

Carnegie
Mellon
University

DART 

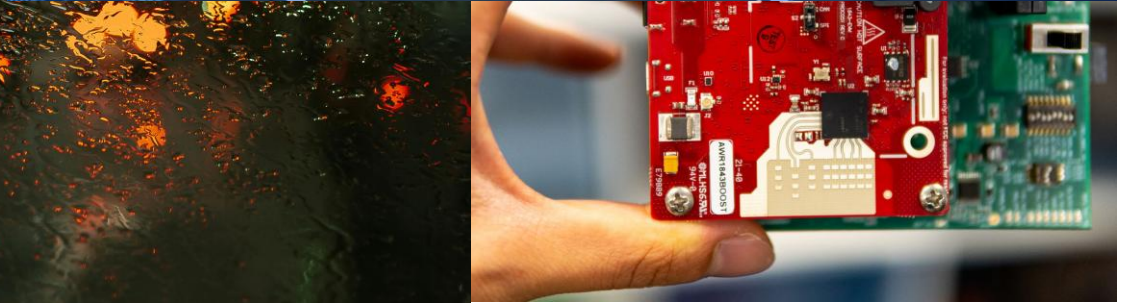
Implicit Doppler Tomography for Radar Novel View Synthesis

Tianshu Huang¹, John Miller¹², Akarsh Prabhakara¹, Tao Jin¹,
Tarana Laroia¹, Zico Kolter¹², Anthony Rowe¹²

¹Carnegie Mellon University, ²Bosch Research

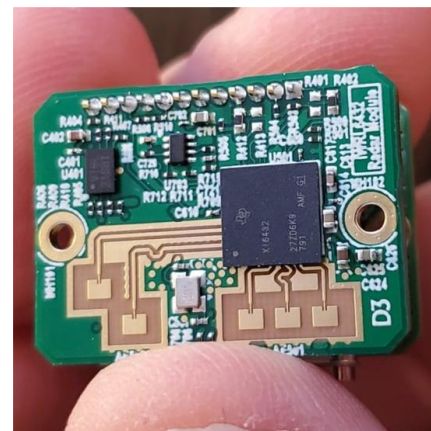
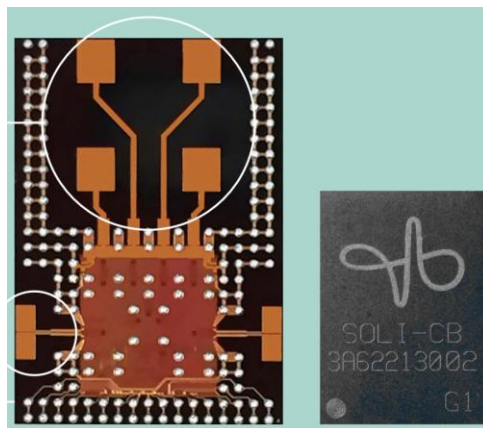
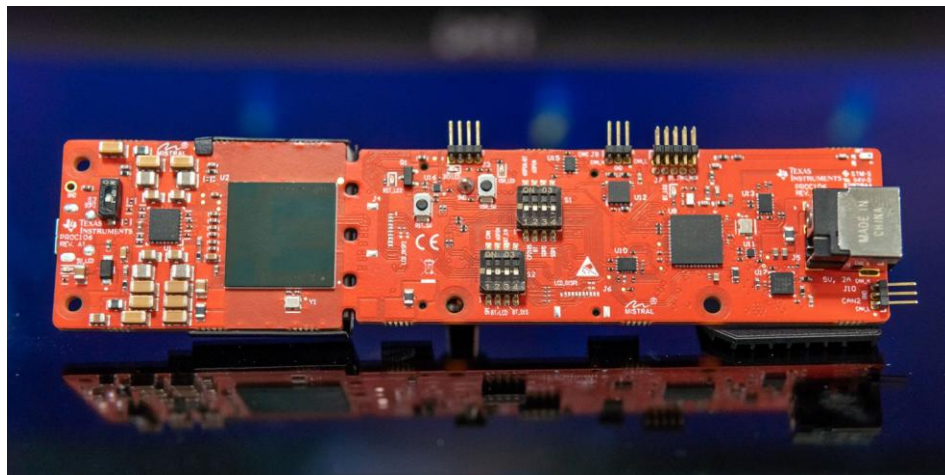
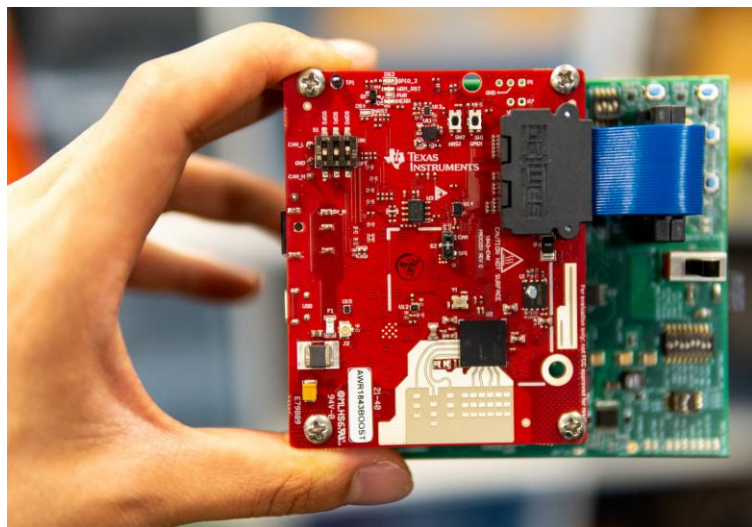


Radar vs Cameras



Small mmWave Radars

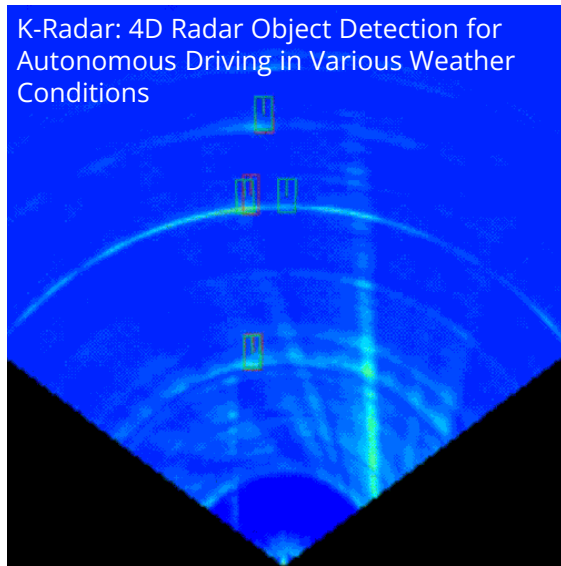
- Compact
- Low Cost



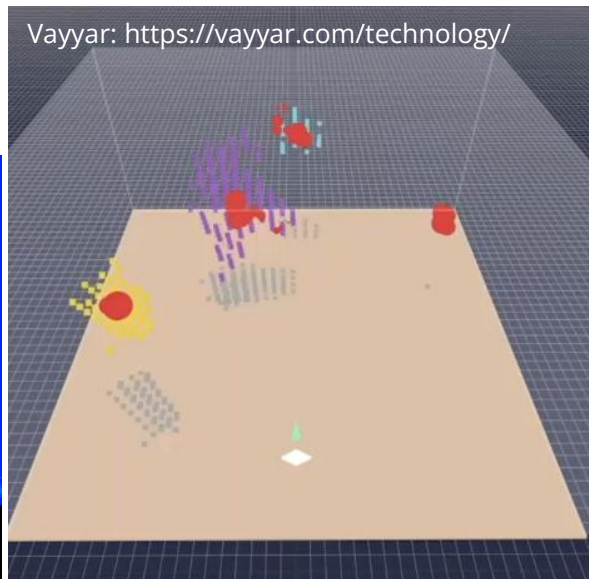
Radar Imaging

Detection

K-Radar: 4D Radar Object Detection for Autonomous Driving in Various Weather Conditions

