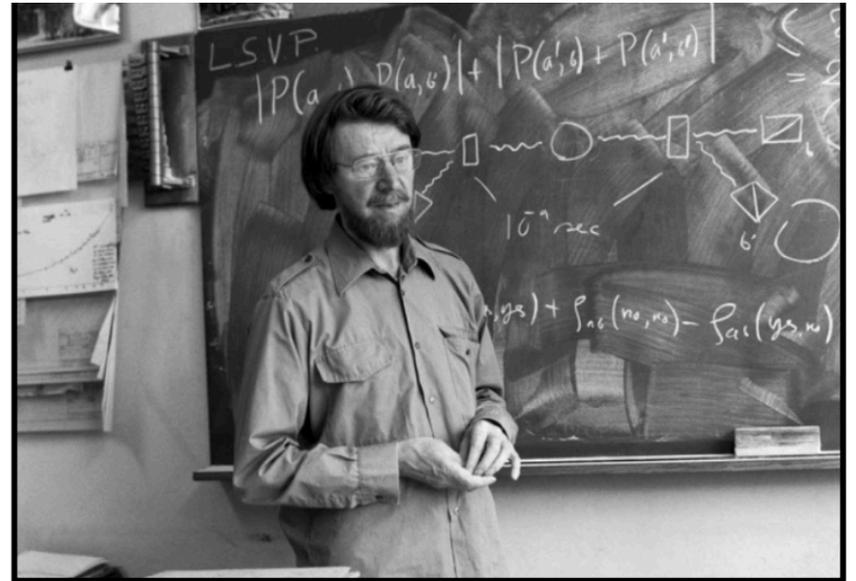


Quantum Prophet

- John Bell: CERN 1960/90
- Particle/accelerator physics
- Quantum physics foundations: Bell inequalities
 - “Spooky action at a distance”
- Long-range correlations > classical physics
 - Verified in laboratory experiments (Aspect et al.)
- Destruction if somebody eavesdrops
 - Applications in quantum cryptography, ...



“Quantum engineering” to “Quantum cosmology” to “Quantum finance”?

Long-Distance Correlations

- Observed between Geneva & CERN

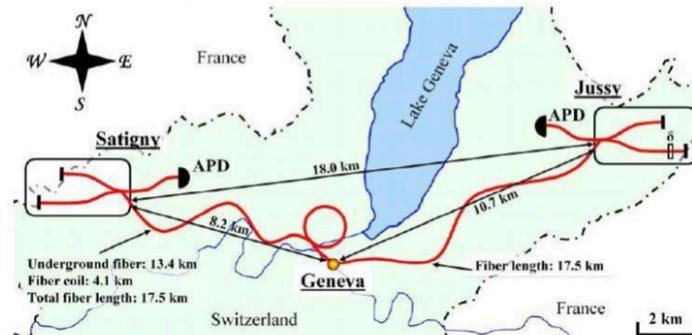
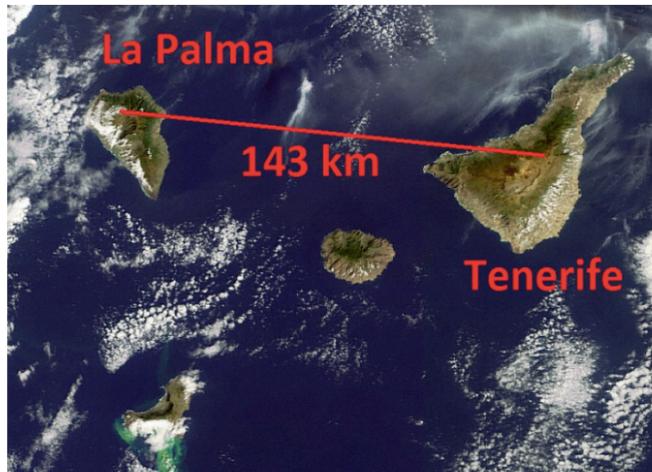


