



Introduction to the SKA

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Jodrell Bank, 28 June 2011

Top-level description



a large radio telescope for transformational science

- up to 1 million m² collecting area distributed over a distance of 3000+ km
- operating as an interferometer at frequencies from 70 MHz to 10 GHz (4m-3cm) with two or more detector technologies
- connected to a signal processor and high performance computing system by an optical fibre network

providing

- 40 x sensitivity of EVLA, and
- up to 10000 x survey speed

67 institutes in 20 countries are participating

Timeline



- | | |
|----------|--|
| 1995-00 | Preliminary R&D |
| 2000-07 | Initial Concept Phase |
| 2008-12 | Preparatory Phase <ul style="list-style-type: none">• System design |
| 2012-15 | Pre-construction Phase <ul style="list-style-type: none">• Detailed design, Production readiness |
| 2016-23 | Construction |
| 2020-50+ | Operations |

Top-level description (2)



Construction will proceed in two phases:

SKA_1 , SKA_2

SKA_1 will be a subset ($\sim 10\%$) of SKA_2

Major science observations already possible with SKA_1 in 2020

Phased construction allows maximum use of advances in technology



The Square Kilometre Array

SKA₂ Key Science Drivers

ORIGINS

➤ Neutral hydrogen in the universe from the Epoch of Re-ionisation to now

When did the first stars and galaxies form?
How did galaxies evolve?
Dark Energy, Dark Matter

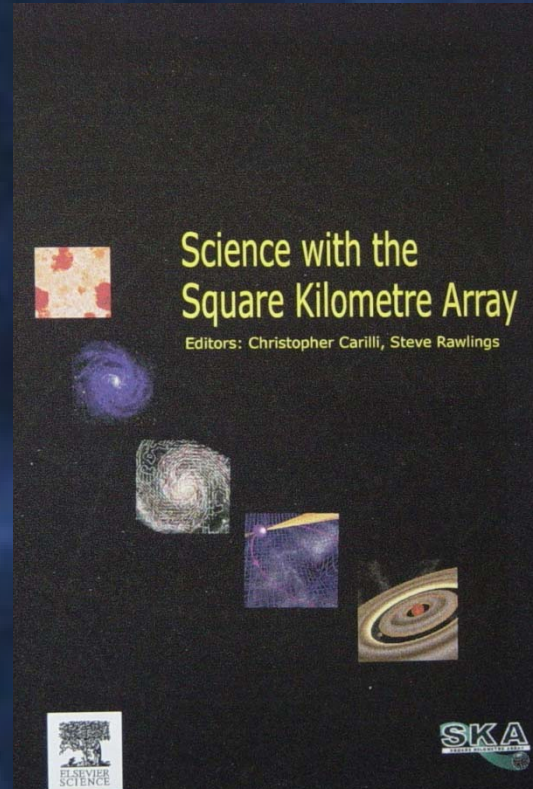
➤ Astro-biology

FUNDAMENTAL FORCES

➤ Pulsars, General Relativity & gravitational waves

➤ Origin & evolution of cosmic magnetism

TRANSIENTS (NEW PHENOMENA)



*Science with the
Square Kilometre
Array*

(2004, eds. C. Carilli
& S. Rawlings, *New
Astron. Rev.*, 48)

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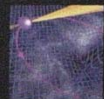
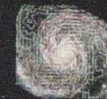
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Science with the
Square Kilometre Array

Editors: Christopher Carilli, Steve Rawlings



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SKA₁ baseline design

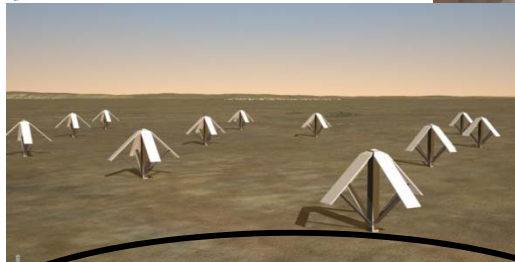


Baseline technologies are mature and demonstrated in the SKA Precursors and Pathfinders

