Science Requirements from the Office Perspective: The Design Reference Mission

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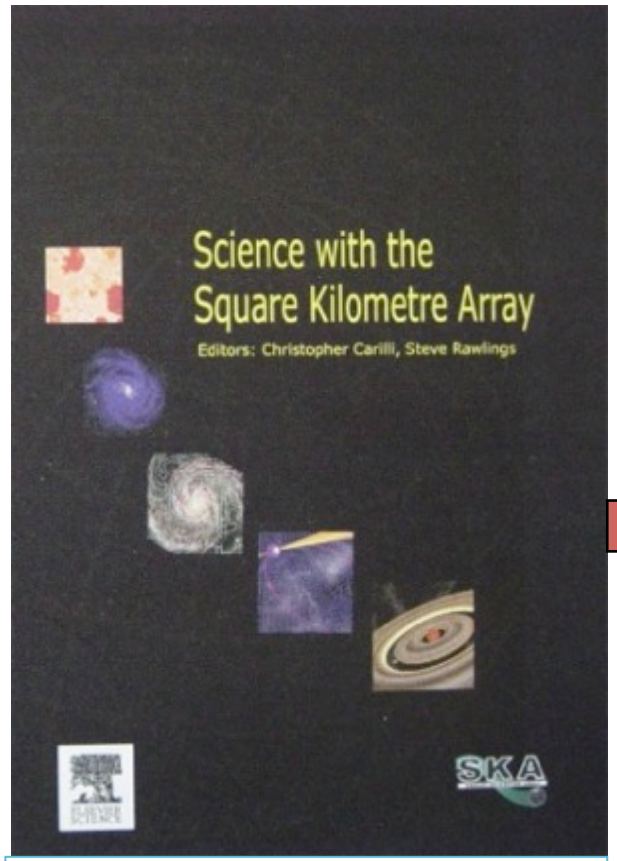
Science Case, DRM, Requirements, Oh My!



Science Case
Lays out **overarching** goals, full suite of science


THE SQUARE KILOMETRE ARRAY DESIGN REFERENCE MISSION: SKA PHASE 1

Design Reference Mission
Set of science observations to set **envelope** of science requirements

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SCI-SYSR-0010
SCI-SYSR-0020
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SCI-S-REQ-0110
SCI-S-REQ-0120
SCI-S-REQ-0130
SCI-S-REQ-0140
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SCI-T-REQ-0110
SCI-T-REQ-0120
SCI-T-REQ-0130
SCI-T-REQ-0140
SCI-T-REQ-0150
…
OPS-REQ-0010
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Requirements Document
Input from science, but from other areas as well

The Design Reference Mission: Intro

- Intended to establish a baseline set of observations required to achieve science goals
- Set the “envelope” of possible technical specifications for the telescope
  - Push capabilities of the telescope
- Analogous to similar documents of other large projects:
  - “Science Goals and Technical Requirements” for eVLA
  - ALMA Reference Science Plan
  - JSWT Design Reference Mission
  - LSST Science Requirements Document
  - Pan-STARRS PS1 Design Reference Mission

Design Reference Mission Structure

Chosen to

I. Describe fundamental science for the SKA1
II. Identify "envelope" for SKA1 (e.g., frequency coverage)

Chapters

1. Scientific Motivation
2. Observational Summary
3. Scientific Requirements

   What does the Universe control? (e.g., H I mass, gravitational wave amplitude spectrum, …)
4. Technical Requirements

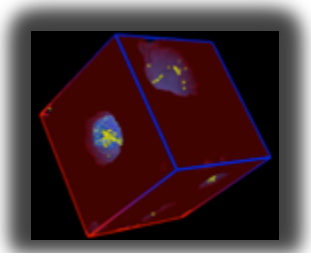
   What do we control? (e.g., A_{eff}, T_{sys}, Ω, ν, baselines, …)
5. Data Products

