SIMULATION OF BINARY BLACK HOLE MERGERS WITH THE SPECTRAL EINSTEIN CODE

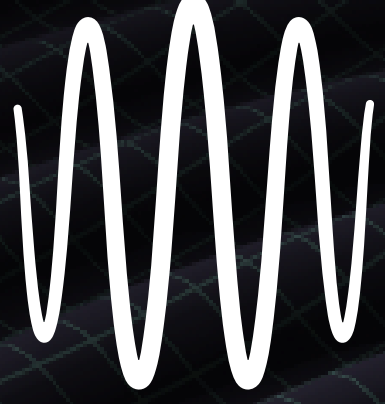
PICASSO

Led by

A. RAMOS

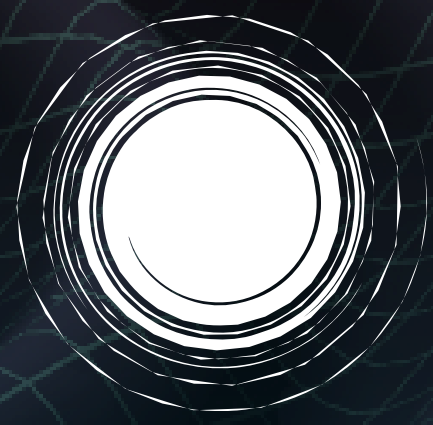
Universitat de les Illes Balears (IAC3)

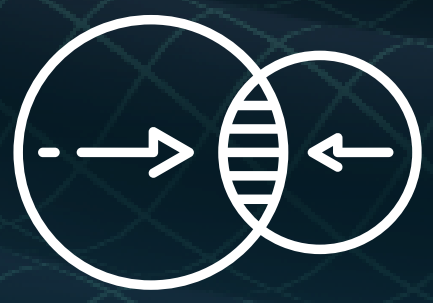
1 WHY ARE GRAVITATIONAL WAVES INTERESTING?



Gravitational Waves (GWs) are **ripples on space-time** that move at the speed of light and interact with matter very weakly

They allow to study **extreme events where light is limited**: neutron stars and black hole mergers and even the first moments of the Universe



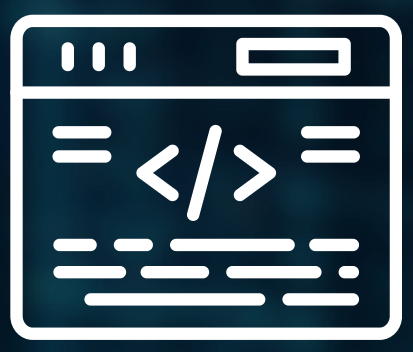


Since the first GW detection in 2015, LIGO, Virgo and KAGRA detectors have observed hundreds of binaries, **mostly black goles and few neutrons stars**

THE ROLE OF HPC RESOURCES 2

Studying these signals accurately require solving Einstein's field equations, very complex equations that **need powerful numerical methods**

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$



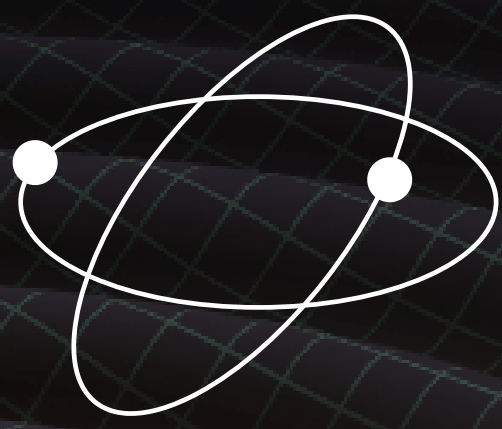
Spectral Einstein Code (SpEC) is **one of the most accurate and efficient codes** able to simulate binary black holes mergers

This project aimed to **deploy and benchmark SpEC in RES facilities** to assess their suitability to simulate this source of GW

