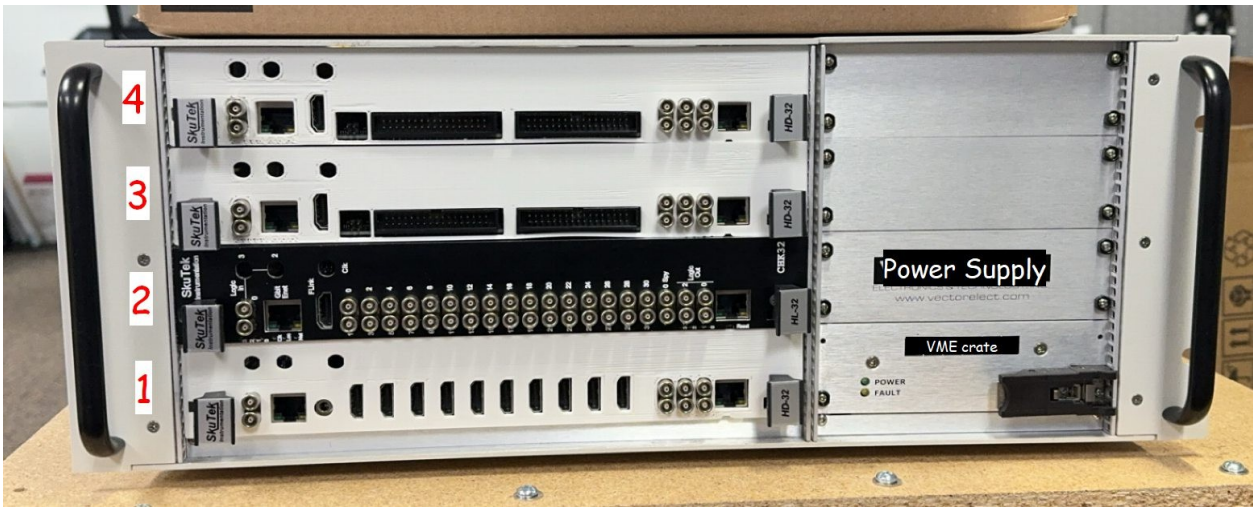
SkuTek Instrumentation

Where Science Meets Industry

Multi Channel DAQ Systems

Modular DAQ Systems with FPGAs and Streaming Readout



SkuTek high performance data acquisition systems with embedded Linux and FPGAare composed of 32-channel Digitizers and optional Logic Modules. The firmware can process the RC-reset signals from silicon or germanium detectors, from “classic” scintillators: CsI(Tl), NaI(Tl), LYSO, BC400, or from liquid noble gases. Either PMT or SiPM can be used to process light with our DAQ. Sub-nanosecond time resolution can be achieved with fast signals thanks to low noise and excellent pulse shape response. The VME crate is used for power, but not for readout.

Digitizer Specifications	
Channel Count	*32 analog channels per digitizer*
Bit Resolution	*14 bits in each channel, yielding 16,384 discrete ADC values*
ADC Sampling Frequency	*100 MHz*
Coaxial LEMO Inputs (Unit #2)	*32 inputs with LEMO (unit #2 in the photo). Inputs are terminated with 50 ohms or 1k ohm, selected with micro switches in each channel. These digitizers are meant for high resolution detectors such as HPGe.*
Multipin Ribbon Inputs (Units # 3 and #4)	*32 inputs with multipin ribbons with FERA pinout (units #3 and #4 in the photo). Inputs are terminated with 50 ohms or 1k ohm, selected with micro switches in each channel. These digitizers are meant for mid resolution detectors such as DSSD with many channels connected to the signal breakout boards with FERA pinouts.*
Analog Input Range	*2 volts total, anywhere within the -2 to +2 volt range. For example (-1 to +1 volt), (-2 to 0 volt), or (0 to +2 volt) are*

	valid input ranges.
Analog Outputs	*Two LEMO outputs with synthesized analog signals with -2 to +2 volt range can render a choice of internal FPGA signals. Default channel A: select any input signal and watch it with a digital scope. Default channel B: an arbitrary waveform with 81.92 us duration. Please inquire in case you need a different choice of synthesized signals.*
Logic Inputs With Coax Connectors	*Four LEMO logic inputs with either NIM or LVCMOS levels selected with a switch. Functions are defined in firmware. Default configuration: trigger in, veto in, time stamp clear in, pulse-per-second (PPS) in.*
Logic Outputs With Coax Connectors	*Four LEMO logic outputs with either NIM or LVCMOS levels selected with a switch. Functions are defined in firmware. Default configuration: trigger / busy out, pulse-per-second (PPS) out. Remaining two outputs can be customized to user's needs.*
Trigger Modes	*Level-0: internal trigger in each channel. Level-1 default: OR of the channel triggers, ORed with external logic input trigger. An advanced trigger can be developed on customer request: any logic function of the above.*
Noise Suppression in the Channel Trigger	*Each analog channel is equipped with user – defined filter between 0 ns (no filter) and 160 ns, followed by a differential comparator in each channel. This is equivalent to a Timing Filter Amplifier followed by a discriminator in each channel.*
External Trigger Input	*One of the LEMO coax logic inputs is devoted to the external trigger with either NIM or LVCMOS logic levels. External trigger can strobe an event at any time.*
Auxiliary "Noise Trigger"	*The embedded CPU can issue "any time trigger" to record noise waveforms.*
Real-Time Pulse Processing	*For each event, firmware will measure the pulse height in each input channel, differentiated pulse height, hit multiplicity, pulse summation of all inputs, time stamp, and other pulse-related quantities. Please inquire about the details.*
Multichannel Analyzer	*MCA is not implemented in the multichannel DAQ.*
Waveform Digitizer Mode	*Each channel can record waveforms of input signals up to 8192 samples, which is up to 81.92 µs @100 MHz sampling.*
Event-by-event files	*Event by event files can be recorded in either ASCII or binary formats. The files will contain pulse heights, time stamps, pulse shape parameters, etc. Optionally, the files can also record event-by-event waveforms. Please inquire about the details of the file format and content.*

