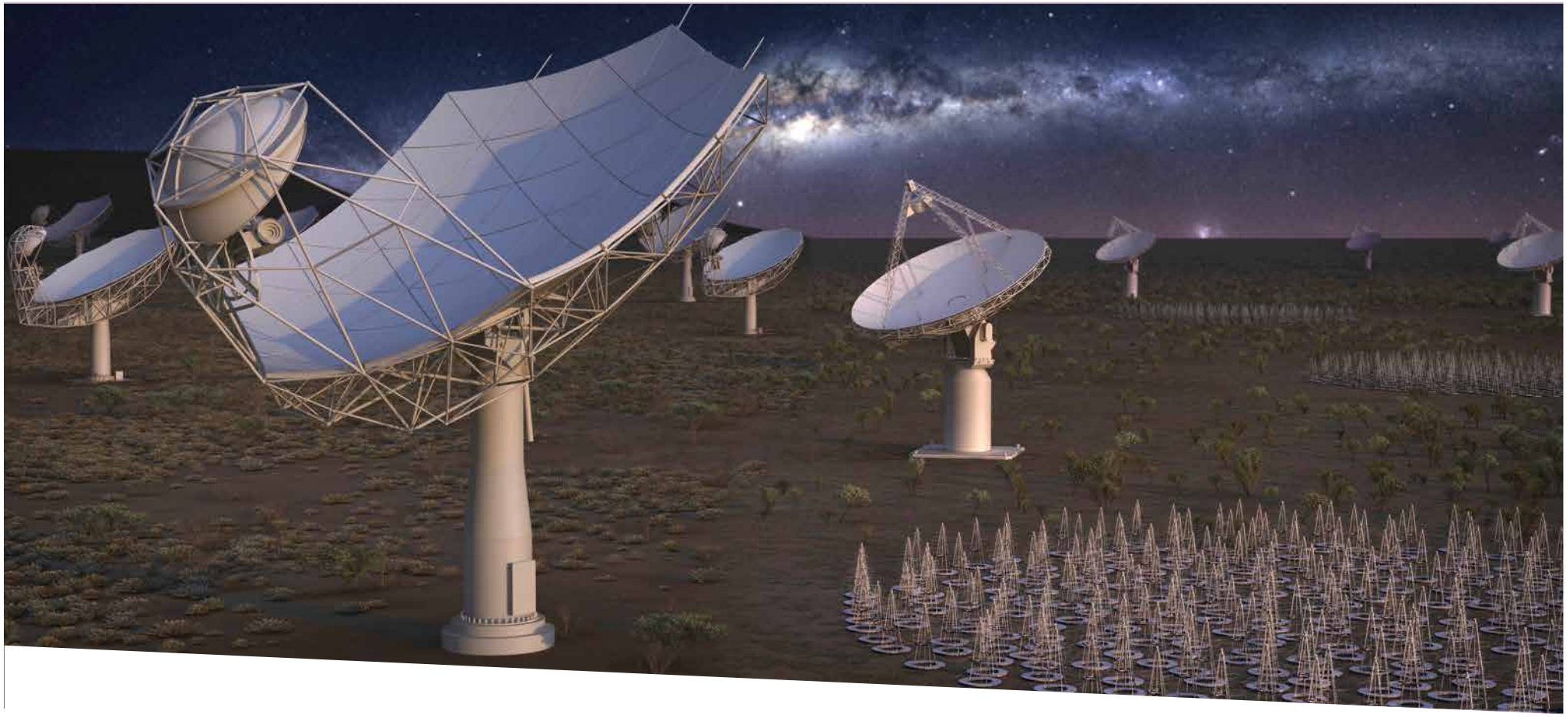
SKA SWG Update



SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

Robert Braun, Science Director

8 May 2018

SKA Board Meeting 26 Outcomes

- 11 – 12 April, Gothenburg, Sweden
- Bridging Plan: (covering interval between design element CDRs and System CDR/Construction Proposal)
  - Board approves centralised management approach and overall activity scope (about 66 FTE years)
- Early Production Arrays
  - Board endorses development of implementation plan
- Operations Model Review
  - Board endorses Panel recommendation of partnership model rather than Service Level Agreements for Telescope Operations, instructs further development

