# The European Laboratory for Gravitation and Atom-interferometric Research (ELGAR) Project

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# The partnership so far…

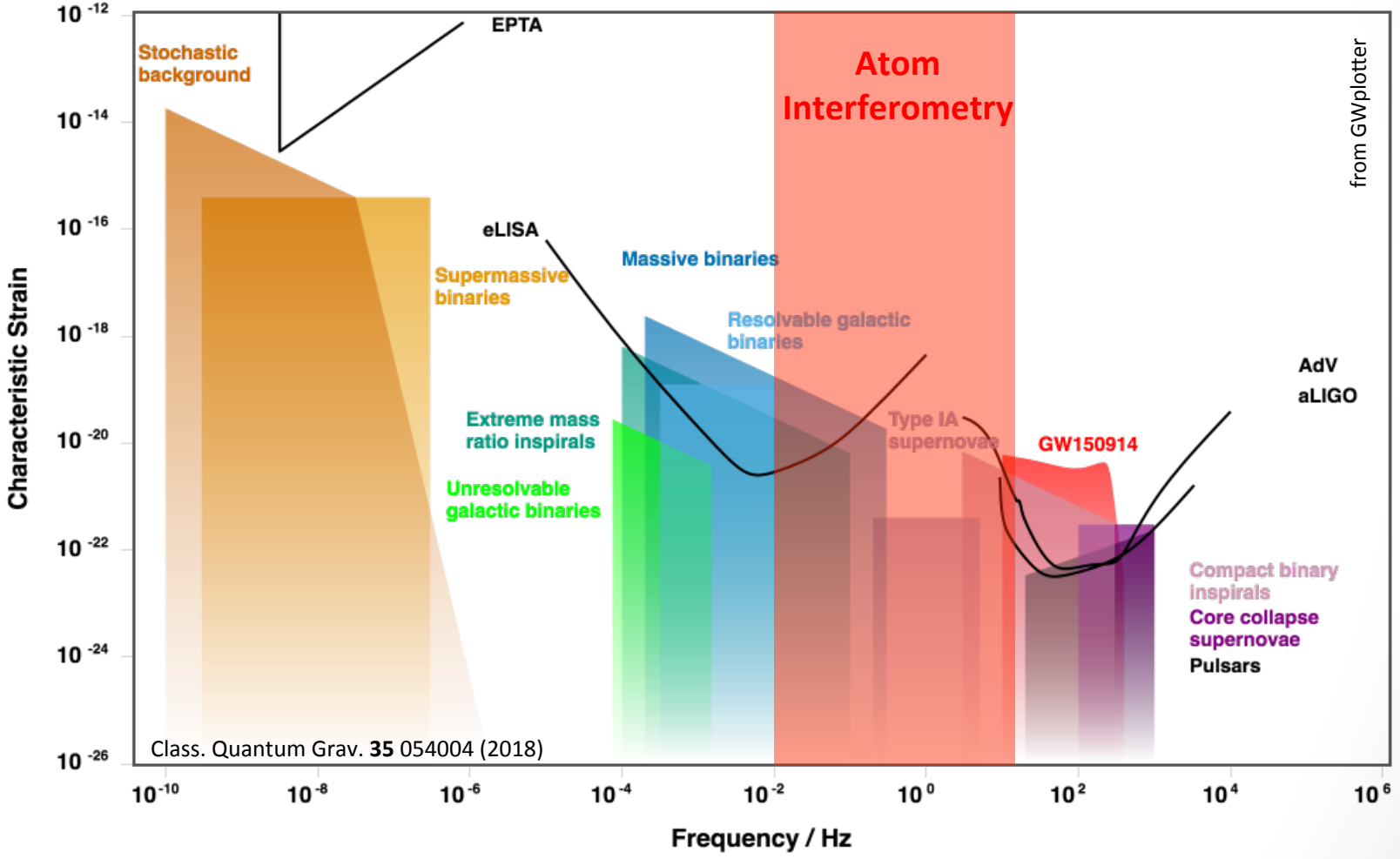
6 countries, 18 institutes.

