



Science and
Technology
Facilities Council

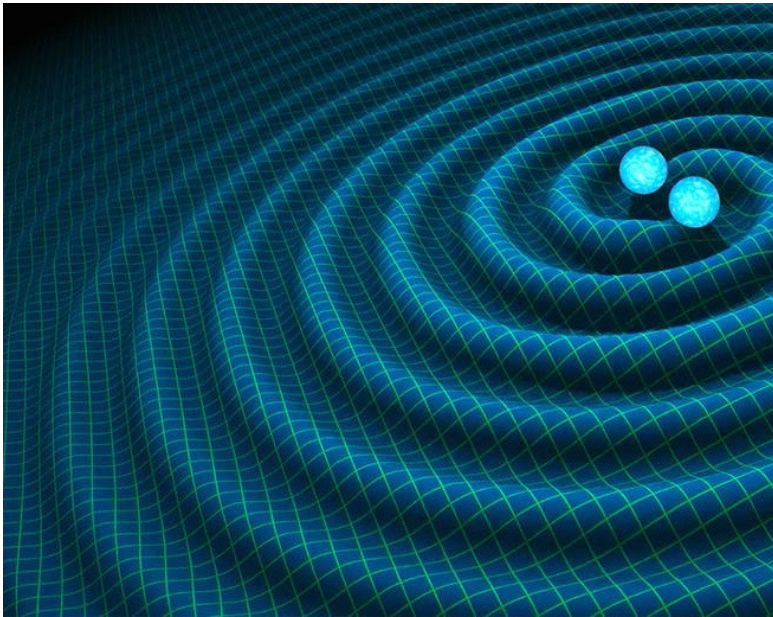
Atom interferometry observatory and network

Mark Bason

23rd February 2023

AION Consortium

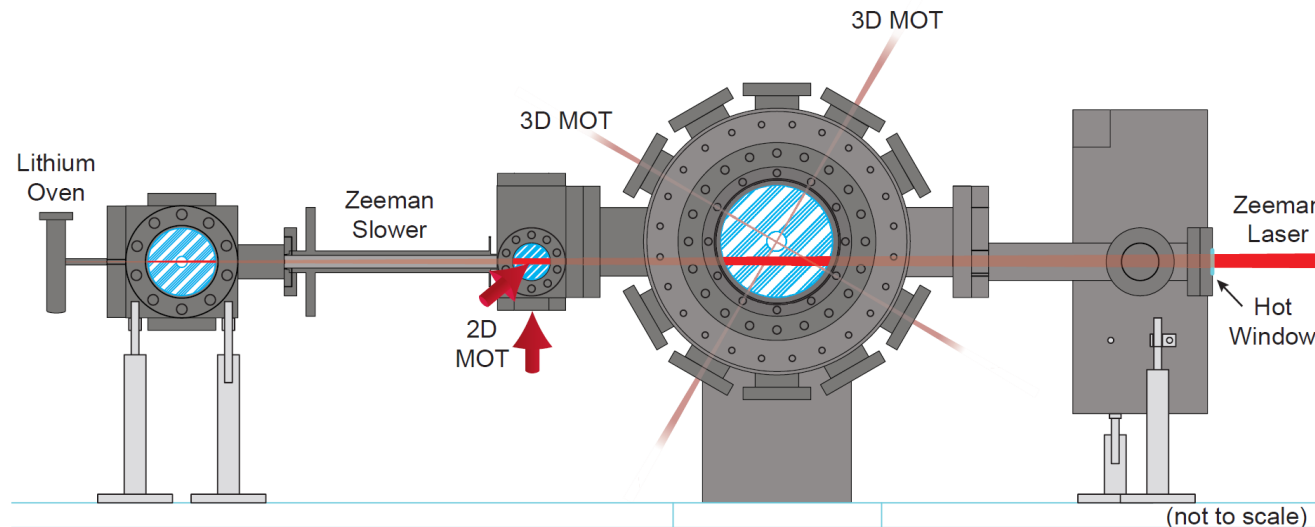
Atom interferometry using strontium atoms