Illustration 1.: Salart et al (2008) Bell-type correlation experiment



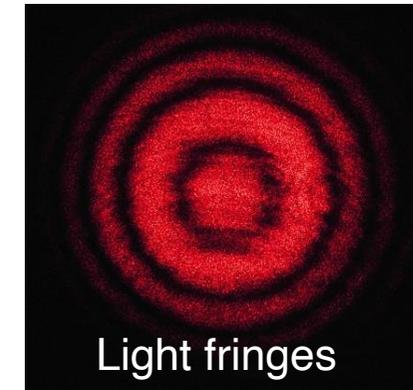
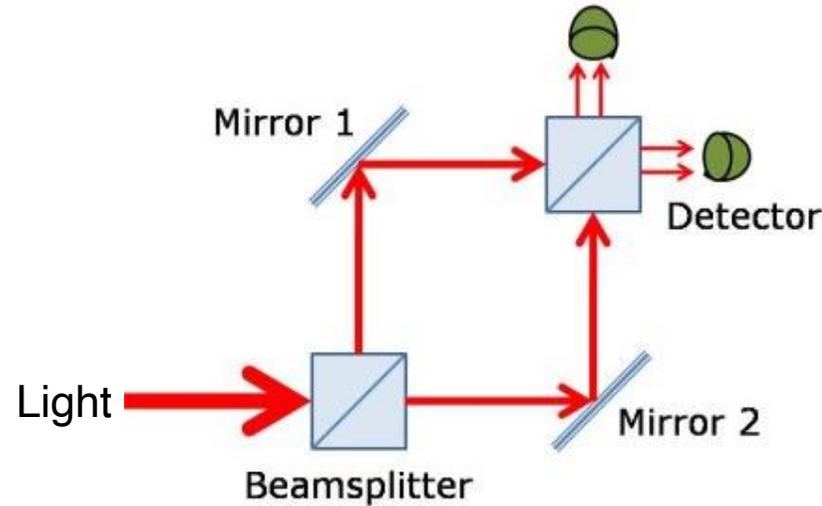
- Between Canary Islands > 100km, Chinese satellite > 1000km



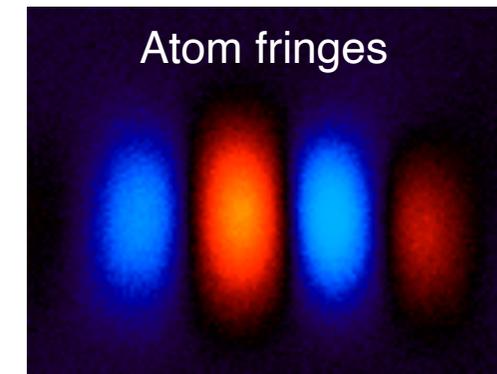
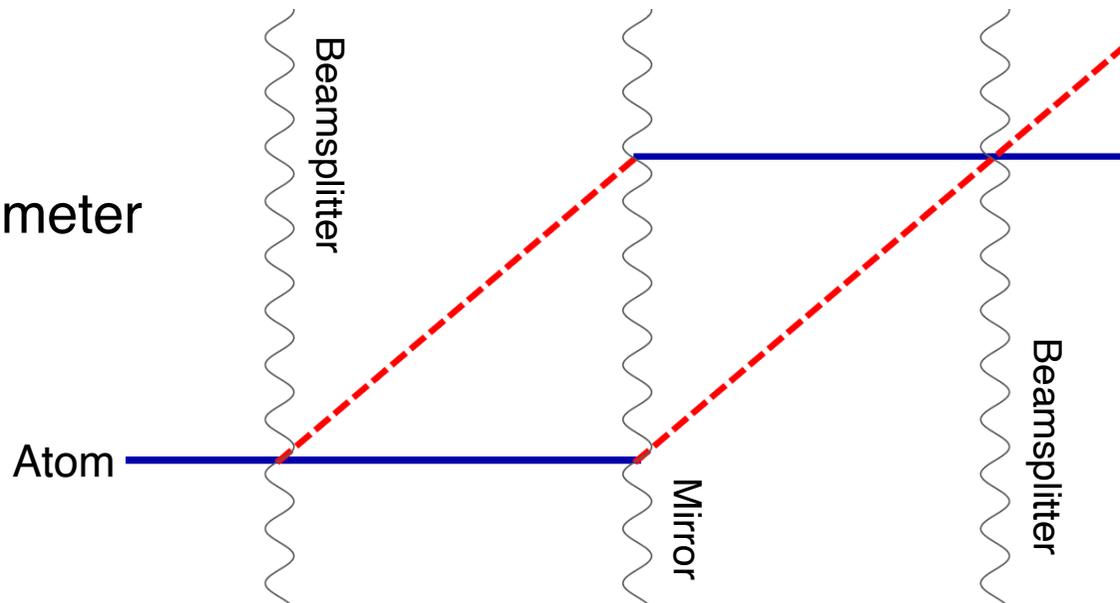
- Next step: between Earth & Moon? Correlation > 10^7c

