Square Kilometre Array:
Dish Verification Program

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Aims of the Verification Programs

- Costed system design
- Determine realistic specifications: inform the Design Reference Mission
- Deliver the best science per €/$

WP2.2 Dish Verification Program (DVP)

WP2.3 Aperture Array Verification Program (AAVP)

The Dish Array

- A Concept Design for SKA Phase 1 (SKA1) SSEC SKA Phase 1 Sub-committee, August 2010 (SKA Memo 125):
  - ...a dish array with Aeff/Tsys of up to 1000 m^2/K using approximately two hundred and fifty 15-metre antennas, employing an instrumentation package that will use single-pixel feeds to provide high sensitivity and excellent polarisation characteristics over a frequency range of 0.45-3 GHz .
- SKA Phase 2: 10,000 m^2/K requiring at least 2500 15-metre dishes

SKA Dish Development

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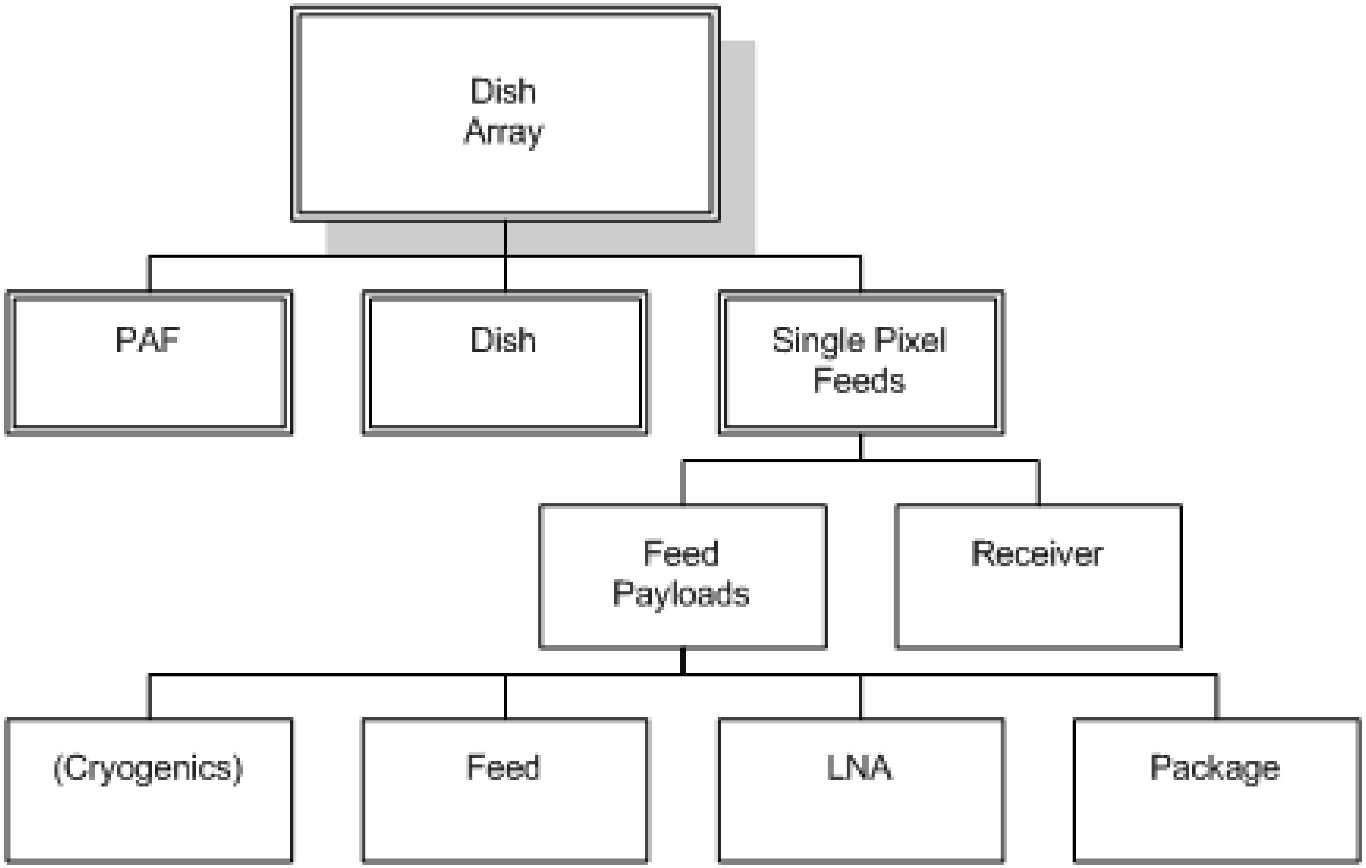

Dish array requirements (1):

What is so special about the SKA?

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- Imaging dynamic range
  - requires the dish to have extremely stable, predictable beam shape and pointing in extreme desert environmental conditions
  - Stability and calibratability of the complete signal chain are also vital
- Mass manufacture
  - Significant improvements in design for manufacture are needed to allow cost effective production of 15 m dishes in quantities of thousands

Dish array requirements (2):

What is so special about the SKA?

- Operating cost
  - Thousands of dish systems will be very expensive to operate unless they are designed for high reliability with minimum maintenance. The maintenance regimes at existing radio astronomy observatories will not be affordable on this scale
  - Routine maintenance intervals of at least one year are anticipated, including dish mechanics and cryogenics

Dish array requirements (3):

What is so special about the SKA?

