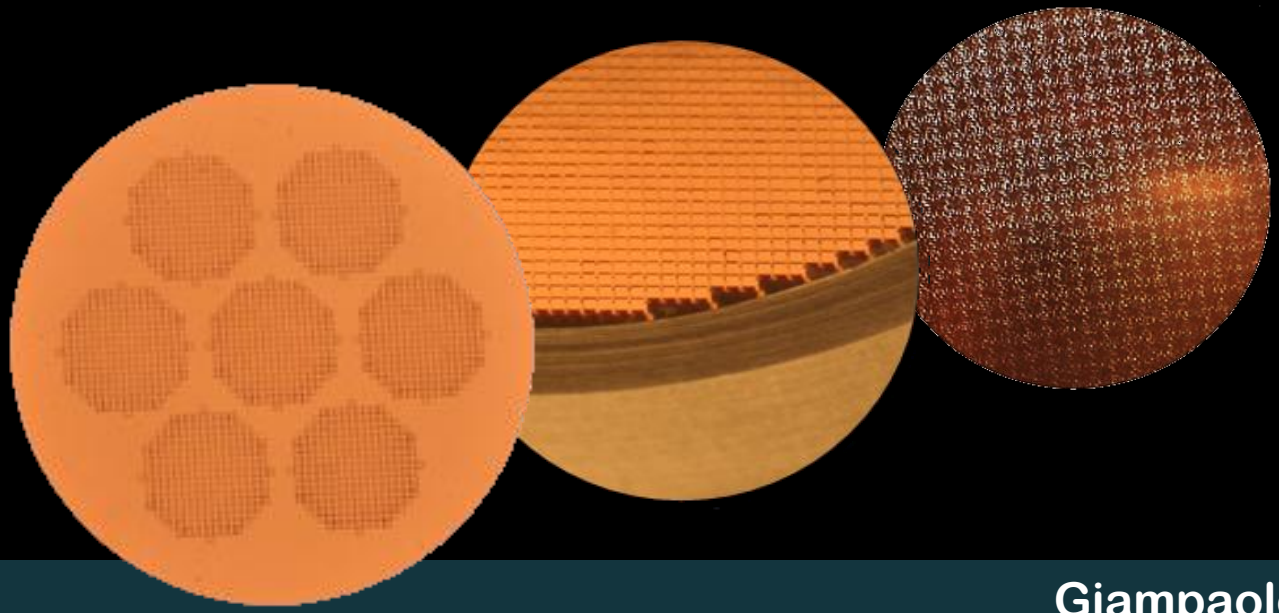
Detector coupling with mesh-lenses



Giampaolo Pisano

on behalf of

Maynooth, Manchester, Cardiff, Rome, Paris APC & Chalmers

ESA project: *"Next Generation Sub-Millimetre Wave Focal Plane Array Coupling Concepts"*

CMB workshop, CERN, May 17-20, 2016

Summary

- **Mesh Filters Technology**
- Mesh Lenses
- Mesh Lens Arrays

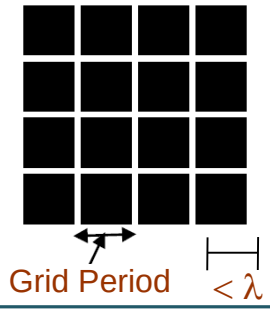
Mesh Technology: Modelling

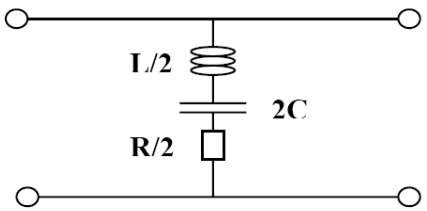
FSSs subgroup

Markuvitz (1951)
Ulrich (1967)

