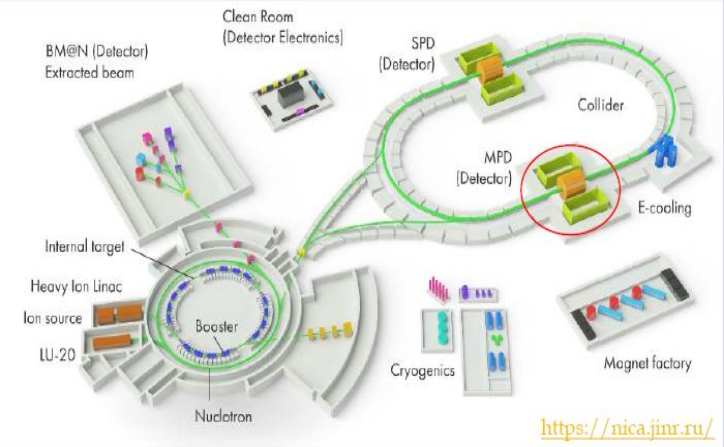
MPD/NICA TPC status (25.02.2020)

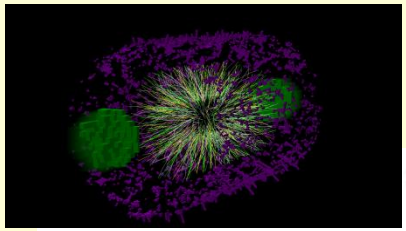
- TPC parameters
- ROC chambers
- TPC assembly
- front end electronics
- gas, cooling, laser and SC systems
- cabling and piping
- integration TPC to MPD
- time schedule

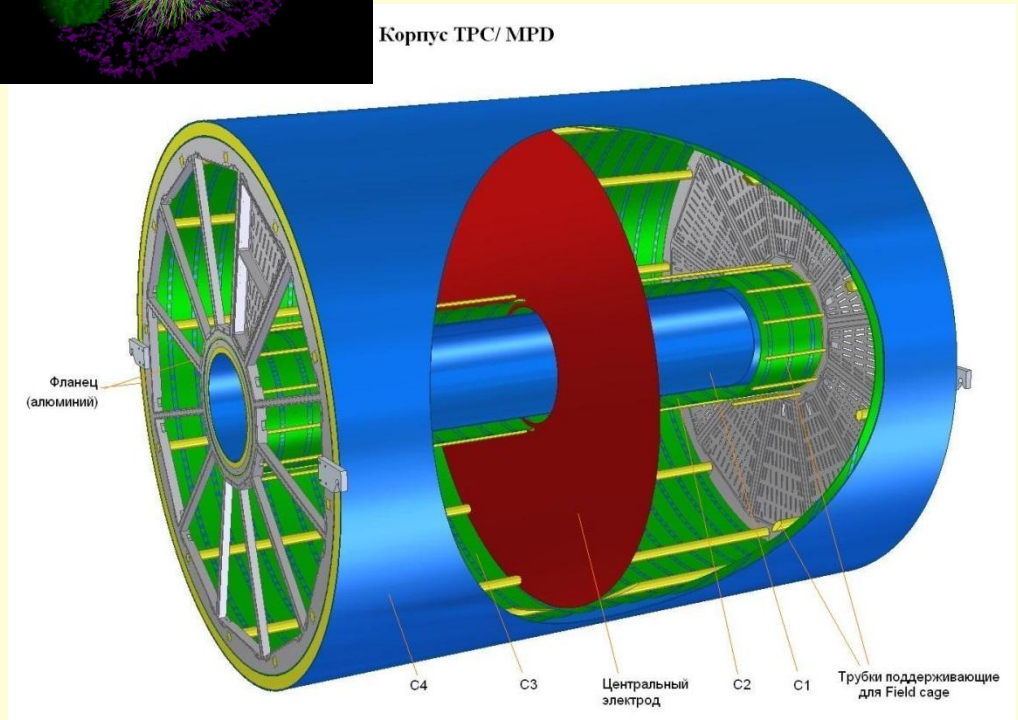


Presented by Sergey Movchan
on behalf of the MPD collaboration

JINR team: 24 persons
Belarus: 6 persons

MPD TPC 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 TDR – http://mpd.jinr.ru/wp-content/uploads/2019/01/TpcTdr-v07.pdf

ROC chamber assembly hall (Bld.40)

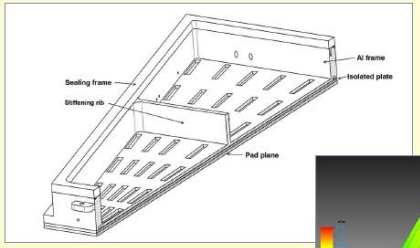
Gluing

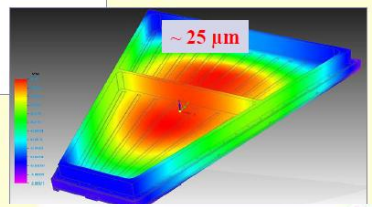
Wiring

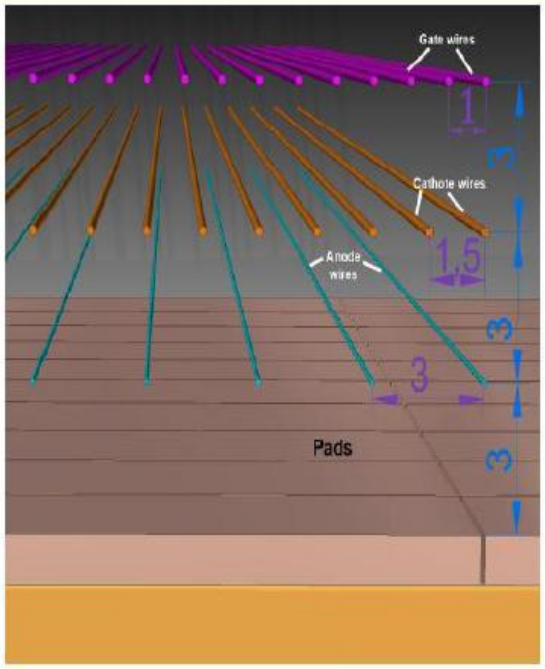
Test set up

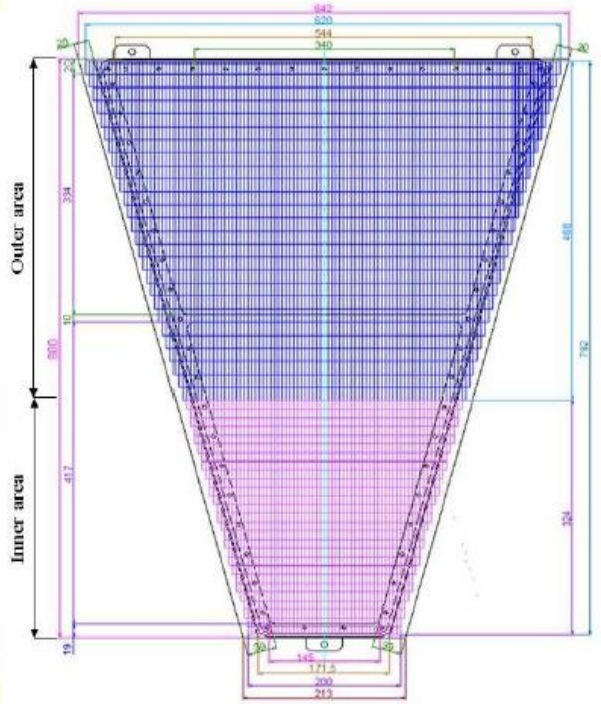
Soldering

Read out chamber (ROC): based on MWPC









Design of Read-Out Chamber (ROC) is defined

Structure of Readout Chamber:

