MPD TPC STATUS (18.04.2023)

TPC:

- vessel assembly, ROC chambers, gating grid system

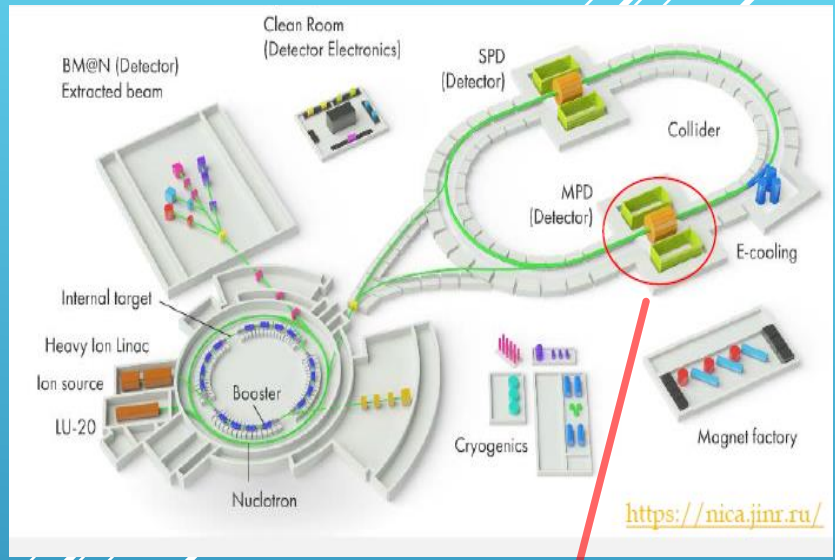
Sub-systems:

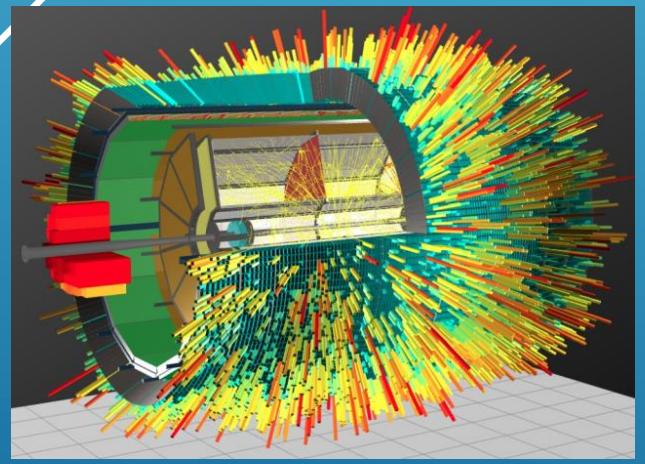
- Electronics
- LV+HV system (CAEN)
- Gas and cooling systems
- Laser calibration

Integration TPC to MPD

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

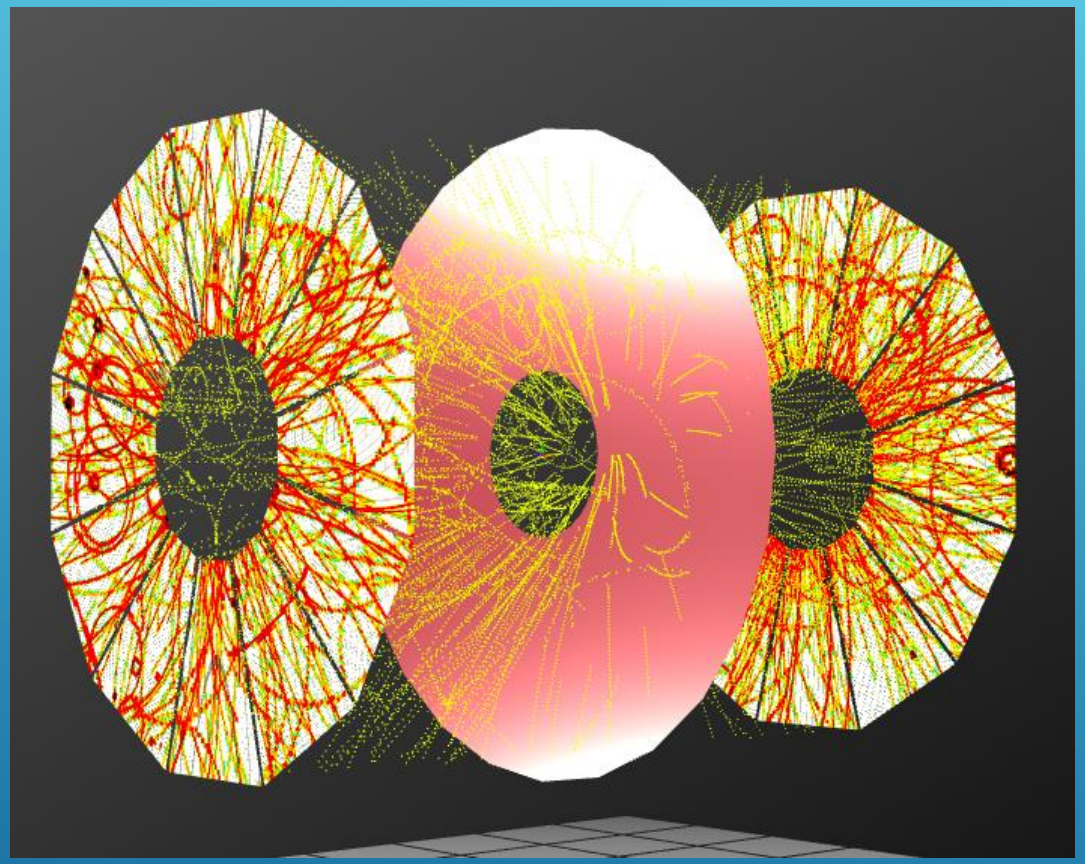
Time schedule





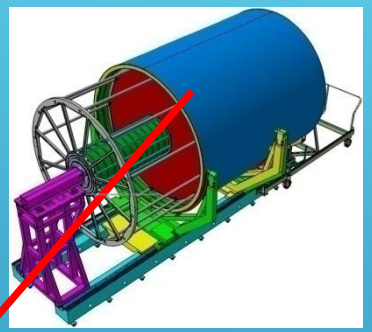
Presented by S.Movchan

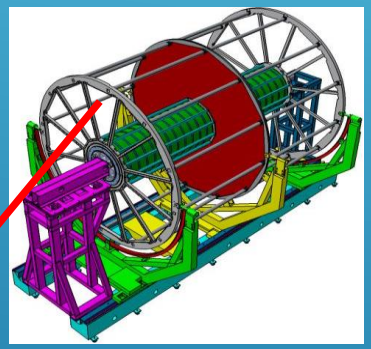
MPD TPC MAIN PARAMETERS

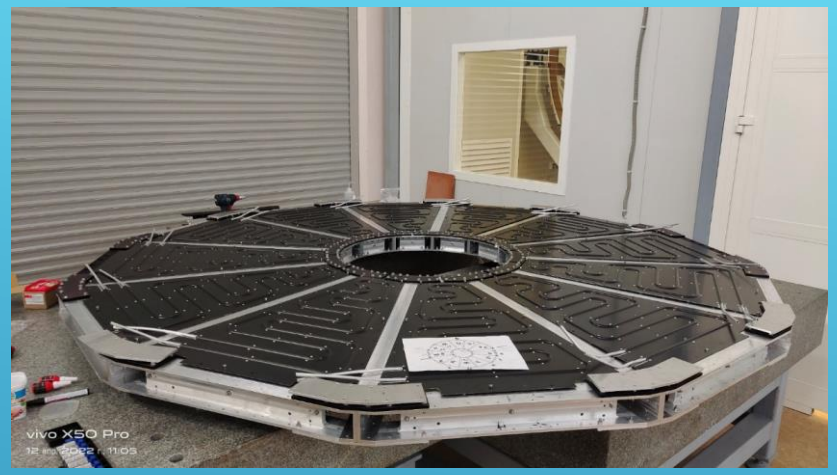


Item	Dimension
Length of the TPC	340cm
Outer radius of vessel	140cm
Inner radius of vessel	27 cm
Outer radius of the drift volume	133cm
Inner radius of the drift volume	34cm
Length of the drift volume	170cm (of each half)
HV electrode	Membrane at the center of the TPC
Electric field strength	~140V/cm;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

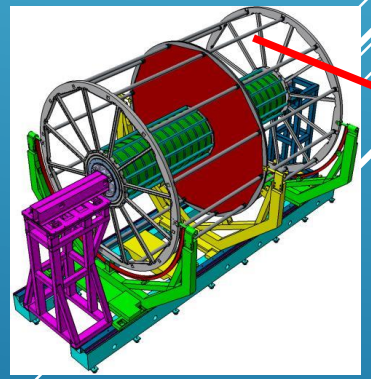






Service wheel with thermal panels (12pc)

Both service wheels - assembled

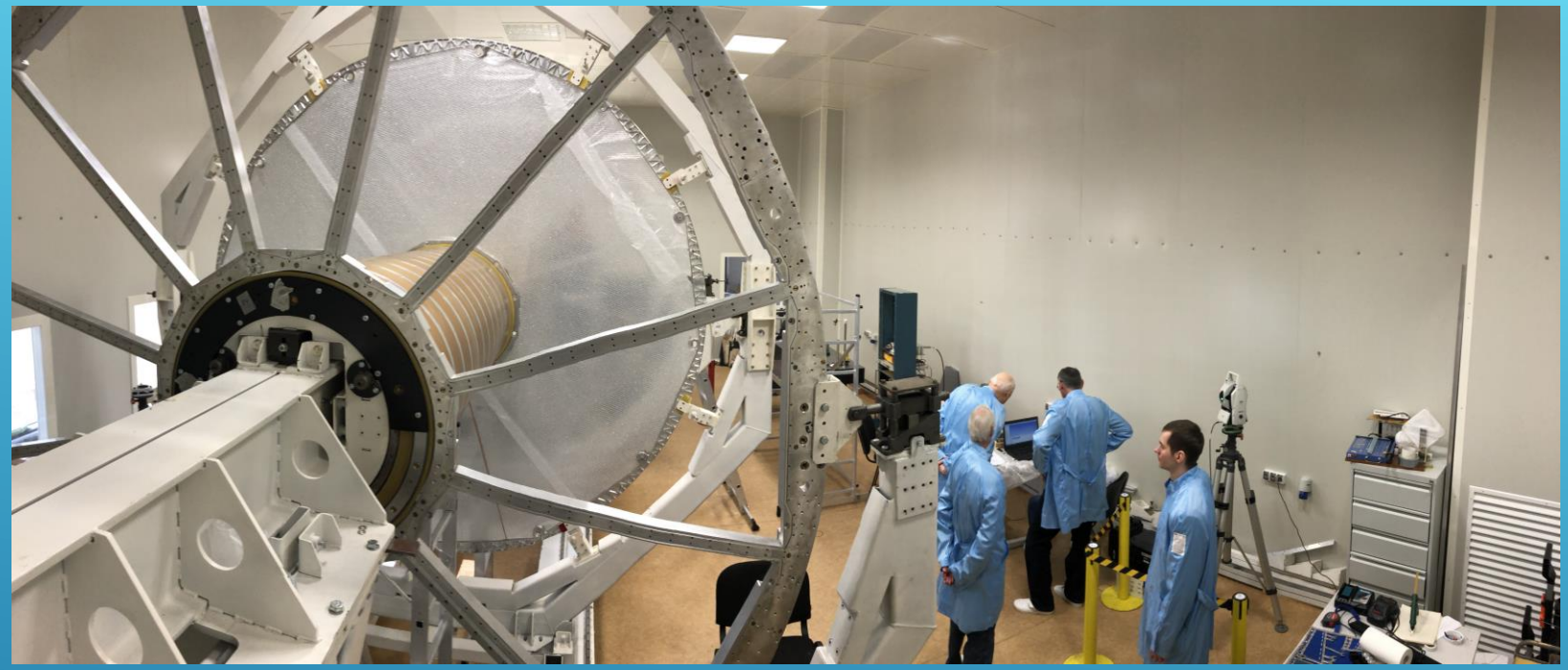


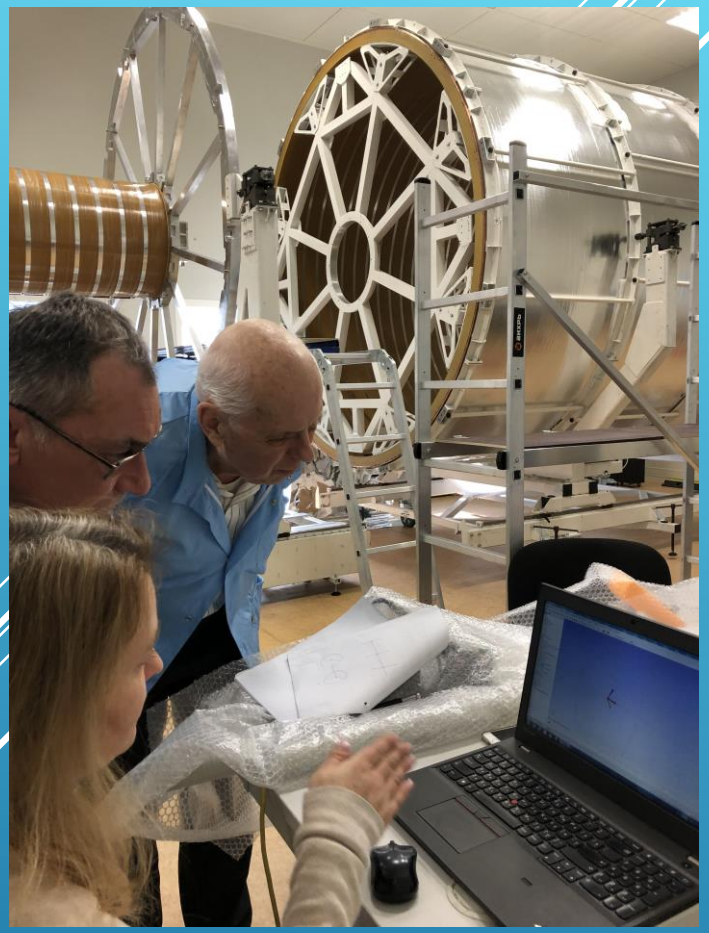
C1-C2 and C3-C4 cylinder – assembled
TPC service wheels (2pc) - assembled
HV membrane – tested
TPC field cage assembly - July 2023
TPC vessel ready – August 2023

