DMRadio-50L Status and Novel ABRACADABRA Analyses Including ML

Jessica Fry

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DMRadio Collaboration
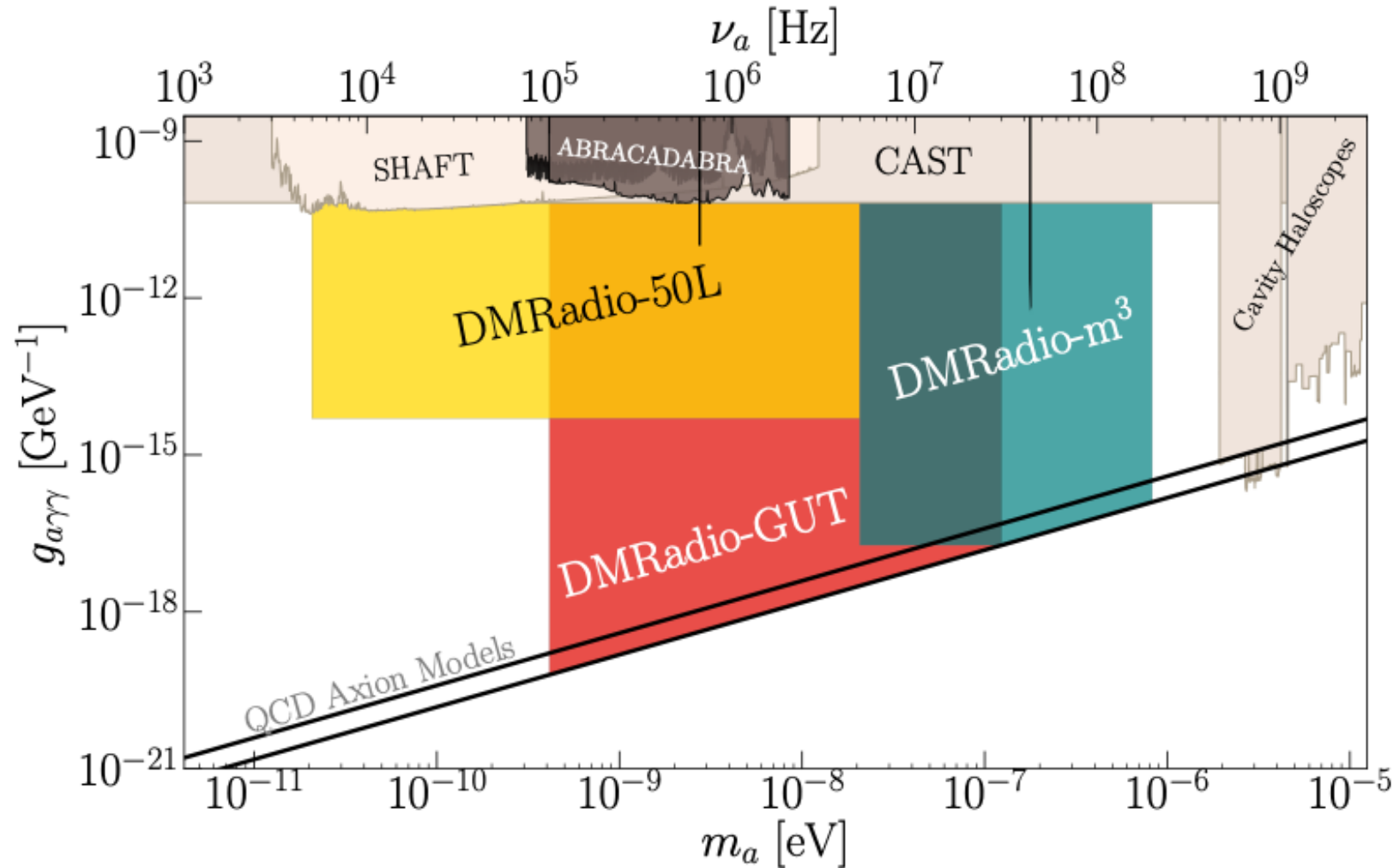
Key Takeaways:

- **Presently commissioning DMRadio-50L with first data early 2026.**

- **ABRA extended science reach with a gravitational wave (GW) search and ML-denoising.**

- **DMRadio analysis pipeline adaptable to GW and ML enhanced searches.**

DMRadio-50L

First of DMRadio suite of experiments.

