Status of some parts of the TPC for the MPD at the NICA project

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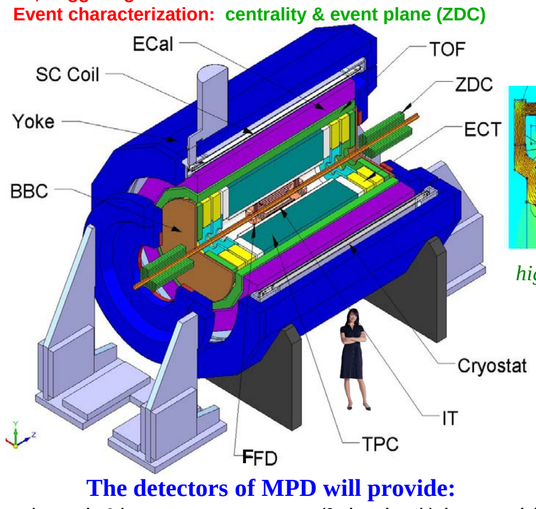
The Time-Projection Chamber (TPC) is the main detector for tracking and charged particles identification in the MultiPurpose Detector (MPD) at the NICA collider experiments.

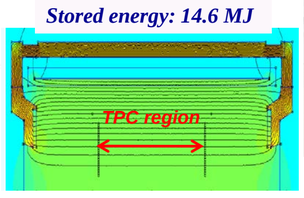
Central barrel of Multi Purpose Detector (MPD)

Magnet: *SC solenoid* B_0=*0.5 T* weight ~ 900 t
Basic tracking: TPC
Particle ID: hadrons, e, g (TOF, TPC, ECal)
T0, Triggering: FFD
Event characterization: centrality & event plane (ZDC)

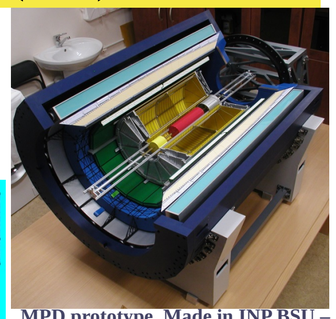
Stage 1: TPC, TOF, ECAL, ZDC, FD



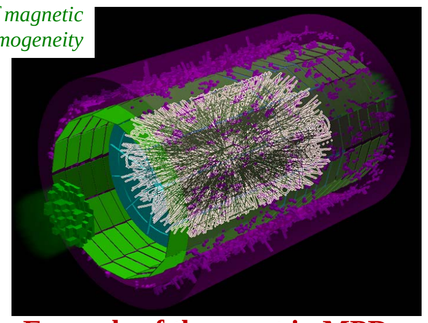
Rated current: 1790 A
Stored energy: 14.6 MJ



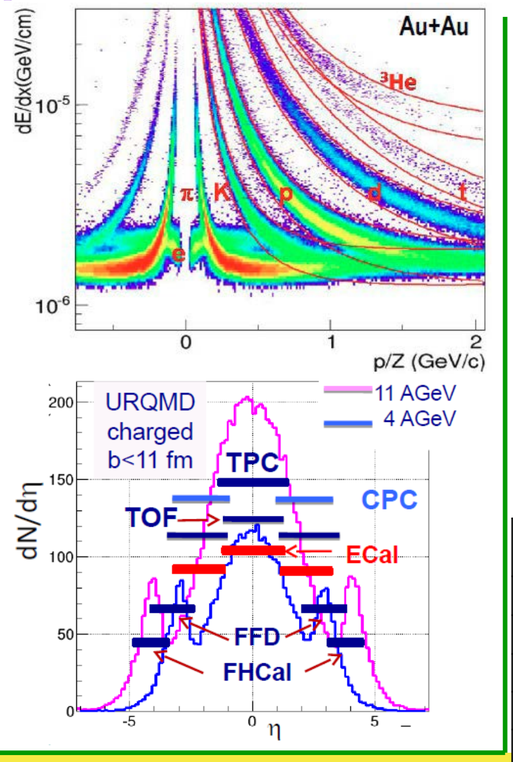
high level (~ 3x10^{-4}) of magnetic field homogeneity



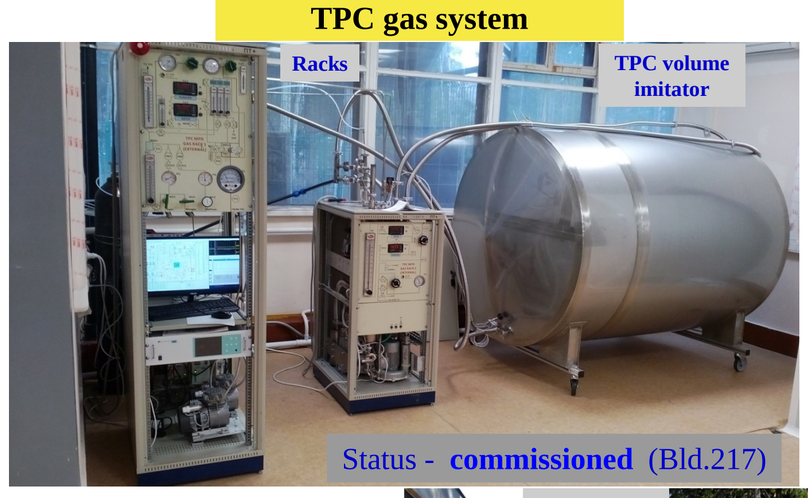
MPD prototype. Made in INP BSU – Artmash, Minsk, Belarus



Example of the event in MPD



TPC gas system



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

Gas mixture	Ar + 10%CH_4 (P10)
TPC gas flow, nominal	200 l/min
TPC overpressure	(2.0 ± 0.1) mBar
O_2 admixture	20 ppm
H_2O admixture	10 ppm
External loop, refresh gas rate	30 l/min
Fresh part of gas mixture add to external loop, range	(0-50) l/min
TPC isolating gas	N_2
N_2 gas flow	(5-20) l/min

Gas system tested with TPC volume imitator at PNPI (2017) and next tested to JINR (2018 and 2019)

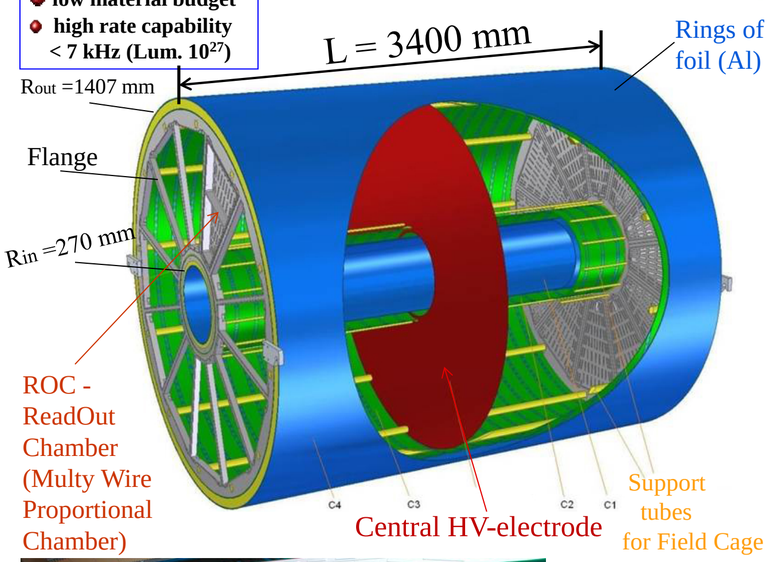
TPC requirements

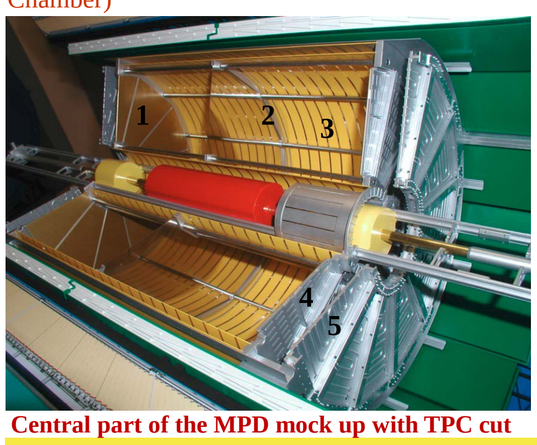
Spatial resolution: σ(x,y) ~ 0.6 mm, σ(z) ~ 1.2 mm;
Two track resolution: about 10 mm;
Momentum resolution: Δp/p ≤ 3% (0.1 < p_t < 1 GeV/c);
dE/dx resolution: better then 8%;
Overall acceptance: $|\eta| \leq 1.15$;
Max. multiplicity: ~ 1000 (central collision Au+Au at $\sqrt{S_{NN}}$ = 11 GeV and the max event rate ~ 7 kHz).

TPC structure

Advantages:
- low material budget
- high rate capability < 7 kHz (Lum. 10^{27})

- Kevlar - Aluminium





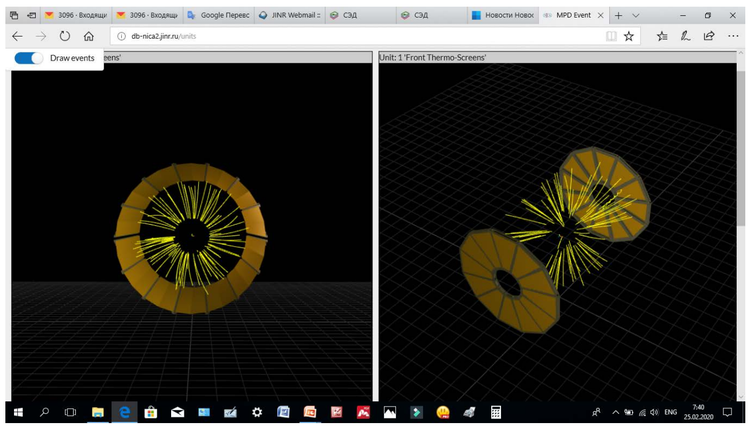
1- MWPC;
2 - HV electrode;
3 - Field cage;
4 - FEE position;
5 - End cap thermal screen.

Central part of the MPD mock up with TPC cut

TPC basic parameters

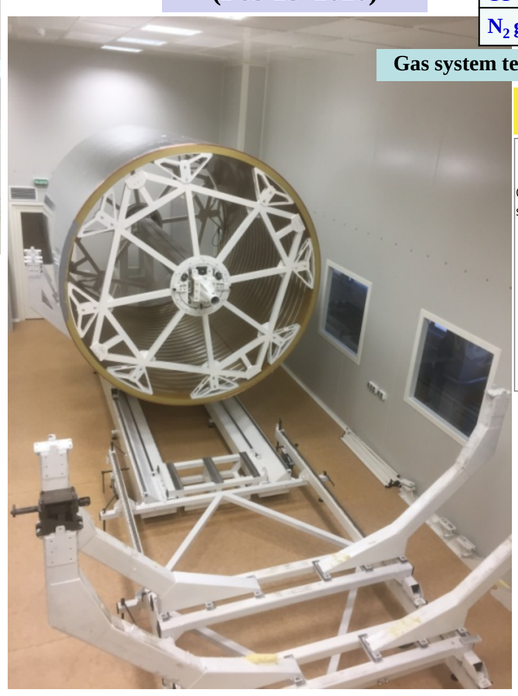
Item	Dimension
Length of the TPC	340 cm (without FEE)
Outer radius of vessel	140 cm
Inner radius of vessel	27 cm
Outer radius of drift volume	133 cm
Outer radius of drift volume	34 cm
Length of the drift volume	163 cm (of each half)
Cathode	Membrane at the center of the TPC
Electric field strength	~140 V/cm (for Ar/CH_4)
Magnetic field strength	0.5 Tesla (max.)
Drift gas	90% Ar + 10% CH_4 (**P10**) at Atmospheric pres. + 2 mbar
Gas amplification factor	~ 10^4
Drift velocity	5.45 cm/μs for **P10** gas mixture
Max. electron drift time	~ 30 μs
Temperature stability	< 0.5 °C
Readout chambers	24 (12 per end plate) sectors
Segmentation in φ	30°
Multiplicity (max.)	~ 1000 (central collision)
Pad size	5x12 mm^2 and 5x18 mm^2
Number of pads	95232
Pad raw numbers	53
Electronics shaping time	~180 ns (FWHM)
Signal to noise ratio	30:1

MPD event display - http://db-nica2.jinr.ru/ (V. Krilov), example for TPC

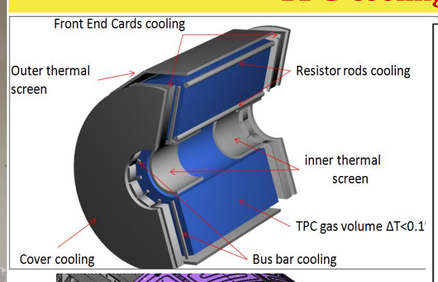


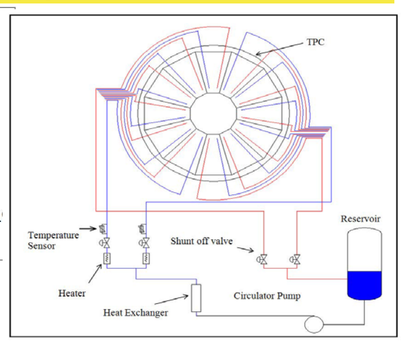
TPC assembly (Bld.217) – common view

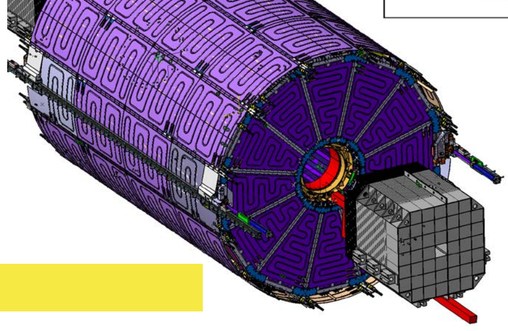
C3-C4 glued (Feb 18 2020)



TPC cooling system



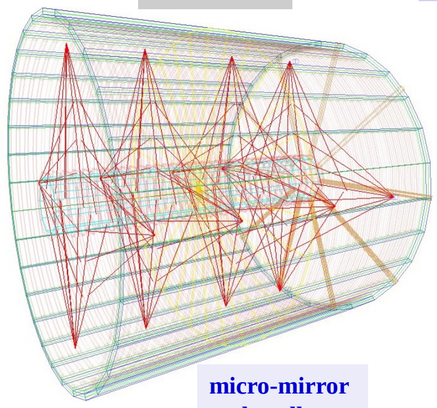




Barrel part – shorter and fixed to TPC instead TOF structure

TPC laser calibration system

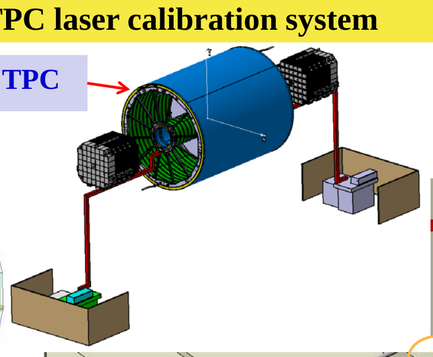
for ½ TPC

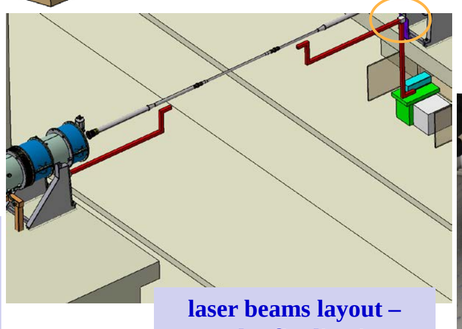


micro-mirror bundles

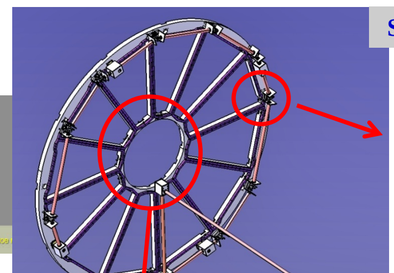
Laser "planes" – 4+4
Points per plane - 4
Beams per point – 7
Laser "tracks", N - 224

TPC

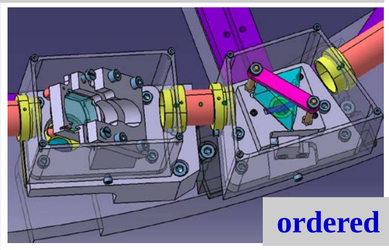




laser beams layout – under finalization



Semi transparency mirror & prism



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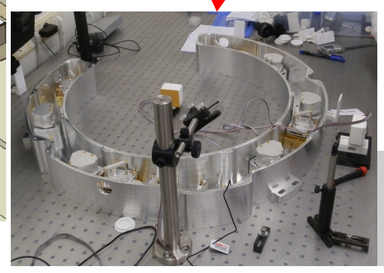
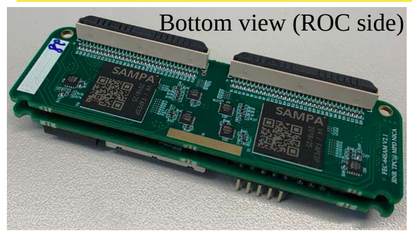
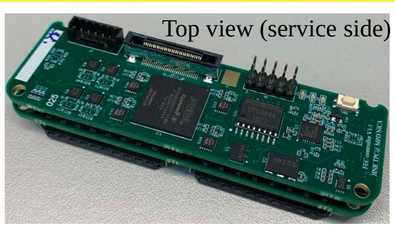


- full set of micro-mirror bundles - assembled
- 2 lasers (special option) – commissioned
- laser beam splitter - delivered to JINR
- laser beam monitors - prototype under tests

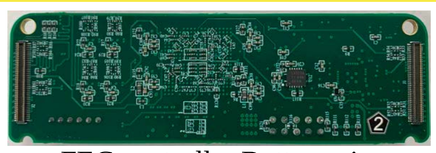
ROC chamber + electronics integration: concept



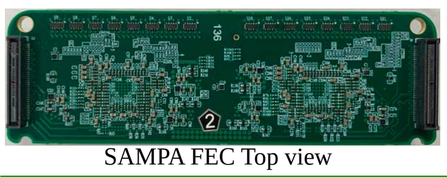


64-channels FEC assembly view (S ≈ 28x91 mm^2)

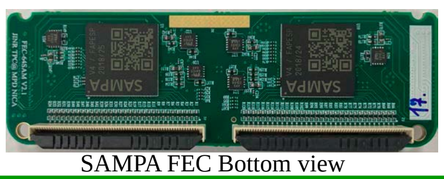
FEC controller Top view



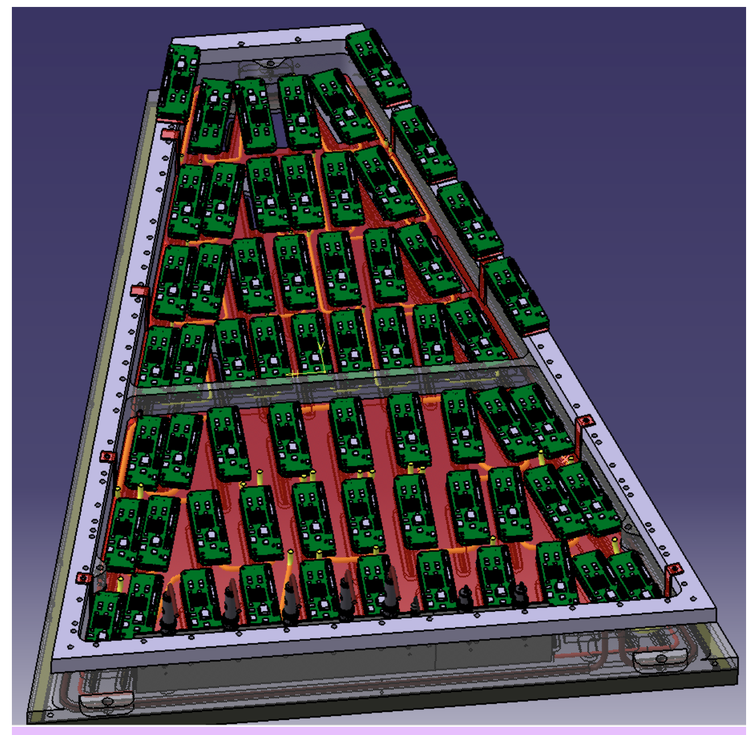
FEC controller Bottom view



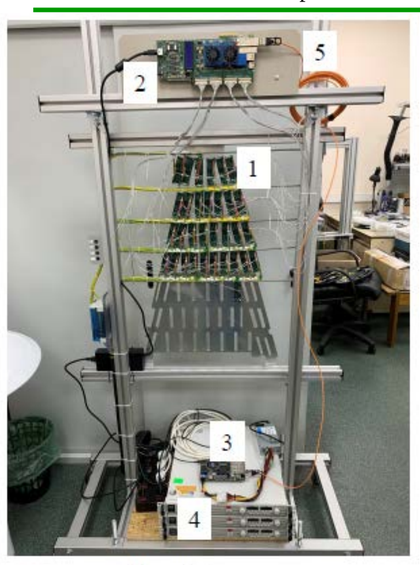
SAMPA FEC Top view



SAMPA FEC Bottom view

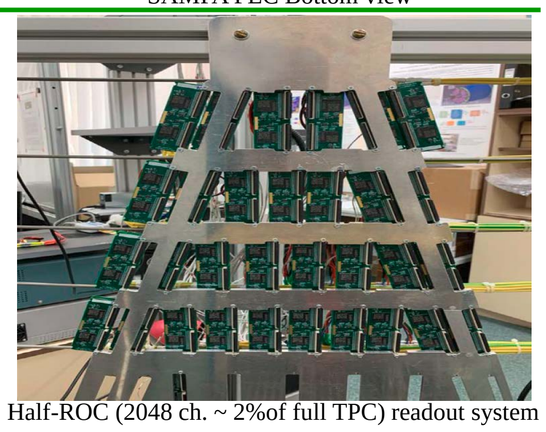


Design FEC + FEC Controller cards with cooling system in ROC

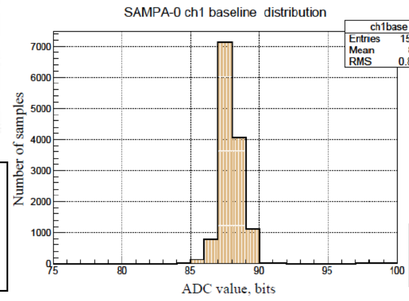


Front view

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



Half-ROC (2048 ch. ~ 2%of full TPC) readout system



ENC ~ 0.8 ADC (~ 500 e$^-$)