| Country | Institution |
|---|---|
| France | Institut d'Optique (IOGS/LP2N) |
| Germany | Leibniz Universitaet Hannover (LUH) |
| UK | University of Birmingham (UoB) |
| Spain | Consejo Superior de Investigaciones Científicas (CSIC) |
| Italy | Istituto Nazionale di Fisica Nucleare (INFN) |
| Greece | Foundation for Research and Technology Hellas (FORTH) |

# Outline

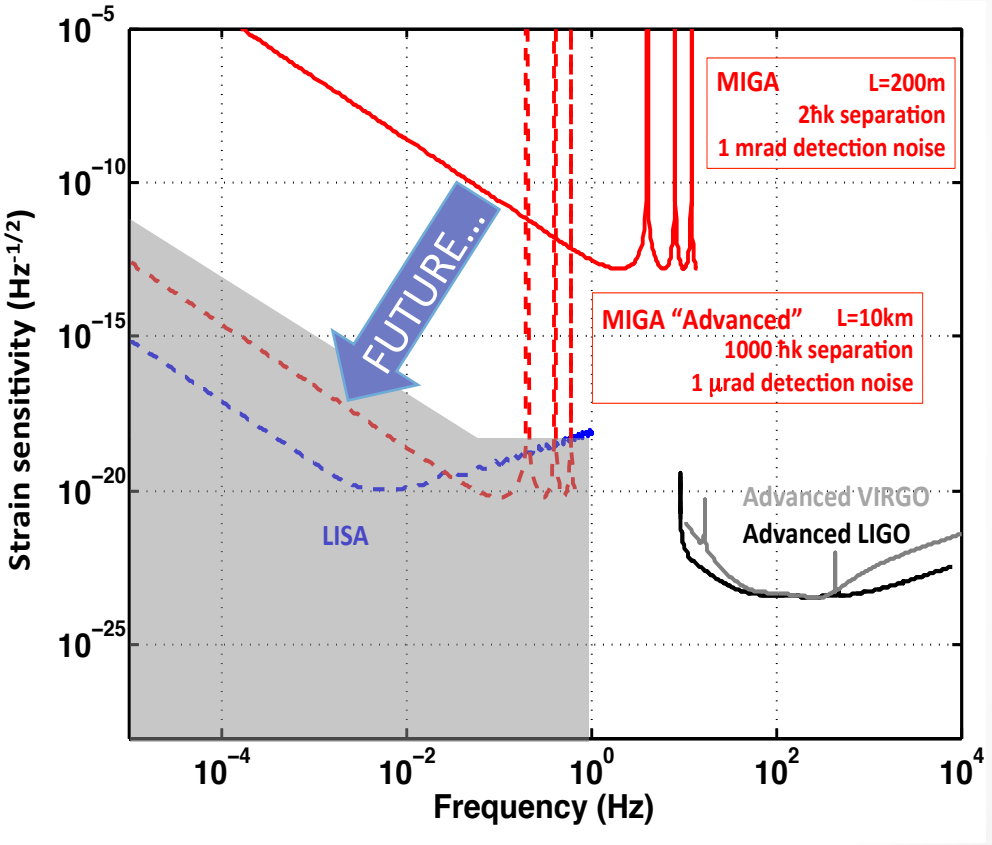
- The case for a design study
- The objective
- The history of ELGAR
- Moving forward
- Conclusion

# The science case



# The case for a design study

- How do we move from predictions and possibilities to working instruments?
- An incredible amount of work must be done to determine our methods, location, goals, funding, and community



# The case for a design study

Challenge for atom optics
- « LMT » techniques
- High atom flux $10^{12}$/s

and

Technical noise reduction:
- Frequency noise
- Residual seismic noise
- Magnetic noise
- Wavefront, scattering ….

