# ORGAN: State of Play & Future Plans

Ben McAllister, Aaron Quiskamp, Graeme Flower, Catriona Thomson, Will Campbell, Cindy Zhao, Maxim Goryachev, Eugene Ivanov, Michael Tobar

# Overview

- ORGAN introduction
- Design considerations
- Photon counting
- Status and run plan

# ORGAN: Axion Detection

- High mass axion haloscope

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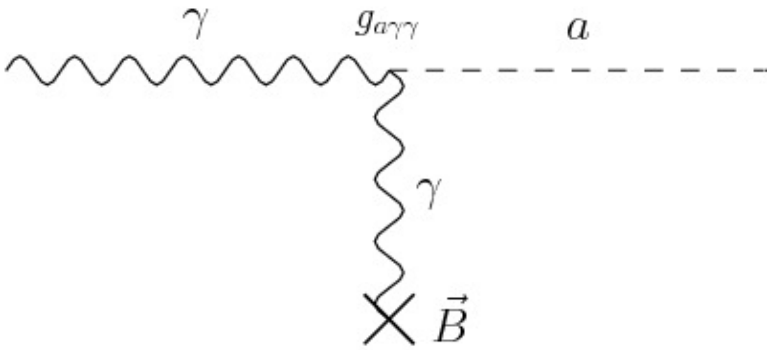

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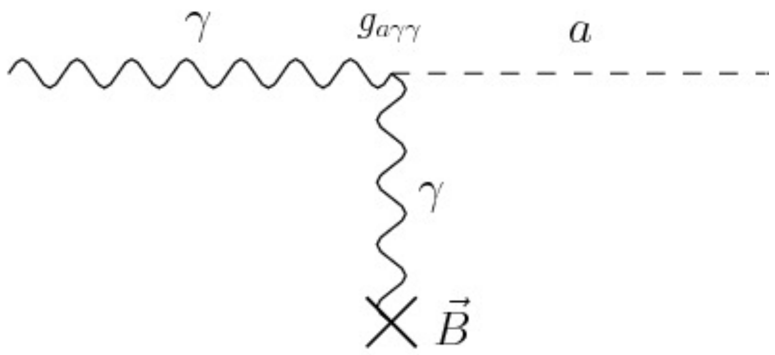

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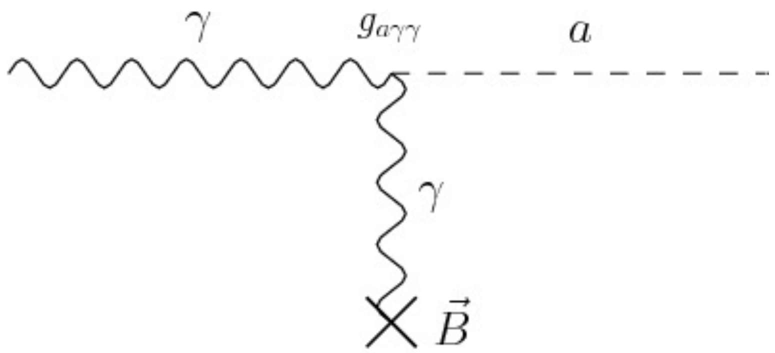

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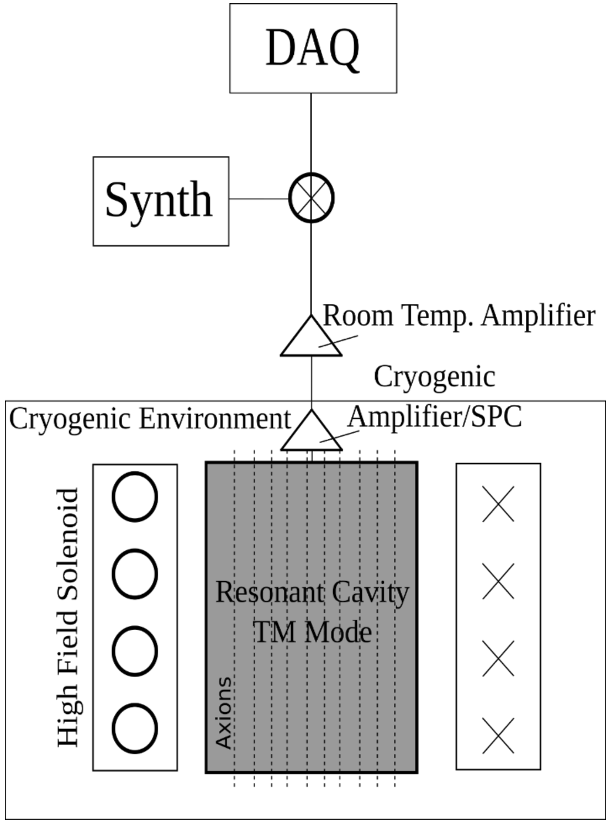

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- Motivations:
  - SMASH model
  - Josephson Junction results
  - High mass range relatively unexplored

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$$\mathrm{C} = \frac{\left| \int dV_c \vec{E}_c \cdot \vec{\hat{z}} \right|^2}{V \int dV_c \epsilon_r \mid E_c \mid^2}.$$

| Mode | Form Factor |
|---|---|
| TM010 | 0.69 |
| TM020 | 0.13 |
| TM030 | 0.05 |

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- Proposed here:

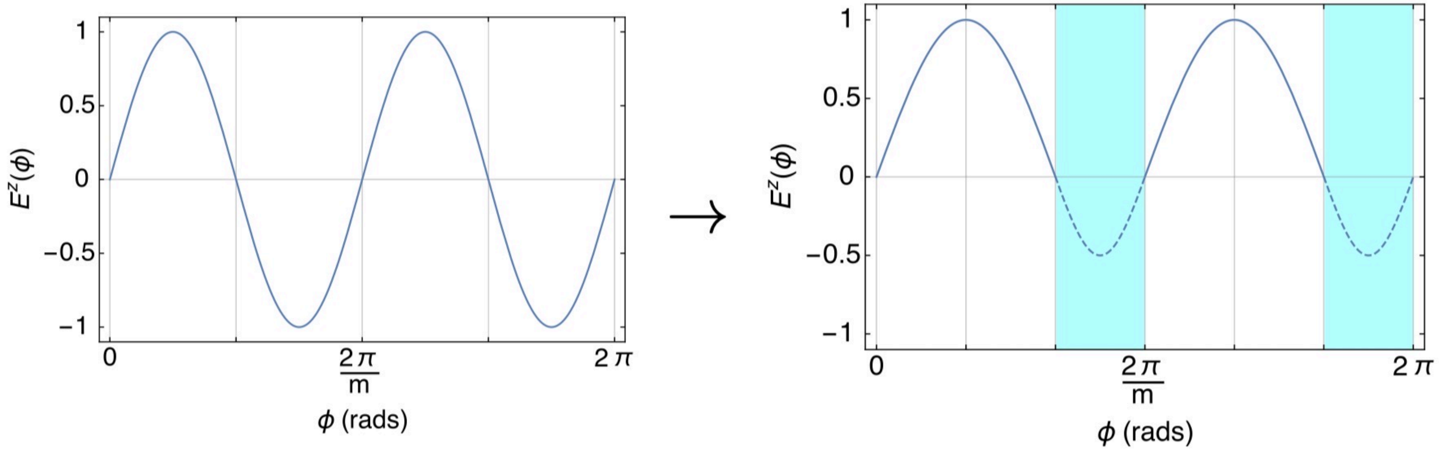
Tunable Supermode Dielectric Resonators for Axion Dark-Matter Haloscopes

Ben T. McAllister, Graeme Flower, Lucas E. Tobar, and Michael E. Tobar
Phys. Rev. Applied **9**, 014028 – Published 26 January 2018

# The DBAS Method in WGM Modes

- Take a higher order azimuthal TM mode and make it axion sensitive by placing dielectric in out of phase regions.

