



# **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**





SPD

(Detector)

Clean Room (Detector Electronics)

BM@N (Detector)

Extracted beam

TPC team – 23 (JINR) + 25 (Belarus)

S.Movchan MPD TPC status, XV-th international school "Actual problems of microworld physiscs", Minsk, Belarus, August 30 2023



Collide

# **MPD TPC MAIN PARAMETERS**



S.Movchan MPE	) TPC status, Minsk,	Belarus, Sept 30 2023
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Itom	Dimension
Length of the TDC	
Center and Provide and Control of	
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 <sup>4</sup>
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 <b>φ</b>	<b>30</b> °
Pad size	5x12mm <sup>2</sup> and 5x18mm <sup>2</sup>
Number of pads	95232
Pad raw numbers	53
Pad numbers after zero suppression	< 10%
Maximal event rate	< 7 kHz ( Lum. 10 <sup>27</sup> )
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
	30.08.2023

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# **TPC VESSEL ASSEMBLY**







ISO-6

C1-C2 and C3-C4 cylinde	er – assembled
<b>TPC service wheels (2pc)</b>	- assembled
HV membrane	– tested
TPC field cage assembly	- Dec 15 2023
TPC vessel ready	– Dec 30 2023



Service wheel with thermal panels (12pc)



#### **Both service wheels - assembled**



VVO KSO Pro Ter 2021 7 421

Rods D=40 mm (24 pc) reassembled - ready Rods D=60 mm (24 pc) – assembling in progress, ready – Oct 10 2023

30.08.2023

**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**



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

# **TPC VESSEL ASSEMBLING**



# **ROC CHAMBERS AND GATING GRID SYSTEM (GGS): STATUS**

#### Test set up for pads calibration

#### Test set up for ROC certification



# 24 pc ROCs – tested

# 24 pc serial ROCs + 4 spare – READY!



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 – Dec 2023

+/- 30 mkm

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#### **Production version of the FE card:**





**TPC SUB-SYSTEMS: ELECTRONICS** 

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



- . RCU prototypes
- E. FECs on the ROC (62 pc)
- 3. LV power supply
- 4. DCU card connected with

**RCUs via fibers** 

5. Readout server

LVN9 stabilization module FE radiators (water cooling)



60 pc LVN9 (INP BSU, 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: ROC + ELECTRONICS TEST SETUP**







62 FE cards





**CAEN LV power supplies** 

in progress ...

# **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
- LV module A3100B (8V/100A)
- LV module A3100HBP (14V/50A)
- HV modules –A3540P (+4kV/1mA)
- HV modules -A3540N (- 4kV/1mA)

#### Status:

LV+HV system: JINR-CAEN contract signed Expected delivery date to JINR: September 2023

test system – tests ongoing

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

#### HV cables - delivered

- 14+2 pc - 48+8 pc - 6 +2 pc

- 8+3 pc
- 2+2 pc



# **STORAGE OF TPC CABLES AND EQUIPMENT AT JINR**





**Slow Control** 



**CAEN EASY3000 crates** 



LV cables



LV protection







CAEN HV system

CAEN LV modules 60pc – will be delivered in September

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S.Movchan MPD TPC status, Minsk, Belarus, Sept 30 2023

