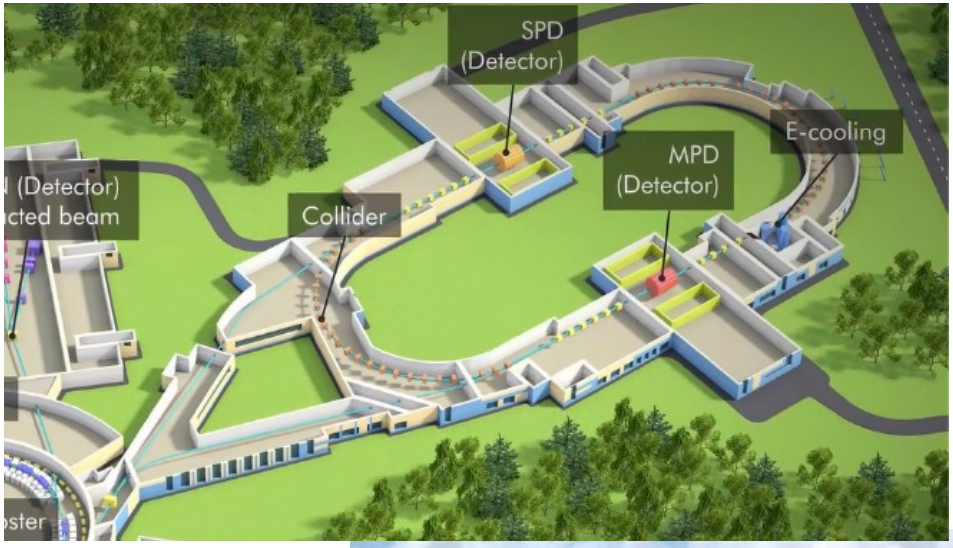
NICA project at JINR

NEC
30.09.2019
Budva

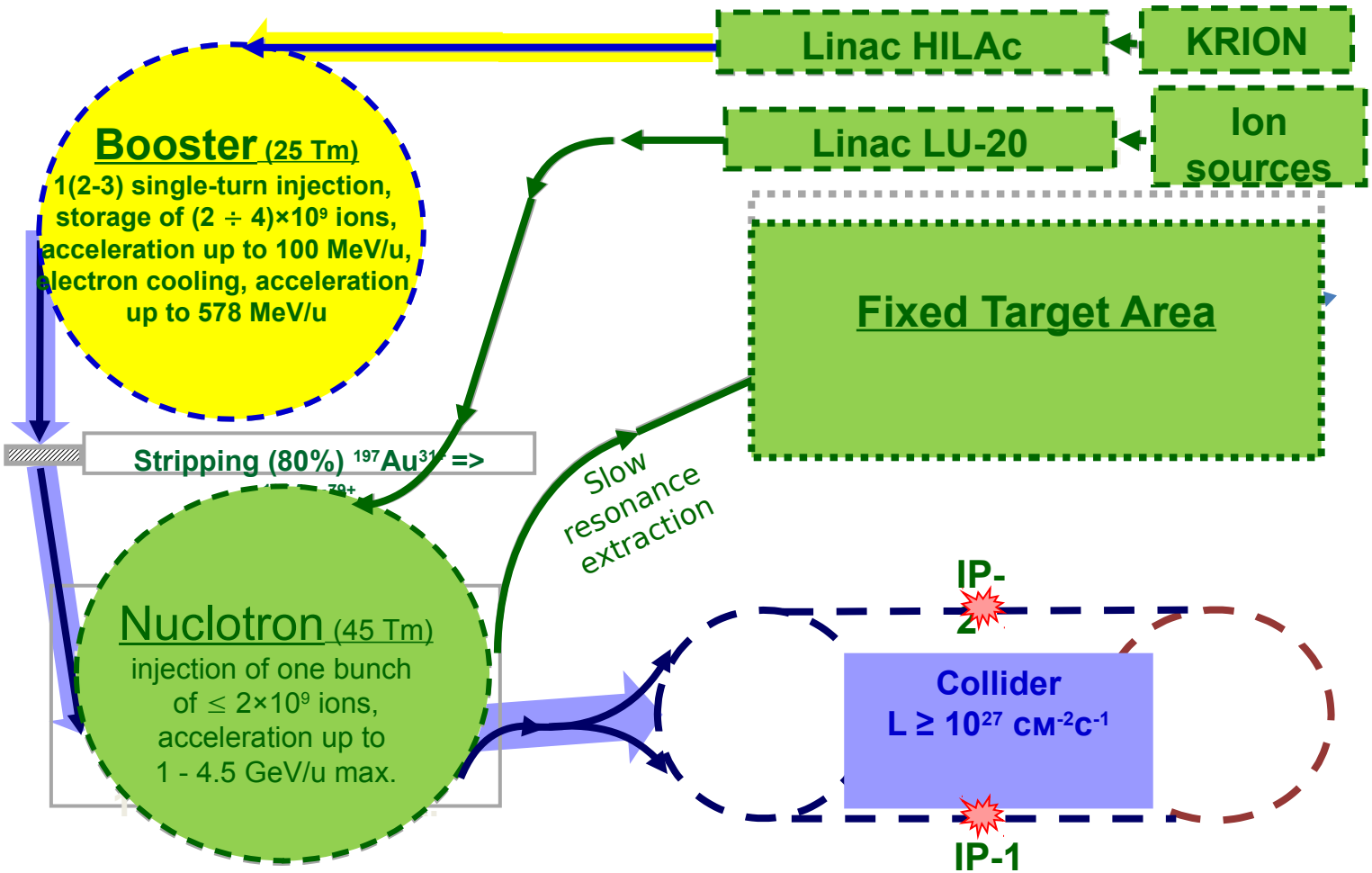
Rogachevsky O.
JINR

NICA site


SPD
(Detector)
E-cooling
MPD
(Detector)
Collider


09-16-2019 Mon 13:28:57

Facility components' – status 2019



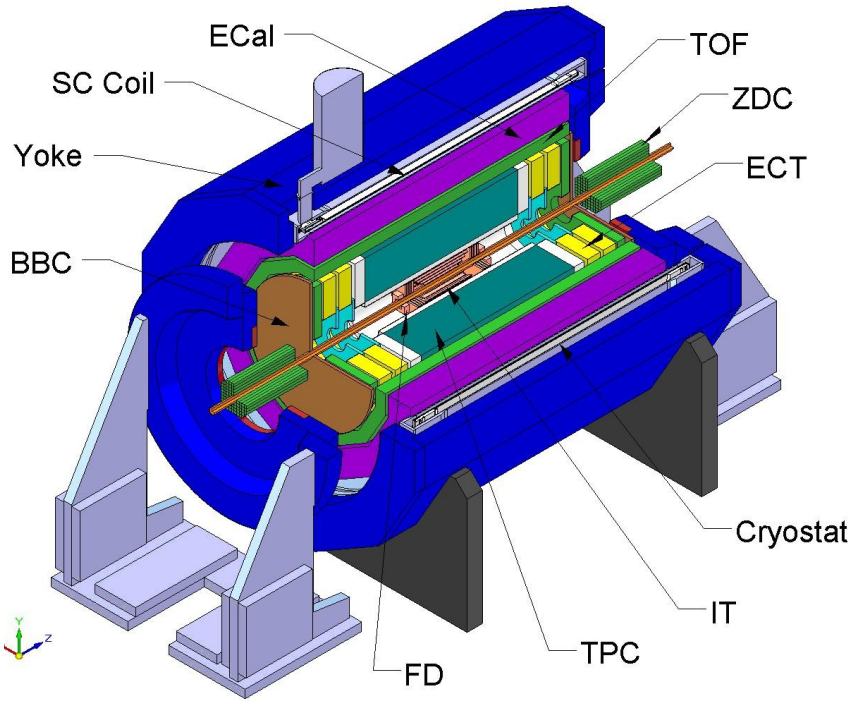
work in progress	assembly	commissioned / existing

