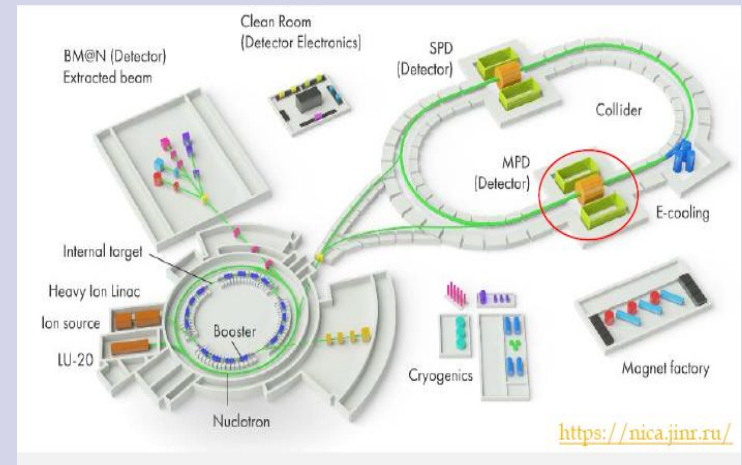


MPD/NICA TPC status (23.04.2020)

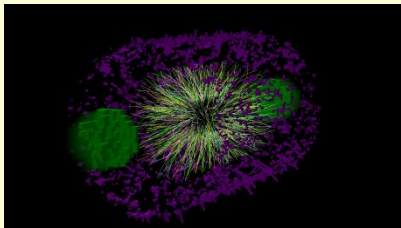
- TPC parameters
- ROC chambers
- TPC assembly
- front end electronics
- gas, cooling, laser and SC systems
- cabling and piping
- integration TPC to MPD
- time schedule



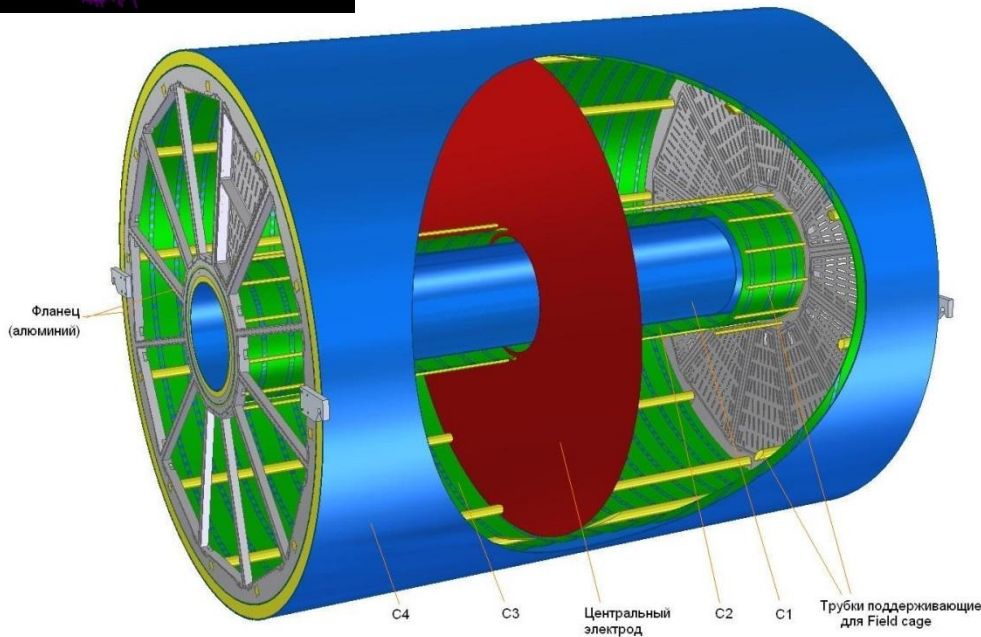
Presented by Sergey Movchan

JINR team: 24 persons
Belarus: 6 persons

MPD TPC parameters



Копия TPC/MPD



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

S.Movchan MPD TPC status, Dubna, Russia, April

22-Apr-20

23 2020

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

ROC chamber: pad plane

ROC chamber assembly hall (Bld.40)

Gluing



Wiring



Test set up



Soldering



2 parts



Connectivity
test

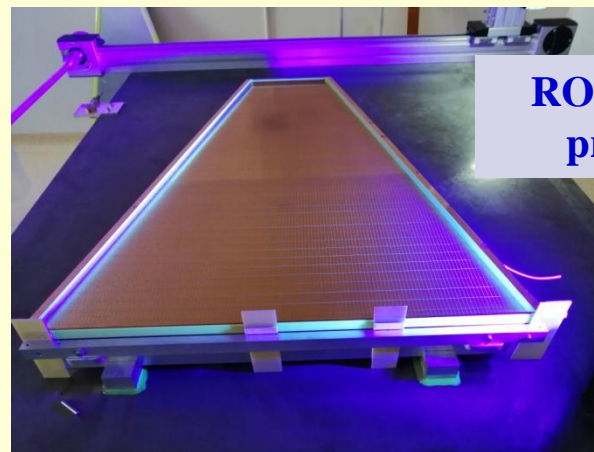


Next **10 serial pad planes** with soldered connectors:
delivered - Jan 2020
connectivity test - ok!
Next (last) **15pc serial pad planes** - **ordered**

