GravNet Collaboration

A Global Network for the Search for High Frequency Gravitational Waves

INFN LNF Istituto Nazionale di Fisica Nucleare

IFAE Institute for High Energy Physics

ICREA

HIM Helmholtz-Institut Mainz

Johannes Gutenberg Universität Mainz

Universität Bonn

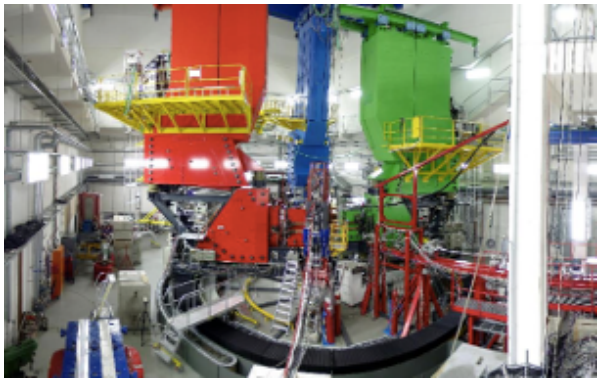
erc European Research Council

Established by the European Commission

Welcome to Mainz

- Mainz is small town, but capital of Rhineland-Palatinate
  - Next to the river Rhine (with some quite nice castles)
  - 20 Minutes from Frankfurt International Airport
  - Founded by romans 2K years ago
- The cathedral is only 1000 years old (and burnt down several times)
- Time-Magazine's man of the millennium:
  - Johannes Gutenberg, who invented the printing press in Mainz

The University of Mainz



- Founded in 1477 and reopened by the French occupation forces in 1946
  - 37.000 students for all subjects (bachelor, master, PhD)
- German cluster of excellence PRISMA for fundamental physics
  - Since September 2018: PRISMA+
  - From 2026 onwards: PRISMA++
- Own electron accelerator MAMI and research reactor
- 60 physics professors and research groups: LHC, IceCube, Xenon, SOX, NA62, JUNO, ALPS,…

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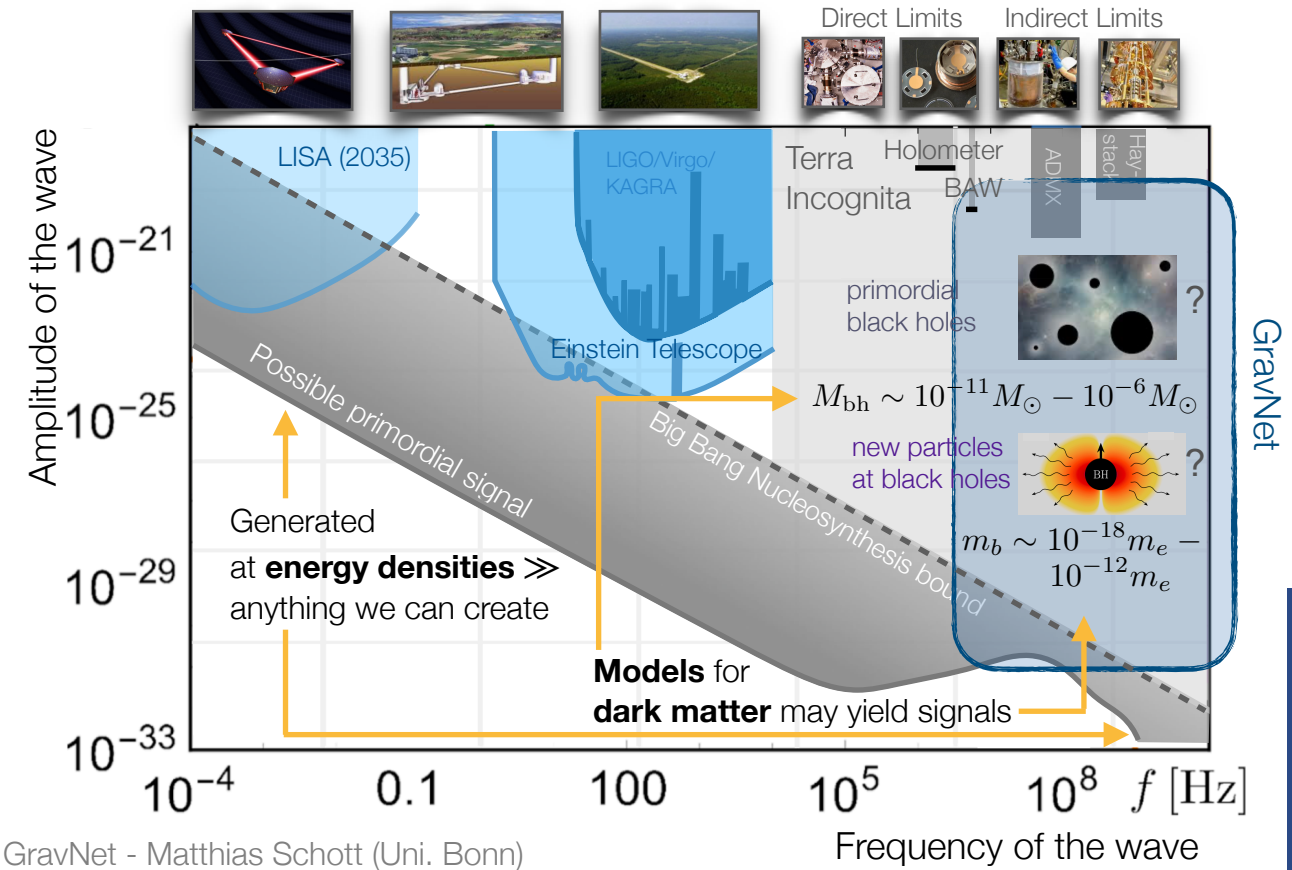
High Frequency Gravitational Waves

