



Preparing for science with the SKA telescopes

Sarrvesh Sridhar - Operations Scientist

Swiss SKA Days – 1 Sep 2026



Setting the scene

1. Capabilities of the SKA telescopes in steady state operations

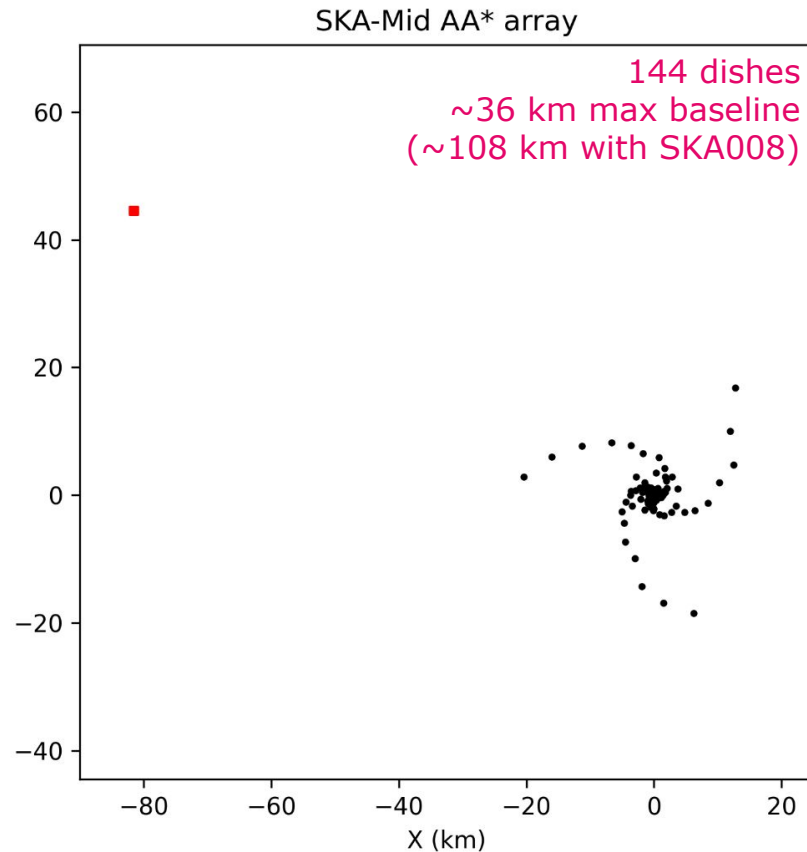
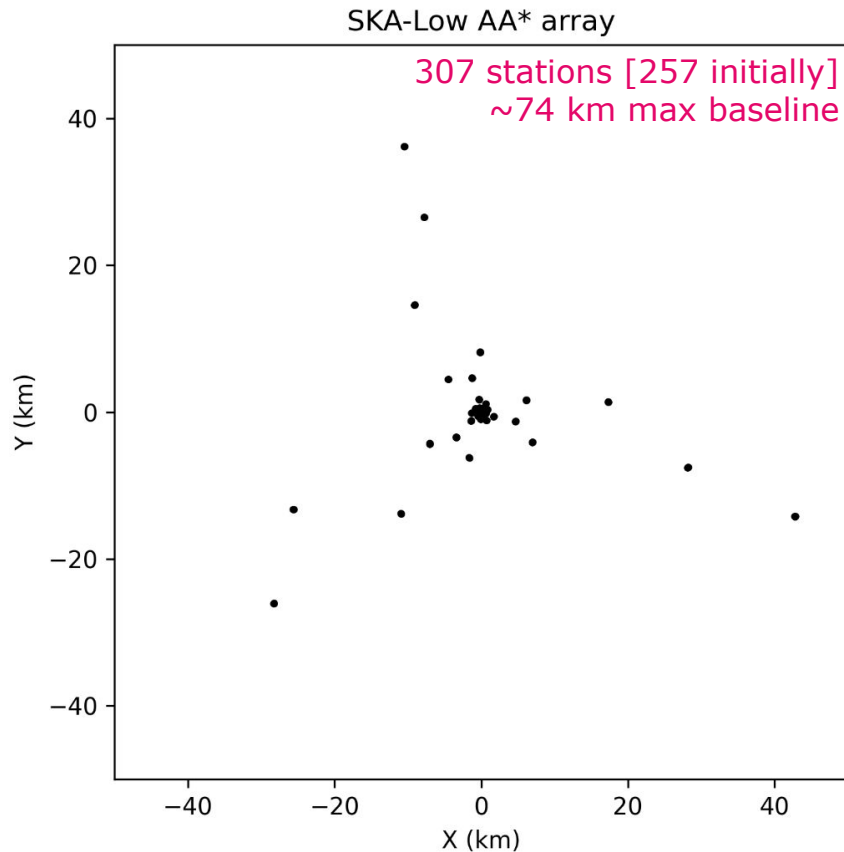
- Array layout
- Observing modes & data products
- Subarraying capability
- Substations with SKA-Low

2. Preparing for Science Verification (i.e.) When can you play with SKA data?

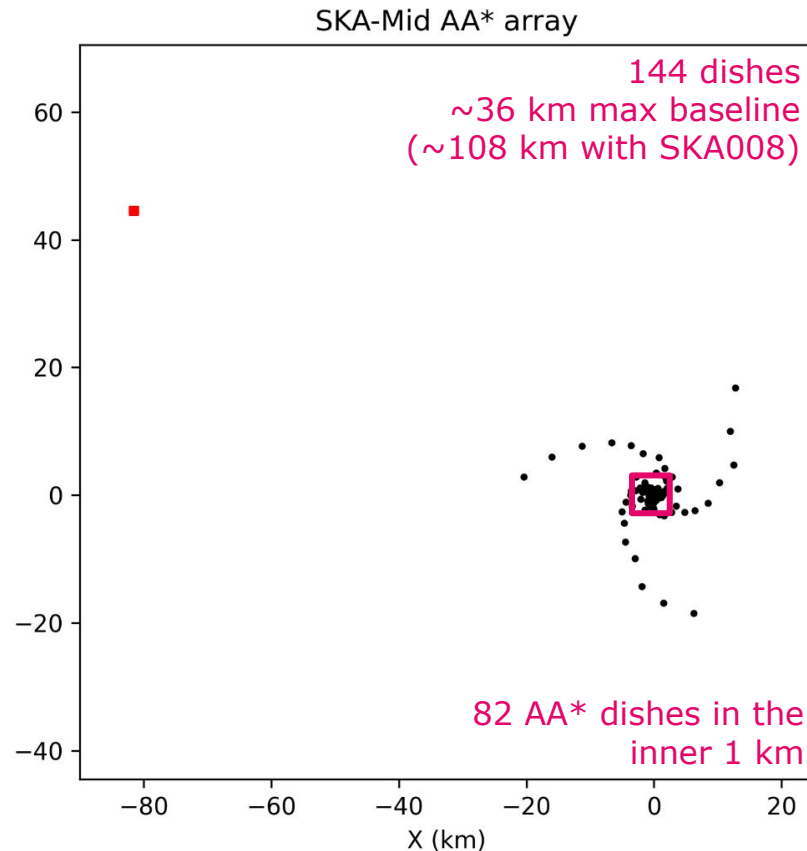
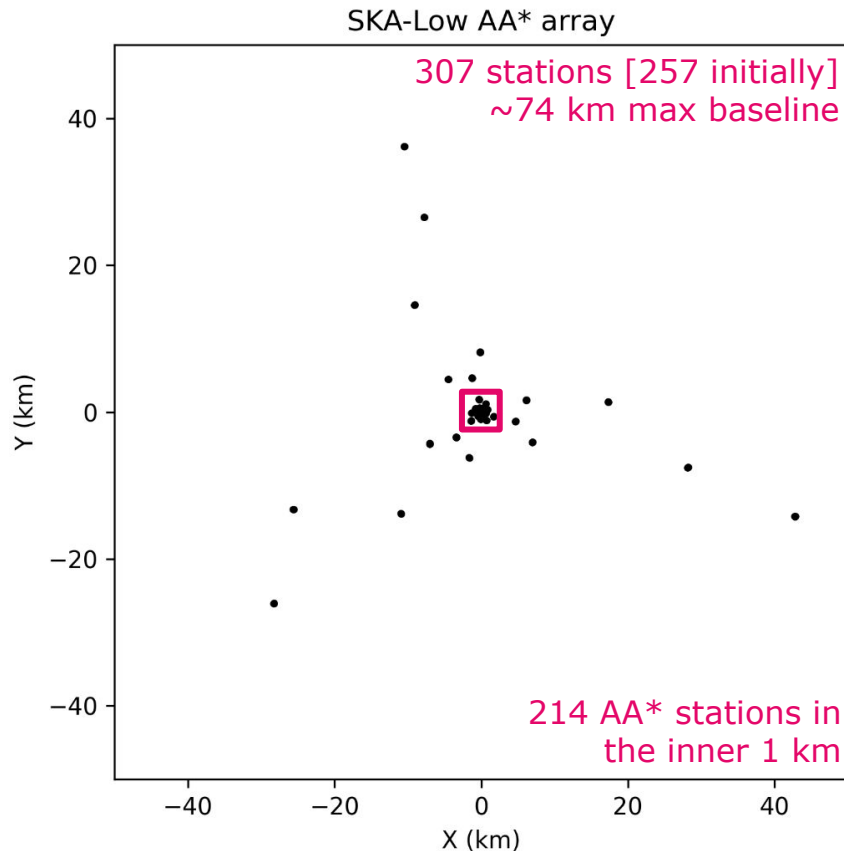
- What data products can you access?
- Timeline
- User tools



