MPD TPC STATUS (18.04.2023)

TPC:

- vessel assembly, ROC chambers, gating grid system

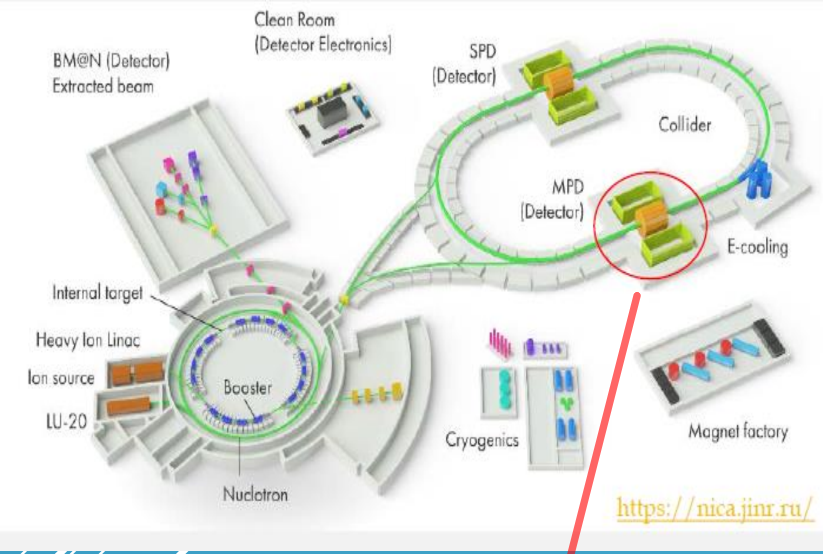
Sub-systems:

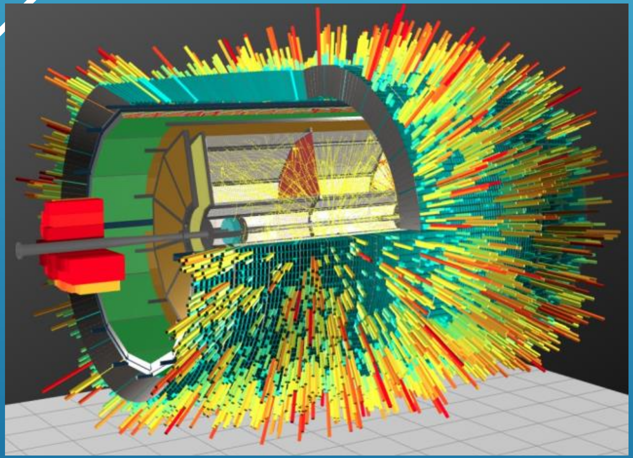
- Electronics
- LV+HV system (CAEN)
- Gas and cooling systems
- Laser calibration

Integration TPC to MPD

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

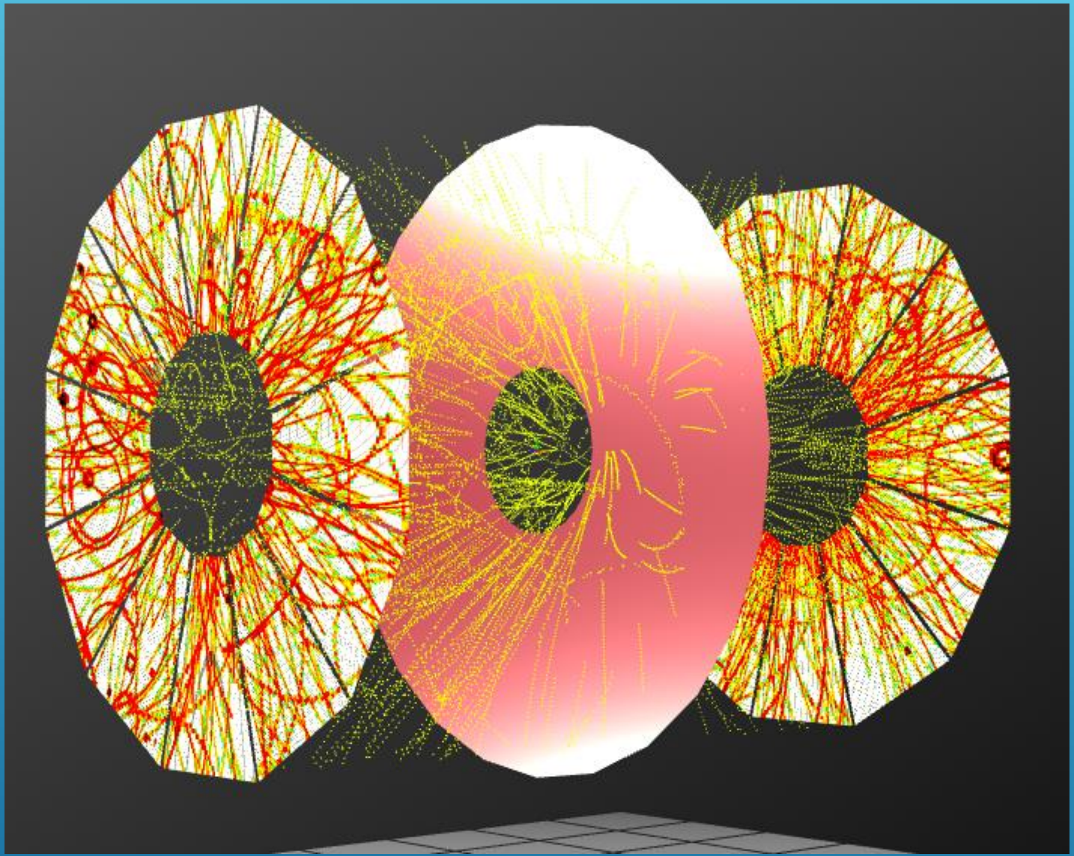
Time schedule





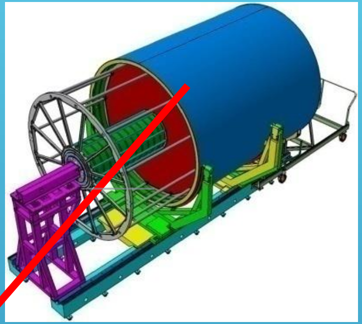
Presented by S.Movchan

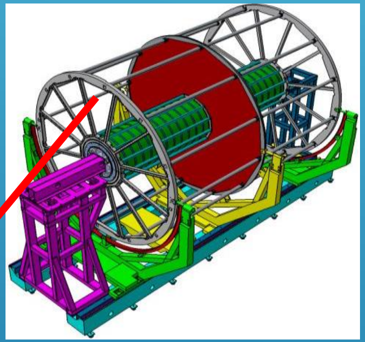
MPD TPC MAIN PARAMETERS



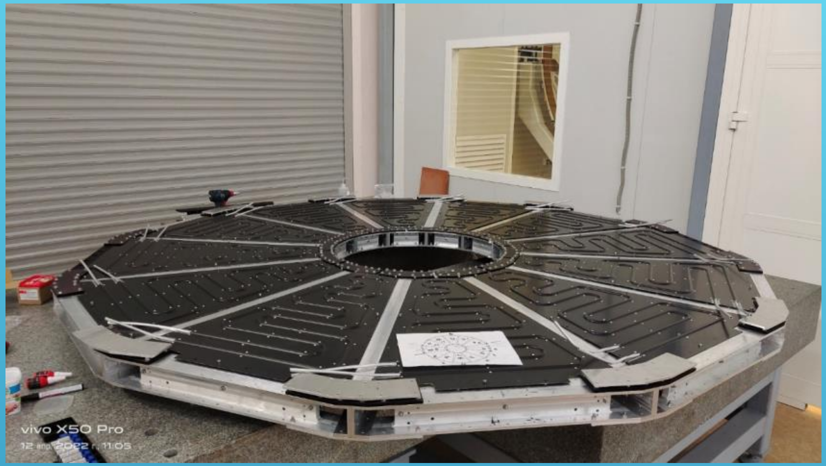
Item	Dimension
Length of the TPC	340cm
Outer radius of vessel	140cm
Inner radius of vessel	27 cm
Outer radius of the drift volume	133cm
Inner radius of the drift volume	34cm
Length of the drift volume	170cm (of each half)
HV electrode	Membrane at the center of the TPC
Electric field strength	~140V/cm;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



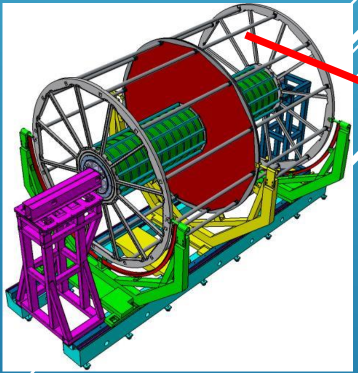


C1-C2 and C3-C4 cylinder – assembled
TPC service wheels (2pc) - assembled
HV membrane – tested
TPC field cage assembly - July 2023
TPC vessel ready – August 2023



Service wheel with thermal panels (12pc)

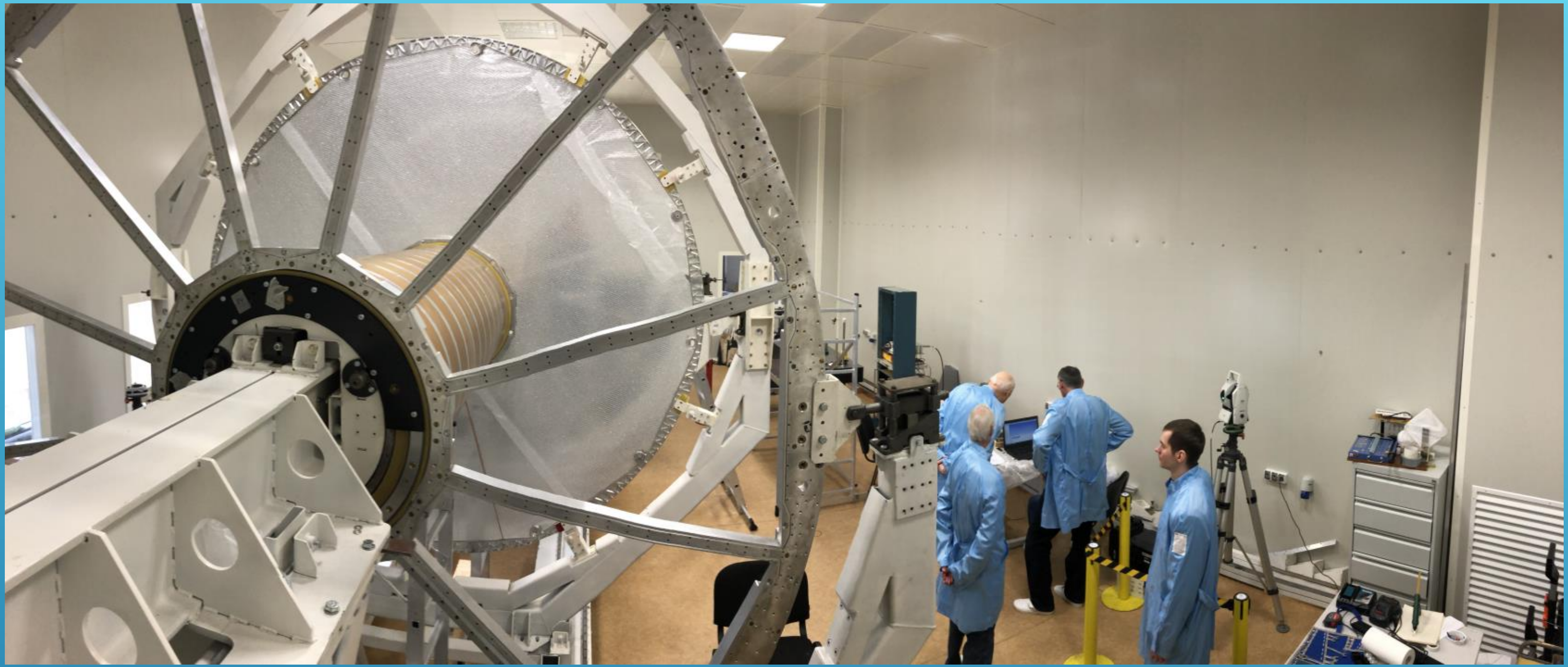
Both service wheels - assembled

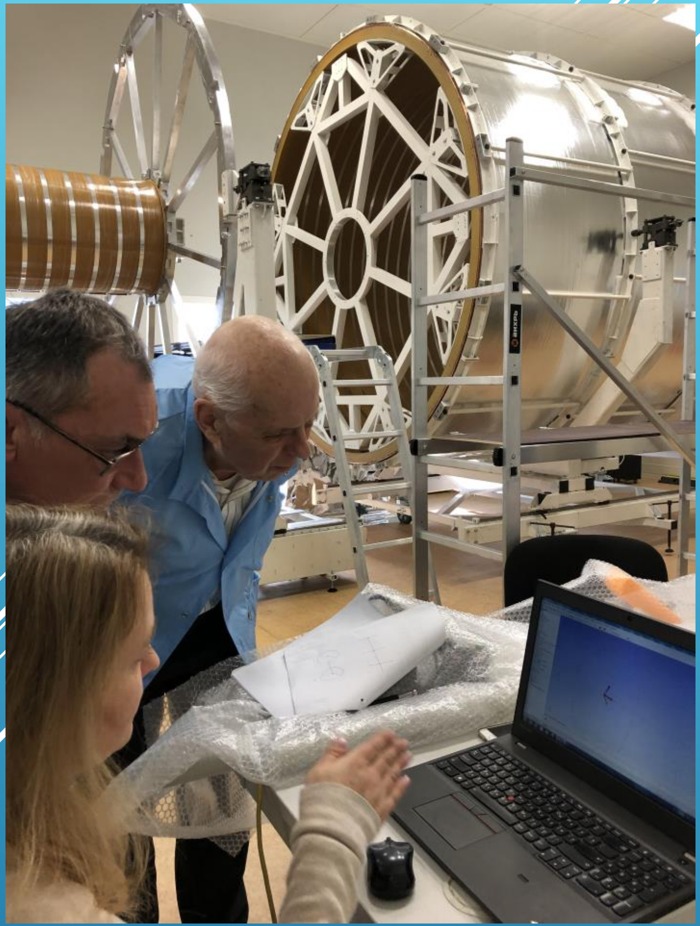


Rods D=40 mm (24 pc) reassembled - ready
Rods D=60 mm (24 pc) – assembling in progress, ready - June 2023