Rods D=40 mm (24 pc) reassembled - ready
Rods D=60 mm (24 pc) – assembling in progress, ready - June 2023

TPC vessel assembly – in progress (see next slide)

TPC VESSEL ASSEMBLING



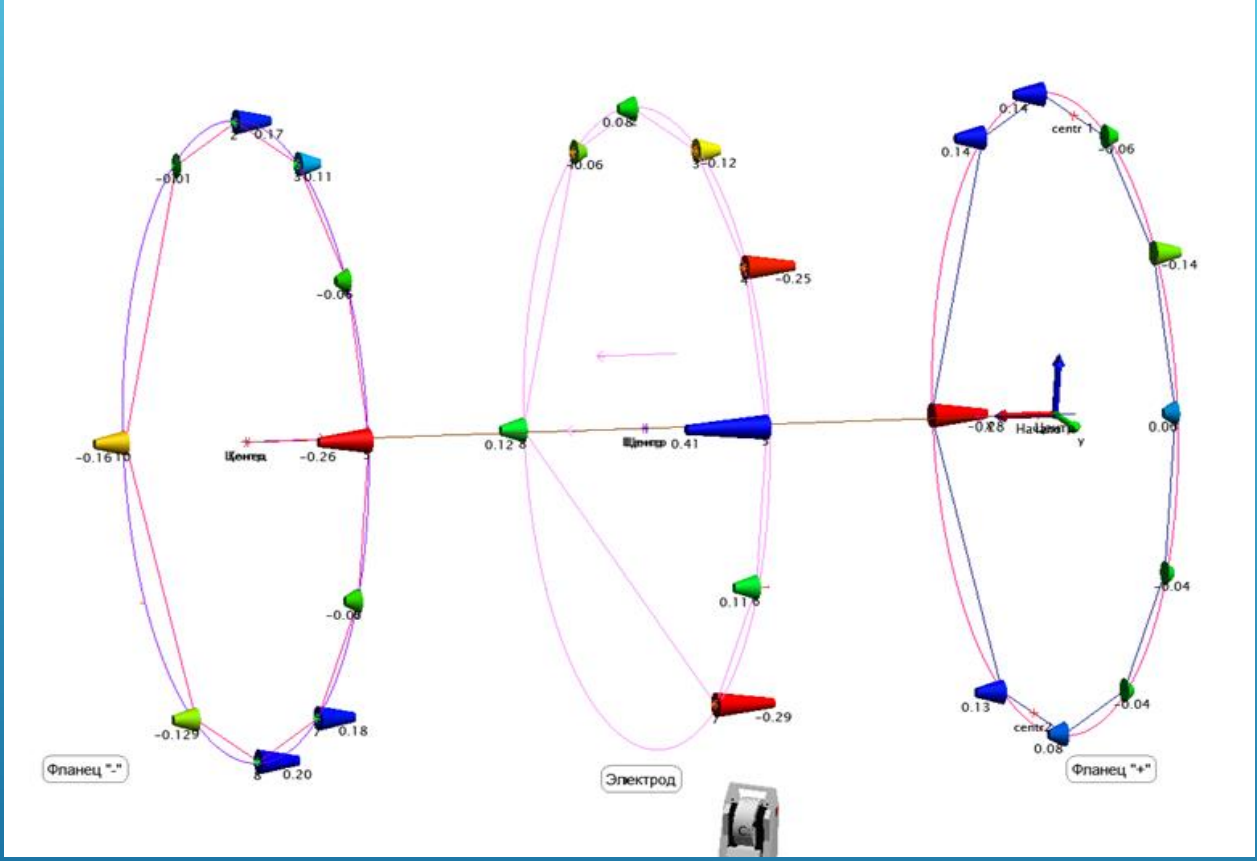


TPC body assembled with test rods for check TPC geometry by laser tracker AT-402 *(reflector type -TBR (R=6.35 mm), reflector center offset L== 12.00 mm)*: **2 flanges, HV electrode and C1-C2 cylinder - miss alignment is about 1 mm**

Goal – improve miss alignment by factor x2

TPC VESSEL ASSEMBLING

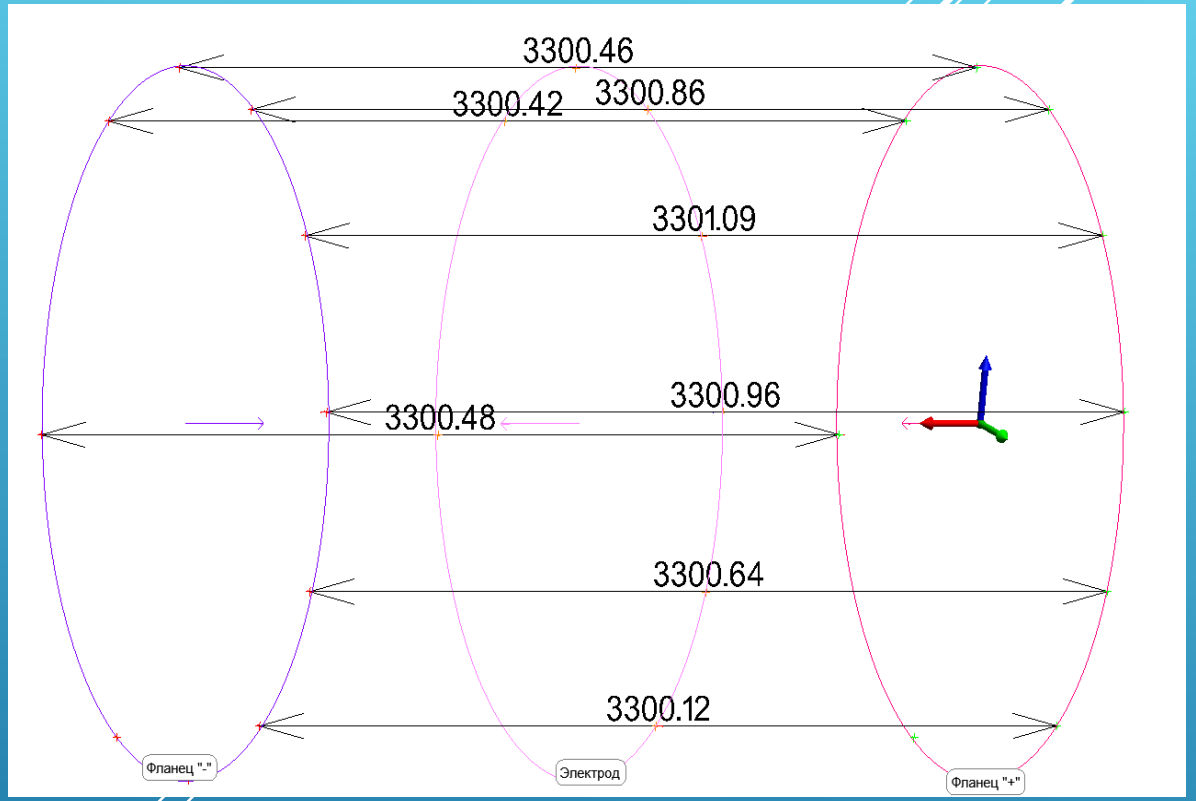
Flanges and HV electrode unflatness



Flanges unflatness – about 0.5 mm

HV electrode unflatness – about 0.7 mm

Flange to flange distance



L=(3300.5 +/-0.5) mm
(nominal – 3300.0 mm)

ROC CHAMBERS AND GATING GRID SYSTEM (GGS): STATUS

Test set up for ROC certification

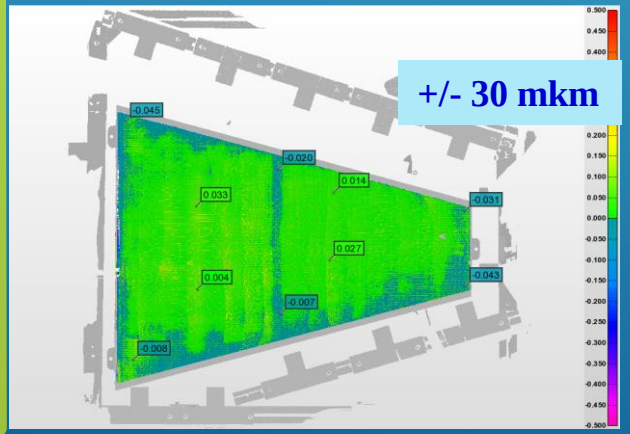
24 pc ROCs – tested

24 pc serial ROCs + 4 spare – READY!

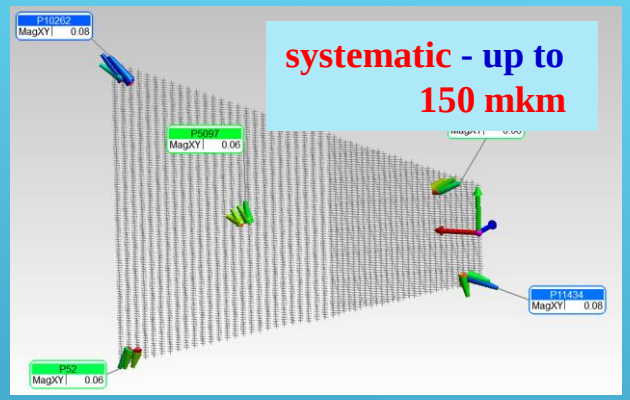
Test set up for pads calibration

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



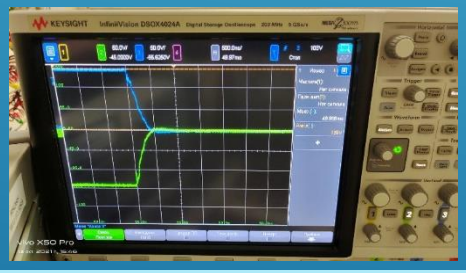
Full set of ROC alignment marks

Summary:

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

ROC gating grid system: test set up

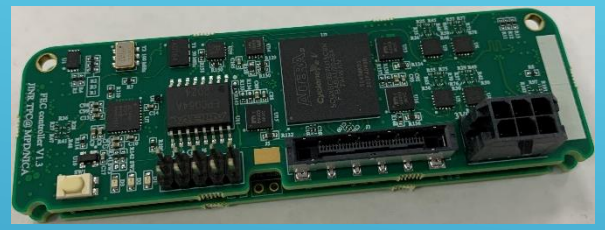
Pulse rise time - 500 ns, OK!