SKA-Low and SKA-Mid arrays in AA*



SKA-Low and SKA-Mid arrays in AA*



Receiver bands in AA*

SKA-Low

SKA-Mid



Field of View



Band 1



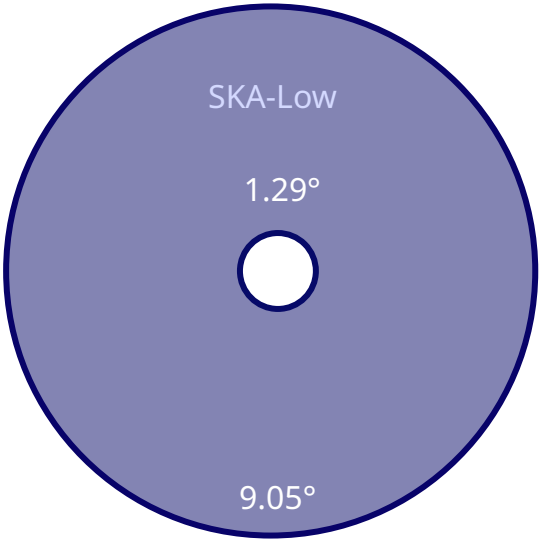
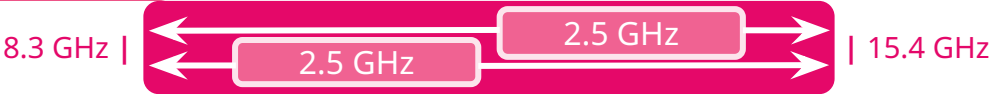
Band 2



Band 5a



Band 5b



Receiver bands in AA*

SKA-Low

SKA-Mid



Band 1

0.35 GHz | 700 MHz | 1.05 GHz

Band 2

0.95 GHz | 810 MHz | 1.76 GHz

Band 5a

4.6 GHz | 3.9 GHz | 8.5 GHz

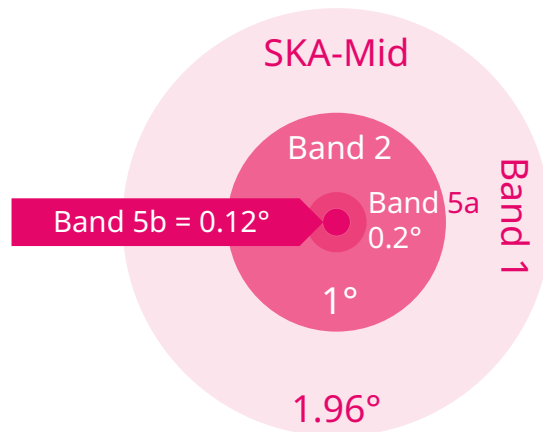
Band 5b

8.3 GHz | 2.5 GHz | 2.5 GHz | 15.4 GHz

Two independently tunable 2.5 GHz SPWs

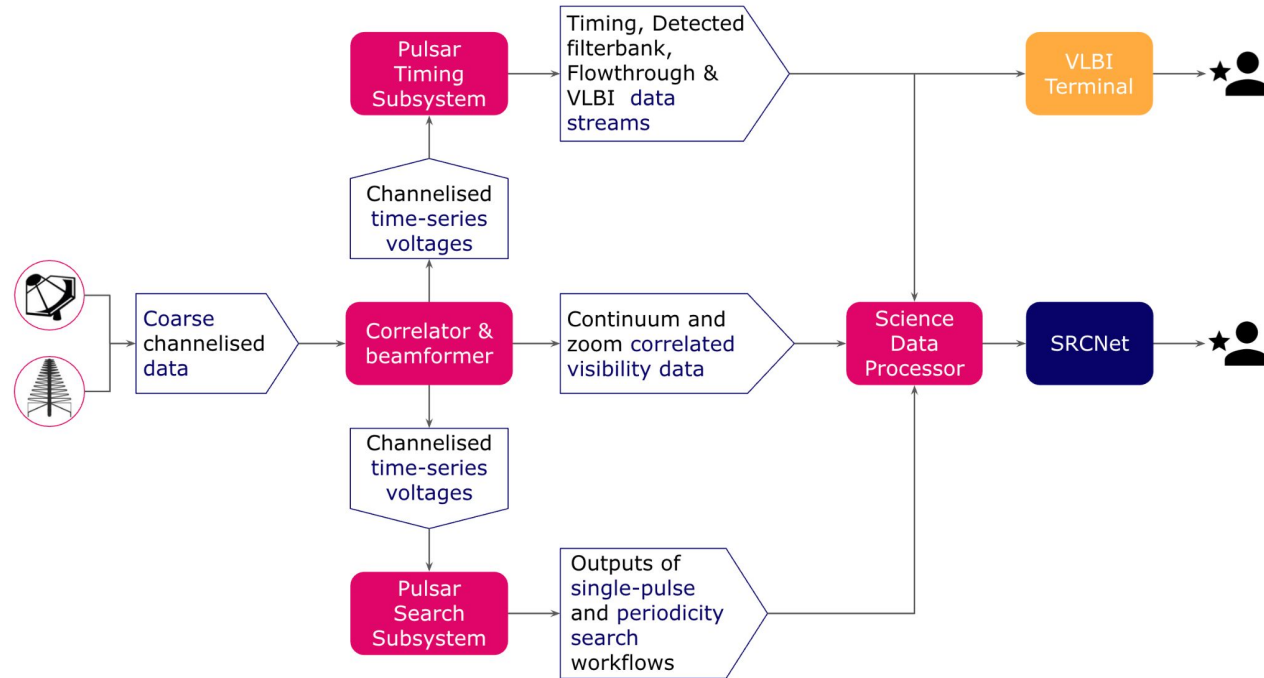
Field of View

(at the centre of each band)