TPC vessel assembly – in progress (see next slide)

TPC VESSEL ASSEMBLING



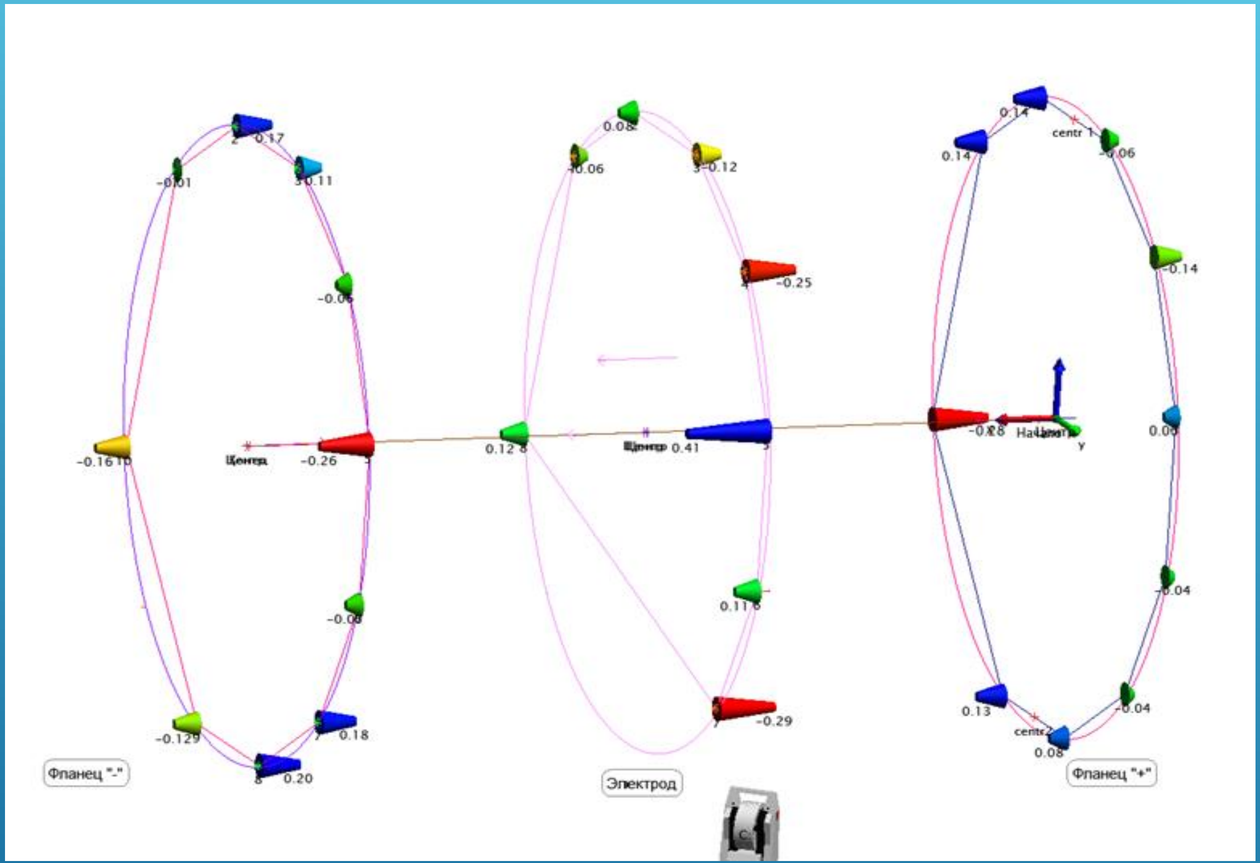


TPC body assembled with test rods for check TPC geometry by laser tracker AT-402 *(reflector type -TBR (R=6.35 mm), reflector center offset L== 12.00 mm)*: **2 flanges, HV electrode and C1-C2 cylinder - misalignment is about 1 mm**

Goal – improve misalignment by factor x2

TPC VESSEL ASSEMBLING

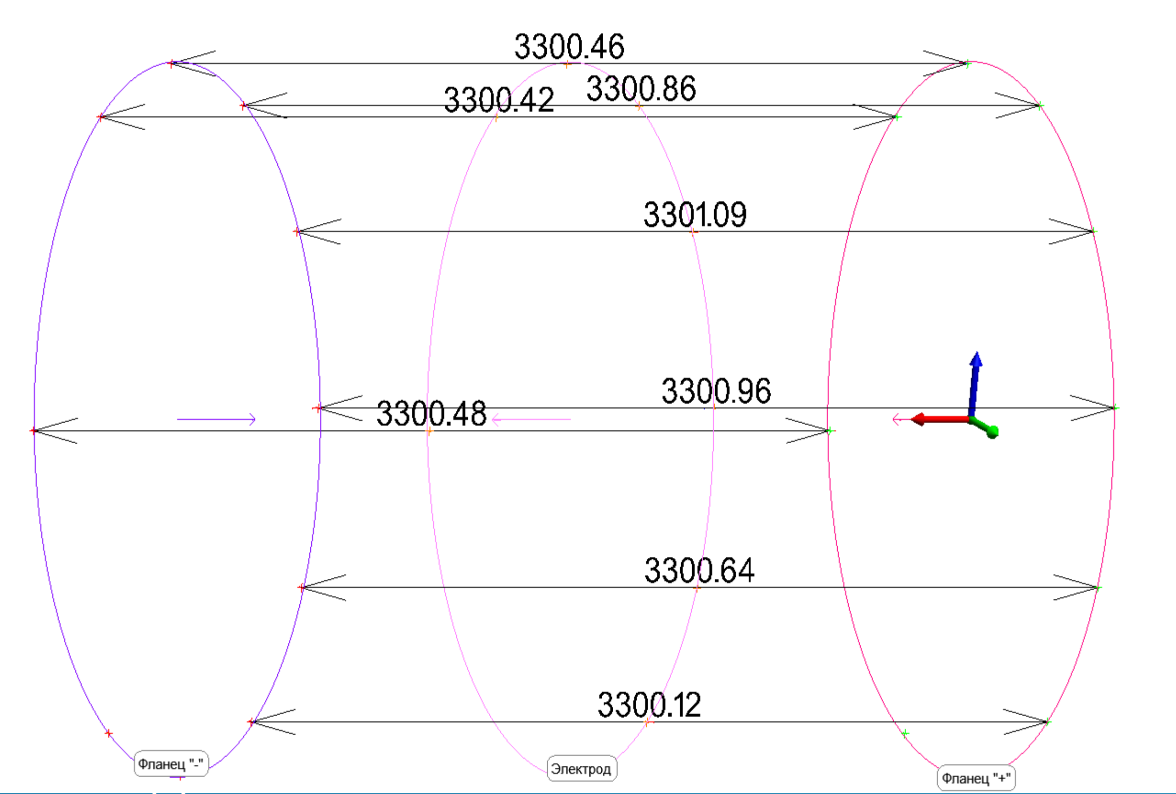
Flanges and HV electrode unflatness



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

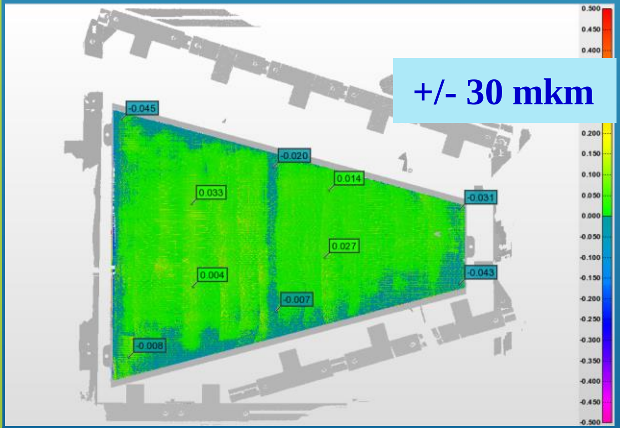
24 pc ROCs – tested

24 pc serial ROCs + 4 spare – READY!

Test set up for pads calibration

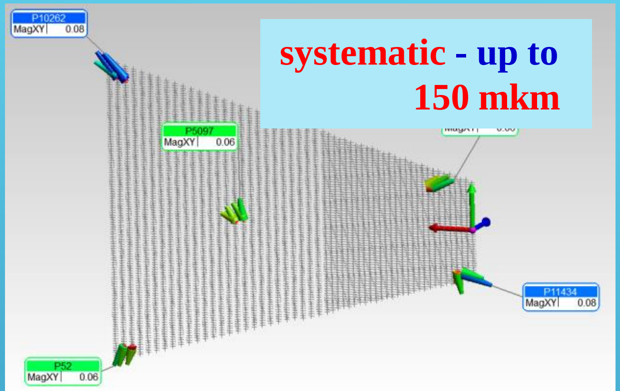
Leica MS60 - 1 second resolution
Leica AT960 +/-10 mkm +5 mkm/m
Leica AT403 +/-15 mkm +6 mkm/m
Scanner AS1+AT960 +/-50 mkm

Pad plane unflatness: example



+/- 30 mkm

Check pads geometry



systematic - up to 150 mkm

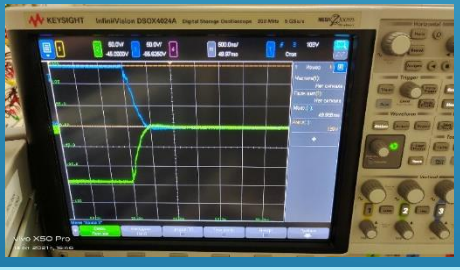
Full set of ROC alignment marks

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

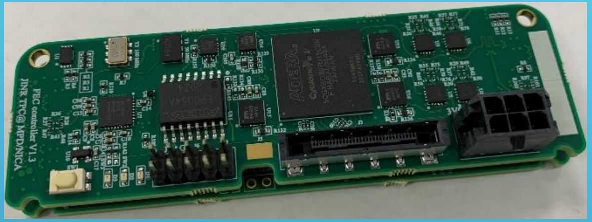
Pulse rise time - 500 ns, OK!



