XXXII IAU GENERAL ASSEMBLY

CAPE TOWN, SOUTH AFRICA, 2024

Vision 2024

The Audacious African Astronomy Vision[1]

[1] Inspired by Khotso Mokhele's "The Audacity of Vision" talk at the 2018 IAU General Assembly

Prologue

On 30th August 2018, the International Astronomical Union (IAU) announced that its 2024 General Assembly will be held in Africa. This followed a bid led by South Africa, on behalf of the continent, to bring this meeting to African soil for the first time in the IAU's 100 year history. It was always pushed as an African bid, even though the proposed location was in Cape Town, South Africa. The support for the bid was overwhelming, and the pro-Africa spirit that prevailed was significant and memorable. ***This document attempts to capture that spirit and consolidate that support into a vision for 2024 that we can strive towards as a united astronomical community.***

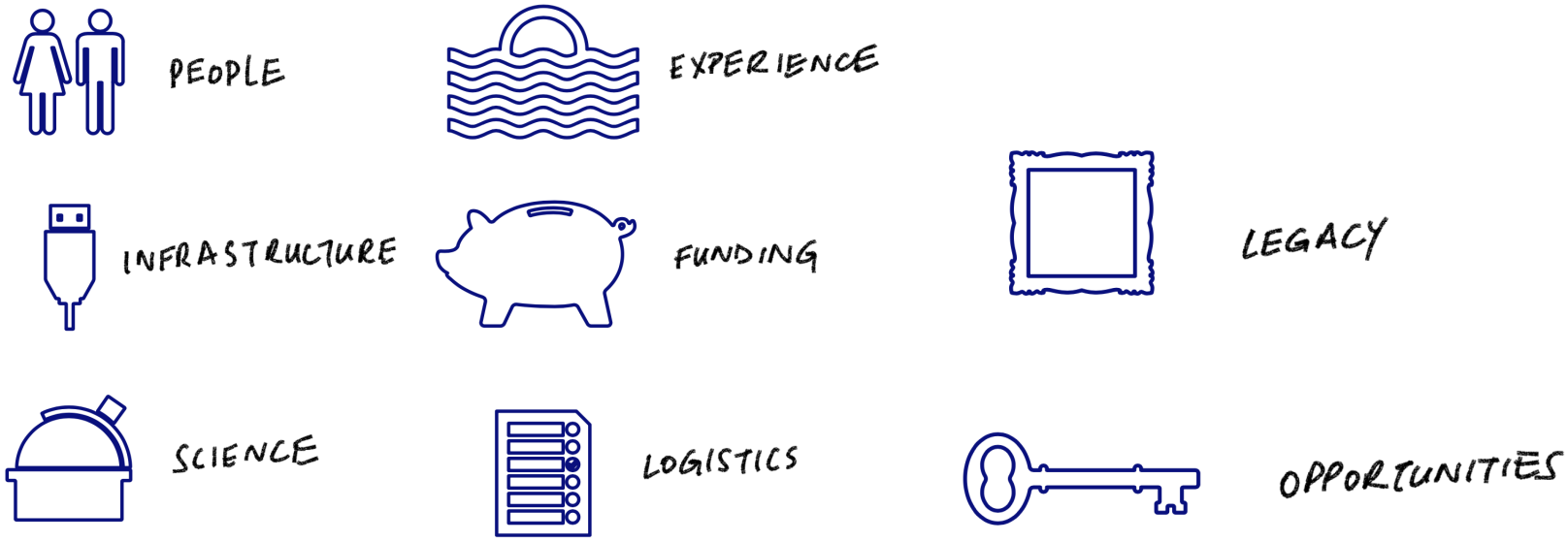
When the world descends onto African soil in 2024, what do we want them to experience? This is not simply an opportunity for astronomy, this is an opportunity to change the way the world sees Africa. When a continent so often looked down upon can lead the world in a field as technical as astronomy, then we change perceptions, we challenge preconceptions, we shake unconscious biases – we make the world think differently about the potential of all people in the world to contribute to the human endeavour. Africa also has a rich culture to share with the world and many stories to tell (both Astronomy and otherwise). 2024 is an opportunity like no other – it is up to us[2] to maximise on that opportunity for the benefit of Africa and the world. We need to be "audacious" in our thinking and carry the continent forward to 2024 and beyond.

IMPORTANT NOTE: This is a working document which serves as both a brainstorming exercise and a planning document for the African astronomy community. It needs to be shaped by the community in order to capture bigger picture aspirations for 2024. Not everything in this document may be related only to the actual IAU General Assembly but it serves to motivate supporters and funders with a vision of where we would like to be by 2024. This document was initiated by several individuals who led the bid for 2024, in order to simply have a starting point. It was then circulated among the IAU National Committee for South Africa (host country for 2024) for consideration and dissemination. ***It has received input from the broader astronomy community in Africa, most significantly at the Forum on Astronomy in Africa[3] in October 2021****. The document is now an open work in progress and is meant to belong to the African astronomy community.*

[2] "us" and "we" refer to all those, from Africa and beyond, who take on the joint responsibility to prepare the continent, and the world, for Astronomy2024.
[3] Virtual meeting from 27 to 29 October 2021, with 430 registered participants (https://tinyurl.com/AfricaAstronomyForum2021)

Please help to shape this vision by sending your thoughts, comments, input or suggestions to IAUGA2024@afasociety.org.

Aspects of the 2024 Vision



People 2024

By 2024 what will the astronomical community in Africa look like? Who will be the faces of astronomy when the continent hosts the world in 2024? What science will they be leading?

Vision	Status/Challenges	Actions Needed	Potential Stakeholders
1. A networked African Astronomy community who know each other and have greater visibility among the international community	• We don't know who exactly all the active astronomers, students, early career researchers are • A well-networked community could come together to launch coordinated and cooperative astronomical projects and programs. • There is a need to unite African Astronomy libraries and share best practice, ideas etc. African Astronomy libraries need to be more representative in the international library landscape.	• Audit[4] of current active astronomers, students, early career researchers in Africa[5] • Establish strong African Astronomical Society • Explore possibility of an Annual or Bi-annual Astronomy Meeting • Build an online database[6] to both track and connect people • Strengthen national astronomy societies on a country-by-country basis and more specifically for an expansion of their membership • Use the opportunities presented by online meetings during the pandemic to increase communication across the continent • Carry out an audit of all astronomy libraries in Africa and try to work with them to improve library services in astronomy.	AfAS Regional OAD offices AfAS AfAS[7] Space In Africa[8] SAAO Library (Theresa de Young)

