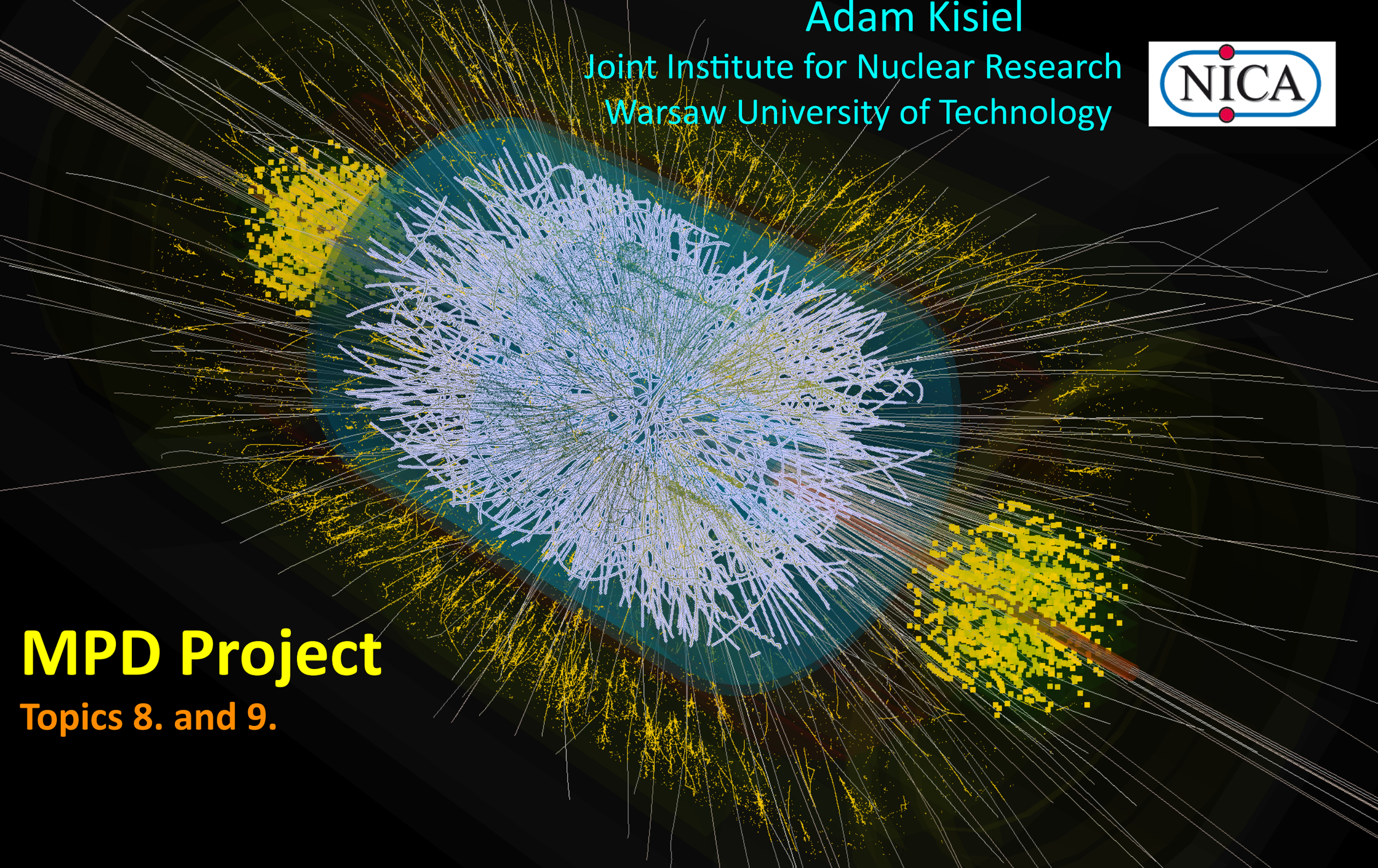
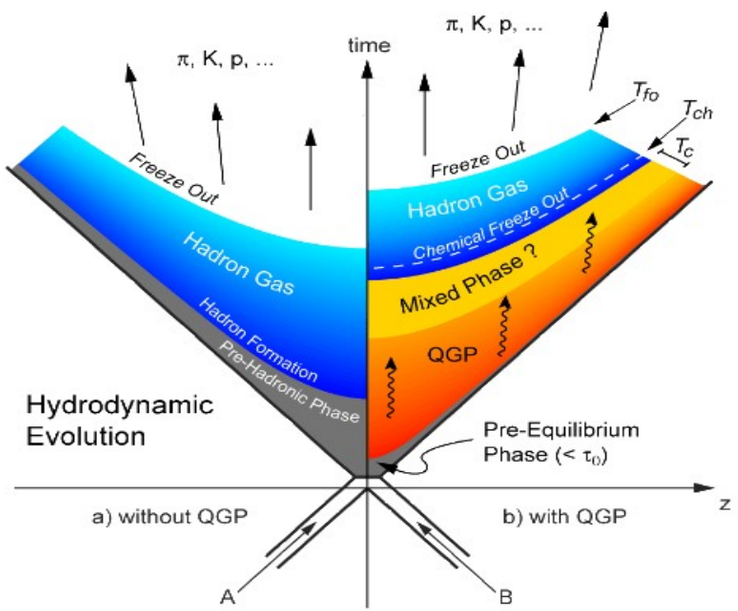
Adam Kisiel
Joint Institute for Nuclear Research
Warsaw University of Technology

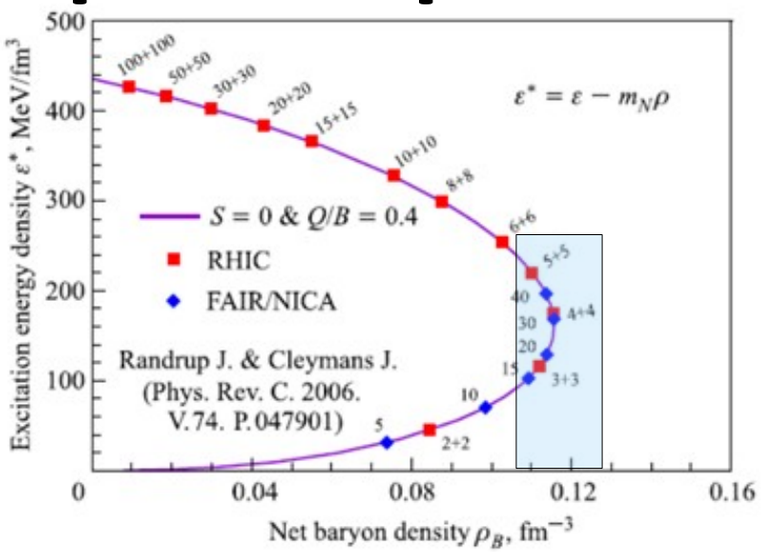


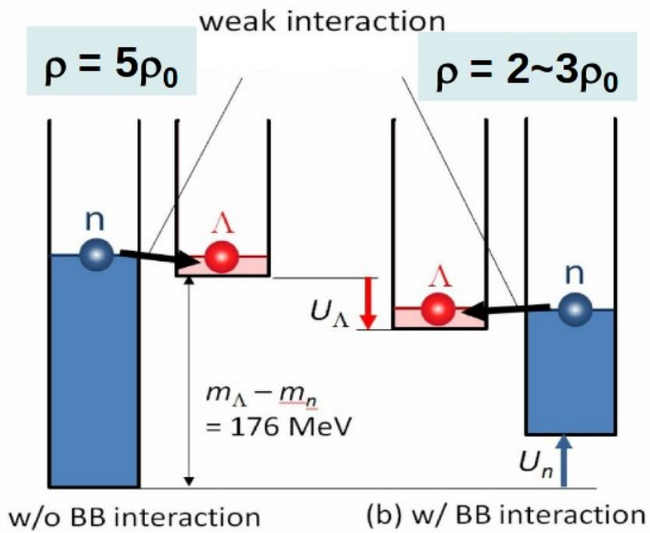
MPD Project

Topics 8. and 9.