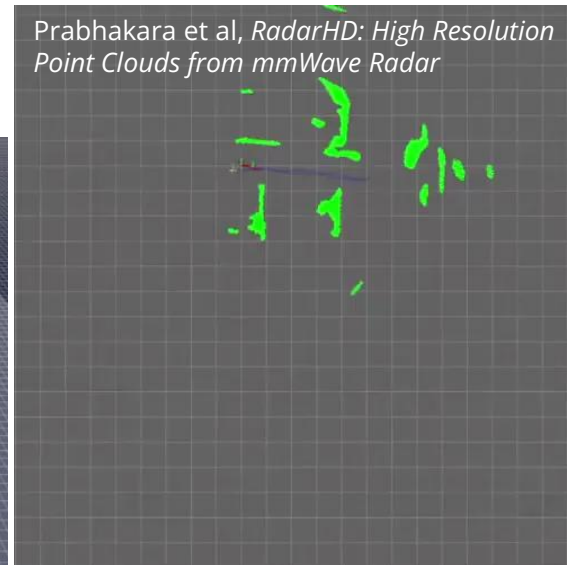


Tracking



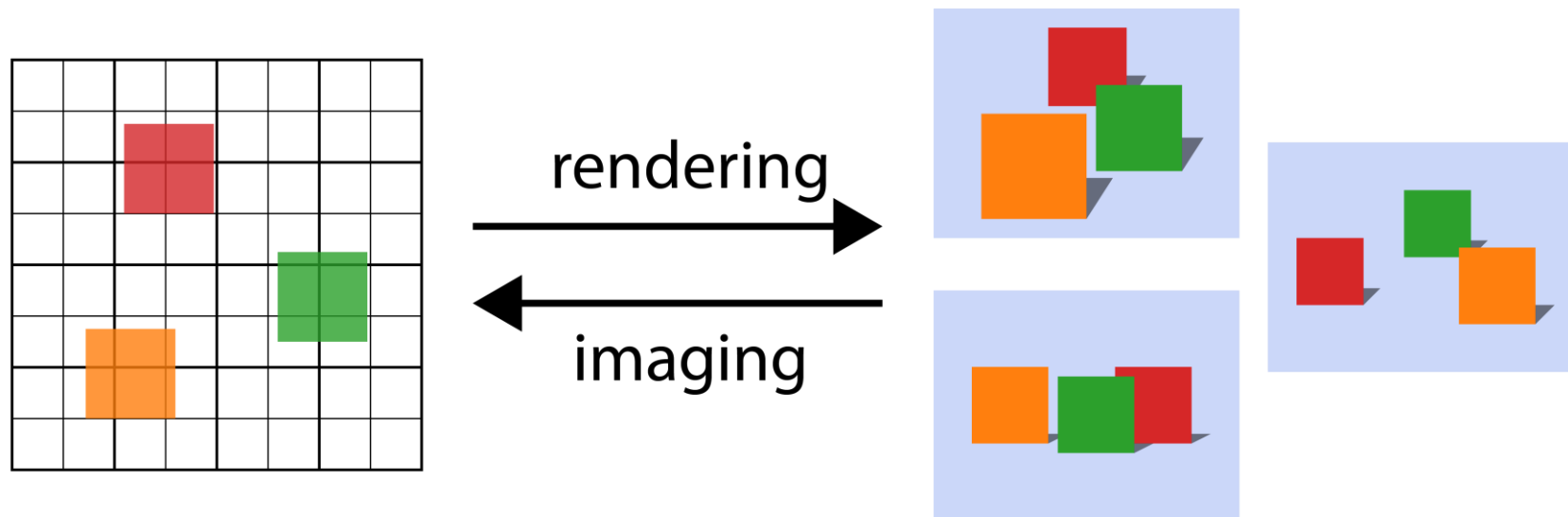
Localization

Prabhakara et al, *RadarHD: High Resolution Point Clouds from mmWave Radar*

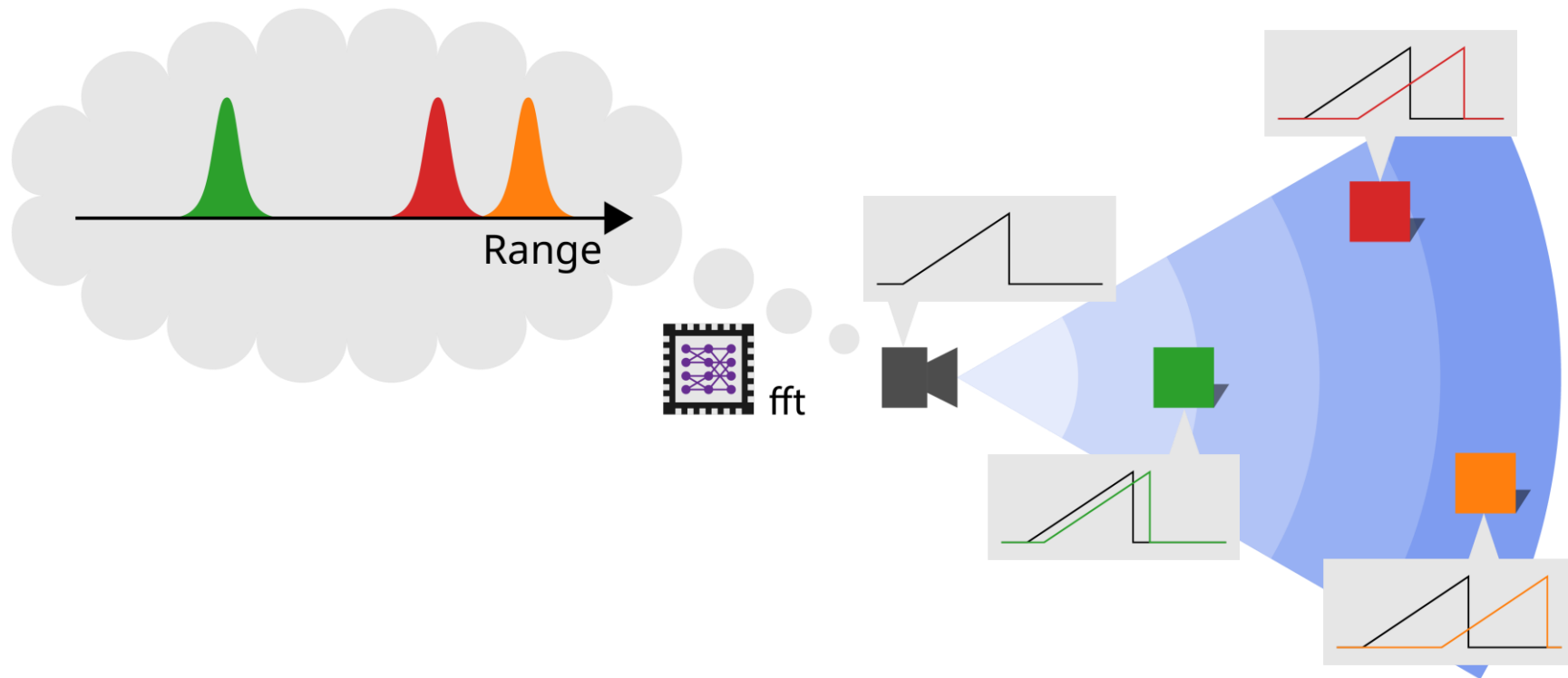


Radar Simulation

Imaging and Simulation are Dual Problems

