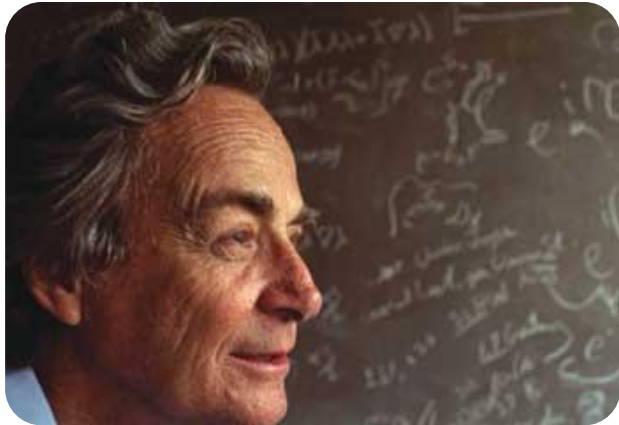




Emerging Multi-functional and High-Performance Metamaterials for Biosensing

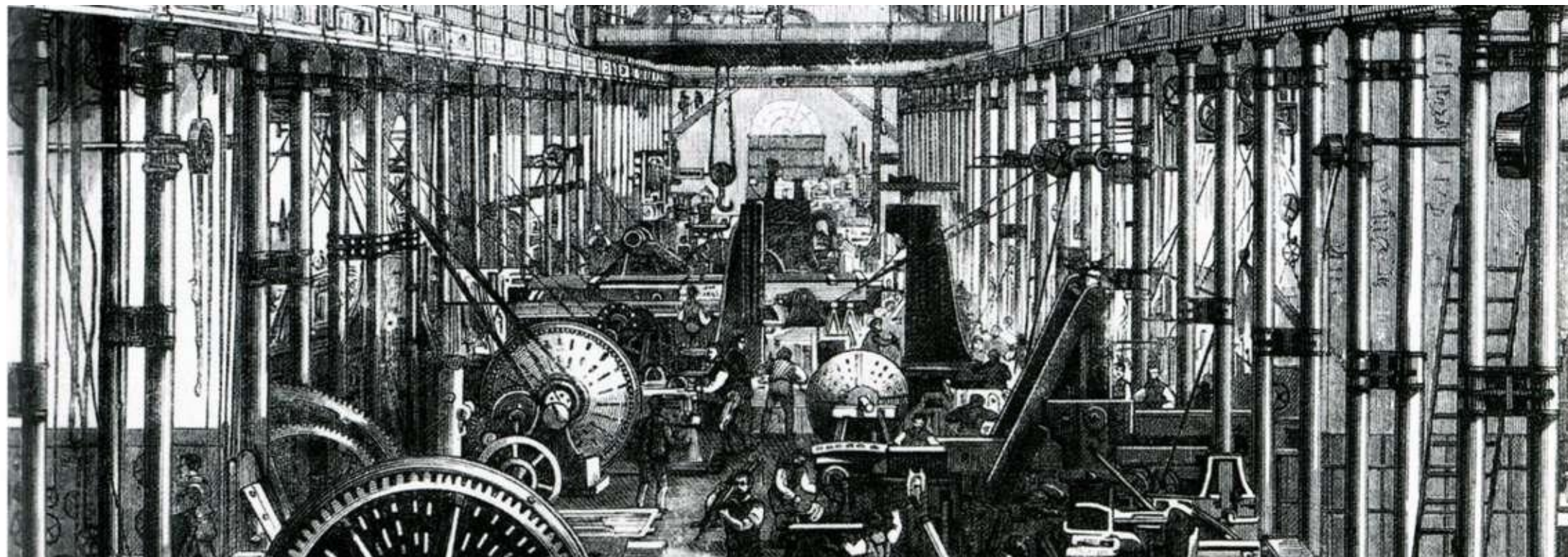
Themos Kallos

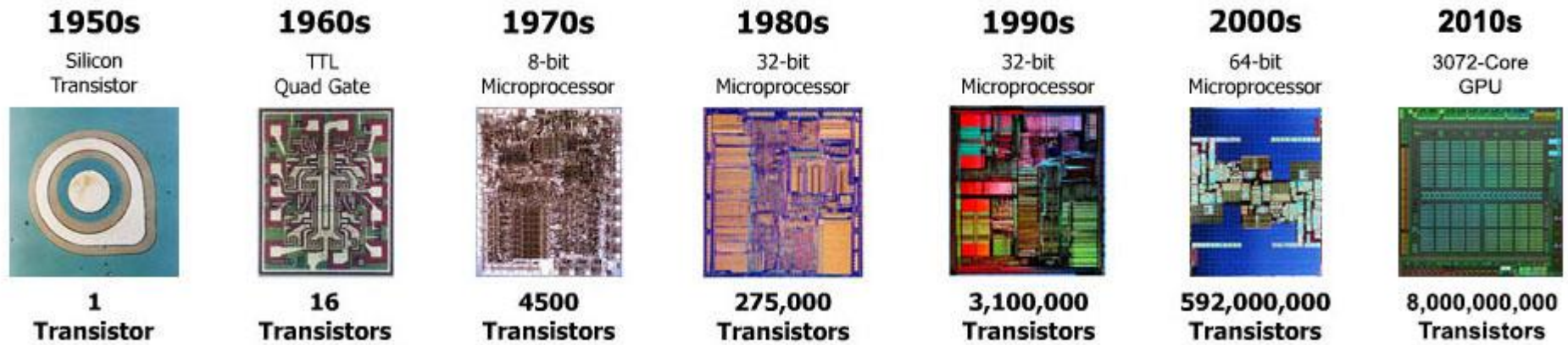
Chief Science Officer



*“I can’t see what exactly would
happen,
but when we have some control of
the arrangement of things in the
small scale,
we will get an enormously greater
range of possible properties that
substances can have.”*

1959





Outline

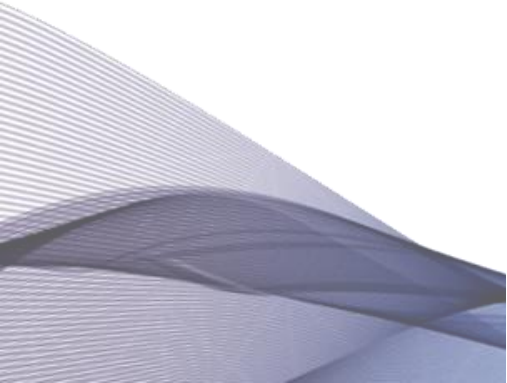
- About META
- META Applications
- Biosensing Applications
- Non-Invasive Glucose Sensing

About META



The META Timeline

2021	1 st Metamaterial Company on NASDAQ
2011	META Founded
2000	Negative Refraction Demonstrated
1968	Veselago's Paper
1865	Maxwell's Equations
1492 AD	America Discovered
55 BCE	Romans invade Britain
776 BCE	First Olympiad
3000 BCE	Great Pyramid Built
10,000 BCE	Farming
200,000 BCE	Early Humans



