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МЕТОДИКА ФИЗИЧЕСКОГО ЭКСПЕРИМЕНТА

CONSTRUCTION AND TESTING OF THE ALICE TRD CHAMBERS AT LHE, JINR

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The current status of construction and testing of Transition Radiation Detectors (TRD) for ALICE at LHE, JINR, is presented. The main purpose of this detector is electron identification at intensive pion background. The whole ALICE TRD system is comprised of 540 wire chambers of total sensitive area ~ 750 m^2. Each chamber consists of drift and amplifying gaps and a radiator. A hundred such TRD chambers will be constructed at LHE, JINR.

Представлен статус работ по созданию и тестированию камер в ЛВЭ ОИЯИ для крупнейшего в мире детектора переходного излучения ALICE TRD. Главной задачей детектора (TRD) является идентификация электронов в присутствии большого фона пионов. TRD состоит из 540 камер с общей чувствительной площадью ~ 750 м^2. Каждая камера включает в себя дрейфовый и усилительный промежутки, а также радиатор. 100 TRD-камер будет изготовлено в ЛВЭ ОИЯИ.

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The ALICE experiment is designed for the study of the physics of strongly interacting matter and quark–gluon plasma in nucleus–nucleus collisions in the new large hadronic collider (LHC) at CERN [1]. Transition radiation detector (TRD) is one of the major components of ALICE setup. The main task of TRD is electron identification with a high efficiency and the work-out of trigger signal for the electrons with a high transverse momentum [2]. The detector consists of 540 wire chambers (12 types of size). The total sensitive area of TRD is ~ 750 m^2, the number of electronics channels is about 1.2 million [3].

Each chamber is a real transition radiation detector, containing a 48 mm thick radiator and a readout chamber (Fig. 1). The chamber contains a 30 mm drift gas gap and a 7 mm conventional wire amplification gap followed by cathode pad readout plane with rectangular pads of average size 7.25×87.5 mm. The drift and amplification gaps are separated by the cathode wire plane. The anode wire plane is centered between the pad plane and the cathode wire plane. The 20 μm diameter gold plated tungsten wire is used for anode plane with a pitch of 5mm. The cathode Cu–Be wires are 75 μm in diameter and have a pitch of 2.5 mm. The cathode wire plane and pad readout plane are kept at the same zero potential (ground). The induced positive signal on the pad plane is read out by front-end electronics.

Mass production of TRD chambers was started at JINR, Universities of Heidelberg and Frankfurt, GSI (Darmstadt) and NIPNE (Bucharest) in 2005.

For TRD chambers construction and testing at the JINR Laboratory of High Energies a new laboratory was equipped with «clean» rooms (with a total area of 120 m^2). This is necessary for construction and testing of more than 100 chambers of six types of size with a sensitive area of about 1 m^2 (total 103 chambers). The construction of a chamber is divided into three major steps:

a) gluing of chamber boxes (together with a radiator) and gluing the pad panel,

b) winding and transfer of cathode and anode wires,

c) assembling of a chamber and its testing.

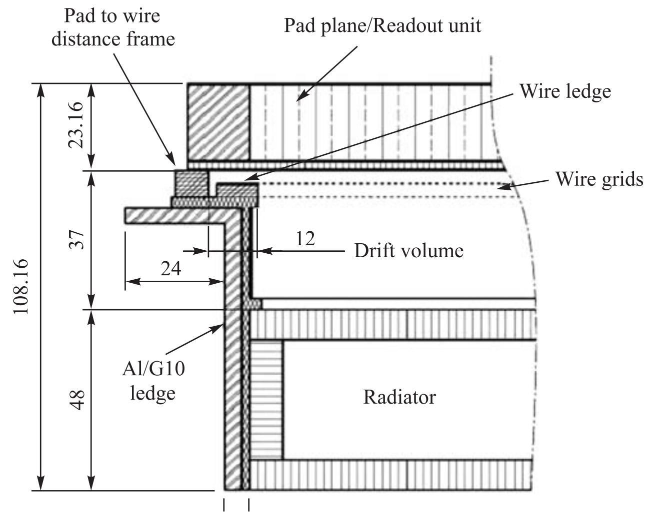

Fig. 1. Cross section of the readout chamber

Two precision assembly tables with a flatness better than 30 μm are used for gluing chambers' boxes. Gluing of the pad panel is made on the vacuum table, which provides also flatness better than 30 μm.

The transfer of wire planes on a chamber's box is carried out in «clean» rooms, which are equipped with the climate control, that makes it possible to hold the constant temperature of 24° and the humidity of 35% at most. Two wire planes (anode and cathode) are prepared for each chamber on a computer-controlled winding machine, which allows one to make wire winding with different tension and pitch. Over each working place, where wire planes are transferred onto a chamber's box, additional filters of air purification are installed to provide a purity class better than 10000. The position of wire planes on a chamber is corrected with the microscopes up to 20 μm (Fig. 2).

