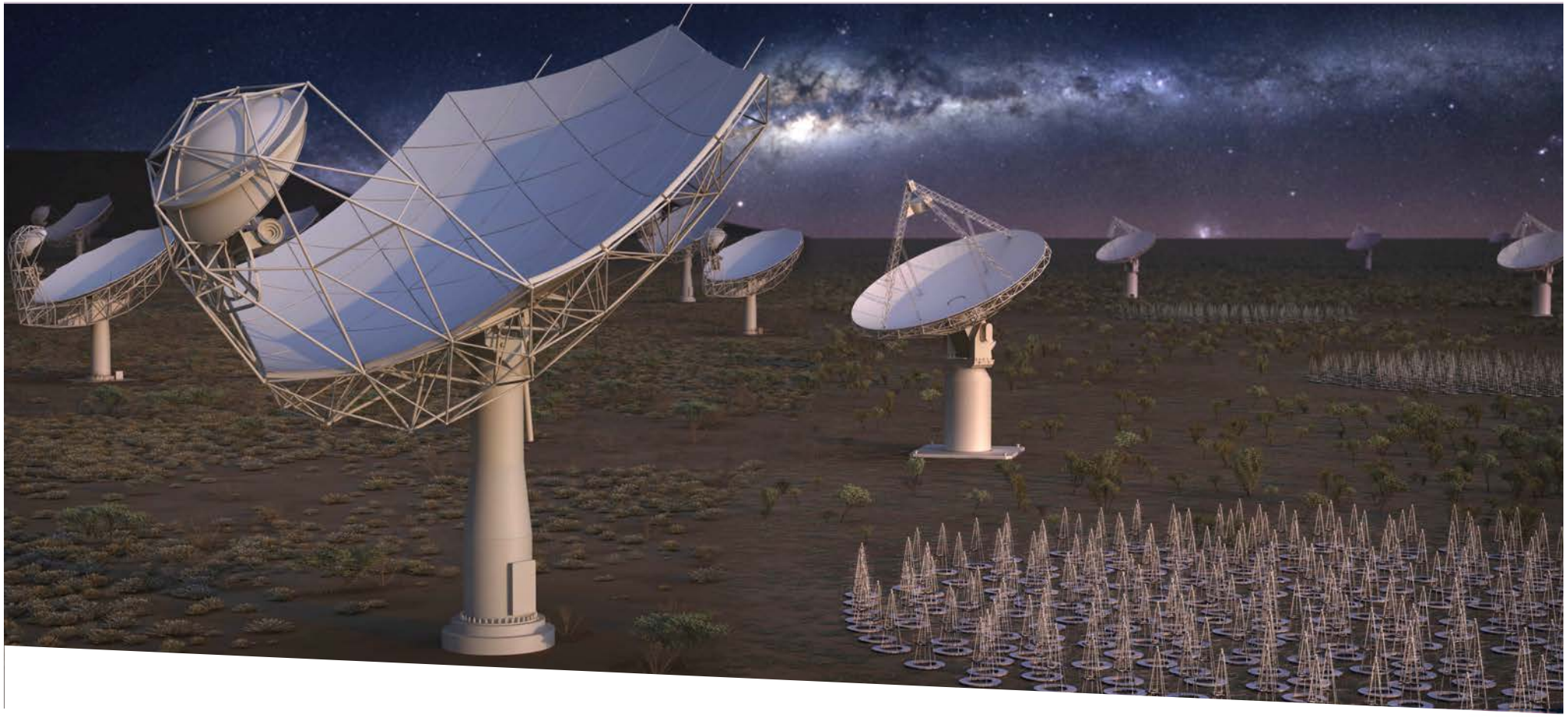
SKA SWG Update



SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

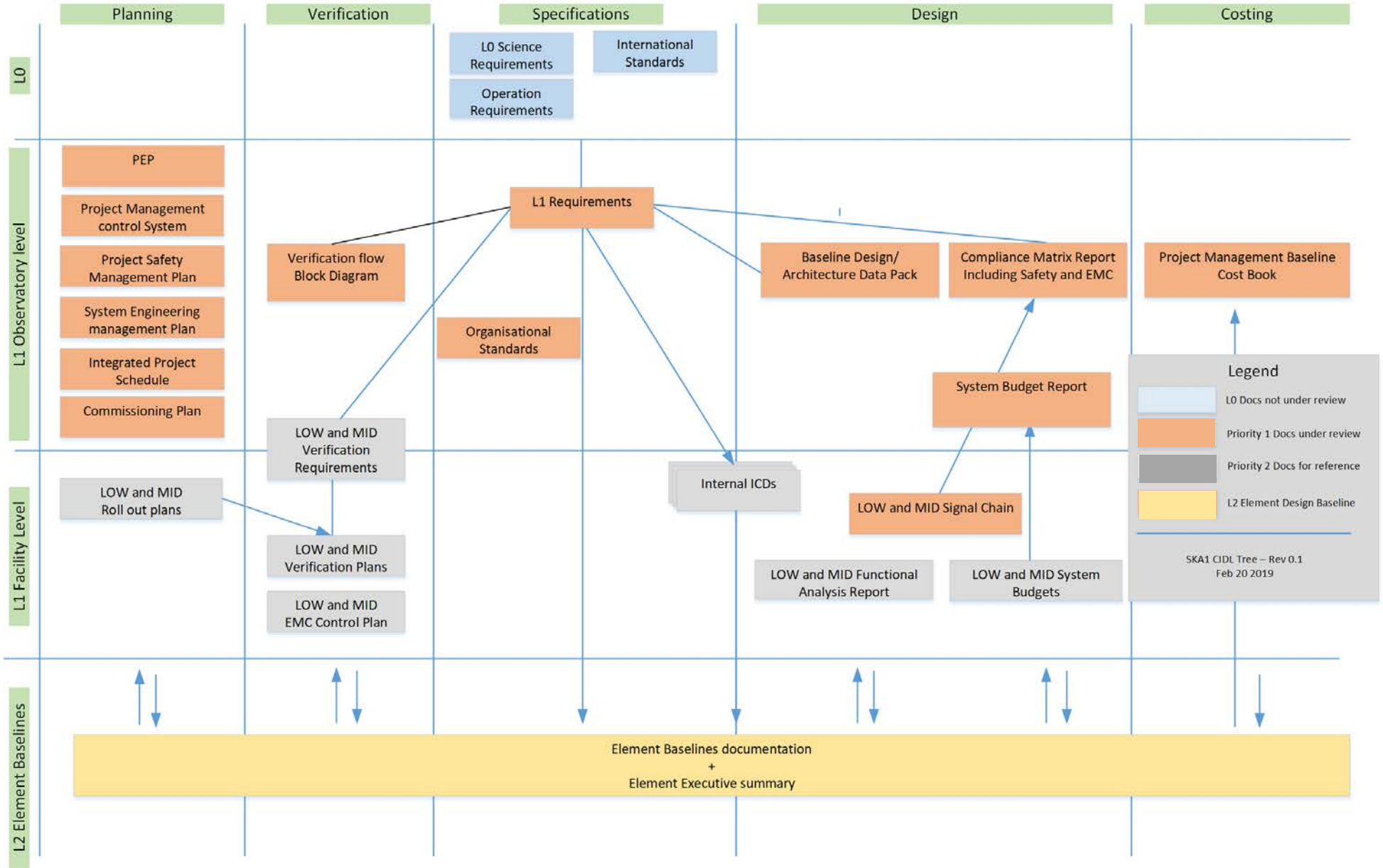
Robert Braun, Science Director

17 Dec 2019

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

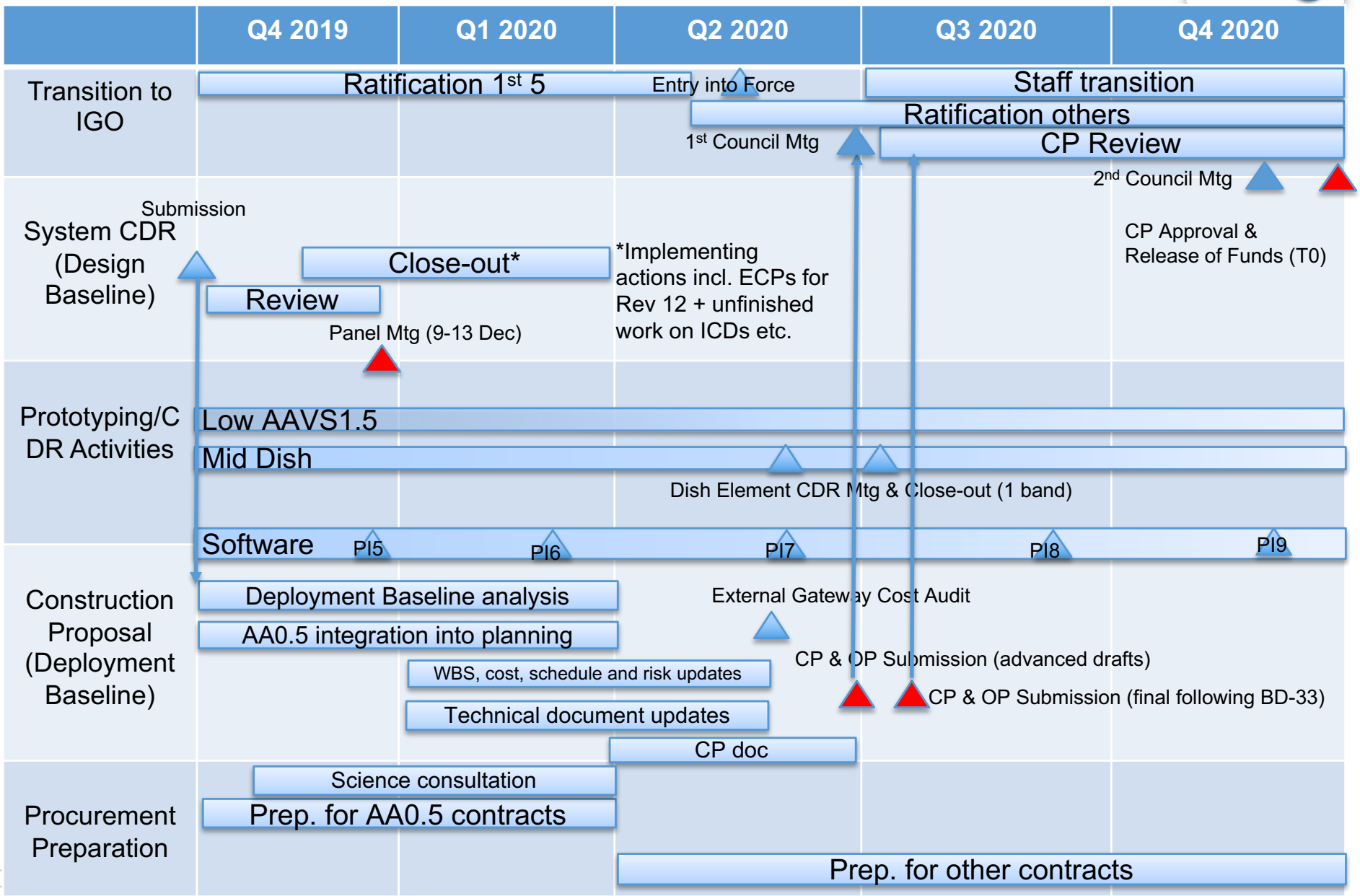
System Critical Design Review



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



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)

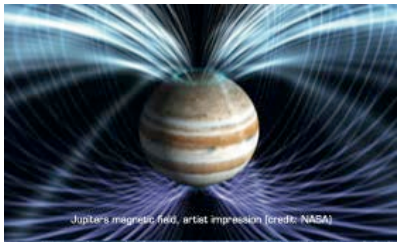
