CDR Chapter 2
Antenna Systems and LNA
Linefeed

Linefeed working group:

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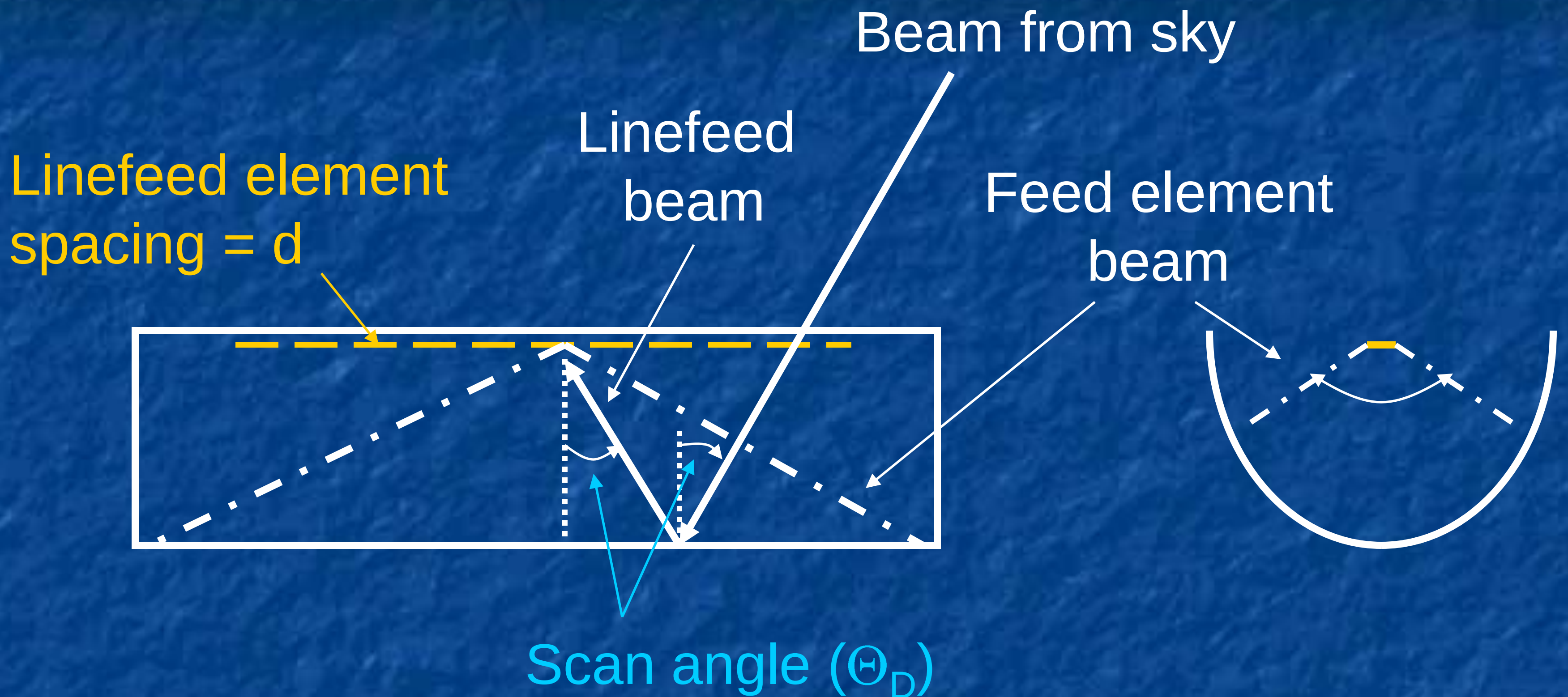
Linefeed for Cylindrical Antenna



Grating lobes require: $d < \lambda/(1 + \sin(\Delta\Theta_D/2))$

Interfaces

Input: reflected radiation from cylinder antenna (either on-axis or off-axis)

Includes LNA and balun between LNA and feed, on a single printed circuit board

Output: LNA output signal

Linefeed Requirements I

Linefeed requirement	Science (or other) requirement	Baseline design	How to choose
bandwidth (f_{lo}, f_{hi})	-redshift range -Impedance match to LNA -grating lobes	cover 1 octave in 2 bands, 1/2 octave each, deploy sequentially	Figure of Merit (FoM) model
$\Delta\theta_D$ = longitudinal illumination beam width	-beam spill -scan range: survey angular area	+/- 60°	FoM model
$\Delta\theta_T$ = transverse illumination beamwidth	-beam spill -grating lobes (transverse) -aperture efficiency: sensitivity	- 10 dB edge illumination	noise contribution
d = element spacing	grating lobes: $d_{max} = \lambda/(1+ \sin(\Delta\theta_D/2))$	d = 0.54 λ	Minimize grating lobe
L = length of entire linefeed	angular resolution $\delta\theta_D = \lambda/L$	100 m consider end-effects	FoM model

