SKA SWG Update





SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

Robert Braun, Science Director

19 March 2019

Science Activity Updates



- Governance
- SWG co-chairs refresh
- Newly released documents
 - HPC and Archive Constraints, Data Challenge Overview
- SKA related meetings (All)
- SWG Posters (Tyler)
- 2019 SKA Science Meeting and KSP Workshop (Evan)
 - Workshop Schedule, please circulate your drafts!

Inter-Governmental Organisation Convention signed by first seven members: 12 March 2019! Now open for additional signatories

ITALY

SOUTH

Exploring the Universe with the world's largest radio telescope

SKA Science Working Groups and Focus Groups



SWGs and FGs	Current Co-Chairs
Extragalactic (non-HI) Spectral Line	Francoise Combes (FR, 03/17), Sebastien Muller (SE, 02/18)
Our Galaxy	Grazia Umana (IT, 03/15), Mark Thompson (UK, 11/18)
Solar, Heliospheric & Ionospheric Physics	Eduard Kontar (UK, 08/15), Divya Oberoi (IN, 08/15)
Epoch of Reionization	Garrelt Mellema (SE, 08/15), Gianni Bernardi (IT, 09/17)
Cosmology	Richard Battye (UK, 12/17), Laura Wolz (AU, 12/17)
Extragalactic Continuum	Mark Sargent (UK, 10/17), Natasha Hurley-Walker (AU, 02/18)
Cradle of Life	Izaskun Jimenez-Serra (ES, 08/17), Doug Jonstone (CA, 10/17)
HI galaxy science	Sarah Blyth (ZA, 10/17), Lourdes Verdes-Montenegro (ES, 11/17)
Magnetism	Ann Mao (DE, 12/15), George Heald (AU, 10/17)
Pulsars	Gemma Janssen (NL, 03/19), Willem van Straten (NZ, 11/17)
Transients	Michael Rupen (CA, 08/15), Jason Hessels (NL, 08/17)
VLBI	Cormac Reynolds (AU, 08/15), Tao An (CN, 11/17)
High Energy Cosmic Particles	Justin Bray (UK, 08/15), Stijn Buitink (BE, 04/18)

Newly released documents



- If you're looking for a document, please look first in:
 - https://astronomers.skatelescope.org/documents/
- "Anticipated SKA1 HPC Requirements" updated to Rev.2
 - https://astronomers.skatelescope.org/wp-content/uploads/2019/03/SKA-TEL-SKO-0000941-02_Anticipated_SKA1_HPC_Req_signed.pdf
- "Scheduling and Archive Constraints" newly released
 - https://astronomers.skatelescope.org/wp-content/uploads/2019/03/SKA-TEL-SKO-0000951-SKA1_Schedule_Archive_Constraints_signed.pdf
- "Data Challenges Overview" newly released
 - https://astronomers.skatelescope.org/wp-content/uploads/2019/03/SKA-TEL-SKO-0001016-SKA_Data_Challenges_V3.3_signed.pdf

