Quality assurance procedures for the construction of ALICE TOF SuperModules

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This paper describes the set of quality assurance procedures developed to check the status of the ALICE TOF SuperModules. Some preliminary results are presented as well.

1. Introduction

A large Time–Of–Flight (TOF) array [1] is the main detector devoted to Particle Identification for the ALICE experiment at the CERN LHC. It will allow hadron identification in the central region ($| \eta | \leq 0.9$) in the momen-

tum range from 0.5 GeV/c up to a few GeV/c.
The ALICE TOF is based on 1638 Multigap Resistive Plate Chamber (MRPC) [2,3] arranged in 90 modules. The whole structure is divided into 18 sectors in ϕ, called SuperModules (SM); five modules are grouped in a line to form one SM. At both ends of each SM special crates host the TDC boards as well as the power supply modules for front–end and readout electronics.

2. Test on the MRPC detectors and TOF modules

The great challenge of the ALICE TOF MRPC production was to garantee the same excellent performances obtained so far for all the prototypes. All the MRPC detectors have been tested during production for HV, signal short circuits and gas–gap width [4]; the overall fraction of rejected chambers is at the percent level. The whole production, as well as the modules assembly, is performed at the INFN Bologna Laboratories. The modules finished are then sent to the CERN laboratory to be arranged inside a SM.
A second level of quality assurance tests concern the TOF modules. The gas tightness is a fundamental demand; this is checked in Bologna after the MRPC insertion, when they arrive at CERN and after the SM assembly operations. Accepted leakage rates are less than 1 mb/h (the average measured value is < 0.2 mb/h). The signal connection between the MRPCs and the front–end channels is checked injecting a pulse directly on the MRPC via a special trace on the cathode printed circuit. This pulse will induce a signal on the pads and as a consequence on the full readout chain. This check is performed after the module assembly in Bologna and after the transport to CERN.
Once at CERN, all the modules are operated under cosmic rays in the Cosmic Ray Facility shown in Fig. 1 to study their global preformances. The facility contains a stack of 5 modules; two arrays of scintillator tiles with MRS APD light readout [5] placed at the top and at the bottom of the stack are used to tag cosmic rays. Modules on this facility undergo a one–week gas and HV conditioning; once the working voltage is reached a map of the modules is done with dedicated cosmic runs.

3. Test on crates and readout electronics

The ALICE TOF crates are custom VME 9U crates [6], each one containg a 12–slot VME64X bus. Two of these crates are placed at each end of a SM and house a Data Readout Module (DRM), that acts as VME master,

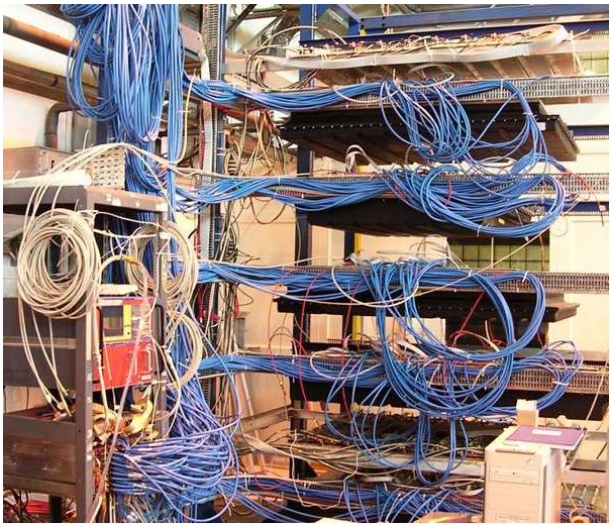

Fig. 1. Picture of the Cosmic Ray Facility at CERN with a stack of 5 TOF modules.

a Local Trigger Module (LTM) for trigger purposes, a Clock and Pulser Distribution Module (CPDM) hosted only in one crate every two, and 9 or 10 TDC Readout Modules (TRMs). The high–current low voltage for the VME boards is supplied by DCDC Converter modules placed inside the crate and designed to operate in a magnetic field (up to 5kGauss) and moderate radiation environment. Each crate fully equipped with all the VME boards is burned out and stressed for at least one week before being accepted. The crate performances including the readout electronics and the cooling system are checked during this commissioning test.