CDR Activity – Updates

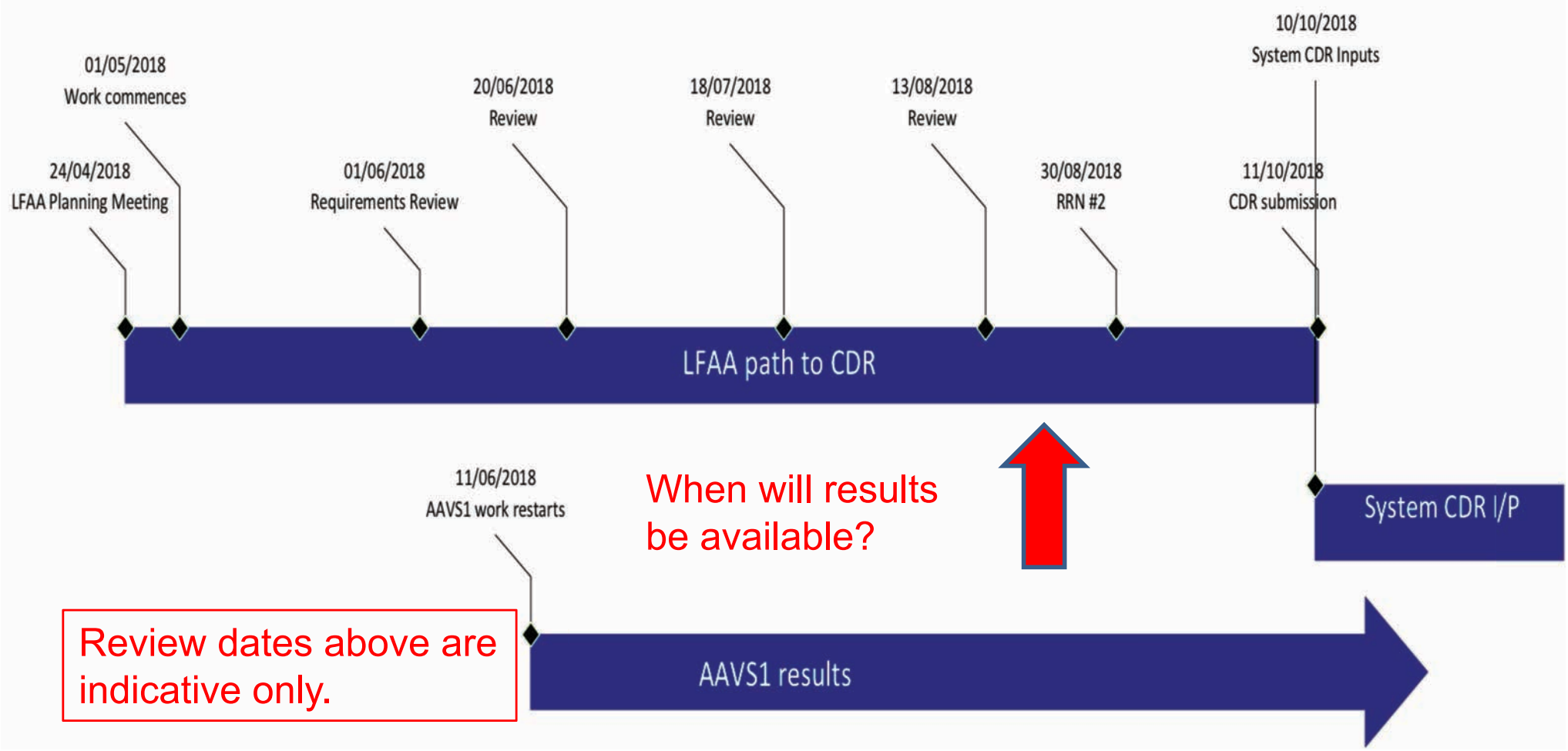
Element	RRN Submission	CDR Submission	CDR Meeting
SaDT & SAT	17 January 2018	28 February 2018	15-18 May 2018
TM	29 January 2018	28 February 2018	17-20 Apr
CSP	18 May 2018 - PSS Sub-Element CDR - PST Sub-Element CDR - CBF-Low Sub-El CDR - CBF-Mid Sub-El CDR	30 June 2018	25 – 28 Sept 2018
INAU	19 March 2018	30 April 2018	27-29 June 2018
INSA	19 March 2018	30 April 2018	2-4 July 2018
LFAA	30 March 2018	TBD	TBD
System CDR (incl. AIV) close	See Roadmap	See Roadmap	30 March 2019
SDP	17 September 2018	31 October 2018	31 December 2018
DSH	ECP Pending - SPF B2 Sub-element CDR	ECP Pending	ECP Pending

Green: Successful phase
Red: Potential schedule change
Blue: Updated from last report