Linefeed Requirements II

Feed Requirements	Science (or other) Requirements	Baseline Design	How to Choose
2 polarizations beam symmetry	foreground removal	orient 45° to cylinder axis	Foreground removal modeling
packaging	easy: fabrication Installation maintenance replacement		
cost	must be < cost of following electronics	$150/channel (feed +/grpundplane/ LNA/ structure)	Scale from existing parts at CMU

Linefeed Design Choices

- Co-add signals from multiple feeds? No
- Feed elements?   TBD
- On vs off-axis reflector?
  - On-axis: easier to feed low f/D with small feed elements
  - Off-axis: no beam blockage, easier to access

Off-axis Feed

QuickTime™ and a
decompressor
are needed to see this picture.

We want F/D < 0.5 so horizon is blocked

Linefeed Design Details

1) Feed and LNA on same circuit card -- antenna impedance forms part of the noise match to the LNA
2) Change the center frequency of the feed by installing new feed-LNA card (Phase I --> Phase II). New center frequency --> new spacing
3) Each feed and LNA feeds a single digitizer
4) Feed is below lip of reflector: f ratio f/D is < 0.5
5) Linefeed is ~ 5 m up. Need mechanism to lower to ground for replacement, switch cables to digitizers

Feed Element Options

Type	Impedance BW (return loss < -10 dB)	Size	Scanning BW (+/- 60°)	Pattern BW	Xpol on boresite	HPBW	Complexity
Log periodic	22:1	>1.0 λ			< -25 dB	~ 45°	hi
Wideband dipole (SKAMP)	2:1	0.35 λ	1.5:1	1.8:1	< -30 dB	60°- 90°	low
Slot (McGinnis)							low
Dipole (Pittsburgh)	1.1:1	0.45 λ	1.2:1				low
Wideband patch	1.7:1	0.4 λ	1.3:1	1.7:1	< -22 dB	60°-90°	moderate
Densely-spaced array	5:1	0.1 λ	5.3:1		< -26 dB		Hi
Sinuous	2:1	0.5 λ	1.1:1		< -10 cB	45°-90°	low