- Result → decreased $E_Z$ field in those regions → increase in C



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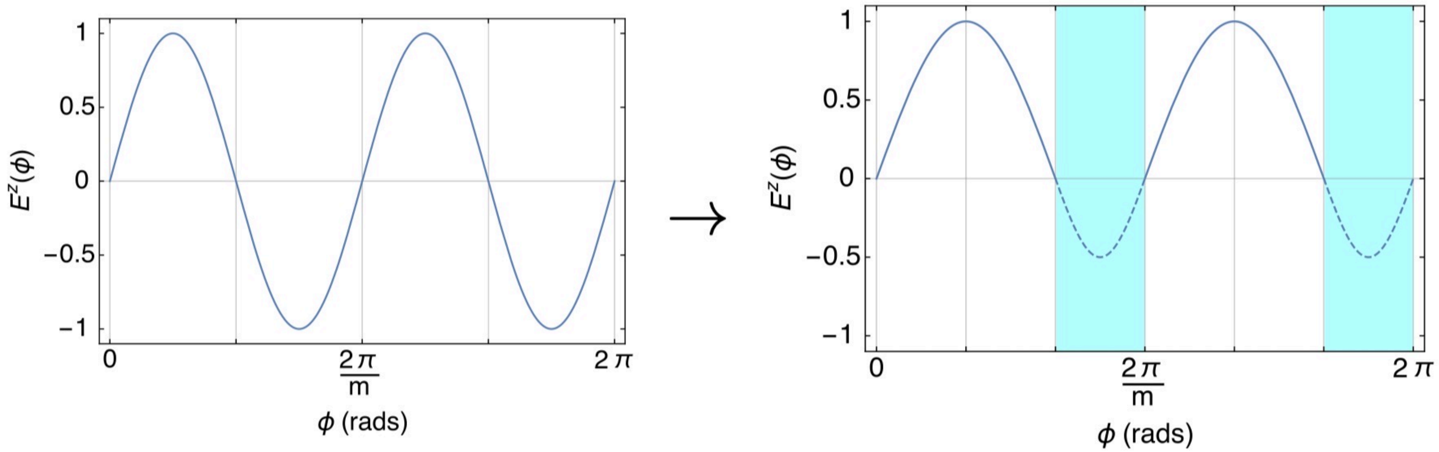
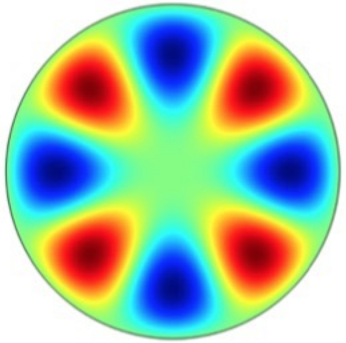


TM410



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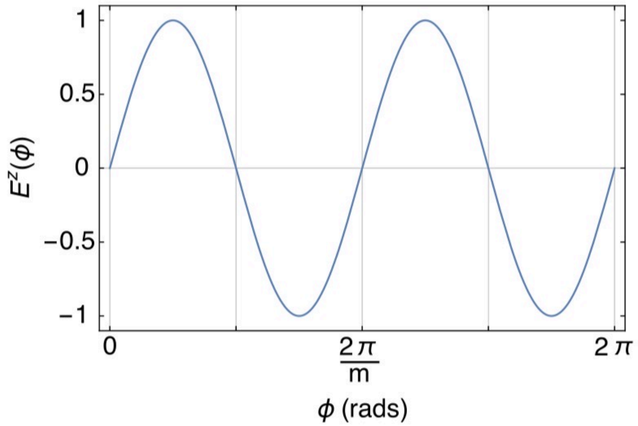

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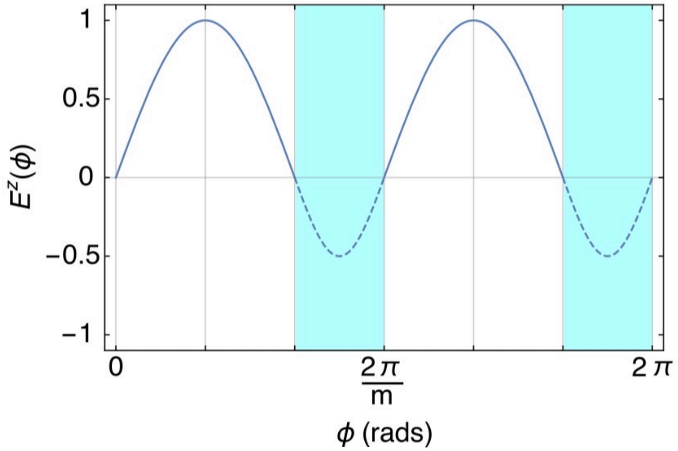

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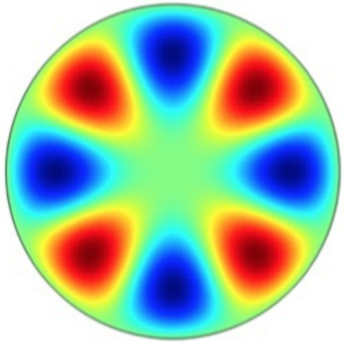

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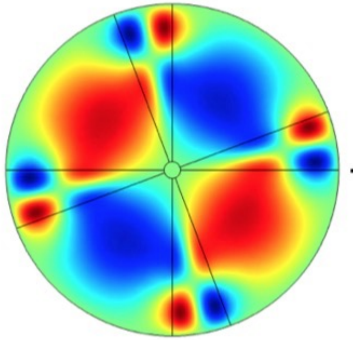

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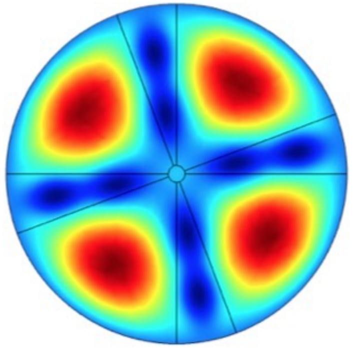