- Ultra-light dark matter
- Mid-frequency gravitational waves (0.01 Hz - few Hz)
- Variations in fundamental constants
- Fundamental physics principles

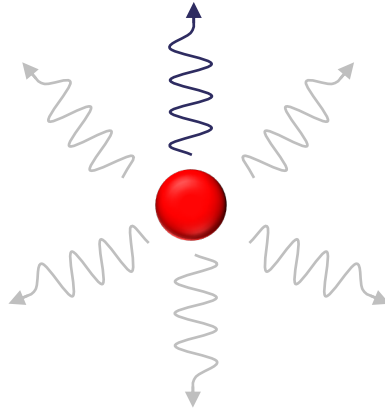
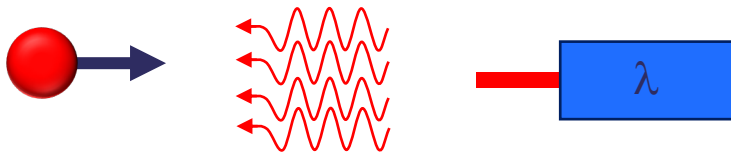


Slower than being slow



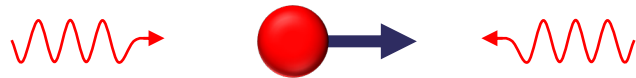
Laser cooling

Atom absorbs incoming photon and its momentum

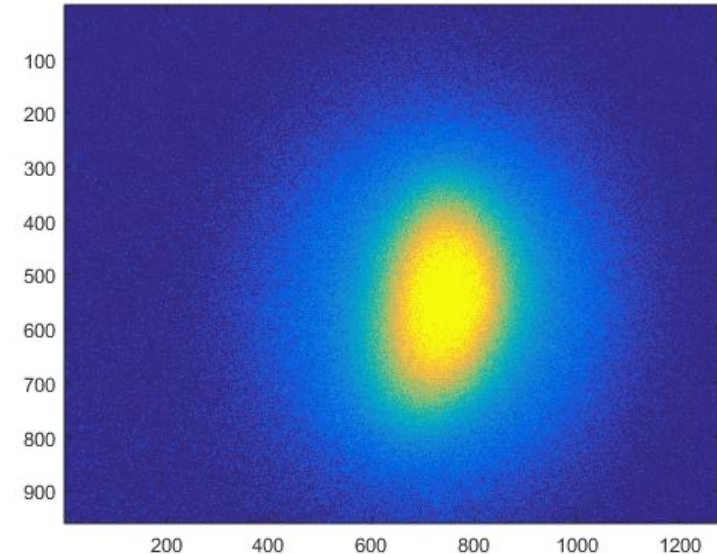


Later, spontaneous emission occurs in a random direction

But what about the other direction....?



Doppler effect causes light to be shifted onto resonance

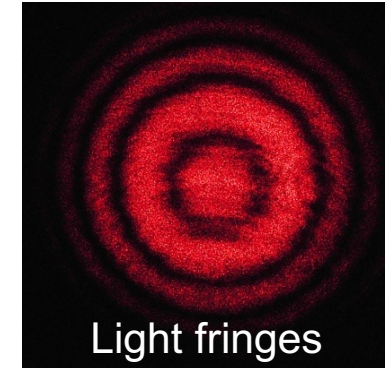
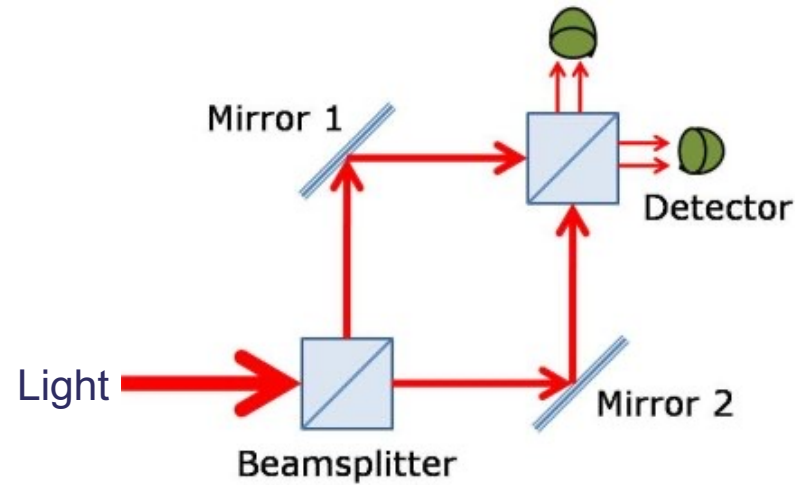