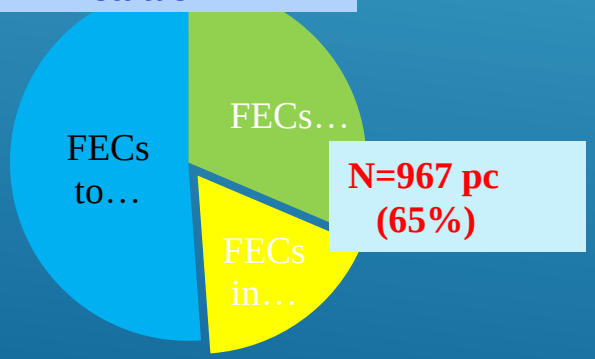
Mass-production – in progress
Delivery to JINR – Sept 2023

TPC SUB-SYSTEMS: ELECTRONICS

Production version of the FE card:



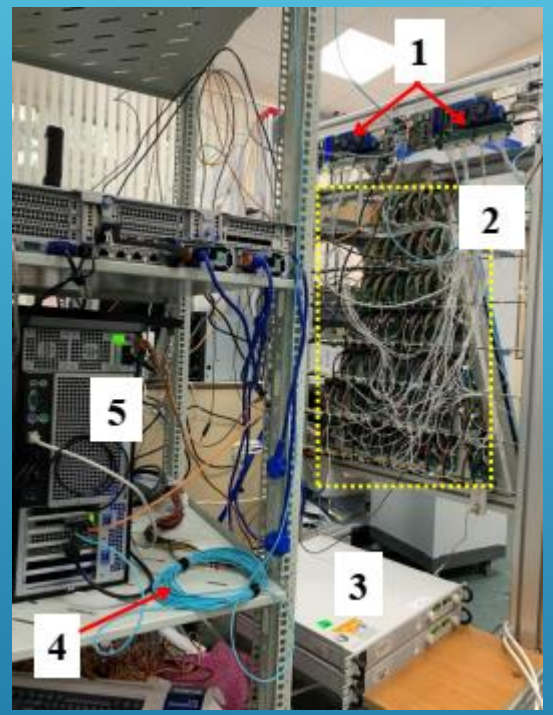
TPC FE cards production status



N=967 pc (65%)

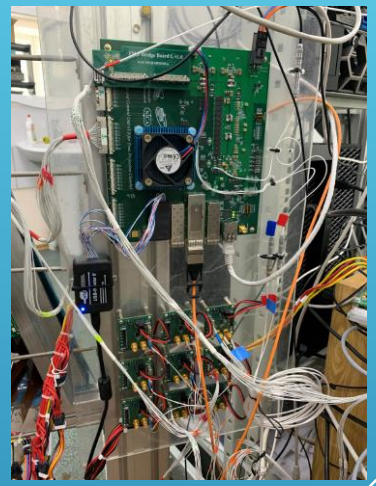
15 ROCs chambers can be completed (from 24 ROCs)

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



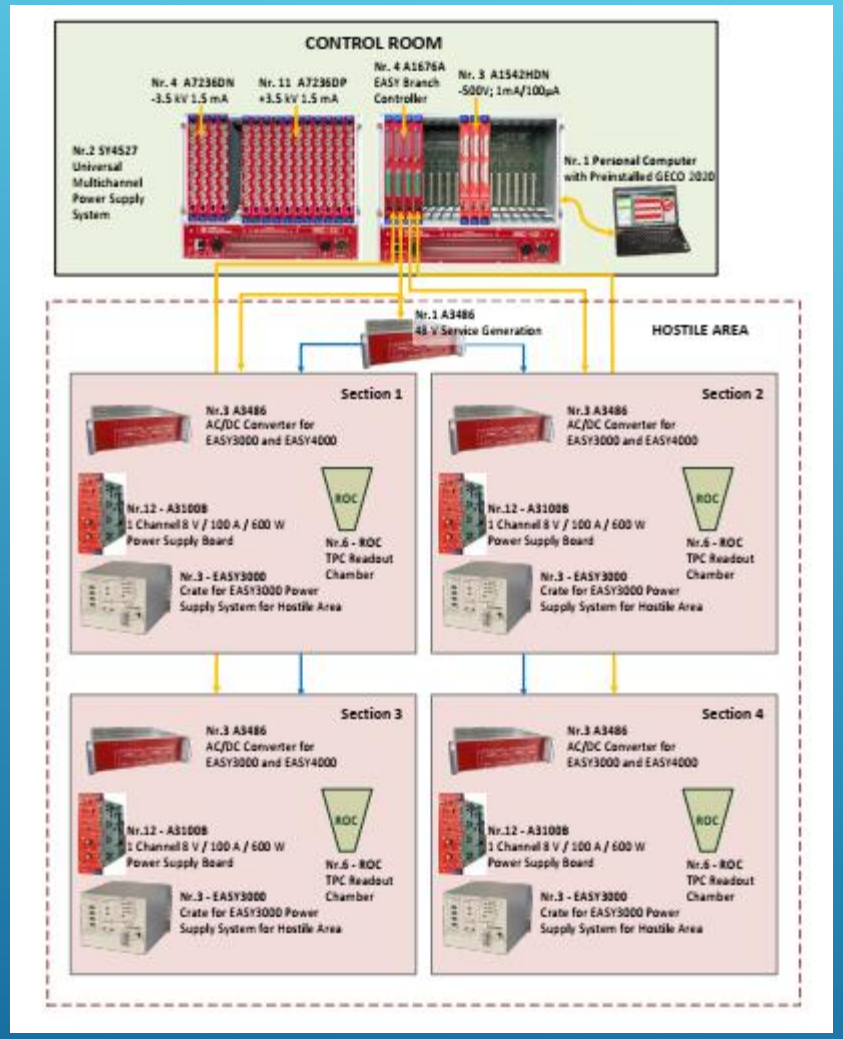
LVN9 stabilizer

FE radiators (water cooling)

60 pc LVN9 were send back to Minsk:
- modification connection of power cables to LVN9 - in progress
- modification of LVN9 output voltages to FECs - in progress
- test of LVN9 with cooling radiator under full load (analog – 70 A, digital – 50 A) – in progress

- **967 FECs of 1500 were produced.**
- **Tests of the FEC basic functionality were shown the target characteristics (noise and stability).**
- **Testing of the readout system for one ROC is ongoing.**

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: JINR-CAEN contract signed

Expected delivery date to JINR: August 2023

test system – tests ongoing

LV cables (halogen free, low smoke):

S=50 mm2 – delivered

HV cables - ordered

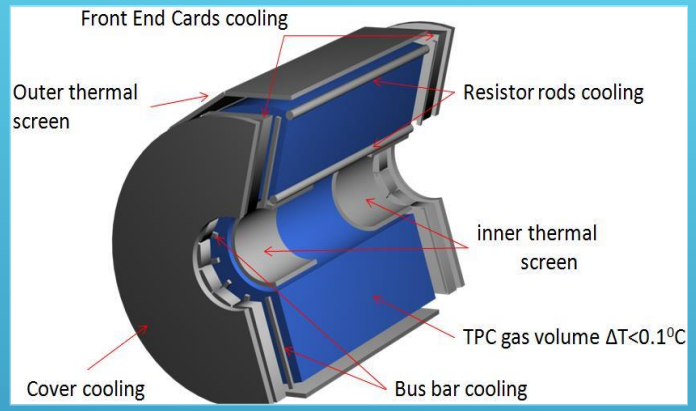
TPC SUB-SYSTEMS: GAS AND COOLING

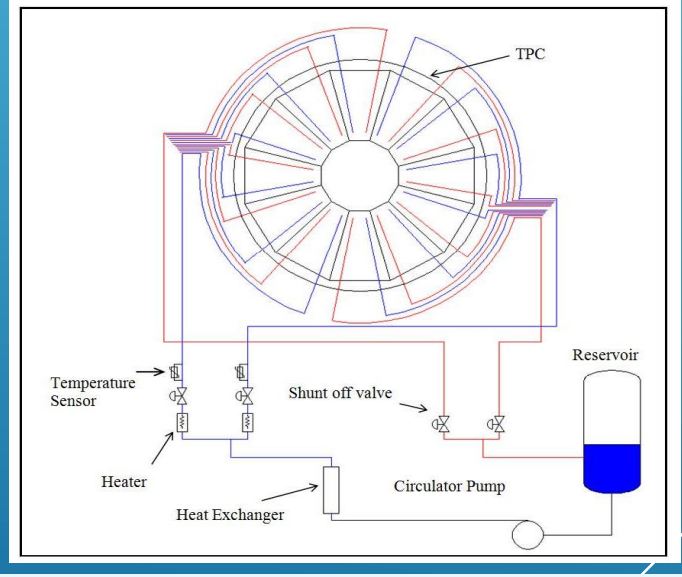
Gas system (Ar/CH4, 90:10)

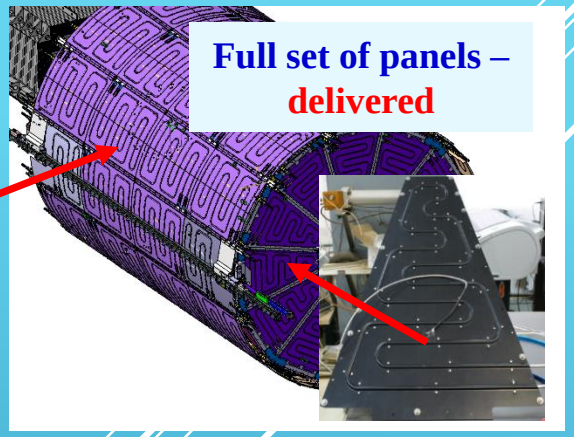
Racks

TPC volume imitator

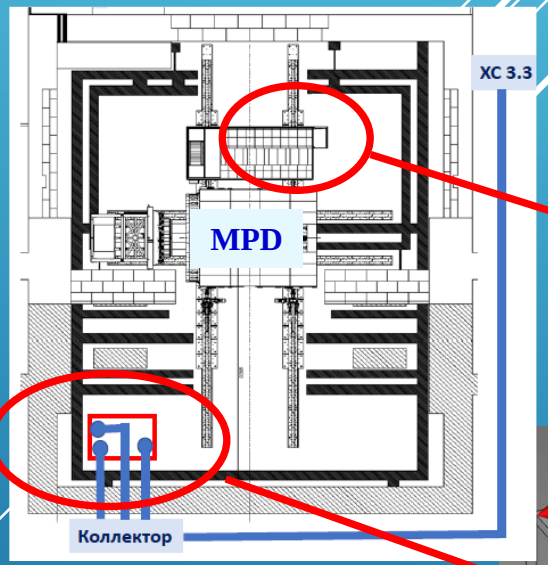
Water cooling system

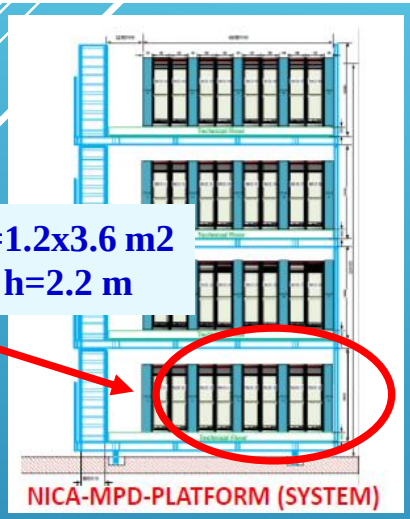


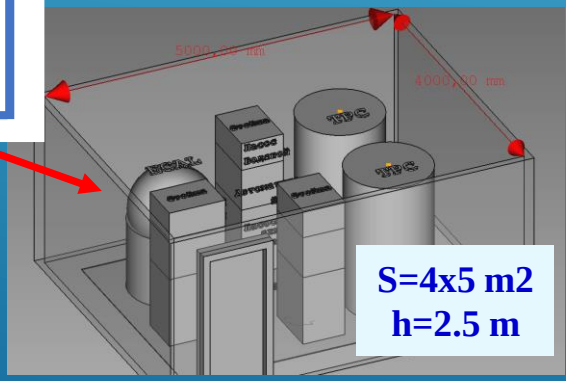




MPD hall







Tests - in progress
(H20 and Q2 sensors are replaced)

contract JINR-INP BSU (Minsk) – in progress
delivery – 30 September 2023
operation under manual control – during beam test 2024
fully automatic control – 30 September 2024

