MPD TPC ASSEMBLING (27.08.2025)

TPC:

- **vessel assembly, ROC chambers**

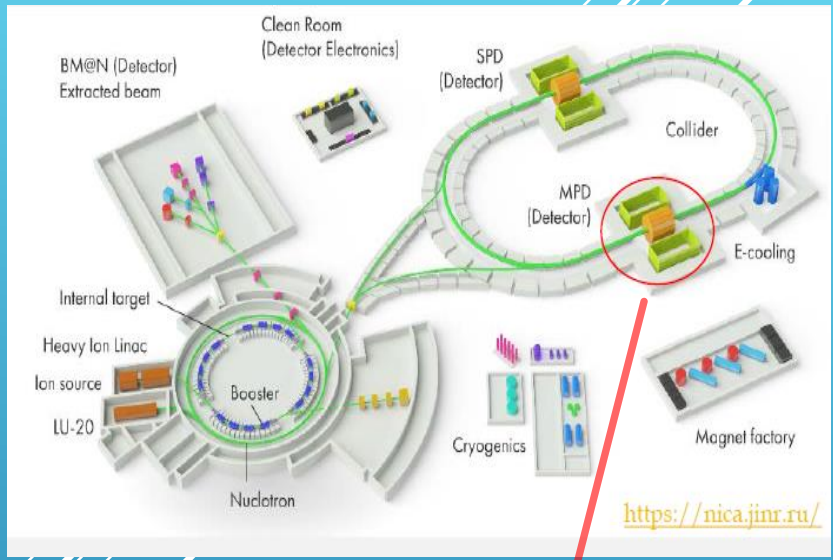
Sub-systems:

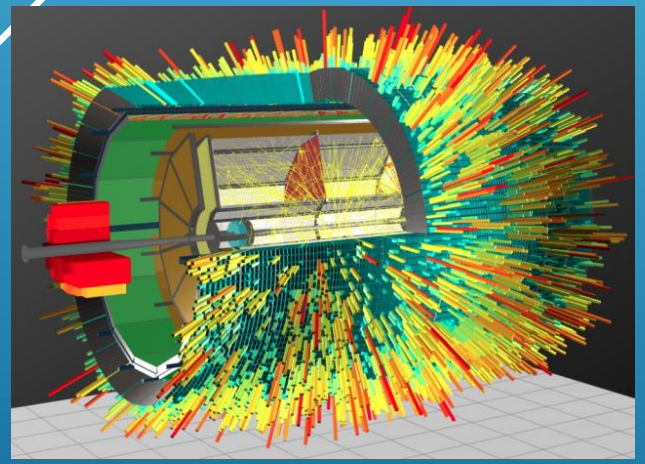
- **Gating grid system**
- **Electronics**
- **LV+HV system (CAEN)**
- **Gas system**
- **Cooling system**
- **Laser calibration system**
- **Slow control**

Integration of TPC to MPD

- **Electronics platform**
- **Cabling and piping**
- **Installation TPC to MPD**

Time schedule

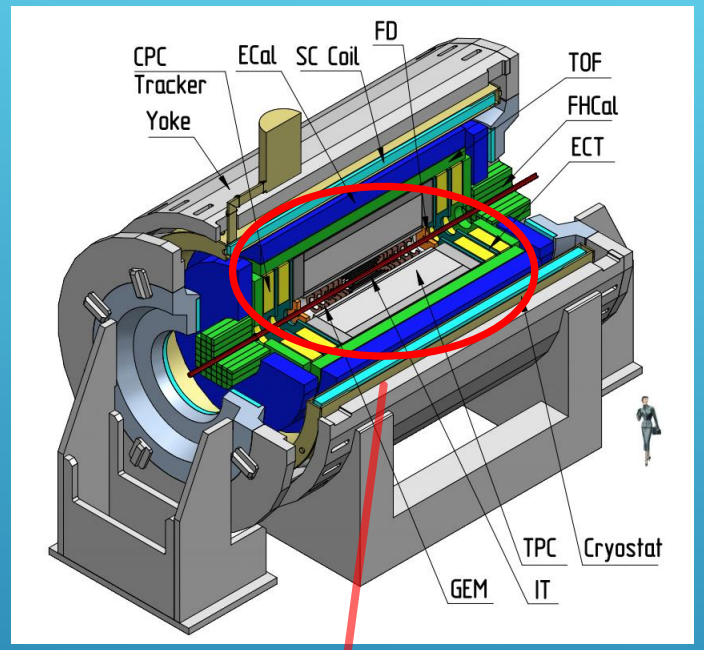




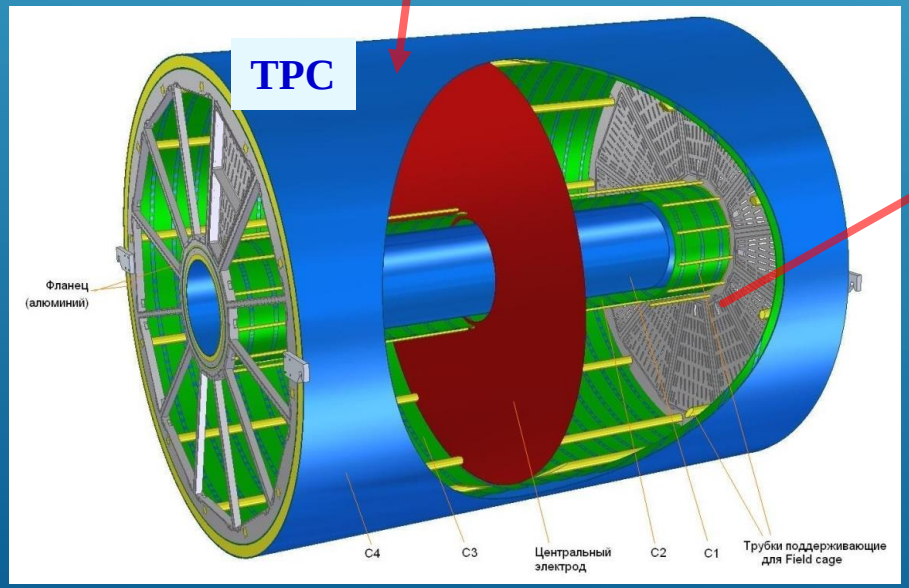
Presented by S.Movchan

TPC team – 29 (JINR) + 25 (Belarus)

MPD concept

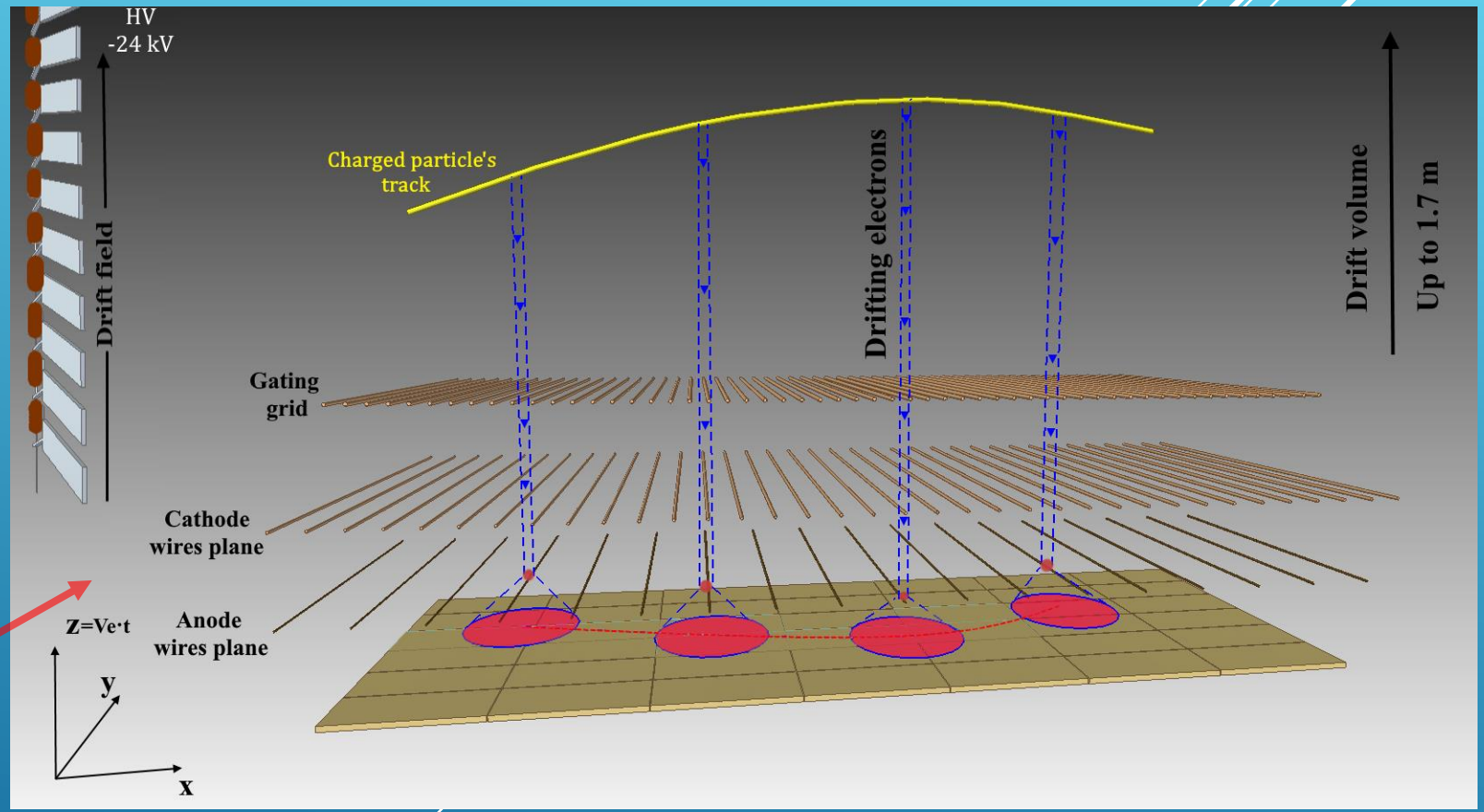


TPC

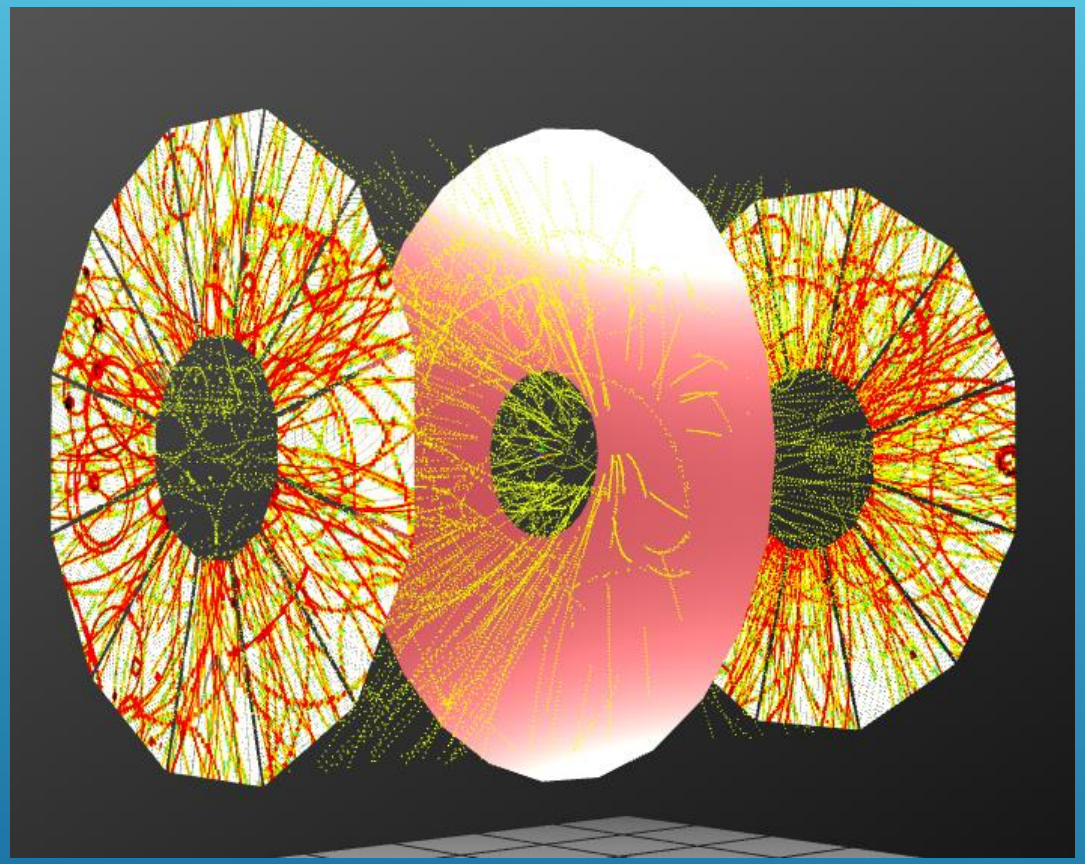


TPC: PRINCIPAL OF OPERATION

Read out based on MWPC



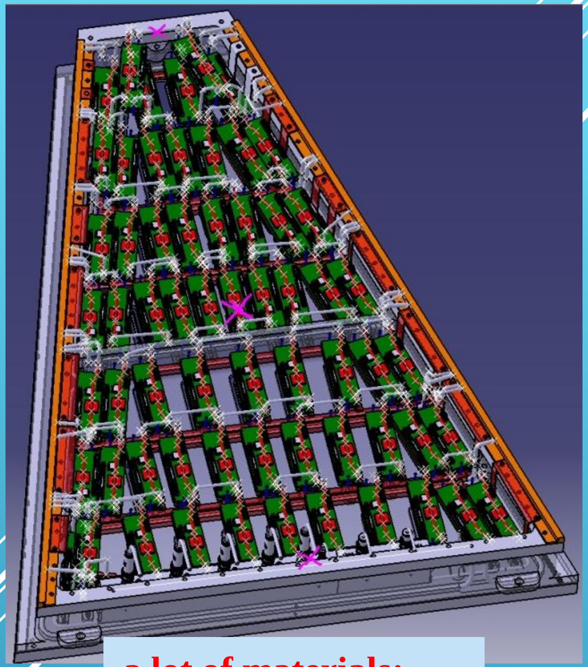
MPD TPC MAIN PARAMETERS



Item	Dimension
Length of the TPC	340cm
Outer radius of vessel	140cm
Inner radius of vessel	27 cm
Outer radius of the drift volume	133cm
Inner radius of the drift volume	34cm
Length of the drift volume	170cm (of each half)
HV electrode	Membrane at the center of the TPC
Electric field strength	~140V/cm;
Magnetic field strength	0.5 Tesla
Drift gas	90% Ar+10% Methane, Atmospheric pres. + 2 mbar
Gas amplification factor	~ 10^4
Drift velocity	5.45 cm/μs;
Drift time	< 30μs;
Temperature stability	< 0.5°C
Number of readout chambers	24 (12 per each end-plate)
Segmentation in φ	30°
Pad size	5x12mm^2 and 5x18mm^2
Number of pads	95232
Pad raw numbers	53
Pad numbers after zero suppression	< 10%
Maximal event rate	< 7 kHz (Lum. 10^{27})
Electronics shaping time	~180 ns (FWHM)
Signal-to-noise ratio	30:1
Signal dynamical range	10 bits
Sampling rate	10 MHz
Sampling depth	310 time buckets