Principle of Atom Interferometry

Light interferometer



Atom interferometer

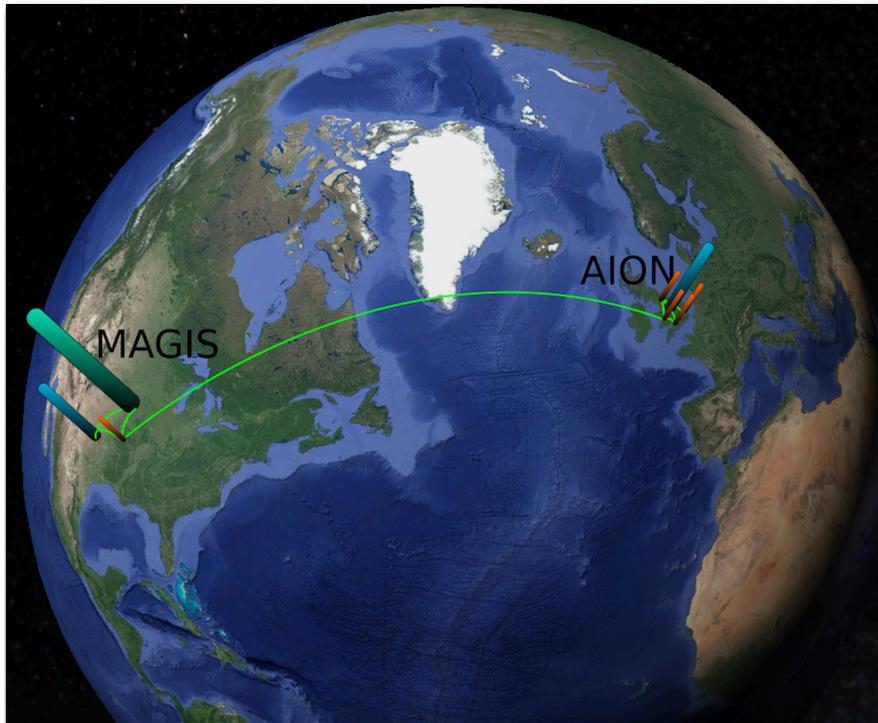


Atom Interferometer Observatory & Network



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 D. Bortoletto¹, J. Bowcock⁵, W. Bowden^{6,*}, C. Brew², O. Buchmueller⁶, J. Coleman¹, J. Carlton¹,
 G. Elert¹, J. Ellis^{1,*}, C. Foot³, V. Gibson⁷, M. Haehnel⁷, T. Harte⁷, R. Hobson^{6,*},
 M. Holynski¹, A. Khazov², M. Langlois⁴, S. L'Allemand⁴, Y.H. Lien⁴, R. Maiolino⁷,
 P. Majewski², S. Malik⁶, J. March-Russell¹, C. McCabe¹, D. Newbold², R. Preece³,
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⁴University of Birmingham, ⁵University of Liverpool, ⁶Imperial College London, ⁷University
 of Cambridge



