

A PROTOTYPE OF THE SELF-TRIGGERING FRONT-END STATION FOR TREND

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OUTLINE

- ✘ Introduction to Radio Detection & TREND
- ✘ The DAQ system of TREND (Current & New)
- ✘ The self-triggering front-end station
- ✘ The field test of the prototype



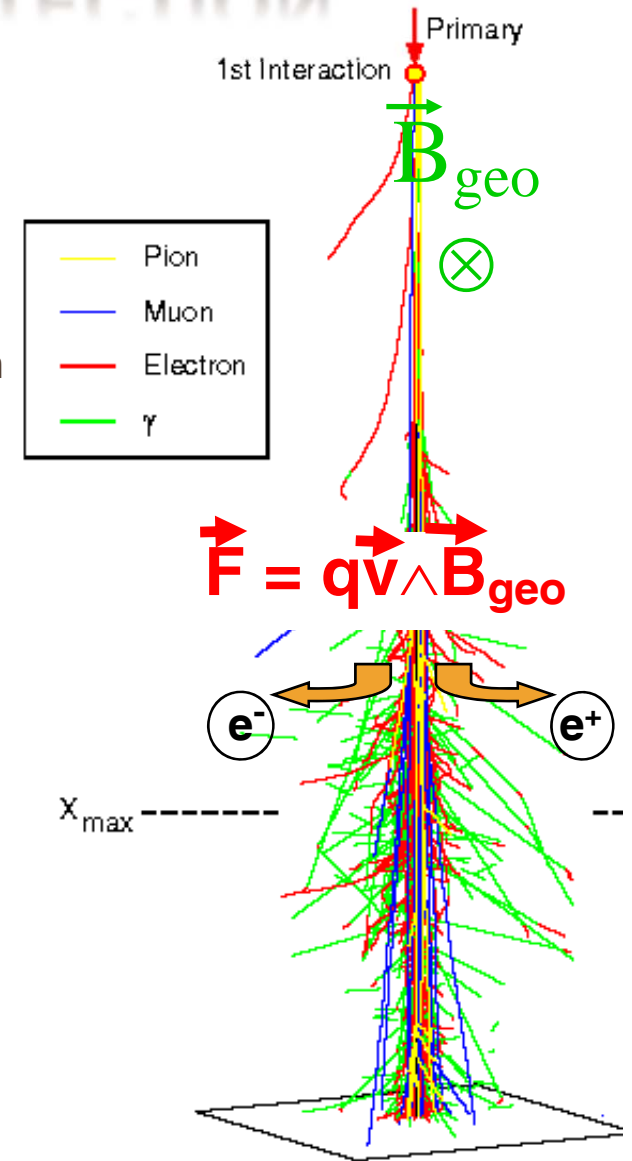
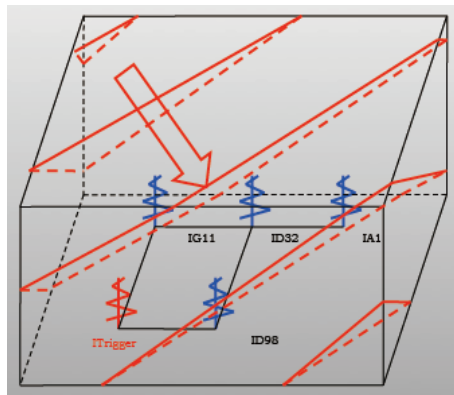
INTRODUCTION TO RADIO DETECTION

✘ General Process:

- + Particles interact with the atmosphere or mountains
- + Electromagnetic shower → electron & positron
- + Deflect in geomagnetic field → electromagnetic radiation
- + Acquire the radio information → get the particle information

✘ Advantages:

