



8th International conference on particle physics and astrophysics (ICPPA-2026)



OCTOBER
27-30
Moscow
Russia

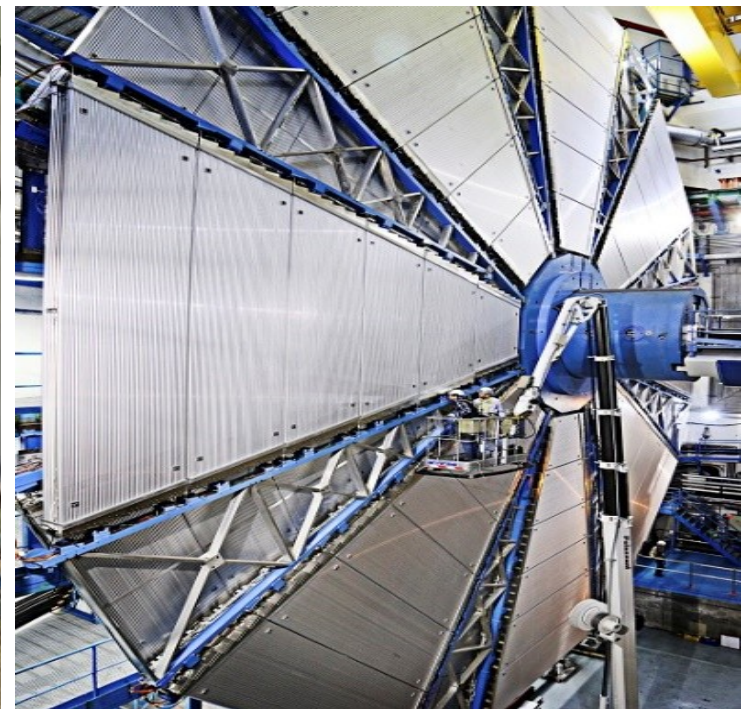
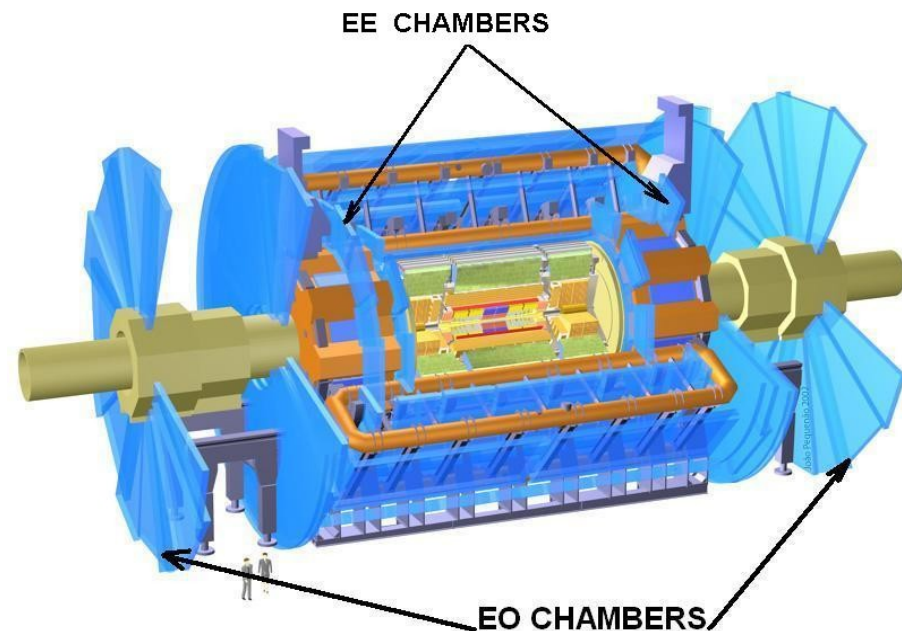


Development of muon trackers from 52-mm drift tubes for physical facilities of the U-70 accelerator complex



Rinat Fakhрутdinov, on behalf of NRC "Kurchatov institute" – IHEP group

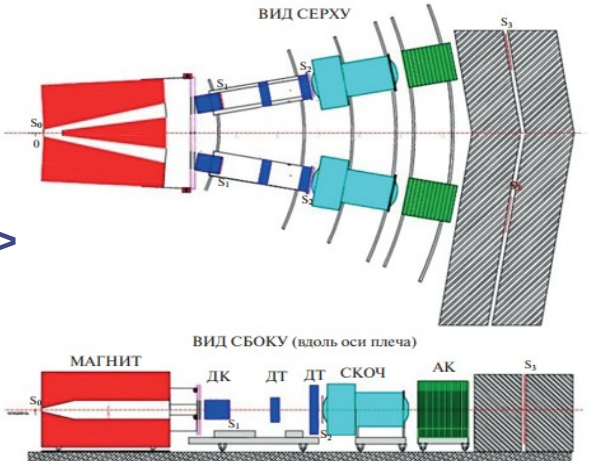
NRC "Kurchatov institute" – IHEP is experienced in construction of track chambers made of drift tubes. Particularly, it was responsible for creation of EO&EE MDT (monitored drift tube) chambers for the ATLAS muon spectrometer at the LHC. ATLAS-DTs are housed inside aluminum tubes *OD* 30 mm and 15 mm, wall thickness 0.4 mm.



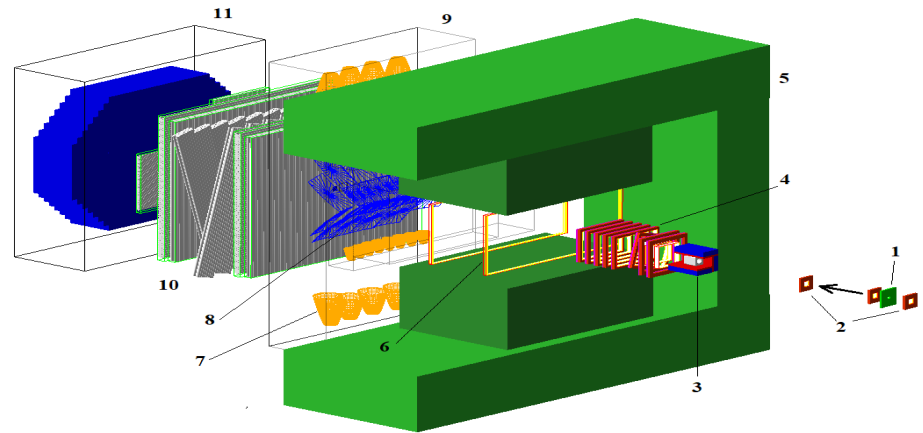
NRC "Kurchatov institute"–IHEP Accelerator Complex.