Global Footprint



Halifax, Nova Scotia, Canada

Head Office
Research and development
Manufacturing facility

London, England, United Kingdom

EU Europe Sales office
Research and Development

Boston, MA, United States

USA HQ

Pleasanton, California, United States

U.S.A. sales office
Research and development head office

Minato-ku, Tokyo, Japan

Cornes Technologies Ltd.
Japan sales office

Copenhagen, Denmark

SATAIR (Airbus subsidiary)
Sales distribution partner

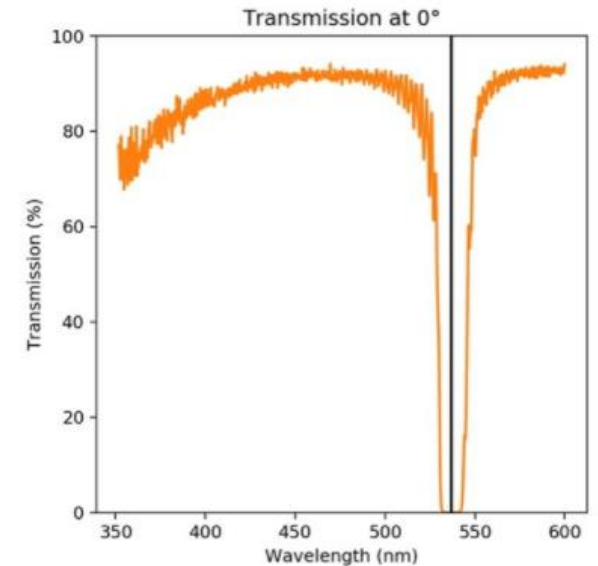
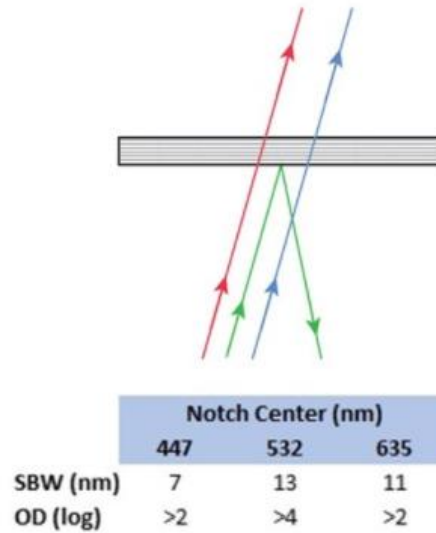
META Applications

Functional Films for the People

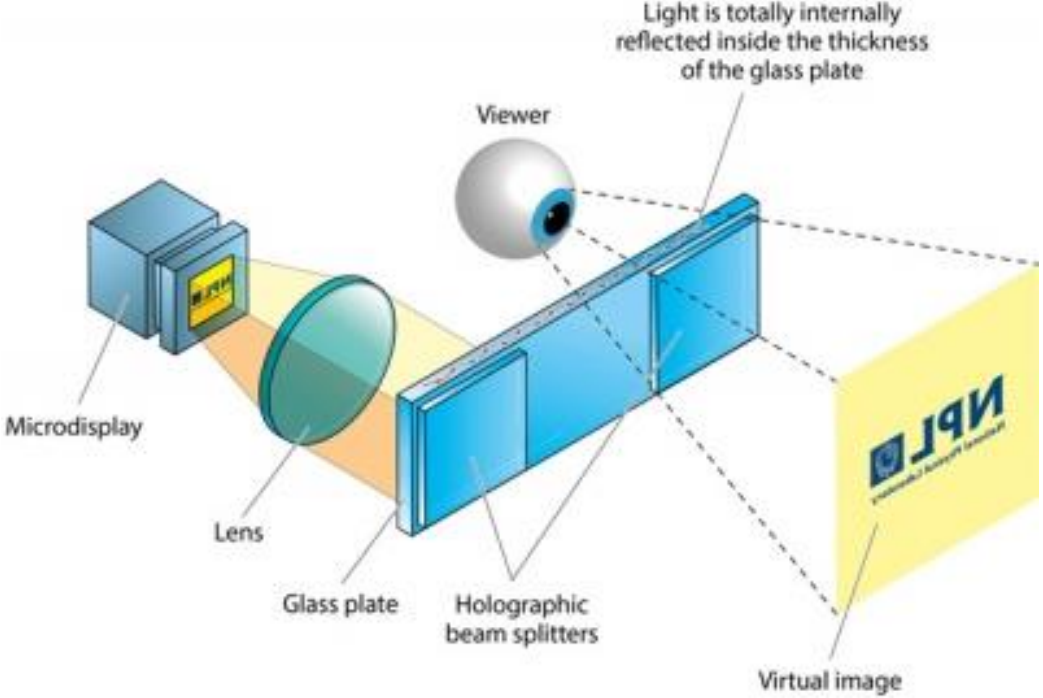


metaAIR[®] Laser Glare Protection Eyewear

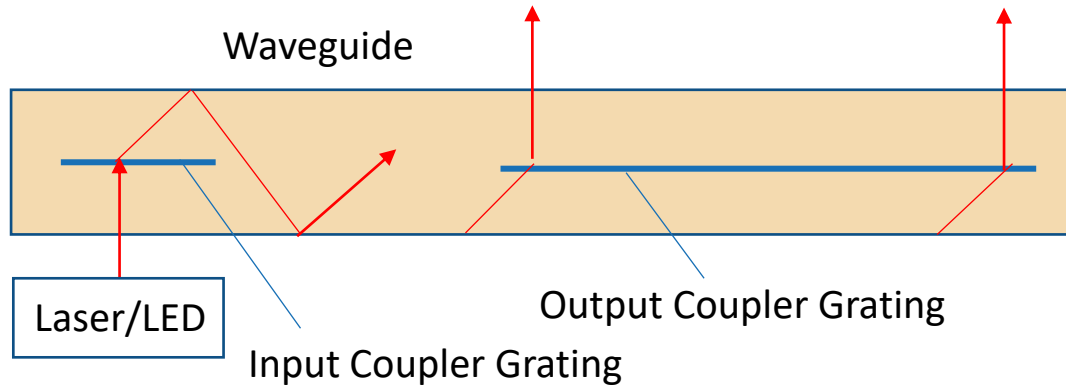
META[®]



Augmented Reality



Augmented Reality: ARfusion™ & holoOPTIX™



- Illumination expansion
- Beam geometry shaping
- Illumination structures: diffuse, uniform, structured light, etc.
- Polarization control
- Optical power for light condensing and collection
- Wavelength diversity
- Angular diversity
- Multiplexed optical functions
- Switchable optical functions
- SERS integration: pump beam management and signal collection

