

Ultra-lightweight metamaterial optics for Earth observation applications (MetaTel)

CEOI Pathfinder Project (RP10G0435A203)

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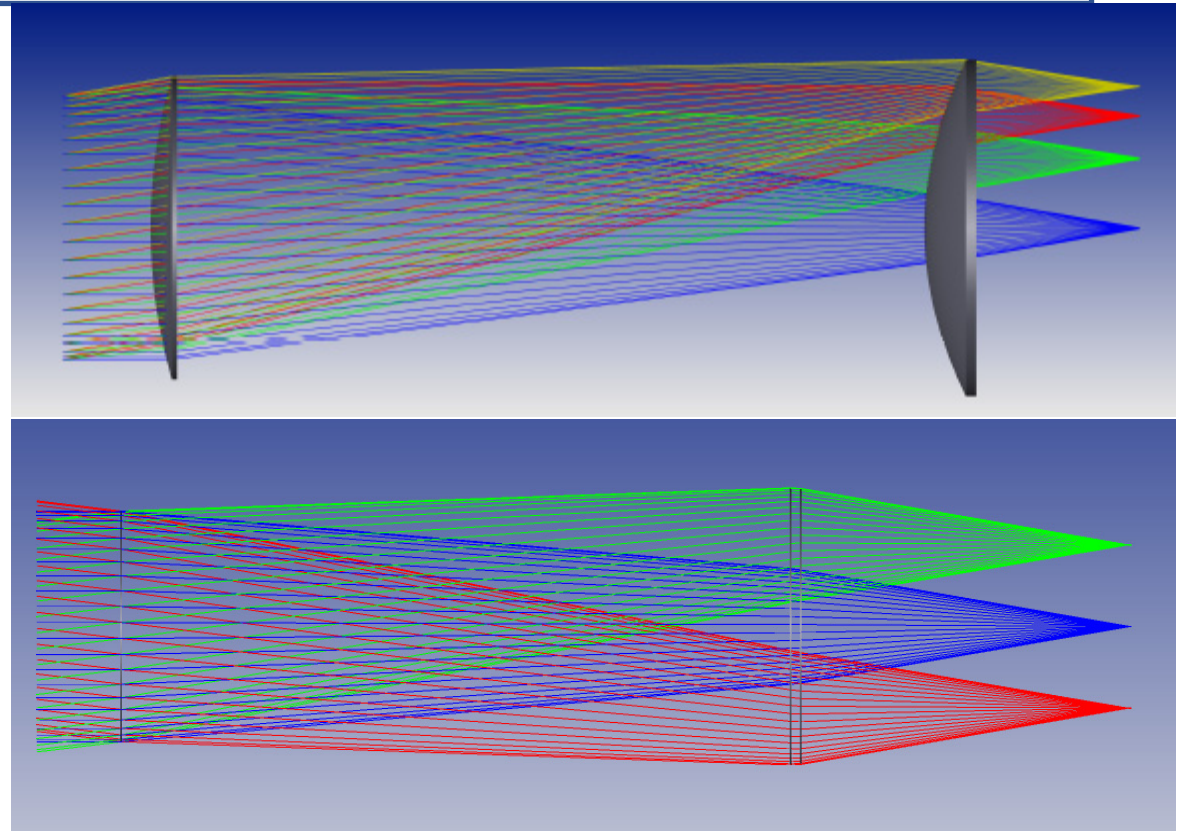


Objective

Develop metamaterial “flat lenses”, and demonstrate a wide-field metamaterial telescope

- Goals

- Optimise for 45GHz-190GHz
- 300mm clear aperture
- IFoV +/- 10°
- Telecentric f/3 focal plane
- Total optical efficiency >80%