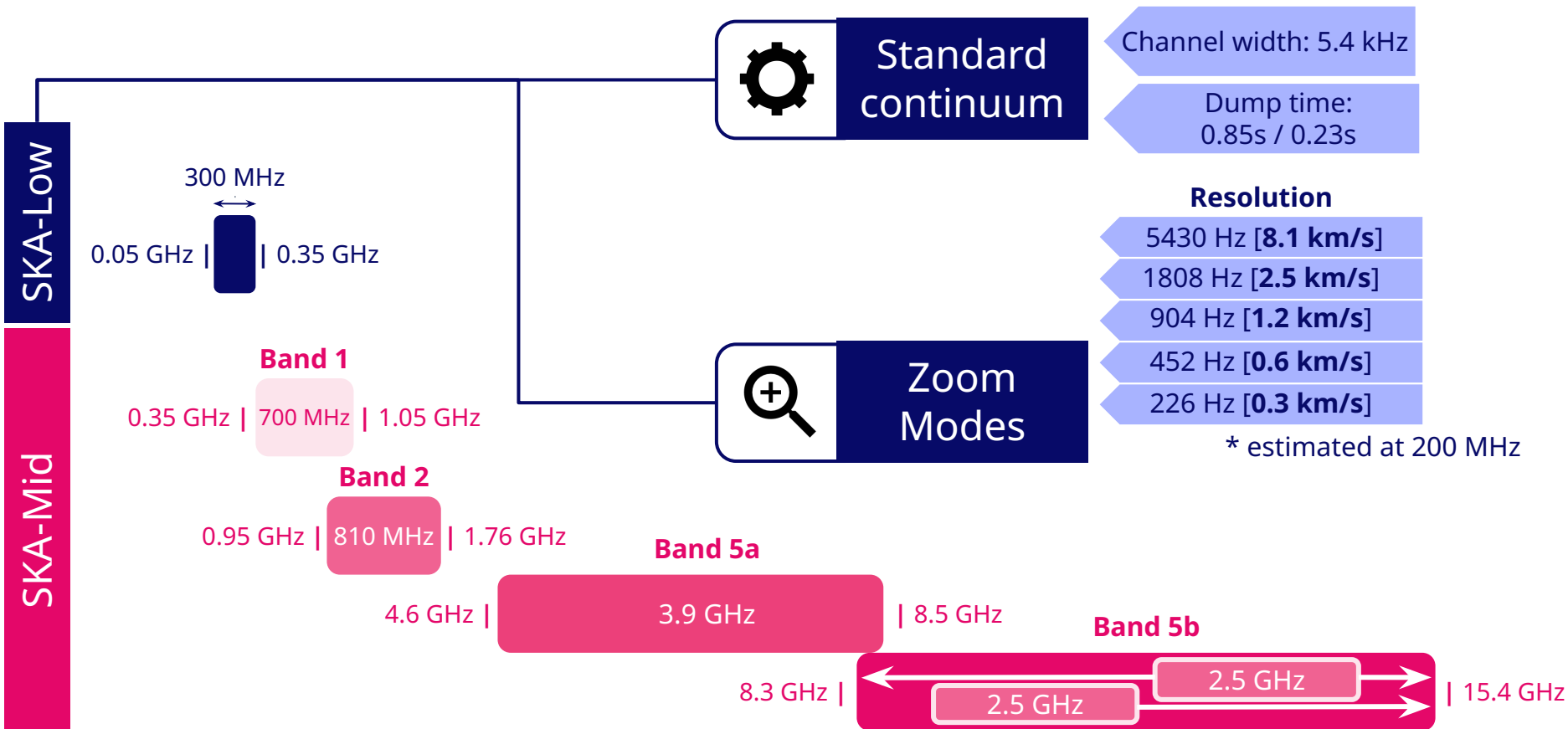


Observing modes

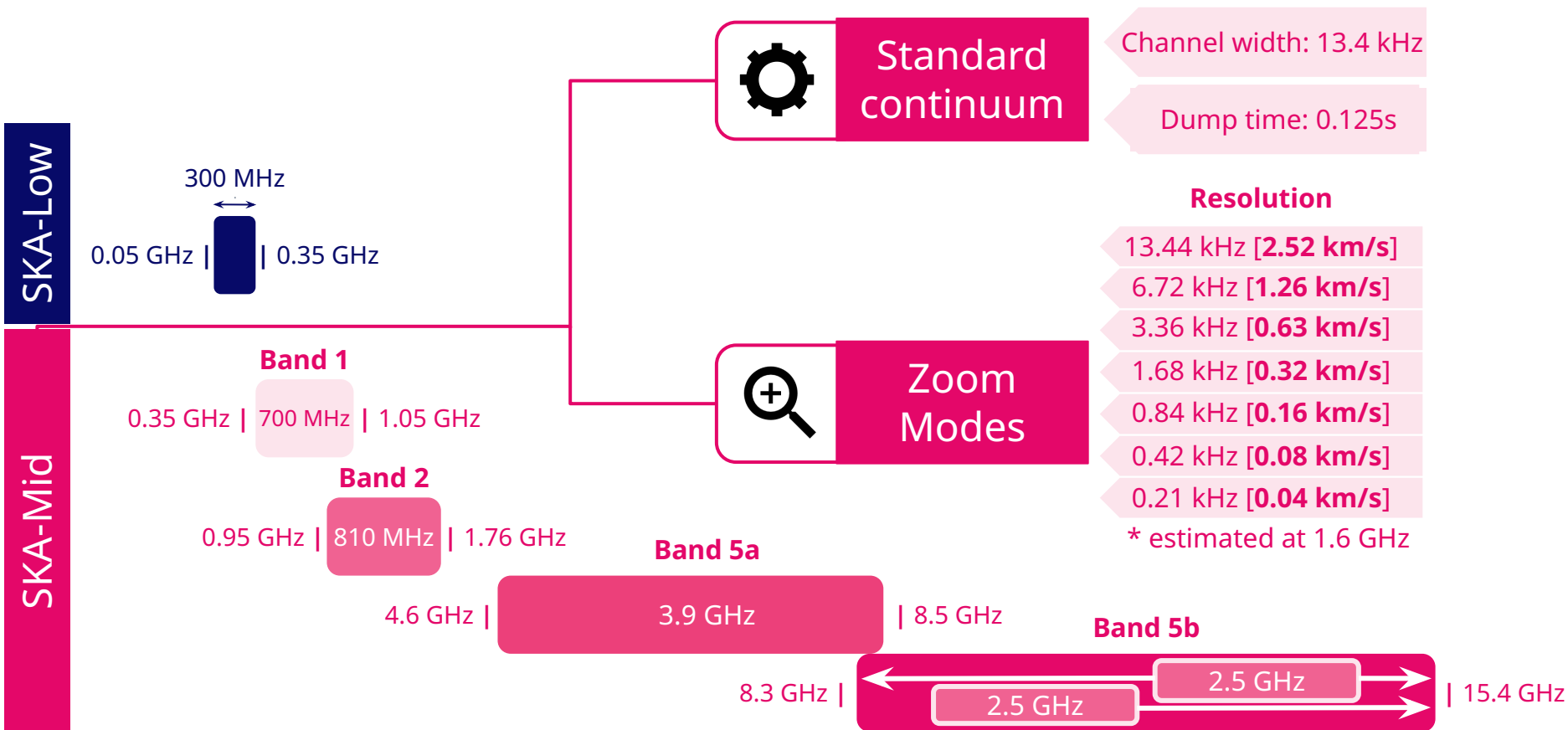
- Imaging
 - Continuum
 - Spectral line
- Tied array beamforming
 - Pulsar search
 - Pulsar timing
 - VLBI
- Buffer dump



Imaging modes with SKA-Low



Imaging modes with SKA-Mid



Pulsar Search Subsystem (PSS)

- Tied array beams used to search for pulsars and transients over a large field of view
- Single-pulse and periodicity search
- Single-pulse search can trigger a transient buffer dump

SKA-Low

- 250 PSS beams
- 118.52 MHz bandwidth
- 69.12 μ s time resolution
- 14.5 kHz frequency resolution

SKA-Mid

- 1125 PSS beams
- Up to 300 MHz bandwidth
- 65 μ s time resolution
- 107.5 kHz frequency resolution



Pulsar Timing Subsystem (PST)

- 8 PST beams in SKA-Low. 16 PST beams in SKA-Mid
- Up to 300 MHz bandwidth on SKA-Low. Up to 2500 MHz bandwidth on SKA-Mid
- Each PST beam can be independently configured to operate in one of the following three modes

Pulsar Timing

- Converts tied-array dual-polarisation voltage beams into folded integrated pulse profiles,
- time resolution of 207.36 μs for Low & 18.60 μs for Mid
- Scan lengths limited to ≤ 300 min

Detected filterbank

- Previously called dynamic spectrum
- converts channelised time-series voltages into time- & frequency-resolved spectrum with configurable time & frequency resolutions