- three wire planes
- pad plane
- insulation plate
- trapezoidal aluminum frame

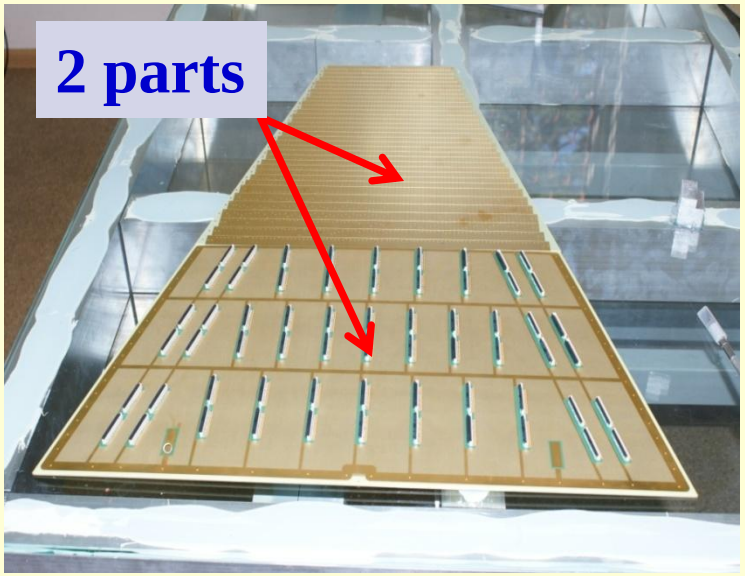
Wire structure:

- anode wire (Ø=25 µm) pitch - 3 mm
- cathode wire (Ø=75 µm) pitch - 1.5 mm
- gate wire (Ø=75 µm) pitch - 1 mm
- wires gap - 3 mm

Pads:

- rectangular shape
- 27 rows of pad with size 5x12 mm² at inner area
- 26 rows of pad with size 5x18 mm² at outer area

ROC chamber: pad plane



Pads capacitor measurement

Connectivity test

Next 10 serial pad planes with soldered connectors:

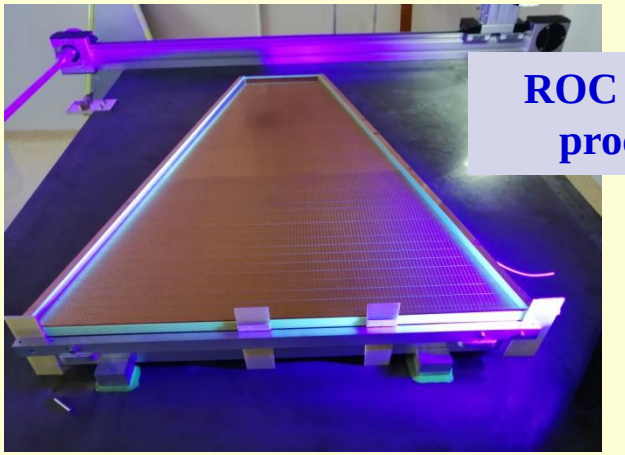
delivered - Jan 2020

connectivity test - ok!

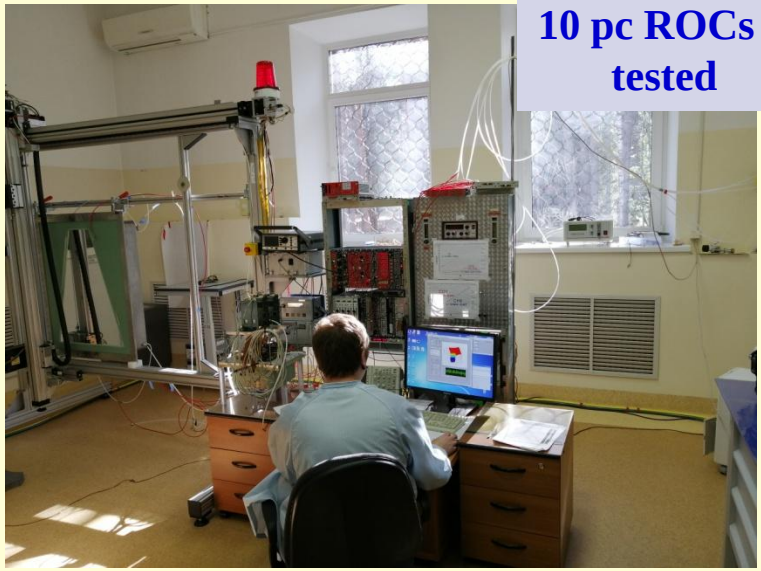
Next (last) 15pc serial pad planes - ordered