4. Test on Supermodules

A SM is assembled arranging the 5 modules on an assembly table and joining them together with aluminium supports. During and after cabling a new set of tests starts:
- *Gas system.* Gas–pipe tightness is checked before and after connecting the pipes to the modules. The pipes are filled with compressed air with an overpressure up to 100 mb; no leakage should be measured.
- *Cooling system.* The front–end cards (FEA) and the crate cooling pipes are first tested with air pressure at about 100 mb once the assembly of the SM is completed; if ok, the two complete systems are tested with water at

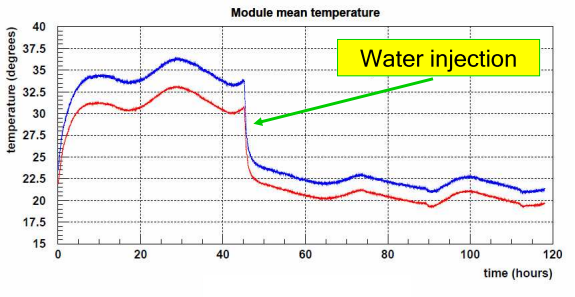

Fig. 2. Temperature test over a SM.

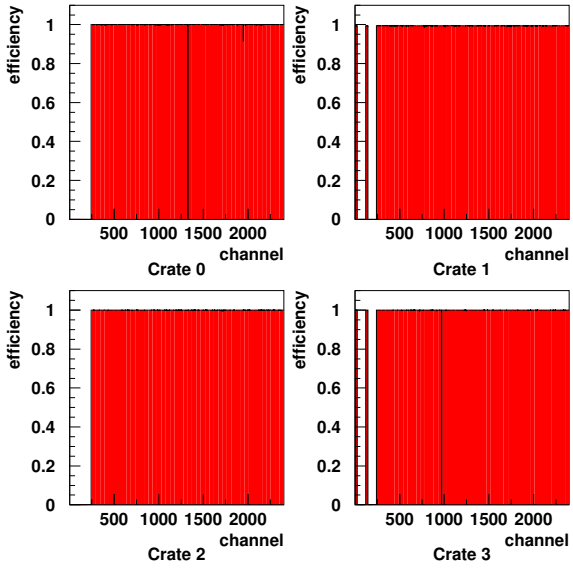

Fig. 3. Result of pulser test on SM10; from the plot only 2 dead channels over a total of 8736 can be seen.

10 bar for 20 minutes. Several tests have shown that both cartes and FEAs (Fig. 2) can be cooled to temperatures below the 25 ^oC limit required inside the ALICE magnet.
- *LV system*. Because of different cable lengths connecting the FEAs with the crates, all the LV channels have to be tuned in order to feed each FEA with the correct voltage. The LTM capability to provide the signal for the setting of the threshold voltages for more than 90 FEAs is also checked at this time.
- *HV test*. An HV up to 3kV is applied to all the MRPCs.
- *New pulser tests*. The test consists in inducing a pulse signal directly on the MRPC pickup pads and in checking the presence of the corresponding hits on the TDCs at the end of the electronic readout chain.
Fig. 3 shows the results of a pulser test over a full SM (4 crates); from the plot only two dead channels can be seen. Complementary to these tests are the noise tests, where data for a total time of about 1 second are collected without pulsing the dectector, searching for hot electronic channels. Most of bad and hot channels could be restored; the fraction of the remaining channels after the test of 11 SMs (96096 channels) is at the level of few channels over a thousand.

5. Conclusion

At the present 11 ALICE TOF SMs have been assembled and tested. Two of them are already installed in the ALICE experiment and in autumn 2007 also the others will follow. The complete installation is foreseen in the first months of 2008. Most of the tests described in this paper are repeated once the SM is installed as part of the commissioning procedure.

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