Unexplored phase space in QCD diagram

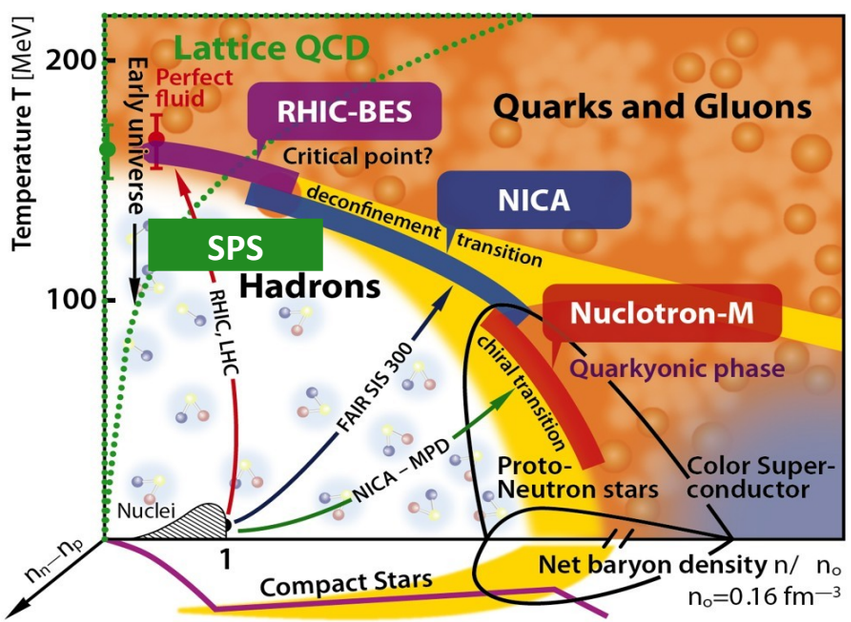


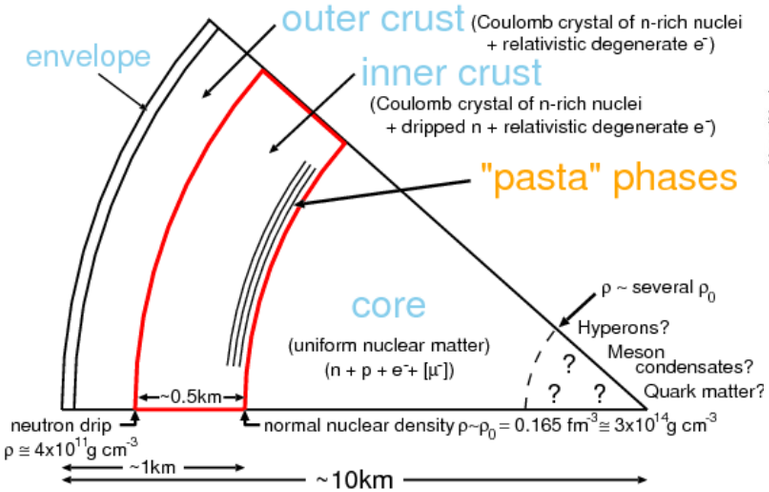




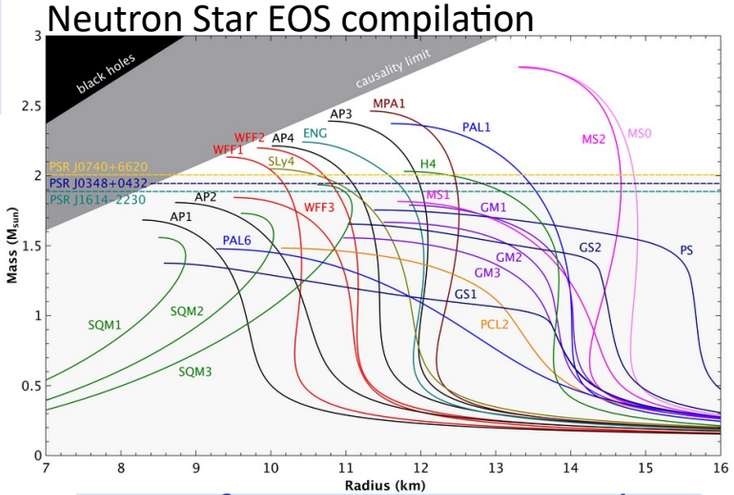
H. Tamura, Hadron 2017

neutron star mergers probe region of high density and moderate temperature – phase transition?



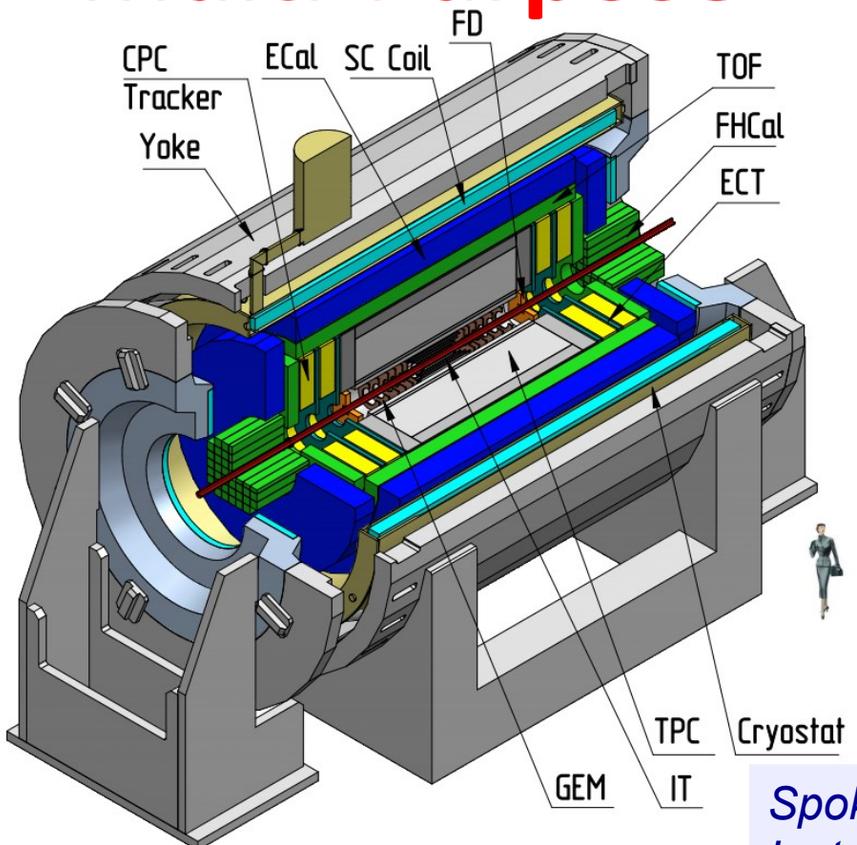


Neutron Star EOS compilation



core of neutron stars reaches density several times larger than nuclear density

Multi-Purpose Detector (MPD) Collaboration



11 *Countries,* ***>500*** *participants,*
39 *Institutes and* ***JINR***

NICA

Spokesperson: ***Adam Kisiel***
Inst. Board Chair: ***Fuqiang Wang***
Project Manager: ***Slava Golovatyuk***

Deputy Spokespersons:
Victor Riabov, Zebo Tang

AANL, Yerevan, ***Armenia;***
Baku State University, NNRC, ***Azerbaijan;***
University of Plovdiv, ***Bulgaria;***
University Tecnica Federico Santa Maria, Valparaiso, ***Chile;***
Tsinghua University, Beijing, ***China;***
USTC, Hefei, ***China;***
Huzhou 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;
FCFM-BUAP (Mario Rodriguez) Puebla, ***Mexico;***
FC-UCOL (Maria Elena Tejeda), Colima, ***Mexico;***
FCFM-UAS (Isabel Dominguez), Culiacán, ***Mexico;***
ICN-UNAM (Alejandro Ayala), Mexico City, ***Mexico;***
CINVESTAV (Luis Manuel Montaño), Mexico City, ***Mexico;***
Institute of Applied Physics, Chisinev, ***Moldova;***
WUT, Warsaw, ***Poland;***
NCNR, Otwock – Świerk, ***Poland;***
University of Wrocław, ***Poland;***
University of Silesia, ***Poland;***
University of Warsaw, ***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;***
St. Petersburg State University, ***Russia;***
SINP, Moscow, ***Russia;***
PNPI, Gatchina, ***Russia;***

V-th MPD Collaboration Meeting, 23-24 Apr 2020

- Due to travel limitations the V-th MPD Collaboration Meeting has been organized in a **remote-only** mode using the ZOOM Platform
- New instituion admitted to MPD: University of Silesia, Poland
- 157 registered international participants – up to 140 simultaneous users on the ZOOM Platform
- 27 submitted talks
- Presentation of recent progress in MPD construction and physics analyses

MPD Civil Construction status

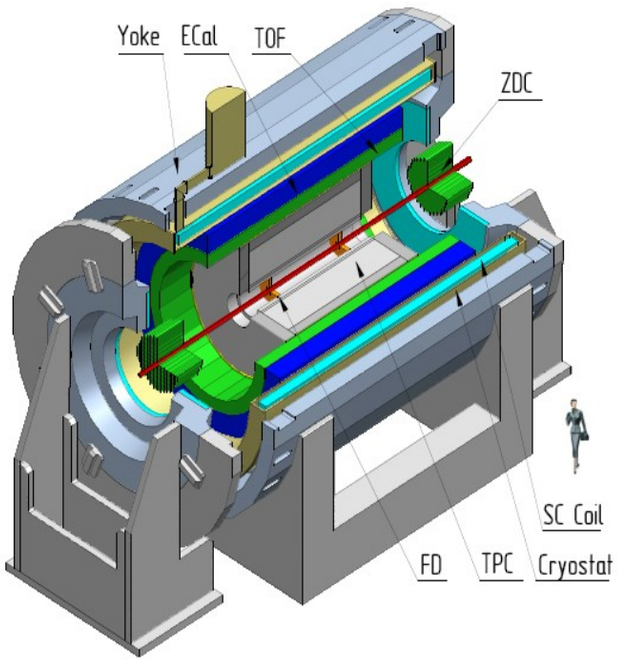
- MPD Hall close to ready for equipment installation

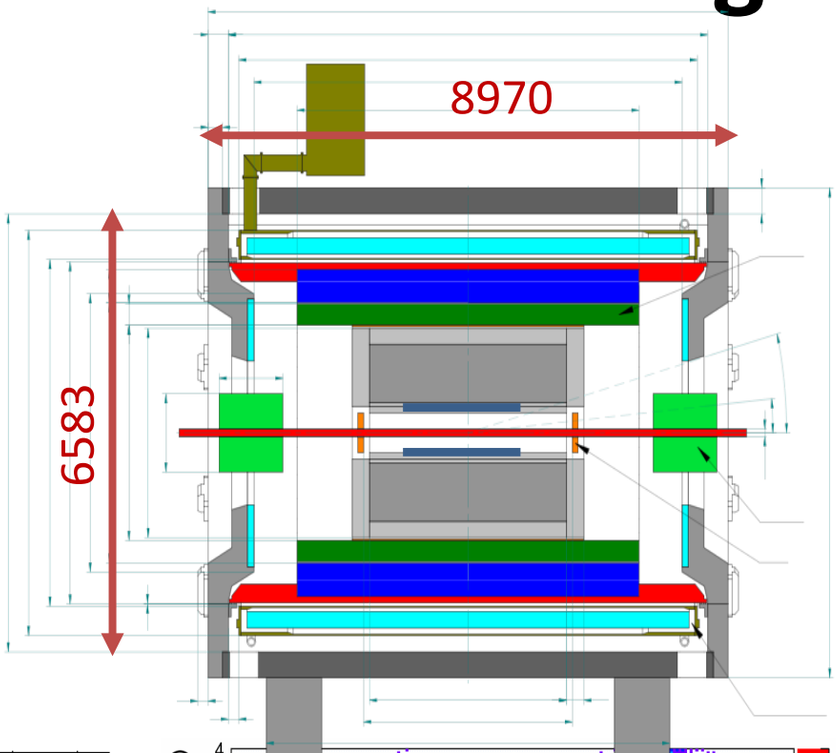
MPD Hall external covering

MPD Hall crane weight test

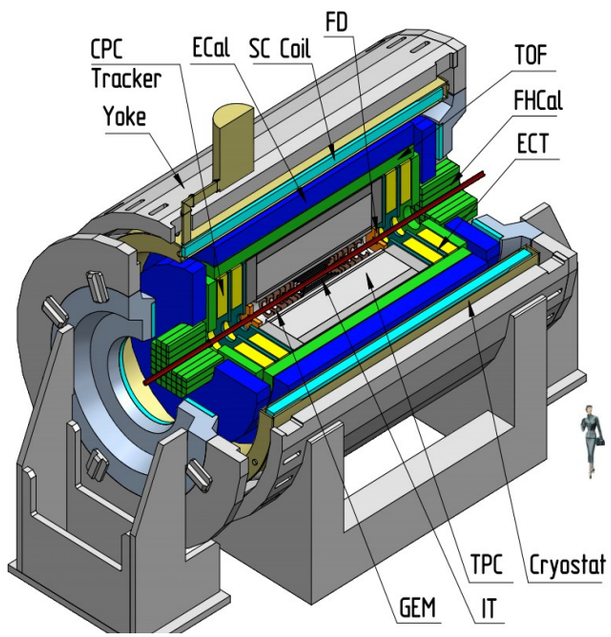
Transportation of MPD Magnet Yoke parts into the MPD pit (inside MPD Hall)