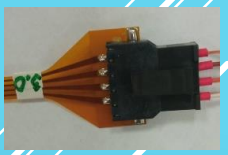
COOLING PROTOTYPE

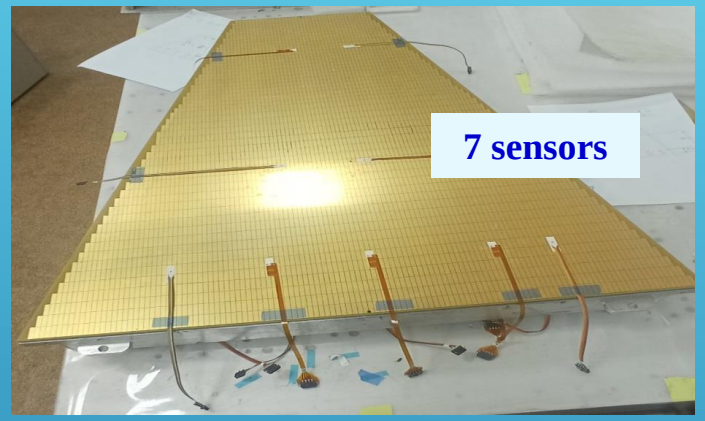
Bottom cooling plates

Set of top cooling plates

Cu tube Din - 3.16 mm
Plates thickness - (4+4) мм

T sensor based on Pt100

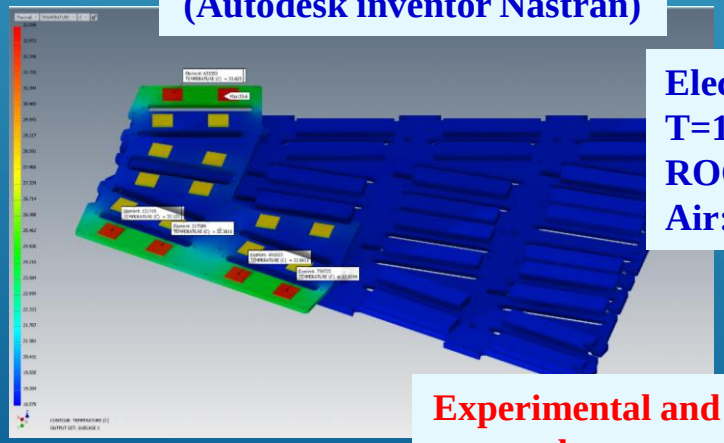




7 sensors

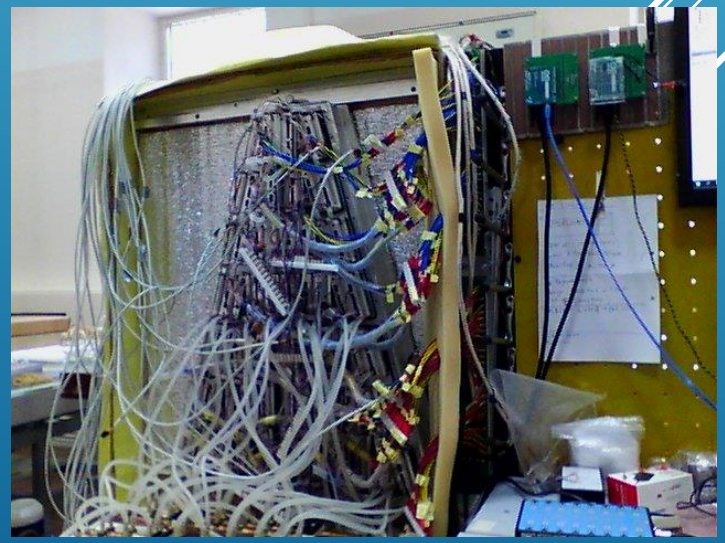
7 sensors

Cooling simulation (Autodesk inventor Nastran)



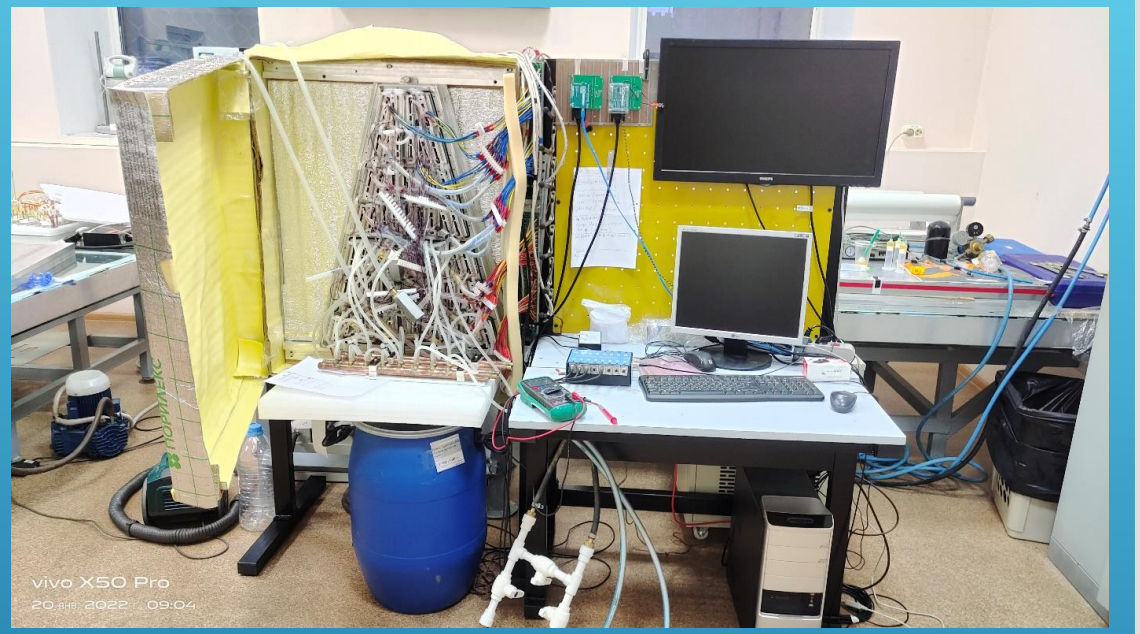
Electronics water:
T=19 C
ROC water: T=22 C
Air: T=23 C

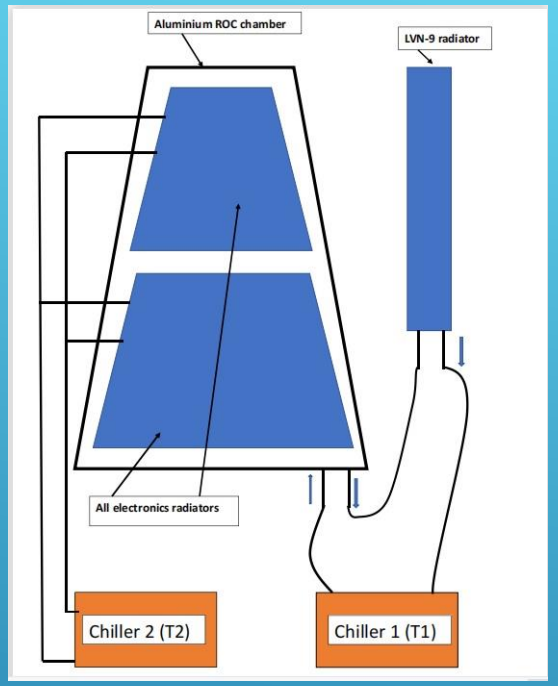
Experimental and simulation results are compatible



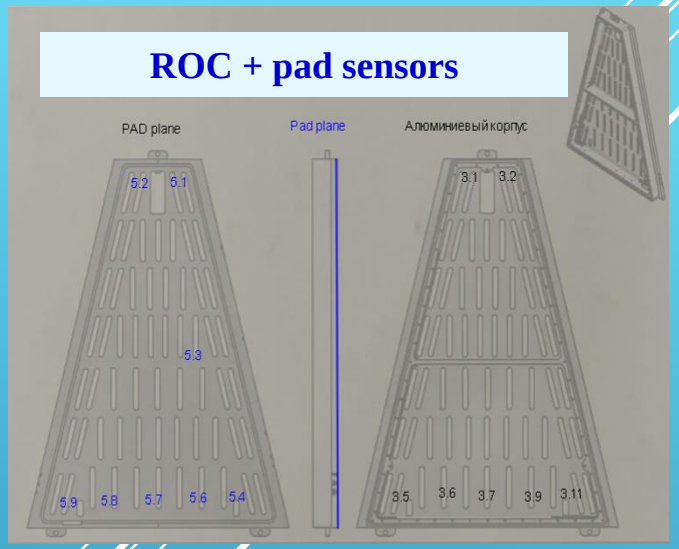
COOLING PROTOTYPE: RESULTS

Set up





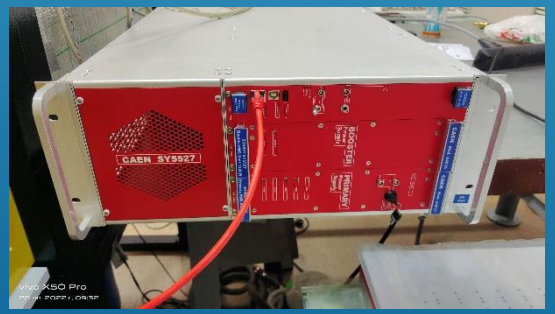
ROC + pad sensors



FE card sensors

Chiller

LV power

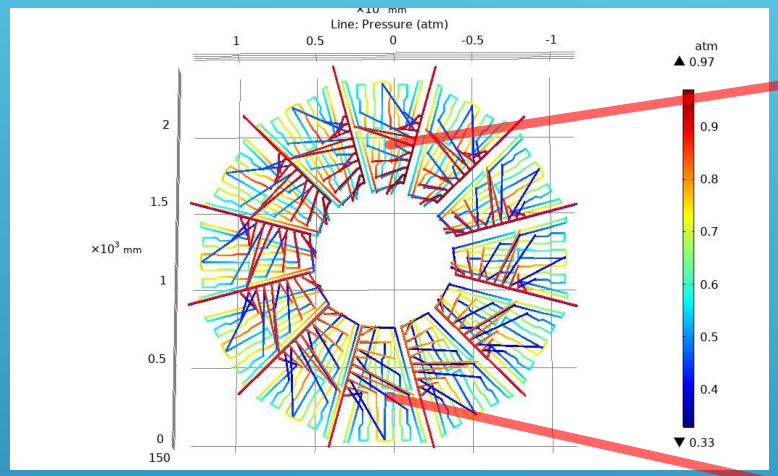


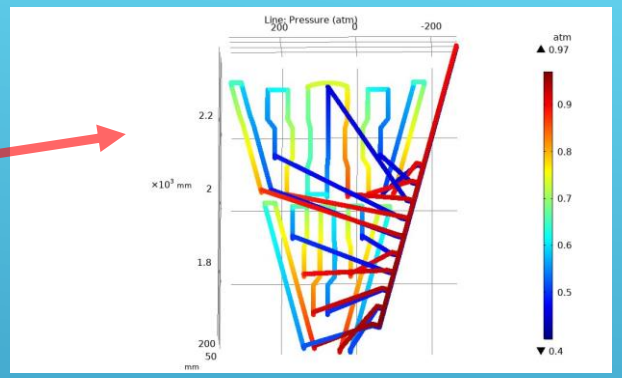
Air: T=23 degree (C)

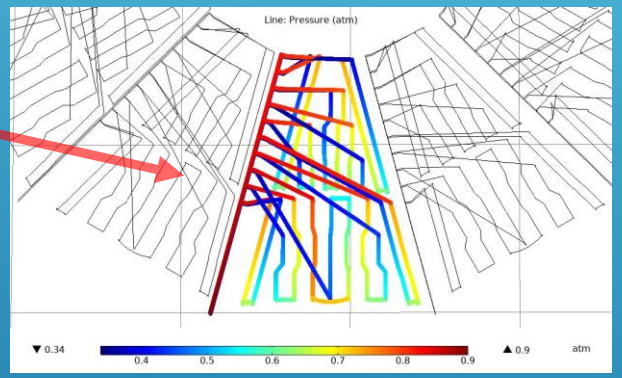
Water FECs T (C)	Water ROC T(C)	SAMPAs dT (C)	FPGAs dT (C)	Pads dT (C)	ROC dT (C)	T Min (C)	T Max (C)	Comments
17	25	3÷5	7	0.27	0.6	18	33	
19	22	3÷5	7	< 0.2	0.2	20	35	optimum

SERIAL COOLING SYSTEM: STATUS

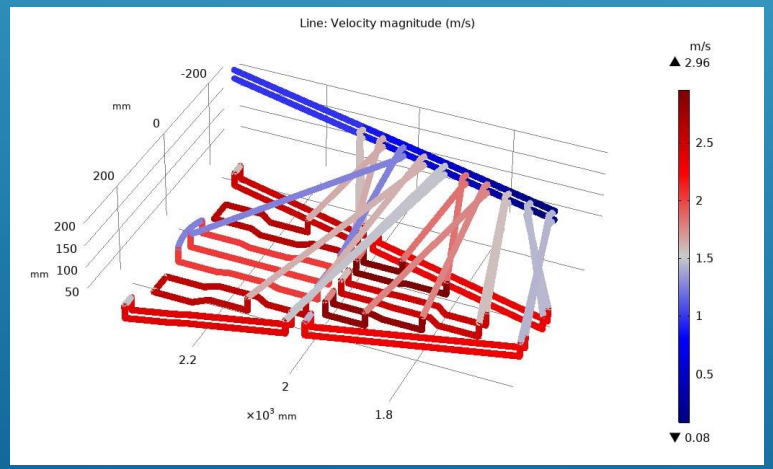
Hydraulic pressure drop for ROC chambers