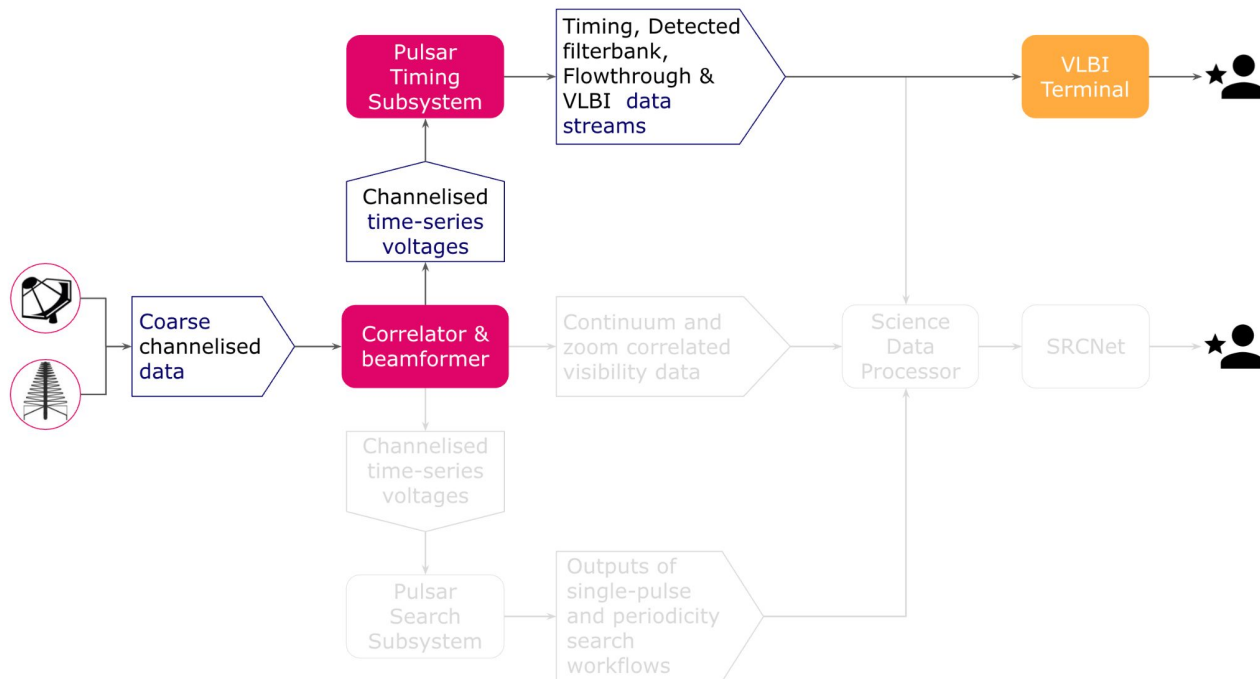
Flow Through

- Flow-through mode transmits channelised time-series voltages from tied-array PST beam to SDP with minimal signal processing



VLBI observing mode

- PST beams can be repurposed to record VLBI data streams
- Up to four 64 MHz bandwidth with SKA-Low
- Up to four 2.5 GHz bandwidth with SKA-Mid

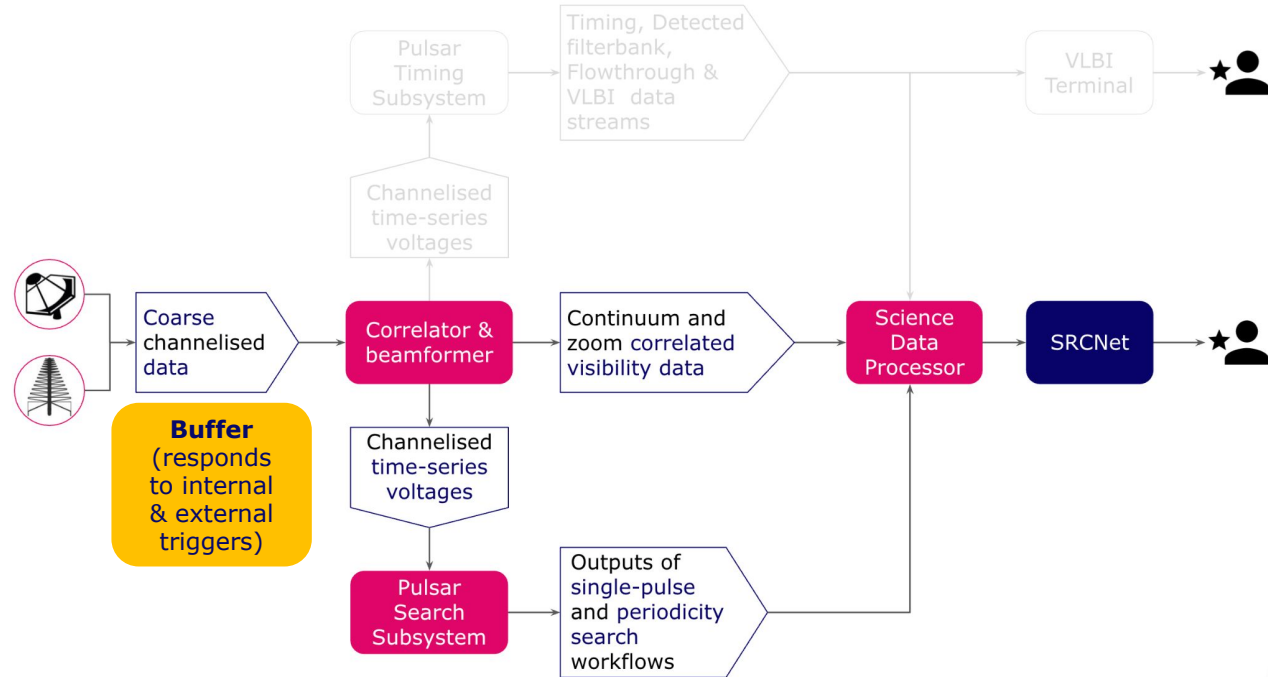


VLBI data streams are forwarded to an external correlation facility; no further data processing on SKAO infrastructure

Observing modes

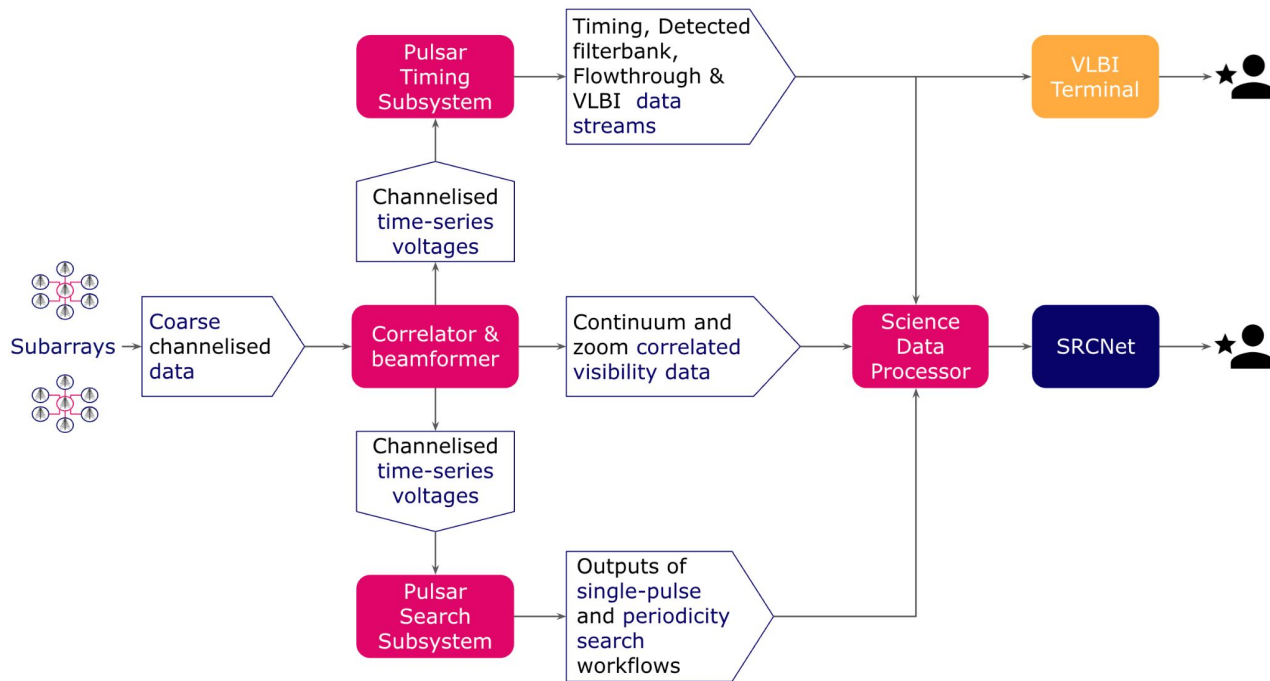
- Imaging
 - Continuum
 - Spectral line
- Tied array beamforming
 - Pulsar search
 - Pulsar timing
 - VLBI
- Buffer dump

