Le Centre de Physique Théorique est structuré en 8 équipes de recherche réparties en 3 groupes. Le groupe "**Interactions Fondamentales**" participe aux activités de l'**IPhU**.

Institut Physique de l'Univers
Aix*Marseille Université

Groupe « Interactions fondamentales »

Physique des particules

En lien avec les expériences de physique des particules et la recherche de matière sombre, nous testons les limites du Modèle standard et explorons des modèles de physique fondamentale nouvelle qui pourraient expliquer certaines de ses lacunes.

Géométrie, Physique et Symétries

Nos activités concernent la description mathématique des lois physiques, en particulier les interactions fondamentales. Elles font émerger de nouvelles structures mathématiques ou peuvent avoir des applications physiques immédiates.

Cosmologie

En étudiant la structure de l'espace-temps à l'échelle cosmique, nous cherchons à comprendre des phénomènes énigmatiques, comme l'accélération de l'expansion de l'univers (énergie sombre) ou les anomalies dans le mouvement et la distribution de matière dans l'univers (matière noire).

Gravité quantique

Notre équipe étudie les propriétés quantiques de la gravité, c'est à dire les aspects quantiques du temps et de l'espace. Elle est leader dans l'approche à boucles, appliquée à la cosmologie et aux trous noirs, pour chercher des confirmations expérimentales.

CPT
Centre de Physique Théorique

Aix*Marseille université

Cosmology Team

Physical foundations of the Standard Model of Cosmology

DARK ENERGY beyond standard gravity

DARK MATTER (perturbation theory, clustering)

Gravitational Wawes Cosmology

Members

Staff
J. Bel,
M. Mancarella
C. Marinoni,
F. Piazza,

7 PhD Students
6 Postdocs

LAM
LABORATOIRE D'ASTROPHYSIQUE DE MARSEILLE

Laboratoire d’Astrophysique de Marseille (LAM)

https://www.lam.fr/en/

~ 200 researchers and engineers

cnrs

cnes

Aix*Marseille université
Socialement engagée

- Scientific topics of the GECO team (stars, galaxies et cosmology) :

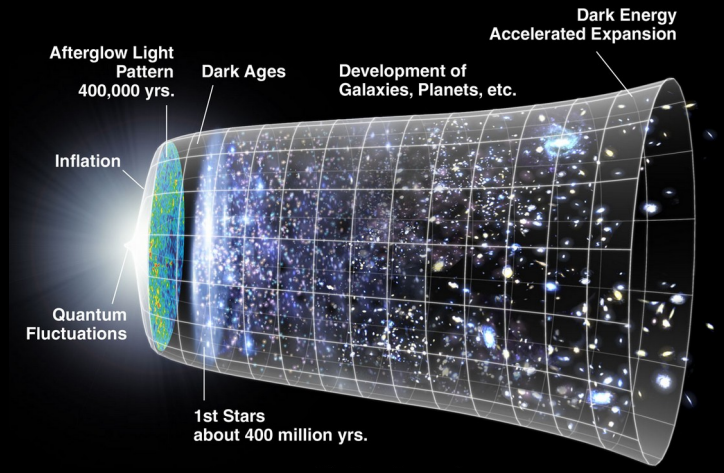
  - Star formation regions, massive stars and transients,

  - Formation, dynamics and evolution of galaxies and their environment, including interstellar and intergalactic media

  - Active galactic nuclei (accretion/ejection; feedback with their host galaxies),

  isolated and binary supermassive black holes, tidal disruption events, gamma-ray bursts.

  - Galaxy clusters, dark matter, dark energy and cosmology



- Strong implications in :

  - Cosmological surveys (galaxies and dark matter) : Euclid, LSST, WEAVE, DESI, …

  - Multi-wavelength observational facilities : E-ELT, JWST, WFIRST, LUVOIR, …

  including the hot and/or energetic Universe : SVOM (China/France, X-rays),

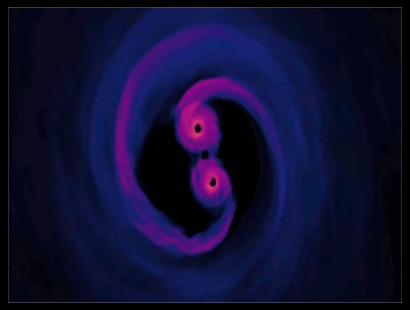
  THESEUS (ESA/M7, X-rays), NewAthena (ESA/L, X-rays), COLIBRI (optical/IR), …

