

# Software system for data acquisition and real-time analysis operating the ATLAS-TPX Network

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**Abstract**—A network of 15 Timepix pixel detectors was installed within the ATLAS experiment at CERN, Geneva. The network is capable of real-time measurement of the composition and spectral characteristics of the radiation fields. Its operation is managed by a dedicated software system. The presented article describes primary components of this system responsible for communication with detector hardware, online operation monitoring, remote acquisition control, automated data verification and analysis. The processed data can be accessed through an interactive web-based Data Visualization Application, which is publicly available to the scientific community.

## I. INTRODUCTION

The ATLAS-MPX Network has been installed in the ATLAS cavern at the LHC at CERN [1]. During the 2013-2014 shut-down period this network was upgraded to a two-layer Timepix design (ATLAS-TPX) with a faster readout system and improved capabilities to discriminate charged particles and gamma rays against neutrons.

Operation of the network is managed by a distributed software system comprised of several independent components:

- The Acquisition and Control Subsystem handles communication with detectors through the readout interface.
- The Data Analysis Subsystem automatically verifies and processes frames taken by detectors.
- The Data Visualization Application displays processed data in the form of pixel matrices and trace flux charts.

## II. DEVICE DESIGN

Each ATLAS-TPX device consists of two Timepix [2] readout chips with silicon sensor layers of thicknesses  $300\ \mu\text{m}$  and  $500\ \mu\text{m}$  facing each other. They are interlaced by a set of neutron converters. The Timepix ASIC (application specific integrated circuit) divides the sensor area into a square matrix of  $256 \times 256$  contiguous pixels with a pixel dimension of  $55\ \mu\text{m}$ . It allows a configuration of each pixel in either of the three modes of operation:

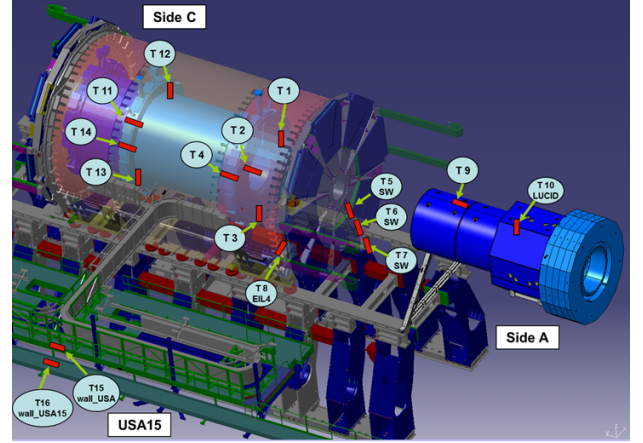


Fig. 1. Artistic view of the device positions of the ATLAS-TPX network in the ATLAS experiment.

- In the spectroscopic Time-over-Threshold (ToT) mode the energy deposition in the sensor material is measured.
- In the Time-of-Arrival (ToA) mode the time from an interaction with respect to the end of the exposure is recorded (precision up to 25 ns).
- In the counting mode, the number of interactions with energies above 5 keV during the exposure time are counted.

Data are taken in so-called frames, representing the counter contents of all individual pixels after an adjustable exposure time (often also referred to as frame acquisition time). In each frame, interacting quanta of ionizing radiation can be seen as tracks on the pixel matrix, which have characteristic shapes, depending on the particle range in silicon, its deposited energy, angle of incidence, and particle type.

## III. HARDWARE ARCHITECTURE

Given the harsh radiation environment within the ATLAS machine, ATLAS-TPX devices have to be connected to the rest of the system through a dedicated read-out interface. This interface is a special hardware device that reads data and controls acquisition of the detector [3]. The ATLASPIX interface (see Fig. 2) was developed by modifying a regular FITPix interface [4].

The interface has two parts connected by four cables. The detector itself is positioned and oriented within the ATLAS machine (see Fig. 4), whereas the rest of the interface is placed in a nearby server room, shielded against ionizing radiation. Cables connect both parts, allowing protected hardware to

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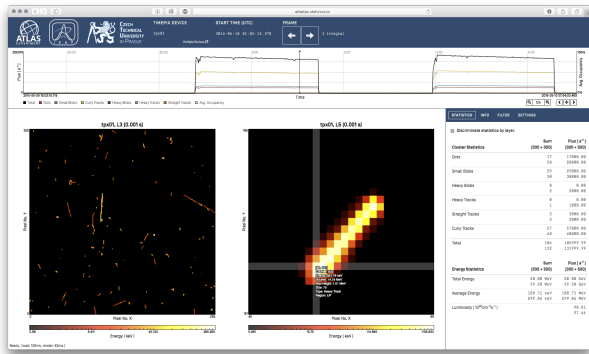


Fig. 4. Screenshot of the Data Visualization Application. [8] Top chart shows flux of characteristic traces in frames in specified time range, bottom charts show pixel matrices at a specified time.

ATLAS-TPX network. All components of the system are fully operational. The Data Visualization Application is publicly available to the scientific community upon request.

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