



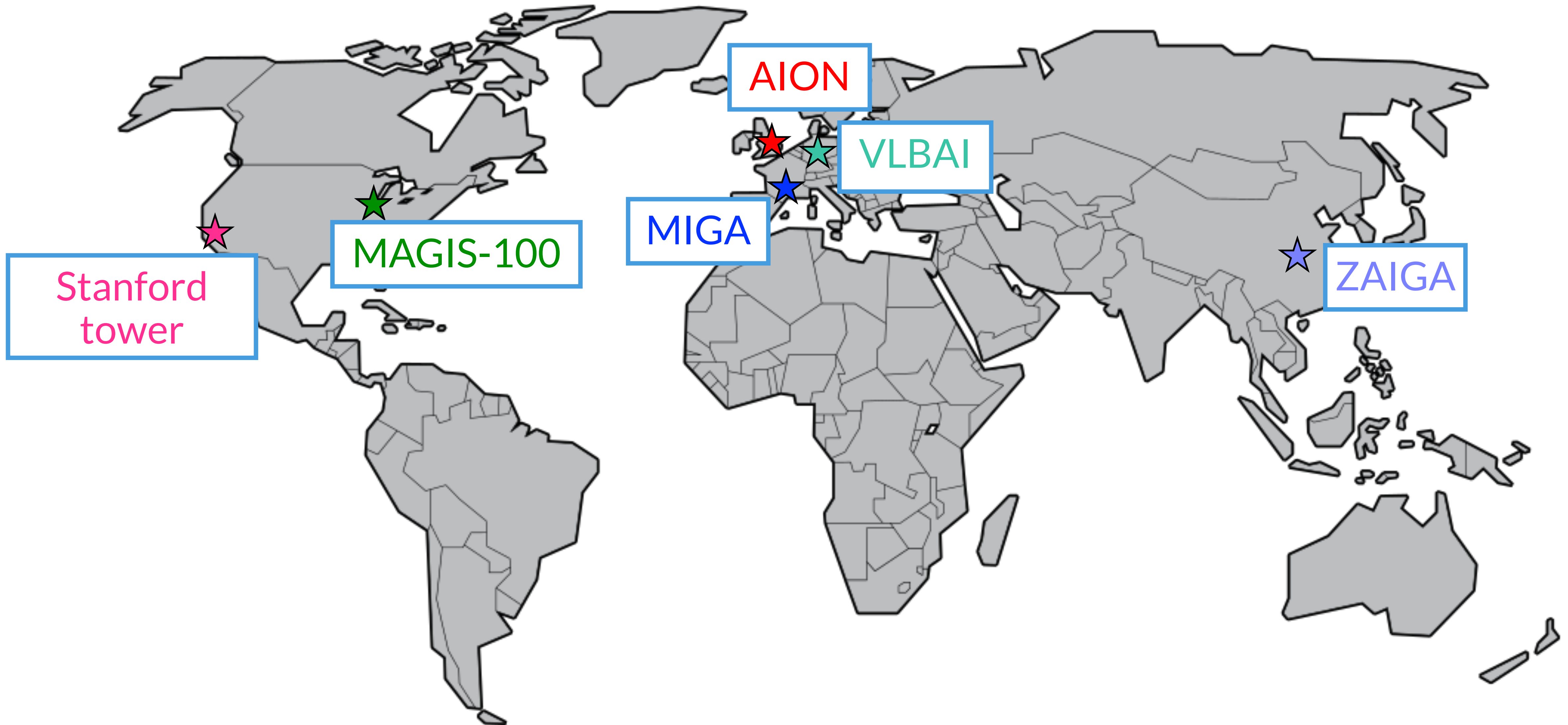
Atom interferometry observatory and network