adapted from M. Leung 2008

Pittsburgh Dipole

0.7 λ

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Four-square Feed

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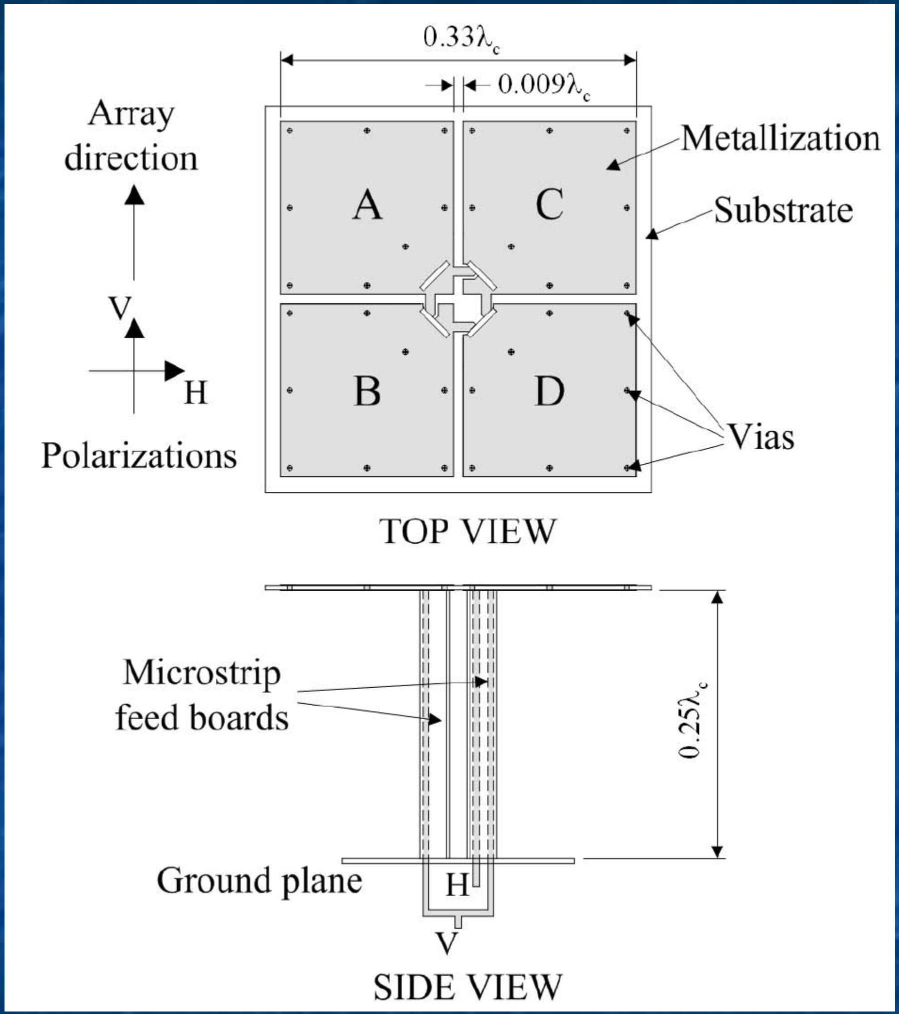
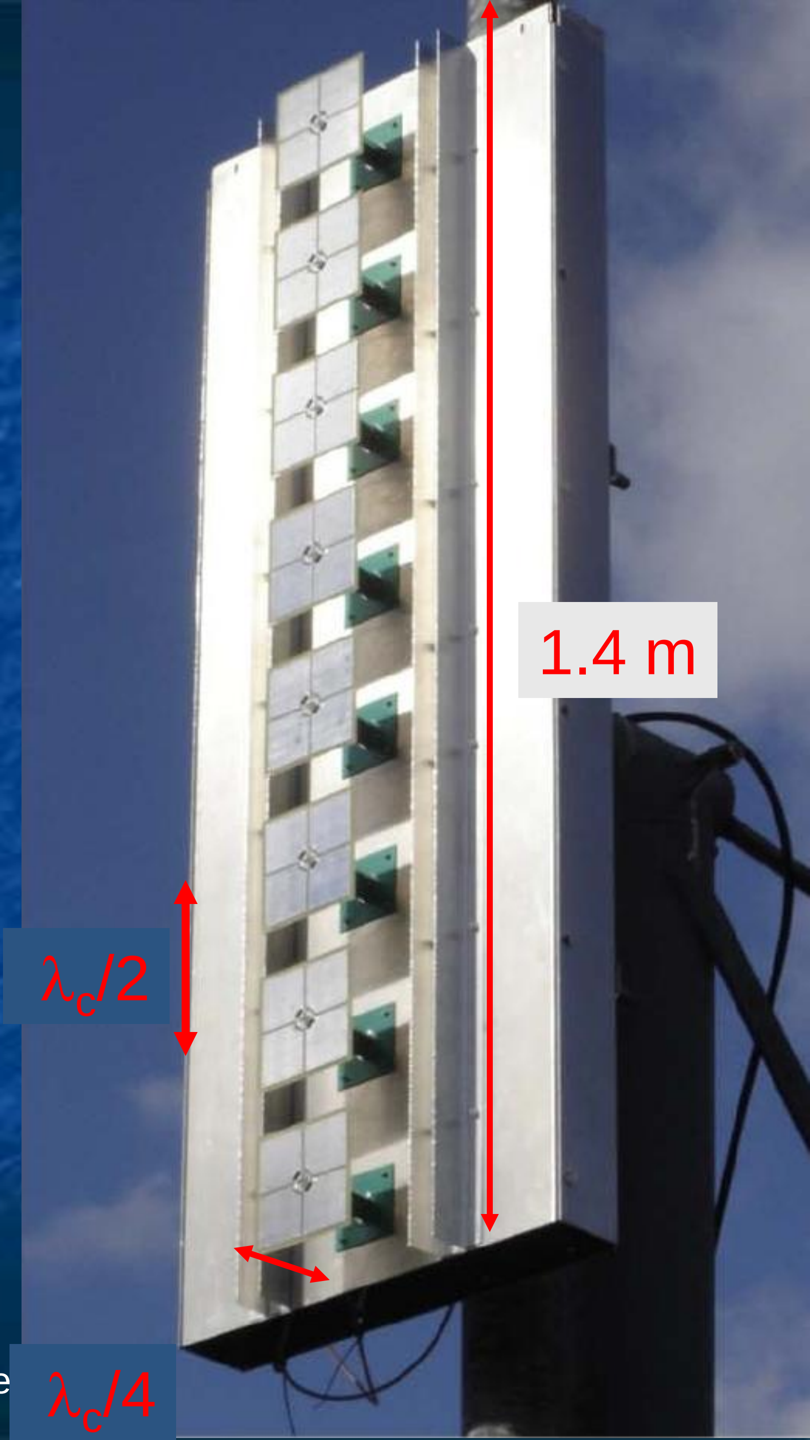
Molonglo Observatory Synthesis Telescope/ SKAMP

- 11.6 x 778 m cylinder
- 300 - 1400 MHz

SKAMP Linefeed





f_c = 866 MHz, λ_c = 35 cm

Next Steps

EM models of feed beams + sky beams

- Bandura - NEC
- McGinnis - homebrew
- Others?

Integrate beam models into survey models

- Sidelobe requirements
- Beam symmetry (2 polarizations)