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K. S. Viriasov, Yu. V. Gusakov, I. A. Zhukov,
V. D. Peshekhonov, A. A. Savenkov

TWO-WIRE ANODES FOR THE STRAW DETECTORS

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Вирясов К. С. и др. E13-2005-127
Разработка и исследование двухпроволочных анодов
для строу-детекторов

Разработана методика изготовления гальванически раздельного двухпроволочного анода тонкопленочных дрейфовых трубок с целью повышения их загрузочной способности для экспериментов на ускорителях в условиях высоких потоков частиц. Используемые для этого стеклянные капиллярные трубки не ухудшают прямолинейность анодов и вносят пренебрежимо малое дополнительное количество вещества.

Работа выполнена в Лаборатории физики частиц ОИЯИ.

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Two-Wire Anodes for the Straw Detectors

The technique of manufacturing of the two-wire anodes of the straws is developed, for the purpose to increase rate capability of the straws for accelerator experiments. The straightness of the anode is kept. The small weight of the glass tubes slightly increases the detector radiation length.

The investigation has been performed at the Laboratory of Particle Physics, JINR.

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INTRODUCTION

Thin-walled drift tubes, further «straws», are widely used now at the accelerator experiments, mainly, as tracking detectors for high-rate environment application [1, 2]. To increase the rate capability of the detectors, the small-diameter straws filled with fast gas mixture and the fast readout electronics (FRE) are used. The aspiration for extremely high uniformity of the multichannel detectors, at their reasonable cost, limits the reduction of the straw diameter up to 3–4 mm. The use of two electrically separated end-to-end anode wires inside the straws provides an additional increase of the straw rate capability. Such straws with two-wire anodes can be made by glass capillaries that form what is called the glass wire-joint. The «two-anode straws» are read out from each of their ends independently. Similar straws are used, for example, at barrel of the transition radiation tracker of the ATLAS LHC [3]. The CBM project discussed now in GSI (Germany) assumes the use of the TRT also [4]. We study the possibility of manufacturing the two-anode straws in mass-production mode.

1. GALVANICALLY SEPARATE CONNECTION OF TWO-WIRE ANODES

One of the basic requirements to developed detectors are minimization both of the inner detector matter and of the size of the inner detector insensitive area. The use of the glass capillary tubes 5 or 6 mm in length and 0.1 and 0.25 mm in the inner and outer diameters, correspondently, well meets these requirements. The weight of such a borosilicate glass capillary tube is 0.094 mg per 1 mm of its length.

Two anode wires soldered into the capillary tube are electrically separated end-to-end by the form which is called a glass wire-joint (Fig. 1). Developed for this purpose production station contains:

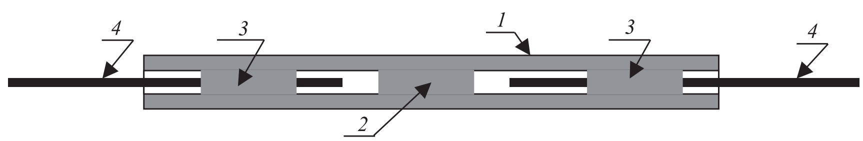

Fig. 1. Glass capillary tube (1) for the electrically separate connection of two anodes (4). Central isolation part (2), zone of the wire solder (3)

- the mechanical tools for the fixing of the capillary tube, for input in it of the two anode wires and their supports, and also a mobile gas torch with elements of a heat-conducting path for the glass tube melting;

- the microscope, providing a free manipulation for the operator during manufacturing of the central isolation cross-pieces, installations of the left and right wires in a capillary tube and their soldering, and also providing sufficient increase for carrying out the operative control;

- the camera and the personal computer for inspecting the joints under theirs manufacturing in real time and for the quality control of fruits of the production. The developed equipment allows manufacturing of the wire-joints with 5- or 6-mm capillary tube. The golded tungsten wire 30 μm in diameter was used for the two-wire anode of the straws. Upgrade of the mechanical tools should decrease the minimal length of the glass tube to 3–4 mm.

2. PARAMETERS OF TWO-WIRE ANODES

Electrical and mechanical properties of the made two-wire cathodes were checked. Figure 2 shows the straightness of the capillary tube of 5-mm length. It is visible that the straightness of two-wire anodes is practically kept. The cross-piece about 0.5 mm in width and the fixing of the wires are well visible. These fragments of the joint are also shown in Fig. 3. Figure 4 illustrates good co-axis between the tube and the wire soldered in it.

