

MAGIS: Expanding High-Energy Physics with Atom Interferometry

Synergies with and Opportunities for DOE

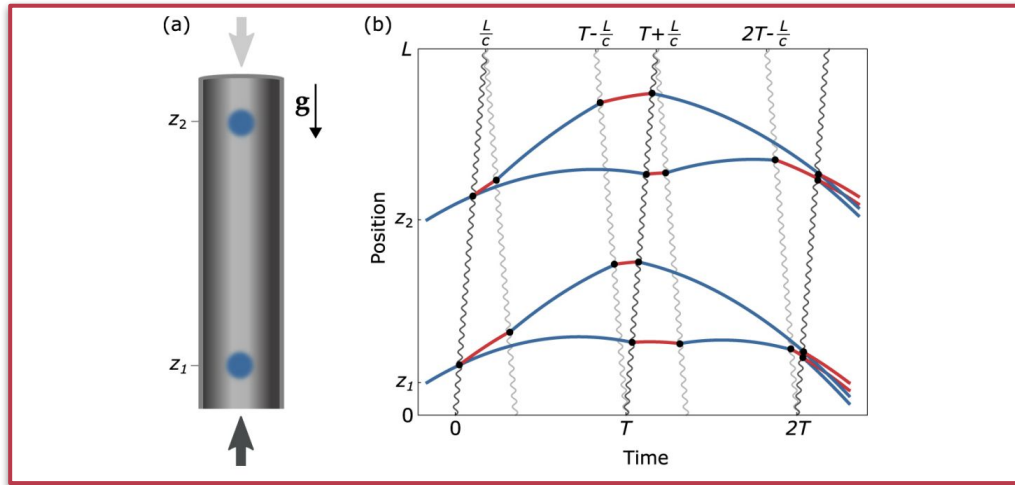
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on behalf of MAGIS Collaboration

Quantum Sensors for HEP @ Yale University
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Science Opportunities with MAGIS

MAGIS: long-baseline atom interferometry

- Ultralight dark matter searches
- Mid-band gravitational waves (cosmological sources)
- Quantum mechanics at unprecedented scale



Quickly growing global interest / investment

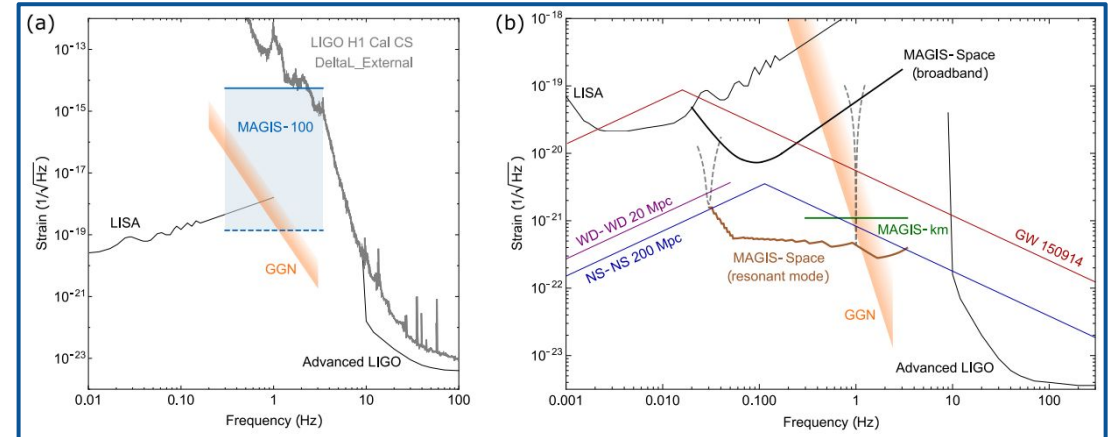
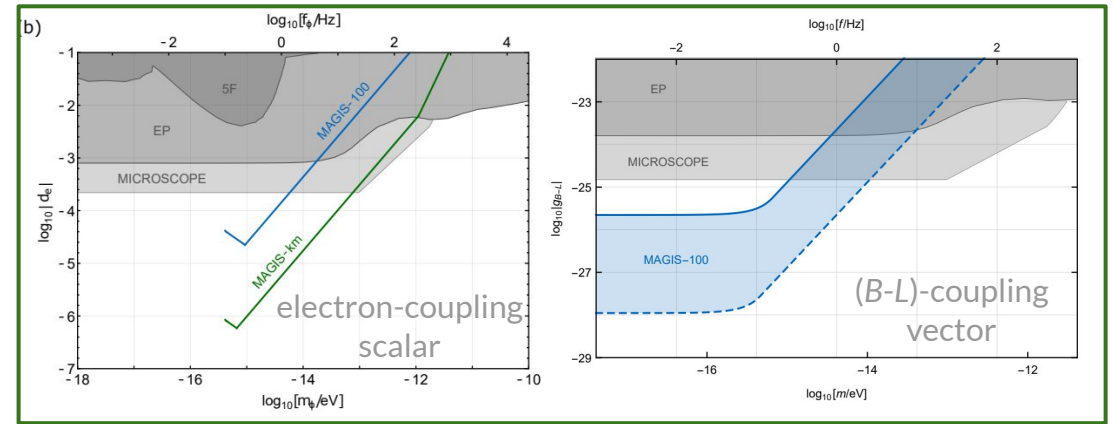
- [ELGAR](#) @ EU, [MIGA](#) @ France, [ZAIGA](#) @ China
- [AION](#) @ UK is already a close partner of MAGIS
- [100m feasibility study](#) @ CERN (Physics Beyond Colliders)

An opportunity for US leadership in a global network!

2 / MAGIS & DOE HEP

DOE HEP Science Drivers

- “Identify the new physics of dark matter”
- “Understand cosmic acceleration: dark energy and inflation”
- “Explore the unknown: new particles, interactions, and physical principles”



DOE & Long Baseline Atom Interferometry

MAGIS-100 = First atom interferometer at 100m scale, currently under construction @ Fermilab

DOE can enable MAGIS with:

- Facilities / Sites
- Large-scale instrumentation: lasers, UHV, detectors
- Computing
 - High-performance computing for large-scale simulations
 - Data management & analysis
- AI/ML used for simulators, reconstruction, and analysis
- **These are all areas of DOE expertise!**

MAGIS at DOE Labs wil:

- Pursue science goals complementary to LHC, DUNE, etc.
- Absorb and grow personnel, more atomic/quantum expertise
- Expand DOE expertise to atomic physics & quantum sensing
 - Precision alignment, laser cooling & trapping, large-momentum transfer (LMT), spin squeezing, etc.
- **Prepare for quantum era, more QIS experiments in the future!**

Experiment	(Proposed) Site	Baseline L (m)
Sr prototype tower	Stanford	10
MAGIS-100 (initial)	Fermilab (MINOS shaft)	100
MAGIS-100 (final)	Fermilab (MINOS shaft)	100
MAGIS-km	Homestake mine (SURF)	2000
MAGIS-Space	Medium Earth orbit (MEO)	4×10^7

