

Status of some parts of the TPC for the MPD/NICA experiment

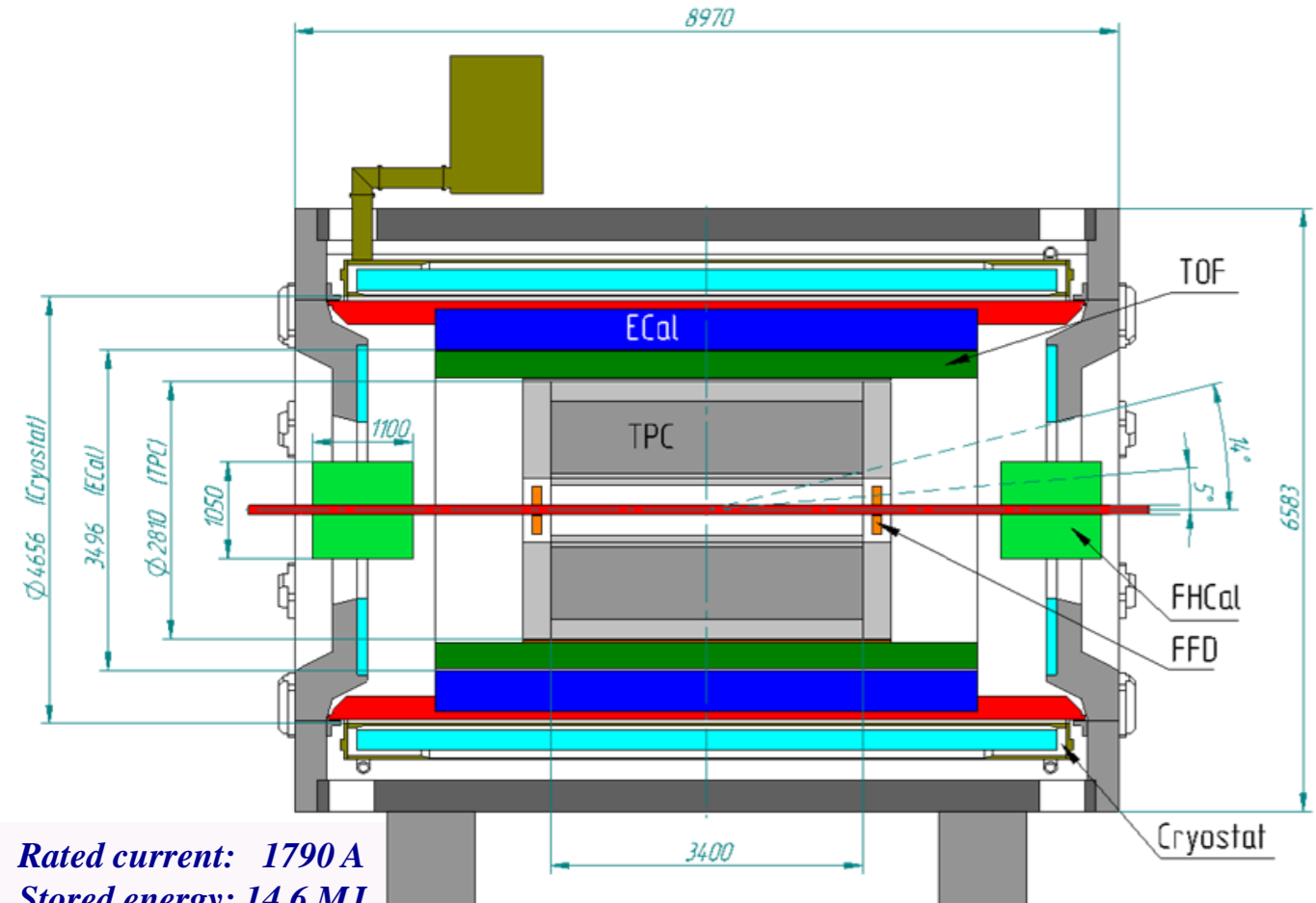
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As part of the creation of a new accelerator complex NICA, a Multi-Purpose Detector (MPD) is being developed. The Time Projection Chamber (TPC) is used for charge particle tracking and particle identification. The TPC being a large but conceptually simple detector must be assembled with very high precision to reduce nonlinear systematic effects. High stability of the mechanical structure and uniformity of the drift E field, the stability of temperature, the drift gas purity and the gas gain uniformity have to be provided to get precise track reconstruction and energy-loss measurements. The TPC has a cylindrical body with a diameter of 2.8 m and length of 3.4 m and is placed in the magnet with solenoidal field of 0.5 T. The sensitive volume contains around 17.6 m³ of argon-methane mixture. The detector will register charged products of heavy ion collisions and provide registering events with a trigger rate up to 7 kHz.