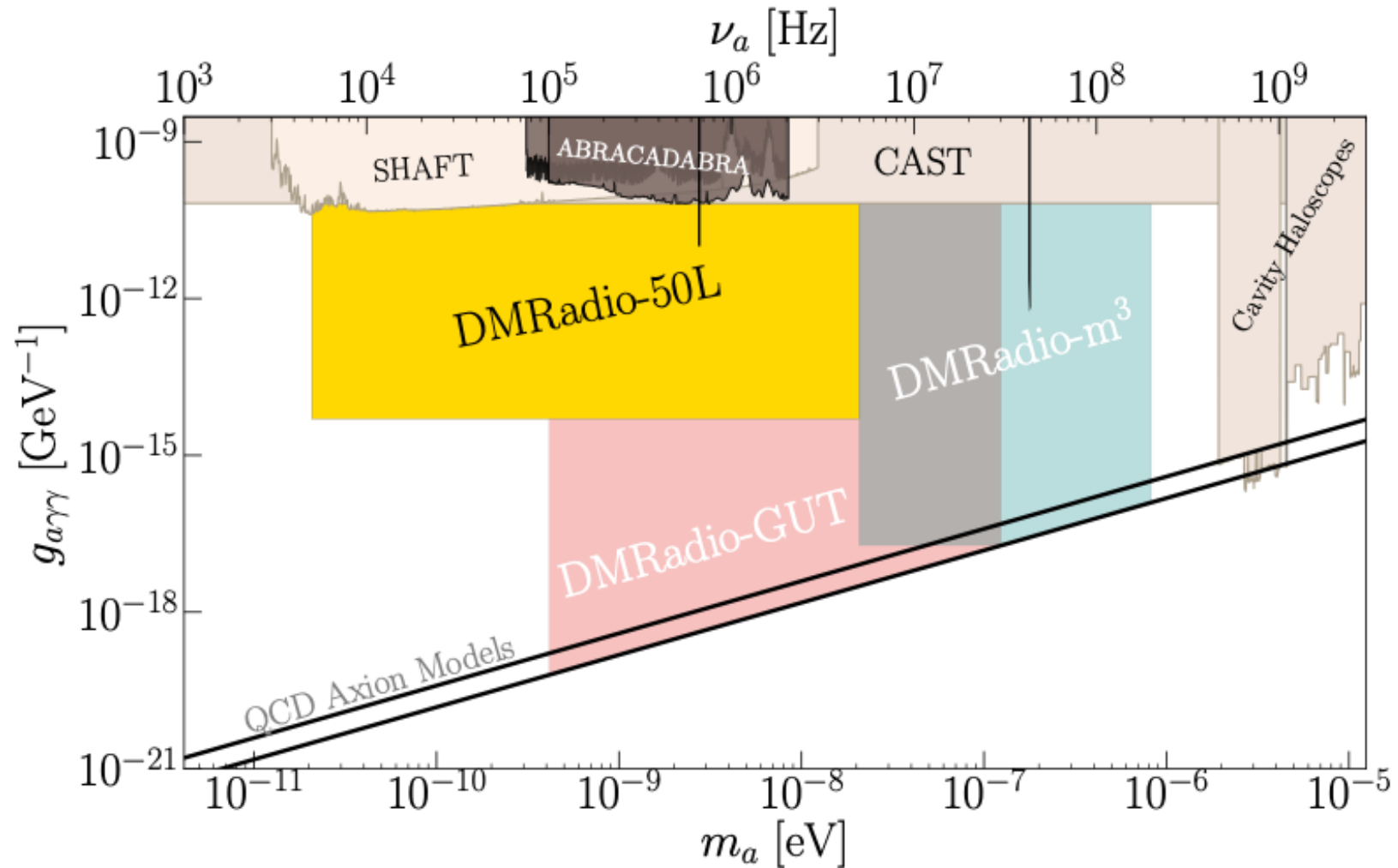Probing pre-inflationary axions with electromagnetic coupling.
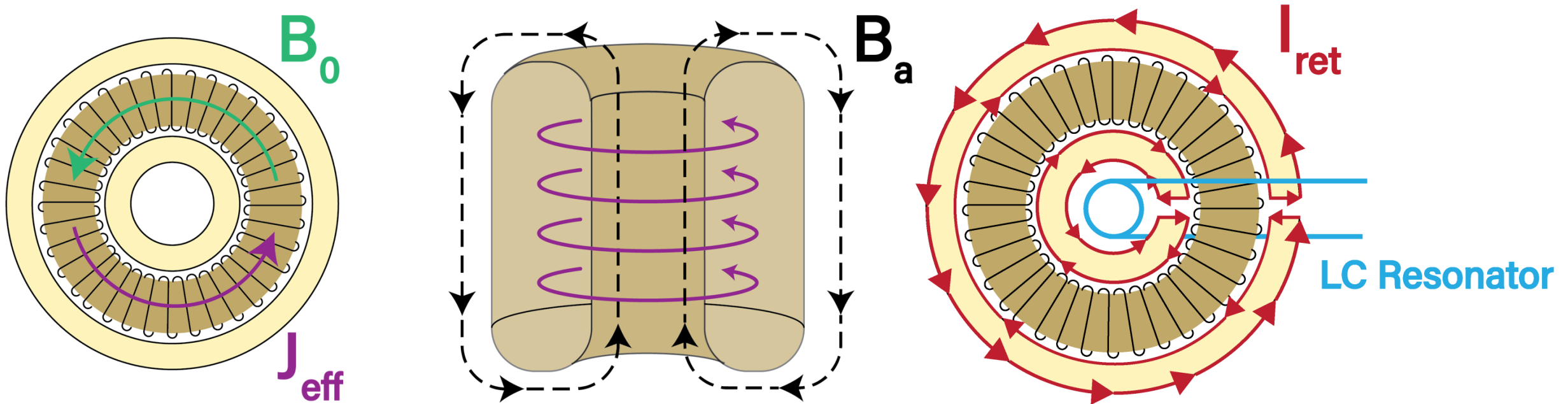
DMRadio-50L

