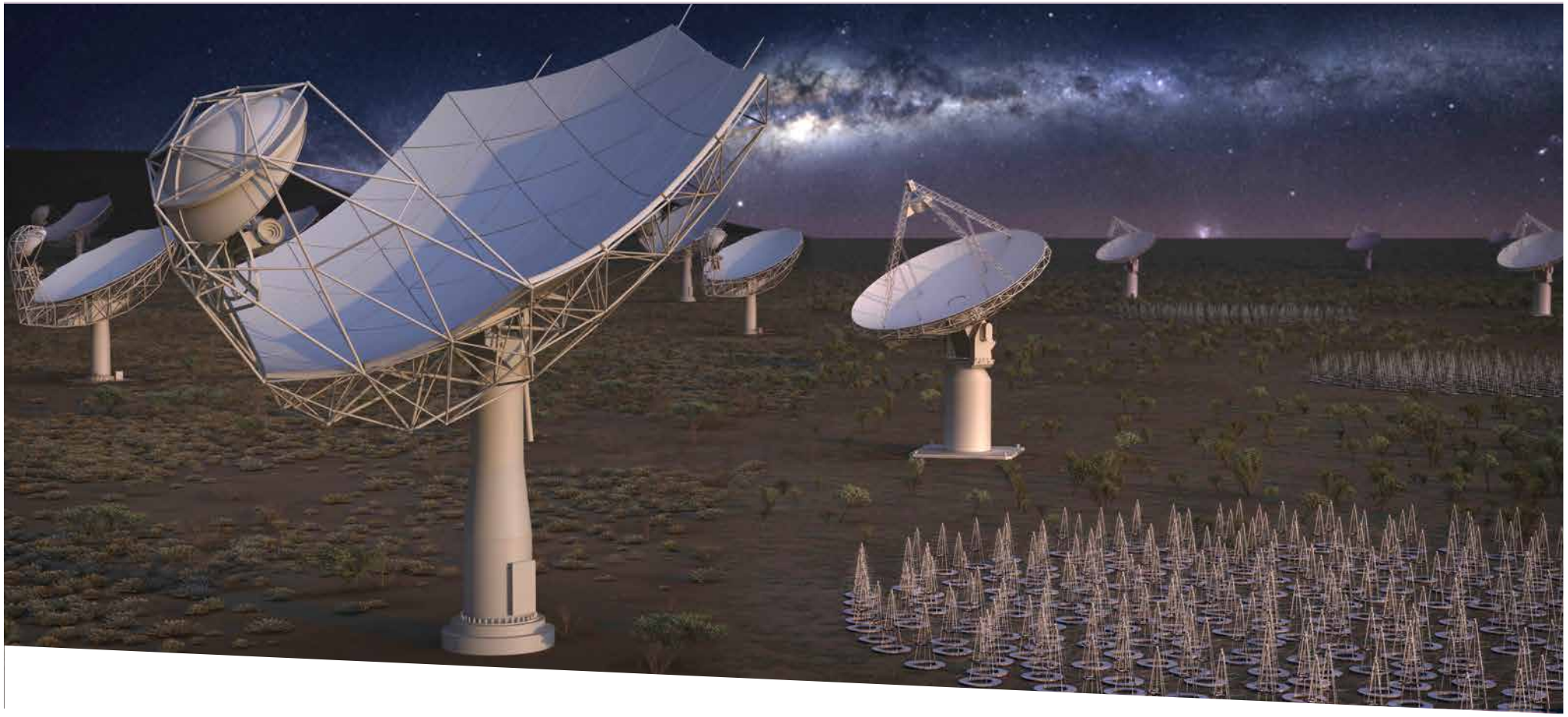
SKA SWG Update



SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

Robert Braun, Science Director

14 August 2018

Agenda

- CDR Activities
- SKA Dish progress
- MeerKAT inauguration
- SKA calibration strategy and possible consequences of constrained initial HPC and archive capacity
- SKA Science Meetings
- Community Updates

