



SUCCESS FACTORS IN LARGE SCIENCE INFRASTRUCTURE A COMPARISON BETWEEN TWO PROJECTS



Rob Adam, ASP2018, Windhoek 4th July 2018

What is the SKA?



The Square Kilometre Array (SKA) project is an international effort to build the world's largest radio telescope, up to 50 times more powerful than any existing facility.

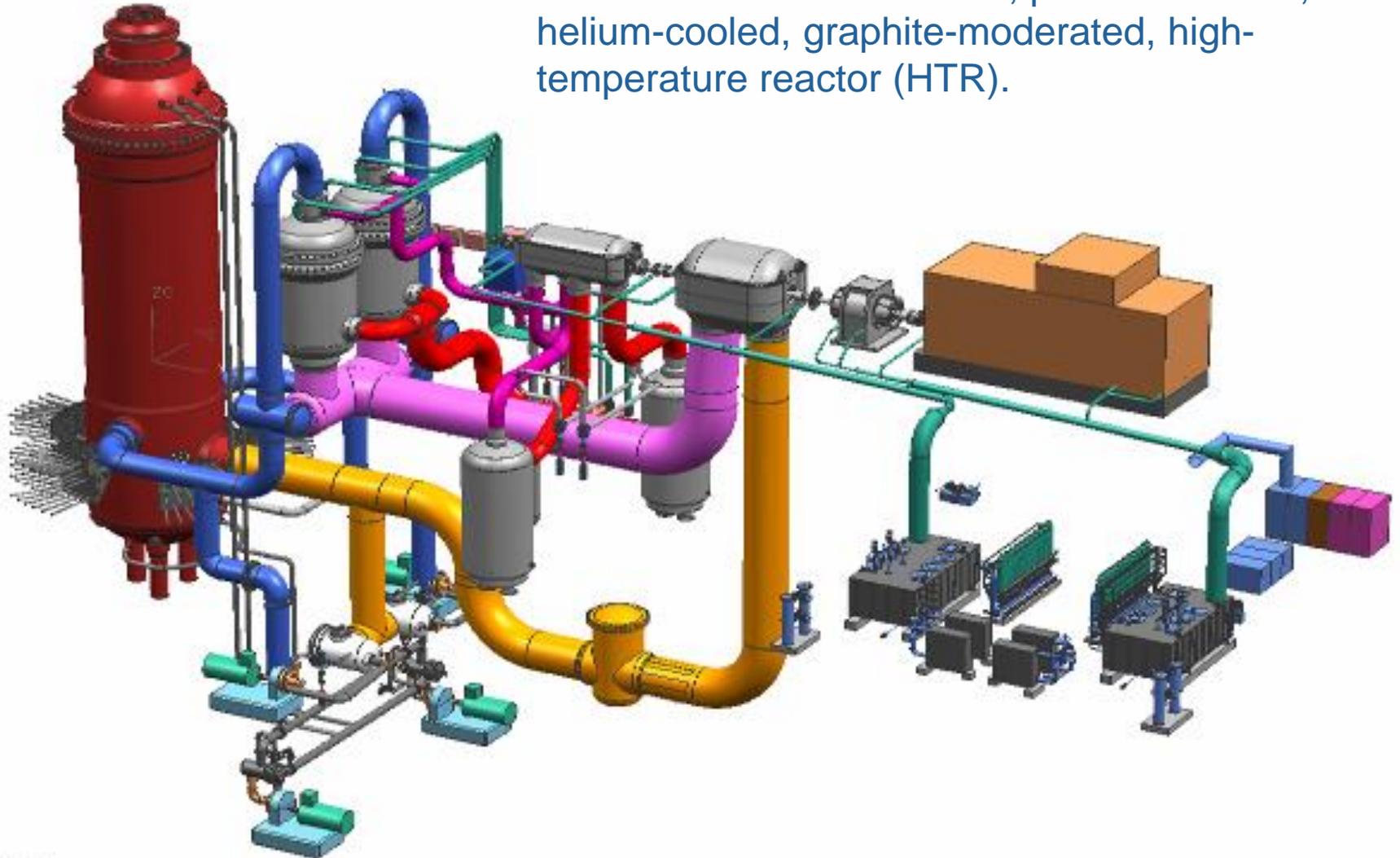
Hundreds and eventually thousands of mid to high frequency 15m dishes will be located in South Africa and Africa



Hundreds of thousands and eventually up to a million low-frequency antennas will be located in Western Australia.

What was/(is?) the PBMR?

