NEW APPROACHES FOR MULTI-MESSENGER REAL TIME ANALYSIS

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Multi-messenger astronomy and challenges for the next years

The detection of GW170817 and its electromagnetic (EM) counterparts marked the birth of multi-messenger (MM) astronomy with gravitational waves (GWs) and clearly shown the huge informative power of MM observations

In the next years, 2nd generation and 3rd generation GW interferometers (e.g., ET) will take data with high sensitivity; furthermore, many new telescopes will be operative (e.g., Athena, CTA, LSST...)



 \Rightarrow increase in the data rates and in the data complexity.

To maximize the scientific return of future observations, it would be important to have:

- · Common platforms to store and analyze multi-messenger data
- Tools to analyze in real time large streams of multi-messenger data
- Tools to combine informations from multi-messenger detections
- Optimized codes for source classification

This has to been combined with the use of techniques that make more efficient the detection of the sources, the parameter estimation etc (e.g., Machine Learning)

The idea: Real time multi-messenger analysis



The project

For real time analysis of gravitational wave (GW) data we have **Wavefier**: a prototype for a real time pipeline for the detection of transient signals and their automatic classification

Wavefier W block

Real time Gravitational Wave transient signal classifier

- The detection of transient signals is based on the wavelet decomposition of the data
- The classification of the detected signals is done with Machine Learning
- E. Cuoco et al., https://gitlab.in2p3.fr/escape2020/wavefier

Idea: extension of Wavefier to other messengers (e.g., photons)

The project

First step (ongoing): create a synthetic database of GW and EM coincident signals from transient astrophysical sources, to be used to test the pipeline; this includes:

- simulated GW data from LIGO, Virgo and KAGRA
- simulated EM data from Fermi and CTA



Next steps:

- Add low-level CTA data (Memorandum of Understanding in progress)
- GW and EM data injection, GW and EM data analysis
- Add neutrino data