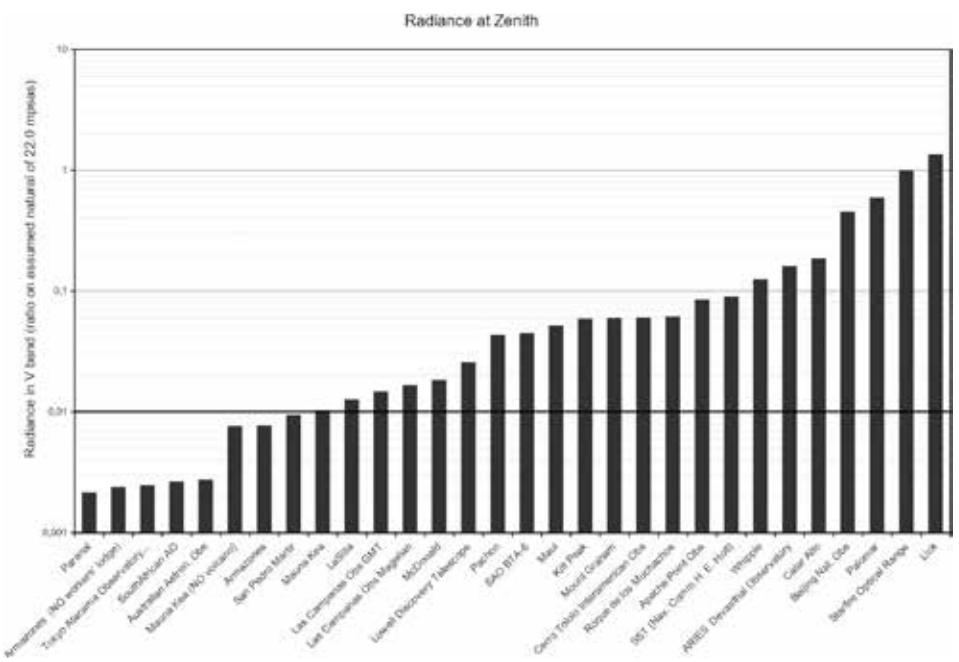
ORIGINS & VISION:

CONCEIVING SALT

In the late 1990s, South Africa's scientific leaders put forth an audacious vision: to build a 10-metre-class optical telescope in the southern hemisphere as a flagship for the new South Africa. In June 1998, the South African government committed US$10 million toward this dream. Dr Khotso Mokhele, then President of the NRF, championed SALT not only for world-class research but also as a tool to train a new generation of South African scientists reflective of the country's demographics. The Southern African Large Telescope, dubbed SALT, was closely modelled on the Hobby–Eberly Telescope (HET) in Texas, leveraging its cost-effective design. By forming an international consortium, the project gained momentum: partners from Poland, the United States, Germany, the UK and New Zealand joined South Africa to fund construction and contribute expertise. The vision for SALT extended beyond astronomy — it was "a unique synthesis between universities and researchers" and a statement that South Africa was "kick-starting its science and technology base" with a bold project. Conceived as "Africa's Giant Eye on the Sky", SALT's mission was clear: enable first-rate science on southern skies, inspire society with the wonders of the Universe, and build local high-tech capacity. This grand vision set the stage for what would become the largest single optical telescope in the southern hemisphere, a symbol of scientific renaissance on the African continent.

Former President of the NRF Khotso Mokhele

SAAO's Sutherland site is among those observatory sites with the darkest sky. This plot shows the radiance in the optical at the zenith for all major observatories (as a ratio over an assumed background of 22.0 mag/arcsec^2). The SAAO site is one of five sites that has a significantly low radiance.– Credit: F. Falchi.



BUILDING THE TELESCOPE:

CONSTRUCTION PHASES

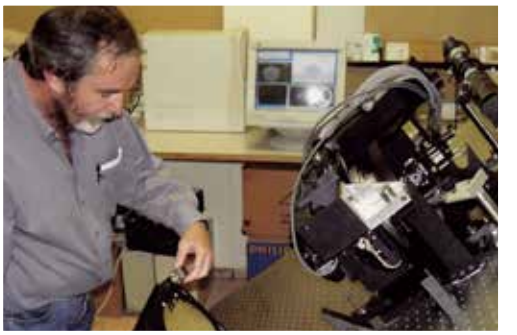
After years of planning, SALT's construction began on a Karoo hilltop near Sutherland in early 2000. The site — arid, dark, and 1,800 m above sea level — offered superb viewing conditions. Construction unfolded in three major phases: groundbreaking and foundation work in 2000, erection of the 45-ton steel telescope structure and 25-m spherical dome in the early 2000s, and installation of SALT's precise optics by mid-decade. By March 2004, engineers began mounting the 91 identical 1-metre hexagonal mirror segments into the massive mirror frame. Just 14 months later, in May 2005, the final mirror segment was put in place, completing the full 11-m hexagonal primary. Throughout construction, teams from the partner countries collaborated — for example, the Robert Stobie Spectrograph (RSS) was designed and built by a University of Wisconsin team (originally called the Prime Focus Imaging Spectrograph, PFIS). SALT's design included a sophisticated four-mirror spherical aberration corrector to give a 10-arcminute wide field of view at prime focus. On 1 September 2005, SALT achieved "First Light" with the full mirror: it captured focused images of the two star clusters 47 Tucanae and NGC 6152, the NGC 6744 galaxy, and the Lagoon Nebula. President Thabo Mbeki officially inaugurated SALT on 10 November 2005, unveiling a plaque and declaring the telescope open. In its construction phase, SALT benefited from the experience of its Texas twin HET and from intense local effort, for example, South African engineers built key components. The successful completion of SALT's construction on time and within a budget of ~$24 million was a remarkable achievement, heralding the start of a new era of astronomy in Africa.

