Readout Electronics for high-count-rate high-resolution X-ray spectroscopy

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Products

- Hybrid Electronics
- ASICs
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Expertise

Detector

Low Noise Front-End

Processing and MCA

Software
SUMMARY

CUBE: new Front-End readout for detectors

DPP: High Rate X-ray spectroscopy (digital shaping)

VERDI-3: Versatile Electronics for Multichannel systems
A full CMOS preamplifier can replace the single front-end JFET ASICs: CUBE

Advantages:

1. High signal level at the output of the module.
2. No sensible loop outside the module.
3. Possibility to drive “long” connection.
4. Preamp Compactness
5. Superior performance respect to all the front-end JFET available at short shaping time.
Comparison with available JFET

Measured energy resolution with identical SDDs

- MOS preamplifier (CUBE)
- JFET-based preamplifier

Trapezoidal filter
25mm² SDD

0.2us

0.1us
Spectroscopy performances of CUBE connected to a SDD

$^{55}$Fe spectrum

123 eV FWHM

1μs shaping time (optimum)
ENC = 3.7e- rms

Commercial analog shaper: 7th-order Semi-Gaussian complex-pole
Spectroscopy performances of CUBE connected to a SDD

No worsening at cryogenic temperature

CUBE also suited for HPGE, SiLi and RTD
Digital Pulse Processor Platform

- Input stage optimized for CUBE output (dynamic range, gain, etc...)
- Provide best possible energy resolution
- Provide good performance at fast count-rate (peaking down to 120ns)
- Handle very high input count-rate (ICR up to 3Mcps)

US patent: 7763859, 8039787, 7855370, 7807973
CUBE + DPP performances

Detector SDD
- CUBE preamplifier
- Temp = -60°C
- Collim. Area = 50mm²
- Signal rise = 300ns
- Flattop = 330 ns

Energy Resolution

Energy (keV)

Counts

FWHM = 155 eV

Mn-Kα

Mn-Kβ
DPP performances

Graph showing the relationship between 6-keV FWHM and Energy Resolution for different Peaking Time values (0.11, 0.22, 0.50, 1.00, 2.00, 3.00). The x-axis represents ICR (kcps), and the y-axis represents 6-keV FWHM.
DPP performances

98.5% dead-

time

55 Fe spectra

55 Fe + X-ray tube spectra

Peaking Time (uS)

- 0.11
- 0.22
- 0.50
- 1.00
- 2.00
- 3.00

98.5% dead-time
- Compact single-board design, low power
- Design to the reconfigurable and adaptive to several applications
- Scalable to multi-cannel system (in days chain mode)
- High performance 16-bit 125-MHz ADC. High performance FPGA
- Possibility to add list mode operation
- USB2.0 or Ethernet TCP/IP
- Simple DLL libraries, or LabView

DPP customization

Supply: +/- 5V
Power: 1.5W

10 cm
Silicon Detectors
(Segmented, Coaxial, Planar)

Germanium Detectors
(Segmented, Coaxial, Planar)

Silicon detectors
(PIN, SDD, SSDD for gamma scintillator)

Multi-channel readout of different detector for several applications

PMTs (or SiPM)
VERDI Module

8 complete analog channels
Single +5V power supply
USB2 interface, driver and DLL
XRF application with SDDs

**VERDI config.**
- Pulsed-reset
- External preamp.
- Internal shaper, PKS.
- Energy range = 0 - 40 keV
- Output = Multiplexer

Fe55 Source
25mm² single-anode SDD
Temp. = -30°C
Detector main characteristics:
- Structured HPGe monolithic detector
- Thickness 11mm
- 16 pixel with 6mm pitch
- Pixel area 36mm²
- Operation close to LN2 temperature

Experimental setup

Energy resolution with an Americium 241 source

Pixel with higher leakage current

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• Structured HPGe monolithic detector
• Thickness 11mm
• 16 pixel with 6mm pitch
• Pixel area 36mm²
• Operation close to LN2 temperature
Thank you