SKA1　スケジュール

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国立天文台SKA1検討グループ

SKA1の構成　1

SKA GHQ　計画の統括

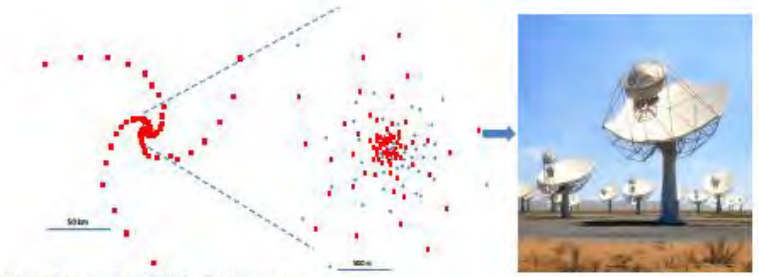
Figure 102. The SKA headquarters building at Jodrell Bank Observatory in the UK.

SKA1 LOW

Figure 122 Left: A close-up of a station. Right: overhead view of a station.

50－350MHz
512局（13.1万基）
65㎞　最大基線長

SKA1 MID



for pulsar and transient astronomy.

Figure 110. Left: The entire Mid array configuration; Middle: the inner 2 x 2 km region of the array (blue dots are the MeerKAT dishes). Right: A simulated view of the inner part of the array.