Films in Casted Lenses

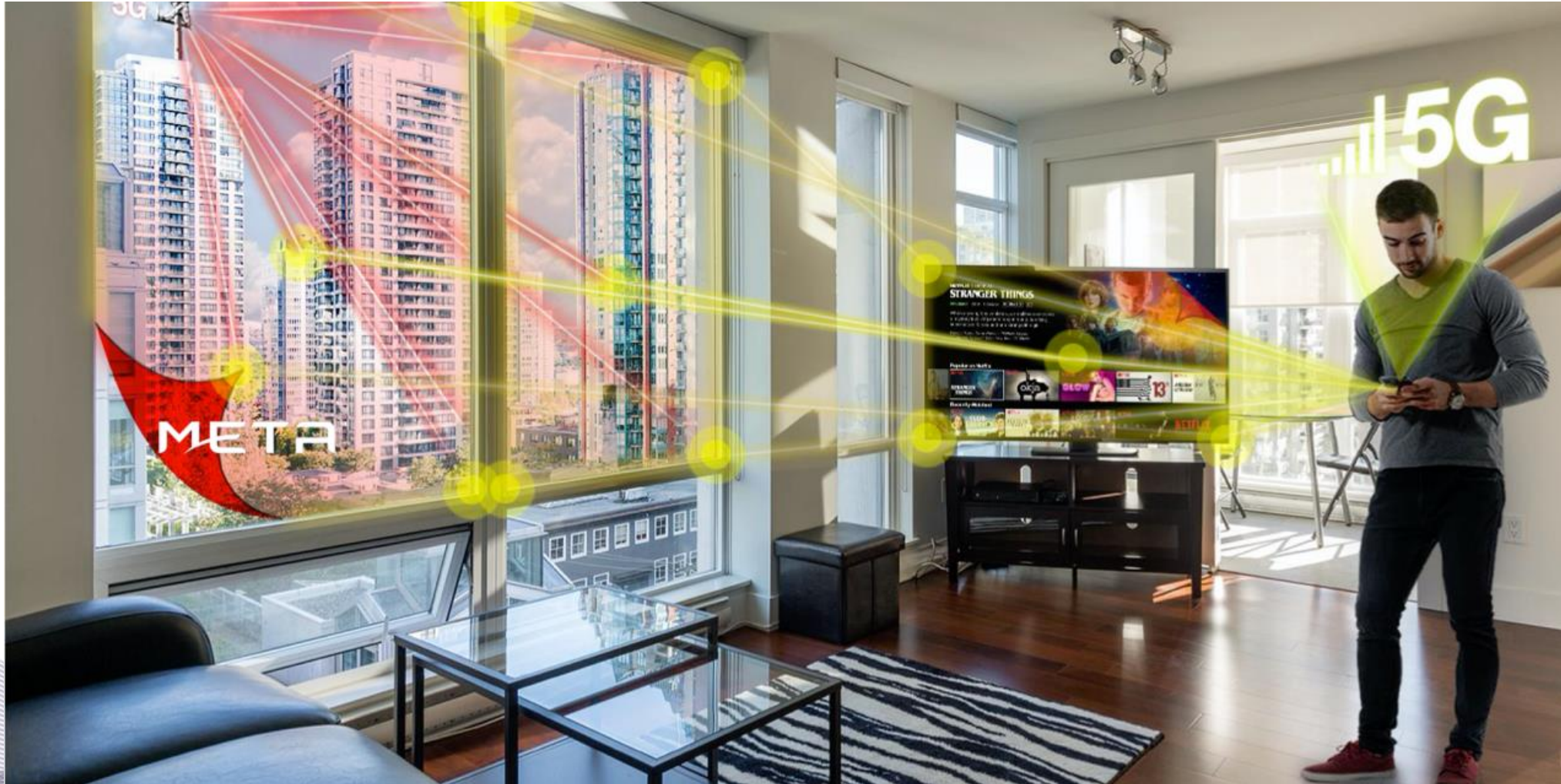


Outdoor 5G Coverage Enhancement

META®



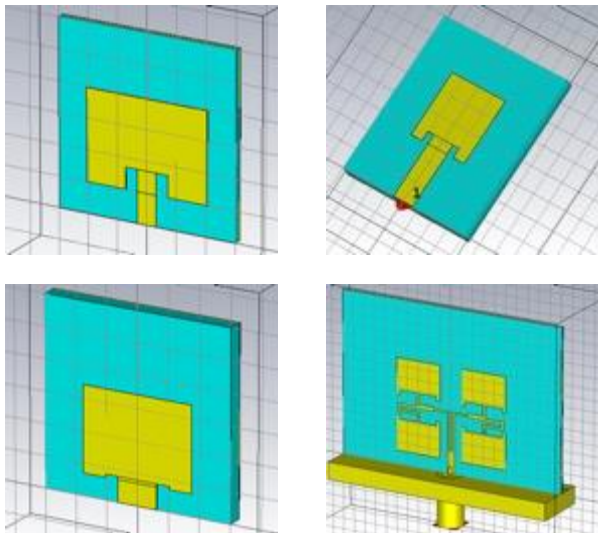
Indoor Coverage Enhancement



NANOWEB® 5G Antennas



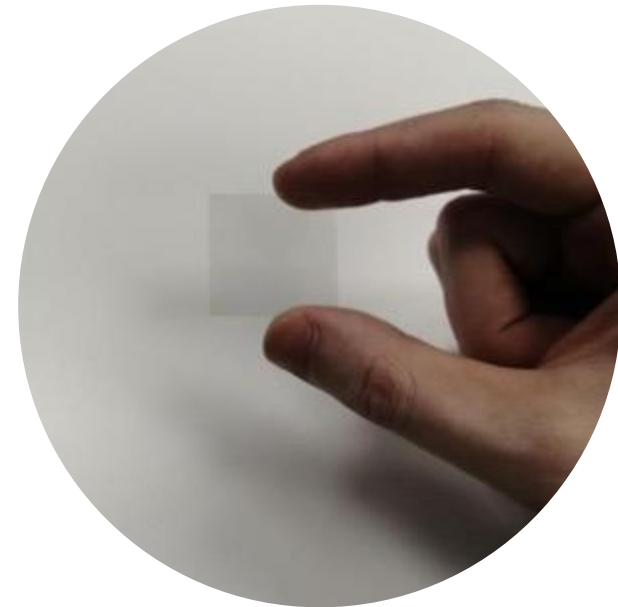
Custom Design & Simulation



Precision Fabrication



High Performance & Transparency



Transparent Microwave Doors

META[®]



EMI Shielding & Nano-heater to Protect Sensors - Transparent to RADAR and LIDAR Simultaneously

META[®]



Secure Currency & Brand Protection

- Produce motion, depth and color without inks or dyes.
- Full color, nearly impossible to reproduce.
- Engaging security features with RGB color, 3D images, and movement.
- Developing new security feature for a confidential top-10 central bank.



UEFA Euro Cup Tickets

Biosensing Applications

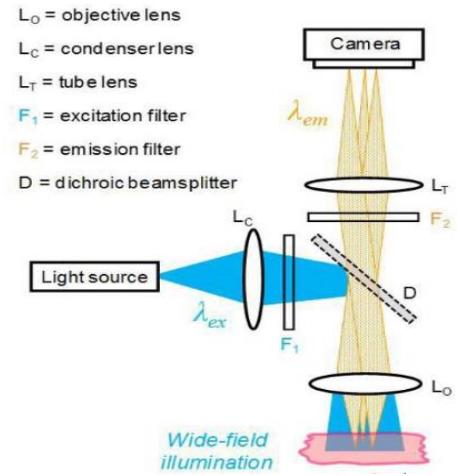
Seeing through the skin

META[®]
Go Beyond.

Microscopy (Fluorescence and Colour Imaging)



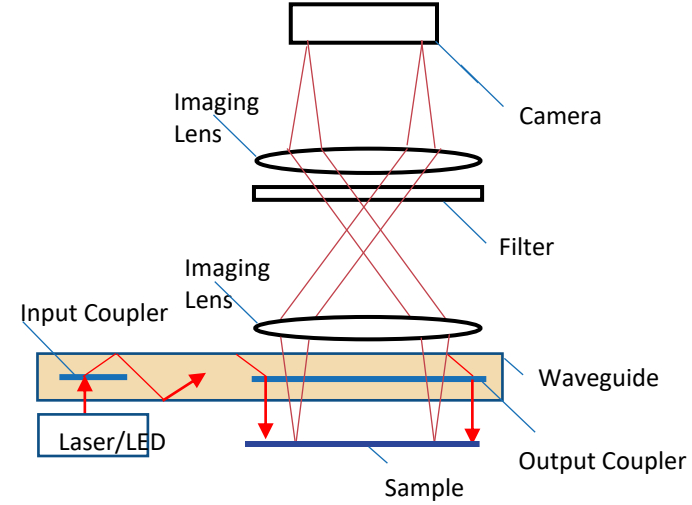
Thermo Fisher Scientific
EVOS XL Core Imaging
System



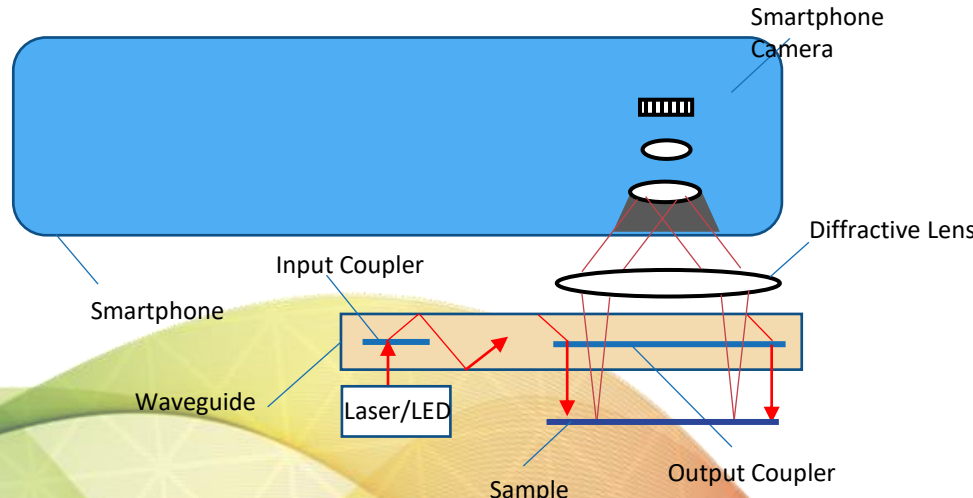
L_o = objective lens
 L_c = condenser lens
 L_t = tube lens
 F_1 = excitation filter
 F_2 = emission filter
 D = dichroic beamsplitter

