Vibration Mitigation In Automotive Radars

RFNav Advances the State of the Art

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Eliminating the Barriers to All Weather AV

RFNav Innovation and Leadership

- **New Radar Architecture**
  - > 0.23° Azimuth beams
  - > 1.00° Elevation beams
- **New Deblurred Imaging Algorithms**
  - Single Look, Low Ghost Count
- **New Crisp Fusion Algorithms**
  - Fast Time, Single Look, Low Covariance
- **New Tracking Algorithms**
  - High Precision Tracking in Dense Scenes
- **New Object Identification Algorithms**
  - High Performance Object ID

Latest Development

- **New Vibration Mitigation Algorithms**

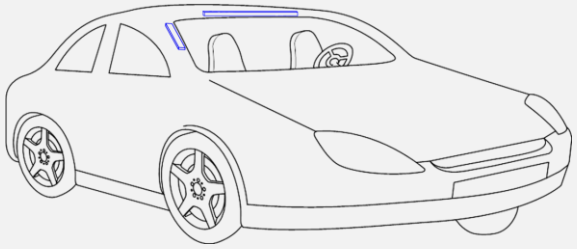
The Problem of Aperture Motion (Vibration) in Autonomous Vehicle Sensors

- Tiny, non-visible, relative motions across an aperture induce significant phase modulation (PM) corrupting sensor performance
  - Example: 450 microns of displacement @ 77 GHz = 42° phase shift
- Elevation/Azimuth Angle & Doppler are all susceptible to vibration PM
  - Especially challenging: Large Aperture Sensors
- Sources and Causes of AV Radar Vibration
  - … engine block motion, engine rpm, the transmission, tire treads, road surface morphology, vehicle speed, sensor mounts, radome vibrations, Young's modulus of PCB, component layout, ….

RFNav Vibration Mitigation

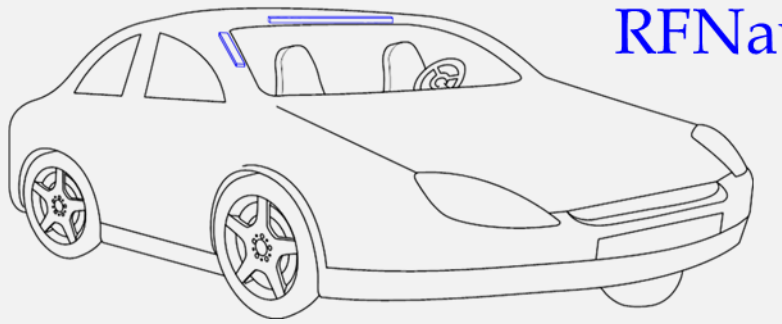
New RFNav Techniques

- Mitigates Vibration Induced Phase Modulation
  - Az Angle, El Angle & Doppler
- Radically Different Approach
  - No Target Assumptions
    - High Scene Density Capable
  - Fast(Single Look) & Slow Time Capable
  - Applicable before or after beam forming
  - Low Latency
  - Reasonable Computation Cost