Booster & collider

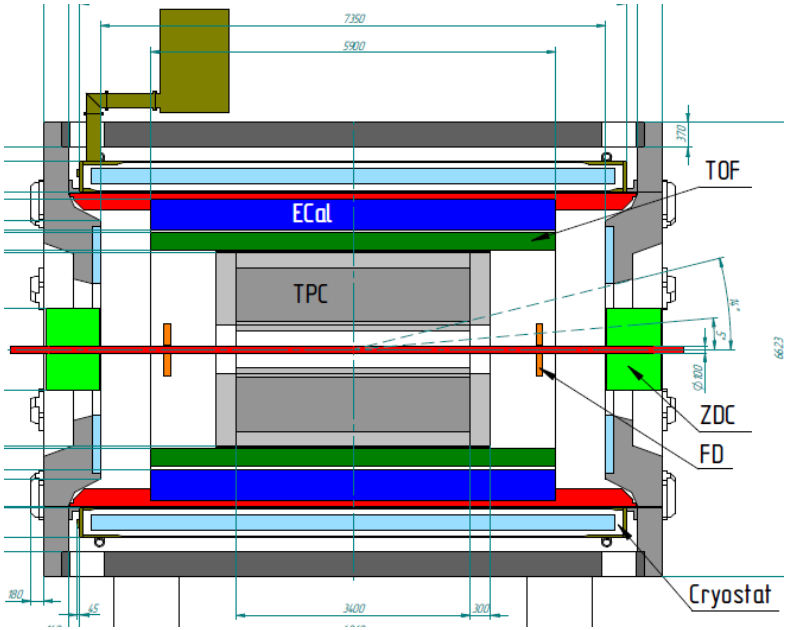
	Booster	Collider
Dipoles	40	80+8
Quadrupoles	24 * 2	78+12
Corr. magnets	32	136
Total	**64**	**178**
	242	

	% delivered
dipoles' yokes	54%
quads' yokes	11%
beam pipes	30%
dipoles vacuum shells	100%

MPD experiment



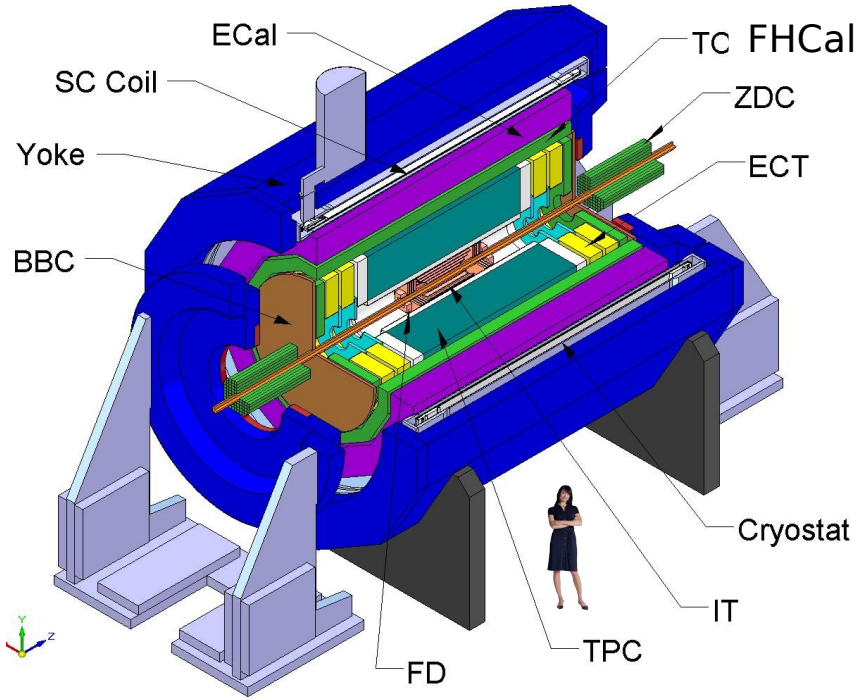
First stage



MPD Collaboration:

*spokesperson – **A. Kiesel WUT, Poland***

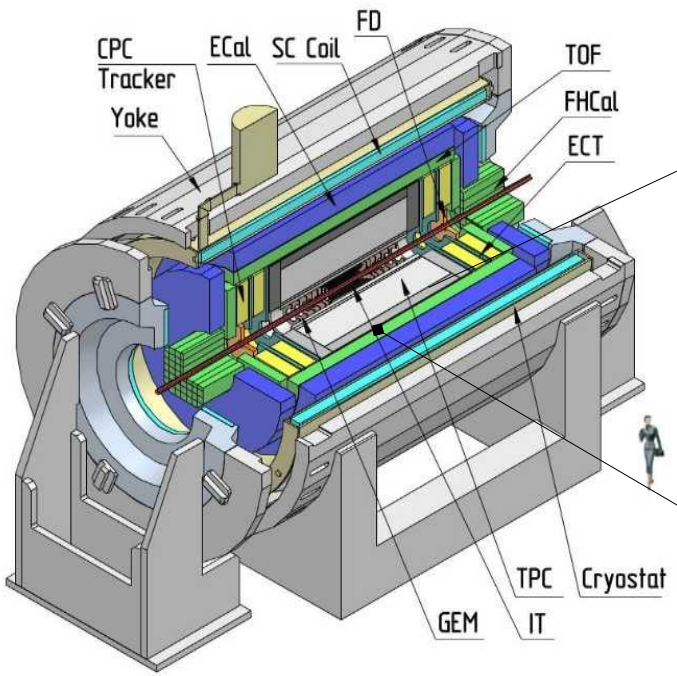
***10** Countries, **32** Institutes, **465** participants*



*Baku State University, NNRC, **Azerbaijan**;*
*University of Plovdiv, **Bulgaria;***
*University Tecnica Federico Santa Maria, Valparaiso, **Chili**;*
*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**;*

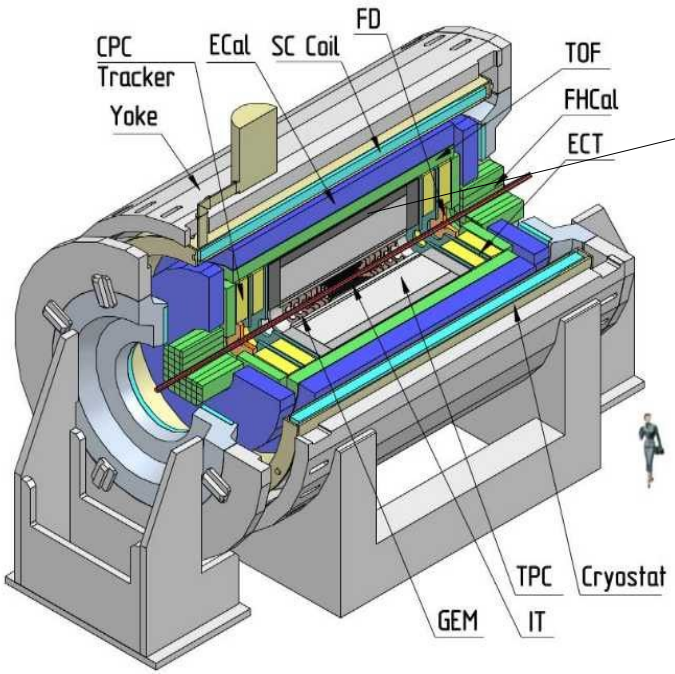
*IHEP, Beijing, **China**;*
*University of South China, **China**;*
*Palacky University, Olomouc, **Czech Republic**;*
*NPI CAS, Rez, **Czech Republic**;*
*Tbilisi State University, Tbilisi, **Georgia**;*
*Tubingen University, Tubingen, **Germany**;*
*Tel Aviv University, Tel Aviv, **Israel**;*
Joint Institute for Nuclear Research;
*IPT, Almaty, **Kazakhstan**;*
*UNAM, Mexico City, **Mexico**;*
*Institute of Applied Physics, Chisinev, **Moldova**;*
*WUT, Warsaw, **Poland**;*
*NCN, Otwock – Swierk, **Poland**;*
*UW, Wroclaw, **Poland**;*
*Jan Kochanowski University, Kielce, **Poland**;*
*INR RAS, Moscow, **Russia**;*
*MEPhI, Moscow, **Russia**;*
*PNPI, Gatchina, **Russia**;*
*INP MSU, Moscow, **Russia;***
*KI NRS, Moscow, **Russia**;*
*SPSU - Dept. of NP, **Russia;***
*St. Petersburg, **Russia**;*
*SPSU – Dept. of HEP, St. Petersburg, **Russia**;*
*North Ossetia State University, Vladikavkaz, **Russia**;*