Network with MAGIS project in US

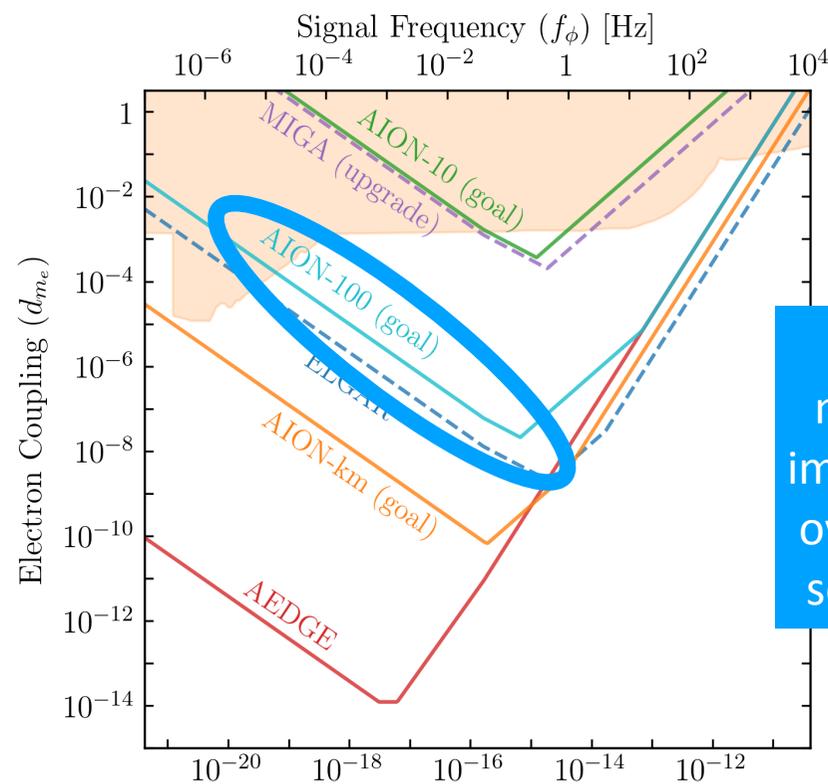
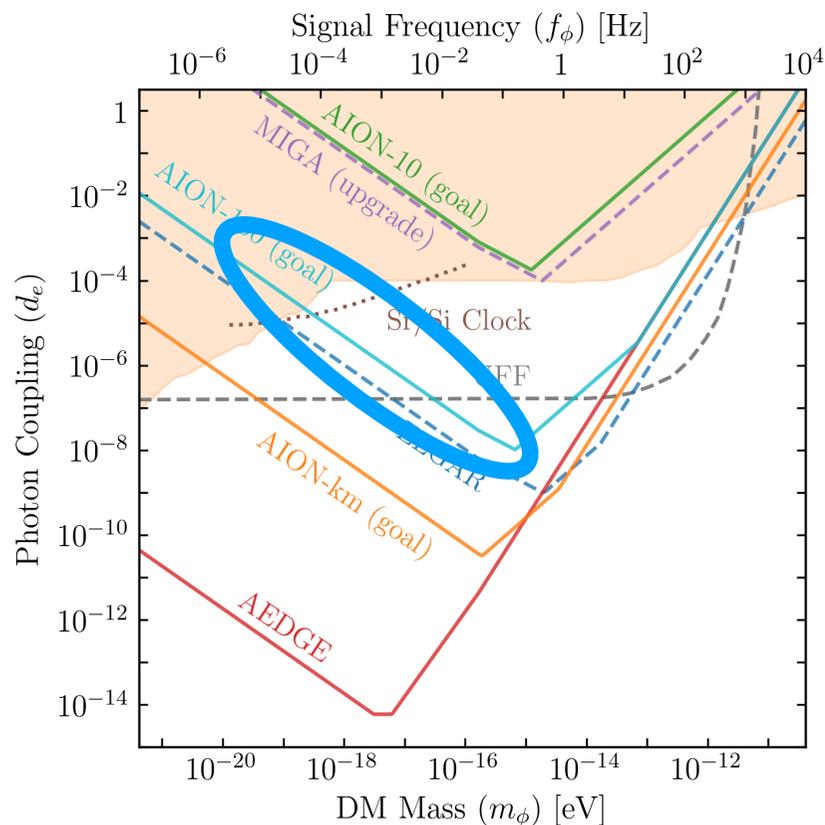
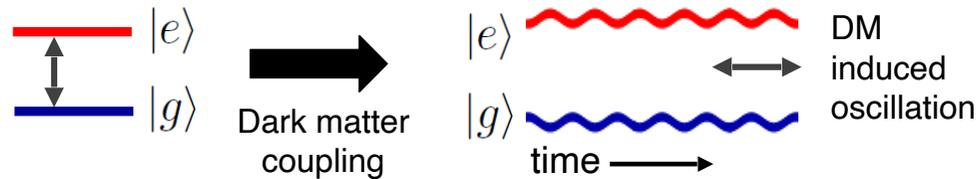
MAGIS Collaboration (Abe et al): arXiv:2104.02835