SALT's First Light image of the central Lagoon Nebula (M8) demonstrated the telescope's capabilities, with its 91-segment mirror showcasing SALT's potential.

EARLY HURDLES:

CHALLENGES & LESSONS LEARNED

Building SALT was only half the story — the early operational years brought significant challenges. Initial test images in 2005 revealed an image quality problem: stars appeared distorted and out of focus across the field. This was a serious setback for a brand-new telescope. A forensic investigation traced the root cause to the optical alignment of the Spherical Aberration Corrector (SAC) — a mechanical interface was improperly toleranced, causing a focus gradient and aberrations across the 10-arcminute field. In April 2009, SALT took the drastic step of lowering the entire SAC from the telescope and dismantling it for repairs. The four corrector mirrors were individually tested, realigned, and the faulty mounting interface was rebuilt. By August 2010, the SAC was reinstalled, and soon SALT was delivering uniform ~1-arcsecond images across the full field of view — essentially meeting its design specification. Another early hurdle was a low throughput in the RSS spectrograph's UV regime, which was traced to contaminated optical assemblies that eventually had to be replaced.



Darragh O'Donoghue conducts optical acceptance tests on SALTICAM, the telescope's acquisition and imaging camera.

These technical challenges led to an extended commissioning period; effectively, full science operations were delayed until 2011 while fixes were implemented. The SALT team, with international expert support, learned invaluable lessons in this period — about diligent systems engineering, the importance of on-site test infrastructure, and risk management. The payoff came once the issues were resolved: SALT could finally deliver the sharp images and quality spectra it was designed for. These early hurdles, though difficult, ultimately strengthened SALT's operations. The observatory emerged from "first light frustrations" with improved hardware and a more seasoned team. The experience cemented a culture of resilience and innovation that continues to benefit SALT to this day.

SALT team members.

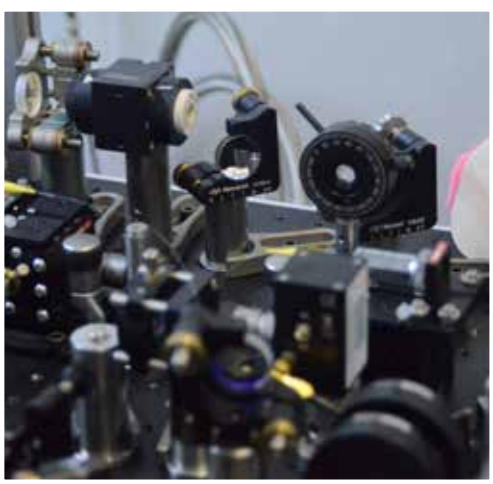
2011:

SCIENCE OPERATIONS BEGIN

By 2011, SALT was ready to fulfil its scientific promise. Following the successful repair of the optics and extensive testing, SALT finally transitioned to full science operations: The SALT Board formally declared "Phase I" construction complete and Phase II science operations underway, turning attention to maximising scientific return. For the first time, astronomers from the partner countries could rely on SALT to execute their observation programmes in a queue schedule, and each new semester saw dozens of proposals from consortium astronomers. Notably, South African researchers embraced SALT — from day one all South African astronomers had open access to SALT time, kickstarting many local projects. SALT's service-observing model (with SALT Astronomers performing observations for all proposals) proved especially valuable, allowing efficient use of every clear night and hour. Early science verification projects demonstrated SALT's capabilities: for example, observations of an eclipsing binary (UZ Fornax) in November 2011 showed SALT's unique strength in time-domain spectroscopy, capturing rapid optical variations in tandem with other telescopes. In 2012, SALT yielded its first science publications, including studies of hot subdwarf stars and distant quasars, heralding a productive research output.

The year 2011 thus marked a turning point: SALT was no longer a construction project overcoming teething problems, but a working observatory delivering data to scientists. The lessons of the preceding years had been integrated into robust operations. With a stable of instruments (imager, medium-resolution spectrograph, and a high-resolution spectrograph added in 2011–2014), SALT began producing high-impact results. From this starting point, SALT's scientific output would grow steadily, paving the way for the remarkable discoveries of the next decade.

SALT's view of the globular star cluster 47 Tucanae.



Detailed view of the High-Resolution Spectrograph

SALT TIMELINE:

MILESTONES AT A GLANCE

2000: Groundbreaking ceremony at Sutherland.

1998

South Africa announces plans for a 10-m class telescope; the government pledges initial funding. International partnerships begin forming under NRF leadership.

2000

Groundbreaking at Sutherland. Construction of SALT's enclosure and pier commences.

2003

SALT's giant dome (25-m diameter) and telescope structure installed on site.

2004

Installation of the 91 primary mirror segments is underway; the first segment was placed in March 2004.

MAY 2005

All mirror segments in place, completing the 11-m primary.

1 SEP 2005

First Light achieved with the full mirror: SALT images star clusters and the Lagoon Nebula at ~1" resolution.

10 NOV 2005

SALT officially **inaugurated** by President Thabo Mbeki. Science commissioning begins.

2006–2007

First science-grade instruments (SALTICAM imager and RSS spectrograph) commissioned. Early science observations start in limited capacity.

2007

AMNH and IUCAA join the partnership.

2005: Inauguration event on 10 November.

2022: Suspense in the control room when the NIRWALS First Light spectra appear on the screen.November.

SALT's 20-year history is marked by many significant milestones. Here is a timeline of key moments in the conception, construction, and growth of SALT:

2008 – 2010

Image quality problems investigated and resolved. SAC optics repaired (2009) and re-aligned (2010).

2011

Science operations begin in earnest. SALT conducts routine observations for consortium astronomers.

JUNE 2015

SALT's first major science **conference** held in South Africa, bringing users together (10th anniversary of first light).