Capacitive Low-Pass Filter

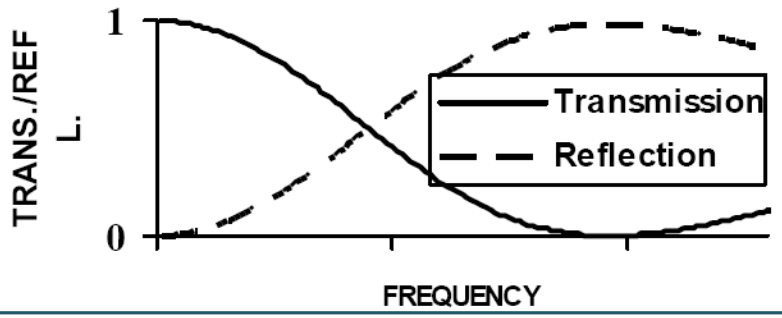
Sub-wavelength periodic structures



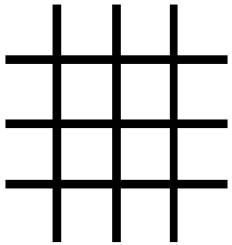


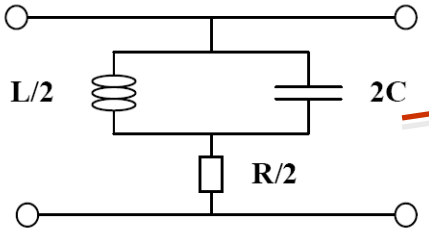
Equivalent Circuit

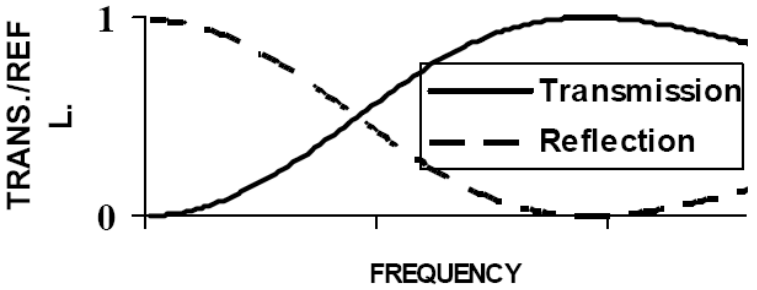
Spectral response



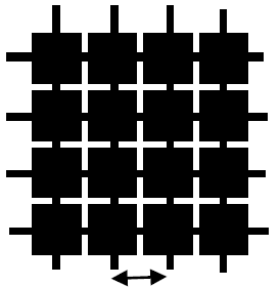
Inductive High-Pass Filter

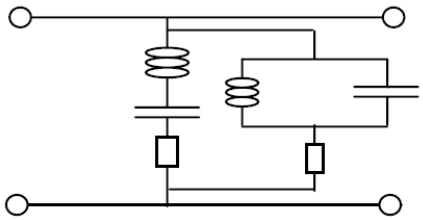


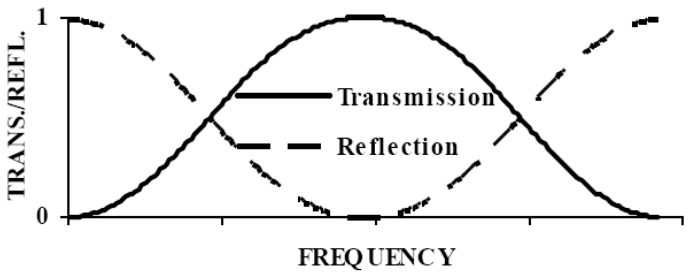




Resonant Band-Pass Filter

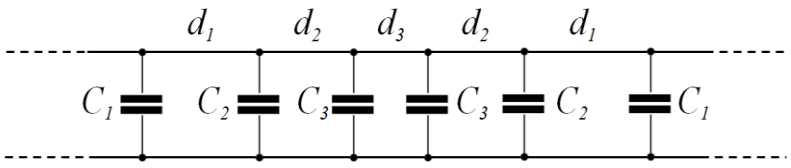


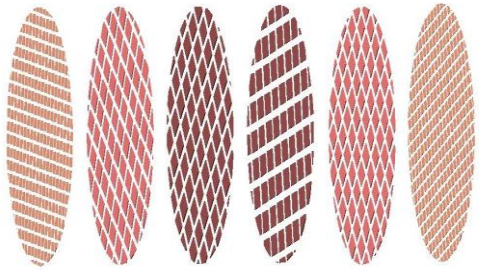


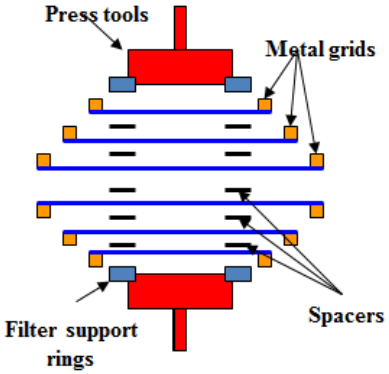


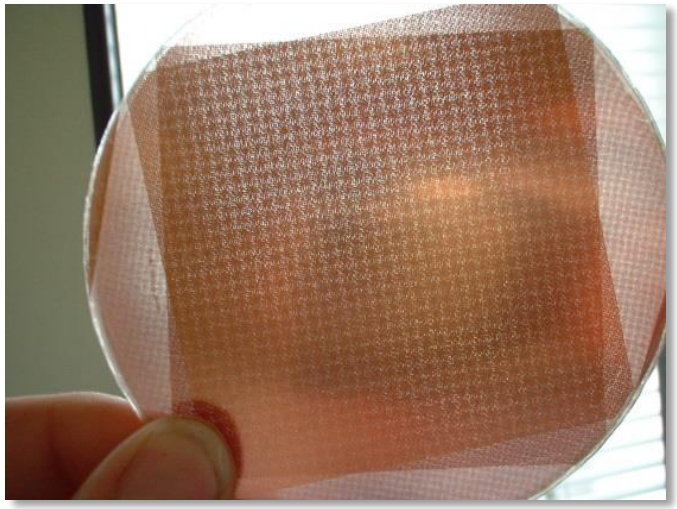
Mesh Technology: Manufacture

Free standing (air-gap) multiple-mesh devices

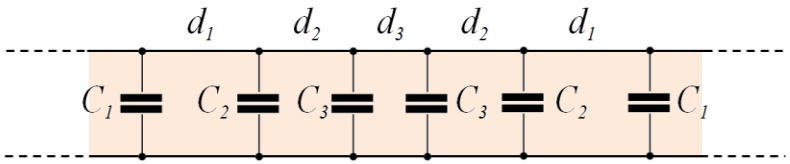


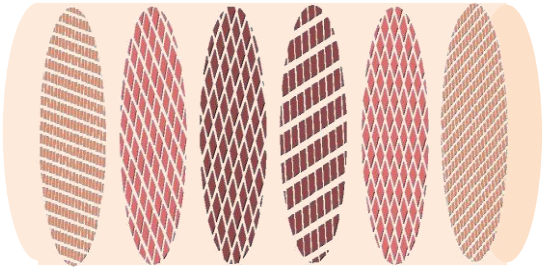


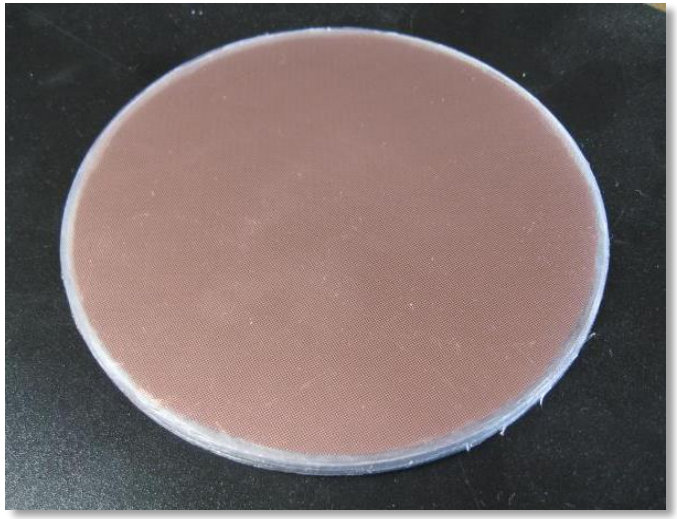




Dielectrically embedded multi-mesh devices

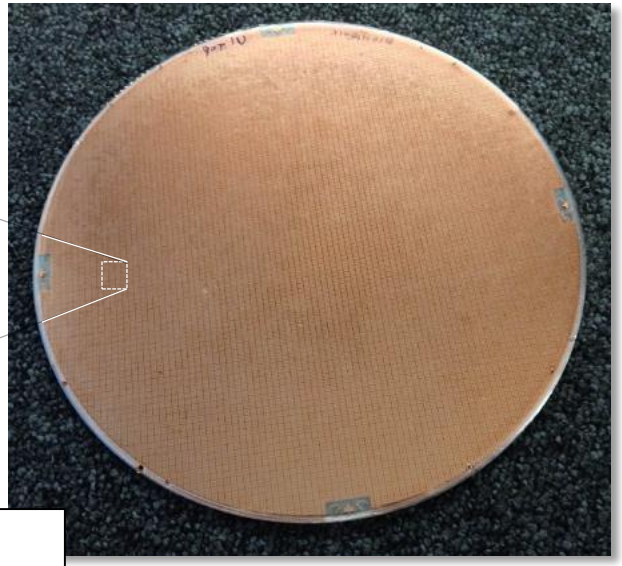


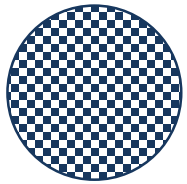




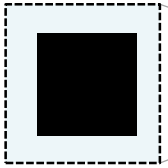
Mesh Filters: Band defining

FSSs

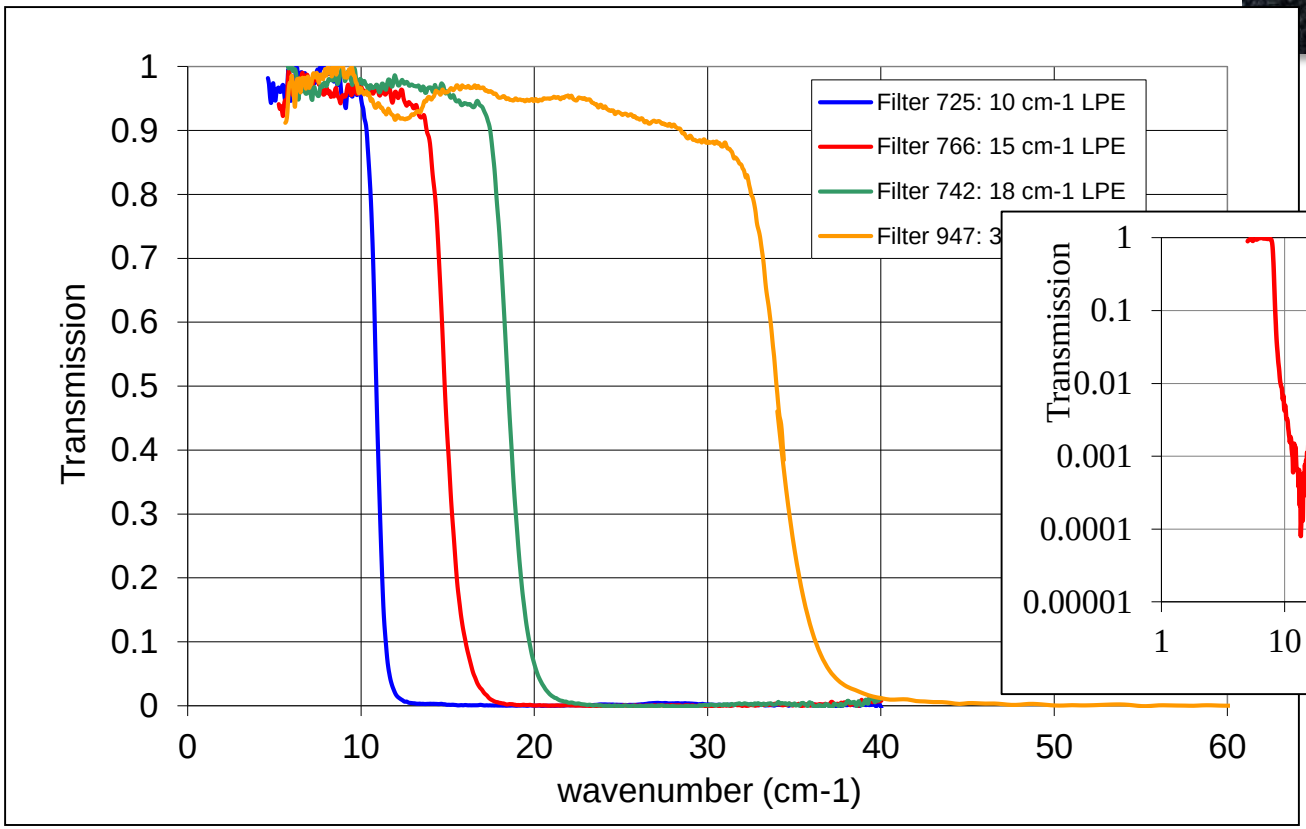


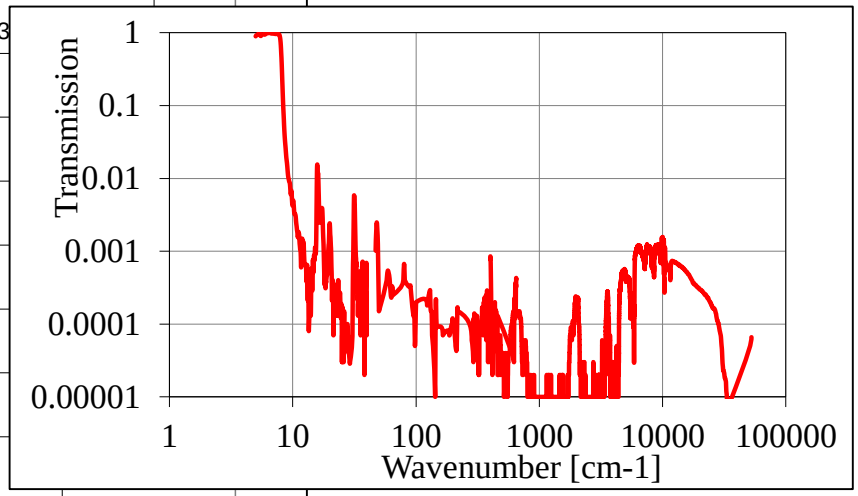


Homogeneous grids



Low Pass Capacitive Hot Pressed Mesh Filters (10 grids)