Central barrel of Multi Purpose Detector (MPD)

MPD - Stage I: TPC, TOF, ECAL, ZDC, FFD



TPC: $|\Delta\phi| < 2\pi$, $1.15 \leq |\eta| \leq 1.6$
TOF, EMC: $|\Delta\phi| < 2\pi$, $|\eta| \leq 1.4$
FFD: $|\Delta\phi| < 2\pi$, $2.9 < |\eta| < 3.3$
FHCAL: $|\Delta\phi| < 2\pi$, $2 < |\eta| < 5$

TPC structure



Central part of MPD mock up with TPC cross-section

TPC design requirements

Momentum resolution: $\Delta p/p \leq 3\%$ ($0.1 < p_t < 1$ GeV/c); better than 8%;
dE/dx resolution: about 10 mm;
Two-track resolution: up to 100 GBps at trigger rate 7 kHz
Data flow rate: ~ 1000 (central collision Au+Au at $\sqrt{s_{NN}} = 11$ GeV).

TPC vessel assembly



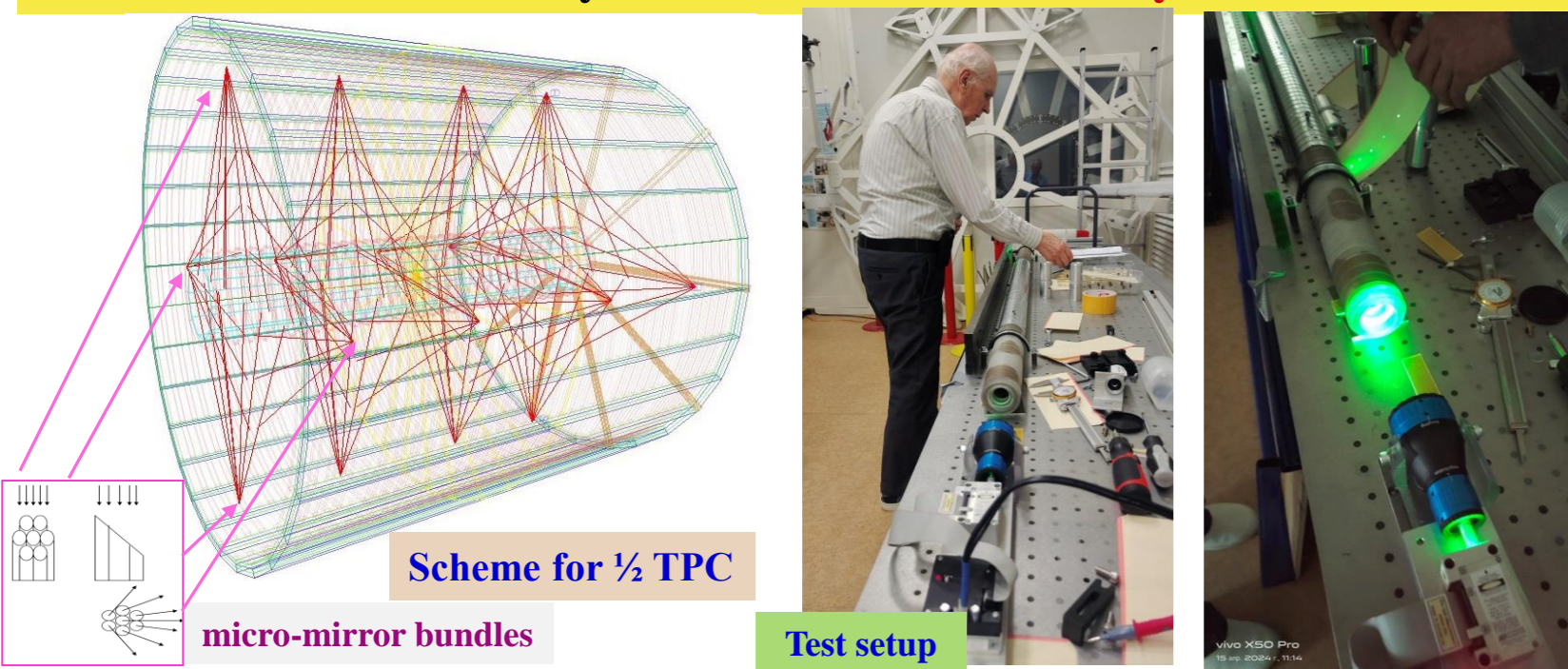
