SKA Prospectus Workshop Notes

The non-science impacts of the SKA

2 December 2014
SKA Organisation Headquarters, Jodrell Bank Observatory, UK

Start	Description		Speaker
08:30	Arrival, Tea and Coffee		
09:00	(1)	**Words of welcome**	Jonathan Kings
	9:00	The prospectus process and the workshop objectives	Simon Berry
	9:10	The GO-SKA project: contributions to the SKA prospectus	Patricia Vogel
09:30	(2)	**Keynote speaker** Big steps: towards an inspiring SKA in 2050	Tim O'Brien
10:00	Tea and coffee break		
10:20	(3)	**Addressing Global Challenges**	
	10:20	Understanding global challenges: The potential of SKA	Viola Tegethoff
	10:30	The Big Data challenge	Viola Tegethoff
	10:35	Brainstorm: Identifying further challenges	
	10:50	Global lessons from of the Australian case for SKA	David Luchetti
	11:00	FAST as a new engine for local development	Bo Peng
	11:10	Global lessons from the South African case for SKA	Bernard Fanaroff
	11:20	Plenary Discussion	
12:20	Lunch break		
13:20	**(4) The impact on Society and Industry**		
	13:20	The global impact of Radio Astronomy	Matthew Johnson
	13:30	Non-science impact from large science projects	Claire Dougan-McCallie
	13:40	ESS: Managing long term expectations for impact	Kjell Möller
	14:00	Plenary Discussion	

Start	Description		Speaker
14:30	**(5) The impact on industrial return**		
	14:30	Maximizing the impact on industrial return	Corrado Perna
	14:40	XFEL: Insights on in kind contributions	Antonio Bonucci
	15:00	Plenary Discussion	
15:20	Tea and coffee break (optional)		
15:35	**(6)**	**Future Developments: Creating an ongoing case**	
	15:35	LOFAR, evolving the case for investment	Michiel van Haarlem
	15:55	Discussion: Developing a 50+ year case	Jonathan Kings
16:20	**(7)**	**Conclusions, Consensus and Closing**	Jonathan Kings
	16:20	Refreshing our memories	Patricia Vogel
	16:30	Plenary Discussion	
	17:00	Take home challenges for SKAO and StratCom	
17:15	(8)	**Keynote speaker** The SKA in the world of 2050	Jill Tarter
18:00	End of program, departure to hotel for refreshments and dinner		

Executive summary and notes

Introduction

The summary and notes of this workshop should allow you to have an impression of the flavour of the workshop and be informed on the main non-science impacts of the SKA.

Whilst the science case may be the primary driver for the SKA, its non-scientific benefits also show great potential contributing to society. Therefore the SKA Prospectus workshop was aimed at presenting and exploring the non-scientific impacts of SKA.

The GO-SKA work packages presented their output alongside external speakers, that were invited to share their experiences and to offer their (external) views in the discussions on the various topics. This resulted in interesting perspectives on the building the SKA business case.

In addition to stimulate the thinking on the long term embedding of the SKA Observatory in the society of 2050, two visionary speakers were invited. The question posed to them was: 'In which way would the SKA Observatory be meaningful and have an impact on science and society?"

Below you will find in paragraph 1 the executive summary, including a checklist and overview of the uniqueness and importance of the SKA and in paragraph 2 the introduction to the programme, and in paragraph 3 the highlights of the presentation and 'take home insights' per session.

These notes and executive summary of our workshop should be considered as the outcome of our session 7 of the Workshop programme. Therefore session 7 is not listed in the highlights of the presentations below.

1. Executive Summary

The development of the Prospectus is a coordinated effort to build a central global business case and to provide a foundation stone for the individual national business case. The SKA is a truly worldwide project with 11 member countries, whose inhabitants represent 40% of the worlds population. The impact on ICT, industry and public services and social development are potentially unparalleled. So a compelling case can be made to supplement the excellent science case, to show why the SKA Project is indeed important to be invested in by governments. After all, when put into perspective the costs are not so high compared to such things as commercial airliners, especially when considering its impact.

With regard to the non-science impact two central questions are to be addressed in the Prospectus:

- What is unique about the SKA?
- Why are projects like SKA important?

1.1. Reaping the harvest of the Prospectus Workshop

Checklist to develop an ongoing case for the SKA large scale research infrastructure:

- ✓ Win the heart and mind of the public, outreach, science related events, direct collaboration, profiling the ambition of the Project
- ✓ Embark in the national agenda of the governments
- ✓ Realism in the claims and expectations of the SKA (cost, schedule, quality)
- ✓ Define a (long term) future outcome and (short term) innovation
- ✓ Agree on the global branding profile: focus on the distinct features of the Project, make it a brand
- ✓ Outreach and communications strategy, copy and apply to national formats
- ✓ Opportunistic and open to opportunities to use, look outside your own comfort zone (there is no one size fits all)
- ✓ Be involved in the grand challenges of society heading for 2050
- ✓ Develop a methodology to collect the data to keep track of the achievements in the impact, build an evidence based show case
- ✓ Establish a global methodology for the impact studies of large scale facilities and more specific the SKA Project.
- ✓ Be careful about the comparison with other existing facilities
- ✓ Look for an charismatic SKA Ambassador

Zooming in on the uniqueness and importance of the SKA Project:

- What is unique about the SKA?
- Why is the SKA Project important?

Uniqueness:

- It is a global project, inspirational for future worldwide collaborations to address the global challenges
- International collaboration, dual site facility in SKA1 and multiple site facility in SKA2
- SKA is the lighthouse project for Big Data, make use of that profile in all potential area's
- SKA aims to be sustainable in operations
- SKA is a "science user" facility as opposed to other "industrial user" facilities
- Science case is the common driver for the project, the other drivers may vary per country
- SKA beats the others facilities in the same field
- the SKA project as a means of sustaining life as we know it on this planet and detecting it elsewhere!

