SKA SWG Update

Robert Braun, SKAO Science Director

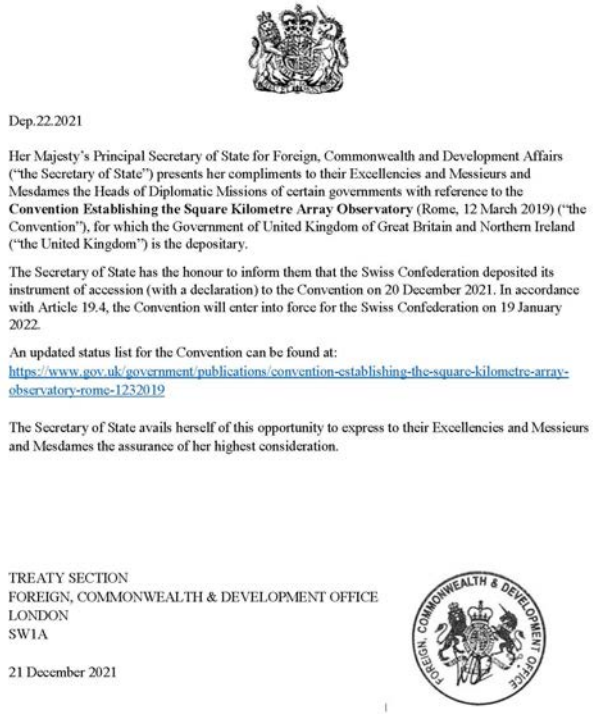
18 January 2022

SKA Science Update

- SKAO Membership
- Construction Progress
- Science Data Challenges
- AOB

SKAO Membership

- Switzerland Instrument of Ascension deposited with UK FCDO on 21 Dec.; formal Member per 19 January
- Spain, France, Canada, Sweden, India all advancing toward membership with suitable interim arrangements that allow for construction contracting
- Germany; agreement is progressing



Dep.22.2021

Her Majesty's Principal Secretary of State for Foreign, Commonwealth and Development Affairs ("the Secretary of State") presents her compliments to their Excellencies and Messieurs and Mesdames the Heads of Diplomatic Missions of certain governments with reference to the **Convention Establishing the Square Kilometre Array Observatory** (Rome, 12 March 2019) ("the Convention"), for which the Government of United Kingdom of Great Britain and Northern Ireland ("the United Kingdom") is the depositary.

The Secretary of State has the honour to inform them that the Swiss Confederation deposited its instrument of accession (with a declaration) to the Convention on 20 December 2021. In accordance with Article 19.4, the Convention will enter into force for the Swiss Confederation on 19 January 2022.

An updated status list for the Convention can be found at:
https://www.gov.uk/government/publications/convention-establishing-the-square-kilometre-array-observatory-rome-1232019

The Secretary of State avails herself of this opportunity to express to their Excellencies and Messieurs and Mesdames the assurance of her highest consideration.

TREATY SECTION
FOREIGN, COMMONWEALTH & DEVELOPMENT OFFICE
LONDON
SW1A

21 December 2021

FOREIGN, COMMONWEALTH & DEVELOPMENT OFFICE

Construction Contracts

Schedule: Jan 2022 (T0+6 months)

- 29 contracts awarded
- Total value: ~€92M

Imminent (2022 Q1)

- Infrastructure
- Contracts for the initial component/ subsystem deliveries for AA0.5

