SALT
Newsletter

August 2022

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Editor: Anja C. Schröder

Cover image: Face-on view of the 62 fibres in the sky bundle (left) and the 228 fibres in the IFU (right) of the NIR. -- *Credit*: Lisa Crause

Letter from the Head of Astro Ops

Dear SALT Community,

If you haven't heard it yet, NIR arrived safely in South Africa in May, and, after a burst of furious activity by the local and UW teams, it achieved on-sky first light on the night of 7 July 2022! ☺ And it was just in time, as the UW team had to depart the very next morning for the SPIE "Astronomical Telescopes and Instrumentation" conference in Montreal in early July, where the RSS PI, Marsha Wolf, was due to give a presentation on NIR on day 1 – luckily with good news! Moses writes about it below.

In fact, several of us in the SALT team, together with some SAAO staff, attended and presented our work at SPIE – and we had planned on writing a newsletter article about it, but preparation for NIR on-sky commissioning is pretty intense at the moment, so we'll tell you in the next newsletter. In the meantime, Daniel Cunnama, the SAAO's science engagement astronomer, has been running the SALT booth at a couple of conferences this year (EAS in Spain in June and the IAU-GA in S. Korea a couple of weeks ago), and he writes about the experience below.

The call for NIR shared-risk proposals was well received by the SALT community – it's good to see that so many people are as excited about NIR as we are! We at AstroOps are hard at work preparing all of the tools ready for phase 2, from the simulator to the planning tools and observing tools, all the way to a full data reduction pipeline – we'll keep you posted!

We also have some more news for you: as you know, we had planned to install some new optics on RSS in September. However, due to some delays with getting the telescope ready for NIR, and preparing for a very important review for our red arm of RSS, we have decided to postpone the RSS optics installation until February next year. So our RSS users will be happy to hear that we will have RSS available for the rest of the semester.

We'd also like to extend a very warm thank you to all of you who completed our survey last June. We summarise the results and our plans below. In fact, our plans involve a hybrid SALT workshop in November, which Ros explains below.

And finally, here's your opportunity to put a face to a well-known name and get to know him a little better: Solohery introduces himself below.

Clear skies and stay safe!

Encarni

SCIENCE HIGHLIGHT

Search for eXtremely Metal-Poor galaxies in the Local Universe

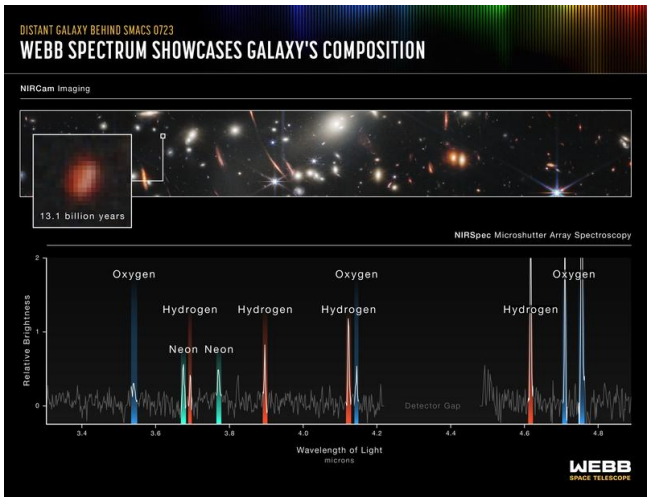
by Alexei Kniazev (SAAO/SALT)

In the framework of the modern cosmological paradigm, the great majority of galaxies have been formed during the first 1–2 Gyr after the Big Bang, which occurred ~13.7 Gyr ago. Initially, galaxies were purely gas objects (protogalaxies) with the so-called 'primordial' element composition, consisting of Hydrogen and Helium. Under the gravitational force, gas was compressed and formed the first stars. Due to the thermonuclear reactions, elements heavier than He (dubbed 'metals') were synthesised in the stellar interiors. At the end of a massive star's life, the metals were deposited into the surrounding gas and mixed over the entire galaxy, thus increasing the Z(gas)-metallicity of the interstellar matter. Galaxy evolution is the combination of two related processes: transformation of gas into stars and the enrichment of the interstellar gas by products of stellar evolution. Therefore, the parameters 'gas mass fraction' M(gas)/[M(gas)+M(stars)] and metallicity Z(gas) characterise the stages of galaxy evolution. Large disc galaxies, for example, are evolutionary evolved. They have a gas mass fraction of 5–20% and a metallicity Z(gas) of about $Z_\odot$ = 0.02 (where $Z_\odot$ is the metallicity of the solar matter). In smaller disc galaxies, the gas mass fraction can reach a few tens of percent, while its metallicity is several times lower, down to the level of $Z_\odot$/10.