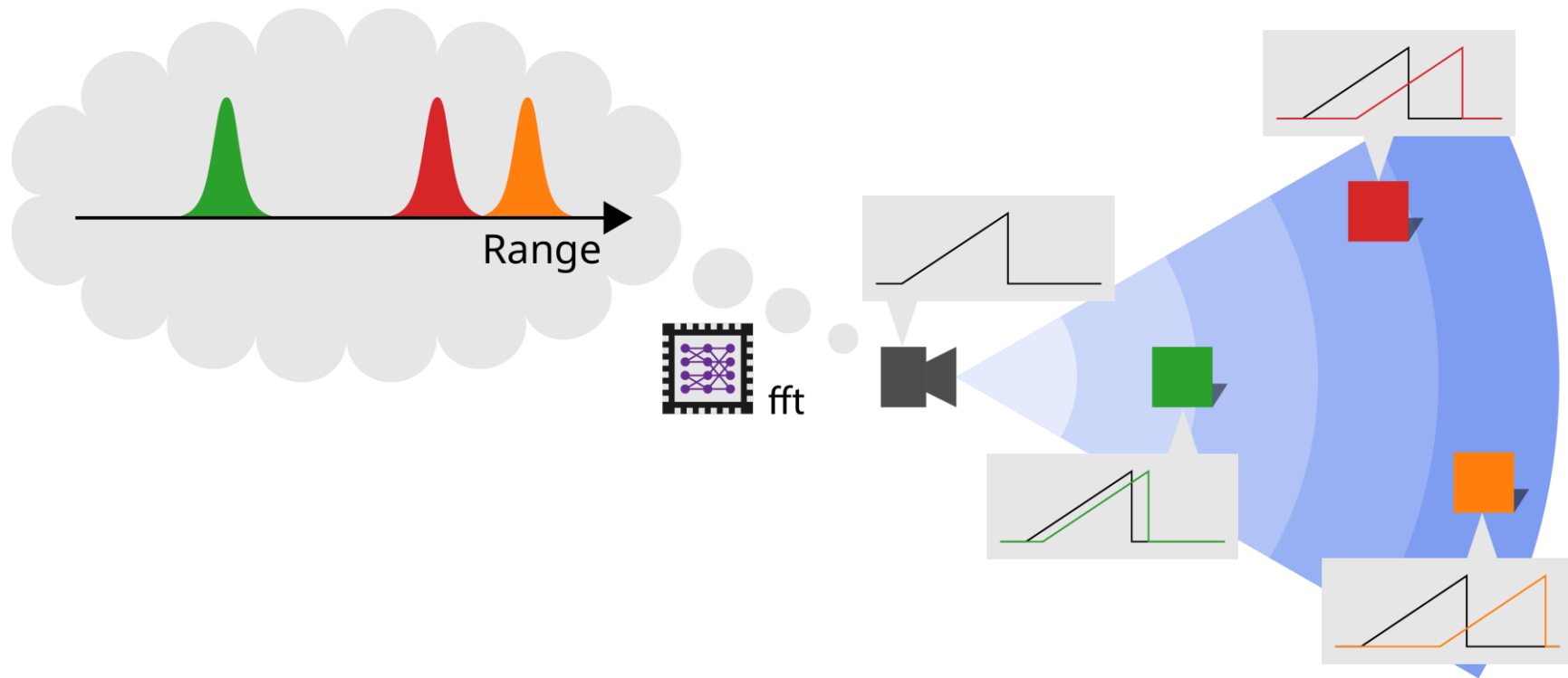


Radar: Radio Detection and Ranging



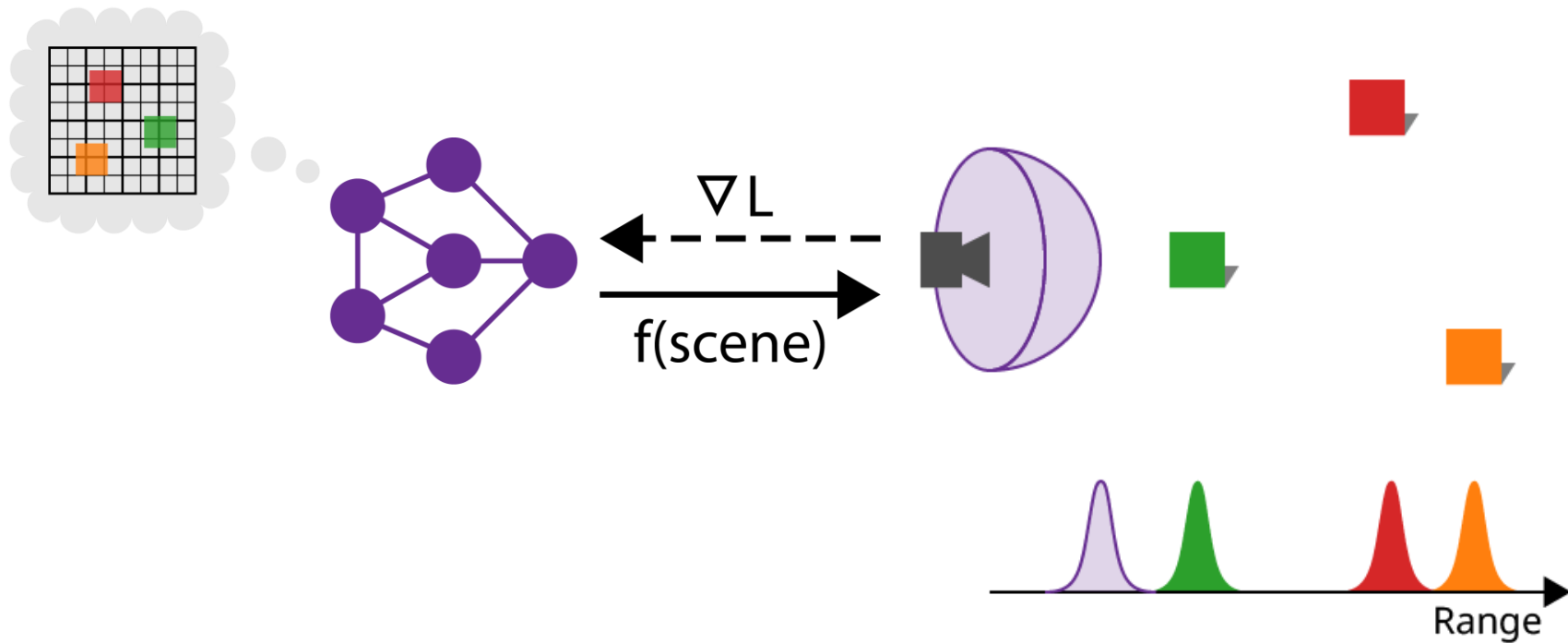
Implicit Inverse Imaging for Radar

A Naive Approach

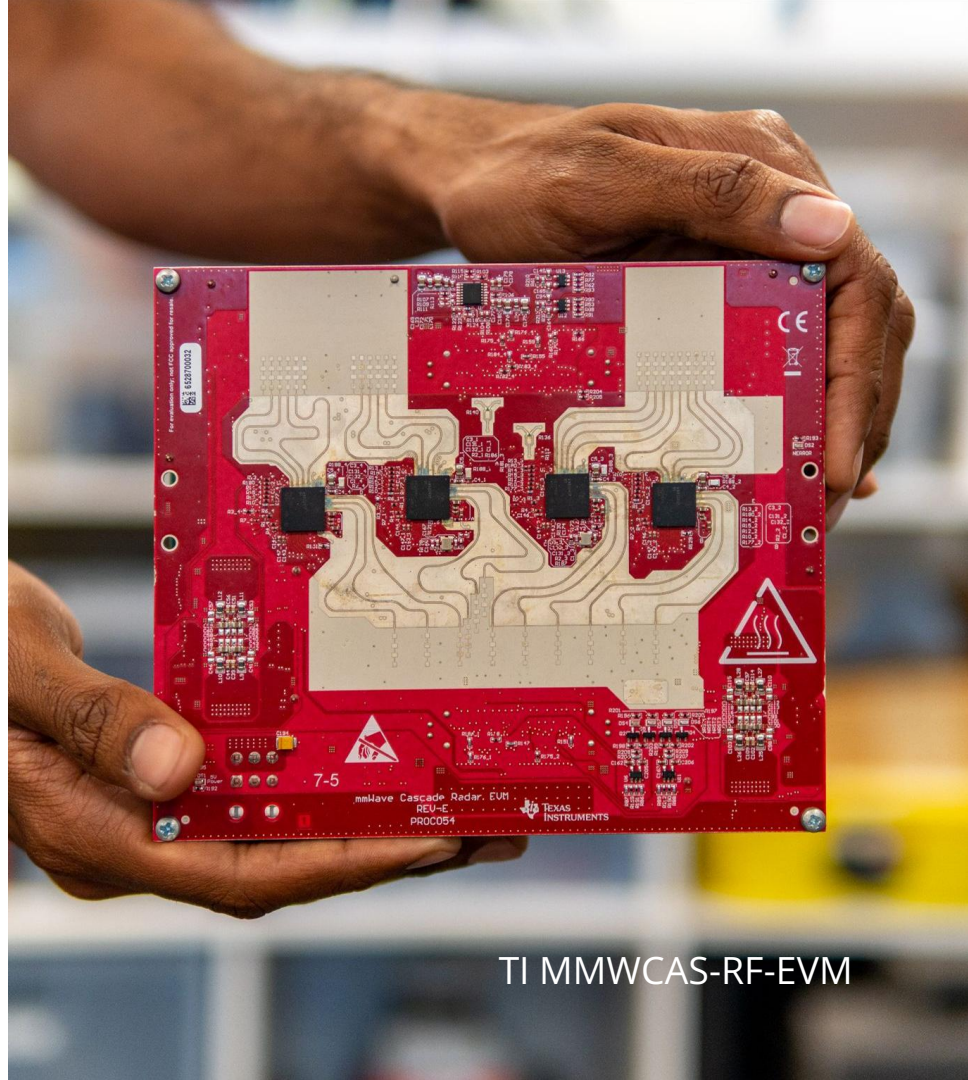
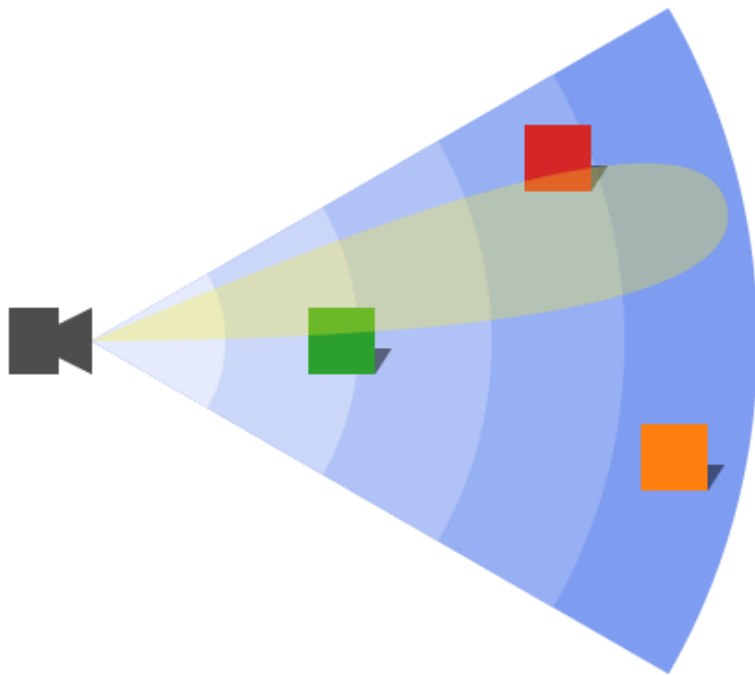


