

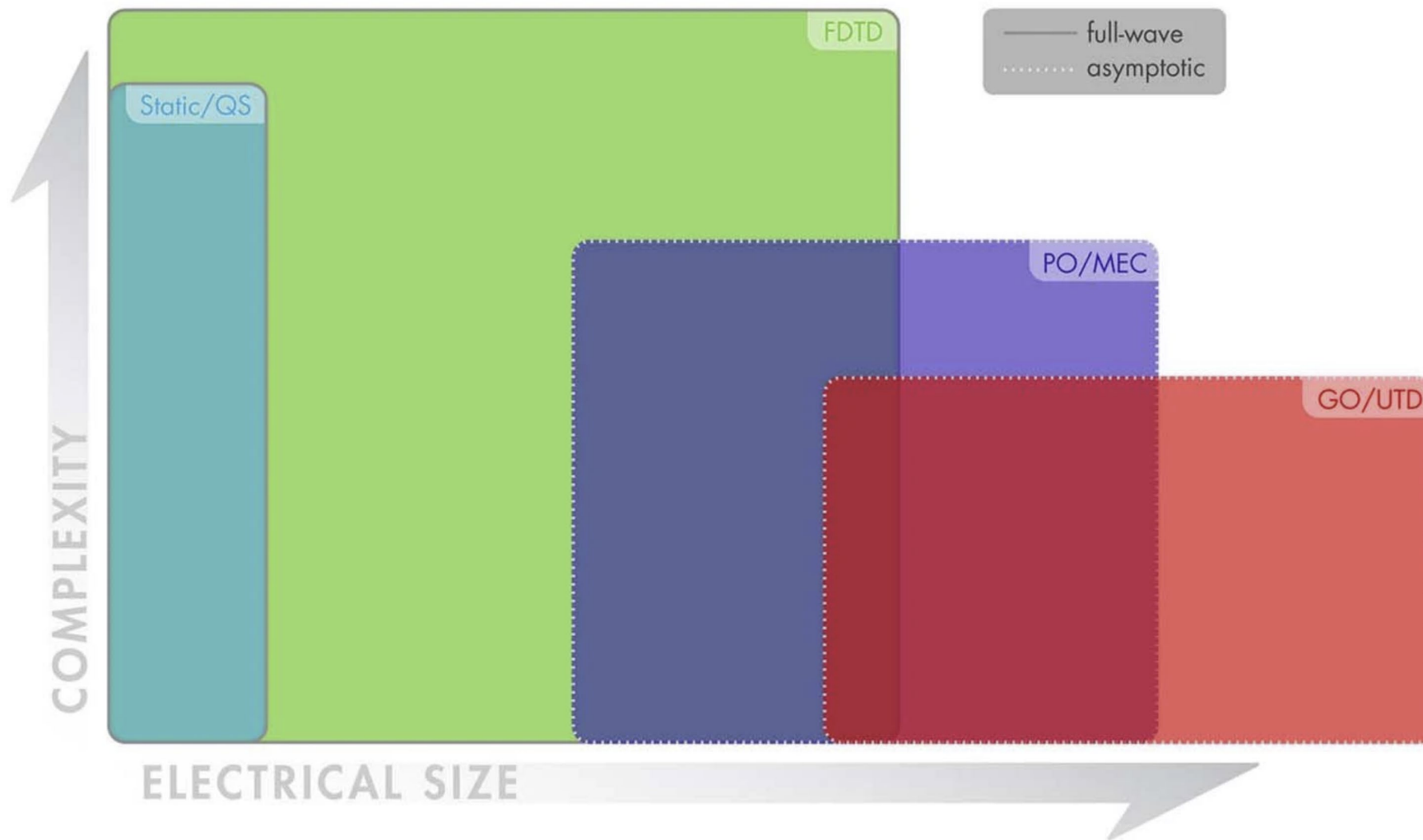


Electromagnetic Simulation Software

RF Wireless System Digital Twins and Automation for AI

Tarun Chawla

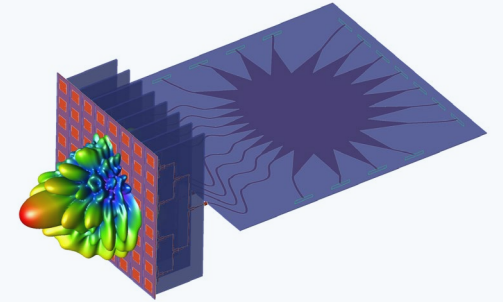
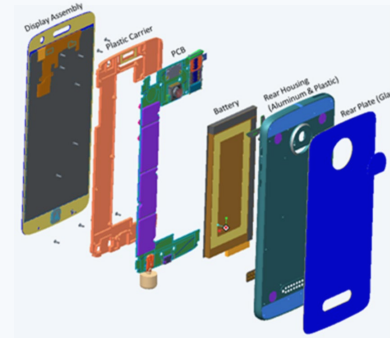
Computational EM Complexity vs Size



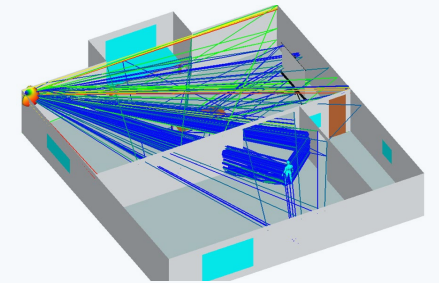
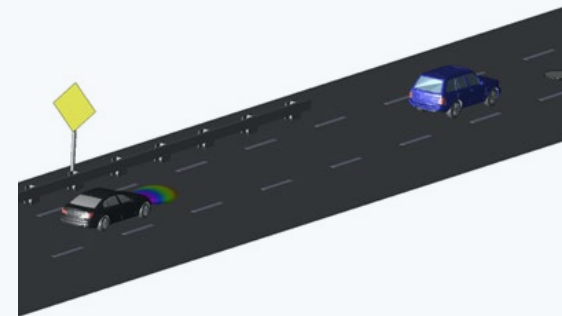
3D Simulation Platform



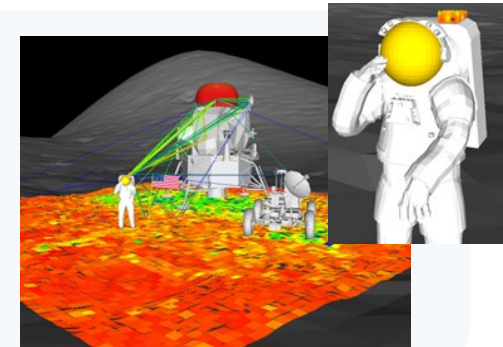
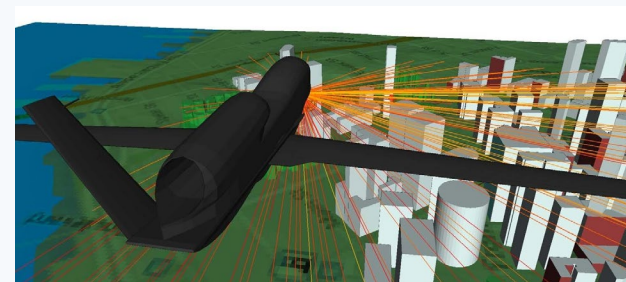
EM GPU FDTD:
Antennas, RF, Bio, RCS
Photonics



EM GPU Ray Casting:
Mobile Sensing
Scenarios for Radar/RCS



EM GPU Ray Tracing:
Mobile platforms for
wideband channel
modeling



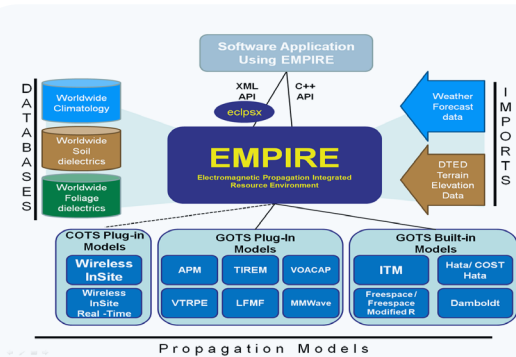
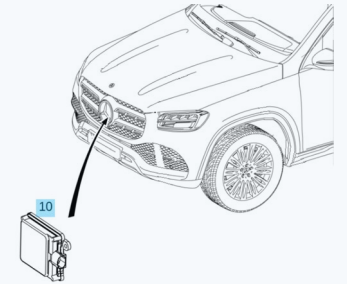
Markets