MPD TPC

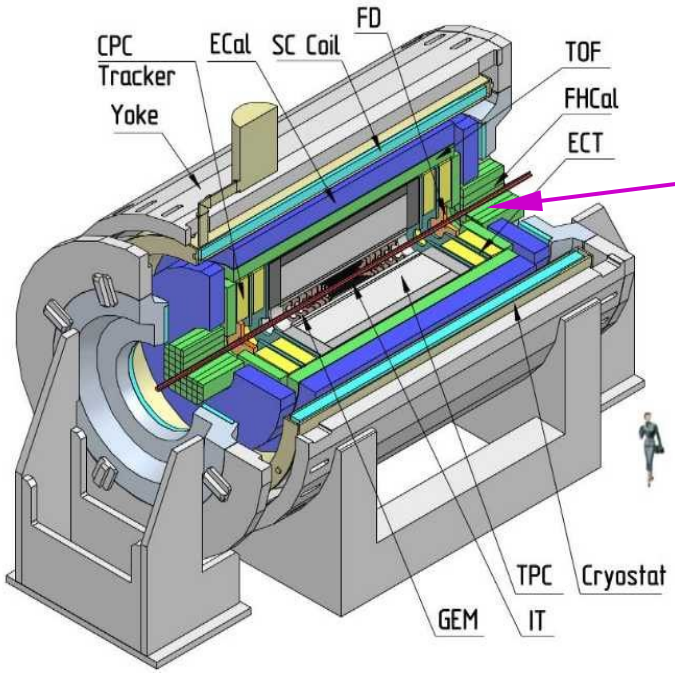


TPC outer walls
& membrane

MPD TOF


CPC
Tracker
Yoke
ECal
SC Coil
FD
TOF
FHCal
ECT
TPC
Cryostat
GEM
IT

MPD FHCal


CPC
Tracker
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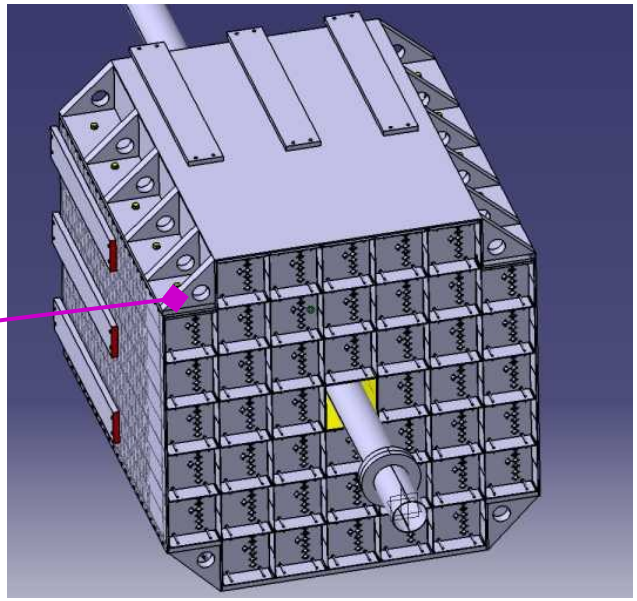
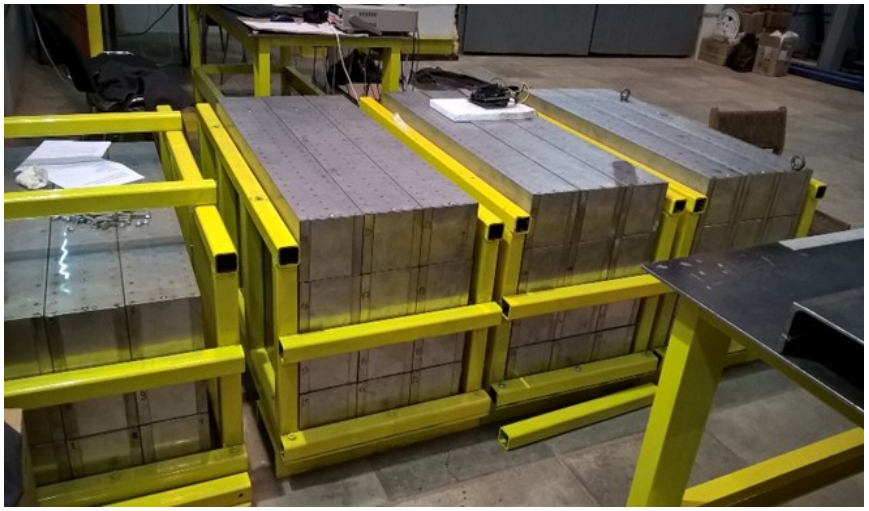
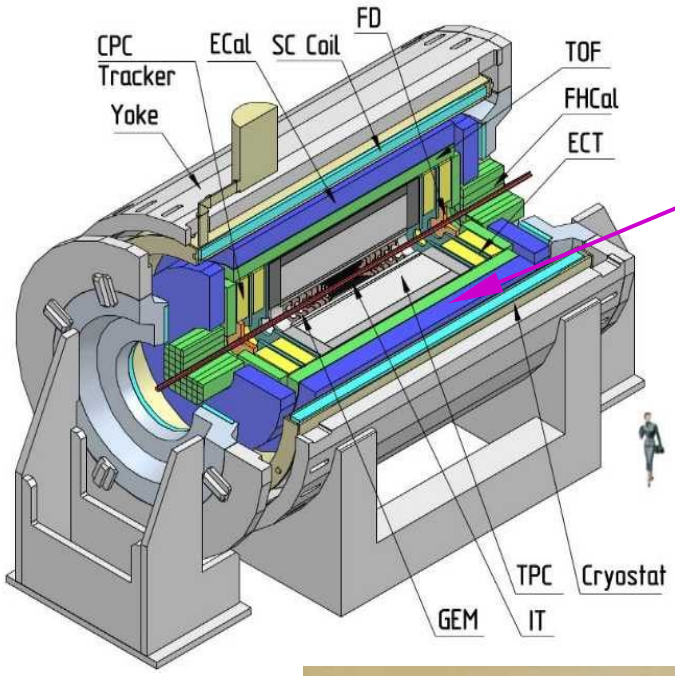
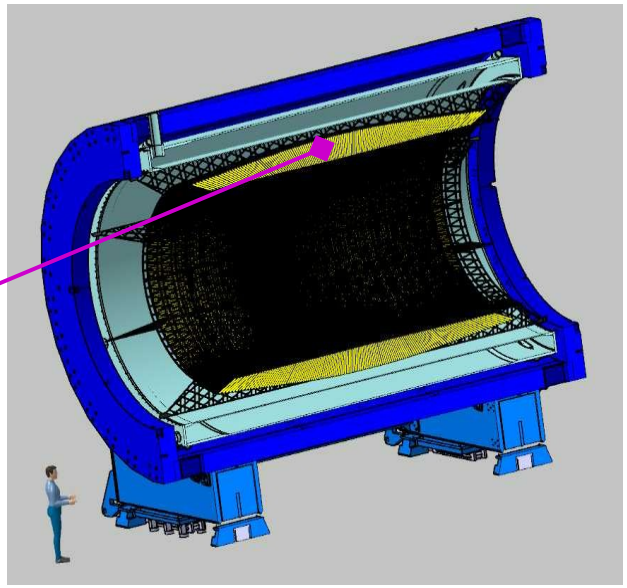