$N \sim 10^9$ Atoms

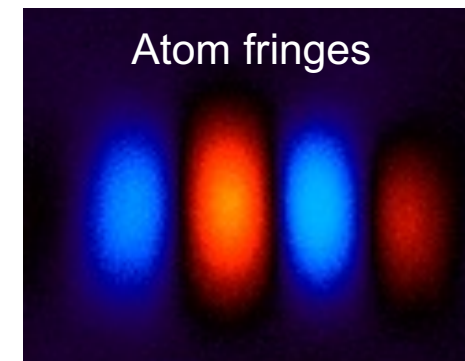
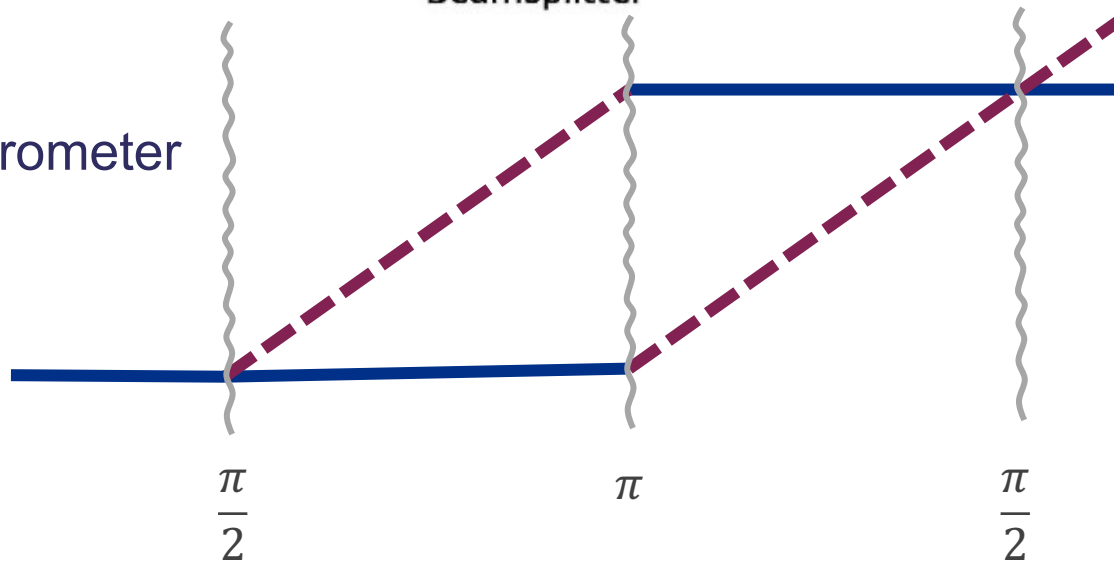
$T = 15(2) \mu\text{K}$