TRD chambers are constructed as completely glued (nondismountable) modules. It imposes some extra strict requirements upon the technology of their construction and testing. Each chamber is tested four times during construction. The first time dark current is measured with HV of 1800 V on the chamber anode immediately after the cathode and anode plane transfer, in order to remove (if necessary) badly cut wire's tips. The second time this procedure repeats after the epoxy glue polymerization in construction gaps (to check insulating

Fig. 2. Wire's plane transfer onto TRD chamber frames

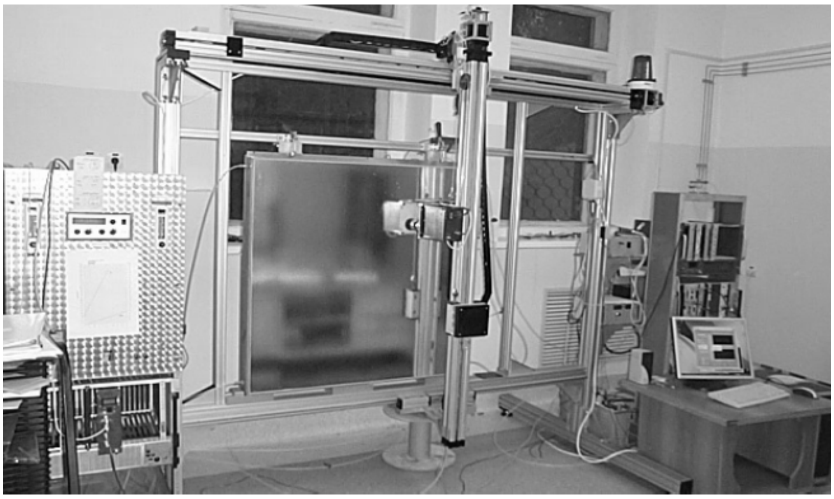

Fig. 3. Test setup in a new laboratory

parameters of the glue). After this a not yet glued chamber (the pad panel is glued by scotch tape) is tested on the computer-controlled test stand (Fig. 3). This stand is equipped with an X-ray tube which can move with a high accuracy in x, y directions and makes it possible to scan the full area of the chamber. Additional scanning (perpendicularly to the wires of the anode plane) by a «flat» X-ray beam (using a slit collimator) with a pitch of ~ 2 mm makes it possible to find badly soldered anode wires. In this case, the local modification of a signal from the anode plane (more than 10%) shows that there is such a wire. So, this allows one to improve the defect at this stage. However, such a modification of the signal from the anode plane may be caused also by some radiator's defect. Double scanning with different angles to the wires makes it possible to define the reason of the signal fluctuation. If no defects are detected, the chamber can be completely glued.

The finally glued chamber is tested one more time again. In Fig. 4 the anode current is shown as a function of the X-ray tube position along the lines perpendicular to the anode wires. This plot shows a uniformity of gas amplification on the chamber's area. The nonuniformities of current (up to 80 μA) are defined by the walls of the radiator cells. Since the total chamber area is more than 1 m^2 the pad panel can be deformed by additional gas pressure inside the chamber and the gas amplification at the central chamber area will be decreased. Additionally, the chamber gas amplification as a function of anode high voltage is measured. The gas amplification is about 10^4 at the anode high voltage of 1600 V and at drift voltage of 1985 V for 70% Ar + 30% CO_2 gas mixture.

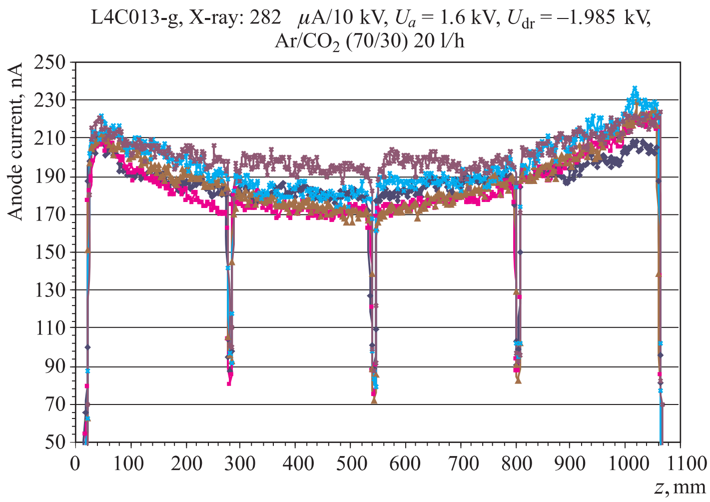

Fig. 4. Relative gain over the whole L4C0 chamber

The important point here is its gas tightness. The level of gas leakage is defined by measuring oxygen content in gas of the chamber; it must be less than 1 mbar · l/h.

Finished and tested TRD chambers are sent to GSI (Darmstadt), where they are to be assembled with readout electronics. After transportation the chambers are tested again for gas tightness and break of the wires.

Presently 90 chambers have been constructed at LHE, JINR, 65 of which have been sent to Germany, where they are additionally tested and prepared for the assembling to 18 TRD supermodules [4].

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REFERENCES

1. ALICE Physics Performance Report // J. Phys. G: Nucl. Part. Phys. 2005. V. 30. P. 1517–1763.

2. ALICE TRD. Technical Design Report. CERN/LHCC 2001-021.

3. *Lippmann C. et al.* The ALICE Transition Radiation Detector // Proc. of the SNIC Conf., SLAC, April 3–6, 2006.

4. ALICE Forges Ahead with Detector Installation // CERN Courier. 2006. V. 46, No. 10. P. 6.

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