



Memo 83

SKA Key Science Requirements Matrix 2006 Prime Science Drivers

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This document and the associated matrix have been compiled from input from members of the SWG. Both this discussion document and the matrix were updated during 2005 and 2006, as a result of discussions at Key Science workshops and at Pune and Paris. These have created a consolidated description of the SKA key science goal SKA requirements.

Background

In an earlier SKA memo (#29, www.skatelescope.org) a simple parameter space analysis was compiled, based on the SKA science case of 1998 (Taylor et al.). As that science case made no prioritisation of the individual goals, all science drivers were treated with equal weighting. By identifying the requirements of the individual science drivers with respect to a wide range of simple specifications (e.g. frequency requirements, requirement for multiple fields of view, continuum or channel sensitivity etc) we illustrated that even a simple analysis could offer insight into the 'best-fit' SKA specification.

Since 1998 the SKA science case has developed markedly – both with the advent of what might be considered far more challenging experiments (e.g. 'Dark Energy' and 'the Epoch of Reionization') and the identification of the 'Key' science drivers: these being the head-line experiments which the SKA would be capable of addressing (Gaensler et al, SKA memo #44).

This analysis

This new analysis has reviewed the parameters in the matrix, using the SKA specification goals set out by Dayton Jones et al (SKA memo #45). This matrix and explanation document build on the content of memo #45 as here we break down the requirements per KSG experiment. We can clearly see where the demanding overall SKA specification originates. An important point to remember is that 4/5 of the "Key Science Goals" are themes, and whilst they collect together highly-related topics, the requirements of their 3 experiments can be radically different – producing an 'SKA specification' that detractors like to quote as being from 'DC to daylight'.

The Prime drivers

At the Pune SKA meeting in November 2005, the SWG discussed the Key Science Projects and set out a list of "Prime Drivers" – the 'vital' or headline parts of the key science projects - as being

The Cradle of Life

Planet formation in Protoplanetary disks

Strong field tests of gravity using pulsars & black holes

tests of gravity using binary pulsars with NS & BH companions
nHz gravitational waves using MSP timing array

Cosmic Magnetism

RM grid

Galaxy Evolution & Cosmology

Galaxy evolution (emission to $z \sim 3$, abs $z > 3$)
Dark energy (HI baryon oscillations)

Probing the Dark Ages

Map EoR from redshifted HI

& New Discovery Space

These experiments are highlighted in yellow in the matrix.

Description of matrix values for each experiment

This section defines the columns/sections and values adopted in the shorter KSG science requirement matrix.

1 SKA Frequency range requirements

Shows the frequency range necessary for the experiment. Values in brackets show the useful, but not critical frequency range.

2. Beta

The instantaneous fractional bandwidth coverage at the mid frequency.

3. FOV

The continuous FOV size (not necessarily for imaging).

4. Spatial Resolution

The angular resolution required to achieve the science goal.

5. Maximum baseline

6. Dynamic range

The dynamic range requirement selected from one of 3 values:

Superb i.e. $\Rightarrow 10^{**7}$

Good, $\sim 10^{**6}$

Moderate – around 10^{**4} to 10^{**5}

7. Signal to noise ratio requirement

8. # separate FOVs (multi-field of view requirement)

The number of separate FOVs required at the full sensitivity of the SKA, chosen from

Y – separate FOVs are necessary for the experiment, with number in ()'s being the minimum number required

N – not a requirement to achieve experiment, but number in () shows useful number if they are available.

9. Polarisation requirements

10. sub array utility

11. Sky area to be covered in survey/experiment

12. strategy of the experiment

13. Critical requirements for the experiment

Here we list the 'show stoppers' for the experiment – if there are any. These comments and their justification should be in the accompanying document which captures this detail.

14. Total observing time considerations

15. Other comments

Anything else which critically drives the SKA spec for that experiment. This is probably a redundant column and may not be kept. These comments should be kept in the text document for the KSG as well.

Note: Total power calibration added March 2006 following comment from Jill Tarter to Peter Hall. Probably needs to be ~1% for surveys to be matched across the sky.