News from the Axion Dark Matter eXperiment (ADMX)

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February 18, 2015

Overview

- Theory behind ADMX
- Experimental setup
- Recent results

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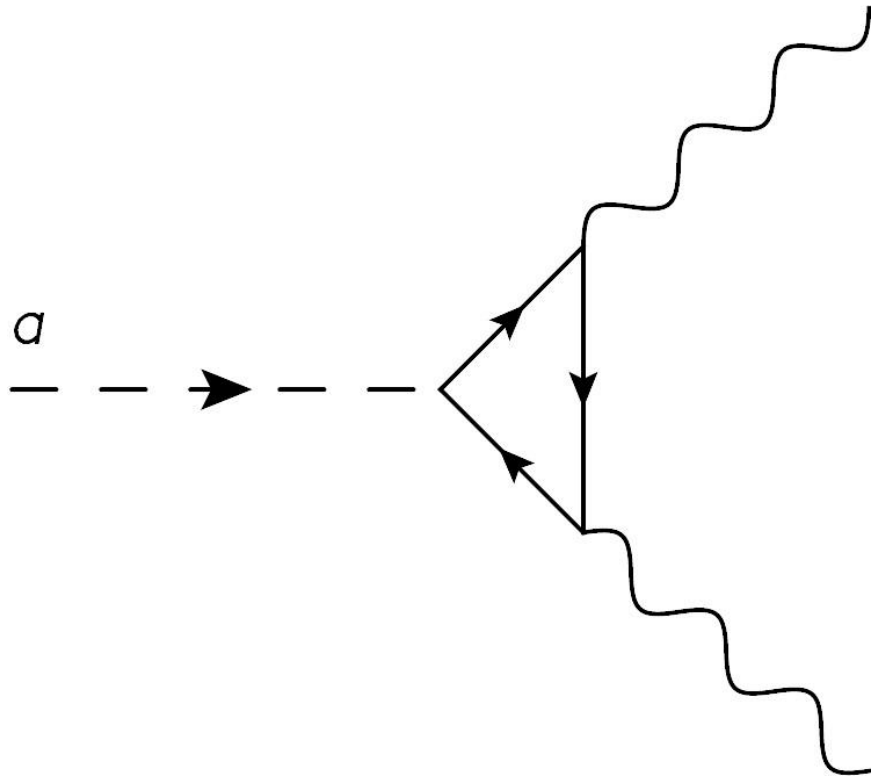
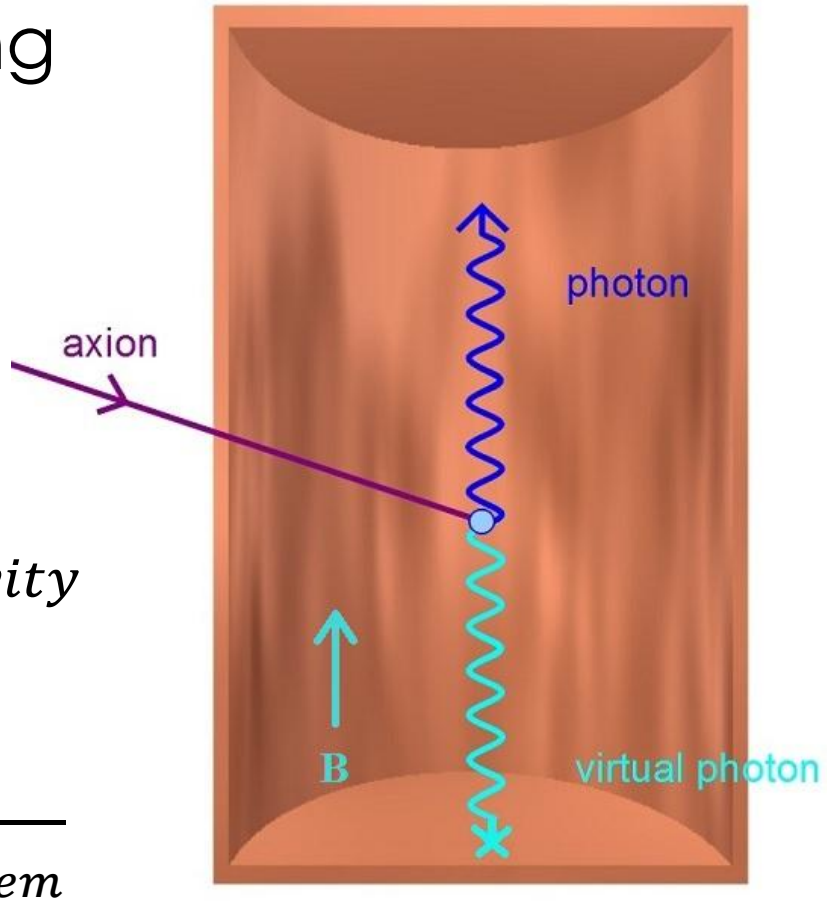
Axion theory

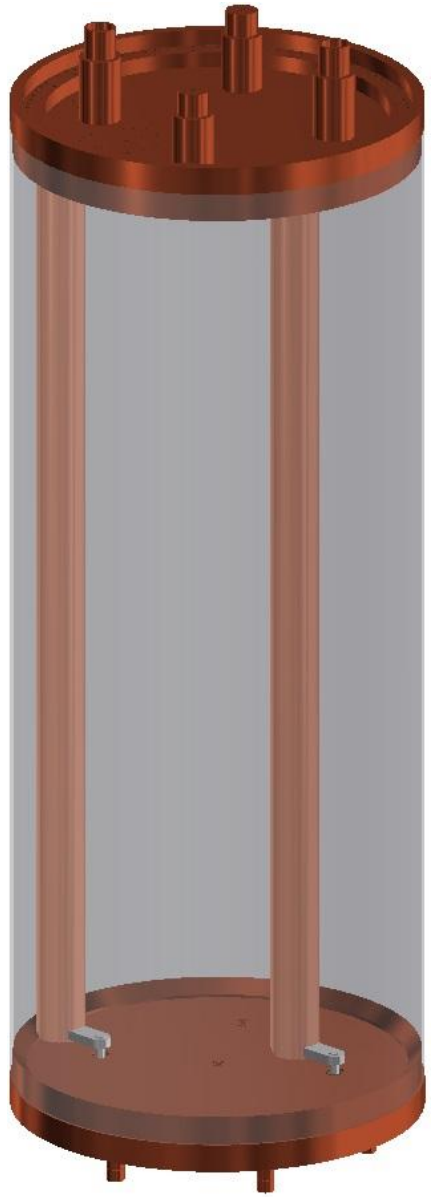
- The Axion Dark Matter eXperiment (ADMX) looks for axions
- Axions are hypothetical particles that solve the Strong CP Problem and account for dark matter
- An axion can decay into two photons
- $\tau_{a\to\gamma\gamma} \approx 10^{40}\ yr$



