Progress towards the realization of the MPD project

Within the JINR theme 02-0-1065-2007/2019

Adam Kisiel
(WUT)

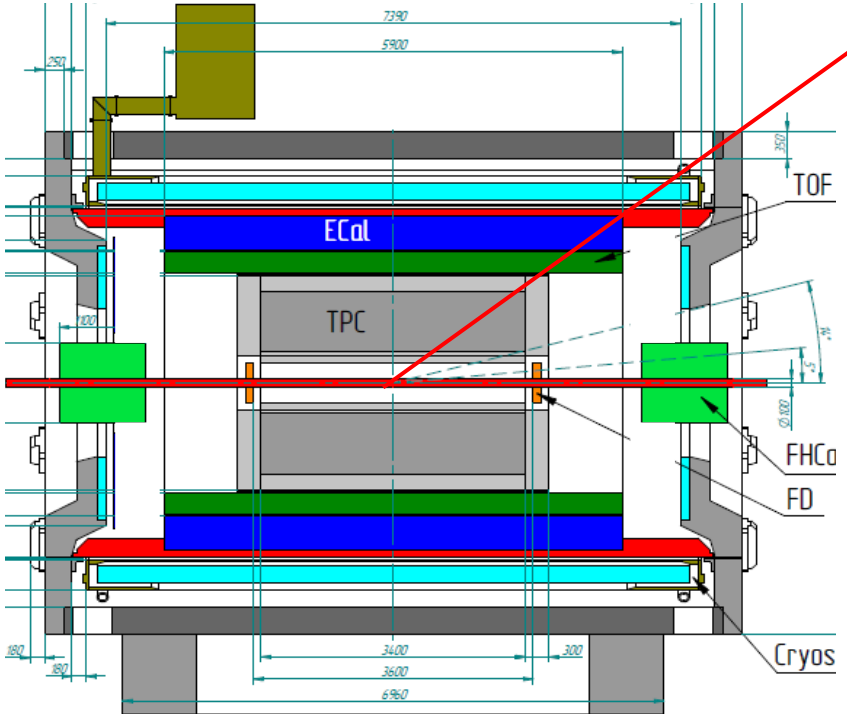
On behalf of the MPD Collaboration

Programme Advisory Committee for Particle Physics
50th Meeting
January 21-22, 2019

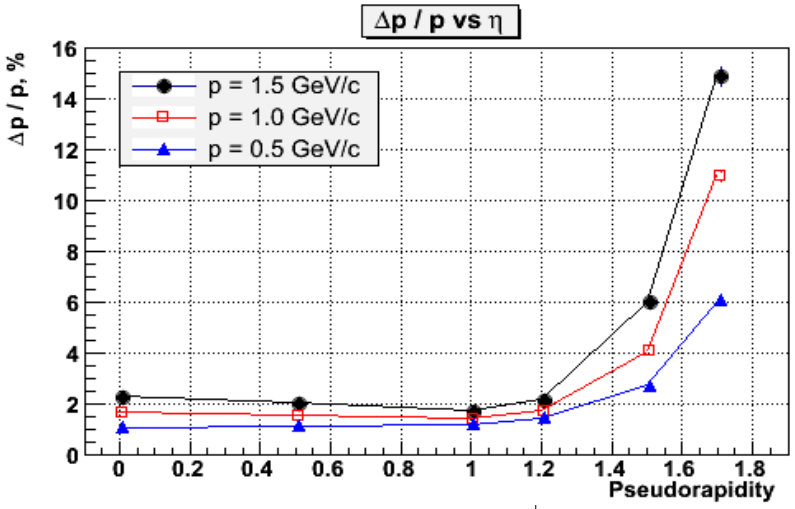
Outline

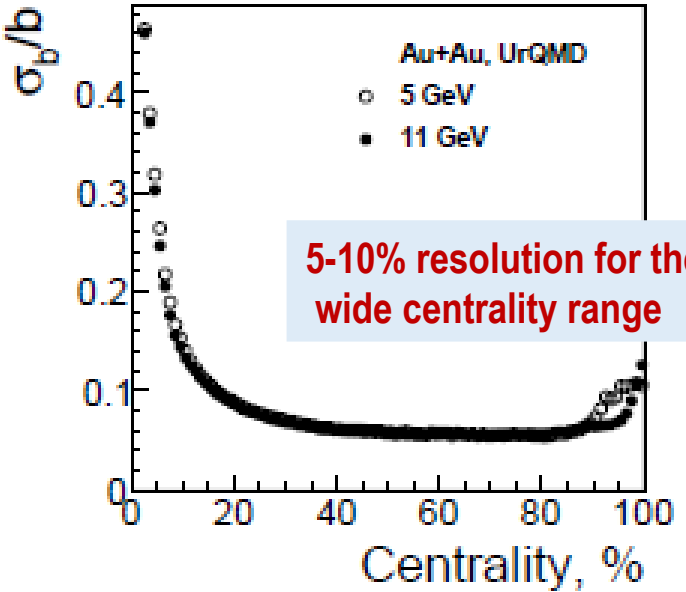
- Introduction
- Progress in MPD project realization:
  - Recent results from MPD simulation
  - MPD TDR preparation
  - MPD mass-production: readiness status
  - Formation of the MPD Collaboration
- Summary

MPD detector at NICA (Stage'1 setup)

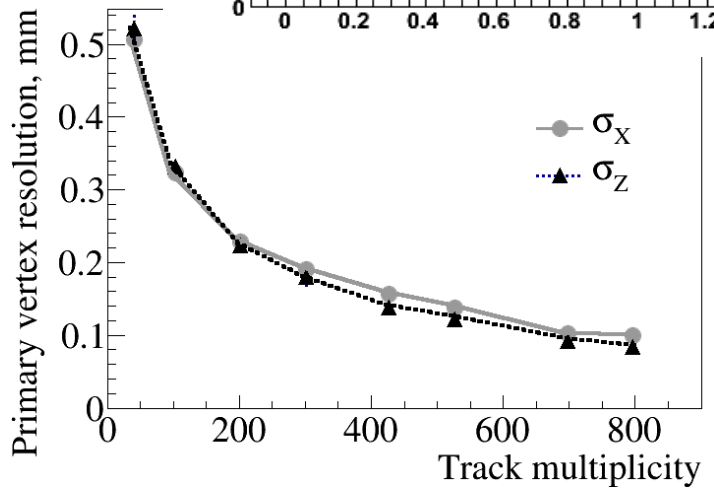


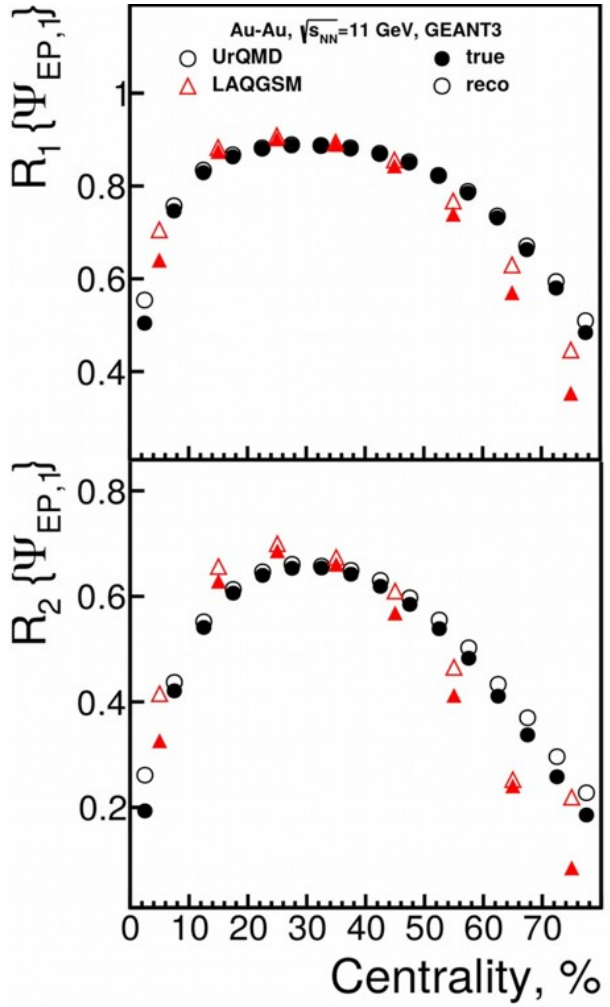
- ***TPC*** *tracking:* $|\eta|<1.6$ ($N_{points}>15$)
- ***PID****: dE/dx+TOF+ECAL* $|\eta|<1.2$, $0.1<pT<4$ GeV/c
- ***FHCAL****:* $2<|\eta|<5$
- ***Trigger&T0****: FFD*





5-10% resolution for the wide centrality range



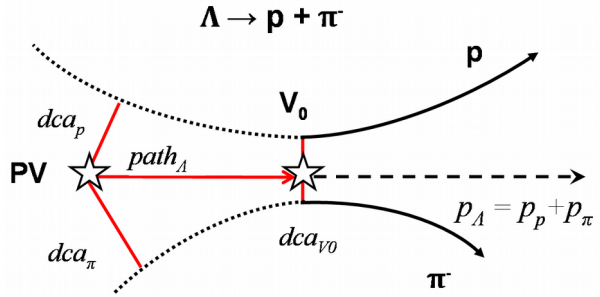


FHCAL coverage and granularity provides good event plane resolution

Strangeness production at NICA: news on (anti)hyperons

V.Vasendina, A.Zinchenko, V.Kolesnikov (VBLHEP)

Study of the centrality dependence for hyperon spectra & yields



Data set: 2M minbias Au+Au @ 11 GeV (PHSD)

MPD setup: TPC & TOF, ideal centrality binning (no FHCAL)

Selection criteria: $|\eta| < 1.3$, $N_{hits} \geq 10$ + standard quality/analysis cuts

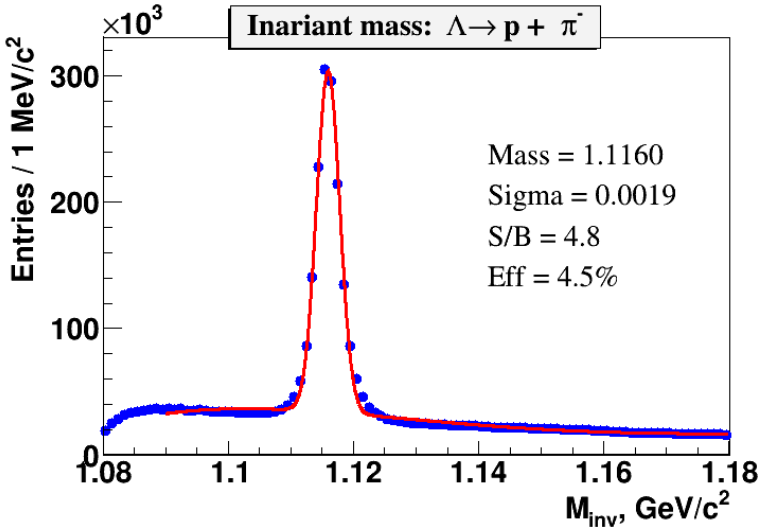
Realistic track reconstruction: clustering in TPC

