Digital acquisition in high count rate spectrometry - upgrade

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A data acquisition system (DAQ) for high resolution spectrometry measurements at Mcps rates, DNG@NCBJ (Digital Neutron Gamma @NCBJ), was developed at NCBJ [1]. Data acquisition and signal processing operations are performed using an FPGA with an ARM9 processor on a Xilinx ZC706 evaluation board. The measurement system is based on direct sampling of the input signal. A high speed Texas Instruments ADS5400 (12-bit 1 GSPS) ADC is used. A dedicated IP core has been developed to fulfill the system requirements with a strong focus on high count rate pulse processing capability.

The upgrade of this system is divided into two parts. The digital board with the FPGA is replaced with a Mini ITX form factor board, see Fig. 1. A standard computer form factor allows a 19" size compact instrument to be built, ready to be mounted in a larger infrastructure. An Avnet AES-Mini-ITX-7Z045-G evaluation board was selected [2]. Both the architecture and specification of this board (FPGA part number, available memory, FMC connector, communication standards) are compatible with the previous board. This allows us to move all the IP cores and software between boards with only small changes in the board definitions files. Several scripts were added to simplify the measurement process. An option to use the Linaro Linux distribution with access to install software using a precompiled packet software data base instead of embedded Linux was added.

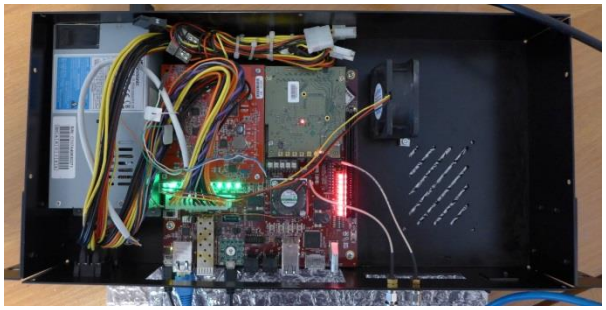

Fig. 1. Upgraded DNG@NCBJ digital acquisition system in a 19" case.

In the second part of the upgrade, a new FMC standard board with an analogue to digital converter was developed, see Fig. 2. The main goal was to develop a board using the same ADC as in the previous board and redesign the analogue signal chain to keep the software and IP core compatibility. Several changes were made to minimalize noise and reduce sampling clock jitter.

The main changes in the upgraded DNG@NCBJ may be summarized as follows:

- generation and distribution chip for low noise crystal clock,
- low noise voltage controlled oscillator,
- low-dropout regulators (LDO) characterized by low noise and high power supply rejection ratio (PSRR) for each crucial analogue chip.

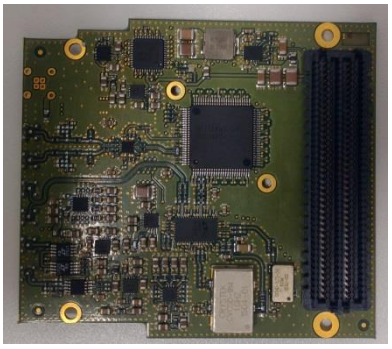

Fig. 2. Upgrade of the FMC standard board with analogue to digital converter.

In Fig. 3 an energy spectrum registered with the upgraded data acquisition system, a Photonis XP5500 photomultiplier and a 1"×1" $LaCl_3$:Ce scintillator is presented. A ^{60}Co source was used simultaneously with a strong ^{137}Cs source, with an activity of ~400 MBq, in order to increase the event rate.

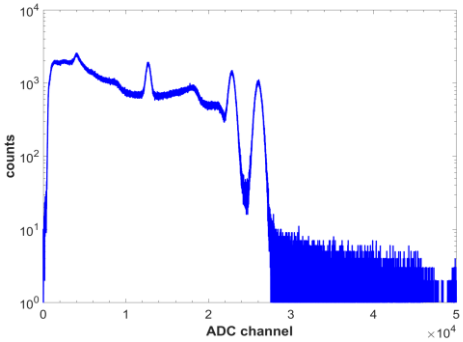

Fig. 3. Energy spectrum of ^{137}Cs and ^{60}Co measured with a 1"×1" $LaCl_3$:Ce and the upgraded DNG@NCBJ DAQ.

References

[1] *S Korolczuk et al*, Digital Acquisition in High Count Rate Gamma-Ray Spectrometry, *IEEE TNS, 63 (2016) 1668.*

[2] *http://*zedboard.*org/*product*/mini-itx-board*

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