



# SKA SWG Update

Robert Braun, SKAO Science Director

15 February 2022



# SKA Science Update

- SKAO Establishment Progress
- Highlights from SKA-Low Workshop (Jeff)
- Highlights from SRC Containerisation Workshop (Anna)
- SWG Banners (Tyler)
- AOB



# SKAO Establishment Progress

- Establishment of SKAO in Australia and South Africa proceeding well
- Staffing: ~140 UK; ~10 Australia; ~11 South Africa; numbers grow continuously
- Engineering Operations Center (EOC), Science Operation Center(SOC) development
- Spectrum Management: MOU with IAU and AURA/NoirLab establishing IAU Centre for the Protection of Dark and Quiet Skies has been signed





## SKAO Employees (RSA)

In role:

- Telescope Dir: Lindsey Magnus
- Site Con Dir: Tracy Cheetham
- ITF Manager: Benjamin Lunsky
- Infra PM: Jonker de Bruyn
- Mech Eng: Ockert Styrdom
- Sr Contracts Spec: Zaid Patel

Advertised:

- Head of Science Operations,  
Legal Manager

In role (SARAO):

- Site Manager: Hendrik Hurter
- ITF Test Engineers: Monde Manzini, Vhulahani Manukha
- Comms Manager: Letebele Jones

Appointed/offer:

- Deputy Telescope Dir
- RFI/EMC Engineer



# SKAO Employees (AUS)

In role (SKAO):

- Telescope Dir: Sarah Pearce
- Site Con Dir: Ant Schinckel
- AIV Lead Eng: Lucio Tirone
- ITF Manager: Felipe Gonzalez
- Infra PM: Kaushik Bose

Advertised:

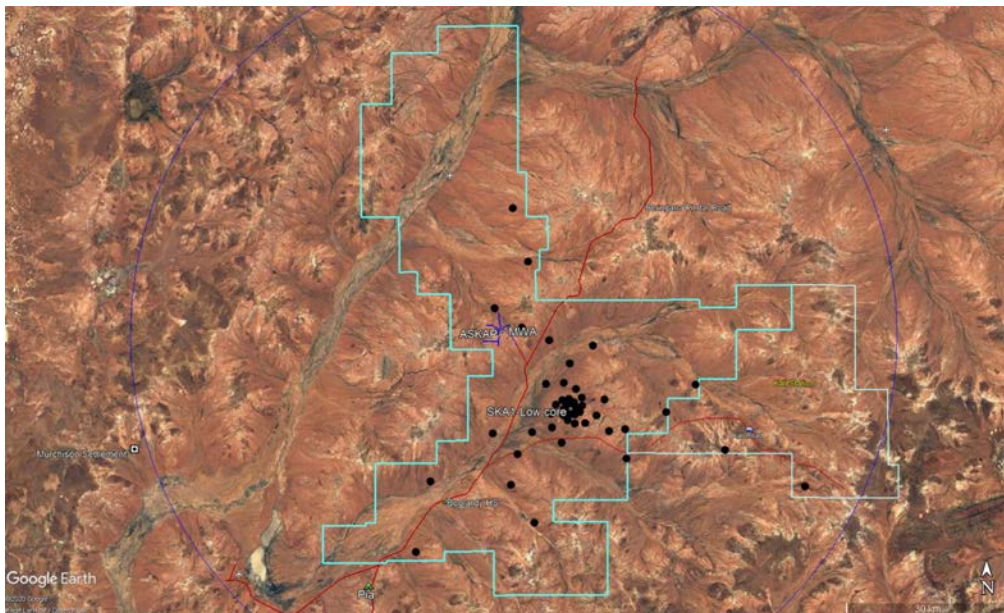
- Head of Sci Ops, Head of Eng Ops, Head of Computing and Software, HR Business Partner, Senior Network Engineer

In role (CSIRO):

- Deputy Telescope Dir: George Simpson
  - HSE Manager: Rob Grazziadelli
  - Communications Manager: Liz Williams
  - RFI Engineer: Paul van der Merwe
  - Site Manager: Mark Bennett
  - IT Manager: Tony Ambaum
- Appointed/offer:
- Verification Engineer



# SKA-LOW



The MRO in WA – 600km NE of Perth.  
Murchison approx. size of NL –  
population  $\pm 100$

## Murchison SKA site

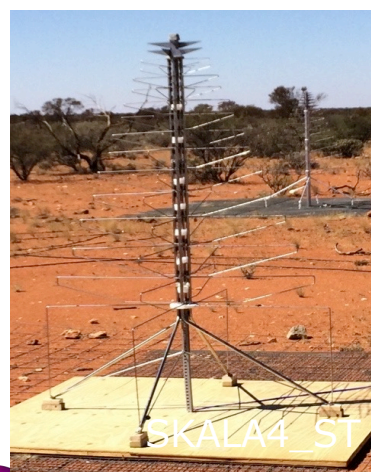
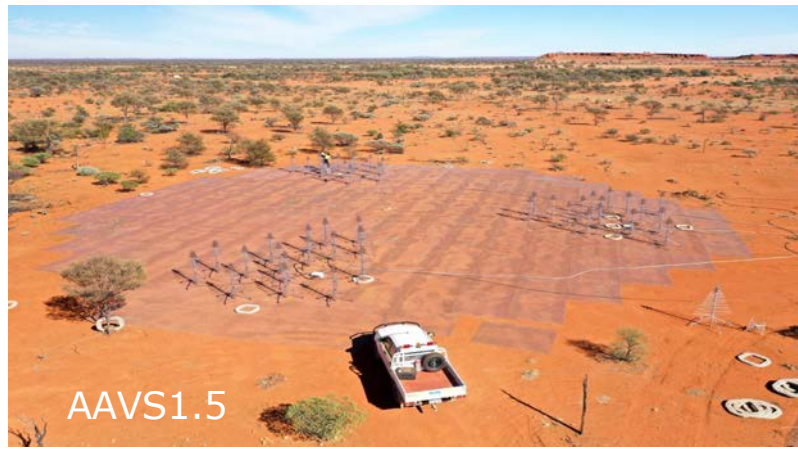


Aperture Array Verification System, AAVS2.0  
(image credit: INAF/Curtin Univ)





# SKA-Low: Station Prototyping



Many prototyping activities have been undertaken, including:

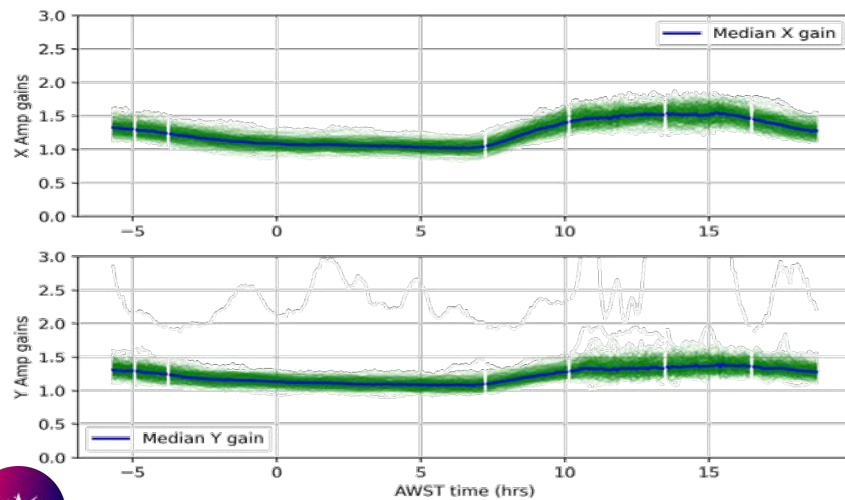
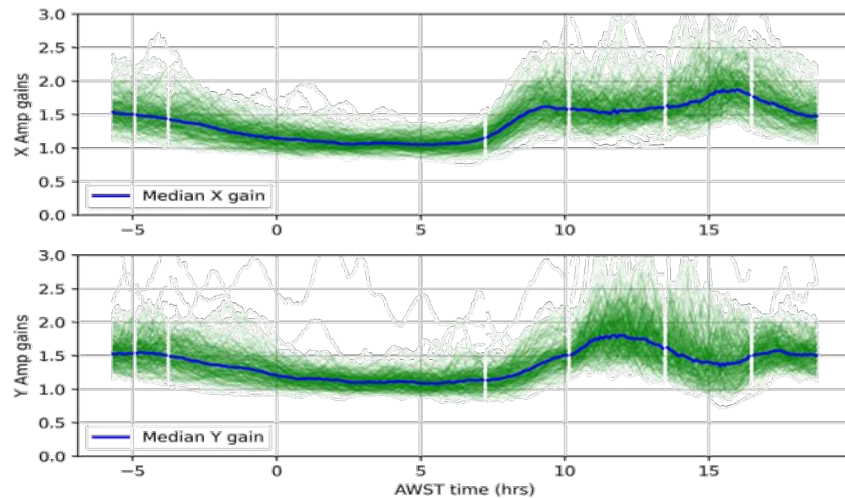
**AAVS1:**  
256 SKALA2 antennas  
at the MRO

**AAVS1.5:**  
48 SKALA4.1 antennas  
at the MRO

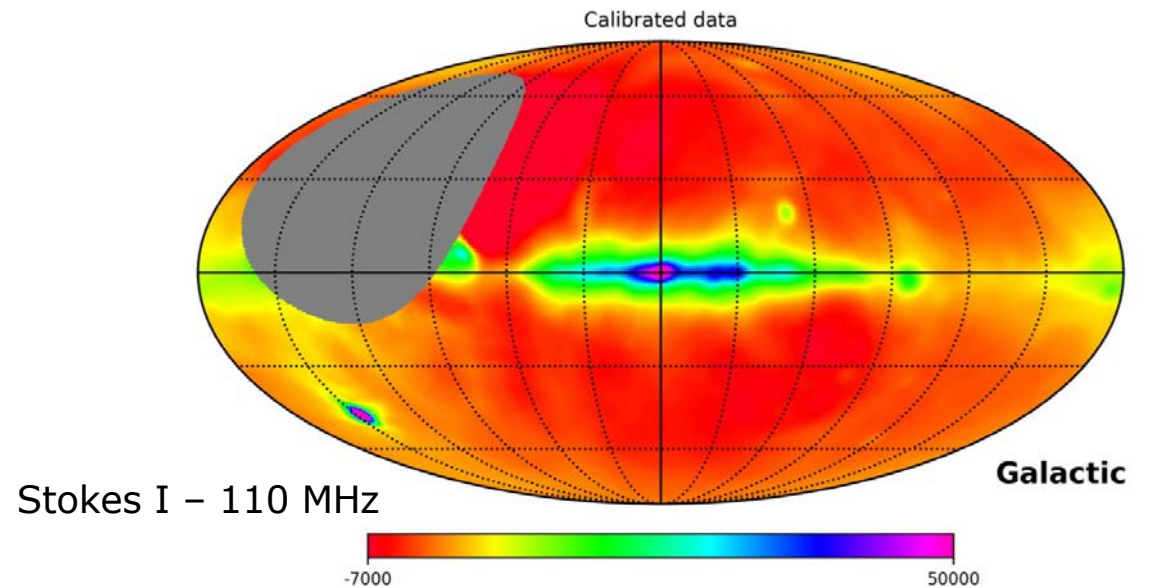
**AAVS2.0:**  
256 SKALA4.1 antennas  
at the MRO