Dual polarisation raw voltages



Flexibility to create independent subarrays

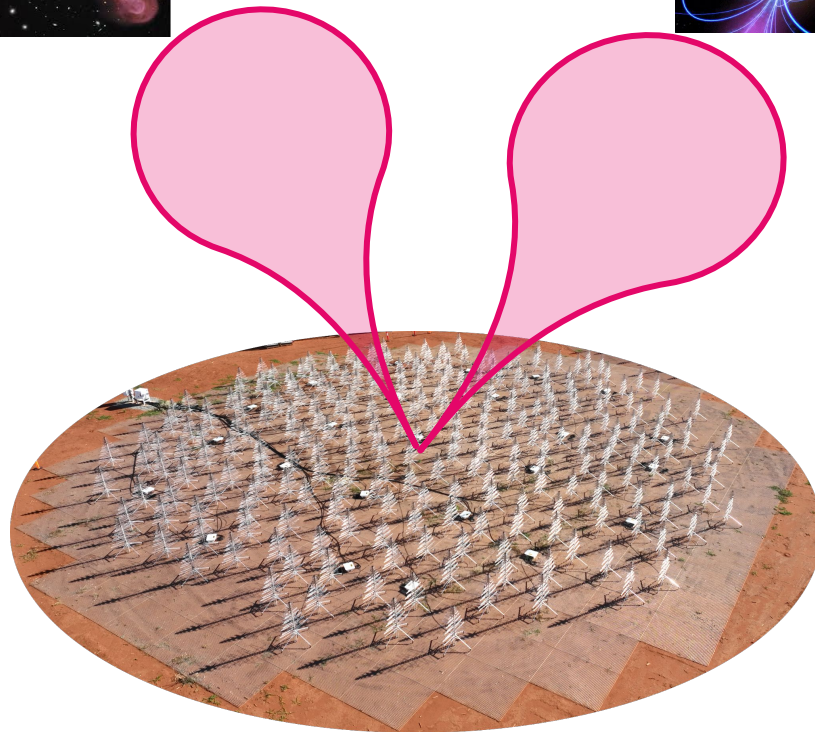
- Correlated and beamformed observations can run commensally
- Greatly improves the observing efficiency of the telescope
- LOW and MID arrays can be split into independent subarrays (upto 16)



SKA-Low will form up to 48 station beams



**Increases the
instantaneous
sky
coverage
(transient
monitoring,
large-area
surveys, ...)**



**Reduces
bandwidth per
station beam
(shared 300
MHz per
station)**



Substations with SKA-Low

Each Low station has 256 LFAA

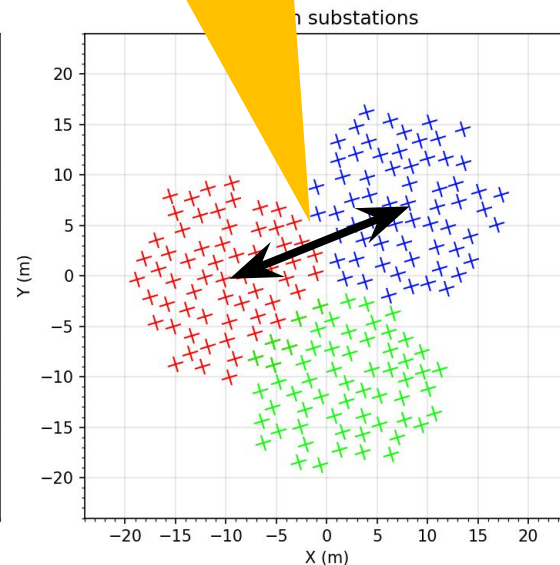
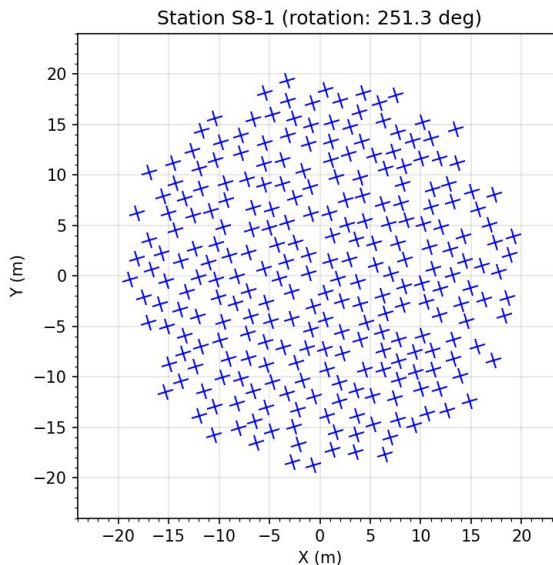
Benefits (compared to full stations)

- Shorter baselines
- Larger field of view

At the cost of

- reduced sensitivity per baseline
- Reduced instantaneous bandwidth

Access to shorter baseline lengths



Substation layout for illustration purpose only. No science use case assumed.



Substations with SKA-Low

Each Low station has 256 LFAA

Benefits (compared to full stations)

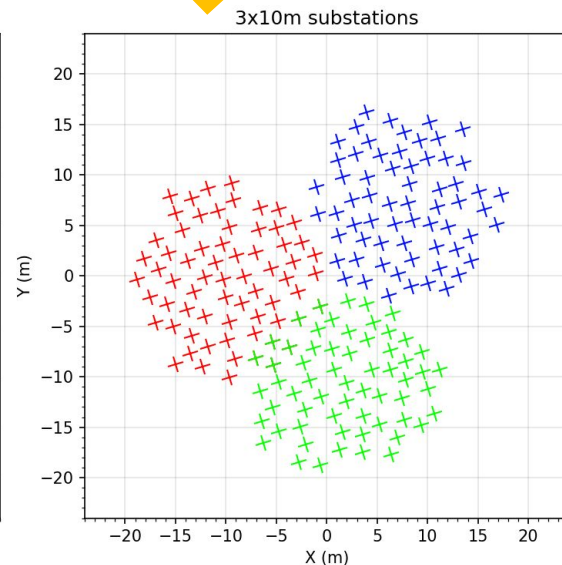
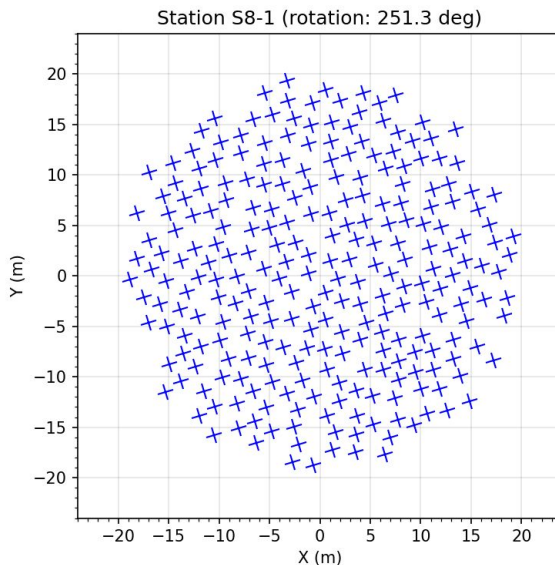
- Shorter baselines
- Larger field of view

At the cost of

- reduced sensitivity per baseline
- Reduced instantaneous bandwidth

Each substation produces an independent data stream

Max. 1440 substations



Substation layout for illustration purpose only. No science use case assumed.