Light vs. Cold Atoms: Interferometry

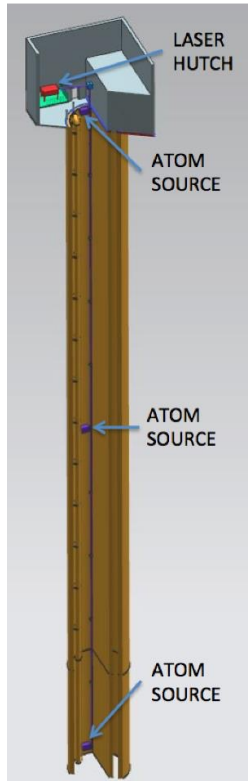
Light interferometer



Atom interferometer



Ground Based Large Scale AIs

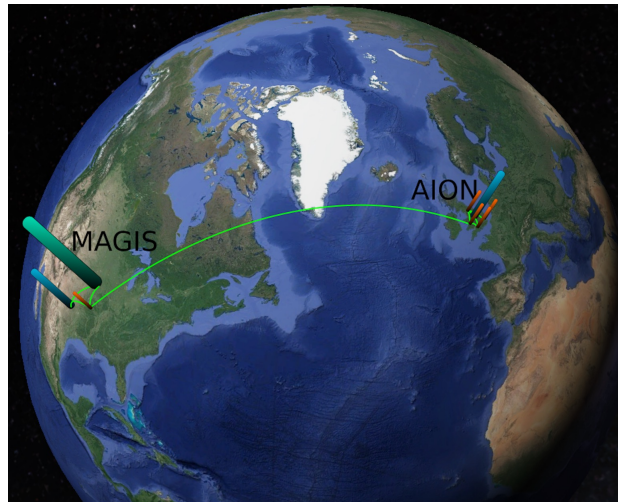


MAGIS: Terrestrial shaft detector using atom interferometer at $O(100\text{m})$

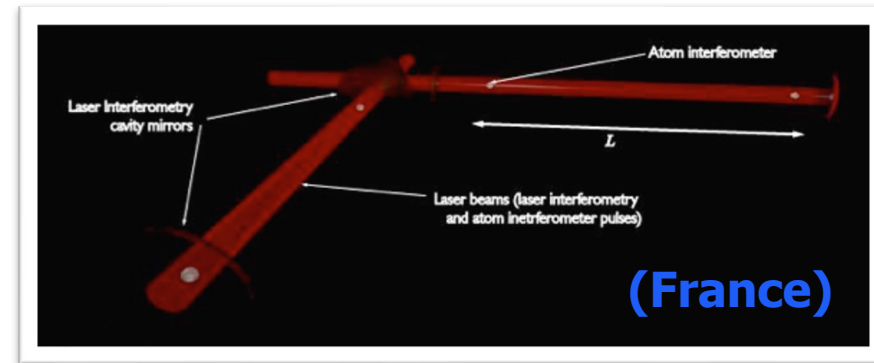
(US)

AION: Terrestrial shaft detector using atom interferometer at 10m – $O(100\text{m})$ planned

(UK)

