

Circuit-GNN: Graph Neural Networks for Distributed Circuit Design



Guo Zhang



Hao He



Dina Katabi

Poster #248



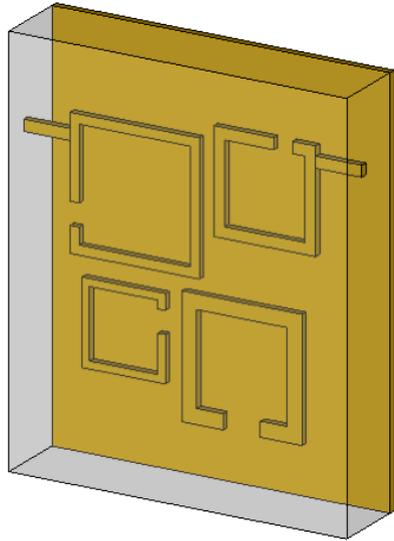
Distributed Circuit Design

Design high frequency circuits

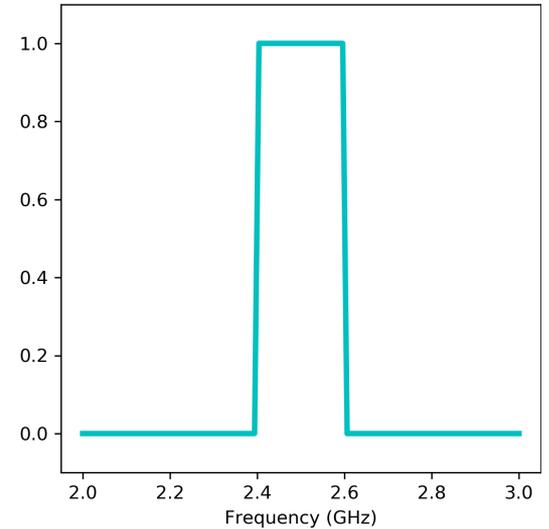
Important for 5G and future cellular networks!

Distributed Circuit Design

Circuit

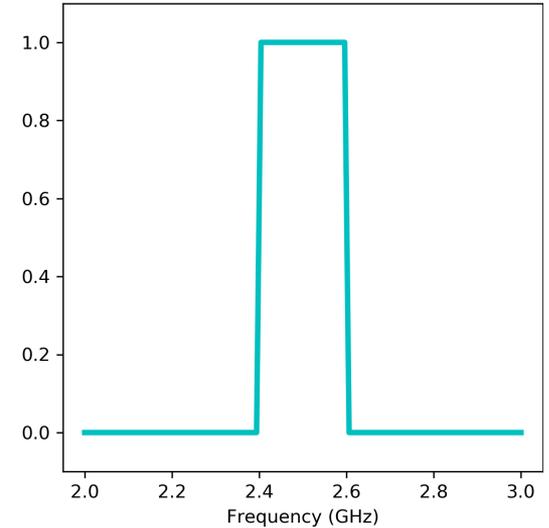
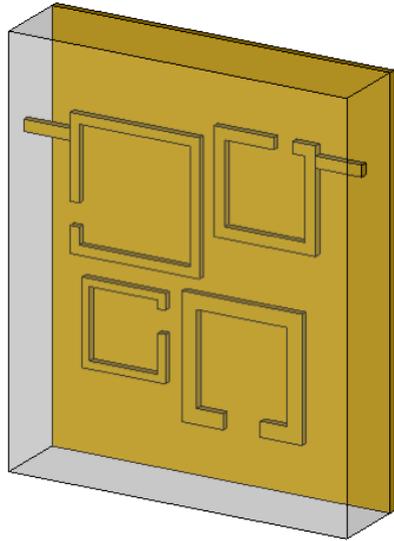