MPD TPC RADIATION LENGTH (BASE LINE OPTION)

TPC radiation length						
	for η = 0 Θ = 90°	for η = 1.04 Θ = 38.87° Cos(90°-38.87°) = 0.628		for η = 1.14 Θ = 35.55° Cos(90°-35.55°) = 0.581	for η = 1.51 Θ = 25.03° Cos(90°-25.03°) = 0.423	for η = 2.06 Θ = 14.51° Cos(90°-14.74°) = 0.251
C1 h=3 mm + Al foils	1.061	1.689		1.826	2.508	4.227
N_2 (gap C1-C2) h=65 mm	0.020	0.032		0.034	0.047	0.080
C2 h=3 mm + Al strips on C2	0.958	1.525		1.649	2.265	3.817
TPC gas mixture L = 989 mm for η = 0	0.771	1.228 (L=1574.8 mm)		1.125 (L=1443.8 mm)	0.830 (L=1164.8 mm)	0.252 (L=322.7 mm)
Potential degrader rods + field cage	0.085	0.135				
C3 h=4.05 mm + Al strips	1.275	2.030				
N_2 (gap C3-C4) h=67 mm	0.020	0.032				
C4 h=6.4 mm	1.972	3.140				
TPC shielding Al, h=0.1 mm	0.112	0.178				
TPC thermal-screen (top) Al + H_2O, h=1.5mm	2.942	4.686				
Air (C4 up to TOF) h = 60 mm	0.020	0.032				
Sum [C1+N2(gap C1-C2) + C2 + gas mixture]:	= 9.24	= 14.71		4.63	5.65	8.38
			for Θ = 0°	for Θ = 35.55° Cos(35.55°) = 0.814	for Θ = 25.03° Cos(25.03°) = 0.906	for Θ = 14.51° Cos(14.51°) = 0.968
ROC						
1. Wires			0.30	0.37	0.33	0.31
2. Pad plane h=3.4 mm + inside glue			2.83	3.48	3.12	2.92
3. Insulating plate h=3 mm			1.88	2.31	2.08	1.94
4. Al frame h=5 mm & ROC reinforce rib + ROC cooling tube (Cu) with water			6.54 + 0.91	8.03 + 1.12	7.22 + 1.00	6.75 + 0.94
5. Epoxy glue (2x0.1 mm)			0.056	0.069	0.062	0.058
6. Connectors + solder			0.34	0.42	0.38	0.35
Air gap L=100 mm			0.033	0.041	0.036	0.034
ROC MWPC sum:			12.89	15.84	14.23	13.30
FE (based on SAMPA chip)						
Components FE – (2x12 layers)x2 Connectors + solder			0.33 2.32 0.34	0.41 2.85 0.42	0.36 2.56 0.38	0.34 2.40 0.35
FE sum:			2.99	3.68	3.30	3.09
FE Cooling						
Al plates on chips + Cu & Al pipes + water			7.10 + 3.68	8.72 + 4.52	7.84 + 4.06	7.33 + 3.80
FE Cooling sum:			10.78	13.24	11.90	11.13
LV & DAQ+SC cables + signal cables + flat cables			~ 8.82 + 0.19	~ 8.82 + 0.23	~ 8.82 + 0.21	~ 8.82 + 0.20
Service wheel (SSW) 12.5 kG (Al) + 0.25 kG bolts			NO			
Flange C1&C2 to C3&C4 (Al) 170 kg			NO			
TPC thermal-screen Al (flange)+Al (clamps) [m(Al) = 21 kG] + H_2O			~1.46 ~0.01	~1.79 ~0.01	~1.61 ~0.01	~1.51 ~0.01
Summary:	[illegible]	= 14.71	37.14	[illegible]	[illegible]	[illegible]

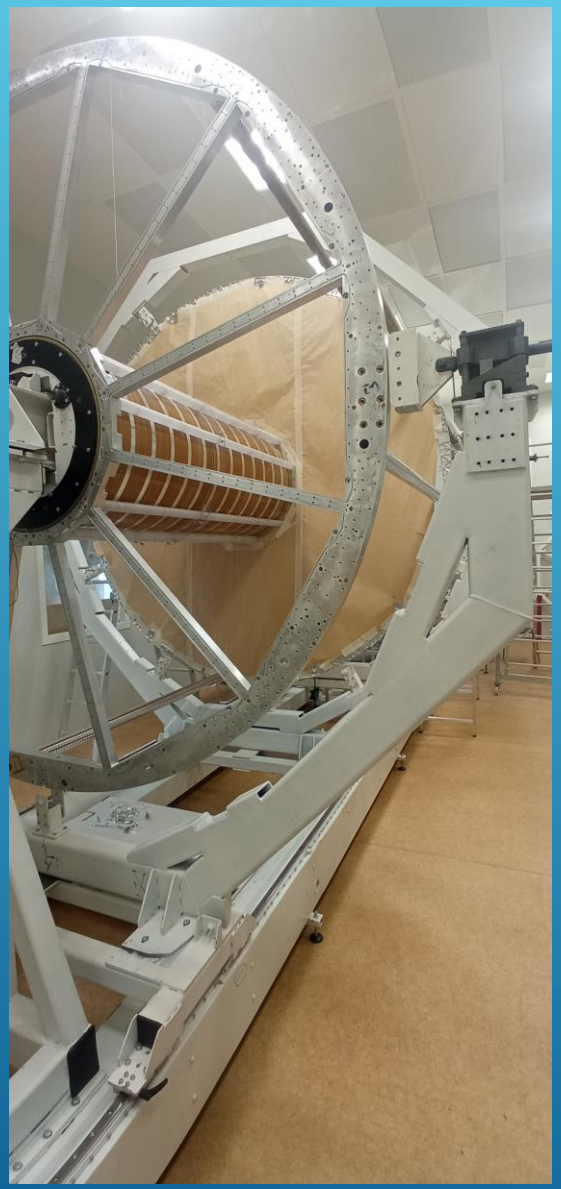


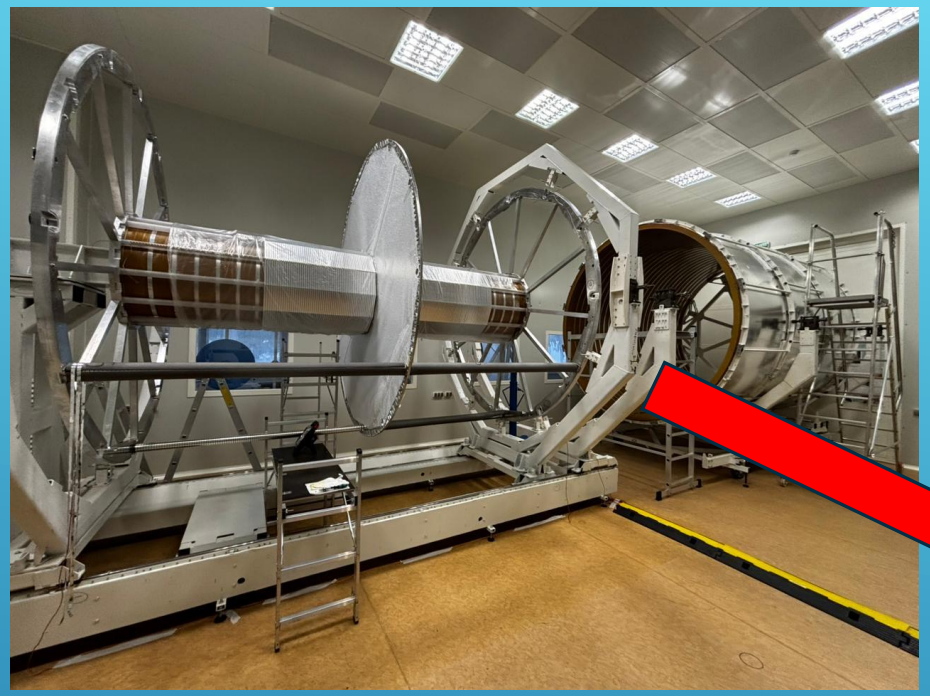
a lot of materials:
- ROC chamber
- Al chamber frame
- FE electronics
- cooling radiators
- cables
- pipes

END CAPS (η = (1.14÷2.06)):
X/X0 = (47+/-1) %

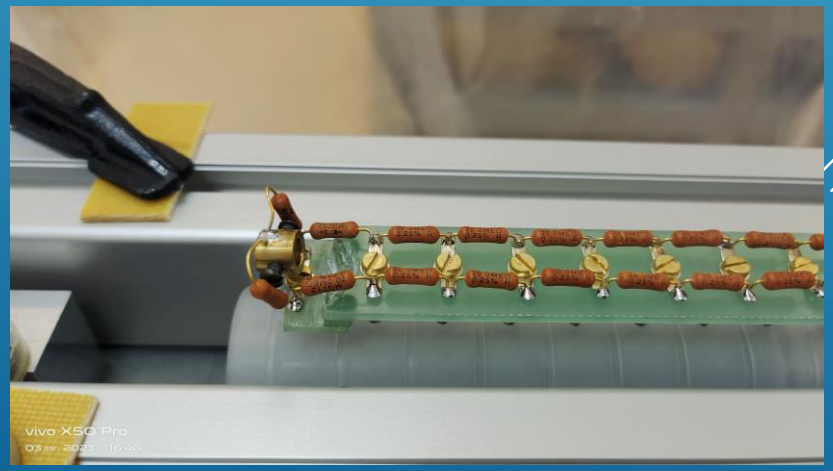
BARREL (η = (0÷1.04)):
X/X0 = (12+/-2.7) %

TPC VESSEL ASSEMBLING: RODs D=40 MM WITH FIELD CAGE STRIPS





Rod with HV divider



Field cage HV strips

All 24 pc RODs D=40 mm are installed
HV tested at -25 kV

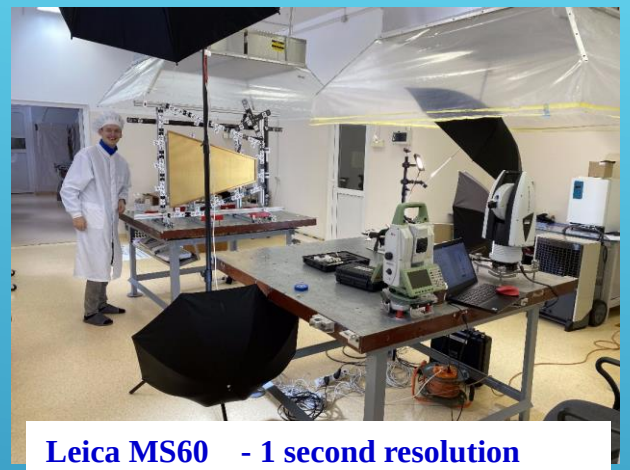
TPC ROC CHAMBERS

Test setup for ROC certification

24 pc ROCs – tested

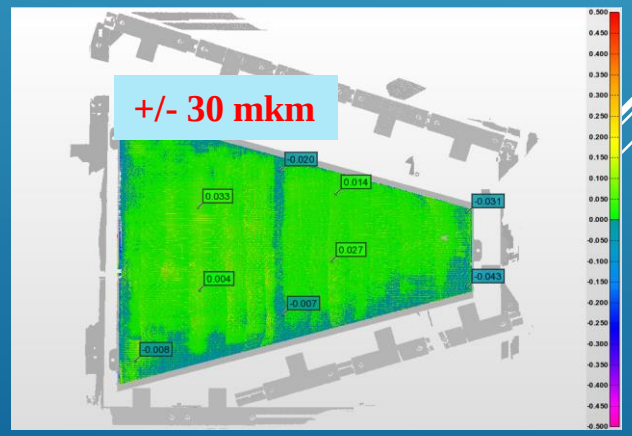
24 pc serial ROCs + 4 spare – READY!