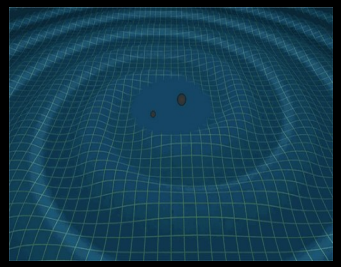
  - Multi-messenger astrophysics and cosmology :

  Gravitational waves : LISA mission (ESA, L), neutrinos : KM3NeT

Science topics related to LISA and PTA observations

- Study of electro-magnetic signatures of massive black hole binaries :





→ Understand the (co-)evolution of galaxies and supermassive black holes

→ Probe the behavior of matter during an extreme change of spacetime

But so far only candidates at milli-parsec separation (cannot yet be spatially resolved)

→ Crucial to determine spectral and/or timing smoking-gun characteristics to differentiate between isolated AGNs and binary AGNs

- Measure of the Hubble constant:

Gravitational waves → luminosity distance
Electro-magnetic observations → redshift

⇒ distance-redshift relationship measured to high accuracy ⇒ H_0

- Build catalogs of galaxies from deep surveys:
→ Precise location on the sky of the gravitational wave events
→ Redshift (Ho measurements), ...

CENTRE DE PHYSIQUE DES PARTICULES DE MARSEILLE

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NUCLÉAIRE
& PARTICULES

Aix Marseille Université

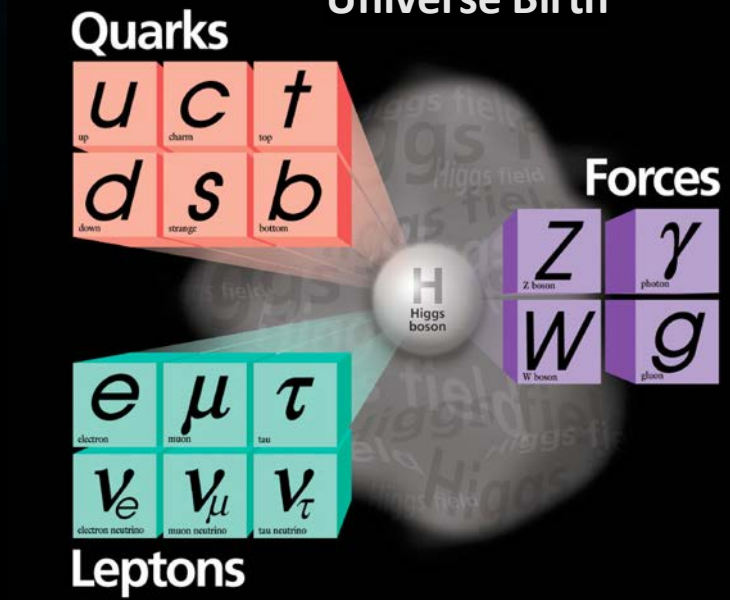
Les deux infinis/ The two infinites

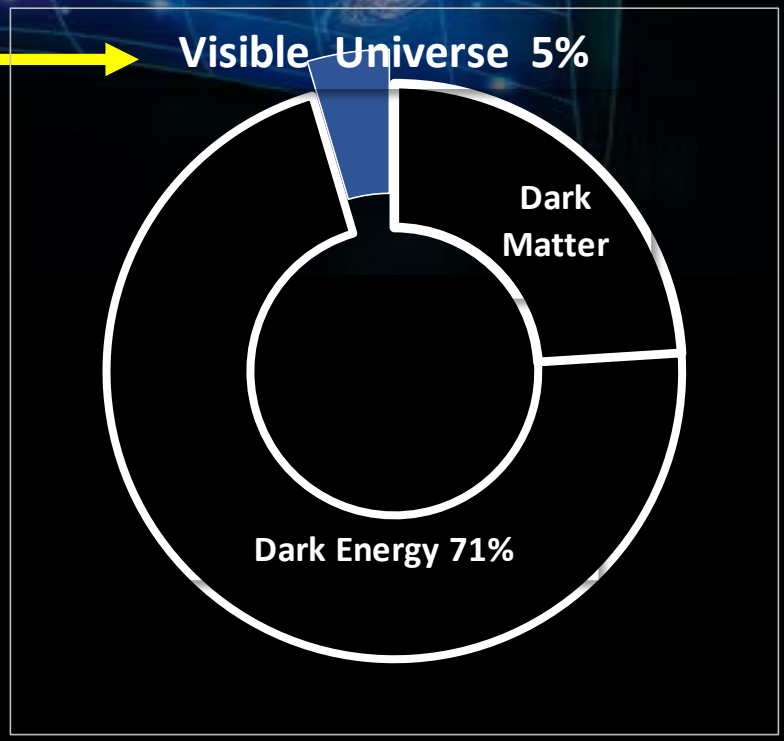
Infinitely small/
Infinimment petit

Infinitely large/
Infinimment grand

13.7 Byears

Universe Birth





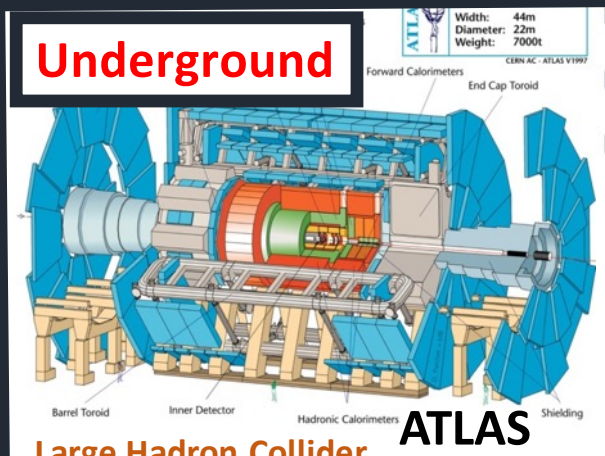
CPPM Mission

- **Explore the intimate structure and physics of matter and the Universe**

- **International flagship programmes**
- **Technological strength for fundamental research**
- **Interdisciplinarity and valorisation**
- **Education and scientific culture**

- **Rich of about 200 people :**
  45 Physicists 30 PhD Students 15 postdocs 80 Engineers/Tech.
  30 interns/yr

