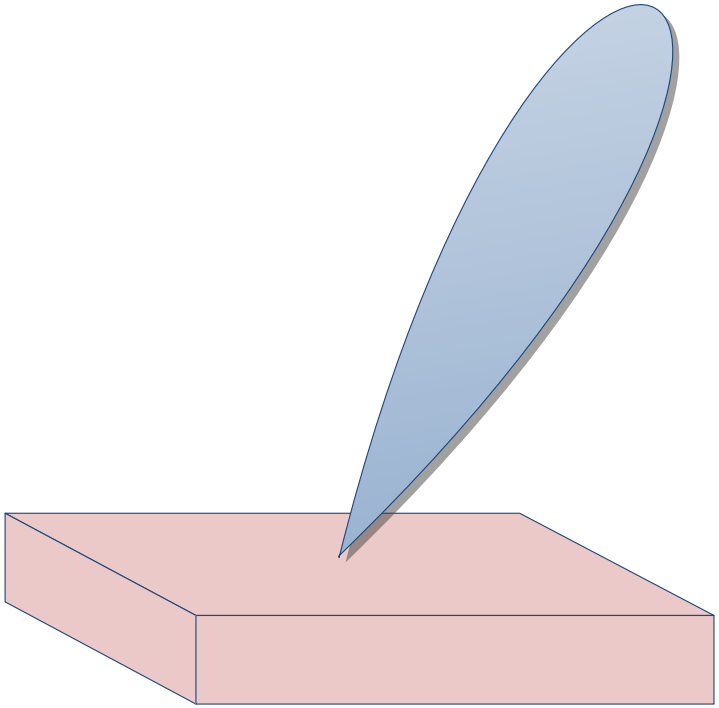
Mid Frequency Aperture Arrays

System Design

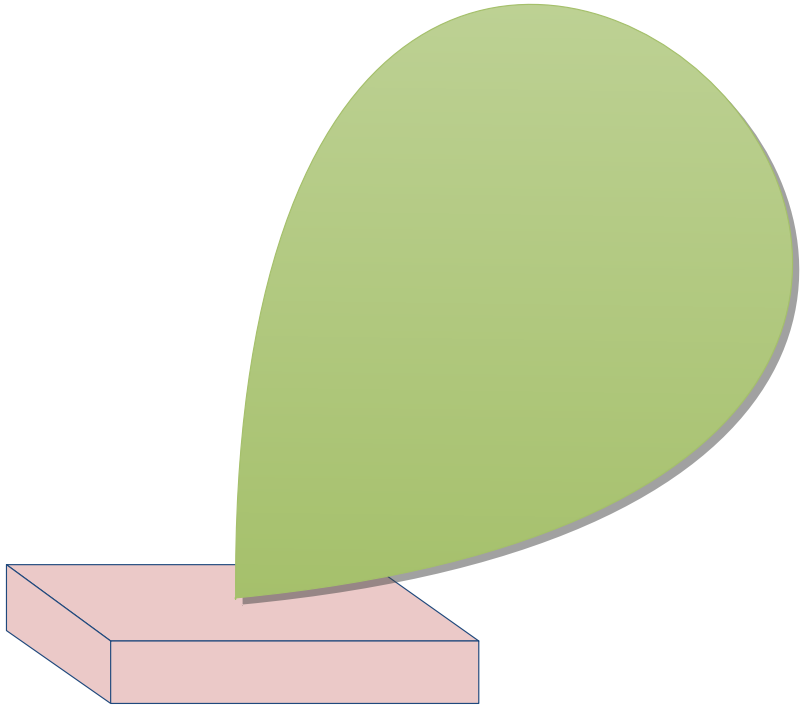
Assumed Requirements (for the bid)

Parameter	Requirement	Unit
Frequency range	300 - 1000	MHz
Survey speed	1.00E+10	m^4deg^2/K^2
ΔΩ	100 @ 500 MHz	deg^2
Aeff/Tsys	10000 from 400 - 800 MHz	m^2/K
Polarisation	2	
RF beams	1	
Electronic scan angle		
Instantaneous bandwidth	250	MHz
Number of stations	250	

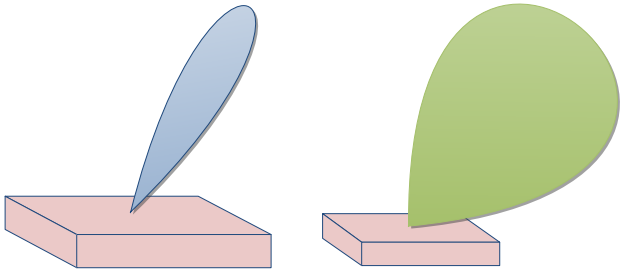
$$SS = \left(\frac{A_{eff}}{T_{sys}}\right)^2 . \Delta\Omega$$