CDR Activity – Updates

Element	RRN Submission	CDR Submission	CDR Meeting
TM	29 January 2018	28 February 2018	17-20 April 2018
SaDT & SAT	17 January 2018	28 February 2018	15-18 May 2018
INAU	19 March 2018	30 April 2018	27-29 June 2018
INSA	19 March 2018	30 April 2018	2-4 July 2018
CSP	18 May 2018 - PSS, PST, CBF-Low, CBF-Mid Sub-Element CDRs	30 June 2018	25 – 28 September 2018
SDP Pre-CDR SDP CDR	9 March 2018 17 September 2018	25 April 2018 31 October 2018	20 – 22 June 2018 17 – 19 December 2018
LFAA	30 August 2018	11 October 2018	17 – 19 December 2018
AIV	30 July 2018	10 September 2018	8 January 2019
DSH Pre-CDR DSH CDR	7 September 2018 1 Apr 2019 - Band 1, LMC Sub-CDR 20 Sept 2018 - DSH Struct Sub-CDR 12 May 2019 - Band 2 Sub-CDR 29 May 2019 - Band 5 Sub-CDR 23 May 2019	28 September 2018 22 April 2019	8 November 2018 5 June 2019
System			March 2019

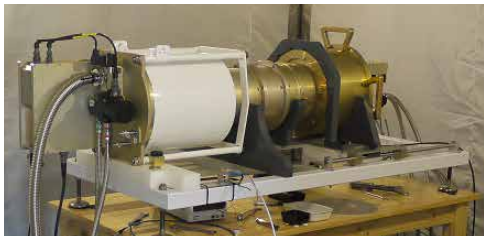
Green: Successful phase

Blue: Updated from last report

Red: Post System CDR

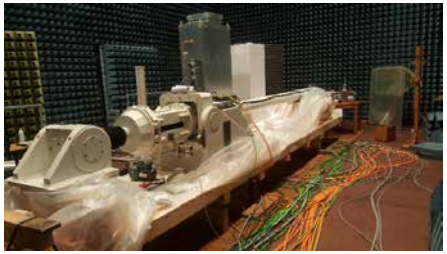
Dish Progress

Dish Feed Indexer test at S.A.M Italy



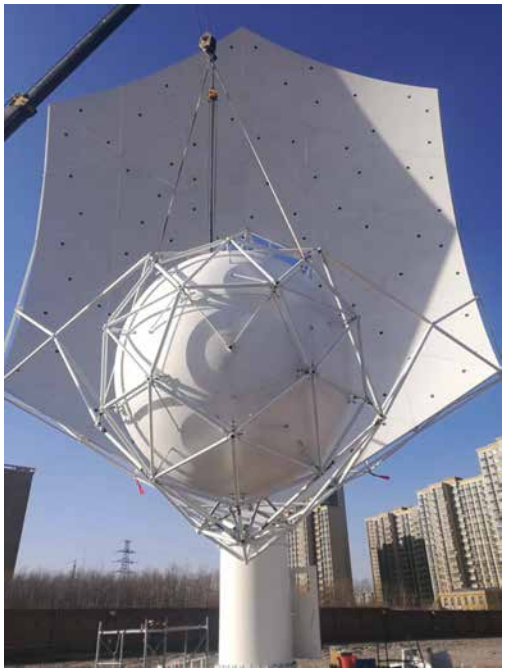
Band 2 Single Pixel Feed under test at EMSS SA

