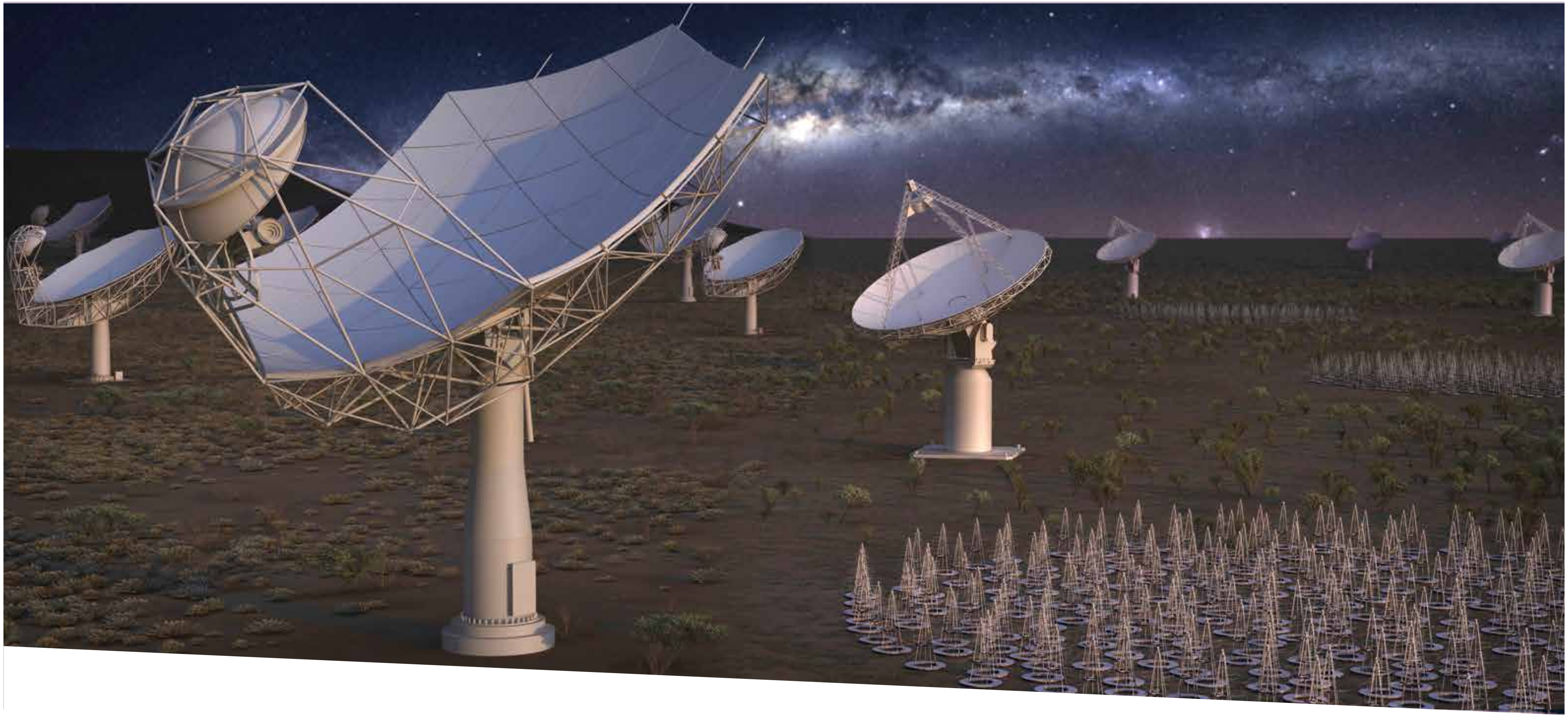
SKA SWG Update



SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

Robert Braun, Science Director

14 March 2017

Cost Control Process

- The top-level process for the Cost Control Project was as follows:
  - Initiation of the project and creation of workstreams
  - Receipt of inputs
  - Initial assessment of cost-reduction options
  - Triage of cost-reduction options
  - Aggregation of remaining cost-reduction options into scenarios
  - Detailed assessment of scenarios

