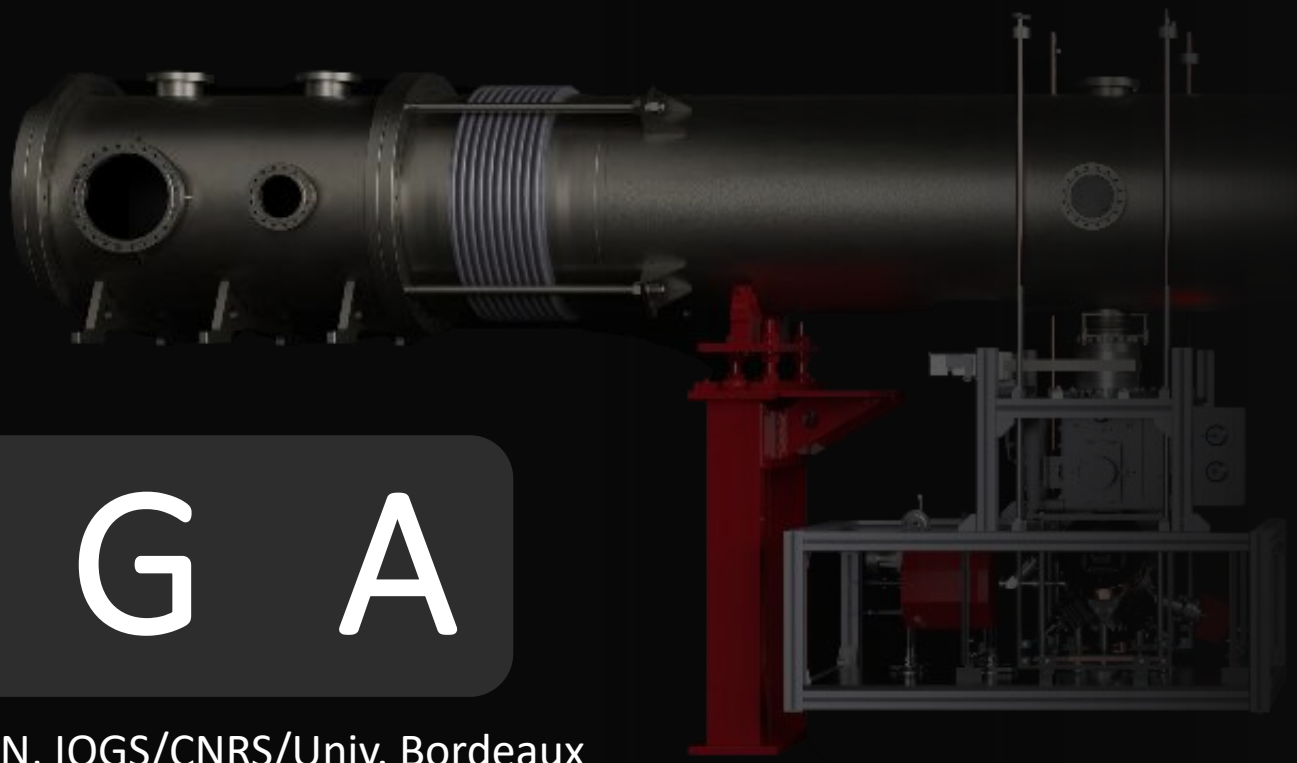
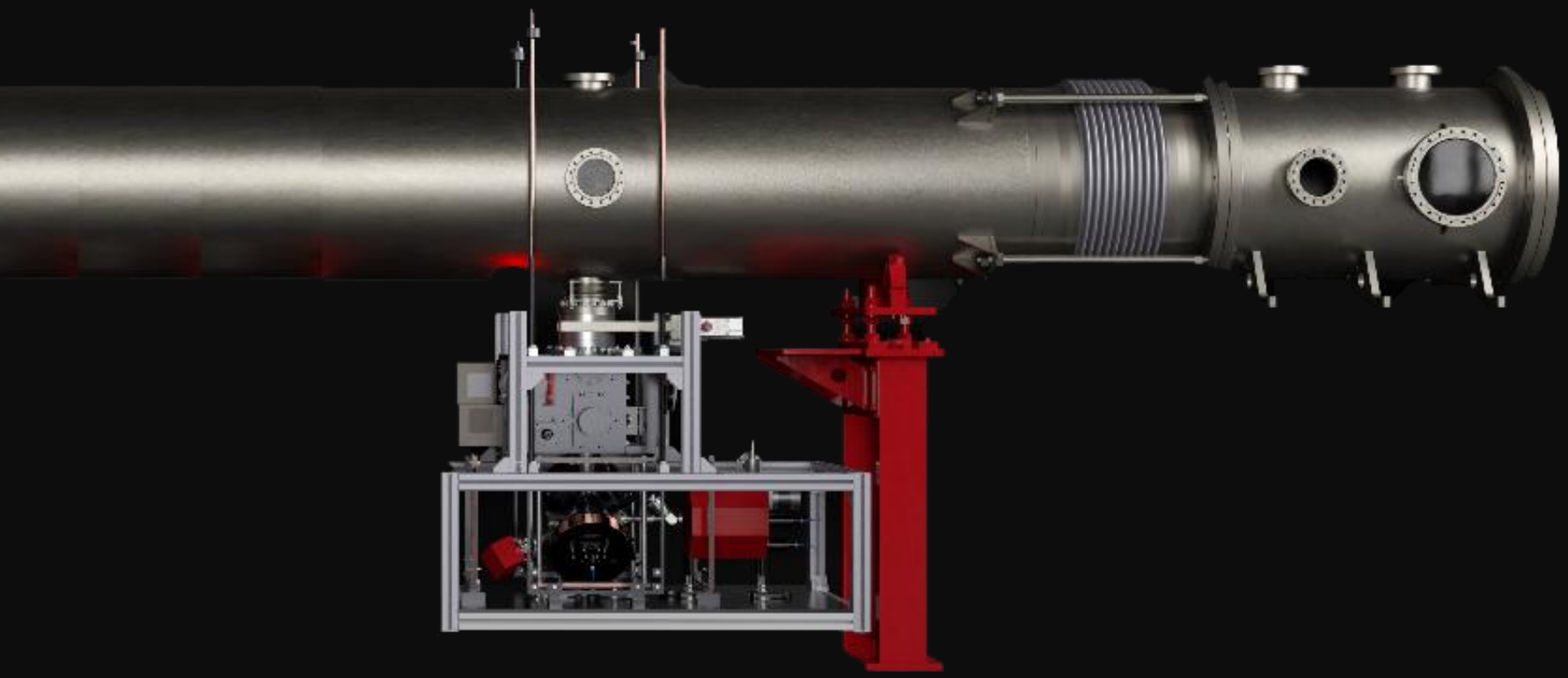
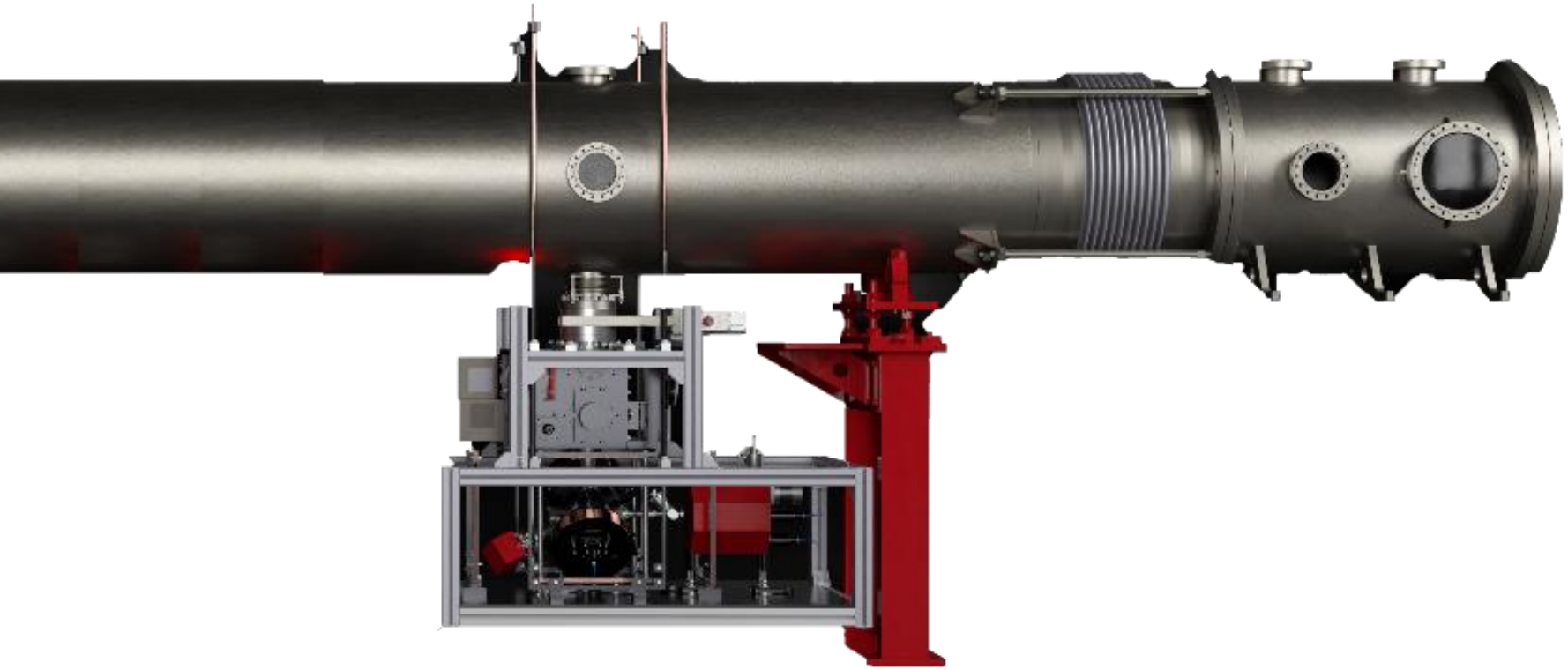


