Design and Simulation of Various KID Geometries used to Readout Elements of a mm-wave Filter Bank Spectrometer

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July 28, 2011

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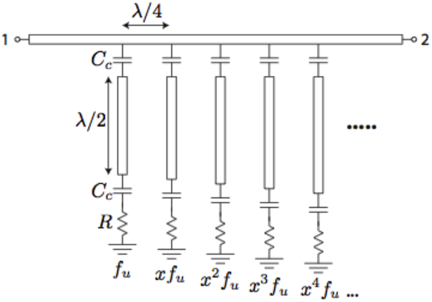
Overview

- Briefly describe the SuperSpec concept
- Discuss the simulation results of various mm-wave resonator geometries
- Discuss possible coupling schemes for KID readout

SuperSpec Concept

- Superconducting filter bank utilising KID technology
- Antenna guides broadband radiation onto planar transmission line (e.g. CPW, microstrip)
- Series of half-wave ($\lambda_n/2$) resonators separate mm-radiation into N_C frequency bands (λ_n is central wavelength of channel n)
- KID is coupled to each individual channel allowing simultaneous readout of all channels



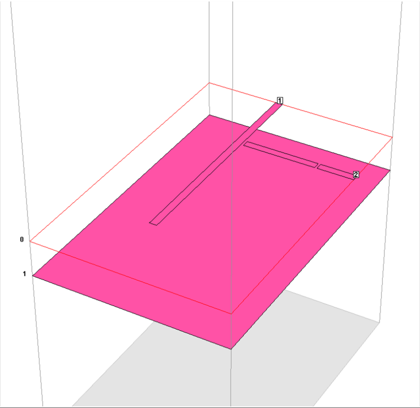
Zmuidzinas and Kovacs memo (2010)

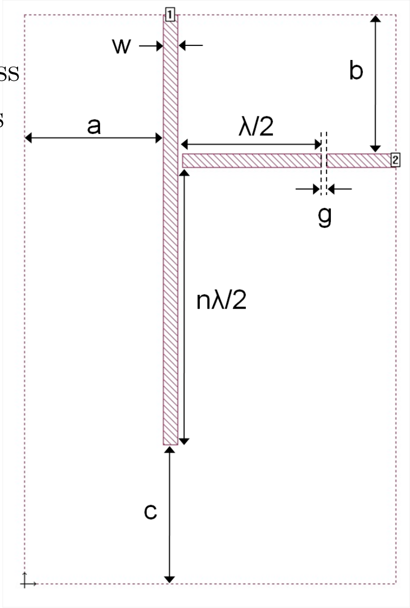
mm-Wave Filter Designs

- Simulation software - Sonnet EM and ADS
- $\lambda/2$ open circuit termination - theoretically 100% in band power transmission to detector
- Matched termination to feedline characteristic impedance (Z_0) - 80-85% power transmission - the 'U' resonator
- Only microstrip architecture presented here

$\lambda/2$ Open Circuit Termination

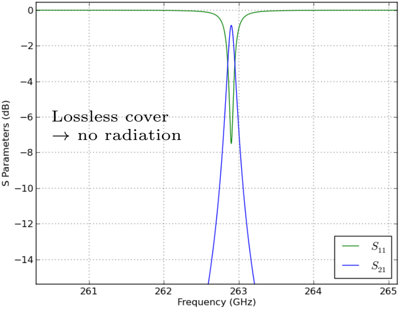
- Microstrip using h/w
  $Z_0 \simeq 50\,\Omega$, h = substrate thickness
- Antenna and detector modeled as lumped port impedance

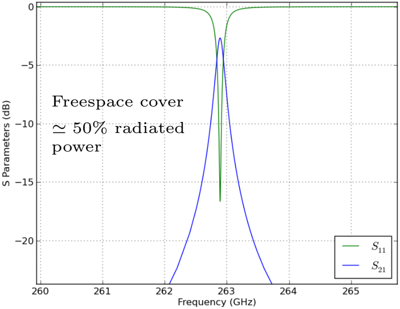




$\lambda/2$ Open Circuit Termination

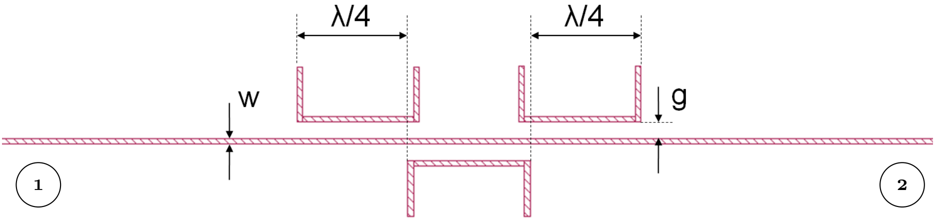
- Problem with amount of power radiated
- $P_{rad} = 1 - (|S_{21}|^2 + |S_{11}|^2)$
- Possible solution to meander a λ resonator (not shown here)