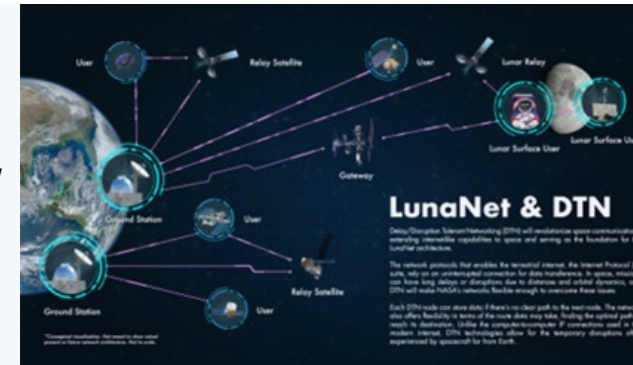
Consumer Electronics



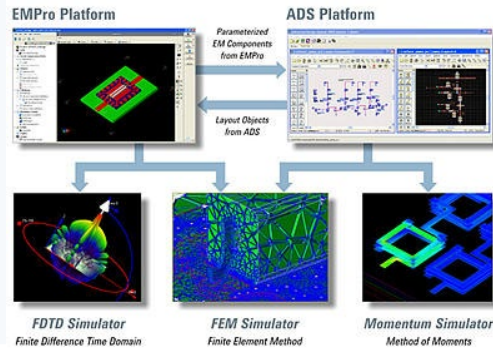
Automotive



DoD/Space

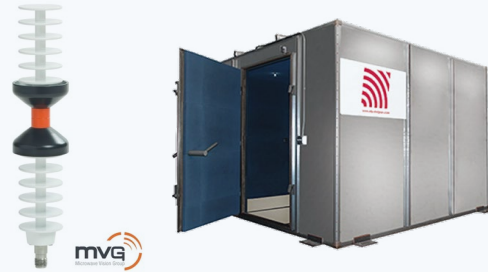
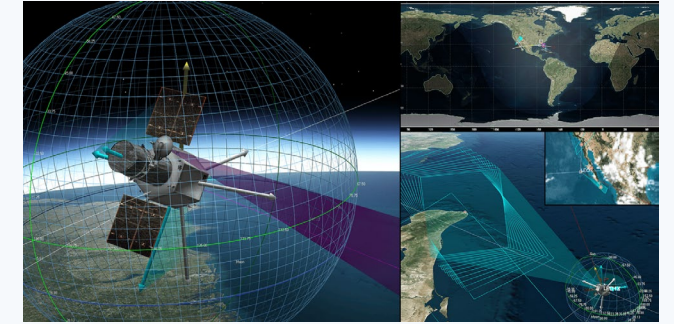
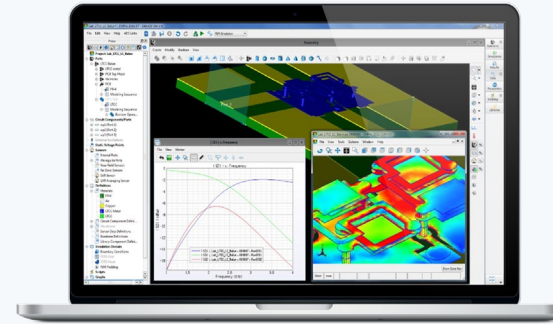


Partners



Keysight EDA

Ansys AGI STK



OTA Hardware Emulation



Anritsu × 構造計画研究所
KOBUN KEIKAKU KYOKAIEN KAISHA, LTD.

ソリューション

ローカル5G導入・運用時の課題とソリューション

提供サービス

シミュレーション解析サービス
測定サービス
ラボ見学・利用サービス

Joint Collaboration: Remcom Inc + NIST

Animating Visual Signs in Radar Simulations: Comparing Physical Optics Against 28.5 GHz Channel Measurements

Fig. 1. Comparison of simulated PO and measured PO.

API Integrators

PHY Layer Datasets



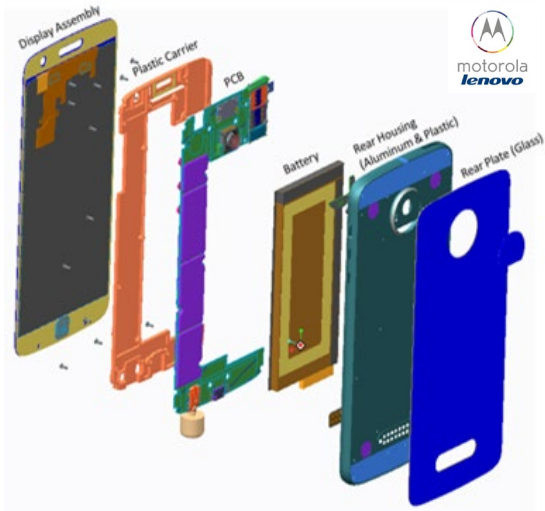
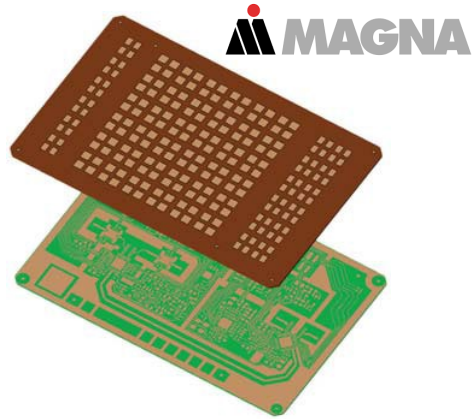
DeepMIMO

DeepVerse 6G

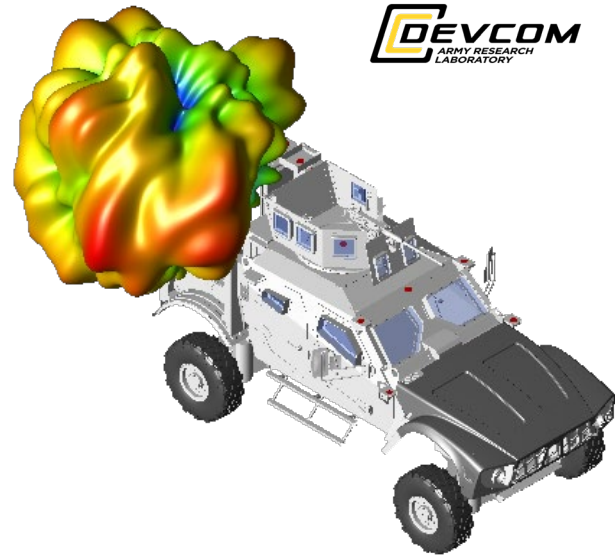
A Digital Twin Dataset for Wireless Communication and Sensing

