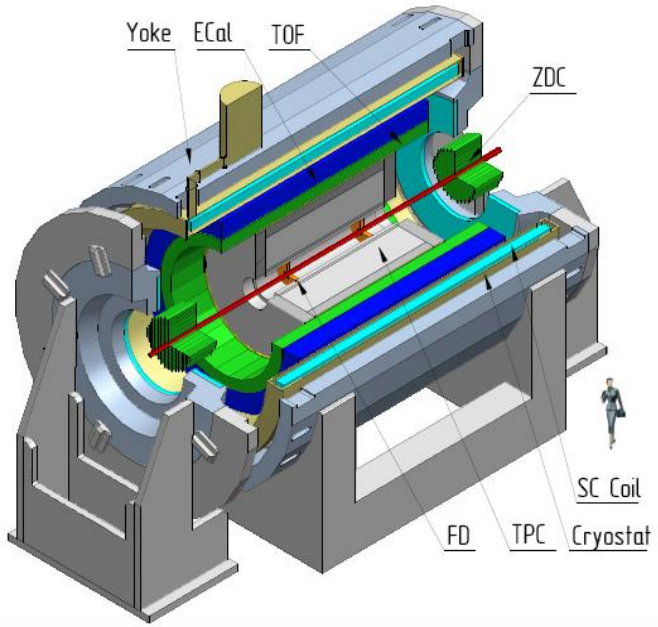
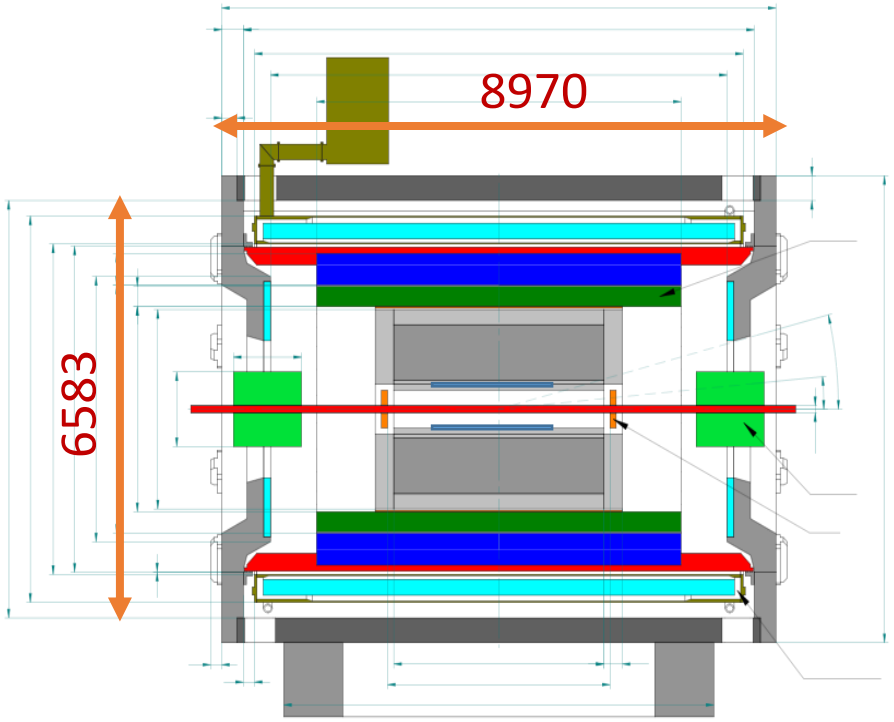
Status of the MPD project

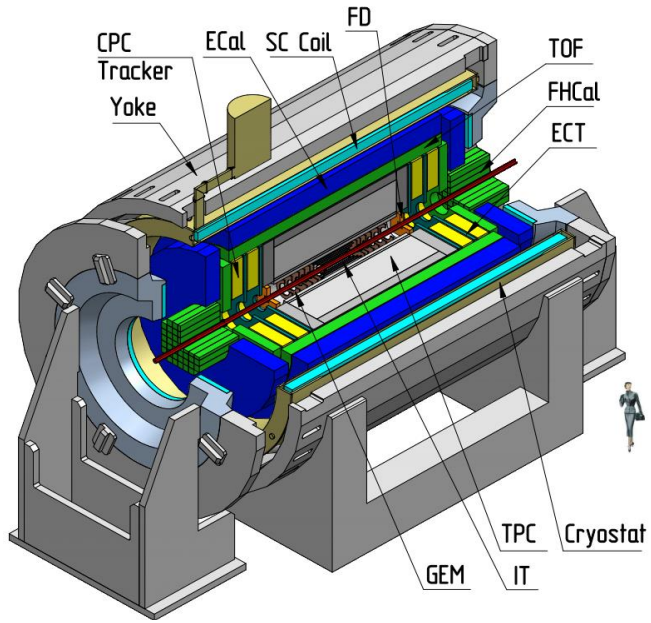
Viacheslav Golovatyuk
(JINR)