Central Region



250 Dishes



50 Sparse Aperture Arrays



Single pixel feed

Advanced Instrumentation Program



1. Development of innovative wide-field “radio camera” technologies at mid-frequencies
 - mid-frequency aperture array (FoV ~ 200 deg²)
 - phased array feeds (PAFs) on the dishes (FoV ~ 30 deg²)
2. Ultra-wideband single pixel feeds

The AIP is designed to build maturity and retire risk

Has the potential for enhancing SKA₁ and being a major part of SKA₂

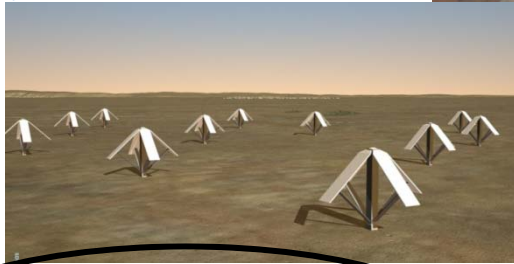
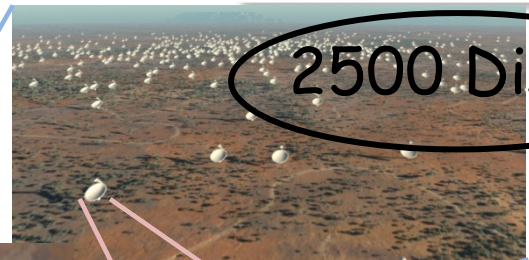
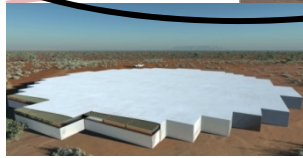
- Evaluation point in 2014
- Final decision in 2016

SKA₂ including AIP technologies



250 Dense Aperture Arrays

2500 Dishes

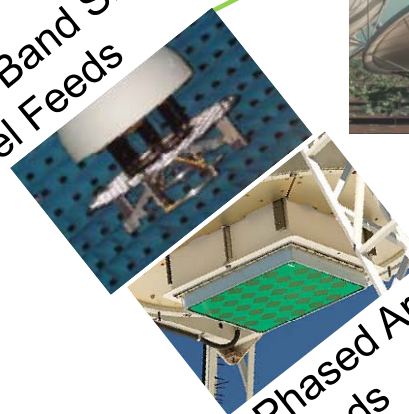


250 Sparse Aperture Arrays

Wide Band Single Pixel Feeds



Phased Array Feeds



Artist renditions from Swinburne Astronomy Productions

Exploring the Universe with the world's largest radio telescope

SKA System Design (2007-2012)



Contributing programs

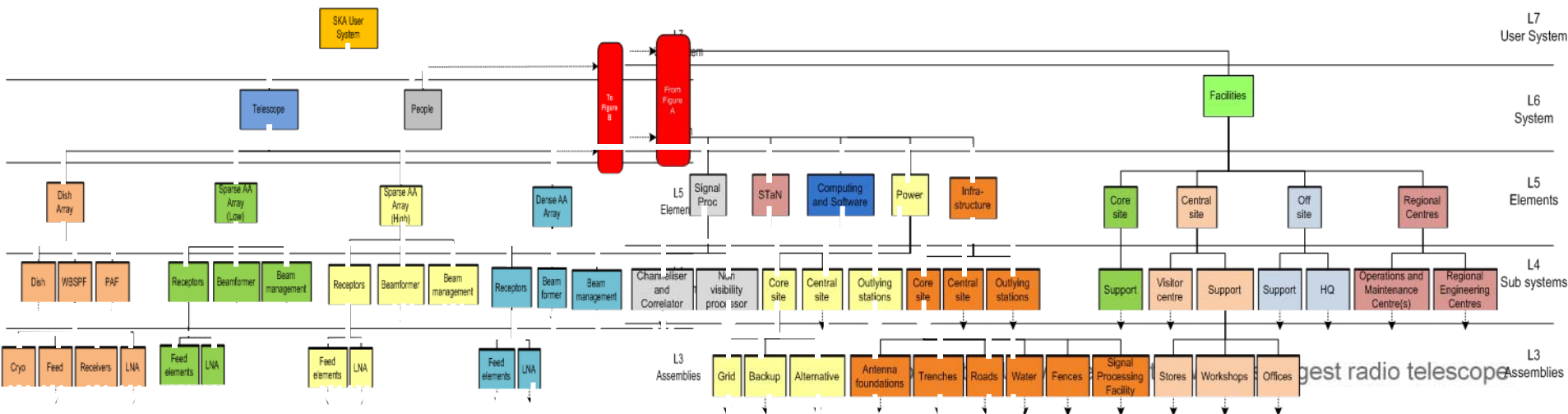
EC FP6 SKA Design Study (SKADS)