Hardware Contracts

Square Kilometre Array Procurement Plan - Tier 1 Contracts	ILO Notification	Market Survey Start	PQQ Start	PQQ Finish	ITT	Tendering Finish	TSC /In-Kind Committee Finish	Contract Award
Project Milestones								
MID TELESCOPE								
MID INFRA								
MID INFRA PSC Zutari	Not Applicable	Not Applicable	21/Apr/21 A	06/May/21 A	31/Jul/21 A	Not Applicable	07/Sep/21 A	22/Sep/21 A
MID INFRA PSC SARAO	Not Applicable	Not Applicable	21/Apr/21 A	06/May/21 A	26/Jul/21 A	Not Applicable	08/Oct/21 A	29/Oct/21 A
MID INFRA 1 (Access, Foundations, Power & Fibre Networks, S	05/Mar/21 A	30/Jul/21 A	02/Aug/21 A	20/Aug/21 A	14-Jan-22	11-Mar-22	20-Jun-22	27-Jun-22
MID INFRA 2 (Buildings - Upgrade, Power Facility, BMS)	04/Mar/21 A	23/Jul/21 A	02/Aug/21 A	20/Aug/21 A	21-Jan-22	18-Mar-22	27-Jun-22	04-Jul-22
MID INFRA 4 (Communications)	04/Mar/21 A	23/Jul/21 A	02/Aug/21 A	20/Aug/21 A	25/Oct/21 A	17-Jan-22	23-Mar-22	30-Mar-22
MID DISH								
MID DISH ELEMENT	Not Applicable	Not Applicable	21/Oct/21 A	26/Oct/21 A	16-Dec-21	27-Jan-22	25-Mar-22	01-Apr-22
MID DISH STRUCTURE	Not Applicable	Not Applicable	02-Feb-22	15-Feb-22	20-May-22	17-Jun-22	16-Sep-22	23-Sep-22
MID BAND 1	04-Mar-22	04-Feb-22	07-Mar-22	25-Mar-22	01-Apr-22	27-May-22	26-Aug-22	02-Sep-22
MID BAND 2	03-May-22	31-May-22	01-Jun-22	21-Jun-22	19-Jul-22	13-Sep-22	01-Nov-22	08-Nov-22
MID BAND 5	02-Nov-22	06-Dec-22	07-Dec-22	10-Jan-23	07-Feb-23	04-Apr-23	07-Jun-23	14-Jun-23
MID CRYO	09-May-22	11-May-22	11-May-22	24-May-22	14-Jun-22	26-Jul-22	27-Sep-22	04-Oct-22
MID SPF SERVICES	16-Feb-22	10-Mar-22	11-Mar-22	07-Apr-22	12-May-22	07-Jul-22	26-Aug-22	02-Sep-22
MeerKAT Integration	Not Applicable	02-May-23	02-May-23	29-May-23	19-Jun-23	14-Aug-23	10-Oct-23	17-Oct-23
MID NETWORK	19-Oct-22	10-Nov-22	11-Nov-22	08-Dec-22	19-Jan-23	16-Mar-23	09-Jun-23	16-Jun-23
MID SPFRx123	05-May-22	27-May-22	30-May-22	24-Jun-22	22-Jul-22	16-Sep-22	28-Nov-22	05-Dec-22
MID SPFRx45	26-May-23	23-Jun-23	26-Jun-23	21-Jul-23	18-Aug-23	13-Oct-23	08-Jan-24	15-Jan-24
MID SPFRxRXPU SW/FW	05-May-22	27-May-22	30-May-22	24-Jun-22	22-Jul-22	16-Sep-22	28-Nov-22	05-Dec-22
MID CSP	Not Applicable	04-Jan-22	03-Jan-22	03-Jan-22	24-Jan-22	21-Feb-22	16-May-22	23-May-22
MID CBF	Not Applicable	04-Jan-22	04-Jan-22	04-Jan-22	24-Jan-22	21-Feb-22	16-May-22	23-May-22
MID COMPUTING & NETWORKING HARDWARE PROCUREMENT								
MID SPC	07-Jun-23	12-Jul-23	13-Jul-23	23-Aug-23	28-Sep-23	23-Nov-23	09-Feb-24	16-Feb-24
MID CPF	29-Sep-22	03-Nov-22	04-Nov-22	15-Dec-22	26-Jan-23	23-Mar-23	26-May-23	02-Jun-23
MID AIV								
MID AIV	Not Applicable	Not Applicable	26/Jul/21 A	14/Sep/21 A	08/Nov/21 A	15/Nov/21 A	16-Feb-22	23-Feb-22
LOW TELESCOPE								
LOW INFRA								
LOW INFRA PSC	Not Applicable	Not Applicable	08/Apr/21 A	15/Apr/21 A	25/Oct/21 A	01-Dec-21	28-Jan-22	04-Feb-22
LOW INFRA 1 (Access, Foundations, Power & Fibre Networks)	11/Mar/21 A	04/Oct/21 A	21/Jul/21 A	22/Oct/21 A	01-Dec-21	24-Feb-22	12-May-22	19-May-22
LOW INFRA 3 (Buildings - CPF and RPFs)	11/Mar/21 A	26/Jul/21 A	28/Jul/21 A	25/Oct/21 A	03-Dec-21	24-Feb-22	11-May-22	18-May-22
LOW INFRA 5 (Site Monitoring)	Not Applicable	Not Applicable	06-Apr-22	26-Apr-22	17-May-22	14-Jun-22	23-Aug-22	30-Aug-22
LOW Infra 6: Temp Accommodations	05/Mar/21 A	30/Jun/21 A	01/Oct/21 A	27/Oct/21 A	18/Oct/21 A	25-Jan-22	15-Mar-22	22-Mar-22
LOW Infra 7: Main Access and Airstrip	11/Mar/2021 A	04/Oct/2021 A	23/Aug/21 A	22/Oct/21 A	25/Nov/21 A	16-Feb-22	06-Apr-22	13-Apr-22
LOW Infra 8: AARNET Fibre - design and build	11/Mar/2021 A	04/Oct/2021 A	04/Oct/21 A	07/Nov/21 A	08-Feb-22	22-Mar-22	04-May-22	11-May-22
LOW NETWORK	18-Nov-22	06-Jan-23	09-Jan-23	27-Jan-23	24-Feb-23	21-Apr-23	16-Jun-23	23-Jun-23
LOW APERTURE ARRAY								
LOW station management & integration	Not Applicable	Not Applicable	15-Dec-21	04-Jan-22	25-Jan-22	22-Feb-22	26-Apr-22	03-May-22
Low Field Node Deployment	31-May-22	19-Jul-22	20-Jul-22	23-Aug-22	20-Sep-22	15-Nov-22	07-Feb-23	14-Feb-23
LOW POWER AND SIGNAL DISTRIBUTION	26/Aug/21 A	17/Nov/21 A	19/Nov/21 A	12-Jan-22	22-Apr-22	17-Jun-22	26-Aug-22	02-Sep-22
Low Antenna Assembly AA1 AA2 AA3	26/Aug/21 A	25/Oct/21 A	08/Nov/21 A	27-Jan-22	25-Feb-22	22-Apr-22	01-Jul-22	08-Jul-22
LOW SPS	17-Jan-22	01-Mar-22	02-Mar-22	12-Apr-22	10-May-22	05-Jul-22	14-Sep-22	21-Sep-22
LOW SAT Frequency Distribution	30-Jun-22	08-Jul-22	11-Jul-22	29-Jul-22	05-Aug-22	30-Sep-22	02-Dec-22	09-Dec-22
LOW CSP	18/Oct/21 A	25/Oct/21 A	25/Oct/21 A	08/Nov/21 A	30/Nov/21 A	08-Feb-22	29-Mar-22	05-Apr-22
LOW CBF	21/Oct/21 A	18/Oct/21 A	19/Oct/21 A	08/Nov/21 A	30/Nov/21 A	08-Feb-22	29-Mar-22	05-Apr-22
LOW COMPUTING & NETWORKING HARDWARE PROCUREMENT								
LOW SPC	16-Jun-23	21-Jul-23	24-Jul-23	01-Sep-23	29-Sep-23	24-Nov-23	09-Feb-24	16-Feb-24
LOW CPF	07-Oct-22	11-Nov-22	14-Nov-22	06-Jan-23	03-Feb-23	31-Mar-23	02-Jun-23	09-Jun-23
LOW AIV								
LOW AIV	Not Applicable	Not Applicable	01/Sep/21 A	02/Sep/21 A	03/Sep/21 A	01/Nov/21 A	14-Dec-21	04-Jan-22
LOW and MID Synchronisation and Timing	21/Jun/21 A	30/Jul/21 A	30/Aug/21 A	23/Sep/21 A	28/Oct/21 A	27-Jan-22	24-Mar-22	31-Mar-22
SAT Activity Management (UoM)	Not Required	Not Required	17/Nov/21 A	07/Dec/21 A	05-Jan-22	16-Feb-22	24-Mar-22	31-Mar-22

