Broadband mid-infrared silicon metasurfaces based on data-driven inverse design for space deployment

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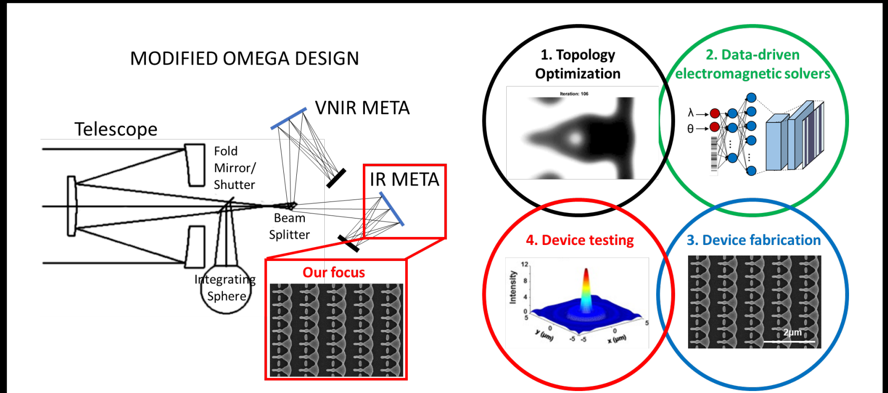
Research objectives

- We will demonstrate large area metasurfaces (~1 cm^2) that can disperse and focus mid-infrared radiation over one octave of bandwidth.
- We will innovate new inverse design tools and data-driven electromagnetic solvers to realize the ultimate limits of metasurface performance.
- Our approach will supersede the existing SOA by a wide margin.
- We will start at TRL1 and end at TRL3 with an experimental demo.



We will innovate polarization-independent, centimeter-scale metasurfaces that can efficiently diffract and focus light (λ = 8 to 16 microns), for the purposes of dramatically reducing the size and weight of space-bound spectrographs.

Approach

- We will apply topology optimization algorithms to dispersion-engineer freeform metasurfaces.
- We will create a fast surrogate electromagnetic solver.
- We will fabricate designs in state-of-the-art facilities and characterize components in custom testbed.
- We will apply modeling, design and simulation tools to understand potential and limitations of curved metasurfaces in space applications.

Potential Impact

- Design and modeling tools will provide a general pathway to high performance infrared metasurfaces.
- Metasurfaces will enable photonic components with new capabilities.
- Metasurfaces will reduce mass and number of components in mirror-based spectrometer systems by a factor of three.
- We anticipate application in space-based IR imaging systems after further TRL advancement.