

## 4-Channel CompactPCI Digital Spectrometer

### GENERAL DESCRIPTION

The DGF PIXIE-4 is a 4-channel all digital spectrometer on a single 3U CompactPCI/PXI card. It has been designed for fast high-precision coincidence  $\gamma$ -ray spectroscopy using HPGe-detectors, and is especially well-suited to work with 4-fold clover detectors. In addition the device acts as a waveform digitizer, acquiring data at rates of 75MSPS using 14-bit ADCs. Multiple units can be synchronized and combined into a larger data acquisition system to support applications using segmented Ge-detectors and others.

Each channel has variable gain and offset and can accept signals from almost any radiation detector. Signals as fast as having a 230ns decay time (from NaI(Tl) for instance) can be processed without the need for integrating preamplifiers.

The spectrometer can provide 32K channel spectra. For operation with 4-fold clover detectors, the DGF-PIXIE-4 can provide an add-back spectrum in addition to the 4 singles spectra. The add-back is created from summing the energy in all those channels that report a hit in coincidence.

The instrument uses 14-bit ADCs operating at 75MSPS. There is a 1024-cell long FIFO memory for waveform capture (up to 13.7 $\mu$ s). These data can be used in online pulse shape analysis in a variety of applications.

Multiple PIXIE-4 cards can be synchronized and can be made to share triggers and multiplicity information. No external electronics is required to achieve this.

A 4-slot CompactPCI/PXI crate can house a data acquisition computer with a hard disk, a PIXIE-4 card, a HV-card and a preamplifier power supply card to create the world's most compact clover read out system. It weighs less than 6kg, and its largest dimension is 26cm (10inch).

### FEATURES

- Designed for high precision  $\gamma$ -ray coincidence spectroscopy with HPGe detectors.
- One card instruments a 4-fold clover detector, including add-back spectrum. No external electronics required.
- Directly compatible with scintillator/PMT combinations: NaI, CsI, BGO, and many others.
- Input signal decay time: as fast as 150ns and up to 10ms, exponentially decaying.

- Wide range of filter rise times: from 27ns to 107 $\mu$ s, equivalent to 12ns to 50 $\mu$ s shaping.
- Selectable spectrum length: from 1K to 32K channels,  $4.3 \cdot 10^9$  counts per bin.
- Excellent pile up inspection: double pulse resolution of 50ns.
- Instrument settings automatically optimized to match detector characteristics.
- Digital oscilloscope and FFT for health-of-system analysis.
- Triggered synchronous waveform acquisition for advanced R&D: 1024 samples, 14-bit (up to 13.7 $\mu$ s).
- Full speed 32-bit, 33MHz PCI interface to host. 132Mbyte/s max, 109 Mbyte/s readout of onboard memory.

### SPECIFICATIONS

#### Front Panel I/O

4 analog signal inputs, selectable input impedance: 50 $\Omega$ , 10k $\Omega$   
2 digital inputs or outputs for triggers or veto signals.

#### Backplane I/O

System clock distributed from master module to all other modules.  
Veto line to inhibit data acquisition by external signal.  
Sync line to simultaneously start and stop runs.  
Waveform and event trigger lines for coincident data acquisition.  
Multiplicity trigger via daisy-chained token ring.  
External access to all backplane I/O with XIA's PXI PDM module.

#### Interface:

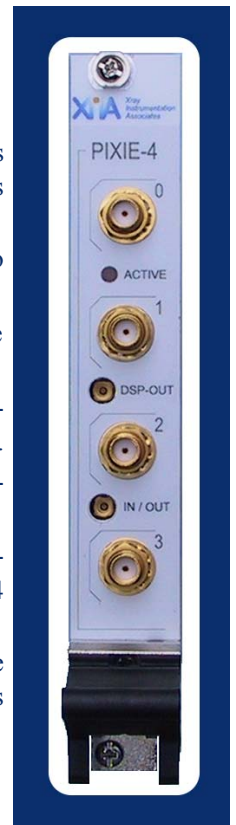
PCI: 32-bit, 33MHz, target only. 109Mbyte/s

#### Digital Controls

Gain: 10:1 gain range in fine steps.  
Shaping: Digital trapezoidal filter. Rise time and flat top set independently: 0.027 - 107 $\mu$ s in small steps

#### Data Reported

Spectra and list mode data, including hit patterns, energies, timestamps and waveforms.



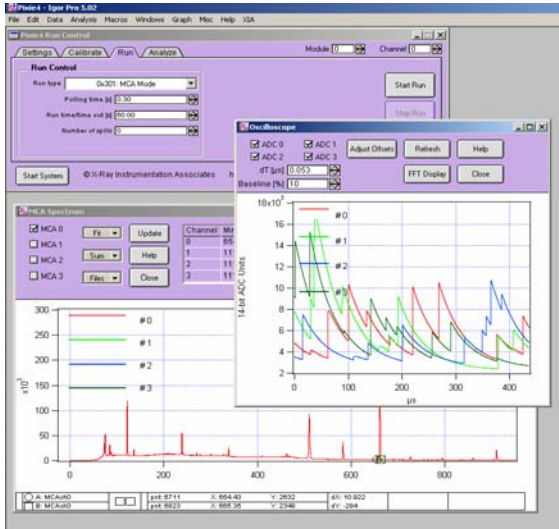


Figure 1: Screenshot of Pixie Viewer

## SOFTWARE

The **Pixie Viewer** is a graphical user interface for the Pixie-4, based on Wavemetrics' Igor Pro. It calls functions from a C driver library to carry out the communication between the Pixie-4 modules and the interface. All parameters can be saved to disk for easy switching between applications.

