MatSing Lens vs Beamforming Comparison

MS-MBA-3-C4A3, MS-MBA-3-F4A3, 8T8R RevA, 8x8 (64T64R) RevA

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Overview

- To show the practical limits based on physics of beamforming solutions MobileNet Services was tasked with propagating beamforming antennas 8x8 (64T64R) and 8T8R for 120-degree coverage along with MatSing MS-MBA-3-C4A3 / MS-MBA-3-F4A3 for 120-degree coverage.
  - 8x8 (64T64R) and 8T8R antenna models were simulated with EZNEC for the 0° elevation beams.
    - 8x8 (64T64R) is a 64-element array antenna
    - 8T8R is a 4-column array antenna
  - MatSing MS-MBA-3-C4A3 & MS-MBA-3-F4A3 are 4x4 MIMO capable 3-beam antennas.
- Based on propagation plots, 120-degree coverage from beam forming solutions is outside the high-performance range and closer to 60 degrees is more within practical limits.

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Design

Forsk Atoll was used to run simulations with the following design information.

- An existing site was used from a 70-site cluster
- Center frequency: 3.795 GHz
- Antenna Height: 29m
- PA Power: 20W (43dBm)
- 3° mechanical downtilt on beamforming antennas.
- 3° downtilt on each MS-MBA-3-C4A3 beam.
- Standard Propagation model used was calibrated for the region.
- 5m terrain and clutter files were used for propagation modeling.

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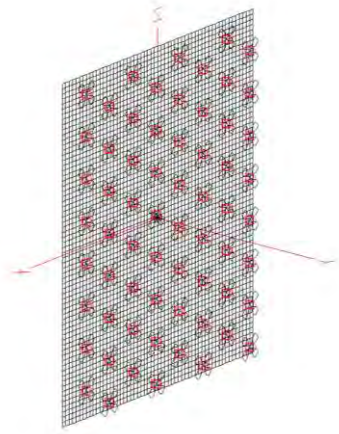
8x8 (64T64R) and 8T8R Beamforming Antennas

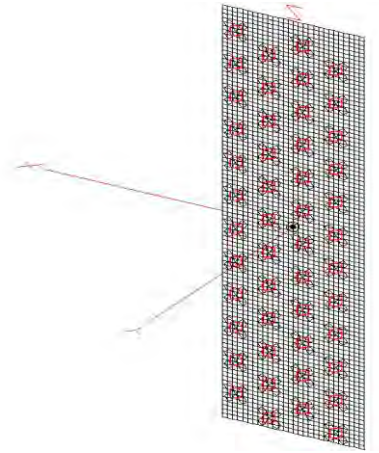
- 8x8 (64T64R) and 8T8R patterns simulated with EZNEC tool
- 8x8 (64T64R) is a 64-element array antenna
  - Antenna Size: 224 x 800 mm
  - Column Spacing: 0.65 λ at 3.7 GHz, 52.8mm
  - Vertical Element Spacing: 0.8 λ at 3.7 GHz, 64mm

8x8 (64T64R)					
Scan Angle (deg)	Gain (dBi)	AZ BW (deg)	EL BW (deg)	SPR (%)	SPR (dB)
±52.5°	16.9	no meaning	8.1	80.1	-1
±37.5°	20.8	12.6	8.2	49.1	-3.1
±22.5°	23.5	10.8	8.2	14.6	-8.4
±7.5°	23.9	9.9	8.1	9.2	-10.4



- 8T8R is a 4-column array antenna
  - Antenna Size: 430 x 520 mm
  - Column Spacing: 0.65 λ at 3.7 GHz, 52.8mm
  - Vertical Element Spacing: 0.8 λ at 3.7 GHz, 64mm

8T8R				
Scan Angle (deg)	Gain (dBi)	BW (deg)	SPR (%)	SPR (dB)
±45°	17.8	20	67.9	-1.7
±30°	20.5	21	37	-4.3
±15°	22.1	19	14.3	-8.5
0°	22.3	18	12.6	-9



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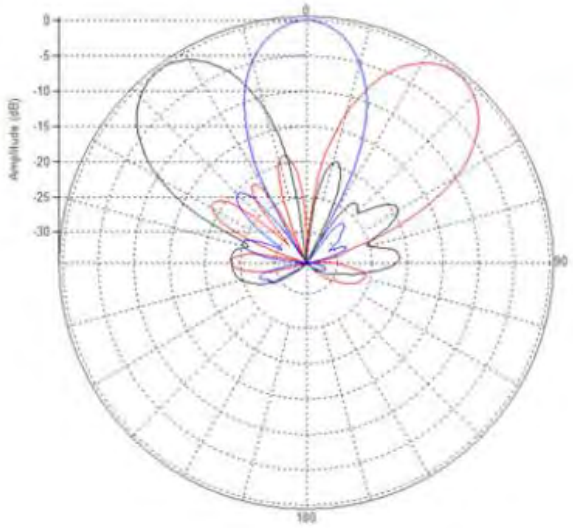
MatSing MS-MBA-3-C4A3

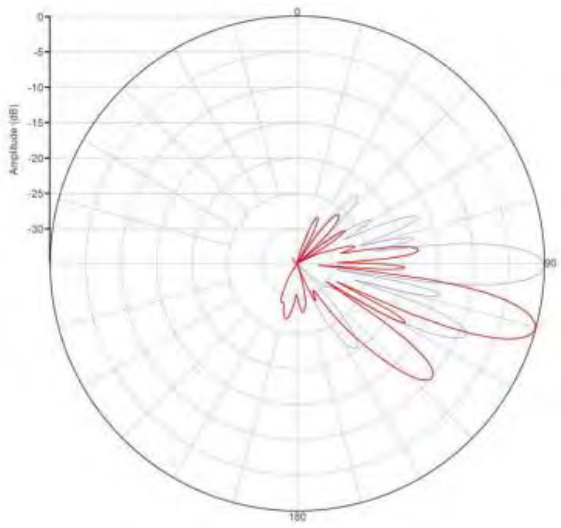
- Three beam antenna
  - Beam Azimuths
    - -40°, 0°, 40°

PATTERN RESULTS:

C-Band Horizontal Pattern (3.7GHz)



C-Band Vertical Pattern at 0° and 15° Tilt (3.7GHz)



