Cost Control Plan Explanation

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The cost control process has been described at some length in the report at the link below,

http://astronomers.skatelescope.org/wp-content/uploads/2017/04/SKA-TEL-SKO-0000751-01_Cost_Control_Project_Report-signed.pdf

A preliminary ordered list of cost savings measures has been prepared to provide clarity to the SKA Board on the scope of SKA1 deployment that would be enabled by a particular construction budget, based on the current understanding of the technical design. The SKAO was instructed by the Board to demonstrate the scope of deployment foreseen both at the level of the construction Cost Cap of 674 M€ (indicated by the heavy black line in the table) as well as with larger and smaller budgets. The attached list provides some brief explanation of each of these cost savings measures and an indication of the likely scientific implications. More detailed explanations are provided in the report noted above as well as within the individual Workstream areas. Provision of measures that go well below the construction cost cap has necessitated inclusion of some measures that were not specifically analysed within the Workstreams. These are identified by the "Deeper Savings" designation in the first column of the table. The colour coded column labelled "Science Impact" is defined on page 25 of the Cost Control Process report. The four numbered categories vary from 1 (no impact) to 4 (severe impact / lost capability).

The list has been constructed from the perspective of attempting to preserve those aspects of the current SKA1 design that would be the most difficult to reinstate, should they not be deployed from the outset. In particular, the anticipated 5 year refresh cycle for all SDP High Performance Computing (HPC) and Pulsar Search System (PSS) hardware has been considered, since the funding for this refresh is already part of the planning for Operations of the observatory. Although the correlator hardware has a longer anticipated refresh cycle, its central location also enables a more straightforward upgrade and reinstatement path than some other measures. The most challenging measures to reinstate would be those that relate to significant reductions in the number of dishes and stations that are deployed. This is why such measures have only been considered once all other options for cost reduction have been exhausted.

In the first segment of the Table are several line items (noted by the different colour designation) which constitute pairs of options, from which a down-select will be made once all the necessary technical information is in hand. The current System requirements will form the basis of that assessment and as such the outcome should be "science neutral".

The SWGs are being asked to consider this preliminary list and:

1) Endorse or suggest reordering of items in the list of cost savings measures
2) Affirm or not the transformational science capability of the cost-capped observatory (adopting the measures above the heavy line) for each SWG/FG science area

As further context for this assessment, you should assume that any capability that is not specifically mentioned within the list of cost saving measures is retained as currently specified within the System Requirements (Release 10 plus all accepted Engineering Change Proposals) which can be found at the two links below.

http://astronomers.skatelescope.org/wp-content/uploads/2016/12/SKA-TEL-SKO-0000008_10-SKA1_System_Requirement_Specification.pdf

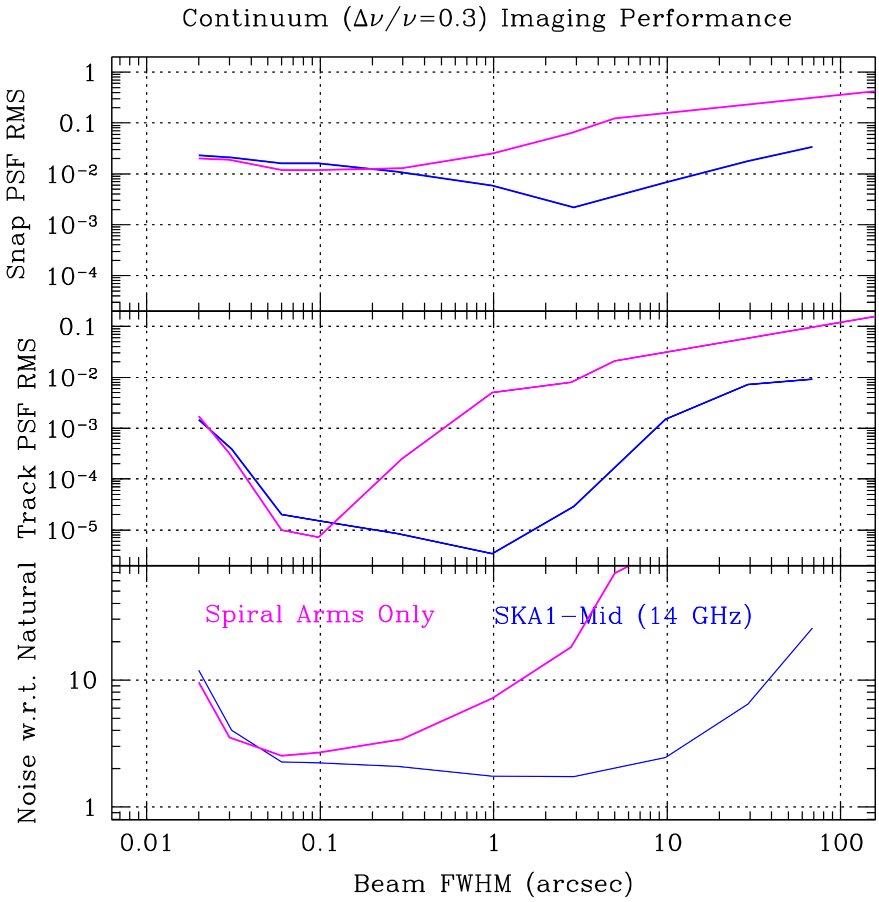
http://astronomers.skatelescope.org/wp-content/uploads/2016/12/SKA-TEL-SKO-0000692_01_AdditionalECPsAppendixSystemRequirements.pdf

