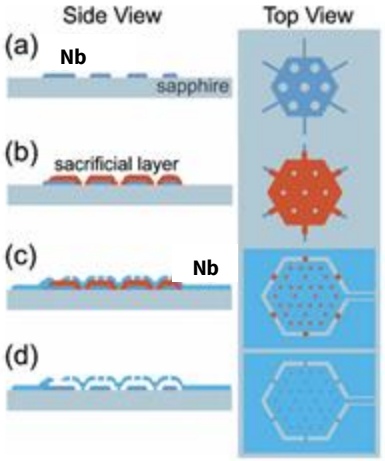
Superconducting Parallel Plate Capacitors with High Kinetic Inductance



Poster Presentation

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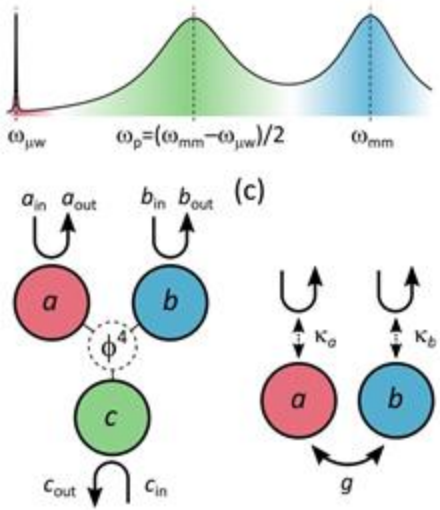
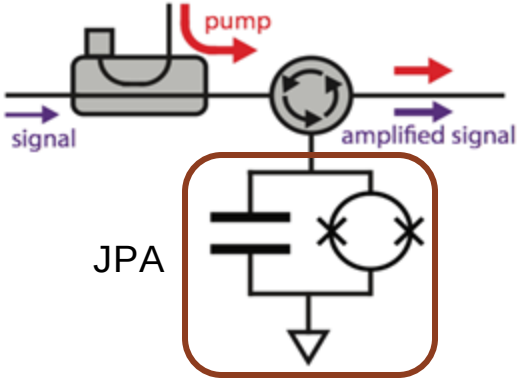
Motivation:

- ***Microwave to mm-wave transducers***[1] for near lossless transmission between dilution refrigerators as a stepping stone for scalable Quantum Networks





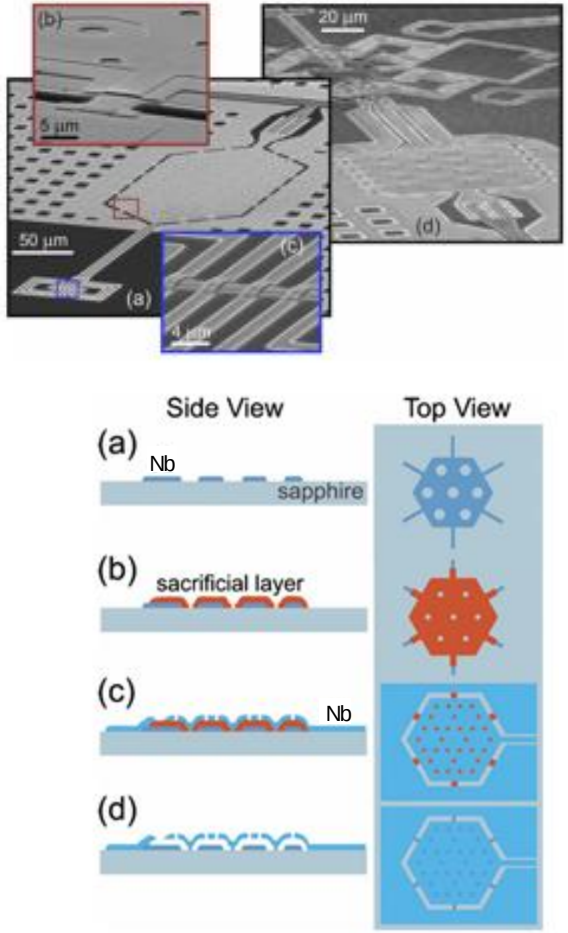
- ***Josephson Parametric Amplifiers (JPAs)*** for studying quantum jumps, generation, and detection of the squeezed microwave field, quantum feedback, real-time tracking of qubit state evolution and quantum error detection[2]

[1] M. Pechal, A. Safavi-Naeini, *Phys. Rev. A.*, 96 (2017)
[2] Tanay Roy et al., *Appl. Phys. Lett.* 107, 262601 (2015)