Wide-field illumination

Integrated illuminator solutions



Smartphone integrated solutions

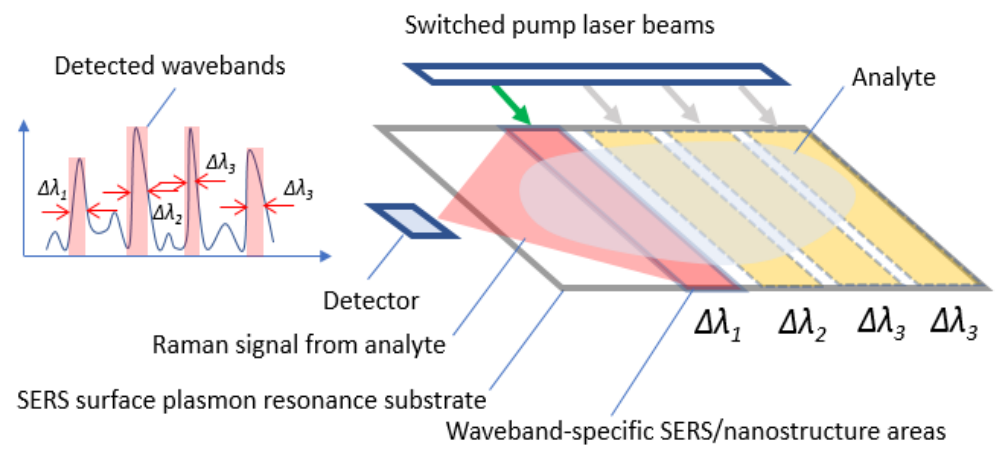


Improvements to fluorescence and color imaging system:

- Lasers – *form factor, image brightness, wavelength diversity, DOE-enablement*
- Homogenization – *phase randomization for uniform illumination*
- Diffractive condensers – *precise beam shaping, precise beam-shaping solutions*
- Dichroic beam splitters – *separated of source and fluorescent wavelengths*
- Thin imaging optics – *more advanced nanostructures can replace imaging lenses*
- Compact form factors – *smartphone application enablement*

Raman Spectroscopy for Infectious Diseases

PROBLEM: Current gold standard equipment is very expensive, and too bulky to be brought to the patient, let alone scalable to a personal device. Current equipment is unsuitable for deployment in GP surgeries, pharmacies or care homes or for the large-scale testing.



SOLUTION:

- Compact low cost solutions for consumer applications, e.g. Covid-19 detection
- Optical function compression and thin form factor for smartphone integration
- Efficient integration of SERS and nanostructures
- Laser beam delivery using switching gratings
- Compact application-customized nanostructure-based spectrometer solutions

Focus Application

Non-Invasive Glucose Sensing

META[®]
Go Beyond.