Rods D=60 mm - in manufacture

Rods D=40 mm - ready for installation

HV divider (2 pc) - ready

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

TPC Sub-Systems: Laser Calibration System



Scheme for 1/2 TPC

micro-mirror bundles

Test setup

TPC ROC chambers

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 ASI+AT960 +/-50 mkm

Summary:
- measurements to do for all ROCs
- calibration of ROC marks and 3960 pads respect to ROC "reference hole" - in progress

24 pc serial ROCs + 4 spare - READY!

TPC Sub-System: Cooling System for ROC chamber FE Cards

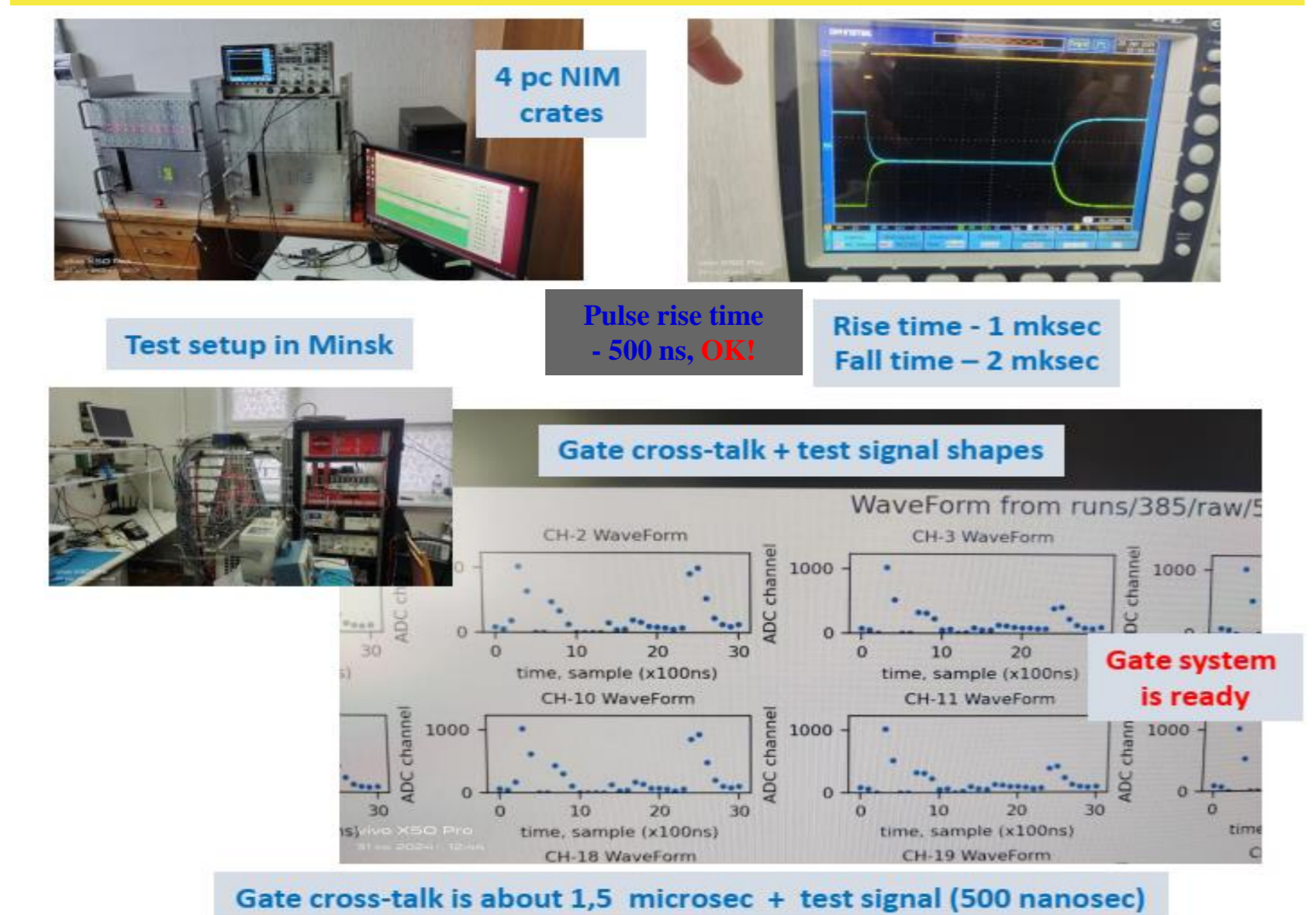
Goal of study: check temperature distribution on serial ROC chamber pads



