Digital Approach To High Rate Gamma-Ray Spectrometry

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Basic concepts and preliminary results obtained with a high rate digital spectrometry system using efficient ADCs and FPGA are presented.
A data acquisition system DNG@NCBJ

Digital Neutron Gamma @NCBJ

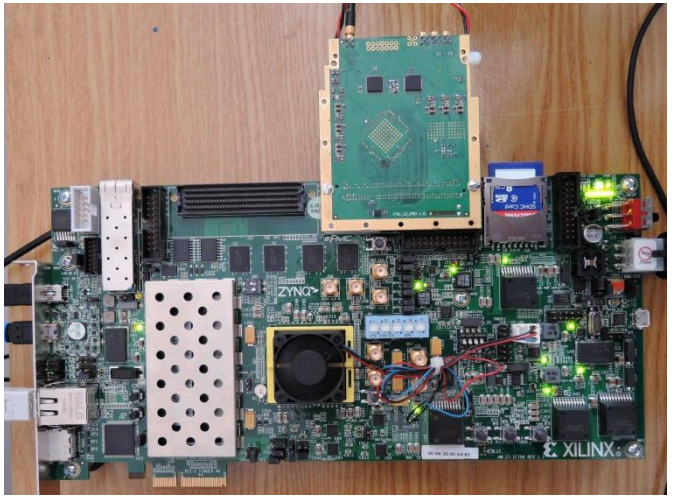
for high resolution spectrometry measurements at Mcps event rates is under development at the National Centre for Nuclear Research (NCBJ).

DIGITAL NEUTRON GAMMA DNG@NCBJ

- DNG@NCBJ measurement system is based on a direct sampling of the input signal.
- Data acquisition and signal processing operations are performed in the digital way by FPGA SoC with ARM9 processor on Xilinx ZC706 evaluation board.
- DNG@NCBJ prototype acquisition system is based on Texas Instruments ADS5400 (12 bit/1 GSPS) ADC.
- Data acquired from ADC is processed on line by FPGA.
- Dedicated IP core was developed to fulfill system requirements.

Following major operations are implemented:

1. baseline estimation (offset compensation),
2. pulse detection (triggering),
3. pulse energy estimation,
4. list mode creation,
5. communication.

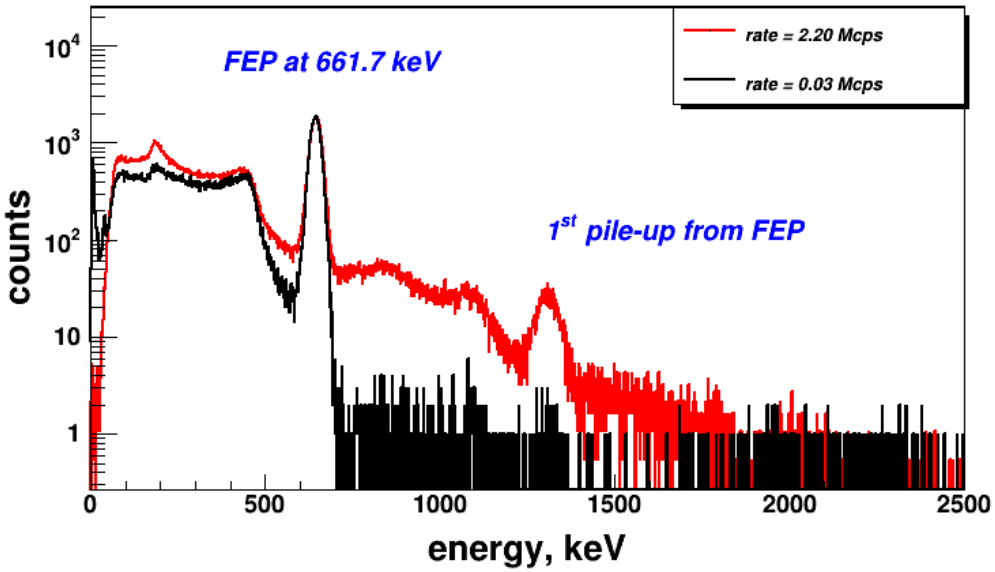


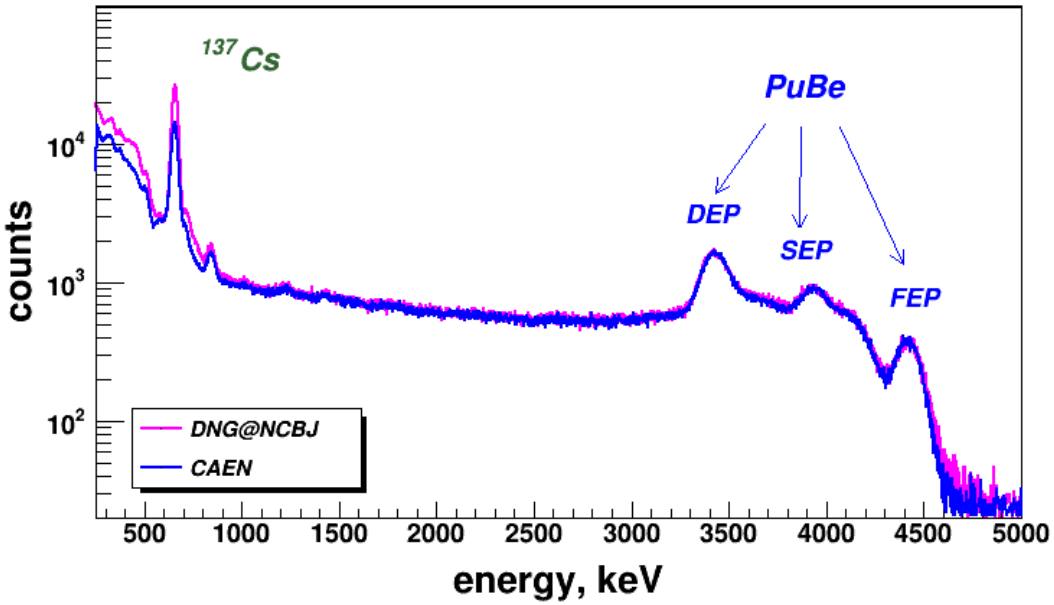
MEASUREMENTS

Deuterium-tritium (DT) plasma experiments, planned at JET, demand measurements of gamma-ray spectra at Mcps count rates with a good energy resolution.

DNG@NCBJ

- **1”×1” $LaCl_3$:Ce scintillator coupled to a Photonis XP5200 PMT, equipped with a dedicated active voltage divider**
- **a strong ^{137}Cs (661.7 keV) gamma sources used to increase the rate of events**





Measurements performed with DNG@NCBJ and CAEN Desktop Digitizer DT5720 at count rate of 0.2 Mcps

FWHM with DNG@NCBJ:
at 661.7 keV: 5.4%, at 3.4 MeV: 4.3%, at 4.4 MeV: 3.3%

PuBe full energy peak (FEP) at 4.4 MeV, single escape peak (SEP) at 3.9 MeV and double escape peak (DEP) at 3.4 MeV are shown.

CONCLUSIONS

- **DNG@NCBJ integrated into a single compact unit.**

- **Measurements with DNG@NCBJ performed up to 2.2 Mcps.**

- **Almost identical spectra obtained with DNG@NCBJ and commercially available CAEN Desktop Digitizer DT5720.**

- **Easy to create data acquisition system for a multi-detector setup.**

- **Off-line processing for setting optimization.**

- ***In progress: pile-up corrections. The corrected piled-up events can still be used without being discarded.***

- ***Continuation with dedicated software for, e.g., ITER experiments.***