Element CDRs

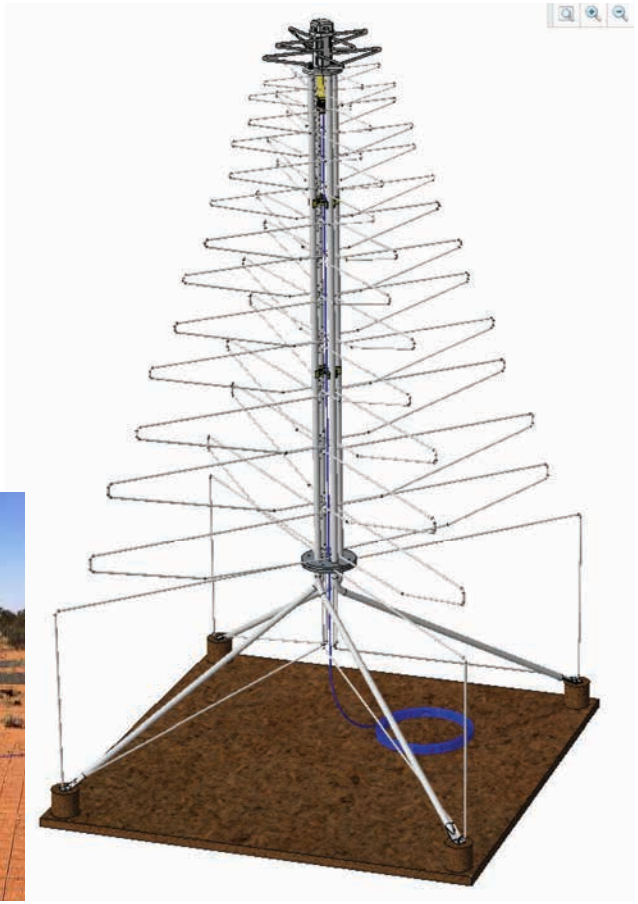
- **SADT** – over 1000 observations; review meeting still on track for mid-May
- **TM** – CDR passed, now focused on closing out some 500 review tickets
- **CSP** – Sub-system CDR reports have been released
- **INFRA** – passed the Review Readiness for their CDR and delivered packs
- **SDP** – passed the Readiness Review for their pre-CDR and delivered the pack
- **LFAA** – Readiness Review unsuccessful, see below
- **DSH** – Some delays to dish structure; sub-element CDRs planned throughout 2018, a few in early 2019

LFAA Recovery Plan



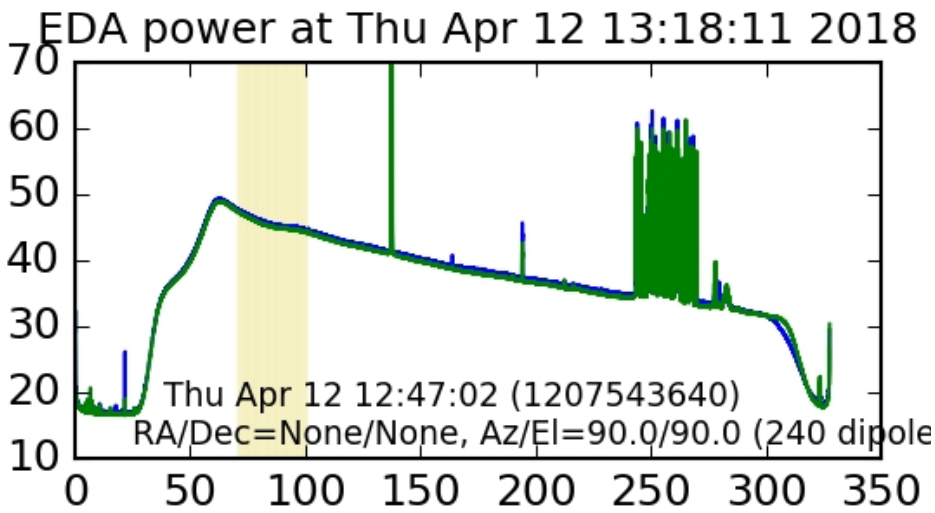
- Integrated Resolution Teams with substantial SKAO support
- Goal of keeping overall delay below 5 months