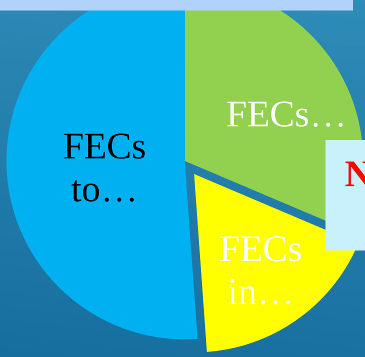
Mass-production – in progress
Delivery to JINR – Sept 2023

TPC SUB-SYSTEMS: ELECTRONICS

Production version of the FE card:



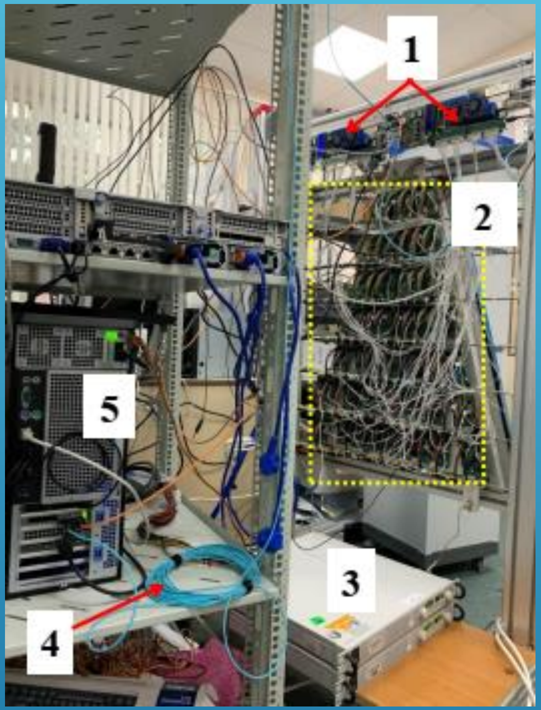
TPC FE cards production status



N=967 pc (65%)

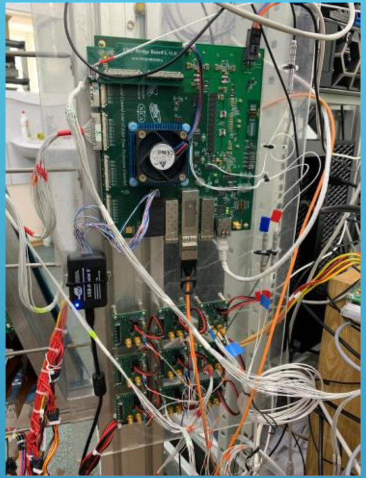
15 ROCs chambers can be completed (from 24 ROCs)

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



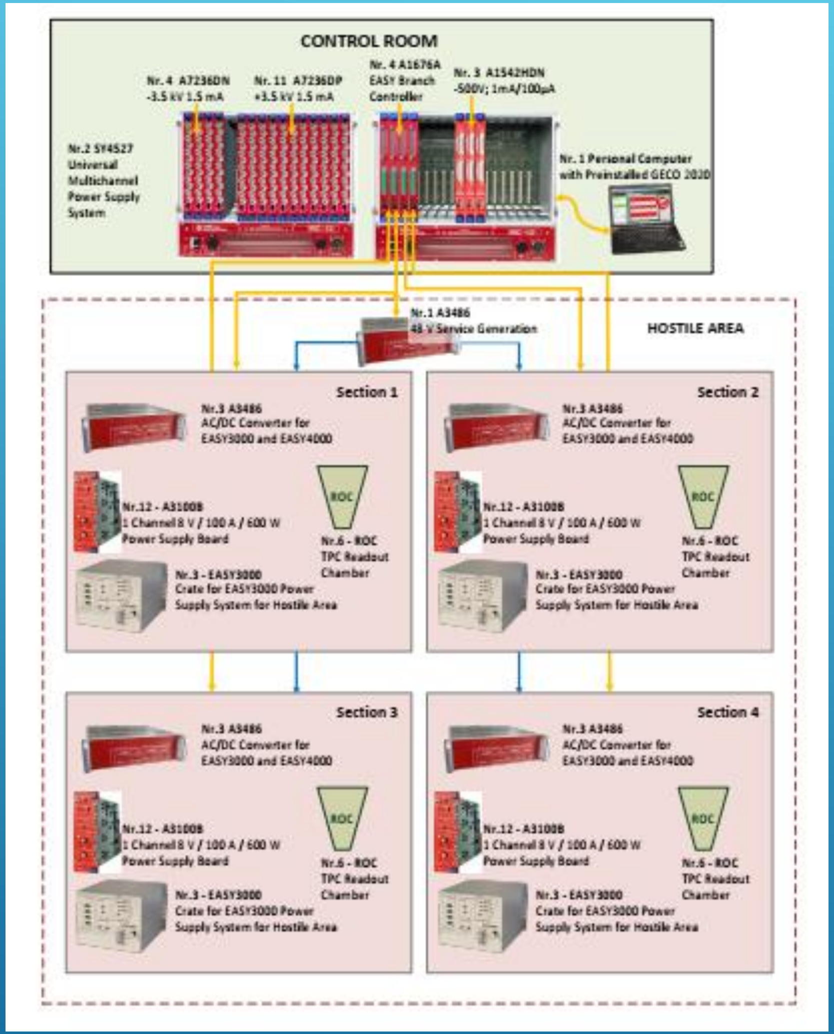
LVN9 stabilizer

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)

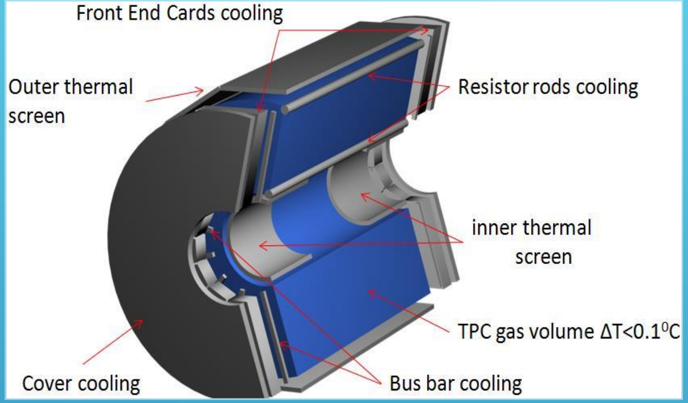

Gas supply

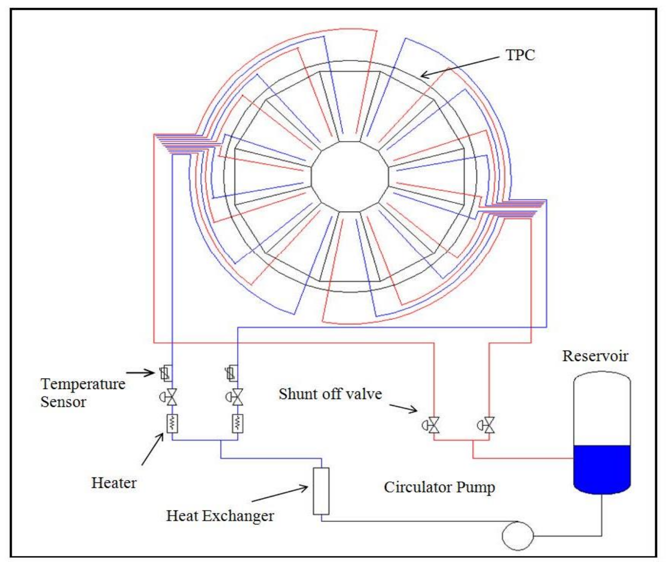
Racks

TPC volume imitator

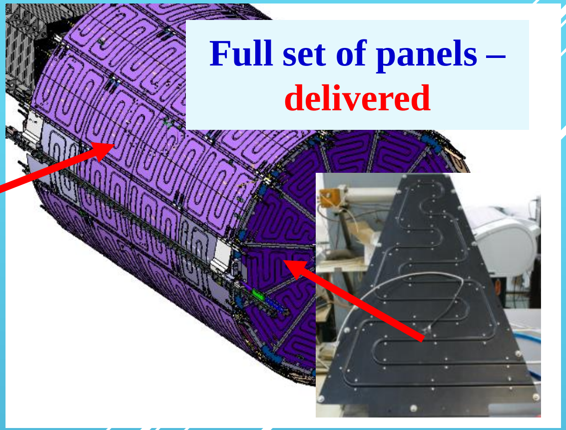
Tests - in progress
(H20 and Q2 sensors are replaced)

Water cooling system

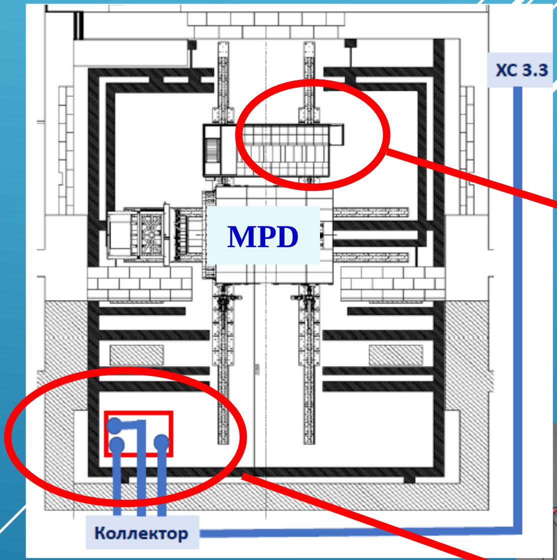


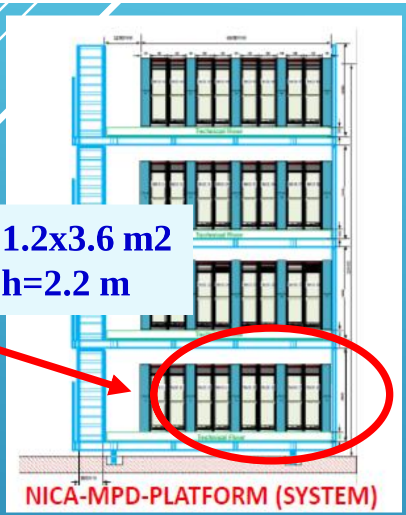


contract JINR-INP BSU (Minsk) – in progress
- delivery – 30 September 2023
- operation under manual control – during beam test 2024
- fully automatic control – 30 September 2024

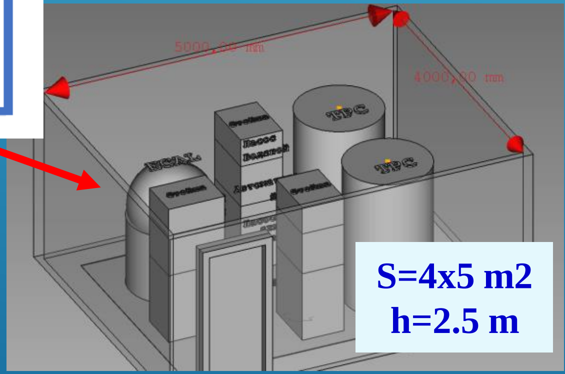

Full set of panels – delivered

MPD hall





S=1.2x3.6 m2
h=2.2 m



S=4x5 m2
h=2.5 m

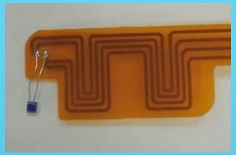
COOLING PROTOTYPE

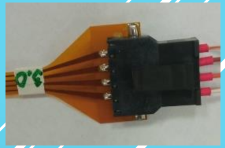
Bottom cooling plates

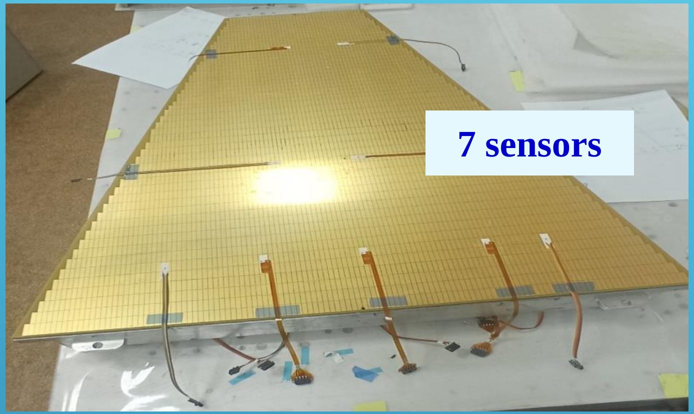
Set of top cooling plates

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

T sensor based on Pt100



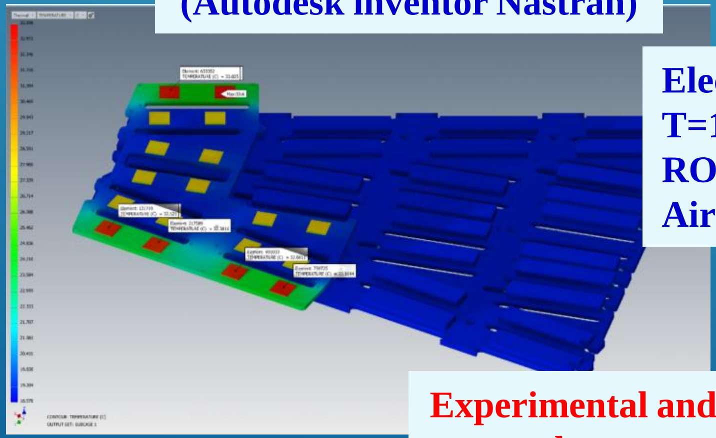




7 sensors

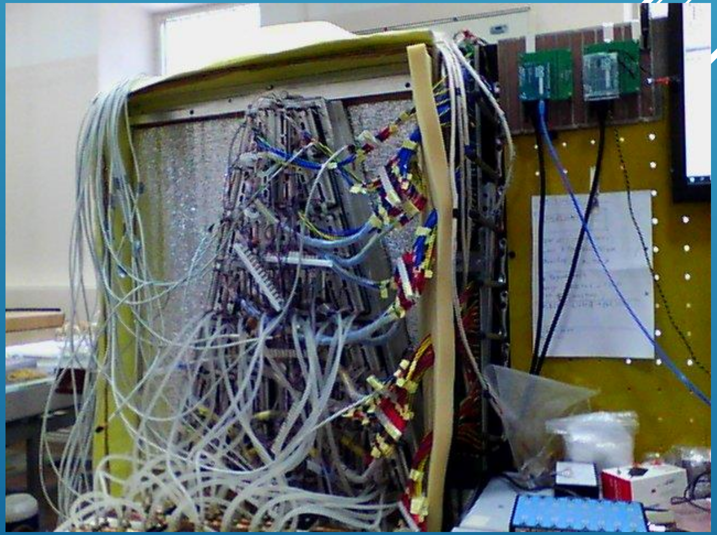
7 sensors

Cooling simulation (Autodesk inventor Nastran)