- Deliver Construction Proposal and Operations Plan
  - Construction Proposal
    - Deployment Baseline Reference Design
    - Integration, Acceptance, Commissioning, Science Verification Plans
    - Schedule
    - Cost book
    - Management Plans for Monitor and Control
  - Operations Plan
    - Observatory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

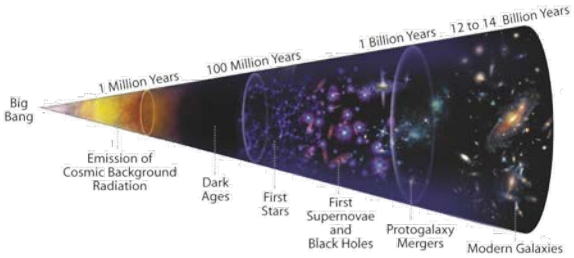
SKA Observatory Development Programme Rationale

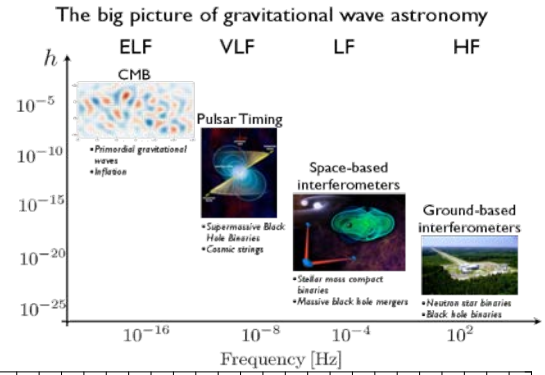
