LGWA LUNAR GRAVITATIONAL WAVE ANTENNA

A first-generation lunar GW detector

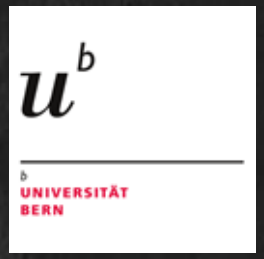
P.I. Prof. Jan Harms - Gran Sasso Institute

Web page: lgwa.unicam.it

Paola Severgnini
INAF – Osservatorio Astronomico di Brera
On behalf of the full collaboration

LGWA COLLABORATING INSTITUTIONS

UNIVERSITY OF TWENTE.



POLITECNICO
MILANO 1863

Credits: J. Harms

MISSION CONCEPT:

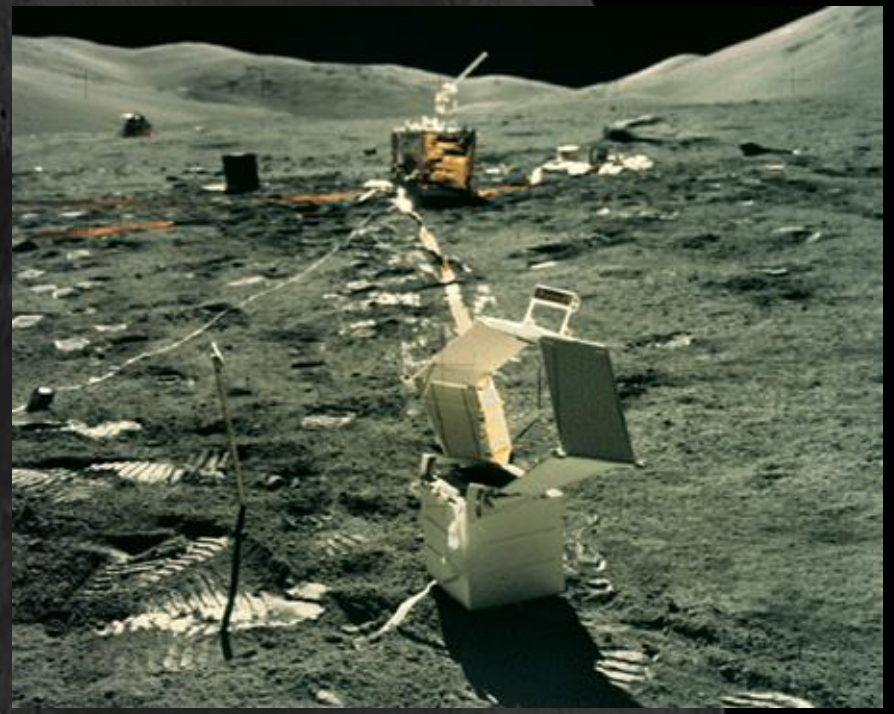
Measure oscillations of the Moon caused by GWs

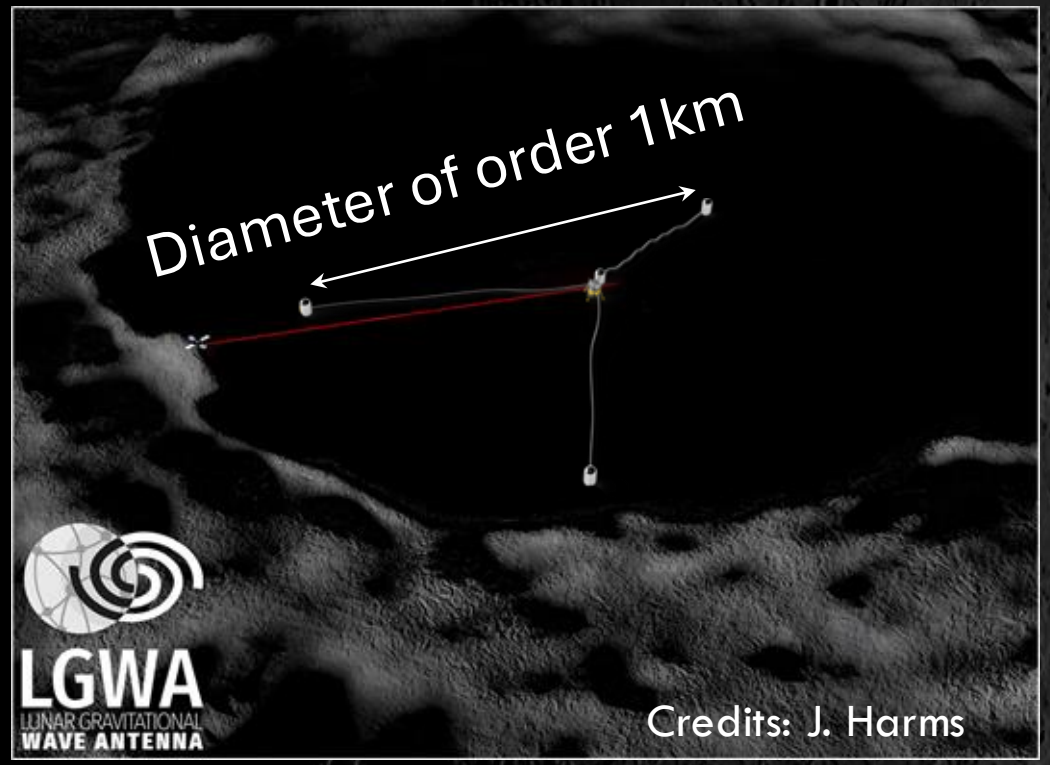
Use the Moon as a planetary-scale antenna for space-time fluctuations