2015

High Resolution Spectrograph (HRS) fully operational, expanding SALT's capabilities.

2017

SALT participates in observations of the first neutron star merger (gravitational wave event), the **start of multi-messenger astronomy**.

2018

Partnership changes: Universities of Göttingen (Germany) and Canterbury (NZ) conclude their membership.

2020

Shortly after the initial COVID-19 shutdown, SALT transitions to **remote** operations as one of the earliest of large telescopes around the world. A new data archive is launched with over 1,300 SALT programmes' data available online. UNC Chapel Hill concludes their membership.

2021

Major upgrades approved: the "RSS Big 5" instrument improvements and a laser frequency comb for HRS (for ultra-precise wavelength calibration). SALT resumes regular operations post-pandemic.

2022

New instrument installed: **NIRWALS**, Africa's first near-infrared integral-field spectrograph on SALT, achieves First Light.

2024

Installation of a compact laser frequency comb on HRS for better radial velocity precision begins (ongoing). A new Slitmask Integral Field Unit mode is introduced on the RSS spectrograph.

2025

SALT celebrates 20 years since its inauguration. An anniversary event in November 2025 honours stakeholders and highlights SALT's scientific and societal impact. Plans for future expansion (additional instruments, new partners) are on the agenda.

This trajectory shows how SALT evolved from an idea in 1998 to a mature observatory by 2025. Each milestone — technical or organisational — built upon the last, resulting in today's thriving facility.

DISCOVERY HIGHLIGHTS:

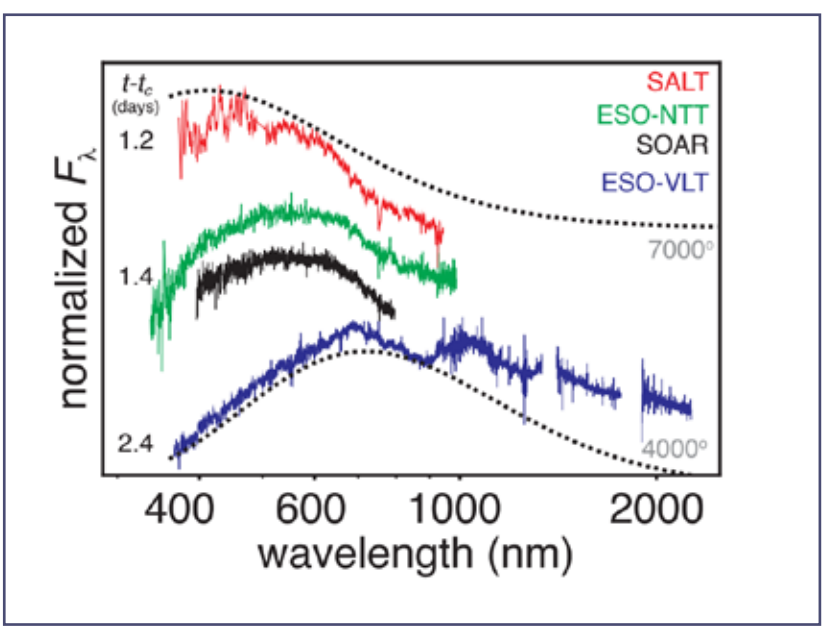
A DECADE OF RESULTS

SALT has enabled a wealth of scientific discoveries across astronomy. Here we highlight just a few standout results from SALT's fourteen years of full operations:

- **Kilonova of GW170817 (2017):** SALT took part in the first multi-messenger event. It was among the first telescopes to observe the optical afterglow of the first detected neutron star merger, obtaining a crucial, early spectrum of the kilonova associated with the gravitational wave event GW170817. These data helped confirm heavy element synthesis models in the merger ejecta — a landmark in multi-messenger astronomy.
- **Exoplanet Microlensing (2019):** SALT played a crucial role in a campaign that used gravitational microlensing to discover new exoplanets. For instance, SALT spectroscopy supported the characterisation of a short-period exoplanet detected by the Korean Microlensing Telescope Network (KMTNet), demonstrating SALT's strength in rapid follow-up of transient planet signals.
- **Eight Super-Hot Stars Unveiled (2020):** Using SALT, astronomers identified eight new extremely hot subdwarf stars — rare helium-burning stars with surface temperatures over 100,000 K. These discoveries provided insight into late stages of stellar evolution, with SALT's UV-sensitive spectroscopy proving crucial in analysing their atmospheres.
- **"Peekaboo" Galaxy Discovery (2022):** SALT helped characterise a tiny nearby galaxy nicknamed the "Peekaboo Galaxy", which had only recently emerged from behind a fast-moving star. SALT spectra showed the galaxy has extremely low metallicity, akin to galaxies in the early Universe. This finding, combining SALT and Hubble Space Telescope data, offers a unique local window into primordial galaxy conditions.
- **Multi-Stellar System (2023):** SALT, together with the University of Canterbury's observatory, discovered an unusual quadruple star system with two pairs of closely orbiting stars. SALT's spectra confirmed the gravitational binding of the four stars, providing a testbed for theories of multi-star formation.

These examples barely scratch the surface — SALT has also contributed to studies of black holes (e.g. monitoring accreting X-ray binaries), supernovae and gamma-ray bursts, large surveys of distant galaxies, and much more. The telescope's work has led to **well over 600 refereed scientific papers** in diverse areas of astrophysics. SALT's unique geographic location and flexible scheduling make it an ideal facility for rapid follow-up observations of new phenomena. Taking advantage of this unique feature, SALT's Project Scientist David Buckly initiated the first Large Science Programme 'Observing the transient Universe' in 2016. Involving five SALT partners and over 60 co-investigators from across the world, it follows up noteworthy transient events and has been extremely productive, accounting for more than 10% of all SALT publications to date.

