National Aeronautics and Space Administration

FY23 Topic Areas Research and Technology Development (TRTD)

Metasurface-Based Multi-Frequency Antennas for Telecommunication and Earth Science Applications

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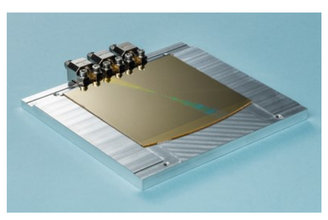
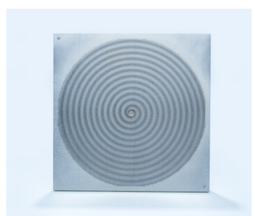
Introduction

Metasurface (MTS) antennas are low profile, light weight, remove the need for polarizer or duplexer, and can be made using additive manufacturing. This proposal aims to develop the first high efficiency dual-frequency MTS for space.

JPL MTS Antenna Portfolio

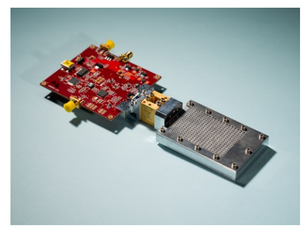


ACT-17: W-band LP MTS (TRL 4)



ACT-17: Ka-band MTS LP & CP (TRL 5) ➔ toward dual-freq

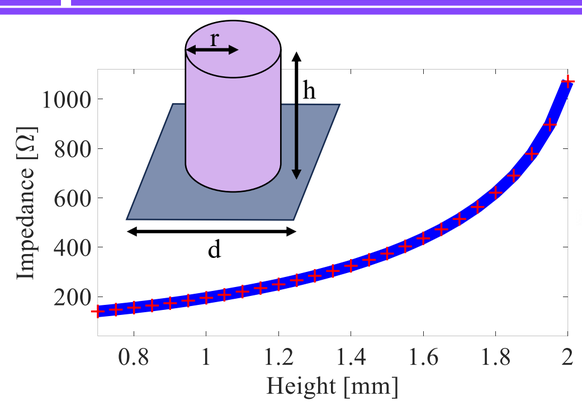
IIP-19: Ku-band MTS LP
Demonstrated on a UAV snow radar (TRL 5)

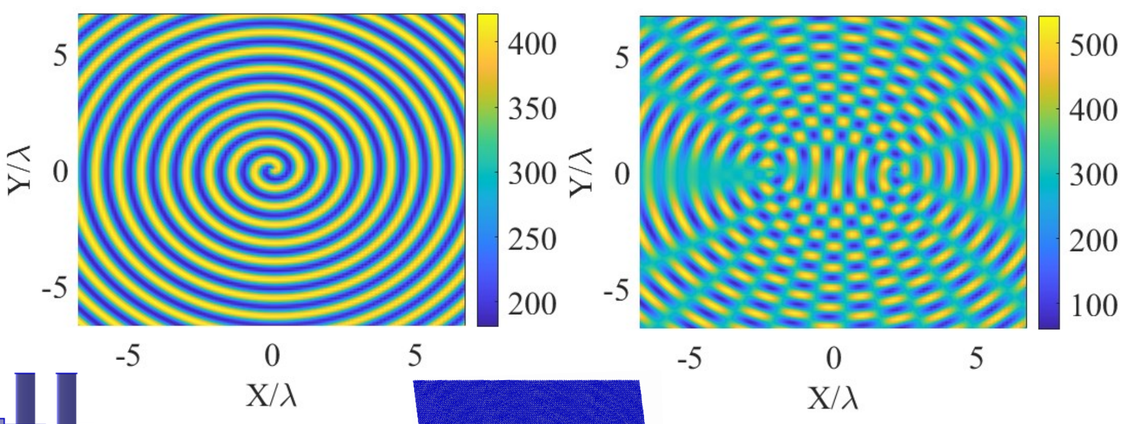


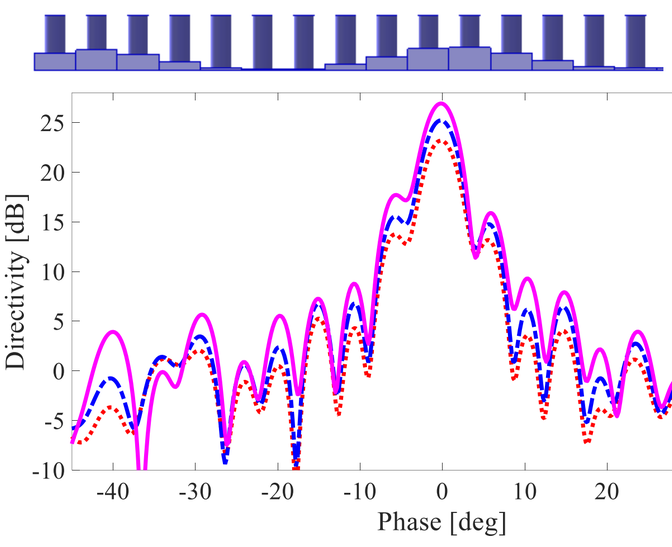
ACT-20: W-band MTS LP (TRL 4)