RED ESPAÑOLA DE SUPERCOMPUTACIÓN

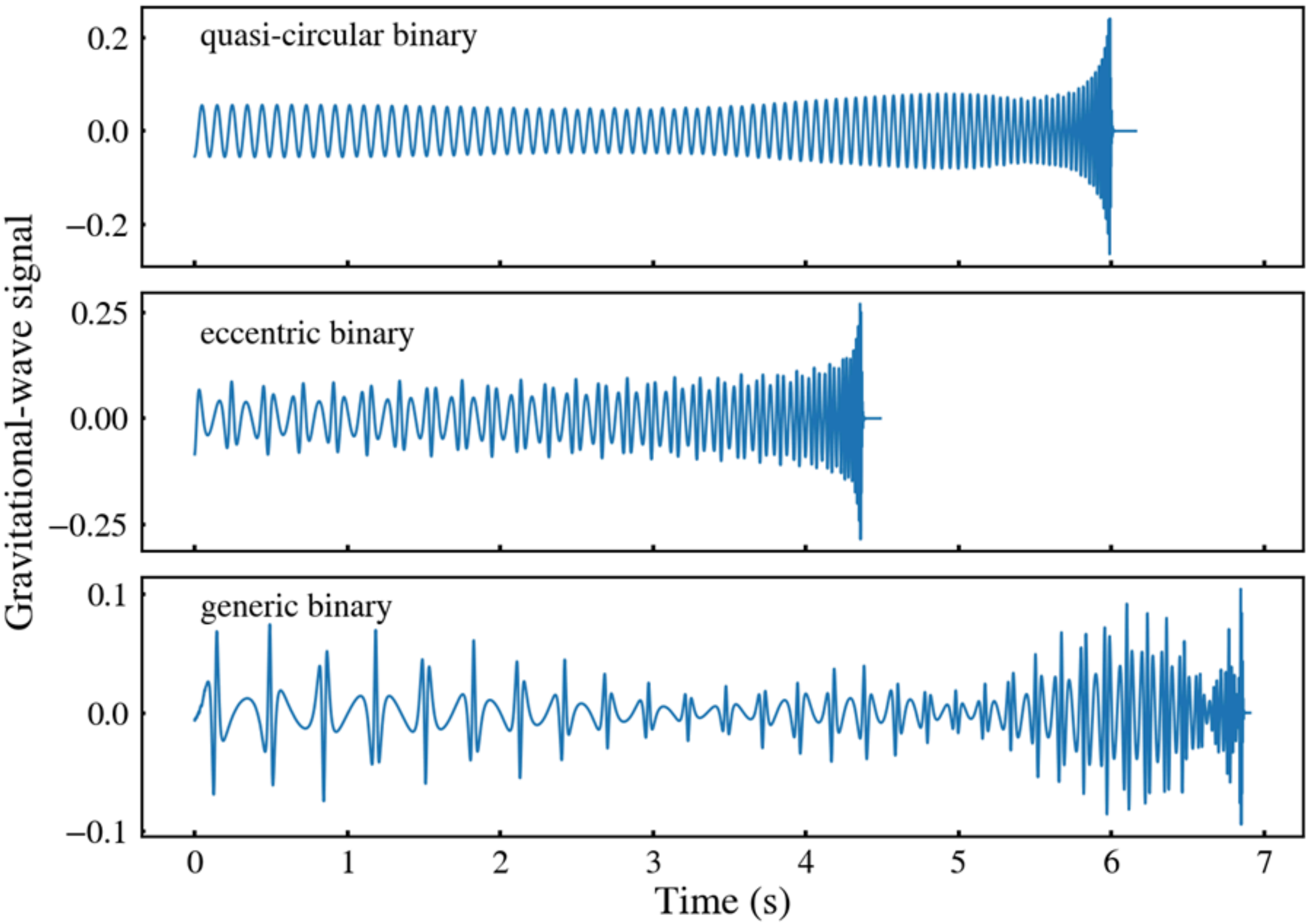
3 USING RES TO UNDERSTAND GRAVITATIONAL WAVES

They simulated **generic orbital configurations** of binary black holes with high accuracy



These simulations are critical to **develop and calibrate new models** to understand the physics behind real GW signals

The project shows that **RES can host this kind of sophisticated codes**, and establishes a strong foundation for **large-scale projects** aimed to advance GW astronomy



Examples of GW signals from binary black hole systems. The bottom panel corresponds to the complicated signals from generic binary black holes targeted during this project.

ICTS
INFRAESTRUCTURAS CIENTÍFICAS
Y TÉCNICAS SINGULARES

EuroCC SPAIN RES

BSC
Barcelona Supercomputing Center
Centro Nacional de Supercomputación

UIB
Universitat de les Illes Balears