# Low Station Calibration



Ravi Subrahmanyam, Randall Wayth and the AAVS team



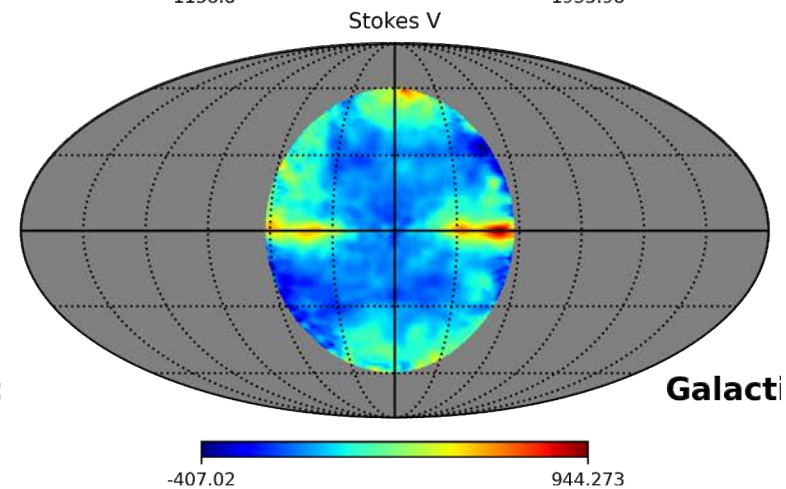
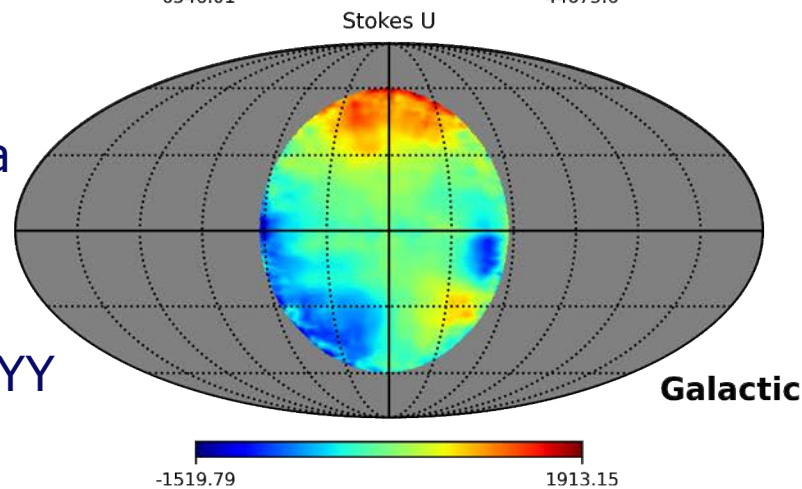
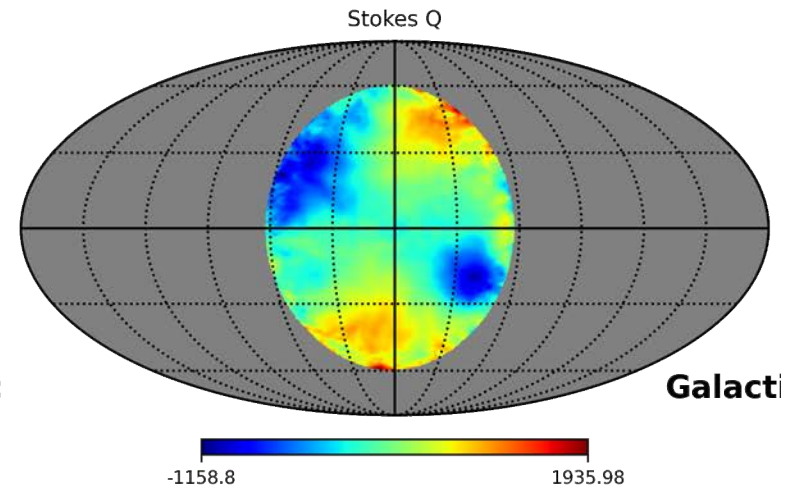
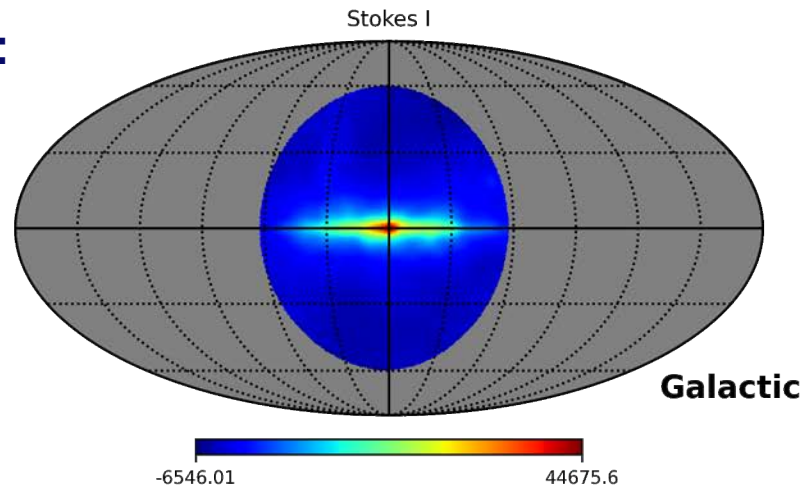
- Antenna amplitude calibration to 3% RMS accuracy using Global Sky Model (GSM)+Sun and Embedded Element Patterns (EEPs)
- Intra-station complex gains stable to within 6%, 6 deg. std.





# AAVS2 polarisation: 110 MHz sky image at meridian transit of the Galactic Centre: Ravi Subrahmanyan

- Polarisation calibration:
- GSM+Sun
- EEP polarised complex voltage beams (FEKO)
- Forward model for visibility prediction
- SELFCAL to compute X and Y complex antenna gains
- X and Y gains used to calibrate XX, XY, YX & YY

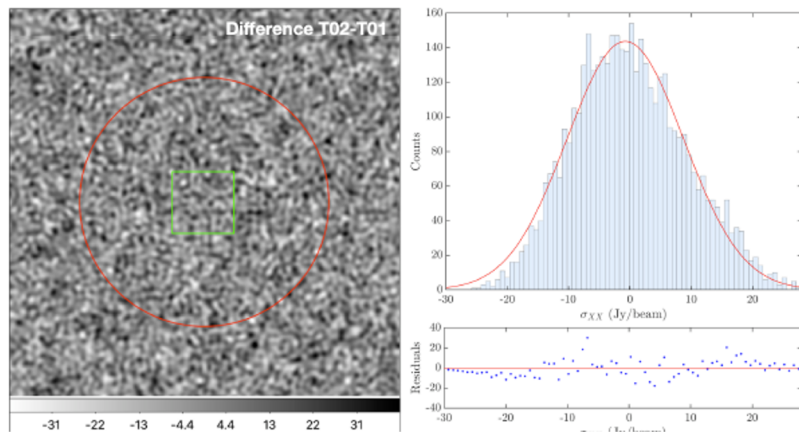
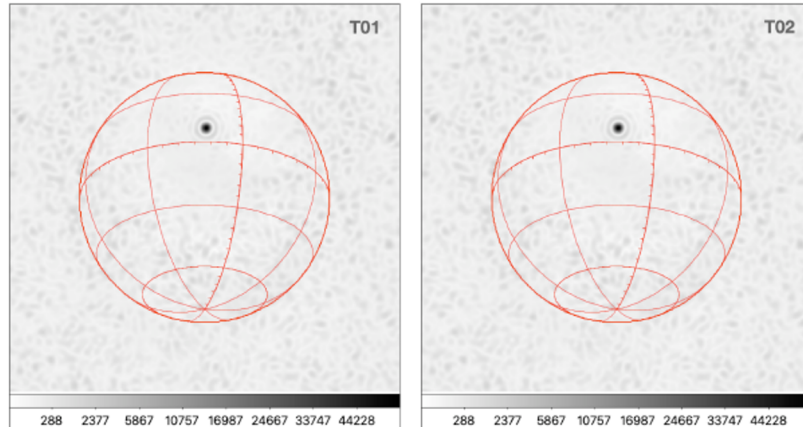


# Sensitivity analysis: difference imaging and A/T estimates

Giulia Macario, Gianni Bernardi and the AAVS team

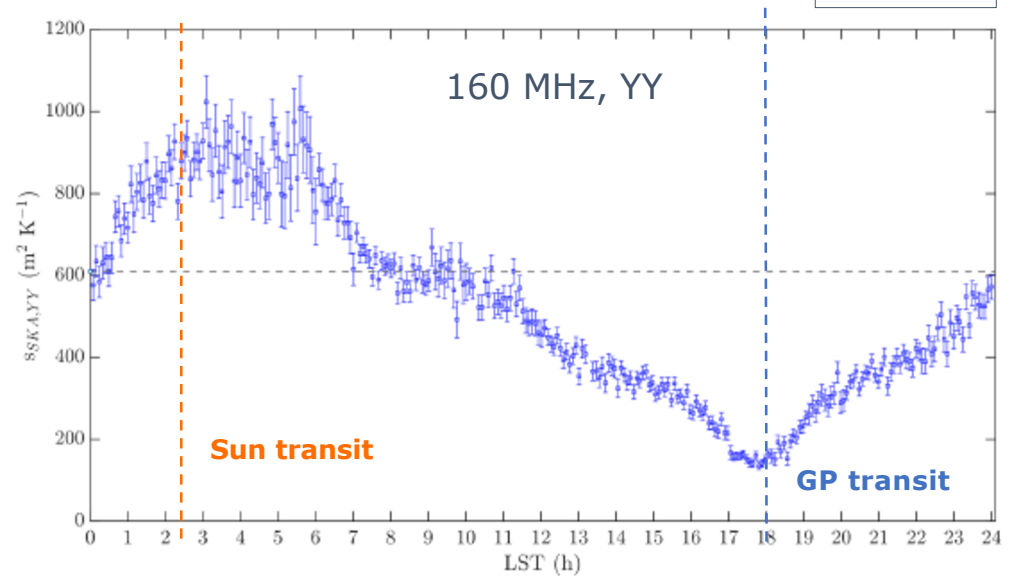
$$\sigma_p = \overline{rms} \times P_{n,\nu,p}(\theta_\odot, \phi_\odot)$$