Importance:

- A broader Science case than radio astronomy: Astro Physics
- Human Capital development covers very diverse area's (science, local economy, global society)
- Socio-demographic availability of human capital will dramatically change the coming 50 years
- Be inclusive in your project and inviting for potential partners, building relationships and collaborate in an early stage. E.g. Startups in embedded systems and digital processes were developed as part of the project
- In Kind Contribution can also be seen as a form of technology management and knowledge transfer, building your community
- The research infrastructure is always a catalyst for the local economy on site, the opportunities may vary in the different nations
- Anticipate the impact on short term innovation and long term outcome (Industry will look for short term interests and long term interests)
- Infographic on the costs; cost are marginal compared to the potential impact
- Drivers for the project vary per country, the science case is valid for all
- SKA is a catalyst for global development in different fields and on different levels of national and local economy

2. Introduction of the programme

The GO-SKA work packages presented and contributed to the workshop to the development the non-science framework of the Prospectus.

The workpackages 2, 4 and 5 presented their output and prepared and initiated a discussion focused on the business case of the SKA by addressing the global challenges, the non-science impact of large scale research infrastructures, a quick scan of the STEM related skills in the SKA project, importance of the maximization of the industrial return with regard to the procurement model.

In addition external speakers were invited to share their experiences and offer their (external) views in the discussions on the various topics.

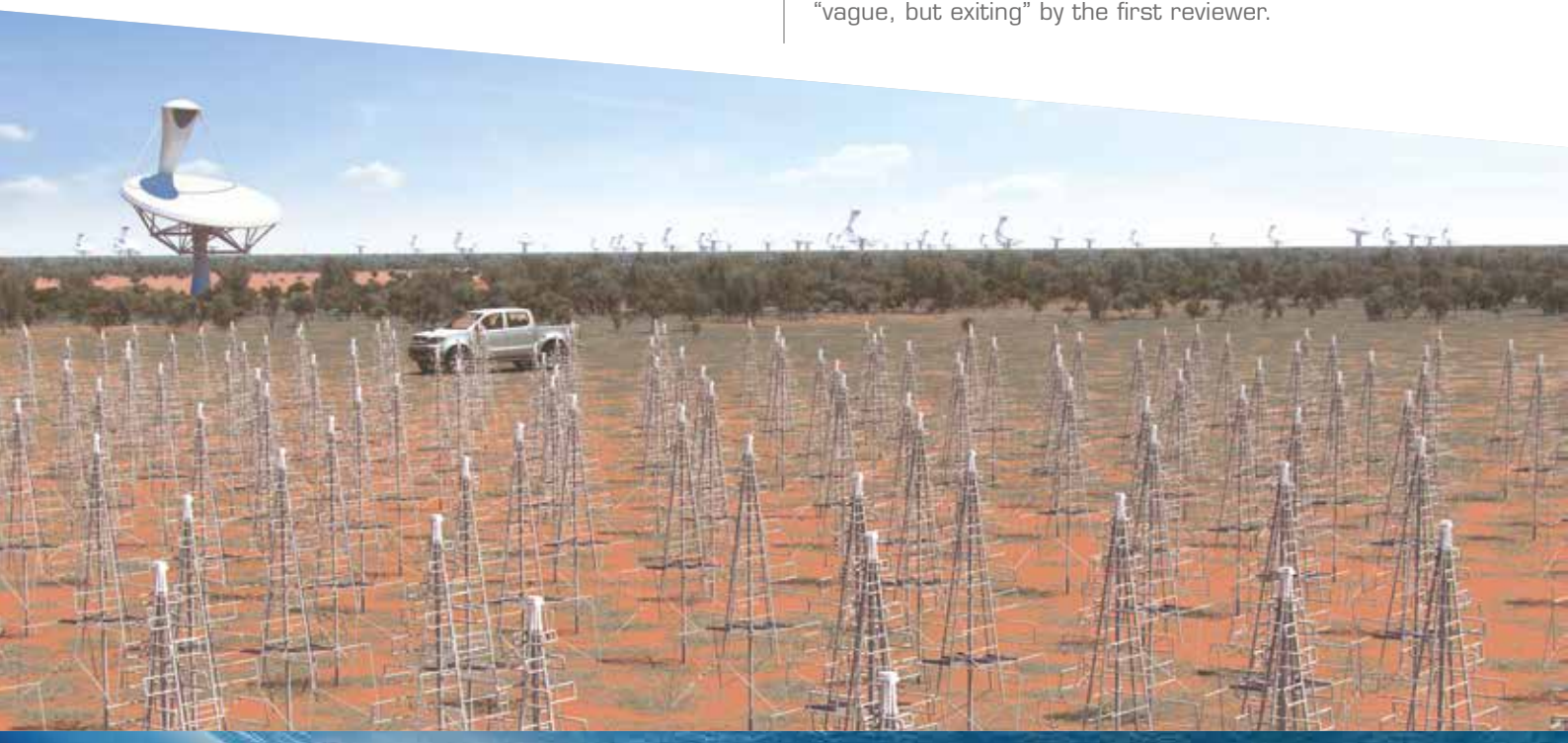
3. Highlights of the presentations and 'take home insights'

Session 2 - Big steps: towards an inspiring SKA in 2050

Tim O'Brien

"Why should I care about the SKA?" From a science perspective it is the next step in our exploration of the universe. As the size of telescopes increases we can look further to ever fainter objects, the SKA being the next step in this development building on the VLA and ALMA. Keep in mind however that no single telescope ever constructed is still used to study its original science case, instead exploring a vastly new region of as of yet unknown discoveries. Such "blue skies" research generates valuable scientific knowledge, spin off and economic impact. Still the most important thing is the inspiration that this research generates, not only for scientists, but for society and humanity itself.