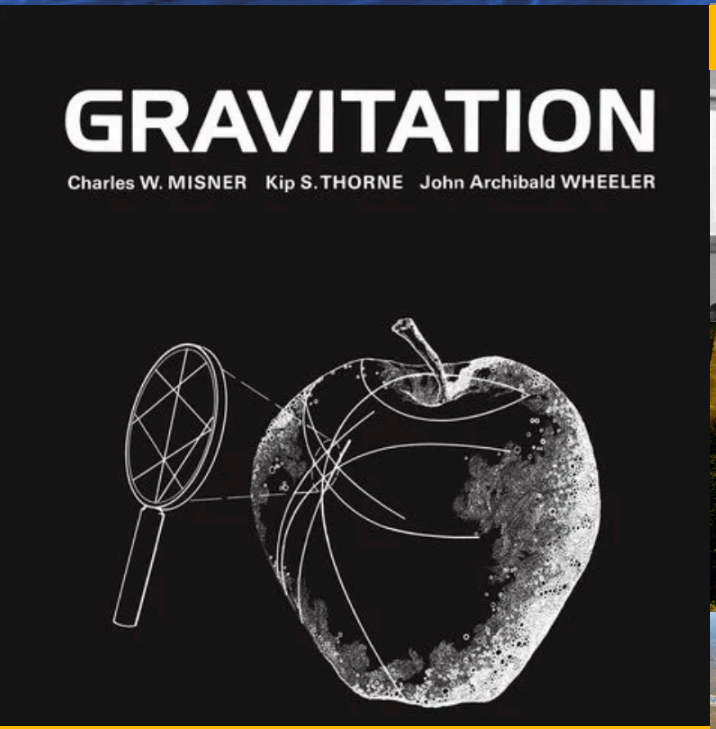
Gravitational Wave Soundscape



- High frequency gravitational wave (HFGW) **sources**
  - could explain dark matter
  - no astrophysical/confusion backgrounds
- Very mild limits for
  - f =1 MHz - 10 GHz

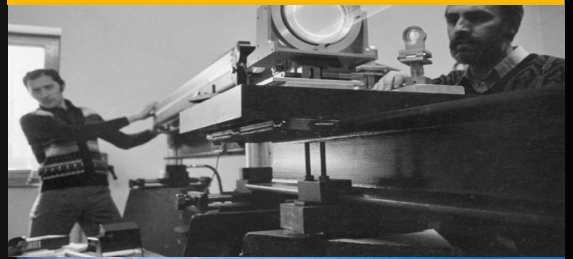
GravNet:
dedicated effort probing high-frequency gravitational waves with cavities

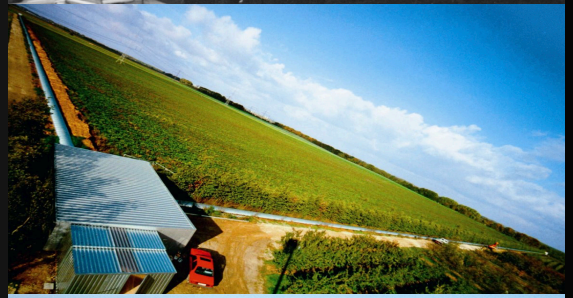
It is a long way ahead…



"[interferometers] have so low sensitivity that they are of little experimental interest"