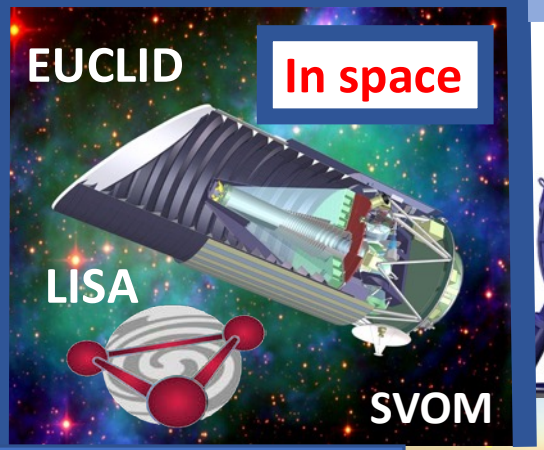
Underground

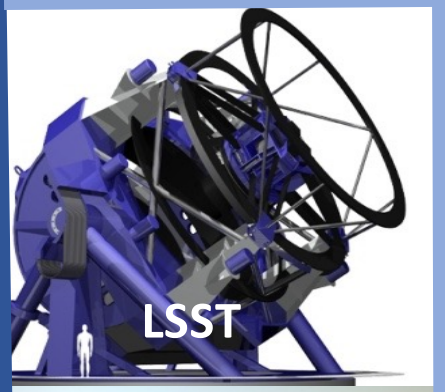


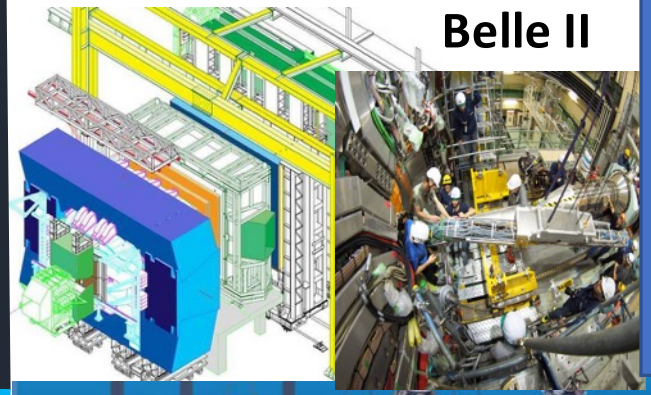
ATLAS

Large Hadron Collider

LHCb







Belle II

CPPM

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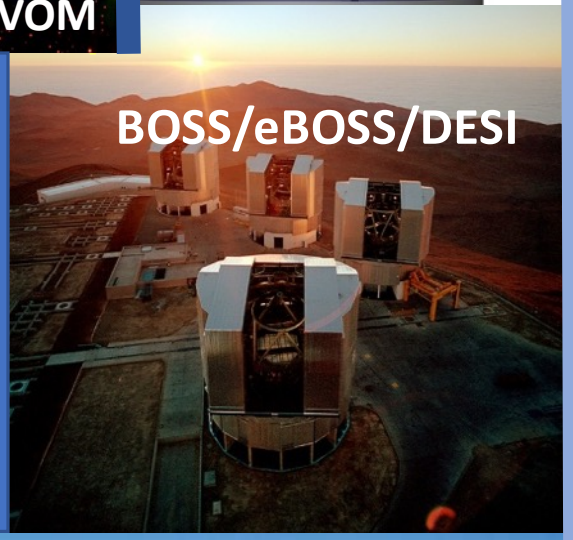
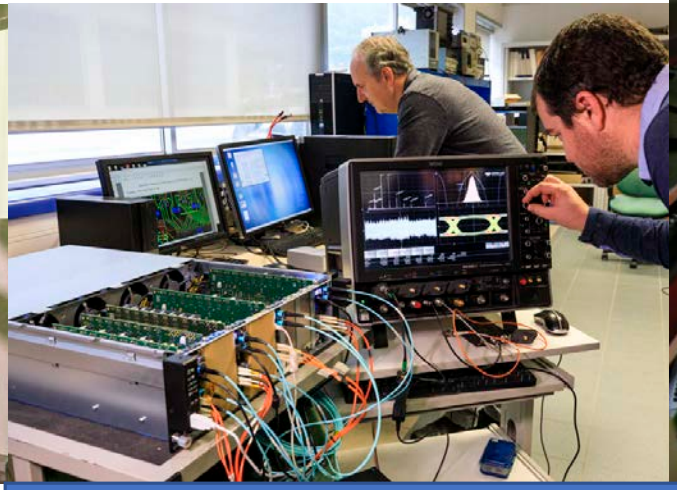
CPPM International Collaborations

