



MPD TPC ASSEMBLING (23.04.2024)

TPC:

- vessel assembly, ROC chambers, gating grid system

Sub-systems:

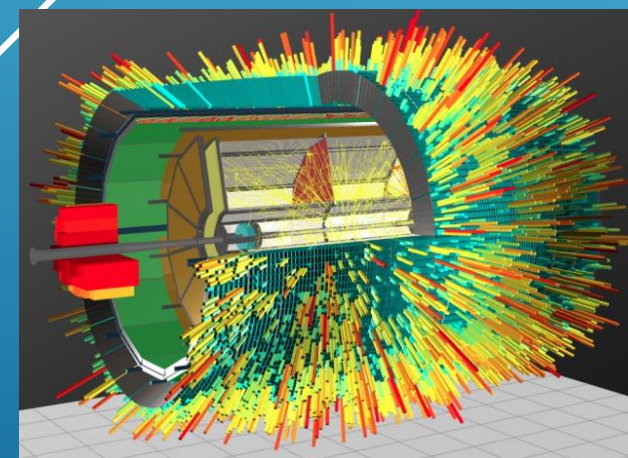
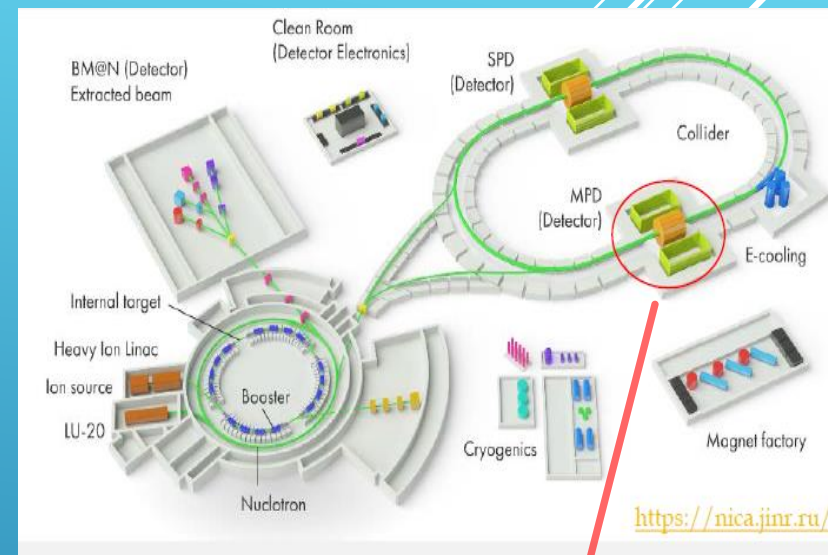
- Electronics
- LV+HV system (CAEN)
- Gas and cooling systems
- Laser calibration system
- Slow control

TPC Integration to MPD

- Electronics platform
- Cabling and piping
- TPC installation to MPD

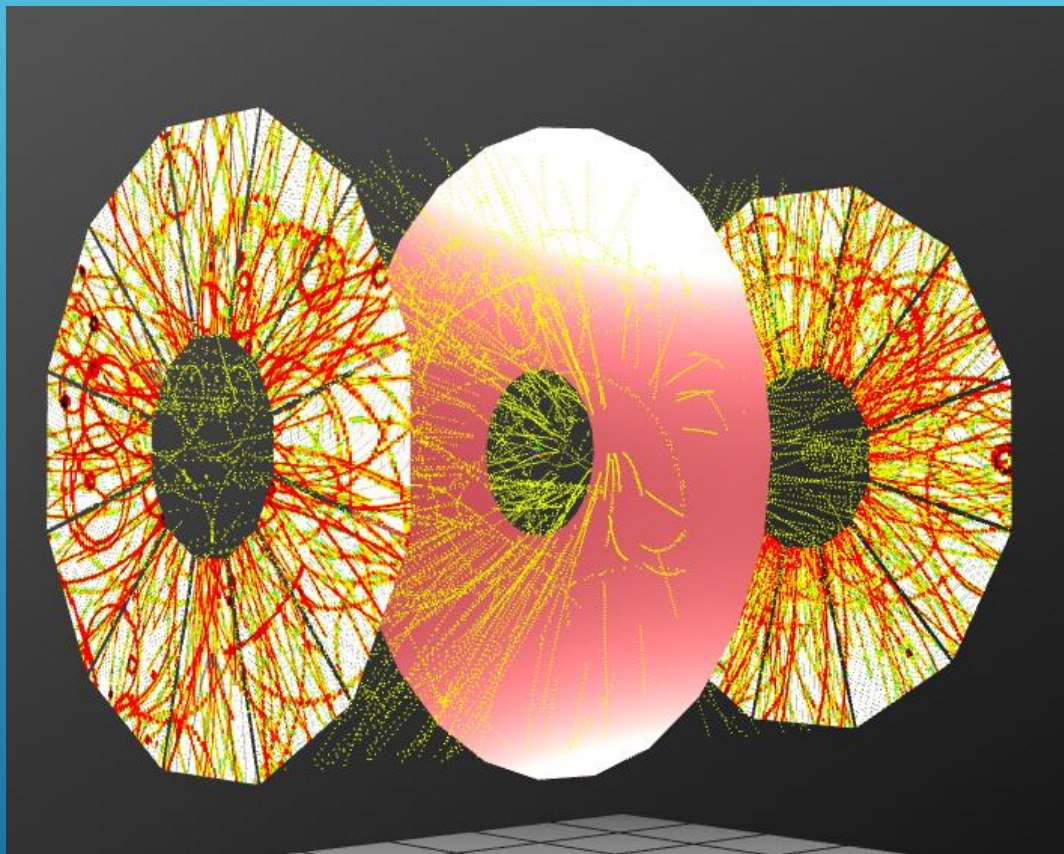
Time schedule

TPC team – 29 (JINR) + 20 (Belarus)



Presented by S.Movchan

MPD TPC MAIN PARAMETERS

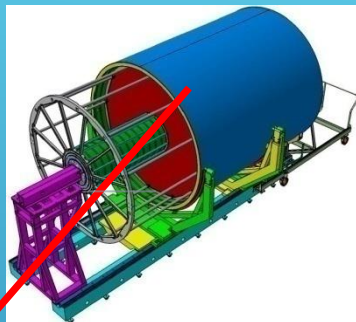


Item	Dimension
Length of the TPC	340cm
Outer radius of vessel	140cm
Inner radius of vessel	27 cm
Outer radius of the drift volume	133cm
Inner radius of the drift volume	34cm
Length of the drift volume	170cm (of each half)
HV electrode	Membrane at the center of the TPC
Electric field strength	~140V/cm;
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

TPC VESSEL ASSEMBLY



Bld. 217



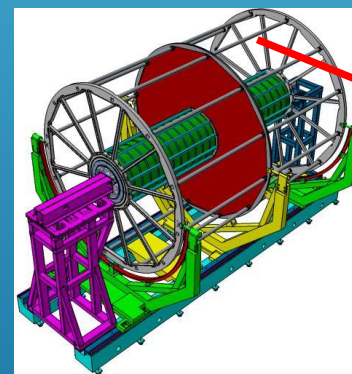
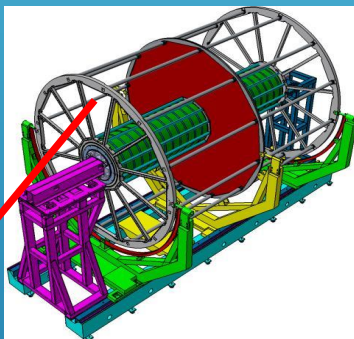
Service wheel with thermal panels (12pc)



Both service wheels - assembled



ISO-6



Rods D=40 mm (24 pc) reassembled - ready
Rods D=60 mm (24 pc) – assembling in progress, ready – May 30 2024



C1-C2 and C3-C4 cylinder – assembled
TPC service wheels (2pc) – assembled
HV membrane – tested
TPC field cage assembly - July 15 2024
TPC vessel ready – Dec 30 2024

TPC vessel assembly – in progress (see next slide)

TPC VESSEL ASSEMBLY



**HV divider (2 pc) –
ready**



**Rods D=60 mm –
in manufacture**

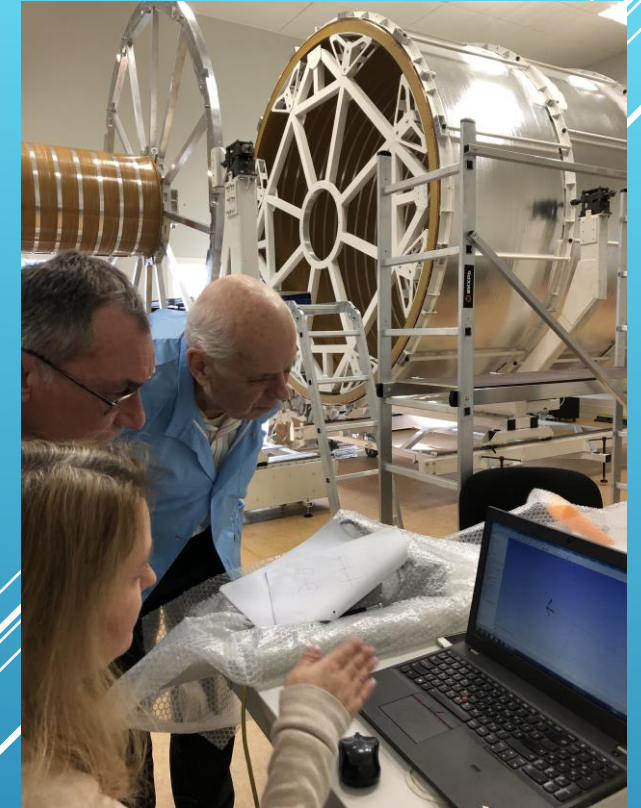
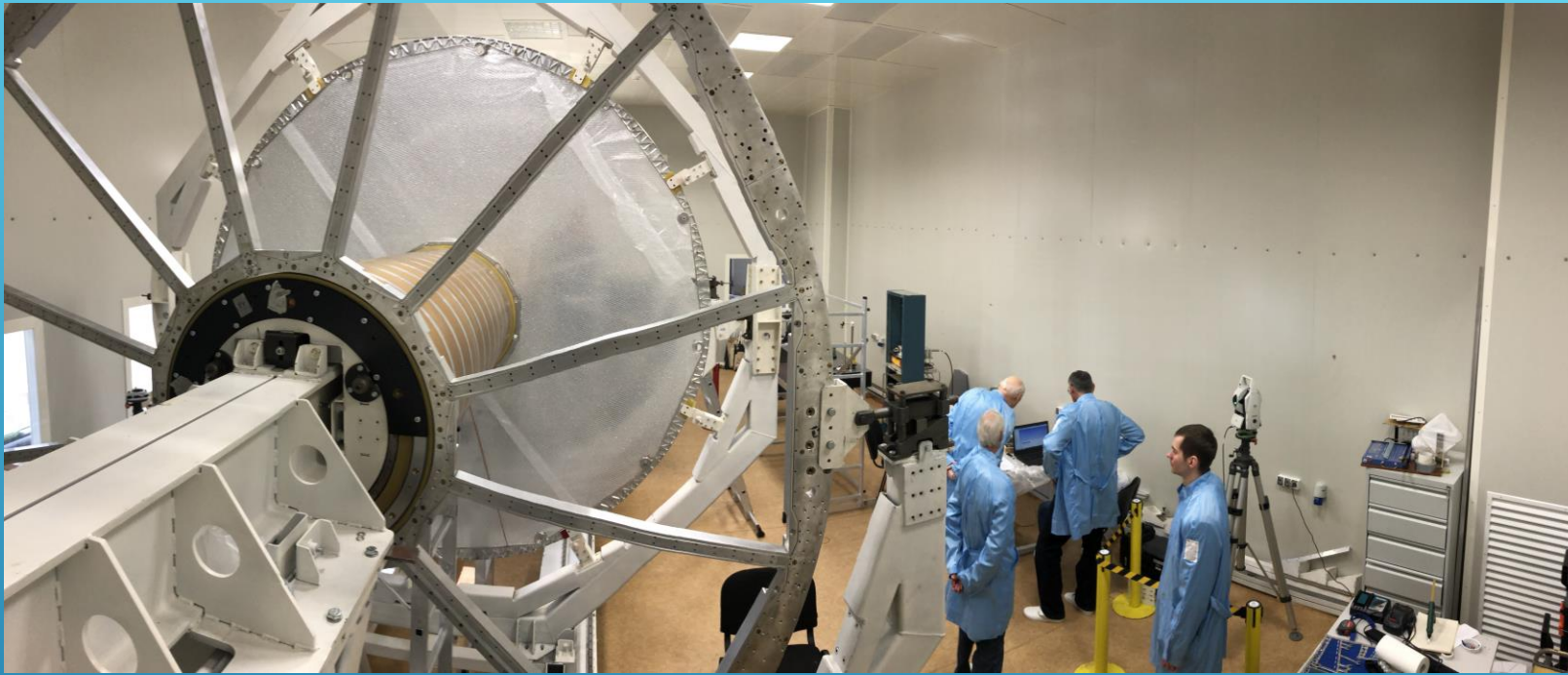