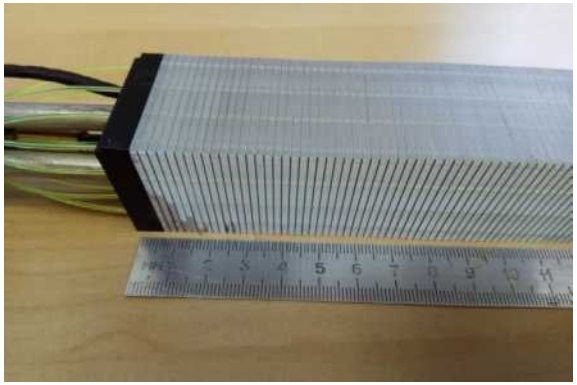


MPD ECal

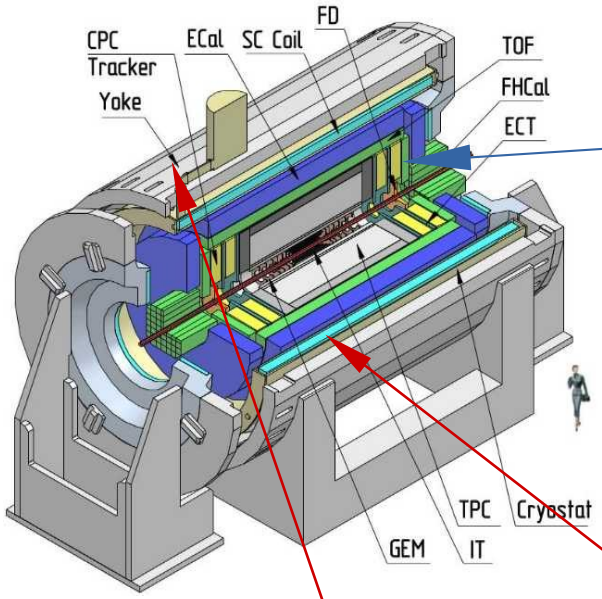


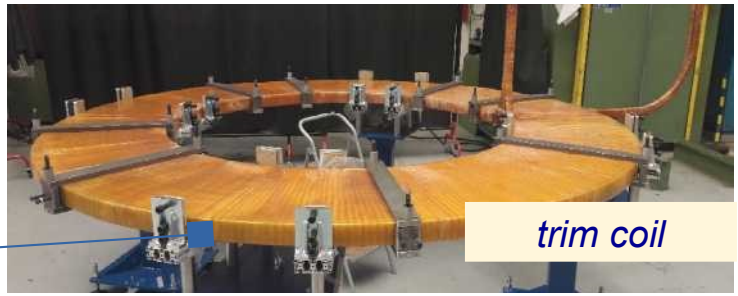


~ 43000 ECAL modules



MPD magnets





trim coil

cryostat

vacuum test

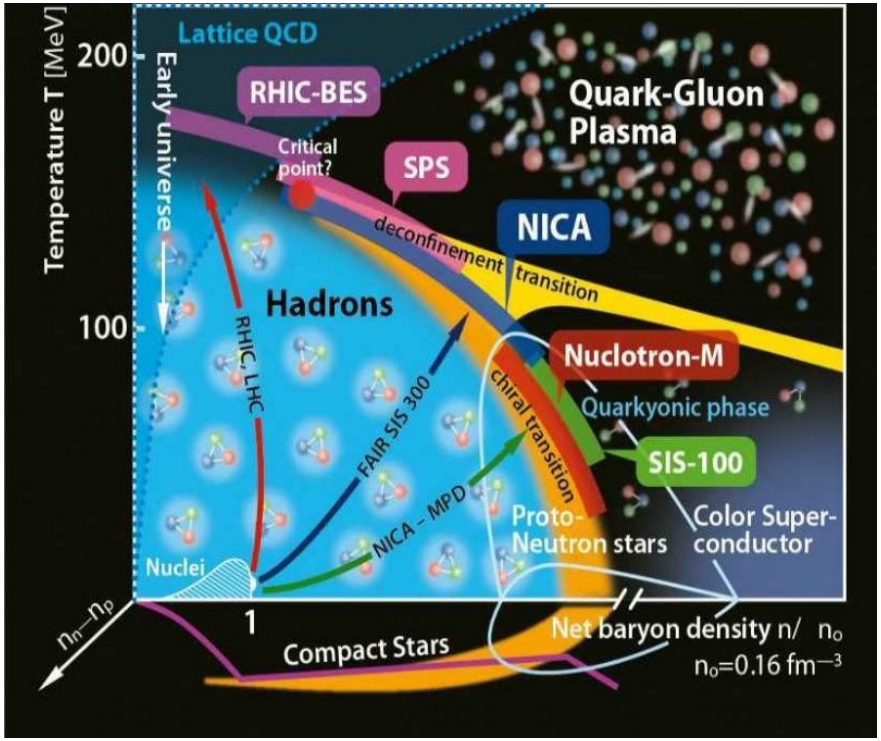
yoke assembly at HM Vitkovice

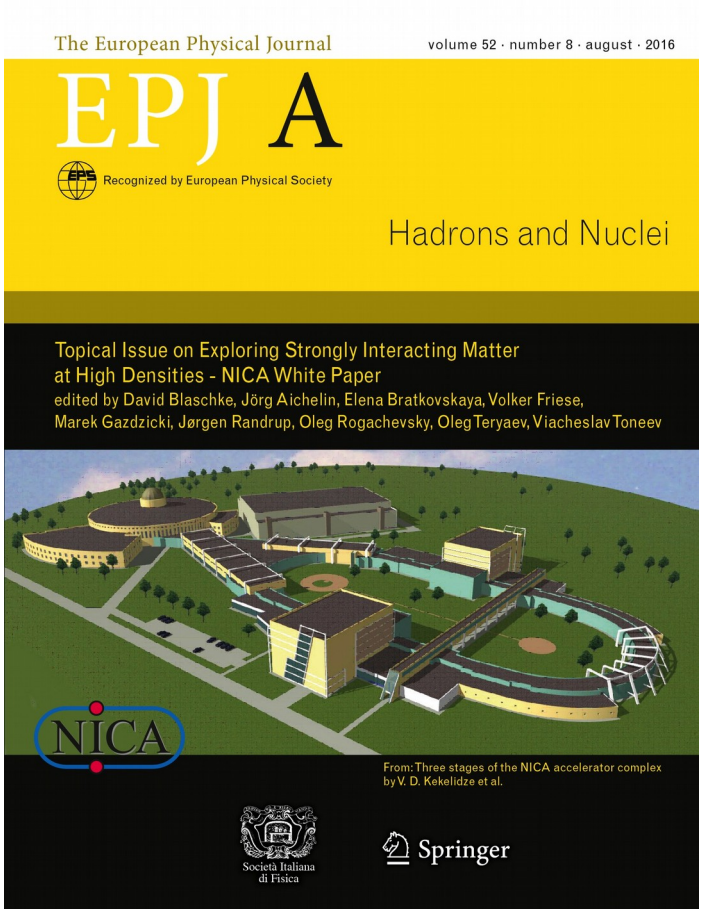
Solenoid assembling

Civil constraction

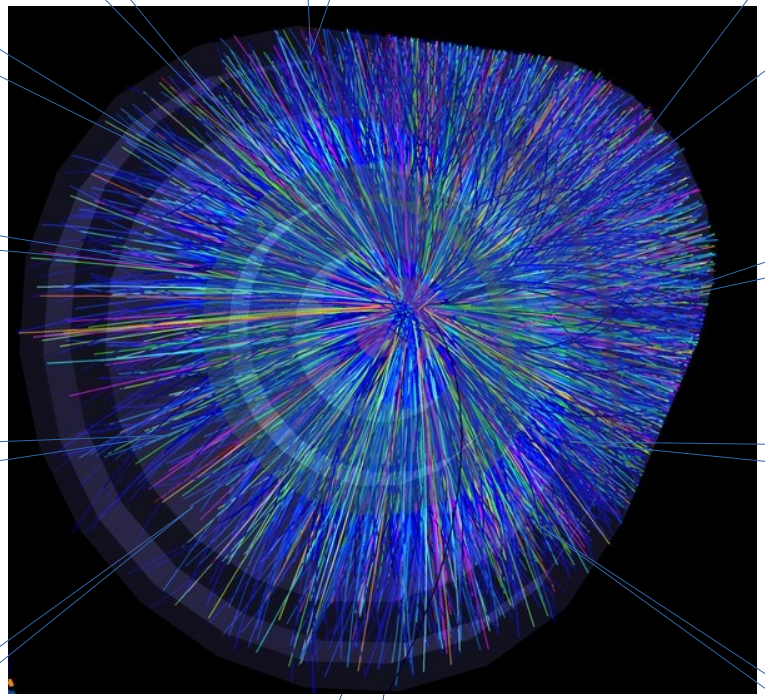
MPD hall: *ready for detector installation* - IV q. 2019
MPD magnet: will be assembled in 2019
whole collider building: readiness of the - IV q. 2020

MPD physics


Temperature T [MeV]
200
100
Lattice QCD
Early universe
RHIC-BES
Critical point?
SPS
Quark-Gluon Plasma
NICA
deconfinement transition
Hadrons
RHIC, LHC
FAIR SIS 300
NICA - MPD
chiral transition
Nuclotron-M
Quarkyonic phase
SIS-100
Color Super-conductor
Proto-Neutron stars
Nuclei
$n_n - n_p$
1
Compact Stars
Net baryon density n/ n_o
n_o=0.16 fm^{-3}


The European Physical Journal
volume 52 · number 8 · august · 2016
EPJ A
Recognized by European Physical Society
Hadrons and Nuclei
Topical Issue on Exploring Strongly Interacting Matter at High Densities - NICA White Paper
edited by David Blaschke, Jörg Aichelin, Elena Bratkovskaya, Volker Friese, Marek Gazdzicki, Jørgen Randrup, Oleg Rogachevsky, Oleg Teryaev, Viacheslav Toneev
NICA
From: Three stages of the NICA accelerator complex by V. D. Kekelidze et al.
Società Italiana di Fisica
Springer

What is the QGP ?