It should be noted, however, that galaxies with metallicities of $Z_\odot$/50 – $Z_\odot$/30 and a gas mass fraction more than 90% are extremely rare in the modern Universe. In terms of their properties, they appear similar to galaxies in the early Universe, while residing really 'close' to us. The nearest of them are at the distances of less than ten Mpc, and thus can be studied in great detail. This gives a strong motivation to search actively for them.

Alexei used a recently published JWST NIR spectrum of a lensed star-forming galaxy at z~10 to estimate the oxygen abundance which seems to be about $Z_\odot$ = 0.02–0.05, demonstrating that there indeed exists a population of galaxies in the early Universe with such low gas metallicity.

– Image credit: NASA, ESA, CSA, and STScI

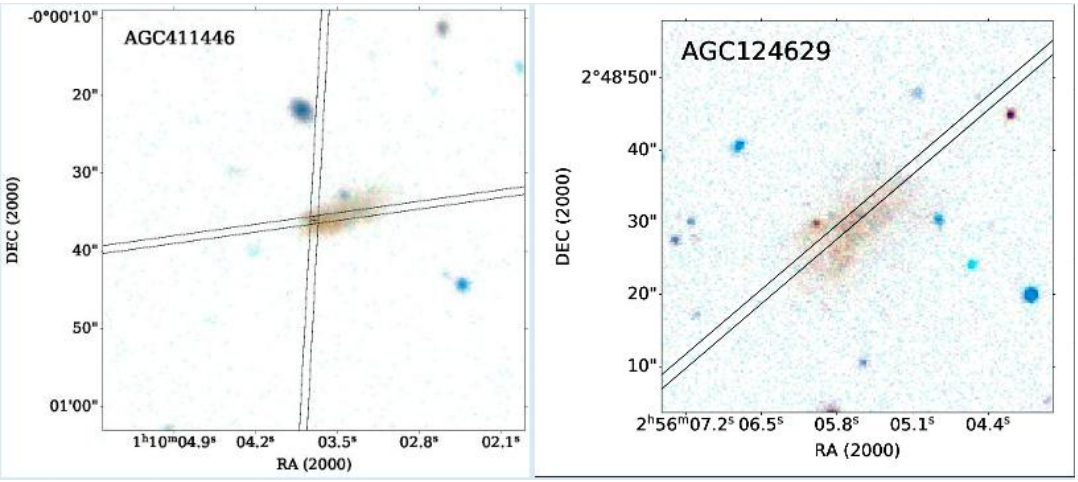


A prototype of such objects in the local Universe, is I Zw 18 with Z(gas) = $Z_{\odot}/30$. It was discovered about 50 years ago. To date, optical spectra of hundreds of thousands of galaxies have been analysed and the estimates of Z(gas) in many thousands of them were obtained. However, only about 10 or so galaxies were found to be the 'eXtremely Metal-Poor' (XMP) objects with Z(gas) ≤ $Z_{\odot}/30$.

Meanwhile, model simulations published over the last five years predict the existence of rare nearby galaxies in which more than half of the stellar mass have been formed within the last Gigayear. They are dubbed 'Very Young Galaxies', VYGs. Of the known objects, I Zw 18 and its companion I Zw18 C can be confidently assigned to this group. Also, several other XMP dwarfs are considered as good candidates to VYGs.

There exist various methods to search for XMP galaxies in the local Universe, though all of them have a low efficiency of ~1:100 – 1:1000. Our team suggested an alternative method for finding XMP galaxies, based on two facts: (1) the great majority of known XMP dwarfs, including I Zw 18 are located in the low-density environments (voids); and (2) our studies of galaxies in the nearby voids confidently demonstrate an overall metallicity deficiency (on average, by a factor of ~1.4) of the late-type galaxies in voids with respect to similar objects in the denser environments.

Realising this approach within the framework of our general project of studying galaxies in nearby voids, we selected 60 *candidate* XMP dwarfs (out of 1,350 galaxies residing in these voids) to study their spectra. To date, using large optical telescopes in both hemispheres (SALT, South Africa, and 6m BTA, Russia), we have obtained spectra of all these candidates. Of these, ten galaxies turned out to be new XMP objects, resulting in a greatly improved efficiency of 1:6. With this addition, the number of these unusual galaxies known has grown to 19. Moreover, we found that the Z(gas) of $Z_{\odot}/28$ – $Z_{\odot}/23$ of twenty further void galaxies is only a little higher than the adopted boundary of $Z_{\odot}/30$. Since such galaxies are also very rare, their addition to the new data-set will enable us to better study the group and individual properties. Therefore, the overall efficiency of our method to find XMPs and very low metallicity dwarfs reaches ~15 and 50%, respectively (see figure).



Finding chart with slit positions of two XMPs.