Implicit Inverse Imaging for Radar

A Naive Approach

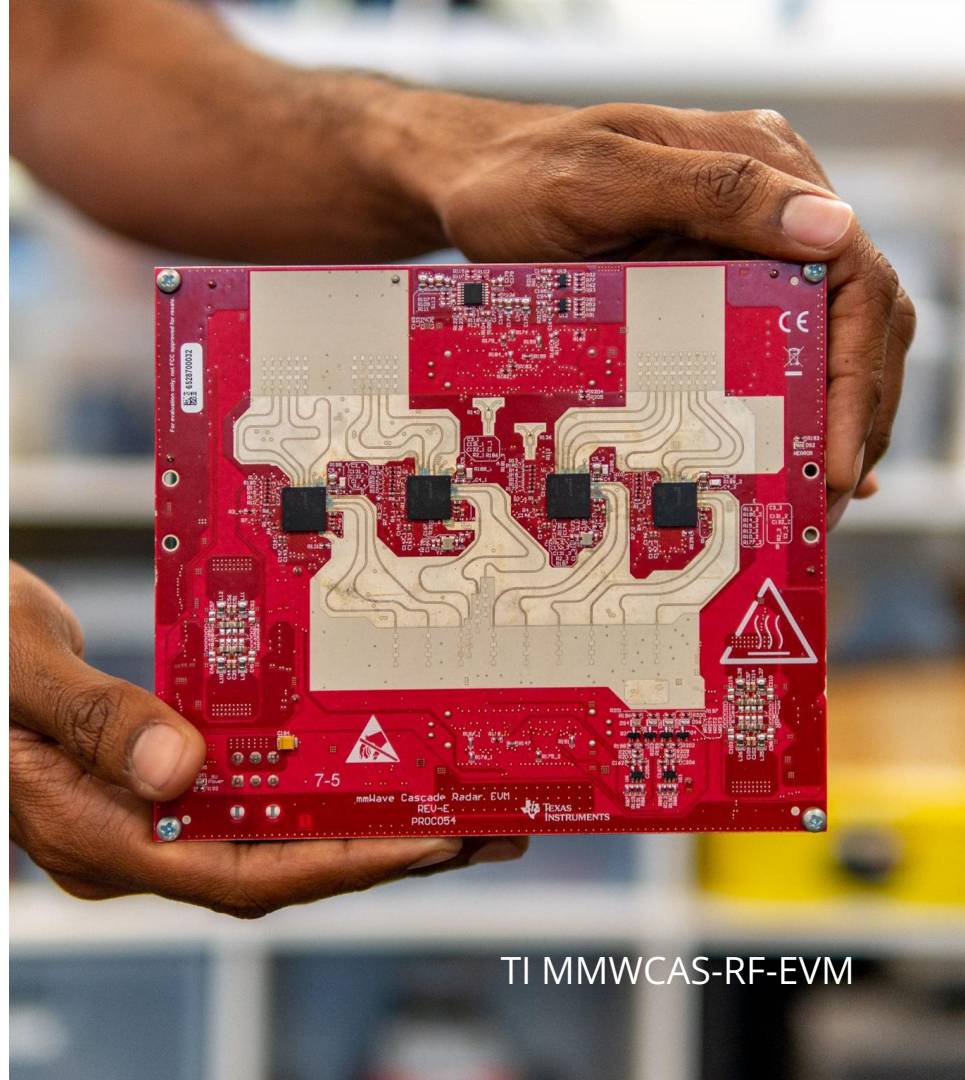
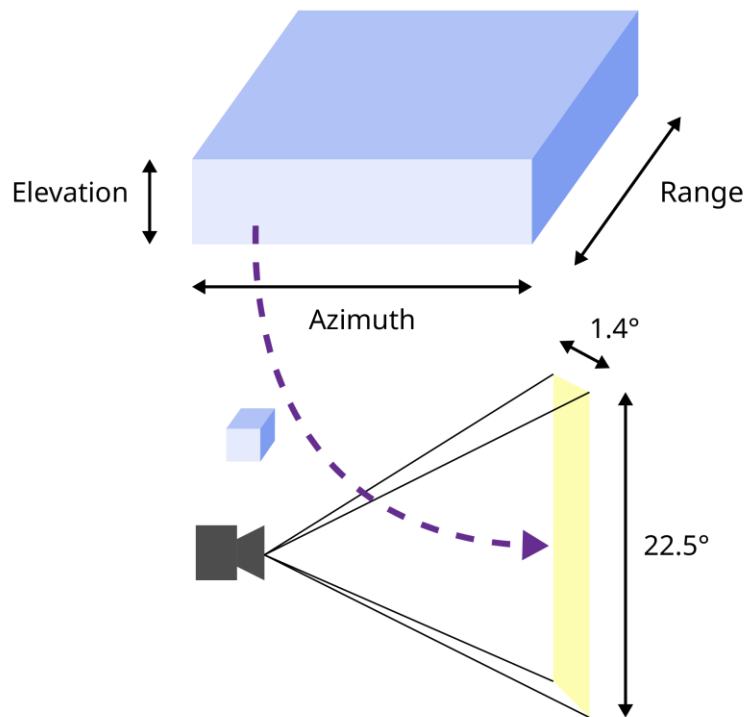