- Hot pressed high frequency rejection continues through diffraction region

Summary

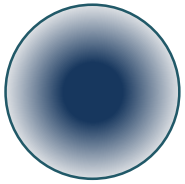
Mesh Filters Technology

Mesh Lenses

Mesh Lens Arrays

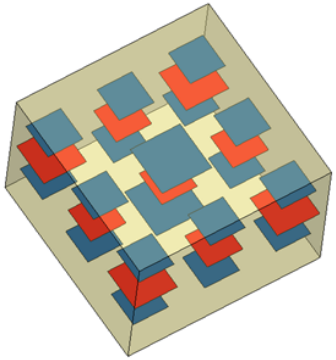
Flat Mesh Lens: Inhomogeneous Phase Delays

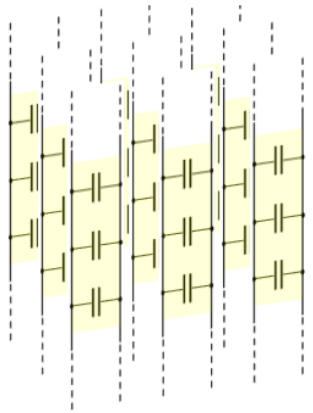
G. Pisano et al.
Applied Optics **52**,n.11, (2013)



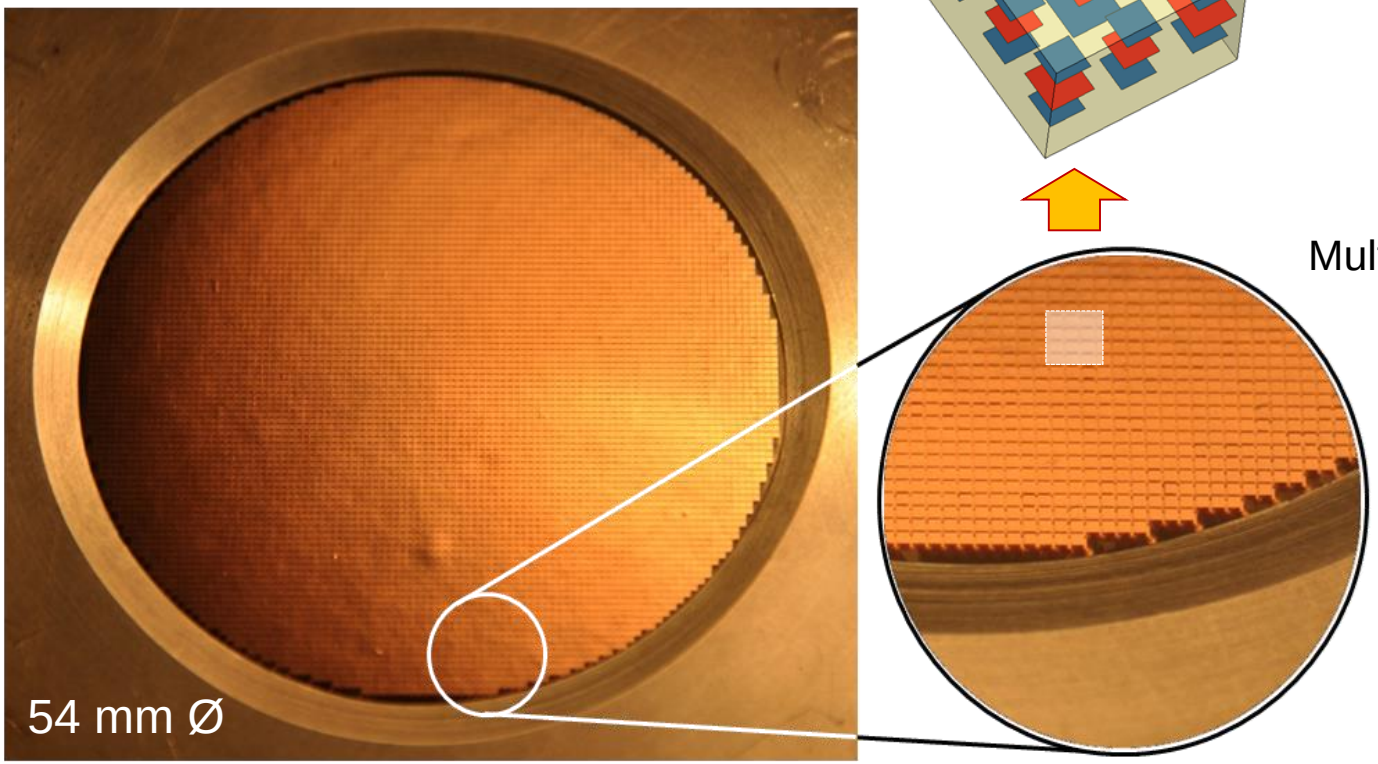
Inhomogeneous grids

Locally variable grid geometries





Multiple transmission lines

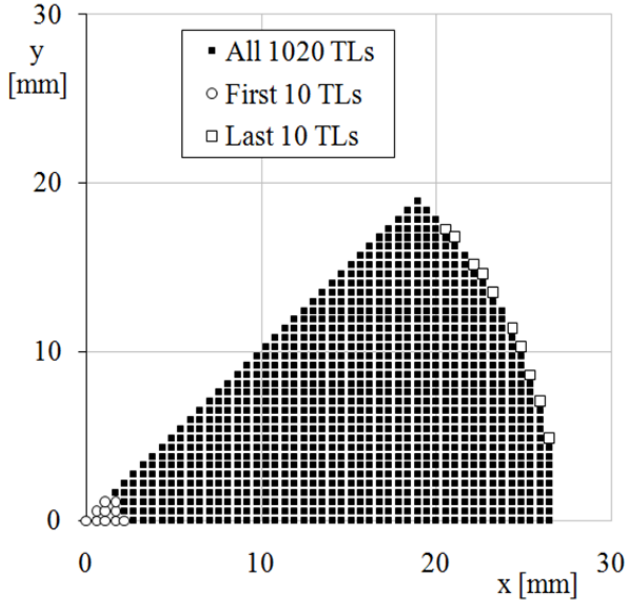


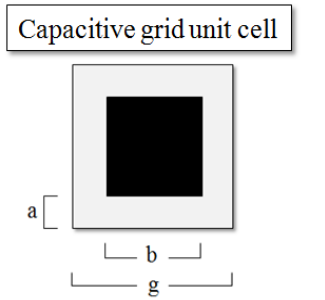
W-Band f/3 lens prototype (1.4mm thick)

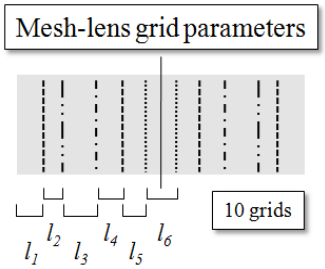
- Very thin and robust
- Very light and low loss
- No Anti Reflection Coatings required

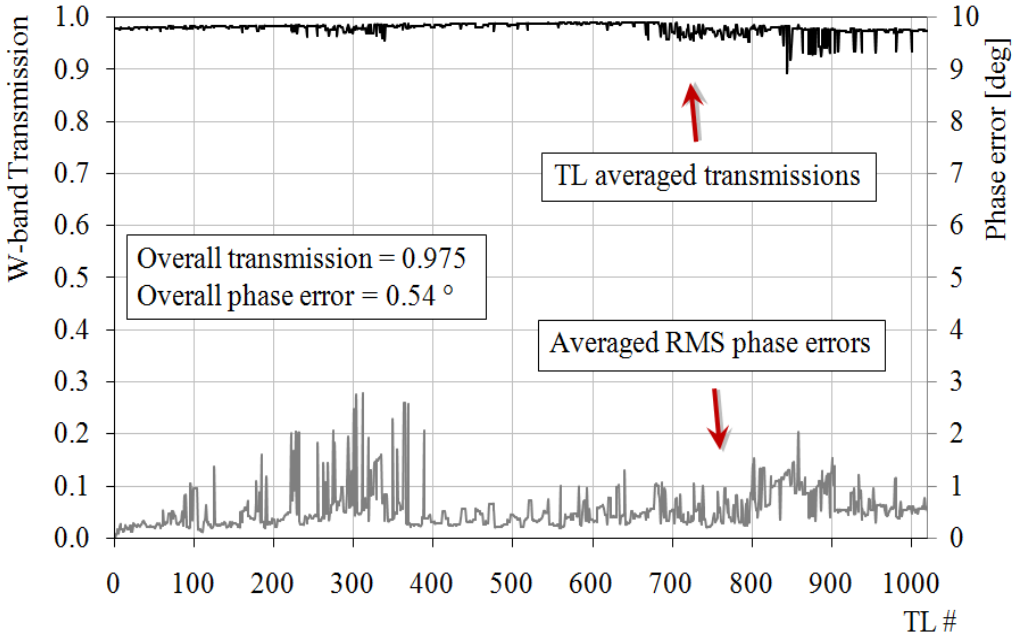
Flat Mesh Lens: Transmission line design