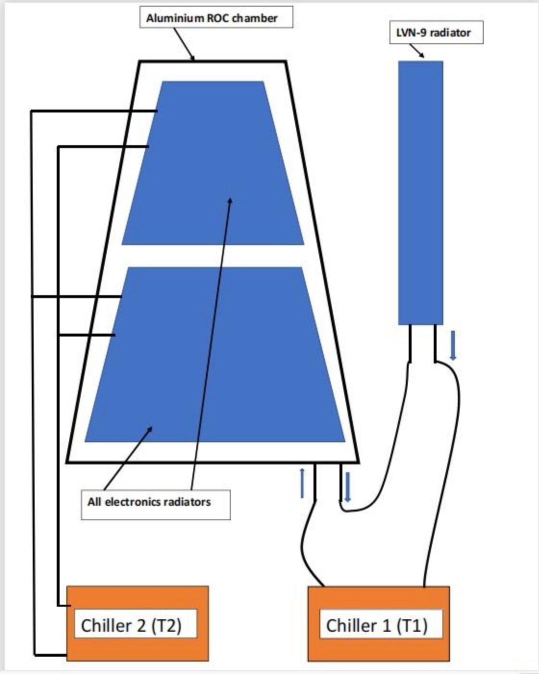
Electronics water: T=19 C
ROC water: T=22 C
Air: T=23 C

Experimental and simulation results are compatible

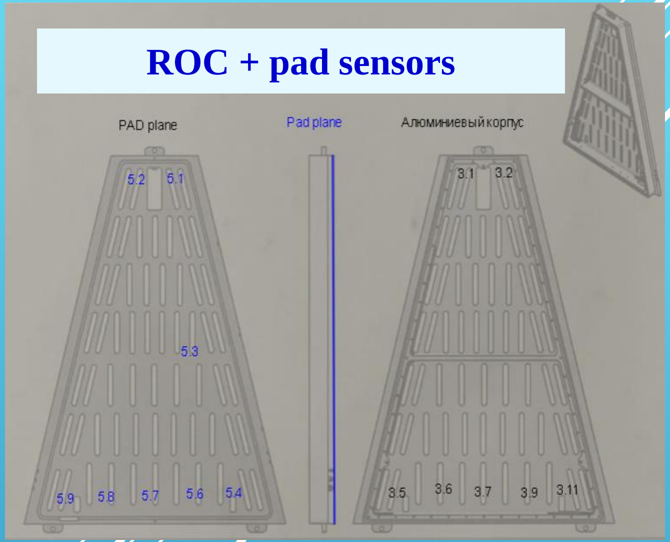


COOLING PROTOTYPE: RESULTS

Set up



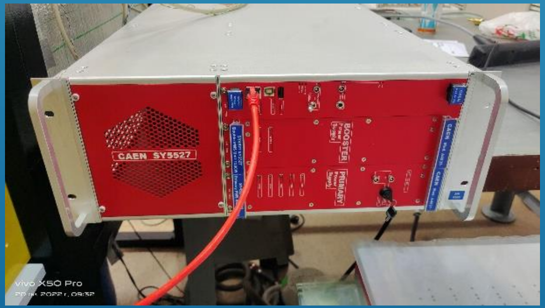
ROC + pad sensors



FE card sensors

Chiller

LV power

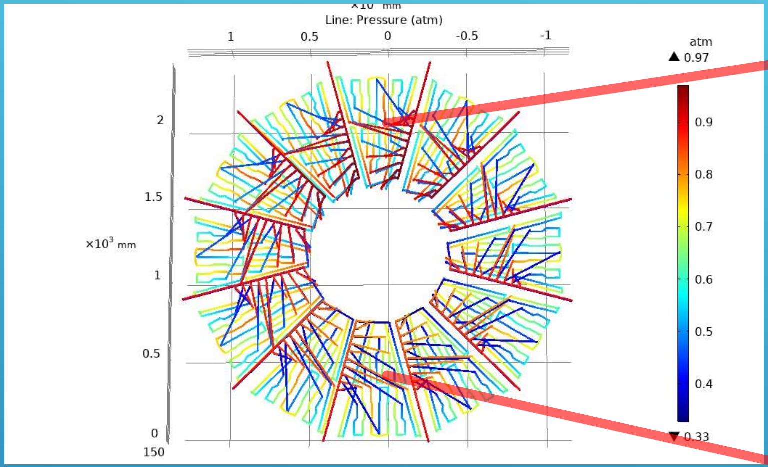


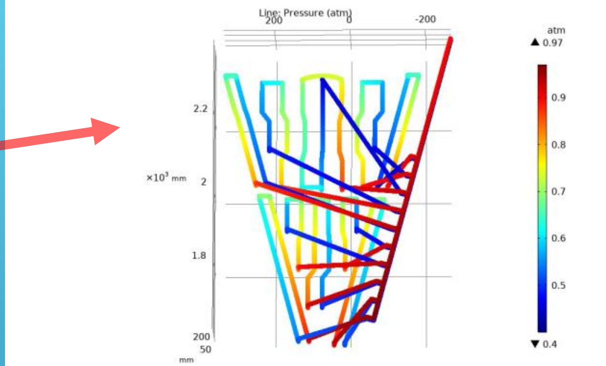
Air: T=23 degree (C)

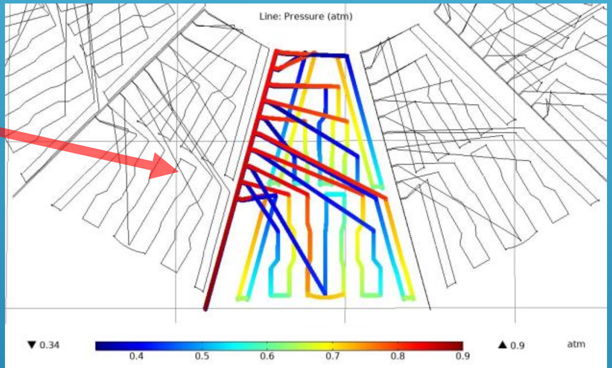
Water FECs T (C)	Water ROC T(C)	SAMPAs dT (C)	FPGAs dT (C)	Pads dT (C)	ROC dT (C)	T Min (C)	T Max (C)	Comments
17	25	3÷5	7	0.27	0.6	18	33	
19	22	3÷5	7	< 0.2	0.2	20	35	optimum

SERIAL COOLING SYSTEM (INP BSU, MINSK): STATUS

Hydrodynamic pressure drop for ROC chambers

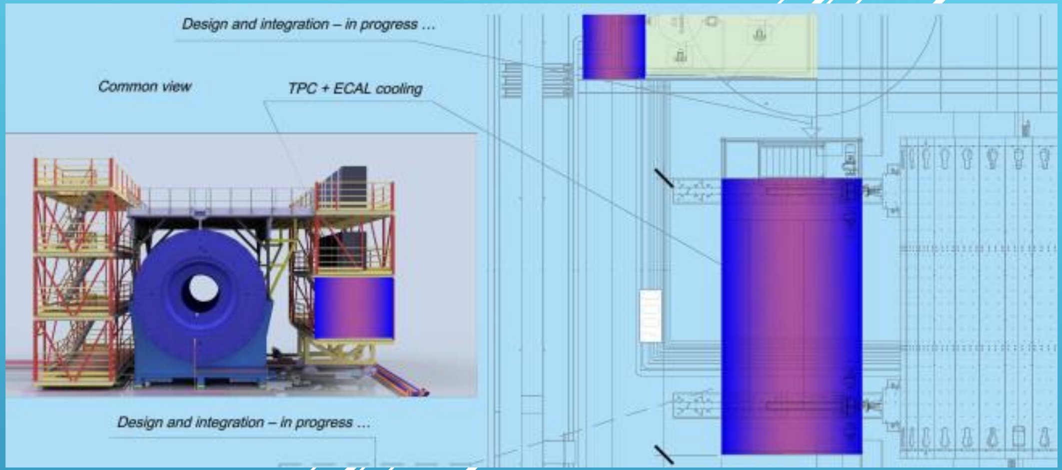


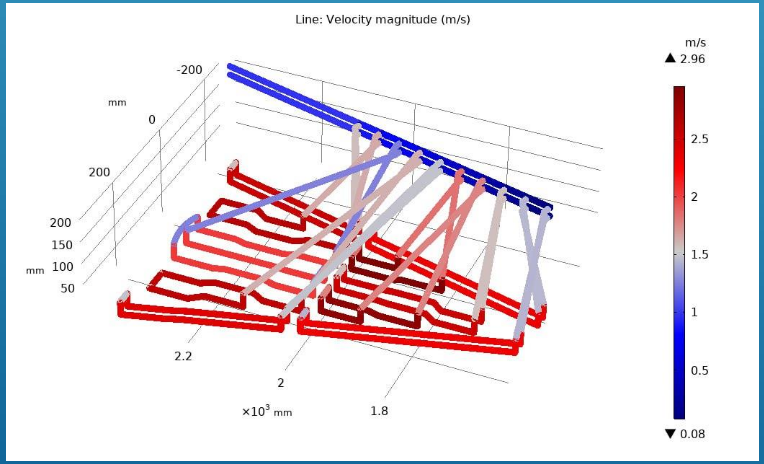




dP ≤ 0.5 atm

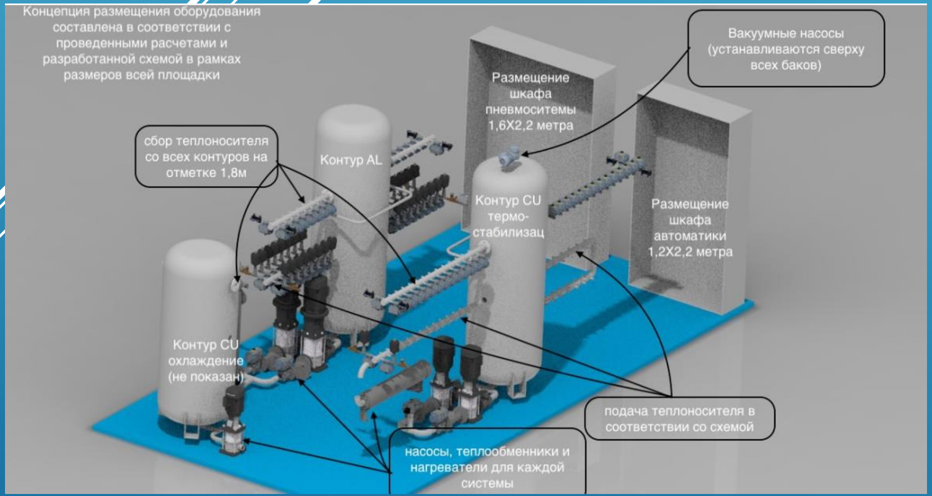
NEW cooling system position –> 2-nd floor of a additional platform – design and optimization in progress