and

- Requires Advanced GGN rejection scheme

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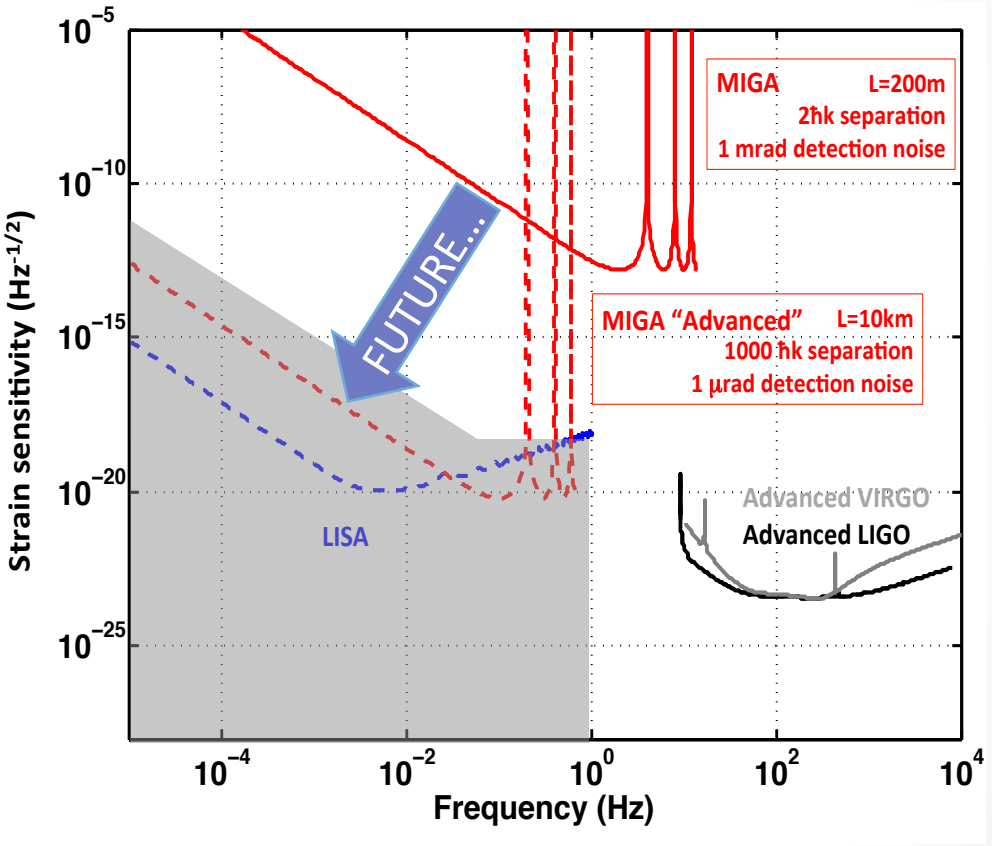
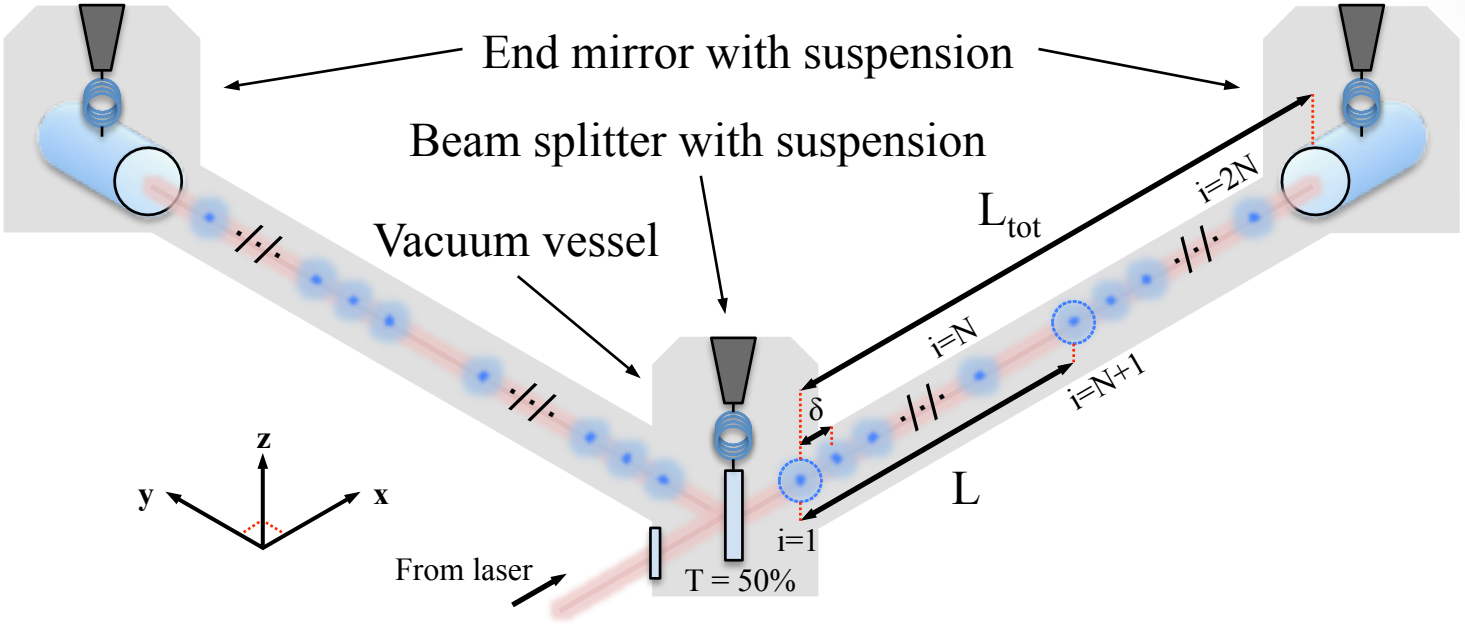