Testing of SKALA4 Prototypes

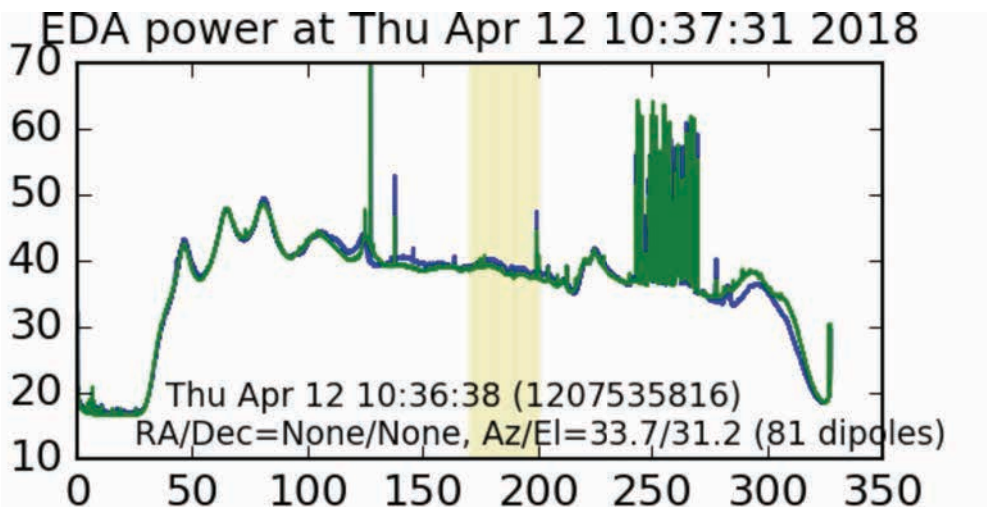


- Two different implementations of new optimised EM design tested at MRO during week of 9 – 13 April