In the course of the on-going project devoted to the spectroscopic study of all void galaxies residing within the Local Volume (D ≤11 Mpc), we found an additional two new XMP galaxies and six new galaxies with $Z < Z_{\odot}/25$.

The majority of newly found void XMP galaxies resemble the representatives of VYGs in their properties. Further detailed studies will enable us to better understand their unusual properties and evolutionary status.

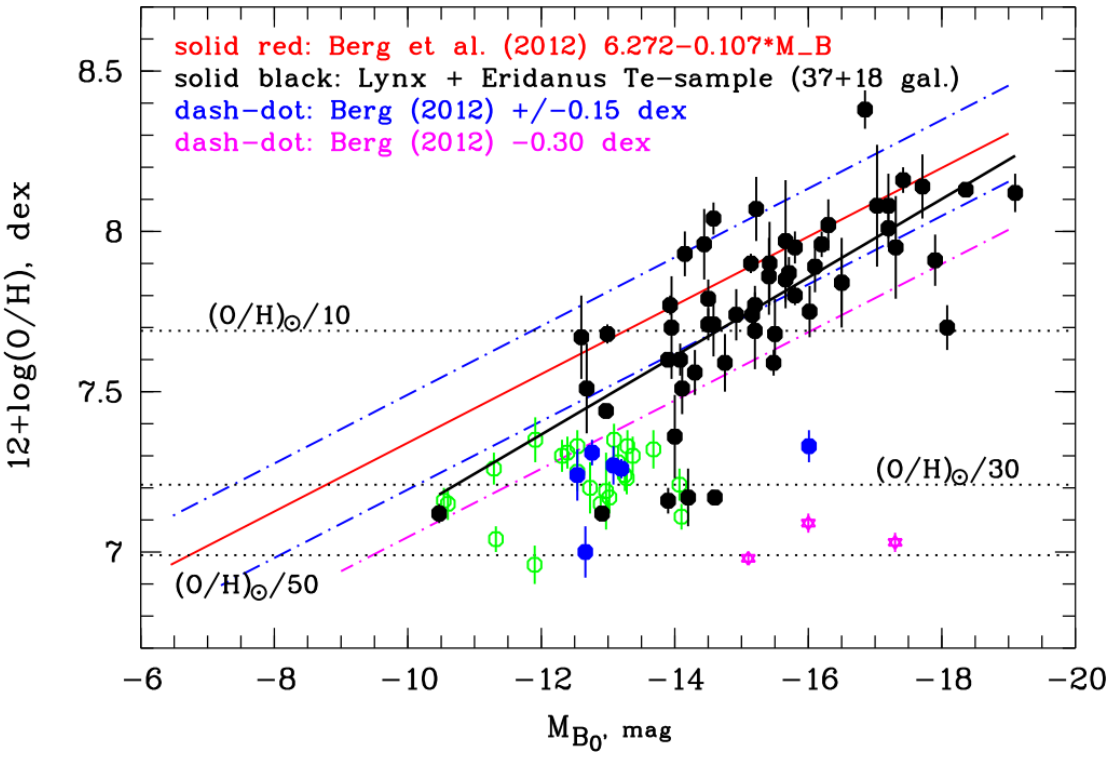


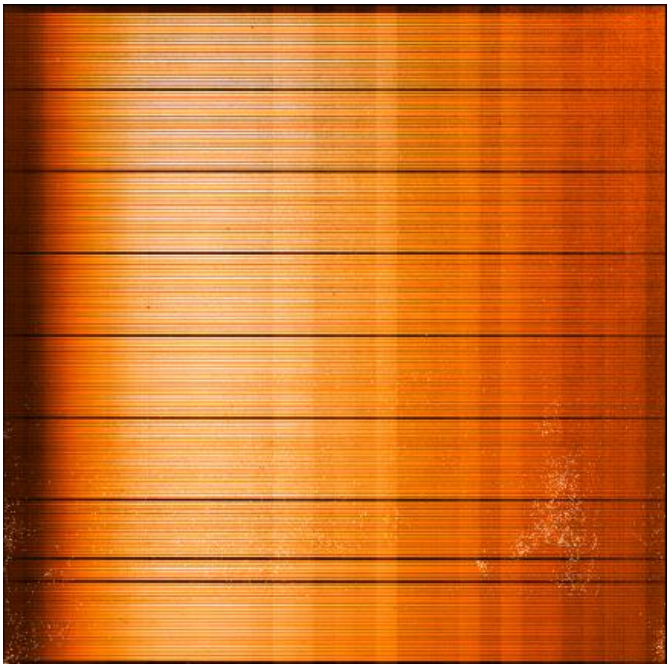
Figure 1:. The relation between log(O/H) (metallicity) and the absolute blue magnitude M_B of void galaxies. The void galaxies shown in the plot are studied in the framework of our previous and on-going projects during the last 10 years. These results are published in 10 papers. Black filled octagons show positions of all galaxies with metallicities derived with the most accurate T_e-method (direct). A total of 55 galaxies are shown (37 galaxies from the Lynx–Cancer void and 18 galaxies from the Eridanus void). The solid black line shows the linear regression on these 55 void galaxies. It runs somewhat steeper than the reference relation defined on the Local Volume sample in a denser environment (shown with solid red line). As a result, the difference to the reference sample is subtle for the more luminous galaxies. However, for galaxies with $M_B \geq -14^m$, the great majority of void galaxies sit well below the reference relation. Green empty octagons show void galaxies observed with SALT and the 6-m BTA telescope, with O/H estimated via the 'strong-line' method. Blue octagons are void dwarfs with O/H(dir) from the literature and 'strong-line' O/H for several dwarfs in the Lynx–Cancer void. Three distant record-low XMP galaxies are shown as purple stars for comparison.

