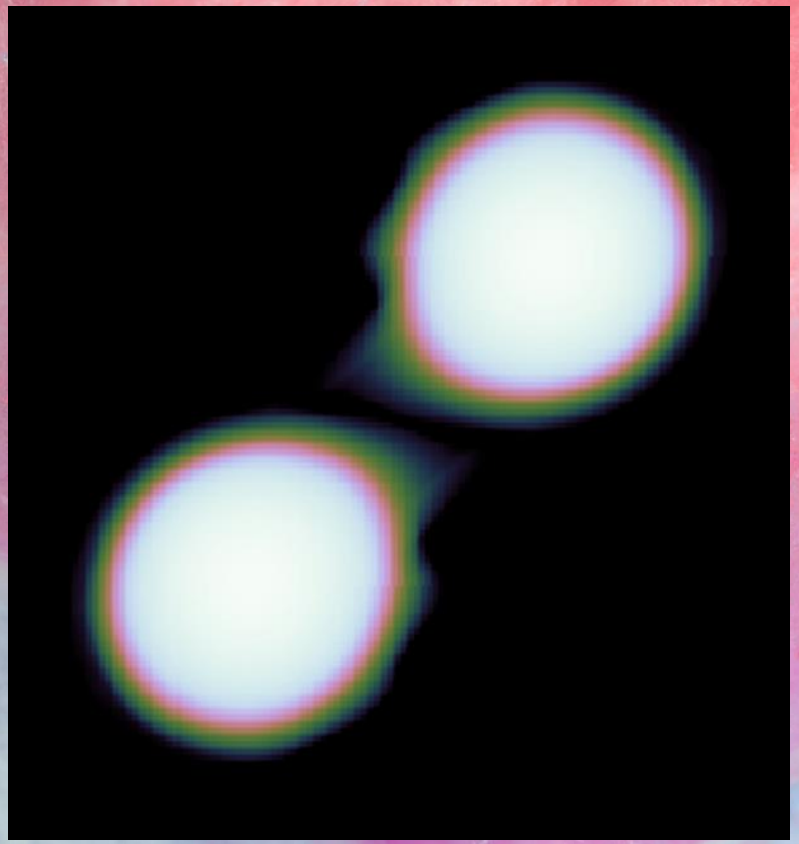
Spritz: Binary Neutron Star Merger Simulations with Microphysical Equation of State