Summary of telescope capabilities

- Brief document summarising the various capabilities of the SKA telescopes
- Available on the SKA website

[Link](#)



A year in the life of the SKA telescopes: overview and main outcomes

SKAO-TEL-0002665 Revision 01
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Role	Name	Designation	Affiliation	Signature	Date
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Released by	Lewis Ball	Director of Operations	SKAO	<i>Lewis T Ball</i>	2025-06-13

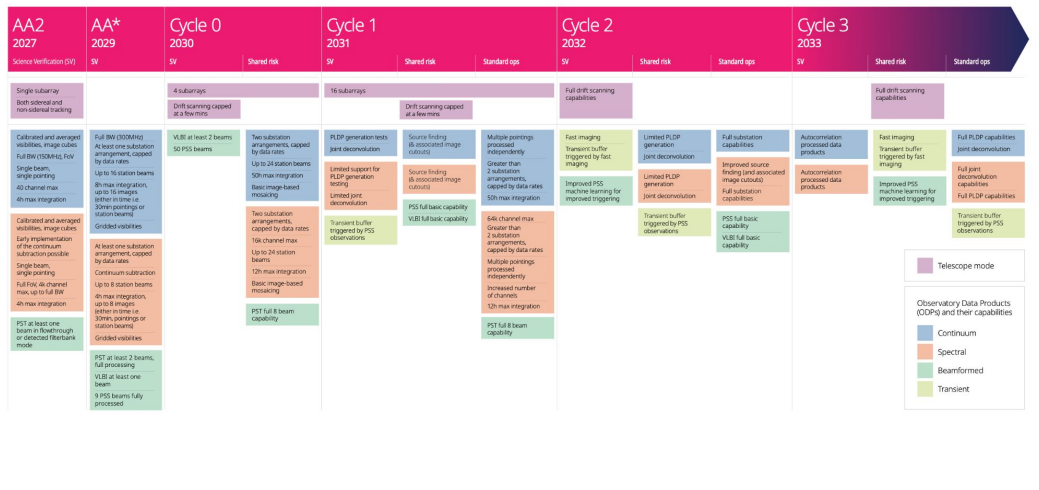


Roll out of modes and capabilities

<https://www.skao.int/en/647/timeline-science>



SKA-Low: Delivery of observing modes and ODPs to the astronomy community



The community will be given access to an increasing set of capabilities as we move through AA2 SV → ~Cycle 3 on each telescope. See our website for full rollout for both Mid and Low.



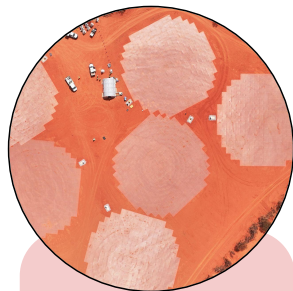
Science Verification



SKAO milestones

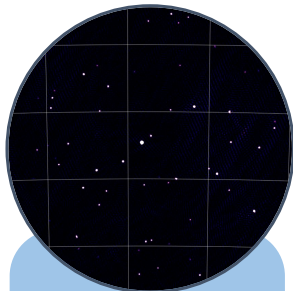
Community involvement starts

Credit: I. Heywood, SARAO



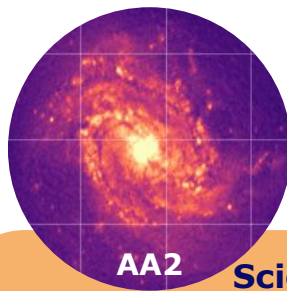
Construction

- Building antennas, dishes, roads...
- Followed by Assembly, Integration and Verification



Commissioning

- SKAO activity
- Collaborative across system verification and science commissioning



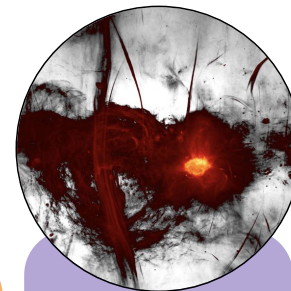
AA2

Science Verification

- **Primary purpose of SV is verification of the scientific capability, overall workflow and usability of the system** → science is a bonus, not guaranteed.
- Provide an end-to-end test of the system for each mode/ODP
- Must not place unnecessary burden on the SKA user community
- Build trust in operational model and excitement on our way to science



AA*



Cycle 0

- Shared-risk PI projects
- SRCNet resources ready for user
- proprietary periods



Now

Now

Mid 2027*

The start date for Low AA2 SV is currently under significant pressure

First half 2029

2030



Now

Now

First half 2029

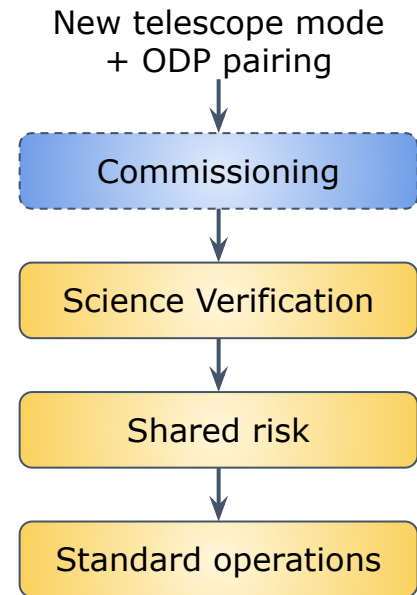
First half 2031

2032



High-level Science Verification

- Once a telescope mode and Observatory Data Product (ODP) pair have passed Science commissioning and internal checks, it will go through Science Verification (SV) → complexity and diversity of modes built up over time
- The community can suggest targets for SV, we will observe a set and deliver the data publicly
- SV will provide the first community access to SKA data
- Observations for SV will typically be simple, starting out with single source, single beam/pointing, single frequency, single epoch etc



T-6
month**Call for Science Verification (SV) Ideas**

Call(s) issued to the community for SV ideas to test specific modes and capabilities. Open for **2 months**. SKAO plans for SV targets and Observatory-led data products will be included.

T-6
month**Idea Submission**

Submit a SV idea through the SV Idea Submission Tool. Will require title, mode to be tested, summary of idea and verification opportunities, target.

T-4
month**Idea Assessment**

A light touch internal appraisal providing us with a pool of well suited, prioritised targets and ideas to test the modes and capabilities. Breadth of science coverage will be considered to ensure diverse user engagement.

T-3
month**Announcement of SV Target Set**

SV targets announced, including Observatory-led data product plans.

T-2.5
month**Call for SRCNet Resource Requests**

Expecting **restricted resource availability at first**, building as we go through SV stages. Resource request will include plan for verification of SV target, intention of providing feedback, feasibility.



T-0

**SV Idea Execution!**

Schedule block creation, observations scheduled and executed. ODPs created using SKAO systems and pipelines. Undergo rigorous Quality Assessment

**ODP delivery**

The data products available for download and analysis via the SRCNet. Includes both highly processed ODPs + more raw products. Includes processing descriptions and Quality assessment report.

**Feedback**

Encouraged to provide feedback on ODPs and overall experience of the system (SKAO + SRCNet). Bar will be low - simple form, no mandatory questions.

**SV Memo series**

Avenue of publishing detailed technical assessment of SV ODPs. Submissions reviewed by a panel. Functionality to pair with updated documents/make comments.

**Publications**

Although not the focus we are of course expecting some science publications. Anyone can publish, not expecting builders lists.



SKA-Low: Delivery of observing modes and ODPs to the astronomy community

AA2
2027

Science Verification (SV)

Single subarray

Both sidereal and
non-sidereal tracking

Calibrated and averaged
visibilities, image cubes
Full BW (150MHz), FoV

Single beam,
single pointing
40 channel max
4h max integration

Calibrated and averaged
visibilities, image cubes
Early implementation
of the continuum
subtraction possible

Single beam,
single pointing
Full FoV, 4k channel
max, up to full BW
4h max integration

PST at least one
beam in flowthrough
or detected filterbank
mode



1 subarray



1 pointing

50% bandwidth

150 MHz



Max 4 hrs

1 beam

Sidereal & non-sidereal tracking

AA2 Science Verification observations

Continuum

Up to 150 MHz bandwidth
with ~28k channels
at 5.4 kHz
(native cont. spectral
resolution)

Pulsar timing (PST)

At least 1 PST beam
up to 150 MHz

Spectral Line

Up to 150 MHz bandwidth
with ~28k channels at 5.4 kHz

Limited bandwidth in Zoom
resolution: 226 - 1808 Hz

Expecting to
exclude Galactic observations
at this stage as we build the
Global Sky Model

2027

68



AA2

65 km

2029

257*



AA*(Mod)