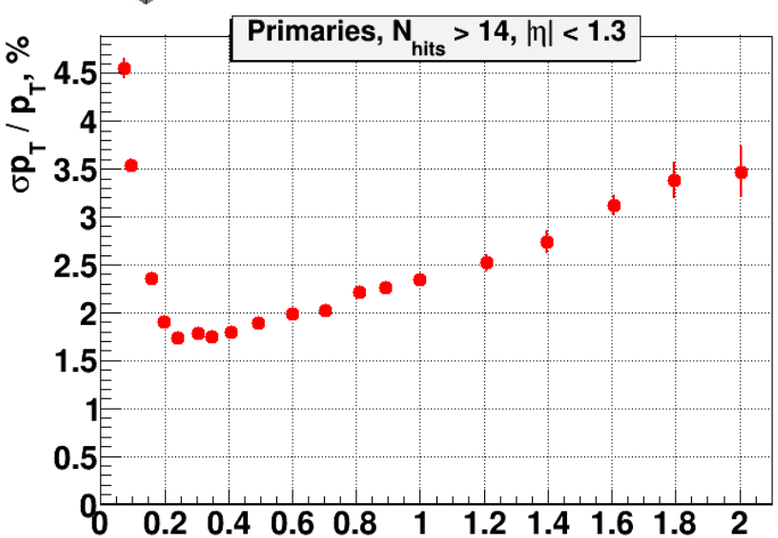
MPD - stage I



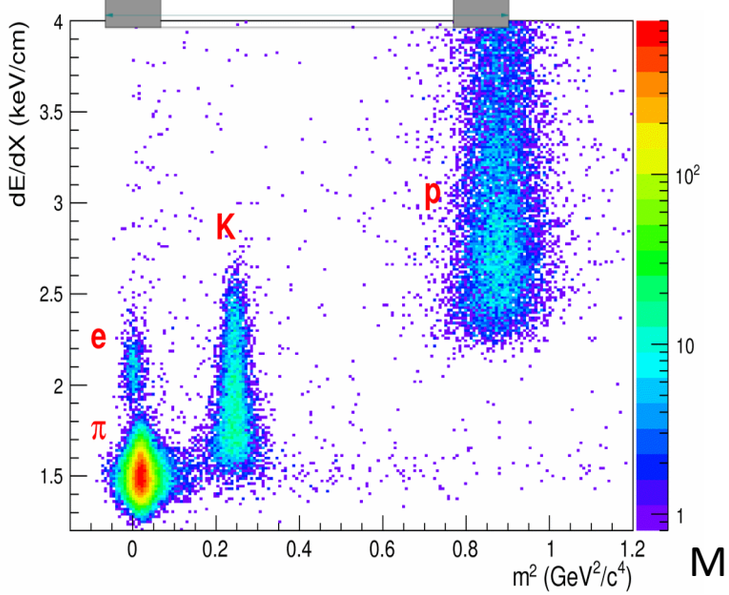


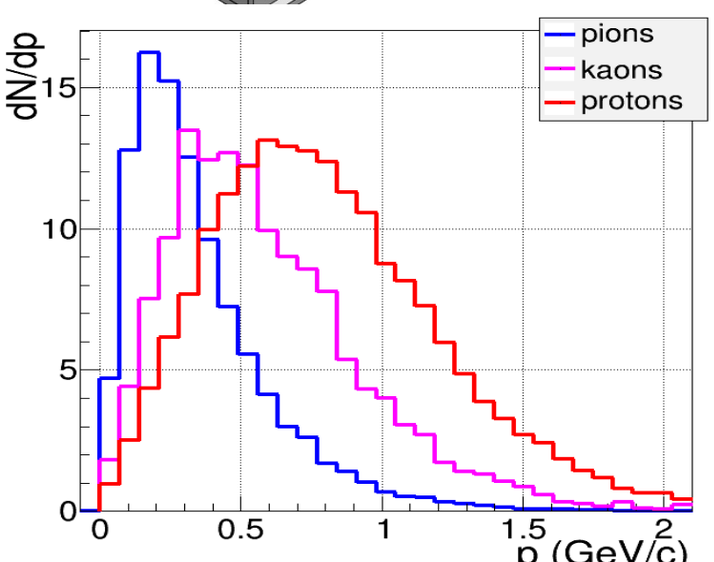
MPD - Stage II





Momentum resolution with TPC





Momentum distribution of secondary particles

MPD Physics Programme

G. Feofilov, A. Ivashkin

Global observables

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

V. Kolesnikov, 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

V. Riabov, Chi Yang

Electromagnetic probes

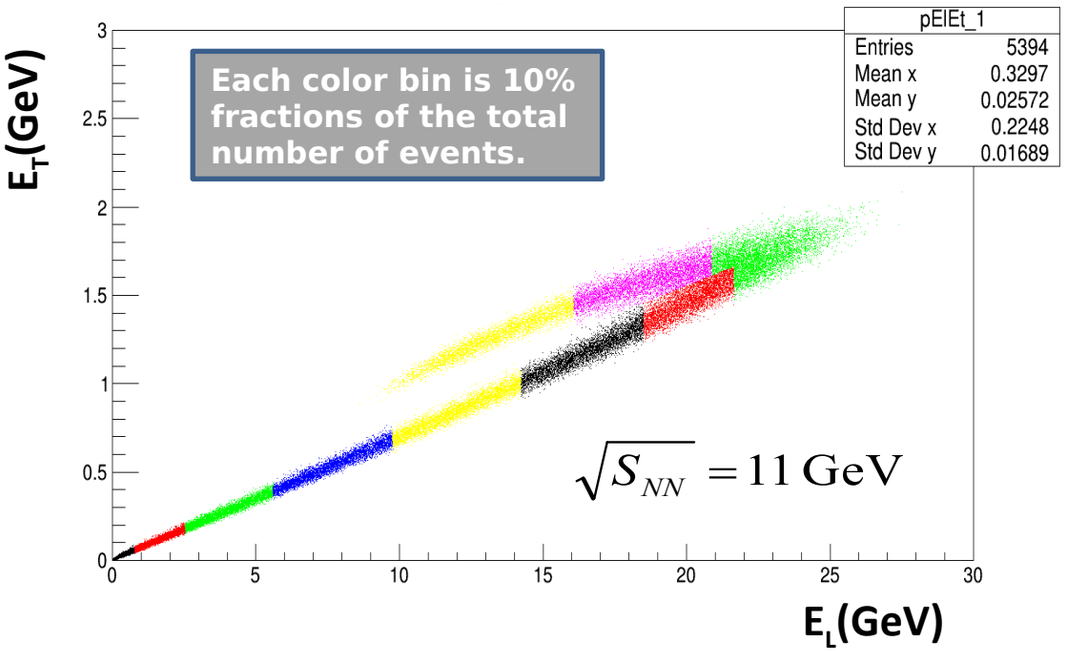
- Electromagnetic calorimeter meas.
- Photons in ECAL and central barrel
- Low mass dilepton spectra in-medium modification of resonances and intermediate mass region

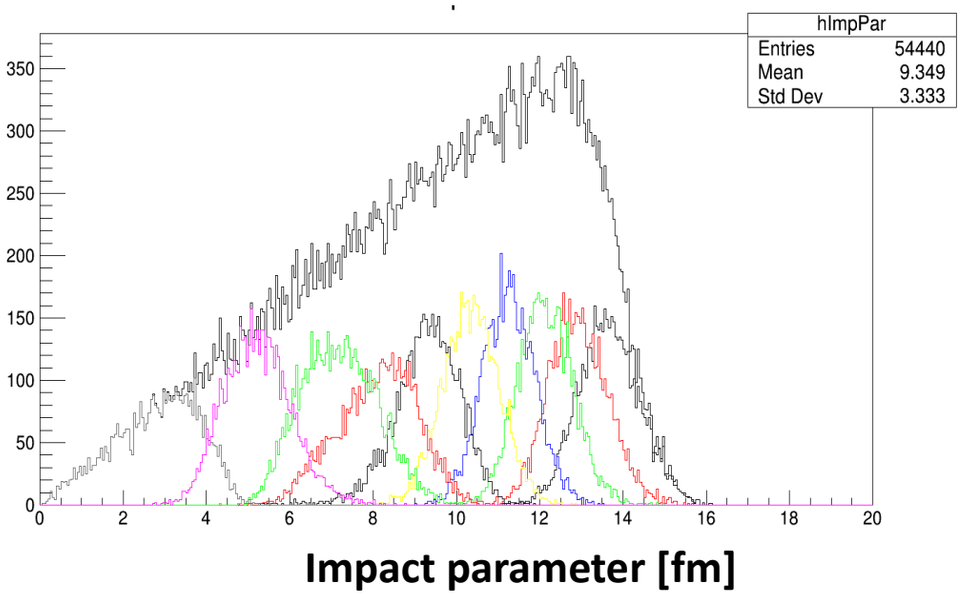
Wangmei Zha, A. Zinchenko

Heavy flavor

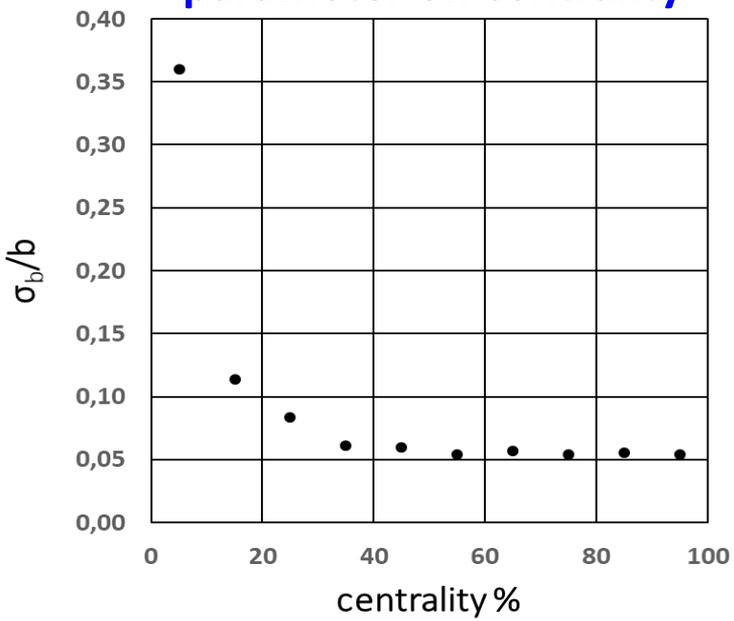
- Study of open charm production
- Charmonium with ECAL and central barrel
- Charmed meson through secondary vertices in ITS and HF electrons
- Explore production at charm threshold

