A Portable Telescope Based on the Alibava System for Test Beam Studies

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The Alibava Telescope

The Alibava based test beam telescope is a system with four tracking stations, each one built from 2 micro-strip detectors which measures track parameters with reasonable precision and determines the position of the beam particle interactions with a device under test (DUT).

Characteristics of detectors before and after irradiation, as a function of bias voltage or other variables (temperature, influence of magnetic field, etc.) can be studied in real operation conditions.

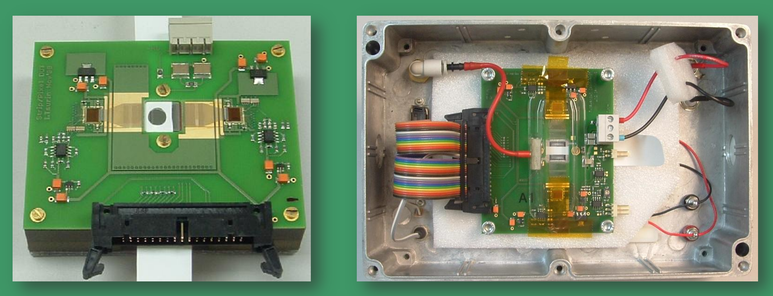
Usually, the set-up of a test beam is laborious and time consuming.

Our telescope has been conceived

-to be easy handling and portable,
-to minimize the set-up time,
-provide high resolution and high rate tracking
-with early feedback from analysis of the recorded data

Detector Boards

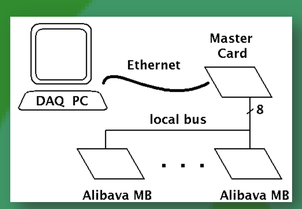
-There is a new Detector Board (DB) with two micro-strip detectors at 90 degrees.
-Each DB constitute an XY plane.
-To read out the DUT there is a new special detector board and a cooling box for irradiated detector testing.



Picture of the DUT Board (left) and the cooling box with an irradiated detector (right).

Hardware Architecture

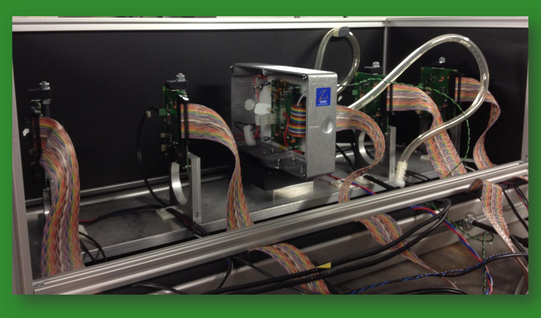
-It is based on the existing Alibava readout system we have developed a multi plane system to be used as a test beam telescope.
-Every Alibava Mother Board is controlled and synchronized by a Master Card and a PC.
-Local data/address bus between the master card and Alibava MBs.
-Log data to PC via 100M Ethernet.



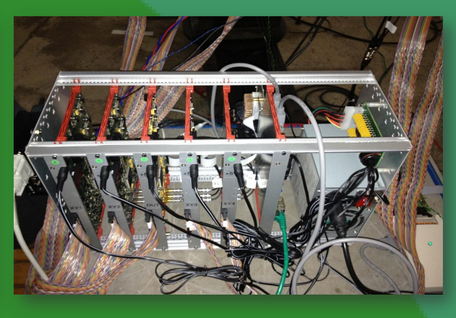
Hardware architecture scheme

Mechanics

The prototype is installed in an aluminum crate with a protecting box where are aligned the XY detector boards and the DUT.



Picture of the 4 the telescope's planes and the DUT



The ALIBAVA MotherBoards and MasterCard that control all the telescope's planes

Data Acquisition and Analysis

The Acquisition is controlled by one PC connected to the Master board via Ethernet. Clock and trigger are controlled by the Master Board and sent to the rest of MBs.

-Trigger generated by two scintillators situated at each end of the telescope
-Trigger rate is 4 kHz

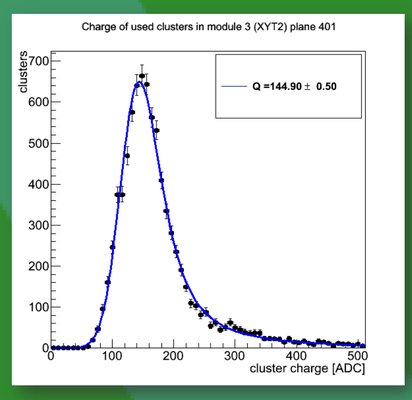
Data are stored in a binary file with the following structure:

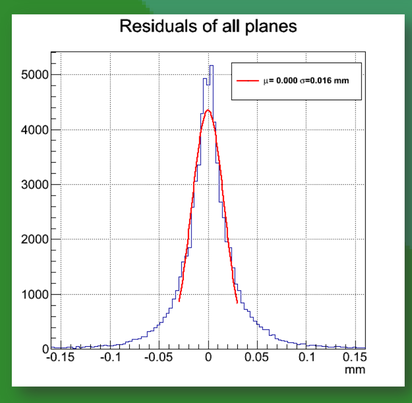
Event structure:
4 bytes event number
26 bytes DUT temperatures
5x 658 bytes motherboard data block:
6 bytes MAC header
2 bytes Status register
4 bytes Event number
4 bytes TDC value
320 bytes ADC values ASIC 0
320 bytes ADC values ASIC 1
2 bytes NTC reading

The off-line analysis software based on ROOT has been developed to study the charge collection, cluster width, tracking efficiency and the resolution of the devices under test. The track fitting is performed via the minimization of the track-hit residuals c2.

$$\chi^2 = \mathbf{r}^T V^{-1} \mathbf{r} \qquad \frac{d\chi^2}{d\mathbf{t}} = 0$$

t= *Track parameters*
r= *Residuals*

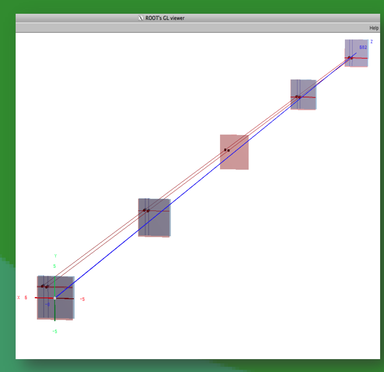




The cluster charge is defined as the sum of the charge of all channels in the cluster Channels are considered if S/N > 3

$$\mathbf{r}(\mathbf{t}) = \mathbf{m} - \mathbf{e}(\mathbf{t})$$

m= *measurement*
e(t)= *track extrapolation*



Event with two parallel tracks

The residuals are computed as the difference between measured point and the track extrapolation.

Conclusions:

- The ALIBAVA TELESCOPE is ready and operational. Tested on the beam-lines of DESY and CERN with more than one million events.
- The system allows to study the spatial resolution (16μm) of solid state ionization sensors with proper LHC speed electronics.
- The system is suitable to test high irradiated silicon detectors for the HL-LHC experiments at CERN.
- The aimed resolution for our tracker with the use of new sensors with intermediate readout strip and smaller pitch is below 10 μm.

References:

Marco-Hernández, R., et al. "A portable readout system for silicon microstrip sensors.",Nuclear Instruments and Methods in Physics A, Vol. 623, Issue 1, Nov. 2010, Pages 207–209