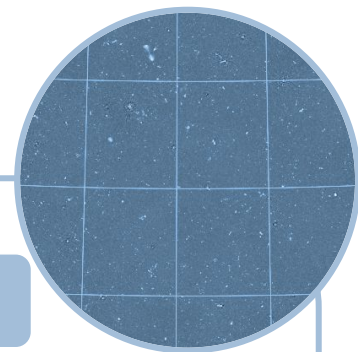
2030



0



Anticipated ODP delivery AA2 Low - Continuum



Continuum image cube example



1 source



Full polarization



Full FoV

Image cube

Up to **40** channels imaged if required
up to **5.4 kHz**

Default: **10** evenly spaced channels
covering up to the full bandwidth (150 MHz)

may be accompanied by a
bandwidth-averaged multi-frequency
MFS image in some cases

Calibrated visibilities*

averaged to **3.4 s** and **21.7 kHz**
up to the max available bandwidth.
(including calibrator visibilities)

Ancillary data products

Detailed QA
Local sky model
completed processing description

* This is an additional deliverable exclusive for SV to enable a thorough, end-to-end validation of the images



Anticipated ODP delivery AA2 Low - Spectral

Spectral image cube example



1 source



Full polarization



Full FoV

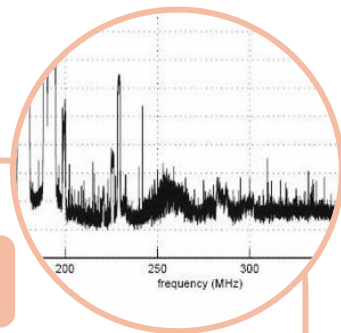


Image cubes

Up to **4k channels** for all products
(e.g., image, model, residual, psf)

Ancillary data products

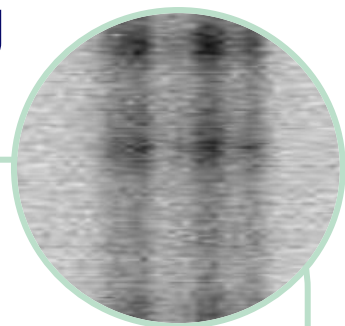
Detailed **QA**
Local sky model
completed **processing description**

Calibrated visibilities*

averaged to **3.4 s**
and the spectral resolution of the delivered spectral/zoom cube
(including calibrator visibilities)

* This is an additional deliverable exclusive for SV to enable a thorough, end-to-end validation of the images

Anticipated ODP delivery AA2 Low- Pulsar Timing



Pulsar Timing (PST) example

Detected filterbank

Full polarization cubes, averaged to the requirements of the idea, capped by data rates.

OR

Flowthrough

dual-polarisation beamformed voltages, configurable bit depth averaged to the requirements of the idea, capped by data rates.



1 beam

Ancillary data products

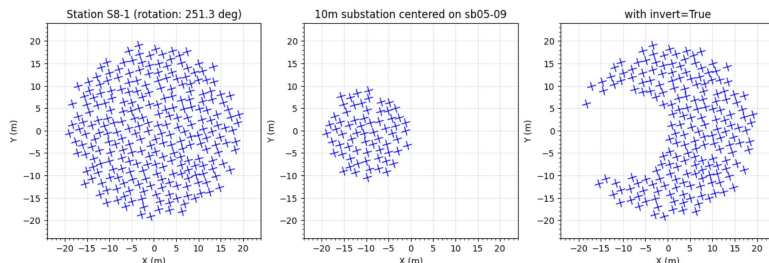
Detailed QA
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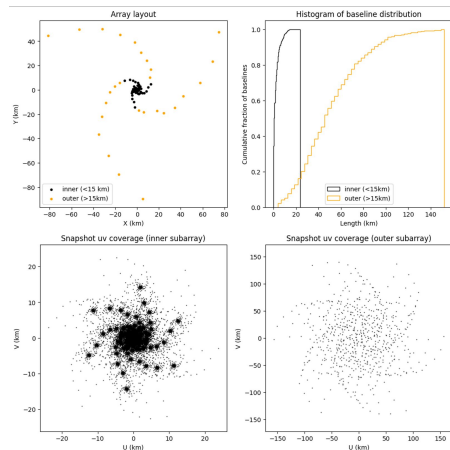
SKA User Tools



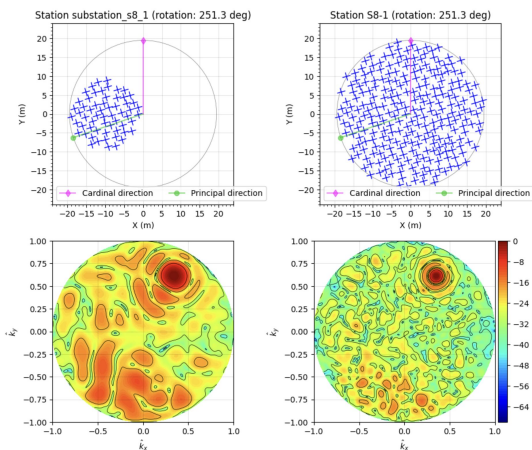
SKA-Low Station Layouts



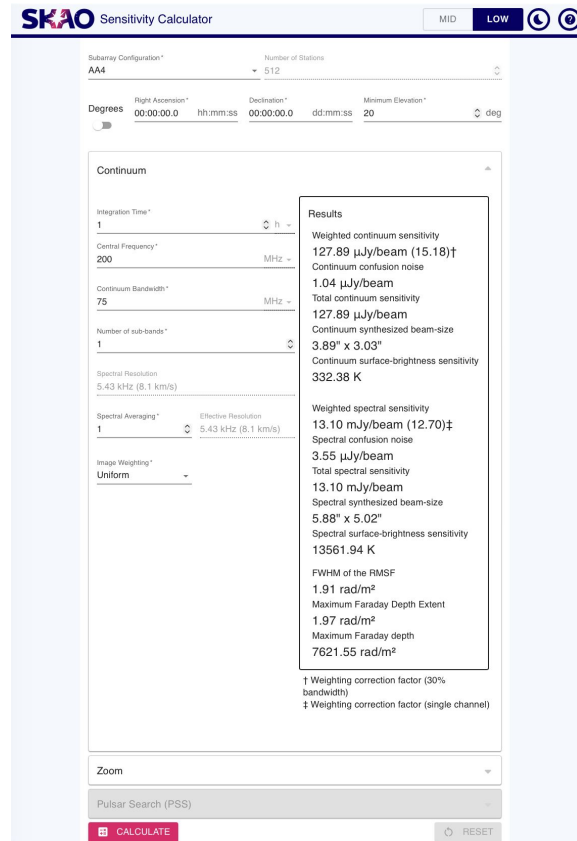
Array Assemblies & Subarrays



SKA-Low Station Beam Response



Sensitivity Calculator



How you can get involved?



Join a Science Working Group



Volunteer for current & future community testing opportunities



Follow the SKAO science community webinars & newsletter (every 4 months)

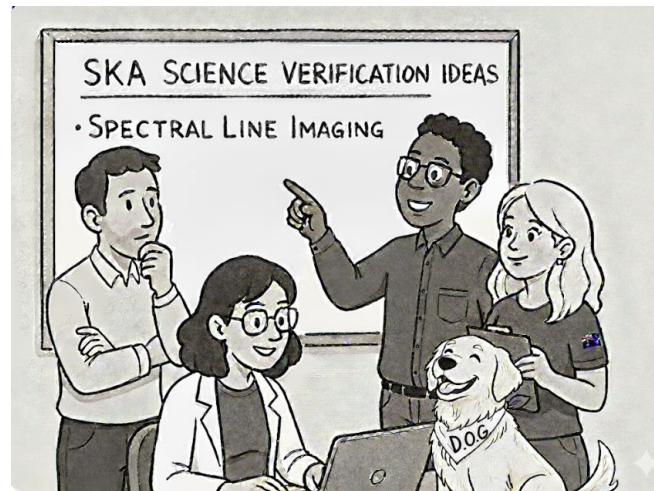


Summary

- SV is an exciting phase for both the Observatory and the community and it is coming soon - time to start thinking about ideas!!
- SKA Helpdesk (SKAO + SRCNet) available soon, but in the meantime feel free to reach out to sciops@skao.int