EC FP7 Preparatory Phase (PrepSKA)

US Technology Development Program

“Precursor” telescopes on the candidate sites
(ASKAP (AU), MeerKAT (SA))

“Pathfinder” telescopes like LOFAR, APERTIF



Conceptual Design Reviews in 2011



- 23-25 Feb System delta-CoDR on SKA₁ ✓
- 14-15 Apr Signal Processing ✓
- 19-20 Apr Aperture Arrays ✓
- 28-30 Jun Signal Transport & Networks ✓
- 13-15 July Dish and Dish Arrays
 - 2-3 Feb CoDR Dish Verification Antenna #1
 - 2011Q4 CDR Dish Verification Antenna #1
- 12-14 Oct Software & Computing
- Nov Monitor & Control

To be followed by System Requirements Reviews in 2012

Pre-construction Phase



- PEP (2012-2015)
 - 11 work packages
 - proposed funding: 91 M€
 - 28 M€ for SPO staff and operations (30%)
 - 63 M€ for WP Consortia under contract to SPO (70%)
 - Review panel
 - SKA is ready to transition from “science project” to “big project”

Pre-construction Phase (2)



- **Governance**

- interim Founding Board created 2 April 2011
- Nine signatories at Government or Funding Agency level

Australia
China
France
Germany
Italy
Netherlands
New Zealand
South Africa
UK

Tasks

1. Establish a legal entity for the SKA Organisation
2. Decide location of the SKA Project Office
3. Agree a resourced Project Execution Plan

+ observers (Canada, Japan, Korea, India)

Pre-construction Phase (3)