SKA MPI in SA



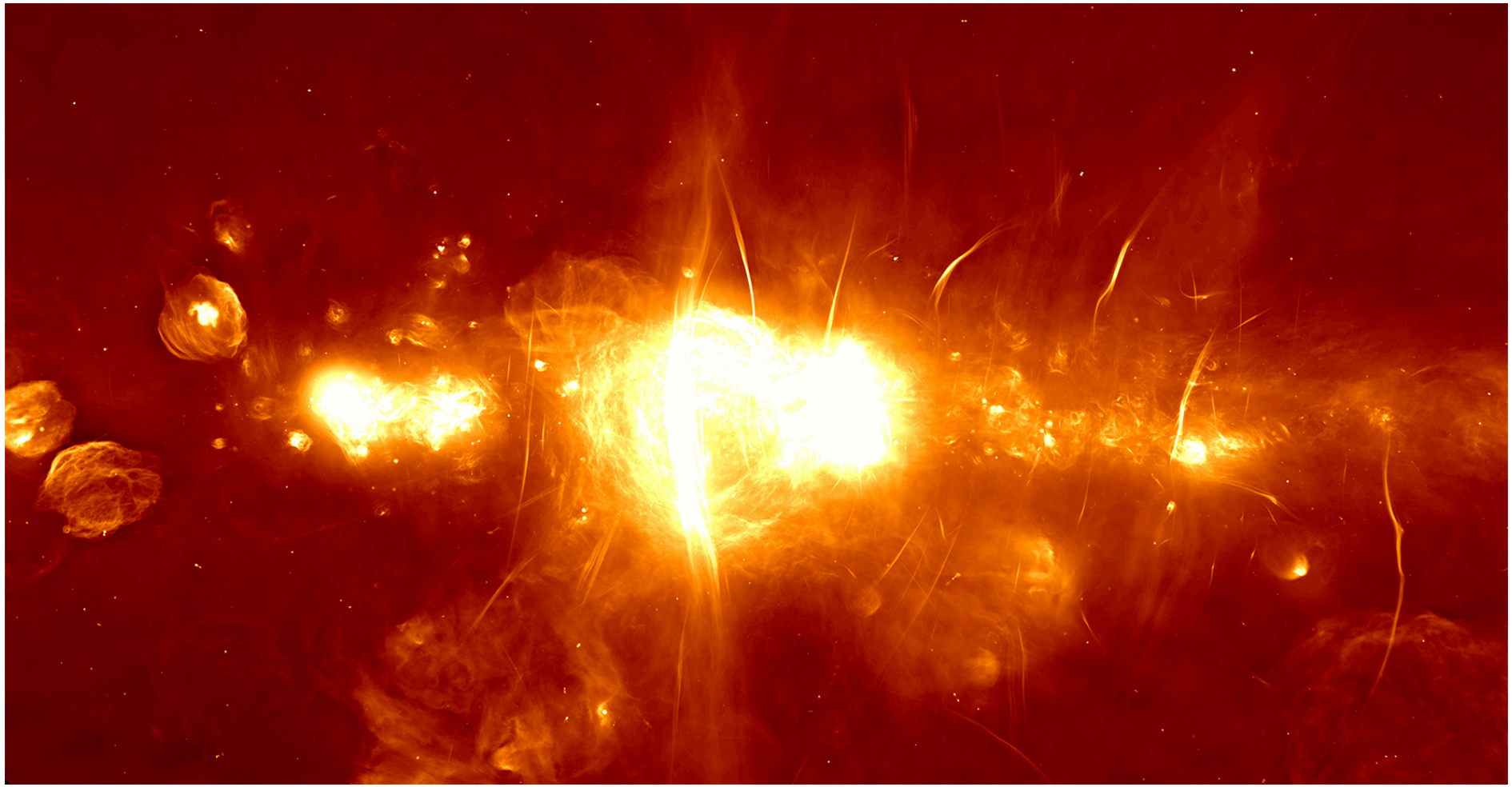
EMI Testing of actuator

Band 1 Single Pixel Feed transport to site!



SKA P @ CETC54 China

MeerKAT Inauguration, 13 July



- Eg. 20 pointing 1.4 GHz MeerKAT mosaic plus GBT total power
- Some Large Survey Projects will now get underway

SKA1 Calibration Requirements (Doc #941 released)