Project Goals:

- We propose the fabrication of the ***parallel-plate capacitors*** analogous to the process in the study of K. Cicak et al. using Aluminum structures[3]. We are using ***Niobium*** instead (high kinetic inductance material)

- Designing ***5 GHz resonators*** with a large capacitance achievable with parallel-plate capacitors compatible with a superconducting device coupled to mm-waves[4]



[3] K. Cicak et al., *Appl. Phys. Lett.* 96 (2010)
[4] H. Stokowski et al. *IRMMW-THz 2019*, Paris, 1-6 Sep. 2019

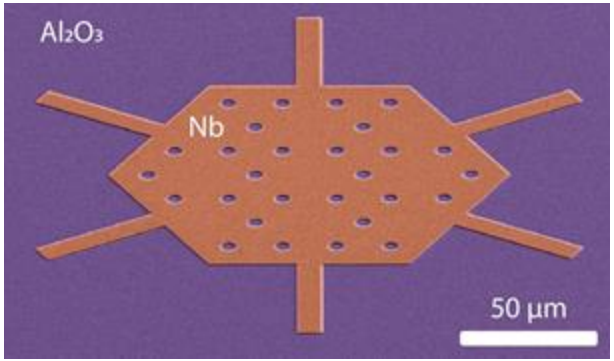
Benefits to SNF:

Fall Quarter:

- Characterization of ***selective Nb etching*** in CF_4 plasma – 3 parameters DOE
- Characterization of ***selective SiO_2 etching*** in CF_4:CHF_3 plasma – 3 parameters DOE
- Characterization of lesker-sputterer in the context of ***Nb Deposition***
- ***Evaporation*** of good-quality Niobium films

Winter Quarter:

- Process flow for ***vapor HF*** etching of the SiO_2 and releasing Nb structures:
    - Air Bridges for Spiral Inductors
    - Parallel Plate Capacitors
- Process for creating ***vias*** to galvanically connect two planes

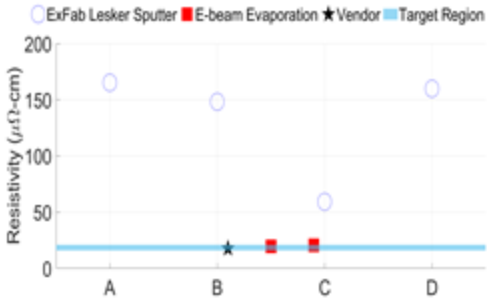


Highlights of the Fall Quarter:

Total Expenditure: $5632.01

Nb deposition

Lesker Sputtering system deposits films with inadequate electrical properties. We will characterize the new Lesker and explore Nb evaporation, which has shown favorable results so far.

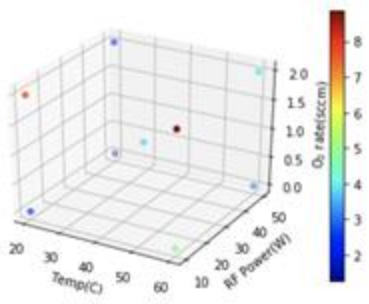


Selective Nb etching

3-point DOE finished, selectivity to SiO_2~9 achieved.

Main factors identified:

- RF Bias power
- Chamber Pressure

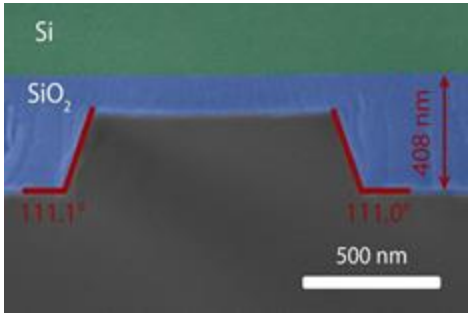


SiO_2 deposition and patterning

3-point DOE done in CF_4/CHF_3 plasma. Selectivity to Nb ~10 achieved.

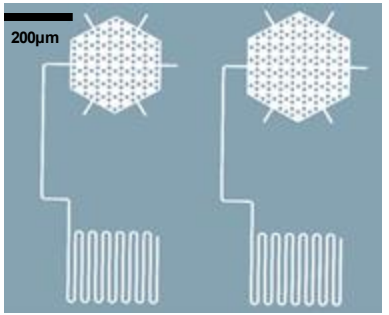
Main factor identified:

- CHF_3 content (quadratic)



Nb meander inductor

Meander inductors patterned with Nb on sapphire platform



Thank you!
See you at the poster