RF cavity technique

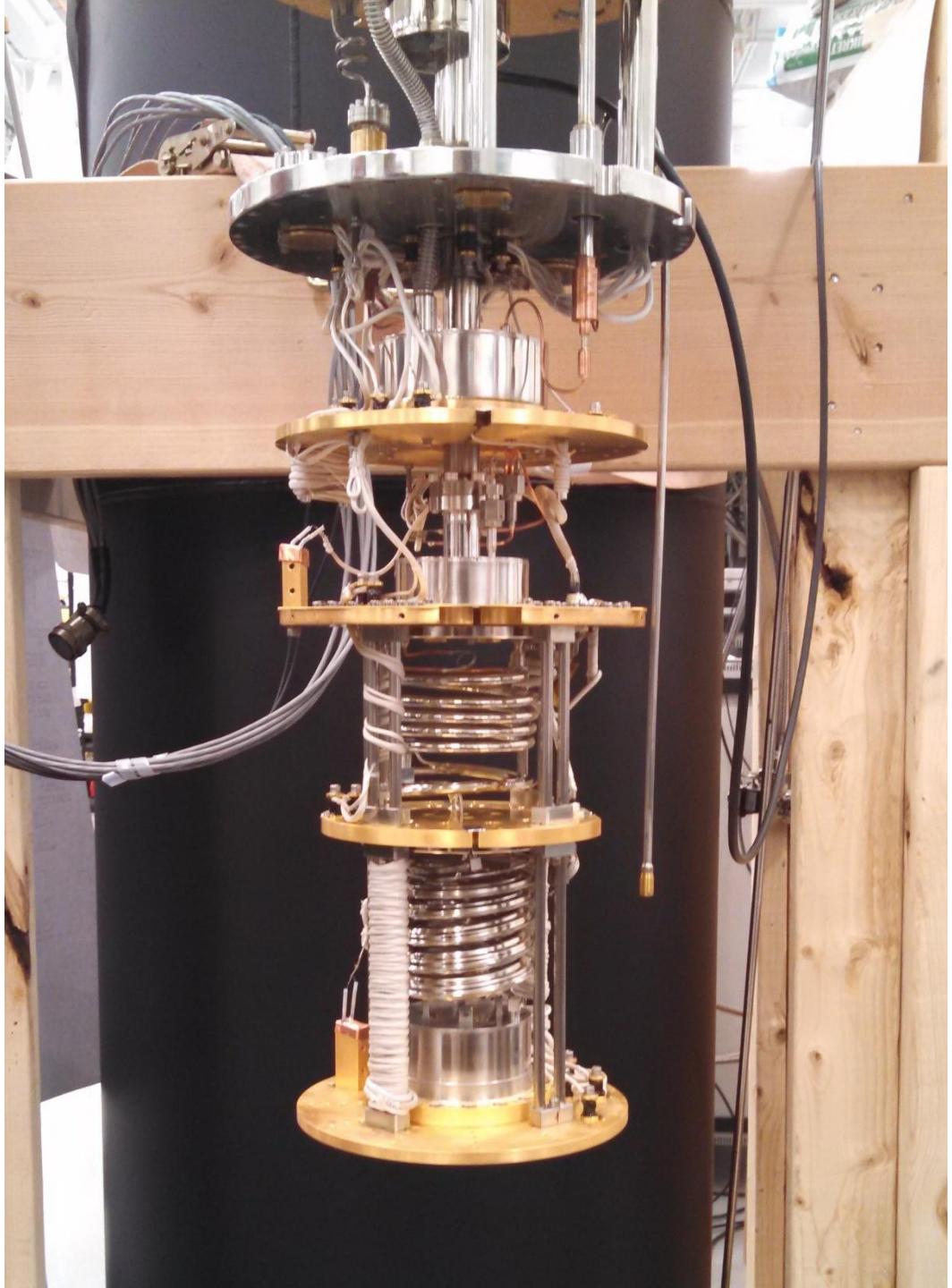
- ADMX uses a strong magnetic field to induce $a \rightarrow \gamma\gamma$
- Interaction is enhanced in resonant cavity when $m_a c^2 \approx h f_{cavity}$
- f_{cavity} is tuneable
- Scan speed $\propto \frac{1}{T_{system}^2}$





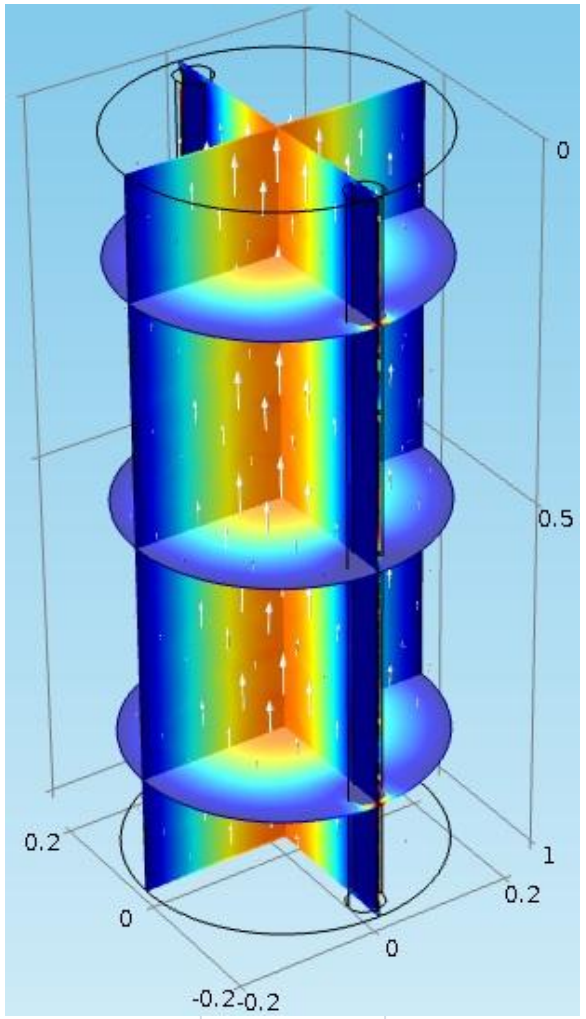
Colder is better

- ADMX was upgraded to use a dilution refrigerator
- Cavity and amplifier physical temperatures will drop to 100 mK
- 2014 data was collected at ~1.5 K (as were previous runs)