# **TPC SUB-SYSTEMS: GAS AND COOLING**



# **TPC SUB-SYSTEM: SERIAL COOLING SYSTEM**



Water velocity: (1.5-2.5) m/s





Systems parameters optimization by calculations – in progress



design fix – November 2023

1. About ROC+FE cards cooling and it optimization with help of prototype - see next talk of A.Makarov

2. The computer-aided design of cooling system - see next talk of A.Fedotov

#### Scheme for <sup>1</sup>/<sub>2</sub> TPC





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







# TPC laser calibration for electron drift MPD velocity (root version)







#### 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)

#### Bychkov A.

Successful
Sucesful
Sucesful
<

# **INTEGRATION: NICA-MPD-PLATFORM (NMP)**



**Integration – in progress ...** 

# **TPC** equipment in racks on the 4<sup>th</sup> floor

47	F4-R1 annañ	47	F4-82 LV	47	F4R3 LV	47	F4-R4	47	F4-85	47	F4-R5 (LV) 47		F4-87 (LV)	47	F4-R8 (rpssuil)
46	Cable organizer	-46	Cable organizer	-45	Cable organizer	46	Cable organizer	46	Cable organizer	46	Cable organizer	-46	Cable organizer	46	Cable organizer
-45	Patch Panel Fiber	45	Patch Panel Fiber	45	Patch Panel Riber	45	Patch Panel Fiber	45	Patch Panel Riber	45	Patch Panel Fiber	45	Patch Panel Fiber	45	Patch Panel Fiber
44	Aruba 3810M 245 (146W) 6kg	44	Aruba 3810M 24G (146W) 6kg	44	Aruba 3810M 24G (146W) 6kg	44	Aruba 3810M 24G (146W) 6kg	44	Aruba 3810M 24G (146W) 6kg	44	Aruba 3810M 24G (146W) 6kg	44	Aruba 3810M 24G (146W) 6kg	44	Aruba 3810M 24G (146W) 6kg
42	Gectema GATE	42	ABHRE NES (BROVAC-ROVDC)	42	A3486 NH (280VAC-40VDC)	42	ABHRE NV7 (BROVAC-40VDC)	42	A3485 NHB (380VAC-40VDC)	42	A3486 N/9 (380VAC-40VOC)	42	A3486 NH2 (380VAC-40VDC)	43	A3486 Nr15 (380VAC-40VDC)
41	40W x 12 xawep = 500W	41	3kW, max.4kW 380k/15A	41	3kW, max4kW 380V/15A	41	Fortainure SC gan aces speliton EASY	41	3kW, max.4kW 380V/15A 30kg	41	3kW, max.4kW 380V/15A	41	3kW, max.4kW 380V/15A	41	max.3.5kW 38Dv/15A
40	220V/10A	40	10 <sub>10</sub>	40	10 <sub>16</sub>	40	3804/154, 3 kW (max 4 kW), 30kg	40	3000.0%)	40	304	40	304	40	304
39	20kg	39		39		39		39		39		39		39	
38		38	Crate EASY 3000 Nrt	38	Crate EASY 3000 Net	36	Crate EASY 3000 Nells (HV)	38	Crate EASY 2000 Nedle (HV)	38	Crate EASY 3000 Neg	38	Crate EASY 3000 Net2	36	Crate EASY 2000 No15
37	Coctowa GATE	37	romanose + 48V Sepance of A2486	37	numawwe + 48V Separat on A3486	37	Net	37	Nortainus + 48V Seperce of A3486 No.14	17	nutawae + 48V Seperce of A3485	37	nutaeue - 48V Seperce of A3485	37	nuta we + 48V Separtos of A3486
36	40W x 12 xawep = 500W	36		36		36		36		36		36		36	
15	220V/10A	15	47504	15	47.54	15	47 Ge	15	47.54	15	4754	25	42.54	15	40 Sie
11	~~	11		11		11	nang -	11		11	Toolg	- 11	Total	11	
32		12		32		32		32		12		32		33	
31	MINT, FEMALES	31	BENT, BENEN	31	BHR. RBHRA	31	BOAT, BANANA	31	BEAT. BRANDA	31	BANK, RUNNAL	31	BINT, REVIERS	31	BIHT, REHINK
~						30				~		~			
29	Cecteera SPECTRA	29	ABHEE Nr2 (280VAC-40VDC)	29	A3486 NrS (380VAC-40VDC)	29	Crate SC gas LVN9	29	Crate SH4527 (HV)	29	A3486 Nr10 (280VAC-40VDC)	29	A3486 No13 (380VAC-40VDC)	29	GICTIONIS GATE
27	220//15A	27	10a	27	No.	27	230//304	27	220//204	27	No, machine and prov	27	304	27	220//10A
									I wagyne x 13ch#96ch+3.5kV/SmA					-	
26	SONE	26		26		26	64	26	•	26		26		26	20kg
25		25	Crate EASY 3000 Nr2	25	Crate EASY 3000 NrS	25	система медленного контроля	25 2	wogyne x 13ch + 24ch-500//1mA)	25	Crate EASY 3000 Ne30	25	Crate EASY 3000 Net3	25	
24		24	restance + 48V Separce of A3486	24	numawwe + 48V Seperce of A3485	24	naurawa LVN9-48 ur.)	24	45ig	24	Buttanue + 48V Sepertra of A3485	24	tertanee + 48V Seperce of A3485	24	GICTIONIS GATE
						- 11									
22	BIHT, REHING	22	47.61+	22	415-	22	Crate VMDB100/11	22	BOAT, BANKAN	22	1154	22	43.5%	22	220W10A
			n		June 1		and the second				Torig		- Teang		
10	Maggas teperawetpes N	20		20		10	230i/15A	20	Crate VMEB300/11	20		20		20	
18	220V	10	BENT, BANKA	10	800.020M	18	~~1	18	220v/15A	18	BINT. REMARK	18	BINT, REHITS	15	BIHT, DAHERS
17	Sig	17		17		17		17	30kg	17		17		17	
16		16	ABHEE NIB (BROVAC-40VDC)	16	AB486 NH6 (380VAC-40VDC)	16		16		16	A3486 Nr11 (380VAC-40VDC)	16	AB486 NH14 (BB0VAC-40VDC)	16	Spars: Cectowa SPECTRA
15		15	3kW, max.4kW 380ky/15A	15	3kW, max.4kW 380V/15A	15	BENT, BANKA	15		15	3kW, max.4kW 380V/15A	15	3kW, max.4kW 380V/15A	15	500W
14	PC Laser system synchronization	14	10kg	14	30kg	14		14		14	104	14	304	14	220V/15A
13	200W, 220V	13		13		13	Crate NIM	13	BENT, TANKA	13		13		13	50%
12	Skg	12	Crate EASY 3000 Nr3	12	Crate EASY 3000 Nes	12	610W, max. 1.15kW	12		12	Crate EASY 2000 Ne11	12	Crate EASY 3000 NeS4	12	
11		11	restance + 48V Separce of A3486	11	numanue + 48V Seperce of A3485	11	2304/30A	11	Crate NIM	11	Buttanue + 48V Seperce of A3485	11	nutaxue + 48V Seperce of A3485	11	
10	TPC HV membrane - 30kV	10		10		10	10kg	10	610W, max. 1.15kW	10		10		10	
9	25DW	9		9	115-	9		9	2201//104	9	115-	9		9	BIHT, REHIERS
	1400	1	acag		47.90	- 1		- 1	AN A	1	4730	-11	arad	- 1	
7	Tug	7		7		7	BENT, BANNIS	7		7		7		7	Мадуль термаметрия N
5		5	BANK, BANKA	3	800.020A	5		5	BARE DAMAGE	5	BINT, DAVIDA	5	Berrit, Darrieth	5	220V
- 4		4		4		4		4		4		- 4		4	Skg
3		1		1		1		1		1		1		1	
-1				- 1		1		1		1		1			
		_												_	