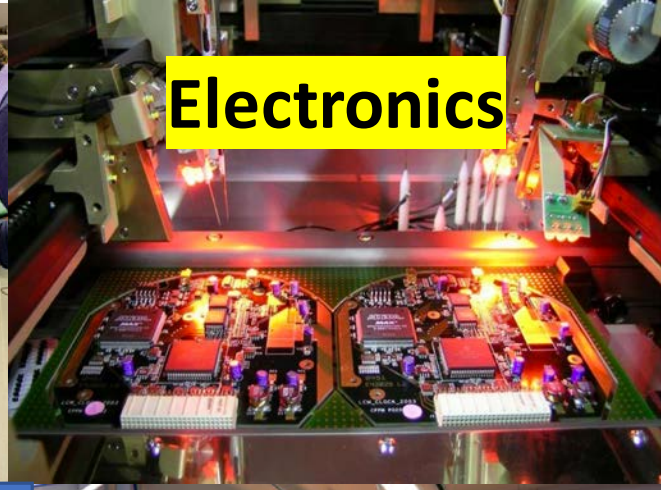
Matter and Universe



Under the sea

On top of mountains





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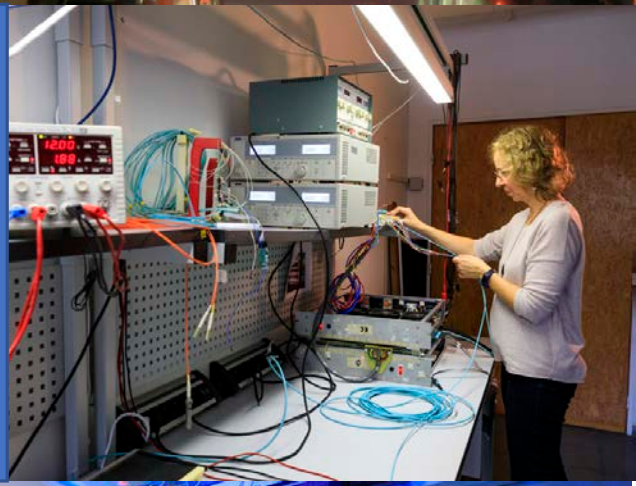
Cutting edge Technology

Matter and Universe



Detectors and Data


Laboratoire Sous-marin
Provence Méditerranée
High-Performance
Computing platform
CENTRE DE PHYSIQUE DES PARTICULES DE MARSEILLE
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High-Tech
Plateforms
Matter and Universe
Crédits photos : Collaboration KM3NeT, CPPM ; Camille Moirenc
Création graphique : OuvreBoîte
Radon Plateau
Infrared Plateau

team **GW/LISA@**

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LISA CONSORTIUM

GW/LISA @ CPPM

Technical Activities
A. Secroun

AIVT LISA IDS/BSIM.CCU

E. Kajfasz (Resp. Sci.)
M. Dupont (Resp. Tech.))

C. A. Ranely (CDD IR) – funded by CNES

IR Photodiode Characterization
E. Kajfasz
J. Royon et atelier mécanique (support)

Scientific Activities
E. Kajfasz

Gravitational Waves (GW) (Cosmo)

E. Kajfasz (Resp. Sci.)

J. Bautista (suivi – cosmo)
Y. Boursier (suivi - waveforms)
D. Dornic (suivi - multimessengers)
S. Escoffier (cosmo & physics)
W. Gillard (suivi – cosmo & physics)
S. Ferraiulo (2nd-yr PhD student - cosmo)
P. Vielzeuf (suivi cosmo)
J. Zoubian (data science & AI)

Nicolas Hatchodourian (Master Intern)

If you want to know more about CPPM
Please contact Eric Kajfasz
kajfasz@cppm.in2p3.fr

amU Aix Marseille Université

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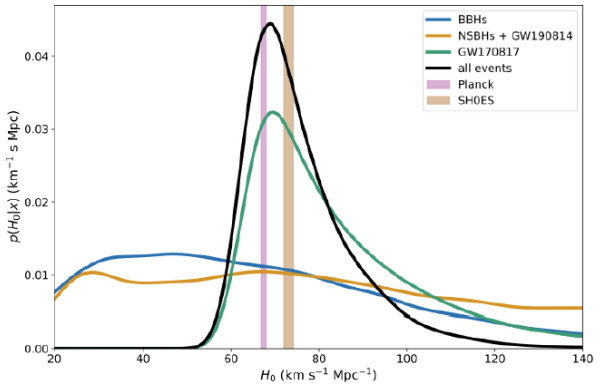
Current involvements:
Cosmology with GW dark sirens