SKA1 Cost Control Action Plan

Ref	Work stream	Potential Outcome
1	**Review precursors and pathfinders**	Options that could be carried over
2	**Review alternative antenna designs** against SKA1 science requirements	Align on an effective design within budget
3	**Review Operating Model** for potential cost savings	Test assumptions against cost
4	**Review and critically evaluate Consortium cost estimates.**	Identify areas of highest potential impact for cost reduction.
5	**Review Identified Cost Reduction Options**.	Develop suggestions with most relevant savings
6	**Carry out review of requirements** to ensure there are no over-egged requirements that drive costs higher.	Reduce requirements on solution
7	**Carry out review of designs** to identify where over designed and relaxing design to specification can save budget	Remove any gold-plating
8	**Explore SDP Savings** taking into account roll-out of science cases	Resolution Team

Science Assessment

- **No significant impact.** There are a variety of measures that appear to be genuine savings that have essentially no negative impact on the science capabilities.
- **Increased observing time.** Some measures result in a quantifiable increase in the amount of net observing time required to meet an objective, but do not otherwise impede its achievement.
- **High risk.** Some options modify an essential aspect of the system that puts one or more objectives at high risk of failure. While still possible in principle, there is a significantly reduced confidence in achieving success.
- **Lost capability.** Finally, there are options that make particular objectives essentially impossible to achieve.

Science Assessment against HPSOs

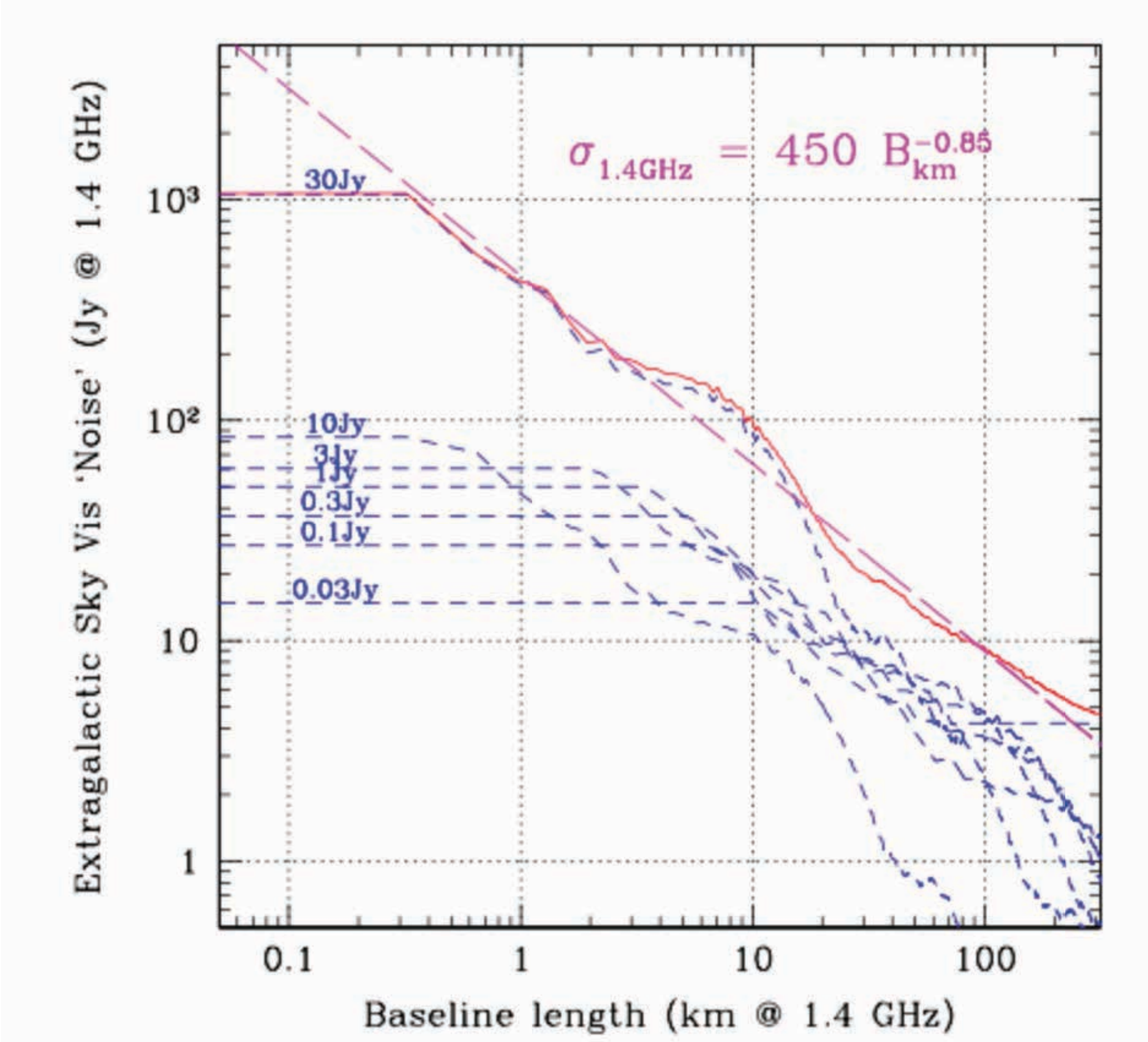
HPSO	Telescope	Band(s)	Bmax (km)	Viable?	Time (X)
1 EoR Imaging	Low	50-200 MHz	65	1	1
2 EoR Power Spectrum	Low	50-200 MHz	Core/65	1	1
4 Pulsar search	Low/Mid	150-350 MHz + SPF1 + SPF2	core	1	1
5 Pulsar Timing	Low/Mid	150-350 MHz + SPF2	10	1	1
13 HI high Z	Mid	SPF1	45	1	1
14 HI low Z	Mid	SPF2	25	1	1
15 HI Galaxy	Mid	SPF2	25	1	1
18 Transients (FRBs)	Mid	SPF1	100	1	1
22 Planetary Disks	Mid	SPF5	150	1	1
27 RM grid	Mid	SPF2	50	1	1
32 Intensity Mapping	Mid	SPF1	AC	1	1
33 ISW	Mid	SPF2	50	1	1
37/38 SFHU	Mid	SPF2 + SPF5	150	1	1
				100	**1**

