Our consortium

Quantum-Enhanced Interferometry for New Physics

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- 8 investigators from 5 UK institutions
- 8 project partners (UK quantum hubs, MIT, Caltech, NIST, Fermilab, DESY, Max Planck)

Goals

Quantum Enhanced Interferometry for two fundamental physics questions:

- Dark matter (2 experiments)
- Observational signatures of quantized gravity (2 experiments)

Quantum technologies:

- Squeezed light
- TES (transition edge sensor)

Unifying technology:

- Interferometry with extreme performance optical coatings

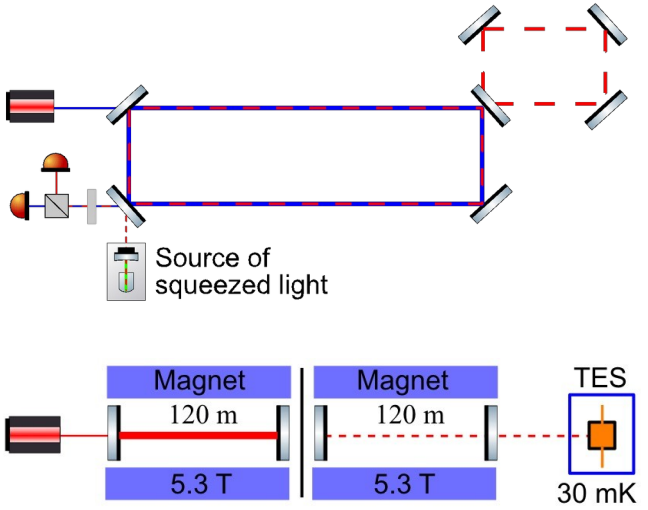
Experiments

Experiment 1: Axions in the galactic halo

- An ‘interferometry haloscope’ (PRD 101, 095034)
- Axions with masses from 10^{-16} eV up to 10^{-8} eV

Experiment 2: Light-shining-through-wall (collab.)

- Making and detecting axion-like particles
- Transition edge sensor with background $<10^{-6}$/s



ALPS II at DESY

ALPS II magnet string installed at DESY.
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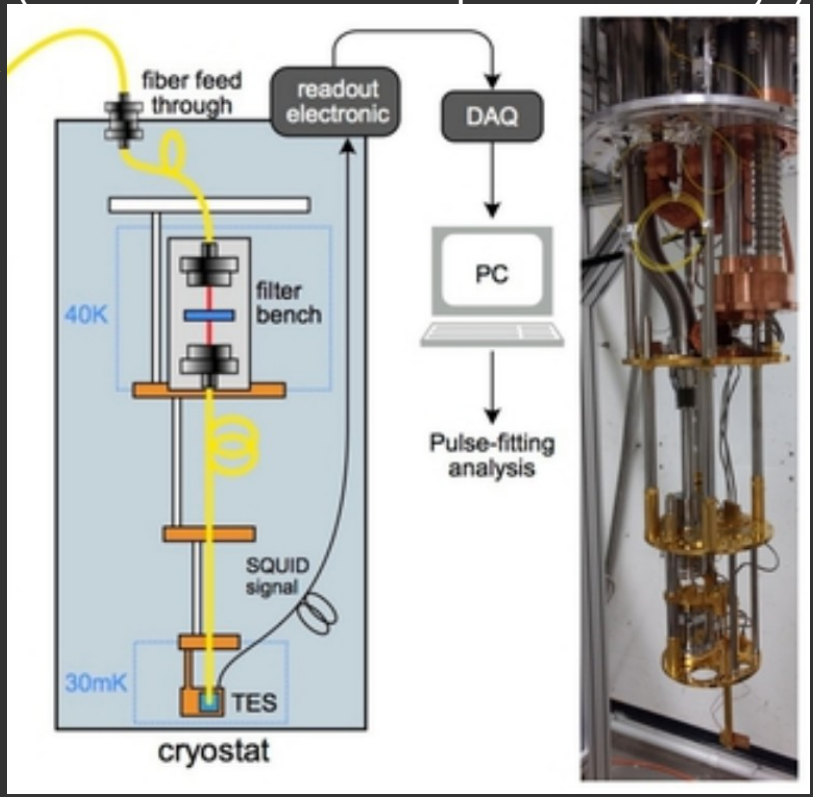
Single photon detector
(noise of less than one photon in 10 days)



