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#03-79 Metrology of acquisition chains and signal processing of LMJ experiments

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Since the first experiment in 2014, more and more plasma diagnostics are being deployed on the Laser Méga-Joule (LMJ) facility manufactured by CEA/DAM. These diagnostics aim at measuring radiations or particles emitted during laser experiments to study high-energy physics, especially inertial confinement fusion (ICF). Up to 176 laser beams, converging on a millimeter-sized target placed at the center of a 10-meter diameter chamber will be installed. Different types of sensors surround the LMJ target chamber (coaxial diodes for soft x-rays, photomultipliers and scintillators for neutrons, etc.⋯) and realize the conversion of the quantities of interest to an electric signal. The signal is then transmitted via coaxial cables, acquired by a broadband oscilloscope, and digitally post-processed. Each step of this typical acquisition chain adds measurement errors and increases the global uncertainty. In this paper, a study of the whole acquisition chain, including signal processing algorithms, will be presented. First, a numerical model of the digitizer alongside a specific hardware system designed to perform its metrology in situ will be presented. This system has been customized to be included inside an acquisition rack, and it allows quantifying several parameters before each laser experiment. It computes errors sources such as offset, gain and skew, and provides a measurement of the effective number of bits (ENOB) of the digitizer. This number gives insights concerning thermal noise, phase noise and non-linearity, and the ENOB is measured at different frequency values in the range of interest. This range can go up to a few GHz for the measurement of a hohlraum radiation temperature for example. The experimental characterization of the electrical chain via its transfer function measurement will also be detailed. Finally, the numerical methods deployed to handle the inverse problem, based on deconvolution processes, will be introduced, including future developments exploiting Bayesian inferences and statistical approaches.

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