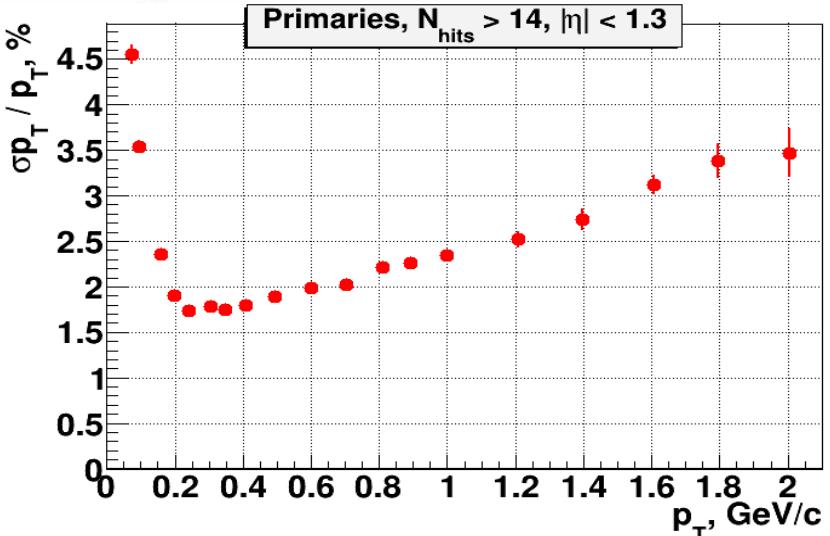
MPD - stage I



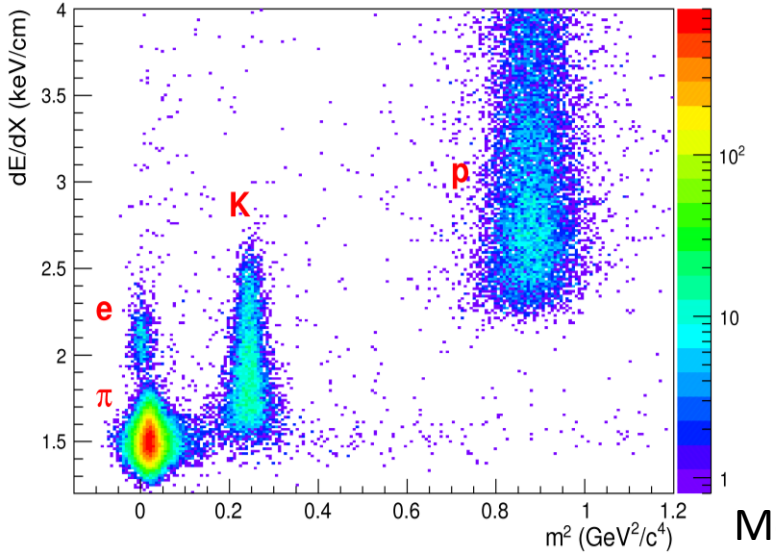


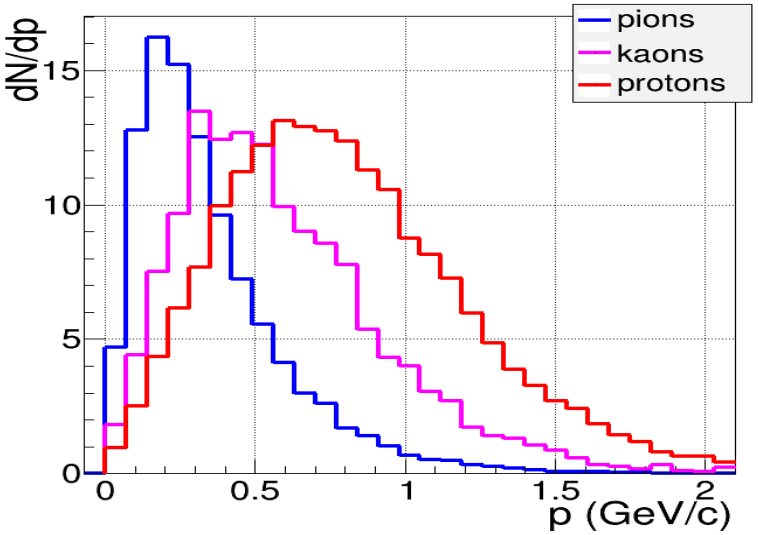
MPD - Stage II



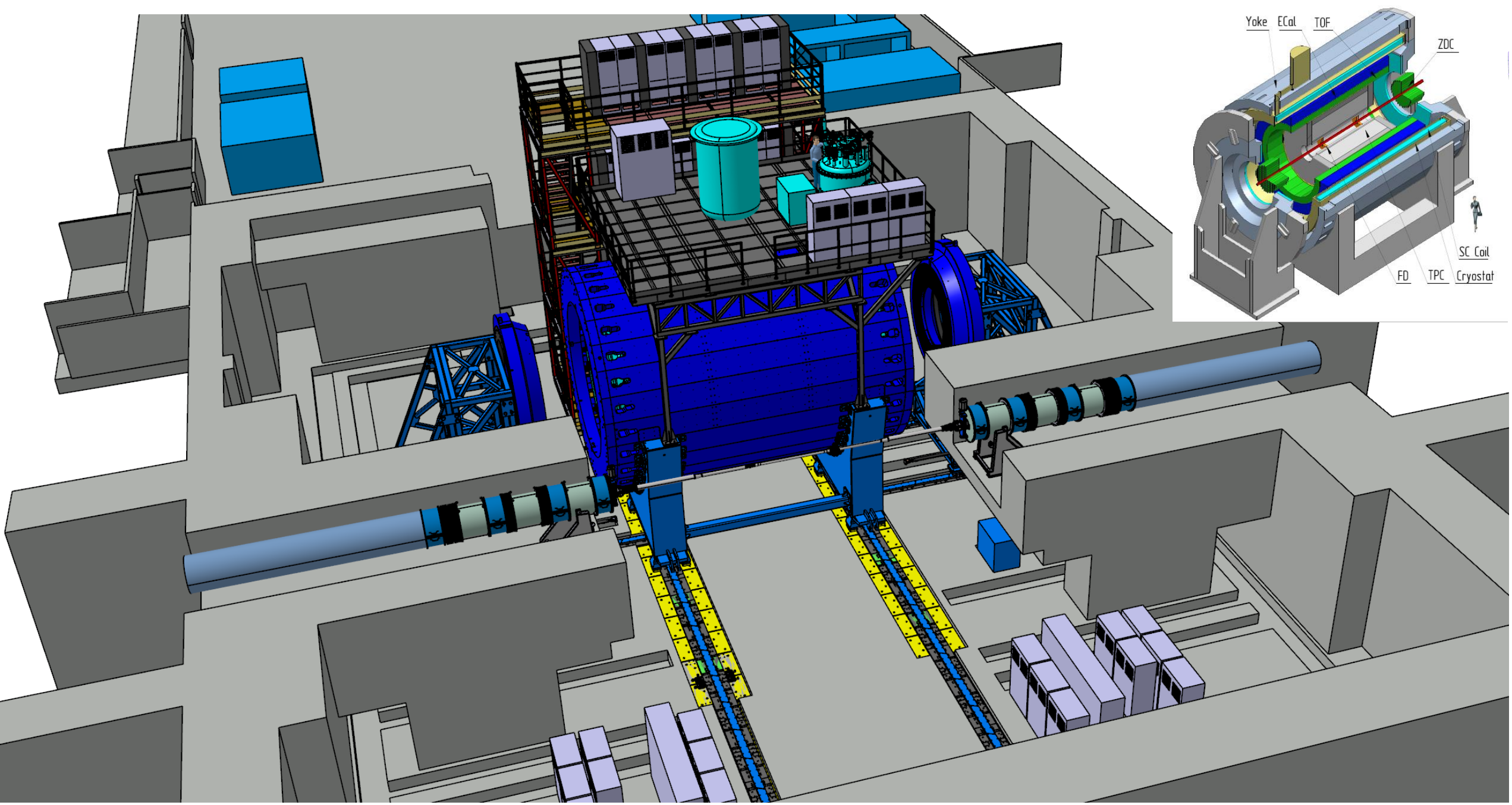


Momentum resolution with TPC

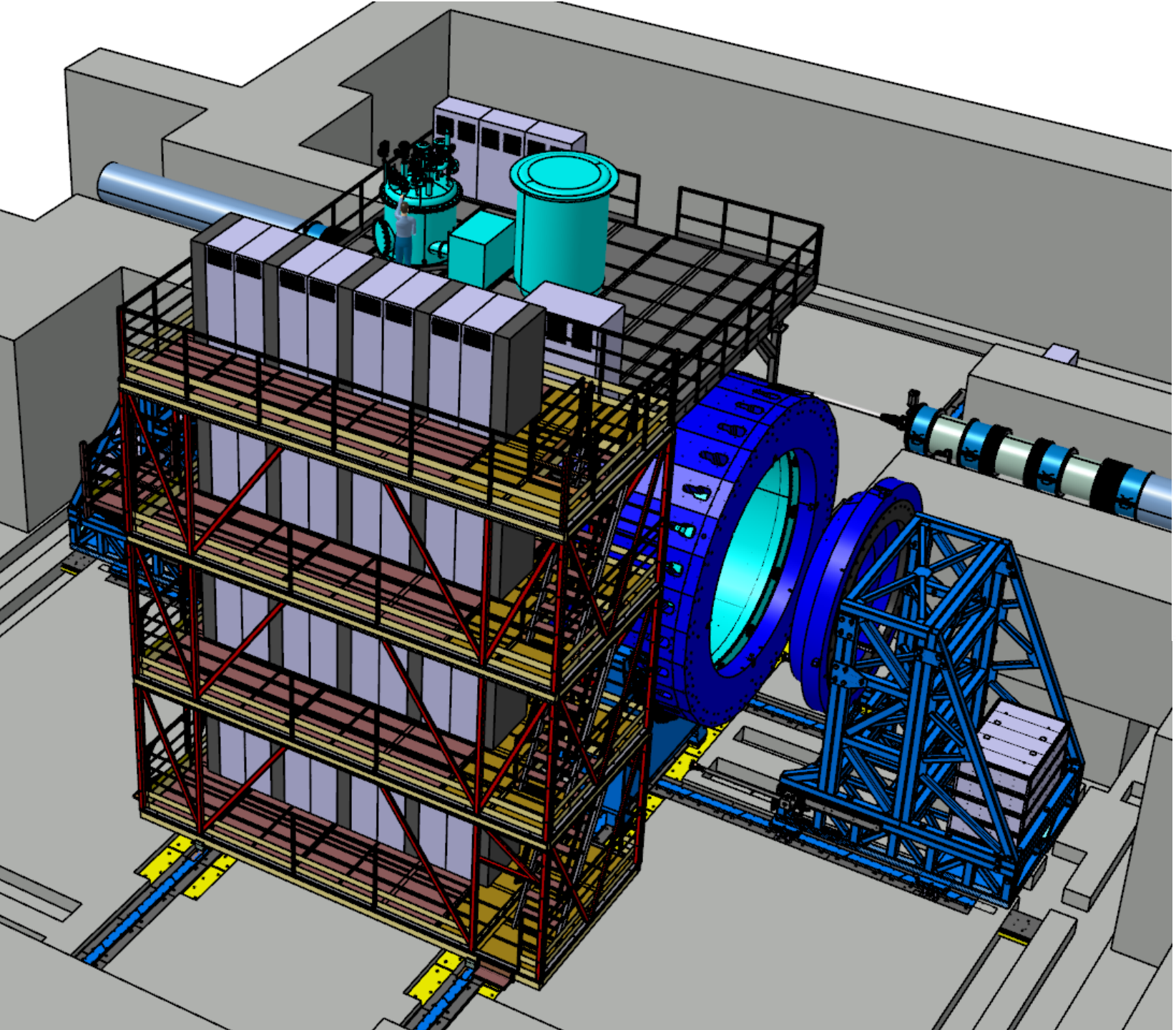


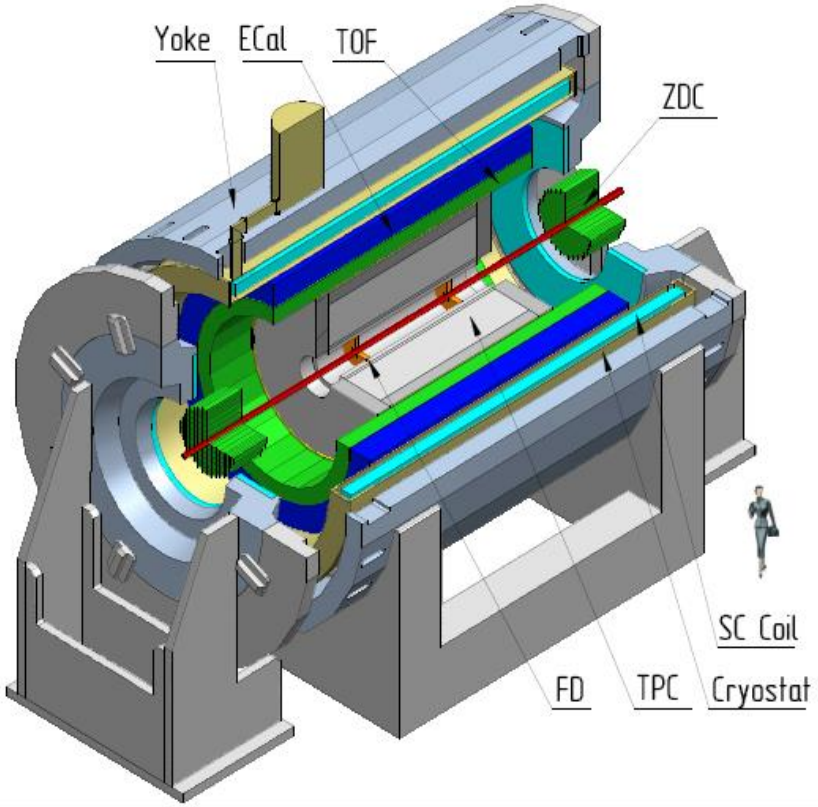


Momentum distribution of secondary particles



The MPD experimental Hall

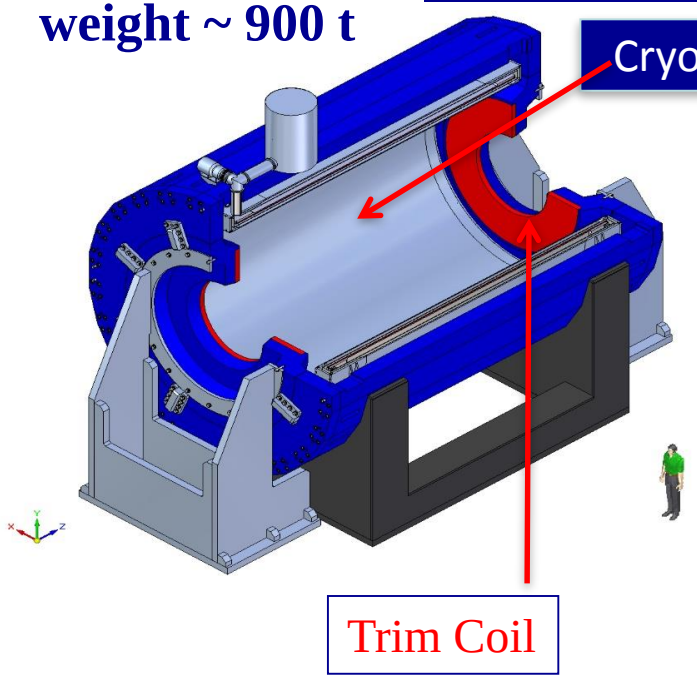




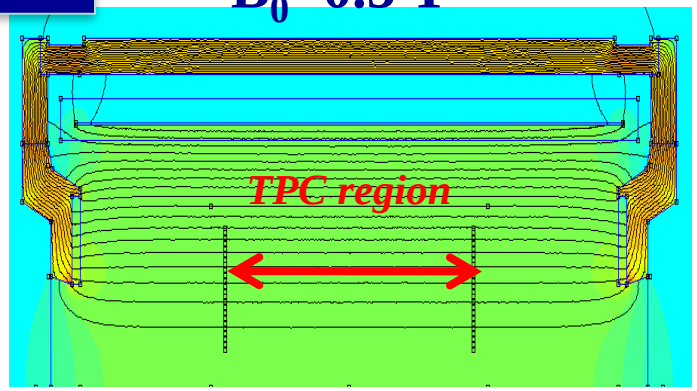
The MPD experimental Hall

Magnet fabrication: *ASG (Genova) & Vitkovice HM*

weight ~ 900 t



B_0=0.5 T



high level (~ 3x10^{-4}) of magnetic field homogeneity

Solenoid assembling

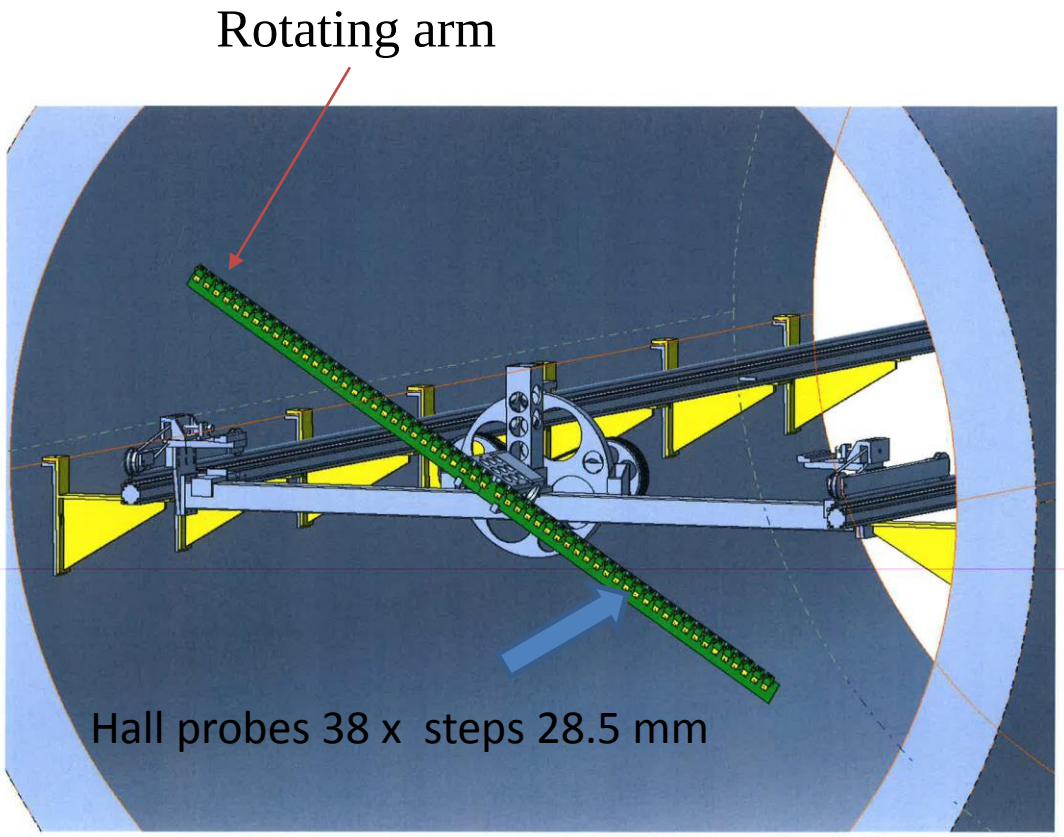
Tests at low temperature LN at ASG (Italy)