Credits: J. Harms

MISSION CONCEPT:

LGWA is an evolution of the Lunar Surface Gravimeter deployed on the Moon with Apollo 17 in 1972 …

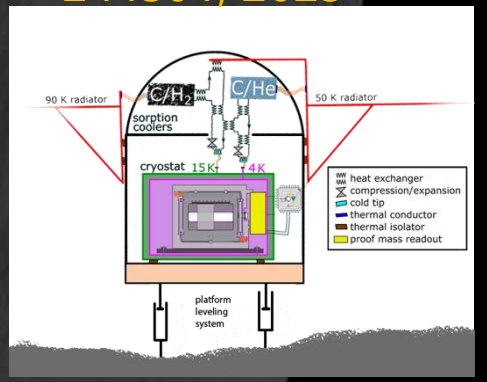




In 2020 J. Harms and collaborators proposed deploying a sensor array inside a permanently shadowed region (PSR)

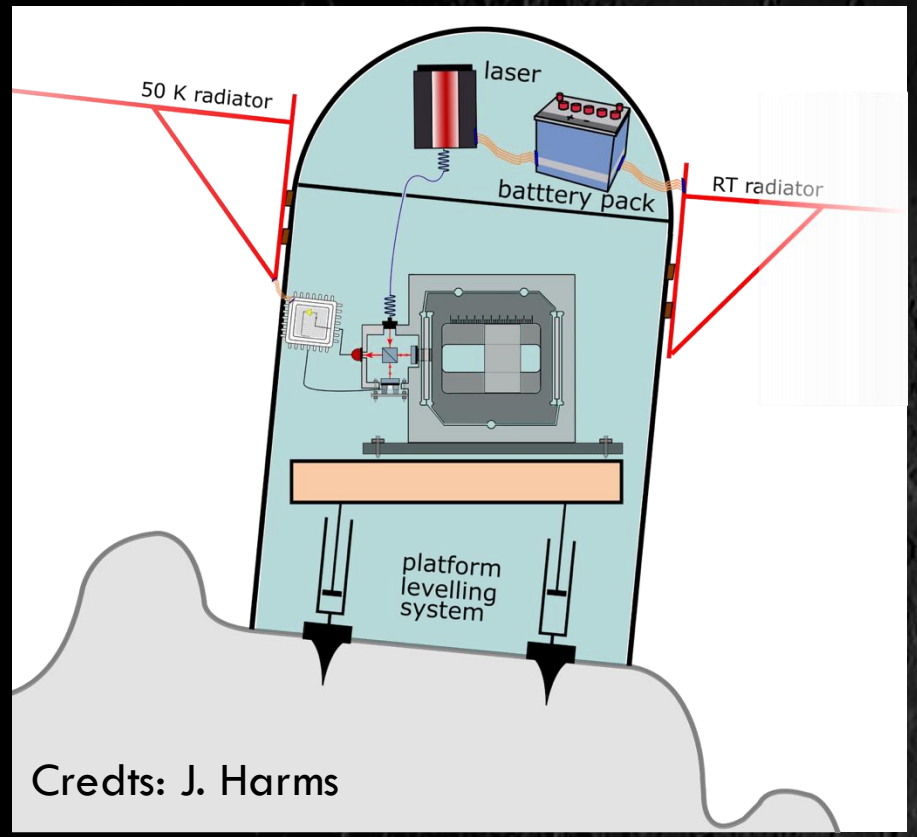
Observation band:
1 mHz to 1 Hz

J Appl Phys 131, 244501, 2023



SOUNDCHECK

Selected by ESA in 2023 into the Reserve Pool of Lunar Activities



Credts: J. Harms

LGWA's pathfinder mission:
a single geophysical station to be deployed inside a PSR