[4] Perhaps build on the SA spreadsheet here: https://docs.google.com/spreadsheets/d/1N5olRYZCKXVgAWJvH-Zg4nkP0oACm6sCAE59LcoDQXg/edit?usp=sharing
[5] See: Astronomy in Africa Survey - https://docs.google.com/forms/d/e/1FAIpQLSf9l9rV-meoPOPZtfThFr9rVD-R-RcvDmcIfr4JqHXwAdwg_w/viewform?vc=0&c=0&w=1&flr=0
[6] For example this one for STEM women could be a possible model: https://www.stemwomen.org.au/
[7] There is the AfAS annual conference already in place (https://www.africanastronomicalsociety.org/)
[8] Space in Africa is conducting a baseline survey, with funding from the African Union: https://spaceinafrica.com/auc-baseline-studies-and-socioeconomic/

2. Strong international collaborations with African astronomers well connected with astronomers worldwide	• Acknowledging the many existing international collaborations, there is still room for more connections between African astronomers and other astronomers worldwide	• Showcase the work of African astronomers in international fora, and vice versa, in order to establish more international collaborations • Encourage international experience/training, particularly for young people, but ensure they have something good to return to in Africa. • Facilitate/encourage the participation of African astronomers in international working groups and collaborations (e.g. SKAO Science Working Groups)	Facilities (e.g. SKAO[9]) Universities AfAS EAS
3. Diverse representation at decision making levels nationally, continent-wide and beyond (within international bodies & organisations)	• Current demographics at higher levels need improvement (gender, age, race, etc). The involvement of more diverse astronomers in the top level research and astronomy decision making across the continent is important - and should be further promoted to 2024 and beyond.	• Build on mentorship[10] and "career pathing" initiatives to ensure an environment is created for a diverse set of people to succeed. • Encourage the establishment of National Associations and get the leadership of such associations involved in astronomy-related decision making • Increased visibility of job offers and employment/secondment/internship opportunities internationally (e.g. AAS mailing list, ESO, SKAO, etc.) • Encourage facilities and institutions to implement the IAU Springboard to EDI Action, and in particular to develop achievable metrics of success; gather and publish statistics on diversity, equity and inclusion; and work to	

[9] SKAO organises regular international science conferences and would welcome stronger participation from African astronomers, as well as in working groups

[10] For example Supernova Foundation (https://supernovafoundation.org/) provides mentoring support to young women and gender minorities who are looking to pursue careers in Physics.

		offer scholarships that support students and teachers[11]	
4. All students and early career researchers have clear career paths and guidance	• Currently students/early career researchers may not see where their careers could go and may not have enough mentorship • Insufficient tenured positions, which would be the best and highest-dividend way to build a community in the long term	• Set up a programme of "career pathing" where any student/young astronomer[12] could receive personalised guidance/mentorship[13] from astronomers worldwide • Source funding for more tenured positions across the continent • Source funding for programmes such as PASEA to enable African students gain more exposure to career opportunities	NASSP at Honours/MSc student level, AfAS Early Career Researcher Sub-Committee PASEA Mentoring Group AfAS Science Committee
5. We have a record of where students of astronomy end up	• Currently we don't know where most students of astronomy end up (as well as students who chose not to complete their courses) • Astronomy can take people across the world, and some may leave astronomy and then re-enter at a later stage, so some sort of monitoring would be useful	• Set up an open alumni system/network for students who have completed an MSc/PhD in astronomy related fields in order to track what careers they end up in[14] • Also track students who choose not to complete their courses?	NASSP in SA, SARAO Human Capital Development Programme National Astronomical Associations DARA/DARA Big Data (for their students)
6. Clearly communicated and	• Although the communication of scholarships could be better organised,	• Find new sources of funding for scholarships	NASSP+AfAS

[11] Published, measurable Gender Equality Plans with dedicated resources are now a requirement of the European Commission to access Horizon Europe funds, so it's important to prepare institutions to meet such requirements to continue to access funds from the EU.
[12] This could include students as early as high school as some may not realise the opportunities enabled by physics/astronomy/engineering/computer science at university.
[13] Potential collaborators on this include the SKIES project and PASEA's mentorship programme.
[14] NASSP has been tracking ex-students who have been through the Master's level programme since 2003 - difficult to keep track of people post-PhD though. This probably needs to be a broader effort from multiple organisations and perhaps someone to pull it together e.g. there is a spreadsheet with astronomers at South African institutions

abundant scholarship opportunities	the demand for scholarships still exceeds the supply ● NASSP and AIMS were the main programs for education on the continent. NASSP stops at MSc level and no longer supports non-SA students. AIMS has centres in Cameroon, Ghana, Senegal, Rwanda and Tanzania. DARA and DARA-Big Data have funded students in SKA-partner countries[15]. The SKA Human Capital Development program has been very successful at funding a number of African students. ● In South Africa, funding non-SA students is currently one of the major barriers to continental human capital development ● Pan African University Space Sciences Institute will be based in South Africa at the Cape Peninsula University of Technology and should have several pan-African scholarships available	● Find ways for NASSP to accept more African students ● Establish a consolidated repository of scholarship opportunities[16]	
7. African astronomers have enough time to perform their research (as opposed to being	● The teaching load on African astronomers is often too high for them to engage in meaningful research	● Engage with all concerned parties to think of strategies and alternatives, then find the funding to support these strategies.	AfAS

[15] These funds will end soon and they are currently looking for new sources of funding (Oct2021)
[16] For example the AfAS science portal which should help to address some of these issues

overloaded with teaching duties)	● There is significant potential in online learning and we've learnt a lot about the pros and cons of this through "pandemic teaching". The main issue is internet connectivity that has to be reliable, but which could potentially be mitigated with more asynchronous ways of teaching/interacting.	● Establish "quick wins" such as a question bank or course lectures online for other universities to follow/use. ● Explore ways of sharing lecturers for short periods of time like the AIMS[17] model, EPFL model[18]and raise respective funds for it ● Provide training and peer exchanges on how to make better lectures, exams, etc. ● Explore the possibility of a pan-African sabbatical program ● Provide guidelines for use of MOOCs or online courses which can reduce the individual load and provide broader courses across the continent or worldwide (noting that most will not necessarily conform to senate approved study programmes at universities). ● Provide a platform to enable guest lecturers from basically anywhere through online learning and other methods of sharing and teaching content.	Universities and facilities involved in teaching Distance learning institutions, in particular, e.g. UNISA, Open University etc.