Strangeness enhancement

Flow

CME

Jet quenching
High p_T suppression

Femtoscopy

Horn

Baryon stopping power

Fluctuations

Ridge

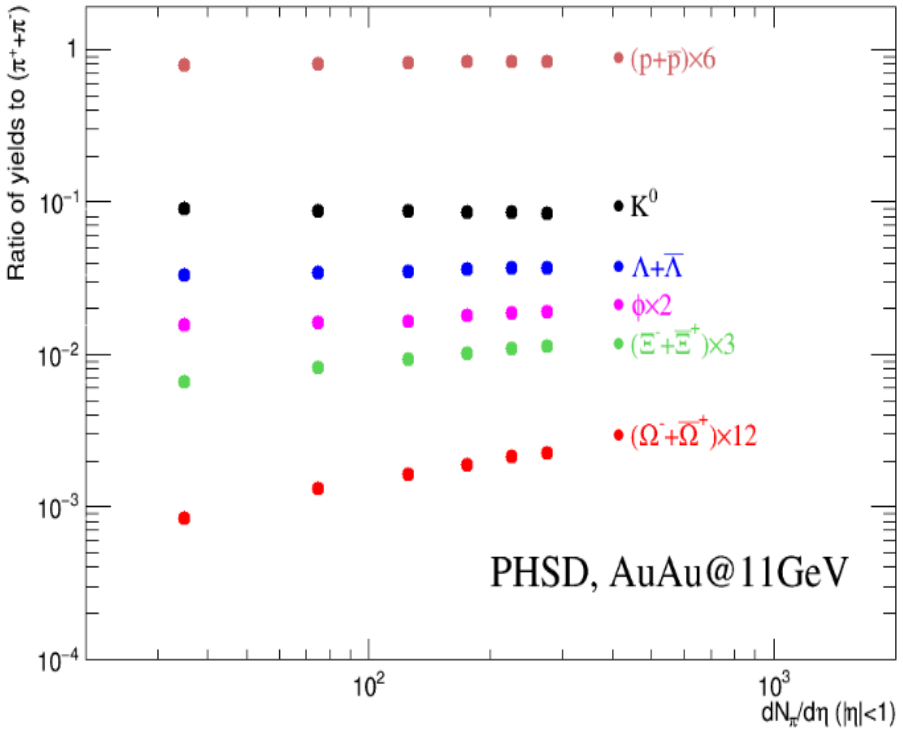
N_{cq} scaling

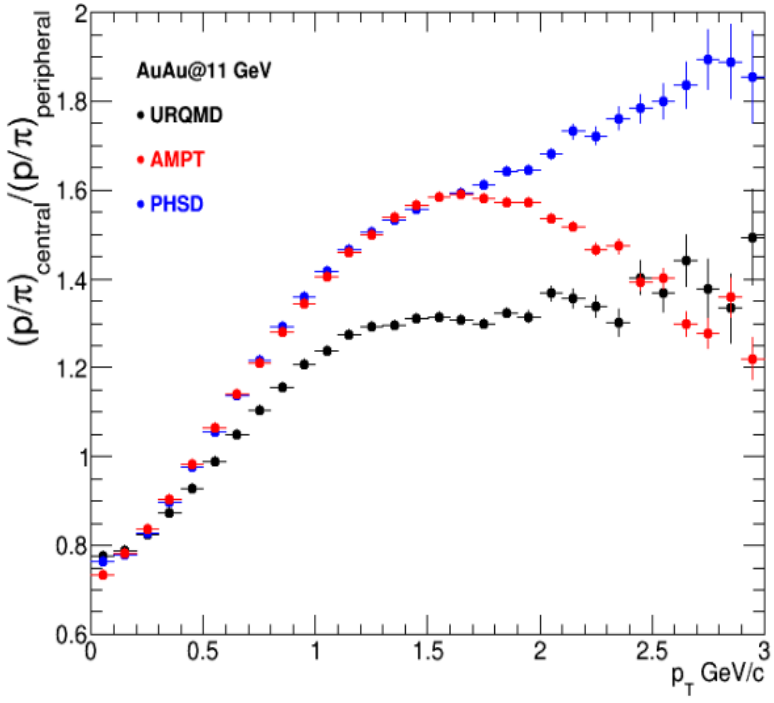
CVE

MC generators:

UrQMD	Prog. Part. Nucl. Phys. 41 (1998) 225
HIJING:	Phys. Rev. D 44 (1991) 3501
AMPT:	Phys. Rev. C 72 (2005) 064901
Hybrid UrQMD:	Phys. Rev. C 78 (2008) 044901
PHSD:	Nucl. Phys. A 856 (2011) 162
VHLLE:	Comput. Phys. Commun. 185 (2014) 3016
DC-QGSM:	will be published soon
3 Fluid Dynamics:	Phys. Rev. C 73 (2006) 044904
Theseus:	Phys. Rev. C 94 (2016) 044917
PHQMD:	arXiv:1907.03860
IHKM :	Phys. Rev. C 93 (2016) 024902

Model predictions





Feasibility study for resonances in heavy-ion collisions

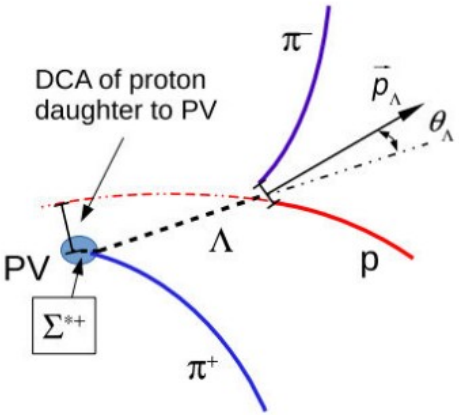
Particle	Mass (MeV/c^2)	Width (MeV/c^2)	Decay	BR (%)
ρ^0	770	150	$\pi^+\pi^-$	100
$K^{*\pm}$	892	50.3	$\pi^\pm K_s$	33.3
K^{*0}	896	47.3	πK^+	66.7
ϕ	1019	4.27	K^+K^-	48.9
Σ^{*+}	1383	36	$\pi^+\Lambda$	87
Σ^{*-}	1387	39.4	$\pi^-\Lambda$	87
$\Lambda(1520)$	1520	15.7	K^-p	22.5
Ξ^{*0}	1532	9.1	$\pi^+\Xi^-$	66.7