- Enhance SKAO science capabilities
- Keep SKAO up-to-date
- Retain/develop expertise within SKAO member labs/institutes

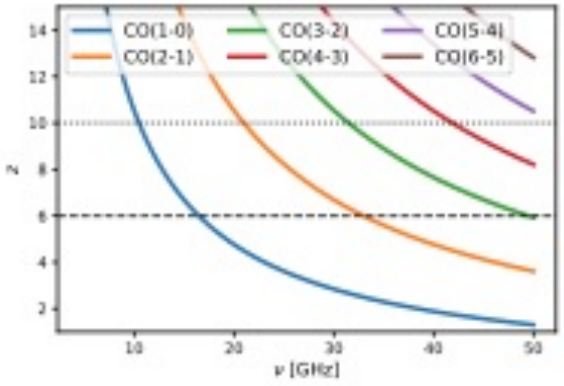
Example areas that require development

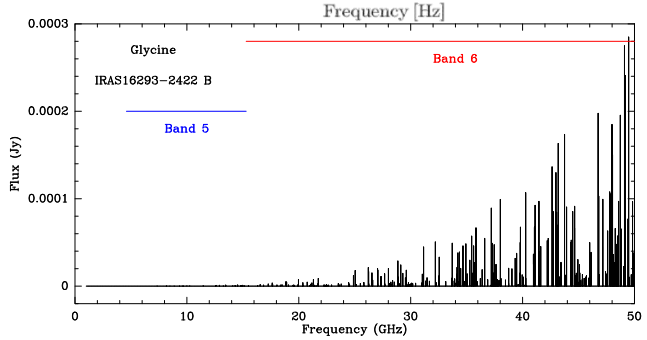
- Complete and extend frequency coverage
  - 20 – 50 MHz
    - Exo-planets
    - Cosmic Dark Ages
  - 2 – 5 GHz
    - Precision pulsar timing
  - 15 – 25/50 GHz
    - Astrochemistry
    - High-z CO
    - Transients