CAD for Manufacturing and Testing

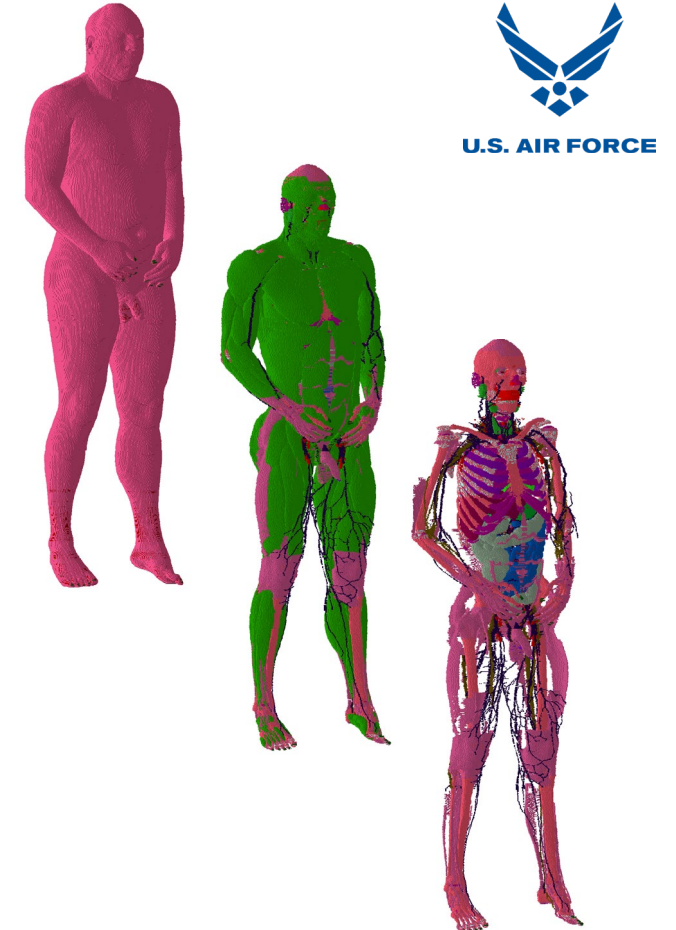
ECAD



MCAD



Voxel/Tissue



Digital Twin Datasets

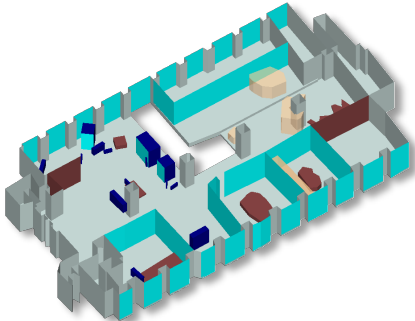
Datasets

Outdoor



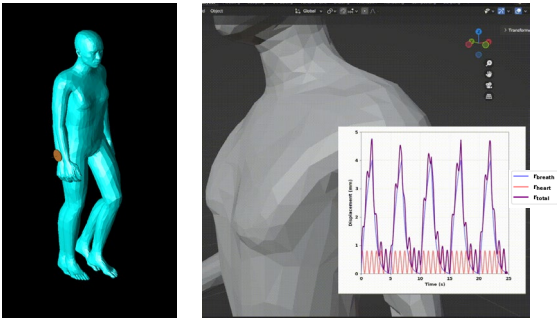
Terrain, Buildings, Foliage

Indoor



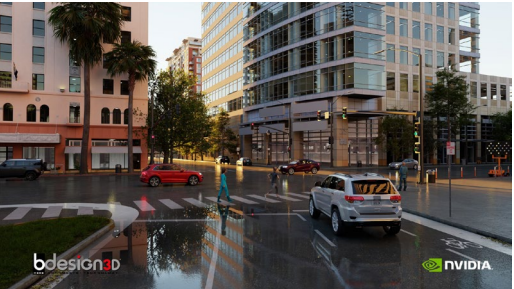
Floor, Ceiling, Objects

Humans



Breathing with Heartrate

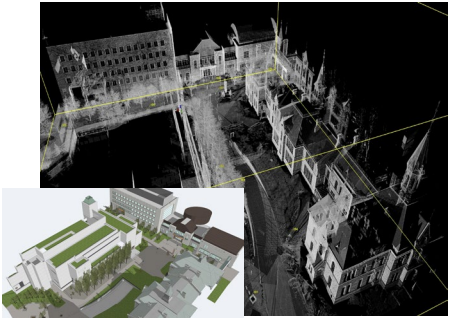
Processing Tools



Digital Twin Capture Methods

Outdoor

LiDAR/Camera



Terrain, Buildings, Foliage

Indoor



Floor, Ceiling, Objects

Humans



Face, Arms, Joints, Legs

Data Acquisition

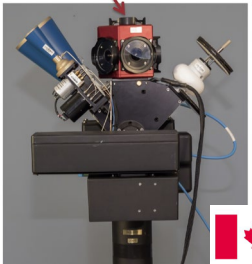


Community, Land, Soil

構造計画研究所
KOZO KEIKAKU ENGINEERING Inc.



Panoramic camera



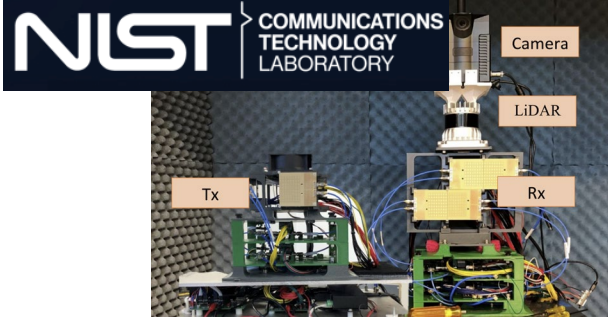
NAVVis
IVION



Artec 3D



Innovation, Science and Economic Development Canada



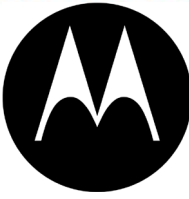
MOVESENSE



ECG, Heart Rate

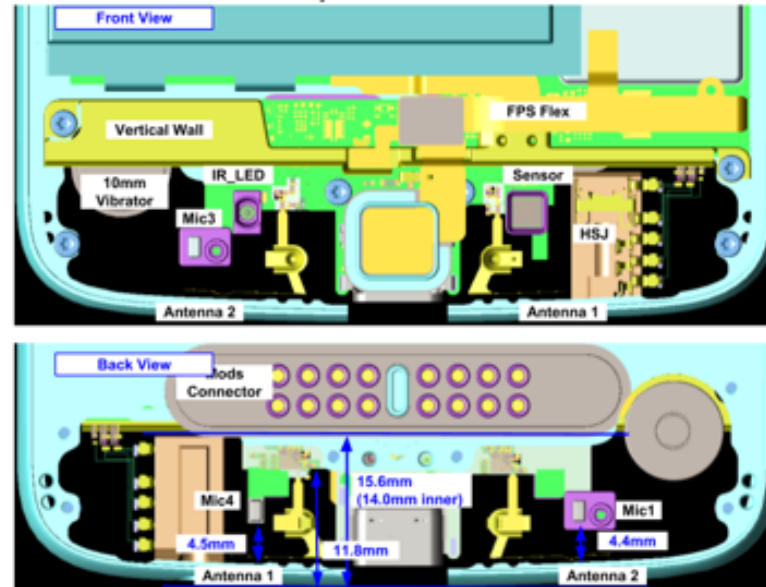
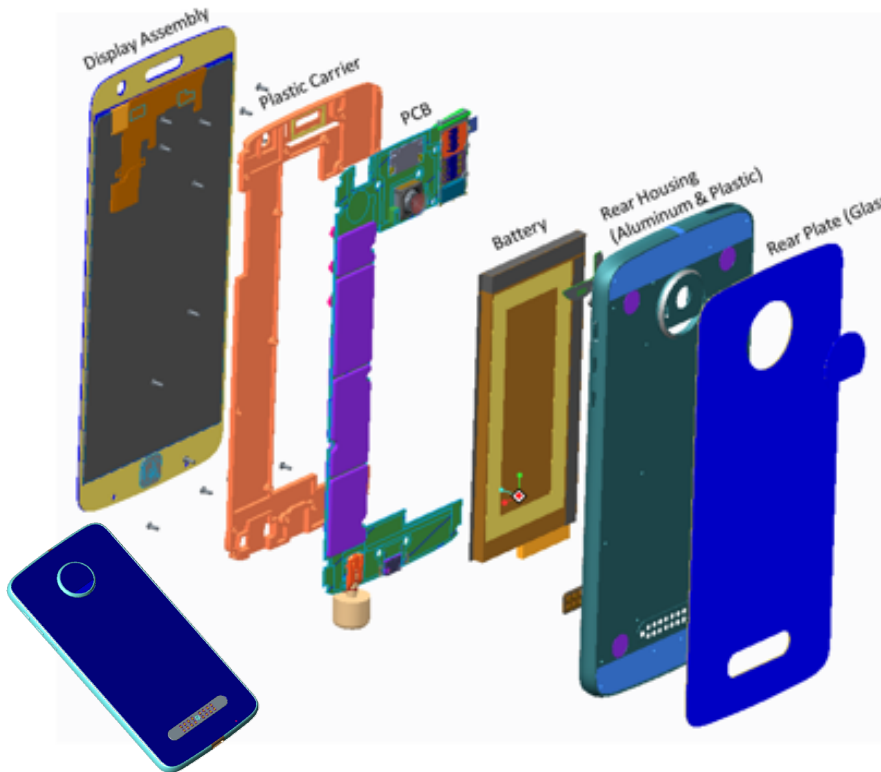


Simulation Validation



Motorola Phone – Nearfield Correlation

Full mechanical model (>1000 parts) with full PCB



Frequency Band	Delta TIS (dBm)
B2 (1900 MHz)	0.72
B4 (1710 MHz)	-0.32
B5 (824 MHz)	1.7
B13 (777 MHz)	1.42