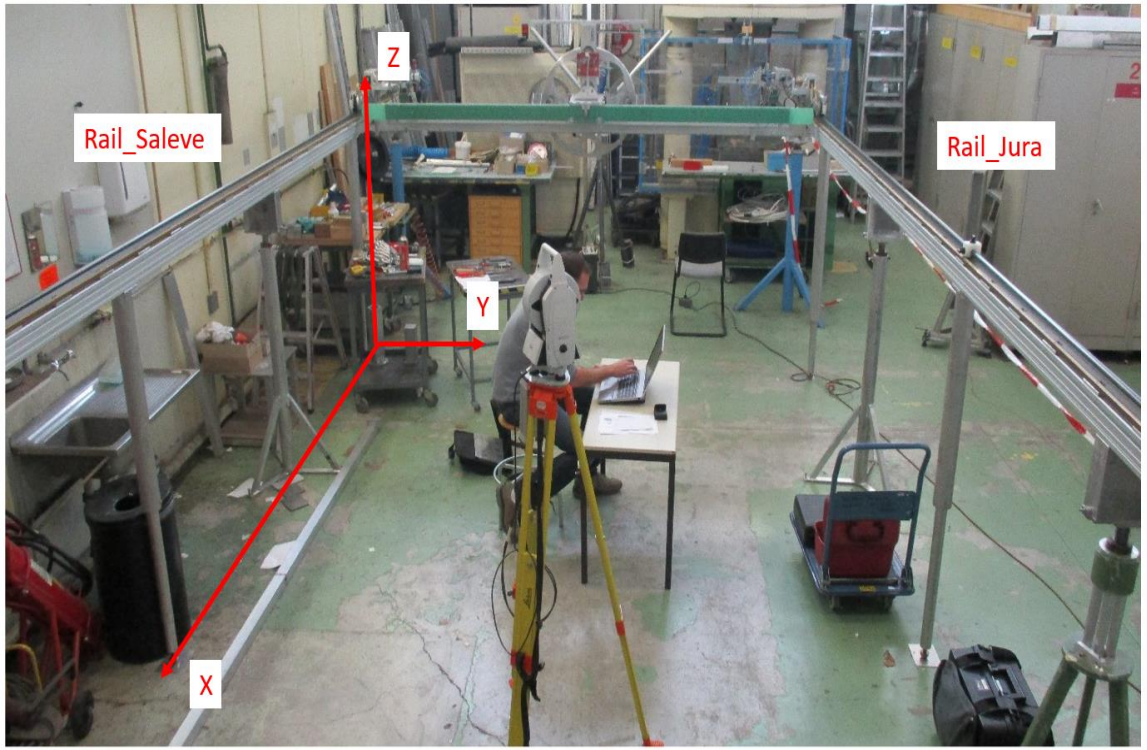
We expect Solenoid arrival at JINR in September this year. At the moment it is assembled and awaits cold test at ASG. At JINR we have to prepare all services to switch it on. For that we are working on construction the system of LHe and LN supplying lines in the MPD building and containers for mentioned liquid gases. Due to delay of civil construction we have a hard time to complete the cryogenic service system at the time of Solenoid arrival.

yoke control assembly at HM Vitkovice

Mapper for Magnetic Field measurements

R.Shindin, Yu.Lobanov, A.Efremov, A.Livanov, E.Kulikov



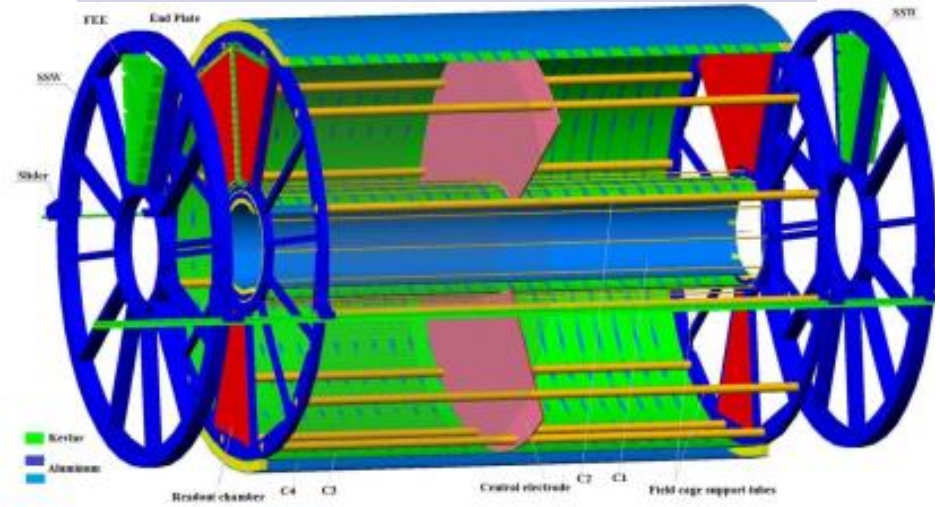


$$\left|\frac{B_r}{B_z}\right| = 5.2\times10^{-4} \qquad \int_{-1700}^{1700} \frac{B_r}{B_z}\,dz \le 1{,}5mm$$

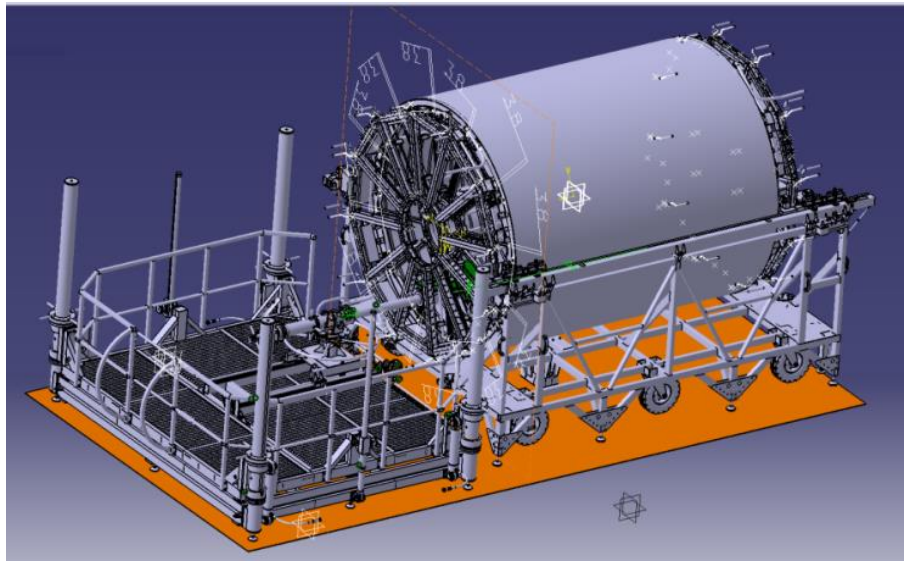
Testing magnetic field mapper for MPD in the CERN site.

MPD Time Projection Chamber
S.Movchan

- **Sensitive length: 326 cm**
- **Radius: 34/133 cm**



Item	Dimension
Length of the TPC	340cm
Outer / Inner radius of vessel	140cm / 27 cm
Outer / Inner radius of the drift volume	133cm / 34cm
Length of the drift volume	163 cm (of each half)
Electric field strength	~ 140 V/cm
Drift gas	90% Ar+10% CH_4 / 80%Ar+20%CO_2
Gas amplification factor	~ 10^4
Drift velocity	5.45 cm/μs;
Drift time	< 30 μs;
Temperature stability	< 0.5°C
Number of readout chambers	24 (12 on each side)
Number of pads	95232
Maximal event rate	< 7 кHz (at Lum.= 10^{27})
Electronics shaping time	~180 ns
Signal-to-noise ratio	30:1
Signal dynamical range	10 бит
Signal sampling	10 МГц
Two-track resolution	~1 cm



Robot for ROC installation

MPD TPC FEE based on SAMPA

TPC assembling so far didn't meet big problems. C3 and C4 cylinders are assembled, C1 and C2 are prepared for gluing.

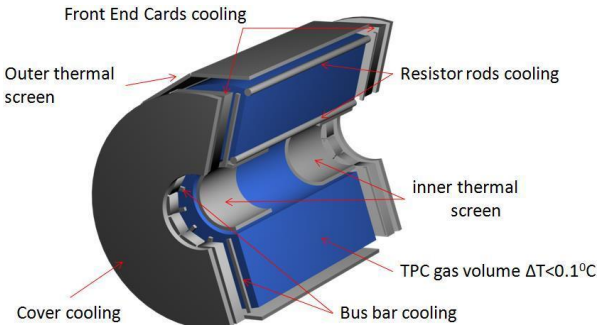
According to schedule assembling of TPC (without ROC chambers) will be finished at the end of 2020.

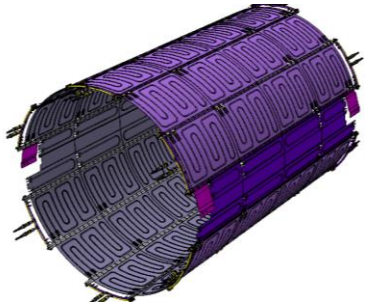
ROC chambers (12pc) are tested.

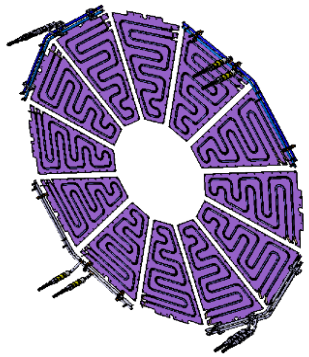
Last 12pc ROC chambers will be manufactured up to end of 2020.

