SAND2014-2663C

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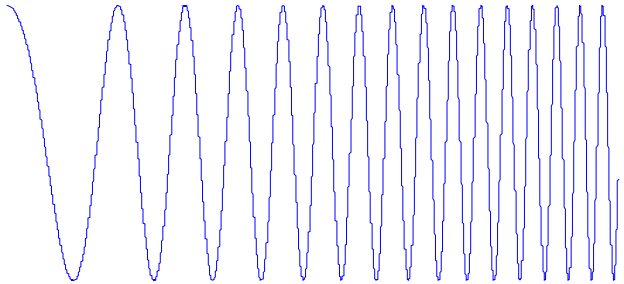

Put the hill here

Arbitrary Scene Simulation for Synthetic Aperture Radar

Cameron Musgrove, Richard Naething, John Schilling

U.S. DEPARTMENT OF ENERGY | NNSA

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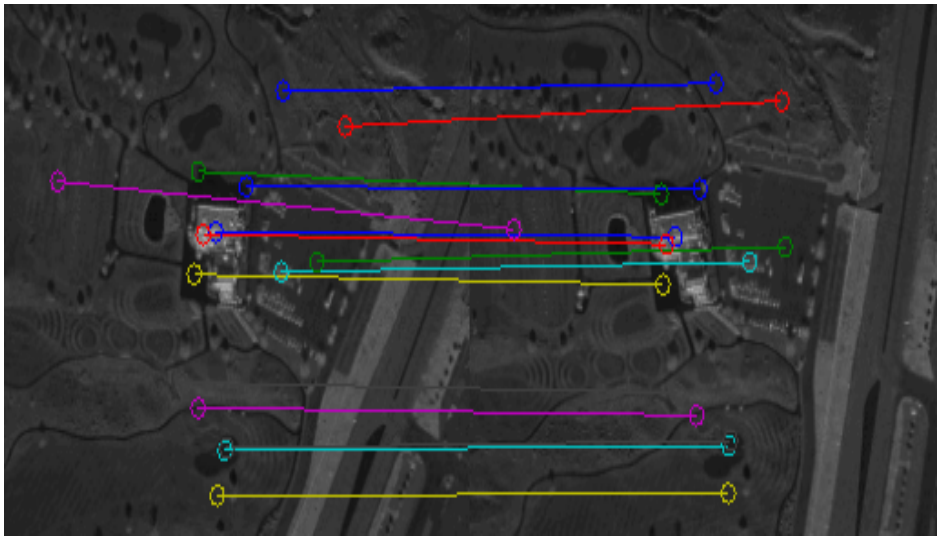
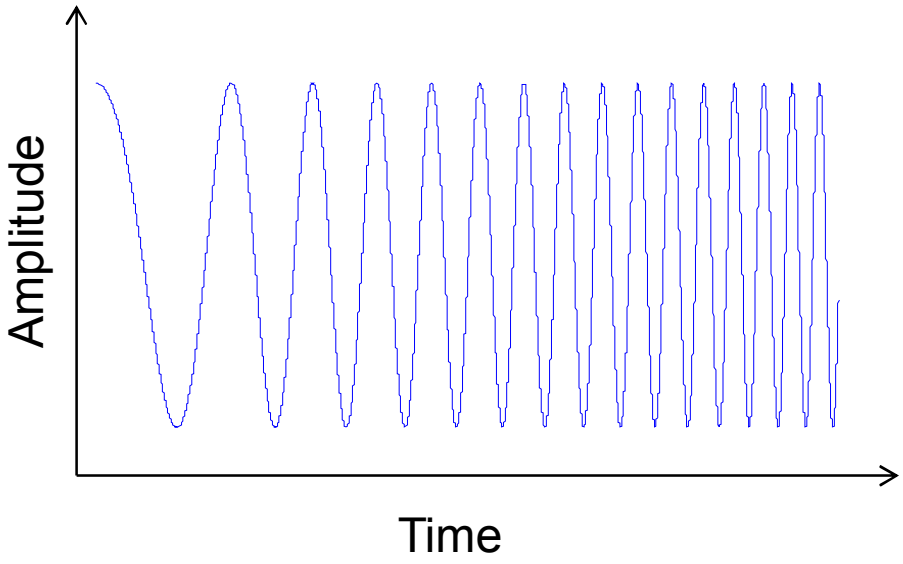
Motivation

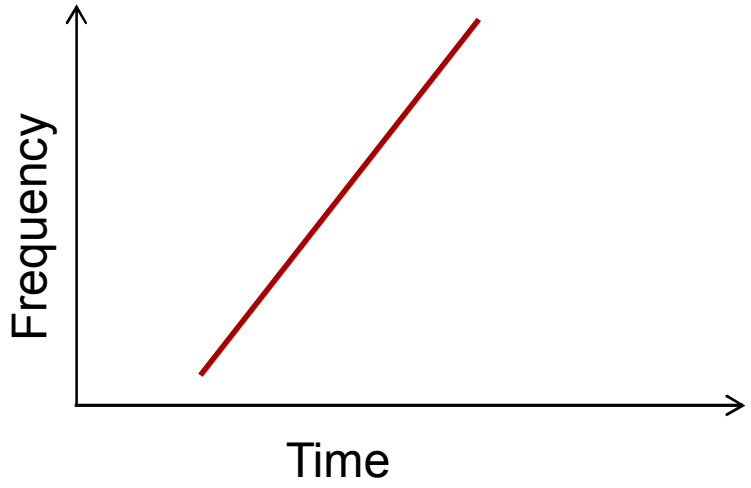
- Reduce flight testing
- Expand lab testing for data driven modes
- Test scene/terrain limits that may not be available within flight test area



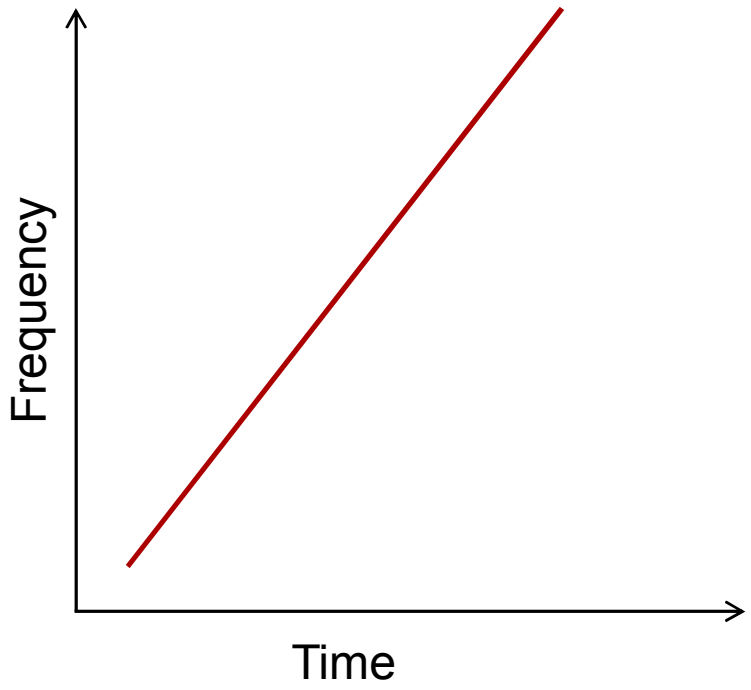
Radar Parameters

- Ku band radar using a linear frequency modulated waveform and stretch processing.
- Chirp waveform decouples time and bandwidth