Individual assessments of ~50 options

Ref	Name of Cost Reduction Option	Topic	Capex		Opex		Programmatic Risk	Science Impact				
			Capex saving incl. contingency	Capex Estimate Confidence	Opex saving incl. contingency	Opex Estimate Confidence	Impact of Pre-Construction Schedule Slip	Work Stream Science Score - Science Score where 100 = no loss	Lost HPSOs are shown in RED. High Risk HPSOs are shown in PURPLE.	Slowed HPSOs	Increased Time	Ability to Recoup current baseline science capability
6.5	Pulsar timing	Common	0.250 M€				12	92	5			Pulsar L1 time standard needed.
6.6	Sweep of non-functionals	Common					TS					
7.00	Work Stream 7 Over Design (Common)	Common	10	M	0		3		1			NA
7.00	Work Stream 7 - Over Design (LOW)	LOW	9	M	0		3		1			NA
7.00	Work Stream 7 Over Design (MID)	MID	2	M	0.2	L	1		1			NA
8.0	Work stream 8 - Explore SDP Savings (Deploy 150 PFLOPs - down from 259 PFLOPs)	Common	20	L	8.9	M	1	77-96 (depending on years delay)		1,2,22,37/38	1.2 - 1.6	There is some scope for delaying HPC roll-out. More scope on Mid than on Low.
9.0	Work Stream 9 - Procurement Model	Common					IH					

