



*Addressing SKA requirements with  
axi-symmetric optics*

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# Agenda, addressing SKA requirements with axis-sym. optics



13/15 July '11

- Requirements introduction
- Requirements
  - Telescope dimensions
  - Feed
  - Operations
  - Environment
- Summary

# Requirements introduction



13/15 July '11

- Concept of axis symmetric dish
- Maximizing  $A_{\text{eff}}/T_{\text{sys}}$  per cost unit (Euro, Dollar, ..)
  - Axi symmetric dish
  - Wide Band Single pixel feeds, 2x
  - Simple basic construction and system
  - Design suitable for SKA phase 2 requirements
- Chinese and Thermoplastic axi symmetric dish
- SKA requirements with axi-symmetric optics derived from:  
System Engineering Management Plan (SEMP) WP2-005.010.030-MP-001 Reference 3

# Requirements

- Telescope dimensions
- Feed
- Operations
- Environment

1 Telescope dimensions								
id	Type	Description	Variable	min	nominal	max	unit	comments
2		Diameter	D	12		15	m	
3		focal length	f	5,04		6,3	m	
4		focal ratio	f/D	0,35/0,45	0,42	0,35/0,45	ratio	Investigate only 0,42 for both telescopes when time is limitted As agreed with SPDO director 20 jan 2011. Option for change for SKA phase 1
5		frequency range	f	1,2		10	GHz	
6		Accuracy overall	RMS			1,00	mm	at 1/30 wave length. The overall RMS includes: fabrication, gravity, wind load and thermal related errors
7								Alternative is an equatorial mount telescope
8		Dish Mount type						Alt-Azimuth
9 Feed								
id	Type	Description	Variable	min	nominal	max	unit	comments
10		Feed weight		100	135	170	kg	pixel feed receivers
11		Feed mount type						Four leg attached to the edge of the dish
12 Operations								
id	Type	Description	Variable	min	nominal	max	unit	comments
13		Azimut range		-270		270	deg	
14		Elevation range		15		91	deg	
15		Azimut rate		0.0042		1.5	deg/sec	min rotation rate = Earth rotation and maximum is tracking a passing plane at 10km high
16		Elevation rate		0.0014		0.5	deg/sec	1/3 of azimuth
17		Azimute slew rate		3	3	3	deg/sec	
18		Elevation slew rate		1	1	1	deg/sec	
19		Beam size	FWHM	0,17		0,14	deg	FWHM at 10 GHz
20		Pointing accuracy		0,52		0,42	arc-min	pointing accuracy = 1/20 x beam width x 60 sec
21		Windspeed		0	4	12	m/sec	Average wind speed is about 4 m/sec ref: SKA site Climate data v ref: SKA site Climate data v 0.2
22 Environment								
id	Type	Description	Variable	min	nominal	max	unit	comments
23		Temperature		1		40	°C	ref: SKA site Climate data v 0.2
24		Airtemperature change rate				4	°C/hr	ref: SKA site Climate data v 0.2
25		Solar irradiation		0	750	980	Watt/m <sup>2</sup>	
26		Solar irradiation change rate						Irradiation varies over 12 hr with a sinus function
27		Stow wind speed				18	m/sec	
28		Survival wind speed				45	m/sec	
29		Humidity		20	50	100	%	
30								it is expected that 11 feed systems will be used with optimal Ae <sub>eff</sub> /Ts <sub>sys</sub>
31		Aperture efficiency			60		%	
32		first side lobe level			-30	-25	dB	
33		maintenance interval		1	5		year	
34		lifetime		20	30	50	year	
id	Type	Description	Variable	min	nominal	max	unit	comments
35		Monitor and control						see SKA system requirements
36		Safety and security						see SKA system requirements
37		Lightning protection						see SKA system requirements
38		Manufacture and shipping						Design for low cost mass manufacture including shipment to a remote site.