ROC chambers status

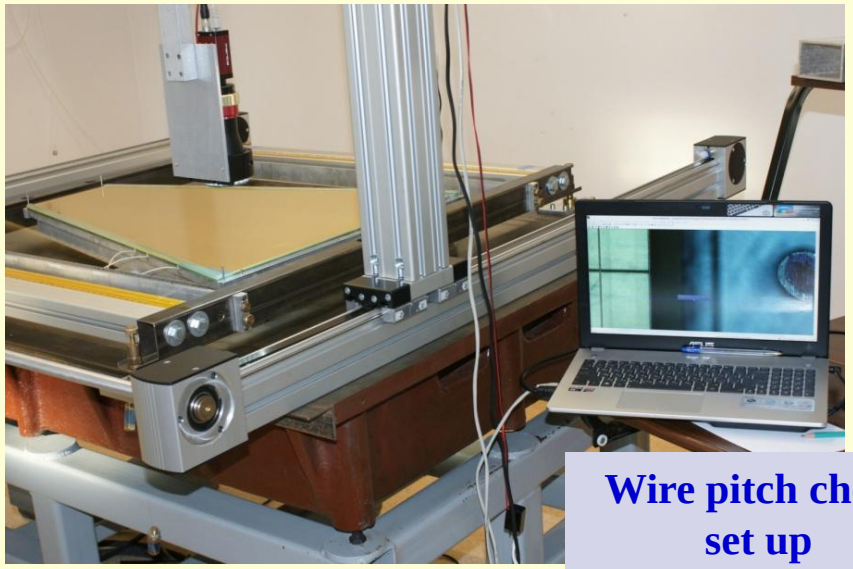
26 pc
ROC frames
- in stock



ROC cleaning procedure

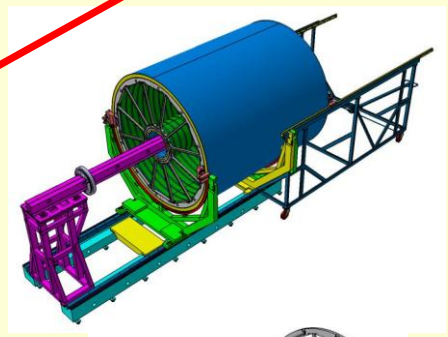


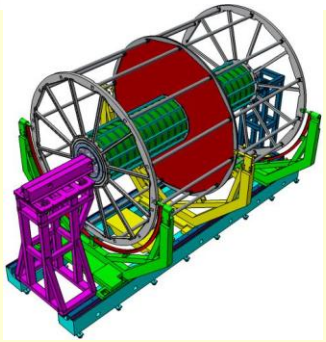
10 pc ROCs - tested

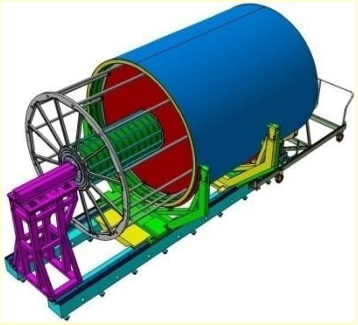


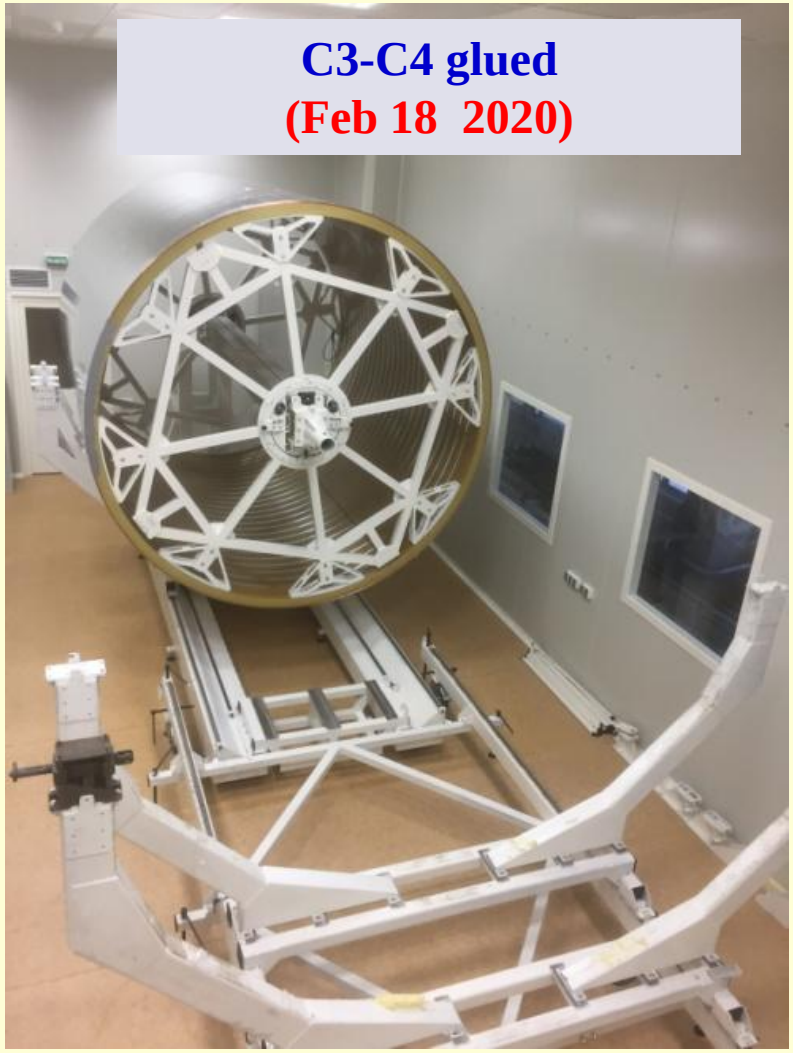
Wire pitch check set up

TPC assembly (Bld.217) – common view









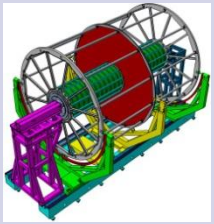
TPC and ROCs: summary

ROC chambers:

serial ROC chambers manufacture	- in schedule (10 pc tested)
frames (26 pc)	- ready
serial pad planes (20 pc ready)	– last 15 pc ordered, ok!
HV for ROC gate mesh	– design started … on critical path
test chamber with 2048ch r/o system	– Nov 2019 -> Feb-March 2020

TPC assembly:

C3- C4 gluing	- done (Feb 18 2020)
C1- C2 gluing	- Feb-Mach 2020
field cage rods (30 pc + 30 pc)	- in manufacture
field cage mylar strips manufacture	- March 2020
flanges finishing (add holes and grooves)	- March 2020
start of TPC internal structure ass.	- Jan 2020 -> March 2020



TPC transportation platform and manipulator for ROC chamber installation - ready

TPC electronics requirements

Data rates:

- trigger mode – 20 GByte/sec *(N=1000 tracks)*

- continuous readout mode - 300 GByte/sec

Particle fluence *for R=35 cm & 10 years (October 2019 update)*:

neutrons + protons – 1011 p/cm2 per year**

e- & e+ - 2x1010 p/cm2 per year**

ions - 10 5 p/cm2 per year**

Dose:

Expected dose - 2 kRad per 10 years

SAMPA v3/v4 tested at:
*proton fluence - up to N=10**12 per cm2*
*ion fluence - up to N=10** 7 per cm2 & LET=(3-125) MeV cm2/mg*
T chip=(45-85) degree =>
SEL =1x10-7 cm2 for LET=16 MeV cm2/mg

TID and SEL - ok!

FPGA Cyclon V (technology -130 nm): 28 nm):
TID – up to 100 kRad, SEL < 0.5 sec for LET=26.6 MeV cm2/mg

TID – ok!, SEL – no so good

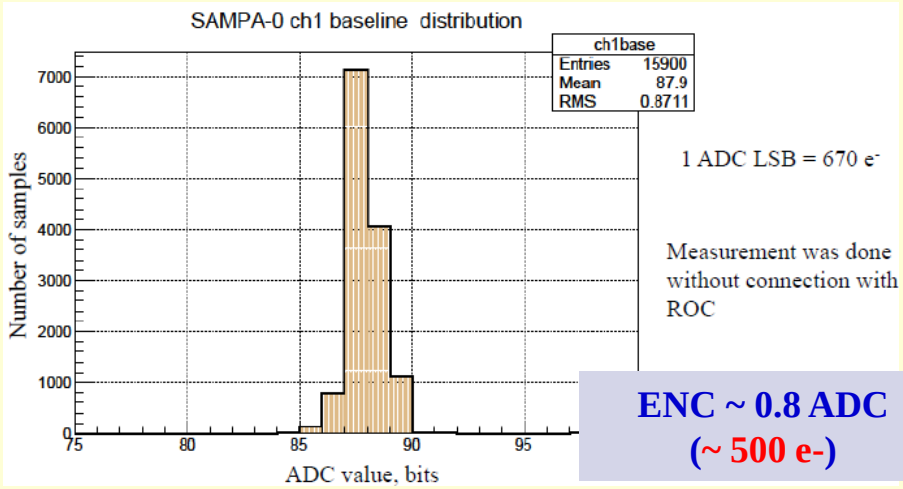
TPC electronics: FE cards

Top view (service side)

- The total number of registration channels: 64
- Input signal dynam. range: 100 fC
- ADC resolution: 10 bit
- ENC: less than 1000e$^-$
- SAMPA chips configured and controlled via FPGA
- Readout serial interface: up to 2.5 Gbps

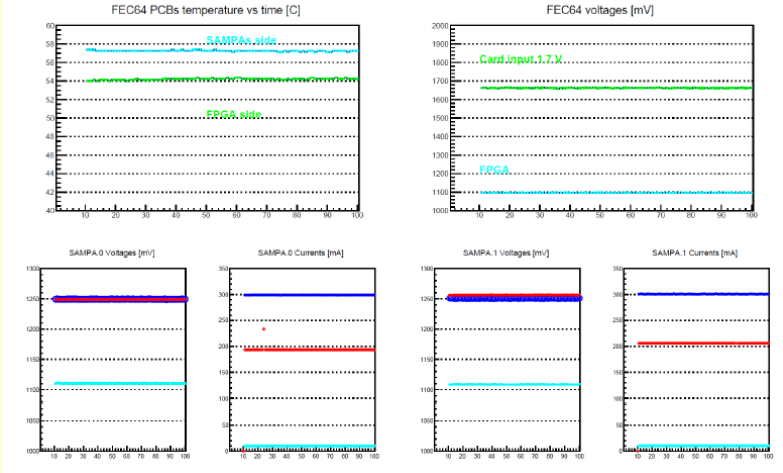
➢Double-board FEC provides opportunities for possible upgrade of the card readout.
➢Transfer of data and trigger signals was realized with the same high-speed serial interface.
➢16 values of currents, voltages and board temperatures are controlled with ADC.
➢External circuit and embedded protection functionality against SEU are provided.
➢Remote system update for FEC firmware was provided.