Test setup for pads calibration



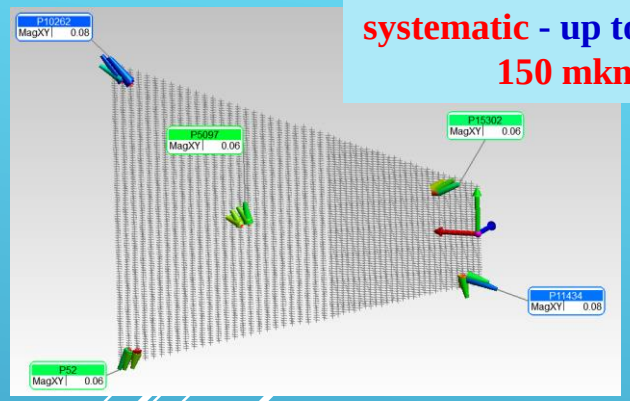
Leica MS60 - 1 second resolution
Leica AT960 +/-10 mkm +5 mkm/m
Leica AT403 +/-15 mkm +6 mkm/m
Scanner AS1+AT960 +/-50 mkm

Pad plane unflatness: example



Check pads geometry

systematic - up to 150 mkm



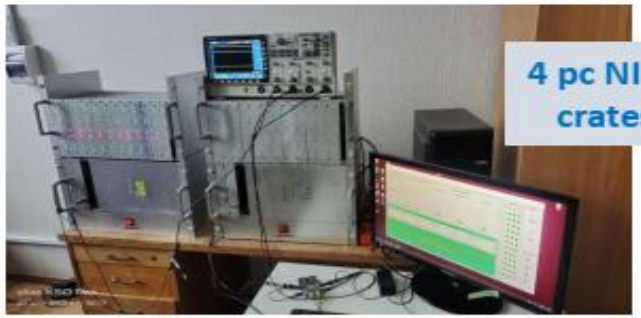
Full set of ROC alignment marks

Summary:
- measurements done for all ROCs
- mapping of 3968 pads respect to ROC "reference hole" for each chamber
- in progress

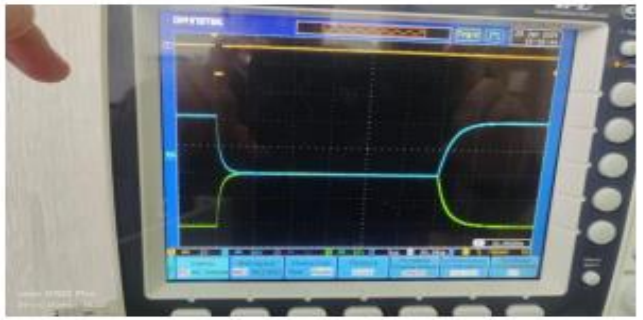
TPC SUB-SYSTEMS: GATING GRID SYSTEM (GGS)

ROC gating grid system: test setup

TPC Gating grid system



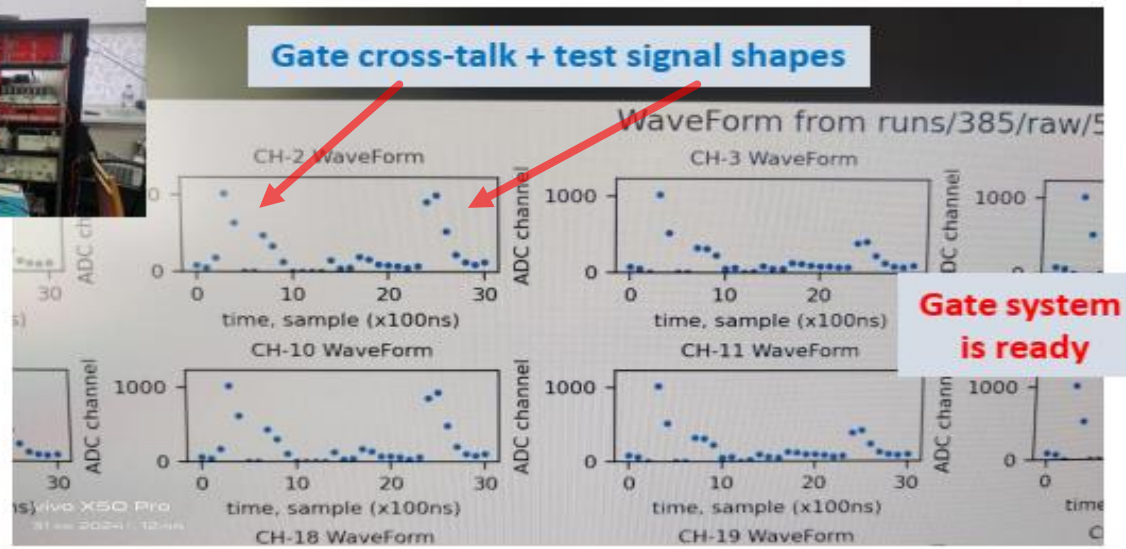
4 pc NIM crates



Test setup in Minsk

Rise time - 1 mksec
Fall time – 2 mksec

Gate cross-talk + test signal shapes

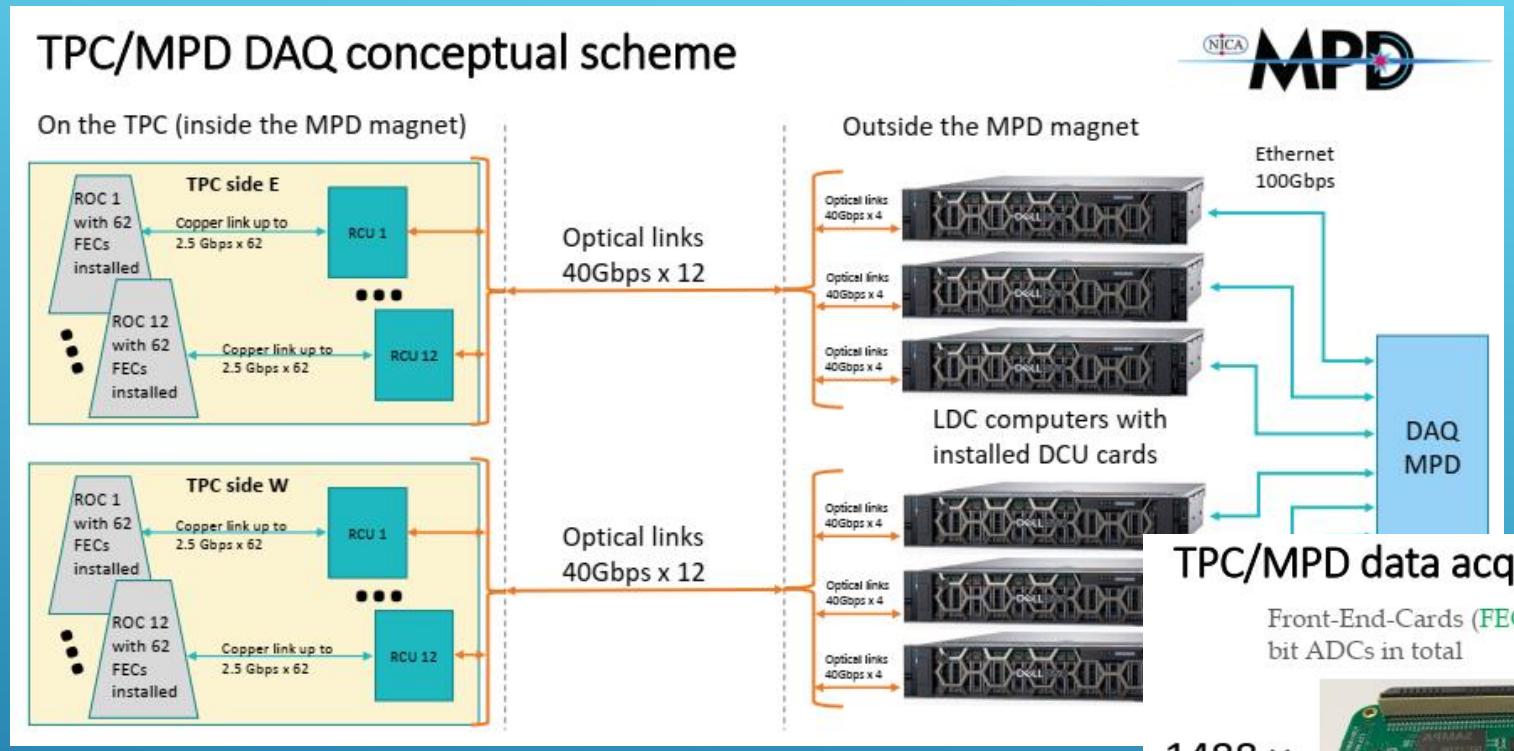


Gate system is ready

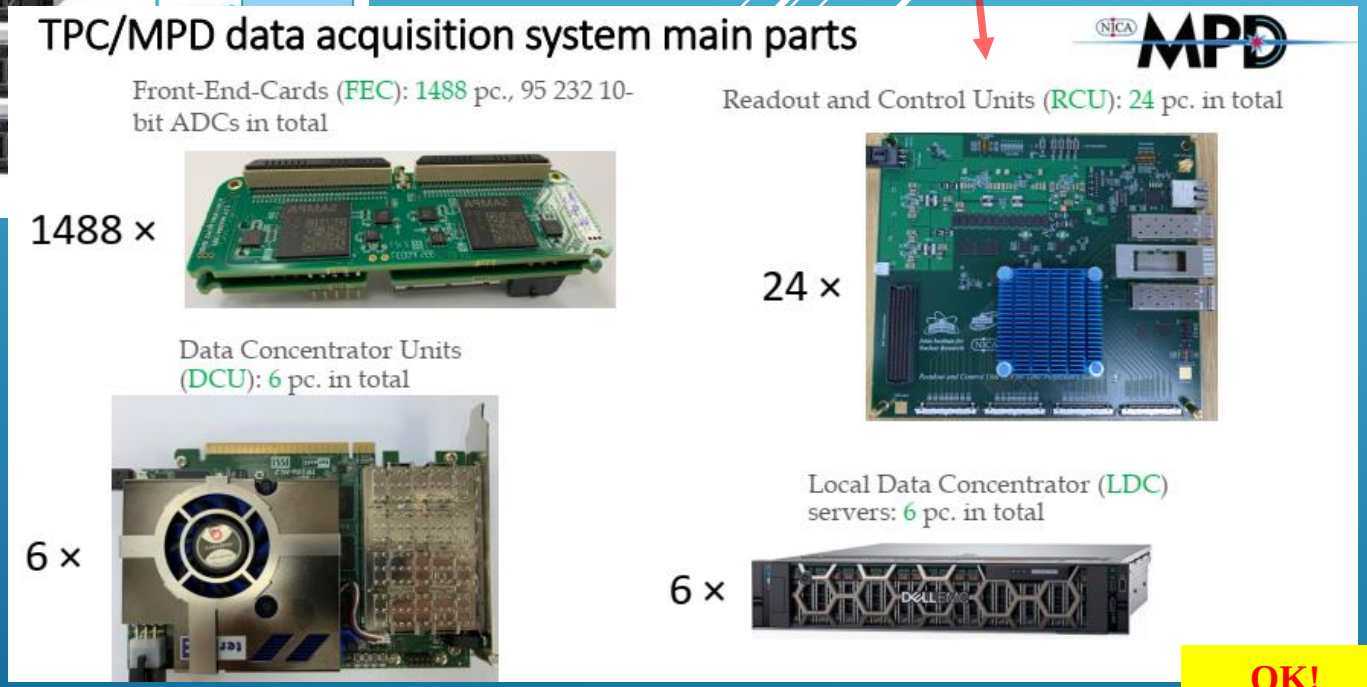
Gate cross-talk is about 1,5 microsec + test signal (500 nanosec)

System long term test at Minsk – ongoing …

TPC SUB-SYSTEMS: DAQ



Controller (RCU) rev 1.2– under tests … mass-production (30pc) – Sept 2025



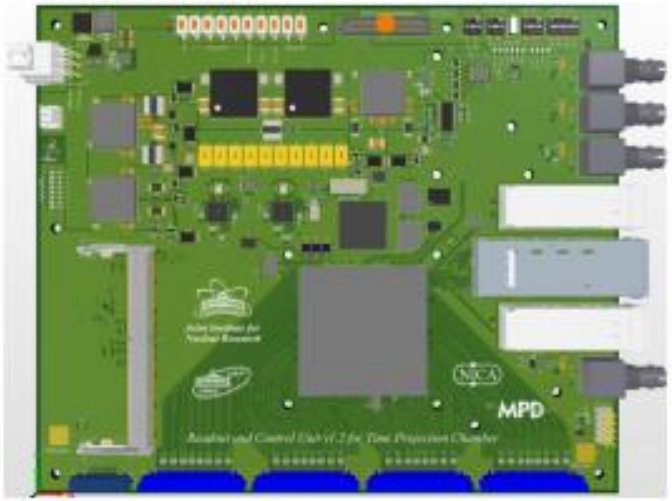
OK!

TPC SUB-SYSTEMS: ELECTRONICS

Readout and Control Unit (RCU)

After RCU v.1.1 testing small corrections have been done and new one is under production now.