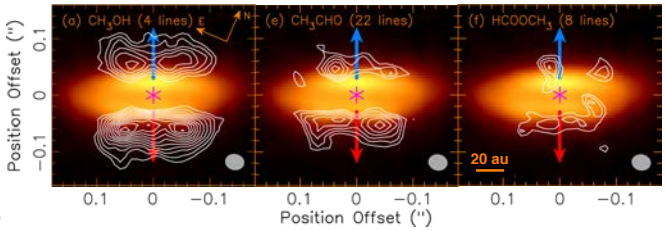






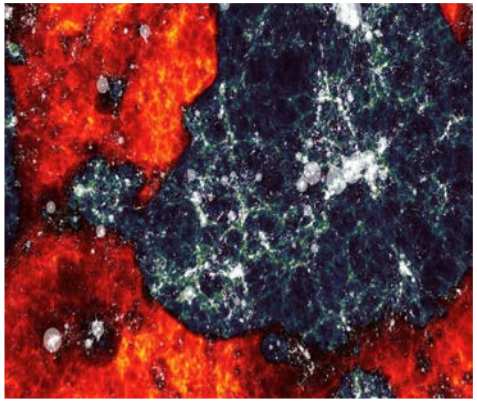


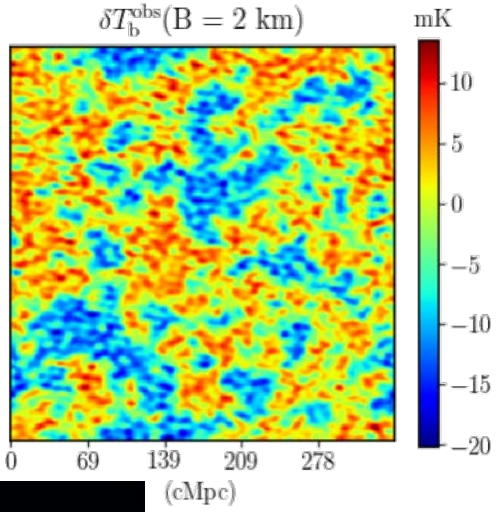


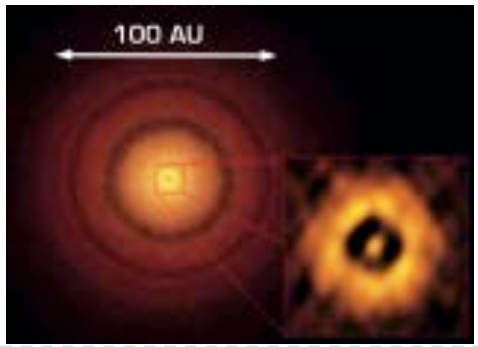


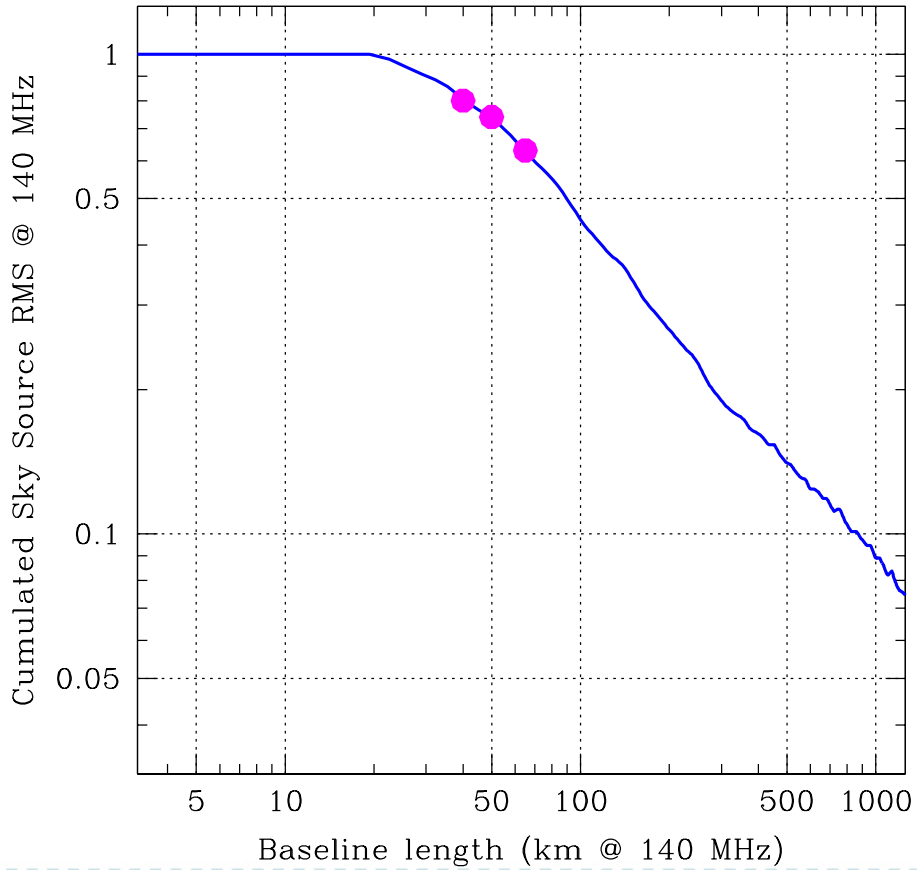
Example areas that require development

- Extend B_{Max} beyond current Design Baseline (in VLBI mode – low cost time/freq standards and data acquisition)
  - B_{Max} to 200 – 300 km for both, <u>but particularly for LOW</u>!!
  - Ultimately 1000s of km