Desired Circuit Function

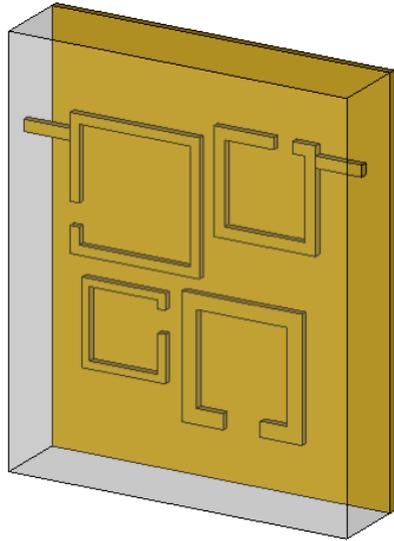


Distributed Circuit Design

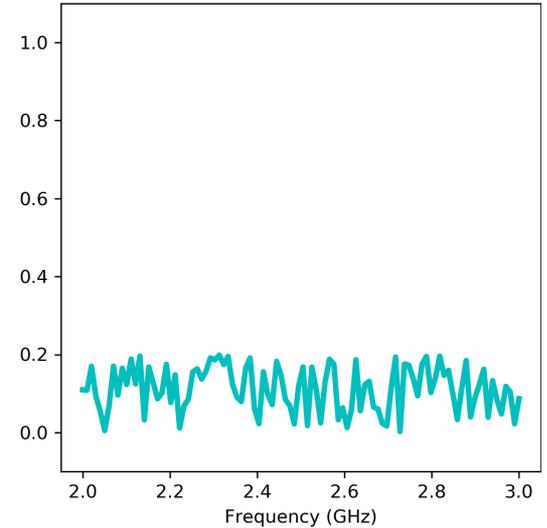
Initial Guess by Expert



Distributed Circuit Design

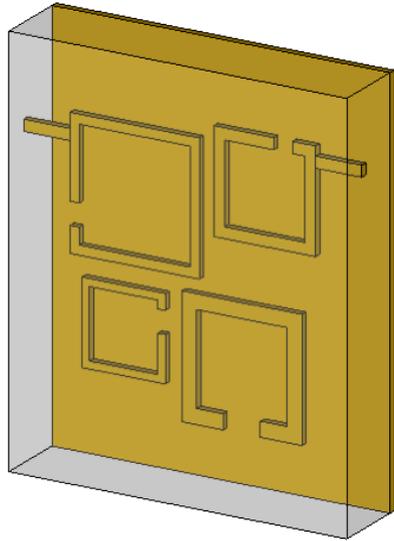


Simulation

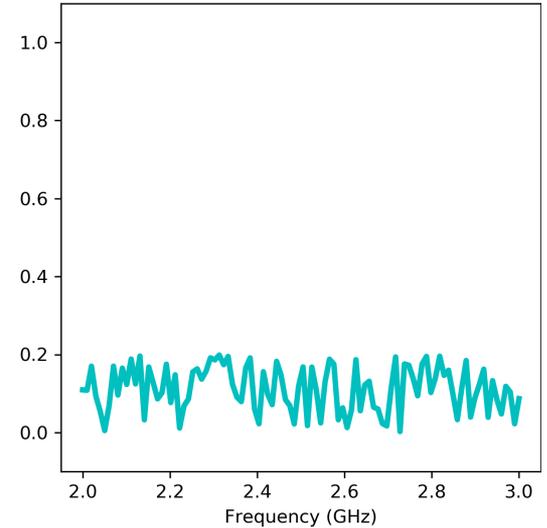


Distributed Circuit Design

Tune Design

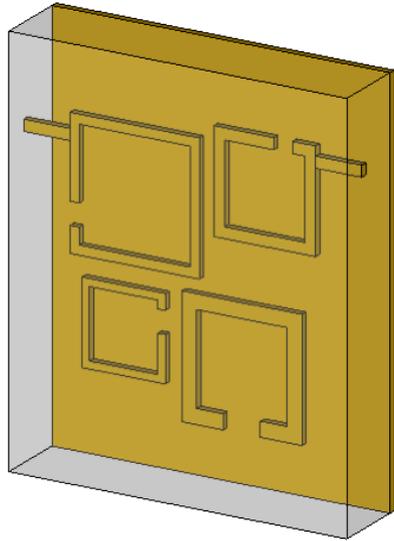


Simulation

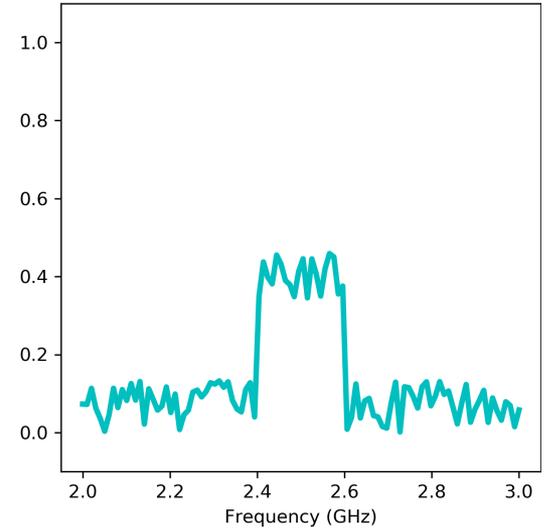


Distributed Circuit Design

Tune Design

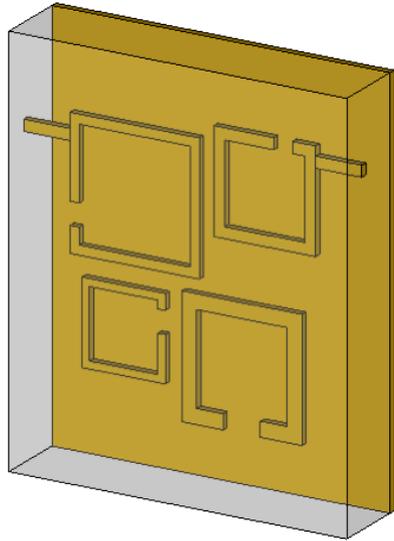


Simulation

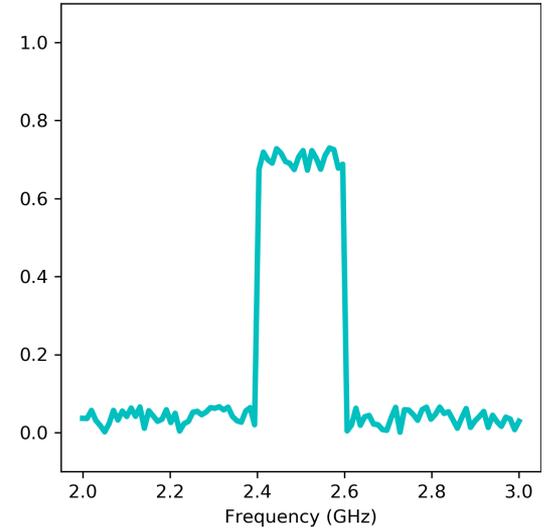


Distributed Circuit Design

Tune Design

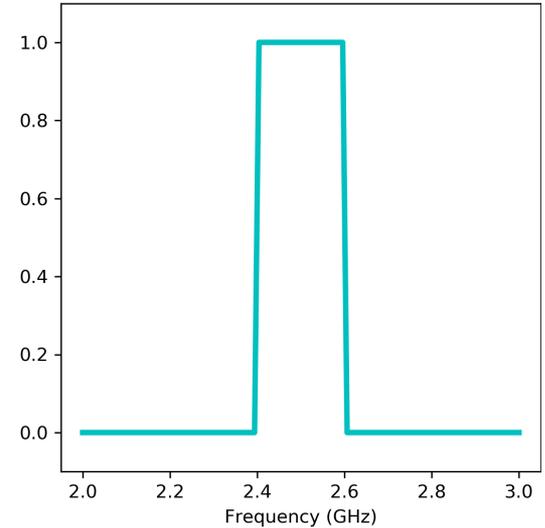
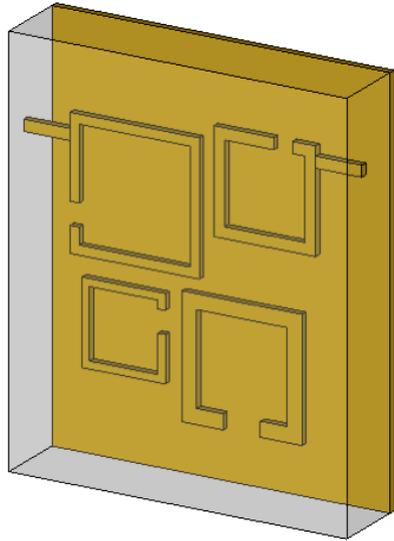


Simulation



Distributed Circuit Design

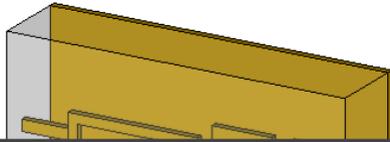
Tune Design



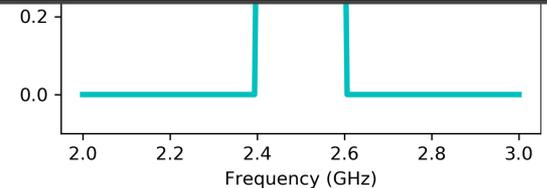
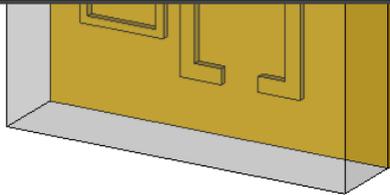
Simulation

