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P1.47: Digitizing solutions for high-resolution nuclear spectroscopy

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DAQ (Digital Acquisition) systems have progressively replaced the traditional analogue spectroscopic chains during the last two decades in the vast majority of nuclear physics experiments. The flexibility offered by the implementation of digital algorithms (both real-time implemented typically on FPGAs and offline implemented on computational clusters), as opposed to the fixed and limited functions of analogue modules, allowed for new experimental techniques that were simply unfeasible before. A good example of this evolution are the gamma-ray tracking techniques performed with the digital acquisition of the signals from segmented HPGe (High-Purity Germanium) detector arrays [1]. Another example is the implementation of digital pulse-shape analysis algorithms for ion discrimination using silicon detectors [2]. In both these two cases the signal digitization is performed with dedicated flash-ADC-based digitizer boards.

The first actor in this scene is the digitalization infrastructure, that can be reduced to the ADC chip and the front-end analogue signal conditioning circuit. The DAQ performance is strictly dependent on the ADC sampling frequency and bit depth. Such chips, however, are never designed specifically for nuclear spectroscopy, being others the main market applications (Network Analyzers, Military applications, Telecommunications, Microwave Receivers, Software-Defined Radios, just to name a few). In the same way, the typical AC-coupled (often transformer-based) front-end signal conditioning circuits suggested in datasheets and application notes are not suited to the spectroscopy techniques with semiconductor radiation detectors.
Signal conditioning circuits that are suitable for nuclear spectroscopy are discussed together with preliminary results obtained with the ADC32J4X family from Texas Instruments as a substitution for the now-obsolete ADC1413D. Thermal figures show the dramatic effects of the difference in power consumption between the two different ADC chips mentioned above.

[1] Reiter P., γ-ray tracking with AGATA: A new perspective for spectroscopy at radioactive ion beam facilities (2020) Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms, 463, pp. 221 - 226.
[2] Cieplicka-Oryńczak N. et al., Towards the lowest-energy limit for light ions identification with silicon pixel-type detectors, (2018) European Physical Journal A, 54 (12), art. no. 209.

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