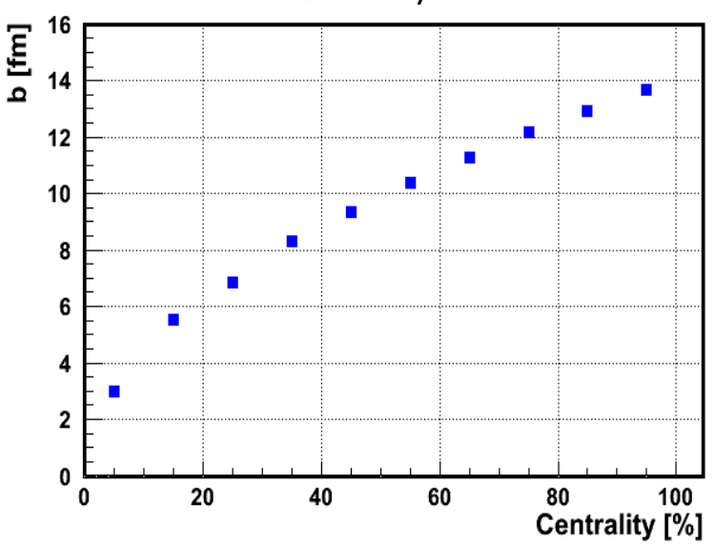
Centrality for (E_T, E_L) correlations in FHCal





Dependence of resolution of impact parameter on centrality



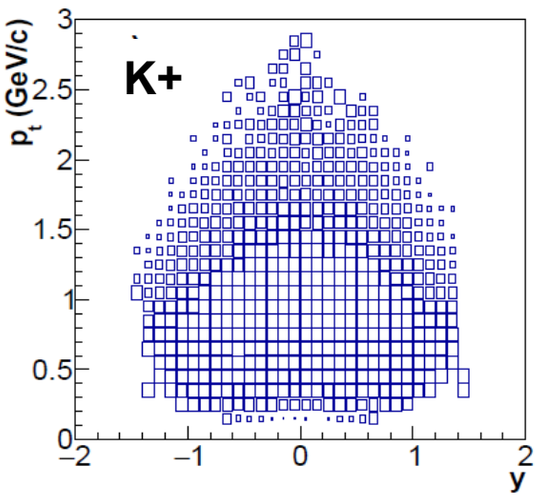


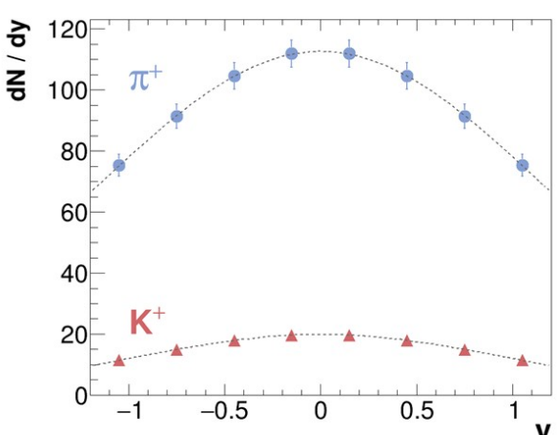
Hadroproduction with MPD

- **Particle spectra, yields & ratios are sensitive to bulk fireball properties and phase transformations in the medium**
- **Uniform acceptance and large phase coverage are crucial for precise mapping of the QCD phase diagram**

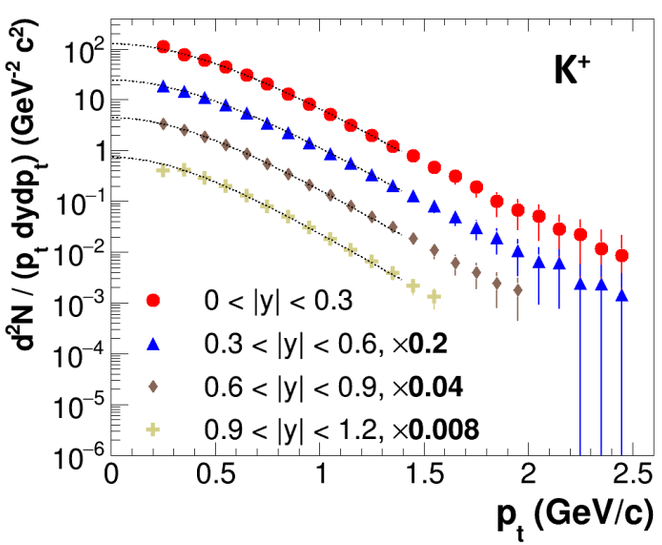
✓ *0-5% central Au+Au at 9 GeV from the PHSD event generator, which implements partonic phase and CSR effects*

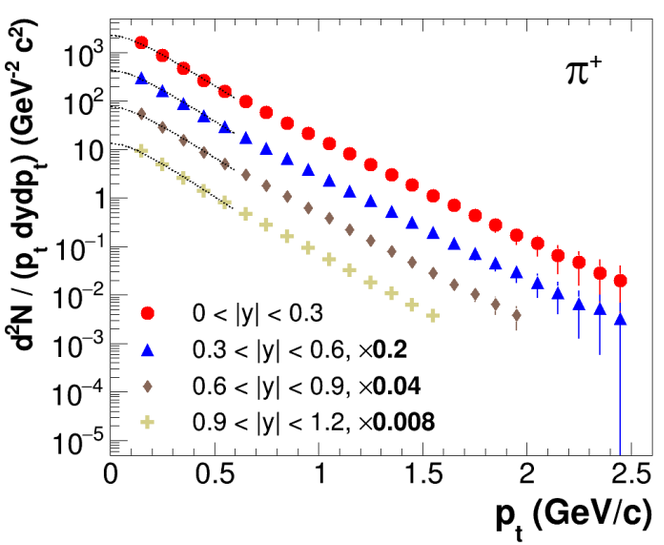
✓ *Recent reconstruction chain, combined dE/dx+TOF particle ID, spectra analysis*





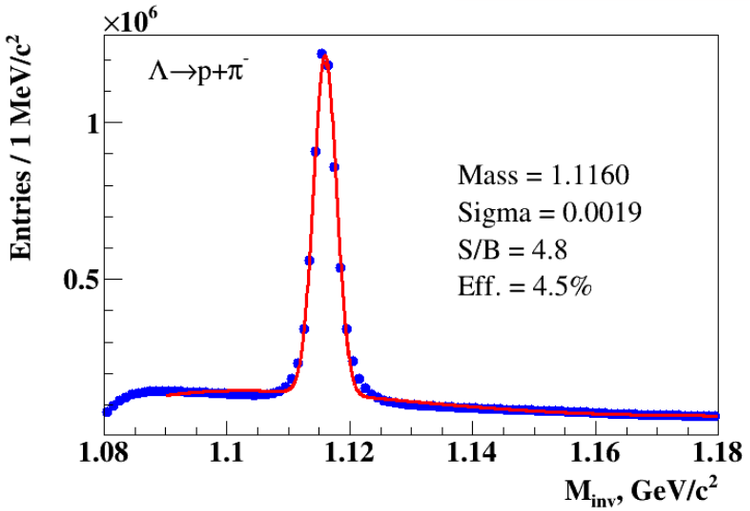
- MPD provides large phase-space coverage for identified pions and kaons (> 70% of the full phasespace at 9 GeV)
- Hadron spectra can be measured from p_T=0.2 to 2.5 GeV/c
- Extrapolation to full p_T-range and to the full phase space can be performed exploiting the spectra shapes (see BW fits for p_T-spectra and Gaussian for rapidity distributions)

