

## **SKA SWG Update 19 July 2022**

SWG Chairs: Jason Hessels, Stijn Buitink, Andrei Mesinger, Francoise Combes, Abhirup Datta, Barbara Catinella, Anna Nelles, Betsey Adams, Valentina Vacca, Stefano Camera, Tess Vernstrom, Adriano Ingallinera, Cherry Ng, Mark Sargent, Natasha Hurley-Walker, Divya Oberoi

Other Guests: Fernando Camilo

SKAO Science Team: Wendy Williams, Robert Braun, Philippa Hartley (notes), Harry Qiu, Tyler Bourke

Apologies: Aris Karastergiou, John Ilee, Marta Spinelli, Patrick Woudt, Sebastien Muller, Samaya Nissanke

### **PSS Architecture review (Philippa)**

The teams that look after the PSS have just completed an architectural review. Want to mention the review as a taster of the work being done on the pulsar search capabilities. This review is just being completed and we can talk about its outcomes in more depth at a future meeting. For now, wanted to give a brief outline of what the review was for and what it involved

PSS:

Integral part of SKA in both MID and LOW: a critical component. Operates commensally with other Central Signal Processor elements. Generates pulsar candidates on the fly and sends to SDP. PSS is composed of hardware and software. Hardware: CPUs, GPUs, FPGAs. Any review must consider the hardware and the software

Meets needs of two key science objectives: Pulsar-black hole binaries (test GR) and transients and unknown sources.

Commissioning drivers also:

It's a powerful tool of telescope functionality. Can verify beam-forming capability. Can help to test telescope performance and low-level RFI in time domain (the high time resolution allows us to detect RFI spikes that would otherwise be averaged out).

Francoise: What is the typical scan duration for beam-formed data analysis?

Jason: A single pointing would typically be tracked for 15 minutes.

Jason: Where are the computational bottlenecks? Is it RFI? Filtering RFI will become more challenging over time.

Philippa: The sheer volume of data is already a challenge. Refer to Aris K for more details on the breakdown of computational costs over various components like: RFI filtering, single pulse searches, periodicity and DM searches, etc.

## **SKA-Low station layouts and antenna orientation (Robert)**

Bandpass resonances are found in AAVS station layout (pseudo random currently). A lot of antenna-antenna distances are short, leading to strong interactions.

Now exploring antenna orientation diversity in order to further reduce resonances: antenna orientations are not constrained to be identical if beam-forming is done digitally with a full complex Jones matrix and there are some substantial advantages to combining deliberately different orientations.

EM simulations are being used to investigate different antenna orientations. First using just two nearby antennas, to look at the effect on gain with look direction. Can see reduced resonances for rotated antennas. Additional improvement is seen when moving antennas from 1.5 to 2m apart. The resonance effects are diluted as the number of beam-formed antennas increases. Being explored with a view of putting together an Engineering Change Proposal.

Anna Nelles: Great to see the simulations; but from past experience it's hard to achieve accuracy with the simulations. E.g., at LoFAR, attempts to account for antenna model did not work. The results from the simulations do not materialise in exactly the same way in the field. You may amplify problems when using different stations everywhere.

RB: The first sign of the resonances was in the experimental data. Not seen in simulations due to too coarse a sampling frequency. Follow up simulations confirmed what was measured.

Anne: Agreed, the resonances are seen in both model and simulations, but will differ in detail.

RB: Agreed, however, the use of simulated individual beam patterns has led to dramatic improvements in prototype station calibration compared to a simple theoretical beam model or even the average simulated antenna pattern, so the simulations have been shown to have useful predictive power in the field. Regarding the use of different (rather than identical) station layouts, this is done to diminish the far sidelobe response of the cross-correlation station beam. Above 110 MHz, where the SKA-Low stations are increasingly sparse this makes a major difference (about 20 dB at 350 MHz) to the far sidelobe response.

Jason: Is it possible to select subsets of antennas in the beam-former for study?

RB: The prototype data being analysed uses all individual antennas correlated with one another, so indeed any desired subset of antennas is accessible. Even in the long term, all sky imaging based on a single station will be a viable operational mode, whereby any desired antennas can be used.

Abhi: How will the bandpass change with e.g. temperature, rain etc?