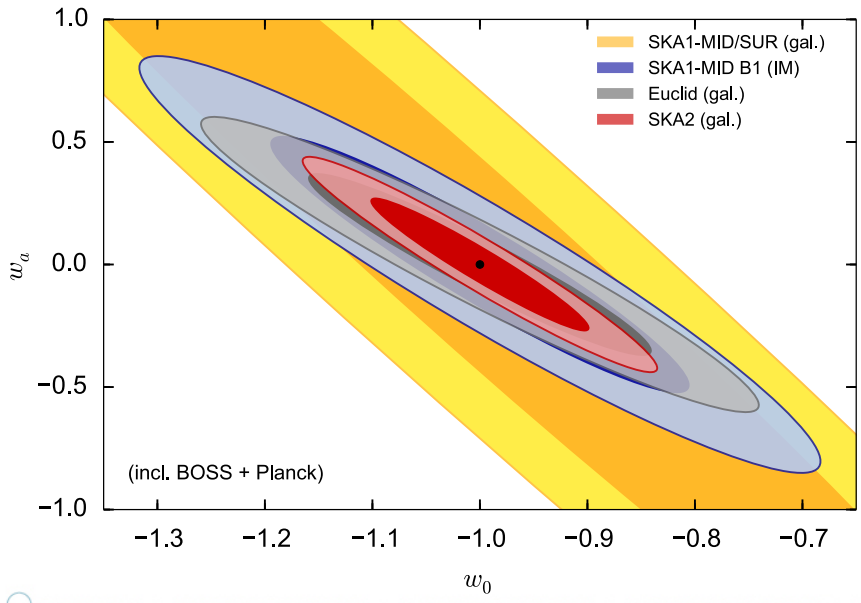


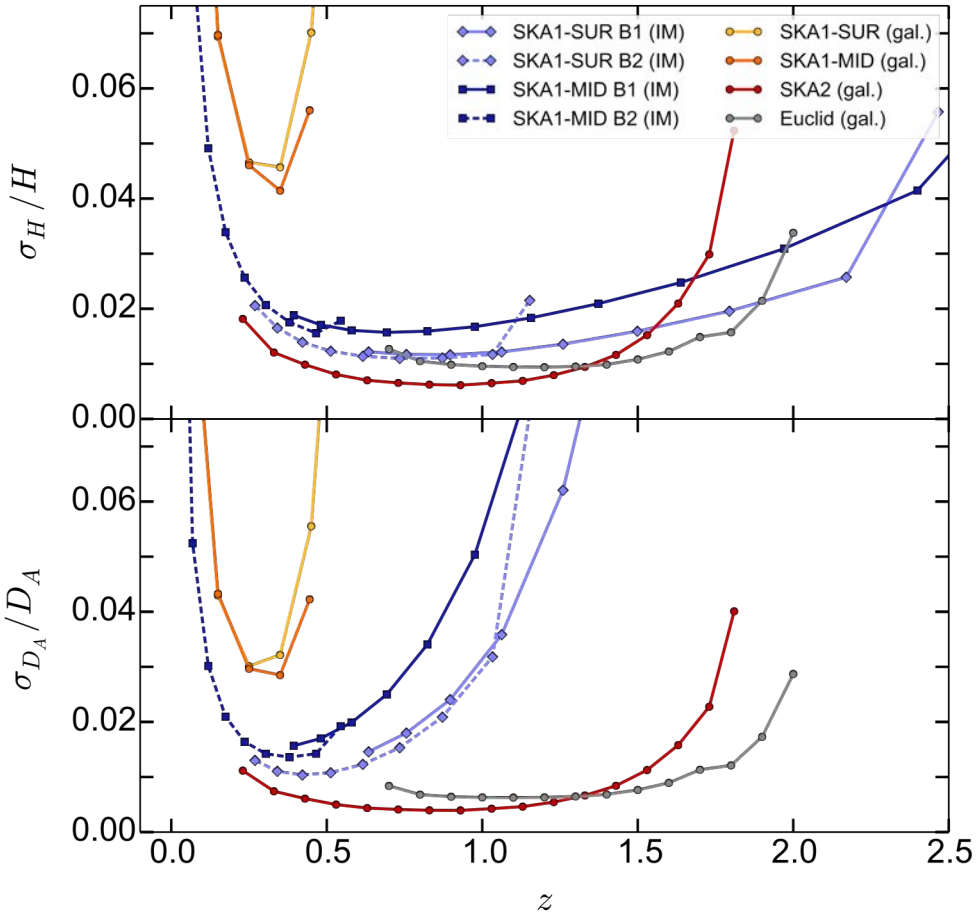




Example areas that require development

- 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_{Max} beyond current Design Baseline (in VLBI mode)
  - B_{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(?) deg^2**
    - **Resolved plus unresolved targets**
  - Polarisation
    - Introduce plausible Q,U signatures into continuum sky model and generate (I,Q,U) cubes N(?) deg^2 with suitable frequency sampling (Freq_Max, Freq_Min, Delta_Freq)?
  - Foregrounds
    - Explore foreground removal effectiveness for EoR and Intensity Mapping applications