G. Pisano et al.
Applied Optics **52**,n.11, (2013)

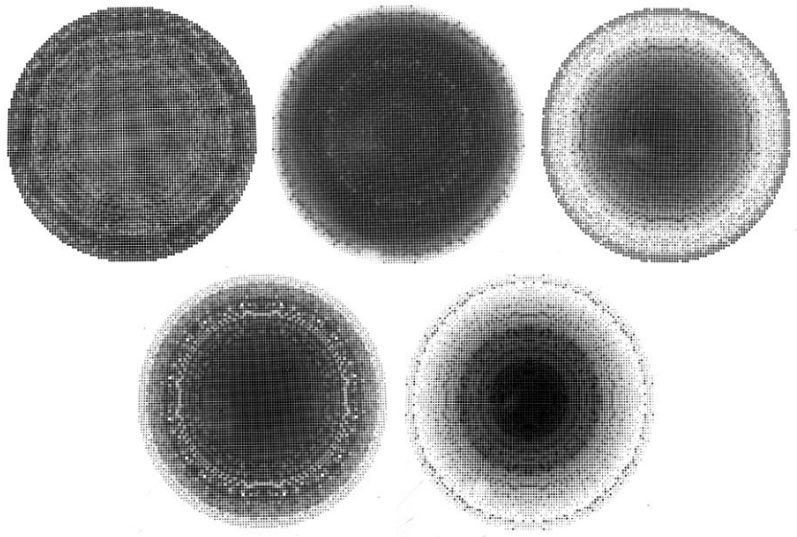








- Lens consisting of ~ 8000 TLs
- Solution of just 1/8 of the surface
- Optimisation for max transmission & appropriate differential phase shift



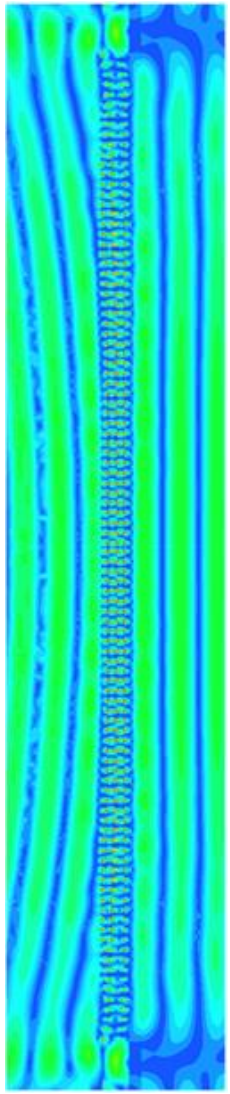
Flat lens made with 10 grids (5+5)

Flat Mesh Lens: Finite-element modelling

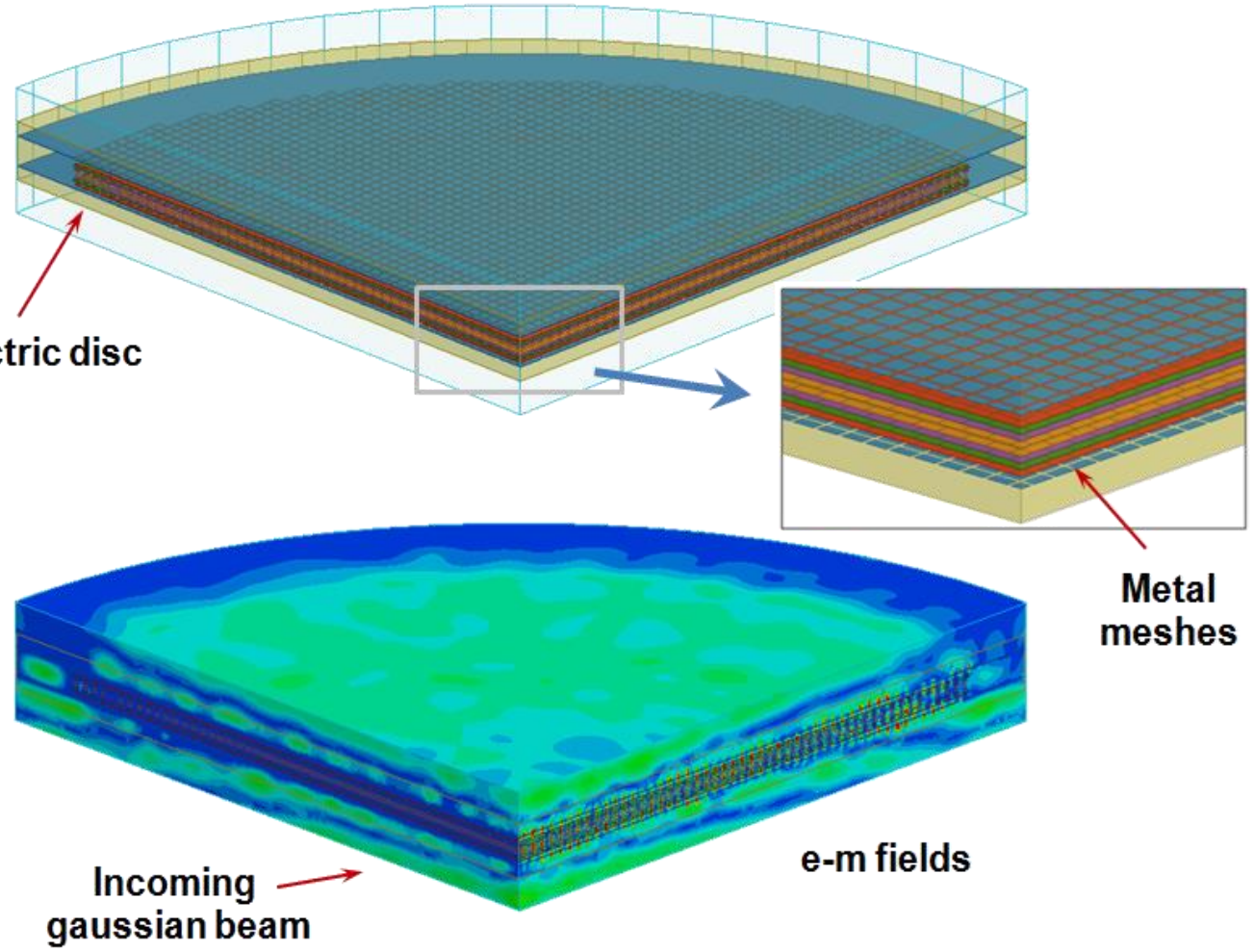
G. Pisano et al.
Applied Optics **52**,n.11, (2013)

2D model (cylindrical)