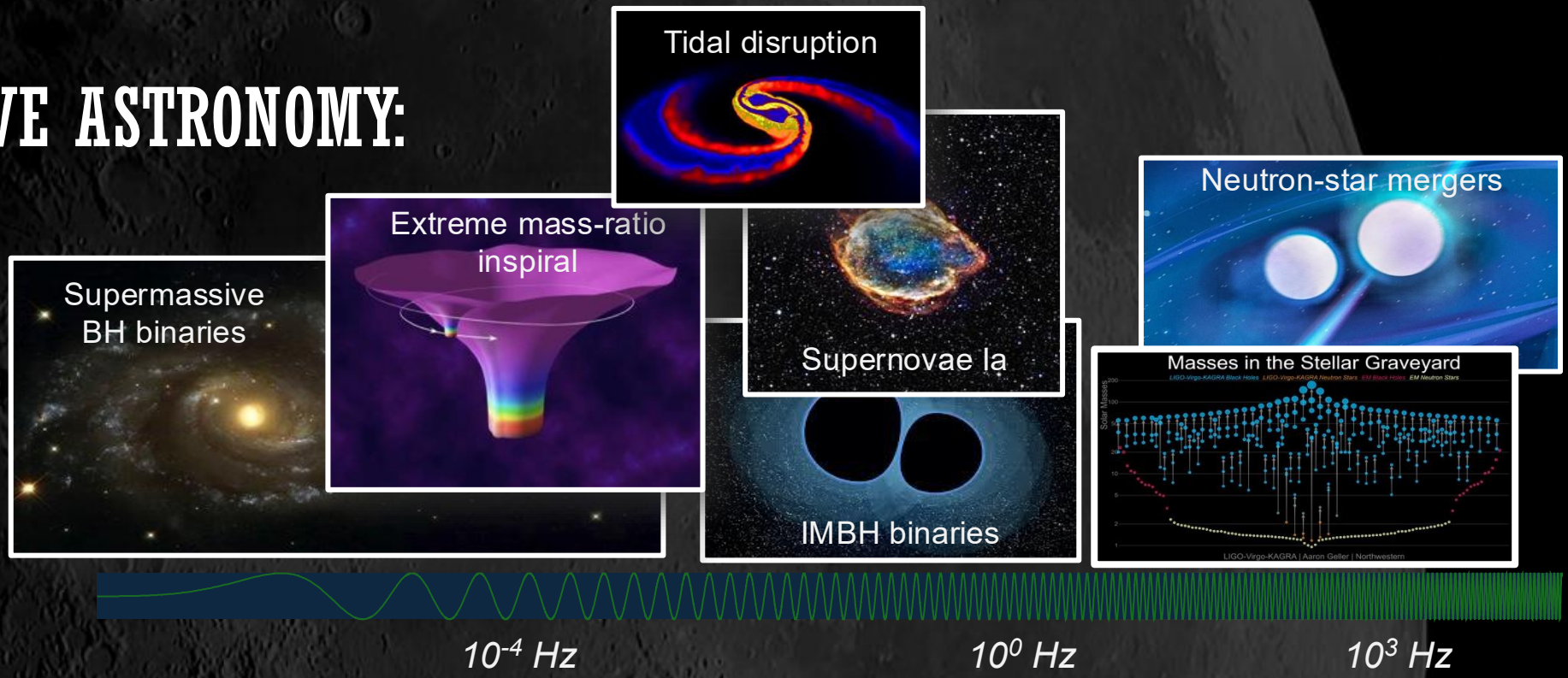
Carrying out measurements of seismic surface displacement, magnetic fluctuations and temperature

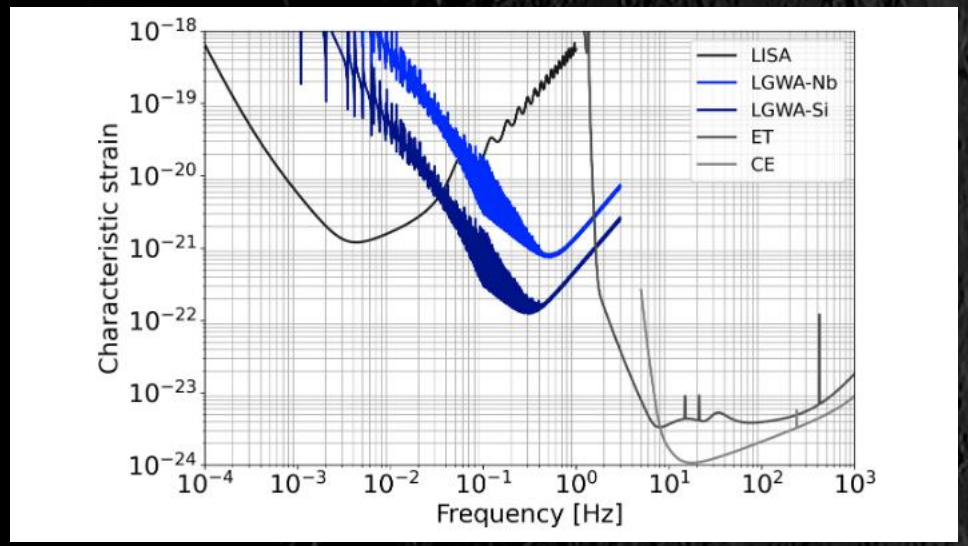
Soundcheck mission will be the first technology demonstration

