Scanning for fault detection of the Cathode Pad Chambers of ALICE second muon tracking station using an Amptek Mini X-ray source

W. Shaikh[1],* T. Sinha[1], I. Das[1], and S. Chattopadhyay[1]
High Energy Nuclear and Particle Physics Division,
Saha Institute of Nuclear Physics, Kolkata - 700064, INDIA

Introduction

A Large Ion Collider Experiment (ALICE) is designed to study the strongly interacting matter at extreme high temperature and/or energy density, where a new phase Quark-Gluon Plasma (QGP) is created. The ALICE is a general purpose detector for studying QGP via different signals, such as quarkonia, heavy- flavours, light hadrons, jets and photon.

The Muon Spectrometer (MS) [1] of ALICE has the capability to measure the quarkonia and open heavy flavours via their muonic decay channels down to zero transverse momentum at forward rapidity $2.5 < y < 4$. It consists of a front absorber, a dipole magnet, 5 muon tracking stations and 2 muon trigger stations along downstream of muons from the interaction point. Each tracking station is composed of two chambers. These muon chambers are constituted of Cathode Pad Chambers (CPC) and each CPC consists of a anode wire plane sand witched between two segmented cathode planes. The MS has participated in data collections with MANAS chip [2] in the various LHC beam conditions with different colliding energies, namely pp collisions at 900 GeV, 2.76 TeV, 5.02 TeV, 7 TeV, 8 TeV and 13 TeV, the p–Pb collisions at 5.02 TeV and 8.16 TeV and Pb–Pb collisions at 2.76 TeV and 5.02 TeV. It has been operational since 2007 till date.

Several problems have been encountered due to broken wire, loose wire, oxidized glue junctions and unexpected dusts during this testing. These problems are recovered during the period when there is no LHC beam usually. The detectors are then allowed to bring at ground level from the ALICE cavern which is 60 meter below the surface. In the present draft, we will report the first use of X-ray source to locate the notoriously difficult loose wire and oxidized glue junctions for the CPC quadrants of second tracking station of MS. We have used a Amptek Mini X-ray source for the above mentioned study.

*Electronic address: `wadut.shaikh@saha.ac.in`

The experimental set-up

A dedicated experimental set-up within concrete shielding has been arranged at CERN P2 buffer zone to carry out X-Ray scanning. In Fig. 1, one quadrant of 2^{nd} tracking station together with X-Ray source and the gas distribution rack have been shown.

The muon quadrants were tested with Ar/CO2 (80:20) gas flow and an operating voltage at 1650 V. The gas cylinder and the High Voltage (HV) power supply were kept out side of buffer zone and connected to the detector via gas distribution rack and long HV cables, respectively. A movable stand hold the X ray source at a maximum distance of 40 cm from the surface of detector. The detectors were irradiated with the in order to assess their stability at high ionization fluxes. The X-Ray source was typically operated at a voltage of 25 kV and a varying current up to 100 μA so that the maximum current flow in a single anode card ≈ 7 μA. The detector was irradiated for 10 minutes for each marked point of Fig. 2. During this period we had observed for possible HV trip. If such trip was observed, it was marked and X-ray source was

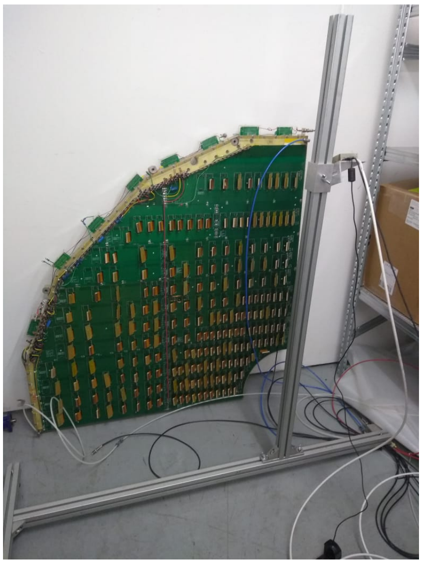

FIG. 1: Systematic arrangements of X-Ray testing.

moved to next test point at a distance of 10 cm approximately.

Results

We had tested eight quadrants of tracking station 2 of MS and localised the faulty positions. In Fig. 2 (left), the faulty positions of Chamber 3 Right/Top were marked as red marker by keeping the source at distance 40 cm from the detector. We had found trip at position "6" of the detector.

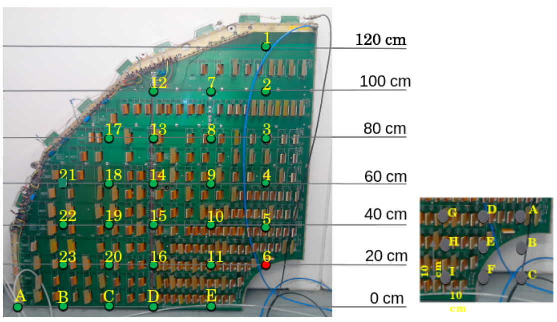

FIG. 2: X-Ray scan of Chamber 3 Right/Top detector of MS.

We had scanned horizontally and vertically in finer steps around the position "6" by keeping the source at distance 10 cm form the surface of detector as shown in Fig. 2 (right). The trips are found at position "E" and "H" of Fig. 2 (right). The faulty positions of all the detectors are reported in following Table-I.

Quadrant	Trip position
Ch3R/Q1 (top)	S1 (6)
Ch3R/Q2 (top)	S2(broken wire), S3(16)
Ch3L/Q3 (bottom)	S2(14,15), S3(19,20,22,23,A,B,C)
Ch3L/Q4 (bottom)	S1 (broken wire), S2 (10,11,D,E), S3 (23,A,B,C)
Ch4R/Q1 (top)	S1 (6), S3 (A)
Ch4L/Q2 (top)	S1 (2), S2(7), S3 (A, B)
Ch4L/Q3 (bottom)	S1 (6), S3 (17,20,A,B)
Ch4L/Q4 (bottom)	S3 (A,B)

TABLE I: Trip positions of all detectors

Conclusion

We had scanned eight CPC detectors using the X-ray source to localize the possible faulty regions in this exercise. On the other hand the HV can be raised 1650 V in all these detector if the ionization radiation is absent. This clearly indicates the presence of dielectric materials on the cathode surface which charges up in the presence of the ionization radiation providing a leakage path to the HV on the anode wires. These problems will be addressed in future as a part of High Voltage upgrade work for those detectors.

References

[1] **ALICE** Collaboration, B. B. Abelev *et al.*, "Performance of the ALICE Experiment at the CERN LHC" *Int. J. Mod. Phys.* **A29** (2014) 1430044, arXiv:1402.4476 [nucl-ex].

[2] **ALICE** Collaboration, P. COURTAT *et al.*, "The electronics of the Alice Dimuon Tracking Chambers" **ALICE-INT-2004-026**.