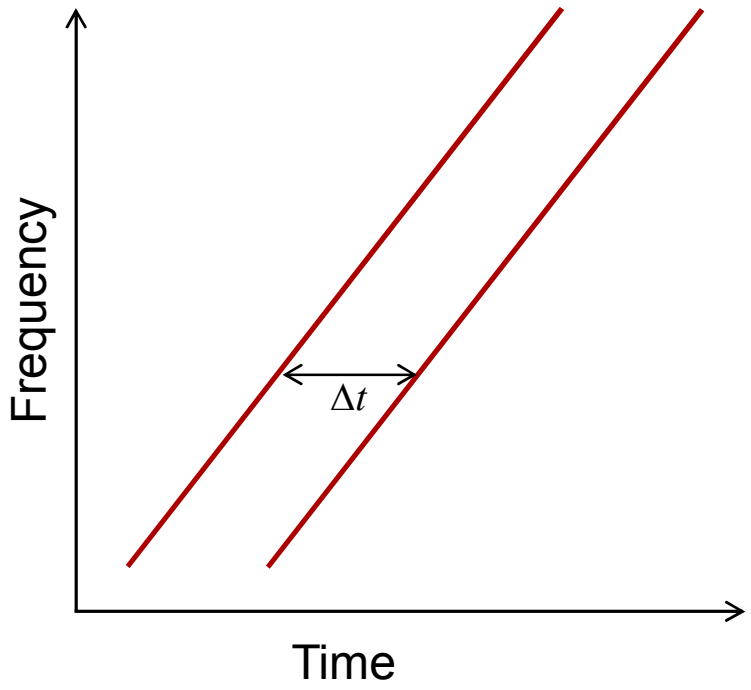




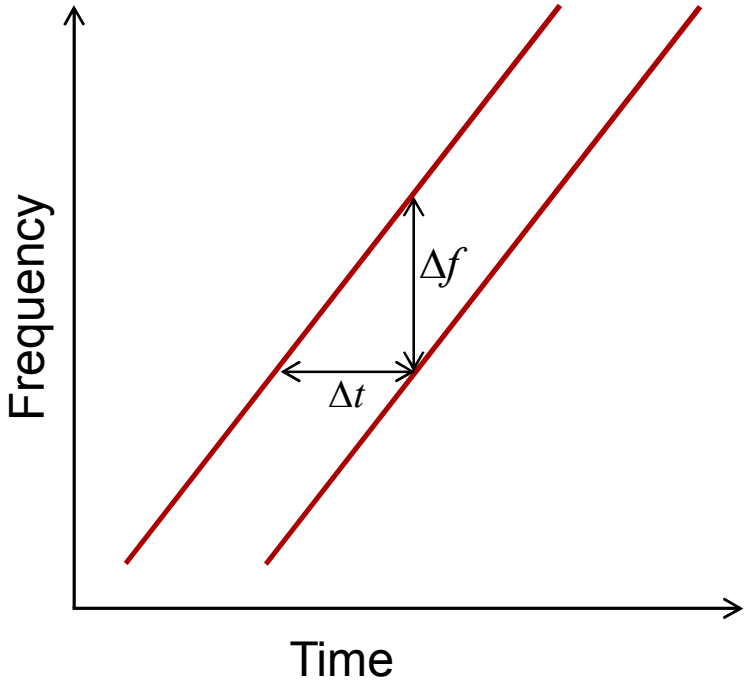
Time-Frequency



Time-Frequency

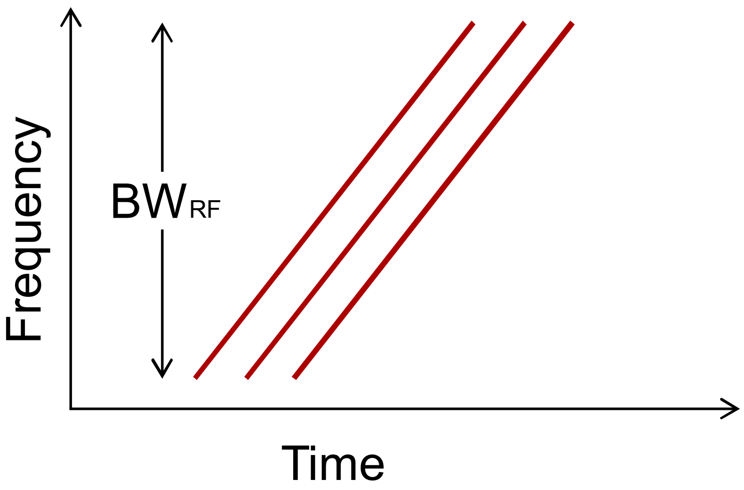


Time-Frequency



$$\Delta f = \gamma\left(\Delta t\right)$$

Stretch Processing

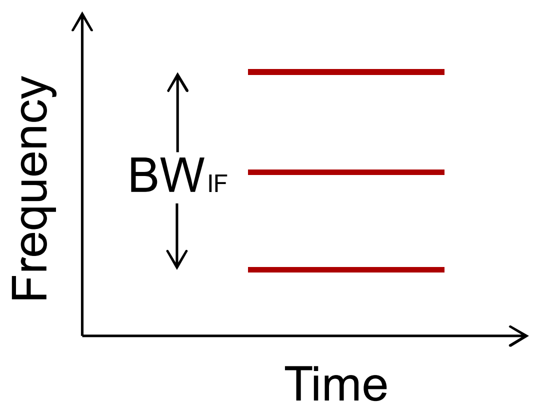


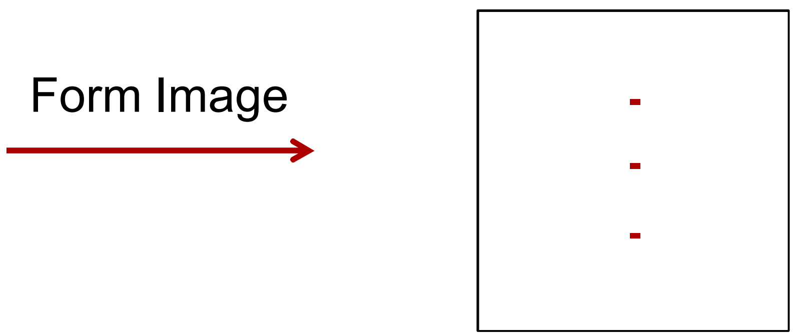
$$\Delta f = \gamma(\Delta t)$$

$\exp j\{$ Considering removing this $\Delta t)\}$

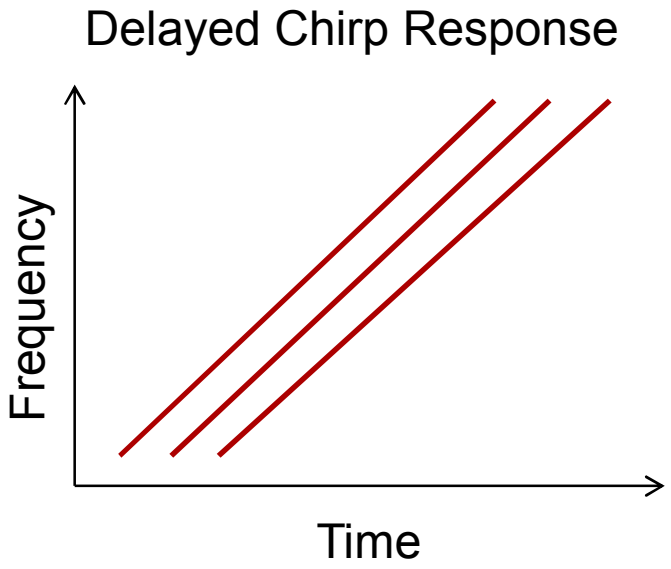
$BW_{RF} >> BW_{IF}$

Deramp





Time-Frequency



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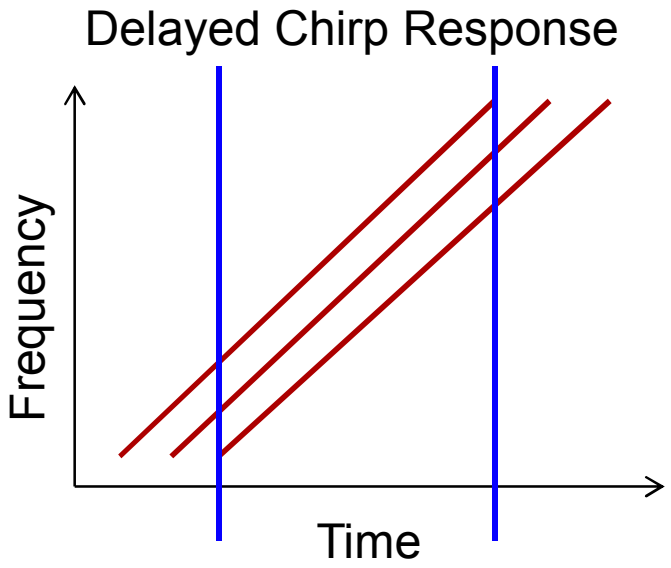
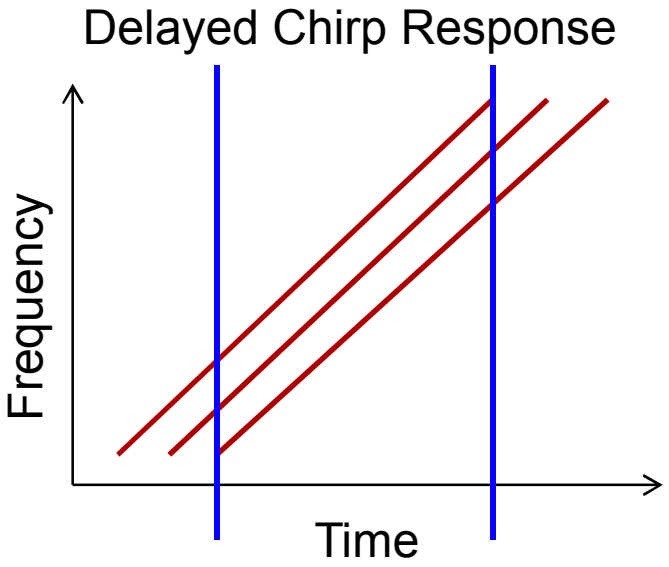
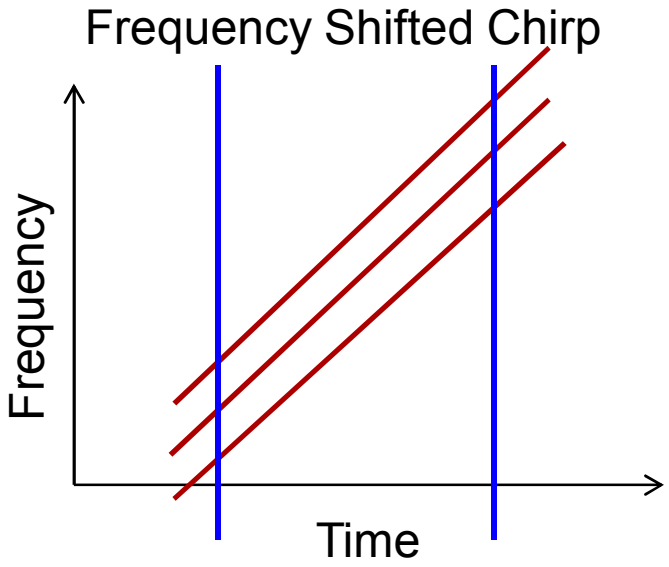
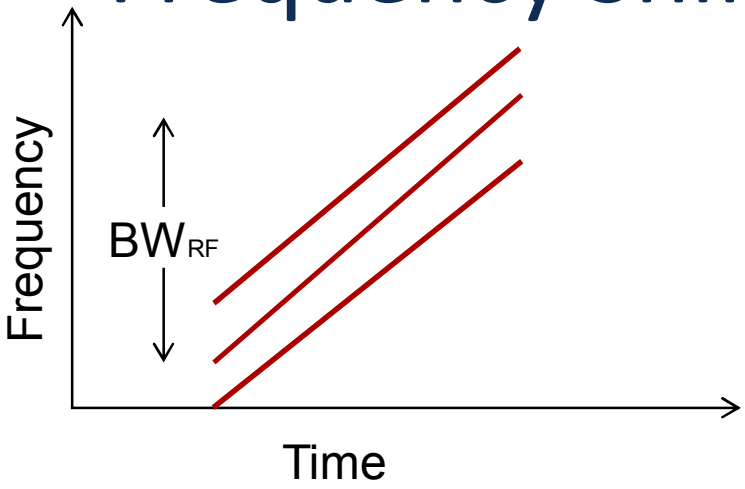