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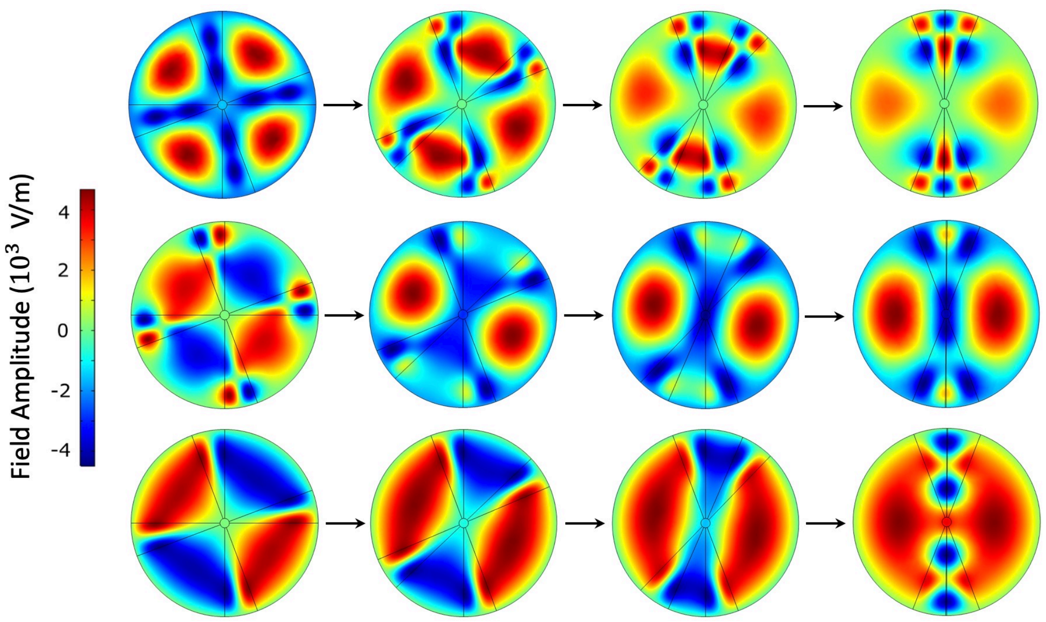

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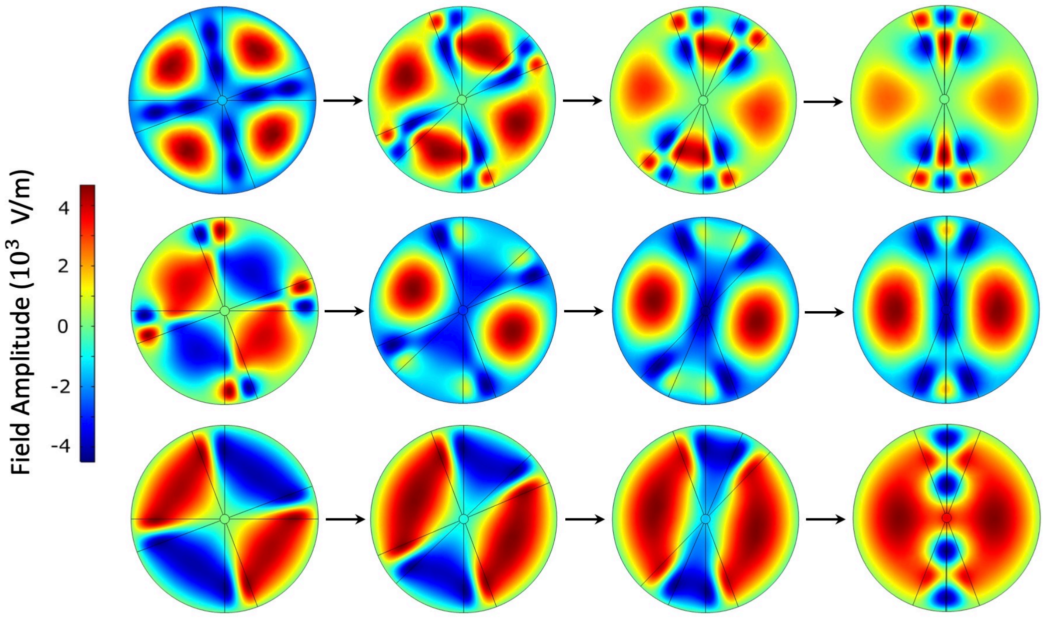