R. H. Hadfield Nat. Photon 3 696 (2009)
A. Lita et al. Optics Express 16 3032 (2008)
A. Lita et al. Proc. SPIE 7681 (2010)

Experiments

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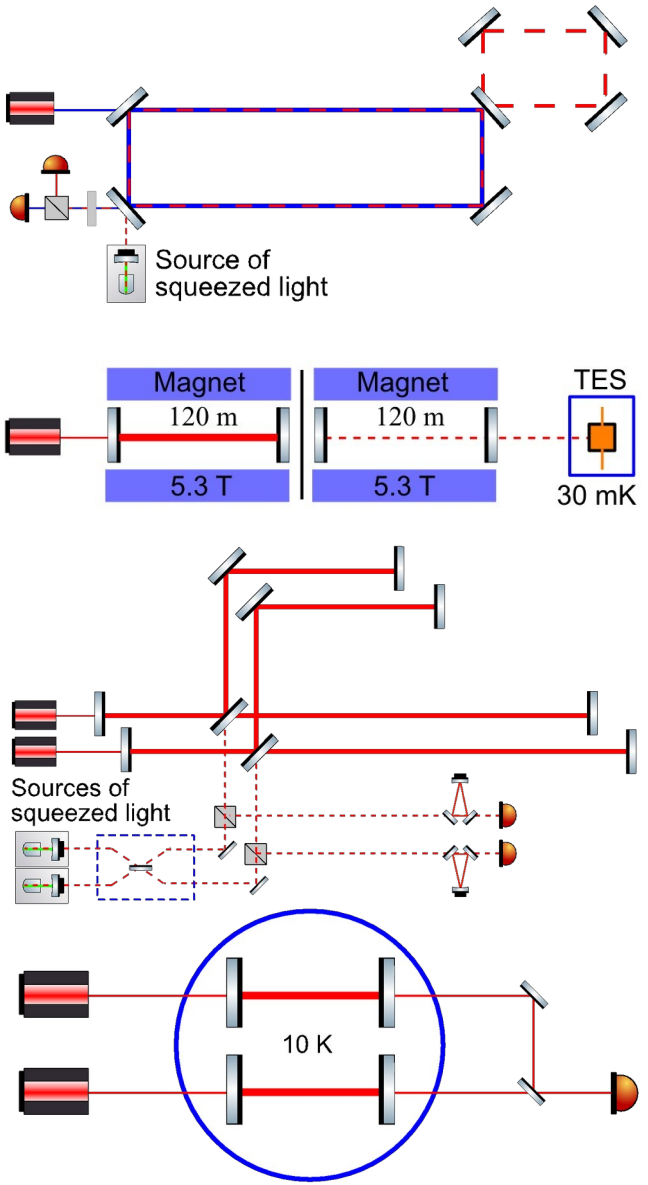
Experiment 3: Quantisation of space-time