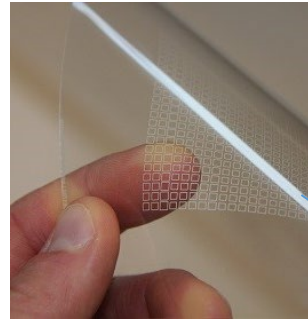
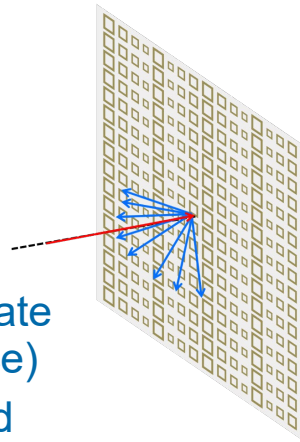
Images provided Courtesy of Motorola Mobility LLC, a wholly owned subsidiary of Lenovo

Metamaterial - Indoor mmWave Multipath

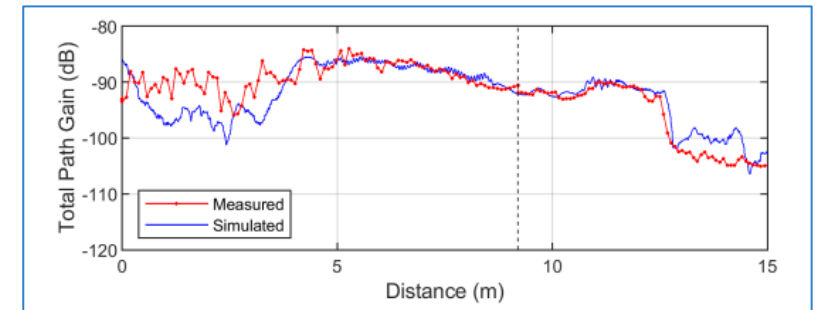
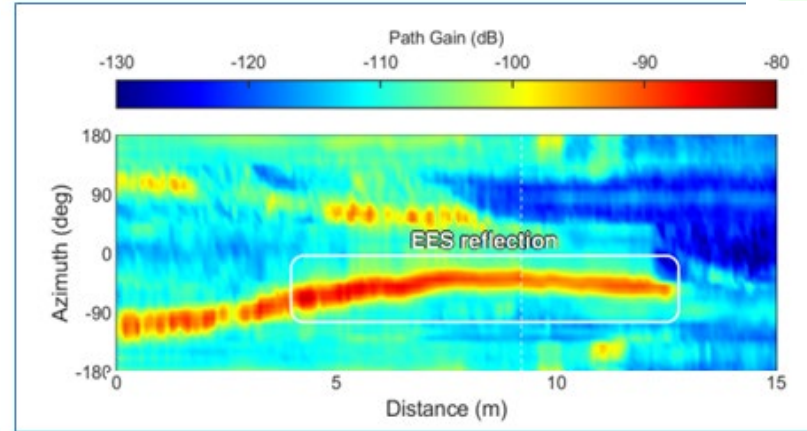
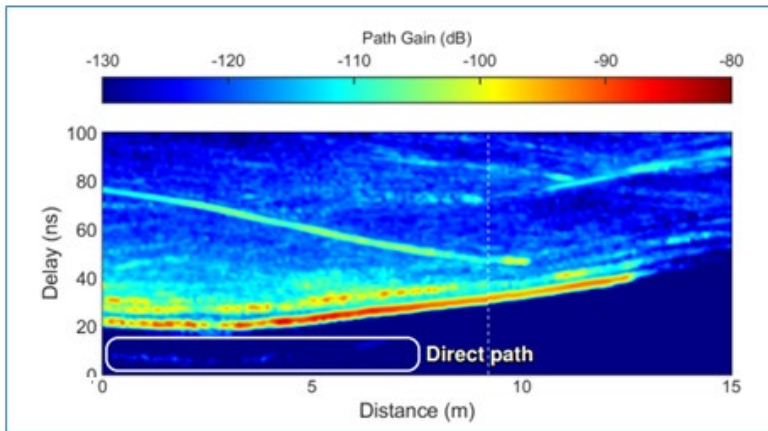
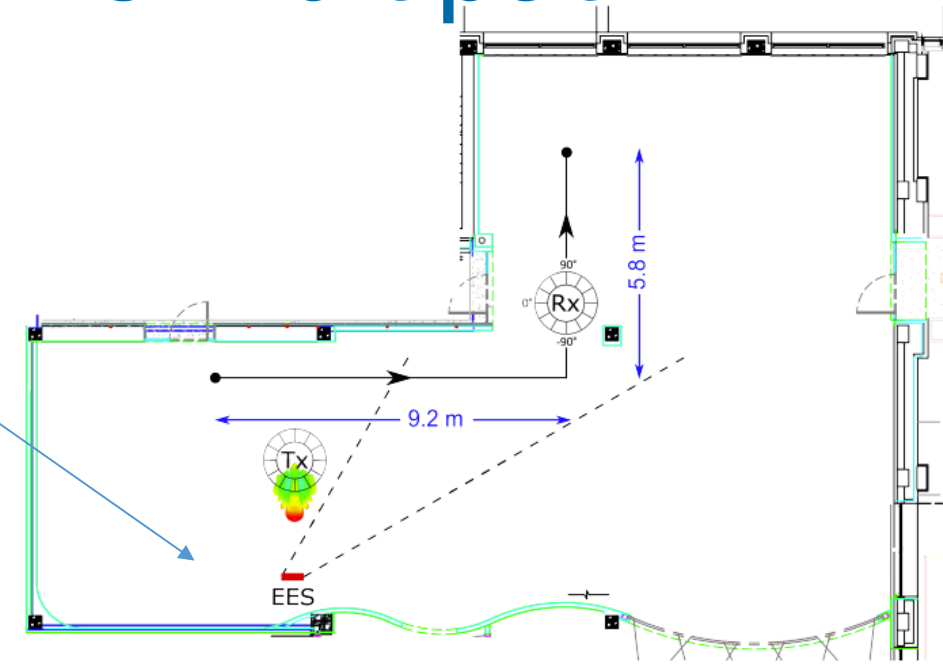


Compares CRC Theory & Measurements to Wireless InSite prediction in an indoor office environment

- Tx directed at an Diffuser plate (30-60 deg, normal incidence)
- Rx route, in LOS and around corner



Diffuser

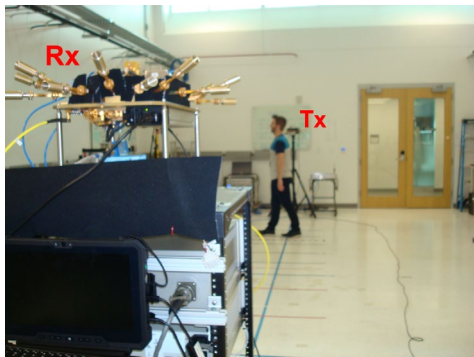


Measured multipath gain distributions versus distance along the Rx

Total path gain: measured vs. Wireless InSite

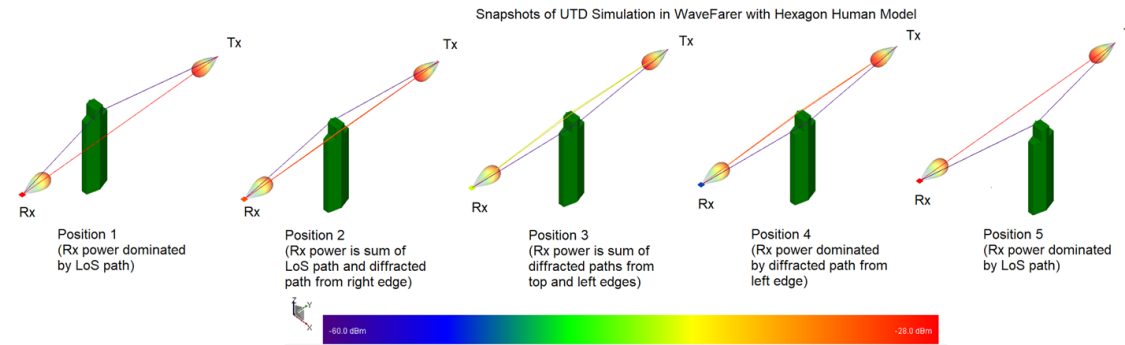
Human Shadowing - Correlation

Measurement Campaign

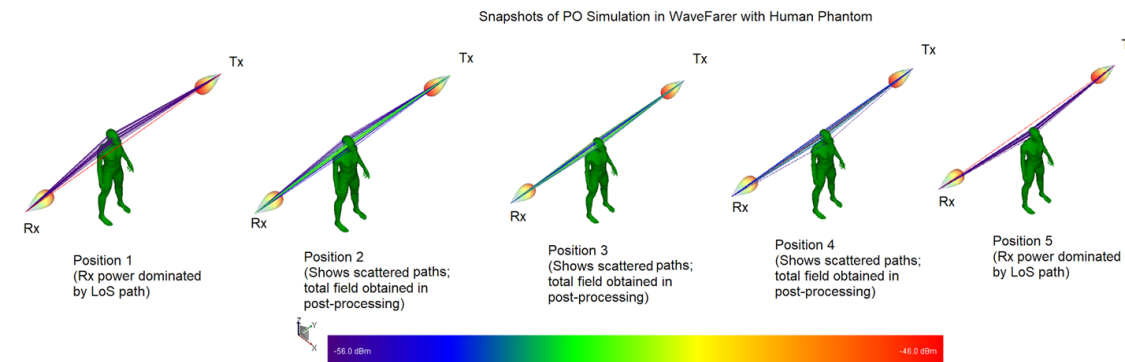


Ray Diagram of UTD and PO simulations in WaveFarer for certain positions of the human model