Distributed Circuit Design

Tune Design



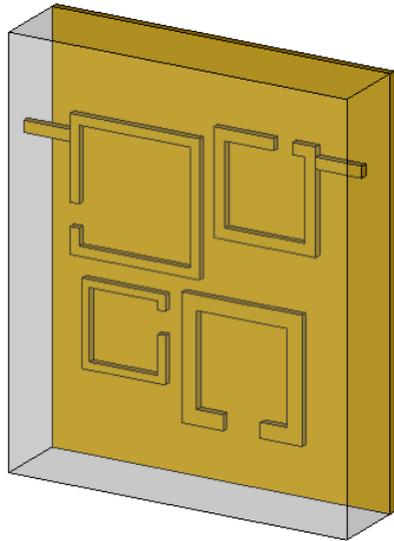
Many iterations which take **weeks or even months!**



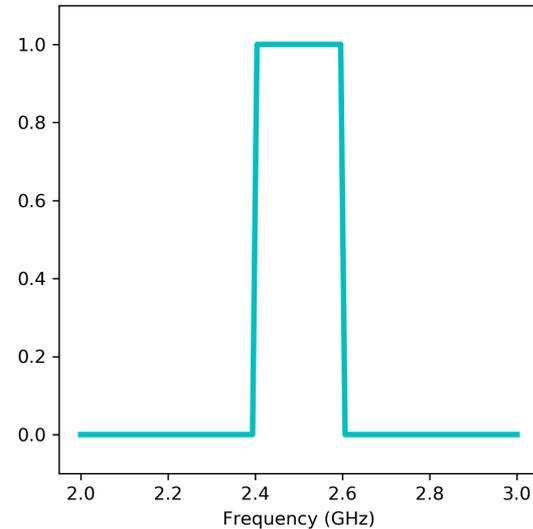
Simulation

Our Approach

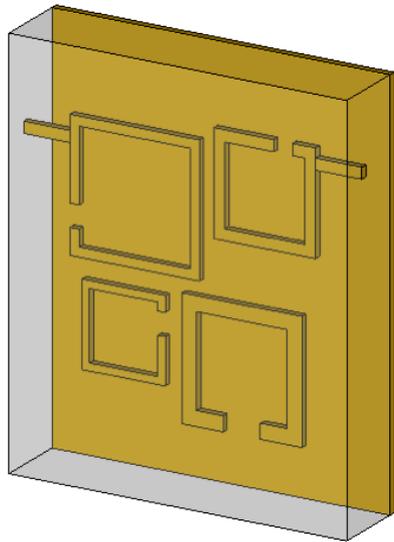
Tune Design



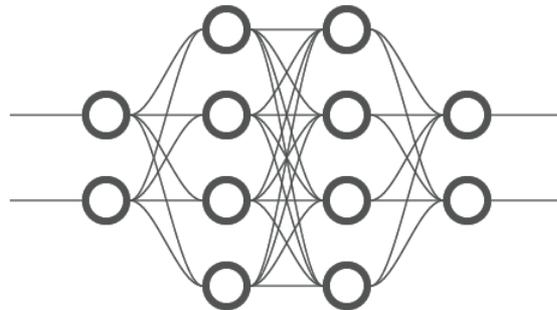
Simulation



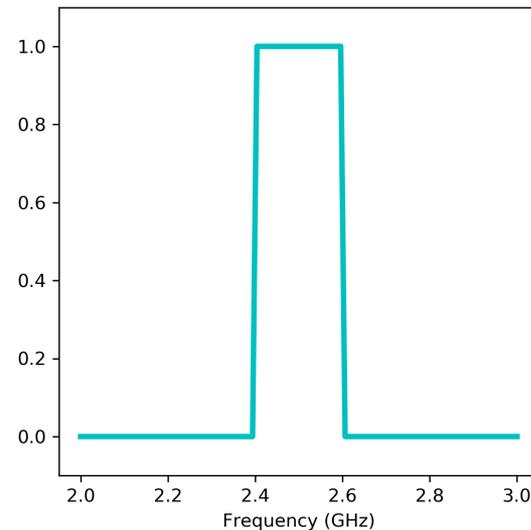
Our Approach



Back-propagation



Neural Simulator



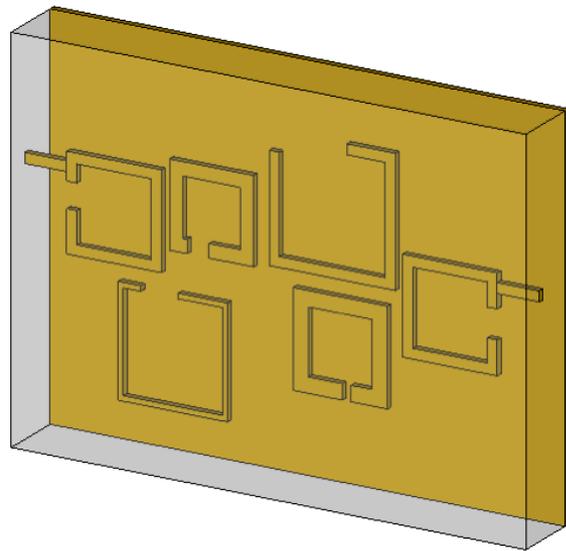
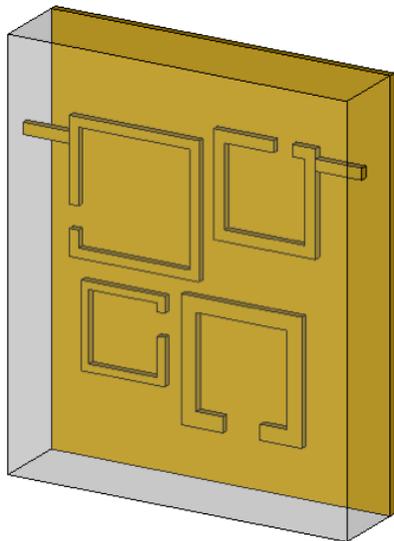
Our Approach