[17] The African Institute for Mathematical Sciences has centres across Africa and uses a model of a visiting lecturer spending as little as 3 weeks lecturing. Many of these visiting lecturers then contribute to a full programme

[18] EPFL Extension school is a platform to train people on technologies that doesn't require a full formal university curriculum, is more applied and practical professional development but carries the weight and quality seal of EPFL (https://exts.epfl.ch)

8. We have sufficient high quality teaching capacity on the continent	• There is a need to improve teaching capacity as well as astronomy skills across the continent – astronomers are not necessarily taught how to teach or supervise students • Postgrad students who attend courses through NASSP, SKA, DARA, etc. could eventually become teachers, and would benefit from learning teaching skills during their studies. This is also potentially cost effective as it can be done in-house within universities.	• Identify human capacity development[19] ambitions of individual countries and establish programmes to address these • Organise teaching skills development workshops, possibly with partners such as the IAU and others, noting that a lot of universities probably have these[20] and would be worth engaging with them to share with astronomers • Teaching skills should be included as part of advanced training in e.g. NASSP, SKA and DARA training.	NAECs IAU WiA WG PASEA[21]
9. Skills gained within an astronomy degree/career are easily transferable to industry	• There is often a gap between academia and industry in terms of the skills taught vs skills needed • Of students who start undergraduate studies, only a minimum will do postgraduate studies. Therefore it would be beneficial to have transferable skills taught at undergraduate level.	• Establish links/collaborations with relevant industries[22] and adapt teaching/training such that someone with astronomy training could more easily transition into a career in industry • Explore the establishment of Excellence Centers, with focus on physical training, hands-on, workshops, simulations. • Establish an industry/business forum or exhibition space at astronomy meetings and vice versa, that showcases skills transfer into industry and business	SARAO, SKAO, DARA NASSP alumni in industry African Union? University Physics and Astronomy Departments

[19] See researcher skills development at Cambridge Institute for Astronomy (https://www.ast.cam.ac.uk/students/current.postgraduates/transferrable.skills)
[20] For example there is an MoU between SAAO and UCT
[21] PASEA gives professional development to university-level instructors (with real-time practice and feedback) on inquiry-based teaching and designing interactive lessons.
[22] For example, industry collaboration is part of the DARA project

		● Encourage the teaching of transferable skills to undergraduate students.	
10. Build astronomy engineering and instrumentation skills	● There is a huge need for instrumentation skills. Can be challenging to include astronomy from the engineering side but easier to including more technical courses from the astronomy side	● Explore the establishment of astronomy engineering/instrumentation departments or programmes at universities (similar to medical engineering programs/departments at colleges of engineering) ● Include instrumentation skills wherever possible in activities related to astronomy skills development ● Opportunities for secondments at facilities and observatories	SARAO, SKAO, AFAS, IAU, African Union? African Parliament? SAAO, NASSP University VCs - to cut across bureaucratic obstacles
11. A networked astronomy education, public outreach and development community with coordinated goals	● There are numerous initiatives across the continent which don't necessarily coordinate with each other ● We have had numerous great initiatives by people/organisations outside Africa – these should be rallied. ● Modern astronomy appears to continue to lack any serious public appreciation in Africa, especially the developing countries in Africa, so there is a need to create awareness and teach the public about astronomy.	● Connect relevant individuals/organisations across the continent, and beyond, and establish a vision document for astronomy education and outreach in Africa. That document should use 2024 to advance its goals. ● Involve other relevant networks such as the OAO NOCs, OAE NAECs, planetarium community, science centres, etc. ● Encourage awareness of and participation in Communicating Astronomy to the Public (Journal and conference) and access to OAO and OAE resources (newsletter, astroEDU, etc.)	AfAS, NAECs, APA

12. A vibrant and networked amateur astronomy community	● There are several active amateur astronomy groups around the continent. These groups comprise a large community of individuals with diverse skills and professions, who all share a passion for astronomy. 2024 should be an opportunity to rally this community of amateur astronomy.	● Identify active amateur astronomy groups across the continent and nurture a network in the build-up to 2024. ● Skills from this community should be tapped into for professional observation (e.g. through AAVSO[23] and such), education, public outreach and development. ● Provide support for new or very small amateur astronomy groups	ASSA, AfAS, Am Astro whatsapp group.

[23] The American Association of Variable Star Observers (AAVSO) is a non-profit worldwide scientific and educational organization of amateur and professional astronomers who are interested in stars that change in brightness—variable stars (www.aavso.org)

Infrastructure 2024

What infrastructure would be needed to make all this happen?

There needs to be a concerted effort towards improving not only the funding for research, but also the upgrading of key communications and IT infrastructure, and ensuring access to such infrastructure for staff and students. This is of paramount importance for participation in global science endeavours.

Vision	Status/Challenges	Actions Needed	Potential Stakeholders
1. Good, reliable internet access at universities	• Internet access can be intermittent, unreliable, or non-existent at universities • Being able to connect to the internet is crucial for many rural people. Hence access to information is a challenge to many people. Therefore for Astronomy to reach out to rural areas in African Countries an initiative should be formed (or collaborated with) to enhance connectivity[24]. • OneWeb and Starlink (and other future technologies) could benefit the African continent, noting the concerns around satellite interference on astronomy facilities[25].	• Involve high level decision makers to ensure that internet access is addressed at key institutions (including universities, observatories, conference centres, etc) • Explore partnerships with innovative initiatives that could provide internet access in a sustainable way.	NRF, African Union?
2. Access to computing at universities, making	• Limited access to high performance computing facilities. Efforts currently	• Pursue a coordinated agenda developing both cloud computing infrastructure (focus on access	IDIA, CHPC

[24] Example of an Initiative: 'ConnectRural'

[25] This could be done in a sustainable manner and build on work of the upcoming IAU Centre for the Protection of the Dark and Quiet Sky from Satellite Interference

competitive research and skills development possible	underway by CHPC and others to establish HPC hubs across Africa. ● Emerging cloud computing initiatives e.g. IDIA ● It is difficult to communicate if we do not have a mutually understandable language. Many young scientists are using windows as operating systems and do not know about Linux or scripting languages (like Python)	to data and compute power at universities, interoperability, ease of use and training) and access to HPC (focus on performance for computationally intensive applications, e.g. simulations, requiring a dedicated facility). ● Coordinate those development efforts with astronomy development efforts, and related skills development e.g. Python	
3. Small telescopes at universities	● Many universities starting astronomy programs wish to have small telescopes for both training and outreach e.g. Unizulu has purchased one, DARA have funded several small optical telescopes with CCD, laptop and software as well as radio telescopes at African universities ● It may be much more likely to get research training/publications using virtual observatories than via a small telescope, but there are other advantages to having a small telescope at a university.	● Establish a suite of small telescope "packages" (list of equipment, capabilities, related teaching exercises, guidelines, etc)[26] ● Identify potential host institutions for small telescopes and source funding to roll out the above package. ● Identify engineers and people who have the relevant capability to build small telescopes. ● Encourage Astronomy Instrument development with locally sourced materials[27]	HartRAO/SARAO, SAAO, NWU, UCT
4. Access to remote observing facilities	● There are many opportunities to access telescopes remotely. A trial consolidated list[28] was developed at the OAD.	● Update and publicise existing lists of remote observing opportunities	Vanessa Moss (ATCA)

