Tracking System of the muon spectrometer

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L'installation des chambres à fils de type latte des stations de trajectographie 3, 4 et 5 a débuté au CERN en 2006 et s'est poursuivie jusqu'au démarrage du LHC. Cette installation a été menée en collaboration avec les équipes du CEA (Saclay-France), de l'IPN d'Orsay, de l'INFN (Cagliari-Italie) et du PNPI (Gatchina-Russie). L'ensemble de la chaîne de détection du spectromètre ainsi que les logiciels associés ont été testés avec succès au CERN. Le système de trajectographie des muons pourra acquérir et analyser les données des premières collisions proton-proton.

Slat description:

The main idea of the 41 slat design is to reduce the material budget by reducing all metallic parts of the detector except the anode wires and the copper of the PCB. Consequently, only composite and synthetic materials are used in the assembly process of the slat. The anode plane is made with 20 microns diameter Tungsten Rhenium wires glued with epoxy resin on a Noryl spacer. The positioning (pitch and gap) of the wire is achieved by a V-shaped groove. The anode wire pitch and the anode to cathode distance are 2.5mm. Thus the two cathode planes are separated by a 5mm gap filled with Ar-CO_2 (80:20) gas mixture. Each cathode plane is glued on a 8.4mm thick carbon sandwich panel made with two 200µm carbon skins separated by a 8mm Nomex honeycomb layer. To minimize the electronic noise, the capacitance has been decreased by gluing a 0.25mm Nomex foil between the PCB and the carbon sandwich. The cathode pads are printed on 400µm thick FR4 board. The dimension of a slat's active volume could range from $80\times40mm^2$ up to $2400\times40mm^2$. The slat near the beam pipe have half-moon or rounded shapes. The size of the pads is $25(50 \text{ or } 100)\times5mm^2$ in the bending plane and $7.14\times25(50 \text{ or } 100)mm^2$ in the non-bending plane (respectively named density 1, 2 and 3).

The front end electronics is plugged sideway from the active area. The so-called MANU card [1] is equipped with 4 MANAS (former Glassiplex) provided by Saha (Kolkata-India) and a MARC chips. The 16 channel MANAS chip pre-amplifies and shapes the signal from the pads. The multiplexed readout is steered by the MARC chip. The continuity of the readout bus between two PCBs is performed via a bridge board. The connection between the readout card (CROCUS), via the bus-patches (flat cable), and the slat is done with the translator board.

These slats equip the three last stations (over 5) of the DiMuon tracking system. Each of these stations is formed by two parallel chambers themselves composed of two half-chambers located from each side of the beam.

Installation and commissioning:

The production of slats finished in 2006. Then the installation on-site has started during 2006 summer. First every detector has been tested in gaz and read-out. High voltage has been also turned on to check if they could stand the nominal value (about 1650 V). The response of the slats has been tested using a radioactive source by monitoring the drawn current. When if all these tests were successful, slats have been mounted on their frame corresponding to one half-chamber. When detectors have been installed in the cavern (see fig. 1), all services

(voltages, gaz) were plugged and the connection to the CROCUS done. Then the same tests were performed once more to check if the transportation did not damage the detectors. Finally, the CROCUS crates were connected to the LDCs (Local Data Concentrators) therefore the Tracking system could have been controlled from the Alice Control Room with the ALICE data acquisition programs. The good behaviour of the spectrometer has also been tested during the cosmic run periods (from December 2007 to June 2008).

Software Development:

A big effort has been provided on the software part of the Tracking project both in the on-line and off-line parts. The Detector Algorithm (DA) has been developed in order to compute from calibration data the pedestal and noise of every channel, in order to determine the thresholds to apply for the zero-suppression, but also their gain. The so-called “shuttle” has been written to get these data and the voltages and send them to the Off-line Condition Data Base (OCDB), which contains information useful for the reconstruction of tracks. The DiMuon Tracking System plug-in has been developed for the on-line monitoring programs, which were used during the commissioning and the cosmic runs. The performance of the clustering and reconstruction algorithms has also been ameliorated. The contribution of Subatech to these topics is important and recognized by the collaboration.

The DiMuon Tracking System will be able to acquire data and to perform analysis of the first proton-proton collisions in 2008.

References

[1] P. Courtat, B. Espagnon et al., ALICE-INT 04-026 (2004).

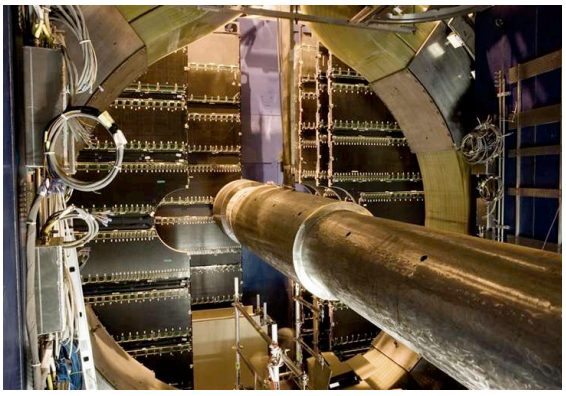

Fig. 1 : View of half-chambers of stations 4 and 5 from inside the dipole. Here station 3 was missing and detectors were not set in final position.

Les laboratoires du CEA (Saclay-France), INFN (Cagliari-Italie), PNPI (Gatchina-Russie) et SUBATECH (Nantes-France) sont responsables de la construction des 162 chambres a fils de type latte. L’originalité de ces dernières est d’être montée avec des matériaux composites afin de limiter la matière traversée par les particules. Des techniques et des composants novateurs ont été utilisées afin de répondre aux exigences de la physique (une résolution spatiale des chambres meilleure que 100µm dans le plan de déviation du spectromètre). Notre laboratoire a contribué de façon importante à l’élaboration des parties mécaniques (panneau sandwich, espaceurs, etc..) mais aussi dans les parties électroniques (cartes, circuit imprimés, etc.).
L’installation en caverne des lattes a duré 2 ans de 2006 à 2008 au CERN. Durant cette période, tous les détecteurs ont été testés en lecture, en tension et en gaz. L’inclusion de ce détecteur dans le système d’acquisition de l’expérience ALICE a été un succès. Les périodes de tests lors des prises de données en cosmiques ont permis de valider le bon fonctionnement du détecteur et des procédures de calibration.
Une part importante des logiciels utilisés en ligne a été développée, testée et validée. Le logiciel d’analyse a été amélioré notamment la partie concernant la reconstruction des traces.
Le système de trajectographie des muons d’ALICE est prêt pour les premières prises de données de 2008.
Le groupe de Subatech est impliqué à tous les niveaux de ce projet et sa contribution est reconnue par la collaboration.