Bottom view (ROC side)



ENC ~ 0.8 ADC (~ 500 e-)

FEC slow control data

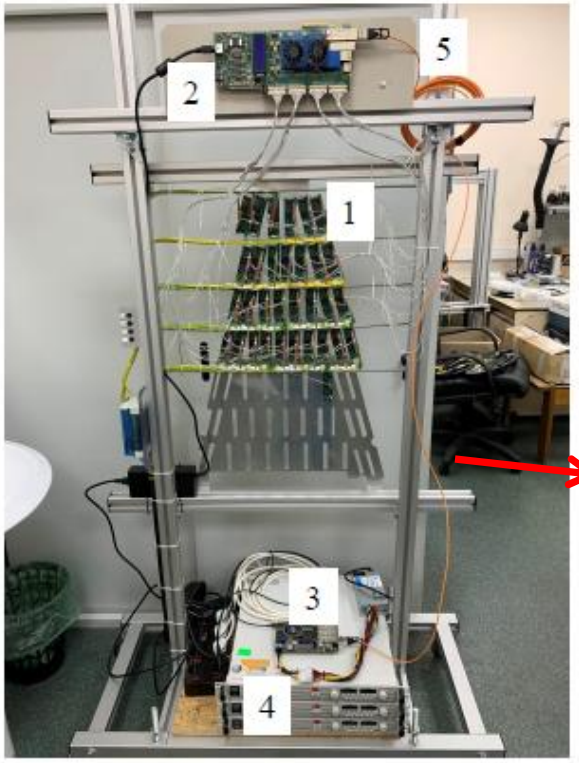


SAMPA chips (4500 pc) delivered to JINR - June 2019

for more details - see S.Vereschagin talk

TPC electronics: status and schedule

Bench test



Front view

1) 32 FECs; 2) RCU prototype; 3) DCU module; 4) LV power supply; 5) Optical link.

Item	Date	
Testing 512-channel system (FEC v1.0) finished	Jan. 2019	✓
Testing 256-channel system (FEC v2.0) finished	Feb. 2019	✓
Preproduction vervion FEC PCBs sent for fabrication	Mar. 2019	✓
Half-ROC readout system base design finished	Mar. 2019	✓
Receive SAMPA V4 chips at Dubna	Jul. 2019	✓
34 preproduction version FEC assembled and tested	Nov. 2019	✓
32 preprod. version FEC installed on Pilot 2048 ch. Syst.	Dec. 2019	✓
Instrumented Half ROC system testing	Feb. 2020	
Testing instrumented ROC finished	Apr. 2020	
Production vervion FEC PCBs ready	May 2020	
1st batch of prod.ver FEC (130 pcs) fabricated	Jul. 2020	
2nd batch of prod.ver FEC (800 pcs) fabricated	Sept. 2020	
3rd batch of prod.ver FEC (800 pcs) fabricated	Dec. 2020	

TPC LV+HV system

LV&HVsystem based on CAEN rad. hard design:

(up to 2000 Gauss and 15 kRad)

- **power converters A3486 AC/DC (380 V -> 48 V)**
- **CAEN EASY3000 system**
- **LV module - A3100B (2÷7V/100A)**

Status:

- ***test system – ordered***
- ***quotation for full TPC LV+HV system got, procurement – in progress***

LV cables (halogen free, low smoke):

S=50 mm2 – delivered to JINR Dec 2019

S=120 mm2 – delivered to JINR Dec 2019

in progress …

HV cables - will be delivered July 2020

LVDB boards (60 pc) - delivered

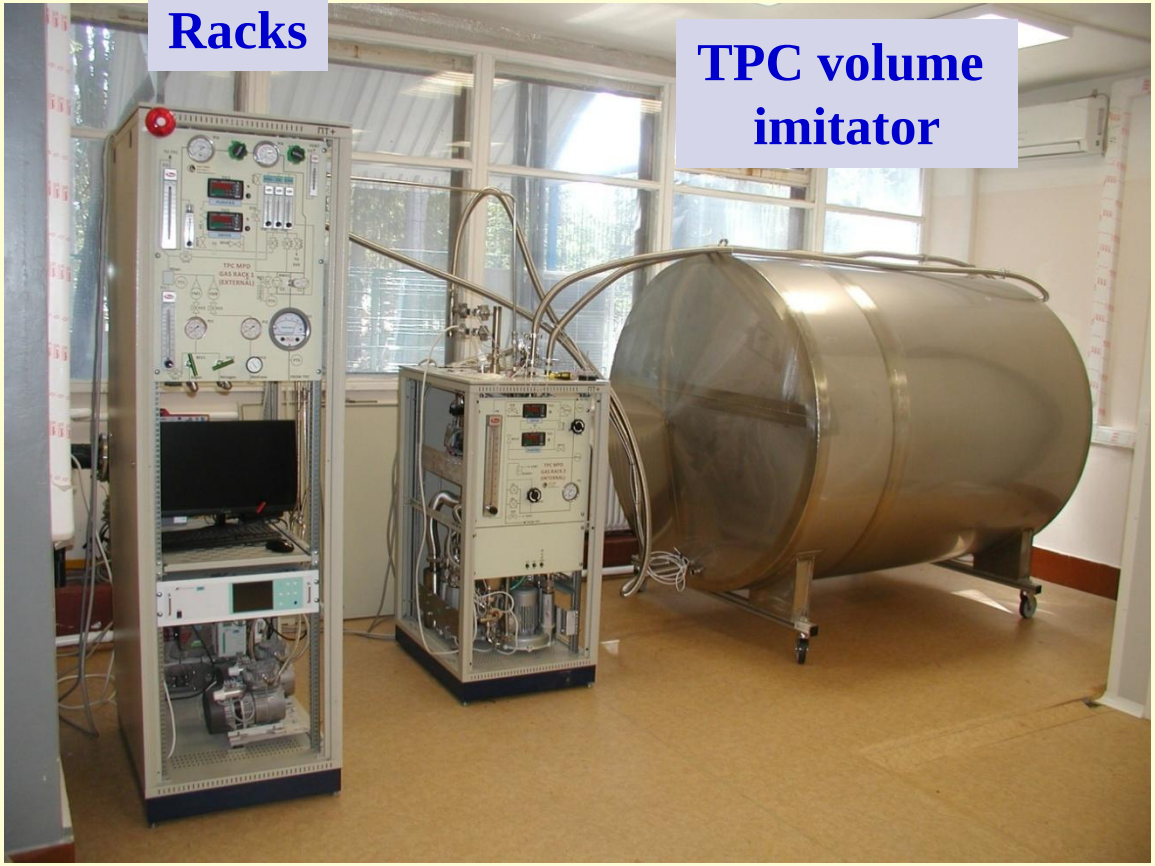
INP BSU (Minsk)

