The electronic readout design of the Second Tracking Station of ALICE-MS to comply with High Luminosity LHC Beam

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Introduction

ALICE is designed to perform measurements of high-energy nucleus-nucleus collisions in order to study quark matter at extremely high temperature and very large energy density. In particular, ALICE focuses on the properties of the hot and dense matter created in ultra-relativistic heavy ion collisions. The ALICE experiment features tracking to low transverse momentum as well as a variety of particle identification techniques, and jet identification.

After the LS2 (Long Shutdown during 2019-2020), ALICE will focus on rare probes, such as heavy-flavors, quarkonia, photons and jets with the improved precision using high luminosity beam (L = 6 x 10^{27} cm^{-2} s^{-2}) provided by the LHC and to collect 10 nb^{-1} at the collision rates of 50 kHz for Pb-Pb collisions in Run3 [1].

The Muon Spectrometer (MS) of ALICE is a unique detector of LHC which has the capability to measure the quarkonia and open heavy flavour down to zero transverse momentum at forward rapidity 2.5<y<4. The existing muon chambers are based on multi-wire proportional chambers called Cathode Pad Chambers (CPC). The MS of ALICE detector consists of 5 tracking stations, each station composed of 2 chambers. The first two stations are based on a quadrant structure, smaller in size and thus contain high density readout lines across the detector. In contrast, the stations at the downstream side have well separated electronic lines due to lower channel densities. The flexible kapton cables with 64 electronic channels from the cathode planes of all muon detectors are connected with the Front-End-Electronics (FEE) and the existing muon chambers will be used for the experiments with high luminosity LHC beam.

Muon System upgrade

In order to collect data with interaction rate of 50 kHz, the design of readout rate has been set to 100 kHz as safety margin. The existing FEE are needed to be replaced. The ASIC chip SAMPA will comply with this high rate collision and this chip will be used replacing the existing MANAS chip of five tracking stations of the ALICE-MS. The upgraded FEE will be connected via GBT optical links to the common readout unit (CRU). The SAMPA chip can read the detector signal either after the arrival of external trigger or in continuous self-triggered readout mode. The data flow will be reduced by the online computing system and then sent to the offline system. The layout of Muon tracker system upgrade is shown in the Fig.1.

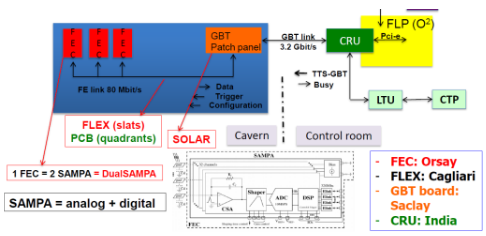

Fig. 1 A schematic diagram of Muon Tracker readout in Run3.

The electronic readout (R/O) of Second Tracking Station

The Second Tracking Station of ALICE-MS is being designed, fabricated, installed and commissioned by Indian collaborators (Saha Institute of Nuclear Physics and Aligarh Muslim University). Therefore, the responsibilities of design and fabrication of upgraded R/O has been taken by Indian group of Muon collaboration. Each CPC quadrant has two electronics readout planes i.e. the bending (B) and the non-bending (NB). The FEE of each plane (B/NB) of CPC quadrant has been segmented in seven Printed Circuit Boards (PCB). The Fig.2 shows the arrangement of the PCB for Second Tracking Station.

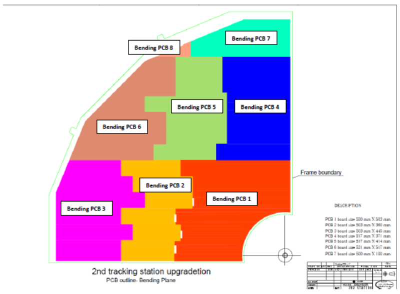

Fig. 2 The arrangement of PCBs on CPC quadrants of Second Tracking Station.

The status of the production of prototype PCB for upgraded R/O

Each PCB has maximum 6 rows of readout lines. Each row consists of maximum three blocks of 5 Dual Sampa (DS12) cards. The cathode of B/NB plane of CPC quadrant has 221 flexible kapton cables which are connected to DS12. Each five blocks of DS12 is connected with EHF connector. These EHF connectors are connected to SOLAR card using a flat, long ribbon cable. The SOLAR card is connected to the DAQ board through a optical fiber cable. The bus lines of each PCB has both analog and digital voltage supplies through common ground. The Table 1 shows the number of DS12 for each PCB of B/NB plane.

Table 1: The number of DS12 for each PCB of B/NB plane

PCB #	No. of DS12	No. of blocks of 5
1	79	16
2	30	6
3	23	5
4	35	7
5	25	5
6	20	4
7	9	2
8	-	
TOTAL	221	45

The prototype of PCB-2 of bending plane has been fabricated in the company ‘Keerthi Industries Limited’ at Hyderabad, India. The full PCB has been tested using the DAQ setup at SINP, Kolkata. This In-house work has been done during the end of August, 2018. So, the In-house test bench is ready to test all PCBs in prototype and production level. The PCB-2 has been tested with Minimum Ionizing Particles (MIP) which are muon beam at SPS, CERN, Switzerland in the second week of September, 2018. The test result is satisfactory with few modifications of the PCB fabrication are required. The Fig.3 shows the prototype of bending PCB-2 is being tested in the set ups of In-house and Test beam at CERN.

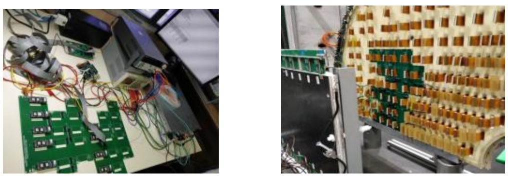

Fig. 3 The prototype of bending PCB-2 is being tested in In-house and Test beam at CERN.

References

[1] Nuclear and Particle Physics Proceedings 267–269, 382–391 (2015).
[2] ALICE-TDR-Draft V1.1, October 28, 2013.