Christopher McCabe - KCL

Mark Bason - RAL

Setting the scene

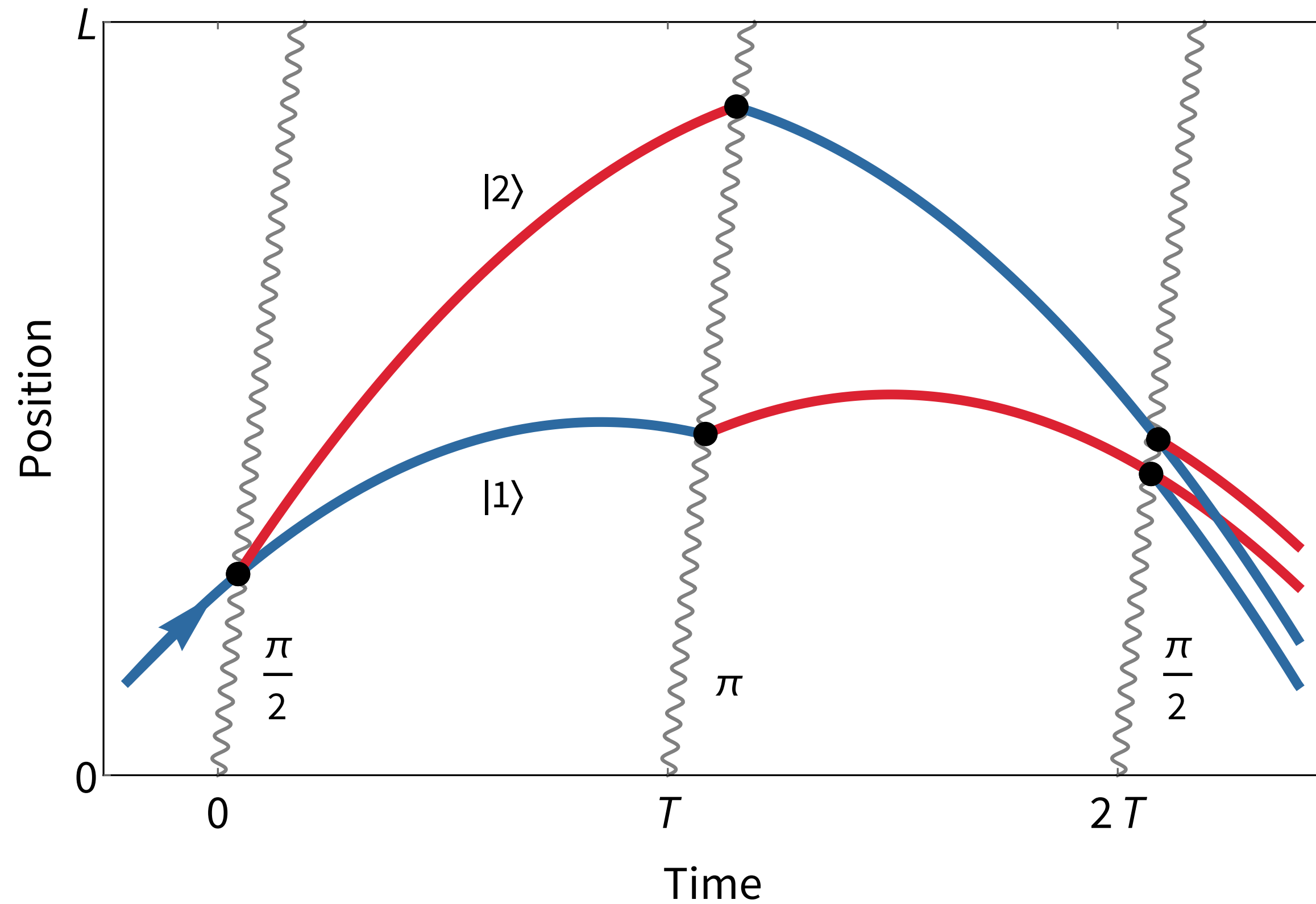
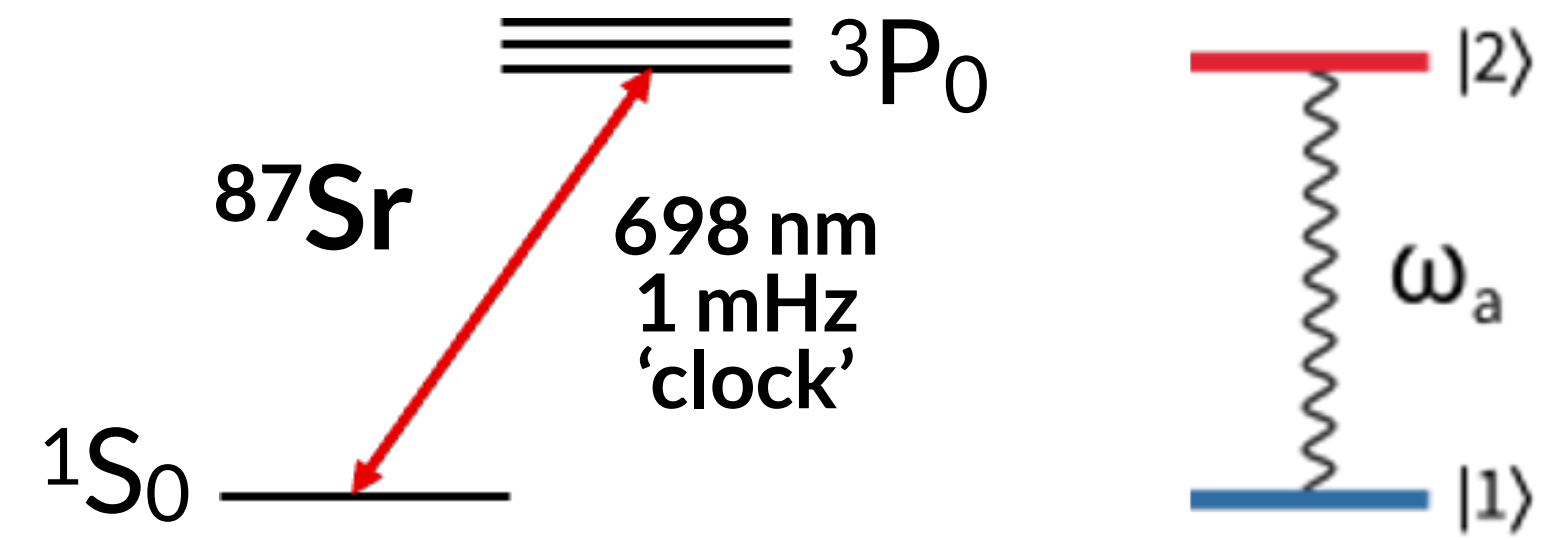
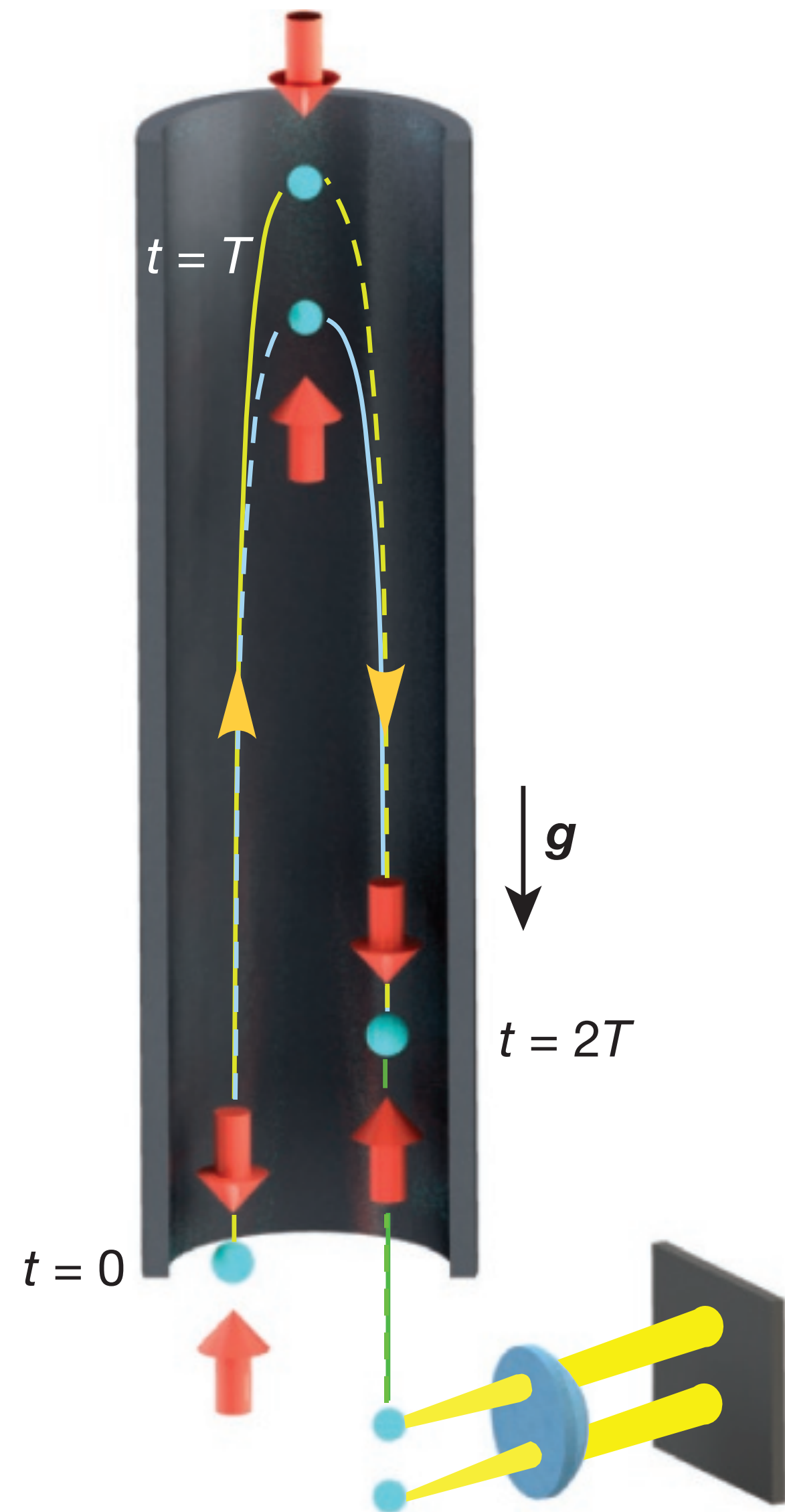
New atom interferometers across the world coming online



MAGIS-100, arXiv:2104.02835; MIGA, arXiv:1703.02490; AION, arXiv:1911.11755; VLBAI, arXiv:2003.04875; ZAIGA, arXiv:1903.09288

What is an atom interferometer?

Light pulse atom interferometry

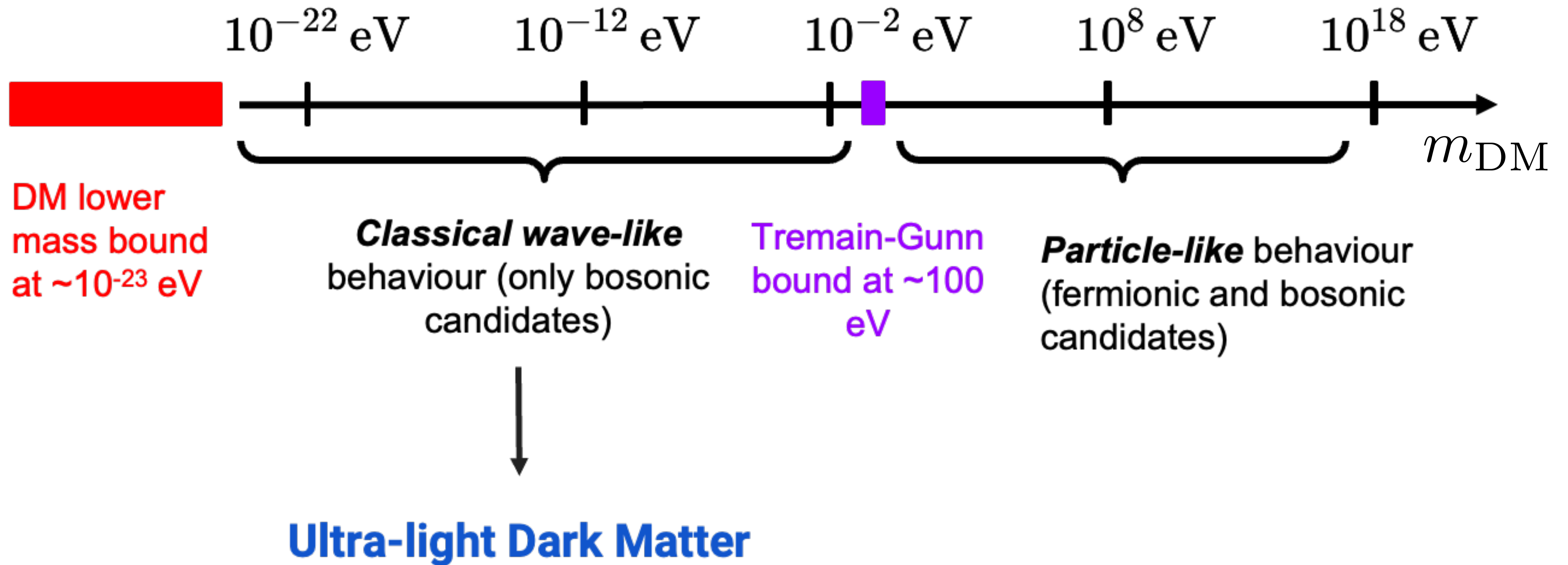


***Atom interferometers provide
exquisite sensitivity to changes in timings,
atomic structure, and local accelerations***