From cosmic explosions to exoplanets, from galaxies in voids to Galactic nebulae, SALT's science has been rich and impactful — laying a strong foundation for even greater discoveries in the next 20 years.



Follow-up observations of the multi-messenger event GW170817: four early spectra taken with SALT (after 1.2 days), ESO-NTT (after 1.4 days), the SOAR 4 m telescope (after 1.4 days), and ESO-VLT-XShooter (after 2.4 days).

CONNECTING:

SALT CONFERENCES & COMMUNITY

A cornerstone of SALT's success is the vibrant community of astronomers and stakeholders it has cultivated. The SALT Science Conferences are a prime example: starting with the 10th anniversary Science Meeting in 2015 held in Stellenbosch near Cape Town, regular SALT conferences and workshops have brought users together to share results and plan collaborations. These meetings rotate among partner countries, strengthening ties across the consortium. SALT astronomers are also active in broader gatherings — for instance, SALT featured prominently at the African Astronomical Society conferences (with SAAO hosting AfAS 2023) and at the International Astronomical Union General Assembly in 2024.

Beyond formal conferences, the SALT user community stays connected through newsletters, mailing lists, and working groups. SALT's webpages keep scientists informed about current observing conditions and telescope status, and the operations team issues regular *SALT eNews*[1] updates to inform about proposal calls, meetings and newsletters. This open communication helps maintain engagement even during challenging times like the COVID-19 shutdown. The community aspect extends to students as well — SALT partners host exchange students and joint workshops (for example, a SALT summer school for young researchers was held in Poland in 2018).

Crucially, SALT's reach extends into the public sphere. Community open nights and visitor tours at Sutherland have welcomed thousands of members of the public per year, often with SALT as the star attraction. On-site staff and the SALT Astronomers guide local school groups and tourists, answering questions about the telescope and astronomy. SALT's Collateral Benefits Programme further integrates the observatory with the community via science festivals and school initiatives.

In summary, SALT is more than a telescope — it's the centre of a global community of practice in astronomy. The exchanges of ideas at conferences, the camaraderie among the international partners, and the outreach to the broader public all enhance SALT's impact. As we celebrate 20 years, we also celebrate the SALT community, whose enthusiasm and collaboration keep the observatory thriving.

Group photo of the first SALT Science conference, held in Stellenbosch from 1 to 5 June 2015.

[1] *https://list.saao.ac.za/wws/subscribe/saltenews*

STUDENTS & TRAINING:

BY THE NUMBERS

Training the next generation of scientists and engineers has always been a core goal for SALT. Two decades on, the numbers attest to a strong human capital impact: hundreds of students have gained experience through SALT-related projects, from undergraduate projects to PhD dissertations, including some valuable hands-on observing experience. SALT's partners have also sponsored dedicated fellowships: for example, the UK SALT Consortium has hosted about six "SALT Stobie" scholarship students from South Africa, boosting the production of astronomy PhDs. The SALT Collateral Benefits Programme has provided undergraduate bursaries for students from the Northern Cape province in science and engineering, lowering barriers for talented youth in the telescope's host province. Recent statistics highlight the pipeline of new talent: in the 2022–2023 period alone, 2 PhD and 4 MSc students supervised by SAAO/SALT staff graduated successfully. Many have gone on to postdoctoral positions and professional roles, contributing back to the astronomy community. SALT also develops technical skills — several instrumentation students and interns have trained at SAAO's workshops while working on SALT upgrades. The telescope's international nature means students benefit from global mentorship; exchange programmes have enabled South African students to visit partner institutions abroad (and vice versa) for specialised training. By the numbers: more than 50 doctoral theses across the partnership have been based on SALT data (and counting), and dozens of postgraduates have built careers via their SALT experience. Many early-career astronomers who cut their teeth on SALT now occupy faculty or researcher positions, expanding the network of SALT expertise worldwide. In summary, SALT's first 20 years have not only produced great science — they have produced people. Investing in students and training is perhaps SALT's most lasting legacy, ensuring that the telescope's impact will be felt for generations to come in the form of skilled professionals inspired by the night sky.

Previous SALT–Stobie scholars: Retha Pretorius, Elmé Breedt, Vanessa McBride and Tana Joseph.

NEW CAPABILITIES:

RSS "BIG 5", NIRWALS & OTHERS

To remain at the forefront of astronomy, SALT has continually upgraded its instruments and technology. A major recent initiative is the "RSS Big 5" project — a comprehensive upgrade to SALT's workhorse imager/spectrograph, the Robert Stobie Spectrograph (RSS). The "Big 5" refer to five key enhancements identified in 2020: replacing two problematic optical assemblies (a doublet and a triplet) within the collimator to improve the throughput of the instrument, installing a new high-throughput 700 l/mm grating to optimally capture the full optical range of the spectrograph in a single spectrum, upgrading the operationally worn long-slit masks and the "letterbox" (where the slitmask gets inserted into the beam) to improve operational efficiency and data quality, and a complete detector upgrade (a monolithic large-format CCD with a new controller architecture to replace the current obsolete controllers). As of 2025, most of the "Big 5" are completed — the new RSS detector is in development with first light expected in the first half of 2026. These upgrades will significantly boost RSS performance, keeping SALT scientifically competitive.

In parallel, SALT has acquired a brand-new capability in the Near-Infrared (NIR). The instrument known as NIRWALS — Near InfraRed Washburn Astronomical Labs Spectrograph — is the first SALT instrument to operate beyond 900 nm. Built by a UW–Madison-led team, NIRWALS is an IFU-fed spectrograph using a fibre bundle to sample an extended field, opening up SALT to the infrared sky (J and H bands) for the first time. This capability is critical for studies of AGN and the big question on how these systems have regulated the star formation histories of galaxies. The data will add information on shocks in the gas from AGN outflows, past supernovae, and the very youngest stellar populations. Other areas of interest are redshifted galaxies and dust-obscured objects. NIRWALS effectively places South Africa at the forefront of time-domain infrared astronomy, complementing projects like the Vera Rubin Observatory by enabling rapid NIR follow-up. NIRWALS is in the commissioning phase and not yet available to the wider science community.