Construction Contracts

Schedule: Jan 2022 (T0+6 months)

- 29 contracts awarded
- Total value: ~€92M

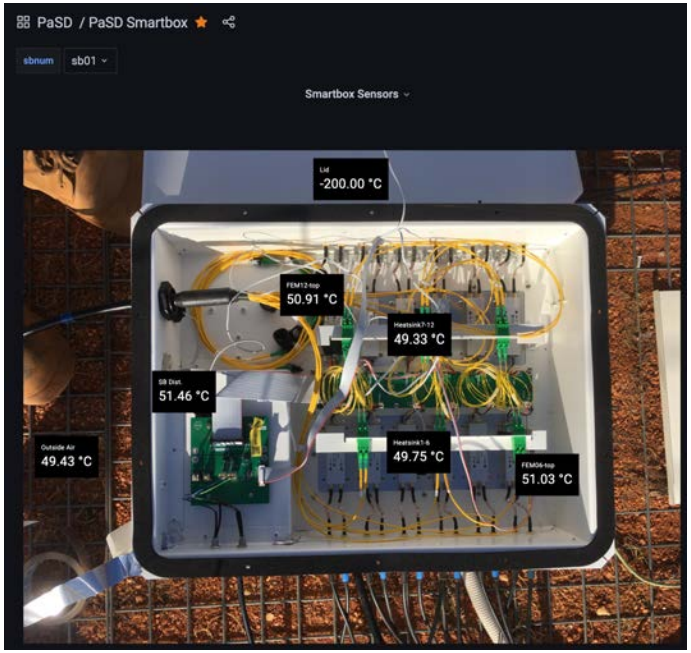
Imminent (2022 Q1)

- Infrastructure
- Contracts for the initial component/ subsystem deliveries for AA0.5