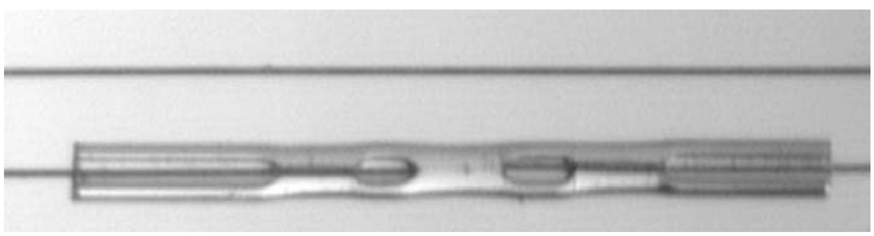

Fig. 2. Wire-joint by the glass tube contains two soldered wires inside the tube. Diameter of the wire is 30 μm. The similar wire is stretched above the joint to show its straightness

The principal mechanical test of the wire-joint monitored wire slippage and breakage. The set of 125 two-wire anodes was used for the testing. The tension of the anode wire increased from small value up to 120 g. It was possible to expect slipping of a wire or breakage of the glass tube. The slipping of one wire was at a tension of $\sim$90 g and of five other wires at a tension of $\sim$100 g. So, only six two-wire anodes from this set were rejected. We had neither breakage of the wires nor the tubes breakage.

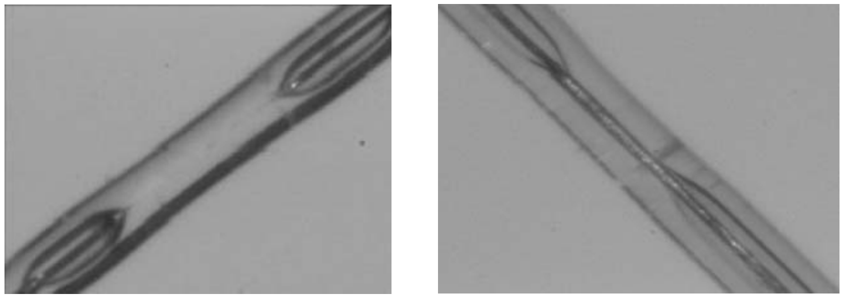

Fig. 3. Fragments of the capillary tube. The central isolation part (left) and zone of the wire solder inside the tube (right)

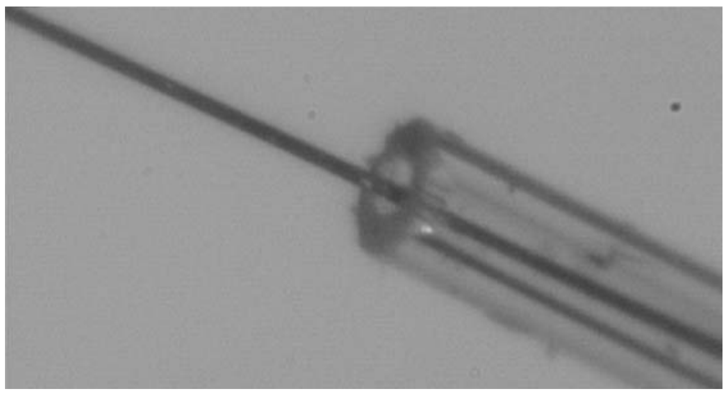

Fig. 4. End face of the capillary tube with the soldered anode wire

Some two-wire anodes were maintained under 90-g tension at the laboratories for long-term observation without something changing.

The two-wire anodes had been tested under high voltage. One wire of the anode placed in air was grounded and the second wire was under 2.5 kV. Validation value of the measured dark current was 50 pA. All samples have successfully passed this test in conditions of the air humidity less than 50 %. At higher humidity, the increase in current of run-off is observed, mainly, from dust onto wires. The blow of the wires by ionization pistol excludes this problem. It shows necessity of their cleaning before installation in straws.

CONCLUSIONS

The technique of manufacturing of the two-wire anodes is developed, for the purpose of increasing the rate capability of the straw chambers for experiments on accelerators. Thus, straightness of the anode with the wire-joint does not worsen and the space resolution of the detector is kept. The small weight of the glass tubes slightly increases the detector radiating length and adds the insensitive length of the two-anode straw equal to the joint length of $\sim$2 mm. Using this method, the readout is carried out for the wire with nonterminated second end whose length is limited to less than one meter. The similar capillary tubes can be used for creation of the inner insensitive area of the multiwire coordinate detectors.

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REFERENCES

1. ATLAS ID TDR. Geneva: CERN, 1997; CERN/LHC/97-17.
2. *Bychkov V. N. et al.* // Part. Nucl. Lett. 2002. No. 2[111]. P. 64.
3. *Oh S. H., Wang C. H., Ebenstein W. L.* // Nucl. Instr. Meth. Phys. Res. A. 1999. V. 425. P. 75.
4. *CBM Collab.* Letter of Intent. Darmstadt, 2004.

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Издательский отдел Объединенного института ядерных исследований
141980, г. Дубна, Московская обл., ул. Жолио-Кюри, 6.
E-mail: publish@pds.jinr.ru
www.jinr.ru/publish/