TECHNICAL SPECIFICATIONS PER BEAM	
Frequency	3700 MHz - 4200 MHz
Gain	20.5dBi
VSWR	< 1.5:1
Polarization	Dual Slant ±45°
Horizontal Coverage	120°
Horizontal Beamwidth (3dB/10dB)	25°/45°
Vertical Beamwidth (3dB)	8°
Beam Crossover	8 dB typical
Total Number of Beams	3
Number of Ports per Beam	4
Total Number of Ports	12
Tilt per Cross-Pol	0°-15°
USLS (Upper Sidelobe Suppression)	16 dB
Front to Back Ratio	28 dB
Isolation Port to Port - Polarization	28 dB
Isolation Port to Port - Beam	28 dB
Power Rating	150W per port
Intermodulation	< -153dBc
Impedance	50 Ohm
Connector Quantity and Type	12 x 4.3-10 female

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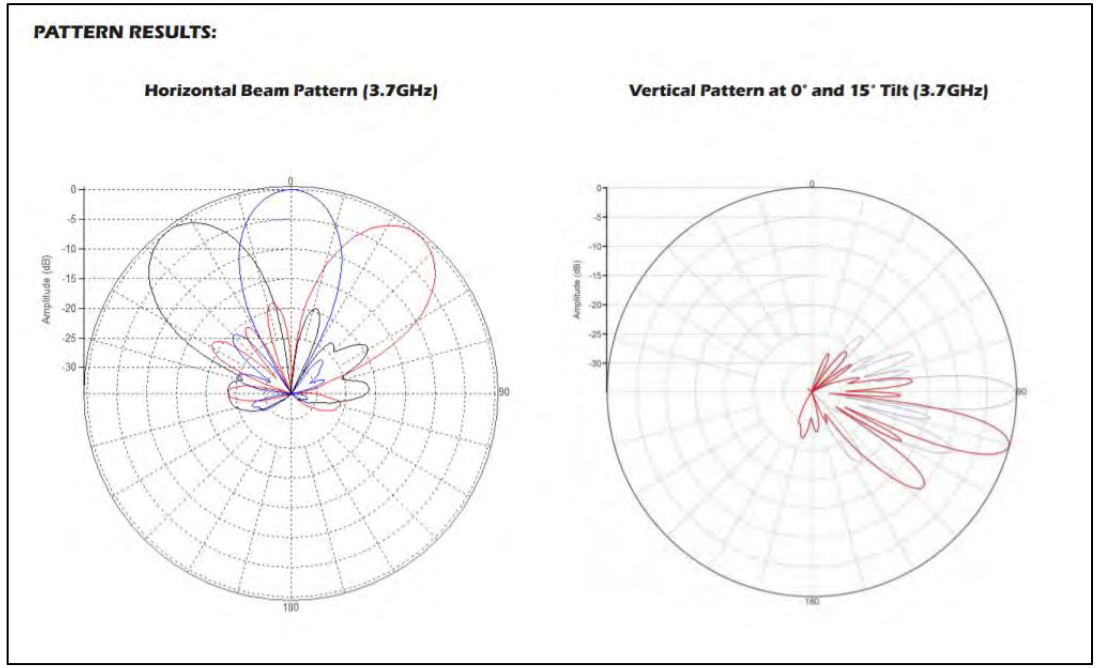
MatSing MS-MBA-3-F4A3

- Three beam antenna
  - Beam Azimuths
    - -40°, 0°, 40°



TECHNICAL SPECIFICATIONS PER BEAM	
Frequency	3300 MHz - 4200 MHz
Gain	20dBi
VSWR	< 1.5:1
Polarization	Dual Slant ±45°
Horizontal Coverage	120°
Horizontal Beamwidth (3dB/10dB)	25°/45°
Vertical Beamwidth (3dB)	8°
Beam Crossover	8 dB typical
Total Number of Beams	3
Number of Ports per Beam	4
Total Number of Ports	12
Tilt per Cross-Pol	0°-15°
USLS (Upper Sidelobe Suppression)	16 dB
Front to Back Ratio	28 dB
Isolation Port to Port - Polarization	28 dB
Isolation Port to Port - Beam	28 dB
Power Rating	150W per port
Intermodulation	< -153dBc
Impedance	50 Ohm
Connector Quantity and Type	12 x 4.3-10 female

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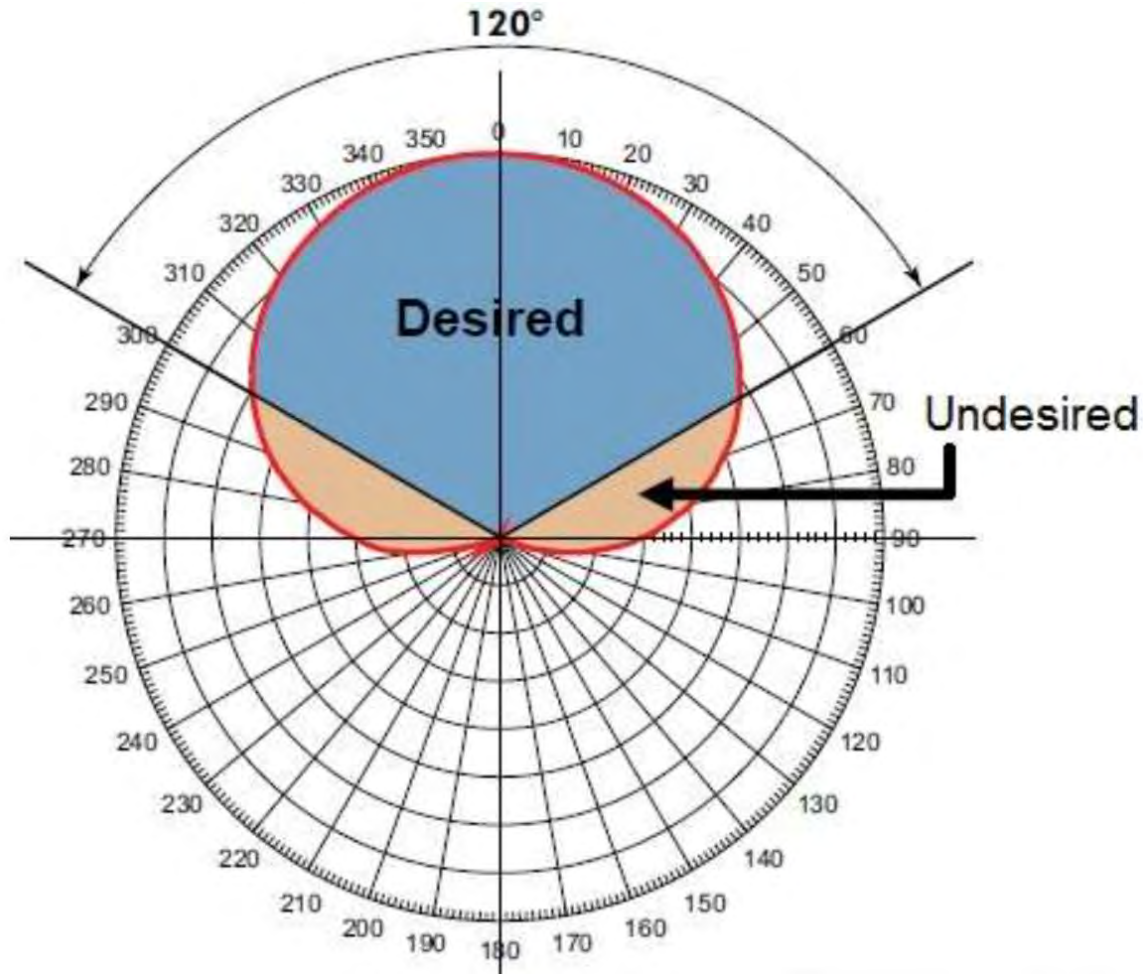
Sector Power Ratio