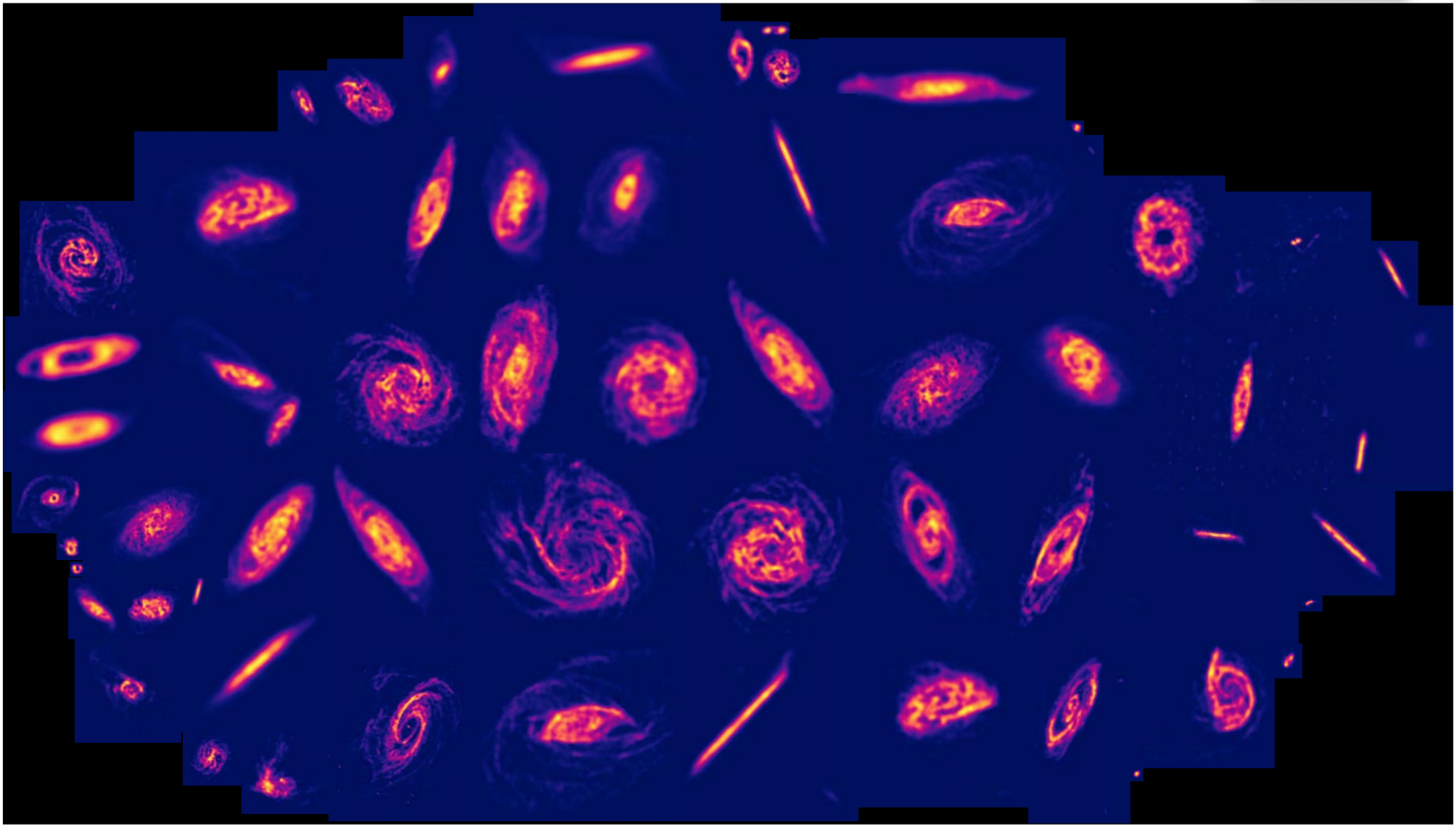
SDC2 Update, possible specs.

- SKA1-Low
  - 150 – 350 MHz
  - θ = 10 arcsec, $\Delta\nu/\nu \sim 3\ 10^{-5}$
  - 100 deg^2, 2000^h
  - HI absorption signatures: associated plus intervening
- SKA1-Mid
  - 950 – 1420 MHz
  - θ = 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.