**Rods D=40 mm –
ready for installation**

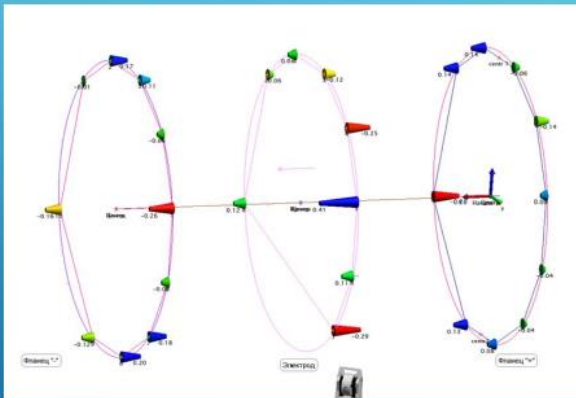


**Both flanges and HV electrode: alignment to do
and all elements glued to C1-C2 - 11/07/2023**

TPC VESSEL ASSEMBLING



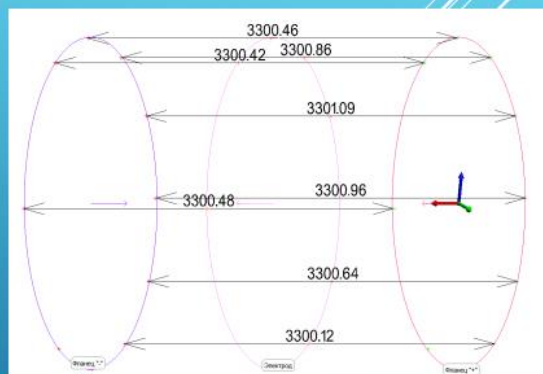
Flanges and HV electrode unflatness



Flanges unflatness – about 0.5 mm

HV electrode unflatness – about 0.7 mm

Flange to flange distance



$L = (3300.5 \pm 0.5) \text{ mm}$
(nominal – 3300.0 mm)

TPC body assembled with test rods for check TPC geometry by laser tracker AT-402 (reflector type -TBR ($R=6.35 \text{ mm}$), reflector center offset $L = 12.00 \text{ mm}$):

- flanges unflatness – 0.5 mm
- asymmetry - $L_{\text{left}} = L_{\text{right}} + 2 \text{ mm}$

TPC ROC CHAMBERS

Test setup for ROC certification



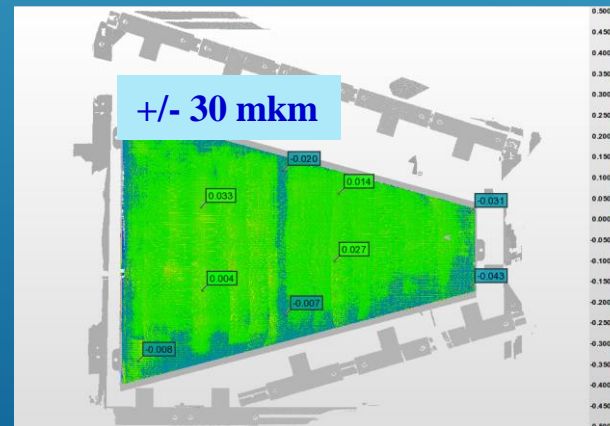
24 pc ROCs – tested

Test setup for pads calibration

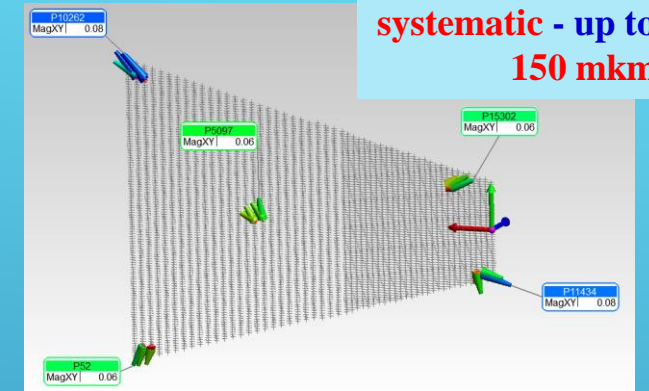


Leica MS60 - 1 second resolution
Leica AT960 +/-10 mkm +5 mkm/m
Leica AT403 +/-15 mkm +6 mkm/m
Scanner AS1+AT960 +/-50 mkm

Pad plane unflatness: example



Check pads geometry



Full set of ROC alignment marks

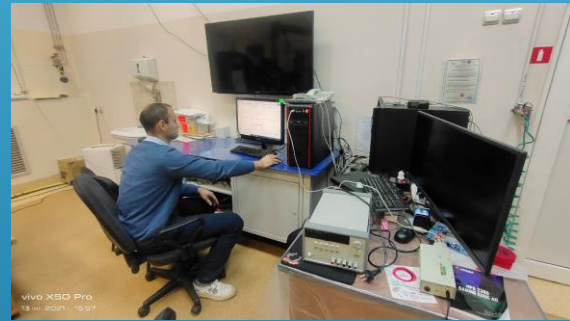


Summary:

- measurements to do for all ROCs
- **calibration** of ROC marks and 3968 pads respect to ROC
- “reference hole” - **in progress**

TPC SUB-SYSTEMS: GATING GRID SYSTEM

ROC gating grid system: test setup



Pulse rise time
- 500 ns, **OK!**

TPC Gating grid system



4 pc NIM
crates

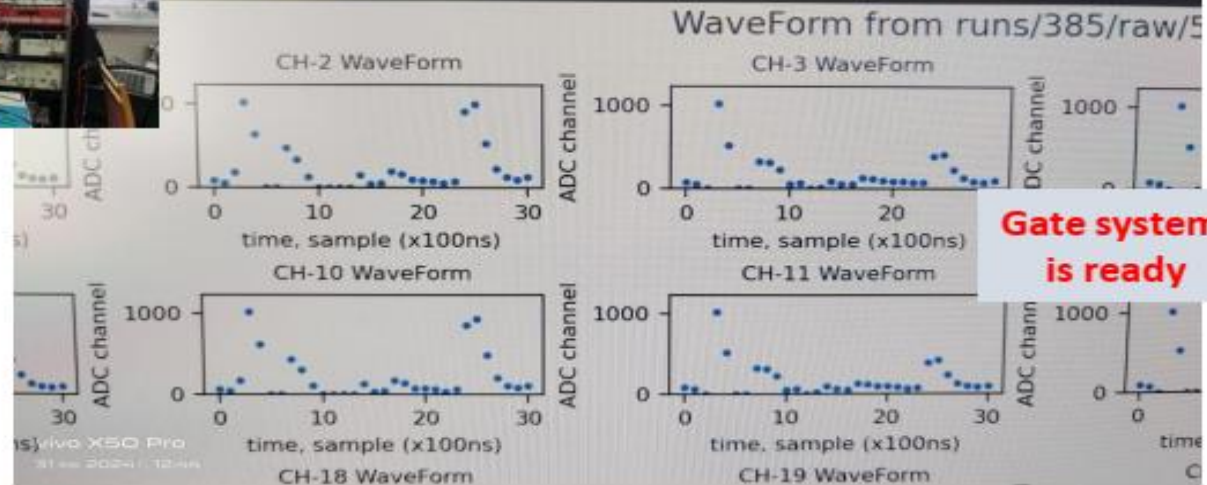


Rise time - 1 mksec
Fall time - 2 mksec

Test setup in Minsk



Gate cross-talk + test signal shapes



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

TPC SUB-SYSTEMS: ELECTRONICS

Production version of the FE card:



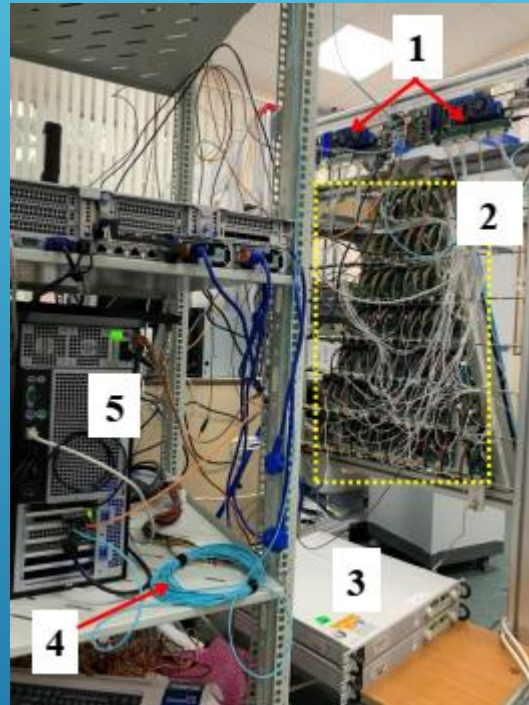
**TPC Front-End Cards
Production status
of April 1, 2024**

PCBs & components are ready for 271 pc

N=1217 pc (81%)

FECs Manufactured - 1217...