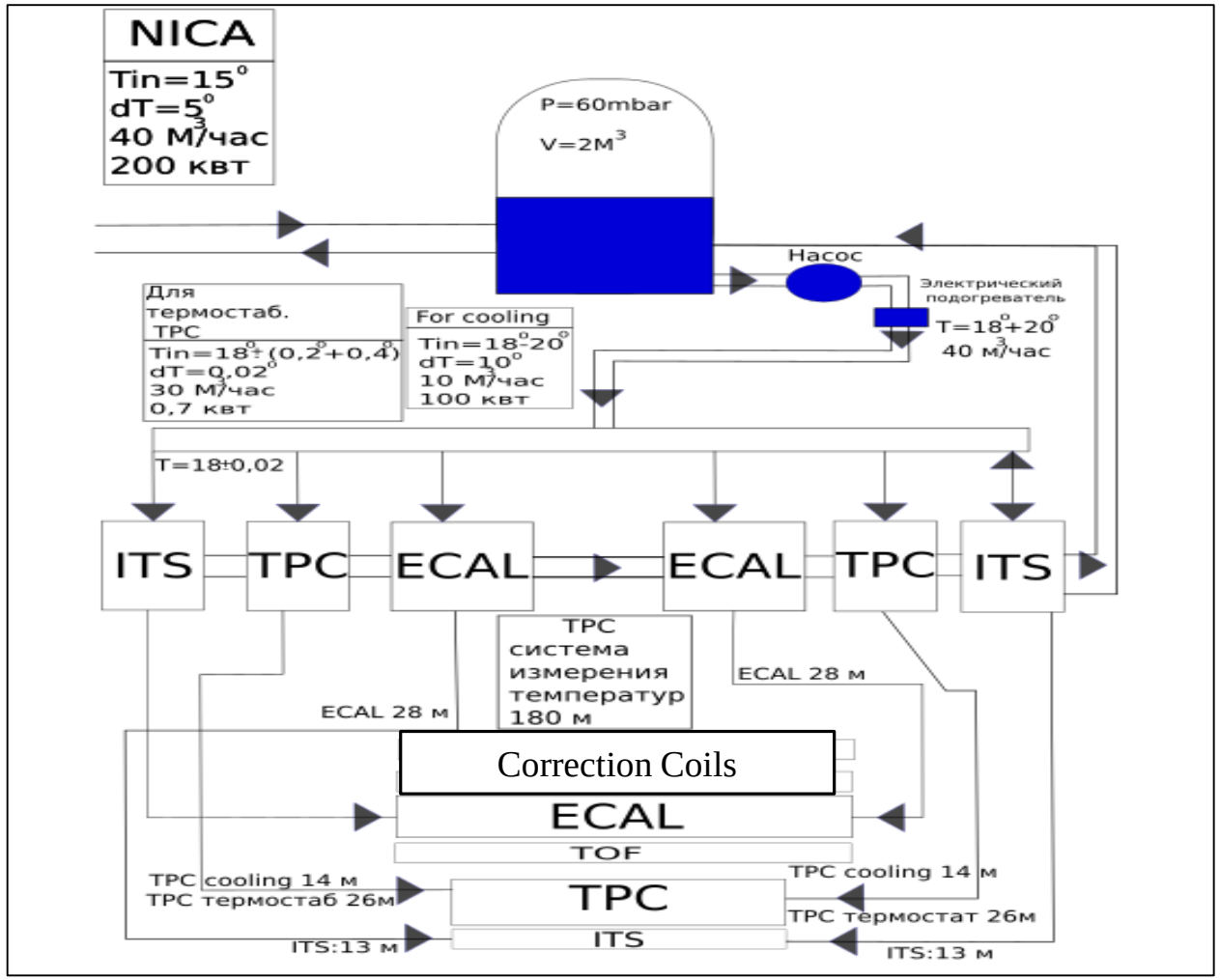
At the moment the Front End electronics have been produced for one sector (2x62 boards). Before to start electronics mass production for all 24 sectors one have to complete tests of one ROC chamber with full set of FE electronics on cosmic and/or on the beam. So far group has plan to finish tests this year and start mass production of FE electronics at the beginning of 2021.

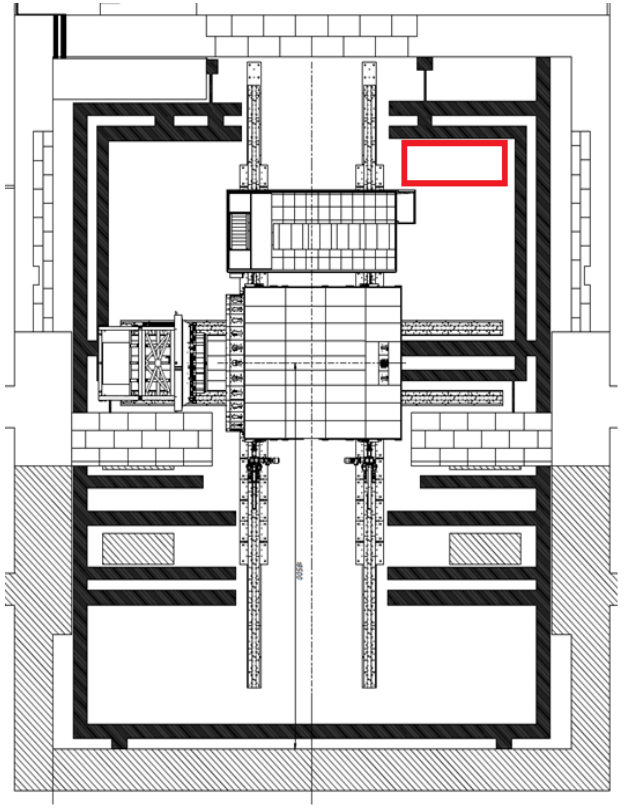
Scheme of the MPD Cooling









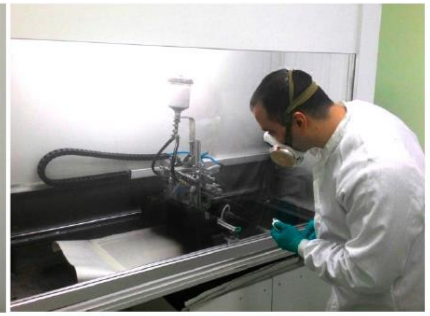


We are planning to design cooling system for three subsystems: TPC, Ecal and ITS. TPC cooling system consists of two independent parts: front end electronics cooling and thermo-screens. Barrel and endcap thermo-screens (full set) are ready. First prototype of FE electronics cooling is tested. Integration electronics cooling with ROC chamber - in progress.

MPD TOF

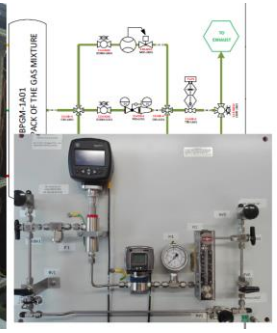
V.Babkin

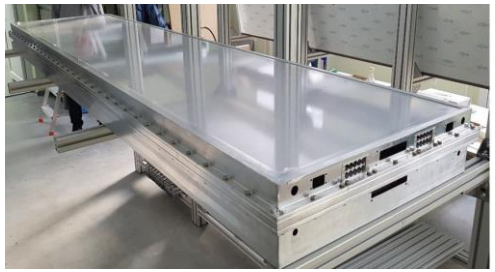
Ultrasonic wave glass cleaning

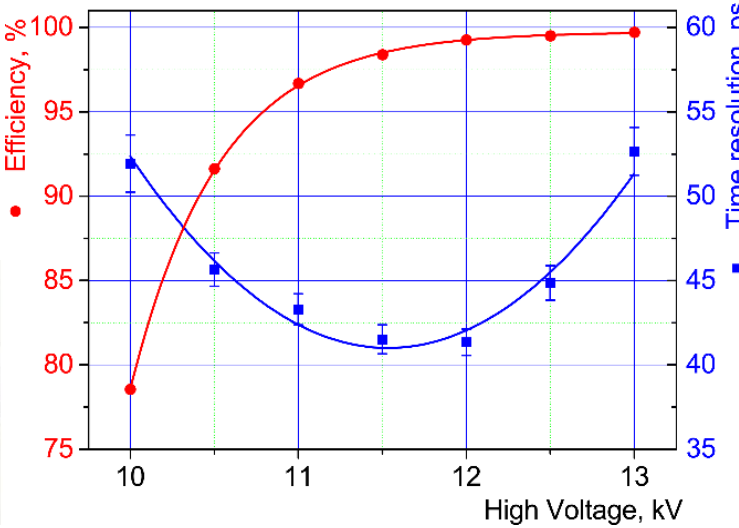


Painting of the HV conductive layer

MRPC assembling

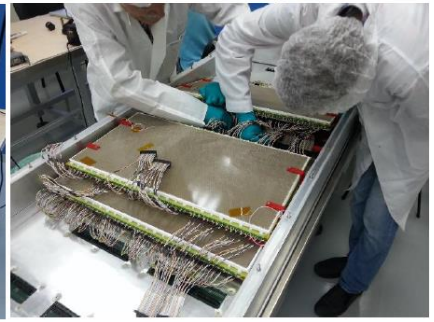






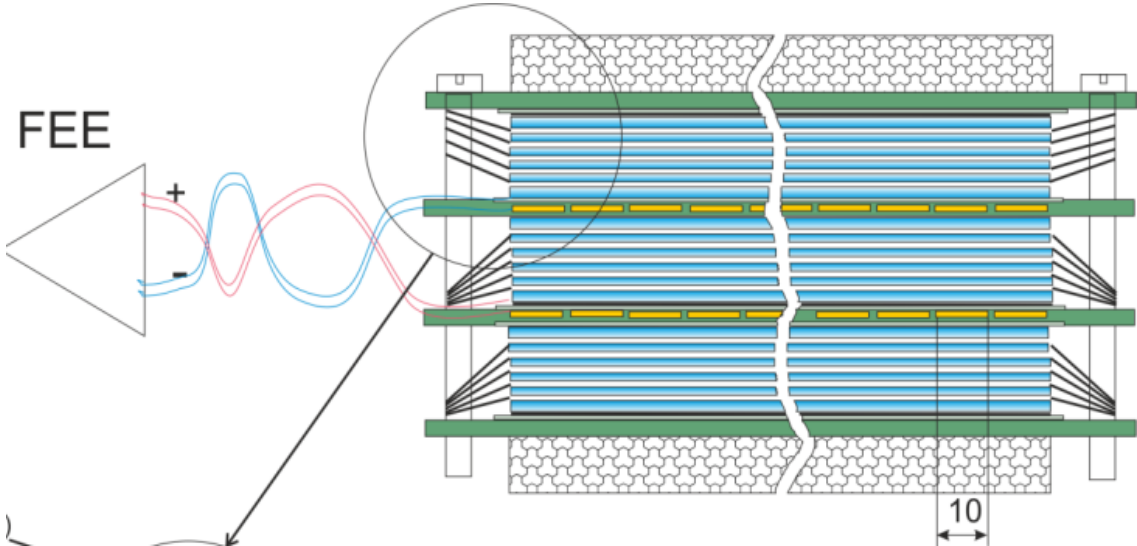
Optical quality control

Cables and connectors soldering

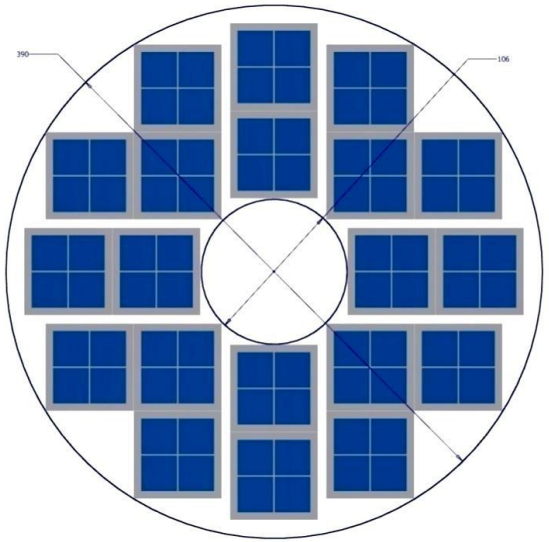


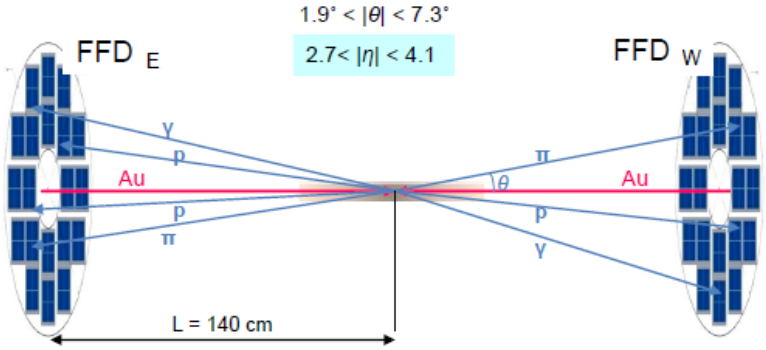
Detectors installation to the TOF box

	Number of detectors	Number of readout strips	Sensitive area, m^2	Number of FEE cards	Number of FEE channels
MRPC	1	24	0.192	2	48
Module	10	240	1.848	20	480
Barrel	280	6720	51.8	560	13440 (1680 chips)



