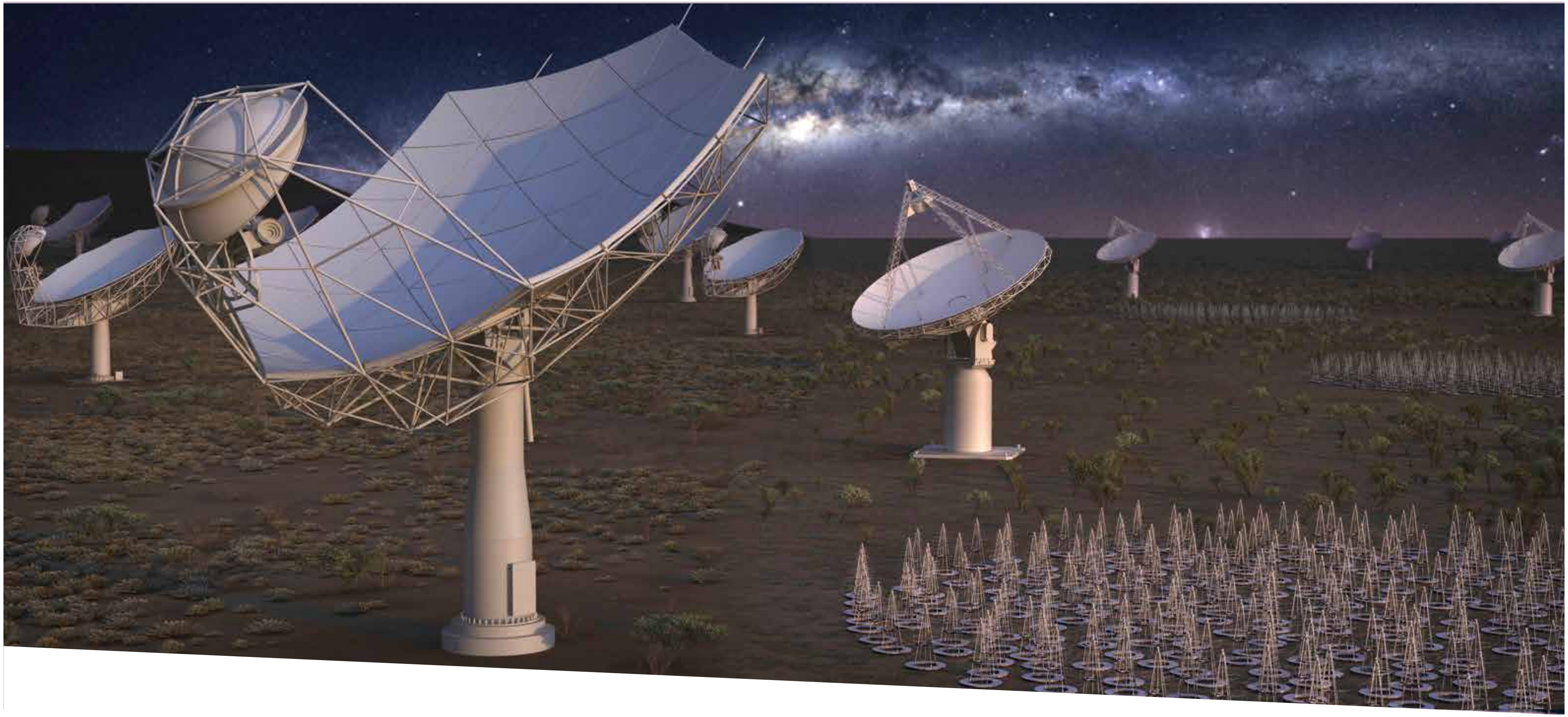
SKA SWG Update



SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

Robert Braun, Science Director

11 July 2017

SKA Science Working Groups and Focus Groups

SWGs and FGs	Co-Chairs
Extragalactic (non-HI) Spectral Line	Rob Beswick (04/15), Francoise Combes (03/17)
Our Galaxy	Mark Thompson (03/15), Grazia Umana (03/15)
Solar, Heliospheric & Ionospheric Physics	Eduard Kontar (08/15), Divya Oberoi (08/15)
Epoch of Reionization	Jonathan Pritchard (08/15), Garrelt Mellema (08/15)
Cosmology	Mario Santos (03/15), Xuelei Chen (03/15)
Extragalactic Continuum	Rosella Cassano (06/15), Minh Huynh (06/15)
Cradle of Life	Andrew Siemion (08/15), Di Li (08/15)
HI galaxy science	Erwin de Blok (04/15), Martin Meyer (04/15)
Magnetism	Ann Mao (12/15), Russ Taylor (03/15)
Pulsars	Andrea Possenti (10/15), Ingrid Stairs (02/16)
Transients	Michael Rupen (08/15), Jean-Pierre Macquart (06/14)
VLBI	Zsolt Paragi (08/15), Cormac Reynolds (08/15)
High Energy Cosmic Particles	Justin Bray (08/15), Clancy James (08/15)