The cost is far from ridiculous looking at the real numbers in an international context. Research infrastructures deliver real value for the money. Looking at CERN its most visible contribution, the internet, was originally considered "vague, but exiting" by the first reviewer.



Involvement outside science needs a communications strategy. E.g. the LHC did put a four year communications strategy in place to promote it, showing how important it has become to show the impact.

SKA is a unique project considering the human development in the region, engaging not only science communities but also engaging local communities and stimulating local economy development, such as tourism. For example Jodrell Bank was estimated to generate at least £27m worth through regional visitors to its exhibitions, though far more has likely been achieved as visitor numbers have far exceeded those used in to make the estimate. Further outreach and inspiration is generated by these facilities as they tend to become part of popular culture, from movies to documentaries and even live media. SKA in 2050 will have been in operation for 30 years. It will likely become a global icon for science and engineering, having delivered world-leading science and inspiring future generation.

Session 2 Take Home insights

- Win the heart of the public first, by getting a place in their hearts and minds. Don't ignore government, but the public is key. After all, the government is elected by the public. The popular science inspires the "real science".
- The global aspects provides a new dimension for outreach.
- Tourism might be developed, even on site without causing RFI. E.g. CERN LHC did using immersive spaces around the work and give the public a sense of what this is like. Also let scientists "spread the word" from the sites to places worldwide.
- In operating the SKA Facility, all should be aware of other spinoff than science.
- There is a need for an iconic charismatic ambassador, taking care to also consider female role models. There is a great potential in engaging astronomy talent and a broader scientific group. You can either choose an ambassador or let the media and public make their own selection.

Session 3 - Addressing Global challenges

3.1. GO-SKA Workpackage 5, Viola Tegethoff, MPifr

SKA has a lighthouse character in many areas not only in Big Data but also in other areas it can stimulate innovations. For example in the building and development of human capacity in the Science Technology Engineering and Mathematics (STEM) and innovations in sustainable Energy and High Performance Computing. Generate a snowball by focusing on three key potentials.

With regard to the ICT - It might not be necessary that astronomers are reinventing the wheel. Industry is simply looking for customers to extend their knowledge in implementation. Industry is addressing the demands, but may not ask the right questions and might benefit from the required specifics of the astronomy community.

The EU believes that research data will be the new scientific infrastructure, Horizon 2020 is ambitious and the research data alliance is important. Especially now that the vision is to have open access to research data..

Societal opportunities to improve conductivity in remote areas and invest in small e-infrastructure to fight poverty. Evolving infrastructure will make remote communities benefit from connectivity.

With regard to the required capacity building in STEM Is the trend in demography hindering the building up, as the available working population decreases.

What would be a sensible approach to be able to respond to an increasing demand for stem staff. What are recommendations of national advisory boards? Routes, best practices and international sharing (also in SKA communities).

SKA is the show case of the connection between disciplines in STEM, and could create role models.

With regard to the energy and climate change the SKA should label her activities as a sustainable SKA does not destroy the planet for understanding the cosmos.

Finances, ecology and sustainability, ethical, innovation and exploitation. The largest challenge is storage for 24/7 exploration.

Brainstorm on potential challenges:

Big data/ICT

- Call in Horizon 2020 to help the industry
- Need more definition to enable joining
- Make the scale of data affordable

Human capacity building

- Training a new generation of leaders in science that can explain science and see the multidisciplinary aspects
- Citizen science, making the public having a share in the facilities and fully open up the data, a network of brains
- Restart these developments in the underdeveloped 'green fields' of capacity SKA rides the wave of science 2.0 and embrace its values.

Innovation in Energy

- Aiming for sustainability in all aspects
- Make it a model for sustainability

More generic issues relating to develop the key potentials of the SKA:

- Realism is as important as the ideas
- Brand is identifiable, use that to help others
- Industry must see the real approach to realize these visions, by a clear roadmap: practical and achievable
- Making the impact itself sustainable in the future
- Think about funding as much as innovation, as we simply have a cost cap and cannot do everything
- Keep expertise in house

3.2. David Luchetti: The Australian Case for the SKA Potential

What will it do for science, Australia, community and industry? Participating will allow to lead in our scientific strong points and enable industrial developments. There is limited time to convince politicians and governments due to short terms and short term priorities. Financial benefits are clear and easy to sell, non-financials however are fairly intangible.

Show cases: Pawsey HPC Centre cooling that uses deep aquafiers for cooling. CSIRO involved with Wi-Fi technology development in 1999s.

The business case should be able to withstand scrutiny from government departments. Opportunity costs are critical for governments, look for tie-in with their agenda. Be careful about messages due to their records. Advice and confirm that risks can be mitigated. Public support is infectious for generating enthusiasm. Engaging the public (675 events in a few months) allows for growing recognition. Demonstrate you can deliver on the vision.

3.3. Bo Peng: The Chinese Case on FAST potentials

FAST was born during the SKA process. 30 years of adaptability needs strong, reliable and durable cables that could see impact elsewhere. Also CCD technology is developed. FAST is promoting economic development through big data business case.

The development of the FAST data centre (and maybe future SKA data centre) development will benefit from a natural cooling cave. Also because of FAST a centre for astronomy skilled young academics is been planned and developed.

FAST has also a non-science impact like road development that significantly reduces traveling times in the area. Scientific tours, from the astronomy town, provide the region with touristic opportunities and green industry. This makes FAST a new engine for the local society. It is the poorest prefecture, but the local people are using FAST for their local motivation and development.

On the larger scale FAST and SKA can be used for cultural propagation and as an ambassador to peace.

3.4. Bernard Faranoff: The South African Case for the SKA Potential

Republic of South Africa is seen as the next business destination. Therefore the infrastructure and availability of skills should be in place. A high profile project like SKA excites people about and in Africa. Support from European Parliament and the African Union heads of state. In 1996 SA government white paper decided to develop radio astronomy as a driver to create knowledge and intelligence. Nowadays the SKA and MeerKAT are key focus points for the government as nominated as one of the 16 Special Infrastructure Projects.