Time-Frequency





Stretch Processing – Frequency Shifted Chirp

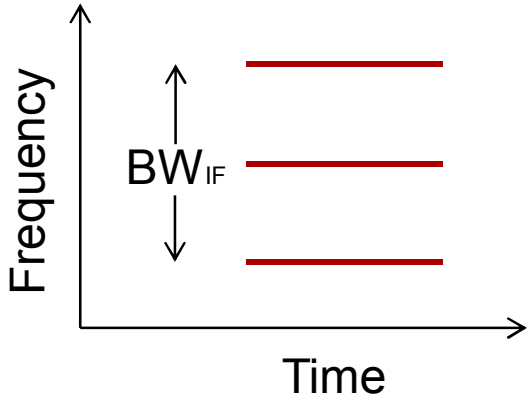


$$\Delta f = \gamma\left(\Delta t\right)$$

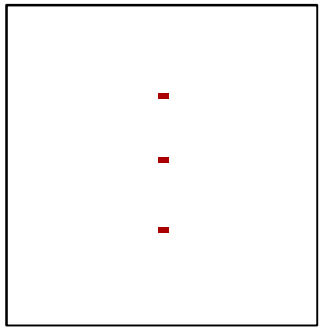
$$\exp j\{\ldots\left(\Delta t\right)\}$$