Vibration Mitigation Example

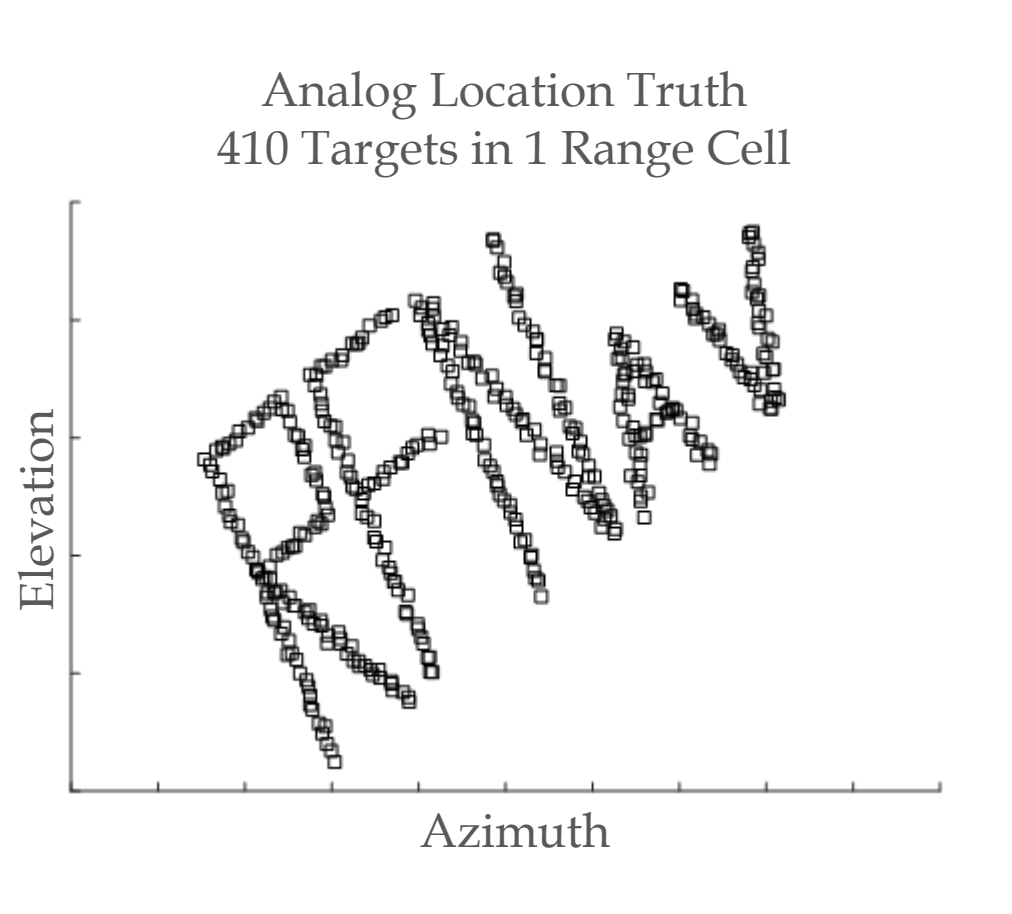
- RFNav Kiju Class High Definition Imaging Radar
  - > 0.23° Azimuth beams
  - > 1.00° Elevation beams
  - Real Beam Radar (not Synthetic Aperture Radar)
  - Low Cost
  - Low Profile
  - Easy Installation