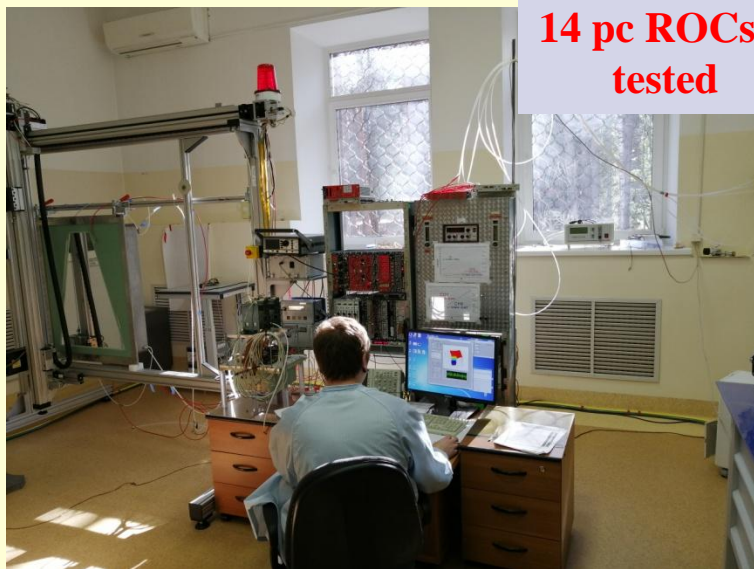
ROC chambers status



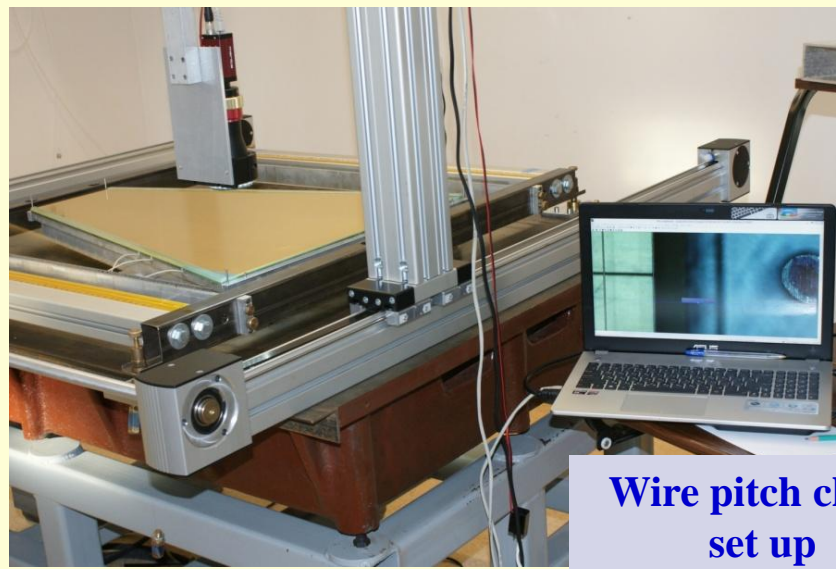
26 pc
ROC frames
- in stock



ROC cleaning
procedure

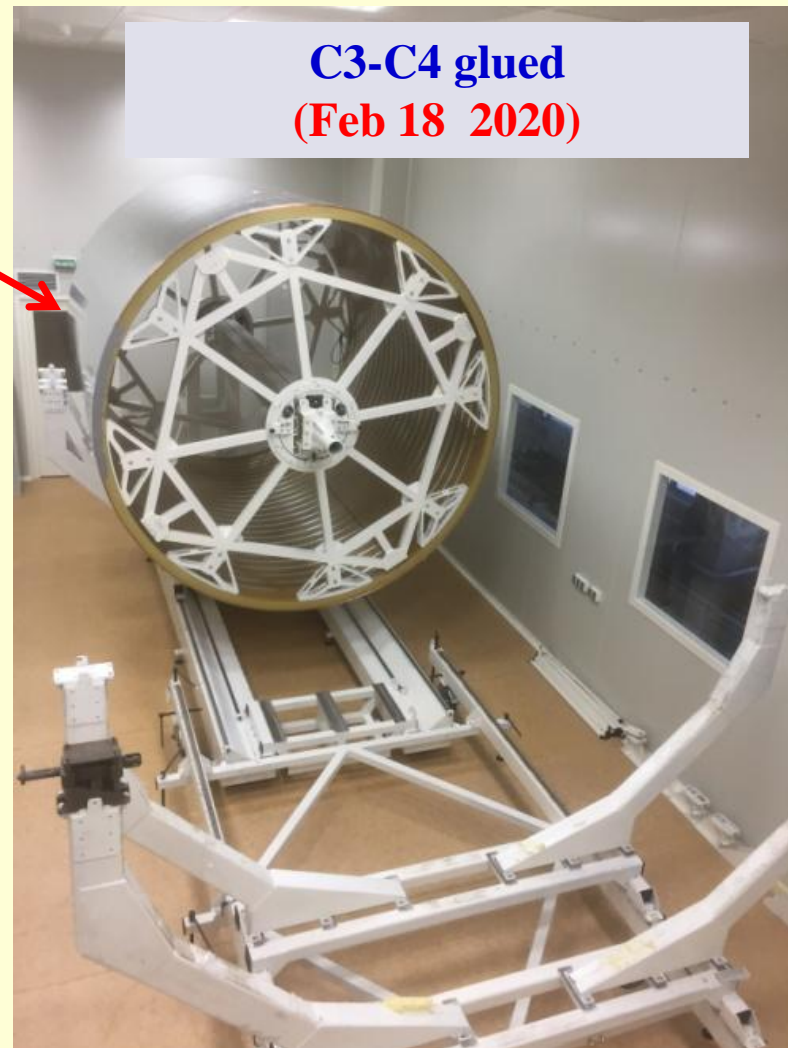
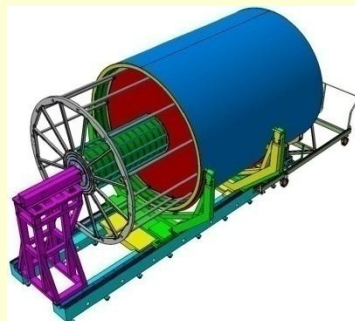
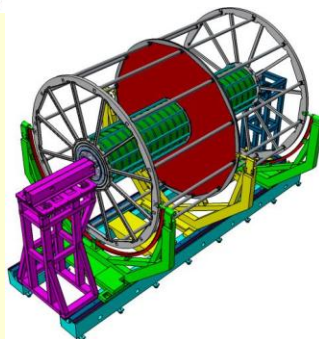
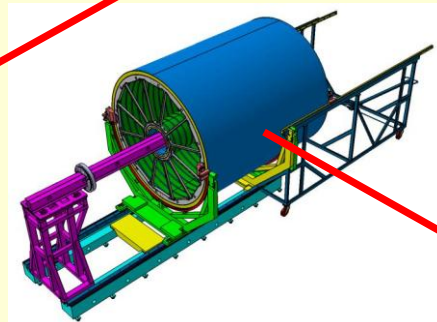


14 pc ROCs -
tested



Wire pitch check
set up

TPC assembly (Bld.217) – common view



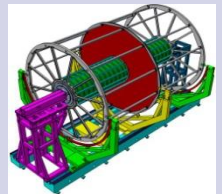
TPC and ROCs: **summary**

ROC chambers:

- serial ROC chambers manufacture - in schedule (14 pc tested)
- frames (26 pc) - ready
- serial pad planes - last 15 pc ordered, ok!
- HV for ROC gate mesh - design started ... **on critical path**
- test chamber with 2048ch r/o system - **ready for tests**

TPC assembly:

- C3- C4 gluing - done (Feb 18 2020)
- C1- C2 gluing - Mach 2020 → **May 2020 ?**
- field cage rods (30 pc + 30 pc) - manufactured
- field cage mylar strips manufacture - March 2020-→ **May-June 2020 ?**
- flanges finishing (add holes and grooves) - March 2020 -> **May-June 2020 ?**
- start of TPC internal structure ass. - March 2020 -> **Lune 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 – **10^{11} p/cm²** per year
- e- & e+ – **2×10^{10} 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 = 1×10^{-7} cm² for LET=16 MeV cm²/mg

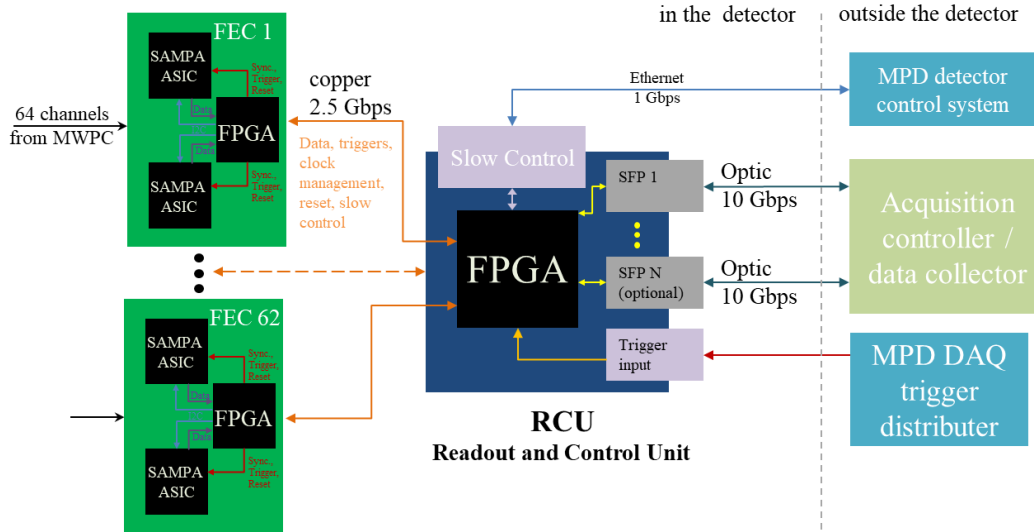
TID and SEL - ok!

FPGA Cyclon V (technology ~~130~~ nm): 28 nm):

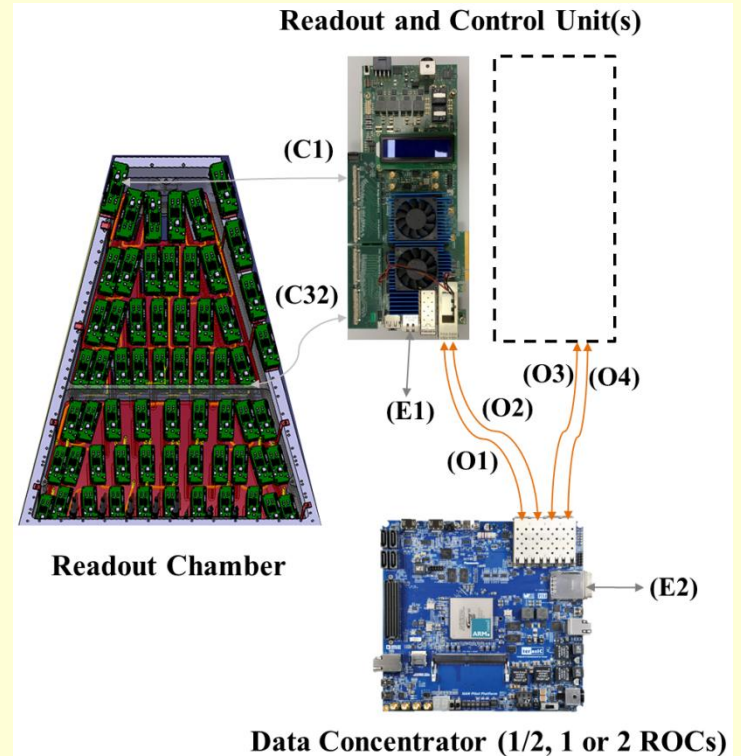
TID - up to 100 kRad, SEL < 0.5 sec for LET=26.6 MeV cm²/mg

TID - ok!, SEL - no so good

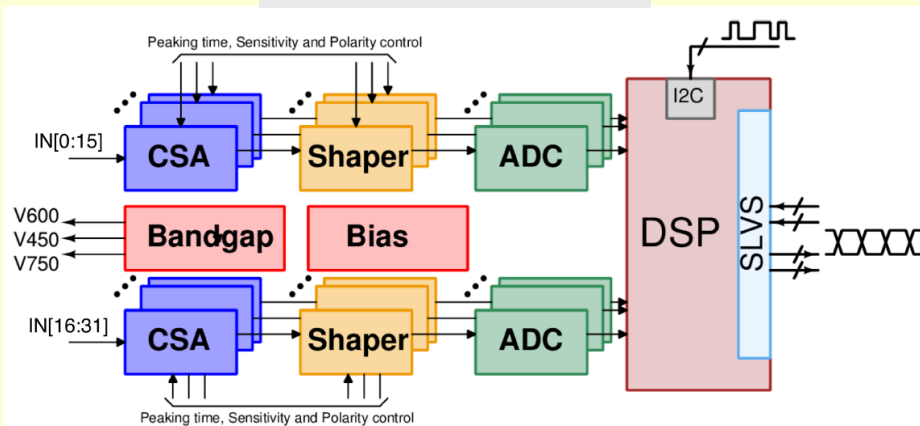
TPC electronics: **block diagram** of one chamber readout