[26] See also example of the African Radio Astronomy Network presented by James Chibueze at the Forum on Astronomy in Africa and https://www.gerafoundation.com/
[27] See affordable radio telescope example presented by Ikechukwu Obi at the Forum on Astronomy in Africa.
[28] http://www.astro4dev.org/remote-telescopes/

	• SAAO has several new remote observing opportunities in Sutherland • The Australia Telescope Compact Array (ATCA) is running online trainings • e-MERLIN has a special call out for African astronomers • AstroLab[29] is a project that provides training on using telescopes remotely • Access to world telescopes (eg. NOT, CFHT, AAT, LCO etc) is possible via the ORP bi-annual call	• Explore new opportunities e.g. Universities with automated telescopes could also offer remote access to partners who don't have their own[30] • Reserve substantial time on a small professional telescope for training. • Build into future workshops the training to use telescopes remotely • Exploit opportunities to use virtual observatories to access/use observations from international observatories.	IVOA (can help to provide info) Kshitij Thorat (can help with Astrolab) Encarni and David Buckley work with ORP - can distribute bi-annual calls via email
5. Innovative use of mobile networks for training, education and outreach	• It is often the case across Africa that it is easier to access the internet via mobile networks than landlines/fibre.	• Explore innovative ways of using the mobile network infrastructure for astronomy training, education, and outreach[31] • Explore the possibility of a portable and affordable kit that enables a combination of power(e.g. solar) and internet (e.g. Terrestrial or satellite mobile wifi).	NAECs[32], Local Universities
6. An African Astronomical data archive	• Astronomical data from African facilities is not currently easily accessible or usable, even when outside proprietary periods, yet modern archives are both a source of new science, training and citations.	• Development of an astronomical data archive (or several well-linked archives from a central database) for observations carried out in African observatories	SALT is willing to contribute/help.

[29] The latest training event was held at Unizulu and aimed at training tutors in Southern Africa - http://www.unizulu.ac.za/astrolab-background/
[30] For example, UCT is aiming to build in remote access to their teaching radio telescopes so they can share access with other institutions and enable students to take data remotely which they can then analyse at their home institute
[31]For example, see existing tools such as x2go, which can allow "low-cost" image viewing when optimised. Centres for image storage can then easily be centralised
[32] It is important that NAECs have some sort of relationship with teachers and other astronomy practitioners.

	● Increasingly, observatories are adopting the IVOA protocols[33] and make their data available through APIs such as astroquery[34] or pyVO[35] and some even offer remote access to work with the data[36]. ● SARAO are developing an archive for MeerKAT data ● SKAO are developing their archiving requirements now for SKA data (2025+) ● SALT data is available[37] and an archive for other SAAO data is under development ● Establish Astronomy archives and libraries in countries without them to enhance availability of astronomical information.	● Provide support for African observatories to ensure their data archives are of high quality and follow international standards (VO, FAIR[38] principles), which will enable greater collaboration and sharing/use of data. ● Publicise existing archives and related resources e.g. educational resources using data from African archives ● Explore potential offline data usage e.g. distribution of CDs or Flash drives with VO and data already on the drive in remote areas where internet access is difficult	
7. An African Astronomy Heritage Archive	● There is limited coordination in terms of the recording, preserving, and sharing astronomy heritage data in Africa (including indigenous knowledge)	● Create a digital repository for African Astronomy Heritage data[39] ● Initiate a working group with candidates from each African country	Auke, Sivuyile, SKAO Somaya Saad

[33] http://www.ivoa.net/deployers/intro_to_vo_concepts.html
[34] See e.g. the entire NASA Space Telescopes archive (MAST) available through the python astroquery package: https://astroquery.readthedocs.io/en/latest/mast/mast.html#
[35] pyVO is intended for access with IVOA standards (https://pyvo.readthedocs.io/en/latest/)
[36] See e.g. https://datalab.noao.edu
[37] https://ssda.saao.ac.za/
[38] https://en.wikipedia.org/wiki/FAIR_data
[39] For example, the UNESCO-IAU Portal to the Heritage of Astronomy https://www3.astronomicalheritage.net/index.php

Science 2024

What are Africa's scientific ambitions for 2024? What science will be presented to the world in 2024 and how do we get there? What science will come from different instruments across the continent and from African participation internationally? To achieve the science vision it would be important to encourage/facilitate participation of African astronomers in international working groups and collaborations relevant to the different topics below.

This section was populated following community discussions coordinated by the Science Sub-Committee of the 2024 General Assembly.

Vision	Status/Challenges	Actions Needed	Potential Stakeholders
1. Symposium on "All-inclusive Active Galactic Nuclei (AGN)"	Observational studies of AGN cover the entire electromagnetic spectrum from X-rays to radio wavelengths. Additionally, with blazars suggesting a connection to neutrinos, AGN studies also reach into the domain of multi-messenger astronomy. Investigating the properties of AGN allows us to further understand the black-hole and host galaxy connection which is critical to answering some open questions related to how galaxies evolve. We wish to bring together the latest results in both observations and simulations, and (particularly) to showcase southern-hemisphere telescopes (MeerKAT, SALT, HESS, VLT, ALMA, MWA, SKA[40], etc). We	• Advertise symposium idea to garner community support • Establish SOC (international) and LOC • Seek letters of support from SPARCS, SARAO, SKAO, SAAO, HESS, ESO, IAU Division J, OAD, Astronomers for Planet Earth • Contact ALL possible IAU Divisions and Commissions for their input and support.	Sthabile Kolwa (UJ) & Sarah White (RU, IAU Junior Member)