U-70 – 70 GeV proton synchrotron; I-100 and URAL-30 – linear accelerators; U-1.5 – fast-cycle booster synchrotron; OKA, VES, SPASCHARM, FODS, etc. – experimental facilities. (DT... - drift tube chambers)

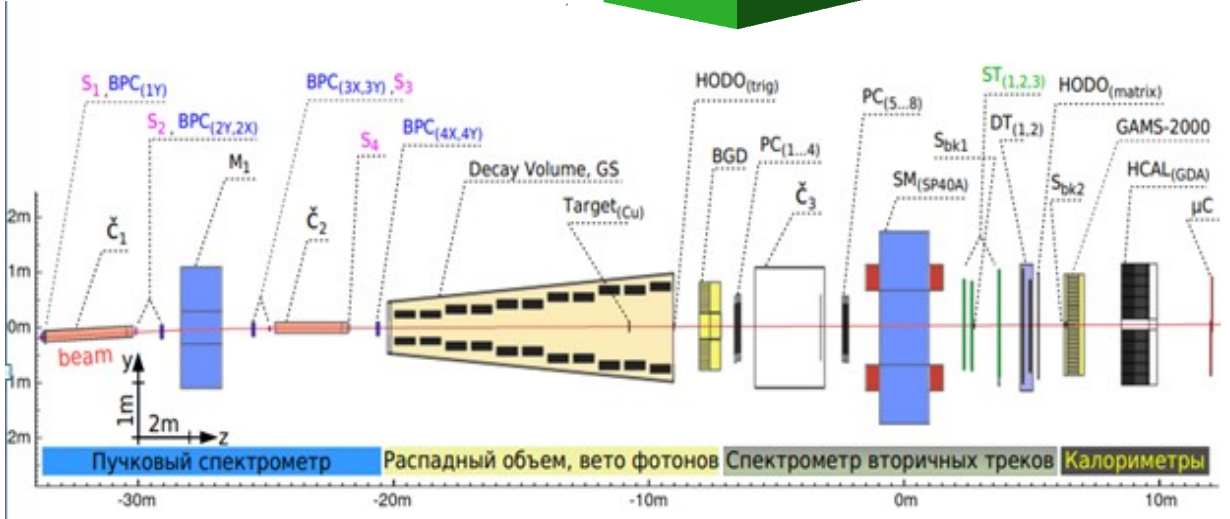
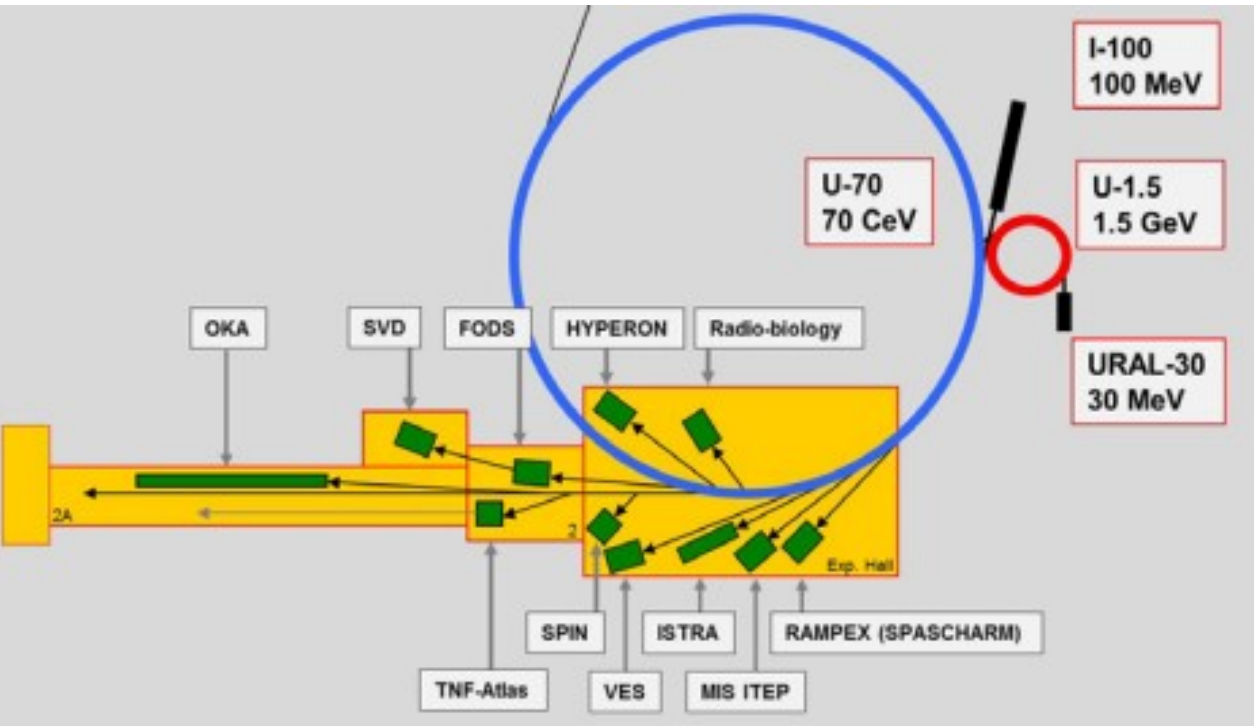
FODS ->



VES ->



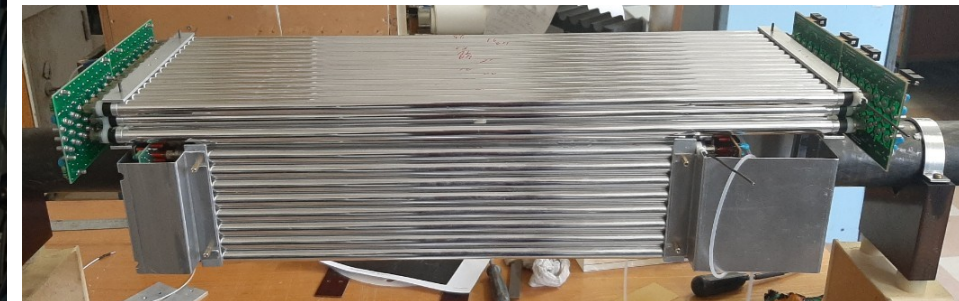
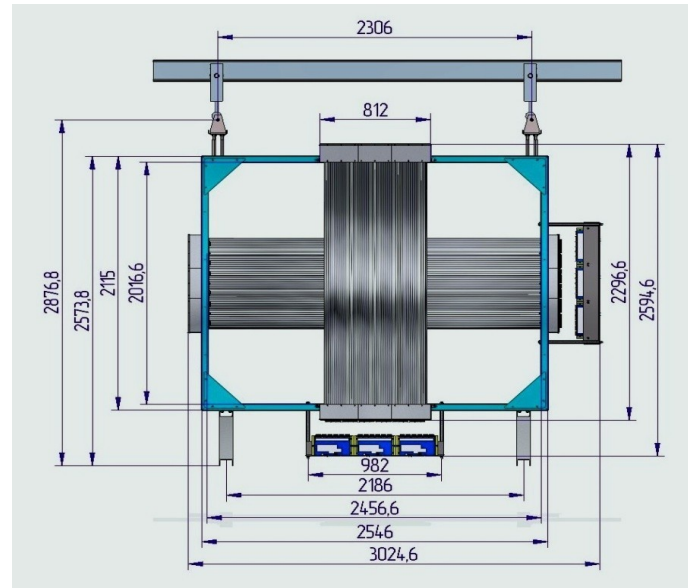
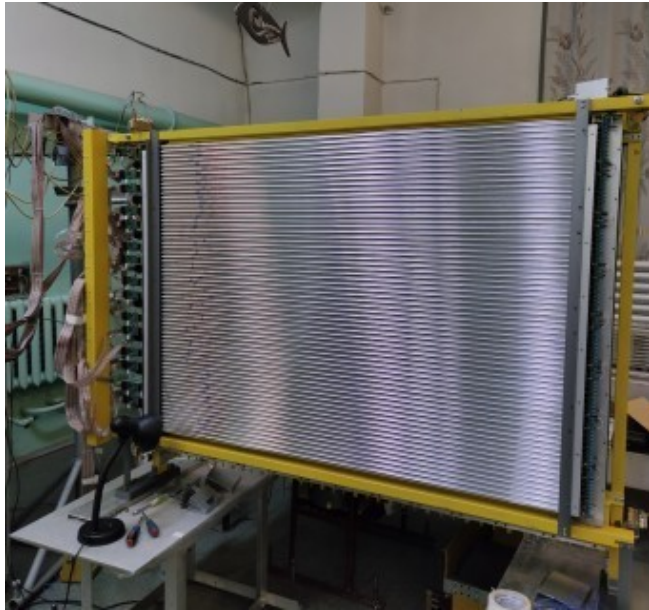
OKA ->