M I G A

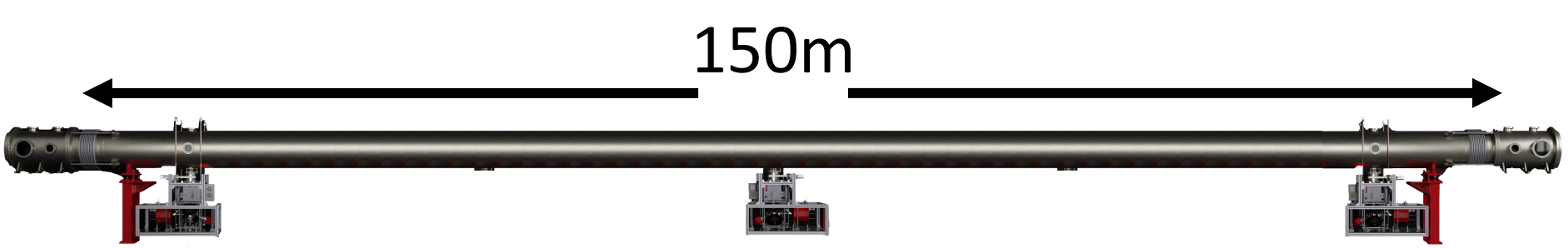
Yiming MENG @ LP2N, IOGS/CNRS/Univ. Bordeaux
for the MIGA consortium



M I G A



M I G A


150m

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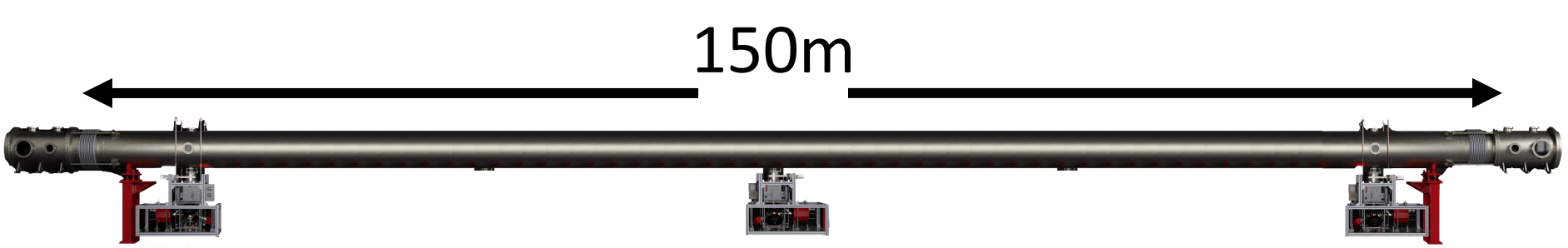
87
Rb
Rubidium
87
Rb
Rubidium
87
Rb
Rubidium
Interferometers



