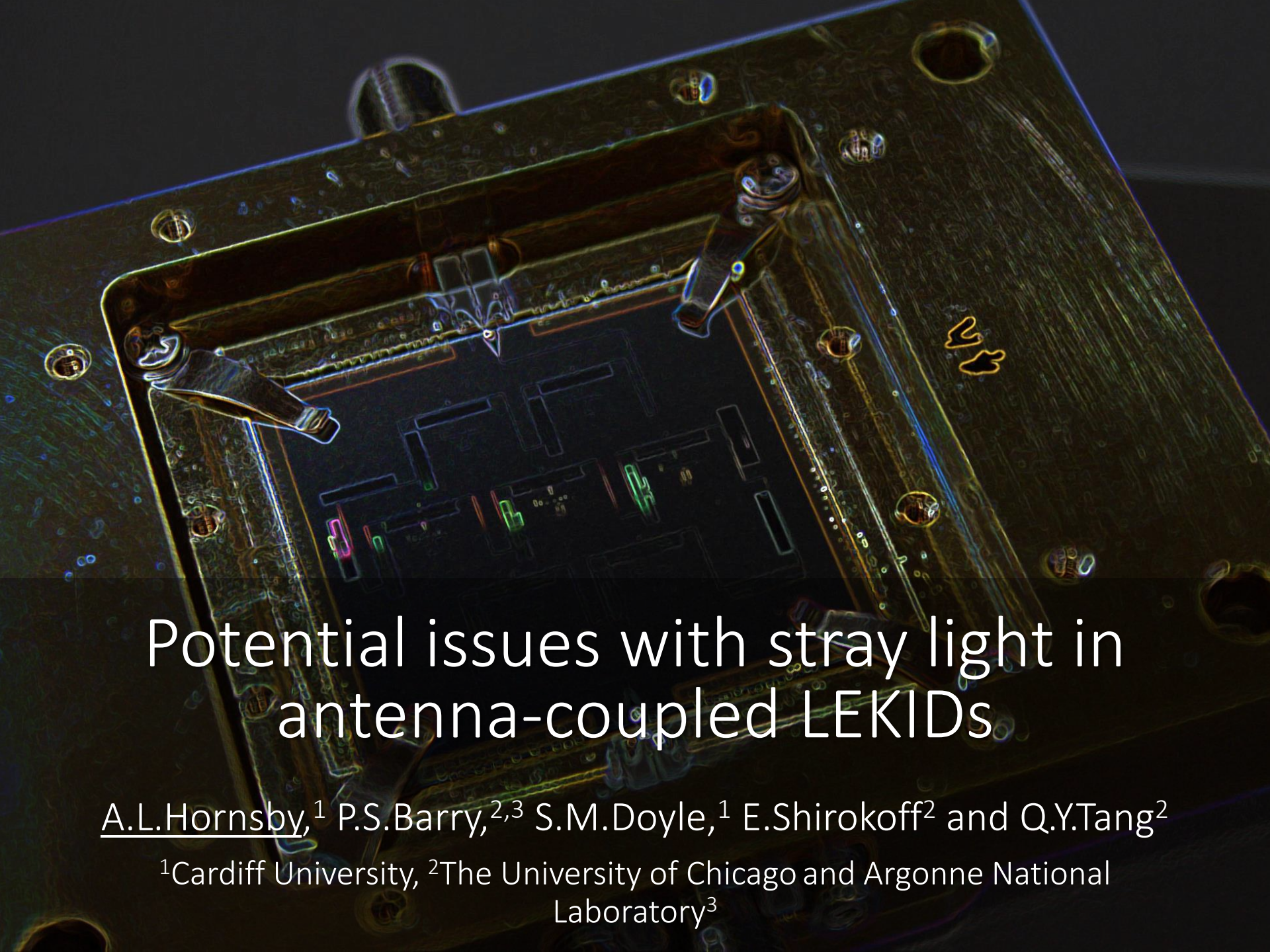


Potential issues with stray light in antenna-coupled LEKIDs

A.L.Hornsby,[1] P.S.Barry,[2,3] S.M.Doyle,[1] E.Shirokoff[2] and Q.Y.Tang[2]

[1]Cardiff University, [2]The University of Chicago and Argonne National Laboratory[3]