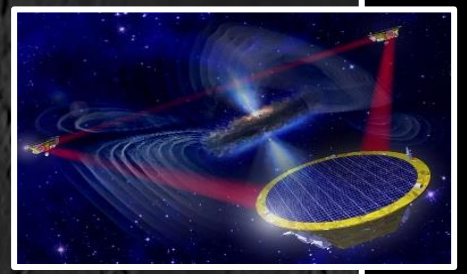
Targeted mission lifetime: 2 months

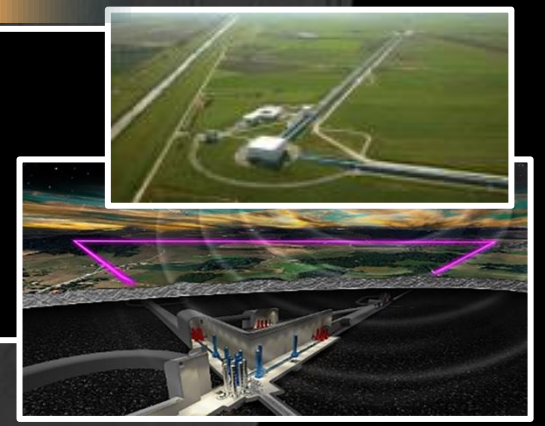
GRAVITATIONAL WAVE ASTRONOMY:

The LGWA will fill the gap between the sensitivity range of the LISA detector and ground-based detectors









LGWA Science White Paper

LGWA ASTROPHYSICAL SOURCES

- Close White Dwarf binaries
- WD mergers
- BH/NS close binaries well before merger
- Tidal distruption event of WD-BH
- Intermediate mass black hole merger
- Extreme mass ratio inspiral
- Core collapse SN
- Relativistic jets
- …..

A full description of the science cases
LGWA Science White Paper

The Lunar Gravitational-wave Antenna: mission studies and science case 2025, JCAP, 01,108

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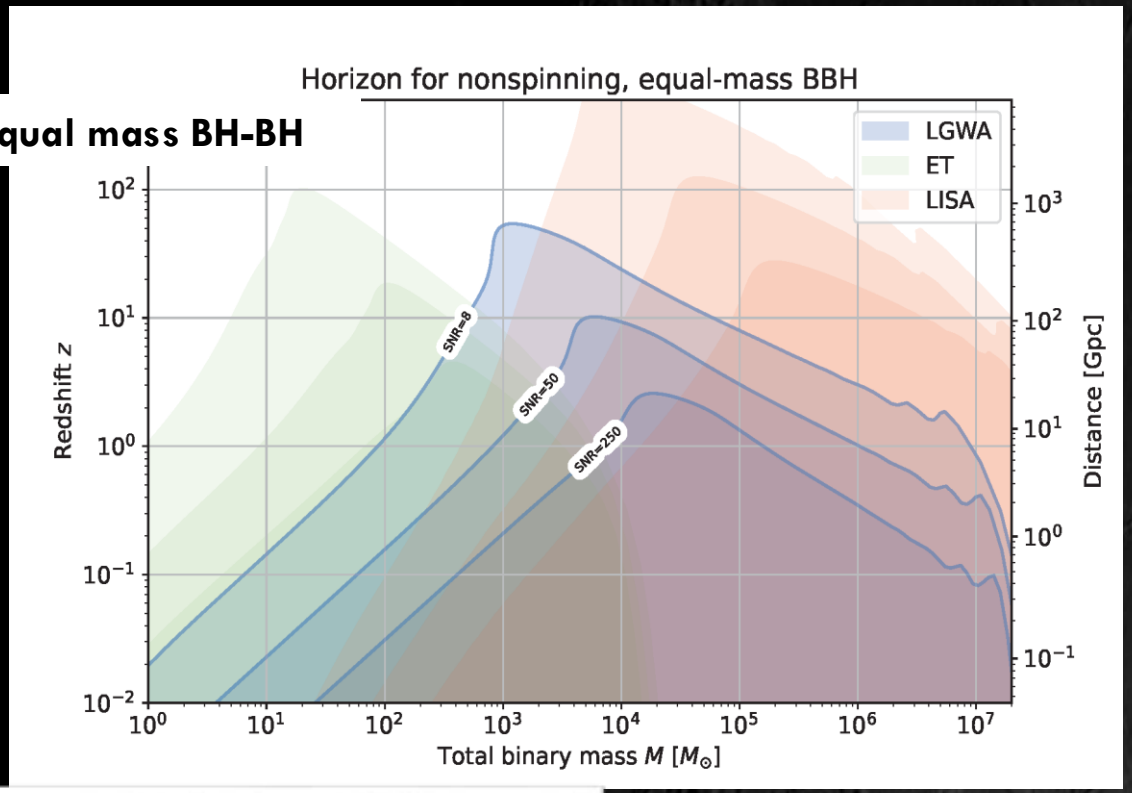
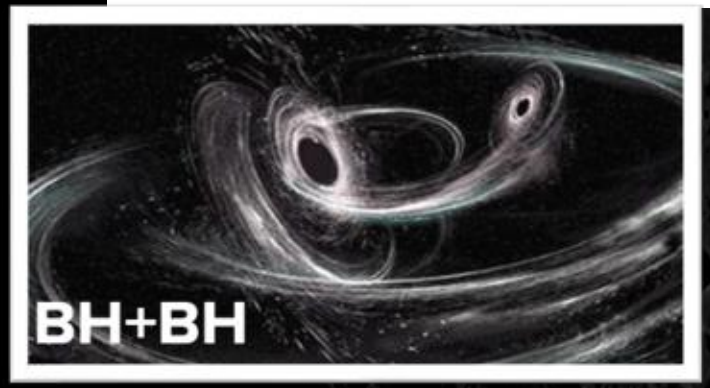
OBSERVATIONAL CAPABILITIES:

- **Equal mass BH-BH**



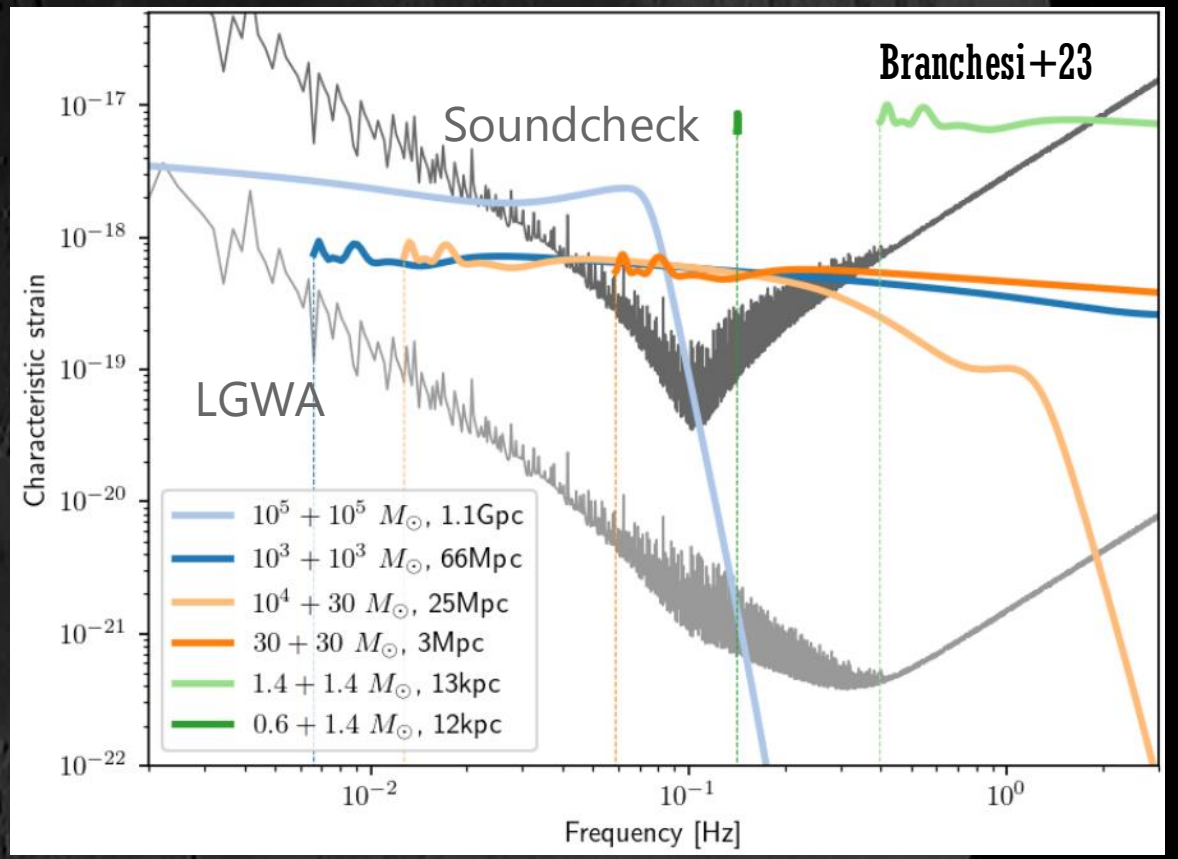


LGWA Science White Paper

See also Singh+25

Massive BH binary will be observed by LGWA for days/hours

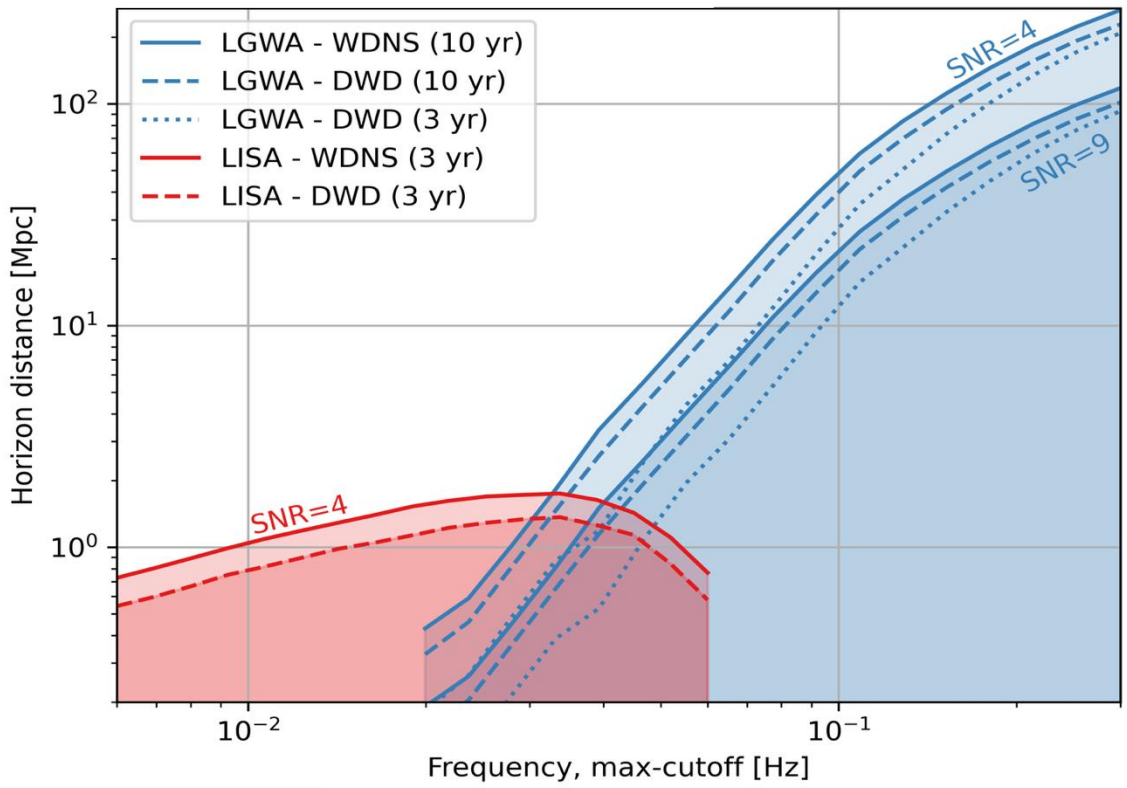
Multi-band LISA-LGWA observation will be crucial for the sky localization and EM observations



OBSERVATIONAL CAPABILITIES:

Solar-mass **compact binaries** will be observed by LGWA for several weeks to years.
sky localization < 1 deg^2

❖ **Compact binaries with WD**



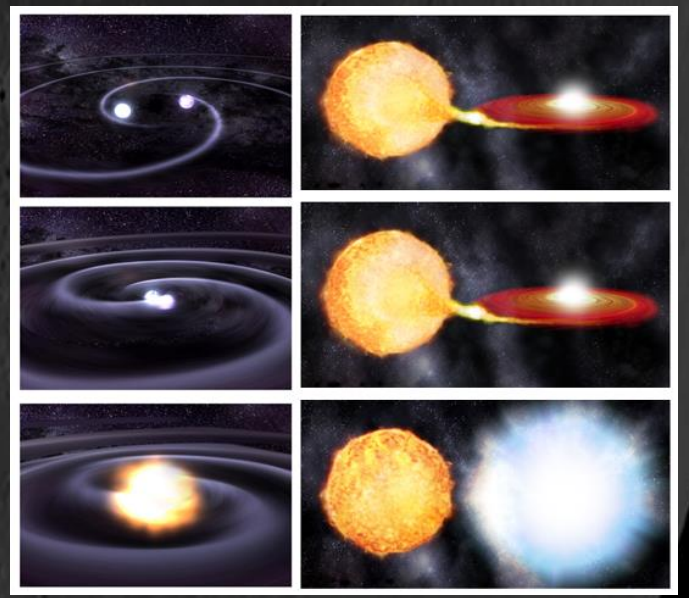
LGWA Science White Paper

SNR + sky localization

⬇

crucial for detecting the onset of the explosion and studying progenitors of SN 1a (see also Benetti+, 2025)