Are extremely metal-poor galaxies in the Local Universe young or not?

There are various arguments. Some people argue that Very Young Galaxies could be found only at the cosmological distances, while locally we see examples where matter was injected from the dwarf galaxy (or other related scenaria). Latest modelling shows that it is possible to have some galaxies in the Local Universe that were born a long time ago but had very low star formation rates for whatever reason and so did not produce sufficient metals. Then suddenly they had a very strong star formation burst about a Gigayear ago, with more than half of their stellar mass having been formed since then. Such galaxies are now called VYGs.

Hot off the press:
We are delighted to announce a very successful NIR first light!

After the arrival of the instrument components to SALT in May, members of the University of Wisconsin team travelled to SALT and worked with the SALT Tech Ops team on the first two stages of the instrument commissioning. The team from University of Wisconsin included PI Marsha Wolf, Mike Smith and Kurt Jaehnig. They spent many weeks unpacking and assembling the various components, integrating the cables and electronics, and testing various systems and mechanisms. They also assembled, aligned and tested the optics. The cooling was tested, and the instrument was tested at both the warm (ambient) and the operational cold (–40 degrees C) temperature. The fibre cable arrived last, and Joshua Oppor, Sabyasachi Chattopadhyay, Mike and Marsha worked with Tech Ops to install it: connecting the fibres to the slit, routing them up the telescope and connecting them to the fibre instrument feed.



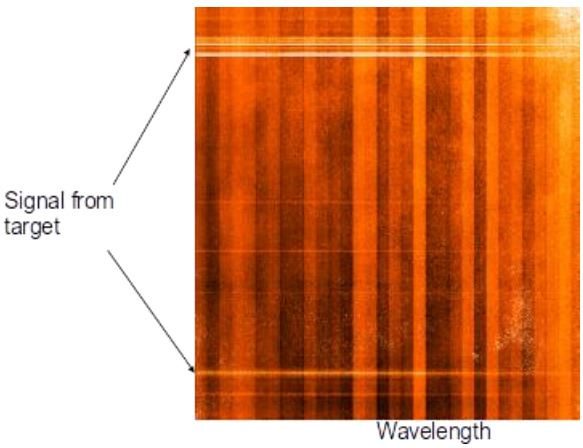
First calsys light through the instrument (7 July, 01:42). This was taken using the QTH2 lamp and optical lightguide and with the instrument setup at the bluest grating angle. The light from all 248 fibres is seen on the detector.

After many long hours of hard work, first calsys light was achieved in the early hours of 7 July, and then the next night (still 7 July), first on-sky light was achieved. Short observations of a few bright stars were made with the instrument, along with some flat fields and arcs using the current “optical” calibration system.

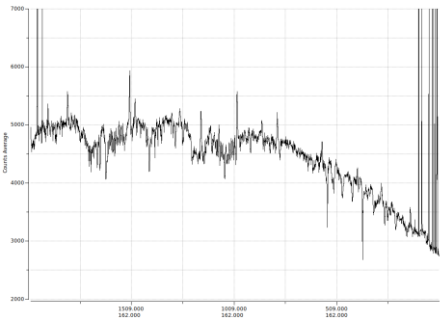
The next steps are for the NIR component of the calibration system to become fully installed, for the new ADC to be installed and for the various software systems to be worked on, so that they are ready for the on-sky commissioning. Dates are still being finalised for when the on-sky commissioning will begin, but the earliest anticipated start is late September (more likely in October). During the on-sky commissioning the instrument operations will be tested and refined, the performance will be tested and the data reduction pipeline will also be tested and refined. In anticipation for the availability of the instrument for science operations later this year, a call for shared-risk NIR proposals was made in the latest SALT Call for Proposals. We live in exciting times!