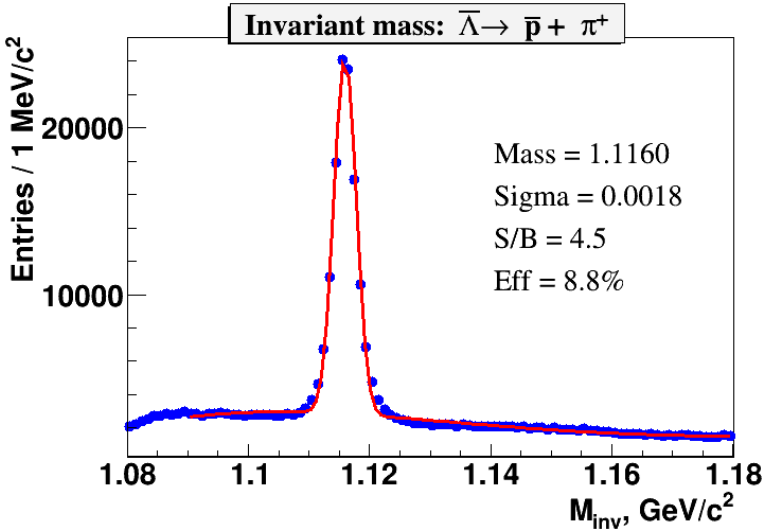
Realistic PID: combined dE/dx+TOF

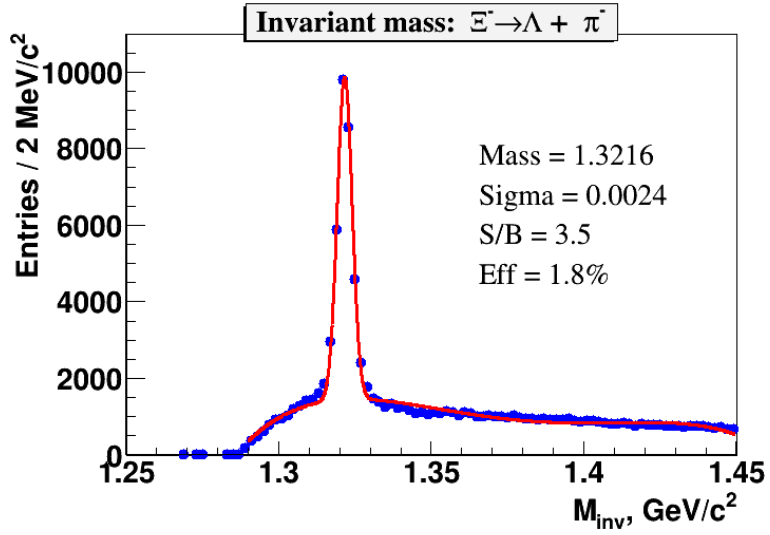
Analysis: secondary vertex finding technique

- **PV** – primary vertex
- **V_0** – vertex of hyperon decay
- **dca** – distance of the closest approach
- **path** – decay length

← All p_T →

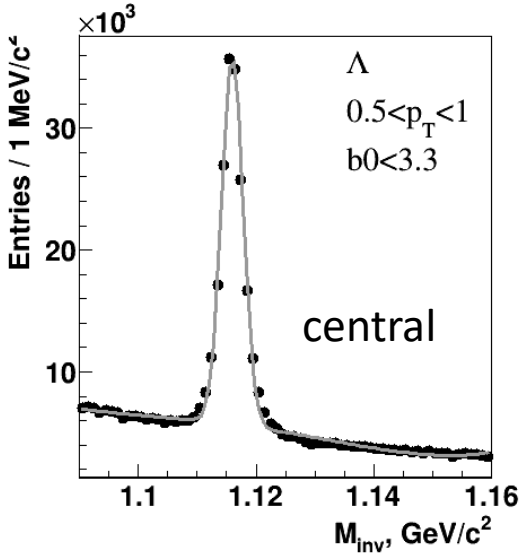


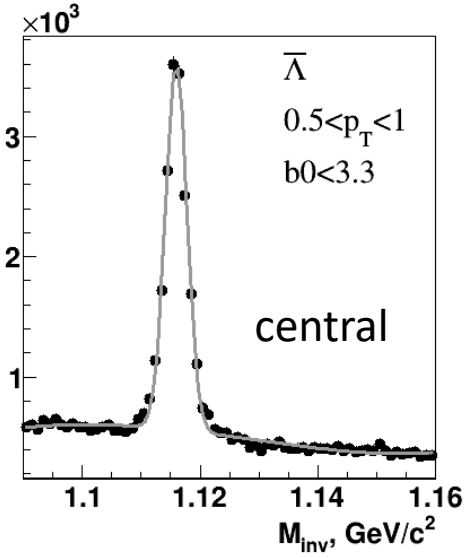


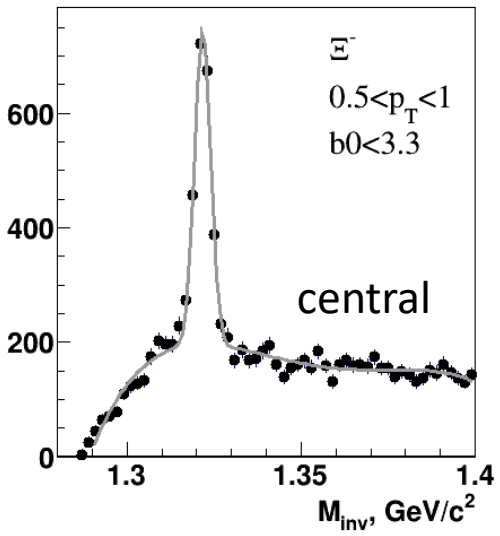


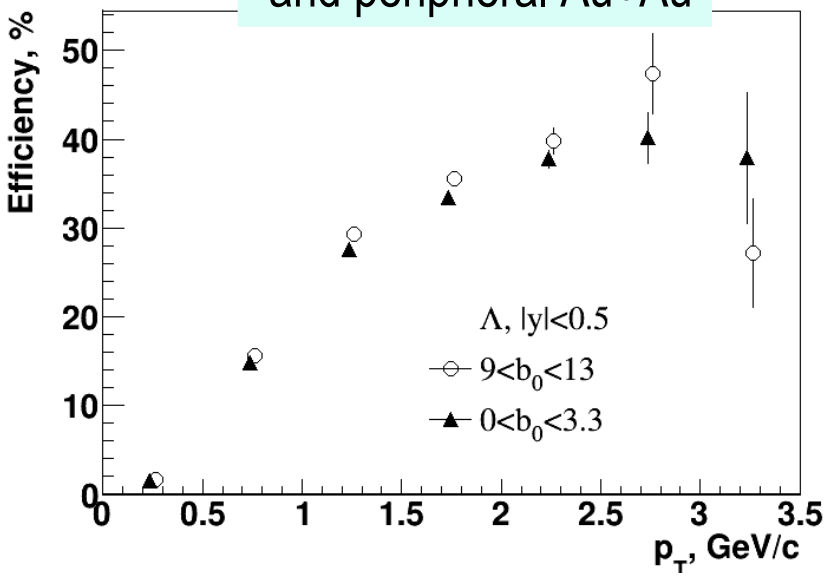
Hyperon reconstruction in centrality bins

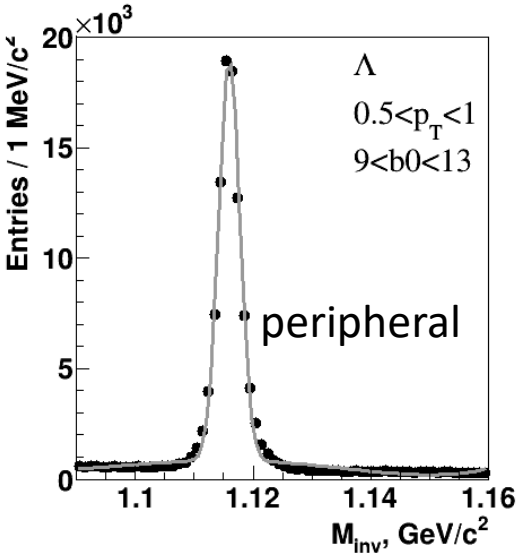
Efficiency in central and peripheral Au+Au