Central TL array

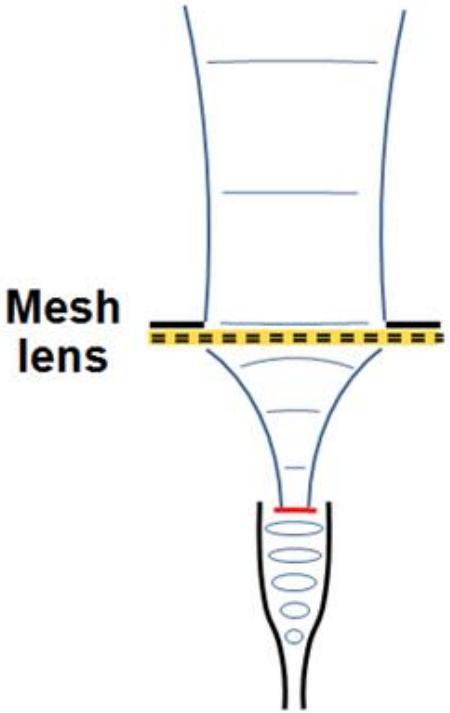


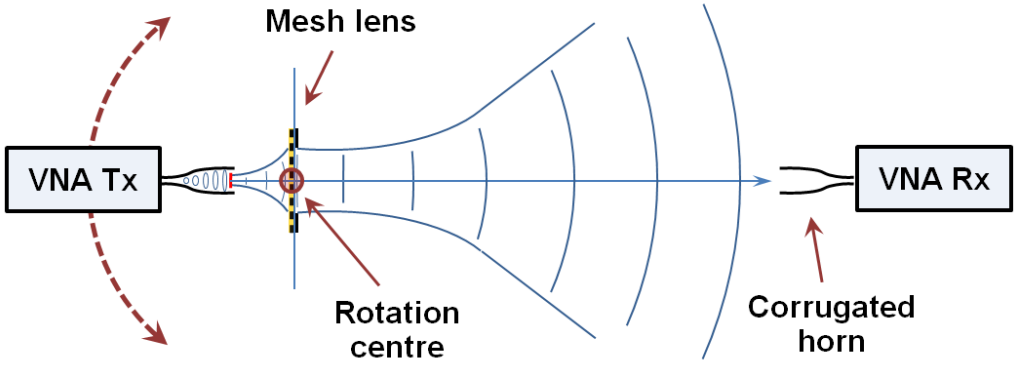
3D full model

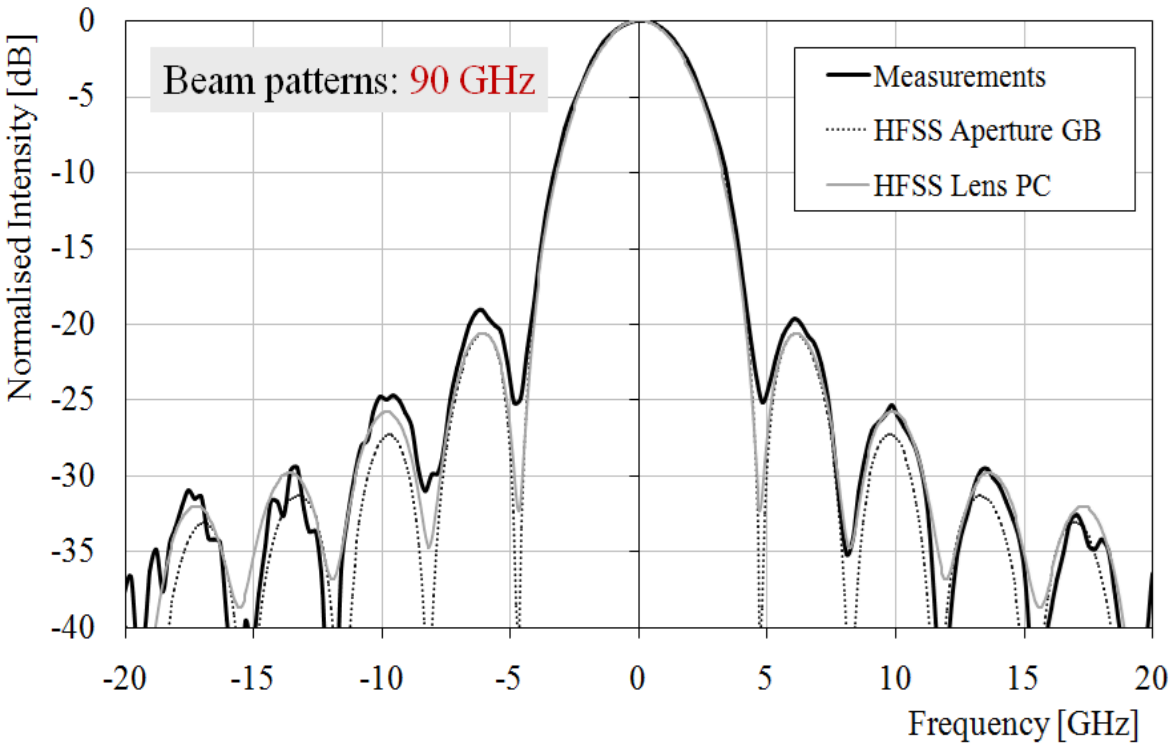


Flat Mesh Lens: VNA beam tests

G. Pisano et al.
Applied Optics **52**,n.11, (2013)







→ Experimental agreement down to the 4th side lobes

Summary

Mesh Filters Technology

Mesh Lenses

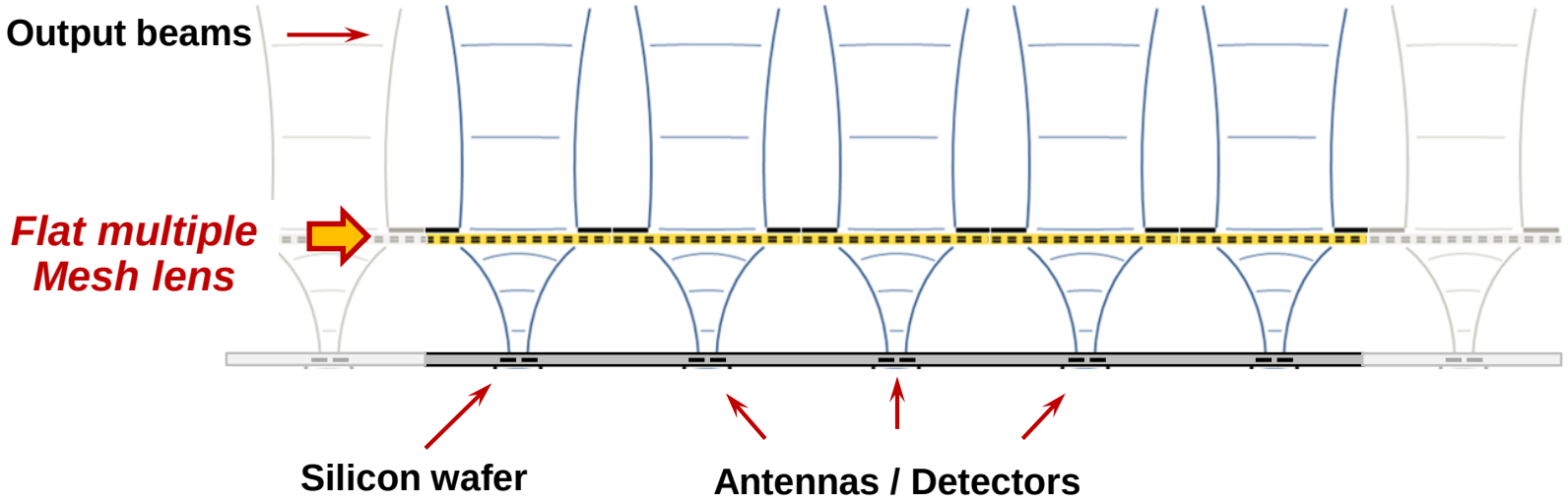
Mesh Lens Arrays

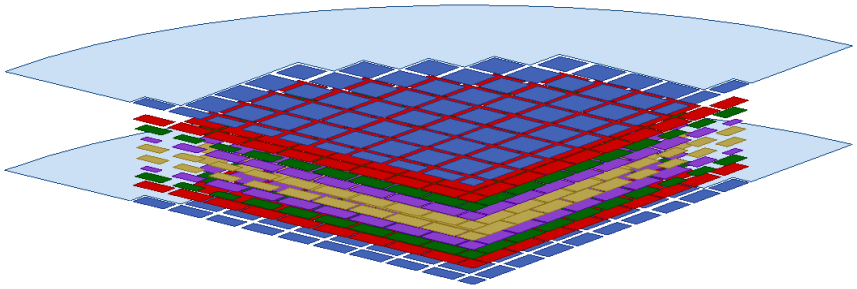
Mesh Lens Array: Concept

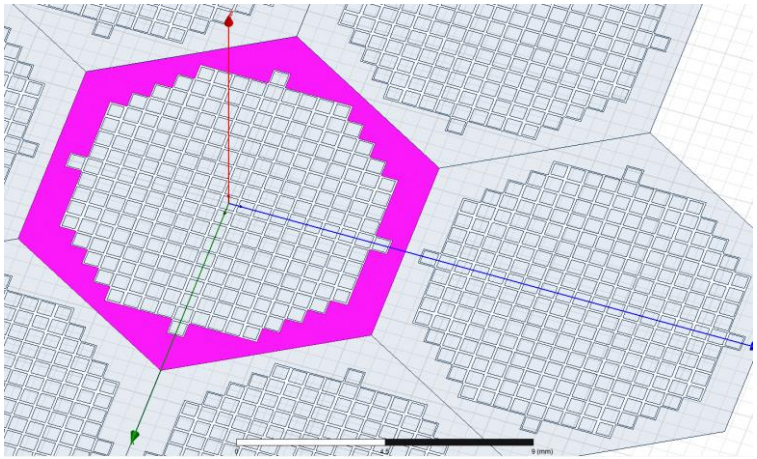
ESA project collaboration:

"Next Generation Sub-Millimetre Wave Focal Plane Array Coupling Concepts"