Monitoring Glucose as a Type 1



Recommended: 8-10 readings per day

Average: 5 readings per day

GlucoWise Wearable Biosensor

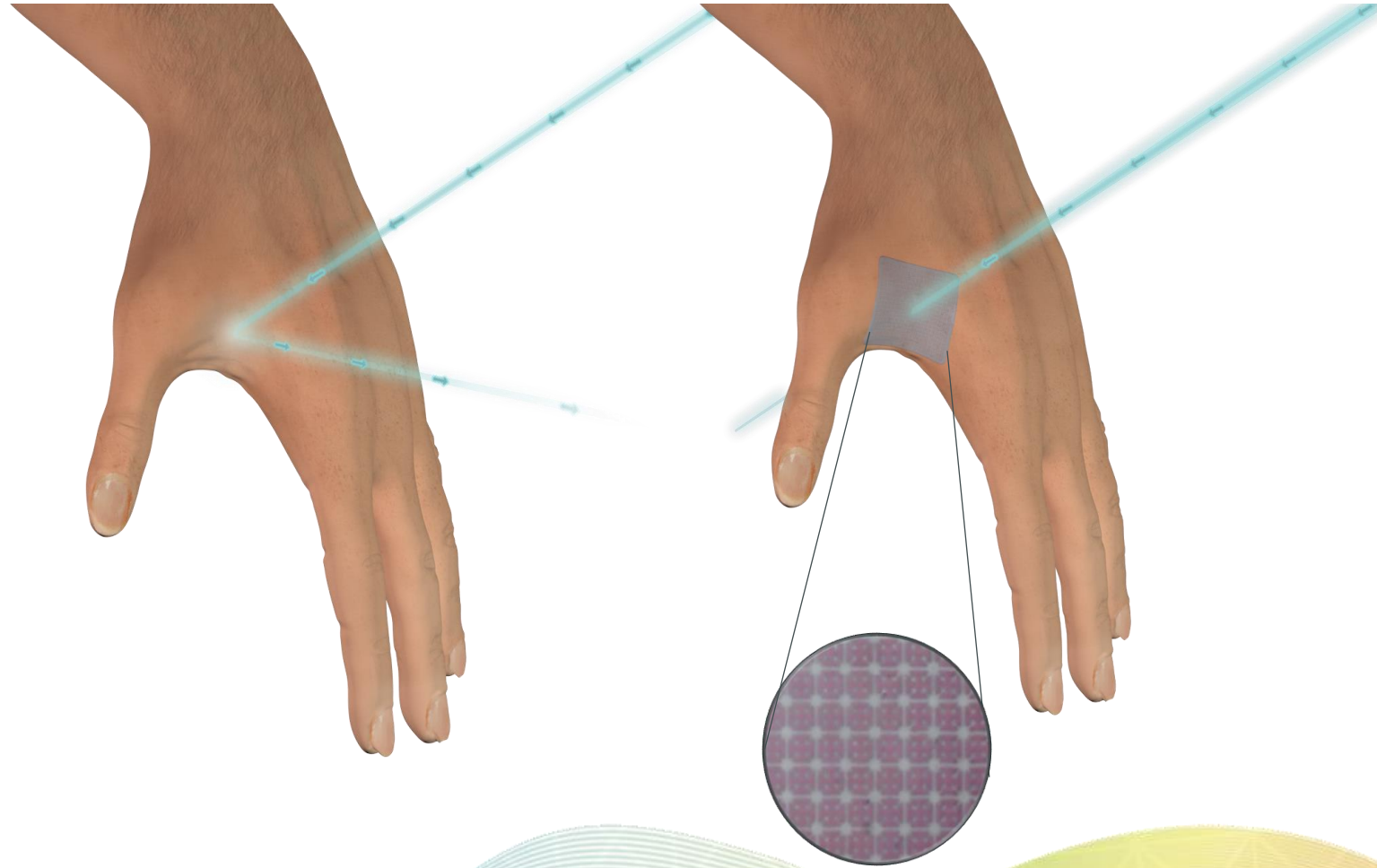


Technology

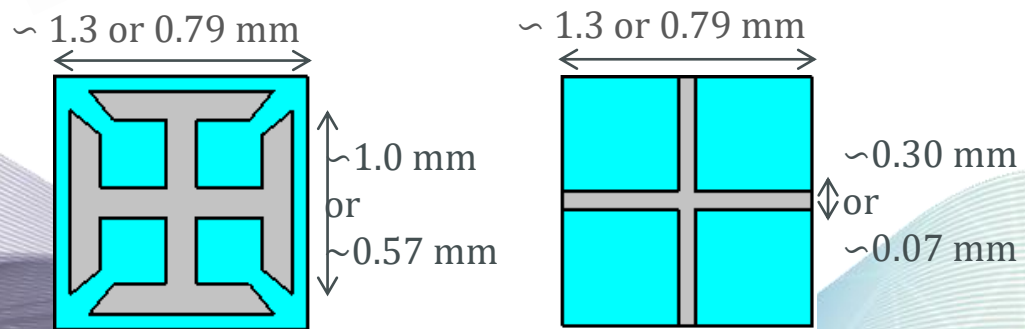
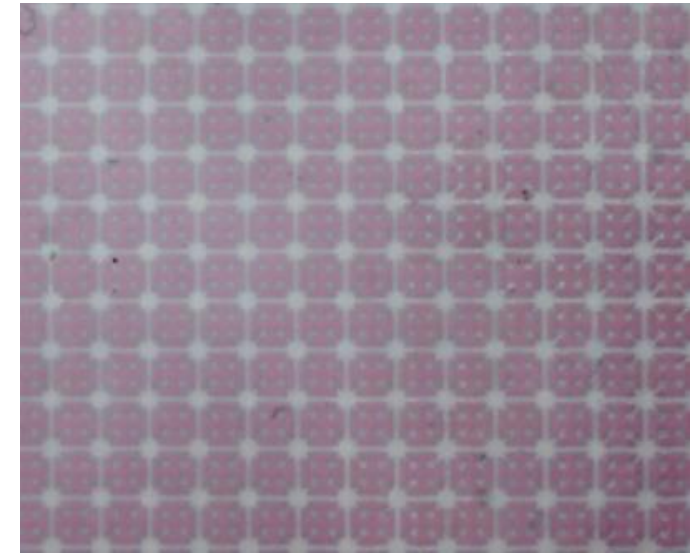
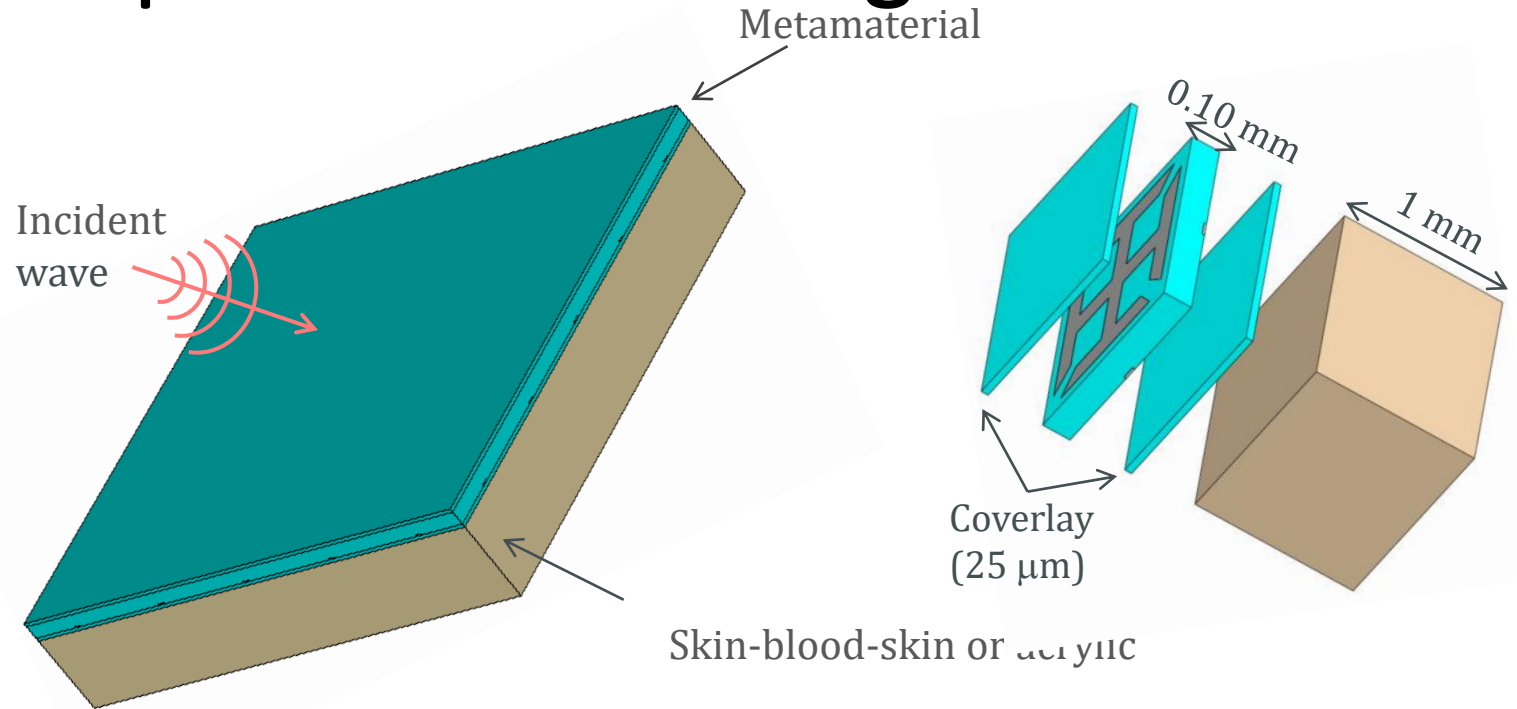
Impedance Matching for Skin

META[®]
Go Beyond.

