Science Verification

Dr Shari Breen, Head of Science Operations

SKA-China workshop on SKA science and operations, September 2022

What is Science Verification?

- All activities that are executed to verify the Telescope system against its Level-0 Requirements, i.e. to ensure that the Telescope system meets the needs of the science and operational user
  - Implemented as a set of end-to-end tests of the system from proposal submission to data delivery
  - Range of targets, emphasis on comparison with results from other telescopes
  - Modes may be verified periodically as array capabilities mature
- Science Operations preforms Science Verification supported by the Commissioning and AIV team
  - Tests reduction tools as well as observational procedures
  - Provides feedback to the Commissioning and Operations teams

How Science Verification fits into the broader delivery of the system

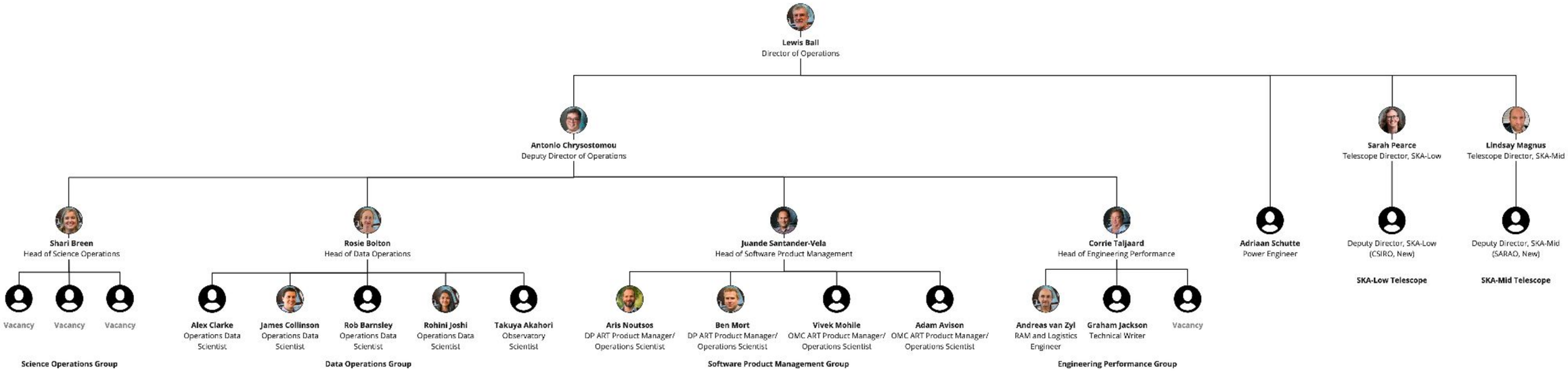
- Series of stages required to delivery a fully commissioned and verified telescope
  - Assembly (establishing products onsite)
  - Integration (incorporate the product into the SKA)
  - Commissioning (ensure a working end to end system)
  - Science commissioning (execution and analysis of astronomical observations)
  - Verification (verification of the system against Level-1 requirements)

  - Science verification (verification of the system against Level-0 requirements, i.e. ensure the telescope meets the needs of the scientific community)

Iterative process expected!

Who is science operations?

- Teams at GHQ, Low and Mid
- Sit in the broader operations team



SKA-Low Science Operations in Australia

Jimi Green
Head of Science Operations

Cath Trott
Chief Operations Scientist

TBC (155.1)
Senior Operations Scientist

- **TBC (155.3)** Operations Scientist
- **TBC (155.4)** Operations Scientist
- **TBC (155.5?)** Operations Scientist
- **TBC (155.6)** Operations Scientist

TBC (155.2)
Senior Operations Scientist

- **TBC (155.7)** Operations Scientist
- **TBC (155.8)** Operations Scientist
- **TBC (155.9)** Operations Scientist
- **TBC (155.10)** Operations Scientist

TBC (49.1)
Senior Data Analyst / Telescope Operator

- **TBC (49.2)** Data Analyst / Telescope Operator
- **TBC (49.3)** Data Analyst / Telescope Operator
- **TBC (49.4)** Data Analyst / Telescope Operator
- **TBC (49.5)** Data Analyst / Telescope Operator
- **TBC (49.6)** Data Analyst / Telescope Operator

TBC (288.1)
Senior Data Analyst / Telescope Operator

Team Leader

- **TBC (288.2)** Data Analyst / Telescope Operator
- **TBC (288.3)** Data Analyst / Telescope Operator
- **TBC (288.4)** Data Analyst / Telescope Operator
- **TBC (288.5)** Data Analyst / Telescope Operator
- **TBC (288.6)** Data Analyst / Telescope Operator

SKA-Low Science Operations in Australia
(Work Management)

Cath Trott
f Operations Scientist

Team Leader

TWO Operations Scientist roles (and TWO Telescope Operator/data analysis roles) to be advertised in the coming weeks. Get in touch if interested!