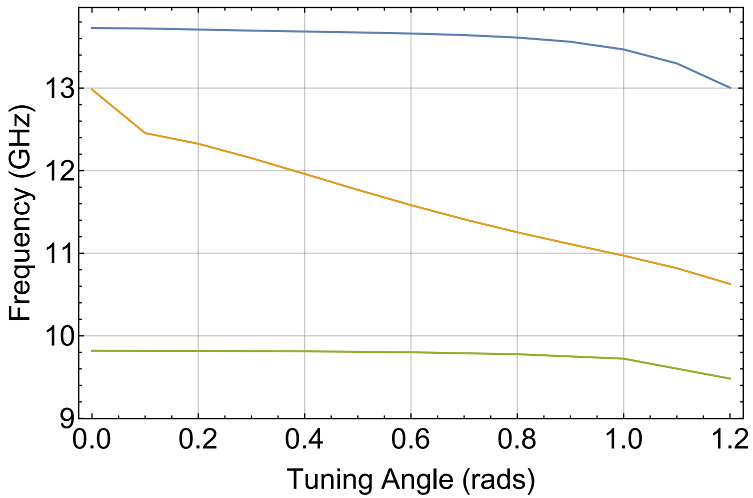

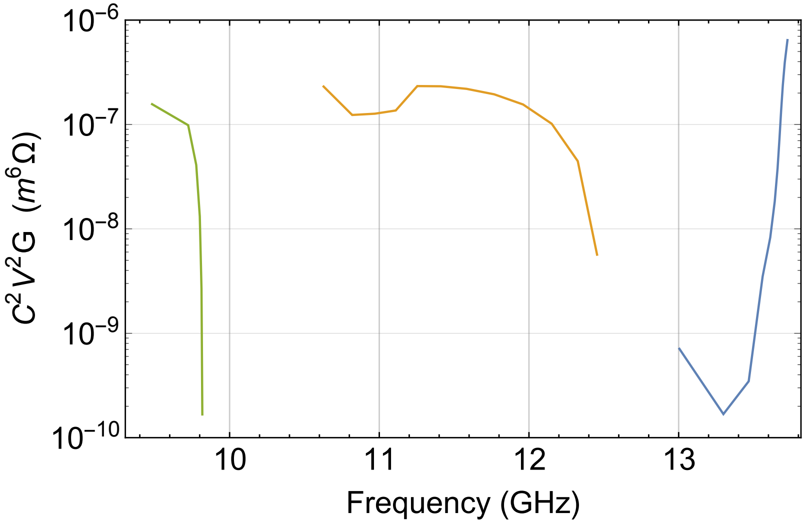

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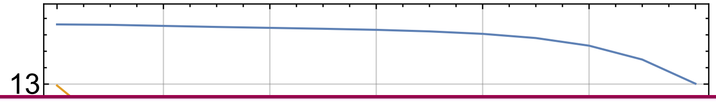
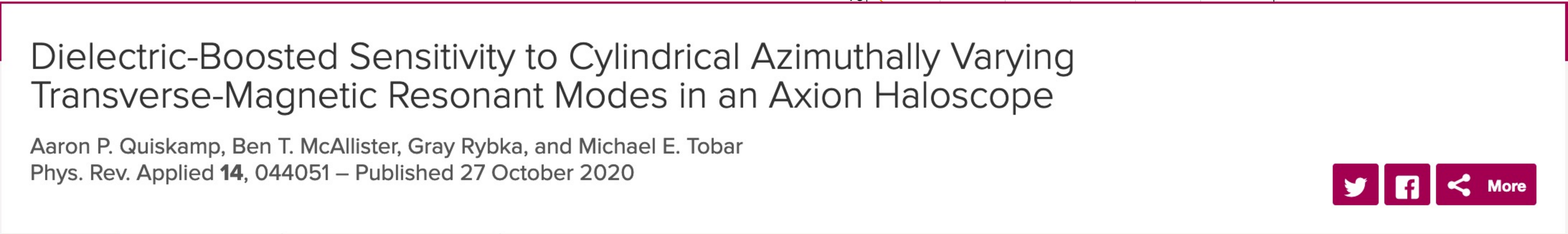
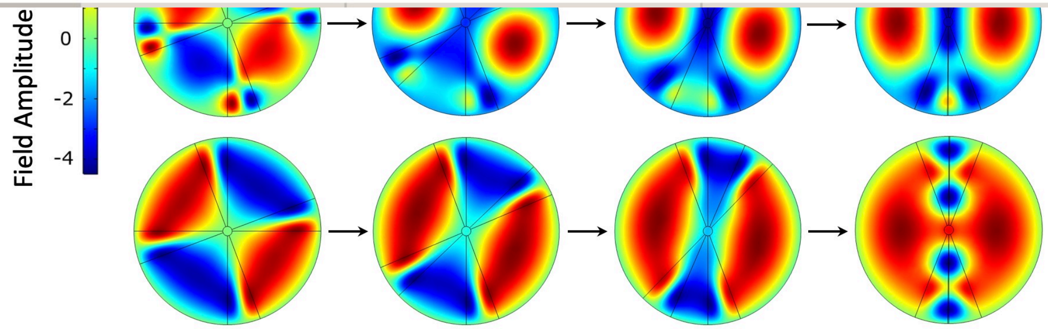
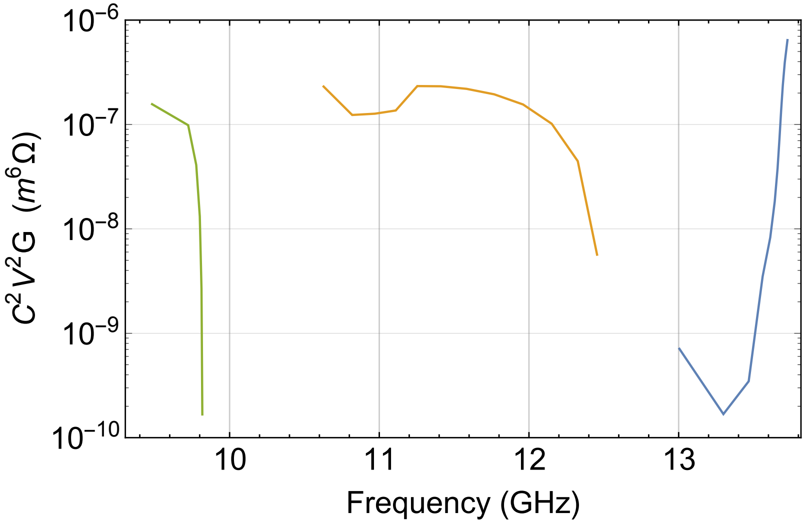




## Dielectric-Boosted Sensitivity to Cylindrical Azimuthally Varying Transverse-Magnetic Resonant Modes in an Axion Haloscope

Aaron P. Quiskamp, Ben T. McAllister, Gray Rybka, and Michael E. Tobar
Phys. Rev. Applied **14**, 044051 – Published 27 October 2020





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- If we lower the temperature this ratio can become order of thousands

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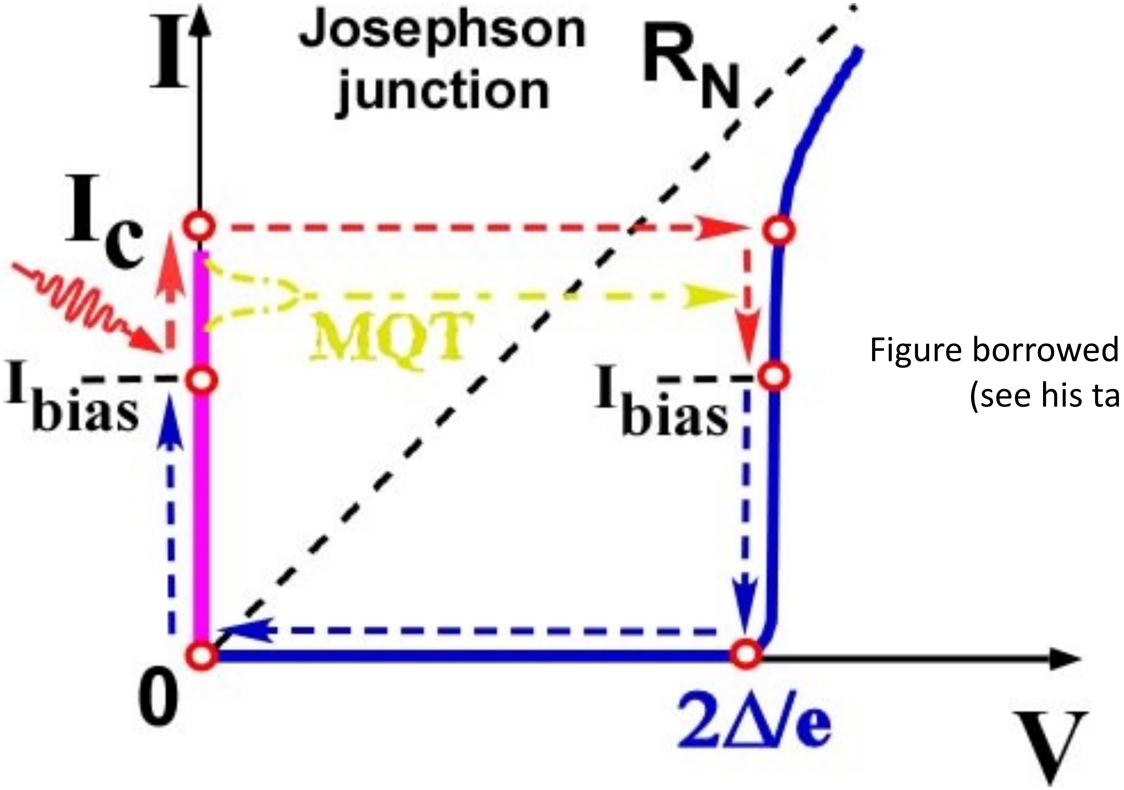

Figure borrowed from Leonid Kuzmin
(see his talk later today)