The PBMR is a small-scale, pebble bed fuel, helium-cooled, graphite-moderated, high-temperature reactor (HTR).



Two iconic high technology projects with a South African footprint

- Both with excellent global value propositions
- Both with excellent local value propositions
- What went wrong and what went right?

PBMR: Global technology case

- **To generate electricity:** The higher temperature output (> 900C) would lead to more efficient electrical plants
- **To provide “process heat”:** A carbon-free heat source for industries that require heat as part of their process
- **To provide high temperature steam:** For specialist applications such as “Enhanced Oil Extraction” (EOE)
- **To generate hydrogen:** By catalytic cracking of water, thereby transferring nuclear-origin energy to transport systems
- **To desalinate seawater:** Fresh water without generation of CO₂

PBMR: Global safety case

- **Thermal stability:** Core cannot melt or overheat beyond fuel failure temperature
- **Nuclear stability:** Nuclear transients will not lead to unacceptable power outputs
- **Chemical stability:** Fuel elements will not corrode excessively
- **Mechanical stability:** Core will not deform or change composition
- **All leading to:** Reactor cannot melt, practically no release of fission products, catastrophe-free nuclear energy

PBMR: Local value case

- **Local manufacturing:** Using PBMR design capability to stimulate a local high tech manufacturing capability
- **Addressing South Africa's "technology balance of payments":** Using SA competence in PBMR technology to capture an increasing part of the global supply chain for other nuclear power systems
- **Energy solution:** PBMR promised flexible load following nuclear power in small modules.
- **Raising our game:** Participation in a massive international engineering project, with deliverables and deadlines Promoting high quality human resource development
- **Geopolitics :** A powerful footprint of modernity on the African continent

SKA: Global science case

- **Transformational Science:** Capable of addressing key questions in physics and astronomy
- **Excellent observing conditions:** Low radio frequency interference
- **Affordable infrastructure:** Power, telecommunications and transport costs reasonable and infrastructure in place
- **Available local skills:** Sophisticated engineering and maintenance sector to ensure competent operations
- **Cooperative Host:** SA Government sees SKA as the jewel in its research system and representing “geographic advantage”

SKA: Local value add

- **Big data:** Development of South African capability in Big Data technologies.
- **Economic diversification:** Diversifying the Northern Cape economy towards technology and engineering support
- **Human resources:** Linking human resource development in South Africa with the best universities in the world
- **Raising our game:** Participation in a massive international engineering project, with deliverables and deadlines Promoting high quality human resource development
- **Geopolitics :** A powerful footprint of modernity on the African continent

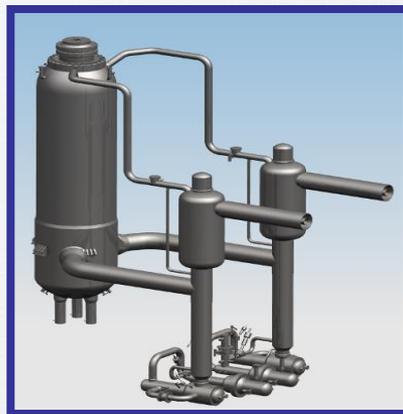
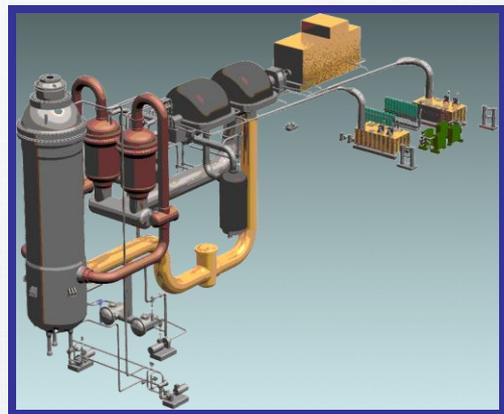
PBMR prototyping



The Arbeitsgemeinschaft Versuchsreaktor (AVR) was a prototype pebble bed reactor located outside the Julich Research Centre in Germany. It was an **indirect** cycle machine, commissioned in 1967 and ceasing operations in 1988.

No South African prototype was planned or built. Instead, the decision was made to go immediately for a **direct** cycle commercial reactor. Various technology problems identified in the AVN reactor were assigned to the in tray of the PBMR Chief Technology Officer, assuming they would be solved.

PBMR went straight from the Julich reactor to detailed commercial designs, which changed continually, causing regulatory delays and market uncertainty.