Programming	*Comprehensive software library is available to users free of charge. Users can develop their own programs in either Python or C to perform custom data processing, write their own recording procedures, perform either periodic or time – triggered data acquisition tasks, etc.*
Customizations	*We can customize the instrument to user's needs under a contract. Note that the users can avoid this cost when they customize the software themselves.*
Internal Clock	*When the external clock is not used, the unit will generate its own, highly stable internal reference clock using a quartz stabilized oscillator.*
Clock Synchronization Input	*Dedicated clock input to synchronize the internal clock to an external high precision 10 MHz reference provided by commercial GPS or White Rabbit. Internal clock will be used when this input is not connected.*
Clock Output	*Two copies of the 10 MHz clock, phase locked to the original.*
Backplane Clock Input	*Each unit can receive the clock from the VME backplane standard clock pin.*
Data Recording Options	*Data files, waveforms, histograms, and settings can be written to an internal SD card or to the remote disks mounted over Networked File System (NFS). A number of options are available because the instrument is running a modern Debian Linux. Our instrument can do anything what Linux can do. Please inquire.*
Event Format	*The event format named GREAT is descended from and compatible with the standard format adopted by GRETA. Description is available on request.*
Physical Dimensions (cm)	*Standard size VME board. Due to a high density of input connectors we highly recommend mounting the board(s) every other slot rather than every slot. The gaps will help with routing the signal cables. The photograph is illustrating this arrangement.*
Digital Linux Interface	*One RJ45 for 1G Ethernet for the Linux SBC. Data rate: about 15 MB/s per board.*
FPGA Ethernet Interface	*One RJ45 for 1G Ethernet connected to the FPGA. Data rate: about 100 MB/s per board.*
FPGA Trigger Interface	*One differential link for the optional logic board (#1 in the photo). This optional link can transport comprehensive trigger and timing protocol. Please inquire.*
VME Trigger Interface	*Several FPGA pins are connected to the VME IRQ lines in order to distribute trigger to other digitizers in the same VME crate.*

User Interface	*Python scripts used for GUI-less operation driven by Python commands or by Jupyter.*
Internal Operating System	*Debian Linux*
Multiple Unit Synchronization	*Method #1: Timestamps and triggers can be synchronized across multiple units, using the optional Logic Board #1 in the photograph. Only one Logic Unit per crate is needed.* *Method #2: Timestamps and triggers can be synchronized across multiple units, using the logic inputs and outputs. This method can be also used for connecting SkuTek digitizers with DAQ systems from third party vendors. Please inquire about the details.*
Real Time Event Building	*SkuTek modules can build events in real time, using the internal Level-1 trigger criteria (e.g., coincidences among inputs). The modules can also use external NIM logic pulses. The externally strobed events will be either written to the time stamped event files, or streamed to Data Collector computers, and processed offline. Please inquire.*
Power	*5 volt from the VME backplane. Other voltage rails are not used (+/- 12 V or 3.3 V).*
Weight	*About 0.5 kg*
	Additional Items
VME64x Crate	*All boards can be hosted in any VME crate from which they draw +5V power. However, we highly recommend a VME64x with the 160 – pin J1/J2 and 96 – pin P0 installed in all slots. Depending on the number of units, we will provide a crate between 2 and 19 slots.*
Rear Transition Module with 10G Ethernet	*Event streaming performance can be improved 10x, from 1 gigabit/s to 10 gigabits/s per module, with the SkuTek Rear Transition Module installed in the back cage of VME64x.*
Data Collection Computer	*We highly recommend ordering a Data Collection Computer alongside the DAQ. The computer will receive multiple 1G or 10G streams and record them to disks.*

We are a small company dedicated to serving physics researchers worldwide. We specialize in high-speed Data Acquisition systems and Digital Pulse Processing electronics. Our product line comprises the whole data acquisition chain: detectors, digitizers, firmware pulse processing, and data management for scientific big-data applications.