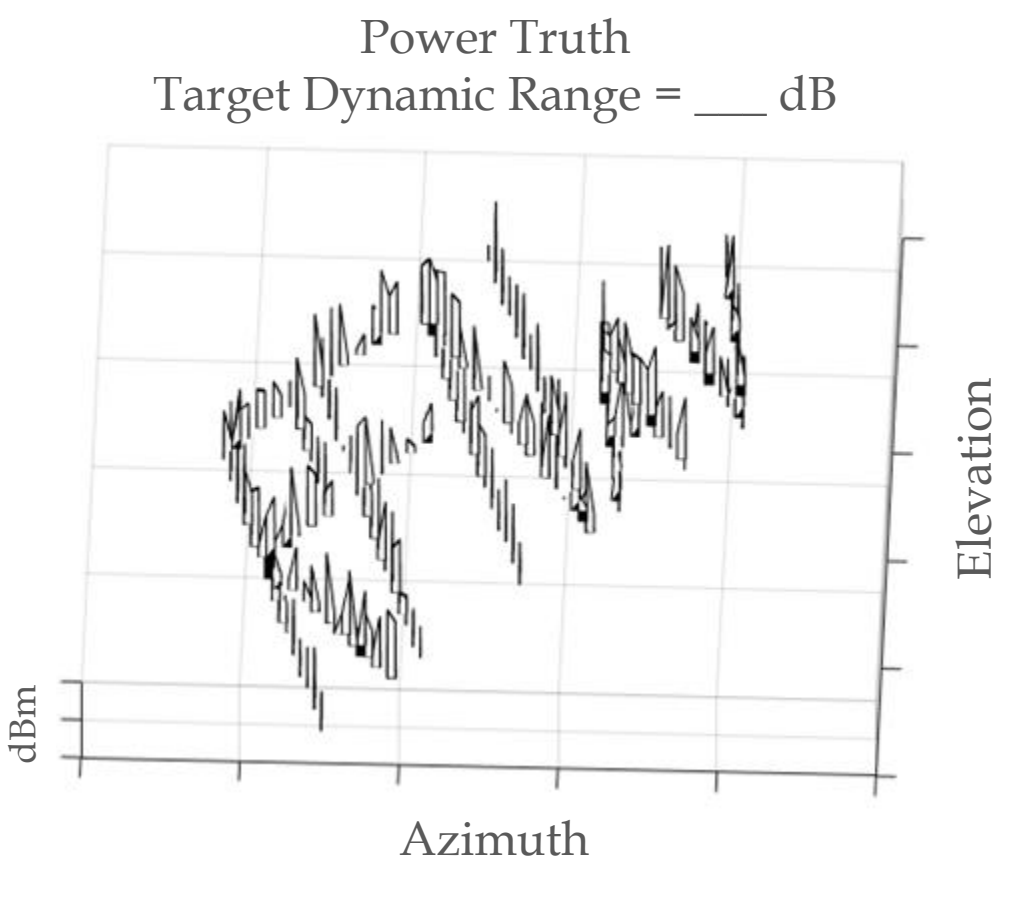


RFNav Kiju Radar

Example

Target Truth



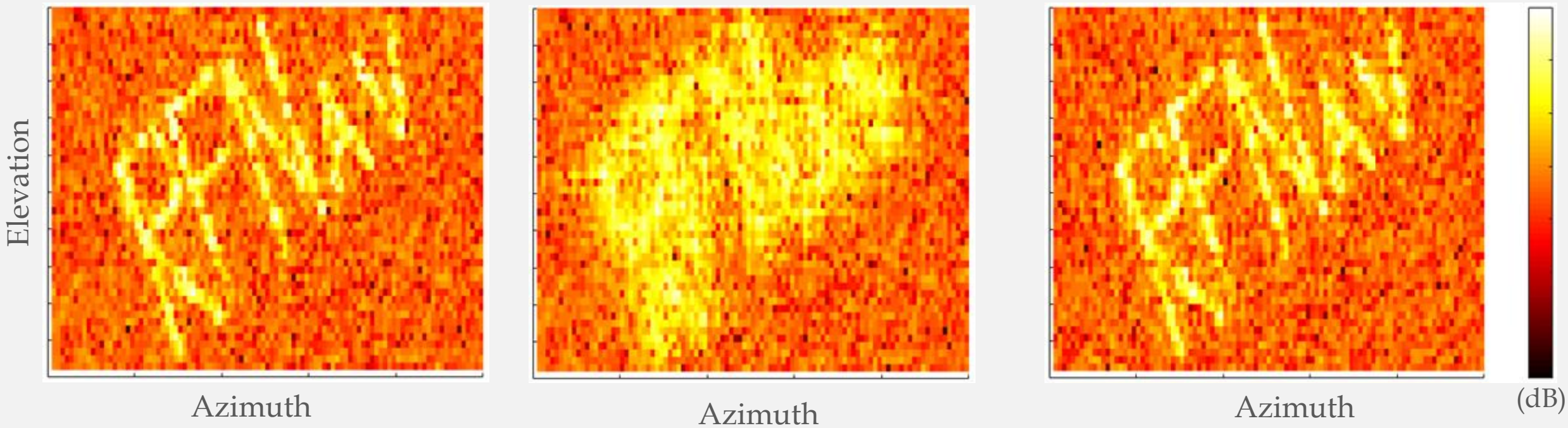


Example 1: High SNR

Single Look Radar Image

Image Corrupted by Aperture Internal Motion & Vibration

RFNav Vibration Algorithm Image Reconstruction



RVision1 Vibration Mitigation Algorithm

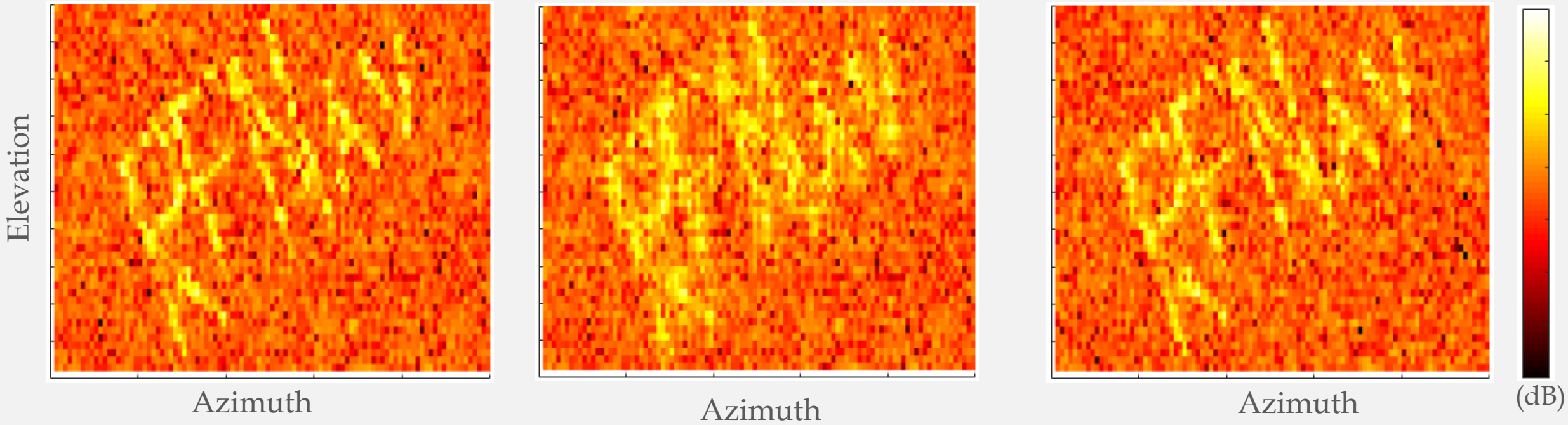
- No assumptions about the targets in the scene
- Performs in highly dense scenes
- Fast Time(Single Look) or Slow Time
- Low Latency
- Reasonable Computational Cost

Example 2: Low SNR

Single Look Radar Image

Image Corrupted by Aperture Internal Motion & Vibration

RFNav Vibration Algorithm Image Reconstruction