Also, there are three Science Assessment teams currently looking at some specific design issues, whose membership and Terms of Reference can be seen at this link:

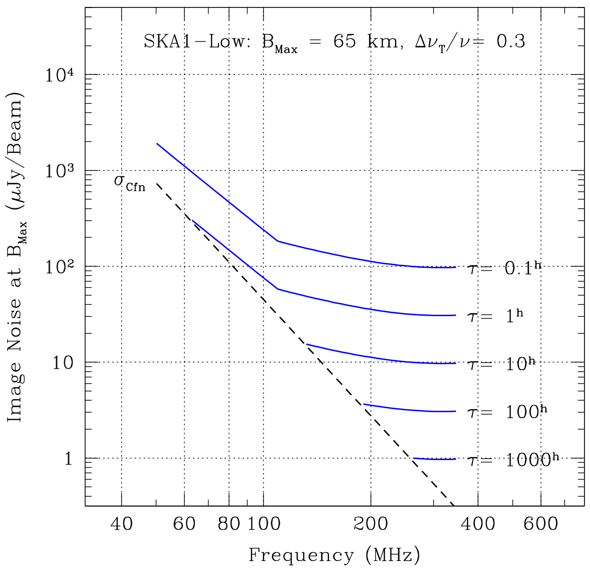
http://astronomers.skatelescope.org/science-assessment-teams/

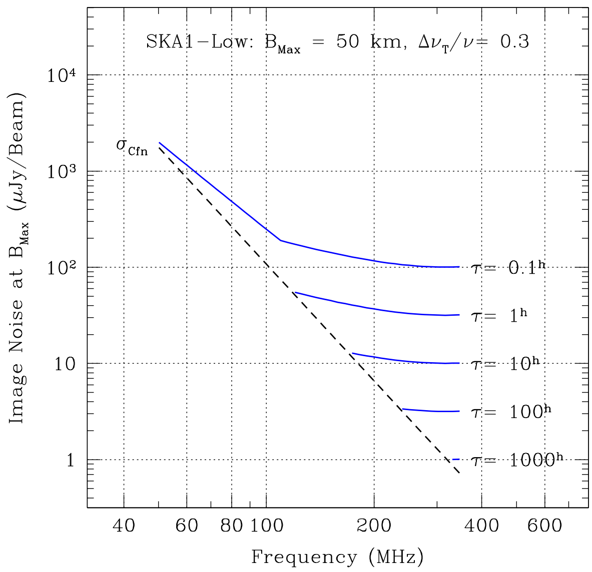
Some other relevant information for a few of the cost savings measures, beyond what is to be found attached or in the links above, is included below.