...why they are interesting for particle physics

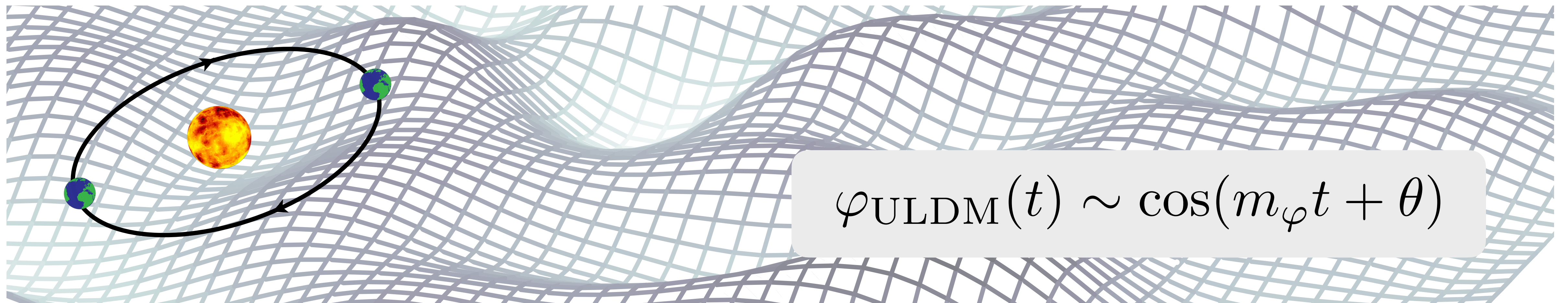
Near-term aim: probe dark matter

DM landscape: classifying by mass



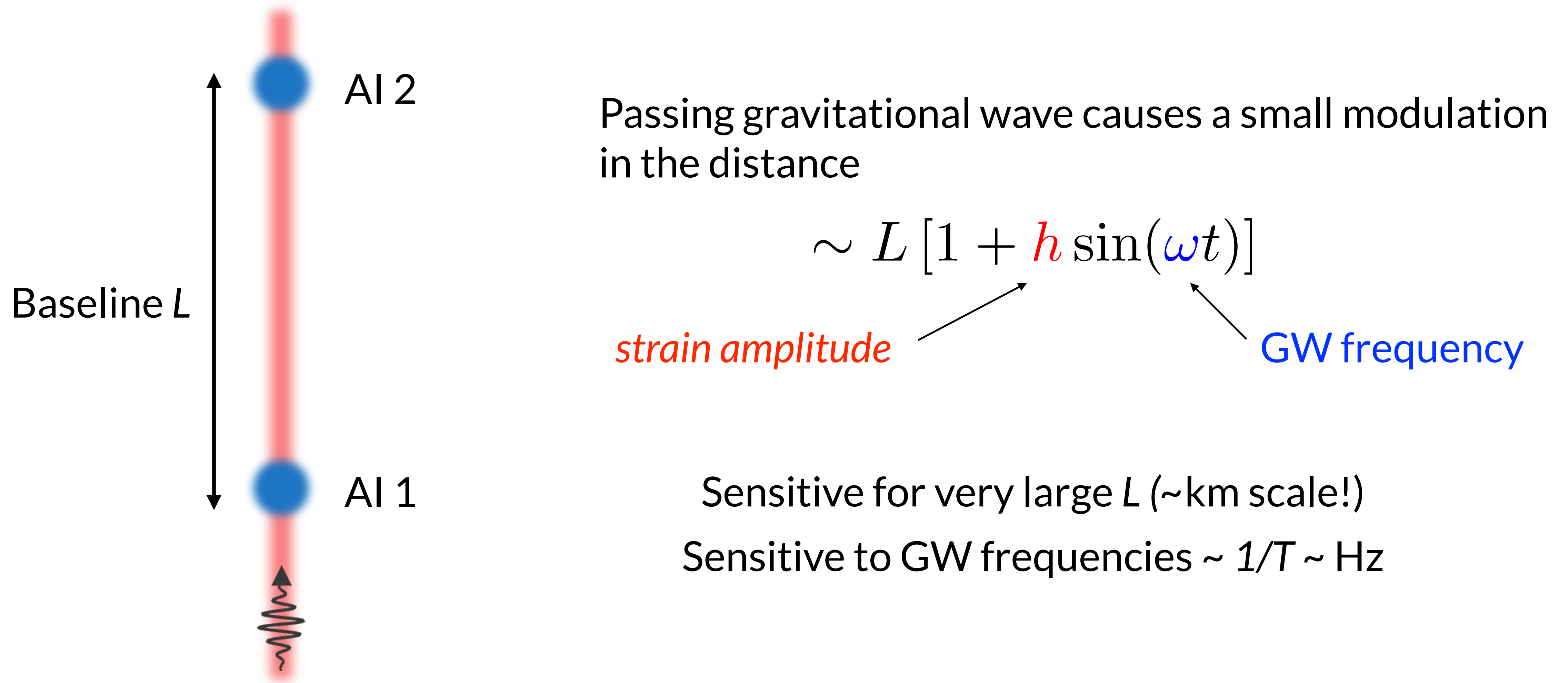
Ultra-light dark matter effects testable with atom interferometers

1. Scalar ULDM produces time-dependent changes in fundamental 'constants'
2. Vector ULDM produces accelerations between different atomic isotopes
3. Pseudoscalar ULDM leads to recession of spins



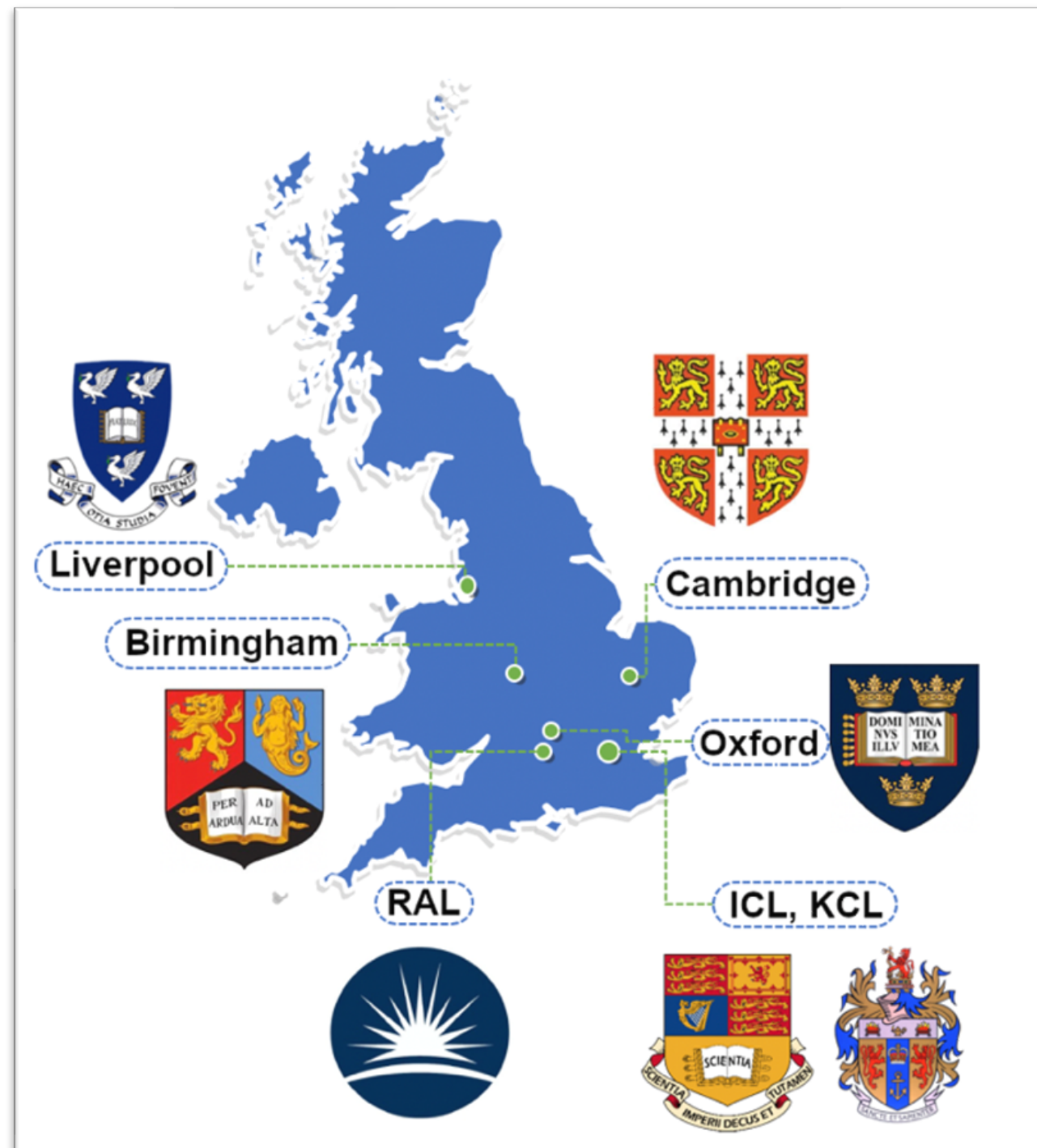
Longer-term aim: gravitational wave searches