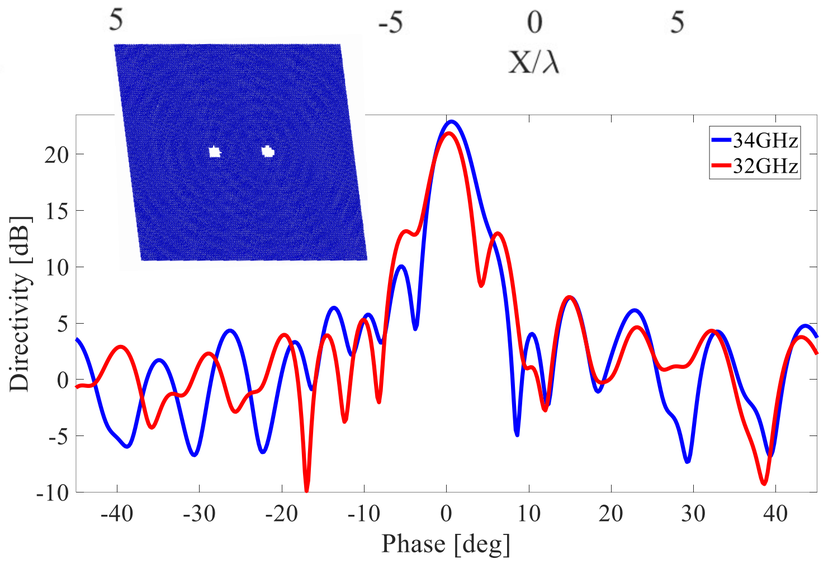
Approach

- Use metallic pins of varying heights to make impedance database
- Map the database to the isotropic theoretical surface impedance to excite a surface wave
- Vary the modulation index to improve performance
- Expand design to dual band with two frequencies by superimposing impedance profiles
- Use two excitations to illuminate the different frequencies