First of DMRadio suite of experiments.

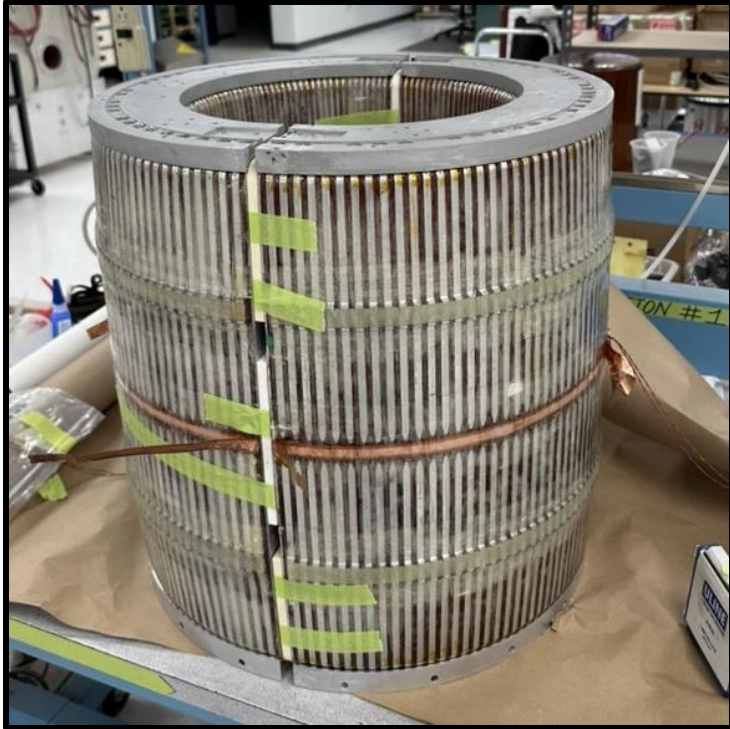Probing pre-inflationary axions with electromagnetic coupling.

5 kHz - 5 MHz

DMRadio-50L
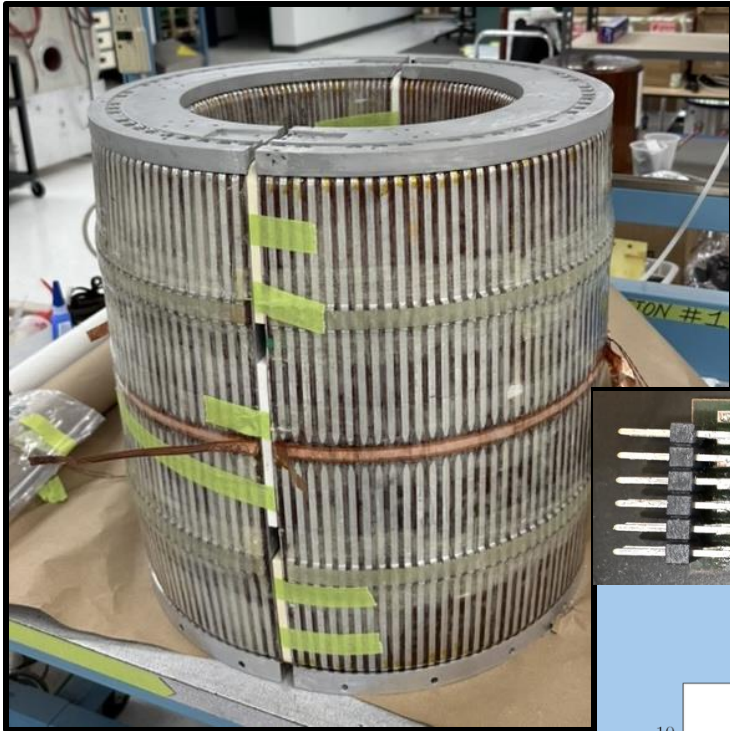
Tunable high-Q LC resonator to amplify axion signal.