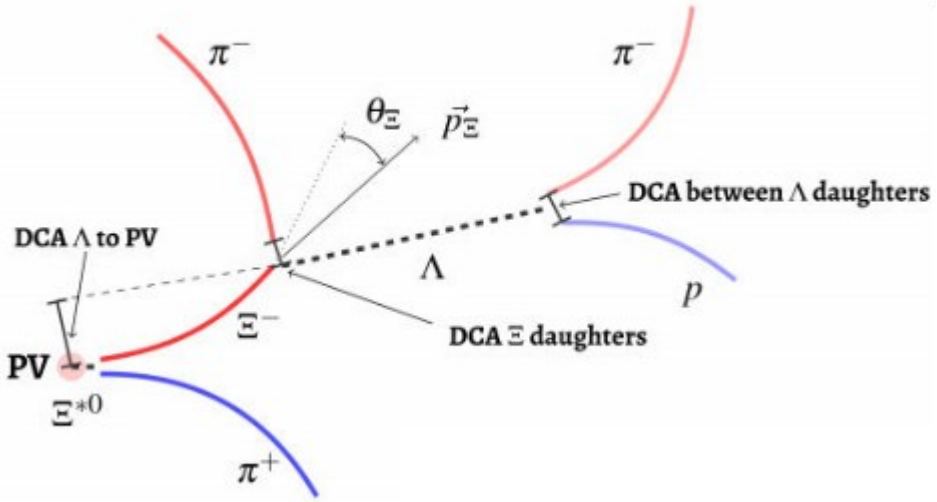
Resonances decay

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

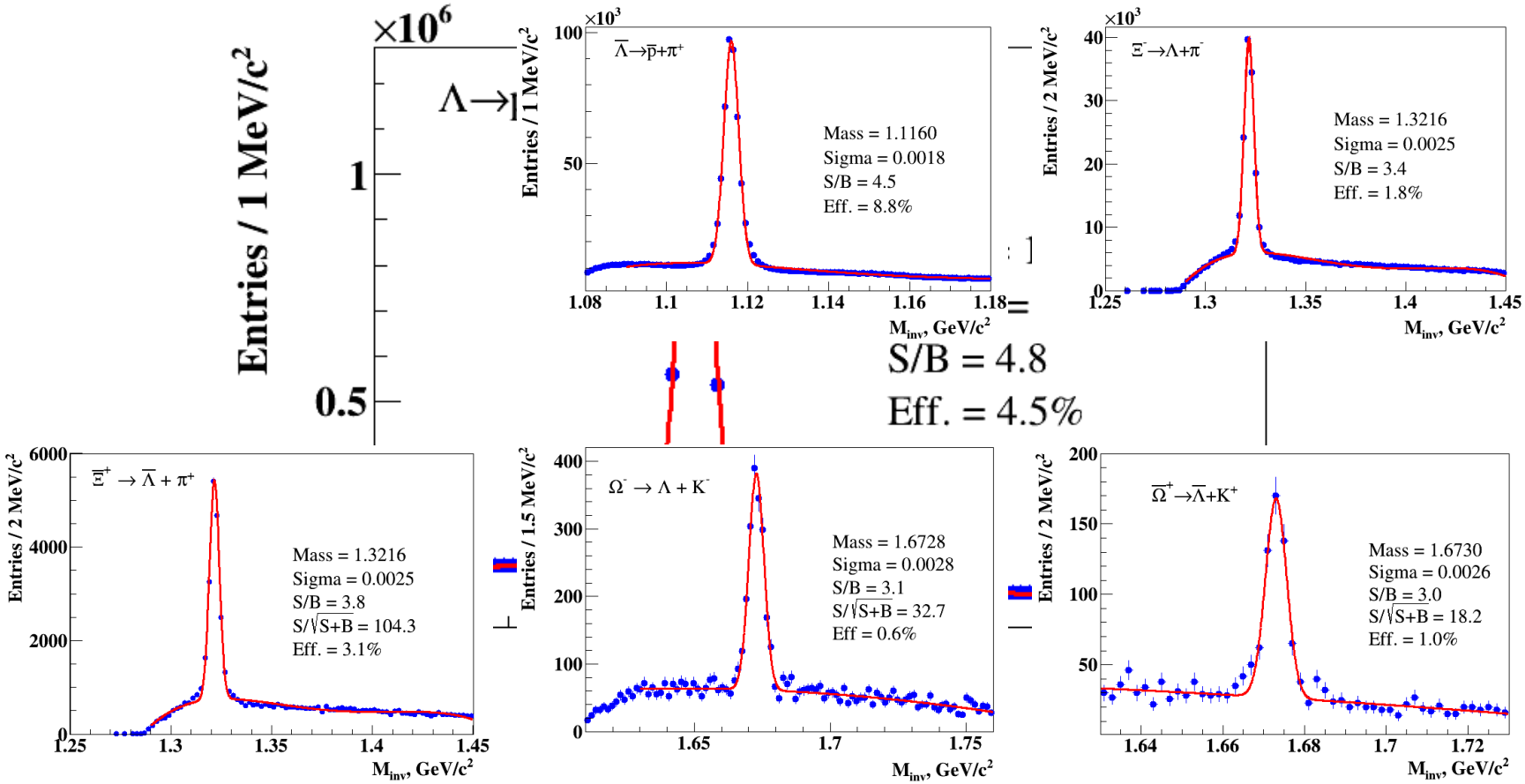
$\Lambda(1520) \rightarrow pK^-$

$\phi(1020) \rightarrow K^+K^-$, BR = 48.9 %

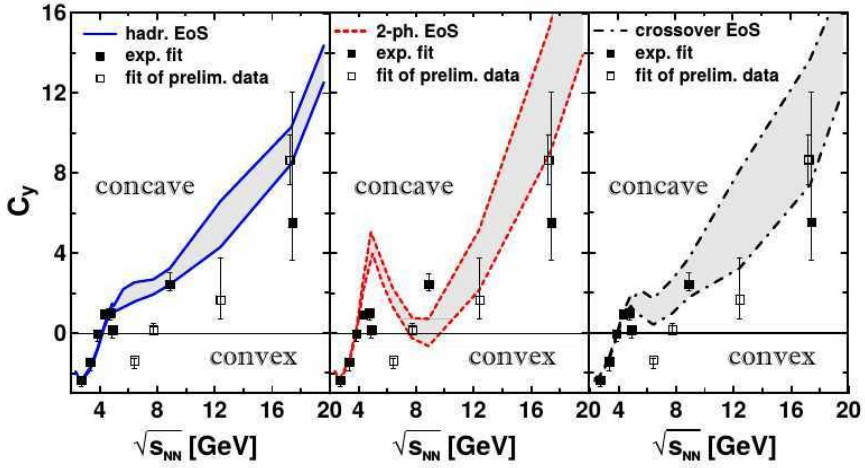




Hyperon reconstruction and analysis at MPD

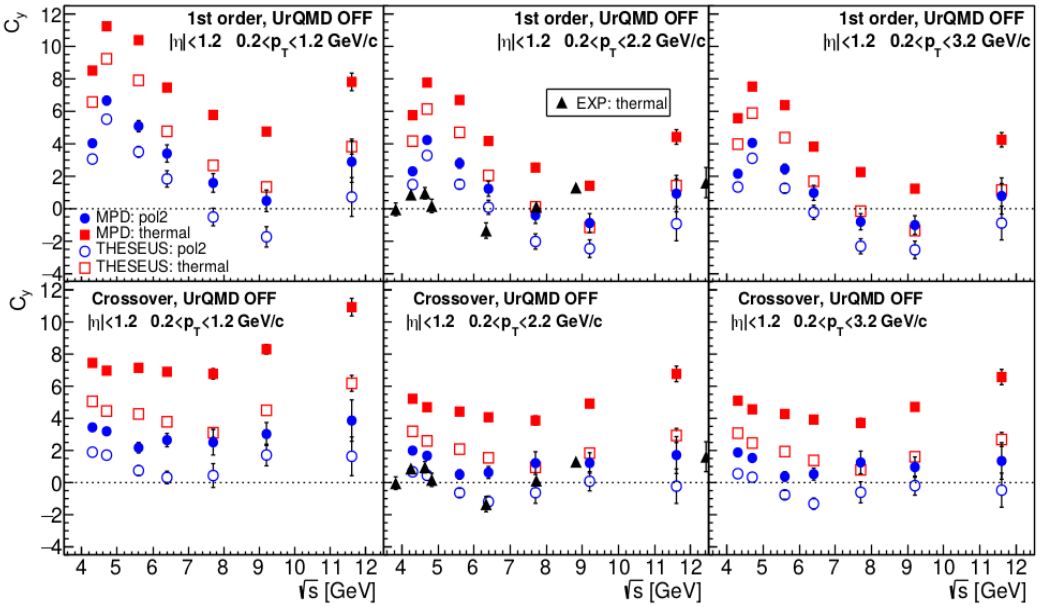


Midrapidity reduced curvature



Yu.B. Ivanov, Phys. Lett. B721 123 (2013)

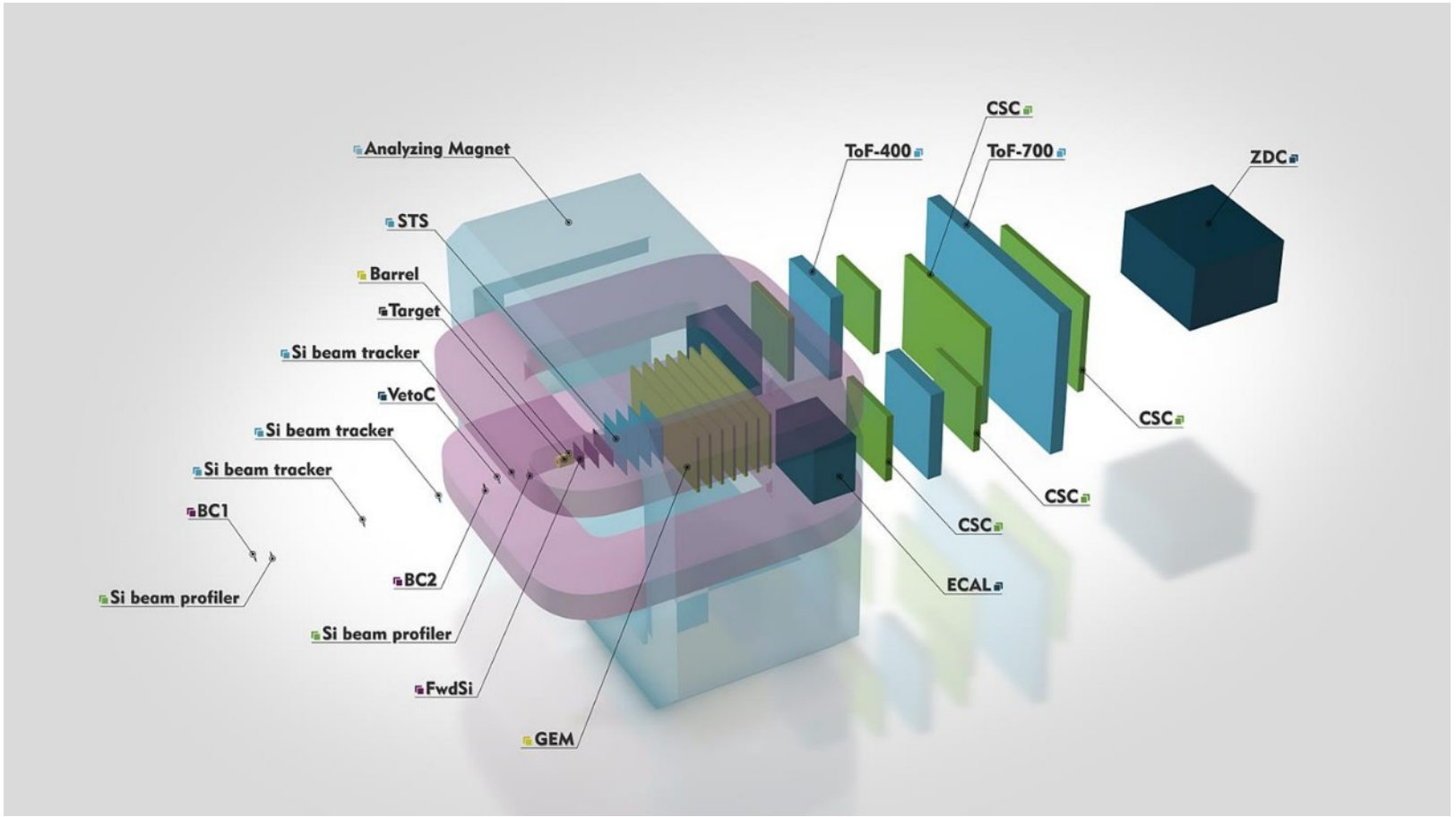
$$C_y = \left(y_{\rm beam}^3 \frac{d^3N}{dy^3}\right)_{y=0} \Big/ \left(y_{\rm beam}\frac{dN}{dy}\right)_{y=0} = (y_{\rm beam}/w_s)^2\left(\sinh^2 y_s - w_s \cosh y_s\right)$$