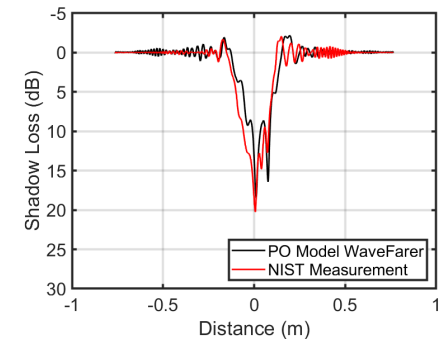
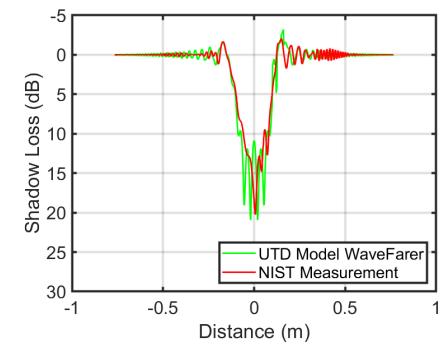
Using UTD



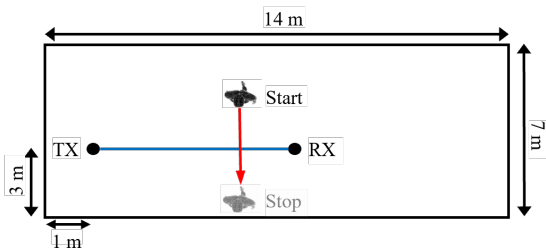
Using PO



Validation Examples



Varied Tx-Rx separation and position of person

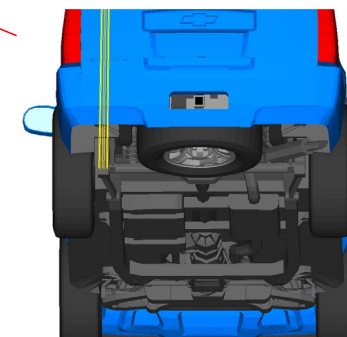
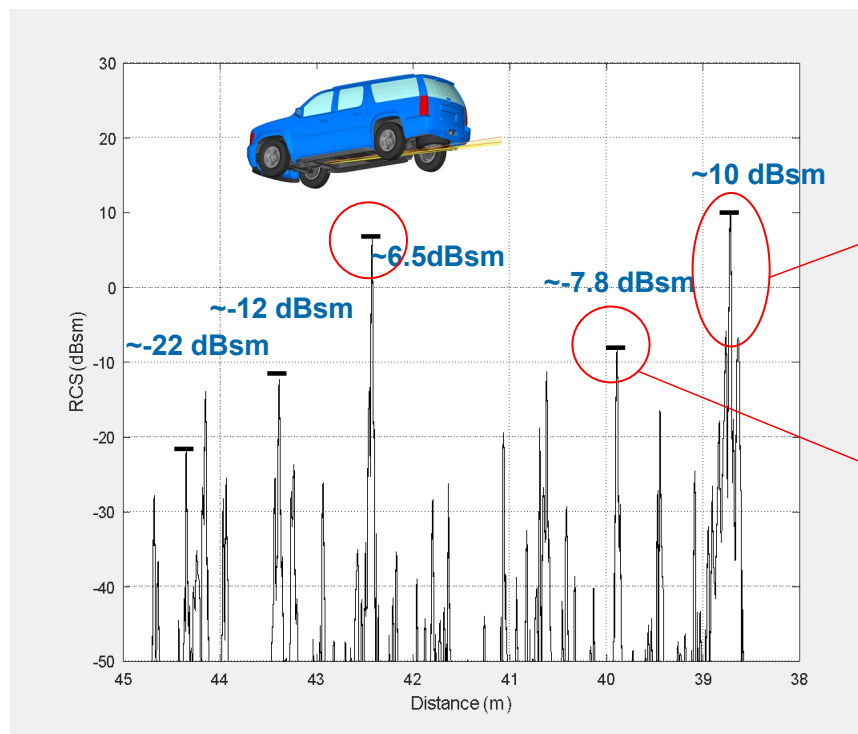
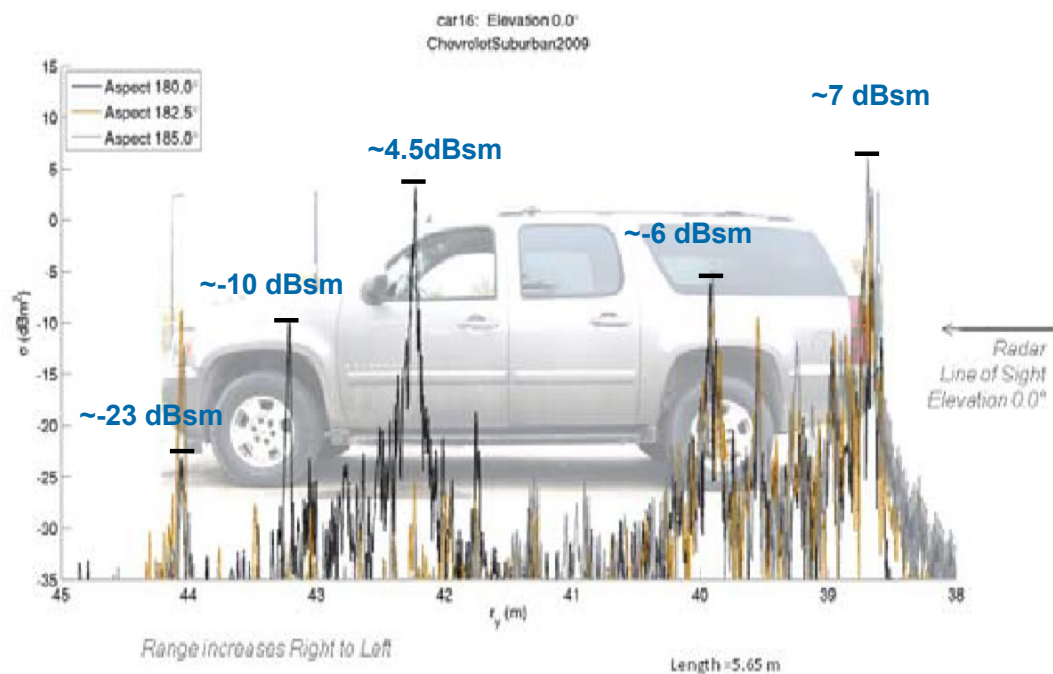


S. Mukherjee, G. Skidmore, T. Chawla, A. Bhardwaj, C. Gentile and J. Senic, "Scalable Modeling of Human Blockage at Millimeter-Wave: A Comparative Analysis of Knife-Edge Diffraction, the Uniform Theory of Diffraction, and Physical Optics Against 60 GHz Channel Measurements," in *IEEE Access*, vol. 10, pp. 133643-133654, 2022, doi: 10.1109/ACCESS.2022.3231812.

Automotive NHTSA Measurements

Compared high-range resolution (complex impulse response) RCS

- 94 GHz with 8 GHz bandwidth



1. Buller, W., et al., "Radar Measurements of NHTSA's Surrogate Vehicle SS_V," National Highway Traffic Safety Administration (NHTSA), U.S. Dept. of Transportation Report DOT HS 811 817, August 2013.