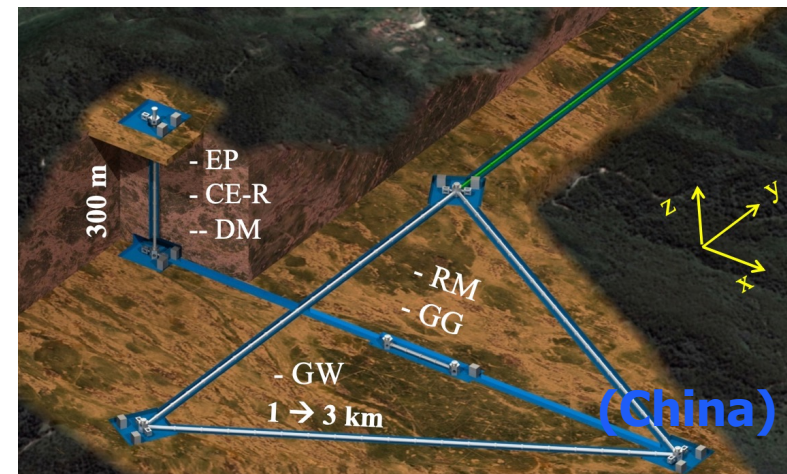


MIGA: Terrestrial detector using atom interferometer at $O(100\text{m})$



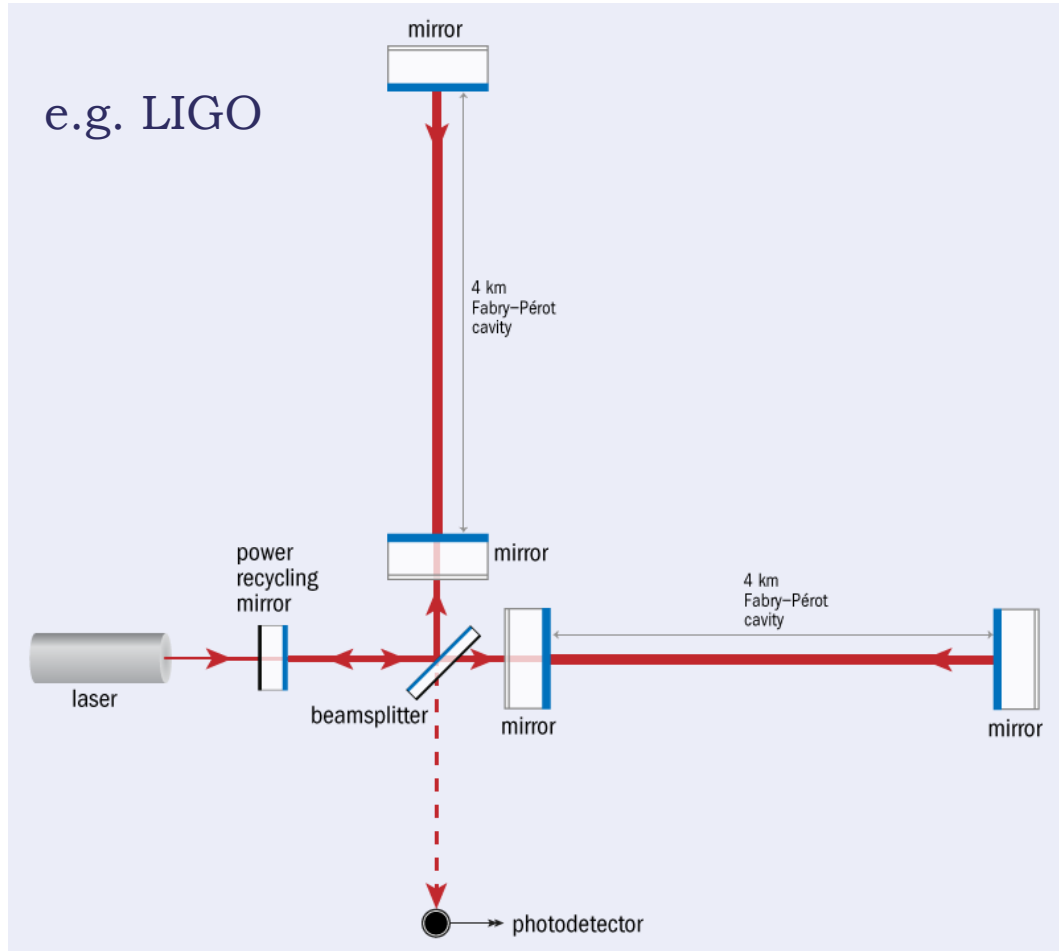
(France)

ZIGA: Terrestrial detector for large scale atomic interferometers, gyros and clocks at $O(100\text{M})$



