# A PXI-based, Multi-channel Ultra-fast Data Acquisition System for Transient Pulsed Signal

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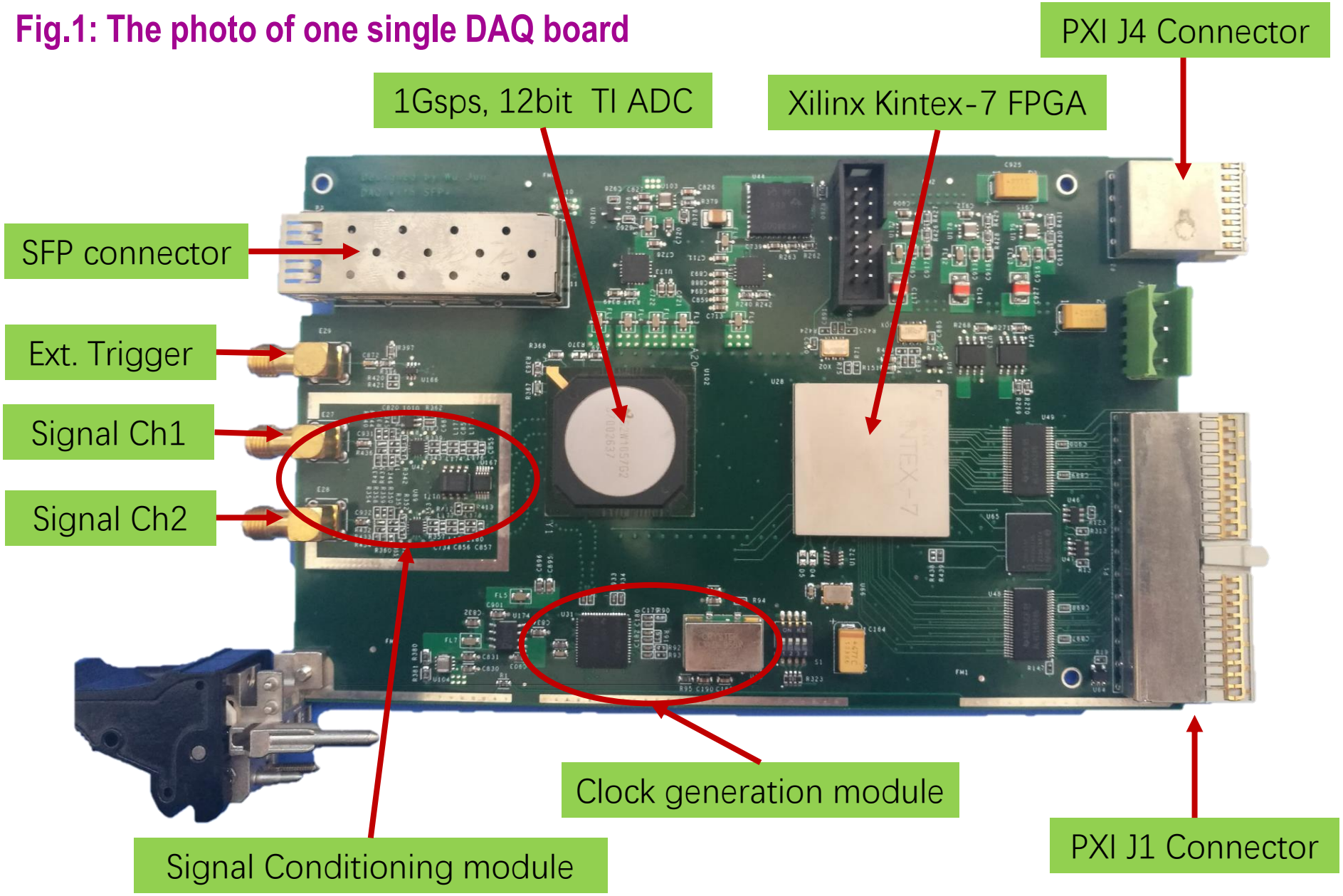
**Fig.1: The photo of one single DAQ board**