Testing of SKALA4 Prototypes



S4-AL (INAF/SIRIO) both X&Y



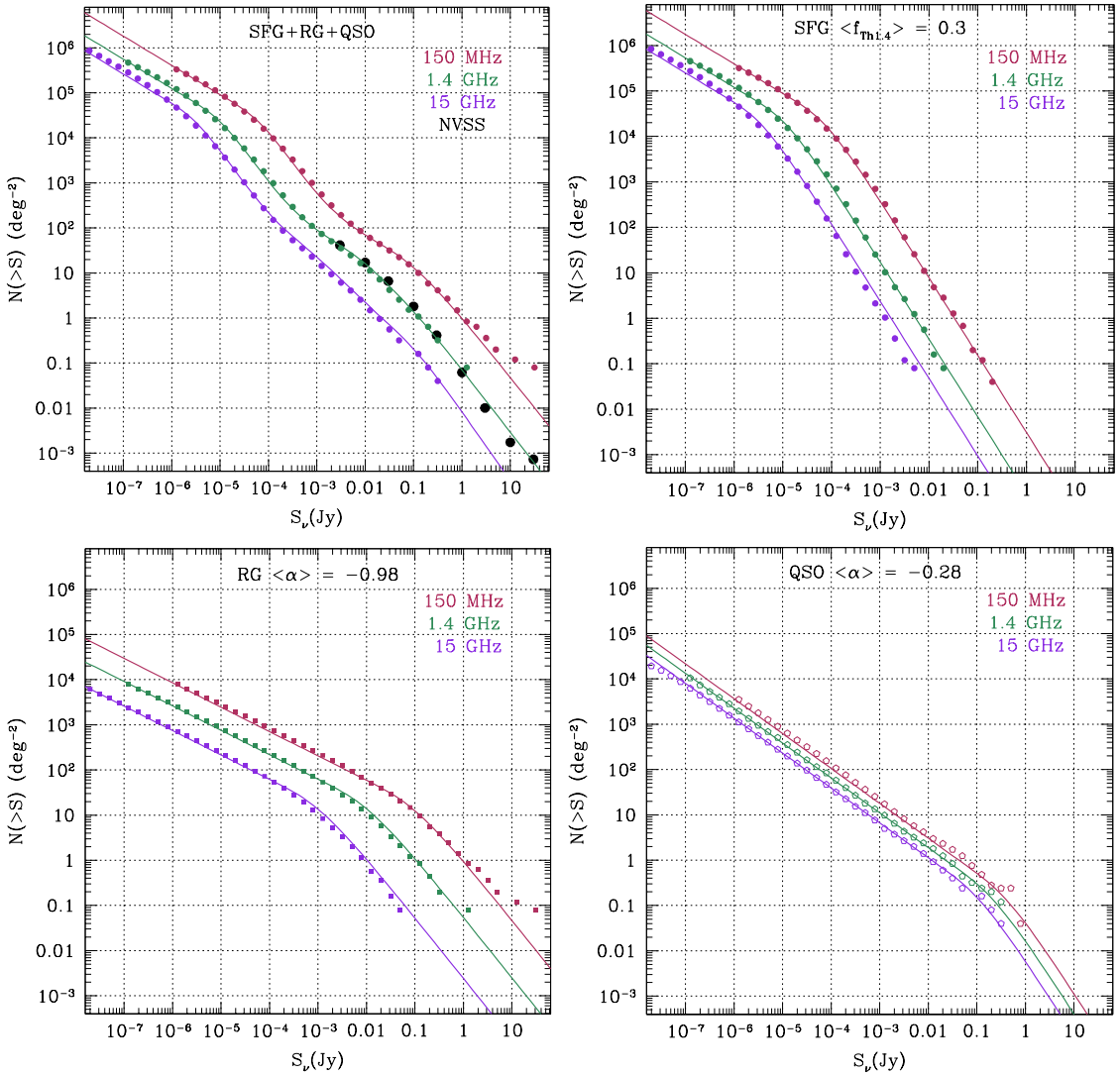
S4-ST (UCAM/CCL) both X&Y

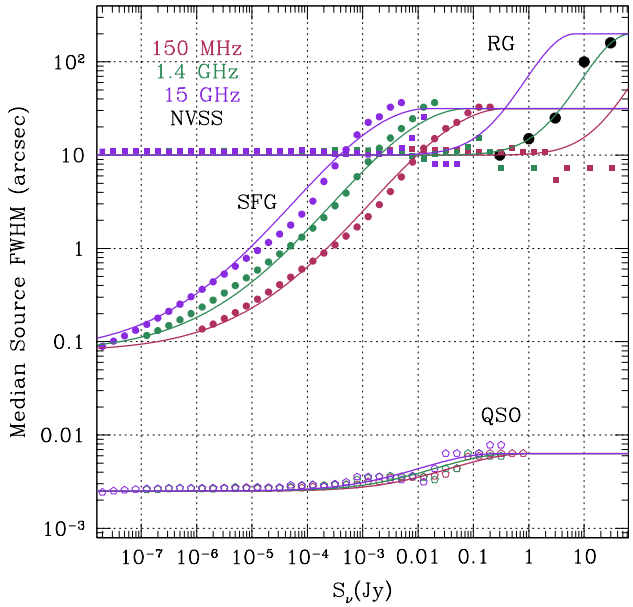
- Good prospects for flatter bandpass and generally improved performance (apparent high frequency cut-off at 300 MHz is artifact of measurement method)

SKA1 Science HPC Requirements

- In-depth study of SKA1 computing requirements from Science perspective underway
- SDP Parametric Model key parameters:
  - Use-Case Parameters: B_{Max}, ν_{Min} and ν_{Max}, T_{Point} (**total** depth for pointing)
  - Calibration Parameters: N_{Ateam}, N_{Source}, $N_{SelfCal}$, N_{Major}, $N_{Ipatches}$ all are strong functions of (B_{Max}, ν and T_{Point})
  - Model for functional dependence of the Calibration parameters on the Use-case parameters
  - Improvements ongoing to: source population numbers and sizes, dish/station beams