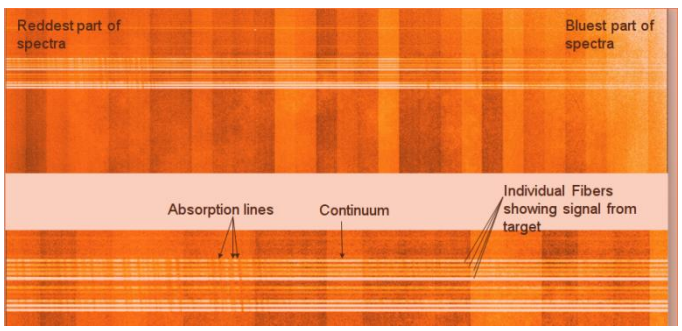
The night of First Light: the tension mounts in the SALT control room.

And here is the very happy PI, Marsha Wolf: after inserting the grating, she snapped a four-second exposure and there it is: the very first on-sky NIR spectra!

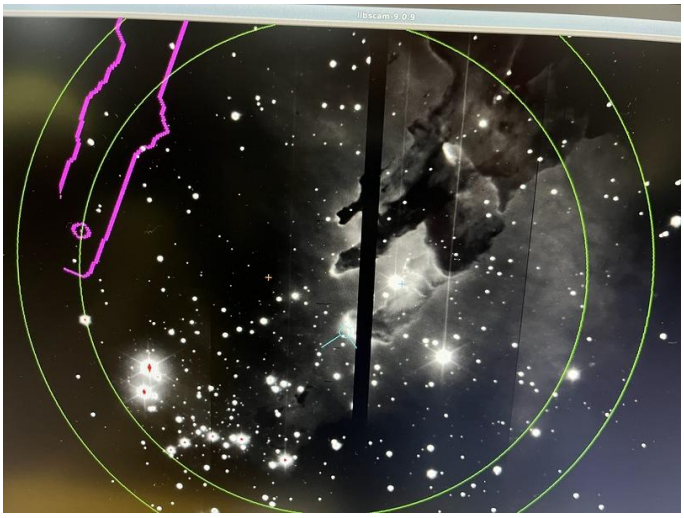


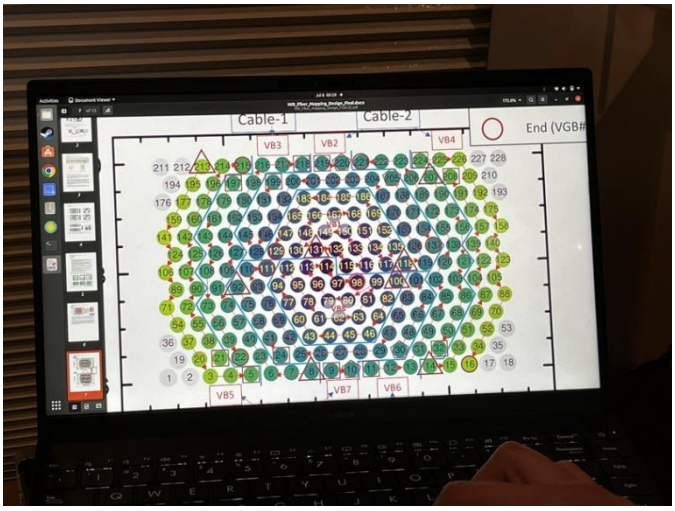
A closer view of the first on-sky light through the instrument (7 July, 22:38). This is uncalibrated data from a 4s observation of the bright star HD189140 (Type=MOII/III, V=6.1mag, J=3mag). The bright horizontal traces are from the star, which appears on multiple traces because the mirror had not been aligned yet.





Zoomed-in view of the fibres showing the signal of the target: Since the mirror was not aligned, light was spread over more than one fibre, which proved to be helpful.





Next, a target from the "Nice Stuff" catalogue – the spectacular *Eagle Nebula* – was selected, first snapping a few shots through different filters to get a pretty image. The team then proceeded to do some tests with it to check the orientation of the IFU on the sky and to verify the performance of the FIF, while carrying the NIR IFU and sky bundle. The FIF positioning was spot-on and neatly repeatable, with the fibre arrangement being confirmed.

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Finally, after successfully conducting more tests and finishing the night's operations at the telescope, the celebration was on for achieving on-sky first-light, with Marsha doing the honours.

