

RF-Native Research via AERPAAW

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Goal: Leverage Wireless Signals to Understand the 3D Radio Environment

Our research direction uses RF for communication and sensing

- Create ML architecture that learns how physical obstacles affects a signal without explicit knowledge of environment
 - Useful to reconstruct wireless channel, perform localization, and sense physical objects
- Reliant on RF measurements distributed over time, space, or frequency
- Research angle 1: Difficult to capture and process a site's physical environment at scale (maps, LiDAR)
- Research angle 2: Physical environment can change, map/geometric data can become stale

RF-native models have potential to fit in time and compute profile to benefit AI-native wireless system workflows

PropSplat Paper:



W. Bjorndahl, M. P. Singh, F. Nouri and J. Camp,
"PropSplat: Map-Free RF Field Reconstruction via 3D Gaussian Propagation Splatting,"
2026 IEEE International Symposium on Spectrum Innovation (DySPAN),
Washington, DC, USA, 2026, pp. 217-224, doi: 10.1109/DySPAN69846.2026.11571104.

Utilizing AERPAW to Conduct RF-Native Wireless Research

Value of open measurement sets and artifacts for research

- Research community has been emphasizing reproducibility
- Openly available datasets are foundation of repeatable research and iteration of ideas
- Especially useful since it can be costly or difficult to run drone/radio experimentation → reduces barrier to entry

Advantage of digital twin informed experimentation prior to test in real world

- Digital twin allows testing drone flight and wireless measurement collection prior to deploying in field
- Seamless experience transitioning from digital twin to running on real-world drone and radio hardware

- End user system



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Use Case: Comparing NVIDIA Sionna Ray Trace to our RF-Native Model

Used AERPAW Dataset 21 to compare Sionna ray trace and real-world RF-native model

- NSF I-Corps most frequent request across 100+ interviews → comparison of RF-native models versus Sionna Ray Trace
- Prior to Dataset 21, gap in measurements that had real-world wireless data & corresponding 3D model for ray-trace

Sionna vs our radio native architecture, PropSplat

Sionna 3D model and terrain environment

PropSplat 3D Gaussian model & RF prediction

Dataset 21: <https://aerpaw.org/dataset/dataset-21-uav-ray-tracing-simulations-with-5-towers-at-lake-wheeler/>

Antenna Radiation Pattern Modeling

Characterizing antenna radiation requires dense measurements

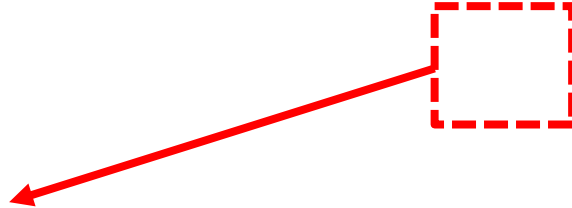
- AERPAAW Dataset 7 contains 3D antenna patterns in an anechoic chamber for various antennas
- SPARK (presented at IEEE INFOCOM 2026) proposed way to store and compress model of hardware behavior
- SPARK model can be used in hardware loops, digital twins, simulation platforms



Current and Future Work using AERPAW

Integrate PropSplat to be propagation engine in AERPAW digital twin

- AERPAW currently uses a two-ray ground-reflection model by default
- One outcome of NSF I-Corps → integrate research as propagation engine



Thank you

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