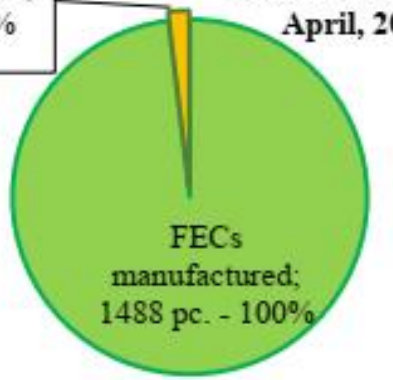
RCU v.1.1

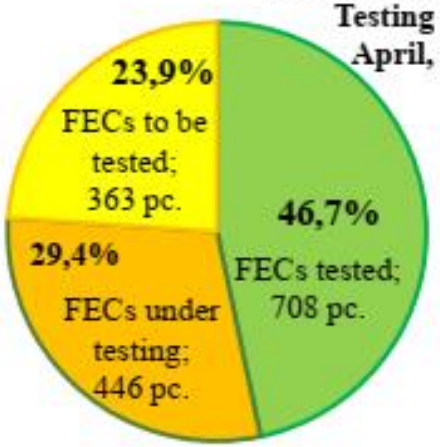


RCU v.1.2

Front-End Cards (FEC)

Reserve FECs; 29 pc. - 2%





FEE synchronization modules

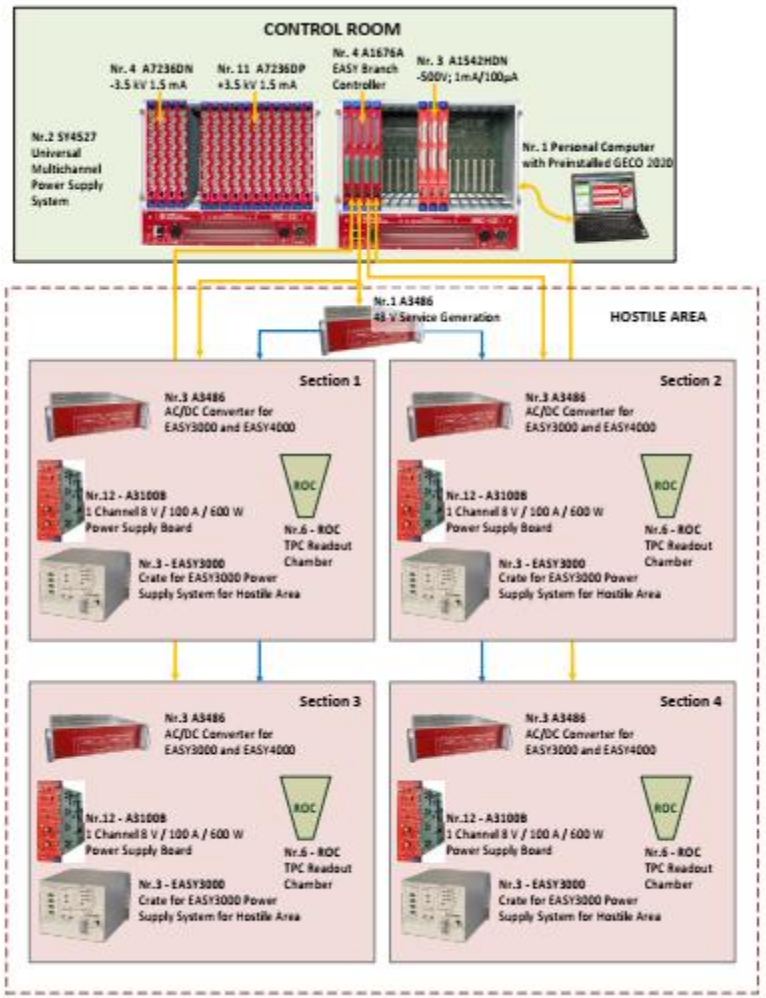
Fanout 2x8 and translation to the optical signals. Will be installed on the MPD platform.

One ROC fanout module. Will be installed on the ROC (inside MPD magnet). On production now.

GUI software for ROC FEE control and monitoring

OK!

TPC SUB-SYSTEMS: LV+HV (CAEN)



LV&HV system based on CAEN rad. hard design:
(up to 2000 Gauss and 15 kRad)

- **power converters A3486 AC/DC (380 V -> 48 V) – 15+3 pc**
- **EASY3000 crates - 14+2 pc**
- **LV module - A3100B (8V/100A) - 48+8 pc**
- **LV module - A3100HBP (14V/50A) - 6 +2 pc**
- **HV modules –A3540P (+4kV/1mA) - 8+3 pc**
- **HV modules –A3540N (- 4kV/1mA) - 2+2 pc**

Status:

LV+HV system - delivered

LV cables (halogen free, low smoke, S=50 mm2)– delivered

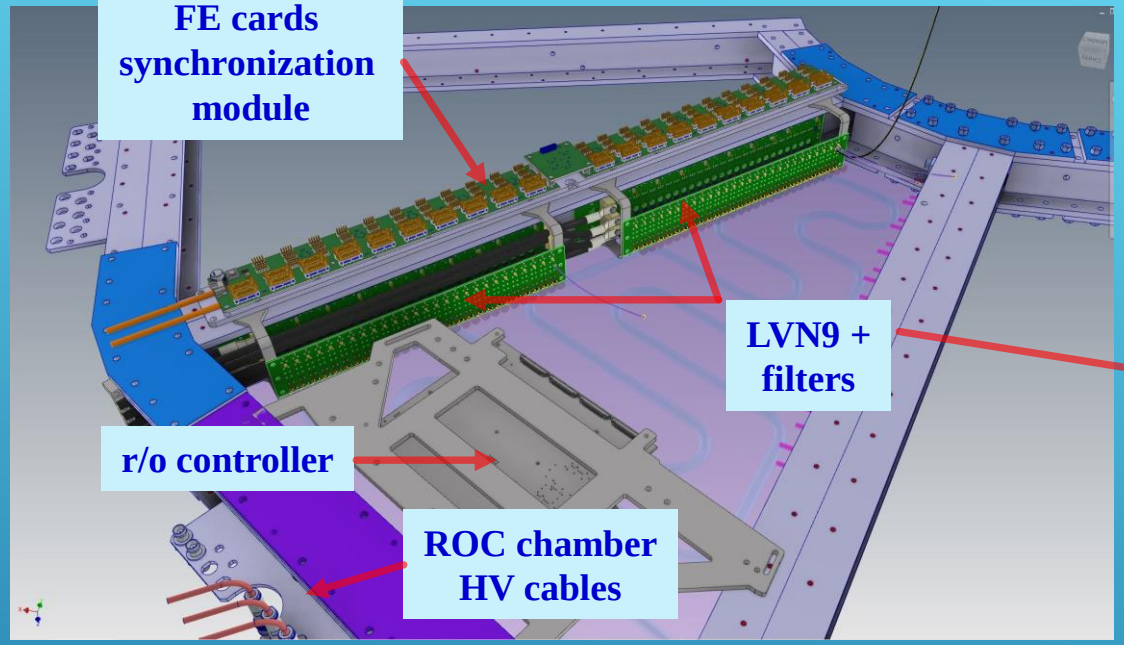
HV cables – delivered

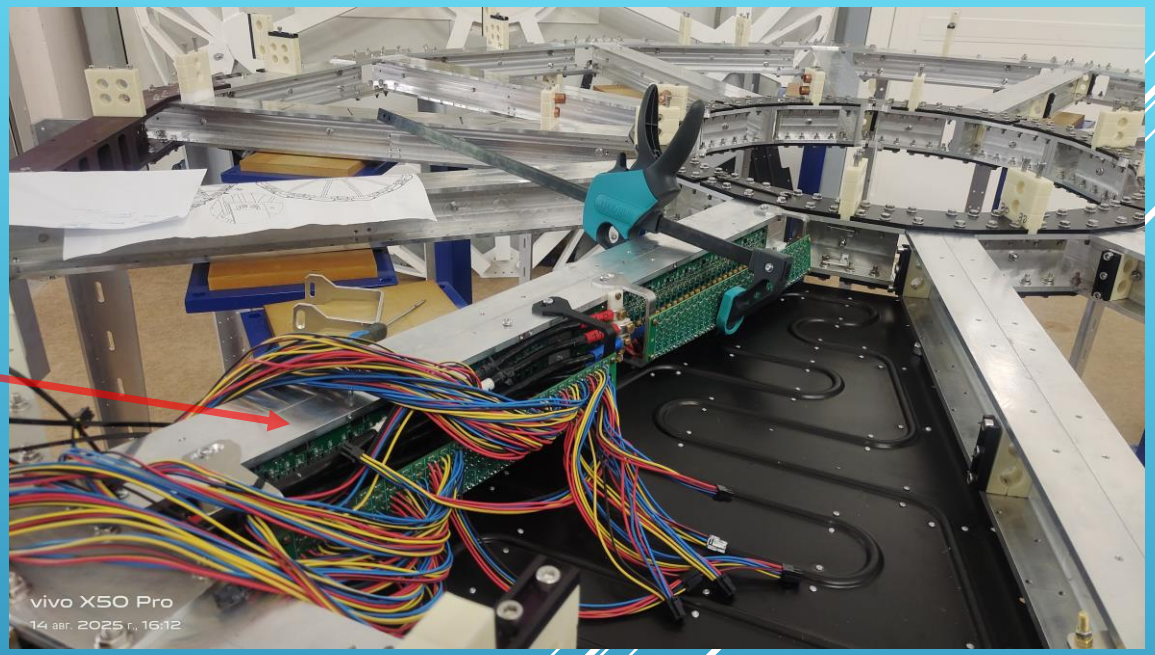
LV test setup – *tests ongoing*

CAEN installation – a waiting…

Cabling:
Thermometry (~300) – Sept-Oct
LV power (~120) – Aug-Sept

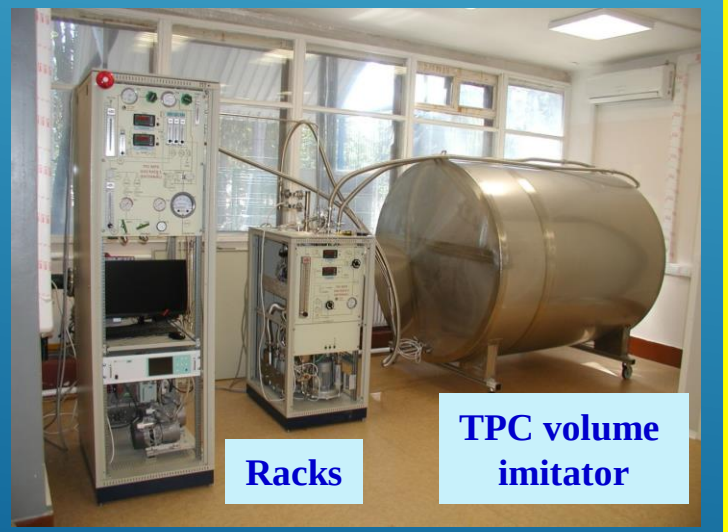
TPC SUB-SYSTEMS: LV BOARS INTEGRATION TO SERVICE WHEEL





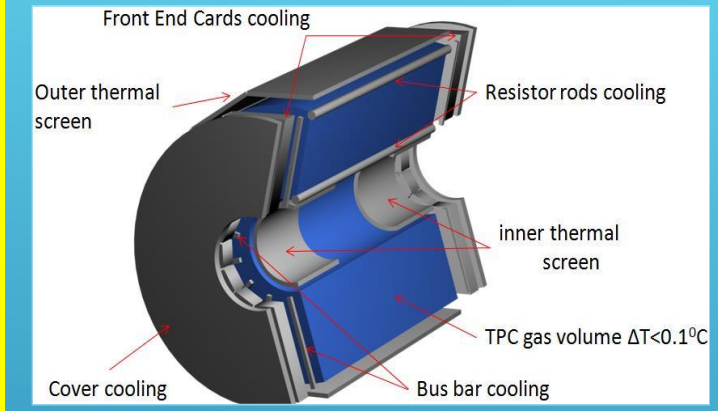
TPC SUB-SYSTEMS: GAS AND COOLING

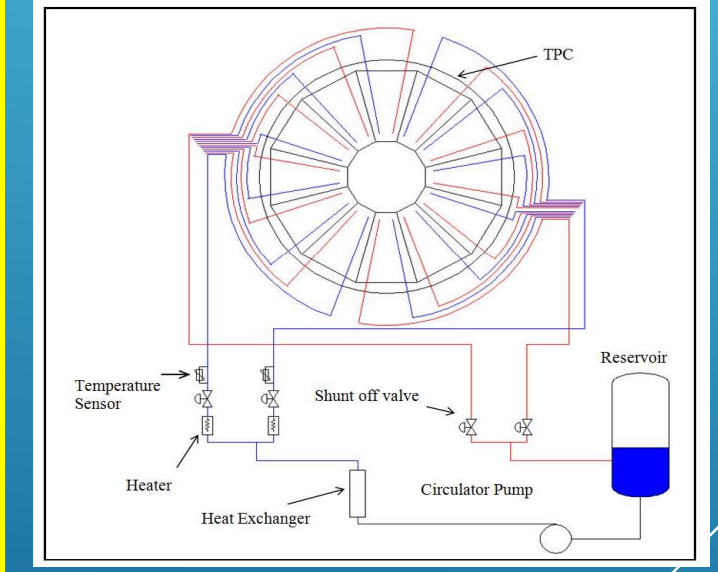
Gas system (Ar/CH4, 90:10)