DAQ prototype:
62 FE cards, RCU prototypes, ROC, 2pc LVDBs, server interface board - **tests ongoing**



1. RCU prototypes
2. FECs on the ROC (62 pc)
3. LV power supply
4. DCU card connected with RCUs via fibers
5. Readout server

RCU-64 controller:
testing with FEE



LVN9 stabilization module



FE radiators (water cooling)



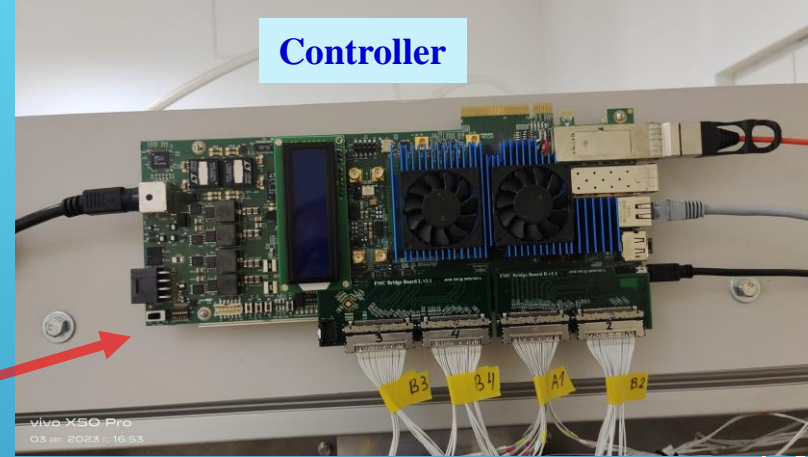
60 pc LVN9 (INP BSU, Minsk):

- modification LVN9 - **in progress**
- modification of LVN9 output voltage cables to FECs - **in progress**
- test of LVN9 with cooling radiator under full load (analog – 70 A, digital – 50 A) – **done**

- **1217 FECs** of 1500 were produced.
- Tests of the FEC basic functionality were shown the target characteristics (noise and stability).
- Testing of the readout system (on two **ROCs**) is **ongoing**
- **RCU-64 controller v1.1 – in production**

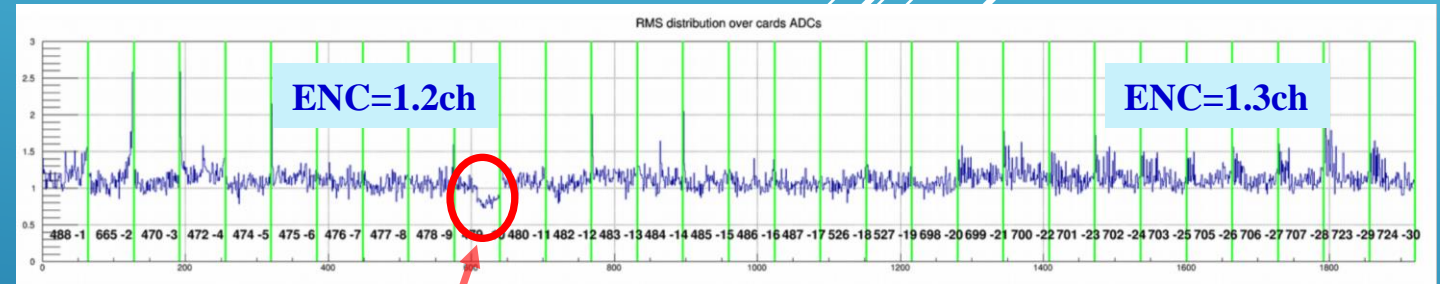
19 ROCs chambers can be completed (from 24 ROCs)

TPC SUB-SYSTEMS: ROC + ELECTRONICS TEST SETUP



Controller

ENC vs channel #



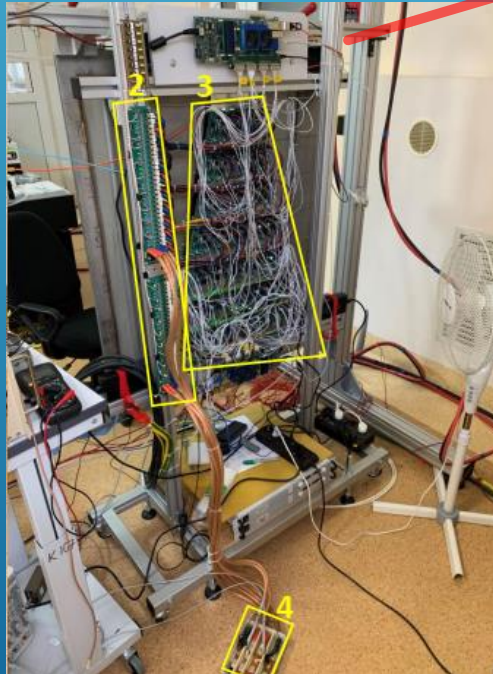
Channel noise [ADC bits]

ADC channel

Links 1 – 20: small pads; links 21 – 30: large pads. At link 10 (FEC 479) one flat cable has been disconnected.

in progress ...

Status of test FE cards at Minsk – see talk Yu.Galkin



CAEN LV power supplies

- 2 – LVDB board
- 3 – 62 FE cards
- 4 – LV filter

TPC SUB-SYSTEMS: LV+HV (CAEN)

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

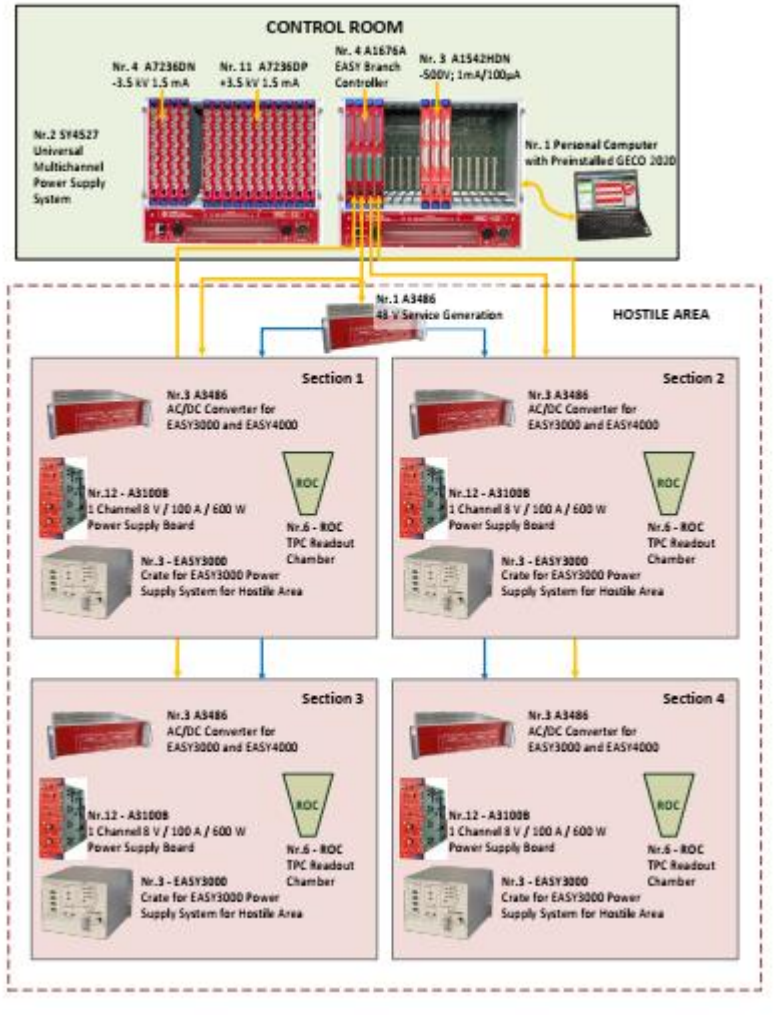
- power converters A3486 AC/DC (380 V -> 48 V) – 15+3 pc
- EASY3000 crates – 14+2 pc
- LV module - A3100B (8V/100A) – 48+8 pc
- LV module - A3100HBP (14V/50A) – 6 +2 pc
- HV modules –A3540P (+4kV/1mA) – 8+3 pc
- HV modules –A3540N (- 4kV/1mA) – 2+2 pc

Status:

LV+HV system - **delivered**

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

HV cables – **delivered**



LV test setup – tests ongoing



LV cables

LV protection

LV EM shielding

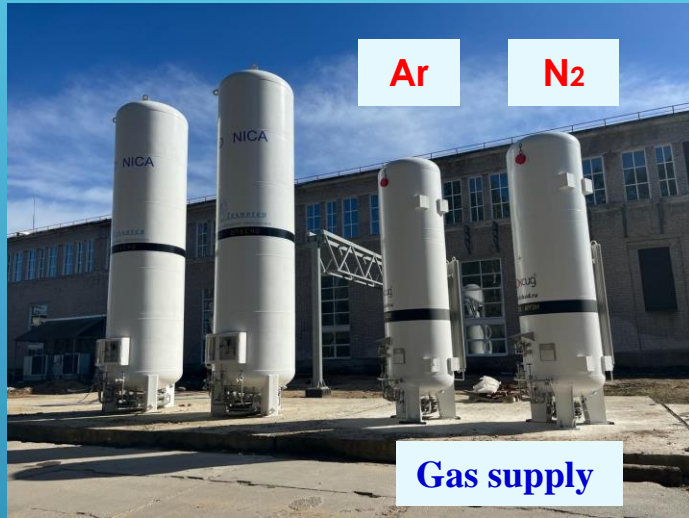
CAEN HV system

+ CAEN LV modules 60pc – delivered in September 2023

Ready for installation to MPD electronics platform

TPC SUB-SYSTEMS: GAS AND COOLING

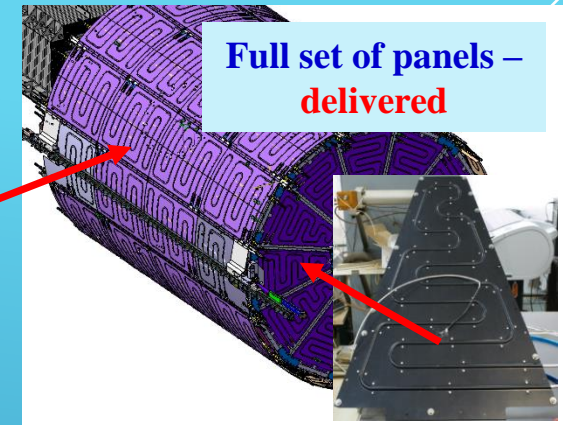
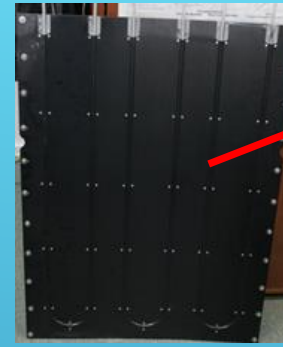
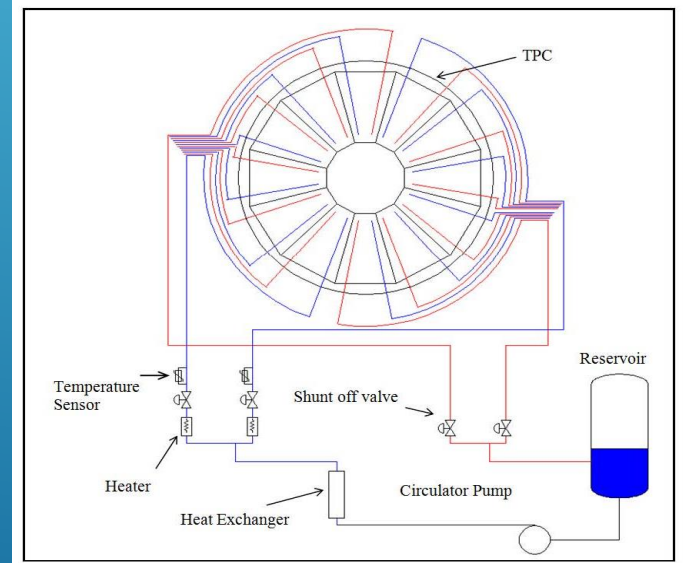
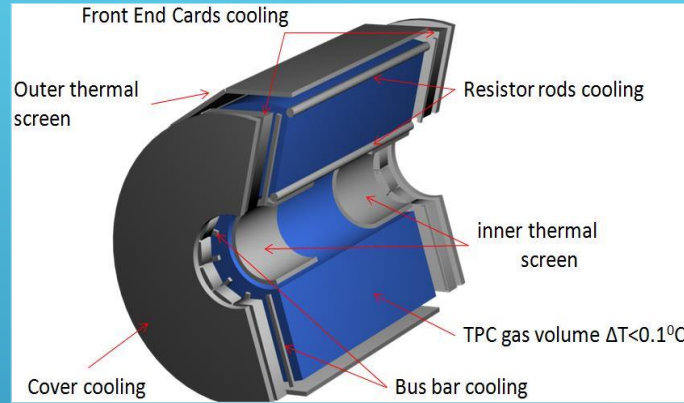
Gas system (Ar/CH4, 90:10)



Ar N2

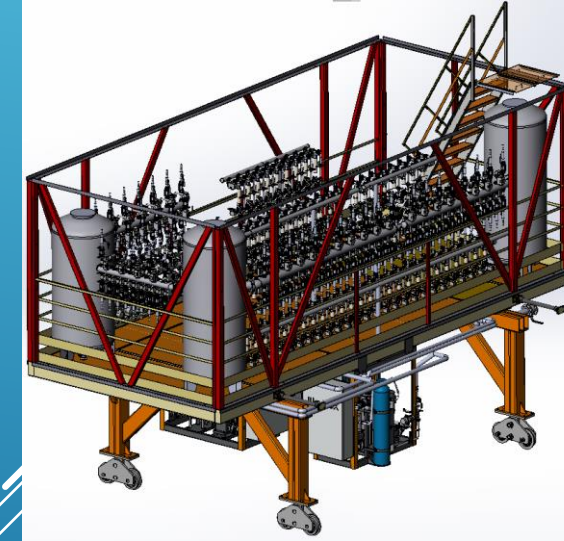
Gas supply

Water cooling system



Full set of panels – delivered

Cooling system - 1-st floor of the South platform

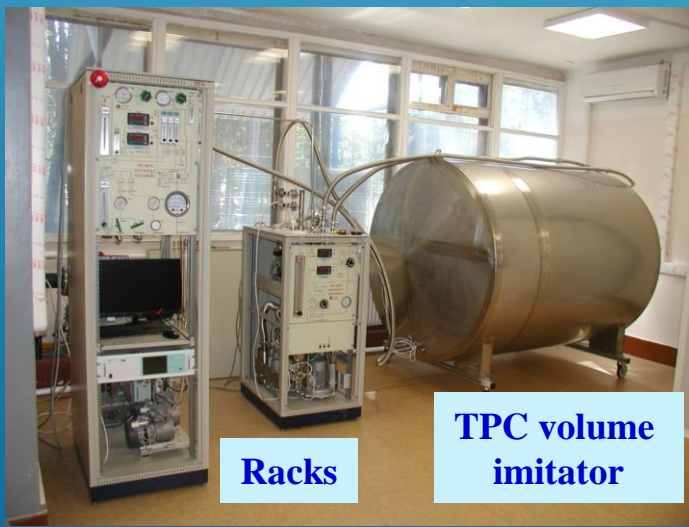


Vacuum tanks

Design, optimization and procurements - in progress ...



Heat exchanger



Racks

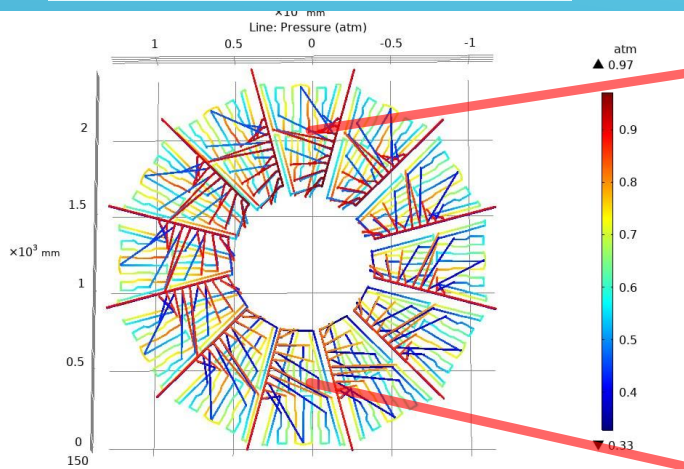
TPC volume imitator

Tests - in progress
(H20 and O2 sensors are replaced)
Ready for piping

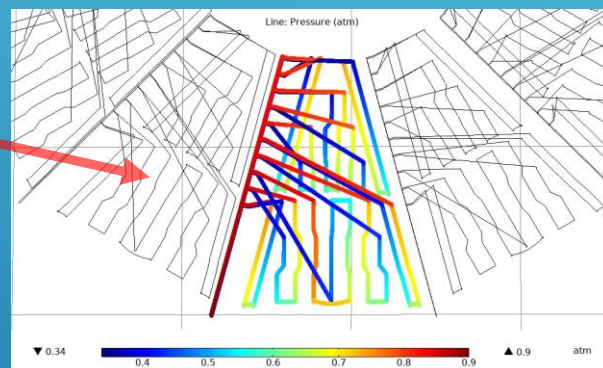
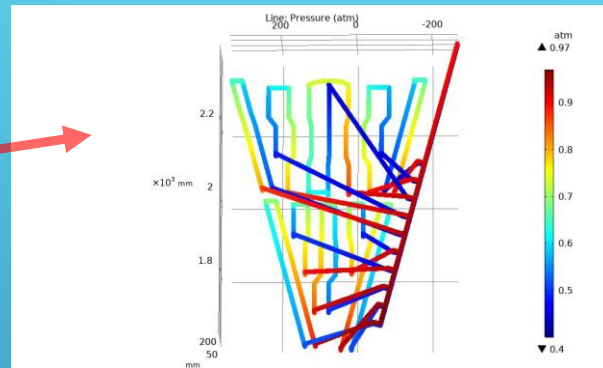
contract JINR-INP BSU (Minsk):
components delivery – September 30 2024
commissioning– December 30 2024

TPC SUB-SYSTEM: COOLING SYSTEM FOR ROC CHAMBER FE CARDS

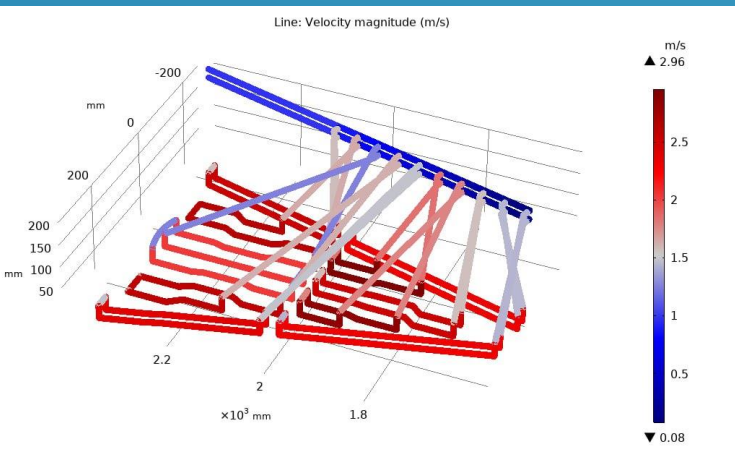
Hydrodynamic pressure drop for ROC chambers



$dP \leq 0.5 \text{ atm}$

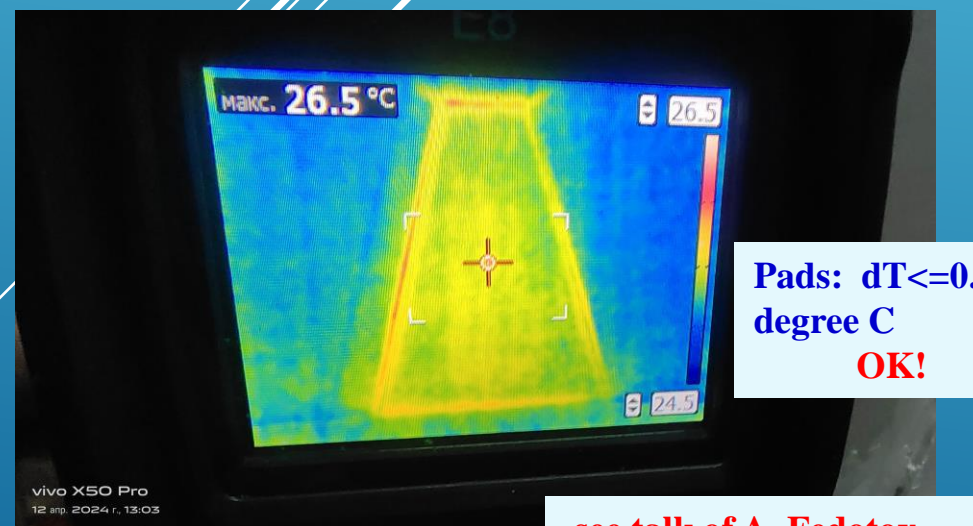


Systems parameters optimization by calculations – in progress



Water velocity: (1.5-2.5) m/s

Goal of study: check temperature distribution on serial ROC chamber pads

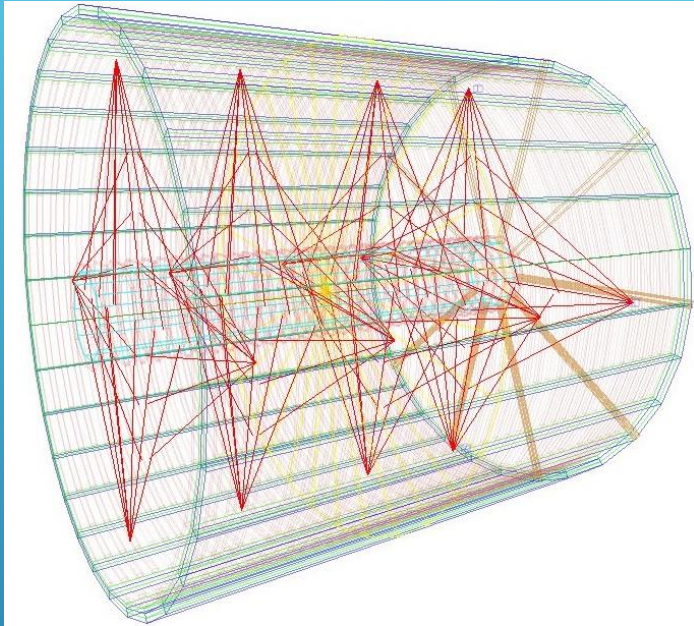


Pads: $dT \leq 0.2$ degree C
OK!