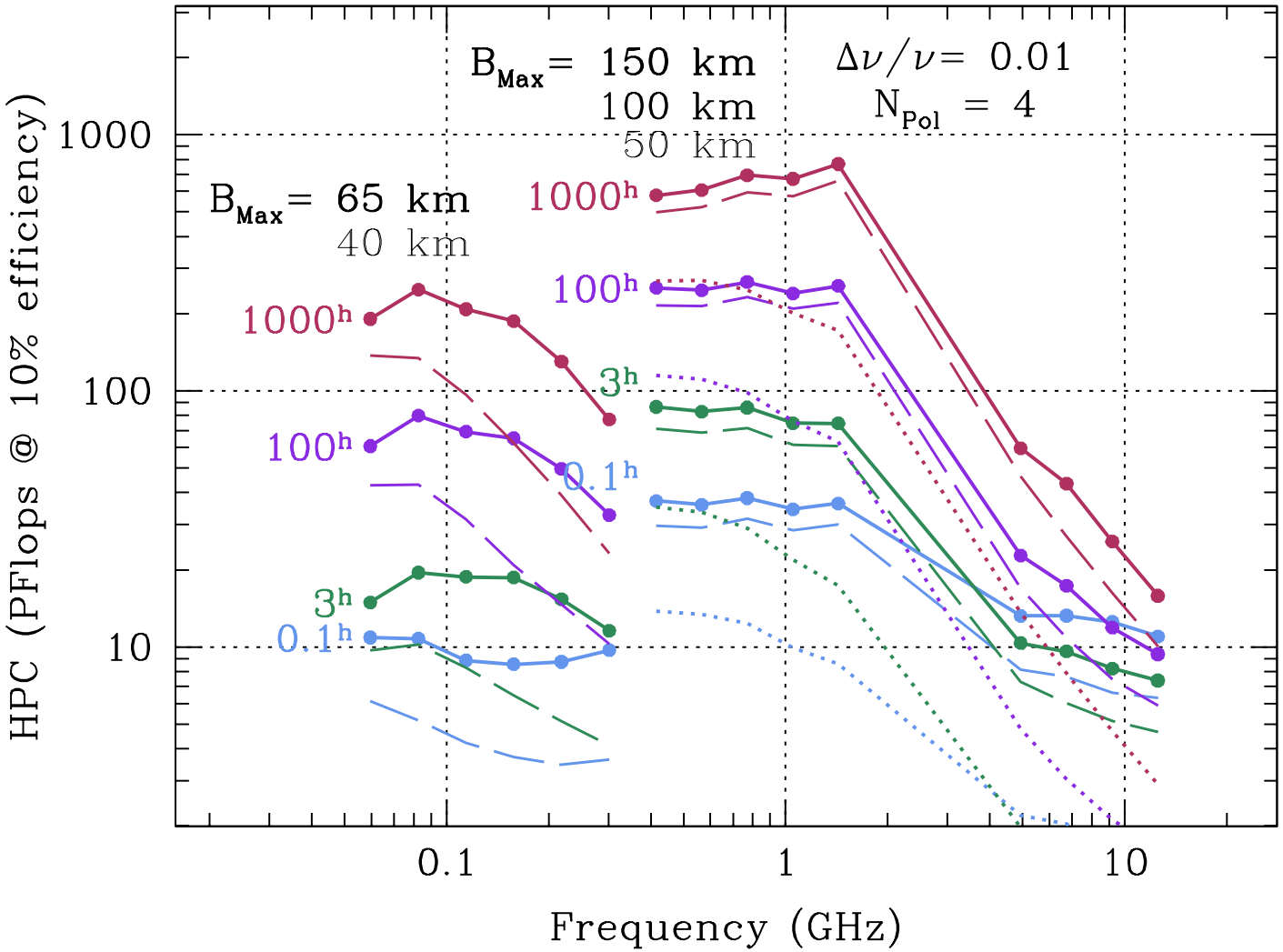
- Science Data Processor Parametric Model for SKA calibration and imaging has key parameters:
  - Use-Case Parameters: B_{Max}, ν_{Min} and ν_{Max}, T_{Point} (**total** depth for pointing)
  - Calibration Parameters: are all strong functions of (B_{Max}, ν and T_{Point})
    - N_{Ateam}, number of all-sky "de-mixing" sources
    - N_{Source}, number of main beam and near-in side-lobe sources
    - $N_{SelfCal}$, N_{Major}, number of self-cal iterations, deconvolution cycles
    - $N_{Ipatches}$, different directions requiring complex gain solution
    - τ_{Sol}, $(\Delta\nu/\nu)_{Sol}$, time and frequency resolution of gain solutions
- SKAO Model for functional dependence of the Calibration parameters on the Use-case parameters
  - Celestial source number densities and sizes
  - Dish/station beam solid angle versus attenuation

SKA1 Calibration Strategy

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

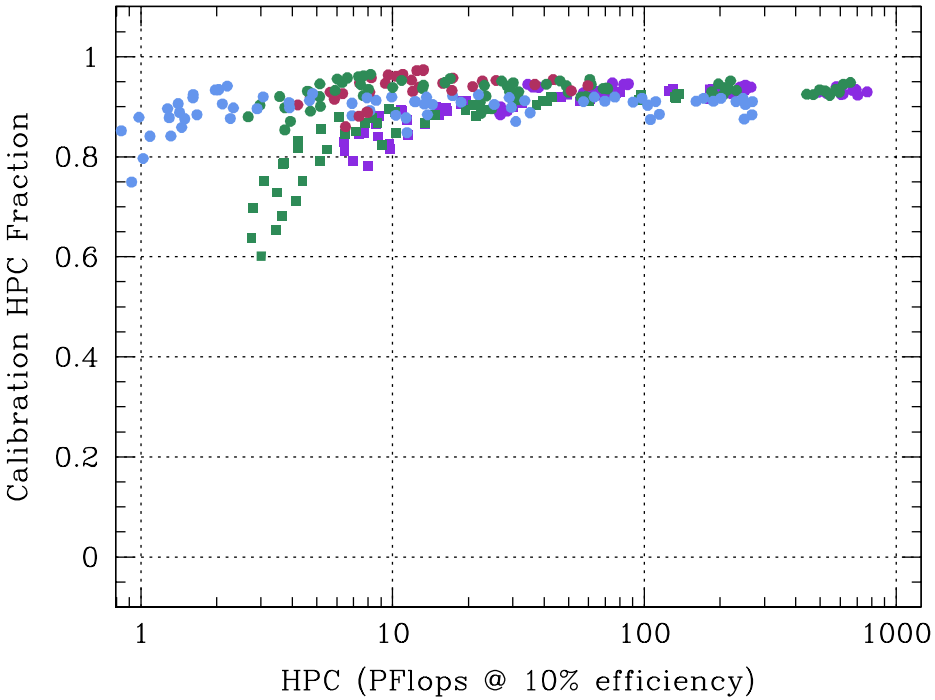
- Modelled calibration parameters that should permit ~thermal noise limited data products within very deep integrations