	Traditional solution
Forward Simulation	Minutes
Inverse Design	Weeks or months

Our Approach

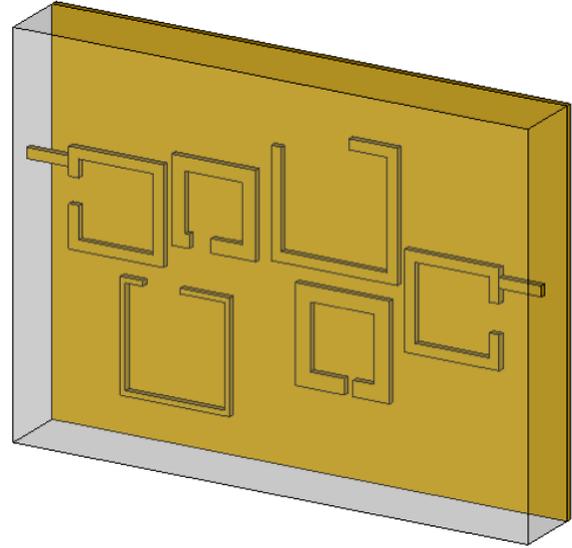
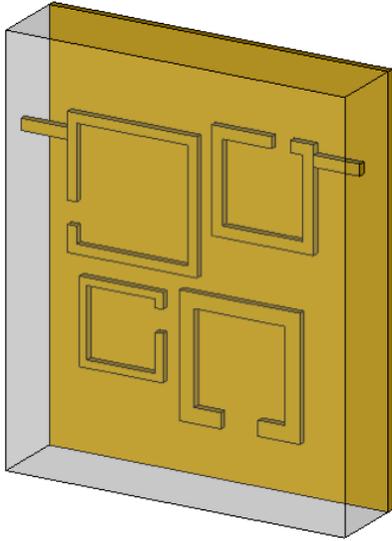
	Traditional solution	Our solution
Forward Simulation	Minutes	Milliseconds
Inverse Design	Weeks or months	Minutes

Challenge 1: One Neural Net for Various Topologies



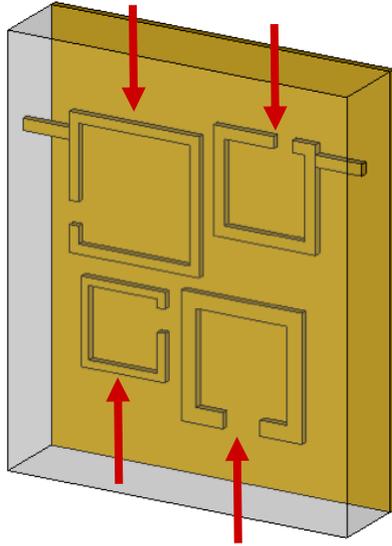
Challenge 1: One Neural Net for Various Topologies

Solution: Graph Neural Net

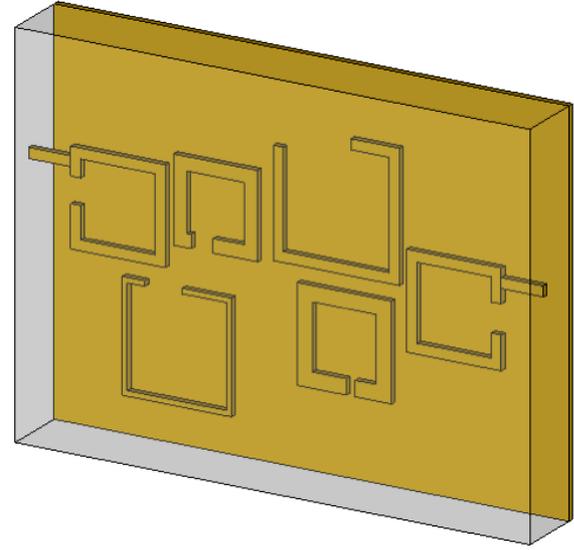


Challenge 1: One Neural Net for Various Topologies

Solution: Graph Neural Net

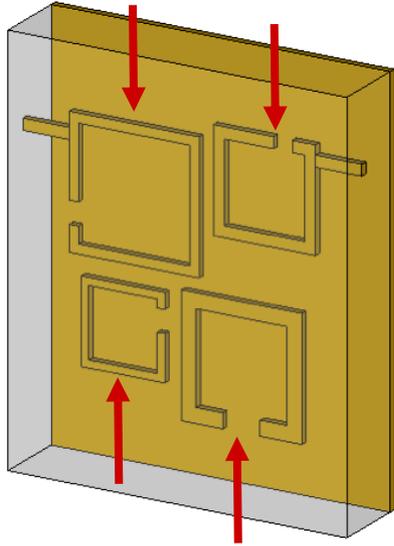


Resonators

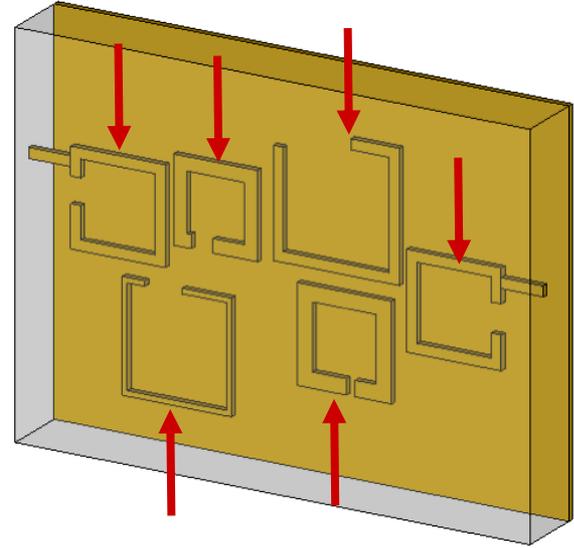


Challenge 1: One Neural Net for Various Topologies

Solution: Graph Neural Net



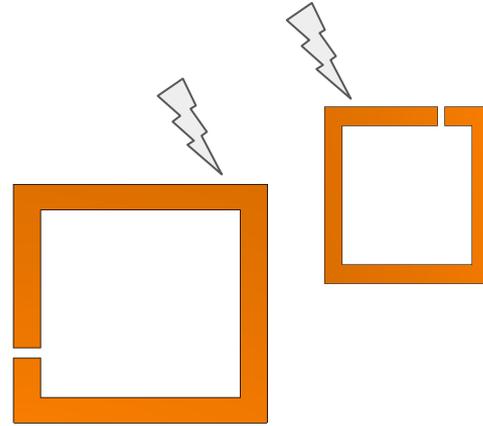
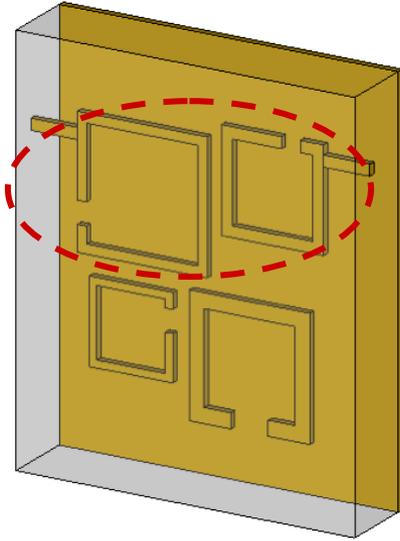
Resonators