Software Contracts

Software								
Sole Source - Cash Framework								
RSA								
Vivo Technical	23/Feb/21 A	Not Applicable	22/Feb/21 A	06/May/21 A	20/May/21 A	23/Jun/21 A	06/Jul/21 A	20/Jul/21 A
AUS								
Sole Source - Cash AUS ICRAR	23/Feb/21 A	Not Applicable	22/Feb/21 A	06/May/21 A	20/May/21 A	23/Jun/21 A	16/Aug/21 A	27/Aug/21 A
Sole Source - Cash AUS Fourier Space	23/Feb/21 A	Not Applicable	22/Feb/21 A	06/May/21 A	03/Sep/21 A	20/Sep/21 A	19/Oct/21 A	29/Oct/21 A
Sole Source - Cash AUS CSIRO	23/Feb/21 A	Not Applicable	22/Feb/21 A	06/May/21 A	21/May/21 A	28/Jun/21 A	16/Aug/21 A	02/Nov/21 A
NL								
ASTRON-	23/Feb/21 A	Not Applicable	22/Feb/21 A	06/May/21 A	20/May/21 A	28/Jun/21 A	06/Jul/21 A	20/Jul/21 A
CGI	23/Feb/21 A	Not Applicable	22/Feb/21 A	06/May/21 A	20/May/21 A	23/Jun/21 A	09/Jul/21 A	21/Jul/21 A
S[&]T	23/Feb/21 A	Not Applicable	22/Feb/21 A	06/May/21 A	21/May/21 A	23/Jun/21 A	12/Jul/21 A	20/Jul/21 A
TriOpSys	23/Feb/21 A	Not Applicable	22/Feb/21 A	06/May/21 A	21/May/21 A	24/Jun/21 A	09/Jul/21 A	20/Jul/21 A
Italy								
IDS	23/Feb/21 A	Not Applicable	22/Feb/21 A	06/May/21 A	20/May/21 A	24/Jun/21 A	12/Jul/21 A	21/Jul/21 A
INAF	23/Feb/21 A	Not Applicable	22/Feb/21 A	06/May/21 A	10/Nov/21 A	17/Nov/21 A	06-Dec-21	08-Dec-21
China								
Guangzhou University	23/Feb/21 A	Not Applicable	22/Feb/21 A	06/May/21 A	21/May/21 A	22/Jun/21 A	16/Aug/21 A	24/Aug/21 A
Sole Source - In Kind Framework								
UK								
STFC	27/Jan/21 A	26/Apr/21 A	30/Apr/21 A	21/May/21 A	13/Jul/21 A	03/Aug/21 A	10/Sep/21 A	24/Sep/21 A
SA								
SARAO	27/Jan/21 A	26/Apr/21 A	30/Apr/21 A	21/May/21 A	09/Aug/21 A	14/Sep/21 A	04/Oct/21 A	14/Oct/21 A
PT								
PT Space	22-Mar-23	16-May-23	18-May-23	08-Jun-23	19-Jul-23	14-Aug-23	28-Aug-23	06-Sep-23
Competitive - Cash Framework								
UK								
Observatory Science	16/Aug/2021 A	02/Sep/2021 A	19/Aug/2021 A	31/Aug/2021 A	10/Sep/2021 A	27/Aug/2021 A	21/Oct/2021 A	04/Nov/21 A
CGI UK	16/Aug/2021 A	02/Sep/2021 A	19/Aug/2021 A	31/Aug/2021 A	10/Sep/2021 A	27/Aug/2021 A	21/Oct/2021 A	04/Nov/21 A
Covnetics	16/Aug/2021 A	02/Sep/2021 A	19/Aug/2021 A	31/Aug/2021 A	10/Sep/2021 A	27/Aug/2021 A	21/Oct/2021 A	04/Nov/21 A
Persistent UK	16/Aug/2021 A	02/Sep/2021 A	19/Aug/2021 A	31/Aug/2021 A	10/Sep/2021 A	27/Aug/2021 A	21/Oct/2021 A	04/Nov/21 A
The NAG	16/Aug/21 A	02/Sep/21 A	19/Aug/21 A	31/Aug/21 A	07/Sep/21 A	01/Oct/21 A	21/Oct/21 A	14-Jan-22
PT								
2-5 companies	16/Aug/21 A	17/Sep/21 A	20/Sep/21 A	08/Oct/21 A	25/Oct/21 A	15/Nov/21 A	03-Jan-22	10-Jan-22
Competitive - In Kind Framework								
India								
NCRA involving TBD companies	27/Sep/21 A	10/Nov/21 A	12/Oct/21 A	07-Dec-21	11-Jan-22	02-Mar-22	13-Apr-22	20-Apr-22

Construction Photos



SDC2 results paper

- Results and analysis from SDC2 now in preparation for submission to MNRAS
- 12 finalist teams from over 40 institutions
- High level findings:
  - complementary methods,
  - mix of new and existing techniques; machine learning and non-machine learning,
  - SoFiA package very popular thanks to excellent documentation and ease of use,
  - Analysis of biases and HI mass recovery with redshift