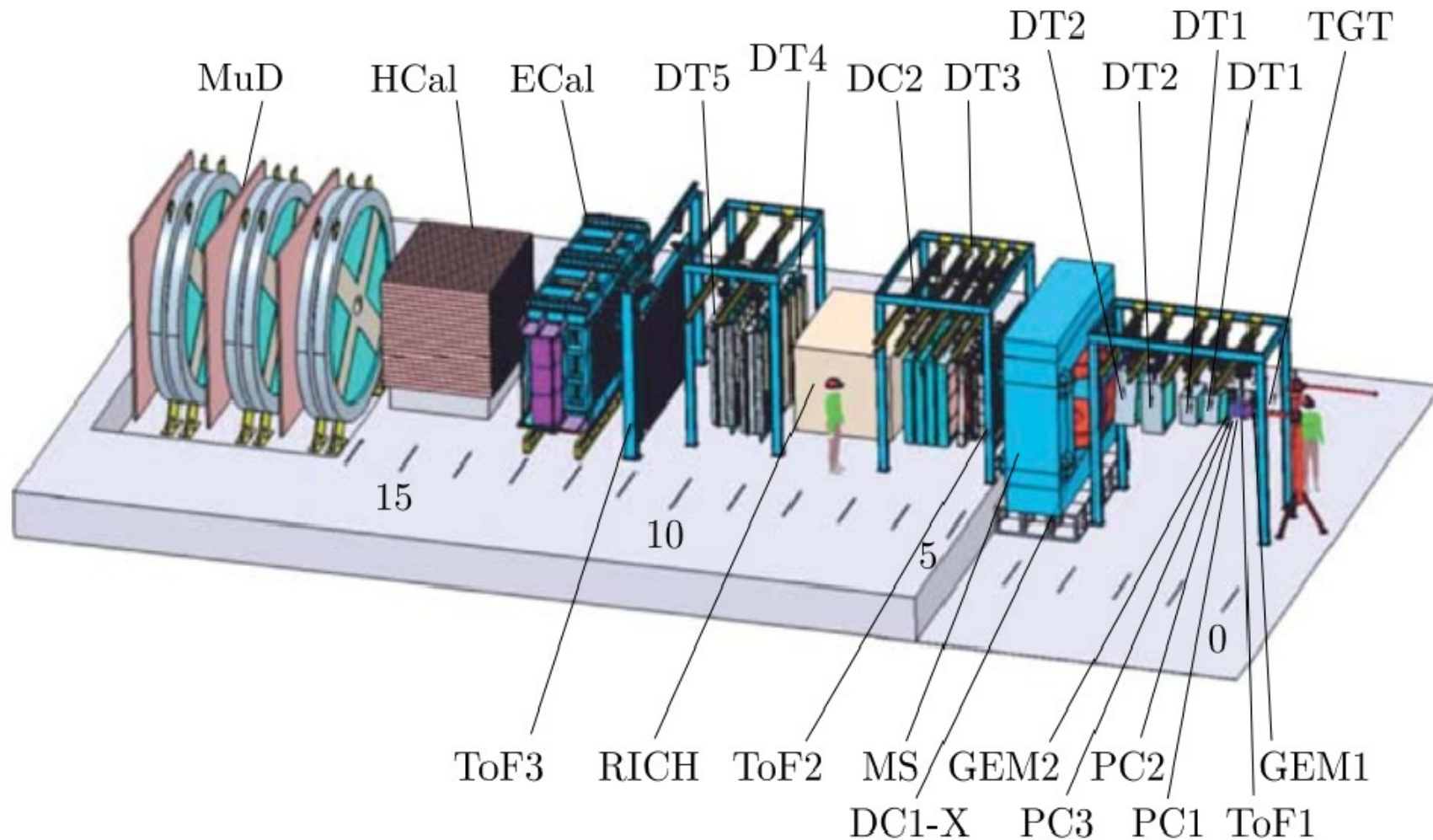
**Mylar drift tube (OD 30 mm) chambers. Maximal DT length – 2.5 m.
35 chambers (totally ~ 5000 DTs) produced for the experiments at 70-GeV accelerator of
NRC “Kurchatov institute” - IHEP**



**Mylar drift tube (OD 15 mm) chambers. Maximal DT length – 2.5 m.
13 chambers (totally more than 2000 DTs) are produced.**



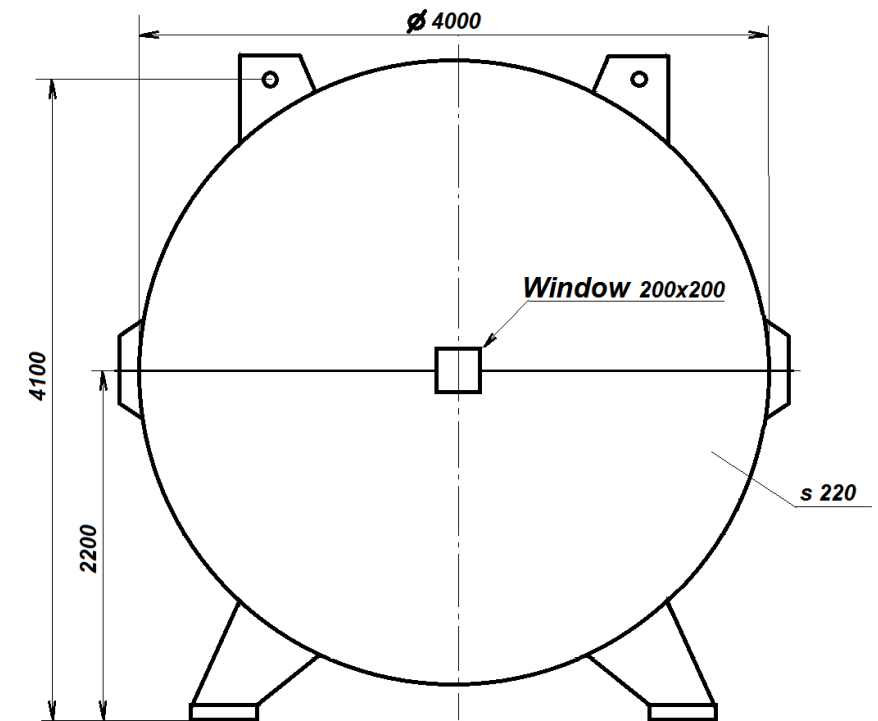
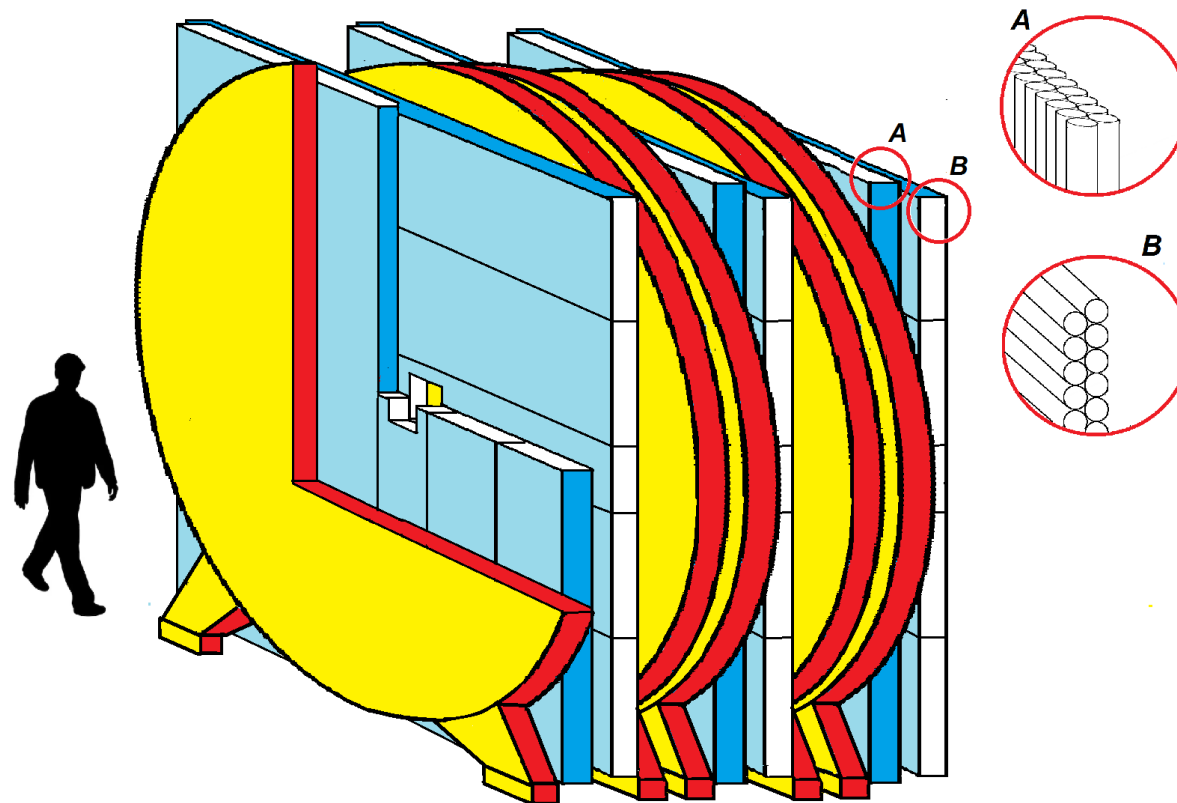
New task: According upgrade plans of the SPASCHARM experimental facility, a muon detector will be added to its end part .