Resonators

Challenge 1: One Neural Net for Various Topologies

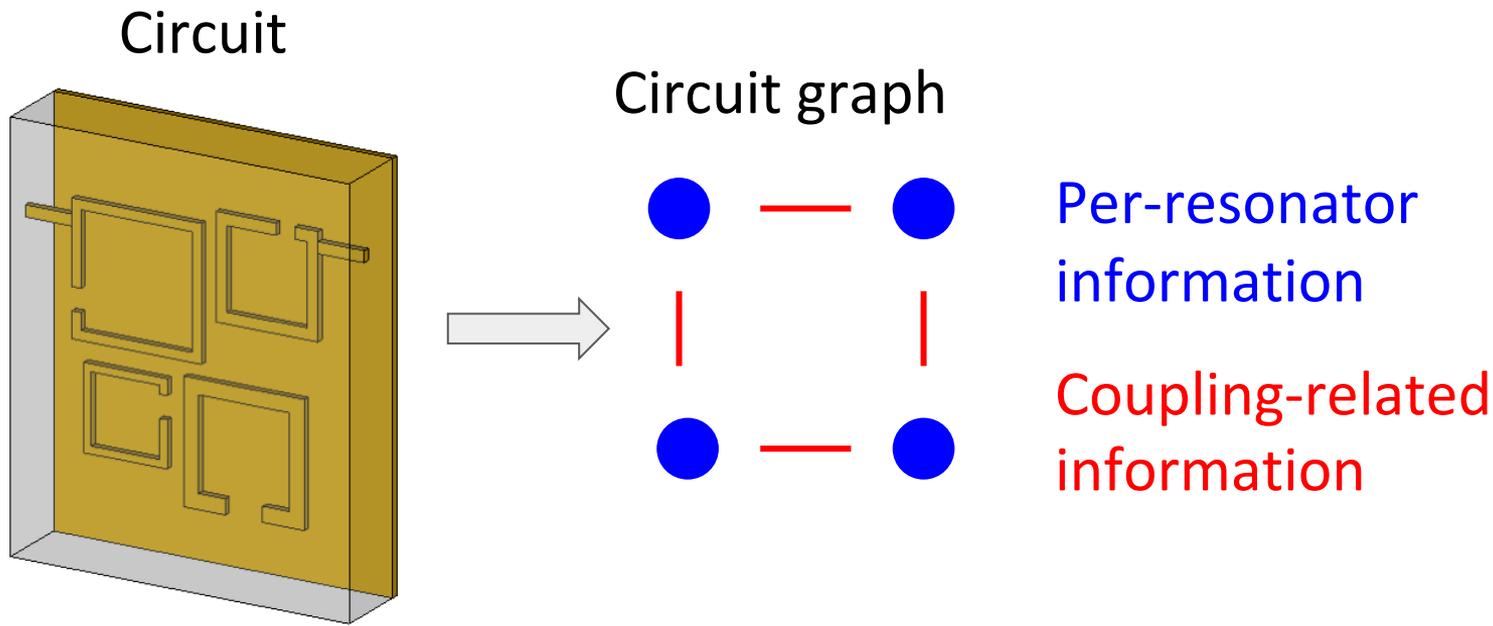
Solution: Graph Neural Net



Resonators Interact via
Electromagnetic Coupling

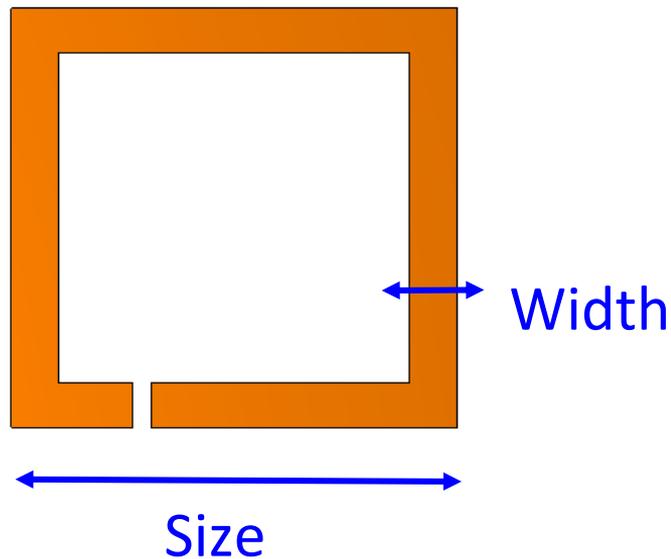
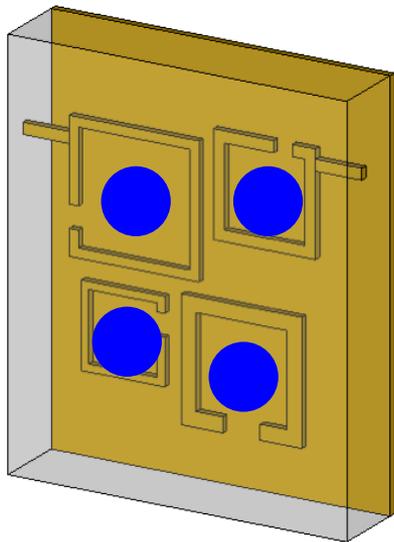
Challenge 1: One Neural Net for Various Topologies

Solution: Graph Neural Net



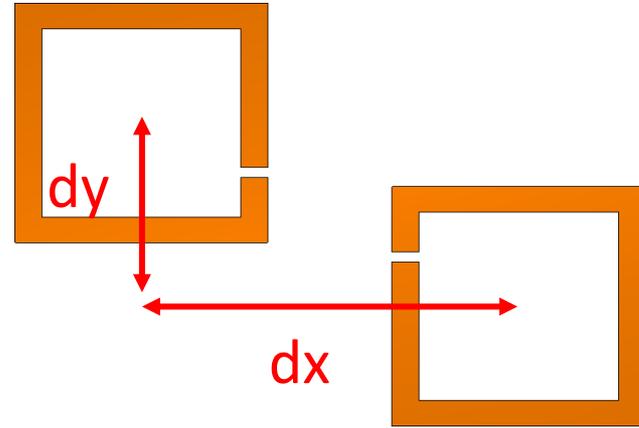
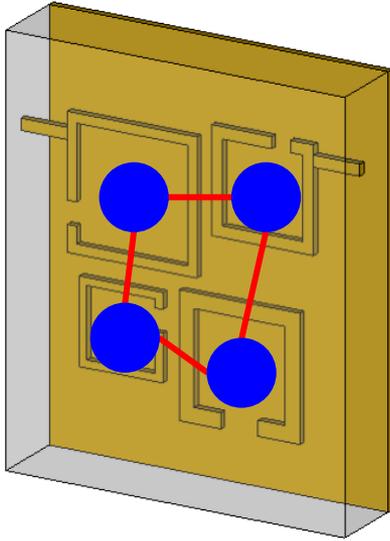
Challenge 1: One Neural Net for Various Topologies

