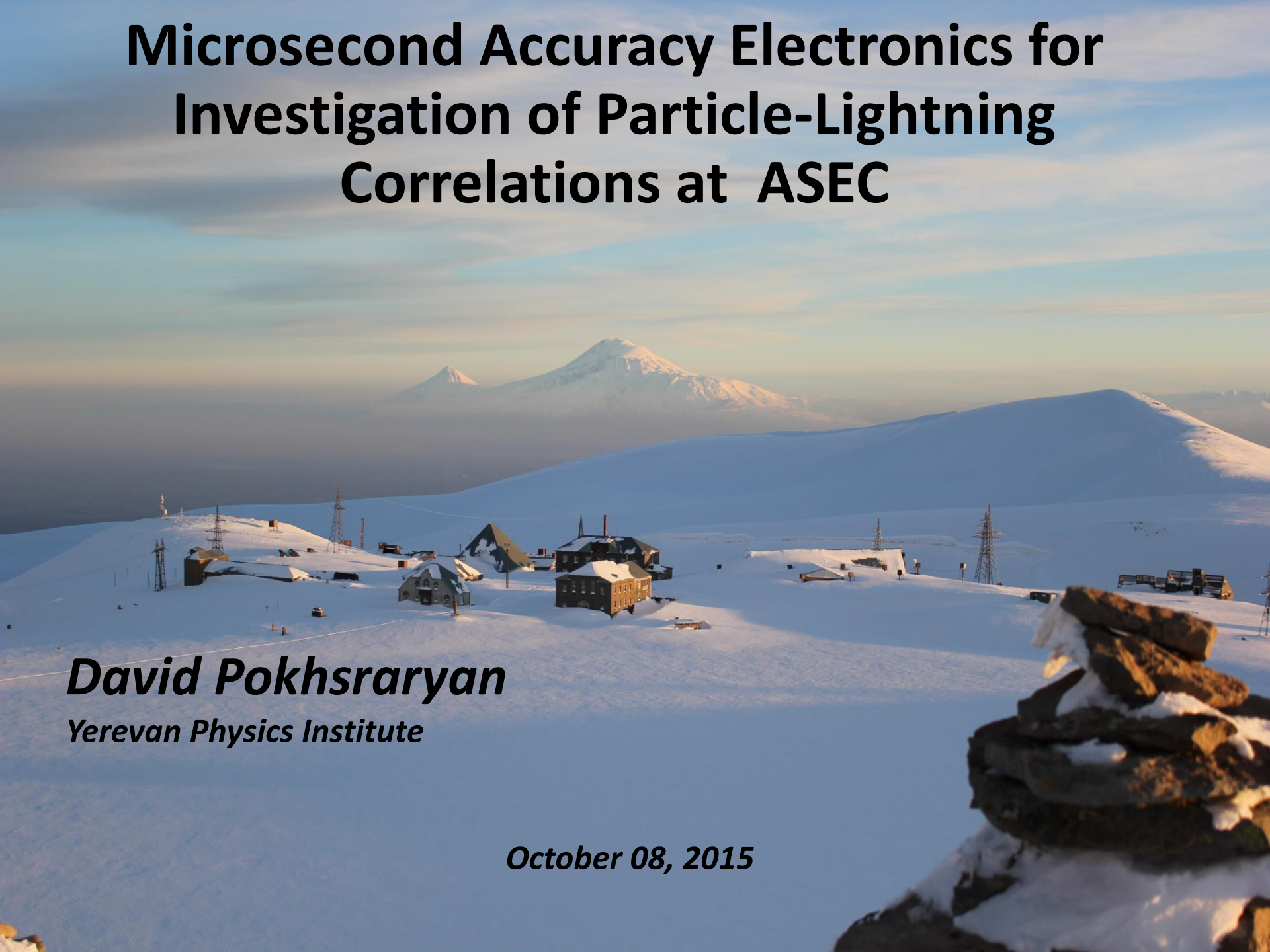


# Microsecond Accuracy Electronics for Investigation of Particle-Lightning Correlations at ASEC

*David Pokhsraryan*  
*Yerevan Physics Institute*

*October 08, 2015*



# DAQ at ARAGATS SPACE ENVIRONMENTAL CENTRE (ASEC)

- Particle detectors
- Electric field miles
- Lightning Detectors
- Weather Stations
- Magnetometers
- Cameras for optical monitoring
- UV and IR detector for registration radiation from lightning
- Nanosecond scale Electric field measurements

Goal: Investigation of particle fluxes enhancements - lightning correlations

An accurate time synchronization is needed...