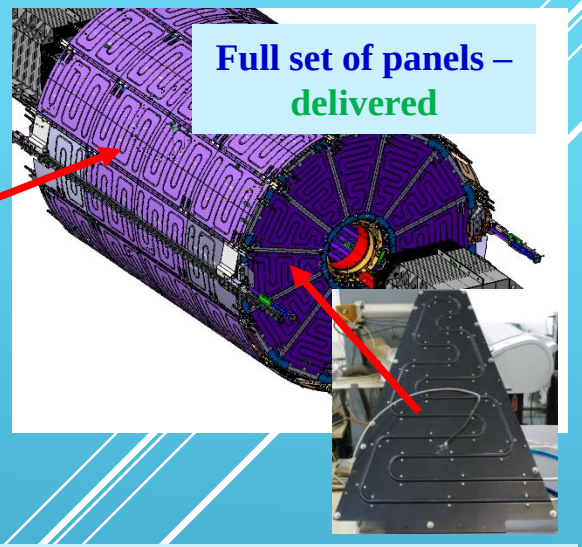


H20 and O2 sensors are replaced
Tests - in progress

Water cooling system

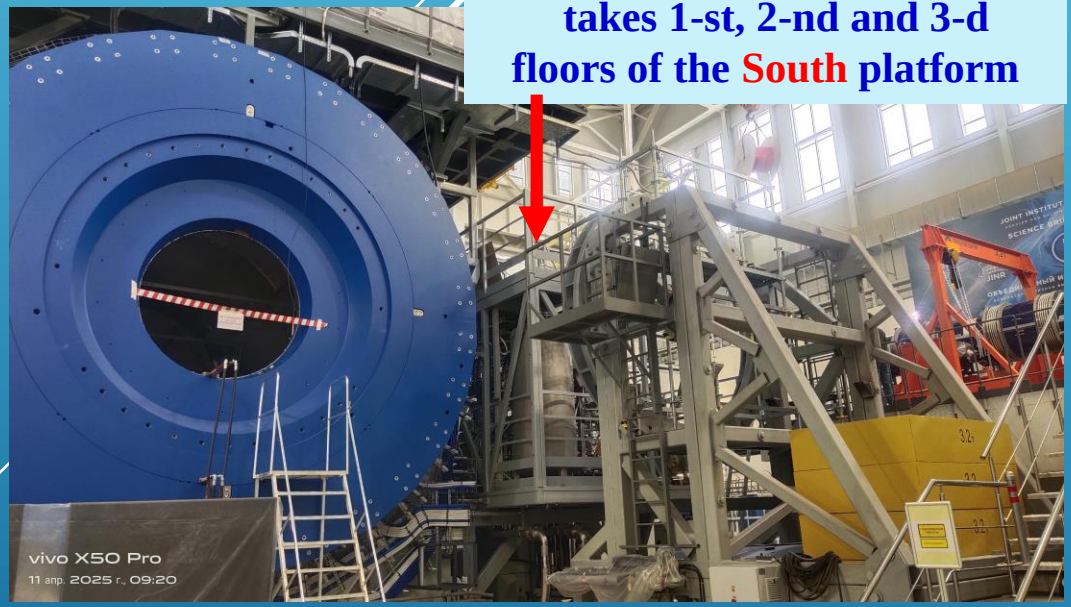






Full set of panels – delivered

TPC+ECAL cooling system takes 1-st, 2-nd and 3-d floors of the South platform

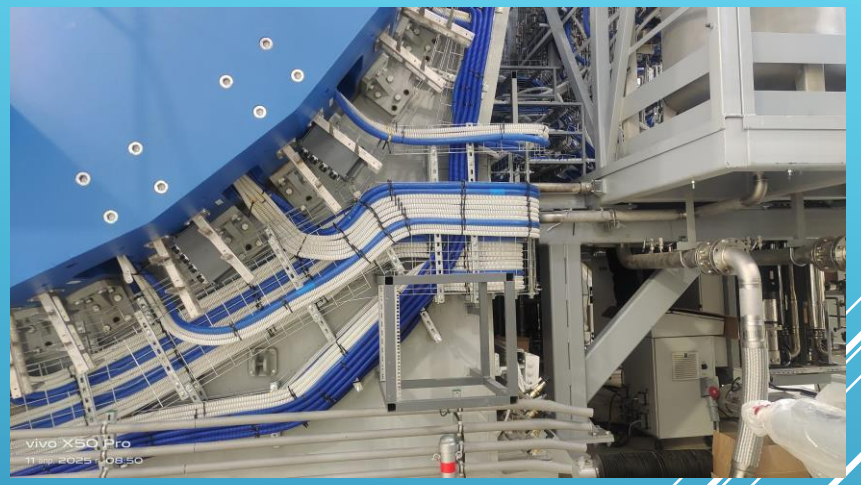


Contract JINR-INP BSU (Minsk) – in progress…

TPC SUB-SYSTEMS: COOLING

Assembling – in progress…

Piping - done



Connection to KOMETA cooling system -ready

3 Pump modules - installed

Assembling and cabling – in progress…

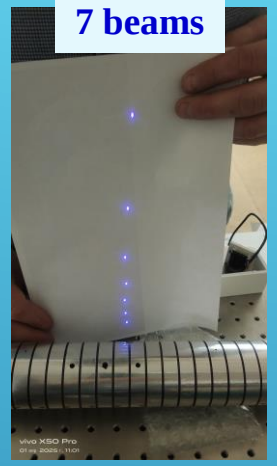
Commissioning – Dec 2025

System status - see also talk of A.Fedotov

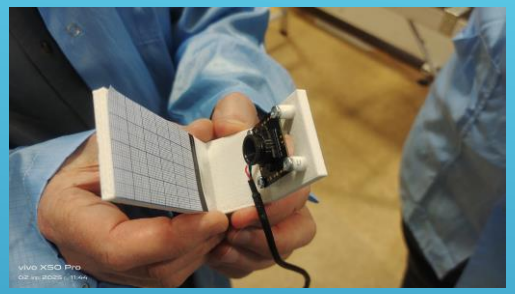
TPC SUB-SYSTEMS: LASER CALIBRATION SYSTEM

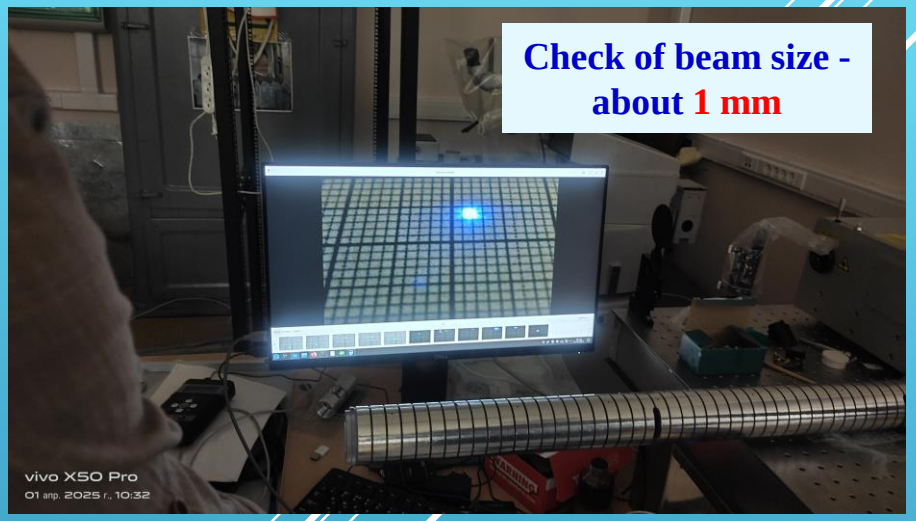
Test set up with UV laser

7 beams

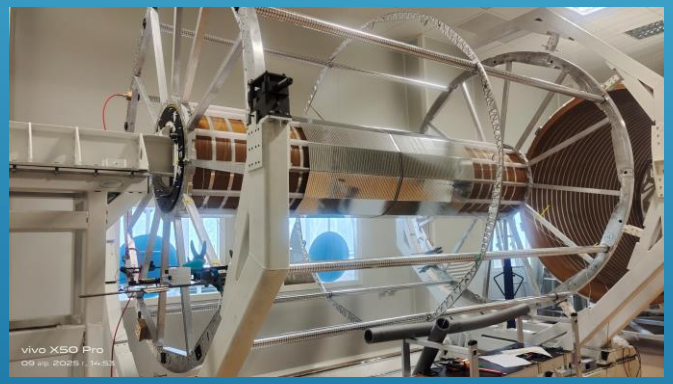


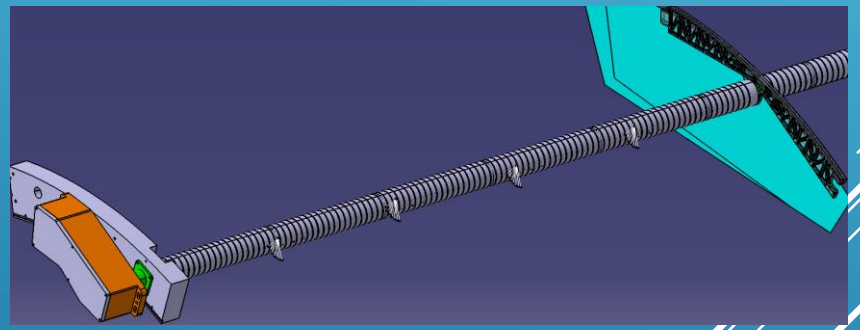
Video camera (MEPHI)

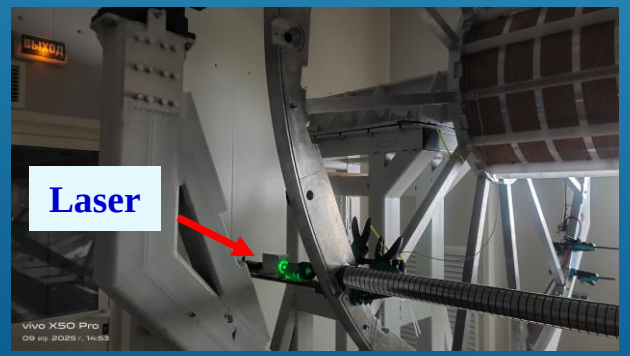




Test tube #7 with ”green” laser





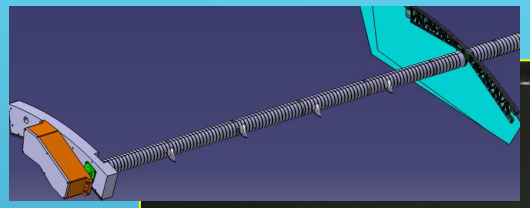


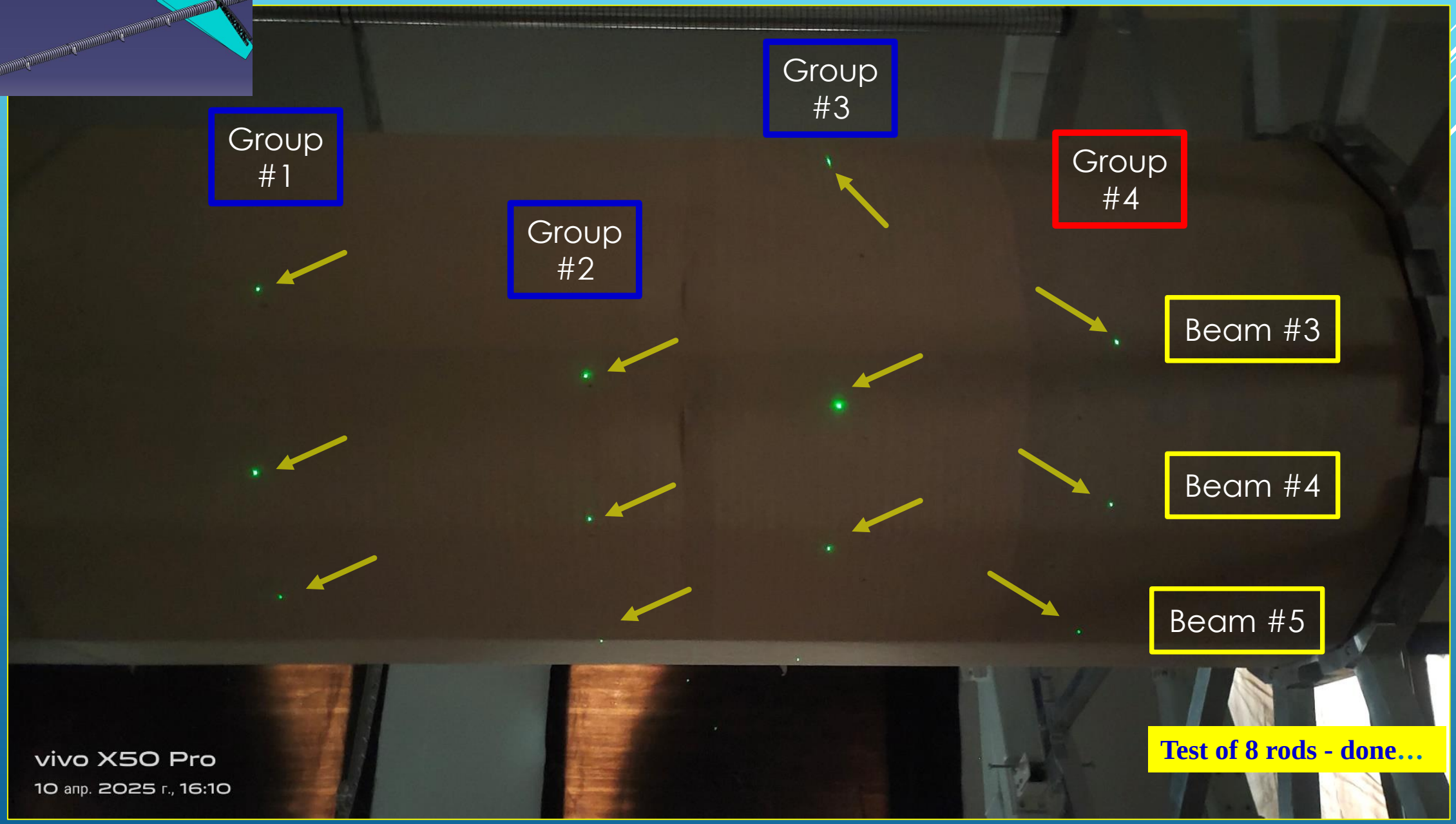
Micro-mirrors bundle

System improvements (MEPhi):
- **add video cameras for check beams position**
- **add pico-actuators for mirrors tuning**