Tile Design 1

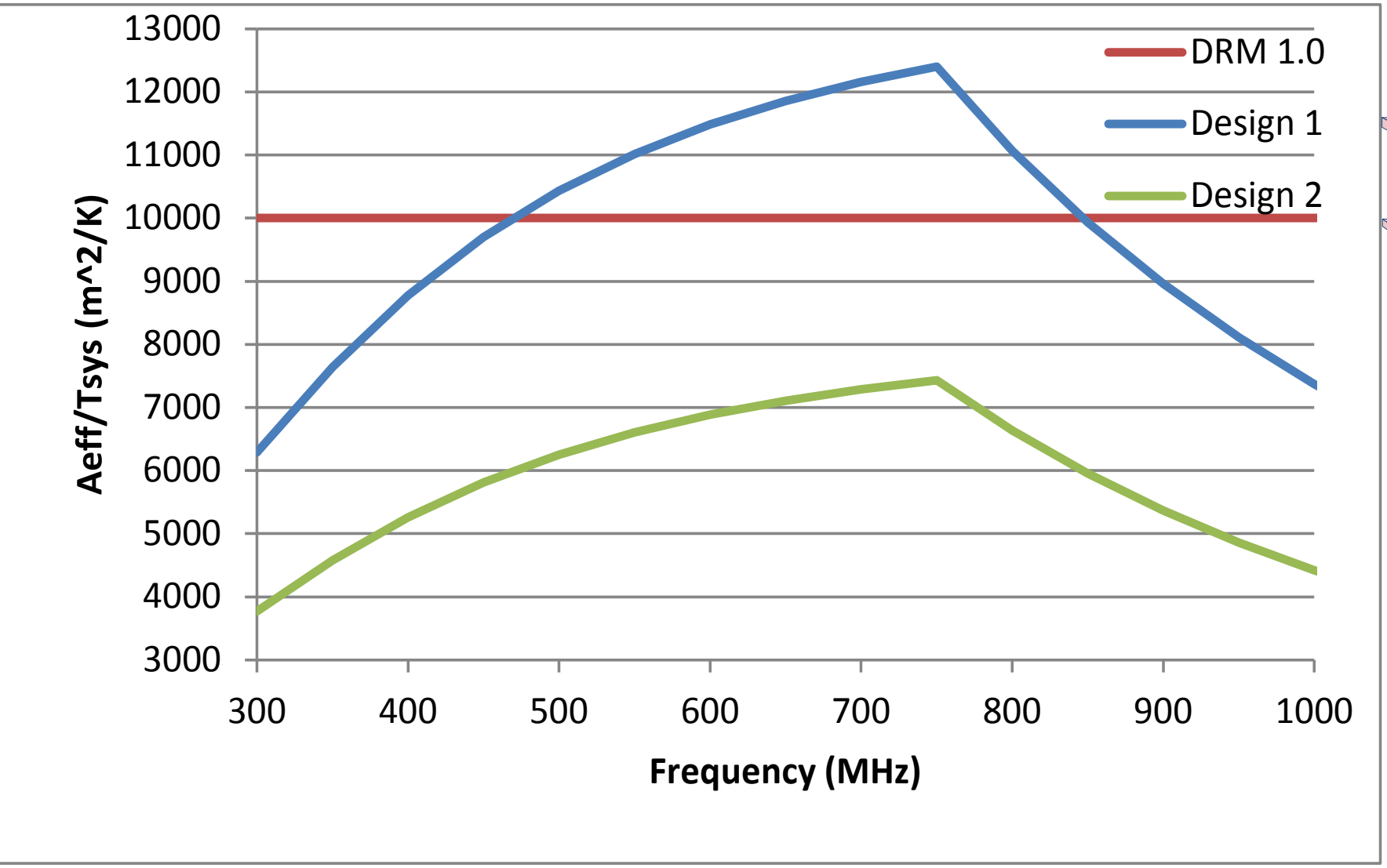


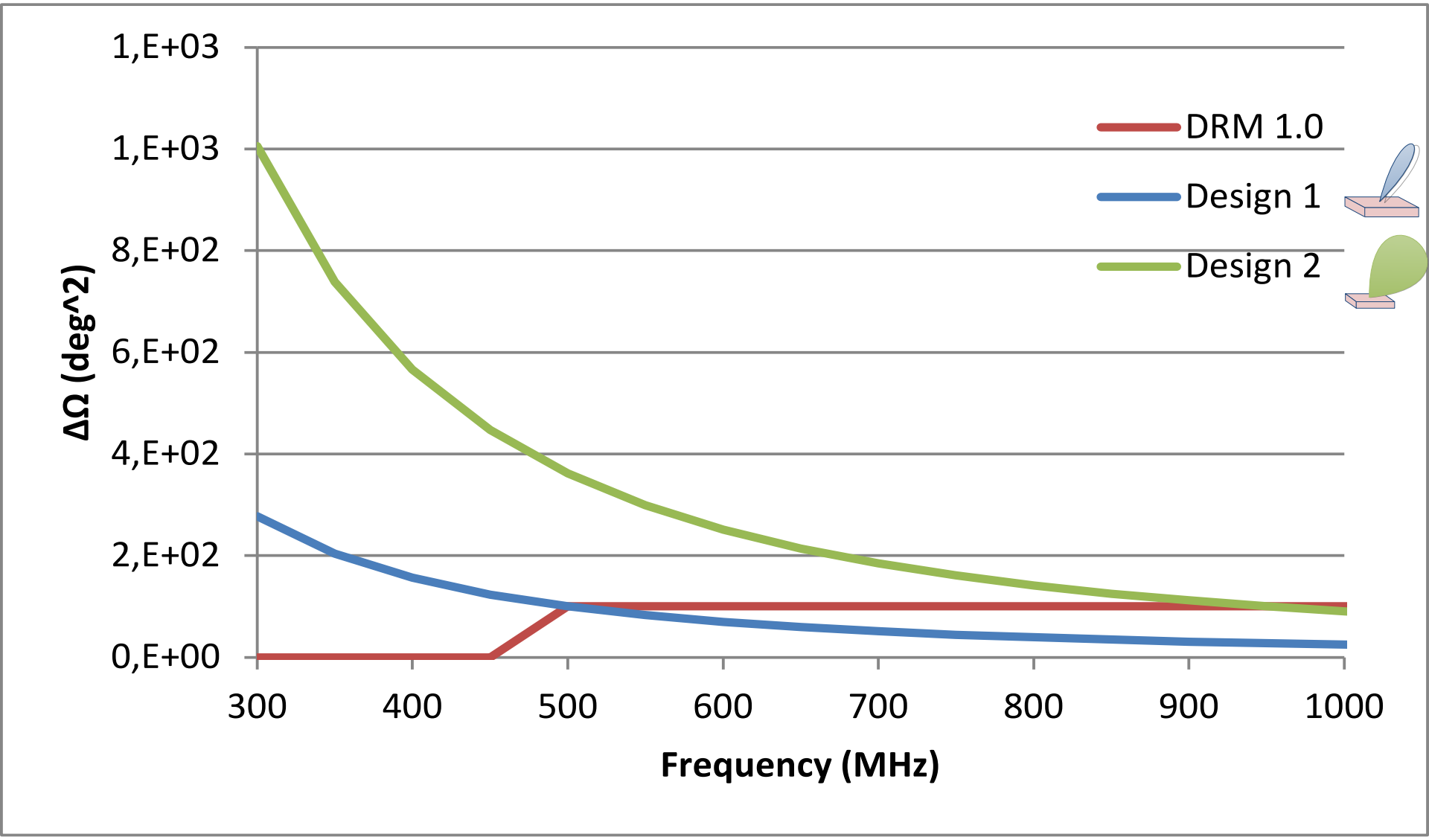
Tile Design 2

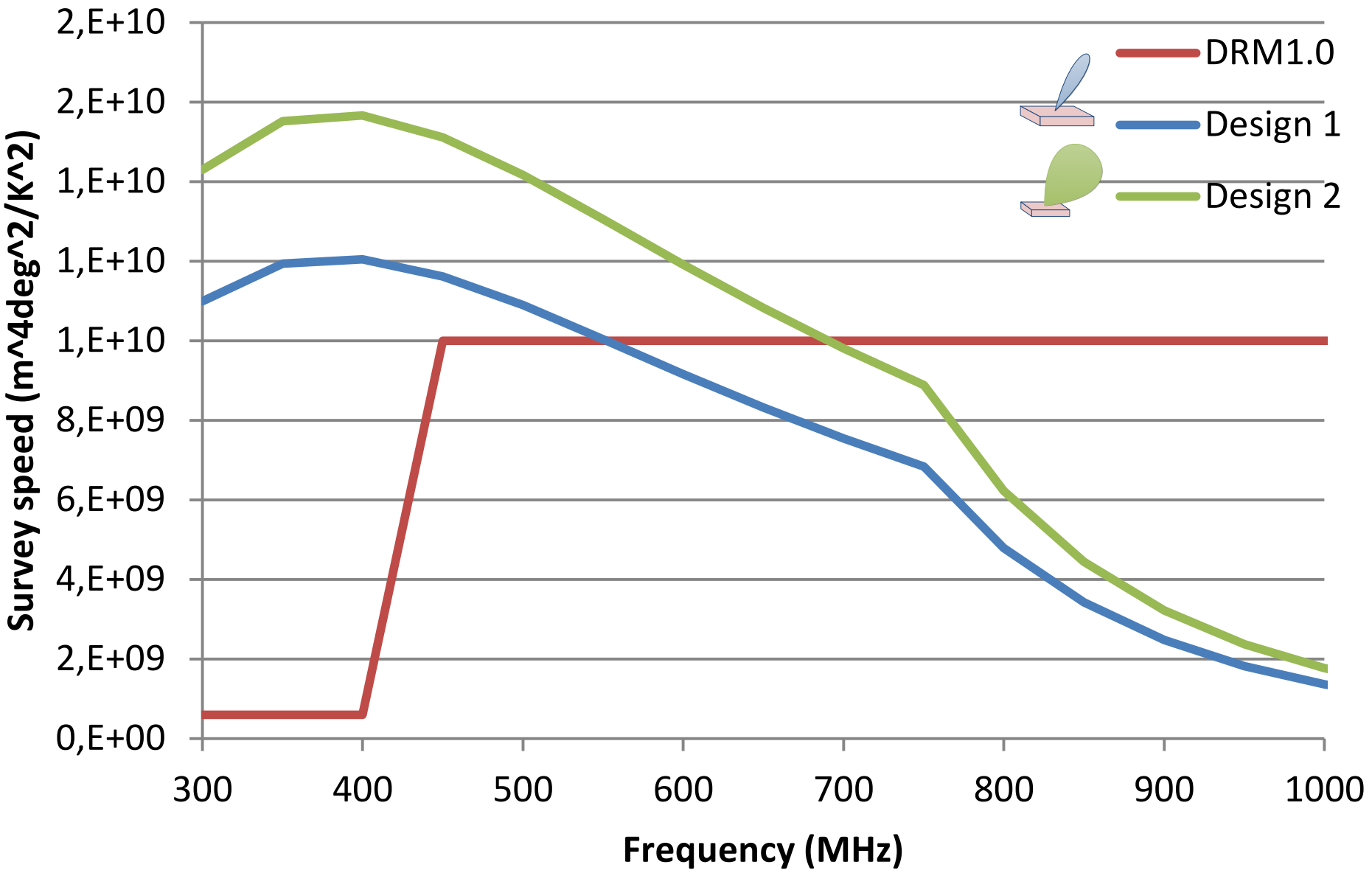


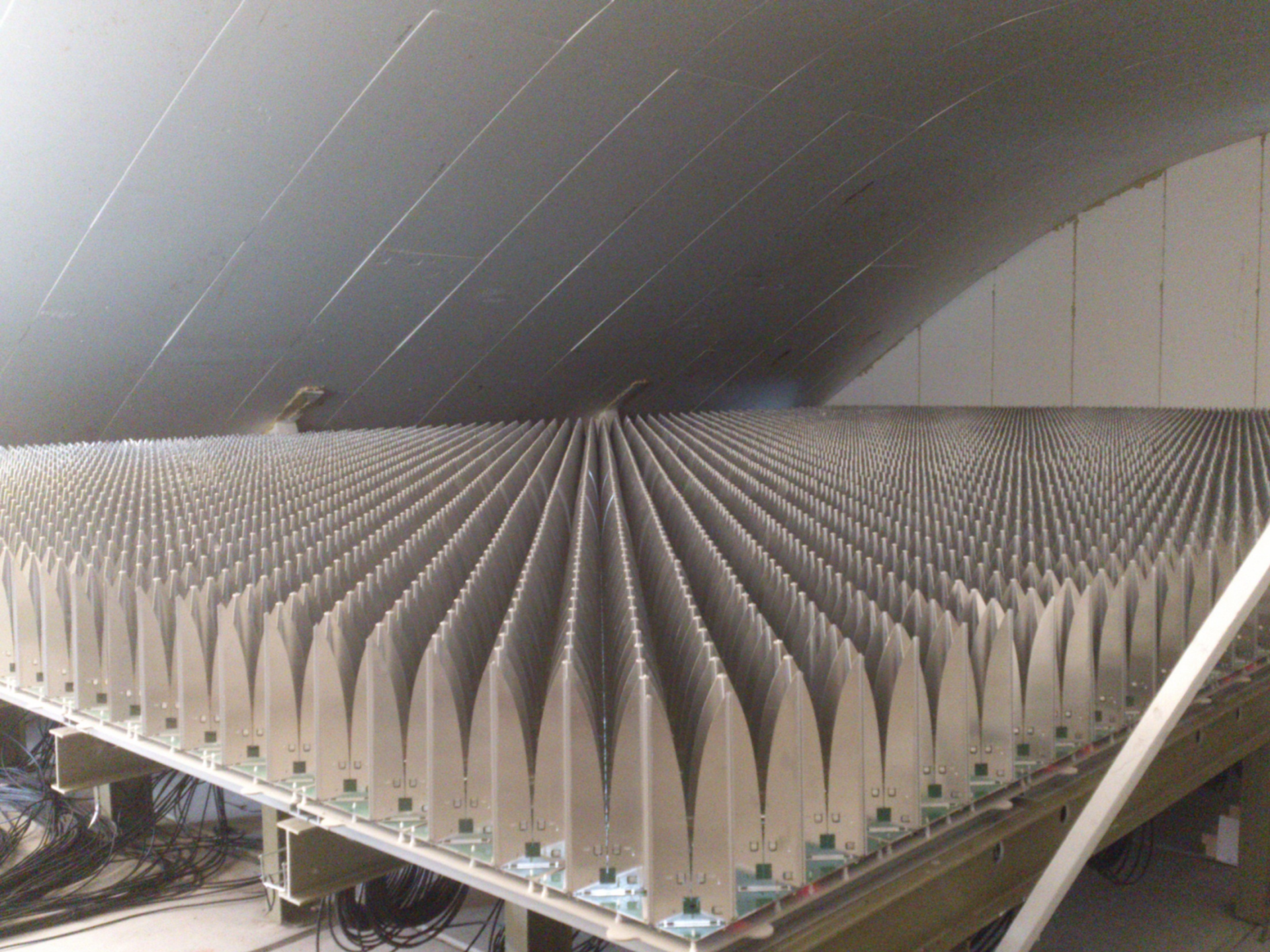
Parameter @ 500 MHz	Design 1	Design 2	Unit
$\Delta\Omega$	100	362	deg^2
Aeff/Tsys	10435	6254	m^2/K
Survey speed	1.09E+10	1.42E+10	$m^4 deg^2/K^2$
Number of elements/tile	72	32	