M Atter-wave laser based

I nterferometer

G ravitational

A ntenna

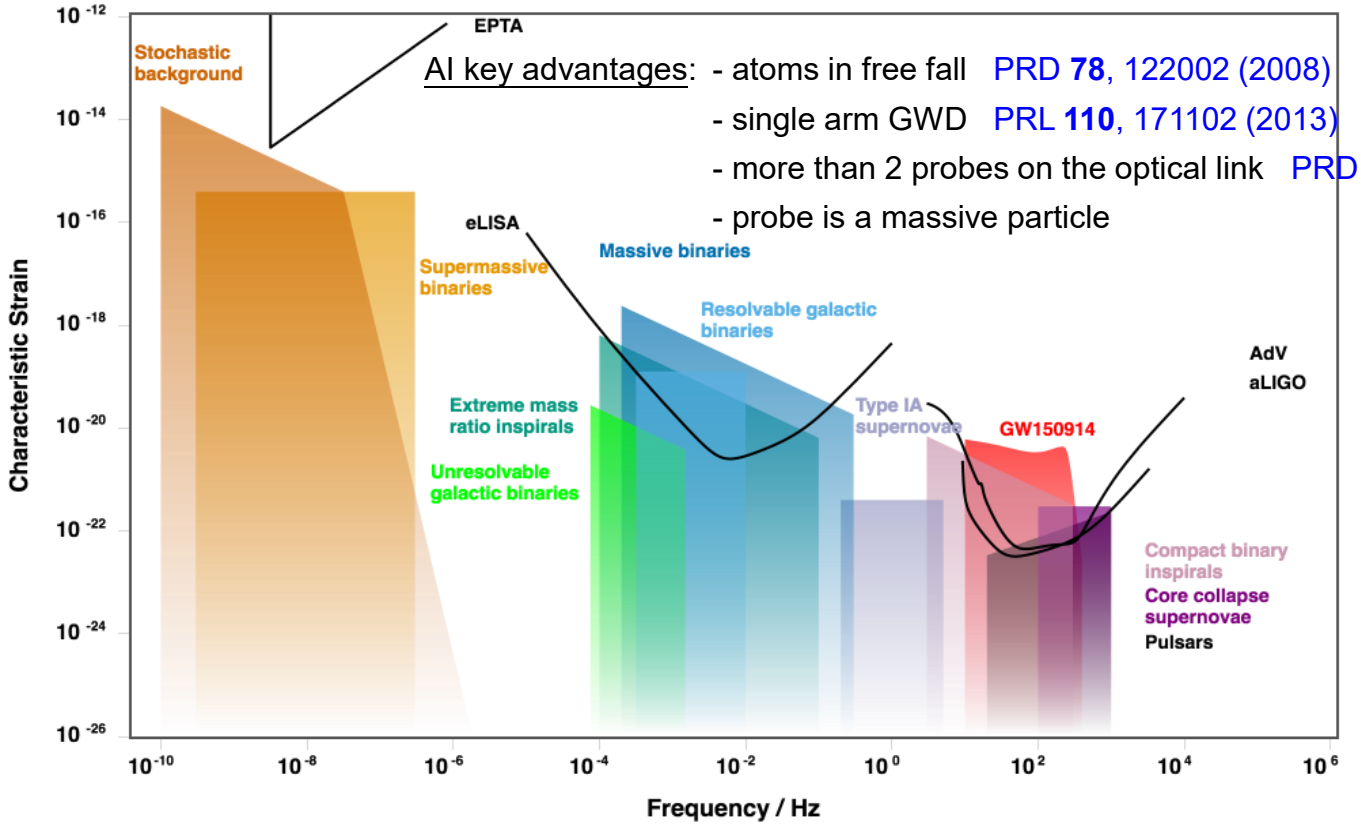
- Construction MIGA@LSBB
- Measure cycle
- MIGA Exploratory Results

- Construction MIGA@LSBB


Google Earth


Google Earth
Data SIO, NOAA, U.S. Navy

Construction MIGA@LSBB



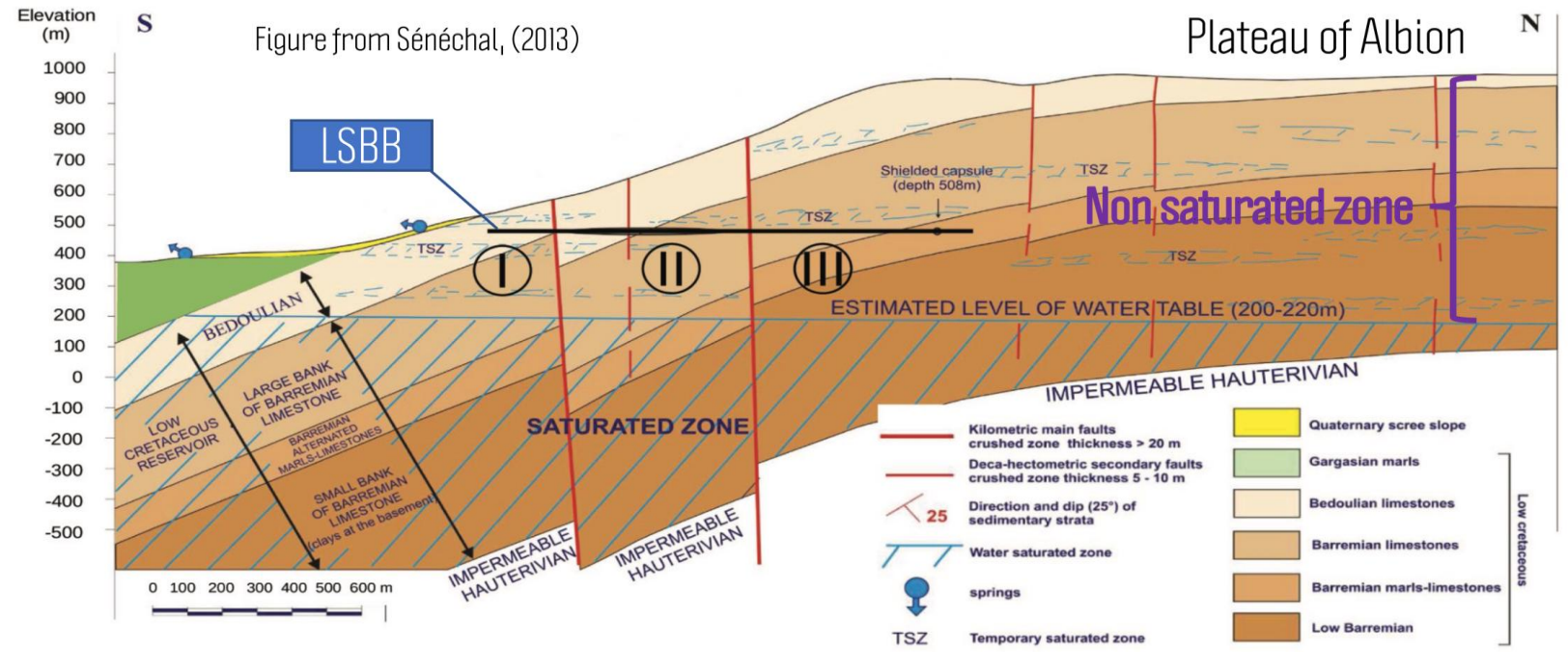
AI key advantages:
- atoms in free fall PRD **78**, 122002 (2008)
- single arm GWD PRL **110**, 171102 (2013)
- more than 2 probes on the optical link PRD **93**, 021101(R) (2016)
- probe is a massive particle

Goal: Development of sub-Hz gravitational-wave detectors

Focus: New methods to characterize gravity-field fluctuations

Applications: Geoscience — geology, seismology, hydrogeology, and related fields

Construction MIGA@LSBB



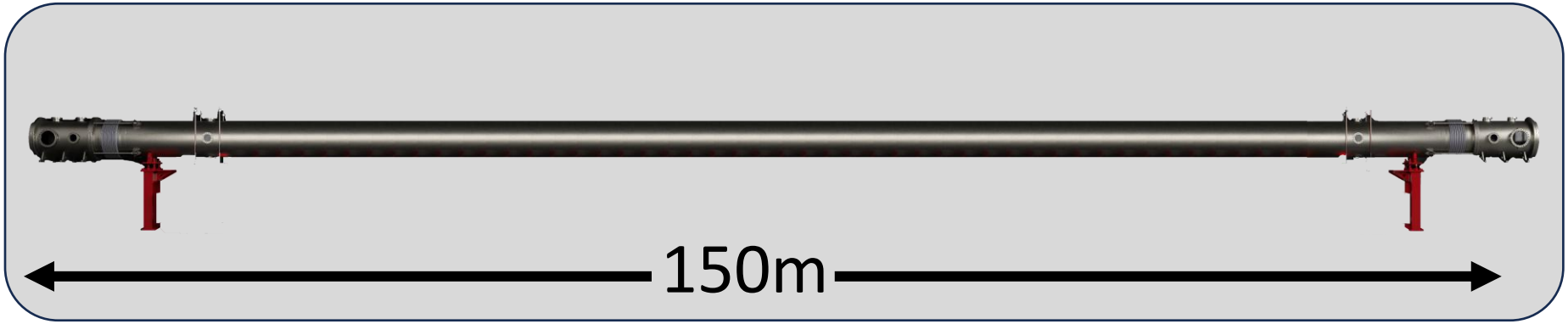
LSBB
Laboratoire Souterrain à Bas Bruit
Low Noise Inter Disciplinary Underground Science & Technology

- LSBB underground site
- Low noise properties(seismic and magnetic)

Construction MIGA@LSBB

- Started about **10 years ago** and involves a large **French consortium**
- Two galleries at LSBB were completed by the end of 2020
- All parts (**vacuum**, **atom heads**, **lasers**) produced and tested.
- A major milestone was achieved!

