Science Activity Updates

• System Critical Design Review
  • Deployment Baseline Definition
  • Information Sessions
• SKA Observatory Development Programme
• Science Data Challenge Update
• SKA related meetings
  • 2020 SKA Science Meeting
• Round table SWG updates (All)
• AOB
System CDR

- Review Meeting 9 – 13 December SKAO HQ
- Panel Members
  - Adrian Russell (Chair), Chuck Gessner, Alison Peck, Jeff Kantor, Gie Han Tan, Heather Marshall, Jaap Baars, Larry D’Addario, David DeBoer, David Boboltz, Jim Oschmann
- 136 Observations ; 47 Major and 89 Minor
- Outcome: STRONG PASS, subject to successful close-out of actions
# From S-CDR to T0

## Transition to IGO

<table>
<thead>
<tr>
<th>Q4 2019</th>
<th>Q1 2020</th>
<th>Q2 2020</th>
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<tbody>
<tr>
<td><strong>Ratification 1(^{st}) 5</strong></td>
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<td>Entry into Force</td>
<td>Staff transition</td>
<td><strong>Ratification others</strong></td>
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<tr>
<td><strong>1(^{st}) Council Mtg</strong></td>
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<td><strong>CP Review</strong></td>
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<td><strong>Close-out(^{*})</strong></td>
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<td><strong>2(^{nd}) Council Mtg</strong></td>
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<td><strong>Panel Mtg (9-13 Dec)</strong></td>
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<td>CP Approval &amp; Release of Funds (T0)</td>
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## System CDR (Design Baseline)

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<tr>
<th>Q4 2019</th>
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<tr>
<td><strong>Low AAVS1.5</strong></td>
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<td><strong>Mid Dish</strong></td>
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<td><strong>Dish Element CDR Mtg &amp; Close-out (1 band)</strong></td>
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## Prototyping/CDR Activities

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<th>Q4 2019</th>
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<tbody>
<tr>
<td><strong>Open AAVS1.5</strong></td>
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<td><strong>Mid Dish</strong></td>
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<td><strong>Dish Element CDR Mtg &amp; Close-out (1 band)</strong></td>
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## Construction Proposal (Deployment Baseline)

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<th>Q4 2019</th>
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<tbody>
<tr>
<td><strong>Deployment Baseline analysis</strong></td>
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<td><strong>AA0.5 integration into planning</strong></td>
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<tr>
<td><strong>WBS, cost, schedule and risk updates</strong></td>
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<td><strong>Technical document updates</strong></td>
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<td><strong>CP &amp; OP Submission (advanced drafts)</strong></td>
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<td><strong>CP &amp; OP Submission (final following BD-33)</strong></td>
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## Procurement Preparation

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<tr>
<td><strong>Science consultation</strong></td>
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<tr>
<td><strong>Prep. for AA0.5 contracts</strong></td>
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<td><strong>Prep. for other contracts</strong></td>
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\(^{*}\)Implementing actions incl. ECPs for Rev 12 + unfinished work on ICDs etc.
From S-CDR to T0 (Release of Construction Funds)

- Development of Deployment Baseline
  - Build on endorsed Cost Control Process of 2017
  - Updated costings of previous cost savings measures
  - Consideration of new cost savings measures
  - Updated savings ladder to reflect science impact
  - Consistency check with SWGs and SEAC (January/February)
  - SKA Board Meeting 28 February 2020: to establish budget
  - Finalise definition March/April
  - Three Information Sessions to communicate outcome to science/engineering/industry:
    - Perth: 30 April
    - Cape Town: 4 May
    - SKAO HQ: first week of May
From S-CDR to T0 (Release of Construction Funds)

• Deliver Construction Proposal and Operations Plan
  • Construction Proposal
    • Deployment Baseline Reference Design
    • Integration, Acceptance, Commissioning, Science Verification Plans
    • Schedule
    • Cost book
    • Management Plans for Monitor and Control
  • Operations Plan
    • Observatory Design (science/engineering operations)
    • Planning, Scheduling and Execution
    • Observing, Observing Modes
    • Science Data Products
    • KPIs
SKA Observatory Development Programme Rationale

- Enhance SKAO science capabilities
- Keep SKAO up-to-date
- Retain/develop expertise within SKAO member labs/institutes
Example areas that require development