Test setup (Minsk)

Pads: $dT < 0.2$ degree C OK!

TPC Sub-Systems: Gating Grid system



4 pc NIM crates

Test setup in Minsk

Pulse rise time - 500 ns, OK!

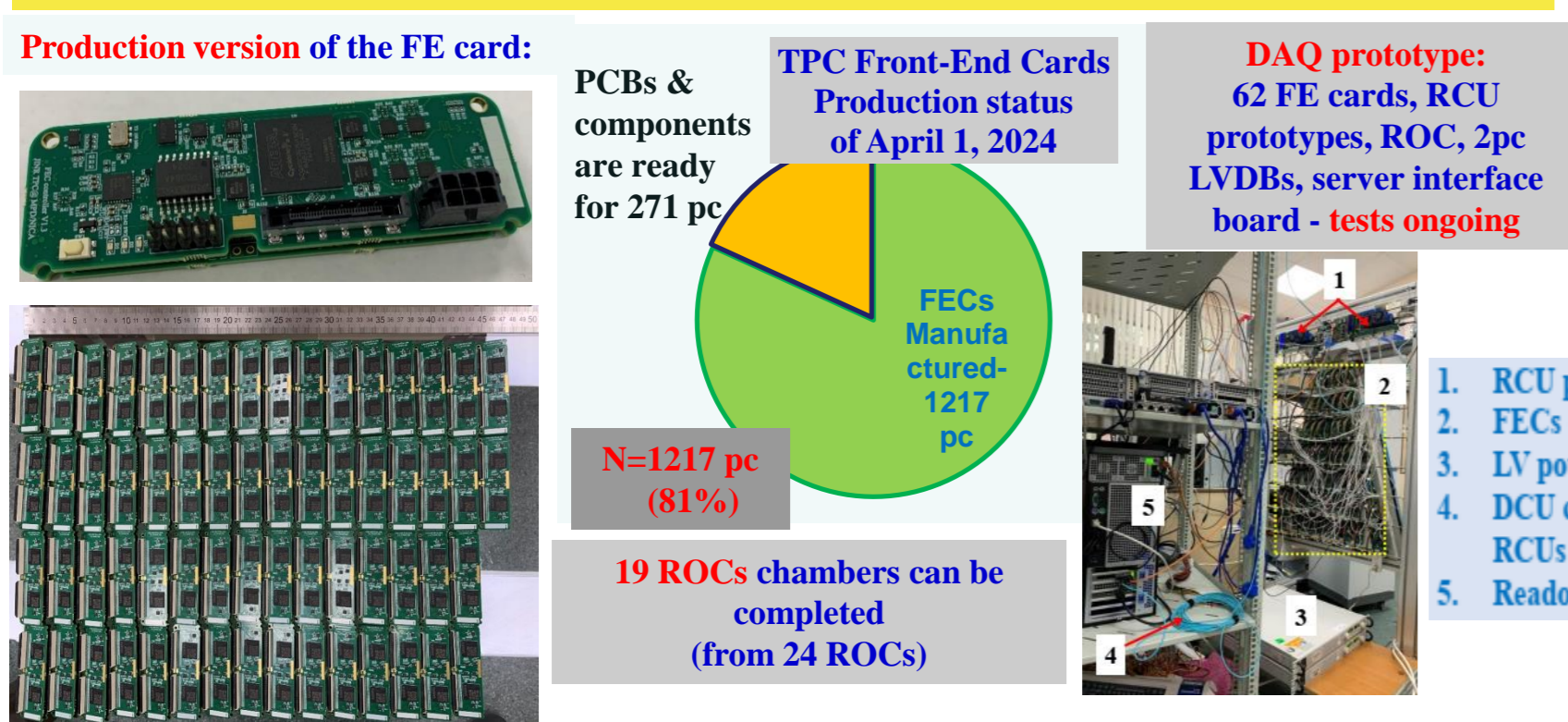
Rise time - 1 mksec
Fall time - 2 mksec

Gate cross-talk + test signal shapes

Gate system is ready

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