Antenna-coupled LEKIDs

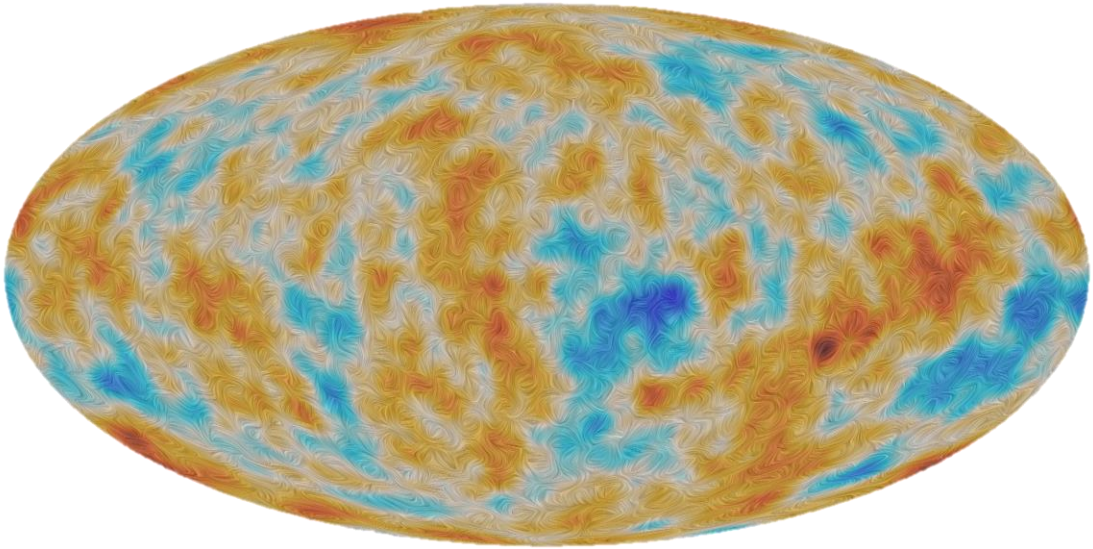


Image: Polarised Cosmic Microwave Background [Planck, ESA]

Cosmic Microwave Background is made up of the oldest photons in the universe (T = 2.73 K, wavelength = 1 mm)

To improve measurements of the CMB, we need:

- **More detectors** to improve mapping speeds
- **Multiple frequencies** to remove contaminating foregrounds