RCU and data concentrator based on commercial kits



SAMPA chip



TPC electronics: FE cards



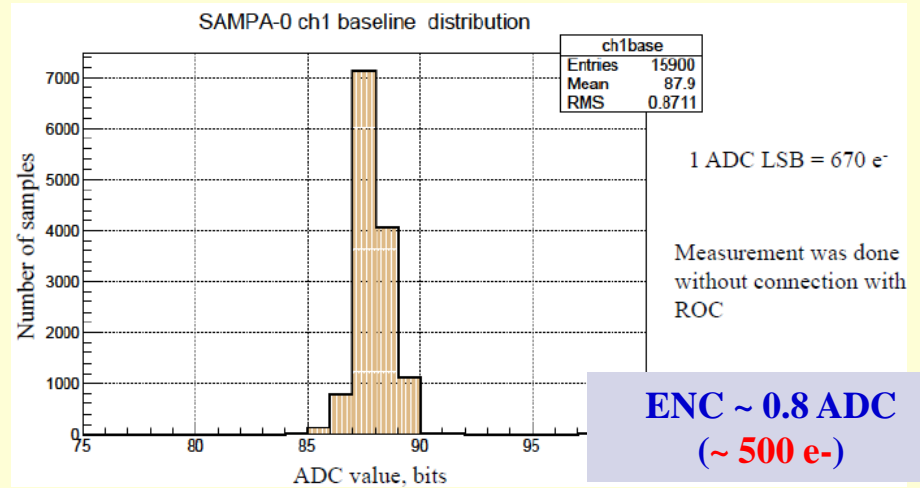
Top view (service side)

- 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.

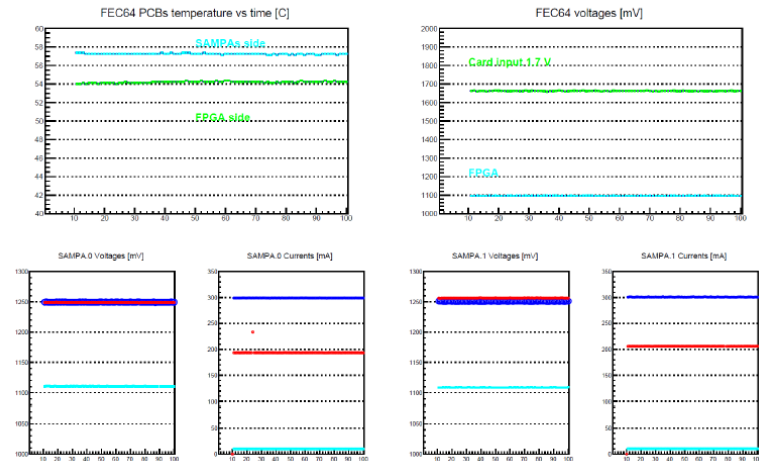
- The total number of registration channels: 64
- Input signal dynam. range: 100 fC
- ADC resolution: 10 bit
- ENC: less than 1000e⁻
- SAMPA chips configured and controlled via FPGA
- Readout serial interface: up to 2.5 Gbps



Bottom view (ROC side)



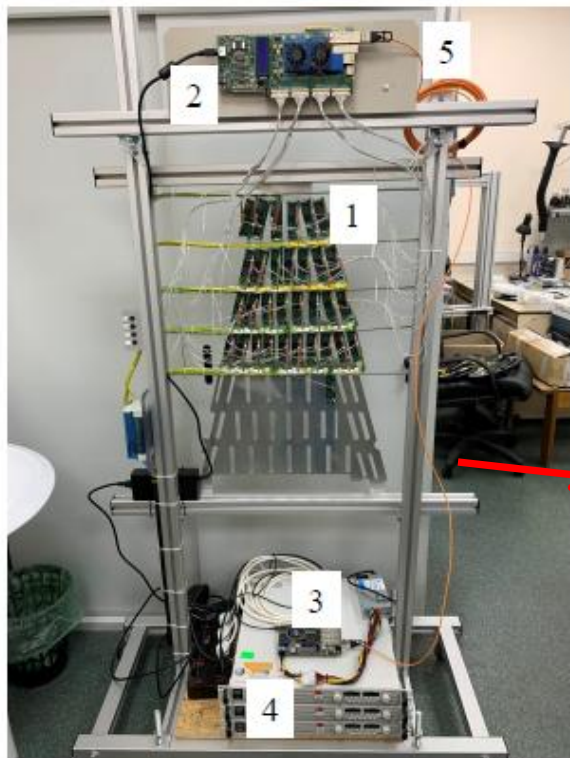
FEC slow control data



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

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.

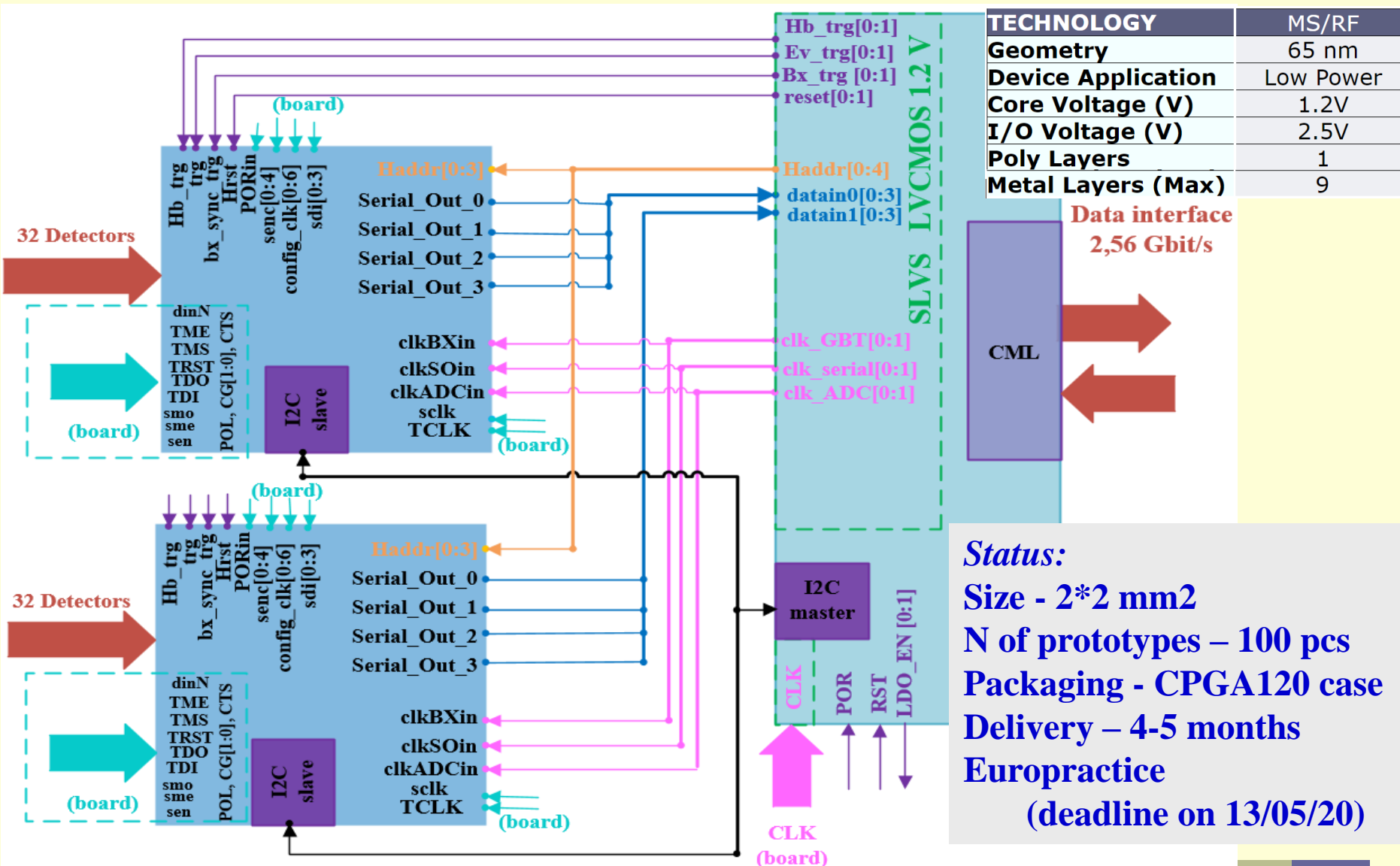
Item	Date	
Testing 512-channel system (FEC v1.0) finished	Jan. 2019	✓
Testing 256-channel system (FEC v2.0) finished	Feb. 2019	✓
Preproduction version FEC PCBs sent for fabrication	Mar. 2019	✓
Half-ROC readout system base design finished	Mar. 2019	✓
Receive SAMPA V4 chips at Dubna	Jul. 2019	✓
34 preproduction 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 version 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	

Test ROC with FE (2048ch) – > **May 2020 ?**

Data concentrator ASIC (NRNU MEPhI)

65 nm CMOS process, Mixed-Signal, Low Power

Bi-directional interface, readout from 2 SAMPA chips (2.56 Gb/s speed, trigger mode, rad-tolerant)



TPC LV+HV system

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) – 13 pc
- EASY3000 crates – 12 pc
- LV module - A3100B (2÷7V/100A) – 55 pc

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

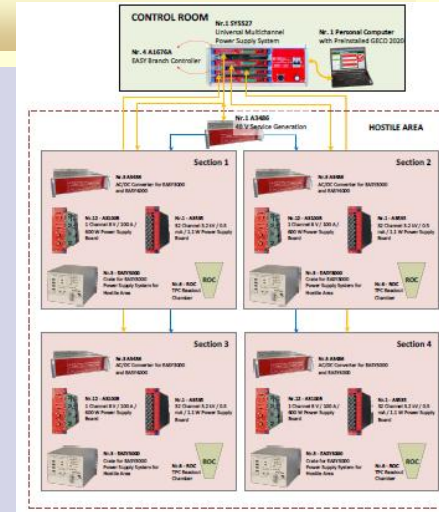
HV cables - will be delivered July 2020

LVDB boards (60 pc) - delivered

INP BSU (Minsk)



Team for cabling and piping – looking ...



TPC gas system

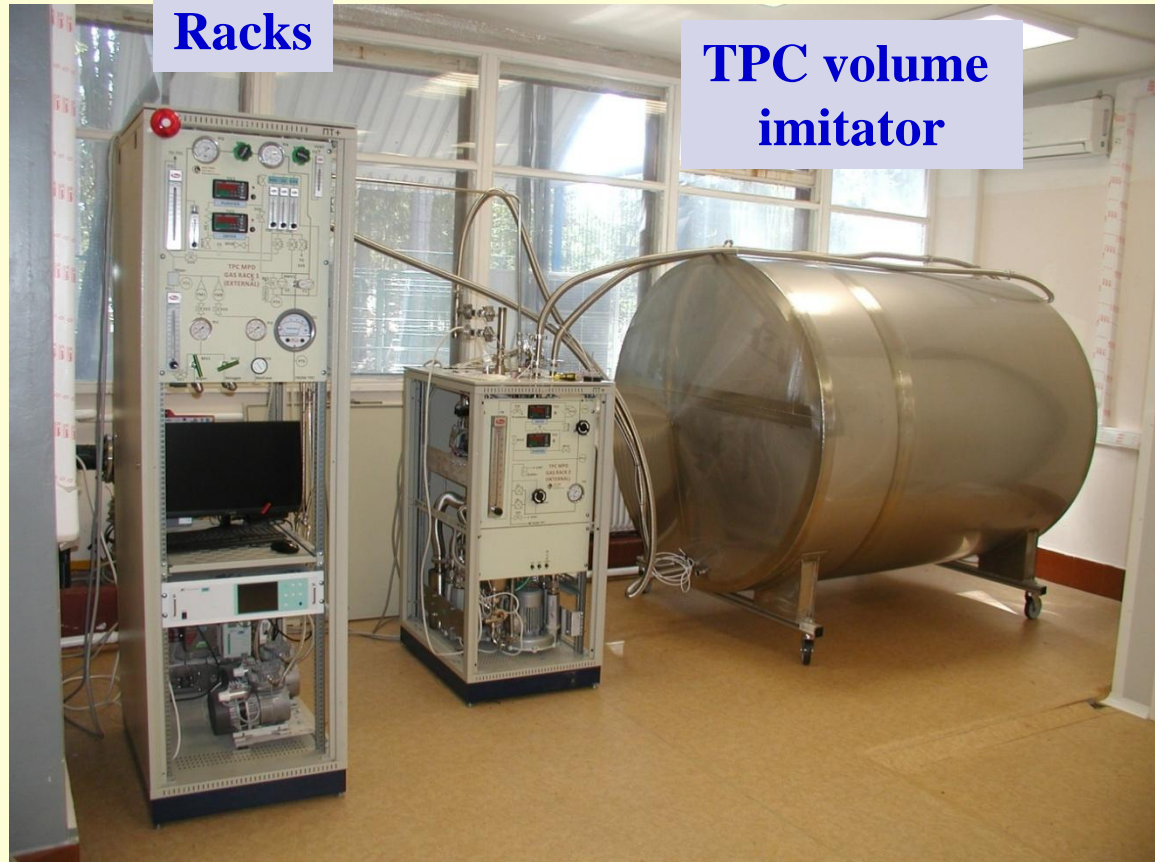
Gas supply



Commissioning -
in progress

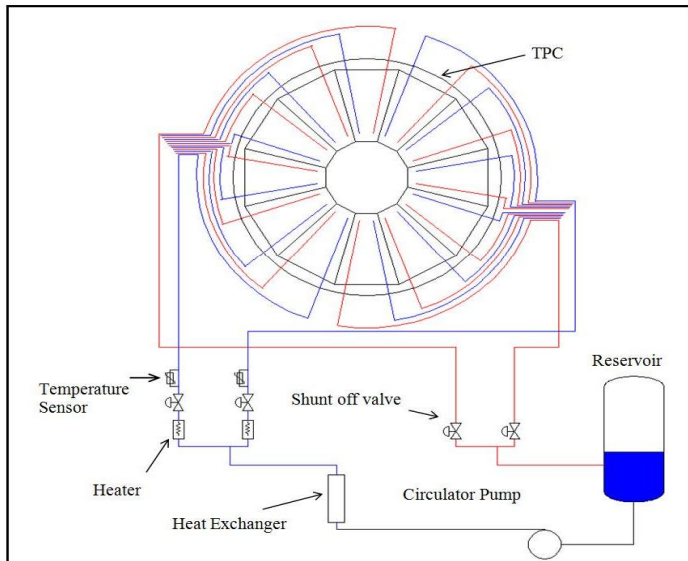
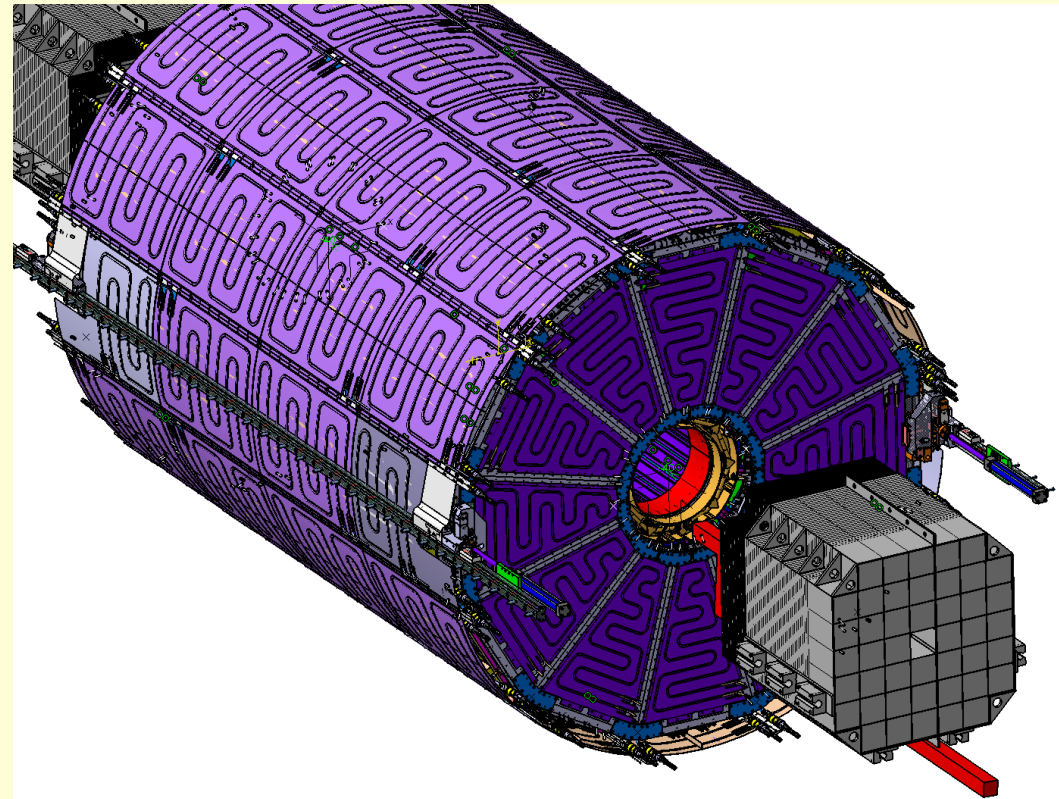
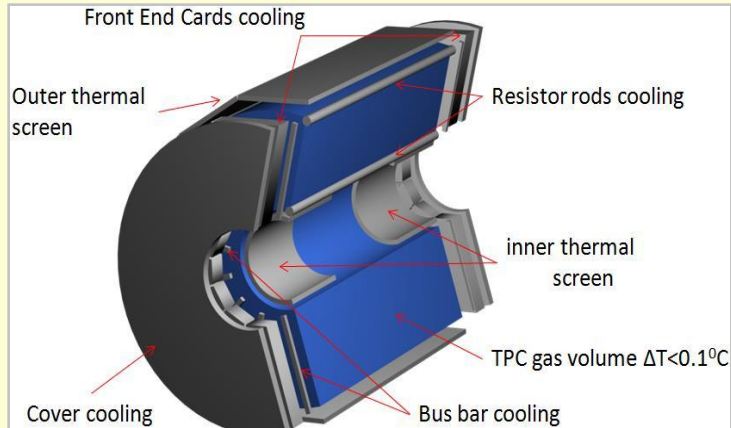
Racks

TPC volume
imitator



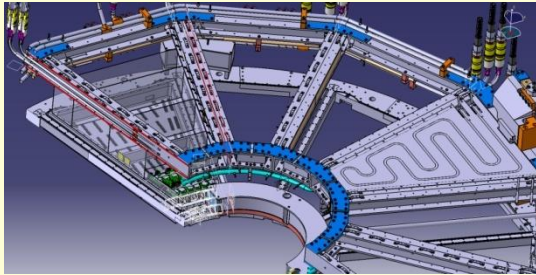
Status - commissioned (Bld.217)

TPC cooling system

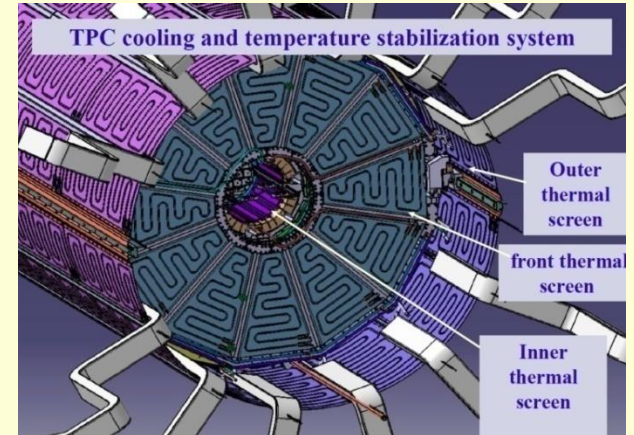


Barrel part – shorter and fixed to TPC instead TOF structure

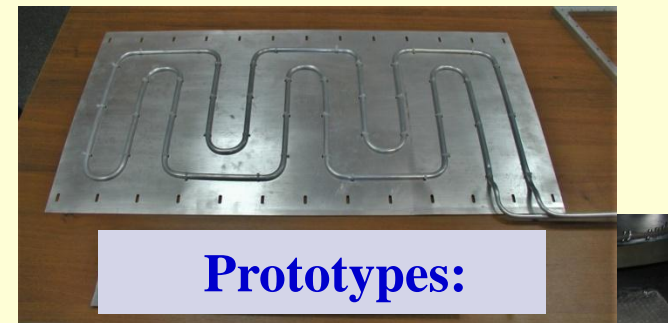
TPC cooling system: pipes layout and thermal panels



Service wheels -
manufactured



Pipes layout
optimization



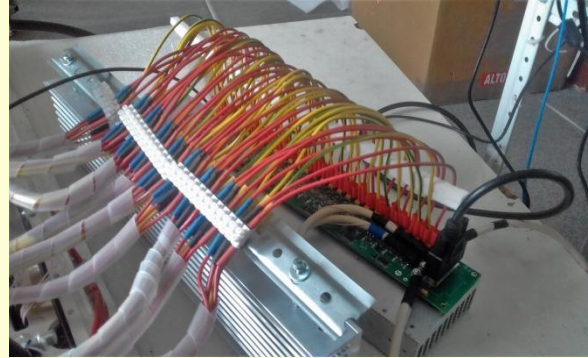
All serial thermal panels –
manufactured

TPC: FE cooling - prototype 1, INP BSU Minsk

Set up



FE power stabilization board



ROC + FE



Water - +17 degree
Al tube, Din - 6 mm
Flow - 6 l/min
CAEN - 177 W
(+3.5V/28.2A, +4/2V/22.0A)

FE power (31pc) - 134.9 W
Thermal pad - 0.8 W/m*K
Al plates thickness - (11+11) mm

Results:

SAMPA chips - (22-25) deg
FPGA chips - (28-33) deg
FE PS cables - 5.1 W

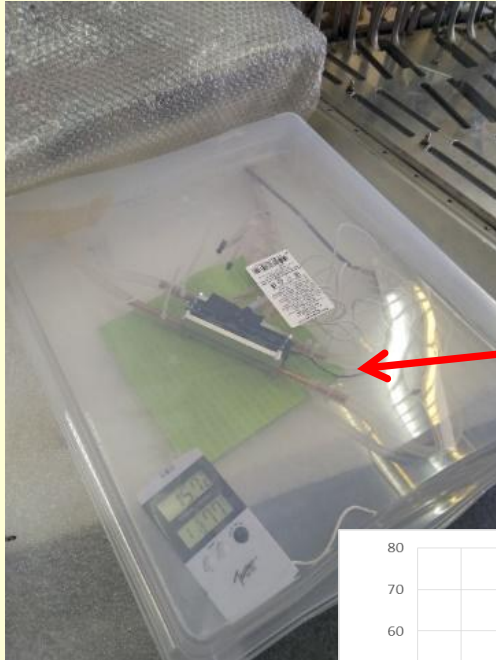
Disadvantages:

Radiation length - 25%
Impossible to do replacement
of FE cards

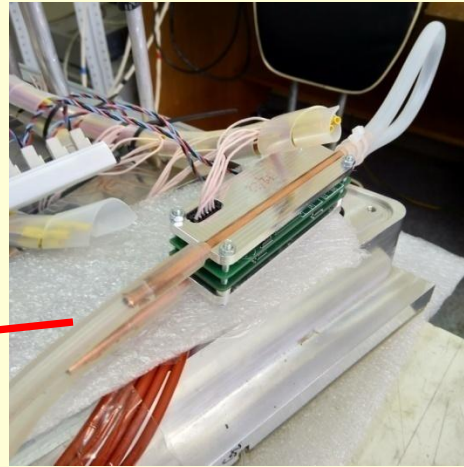
=> New prototype (№2)

TPC: FE cooling - prototype 2, INP BSU Minsk

Set up



Test sample



Water - +15 degree
 Cu tube Din - 3.36 mm
 Flow - (0.3-6) l/min

FE power (1pc) - 5.2 W
 Thermal glue - 6 W/m*K
 Plates thickness - (4+4) mm

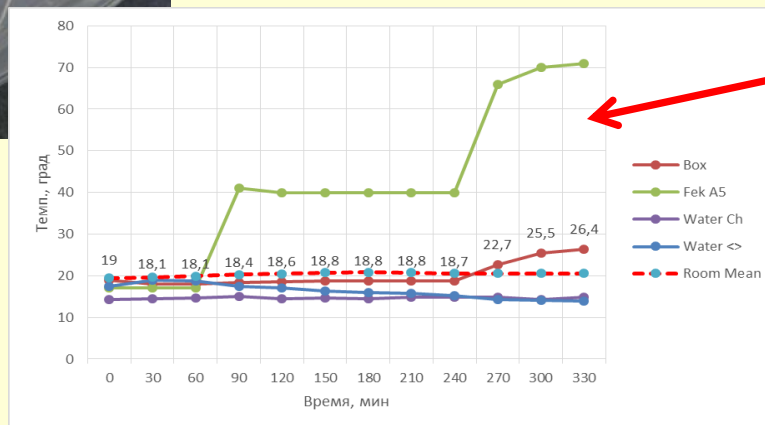
Results:

FPGA chip - 28 deg (6 l/min)
 - 40 deg (0.3 l/min)
 - 70 deg (no water flow)

Advantages:

Radiation length - 9%
 Easy FE cards replacement

=> Prototype №3



TPC: FE cooling - prototype 3, INP BSU Minsk *combination of proto 1+ proto 2*

Bottom cooling plates



Set of top cooling plates

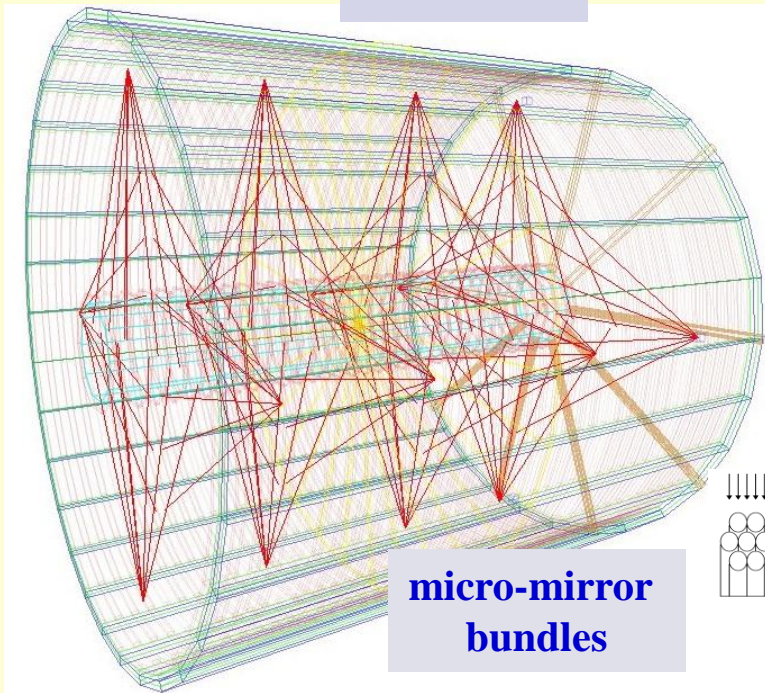


Cu tube Din - 3.36 mm
Plates thickness - (4+4) mm

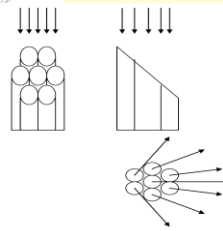
Tests – May 2020 ?

TPC laser calibration system: laser beams layout

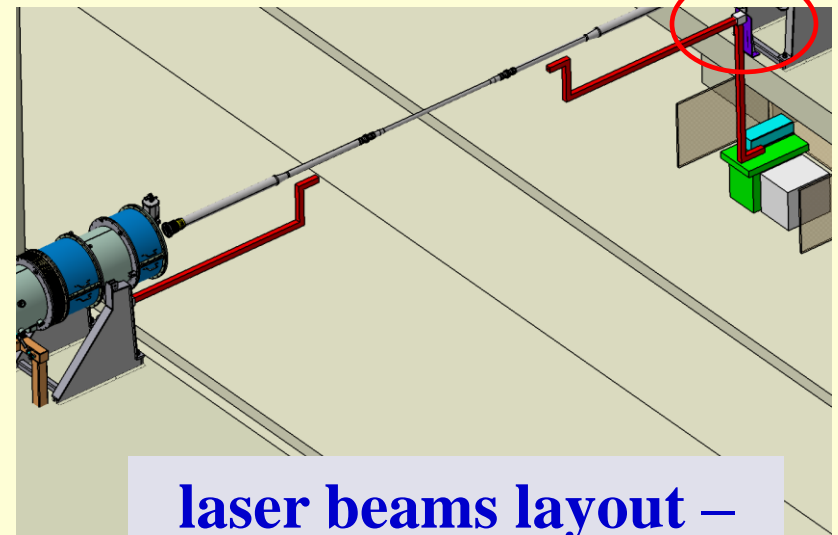
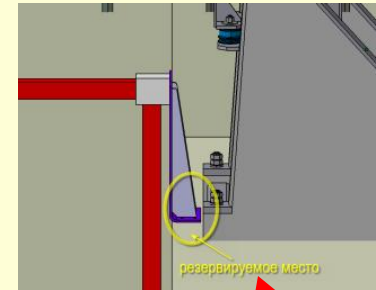
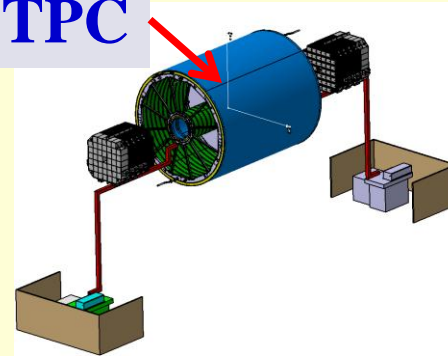
½ TPC



micro-mirror bundles



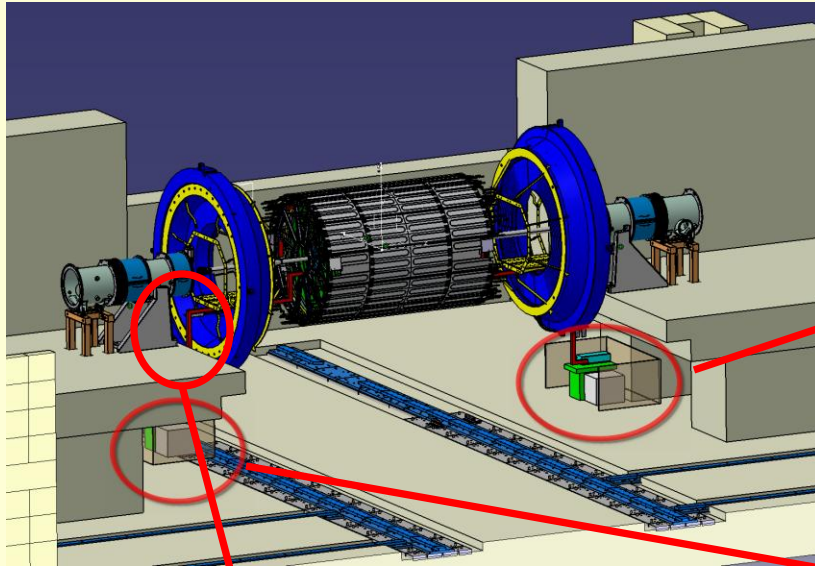
TPC



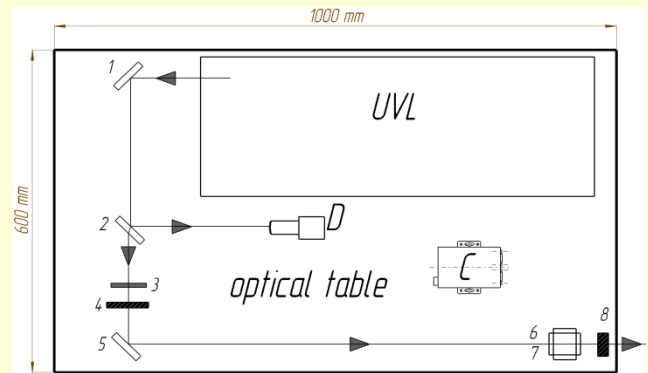
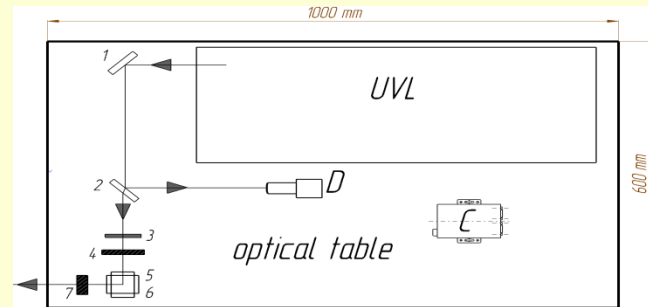
laser beams layout – under finalization

- Laser “planes” - 4
- Micro-mirrors bundles per plane - 4
- Beams from micro-mirrors bundle - 7
- Laser “tracks”, **N** - **224**

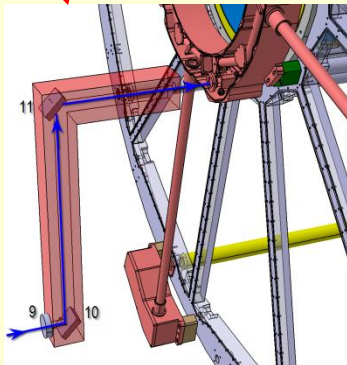
TPC laser calibration system



Optical table schemes

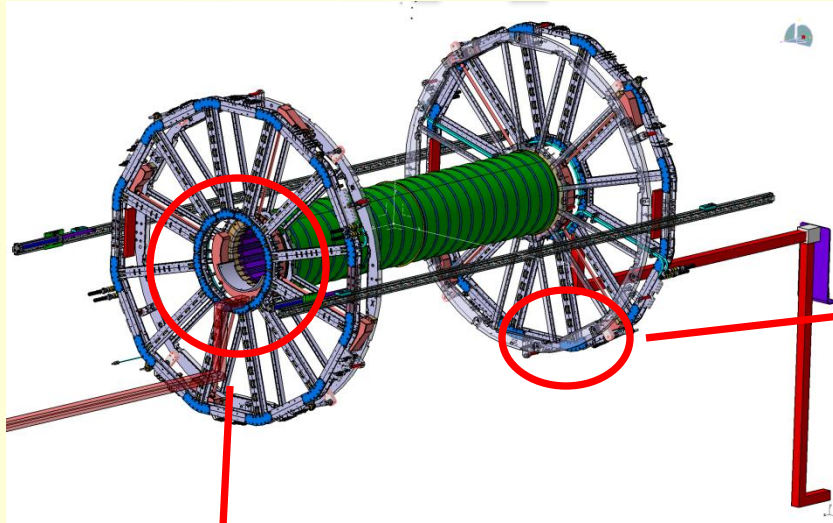


Short periscope scheme

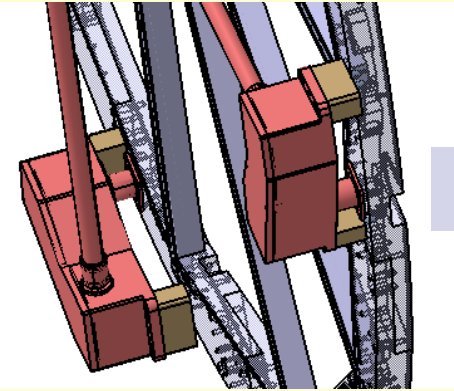


- optical table with components (2pc) – **ordering**
- short periscope (2pc) – **ordering**

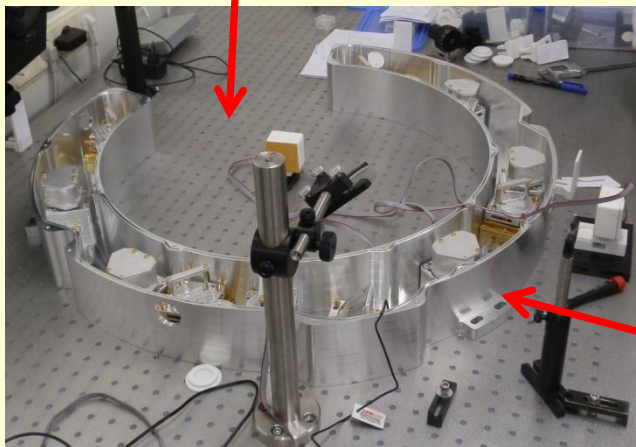
TPC laser calibration system



Semi transparent mirror & prism



ordered



- full set of micro-mirror bundles - assembled
- 2 lasers – commissioned
- laser beam splitter – ready to install
- laser beam monitors - prototype under tests

TPC slow control system: sub-systems status

LV system:

- 1) **CAEN EASY3000** (crate SY5527 (1pc), crate EASY3000 (12pc), module A3486 AC/DC (400V) converter (13pc), module PS A3100B (55pc) + software **GECO 2020 - ok!**)
- 2) **Custom made power stabilizers** (module LVN9 (60pc-ok)) + crate 6U (1pc), custom control units (12pc) + crate controller (1pc) + PC + custom software) - **in progress**

HV system:

- 1) **MWPC** -> CAEN crate EASY3000 + modules A3535P/N 3.2kV/0.5mA – 6pc - **ok!**
Spare option: 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 - ask quotation**
- 3) **HV for ROC gate: custom made system** (crate – 2pc, modules –24pc, crate controller- 2pc + custom software) – **on critical path**

DAQ:

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

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 + thermal sensors (100pc)) – **ok!, custom software - started**

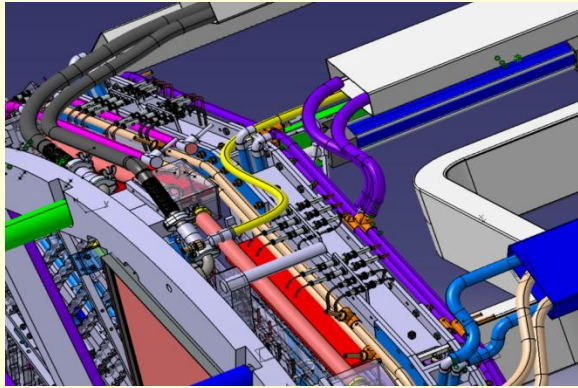
Laser system:

Hardware: PC (1pc), industrial PC (2pc), controllers (2pc), cooling system (2pc), UV laser (2pc) – **ok!**
synchronization module (1pc) and **custom software – design and software not started yet**

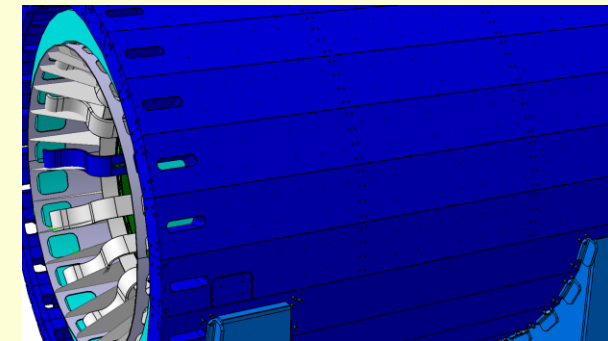
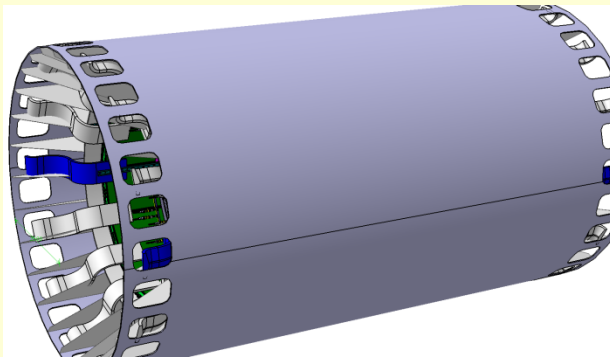
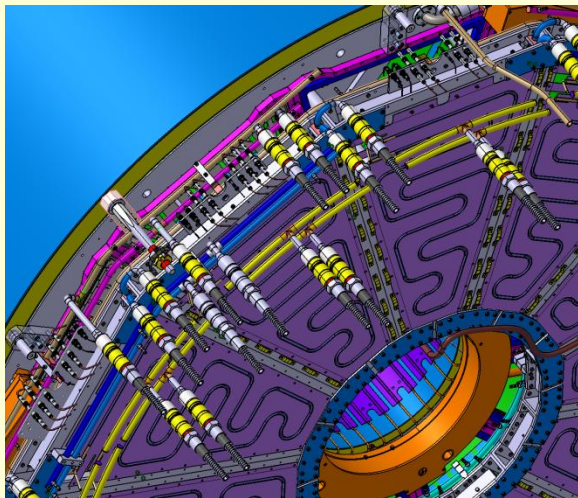
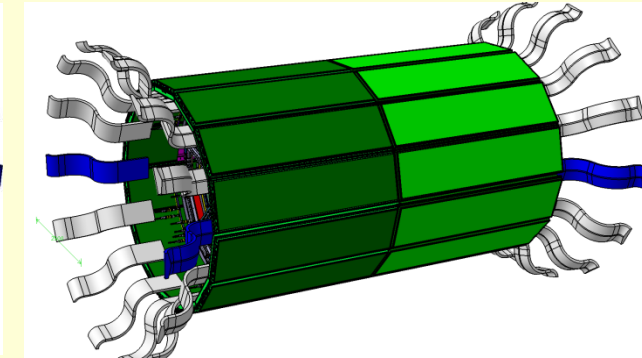
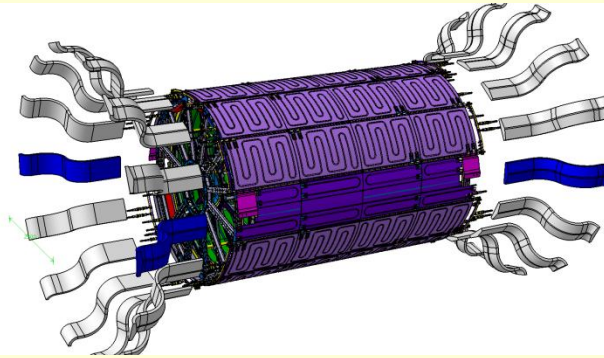
Trigger and synchronization – no info

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

TPC: cables and pipes **integration**

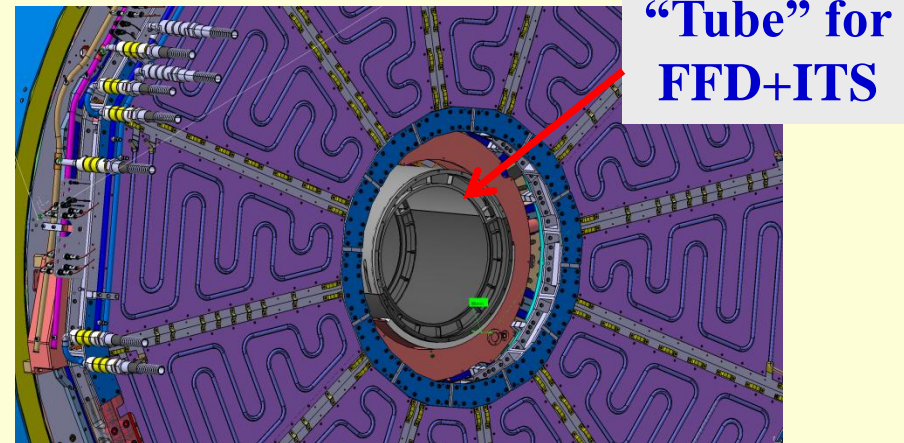
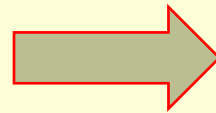
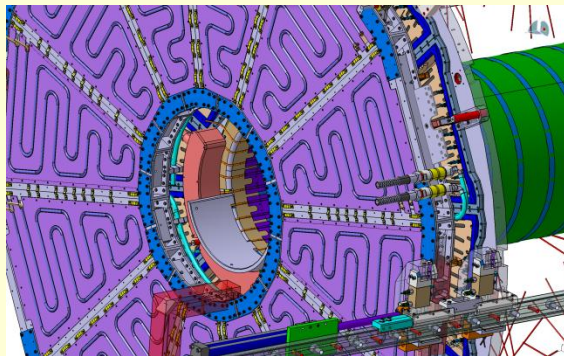
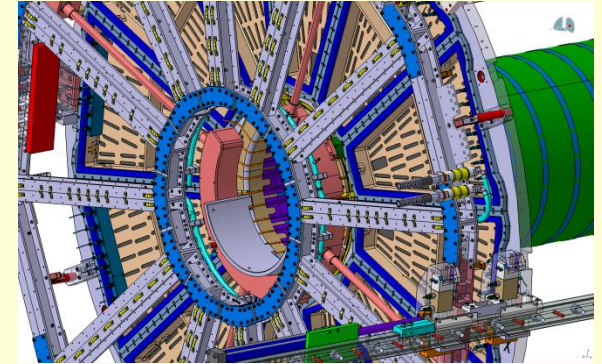
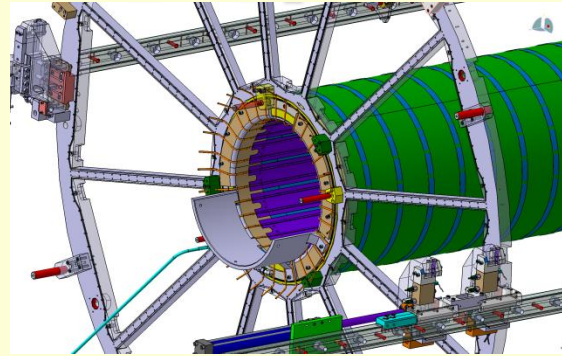
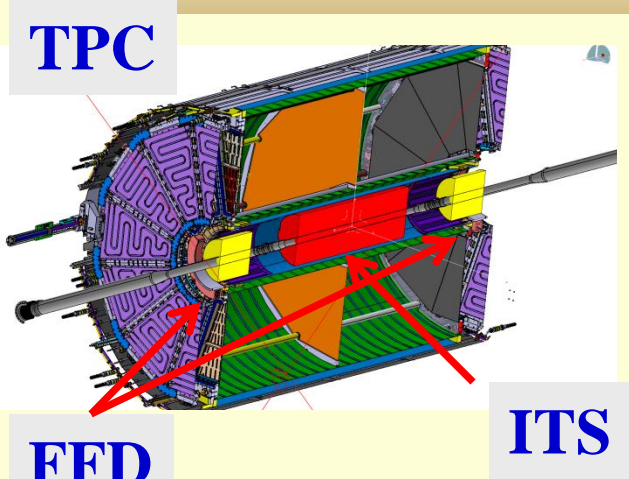


Trays layout concept

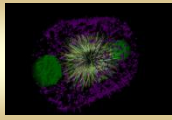
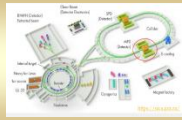


Optimization - in progress

ITS+FFD integration to TPC



Concept – done, design - in progress



MPD TPC status 2020: summary



Status:

• TPC:

vessel (C3-C4 cylinders)

- assembled

TPC internal structure assembly

- March 2020 → **start of June 2020**

• ROC chambers (24pc)

- 14 pc tested, 2 pc in manufacture

next 15 pc pad planes - ordered

• Electronics:

FE electronics (next 32 cards)

- ordered

RCU controller

- design in progress

FE (32 cards) + ROC tests

- March 2020 → **May 2020 ?**

FE cooling prototype 1

- designed, manufactured, tested → **re-design done** (prototype 2)

FE cards mass-production and tests

- **July-Dec 2020** → 2021

FE radiators mass-production

- Sept 2020

• Sub-systems:

local TPC DAQ

- in progress

Gas system

- commissioned, integration to MPD started

Cooling system: full set of thermal screen panels - delivered, FE cooling and system design - in progress

HV+LV systems

- procurement started (CAEN)

Laser calibration system: UV lasers and laser beam distrib. systems - delivered, rest parts - ordered

Slow control system

- sub-systems more less ok, integration to common SC system **not started yet**

• Cabling and piping:

TPC cabling and piping

- in progress

MPD TPC trays filling

- in progress

• Integration TPC to MPD

TPC racks (5 pc) layout

- in progress

tooling for installation TPC to MPD

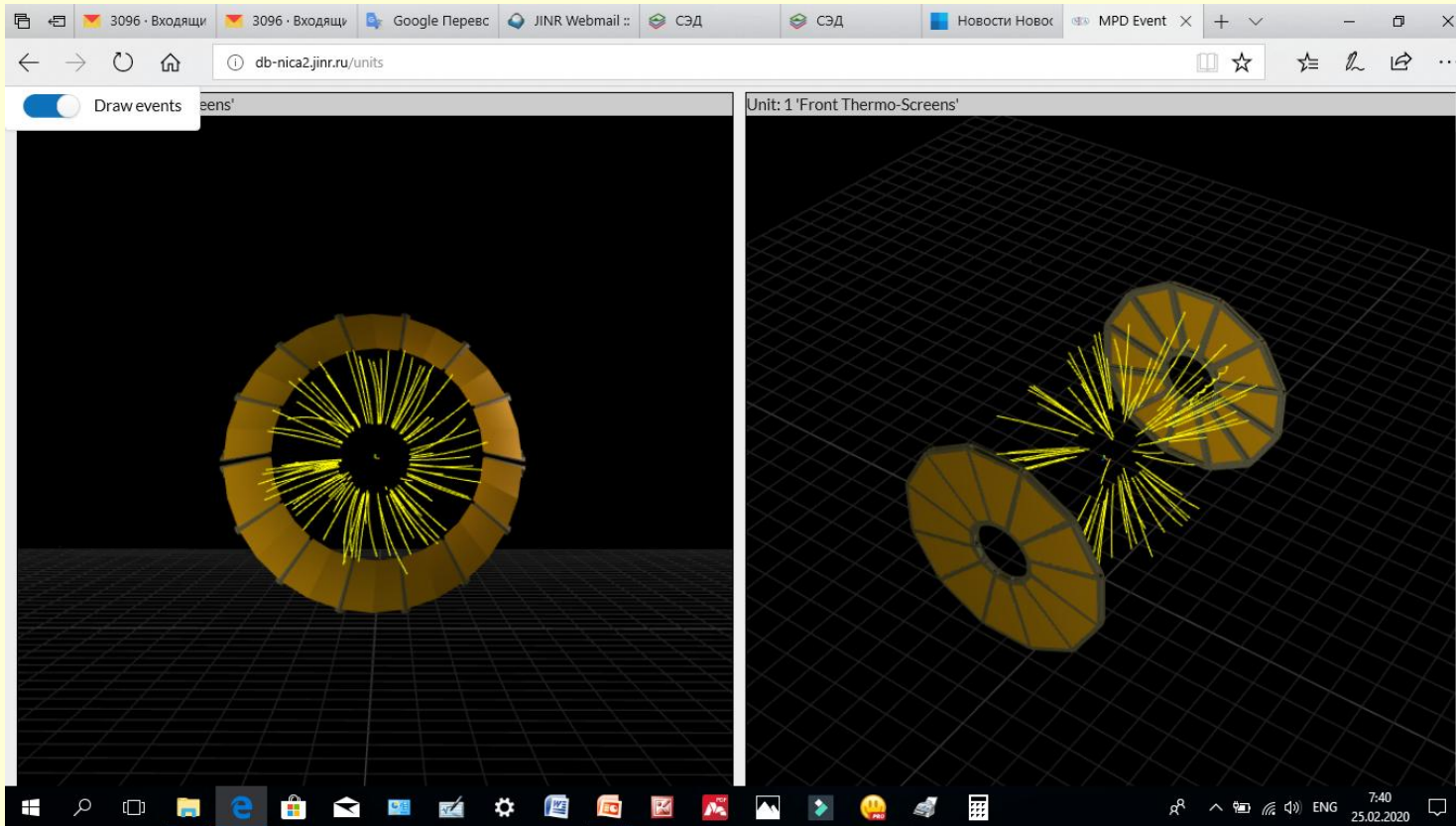
- in progress

• TPC schedule

start of TPC commissioning

- **beginning of 2021**

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!