TPC Sub-Systems: Electronics



Production version of the FE card:

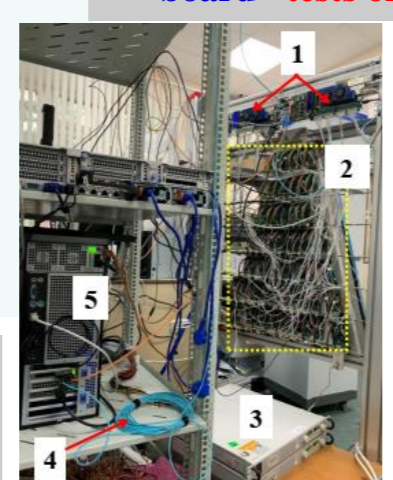
PCBs & components are ready for 271 pc

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

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

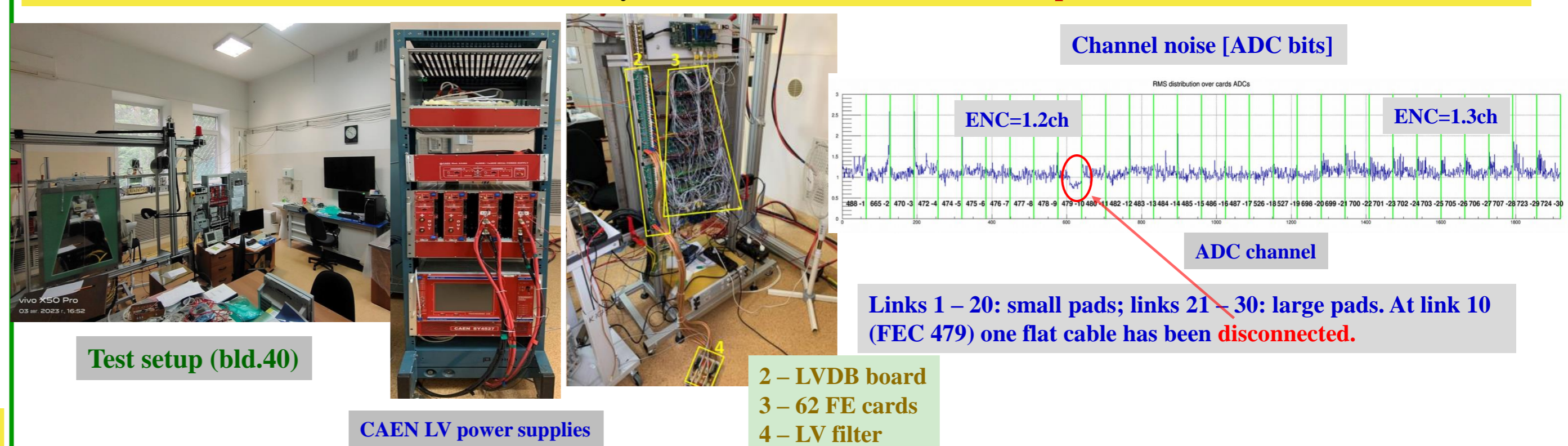
N=1217 pc (81%)