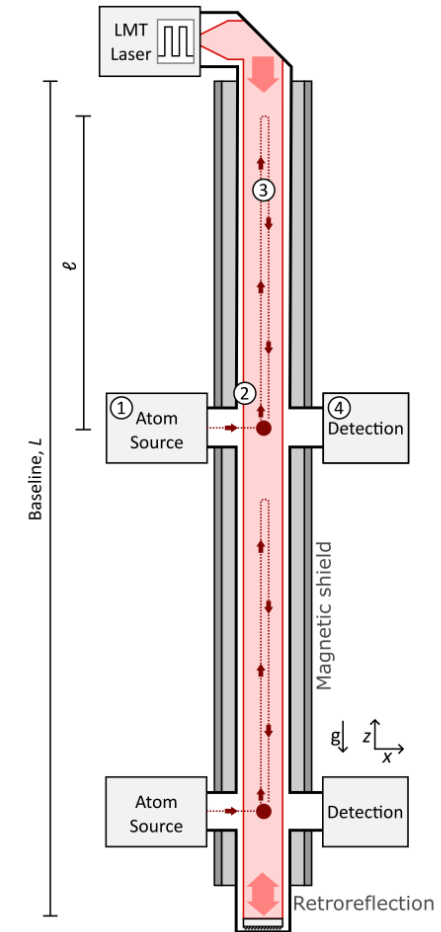
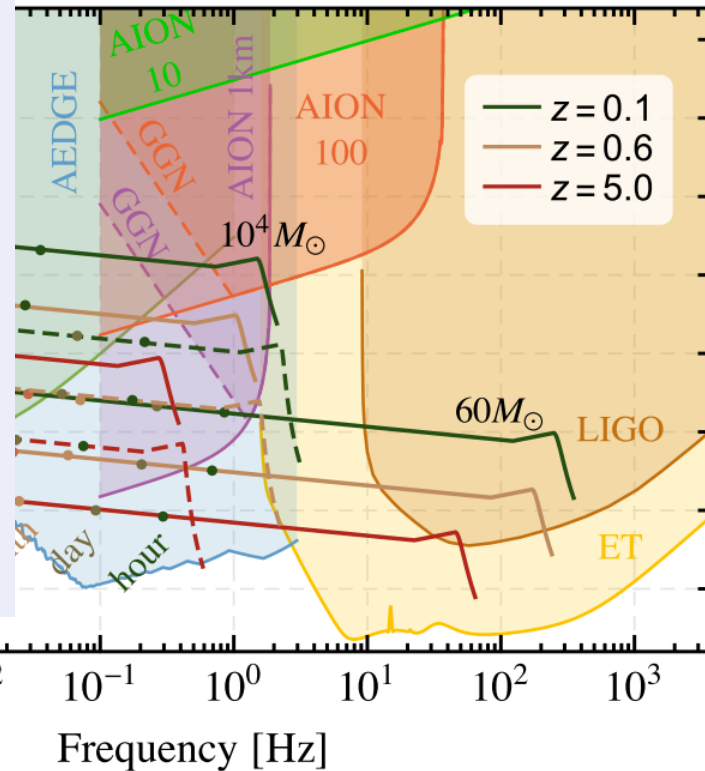
(China)