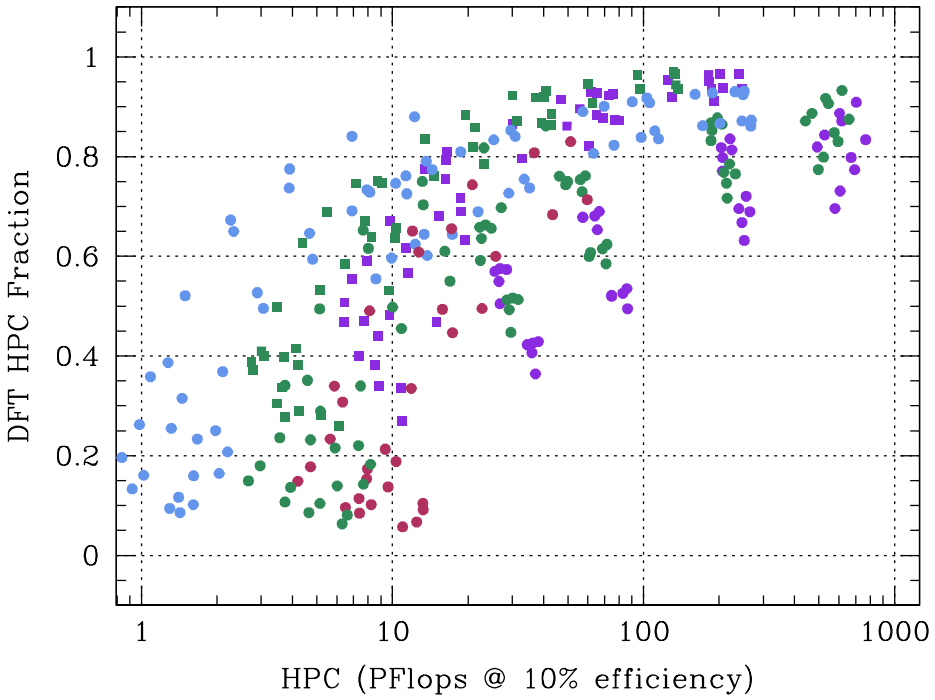
SKA1 High Performance Computing Requirements