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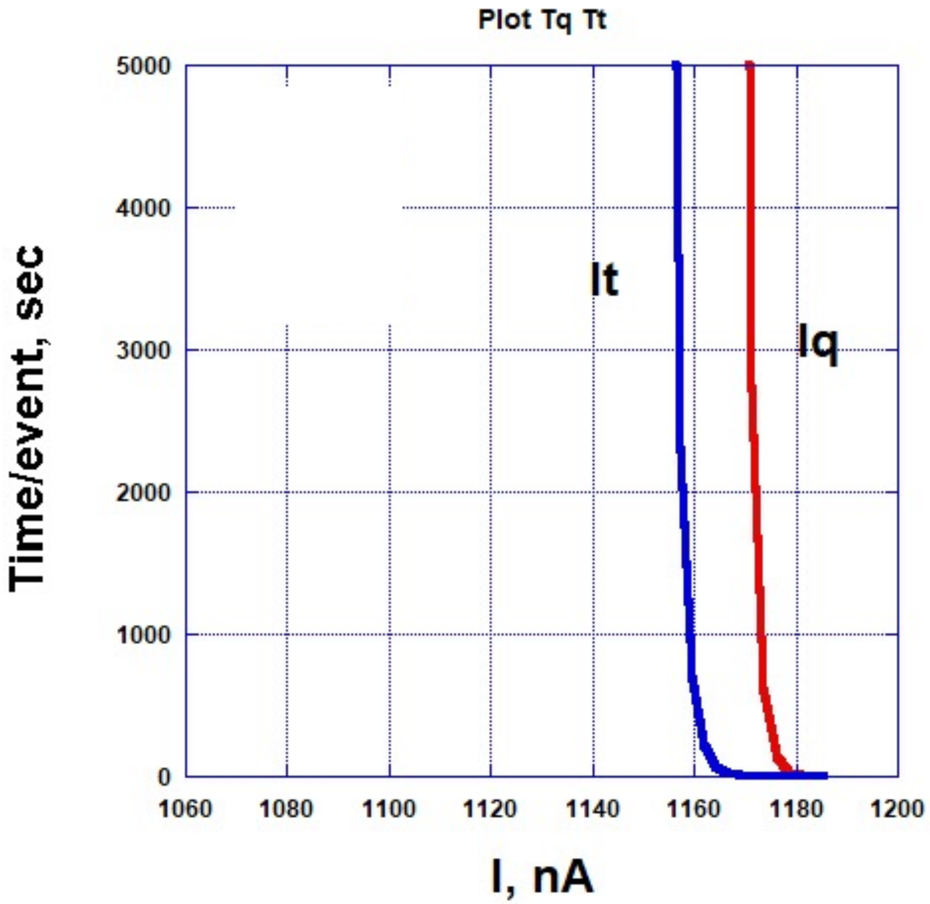

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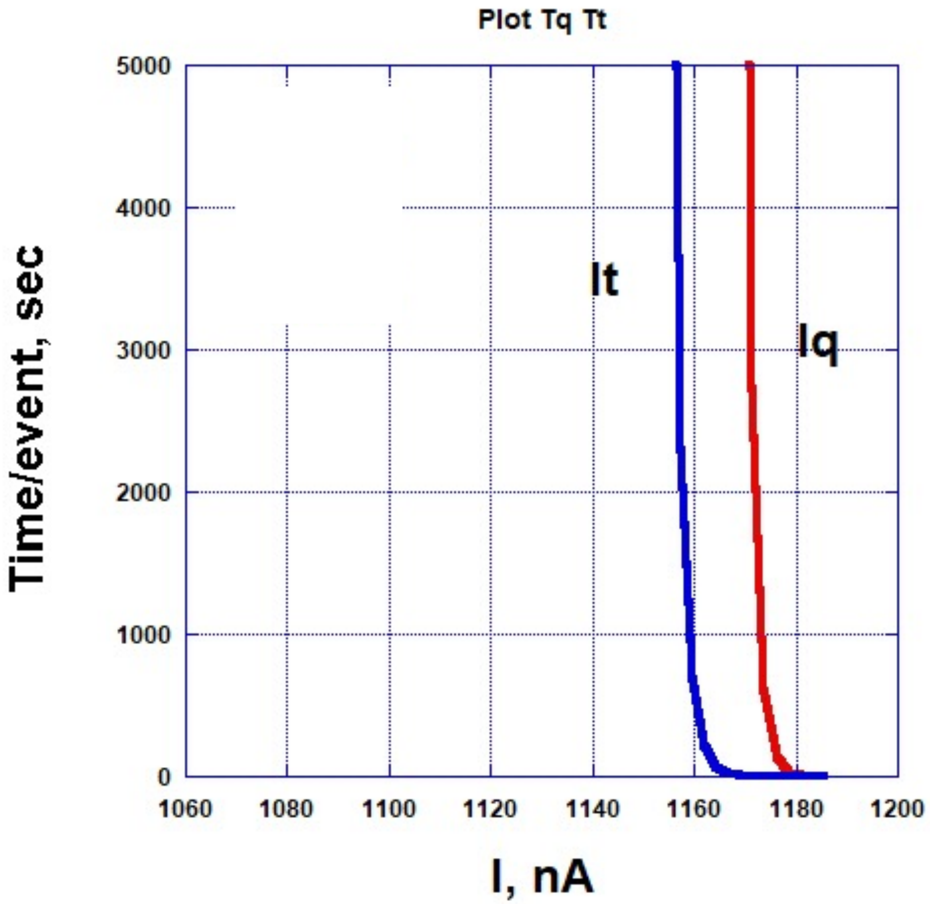