Gravitational wave detection

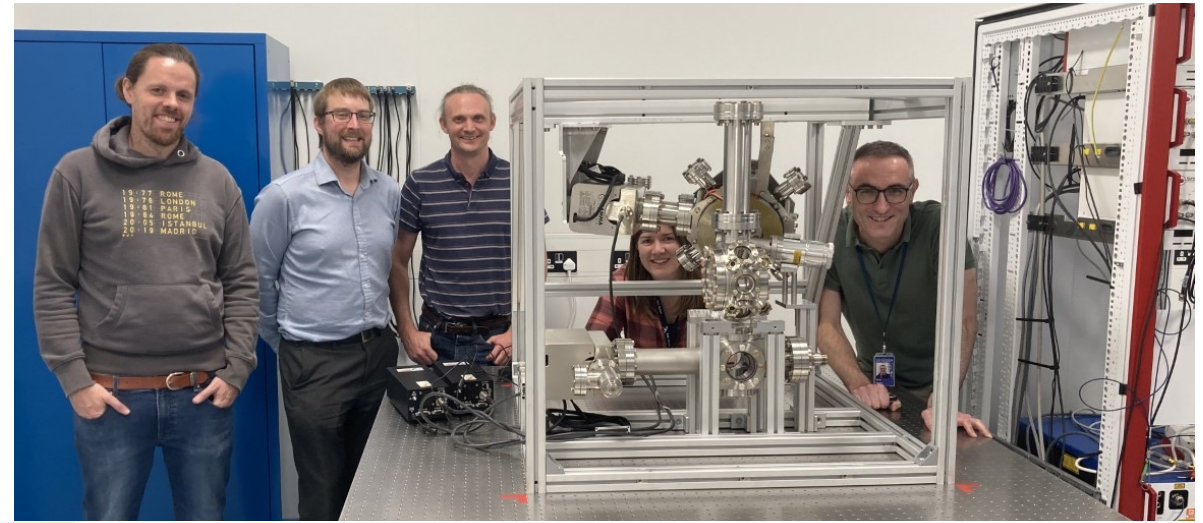
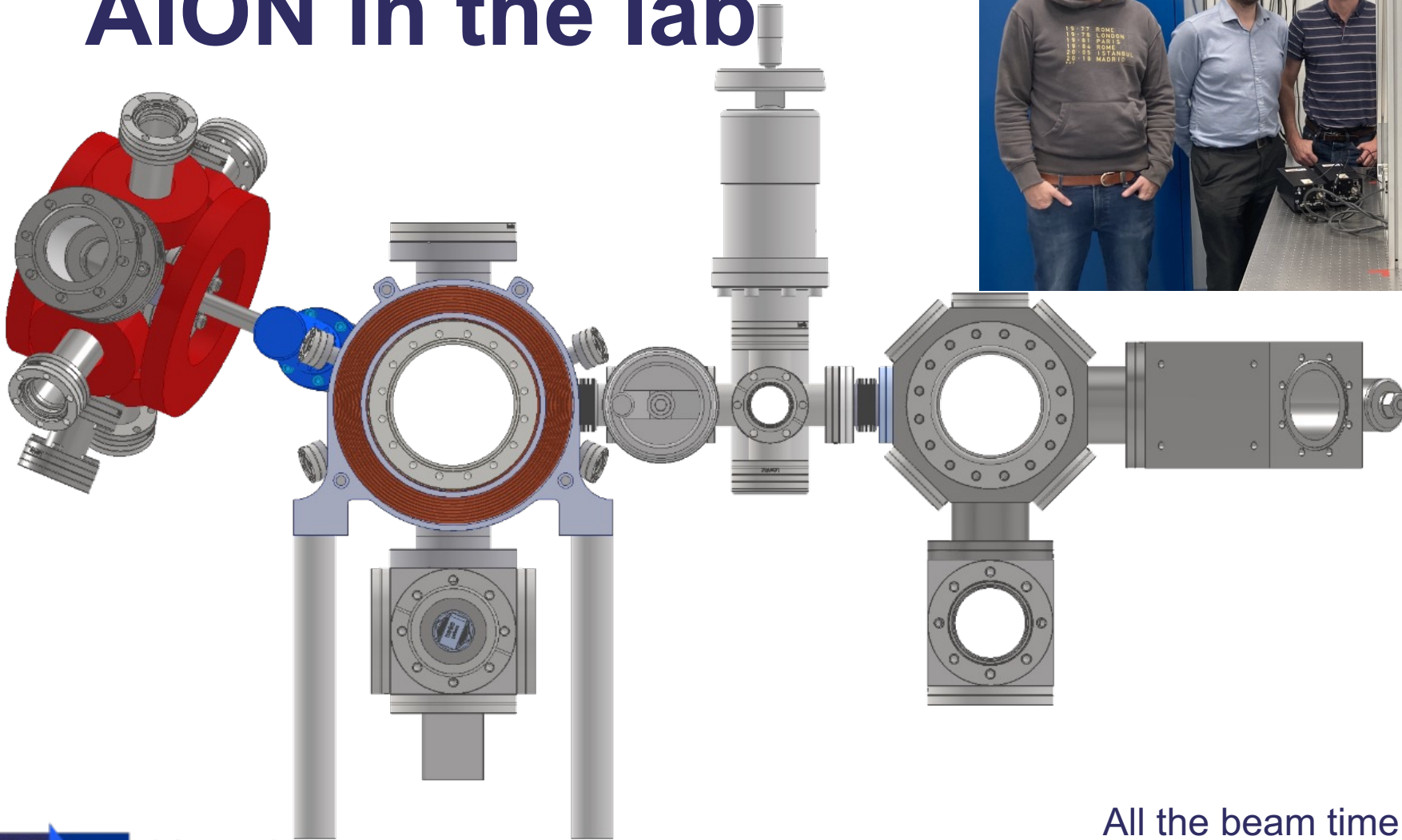