Gravitational wave detection



This PhD project

AION: Atom Interferometer Observatory and Network



7 institutes in the UK

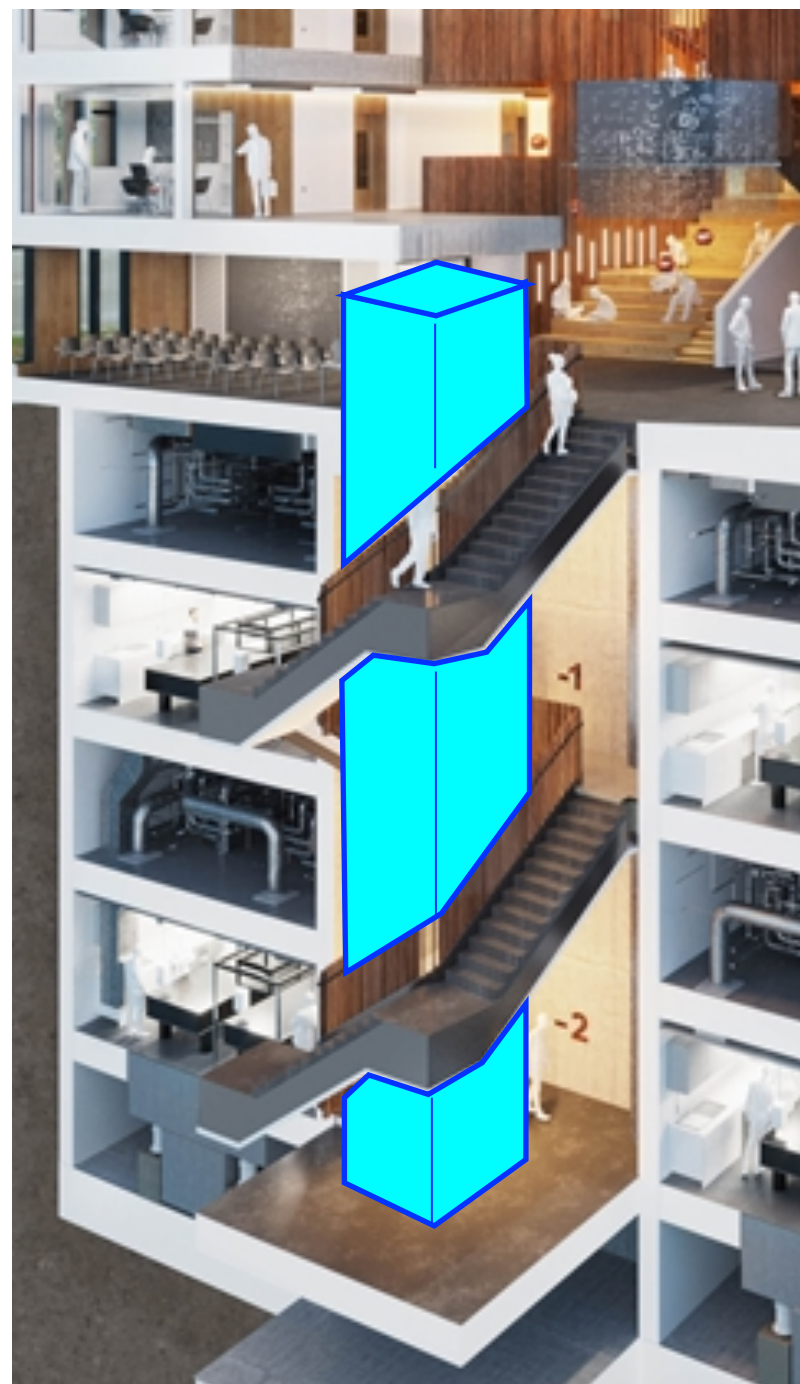


Autumn 2021

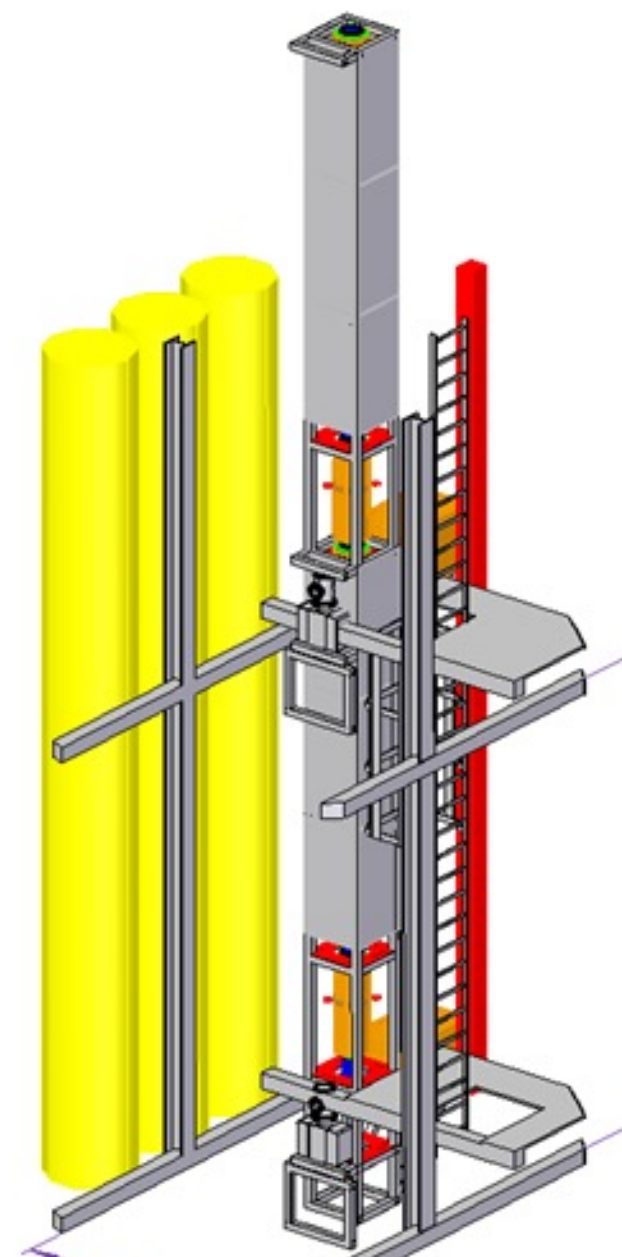
Collaboration ~65 people
Cold atom: fundamental physics ratio is ~2:1