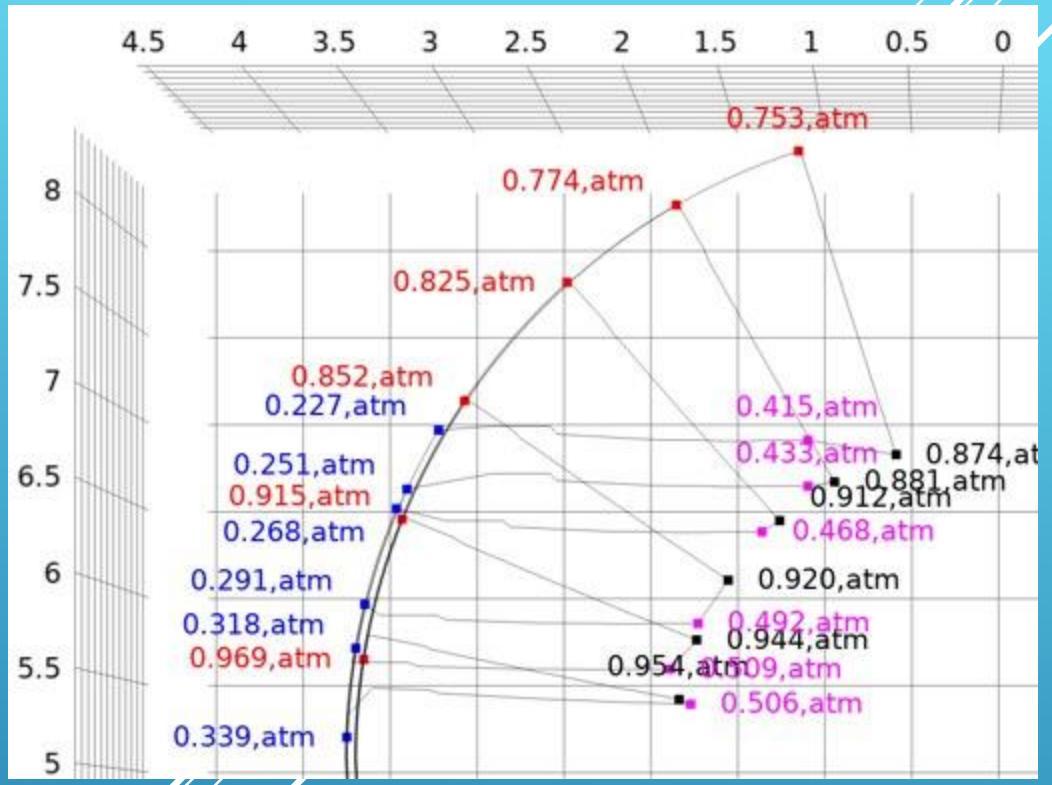


dP ≤ 0.5 atm

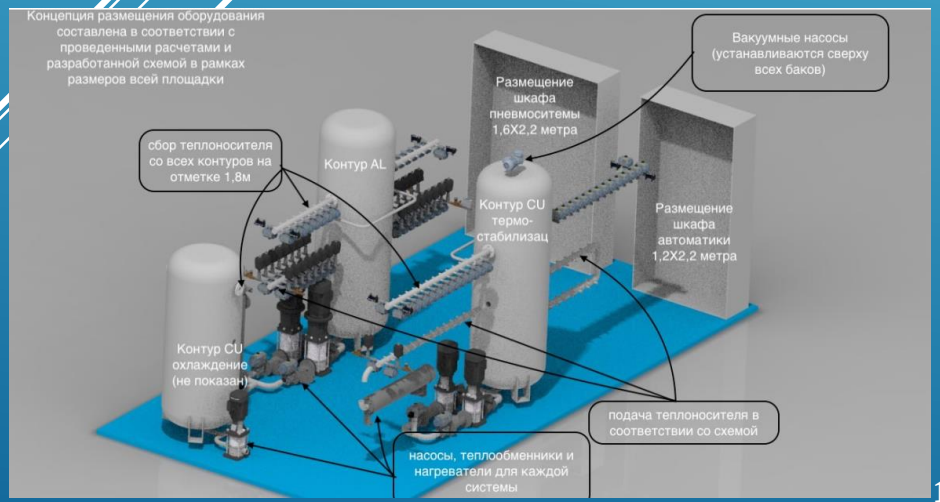


Water velocity: (1.5-2.5) m/s

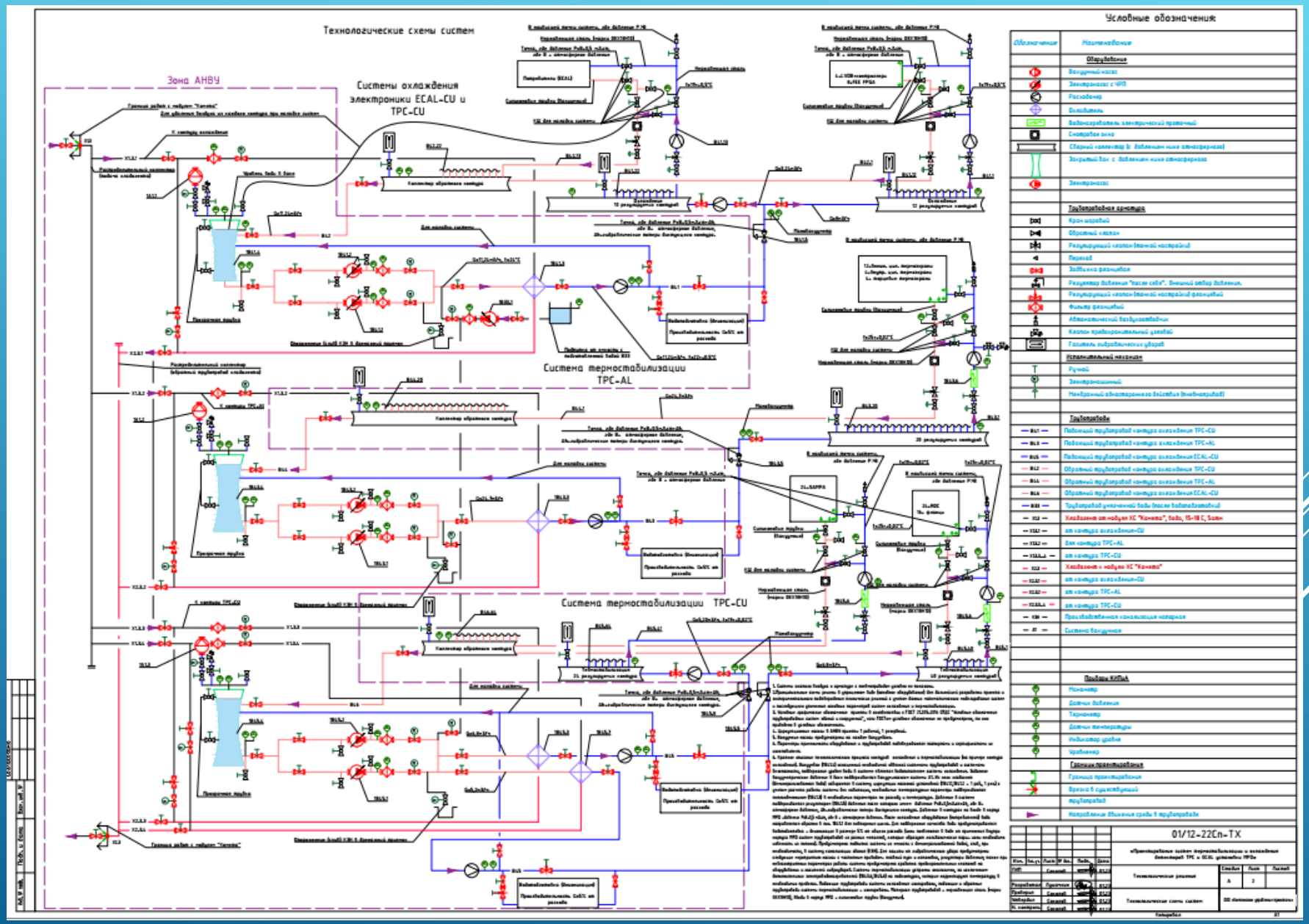
TPC system pressure with water column height

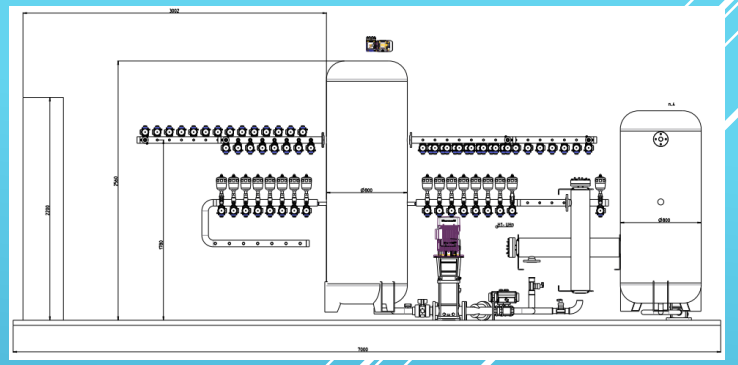


Systems parameters optimization by calculations – in progress



SERIAL COOLING SYSTEM: STATUS





Формат	Зона	Поз.	Обозначение	Наименование	Кол.	Примеч.
				Документация		
A3			PLATFORM_COOL СБ	Сборочный чертеж		
				Сборочные единицы		
A4		1	_COLLECTOR_AL_SB	Коллектор AL	2	
A4		2	_COLLECTOR_AL_SB_P	Коллектор_AL	2	
A4		3	_COLLECTOR_CU-H_1	Коллектор напорный	1	
A4		4	_COLLECTOR_CU_SB	Коллектор CU_LP	2	
A4		5	_COLLECTOR_CU_SB-P	Коллектор напорный	1	
A4		6	_TANK_800	Бак	1	
A4		7	_TANK_1200	Бак	2	
				Детали		
A4		8	_2_D_ANGLE	Тройник	3	
A4		9	_2_D_DN32	Тройник	2	
A4		10	_3_D	Тройник	3	
A4		11	_3_D_T	Тройник	1	
A4		12	_ELECTICAL_CAB	Тройник	1	
A4		13	_PNEUMOAUTOMATIC	Тройник	1	

PLATFORM_COOL

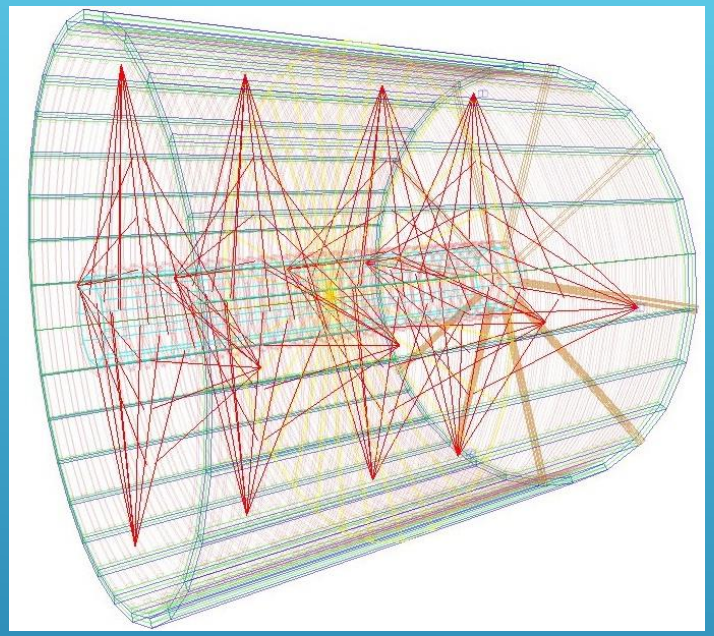
Сборка водяной системы

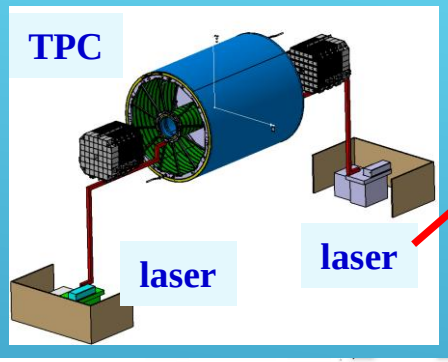
ООО "ТурбоЭнергия"