/

mapping – in progress ...

# **TPC CABLING AND PIPING**

#### W side: cooling and gas pipes scheme

#### **TPC list of cables and pipes**



		List of	cab	les	s ar	nd	pip	es								
			14	12	10	8	6	4	2	1	3	5	7	9	11	13
	Purpose	Diameter, mm	Qty	Qtty	Qty	Qty	Qty	Qty	Qtty	Qty	Qty	Qty	Qty	Qtty	Qty	Qty
EDTC	Data cable	1	0	6	12	18	34	30	36	42	-46	54	60	66	72	78
ESVC	Sense cable	9,4	0	3	6	9	12	15	18	21	24	27	30	11	36	39
EPINC	Power cable	14,7		- 1	6		12	15	- 18	21	24	27	30	- 11	16	39
ESRL	Service cable(1)	2413		-	-	-	12	15	- 18	21	24	27	30	- 11	16	20
EWLI	Watercooking tubes	-70	- °						- 14							-
TSOC	Served	11	10	- 10	10	in the	-			-	-	100	110	130	130	190
THVC	N/	15	0	4	4	1		12	12	16	16	30	20	24	24	28
TLVC	LV Cable	11	1	1	2	2	1	1	4	4	5	5	6	6	7	
TUTC	UTP	6	1	1	2	2	3	1	4	4	5	5	6	6	7	1
TTRL	Trigger (DR)	10	2	2	4	- 4	6	6			10	30	12	12	14	16
TGST	Gas Pipes	12	2	2	- 4	- 4	6	6		1.1	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 LV															
TLPC	LVDB: low-voltage cable supply	12	0			16	36	24	32	12	12	12	40	-40	48	-44
TLSC	LVOR: sense wire	2,5	0	4	4		- <u>-</u>	12	16	16	16	36	20	20	24	2451
TEPE	Controller: low-voltage cable supply	12	0	2	2	4	4	6					10	10	12	124
TESE	Controller: sense wire	2,5	0	1	-	2	2	1	-	- 1-	4		5	5	- 6-	6 19
inc.	STOR. NOW CONTROLLED			-	-		-				-	÷.,				
TIDOC	Controller: show control	7		2	2			6					10	10	12	12
TDOO	Controller: DATA (SFP	apt. 1.1	0	1	1	2	2	1	4	4	4	4	5	5	6	6
		4.1.1	-	-		-		-	-	-	-		-	-		-
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	apt. 1.1	0	1	1	1	1	1	2	2	2	2	2	2	2	2
TOSO	Reserve cables SP+	opt. 3,9x1,8	0	1	- 1	1	1	1	2	2	2	2	2	2	2	2
1040	RUL Cramow	41											16	- 10	10	
TRAC	for HUC: HV power supply for anode sections	4,1	0	0					-			- 20	10	20	10	
TRAC	for NGC IN electron acquiring suppry	41		0					1	1	-	1.1			10	
TRCC	for NGC: He focking give	41	0	0	1	1	2	2	2	2	1	1.0	1.2	5	5	6
TRSC	from ROC: signal cable (anote)	41	0	0	4	4		1		1	12	36	16	20	30	24
	Sensors			-	<u> </u>	-	-	-	-	-						
TSSC	Temperature sensor cable Pt100		0	0	3	3	6	6	6	6	9	12	12	15	15	18
			_			_										
TSPC	Cables from pressure sensers on pipes cooling + stabilization	7,8	0	0	4	4					12	36	16	20	30	24
INTO	Cables from temperature senses on pipes conting a stabilization	7.8			- A -					1 A 1	12	16	16	20	20	24
1.41%	HV TPC central membrane			-	-	-	-	-	-	-						
THEC	Central HV electrode TPC		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				_											
mor	external thermal screen stabilization pipes	12	0	0	2	2	2	4	4	6	6	7		-	10	10
	and internal stated stategies ripes	12	0	0	-		+	4	4	4	- 2	4	4		-	
1101	Pres stabilization BOC chambers becalters	12	0	0	- 6	- 6		6	0	6		2	2	2	2	- 2
1111	TOV Barras stabilization nines with anxies	12		0		0	0		1	1	4	÷	-		-	i i
TIST	Stabilization cipes FE SAMPA	12	0	4	4	6		9	12	12	15	36	17	20	30	24
	Cooling (12 loops)					-										
TCLT	Cooling pipes LVDB, controllers & FE FRGA	32	0	0	0	1	2	2	2	2	2	2	1	3	- 4	4
-	TPC laser system															_
			· .			· .				L						
ILWC	Cable for vista camera control system floor laser beam	1	0	0	1	1	1	1	1	1	1	2	2	2	2	2
TOST	Puter of CIC2 and CIC4 (invest/puter)	12		0			0		0			0	1	1		1
	index and the state of the states												-		<u> </u>	<u> </u>
TSGC	Position centers hydraulic cylinder	6		4	4	4	4	4	4	4	4	4	4	4	4	
	A second s											-				