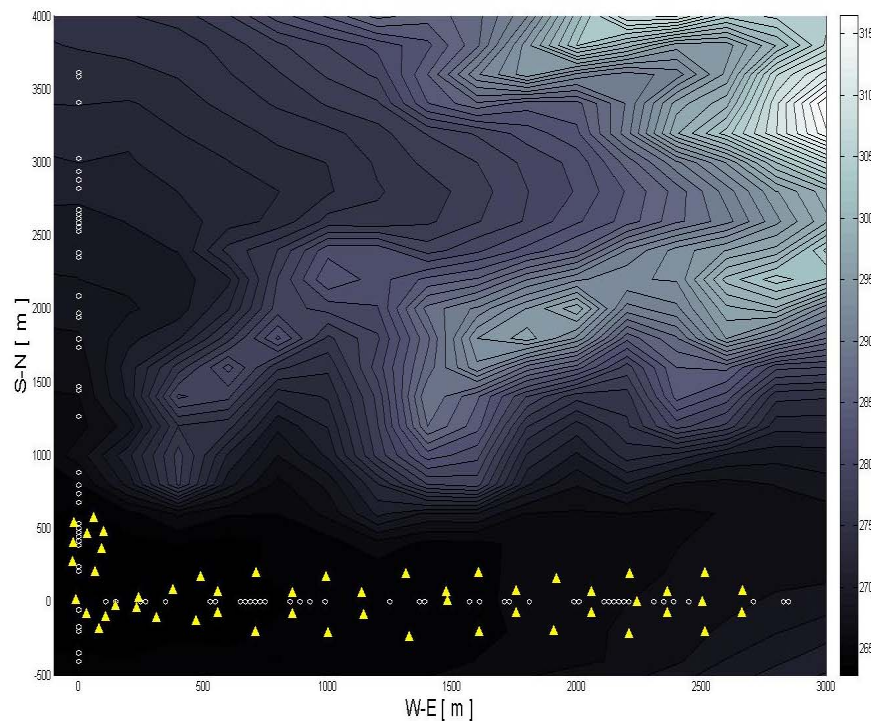
- + Detect the High Energy particles ($>10^{16}\text{eV}$)
- + Cost effective
- + Easy to maintain
- + ...



INTRODUCTION TO THE TREND

- ✘ The aim of the Tianshan radio experiment for neutrino detection (TREND) is to build a large radio array to search for ultra high energy (UHE) neutrinos. The first results of TREND has already been announced (Astroparticle Physics, 2011, 34: 717-731).

- ✘ Distribution of TREND 50 Pods

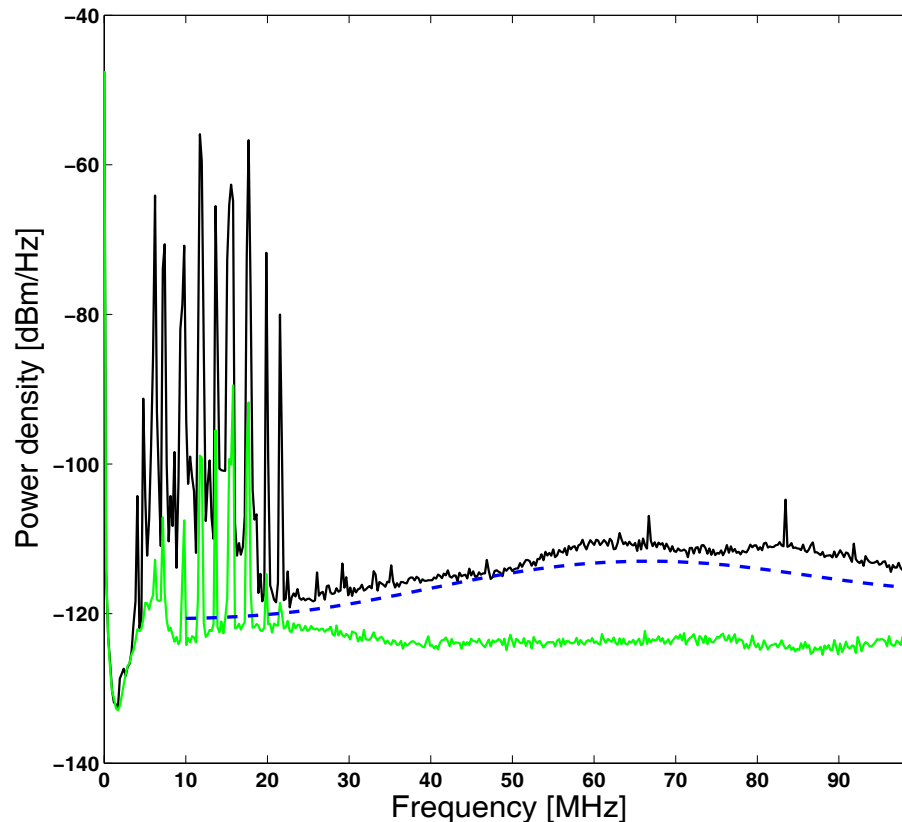


- ✘ One pod



INTRODUCTION TO THE TREND(CONT.)

- ✗ Electromagnetic environment of TREND :
 - + Noise floor is about -120dBm/Hz in 20-100MHz bandwidth



- ✗ Black is measured with 21CMA antenna and a 48 dB low noise amplifier.
- ✗ Green is measured when the cable is disconnected from antenna
- ✗ Blue is the simulated response of an idea system to the galactic signal only.