Construction MIGA@LSBB



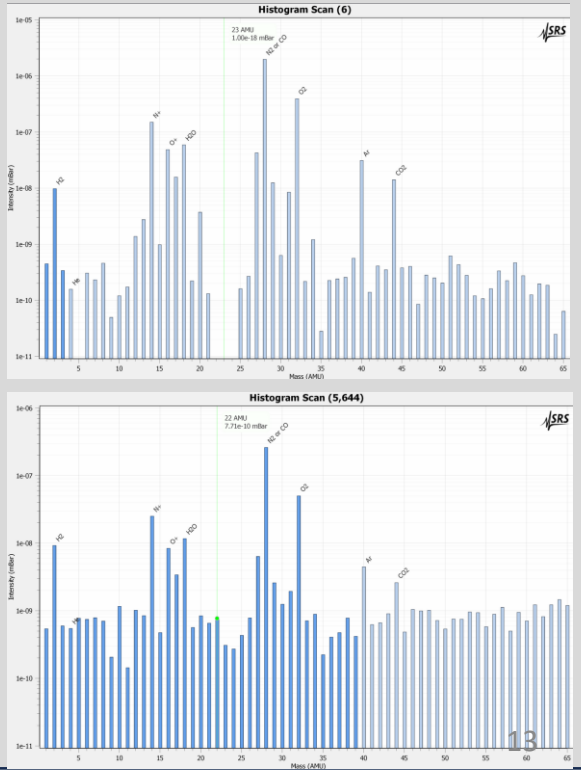
Assemble the full vacuum vessel at LSBB

Vacuum test @ 40 m	1st Test
Pumping time _ Turbo @650 Hz	41 hours
Last pressure reading	**3.5 * 10^{-8} mbar** Single turbo pump
Partial pressure _N2 or CO	4.8 * 10^{-9} mbar
Partial pressure _H20	2.7 * 10^{-8} mbar

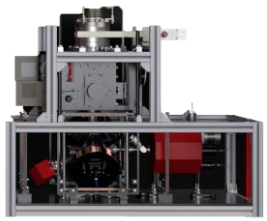
Further reduction of pressure :