Biosensing w/ Impedance Matching

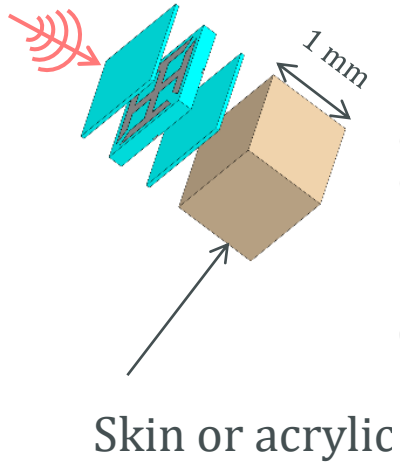


Impedance Matching Metamaterial Design

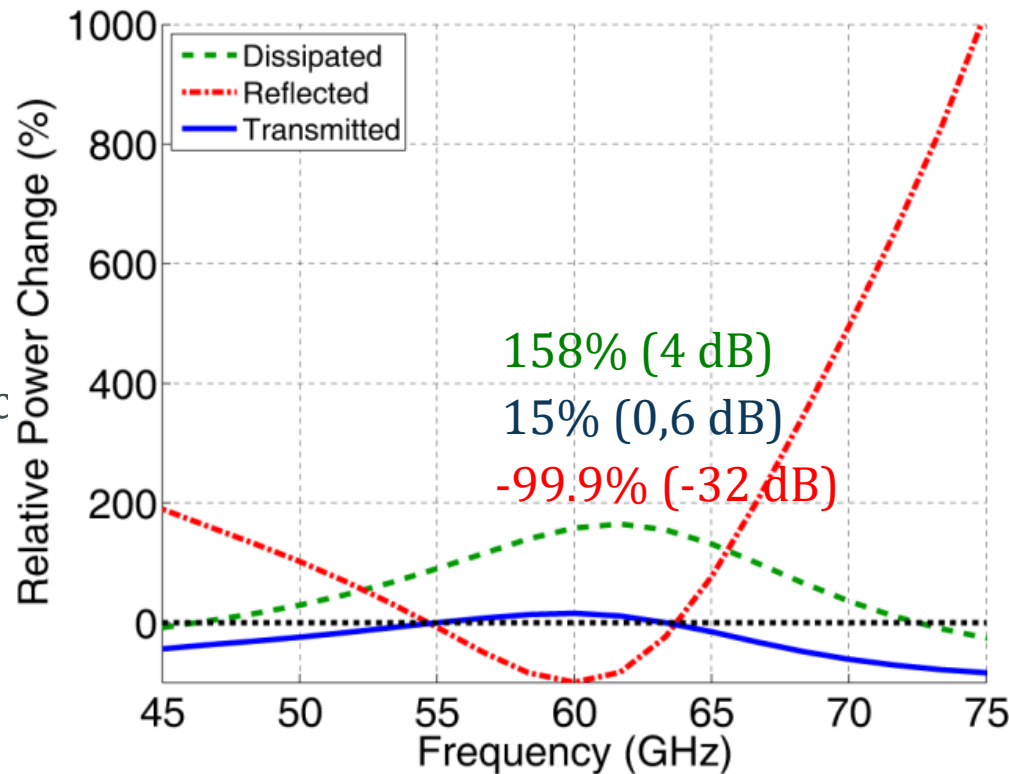


Simulation Results

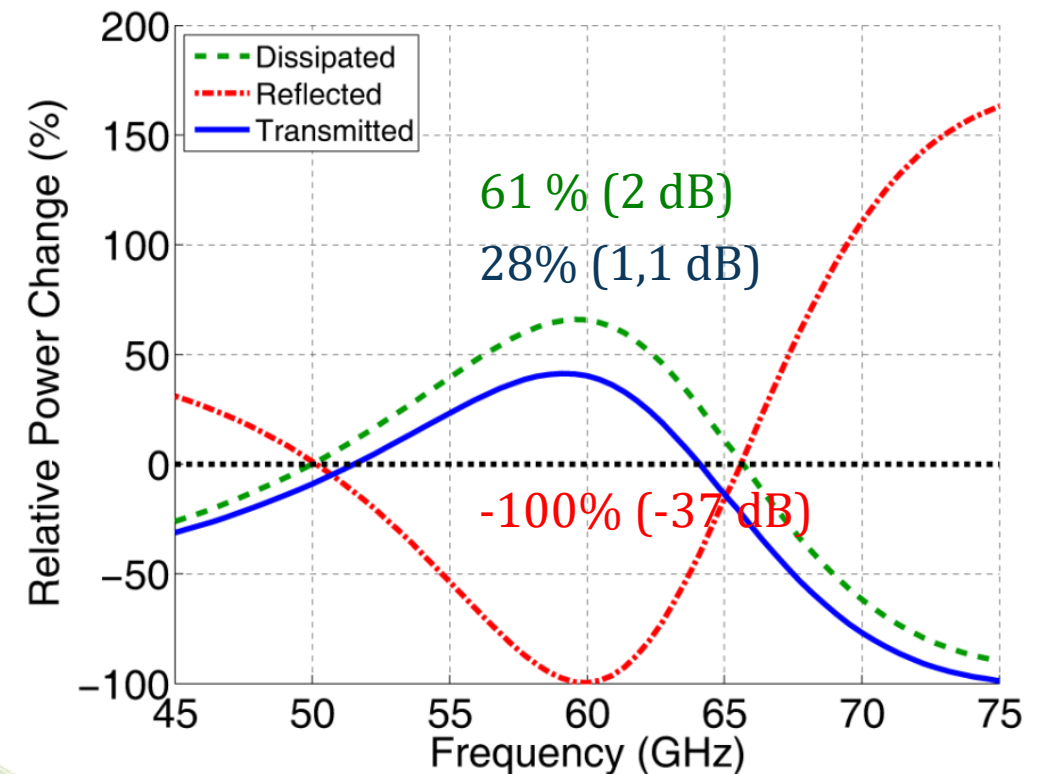
Relative power changes in the dissipated, reflected and transmitted power



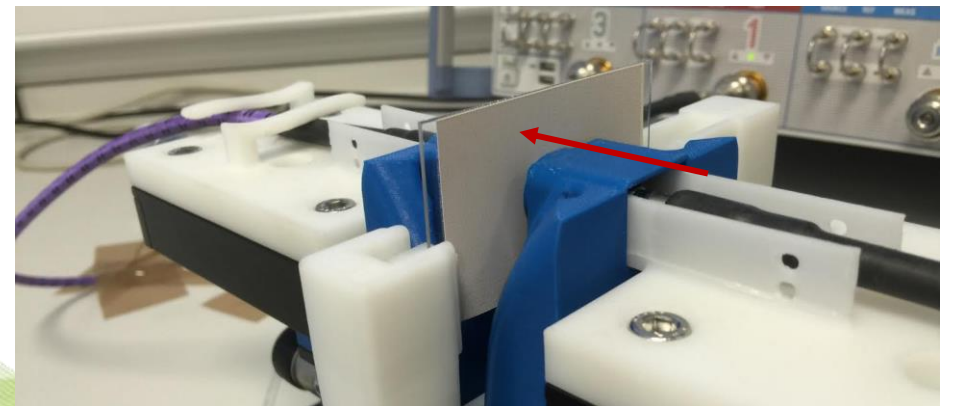
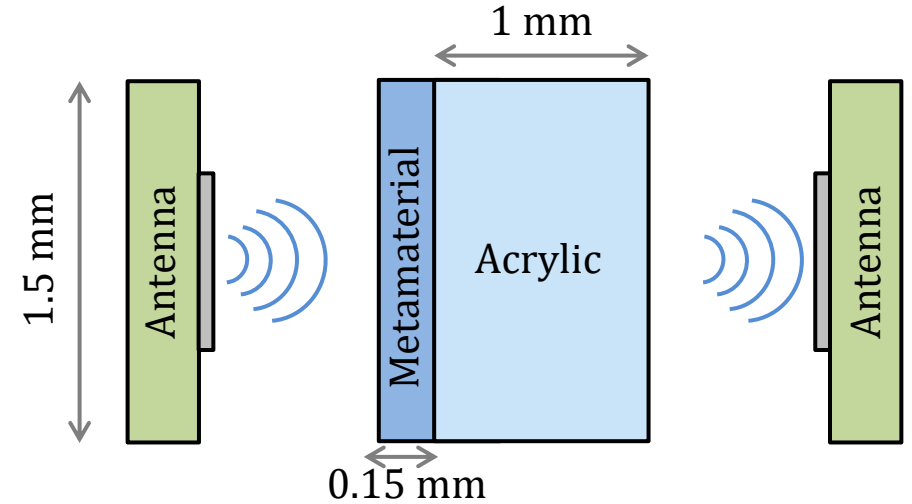
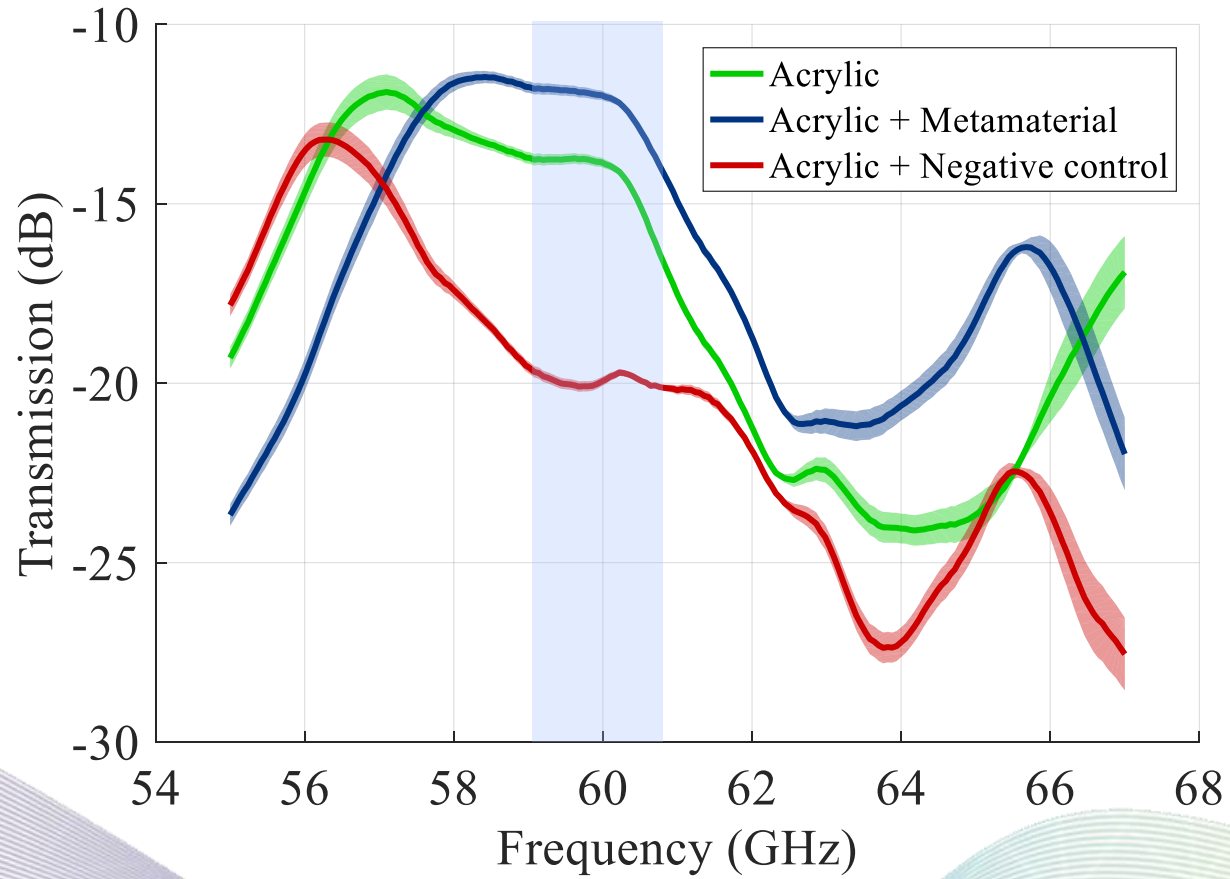
Acrylic Design