AION: envisaged as a multi-stage project

AION-10
2020s ~10m
instrument in
Oxford

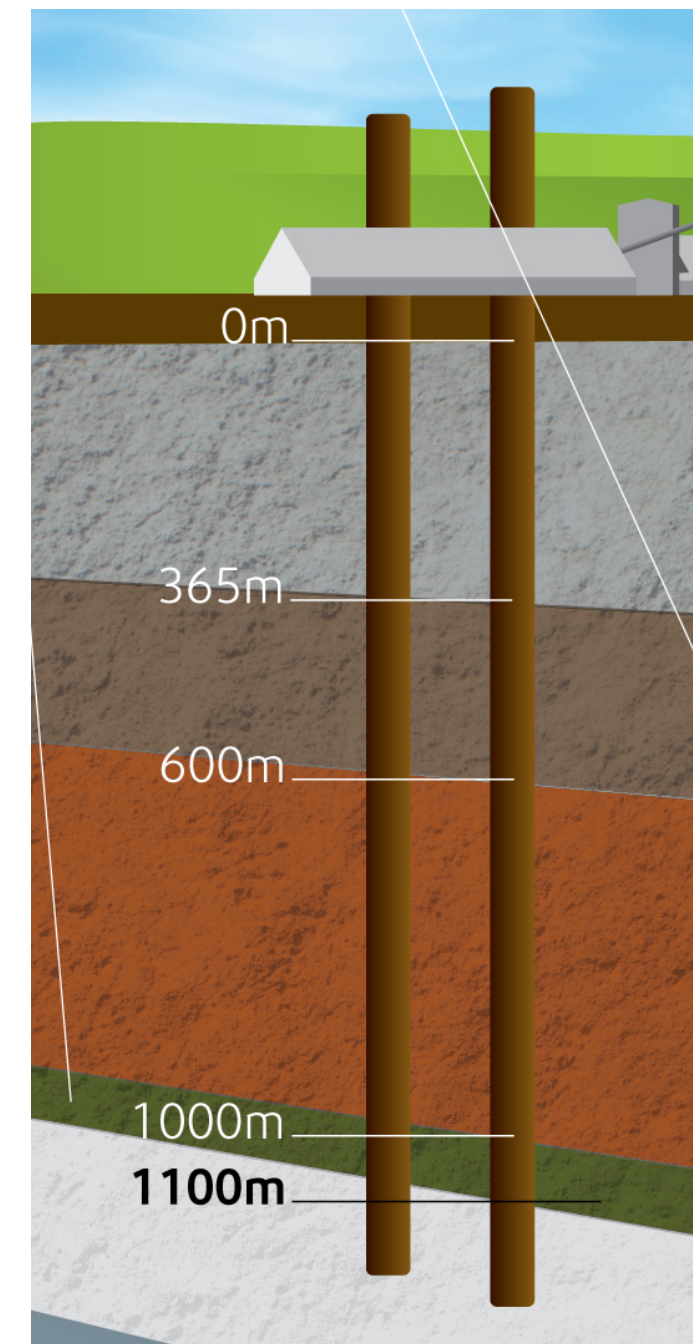


AION-100
2030s ~100m
instrument at
Boulby/CERN/...?

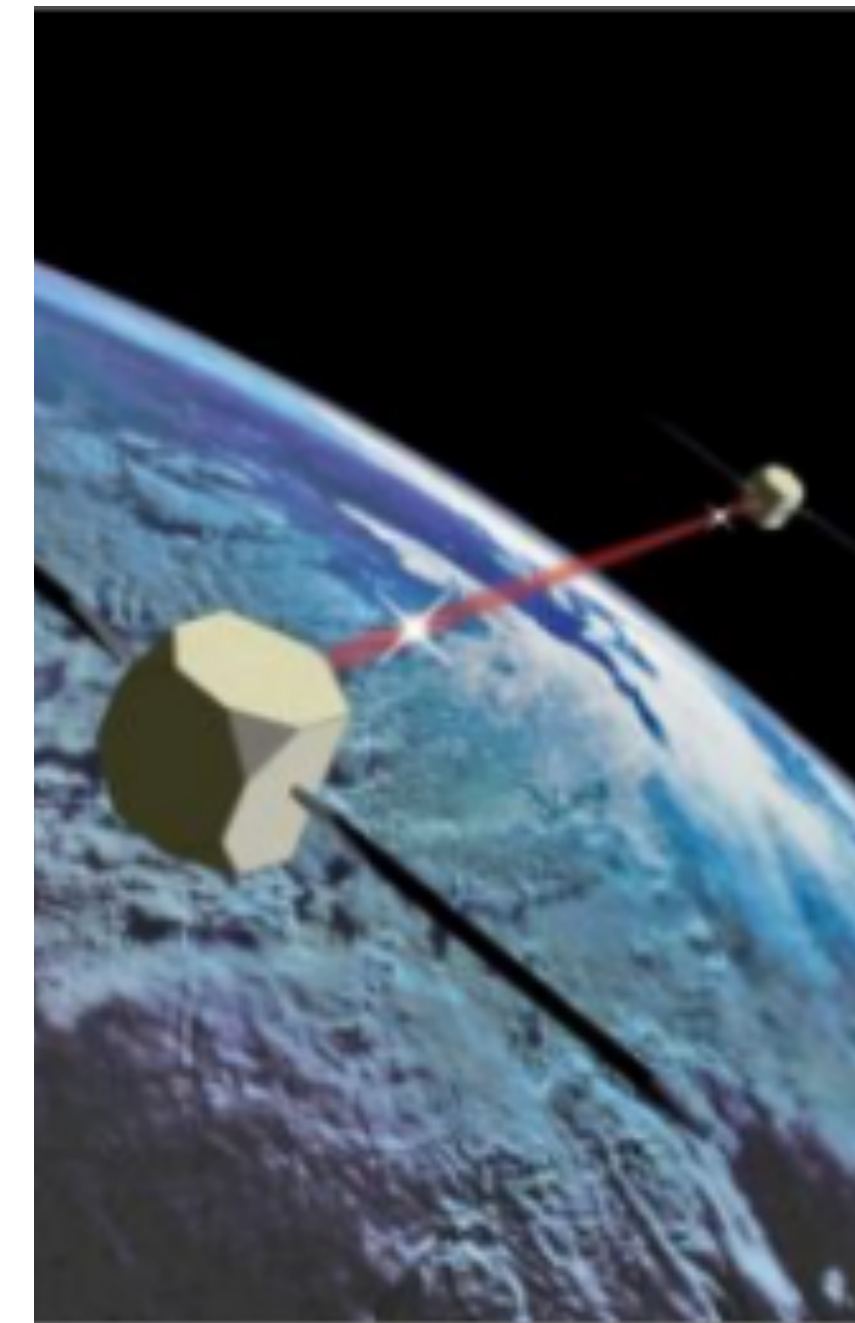


Boulby SHAFT 3

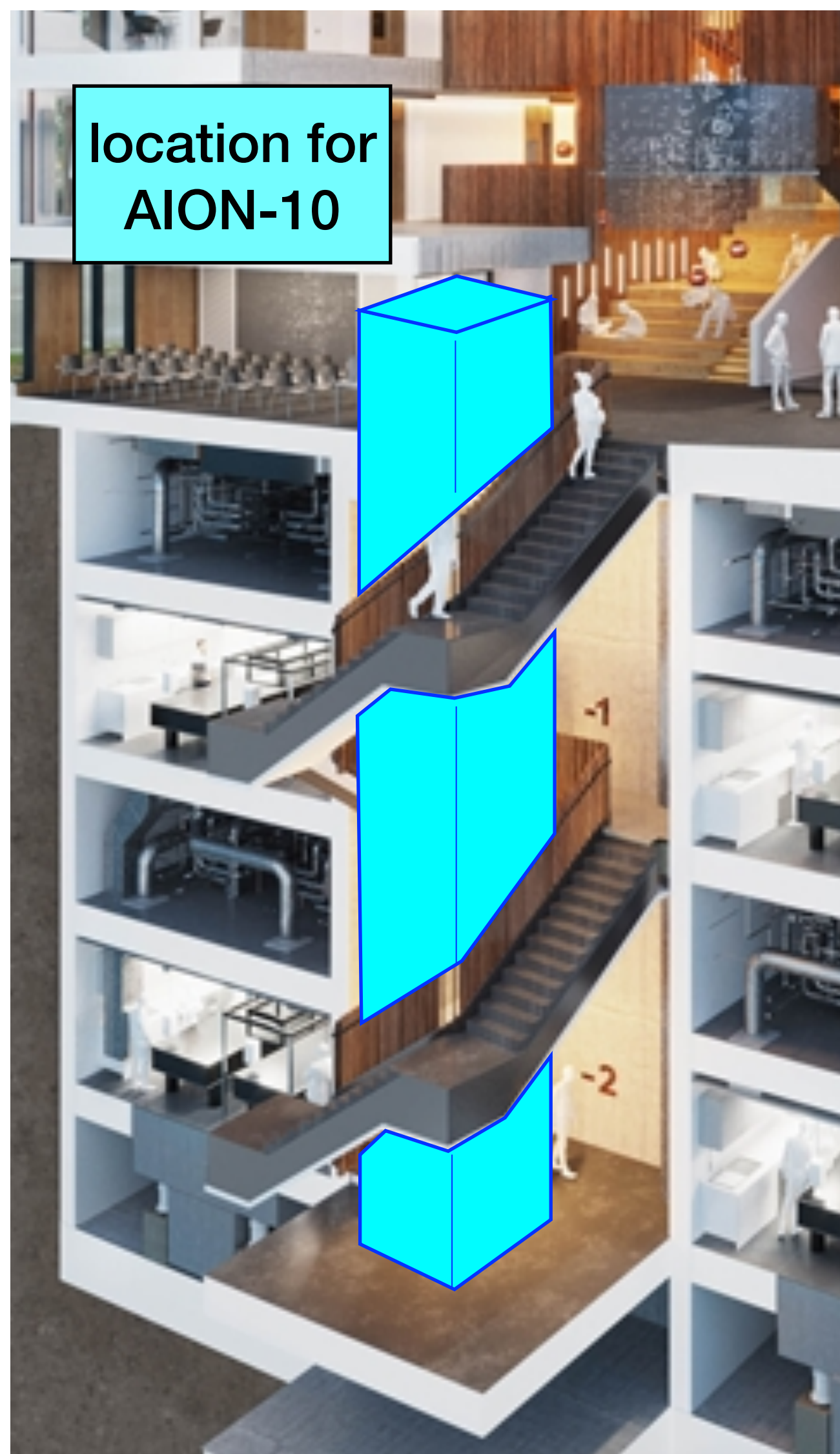
km-instrument
2040s major
international
project