Water velocity: (1.5-2.5) m/s

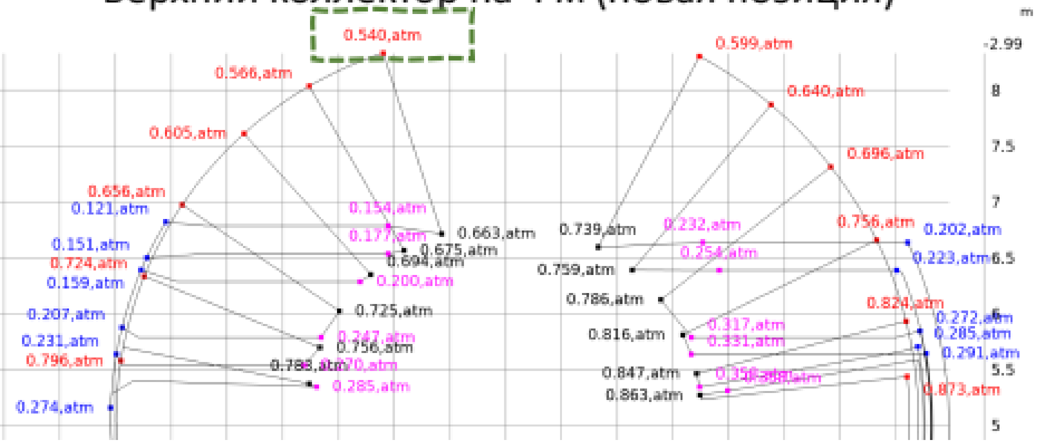
Systems parameters optimization by calculations – in progress



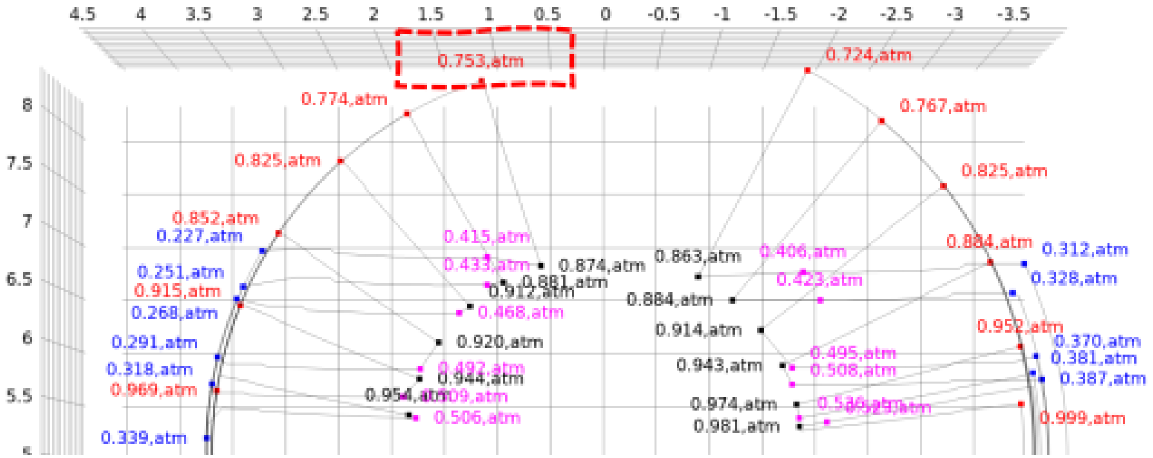
SERIAL COOLING SYSTEM: OPTIMIZATION

Влияние положения бака в системе на давление

Верхний коллектор на 4 м (новая позиция)

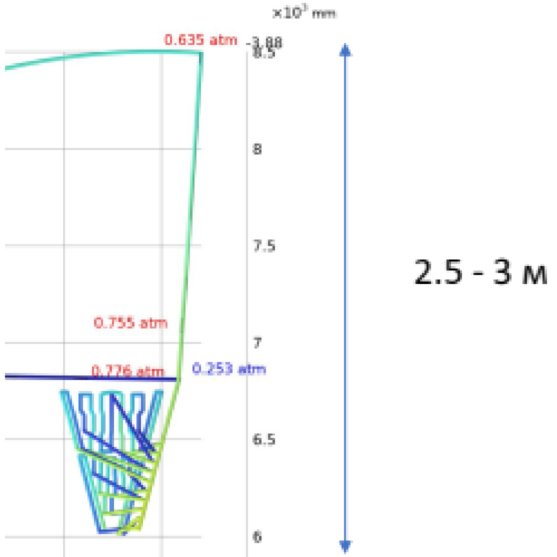


Верхний коллектор на 3 м (старая позиция)



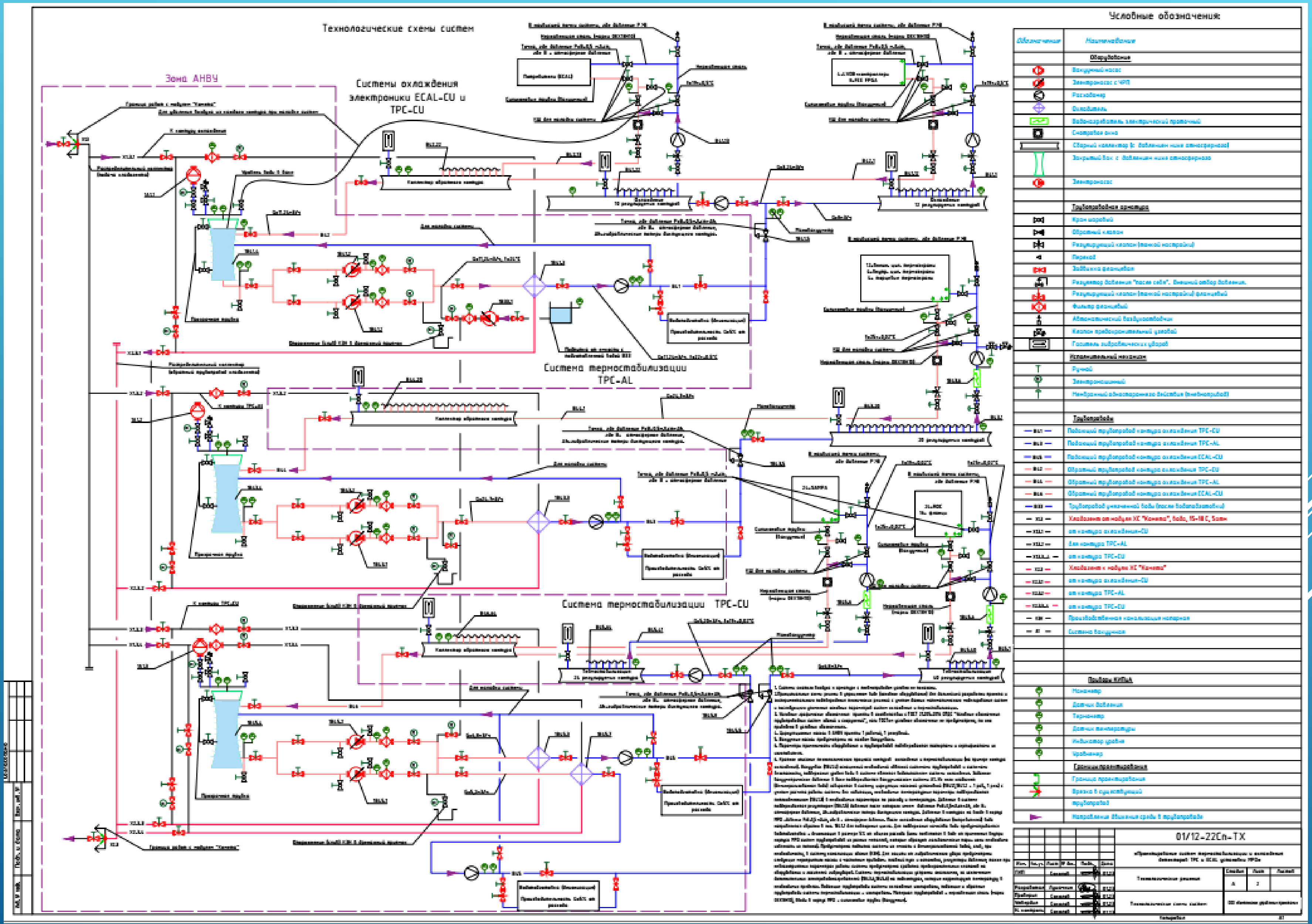
Изменение положения коллектора позволило подвести магистрали в верхние окна MPD с более низким давлением 0.54 атм вместо 0.75.

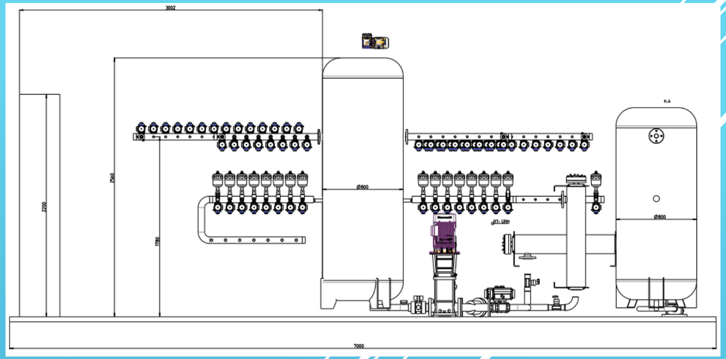
Это поможет сохранить режим *leakless*, поскольку к давлению в верхних окнах MPD в TPC прибавится около 3 м водного столба.