DMRadio-50L Status
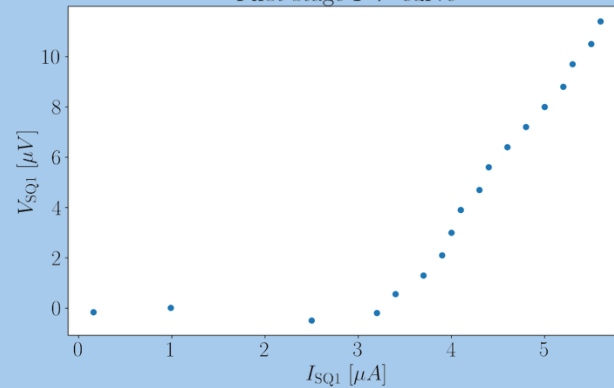

1 T Magnet
Built and testing

DMRadio-50L Status
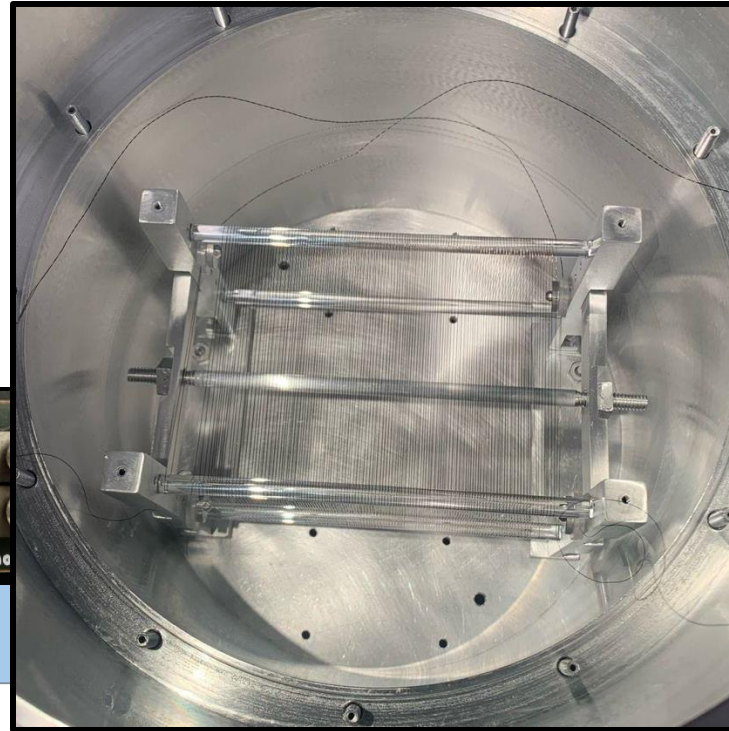

SQUID Amplifier
Characterizing

First stage I-V curve

DMRadio-50L Status

First stage I-V curve

V_{SQ1} [μV] vs I_{SQ1} [μA]