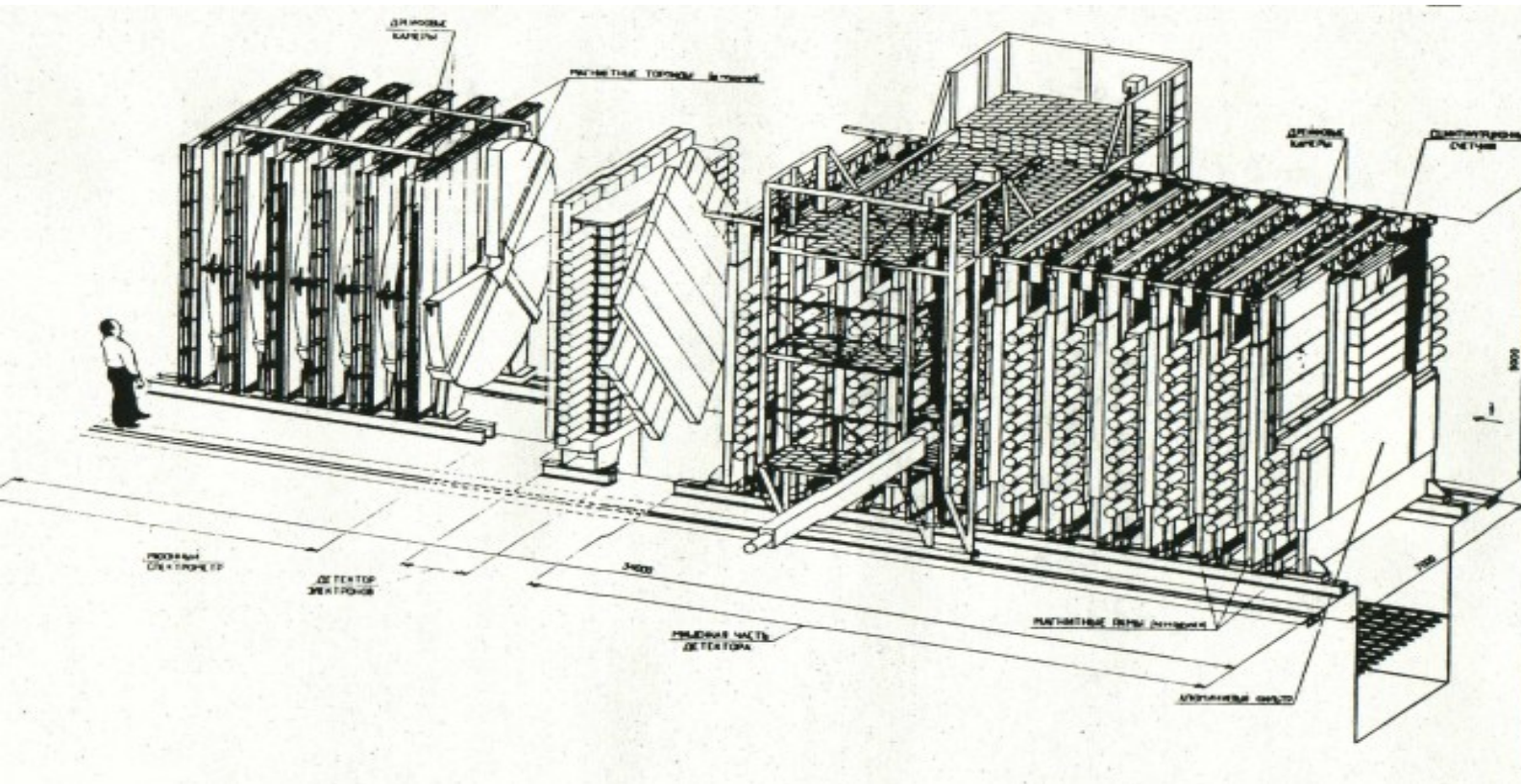
SPASCHARM

A structure consisting of 3 pairs of track planes, interspaced with steel discs with a diameter of ~ 4 m and a thickness of 220 mm, is proposed. Track plane consists of 2 DT planes. DT: thin-walled (0.8 mm) aluminum housing, 3.7 m long, OD 52 mm.

In the central parts of the steel discs and track planes, aligned with the primary proton beam, the “windows” (holes) $\sim 20 \times 20$ cm² are foreseen to prevent overloading of the planes with remnants of the primary beam that did not interact with the target.



Magnetic toroids dismantled from the “IHEP – JINR Neutrino detector” are suggested to be used as steel filters (the windings will be removed from the toroids).