Considering removing this

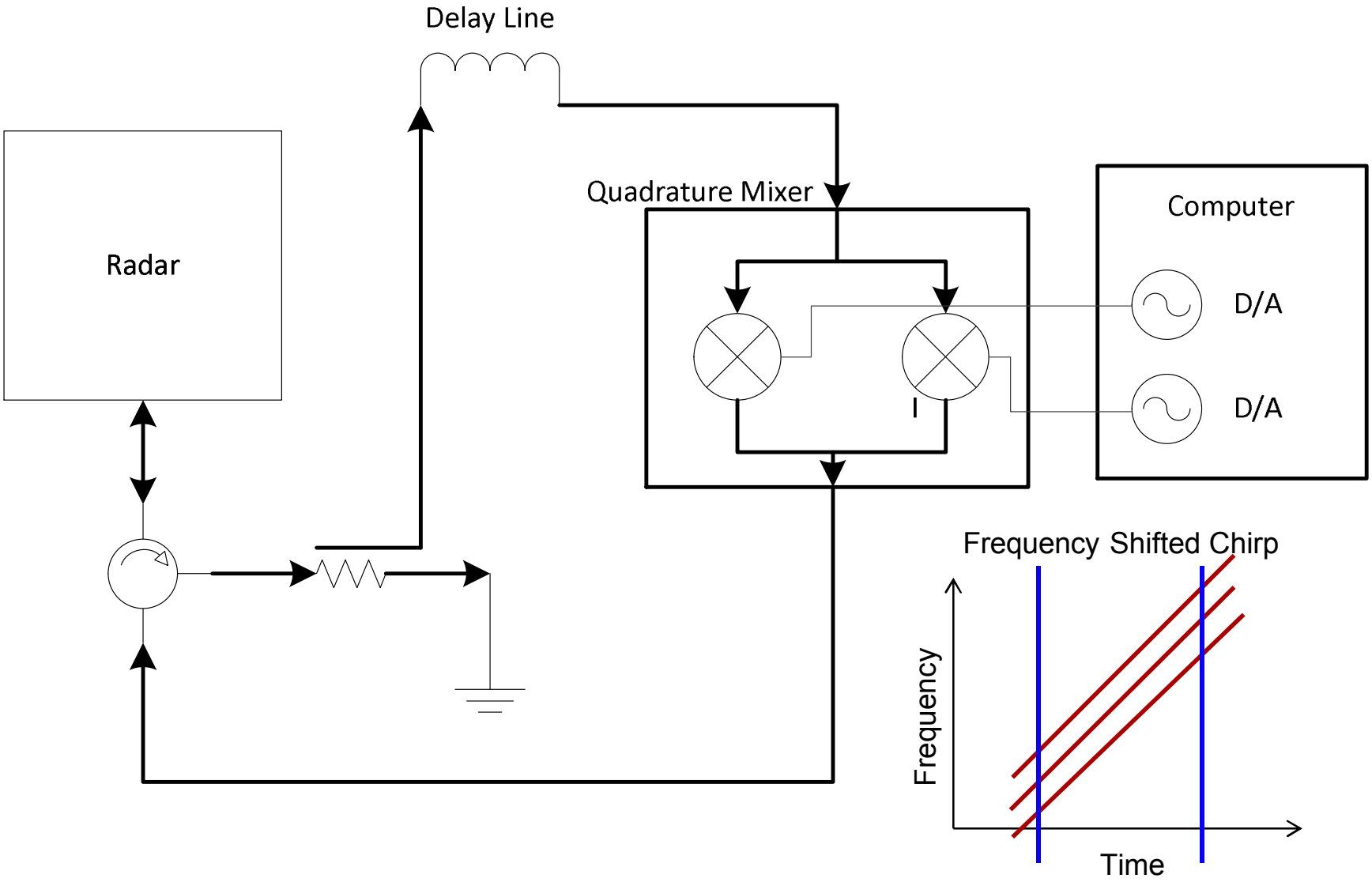
$BW_{RF} >> BW_{IF}$ ↓ Deramp



Form Image →



Synthetic Scene Generator

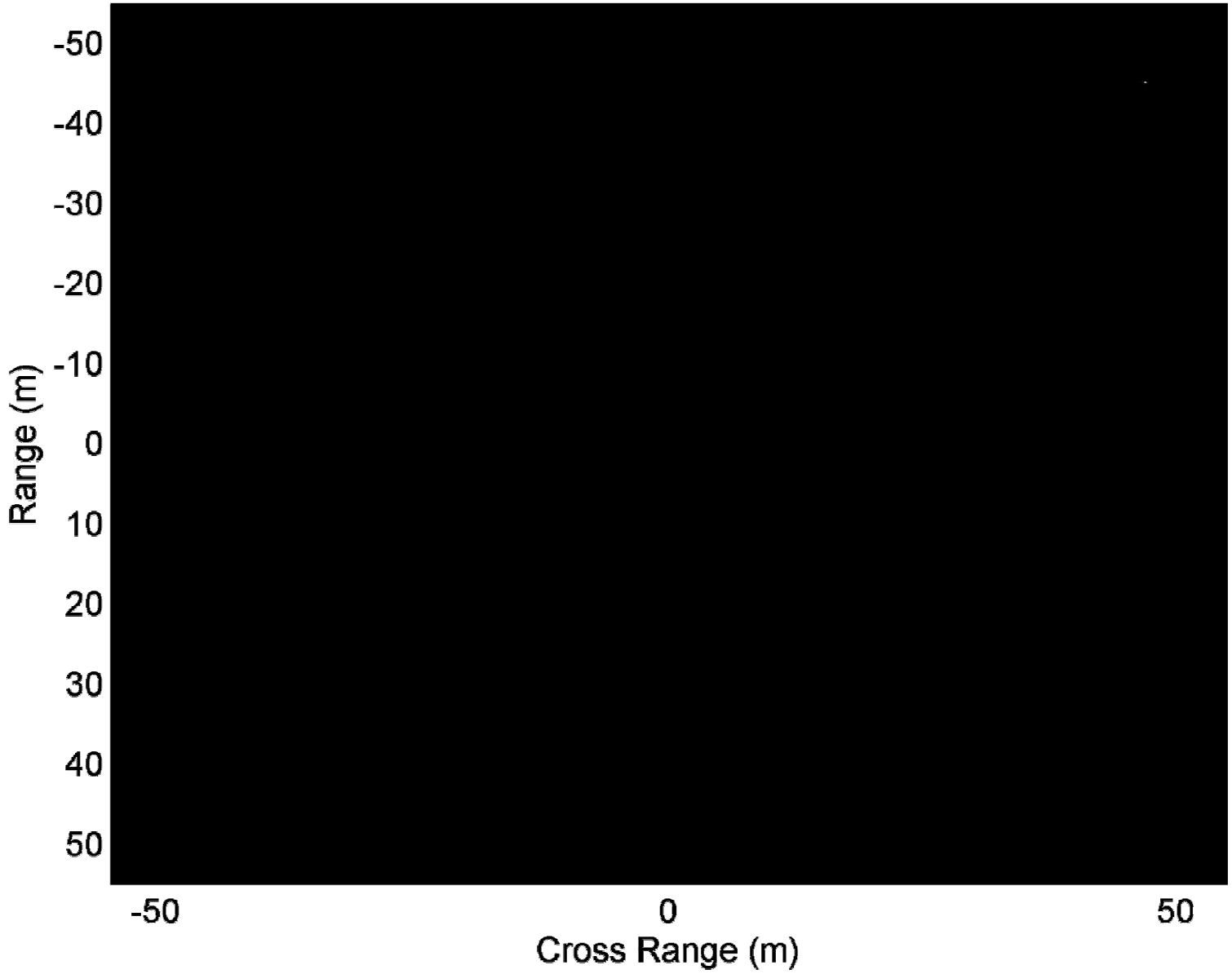


Simulations

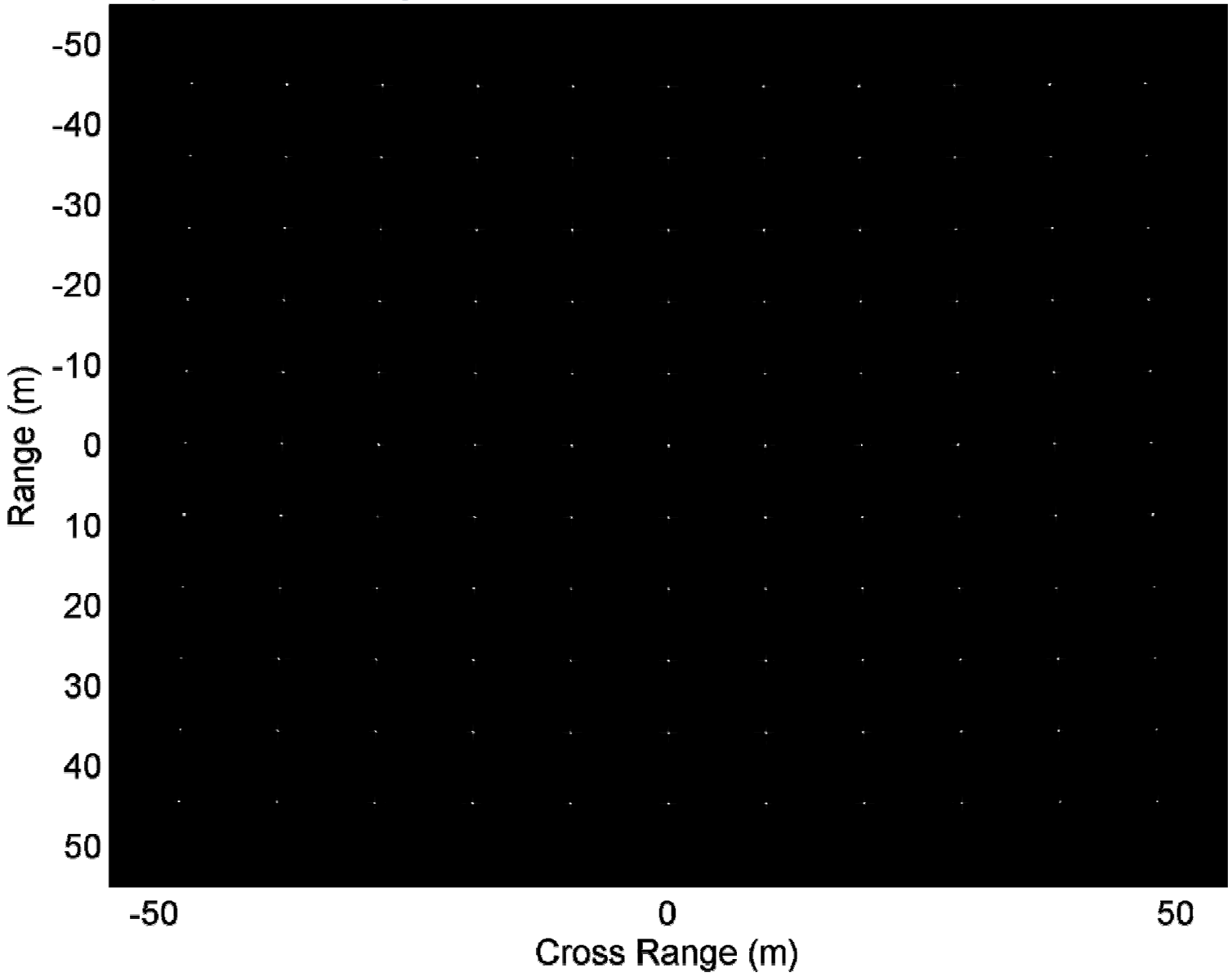
- Point Targets
- Clutter
- Scene Shifting
- Scene Height

Simulation Parameters	
Center Frequency	16.7 GHz
Resolution	4”
Scene Size	110m x 110m