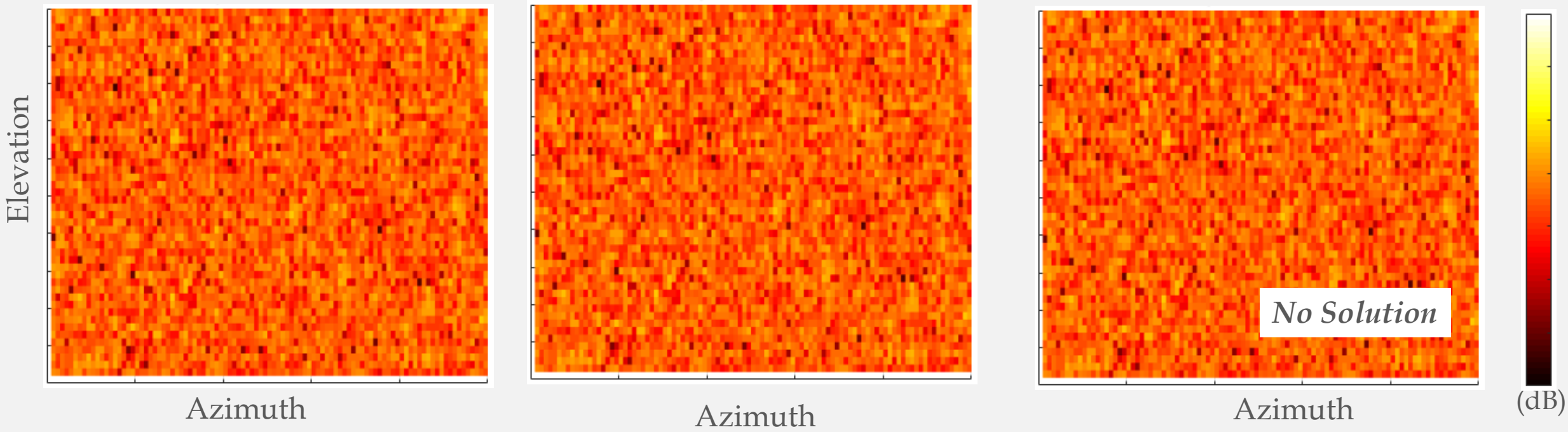


Example 3: No Signal

Single Look Radar Image

Image Corrupted by Aperture Internal Motion & Vibration

RFNav Vibration Algorithm Image Reconstruction



Receiver Noise

Summary

- RFNav's new vibration mitigation techniques remove a fundamental barrier for the deployment of all weather autonomous vehicle navigation systems.
- Radically Different Approach
  - No Target Assumptions
    - High Density Scene Capable
  - Fast(Single Look) & Slow Time Capable
  - Applicable before or after beam forming
  - Low Latency
  - Reasonable Computation Cost

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