SKA Science Data Challenge 2: analysis and results

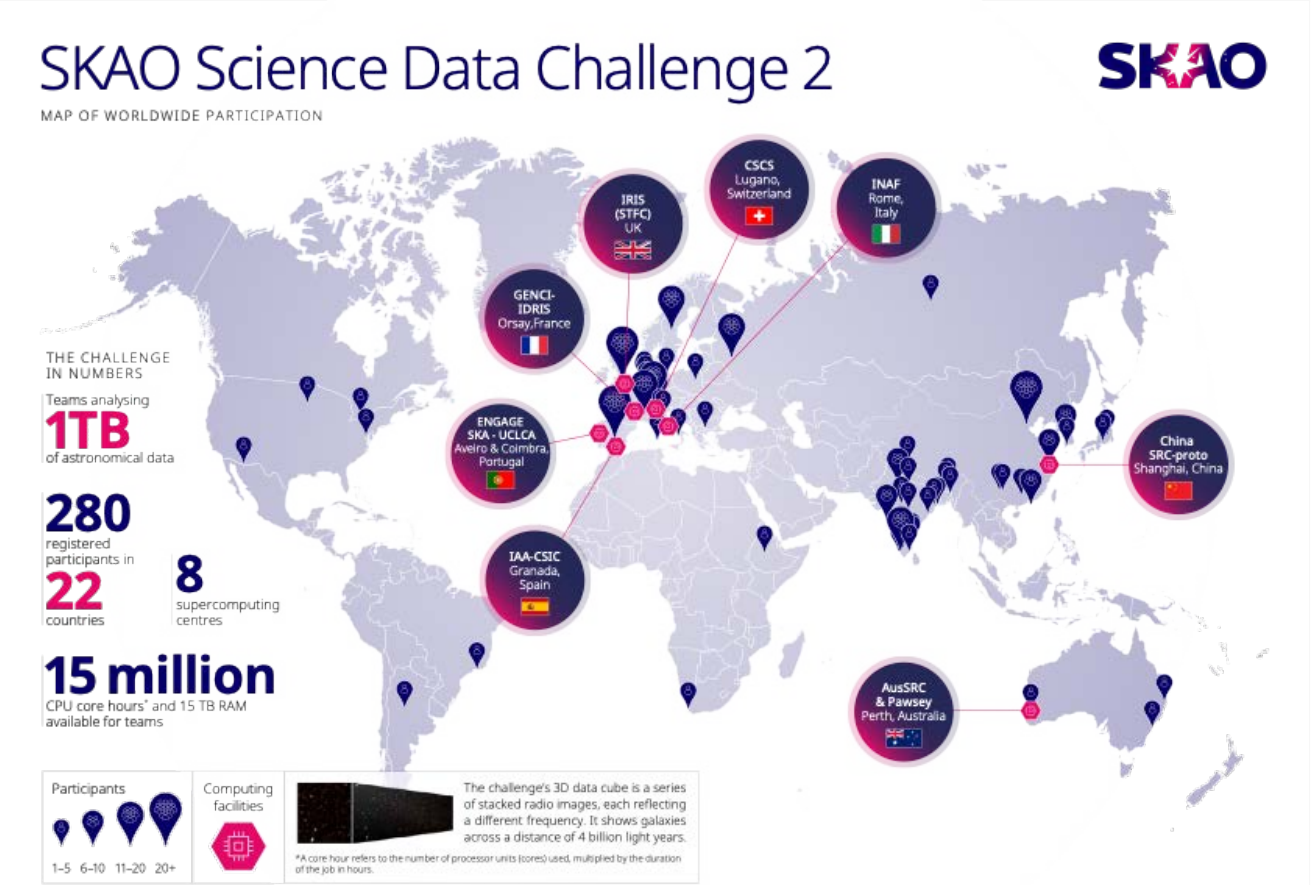
P. Hartley, A. Bonaldi, R. Braun, [Order TBC:] D. Cornu[1], B. Semelin[1], X. Lu[1], S. Aicardi[2], P. Salomé[1], A. Marchal[3], J. Freundlich[4], F. Combes[1,5], C. Tasse[6,7], C. Heneka[8], M. Delli Veneri[9], A. Soroka[10], F. Gubanov[10], A. Meshcheryakov[11], B. Fraga[12], C.R. Bom[12], M. Brüggen[8], A. K. Shaw[13], N. Patra[14], A. Chakraborty[15], R. Mondal[16], S. Choudhuri[17], A. Mazumder[15], M. Jagannath[18], M. J. Hardcastle[19], J. Forbrich[19], L. Smith[20], V. Stolyarov[20,21], M. Ashdown[20], J. Coles[20], H. Håkansson[22], A. Sjöberg[22], M. C. Toribio[23], M. Önnheim[22], M. Olberg[23], E. Gustavsson[22], M. Lindqvist[23], M. Jirstrand[22], J. Conway[23], K. M. Hess[24,25,26], R. J. Jurek[27], S. Kitaeff[28], P. Serra[29], A. X. Shen[30,31], J. M. van der Hulst[25], T. Westmeier[28], A. Alberdi[33], J. Cannon[34], L. Darriba[33], J. Garrido[33], J. Gósza[35], D. Herranz[36], M. G. Jones[37], P. Kamphuis[38], D. Kleiner[29], I. Márquez[33], J. Moldón[33], M. Pandey-Pommier[39], M. Parra[33], J. Sabater[40], S. Sánchez[33], A. Sorgho[33], L. Verdes-Montenegro[33], G. Fourestey[41], A. Galan[41], C. Gheller[29], D. Korber[41], A. Peel[41], M. Sargent[41], E. Tolley[41], B. Liu[42], R. Chen[42], B. Peng[42], L. Yu[42], H. Xi[42], K. Yu[43], Q. Guo[43], W. Pei[43], Y. Liu[43], Y. Wang[43], X. Chen[43], X. Zhang[44], S. Ni[44], J. Zhang[44], L. Gao[44], M. Zhao[44], L. Zhang[45], H. Zhang[45], X. Wang[45], J. Ding[45], S. Zuo[46], Y. Mao[46], A. Vafaei Sadr[47], M. Kunz[47], B. Bassett[48], D. Crichton[49], V. Nistane[47], N. Oozeer[35], S. Jaiswal[50], B. Lao[50], J. N. H. S. Aditya [50], Y. Zhang[50], A. Wang[50], and X. Yang[50]
Affiliations can be found after the references

Accepted XXX. Received YYY; in original form ZZZ

ABSTRACT
The Square Kilometre Array Observatory (SKAO) will explore the radio sky to unrivalled depths in order to conduct transformational science. SKAO data products made available to astronomers will be correspondingly large and complex, requiring the application of advanced analysis techniques in order to extract key science findings. To this end, SKAO is conducting a series of Science Data Challenges, each designed to familiarise the scientific community with SKAO data and to drive the development of new analysis techniques. We present the results from Science Data Challenge 2 (SDC2), which invited participants to find and characterise neutral hydrogen (HI) sources in a simulated data product representing a 2000 h SKA MID spectral line observation. Through the generous support of eight international supercomputing facilities, participants were able to undertake the Challenge using dedicated computational resources. This model not only supported the accessible provision of a realistically large dataset, but also provided the opportunity to test several aspects of the future SKA Regional Centre network. Sitting alongside the main challenge, 'reproducibility awards' were made in recognition of those pipelines which demonstrated Open Science best practice. The Challenge saw over 100 finalists develop a range of new and existing techniques, in results which highlight the strengths of multidisciplinary and collaborative effort. The winning strategy – combining predictions from two independent machine learning techniques – underscores one of the main Challenge outcomes: that of method complementarity. It is likely that the combination of methods in a so-called ensemble approach will be key to exploiting very large astronomical datasets.