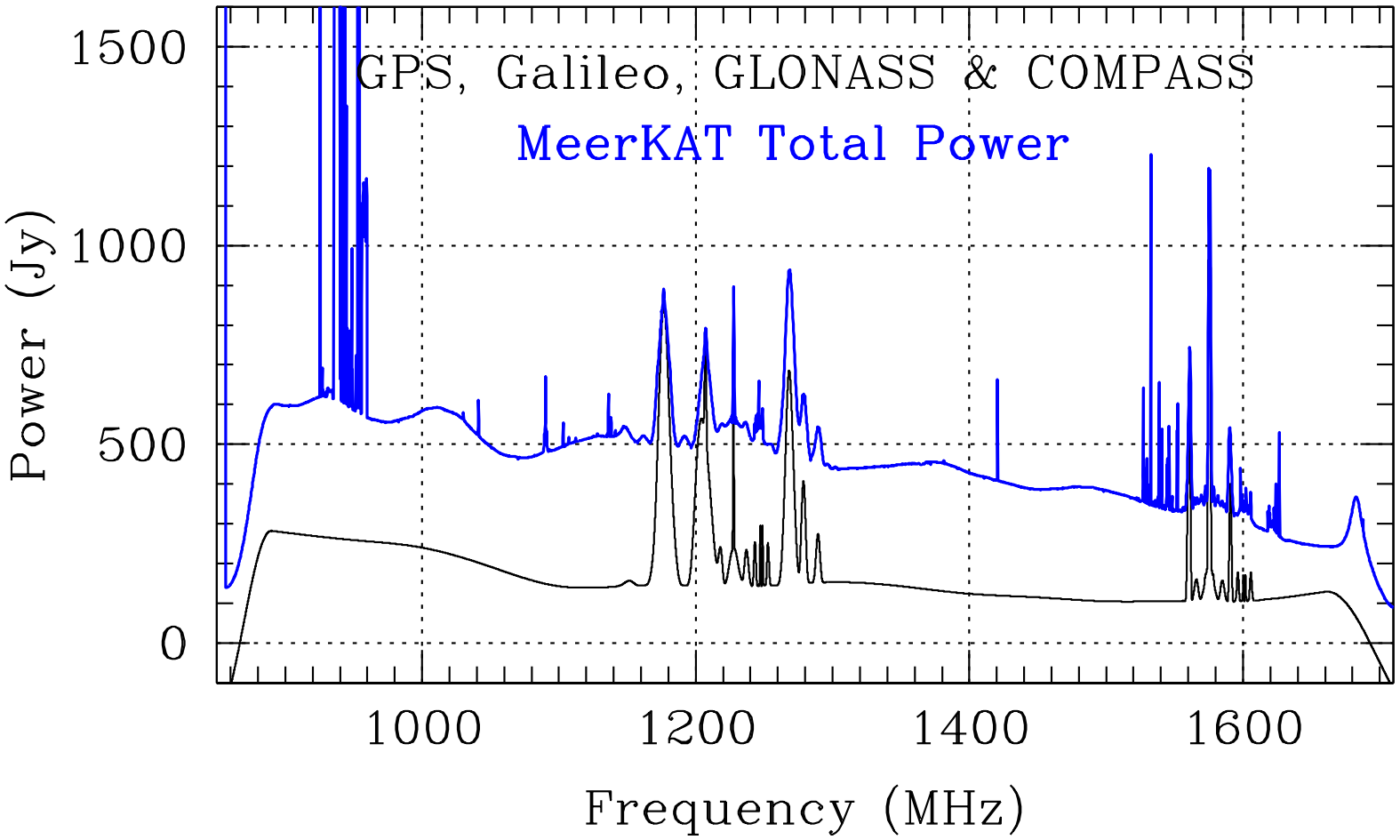
- Extend T-RECS model with new neutral gas “module”
  - Each continuum source has DM halo “home” with suitable stellar population and morphology
  - DM halos populated with HI consistent with stellar pop and assumed HIMF(z)
- HI absorption signatures: associated plus intervening
  - Use atlas of observed 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

SDC2 Update



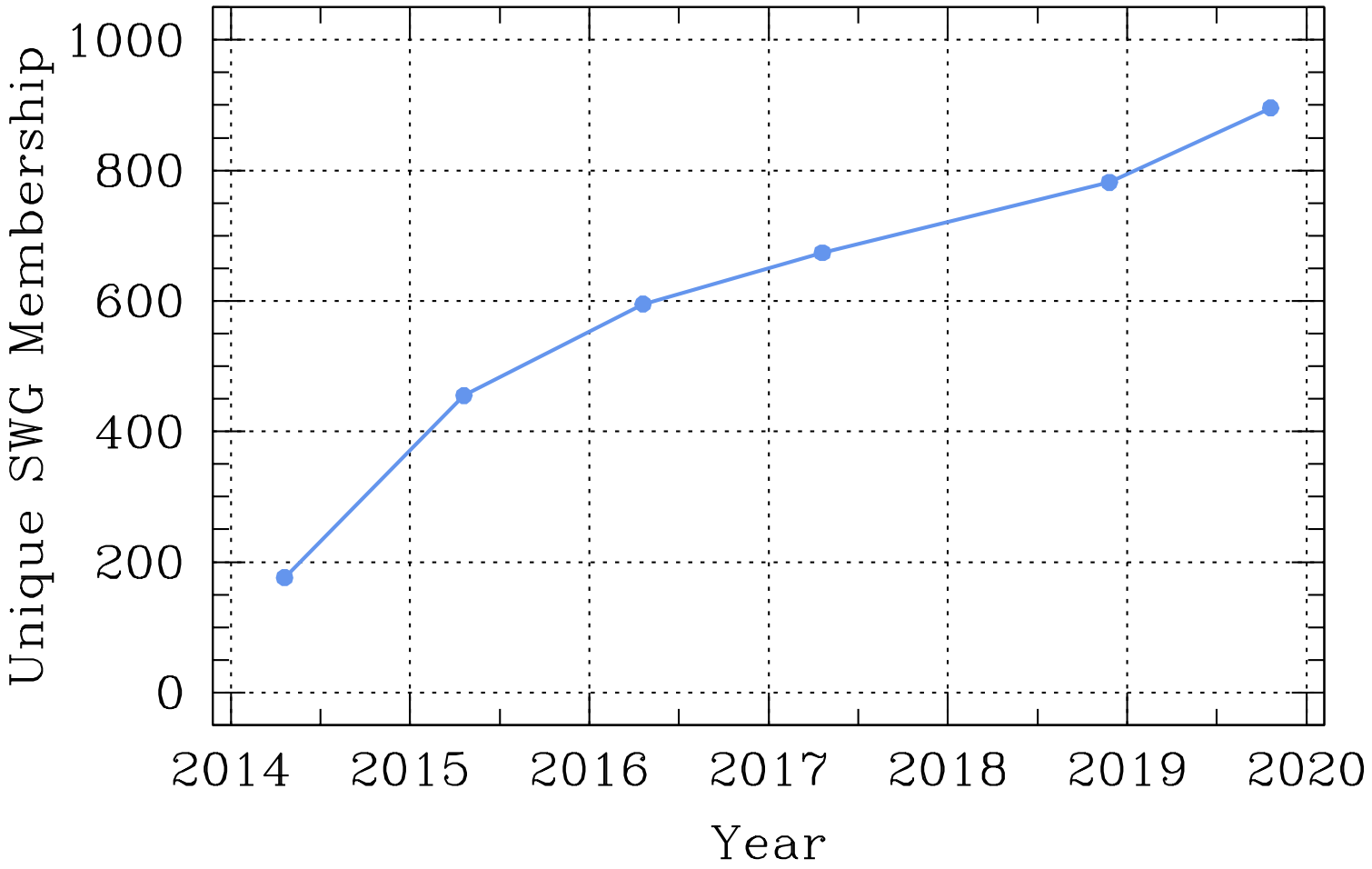
- HI emission signature modelling advancing well