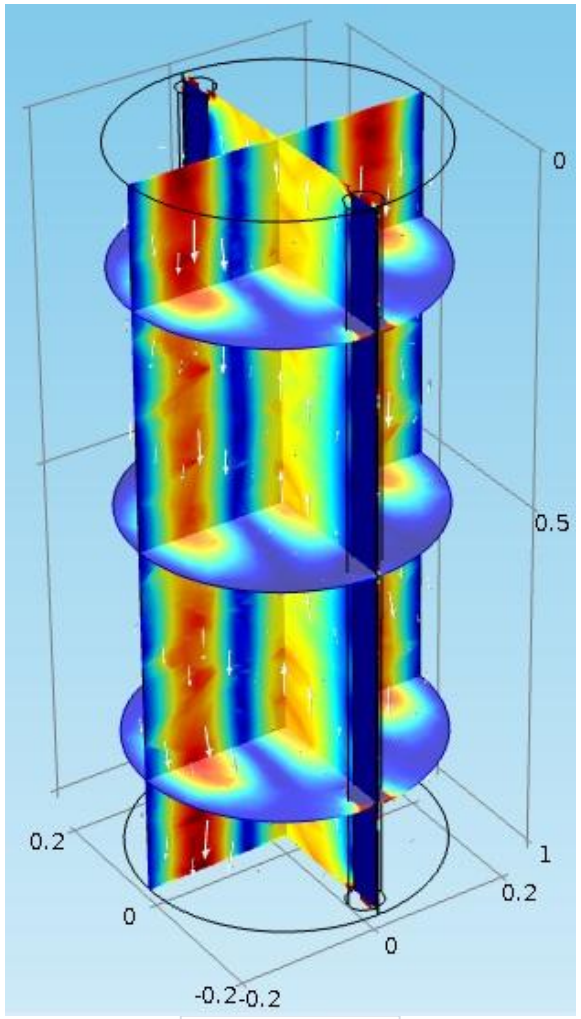


Two channels are better than one

- ADMX sensitive to TM_{0n0} modes
- TM_{010} has best coupling to axions
- For 2014 data was collected from both TM_{010} and TM_{020} modes



TM_{010}



"TM_{020}"

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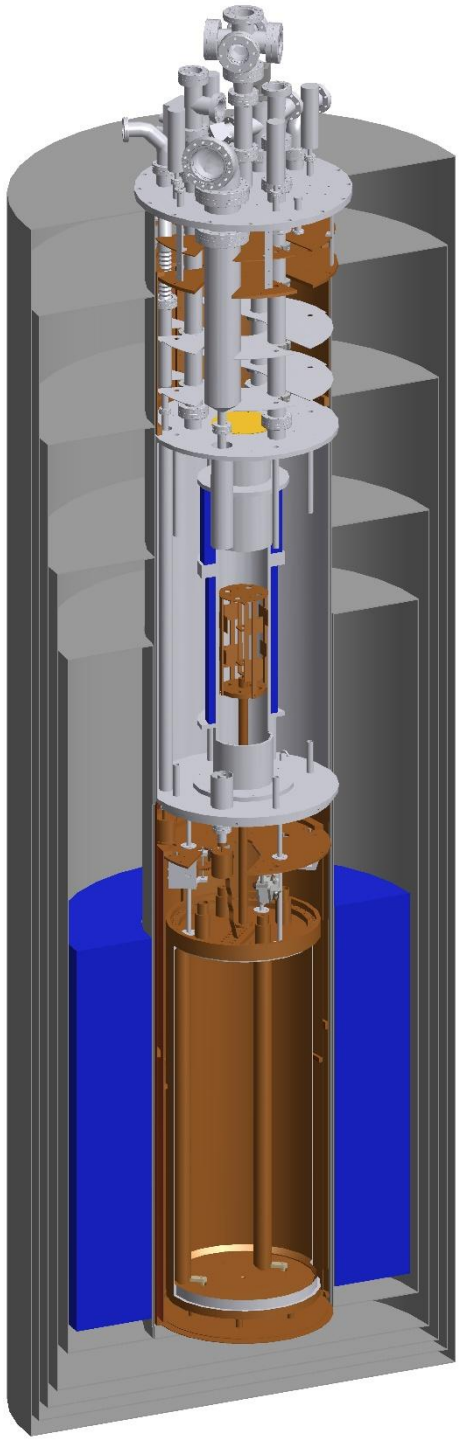
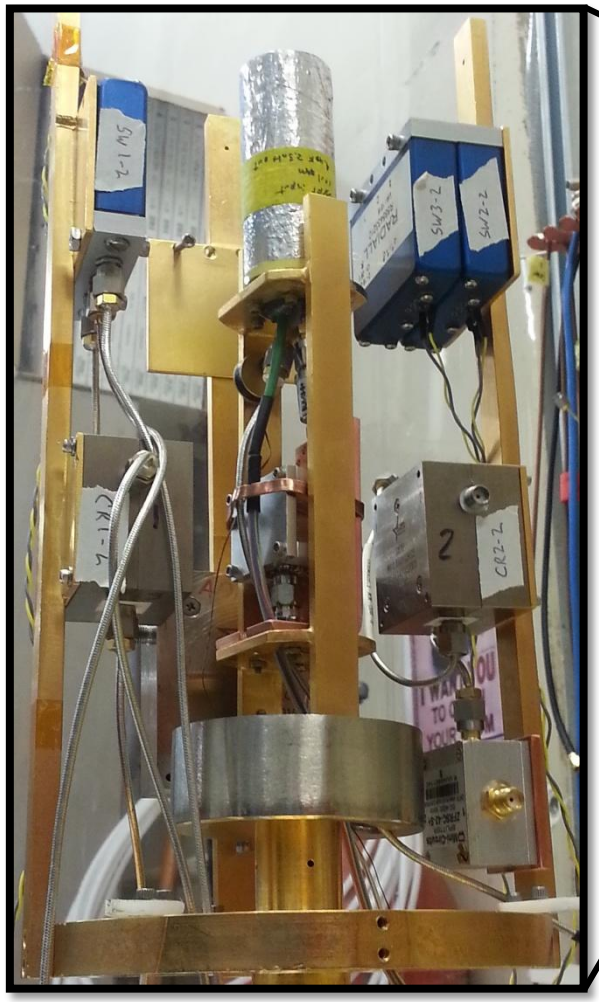
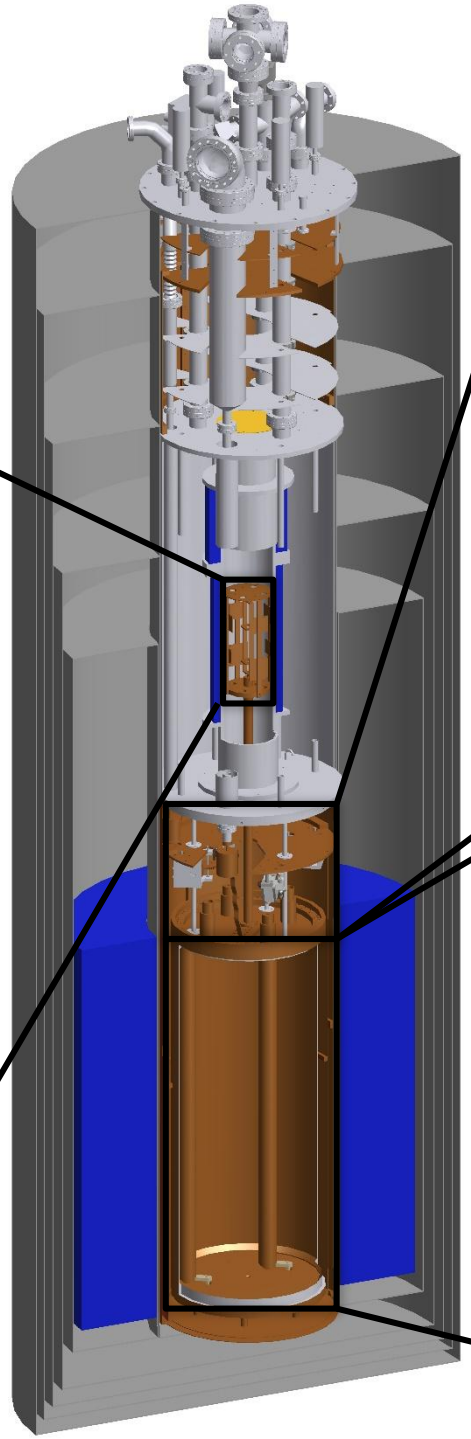
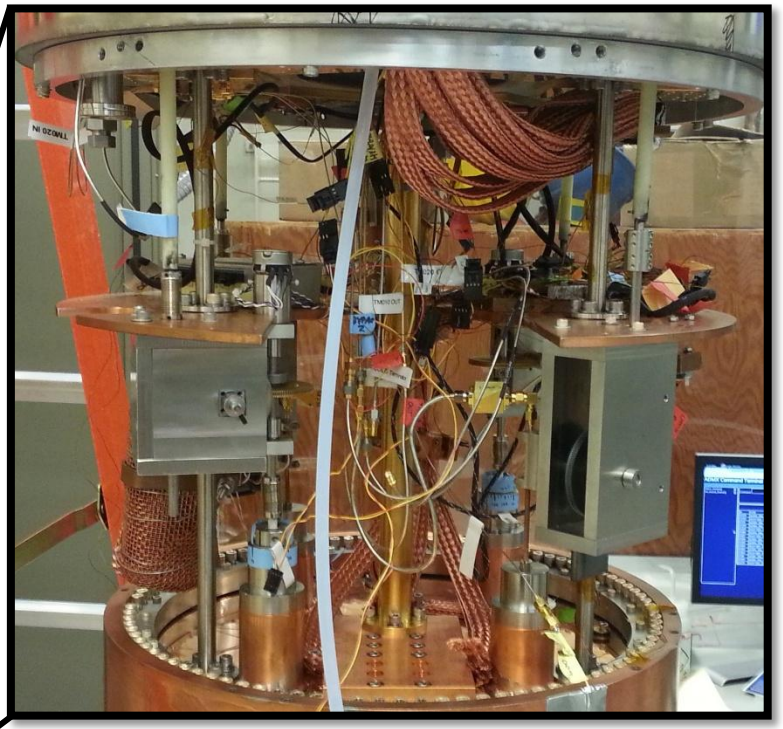
ADMX model