[40] The GA is around the time of array assembly 0.5, and array assembly 1 (8 dishes, 18 low stations) is only a few months after the GA

	also wish to discuss publication of 'null results', and to promote a hybrid format for aiding accessibility, inclusion, and sustainability during the climate crisis (which disproportionately affects the African continent). GA 2024 will be 5 years after IAU Symposium 356 (held in Ethiopia), and so an excellent follow-up to the previous AGN discussion and outreach that took place there.		
2. Pulsars and radio transients	Idea for symposium at GA2024		Marisa Geyer
3. Gravitational wave transients	Idea for symposium at GA2024	Built global 'SOC'; contact IAU divisions+WG	Paul Groot
4. Galactic Plane Surveys	Idea for symposium at GA2024	Define the science areas to be covered and assemble the SOC.	James Chibueze
5. Large scale facilities and growing data archives	Idea for symposium at GA2024		Patrick Woudt
6. Advances in understanding of high mass X-ray binaries	Idea for symposium at GA2024		Itumeleng Monageng & Vanessa McBride
7. Transiting Exoplanets and their atmospheres in the era of the James Webb telescope	Idea for symposium at GA2024	Create a working Group beside AfAS	Zouhair Ben Khaldoun
8. High energy astrophysics,	Idea for focus meeting or symposium. 20 years of HESS, with a focus on multiwavelength and multimessenger links. Clear link with IAU Division D (high energy phenomena and fundamental physics).		Michael Backes (UNAM), Markus Böttcher (NWU)

9. Gas in Galaxy Evolution in the SKA-precursor era	Idea for focus meeting: With their wide frequency coverage, high resolution, and wide-field imaging capabilities, SKA precursor radio telescopes are enabling unprecedented studies of the gas in galaxies and its role in galaxy evolution over cosmic time. As we look forward to the beginning of SKA science observations, it is time to take stock of the current state of the field by highlighting recent key results from HI precursor surveys and predictions from state-of-the-art models of galaxy evolution to inform directions for HI science with the SKA.		Sarah Blyth (UCT), D.J. Pisano
10. Egyptian Large Optical Telescope (ELOT)	Idea for a focus meeting; To bring the attention of the astronomical community to the upcoming 6.5m ELOT and its importance to Egypt and the astronomical community worldwide. ELOT is expected to fill the observational gap between Asia and Chile and between Europe and South Africa. More than 300 photometric nights are expected from ELOT. A lot of work needs to be done to match between ELOT optical design, its attached astronomical instruments and site optical characteristics to fill this gap and to	● Advertise the meeting idea to garner community support ● Establish SOC and LOC. ● contact possible IAU Divisions and Commissions for their support. ● Contact site testing and telescope design experts in the continent and worldwide to introduce their experiences through workshops and lectures to people at NRIAG. ● Prepare for the findings reached upon in the site selection and testing of the sites already found.	Yosry Azzam (NRIAG)

	maximize the importance of this telescope.		
11. Earth based observations of occultations and astrometric/photometric follow-ups of asteroids, comets, TNOs	Preliminary Idea in search for observers/partners in Africa	Organize observational campaigns about interesting objects using meter-sized telescopes. Focus in astrometry, photometry and spectroscopy. Particularly there is a significant interest in occultations on the basis of space missions, like e.g. Lucy and New Horizons, using small (20cm) portable telescopes	Josep M. Trigo-Rodríguez (CSIC-IEEC): trigo@ice.cat Anne Verbiscer (Univ. Virginia, USA) av4n@virginia.edu
12. Use of Virtual Observatories to do Science/Outreach/ Education	Idea for a focus meeting		Khadija, Benhida, Zakaria Belhaj
13. Big-data visualisation in immersive environment	Idea for a focus meeting during the GA2024.		Lucia Marchetti (UCT)

Opportunities 2024

In the lead up to and during 2024, it needs to be made clear what opportunities there are for people to get involved. During 2024 when potentially 3000 or more astronomers come to Africa, we also need to be prepared to put meaningful opportunities for collaboration on the table.

Envisaged Opportunities	Status/Challenges/Description	Actions Needed	Potential Stakeholders
1. Ambassadors of "Astronomy in Africa"	• We will need people across the world to promote Astronomy in Africa and 2024, in order to ensure that the GA in Africa is well attended (both physically and online) and people know more about opportunities in Africa	• Develop explicit mandate/mission (bulleted list of goals, small examples, etc) to attract, inform and guide potential ambassadors • Develop communication "packages" (slides, posters, flyers, communication material) to enable potential ambassadors to talk about the 2024 GA and other opportunities in Africa.	AfAS
2. Student supervision	• To generate the envisaged human capital we will need supervisors and co-supervisors of African students • Quality of supervision is also important, especially the need for supervisors to have the appropriate "soft skills" to better enable them to supervise, mentor and coach students	• A model for joint degrees/co-supervision etc needs to be developed and easily accessible. This may include recognition for degrees/content across borders, as well as standardisation of quality. • Provide skills development opportunities for supervisors including "soft skills", cultural/sensitivity training, etc.[41]	SANSA NASSP University faculty

[41] For example, CREST has an Online Training Course for Supervisors of Doctoral Candidates at African Universities (https://www0.sun.ac.za/crest/dies-crest-online-training-course/)

3. Research collaborations	● In order to ensure that quality science is produced on the continent, it would be important for African astronomers to interact meaningfully with the rest of the world ● There are also potential citizen science [42] projects which could be adapted to increase research collaborations	● Ensure attendance of African astronomers at international conferences in order to highlight research interests to potential collaborators. ● Have a "research opportunities" component of the package for ambassadors; and ambassadors to bring back/communicate international research opportunities to African astronomers ● Engage with citizen science platforms about projects requiring "citizens" at different education levels ● Search for collaborative pathways and research opportunities with other research centers located in Asia, Europe, etc...	
4. Policy and decision maker engagement	● Astronomy in Africa and the IAU GA2024 could be part of the UNGA77 in September 2022 presenting the opportunity for global decision-maker visibility as well as the opportunity to link astronomy to the UN SDGs and Agenda 2030, including becoming an official UN Local 2030 body. This will link the IAU GA with science diplomacy in a way never seen before.	● Develop a concept note for UNGA77 ● Build diplomatic links and cooperation ● Get support of EU, AU, ITU UN Bodies AAS etc	AERAP Takalani AfAS
5. Industry partners	● Not all astronomy-trained individuals will work in astronomy – we need to involve the industries that will employ	● Identify the industries that employ astronomers and develop a package of how they can come on board with 2024, either through sponsorships or	Engage with NASSP alumni in industry

