MPD Collaboration Status

V. Riabov for the MPD Collaboration



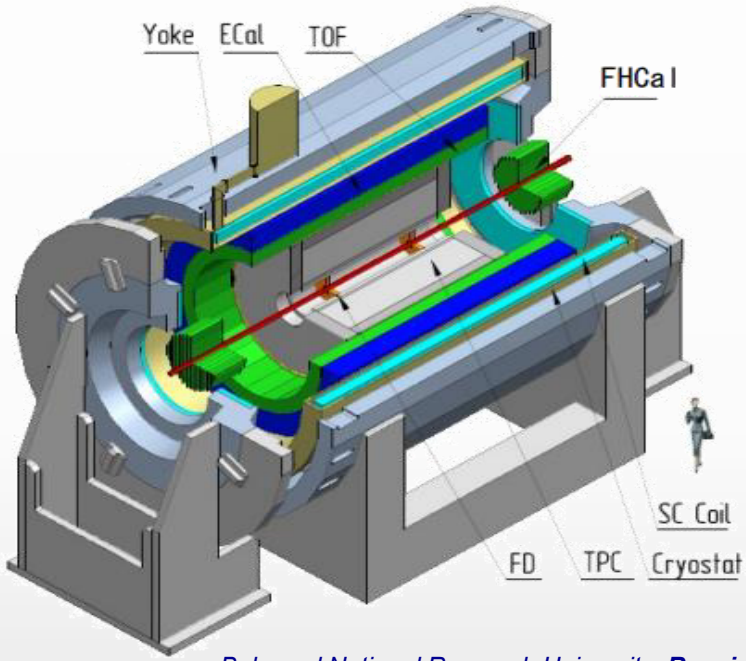
Multi-Purpose Detector (MPD) Collaboration

***MPD** International Collaboration was established in **2018** to construct, commission and operate the detector*

12** Countries, **>500** participants, **38** Institutions and **JINR

Organization

Acting Spokesperson:	***Victor Riabov***
Deputy Spokespersons:	***Zebo Tang, Arkadiy Taranenko***
Institutional Board Chair:	***Alejandro Ayala***
Project Manager:	***Slava Golovatyuk***



***Joint Institute for Nuclear Research**;*
*A.Alikhanyan National Lab of Armenia, Yerevan, **Armenia;***
*Institute for Nuclear Problems of Belarusian State University, **Belarus**;*
*Institute of Power Engineering of the National Academy of Sciences of Belarus, **Belarus**;*
*SSI "Joint Institute for Energy and Nuclear Research - Sosny" of the National Academy of Sciences of Belarus, Minsk, **Belarus;***
*University of Plovdiv, **Bulgaria;***
*Tsinghua University, Beijing, **China**;*
*University of Science and Technology of China, Hefei, **China**;*
*Huzhou University, Huizhou, **China**;*
*Institute of Nuclear and Applied Physics, CAS, Shanghai, **China**;*
*Central China Normal University, **China**;*
*Shandong University, Shandong, **China**;*
*University of Chinese Academy of Sciences, Beijing, **China**;*
*University of South China, **China**;*
*Three Gorges University, **China**;*
*Institute of Modern Physics of CAS, Lanzhou, **China**;*
*Egyptian Center for Theoretical Physics, **Egypt**;*
*Tbilisi State University, Tbilisi, **Georgia**;*
*Institute of Physics and Technology, Almaty, **Kazakhstan**;*
*Instituto de Ciencias Nucleares, UNAM, **Mexico**;*
*Universidad Autónoma de Sinaloa, **Mexico**;*
*Universidad Autónoma Metropolitana, **Mexico**;*
*Universidad de Colima, **Mexico**;*
*Universidad Michoacana de San Nicolás de Hidalgo, **Mexico**;*
*Institute of Physics and Technology, **Mongolia**;*

*Belgorod National Research University, **Russia**;*
*High School of Economics University, Moscow, **Russia;***
*Institute for Nuclear Research of the RAS, Moscow, **Russia**;*
*National Research Nuclear University MEPhI , Moscow, **Russia**;*
*Moscow Institute of Science and Technology, **Russia**;*
*North Ossetian State University, **Russia**;*
*National Research Center "Kurchatov Institute", **Russia**;*
*National Research Tomsk Polytechnic University, **Russia**;*
*Peter the Great St. Petersburg Polytechnic University Saint Petersburg, **Russia**;*
*Plekhanov Russian University of Economics, Moscow, **Russia**;*
*St.Petersburg State University, **Russia**;*
*Skobeltsyn Institute of Nuclear Physics, Moscow, **Russia**;*
*Petersburg Nuclear Physics Institute, Gatchina, **Russia**;*
*Vinča Institute of Nuclear Sciences, **Serbia**;*
*Pavol Jozef Šafárik University, Košice, **Slovakia***

MPD superconducting magnet

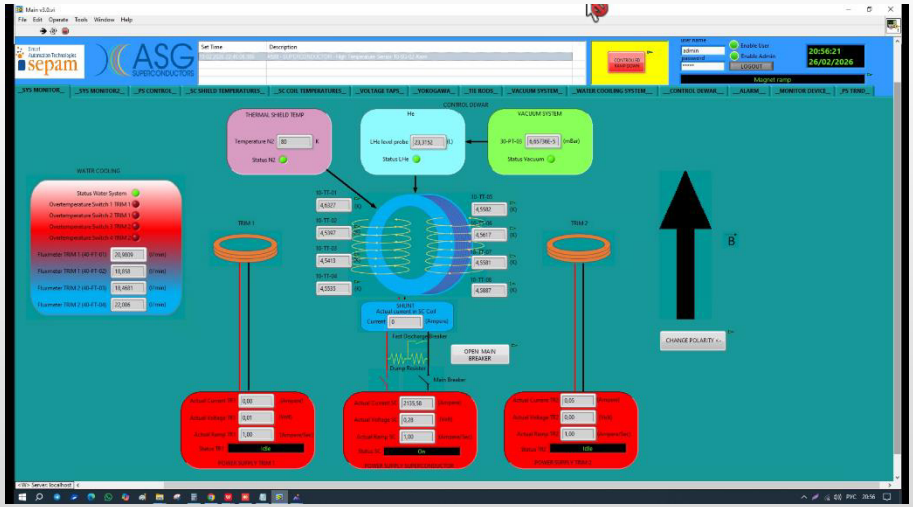
- Cooled the magnet to LN2 and LHe temperatures → nominal magnetic field of 0.57T reached

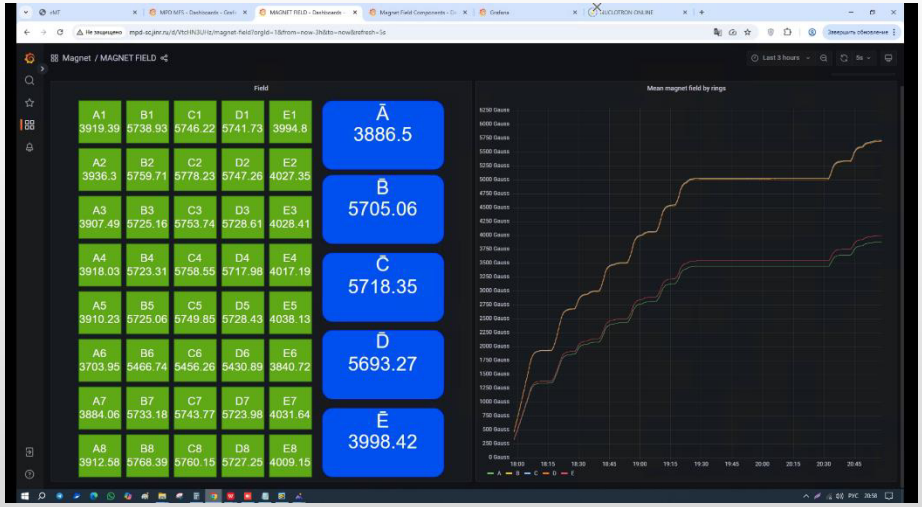
Magnet yoke and cryogenic platform



- ✓ Stable operation with trim coils at maximum field with no current/temperature fluctuations
- ✓ An important milestone reached !!!

Magnet fully operational since mid-February

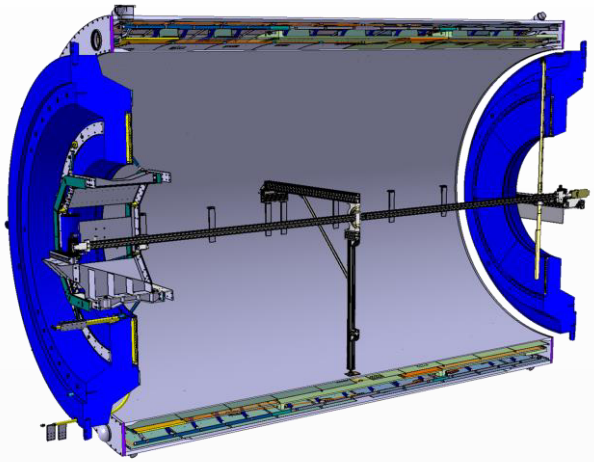


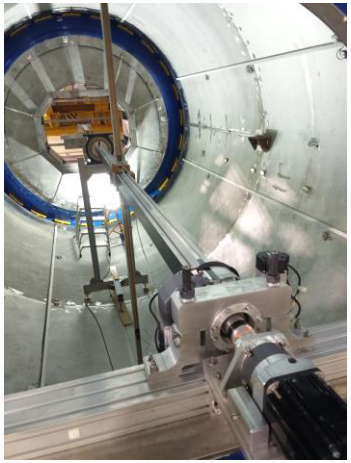


One of the major objectives has been successfully realized – congratulations to entire team !!!

Magnetic field measurements

- Magnetic field measurements (Novosibirsk INP):





	Along radius (R)	Along azimuth angle (ϕ)	Along beam (z)
Step size, см	5	21	10
Total length, см	220	360° (1380 см at max. R)	700
Number of measurements	44	64	70

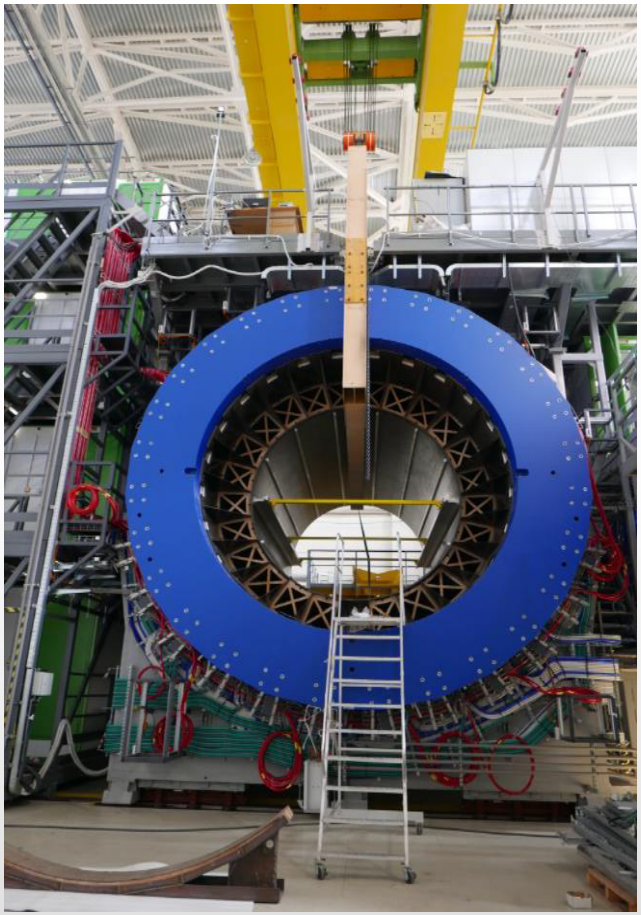
Single 3D Hall probe moves in 3 directions: z , R, ϕ
Accuracy: 0.1 – 0.3 Gs
Fields to measure: 0.2 – 0.5 T
Tunes of the Trim Coil currents (calculations and measurements)

- First magnetic field measurements at 0.2T in December 2025:
  - ✓ field mapper installed and operational
  - ✓ measurements successfully completed
  - ✓ no field map with corrections is available yet
- Second magnetic field measurements at 0.5T in March-April:
  - ✓ technical problems with the mapper at full field
  - ✓ measurements carried out only for a fraction of the TPC volume
  - ✓ no results are available yet
- Another attempt for field measurements in June before TPC installation

Magnetic field measurements become a critical problem !!!

Central barrel subsystems

Carbon fiber frame installed in the magnet



Sagita ~ 5 mm at full load,
rails for the TPC and TOF are installed

ECAL - ready





ECAL ~ 38400 towers (2400 modules)
All half-sectors + spares are ready for installation

TOF - ready



All 28 (100%) TOF modules are assembled and tested, ready for installation.

Installation of the ECAL and TOF is about to start

TPC – central tracking detector

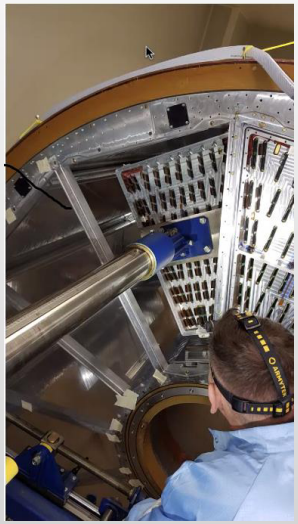
- Gas volume assembled and tested for leaks and HV (central membrane) → passed





- Installation of the read-out chambers (and later electronics) is ongoing → finished this week









- ✓ Installation of ROC chambers on one side is complete
- ✓ Second side to be completed this week
- ✓ Next: HV tests, FEE installation and read-out tests

Forward subsystems

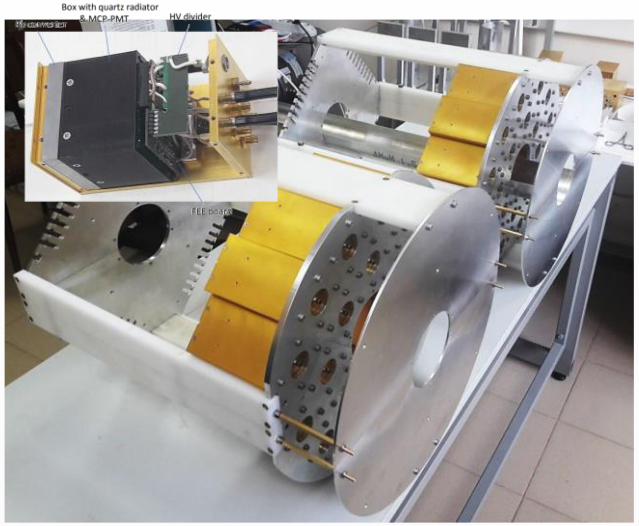
FHCAL - ready





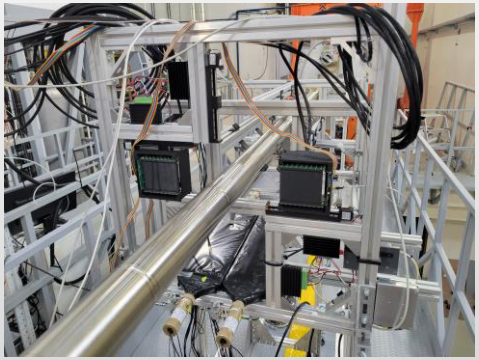
FHCal assembled on the platform, (modules are equipped with FEE)

FFD - ready



Cherenkov modules of FFDE and FFDW, mechanics for installation in container with beam pipe are available

Beam luminosity detector operated at collider start-up





<u>See dedicated talks for each subsystem later today and tomorrow</u>

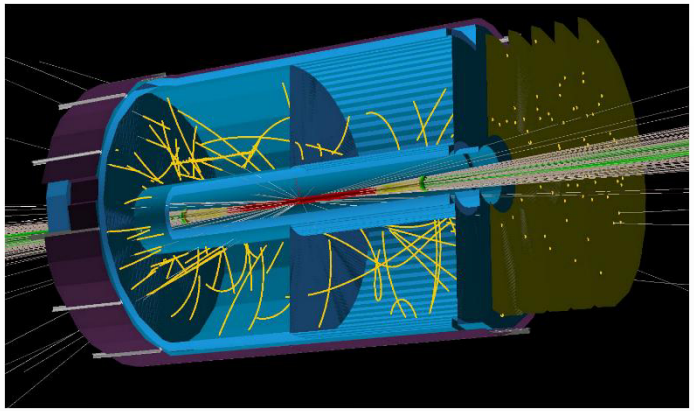
MPD schedule

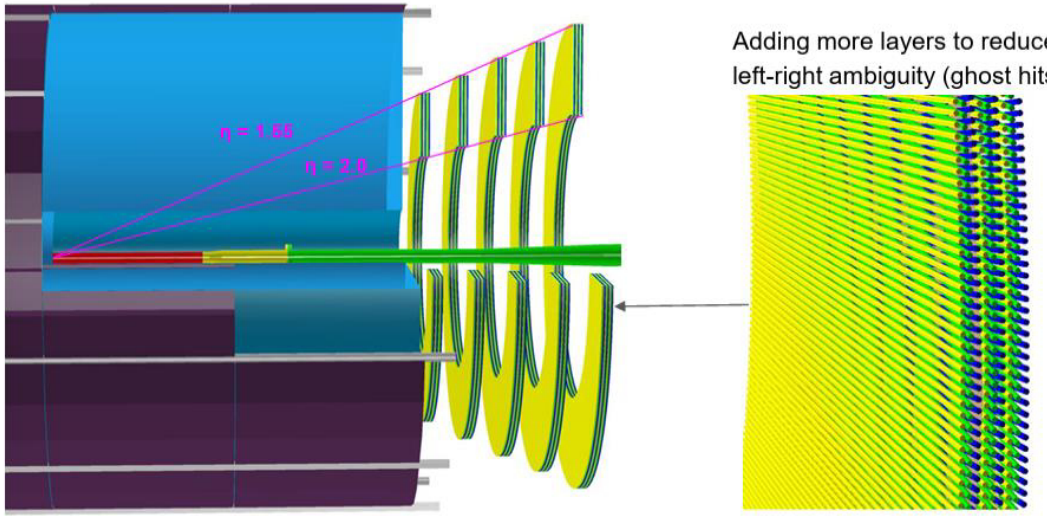
		2026
1	January 12th – January 23d	Fixation the Current leads cooling problem
2	January 26th February 15th	Cooling the Solenoid to working temperature
3	February 25 – March 25th	Magnetic field measurements at nominals 0.5T - 0.4T -0.3T
4	March 30th - April 17th	Support Frame installation into Magnet
5	April 20th – May 30th	Ecal installation from the East side
6	April 20th – April 30th	West side Lifting Platform assembling
7	May 4th – May 30th	Ecal installation from W side
8	May 4th – June 15th	Installation of the TOF modules (access from both sides)
9	June 16th - June 30th	Magnetic field measurements at nominals 0.5T
10	July 10th – September 20th	TPC installation and test
11	September 21st – September 30th	Beam pipe installation
12	October 3 - October 15th	Closing MPD (Installation of Poles)
13	October 17th	Moving MPD to the Collider beam line

MPD in the beam position by the end of October to comply with the NICA Run-2 schedule

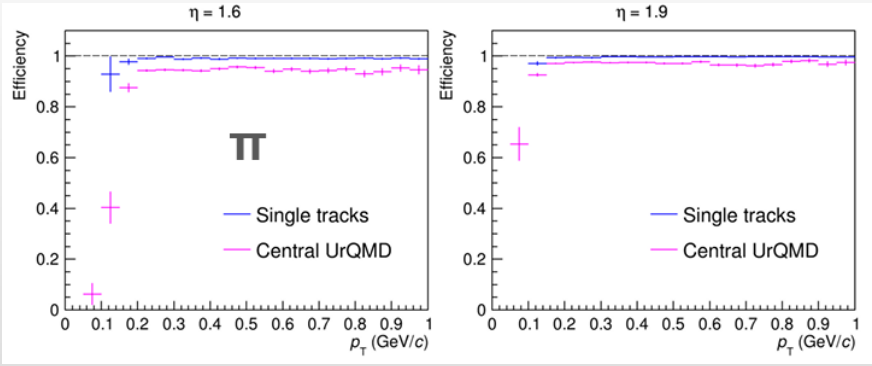
Development of the Forward Spectrometers

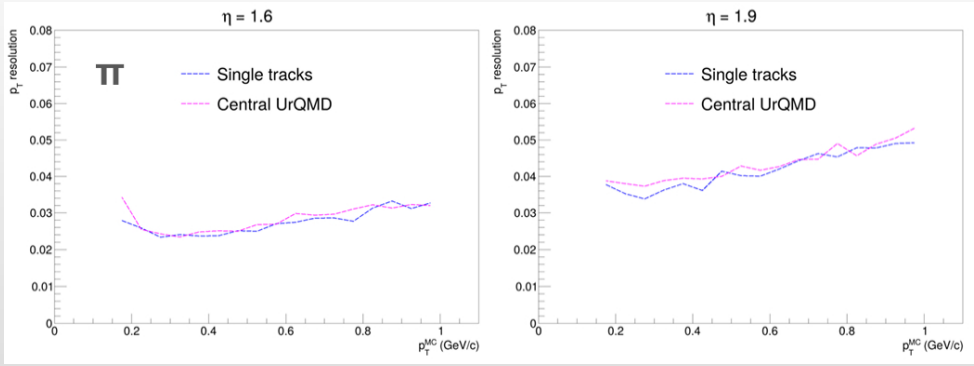
Conception of the Forward Tracker (FTD)





- ✓ 9 layers per station with RUV stereo angles: 0^0, $\pm 7^0$, 0^0, $\pm 7^0$, 0^0, $\pm 7^0$
- ✓ Acceptable radiation length ~ 0.15 - 0.2% per station
- ✓ Total straws for 2 sides: ~ 66k channels





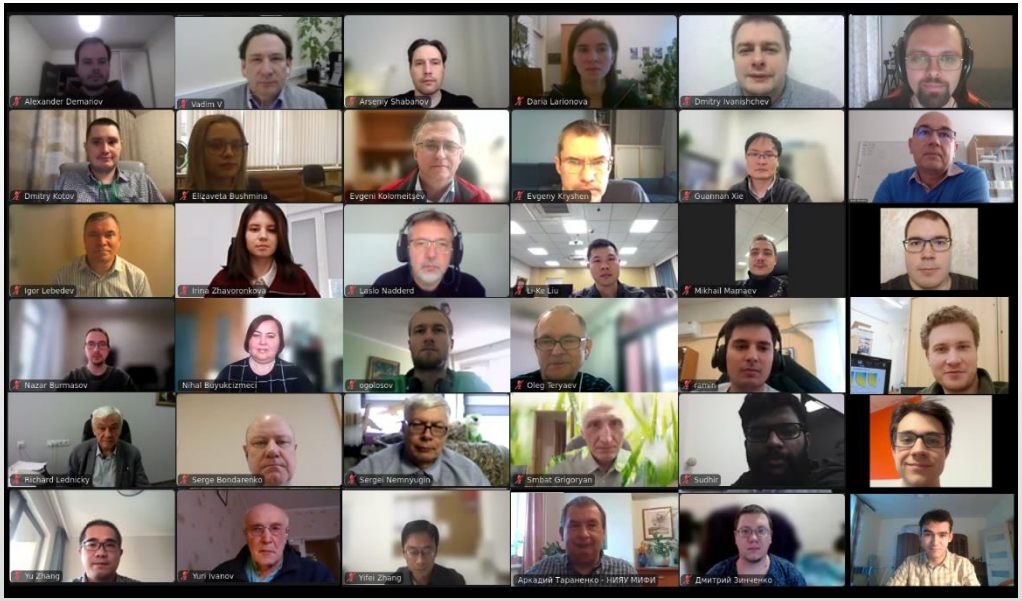
Trying to find optimal technological solutions for the tracking chambers to insure high efficiency of track reconstruction and reasonable momentum resolution → ongoing

Conference activity

- MPD presentations at conferences since last meeting:
  - ✓ India-JINR Workshop on Particle, Nuclear, Neutrino Physics and Astrophysics, NISER, India, November 10-12
  - ✓ 16th Workshop on QCD Phase Transition and Relativistic Heavy-Ion Physics, Guilin, China, October 24-28

- General Laboratory Seminar of VBLHEP:
  - ✓ V. Troshin - Global polarization and collective flow of Lambda hyperon in MPD, April 3, 2026
  - ✓ P. Parfenov - Study of hadron elliptic flow in heavy-ion collisions at NICA, April 10, 2026

- JINR-MEPhI organized International Workshop NICA-2025, Dec. 15-17
  - ✓ discussion of NICA physics at BM@N and MPD
  - ✓ 160+ participants from Armenia, Bahrain, China, Cuba, Egypt, India, Kazakhstan, Nigeria, Russia, Serbia, Slovakia, Turkey, USA, Uzbekistan, Vietnam
  - ✓ 21 presentations by leading scientists

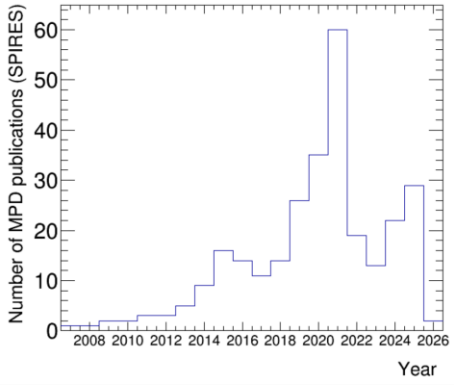


Co-chairs
Arkadiy Taranenko (MEPhI, JINR)
Evgeni Kolomeitsev (JINR, UMB, Banska Bystrica)
Victor Riabov (PNPI, MEPHI)

Organizing commitee
Zebo Tang (USTC, China)
Yi Wang (Tsinghua University, China)
Shusu Shi (CCNU, China)
Natalia Barbashina (MEPhI)
Ivan Astapov (MEPhI)
Dmitry Blau (NRC Kurchatov Institute)
Serge Bondarenko (BLTP JINR)
Fedor Guber (INR RAS)
Vadim Kolesnikov (JINR)

Publication activity

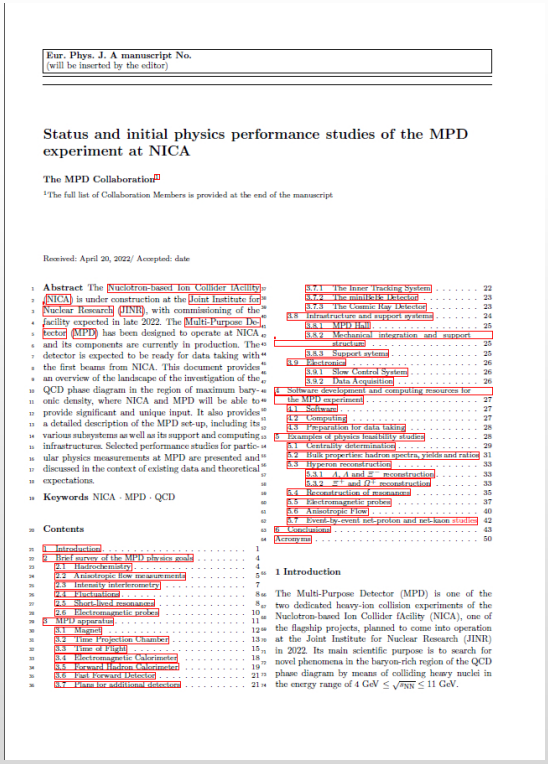
- Overall 250+ publications indexed by SPIRES



- Collaboration papers:

I. **Status and initial physics performance studies of the MPD experiment at NICA**
Eur.Phys.J.A 58 (2022) 7, 140 (~ 50 pages)

II. **MPD physics performance studies in Bi+Bi collisions at $\sqrt{s_{NN}}$ = 9.2 GeV**
Rev.Mex.Fis. 71 (2025) 4, 041201, e-Print: 2503.21117 (~ 40 pages)



Eur. Phys. J. A manuscript No.
(will be inserted by the editor)

Status and initial physics performance studies of the MPD experiment at NICA

The MPD Collaboration

Received: April 20, 2022/ Accepted: date



Nuclear Physics Revista Mexicana de Física 71 041201 1–45 JULY-AUGUST 2025

MPD physics performance studies in Bi+Bi collisions at $\sqrt{s_{NN}} = 9.2$ GeV

Preparation of the 3d collaboration paper

MPD physics performance studies in the fixed-target Xe+W collisions at $\sqrt{s_{NN}} = 2.87$ GeV

The MPD Collaboration

April 16, 2026

Abstract

This paper presents a comprehensive study of the physics performance of the Multi-Purpose Detector (MPD) at the NICA collider complex, specifically operating in the fixed-target regime (FXT). While MPD is primarily designed for collider experiments, the fixed-target mode significantly extends its research potential, allowing for the investigation of dense baryonic matter at lower center-of-mass energies. We evaluate the detector's efficiency in event triggering, particle reconstruction and identification, momentum resolution, and geometric acceptance. We present the MPD capabilities for reconstructing a wide range of physics observables, including collective flow (v_1, v_2), reconstruction of charged light identified hadrons ($\pi^{\pm}$, $K^{\pm}$, p) and short-lived resonances ($\rho(770)^0$, $K^*(892)^{0,\pm}$, $\phi(1020)$, $\Sigma(1385)^{\pm}$), weakly decaying strange mesons (K^0_s) and hyperons (Λ). Furthermore, we evaluate the efficiency in identifying light nuclei (d, t, ^3He) and reconstructing neutral mesons (π^0) via their decay into photons. The simulation framework utilizes the MpdRoot environment, incorporating realistic background conditions and detector responses. The obtained results demonstrates that the MPD FXT configuration provides sufficient geometric acceptance and high-precision particle identification, making it a powerful tool for providing insights into the QCD phase diagram at high net-baryon density.

Content

- ✓ Trigger system and efficiency
- ✓ Event centrality and event plane
- ✓ Light charged identified hadrons π/K/p
- ✓ Weakly decaying Ks, Λ
- ✓ Collective flow (v_1, v_2)
- ✓ Resonances (ρ, K*, ϕ, Σ*)
- ✓ Photons and neutral mesons (π^0)
- ✓ Light nuclei

- Most of material has been compiled in the first draft, see https://mpdforum.jinr.ru/t/paper-draft-mpd-physics-performance-studies-in-the-fixed-target-xe-w-collisions-at-snn-2-87-gev/766
- Target journal – Particles (Q2) – ready to accept the paper for free
- Plan is to finalize the draft by the middle of the summer and then run the approval procedures
- Submit the paper by the end of the year

Funding

- Support program from Russian Ministry of Education and Science for NICA:
  - ✓ Russian groups from subordinated organizations participating in NICA with signed MOUs
  - ✓ 200 MRUB (~2.2 M$) in 2024 for all NICA activities: MPD, BM@N, SPD, ARIADNA collaborations, accelerator
  - ✓ program ends in 2026

- ~ 40 MRUB for MPD per year:
  - ✓ supported organizations: MEPhI, St.Petersburg Polytechnic University, INR RAS, Belgorod National Research University, North Ossetia State University

- Problems:
  - ✓ KI, MSU, SPbSU, HSE University are excluded from the program (not subordinated organizations)
  - ✓ no funds for travel (shifts, etc.)

- Potential extension of the program for the next three years (under negotiations) :
  - ✓ new participating institution are possible
  - ✓ be ready to fill out the applications in emergency mode !!!

MPD physics program

G. Feofilov, P. Parfenov

Global observables

- Total event multiplicity
- Total event energy
- Centrality determination
- Total cross-section measurement
- Event plane measurement at all rapidities
- Spectator measurement

V. Kireev, Xianglei Zhu

Spectra of light flavor and hypernuclei

- Light flavor spectra
- Hyperons and hypernuclei
- Total particle yields and yield ratios
- Kinematic and chemical properties of the event
- Mapping QCD Phase Diag.

K. Mikhailov, A. Taranenko

Correlations and Fluctuations

- Collective flow for hadrons
- Vorticity, Λ polarization
- E-by-E fluctuation of multiplicity, momentum and conserved quantities
- Femtoscopy
- Forward-Backward corr.
- Jet-like correlations

D. Peresunko, Chi Yang

Electromagnetic probes

- Electromagnetic calorimeter meas.
- Photons in ECAL and central barrel
- Low mass dilepton spectra in-medium modification of resonances and intermediate mass region

Wangmei Zha, A. Zinchenko

Heavy flavor

- Study of open charm production
- Charmonium with ECAL and central barrel
- Charmed meson through secondary vertices in ITS and HF electrons
- Explore production at charm threshold

Preserve format of cross-PWG meetings

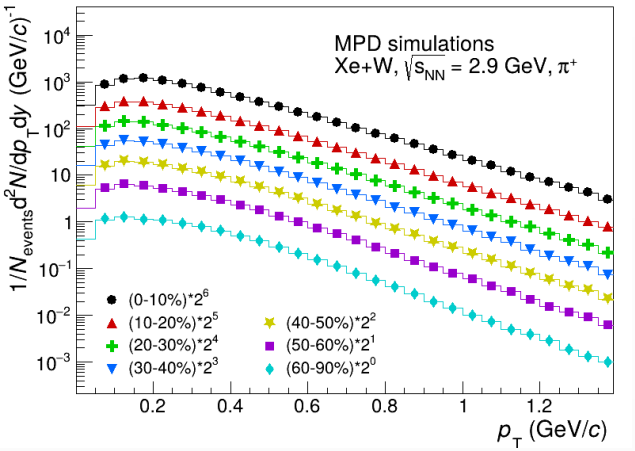
Advancements in analyses

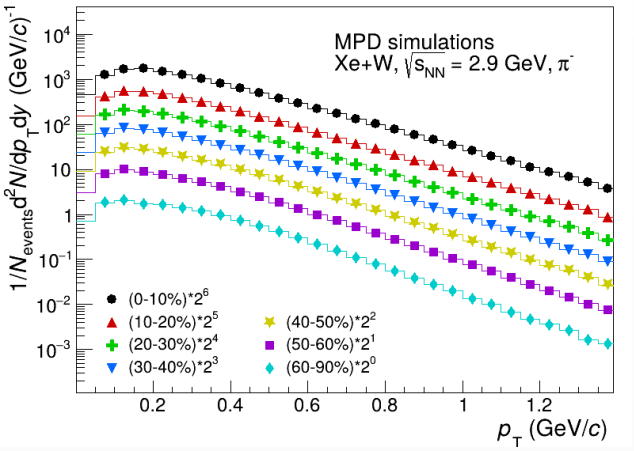
Focus is on MPD-FXT results

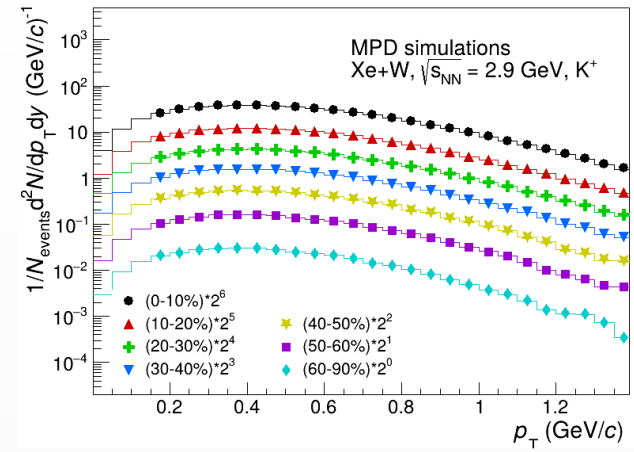
Also please see PWG summary talks and dedicated talks on the third day

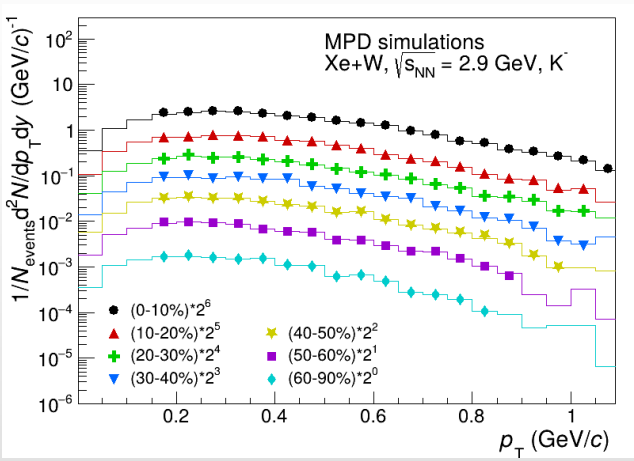
MPD-FXT: π/K/p

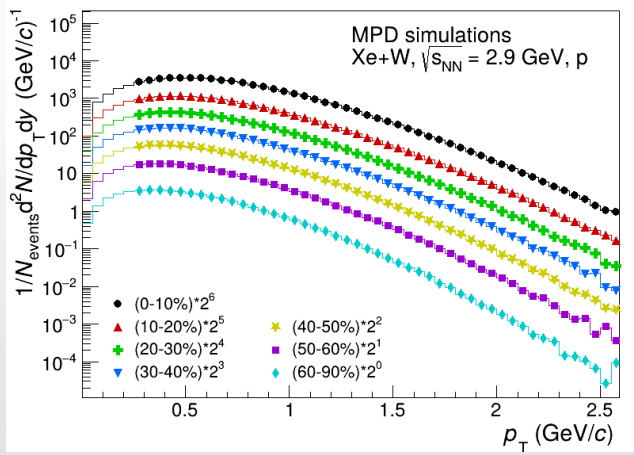
- Request 40 MPD-FXT: XeW@ T=2.5 AGeV (UrQMD), 100M events → full event reconstruction









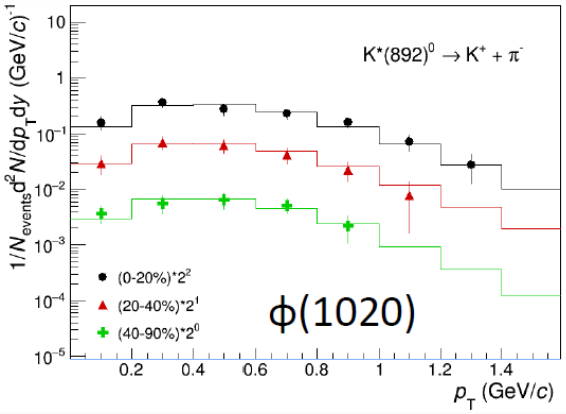


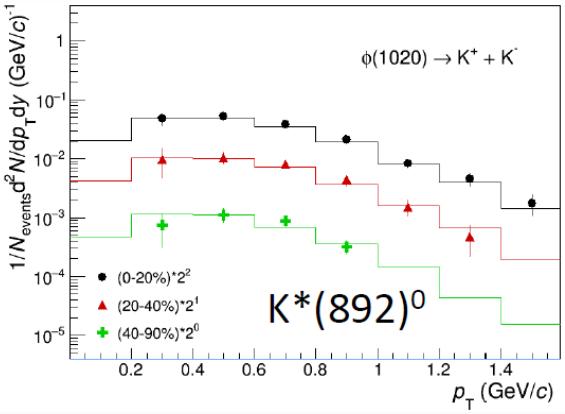
Rapidity coverage $-1.3 < y_{CMS} < 0$

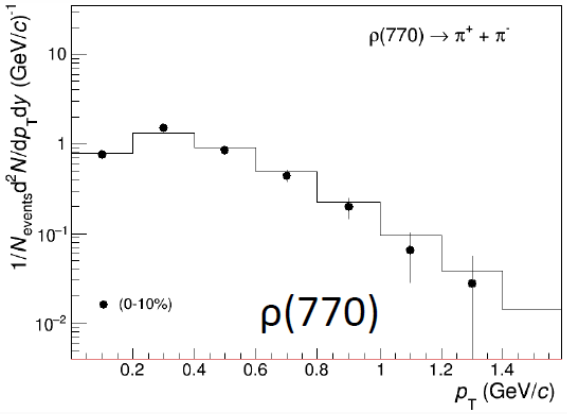
Spectra at mid-rapidity cover the p_T ranges that correspond to production of over 95% (85%) of the total $\pi^{\pm}$ (p) yields and 93% (85%) of K^+ (K^-) → robust basis for extracting the integrated yields

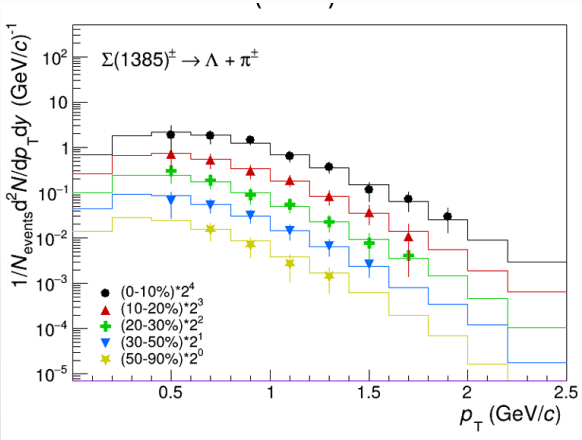
MPD-FXT: resonances

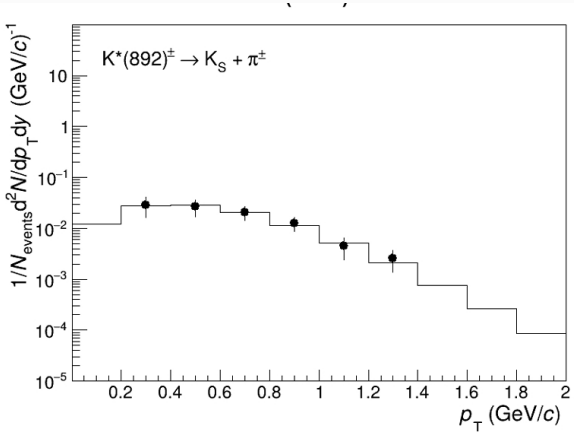
- Request 40 MPD-FXT: XeW@ T=2.5 AGeV (UrQMD), 100M events → full event reconstruction









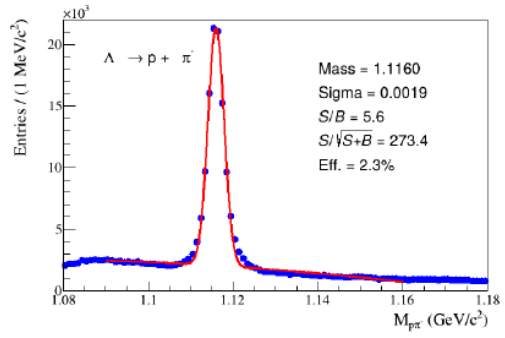


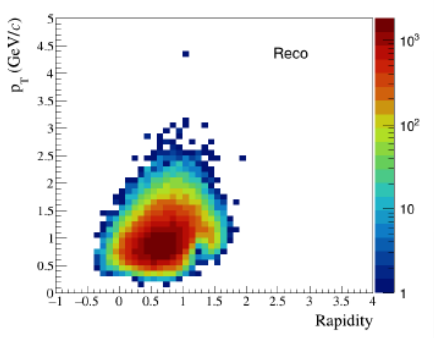
Production of the resonances is possible from low/zero p_T

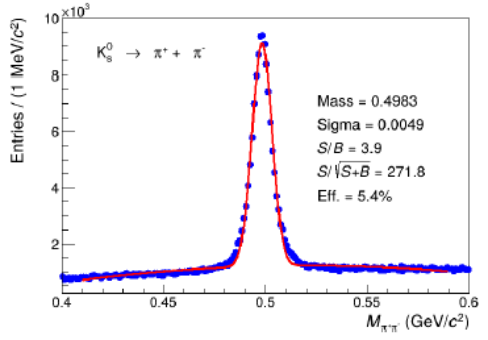
Will be able to study centrality dependent production of $K^*(892)^0$, $\phi(1020)$ and $\Sigma(1385)^{\pm}$

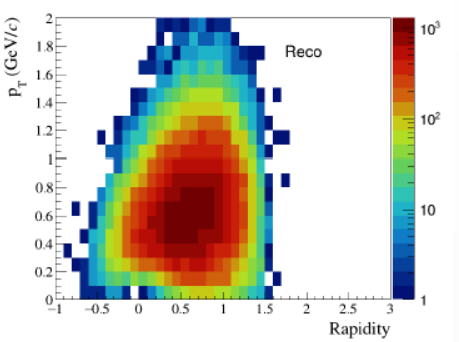
MPD-FXT: weak decays of K_s and Λ

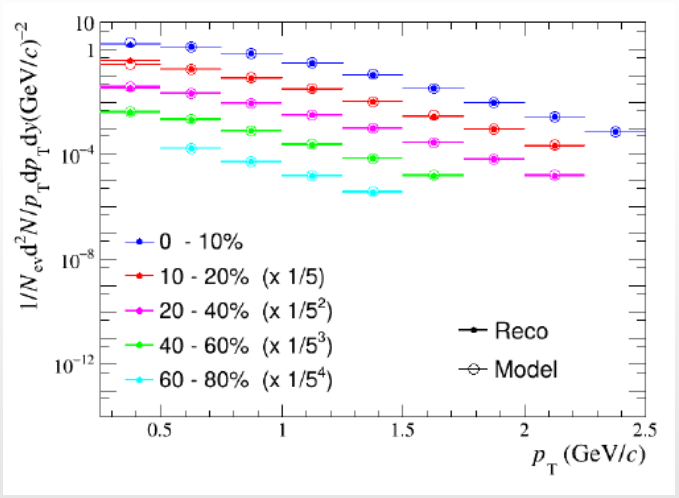
- Request 40 MPD-FXT: XeW@ T=2.5 AGeV (UrQMD), 100M events → full event reconstruction

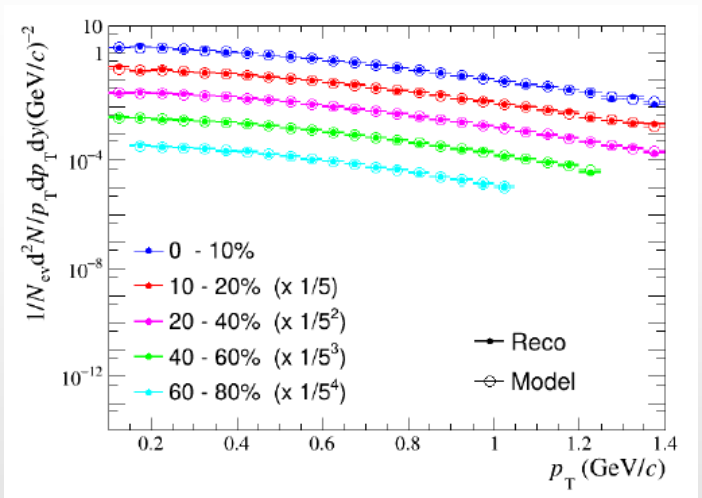










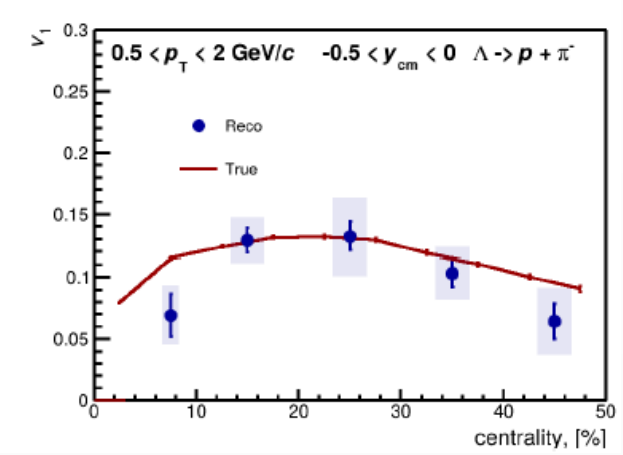


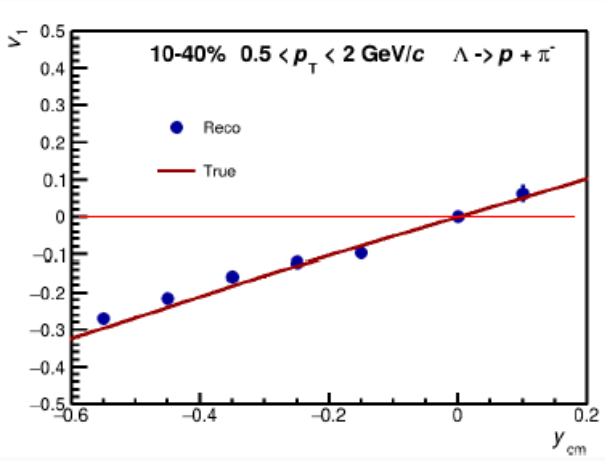
Reliable reconstruction of weak decays using topology selections

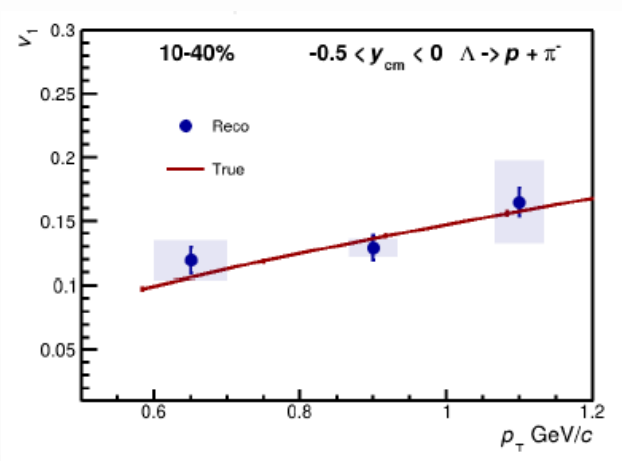
Centrality-dependent study in a wide p_T range possible

MPD-FXT: Λ flow and global polarization

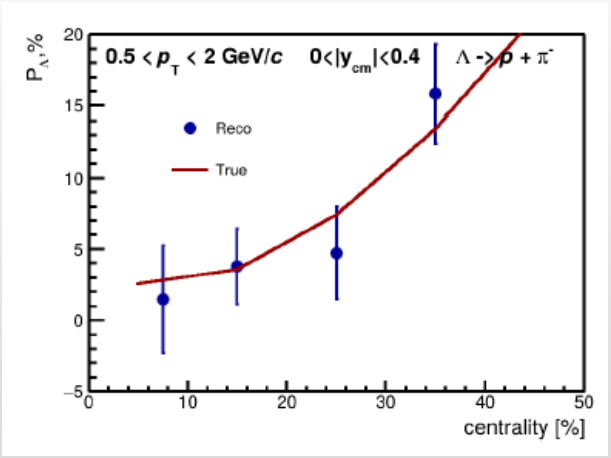
- Request 40 MPD-FXT: XeW@ T=2.5 AGeV (UrQMD), 100M events → full event reconstruction
- Flow and global polarization signals parameterized to comply with STAR measurements

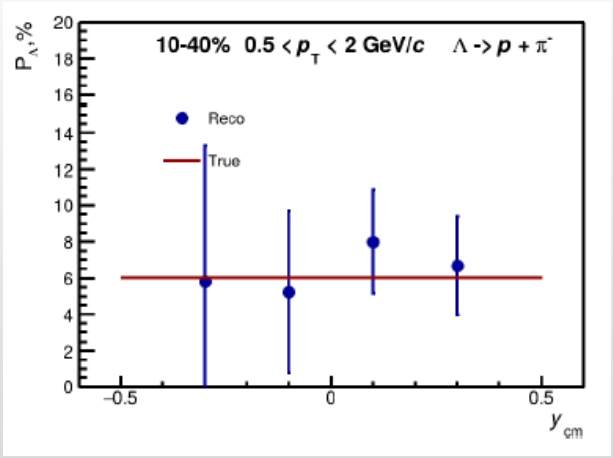






Directed flow v_1 of Λ hyperons as a function of centrality, rapidity and transverse momentum p_T → good agreement

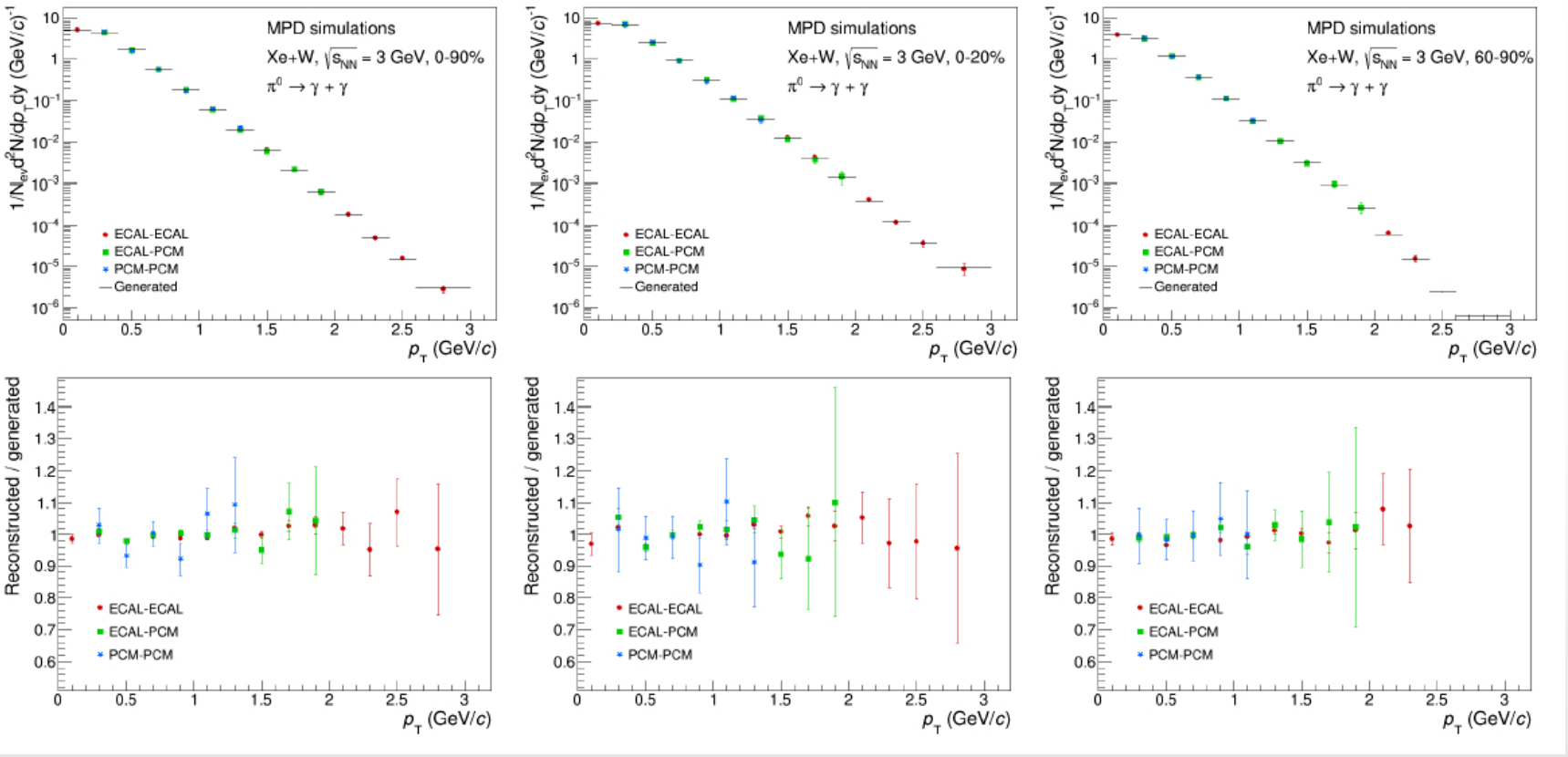




Global polarization signals are reconstructible → very statistics hungry analysis

MPD-FXT: neutral mesons (π^0)

- Request 40 MPD-FXT: XeW@ T=2.5 AGeV (UrQMD), 100M events → full event reconstruction



Rapidity coverage with ECAL-ECAL, ECAL-PCM and PCM-PCM: $-2.0 < y_{CMS} < 1.0$

Measurements with different techniques well agree with each other

Momentum range significantly extends the range covered by tracking system for $\pi^{\pm}$

η - signal is observed but not very significant (prove of principles)

MPD-FXT: Light nuclei production

- Request 28 MPD-FXT: XeW@ T=2.5 AGeV (PHQMD), 15M events → full event reconstruction
- Momentum range of light nuclei measurements is extended towards lower p_T with new analysis approach

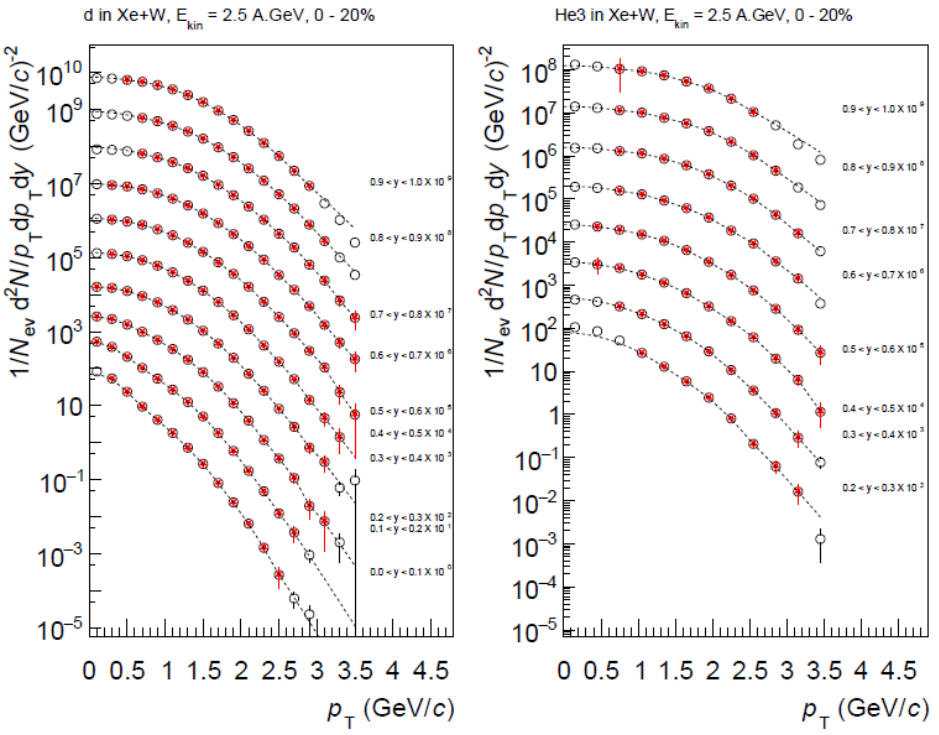
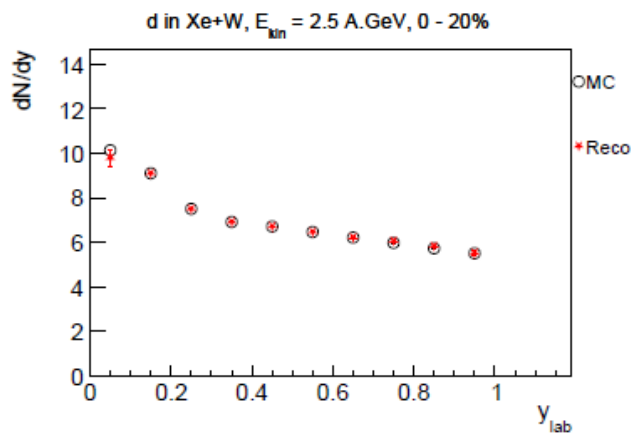
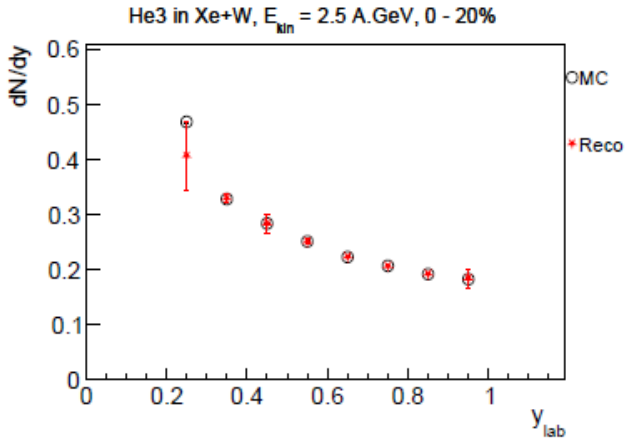


Figure 35: Transverse momentum spectra for d (left panel) and ^3He (right panel) reconstructed for fixed-target Xe+W collisions at $\sqrt{s_{NN}} = 2.87$ GeV. The generated Monte-Carlo spectra are shown by black open circles, the reconstructed spectra by red stars. Black dashed lines are the data-based fit (see text).





Light nuclei measurements are possible in a wide (p_T, rapidity) range

Summary



- Significant progress with detector construction and assembly in the last half an year
- Plan is to have detector in the beam position by the end of October
- Extensive program of physics feasibility studies for MPD-CLD and MPD-FXT
- Prepare software and analysis infrastructure for real data analysis

BACKUP

New Journal – new opportunities

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by scientists for scientists

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Victor MATVEEV
Editor-in-chief

nsr.jinr.int

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ISSN 3079–2738

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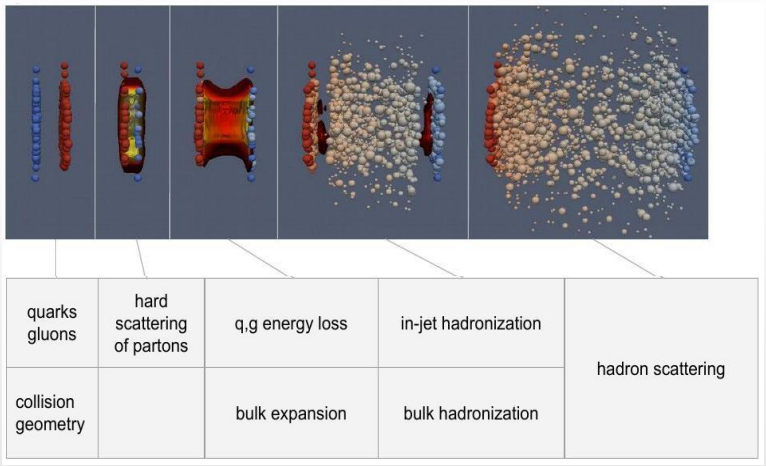
Physics feasibility studies

- Physics feasibility studies using centralized large-scale MC productions
- Centralized Analysis Framework for access and analysis of data → Analysis Train:
  - ✓ consistent approaches and results across collaboration, easy storage and sharing of codes
  - ✓ reduced number of input/output operations for disks and databases, easier data storage on tapes

- Mescheryakov Laboratory of Information Technologies takes active participation in MPD collaboration works. We are grateful for provided computing resources, development and support of IT services.

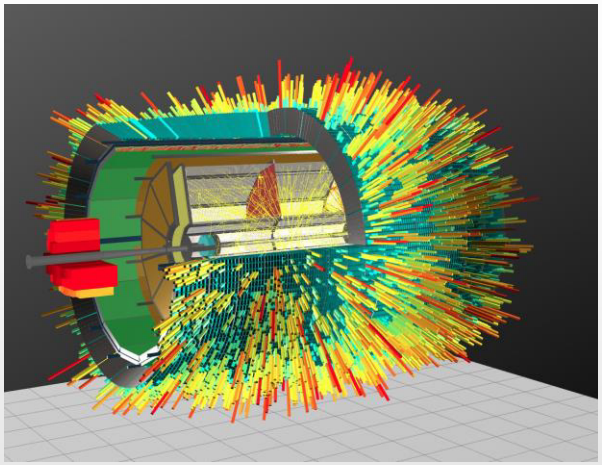
Event generator(s)



MpdRoot

JINR MLIT

Particle propagation & detector response



- Develop physics program, software and analysis infrastructure for real data analysis
- MPD-CLD and MPD-FXT studies with simulations:
  - ✓ collider mode: Bi+Bi @ 9.2 GeV
  - ✓ fixed-target mode: Xe + W @ T = 2.5 AGeV/n