Full-Wave vs Asymptotic Methods

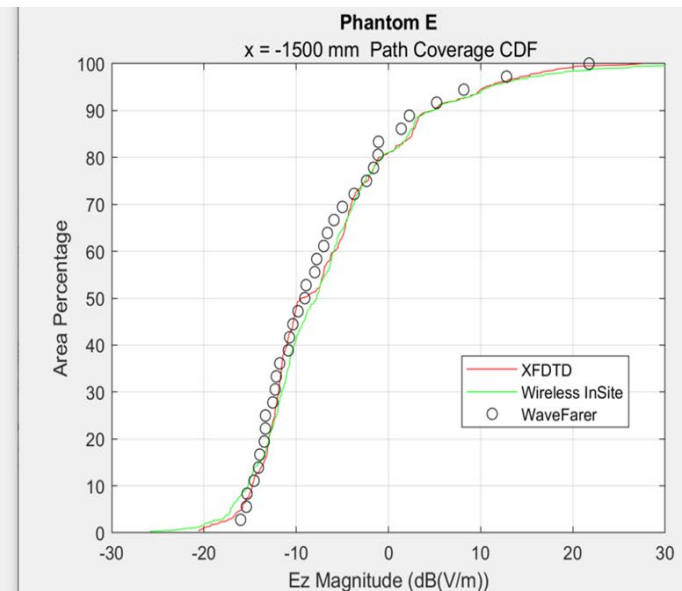
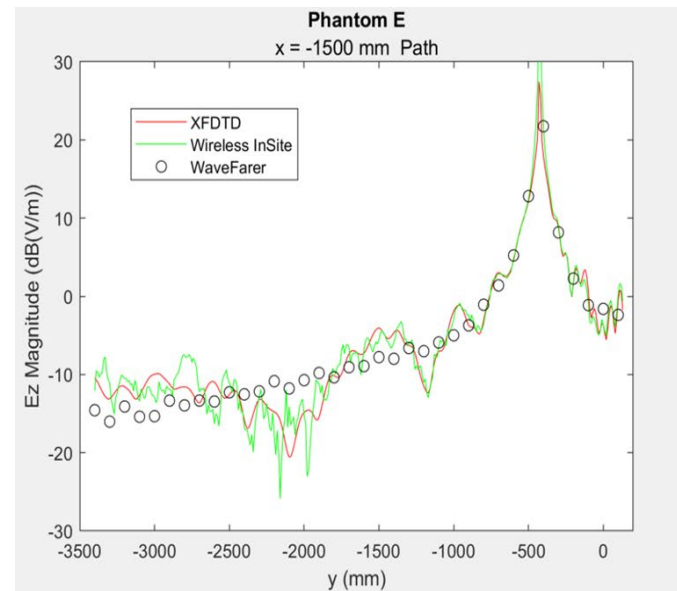
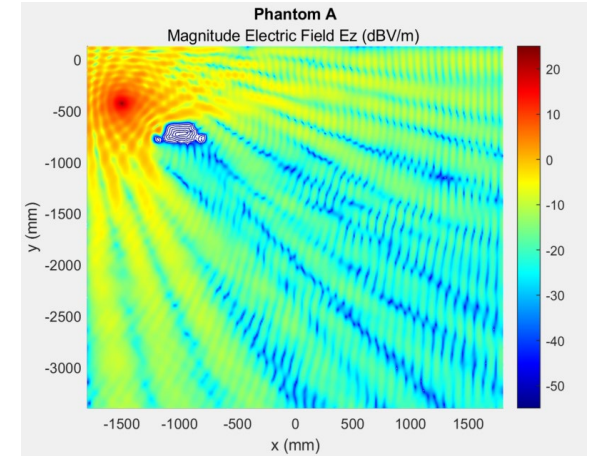
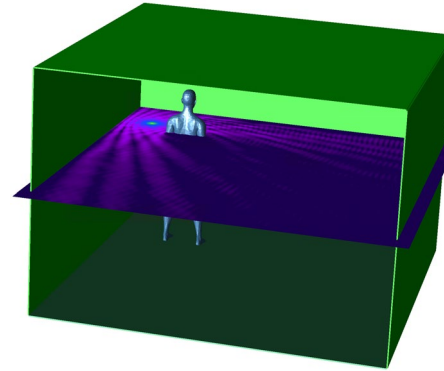
Simulated a salt-water man in a room with a vertically polarized antenna

Compared ray tracing methods full-wave

- Full-wave: FDTD (XFDTD)
- Ray-tracing: Physical Optics (WaveFarer) and the Uniform Theory of Diffraction (Wireless InSite)

Result

- Field magnitudes and CDF show excellent agreement with full-wave solution





Machine Learning Optimization

3D Antenna Design using Genetic Algorithm

3D antenna generation by JPL, Ohio State and Remcom

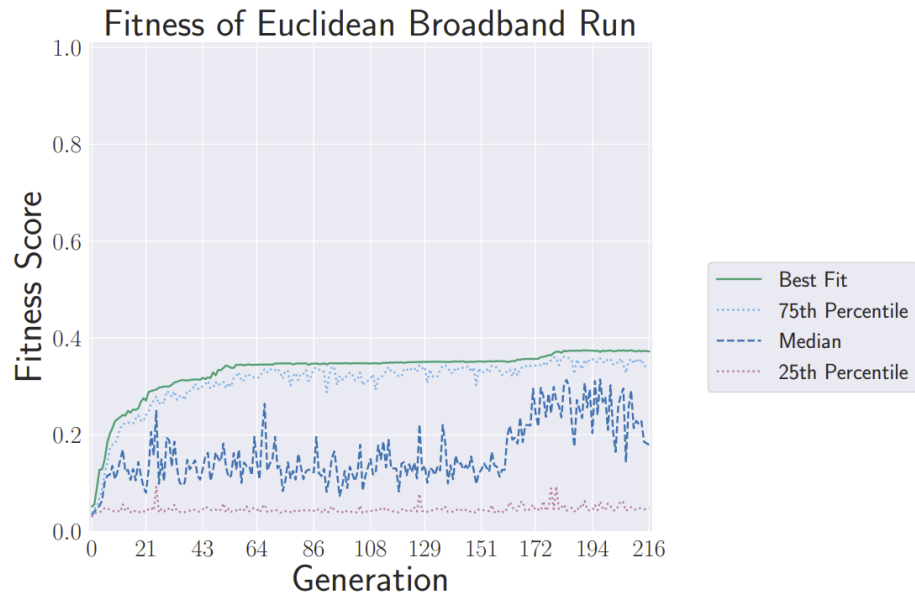


Figure 7. The fitness score of each generation evolving toward a target broadband radiation pattern using the Euclidean distance fitness function. The maximum fitness score and the three quartiles are shown.