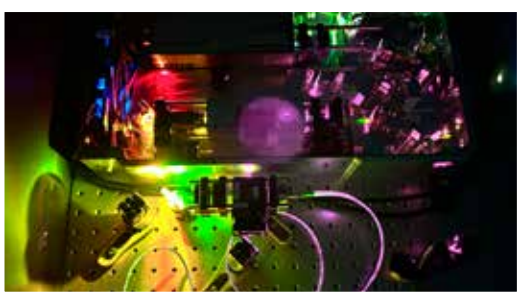
In 2024, the capabilities of the RSS have been expanded into the second spatial dimension through the addition of a novel optical fibre integral field unit (IFU), which sits in its own slitmask cassette and is referred to as a slitmask IFU (SMI). Made in the SAAO machine shop, SMI-200 was designed to fit within a compact volume of 130 × 140 × 8 mm. Managing the routing of many fibres within such a constrained space was a ground-breaking engineering feat, requiring novel solutions to ensure light transmission efficiency. The elongated hexagonal shape of the SMIs is ideal for observing galaxies over a range of inclination angles, and can be used to map more extended objects from Galactic HI regions, to merging and interacting galaxies, to galaxy cluster cores and strongly lensed galaxies. Additionally, the SMIs can be effective as photon buckets for low surface brightness observations.

Another exciting addition is the Laser Frequency Comb (LFC) being integrated with SALT's High Resolution Spectrograph (HRS). The LFC is an ultra-precise wavelength calibration source that produces a "ruler" of spectral lines at known frequencies. Once operational (planned for 2026), the LFC will allow HRS to measure radial velocities to unprecedented precision — a boon for exoplanet hunters searching for minute stellar wobbles, and for studying binary stars and pulsations. The SALT Board approved the procurement of a comb in 2021, recognising it as a strategic upgrade to keep HRS competitive with facilities on larger telescopes. Early tests indicate that SALT will be capable of m/s-level velocity measurements, pushing SALT into the regime of precision radial velocity science including exoplanet work.

Finally, SALT is modernising its operations via the Intelligent Observatory framework. This involves software and hardware upgrades (like robotising smaller telescopes and linking them to SALT) so that SALT can respond autonomously to transient events. One aspect already in use is advanced scheduling software that dynamically reprioritises observations based on real-time alerts — a feature proven by the autonomous running of the 1.0-m Lesedi telescope on site. SALT is gradually integrating into this network, which will eventually enable, for example, SALT to interrupt its queue and slew to a target-of-opportunity within minutes of an alert (e.g. a gravitational wave trigger). The new instrumentation like NIRWALS and the "Big 5" upgrades are being designed with such flexibility in mind.

In summary, at 20 years SALT's technical evolution is in full swing. Upgrades to RSS enhance optical spectroscopy, NIRWALS will open up infrared astrophysics, and the laser comb elevates precision radial velocity capability. These, coupled with smarter observing systems, ensure that SALT remains a "world-class telescope… continually evolving" in the coming decade — much more than the sum of its original parts.

Slitmask IFU.



LFC all aglow.

SALT IN THE GLOBAL CONTEXT:

PARTNERSHIPS & IMPACT

From its inception, SALT has been an international endeavour, and its role on the world stage has only grown. SALT is one of the five 10m-class segmented-mirror telescopes in the world (alongside the two Kecks, HET and Gran Telescopio Canarias). As the largest single optical telescope in the southern hemisphere, SALT provides coverage of southern skies that many northern observatories cannot see, making it a valuable part of the global network. Over 20 years, SALT has built partnerships across five continents. The consortium currently includes institutions from South Africa, the United States (Rutgers University, Dartmouth College, the University of Wisconsin–Madison, and the American Museum of Natural History), Poland (five partner institutions coordinated by Nicolaus Copernicus Astronomical Center (NCAC) of the Polish Academy of Sciences), India (IUCAA), and the United Kingdom (through the UK SALT Consortium which currently includes Armagh Observatory & Planetarium). Former partners are the University of Göttingen (Germany), University of Canterbury (NZ), and UNC Chapel Hill (USA) as well as the UKSC partner universities of Central Lancashire, Keele, Nottingham, Southampton and Open University. The HET Consortium, although not a shareholder, received ten percent of the telescope time for the first ten years of operation, in return for providing all of the designs and plans from the HET, as well as assistance during the construction of SALT. Each partner contributes or has contributed operational funds and in-kind support, receiving observing time in proportion to their share. This model has fostered a collaborative spirit — for instance, astronomers from different countries frequently team up on projects, leveraging SALT's capabilities to complement data from facilities elsewhere.

SALT's scientific impact is amplified by global multi-wavelength collaborations. The telescope often works in concert with space observatories (like Hubble, Swift or JWST) and other ground-based giants (ESO's VLT, ALMA, etc.). For example, SALT has been a key follow-up resource for transient events discovered by facilities like the Zwicky Transient Facility, the MeerKAT radio telescope and the space mission eROSITA, providing optical spectra to characterise objects initially found in other wavelengths. In the era of big surveys (like the upcoming Vera C. Rubin Observatory), SALT is expected to play a major role by obtaining detailed spectroscopy of interesting southern transients — effectively acting as the "spectroscopic eye" for these survey telescopes. Recognising this, SALT joined the Global Rapid Response network and has arrangements to receive alerts from networks for gamma-ray bursts, gravitational waves, and neutrino detections.