Number of signal paths	1922	2592	
Number of beams	1192	2588	
Tile size	2.88	1.28	m^2
Station area	2768	1659	m^2

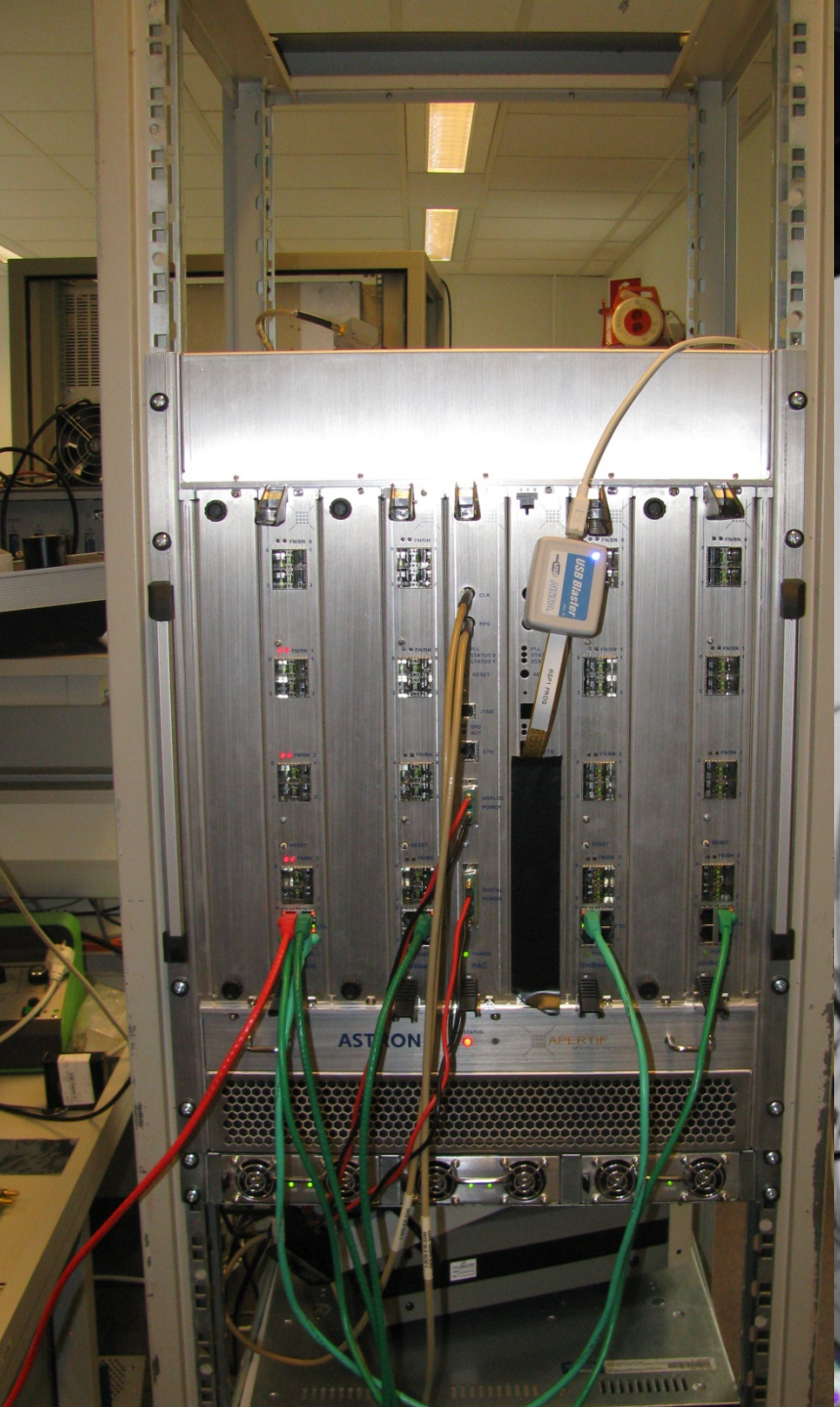
$$SS = \left(\frac{A_{eff}}{T_{sys}}\right)^2 . \Delta\Omega$$


13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
Aeff/Tsys (m^2/K)
300
400
500
600
700
800
900
1000
Frequency (MHz)
DRM 1.0
Design 1
Design 2