Searches for Ultralight Dark Matter

Linear couplings to gauge fields and matter fermions

$$\mathcal{L}_{\text{int}\phi} = \kappa\phi \left[+\frac{d_e}{4e^2} F_{\mu\nu} F^{\mu\nu} - \frac{d_g\beta_3}{2g_3} F_{\mu\nu}^A F^{A\mu\nu} - \sum_{i=e,u,d} (d_{m_i} + \gamma_{m_i} d_g) m_i \bar{\psi}_i \psi_i \right]$$

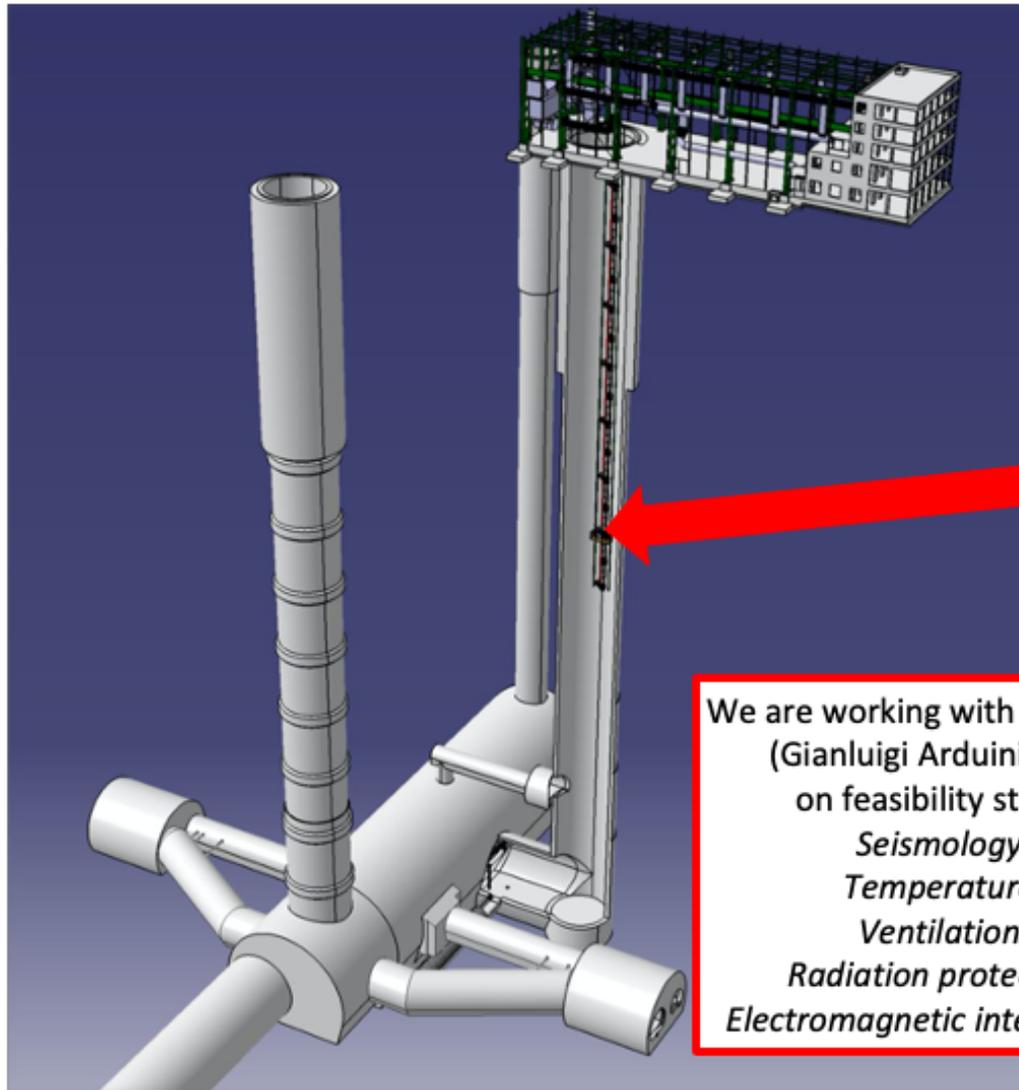