Naive Solution: Large Antenna Arrays



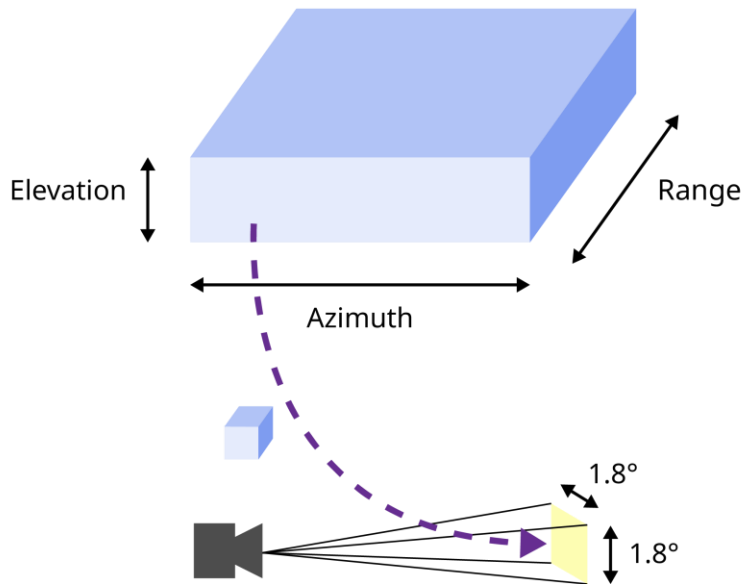
TI MMWCAS-RF-EVM

Naive Solution: Large Antenna Arrays

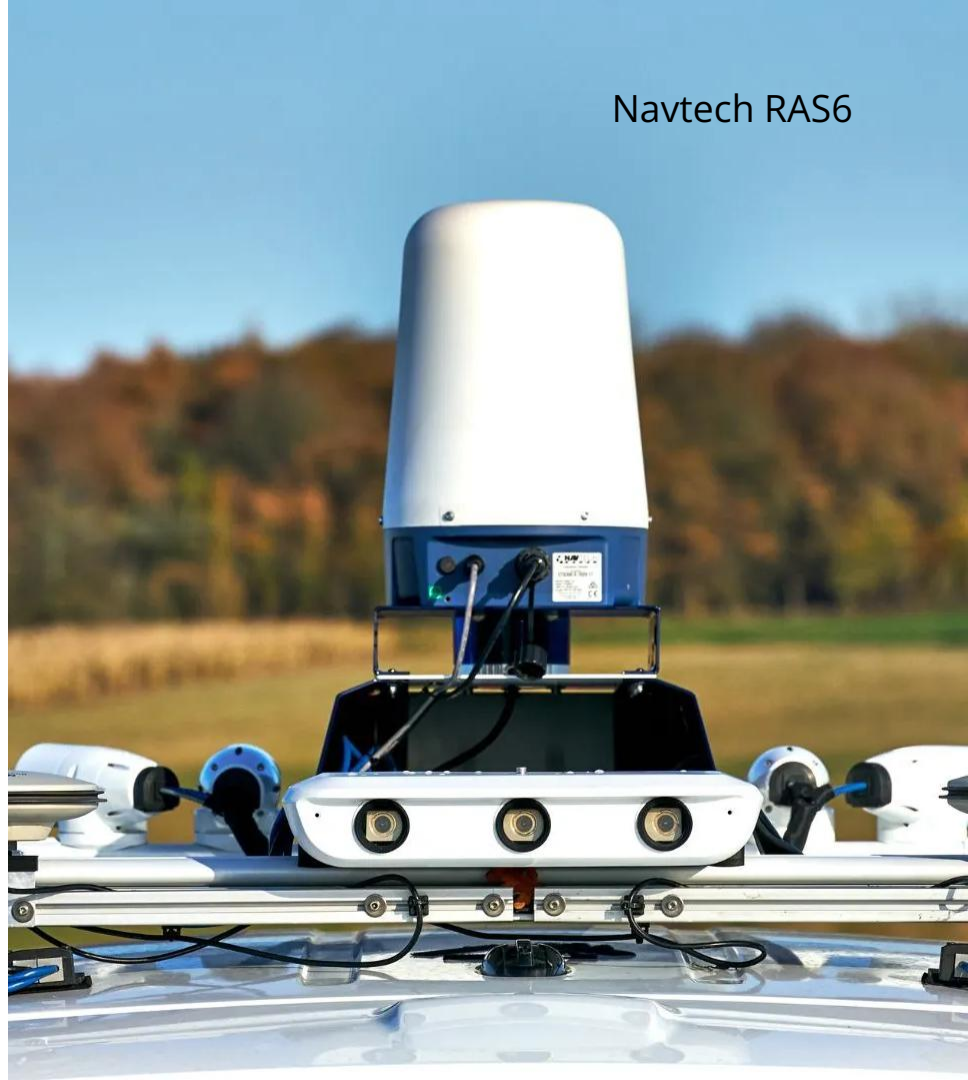


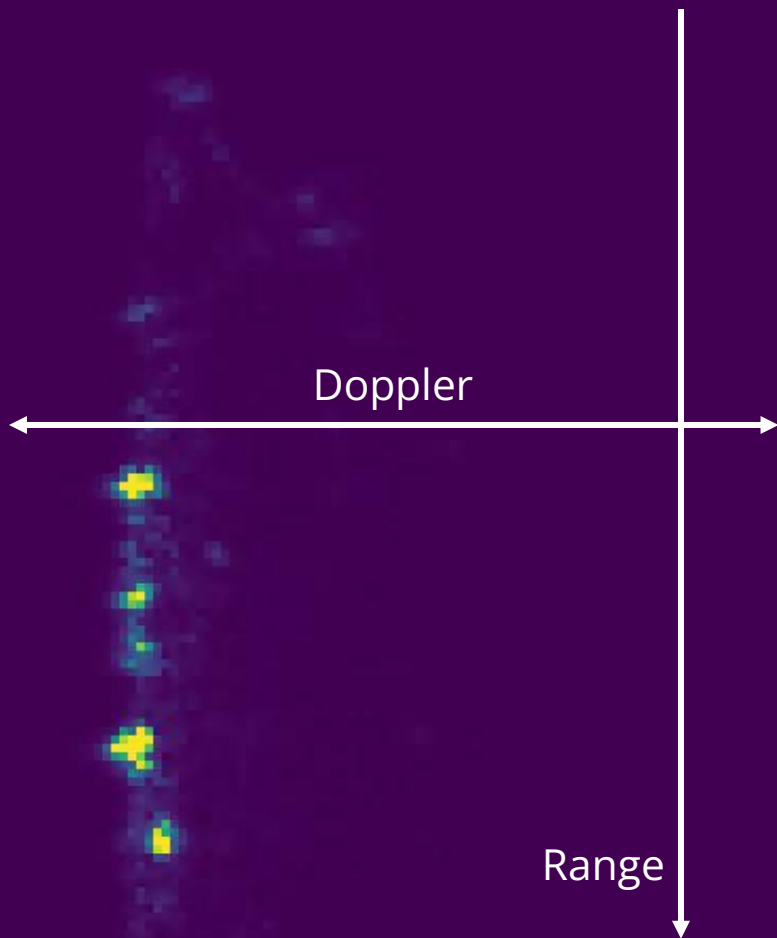
TI MMWCAS-RF-EVM

Naive Solution: Mechanical Radar



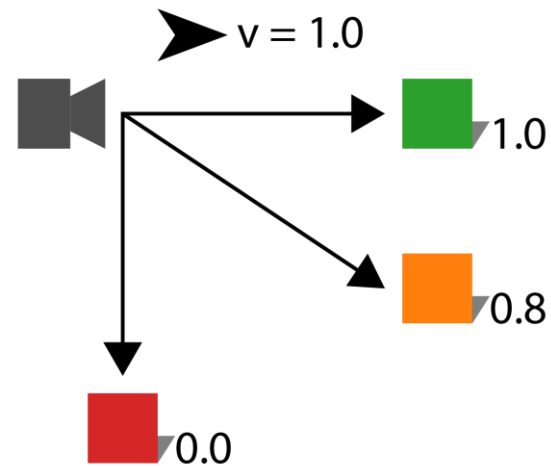
Navtech RAS6

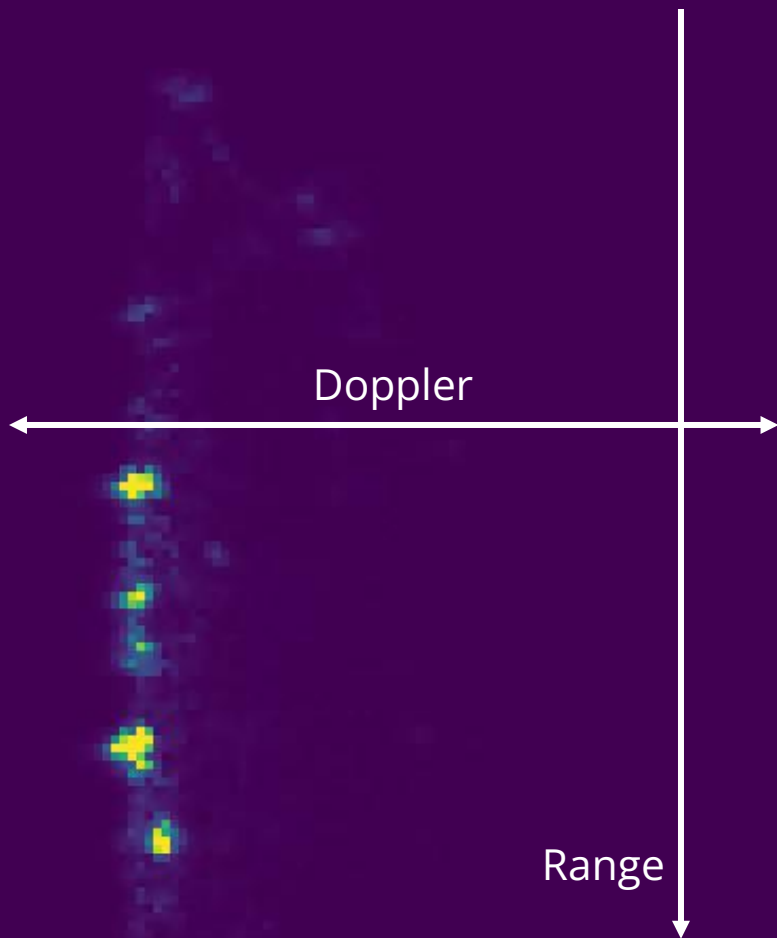




Our approach: Doppler

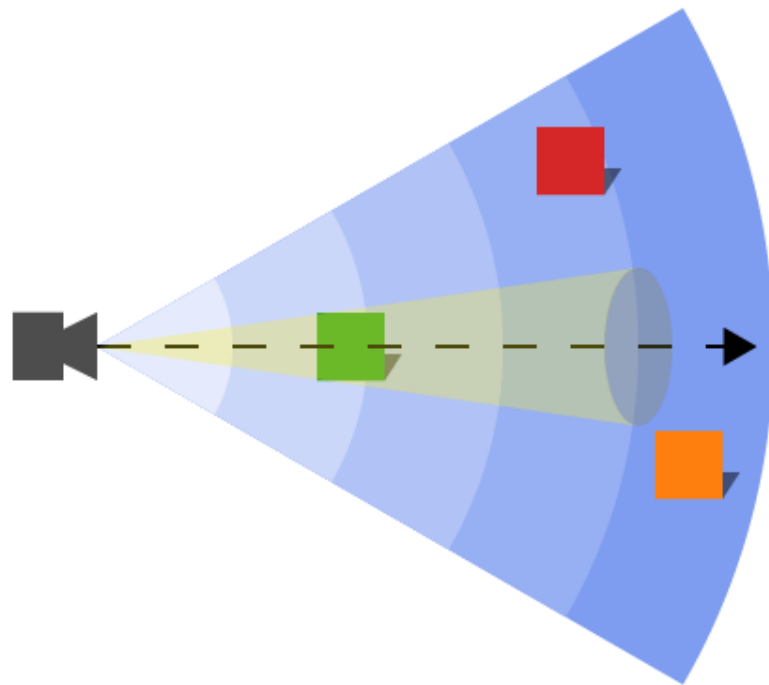