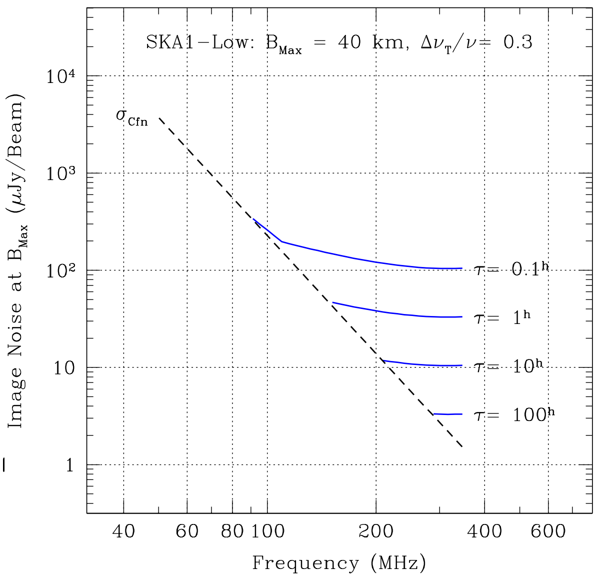
1) In the case of a reduction in the number of SKA1-Mid Band 5 feed systems that would be deployed in the first instance to one half of the current number, there are various ways in which that could be undertaken.
    a. The most straightforward option might be to simply decrease the density of the deployed Band 5 feed systems both within the most concentrated core as well as along the three logarithmic spiral arms. In this case, all of the original objectives might still be addressed, although each would suffer a factor of two loss in sensitivity, that translates into a factor of four increased integration time.
    b. An alternative option might be to deploy the Band 5 feed systems exclusively within the logarithmic spiral arms and not the core. The logarithmic distribution along the spiral arms already provides some central density enhancement in any case, while retaining all of the feeds at large separations from the core implies that high resolution applications can still be addressed with essentially no loss in sensitivity at all, despite the reduction in deployed feed numbers. This scenario is illustrated in Figure 1, where the relative sensitivity as a function of beam size for the fully equipped (133 Band 5 feeds) SKA1-Mid (in blue) is compared to partially equipped (67 Band 5 feeds) SKA1-Mid array (in magenta). At the highest resolutions, there is no loss in sensitivity with this approach, despite the smaller feed number.
    c. A third option might be to deploy the Band 5 feeds only within the core. Although the applications requiring high brightness sensitivity would then be preserved at essentially full sensitivity, the two "High Priority Science Objectives" that utilise Band 5, direct imaging of proto-planetary disks and documenting the star formation history of universe at high physical resolution, would be lost entirely.



2) In the case of reductions to the maximum deployed baseline length of SKA1-Low it is interesting to consider the impact on deep continuum imaging experiments, since these will be more likely to become limited by source confusion. The following three Figures illustrate the continuum noise levels achieved in a sequence of integration times at the highest effective angular resolution (approximated by $\theta = 1.22\ \lambda/B_{Max}$ radians) and constrained by the confusion noise model of Condon et al 2012 (ApJ 758, 23) for the cases of:
   a. B_{Max} = 65 km, $\theta_{Min} \approx$ 4 arcsec
   b. B_{Max} = 50 km, $\theta_{Min} \approx$ 5 arcsec
   c. B_{Max} = 40 km, $\theta_{Min} \approx$ 6 arcsec


SKA1−Low: B_Max = 65 km, Δν_T/ν= 0.3
Image Noise at B_Max (μJy/Beam)
Frequency (MHz)
σ_Cfn
τ= 0.1^h
τ= 1^h
τ= 10^h
τ= 100^h
τ= 1000^h
10^4
10^3
10^2
10
1
40
60
80 100
200
400
600


SKA1−Low: B_Max = 50 km, Δν_T/ν= 0.3
Image Noise at B_Max (μJy/Beam)
Frequency (MHz)
σ_Cfn
τ= 0.1^h
τ= 1^h
τ= 10^h
τ= 100^h
τ= 1000^h
10^4
10^3
10^2
10
1
40
60
80 100
200
400
600


SKA1−Low: B_Max = 40 km, Δν_T/ν= 0.3
Image Noise at B_Max (μJy/Beam)
Frequency (MHz)
σ_Cfn
τ= 0.1^h
τ= 1^h
τ= 10^h
τ= 100^h
10^4
10^3
10^2
10
1
40
60
80 100
200
400
600