Space-instrument
2050s
detectors with
~10⁷km baseline



Towards first science with AION-10



Stage 1: AION-10

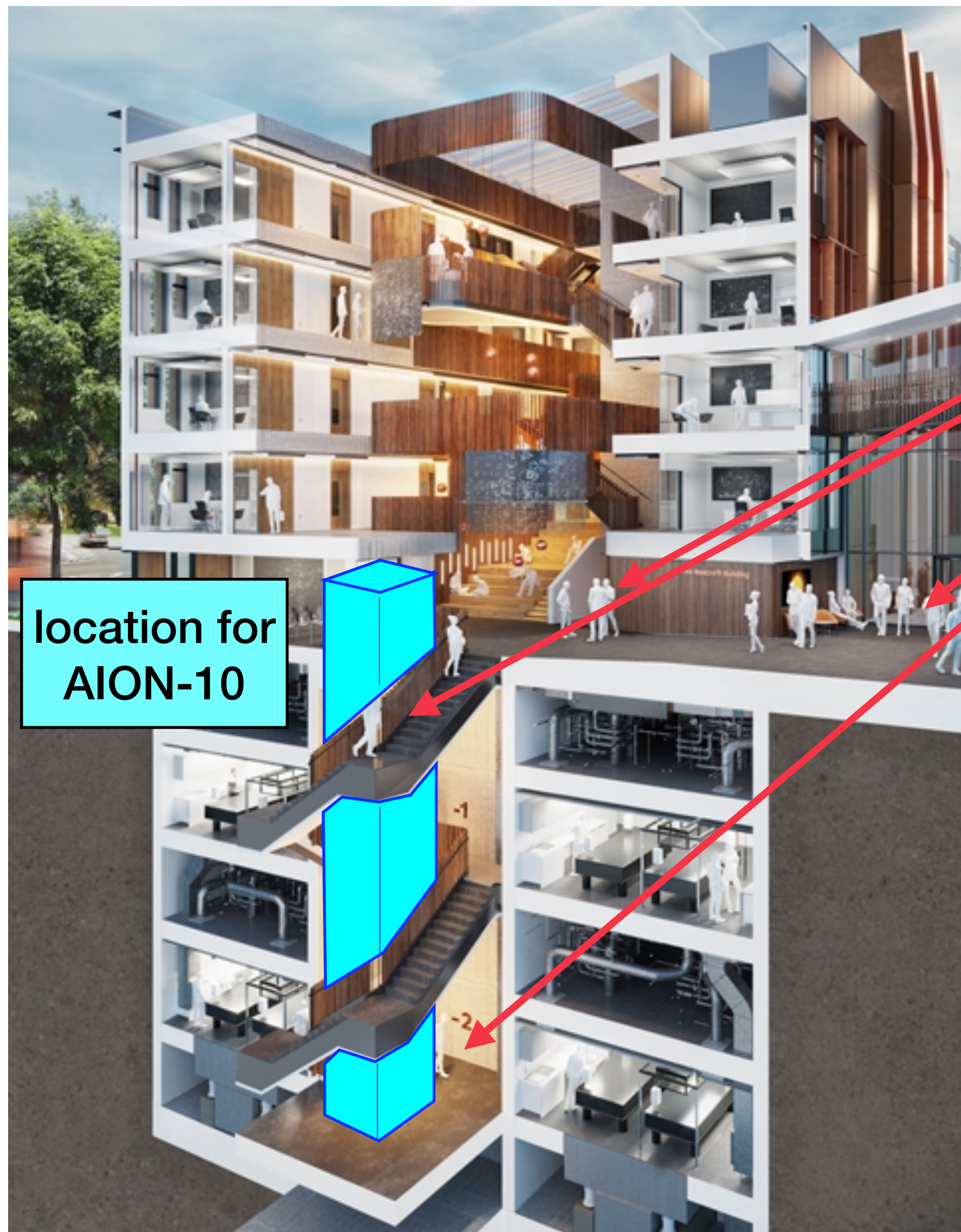
~10m tower in the Beecroft building in Oxford