50 years of work





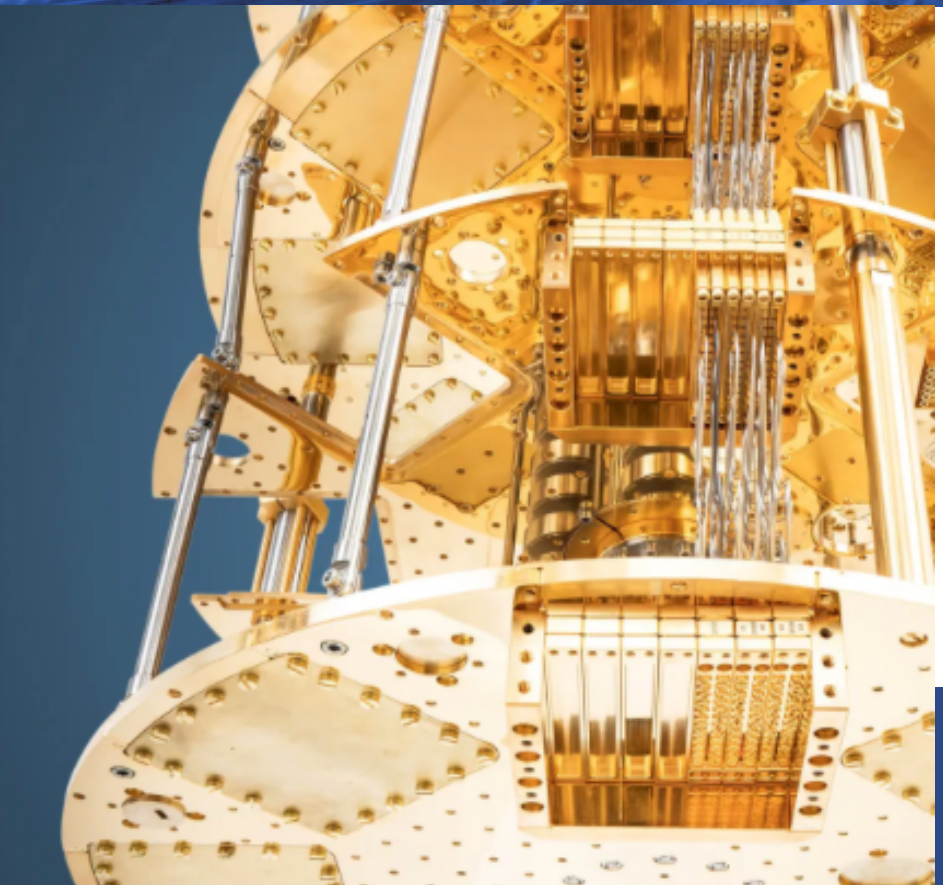
Rainer Weiss
Massachussets Institute of Tech

Barry C. Barish
California Institute of Technology

Kip S. Thorne
California Institute of Technology

Nobel Prize 2017

Which Technologies to Choose?



- GravNet will start with cavities since their technology is mature
- Most interesting HFGW sources are transient
  - Any HFGW search will profit from combining signals
  - Most developments (Quantum sensing, Superconducting cavities, analysis) is from generic use
  - Magnetic fields and ultra cold volumes are used in most approaches