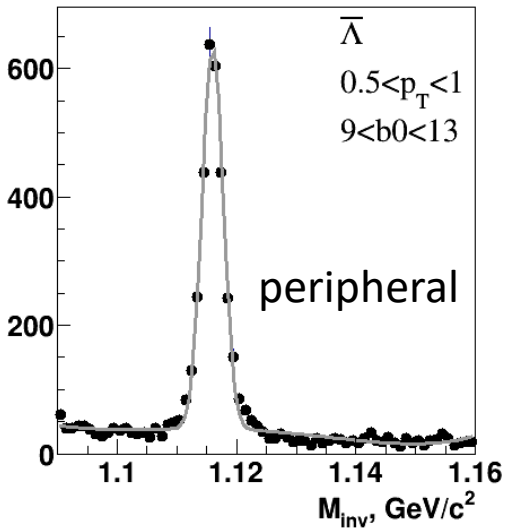


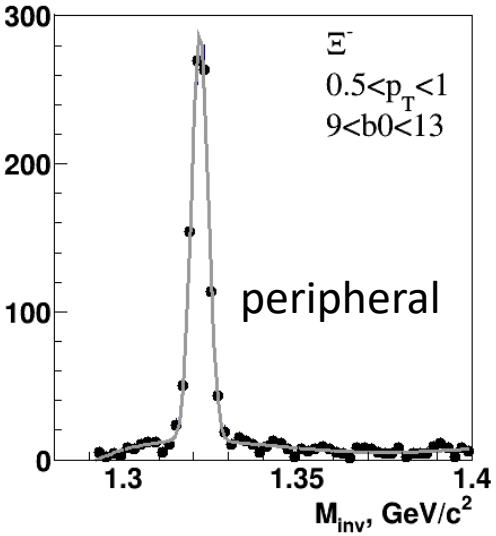


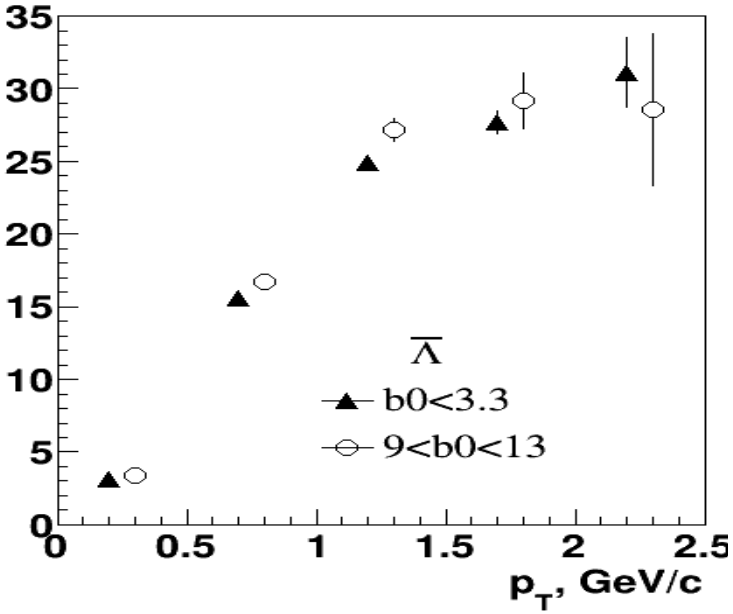






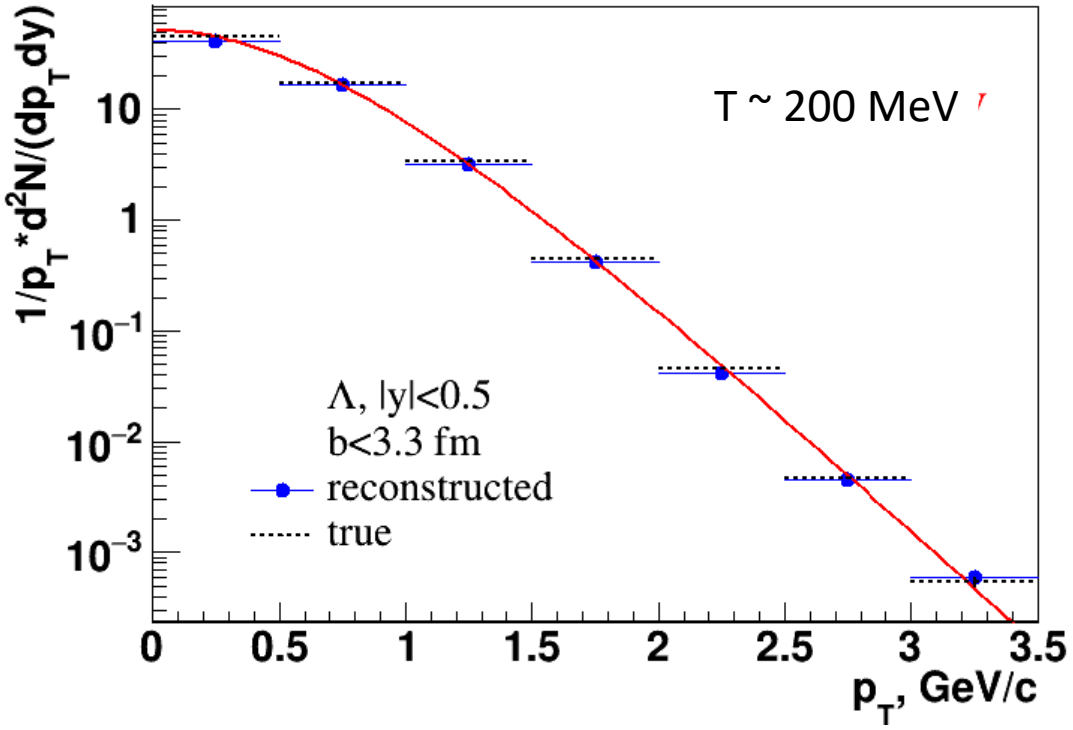


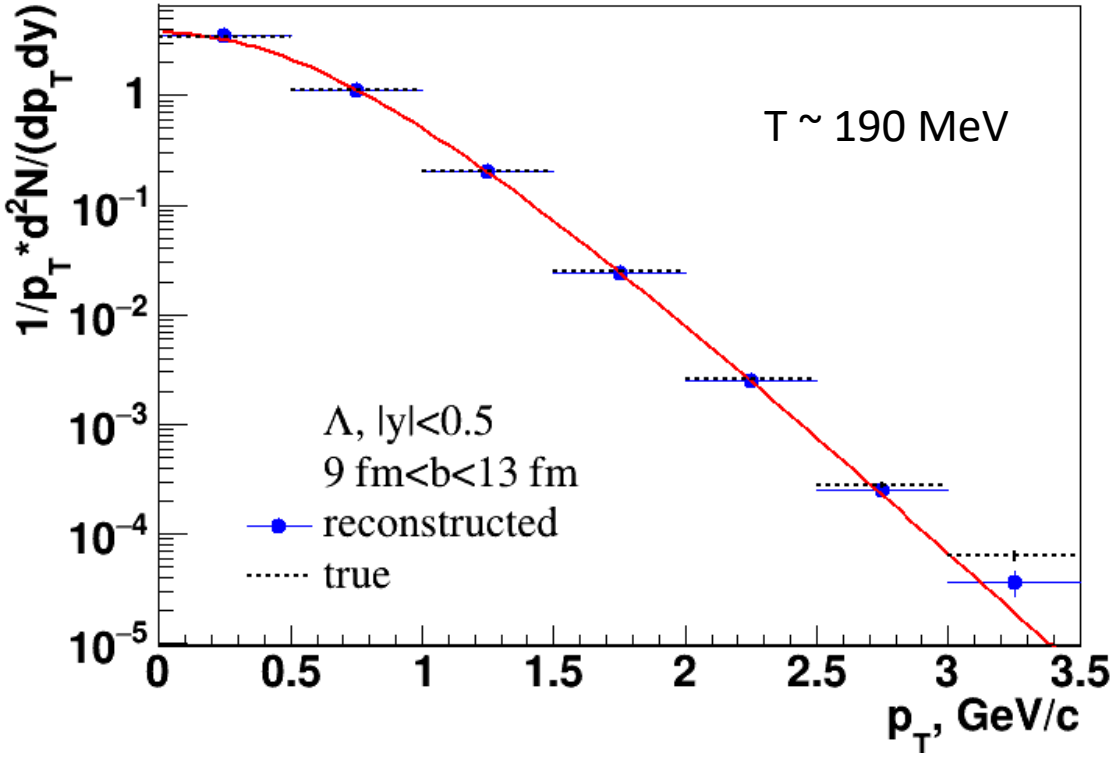




Reconstruction of the midrapidity invariant spectra of Lambda

- Reconstructed spectra are in a reasonable agreement with Monte Carlo
- Similar analysis for other specie and rapidity bins is currently underway

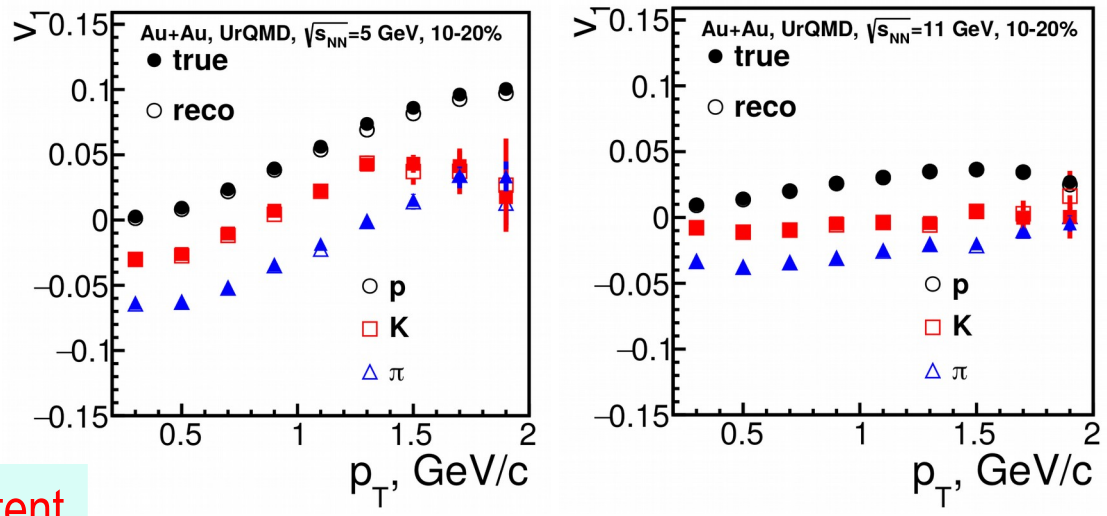




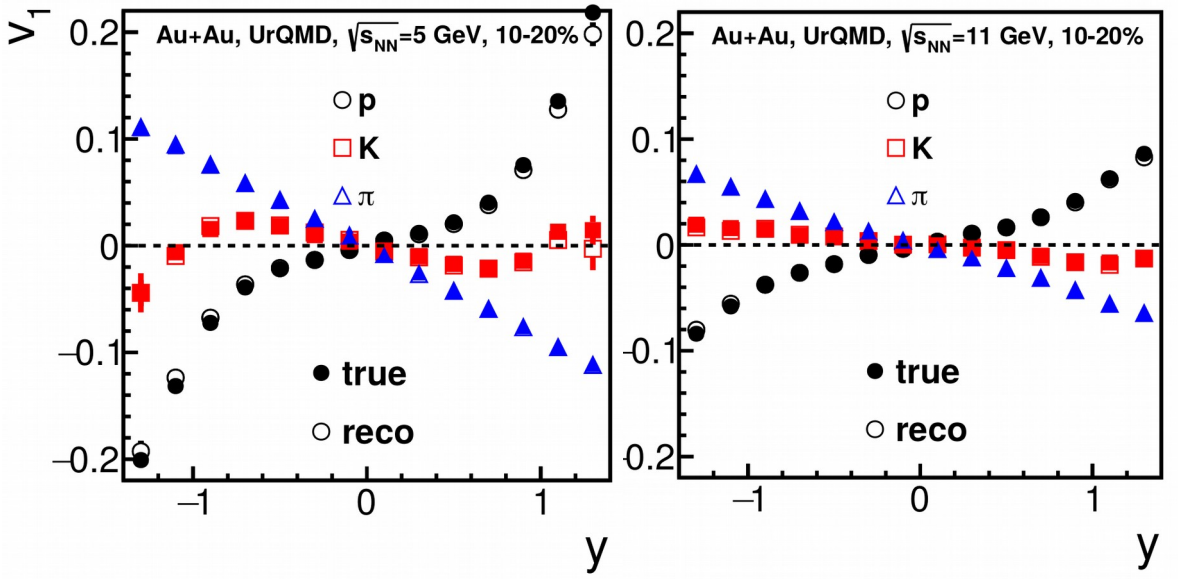
MPD prospects for anisotropic flow studies

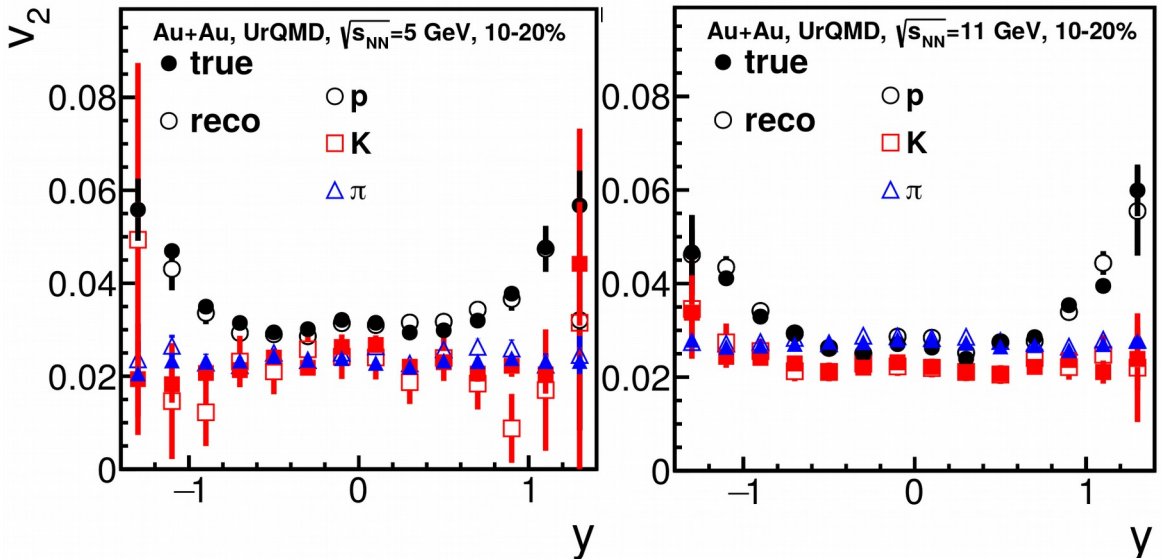
P. Parfenov, A.Taranenko (MEPhI), I.Selyuzhenkov (GSI, MEPhI)

- 4M Au+Au events at 5 and 11 GeV
- Recent MPD reconstruction chain, realistic PID
- N_{points}>32, DCA cut, 0.2<p_T<2 GeV/c, |η|<1.5
- Hadronic shower simulation in FHCAL (GEANT3,4)
- Event plane reconstruction with FHCAL



Both directed and elliptic flow parameters are consistent with those from MC simulation



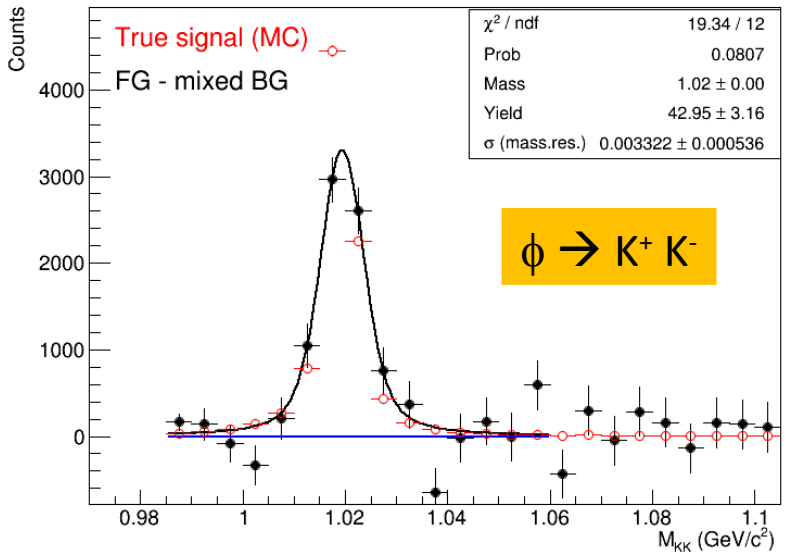


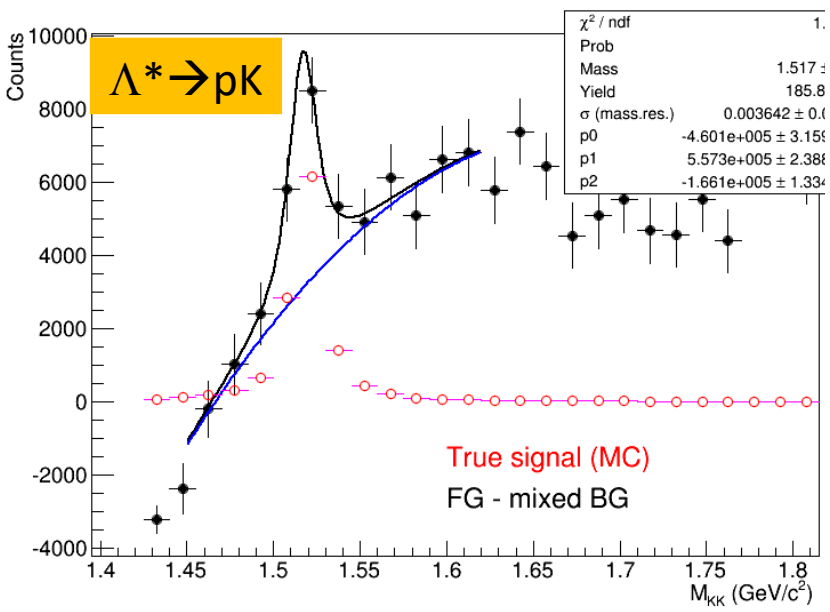
Resonance reconstruction with the MPD detector at NICA