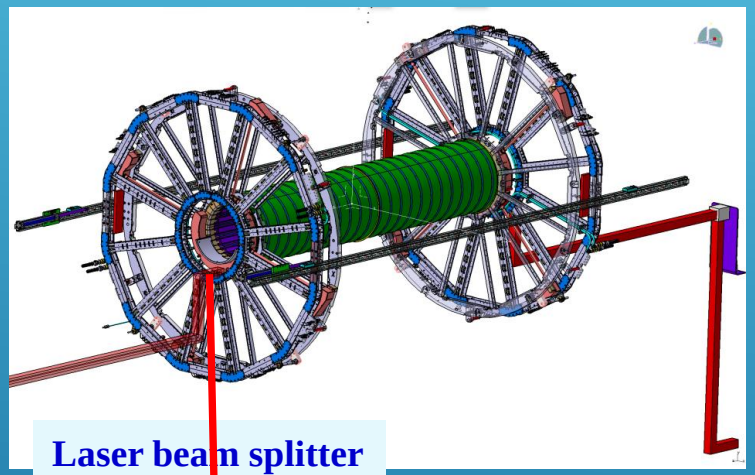
in progress …

TPC SUB-SYSTEMS: LASER CALIBRATION

Scheme for ½ TPC

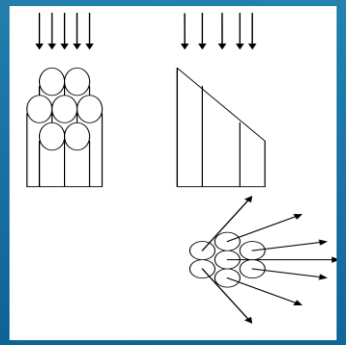


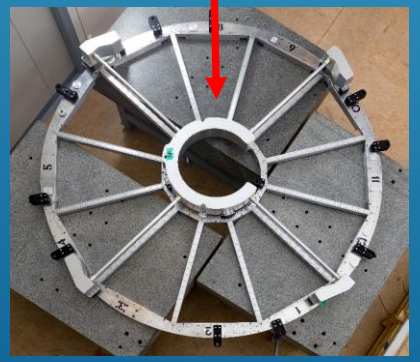




Laser "planes" - 4
Micro-mirrors bundles per plane - 4
Beams from micro-mirrors bundle - 7
Laser "tracks" (N =112x2) - 224

micro-mirror bundles





Laser beam monitor

TPC laser calibration for electron drift velocity (root version)

MPD

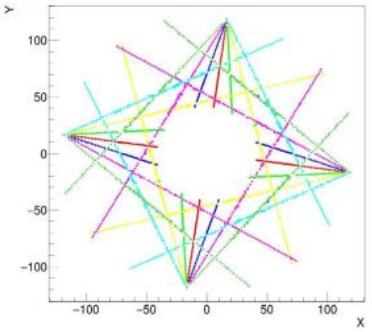
Bychkov A.

Space-charge distortion in TPC volume change the electron drift velocity (≤ 1sec.)– corrections are needed.

Reconstructed hits of the laser grids

Reasons:

- Variation in drift velocity caused by gas mixture, temperature, pressure and electric field variation.
- Radial inhomogenities of magnetic and electric field.
- Space charge distortions due to high multiplicity in nucleus-nucleus collisions.
- TPC misalignment in the magnet and existence of the global E X B effect.



TPC electron drift velocity calibration

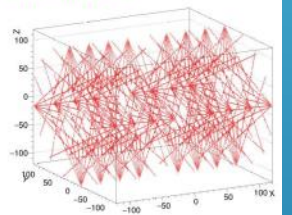
(standalone fast version)

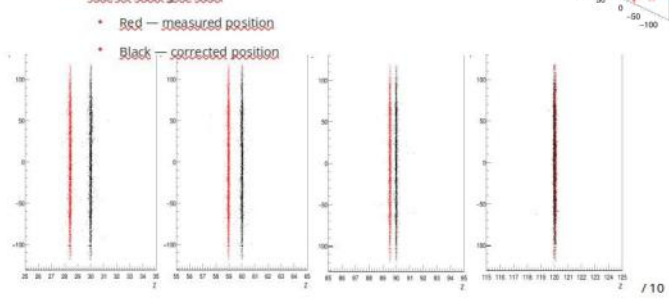
MPD

Bychkov A.

Test for drift velocity correction

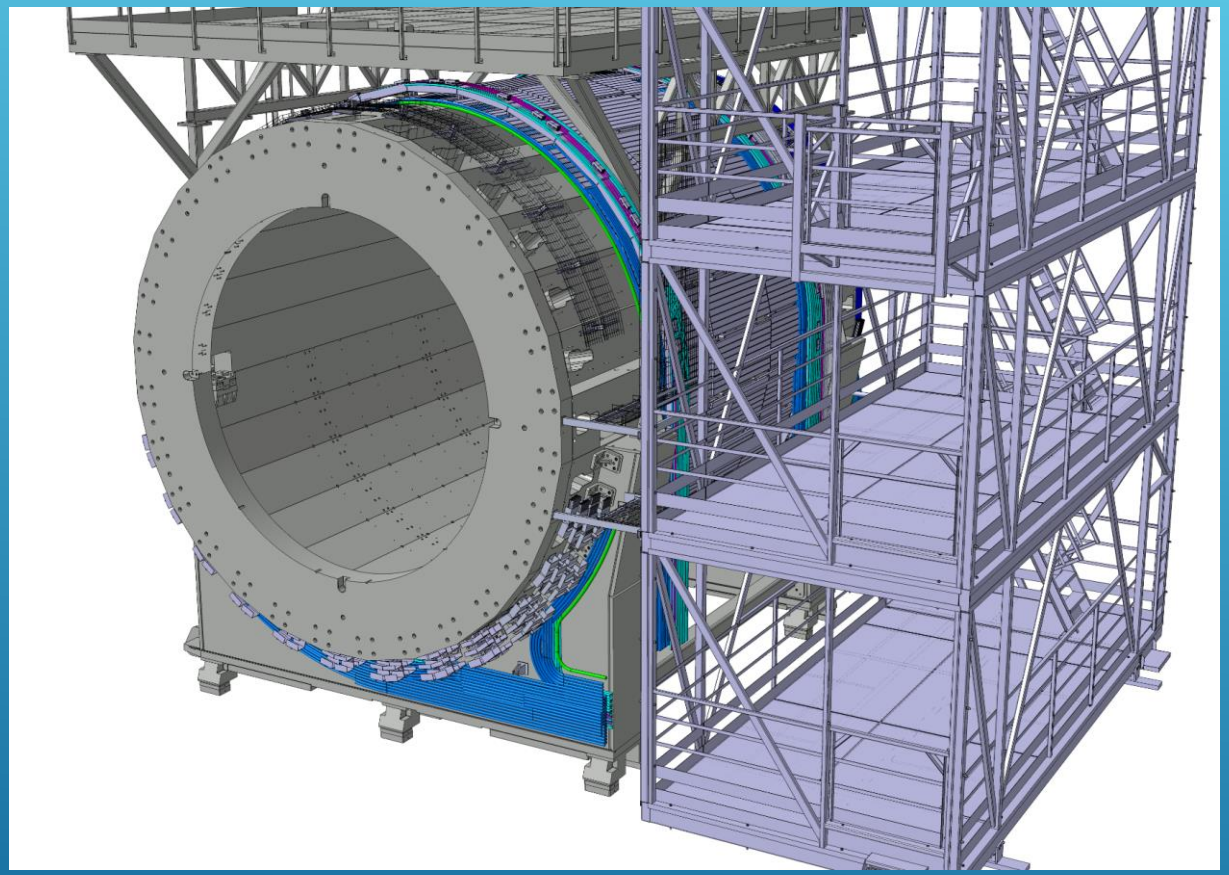
- Source data
  - True drift velocity = 5.5 cm/μs
  - Simulated drift velocity = 5.4 cm/μs
  - Test on laser grid itself
    - Red — measured position
    - Black — corrected position



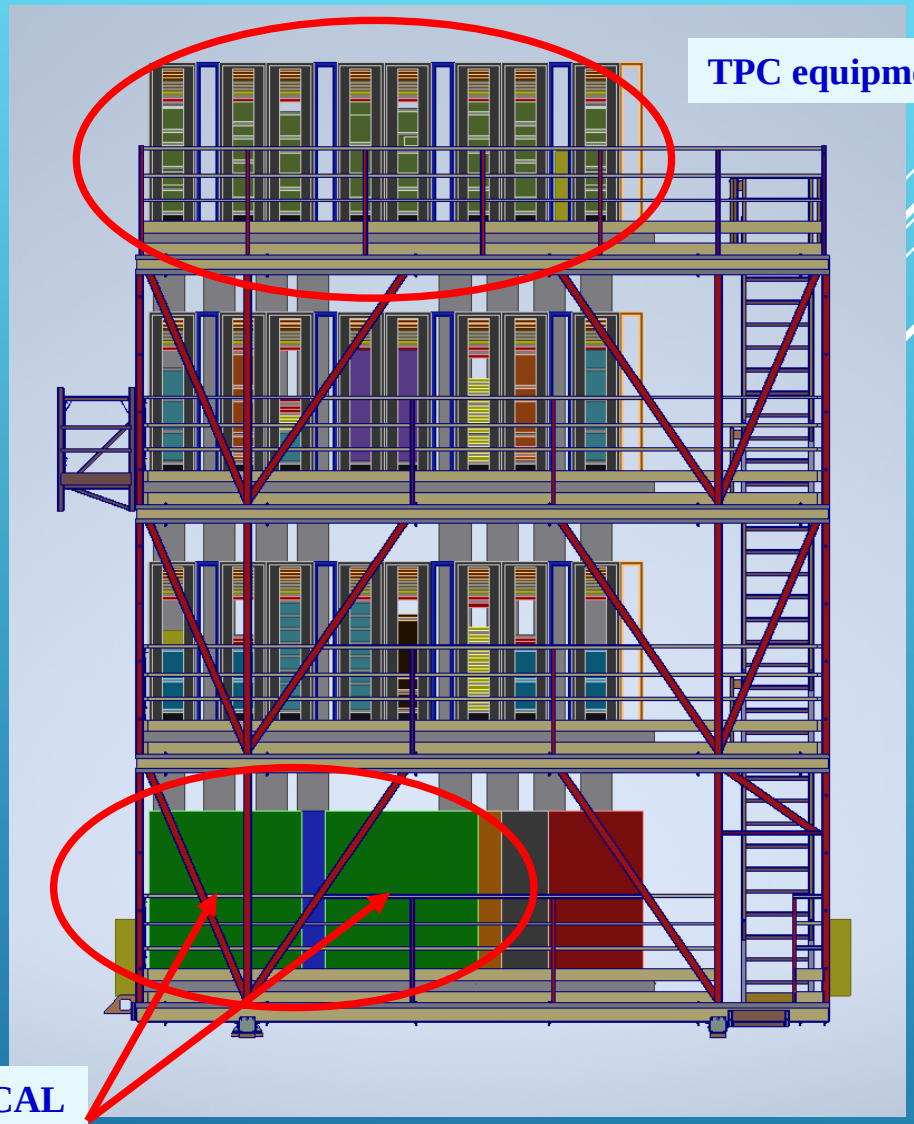


NICA-MPD-PLATFORM (NMP)