- Initial design of 25 GHz+ detector

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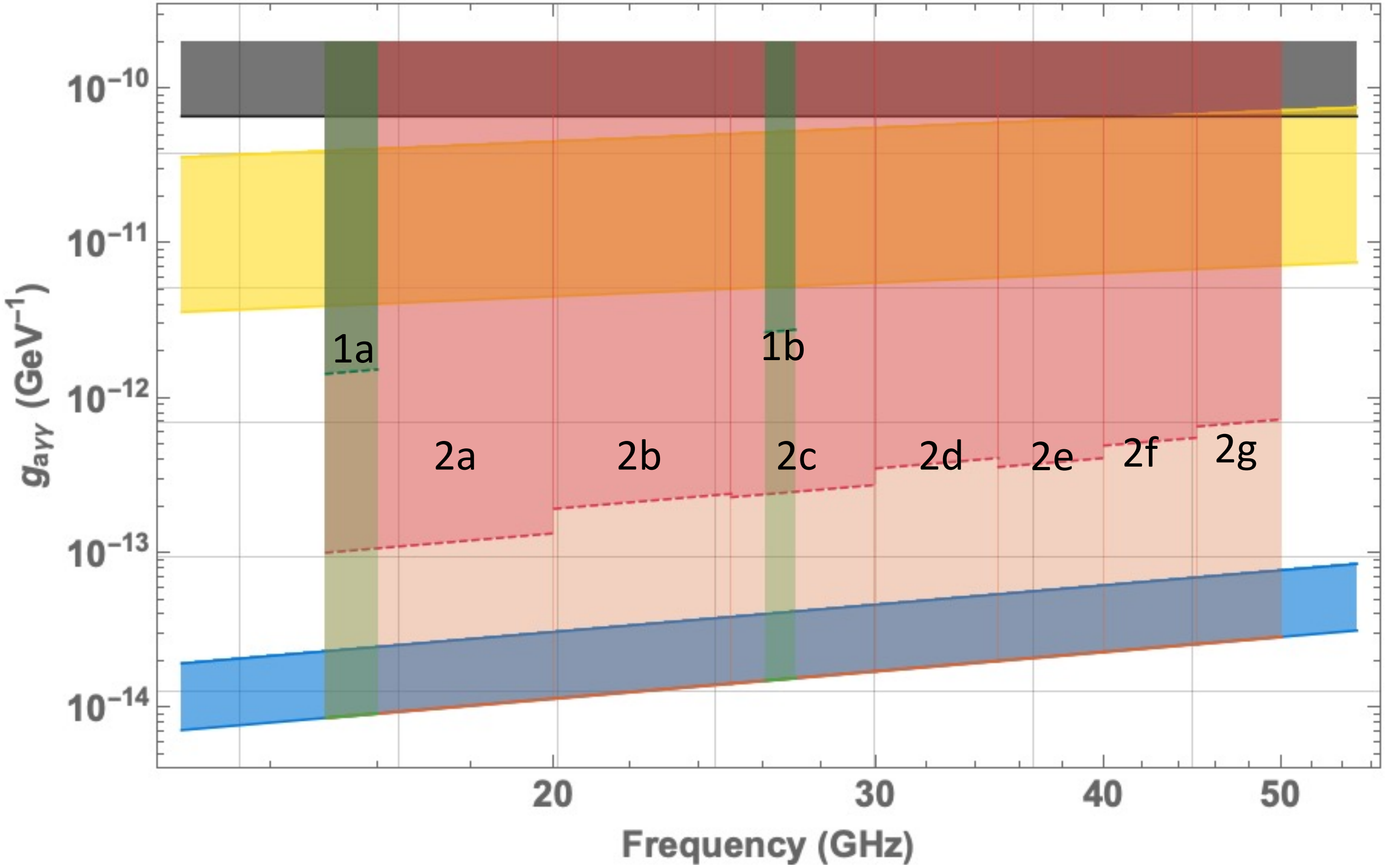

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Rod Resonators

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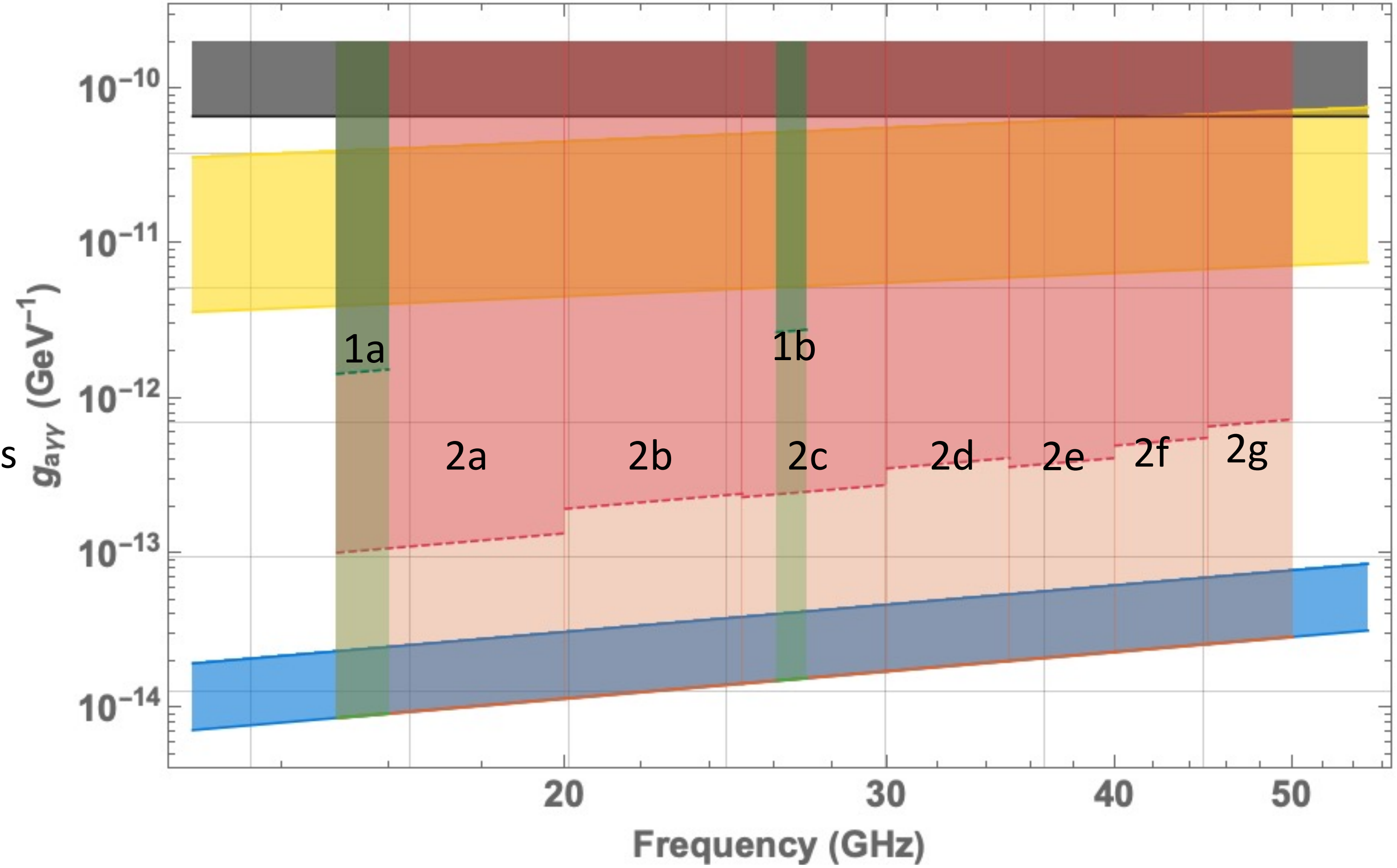