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Senior Operations

TBC (
Operations

TBC (155.4)
Operations Scienti

TBC (155.5?)
Operations Scientist

TBC (155.6)
Operations Scientist

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Operations Scientist

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TBC (288.4)
Data Analyst / Telescope Operator

TBC (288.5)
Data Analyst / Telescope Operator

TBC (288.6)
Data Analyst / Telescope Operator

TBC (49.6)
Data Analyst / Telescope Operator

When will science verification be?

- SKA becomes scientifically interesting around AA2
- Science verification expected to begin in 2026

Event	SKA-Low	SKA-Mid
Start of construction (T0)	✓ 1ST JULY 2021	✓ 1ST JULY 2021
Earliest start of major contracts (C0)	✓ AUGUST 2021	✓ AUGUST 2021
Array Assembly 0.5 finish (AA0.5) SKA-Low = 6-station array SKA-Mid = 4-dish array	FEBRUARY 2024	MARCH 2024
Array Assembly 1 finish (AA1) SKA-Low = 18-station array SKA-Mid = 8-dish array	FEBRUARY 2025	FEBRUARY 2025
Array Assembly 2 finish (AA2) SKA-Low = 64-station array SKA-Mid = 64-dish array, baselines mostly <20km	FEBRUARY 2026	DECEMBER 2025
Array Assembly 3 finish (AA3) SKA-Low = 256-station array, including long baselines SKA-Mid = 133-dish array, including long baselines	JANUARY 2027	SEPTEMBER 2026
Array Assembly 4 finish (AA4) SKA-Low = full Low array SKA-Mid = full Mid array, including MeerKAT dishes	NOVEMBER 2027	JUNE 2027
Operations Readiness Review (ORR)	JANUARY 2028	DECEMBER 2027
End of construction	JULY 2029	JULY 2029

Science Verification: The concept

- Based on the ALMA/ESO model
- Announcement to the community inviting short proposals to utilise specific modes and capabilities of the SKA
- Internal technical appraisal of the proposals received by the Observatory to ensure that they meet the stated objectives
  - Do they provide the tests that we need? Do they use the correct modes?
- Light-touch priority assessment (possibly internal or external panel)
  - Pool of suitable proposals, not a scientific ranking
  - Are there comparison data from similar arrays?

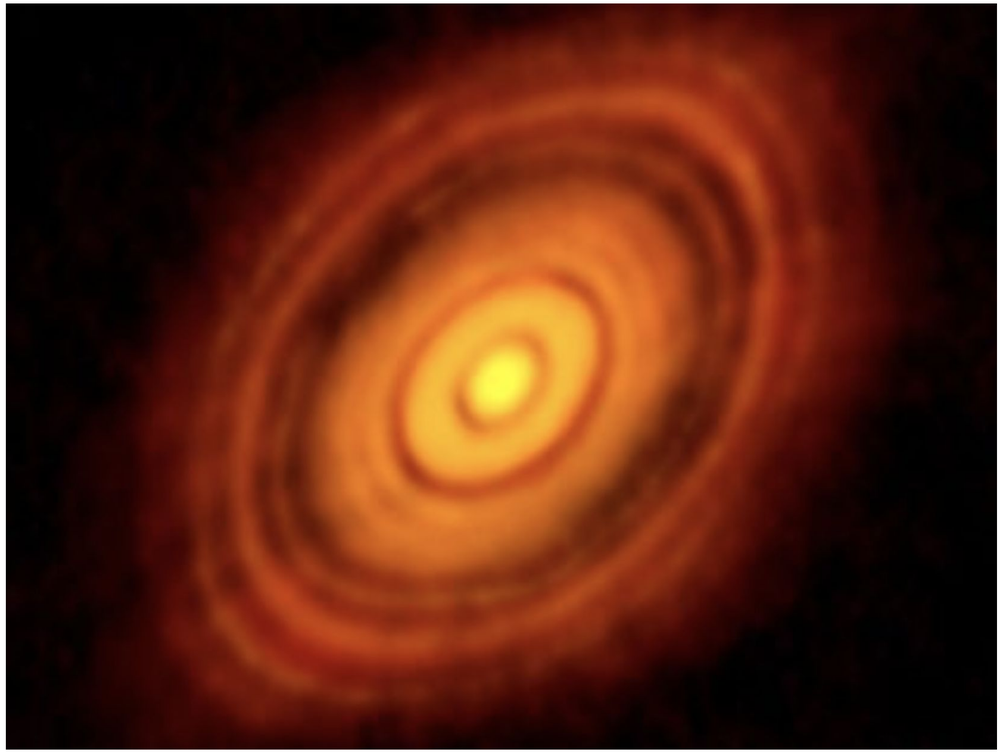
Science Verification: The concept, continued