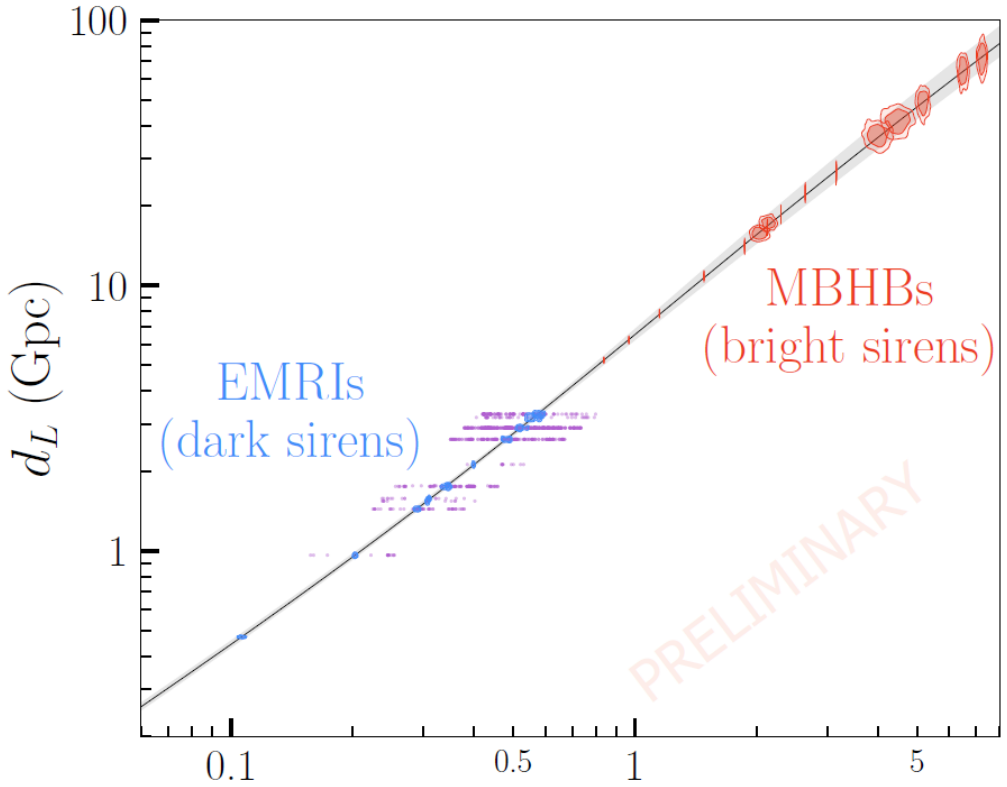
Current dark and spectral standard siren

A joint analysis combining all dark sirens methods (statistical+spectral) + GW170817 provides the best constraint so far (including marginalisation over population parameters)

$$H_0 = 69^{+12}_{-7}\,\mathrm{km\,s^{-1}\,Mpc^{-1}}$$

This represents a ~20% improvement over GW170817 only results





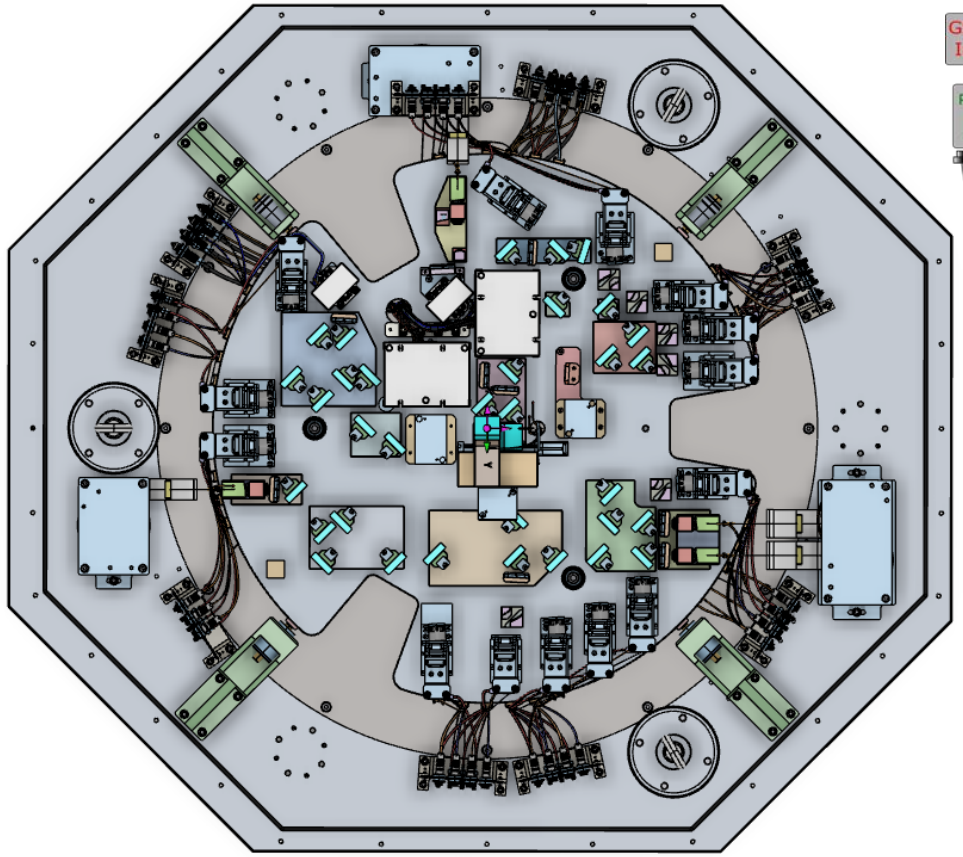
LVK+Euclid (Roma La Sapienza/INFN): **Sarah Ferraiuolo** (PhD student[*]), Simone Mastrogiovanni
Euclid+Lisa (CPPM group): Stephanie Escoffier, William Gillard, Eric Kajfasz, Julien Zoubian