FFD - Fast Trigger L_0 for MPD





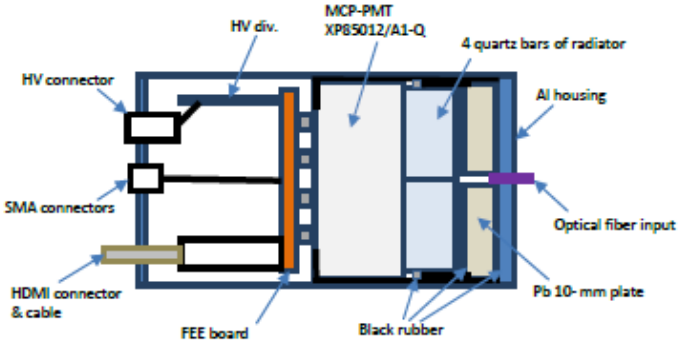


Fig. 4-1. A scheme of the FFD module.

The FFD sub-detector consists of
20 modules based on
Planacon multianode MCP-PMTs
80 independent channels

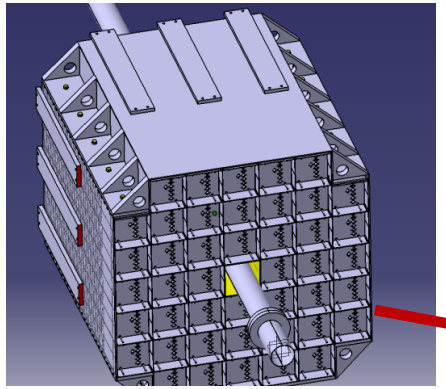
FFD provides information on
- interaction rate (luminosity adjustment)
- bunch crossing region position

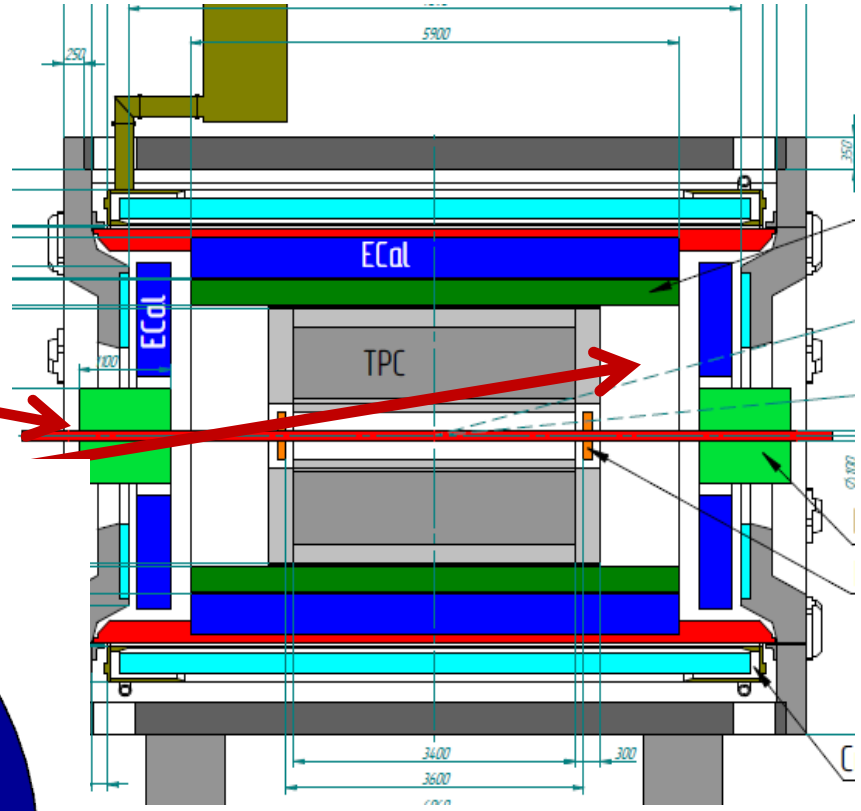
15 mm quartz radiator
10 mm Lead converter

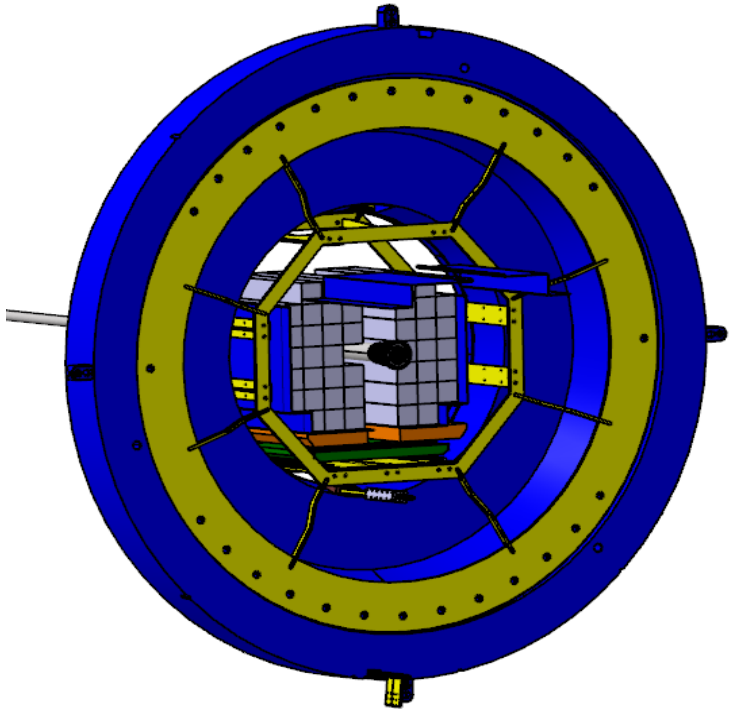
We have to organize MPD trigger group on the base of FFD team
Beside FFD we consider the signals from FHCal to be implemented into trigger L0
The FHCal team have produced trigger electronics.
We need to do Monte Carlo studies to optimize the properties of the L0 trigger

Forward Hadron Calorimeter (FHCal)

Leaders: A.Ivashkin, F.Guber (INR, Troitsk) + MiPhi

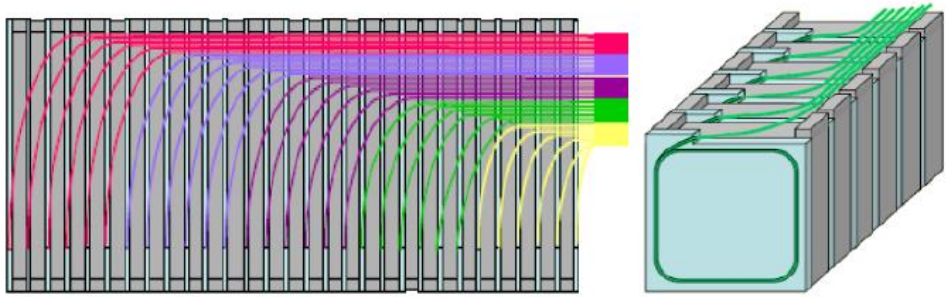


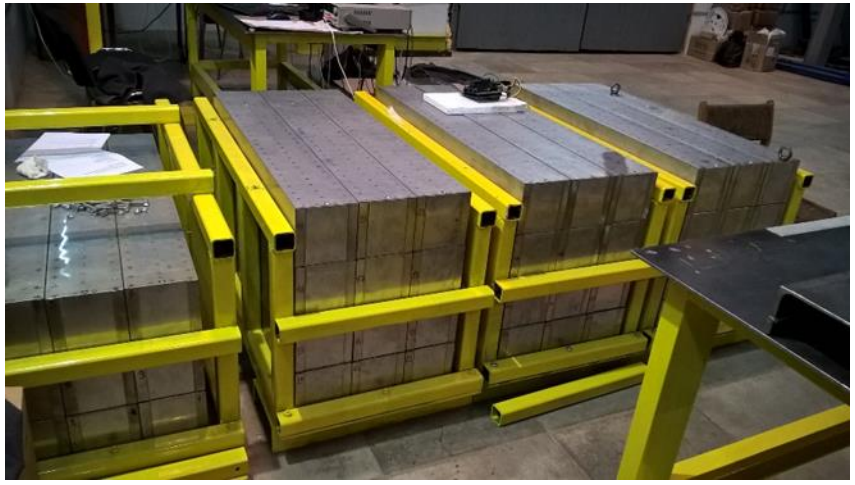




Design of the Support platform for FHCal is under development

- **Two-arms at ~3.2 m from the interaction point.**
- **Each arm consists of 44 individual modules.**
- **Module size 150x150x1100cm^3 (42 layers)**
- **Pb(16mm)+Scint.(4mm) sandwich**
- **7 longitudinal sections**
- **6 WLS-fiber/MAPD per section**
- **7 MAPDs/module**



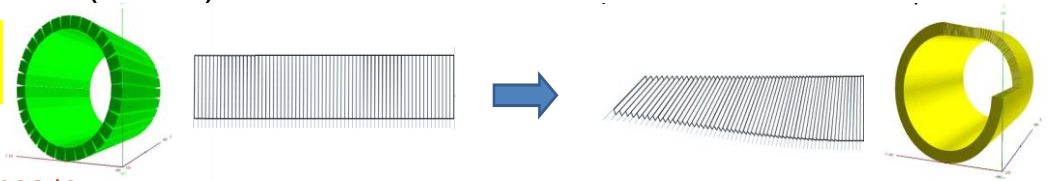


Electromagnetic Calorimeter (ECAL)

ECal – THU – Tsinghua University., Yi Wang
SDU –Shandong University
HU- Huzhou University Fuqing Wang
JINR – production in IHEP (Protvino) and Tenzor (Dubna)

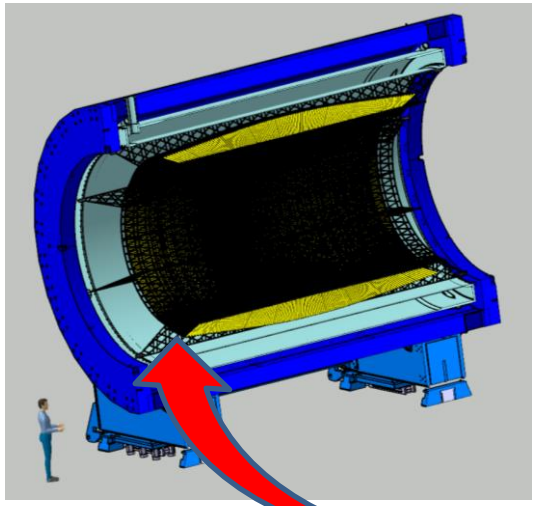
ECal is organized into 25 sectors (50 half-sectors). Each half-sector contains 48 modules.