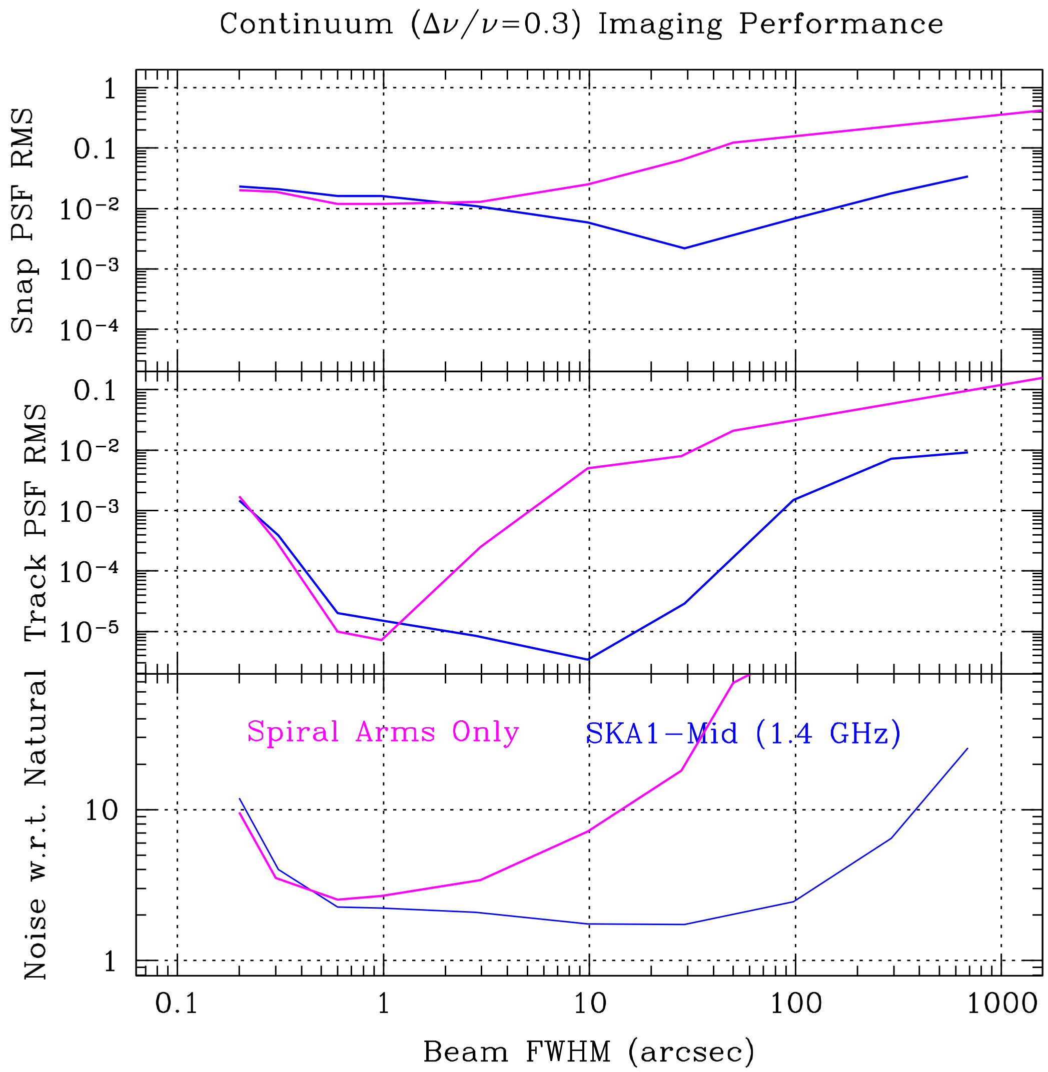
SKA1-Low B_{Max} ?

- Extreme precision of foreground characterisation needed for EoR calibration and foreground removal
- B_{Max} ~ 100 km very desirable
- B_{Max} = 65 km already has high risk
- B_{Max} = 50 or 40 km increases that risk



What if SPF5 were only deployed on half of dishes?

- If 50% deployment were uniformly distributed, every SPF5 application is 4x slower
- Idea of deploying SPF5 dishes only on spiral arms rather than in core
  - Planetary disks and high resolution star formation studies preserve >90% of sensitivity/ PSF quality
  - High T_B applications would take hit (diffuse emission, PSS in GC)
- Return to 100% would be priority in any event!