IHEP – JINR Neutrino detector (disassembled long time ago)



DT: 3.7 m long, OD 52 mm. Aluminum body, wall thickness 0.8 mm

(based on DTs of the "JINR-IHEP Tagged Neutrino Complex", disassembled long time ago)



**ОБЪЕДИНЕННЫЙ ИНСТИТУТ ЯДЕРНЫХ ИССЛЕДОВАНИЙ
JOINT INSTITUTE FOR NUCLEAR RESEARCH**

Д1.13-88-172

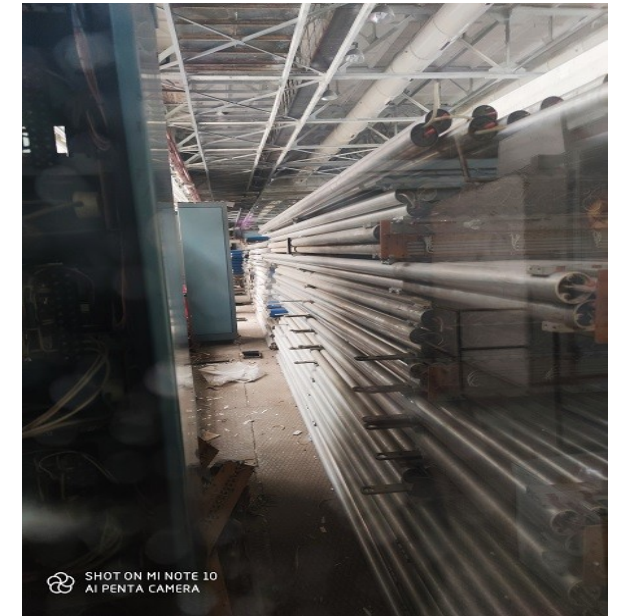
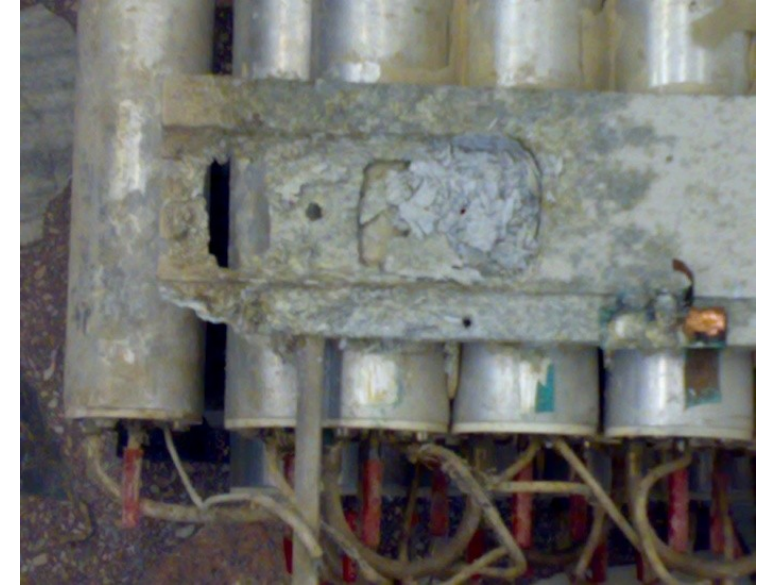
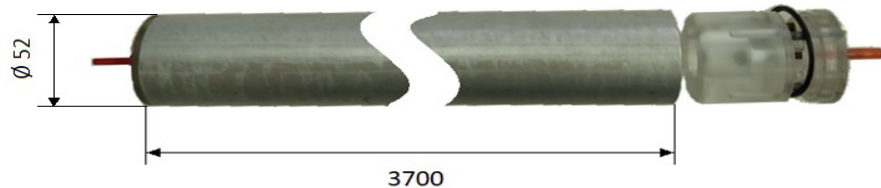
**Международный симпозиум
по координатным детекторам
в физике высоких энергий**

МЮОННЫЙ СПЕКТРОМЕТР КОМПЛЕКСА "МЕЧЕНЫЕ НЕЙТРИНО"

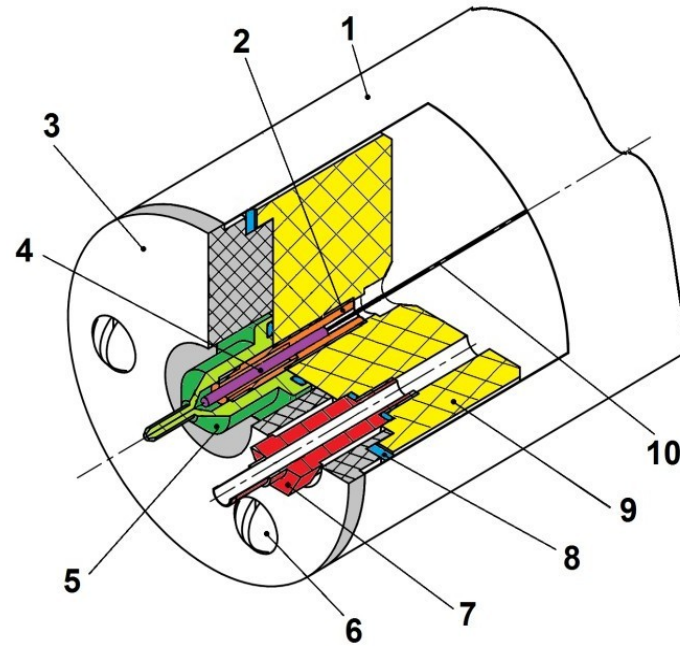
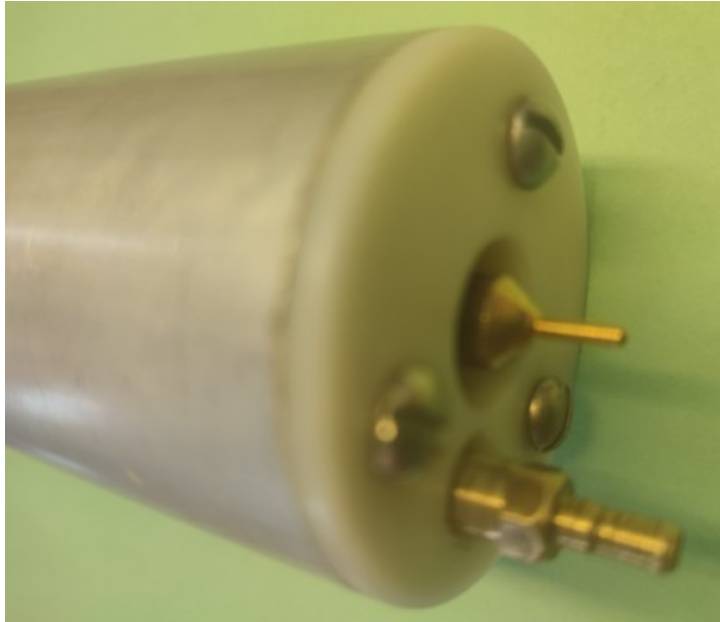
**М.Винде, И.А.Голутвин, В.Х.Додохов, Н.И.Замятин,
А.В.Карпухин, Ю.Т.Кирюшин, Н.М.Лустов, В.Н.Лысяков,
Д.Поле, В.А.Свиридов, В.Н.Сотников**