- **Polarisation capabilities** to uncover the B-modes

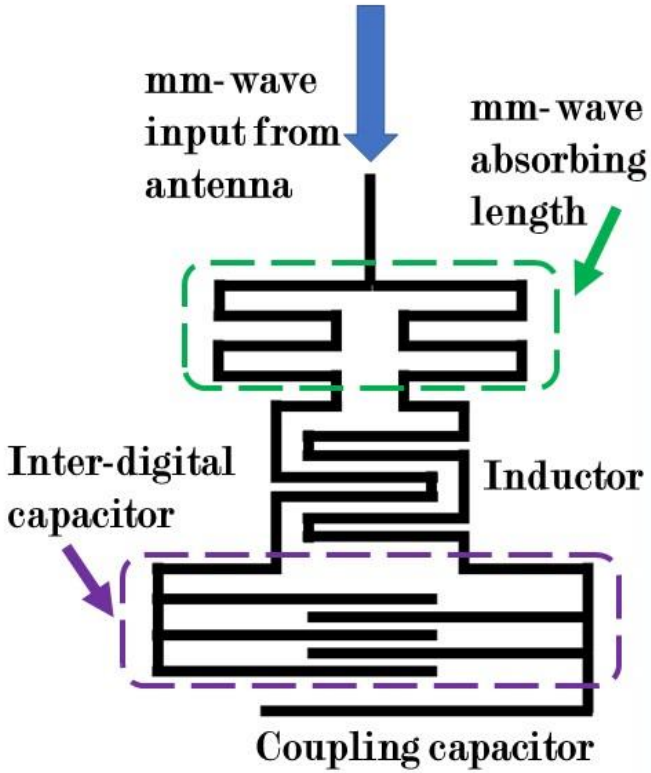
Antenna-coupled LEKIDs

Explore easier, and more reliable methods of fabrication (see Q.Y.Tang et al. J Low Temp Phys (2018))

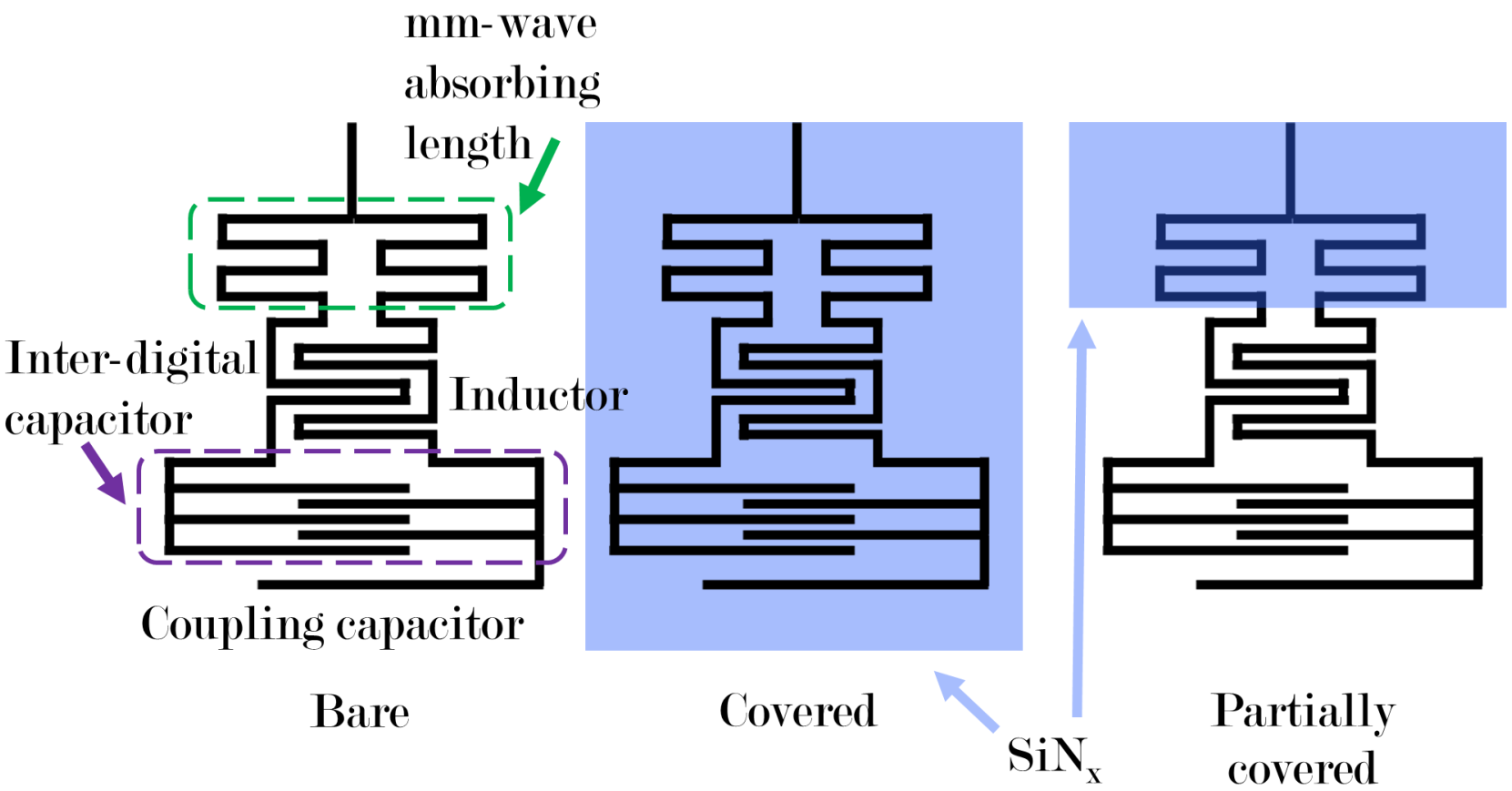
Traditionally, inductor doubles as efficient radiation absorber - e.g. NIKA 2