- SPR is calculated according to the CommScope standard definition
  - Ratio of the summed power outside of the sector to the power inside and outside of the sector.
- 8T8R – SPR is calculated with an assumed 30° sector. This is the approximate 10dB beamwidth of an 8T8R beam where 4 beams would cover a 120° sector of a 3-sector site.
- 8x8 (64T64R) – SPR is calculated with an assumed 15° sector. This is the approximate 10dB beamwidth of an 8x8 (64T64R) beam where 8 beams would cover a 120° sector of a 3-sector site.
- MatSing 3 Beam calculated with 40° sector where 3 beams would cover 120° sector of a 3-sector site.

Sector Power Ratio (cont.)

- 10% SPR good not to exceed target for antenna (90% energy within sector)

	Best Case SPR	Worse Case SPR	Average SPR
MatSing 3 Beam	5%	5%	5%
8x8 (64T64R) Active Array	9%	80%	38%
8T8R	12%	67%	32%



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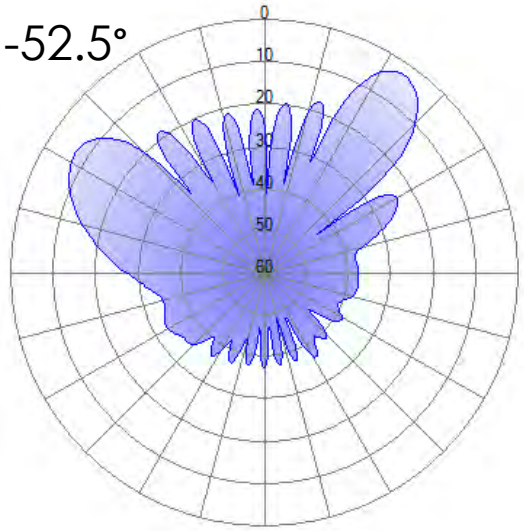
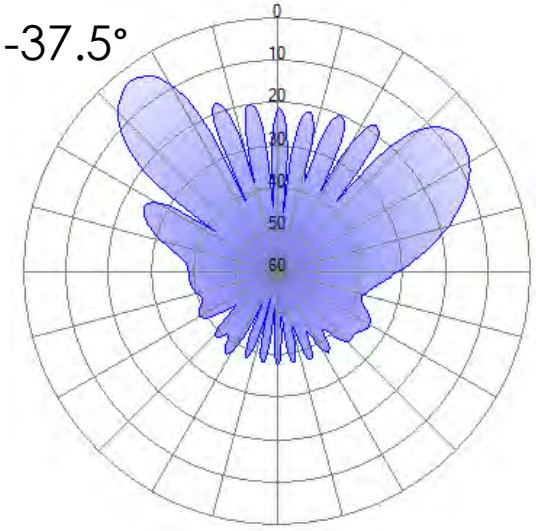
8x8 (64T64R) Horizontal Patterns (Reference Gain 23.94dBi)