**Mainly for Recording of Transient Pulsed Signals !**

- 16 DAQ cards at most
- All-hybrid backplane
- Trigger Distribution

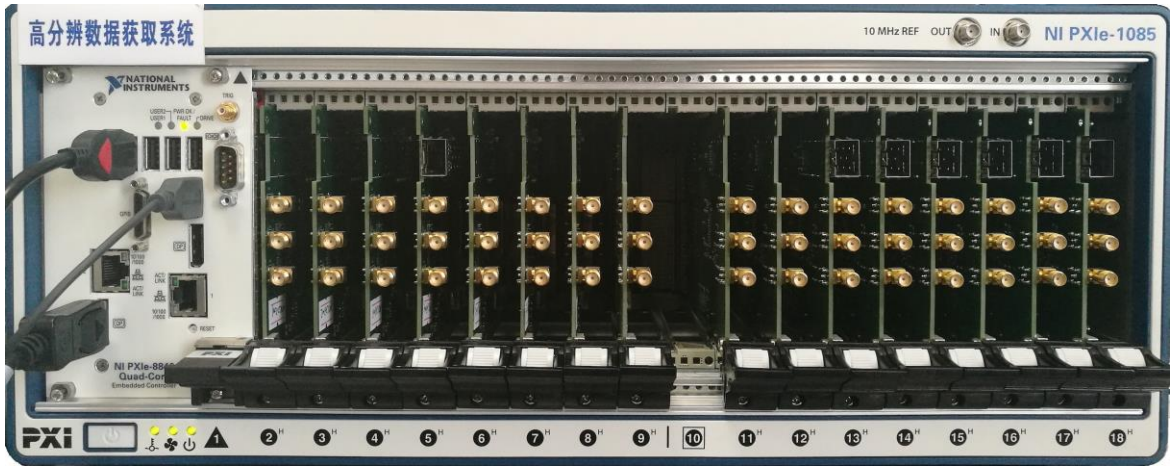



Fig.2: A photo of the designed DAS

Oscilloscopes in a crate!

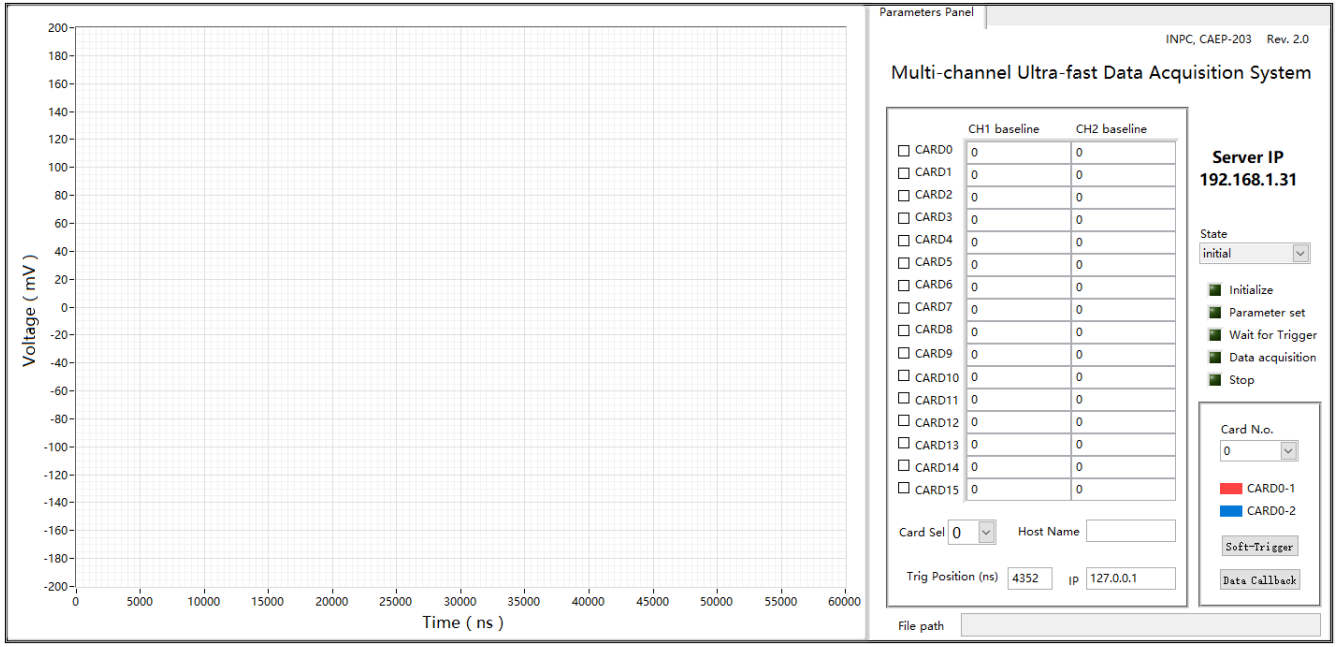



Fig.3: Control software with LabVIEW

# A PXI-based, Multi-channel Ultra-fast Data Acquisition System for Transient Pulsed Signal

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## 1. Overview

This work presents a high speed, high resolution data acquisition system(DAS) with 1Gsps sampling rate and 12 bit resolution, mainly applying to nuclear and particle physics experiments. The system consists of one NI PXIe-1085 chassis, containing a PXIe controller card and 16 data acquisition cards at most. For every single card, the signal conditioning module incorporates one high precision Op Amps converting single-ended signals to differential signals(LVDS) with low additional noise level, and the data acquisition module combines a 12-bit folding interpolating ADC with a Xilinx Kintex-7 FPGA, implementing controls of A/D conversion and high speed data transmission through SFP interface using Aurora protocol. All these cards in the chassis can be synchronized easily using timing and triggering with PXI resources. Besides, a simple software of our system is designed to display the captured waveform signal and communicate with the host PC for remote controlling.