FMCW radars can measure the doppler shift caused by the (relative) velocity of an object.



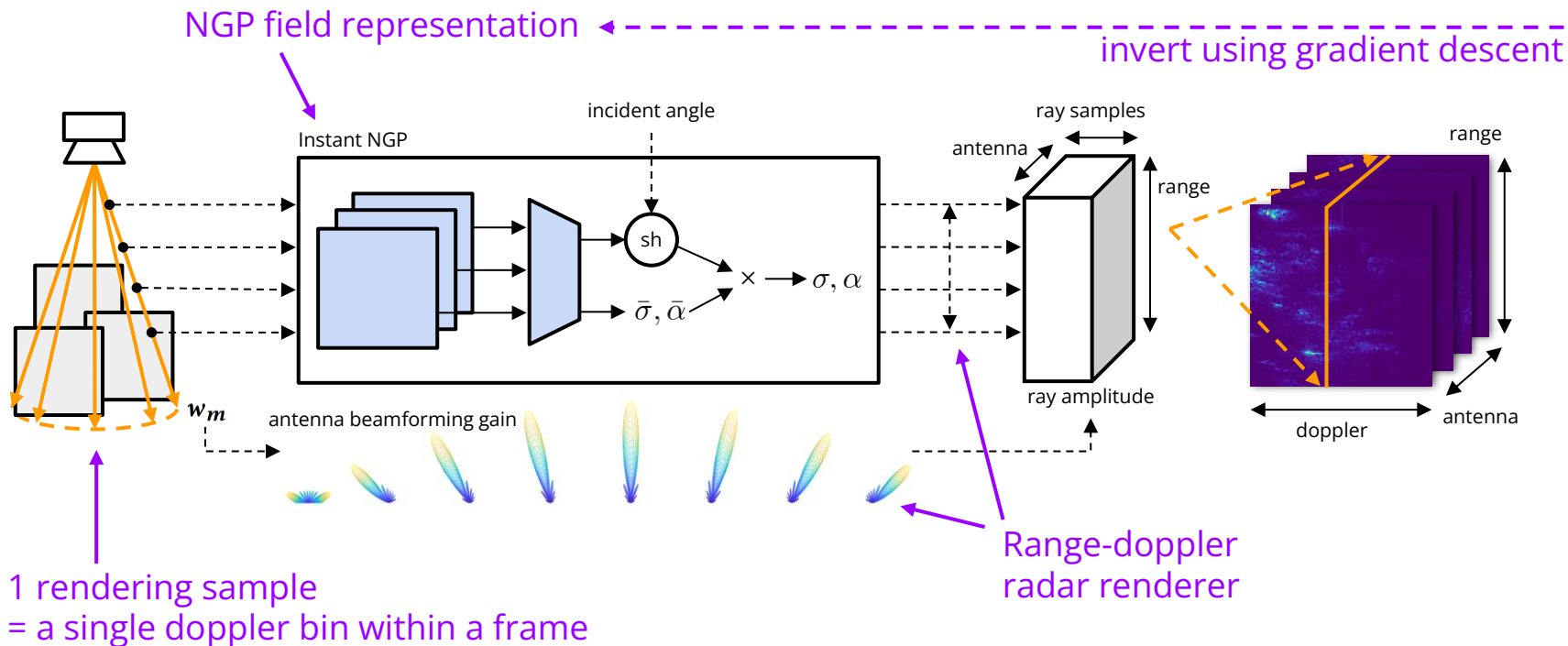


Key assumption: scene is static

$\Rightarrow$ Doppler contains angular information!



DART: Doppler-Aided Radar Tomography



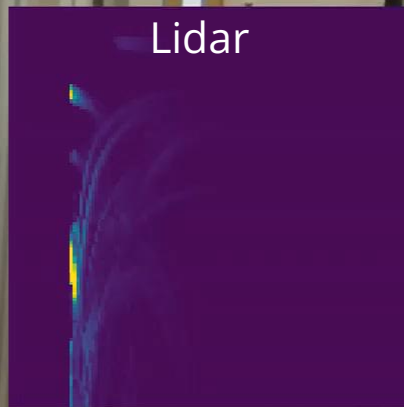
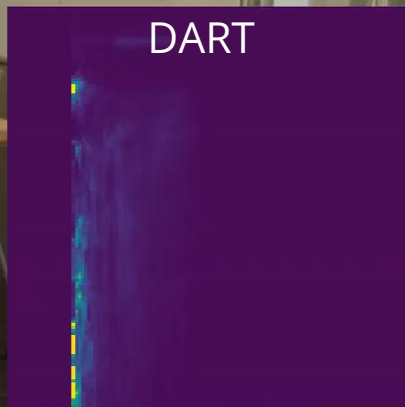
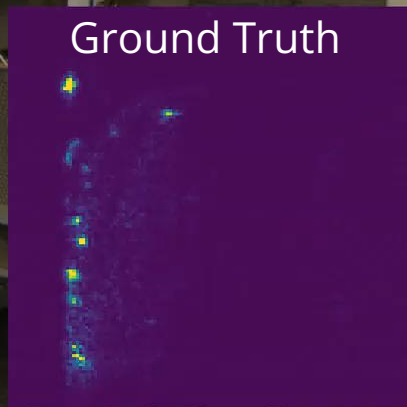
Simulation – Novel View Synthesis