Объединенный институт ядерных исследований, Дубна

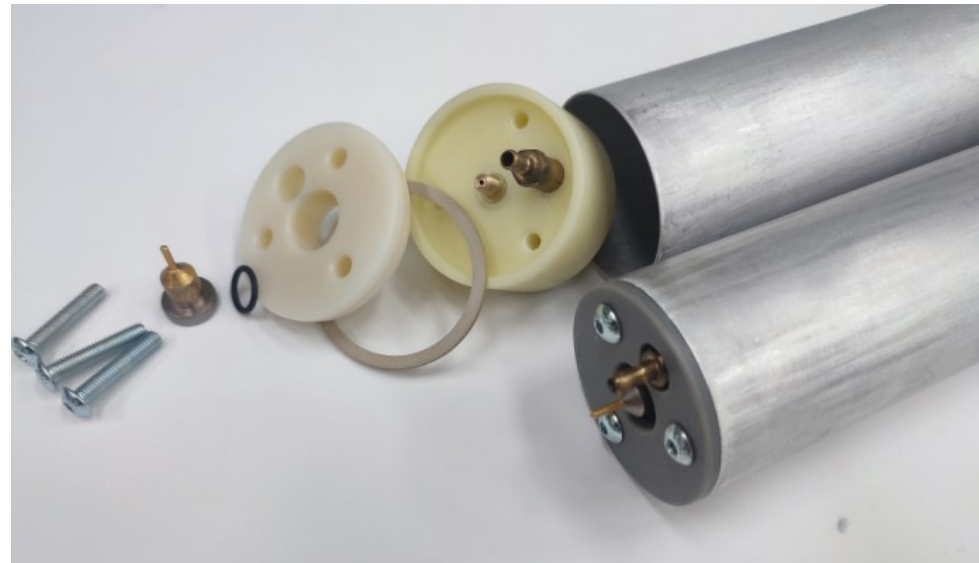
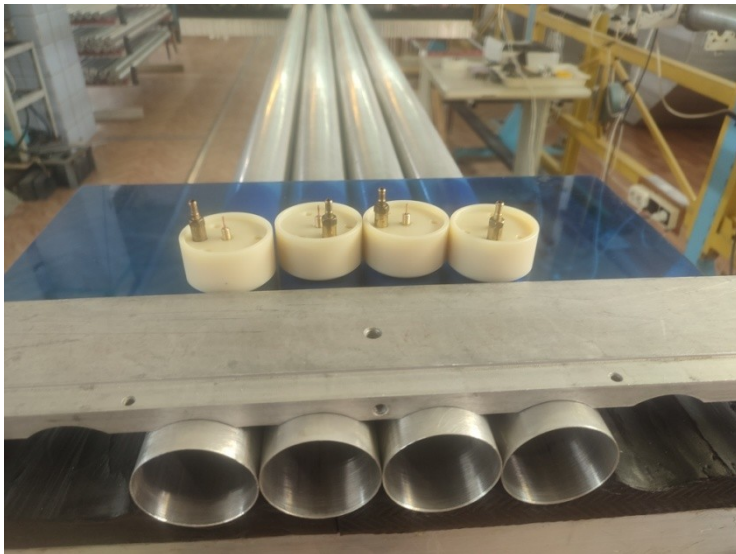
Dubna, 22-25 September 1987



DT housed in aluminum body OD 52 mm, wall thickness 0.8 mm. New design



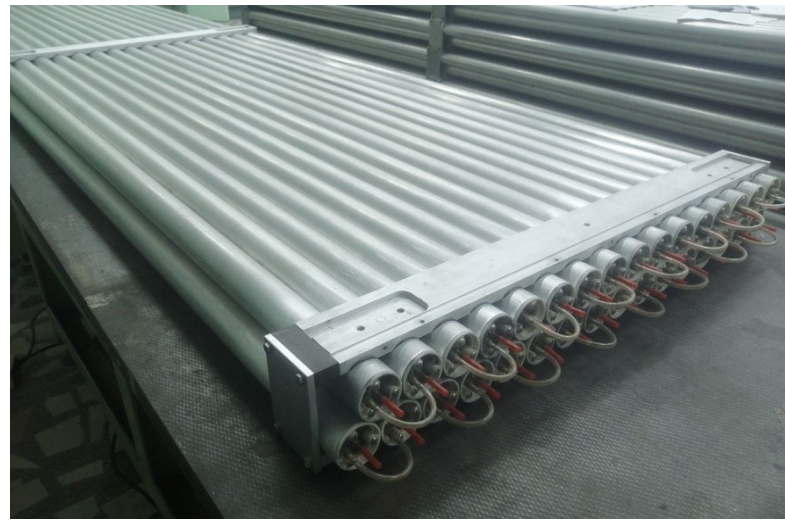
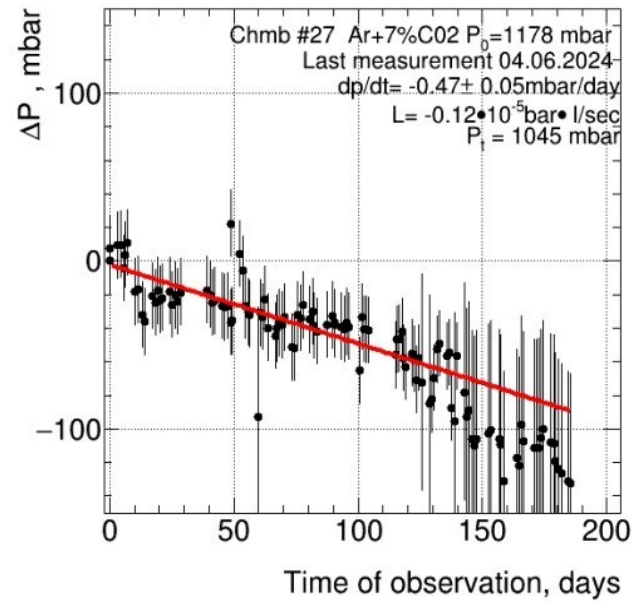
- 1 - Aluminum tube
- 2 - brass bushing
- 3 - endplug cap (caprolon)
- 4 - copper crimping tube
- 5 - signal cap
- 6 - screw
- 7 - gas fitting
- 8 - o-ring
- 9 - end plug body
- 10 - signal wire



Each DT is checked for gas-tightness

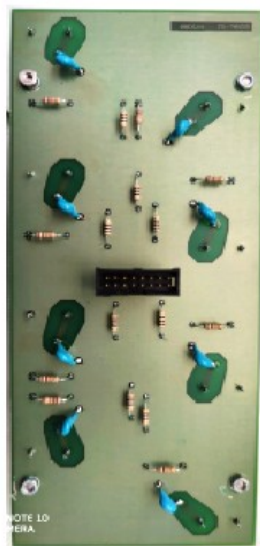
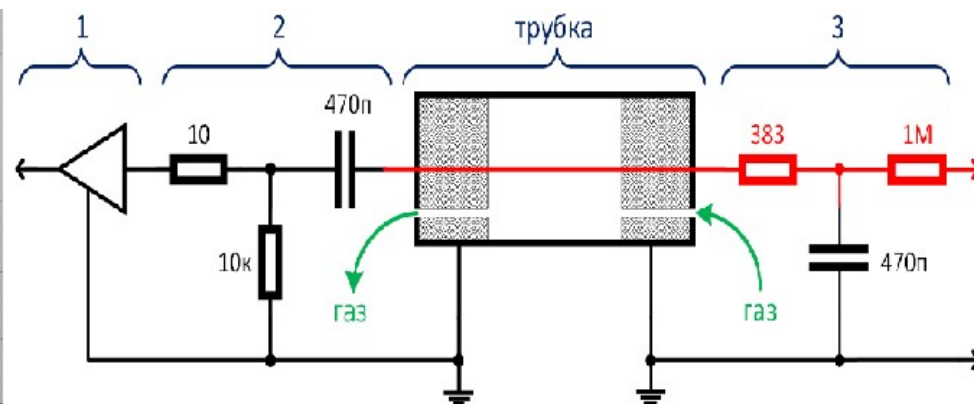
The gas tightness characteristic - the drop of overpressure.

$L = 3700 \text{ mm}$.
 $\text{Ar} + 7\% \text{CO}_2$,
 $P_0 = 1178 \text{ mbar}$

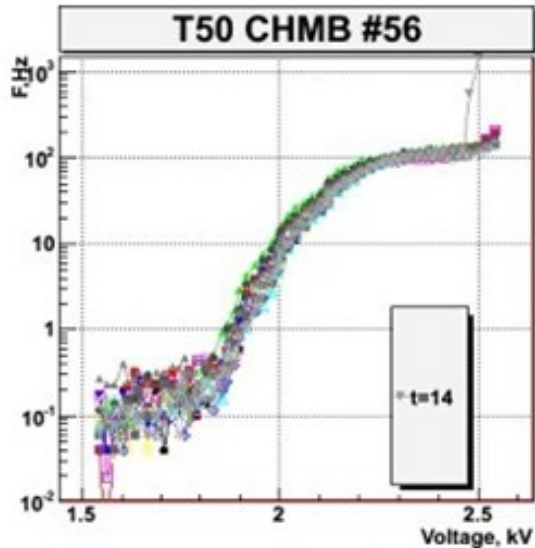


The chambers are designed to be (if necessary) tightly joined together to form a wide, monolithic plane.