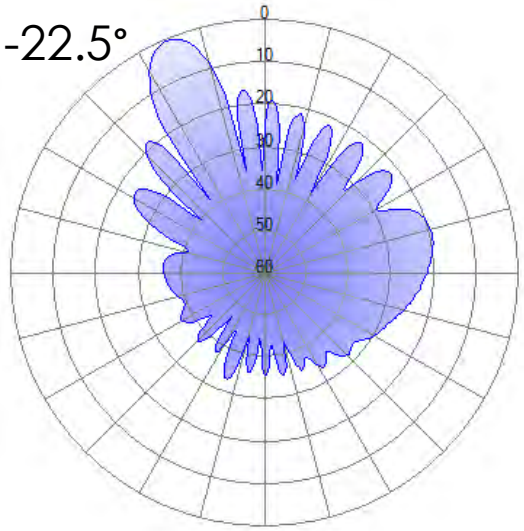
-52.5°



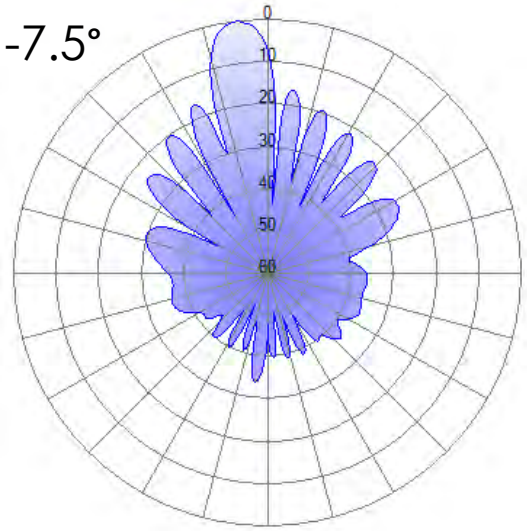
-37.5°



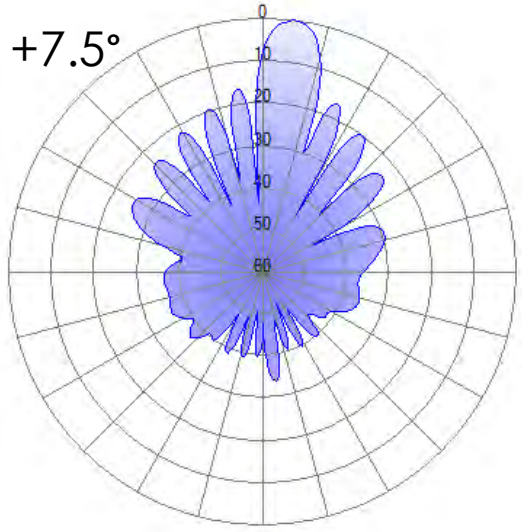
-22.5°



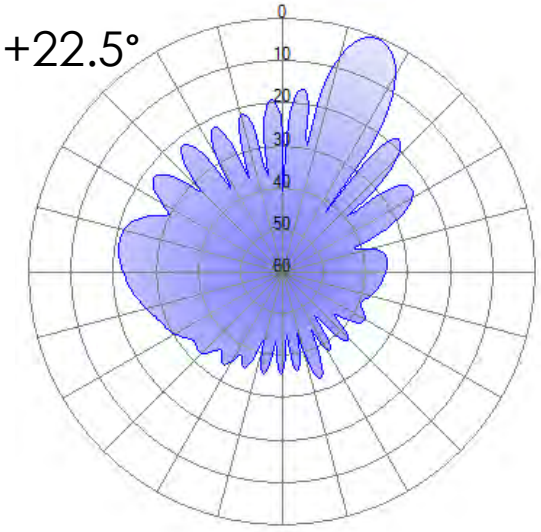
-7.5°



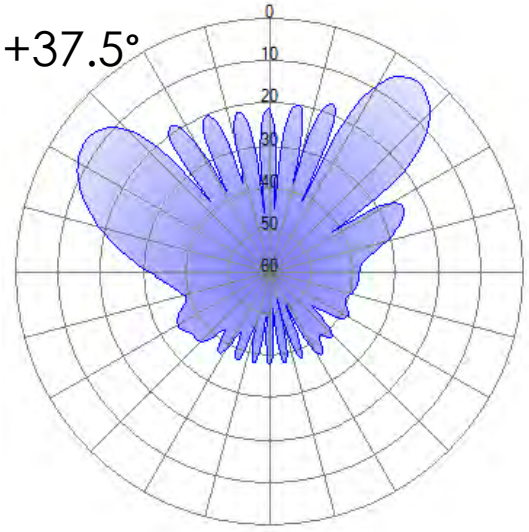
+7.5°



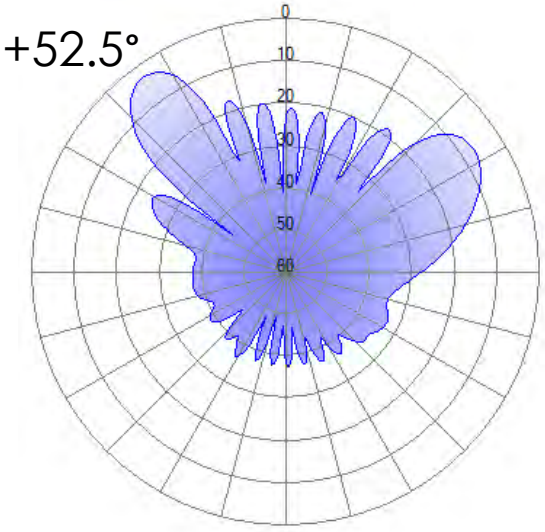
+22.5°



+37.5°



+52.5°



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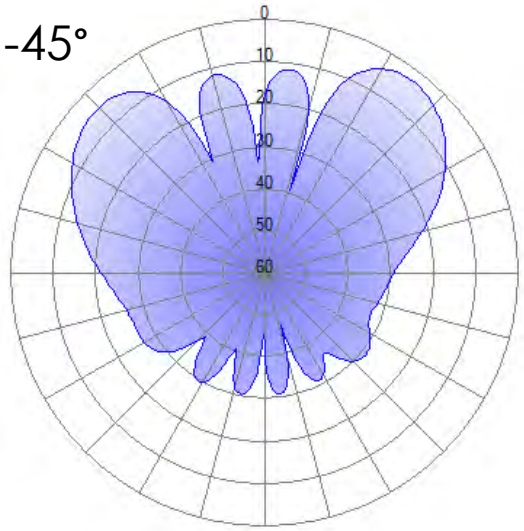
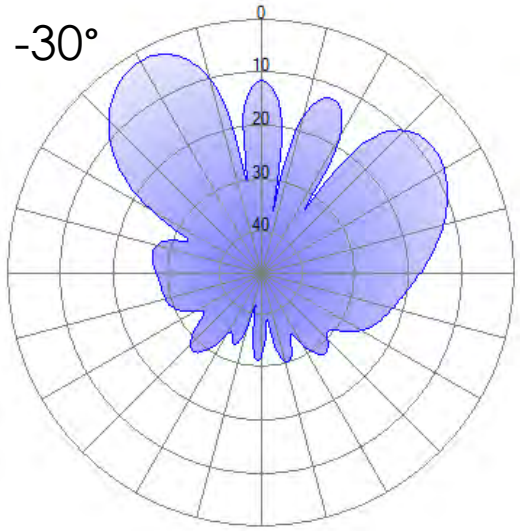
8T8R Horizontal Patterns (Reference Gain 22.3dBi)