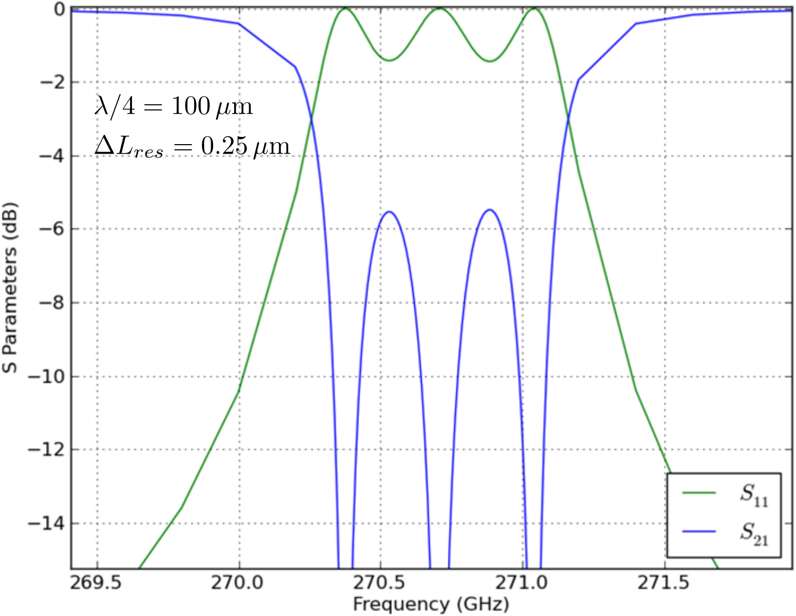


Matched Termination

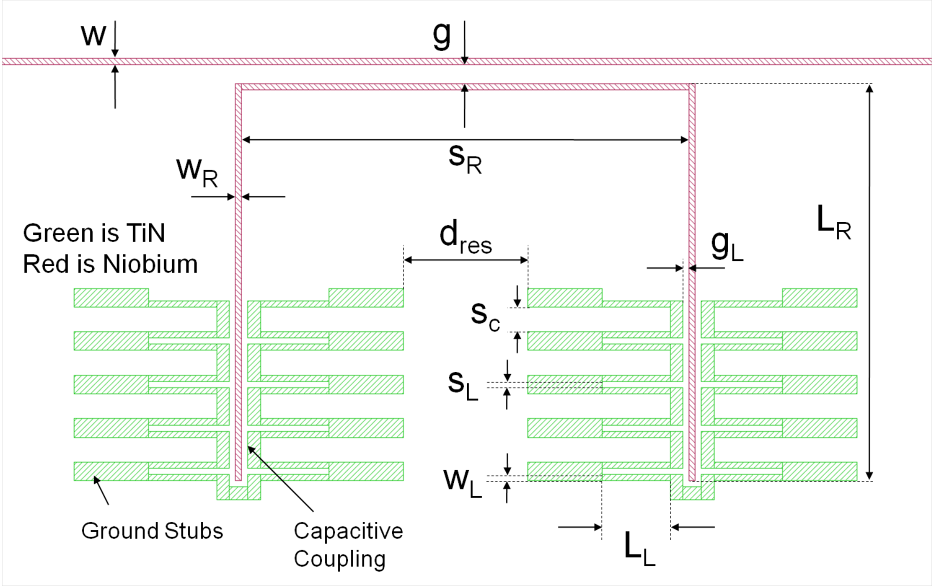
- $\lambda/2$ 'U' resonators coupled to feedline
- $\lambda/4$ spacing of resonators provides constructive inteference
- Able to control Q_C by varying distance from the feedline (g)