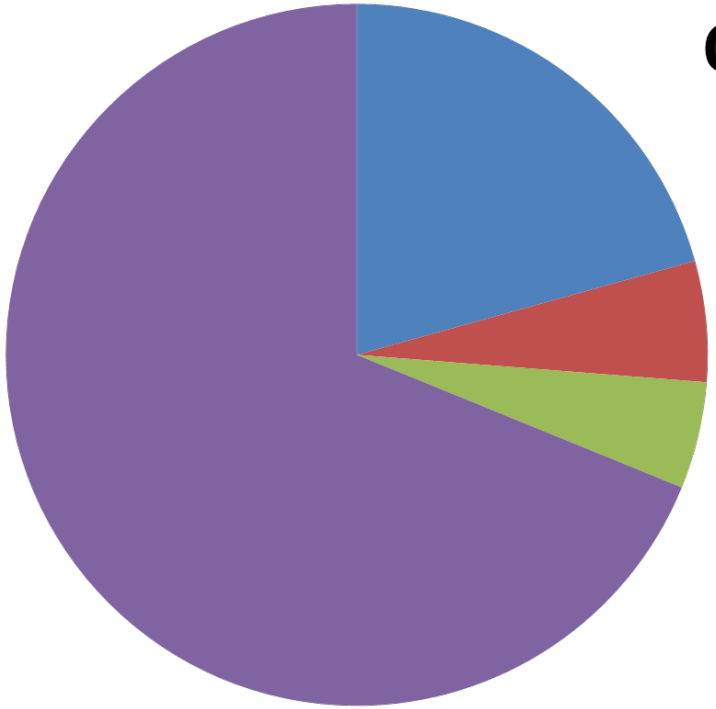

1,E+03
1,E+03
8,E+02
6,E+02
4,E+02
2,E+02
0,E+00
ΔΩ (deg^2)
300
400
500
600
700
800
900
1000
Frequency (MHz)
DRM 1.0
Design 1
Design 2

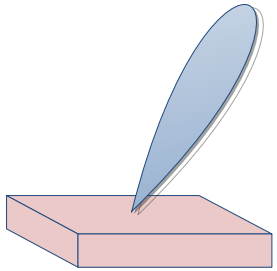

2,E+10
2,E+10
1,E+10
1,E+10
1,E+10
8,E+09
6,E+09
4,E+09
2,E+09
0,E+00
Survey speed (m^4deg^2/K^2)
300
400
500
600
700
800
900
1000
Frequency (MHz)
DRM1.0
Design 1
Design 2

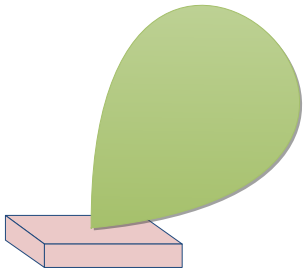



USB Blaster

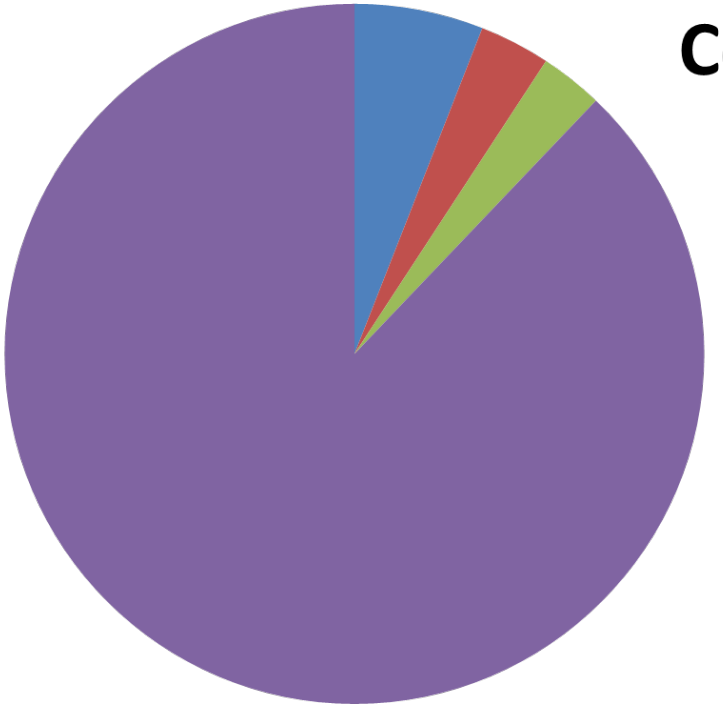
Cost for design 1 (2009)



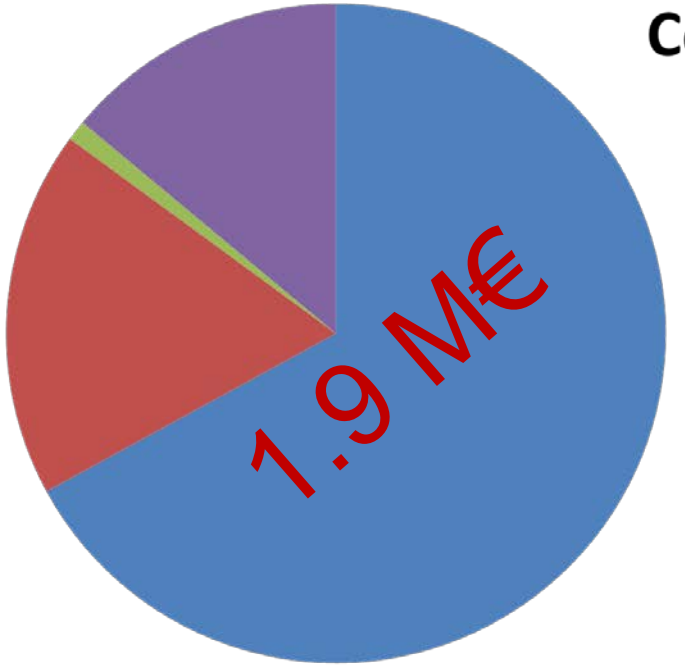




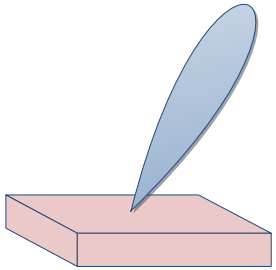
Cost for design 2 (2009)



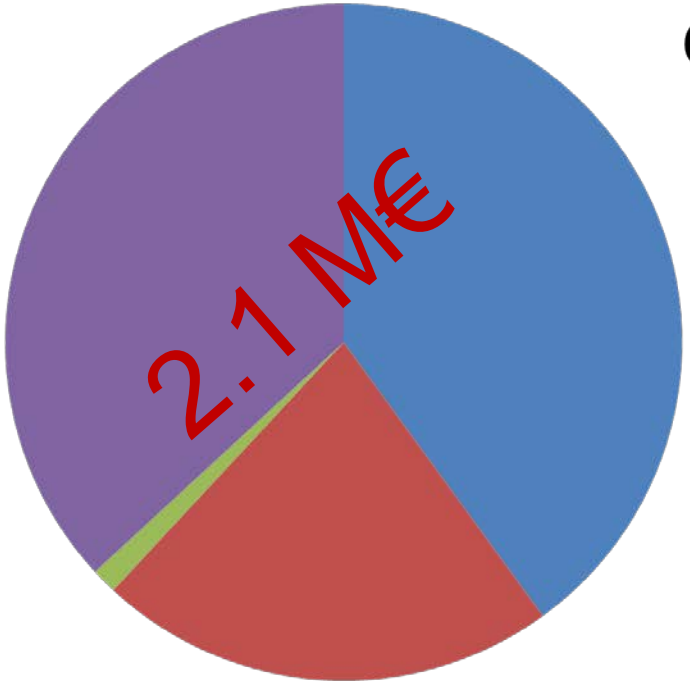
Cost for design 1 (2020)



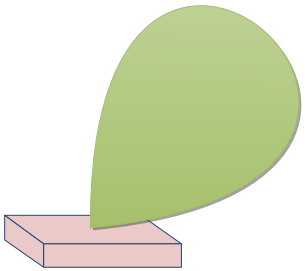
- Tiles
- Receivers
- Antenna processing
- Beamforming