'24-'26: construction

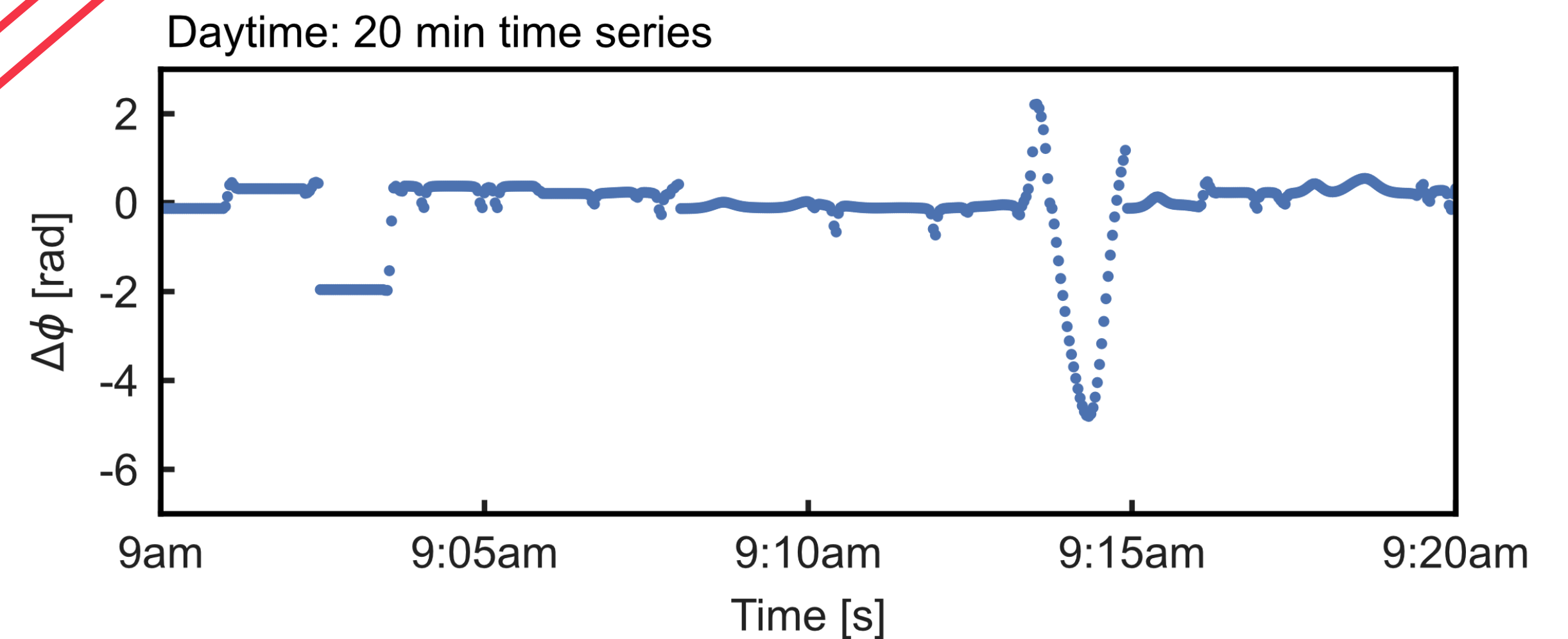
'26-'27: commissioning

2027+: science

Challenge of operating in a university building

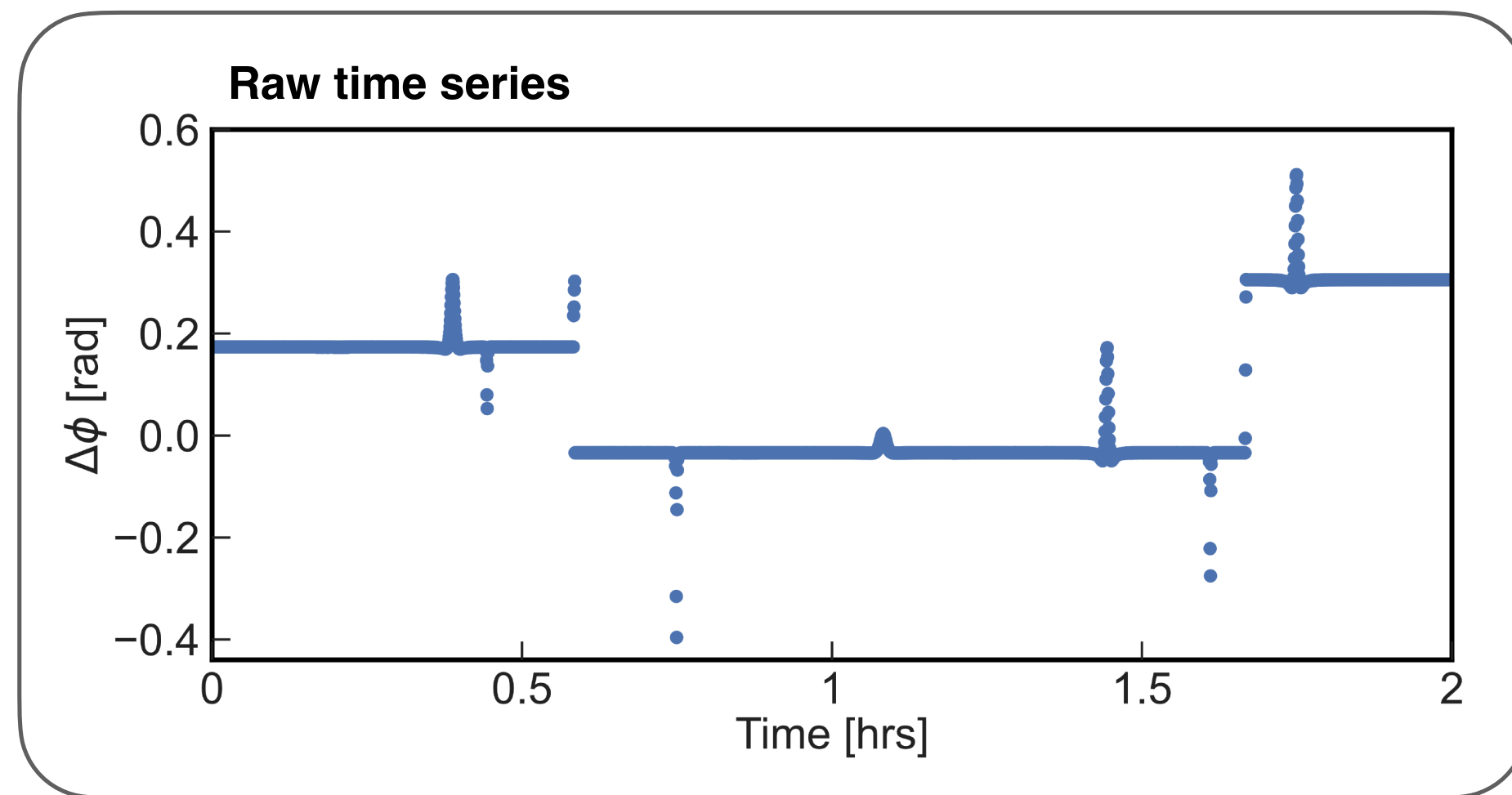


Moving 'test masses' contribute to the phase:

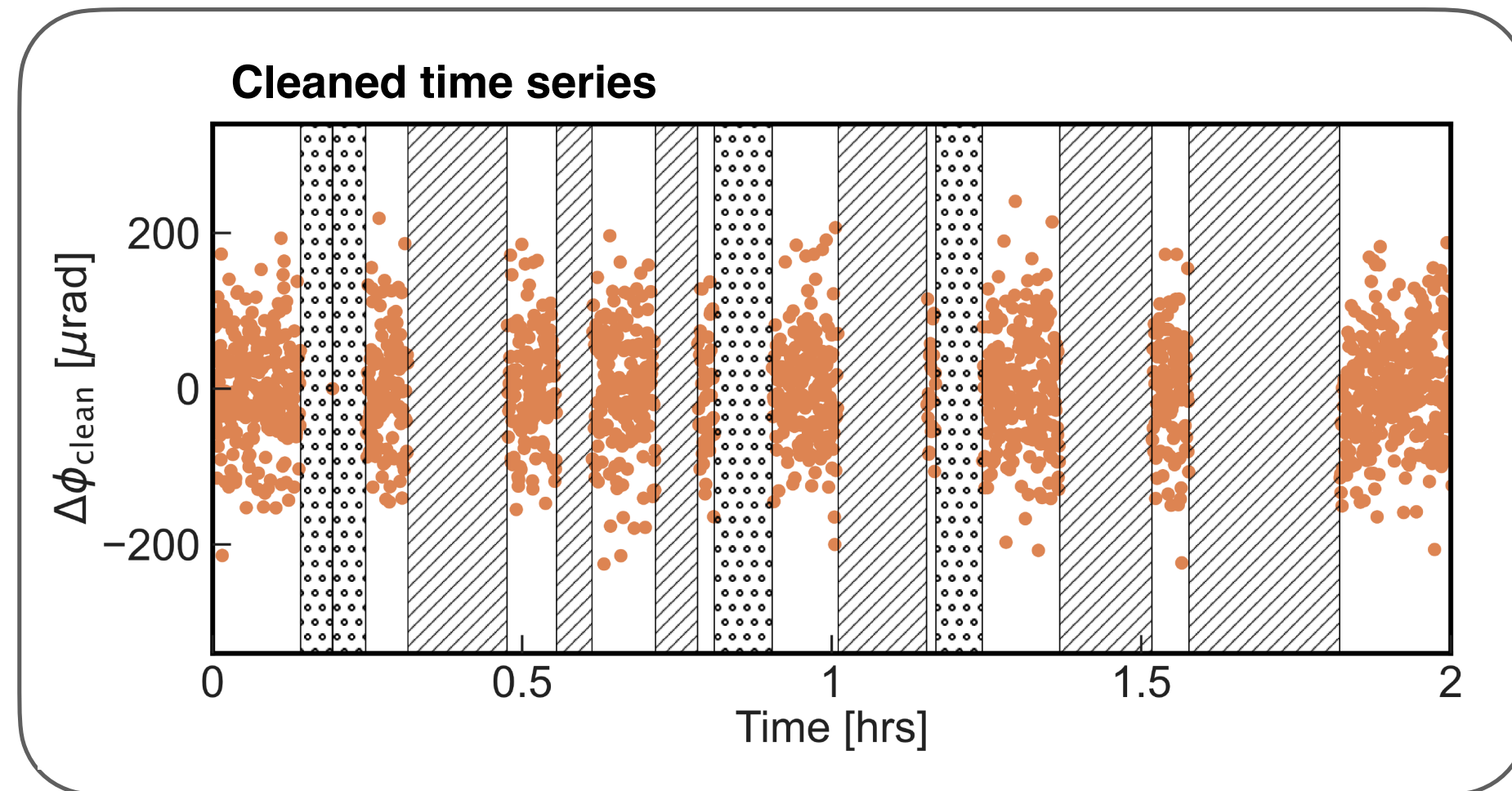
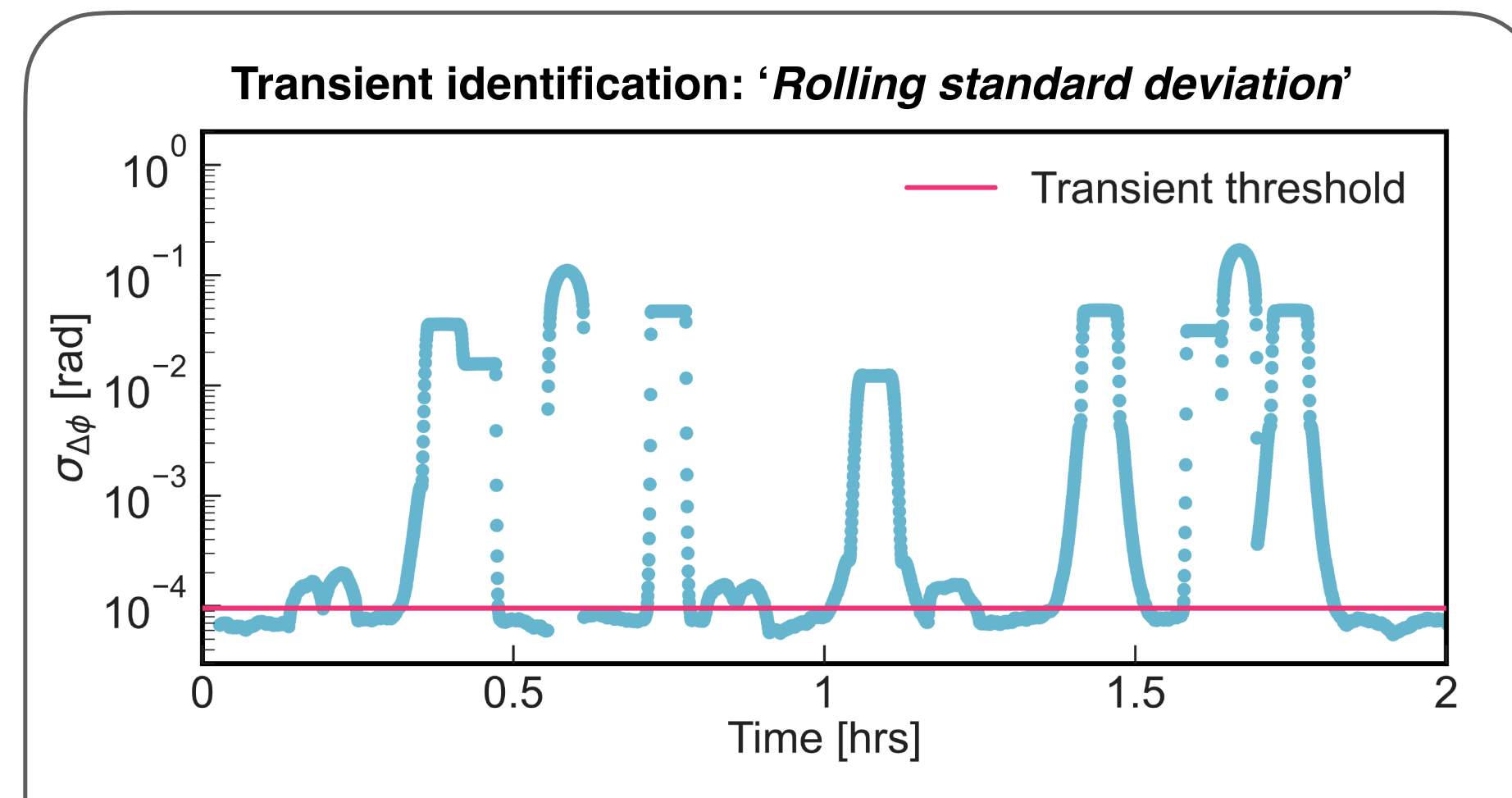


ULDM searches run for many months
*Need to ensure the busy university environment
doesn't hide a particle physics signal*

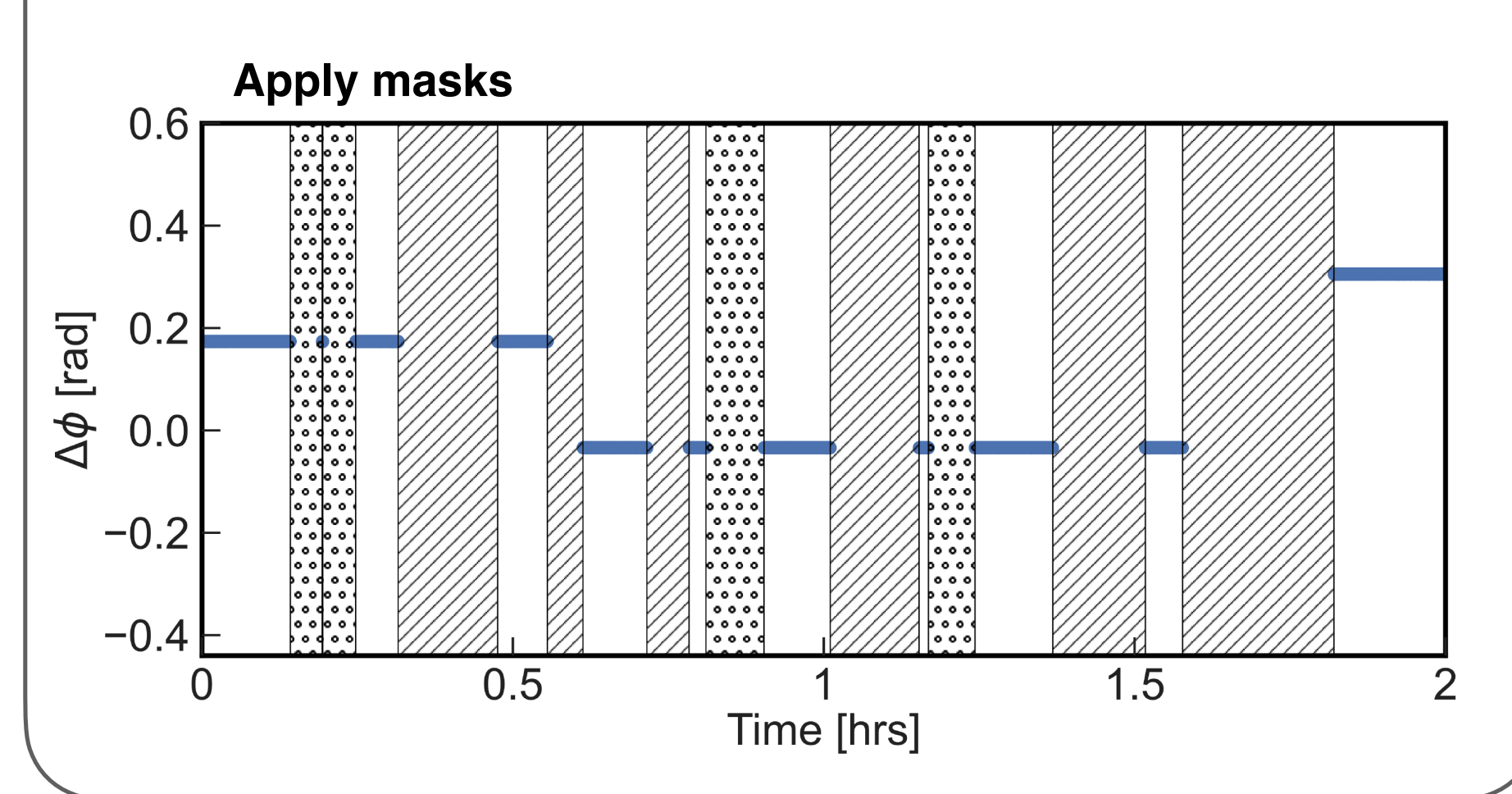
Prototyped some mitigation strategies...but much more to do!



Transient
removal
→



←
Detrend



Join us in pushing the boundaries in particle physics

- We welcome applicants from diverse backgrounds, including those who may not have prior expertise in atom interferometry
 - We will train and support you to help you reach your full potential
- Become an integral part of the AION collaboration
 - Join the KCL AION: includes me, John Ellis and two fellow PhD students
 - Meet with the RAL team today
- If you're interested in finding out more, come talk to us later today

Thank you

