

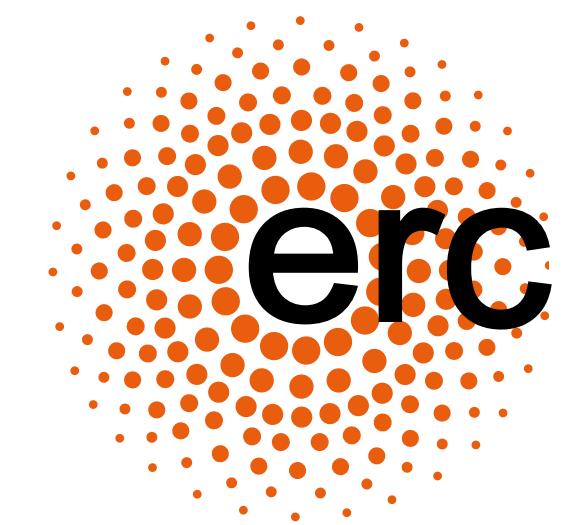
Listening for New Physics with Quantum Acoustics

Based on arXiv:2410.17308 with R.Linehan, T.Trickle, C.Conner, S. Ghosh, T.Lin, and A. Cleland



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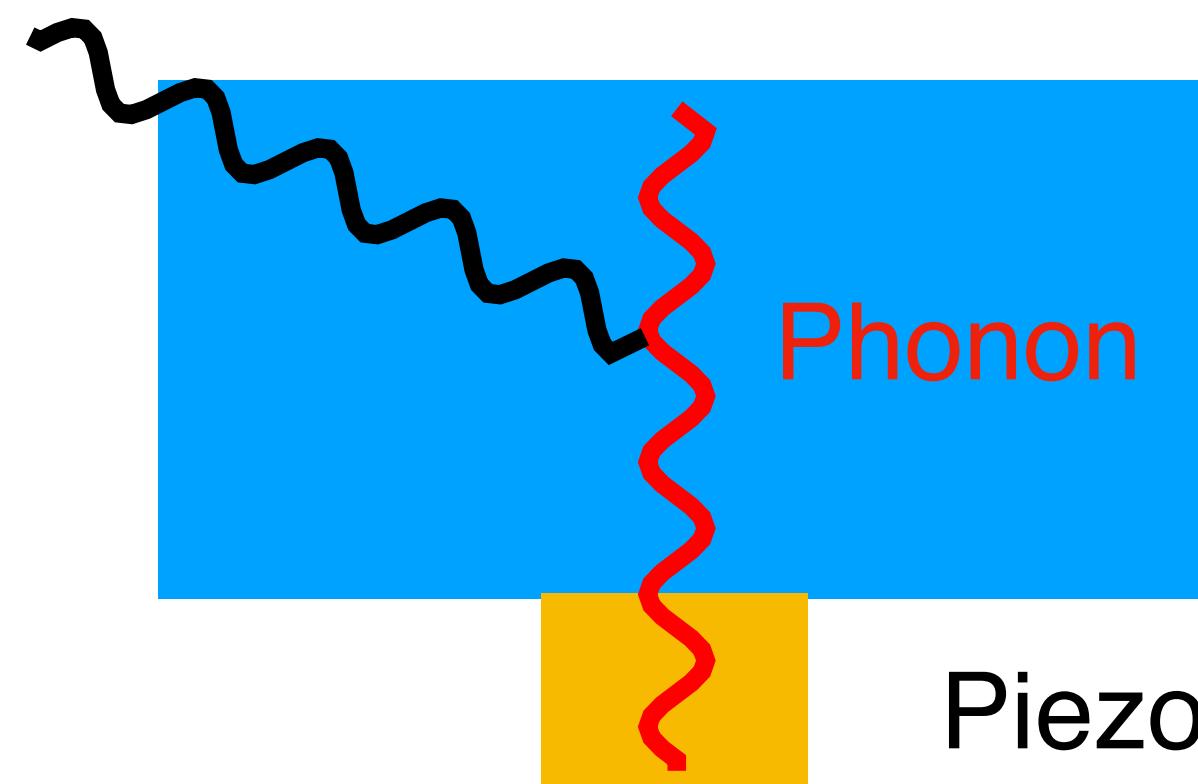
WE-Heraeus Seminar "New windows on the Universe - exploring the interface of particle physics and gravitational waves"
18.05.2025-21.05.2025

Introduction

- Quantization of sound waves : phonons!
- Phonons are an important channel in the direct detection of dark matter
- Typical phonon readout proposals limited to meV thresholds (e.g. using transition edge sensors)
- Materials do host phonon modes below meV (THz) **AND** there could be interesting new physics at these scales (e.g. ultralight fields, GW)
- Recent advances in quantum sensing have shown capabilities of reading out single phonons at microeV (GHz) scale! *arXiv:1703.00342