Maynooth (PI), Manchester, Cardiff, Rome, Paris APC & Chalmers

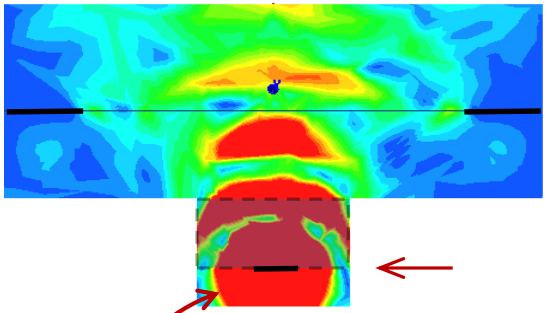




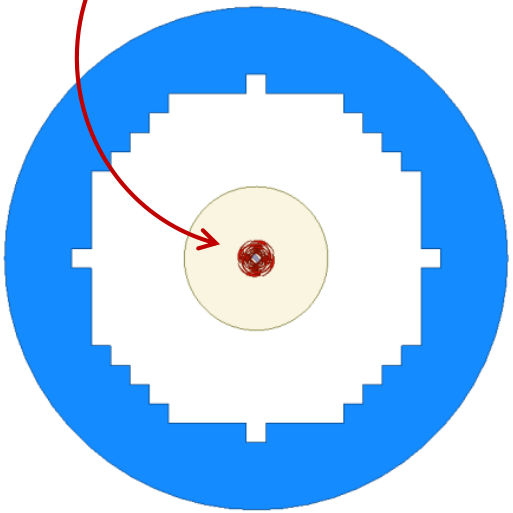


Mesh Lens Array: Coupling to a Sinuous Antenna

Aperture stop

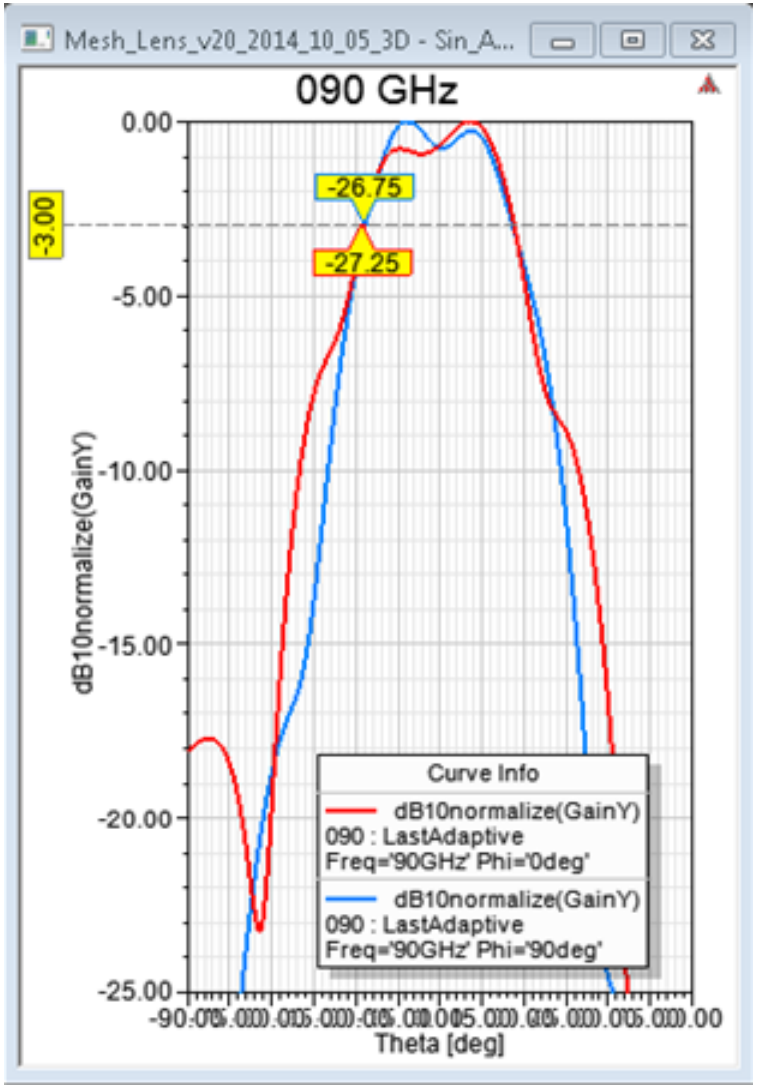


Sinuous antenna on substrate



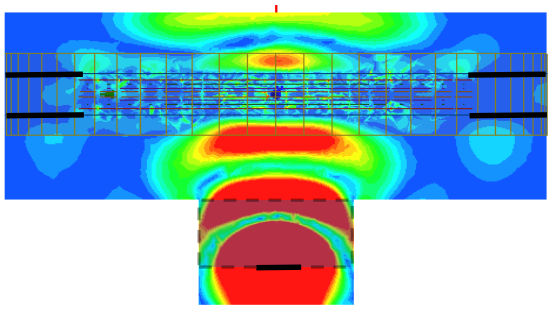
Aperture stop

FEA simulation



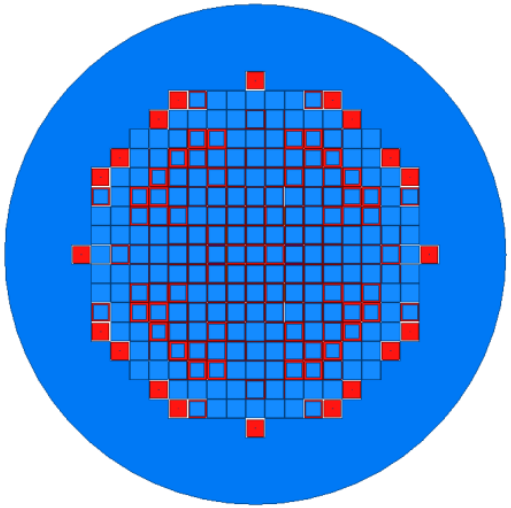
Mesh Lens Array: Coupling to a Sinuous Antenna