← antenna response in the Sun direction (normalized to Zenith), average EEP



$$SEFD_{s,p} \simeq \frac{\sigma_p}{\sqrt{2}} \eta \sqrt{t_i B} \frac{N}{256} \text{ Jy} \quad \text{Macario+ 2022}$$

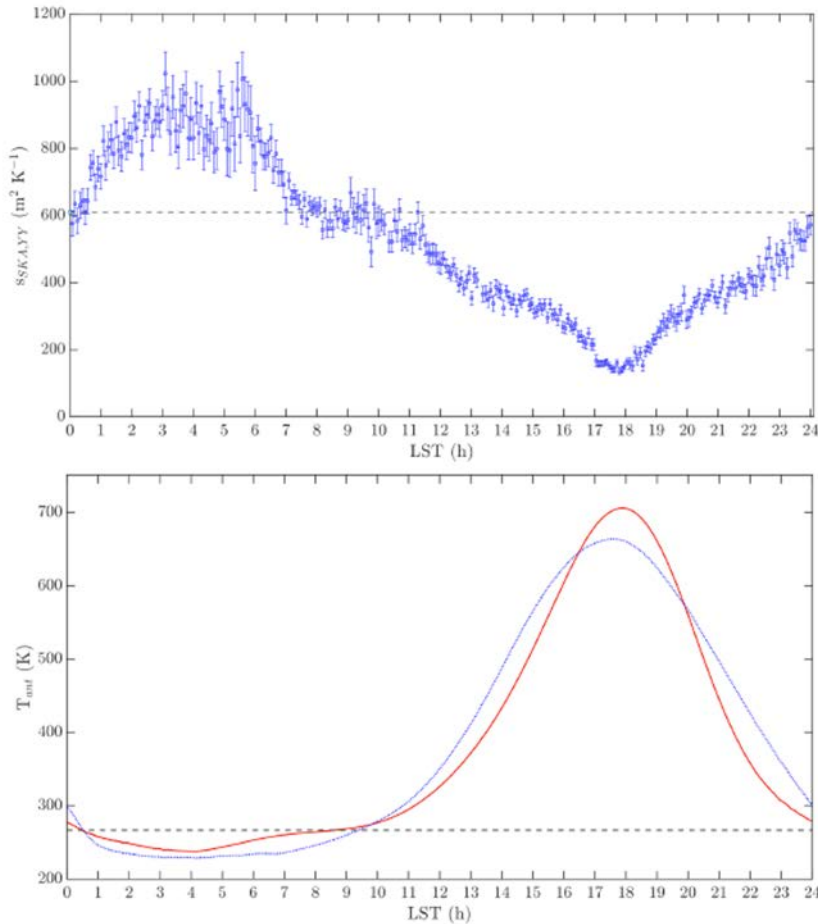
$$s_{s,p} \equiv \frac{A_{eff}}{T_{sys}} = 10^{26} \frac{2k}{SEFD_{s,p}} \text{ m}^2 \text{K}^{-1} \quad \mathbf{x \ 512} \quad s_{SKA,p}$$



