SKA Science Update

- Engineering Change Proposals
- Upcoming Science Data Challenges
- AOB
Update to SKA Low Configuration (approved ECP)

- Access to neighboring property enables improved \((u,v)\) coverage, with slightly enhanced \(B_{\text{Max}} = 70\text{km}\) (and upgrade potential to 100km) without significantly increased cost
Update to SKA Low Station Layout (submitted ECP)

- Change from pseudo-random to “sun-flower” layout strategy under consideration
- Significant improvement of:
  - Bandpass resonance reduction (for Cosmic Dawn success at 78 MHz)
  - Embedded Element Pattern (EEP) homogeneity (for station calibration quality)
  - Station beam sidelobe levels and azimuthal symmetry (apart from AC at high freq)
  - Maintenance access and roll-out simplicity (since only use rotational station diversity)
Upcoming Science Data Challenges

• CD/EoR SWG plan with as many as three “tiers” of challenge
  • Tier 1: Calibration & Imaging (SWG Coordinator: Datta)
  • Tier 2: Foreground Subtraction + 21cm Power Spectrum Extraction (SWG Coordinators: Trott, Jelic)
  • Tier 3: Extraction of Cosmological Parameters (SWG Coordinators: Mesinger, Melema, with support from Greig, Giri)

• Magnetism (SWG Coordinators: Vacca, Heald)
  • Source finding and characterisation within ~100 deg² IQUV cube

• Radio Transients (SWG Coordinators: Hessels, Woudt)
  • Source finding and characterisation within time sequence of images
  • Details still under development
EoR Data Challenge

• Tiers 1&2: Calibration, Imaging, Foregrounds; SKAO Support

• Hybrid approach to Sky Model
  • Diffuse and Faint Sky is Image-based: EoR signal, GSM2016, Filamentary fine scale structure (from MHD simulations), T-RECS for faint compact sources
    • FFT and De-gridding directly to visibilities after applying time variable station beam model
  • A-Team and Bright Sky is discrete components: GLEAM, LoBES, etc.
    • DFT to visibilities using OSKAR simulation
  • Can simulate realistic residual calibration, de-mixing and source subtraction errors
EoR Data Challenge

- Tiers 1&2: Calibration, Imaging, Foregrounds

Above images are all “dirty” images (five short cuts spanning four hours of HA) but excluding A-Team (which otherwise dominates the dirty noise floor)
EoR Data Challenge

- Tier 3: Extraction of Cosmological Parameters (coordinators Mesinger, Melema, support from Greig, Giri); SKAO Support: Bonaldi & Eunseong Lee
- Target Participants: SWGs like CD/EoR.
- Input Data: Foreground removed Image Cubes or lightcones (to discuss format and simplifications: \( T_s \gg T_{cmb} \), no RSDs?, co-eval or lightcone?)

Challenge will be based on:

- ability to extract the IGM and source properties
- Verification of the results from participants
  - comparison with the input EoR history
  - comparison with the input ionizing luminosity functions?
EOR SDC Tier 3

CD/EoR Signal

- 21cmFAST
- C2Ray

Mesinger+ (2016)
**EOR SDC Tier 3**

To Do: insert realistic noise for SKA-Low and possibly some systematics

Figure credit: Eunseong Lee
EOR SDC Tier 3

Proposed score: $\prod_{z_1}^{z_3} P(x_{HI})$

Figure credit: Eunseong Lee
EOR SDC Tier 3

- Storage requirements: minimal (input could be just a power spectrum)
- Processing requirements per team:
  - If performing “forward modelling” inference:
    - Around 256 CPUs having 4GB RAM each
    - Quota few 100K CPU hours
  - If using analytical models / emulators:
    - 8-32 CPUs
    - Quota few K CPU hours
- Disk space per team: 100 GB
- Timescale: challenge start in spring 2022 at the earliest - TBC

Preliminary!
Magnetism SDC in preparation (SKAO Support: Akahori)

- **Update Magnetism Key Science Projects**
  - HPSO: Band 2 all-sky survey (4 uJy/bm, 2”)
    - Plus follow-up observations with LOW and Band 1
  - Goal: construct RM grids and resolve faint diffuse sources

- **Challenges of the MKSPs**
  - Polarisation source finding (position and Faraday depth) and characterisation (e.g., spectral index, EVPA) for a given image quality, polarization purity, and frequency coverage
  - Staged challenge? Stage 1 = B2 only, Stage 2 = LOW+B1+B2

- **Dataset for the challenges**
  - Image cube \((Q, U)(x,y,f)\) + Stokes I catalogue, FoV \(\sim 100\ \text{deg}^2\)
  - ISM/MW + galaxies(AGN, RG, SFG) + LSS, \(z < \text{a few?}\)
    - LoS integration of synchrotron polarisation and Faraday rotation
    - TBD: RFI, ionosphere, depolarising galaxies, ...
Any Other Business

• Upcoming meetings
  • SPARCS 2021 happening this week!
  • ...
• ...???
We recognise and acknowledge the Indigenous peoples and cultures that have traditionally lived on the lands on which our facilities are located.

Thank you