SKA1 High Performance Computing Requirements





HPC Breakdown by Use Case type

 When total HPC significant, then dominated by DFT

Frequency (GHz)	T_Point (h)	Total HPC (PFlops)	Average	Correct	De-grid	De-grid Kernel Update	De-mix	DFT	FFT	Flag	Grid	Grid Kernel Update	ID Comp	IFFT	Phase Rot	Phase Rot Predict	Receive	Re-project	Re-project Predict	Solve	Source Find	Subtract Image Comp	Subtract Vis	Vis Weighting
0.06	0.1	1.1	0	22	3	10	5	27	0	0	3	10	0	4	1	1	0	0	3	0	0	0	0	0
0.08	0.1	1.1	0	16	3	9	6	33	1	1	3	9	0	5	2	2	0	0	3	0	0	0	0	0
0.11	0.1	0.9	0	11	4	9	8	33	1	1	4	9	0	6	2	2	0	0	4	0	0	0	0	0
0.16	0.1	0.9	0	6	4	9	9	38	1	1	4	9	0	5	2	2	0	0	3	0	0	0	0	0
0.22	0.1	0.9	0	3	4	8	12	43	0	1	4	8	0	4	2	2	0	0	3	0	0	0	0	0
0.3	0.1	1	0	2	/	4	13	48	1	1	/	4	0	4	0	0	0	0	3	0	0	0	0	0
0.42	0.1	3.7	0	1	5	5	1	30 40	2	0	5	5	0	10	6	6	0	1	6	0	0	0	0	0
0.37	0.1	3.0	0	2	5		1	40	2	1	5	1	0	10	6	6	0	1	6	0	0	0	0	0
1.05	0.1	3.4	0	2	5	7	0	42	2	1	5	7	0	10	6	6	0	1	6	0	0	0	0	0
1.43	0.1	3.6	0	4	5	2	1	42	2	1	5	2	0	10	5	5	0	1	6	0	0	0	0	0
4.94	0.1	1.3	0	5	5	1	0	10	6	2	5	1	0	30	3	3	0	3	18	0	0	0	0	0
6.74	0.1	1.3	0	5	5	1	0	9	6	3	5	1	0	30	4	4	0	3	18	0	0	0	0	0
9.2	0.1	1.2	0	3	4	1	0	6	6	3	4	1	0	32	5	5	0	3	19	0	0	0	0	0
12.54	0.1	1.1	0	3	15	0	1	5	5	4	15	0	0	28	0	0	0	3	15	0	0	0	0	0
0.06	3	1.5	0	16	2	8	3	46	0	0	2	8	0	3	1	1	0	0	2	0	0	0	0	0
0.08	3	2	0	9	1	5	3	63	0	0	1	5	0	2	1	1	0	0	2	0	0	0	0	0
0.11	3	1.9	0	5	2	4	3	68	0	0	2	4	0	2	0	0	0	0	2	0	0	0	0	0
0.16	3	1.9	0	2	2	4	4	71	0	0	2	4	0	2	0	0	0	0	1	0	0	0	0	0
0.22	3	1.5	0	1	2	4	6	68	0	0	2	4	0	2	1	1	0	0	1	0	0	0	0	0
0.3	3	1.2	0	2	6	3	11	56	0	1	6	3	0	4	0	0	0	0	2	0	0	0	0	0
0.42	3	8.6	0	1	2	5	0	49	1	0	2	5	0	9	6	6	0	1	6	0	0	0	0	0
0.57	3	8.3 9.6	0	1	2	5	0	52	1	0	2	5	0	8 0	6	6 E	0	1	5	0	0	0	0	0
1.05	2	0.0 7 5	0	1	2	4	0	55	1	0	2	4	0	9	5	5	0	1	6	0	0	0	0	0
1 43	3	7.5	0	2	4	- - २	0	52	1	0	ر 2	न २	0	9	5	5	0	1	6	0	0	0	0	0
4.94	3	1	0	7	10	3	0	18	2	3	10	3	0	13	7	7	0	1	8	0	0	0	0	0
6.74	3	1	0	7	10	3	0	13	2	4	10	3	0	11	10	10	0	1	7	0	0	0	0	0
9.2	3	0.8	0	5	11	3	1	10	2	5	11	3	0	11	12	12	0	1	7	0	0	0	0	0
12.54	3	0.7	0	4	13	2	2	8	2	6	13	2	0	13	8	8	0	1	8	0	0	0	0	0

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HPC Breakdown by Use Case type