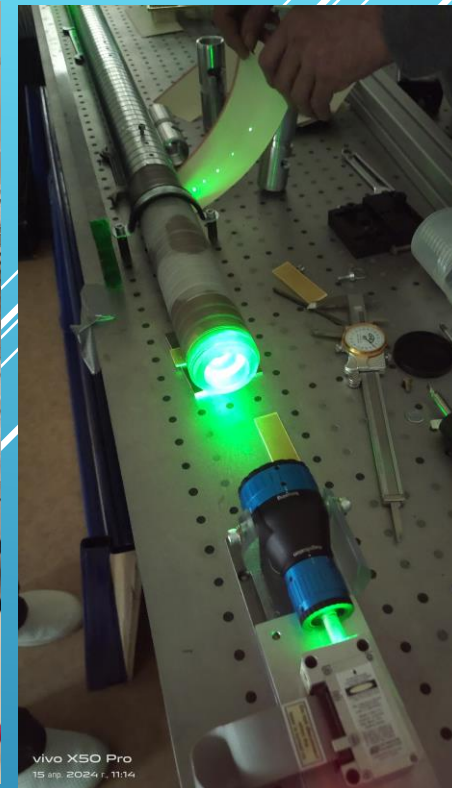
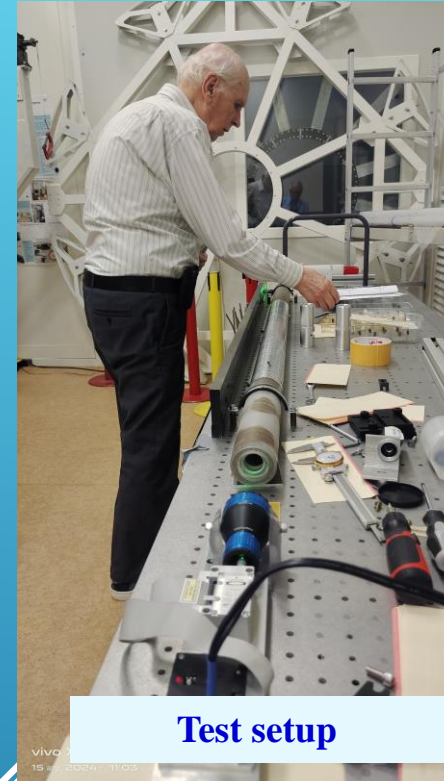
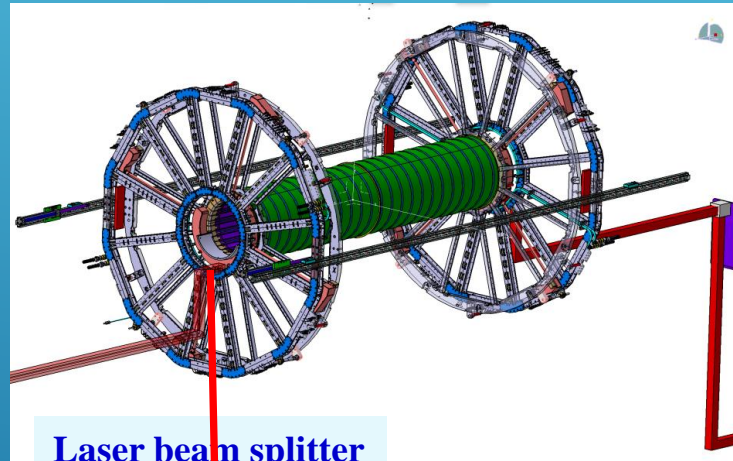
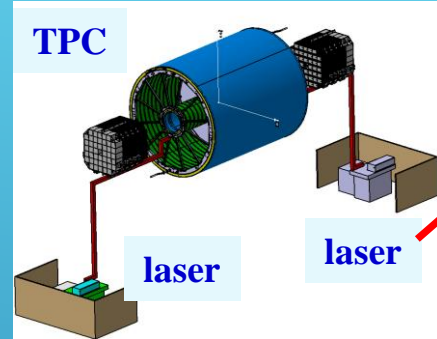
see talk of A. Fedotov

TPC SUB-SYSTEMS: LASER CALIBRATION SYSTEM

Scheme for 1/2 TPC



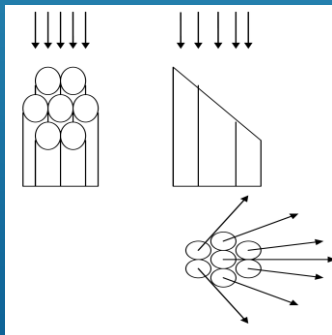
- Laser "planes" - 4
- Micro-mirrors bundles per plane - 4
- Beams from micro-mirrors bundle - 7
- Laser "tracks" (N = 112x2) - 224



Laser beam monitor



micro-mirror bundles



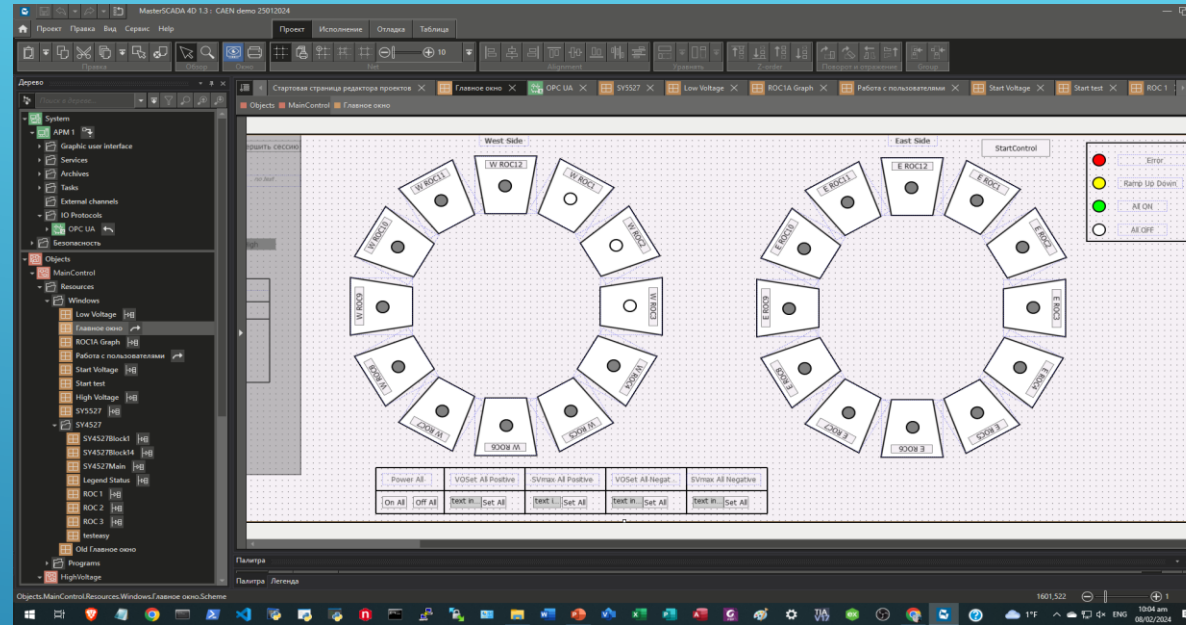
in progress ...

TPC SUB-SYSTEMS: SLOW CONTROL

LV

CAEN LV test setup

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

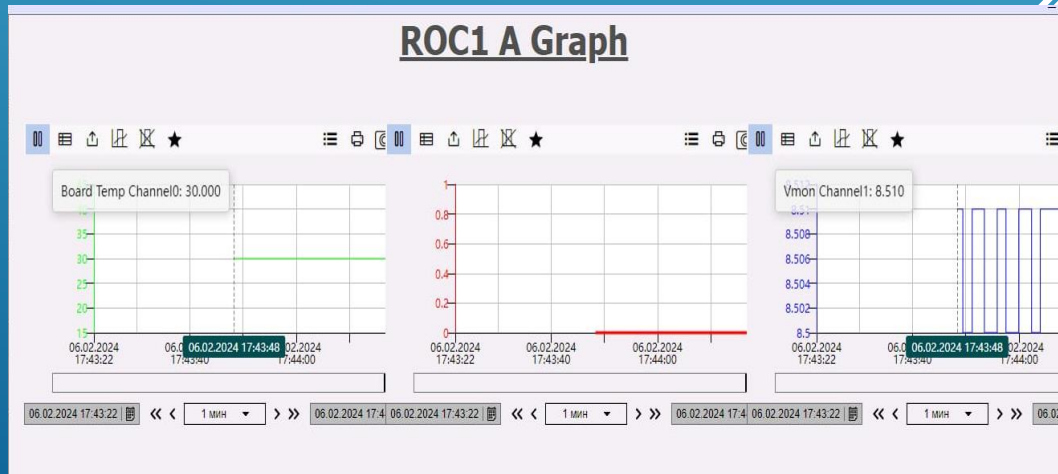


Low Voltage											
Name	PowerON/OFF	IOSet	Imon	VOSet	Vmon	Status	Temp	Trip	SerNum	RemBdName	
CH000	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CH001	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CH002	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CH003	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CH004	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CH005	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CH006	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CH007	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CH008	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CH009	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CH010	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

HV

W ROC 1											
Name	Power	VOSet	IOSet	Vmon	Imon	Status	Trip	SVmax			
A1 CH000 Block1 (PID 27072)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
A2 CH001 Block1 (PID 27072)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
A3 CH002 Block1 (PID 27072)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
A4 CH003 Block1 (PID 27072)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CE CH000 Block14 (PID 20698)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