BUT direct absorber LEKIDs not compatible with multi-band on-chip filters (see P.S.Barry et al. J Low Temp Phys (2018))

Separating L and C provides flexibility to independently optimize design parameters (i.e. volume, F_0, two-level systems)



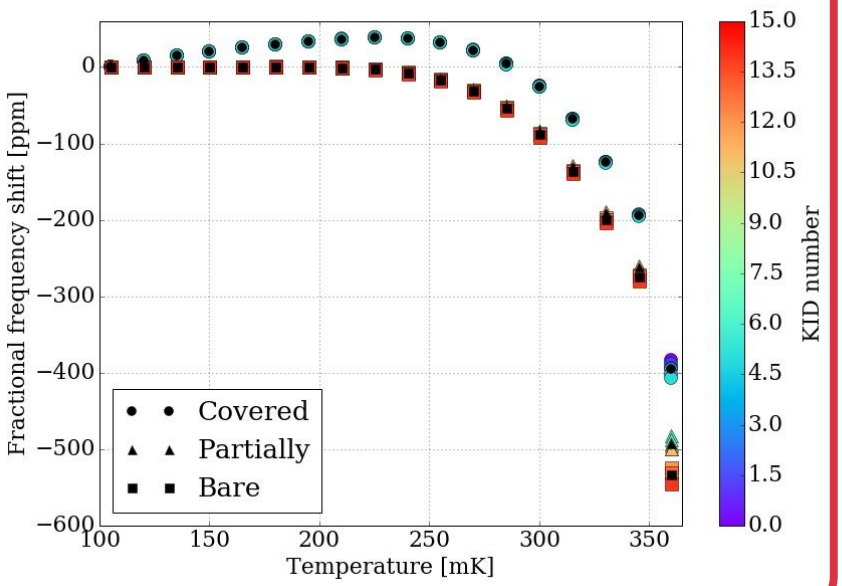
Dielectric coverage



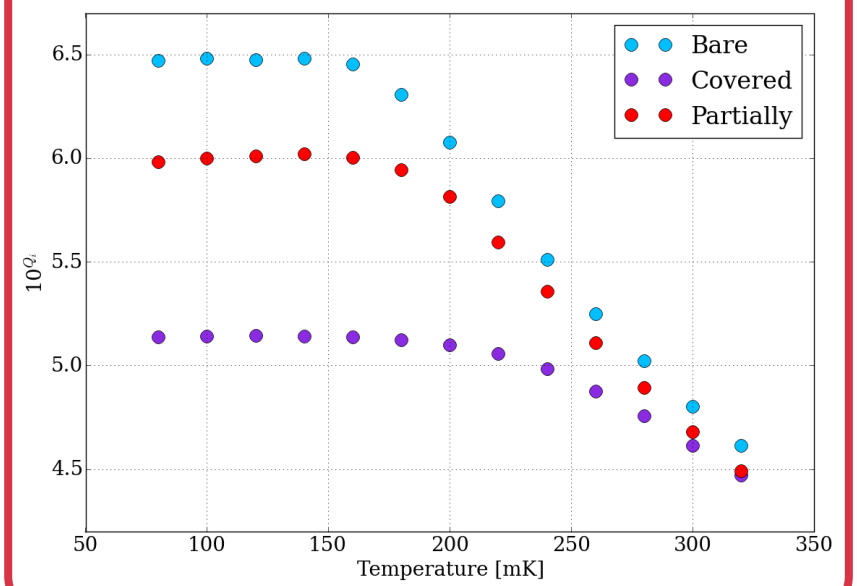
Spatially separated L and C allows us to form a microstrip line from the inductor with **minimal effect on resonator loss**