Matched Termination



Matched Termination - Loaded



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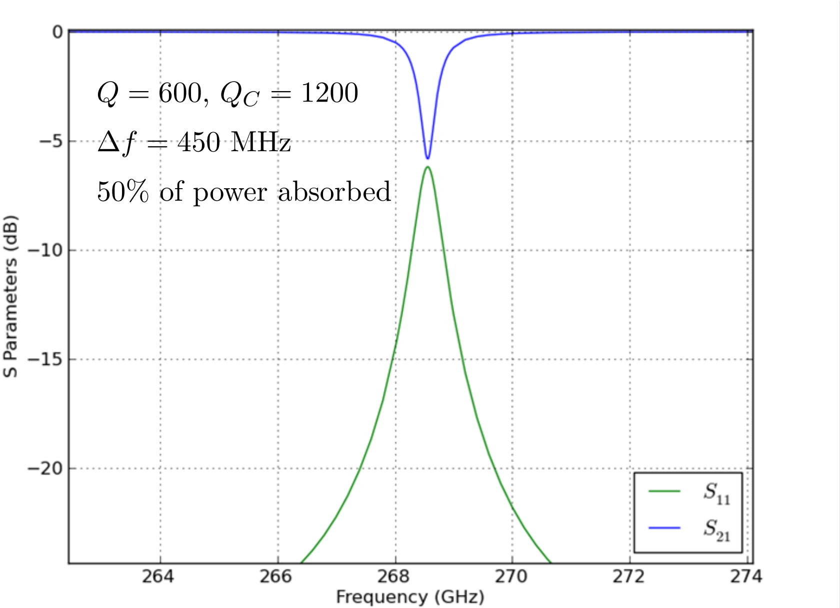

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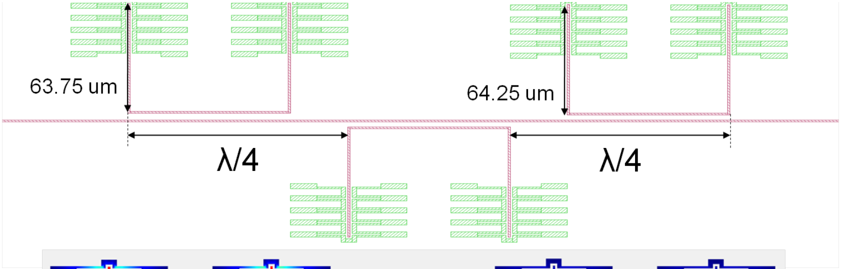
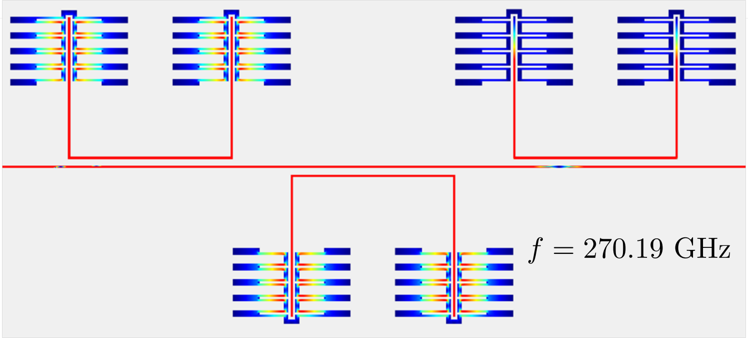
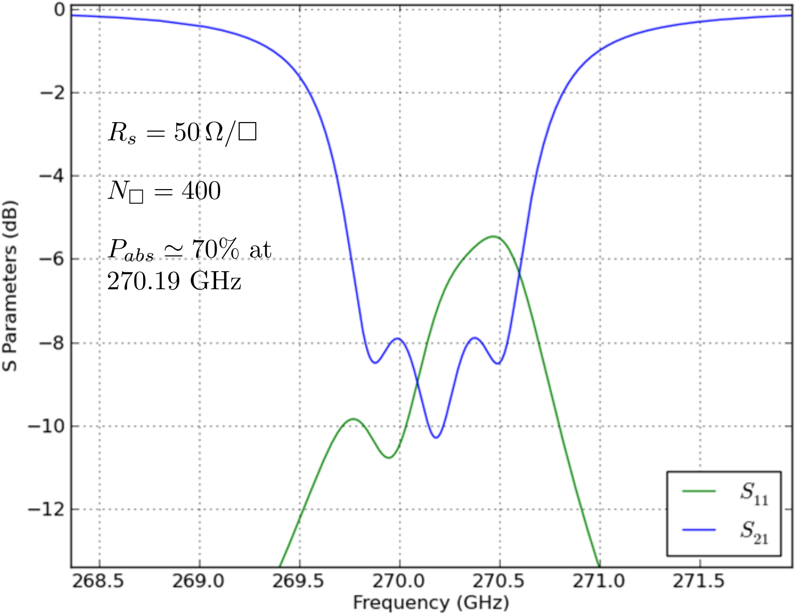