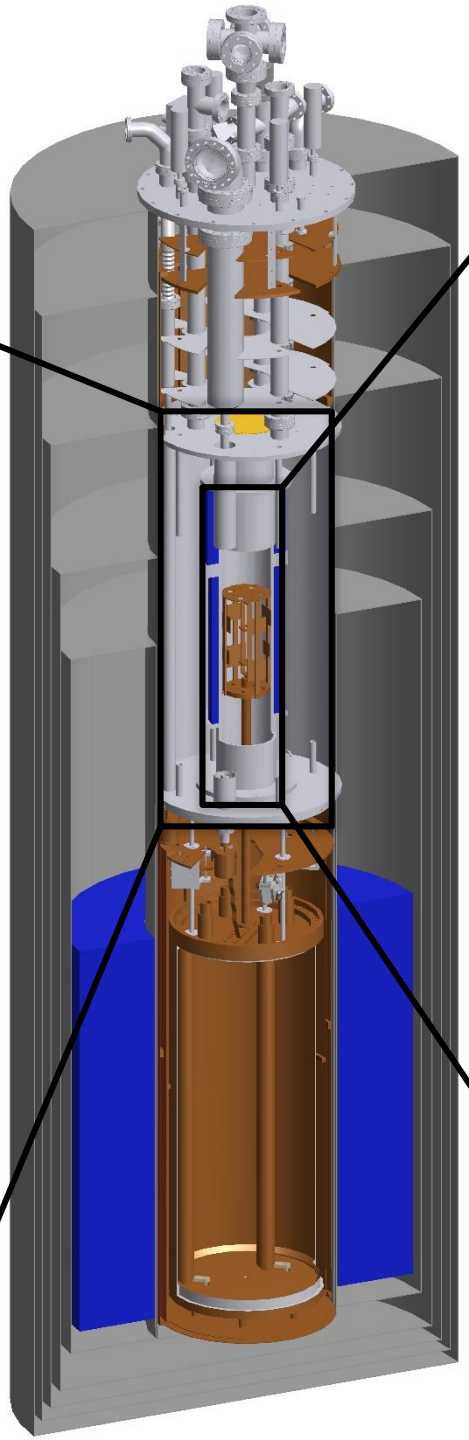
ADMX model



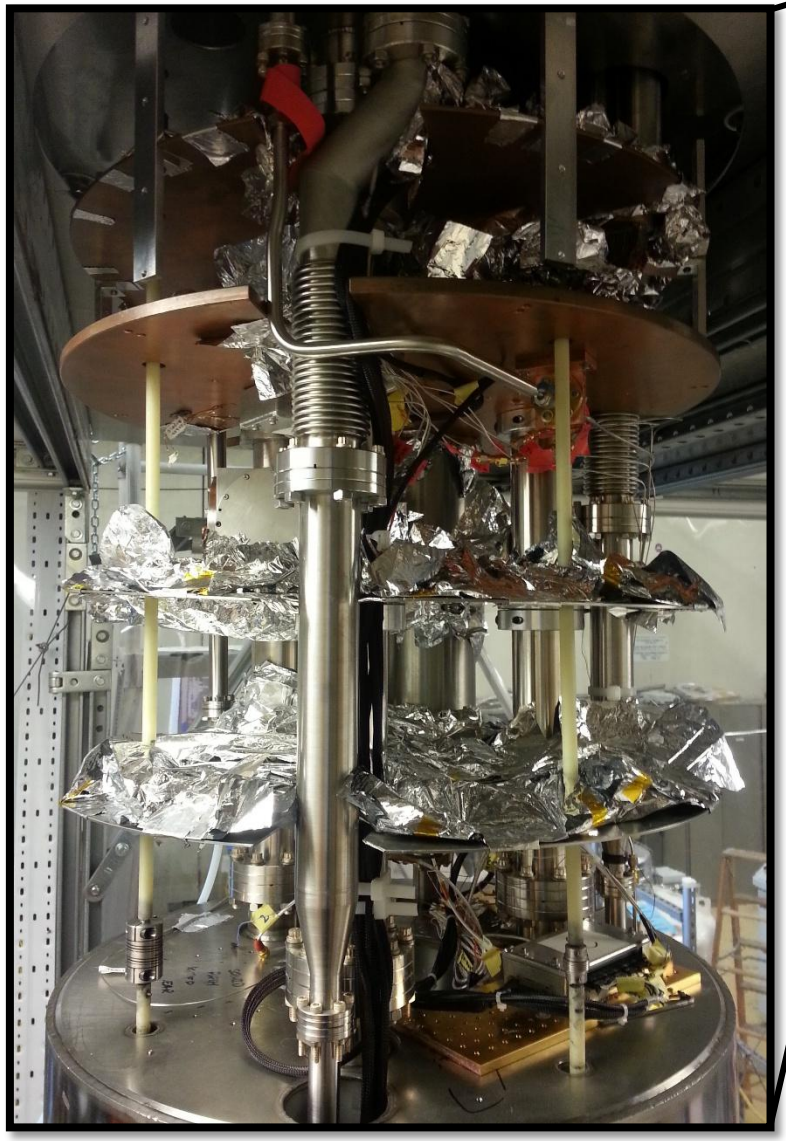


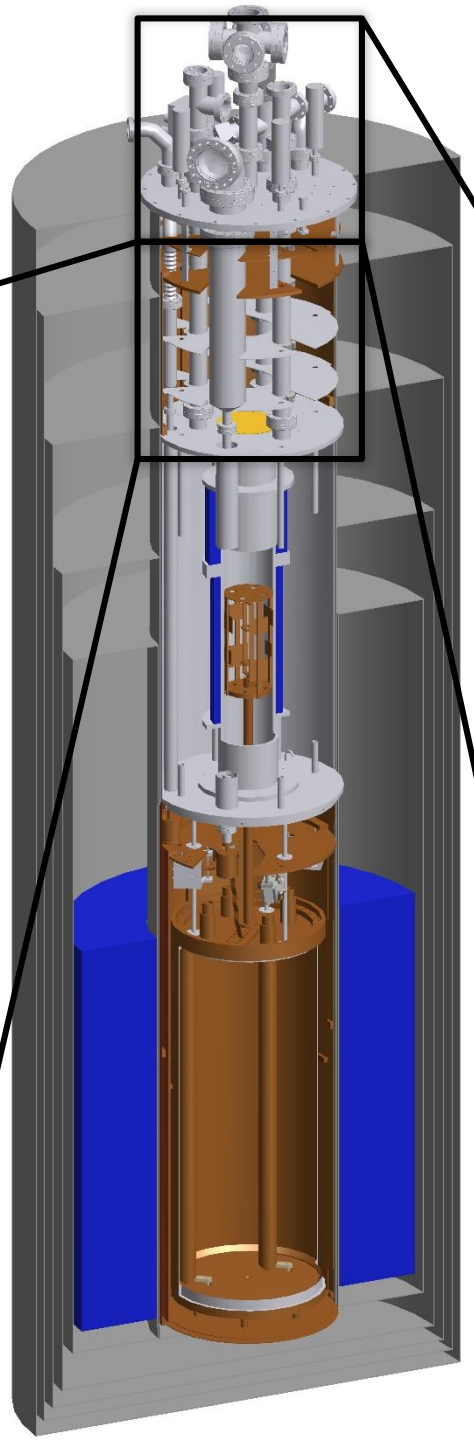