Common view



TPC equipment

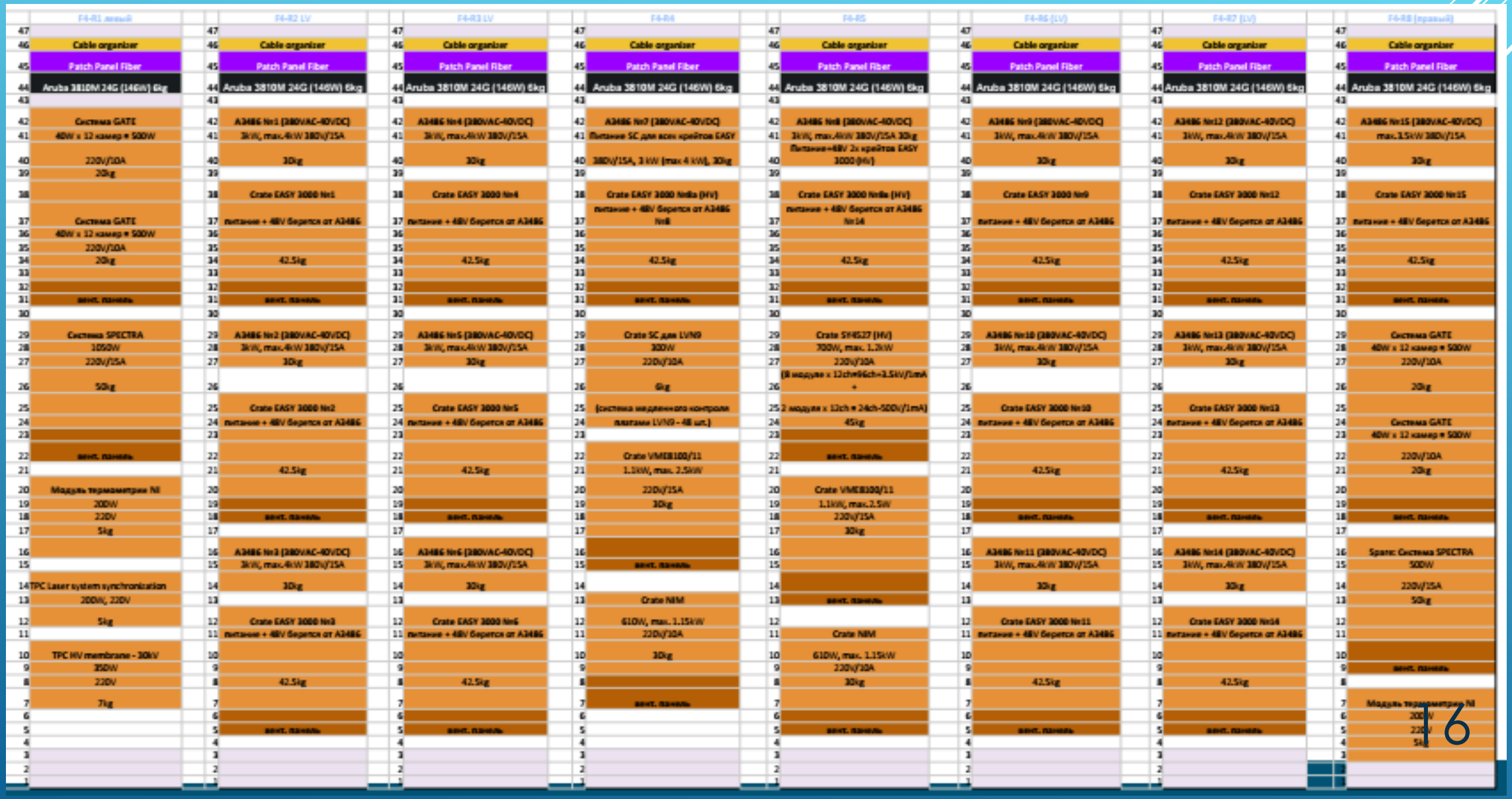


TPC + ECAL cooling

Design and integration – in progress …

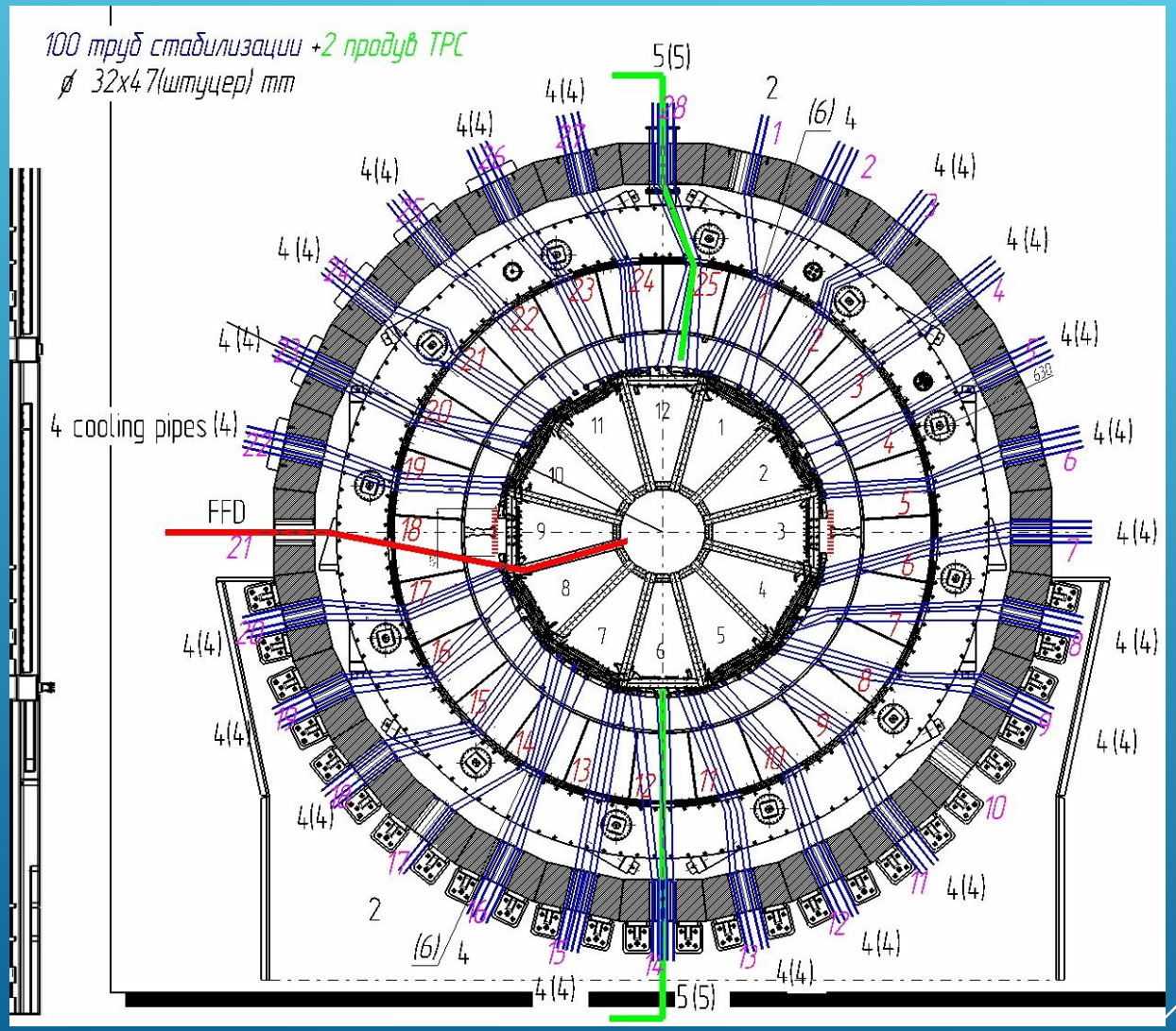
MPD ELECTRONIC PLATFORM

TPC equipment in racks on the 4th floor



TPC CABLING AND PIPING

W side: cooling and gas pipes scheme



TPC list of cables and pipes

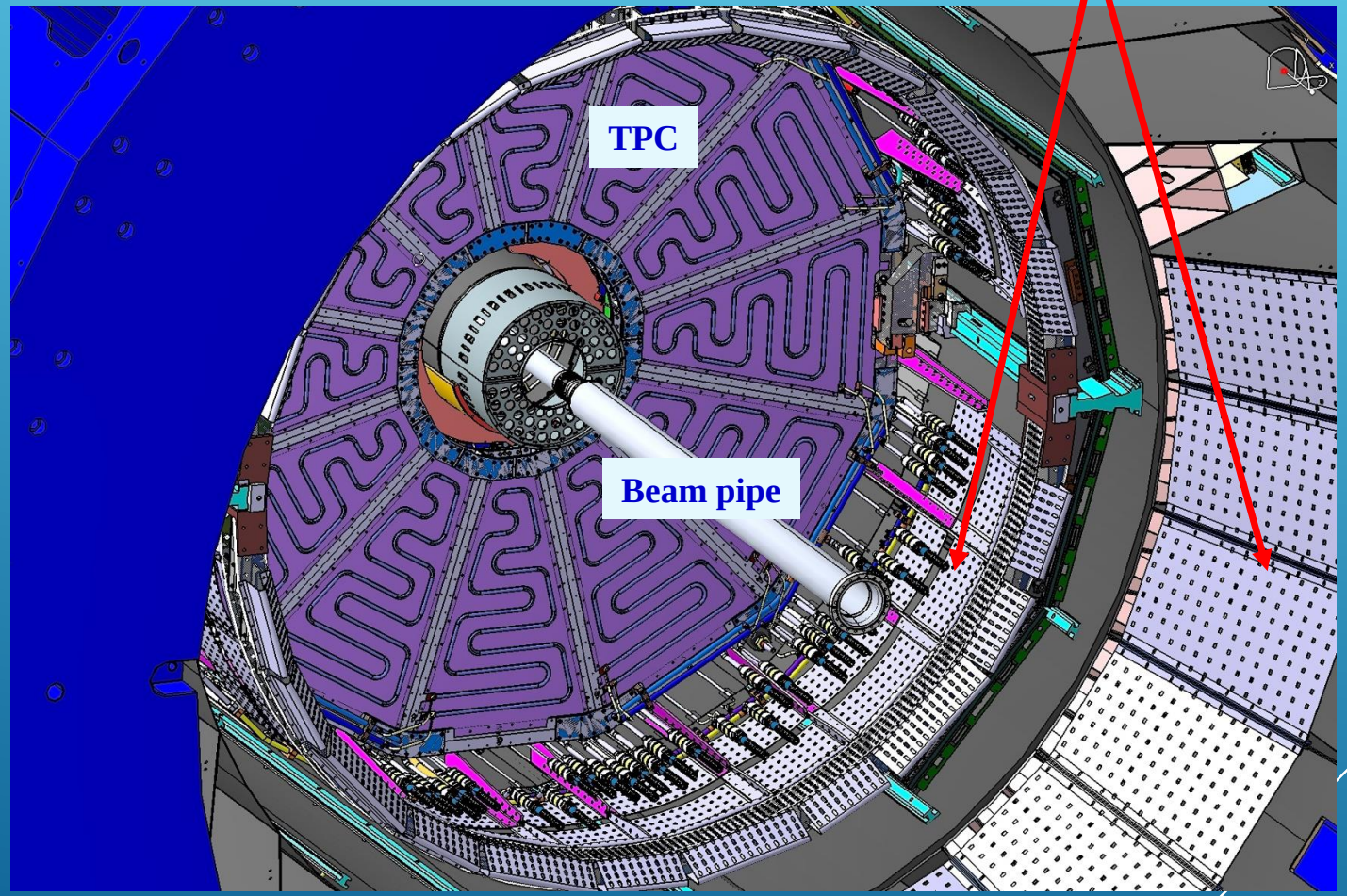
List of cables and pipes

	Purpose	Diameter, mm	14 Qty	12 Qty	10 Qty	8 Qty	6 Qty	4 Qty	2 Qty	1 Qty	3 Qty	5 Qty	7 Qty	9 Qty	11 Qty	13 Qty
EDTC	Data cable	3	0	6	12	18	24	30	36	42	48	54	60	66	72	78
ESNC	Sense cable	9,4	0	3	6	9	12	15	18	21	24	27	30	33	36	39
EPWC	Power cable	14,7	0	3	6	9	12	15	18	21	24	27	30	33	36	39
ESRL	Service cable(1)	1x13	0	3	6	9	12	15	18	21	24	27	30	33	36	39
EWCT	Watercooling tubes	~20	0	2	4	6	8	10	12	14	16	18	20	22	24	26
EACT	Air cooling tubes for FE and BOX	~20	0	2	4	6	8	10	12	14	16	18	20	22	24	26
TSGC	Signal	13	10	20	30	40	50	60	70	80	90	100	110	120	130	150
THVC	HV	8,5	0	4	4	8	8	12	12	16	16	20	20	24	24	28
TLVC	LV Cable	13	1	1	2	2	3	3	4	4	5	5	6	6	7	8
TUTC	UTP	6	1	1	2	2	3	3	4	4	5	5	6	6	7	8
TTRL	Trigger (OR)	10	2	2	4	4	6	6	8	8	10	10	12	12	14	16
TGST	Gas Pipes	12	2	2	4	4	6	6	8	8	10	10	12	12	14	16
	TPC gas system															
TGTT	Purge TPC (in/out)	40	0	0	0	0	0	0	0	1	1	1	1	1	1	1
	LV															
TLPC	LVDB: low-voltage cable supply	12	0	8	8	16	16	24	32	32	32	32	40	40	48	48
TLSC	LVDB: sense wire	2,5	0	4	4	8	8	12	16	16	16	16	20	20	24	24
TCPC	Controller: low-voltage cable supply	12	0	2	2	4	4	6	8	8	8	8	10	10	12	12
TCSC	Controller: sense wire	2,5	0	1	1	2	2	3	4	4	4	4	5	5	6	6
TLCC	LVDB: slow control cable	9	0	2	2	4	4	6	8	8	8	8	10	10	12	12
	DAQ															
TDCC	Controller: slow control	7	0	2	2	4	4	6	8	8	8	8	10	10	12	12
TDDD	Controller: DATA QSFP	opt. 3.3	0	1	1	2	2	3	4	4	4	4	5	5	6	6
TDTD	Controller: data and trigger/ sync SFP+	opt. 3,9x1,8	0	1	1	2	2	3	4	4	4	4	5	5	6	6
TDTC	Controller: trigger	6	0	1	1	2	2	3	4	4	4	4	5	5	6	6
TDRC	Controller: Reset	6	0	1	1	2	2	3	4	4	4	4	5	5	6	6
TDSC	Controller: Sync	6	0	1	1	2	2	3	4	4	4	4	5	5	6	6
TDQO	Reserve cables QSFP	opt. 3.3	0	1	1	1	1	1	2	2	2	2	2	2	2	2
TDSO	Reserve cables SFP+	opt. 3,9x1,8	0	1	1	1	1	1	2	2	2	2	2	2	2	2
	ROC chamber															
TRAC	for ROC: HV power supply for anode sections	4,1	0	0	4	4	8	8	8	8	12	16	16	20	20	24
TREC	for ROC: HV electrode adjusting supply	4,1	0	0	1	1	2	2	2	2	3	4	4	5	5	6
TRNC	for ROC: HV locking grid	4,1	0	0	2	2	4	4	4	4	6	8	8	10	10	12
TRCC	for ROC: cameras electrode (cathode), test signal	4,1	0	0	1	1	2	2	2	2	3	4	4	5	5	6
TRSC	from ROC: signal cable (anode)	4,1	0	0	4	4	8	8	8	8	12	16	16	20	20	24
	Sensors															
TSSC	Temperature sensor cable Pt100	8	0	0	3	3	6	6	6	6	9	12	12	15	15	18
TSPC	Cables from pressure sensors on pipes cooling + stabilization	7,8	0	0	4	4	8	8	8	8	12	16	16	20	20	24
TSTC	Cables from temperature sensors on pipes cooling + stabilization	7,8	0	0	4	4	8	8	8	8	12	16	16	20	20	24
	HV TPC central membrane															
THEC	Central HV electrode TPC	8	0	0	0	0	0	0	0	0	1	1	1	1	1	1
THRC	low-voltage cable input for resistors (centr). HV electrode	10	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	Thermostabilization															
TTOT	external thermal screen stabilization pipes	32	0	0	2	2	2	4	4	6	6	7	8	8	10	10
TTTT	end Thermal Shield Stabilization Pipes	32	0	0	0	0	1	2	2	2	2	2	2	3	4	4
TTIT	inner thermal shield stabilization pipes	32	0	0	2	2	2	2	2	2	2	2	2	2	2	2
TTRT	Pipes stabilization ROC chambers housings	32	0	0	0	0	0	0	0	0	0	2	2	2	2	2
TTFT	TPC flange stabilization pipes with spokes	32	0	0	0	0	0	0	1	3	4	4	4	4	4	4
TTST	Stabilization pipes FE SAMPA	32	0	4	4	6	8	9	12	12	15	16	17	20	20	24
	Cooling (12 loops)															
TCLT	Cooling pipes LVDB, controllers & FE FPGA	32	0	0	0	1	2	2	2	2	2	2	3	3	4	4
	TPC laser system															
TLWC	Cable for WIB camera control system floor laser beam	7	0	0	1	1	1	1	1	1	1	2	2	2	2	2
	TPC gas system															
TGST	Purge of C1C2 and C3C4 (input/output)	12	0	0	0	0	0	0	0	0	0	0	1	1	1	1
	Hydraulic actuators															
TSGC	Position centers hydraulic cylinder	6	0	4	4	4	4	4	4	4	4	4	4	4	4	8