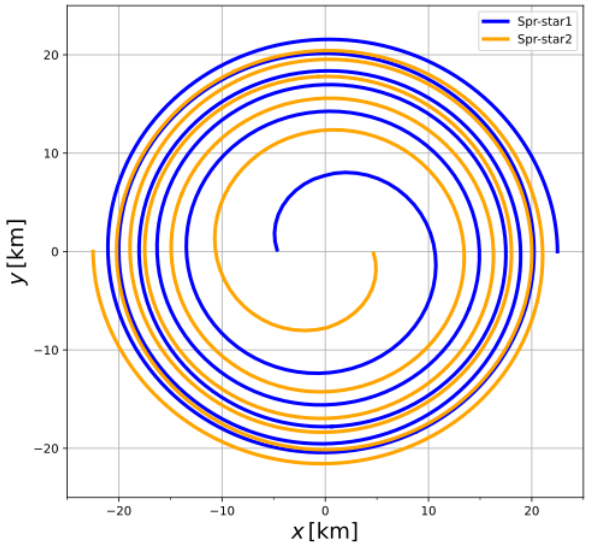


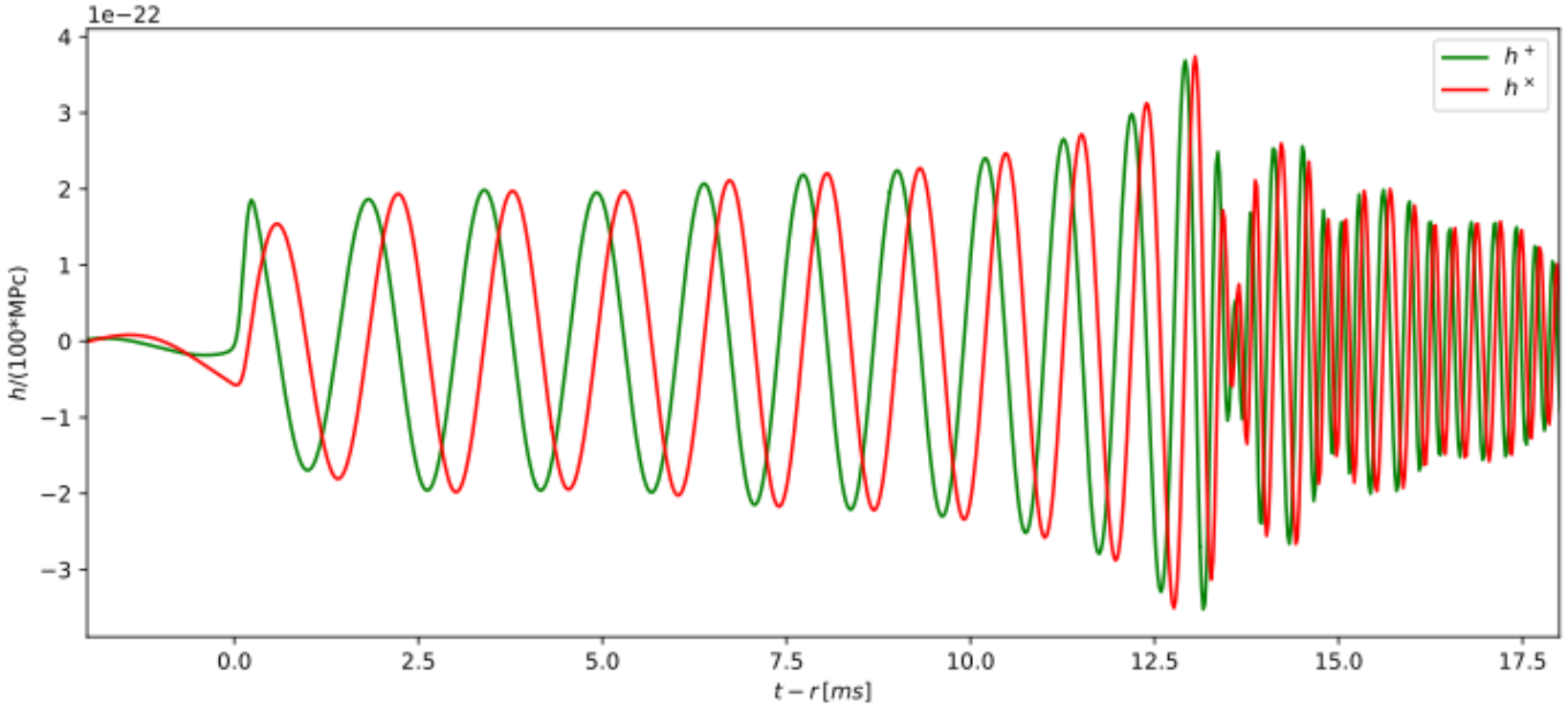
FATEMEH HOSSEIN-NOUR,
INFN AT MILANO-BICOCCA UNIVERSITY

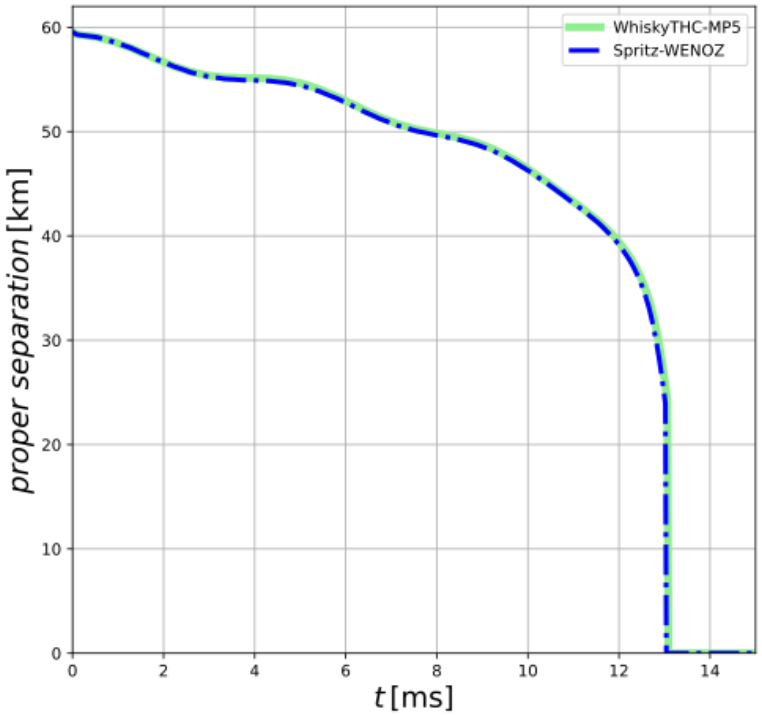
Spritz: Features

- Adopts high resolution shock capturing methods to solve GRMHD equations using **HLLE Riemann solver and 5th order reconstruction method**.
- Built on the **Einstein Toolkit** infrastructure
- Physics implemented: **Microphysics and magnetic field**
- Neutrino transport: **Leakage approximation**
- Magnetic field: vector potential evolution using **generalized Lorenz gauge**
- Publicly available on Zenodo: https://zenodo.org/record/4350072
- For implementation of numerical methods, check out papers:
  Cipolletta et al. 2020, CQG 37, 135010
  Cipolletta et al. 2021, CQG 38, 085021
  Kalinani et al. 2022, PRD 105, 103031
- Tabulated EOS and neutrino leakage successfully tested for single NS. Currently, the code is being tested for BNS merger.