THE DAQ SYSTEM OF TREND-CURRENT

- ✗ Current DAQ system:
 - + One polarized antenna
 - + LNA and Amp Amplifier
 - + 50–100MHz Filters
 - + Optical fiber for Analog signal
 - + 8bits 200MHz ADC

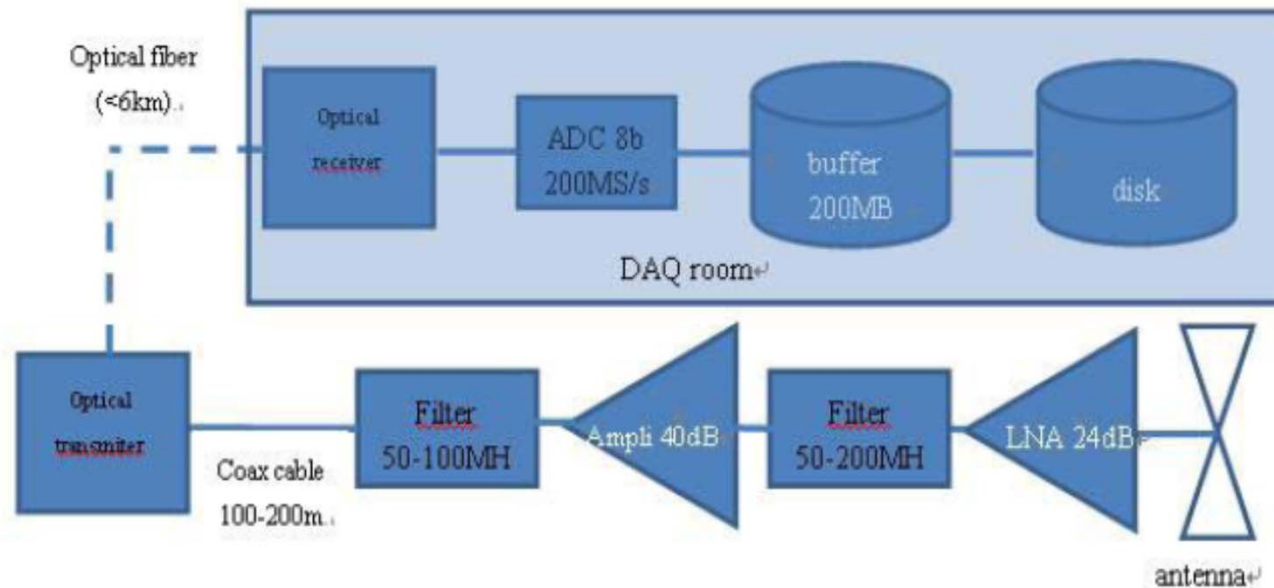
✗ LNA



✗ Filter



✗ Amp

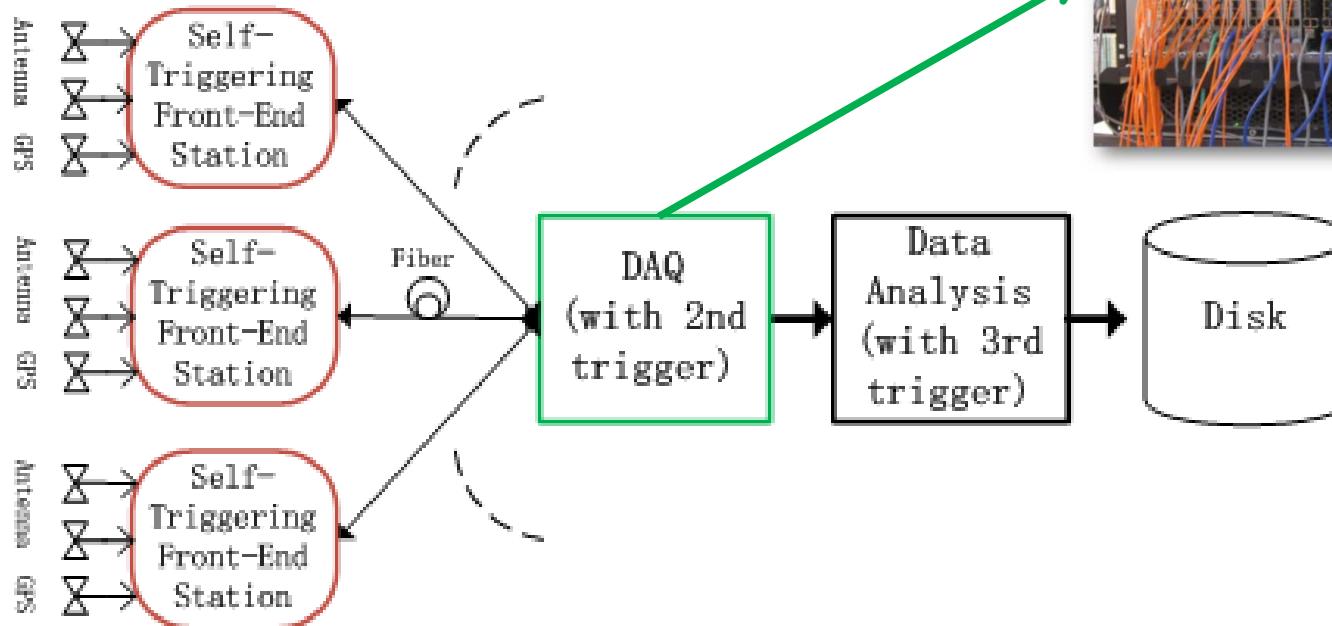
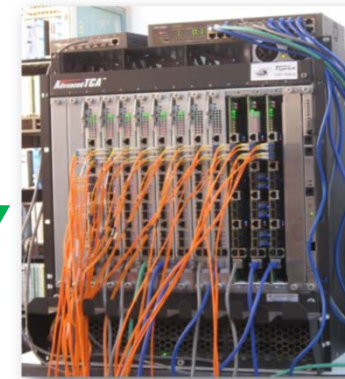


