

The KIT/BUW electronics of the AERA radio detectors

Schule für Astroteilchenphysik 2014

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IPE - INSTITUT FÜR PROZESSDATENVERARBEITUNG UND ELEKTRONIK



AUGER Project (2005-2015)

Aims

Measuring

- arrival direction
- energy
- mass composition

of cosmic-rays above 10^{19} eV (UHECR).

Method

Hybrid measurements with

- SD: **s**urface **d**etectors, Cerenkov water detectors
- FD: **f**lourescence **d**etectors

and auxiliary/associated experiments
(AERA, AMIGA, LIDAR ...)



AERA - Auger Engineering Radio Array

Aims:

Investigating the prospects of radio-detectors as a standalone alternative to conventional air-shower detectors (SD, FD).

- calibration of the radio emission from the air showers, including sub-dominant emission mechanisms, by using super-hybrid air shower measurements;
- demonstration of the physics capabilities of the radio technique, e.g. energy, angular, and primary mass resolution; and
- measurement of the cosmic ray composition in the ankle region, from 0.3 to 5 EeV, with the goal of elucidating the transition from Galactic to extra-Galactic cosmic rays.

DOI: 10.7529/ICRC2011/V03/0556

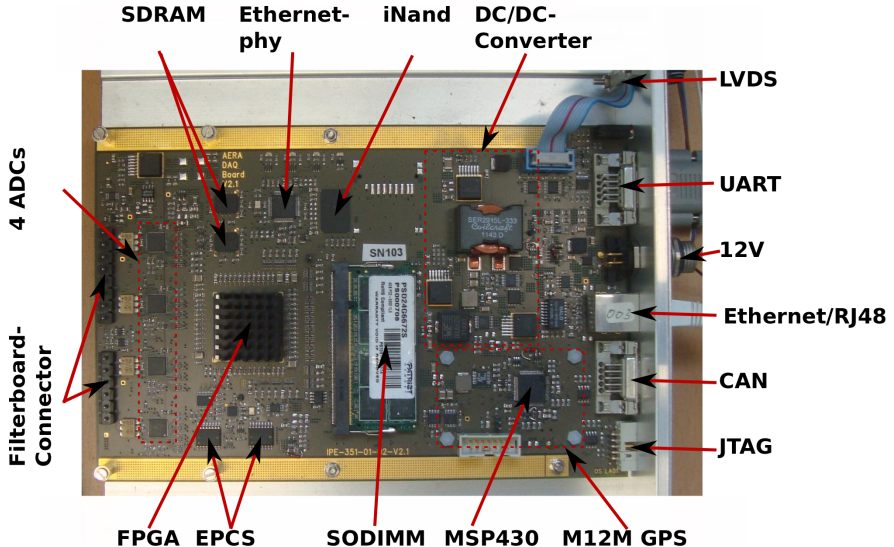
- Testing the scalability of the technology.

Advantages / disadvantages

	AERA	FD	SD
duty cycle	~100%	~10-15%	~100%
X_{max}	yes	yes	no
cost/km ² [k€]	51, 26, 6	2	6
FE trigger rate [Hz]	400		

- The trigger mechanism has to be reviewed.
 - A bigger grid should be tested.
 - Other antennas (3D), WHISK ?
-
- **Flexible front-end electronics are needed for AERA III.**

Digital Board



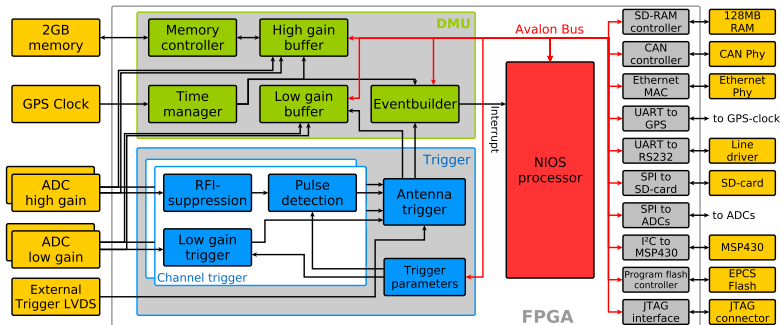
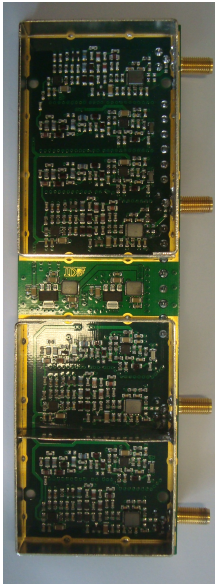