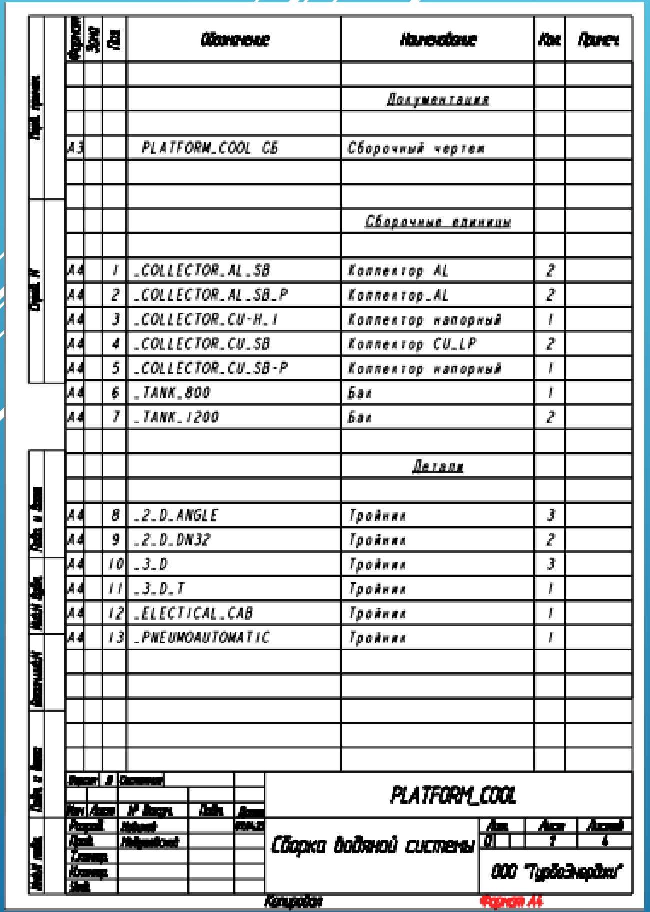


in progress …

SERIAL COOLING SYSTEM: STATUS



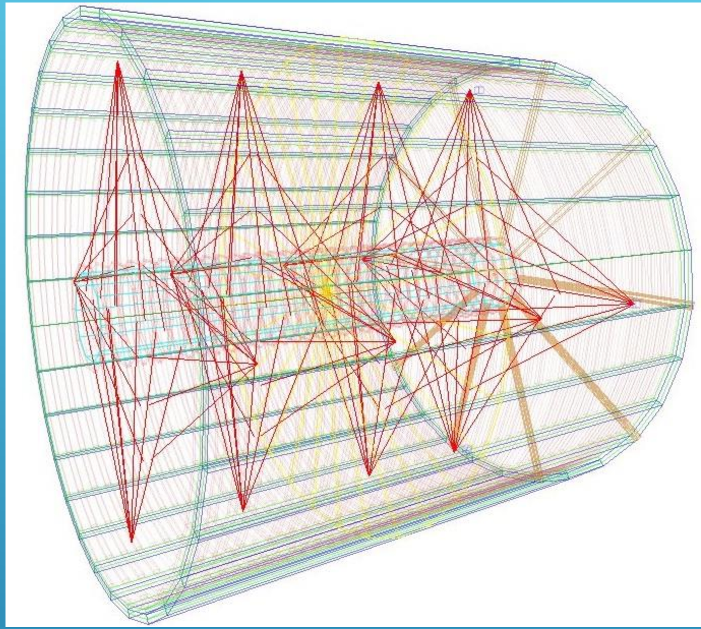


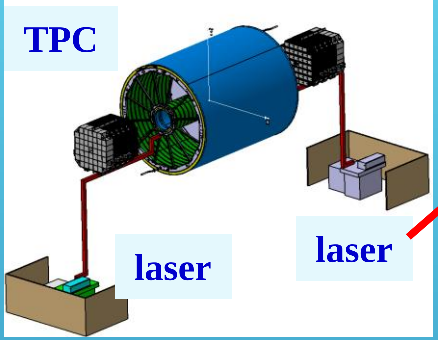


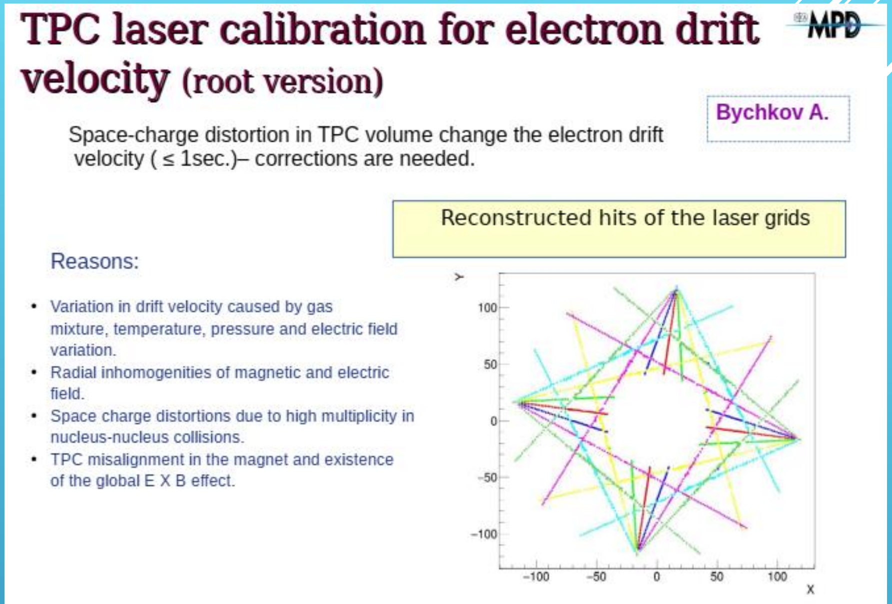
in progress …

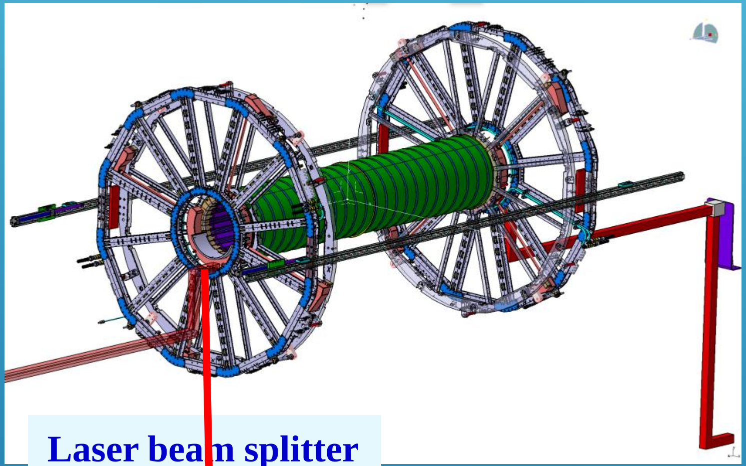
TPC SUB-SYSTEMS: LASER CALIBRATION

Scheme for ½ TPC





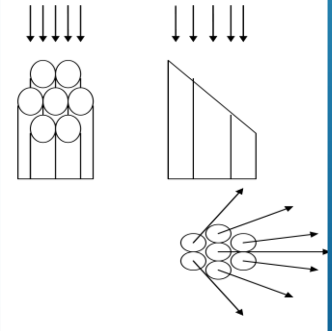


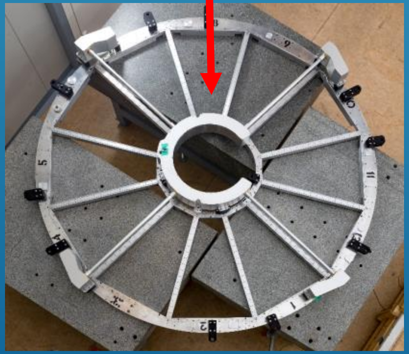


Laser beam splitter

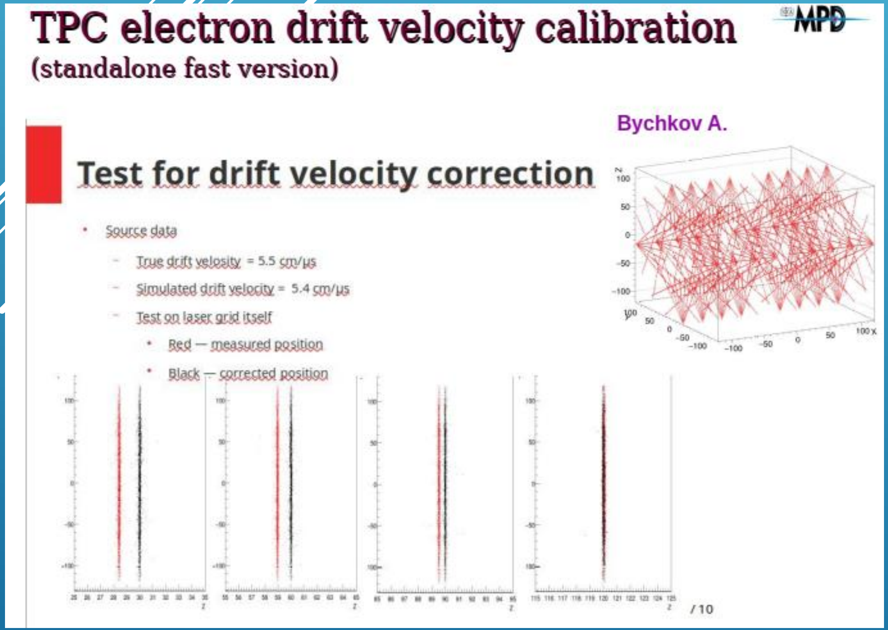
Laser “planes”	- 4
Micro-mirrors bundles per plane	- 4
Beams from micro-mirrors bundle	- 7
Laser “tracks” (N =112x2)	- 224

micro-mirror bundles



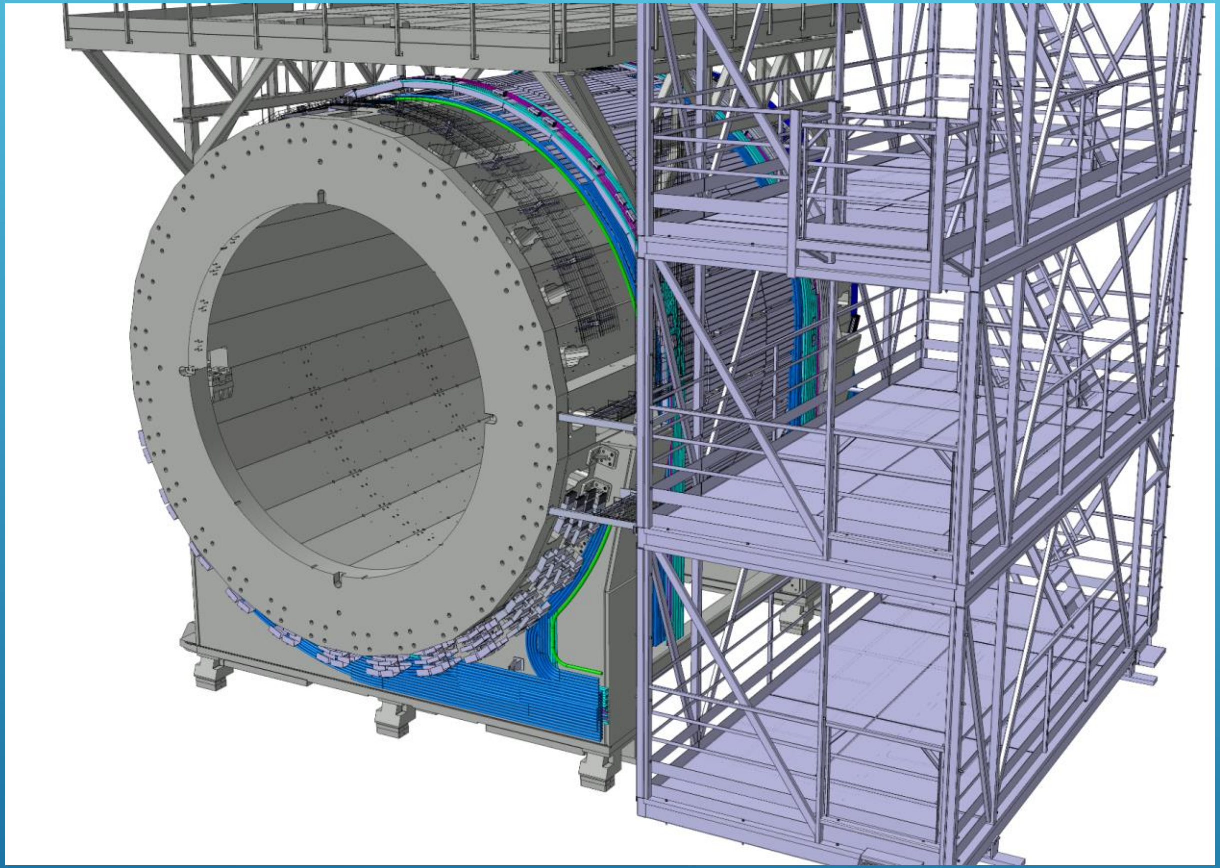


Laser beam monitor

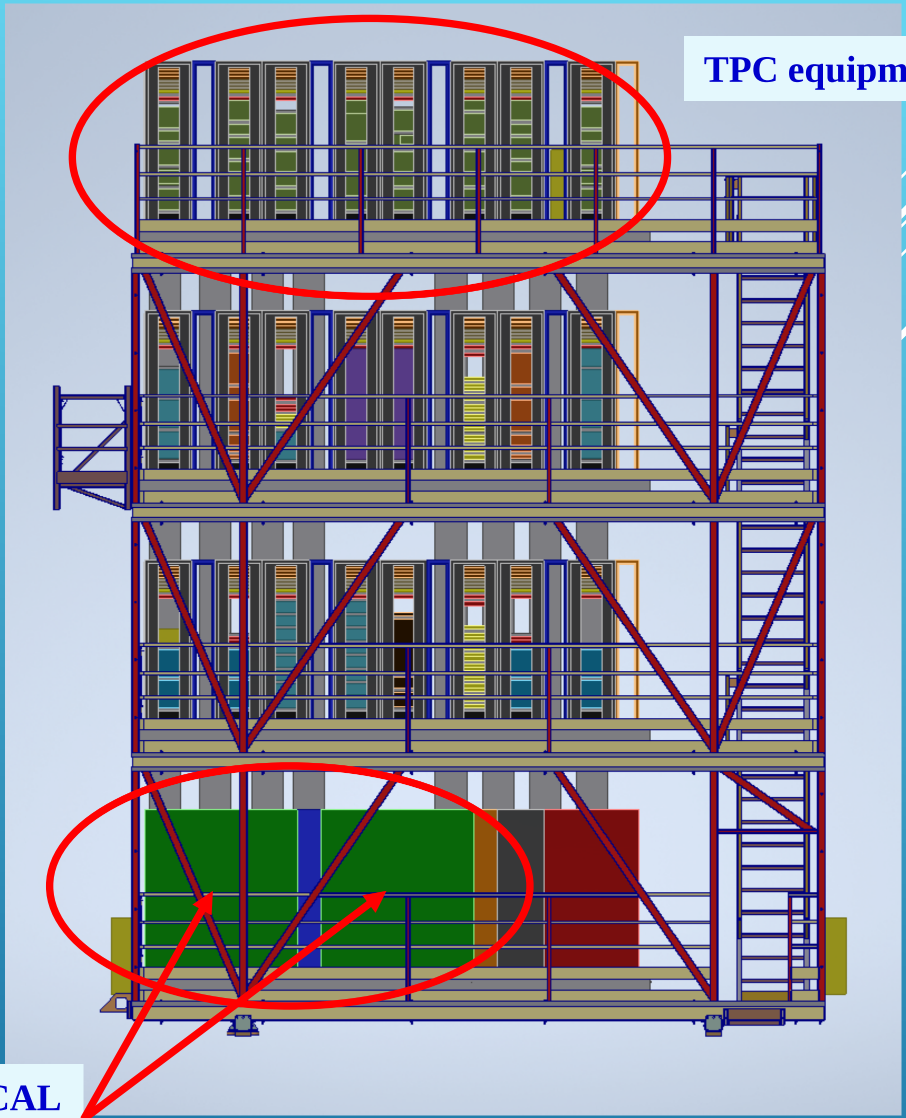


NICA-MPD-PLATFORM (NMP)