- Refresh of SWG Co-Chairs every ~two years, many reaching term, **nominations invited**

SKA Science Assessment Teams

1. Impact on EoR/CD of changes to SKA1-Low maximum baseline length
   - **Emma Chapman (ICL, Chair),** Gianni Bernardi (SKA-SA), George Heald (CSIRO), Jack Line (UMelbourne), Bart Pindor (UMelbourne), Cath Trott (CurtinU), Sarod Yatawatta (ASTRON), Jeff Wagg (SKAO Support)
2. Required timing accuracy to enable successful precision pulsar timing science
   - **Andrea Possenti (INAF, Chair),** Adam Deller (SwinbU), Ingrid Stairs (UBC), Ben Stappers (UMan), Scott Ransom (NRAO), Willem van Straten (AUT), Evan Keane (SKAO Support)
3. Impact of SKA-Low antenna optimised frequency coverage
   - **Chiara Ferrari (ObsCoAz, Chair)**, Leon Koopmans (UGroningen), James Aguirre (UPenn), Annalisa Bonafede (INAF), Jason Hessels (UAmsterdam), Divya Oberoi (NCRA), Philippe Zarka (ObsPM), Francesco de Gasperin (ULeiden), Anna Bonaldi (SKAO Support)

SKA Science Assessment Teams: Conclusions

1. Impact on EoR/CD of changes to SKA1-Low maximum baseline length
   - Early indications suggested that distinctions between B_{Max} = 65, 50 and 40 km were not extreme
   - More detailed simulations indicate an enhanced level of risk associated with the 40 km option. If possible, B_{Max} reductions should not be undertaken
2. Required timing accuracy to enable successful precision pulsar timing science
   - Clock precision (~5 ns) and redundancy for MID are vital
   - LOW requirements can likely be relaxed
3. Impact of SKA-Low antenna optimised frequency coverage
   - Major capability loss if low performance above 200 MHz
   - Biggest hits to Pulsar surveys (MSP yield), but also EoR tail, Solar, and continuum imaging (particularly in combination with a B_{Max} reduction!)

Adjustments to Ordered CCP List (25 May)

- LOW antenna design: Based on the major negative science impact of cuts to both the maximum baseline of SKA1-Low, as well as the higher frequency performance, the intent is to give higher priority to preserving the high frequency performance of the antenna system

- MID Band 5 partial deployment: A wide community consultation will be undertaken to ensure that any partial deployment of the Band 5 feeds takes account of all science constraints

- Reduce CBF-LOW, Reduce PSS-LOW, Reduce PSS-MID, Reduce CBF-MID: All five of these items have been moved down to below the nominal Cost Cap line, since the negative science impact of each is deemed to be too severe in relation to the anticipated cost savings

WS / Origin	Description	LOW / MID / COMMON	Science Implication	Science Impact
5.39	INFRA_SA Renewable energy to outer dishes	MID	None	1
5.3	Maximise use of code produced during Pre-Construction	COMMON	None	1
5.38	Simplify DDBH LOW	LOW	None	1
5.38	Simplify DDBH MID	MID	None	1
5.25.2	Reduce PSS-MID: A, 750 nodes to 500 nodes	MID	Likely none, or small reduction of pulsar search parameter space.	1
5.25.2	Reduce PSS-LOW: A, 250 nodes to 167 nodes	LOW	Likely none, or small reduction of pulsar search parameter space.	1
5.35	Reduce CBF-MID: Freq. Slice variant of CSP design vs. MeerKAT-based design	MID	None	1
5.19	MID Frequency and Timing Standard: SaDT solution vs. MeerKAT-based solution	MID	None	1
5.36	MID SPF Digitisers: DSH solution vs. MeerKAT-based solution	MID	None	1
5.26 / 5.29	LOW RPF: Early Digital Beam Formation vs. Analogue Beam Formation	LOW	None	1
2	LOW Antenna: Log Periodic Design vs. Dipole Design	LOW	None of the current designs meet the L1 requirements	3
8	SDP- HPC: Deploy 200 Pflops (rather than 260 Pflops)	COMMON	Lower allowed duty cycle for HPC-intensive observations.	2
5.24.3	Reduce Bmax MID from 150 to 120 km: Case A, remove 3 dishes, but keep infra to 150km	MID	Reduction of maximum achievable resolution by 20%, although can be partially recovered with data weighting and longer integration times.	3
5.24.2	Reduce Bmax MID from 150 to 120 km: Case B, remove infra, but add dishes to core	MID	Reduction of maximum achievable resolution by 20%, although can be partially recovered with data weighting and longer integration times.	3
5.24.1	Reduce Bmax MID from 150 to 120 km: Case C, remove infra, remove dishes	MID	Reduction of maximum achievable resolution by 20%, although can be partially recovered with data weighting and longer integration times.	3
5.5.2	Reduce MID Band 5 feeds: A, from 130 to 67	MID	Placement to be determined based on full community consultation.	3
5.25.2	Reduce PSS-LOW: B, 167 nodes to 125 nodes	LOW	Likely reduction in processed PSS beam number (1.3x) or pulsar search parameter space	2
5.25.2	Reduce PSS-MID: B, 500 nodes to 375 nodes	MID	Likely reduction in processed PSS beam number (1.3x) or pulsar search parameter space	2