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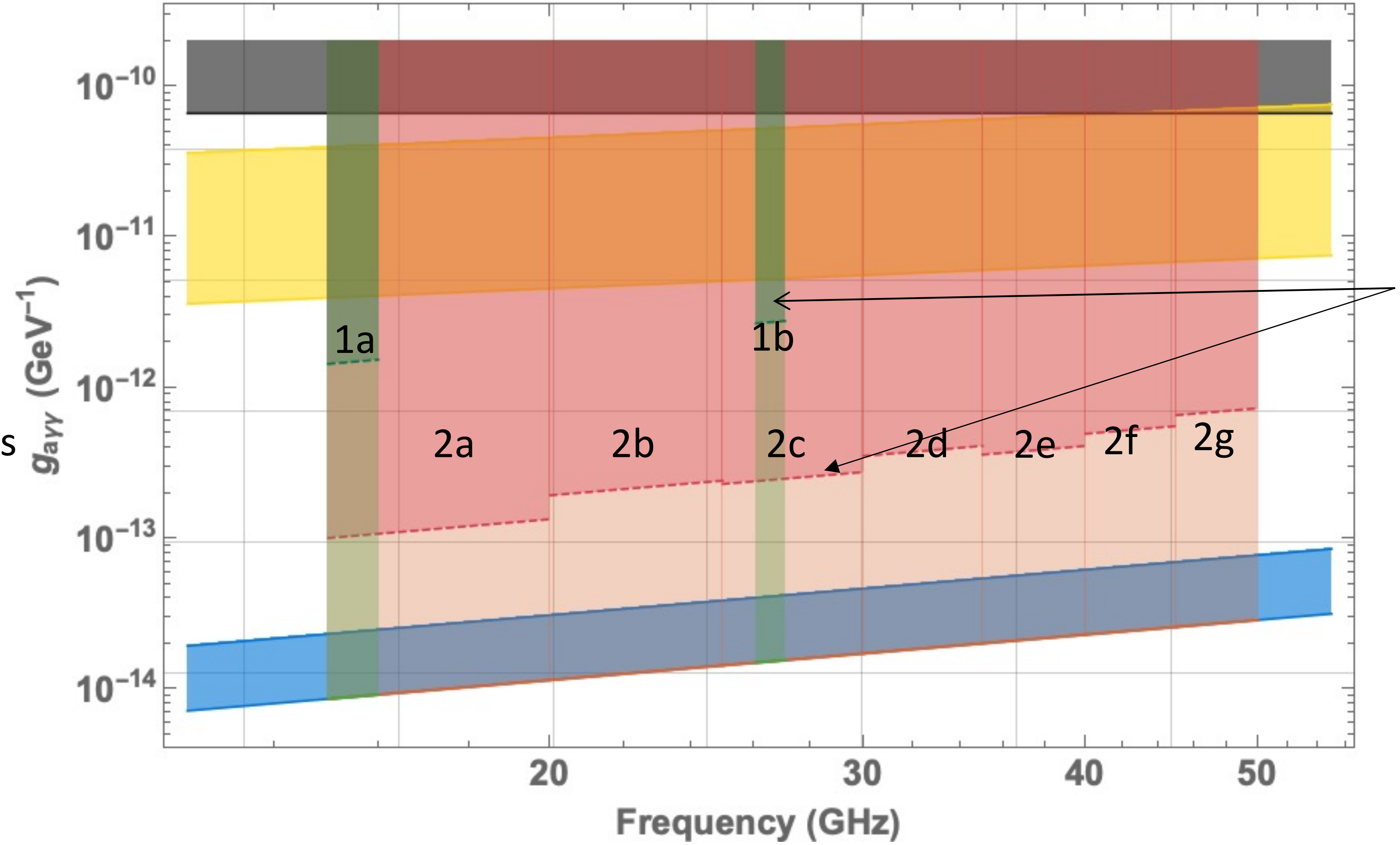

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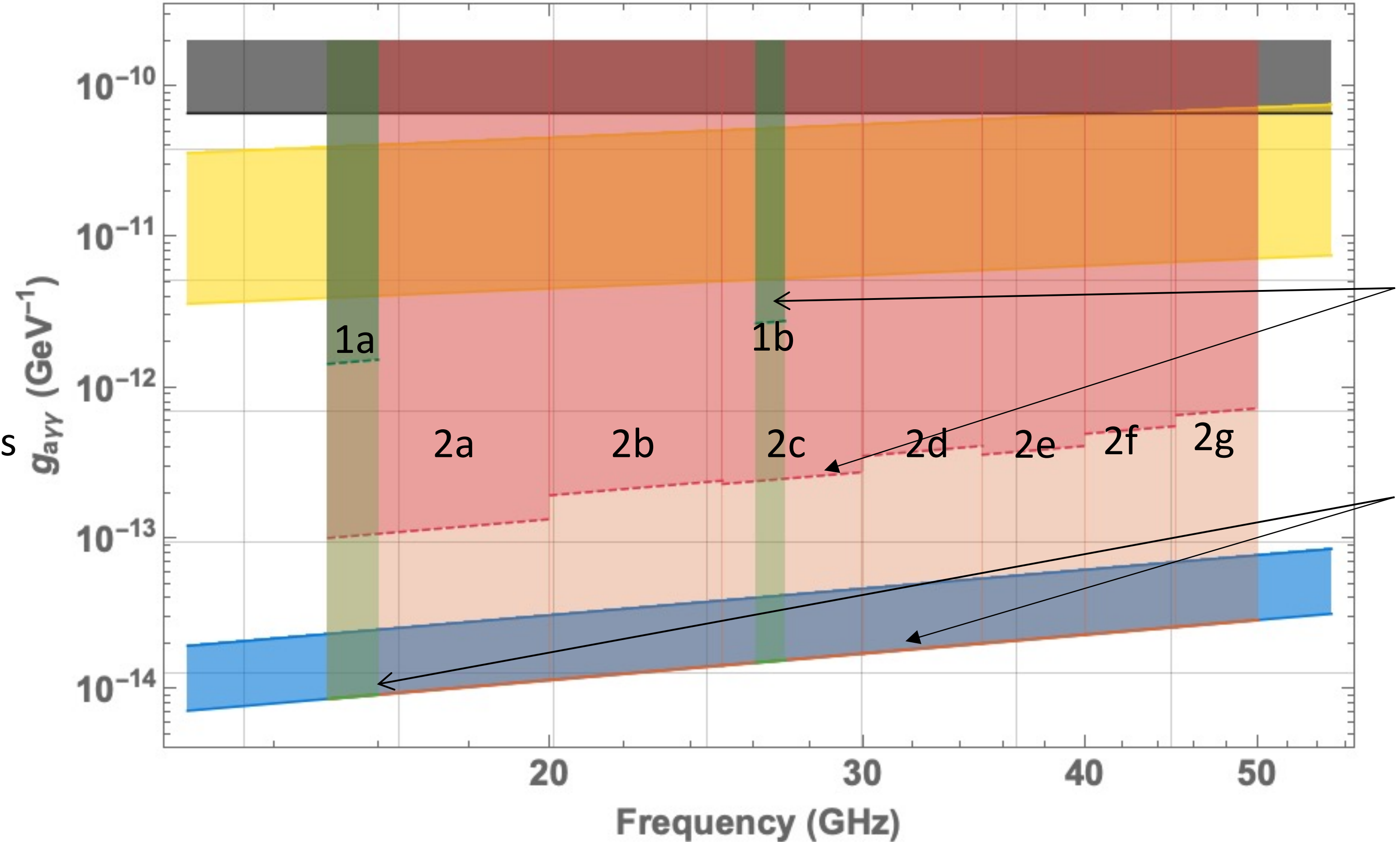