We will switch to the most promising experimental approach in the next years

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Goal of the Workshop

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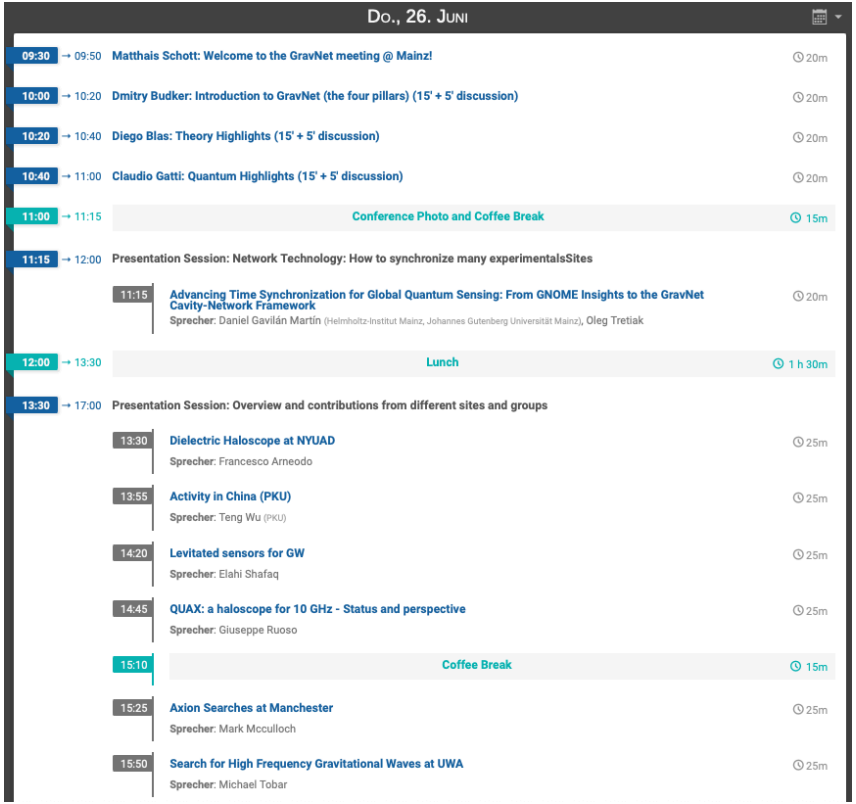
- 1st Goal: Discussion of new ideas and detector concepts on the market
- 2nd Goal: Getting to know each other
- The teams at Mainz, Bonn, Barcelona and Frascati INFN are currently funded by the ERC to search as a network for high frequency gravitational waves
- Our sensitivity on HFGW will scale more or less linearly when including also other sites

- We would be honoured if new teams join
  - Keeping the entry barriers and administration as little as possible
  - Allowing everybody to be still independent, but jet join forces for common data-taking periods