Common view



TPC equipment



TPC + ECAL cooling

Design and integration – in progress …

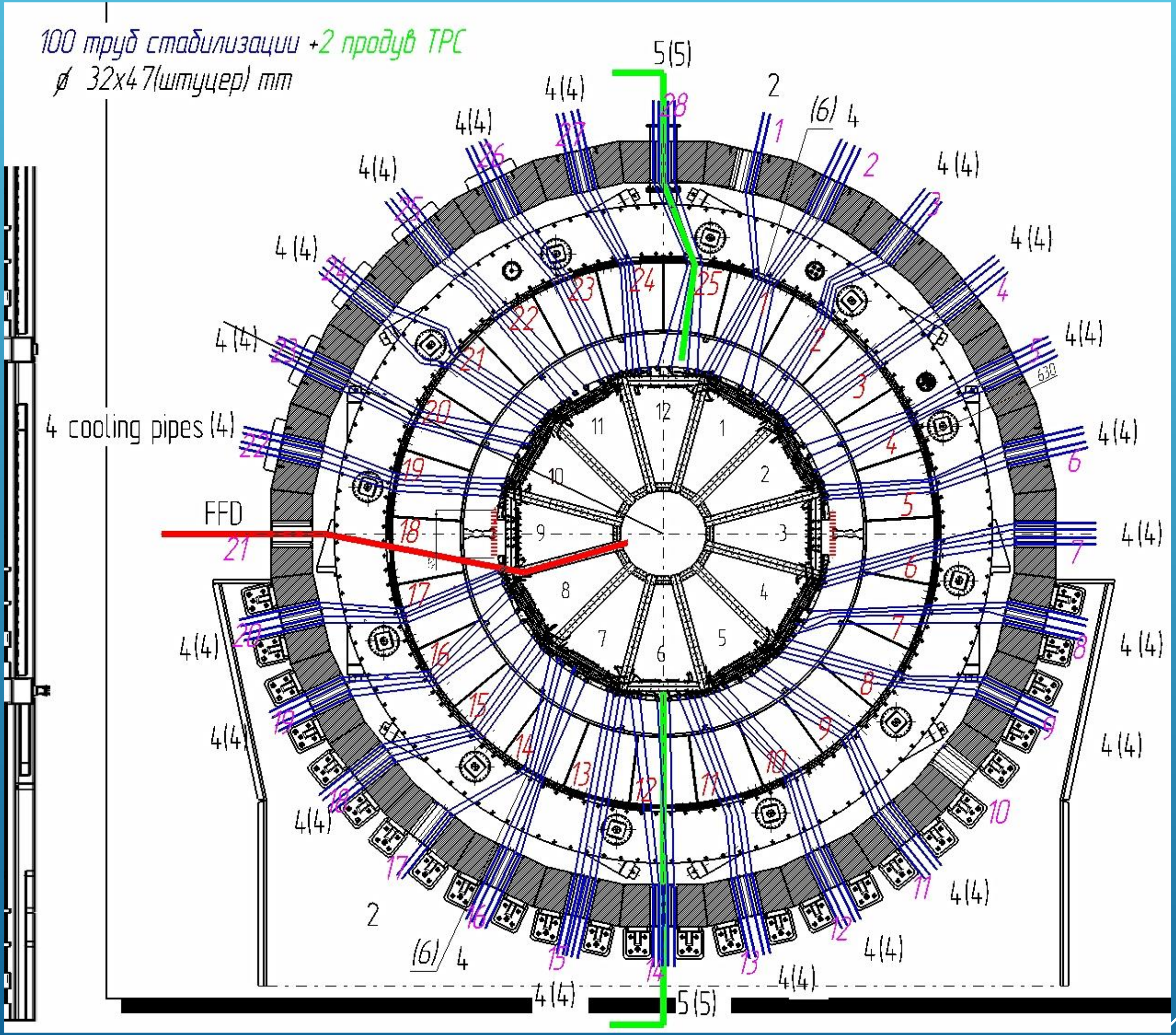
MPD ELECTRONIC PLATFORM

TPC equipment in racks on the 4th floor

U	F4-R1 левый	F4-R2 LV	F4-R3 LV	F4-R4	F4-R5	F4-R6 (LV)	F4-R7 (LV)	F4-R8 (правый)
47								
46	Cable organizer	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	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	Aruba 3810M 24G (146W) 6kg
43								
42	Система GATE	A3486 №1 (380VAC-48VDC)	A3486 №4 (380VAC-48VDC)	A3486 №7 (380VAC-48VDC)	A3486 №8 (380VAC-48VDC)	A3486 №9 (380VAC-48VDC)	A3486 №12 (380VAC-48VDC)	A3486 №15 (380VAC-48VDC)
41	40W x 12 камер = 500W	3kW, max.4kW 380V/15A	3kW, max.4kW 380V/15A	Питание SC для всех крейтов EASY	3kW, max.4kW 380V/15A 30kg	3kW, max.4kW 380V/15A	3kW, max.4kW 380V/15A	max.1.5kW 380V/15A
40	220V/10A	30kg	30kg	380V/15A, 1 kW (max 4 kW), 30kg	Питание+48V 2x крейтов EASY 3000 (HV)	30kg	30kg	30kg
39	20kg							
38		Crate EASY 3000 №1	Crate EASY 3000 №4	Crate EASY 3000 №8a (HV)	Crate EASY 3000 (HV)	Crate EASY 3000 №9	Crate EASY 3000 №12	Crate EASY 3000 №15
37	Система GATE	питание + 48V берется от A3486	питание + 48V берется от A3486	питание + 48V берется от A3486 №8	питание + 48V берется от A3486 №14	питание + 48V берется от A3486	питание + 48V берется от A3486	питание + 48V берется от A3486
36	40W x 12 камер = 500W							
35	220V/10A							
34	20kg	42.5kg	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	вент. панель
30								
29	Система SPECTRA	A3486 №2 (380VAC-48VDC)	A3486 №5 (380VAC-48VDC)	Crate SC для LVN9	Crate SY4527 (HV)	A3486 №10 (380VAC-48VDC)	A3486 №13 (380VAC-48VDC)	Система GATE
28	1050W	3kW, max.4kW 380V/15A	3kW, max.4kW 380V/15A	300W	700W, max. 1.2kW	3kW, max.4kW 380V/15A	3kW, max.4kW 380V/15A	40W x 12 камер = 500W
27	220V/15A	30kg	30kg	220V/10A	220V/10A	30kg	30kg	220V/10A
26	50kg			6kg	(8 модулей x 12ch=96ch-3.5kV/1mA +			20kg
25		Crate EASY 3000 №2	Crate EASY 3000 №5	(система медленного контроля	2 модуля x 12ch = 24ch-500V/1mA)	Crate EASY 3000 №10	Crate EASY 3000 №13	
24		питание + 48V берется от A3486	питание + 48V берется от A3486	платами LVN9 - 48 шт.)	45kg	питание + 48V берется от A3486	питание + 48V берется от A3486	Система GATE
23								40W x 12 камер = 500W
22	вент. панель			Crate VME8100/11	вент. панель			220V/10A
21		42.5kg	42.5kg	1.1kW, max. 2.5kW		42.5kg	42.5kg	20kg
20	Модуль термометрии NI			220V/15A	Crate VME8100/11			
19	200W			30kg	1.1kW, max.2.5W			
18	220V	вент. панель	вент. панель		220V/15A	вент. панель	вент. панель	вент. панель
17	5kg				30kg			
16		A3486 №3 (380VAC-48VDC)	A3486 №6 (380VAC-48VDC)			A3486 №11 (380VAC-48VDC)	A3486 №14 (380VAC-48VDC)	Spare: Система SPECTRA
15		3kW, max.4kW 380V/15A	3kW, max.4kW 380V/15A	вент. панель		3kW, max.4kW 380V/15A	3kW, max.4kW 380V/15A	500W
14	TPC Laser system synchronization	30kg	30kg			30kg	30kg	220V/15A
13	200W, 220V			Crate NIM	вент. панель			50kg
12	5kg	Crate EASY 3000 №3	Crate EASY 3000 №6	610W, max. 1.15kW		Crate EASY 3000 №11	Crate EASY 3000 №14	
11		питание + 48V берется от A3486	питание + 48V берется от A3486	220V/10A	Crate NIM	питание + 48V берется от A3486	питание + 48V берется от A3486	
10	TPC HV membrane - 30kV			30kg	610W, max. 1.15kW			
9	350W				220V/10A			вент. панель
8	220V	42.5kg	42.5kg		30kg	42.5kg	42.5kg	
7	7kg			вент. панель				Модуль термометрии NI
6								200W
5		вент. панель	вент. панель		вент. панель	вент. панель	вент. панель	220V
4								5kg
3								
2								
1								

TPC CABLING AND PIPING

W side: cooling and gas pipes scheme



TPC list of cables and pipes

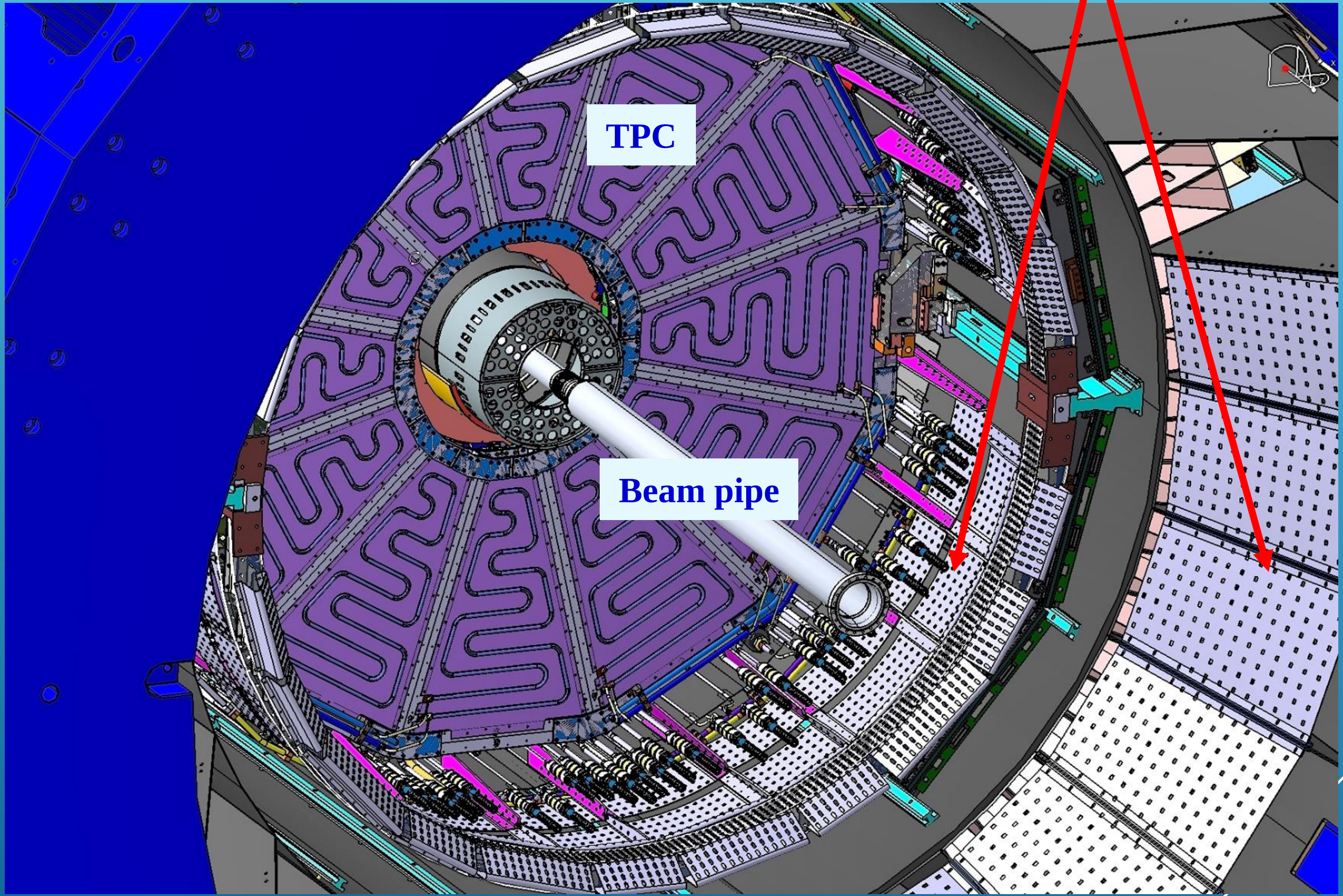
List of cables and pipes

	Purpose	Diameter, mm	14	12	10	8	6	4	2	1	3	5	7	9	11	13
			Qty	Qty	Qty	Qty	Qty	Qty	Qty	Qty	Qty	Qty	Qty	Qty	Qty	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
TDDO	Controller: DATA QSFP	opt. 3.3	0	1	1	2	2	3	4	4	4	4	5	5	6	6
TDTO	Controller: data and trigger/ sync SFP+	opt. 3/3x1,8	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. 3/3x1,8	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 WEB 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