TLS backbending and Q_i

Dark results



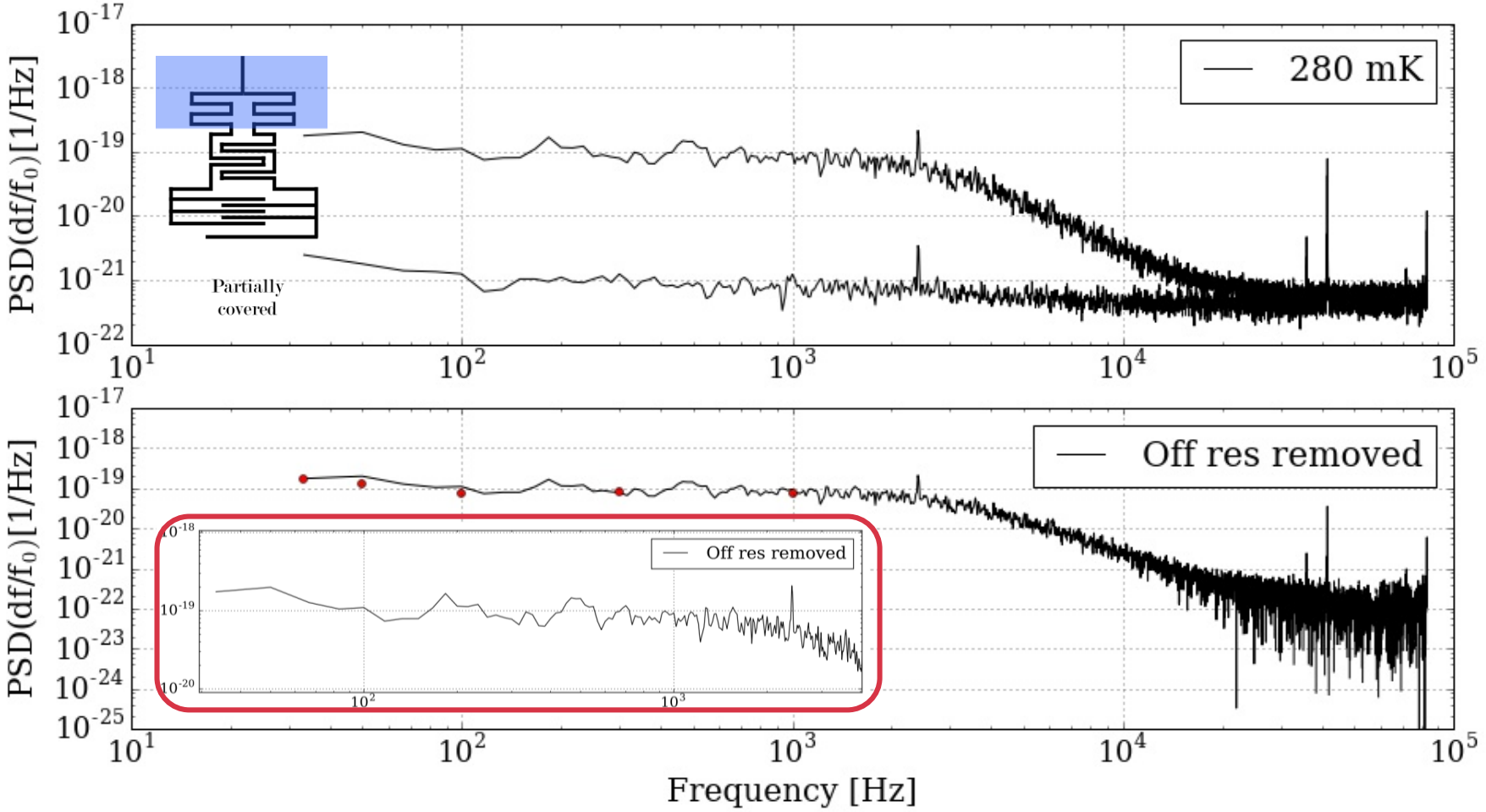
Intrinsic Quality Factor



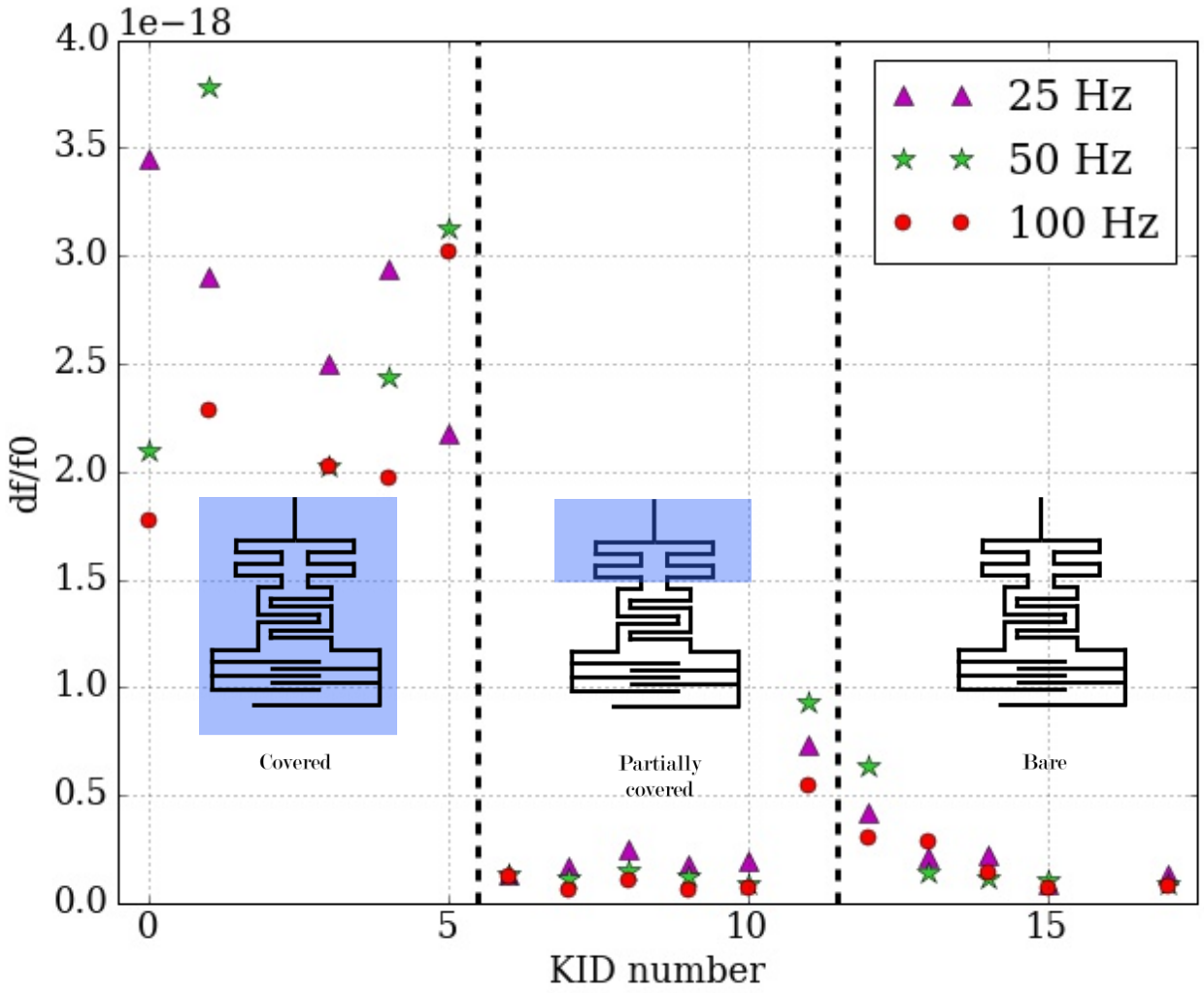
Varied the temperature of the baseplate and measured S_{21}

- Intrinsic quality factor, $Q_i > 10^5$
- TLS back-bending reduced via dielectric removal