The **Pixie-4 driver library** is a set of functions written in ANSI C. This library is free to users that plan to integrate the Pixie-4 into an existing acquisition system. Also available is a **LabView** interface based on the same library.

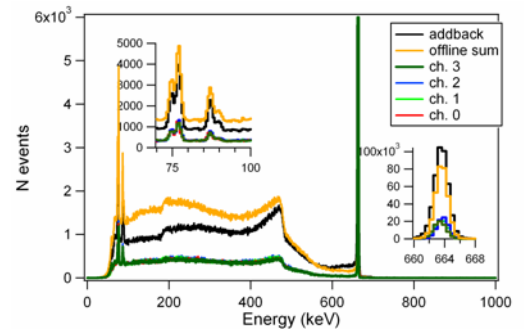


Figure 2: Clover addback spectrum ( $^{137}\text{Cs}$ )

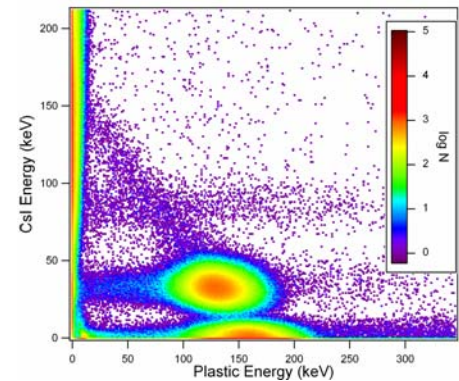


Figure 3: 2D histogram from phoswich detector for beta-gamma coincidences ( $^{131m}\text{Xe}$ )

## APPLICATIONS

The Pixie-4 can be used in a variety of applications, including **clovers** or individual **HPGe detectors** with a single card; **multiple detector setups requiring coincidences** to suppress unwanted events; small **beam-line detector systems** with multiple cards; as well as scintillator applications using pulse shape analysis e.g. to identify particles. A CAMAC version with high speed USB readout is available for compatibility with earlier DGF models.

Fig. 2 shows spectra from a clover detector, illustrating the increased peak efficiency and lower Compton background using the online addback spectrum.

In Fig. 3, a phoswich detector (plastic scintillator surrounded by CsI crystal), generates fast pulses for betas, slow pulses for gammas and mixed pulses for coincidences from Xe isotopes. Using the pulse shape analysis functions of the Pixie-4, the three responses can be separated and the energy deposited in each scintillator measured separately (Fig. 3).

## SAMPLE PERFORMANCE

Resolutions for a multi-source spectrum are shown in Fig. 4. Note the clear separation of lines at 80-90 keV for an overall dynamic range of 3.2 MeV. Resolutions at 1.3 MeV remain below 1.8 keV for up to 25,000 cps (results are detector specific)

The measured maximum throughput of the Pixie-4 is 245,000cps for unrelated pulses in a single channel. For coincidence pulses in 4 channels, the throughput is up to 484,000 pulses/s (121,000 cps in each channel).

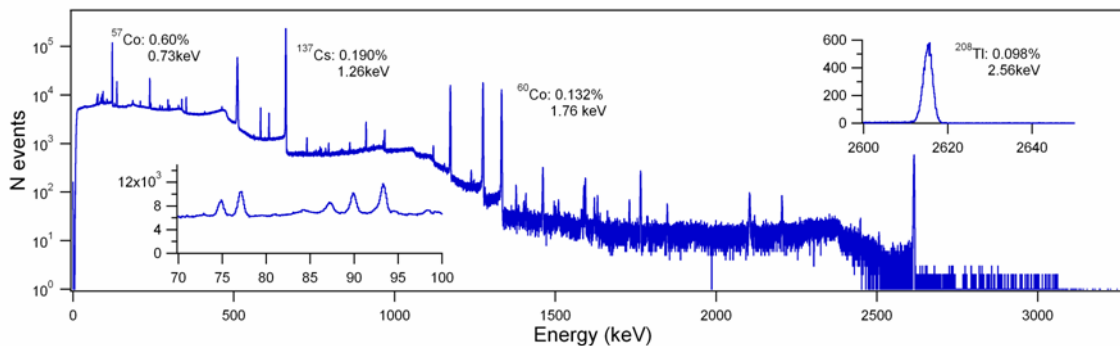


Figure 4: Multi-source spectrum acquired with Pixie-4 and a 40% Aptec HPGe detector (~8kcps).