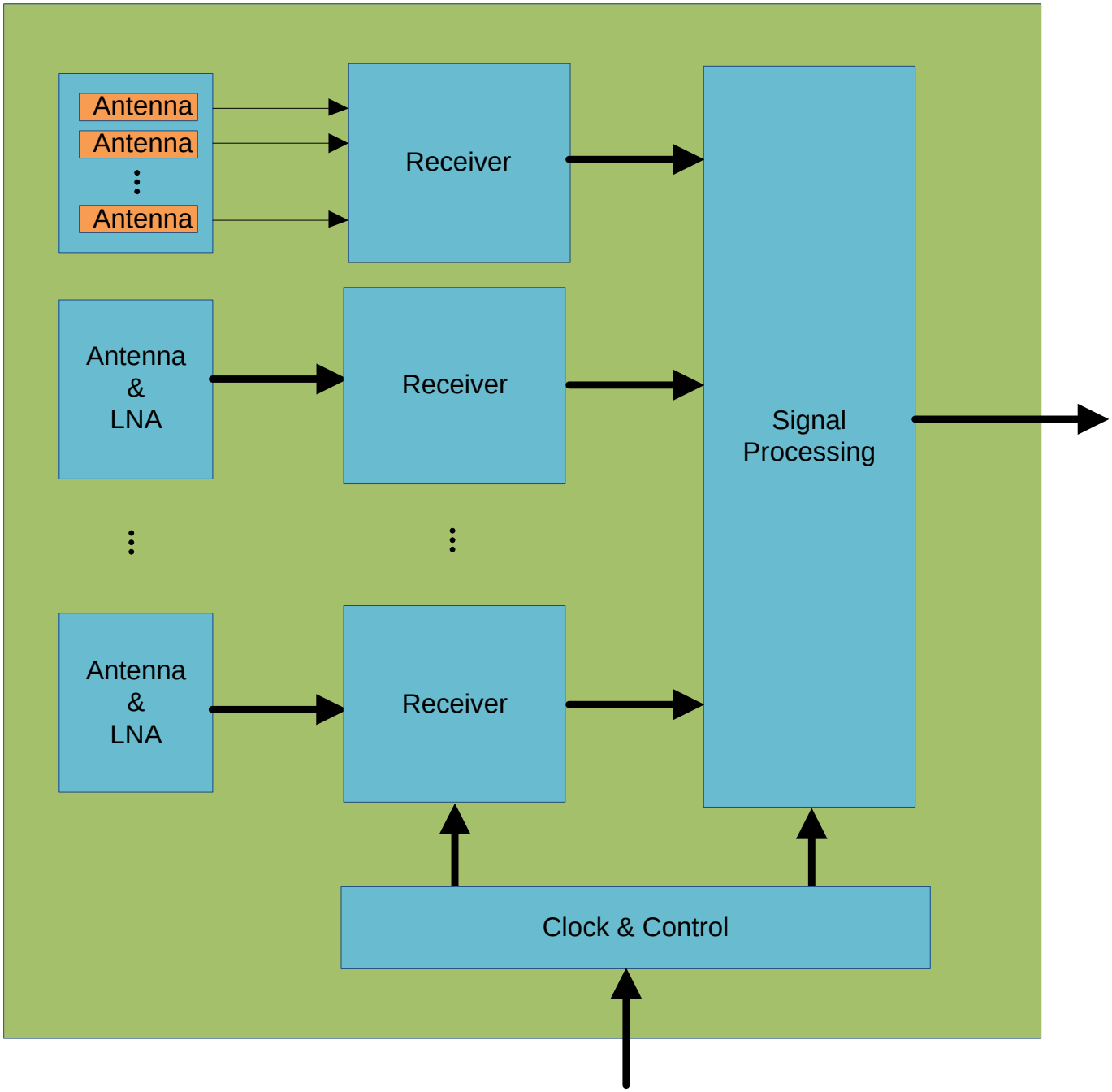


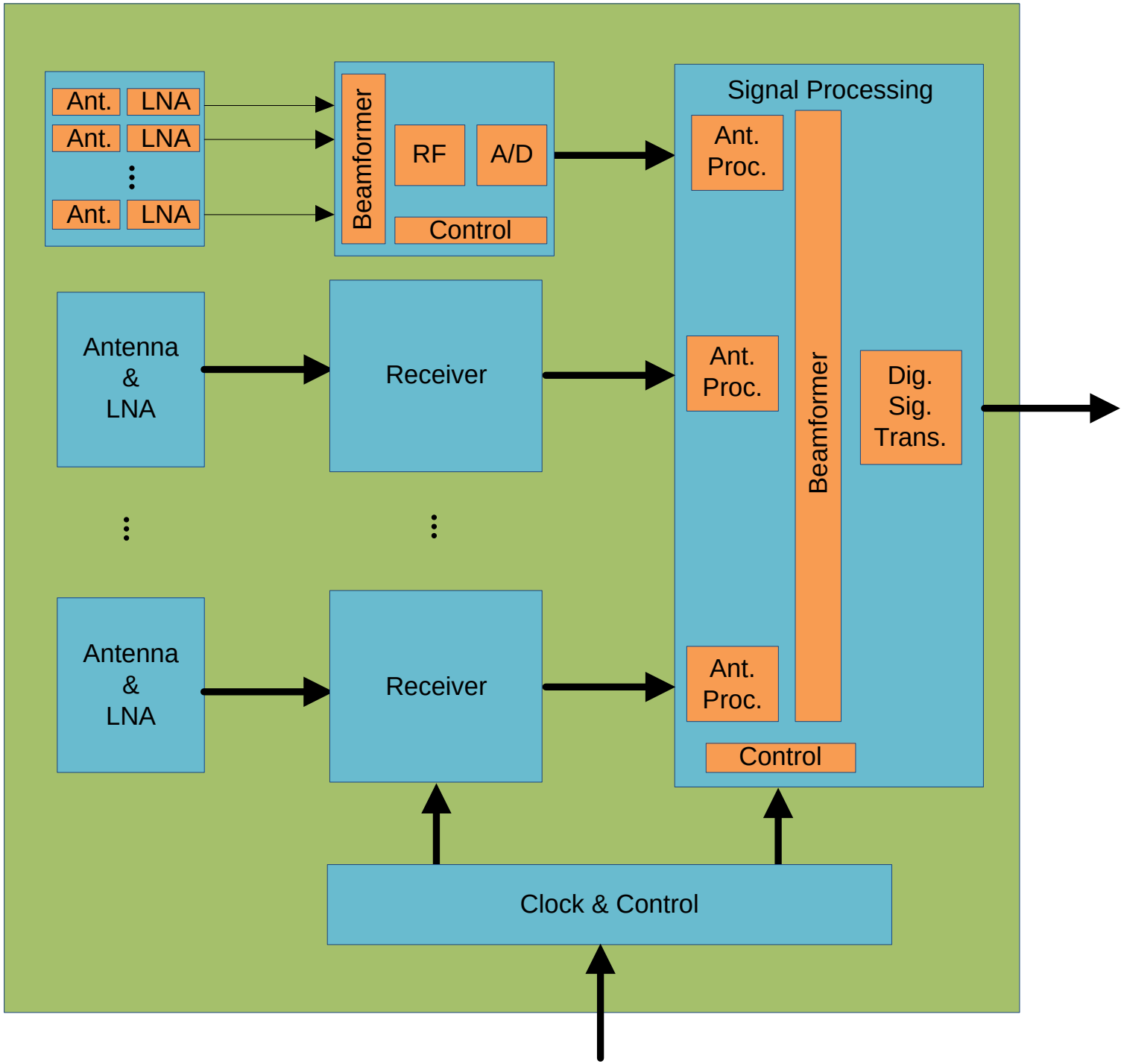
Cost for design 2 (2020)