- Execution of full end-to-end test, starting with mock proposal and ending with Quality Assurance and data delivery
  - Partial in early phases
- Data releases will be public and announced in advance
  - Made by SRCNet
  - Full processed data products (e.g. image cubes, averaged visibilities)
  - Visibility data in earlier phases
- Each SV observation generates a report which can be used to assess the status of the associated observing mode

Importance of science verification

- Astronomy community will be closely involved!
  - Provide the targets
  - Public data releases involve the community in the scientific exploitation at and early stage and fostering an early science return!
  - Allowing us to demonstrate the potential of an observing mode to the wider community
  - Validating data reduction workflows (allowing the SKA to begin to build trust in our generated data products)

- End-to-end test of the system
  - Do all our systems work? Proposal process, observing mode, tools, data processing, data delivery, SRCNet analysis, are our people prepared etc!
  - Important milestone before we put out a call for proposals



HL Tau Science Verification image from ALMA! Credit: ALMA (NRAO/ESO/NAOJ); C. Brogan, B. Saxton (NRAO/AUI/NSF)

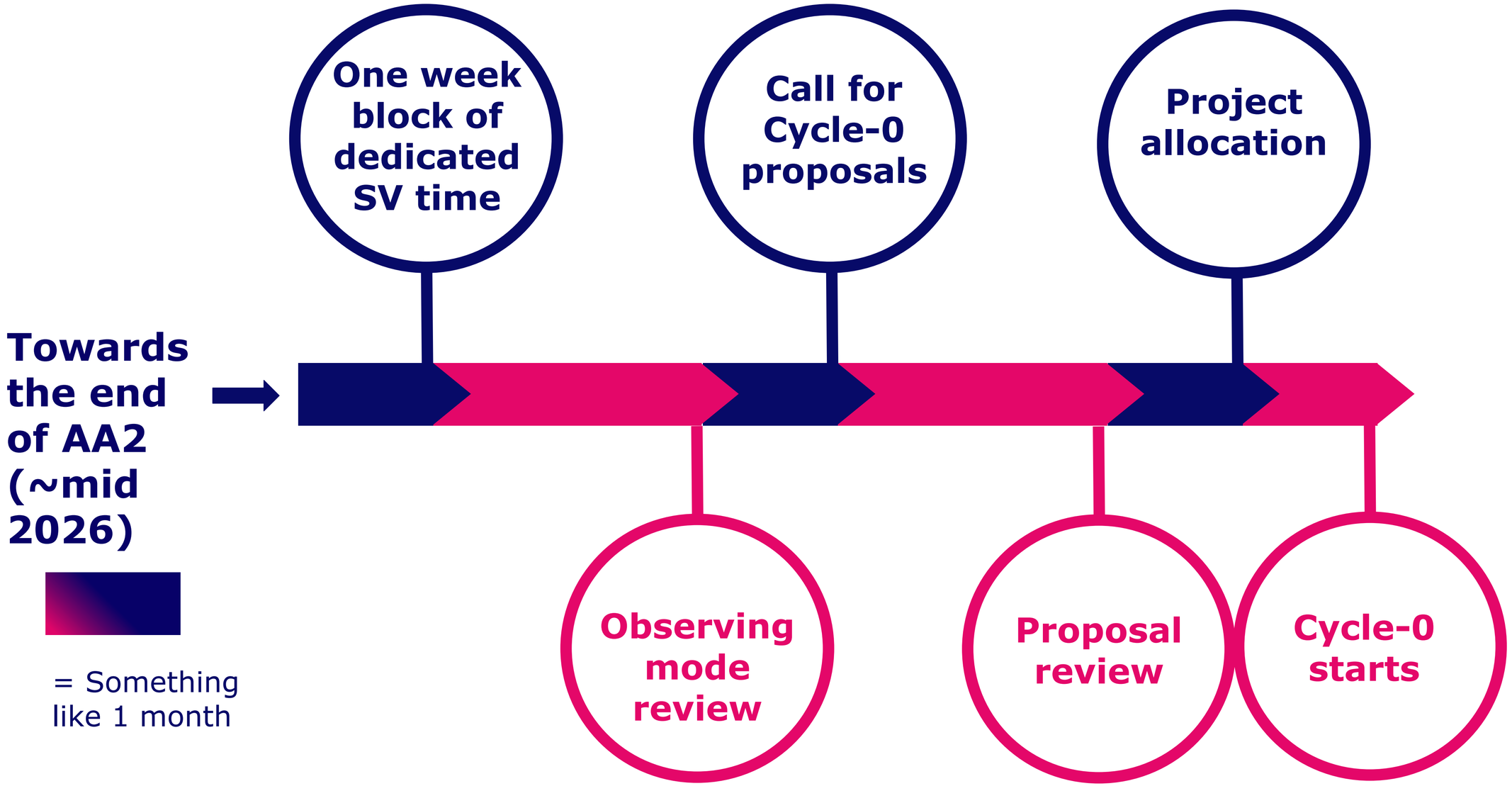
Stages of Science verification and beyond