Solution: Graph Neural Net

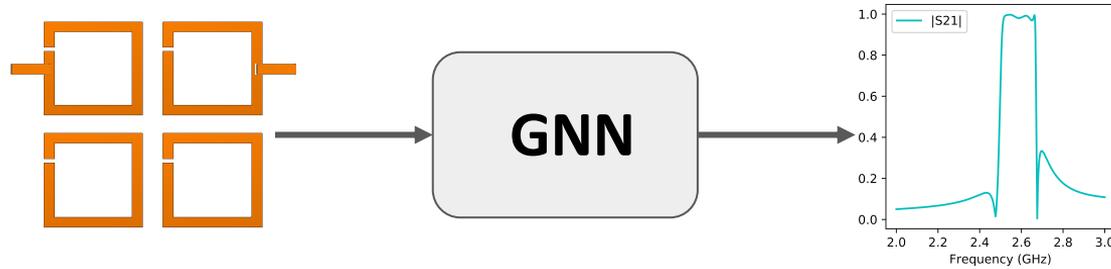


Challenge 1: One Neural Net for Various Topologies

Solution: Graph Neural Net

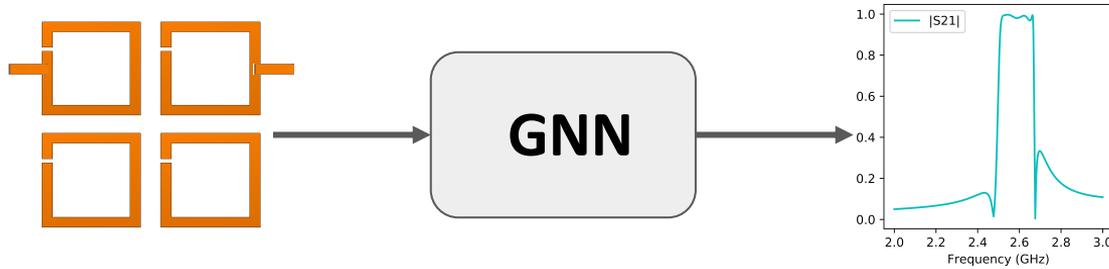


Circuit Simulation with GNN



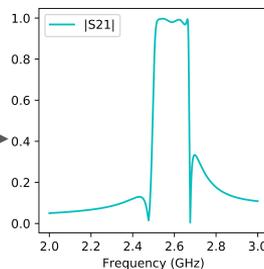
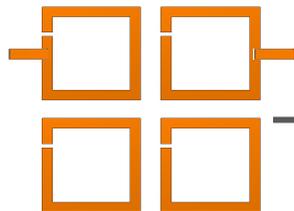
Design Circuit with Back-Propagation