Orders of magnitude improvement over current sensitivities

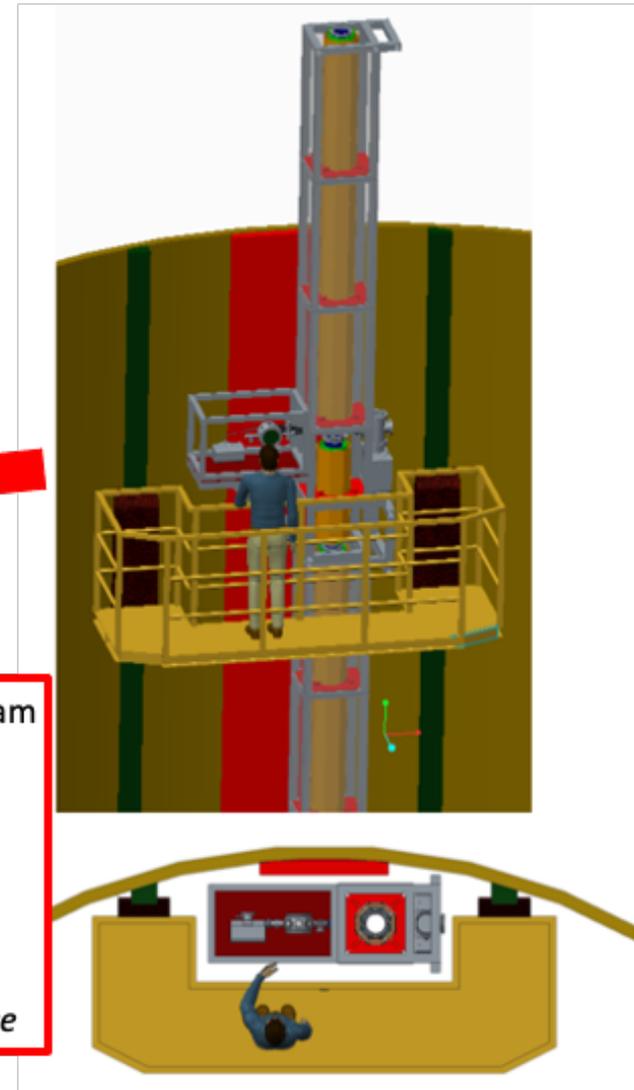
Possible CERN Location of AION-100m

General view of LHC Point 4

Possible layout in PX46 shaft

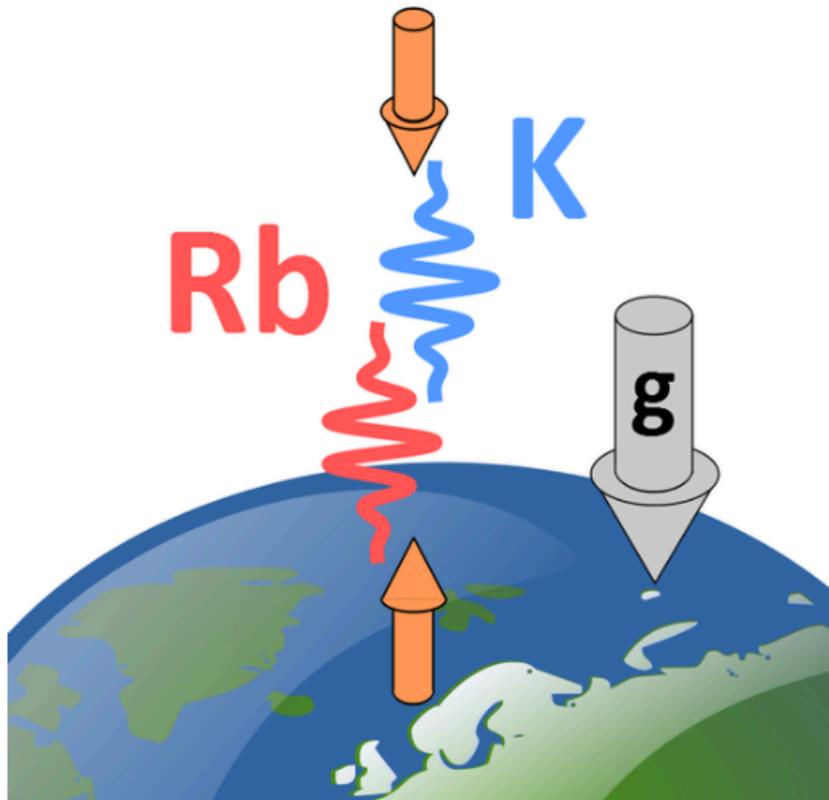


We are working with PBC Team
(Gianluigi Arduini et al)
on feasibility study:
Seismology
Temperature
Ventilation
Radiation protection