LC Resonator
Q ~ 2e6 Prototype

DMRadio-50L Status
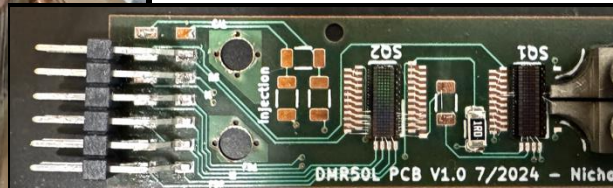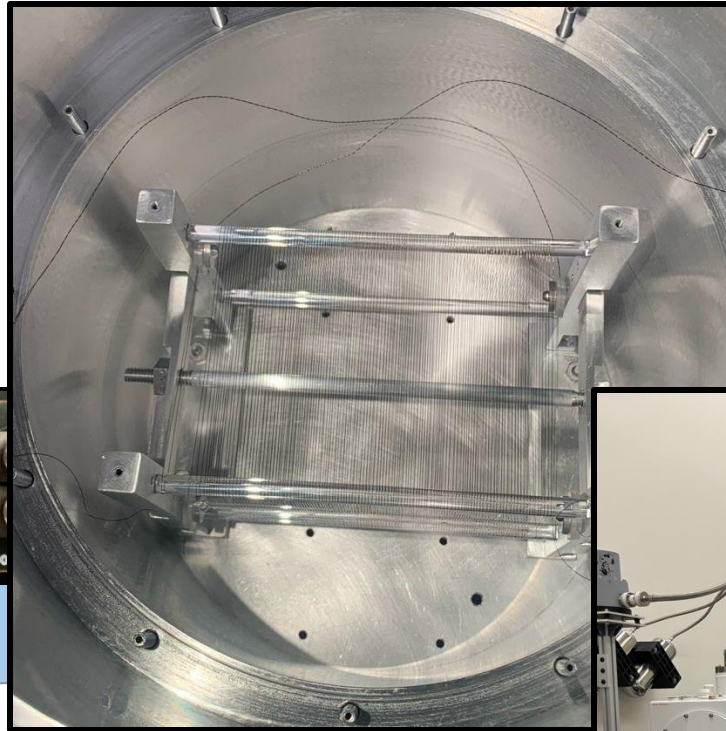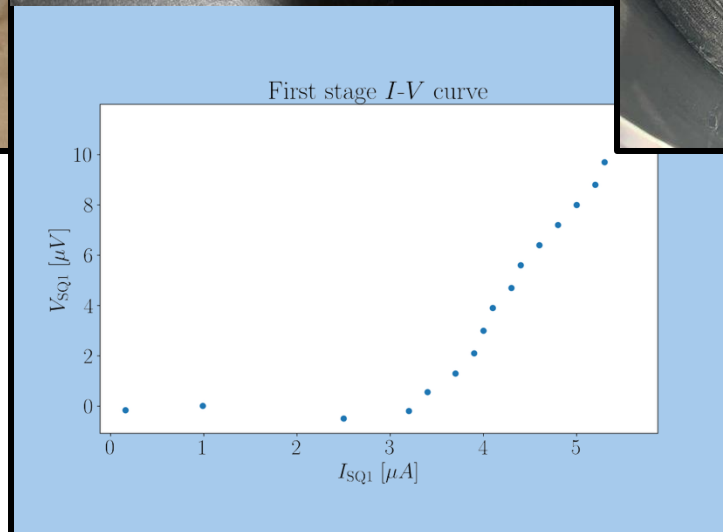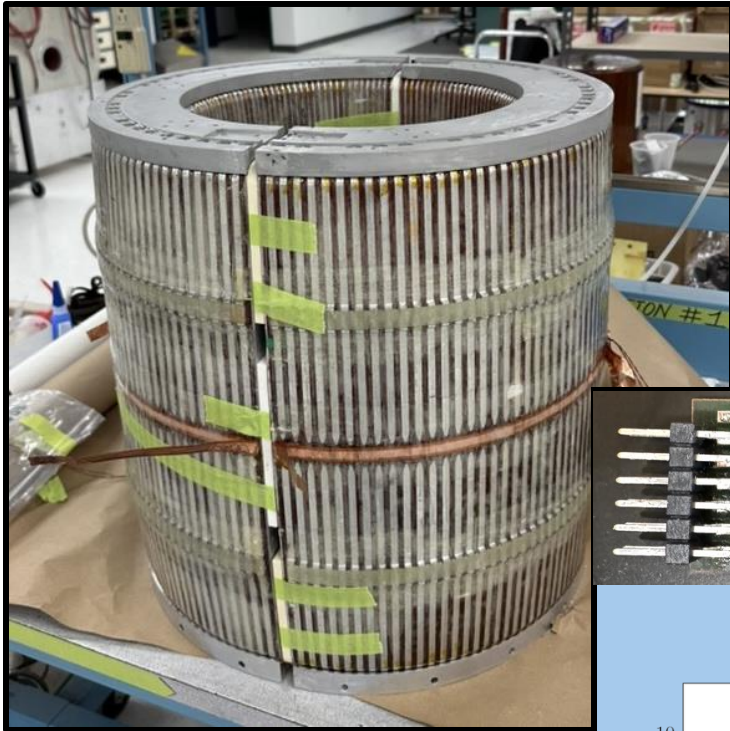
First stage I-V curve
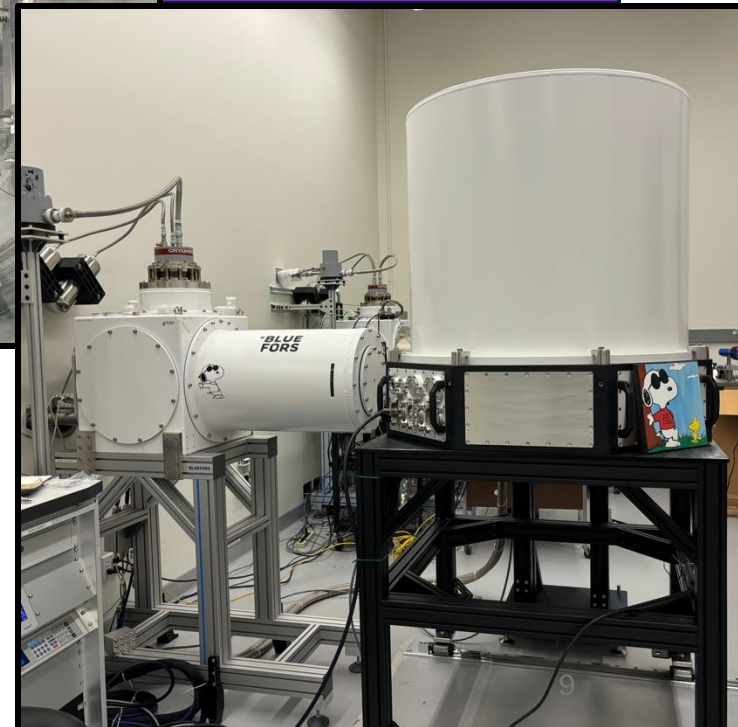
DMRadio Analysis Pipeline