# Requirements



13/15 July '11

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5		frequency range	f	1,2		10	GHz	As agreed with SPDO director 20 jan 2011. Option for change for SKA phase 1
6			$\lambda$	249,83		29,98	mm	wave length
7		Accuracy overall	RMS			1,00	mm	at 1/30 wave length. The overall RMS includes: fabrication, gravity, wind load and thermal related errors
8		Dish Mount type		Alt-Azimuth				Alternative is an equatorial mount telescope

# Requirements



13/15 July '11

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# Requirements



13/15 July '11

- Feed

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# Requirements



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16		Elevation rate		0.0042		1.5	deg/sec	
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27		Stow wind speed				18	m/sec	
28		Survival wind speed				45	m/sec	
29		Humidity		20	50	100	%	
30								
31		Aperture efficiency			60		%	it is expected that 11 feed systems will be used with optimal Aeff/Tsys
32		first side lobe level			-30	-25	dB	
33		maintenance intervallifetime		1	5		year	
34		lifetime		20	30	50	year	

# Requirements



13/15 July '11

- Environment

35	Monitor and control					see SKA system requirements
36	Safety and security					see SKA system requirements
37	Lightning protection					see SKA system requirements
38	Manufacture and shipping					Design for low cost mass manufacture including shipment to a remote site.
39	Installation and commissioning					Design for rapid installation using a minimum of manpower and tools

# Requirements summary



13/15 July '11

- Maximizing  $A_{\text{eff}}/T_{\text{sys}}$  per cost unit (Euro, Dollar, ..)
  - Axi symmetric dish
  - Wide Band Single pixel feeds, 2x, exact bandwidth tbd
  - Simple basic construction and system
  - Design suitable for SKA phase 2 requirements
- Chinese and Thermoplastic Concepts matches on basic principles
- Some prime requirements are different, mainly accuracy of reflector
- SKA phase 1 and 2 requirements met

# Chinese require

Items	Specification	
Antenna type	Prime Focus Antenna	
Diameter	15 meter	
Focal length / Diameter ratio (f/D)	0.4	
Mount type	AZ-EL-POL mount (AZ, POL: Gear , EL: Screw)	
Frequency switch manner	Feed switch (within 30s)	
Surface accuracy	$\leq 1.1\text{mm r.m.s. (at night and no wind)}$ TBC(at daytime, with wind)	
Pointing accuracy	$\leq 10 \text{ arcsec r.m.s. (at night and no wind)}$ TBC(at daytime, with wind)	
Travel range	AZ: $-270^{\circ}\sim 270^{\circ}$ EL: $15^{\circ}\sim 85^{\circ}$ POL: $-180^{\circ}\sim 180^{\circ}$	
Slew rates (Max)	AZ: $3^{\circ}/\text{s}$ , EL: $1^{\circ}/\text{s}$ , POL: $3^{\circ}/\text{s}$	
Acceleration (Max)	AZ: $3^{\circ}/\text{s}^2$ , EL: $1^{\circ}/\text{s}^2$ , POL: $3^{\circ}/\text{s}^2$	
Feed type	2 wide-band SPF (see note 2)and a PAF	
Frequency band(GHz)	0.3~1.5	1.5~10

# Chinese requirements



13/15 July '11

Items	Specification					
Wavelength (cm)	20~100			3~20		
Antenna aperture efficiency (%)	0.3 GHz	0.9 GHz	1.5 GHz	1.5 GHz	6 GHz	10 GHz
	60	60	65	65	60	50
First sidelobe level (dB)	≤-20			≤-20		
Polarisation	Dual-CP	Dual-LP		Dual-CP	Dual-LP	
VSWR	≤1.5	≤2		≤1.5	≤2	
Ambient temperature	-10°C~50°C					
Wind velocity	Drive to stow at zenith: 70 km/h Survivable at zenith: 160 km/h					
Design lifetime	≥30 years					
<p><b>Notes:</b> This table is based on the following conditions, if the requirement changed, further investigation will be needed.</p> <ol style="list-style-type: none"> <li>1. At night, windless,</li> <li>2. Two wideband single-pixel feeds (WBSPFs, developed by JLRAT team)</li> </ol>						