see also Benthem+ 2021, Sokolowski+ 2021, Wayth+2022

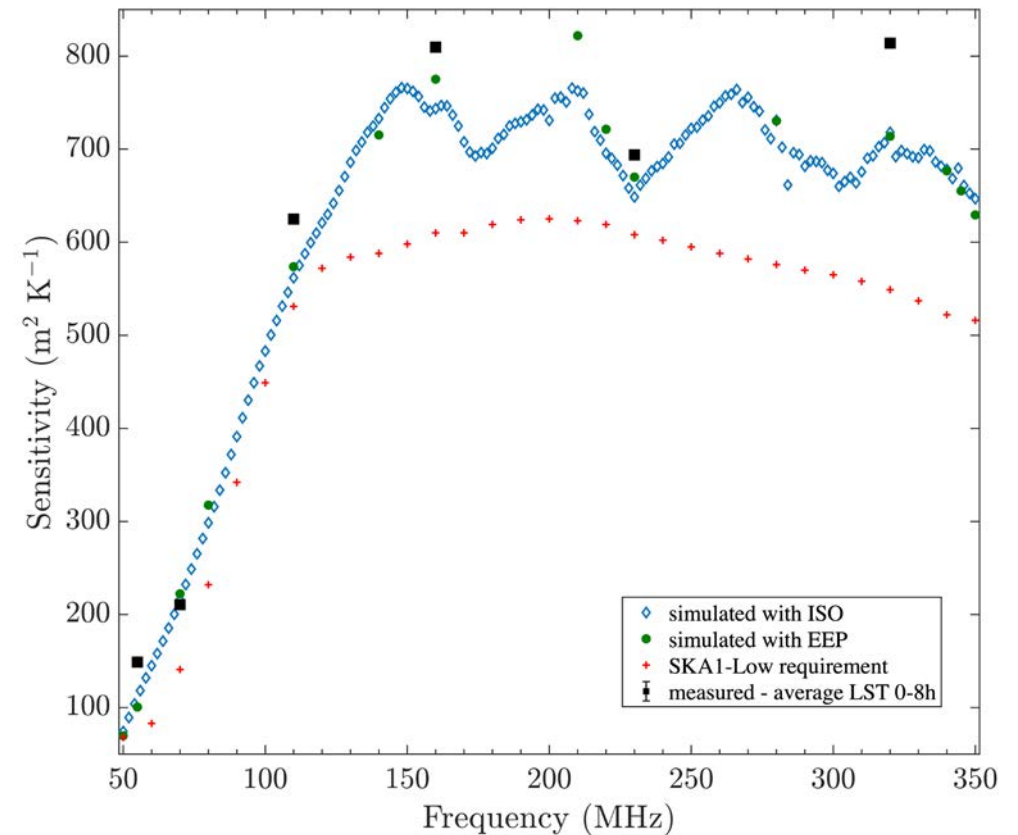


# Sensitivity analysis: results



Macario+ 2022

Giulia Macario, Gianni Bernardi and the AAVS team



**1. good agreement with simulation ( $\approx 13\%$ )**

**1. meet SKA-Low req. at all frequencies  
(up to  $\sim 2.3$  above)**

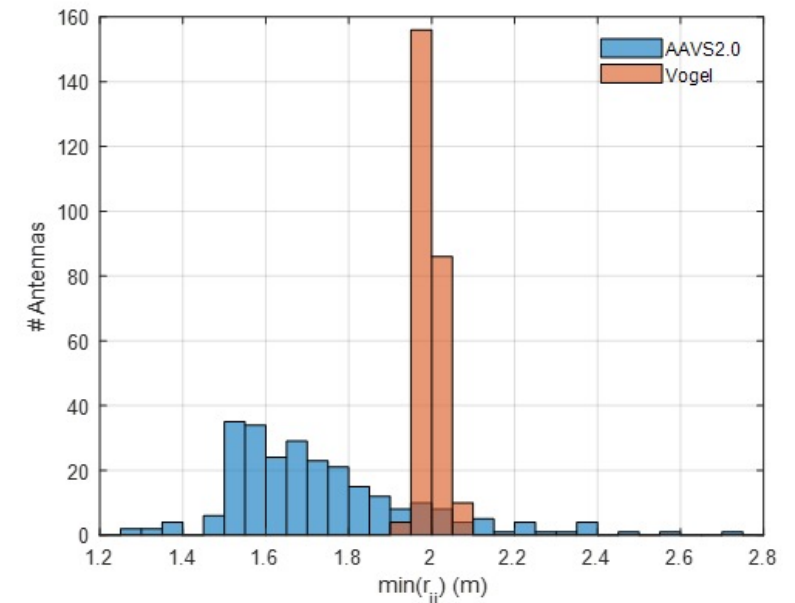
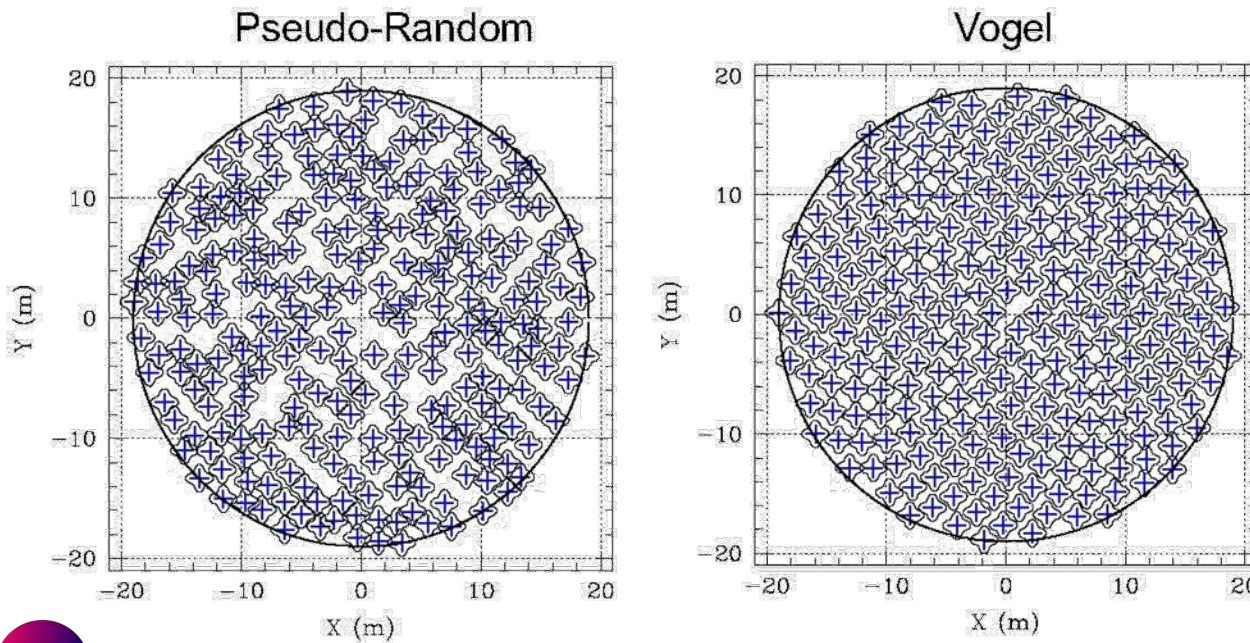




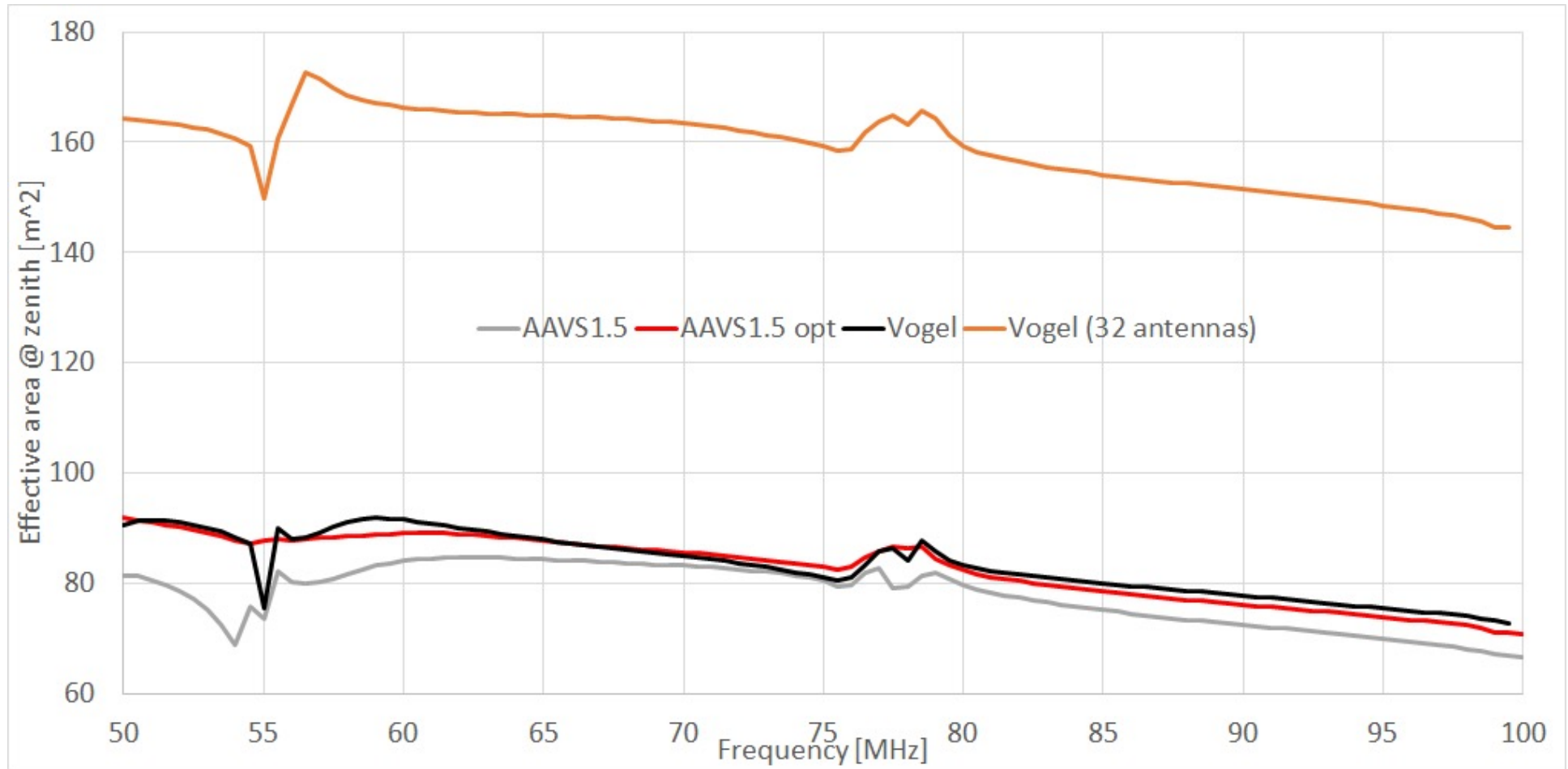
# Vogel layout

A new layout strategy based on the "Vogel" maximally non-redundant spiral pattern has been proposed by R. Braun. This positioning strategy avoids placing adjacent antennas with their principal planes closely aligned.