Ground Truth

DART

Lidar

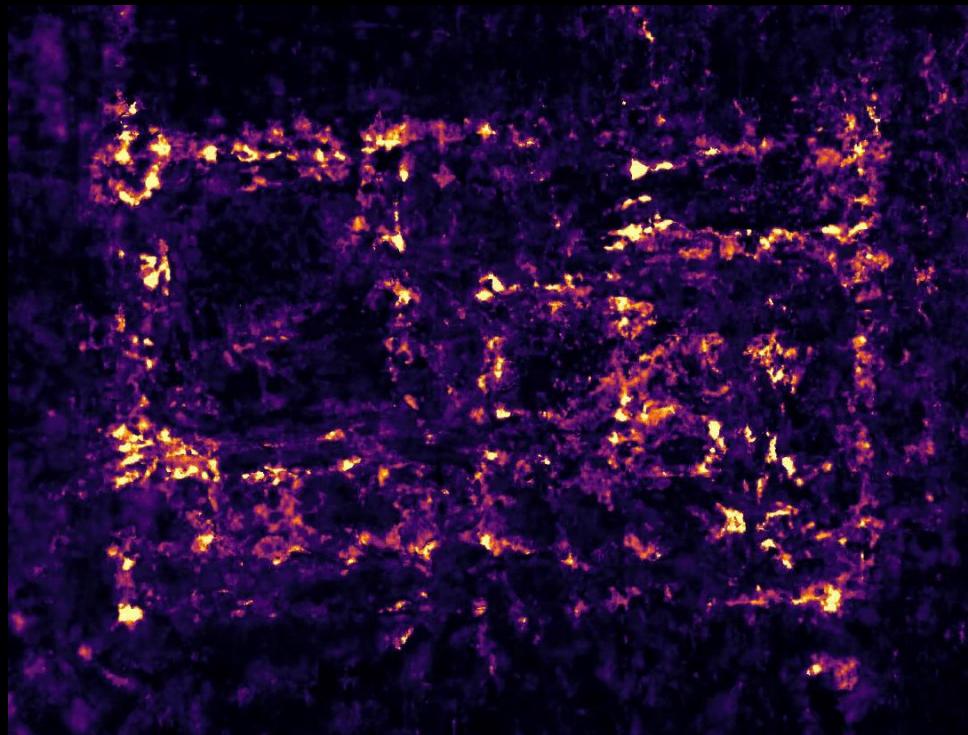
CFAR



Radar Imaging – Tomography

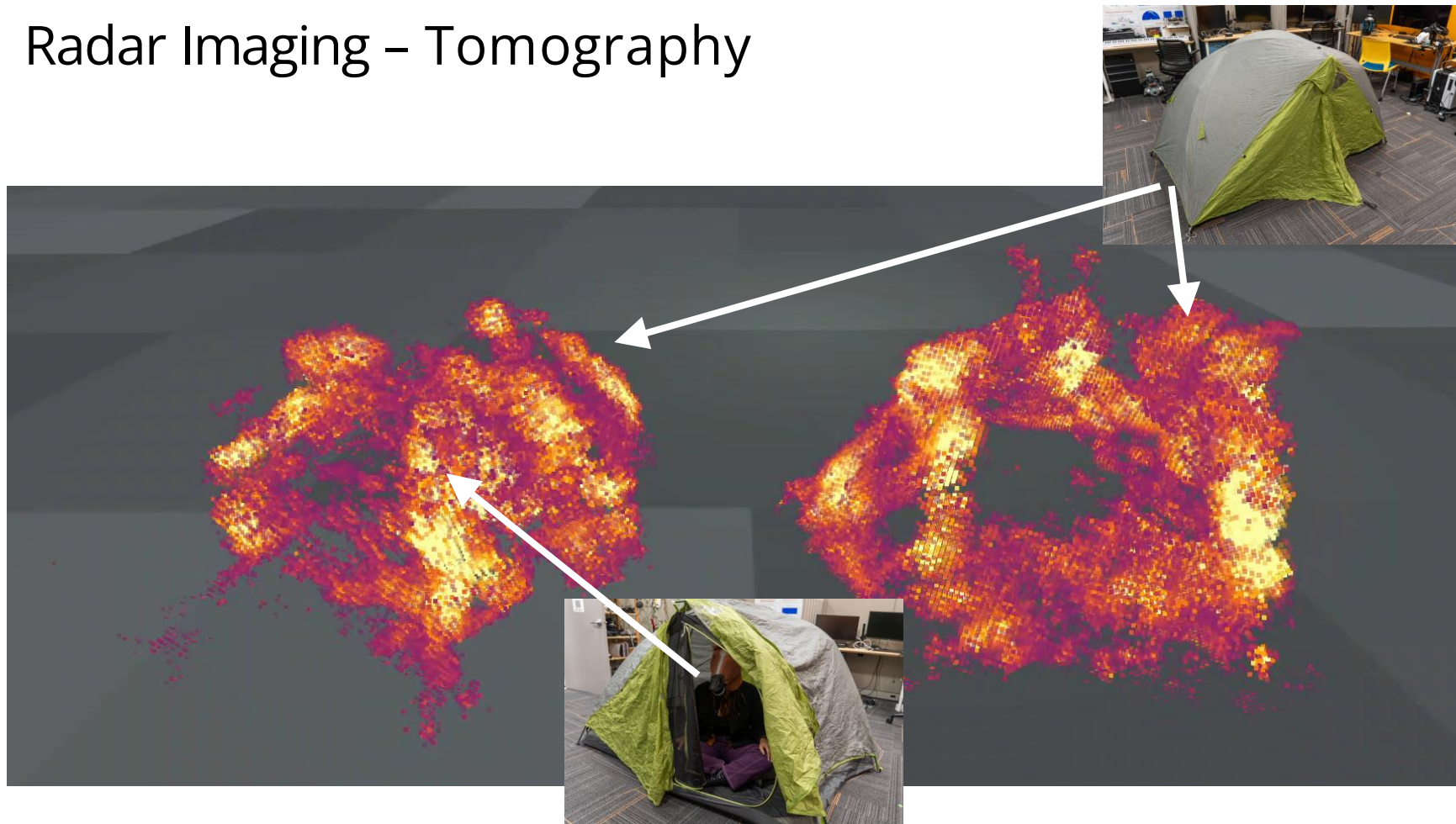


CFAR – Point Cloud



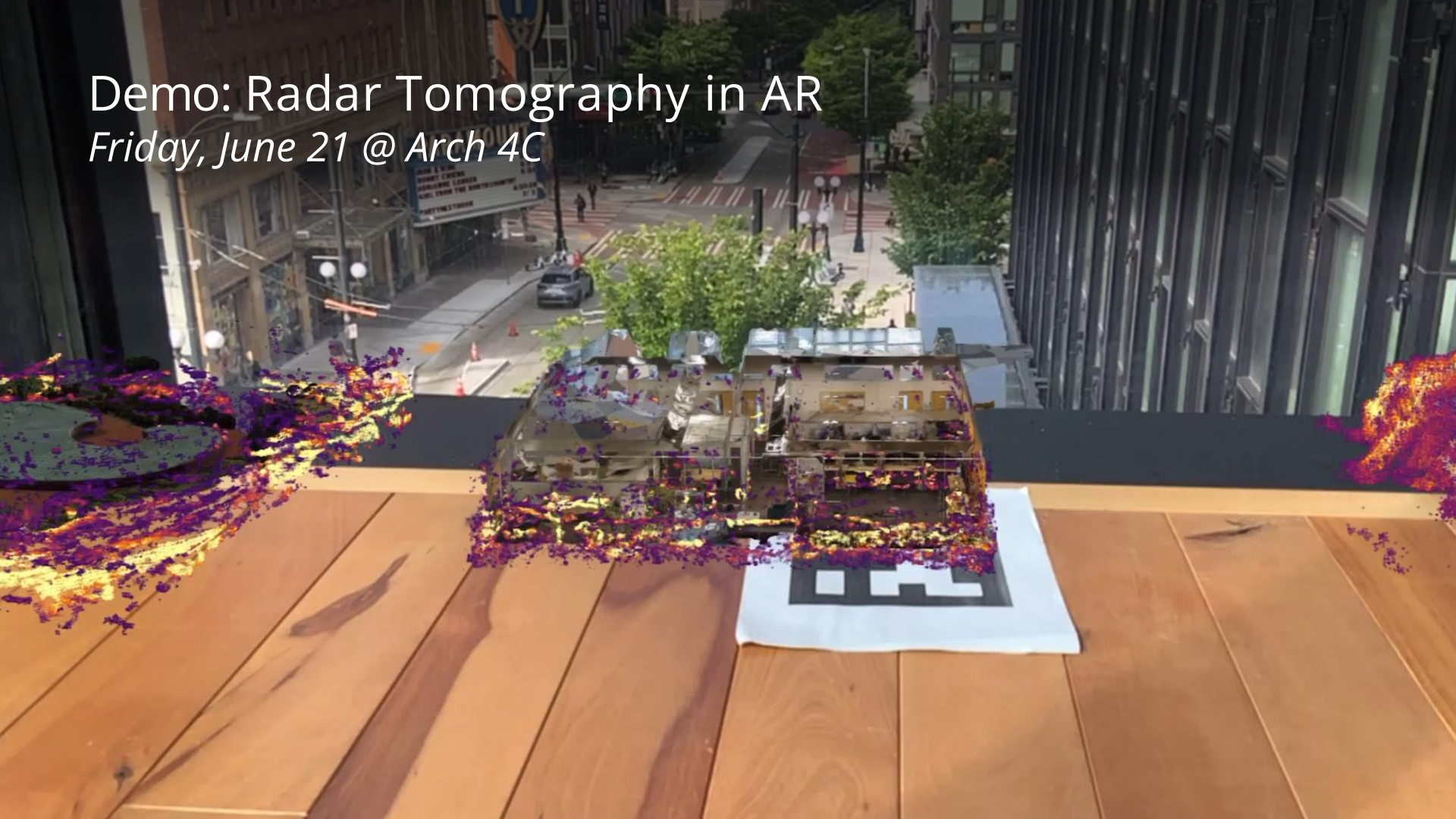
DART – Dense Tomography

Radar Imaging – Tomography



Demo: Radar Tomography in AR

Friday, June 21 @ Arch 4C



Data Collection Rig

Handheld (with backpack)