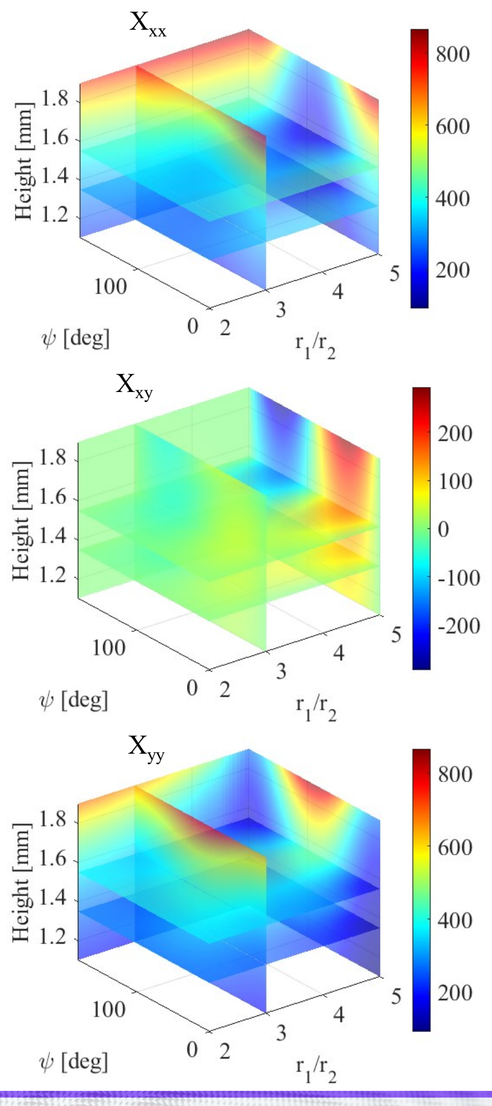


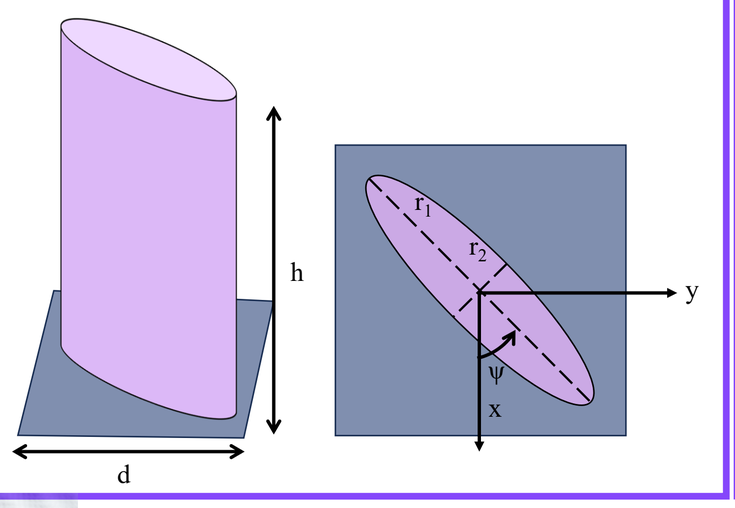




Improving Design

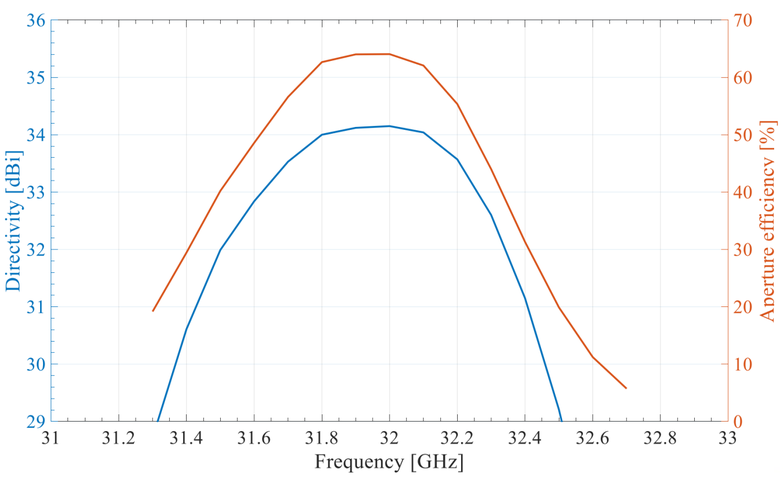
- Introduce anisotropy by using elliptical pin and varying height, ellipticity, and rotation
- Creates a tensorial 3D database
- Anisotropic surface impedance allows more control of radiation pattern

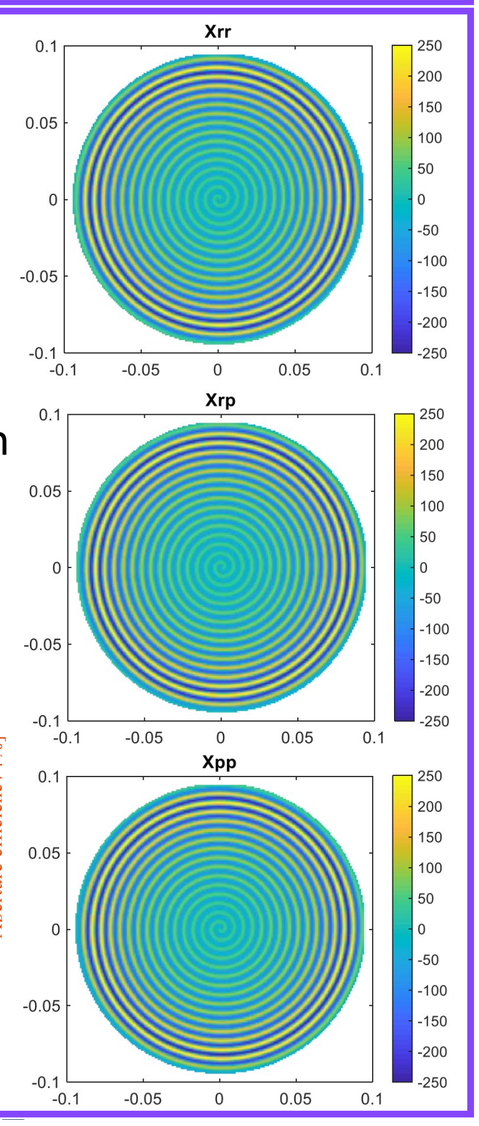




On-Going Work

- Introduce tapering to single frequency to create a high efficiency antenna
- Goal: antenna that operates at dual frequencies incorporating anisotropic impedance modulation and tapered impedance modulation





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Publications:
[A] K. Hecht, N. Chahat, G. Chattopadhyay, E. Martini, and M. J. Mencagli, “A New Strategy for Designing Dual-band Antennas Based on Double-Layer Metasurfaces,” submitted to IEEE Trans. Antennas & Propag., 2023.
[B] K. Hecht, N. Chahat, G. Chattopadhyay, E. Martini, and M. J. Mencagli, "Dual-Layered Metasurface Antennas for Dual-Band Operations", URSI EMTS, Vancouver, Canada, May 2023.
[C] Hecht et al. Patent CIT-8923-P, "Orthogonally Selected Multi-Band Metasurface Antenna for Next Generation Telecommunication and Remote Sensing Applications", filed on11/21/2022.
[D] Chahat et al., Patent CIT-8849-P, "Metal-only flat metasurface antenna for single or multiple beams", filled on July 7, 2022

Patent pending:
[1] Hecht et al. Patent CIT-8923-P, "Orthogonally Selected Multi-Band Metasurface Antenna for Next Generation Telecommunication and Remote Sensing Applications", 11/21/2022.
[2] Chahat et al., Patent CIT-8849-P, "Metal-only flat metasurface antenna for single or multiple beams", July 7, 2022

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