Detector and operation idea

New physics



Qubit tuned to
new physics
frequency and
set to ground
state

Piezoelectric transducer

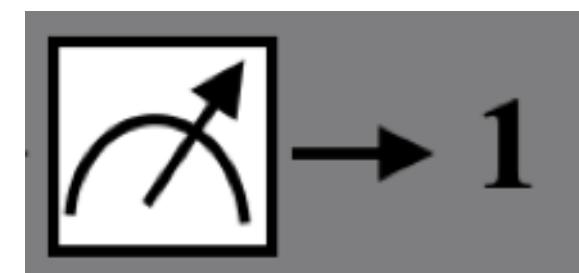
2-state superconducting
qubit (initially *off-resonance*)

$|e\rangle$
 $|g\rangle$

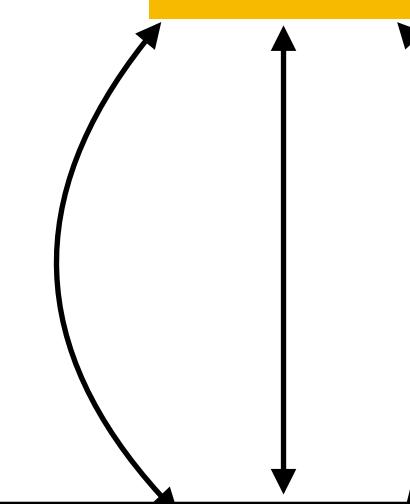
Search phase



Readout of
the qubit
state



Rabi
oscillations



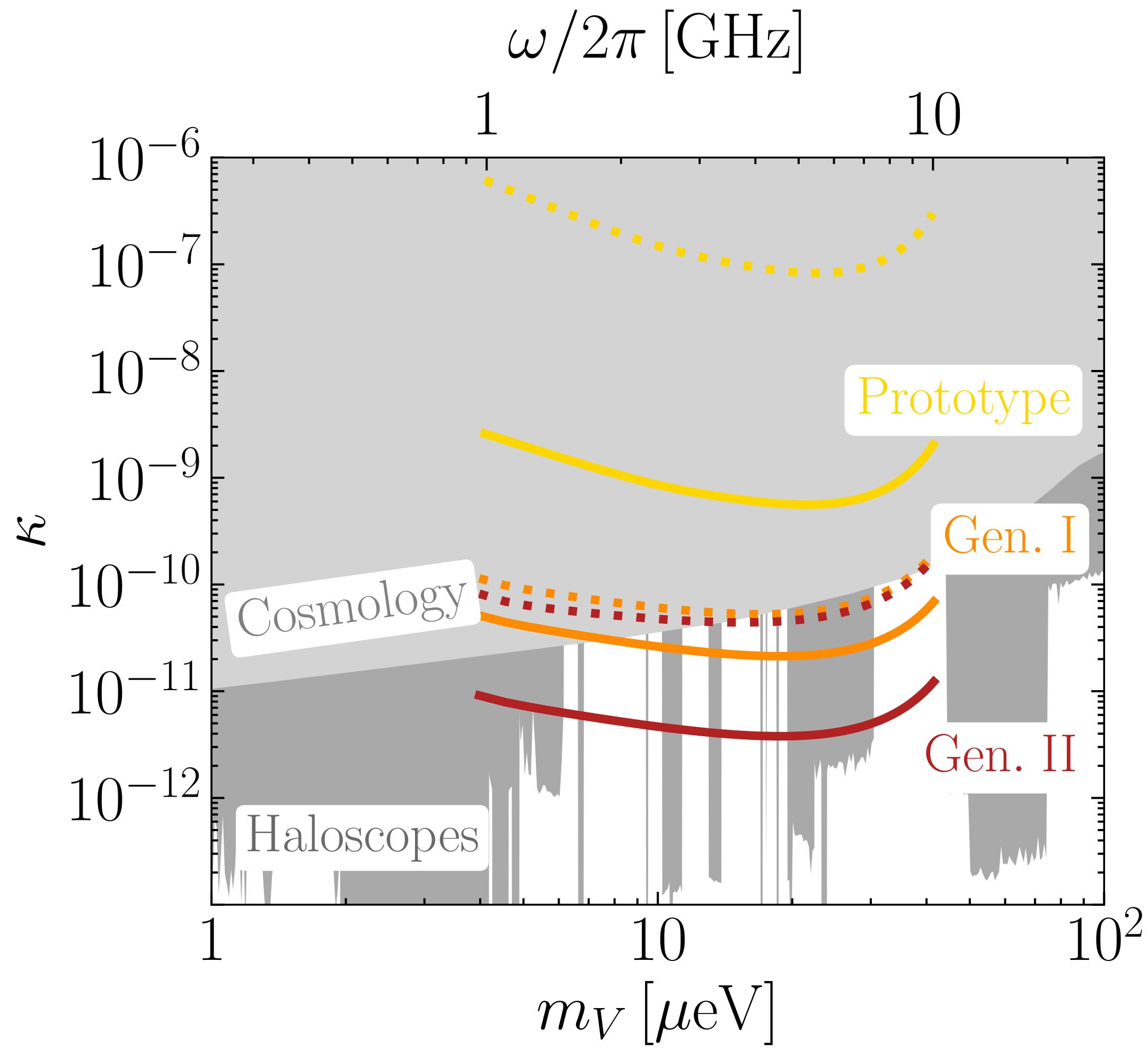
Phonon swapped
into the qubit!