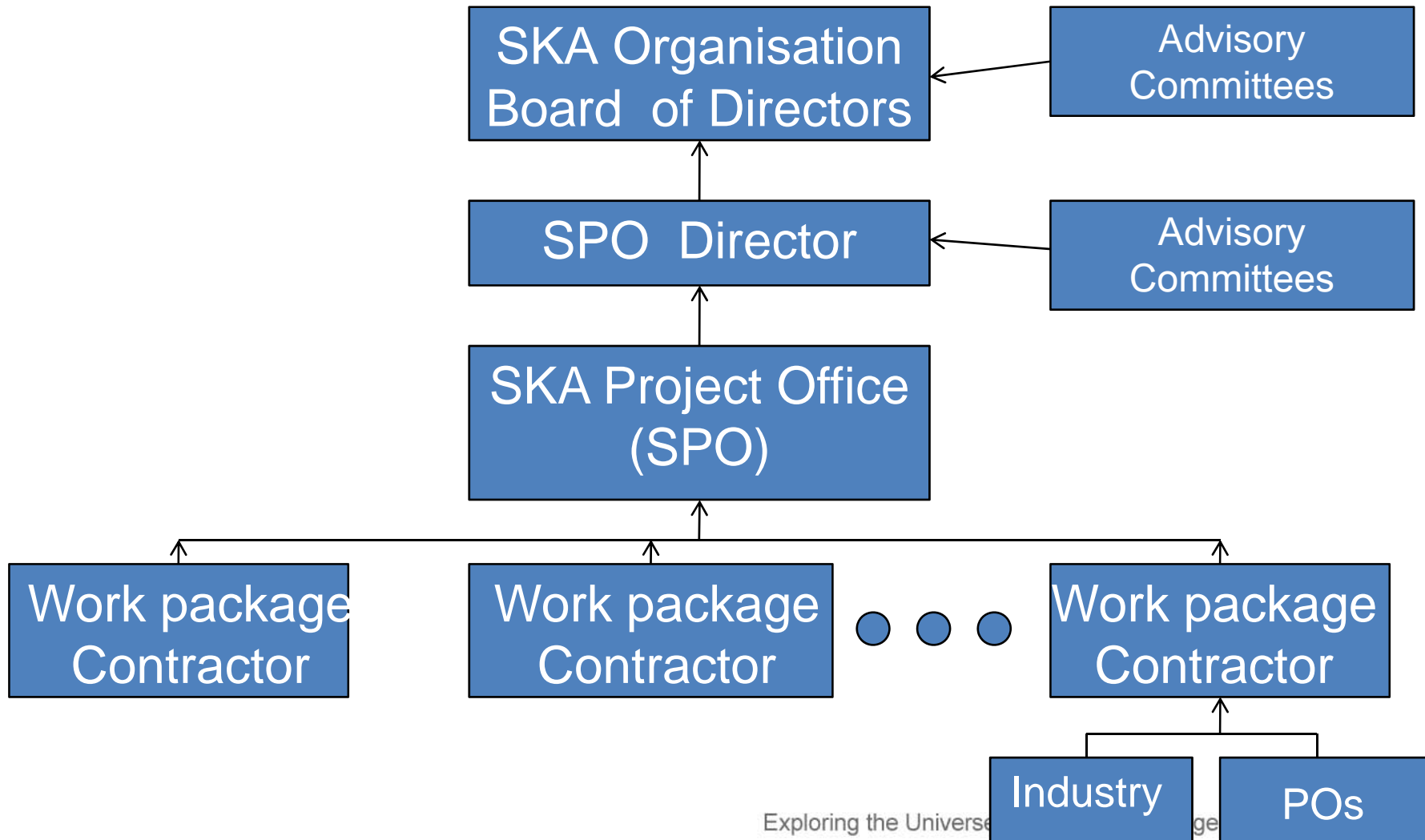


- **Governance (2)**

FB to be replaced by a legal entity in July 2011

- **Company Limited by Guarantee in the UK**
 - Membership Agreement and Articles of Association currently in draft form
- **Board of Directors to run the company**
 - Two Directors per Member
- **General Director**
 - SPO

Governance: January 2012 →



Site selection

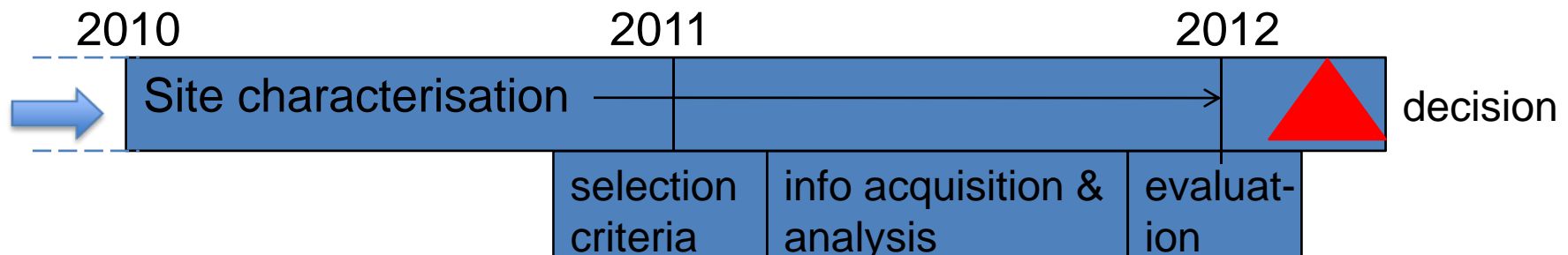


Physical requirements

- Extremely radio quiet environment
- At least 3000 km in extent
- Low ionospheric turbulence
- Low tropospheric turbulence