[42] See for example https://www.zooniverse.org/

	them - these include business, civil society, local government, schools, etc. ● University academics are not always aware of the needs of industry	some sort of partnership e.g. industry-academia skills gap training, start-up business support, data science freelancing opportunities, paid hackathons, etc. ● Develop ways to turn the needs of industry into research projects at universities. Here, universities or advisors have to be aware of the needs of industry.	
6. Education, outreach and development	● Professionals in education, outreach and/or development should have opportunities before, during and after the GA to engage with projects and activities across the continent. ● Information and knowledge about Astronomy can be limited, even with some not being able to distinguish between Astronomy and pseudosciences .	● For physical activities, connections need to be made well in advance to ensure that itineraries are planned such that side activities are planned and carried out as part of delegates' travel to the GA ● All participants of the GA (physical and virtual) could be engaged in advance to contribute online education, outreach and development activities	SAASTA, The Travelling Telescope OAD, OAO, OAE
7. Schools	● It could be extremely worthwhile to encourage students/teachers from schools across Africa, from all age groups, to attend the conference (physically or virtually). This could enable links between the African astronomy community and African "civilians" in their own communities	● Establish a formal programme[43] for schools participation in the General Assembly ● Explore the potential for pan-African opportunities such as an African Astronomy Olympiad	Claire Flanagan, Sivu. NAECs OAE/NAECs

[43] For example, the Observatoire de Paris organises "parrainages" throughout the French metropole (Alain Doressoundiram is the point of contact)

	● While there are many local education activities, there are limited pan-African opportunities for schools ● Astronomy is not always a part of the school curriculum. A high level effort to get astronomy into schools could enhance the interest and participation in astronomy	● Explore options to support organisations and individuals to drive the inclusion of astronomy in national school curricula across Africa	
8. Volunteers	● In the Vienna 2018 GA there were scores of volunteers from around the world who covered their own travel to the meeting but had their registration fees waived in exchange for volunteering on the organising team ● Volunteers are not only about extra hands for the GA but also an opportunity to provide exposure and experience to the volunteers themselves	● Volunteer opportunities need to be advertised for before, during and after the GA, in order to have extra hands on the organising teams, as well as hands for education, outreach and development activities.	
9. Side meetings/trips	● Using the opportunity of people travelling to Cape Town, one could envisage a carefully crafted set of opportunities to visit other locations across the continent en route to/from the GA	● Identify and promote opportunities for side meetings/trips e.g. Ethiopian airlines is a cost effective way of travelling to Cape Town from Europe/Asia and comes via Addis Ababa where one could stop for a few days (at no extra cost) to visit the Entoto Observatory and Research Centre	ESSTI, Alemiye

10. Hybrid conferencing	• The global pandemic has changed the way meetings are conducted, with online and hybrid being the norm in 2021. This creates an opportunity to be creative and set new standards for effective hybrid conferencing. • Many large astronomy meetings are seeing factors of 2 increase in attendance when they have effective online attendance	• Explore innovative ways[44] of implementing effective hybrid conferencing and build into the planning of the GA itself in order to expand and enhance participation • All aspects of GA planning (including this document) should assume hybrid participation	Vanessa Moss/TFOM NOC, IAU, organisers of other conferences (e.g. ADASS XXXI) that have done this

[44] For example, see outcomes of The Future of Meeting Symposium held in September 2020

Experience 2024

What would we want people to experience when they participate (either physically or virtually) in the 2024 GA?

Envisaged Experience	Status/Challenges/Description	Actions Needed	Potential Stakeholders
1. Shared pride among all Africans for hosting the astronomy world on the continent	• One has to ensure from the outset that 2024 is a pan-African project and not centred around the host country too much • Small national and regional activities in build up towards the GA may help with collective ownership	• Ensure inclusive participation in the organising of the event (diverse organising committees, open opportunities for input, etc) • Promote and communicate 2024, as well as awareness of astronomy and African astronomy research, widely across the continent	
2. Tours of African astronomy facilities	• all African astronomy facilities should be prepared to open their doors during the time surrounding the GA • There is much potential for a virtual experience of Africa, which can be much broader and inclusive of people who cannot travel for whatever reason. Africa could lead the way into what the future might look like and really set a precedent.	• Years in advance tour options should be available such that people may plan multi-stop trips to go via other facilities e.g. Morocco, Egypt, Ghana, Ethiopia, Namibia. • Tours to Sutherland and Carnarvon should be smoothly built into the GA experience with various options such as 1, 2 or 3 day trips. • Consider the experience that may not take place physically on African soil e.g. virtual tours	NRF/SAAO, NRF/SARAO and SKAO and coordinators from other Observatories in Africa Northern Cape Tourism Agency Tour Operators Intrepid Travel (Morocco)
3. Astrotourism	• Astrotourism is a growing field/industry with numerous options across the continent. Apart from visits	• Encourage the growth of the amateur astronomer community and any other potential astro-tourism	NRF/SAAO,Tourism Enterprises,

	to astronomical facilities, participants should be able to experience dark skies sites anywhere on the continent through the promotion of astrotourism options. ● Astrotourism could be linked to efforts at creating multilingual books, media support, etc for a variety of African and international audiences. ● The Towns of Carnarvon & Sutherland should be Astro-Tourism Friendly	stakeholders, not just for external tourism, but internally as well. ● Explore "low-cost" resources such as astronomy related books, etc targeted at potential astro-tourists ● Conduct awareness workshops with the communities around Carnarvon and Sutherland so that they have an opportunity to be involved ● Work with relevant stakeholders to explore the possibility for areas around major observatories (e.g. Sutherland, Carnarvon) to be designated dark-sky areas by the International Dark Sky Association (IDA). This helps attract tourism. ● Work with travel guide publishers (e.g. Lonely Planet) to include section on astro-tourism offer in in their 2024 edition (this was done in Chile and very successful)	Observatories in Africa The Travelling Telescope ASSA APA Titritland (Morocco, Zakaria Belhaj) Northern Cape Tourism Agency and Regional Municipality Intrepid Travel (Morocco)
4. Africa's Scientific and Technological prowess	● Science and Instrumentation from the African continent should be showcased with pride. All attendees of the 2024 GA should leave without doubt that Africa is a world leader in astronomy and growing.	● Develop consolidated communication packages incorporating science and instrumentation across the continent and wavelengths. ● The exhibition space at the GA should be dominated by African science and technology	S&T professional bodies in SA (eg SAIP),
5. Diverse Faces of Team Africa	● We should identify and ensure that the host "face" is a diverse and continental one	● The organising team and conference hosts should be representative of the continent and of the demographics of the population	NOC
6. An African GA	● From the outset the spirit of the conference should be an African one, with any cultural events or activities	● Seek strategic cultural partners from the arts and entertainment industries, who would serve on relevant committees and design key events accordingly.	