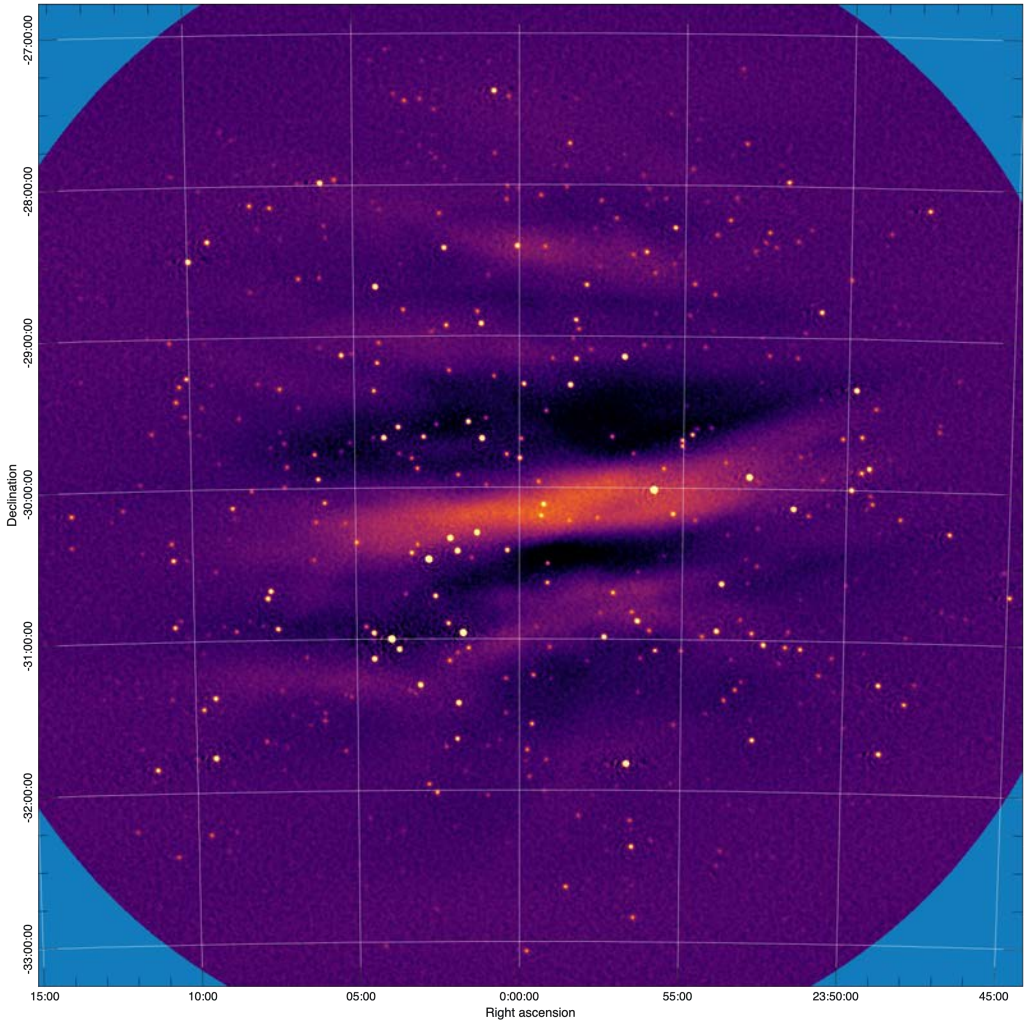
SDC computational facility partners

- Support from eight facilities essential to success of SDC2
- Enabled accessible provision of realistically large dataset
- Testbed for future SRC technologies
- Outcomes will feed into future SDCs and SRC planning
- Ongoing collaboration for next SDC → call for additional facilities to join us as we plan for next challenge