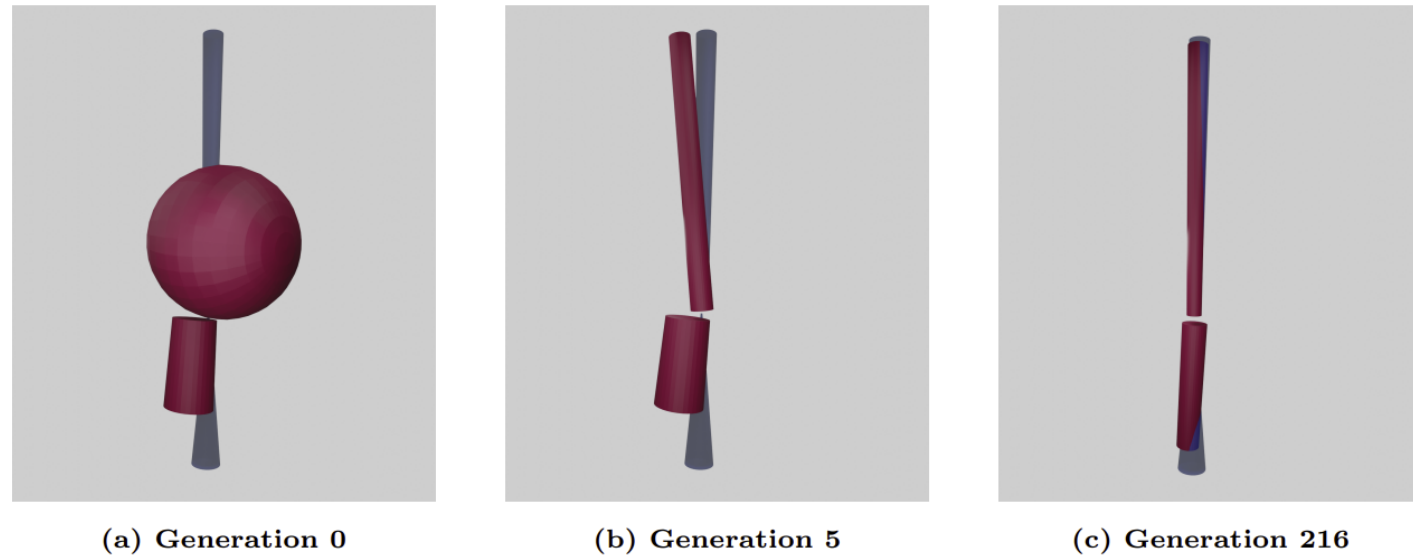
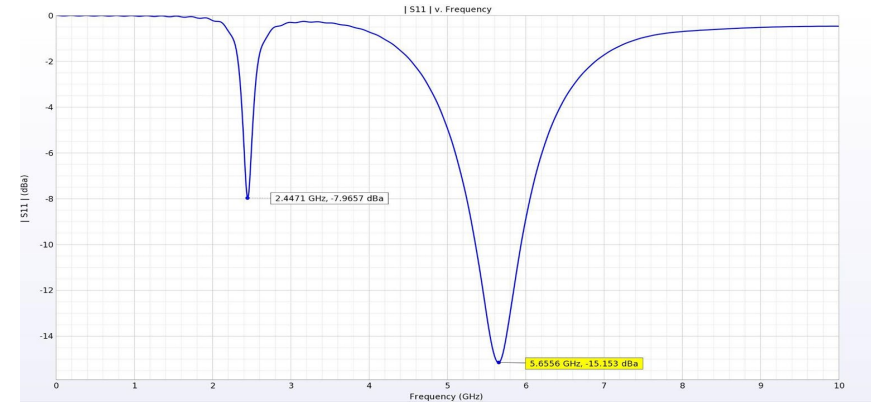
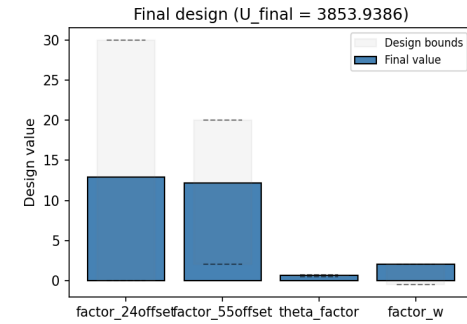
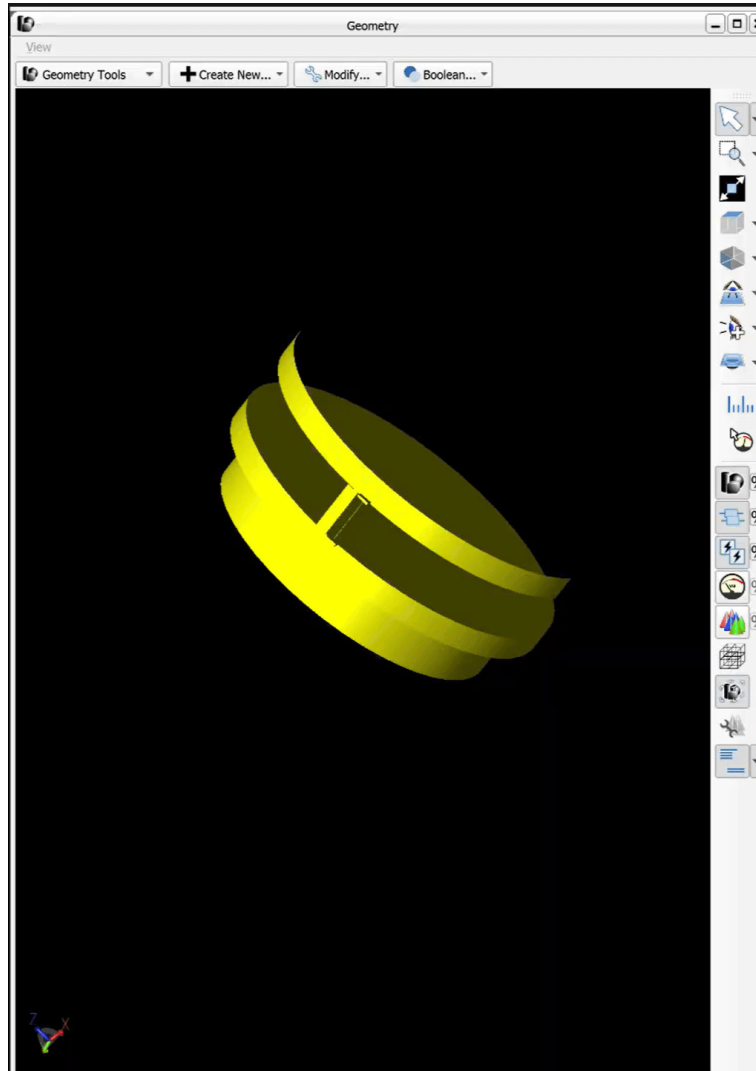
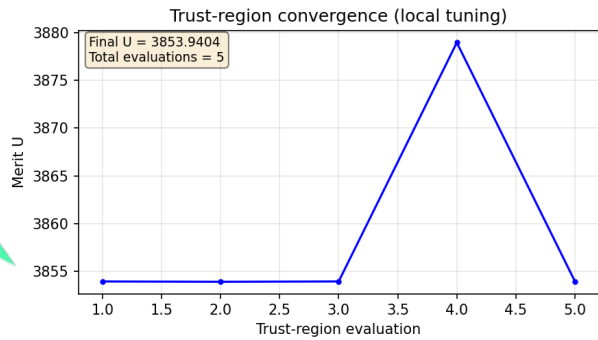
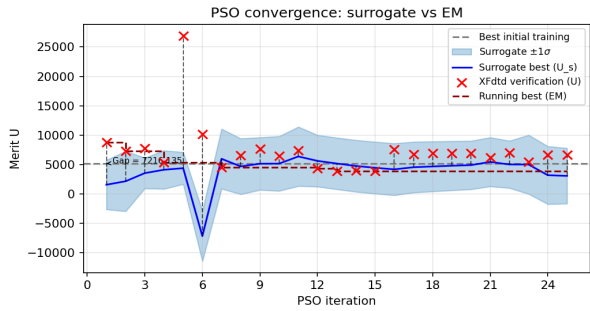
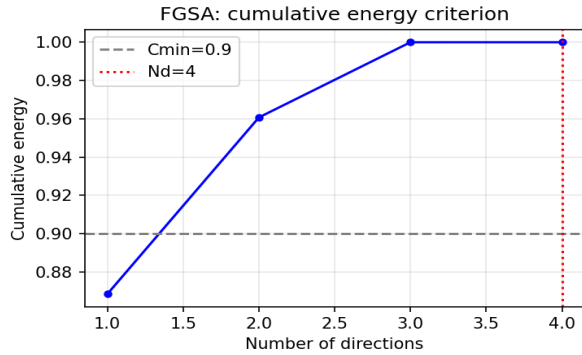
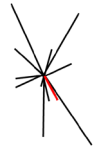


Figure 8. Three example models of the best individuals from generations 0, 5, and 216 are shown, illustrating the evolution of broadband antenna using the Euclidean distance fitness function. The antenna that produced the target gain pattern is given in blue, and the individual is shown in red.