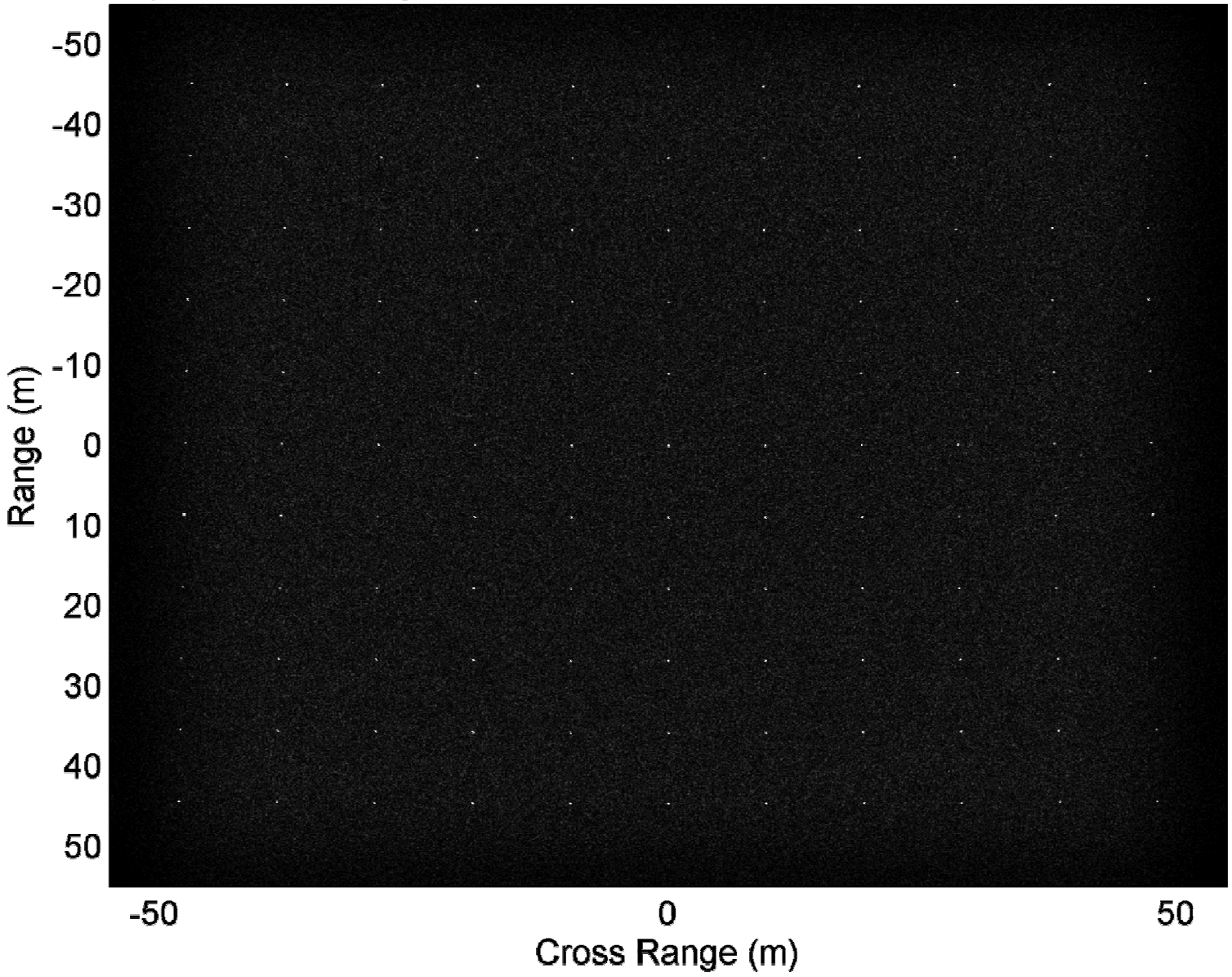
Single Target



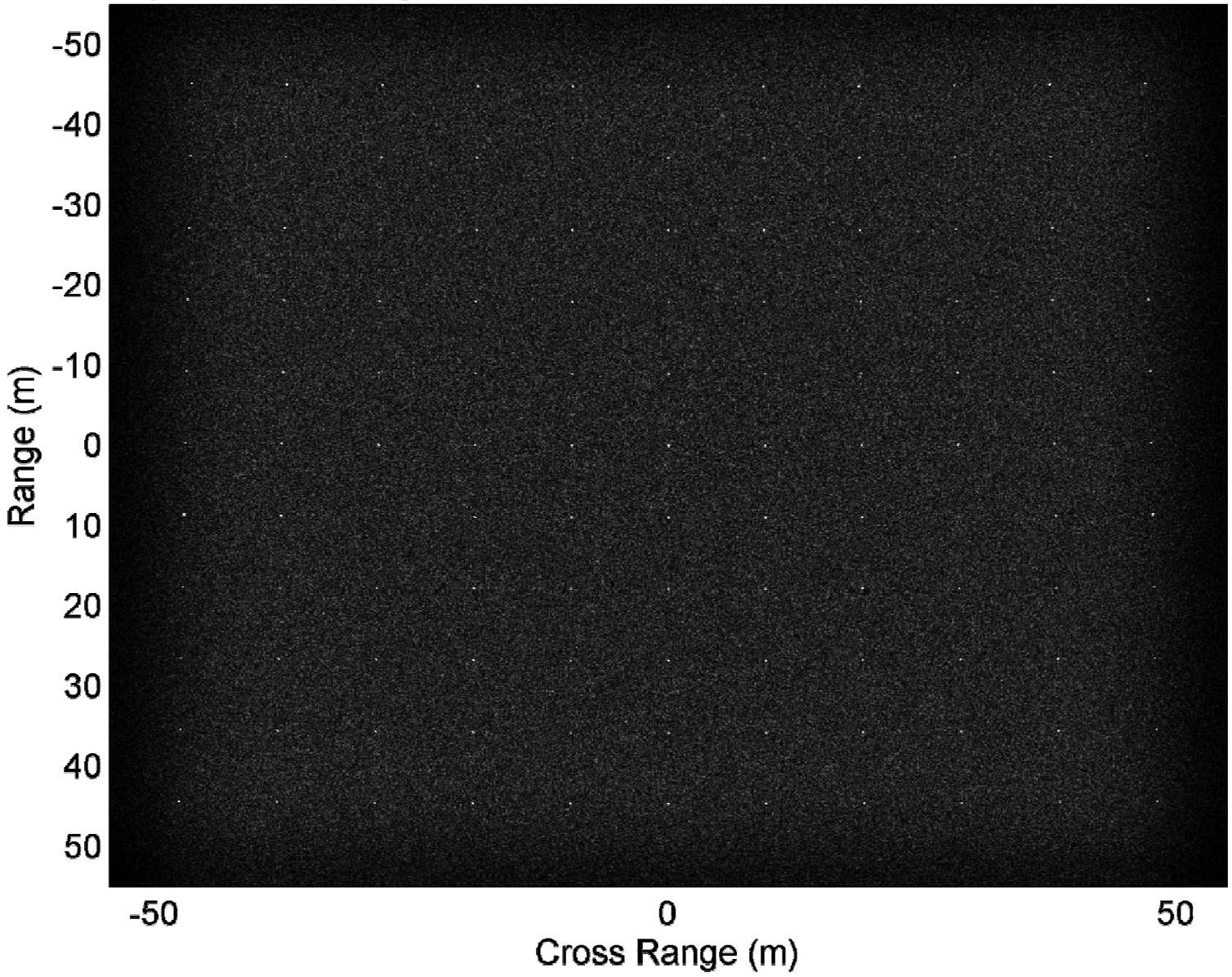
Multiple Targets



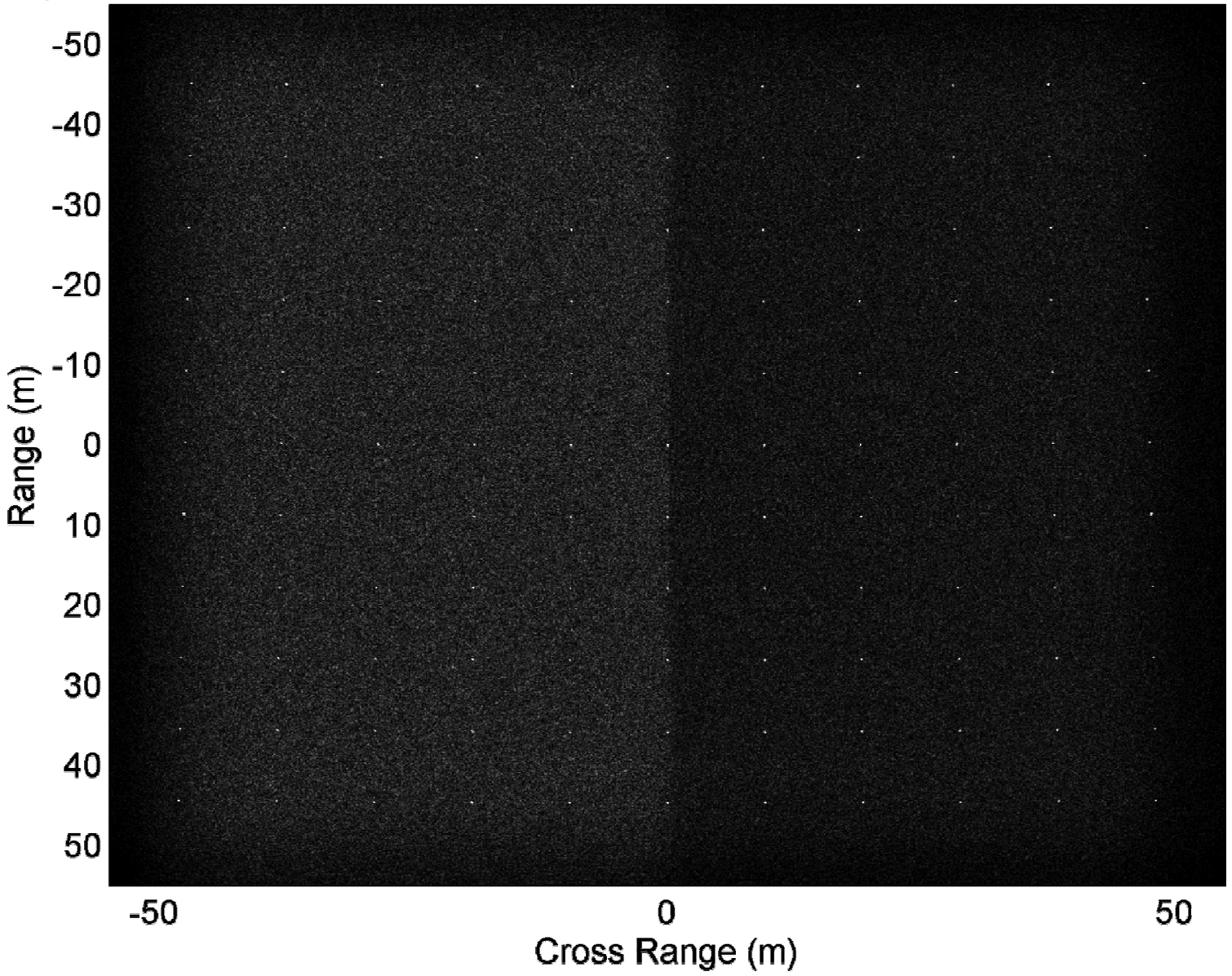
Multiple Targets and Clutter



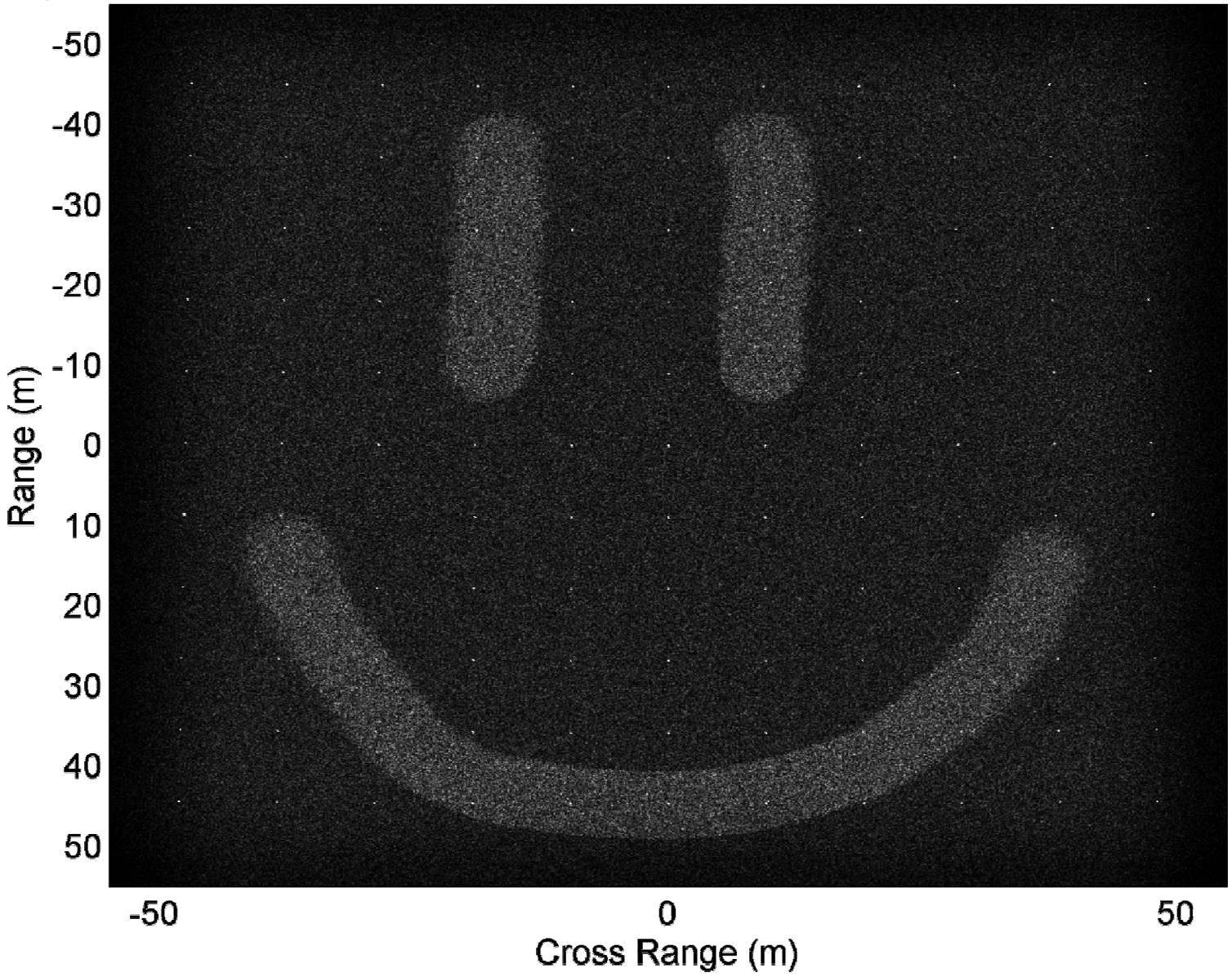
Multiple Targets and Clutter



Separate Clutter Areas

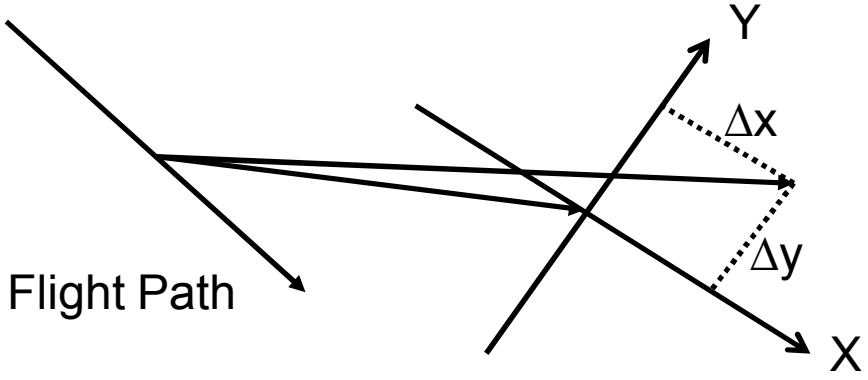