BM@N

NICA

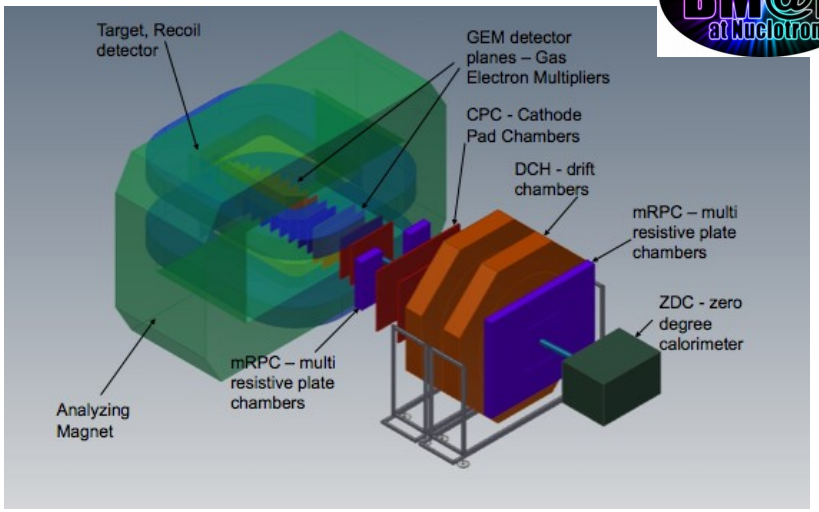
Next run (2020?)



Baryonic Matter at Nuclotron

11 *Countries,* ***21*** *Institutions,*
230 *paricipants*

spokesperson – ***M. Kapishin****,* ***JINR***

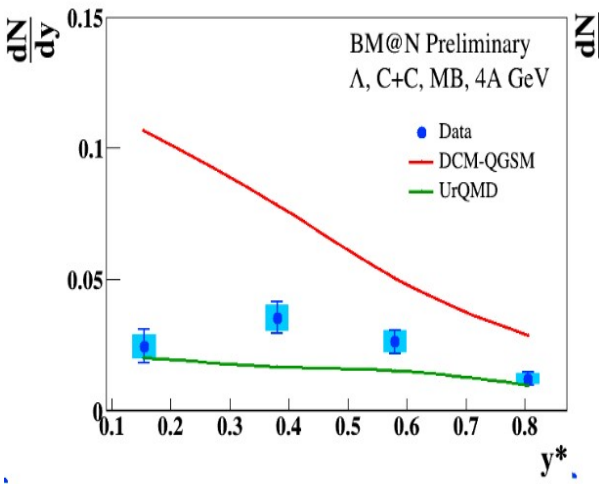


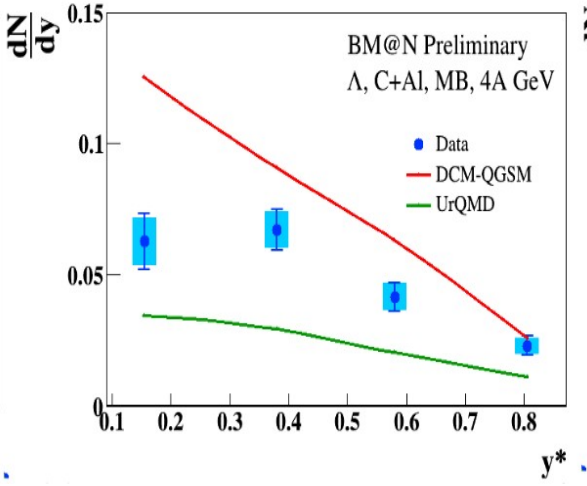
University of Plovdiv, ***Bulgaria;***
Institute of High Energy Physics, ***China;***
Shanghai Institute of Nuclear and Applied Physics, CFS, ***China;***
Tsinghua University, Beijing, ***China;***
Nuclear Physics Institute CAS, ***Czech Republic;***
Tubingen University, ***Germany;***
Tel Aviv University, ***Israel;***
Joint Institute for Nuclear Research;
Almaty Institute of Physics & Technology, ***Kazakhstan;***
Institute of Applied Physics, Chisinev, ***Moldova;***
Warsaw University of Technology, ***Poland;***
University of Wroclaw, Wroclaw, ***Poland****;*
Institute of Nuclear Research RAS, Moscow, ***Russia;***
Institute of Theoretical & Experimental Physics, NRC KI, Moscow, ***Russia;***
NRC Kurchatov Institute, Moscow, ***Russia;***
Moscow Engineer and Physics Institute, ***Russia;***
Skobeltsin Institute of Nuclear Physics, MSU, ***Russia;***
Massachusetts Institute of Technology, Cambridge, ***USA.***

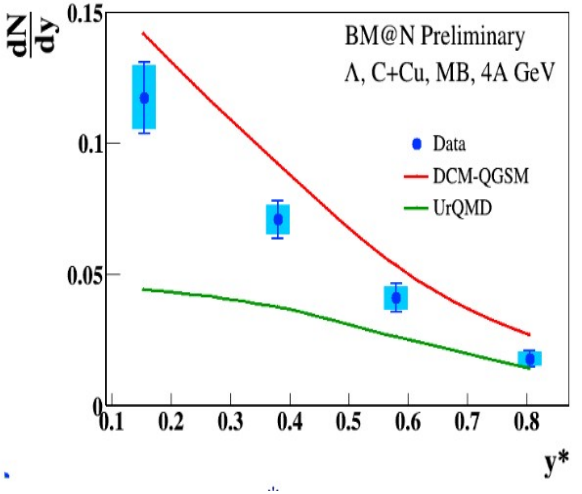
Λ hyperon yield

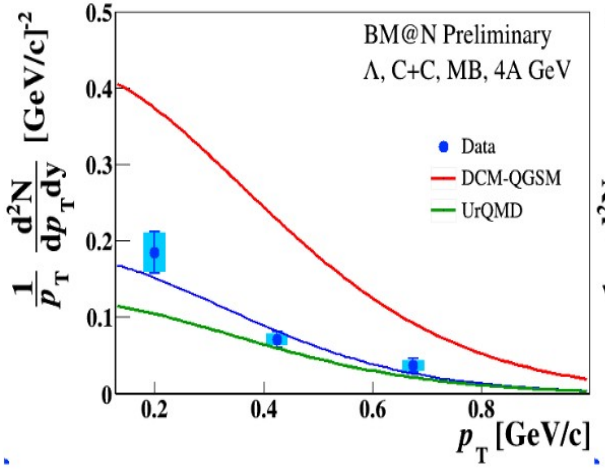
C+C: 4.6M triggers
C+Al: 5.3M triggers
C+Cu: 5.3M triggers