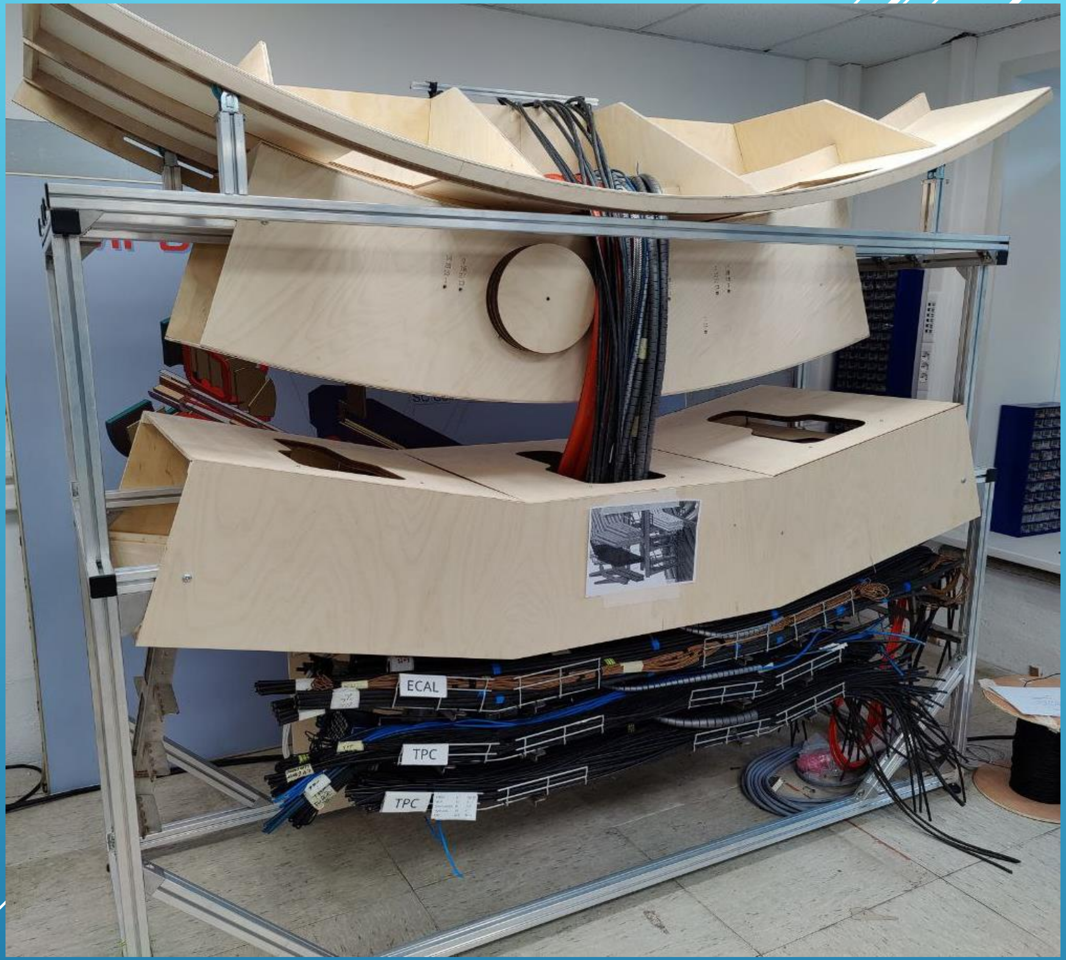
Integration …

Structures for cables and pipes fixation



Structure design - in progress

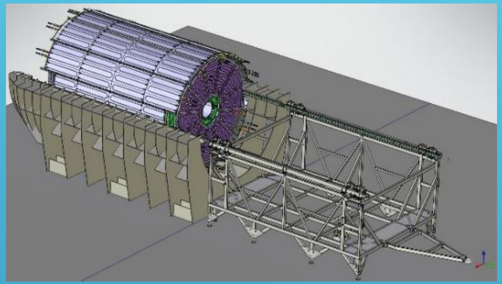
Prototype for cabling and piping



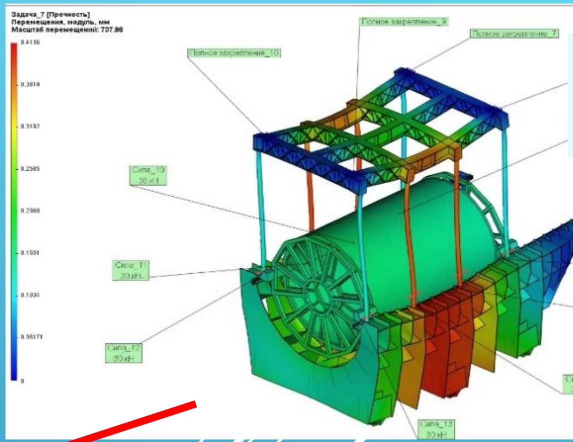
TPC+TOF+ECAL cabling – in progress
Piping – not started yet

TOOLING FOR INSTALLATION TPC TO MPD

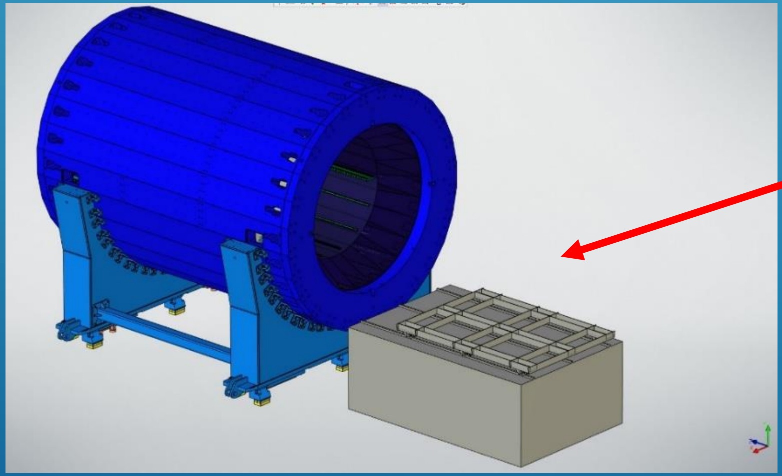
Bld. 217

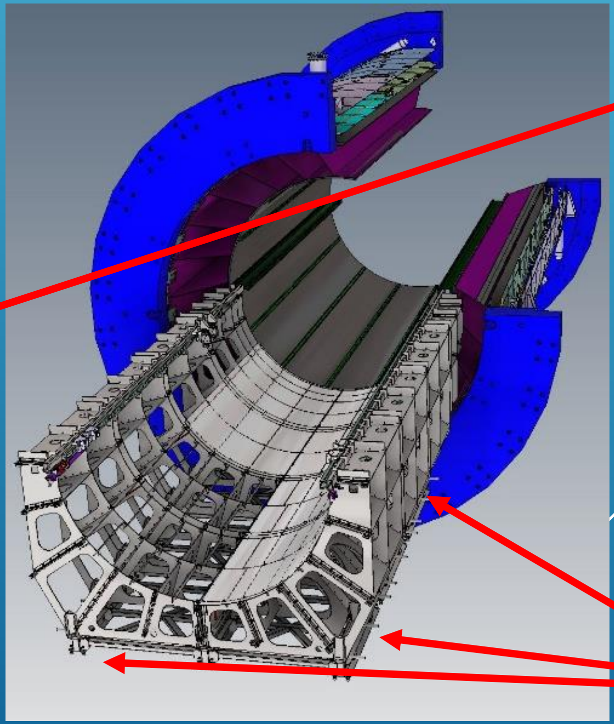


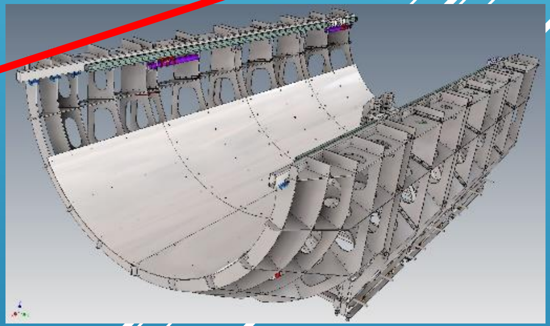
Bld. 217 (MPD)



24 tons,
max=0.41 mm

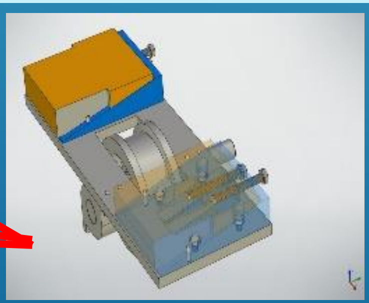






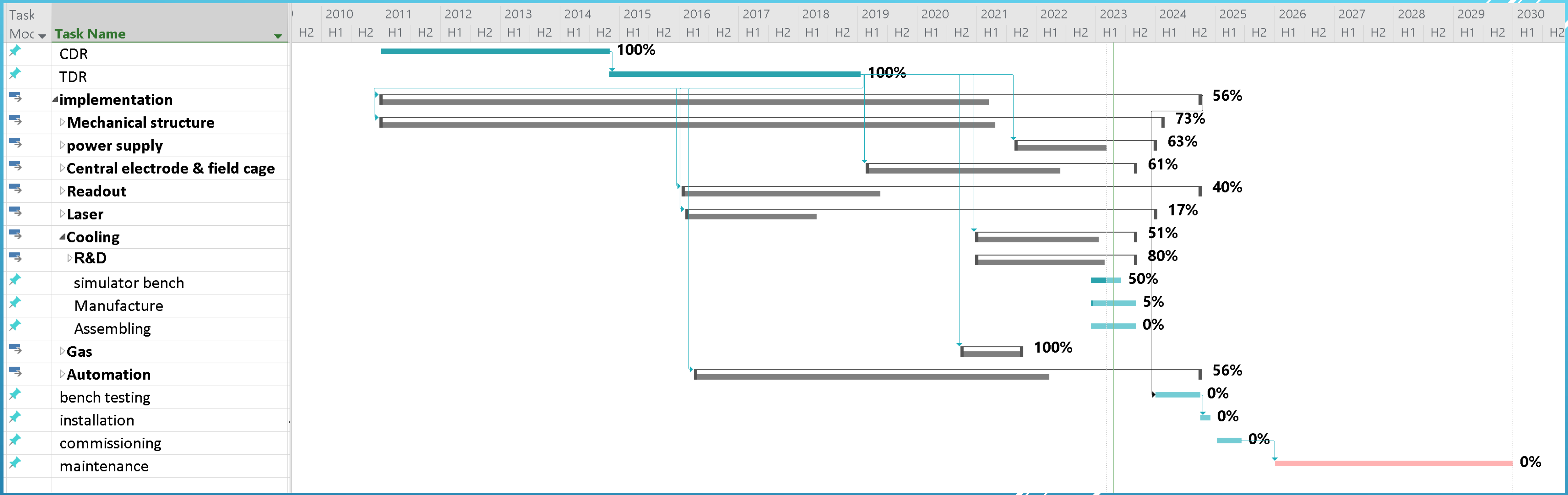
Design under optimization,
Prototype 1:5 –
June 2023

4 units for adjustment X, Y, Z



Tooling manufacture –
July 2023-Feb 2024
Delivery to JINR –
Spring 2024

PLANNING (DRAFT)



in progress …

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 !