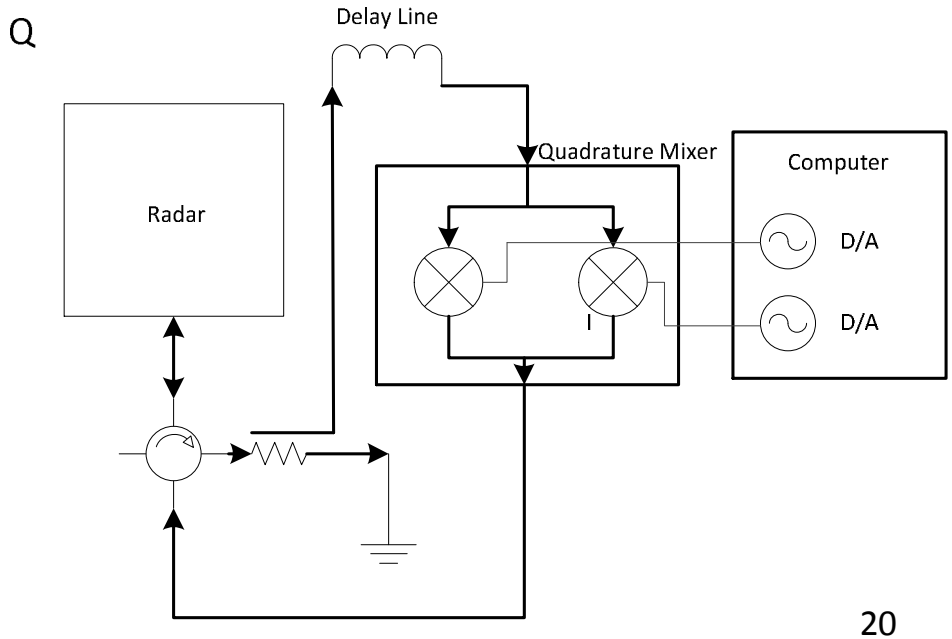
Separate Clutter Areas



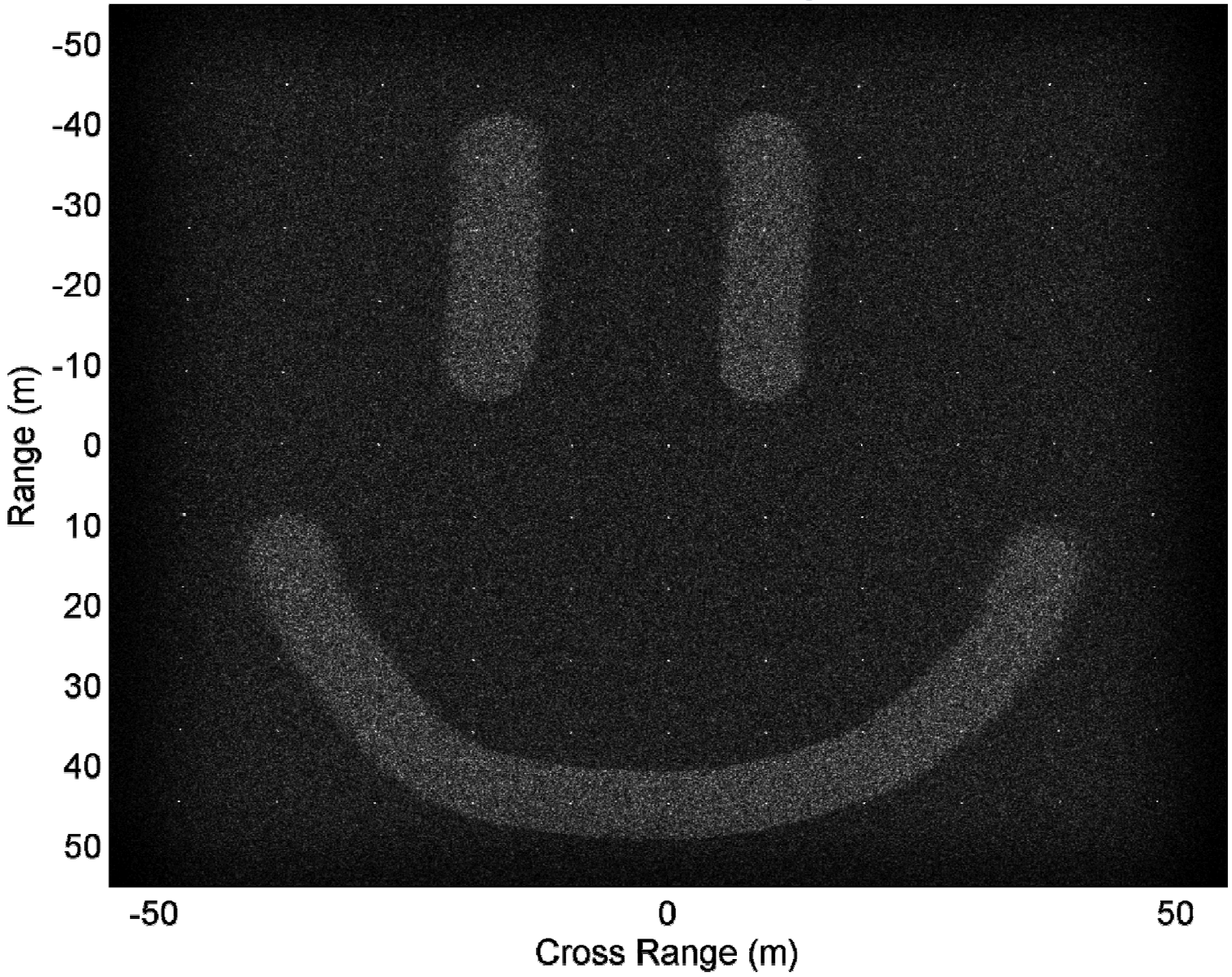
Shift Entire Scene

1. For point targets, recalculate phase history based on desired shift
2. For clutter, shift the mask to adjust which part of clutter is amplified in value
3. Calculate a phase offset to apply to existing phase history