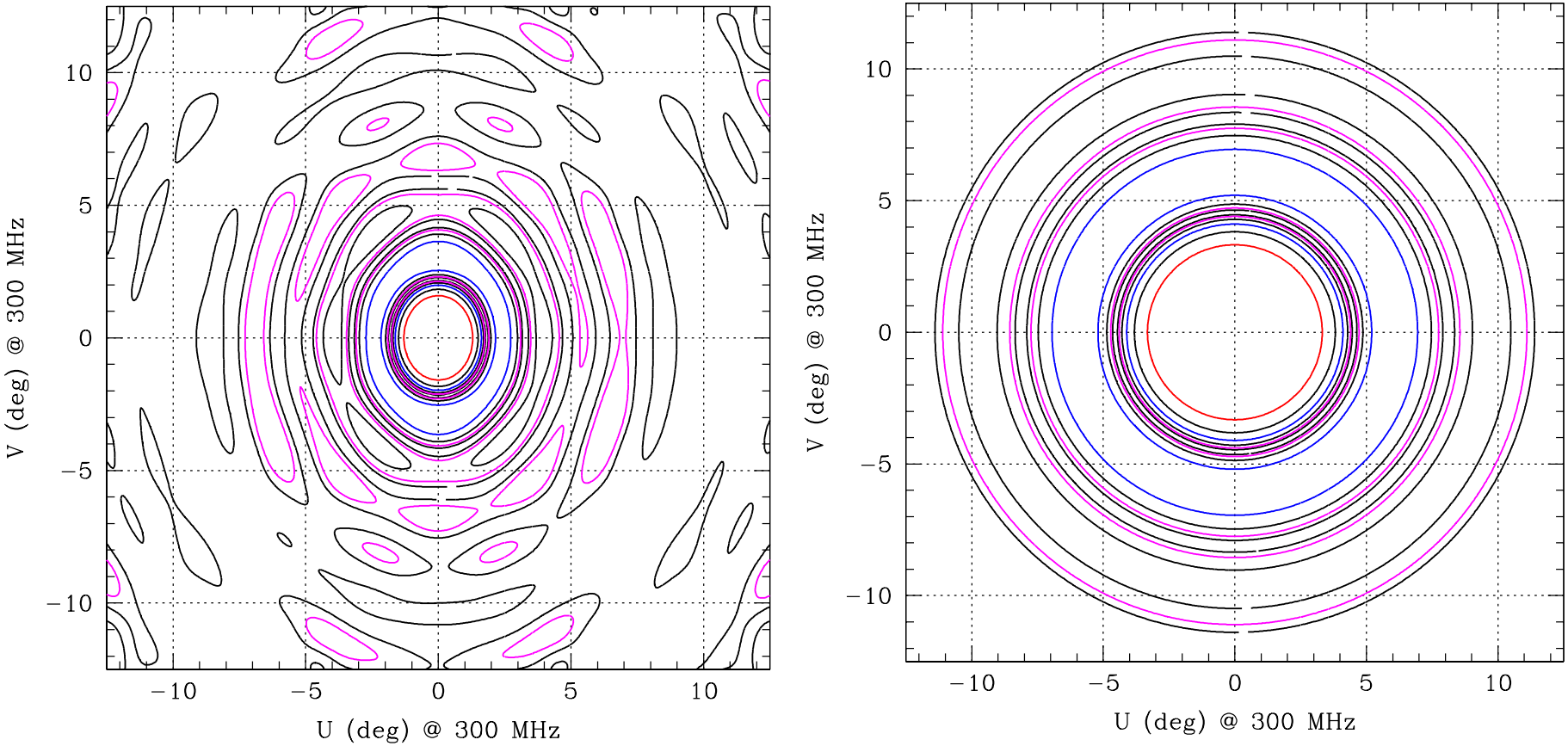
Updated Source Models





- T-RECS simulation outputs at 0.15, 1.4 and 15 GHz

Station/Dish Beam models



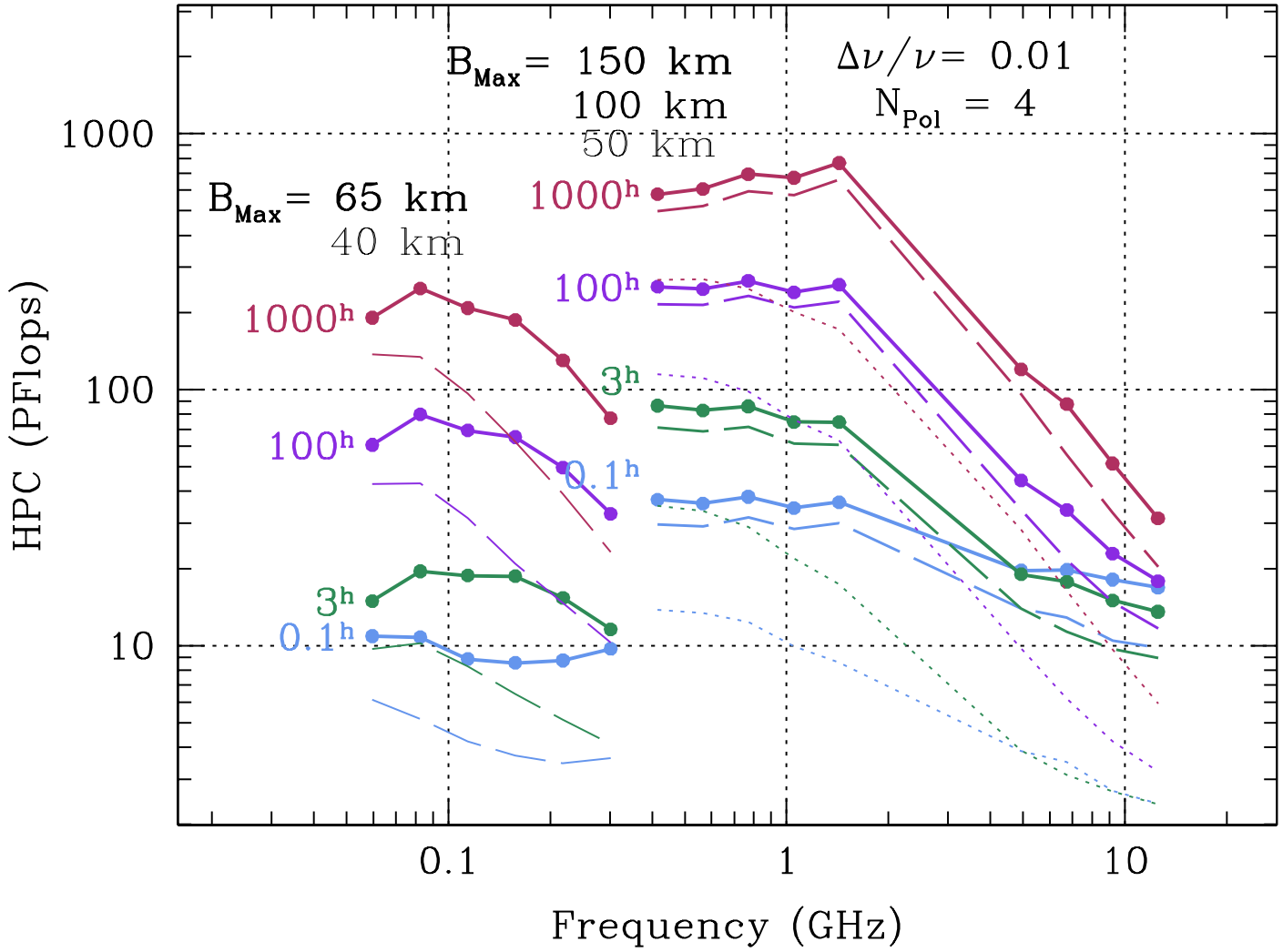
- Improved beam modelling of both SKA1-Low stations and SKA1-Mid dishes for integration of source counts, including side-lobes

