Fast Data Acquisition, Signals Processing And Its Integration Within Instrument Control

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The basic role of any data acquisition system is to obtain a numerical and/or graphical representation of the events arriving at the detector and to store them on a non-volatile support. Moreover, the increasing complexity of the measurements, requiring accurate synchronization of several devices, shows clearly the need of a high level of integration between the acquisition electronics and the rest of the equipment in use on the instrument during an experiment. A variety of acquisition modes, ranging from the simple integral count on single or multi-detectors to Time-of-Flight and Kinetic modes, are standard applications on different instruments at the Institut Laue-Langevin. Those, together with the development of new measurement techniques like the Time Resolved Small Angle Neutron Experiment (TISANE), the Light-induced modulation or all those experiments requiring phase locking to the incident neutron pulses, are only a few examples of applications requiring high timing accuracy. On the other hand, very high data rate and the best possible energy resolution are fundamental ingredients for state-of-art γ-ray spectroscopy. The use of large arrays of High Purity Germanium detectors (HPGe) often coupled with anti-Compton active shielding to reduce the ambient background increases the complexity of the required instrumentation. The possibility of handling such a complex system using traditional analogue electronics has shown rapidly its limitation due, first of all, to the not negligible cost per channel and, moreover, to the signal degradation associated to complex analogue path. Nowadays, digital pulse processing systems are available, with performances equal when not better than the corresponding analogue ones for a fraction of the cost per channel. The present lecture will cover the different aspects of both analog and digital data acquisitions, from high accuracy timing to the handling of extreme event rates.