350MHz-15.4GHz
197局（133局＋64局（MeerKat））
150㎞　最大基線長

SKA1の構成　2

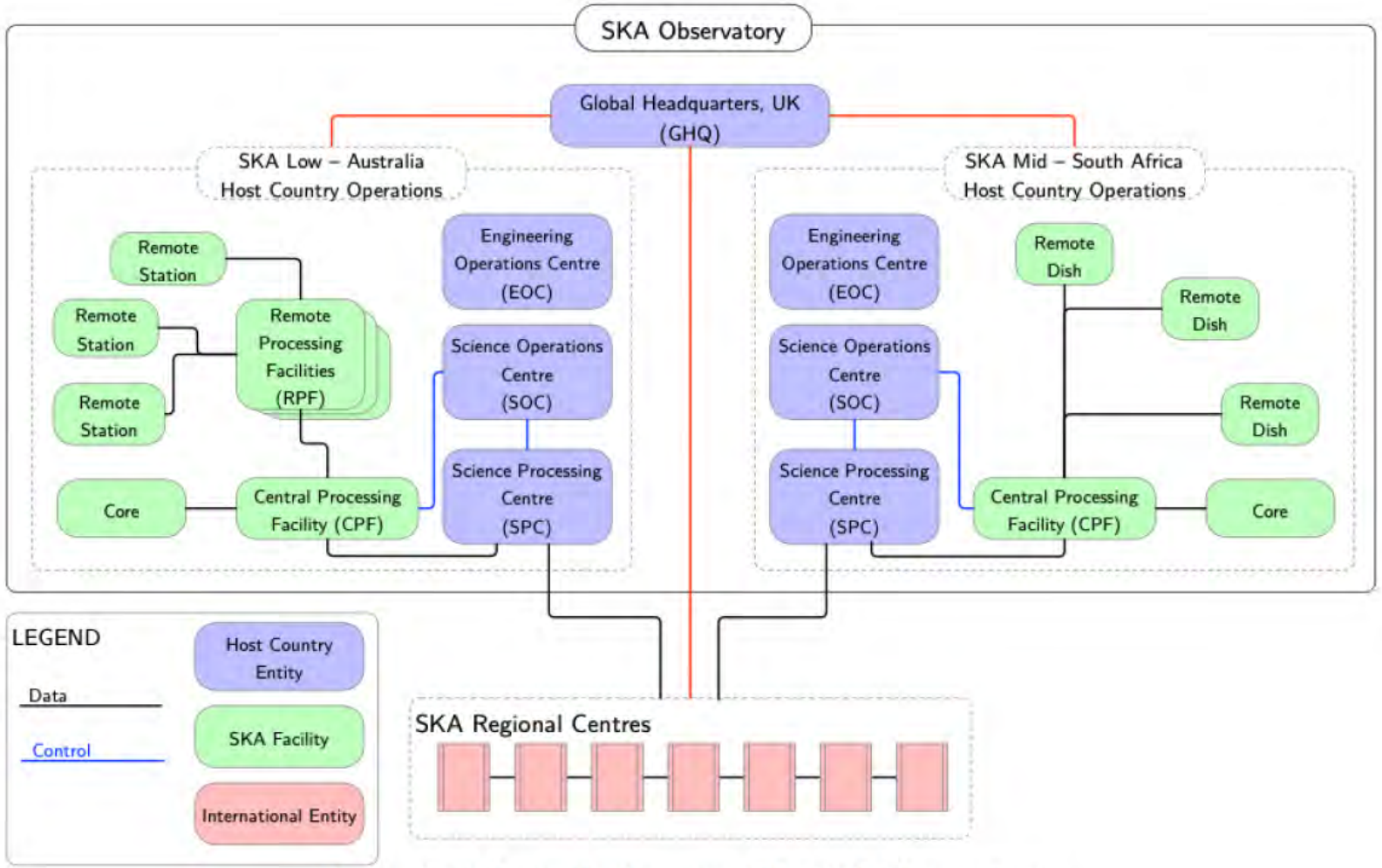


Figure 86. Schematic diagram of the SKA Observatory.

参加国（2021年2月現在）

■メンバー国（国際条約を批准し、政府として参加）

- イギリス・南アフリカ・オーストラリア（ホスト国）
- オランダ・イタリア・ポルトガル

■オブザーバ国

- メンバーを目指す国（条約の批准待ち）
  - ✓カナダ・中国・フランス・インド・スペイン・スウェーデン
- アソシエイトメンバーを目指す国（条約を結ぶが、政府機関としては参加しない）
  - ✓ドイツ・スイス・（韓国）
- コーポレーションアグリーメント（条約は結ばない）
  - ✓日本・韓国・（スイス）

建設の分担案

Contract	Tier 1 Lead	Status	Other Participating Countries	Contract type
Low Infrastructure	Australia	Conditional	-	ECCs
Low Infrastructure PSC	Australia	Conditional	-	PSC
Low Field Node	Italy	Conditional	Australia, United Kingdom	PSC, ECC (SC)
Low Digitisation	Italy	Conditional	Australia, India, United Kingdom, Netherlands	PSC, ECC (SC)
Low AIV PSC	Australia	Conditional	Japan, Netherlands	PSC
Low CSP	Netherlands	Conditional	Australia	ECC
Low Clocks	United Kingdom	Conditional	Switzerland	ECC
Low Timing	United Kingdom	Conditional	China, Spain	ECC
Mid Infrastructure	South Africa	Conditional	-	ECCs
Mid Infrastructure PSC	South Africa	Conditional	-	PSC
Mid Dish Structure	China	Conditional[1]	Italy, South Africa, Spain, Germany	ECC (SC)
Mid Dish PSC	South Africa	Conditional	-	PSC
Mid Digitisation	Sweden	Provisional[1]	Canada, France, South Africa	ECC
Mid AIV PSC	South Africa	Conditional	Japan and Portugal	PSC
Mid CSP	Canada	Conditional	TBD	ECC
Mid Clocks	United Kingdom	Conditional	Switzerland	ECC
Mid Timing	United Kingdom	Conditional	Australia, Spain	ECC
Mid Cryo	United Kingdom	Conditional[1]	(France, Germany)	ECC
MID SPF Services	South Africa	Conditional	-	ECC (SC)
Mid Band 1 SPF	Sweden	Conditional	India, Spain	ECC
Mid Band 2 SPF	South Africa	Conditional	-	ECC
Mid Band 5 SPF	United Kingdom	Conditional[1]	Sweden, (France, Portugal, Spain)	ECC
Low SPC	France	Conditional[2]	-	ECC (PSC)
Mid SPC	France	Conditional[2]	-	ECC (PSC)
Low Networks	Unallocated	-	-	ECC
Mid Networks	Portugal	Conditional[2]	-	ECC (PSC)
OMC	India	Conditional	Italy, Portugal, South Africa, United Kingdom	PSC
SDHP	United Kingdom	Conditional	Australia, China, Germany, India, Italy, Netherlands, Portugal, South Africa	PSC
Low CPF	United Kingdom	Conditional[2]	-	ECC (PSC)
Mid CPF	United Kingdom	Conditional[2]	-	ECC (PSC)
MeerKAT integration	South Africa	Conditional	-	PSC

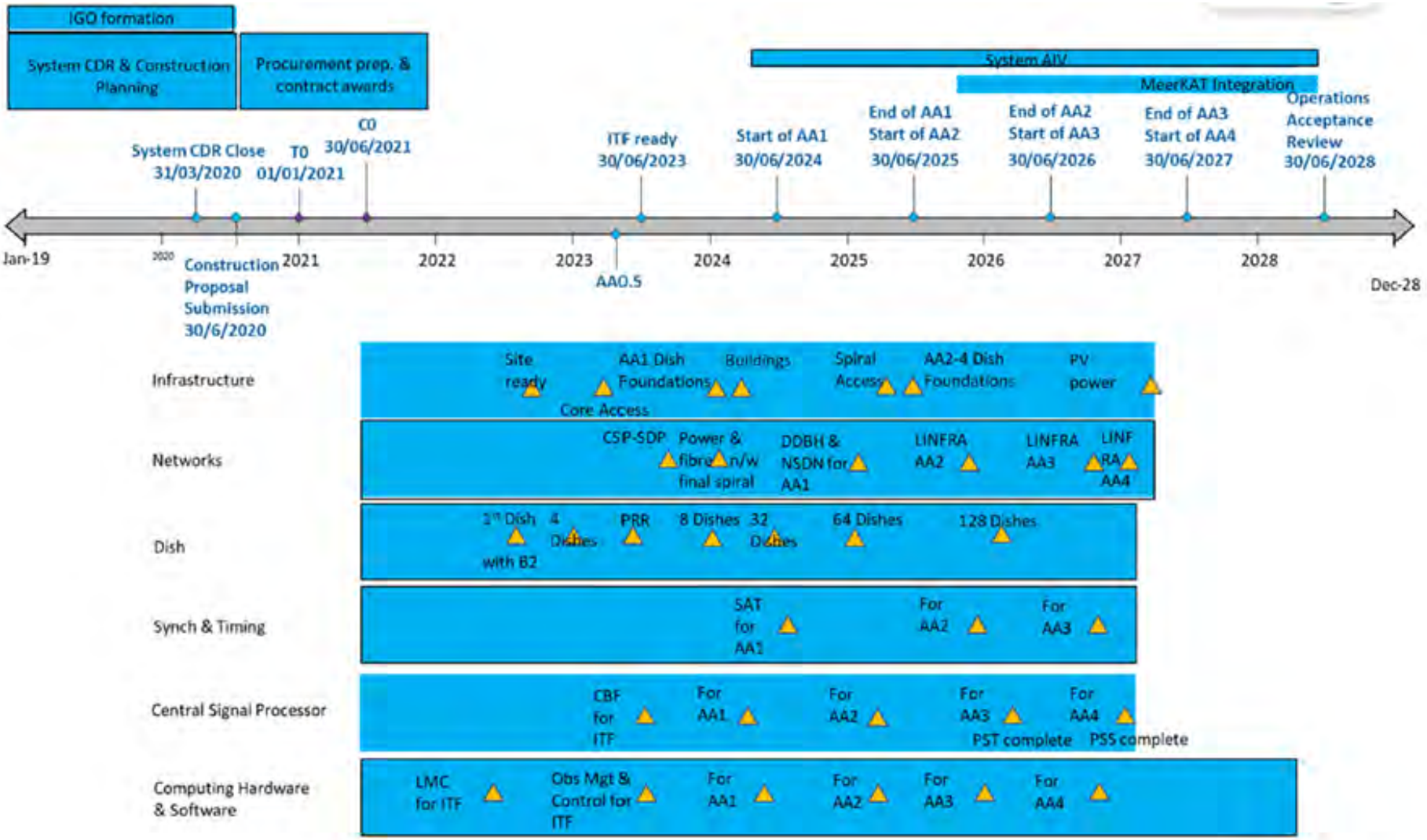
SKAはFair Work Return（FWR）を原則にしており、貢献額の70%をその国で調達する。

スケジュール

Table 12: Level 1 milestone completion dates.

Key project milestone	Identifier	LOW Telescope	MID Telescope
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	February 2024	March 2024
Array Assembly 1 finish	AA1	February 2025	February 2025
Array Assembly 2 finish	AA2	February 2026	December 2025
Array Assembly 3 finish	AA3	January 2027	September 2026
Array Assembly 4 finish	AA4	November 2027	June 2027
Operations Readiness Review	ORR	January 2028	December 2027
End of Construction		July 2029	July 2029

SKA1 MID Timeline



Schedule（MID）

- AA0.5
  - 4-dish array
    - Basic array element calibration demonstrated
    - Observation calibration demonstrated
    - Basic imaging
    - Data reduction expected to be off-line. No Science Verification in AA0.5.
- AA1
  - 8-dish array
    - Basic array element calibration demonstrated
    - Observation calibration demonstrated
    - Basic imaging
    - Data reduction expected to be off-line. No Science Verification in AA1.
- AA2
  - 64-dish array; baselines mostly <20km
    - Demonstrate ability to form at least one, steerable tied-array beam
    - Show that known pulsars can be detected and timed
    - Demonstrate imaging of a quality comparable to that of Extended MeerKAT in Bands 1 and 2
    - Refinement of calibration
    - Demonstrate ability to operate two independent subarrays
    - Data reduction expected to be off-line.
    - Demonstrations performed as Science Verification observations; data released publicly.
- AA3
  - 133-dish array, including long baselines
    - Demonstrate imaging including at least one zoom mode.
    - Demonstrate simultaneous use of three subarrays
    - Complete initial calibrator survey.
    - Data reduction by SDP operational system pipeline.
- AA4/Operations Readiness Review
  - Full MID array including MeerKAT dishes
    - Demonstrate imaging in Bands 1 and 2 and with SKA1 dishes in Band 5.
    - Demonstrate pulsar search, pulsar timing and dynamic spectrum with multiple beams.
    - Demonstrate commensal imaging and transient search.
    - Demonstrate full end-to-end operation, including data processing at full scale and data delivery to Regional Centres.

SKA1 MID 目標性能

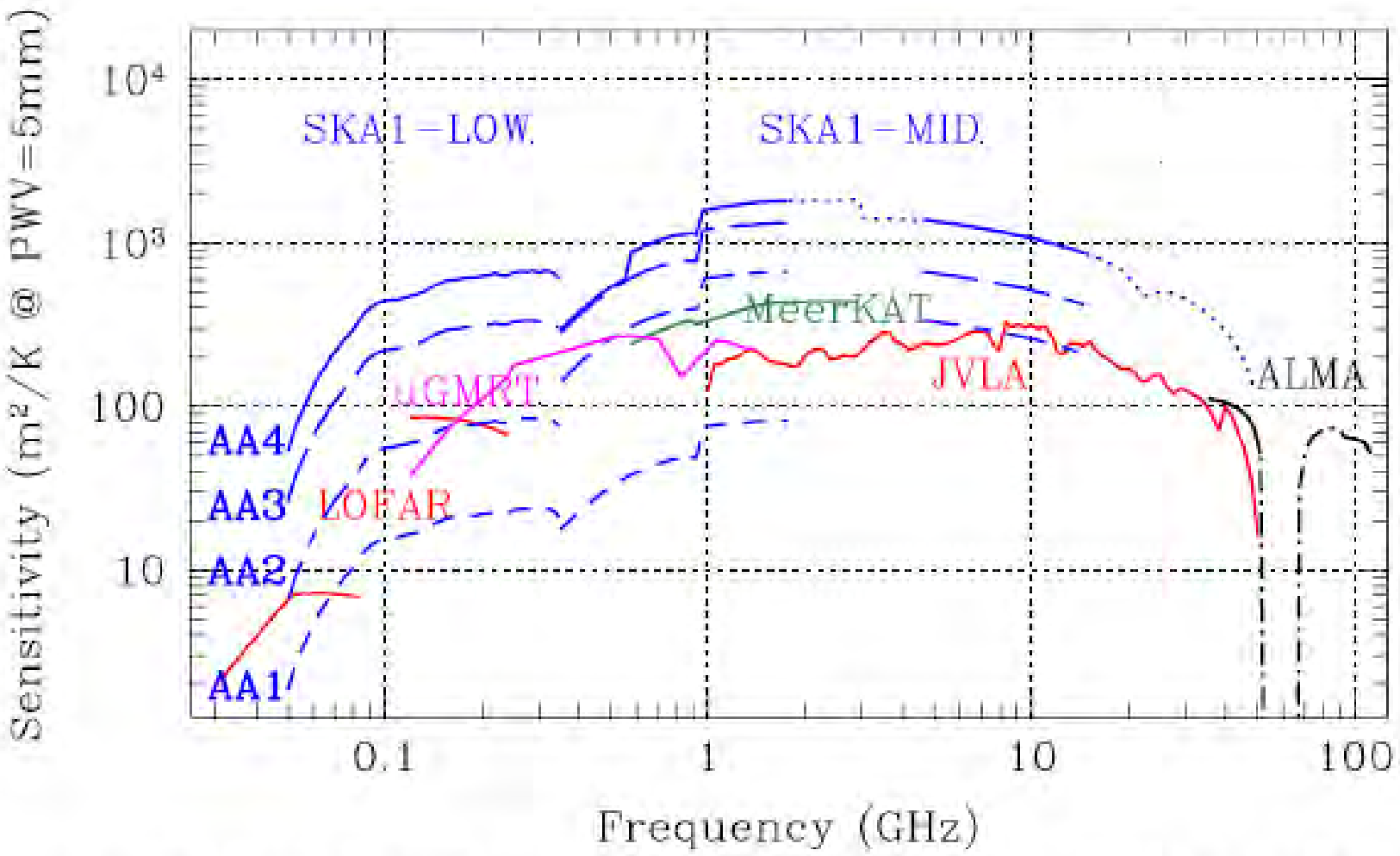


Figure 161 Sensitivity as function of frequency for AA1 through AA4, contrasted with existing facilities.

SKA 1 MID Roll-out Plan

Table 17: SKA1-Mid Roll-Out Plan.

	# Dishes	Frequency Bands	Imaging	Pulsar Timing	Dynamic Spectrum	Pulsar Search	Transient Capture	VLBI
AA0.5	4	Band 1 Band 2 Band 5: goal on 4 Dishes, but may not be supported by correlator	✓ • Basic Continuum and Spectral Line imaging • Using CASA • 16k channels • 800 MHz bandwidth					
AA1	8	Band 1 Band 2 Band 5: on 2 Dishes, goal on 4	✓ • Basic Continuum and Spectral Line imaging • Using CASA • 16k channels • 800 MHz bandwidth	✓ • Basic • 1 boresight non-steerable beam • 400 MHz bandwidth				
AA2	64	Band 1 Band 2 Band 5: on 32 Dishes	✓ • Basic Continuum and Spectral Line imaging • Using CASA • 16k channels • 800 MHz bandwidth	✓ • 6 steerable beams • With de-dispersion • 800 MHz bandwidth		✓ • 16 steerable beams • Not fully pipelined • Non-real time operation • Full bandwidth		
AA3	121 Includes 8 MeerKAT Dishes	Band 1 Band 2 Band 5: on 64 Dishes	✓ • Continuum and Spectral Line imaging pipelines • 64k channels • Zoom mode • 5200 MHz bandwidth	✓ • 16 steerable beams • With de-dispersion • Full bandwidth	? • Maybe	✓ • 128 steerable beams • Not fully pipelined • Non-real time operation • Full bandwidth	? • Maybe	
AA4	197 Includes all MeerKAT Dishes	Band 1 Band 2 Band 5	✓ • Full Continuum and Spectral Line imaging pipelines • 64k channels • Zoom mode • Full bandwidth	✓ • 16 steerable beams • With de-dispersion • Full bandwidth	✓ • Supported by PST	✓ • 1500 steerable beams • Fully pipelined • Real time operation • Full bandwidth	✓	✓ • 4 beams

✓ Functionality is partially implemented
✓ Functionality is fully implemented
? Not sure if functionality will be implemented

Early Science

Schedule（LOW）

- 6-station array
  - Basic array element calibration demonstrated
  - Observation calibration demonstrated
  - Imaging validated by comparison with results from MWA
  - Data reduction expected to be off-line.

- AA1
  - 18-station array
    - Basic array element calibration demonstrated
    - Observation calibration demonstrated
    - Imaging validated by comparison with results from MWA
    - Data reduction expected to be off-line.

- AA2
  - 64 stations
    - Demonstrate ability to form multiple beams.
    - Demonstrate timing of pulsars.
    - Demonstrate imaging
    - Refinement of array element and observation calibration
    - Demonstrate ability to operate two independent subarrays
    - Data reduction expected to be off-line.
    - Demonstrations performed as Science Verification observations; data released publicly.

- AA3
  - 256-station array including long baselines
    - Demonstrate imaging.
    - Demonstrate simultaneous use of three subarrays
    - Deliver initial Global Sky Model.
    - Data reduction by SDP operational system pipeline.

- AA4/Operations Readiness Review
  - Full LOW array
    - Demonstrate imaging with optimised direction-dependent calibration.
    - Demonstrate pulsar search, pulsar timing and dynamic spectrum with multiple beams.
    - Demonstrate commensal imaging and transient search
    - Demonstrate full end-to-end operation, including data processing at full scale and data delivery to Regional Centres.

SKA1 MID 目標性能

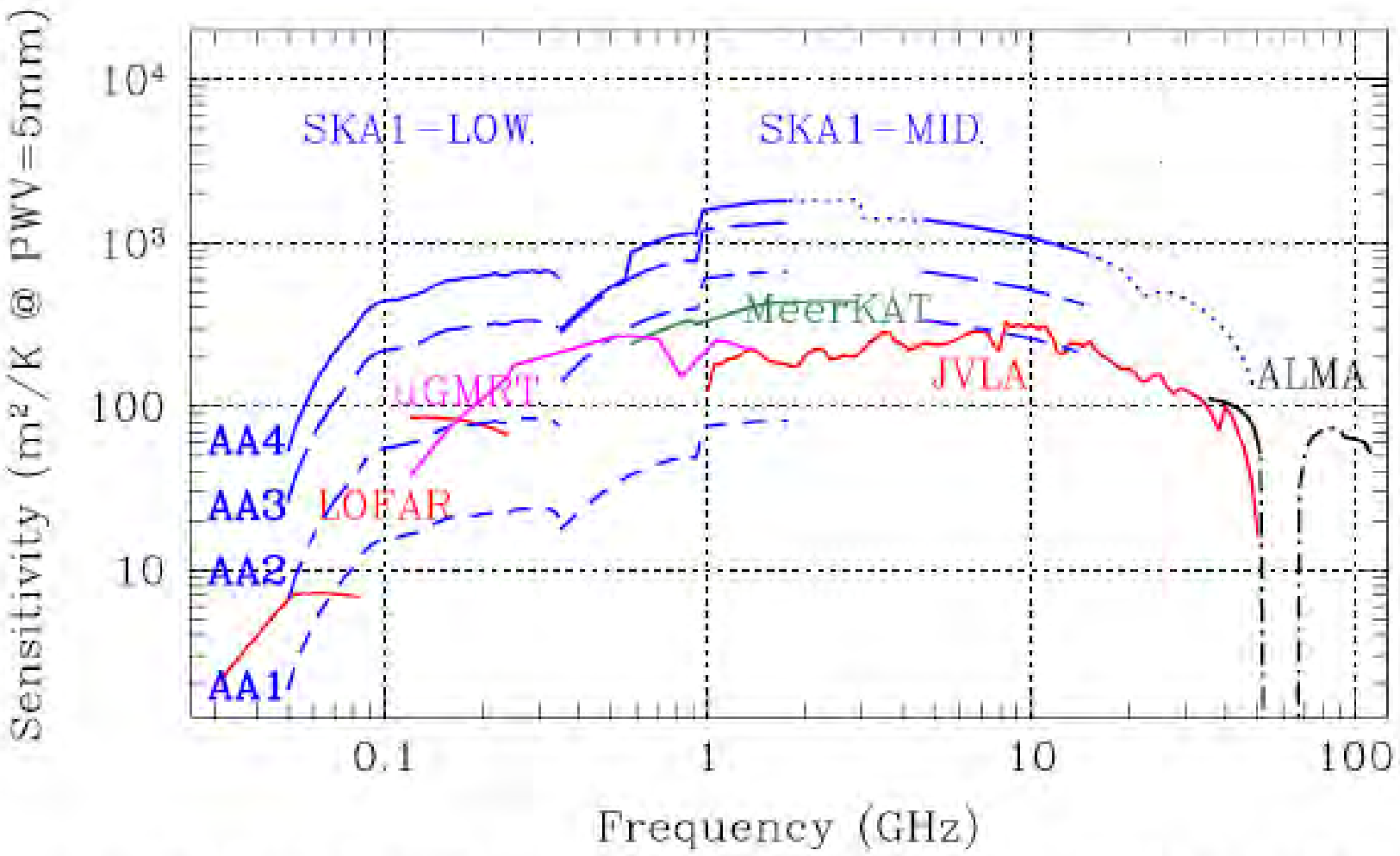


Figure 161 Sensitivity as function of frequency for AA1 through AA4, contrasted with existing facilities.

SKA1 LOW Roll-out Plan

	# Stations	Imaging	Pulsar Timing	Pulsar Search	Dynamic Spectrum	Transient Capture	VLBI
AA0.5	6	✓ • Basic Continuum and Spectral Line imaging • Standard Channelization • 75 MHz bandwidth					
AA1	18	✓ • Basic Continuum and Spectral Line imaging • Standard Channelization 75 MHz bandwidth					
AA2	64	✓ • Basic Continuum and Spectral Line imaging • Standard Channelization • 0.9 and 1.8KHz zooms • 75 MHz bandwidth	✓ • 4 beams		✓ • Supported by PST		
AA3	256	✓ • Basic Continuum and Spectral Line imaging • Standard Channelization • 0.2, 0.43, 0.9, 1.8KHz zooms • 150 MHz bandwidth	✓ • 8 beams	✓ • 125 beams • Pulsar de-dispersion and acceleration processing	✓ • Supported by PST	✓ • Transient response and commensal observing	
AA4	512	✓ • Basic Continuum and Spectral Line imaging • Standard Channelization • All zooms • 300 MHz bandwidth	✓ • 16 beams	✓ • 500 beams • Pulsar de-dispersion and acceleration processing	✓ • Supported by PST	✓ • Transient response and commensal observing	✓ • Full capabilities

Early Science

SKA1 目標性能（Mapping speed）

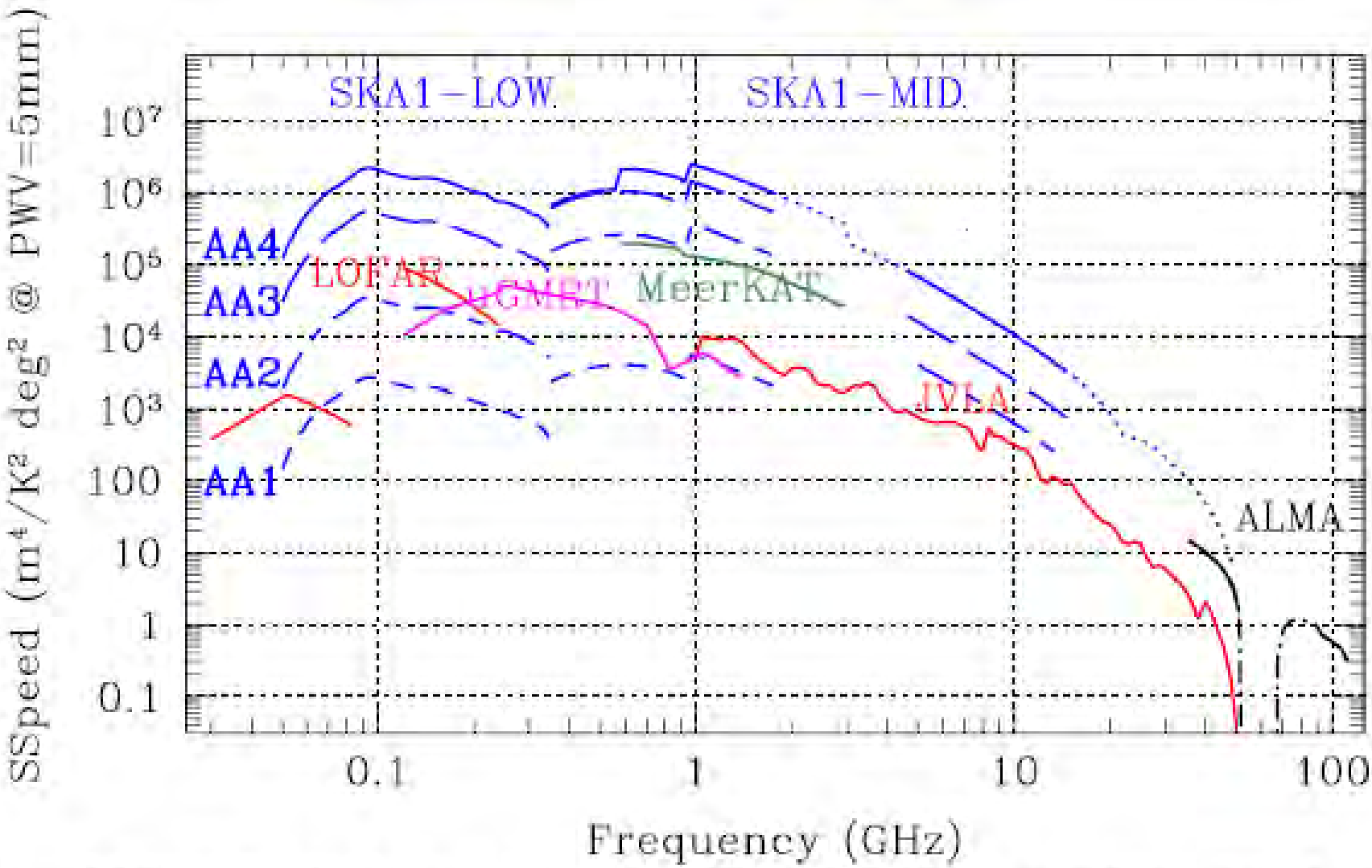


Figure 162 Survey Speed as function of frequency for AA1 through AA4, contrasted with existing facilities.

まとめ

■SKAの組織

- GHQ（イギリス）、LOW（オーストラリア）、MID（南アフリカ）

■メンバー国

- 6つのメンバー国、10のオブザーバー国

■スケジュール

- 2025年（AA1）、2026年（AA2）、2027年（AA3）、2028年（AA4）、2029年完成
- 2026年から初期科学運用