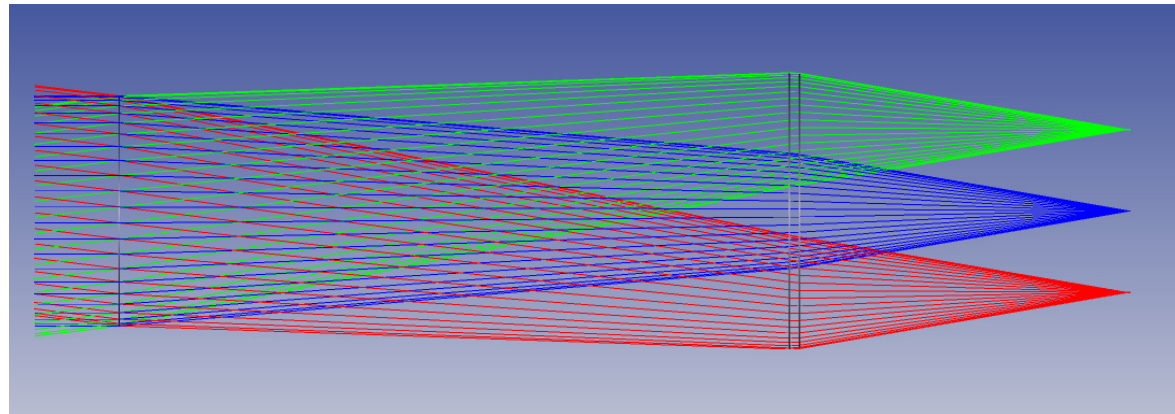
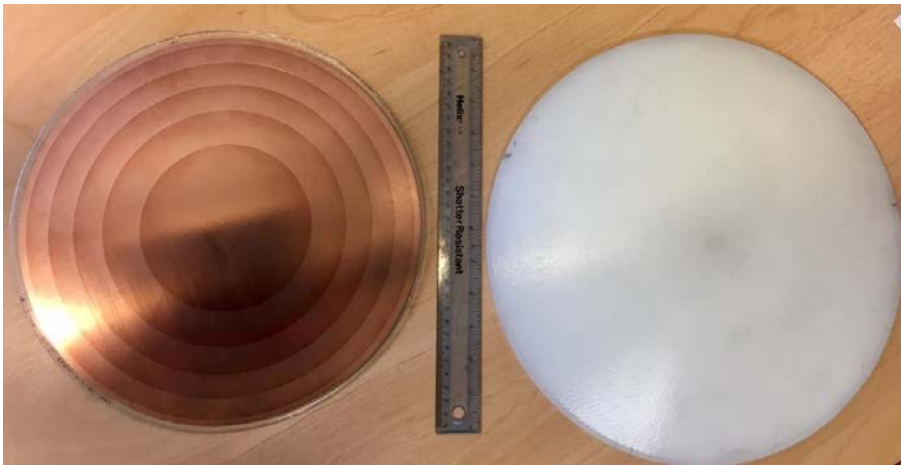
Technology: embedded metal-mesh metamaterial structures

Example:

“Traditional” lens is 40 mm thick through the centre, quite lossy, and weighs 3.5 kg. The metamaterial equivalent is flat, only ~2-3mm thick, and weighs only 100 g, with excellent thermo-mechanical stability.

Metamaterial telescope:

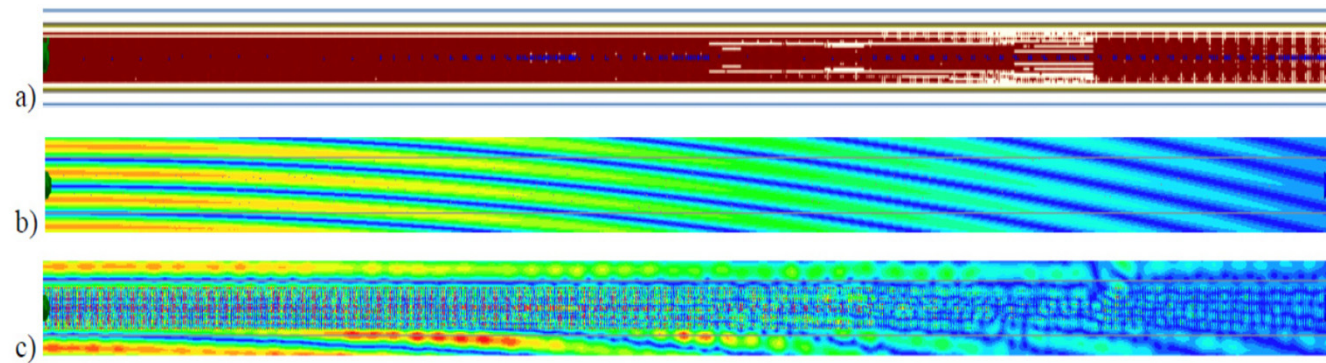
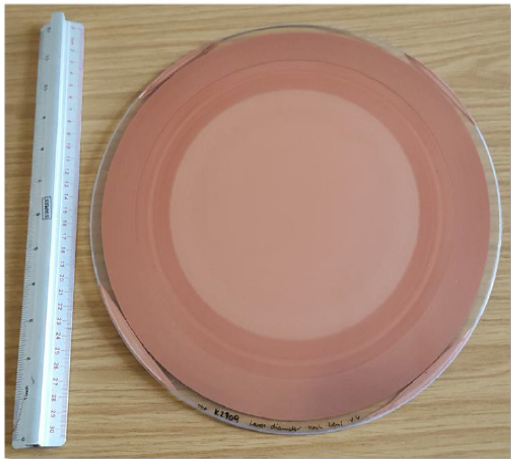
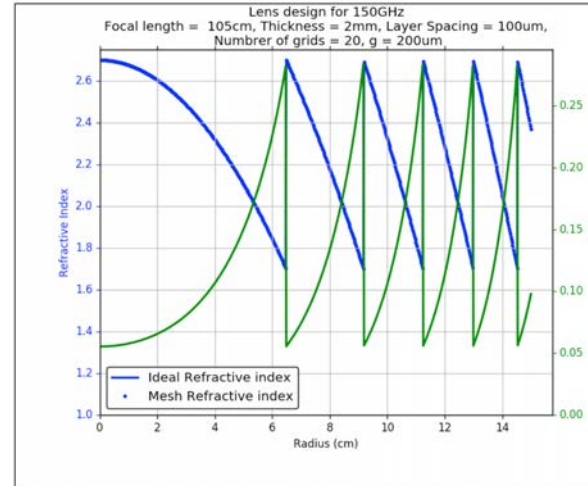
- Lightweight
- Low loss
- Axial system – excellent beam quality over large, telecentric focal plane