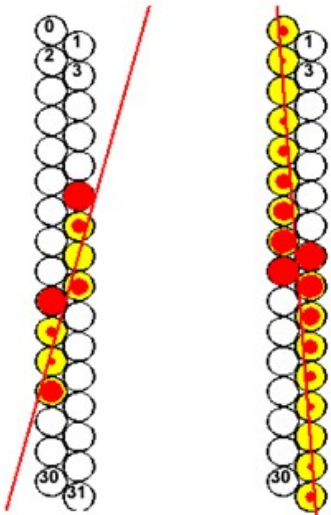
The signal removal from the anode wire and high voltage supply are carried out from the opposite sides of the DT. For this purpose, “passive” electronics boards containing only resistors, capacitors and connectors were developed. Each board is designed to connect 8 DTs.



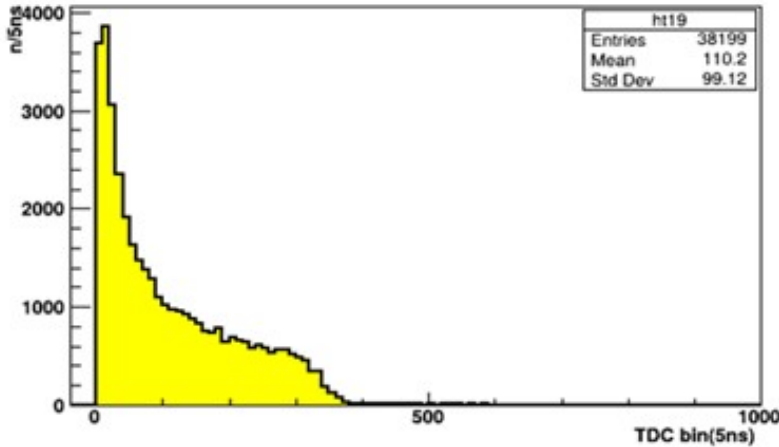
DT chamber checking using cosmic rays. DT length 3.7 m. 93%Ar+7%CO₂. Test electronics.



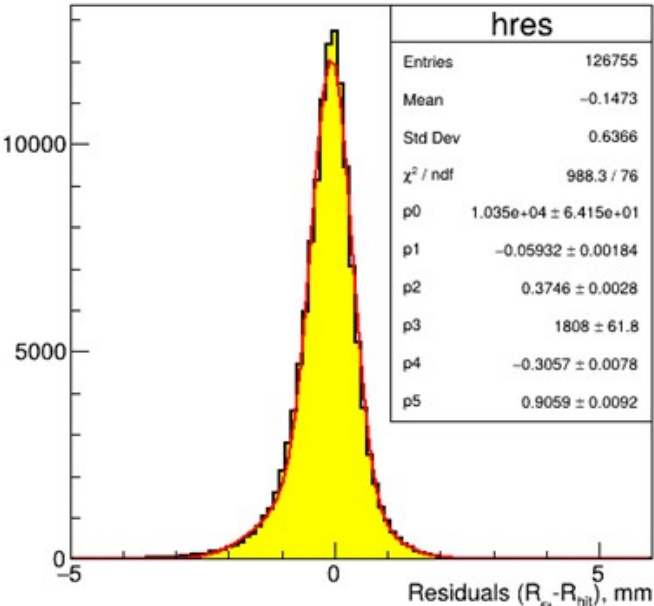
Counting rate of natural radiation vs. voltage. All drift tubes (32 pcs).



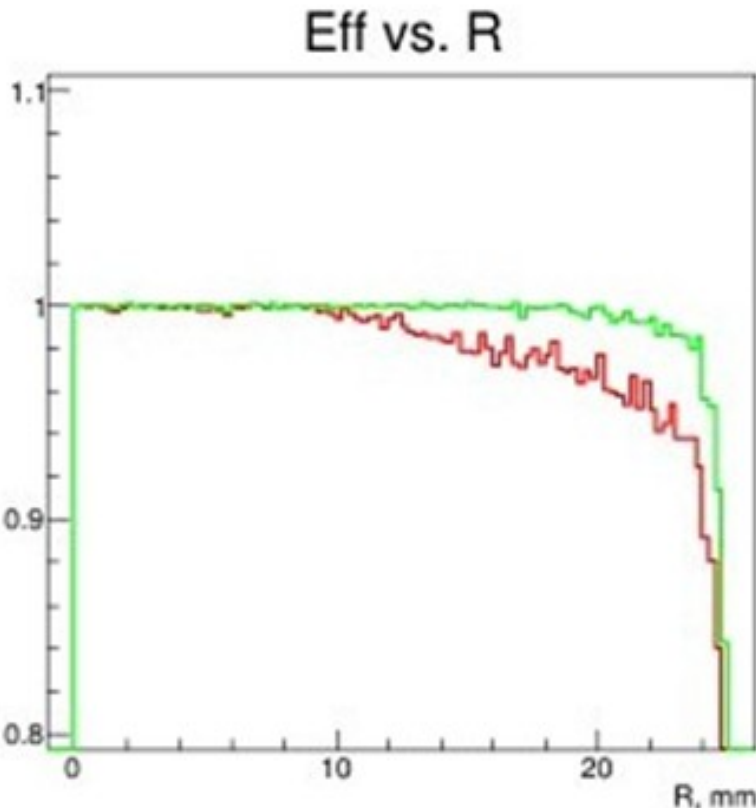
Cosmic muon track reconstruction examples



TDC- spectrum of individual DT



Residuals distribution



Green: drift tube efficiency vs. track distance from its anode wire.
Red: – track reconstruction efficiency degradation due to δ -electrons

DT chamber with «window»

As stated above, the “windows” $\sim 20 \times 20 \text{ cm}^2$ are needed in the central parts of the track planes. Possible solutions: 1) Instead of one long DT (for SPASCHARM – 3.7 m, for OKA – 2.4 m), use two short ones, spaced apart to form a “window”. Shortcomings: the tube ends with electronics fall into the beam zone, and the number of channels is increasing; 2) In a long DT, “necrotize” a required part of the wire by thickening it using the galvanic method, or, using intermediate locators, use pieces of wire with increased diameter at required places. Shortcoming: The dead zone of the tube is not empty - it contains a passive substance introduced by the tube walls.

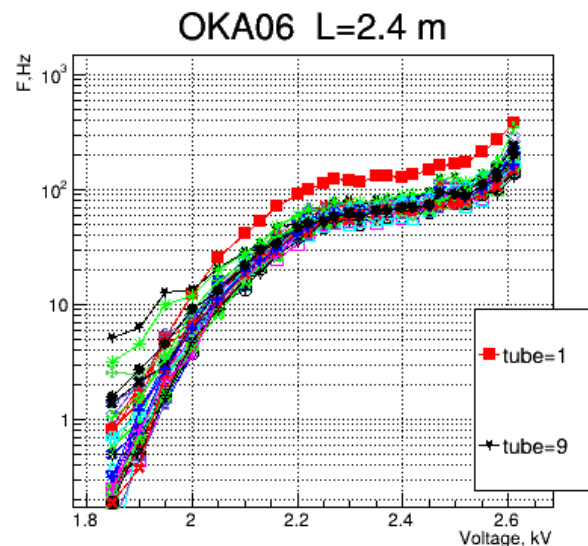
Our solution: Instead of using one long DT, use a “composite” one consisting of two shortened DTs, separated from each other by the required distance and connected to a common amplifier. That is, the outer end of one of the short DT has only a standard connection to the amplifier, while the outer end of the other one is connected only to the HV source. The signal wires at the inner ends of these DTs are connected to each other “in the air.” The option has been tested, and it works.