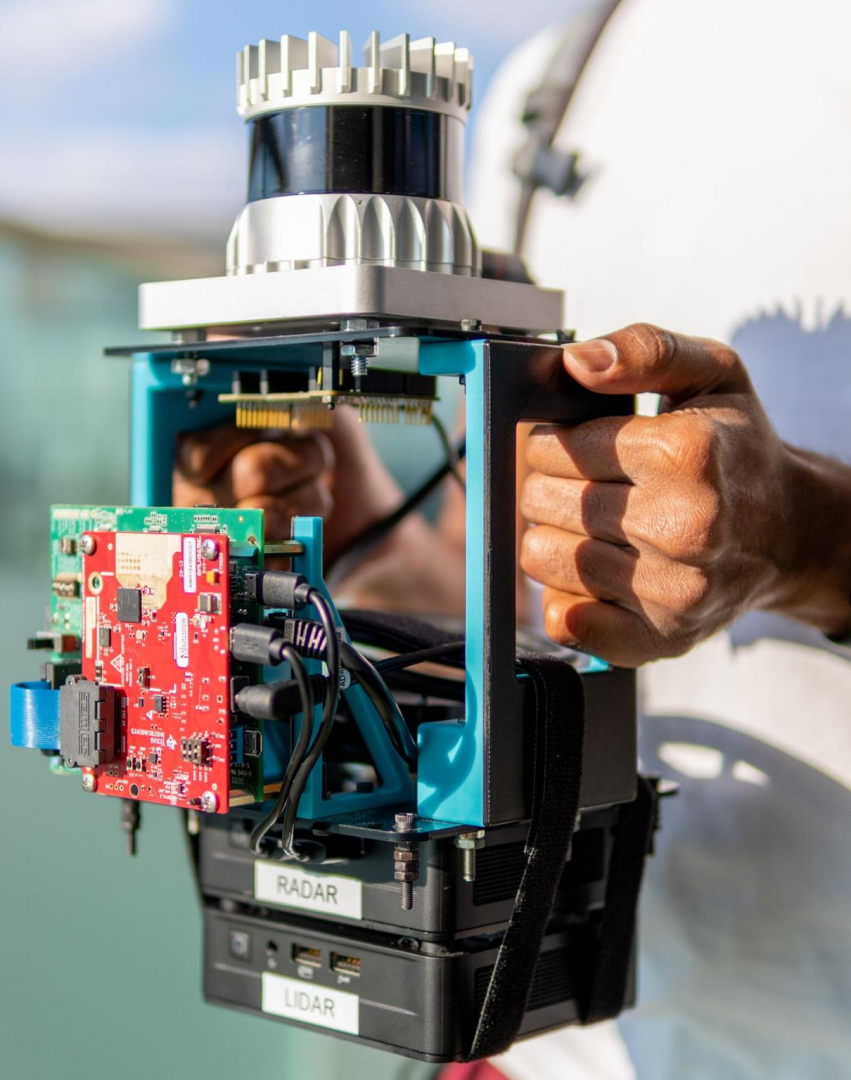
Lidar Slam using Cartographer

TI AWR1843 mmWave Radar

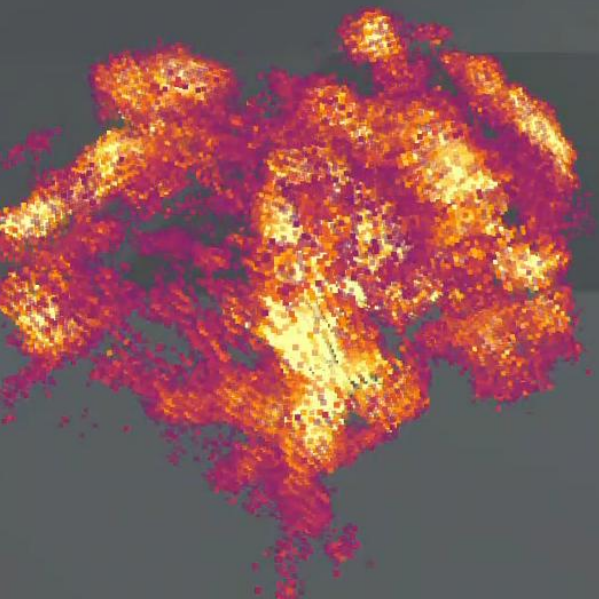
- 2TX × 4RX antenna
- 4cm range resolution
- 0.01m/s doppler resolution

All collection & processing software is open source:

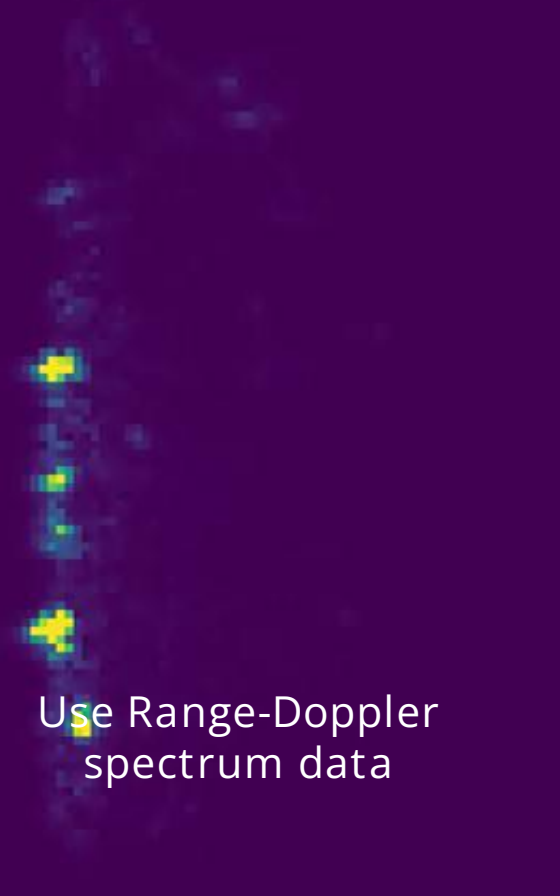
<https://github.com/wiseLabCMU/rover>



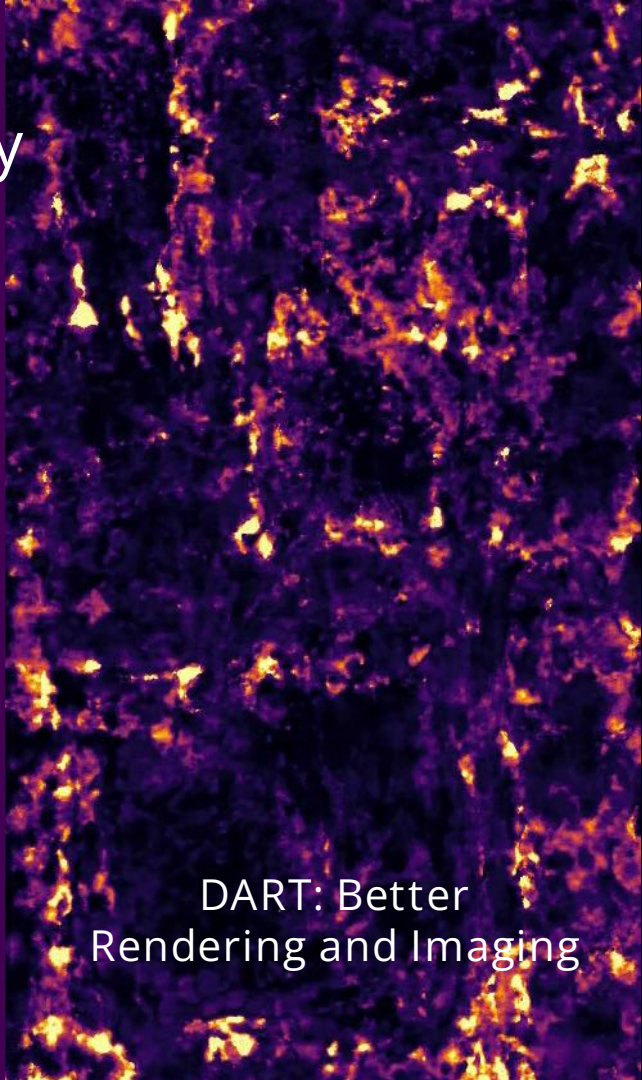
DART: Doppler-Aided Radar Tomography



Radar can
complement cameras



Use Range-Doppler
spectrum data



DART: Better
Rendering and Imaging

Akarsh Prabhakara
Asst Prof, Jan 2025
Wisconsin-Madison CS

Wireless & Cyber-Physical Systems

- ML for wireless
- Robust autonomous systems
- Frugal embedded sensing





Radar can
complement cameras

DART 

Implicit Doppler Tomography
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Use Range-Doppler
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DART: Better
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