	taking inspiration from across the continent	● Involve artists such as poets, musicians, etc to produce astronomical pieces ● Use the media to sensitize the public about Astronomy and the events that surround it, including its benefits not only to Africa but the entire world.	
7. Immaculate and efficient organisation	● It will be vital that the meeting organisation is, for all intents and purposes, perfect. Attendees should leave the meeting with an unequivocal belief and confidence in Africa's ability to host meetings of any size	● Establish a large efficient team who will essentially do less work over a long period as a team, rather than more work individually close to the end. ● Minimise some degree of logistical overhead by approaching conference management with automation in mind e.g. aiming to reduce the amount of busy work or paperwork with particular approaches to data management. ● Consult widely with previous GA organisers and participants to establish a consolidated picture of what works and what doesn't work	
8. Innovative ways of conferencing	● As times change, the way we interact also changes. In the current climate of lightning talks, interactive posters, live-tweeting presentations, unconferences, hackathons, etc, 2024 will be an opportunity to reinvent how conferencing is done, in line with the latest trends available by then. A GA in Africa could showcase innovative new ways of getting the most out of a conference ● Online/hybrid aspects need to be built into the meeting as a whole given the	● Engage with organisers of meetings that have been changing the way meetings are done e.g. dotastronomy, Google SciFoo, JEDI, TFOM, etc. and incorporate key innovations into the programme for 2024. ● Ensure virtual attendance is possible in a smooth, current, user-friendly and accessible manner (see Hybrid Conferencing under Opportunities)	Carolina, Vanessa Moss/TFOM

	current pandemic situation, as well as the impact that in-person travel has on accessibility, inclusivity and sustainability.		
9. Understanding of development challenges	● We should not shy away from showing people what challenges are being faced on the continent. It is an opportunity to help give people an important view of what development means and at the same time to offer them the chance to participate in/contribute to addressing the challenges	● Highlight the work of the OAD and showcase opportunities therein for people to use astronomy for development. ● Establish partnerships with organisations involved in development across the continent and invite them to participate in 2024	OAD
10. Show of political support	● 2024 will be an opportunity to demonstrate to the world the high levels of political support for astronomy and science in general across Africa. It is also an opportunity to use 2024 to galvanise greater political support through involving government officials in the event.	● The 2024 meeting of Science and Technology Ministers from all nine SKA Partner countries (or other inter-ministerial meetings such as AMCOST) should be planned to coincide with the GA, ideally with the South African president hosting them, in order to demonstrate at a plenary event the high level of political support for astronomy, and thus the opportunities that exist in Africa	South African Department for Science and Innovation National Research Foundation OAD
11. Multi-disciplinary participation	● Given the existence of four IAU offices (education, outreach, young astronomers and development) there is an opportunity to attract people from other fields of science to participate in specific sessions or side activities of the GA	● Engage early with the International Science Council, academies, universities and individuals from relevant fields who could contribute to the 2024 GA, and astronomy in general ● Based on the engagements above, build interdisciplinary aspects into the programme for 2024	

	● With the establishment of the International Science Council, of which IAU is a member, there is space for conversations across disciplinary lines in order to achieve common goals e.g. education, development, big data challenges, publishing, etc. ● As part of efforts to address north-south biases, seasons, history of astronomy, etc, African studies & language departments in Universities across the continent have expertise to create or translate existing physics, mathematics & astronomy textbooks into languages accessible to broader audiences. ● Interdisciplinary research is key to progress in science, not just astronomy. Need to involve the Academies and the Universities.	● Explore the possibility of attendance of the GA by scientists from other fields (e.g. SAIP, SAWISE, etc.), and advertise accordingly	
11. Multilingual participation	● Conferences can be exclusive as they are normally conducted in a single language (usually English). To increase participation and accessibility (especially from a multilingual continent) innovative ways to address language barriers need to be found	● Engage with relevant groups to explore ways of incorporating translation and collaboration across potential language barriers ● Ensure all preparations and communications in preparing for the GA (including this document) are as accessible as possible.	Thembela, Sibusiso, Carolina, Vanessa Moss/TFOM

12. Africa as the cradle of humankind	● 2024 is an opportunity to highlight how in a sense this is a "Coming back home" of sorts for humanity and our scientific endeavour - especially with the many recent discoveries (e.g. the cave paintings and skeletons) that show how modern humans developed thought, art and culture etc. on the continent. Not only should we show attendees the progress and contribution that Africa is making to astronomy but also the way in which Africans have thought of the sky	● Engage with relevant fields including palaeontology, anthropology and African studies to enhance the content of the program and the experience. ● Highlight connections with NASA's Lucy mission (named for the Lucy fossil found in Africa) and the support observations being done (via stellar occultations) in Africa for the Lucy mission.	Hilda Hermann Turkana Basin Institute - Dr. Richard Leakey

Organising 2024

What are some of the key things that need to be put in place in order to both organise a successful meeting in 2024 and to fulfil this vision?

Organisational matter	Status/Challenges/Description	Actions Needed	Potential Stakeholders
1. Organising structure	● We need to go beyond an organising committee and have an organising structure, with a core team and various sub-teams. The core team should be highly effective people who gel well together. They should all recognise that internal conflicts place the event at risk and should thus be dealt with swiftly and amicably. We should set an example of teamwork which does not require a handful of astronomers giving up their research career for a year to organise a GA. ● The core team should each have respective teams of volunteers behind them e.g. programme team, social events team, finance team, etc. Anyone willing to contribute their time towards the organising should be welcome to do so in a clear, structured way.	● Establish a core team of leaders with respective teams taking on various aspects of this document. ● Set up a system that enables anyone to contribute in some way to the organising of the GA. The system should include sign-up instructions and clear descriptions of the different aspects of the preparations, so that people can know where to volunteer and what they would be in charge of	
2. Advisors	● The core team of lead organisers should be supplemented with a group of advisors which are representative of all major stakeholders e.g. DSI, NRF, industry, SARAO, SKAO, SAAO, AfAS, other African countries, etc.	● Establish a team of advisors ensuring that all relevant parties are well represented. This team will meet less frequently than the core organising team.	NOC

3. Professional conference organiser	● A company would be employed to handle all the logistics and a senior representative of that company would be part of the core team of leaders mentioned above. Important to ensure at the outset that this company would need to work closely with the organising structure and be flexible enough to cater for specific needs of astronomers.	● Identify a list of potential conference organisers who would bid for the contract to organise 2024 ● Consult with previous clients of those conference organisers ● Appoint PCO through the NRF process	NOC
4. Standing agenda item until 2024	● Astronomy2024 should be a standing agenda item in all recurring meetings such as the Astronomy Advisory Committee, Astronomy town meeting, DSI Exco, NRF Directors Forum, SKA Partner Countries Ministerial Meetings, SAIP, ASSAf, ISC ROA, etc.	● Consult with the relevant officials to ensure that 2024 is a standing item of discussion at all relevant meetings	
5. Accessibility	● Accessibility of the conference can be achieved in several ways; also need to consider accessibility in general, of facilities, of software for astronomers, of content, etc.	● Ensure all aspects of the planning and implementation of the GA appropriately considers the issue of accessibility	

Funding 2024

What will all this cost and who will pay for it?

