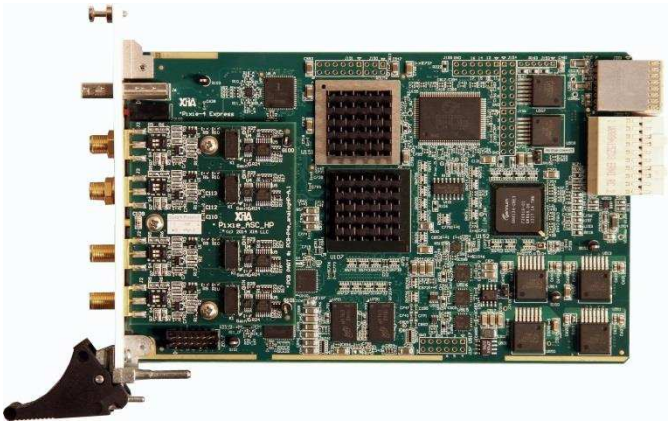
Pixie-4e

Instruments That Advance The Art

Pixie-4e

Four channel 125-500 MHz PXI Express Digital Processor



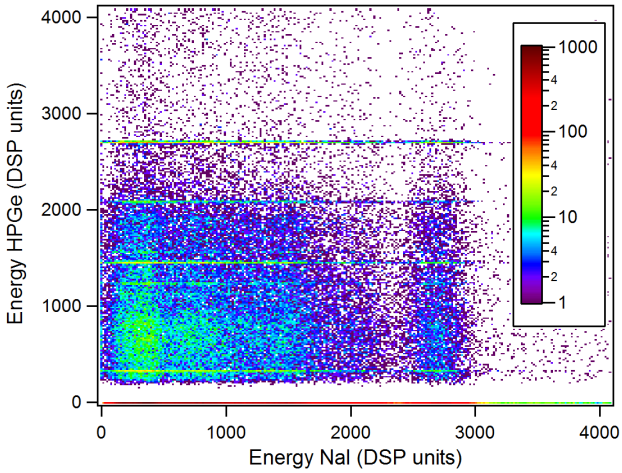
FEATURES

- **Four channel 12-16 bit, 125-500 MSPS pulse processor.**
- **32K MCA spectrum per channel.**
- **Processor peaking times adjustable from 0.048 - 63.4µs.**
- **Waveform capture and Pulse Shape Analysis.**
- **Sophisticated pile-up inspection.**
- **Sub-nanosec Timing Resolution.**
- **PXI Express platform: x4 link.**
- **Front and back panel digital I/O signals.**
- **Customizable GUI, DSP, FPGA, and Hardware.**

OVERVIEW

The Pixie-4 Express is a 4-channel digital pulse processor on a single 3U CompactPCI/PXI Express card. Designed for fast high-precision coincidence gamma-ray spectroscopy using HPGe detectors, scintillators, and silicon detectors, the Pixie-4 Express not only offers very high speed waveform acquisition but also pulse height measurements and time stamping for event reconstruction. Incoming signals are digitized at 125-500 MSPS with 12-16 bit ADCs, depending on the option purchased. The digital stream is used for triggering, pile-up inspection and filtering in real time. Waveforms of up to 4K samples per pulse can be stored in an onboard 256 MB FIFO. Pulse height reconstruction, accumulation of a 32K MCA spectrum for each channel, and optional pulse shape analysis is performed on an event-by-event basis by a 300 MHz floating point SHARC digital signal processor and an Artix 7 FPGA. Waveforms and spectra can be read out through the x4 PCI Express data interface at rates of several hundred MByte/s (theoretical limit 800 MByte/s per slot). The readout does not interfere with the data acquisition. Multiple Pixie-4 Expess modules can share clocks and triggers through the PXIe chassis backplane, which implements bussed and nearest neighbor signals between slots.

The Pixie-4 Express can be customized on many levels for specific applications, either by XIA or an experienced end user. This includes the top level GUI, the C driver library, the DSP, the FPGA, and the hardware (ADC specs and analog front end). Consult our engineering staff for more infomation.



2D energy histogram of coincident energies from HPGe and NaI detector

APPLICATIONS

- **Scintillator detectors.**
- **HPGe detectors.**
- **Clover detectors.**
- **Silicon strip detectors.**
- **Multi-detector systems.**
- **Real-time Pulse-Shape Discrimination.**
- **Waveform analysis.**
- **Time dependent spectroscopy.**

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SPECIFICATIONS

Front Panel I/O

- 4 analog signal inputs.
  Impedance 50 Ω or 2 kΩ. Optional 1/8 attenuation.
  Pulse amplitudes up to (2.0V) / (gain * attenuation)
- 11 digital inputs / ouputs for triggers or veto signals.
  (Also configurable as 5 high speed differential signals.)

Backplane I/O

- Low skew system clock distributed to all modules.
- Configurable LVTTL and LVDS lines for veto, run synchronization, multiplicity, and trigger distribution.