Example of step-wise reduction scenario

WS	Description	LOW MID COMM	Potential Saving	Comment	Science Impact	Recovery	Cost saving Error	Technical risk (TMT)	Pre-C Schedule Delay (Months)	Comulative Cost saving (Meuro)	Total Cost Estimate (Meuro)	
5.3	Maximise use of code produced during Pre-Construction	COMM	10	GMRT, ASKAP, MerKAT – further investigation (€12M claimed)	1	NA	>40%	2	3-6	10.0	819.0	
5.38	Simplify DDBH LOW	LOW	2.9		1	NA	20% -40%	2	1-3	12.9	816.1	
5.38	Simplify DDBH MID	MID	2.2		1	NA	20% -40%	2	1-3	15.1	813.9	
5.25.2	Reduce PSS-MID: A, 750 nodes to 500 nodes	MID	4	From 2 to 3 Beam/node	1	YES	20% -40%	2	1-3	19.2	809.8	
5.25.2	Reduce PSS-LOW: A, 250 nodes to 167 nodes	LOW	2	From 2 to 3 Beam/node	1	YES	20% -40%	2	1-3	21.1	807.9	
5.39	INFRA_SA Renewable energy to outer dishes	MID	3	Applied to 9 outer dishes	1	NA	>40%	1	1-3	24.1	804.9	
5.35	MID CBF: Talon Frequency Slice (34-Slices, BW: 5 GHz Imaging, PSS: 1500 bms, PST: 16 bms of 5 GHz, zoom windows..)	MID	18	Currently €48M	1	YES	>40%	6	6-12	42.1	786.9	
5.26	LOW RPF: Early digitisation	LOW	20	Only the front end included in estimation	1	NA	>40%	8	>12	62.1	766.9	
8	SDP- HPC: Deploy 200 Pflops (rather than 260 Pflops)	COMM	10	Science Risk to HPC-intensive objectives (lower allowed duty	2	YES	>40%	1	1-3	72.1	756.9	757Meuro
5.24.3	Reduce Bmax MID to 120 km: A, remove 3 dishes, but keep infra to 150km	MID	3	Reduced number of dishes, prepare for dishes	2	YES	20% -40%	1	1-3	75.4	753.6	
5.24.2	Reduce Bmax MID to 120 km: B, remove infra, but add dishes to core	MID	9	(1.5 in power savings not realised for outer 3 dishes)	2	NO	20% -40%	2	1-3	84.3	744.7	
5.24.1	Reduce Bmax MID to 120 km: C, remove infra, remove dishes	MID	4	(1.5 in power savings not realised for outer 3 dishes)	2	NO	20% -40%	1	1-3	88.7	740.3	
5.13.2.1	Reduce CBF-MID: (34 to 26 Slices: 2.5 GHz Band 5 imaging, 1500 beams PSS 300MHz, 8 beams PST 2.5 GHz, zoom windows with a reasonable but not full level of comensality.)	MID	2		2	YES	>40%	6	6-12	90.5	738.5	
	Reduce Bandwidth output of band 5 to 2.5GHz	MID	2		2	N	20% -40%	2	1-3	92.8	736.2	
5.13.2.1	Reduce MID Band 5 feeds: A, from 133 to 67	MID	11.2	Deploy in arms, but not core	2	YES	20% -40%	1	1-3	104.0	725.1	
5.25.2	Reduce PSS-LOW: B, 167 nodes to 125 nodes	LOW	1		2	YES	20% -40%	3	1-3	104.9	724.2	
5.25.2	Reduce PSS-MID: B, 500 nodes to 375 nodes	MID	2		2	YES	20% -40%	3	1-3	106.9	722.2	
5.13.2.2	MID CBF: Talon Frequency Slice (18-Slices, BW: 1 GHz Imaging, PSS: 1500 bms, PST: 16 bms of 1GHz, zoom windows..)	MID	2		2	YES	20% -40%	6	6-12	108.7	720.4	
5.31	Reduce CBF-LOW BW: A, 300 to 200 MHz	LOW	1		2	YES	20% -40%	2	6-12	109.7	719.4	
8	SDP- HPC: Deploy 150 Pflops (from 200 Pflops)	COMM	10	Science Risk to HPC-intensive objectives (lower allowed duty	3	YES	>40%	1	1-3	119.7	709.4	709Meuro
5.30.0	Reduce Bmax LOW to 50km: A, remove infra, add 18 stations to core	LOW	10	High Science Risk to EoR: Bmax. With Deployment in the inner	3	NO	>40%	2	1-3	129.7	699.4	
5.30.0	Reduce Bmax LOW to 50km: B, remove 18 stations	LOW	3	High Science Risk to EoR: Bmax	3	NO	>40%	1	1-3	132.7	696.4	
5.30a	Reduce Bmax LOW to 40km: B, remove next 18 stations	LOW	10	High Science Risk to EoR: Bmax	3	NO	>40%	1	1-3	142.3	686.8	
8	SDP- HPC: Deploy 100 Pflops (from 150 Pflops)	COMM	10	Science Risk to HPC-intensive objectives (lower allowed duty	4	YES	>40%	1	1-3	152.3	676.8	676Meuro
5.24.a	Reduce Bmax MID to 100 km: D, remove infra, remove next 3 dishes	MID	7	Lose Science (Planetary disks, Star Formation)	4	NO	20% -40%	1	1-3	158.8	670.3	
5.5.1	Remove MID Band 1 feeds: 133 to 0	MID	12	Lose Science (Cosmology, Galaxy Evolution) Excluded the already counted 6 Band1 because shorter baseline	4	YES	20% -40%	1	1-3	170.5	658.6	
5.5.2	Reduce MID Band 5 feeds: B, from 67 to 0	MID	10	Lose Science (Plantary disks, Star Formation) Excluded the already counted 6 Band5 because shorter baseline	4	YES	20% -40%	1	1-3	180.6	648.4	