«SKA-Low Station Layouts Revisted»  
SKAO-TEL-0001829

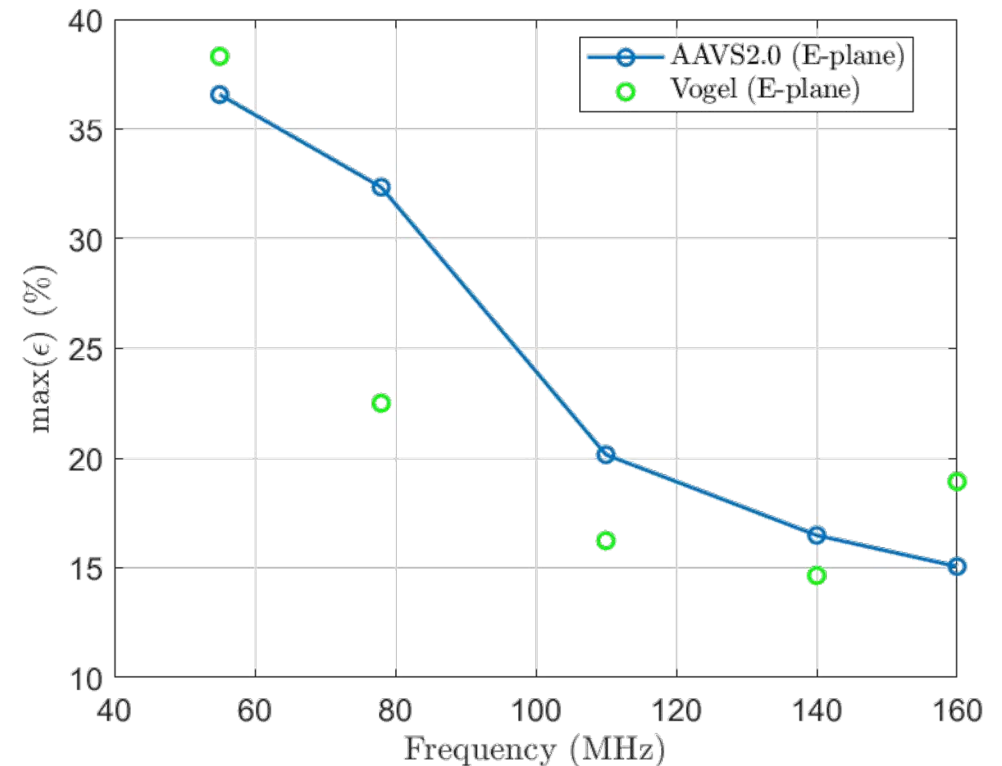


# Preliminary results on spectral smoothness with Vogel layout



# EEP variability (AAVS2.0 vs Vogel)

- 210 – 350 MHz: No significant differences between AAVS2.0 & Vogel EEPs
- 50 – 160 MHz: Vogel shows lower variability at 78 MHz and 110 MHz.



Maximum of the normalised std. Dev.

- Same approach described in *Computational electromagnetics for the SKA-Low prototype station AAVS2* (JATIS-21099SS, 2022)
- $\max(\epsilon)$  within  $\pm 45^\circ$  zenith angle

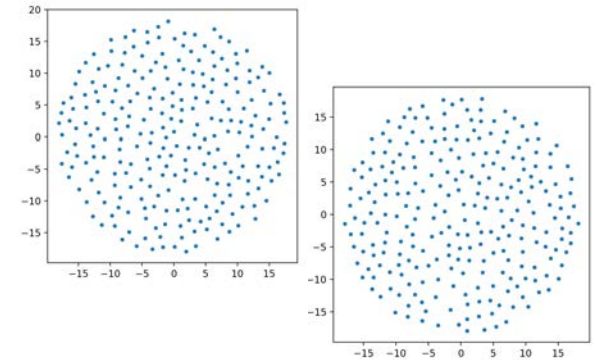




# Previous station layout simulations (Feb/Mar 2020)

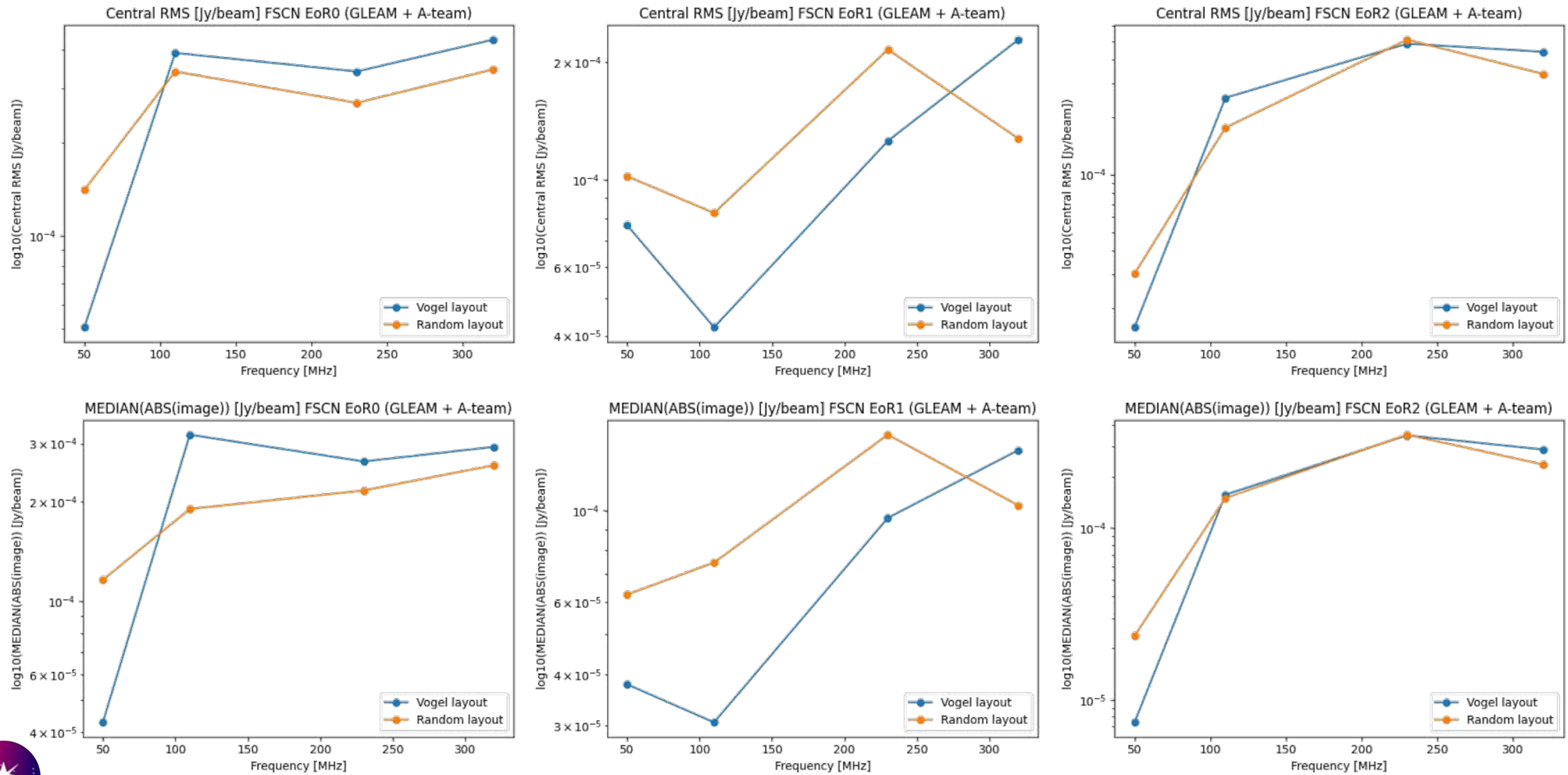
Fred Dulwich, Maciej Seljak, Robert Laing