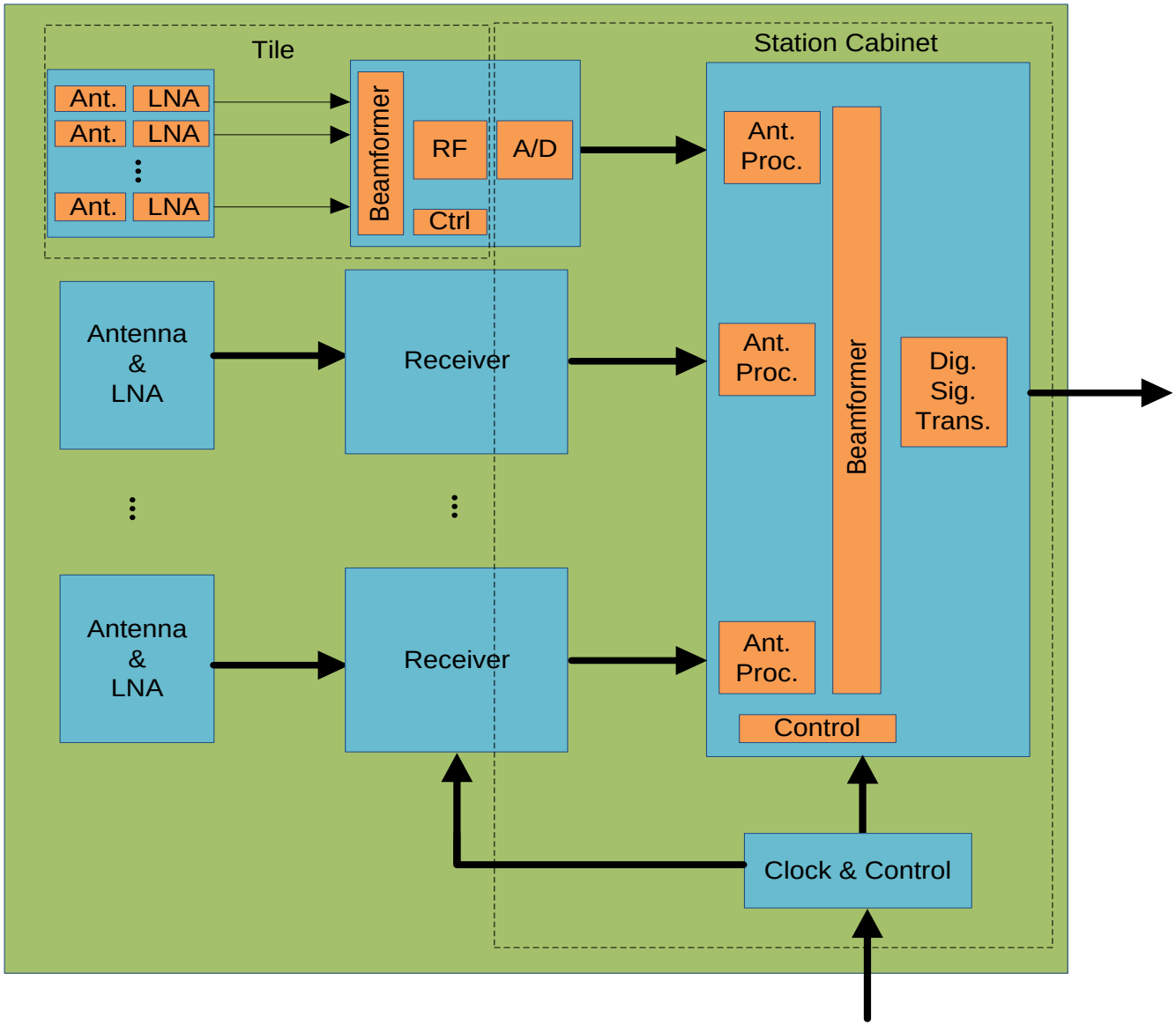
- Tiles
- Receivers
- Antenna processing
- Beamforming



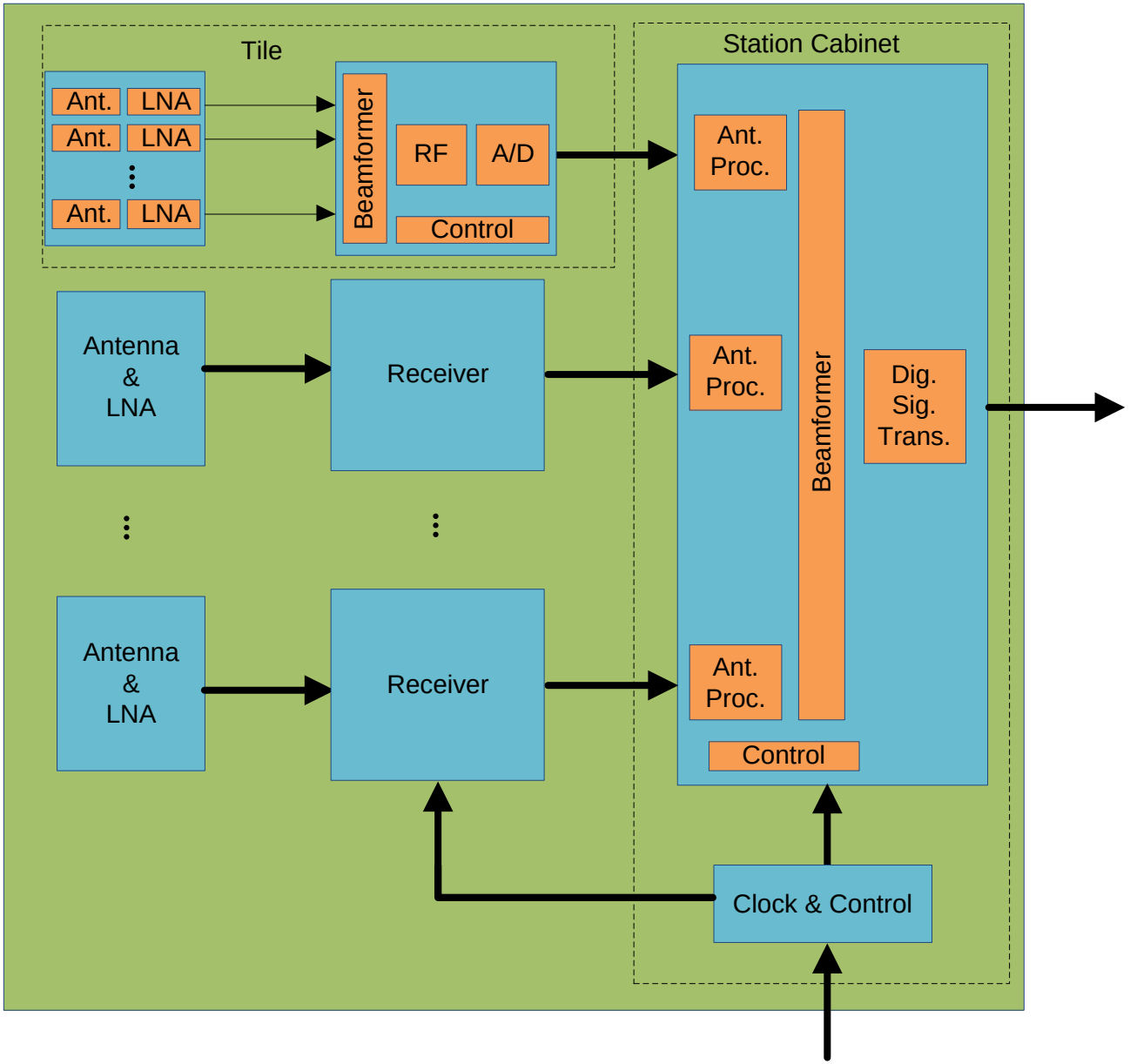

Antenna
Antenna
Antenna
Receiver
Antenna & LNA
Receiver
Signal Processing
Antenna & LNA
Receiver
Clock & Control