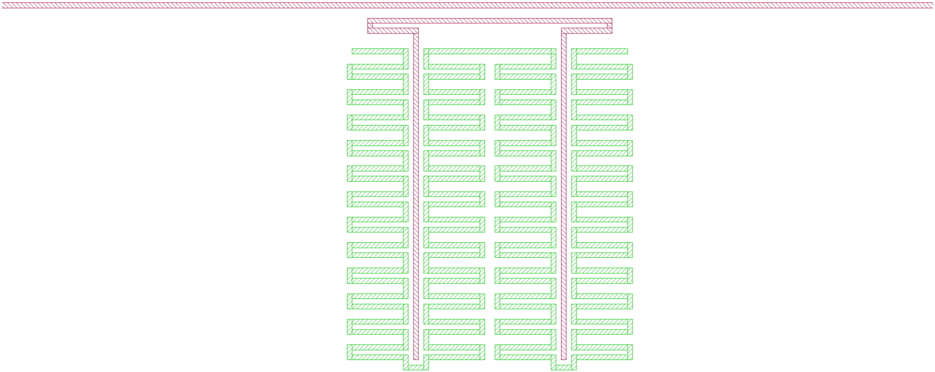


Matched Termination

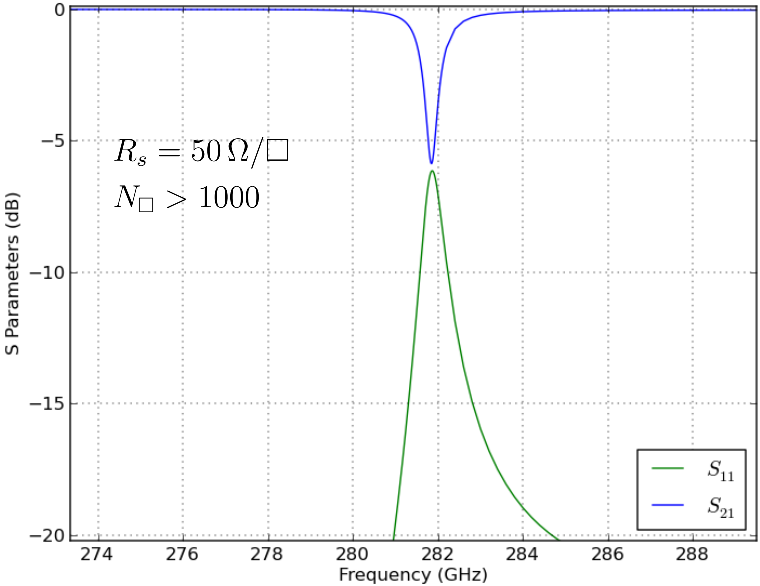


Matched Termination - Loaded

- Motivated by desire to decrease the MKID readout frequency
  → higher inductance required
- Also have a lot of unused space

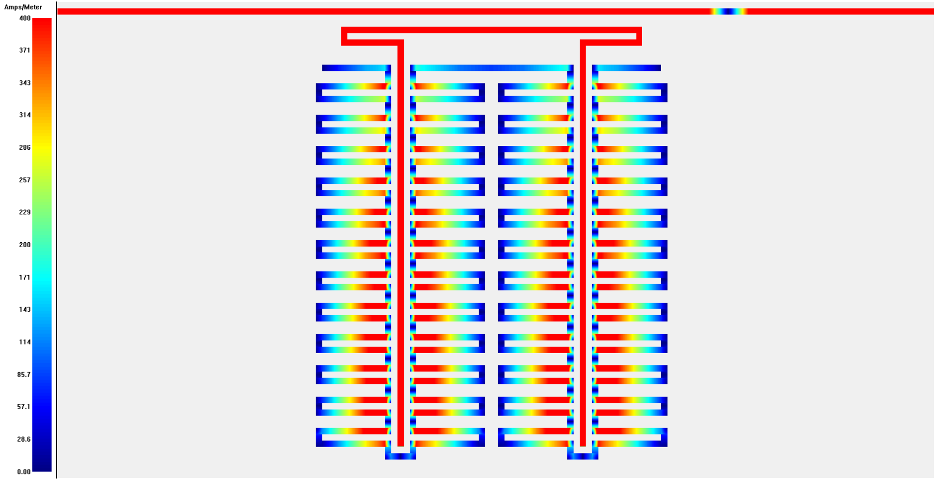


Matched Termination - Loaded



Matched Termination - Loaded

- Current distribution at 281.8 GHz



Conclusions

- Starting to converge on a viable mm-wave design
- Next step is to add in the readout feedline to see effect on mm-wave circuit

Thanks to

- P. Mauskopf, S. Doyle (Cardiff)
- J. Zmuidzinas, A. Kovacs, M. Bradford, P. Day, G. Chattopadhyay, S. Padin, D. Marrone (apologies if I missed anyone out)