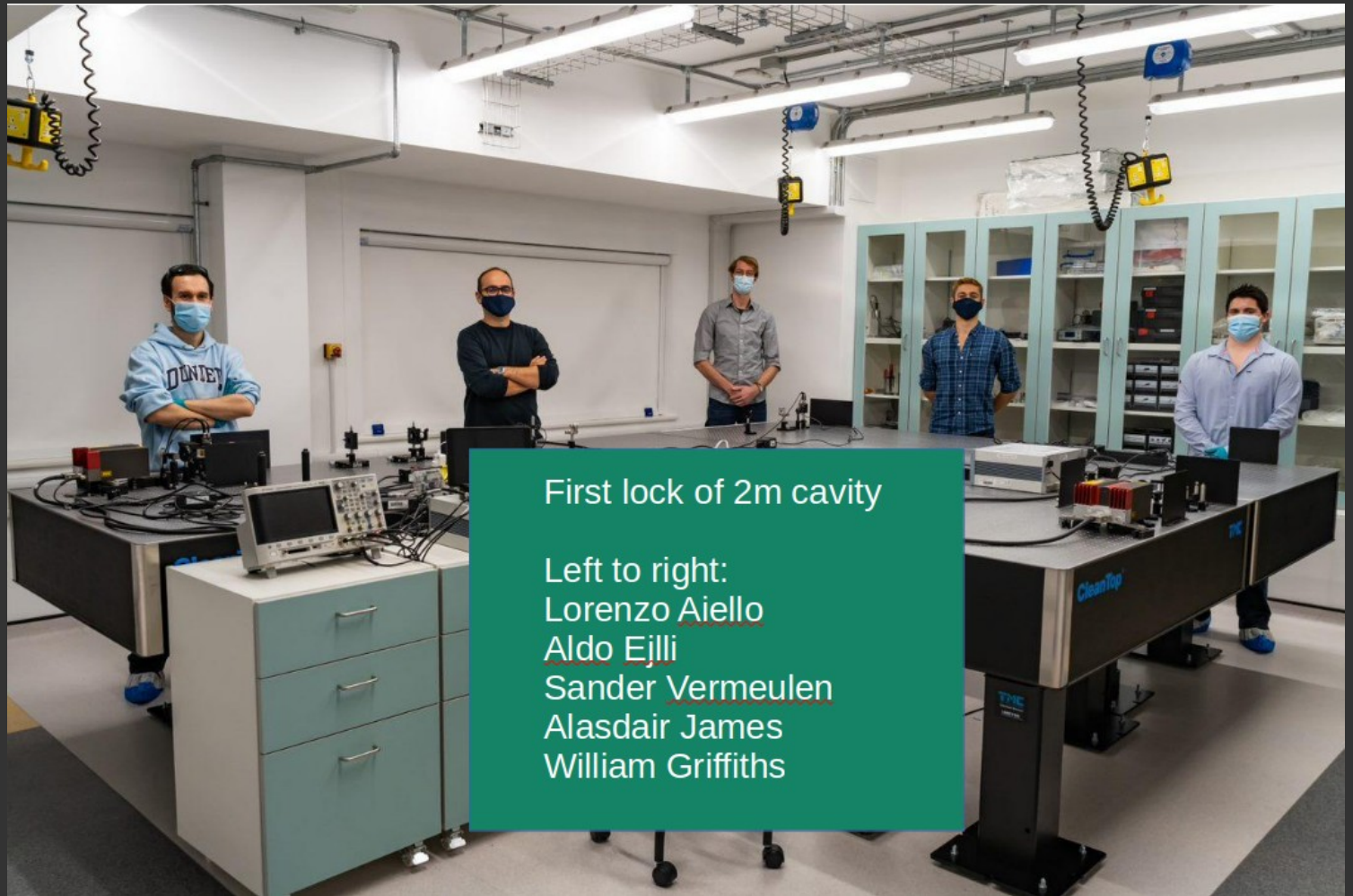
- Testing ideas on quantization of space-time
- Sensitivity of 2x10^{-19} m/rt(Hz) above 1 MHz

Experiment 4: Semiclassical gravity

- Testing semiclassical gravity predictions
- Expect to confirm or rule out



Experiment 3



Outlook

Experiment 1: Axions in the galactic halo

- Scalable to km-scale facilities

Experiment 2: Light-shining-through-wall (collab.)

- Scalable to km-scale
- Transition edge sensor for future dark matter searches

Experiment 3: Quantisation of space-time

- Scalable and reconfigurable for different geometries (CQG 38, 085008)
- Advanced squeezing schemes

Experiment 4: Semiclassical gravity

- Testbed for more quantum-gravity exploration using interferometry (arXiv 2104.04414)