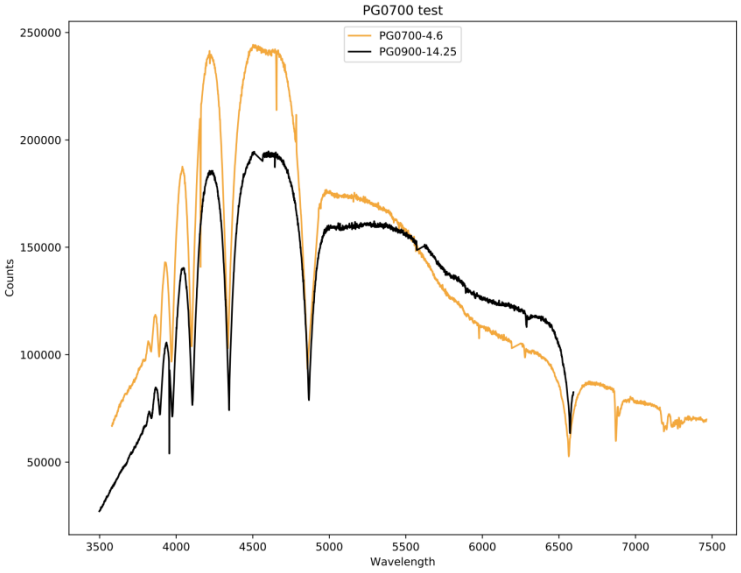
Moses Mogotsi.—

RSS upgrade

Following on from a successful RSS shutdown in October 2021, we are now close to being ready for the second planned period of RSS removal and upgrade. A period of around four weeks has been designated to bring RSS off the payload and is currently scheduled for (tentatively) February next year. The main purpose is to replace the main collimating optics and to install the PG0700 grating.

PG0700

Since the delivery and very brief commissioning of the PG0700 grating late last year, it was necessary to decide which grating it would ultimately replace. As the PG0300 and PG3000 gratings are the least used of the suite available, these were considered as candidates for removal. Some time was taken by SALT Astro Ops earlier this year to engage with users of PG0300 and PG3000, essentially asking which grating they would like to keep and why. The response from the community was emphatically in favour of keeping the PG3000 grating – thank you to everyone who engaged with this process! The PG0300 will now be replaced and kept in storage. The PG0700 will be aligned and commissioned in September, and has been already offered to the community for use in the upcoming 2022-2 semester. The plot shows a comparison of the PG0700 and PG0900 gratings. Note that PG0700 turned out to be slightly more blue optimised than expected, but a proper alignment has not yet been done.



Doublet and triplet

Since the triplet and PG0700 grating are safely tucked away at SAAO, the project on the critical path of the upcoming shutdown is the doublet. We are expecting the delivery of the new doublet from The Pilot Group at the start of September, at which time the RSS upgrade project can commence.

Long-slits

The replacement of the existing set of long-slits is one part of the ongoing upgrade of RSS that is not directly dependent on RSS being removed from the payload.

Last August, we reported on samples received from the manufacturer, which did not meet the design specifications of 1.5micron straightness, and so had to be re-worked. But even that re-worked set was not good enough. Subsequently, the team decided to undertake a survey of the existing slits to better understand the requirements for the replacement set. This included a set of measurements to characterise the slit straightness level, the flatness of the reflecting

surface and the reflectivity of the reflecting surface. These measurements had to happen quickly, during a period of RSS downtime, where they were removed from the telescope, shipped to Cape Town and measured up on an optical comparator and the SAAO coordinate measuring machine (CMM).

These measurements were quite revealing, showing that the precision level of the existing slits is not as high as anticipated. Some of the long-slits also showed heavy wear from many years of operations. The 1.5" x 8' slit, in particular, suffers from scratches close to the middle of the slit where science targets would ideally be placed. Furthermore, in order to completely understand the problem, the measured levels of precision were mapped to system performance. The conclusion of this process was that ultimately the overall system is working satisfactorily – but it is acknowledged that due to the condition of the existing slits, there is definitely room for improvement!

Currently, we are having a couple of prototypes made in replication of existing slits, using EDM (wire-cutting) technology. Initial indications are that we will surpass the tolerance levels of the existing set of slits. Below is a picture of a prototype used to quantify (by inspection) the slit straightness.

As a result, this particular sample cut yielded straightness of the order of 2 microns deviation over about a 30mm length, with 10 data points taken. This far exceeds the existing tolerance bands on the telescope. This specification must now be tested more extensively for repeatability (due to the nature of the geometry and the measurement resolution of the equipment, such measurements are quite tricky).

Detector

The design of the new cryostat for the RSS detector upgrade project is progressing well, with an advanced development model due to be produced in the lab in Cape Town in the next few months, followed by the Critical Design Review. The CCD is being tested by the manufacturer and expected to be delivered in the next quarter. A redesign of the detector software will be required and this is likely to require a big effort over the next year. Most of the SALT software team are currently tied up with other projects and a big ongoing effort to ready the telescope for the NIR instrument. New members of the team have learnt a huge amount in the process that will stand them in good stead for the detector upgrade project.