PXI Express Platform

- 3U CompactPCI form factor with x4 PCI Express interface.
- Measured sustained data rate over 400 MBytes/s from module to host PC memory.
- Parallel readout of modules with suitable chassis and PC. (E.g., a x16 host PC can read 4 modules in parallel.)

Digital Controls

- Coarse gain 1.6 to 22.6 in 8 steps for 125 MSPS version
  Coarse gain 2 or 5 for 500 MSPS version
- Fine gain ± 10% digital adjustment.
- DC offset compensation: -3V to +3V (before gain)
- Energy filter: Rise time and flat top: 0.048 - 63.4 µs.
- Acquisition: Local and shared trigger, hit pattern, coincidence window.

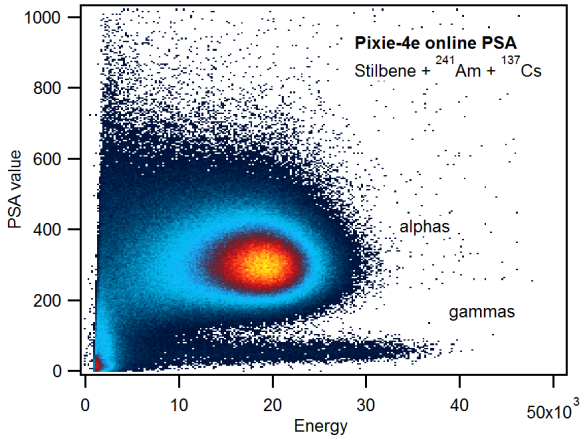
Pulse Processing

- Signal digitized at 125-500 MSPS, 12-16 bit.
- Waveform capture at full ADC rate.
- Energy filter operated at 125 MHz.
- Real time pulse shape analysis (charge integration)
- Real time constant fraction timing (500 MSPS version)

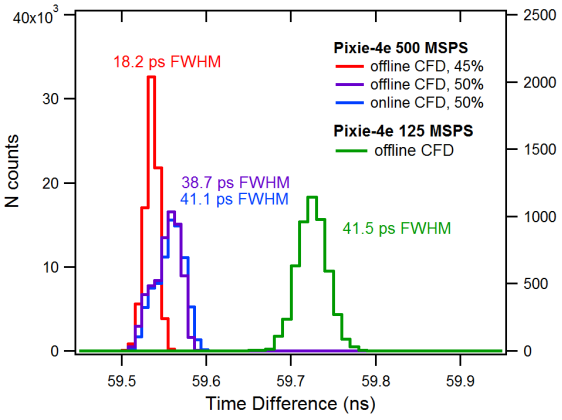
Data Reported

- Energy spectra (32K per channel).
- List mode data (energies, timestamps, and waveforms).
- Run statistics.

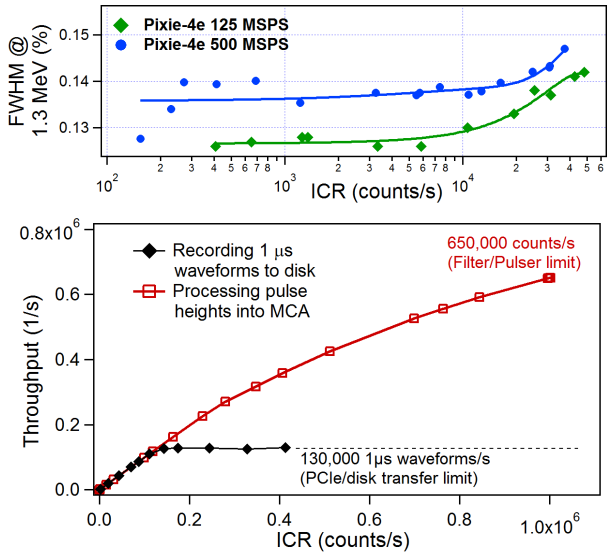
SAMPLE PERFORMANCE



Pulse shape analysis of signals from a Stilbene crystal separating alpha from gamma interactions. PSA sums are computed online in the Pixie-4e FPGA.



Timing resolution for Pixie-4e variants using an Agilent pulser split and delayed between two inputs. Online processing performed in FPGA using real time data; offline processing using captured waveforms with finer tunable settings.



Energy resolution (top) and throughputs (bottom) of energies to on-board MCA and of 1µs waveforms to host PC's disk for short filter as a function of input count rate.

SOFTWARE

The Pixie-4 Express is operated through a graphical user interface based on Wavemetrics' Igor Pro. ROOT or LabVIEW demo interfaces are also available. All interfaces call functions from the same C driver library, which handles conversion of physical parameters (e.g. filter times) into numbers used by the firmware. All parameters can be saved to disk for easy switching between applications.

The C library is largely compatible with Linux and code is available to users who plan to integrate Pixie modules into a custom data acquisition system. All host software is provided as open source. Users can also add their own functions to the DSP events processing code. Blocks of the FPGA have been reserved for custom user logic.

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