THE DAQ SYSTEM OF TREND-NEW

✘ New DAQ system :

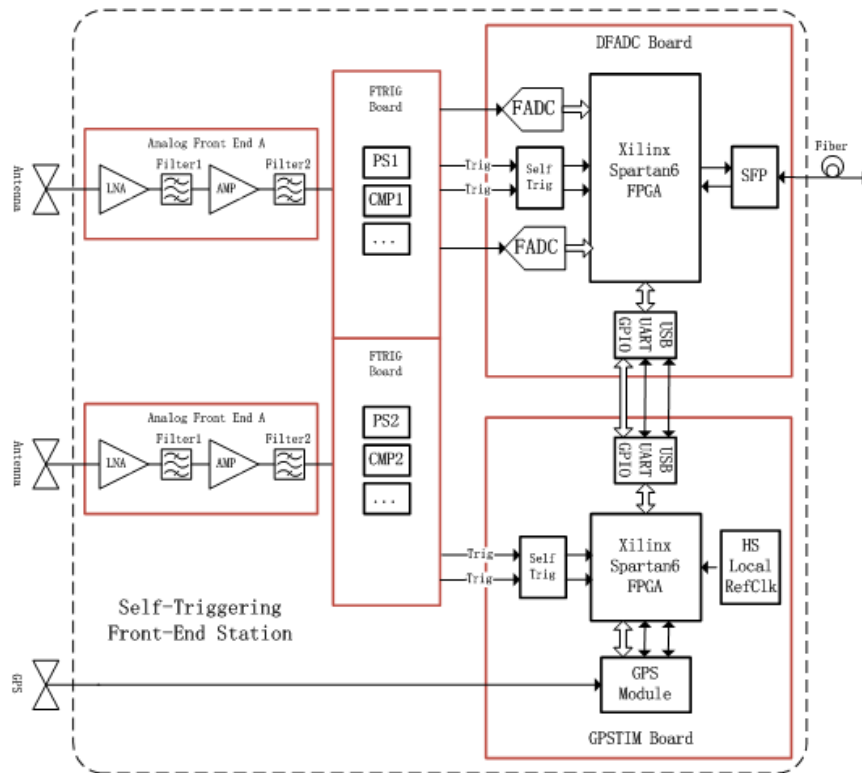
- + Two polarized antennas and One GPS antenna
- + Self-Triggering Front-End Station
- + DAQ system with 2nd trigger
- + Data Analysis with 3rd high level trigger
- + Disk array for recording the event data

✘ ATCA(MicroTCA)



THE SELF-TRIGGERING FRONT-END STATION

- ✘ Self-Triggering Front-End Station:
 - + Two Analog Front Ends for the signals from the antennas
 - + Two FTRG boards to generate the self trigger signal
 - + One DFADC board for two channel digitizer
 - + One GPSTIM board for time stamp