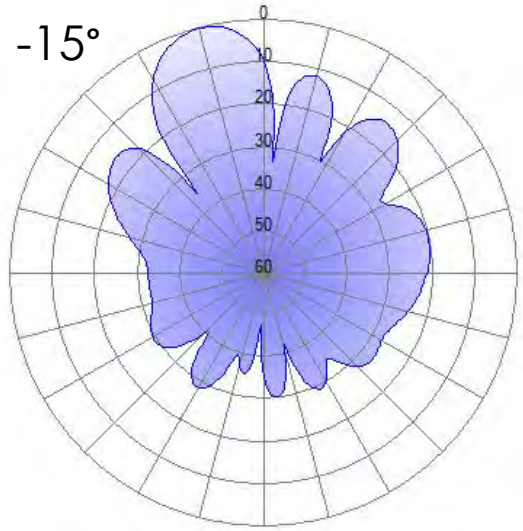
-45°



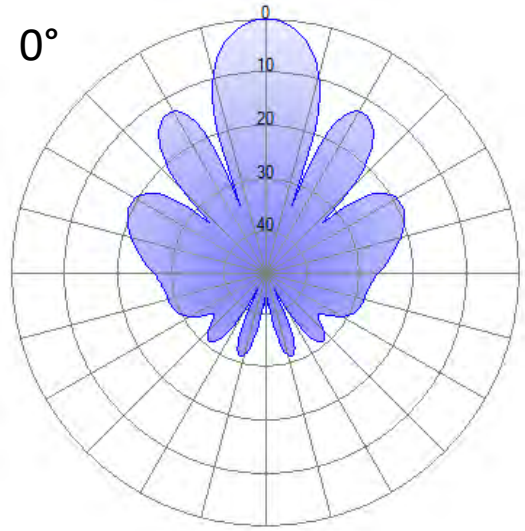
-30°



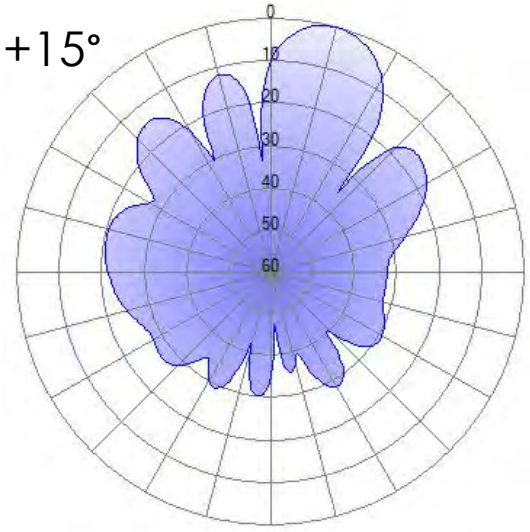
-15°



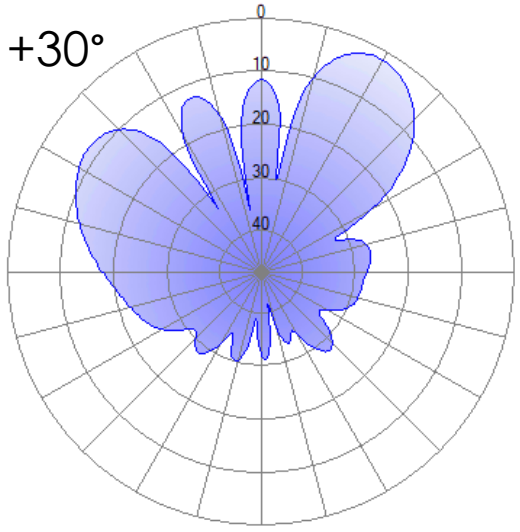
0°



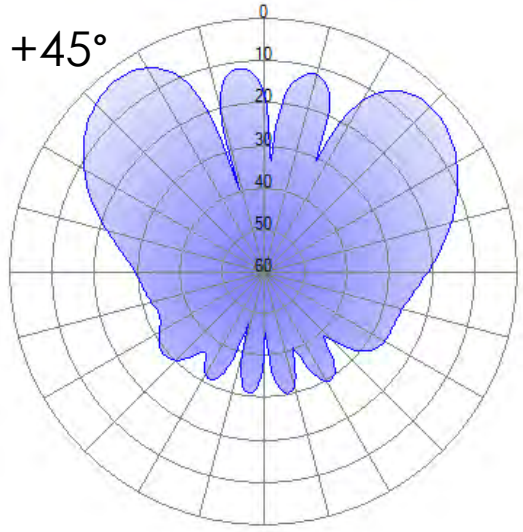
+15°



+30°



+45°



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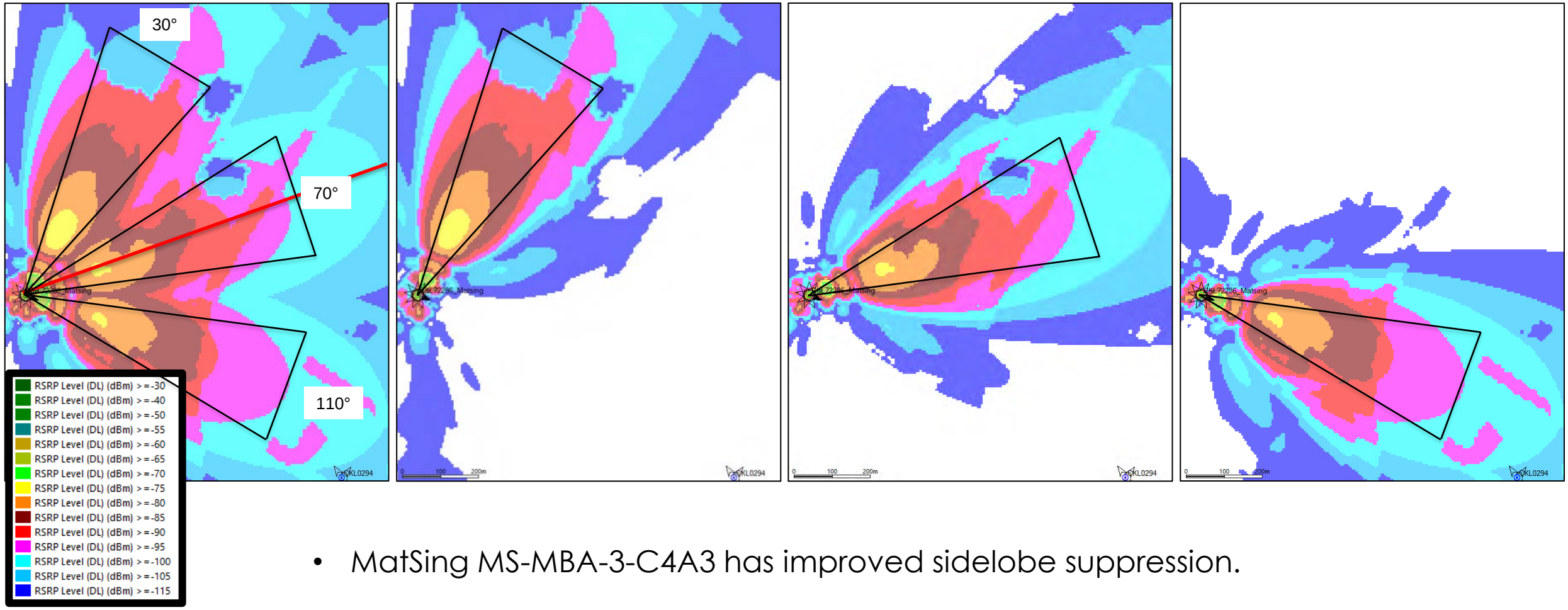
MS-MBA-3-C4A3

All Beams
70° Antenna Boresite

Beam 1	
Azimuth	30°

Beam 2	
Azimuth	70°

Beam 2	
Azimuth	110°



- MatSing MS-MBA-3-C4A3 has improved sidelobe suppression.

