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# Final test of the MRPC production for the ALICE TOF detector

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ABSTRACT

During the autumn of 2006 a final test of a sample of double-stack MRPC (Multigap Resistive Plate Chamber) strips, randomly chosen from two years of mass production (the ALICE Time-Of-Flight detector is made of 1638 strips), was carried out at the CERN Proton Synchrotron facility. The results on the performances of the MRPCs and of the front-end and readout electronics will be presented. It is confirmed that these devices have a very good uniformity of response, a long streamer-free plateau, an efficiency higher than 99% and an "intrinsic" time resolution better than about 40 ps.



## 1. Introduction

The ALICE experiment [1] at LHC is optimized for the study of the heavy-ion collisions at a centre-of-mass energy of 5.5 TeV/nucleon pair. The prime aim of the experiment is to investigate the behaviour of nuclear matter at extreme densities and temperatures, focusing the attention on the QCD phase transition of nuclear matter into a deconfined state of quarks and gluons: the Quark Gluon Plasma (QGP).

In this scenario particle identification (PID) is a key element to study the QGP. The PID power of a very large Time-Of-Flight (TOF) system covering the central rapidity region ($|\eta|<0.9$) is of crucial importance in the ALICE experiment. The TOF system provides charged PID with momentum up to 2.5 GeV/$c$ for $\pi$/K and up to 4 GeV/$c$ for K/p. The event-by-event hadron identification allows to measure with high statistics the shape of $p_t$ distributions and the $\pi$/K/p ratios which can be used to probe the nature and dynamical evolution of the system produced in ultra relativistic heavy-ion collisions at LHC.

The TOF system [2] covers a cylindrical surface of polar acceptance $|\theta-90^{\circ}|<45^{\circ}$ and full coverage in the azimuthal angle $\phi$. The inner radius of the TOF from the interaction point is 3.70 m.

The whole system is divided into 18 SuperModules (SM) (see Fig. 1) along $\phi$ and each SM is composed of 5 Modules along $\theta$ of three different types (2 outer, 2 intermediate and 1 central). At both ends special crates contain the readout electronics (HPTDCs and controllers) as well as the slow control modules.

In order to keep the detector occupancy below the 15% level with a few $10^3$ primary charged particles produced per unit of rapidity the ALICE TOF surface (about 150 m$^2$) is segmented into 1638 double-stack Multigap Resistive Plate Chamber (MRPC) strips [3] (each of $120\times7.4$ cm$^2$ active area) for a total of 157 248 readout channels of $3.7\times2.5$ cm$^2$.

The MRPCs (see Fig. 2) are placed orthogonally with respect to the beam direction and tilted in such a way as to be perpendicular to the particle trajectory from the interaction point. To minimize the dead area, adjacent MRPCs inside the modules are overlapped by about 2 mm.

## 2. MRPC mass production

During the last two years the MRPC mass production was carried on at the INFN TOF laboratory in Bologna (Fig. 3).

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Fig. 1. Photo of one SuperModule.

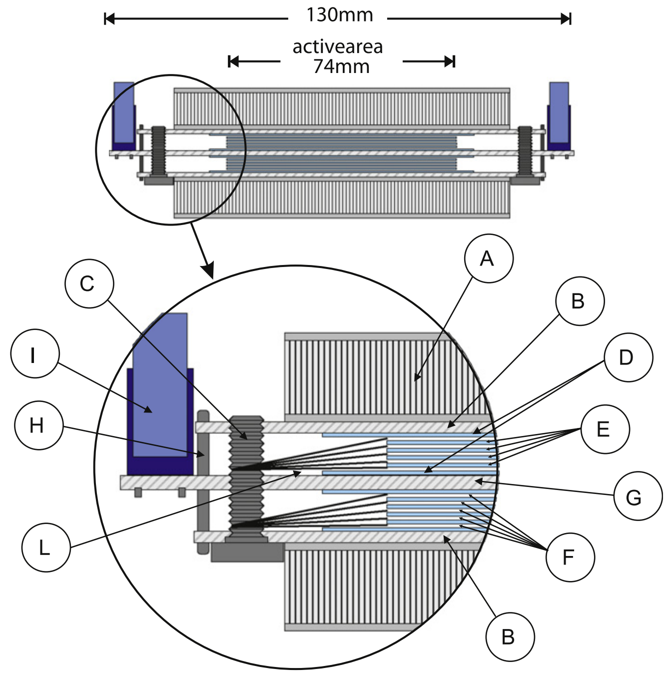


**Fig. 2.** Cross-section of the double-stack MRPC of the ALICE TOF system: (A) 10 mm thick honeycomb panel used to guarantee a good mechanical rigidity; (B) Printed Circuit Board—PCB (0.8 mm thick) with the cathode pickup pads; (C) nylon pin to hold the fishing-line spacer; (D) 0.55 μm thick external glass plates (with an acrylic paint loaded whit metal oxide) used to apply the voltage; (E) four 400 μm thick internal glass plates; (F) five gas gaps of 250 μm; (G) central PCB (1.6 mm thick) with the anode pickup pads; (H) 384 metallic pins used to bring cathode signals to central PCB and also to hold the stacks together; (I) 32 connectors for differential signals sent from the MRPC to the front-end electronics; (L) fishing-line spacers.

To simplify, automate and speed up the MRPC assembly, a series of tools and procedures were developed, as for example:

- a washing/drying system (Fig. 4) consisting of an ultrasound tank (A), two rinsing water tanks (B and C), a oven (D) and a water filtering system (E) to clean at the same time about 100 internal glass plates (E in Fig. 2);
- two fishing-line machines (see Fig. 3) used to run the spacer across the surface of the glass plates around the nylon pins (C in Fig. 2); in this way it takes only a few minutes to place each fishing-line layer.

Moreover all the components of each MRPC were checked and selected before the assembly of the single detector to guarantee the uniformity of the production. In fact a set of quality assurance tests was developed for this purpose (for more details see Ref. [4]). In particular, before the MRPC assembly the following tests were done:

- the measurement of the red-glass resistivity in five different points;
- the check of the honeycomb plates (A in Fig. 2) and PCB (B and G in Fig. 2) planarity.

After the MRPC assembly:

- the measurement of the global resistance of the resistive glass plates;
- the measurement of the gas-gap size (F in Fig. 2) in five different positions by using a microscope and a high-resolution analog CCD device;

Fig. 3. Photo of the INFN TOF laboratory in Bologna.

- the high voltage test in air up to ±3 kV;
- the signal-connector (I in Fig. 2) soldering test (there are 1664 solderings/MRPC) and the anode–cathode connections (the soldering of the pins, H in Fig. 2);
- the high voltage test in gas;
- the measurement of the efficiency and time resolution with a cosmic ray telescope on a sample of about 3%.

Thanks to these procedures and tests the total rejection of the MRPC production was less than 2%.