ROOT Enhanced Advanced Signal Processing with KFR library in the Gravitational Wave Community.

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The prompt and intricate detection of mergers within stellar binaries holds paramount significance in both astrophysics and nuclear physics. The identification of gravitational waves coupled with their electromagnetic counterparts, exemplified by the GW170817 event in 2017, presents a unique opportunity to delve deeply into the inner core of these celestial entities. The development of novel software assets geared towards expediting signal processing analysis is crucial, paving the way for transformative shifts in the scalability and maintainability of expansive research projects.

To achieve this enhancement, we employ the KFR modern C++ library, specifically designed for advanced signal processing and digital complex filtering. This integration is seamlessly performed in use of ROOT software developed and meticulously maintained at the CERN laboratory in Geneva, Switzerland. The culmination of these efforts not only ensures the optimization of gravitational wave analysis but also enables the possibility to perform a complete analysis in one go including leveraged contemporary machine learning techniques through the ONNXRuntime library and the Toolkit Multivariate Analysis (TMVA) in C++ language.

To validate the efficiency of this enhancement, a performance benchmark test will be presented, comparing the capabilities of the FFTW and KFR libraries across a few scenarii. This comprehensive approach not only contributes to the advancement of signal processing in gravitational wave research but also establishes a benchmark for evaluating the performance of these libraries to be used in other analytical situations such as mechanical vibration analysis or examination of the spectrum of particle beams in particle physics.