Initial Design

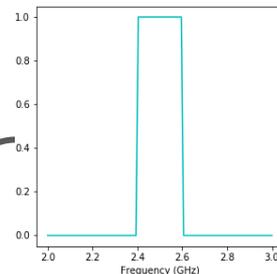


Design Circuit with Back-Propagation

Initial Design

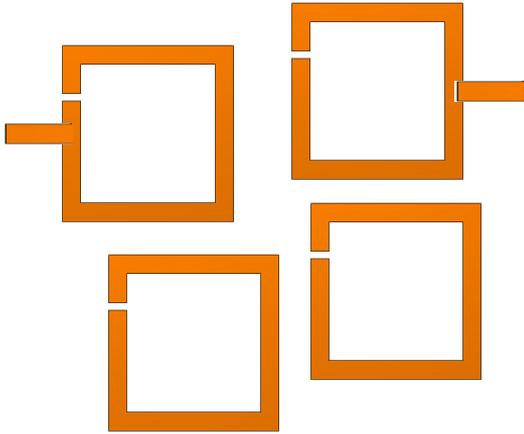


Target function

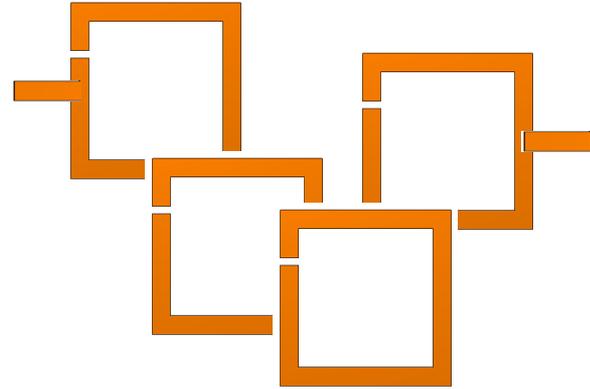


L2 distance

Challenge 2: Ensure Valid Design

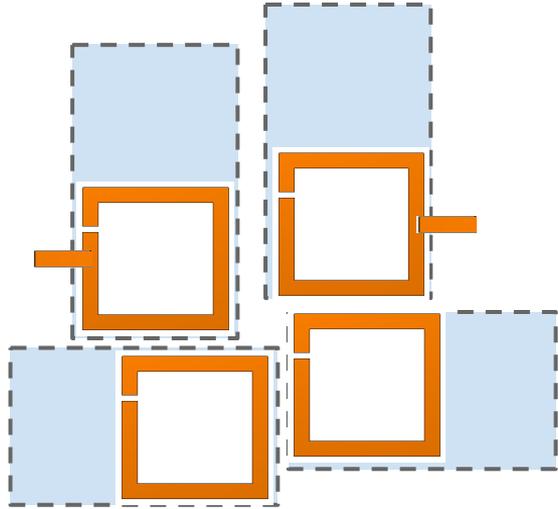


Valid Design



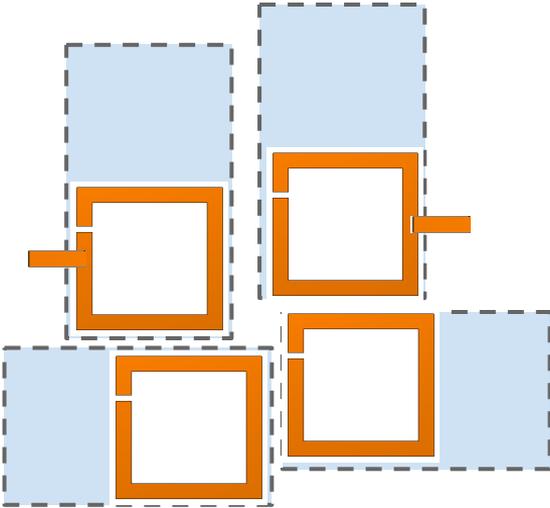
Invalid Design

Solution: Moving Range Constraints

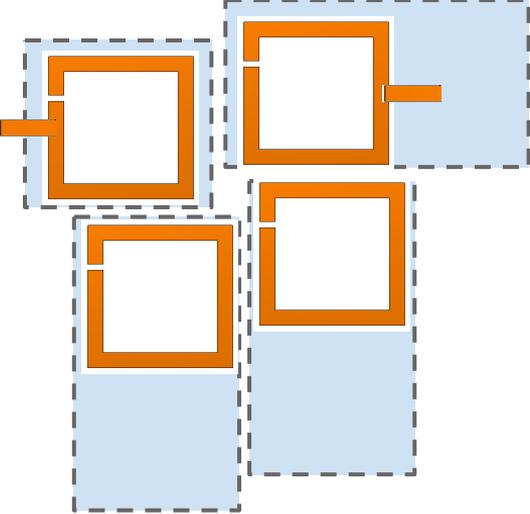


Step 1

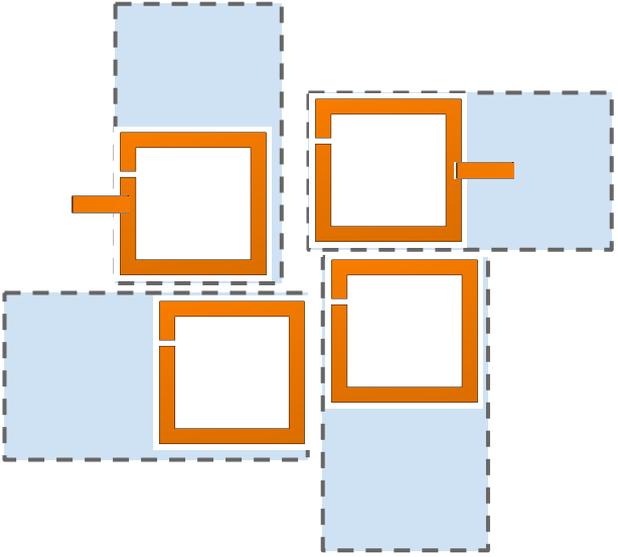
Solution: (Stochastic) Moving Range Constraints