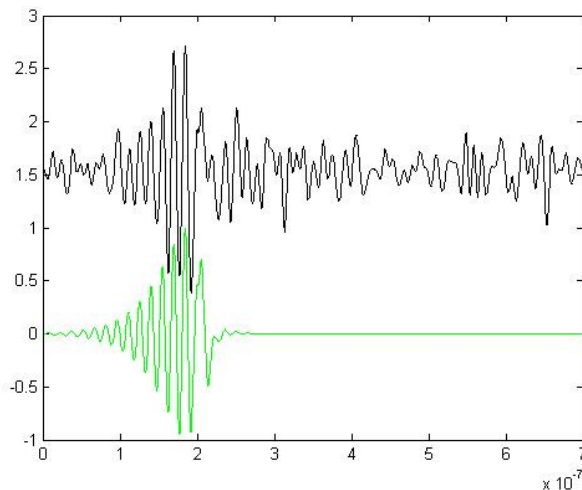
The prototype of the Self-Triggering Front-End Station without the analog front end

THE SELF-TRIGGERING FRONT-END STATION(CONT.)

- ✘ The Analog Front Ends :
 - + Make up with polarized antenna, LNA, filters
 - + Bandwidth: 20—100MHz
 - + Amplifier: 45-60dB (2Vpp suitable for ADC inputs)



The polarized butterfly antenna



Gray: the simulation signal with noise

Green: the simulation signal without noise

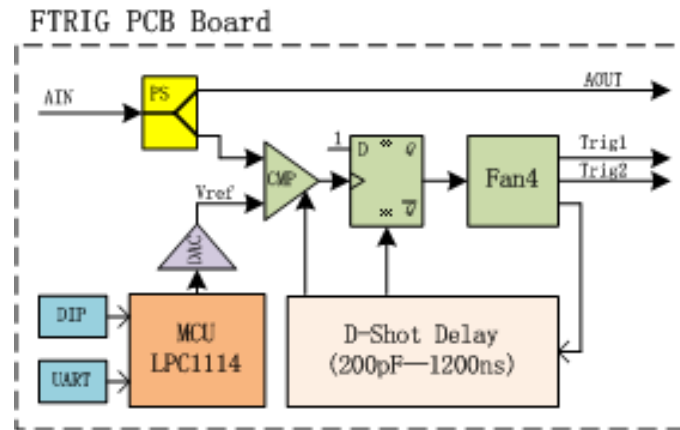


The current LNA, Filters

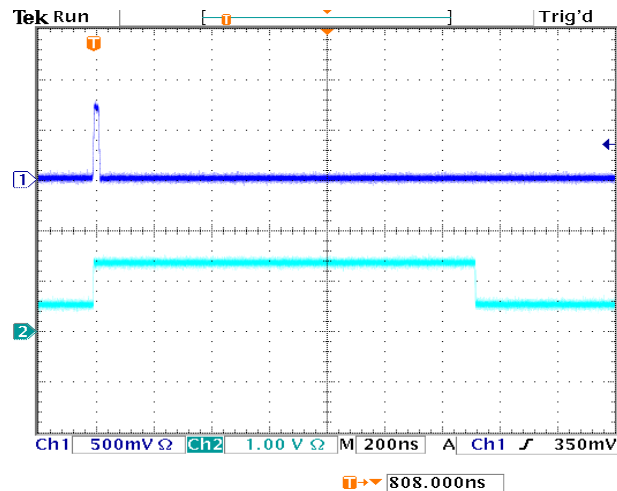
THE SELF-TRIGGERING FRONT-END STATION(CONT.)

FTRIG Board:

- + Power Splitter(-3dB loss)
- + Comparator(>100MHz)
- + DAC & MCU
- +



Function block of the FTRIG board



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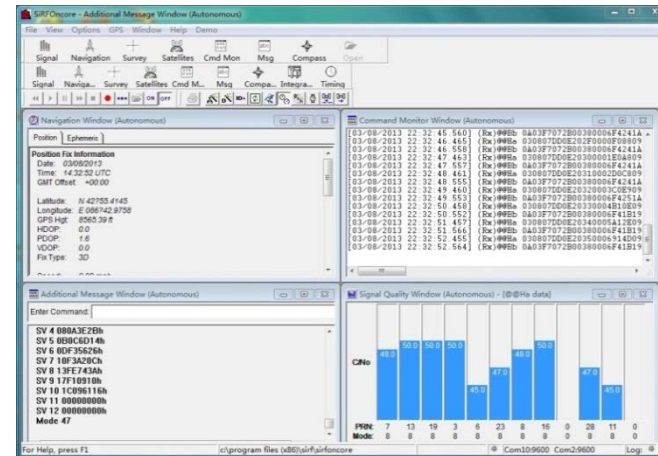
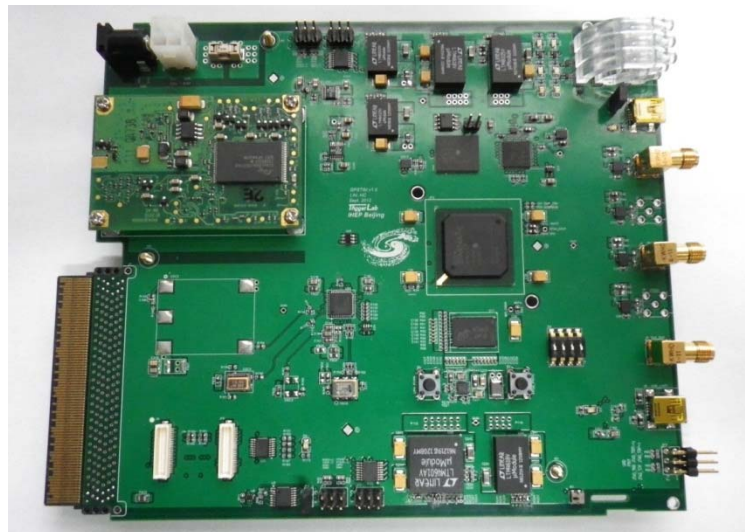
Input: 20ns 100KHz Pulse Signal
Output: 1500ns 100KHz Trigger Signal



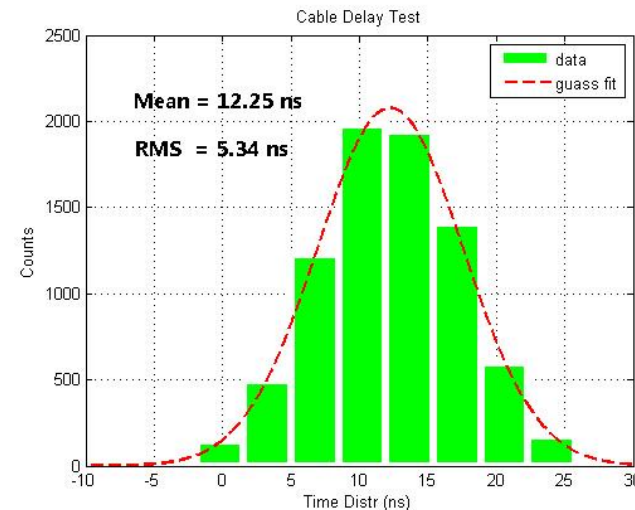
THE SELF-TRIGGERING FRONT-END STATION(CONT.)

GPSTIM Board:

- + Spartan 6 FPGA
- + GPS Module
- + High Stability Clock
- + 1Gb DDR2 RAM
- + USB peripheral Interf
- + ...



GPS signals on Ulastai in sunny day



relative precision of two GPSTIM boards
with 10 Hz pulse signal input in 800 seconds

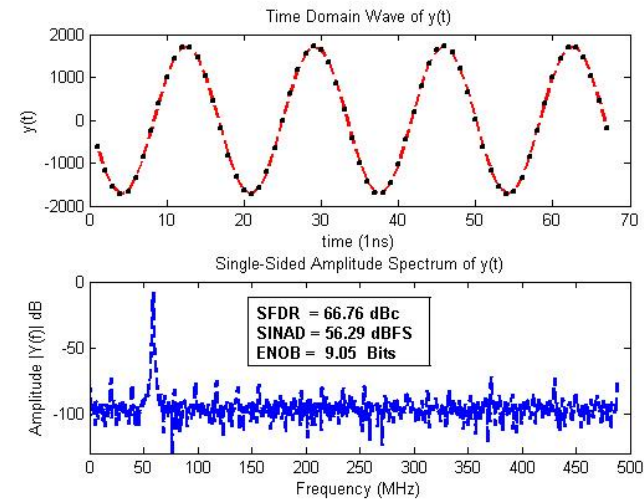
THE SELF-TRIGGERING FRONT-END STATION(CONT.)

DFADC Board:

- + Spartan 6 FPGA
- + 12bit 1Gbps ADC(2 chns)
- + 1Gb DDR2 RAM(2 Chips)
- + 2 optical Link(3.125Gbps)
- + USB host/peripheral Interf
- + ...