A “window” in an enlarged scale

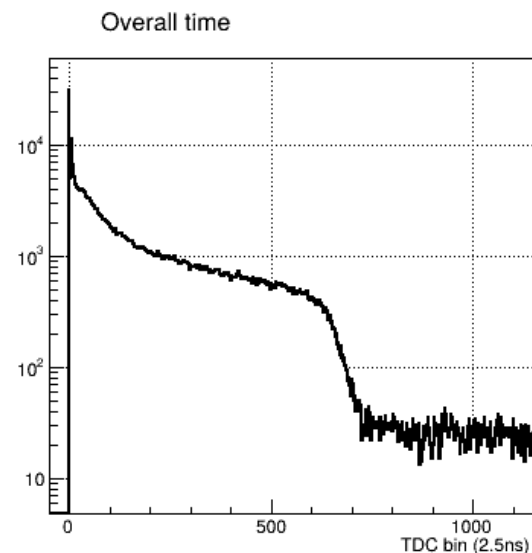
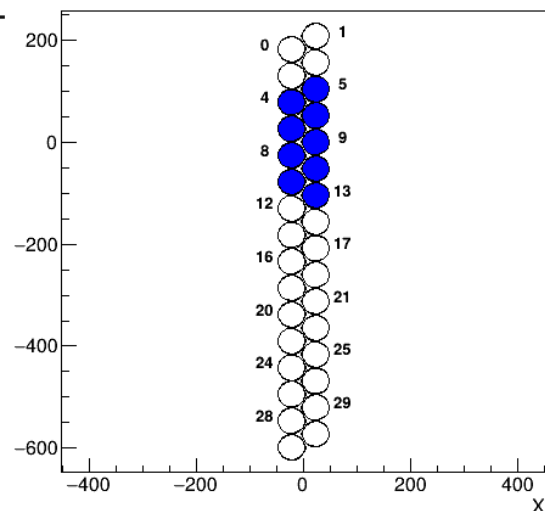
Track plane for OKA with a “window” made of the “composite” DT

DT chamber for OKA (L = 2.4 m) with “window”.

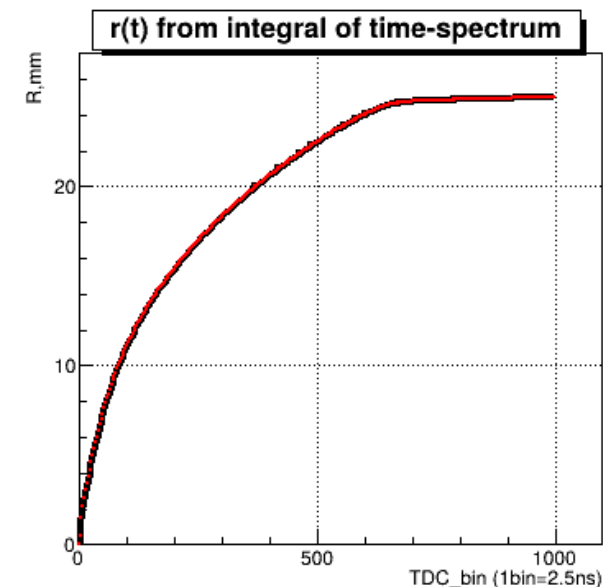


Counting rate of natural radiation vs. voltage. All tubes

OKA6 tube numbers, blue are cut

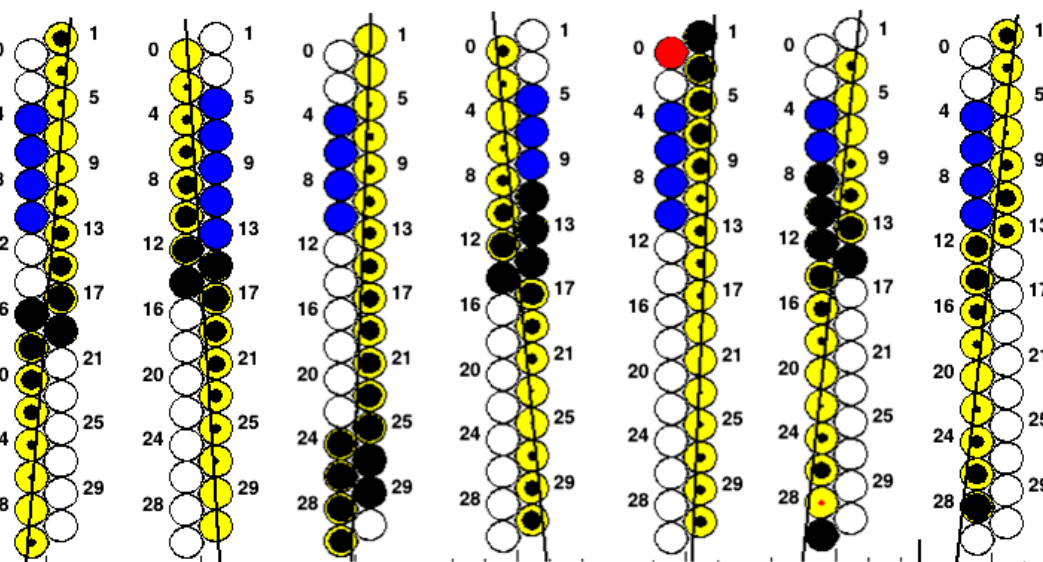
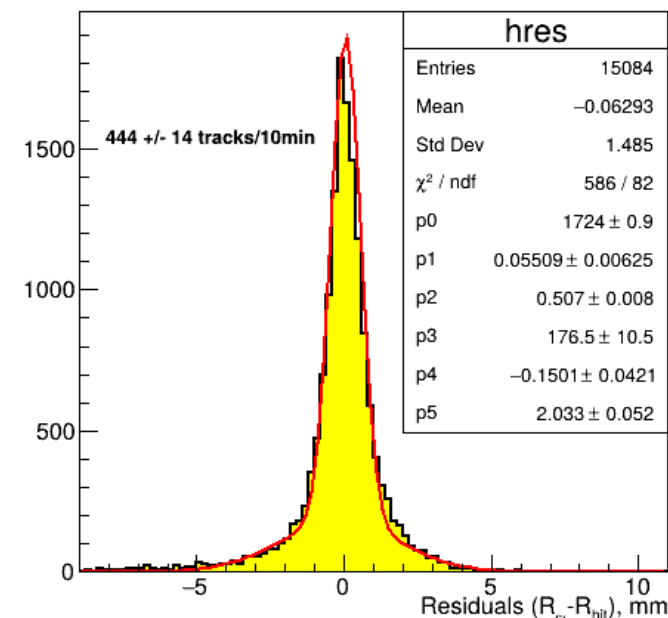


TDC-spectrum, all tubes



R(t) - relation

Overall residuals



Cosmic muon track reconstruction examples

CONCLUSIONS

- A design of the trackers for the IHEP experimental facilities SPASCHARM (3.7 m long tubes) and OKA (2.4 m) is developed. The trackers consist of modules which are 0.83 m wide chambers made of 52 mm diameter drift tubes distributed in 2 layers of 16 pieces in each;
- Spatial resolution of the chambers is as good as 0.5 mm;
- A required number of chambers can be tightly joined together to form a wide, monolithic plane;
- Using "composite" DTs, there is a possibility to make insensitive zones in the chambers;
- The characteristics of the track chambers that will be used in trackers, including those with "composite" DTs, have been studied.

Thank You for Your attention!