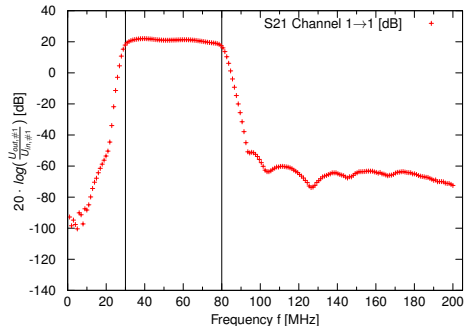
Figure : current firmware blocks V2 [C.Rühle]

DMU/Trigger \Leftrightarrow NIOS \Leftrightarrow Ports/DAQ

Analog Filter-board



- 4 channels with equal gain
- band pass filters of order 16
- attenuation -40dB, amplification 20dB
- applicable to V2



Firmware/Software for the 4-channel digitizer

FPGA-Firmware

- Changed memory access to save 1 to 4 channels efficiently

Linux driver

- Variable block size of samples to read
- Variable number and assignment of channels
- More bits to describe the time stamps

Application software

- Changes due to the new driver
- Simple configuration of the channels

Firmware and software will be available for digitizers V2 and V3

First test-results I:

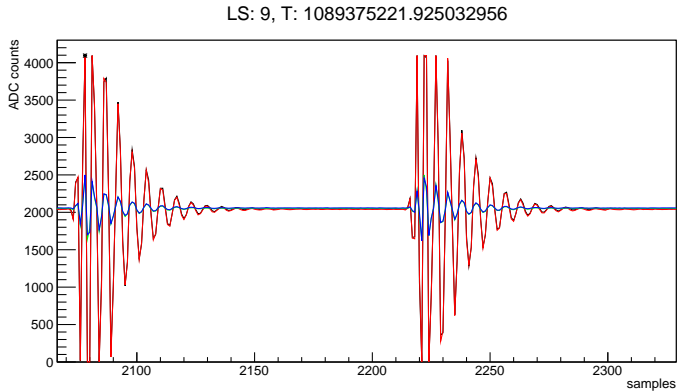
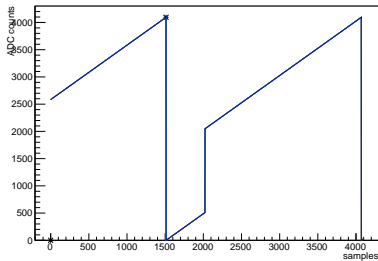


Figure : Measured test-puls in 4 channels

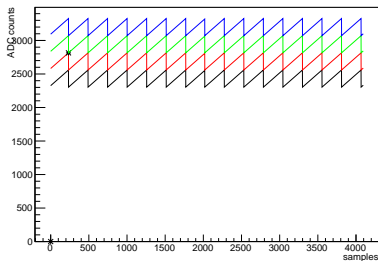
First test-results II:

Timing - Readout - Test

LS: 9, T: 1089375251.000000001



LS: 9, T: 1089375240.999999999



AERA (III) continues reviewing the prospects of UHECR radio detection.

Flexible backward compatible FE electronics are required.

Contributions of the IPE:

- 40 digitizers V3 are going to be produced.
- 42 4-channel filter-boards are going to be produced.
- 30 digitizers will be sent to Argentina.
- Firmware and Software are adapted to the new needs.