see also talk of J.Shafarevich

TPC SUB-SYSTEMS: LASER CALIBRATION SYSTEM





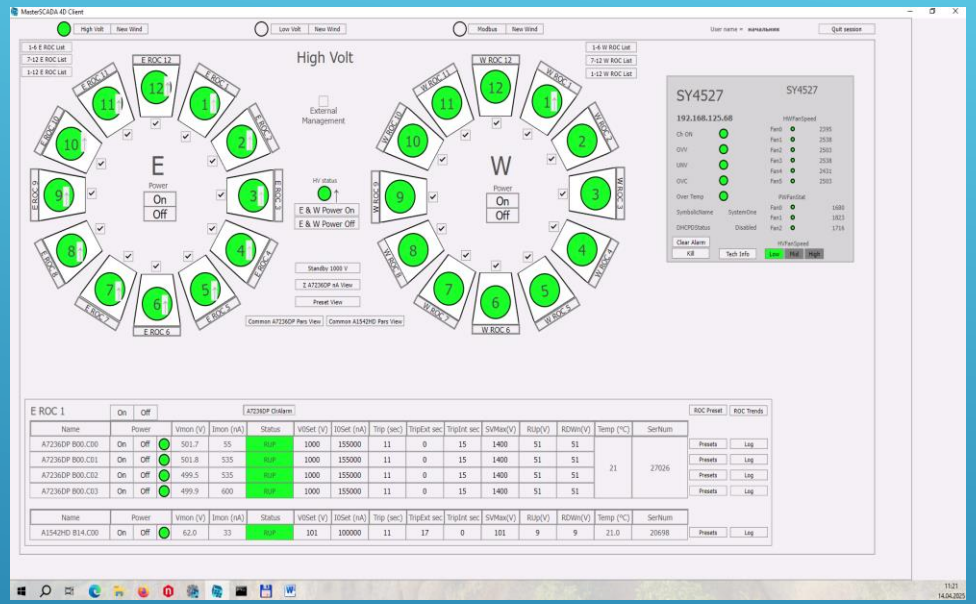
Test of 8 rods - done…

TPC SUB-SYSTEMS: SLOW CONTROL

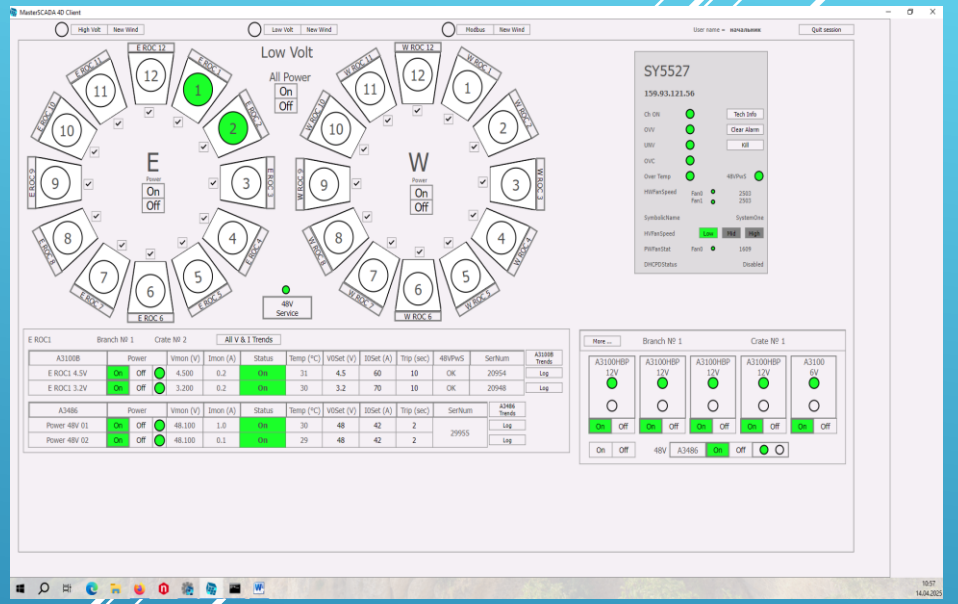
CAEN LV test setup

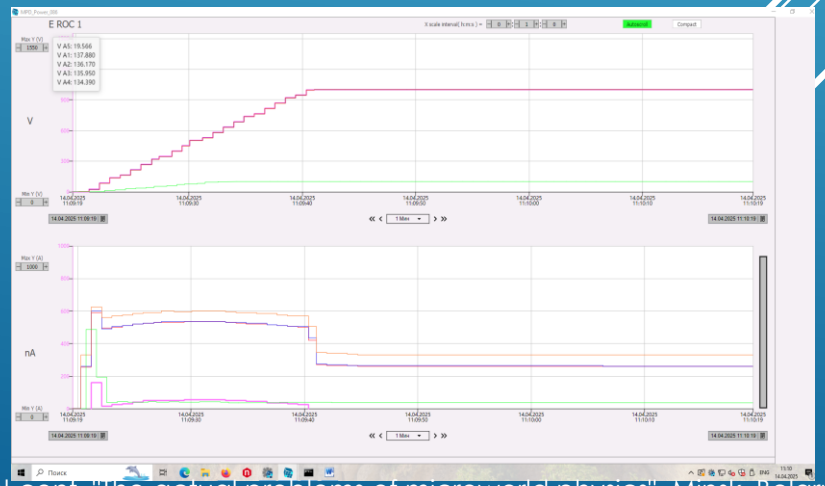
Main window of LV+HV GUI based on MasterScada 4D

HV



LV



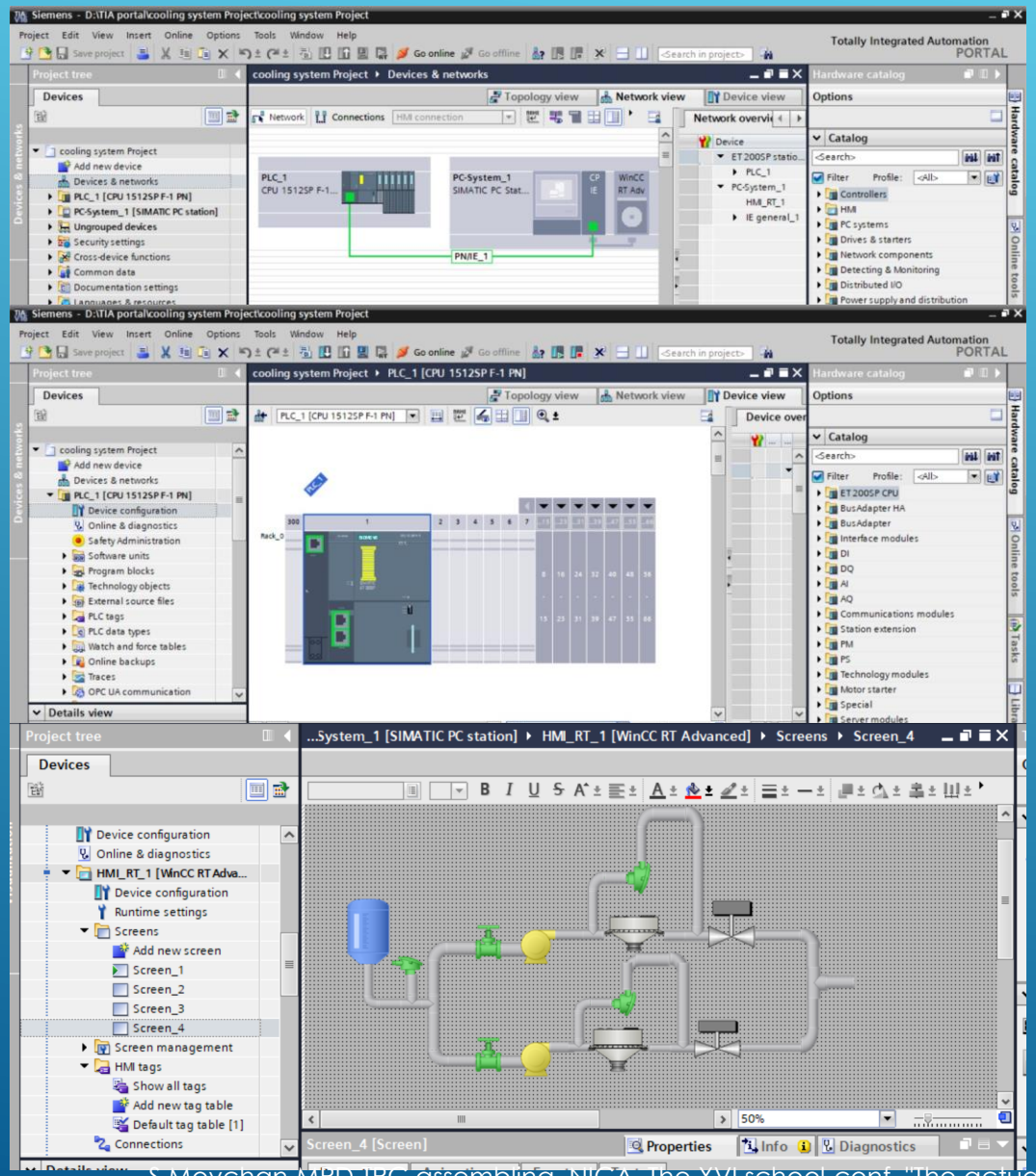


DATA transfer from MasterScada 4D to the DB POSTGRESQL16 – OK!

in progress …

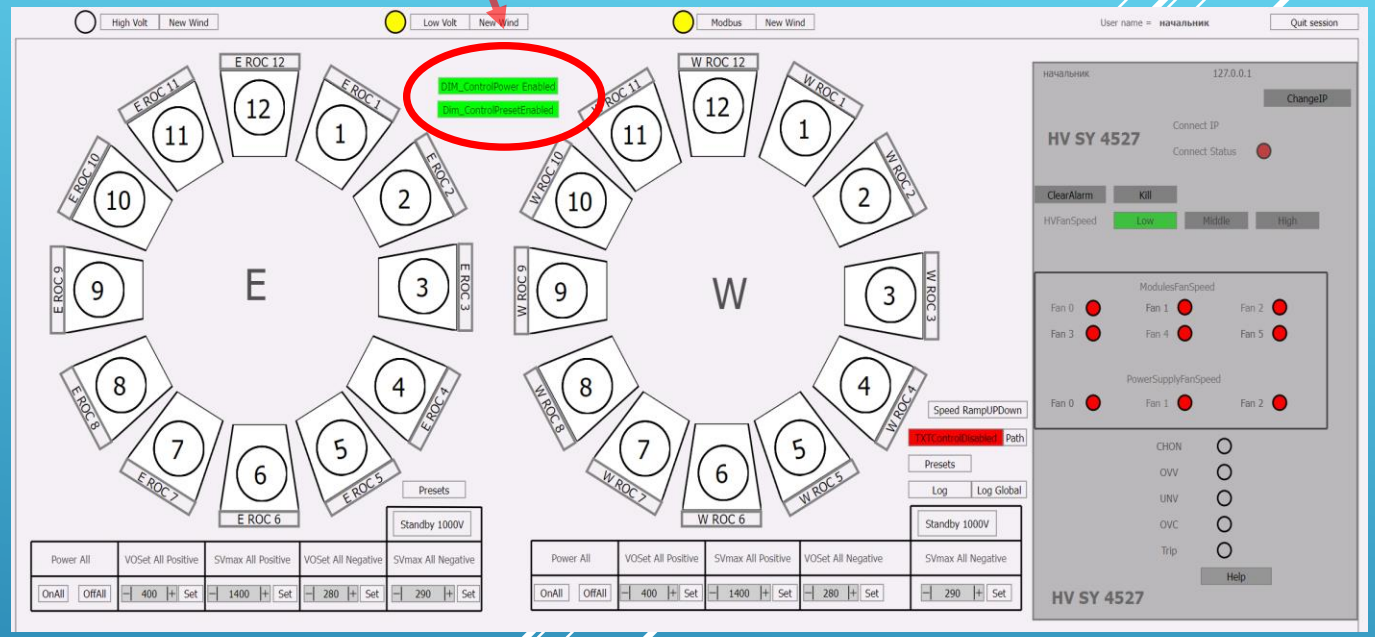
TPC SUB-SYSTEMS: TPC SLOW CONTROL => MPD DCS

GUI for cooling system

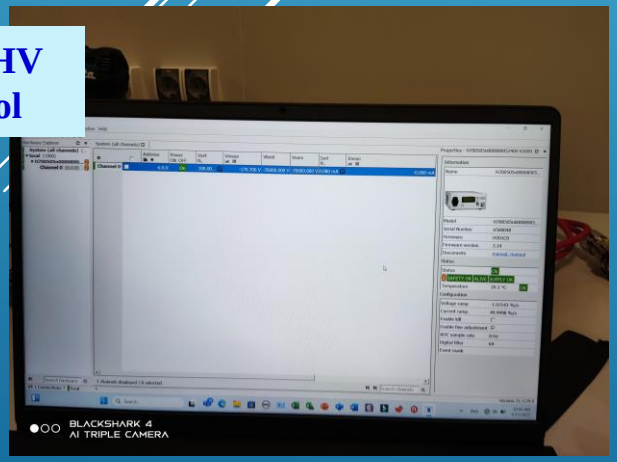


Connection with MPD DCS (DIM protocol)