DAQ PCs are synchronized using NTP Time Synchronization Protocol  
(Sync Accuracy 50-100ms).

# Requirements on Data Acquisition (DAQ) System

- **DAQ System must be equipped with a GPS synchronization for accurate time stamping.** 1PPS signals from GPS receivers anywhere in the world are all in synch, to within the accuracy of the non-military GPS system (about 100 ns.) A logic must be implemented on FPGA to records the counter value during which the 1PPS is received. This feature allows accurate time synchronization; the estimated resolution to meet is 100 ns.
- **The time span of time series must be a tunable parameter from 50ms to 60sec.**

# NI myRIO

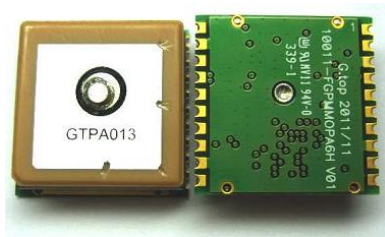


- Xilinx FPGA and dual-core ARM Cortex-A9 processor
- 10 analog inputs (12bit, 500 kS/s)
- 6 analog outputs (12bit, 345 kS/s)
- 40 digital I/O lines
- Wireless
- USB Host Port, USB Device Port

The heart of the system is NI-myRIO a portable reconfigurable I/O (RIO) device . It combines the Xilinx Zynq All Programmable SoC with a ready-to-go Linux-based real-time OS (RTOS). It places 40 GPIOs (general purpose input output), wireless capabilities, a dual-core ARM real-time processor, and a customizable Xilinx FPGA.

# GPS Module

MediaTek MT3329 Single Chip. UART interface. RTC battery-compatible, Built-in data logging. High accuracy 1-PPS timing support for Timing Applications (10ns jitter).



- Satellites: 22 tracking, 66 searching
- 1PPS Accuracy: 10 nsec
- Position Accuracy: 1.8 meters
- Warm/cold start: 34 seconds
- Jammer detection and reduction
- Multi-path detection and compensation

Up to 12 multi-tone active interference canceller. Supports up to 210 PRN channels with 66 search channels and 22 simultaneous tracking channels.

Features an “Antenna Advisor” that helps with the detections of different antenna statuses, including active antenna connection, antenna open circuit and antenna shortage.