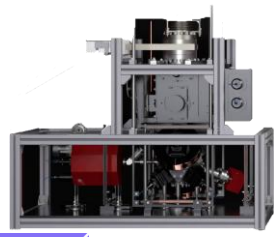
1E-9mbar via system baking

Vacuum test @ 150 m



Construction MIGA@LSBB





LTE

Control system

Control system

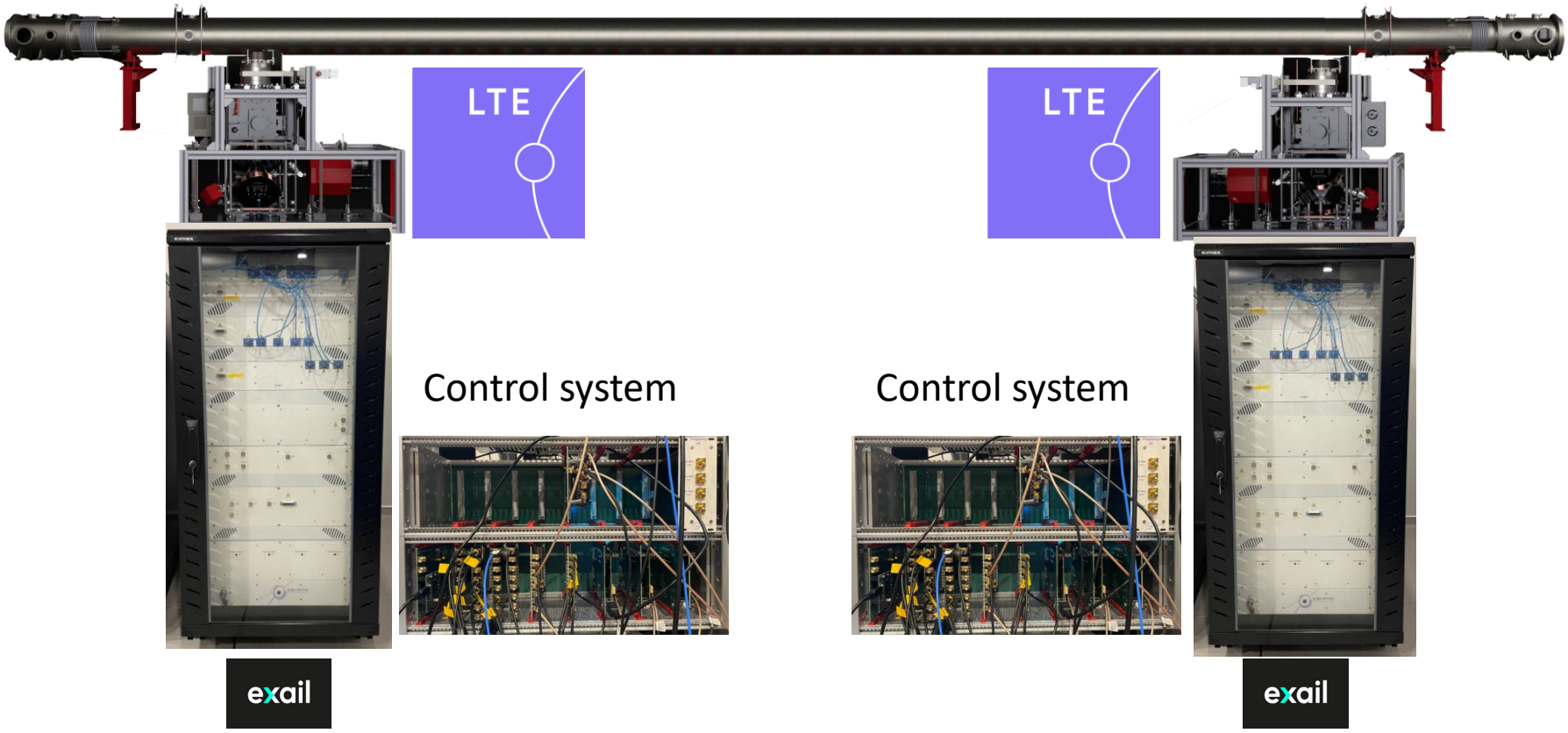
exail

exail

Construction MIGA@LSBB

Good Vacuum quality

2 atom head 2 Laser system



Control system

Control system

Install in **November**

Produce cold atoms by **the end of the year**

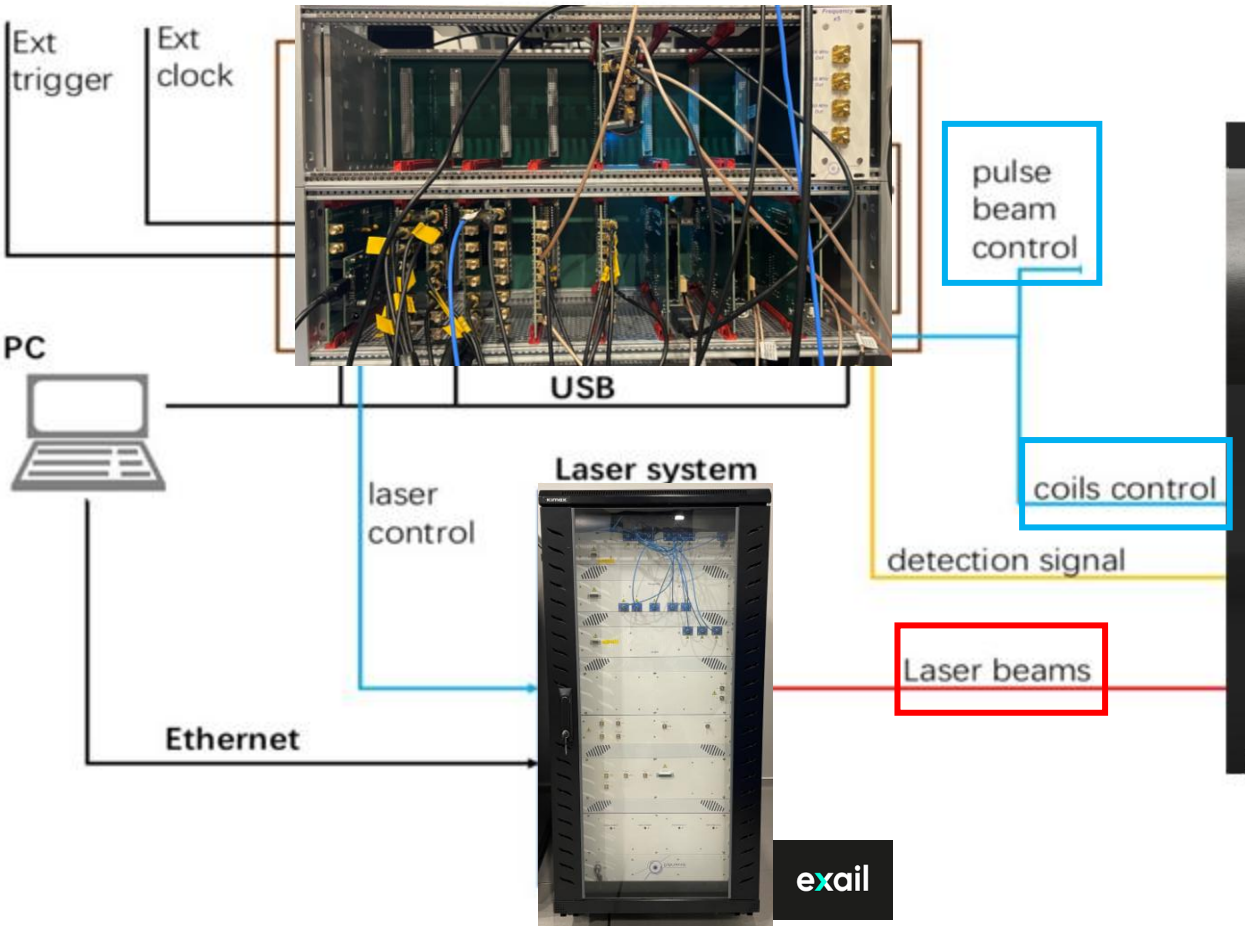
- Construction MIGA@LSBB
- Measurement cycle
- MIGA Exploratory Results

Measurement cycle

RSI **91**, 033203 (2020)

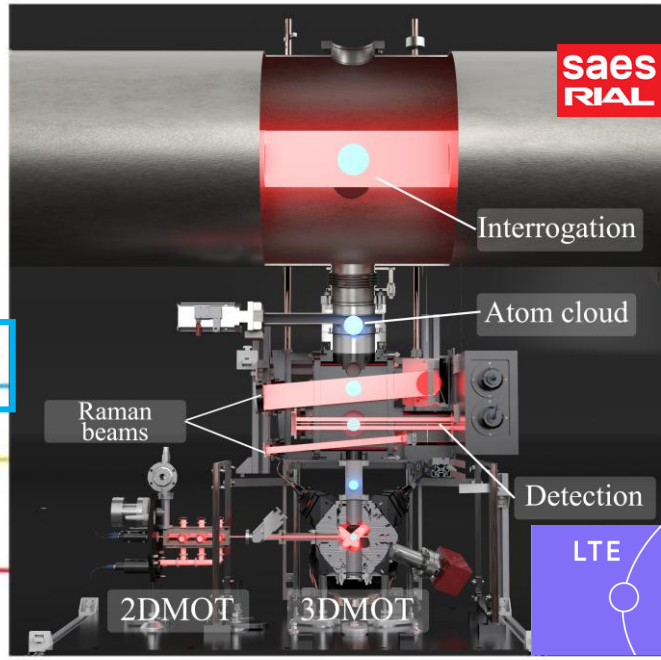
arXiv: 2011.09324

Control system



Sci. Rep. **10**, 3268 (2020)