CCP Process w.r.t Capability Reductions

5 Capability Reductions

The SKA Board have mandated that the current Cost Control Project is intended to preserve, to the largest extent possible, the transformational science capabilities of SKA1. The science impact analysis described above will be presented to the SEAC for their review during the Pisa face-to-face meeting in March. In the event that one or more of the HPSOs are deemed by the SEAC to be significantly negatively impacted by a package of measures being considered for recommendation, then the following additional steps would be undertaken. The process described is similar to that undertaken for Re-Baselining.

5.1 Science Assessment Workshops – Community Consultation

A workshop would be scheduled in April/May 2017 to bring together a group of independent representative experts within each science area that is deemed to be negatively impacted, to critically consider the proposed change of capability and provide a detailed assessment of continued scientific viability within the context of such a change. A written report to the SKAO would summarise the findings of each assessment workshop.

5.2 Science Review Panel Consultation

In the event that multiple science areas are negatively impacted by the package of changes being considered, then the "ad hoc" Science Review Panel would be reconvened in early June 2017 and asked to consider the overall trade-off of priorities between the science areas in question. They would make use of the reports provided by the Science Assessment Workshops and provide a written report that recommends the relative priority that should be considered for each area.

5.3 SEAC Consultation

The complete set of assessment workshop reports and potential SRP report would be provided to and discussed in detail with the SEAC, to allow a suitable recommendation to be formulated for the July 2017 Board meeting.

EWASS17, URSI-GA17, IAU-GA18

- EWASS-2017, Prague, 26 & 27 June
  - "Scientific Synergies enabled by the SKA, CTA and Athena" (Organisers: Andrea Possenti & Evan Keane, Xavier Barcons, Emma de Ona)
  - Six sessions of 1.5h
    - Athena – Other
    - CTA – Other
    - SKA – Radio
    - SKA – mm/sub-mm,IR
    - SKA – Optical, X-ray
    - SKA – Other (GW, particles,…)

EWASS17, URSI-GA17, IAU-GA18

- URSI-GA-2017, Montreal, 19 – 26 August
  - “The SKA and its pre-cursors” (Organisers: Bock, Jonas & Braun)
  - Eleven (rather than seven) “technical” talks in three sessions
  - Review of the 20 submitted papers underway now

EWASS17, URSI-GA17, IAU-GA18

- IAU-GA-2018, Vienna Symposium Proposal
  - "Science with the SKA Precursors and Prospects for the SKA" (Organisers: Bock, Camilo, Wayth, Parsons, Braun)
  - Eight science (rather than facility)-based sessions
    - Session 1: Probing the origins of life
    - Session 2: Understanding the Sun and the heliosphere
    - Session 3: Testing general relativity
    - Session 4: The cycle of matter in our Galaxy
    - Session 5: Elucidating galaxy evolution
    - Session 6: Constraining theories of dark energy and structure formation
    - Session 7: Witnessing cosmic dawn and the epoch of re-ionisation
    - Session 8: New insights into transient events

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