 When total HPC significant, then dominated by DFT

Frequency (GHz)	T_Point (h)	Total HPC (PFlops)	Average	Correct	De-grid	De-grid Kernel Update	De-mix	DFT	FFT	Flag	Grid	Grid Kernel Update	ID Comp	IFFT	Phase Rot	Phase Rot Predict	Receive	Re-project	Re-project Predict	Solve	Source Find	Subtract Image Comp	Subtract Vis	Vis Weighting
0.06	100	6.1	0	4	0	2	0	82	0	0	0	2	0	1	0	0	0	0	1	0	0	0	0	0
0.08	100	8	0	2	0	2	0	87	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0
0.11	100	6.9	0	1	0	1	1	87	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0
0.16	100	6.5	0	0	0	1	1	88	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0
0.22	100	2 2 2	0	0	0	2	2	86	0	0	1	2	0	1	0	0	0	0	1	0	0	0	0	0
0.3	100	5.5 25.2	0	0	1	5	3	62	1	0	1	5	0	2	2	2	0	1	1	0	0	0	0	0
0.42	100	23.2	0	0	 1	4	0	66	1	0	1	2 2	0	6	י ר	י ר	0	0	2 2	0	0	0	0	0
0.77	100	26.5	0	0	1	3	0	68	1	0	1	3	0	6	3	3	0	0	4	0	0	0	0	0
1.05	100	24	0	0	1	3	0	69	1	0	1	3	0	6	3	3	0	0	4	0	0	0	0	0
1.43	100	25.6	0	0	1	2	0	72	1	0	1	2	0	5	3	3	0	0	3	0	0	0	0	0
4.94	100	2.3	0	3	4	2	0	49	1	1	4	2	0	8	6	6	0	1	5	0	0	0	0	0
6.74	100	1.7	0	5	6	2	0	44	1	2	6	2	0	8	5	5	0	1	5	0	0	0	0	0
9.2	100	1.2	0	8	7	2	1	33	1	4	7	2	0	7	8	8	0	0	4	0	0	0	0	0
12.54	100	0.9	0	10	10	2	1	21	2	5	10	2	0	10	6	6	0	1	6	0	0	0	0	0
0.06	1k	19.1	0	1	0	1	0	91	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
0.08	1k	24.8	0	0	0	1	0	93	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0.11	1k	20.8	0	0	0	1	0	93	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0.16	1k	18.7	0	0	0	1	0	93	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
0.22	1k	13	0	0	0	1	0	91	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
0.3		7.7	0	0	1	2	1	87	0	0	1	2	0	1	1	1	0	1	1	0	0	0	0	0
0.42	1K 1	57.9 60.7	0	0	1	4	0	09 73	1	0	1	4	0	5	1	1	0	1	4	0	0	0	0	0
0.37	1k	69.4	0	0	 1	3	0	73	1	0	1	י ר	0	4	1	1	0	0	4	0	0	0	0	0
1.05	1k	67.2	0	0	1	2	0	79	0	0	1	2	0	4	1	1	0	0	3	0	0	0	0	0
1.43	1k	76.7	0	0	0	2	0	83	0	0	0	2	0	3	1	1	0	0	2	0	0	0	0	0
4.94	1k	6	0	1	2	2	0	71	1	0	2	2	0	5	3	3	0	0	3	0	0	0	0	0
6.74	1k	4.3	0	2	2	1	0	68	0	1	2	1	0	4	4	4	0	0	3	0	0	0	0	0
9.2	1k	2.6	0	3	4	1	0	59	1	1	4	1	0	6	3	3	0	0	4	0	0	0	0	0
12.54	1k	1.6	0	6	5	1	1	49	1	3	5	1	0	6	6	6	0	0	3	0	0	0	0	0



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 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



- 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 used to provide load balancing



- 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

Desired HPC, Network and Archive Capacity



- Vital to co-design software and hardware tuned to eliminate bottlenecks
- Data transport
 - SKA1-Low: 1 − 2 x 100 Gb/s
 - SKA1-Mid: 5 10 x 100 Gb/s
- Archive
 - SKA1-Low: 300 600 PB/yr
 - SKA1-Mid: 1500 3000 PB/yr