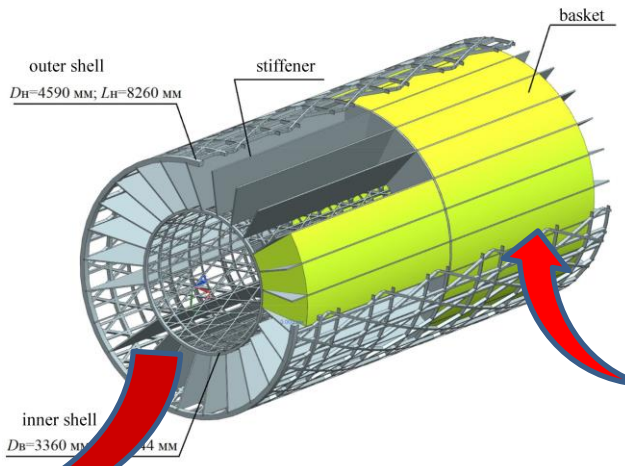
Barrel ECAL ~ 38400 ECAL modules

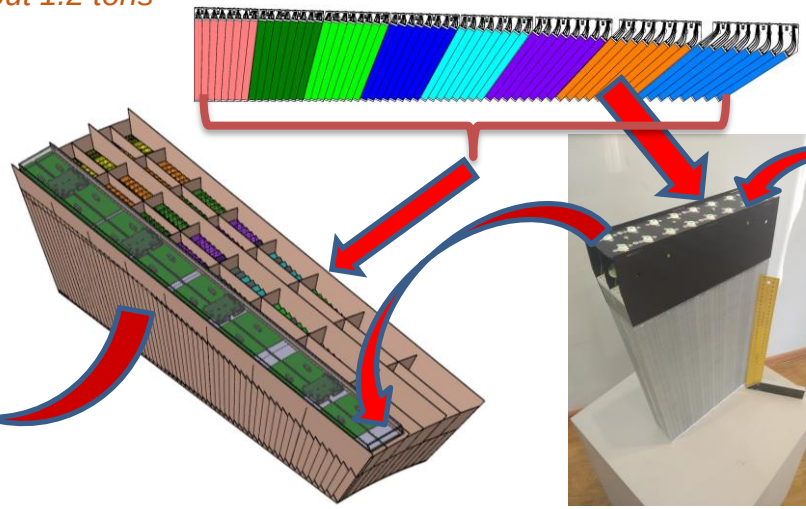


Container is made of Carbon composite

Total load of about 1.2 tons







We need Containers for sectors

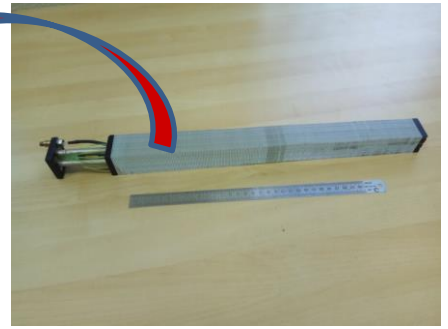


Photo of one element

There was preliminary agreement that 25% of all modules are produced by JINR (production area in Protvino) and
The rest - 75% in China. There are 3 sites are prepared for that.
However beginning this year the Ministry of Science and Education of China allocated funds only for 25% all modules and electronics for them. We have to leave the production of other 50% of Ecal to the Stage II

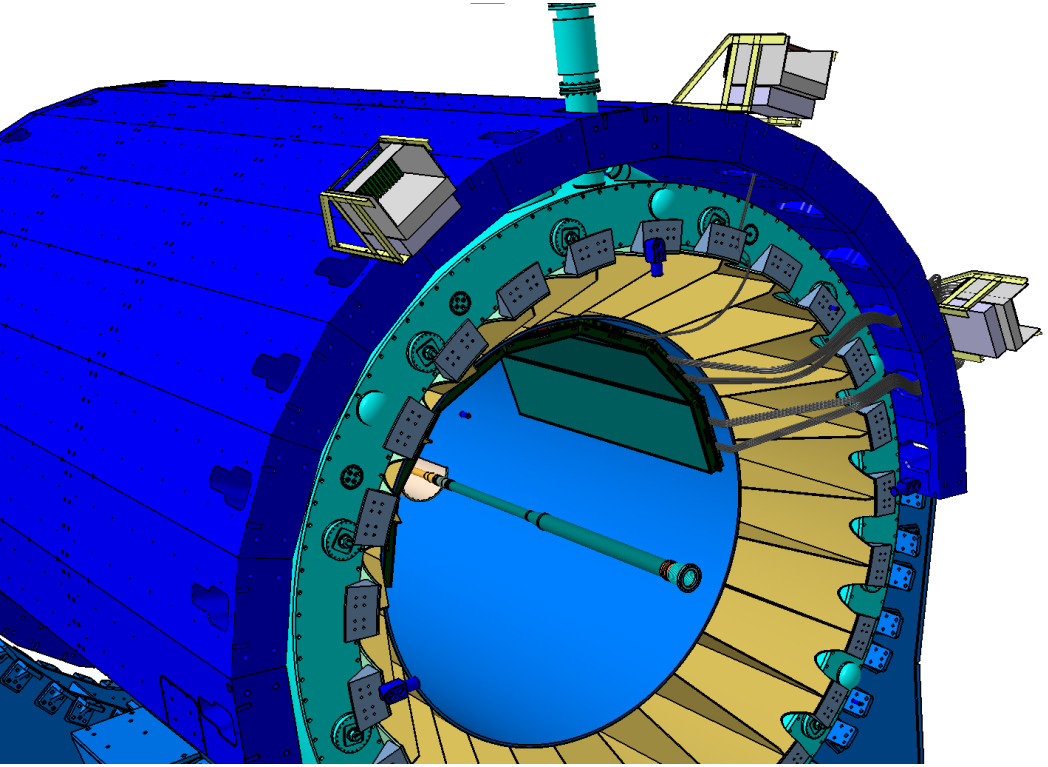
A good news is that Tsinghua University will receive funds pretty soon, maybe next month

Support Frame for detectors inside of the Solenoid

S.Sukhovarov

The structure of Support Frame is made of carbon fiber which allows for deformation less than 3 mm under load with detectors (~80 T). The thickness of the walls is 2-4 mm.

Producer - The Central Research Institute for Special Machinery, Khotkovo, Moscow region is a leading Russian enterprise in design and production of structures on the basis of advanced polymer composite materials for rocket & space engineering, transport, power, petrochemical machinery and other industries.

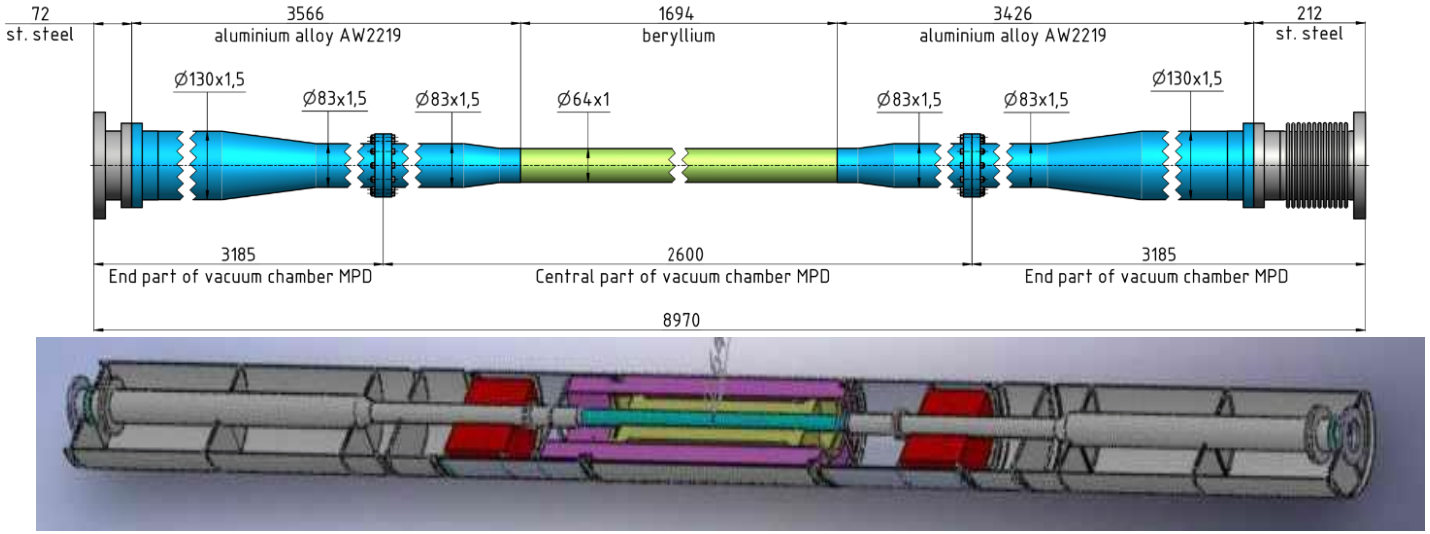


- according to schedule the Frame will be transported to Dubna in November – December 2020
- Representatives of the Company participate in the process of installation of Support Frame into MPD and its alignment

Beam Pipe Stage I:

A.Galimov,I.Moshkovsky

Our requirement for vacuum in the straight part of MPD is not worse than $5 * 10^{-10}$ torr.
Working version of pipe will consists of three parts – central made of Beryllium and two end parts made of Aluminum allow.
So far we have contract with Institute of Beryllium in Moscow for production two Be beam pipes with inner diameter 62 mm.
For Aluminum beam pipes (pc) we have prepared Contract with two Companies in Moscow



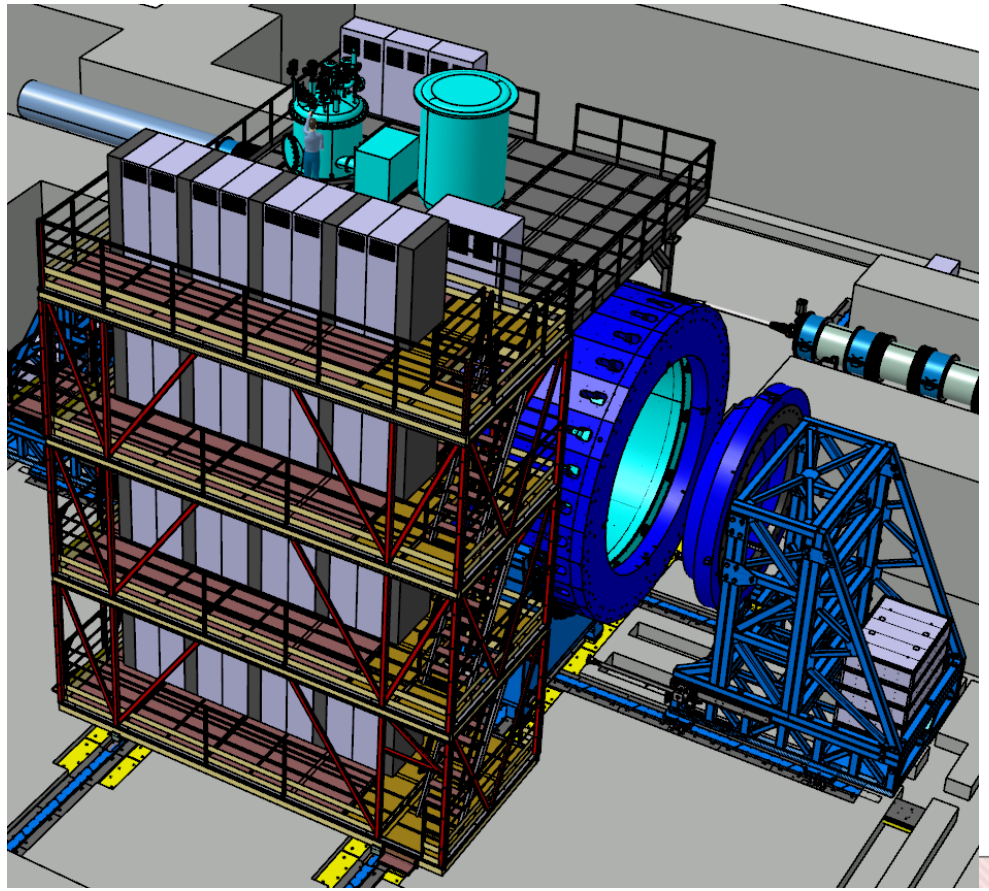
We plan to start work of MPD with Aluminum beam pipe in order to get experience with installation. In order to avoid electron clouds treatment of the inner surface of the beam pipe is required. Laser treatment or gettering are used for this purpose. There are no experts in this field among JINR's engineers. WE have to find company or Institute familiar with these processes.