Technology: embedded metal-mesh metamaterial structures

Two approaches:

- Gradient index (GrIn) lens
- Phase engineered lens (phase gradient)

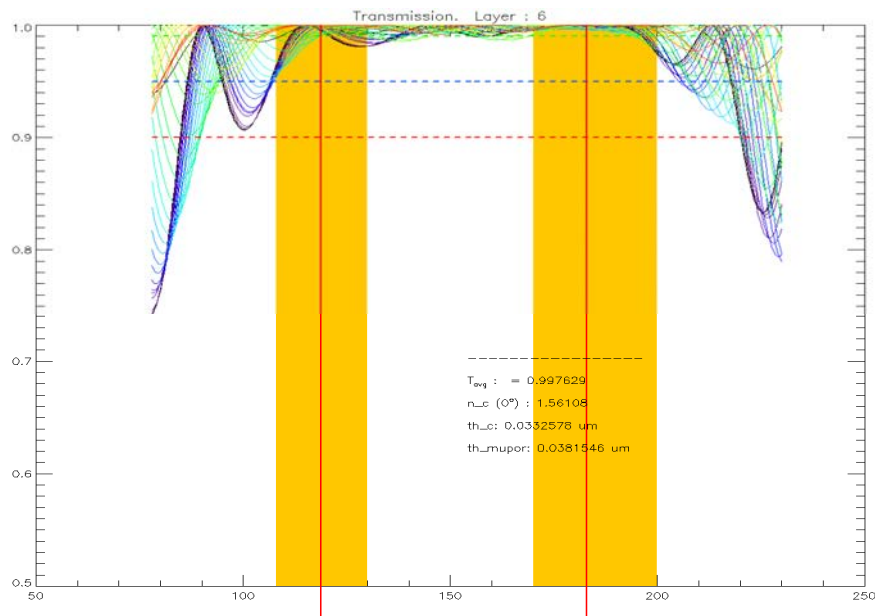


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MetaTel developments

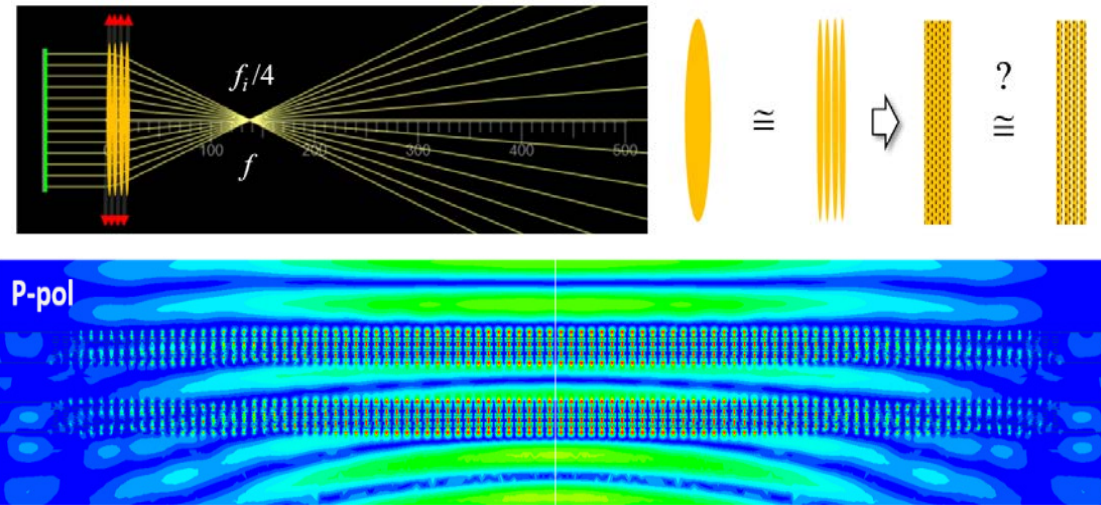
GrIn lens

- Optimised design for 200mm diameter f/8 lens with intrinsic metal-mesh graded A/R coating.
- Scalable to 400mm diameter
- >98% transmission 110-195GHz



Phase engineered lens

- Removal of large, steep frequency-dependent phase shifts
- Cascade identical thin lenses to achieve desired focal lengths
 - Drastic reduction in number of grid types
 - Avoidance of Fresnel-type discontinuities



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Current status

- Test components submitted for manufacture in March 2020...



Thank you!