Mesh Lens

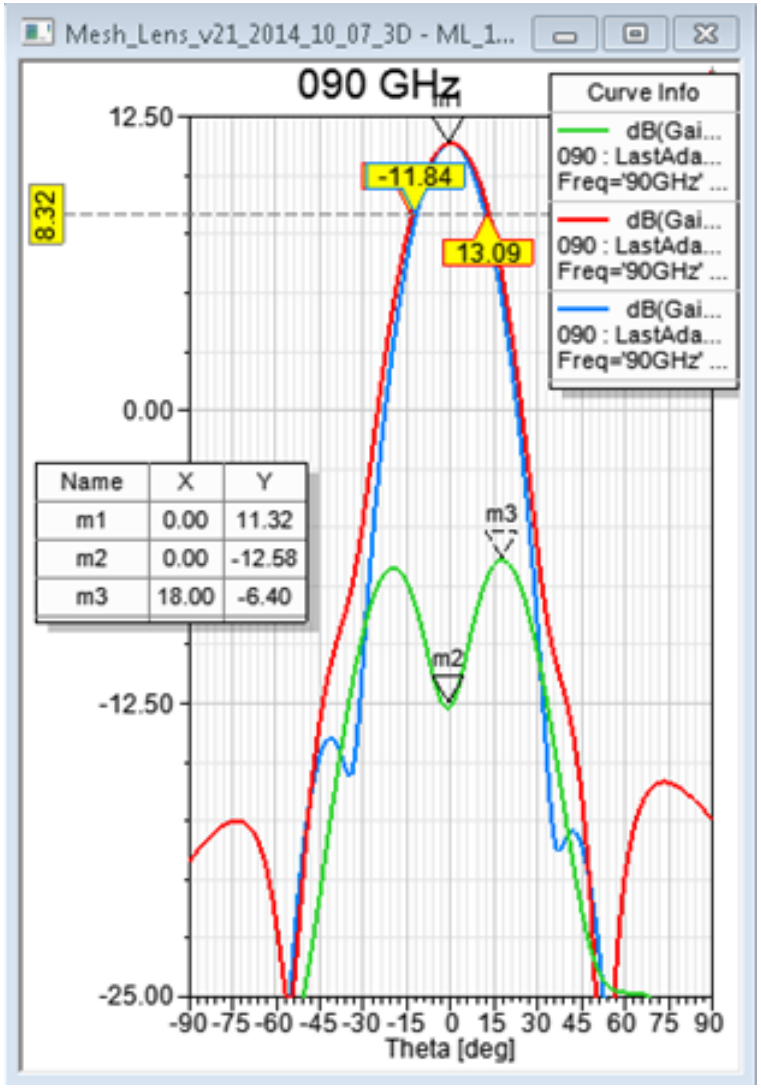


Sinuous antenna on substrate

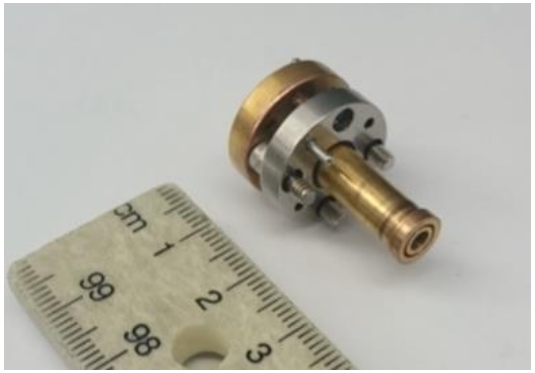
Mesh Lens

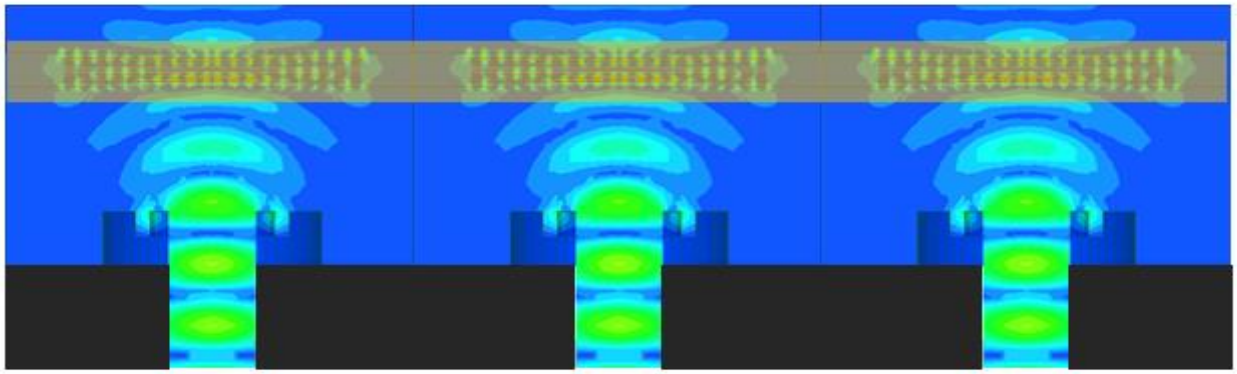


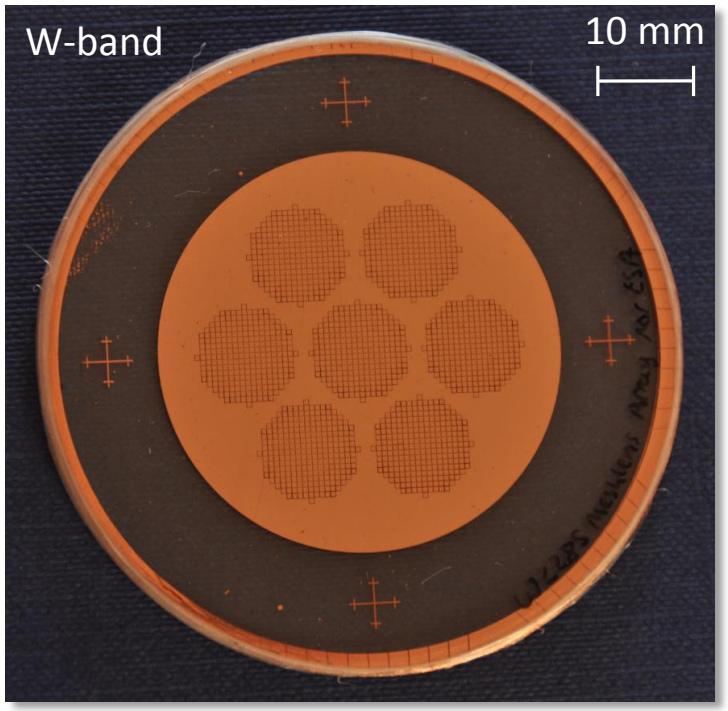
FEA simulation

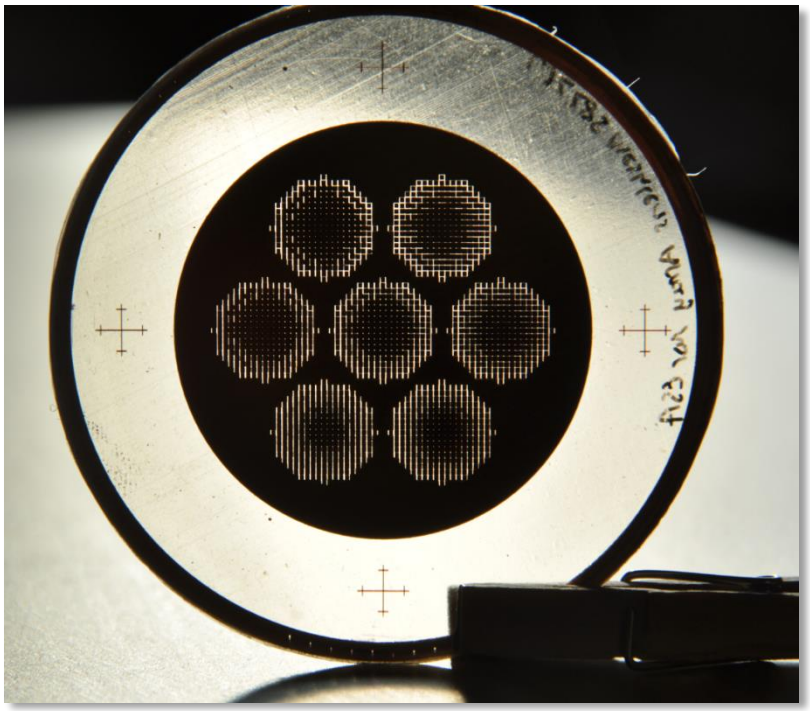


Mesh Lens Array: Coupling to a Waveguide Probe Antenna

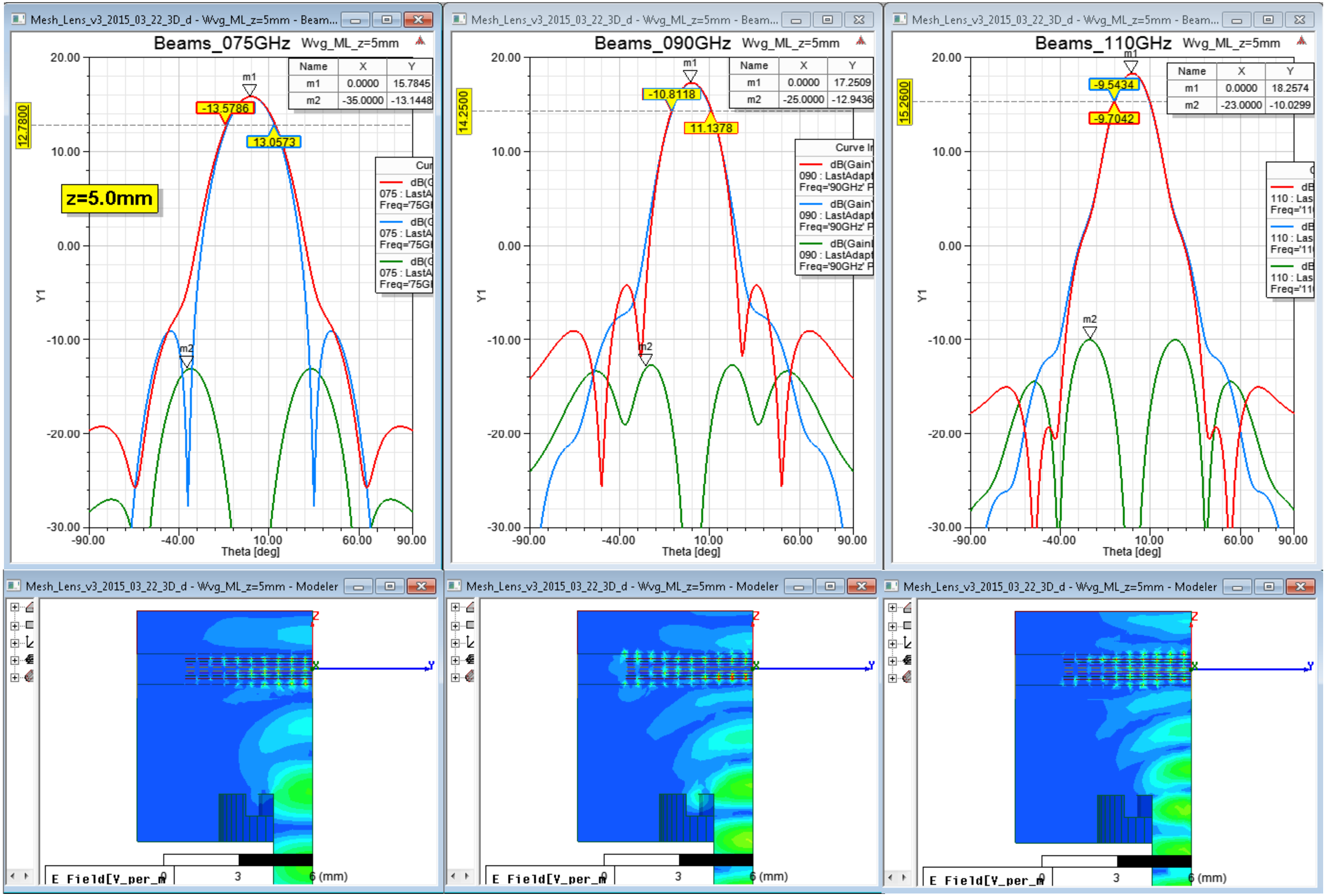




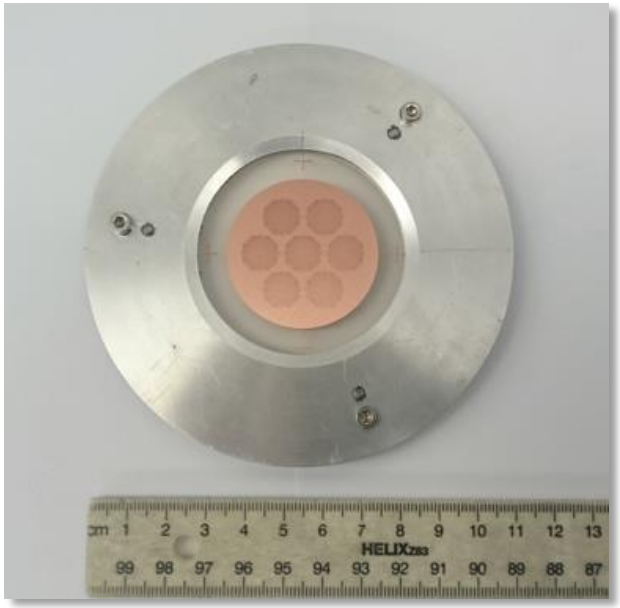


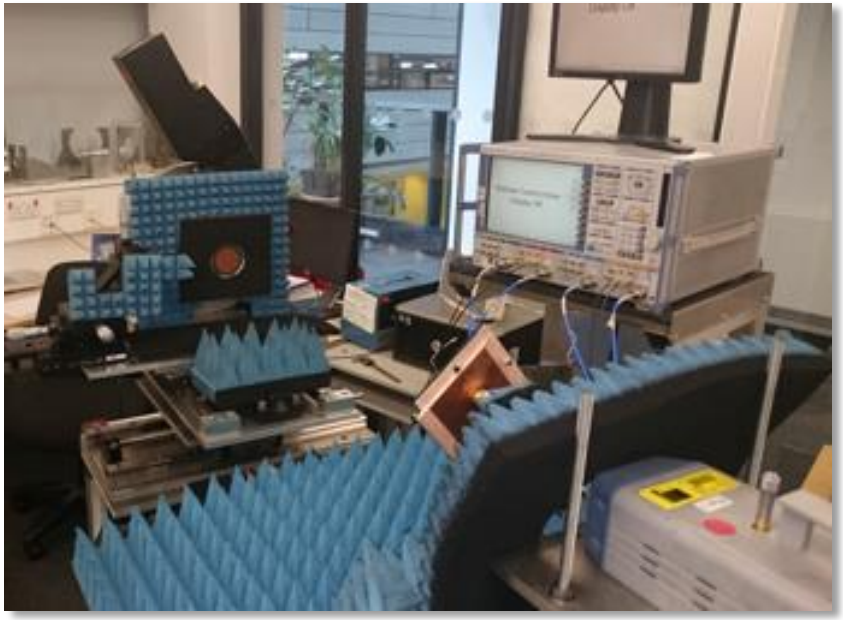


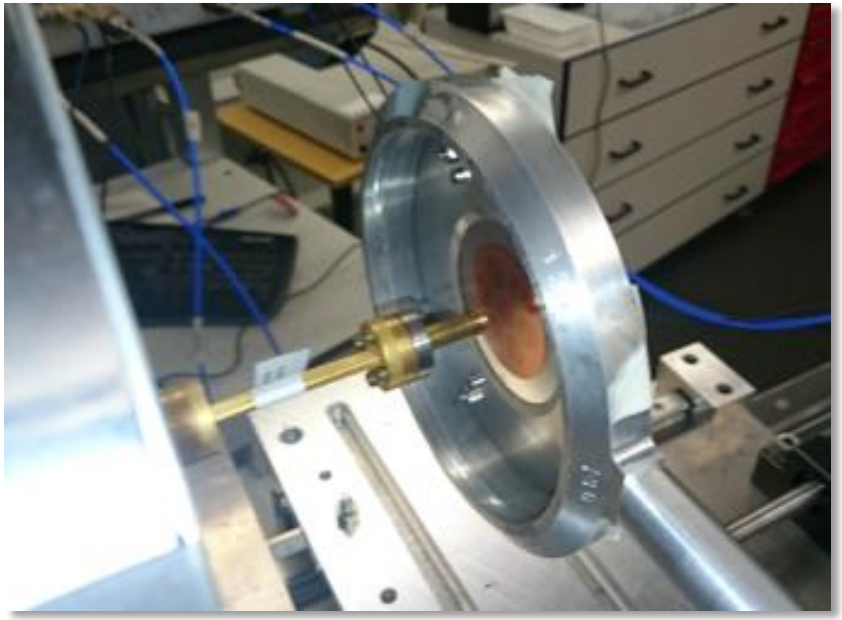
Mesh Lens Array: Waveguide Probe Antenna - Simulations



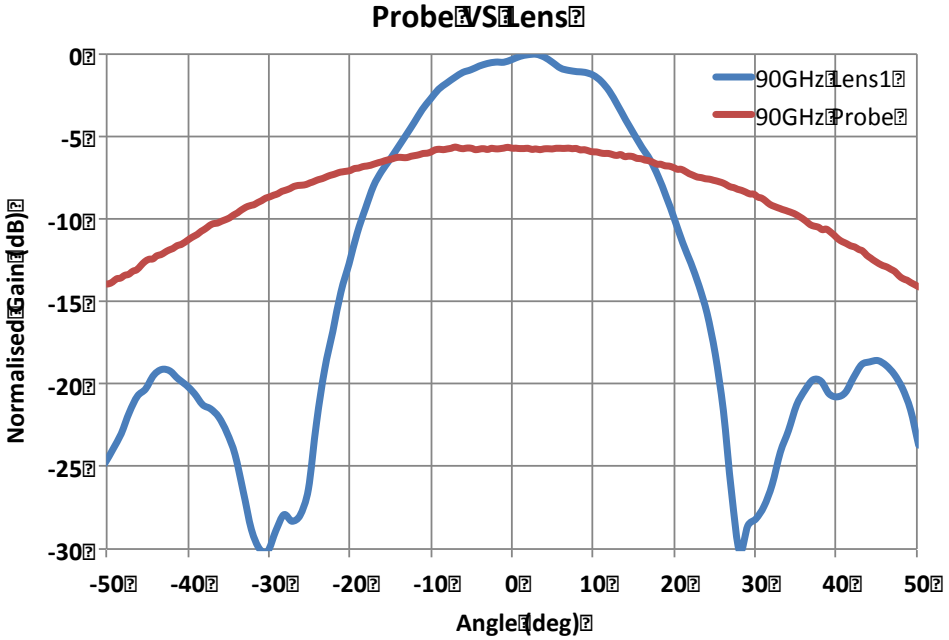
Mesh Lens Array: Waveguide Probe Antenna - VNA tests setup

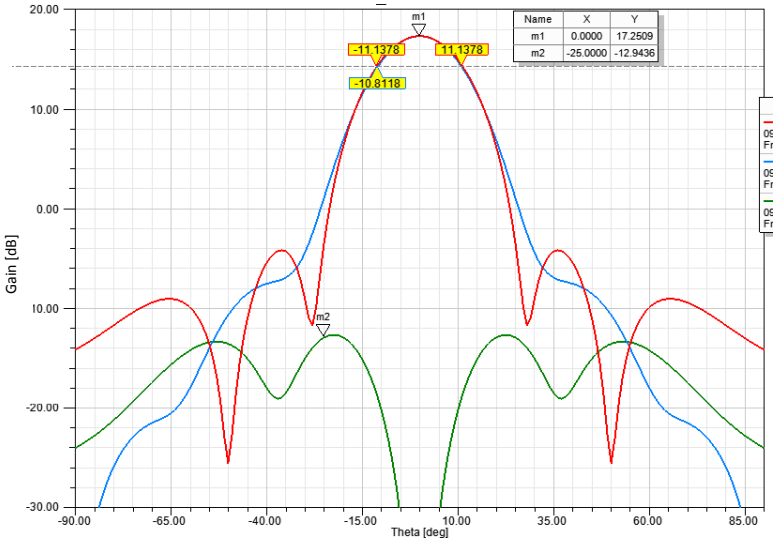






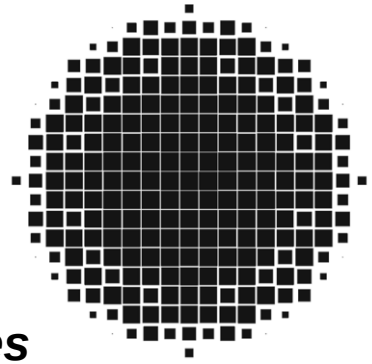