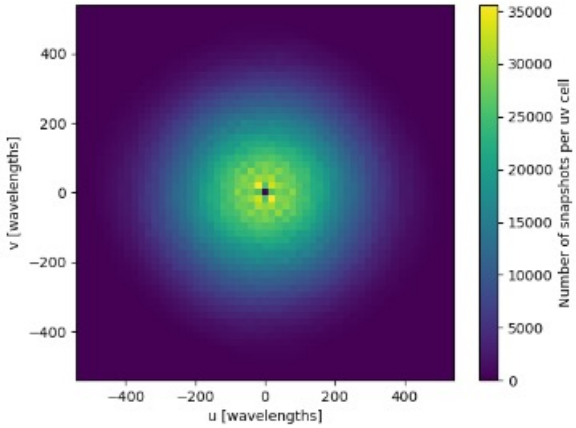
EoR Tier 1+2 Data Challenge

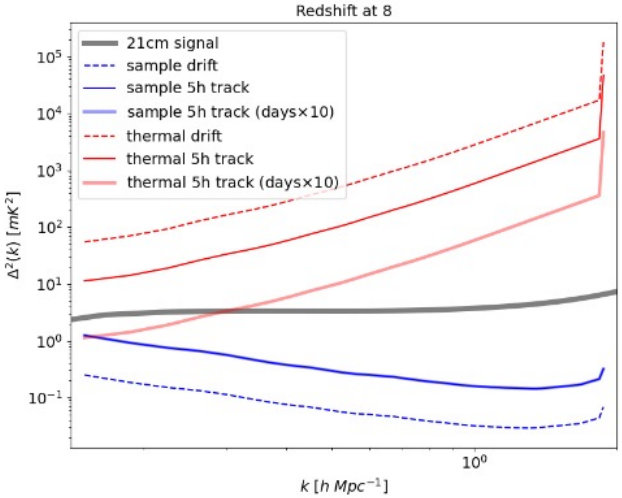
- Hybrid Sky Model progress
  - Image-based: EoR signal, GSM2016, MHD simulations, faint T-RECS; taper, FFT plus de-grid via *miriad* (with *OSKAR* station beams*)*
  - Direct DFT: A-Team, GLEAM, LoBES bright sky via *OSKAR*
  - Will simulate realistic residual calibration, de-mixing and source subtraction errors; *casa* imaging
  - *Casacore* and *miriad* have now been updated to allow UVFITS for >255 antennas: special thanks to Mark Kettenis and Mark Wieringa!!



EoR Tier3 Data Challenge Update

- Eunseong Lee et al. plus EoR SWG
- Progress in the challenge design
- Simulation tools identified; “proof of concept” pipeline almost ready
- Challenge score defined
- Computational cost for solving the challenge estimated
- Target for delivery spring 2022

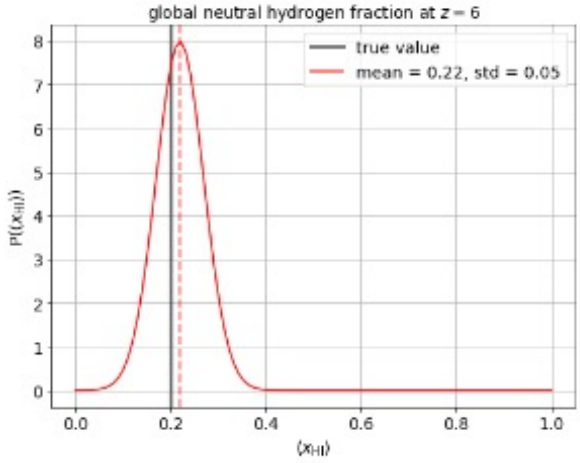




Top left: uv coverage for the observation, assuming track observation of 5 hours.

Right: challenge score analysis

Simulation performed with 21cmfast and 21cmsense



Magnetism Data Challenge Update

- Takuya Akahori et al. plus magnetism SW
- Progress in the challenge design
- Simulation tools identified; needs organizing into a coherent pipeline
- Challenge score defined
- Target for delivery late 2022

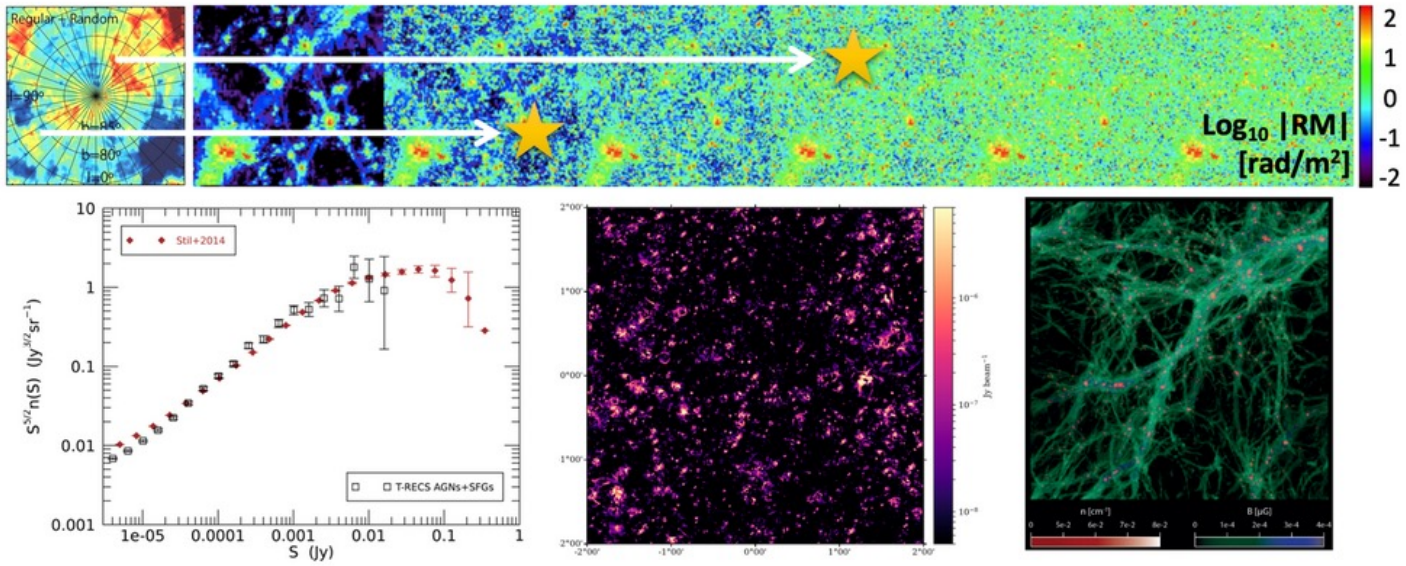
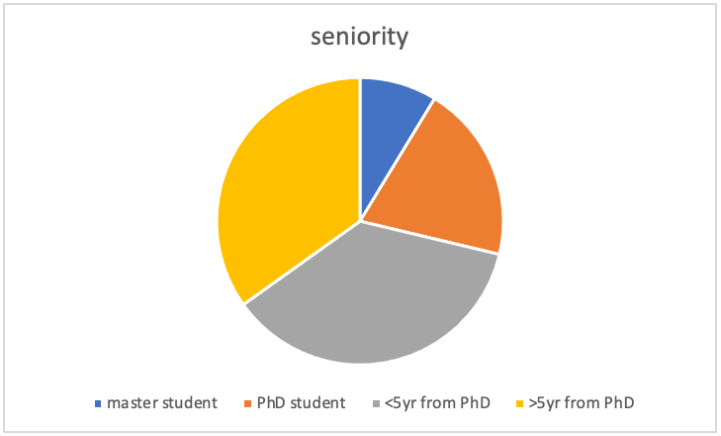