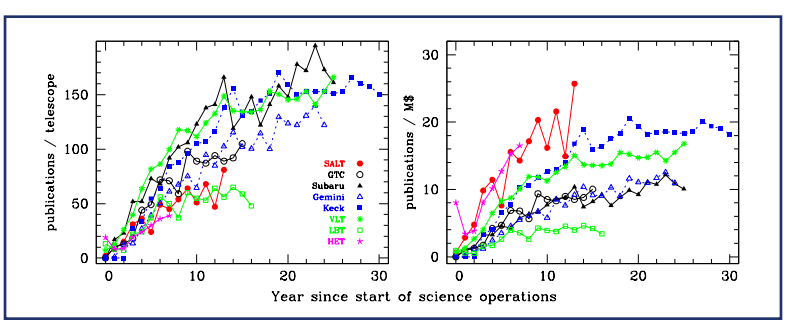
On the diplomatic front, SALT has enhanced South Africa's profile in science. It was frequently cited as a pathfinder project for the SKA radio telescope — showing that cutting-edge mega-science projects can succeed in Africa. The presence of SALT helped Cape Town secure the bid to host the IAU General Assembly 2024, the first time this prestigious event came to African soil.

In terms of raw output, SALT punches above its weight in cost-effectiveness — it has been called "the most cost-effective large telescope and science producer in the world." An average of ~50–60 refereed papers per year were produced in recent years using SALT data, with a record 82 papers in 2024 alone. While this is less than most large (and far more expensive) telescopes, if the operations costs are taken into account, the science output of SALT remarkably exceeds that of most of these facilities. These papers are well-cited, showing that SALT data are meaningfully contributing to our understanding of the universe. SALT's niche of flexible scheduling and spectroscopy allows it to carve out a complementary role alongside its peers.

Importantly, SALT's global impact is also about people: the project has created a network of astronomers and engineers across partner countries. Many early-career researchers trained on SALT have moved into positions around the world, spreading expertise and often continuing to collaborate on SALT projects. The observatory's governance (with Board meetings rotating among partner countries) ensures continued engagement at institutional levels. As SALT looks to the future, it is actively engaging with potential new partners to possibly join the consortium, which would infuse fresh investment and broaden SALT's geographic reach. Sustaining and expanding international partnerships will be crucial for SALT's next 20 years.

SALT stands as a global scientific asset and a model of international cooperation. It contributes unique southern-sky capabilities, integrates into worldwide observing campaigns, and elevates Africa's status in big science. The first 20 years have demonstrated SALT's value; the world is taking notice, and SALT's global role is poised to grow even further.

Refereed publications since science operation started for major telescopes. Left: publications per year and per telescope; right: publications per year and per operation cost in million US Dollars.



PEOPLE:

SOCIETAL IMPACT

SALT's influence reaches well beyond the realm of research. Nationally in South Africa — and especially in the Northern Cape province — SALT has had a transformative impact on education, public engagement, and the local economy. During SALT's construction, the SALT Collateral Benefits Programme (SCBP) was established to maximise socio-economic benefits. This programme has continued ever since, focusing on improving math and science education in rural communities and creating opportunities linked to SALT. For example, SCBP funds a full-time mathematics teacher in Sutherland's schools to uplift STEM skills, a direct investment in the small town hosting the telescope. The programme also runs annual science workshops for teachers, astronomy quizzes and competitions for students, and has provided infrastructure like a community computer lab. Each year, thousands of South African learners are reached through SALT-driven outreach initiatives. In 2024, as part of the IAU General Assembly legacy, SAAO distributed 100 digital screens and mini-computers to under-resourced schools (equipment originally used for the hybrid conference) — extending SALT's educational impact far beyond Sutherland.

Economically, SALT has helped put the remote Karoo town of Sutherland on the map as a tourist destination. Astro-tourism has boomed: before the pandemic, over 11,000 visitors per year travelled to Sutherland, drawn by the observatory (compared to only a few hundred visitors annually before SALT was built). Local guesthouses, B&Bs, and restaurants have flourished. "The town of Sutherland has been reshaped by astro-tourism" — astronomy has become part of the town's identity. At the same time, vast challenges remain: Sutherland is a community with high levels of poverty and unemployment and harsh winters. Acknowledging this, SALT (through NRF-SAAO) has contributed to local welfare projects. During COVID-19 lockdowns, SALT helped coordinate food parcel distributions in the town (with NGO Gift of the Givers) to support indigent families. SALT also works closely with the local municipality and other stakeholders on initiatives. Plans to mark the 20th anniversary include a trauma room at the police station and a safe house for those affected by abuse or violence, as a thank-you to Sutherland for hosting the facility.

Nationally, SALT has become a source of pride and inspiration. The telescope's iconic dome (featured on South African postage stamps, in adverts and science magazines) symbolises the country's scientific ambitions. Public open nights at the SAAO in Cape Town routinely feature SALT updates and draw large crowds, helping cultivate a culture of science appreciation. SALT and SAAO staff frequently appear in the media, and SALT's discoveries — such as colliding neutron stars or peculiar new stars — have been reported in the popular press, igniting imaginations. SALT's success also provided momentum for other large science projects like the SKA radio telescope; it demonstrated to policymakers that investing in big science pays off in prestige, human capital, and innovation. In 2018, Dr Khotso Mokhele (SALT's early visionary) reflected that SALT "has laid the foundation for South Africa's knowledge economy" — not only through research but through skills development and international partnerships.