each interferometer

<https://physicsworld.com/a/ligo-detects-first-ever-gravitational-waves-from-two-merging-black-holes/>



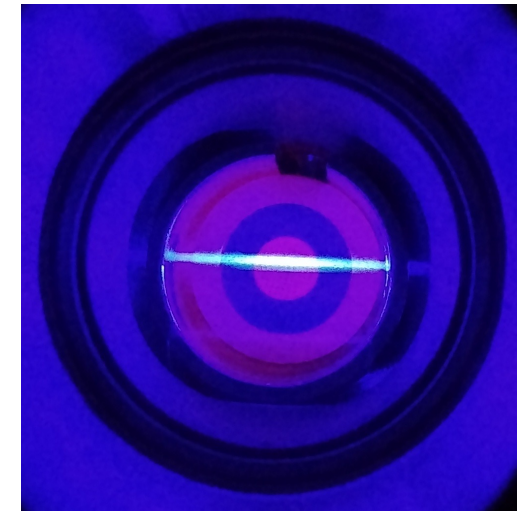
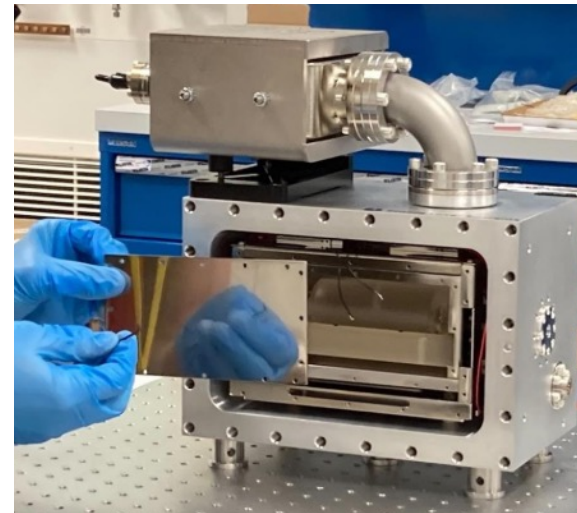
AION in the lab



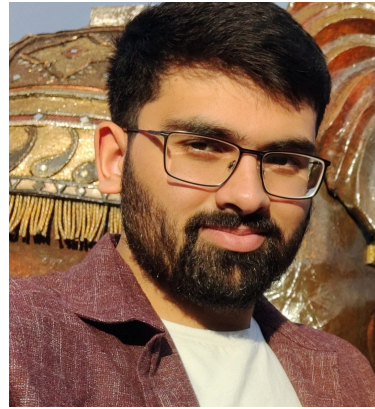
All the beam time you could want!

Skills

- Optics
- Ultra-high vacuum
- Computer Aided Design
- Electronics
- Experiment modelling
- Programming
- Troubleshooting
- Communication
- Collaboration



RAL Team



+ AION & MAGIS collaborators