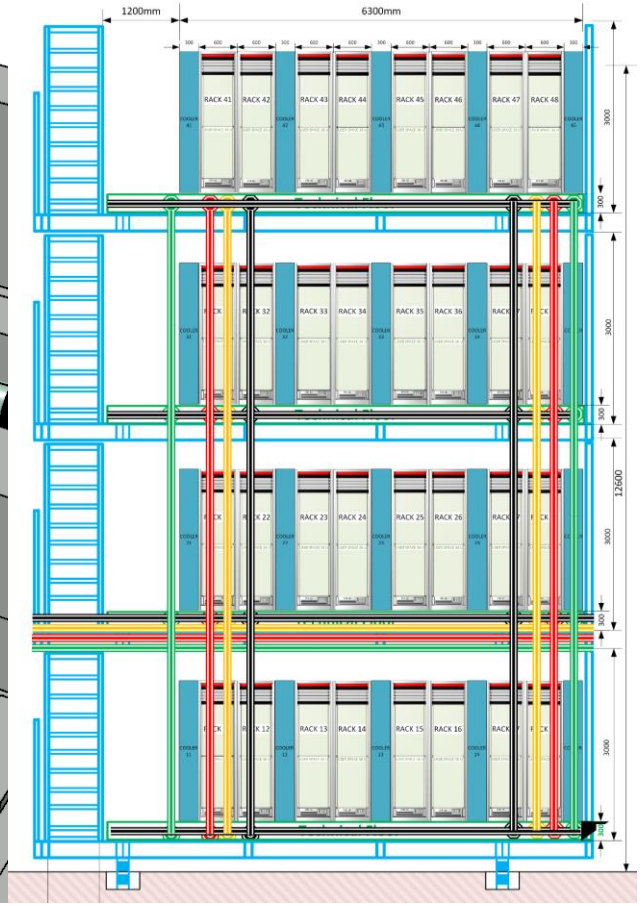
We need in the MPD team one or two experts on Ultra High Vacuum Technics

Two Beryllium beam pipes arrived to JINR in March this year.
They are prepared for vacuum test.

MPD electronics platform

M.Peryt, S.Bazylev, N.Topilin, S.Piyadin





- Electronics platform have 4 levels with 8 racks on each level
- Each Rack provides cooling, fire safety and radiation control system
- Cable ducts connect detectors inside of MPD and Electronics Platform

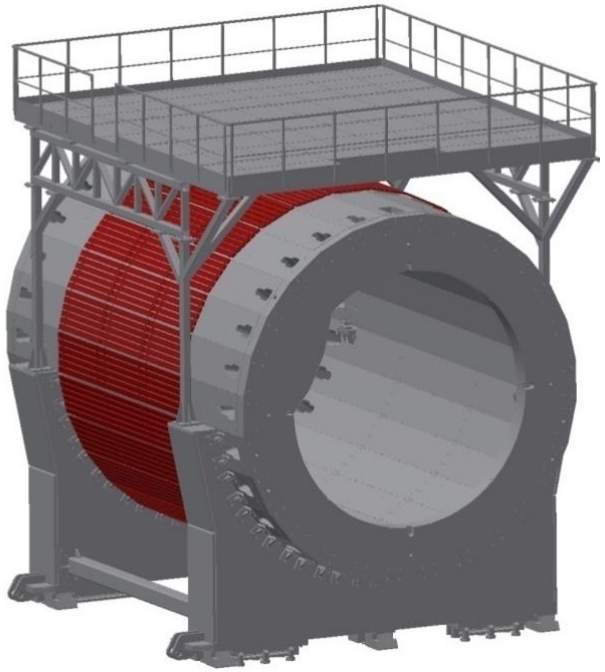
The mechanical part of the Platformed is ready

MPD Cosmic Ray Detector (MCORD)

NCBJ, Swerk - WUT, Warsaw (Poland)
18 scientists+12 engineers

As soon as we plan to start tests of MPD subsystems before Collider operation,-
the Cosmic Ray Detector will be requested for Commissioning and tests of the MPD.
The signals from MCORD will be used for TPC and TOF tests after their installation.
We'll need the elements of MCORD (as scintillation panels with readout electronics) as soon as March 2021

Cosmic Ray Detector consists of plastic scintillators with SiPM (Fototubes) light converters

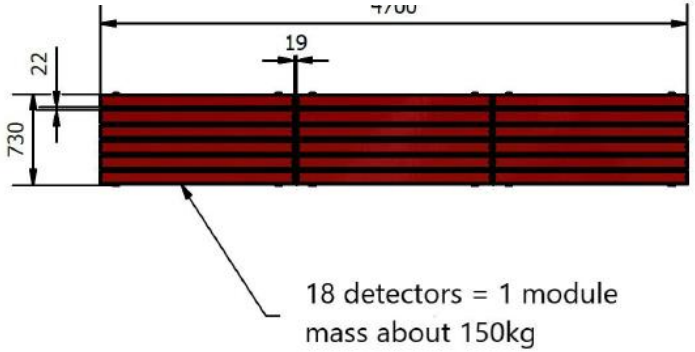


a) Trigger (for testing or calibration)
- testing before completion of MPD (testing of TOF, ECAL modules and TPC)
- calibration before experimental session

b) Veto (normal mode - track and time window recognition)
Mainly for TPC and eCAL

Additionally

c) Astrophysics (muon shower and bundles)
- unique for horizontal events
Working in cooperation with TPC



5. MCORD Detector

SCINTILLATORS

Number of scintillators:	660 pcs
Dimensions of scintillators:	95x25x1500 [mm]
Dimensions of detector:	100x30x1554 [mm]
Scintillators are placed in the rectangle profile	10x30x2.5 [mm]
Weight of detector:	6.5 kg
Material of scintillators casing:	Aluminum alloy

MODULES

Number of detector in one module:	18
Number of Modules:	28
Dimensions of module:	730x90x4700 [mm]
Weight of one module:	150 kg

SiPM/MMPC

Number of SiPMs (Chanels)	1320
Number of SiPMs (with two fibers)	2640

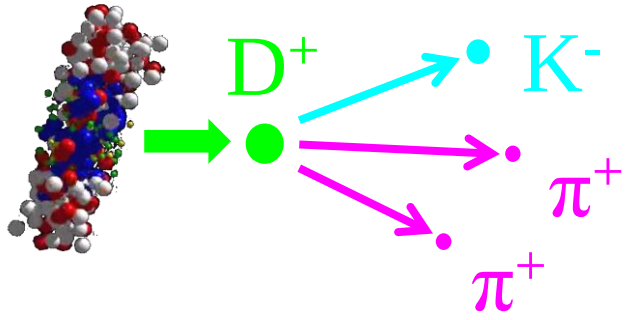
RESOLUTION

Position resolution: In X axis – up to 5 cm, In Y axis – 5-10 cm
Time Resolution – about 300-500 ps

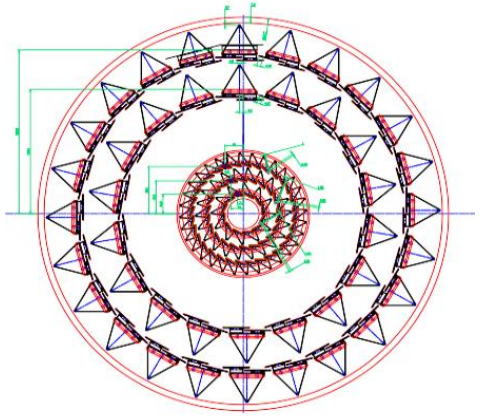
Number of events (particles):	about 100-150 per sec per m2
Calculated Coincidence factor:	about 98%

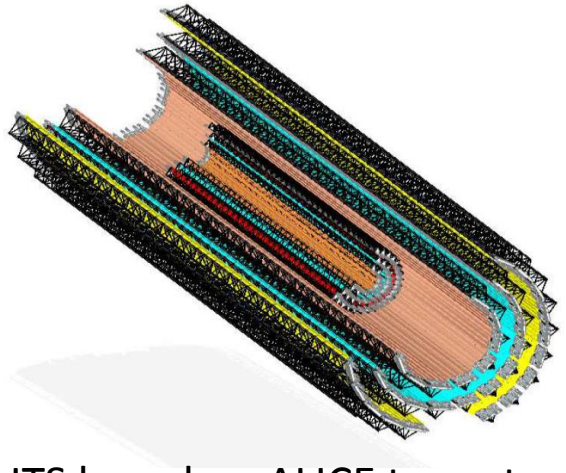
ITS for MPD Experiment

Consortium includes JINR, NICA (BM@N & MPD) , **FAIR, Russian, Poland and Ukrine Insitutes + CCNU Central China Normal Univ – Wu Han and Feng Liu**
IMP- Institute of Modern Physics - Lan Zhou and Nu Xu
USTC – Hefei - Zebo Tang

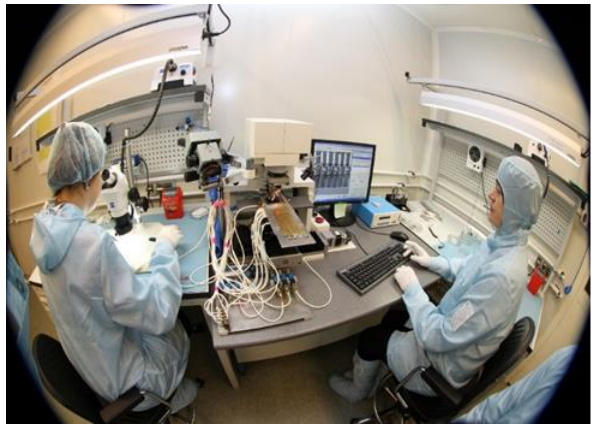


The status of the MPD ITS has change from the moment when the Protocol # 134 between CERN and JINR stating the legal terms for transaction of CERN developed novel technology and the know-how for building the MPD-ITS on the basis of Monolithic Active Pixel Sensors *(the MAPS*) ALPIDE was signed in 2018. This document laid a clear road towards the MPD ITS.