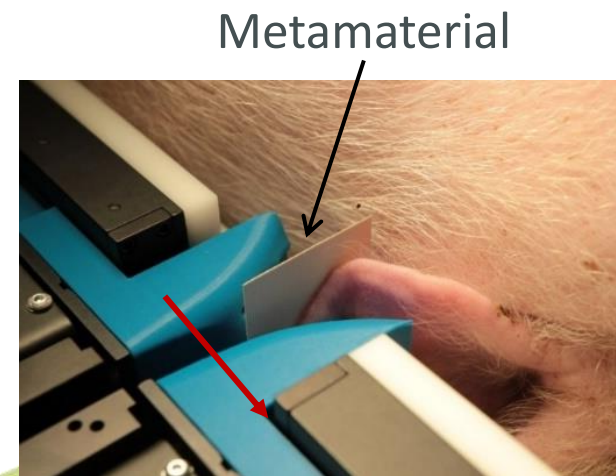
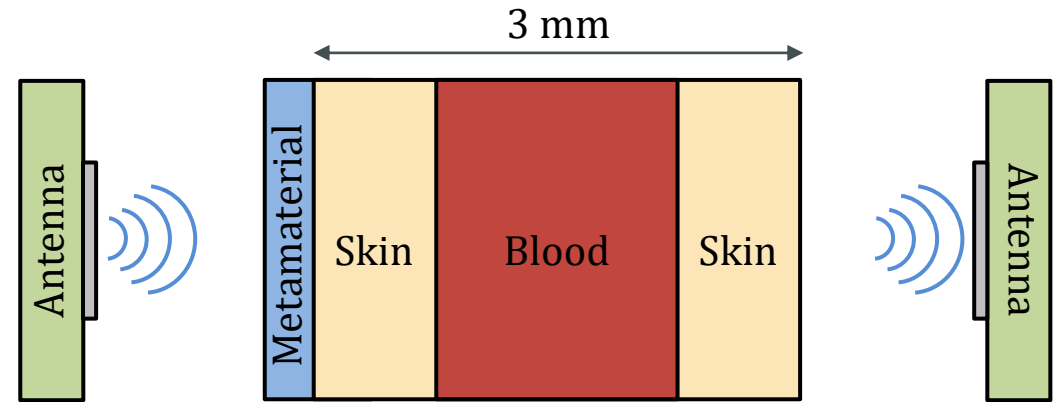
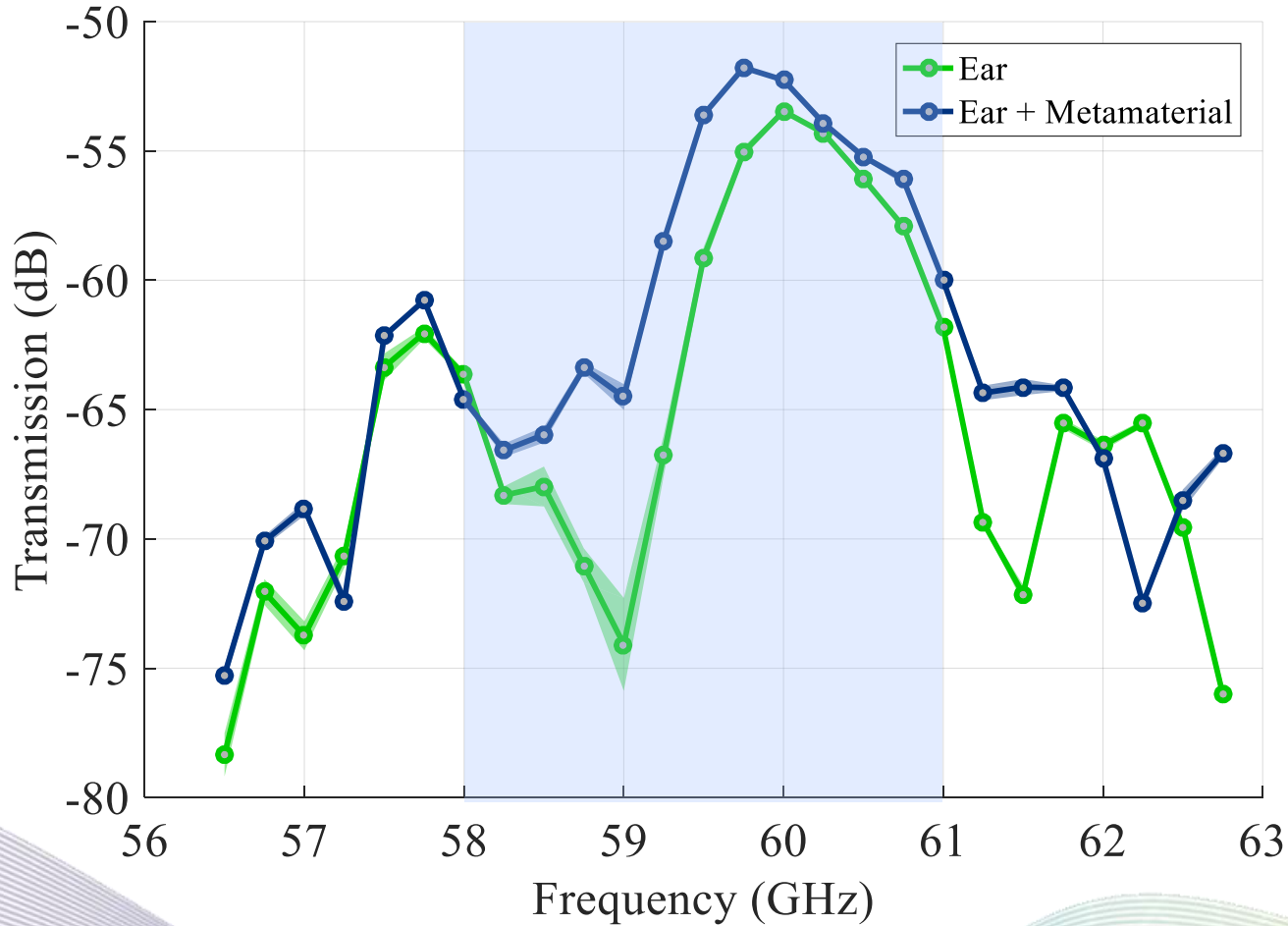
Skin Design