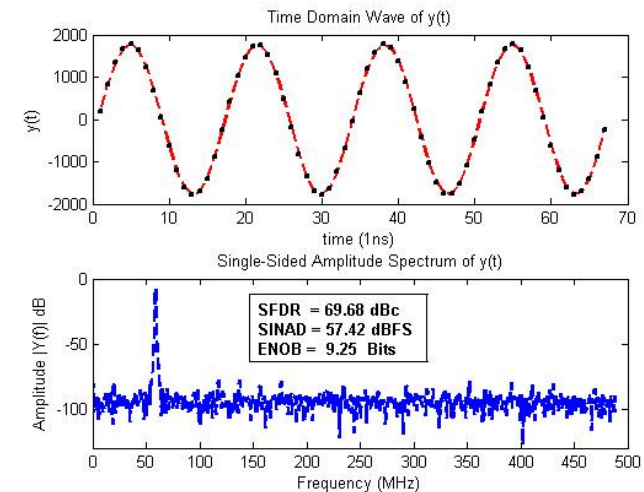


ADC1



-1.3dBFS 60MHz sine signal input

ADC2

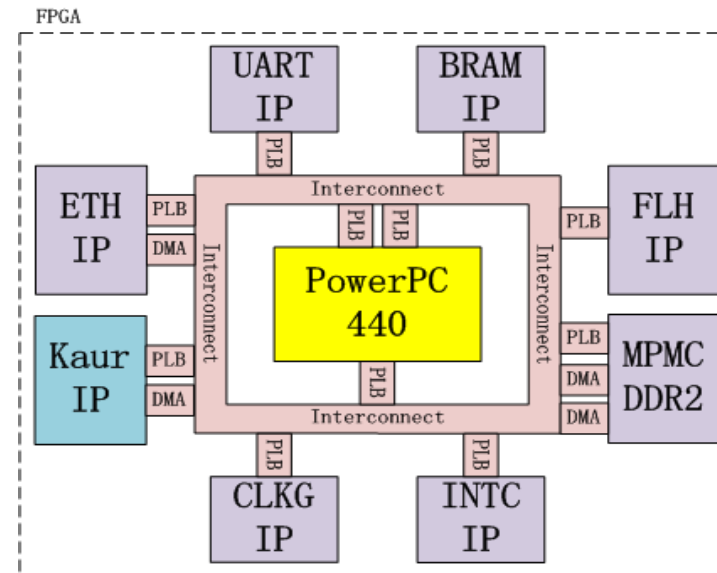


-1.3dBFS 60MHz sine signal input

THE FIELD TEST OF THE PROTOTYPE

DAQ Board :

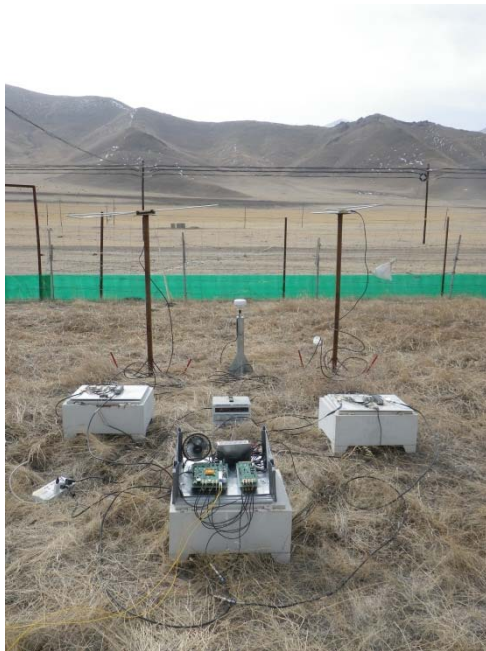
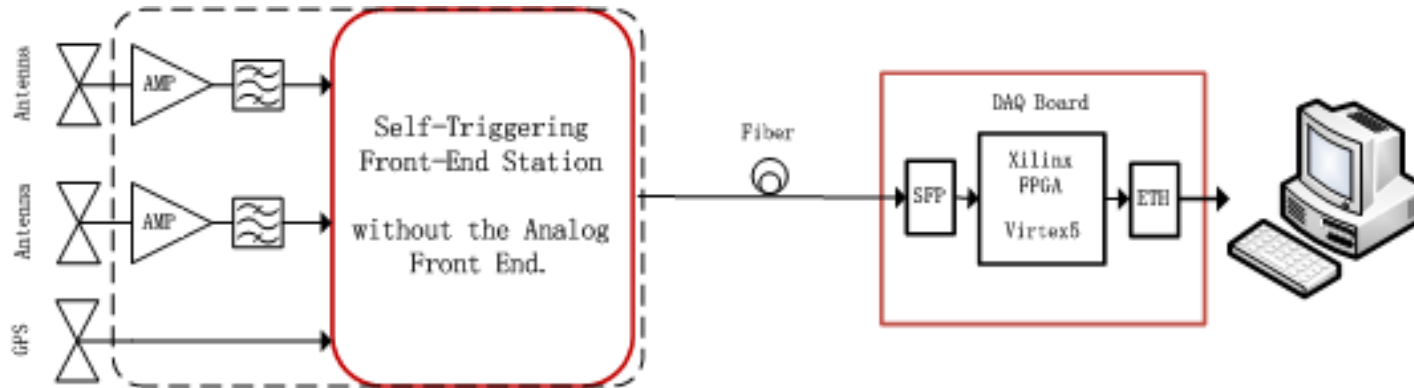
- + Xilinx Virtex-5 FPGA
- + 4 SFP interface (4x3.125Gbps)
- + 2 SODIMM memory (2x2GBytes)
- + 2 Flash (2x256Mbit)
- + 1 Gigabit Ethernet
- + AMC interface
- +