One cannot overlook the cultural impact as well. Astronomy in South Africa has a 200-year legacy, but SALT has helped democratise it. Programmes to translate SALT educational materials into local indigenous languages have been carried out. SALT's 20th anniversary celebrations include art and poetry competitions in the Karoo, blending science with local culture. By engaging with society in multiple ways, SALT exemplifies how a scientific facility can be a catalyst for broader development. It stands as both a scientific monument and a community partner in South Africa. As we celebrate SALT's achievements, we also celebrate the students inspired, the jobs created, and the curiosity sparked in countless minds over the last two decades — a truly incalculable impact.

LOOKING AHEAD:

THE NEXT DECADE

As SALT enters its third decade, plans are underway to ensure the telescope remains productive and relevant into the 2030s. One key focus is sustainability — both financial and technical. The SALT Board and NRF are actively exploring new partnerships to expand the consortium (targeting an additional ~10% share partner). New member institutions would bring fresh expertise and funding for operations and instrument development, keeping SALT and its instruments state-of-the-art. The renewal of the Spherical Aberration Corrector (SAC) marks a major step forward for SALT. Restoring the throughput to its original pristine level will effectively deliver a better SALT than ever before — not only regaining full optical performance, but doing so at a time when the telescope's suite of instruments and observing modes has expanded far beyond what was available in its early years. Together, these developments will open new scientific opportunities and greatly enhance SALT's overall impact and flexibility as a research facility.

Looking beyond the SAC renewal, plans for future developments remain open. The next step will be to engage the community to identify the most compelling scientific and technical opportunities. Potential areas for exploration include modular spectrographs, extended NIR capabilities for the HRS, and deployable IFUs. These ideas are still at an early stage and will be refined through consultation to ensure that future investments align with SALT's long-term scientific vision.

The Intelligent Observatory programme will continue to grow. Within a few years, we envision SALT being fully integrated into an automated network where it can respond to alerts (like supernovae or gravitational waves) within minutes. The success of autonomous operation on the smaller telescopes at Sutherland paves the way for SALT to adopt similar modes for certain programmes. For astronomers, this means SALT could capture fleeting events that previously would have been missed. Efforts are also ongoing to improve observing efficiency — an "efficiency project" launched in 2022 has already optimised procedures, reducing overhead time by 17%. Future initiatives may include queue-scheduling algorithms enhanced by AI to maximise the use of every second of clear sky.

On the science front, SALT's strategic priorities align with the broader direction of astronomy. Transient and time-domain science will likely dominate the next decade, and SALT is well-positioned as a go-to transient follow-up telescope. The Vera C. Rubin Observatory is set to begin full survey operations in 2025/26, and SALT is preparing to be a major resource for spectroscopic follow-up of LSST discoveries in the south. The telescope's spectroscopic capabilities enable the characterisation of kilonovae, supernovae, variable stars, etc, that the Vera C. Rubin telescope will find by the thousands. Similarly, SALT will synergise with the SKA in multi-wavelength studies (combining optical with the radio) well into the 2030s. SALT's strategic vision, initially developed by the community in 2017 and updated in 2025, highlights transients and galaxy evolution as focus areas. Additionally, exoplanet science is on the rise at SALT — with the LFC improving HRS, SALT could join the search for exoplanets around bright southern stars and follow up planet candidates from new missions such as PLATO with precise radial velocities.

Infrastructure-wise, the next decade should see further improvements at the observatory. Plans exist for a significant computing upgrade to handle the growing data rates and to enable on-the-fly data reduction (so astronomers can get quick feedback on spectral quality for transients). There is also discussion of enhancing visitor facilities, perhaps building a second small visitor telescope for public viewing, as astronomy tourism demand increases. On the power side, SALT has already installed a 40 kVA solar plant in 2020 to offset electricity costs; by 2030, the goal is to steadily increase the use of renewable energy. This not only cuts costs but also demonstrates environmental responsibility in the ecologically sensitive Karoo region.

Finally, the human element remains crucial looking ahead. The coming years will involve training a new cohort of technicians and observers to replace retiring staff — knowledge transfer programmes are in place to ensure skills continuity. The SALT partners will also continue to support students; one idea for the next decade is a "SALT Fellows" programme, where early-career scientists are funded to work with SALT data and participate in observatory service observing, thereby deepening the user base's expertise. The SALT Foundation and NRF have committed to maintaining robust funding for outreach and education, keeping SALT's social impact strong.

In summary, the next decade for SALT is bright. With careful planning, new partners, and technical upgrades, SALT will remain "Africa's Giant Eye" and a versatile, modern research tool. By 2035, SALT could very well be operating with multiple advanced instruments, perhaps fully automated on many nights, and playing a central role in global transient networks. The foundation laid in the first 20 years gives confidence that SALT's best is yet to come — the next chapter of discoveries and innovations is on the horizon, and we are ready to seize it.

SALT under a sky of countless stars. As it enters its third decade, SALT is poised to continue exploring the southern skies and inspiring the next generation of scientists.

FINAL REMARKS:

ACKNOWLEDGEMENTS & PARTNERS

SALT's achievements over 20 years are a testament to the dedication of many organisations and individuals. First and foremost, we acknowledge the SALT partners — without their vision and support, this project would not exist. The National Research Foundation (NRF) of South Africa (through the South African Astronomical Observatory, SAAO) provided roughly one-third of the construction funding and remains SALT's largest shareholder and operational home. We thank our international partners: Rutgers University, Dartmouth College, University of Wisconsin–Madison as well as American Museum of Natural History from the United States, the Polish SALT consortium led by the Nicolaus Copernicus Astronomical Centre (NCAC), The Inter-University Centre for Astronomy & Astrophysics (IUCAA) representing India, and Armagh Observatory & Planetarium representing the UK SALT Consortium. These partners not only contributed funds and hardware but also lent significant technical expertise and staff time during commissioning and upgrades. We also recognise our former partners — Göttingen University (Germany), the University of Canterbury (New Zealand), UNC Chapel Hill (USA), Open University and the Universities of Central Lancashire, Keele, Nottingham, and Southampton (UK), and the HET consortium — for their equally important contributions in SALT's early years. SALT's success belongs to all of you.