Transmission Through an Acrylic Slab

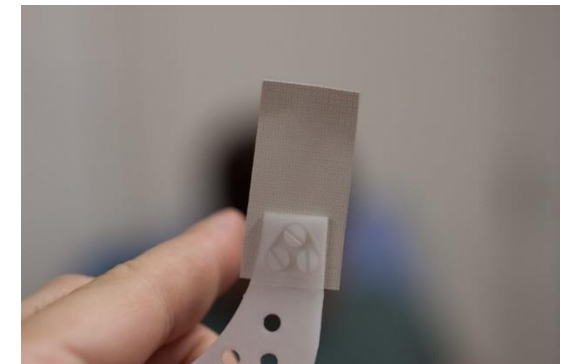
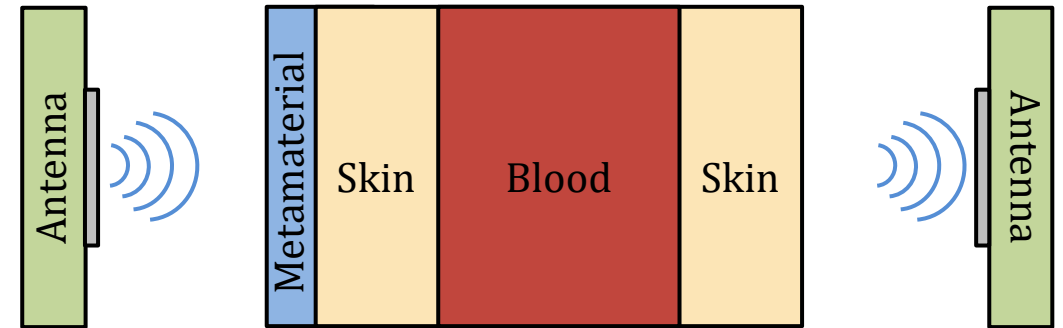
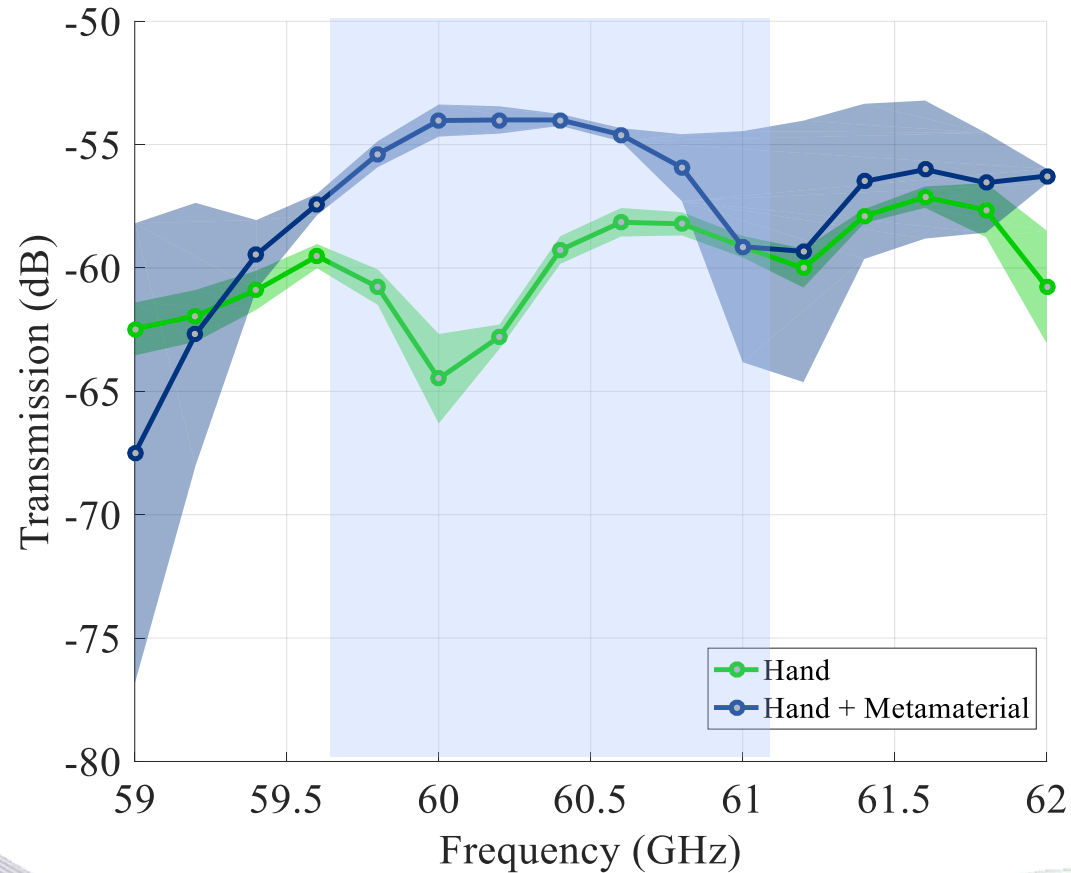


Transmission Through a Pig Ear



H. Cano-Garcia, P. Kosmas, and E. Kallos, "Demonstration of enhancing the transmission of 60 GHz waves through biological tissue using thin metamaterial antireflection coatings," in *2016 10th International Congress on Advanced Electromagnetic Materials in Microwaves and Optics (METAMATERIALS)*, 2016.

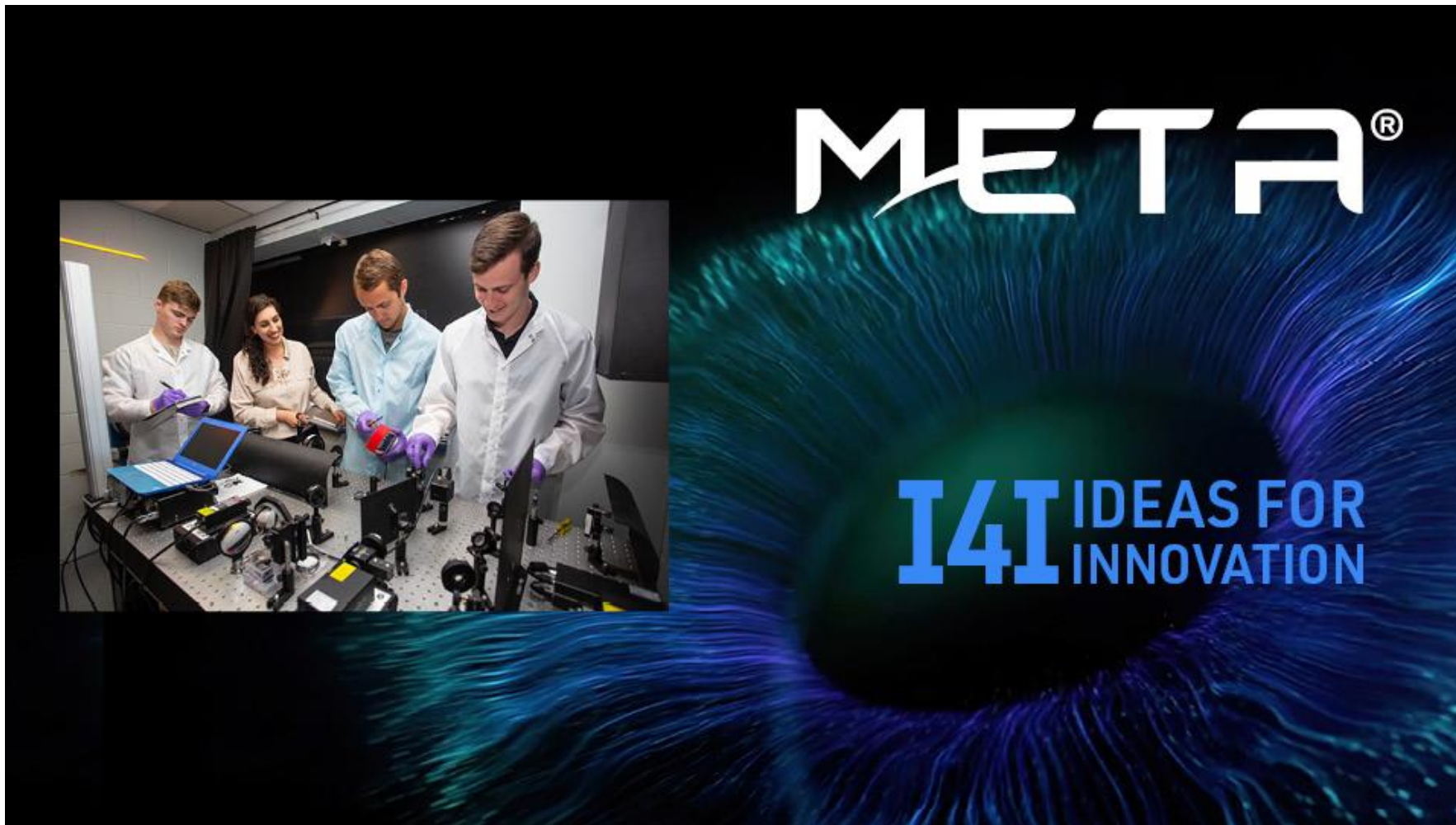
Transmission through Human Tissue



Thank You!

themos.kallos@metamaterial.com

META[®]
Go Beyond.



META®

I4I IDEAS FOR INNOVATION