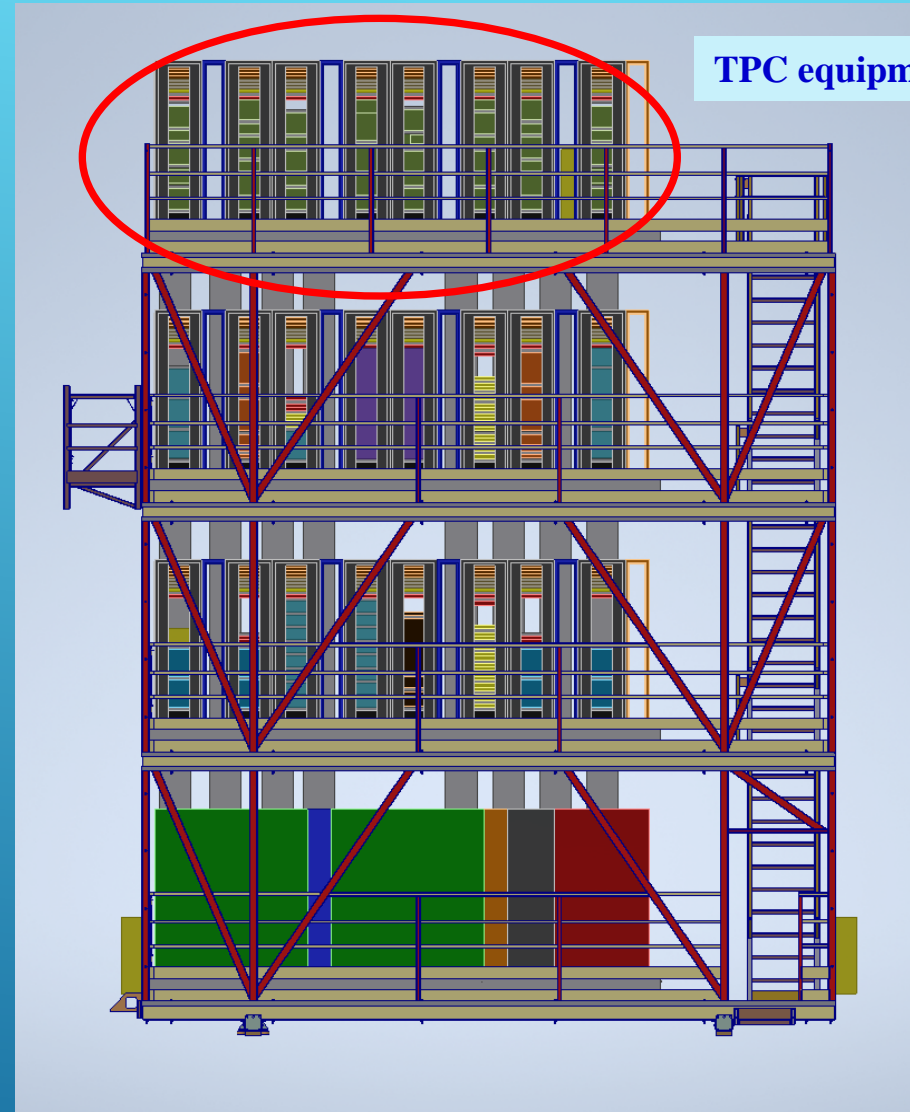
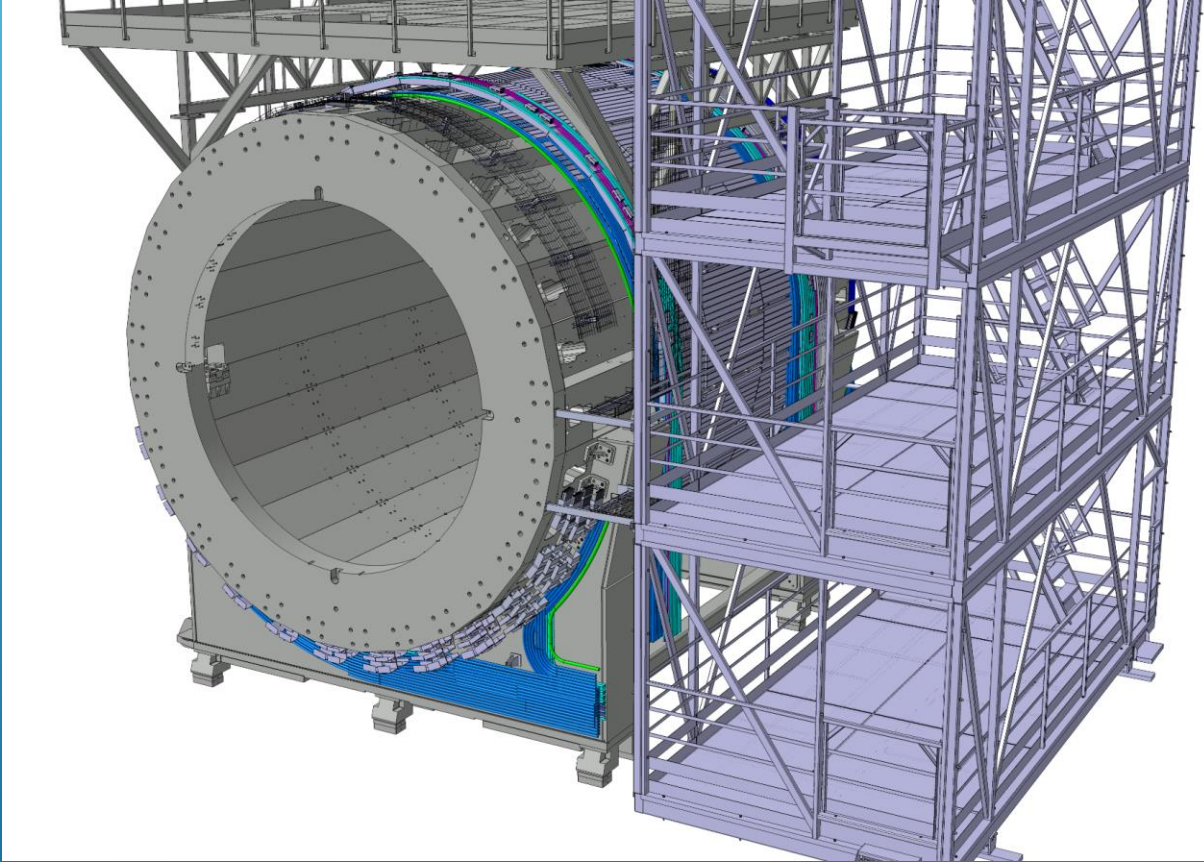
DATA transfer from MasterScada 4D to the DB POSTGRESQL16 – OK!



in progress ...

INTEGRATION: NICA-MPD-PLATFORM (NMP)

Common view



TPC equipment

Integration – in progress ...