$|e\rangle$
 $|g\rangle$

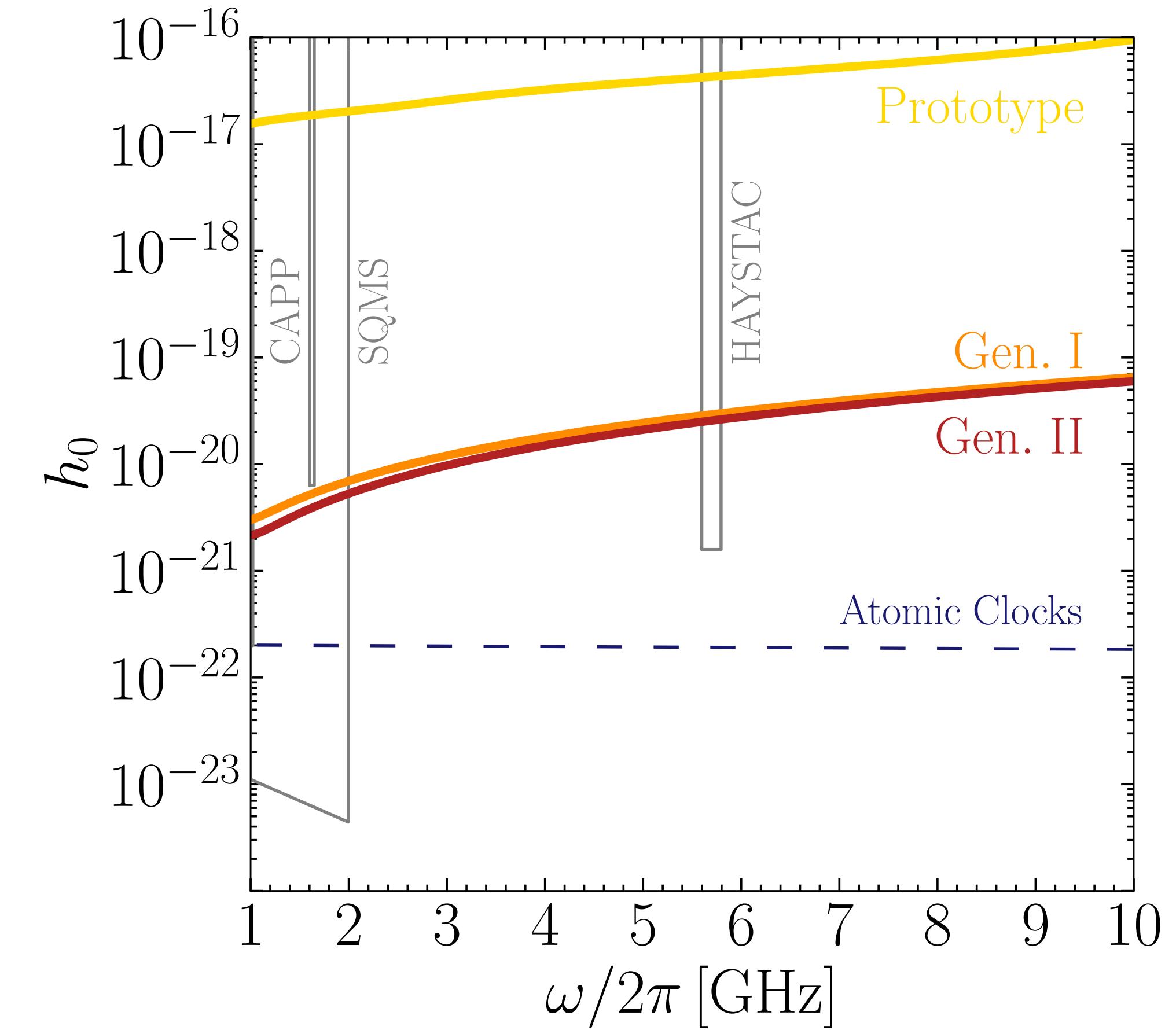
Swap phase

Sensitivity projections

Dark photon dark matter



Gravitational waves



Detector can be tuned to gain sensitivity to new physics that is complementary to haloscope sensitivity