- Feed flexibility
  - Multiple single pixel feeds and a phased array feed are to be accommodated
  - A significant means of improving overall SKA system performance will be obtained through enhancement of feeds and receivers, especially in the transition of SKA Phase 1 to SKA Phase 2

Dish array requirements (4):

What is so special about the SKA?

- Rapid installation
  - Dish systems will need to be installed rapidly using minimal on-site manpower and equipment
  - This is to minimize the impact on observations, as well as keep down the manpower cost
  - The ATA design has provided a good example of this approach for smaller dishes, but this needs to be further developed for the SKA dishes

Dish array requirements (5):

What is so special about the SKA?

- Enormous A/T
  - Maximize sensitivity per €/$ whilst meeting other requirements
  - Wide bandwidths and wide frequency tuning ranges are challenging

How can we meet SKA requirements?

- Skilful design of a dish array aimed specifically at SKA requirements
- Computer modelling of design options
- Careful construction and testing of prototypes
- Modification of designs in light of prototype test results

DVA1 – the first SKA prototype dish

- The TDP’s DVA1 prototype is the only dish whose design is specifically aimed at SKA requirements.
- ASKAP, KAT7 and MeerKAT dishes will provide valuable data, but their designs are targeting different applications.

Lessons from the Precursors: ASKAP and MeerKAT

- Infrastructure
- Installation
- Integration
- Industrialization
- Testing
- Environmental
- Operation and maintenance

Dish Verification Testing

- There will be two phases to the testing of DVA1: stand alone dish tests and tests with a well characterised array.

- We hope to carry out ‘deep’ verification testing at the EVLA.

SKA_1 → SKA_2

- ~ 250 dishes for SKA_1: large investment
- Structural parts of the dish will be designed for SKA_2 insofar as we know what that means
- SKA_1 feeds/LNAs and receivers may be replaced
- PAF deployment mechanism is included in the design

PrepSKA Work Packages (PrepSKA contract)

- **WP2.2.1 Antenna Design**
  - *'…this task will focus on producing a costed design for an offset-fed Gregorian antenna, utilising a metal or composite reflector, optimized for operation in a number of frequency bands. If this design cannot meet requirements, a fall-back design will be a symmetric reflector. The task will draw on progressive results in WP2.1 (system design) in order to specify the dish diameter and related attributes of system-wide importance.*'

PrepSKA Work Packages (PrepSKA contract)

- **WP2.2.1 Antenna Design (contd.)**
  - '*A study of optical designs is the starting point in the design process*…'
  - Bill Imbriale will report on progress in optics design and analysis on behalf of the TDP
  - This includes analysis of phased array feeds

PrepSKA Work Packages (PrepSKA contract)

- **WP2.2.1 Antenna Design (contd.)**
  - *'…followed by an examination of a range of antenna design options with a view to optimizing the mechanical design to give the best possible performance versus cost. This optimization will include selection of materials and manufacturing processes for the reflector manufacture*…'
  - Gordon Lacy (DRAO) and Matt Fleming (TDP) will report on progress in this area.
  - European dish manufacture study

PrepSKA Work Packages (PrepSKA contract)

- **WP2.2.2 Wide Band Single Pixel Feed and RF Design**
  - WP2.2.2.1 Feeds
    - '…*will evaluate at least four wideband feeds…' '…will include electromagnetic design and evaluation of the feed designs in conjunction with the dish optics-analysis and structural work.' 'Feed designers will work closely with LNA designers to produce integrated feed/LNA packages*.'

PrepSKA Work Packages (PrepSKA contract)

- **WP2.2.2 Wide Band Single Pixel Feed and RF Design (contd.)**
  - WP2.2.2.2 LNAs
    - '*LNA design and development will necessarily be carried out in close collaboration with feed and antenna element designers*.'
  - WP2.2.2.4 Cryogenic cooling for LNAs
    - '…*will identify cost-effective cryogenic solutions for use with single-pixel feeds*.'
  - Bill Imbriale will report on progress on feeds, LNAs and cryogenics on behalf of the TDP

- **WP2.2.2 Wide Band Single Pixel Feed and RF Design (contd.)**
  - WP2.2.2.3 Receivers
    - ‘*Receivers for single-pixel feeds will need to process the very wide frequency RF channels to produce wide-band baseband or quasi-baseband outputs in digitized optical format suitable for distribution to the correlator. They must be capable of sufficient RF dynamic range to handle interference at the two candidate sites. They must also be sufficiently stable so as not to be a limiting factor in system performance*.’
  - Russell Gough will report progress on behalf of CSIRO.

PrepSKA Work Packages (PrepSKA contract)

- **WP2.2.3 Phase Array Feed Design**
  - '*This task will show, through simulation and demonstration, the suitability of PAF technology for the SKA, adapted for use with the dish-optics design selected for study in WP2.2.1. It will leverage work in ASKAP and APERTIF, which will be the first interferometers to use PAFs. Performance, cost, power and bandwidth will be major issues to be studied. The task will also address methodologies for large-scale manufacture of PAFs*.'
  - Stuart Hay will report progress on behalf of CSIRO.

End

Receptors meeting: Saturday morning

• Miroslav Pantaleev	Eleven Feed
• Bill Imbriale	Caltech wide band feed etc.
• Kris Zarb Adami	Aperture array antenna and low noise work at Oxford
• Isak Theron	MeerKAT feed package
• Russell Gough	ASKAP LNA and receivers
• Matt Fleming	Further details on the design of DVA1
• Mike Jones	Lessons from the C-Bass dish design