TPC racks on the 4th floor

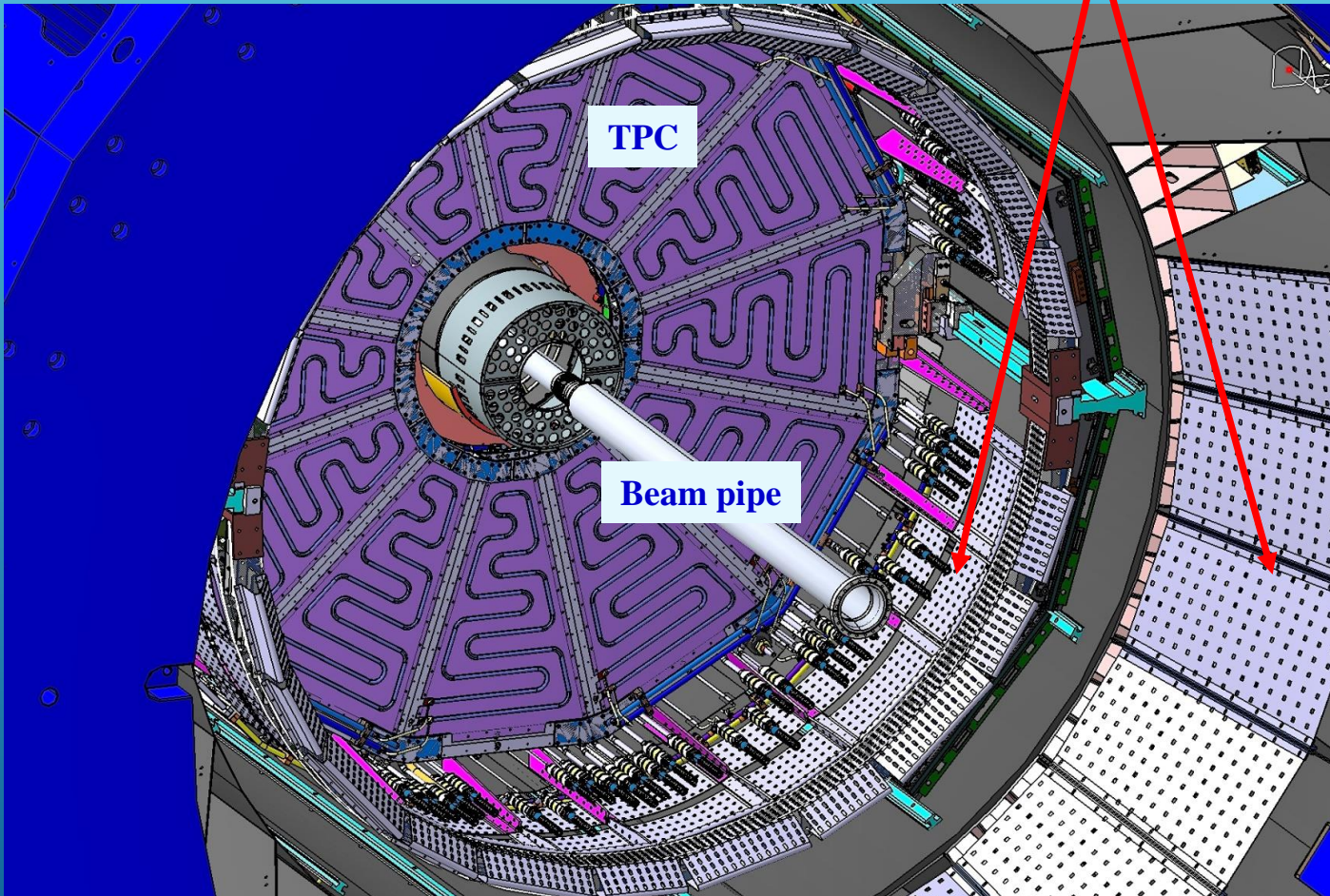
F4-01 (расшир)	F4-02 LV	F4-03 LV	F4-04	F4-05	F4-06 (LV)	F4-07 (LV)	F4-08 (расшир)
47							
46	Cable organizer	Cable organizer	Cable organizer	Cable organizer	Cable organizer	Cable organizer	Cable organizer
45	Patch Panel Fiber	Patch Panel Fiber	Patch Panel Fiber	Patch Panel Fiber	Patch Panel Fiber	Patch Panel Fiber	Patch Panel Fiber
44	Aruba 3810M 24G (146W) 6kg	Aruba 3810M 24G (146W) 6kg	Aruba 3810M 24G (146W) 6kg	Aruba 3810M 24G (146W) 6kg	Aruba 3810M 24G (146W) 6kg	Aruba 3810M 24G (146W) 6kg	Aruba 3810M 24G (146W) 6kg
43							
42	Система GATE	A3486 Nr1 (280VAC-40VDC)	A3486 Nr4 (280VAC-40VDC)	A3486 Nr7 (280VAC-40VDC)	A3486 Nr8 (280VAC-40VDC)	A3486 Nr9 (280VAC-40VDC)	A3486 Nr12 (280VAC-40VDC)
41	40W x 12 камер x 500W	3kW, max.4kW 380V/15A	3kW, max.4kW 380V/15A	Питание SC для всех приборов EASY	3kW, max.4kW 380V/15A 30kg	3kW, max.4kW 380V/15A	3kW, max.4kW 380V/15A
40	220V/10A	30kg	30kg	380V/15A, 1kW (max 4 kW), 30kg	3000(hv)	30kg	30kg
39	20kg						
38		Crate EASY 3000 Nr1	Crate EASY 3000 Nr4	Crate EASY 3000 Nr8a (HV)	Crate EASY 3000 Nr8a (HV)	Crate EASY 3000 Nr9	Crate EASY 3000 Nr12
37	Система GATE	питание + 48V Sepetca от A3486	питание + 48V Sepetca от A3486	питание + 48V Sepetca от A3486	питание + 48V Sepetca от A3486	питание + 48V Sepetca от A3486	питание + 48V Sepetca от A3486
36	40W x 12 камер x 500W						
35	220V/10A						
34	20kg	42.5kg	42.5kg	42.5kg	42.5kg	42.5kg	42.5kg
33							
32							
31	вент. панель	вент. панель	вент. панель	вент. панель	вент. панель	вент. панель	вент. панель
30							
29	Система SPECTRA	A3486 Nr2 (280VAC-40VDC)	A3486 Nr5 (280VAC-40VDC)	Crate SC для LVN9	Crate SF4527 (HV)	A3486 Nr10 (280VAC-40VDC)	A3486 Nr13 (280VAC-40VDC)
28	1050W	3kW, max.4kW 380V/15A	3kW, max.4kW 380V/15A	300W	700W, max. 1.3kW	3kW, max.4kW 380V/15A	3kW, max.4kW 380V/15A
27	220V/15A	30kg	30kg	220V/10A	220V/10A	30kg	30kg
26	50kg			6kg	8 модуль x 12ch@96ch=2.5kW/1mA +		30kg
25		Crate EASY 3000 Nr2	Crate EASY 3000 Nr5	(система медленного контроля	25 2 модуль x 12ch = 24ch-500V/1mA)	Crate EASY 3000 Nr8	Crate EASY 3000 Nr13
24		питание + 48V Sepetca от A3486	питание + 48V Sepetca от A3486	платами LVN9 - 48 шт.)	45kg	питание + 48V Sepetca от A3486	питание + 48V Sepetca от A3486
23							
22	вент. панель			Crate VMEB100/11	вент. панель		
21		42.5kg	42.5kg	1.1kW, max. 2.5kW		42.5kg	42.5kg
20	Модуль термометрии NI			220V/15A	Crate VMEB100/11		
19	200W			30kg	1.1kW, max. 2.5w		
18	220V	вент. панель	вент. панель		220V/15A	вент. панель	вент. панель
17	5kg				30kg		
16		A3486 Nr3 (280VAC-40VDC)	A3486 Nr6 (280VAC-40VDC)			A3486 Nr11 (280VAC-40VDC)	A3486 Nr14 (280VAC-40VDC)
15		3kW, max.4kW 380V/15A	3kW, max.4kW 380V/15A	вент. панель		3kW, max.4kW 380V/15A	3kW, max.4kW 380V/15A
14	TPC Laser system synchronization	30kg	30kg			30kg	30kg
13	200V, 220V			Crate NIM	вент. панель		
12	5kg	Crate EASY 3000 Nr3	Crate EASY 3000 Nr6	610W, max. 1.15kW		Crate EASY 3000 Nr11	Crate EASY 3000 Nr14
11		питание + 48V Sepetca от A3486	питание + 48V Sepetca от A3486	220V/10A		питание + 48V Sepetca от A3486	питание + 48V Sepetca от A3486
10	TPC HV membrane - 30kV			30kg			
9	350W						
8	220V	42.5kg	42.5kg			42.5kg	42.5kg
7	7kg			вент. панель			
6							
5		вент. панель	вент. панель			вент. панель	вент. панель
4							
3							
2							
1							

mapping – in progress ...

TPC CABLING AND PIPING

Integration ...

Structures for cables and pipes fixation



Structure design - done

Mockup for cabling and piping



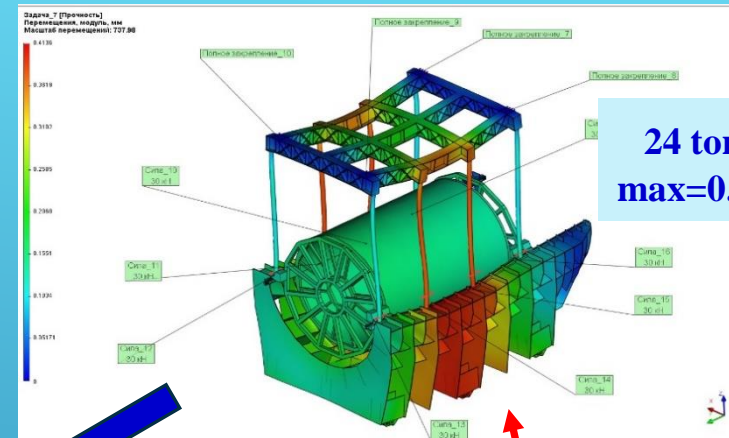
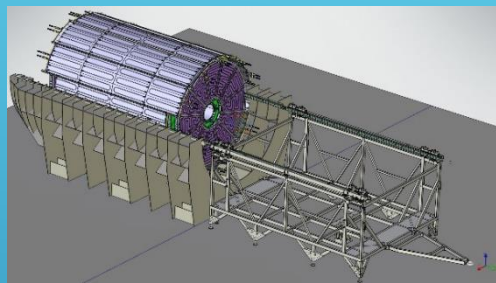
TPC+TOF+ECAL cabling – in progress ...
Piping – not started yet

TOOLING FOR TPC INSTALLATION TO MPD

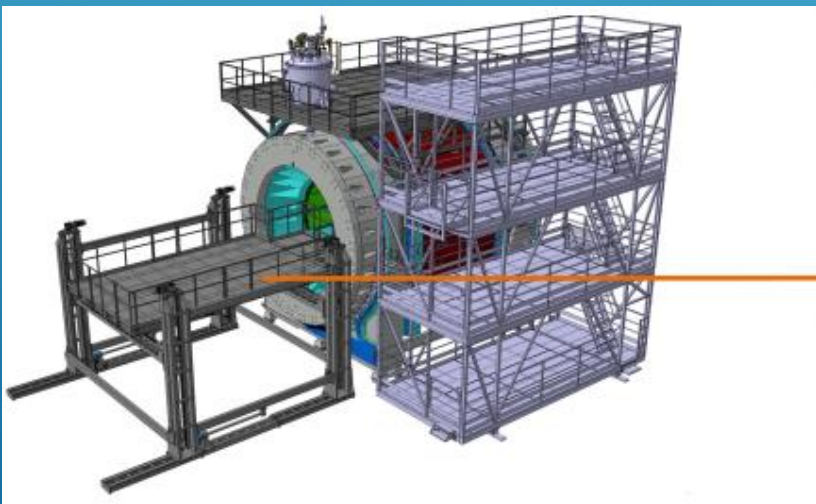
Bld. 217



Bld. 17 (MPD)



24 tons,
max=0.41 mm



Lifting platform



Tooling for TPC installation to MPD delivery - August 2024
TPC installation to MPD - March 03-May 24 2025

Tooling for TPC installation to MPD – in manufacture
status - see talk S. Savitski

STATUS AND TIME SCHEDULE

Status:

TPC vessel	in progress
ROCs (24+6 spare)	ready
FE electronics	81% manufactured (1217 FECs from 1500)
Gating grid system	ready
HV+LV systems	ready for start installation
Gas system	ready for start piping
Cooling system	in progress
Laser system	in progress
Slow control system	in progress

TPC assembling:

TPC:

TPC assembled	Dec 30 2024
TPC tests (with laser tracks and cosmic ray)	March-Sept 2024 → Jan-Feb 2025
TPC rails and installation tooling:	
Rails installation to ECAL support structure	May 30 2024
Tooling for installation TPC to MPD delivery	August 2024
TPC+ECAL cooling systems (INP BSU, Minsk):	
Delivery to JINR	Sept 30 2024
Systems assembling and tubing	Oct 27 2024
Commissioning	Nov 27 –Dec 30 2024
TPC installation to MPD	Nov 30 2024 -> March 03-May 24 2025
Cabling	Jan-June 2025
Start of MPD commissioning	from June 27 2025

Thank you !

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)

НИИ ЯП БГУ, НИИ Физ.-хим. проблем БГУ,
БГУ, ООО «Вист групп сенсор», УП
«АРТМАШ», Институт энергетике ...