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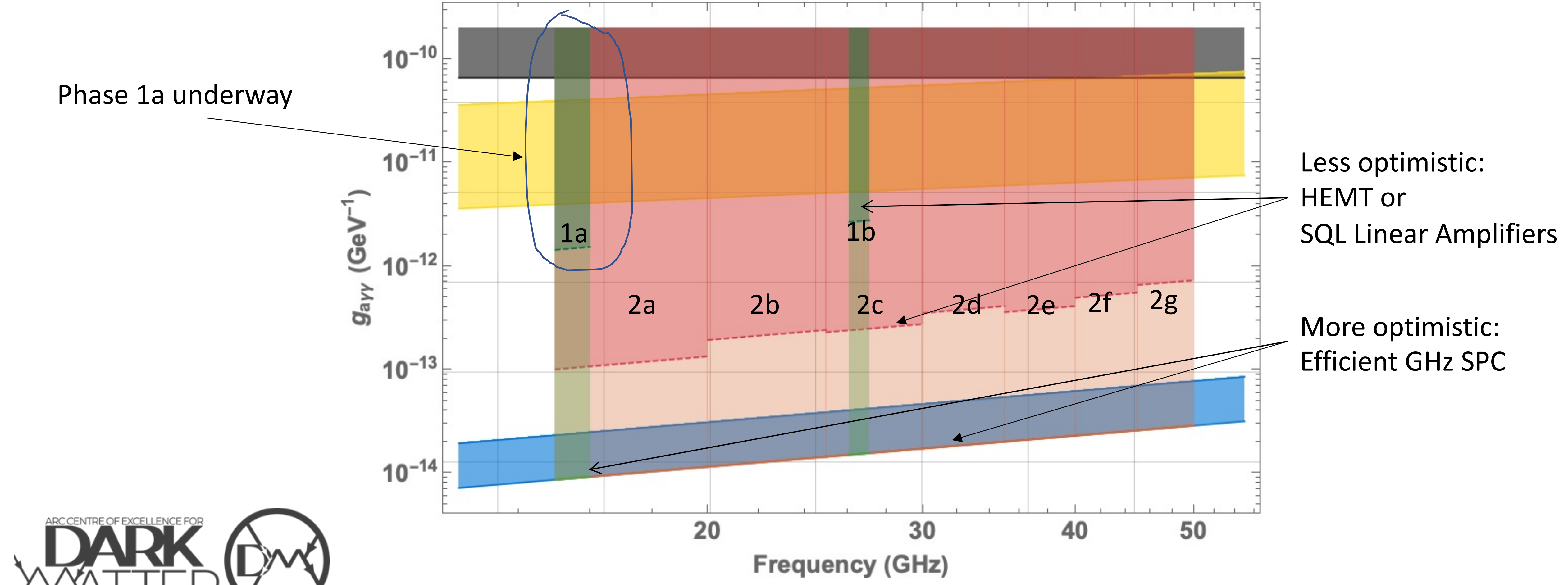

Phase 1a underway

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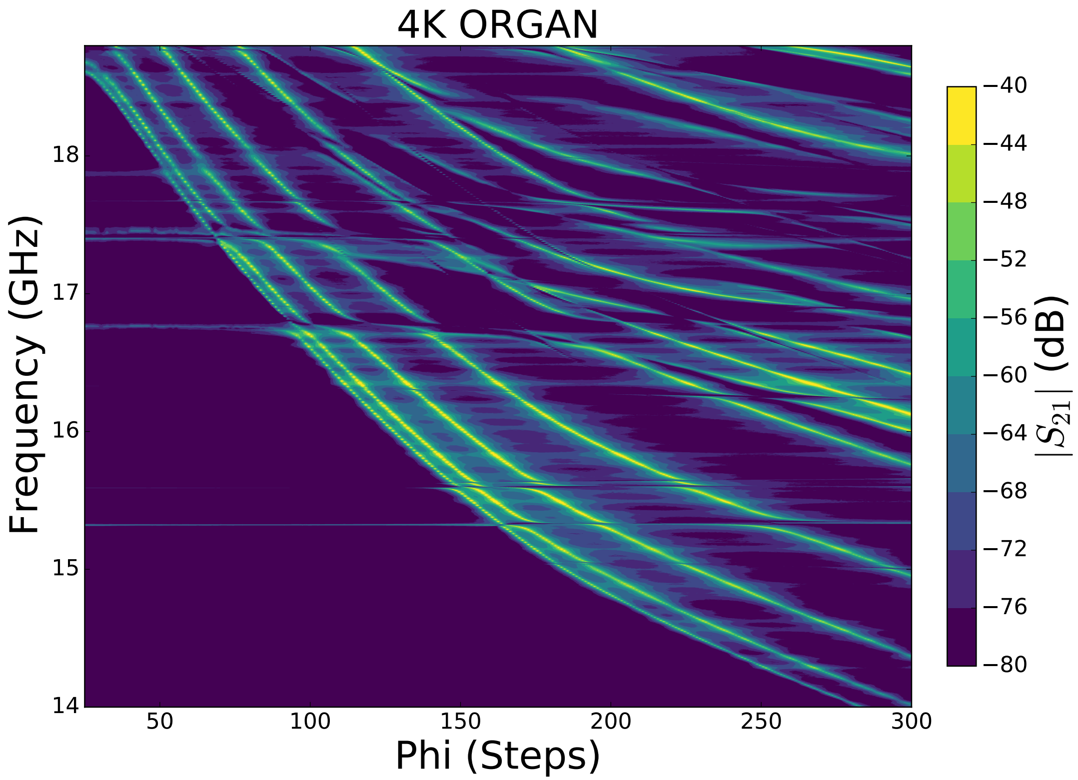

Aaron Quiskamp, PhD Student

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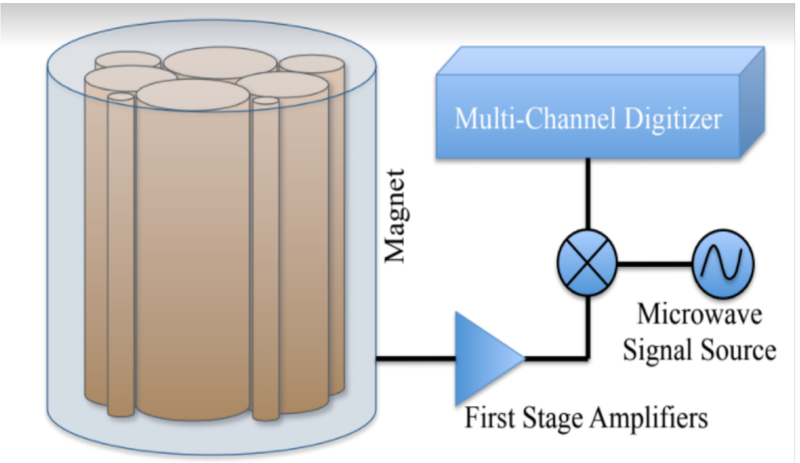

# Conclusion

- ORGAN:
  - High mass axion haloscope
  - 2021 commencement
  - Two phases:
    - Short, targeted scans with existing equipment
    - Longer, broader scans with new technology
- Quantum Sensing
  - Testing a few SPC concepts for integration