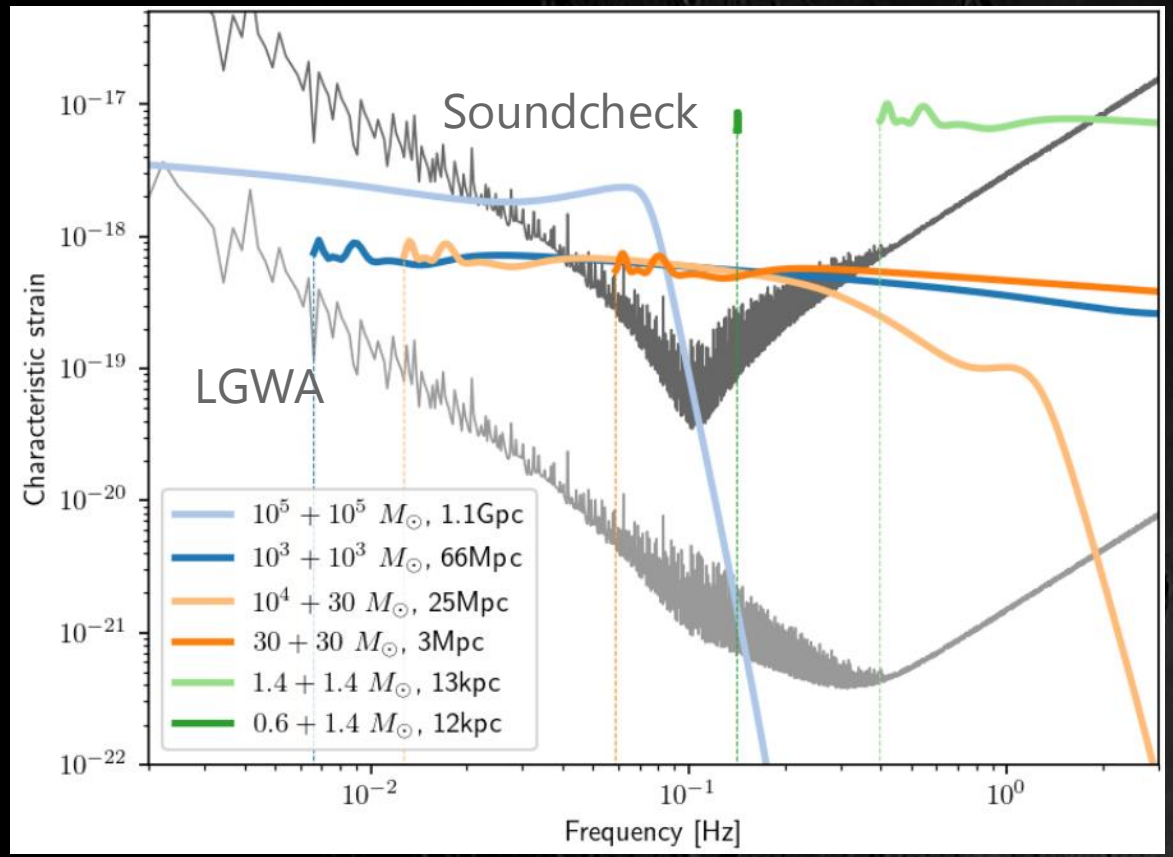
Double degenerate



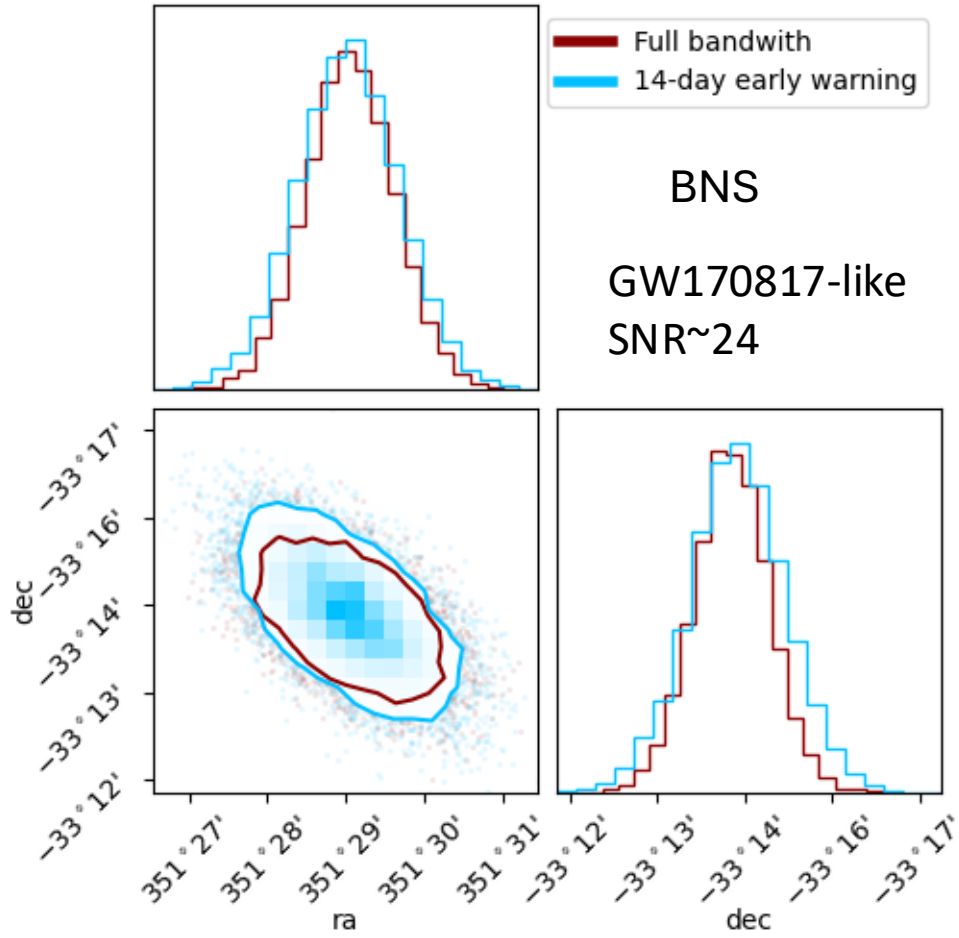
Single degenerate

EARLY WARNING + SKY LOCALIZATION
BNS

Branchesi+23



J. Tissino

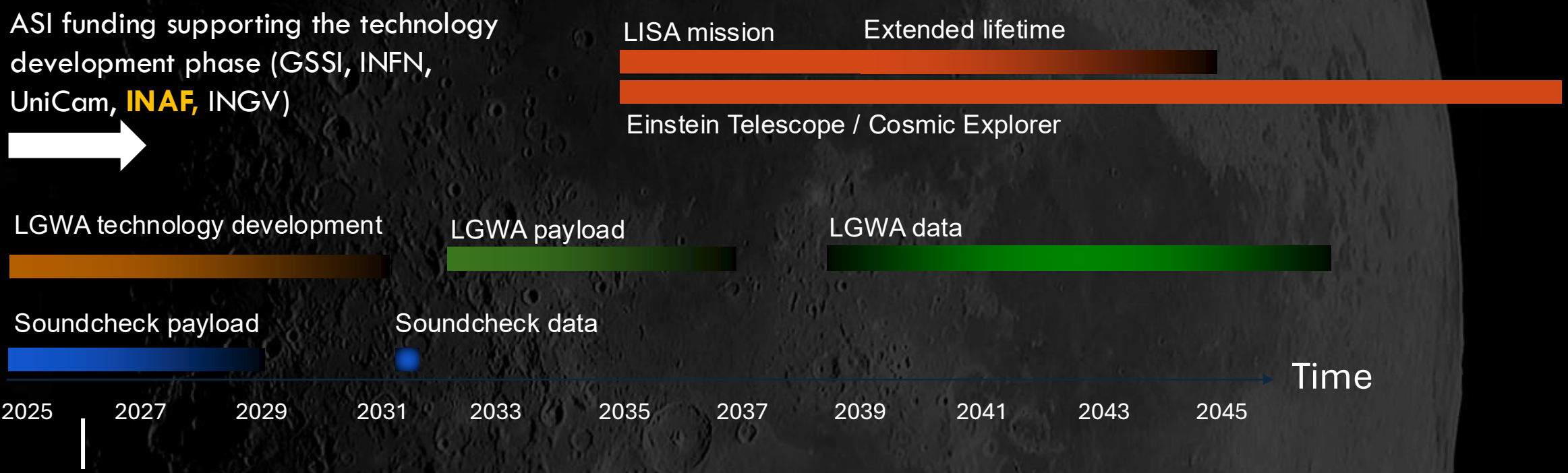


LGWA can provide early warnings weeks before the mergers of compact binaries formed by NSs together with excellent sky localization

PLAUSIBILE TIMELINE

Credits: J. Harms

ASI funding supporting the technology development phase (GSSI, INFN, UniCam, **INAF,** INGV)



2026 LGWA MEETING
Liège Belgium
Sep. 28 to Oct. 1

LGWA will be a part of a Global GW Roadmap
Fits naturally into the "second era of lunar exploration" that is already beginning.

LGWA ORGANIZATION

If you are interested in joining the LGWA collaboration, please contact any of the coordinators listed here

Steering Committee: **Coordination of collaboration activities**

Chair: J. Harms jan.harms@gssi.it

Working Groups:

- WG1: GW science and multi-messenger astronomy

Coordinators: P. Severgnini, A. Maselli, R. Serafinelli; 110 members

paola.severgnini@inaf.it, roberto.serafinelli@mail.udp.cl, andrea.maselli@gssi.it

- WG2: Lunar science and deployment site

Coordinators: A Stallone, A Friggeri; 51 members

angela.stallone@ingv.it, alessandro.frigeri@inaf.it

- WG3: Instrument Science

Coordinators: J. van Heijningen, M Zeoli; 35 members

j.v.van.heijningen@vu.nl, morgane.zeoli@uclouvain.be

Outreach Team: N. Patat; 13 members

fpatat@eso.org

PUBLICATIONS

THANK YOU!