arXiv: 1911.12209

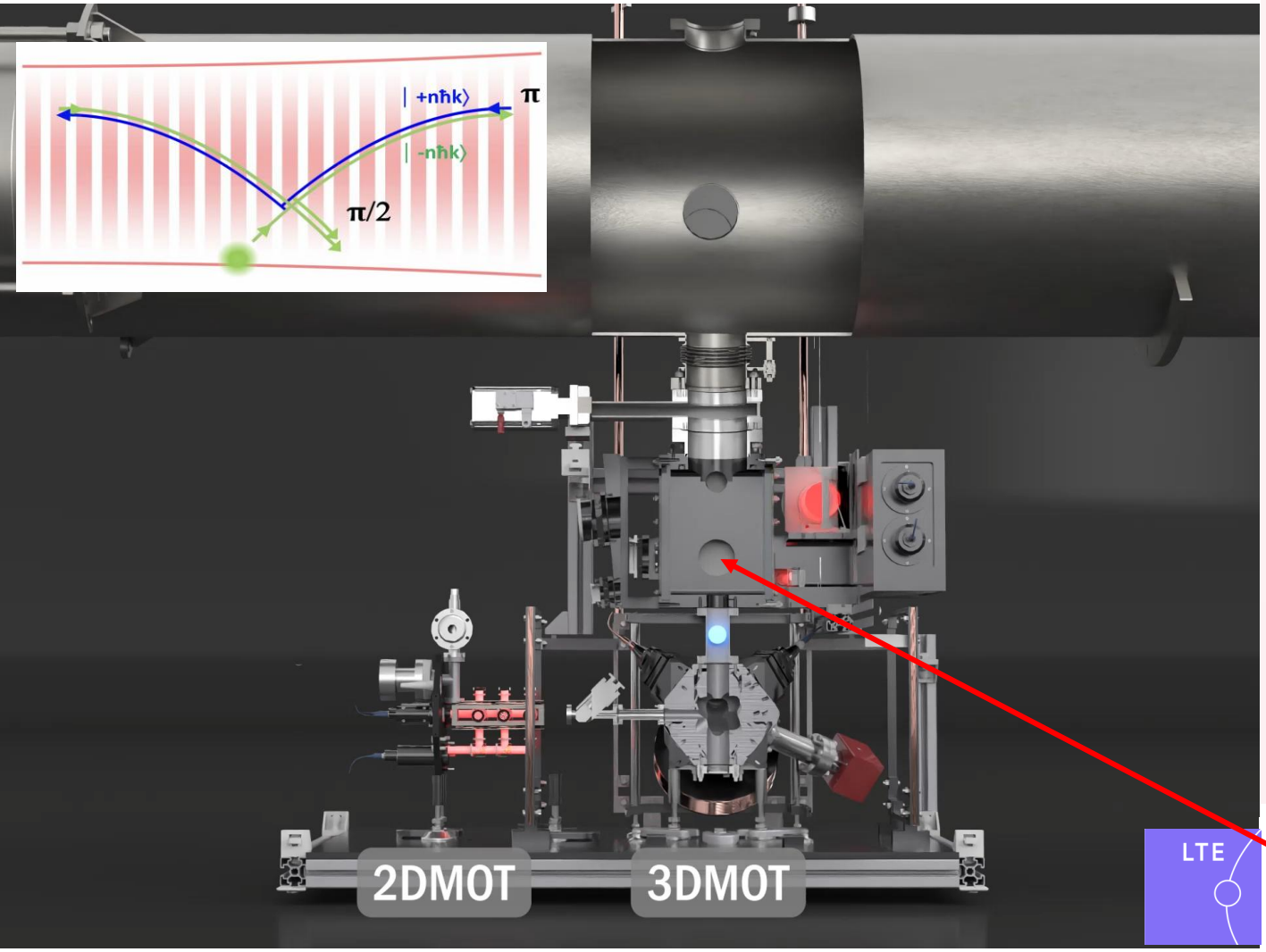


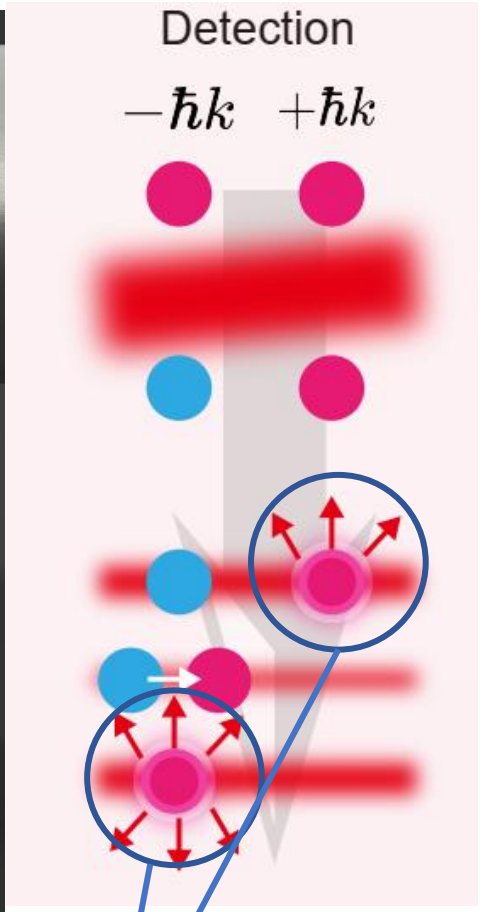
Sci. Rep. **12**, 19000 (2022)

arXiv: 2209.10234

10^7 atoms at 100nK after velocity selection, every s

Measurement cycle





LTE

$$P = \frac{N_2}{N_1 + N_2} = \frac{1 - \cos\Phi}{2}$$

1 loop =**1.1s 300ms** loading time; **800ms** free flight;
4.8E7 atoms in 3DMOT@loading; **1E6** atoms/s flux@detection

By detecting the **2 atom states** recover interferometric phase variation

- Construction MIGA@LSBB
- Measurement cycle
- MIGA Exploratory Results

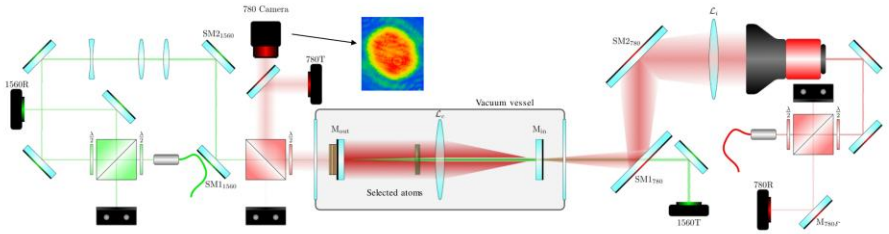
MIGA Exploratory Results: AI in cavity

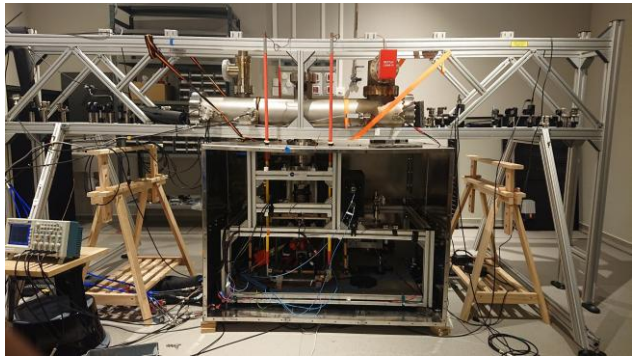
PHYSICAL REVIEW LETTERS **132,** 213601 (2024)

Experimental study on AI inside a horizontal optical cavity

Multiphoton Atom Interferometry via Cavity-Enhanced Bragg Diffraction

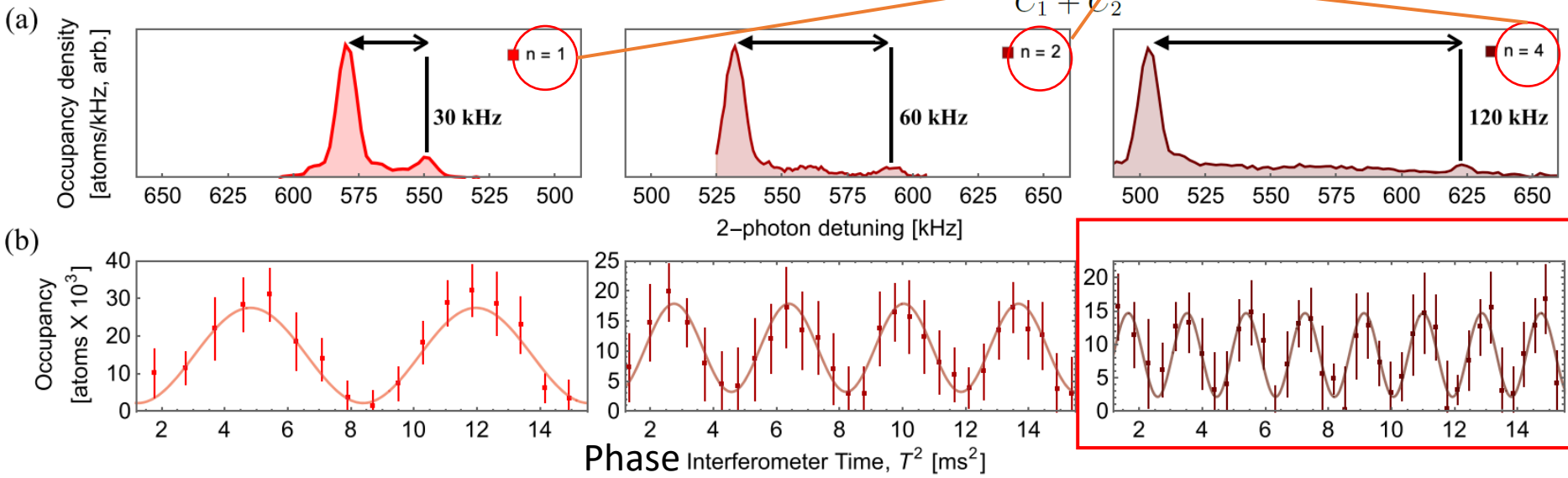
D. O. Sabulsky,[1] J. Junca,[1] X. Zou,[1] A. Bertoldi,[1] M. Prevedelli,[2] Q. Beaufils,[3] R. Geiger,[3] A. Landragin,[3] P. Bouyer,[1,†] and B. Canuel[1,*]