Show that local production is replacing import. Use SKA as a platform to develop the local area, for instance by expanding the telecommunications coverage. Site development has to be outsourced for 75% within SA using local or SA contractors and subcontractors.

Development of human capital by taking 1st and 2nd year students and placing them into a pipeline all the way to the postdoctoral level. Also work to do a lot on the job training including the local community and diversifying the SA SKA office.

Within the Aerap project the obsolete telecom receivers sites all over the African Continent are being converted into scientific instruments to build the skills and develop the capacity in the science and engineering communities.

Human capital is not just highly trained astronomers, but also local workers developing skills.

Session 4 - Impact on Society and Industry

4.1. GO-SKA Workpackage 2, Matthew Johnson, Claire Dougan-Mc Callie

A new Astronomy Impact study has been developed by STFC as part of GO SKA. Since the last one in 1981, the world has changed. Today there is a change from electronics skills to computing. Recent research was done in the astronomy graduates, concluding that the astronomy skills are a good base for an employment status.

The UK and STFC have developed a STEM policy (science, technology, engineering, mathematics) because it is identified to be the key skills for the future, economy and society. Industry shows interest in the SKA Project because it is a showcase and testing ground for new future skills in areas like big data to respond to future demands of the R&D of industry. E.g. two industrial spinoffs originated from the large scale research facilities: NVIDIA (gaming industry) and SCISYS (Mars Rover drilling technology applied in the Oil industry).

Impact of the large scale facilities are at the heart of the STFC Vision. The commercialisations and technology transfers of the more important facilities have been monitored and evaluated.

E.g the Synchotron Radiation Source, the ATLAS computer, the ISIS neutron source have shown significant impact over the long term existence. E.g. new techniques are now applied in the Pharma Industry, the IT development is now applied in the digital animation in e.g. gaming industry.

There is not one size fits all with regard to the methodology to monitor and evaluate the impact of the large scale facilities. Further there is until now, not such culture to share and evaluate. All partners could benefit from exchange of experience with regard to the timescale of the impact (short term/ long term) and with regard of management of the collected data and archiving of the impact data.

4.2. Kjell Moller, Lessons learned from the ESS Case on long term impact

Key words: **inclusiveness, cost capped, schedule.**

Establishing the European Spallation Source has been a long process, keeping everyone on board. Sold as sustainable research center for use by the science community and industry. Ensure that the industry involved in construction to also have an interest in the long term industry in science. Key is to keep to the schedule and drive the process along on 80% certainties. Important to be inclusive, for example involve politicians and industries early on. Kept the cost throughout the process the same right up to the preconstruction phase. Make strategic distribution of in kind contributions, for ESS 70% is contributed in kind. With 17 countries involved in ESS it is essential to have a clear (quality) control mechanism and a clear line of authority. Overall 700 fte are involved, on site 300 fte, mainly engineers for assembling all the components.

The preferred legal structure, ERIC, is driven by political support. Also legal issues, like the ability to get loans are important considerations.

Session 4 Take Home insights

- Use astrophysics instead of astronomy for impact, especially in education. INAF has kept record for the last 10 years in astrophysics statistics.
- SKA is characterized as a “science user” model as opposed to an “industrial user” facility like ESS. But nevertheless, industry will be involved in the construction. Even pure science like CERN has mostly technology spinoff.
- Establish a global methodology for the impact studies of large scale facilities and more specific the SKA Project. It then will be easier to access and generate data for the global partners and to promote the success. Methodology may include annual reporting, many multiyear studies. Both industrial use and spin-off generate significant value and include the lessons learned.
- Most large scale facilities are successful. WHY?? Some may have to realign their goals during the process though. The organization of these research organizations is important, you need a special environment for exploitation after the initial visionary and innovation period.
- The opportunity costs in choosing where to invest is important for industry involvement, the IP policy is part of the investment decision.

Session 5 - The impact on industrial return

5.1. GO-SKA workpackage 4, Corrado Perna, INAF

Key question is "How does this Project meet the national development plan goals?"

Politicians change, the project needs to embark in the national agenda. So develop a spending policy which enables to relate to a national development plan. E.g. Procurement that is focused on maximizing the national industrial return is important. In this it is important to understand how technology has developed and how this could affect contracts. People should be aware of the "International framework". The SKA has a unique role in this as it has global challenges and allows people to work in an international framework. This might boost the national programs. The access to advanced technology, and further advancement, is an incentive to apply for contracts.

Two recent established ESFRI projects XFEL and ESS have adopted an in kind contribution model to build the facility.

5.2. Antonio Bonucci: In-Kind Contributions within XFEL

XFEL is built by 12 countries of which Germany is the largest contributor. The construction costs are estimated at 1.15 B€. There are two sites above the ground and 5 experimental stations with an expected lifetime of 20 years. The total construction project has 48 work packages and 76 In Kind Contributions.

The complete project is built by a mixture of 50 % cash and 50 % in-kind contributions. In 2005 the in kind contribution was decided based in capabilities of members to provide this. Reason for in kind was originally for technical issues and certification, now sometimes also due to crisis cash limits. The process of the in-kind procurement requires a significant administration. It is a major effort to get all the agreements with the different institutes drafted.

In kind contributions is an attractive approach because it make use of the existing know-how of the parties involved, it allows for easy participation of national industries. On the other hand the institutes involved carry part of the technical and financial risk. And of course during the project lifetime the funding is vulnerable because strategy change of the funding agencies.

There is a key role for the work package leaders in the project, as they are the first point of contact for the institutes involved in the work package. The project is mainly controlled by managing milestones and focusing on the integration issues. The risk management is more complicated due to complex structure of the project. It is essential not to treat the institutes as sub-contractors but to actively manage the relations. The focus should remain on the technical rather than the financial issues.