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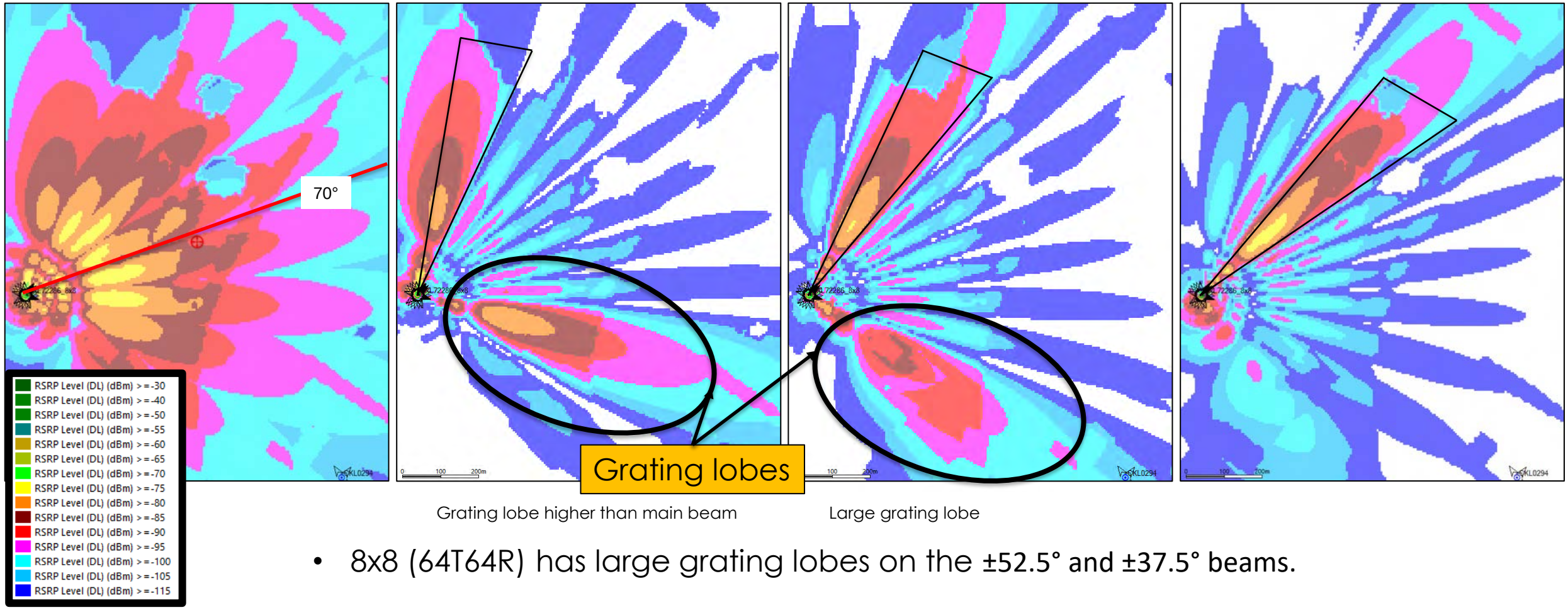
8x8 (64T64R) Beamforming Antenna

Composite Beams
70° Antenna Boresite

-52.5° Beam	
Azimuth	17.5°
SPR	80.1%

-37.5° Beam	
Azimuth	32.5°
SPR	49.1%

-22.5° Beam	
Azimuth	47.5°
SPR	14.6%



Grating lobe higher than main beam

Large grating lobe

- 8x8 (64T64R) has large grating lobes on the ±52.5° and ±37.5° beams.

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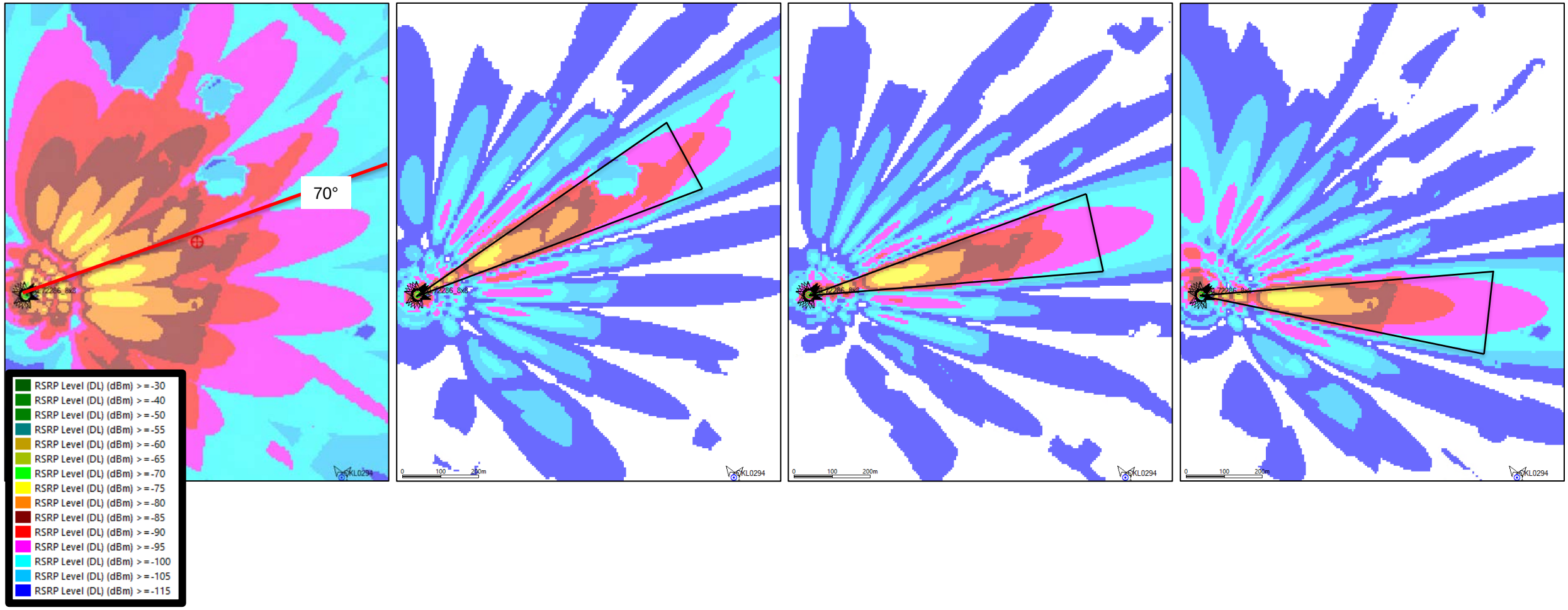
8x8 (64T64R) Beamforming Antenna