TPC CABLING AND PIPING

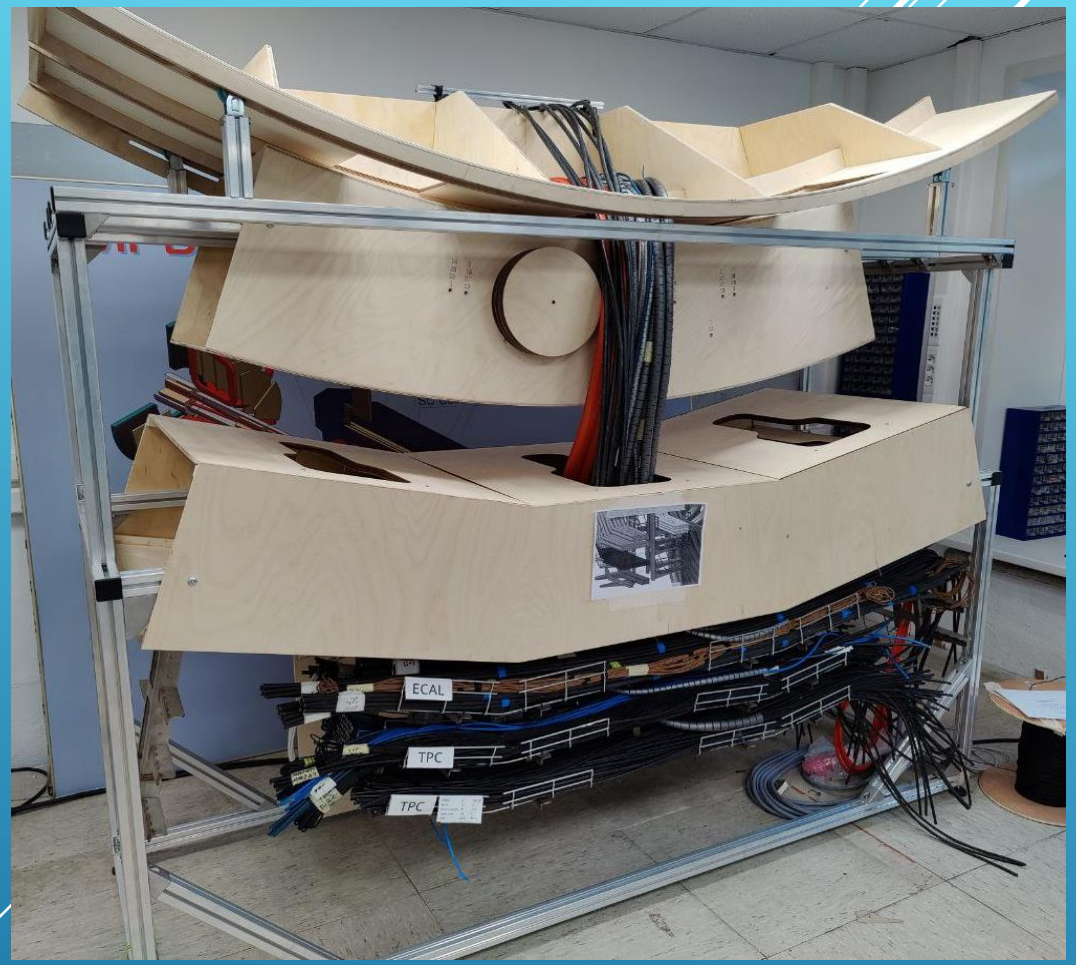
Integration …

Structures for cables and pipes fixation



Structure design - in progress

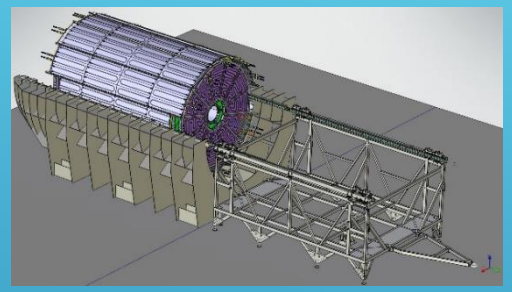
Prototype for cabling and piping



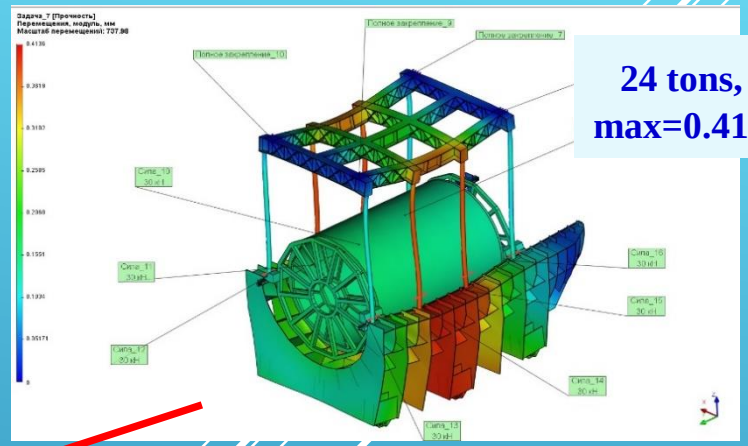
TPC+TOF+ECAL cabling – in progress
Piping – not started yet

TOOLING FOR INSTALLATION TPC TO MPD

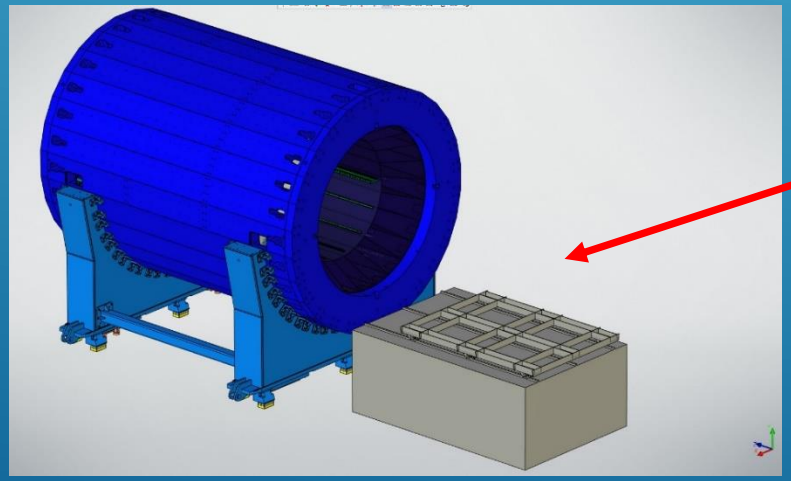
Bld. 217

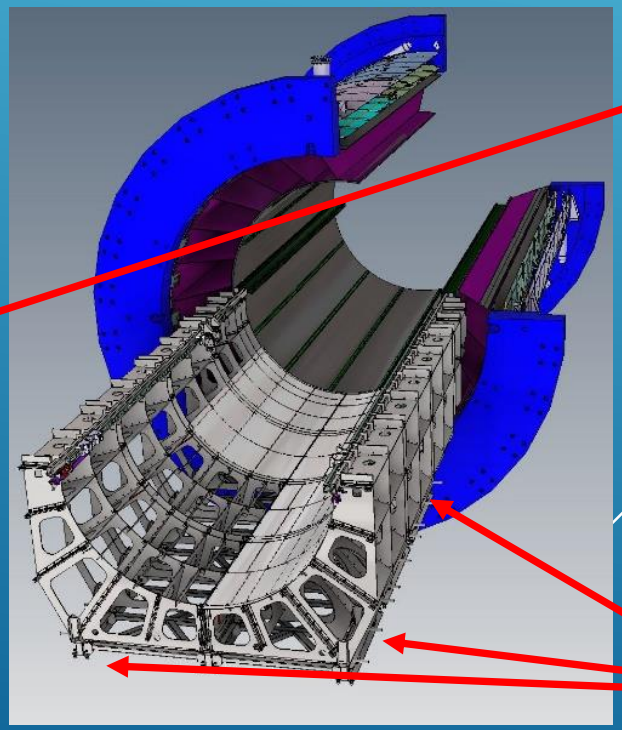


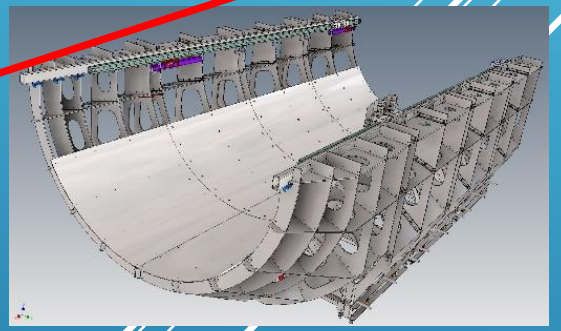
Bld. 217 (MPD)



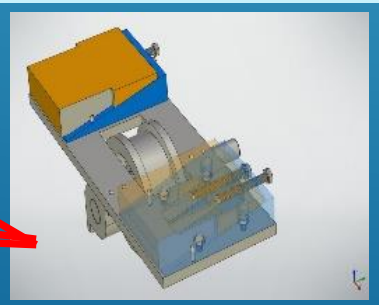
24 tons, max=0.41 mm







4 units for adjustment X, Y, Z



Design under optimization, Prototype 1:5 – June 2023

Tooling manufacture – July 2023-Feb 2024

Delivery to JINR – Spring 2024

TIME SCHEDULE

Status:

TPC assembling:

Field cage assembly	- July 2023
HV tests	- August 10 2023
TPC vessel ready (glue by epoxy)	- August 30 2023
Laser beams position measurements	- Sept 2023
TPC vessel tightness measurements	- Oct 2023
24 ROC chambers installation	- Nov-Dec 2023
TPC tests: laser tracks and cosmic test	- Jan-Sept 2024

Integration TPC to MPD:

TPC racks (8pc) + cabling	- autumn 2023-2024
TPC rails (2pc manufacture and delivery)	- Oct 30 2023
Rails installation to ECAL support structure	- Nov 2023

on critical path !!!

Tooling for installation TPC to MPD:

Design optimization + prototype 1:5	- June 2023
Tooling manufacture	- July 2023 – Feb 2024 (8 month)
Delivery to JINR	- Spring 2024

TPC+ECAL cooling systems: FE cooling	- Nov 2023
commissioning	- Sept 30 2024

TPC installation to MPD	- Oct 1-Nov 30 2024
MPD commissioning	- Jan 10 - Feb 2025

Thank you !