Team for cabling and piping – looking …

TPC gas system

Racks

TPC volume imitator

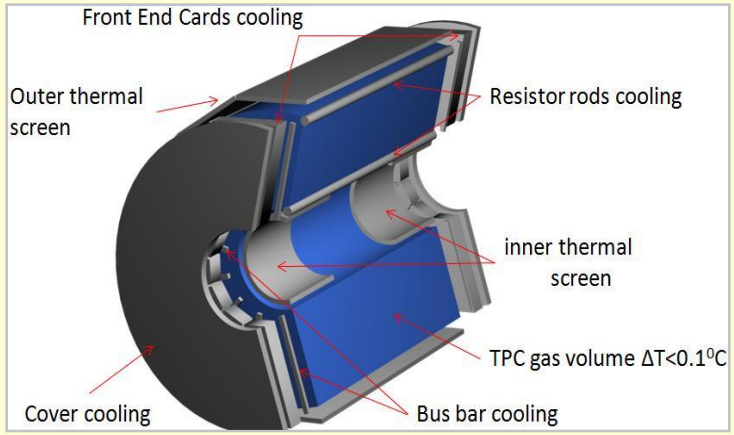


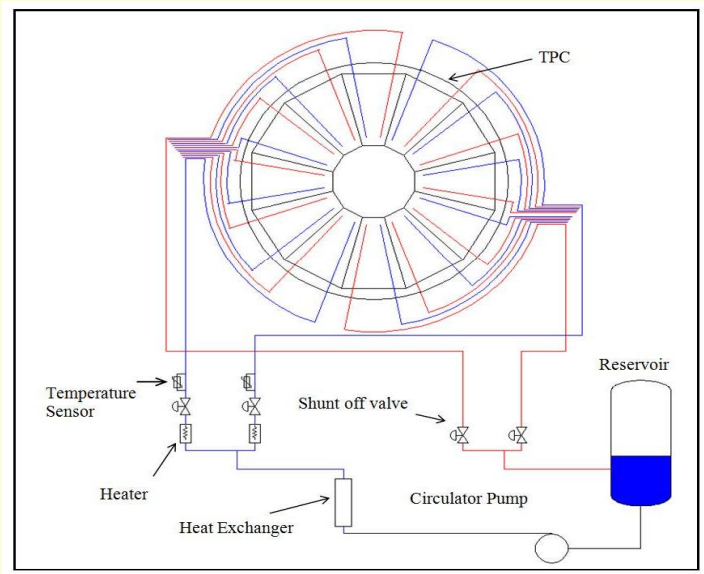
Gas supply

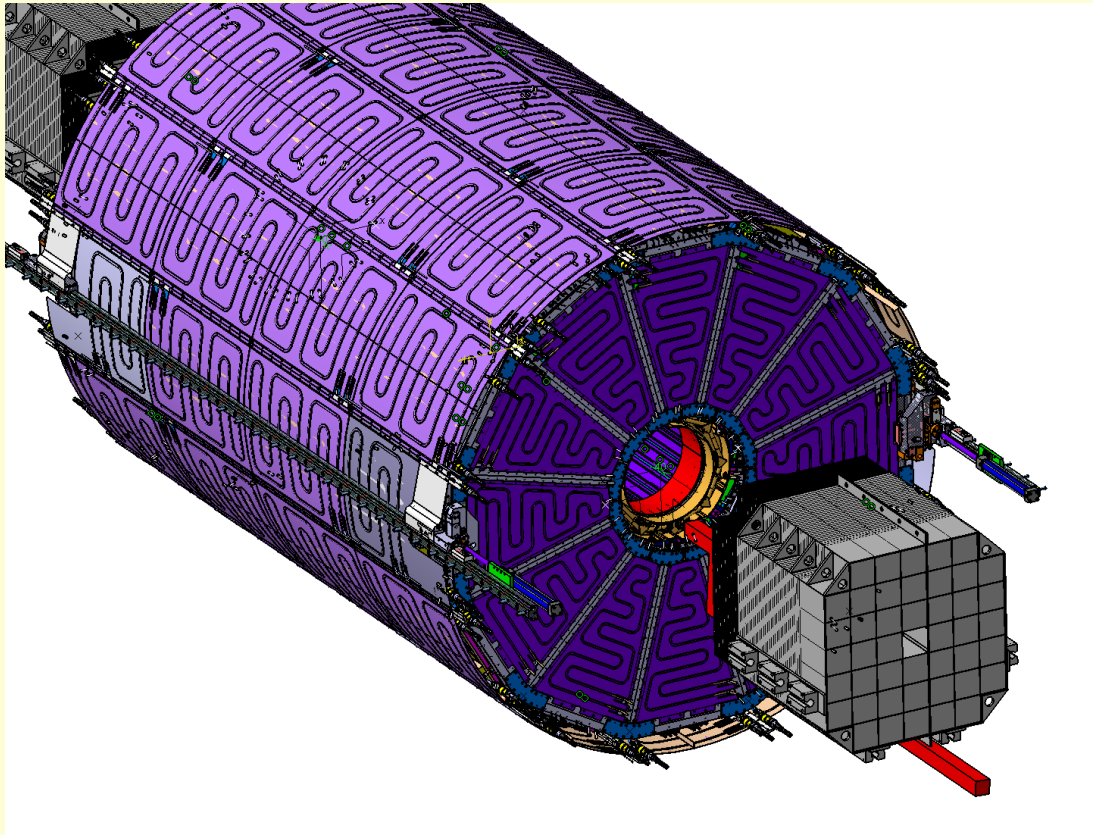
Commissioning - in progress

Status - **commissioned** (Bld.217)

TPC cooling system

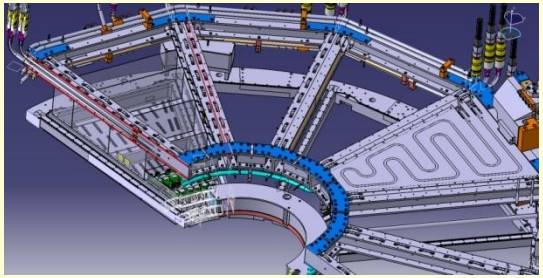




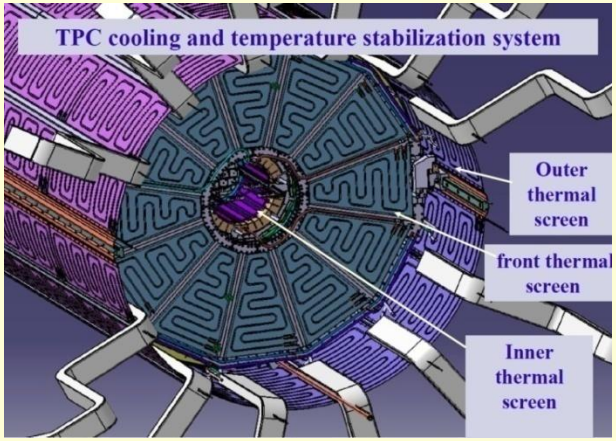


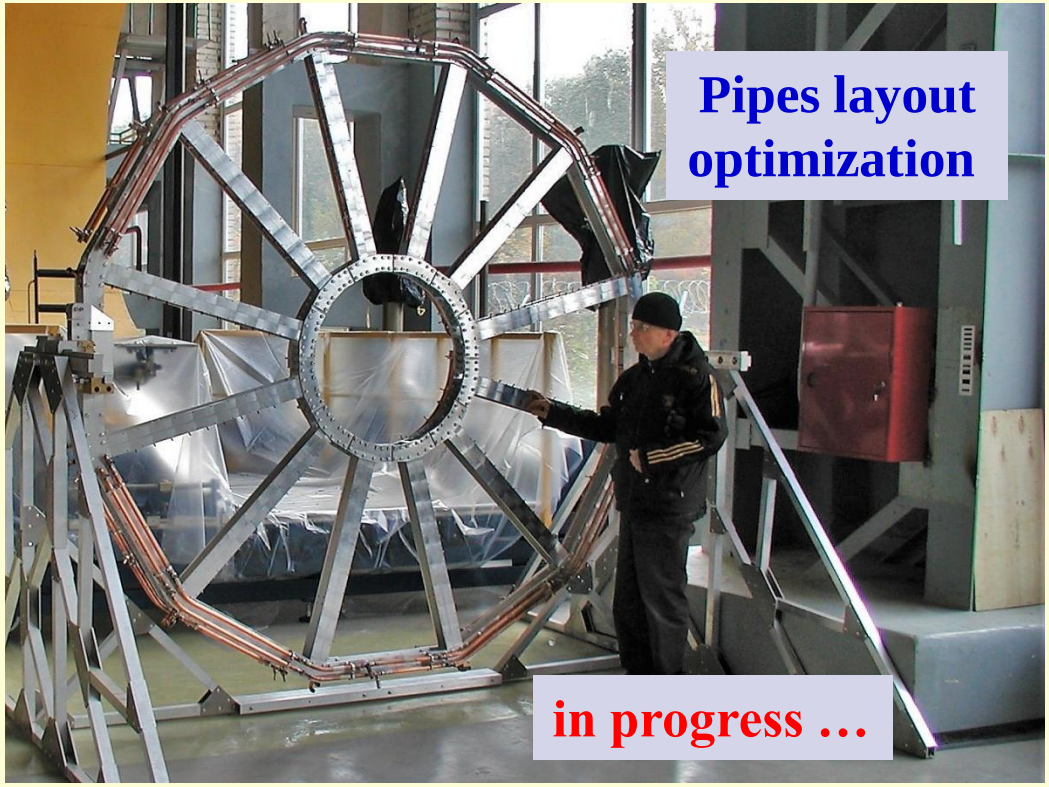
Barrel part – shorter and fixed to TPC instead TOF structure