SDC2 Update



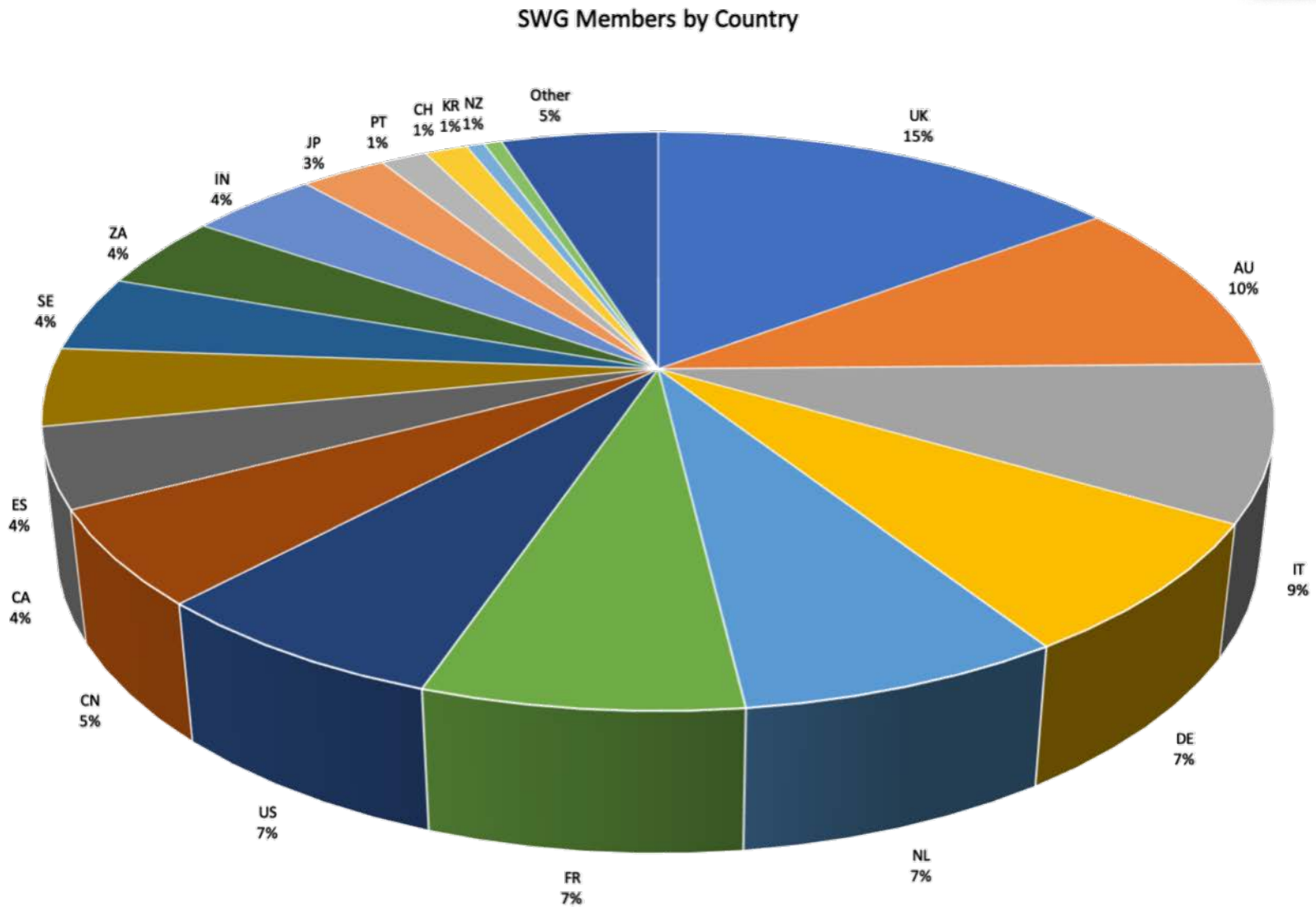
- RFI modelling advancing well
  - Code being developed to support ephemeris-based de-mixing of GNSS signatures from visibility data

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

http://www.sexten-cfa.eu/event/next-generation-cosmology-with-next-generation-radio-telescopes-ii/

- 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/

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www.skatelescope.org