LV+HV



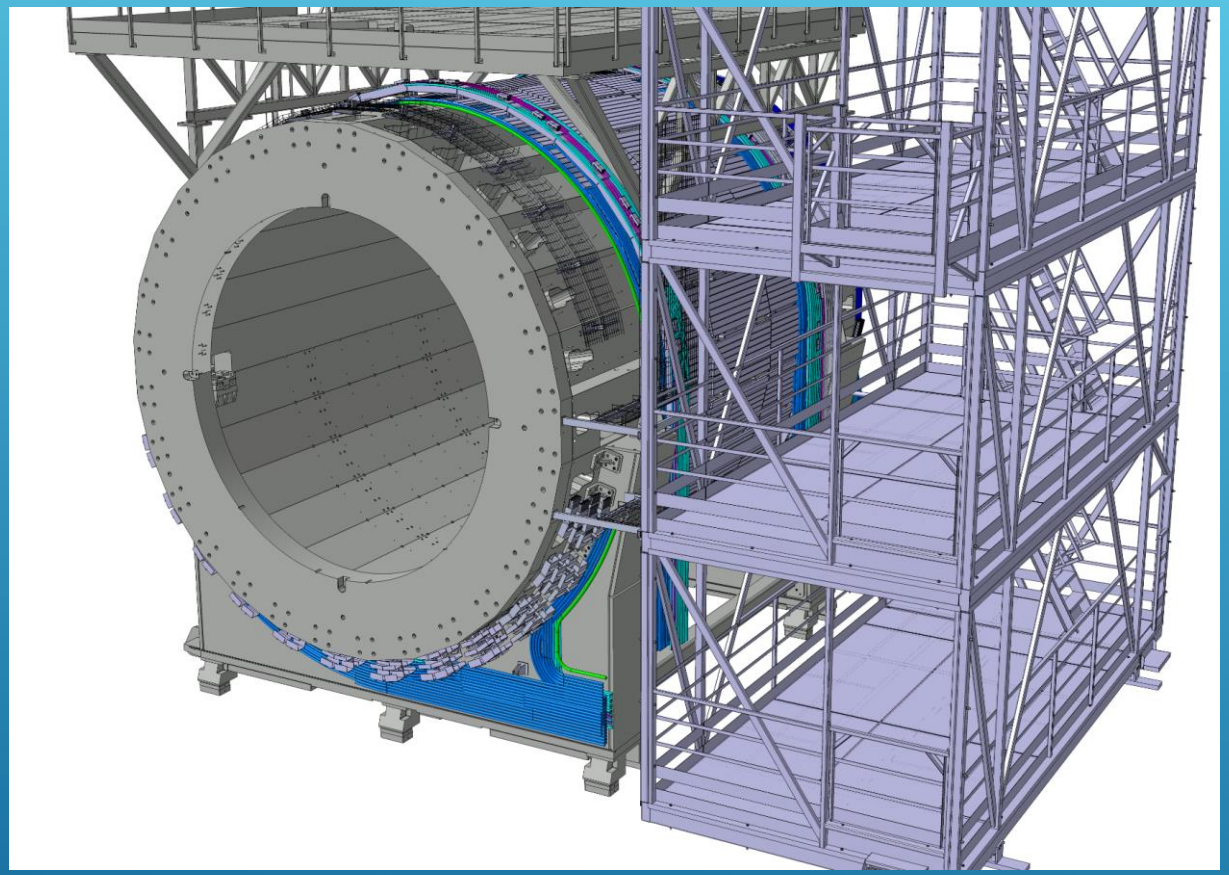
ISEG HV control

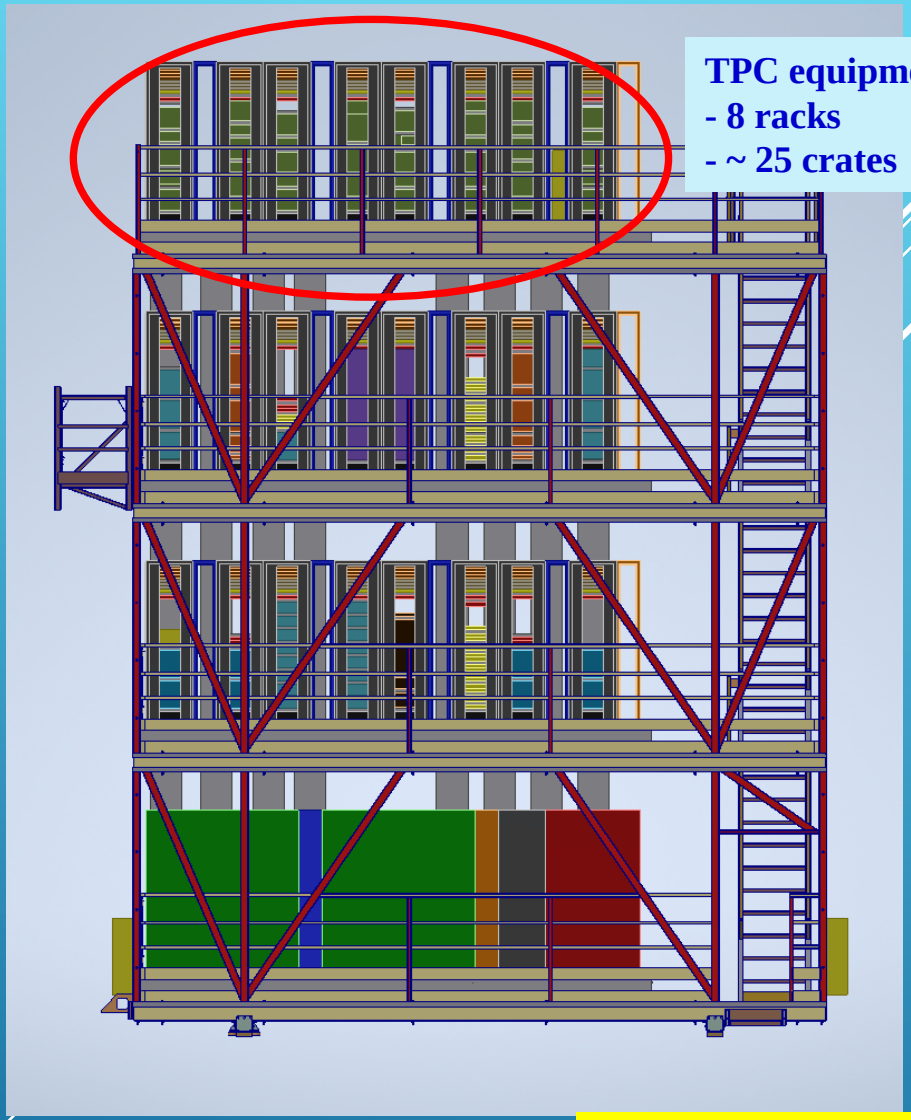


in progress …

INTEGRATION: “ELECTRONICS” PLATFORM (NORTH)

Common view





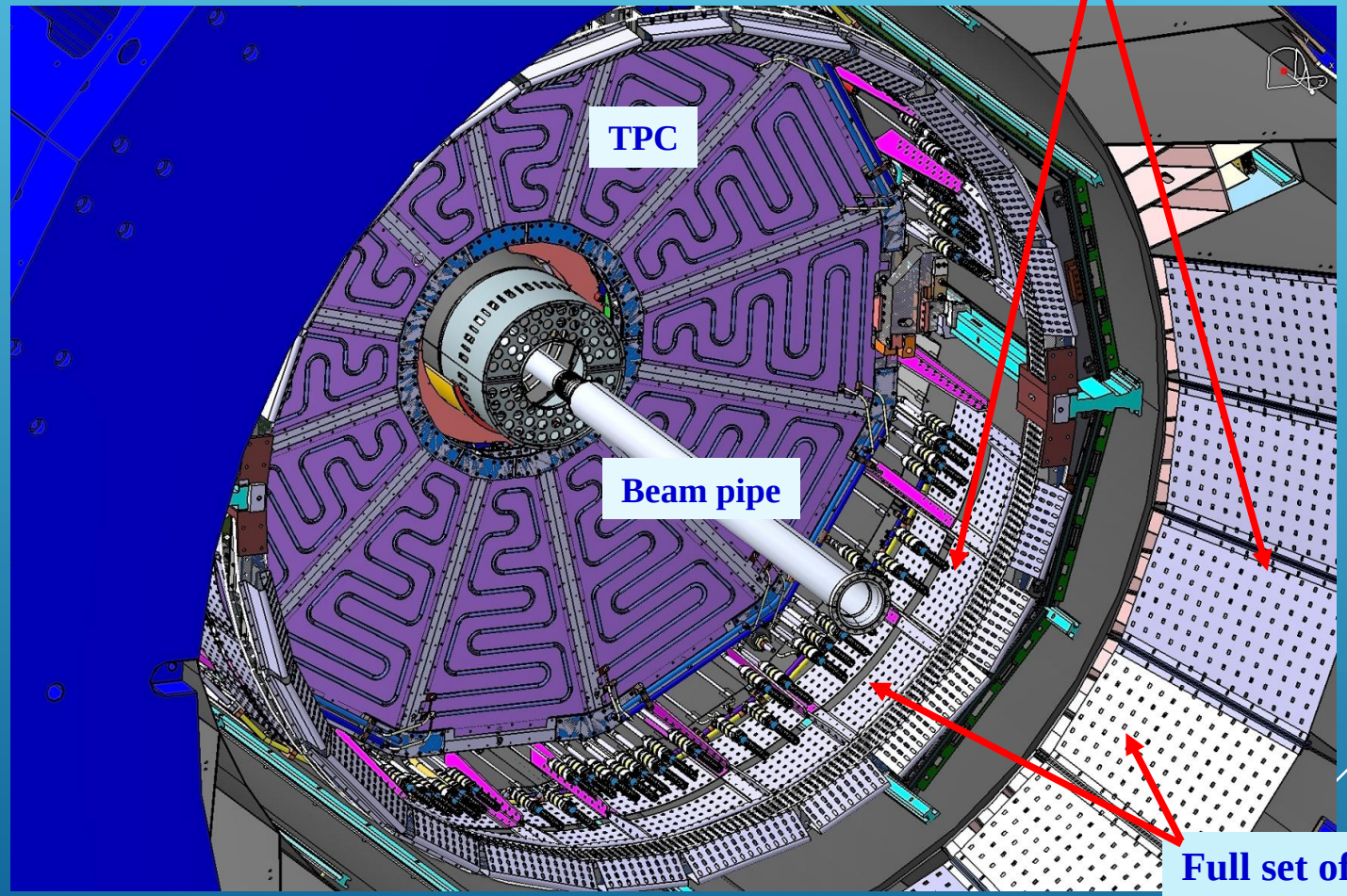
TPC equipment:
- 8 racks
- ~ 25 crates

Integration – in progress …
Installation – Sept - Oct

TPC: PIPING AND CABLING

Integration …

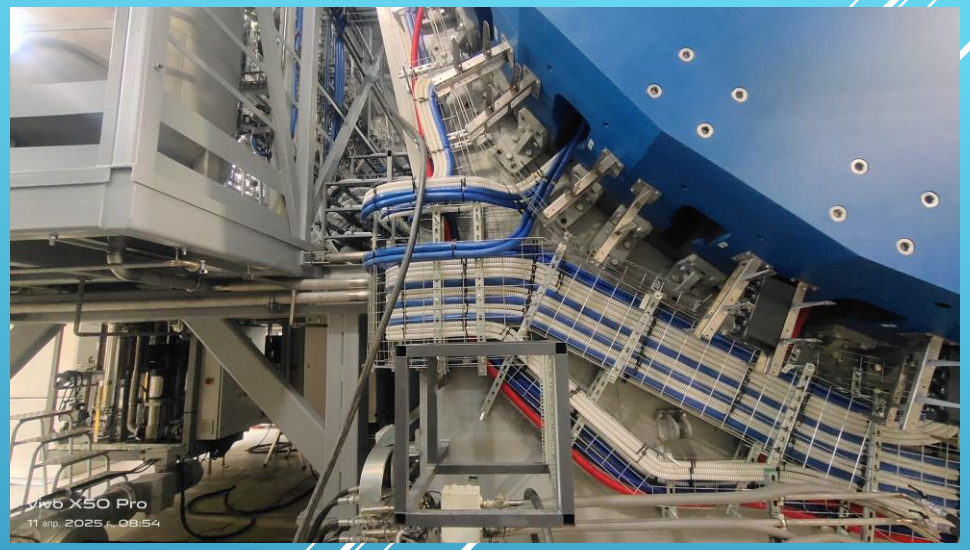
Mesh for cables and pipes fixation

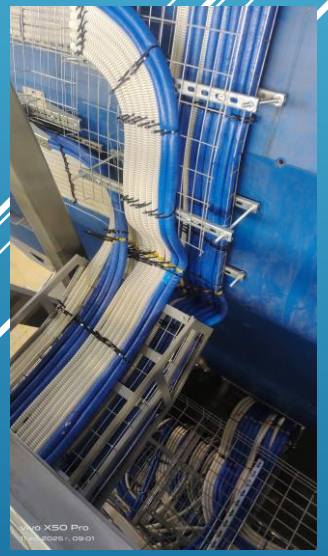


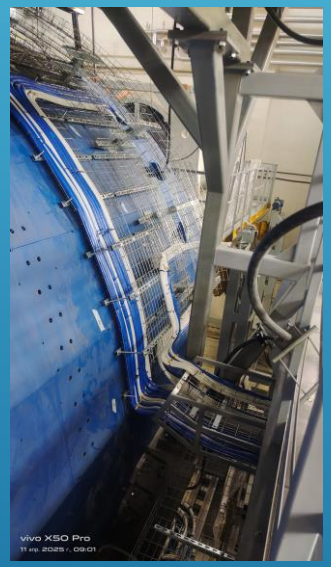
Full set of parts – in manufacture

Mesh support design - done

TPC piping (water)