Composite Beams
70° Antenna Boresite

-7.5° Beam	
Azimuth	62.5°
SPR	9.2%

+7.5° Beam	
Azimuth	77.5°
SPR	9.2%

+22.5° Beam	
Azimuth	92.5°
SPR	14.6%



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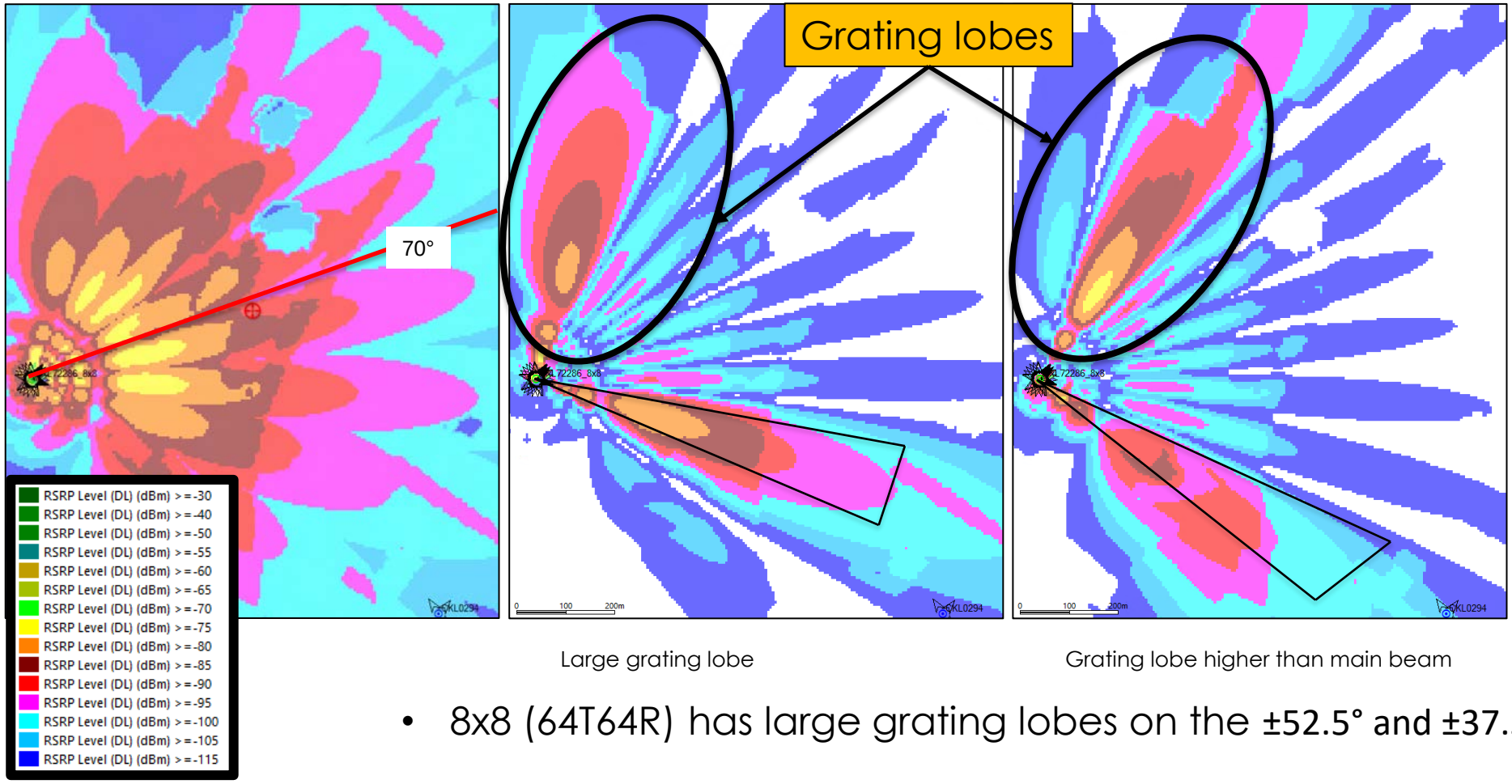
8x8 (64T64R) Beamforming Antenna

Composite Beams
70° Antenna Boresite

+37.5° Beam	
Azimuth	107.5°
SPR	49.1%

+52.5° Beam	
Azimuth	122.5°
SPR	80.1%



Large grating lobe

Grating lobe higher than main beam

- 8x8 (64T64R) has large grating lobes on the ±52.5° and ±37.5° beams.