SKA1 Calibration Requirements

ν_{min} (GHz)	ν_c (GHz)	ν_{max} (GHz)	Sub-band	Band	N_{Ateam}	N_{Source}	S_{Max} (Jy)	S_{Min} (Jy)	$N_{SelfCal}$/ $N'_{SelfCal}$	N_{Maj}/ N'_{Maj}	N_{Ipatch}
0.050	**0.060**	**0.069**	Low sb1		19	36820	68	14m	6/1	3/1	336
0.069	**0.082**	**0.096**	Low sb2		15	35270	32	3.9m	6/1	3/1	180
0.096	**0.114**	**0.132**	Low sb3		12	28390	14	1.4m	5/1	3/1	93
0.132	**0.158**	**0.183**	Low sb4		10	24760	6.3	0.7m	5/1	3/1	48
0.183	**0.218**	**0.253**	Low sb5		9	17050	2.8	0.5m	5/1	3/1	25
0.253	**0.302**	**0.350**	Low sb6		8	9602	1.3	0.5m	5/1	2/1	20
0.35	**0.41**	**0.48**	Mid sb1	B1	8	29860	2.0	0.3m	6/1	3/1	36
0.48	**0.56**	**0.65**	Mid sb2	B1	5	25140	0.9	0.1m	6/1	3/1	20
0.65	**0.77**	**0.89**	Mid sb3	B1	3	21530	0.4	60μ	5/1	3/1	20
0.89	**1.05**	**1.21**	Mid sb4	B2	2	18770	0.2	20μ	5/1	3/1	20
1.21	**1.43**	**1.65**	Mid sb5	B2	1	16290	90m	15μ	5/1	3/1	20
1.65	**1.95**	**2.25**	Mid sb6		0	11430	50m	9μ	5/1	3/1	20
2.25	**2.66**	**3.07**	Mid sb7		0	6660	31m	7μ	5/1	3/1	20
3.07	**3.63**	**4.18**	Mid sb8		0	3770	20m	6μ	5/1	3/1	20
4.18	**4.94**	**5.70**	Mid sb9	B5a	0	2087	13m	5μ	5/1	2/1	20
5.70	**6.74**	**7.78**	Mid sb10	B5a	0	1117	8m	4μ	4/1	2/1	20
7.78	**9.19**	**10.61**	Mid sb11	B5b	0	582	5m	4μ	4/1	2/1	20
10.61	**12.53**	**14.46**	Mid sb12	B5b	0	293	3m	3μ	4/1	2/1	20