- Analysis pipeline in testing
- Minimizing negative log likelihood test statistic for each spectrum with signal candidate allows for easily adaptable signal candidates (i.e. non-standard halo model, GW, etc.)
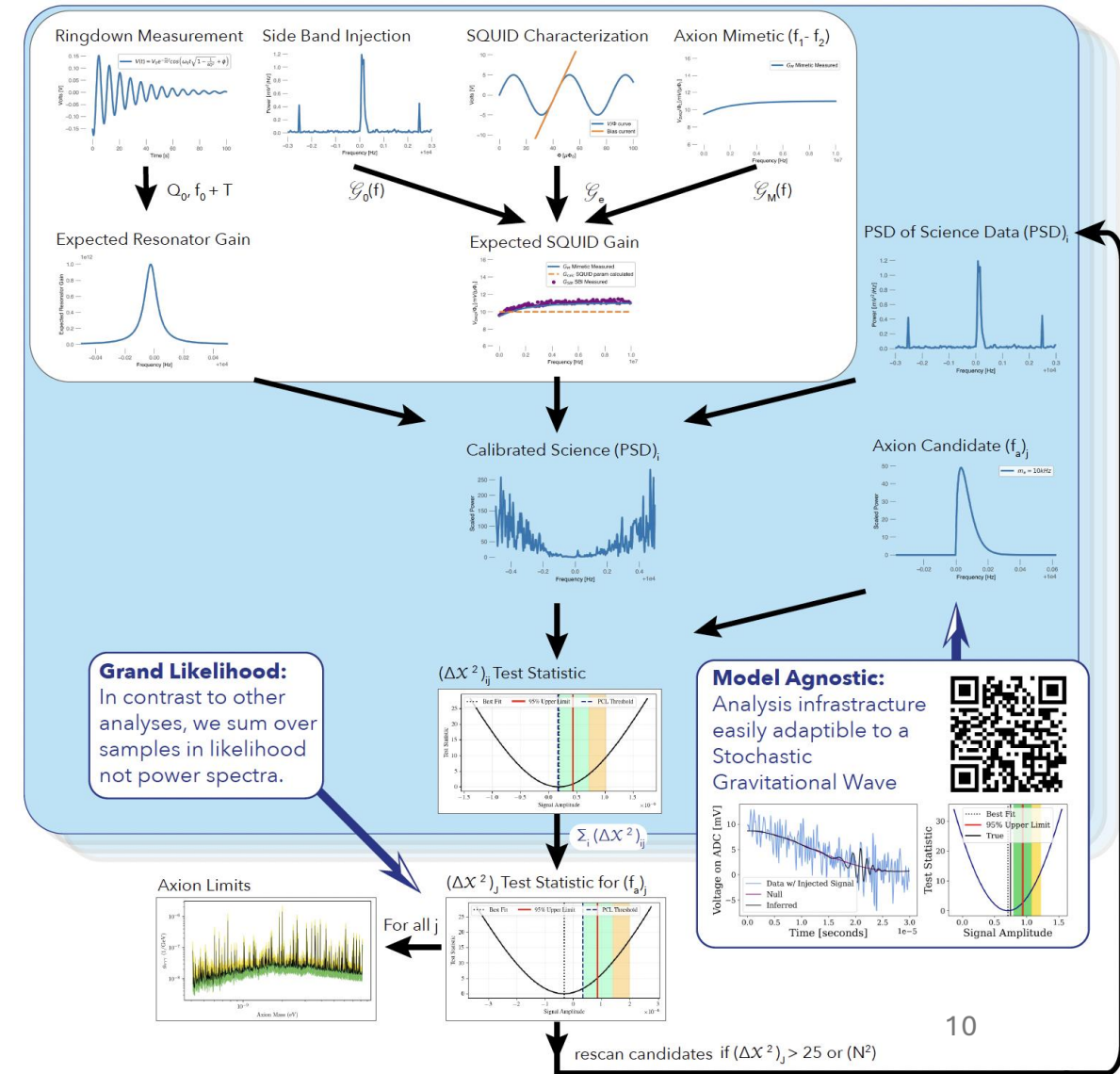
ABRA-Grav

1. Achieved projected sensitivity to high frequency gravitational waves.
2. Performed simultaneous GW and axion search.
3. Performed pathfinder transient analysis.