TPC cooling system: pipes layout and thermal panels



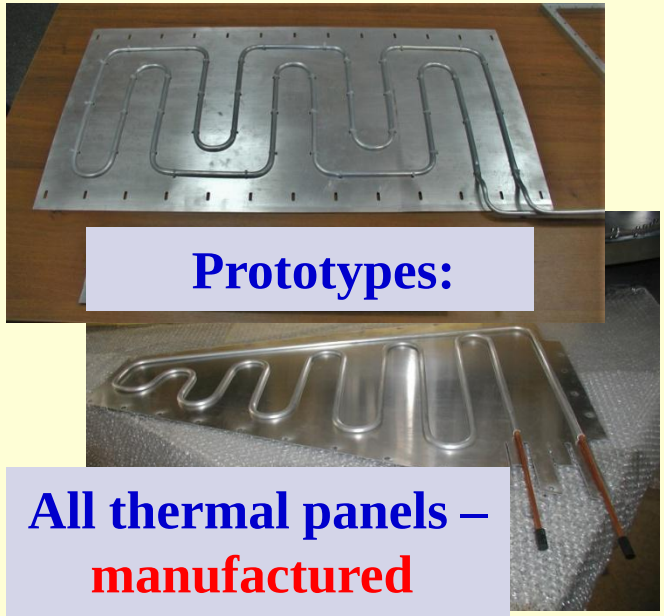
Service wheels - manufactured





Pipes layout optimization

in progress …

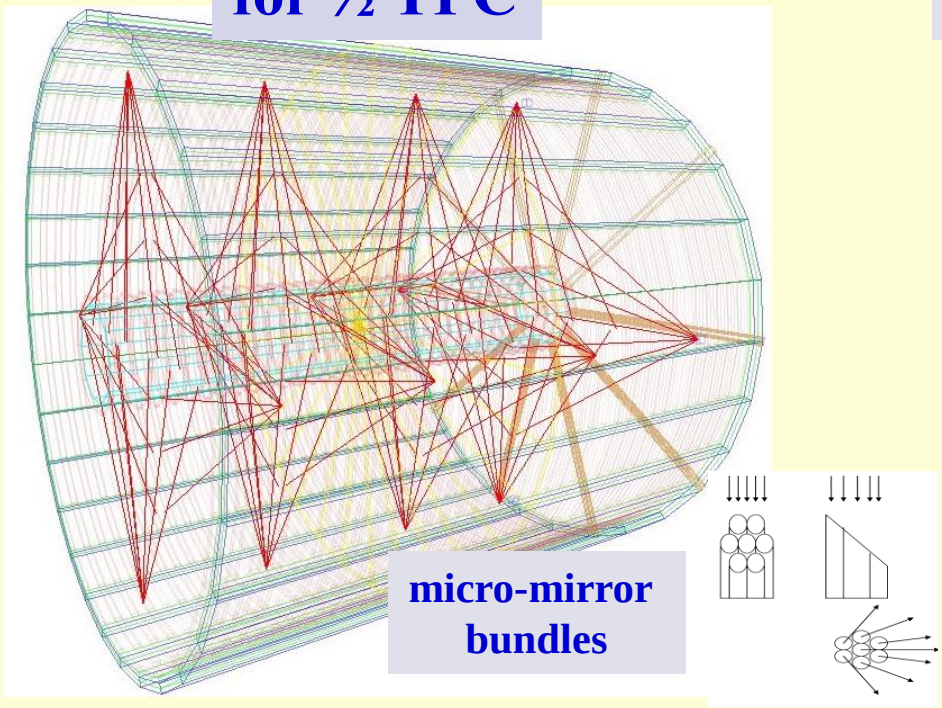


Prototypes:

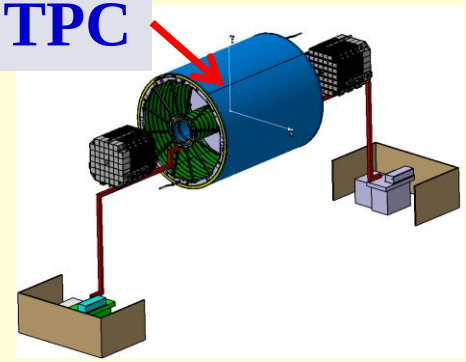
All thermal panels – manufactured

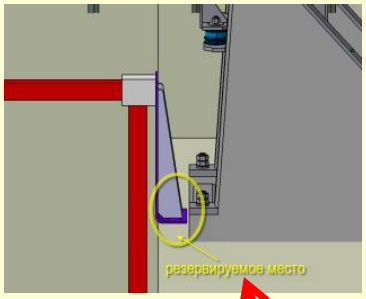
TPC laser calibration system: laser beams layout