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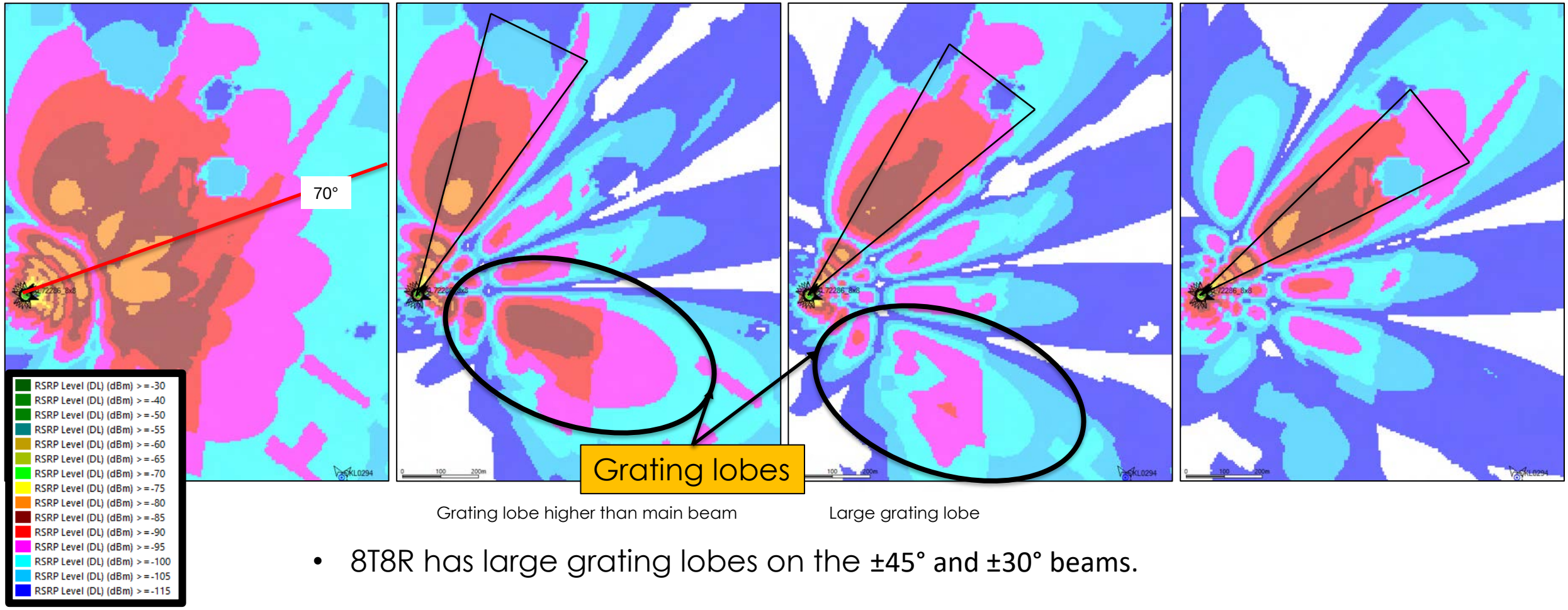
8T8R Beamforming Antenna

Composite Beams
70° Antenna Boresite

-45° Beam	
Azimuth	25°
SPR	67.9%

-30° Beam	
Azimuth	40°
SPR	37.0%

-15° Beam	
Azimuth	55°
SPR	14.3%



Grating lobe higher than main beam

Large grating lobe

- 8T8R has large grating lobes on the ±45° and ±30° beams.

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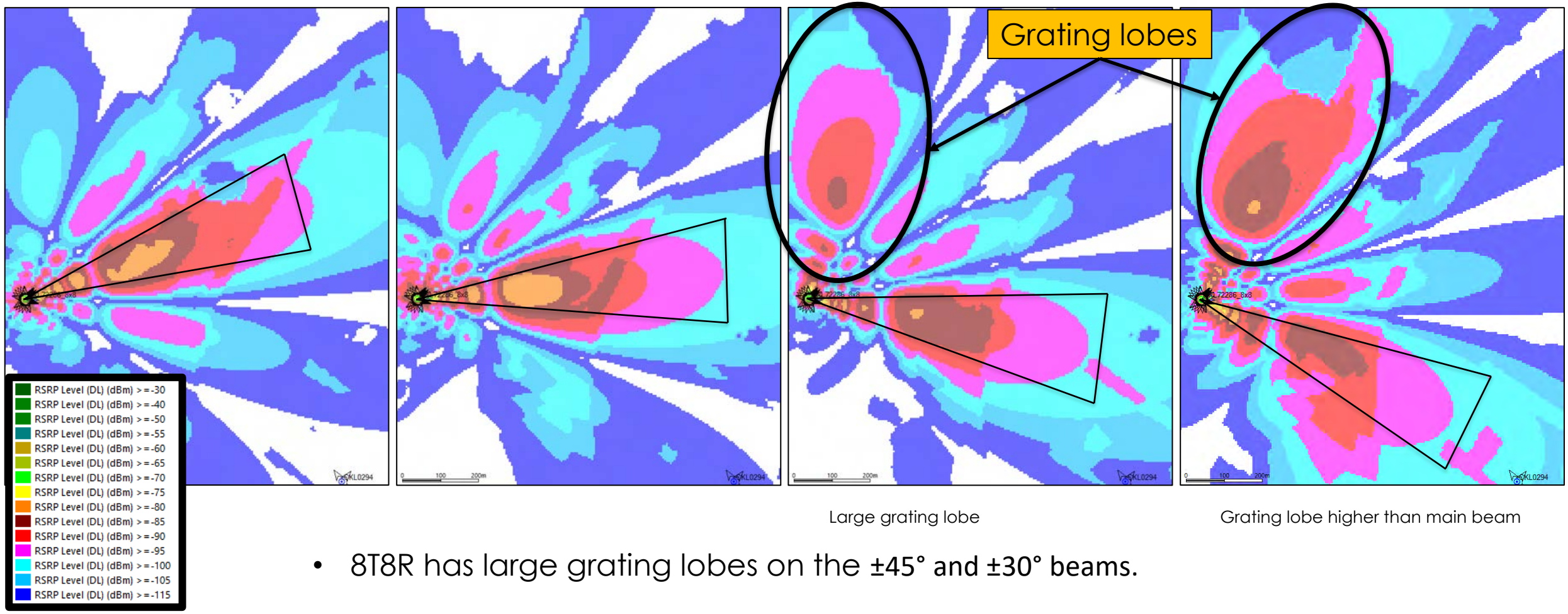
8T8R Beamforming Antenna

0° Beam	
Azimuth	70°
SPR	12.6%

+15° Beam	
Azimuth	85°
SPR	14.3%

+30° Beam	
Azimuth	100°
SPR	37.0%

+45° Beam	
Azimuth	115°
SPR	67.9%



Large grating lobe

Grating lobe higher than main beam

- 8T8R has large grating lobes on the ±45° and ±30° beams.

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Summary

- The beams on the beamforming antennas, 8x8 (64T64R) and 8T8R, oriented farthest from boresight have the highest sector power ratios.

- This results in large grating lobes on the ±52.5° and ±37.5° beams of the 8x8 (64T64R) antenna and on the ±45° and ±30° beams of the 8T8R antenna.

- Some useful tools when designing with MatSing antennas can be found in following location:
  - https://matsing.com/tools
  - MBA 3&4 BEAM 8T8R RRH CONFIGURATION

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Thank You

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