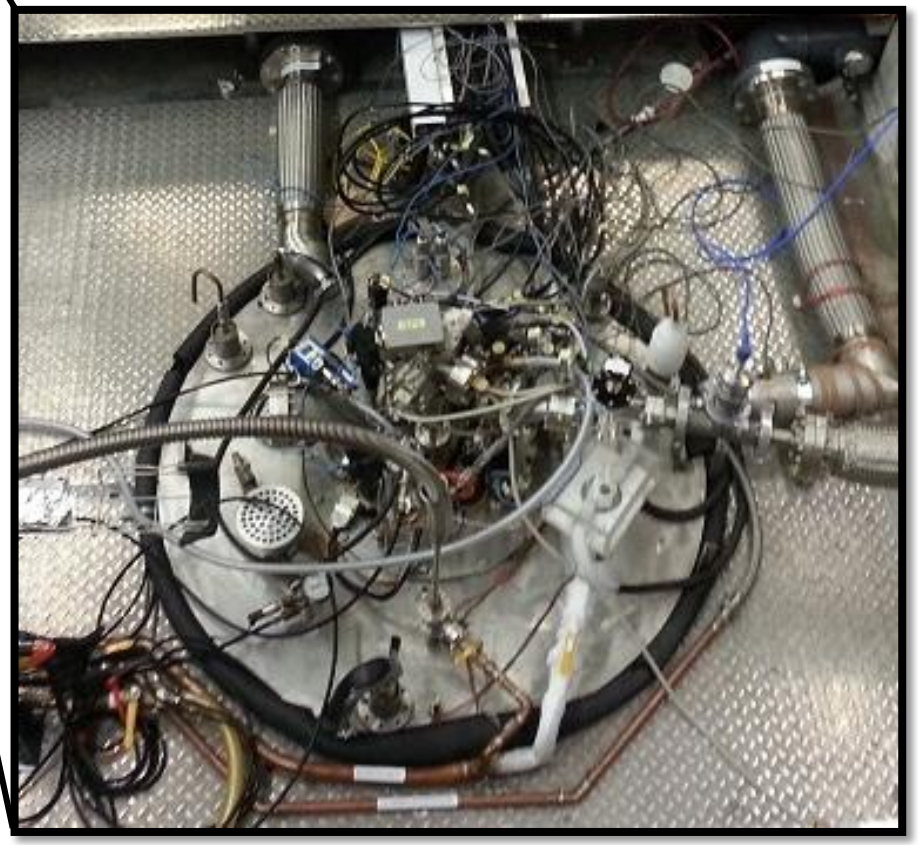
ADMX model



ADMX model







Insertion and extraction