RB: Some experience is being built up on the quality of the broad-band calibration and its time stability. In terms of potential bandpass variations there is less hard information in hand. There are no indications of high sensitivity of the bandpass to temperature or humidity, but it will be important to keep such effects in mind.

Stijn: Cosmic ray detection may be able to help here, providing in-field calibration of all the antennas and all the pointing directions. For cosmic ray detection you have a smooth frequency dependence. So at the start of the experiment, we could calibrate this out using just a few particle detectors to trigger on and which to monitor. For cosmic rays, signal changes a bit from antenna to antenna but smoothly, so we can immediately see differences.

RB: Sounds interesting.

**AOB:**

Coordinated surveys of the Southern Sky: meeting date has changed to mid-November: details to follow (now confirmed to be 14 - 18 November)

SKA/ngVLA 2023 Q2 Science meeting nearly finalised.

Betsey: SPARCS meeting will be 21 - 25 November: a clash?

RB: Either week of 7th or 14th November will be the ESO/SKA Coordinated Surveys meeting (now confirmed to be 14 - 18 November).

Betsey: IAU 2024 meeting in Cape Town. Letters of intent for Symposia due 15 September. Will SKAO be involved? 5 - 16 August 2024

RB: We don't have anything in the works yet. Welcome suggestions on how we can best use this opportunity and what its scope could be.

Betsy: Will possibly develop a topic in HI community, but also interested to hear what SKA plans are, in order to contribute. Broad SKA community symposium vs more by science topic?

Tyler: Comms and outreach group is planning a presence at this meeting

RB: Please pass along ideas of focus for this meeting

Betsey: Broad scope could be good: pull in new community members; make connections to multiwavelength

Jason: Short and sweet might be best, pitching the science to the broader community.

## **SWG Updates:**

Andrei: Logistical Problems with the Science team meeting in Bologna due to clash with another meeting locally. HERA precursor experiment: final stages of the draft in progress

Francoise: In France, we had a day focused on SKA and precursors, attracting non-radio astronomers. December a workshop about galaxies and SKA.

Jason: Having discussions about the next SALF (science at low frequencies) meeting: still seems a need to host online. If there is an appetite to host in-person, please do get in touch.

Stijn/Anna: For high energy particle group: transitions from focus group to a science working group. Had very good results for the science case recently, promising for SKA.

Betsey/Barbara: Joint HI+Exgal Continuum SWG on-line workshop on July 22. At the recent EAS we had a one-day Special Session on HI surveys highlighting science from the HI side.

Valentina/Tessa: Magnetism Data Challenge is progressing well, led by Takuya Akahori. Data Challenge to take place in 2023. Next week we will have a plenary of the SWG: scientific then technical. Anna and Tyler helped to go through the member list and update, with some members changing between core/associate. Also looking at planning a joint meeting with another SWG. SPARCS meeting: planning a hybrid meeting <https://www.idia.ac.za/sparcs-2022/>

Stefano: Cosmology SWG has mainly worked in focus groups with pathfinder data. Also, joint HI and cosmology work. Focussed meeting on intensity mapping with pathfinder data.

Adriano: A two-day meeting at EAS with Cradle of life, very fruitful, much discussion, identifying science cases involving galaxy and dust interactions, ALMA and SKA.

Cherry: In Cradle of Life, winding down a bit for the summer, speaker series on hold to restart in September. Speaker nomination form will be circulated soon.

Mark Sargent: The meeting on Friday will cover both modelling efforts and observational commensality. 1.5 hours presentations, 1.5 follow up discussion. Following news from JWST, multi-wave context is very relevant. Some of the data from JWST deep field will be becoming available: considering precursor proposals to follow up. Mark has been giving regular monthly updates to the Swiss community, recapping the monthly SWG chairs meetings.

Divya: The next two days we have the MWA project meeting. Focus on the early career scientists this year.

Fernando: We continue to review the MeerKAT proposals that closed in May. At the recent SKA Council meeting the suggestion was made that real data from SKA precursors could be used for SKA Science Data Challenges.

RB: Good suggestion: keen to hear people's thoughts on this. What challenge might we best address with existing precursor data? We would like to capitalise on growing archival data volumes. What are the challenges that could capitalise on these resources that are of general interest to the SWG community?