- Complete and extend frequency coverage
  - 20 – 50 MHz
    - Exo-planets
    - Cosmic Dark Ages
  - 2 – 5 GHz
    - Precision pulsar timing
  - 15 – 25/50 GHz
    - Astrochemistry
    - High-z CO
    - Transients

In summary, if supplied with the Band 6 high-frequency receivers, the SKA could become a pioneer instrument in the detection of large prebiotic molecules in space. An extension of the frequency coverage of the SKA to frequencies >15 GHz, would allow searches of large prebiotic molecules such as the amino acid glycine, opening a new era of discovery. The discovery of amino acids in the ISM would settle the question of whether these macro-molecules could form in space, providing key information about the origin of life on Earth and having important implications for the origin of life in other planetary systems.

2.2.3 Simulating SKA observations of COMs toward TW Hya

TW Hya is the closest T Tauri star to Earth, located at a distance of 60 pc (Bailer-Jones, et al., 2018). With a stellar mass of 0.8 $M_{\odot}$ and an age of 10 Myr (Andrews, et al., 2016), it is one of the best studied analogues to the young Solar System. It is also surrounded by one of the few protoplanetary discs around a low-mass star in which complex molecules have been found, with emission from methanol (CH$_3$OH) being detected by ALMA (Walsh et al., 2016). TW Hya therefore serves as an important benchmark to determine the observability of COMs across lower frequencies.

Following the approach of Walsh et al. (2014), we have calculated the disk-integrated line flux density under local thermodynamic equilibrium for several COMs of interest: formamide (NH$_2$CHO), glycoaldehyde (HOCH$_2$CHO), methyl formate (HCOOCH$_3$) and dimethyl ether (CH$_3$OCH$_3$) for TW Hya. For the calculations, we utilise the disc physical structure determined by Kama et al. (2016), which is assumed to sit in a face-on orientation ($i = 0$). We assume the reservoir of each COMs is located in the midplane ($z/r = 0 – 0.1$) between radial distances of 30–100 au from the central star. This well fits the methanol emission in TW Hya detected by ALMA. Such regions are characterised by gas temperatures of between 15–30 K. We take the fractional abundance of each molecule to be $1 \times 10^{-10}$ within the reservoir, and $1 \times 10^{-16}$ elsewhere, in order to approximate results from dedicated COM modelling (Walsh et al., 2014). Figure 7 shows the physical structure of the disk, along with the resulting line emission for each species. A clear result emerges from these simulated observations – the strongest transitions of these molecules are located between $\sim 30–50$ GHz.
Example areas that require development

• Extend $B_{\text{Max}}$ beyond current Design Baseline (in VLBI mode – low cost time/freq standards and data acquisition)
  • $B_{\text{Max}}$ to 200 – 300 km for both, but particularly for LOW!!
  • Ultimately 1000s of km
Example areas that require development

- Enhance survey speed with FoV
- More station beams for LOW
- PAFs for MID
- MFAAs
Example areas that require development

- Complete and extend frequency coverage
  - 20 – 50 MHz
  - 2 – 5 GHz
  - 15 – 25/50 GHz
- Improve existing band performance (@reduced ops cost?)
- Extend $B_{\text{Max}}$ beyond current Design Baseline (in VLBI mode)
  - $B_{\text{Max}}$ to 200 – 300 km for both, but particularly for LOW!!
  - Ultimately 1000s of km
- Enhance survey speed with FoV
  - More station beams for LOW
  - PAFs for MID
  - MFAAs
- Digital enhancements (processed bandwidth, PSS/PST, ...)
- Novel algorithms, pipelines or even new S/W approaches
- Enhance sensitivity: develop effective SKA2 design
SKA ODP Approach

• Encourage, via co-funding, technology development across full spectrum of development areas to permit wide range of deployment options with high TRL
  • Solicit co-funding proposals
  • Technical assessment of proposals undertaken by SKAO Prog/Ops
  • Scientific assessment of proposals coordinated by SKAO Science Team
  • Selection and allocation based on (science and technical) merit

• Support healthy mix of low and high-risk approaches:
  • Short term/low risk
  • Medium term/risk
  • Long term/high risk/return