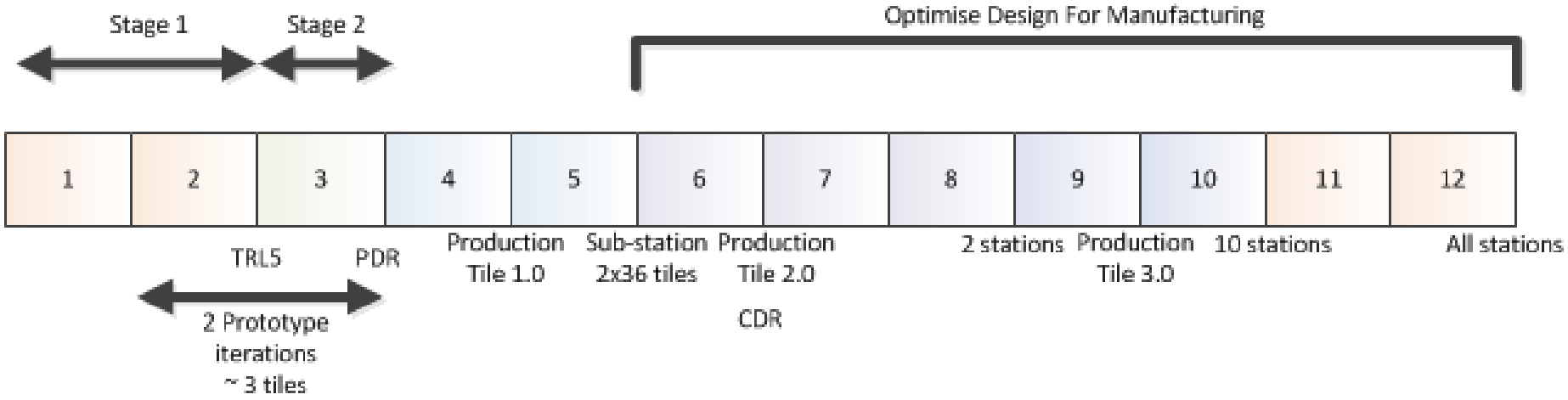

Ant.
LNA
Ant.
LNA
Ant.
LNA
Beamformer
RF
A/D
Control
Signal Processing
Ant.
Proc.
Antenna
&
LNA
Receiver
Ant.
Proc.
Beamformer
Dig.
Sig.
Trans.
Antenna
&
LNA
Receiver
Ant.
Proc.
Control
Clock & Control

Analog Tile

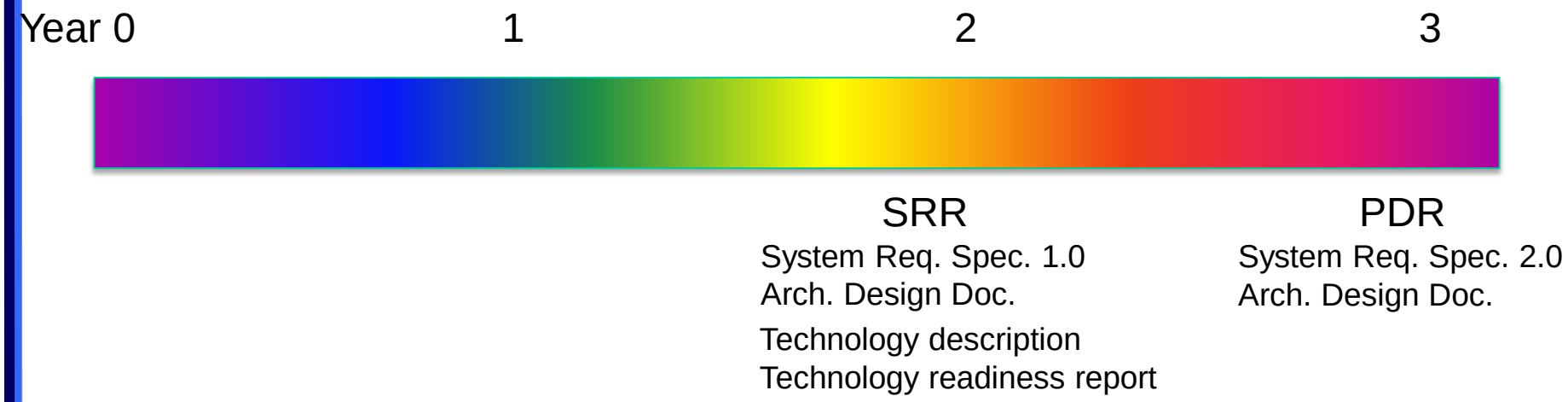

Tile
Station Cabinet
Ant.
LNA
Ant.
LNA
Ant.
LNA
Beamformer
RF
A/D
Ctrl
Ant.
Proc.
Antenna
&
LNA
Receiver
Ant.
Proc.
Beamformer
Dig.
Sig.
Trans.
Antenna
&
LNA
Receiver
Ant.
Proc.
Control
Clock & Control

Digital Tile




Stage 1
Stage 2
Optimise Design For Manufacturing
1
2
3
4
5
6
7
8
9
10
11
12
TRL5
PDR
2 Prototype iterations ~ 3 tiles
Production Tile 1.0
Sub-station 2x36 tiles
Production Tile 2.0
CDR
2 stations
Production Tile 3.0
10 stations
All stations