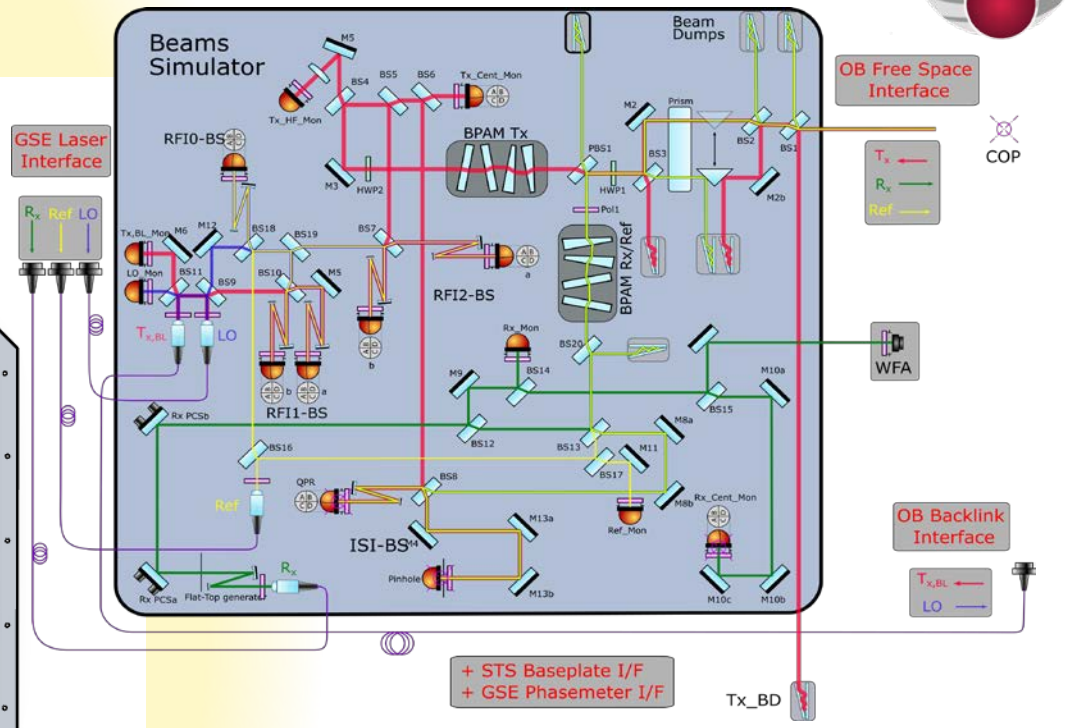
Project: Using LVK GW dark sirens and Euclid galaxy catalogs to constrain H0 and possibly other cosmological parameters.

The combination of different standard sirens will allow LISA to measure the expansion of the universe from $z \sim 0.01$ to $z \sim 10$

Also interested in using EMRIs to test GR and FP
And AI aspects of data acquisition and processing

BSIM Control-Command Software





The BSIM.CCU interfaces with the following BSIM.OB subsystems:

- BPAM (x2) : Beam Pointing and Alignment Mechanism RX / TX
- Datalogger : BSIM Thermal Acquisition System
- SAS : Switchable Attentuation System
- WFA : WaveFront Analyser
- RIN : Relative Intensity Noise
- CoP Calibrator
- Tx Generator