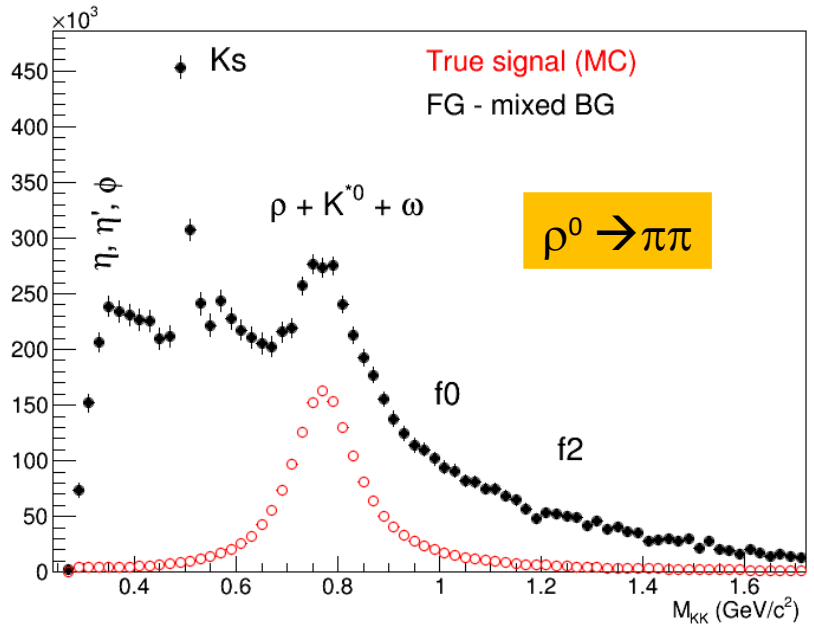
V.Riabov and M.Malaev (PNPI)

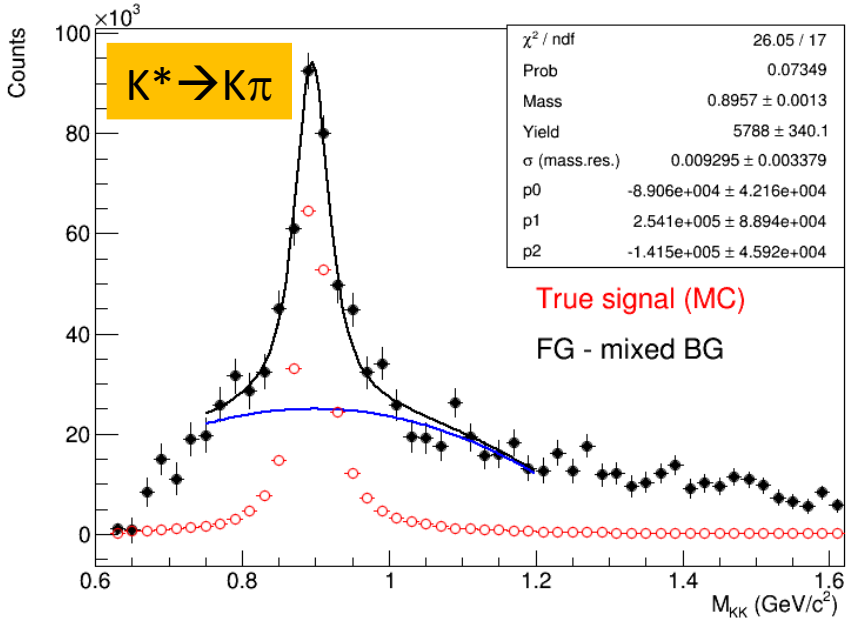
- 0.5M minbias Au+Au@11 GeV by UrQMD3.4
- |Zvrtx| < 50 cm
- number of TPC hits > 39, TPC sector edges cut
- |η|< 1.0, pT > 50 MeV/c
- |DCA(x,y,z)| < 2σ
- TPC+TOF PID probability (π/K/p) > 0.75
- Pair cut: |y| < 1.0
- Combinatorial background: event mixing ($|\Delta_{Zvrtx}| < 2$ cm, $|\Delta_{Mult}| < 20$)

Resonances at MPD – feasible!









Ev-by-Ev fluctuation: cumulants of conserved quantities

A. Mudrokh (VBLHEP)

- Au+Au collisions central (0<b<1 fm), only 50k UrQMD events!
- Cumulants within |y| < 0.5 and 0.3 < p_T < 1.8 GeV/c (0.4<p_T<0.8 GeV/c to compare with STAR)
- Combined PID (protons instead of net-protons)

Corrections for the inefficiency:
A..Bzdak and V. Koch,
Phys. Rev. C 86, 044904 (2012)

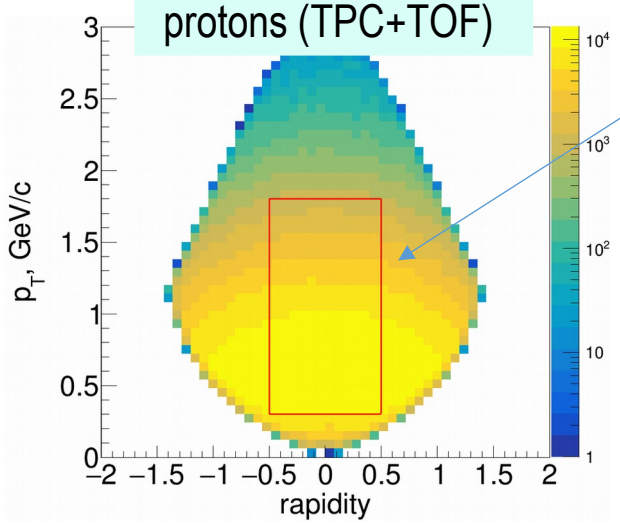
Cumulant ratios are directly compared to susceptibilities and allow fireball volume cancellation

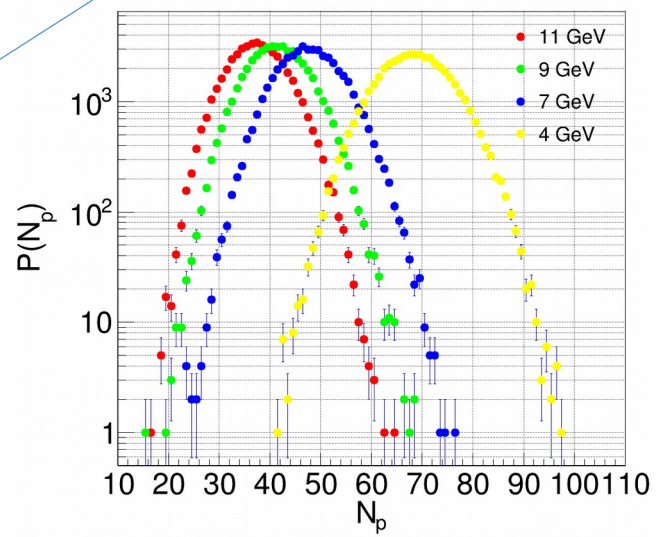
$$S\sigma = \frac{C_3}{C_2} = \frac{\chi_3}{\chi_2}$$

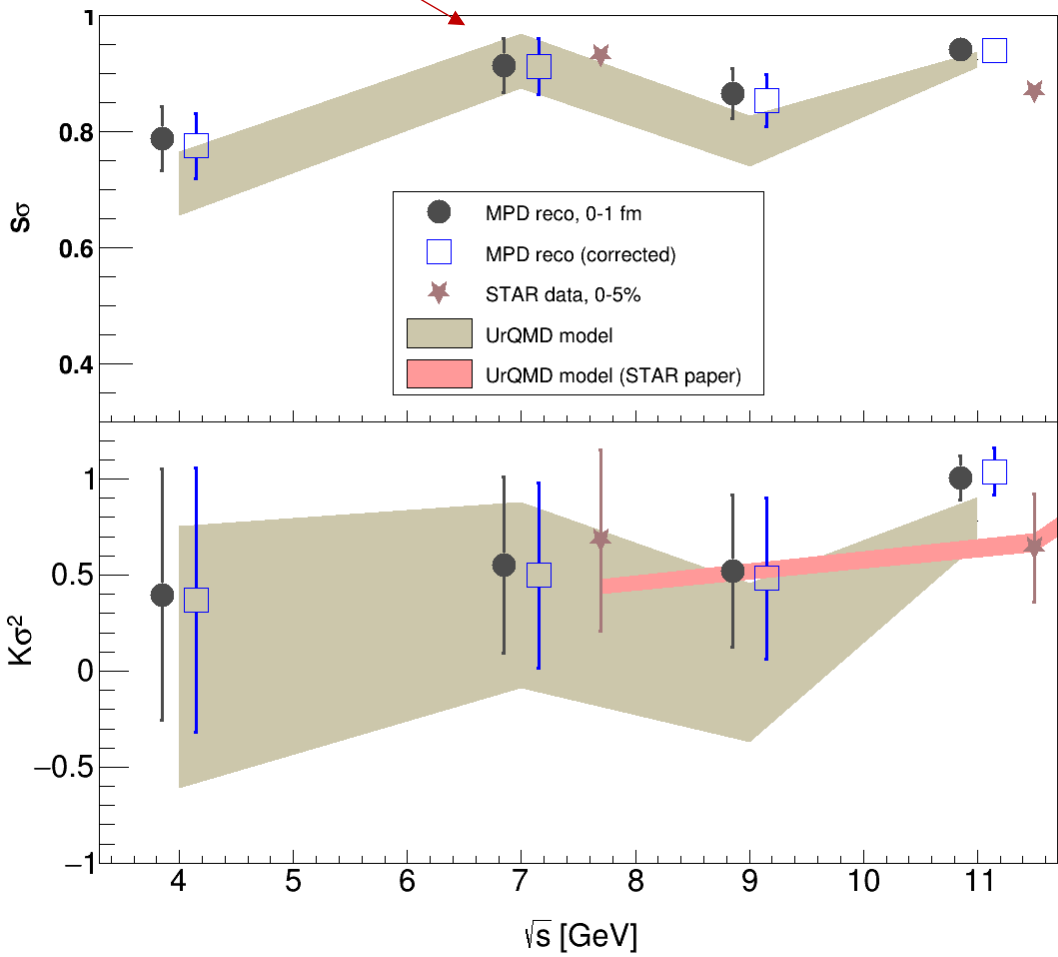
$$\kappa\sigma^2 = \frac{C_4}{C_2} = \frac{\chi_4}{\chi_2}$$

- **Comparison with data in the STAR acceptance Indicates correctness of the feasibility study procedure and results**
- **MPD provides a larger phase-space for E-by-Ev studies (from 30 to 70 PIDed protons/event in the rectangular area)**

MPD phase-space for protons (TPC+TOF)