Example noise plot

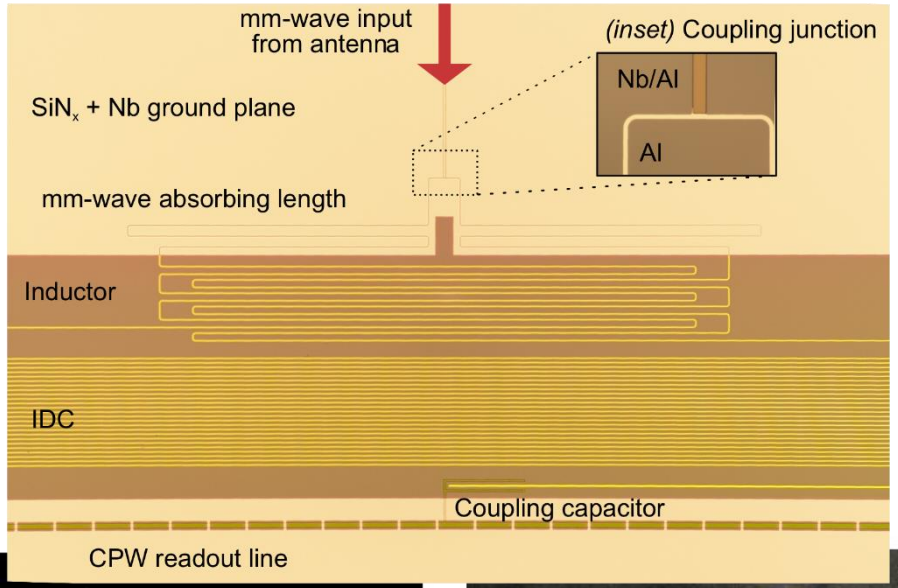


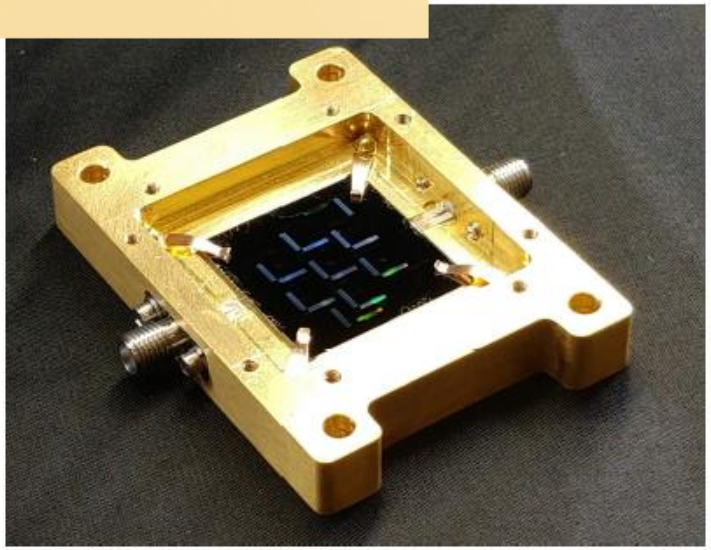
Investigating df/f0



Prototype device

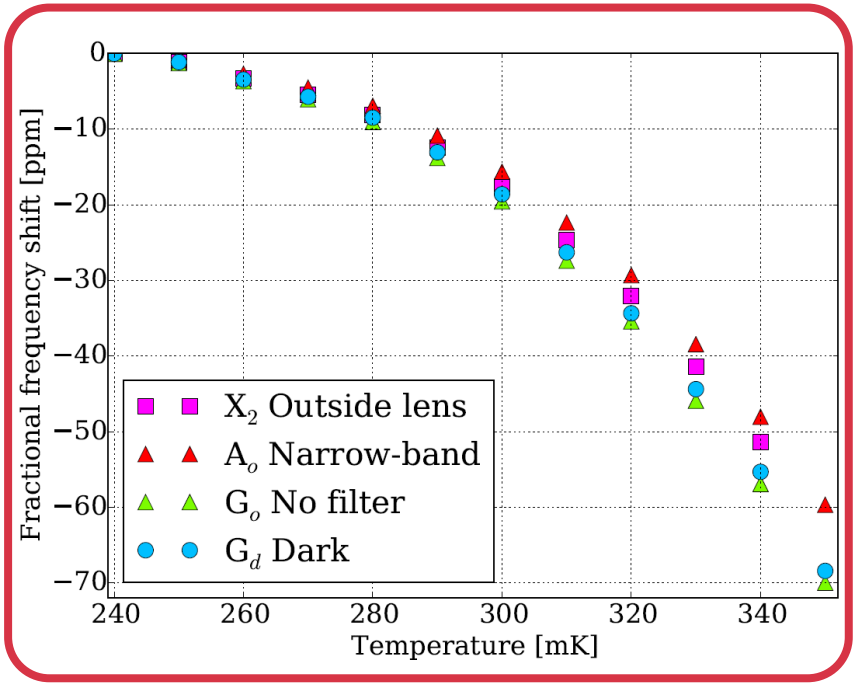
P.S.Barry et al. J Low Temp Phys (2018)