Agenda

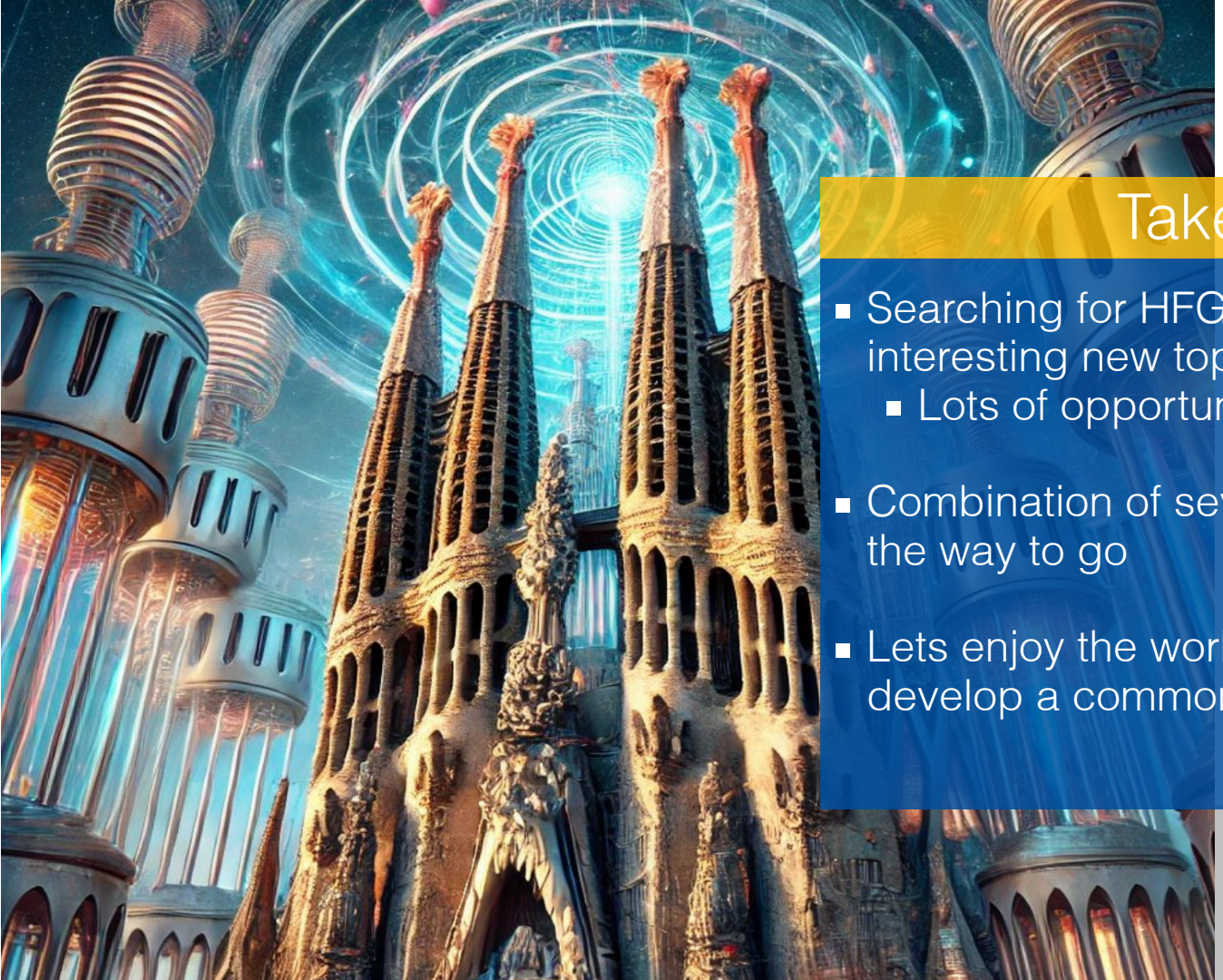


Do., 26. Juni

09:30 → 09:50	Matthais Schott: Welcome to the GravNet meeting @ Mainz!	20m
10:00 → 10:20	Dmitry Budker: Introduction to GravNet (the four pillars) (15' + 5' discussion)	20m
10:20 → 10:40	Diego Blas: Theory Highlights (15' + 5' discussion)	20m
10:40 → 11:00	Claudio Gatti: Quantum Highlights (15' + 5' discussion)	20m
11:00 → 11:15	Conference Photo and Coffee Break	15m
11:15 → 12:00	Presentation Session: Network Technology: How to synchronize many experimentalsSites	
11:15	Advancing Time Synchronization for Global Quantum Sensing: From GNOME Insights to the GravNet Cavity-Network Framework Sprecher: Daniel Gavilán Martín (Helmholtz-Institut Mainz, Johannes Gutenberg Universität Mainz), Oleg Tretiak	20m
12:00 → 13:30	Lunch	1 h 30m
13:30 → 17:00	Presentation Session: Overview and contributions from different sites and groups	
13:30	Dielectric Haloscope at NYUAD Sprecher: Francesco Arneodo	25m
13:55	Activity in China (PKU) Sprecher: Teng Wu (PKU)	25m
14:20	Levitated sensors for GW Sprecher: Elahi Shafaq	25m
14:45	QUAX: a haloscope for 10 GHz - Status and perspective Sprecher: Giuseppe Ruoso	25m
15:10	Coffee Break	15m
15:25	Axion Searches at Manchester Sprecher: Mark Mcculloch	25m
15:50	Search for High Frequency Gravitational Waves at UWA Sprecher: Michael Tobar	25m
16:15	BAUSCIA Project with BAWs Sprecher: Tommaso Tabarelli	20m
16:35	DALI Sprecher: Javier De Miguel	25m
17:00 → 17:40	Lab Tours in Mainz	40m
17:40 → 19:00	Mainz City Tour	1 h 20m
19:00 → 21:00	Conference Dinner	2h

Fr., 27. Juni

09:00 → 11:00	Presentation Session: New Ideas for High Frequency Gravitational Wave Detections	
09:00	Quantum sensing and metrology I review the field of quantum metrology, showing how quantum effects such as squeezing and entanglement can be used to increase the precision of measurements using the same amount of resources. I also discuss how quantum teleportation and similar quantum protocols may be used in very large baseline interferometry (VLBI) to increase the effective dimension of interferometers. Sprecher: Lorenzo Maccone	40m
09:40	New Ideas for HFGW detection ¶	40m
10:20	Astrophysical indication for Asteroid Mass Primordial Black Holes and New Search Strategies Sprecher: Juri Smirnov	20m
11:00 → 11:30	Coffee Break	30m
11:30 → 12:30	Towards a first GravNet Joint Data Taking	1 h
12:30 → 13:30	Lunch	1 h
13:30 → 14:15	Organisation of GravNet	45m
14:15 → 14:30	Coffee Break	15m
14:30 → 14:50	Discussion on ByLaws and MoUs	20m
14:50 → 15:00	Close Out	10m



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Take Away Messages

- Searching for HFGW is one of the most interesting new topics in town
  - Lots of opportunities, lots of challenges
- Combination of several detector concepts is the way to go
- Lets enjoy the workshop and maybe develop a common vision