Figure 1. Some examples of numerical models of the polarized sky. (Top-left) RM of the MW toward high Galactic latitude (Akahori et al. 2013). (Top-right) Cosmological integration of RM due to the intergalactic magnetic fields in galaxy clusters, groups, and filaments (Akahori et al. 2011). (Bottom-left) Comparison of radio source population between the observation and the simulation (Bonaldi et al. 2018). (Bottom-middle) Simulation of radio source distribution in the sky (Hodgson et al. 2021). (Bottom-right) The magnetized cosmic web (Vazza et al. 2021).

SRC Training Event Series: "Hands-on Containerisation" 27 Jan - 14 Feb 2022

https://indico.skatelescope.org/event/876/

- Organised by the SRC "User Engagement" group WG6 TP3
- 259 registrations
- Lectures and hands-on exercises
- All material will be made fully public

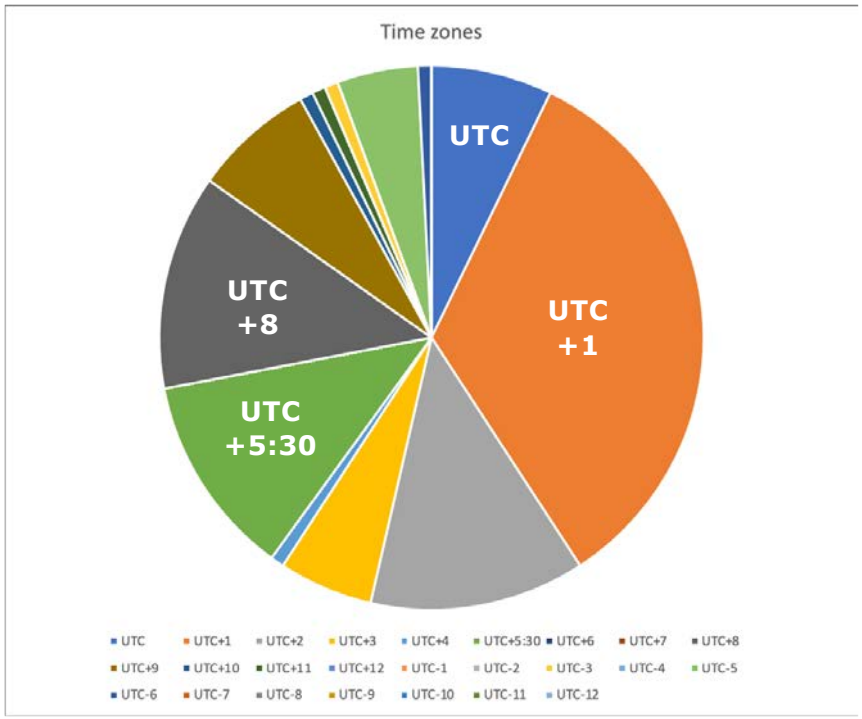


Master student

PhD student

<5yr from PhD

>5yr from PhD



Any Other Business

- Upcoming meetings
  - Cosmology SWG Meeting, 31 Jan - 1 Feb 2022
  - VLBI in the SKA Era, 14 – 18 Feb, (https://whova.com/web/vlbis_202111)
  - 3rd URSI Atlantic Radio Science Meeting, 29 May – 3 June (https://www.atrasc.com/)
  - Timing and Imaging of compact sources with SKA pathfinders, 6 – 12 June (https://www.atnf.csiro.au/research/conferences/2022/Kerastari2022/)
  - EAS2022 "S7: Building bridges: The lifecycle of dust and gas in the Milky Way with ALMA and SKA", 27 June – 1 July (https://eas.unige.ch/EAS_meeting/session.jsp?id=S7)
  - EAS2022 "SS23: Towards the SKA Observatory: Artificial Intelligence in radio astronomy", 27 June – 1 July, (https://eas.unige.ch/EAS_meeting/session.jsp?id=SS23)
- …???

Thank you

We recognise and acknowledge the Indigenous peoples and cultures that have traditionally lived on the lands on which our facilities are located.

SKAO

www.skao.int