Step 1



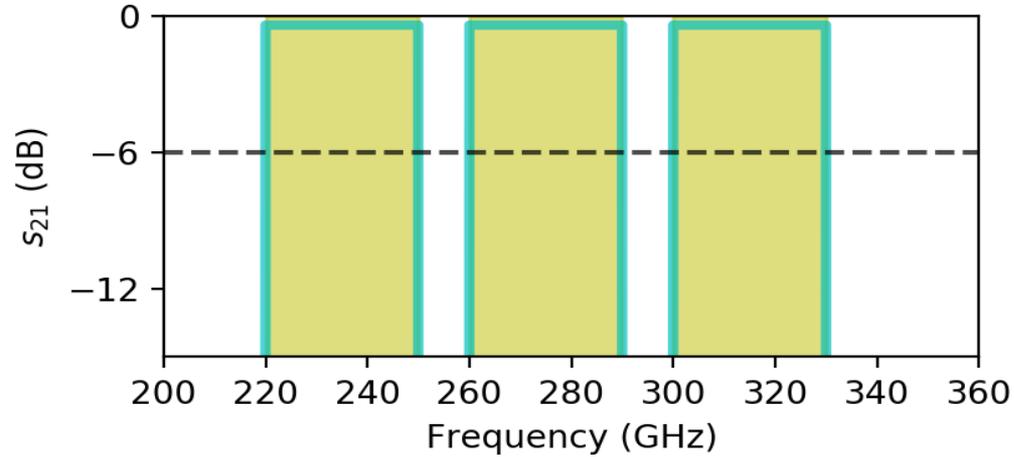
Step 2



Step 3

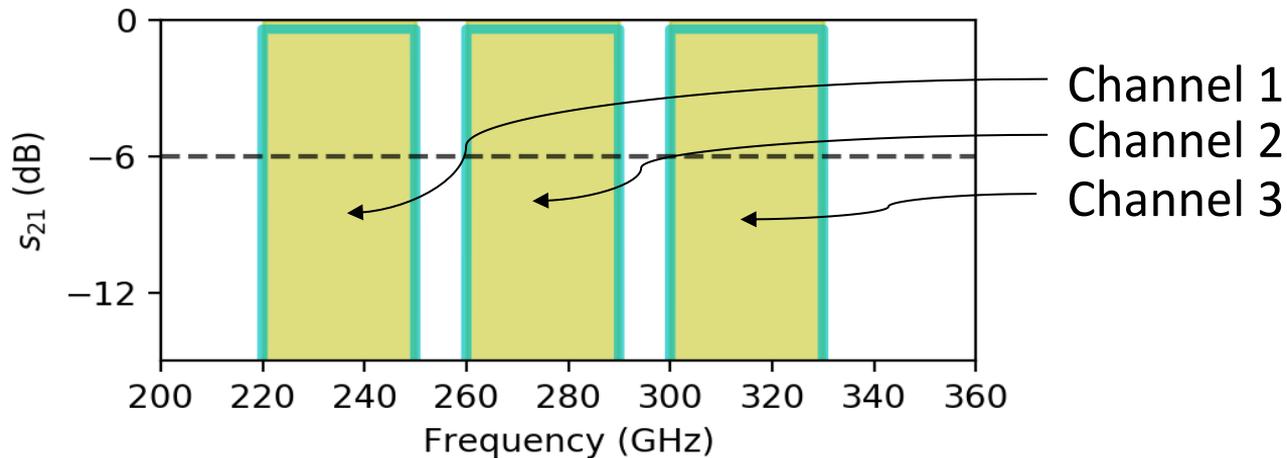
Results – Comparison to Human Expert

**Desired Ideal
Function**



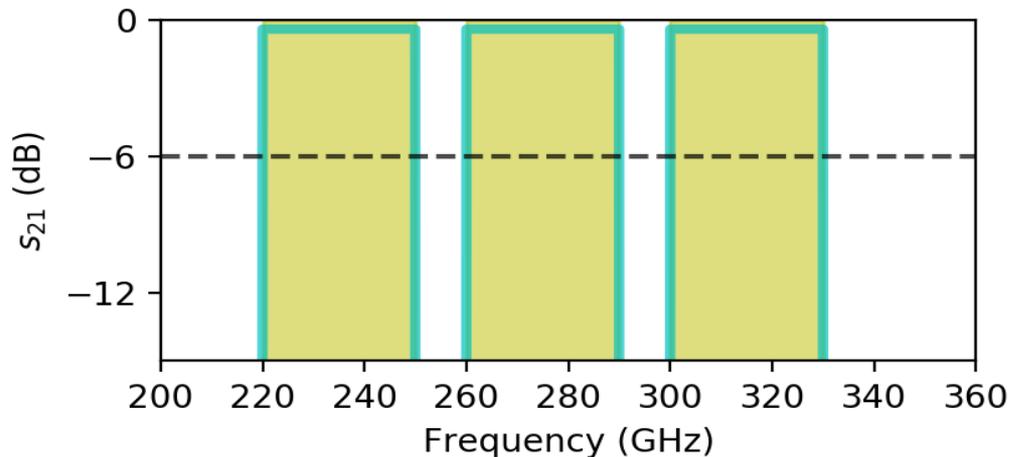
Results – Comparison to Human Expert

Desired Ideal Function

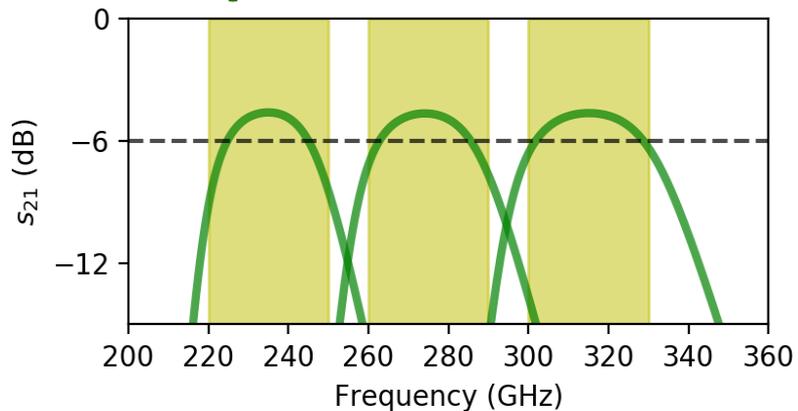


Results – Comparison to Human Expert

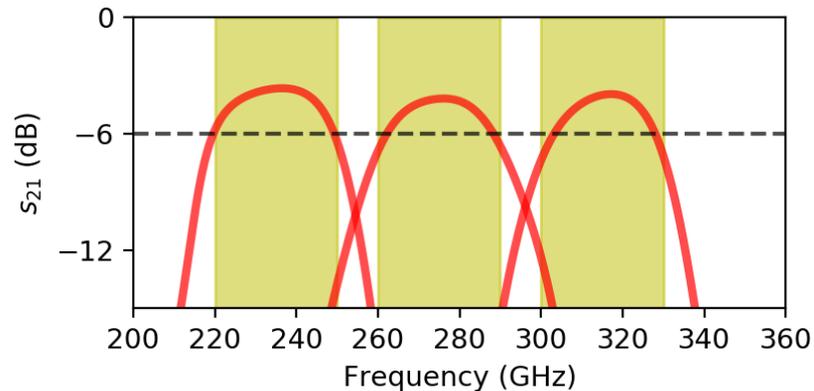
Desired Ideal Function



Expert: 2 months

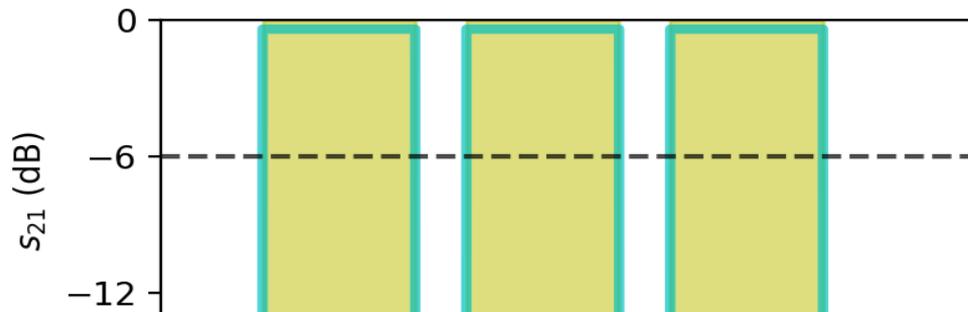


Ours: 5 minutes

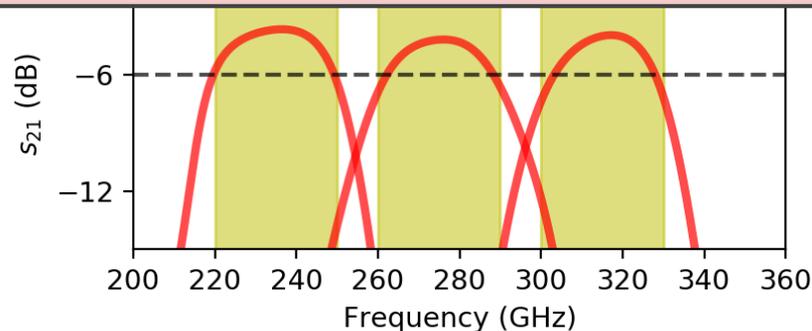
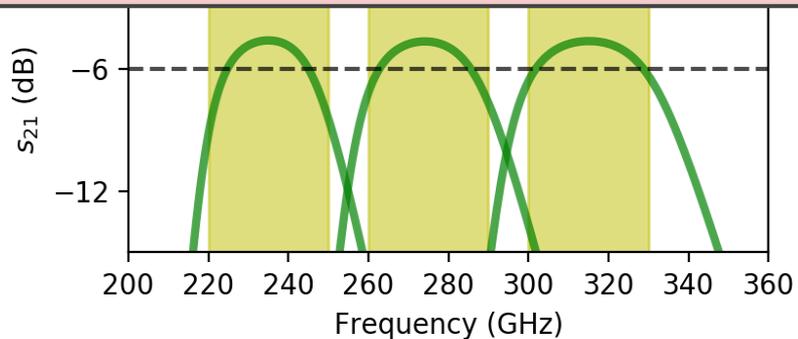


Results – Comparison to Human Expert

Desired Ideal
Function



Speed up **10000X !**
(more results in paper)



Poster

Tue 06:30 -- 09:00 PM @ Pacific Ballroom #248



Project Page