19 ROCs chambers can be completed (from 24 ROCs)



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

TPC Sub-Systems: ROC + Electronics test setup

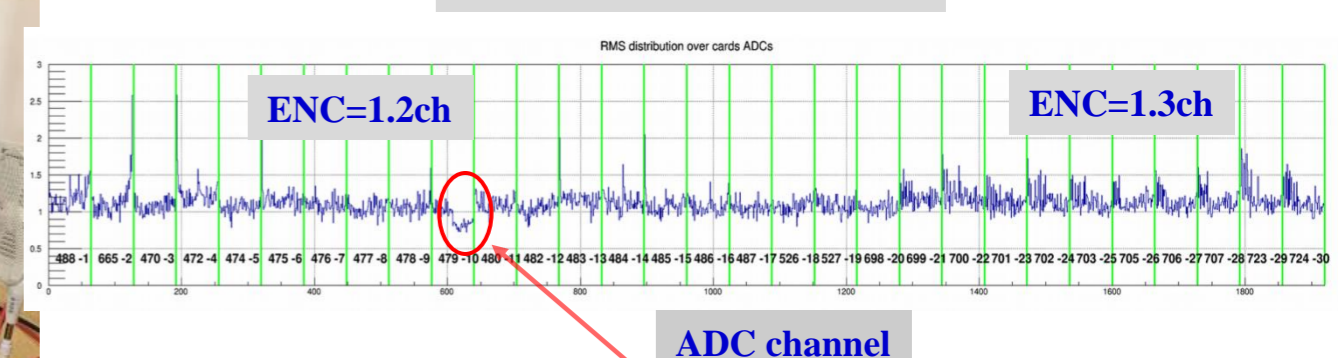


Test setup (bld.40)

CAEN LV power supplies

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

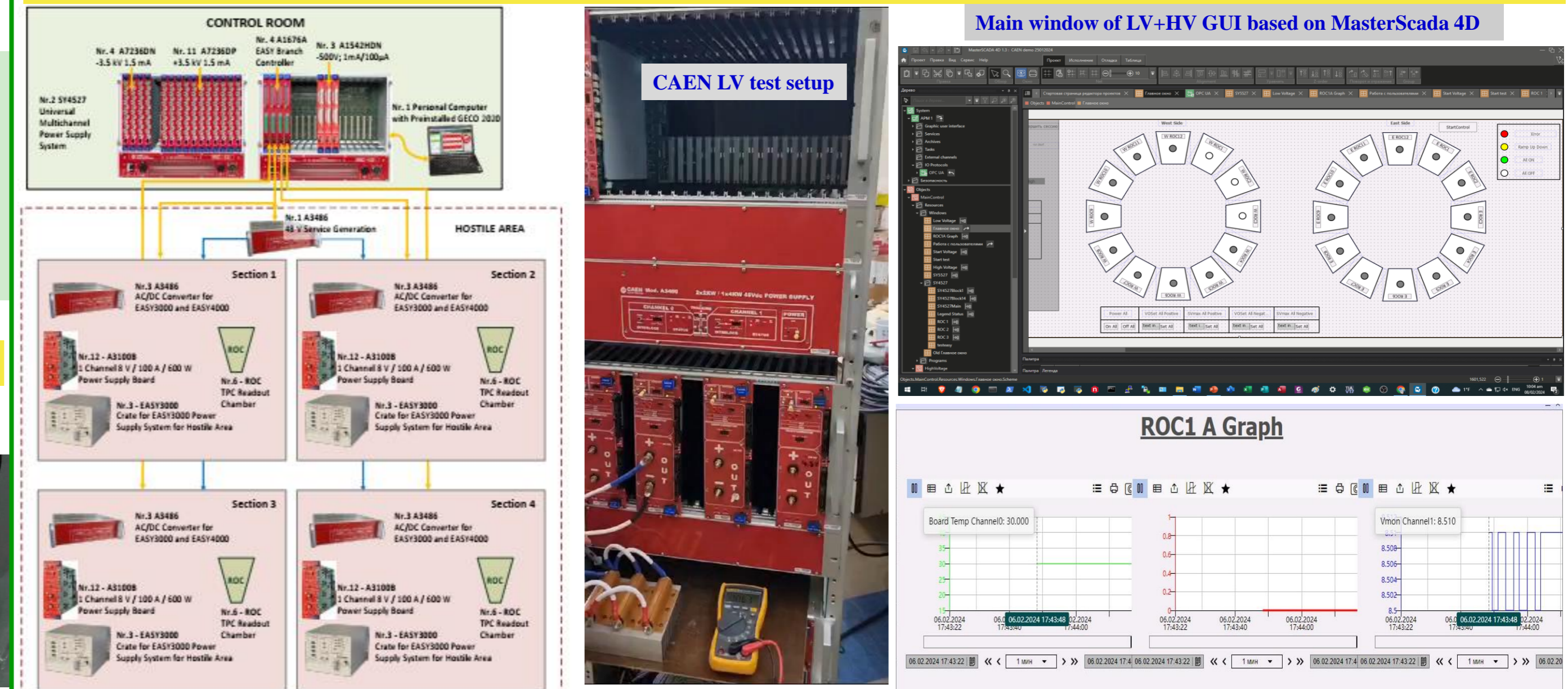
Channel noise [ADC bits]