Two candidates short-listed in 2006: Australia, Sth Africa

Site selection process



Selection Criteria



Categories

1. Science & technical

Current and long-term RFI environment

Ionospheric turbulence

Tropospheric turbulence

Array science performance

Site physical characteristics

2. Other

Customs and excise

Security

Legal

Employment

Working and Support Conditions

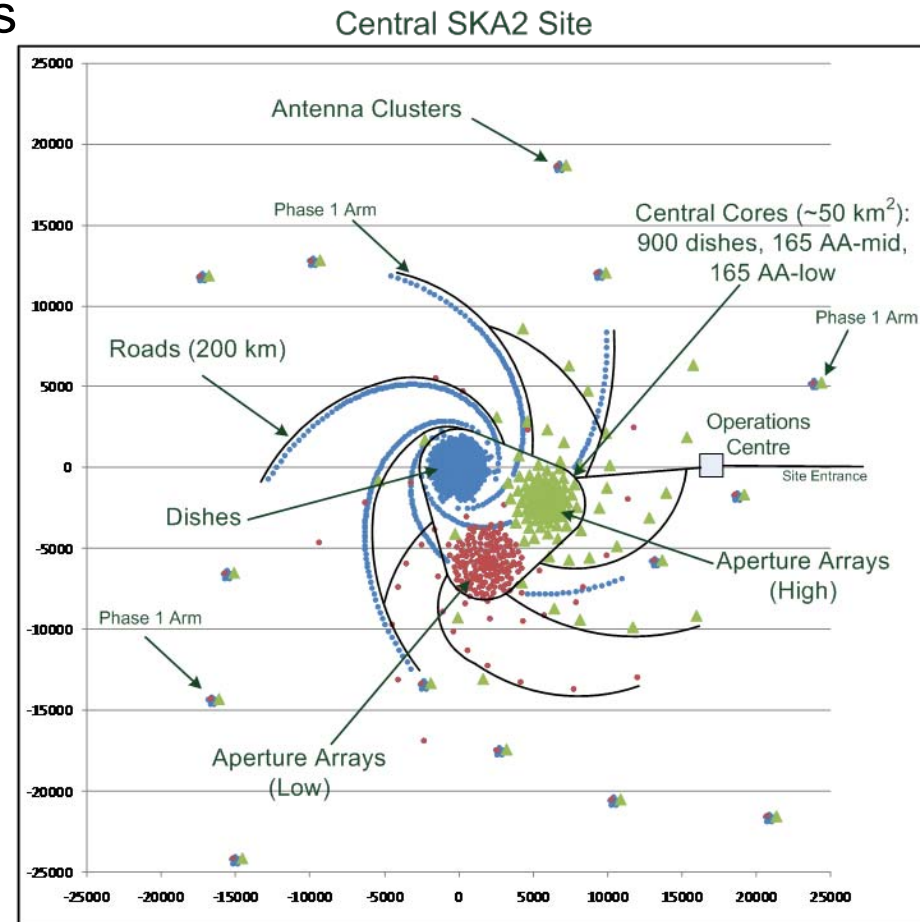
Selection Criteria (2)



3. Implementation plans and costs

- basic infrastructure components
- power provision
- data connectivity

based on a 3-core model
of the SKA



Top level schedule for the SKA



Technical

- 2008-12 telescope system design and cost
- 2012-15 detailed design in the pre-construction phase
- 2016-19 Phase 1 construction
- 2016 Advanced Instrumentation Program decision
- 2018-23 Phase 2 construction
- 2020→ full science operations with Phase 1
- 2024→ full science operations with Phase 2

Programmatic

- 2011 approve funding for pre-construction phase
establish SKA organisation as a legal entity
select location for SKA Project Office ✓
- 2012 site selection
- 2014 approve construction funding for Phase 1 (350 M€, 2007)
- 2018 approve construction funding for Phase 2 (1.2 B€, 2007)



END