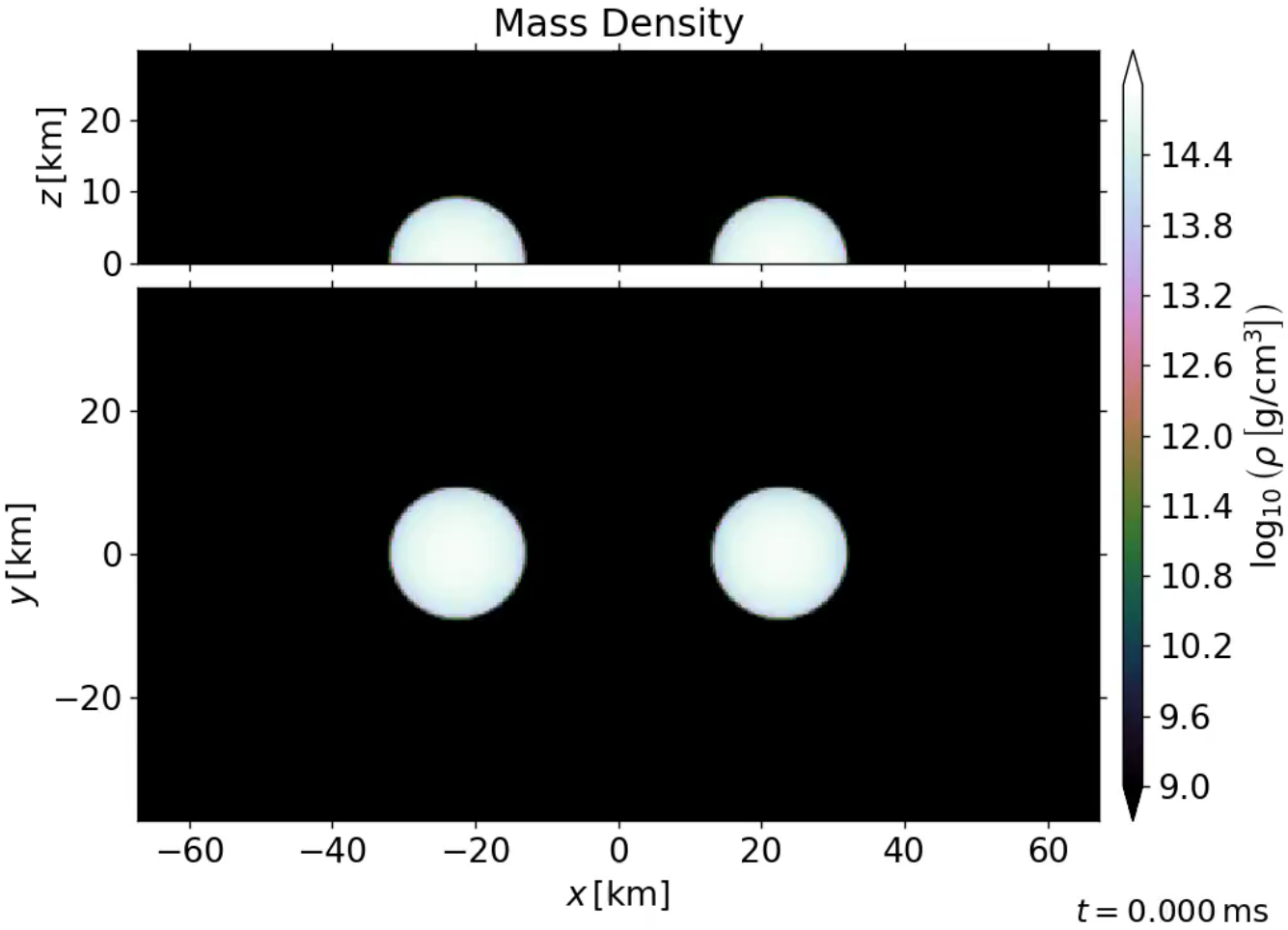
- Equal mass BNS: M_b= 1.63 $M_\odot$
- Initial coordinate separation between the centers: 45 km
- Bombaci-Logoteta EOS, Initial data: Slice constant temperature T=0.01 MeV
- Resolution for finest grid dx = 0.20 $M_\odot$
- Magnetized case: B_{max} at initial time = 3 x 10^{16} G
- Orbital evolution is compared with WhiskyTHC code