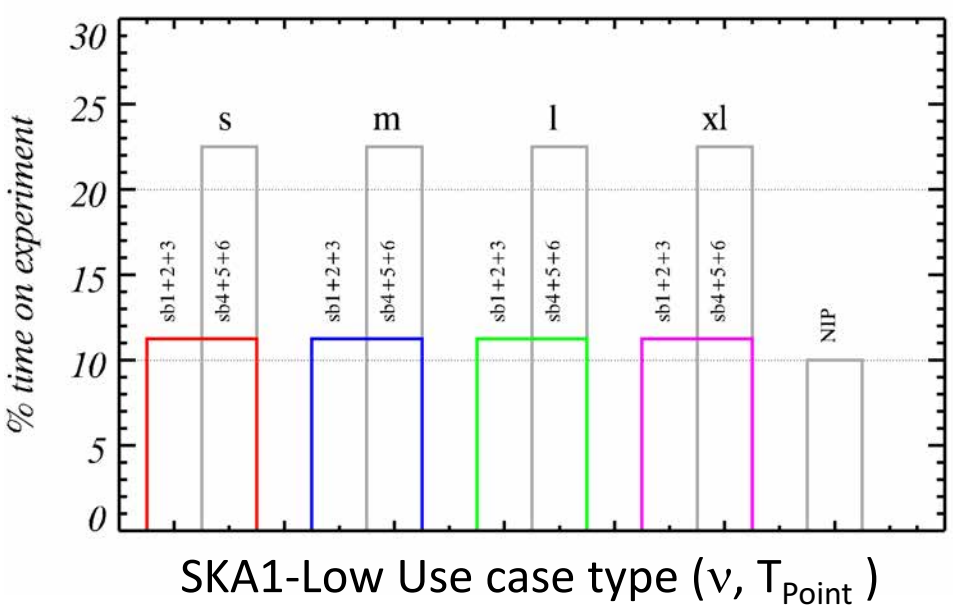
- Modelled calibration parameters that should permit ~thermal noise limited data products within very deep integrations

SKA1 HPC Requirements

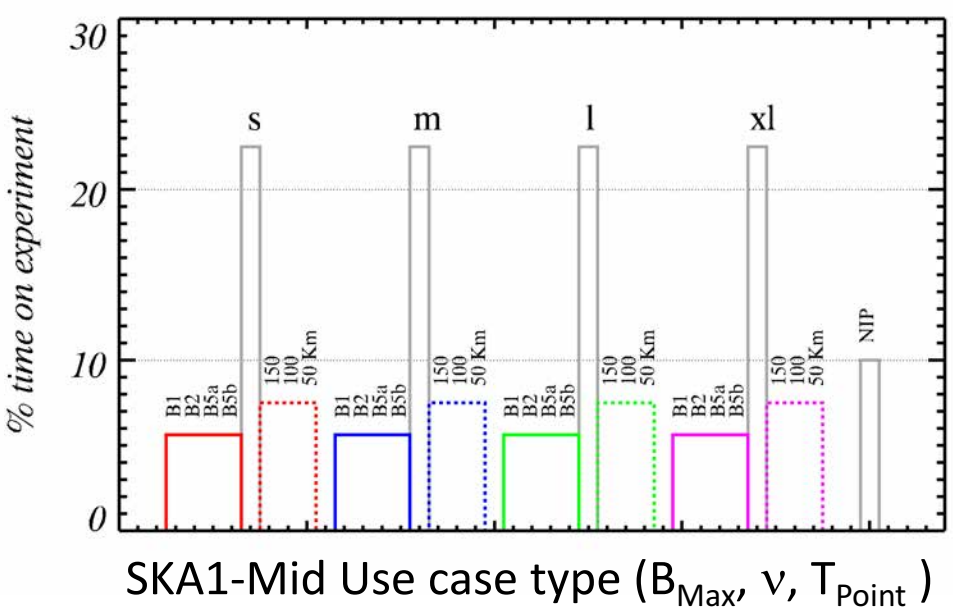


- Instantaneous HPC load as function of (B_{Max}, ν, T_{Point})

SKA1 Science HPC Examples



SKA1-Low Use case type (ν, T_{Point})



SKA1-Mid Use case type (B_{Max}, ν, T_{Point})

- New estimates now in preparation of the use case mix that can be supported with various size HPC deployments
- Even modest HPC can provide significant science return, albeit with duty cycle limitations for the more demanding experiments

SKA1 HPC Caveats

- Computational efficiency assumed to be 10%; could be much better (LOFAR EoR GPU-based pipeline achieving >80% efficiency)
- Better representation of Direction Dependent Calibration methods needed in Parametric model
- HPC costs completely dominated by DFT; could be reduced with partial FFT usage; could be implemented with much higher than 10% efficiency (as noted above for GPUs)

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