Electromagnetic interference



STE-QUEST Proposal to ESA

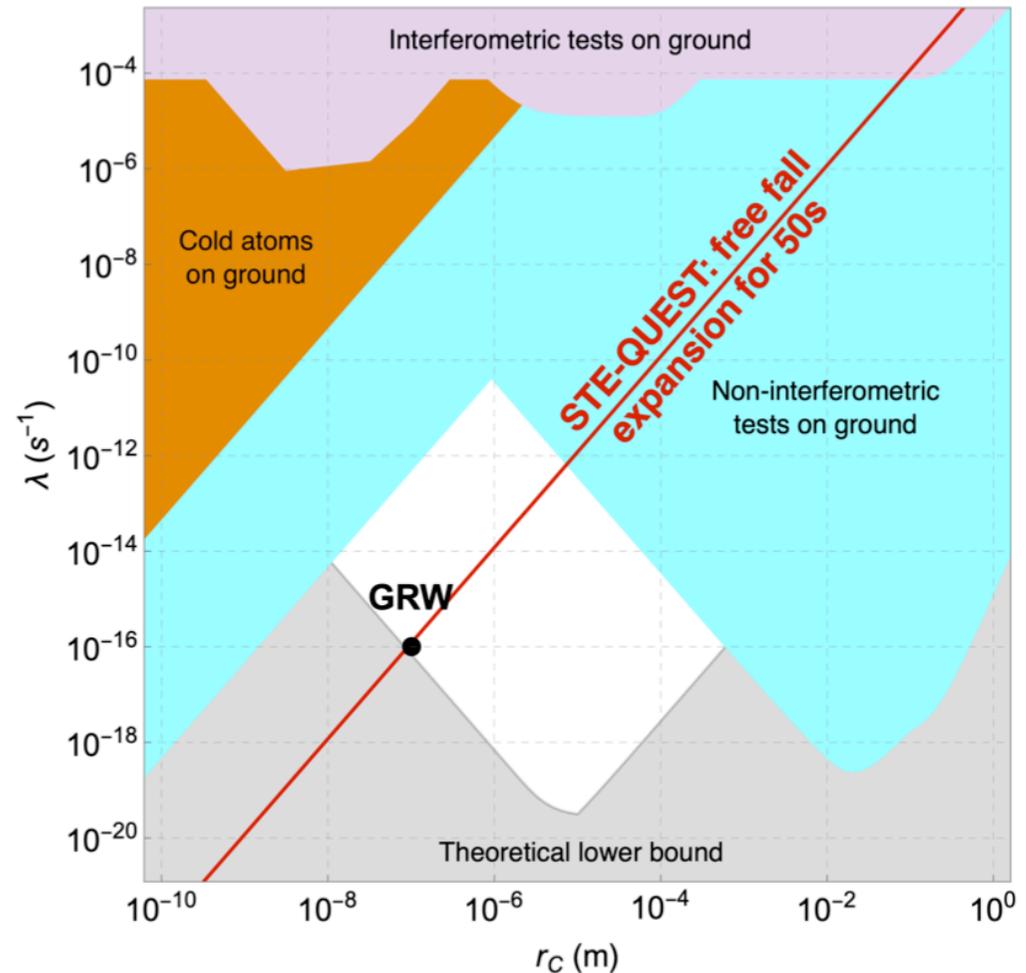
Probes of gravity



Probe universality of free fall
(principle of equivalence)

Search for ultralight dark matter

Probe of quantum mechanics



Models for wave-function collapse parameterised by
time-scale λ and range r_C

GRW = parameters proposed by Ghirardi, Rimini, Weber