- Total of 16 telescope models generated with 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 16, 32, 64, 128, 256, 512 different (random) station layouts
  - Distributed evenly among the 512 stations.
  - All using the same station centre coordinates (fixed by site constraints)
- Far sidelobes should tend to cancel out in the cross-power beam, if station layouts are different



# Far Sidelobe Confusion Noise for 512 Vogel layouts (+avg. SKALA4)

Fred Dulwich, Maciej Seljak, Robert Laing



# SKA-Low Next Steps

- Further LOW imaging simulations required to verify optimal number of station layouts
- Testing of new software for fast station-level EM simulations - H. Bui-Van et al., "Fast and accurate simulation technique for large irregular arrays," IEEE Trans. Antennas Propag., vol. 66, no. 4, pp. 1805-1817, Apr. 2018
- Aperture Array Verification System, AAVS2.5 and AAVS3 using SKALA4.1 antennas, improved Power and Signal Distribution with smart boxes, and possibly Vogel station layout
- Further work on station polarisation, sensitivity comparison between AAVS3 and EDA2, and calibration studies
- Deployment of Array Assembly 0.5 (6 LOW stations) in order to test array-level imaging and calibration performance, timing systems, Assembly Integration and Verification
- Build SKA-LOW!





# SKA SRC Containerisation Workshop

- <https://indico.skatelescope.org/event/876/> All lessons recorded and material available!

## SKA regional centre training event

27 January 2022 to 14 February 2022

UTC timezone

Overview

Scientific Programme

Timetable

Contribution List

Speaker List

Registration

The Science User Engagement (SUE) group of the SKA Regional Centre Steering Committee is glad to announce the

### SKA Regional Centre Training Event Series

#### Hands-on Containerization

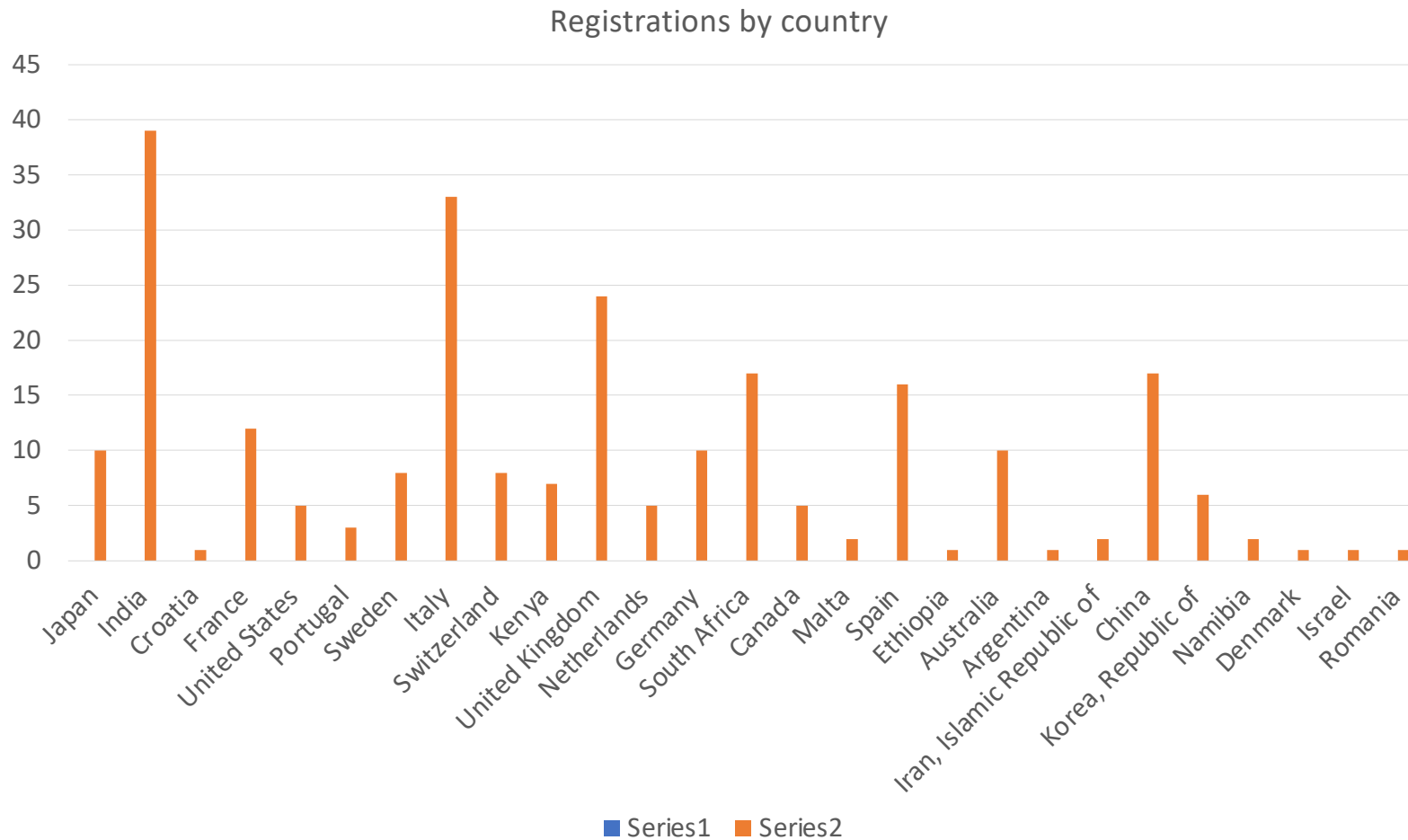
This is the first event of a series that will drive the attendants to understand the basics and dig into more advanced knowledge of the technologies and instruments that will be useful to approach the Square Kilometre Array data. The event will be fully virtual, and it will consist of lectures, tutorials and practicals spread over 3 hour sessions twice a week for three weeks. The format will allow participation and engagement across different time zones.