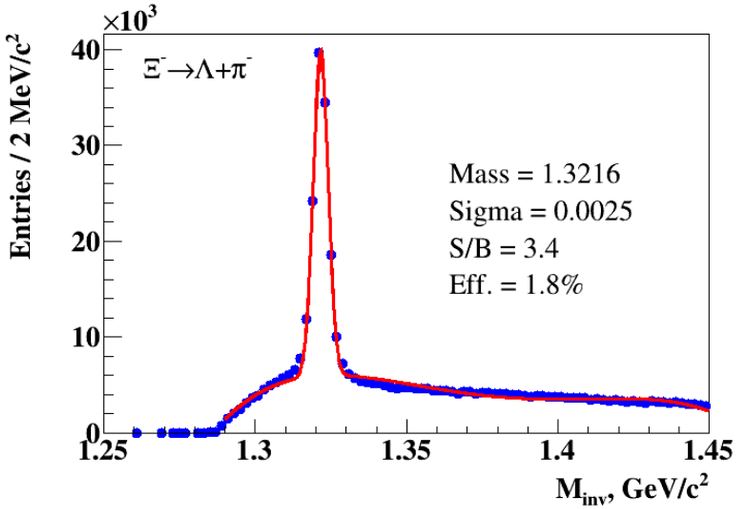


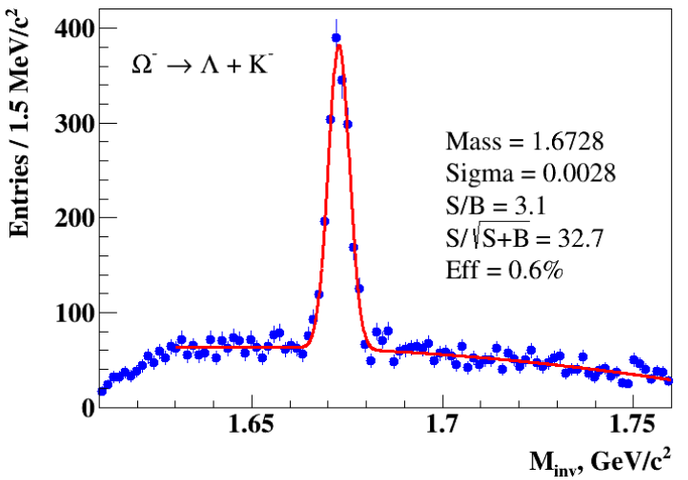


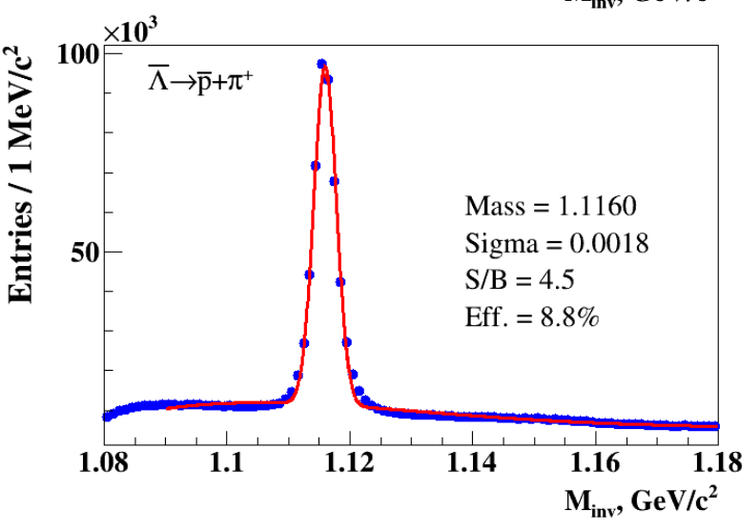
Strange and multi-strange baryons

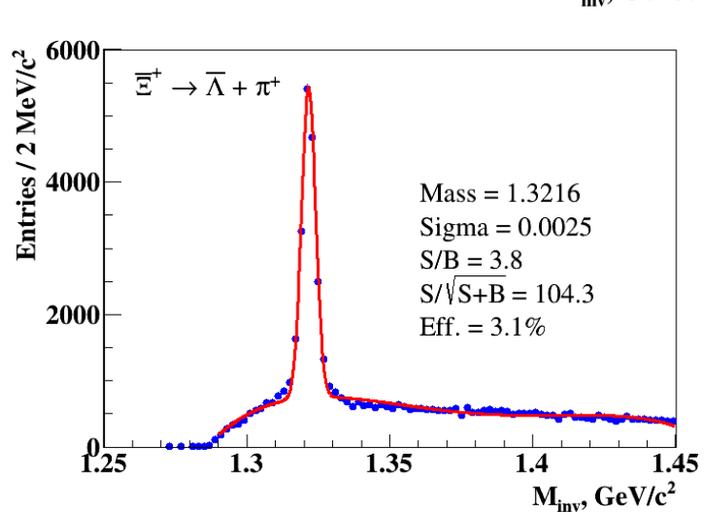
Stage'1 (TPC+TOF): Au+Au @ 11 GeV, PHSD + MPDRoot reco.

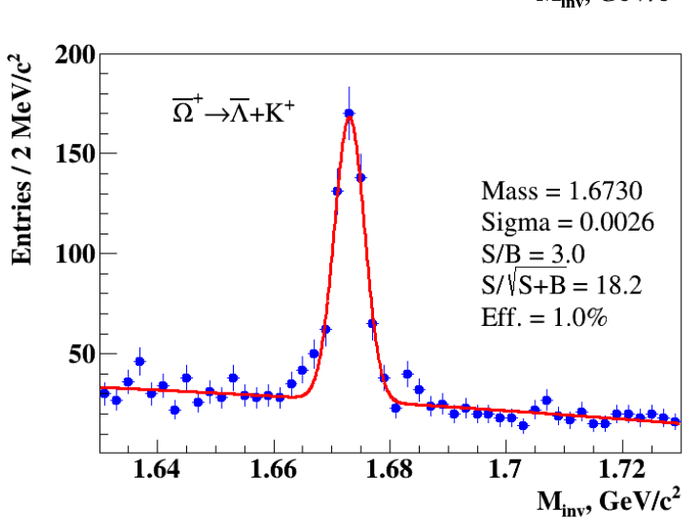










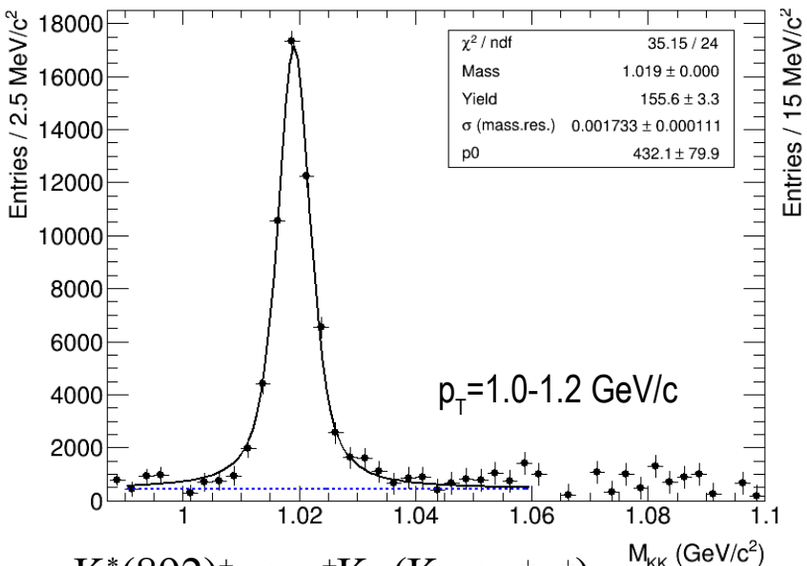


particle	Λ	anti-Λ	Ξ⁻	anti-Ξ⁺	Ω⁻	anti–Ω⁺
yield in 10weeks	$3 \cdot 10^8$	$3.5 \cdot 10^6$	$1.5 \cdot 10^6$	$8.0 \cdot 10^4$	$7 \cdot 10^4$	$1.5 \cdot 10^4$

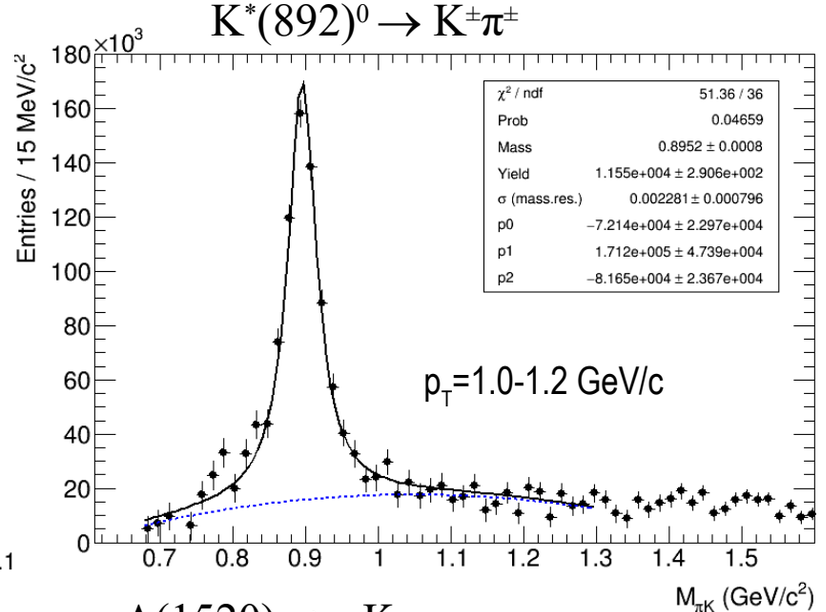
Resonances at MPD

· Minbias Au+Au@11 (UrQMD) · Full reconstruction and realistic PID · Topology cuts and secondary vertex · Event mixing for background

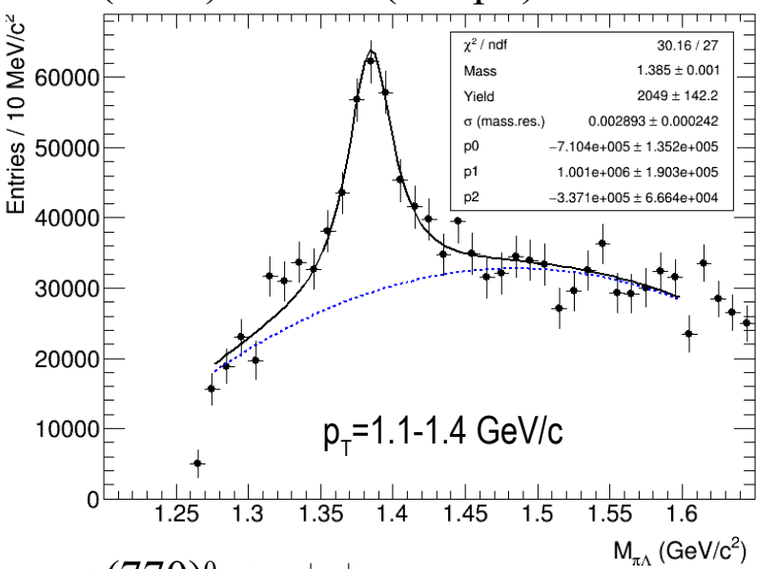
$\phi(1020) \rightarrow K^+K^-$



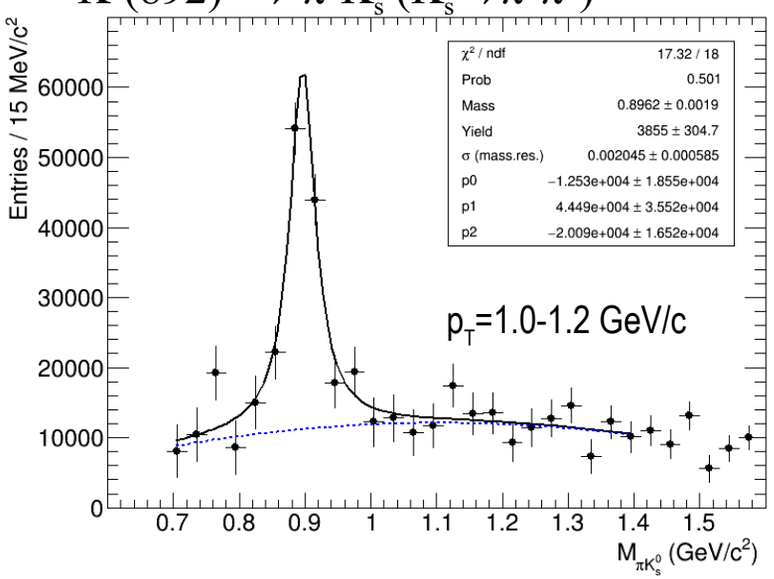
$K^*(892)^0 \rightarrow K^{\pm}\pi^{\pm}$