Status of MPD TDRs

http://*indico.jinr.ru/Projects/NICA/Detectors/DetectorAdvisoryCommitee*

MPD DAC: H. Gutbrod, I. Tserruya, H.-R. Schmidt, N. Xu, L. Musa

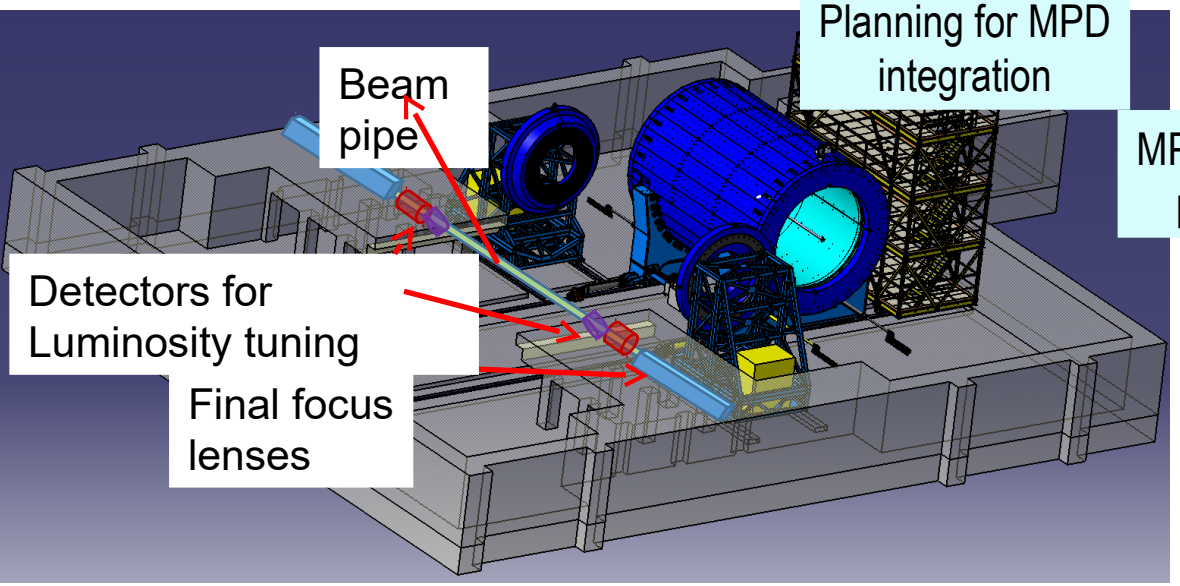
MPD system	Date of recent evaluation	Comments
TPC	30.01.2018	Per DAC request, presented Addendum to TDR on FEE based on PASA and ALTRO
TOF	30.01.2018	Recommendations from DAC implemented, **Got green light** (latest version from 17.11.2018)
FFD	22.07.2017	**Got green light** (22/06/2016)
ECAL	30.01.2018	ECAL TDR updated after recent discussion (latest version from 16.1.2019)
FHCAL	22.07.2017	All recommendations from DAC implemented,**Got green light** (latest version from 28.05.2018)
DAQ	16.12.2015	Version 6 (June'18), still under development (latest version from 27.08.2018)
Computing	2018	VBLHEP+LIT project. Version 1.03. Still progressing

NICA/MPD infrastructure: progress

- **MPD Hall will be soon ready for equipment installation!**
- **Preparatory works: designing place, tooling and service systems for MPD assembling and maintenance**

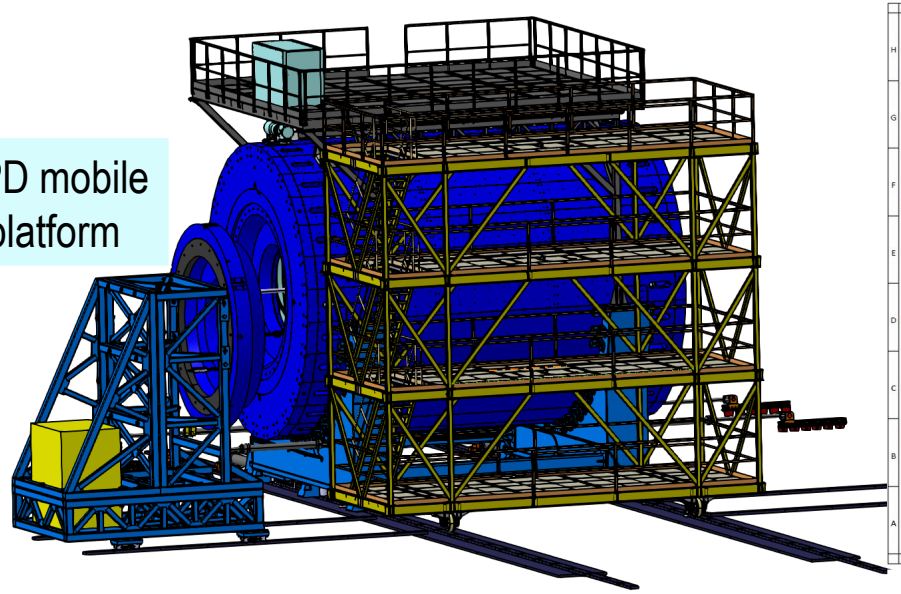
Working place inside/outside of the MPD Hall

- Place & tooling for MPD assembling
- Service & supply systems (cryo, cooling, power, etc.)



Planning for MPD integration

MPD mobile platform



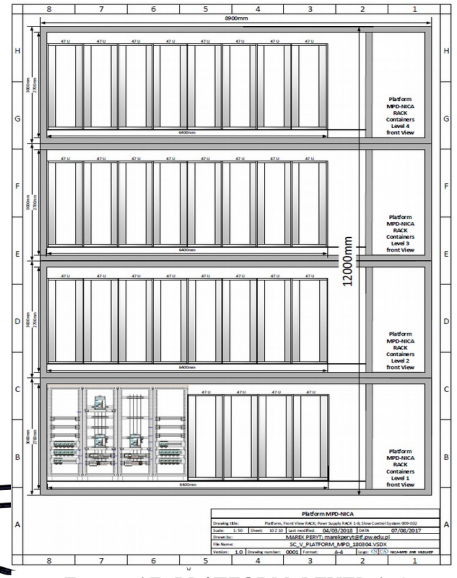
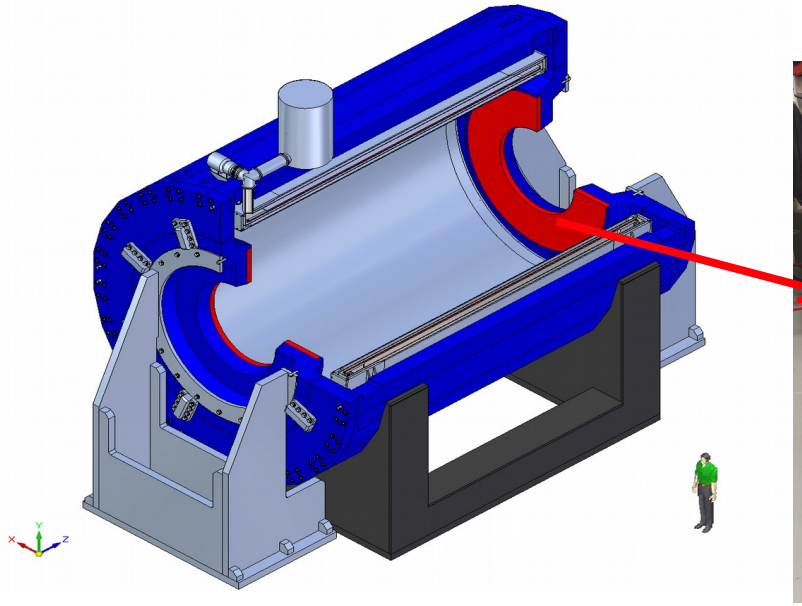
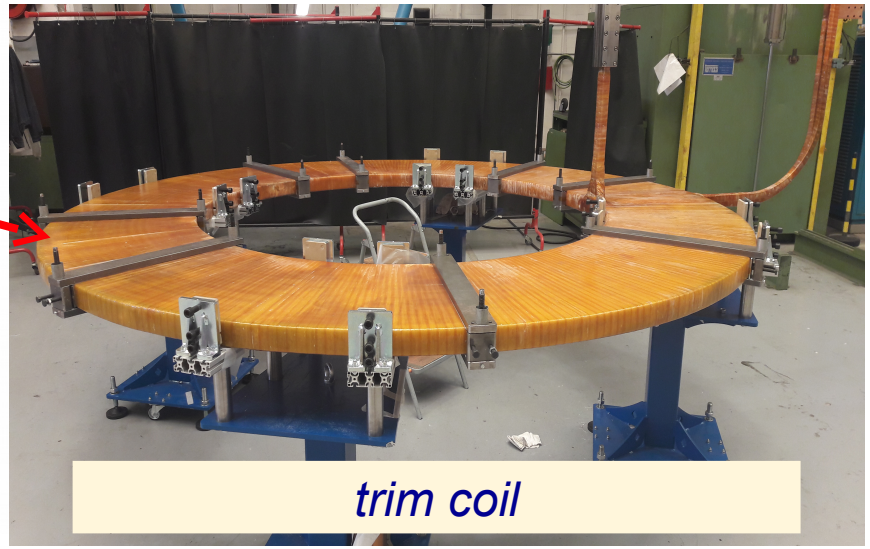


Figure 17; PLATFORM, LEVEL 1-4

Magnet fabrication: ASG (Genova) & Vitkovice HM





trim coil

End of 2018 – SC coils are ready
March 2019 – Solenoid is ready
May 2019 – Transportation to Dubna
Oct 2019 – Assembling of Magnet Yoke and Solenoid at JINR
Nov 2019 – Magnetic field measurements

yoke control assembly at HM Vitkovice

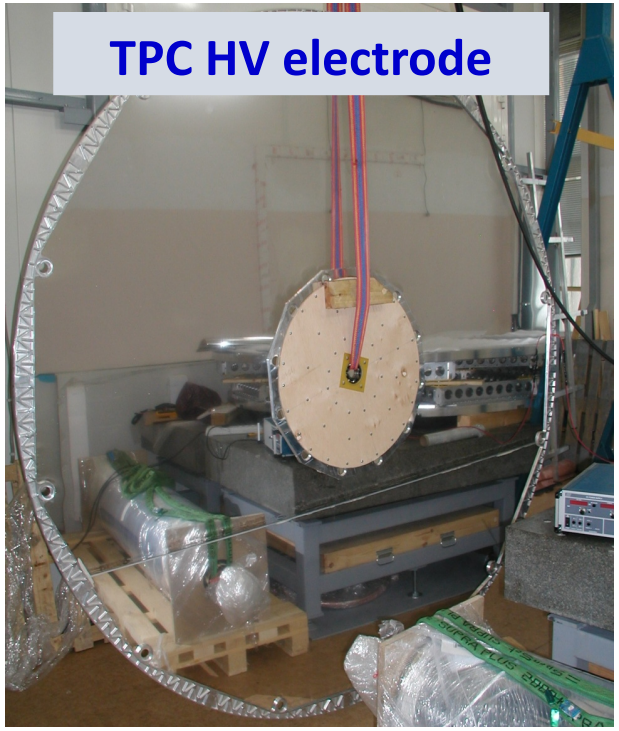
winding machine

cryostat

MPD TPC status

Delivered to JINR

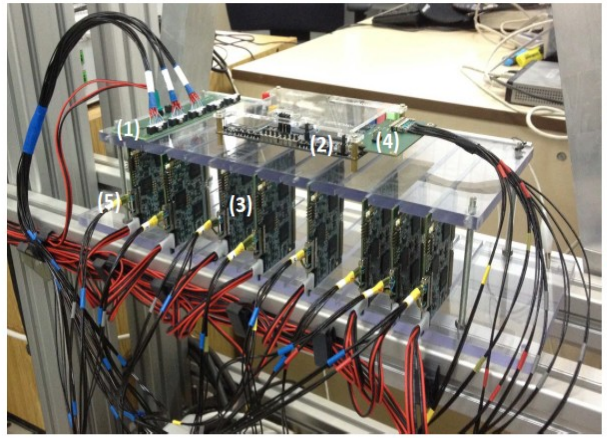
TPC HV electrode



TPC flanges

SAMPA chips (4500 pc) – payment to CERN done

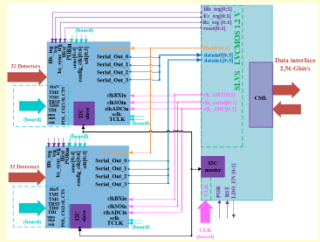
Eight cards pilot system

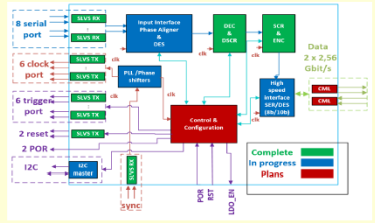


1) Trigger, clock, reset distr. board .
2) System controller.
3) 64-ch SAMPA- FEC.
4) HSSI (up to 2.5 GBps; up to 8 FECs).
5)Data/conf. full duplex HSSI port; clock 40 MHz, trigger, reset.

Concentrator ASIC design (MEPHI)

is intended for data concentration and transfer from two SAMPA chips to counting room via fast bi-directional interface having 2.56 Gb/s speed for getting data out in trigger mode, rad. hard



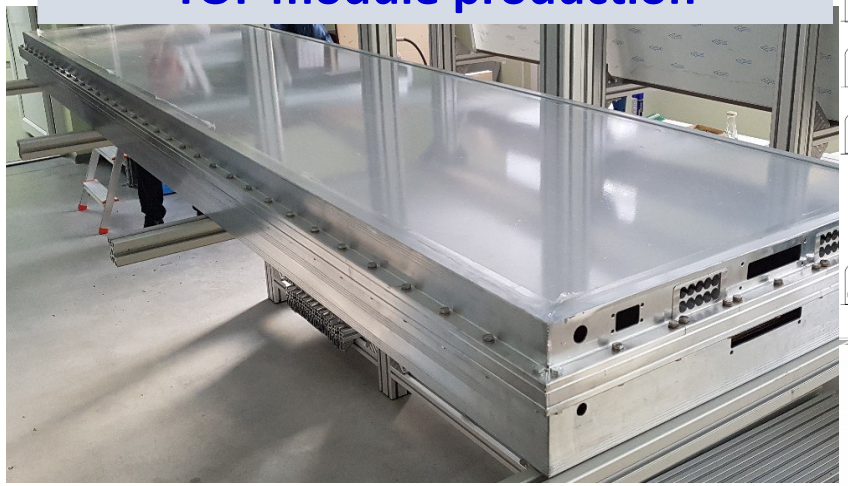


Status – in progress

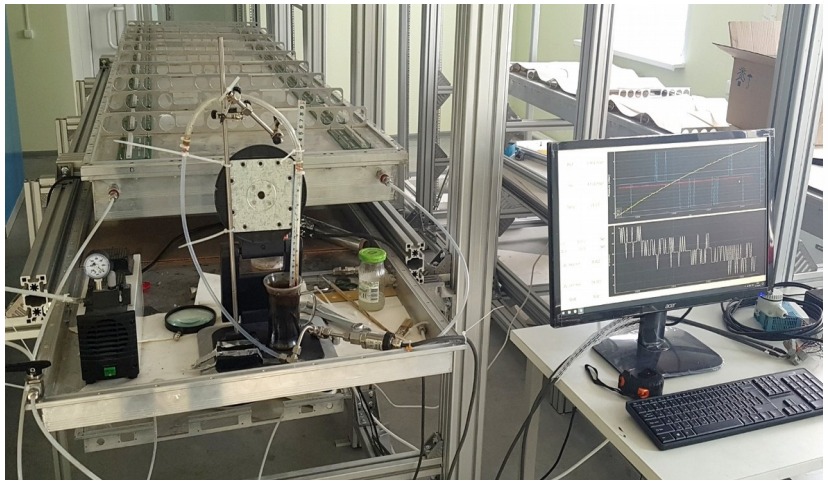
Gas system

MPD TOF status

TOF module production

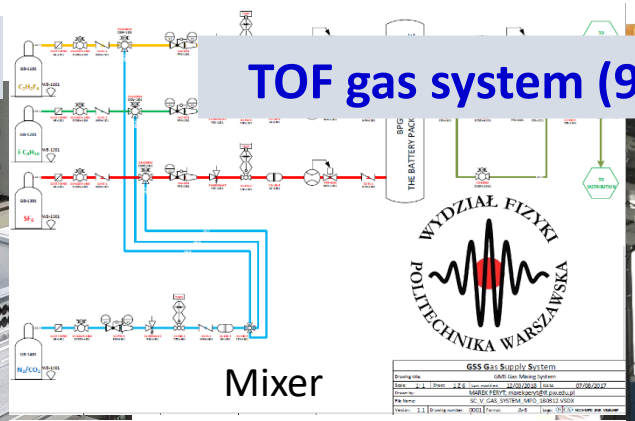


One of the TOF box

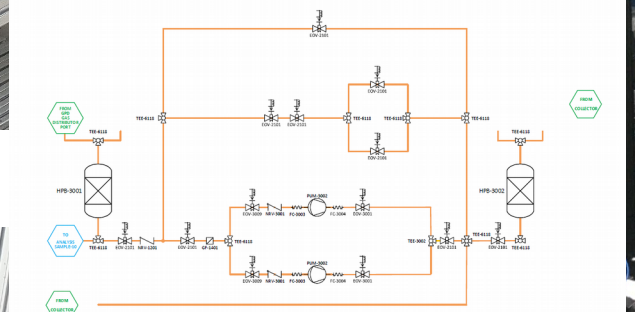


Leakage measurement process

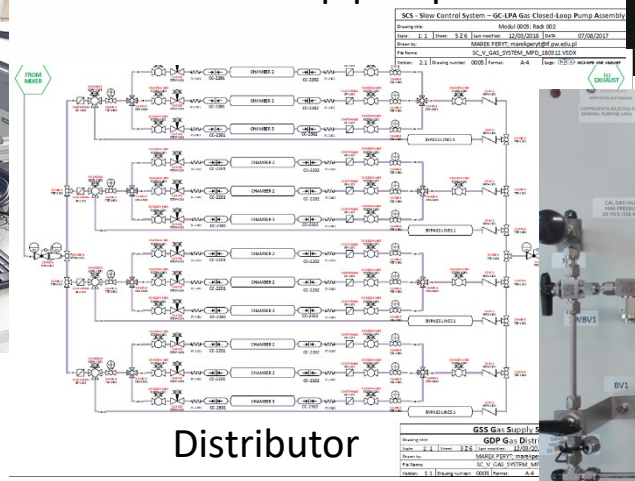
TOF gas system (90% complete)



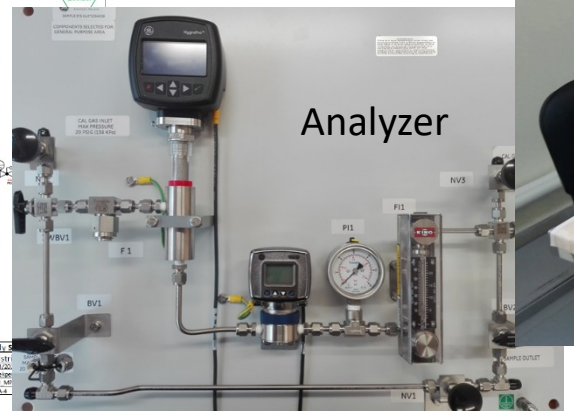
Mixer



Closed loop pump

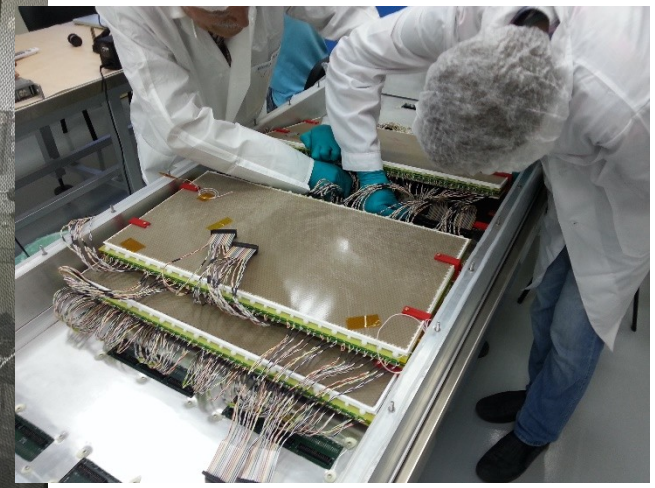


Distributor

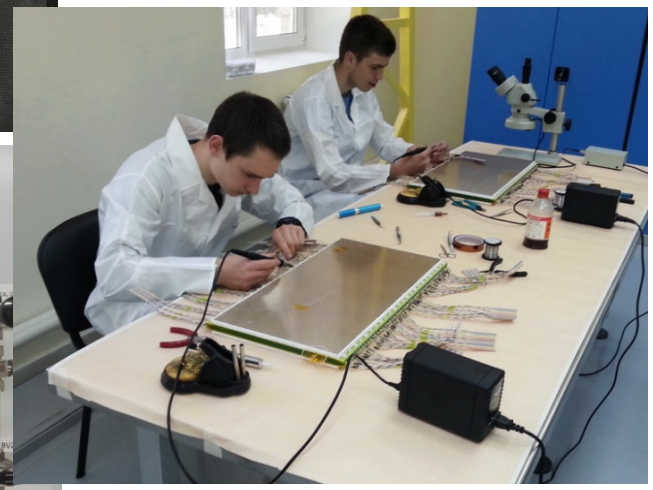


Analyzer

Mass production

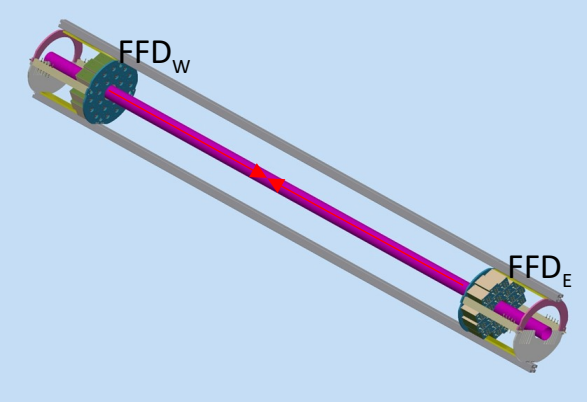


Detectors installation to the TOF box

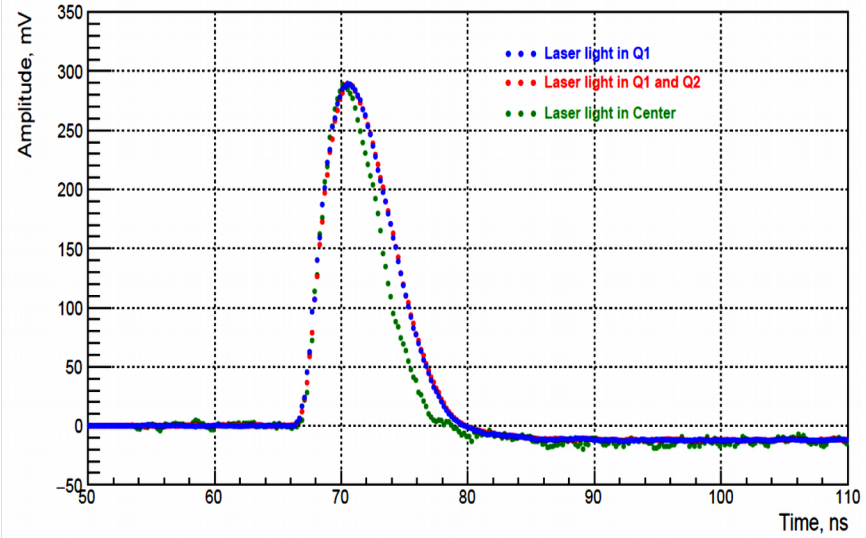


Cables and connectors soldering

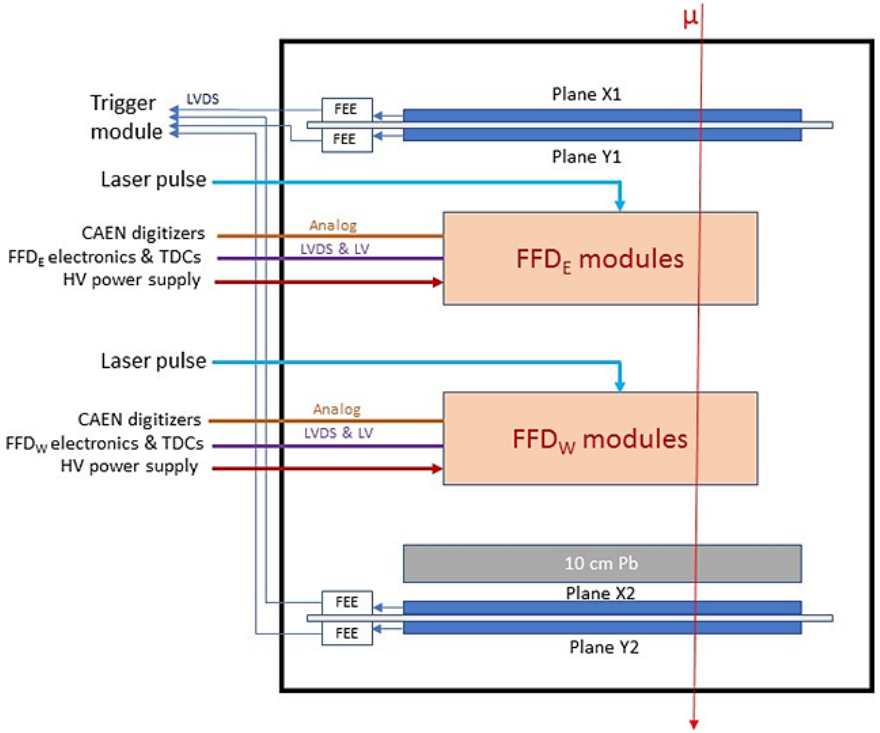
Fast Forward Detector



- Development of experimental stand for test measurements with cosmic muons and laser
- Development of FFD electronics (prototyping)
- Development and test of laser system
- Final design of FFD modules and FEE board
- Development of FFD mechanics
- Final design of cable system
- Study of temperature conditions into FFD module and cooling



The pulse shapes measured with laser for three cases of optical fiber inputs



A scheme of the stand for tests with cosmic muons

Production of the scintillation planes

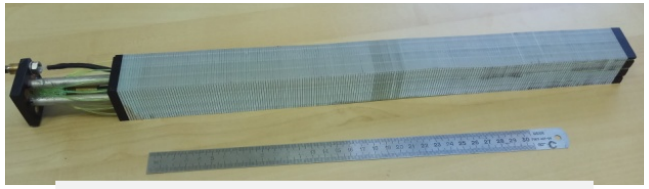
Test of the laser system for FFD calibration

PiLas laser with 30-ps pulse width and 405- nm wavelength

1. PiLas control unit
2. box with laser head and optical system
3. quartz fiber bundles 7.5 m

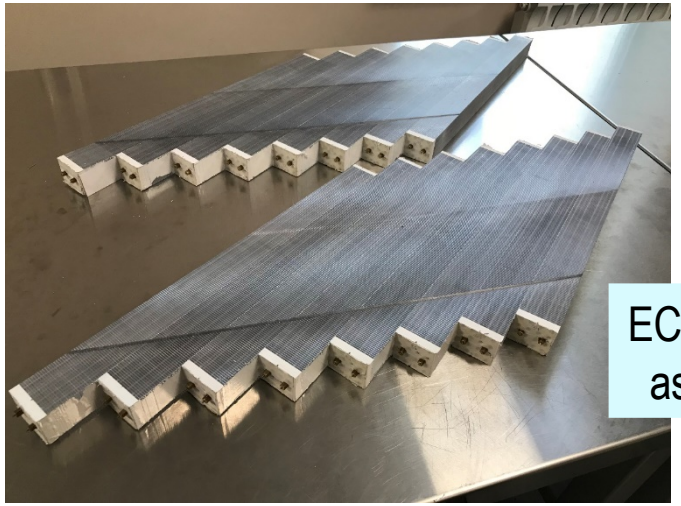
MPD Electromagnetic Calorimeter (ECAL)

I. Tiapkin (VBLHEP), Yi Wang (Tsinghua, China)

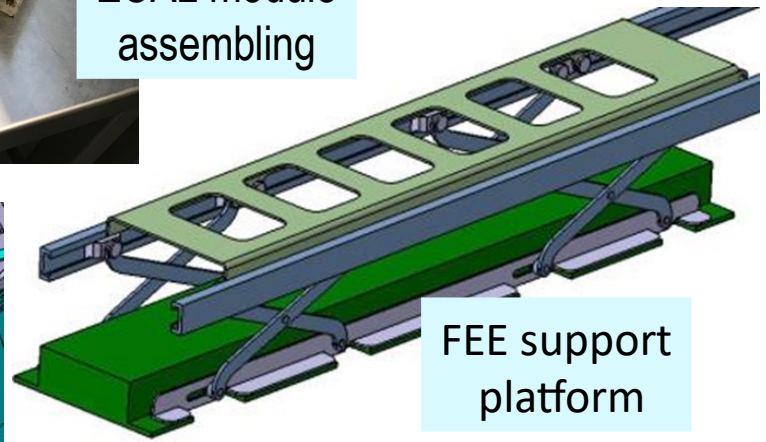


Pb+Scint. (14 X_0, 4x4 cm^2)
WLS fibers + MAPD

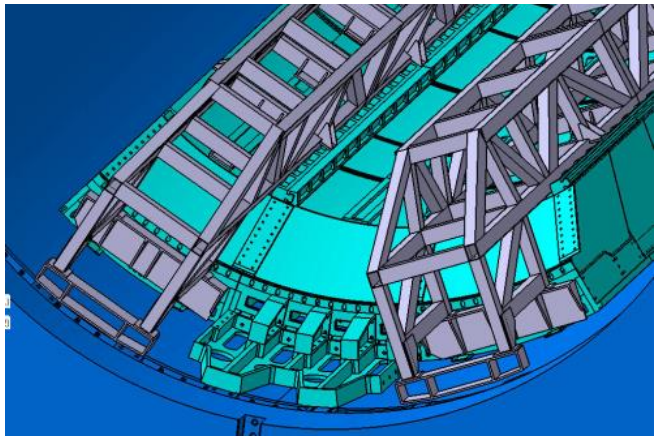
- Finalizing ECAL geometry (design and simulation) – ITEP team
- Mass-production technology testing – 3 workshops at JINR, IHEP, and Tsinghua
- ECAL integration scenario – JINR and ProgressTech Ltd.
- TDR preparation - All



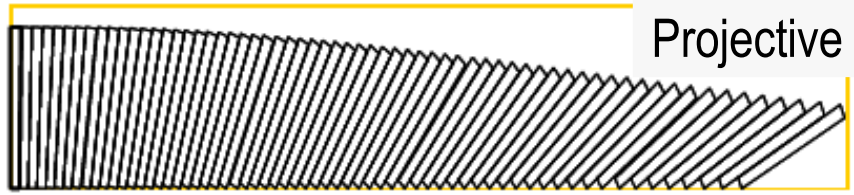
ECAL module assembling

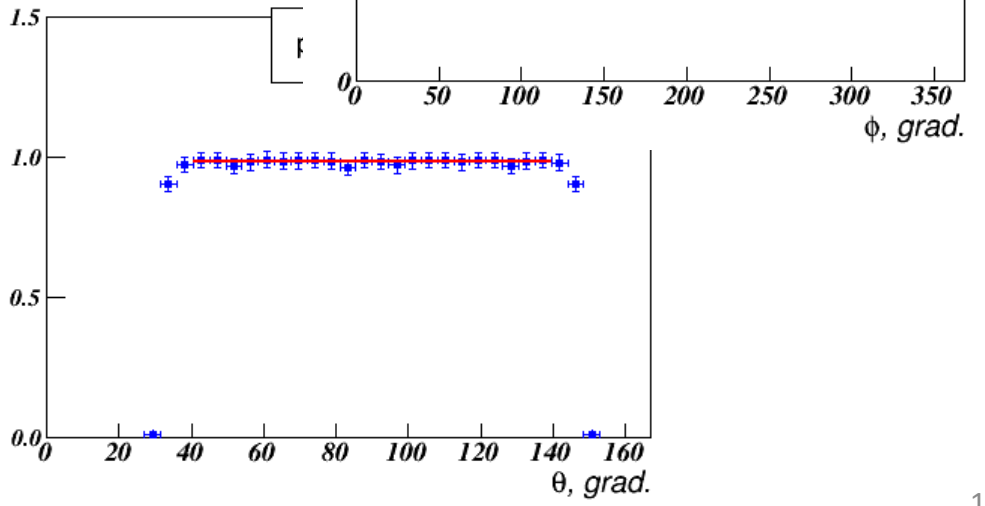


FEE support platform



Projective geometry: response uniformity



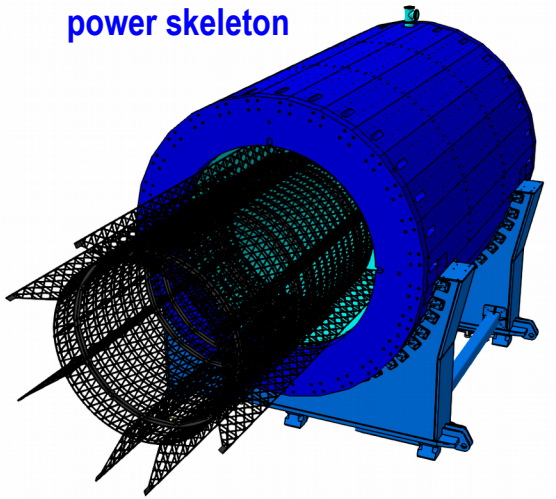


Integration of the Multipurpose Detector

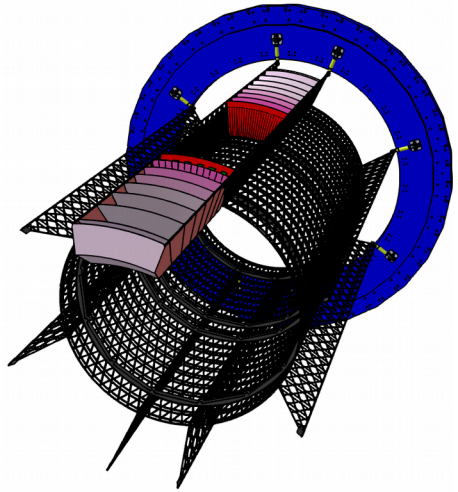
N. Topilin, S. Sukhovarov (VBVLHEP)

- MPD integration scenario
- Mock-up & tooling

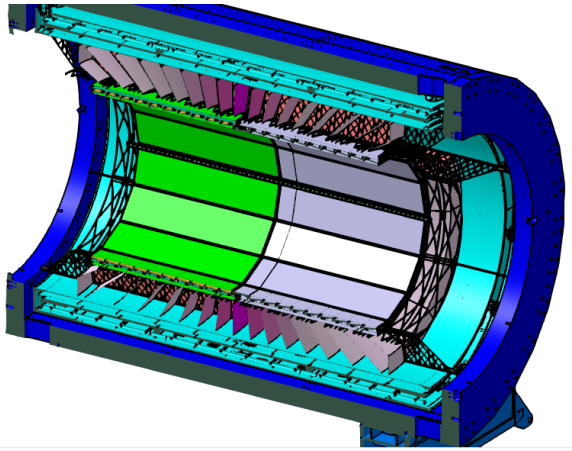
Installation of the power skeleton



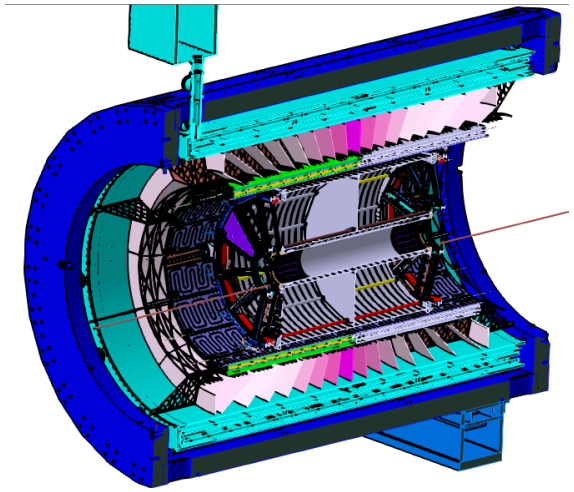
Installation of ECAL "baskets"

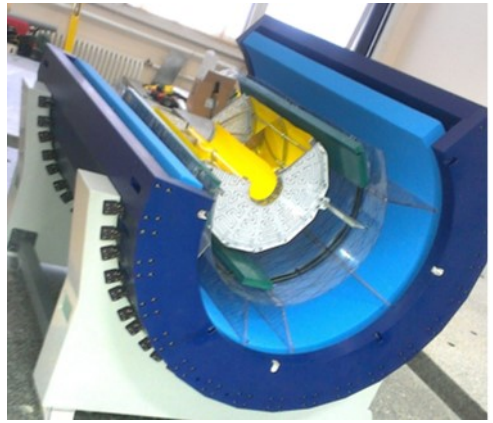


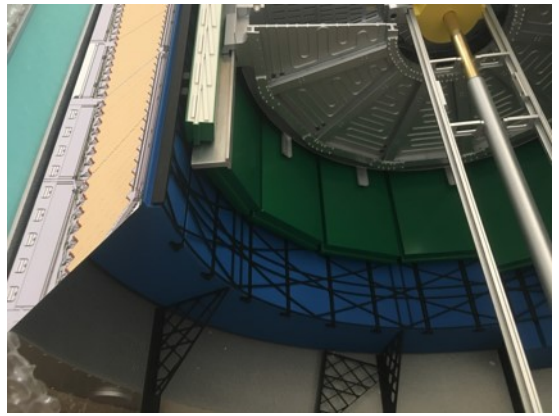
Installation of TOF modules



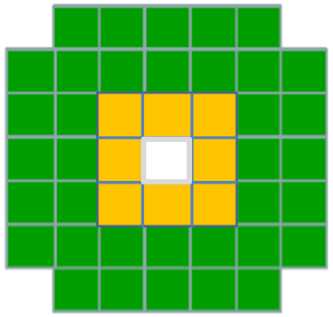
TPC Installation



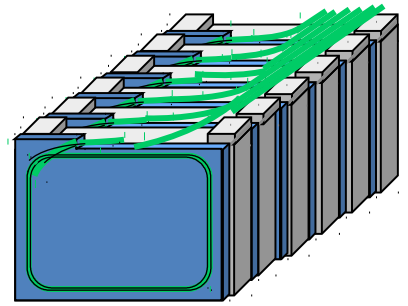




Status of FHCAL



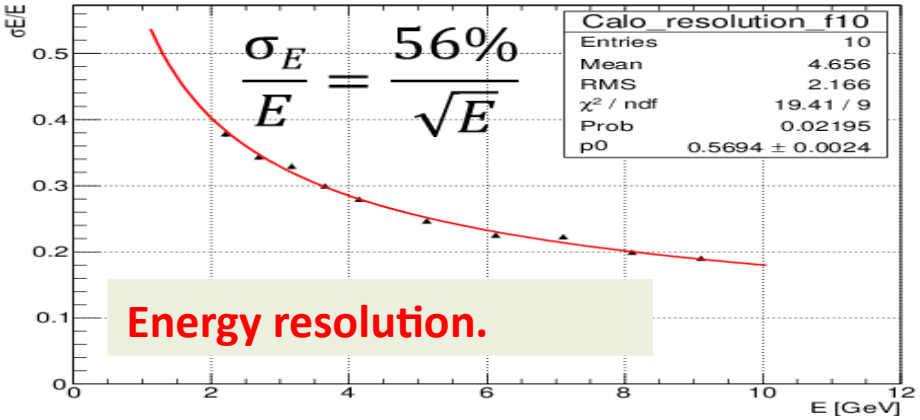
2 x **44** modules (15 x 15 cm^2 each)
located left and right at ~3.2 m from the **IP**)



light collection
WLS-fibers & SiPM

transverse granularity allows to measure:

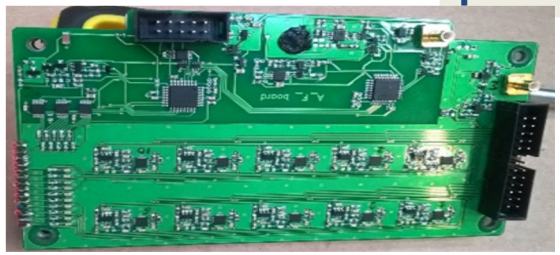
- *the reaction plane with accuracy* **~ 20^0-30^0**
- *the centrality with accuracy* **~ 10%.**



Energy resolution.

Beam tests with 1-10 GeV/c protons were done

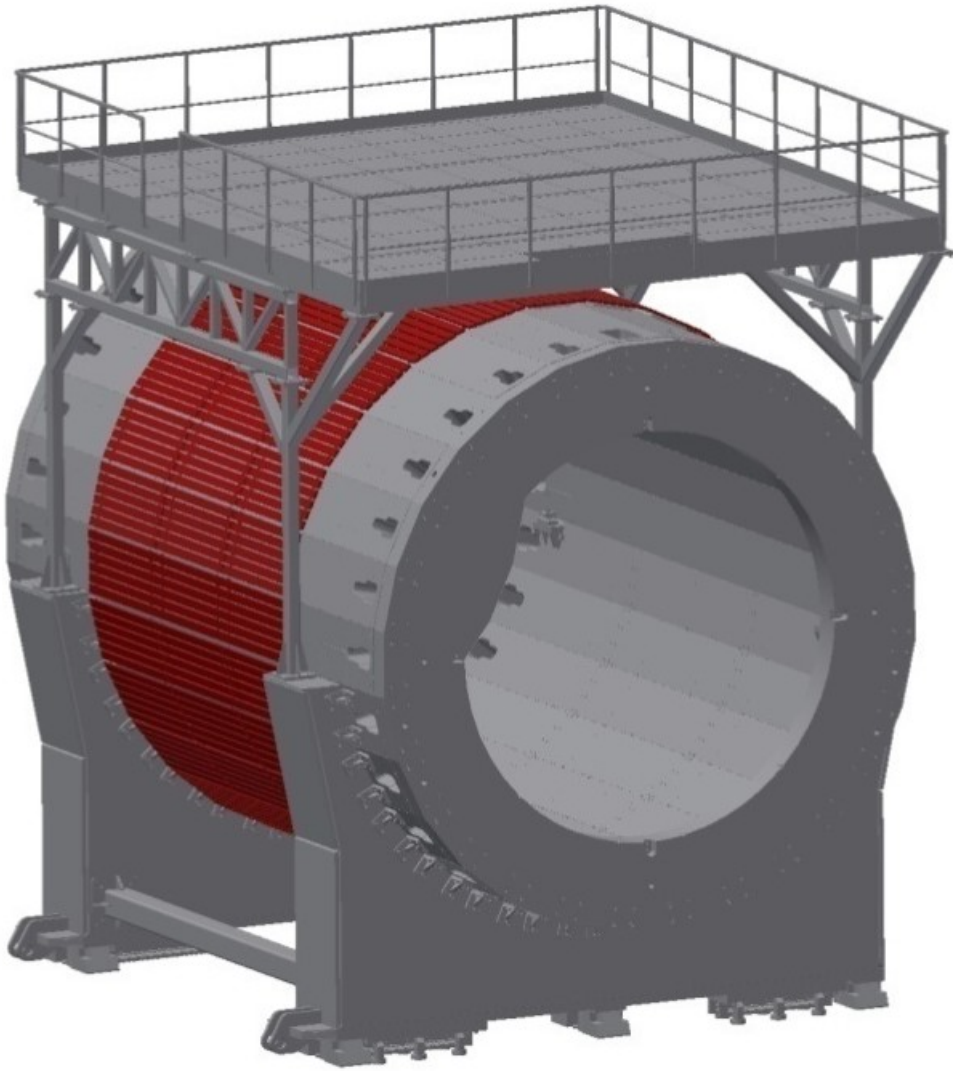
According to the agreement with INR RAS about 80% of FHCal modules are already produced and tested with cosmic muons.



Analog and readout electronics:
Developed and in production now.

MCORD - MPD Cosmic Ray Detector for NICA

Polish Consortium NICA-PL



Proposal to be discussed at MPD DAC meeting (23 Jan 2019)

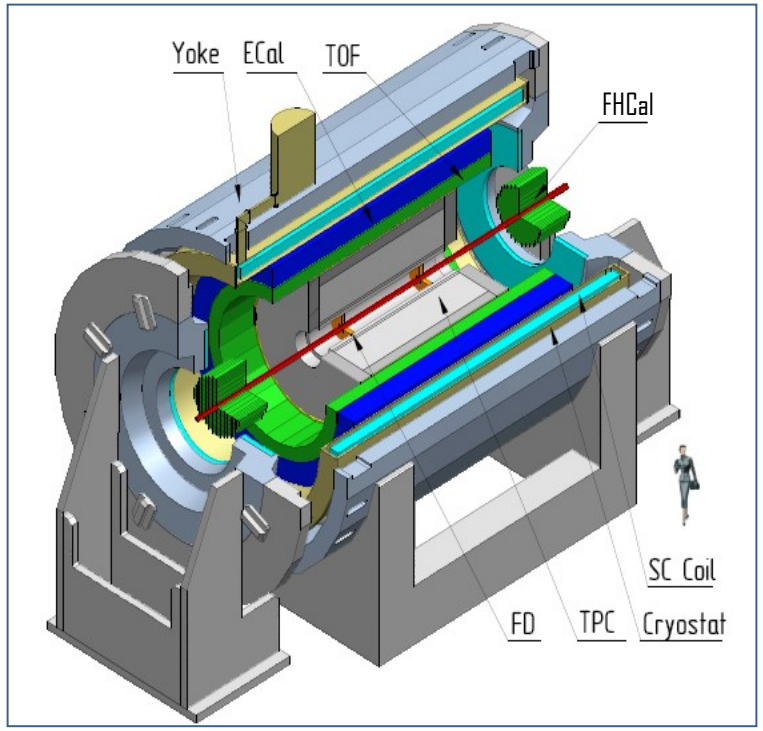
The **M**PD **Co**smic **R**ay **D**etector (MCORD) is needed for:

- discrimination of signals induced by cosmic showers (mainly muons).
- off-beam calibration of the MPD response to muons,
- provide the opportunity for the early tests of the integration of the Subsystems, Triggering, Experiment Control Systems and others.

Plastic scintillators with light readout as most suitable candidates for a detector module. In the initial stage need to choose the optimum shape of scintillators, the configuration of photo-detectors and readout electronics.

TH barrel part consists of little bit more than 500 scintillator modules and about 1000 channels of readout electronics

MultiPurpose Detector (MPD)



Collaboration: >430 members

*Baku State University, NNRC, **Azerbaijan**;*
*University of Plovdiv, **Bulgaria;***
*University Tecnica Federico Santa Maria, Valparaiso, **Chile**;*
*Tsinghua University, Beijing, **China**;*
*USTC, Hefei, **China**;*
*Huizhou University, Huizhou, **China**;*
*Institute of Nuclear and Applied Physics, CAS, Shanghai, **China**;*
*Central China Normal University, **China**;*
*Shandong University, Shandong, **China**;*

*IHEP, Beijing, **China**;*
*University of South China, **China**;*
*Three Gorges University, **China;***
*Institute of Modern Physics of CAS, Lanzhou, **China;***
*Palacky University, Olomouc, **Czech Republic**;*
*NPI CAS, Rez, **Czech Republic**;*
*Tbilisi State University, Tbilisi, **Georgia**;*
Joint Institute for Nuclear Research;
*UNAM, Mexico City, **Mexico**;*
*Institute of Applied Physics, Chisinev, **Moldova**;*
*WUT, Warsaw, **Poland**;*
*NCNR, Otwock – Świerk, **Poland**;*
*UW, Wrocław, **Poland**;*
*Jan Kochanowski University, Kielce, **Poland**;*
*Belgorod National Research University, **Russia;***
*INR RAS, Moscow, **Russia**;*
*MEPhI, Moscow, **Russia**;*
*Moscow Institute of Science and Technology, **Russia;***
*North Osetian State University, **Russia;***
*NRC Kurchatov Institute, ITEP, **Russia;***
*Kurchatov Institute, Moscow, **Russia;***
*PNPI, Gatchina, **Russia**;*
*SINP, Moscow, **Russia;***
*SPSU, St. Petersburg, **Russia**;*

Second MPD Collaboration Meeting
29-30 October 2018

http://jinrmag.jinr.ru/pdf2/18num45-46.pdf

http://mpd.jinr.ru/experiment/

New member institutes (now 32 institutes from 10 countries + JINR)
Spokesperson election: Adam Kisiel (WUT, Poland)
IB Board Chair election: Fuqiang Wang (ZJHU, China)
Project manager endorsement: Slava Golovatyuk (JINR)

MPD Collaboration: organizational activities

- *Formation of structures defined in Collabotaion Bylaws:*
  - *Endorsement of Deputy Spokespersons*
    - *Victor Riabov (SPSU, Russia)*
    - *Zebo Tang (USTC, China)*
  - *Preparation of the Memorandum of Understanding for each institution*
    - *Grouping by Country? Form of involvement of state funding agencies?*
  - *Elections for the Executive Council*
  - *Formation of the Detector Council*

  - *With the help of the Executive Council the following structures will be created:*
    - *Physics Working Groups – the definition of physics topics, selection of Convenors, assignment of Collaborators to Physics Groups*
    - *Formation of formal software and computing structure, assignment of software coordinator*
    - *Discussion on the possibilities and available resources for the MPD Computing paradigm*
    - *Formation of the Talks Committee*

Summary

- **Substantial progress in MPD project realization (Magnet, TPC, TOF, FFD, FHCAL, ECAL, Engineering, Integration, Feasibility studies)**

- **Efficient MPD DAC evaluation process: Stage'1 sub-systems carry out regularly, next meeting on 23/01/2019, several TDRs close to final approval**

- **The international collaboration around the NICA is growing. New partners are invited to join NICA**

- **MPD Collaboration is in the process of creation of organizational structures**

Thank you for your attention!