ENC=1.2ch
ENC=1.3ch
ADC channel

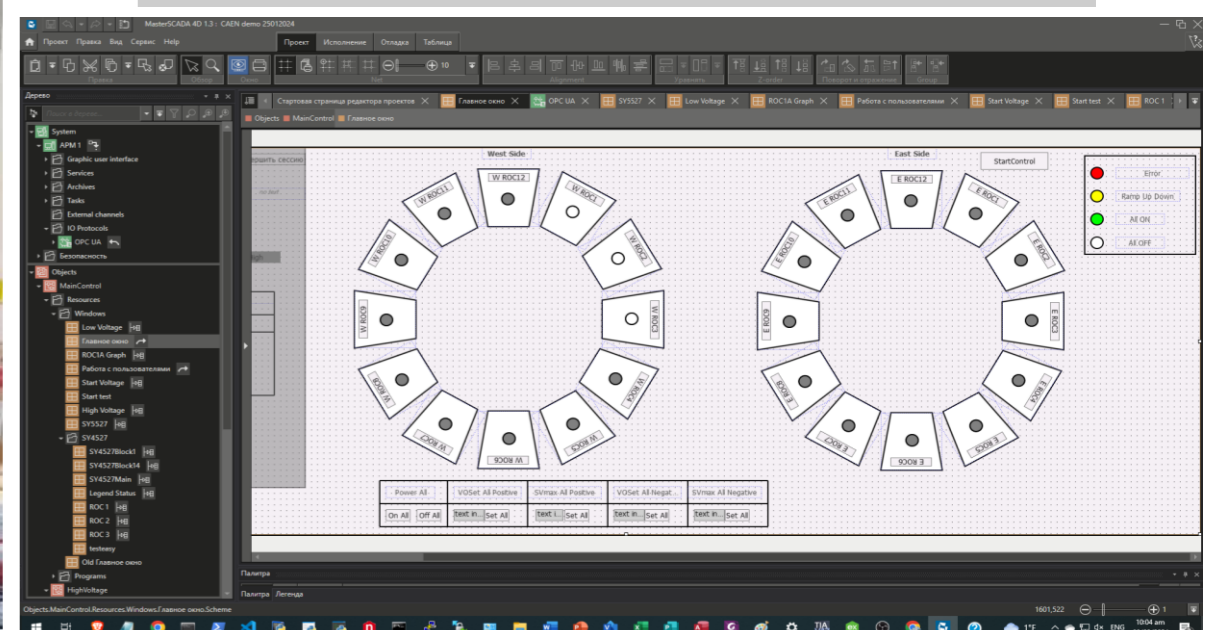
Links 1 - 20: small pads; links 21 - 30: large pads. At link 10 (FEC 479) one flat cable has been disconnected.