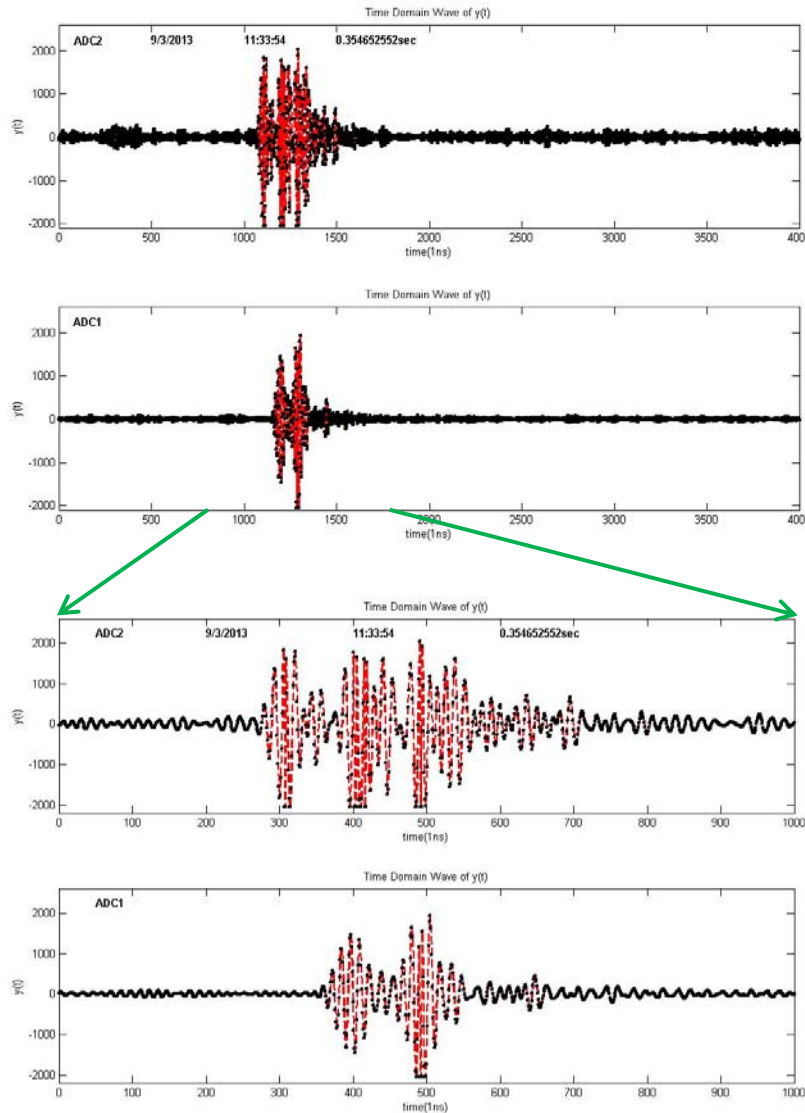
Function block of the embedded powerpc system for daq system



THE FIELD TEST OF THE PROTOTYPE(CONT.)



THE FIELD TEST OF THE PROTOTYPE(CONT.)



✘ Left Picture:

- + up is the signal from the EW polarized antenna (input signal is a little overrange)
- + down is the signal from the NS polarized antenna

✘ A small part of up picture (800:1800)



SUMMARY

- ✘ The field tests confirm a full functionality of the self-triggering front-end station for TREND
 - ✘ Could trigger on the field antennas
 - ✘ System performs well
 - ✘ Get the valuable preliminary data (the base for the optimization of the system)
- ✘ The new prototype of the self-triggering front-end station
 - ✘ Trigger rate ($\sim 1\text{KHz}$)
 - ✘ Remote slow control
 - ✘ trigger threshold
 - ✘ buffer length
 - ✘ MicroTCA ...



The End.

Thanks!