8	SDP- HPC: Deploy 150 Pflops (from 200 Pflops)	COMMON	Lower allowed duty cycle for HPC-intensive observations.	3
5.30.0	Reduce Bmax LOW to 50km: A, remove infra, add 18 stations to core	LOW	Science Risk to EoR: Bmax.	3
5.30.0	Reduce Bmax LOW to 50km: B, remove 18 stations	LOW	Science Risk to EoR: Bmax	3
5.30a	Reduce Bmax LOW to 40km: C, remove next 18 stations	LOW	Science Risk to EoR: Bmax	3
8	SDP- HPC: Deploy 100 Pflops (from 150 Pflops)	COMMON	Lower allowed duty cycle for HPC-intensive observations.	4
8	SDP- HPC: Deploy 50 Pflops (from 100 Pflops)	COMMON	Lower allowed duty cycle for HPC-intensive observations.	4
5.31	Reduce CBF-LOW BW: A, 300 to 200 MHz	LOW	Longer observing times for continuum applications (1.5x)	4
5.25.2 / Deeper Savings	Reduce PSS-LOW: C, 125 nodes to 83 nodes	LOW	Likely reduction in processed PSS beam number (2x) or pulsar search parameter space	4
5.25.2 / Deeper Savings	Reduce PSS-MID: B, 375 nodes to 250 nodes	MID	Likely reduction in processed PSS beam number (2x) or pulsar search parameter space	4
5.13.2	Reduce Bandwidth output of band 5 to 2.5GHz	MID	Longer Band 5 observing times for some applications (2x)	4
5.35	Reduce MID CBF and DSH BW: 5 to 1.4 GHz	MID	Longer observing times to achieve continuum sensitivity in Band 5 (3.6x)	4
5.24 / Deeper Savings	Remove 11 MID Dishes from core	MID	10% Array sensitivity loss in core	4
5.30 / Deeper Savings	Remove 54 LOW stations from core	LOW	10% Array sensitivity loss in core	4
5.24 / Deeper Savings	Remove additional 11 MID Dishes from core	MID	20% Array sensitivity loss in core	4
5.30 / Deeper Savings	Remove additional 54 LOW stations from core	LOW	20% Array sensitivity loss in core	4
5.24.2	Reduce Bmax MID from 120 to 100 km: D, remove infra, remove next 3 dishes	MID	Lose Science (Planetary disks, High resolution Star Formation)	4
5.5.1	Remove MID Band 1 feeds: 105 to 0	MID	Lose Science (Cosmology, Galaxy Evolution)	4
5.5.2	Reduce MID Band 5 feeds: B, from 67 to 0	MID	Lose Science (Planetary disks, Star Formation)	4

Adjustments to Ordered CCP List (25 May)

- Preserve **full ν coverage, BW and commensality** on both LOW (300 MHz) and MID (5 GHz)
- Keep PSS cuts down to only a 30% hit in search speed
- Full community consultation to optimise any partial deployment of SPF5
- Based on updated CCP list:
  - Overall consensus around ordering of measures
  - Transformational science is retained in most areas