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

HPC Breakdown by Use Case type



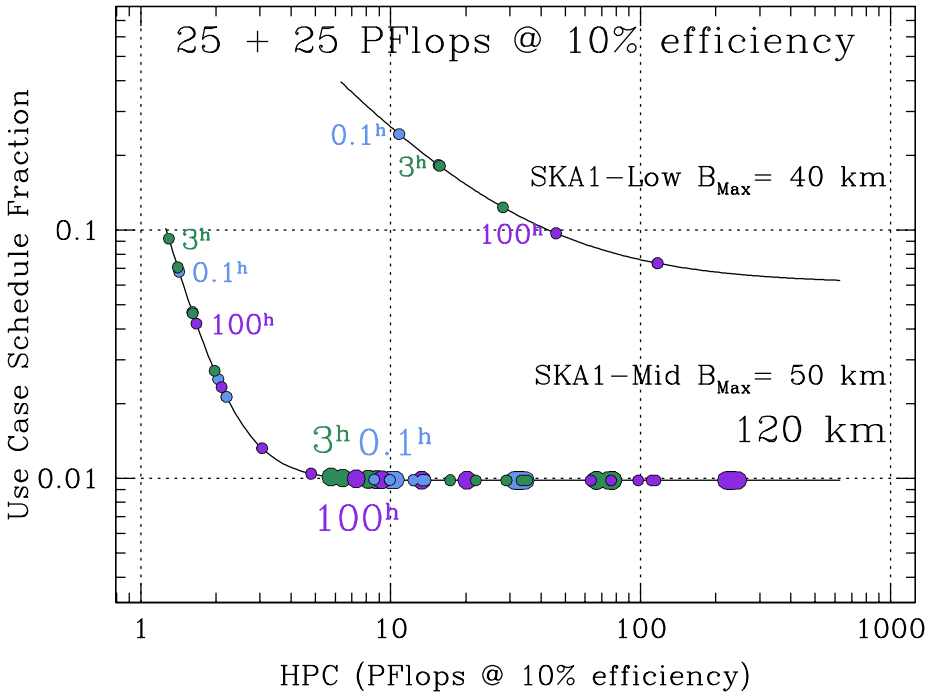


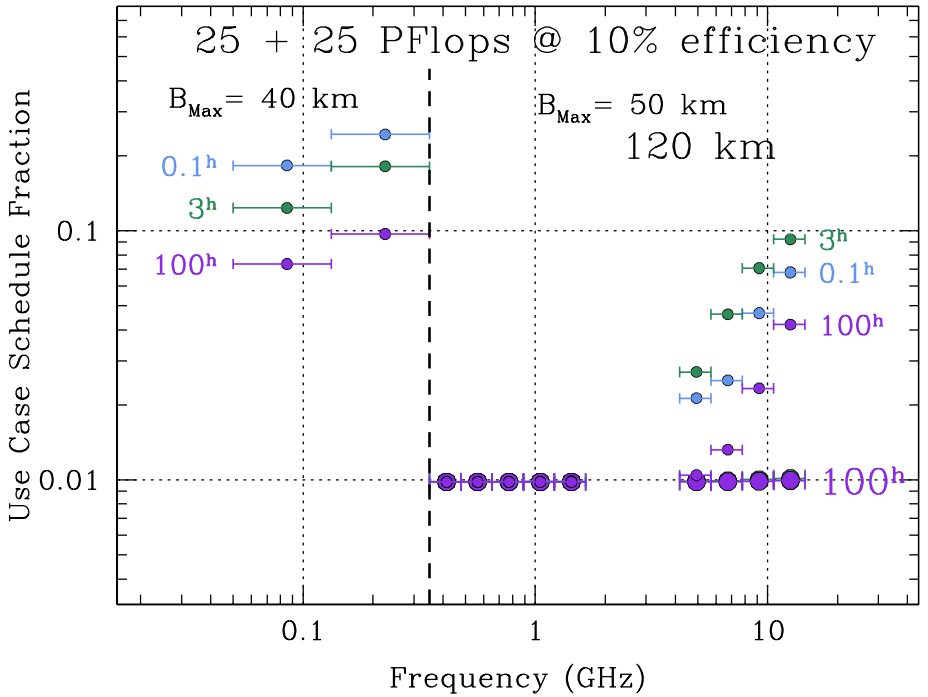
- HPC dominated by calibration, rather than data product generation
  - Implications for central HPC relative to dispersed HPC given limitations on data transmission (only highly compressed visibilities can be exported)
- HPC cost (when significant) dominated by DFT

HPC Prediction Caveats

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

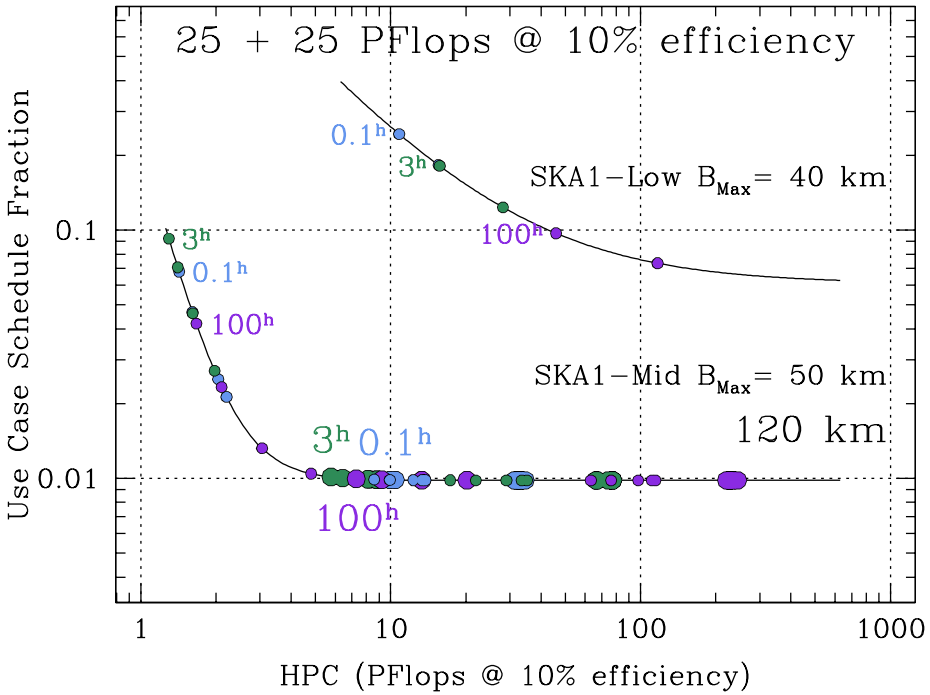
Capped Use Case Distributions (Doc #951)