Time Series Dataset for Discovering **D**ark **M**atter with **AI D**enoising
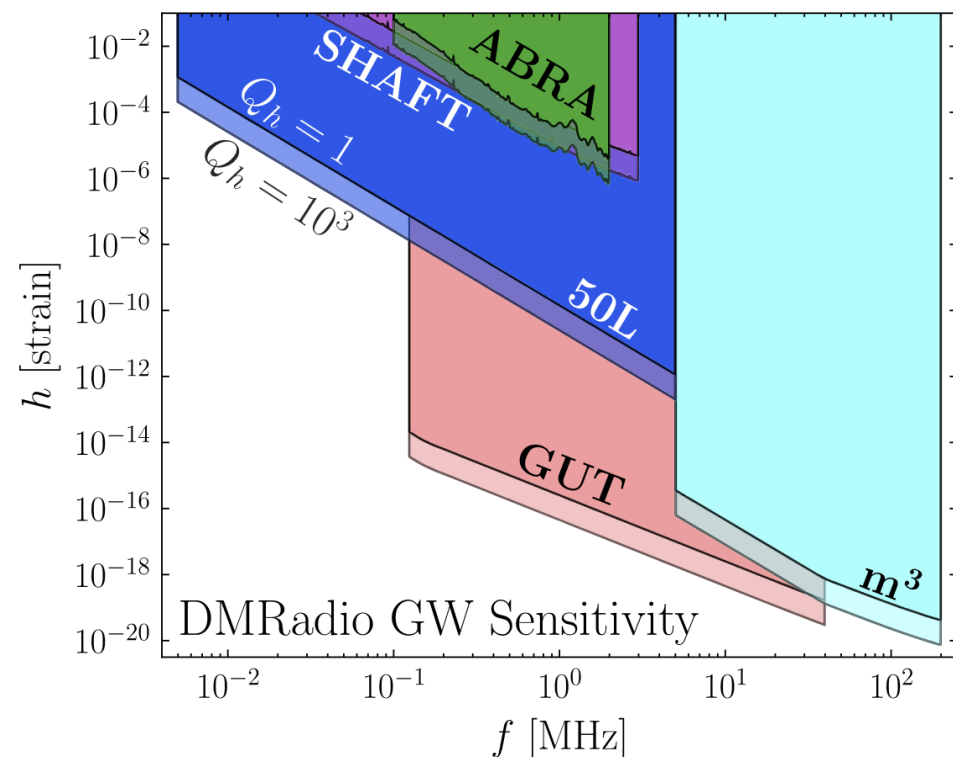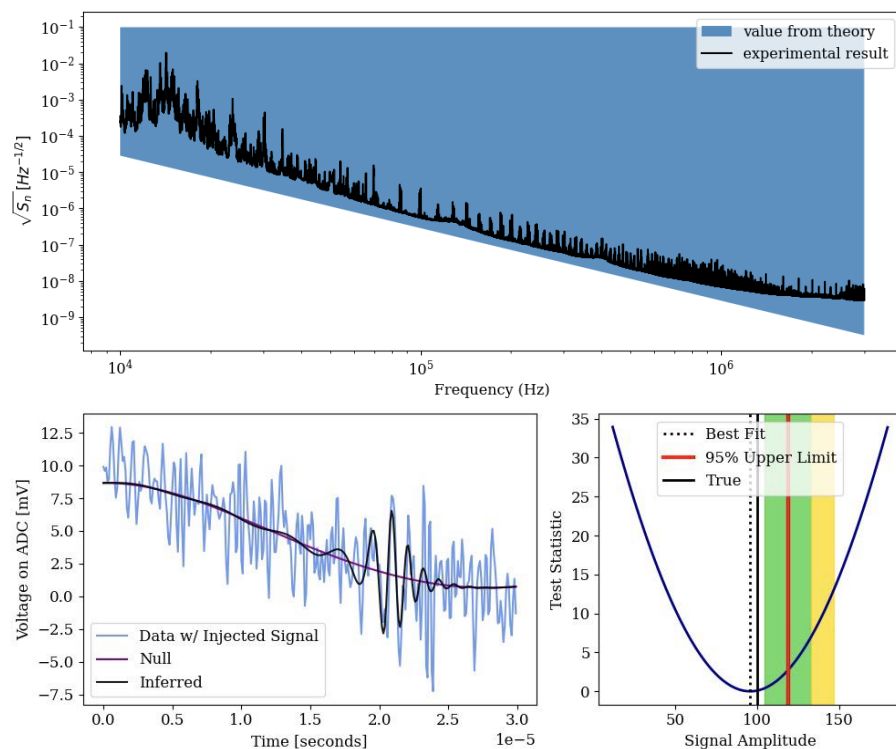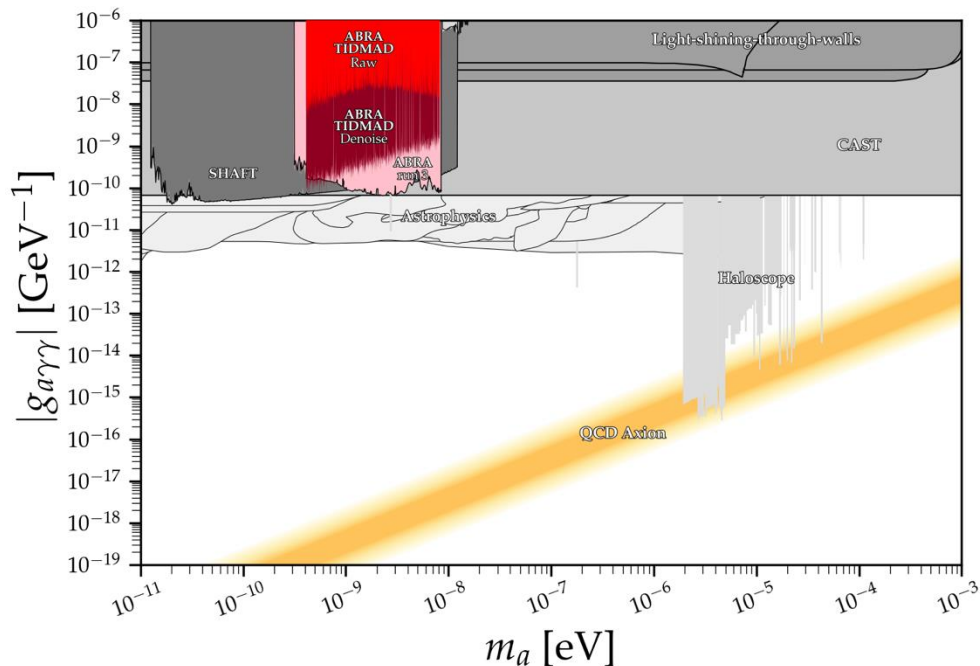
Public data release including (1) calibration training data (2) six trained ML denoising algorithms (3) two novel science-motivated benchmarks.