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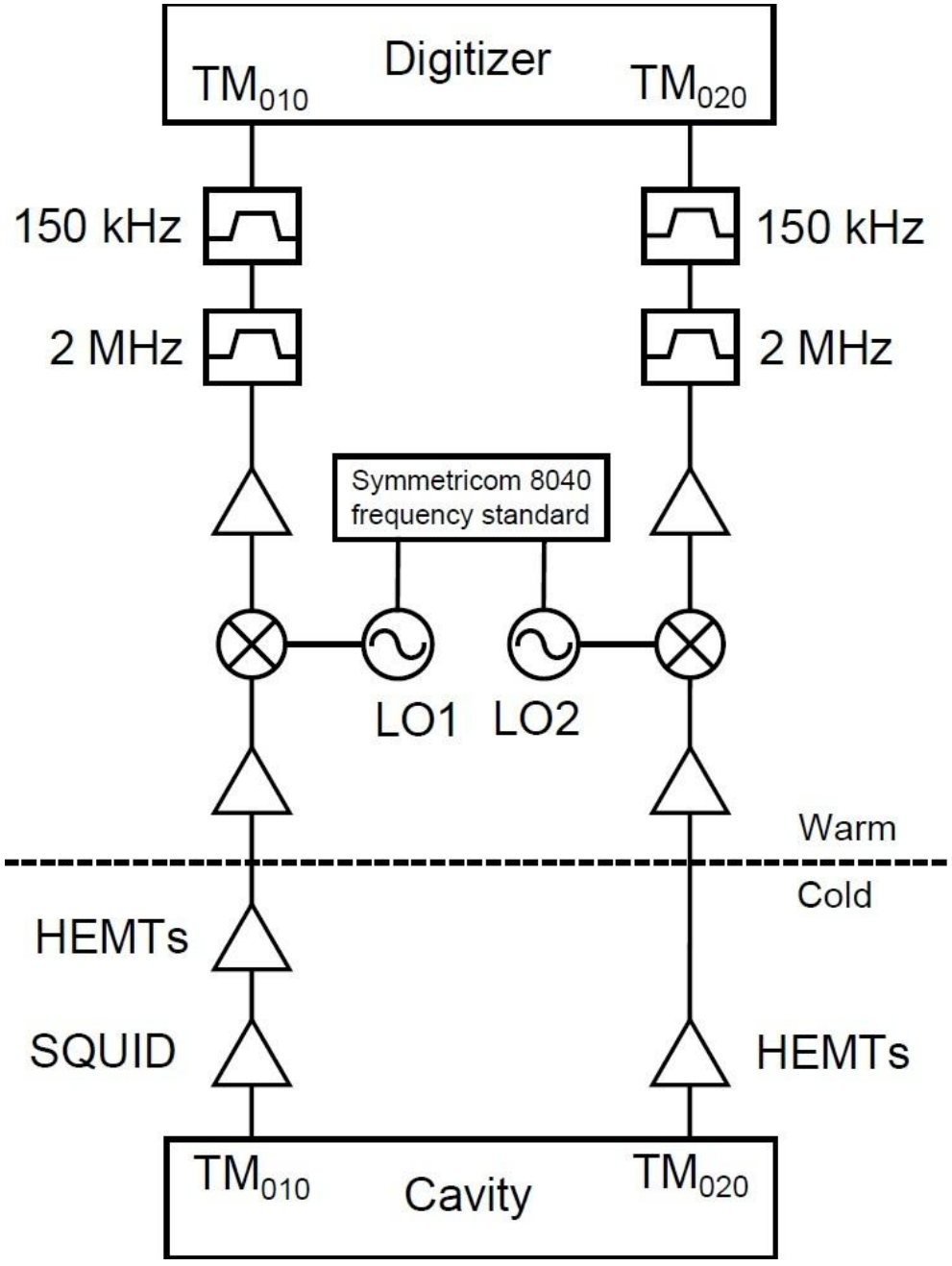
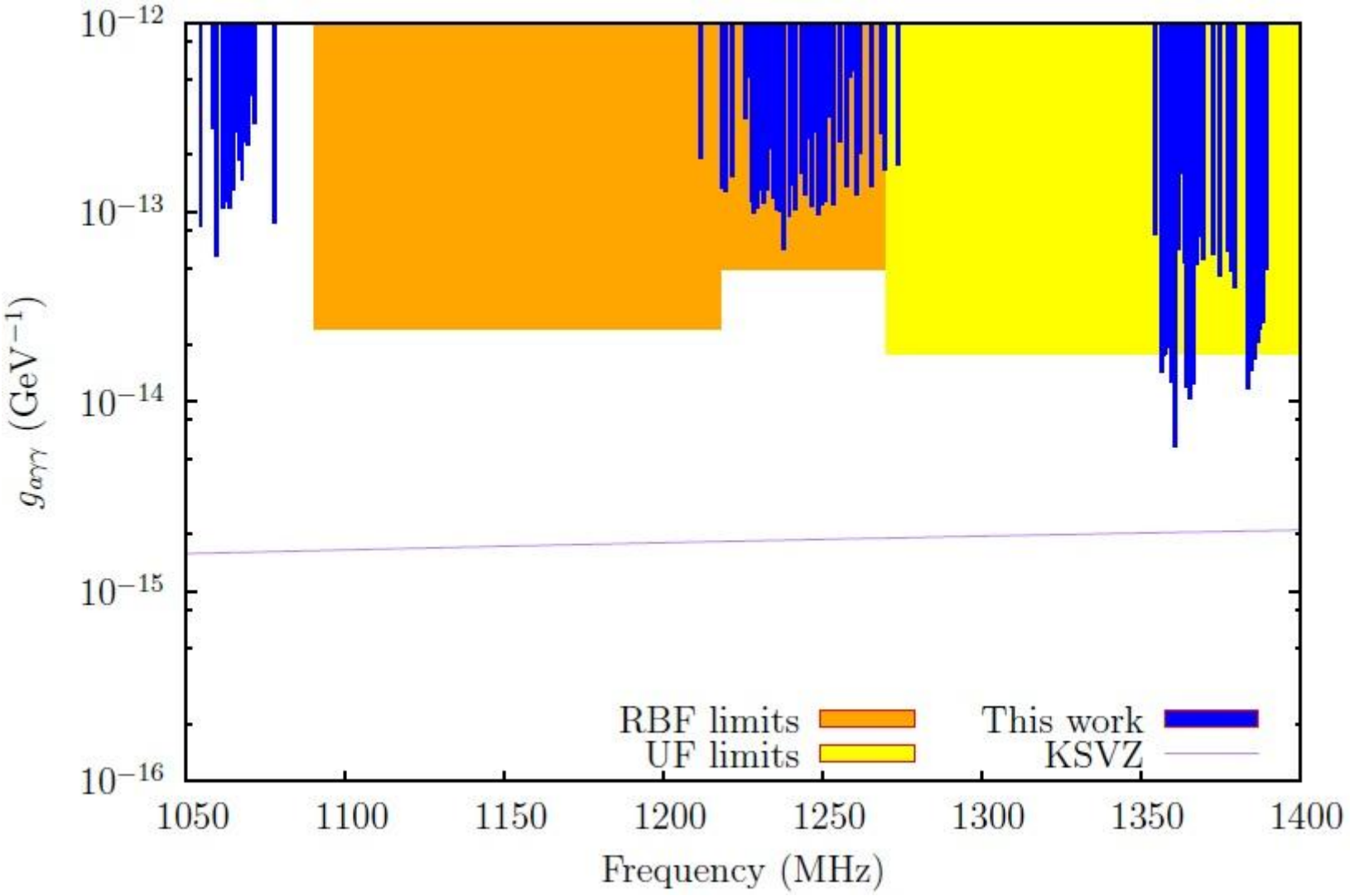
Receiver chain