for questions please email: [SRCtraining@skao.int](mailto:SRCtraining@skao.int)

*Organisers: SRCSC WG6 TP3 core team*



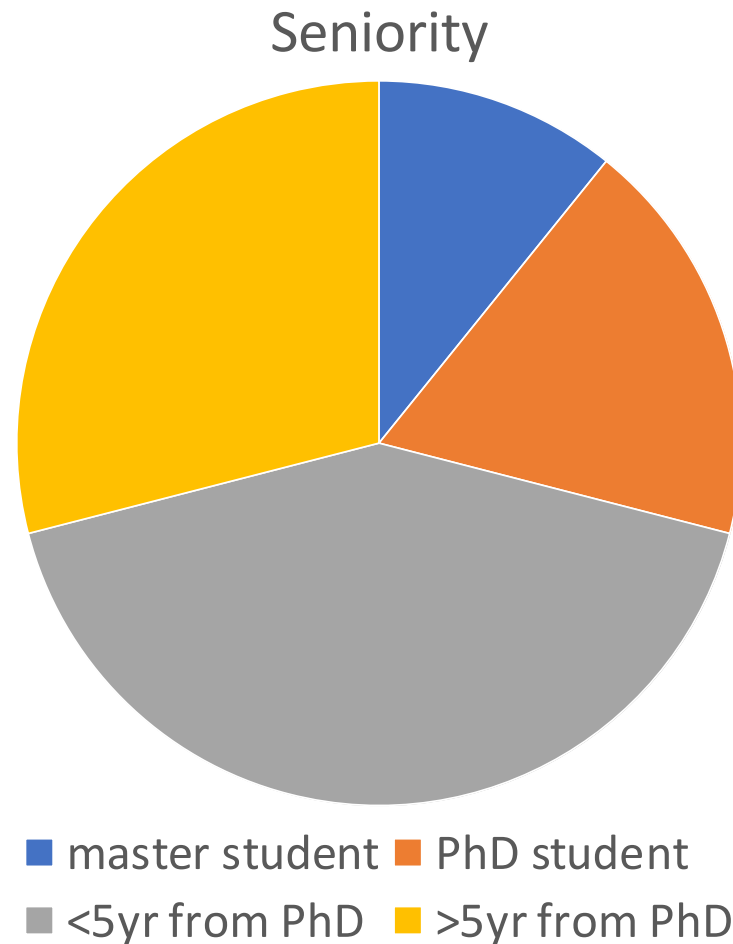
# SKA SRC Containerisation Workshop



260 registrations  
from countries  
all around the  
world



# SKA SRC Containerisation Workshop



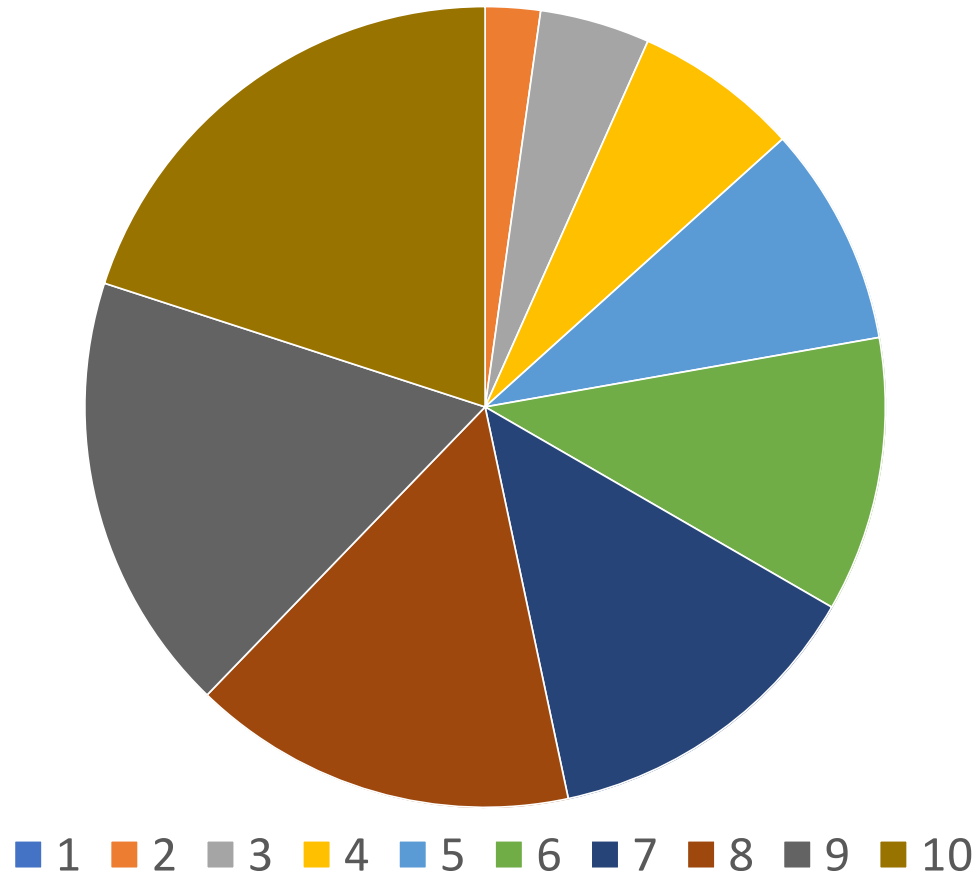
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# SKA SRC Containerisation Workshop

Rate familiarity with the topic



260 registrations  
from countries  
all around the  
world



# SKA SRC Containerisation Workshop

- Help installation on Thursday 27/1
  - 185 users of the dedicated slack channels
  - Support provided for different operating systems
- Lessons Monday 31/1
  - Around 120 live attendees + 20 views
  - Pre-recorded containerization tutorial
  - 125 Views
- Live Q&A sessions on Thursday 3/2
  - About 60 live attendees in total between the 4 sessions
- Lessons Monday 7/2
  - Around 100 live attendees



# SKA Banners (end of Feb target)

- **Will update, or produce a new banner**

- CoL
- Cosmology
- Gravitational Waves (**NEW BANNER**)
- High Energy Particles
- Magnetism
- Our Galaxy
- Transients
- VLBI

- **No Update required**

- Continuum
- EoR
- Exgal Spectral Lines
- HI
- Pulsars
- Solar



# Any Other Business

- Upcoming meetings
  - VLBI in the SKA Era, 14 – 18 Feb, ([https://whova.com/web/vlbis\\_2021111](https://whova.com/web/vlbis_2021111))
  - CoL Webinar Series, 23 Feb, “Isotope chemistry in protoplanetary disks: From planet-forming regions to planetary systems”: (<https://astronomers.skatelescope.org/science-working-groups/galaxy-cradle-life/>)
  - 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](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](https://eas.unige.ch/EAS_meeting/session.jsp?id=SS23))
- ...???





AOB?

*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](http://www.skao.int)