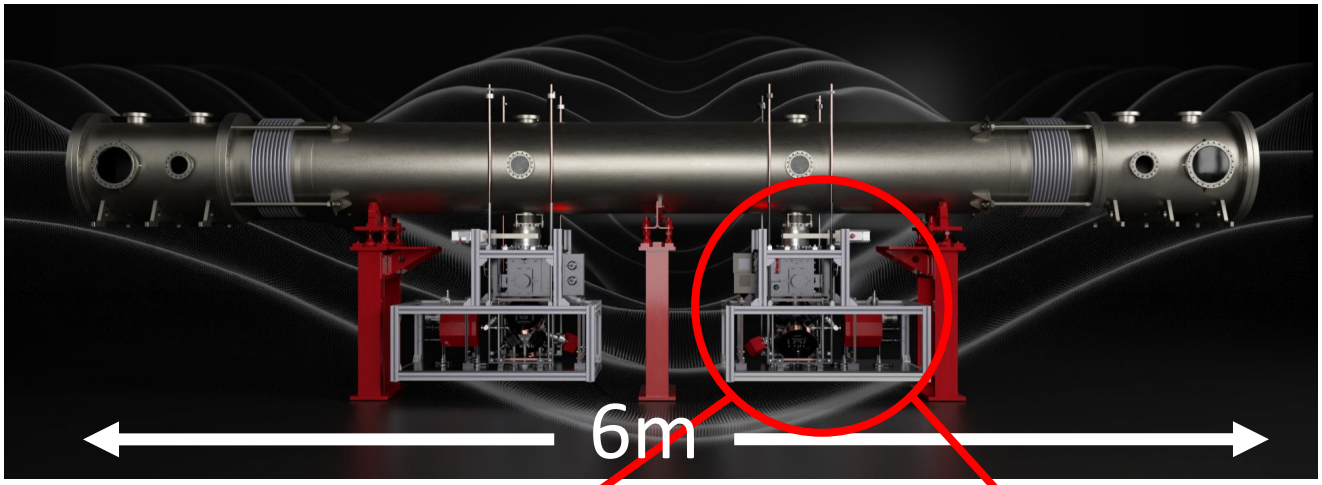
- A **marginally** stable optical cavity
- **High-order** Bragg diffraction

$$P_t(T) = \frac{C_2 - C_1 C_2 \cos(2nk_L \alpha g T^2)}{C_1 + C_2}$$



Enhance sensitivity to phase variations

MIGA Exploratory Results: 6 m gradiometer

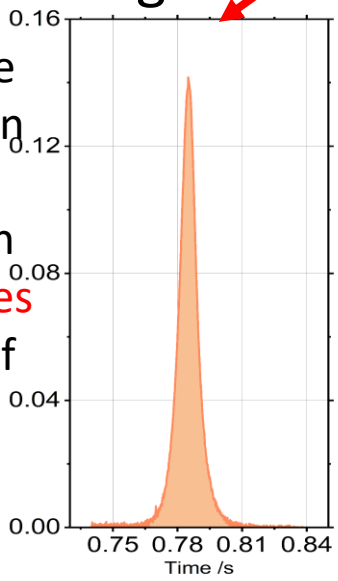


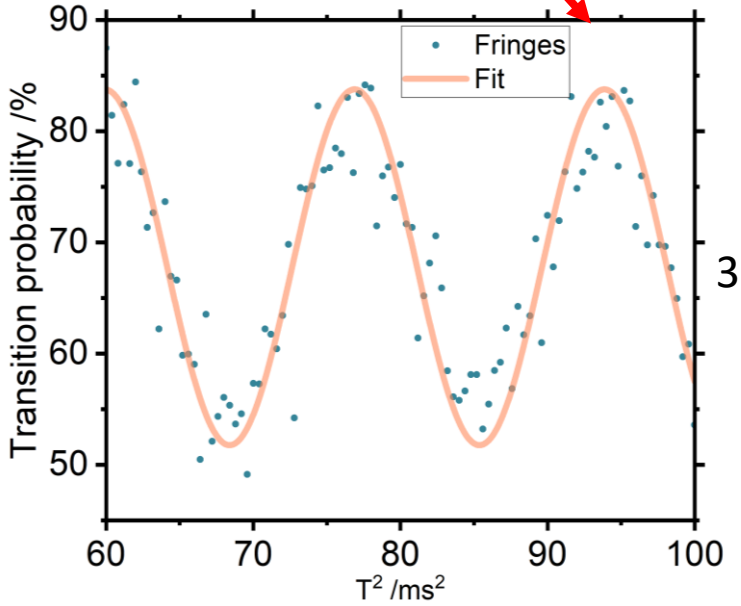
2.7uK

Time of flight

Interferometer fringes with the free space interrogation beam

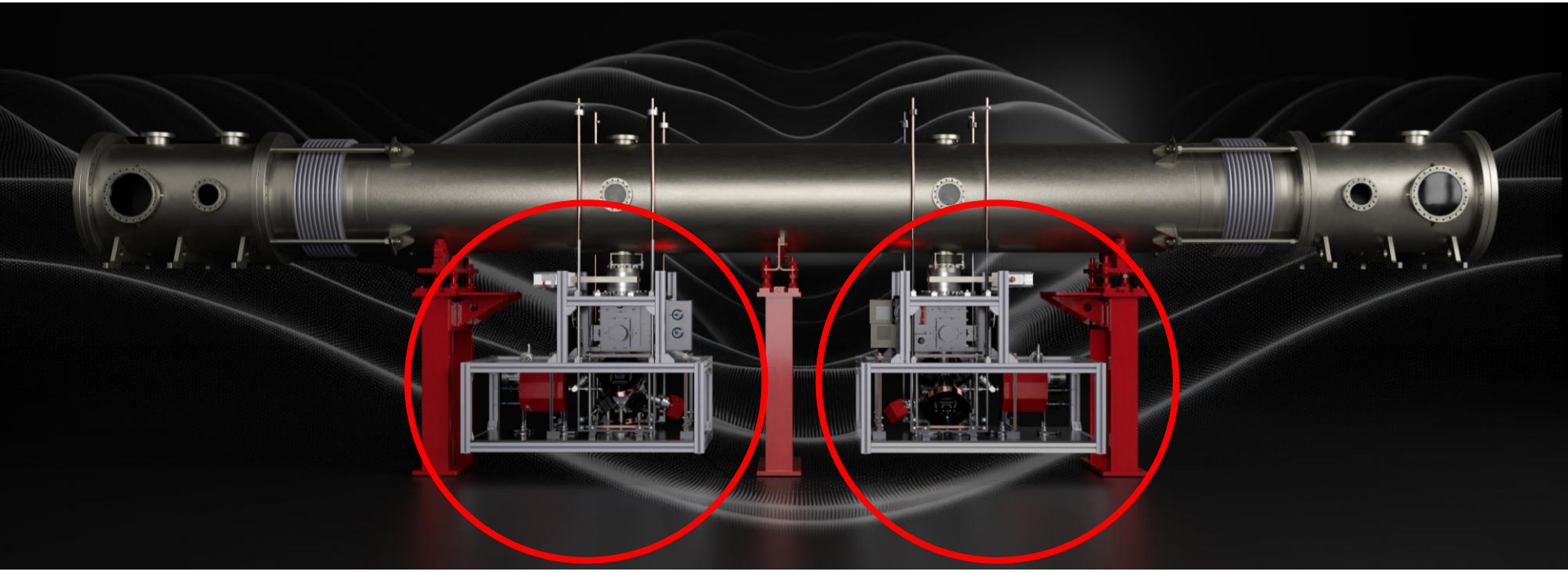
- Use to determine the Phase accumulated in the interferometry
- Enable the extraction of interference fringes and the evaluation of gravitational effects