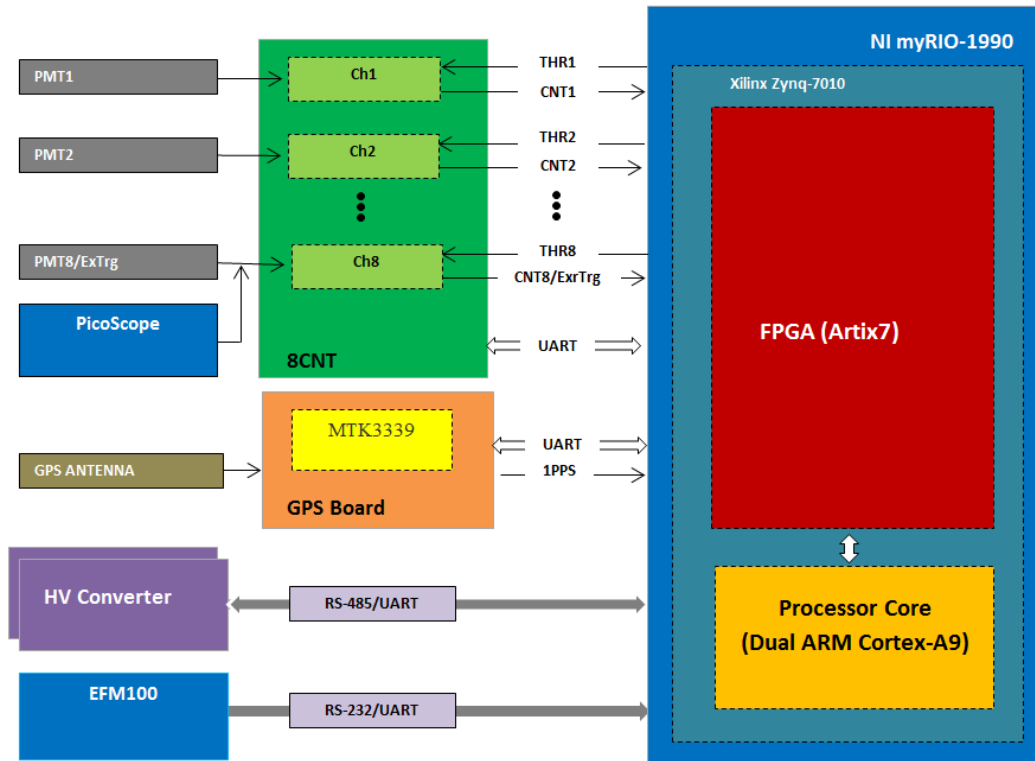
# DAQ System Description

The DAQ System comprises of :

- NI-myRIO (Xilinx Zynq All Programmable SoC )
- GPS Module with an active antenna
  
- 8-Channel Discriminator/Counter Unit (Programmable Thresholds 4mV-1000mV )
- Photomultipliers (PMT)
- High Voltage Power Supplies for PMTs with RS-485 interface
- Buffer Preamplifiers

PMTs , High Voltage Power Supplies , Buffer Preamplifiers as well as 8-Channel Discriminator/Counter Unit (8CNT) are the same as for all Aragats Space Environmental Center (ASEC) DAQ systems. They all are tested and highly integrated into ASEC infrastructure.

# System Schematic



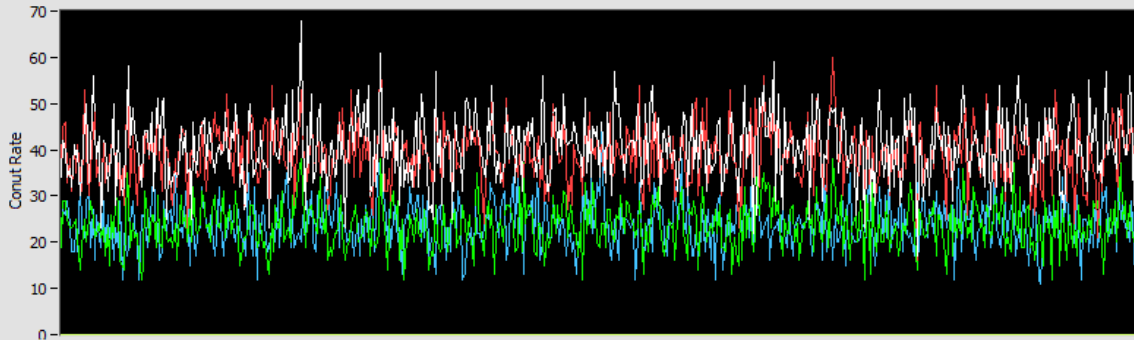
The output pulses of the LADC board are taken to the FPGA. Here is where all logic of event identifying, pulses counting and GPS time stamping is implemented.