Funding consideration	Status/Challenges/Description	Actions Needed	Potential Stakeholders
1. Diverse sources	● The vision for 2024 cannot be seen as only for the GA but for a broader vision for astronomy in Africa that is simply being catalysed by the GA. For example, funds such as those already allocated for student training, can be seen to feed into this vision without necessarily being labelled as such.	● Establish a holistic funding plan that would have a section for the logistics of the GA, but would also give a consolidated picture of astronomy funding for the continent, identifying where gaps exist. This plan would then be used for fundraising and lobbying in a bigger picture context	
2. Government	● Government funds should come from across departments, with African Departments of Science and Technology (or equivalent) providing the bulk of support, but also potentially Tourism, Trade and Industry, etc given the scale of the event. ● The Western Cape Government has already committed over ZAR600k for 2024	● Confirm the funding levels that various African governments would be able to support, especially those from the host country. ● Engage governments regarding policy discussions through engagements at high level meetings e.g. United Nations General Assembly ● Establish a continent-wide picture of funding for astronomy, based on the holistic funding plan.	
3. Private sector	● Since the GA would be an opportunity to showcase African Science and Technology, the relevant players in the	● All companies involved in the construction and operation of MeerKAT, SALT and SKA-mid should be contacted and involved in some way, given that a GA	

	private sector could benefit from showcasing their skills and offerings ● Potential industries who would employ the skills of astronomers could highlight work opportunities in their sectors through sponsorships and presence at the GA ● In the context of language, organisations like Microsoft or Google could be approached for support/sponsorship. Microsoft is already at the stage where they can live caption in other languages, and Google translate is very advanced in online free translation.	in Africa would help showcase their technical capabilities to the international community ● Large international organisations should be approached for support on specific areas e.g. language/translation	
4. High profile individuals	● There are several high net-worth individuals across Africa, mainly business people. They could potentially be brought in to support astronomy in Africa, perhaps via exclusive trips to observatories, named infrastructure, etc.	● Explore ways of engaging high net-worth individuals (and their foundations) to stimulate their interest in astronomy	
5. Innovative fundraising	● The field of astronomy should be used for its rather inspiring nature to attract the pockets of wealthy individuals from around the world. ● Leverage technology to raise more funds. An example is using NFT's (Non Fungible Tokens) to sell exclusive astronomy digital art and other unique products that	● Explore a suite of innovative ways of fundraising. For example the meeting itself should allow for wealthy individuals to buy their way into cocktail events with world famous astronomers through e.g. sponsoring 10 African students' attendance; special tours to astronomical facilities for major sponsors; ask invited speakers to fund themselves in order to support more African participants; etc.	

	champion Africa's role in the larger astronomical community. ● Making use of Crowdfunding, where amateur astronomers, enthusiasts and professionals alike can contribute to the effort. This will add a sense of ownership and pride.		

2024 Legacy

What will happen beyond 2024? What legacy do we hope this GA will create?

Legacy Vision	Status/Challenges/Description	Actions Needed	Potential Stakeholders
1. Transformation of the astronomy community	● With 2024 as a goal, we will be able to ensure the growth and development of young African talent into senior positions within the astronomy community ●	● Identify key promising individuals and establish personal growth and development plans for planned career paths towards 2024 and beyond	
2. Transformation of the way meetings are done	● This GA also has the potential to transform what IAU and similar meetings and interactions might look like going forward	● Ensure that all innovations in terms of conferencing are well documented in order to inform future meetings	Vanessa Moss/TFOM
3. Collaborations	● With careful planning we can secure a significant number of new collaborations that will support the development of astronomy in Africa. Given the current low to modest level of astronomy in most African countries, the opportunity for collaborations, both building up to and surpassing 2024, is great.	● Establish a suite of opportunities for collaborations	AfAS
4. Greater unity in astronomy across Africa	● 2024 offers an opportunity to come together as the African astronomy community, in order to support each other and grow through our respective strengths and resources.	● Use 2024 to galvanise support for this legacy issue, and establish a home for this such as the African Astronomical Society	

5. Education, outreach and development flagships	● Several activities would have taken place – all these should have a sustainability plan associated with them in order to ensure that there is a legacy beyond 2024.	● Incorporate 2024 into other strategy documents relating to education, outreach and development ● Identify specific Outreach flagship projects that could be developed/supported leading up to 2024 and that would last well beyond 2024.	AfAS, NOCs, NAECs, ROADs, APA, IAU WiA WG
6. Science flagships	● There are several potentially large projects related to either infrastructure or scientific collaborations such as a network of telescopes, computing infrastructure, etc. These projects can be supported and enhanced around GA2024 and thus have the potential to leave a lasting impact beyond 2024	● Identify specific Science flagship projects that could be developed/supported leading up to 2024 and that would last well beyond 2024.	NOC, IAU WiA WG
7. Astronomy hubs across Africa	● The idea of an African Astronomy Hub is that it could be a focal point for astronomical activities within a particular geographic or language region in Africa. It may take the form of a physical office hosted within a single institution, or a virtual office located across multiple collaborating institutions.	● Explore the setting up of Astronomy hubs across Africa in partnership with organisations such as AfAS in order to ensure sustainability beyond 2024	AfAS, NOCs, ROADS, NAECs
8. Diversity is strength	● A strong legacy should be the demonstration of the strength of diversity in tackling human challenges, both in terms of astronomy (what Africa has contributed to the field) and in terms of development (how astronomy can work with diverse fields to impact on society)	● Establish strong links with other disciplines that will be enhanced through the 2024 GA ● Ensure that the communication of African contributions to the field of astronomy is strong enough to last beyond 2024.	

9. Greater African representation in the IAU	● Currently there are only a handful of African countries which are members of the IAU	● Encourage more African countries to join the IAU during the 2021 General Assembly, even if they join as interim members/observers. This will give a stronger African presence in the IAU by the 2024 GA.	African ROADS and OAD; IAU WiA WG
10. A more sustainable field of astronomy that meets the needs of society	● There are many societal aspects that could be emphasized through the GA and thus influence the field of astronomy as a whole (energy, carbon footprint, education, development, gender equality, etc.)	● Build into the GA planning and implementation the formulation of recommendations which could influence future astronomy meetings.	
11. Africa established as a destination for talent and investment	● The GA could be used to further attract international talent and investment to the continent (whether that's international collaborations, new facilities, companies, etc.)	● Develop a communications package around work and investment opportunities on the African continent, which can be promoted before, during and after the GA.	