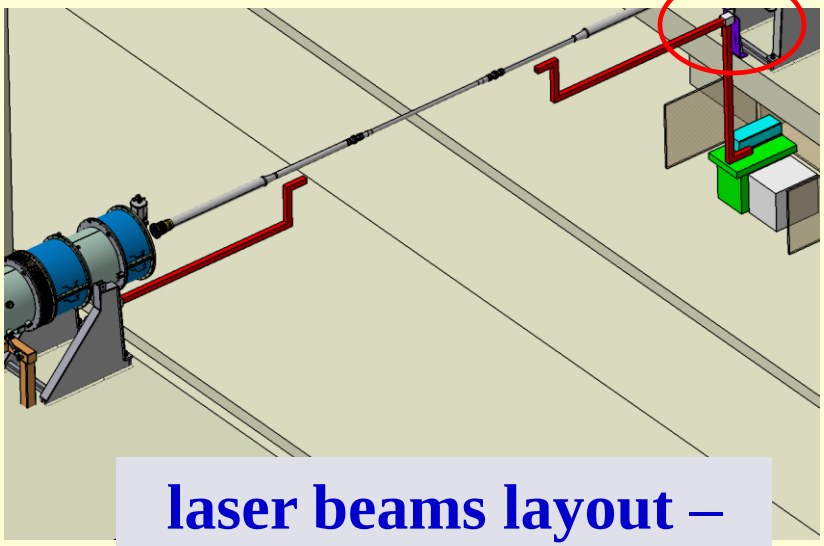
for ½ TPC



TPC



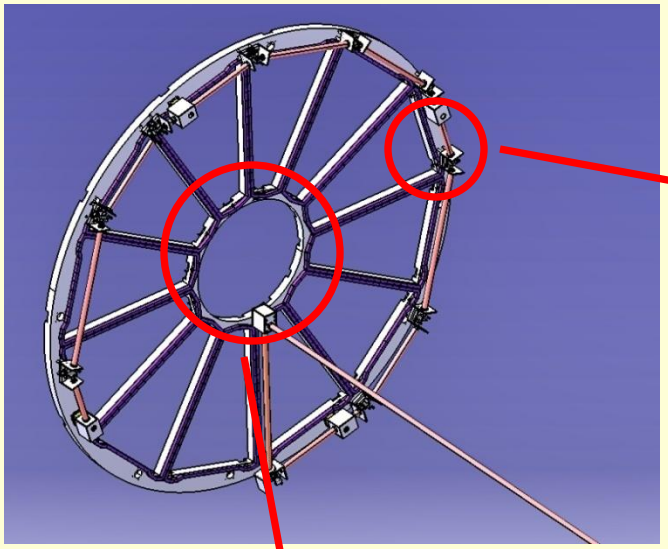


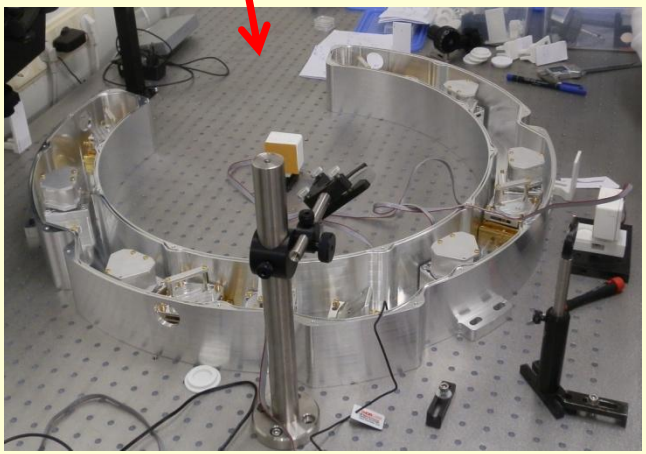


Laser "planes" – 4+4
Points per plane - 4
Beams per point – 7
Laser "tracks", N - 224

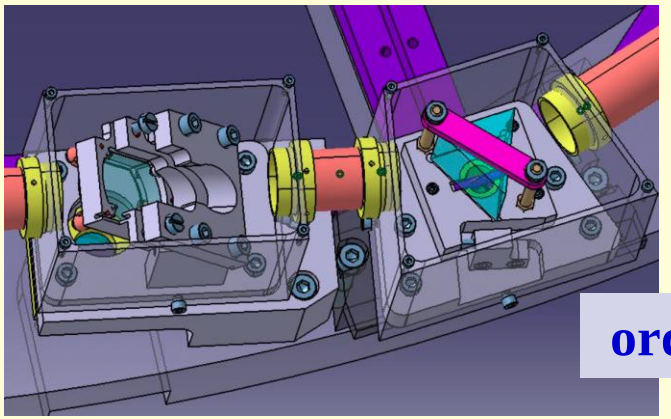
laser beams layout – under finalization

TPC laser calibration system





Semi transparency mirror & prism



ordered

- **full set of micro-mirror bundles - assembled**
- **2 lasers (special option) – commissioned**
- **laser beam splitter - delivered to JINR**
- **laser beam monitors - prototype under tests**

TPC slow control system: sub-systems status

LV system:

1) CAEN EASY3000 (crate SY4527 (2pc), crate EASY3000 (12pc), module A3486 AC/DC (400V) converter (13pc), module PS A3100B (55pc) **+ software GECO 2020 - ok!**

2) Custom made stabilizers (module LVN9 (48pc-ok)) **+** crate 6U (1pc), custom control units (12pc) + crate controller (1pc)+ PC) + **custom software - in progress**

HV system:

1) MWPC: CAEN (crate SY4527-2pc + modules A7236DN -3.5kV/1.5mA, A7236DP +3.5kV/1.5mA, A1542HDN -500V/1mA **) + software GECO 2020 - ok!**

2) TPC HV electrode (- 30 kV): Iseg HV PS + **software - ???**

3) HV for ROC gate: custom made system (crate – 2pc, modules –24pc, crate controller- 2pc) + **custom software - NO**

DAQ:

Hardware: FEC64 (1488pc), ROC controller (24pc), data server (6pc) **+ TPC team firmware and software – in progress**

Trigger and synchronization - NO

TPC slow control system: sub-systems status

Gas system:

Hardware: DAQ32 module + PC (PNPI, Gatchina) + **custom software – ok!**

Cooling system:

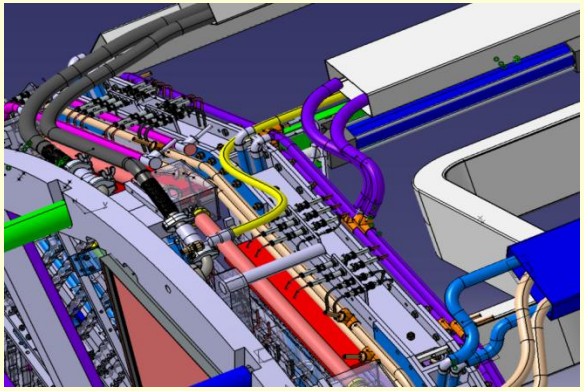
Hardware: NI (National Instruments (crate + ADCs) + 75 channels for hitters control + thermo sensors (100pc)), **custom software - started**

Laser system:

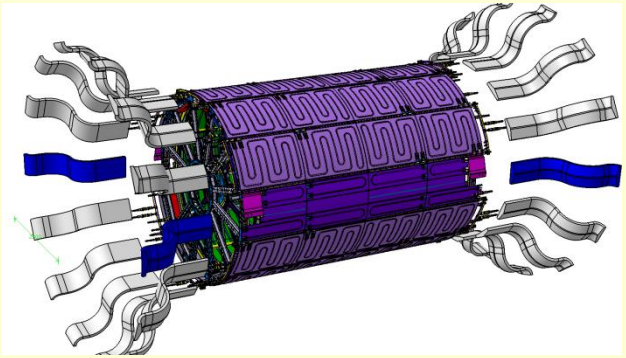
Hardware: PC (1pc), industrial PC (2pc), controllers (2pc), cooling system (2pc), UV laser (2pc) – **ok!** synchronization module (1pc) **–** design not started yet, **custom software – NO**

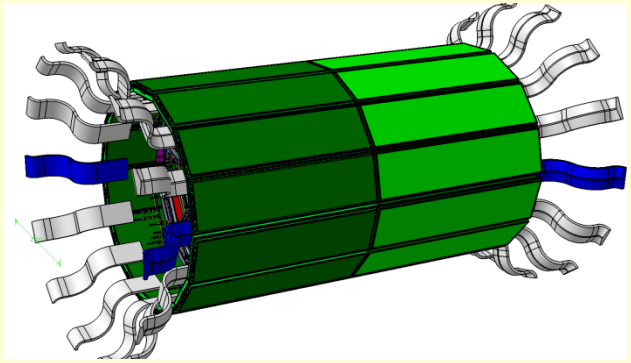
Integration SC sub-systems to common TPC slow control system – not started yet