Edit Operate

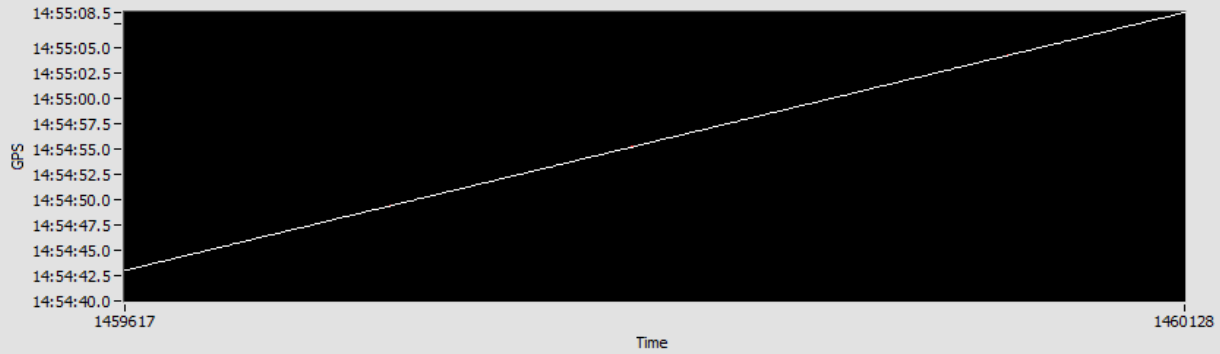
Validity	Satellite in View	GPS Time Date	E-Filed (kV/m)	x-y	
<input checked="" type="checkbox"/>	11	TimeStamp	0.02	50.0002r	
		Date Stamp		Fault	
		10:55:08.500		197	CRC

GPS Time	NTP Time	Counter ch 1	Counter ch 2	Counter ch 3	Counter ch 4	Counter ch 5	Counter ch 6	Counter ch 7	Counter ch 8
14:55:08.645	14:55:08.645	50	35	22	10	0	0	0	0



- ch 1
- ch 2
- ch 3
- ch 4
- ch 5
- ch 6
- ch 7
- ch 8
  
- GPS
- Sys



14:55:08.645  
14:55:08.645



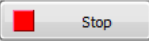
http://192.168.24.65:8000/GPS.html - Windows Internet Explorer

0/GPS.html

Count Rates GPS EFM Treshoulds System Info System Config

http://192.168.24.65:8000/GPS.html

Edit Operate

 Stop

**GPGRMC**

\$GPRMC,105025.000,A,4028.3138,N,04410.9301,E,0.28,231.70,220915,,,A\*60

**GPGGA**

\$GPGGA,105025.000,4028.3138,N,04410.9301,E,1,9,1.04,3198.0,M,17.0,M,,\*6B

**GPGSA**

\$GPGSA,A,3,29,16,26,18,15,20,27,21,13,,,,,1.35,1.04,0.87\*0C

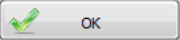
**GPGSV**

\$GPGSV,3,3,11,27,19,311,24,13,15,053,31,38,,,\*78

**\_PMTK\_cmd**

<0> 0

Data

 OK


Odometer  
20:12:06

FPGA CLK synch time (sec)  
-1

System NTP Time 14:50:25.405    GPS Time 10:50:25.000

Last synch time

TimeStamp 07:21:59.000    Date Stamp 22/09/2015

 Load GPS Time

**TimeStamp**

10:50:25.000

**Latitude**

4028.3138 [lat]

**Latitude-Direction**

North

**Longitude**

4410.9301 [long]

**Longitude-Direction**

East

**GPS-Quality**

GPS fix

**Number of Satellites**

9

**Horizontal Dilution of Precision**

1.04 [HDOP]

**Altitude above Mean-Sea-Level**

3198.00 [m]


**Geoidal separation**

17.00 [m]

**TimeStamp**

10:50:25.000

**Validity**



**Latitude**

4028.3138 [lat]

**Latitude-Direction**

North

**Longitude**

4410.9301 [long]

**Longitude-Direction**

East

**Speed in knots**

0.28 [kts]

**True course**

231.70 [deg]

**Date Stamp**

9/22/2015

**Magnetic Variation (East/West)**

0.00 [deg]

**Satellite in View**

11

**Satellite Status**

Satellite ID	Elevation	Azimuth	SNR
26	42	247	19
16	40	288	23
20	39	52	38
29	36	126	19
22	31	214	0
15	29	85	25
27	19	311	24
13	15	53	31
38	0	0	0

Done

Internet | Protected Mode: Off

100%

**Thanks for your  
attention .**

*“That's All I Have To Say About That...”*