The presentation and the slides contain lots of other information and practical advice on managing the IKC process. But the main tool is the relationship between the institutes and to actively manage this.

Session 5 Take Home insights

- As XFEL is an European entity, the EU procurement regulations do apply.
- Tendering for the in kind contribution is done from the institute and each country can apply its own rules. The responsibility for following the procurement rules lies with the tendering institute. The issues with procurement stay on the national level and are not transferred to the XFEL project level.
- It is advised to start with a well-defined agreement. At this stage 3 out of 78 agreements are not finished. But these are technical problems, the work is ongoing without the agreement. Because the in kind contributor is usually very motivated.
- If two institutes want to contribute to the same components, they have to agree to the estimated cost provided by XFEL. The actual selection of the institure is based on the work package and the manpower available.
- The management tool for delivering of the in kind contribution is the relationship of XFEL with the institutes. The project manager is responsible for the "penalty", but the aim is to validate, and accept the delivered contribution. Active management of the relations between and with the institutes is key for timely delivery.

Session 6 - Creating an ongoing case

Michiel van Haarlem: LOFAR, evolution of the original business case

LOFAR is an international phased array in the Netherlands and neighboring regions. The overall investment was 150 M€. Branded as a sensor network with real time processing. It includes other applications with similar needs, like geophones for geophysics, infrasound for meteorology as well as precision instruments for agriculture.

Combined with a conservation area, enabling cost reduction alongside low interference. International LOFAR remote stations have been successfully developed.

Industrial involvement was used to enable mass production, with knowledge exchange between science and industry. Startups in embedded systems and digital processes were developed as part of the project. Training programs were developed with a local university of applied science. But these are just a few of many related activities and projects that have been developed alongside LOFAR. The key collaboration with IBM, which provided the initial supercomputer, has been expanded in the DOME project. This center for exascale technologies will also be of use for the SKA, involving exchange of ideas between science and industry. As a whole the project has generated a significant number of jobs, training programs and has seen to a growth in innovation, exports and new markets for partners.

Session 6 Take Home insights

- After years the Agricultural users do still use and work with the spin off technology of LOFAR. Similarly the geophysicists were facilitated with only minimal design changes. And the sensor technology was even tapped into the healthy aging programmes.
- The coordination and exploitation of the spin off outcomes was assigned to an professional external agency. The project bureau employed 3 or 4 people that enabled brokerage that led to the development of 500+ new positions.
- Initial momentum however is key to start it up. To manage all the expectations it is important to focus on the strong projects that have the potential to be used as a show case for the non-science potential.

Session 8 - The SKA in the world of 2050

Jill Tarter

In 2050: More people means more mouths to feed or more minds to contribute. Africa is the only growing continent growing in relative of population. Unlike in the rest of the world, in Africa and India there will be less dependents. Depending on mitigation the world will be slightly or a lot warmer and a lot dryer. Organized around megacities, not nations, will define the world. A network between them will organize the resources. SKA operations on three sites may thus be defined by this mega city network. For example Feeding the world in 2050 may need vertical farms. This is more than agriculture and involves many other areas of technology. Not warfare, but sustainability will be the key challenge. Thus the world will be filled with opportunities solving these challenges.

Imagine an instrument that maintains its ability and continue to do good for the world. Beyond amazing science it will probably be investigating even more amazing surprises. It will be a tourism hotspot. It will face competition and review and trying to cut its cost.

SKA thus needs a business model, not a business case, to make it relevant and a leader in solutions to the challenges in 2050. SKA could be relevant in the cradle of life challenge. The 21st century will be the century of biology on earth and beyond. We have seen game changers since we started thinking about the SKA: extremophiles, exoplanets and moons. So life beyond earth is even more likely. Discover, detect or even export it. Techno-signatures are where SKA is key. By 2050 it could have interrogated all stars in the milky way galaxy multiple times. Simply by probability of detecting something means a significantly improved possibly of success. If we ever succeed it proved that the longevity of a technological species is large, thus we could also make it ourselves and overcome our challenges.

If we find one, this means there are many. This will make the SKA a true landmark, and will need to be managed like a hospitality opportunity. However SKA is unlikely to be verifiable. This changes the nature of international cooperation, thus the SKA information should be the property of all of humanity.

On the other hand the scale and scope of data that the SKA will produce is not limited to making discoveries in the traditional sense. It can also produce significant null results, thereby disproving existing theories. Ultimately we should also be aware that the process of searching changes us, especially when researching these cosmic questions. The SKA could thus hold a mirror to the public to show just how minute their differences are.

The SKA organization can also help itself by working with the local community. As such, it should stop thinking of farmers as sources of RFI, but as potential partners. For instance in partnering to jointly help prevent forest fires. These are a low level risk in a sparsely populated area, but due to the size of the area and the scope of the array present a very real threat that both could benefit from solving.

Some interesting ways to react to the demands of the SKA Observatory

- Climate change: biochar to make coal from low quality biomass in a zero emission fashion, easily usable in the low quality environment around the SKA sites.
- Energy from twr and modular thorium reactors, solving both energy and nuclear waste problems. Given the public's unease, remote sites like SKA could act as test sites, especially if power lines for excess production are in place.
- Poverty: create fablabs to use smart materials to encourage local people to learn disruptive new skills. Use this additive manufacturing into a sustainable SKA 2.
- rethink SKA to enable space situational awareness. Both to address comet impact and to generate a worldwide sense of mutual trust.