**Cables and pipes integration – in progress ...** 

# **TPC CABLING AND PIPING**



**Structure design - in progress** 

# **TOOLING FOR INSTALLATION TPC TO MPD**

# **Bld. 217**













Tooling design - finished Prototype 1:5 - done (July 2023)

# **TOOLING FOR INSTALLATION TPC TO MPD (MINSK): PROTOTYPE 1:5**





Some improvements – to do and finished

Contract	- Sept-Oct 2023
Tooling manufacture	– 9 months
<b>Delivery to JINR</b>	-August 30 2024

## **TIME SCHEDULE**

#### **Status:**

T

PC assembling:	
Field cage assembly	- Oct 30 2023
HV tests	- Nov 10 30 2023
TPC vessel ready (glue by epoxy)	- Nov 30 2023
Laser beams position measurements	- Dec 10 2023
<b>TPC vessel tightness measurements</b>	- Dec 30 2023
24 ROC chambers installation	- Jan-Feb 2024
TPC tests: laser tracks and cosmic test	- May-Sept 2024

#### **Integration TPC to MPD:**

TPC racks (8pc) + cabling- Start from Nov 2023 ÷ 2024TPC rails (2pc manufacture and delivery to JINR) - Dec 30 2023- 2024Rails installation to ECAL support structure- 2024 ...

Tooling for installation TPC to MPD: Design optimization + prototype 1:5 Tooling manufacture Delivery to JINR

TPC+ECAL cooling systems: installation commissioning

**TPC installation to MPD MPD commissioning**  - done

9 months (expected start - Nov 2023)August 30 2024

- Oct 2023 ÷ Feb 2024 - Sept 30 2024

- Oct 01 ÷ Nov 30 2024 - Jan ÷ Feb 2025

Thank you !

# **BELARUS CONTRIBUTION TO TPC**

Mechanics («ARTMASH», 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)
- installation TPC to MPD tooling 1:5 (1 pc)
- Prototype "TPC rail 3 meters" (1 pc)

#### **Electronics (INP BSU):**

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

**Cooling system for TPC + ECAL (INP BSU - full responsibility)** 

- cooling setup for tests (1pc)
- galvanic couple protection (Al-stainless steel and Cu-stainless steel )

#### R&D (INP BSU, ):

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

#### MPD and SPD detectors grounding (Институт Энергетики БАН)

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

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# Many Thanks!!!!

sorry if anybody forgotten

# TIME SCHEDULE