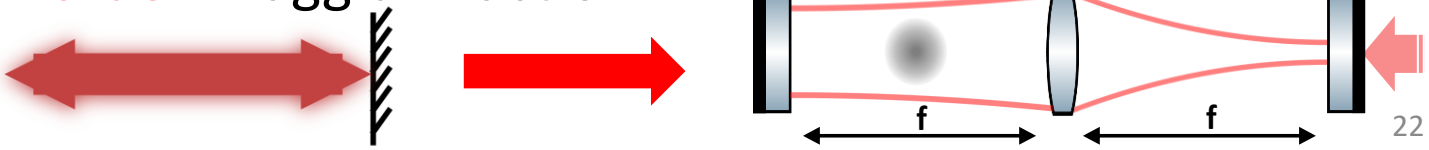
30–40% constrast

MIGA Exploratory Results



Next step:

- **2** atom heads work together as a gradiometer: Differential measurement to reduce noise
- Replace the free space interrogation beam with a cavity for high-order Bragg diffraction



MIGA Collaboration Team

Current members who participate in the setting up and commissioning of MIGA

MIGA @ LP2N:

B. Canuel

A. Bertoldi

K. Verbeke

Y. Meng

Q. Cojean

N.Mandin

M. Prevedelli @ UNIBO

MIGA @ Rustrel:

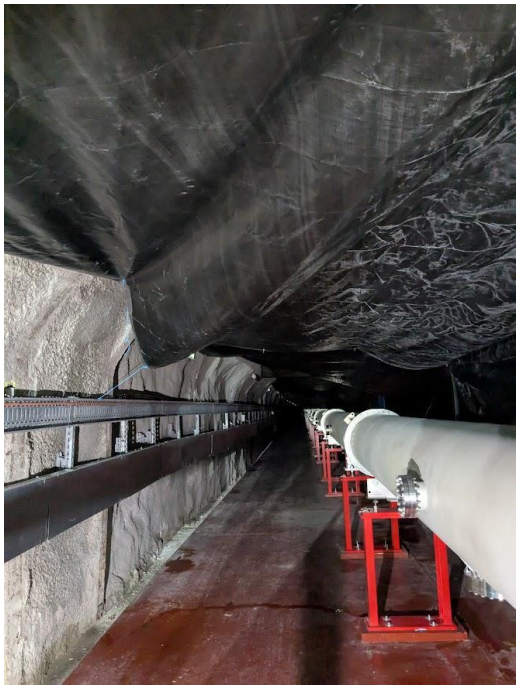
J. Pinon

A. Bodeau

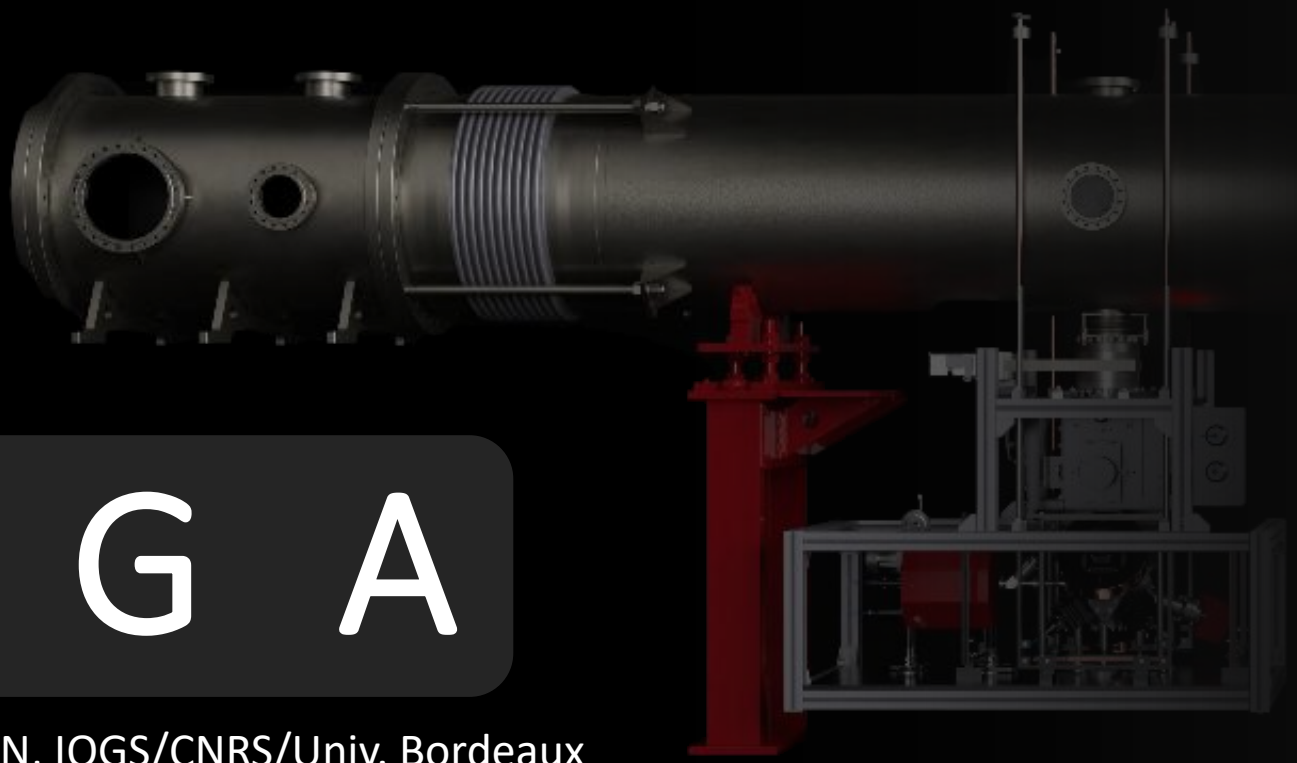
LTE

A. Landragin

Q. Beaufils



Every contribution makes a big difference



M I G A

Yiming MENG @ LP2N, IOGS/CNRS/Univ. Bordeaux
for the MIGA consortium