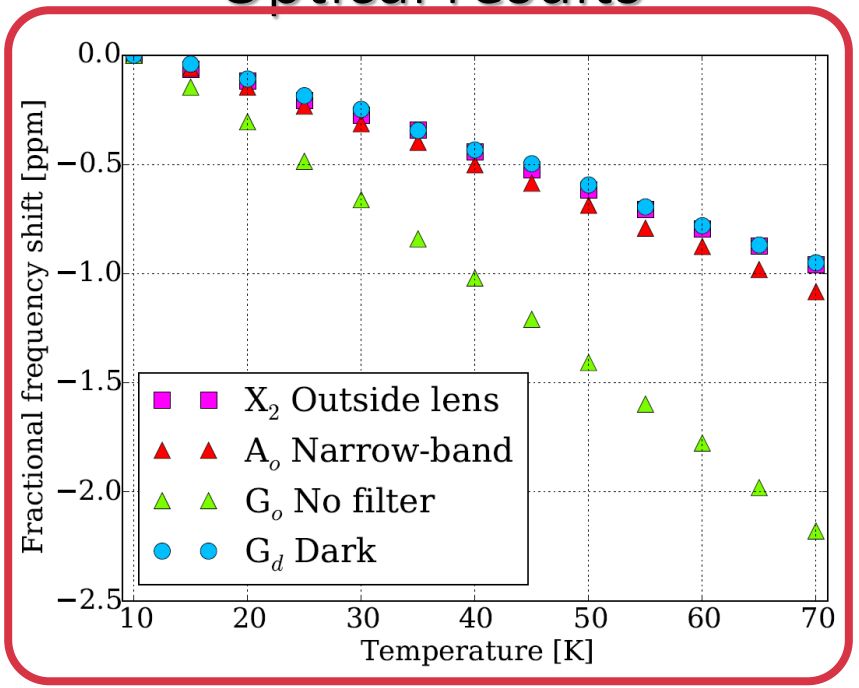


Optical results

Dark results



Optical results

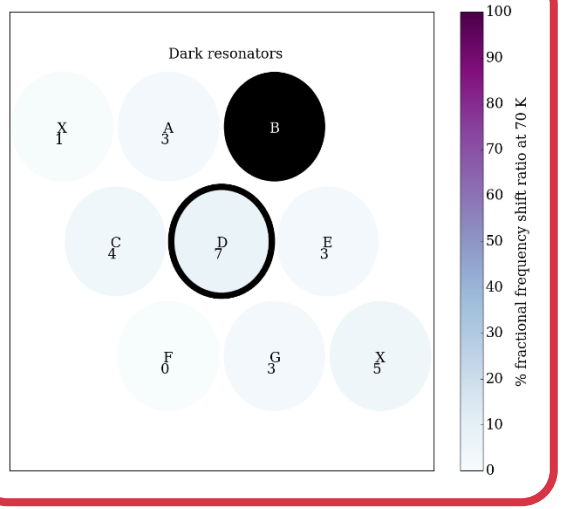


Varied the temperature of the baseplate and blackbody source and measured S_{21}

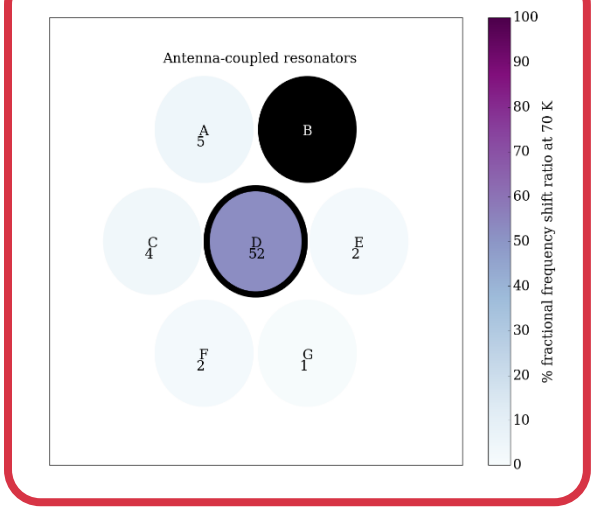
- Intrinsic quality factor still > 10^5
- BUT the dark detectors are responding to light

Metal aperture testing

Dark



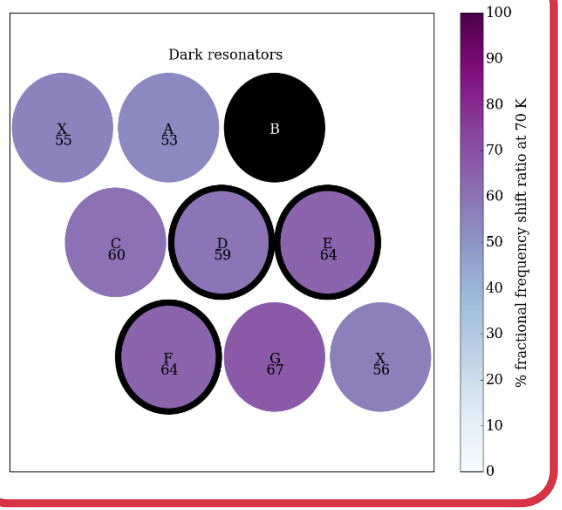
Antenna-coupled



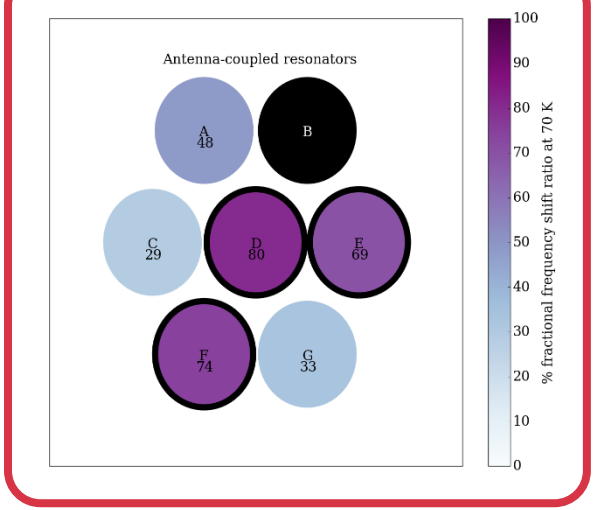
Adding a physical aperture reduced the response of **all resonators,** but the exposed dark and antenna-coupled resonators responded the most