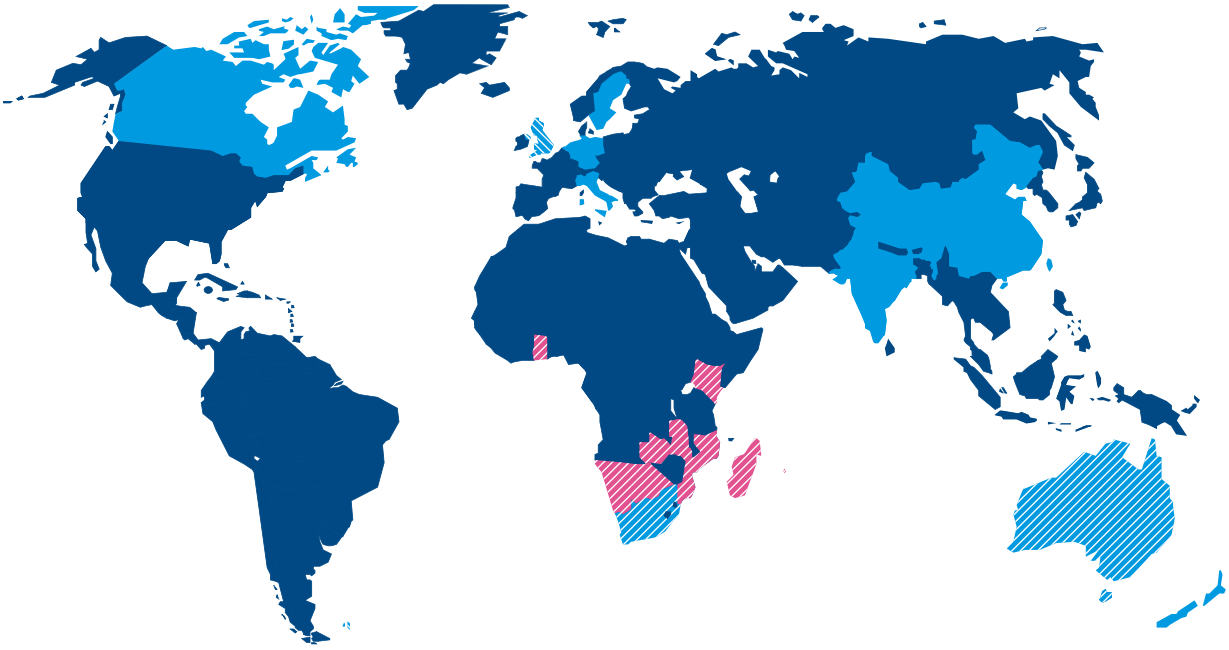
So ultimately we can use the SKA project as a means of sustaining life as we know it on this planet and detecting it elsewhere!

Questions and Answers

- **QA:** Life? Visits? We've not done the experiments nor searches well enough to have significant null results.
- **QA:** Radio loud is a passing phase? Leakage is not likely to be contained, but multi solar system body or intended signal should easily be detectable. For example a radar/radio halo to detect incoming comets. (Though B6-12)
- **QA:** Modified thorium already developed? Invest now and bring them into reality for the 2050 period.
- **QA:** Role of scientist in 2050? SKA should be involved in the grand challenges and be more relevant to survive to 2050.
- **QA:** Should we be leaking? AAAS to discuss this in February to initiate a global debate on this topic.

A global effort

Around 40% of the entire population of our planet supports the SKA project. Eleven countries form the core of the SKA. This is augmented by around 100 organisations spread out over 18 countries. Hundreds of scientists, engineers and researchers, from the world's leading Universities and R&D groups are participating in vast teams formulating the design and development of the SKA. Set up as consortia, these teams are responsible for the individual elements and components that will make up the detailed design of this groundbreaking telescope in a scientific endeavour the scale of which matches those of space programmes or the Large Hadron Collider. Members of the SKA Organisation are Australia, Canada, China, Germany, India, Italy, New Zealand, South Africa, Sweden, the Netherlands and the United Kingdom.



Full members

SKA Headquarters host country

SKA Phase 1 and Phase 2 host countries

African partner countries
(non-member SKA Phase 2 host countries)

This map is intended for reference only and is not meant to represent legal borders

The non-science impacts of the SKA

Whilst the science case may be the primary driver for the SKA, its non-scientific benefits have the potential to contribute greatly to society. Therefore the SKA Prospectus workshop is aimed at presenting and exploring the non-scientific impacts of SKA. We expect that the outcomes of this workshop could thus provide the basic framework for this part of the prospectus. Indeed a summary of the presentations and discussions should allow anyone to see what the main non-science impacts of the SKA could be.

Words of welcome

The day will be opened by presenting the framework of the prospectus process, revealing the timeline and general structure that is envisioned by the SKAO Office. Following this the GO-SKA project, that has been working on the non-science case and governance of SKA, will present preliminary conclusions of their overall contribution.

Addressing Global Challenges using SKA

SKA is envisioned as a technology driver in many areas from big data, high-performance computing and energy as well as enabling scientific human development thus addressing the Global Challenges. In this session we aim to discuss the findings within GO SKA on how the SKA will contribute to these areas and learn how specific nations have already used these topics to generate high levels of national support.

General info on GO-SKA

GO-SKA is a project supported by the European Commission under the 7th European Framework Programme (FP7). GO-SKA's primary aim is to provide guidance at policy-level to the global SKA Organisation in the pre-construction phase, so that it will be optimally prepared for the construction and operation of the SKA. It is a ~900 k€ project with a duration of 39 months (November 2011 – January 2015).

GO-SKA is preceded by PrepSKA, a preparatory study for the SKA. PrepSKA was also funded by the European Commission under the FP7 programme. One of the aims of PrepSKA was to investigate, with active collaboration between funding agencies and scientists, policy-related questions on governance, procurement and funding. The PrepSKA policy work packages have made a significant contribution to the establishment of the current SKA Organisation.

The GO-SKA project builds on PrepSKA deliverables and deals with the new issues of the pre-construction phase. PrepSKA has assembled the best options for SKA; GO-SKA is developing these further.