• Deployment only considered once suitable TRL demonstrated (including reliable costing)

• Deployment proposals to Council based on relative scientific benefit chosen from amongst high TRL options
  • Scientific priority setting coordinated by SKAO Science Team
SKA ODP Funding

• No ODP funding in SKAO 2020 Budget
• Proposal for 20M€/yr from 2027 in long term plan
• Proposal for budget ramp up from 2021 to 2027
  • Strong push-back from some Members
  • Tension with delivery of Construction Budget
• Steps you can take to support early ODP start
  • Stress importance of ODP to your Board/CPTF/Council members
  • Encourage your Board/CPTF/Council members to support an early budget ramp-up (but not at the expense of the Construction Budget)
Science Data Challenges, Moving forward…..

• Suggestions for SDC2 –
  • Transients
    • One sub-band image: Low (200 MHz) and Mid (1.4 GHz), cadence of once(?) per day for entire calendar year(?)
    • Various populations with time constants of days to months
  • HI Emission/Absorption
    • Red-shift / Sky coverage: $z = 0 (?) - 6 (?) / N (?) \text{ deg}^2$
    • Resolved plus unresolved targets
  • Polarisation
    • Introduce plausible $Q,U$ signatures into continuum sky model and generate $(I,Q,U)$ cubes $N (?) \text{ deg}^2$ with suitable frequency sampling $(\text{Freq}_\text{Max}, \text{Freq}_\text{Min}, \text{Delta}_\text{Freq})$?
  • Foregrounds
    • Explore foreground removal effectiveness for EoR and Intensity Mapping applications
SDC2 Update, possible specs.

• SKA1-Low
  • 150 – 350 MHz
  • $\theta = 10$ arcsec, $\Delta \nu / \nu \sim 3 \times 10^{-5}$
  • 100 deg$^2$, 2000$^h$
  • HI absorption signatures: associated plus intervening

• SKA1-Mid
  • 950 – 1420 MHz
  • $\theta = 5$ arcsec, $\Delta \nu / \nu \sim 10^{-4}$
  • 20 deg$^2$, 2000$^h$
  • HI absorption signatures: associated plus intervening
  • HI emission signatures: resolved plus unresolved

• Errors
  • Residual RFI
  • Imperfect continuum subtraction
SDC2 Update, possible specs.

• Extend T-RECS model with new neutral gas “module”
  • Each continuum source has DM halo “home” with suitable stellar population and morphology
  • DM halos populated with HI consistent with stellar pop and assumed HIMF(z)

• HI absorption signatures: associated plus intervening
  • Use atlas of observed high s/n spectra plus assumed distribution function (with z dependence) rescaled as needed

• HI emission signatures: resolved plus unresolved
  • Use ALFALFA atlas of (high s/n) spectra rescaled as needed
  • Use HALOGAS, THINGS cubes
    • Random PA and Inclination (velocity re-scaling plus spatial (de-) compression)
    • Modulate Emission(Velocity) using ALFALFA spectra to diversify
• HI emission signature modelling advancing well
SDC2 Update

- RFI modelling advancing well
  - Code being developed to support ephemeris-based de-mixing of GNSS signatures from visibility data
SKA Science Community

- Now some 900 Science Working Group members based in 40 different countries
SKA Science Community

- Now some 900 Science Working Group members based in 40 different countries
Next Science Meeting

• 2020 SKA Science Meeting and KSP Workshop, September/October?
  • Stellenbosch University
  • Up to 350 participants
  • Title: “The Precursor View of the SKA Sky”

Photo Credit: Jefri Tamba 2018
Upcoming SKA-related Meetings

• “Observing the First Billion Years of the Universe using Next-Generation Telescopes”, 21 – 24 Jan, Indore
• Cosmology SWG meeting, 22 – 24 Jan, Paris
• EoR/CD Meeting, 27 – 31 Jan, Sexten

• SKA Pre-T0 Information Sessions
  • Perth: 30 April
  • Cape Town: 4 May
  • SKAO HQ: early May

• PHISCC 2020 Meeting, 11 – 13 May, Cagliari
  [https://sites.google.com/inaf.it/phiscc2020/](https://sites.google.com/inaf.it/phiscc2020/)
SQUARE KILOMETRE ARRAY
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