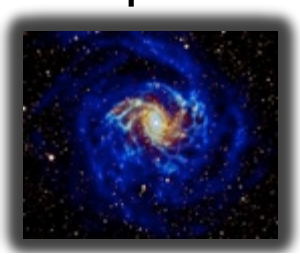
Design Reference Mission Status

- Provides “traceability” or flow from science to technical specifications
- Version 1.0 is the current for Phase 2
- Version 3.0 is the current for Phase 1
  - Baselined in May 2012
- Phase 1 DRM -> Phase 1 Baseline Design
  - Change process currently being finalised

Phase 1 Design Reference Mission: Chapters

1. Introduction
2. Probing the Neutral Intergalactic Medium During the Epoch of Reionization
3. Tracking Galaxy Evolution over Cosmic Time via HI Absorption
4. Probing the Epoch of Reionization using the 21cm Forest
5. Pulsar Surveys with Phase 1 of the SKA
6. Pulsar Timing with Phase 1 of the SKA
7. Pulsar Astrometry with Phase 1 of the SKA
8. Gas in Nearby Galaxies
9. Additional Science Capabilities of Phase 1
10. Additional Telescope Considerations: Phase 1 to Phase 2
11. Overall Telescope Characteristics





SKA Phase 1 DRM

- SKA1 DRM constrained by Memo 125, SKA1 science priorities:
  - Understanding the role of neutral hydrogen in the universe from the dark ages to the present day (EoR, HI in galaxies)
  - Detecting and timing pulsars in order to test theories of gravity and detect gravitational waves

- Several HI chapter possibilities were discussed:
  - WALLABY like survey in Phase 1 ruled out
  - HI in local galaxies

Gas in Nearby Galaxies

- Science Goals:
  - IGM, low column density environments of galaxies, cold gas accretion onto galaxies
  - Detailed gas physics of star formation
- Similar to THINGS (VLA), HALOGAS (WSRT)
- Large number of galaxies, variety of morphologies and environments
  - 100s of galaxies, each with 30 hours of integration
- Drives sensitivity and frequency resolution at ~1.4 GHz

Gas in Nearby Galaxies: Science Requirements

Linear Resolution

- *The SKA Phase 1 shall provide a linear resolution of 300 pc at a redshift of 0.02 or distance of 60 Mpc. .*

Redshift

- *The SKA Phase 1 shall be able to access the H I line over the redshift range of 0 to 0.02.*

HI Column Density

- *The SKA Phase 1 shall be able to reach an H I column density of 5 × 10^{20} cm^{-2} at its highest linear resolution within galaxies and 10^{18} cm^{-2} at low linear resolution characteristics of galactic scales.*

Gas in Nearby Galaxies: Science Requirements

Velocity Resolution

- *The SKA Phase 1 shall provide a velocity resolution of at least 0.5 km s^{-1}.*

Area of Regard

- *The SKA Phase 1 shall provide the capability to image an area of 500 kpc diameter at a redshift of 0.02 or distance of 60 Mpc, with the goal of providing the capability to image an area of 1 Mpc diameter at a distance of 10 Mpc.*

Gas in Nearby Galaxies

Scientific Requirements

Parameter	Value
Linear Resolution	300 pc
Redshift/Distance	0 – 0.02, out to 60 Mpc
HI Column Density	5×10^{20} cm^{-2} (high linear resolution, ~ 300 pc or better) 10^{18} cm^{-2} (low linear resolution, ~ 1 kpc)
Velocity Resolution	0.5 km s^{-1}
Area of Regard	500 kpc at a distance of 60 Mpc

Technical Requirements

Parameter	Value	Comment
Frequency Range	1390 – 1420 MHz	Redshift range
Baselines	50 km	Linear resolution
Spectral Resolution	2 kHz	Velocity Resolution
Brightness Temperature Sensitivity	200 K for 50 km, 0.3 K for 1.5 km	HI Column Density and Linear Resolution
Field of View	0.5 deg FWHM	Area of Regard