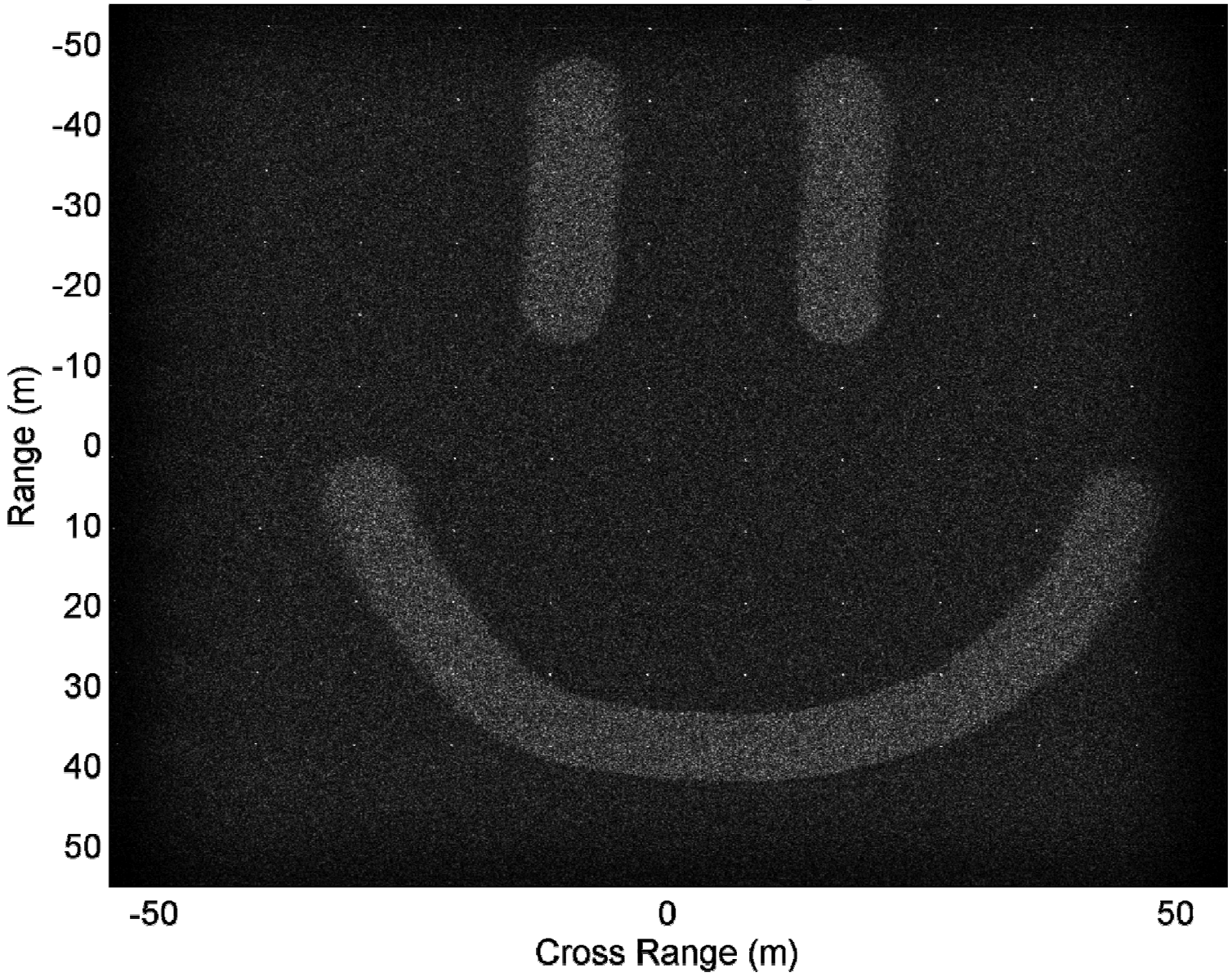




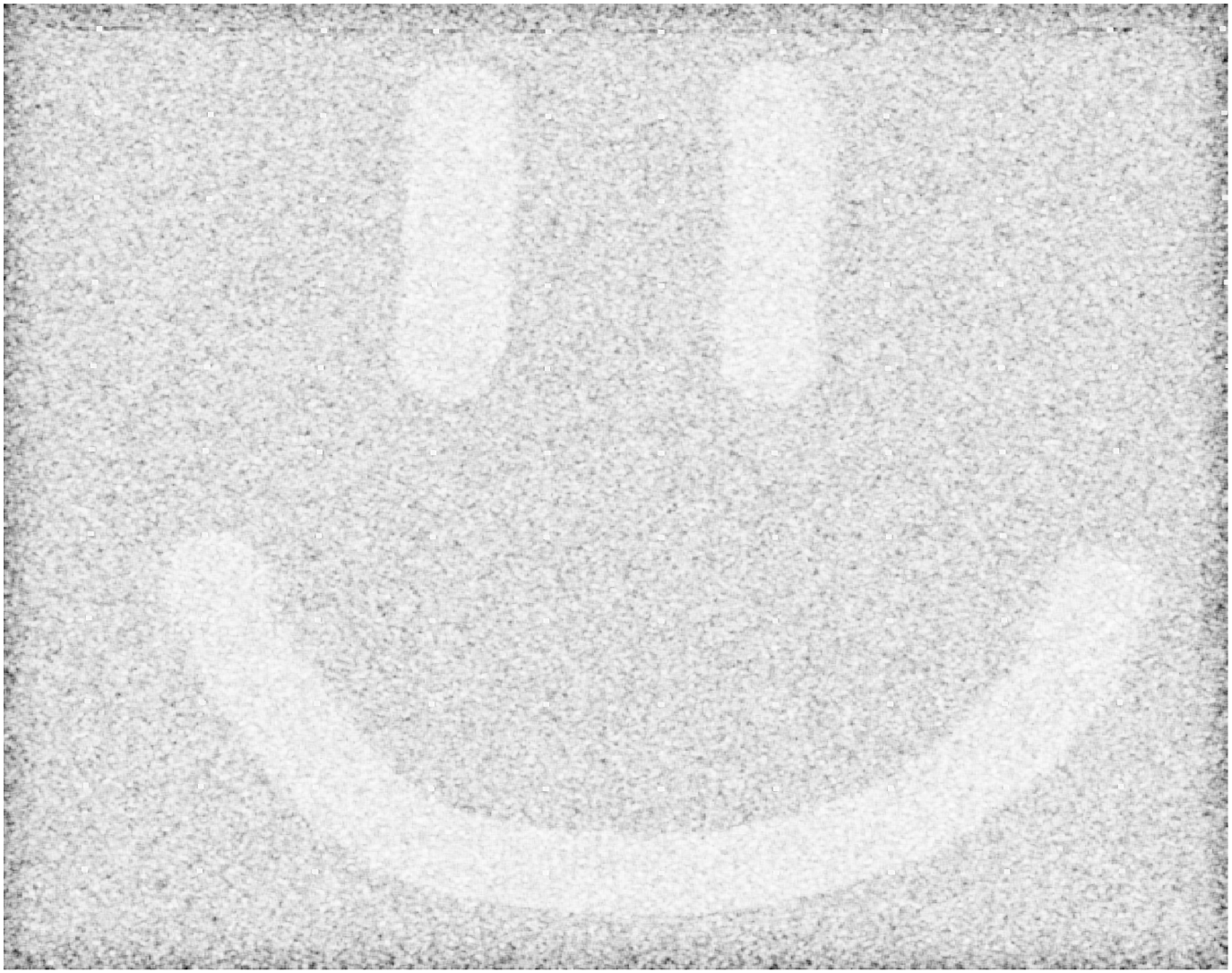
Shift Entire Scene – Image 1



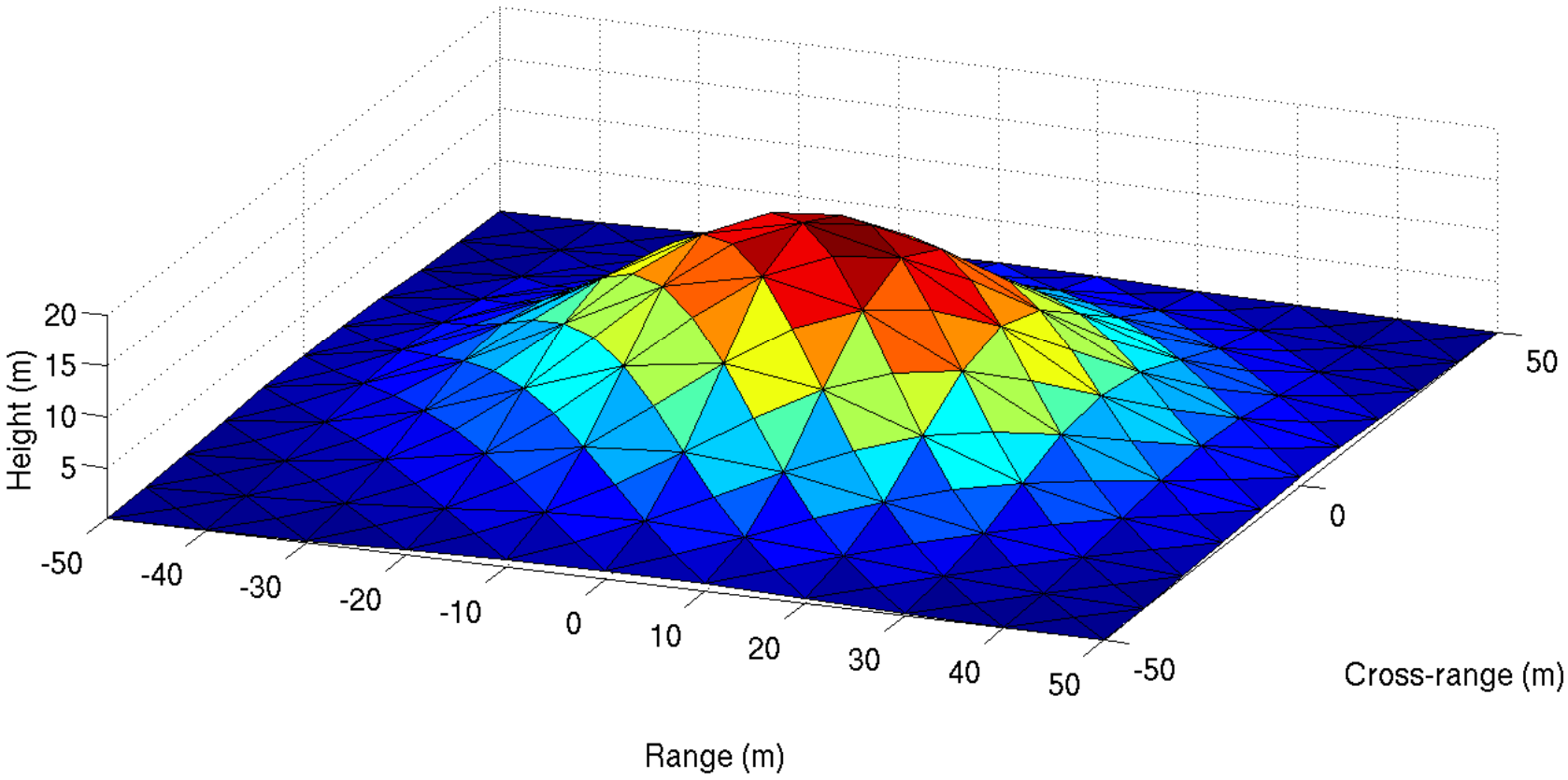
Shift Entire Scene – Image 2



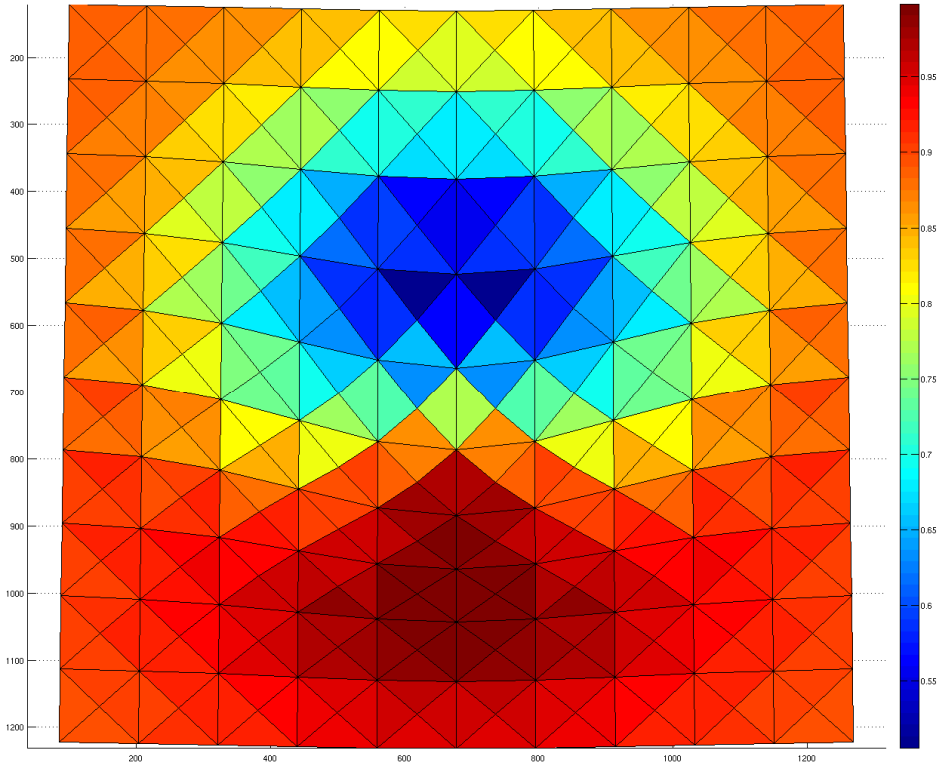
Shift Entire Scene

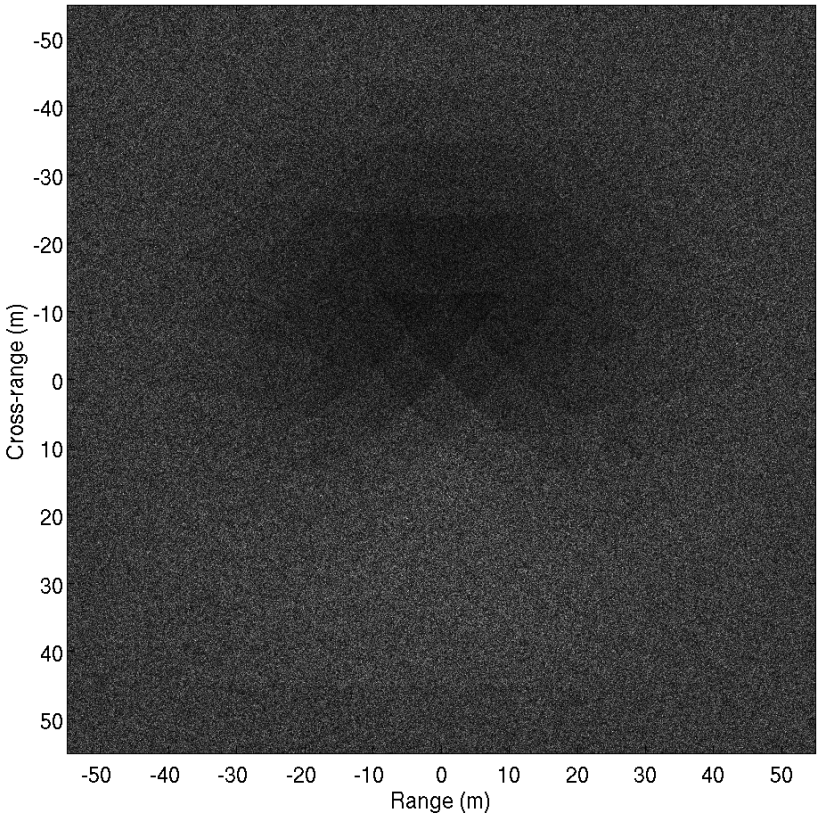


Add Height


Height (m)
20
15
10
5
-50
-40
-30
-20
-10
0
10
20
30
40
50
Range (m)
50
0
-50
Cross-range (m)

Add Height


200
300
400
500
600
700
800
900
1000
1100
1200
200
400
600
800
1000
1200
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55


-50
-40
-30
-20
-10
0
10
20
30
40
50
Cross-range (m)
-50
-40
-30
-20
-10
0
10
20
30
40
50
Range (m)

Questions?

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