Lee Townsend, Tasheen Naicker, Ros Skelton.--

Responses to the SALT Survey Questionnaire

At the end of May, we issued a questionnaire to the SALT user community. The main goal was to evaluate our performance and hear from you how you'd like us to improve our service to you. We received 27 responses – thank you very much!

A quick look through the responses highlighted many things – some things we seem to do very well, especially our helpdesk (thank you!) and some things we really need to improve on. Most of the requested improvements can be grouped into a few main focus areas:

Firstly, we need a fresh look at our pipelines/data reduction tools for HRS and RSS. For HRS, PIs would like us to focus on order stitching, while for RSS, improved support for designing MOS masks is the key issue. This is made more important since we no longer support PySALT (it is provided "as is" in a docker container for ease of installation and usage) because PySALT was iraf-based, which is no longer supported, and the original PySALT developer also left the team. Instead, our tools are now being developed in python. Our users will be glad to hear that we plan to provide wavelength-calibrated 2D RSS spectra as part of the pipeline data products in the near future – so, watch this space! But back to MOS: we will be focusing on the mask designs and give an update in the next newsletter; please get in touch (via salthelp@salt.ac.za) if you need help in the meantime.

Another issue that has been brought forward is our poor communication regarding instrument availability in the shorter term, e.g., when an instrument is down for a few days repairs, which is critical to many programmes but particularly for the transient science groups. We have just made it part of our regular duties to update the SALT Calendar and the Status page on our website (https://astronomers.salt.ac.za/status/) on a daily basis, so hopefully we will now do better! It's still looking rather empty, but we have added relevant proposal deadlines, the dates for our upcoming SALT workshop in November, and we will be updating the NIR on-sky commissioning and the RSS optics repair dates once they're finalised.

The PIPT, as our main submission tool, has quite a few niggles our users would like to see fixed. Christian has made a note of these and hopefully most of these will be resolved soon. In the meantime, are you aware that we have a brand new python-based API and library for proposal and block submission? This means you do not have to use the PIPT – you could make up your own, custom-made submission tool! Please get in touch if you'd like to make use of it.

Many other ideas/suggestions for improvements have been put forward that I haven't mentioned above, but rest assured, they are all receiving attention from the team. And if you missed the questionnaire and you'd still like to provide us with feedback, you're always most welcome to do so by emailing your liaison SA, or via salthelp@salt.ac.za.

Encarni Romero Colmenero.—

Save the date!

SALT workshop: 14 – 15 November 2022

Join us on the 14 – 15 November 2022 for a workshop on making the most of SALT data. The workshop will cover the instruments and modes available on SALT, how to understand and reduce SALT data, the available tools and pipelines, and tips to optimise your use of the telescope, with breakout sessions catering to different interests. The workshop will be held at SAAO in Cape Town, with some sessions in hybrid format for more people to join online. Both current and potential future users of SALT are encouraged to participate. Please sign up to the saltworkshop mailing list to indicate your interest and to receive announcements: sympa@list.saao.ac.za with the subject line (all lower case) “subscribe saltworkshop”.

Participants at the previous SALT workshop at SAAO in February 2017. Five years ago already - how time has flown (particularly with a pandemic in between)!

View of Cape Town with Table mountain and Devil’s Peak in the background and SAAO in the foreground. The main building is in the centre with the McClean telescope to the left and the auditorium, where the workshop will be held, to the right.

Ros Skelton.—

SALT booth

27 June to 1 July 2022 saw the return of the European Astronomical Society meetings in person. EAS 2022 was held in Valencia Spain and saw a record attendance of over 2000 astronomers.

SALT was strongly represented with Petri Vaisanen and Daniel Cunnama operating the stand through the week. There was a powerful African contingent with the Africa Astronomical Society booth located alongside SALT promoting African Astronomy and the IAU General Assembly to be held in Cape Town in 2024.

Visitors to the stand were very engaged and there was a large amount of interest in SALT and its work. We conducted a brief perception survey at the stand the results of which will be included in a future report but the feeling towards SALT was overwhelmingly positive.

Daniel Cunama.—

MEET THE TEAM:

Solohery Randriamampandry

Hello everyone,

I was born in Antananarivo, which is the capital city of Madagascar, located in the centre of the big island. I did my undergraduate in Physics at the University of Antananarivo before moving to South Africa in 2008 to pursue an Honours degree in Astrophysics under the National Astrophysics & Space Science Programme (NASSP) at the University of Cape Town. I then moved on to do an MSc/PhD in Astrophysics at the University of the Western Cape, whilst based at the South African Astronomical Observatory (SAAO). I was later on awarded SKA and PDP post-docs based at the University of KwaZulu-Natal and at SAAO, respectively.