TPC Sub-Systems: LV+HV (CAEN) + Slow Control



CAEN LV test setup

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



ROC1 A Graph



TPC Sub-Systems: Gas and Cooling system



Rack 2

Rack 1

Gas system (Ar/CH₄, 90:10)

Ar N₂

Cooling system - 1-st floor of the South platform

Gas supply tanks

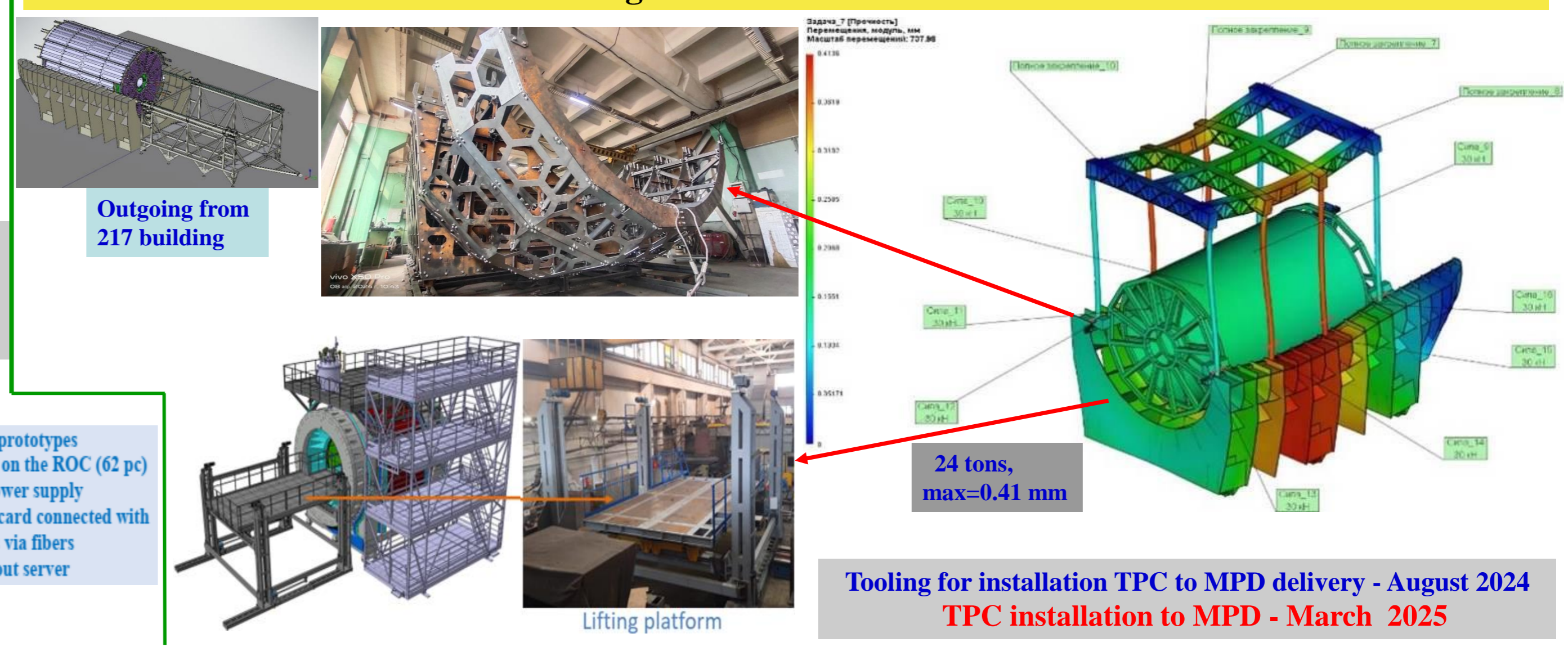
Vacuum tanks

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

Design, optimization and procurements - in progress ...

Tests - in progress (H₂O and O₂ sensors are replaced).
Ready for piping

Tooling for Installation TPC to MPD



Outgoing from 217 building

24 tons, max=0.41 mm

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

Lifting platform