SKA prototyping



KAT-7

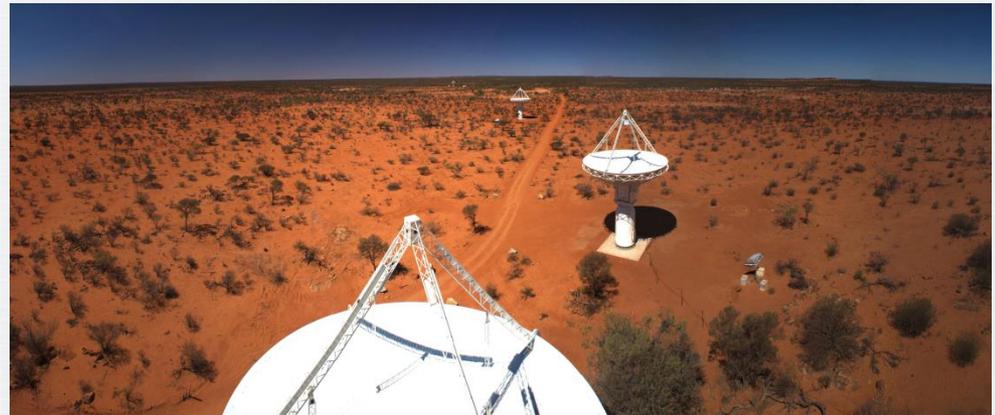


MeerKAT

A strong prototyping culture and practice is embedded. In South Africa we are already on the third generation of precursor instruments. XDM → KAT-7 → MeerKAT. Australia has ASKAP at Mid frequency in parallel with MeerKAT, and South Africa has HERA.



HERA



ASKAP

PBMR relationship with SA government

A Eskom

Eskom bought rights to exploit the PBMR intellectual property. It was seen as a commercially viable project initially, with potential for international sales. Later this view changed and in 2003 the Eskom Board voted to terminate PBMR work.

B Strategic project

The Presidency intervened to ensure continuation of the project for strategic reasons. It was transferred to the dti and later to DPE. PBMR became strongly associated with a particular Minister and little was done to broaden political buy in.

C Other shareholders

Investors other than government proper included Eskom, the IDC, Westinghouse and Exelon. However, no shareholder agreement was concluded.

SKA relationship with SA government

A

DST

DST was and is the anchor department. The SKA has prospered through 6 Ministerial changes, remaining a flagship project.

B

Other departments

From the outset key relationships were established with departments other than DST, particularly DIRCO and DoC.

C

Provincial Governments

The Northern Cape and Western Cape governments are strong champions of the project.

PBMR and the market

A

Energy planning

Although PBMR was highly suitable for smaller isolated towns it did not feature in national energy planning and the DoE regarded it as an R&D project.

B

Eskom

Eskom signed a letter of intent to buy 24 PBMR reactors but this was withdrawn and replaced with an offer to purchase the first reactor for a nominal sum. PBMR then courted Sasol, proposing to reduce their carbon footprint. But nowhere in the world are regulations in place to colocate chemical and nuclear plants.

C

Global

Globally the major vendors were focusing on marketing their large Generation III reactors. Small modular reactors such as PBMR were seen to be in the future. Regulators were also not ready. Much talk in PBMR was about suitability for Africa, which was not ready either.

SKA and its “market”

A

International

The SKA has been prioritised by the national science infrastructure planning processes in a number of countries. Consortia consisting of over 100 companies from 20 countries are involved in technology down selection.

B

Local

In South Africa an ambitious HCD programme where over 1000 researchers and students have been funded to participate in SKA programmes has been undertaken over the past 10 years.

C

Successful prototypes

The excellent performance of the prototypes has whet the appetite of the global radio astronomy community.

Lessons learnt

A

Get something done

In any big project you need to pour some concrete! Unless your political sponsor has something to show they are unlikely to deliver new resources for you. This is linked to prototyping.

B

Have more than one strong champion

A week is a long time in politics. Building **multiple** strong allies will give your project stability no matter what.

C

Understand your market

Don't confuse your actual market with your desired market. Keep it real!

Lessons learnt

A

Prototyping

Separate R&D from construction, otherwise the product keeps changing as you build! Don't pretend to be a company when you are still an R&D project.

B

Have the right culture

Balance a careful, rigorous engineering culture against a brilliant science culture, neither should dominate. The worst is a military gung-ho culture. Don't let success go to your head.

C

Understand your limitations

Select partners to complement you and to share risk. Don't be greedy.

Thank you for listening!