- Early science verification
  - Worthwhile from the later phases of AA2, when capabilities become comparable with existing arrays
  - Interspersed with science commissioning
- Preparation for Cycle 0: first open call, shared risk
  - Observing Modes Review to decide what to offer in Cycle 0
  - Dedicated block of SV observations scheduled to inform this review (end 2026)
- Handover to Operations
  - Formal end of construction is signified by a successful Operations Readiness Review (ORR).
  - Requires a second dedicated SV block (“Dress Rehearsal”) at around the middle of 2027
  - Also acts as the Observing Modes Review for cycle 1

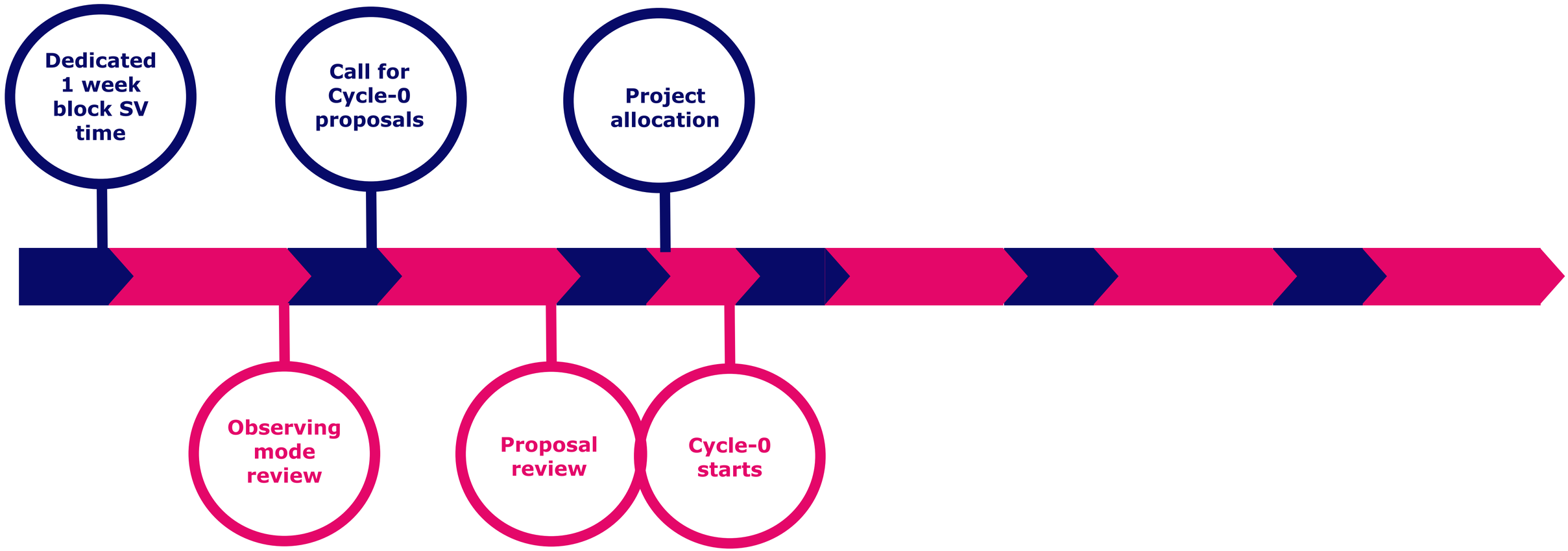
Staged delivery schedule as you were shown yesterday:

Event	Date (MID)	AA (mo)	Date (LOW)	AA (mo)
Earliest AA0.5	Jun 2024 - Dec 2024	7	Jan 2024 - Jun 2024	6
Earliest AA1	Jan 2025 - Nov 2025	11	Jul 2024 - May 2025	10
Earliest AA2	Dec 2025 - Sep 2026	10	Jun 2025 - Jul 2026	14
Earliest AA*	Oct 2026 - Aug 2027	9	Aug 2026 - Aug 2027	13
Earliest Operations Readiness Review	Nov 2027		Oct 2027	
ORR Closeout End construction (including contingency; Monte Carlo 80%)	Jul 2028		Jul 2028	

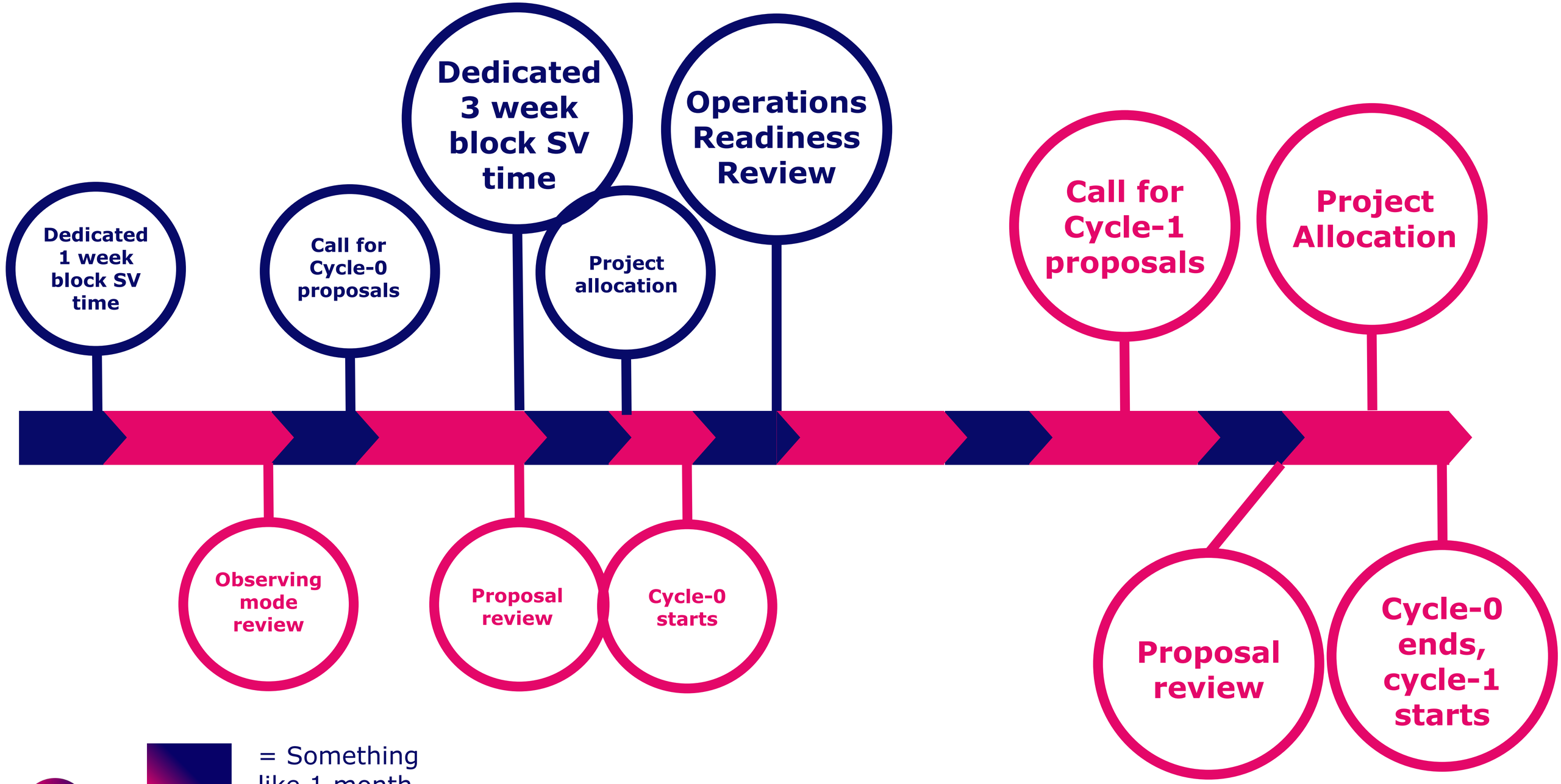
SV ahead of Cycle 0



SV ahead of Cycle-1



= Something like 1 month

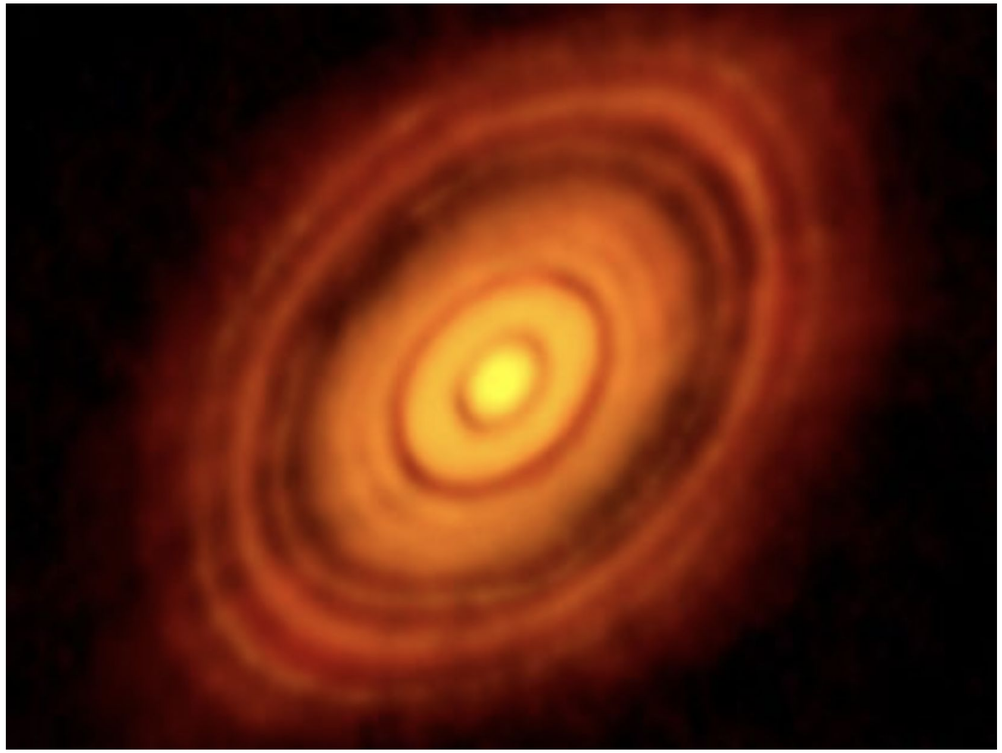

Dedicated 1 week block SV time
Call for Cycle-0 proposals
Dedicated 3 week block SV time
Project allocation
Operations Readiness Review
Call for Cycle-1 proposals
Project Allocation
Observing mode review
Proposal review
Cycle-0 starts
Proposal review
Cycle-0 ends, cycle-1 starts
= Something like 1 month

What modes are planned to be available when?

- Preliminary lists being developed, recent feedback was given by our SEAC and this will be incorporated before we detail the plan more broadly :)

Summary

- The astronomer community will be integral to Science verification!
- We will ask you to submit proposals and help us test our systems
- In return we will provide early access to SKA data for exploitation!
- Many science operations jobs upcoming, including 4 soon to be advertised positions at Low, please get in touch!



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Thank you!

Shari.Breen@skao.int

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