Mesh Lens Array: Waveguide Probe Antenna - Preliminary results





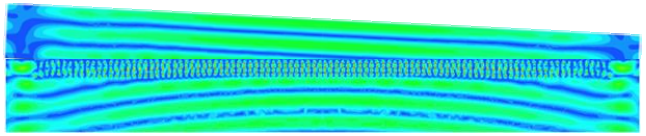
	Measurement	Simulation
FWHM	23.6 deg	22.3 deg
Sidelobes	-18 dB	-21 dB
First minimum	30 deg.	27 deg.

Conclusions

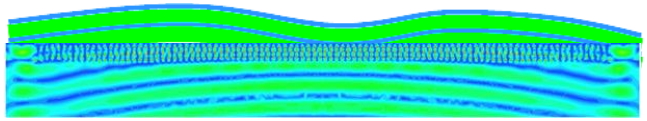


- Mesh lenses advantages:

- *Phase front can be manipulated with hundreds of delay lines*
- *Beam steering for non-normal incidence*



- *Arbitrary beam corrections/optimisations*



- *No complex ARC required*
- *ARC for larger bandwidths are just flat additional layers*
- *Independent from source (only original beam phase front required)*
- *Large arrays produced with the same # of processes for a mesh filter*
- *Arrays can be cut to arbitrary shapes*
- *Mesh filters and polarisers can be added within the same structures*