The main activities of GO-SKA are to:

- broaden and strengthen the involvement of funding agencies and governments around the globe;
- prepare the establishment of global governance for SKA
- investigate world-wide partnerships between industry and the SKA
- develop strategies to further define the conditions by which non-scientific benefits from the SKA can best be integrated into investment decision-making.

The Square Kilometre Array (SKA) project is an international effort to build the world's largest radio telescope, with approximately a square kilometre (one million square metres) of collecting area. This is equivalent to 140 football pitches.

The SKA will not be a single telescope, but use the technique of interferometry to eventually combine vast numbers of three different types of radio telescopes in four unique configurations. This represents a huge leap forward in both engineering delivery and research & development, and will deliver a correspondingly transformational increase in science capability when operational in the 2020s.

The SKA telescope will be co-located in radio quiet zones in Africa and Australia. South Africa, hosting the core of the high and mid frequency instruments, along with several African partner countries, will work alongside Australia, who will host the low frequency dipole antennas and the dish-survey instrument.

The SKA will address fundamental unanswered questions about our Universe including how the first stars and galaxies formed after the big bang, how dark energy is accelerating the expansion of the universe, the role of magnetism in the cosmos, the nature of gravity, and the search for life beyond Earth.

With a range of other large groundbased and space telescopes covering huge swaths of the electromagnetic spectrum already or becoming operational over the coming decades, the SKA will perfectly augment, compliment and lead the way in scientific discovery.

The SKA Organisation, with its headquarters at Jodrell Bank Observatory, near Manchester, UK, manages and formalises relationships between the international partners and consortia and centralises the leadership of the project.

The impact on Society and Industry

A world of information is available on the direct impacts of existing large-scale scientific infrastructure and radio astronomy both on industry and technology. In this session past and current experiences on this kind of impact will be discussed and extrapolated to the SKA to envision its potential impact in tomorrow's society.

Future Developments: Creating an ongoing case

Ultimately the SKA needs to develop a lasting relevance and evolve with its environment, embedding itself in society. By examining examples and discussing how their experiences are relevant for the SKA we aim to develop a long-term picture of how the SKA will evolve and become part of society.

Two Visionary Keynote Speakers - The SKA in the society of 2050

Two visionary talks will bring us from reality to the world and society of 2050 and show us a glimpse of the potential impact of SKA science and derived technology on that era.

Conclusions, Consensus and Closing

Collectively the participants are asked to reflect on the various sessions. By doing this the day's discussions will enable us to formulate take home challenges for the StratCom and SKAO Office to finalise contributions to the prospectus.

Keynote speakers

Professor Tim O'Brien, Jodrell Bank Centre for Astrophysics

"I am a Professor of Astrophysics and Associate Director of The University of Manchester's Jodrell Bank Observatory with particular responsibility for public engagement and external communications.

Within the University's Faculty of Engineering & Physical Sciences, I am Associate Dean for Social Responsibility. The University has Social Responsibility as one of its three core aims, alongside research and teaching, emphasising how we make a difference to wider society outside of academia. This includes in research with wider societal impact, in producing socially responsible graduates, effective public engagement and improved environmental sustainability.

My research has focused largely on the study of stellar outflows, including novae and planetary nebulae. I use a wide range of telescopes around the world and in space, working across the electromagnetic spectrum from radio to X-ray. I also use hydrodynamic simulations to help interpret the data.

I am particularly active in areas of public engagement with research. This year I was awarded the Kelvin Medal of the UK Institute of Physics for innovative public engagement, working with schools, the wider public and the media, particularly through the new Discovery Centre at Jodrell Bank. I make regular contributions in the national broadcast media, including hosting the hugely popular BBC TV Stargazing Live series at Jodrell Bank and discussing topical science in monthly national radio programmes. I am also Principal Investigator for the University of Manchester's Schools-University Partnership Initiative bringing research from across all academic disciplines into schools."

Dr Jill Tarter, Center for SETI Research, SETI Institute

Jill Tarter holds the Bernard M. Oliver Chair for SETI Research at the SETI Institute in Mountain View, California and serves as a member of the Board of Trustees for that institution. Tarter received her Bachelor of Engineering Physics Degree with Distinction from Cornell University and her Master's Degree and a Ph.D. in Astronomy from the University of California, Berkeley.

She has spent the majority of her professional career attempting to answer the old human question "Are we alone?" by searching for evidence of technological civilizations beyond Earth. She served as Project Scientist for NASA's SETI program, the High Resolution Microwave Survey and has conducted numerous observational programs at radio observatories worldwide.

She is a Fellow of the AAAS, the California Academy of Sciences, and the Explorers Club, she was named one of the Time 100 Most Influential People in the World in 2004, and one of the Time 25 in Space in 2012, received a TED prize in 2009, two public service awards from NASA, multiple awards for communicating science to the public, and has been honored as a woman in technology.

She is an Adjunct Professor in the Department of Physics and Astronomy at USC, Asteroid 74824 Tarter (1999 TJ16) has been named in her honor. She is the Jansky Lecturer in 2014.

Since the termination of funding for NASA's SETI program in 1993, she has served in a leadership role to design and build the Allen Telescope Array and to secure private funding to continue the exploratory science of SETI. Many people are now familiar with her work as portrayed by Jodie Foster in the movie Contact.

Workshop speakers

Antonio Bonucci

In-Kind Contributions Supply Chain Manager - European XFEL GmbH

After graduating in Aerospace Engineering at the University of Pisa, I joined SAES Getters in 2000, as responsible for the modeling and simulation department. From January 2008, I was responsible of Application Engineering and System Analysis (AESA). In 2013, I have started the experience as Technology and Opportunity Scouting.

SAES products are used in applications addressing different scientific and technological content. Carrying out my functions, I have developed competences on a wide range of applications that span over the entire SAES business portfolio (displays like FED, PDP, OLED; solar cells as thin film CIS/CIGS; particle accelerators; vacuum technology; MEMs).