3D Geometric ML Surrogate Optimization



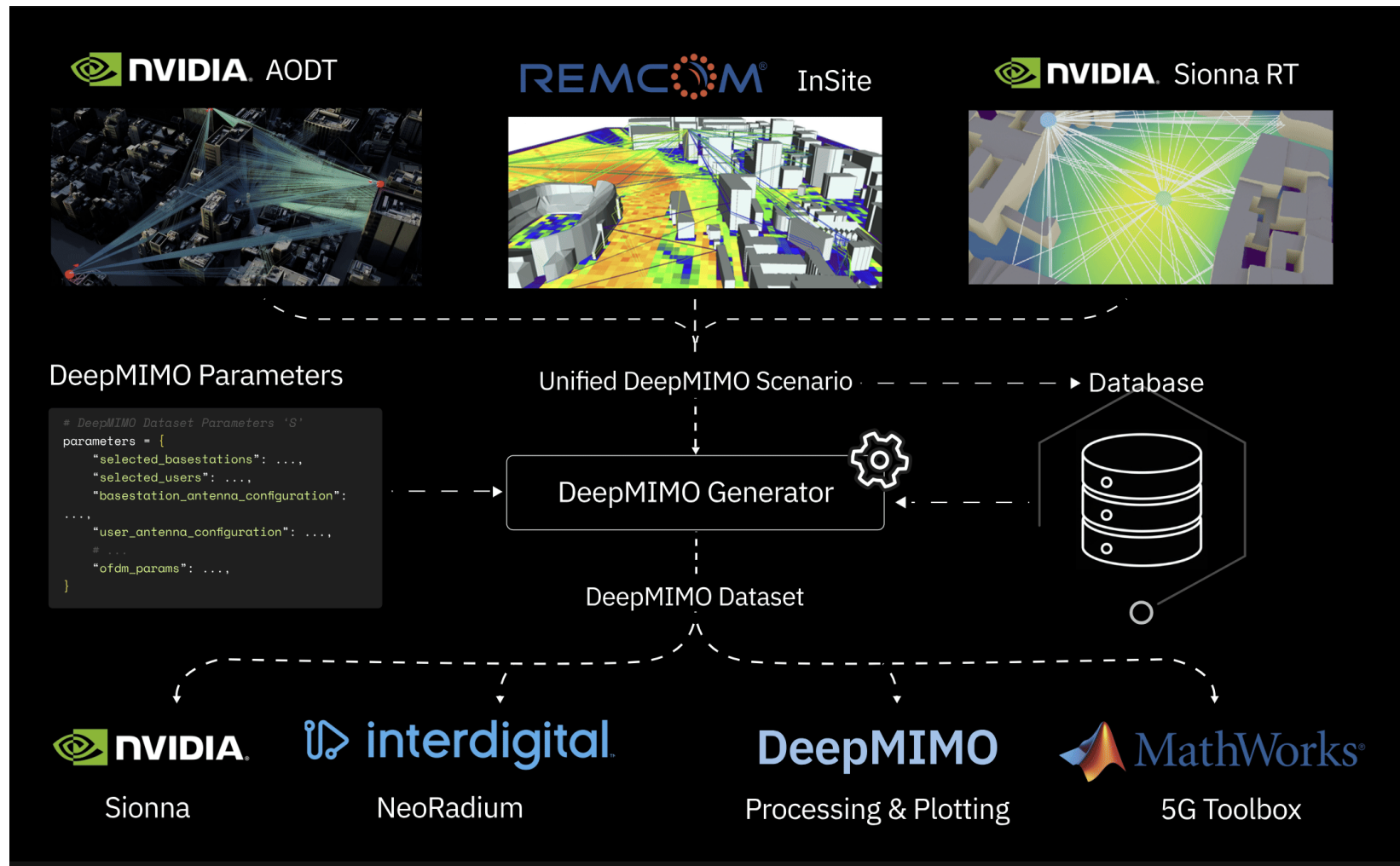
Cost: 160 sims vs 400+ PSO

AI Integrated Sensing and Comms Demo

TUM built an indoor chatbot controlled MMSF data builder. RF data pretrained using Remcom tools



DeepMIMO: The Standard for Ray-tracing Datasets in Wireless



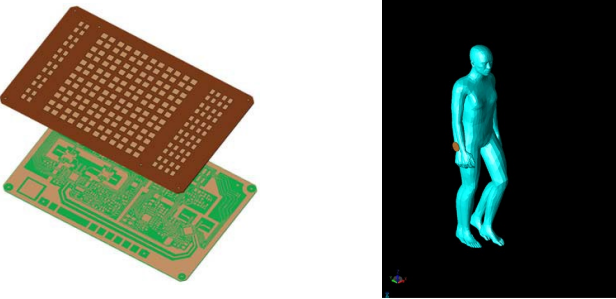


AI Agents – Remcom Fusion Studio

Remcom - Fusion API



Full Device



Radar placement in car

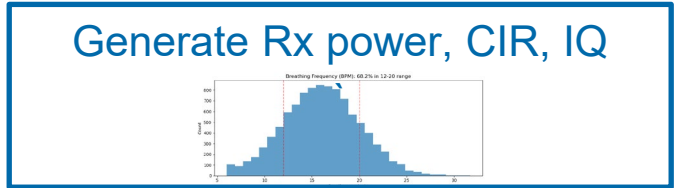
Smartwatch Walking Indoor

Anatomically accurate, reliable, reproducible movement and vital signatures

Map to Scenario, Dataset and Measurements




DeepMIMO

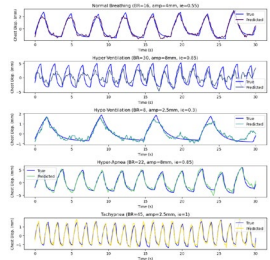


Post-Process

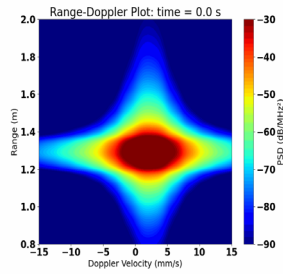
Channel Emulation



Machine Learning



Range Doppler



Remcom Fusion Studio - Agentic Orchestration

The screenshot displays the Remcom Fusion Studio interface, version 0.7.0 alpha. The main workspace shows a workflow graph with the following components:

- Antenna Bank #3**: Contains an **Antenna Bank Manager** node with an **Open Antenna Bank** button and a status of **2 antennas - All converted**.
- Blender #1**: Contains a **SittingHuman.blend** file and an **Extract Animation** button.
- simpleScene.wf**: A workflow node with a play button and a refresh icon.
- Simulation Request #6**: A central node with a dropdown menu for **WaveFarer - node_Wave1**, a **Run Simulation** button, and a **Launch Queue Manager** button.

The **Antenna Pattern Viewer** window is open on the right, showing the following details:

- Antenna Pattern**: **Antenna: Dipole.uan**, **Antenna 1 of 2**, with **Previous** and **Next** navigation buttons.
- Rotation**: **Rotation X: -76.460**, **Rotation Y: 141.538**. Includes **Auto rotate (X)** and **Show axes** checkboxes, and a **Reset View** button.
- Pattern Settings**: **Resolution: 90**, **Gain Scaling: 2.500**.
- Pattern statistics**: **Max gain: 0.00 dB**.

The 3D view shows a color-coded antenna radiation pattern, with a blue line indicating the current rotation axis.

Remcom Fusion Studio – Claude mode

```
Claude Code v2.1.76
Sonnet 4.6 · Claude Pro
E:\RFS-dev\claudeAndFusion

*Voice mode is now available · /voice to enable

> /plan I want to start testing this idea to use claude code with fusion or remcom fusion studio. I want to demo this,
but first I need to make sure it works and you can help me with that. at the end of this testing, I want a couple
prompts I know will work in this project with claude code. I want to export @forClaude\patch-multifreq.xf a gain pattern
and put it into both @"forClaude/wi/House 2/" and @"forClaude/wi/House 1\"
  L Enabled plan mode

• Explore(Explore XF and WI projects)
  L Done (13 tool uses · 57.1k tokens · 46s)
  (ctrl+o to expand)

• 2 Explore agents finished (ctrl+o to expand)
  L Explore XF project simulations and macros · 16 tool uses · 42.3k tokens
    L Done
  L Explore WI project antenna structure · 18 tool uses · 37.3k tokens
    L Done

• Now let me read the key template file and check simulation frequencies before designing the plan.

• Searched for 1 pattern, read 1 file (ctrl+o to expand)

• I need to check which simulations have far-zone sensor outputs (the macro requires them).

• Searched for 4 patterns, read 1 file (ctrl+o to expand)

• Now I have everything I need to write the plan. Let me create it.

• Updated plan
  L /plan to preview

• User approved Claude's plan
  L Plan saved to: C:\Users\benjamin.hardy\.claude\plans\fluffy-crafting-giraffe.md · /plan to edit
  Plan: XFtd Gain Pattern Export → Wireless InSite Import (Demo Workflow)

Context

The goal is to validate a Claude Code demo workflow end-to-end:
1. Export a gain pattern (.uan) from forClaude/patch-multifreq.xf
```



Contact Us

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1-888-7REMCOM (Toll-free in U.S.
and Canada)

Website:

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support.remcom.com

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x.com/RemcomSoftware