Metal aperture testing

Dark



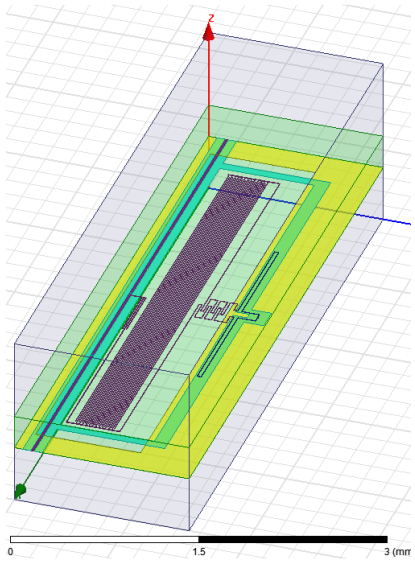
Antenna-coupled

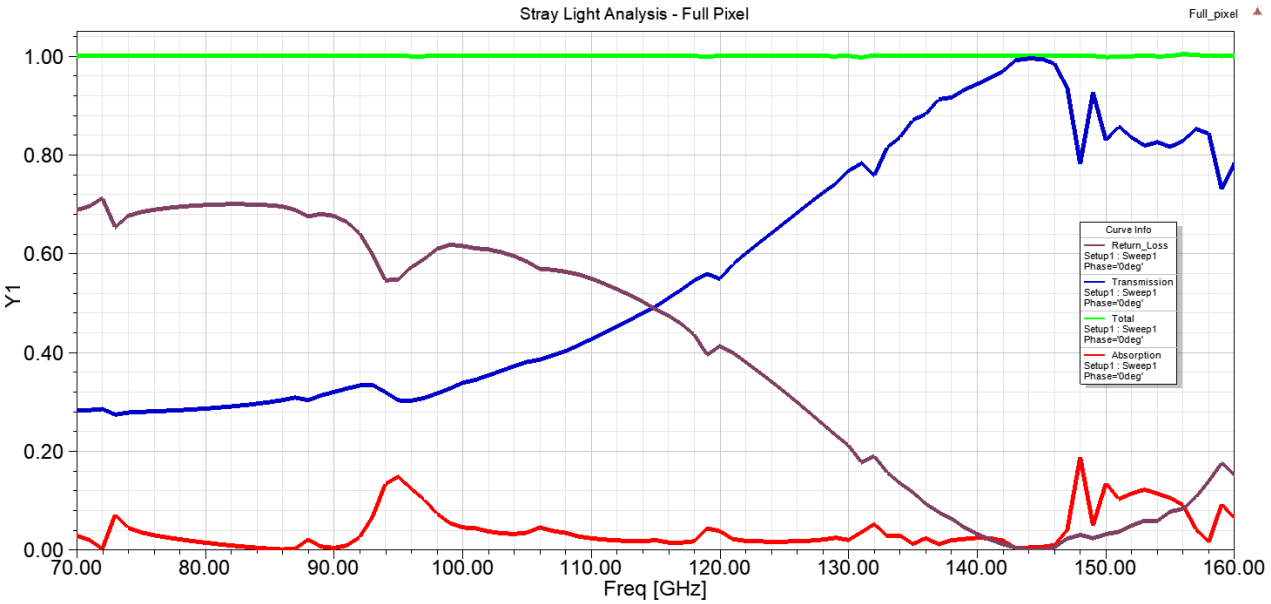


Adding a physical aperture reduced the response of **all resonators,** but the exposed dark and antenna-coupled resonators responded the most

BUT opening further apertures caused all devices to respond more

Future work

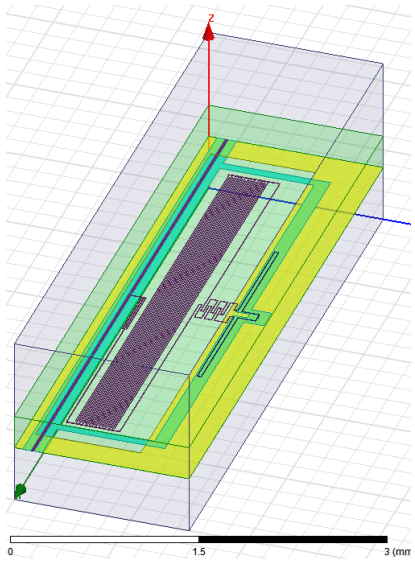


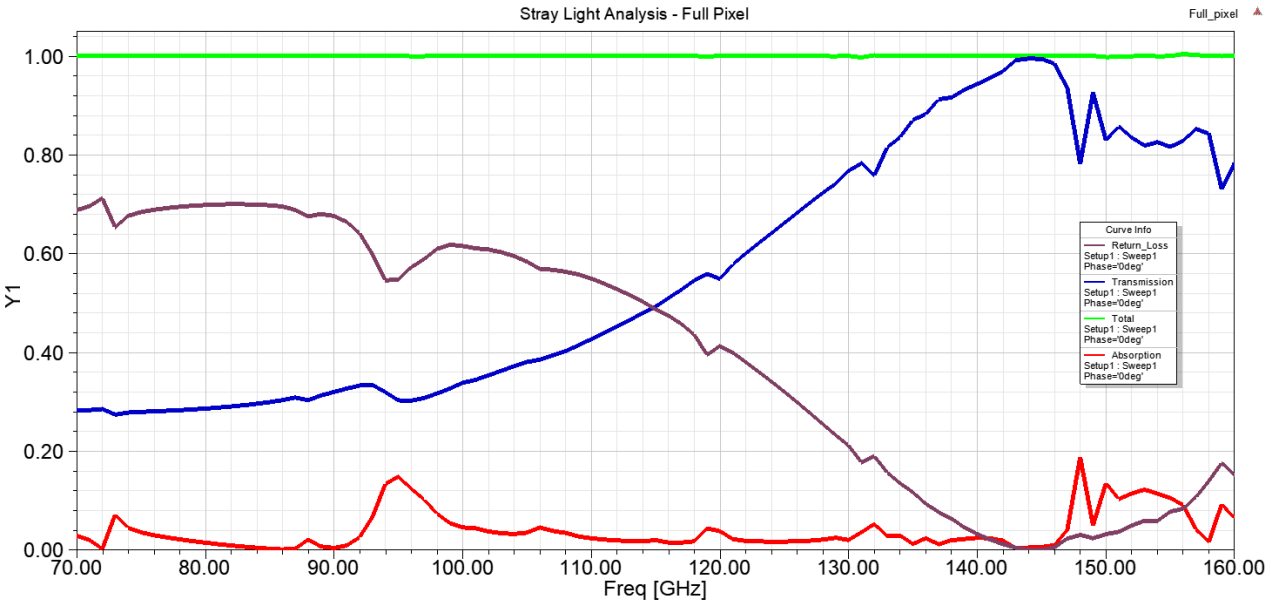


Currently, we are:

- Using HFSS to look at where light is being **directly absorbed** to optimise KID geometry
- Investigating different geometries for an **absorbing layer**

Future work





But we also have to consider coupling to a horn instead of a lens.

Dr. Pete S. Barry (Argonne National Laboratory)

Optical performance of the antenna-coupled lumped-element kinetic inductance detector

Today at 15:35

Conclusion

To summarise:

- Proposing to couple light to **KIDs via a lens and antenna**, but this requires dielectric materials
- Using the separated architecture of LEKID means we can control where dielectrics go
- Dielectric materials can be used in the coupling scheme, just **avoid the capacitive regions**

- Stray light is problematic, causing non-optically-coupled detectors to respond **BUT detectors are not optimised**

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