This work describes the present status and future evolution of the Real Time Data Acquisition with Read Out Driver System for the ATLAS TileCalimeter.

The ATLAS experiment is presently being constructed. In the year 2007 beams of protons are expected to collide at a centre of mass energy of 14 TeV. In parallel to the accelerator, two general purpose detectors, ATLAS (A Toroidal LHC Apparatus) and CMS (Compact Muon Solenoid), are being developed to investigate proton-proton collisions at this new energy domain and to study fundamental questions of particle physics.

Each detector is composed of several subdetectors, TileCal is one of these. They are prepared to read, in each collision and through thousands of electronic channels, a high data volume. Therefore, to make the integrated analysis of all their information it is necessary new real time systems. The work we present here is included in the studies and development currently carried out at the University of Valencia-IFIC for the Read Out Module (ROD) of the hadronic calorimeter TileCal of ATLAS.

The CERN (European Laboratory for Particle Physics) in Geneva is working in new particle physics research. To develop this research, a new accelerator, the Large Hadron Collider (LHC) is presently being constructed.

The RODs operate an optical-to-electrical conversion through optical receivers and ensure full compatibility with the FEB output data format.

Due to the reduced channel density of the TileCal with respect to the LAr calorimeters, the TileCal RODs can operate with 50% of the PUs and S-Link outputs (the RODs support up to four S-Link output mezzanine cards called Link Source Cards).

The TileCal ROD is a redundant data acquisition system. Two optical fibers carry the same data from the front-end electronics to the ROD. This is necessary because of radiation phenomena which could cause malfunctions inside the front-end electronics, and bit and burst errors over data ready to be transmitted to the ROD card. Therefore a primary target is to improve error tolerance, designing a pre-ROD card, called Optical Multiplexer Board (OMB), able to analyze two fibers, both of them carrying the same data, to provide the correct one to the ROD input.

The core of the ROD motherboard are the four PUs mounted as mezzanine boards (120x85 mm) on them. These mezzanine are composed of two DSP blocks each, able to treat up to 128 channels (LAr RODs) or up to 45 channels (TileCal RODs) operating in normal mode. Each DSP block is composed of an input S-Link output (the RODs can operate with 50% of the PUs of the TileCal with respect to the LAr calorimeters, the TileCal RODs can operate with 50% of the PUs and S-Link outputs (the RODs support up to four S-Link output mezzanine cards called Link Source Cards).

The main functionalities of the PUs can be summarized as:

- Dataflow management, data formatting, TTC (trigger) reception, buffering and synchronization.
- Data processing with reconstruction algorithms.
- Error detection.

Recent studies have proved the implementation and performance of Optimal Filter (OF) energy and time reconstruction algorithms simulating the operation of the DSPs. The TMS320C64x DSP family has an architecture specifically designed for real time processing with up to eight 32-bit instructions per cycle (6000 MIPS). The device is only able to operate with MAC instructions as its CPU contains multiplier and ALU units. Divisions are not allowed and only SSI instructions can be implemented.

The precision achieved with these implementations at the DSP level are similar to those obtained with an offline implementation, in all cases with TestBeam data. The plots below show a comparison of the offline and online DSP implementation of the reconstructed energy and time using OF algorithms from 2003 TestBeam data.

The construction of a OMB first prototype is finished. The verification has been realized at CERN this summer. The next step is the development of a new 9U prototype. A new functionality for OMB was proposed, which consists in the implementation of a new operation mode called "Data Injector Mode", to use the OMB like data pattern injector towards ROD for test and verification uses.

The present ATLAS combined TestBeam at CERN is operating with different subdetectors associated to a complete wedge of ATLAS. Data is being acquired for most of them with next-to-final production RODs. In particular, the TileCal modules are being readout satisfactory with a production ROD instrumented with 3 FPGA PUs with two FEI links each. Operation with final DSP PUs is expected before the end of the run, where the simulation results above will be validated with real data operation.