- Two channels
- SQUID in 1^{st} channel, HEMTs in both channel
- 1K noise temperature in 1^{st} channel, 4 K noise temperature in 2^{nd} channel
- 10.7 MHz intermediate mixing frequency is used in both channels



1.0 – 1.5 GHz exclusion limits



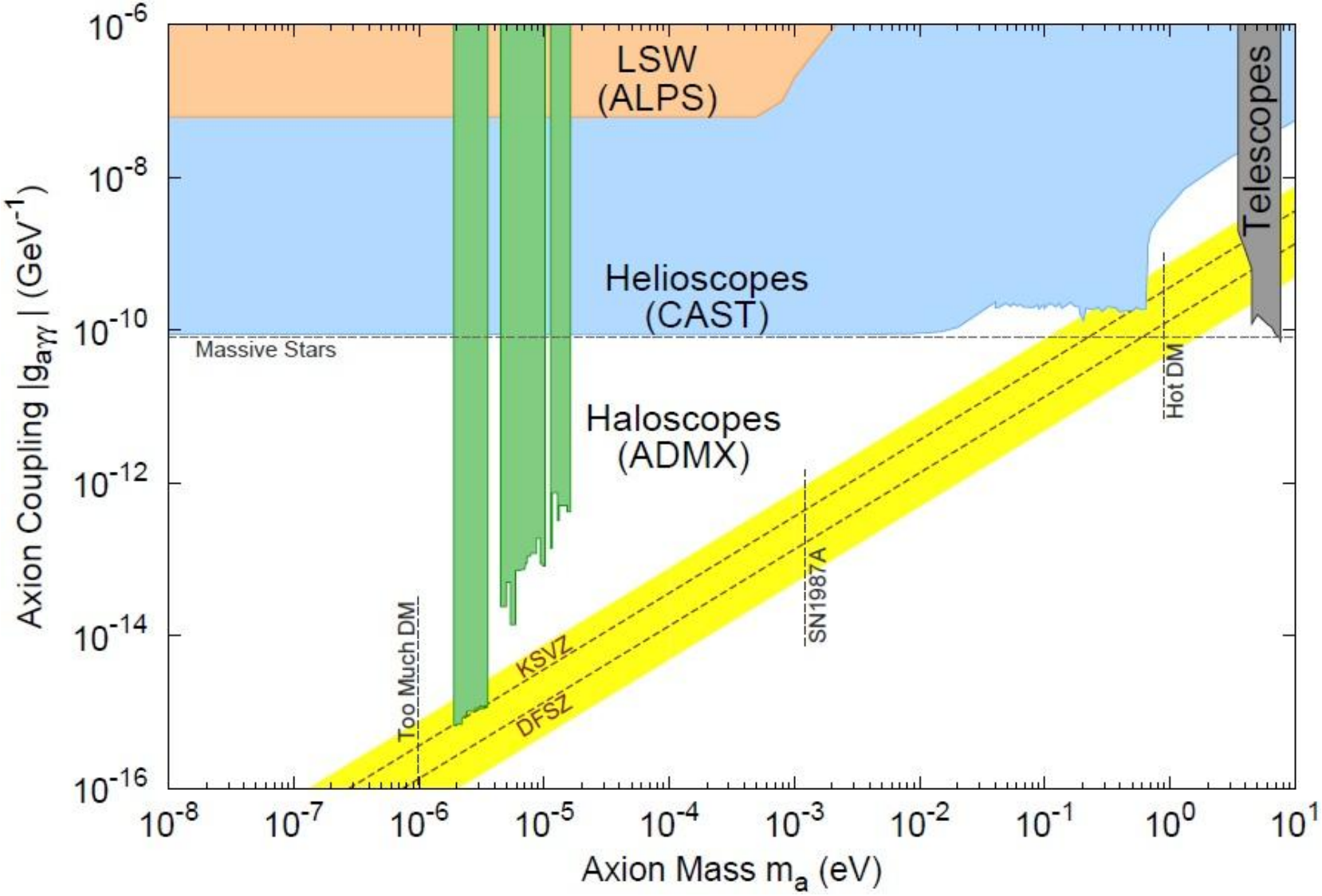
Final words

- New exclusion limits were set from less sensitive TM_{020} cavity mode
- $T_{system} = T_{physical} + T_{amplifier} \approx 6\ K$
- With dilution refrigerator, $T_{system} \approx 200\ mK$
- Stay tuned for mK results from ADMX!