# A rough schematic




- A vertical arm, on site or at a distributed site is on our mind.
- Example of what we are thinking;
  - atomic flux for 1 μrad sensitivity (think flux of $10^{12}$ atoms/s)
  - LMT ~ 1000 ħk
  - target band 100 mHz – 1 Hz
  - T between 1 s and 10 s
  - ~100 sensors between the two arms
  - Total length of ~30 km with some 100s m between heads.

Target strain sensitivity:
~ $10^{-22}$

# Objective of the design study

- A major focus of the study is to coordinate various national initiatives that have been successfully funded to define a future European research infrastructure for gravitational wave observation with matter-wave interferometry.

- Define a roadmap for the construction and integration of pan-European effort into a future facility or distributed facilities.

- Gather all interested actors of the European and International community to contribute and/or act as users of the facility.

- Target applications/communities: **geophysics, gravitational wave detection**, **fundamental physics.**

# What is a research infrastructure?

- Research Infrastructures: ... the term 'research infrastructures' refers to facilities, resources and related services that are used by the scientific community to conduct top-level research in their respective fields.

- ESFRI (European Strategy Forum on Research Infrastructures) proposes a similar definition: They are facilities, resources or services of a unique nature that have been identified by pan-European research communities to conduct top-level activities in all fields. Generally the Research Infrastructures are divided into the following groups:
  - single-sited
  - distributed
  - virtual

# Outcome of the design study

- **Definition of the design and architecture for the future infrastructure**; leads to drafting of concepts, engineering plans, prototypes.

- **Identification of the site and/or structure of the infrastructure**; plans to integrate into existing facilities, identification of new facilities altogether.

- **Definition and implementation of a cost model**; estimated budget for construction and operation…

- **Definition of the coordination structure**; design workable legal and governing strategies and structures.

# Framework details

- Duration; 36 months
- Budget; 3.5 X $10^6$ € (mostly for design/theory team)- Spread over partners

We will be answering H2020-INFRADEV-1-2019: Design Studies, due in November 2019.

We have 18 partners from 6 countries (France, Germany, Spain, Italy, UK, Greece).

# The history of ELGAR

- In 2010 – MIGA design study was evaluated very positively by H2020, but not funded…oddly enough, MIGA was ranked #4 – four projects were supposed to be funded, but budget shortfalls allowed only 3 to be funded.

(H2020-INFRADEV-2014-15: Conceptual and technical design of new research infrastructure)

- After, national initiatives received strong support at the ~ $10^6$€ level. Examples include:

MIGA (France)

MAGGIA (Italy)

HiTech (Germany)

**The point** – <u>As early as 2010</u>, atom interferometry was positively identified as a possible candidate technique for gravitational wave detection by H2020.

# White paper preparation

- End of summer to early fall will see the completion of a white paper detailing the ELGAR proposal – this is where the design study begins.

- It will focus on the state-of-the-art and show that demonstrated techniques and present knowledge can move matter-wave interferometry towards gravitational wave detection.

# Conclusions

- Various national initiatives strengthen the proposal, showing a large community.
- Look out for our white paper this fall!
- The ELGAR design study will be submitted to this year's H2020 call.