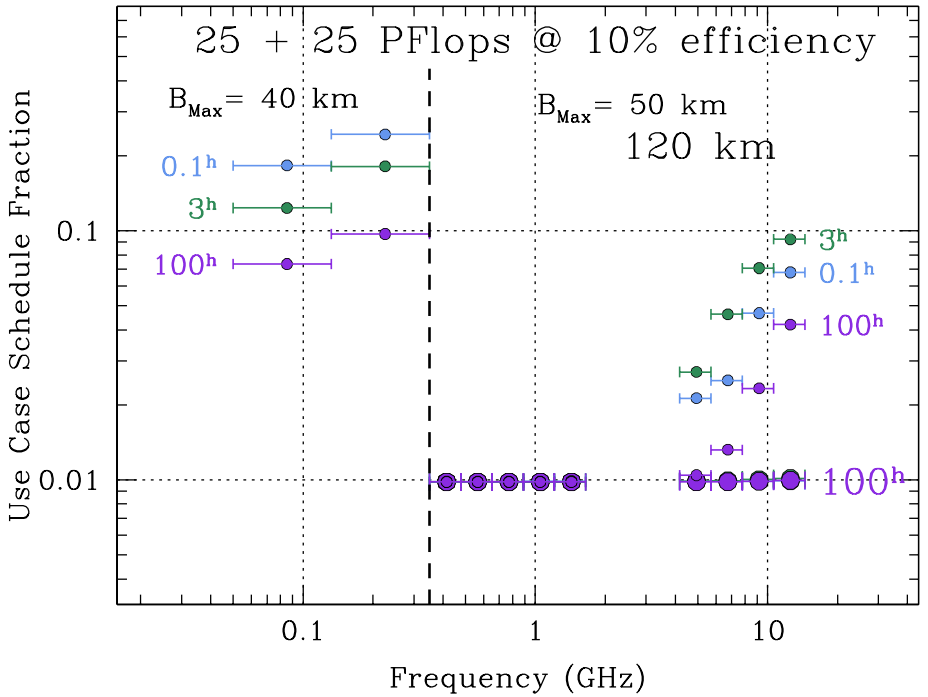




- "HPC Capped Case": 25 + 25 PFlops (@10% efficiency)
  - Process half band: (50 – 350 MHz)/2 (Low); (SPF 1, 2, 5a, 5b)/2 (Mid)
  - Process at resolution: B_{Max} = 40 (Low); 50 or 120 km (Mid)
  - Experiment depths: T_{Point} = 0.1, 3, 100^h
  - Constant + Power law dependence of schedule fraction on HPC load
  - Defer T_{Point} = 1000^h

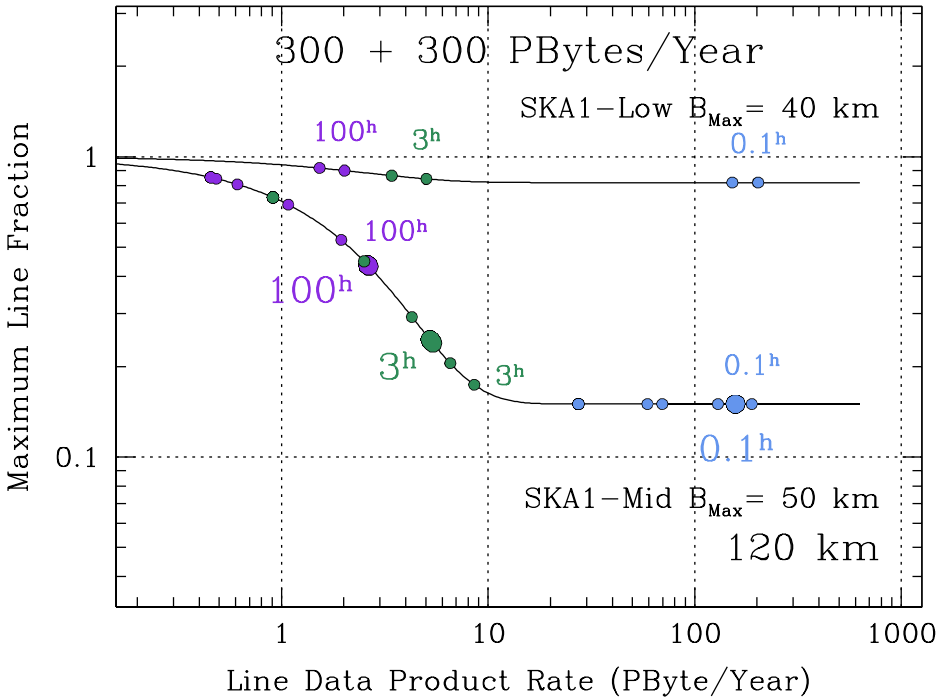
Implications of 25 + 25 PFlops (@10 % effic.)