We extend gratitude to the SALT Board of Directors (past and present) and SAAO leadership for steering the project wisely. Visionaries like Dr Khotso Mokhele, SAAO Director Robert Stobie and former SALT Board chair Prof. Michael Shara provided leadership in critical phases. Our thanks go to the SALT Foundation committees — the Board Executive Committee (BEC), Scientific and Technical Committee (STC), and Finance and Audit Committee (FAC) — for diligent oversight. We thank all those that were involved in building and operating SALT over the years. The on-the-ground heroes are the engineers, technicians, and astronomers at SAAO/SALT who operate and maintain SALT's complex machinery. Their hard work (often in the cold and wind on the plateau) keeps SALT running smoothly. A special thanks to the late Dr Darragh O'Donoghue, whose contributions to the SAC's optical design and the SALTICAM instrument were pivotal.

We acknowledge the Department of Science, Technology and Innovation (DSTI) and NRF in South Africa for unwavering support through funding and strategic backing. SALT's construction and ongoing operations were made possible by the government's commitment to science. We also thank NRF-SAASTA and other outreach partners who help maximise SALT's impact in education. Locally, the community of Sutherland has been a partner in the truest sense — we thank the people of Sutherland and the Karoo Hoogland Municipality for welcoming SALT and working with us to ensure mutual benefits. Initiatives like the SALT Collateral Benefits Programme have only succeeded with the cooperation of local schools, educators, and officials.

To the "future builders" of SALT — the instrumentation teams and collaborators developing the next generation of SALT capabilities — we extend our appreciation. Your innovative work on upgrades like NIRWALS, the laser frequency comb and more will keep SALT at the cutting edge. We are grateful as well to external collaborators and observers around the world who may not be formal partners but have used SALT data and contributed to its scientific legacy.

Finally, a warm thank you to everyone who has shared in SALT's journey: from the tour guides who tell SALT's story to visitors, to the students who ask curious questions on social media, to the support staff who handle logistics behind the scenes. SALT truly has been a team effort on a global scale.

Here's to 20 years of SALT — and with your continued support, to many more years of discovery ahead.

THANK YOU / BAIE DANKIE / RE A LEBOGA / NDIYABULELA!

CURRENT PARTNERS

NRF National Research Foundation | SAAO South African Astronomical Observatory

DARTMOUTH

RUTGERS THE STATE UNIVERSITY OF NEW JERSEY

IUCAA

NICOLAUS COPERNICUS ASTRONOMICAL CENTER OF THE POLISH ACADEMY OF SCIENCES

ARMAGH OBSERVATORY & PLANETARIUM

WISCONSIN UNIVERSITY OF WISCONSIN-MADISON

AMERICAN MUSEUM OF NATURAL HISTORY

FORMER PARTNERS

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN IN PUBLICA COMMODA SEIT 1737

University of Nottingham UK | CHINA | MALAYSIA

THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

UC UNIVERSITY OF CANTERBURY Te Whare Wānanga o Waitaha CHRISTCHURCH NEW ZEALAND

uclan University of Central Lancashire

UNIVERSITY OF Southampton School of Physics and Astronomy

Keele UNIVERSITY

The Open University

ACRONYMS

AfAS	African Astronomical Society
AGN	active galactic nucleus
AI	artificial intelligence
ALMA	Atacama Large Millimeter/submillimeter Array
AMNH	American Museum of Natural History
ASSA	Astronomical Society of South Africa
B&B	Bed and Breakfast
BEC	board executive committee
CCD	charge-coupled device
COVID-19	coronavirus disease 2019
DSTI	Department of Science, Technology and Innovation
eROSITA	extended ROentgen Survey with an Imaging Telescope Array
ESO	European Southern Observatories
FAC	finance and audit committee
GW	gravitational wave (object name prefix)
HET	Hobby–Eberly Telescope
HRS	high-resolution spectrograph
IAU	International Astronomical Union
IFU	integral field unit
IQ	image quality
IUCAA	Inter–University Centre for Astronomy & Astrophysics
JWST	James Webb Space Telescope
KAT	Karoo Array Telescope
KMTNet	Korean Microlensing Telescope Network
LFC	laser frequency comb
LSST	Legacy Survey of Space and Time
MSc	master of science
NASSP	National Astrophysics and Space Science Programme
NCAC	Nicolaus Copernicus Astronomical Center
NGC	New General Catalog
NGO	non-governmental organisation
NIR	near-infrared
NIRWALS	Near InfraRed Washburn Astronomical Labs Spectrograph
NRF	National Research Foundation
PFIS	Prime Focus Imaging Spectrograph
PhD	doctor philosophiae
PLATO	PLAnetary Transits and Oscillations of stars
RSS	Robert Stobie Spectrograph
SAAO	South African Astronomical Observatory
SAASTA	South African Agency for Science and Technology Advancement
SAC	Spherical Aberration Corrector
SALT	Southern African Large Telescope
SALTICAM	SALT Imaging CAMera
SCBP	SALT Collateral Benefits Programme
SKA	Square Kilometre Array
STEM	science/technology/engineering/mathematics
STC	scientific and technical committee
U	university
UNC	University of North Carolina
UV	ultraviolet
UW	University of Wisconsin
VLT	Very Large Telescope

SALTastro

@SALT_Astro

www.salt.ac.za

CAPE TOWN

PO Box 9, Observatory
7935
South Africa

Phone: +27 (0)21 447 0025
Email: salt@salt.ac.za

SUTHERLAND

Old Fraserburg Road
Sutherland
6920

Phone: +27 (0)23 571 1205
Fax: +27 (0)23 571 2456