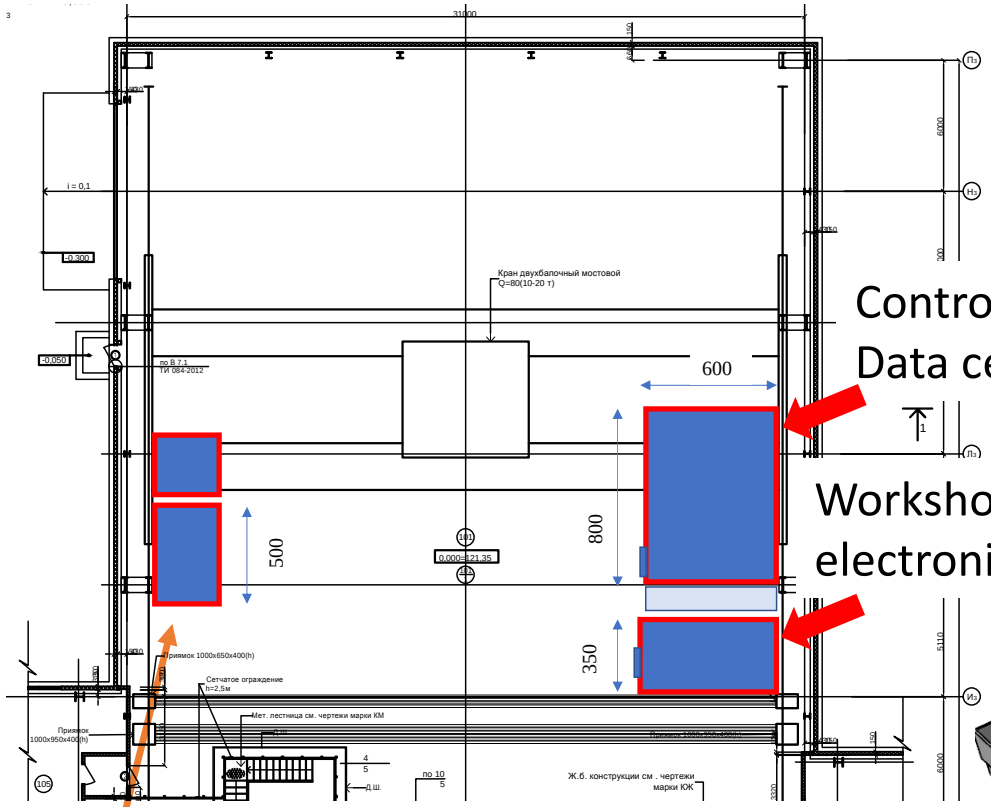


MPD ITS based on ALICE type staves



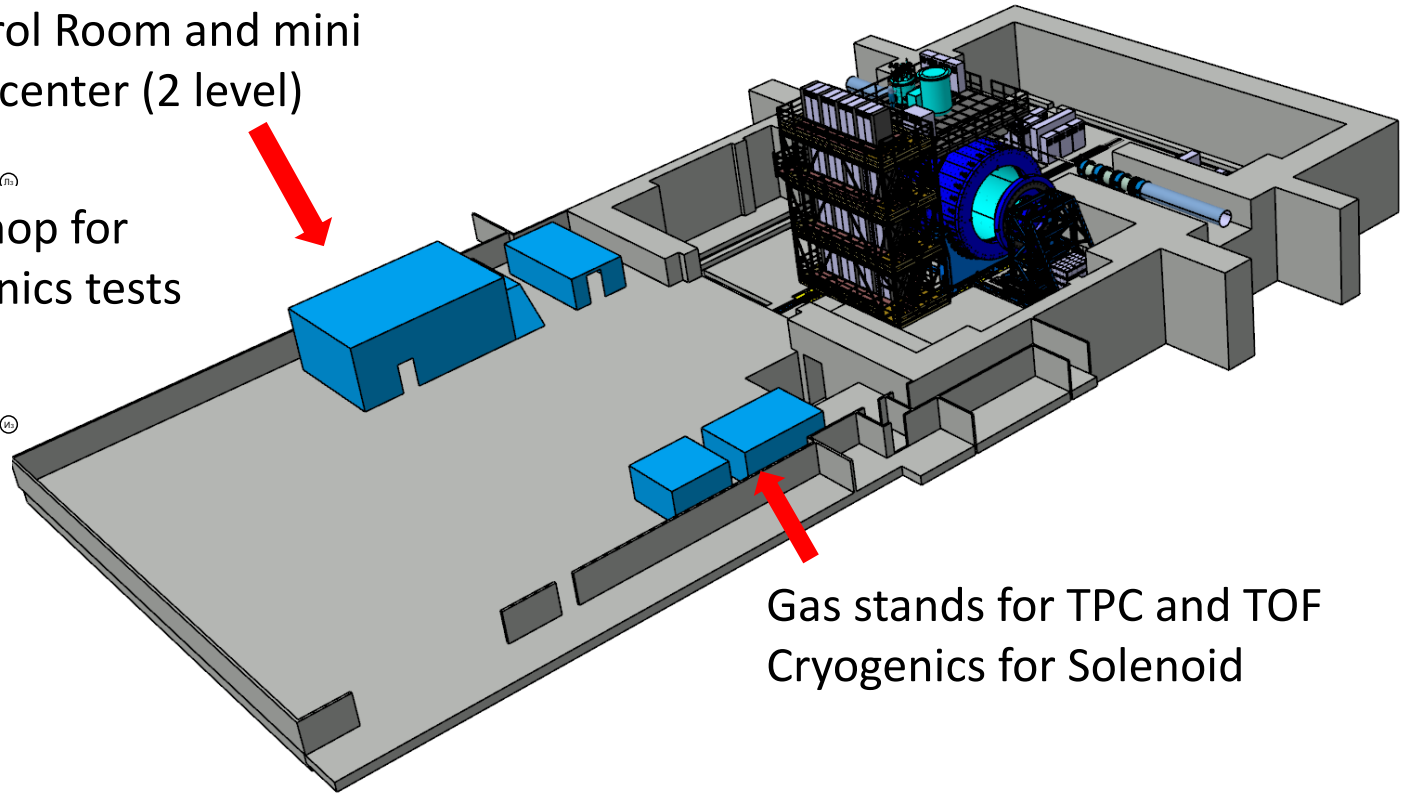
MPD Service Hall (zero level)

N.Topilin



Control Room and mini
Data center (2 level)

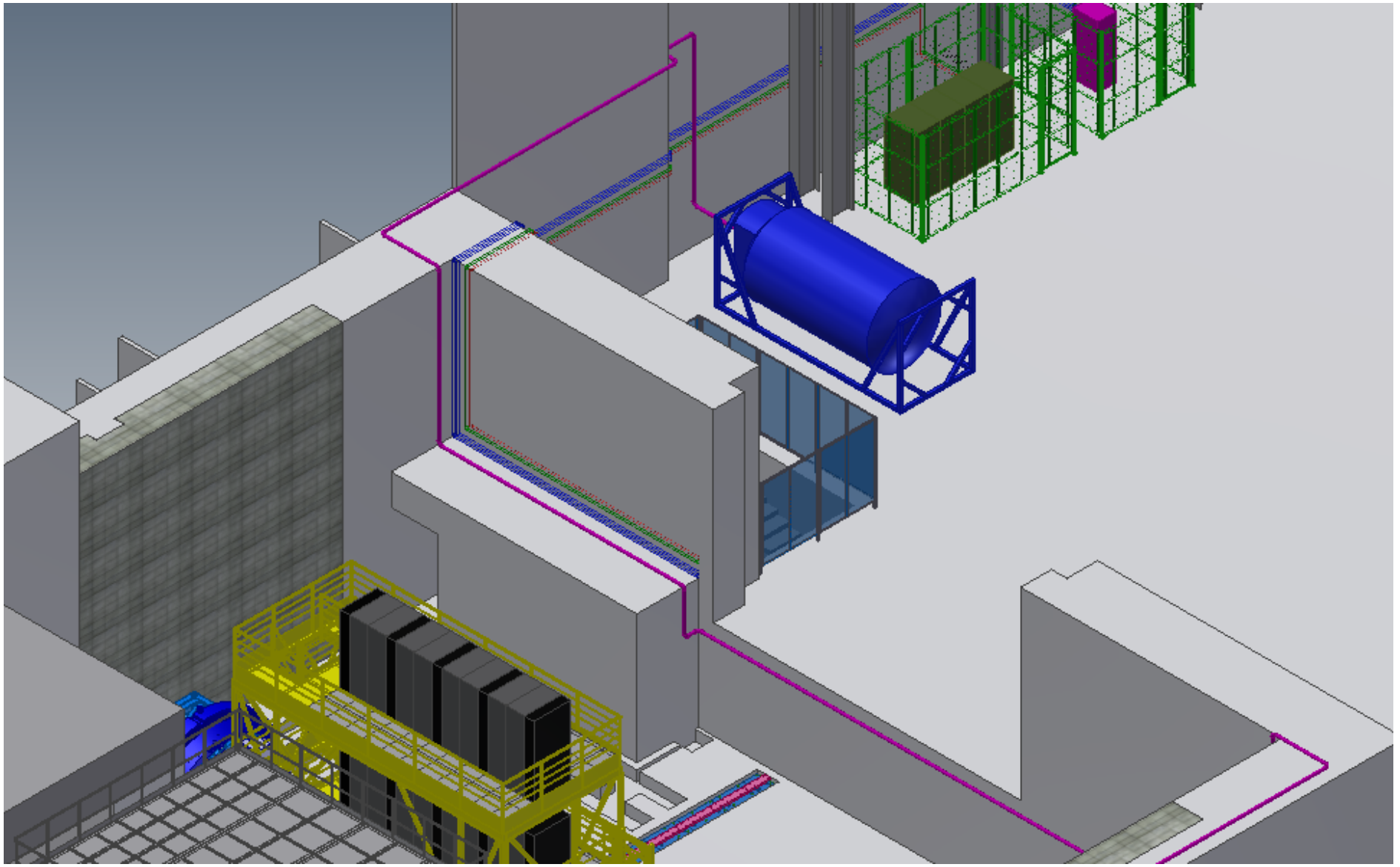
Workshop for
electronics tests



Gas stands for TPC and TOF
Cryogenics for Solenoid

Gas stations for TPC и TOF
And Cryogenics for Solenoid

LHe and LN routes for Solenoid supply



Milestones of MPD assembling in 2020-2021 (optimistic)

Year 2020

1. April 30st - - MPD Hall and pit are ready to store and unpack Yoke parts
2. May-June - Magnet Yoke is assembled for alignment checks
3. August - Solenoid is ready for transportation from ASG (Italy)
4. September - Solenoid is in Dubna
5. November - Assembling of Magnet Yoke and Solenoid at JINR
6. December - Preparation for switching on the Solenoid (Cryogenics, Power Supply et cet.).

Year 2021

7. Febr-Match - Magnetic Field measurement
8. April. - Installation of Support Frame
9. May - Sept - Installation of subsystems, Electronics Platform, Cabling
10. November 2021 -Commissioning MPD
11. December 2021 -Readiness for Cosmic Ray tests

Summary

All components of the 1st stage detector advanced in production.
All efforts of the MPD groups are put on the execution of the schedule plan with minimal delays

Thank you

Forward tracker based on thin gap MWPC with pad (strip) readout.

Technical University of Santa Maria in Valparaiso, Chile (S.Kovalenko)
and Petersburg Nuclear Physics Institute, Gatchina (O.Fedin)