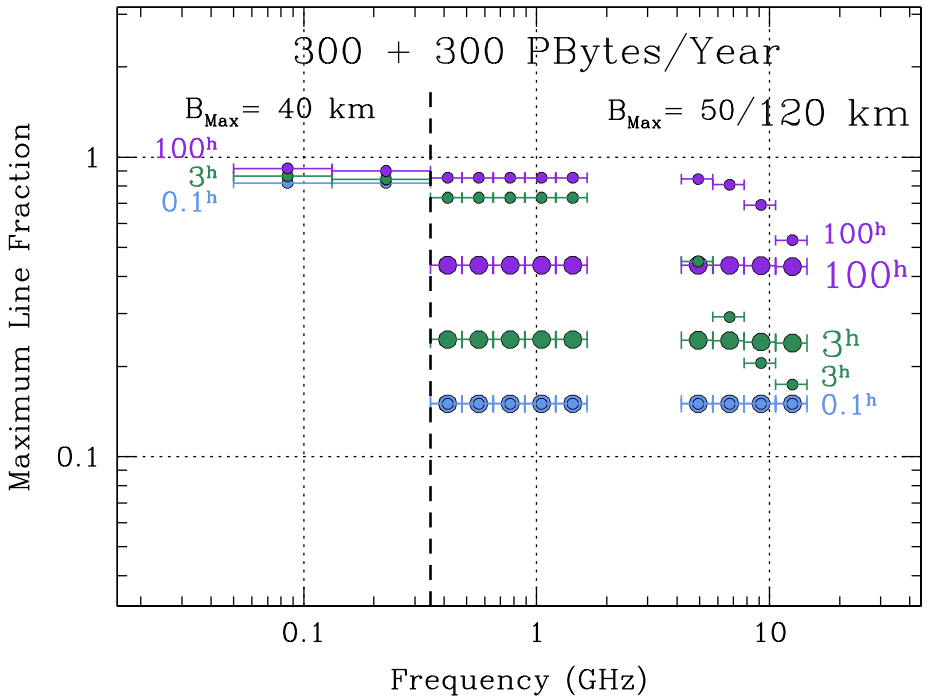




- Deferral of deepest integrations: $T_{Point} \approx 1000^h$
- Loss of simultaneity from half bandwidth
- Relatively low scheduling fractions for 0.35 – 1 GHz (about half "uniform")
- High scheduling fractions for > 5 GHz to provide load balancing

Implications of 25 + 25 PFlops (@10 % effic.)





- Archive Constraints: 300 + 300 PBytes / Year
  - Adopt schedule fractions from Capped HPC = 25 + 25 PFlops scenario
  - Limits on spectral-line fraction imposed by 100 Gb/s per telescope link
  - Constant + exponential dependence of spectral-line fraction on Data Product Rate
  - Only mild constraints on SKA1-Low
  - Strong constraints on short observations with SKA1-Mid imposed by link speed

Science Meetings

- 2018 IAU – GA, 20 – 31 August
  - Good response to SWG request for assistance at the SKA Booth (thanks in advance!!)
  - Please spend some time at the SKA Booth
- 2019 SKA Science Meeting and KSP Workshop
  - Planning progressing well
  - Web site open: https://indico.skatelescope.org/event/467
- 2019 EWASS call for proposals
  - 9 September 2018 deadline
  - Aim to coordinate submissions
- 2020 URSI – GA, 29 Aug – 5 Sept.
  - Call for workshops/sessions

Community Updates

- Science Data Challenges
  - Making progress, links will be posted on website
  - https://astronomers.skatelescope.org/ska-data-challenges/
- Recent and upcoming SWG/FG Meetings?
  - Our Galaxy: 11/12 July, Catania
  - Cosmology: 13/14 September, Turin
  - Other SWGs?
- Updates from participating SWG/FG Chairs
  - ????

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