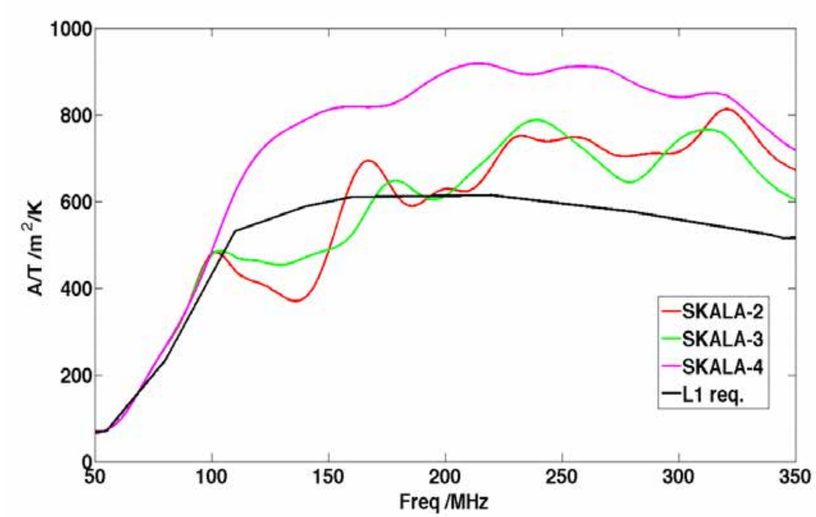
Design Baseline / Deployment Baseline

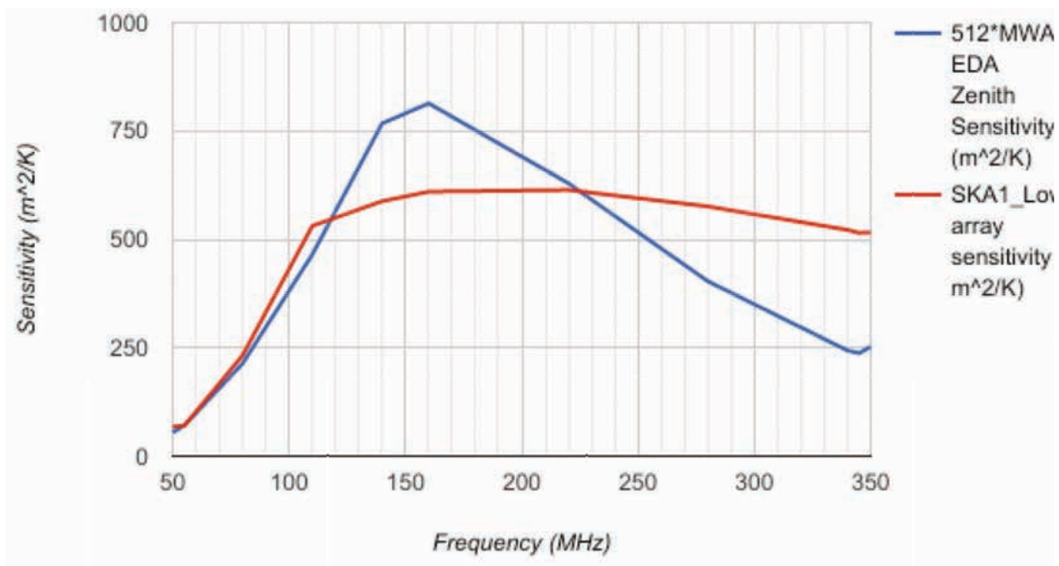
	Design Baseline	Deployment Baseline	Re-instatement ‘+’ means add to system
SKA1-Mid			
No. dishes	133	130	+3 dishes at 150 km
Max. Baseline	150 km	120 km	+ infra to 150 km
Band 1 Feeds	133	130	+3 Band 1 Feeds for 3 dishes
Band 2 Feeds	133	130	+3 Band 2 Feeds for 3 dishes
Band 5 Feeds	133	67	+66 Band 5 feeds
Pulsar Search (PSS)	500 nodes	375 nodes	+125 nodes
SKA1-Low			
No. stations	512	476	+36 stations (18 stns at 49 & 65 km)
Max. Baseline	65 km	40 km	+infra to 65km
Pulsar Search	167 nodes	125 nodes	+42 nodes
Common			
Compute Power	260 PFLOPs	50 PFLOPs	+210 PFLOPs

- Proposal to SKA Board (18&19 July)
  - Design Baseline for which CDRs will be undertaken is unchanged
  - Deployment Baseline is scoped for cost-capped Construction budget
  - Re-instatement of HPC and PSS already part of Operational budget
  - Re-instatement of all other items as soon as funding permits

SKA1-Low Antenna Optimisation

- Preliminary performance projections for the two antenna classes under study
- Ongoing work to optimise performance:
  - Sensitivity
  - Spectral smoothness
  - Polarisation
  - Sky coverage
  - Station footprint
  - Cost





Recent/Upcoming Meetings

- EWASS-2017, Prague, 26 & 27 June
  - “Scientific Synergies enabled by the SKA, CTA and Athena”
- URSI-GA-2017, Montreal, 25 & 26 August
  - “The SKA and its pre-cursors”
- EWASS-2018, Liverpool, 3 – 6 April, 2018
  - Ideas for SKA-related sessions or symposium?
    - Transients with SKA Precursors/Pathfinders
    - From the Galaxy to the Nearby Universe: Connecting SF and other ISM studies to nearby galaxies

SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope