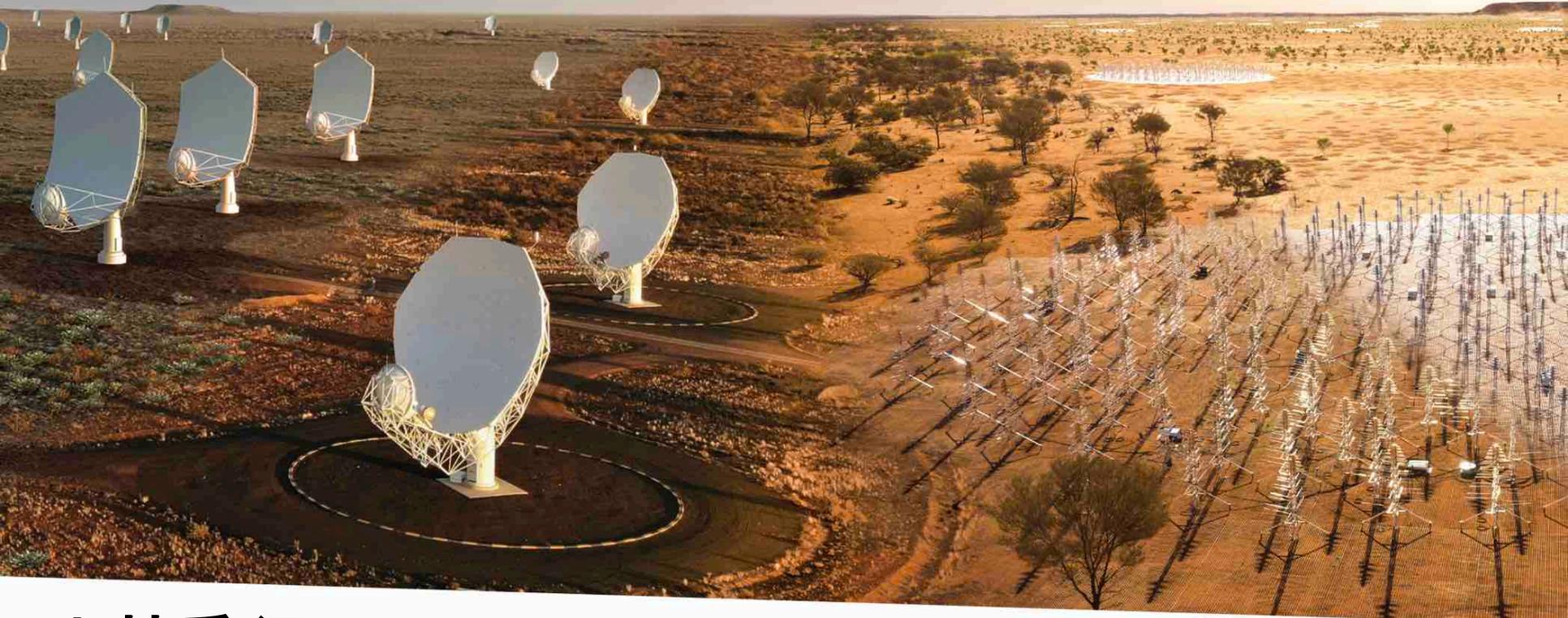


# SKA-MIDシステム構成



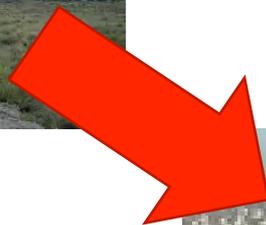
小林秀行  
グループリーダー

NAOJ SKA1 STUDY GROUP  
国立天文台SKA1検討グループ

# 次世代の超大型電波干渉計



**VLA 1980 ~**  
**26m 直径 x 27台**  
**基線長 30km**



**SKA1 2027~**  
**15m直径 x 133台**  
**13.5m直径 x 64台**  
**基線長 150km**

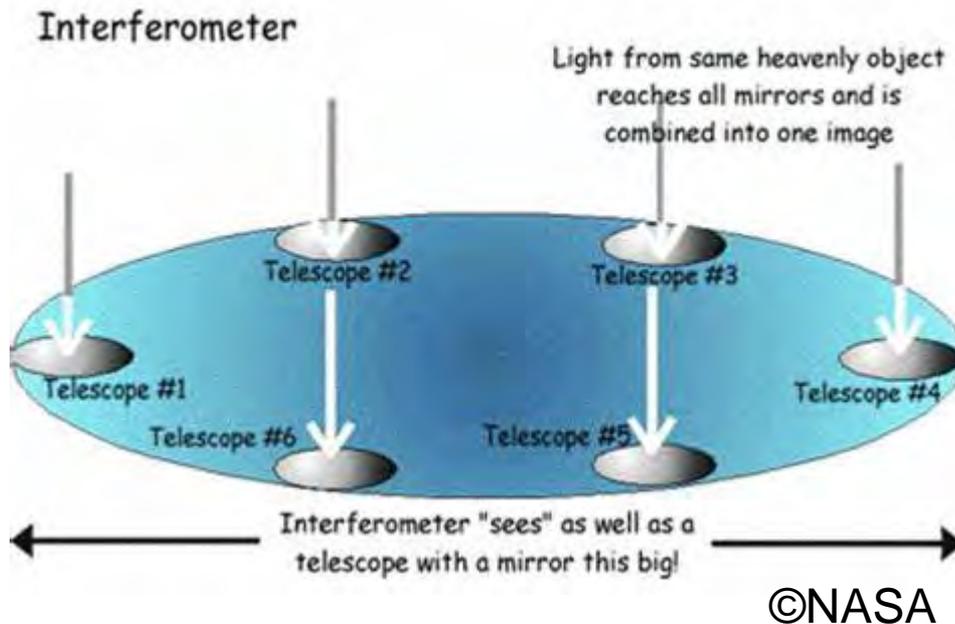


# 電波干渉計のイメージ

- 基線長は空間分解能 ( $\lambda/D$ )
- アンテナ総開口面積は、感度

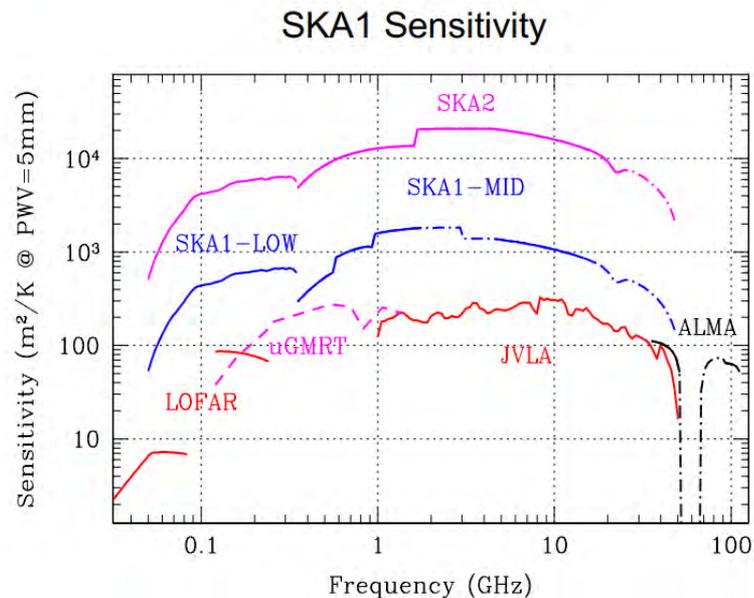
$\lambda$ : 波長  
D: 基線長

$$\Delta S = \frac{2k * T_{sys}}{A_{total} * \sqrt{BT}}$$



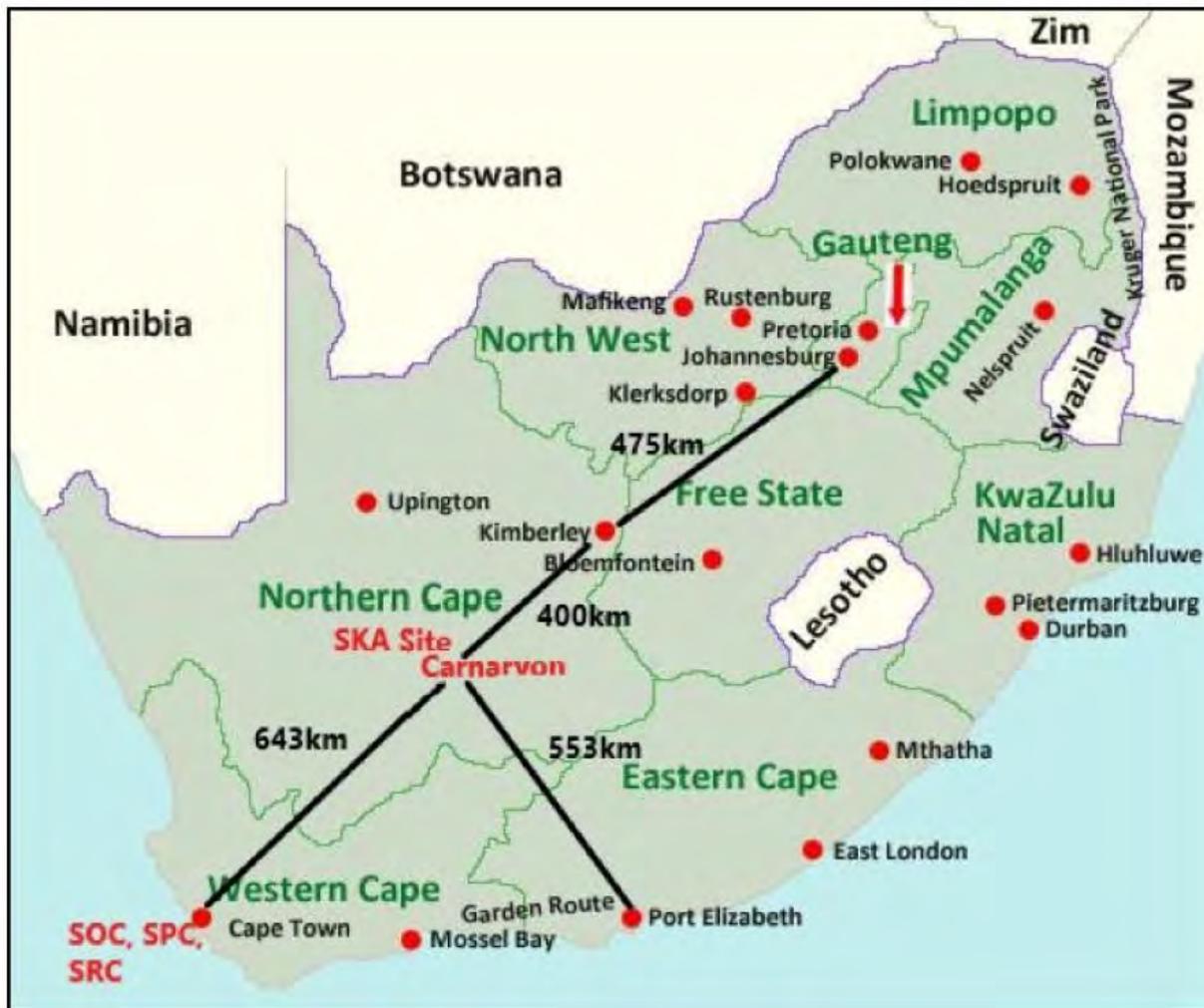
$T_{sys}$  : システム雑音温度 (K)  
 $A_{total}$  : 全開口面積 (m<sup>2</sup>)  
 各素子アンテナの開口面積の総和  
 $B$ : 観測バンド幅 (Hz)  
 $T$ : 積分時間 (秒)  
 $k$ : ボルツマン定数

## Mid Key Parameters

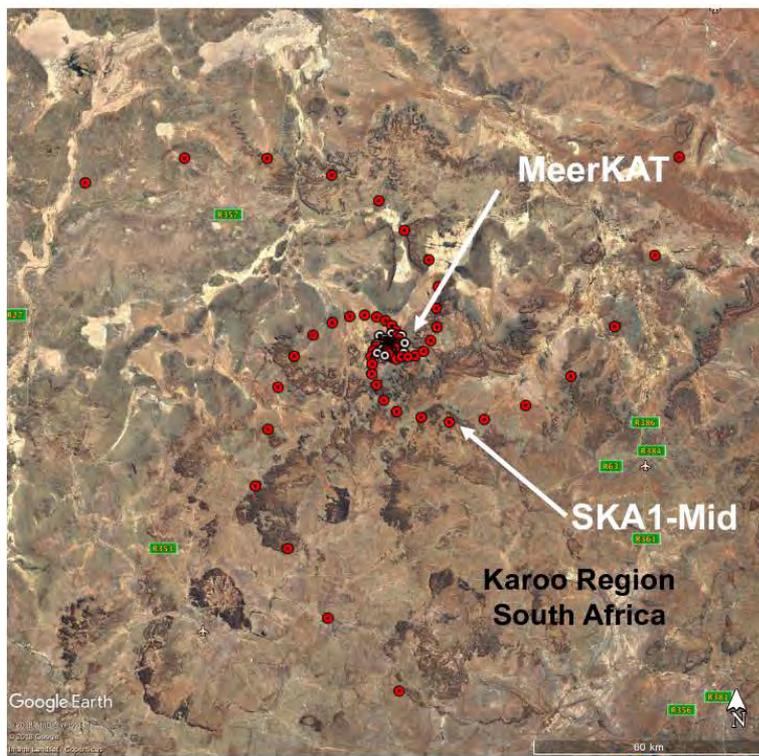


- Modes:
  - Imaging (continuum and spectral)
  - Pulsar Search
  - Pulsar Timing
  - Flow through
  - Dynamic Spectrum
  - Transient Search
  - Very-Long Baseline Interferometry (VLBI)
- High time & spatial resolution
- Flexible Scheduling
- Commensal Observing
- 95% Operational Availability

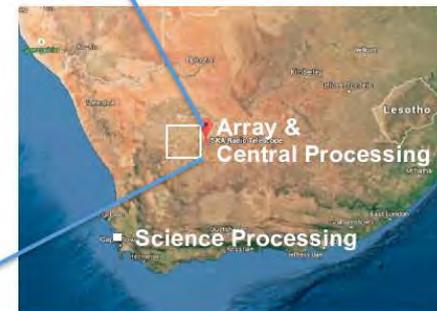
# サイト位置



## SKA1-MID Configuration

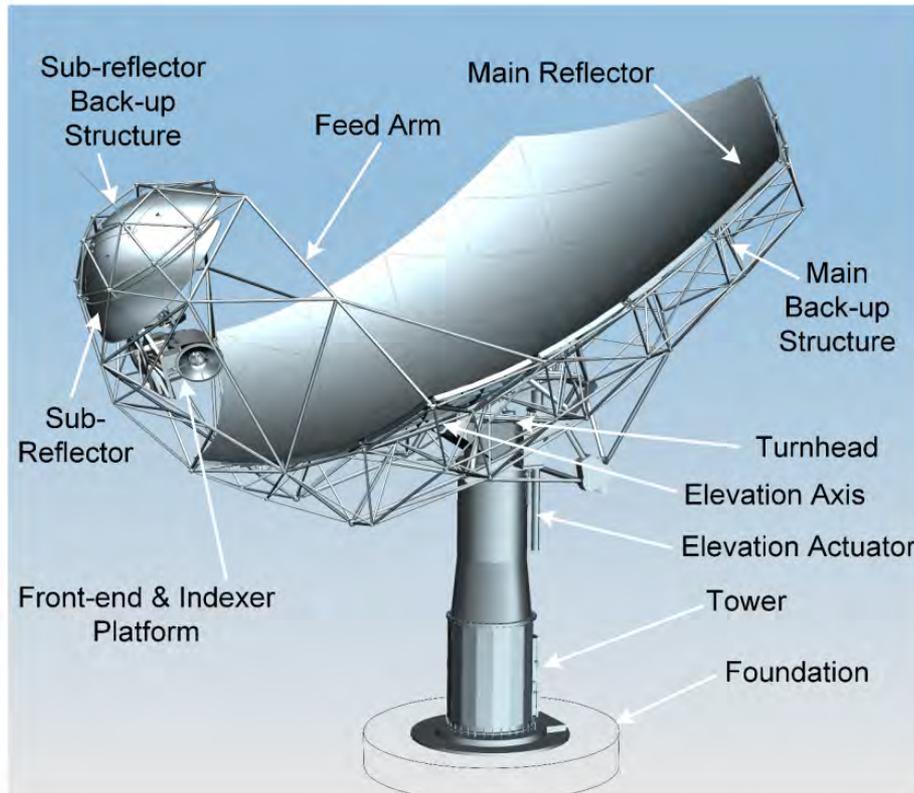


- 133 SKA 15m dishes
- 64 MeerKAT 13.5m dishes
- Maximum baseline 150 km
- 3 logarithmic spiral arms
- Frequency range: 350 MHz to 15.4 GHz



60km

## SKA1 Mid Antenna



### Antenna Features

- Frequency: 350MHz – 20GHz +
- 15 metre offset Gregorian optics
- Sub-reflector: 5 m, with skirt
- Tracking speed: 30 times sidereal rate @ 10arcsec accuracy
- Slewing Speed:
  - 1deg/sec elevation
  - 3deg/sec Azimuth
- Indexing speed: Less than 30 sec

## Antenna Performance



### Sensitivity per Band estimates

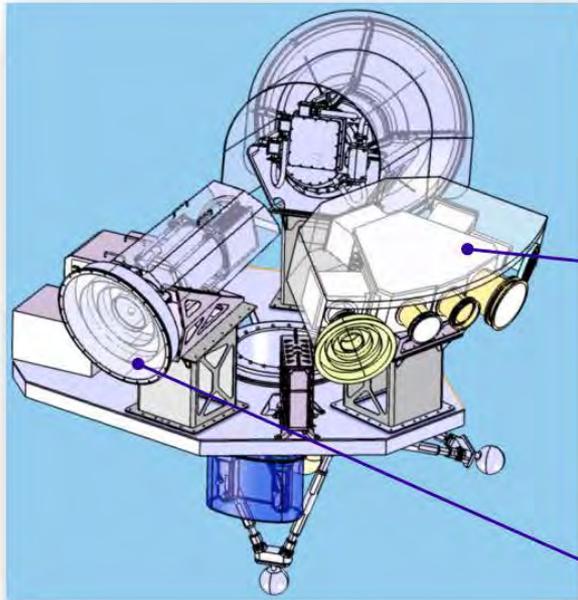
Band	Frequency (GHz)	BW (MHz)	Sensitivity Requirement (m <sup>2</sup> /K)		Design (m <sup>2</sup> /K)
			Array (L1)	Dish (L2)	Dish (L2)
1	0.35 – 0.650 0.65 – 1.050	700	272 – 545 545	2.1 – 4.2 4.2	2.5 – 5.0 5.4
2	0.95 – 1.760	808	916	7.1	10.9
3	1.65 – 3.050	1403	916	7.1	--
4	2.80 – 5.180	2380	833	6.6	--
5a	4.60 – 8.500	3900	1110	8.86	9.52
5b	8.30 – 15.40	7000	805	6.74	7.93

### Pointing performance estimates

		RMS error (arcsec)	RMS error (arcsec)	RMS error (arcsec)
<b>Blind Pointing Error</b>	Requirement	9	18	36
	Design	5.5	11	21.7
<b>Relative Pointing Error</b>	Requirement	1.3	2.6	5.2
	Design	1.2	3.5	6.7
<b>Tracking Stability</b>	Requirement	2.3	4.6	9.2
	Design	1.5	4.4	8

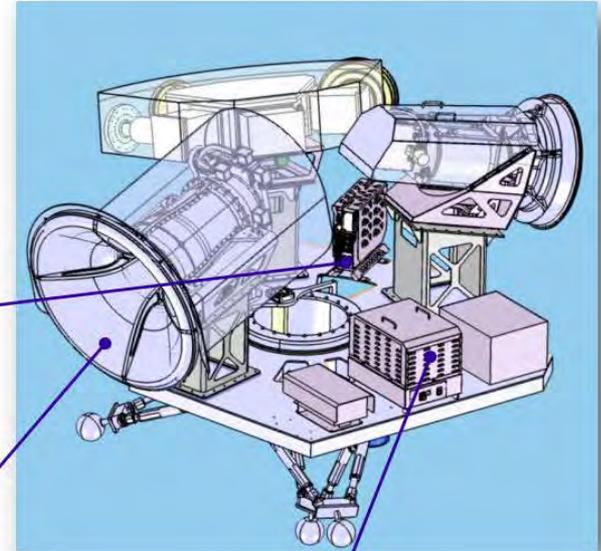
## SKA1-MID Feed Indexer

- Supports 3 feed packages
- Removable sun shields for sunlight and rain protection
- Supports 2 digitisers, vacuum pump, power and fibre



Band 345  
Feed Package

Band 2  
Feed Package



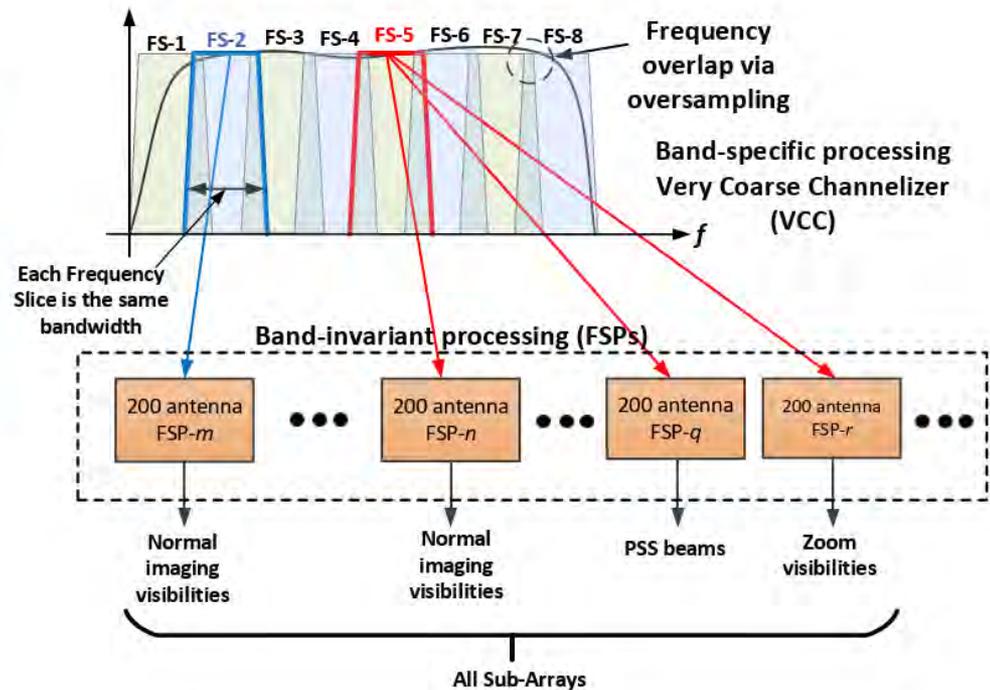
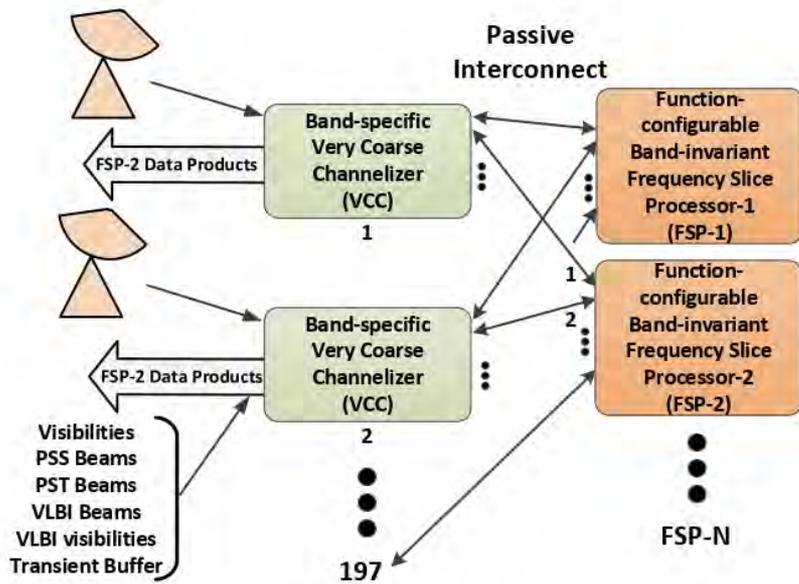
Digitiser

Band 1  
Feed Package

Vacuum Pump

- Rotation: 203 deg (feed packages ~100 deg apart)
- Overall center of mass close to the axis of rotation

# Frequency slice



## SKA1-MID SPF Receiver (Digitisation)

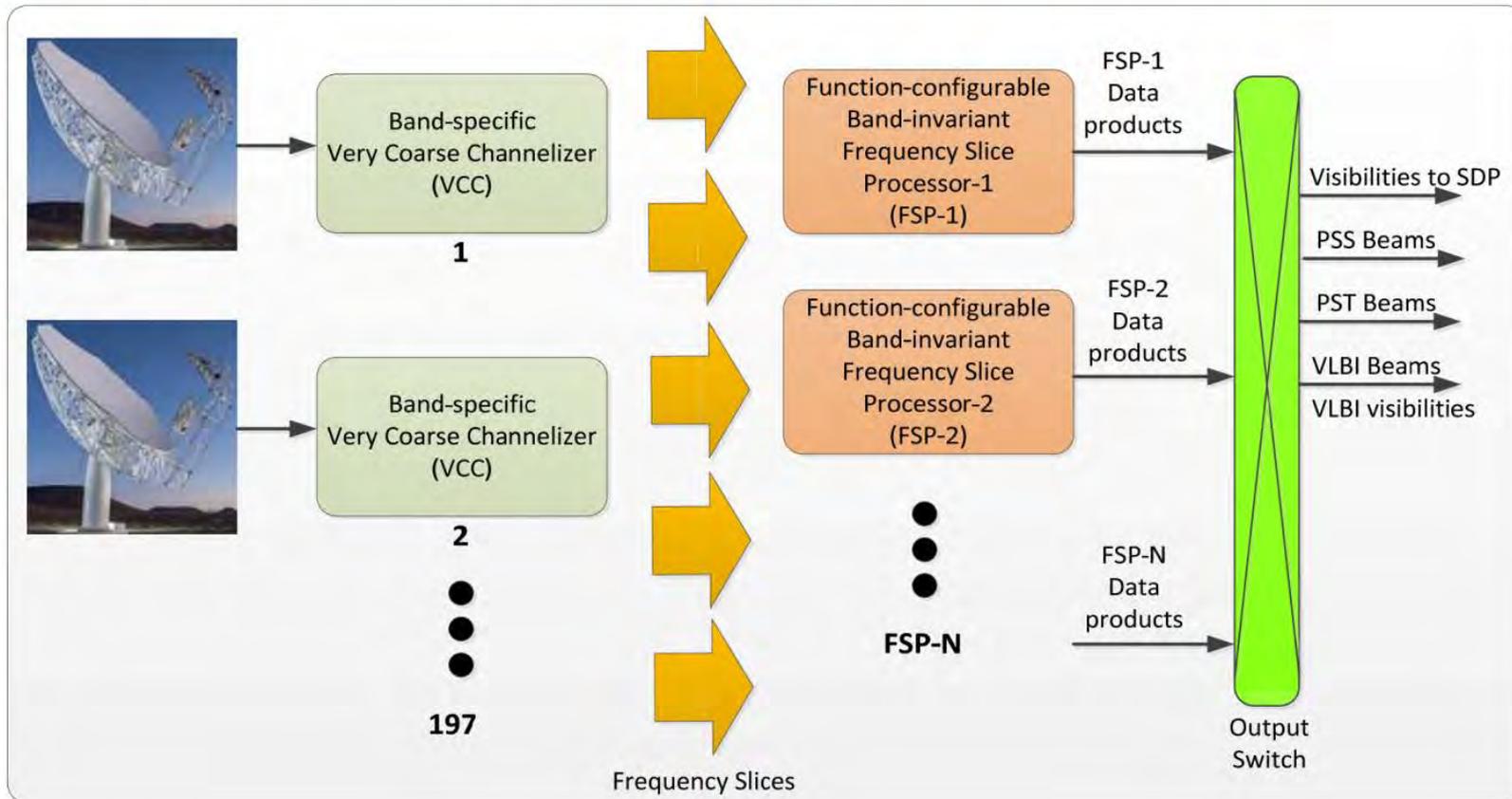


- RF samplers located on the Feed Indexer
- Packetiser, DSP and C & M located in RFI enclosure in the Dish Pedestal (TALON)
- Separate Band 123 and 345 Digitisers

Band	Frequency (GHz)	RF BW (MHz)	Sampling Rate (GSps)	Nyquist Zone	ADC Sampling Bit Depth	Transport Sampling Rate (GSps)	Transport Bit Depth	Transport Data Rate (Gbps)
1	0.35 – 1.050	700	3.96	1	8	3.96*	12	95.04
2	0.95 – 1.760	808	3.96	1	8	3.96*	12	95.04
3	1.65 – 3.050	1403	3.168	2	6	3.168*	12	76.032
4	2.80 – 5.180	2380	15.84	1	4	5.94*	8	95.04
5a	4.60 – 8.500	3900	8.91	2	3	2 x 5.94*	4	95.04
5b	8.30 – 15.40	7000	15.84	2	3	2 x 5.94*	4	95.04

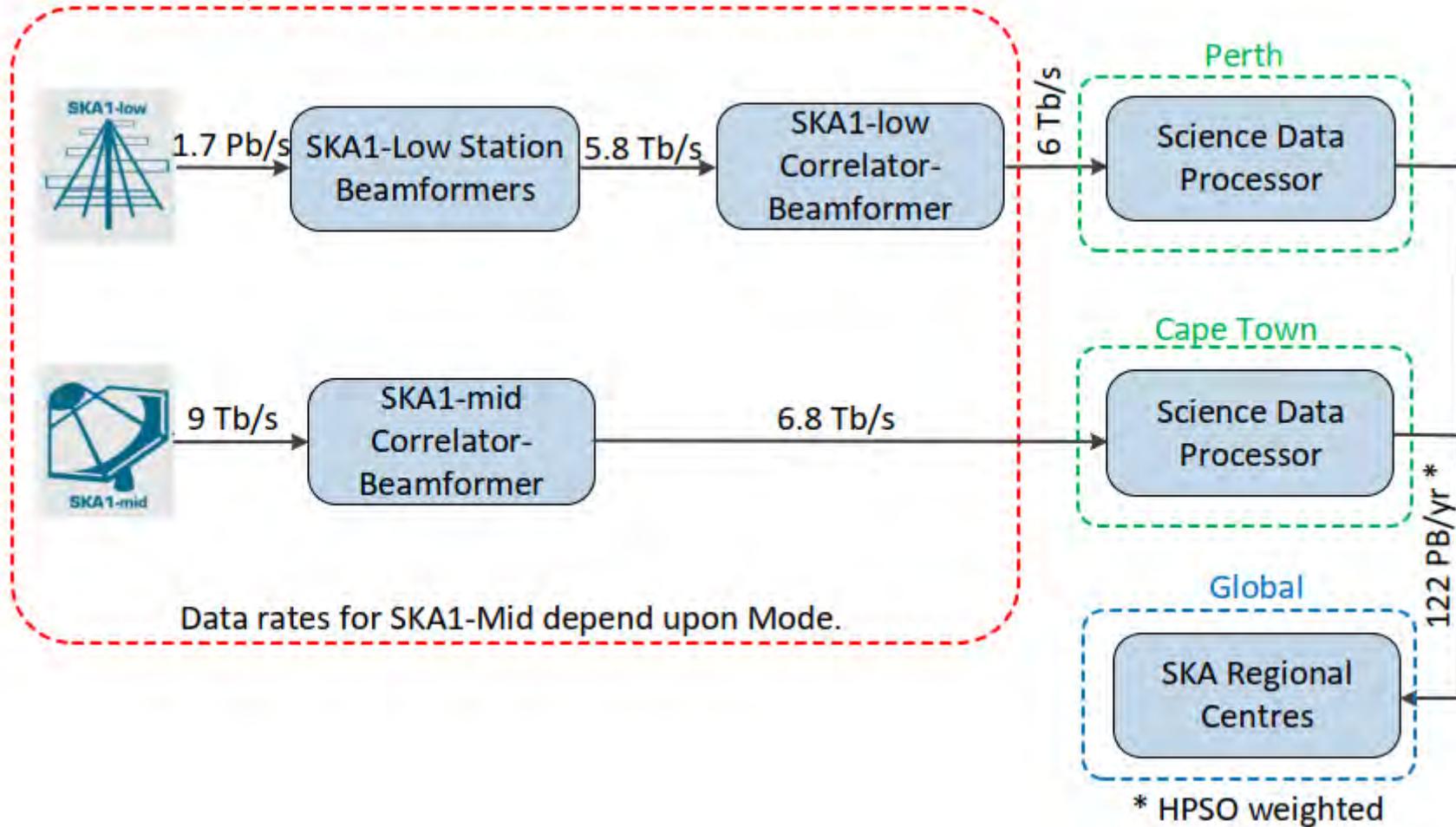
\*Offsets are added to these frequencies to reduce correlated noise

## Correlator Beamformer (CBF)





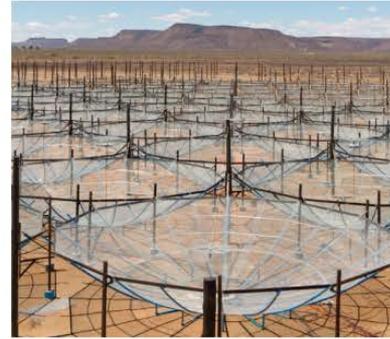
### Telescope Sites



## SKA – Mid Pre-cursors on Mid site



KAT-7



MeerKAT

HERA

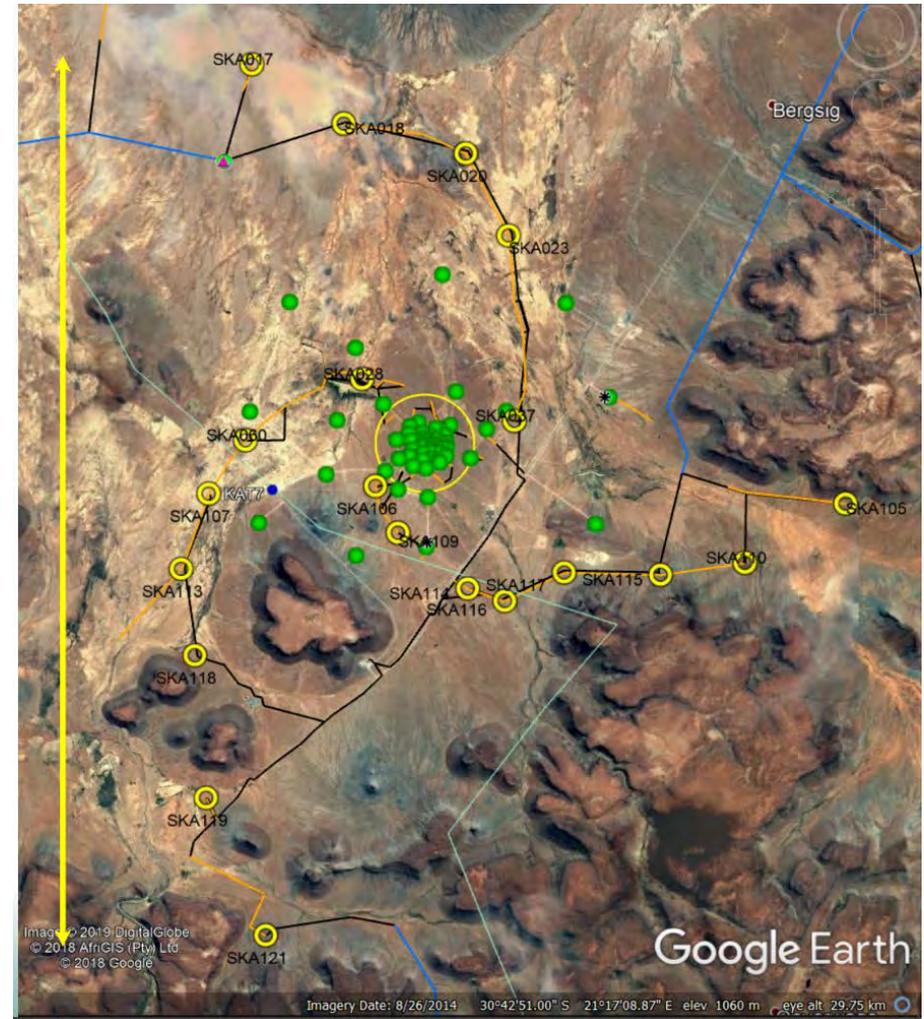


# MeerKat Array configuration

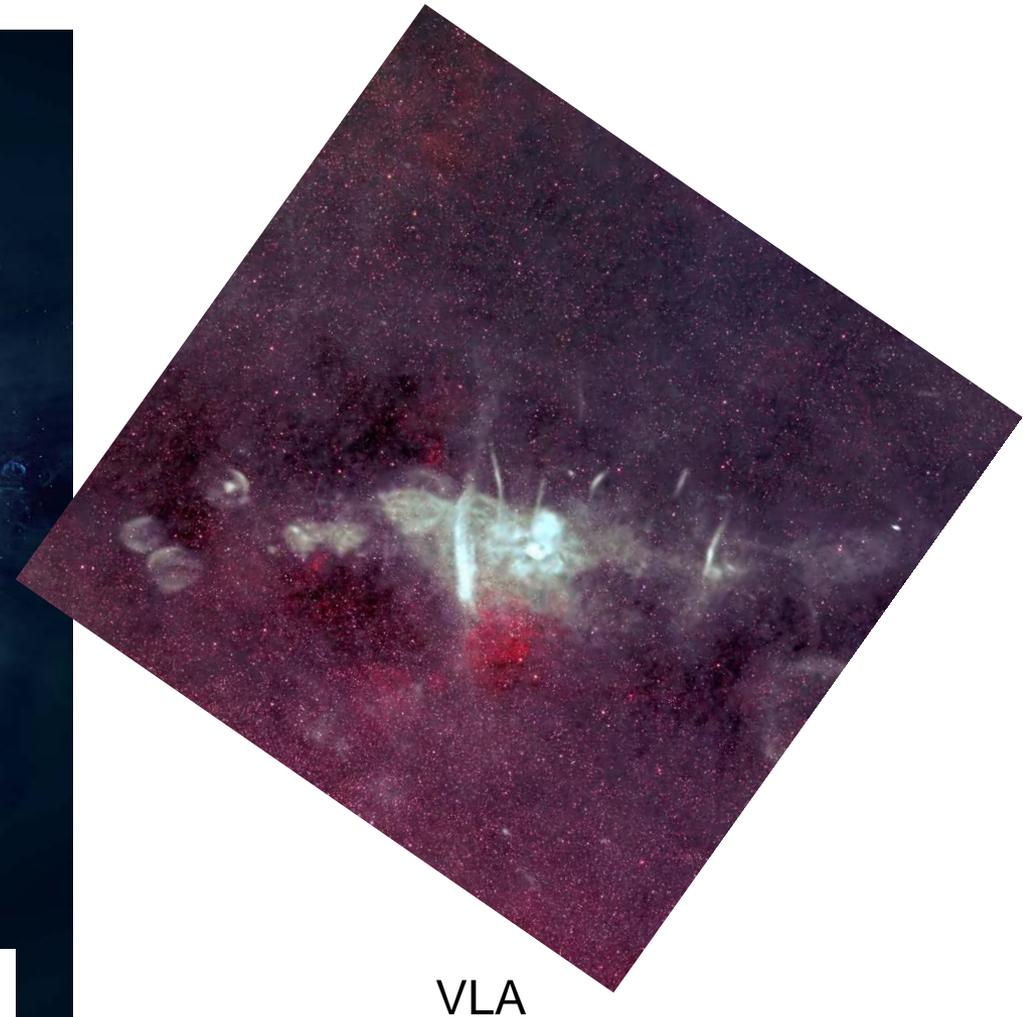
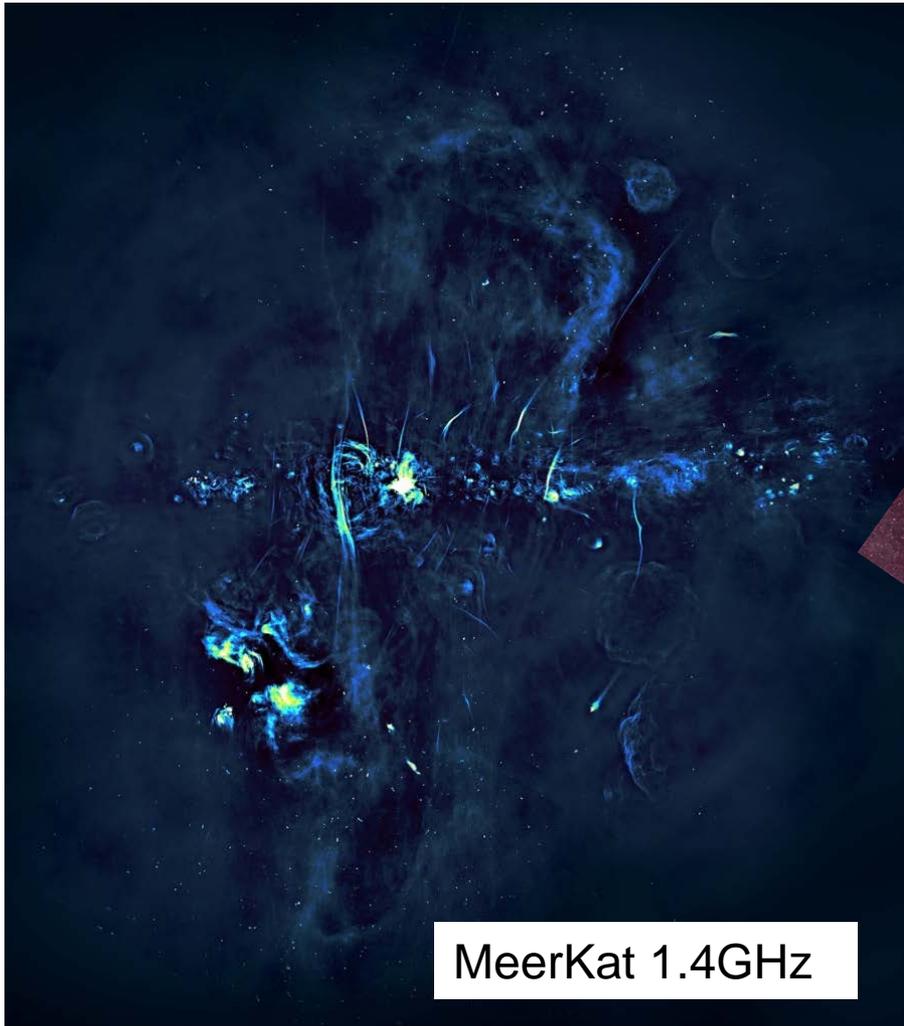


13.5m Diameter x 64 stations

SKA Band2 (0.95-1.76GHz)  
+ S- band (1.75-3.5GHz)



# MeerKat Image (Galactic center)



## Mapping sensitivity

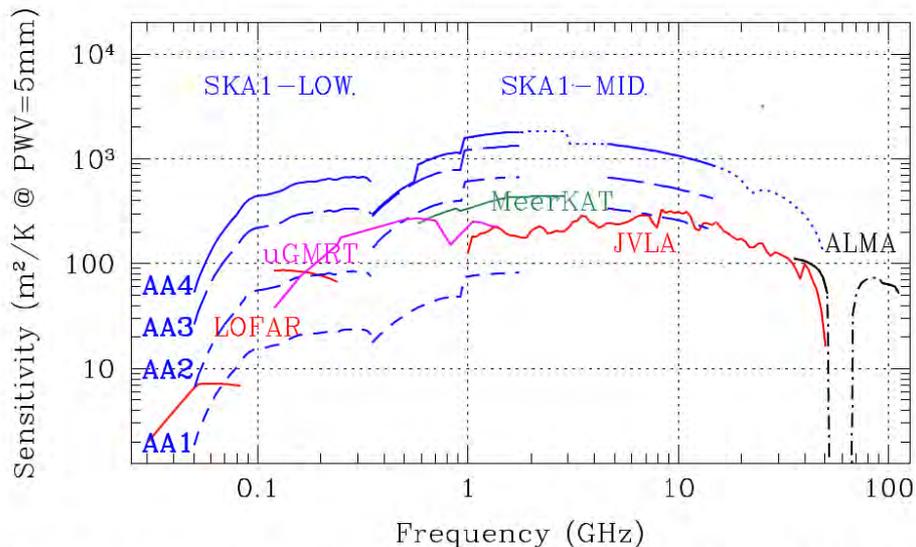


Figure 161 Sensitivity as function of frequency for AA1 through AA4, contrasted with existing facilities.

## Survey Speed

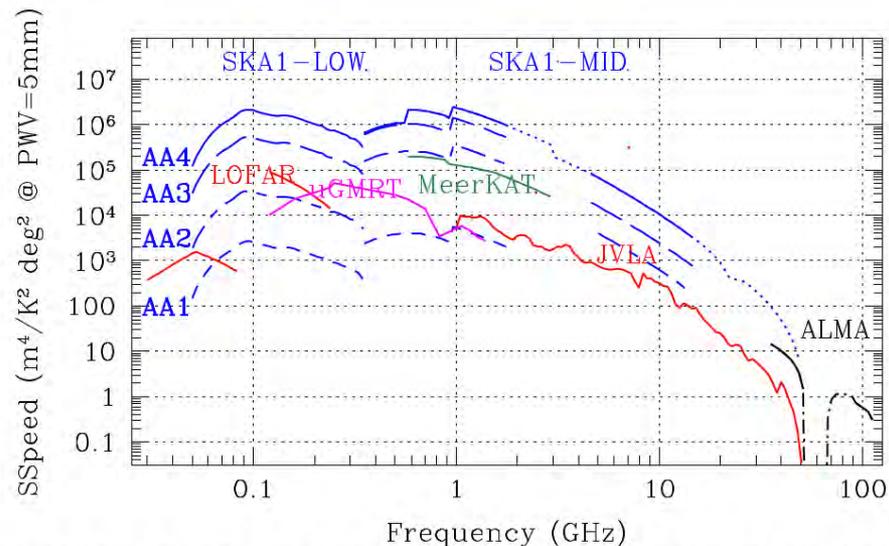


Figure 162 Survey Speed as function of frequency for AA1 through AA4, contrasted with existing facilities.