Important MFAA Milestones

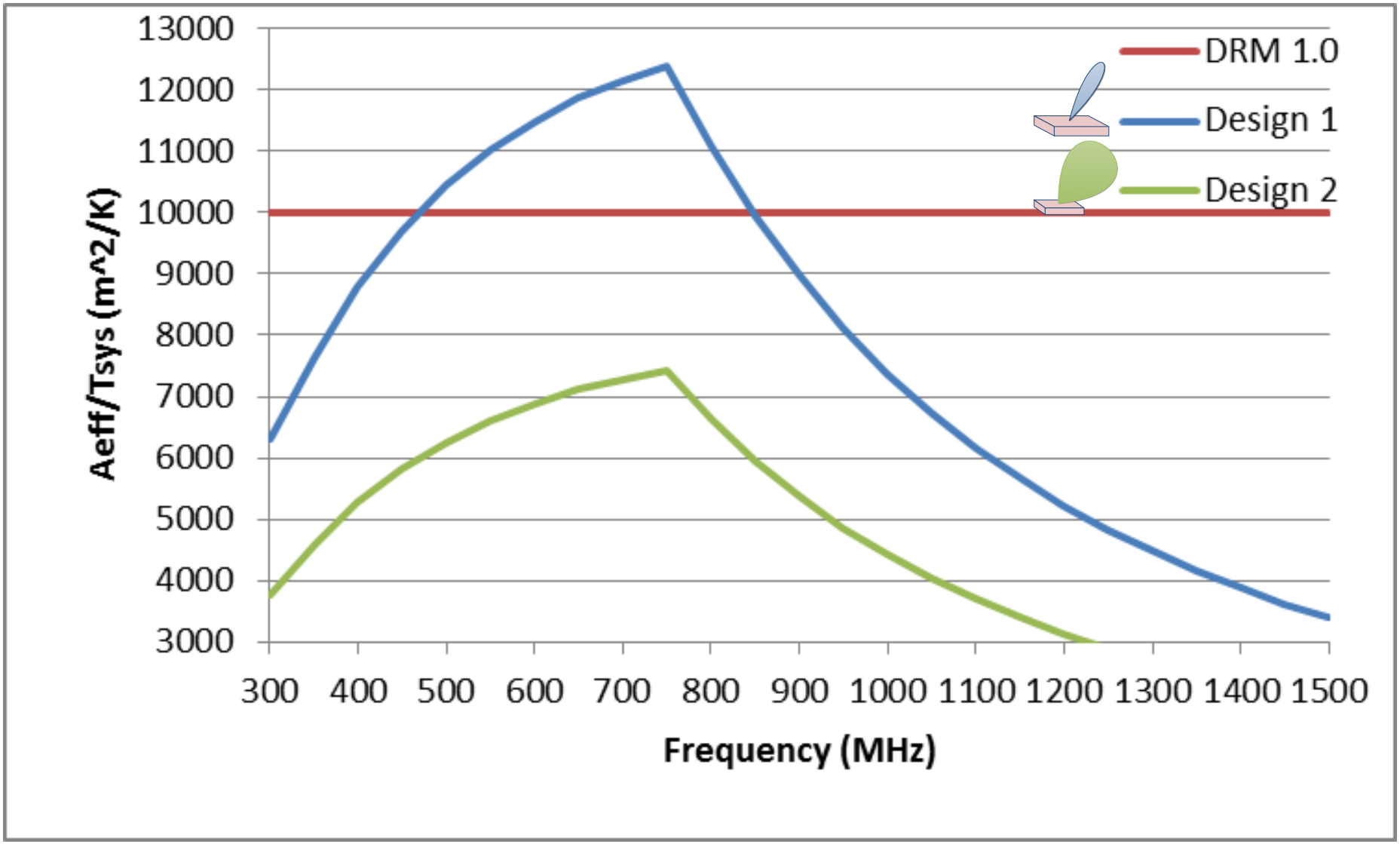


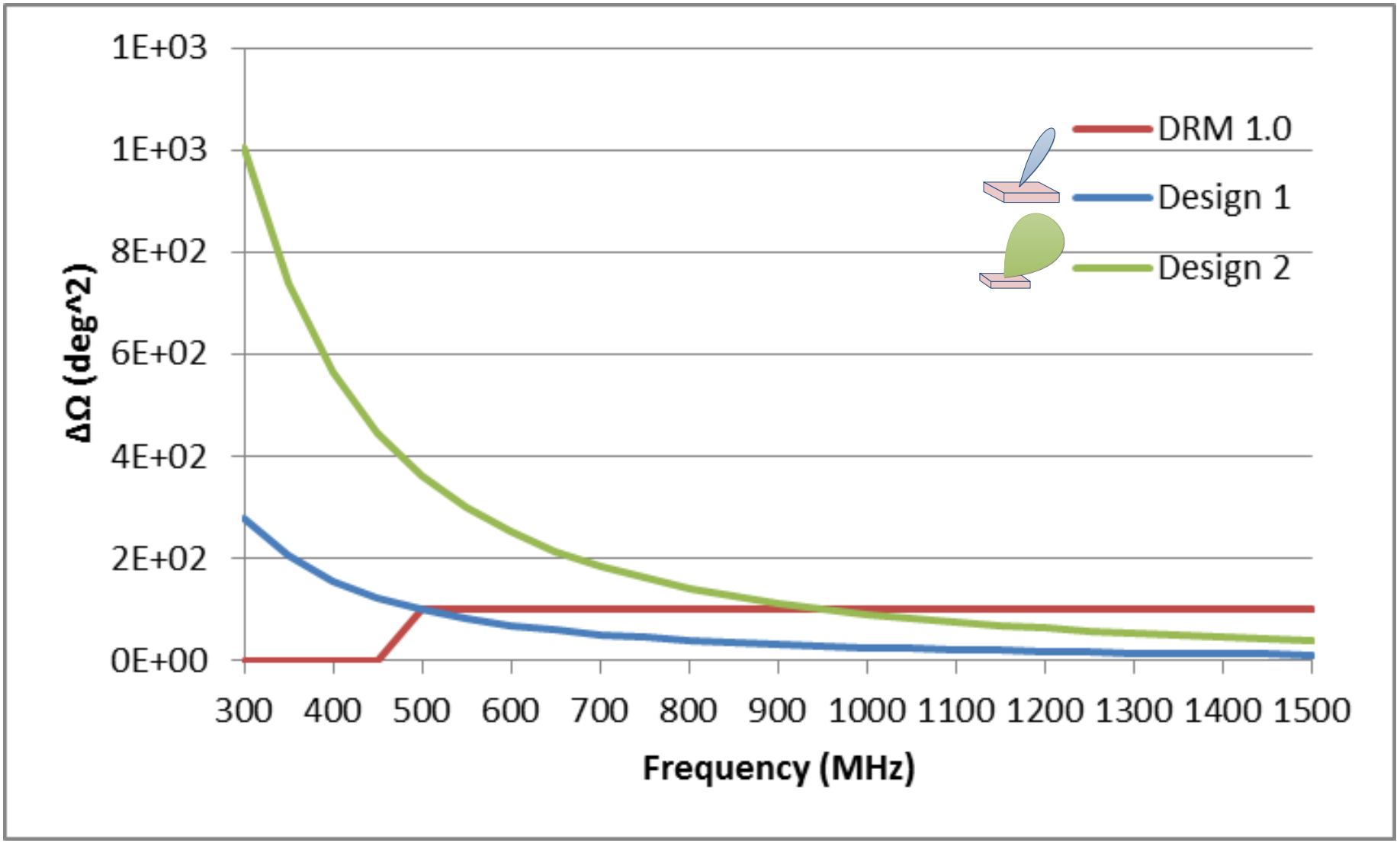
Conclusion

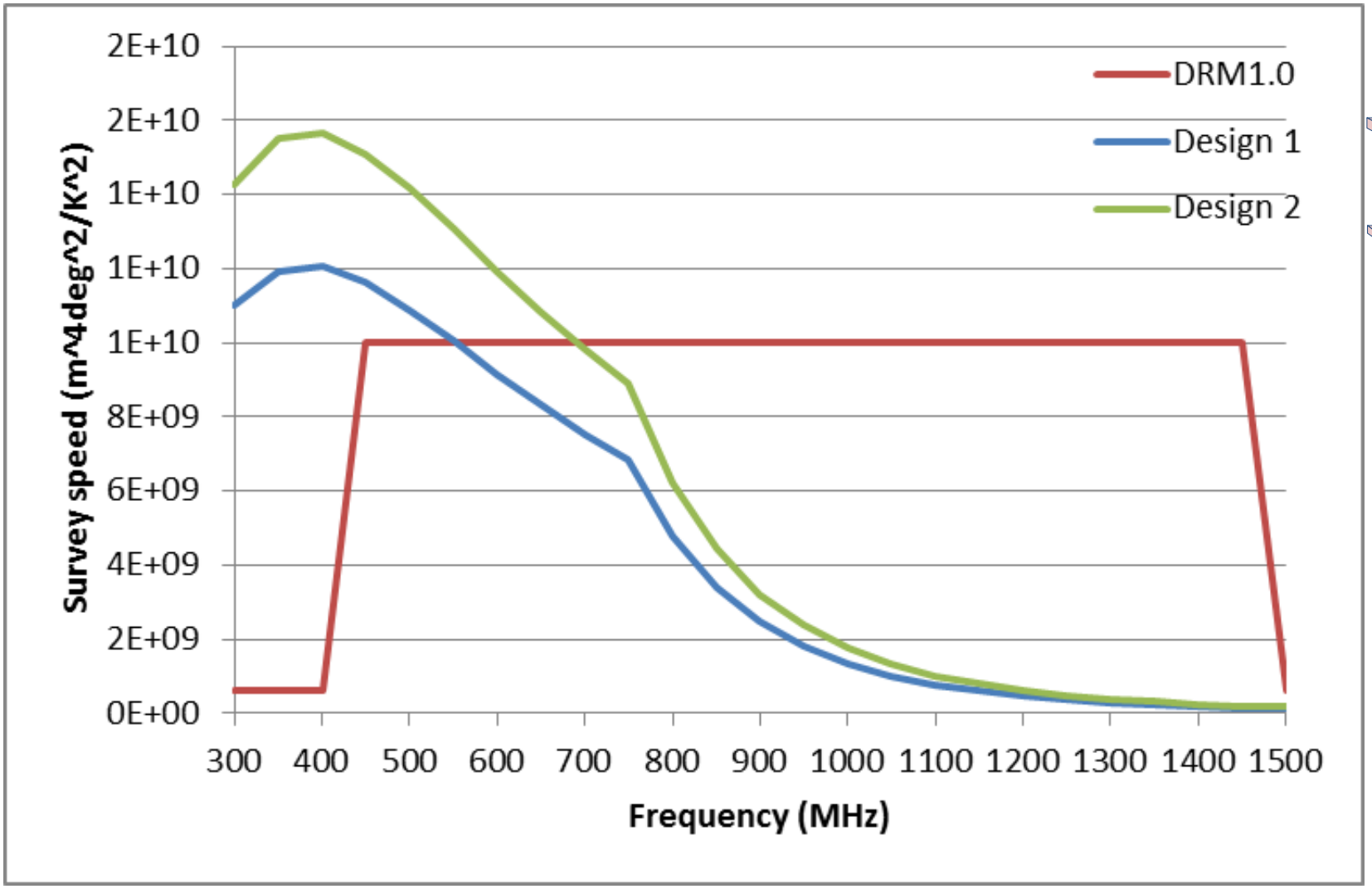
- Question is not: if it is feasible, but when it is feasible
- Crucial to decide on frequency range

Key Item

- Proposed prelim. freq. range: 300-1000 MHz (bid)
- 500 – 1500 MHz?


13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
Aeff/Tsys (m^2/K)
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
Frequency (MHz)
DRM 1.0
Design 1
Design 2


1E+03
1E+03
8E+02
6E+02
4E+02
2E+02
0E+00
ΔΩ (deg^2)
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
Frequency (MHz)
DRM 1.0
Design 1
Design 2


2E+10
2E+10
1E+10
1E+10
1E+10
8E+09
6E+09
4E+09
2E+09
0E+00
Survey speed (m^4deg^2/K^2)
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
Frequency (MHz)
DRM1.0
Design 1
Design 2