My research is on galaxy formation and evolution using multi-wavelength data. I am particularly interested in looking at how do blue star-forming galaxies evolve in the high density region in clusters, and what are the characteristics and roles of star formation and active galactic nuclei activity in the evolution of cluster galaxies at intermediate redshift.

My role at SALT includes observing shifts where I have been enjoying spending more time under the beautiful Sutherland landscape and night sky. I am also involved in astronomy outreach both in South Africa and Madagascar. I am also engaged in teaching astronomy courses at the University of Antananarivo.

Cheers, Solohery

SALT SCIENCE PAPERS

April 2022 – July 2022

Below is the list of SALT publications since our last newsletter (for our full list of publications, please visit http://astronomers.salt.ac.za/data/publications/). We encourage SALT users to inform us of any papers making use of SALT data, and to double check the link above after publication.

- Pennock, C. M., van Loon, J. T., Anih, J. O., et al. 07/2022: The VMC Survey - XLIX. Discovery of a population of quasars dominated by nuclear dust emission behind the Magellanic Clouds, MNRAS.tmp -- https://ui.adsabs.harvard.edu/abs/2022MNRAS.tmp.2008P
- Coe, M. J., Monageng, I. M., Kennea, J. A., et al. 07/2022: SXP 15.6 - an accreting pulsar close to spin equilibrium?, MNRAS 513, 5567 -- https://ui.adsabs.harvard.edu/abs/2022MNRAS.513.5567C
- Randriamanakoto, Z., Väisänen, P., Ranaivomanana, P., et al. 07/2022: The SUNBIRD survey: the K-band luminosity functions of young massive clusters in intensely star-forming galaxies, MNRAS 513, 4232 -- https://ui.adsabs.harvard.edu/abs/2022MNRAS.513.4232R
- Guha, L. K., Srianand, R., Dutta, R., et al. 07/2022: Host galaxies of ultrastrong Mg II absorbers at z 0.5, MNRAS 513, 3836 -- https://ui.adsabs.harvard.edu/abs/2022MNRAS.513.3836G
- Andersson, A., Fender, R. P., Lintott, C. J., et al. 07/2022: Serendipitous discovery of radio flaring behaviour from a nearby M dwarf with MeerKAT, MNRAS 513, 3482 -- https://ui.adsabs.harvard.edu/abs/2022MNRAS.513.3482A
- Hosseinzadeh, G., Sand, D. J., Lundqvist, P., et al. 07/2022: Constraining the Progenitor System of the Type Ia Supernova 2021aefx, ApJL 933, L45 -- https://ui.adsabs.harvard.edu/abs/2022ApJ...933L..45H
- Modiano, D., Wijnands, R., Parikh, A., et al. 07/2022: TUVOpipe: A pipeline to search for UV transients with Swift-UVOT, A&A 663, A5 -- https://ui.adsabs.harvard.edu/abs/2022A&A...663A...5M
- Geist, E., Gallagher, J. S., Kotulla, R., et al. 06/2022: Ionization and Star Formation in the Giant H II Region SMC-N66, PASP 134, 064301 -- https://ui.adsabs.harvard.edu/abs/2022PASP..134f4301G
- Thomas, J. K., Buckley, D. A. H., Charles, P. A., et al. 06/2022: Synchronous X-ray/optical quasi-periodic oscillations from the black hole LMXB MAXI J1820+070, MNRAS 513, L35 -- https://ui.adsabs.harvard.edu/abs/2022MNRAS.513L..35T
- Ramsay, G., Woudt, P. A., Kupfer, T., et al. 06/2022: The OmegaWhite survey for short-period variable stars - VII. High amplitude short-period blue variables, MNRAS 513, 2215 -- https://ui.adsabs.harvard.edu/abs/2022MNRAS.513.2215R
- Ashall, C., Lu, J., Shappee, B. J., et al. 06/2022: A Speed Bump: SN 2021aefx Shows that Doppler Shift Alone Can Explain Early Excess Blue Flux in Some Type Ia Supernovae, ApJL 932, L2 -- https://ui.adsabs.harvard.edu/abs/2022ApJ...932L...2A
- Zhou, G., Wirth, C. P., Huang, C. X., et al. 06/2022: A Mini-Neptune from TESS and CHEOPS Around the 120 Myr Old AB Dor Member HIP 94235, AJ 163, 289 -- https://ui.adsabs.harvard.edu/abs/2022AJ....163..289Z
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Petri Väisänen (SAAO Director, 2nd from left), Encarni Romero Colmenero (Head of Astro Ops, 2nd from right) get to meet the NIR for the first time (in the background), with Kurt Jaehnig (left), Marsha Wolf (PI, middle) and Paul Rabe (Head of Tech Ops, right) making sure they don't get too carried away.