Algorithm	Segment Size	FS	Parameters	Fine Score	Coarse Score
None	N/A	N/A	N/A	1.00	1.10
Fourier Averaging	1×10^8	N/A	10-fold Average	0.24	0.26
Moving Average	1×10^6	N/A	window = 100	0.86	0.95
SG Filter	1×10^6	N/A	window = 19, order = 11	0.95	1.04
FC Net	4×10^4	Yes	See Appendix A2	6.43	6.55
PU Net	4×10^4	Yes	See Appendix A2	3.69	3.84
Transformer	2×10^4	Yes	See Appendix A2	3.95	4.18
WaveNet	4×10^4	No	See Appendix A2	4.99	5.16
RNN Seq2Seq	4×10^4	Yes	See Appendix A2	3.38	3.79

Time Series Dataset for Discovering **D**ark **M**atter with **AI D**enoising

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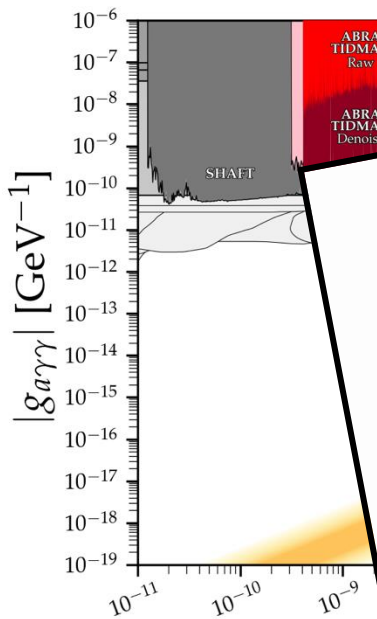
DMRadio Collaboration

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Thank you!

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- **ABRA extended science reach with a gravitational wave (GW) search and ML-denoising.**
- **DMRadio analysis pipeline adaptable to GW and ML enhanced searches.**

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