Fig.1: A photo of the PXI-based, Multi-channel Ultra-fast DAS for Transient Pulsed Signal. (Note: The NI PXIe-1085 18-slot chassis features a high-bandwidth, all-hybrid backplane to meet a wide range of high-performance test . )

## 2. Design and Test

### Hardware Design

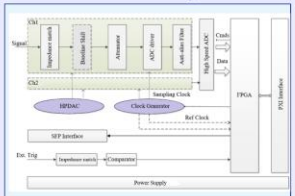

Fig.2: The block diagram of a single DAQ board.

- We deploy serval orders of input range to cover some hundreds of milli-voltages to hundreds of voltages.
- To improve SNR, a three-order Butterworth filter as anti-alias filter is used.
- A baseline shift module is designed for unipolar signals to fully display in the virtual oscilloscope.
- This design chooses TI's LMK04821 as the frequency Synthesizer chip

Fig.3: A photo of a single DAQ board.

### Logic and Software Design

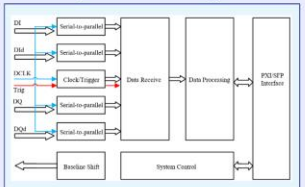

Fig.4: Main Procedures in logic design with Xilinx FPGA .

- Serial-to-parallel: lower date rate per lane
- We use integrated Block RAM IP core to instantiate a module to assemble the captured data
- The resulting data can be transmitted to remote server through SFP connector with optic fibers using Aurora Protocol.
- After creating the VISA-based driver and developing basic communication and DMA support, our control software is built.

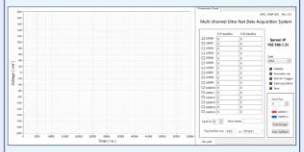

Fig.5: Interface of software designed in LabVIEW environment

### Test Results

- Virtually oscilloscopes in a chassis.
- After calibration, primary test results show as followings

Tab.1: The primary test results of ENOB.

| Anti-alias Filter | 23.723MHz | 58.541MHz | 134.337MHz |
|---|---|---|---|
| Yes | 9.3 | 9.3 | 9.2 |
| No | 9.3 | 9.2 | 9.1 |

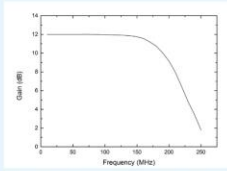


Fig.6: The typical Gain vs f plot of a single channel

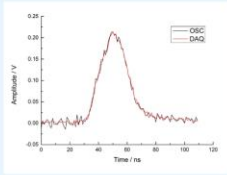


Fig.7: Typical comparison between our DAQ channel and a 12-bit 1Gsps oscilloscope channel when recording a typical transient pulsed signal .

## 3. Summary

- ❑ The DAS can integrate 16 DAQ boards in one chassis. With great scalability, the system can be used for modern big physics experiments.
- ❑ Primary measurements show that the each single card in our DAS achieves an analog bandwidth of higher than 200MHz and an ENOB of more than 9 bit at 1Gsps sampling rate.
- ❑ Each channel has a memory depth of 65kS and the trigger position can be programmable through software interface.
- ❑ The digitized data can be either transferred through PXI 32bit/33MHz bus to the disk of the local controller or through SFP interface to the remote receiver within 1ms.
- ❑ Qualitatively speaking, more research work should be done with record and test of single transient pulsed signals.

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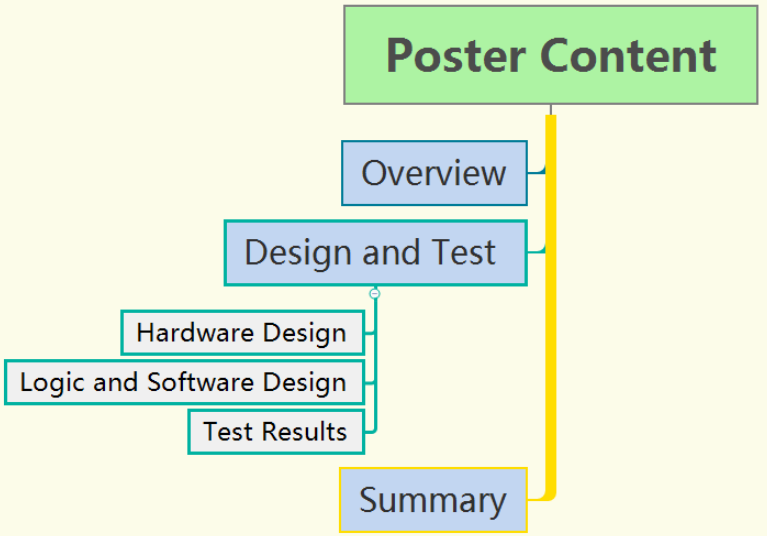


**For more details, come and see poster 479!**

***Any comments will be appreciated!***