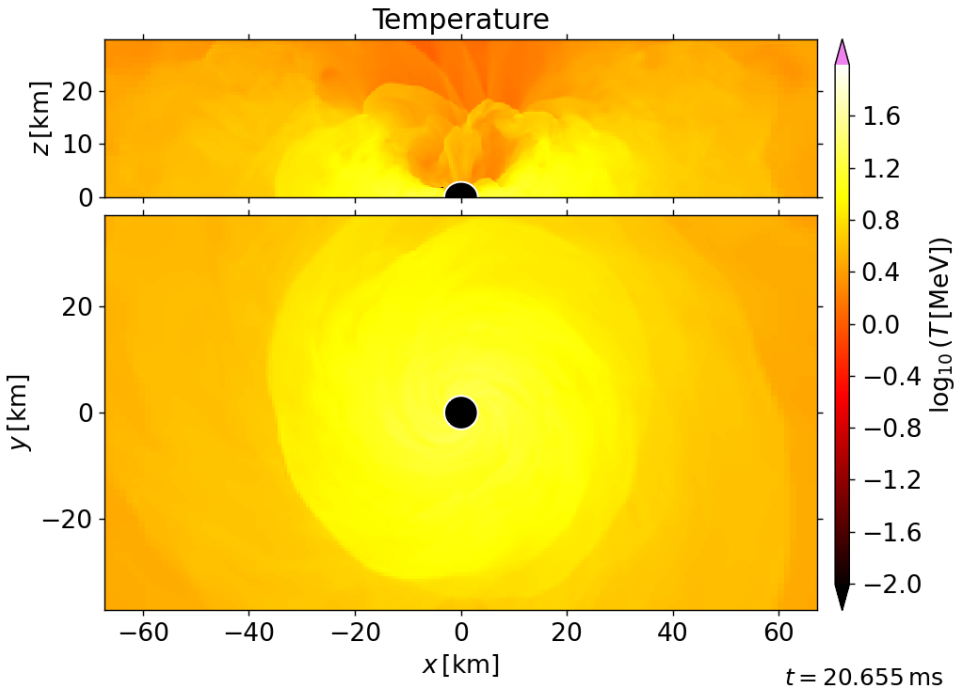


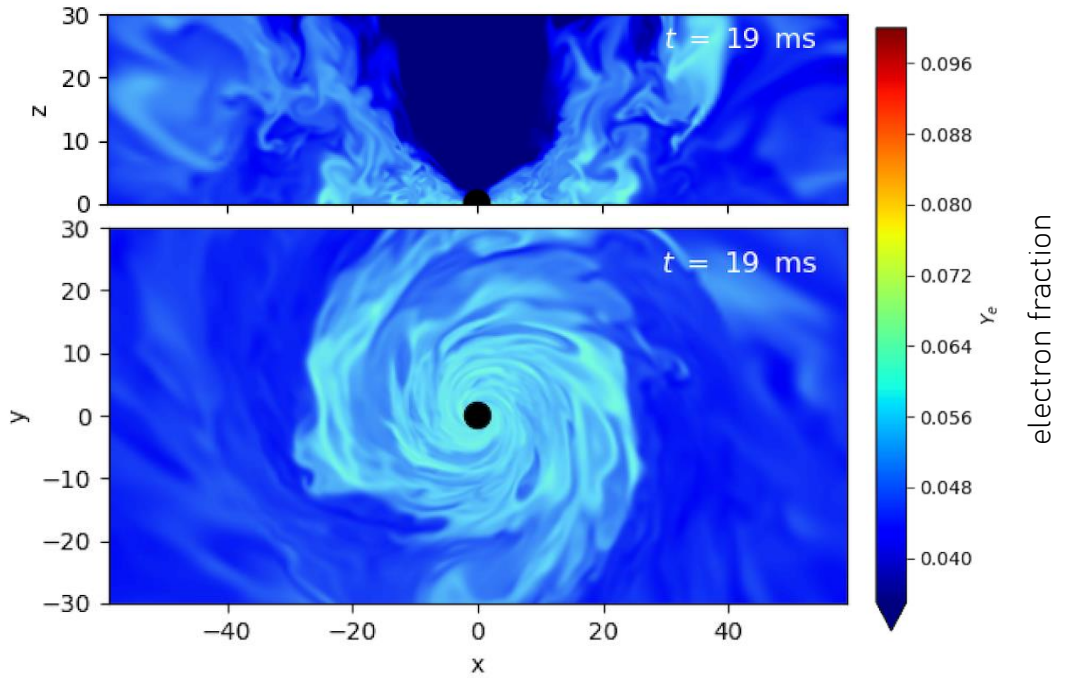




Hydro evolution for non-magnetized case







Apparent horizon is formed ~5 ms after the merger,
HMNS collapse to BH

Current Status and Future Plans

- So far...
- Non-magnetized case: Successful in inspiral, merger and postmerger phases (delayed collapse of HMNS to BH as expected).
- Currently working on the magnetized case

- For Future:
- Extend magnetic field outside the neutron star
- Extend EOS table for low density atmosphere treatment $\rho \sim r^{-6}$ for large scale simulation
- Add more advanced neutrino treatment (M1)