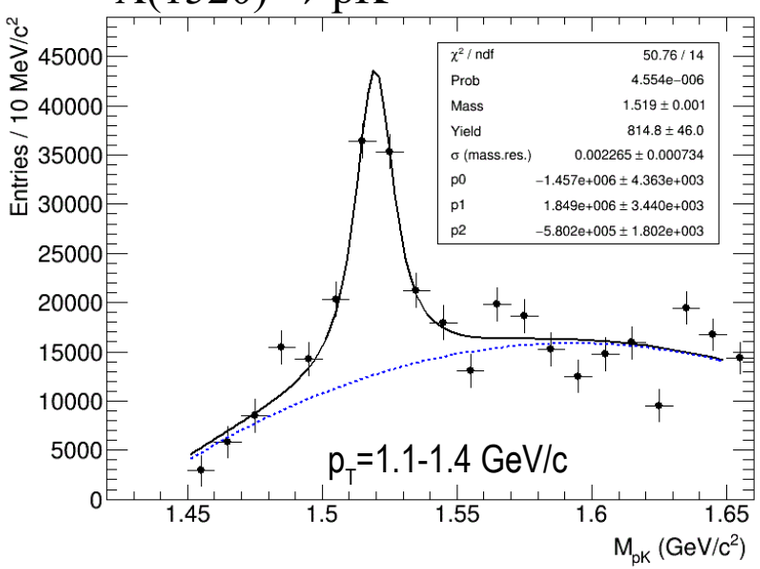
$\Sigma(1385)^{\pm} \rightarrow \pi^{\pm}\Lambda\ (\Lambda \rightarrow p\pi)$



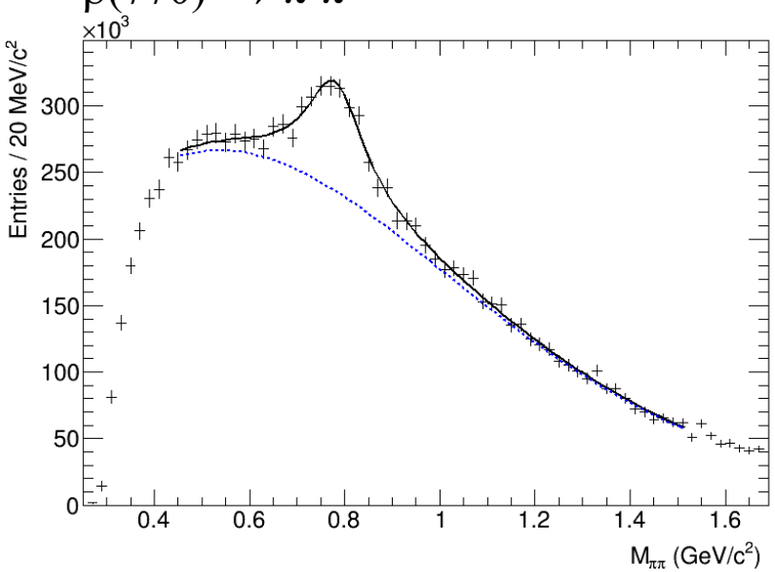
$K^*(892)^{\pm} \rightarrow \pi^{\pm}K_s\ (K_s \rightarrow \pi^+\pi^+)$



$\Lambda(1520) \rightarrow pK^-$

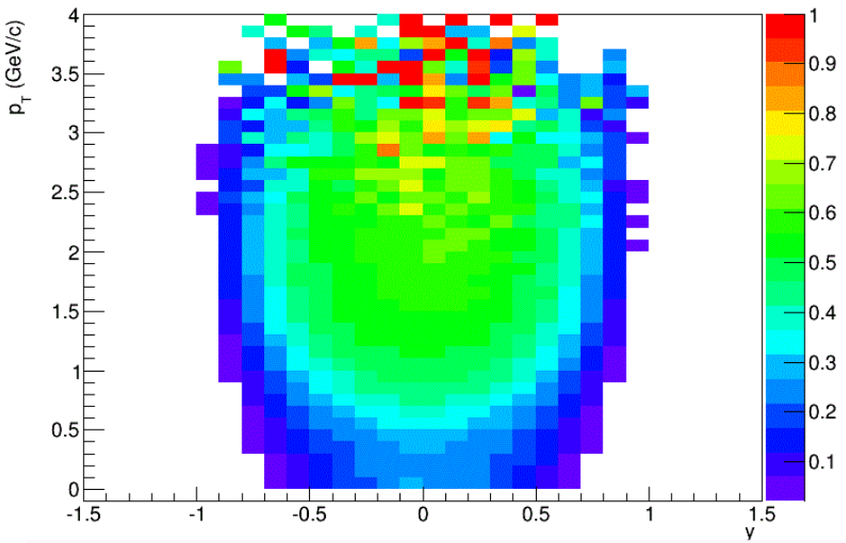


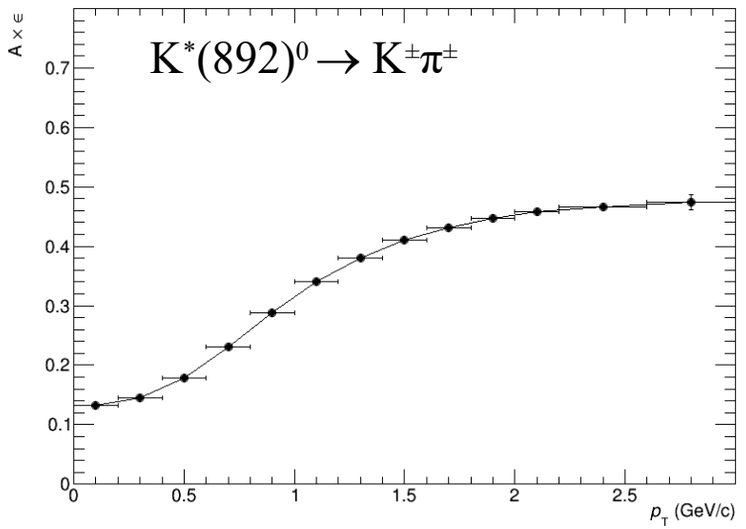
$\rho(770)^0 \rightarrow \pi^{\pm}\pi^{\pm}$

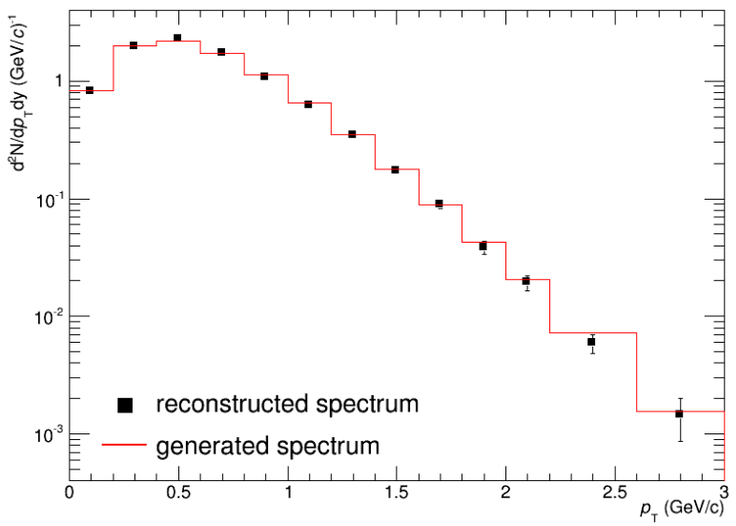


Efficiencies and closure tests examples

· Minbias Au+Au@11 (UrQMD) · Full reconstruction and realistic PID · Topology cuts and secondary vertex · Event mixing for background

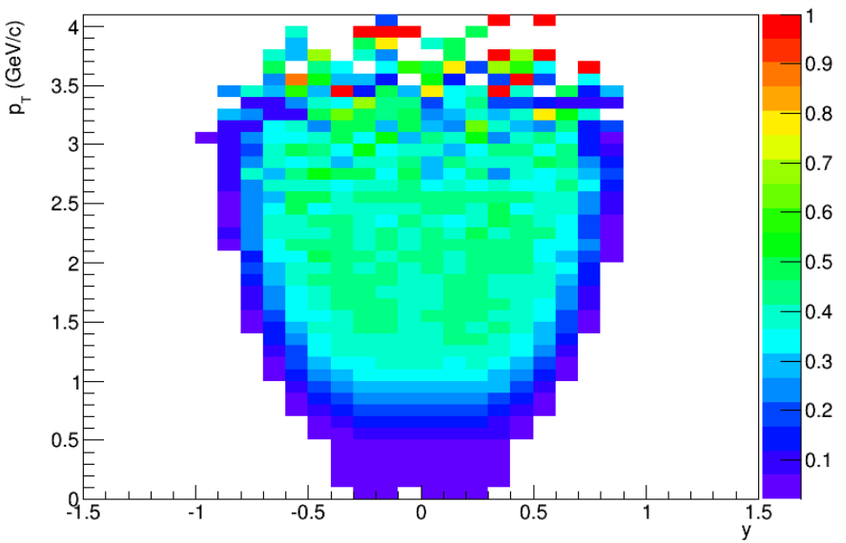


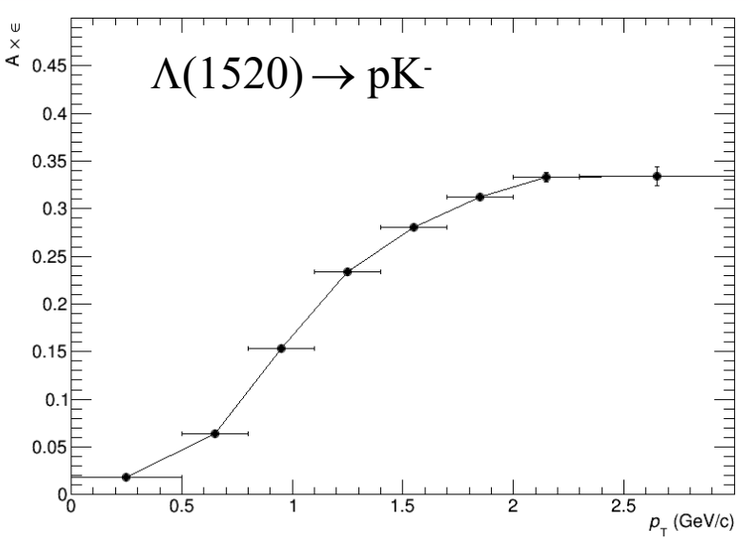


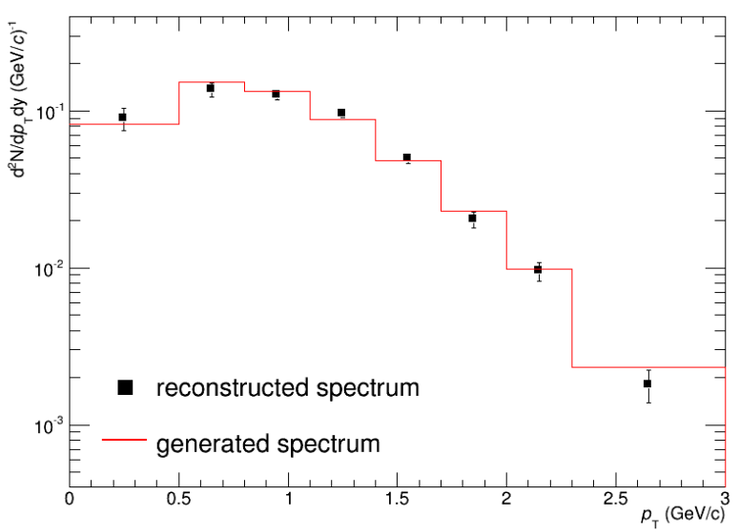


Reconstruction efficiency

Closure Test

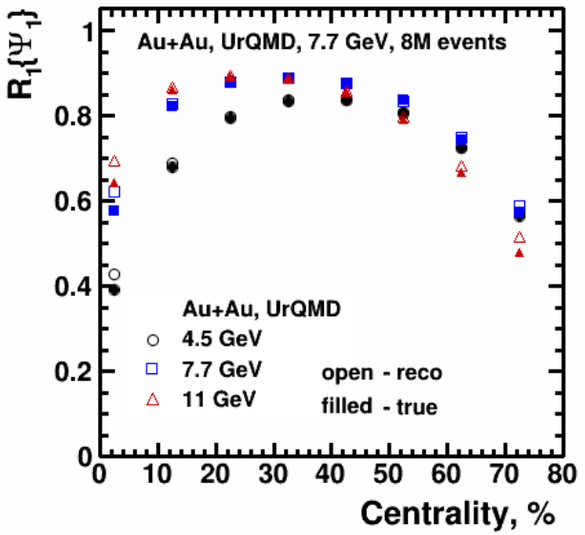


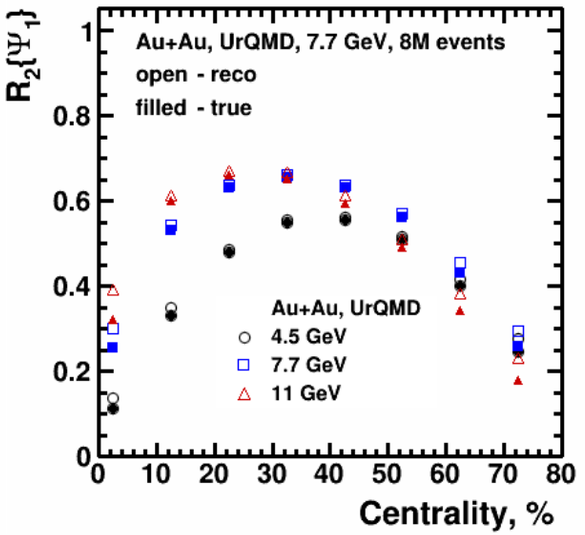


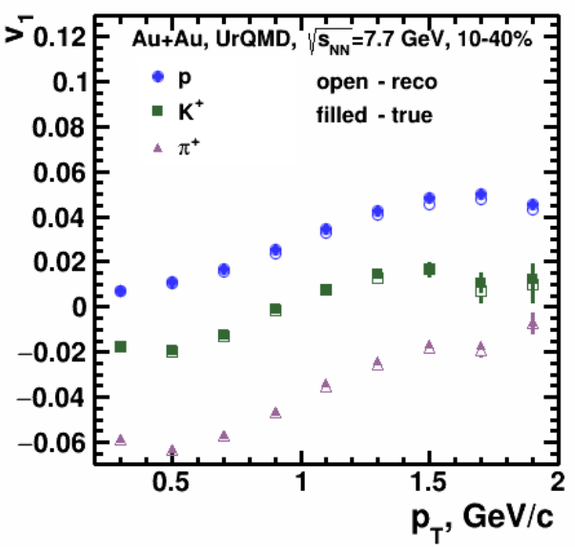


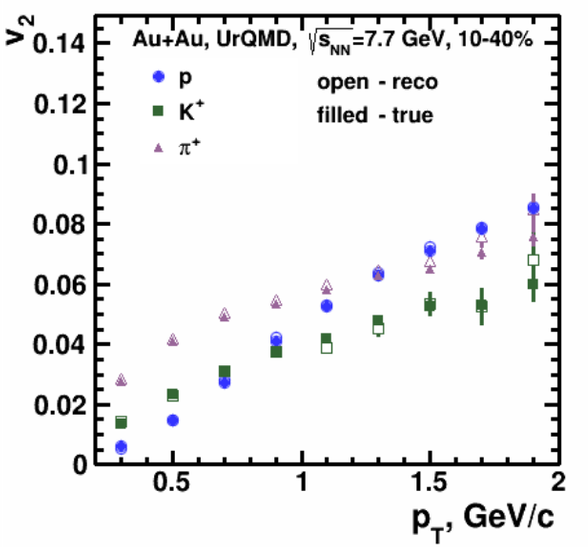
Performance of collective flow studies

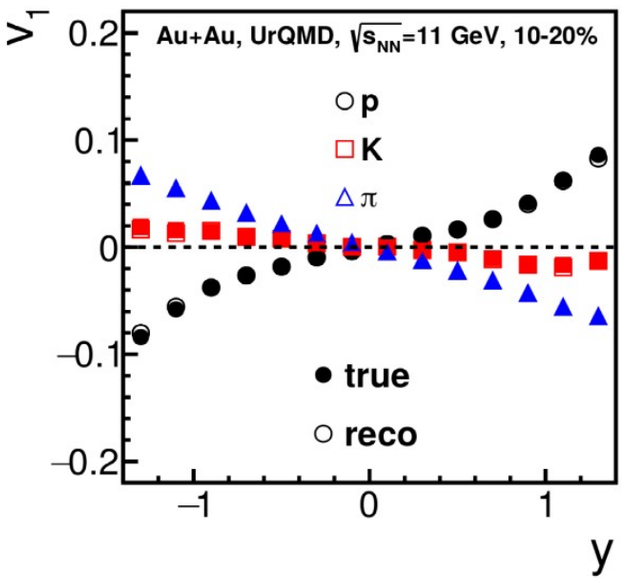
Au+Au, $\sqrt{s_{NN}}$ = 7.7, 11 GeV, UrQMD, GEANT3 + MPDRoot reco.

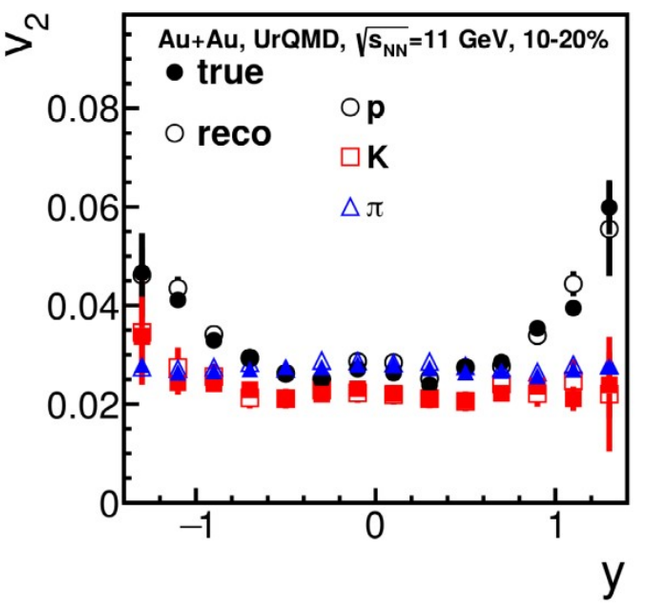






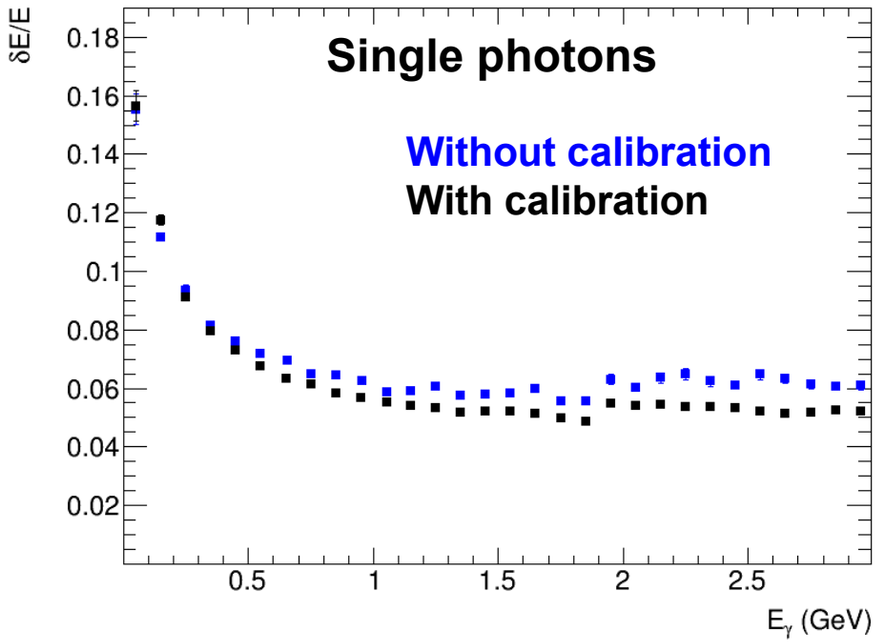


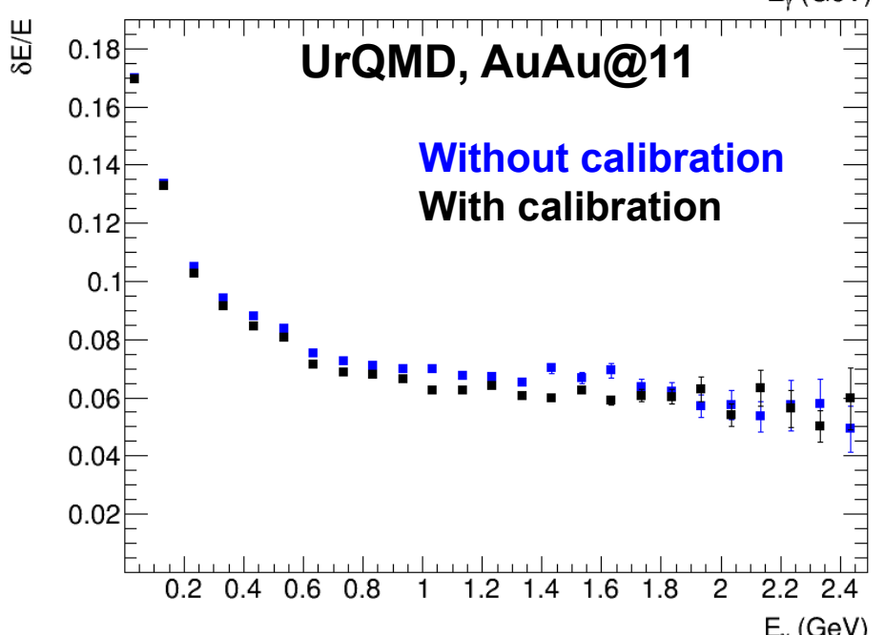




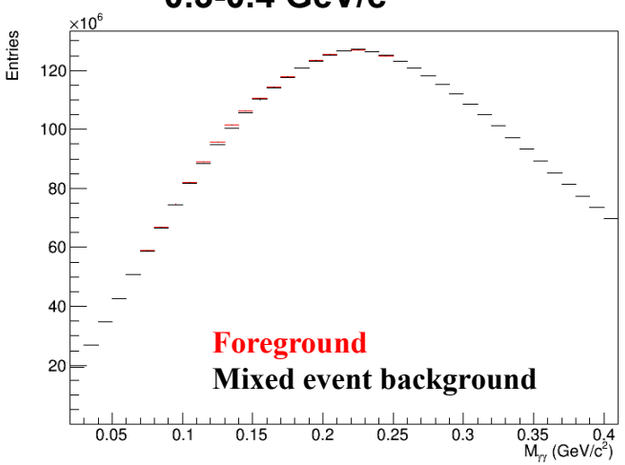
Electromagnetic Calorimeter simulation

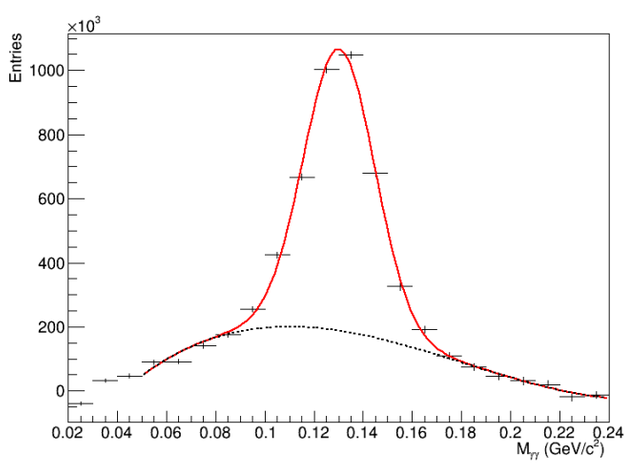
- Realistic ECAL reconstruction & analysis – large acceptance ECAL with good energy resolution: ideal tool for measurement of neutral mesons in a wide momentum range

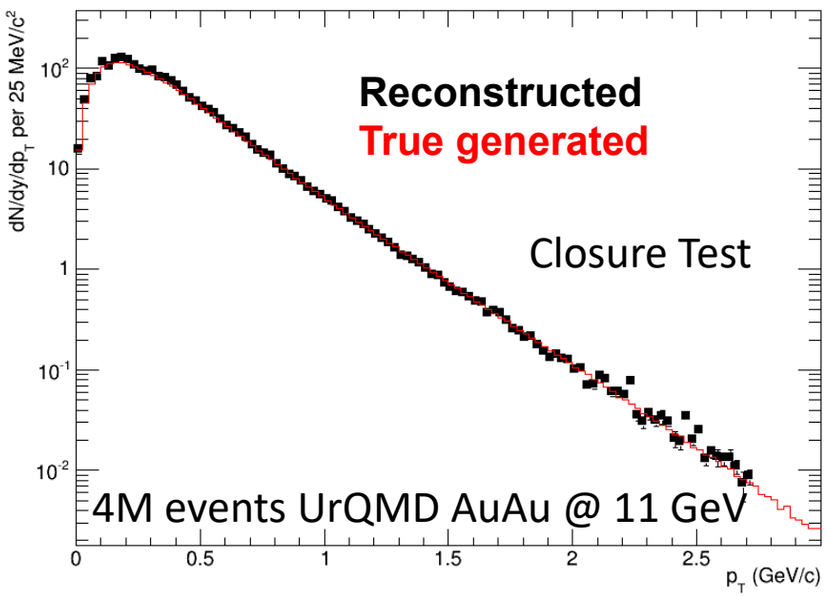


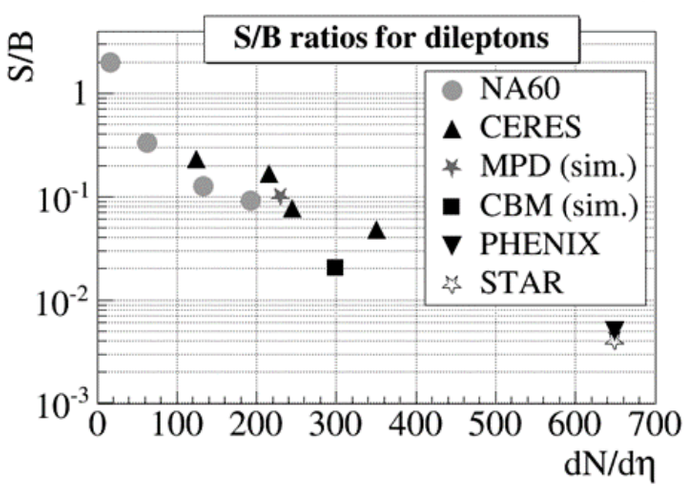


π^0-meson in central Au+Au



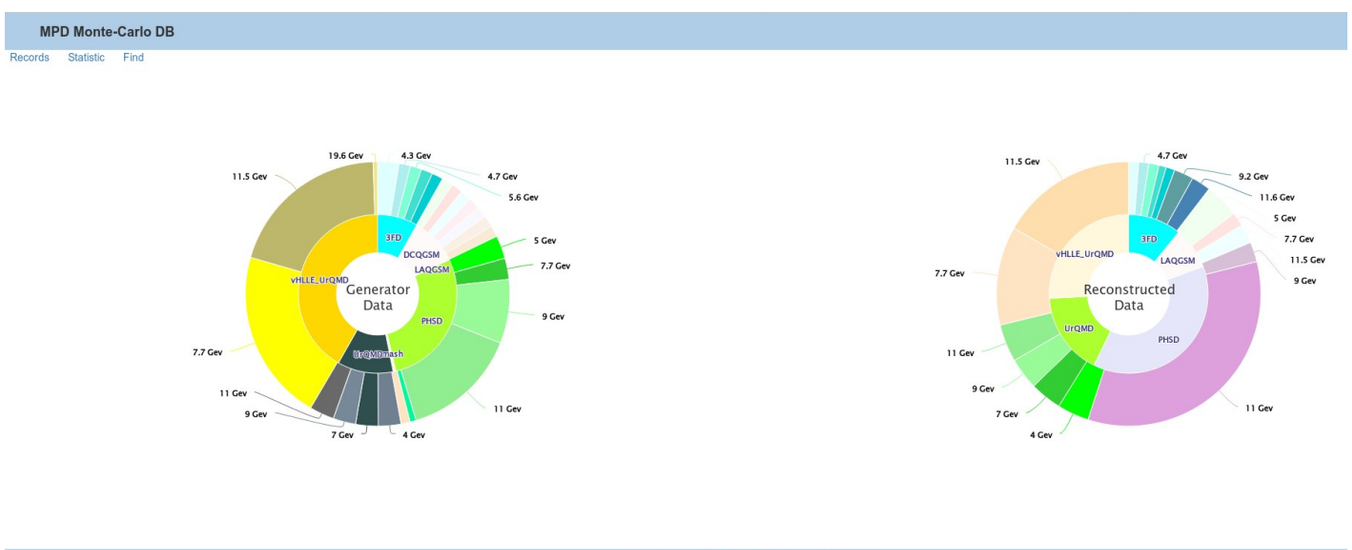






Computing for the NICA Megaproject on the GOVORUN

- HybriLIT computing resources available for MPD Collaborators
- Full MPD software suite available
- Used for massive Monte-Carlo productions
- Dirac framework used to connect other computing centers
- Establishing communications with LIT team



DIRAC
THE INTERWARE

- DIRAC infrastructure enables integration of heterogenous computing resources at multiple sites
- Provide single access point for end users for MPD Computing
- First tutorials given by LIT staff to selected MPD users
- Will be provided to all MPD Collaborators

Significant new computing at LHEP

- Upgrade of the exisiting dedicated NICA Cluster ongoing
- Final computing capabilities provided to the end users, official opening during the previous JINR Scientific Council, recent upgrage to full capacity:
  - 5000 job slots
  - Up to 10 PB of additional disk space (5 PB+5 PB replica, EOS filesystem)
  - Negiotiations ongoing on the division of resources between MPD, BM@N, and SPD
- Successfuly tested for massive production of Monte-Carlo events for new physics performance studies (500 central UrQMD events at top energy per day per core)
- Still needs work on stability (shared disk performance)
- Request to provide more transparent information to the user on the cluster status and plans for works/upgrades

Practice at MPD

- Preparation and analysis of the Monte-Carlo simulations of collisions at the NICA Accelerator
- Management of calculations on large-scale computing farms
- Testing the performance of the MPD Simulation software and the simulated performance of the MPD detector
- Needed: knowledge of C++, bash, ROOT