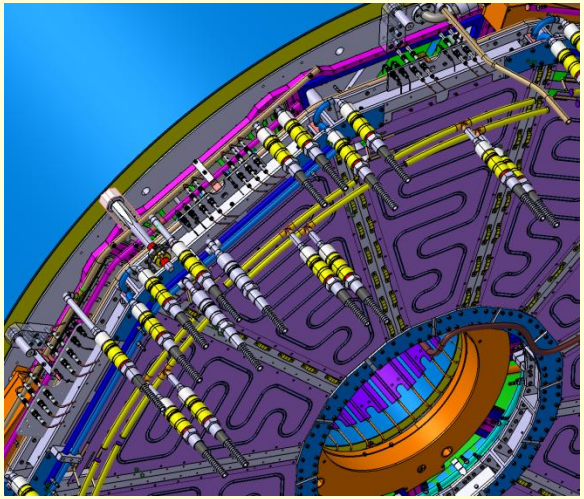
TPC: cables and pipes integration

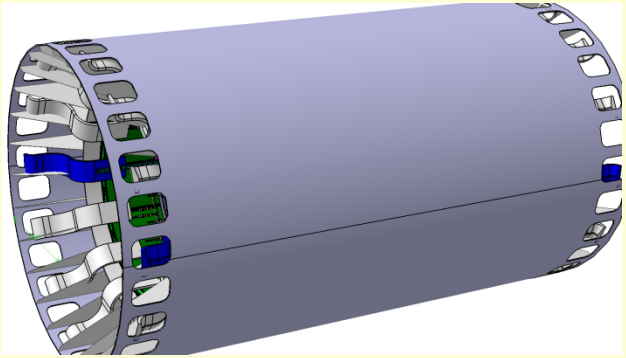


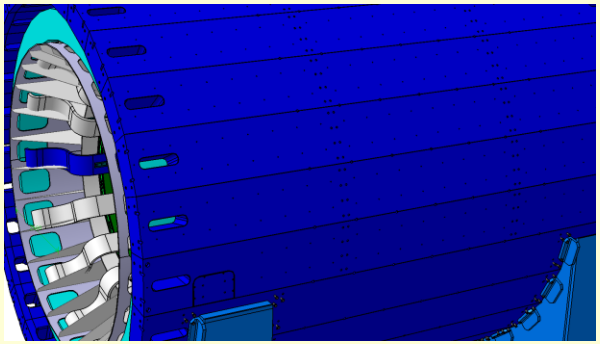
Trays layout concept



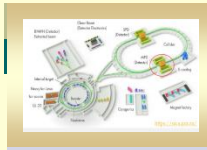
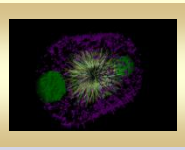




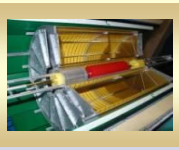




Optimization - in progress

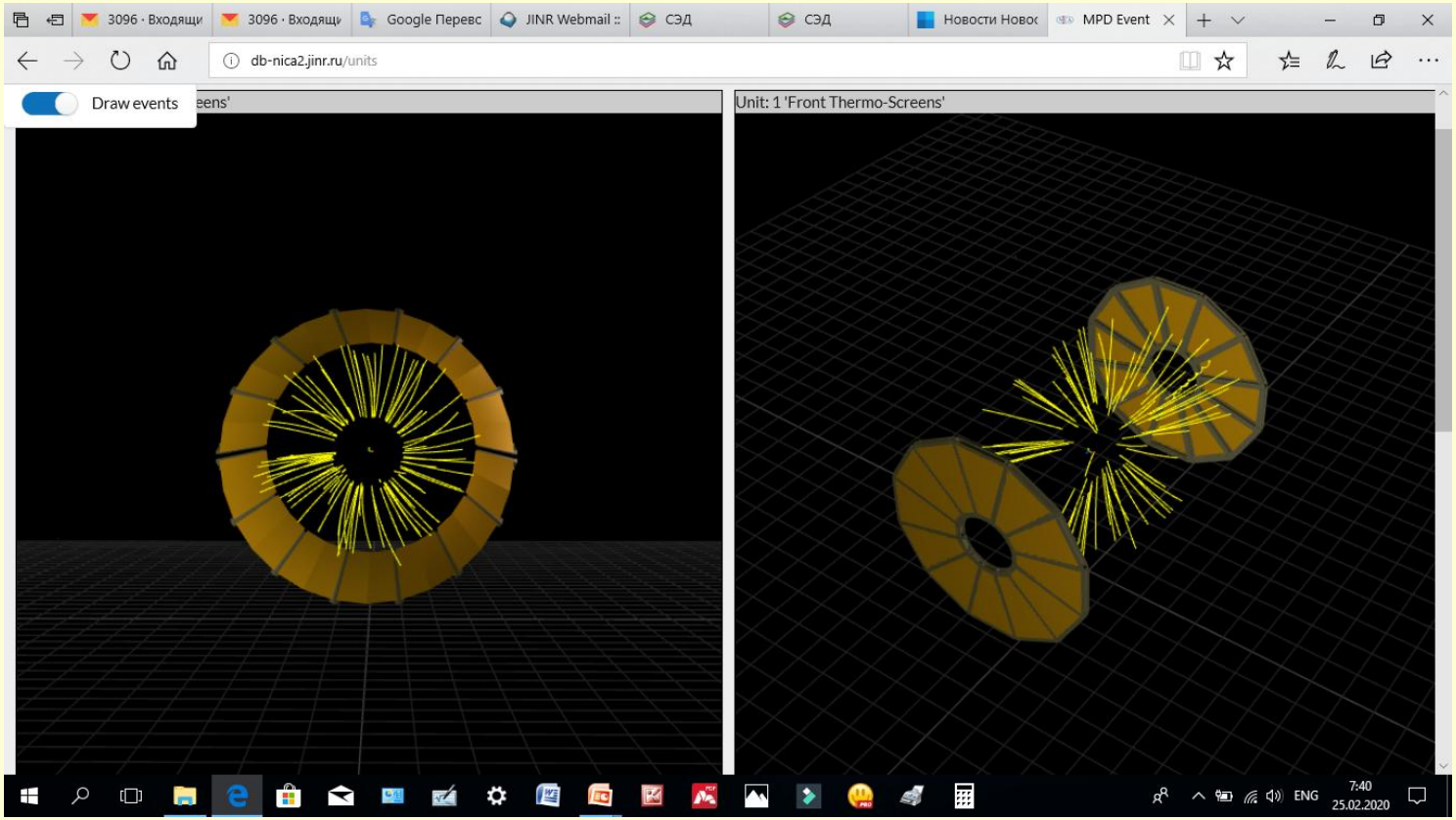
MPD TPC status 2020: summary

Status:

- **TPC:**
  - vessel (C3-C4 cylinders) - assembled
  - TPC internal structure - start assembly March 2020
- **ROC chambers** - 10 pc tested, 12 pc in manufacture
  next 15 pc pad planes - ordered
- **Electronics:**
  - FE electronics (2048ch set up) - testing in progress
  - RCU prototype - testing in progress
  - FE (32 cards) + ROC tests - Feb-March 2020
  - FE cooling prototype - designed, manufactured, tests in progress
  - FE cards mass-production and tests - July-Dec 2020
  - FE radiators mass-production - Sept 2020
- **Sub-systems:**
  - local TPC DAQ - in progress
  - gas system - commissioned, integration to MPD started
  - cooling system - thermal screen panels are delivered, FE cooling radiator tests - in progress
  - HV+LV systems - procurement started (CAEN)
  - laser calibration system - UV lasers and laser beam distrib. systems are delivered, rest - ordered
  - slow control system – sub-systems more less ok, integration to common system not started yet
- **Cabling and piping:**
  - TPC cabling and piping - started, in progress
  - MPD TPC trays design - started, in progress
- **Integration TPC to MPD**
  - TPC racks (~ 10 pc) - racks layout on electronics platform - in progress
  - tooling for installation TPC to MPD - not started yet (a waiting ECAL design)
- **TPC schedule**
  - start TPC commissioning - end of 2020

MPD event display - http://db-nica2.jinr.ru/ (V.Krilov) running on smart phone too …



Example for TPC

http://nica.jinr.ru/
http://mpd.jinr.ru/

TPC TDR – http://mpd.jinr.ru/wp-content/uploads/2019/01/TpcTdr-v07.pdf

Thank you for attention!