Extra slides

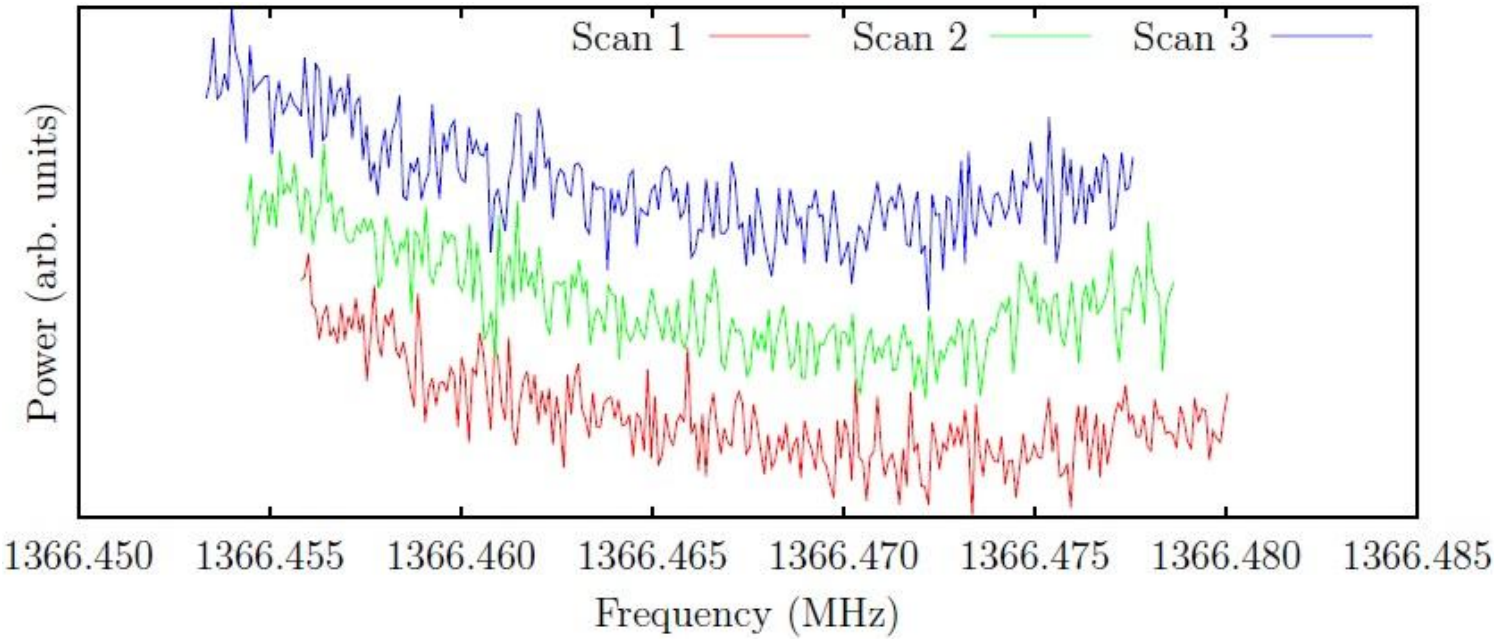
ADMX site

Previous results

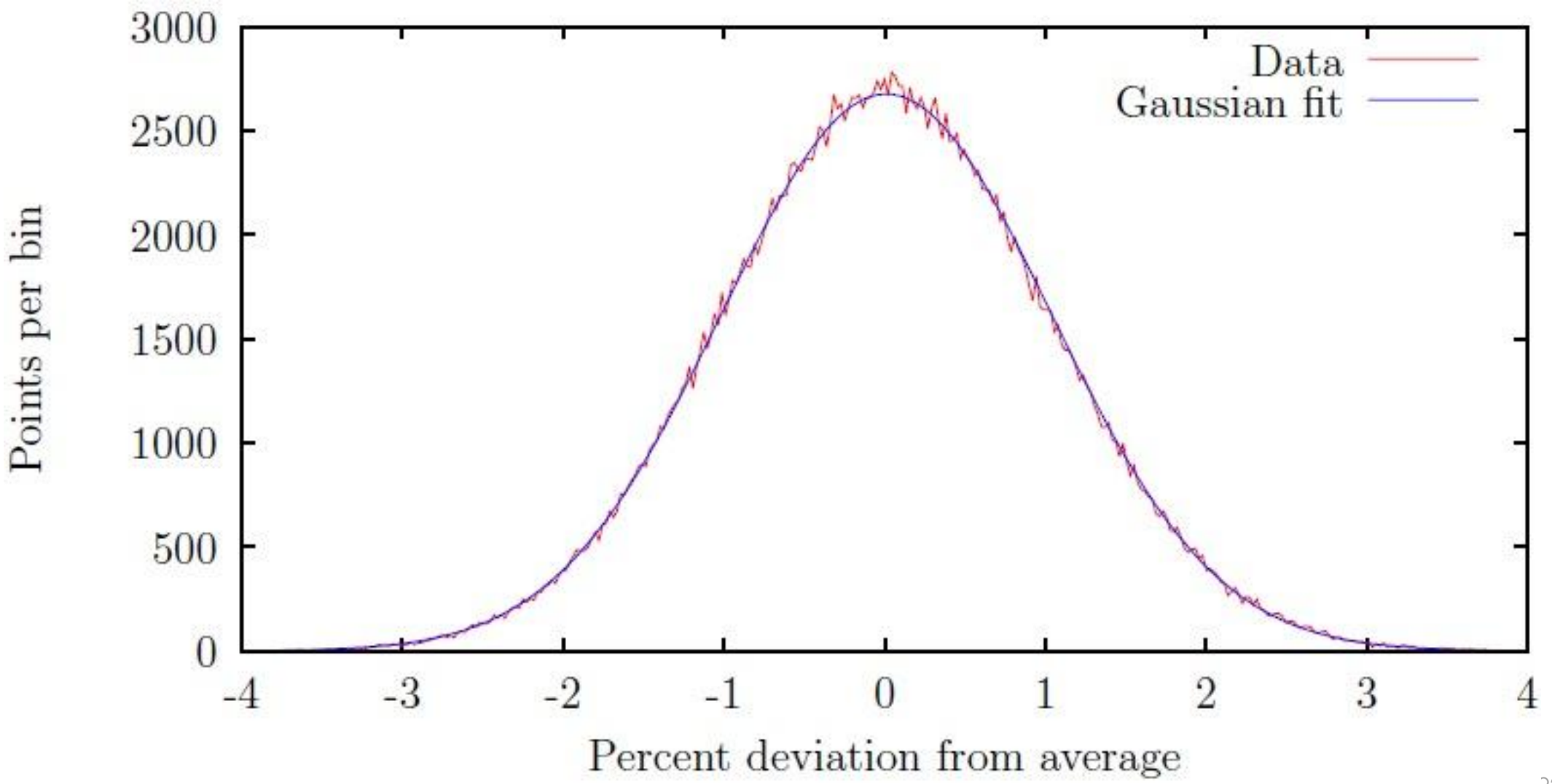


Adding spectra

- Spectra are offset in frequency
- Axion signal adds coherently while noise adds incoherently
- SNR improves as $\sqrt{N_{spectra}}$



Thermal noise 1



Thermal noise 2