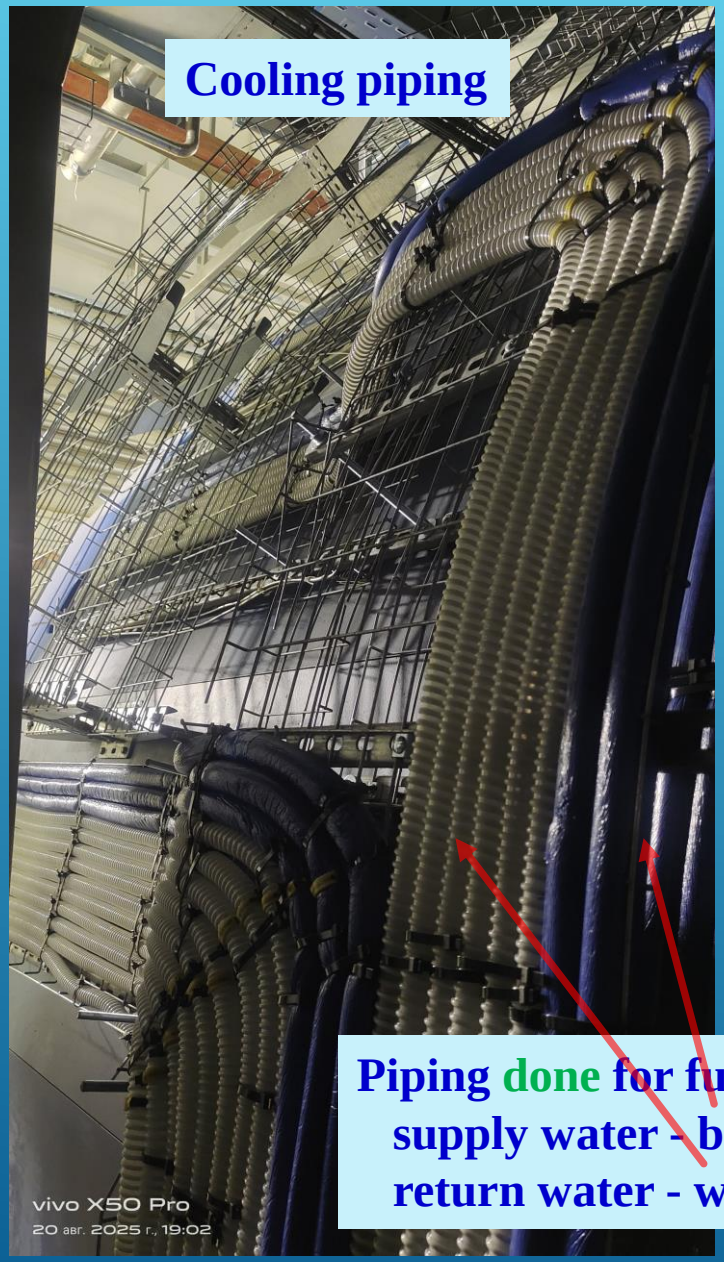




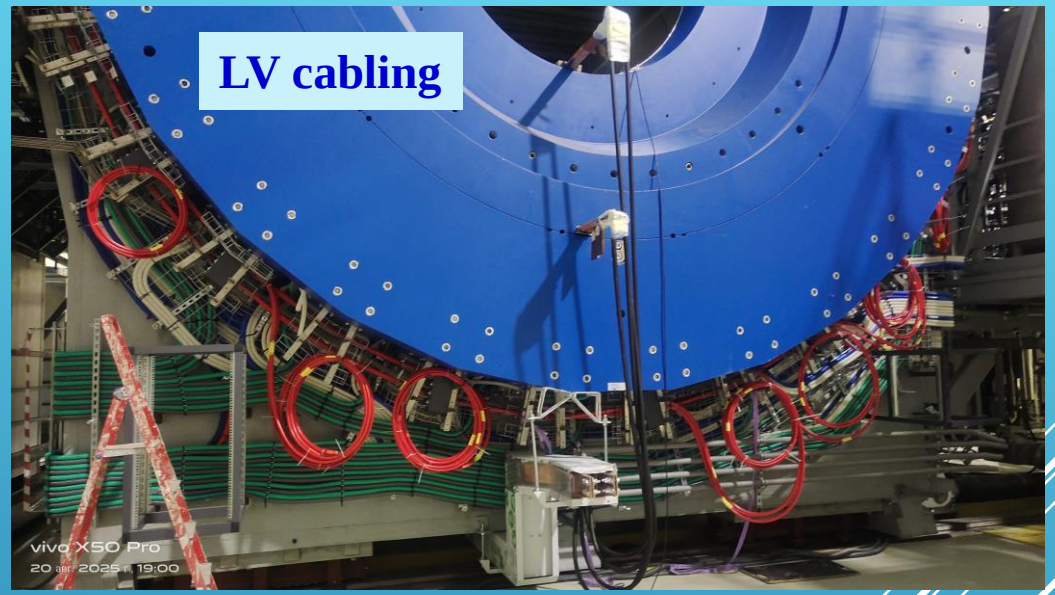


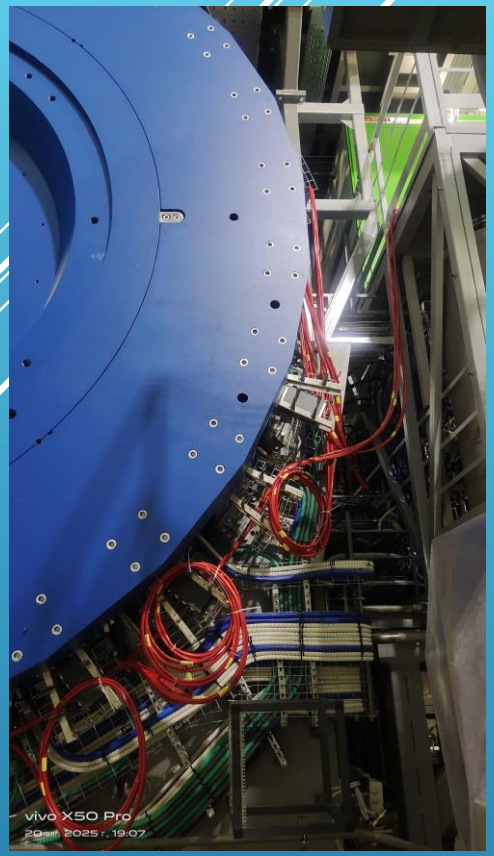
Piping and cabling - in progress …

TPC: PIPING AND CABLING



Piping done for full MPD:
supply water - blue
return water - write

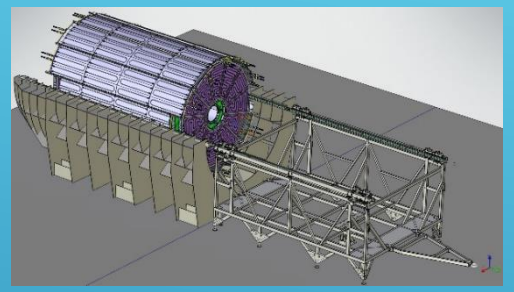




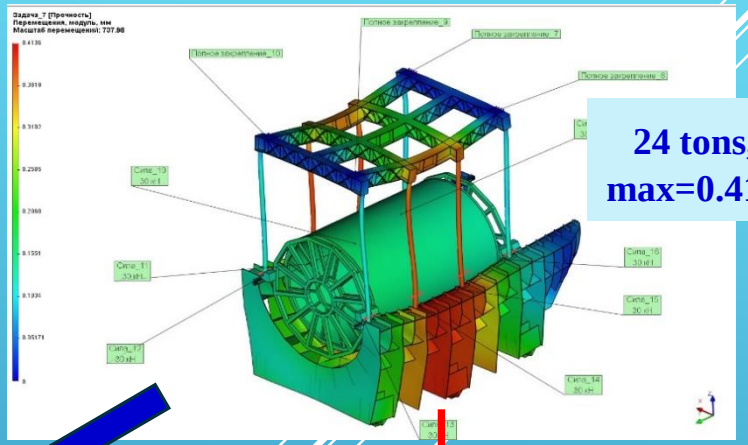
WEST – done
EAST – Sept 2025

TOOLING FOR INSTALLATION OF TPC TO MPD

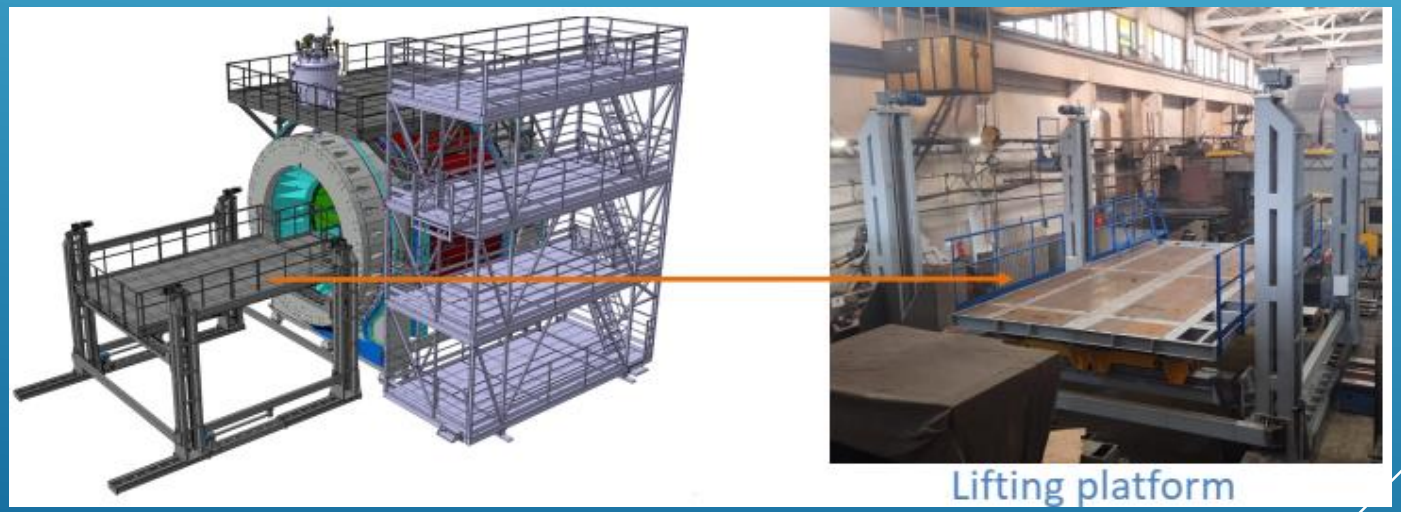
Bld. 217



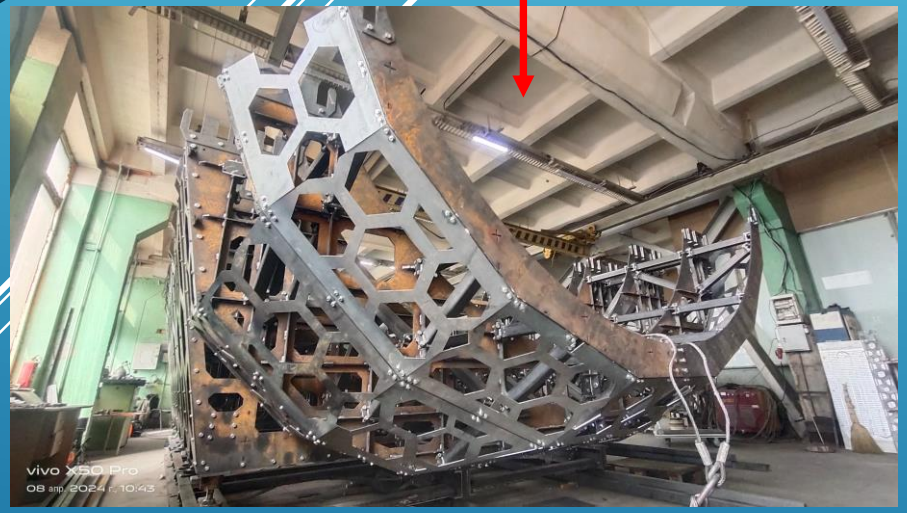
Bld. 17 (MPD)



24 tons, max=0.41 mm



Lifting platform



Tooling for installation TPC to MPD tested and delivered to JINR

TPC installation to MPD – Nov 23 2025

STATUS AND TIME SCHEDULE

TPC sub-systems status:

TPC vessel assembling	in progress …
ROC chambers (24+6 spare)	ready
FE electronics	100% manufactured (1488 FECs)
R/O controller v1.2	Test with ROC chamber – will be started soon => mass-production 30 pc
Gating grid system	ready, long term test at Minsk in progress
HV+LV systems (CAEN)	ready for start installation to MPD TPC racks on Electronics platform
Gas system	ready, waiting of gas piping at MPD building
Cooling system on TPC	in progress (all radiators and thermal sheets ready, TPC collectors manufacture - contracted)
TPC+ECAL cooling system	in progress (piping-done, cabling - in progress, assembling of automatics, software …)
Laser system	in progress (8 TPC rods with mirrors assembled, integration to MPD - started)
Slow control system	in progress (LV +HV sub-systems based on OPS + MasterScada 4D ready, SC for rest TPC sub-systems – started)

TPC schedule:

TPC:	
TPC vessel assembled and tested	Sept 25 2025
ROC chambers installation	Oct 2025
TPC tests (with laser tracks and cosmic ray)	Nov 2025
TPC rails and installation tooling	
Rails installed to ECAL support structure	done (01/08/2024)
Tooling for installation TPC to MPD	delivered (end of 2024)
TPC+ECAL cooling systems (INP BSU, Minsk):	
Delivery to JINR	done (Sept 30 2024)
Systems assembling and start up	up to Nov 30 2025 (3 water vessels and 3 pump modules are installed and tested (Dec 2024))
Commissioning	Dec 2025
TPC installation to MPD	Nov 23 2025
Cabling	Dec 2025
MPD commissioning	Dec 2025

BELARUS CONTRIBUTION TO TPC

Mechanics («ARTMASH» and "KRAINA", Minsk):

- MPD mockup 1:5
- TPC flanges (2 pc) + HV electrode (1 pc)
- service wheel (2pc)
- FE cooling radiators (30 sets)
- LVN9 cooling radiators (9 pc)
- tooling for installation TPC to MP: mockup 1:5 and serial
- TPC serial rails 6 meters (2 pc)

Electronics (INP BSU):

- LVN9 stabilization module (48 pc)
- burning test setup for tests of FE electronics (1 pc)
- setup for test FE cards (1 pc)
- test of FE cards (600 pc) – in progress
- system for anode signal measurements (96ch) – in progress
- gate system for ROC chamber (24ch)

TPC + ECAL cooling system (INP BSU - full responsibility)

- cooling setup for tests (2 pc)
- 3 serial systems - in progress

R&D (INP BSU,):

- ThGEM: tests and study
- DLC like protection coating from sparks for gas detectors
- DLC study: structures and long term stability
- metalize nuclear membrane like mesh for electrons and ions drift

MPD and SPD detectors grounding (Институт Энергетики БАН)

БГУ, НИИ ЯП БГУ, НИИ Физ.-хим. проблем БГУ, ООО «Вист групп сенсор», УП «АРТМАШ», «НП КРАИНА», Институт энергетики, ООО «АркоЛаб», ИП Цехмистренко С.В., ИП

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…

Many Thanks!!!!

sorry if anybody forgotten

THANKS FOR ATTENTION