In fall 2014, I joined European XFEL GmbH as In-Kind Contributions Supply Chain Manager.

The European X-Ray Free-Electron Laser Facility GmbH (European XFEL GmbH) is a multi-national non-profit company. Commissioning is scheduled for 2015; user operation starts in 2016.

The European XFEL facility receives substantial contributions from its international partners in the form of contributions "in-kind." These contributions are manifold: hardware equipment, complete systems, or the provision of services. They cover all areas of the European XFEL facility.

Supply Chain Manager IKC monitor the progress and the contracts related to these contributions.

Claire Dougan-McCallie

Head of Impact Evaluation, Science and Technology Facilities Council (STFC)

Claire graduated with a Masters degree in Physics from Salford University in 1999 and began her career in the high tech start up, Bookham Technology. Whilst there, Claire gained experience in the research and development of optical communication devices in the company's wafer fabrication facilities. For the past 11 years Claire has worked for the UK Research Councils where she supported peer review for large projects in particle physics and astronomy before moving into the Knowledge Transfer arena. She successfully delivered a new knowledge transfer programme including establishing a Proof of Concept fund for innovation projects which continues today.

Claire has spent the last 5 years working in impact evaluation, establishing STFC's well respected impact evaluation framework and strategy. She manages a small team to deliver a range of impact studies and annual impact reports. Claire works closely with colleagues in the UK Government's Department of Business, Innovation and Skills to develop methodologies for assessing the impact of research and delivered two key impact evaluation studies on their behalf. In 2009 Claire completed an Executive Masters in Business Administration and carried out her dissertation on designing an economic impact methodology for large scale science facilities.

My responsibility within Saab moved from initially more technical/ research into business development and international cooperation. The international business included Sales, Offset, Countertrade and In-kind in close cooperation with the Investor related global industries.

Workshop speakers

Dr Bernard Fanaroff

Project Director of the South African Square Kilometre Array Telescope Project.

He has been awarded the Order of Mapungubwe in Silver by the President. He is a non-executive director of Eskom Holdings SOC and a member of the Audit and Risk Committee and the remuneration committee. He is a member of the National Broadband Advisory Council of the Minister of Communications, a Visiting Professor in Physics at Oxford University, a Fellow of the Royal Astronomical Society and a member of the Academy of Science of South Africa.

He holds a BSc Hons in Physics from the University of the Witwatersrand and a PhD in Radio Astronomy from Cambridge University and honorary degrees from six South African universities.

In 1994 he was appointed Deputy Director General in the Office of President N R Mandela and the Head of the Office for the Reconstruction and Development Programme and was later the Adviser to the Minister for Safety and Security, Chairman of the Integrated Justice System Board and Chairman of the Inter-Departmental Steering Committee for Border Control. He was for seventeen years National Organiser and National Secretary of the Metal and Allied Workers Union and the National Union of Metalworkers of South Africa and was a member of the COSATU Central Executive Committee.

He is the first author of the Fanaroff-Riley (FR) classification of radio galaxies and quasars. He has written at various times on industrial policy, trade unions, freedom of information, corruption and administrative justice, as well as published research papers on astronomy.

David Luchetti

General Manager, Australian SKA Office
Department of Industry

David Luchetti has worked in the Industry Department, and its many iterations, since 1990. David has worked in a range of sectoral areas on issues relating to trade and industry policy.

In 1997, David moved to AusIndustry (the program management division of the Department) and managed a number of multi-million dollar programs including the R&D Tax Concession Program and the Venture Capital Programs. This included managing the design, development and implementation of the Innovation Investment Fund.

In October 2004, David took responsibility for the Joint Strike Fighter and Defence Industry Policy Section within the Department. This role required David to work with the Department of Defence to assist Australian industry to access global supply chains and to provide advice to Government on defence industry policy.

Since 2009, David has been General Manager with responsibility for the Square Kilometre Array project.

Kjell Möller

Chairman Onsala Swedish Space Laboratory

Former Programme Director at ESS Lund

I have thorough experience of International collaborations in political and business environments. My experience is based on management of several projects in long-term research and development usually in the Triple helix (Gov't, University and Industry) environment.

The major projects I have been involved in have required multi-culture project management skills. This is valid for projects related to Saab and as well the ESS project.

The ESS project is one of my most challenging workplaces so far. ESS has employees from more than 30 nationalities with a mix from scientists to construction builders. To get the employees to work as one ESS is not simple but achievable. The management structure is as well complex which requires extremely good strategic planning to deliver objectives according to agreed schedule.

Prof. Bo Peng

Deputy Manager, Project FAST, China

Director, JLRAT (Joint Laboratory for Radio Astronomy Technology), China

Director, SKA Board of Directors

Ph.D. in Astronomy at Chinese Academy of Sciences in 1993. Senior staff at NAOC (National Astronomical Observatories, CAS) since 1995, whose research interests cover large scale survey, transient sky, giant radio galaxies, space weather and radio astronomy technology, especially engaged with the FAST (Five-hundred-meter Aperture Spherical radio Telescope) and involved in the SKA (Square Kilometre Array) projects since 1993.

Michiel van Haarlem

Head of the NL SKA Office.
Based in ASTRON.

He is responsible for the coordination of all SKA related activities in the Netherlands - including the NL participation in the global SKA project's work package consortia, the engagement with the Netherland's astronomical community and contacts with industry and government agencies.

He joined ASTRON in 1996 to work on predictions of radio observations of distant galaxies with the SKA. He was subsequently involved from the start (in 1997) in the design and construction of LOFAR, a revolutionary SKA pathfinder. Initially as the project scientist and programme manager and then from 2007 until 2011 as Managing Director for the final design and construction phases of the project.

In September 2011 he became the Executive Officer of the SKA project's Founding Board and upon establishment of the SKA Organisation in November 2011 he was appointed as its first (Interim) Director General. He returned to ASTRON in October 2012.

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