Data Challenges



- 1. Science Data Processor Challenges
 - Algorithms for Calibration and Imaging, particularly where there are competing approaches (hence suitable for challenge)
 - Example: DD Calibration: A-Projection versus DD-Faceting
 - Computational efficiency of pipelines running on the SDP platform, working in conjunction first with Bridging activities in this area, followed by construction.
 - Algorithm development community/SDP engagement
- 2. SKA Regional Centre Challenges
 - Data movement
 - Data formats
 - Protocols
 - Security/data federation
 - Databases
- 3. Science/Key Science Project Challenges
 - Engagement with the scientific community by demonstrating SKA capabilities
 - Preparing the scientific community for SKA data formats and sizes
 - Converting standard SDP products
 - Defining useful added value data products
 - Algorithm development for SRCs and other centres
 - Feedback on specific issues e.g. transient buffers, SDP and SRC design

Science Data Challenge #1



- SDC1 consists of source finding, characterization and classification within simulated broad-band continuum images
- To participate, register your interest by sending an email to <u>skaSDC1@skatelescope.org</u>
- Provisional deadline was 15/3/19, but has been extended to 15/4/19
- Preliminary results will be presented at the SKA science conference in April
- 13 participating teams so far, some of them outside the SKA WG community. Several issues with the data have been reported and remedied, so please download latest release.
- SKAO working on preliminary result assessment and scoring

Science Data Challenges



NO.	Category	Data Challenges	Staffing Requirements	HPC Requirements
1	Source Finding and Characterisation in Image Data Products with/without instrumental systematics	 Continuum Polarimetric HI Galaxy Slow Transients HI Intensity Mapping EoR/CD Mapping Solar/Heliospheric 	External community input + dedicated resource at SKAO	Variable from laptop/desktop to supercomputer
2	Source Finding and Characterisation in Non-image Data Products	- Fast Transients - VLBI	External community input + dedicated resource at SKAO	Variable from laptop/desktop to supercomputer
3	Science extraction from data products with/without noise, foreground emission or instrumental systematics	-EoR/CD signal detection -BAO signal detection with/without foregrounds -analysis of large-scale structure signatures -detection of cosmic shear through weak lensing	External community input + dedicated resource at SKAO	Variable from laptop/desktop to supercomputer
4	Efficient mining and science extraction from catalogues/archival data		External community input + dedicated resource at SKAO	Variable from laptop/desktop to supercomputer

SDC2: let's hear your suggestions on what the next challenge could be!

Upcoming SKA-related Meetings



- CTA 1st Science Symposium, 6 9 May, Bologna
- New Perspectives on Galactic Magnetism June 10-14 2019 <u>https://conferences.ncl.ac.uk/galacticmagnetism/</u>
- EWASS SS11: New Inputs and prospects to model Milky Way Magnetic Fields <u>https://eas.unige.ch/EWASS2019/session.jsp?id=SS11</u>
- EWASS FRBs Special Session, 24 June, Lyon <u>https://eas.unige.ch/EWASS/session.jsp?id=SS24</u>
- EWASS SKA Special Session, 26 June, Lyon https://eas.unige.ch/EWASS2019/session.jsp?id=SS29

SWG Posters



- Aim to have a poster (banner) for each SWG
- Seven posters produced so far, three in final prep: <u>https://www.dropbox.com/sh/yb7tpn0u5b91iid/AAAFhgBkMfsUNjDPQhtRhRNqa?dl=0</u>
- Remaining posters (you know who you are!) please push ahead with submissions ASAP so that you will be represented at the April SKA meeting

SWG Posters





• Aim to have a poster (banner) for each SWG by April

Science Meeting

- 2019 SKA Science Meeting and KSP Workshop, 8 – 12 April
 - ~290 paid registrations
 - HQ Auditorium capacity ~160
 - Use Alderley Park back-up venue (232+XX capacity) for <u>Mon – Fri</u>
 - HQ reception on Monday



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KSP Workshop Schedule



- 2019 SKA KSP Workshop, 11 12 April
 - Thursday morning general introduction plenary
 - SDP data products
 - SRC coordination progress
 - Science Data Challenges current and upcoming
 - Thursday afternoon and Friday morning
 - SWG self-organized break-outs on topics like KSP coordination, pilot studies with path finders, etc.
 - Please circulate your draft schedules ASAP
 - Friday afternoon wrap-up plenary
 - Reporting by SWG on progress to date

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