Science Verification

- Primary purpose of SV is verification of the scientific capability, overall workflow and usability of the system → science is a bonus
- Provide an end-to-end test of the system for each mode/ODP
- Must not place unnecessary burden on the SKA user community
- Build trust in operational model and excitement on our way to science
- Goal to get broad feedback on SKAO operational model and SRCNet from a diverse user community → data will be publicly available for scrutiny



Feedback

is always welcome,
especially in the area of user tools and engagement
opportunities.

sciops@skao.int

*We recognise and acknowledge the
Indigenous peoples and cultures that have
traditionally lived on the lands on which
our facilities are located.*



www.skao.int

Extra slides



Subarray templates library

- During the proposal submission stage, astronomers will pick the appropriate subarray from a template library
- Subarray templates memo (+ simulation tool)
 - Based on a first round of consultation with the SWGs
 - Ample opportunities for more input from the community

[Link](#)



SKA Low and Mid subarray templates

SKAO-TEL-0002380

Revision 02

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UNRESTRICTED

Document type:

REP

Date:

2025-06-10

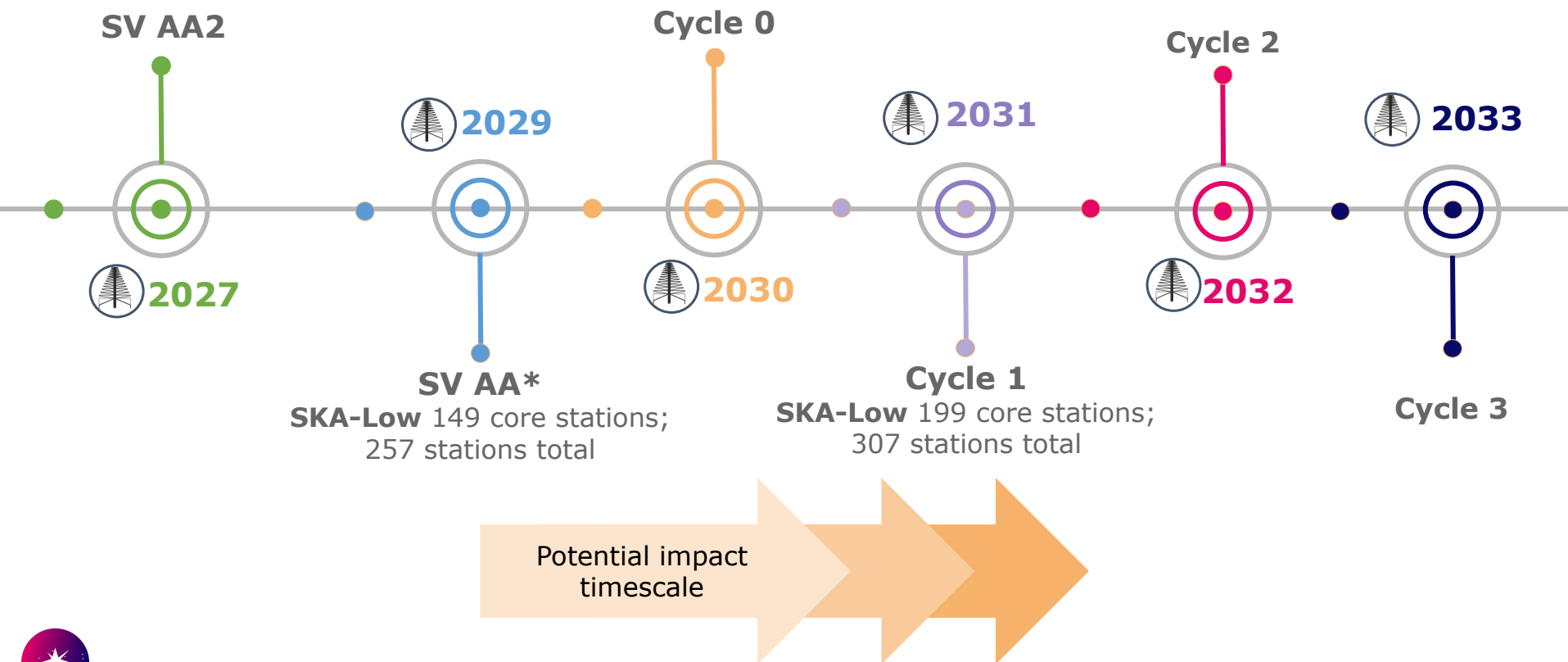
Status:

RELEASED

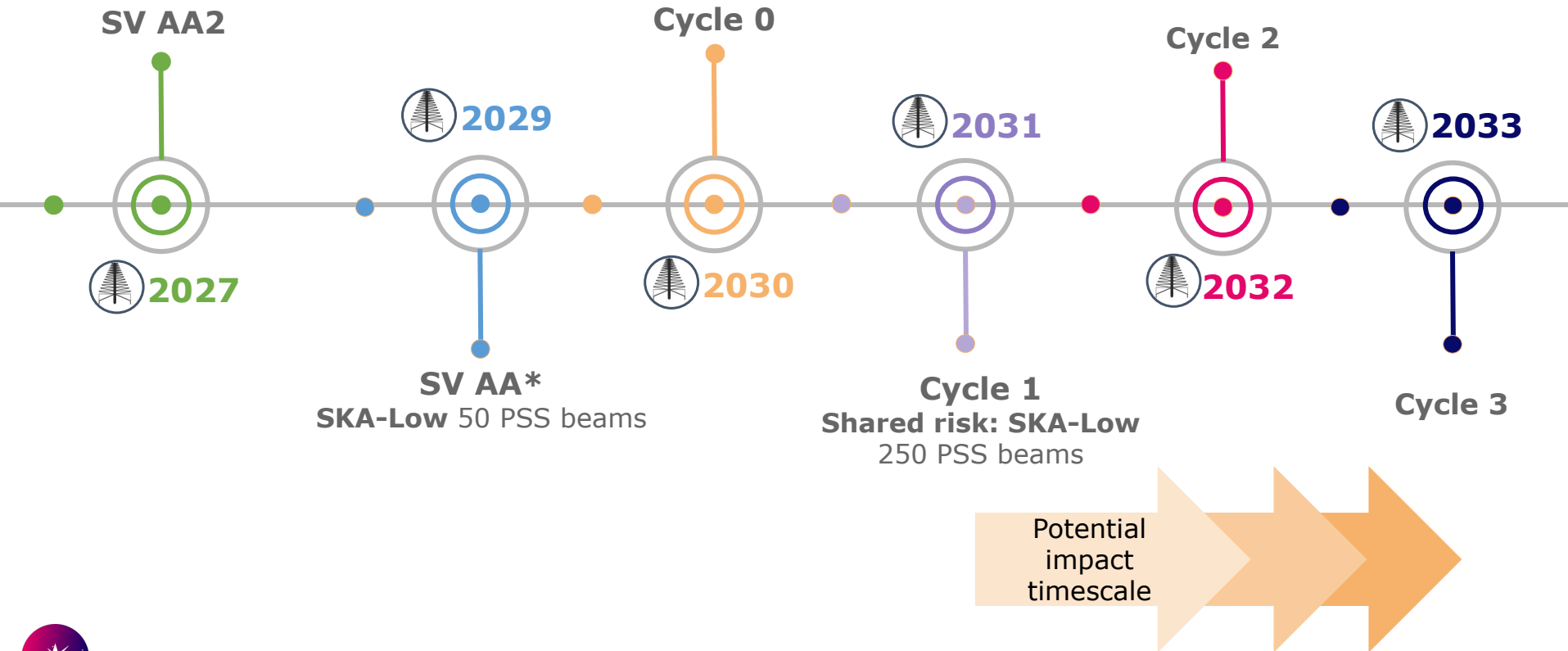
Role	Name	Designation	Affiliation	Signature	Date
Author	Sarrvesh Sridhar	Operations Scientist	SKAO		
Author	Wendy Williams	Observatory Scientist	SKAO		
Owner	Shari Breen	Head of Science Operations	SKAO		
Approver	Shari Breen	Head of Science Operations	SKAO		
Released by	Lewis Ball	Director of Operations	SKAO		



SKA-Low Core Stations: 50 stations deferred



SKA-Low PSS: impact of deferral



SKA-Mid PSS: impact of deferral