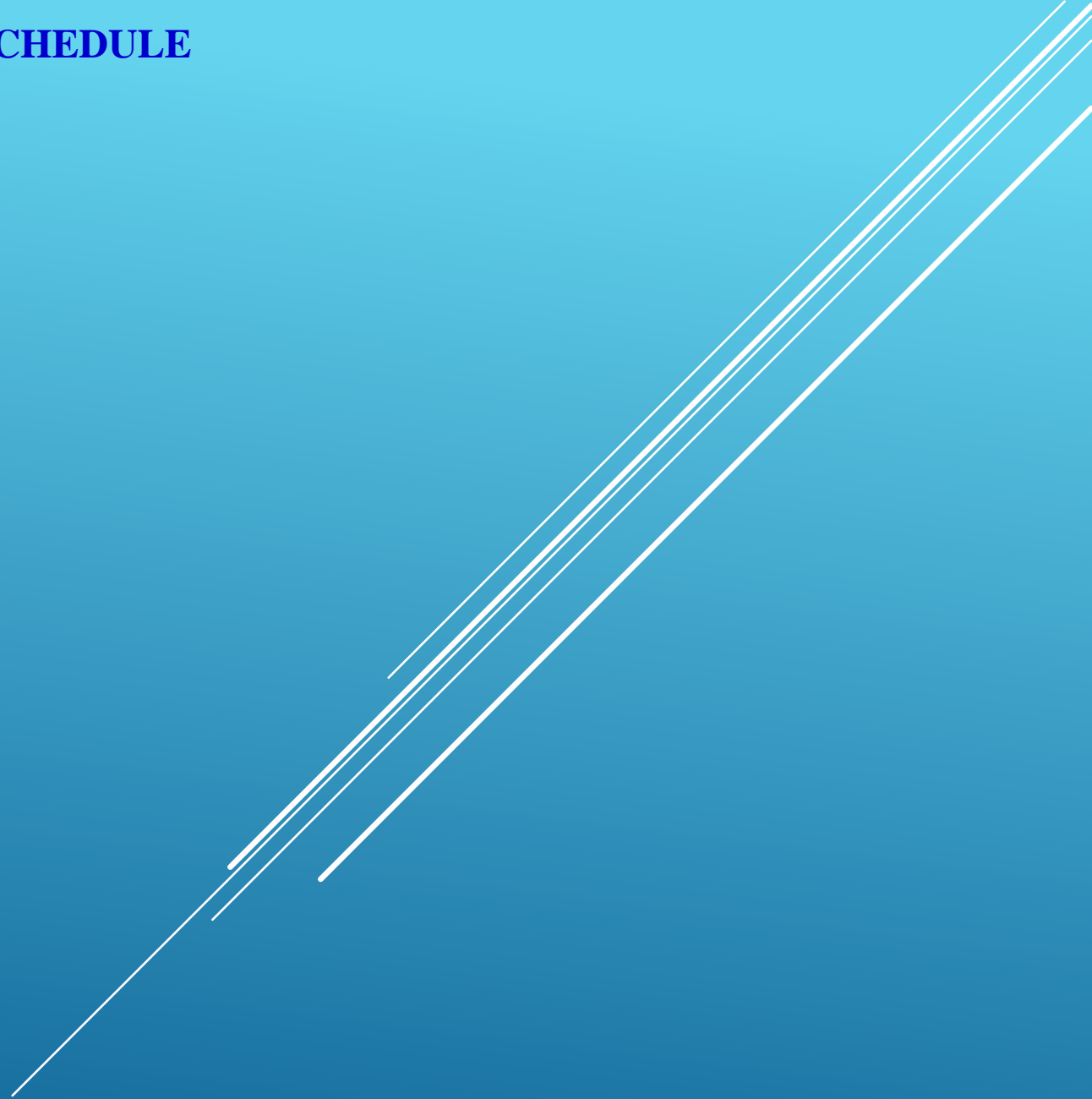
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Bayev V.
Drapezo A.P.
Fedotov A.
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Galkin Ya.
Haluza A.
Kunts A.
Lushachkin D.
Litomin A.
Losev A.
Savitskiy S.N.
Savitskiy S.S.
Senkevich V.
Shmanai E.
Tchekhovskiy V.
Yuhno Yu.M
Vaschilenko M.
Zur I.

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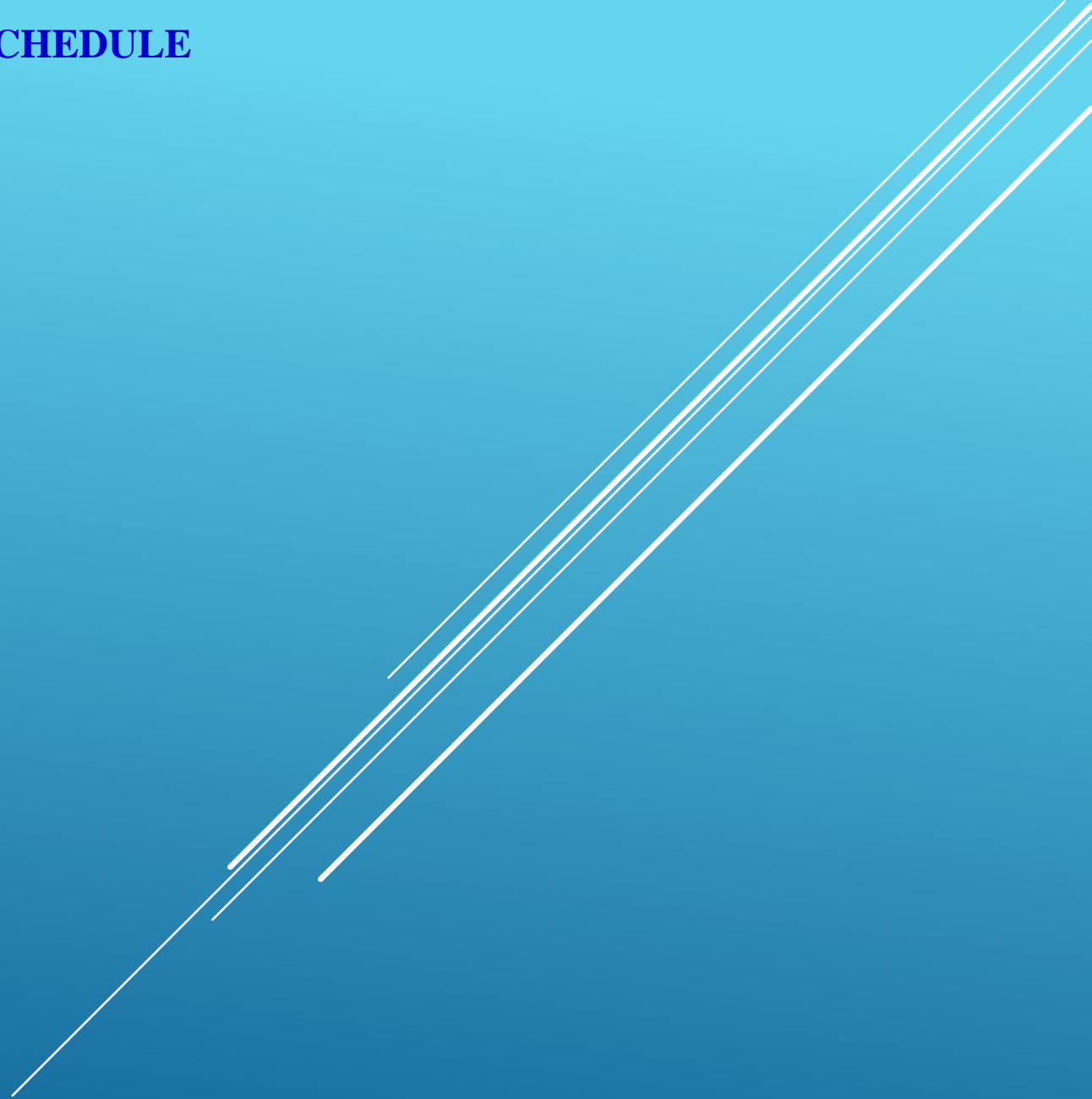
sorry if anybody forgotten

Many Thanks!!!!

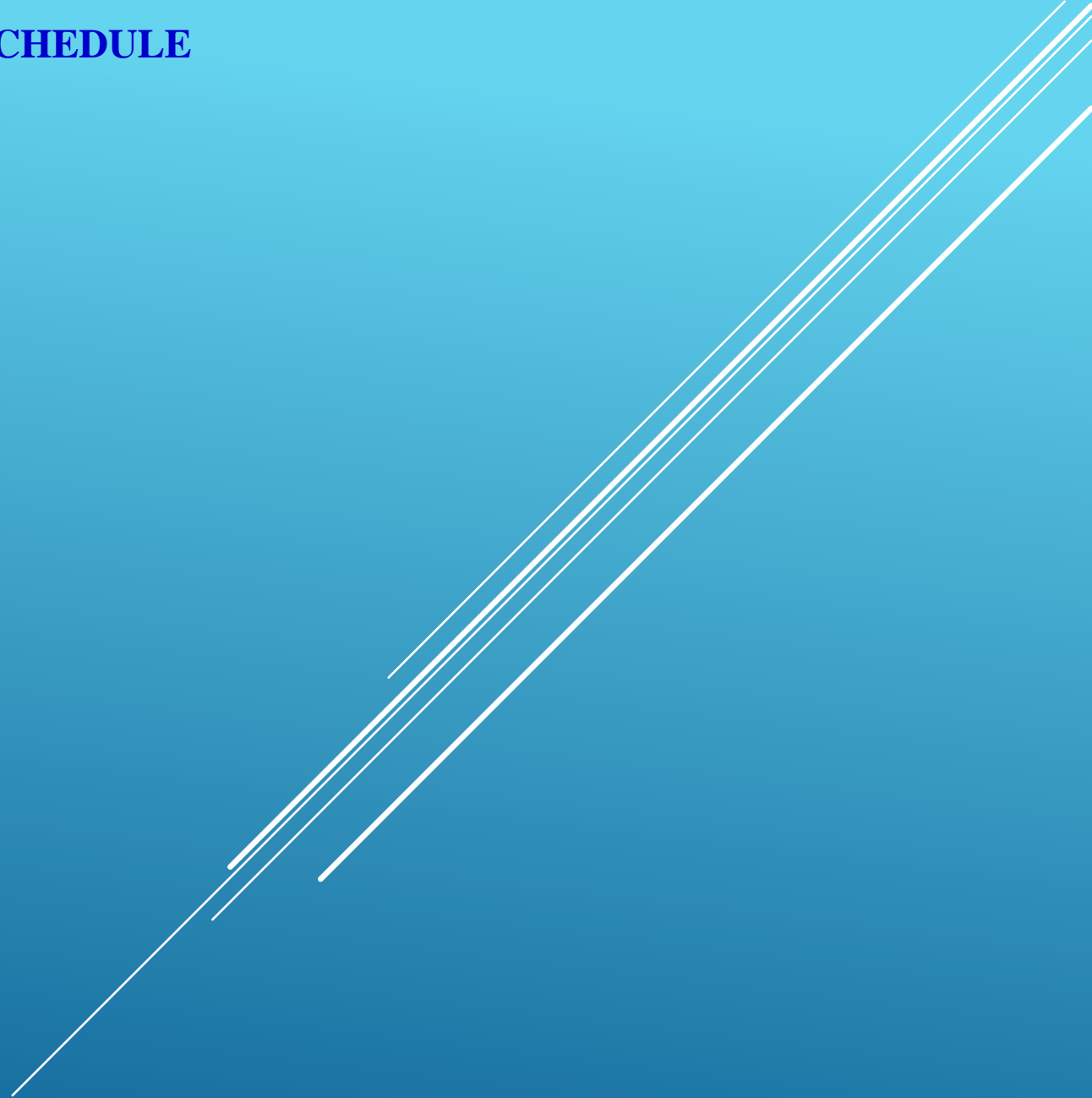
TIME SCHEDULE



TIME SCHEDULE



TIME SCHEDULE



TIME SCHEDULE