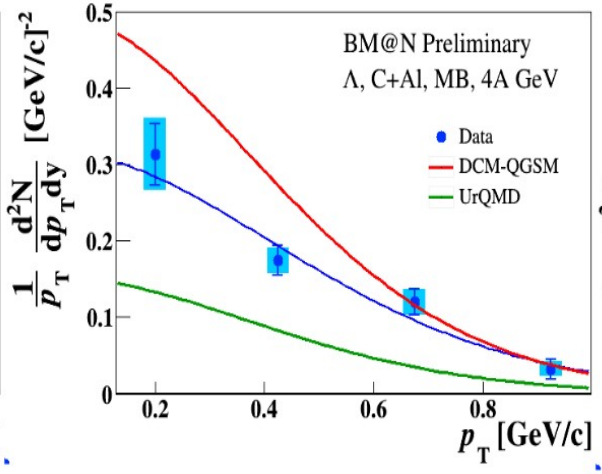
Λ signal width 2.4 – 3 MeV

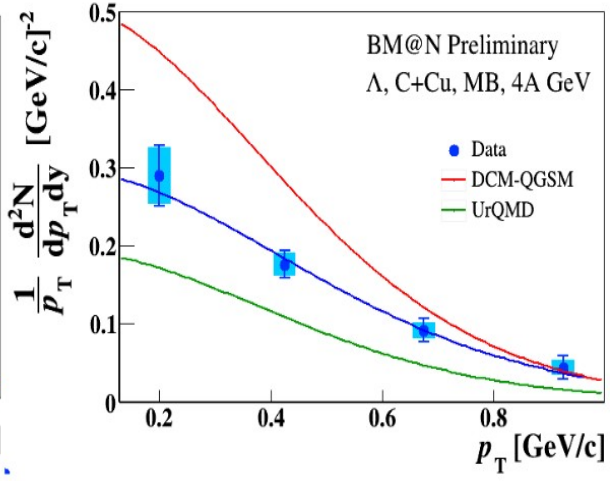






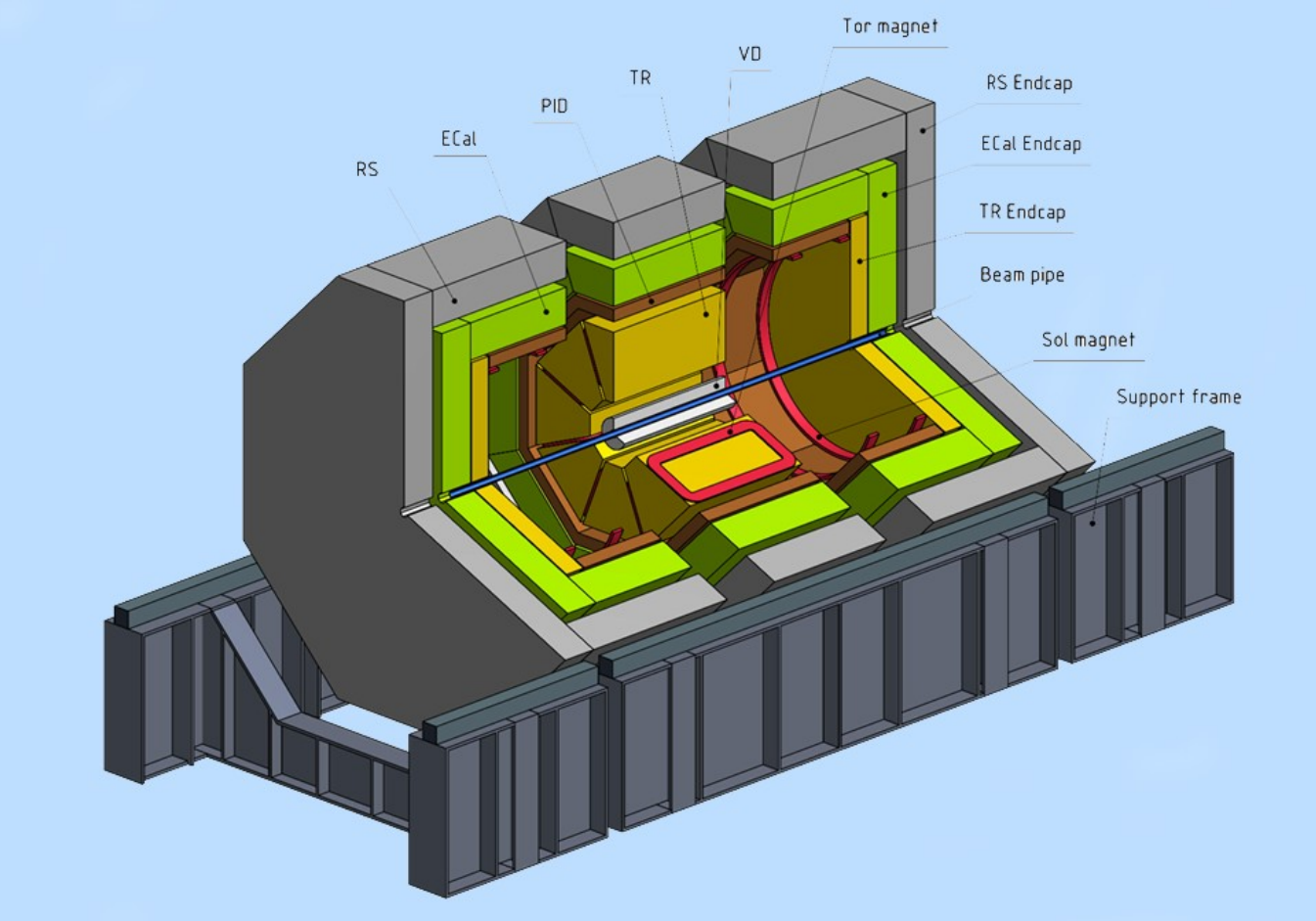






SPD

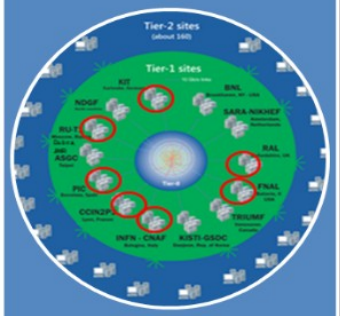
Collaboration, Letter of intent, CDR, detectors development are started



Computing for NICA

NICA cluster
LHEP
3500 cores
3.5PB

100 Gbps



Tier-1:
4160 cores
6.4 PB disk
9 PB tape

Cloud:
850 CPU
4 TB RAM

HybriLIT:
252 CPU
77184 GPU cores
182 PHI-cores
2.4 TB RAM
57.6 TB HDD
142 Tflops

CICC/Tier-2:
3500 cores
2PB disk
NICA off-line cluster and storage system

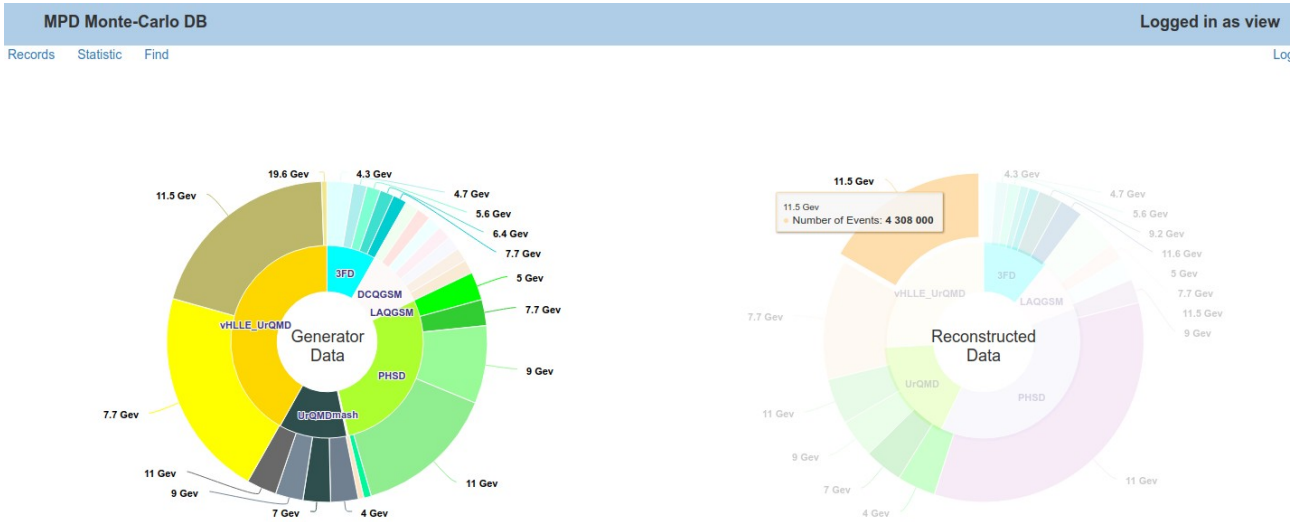
DATALAKE TECHNOLOGY

Network infrastructure:LAN: 10 Gbps WAN: 100 Gbps - 2x10 Gbps

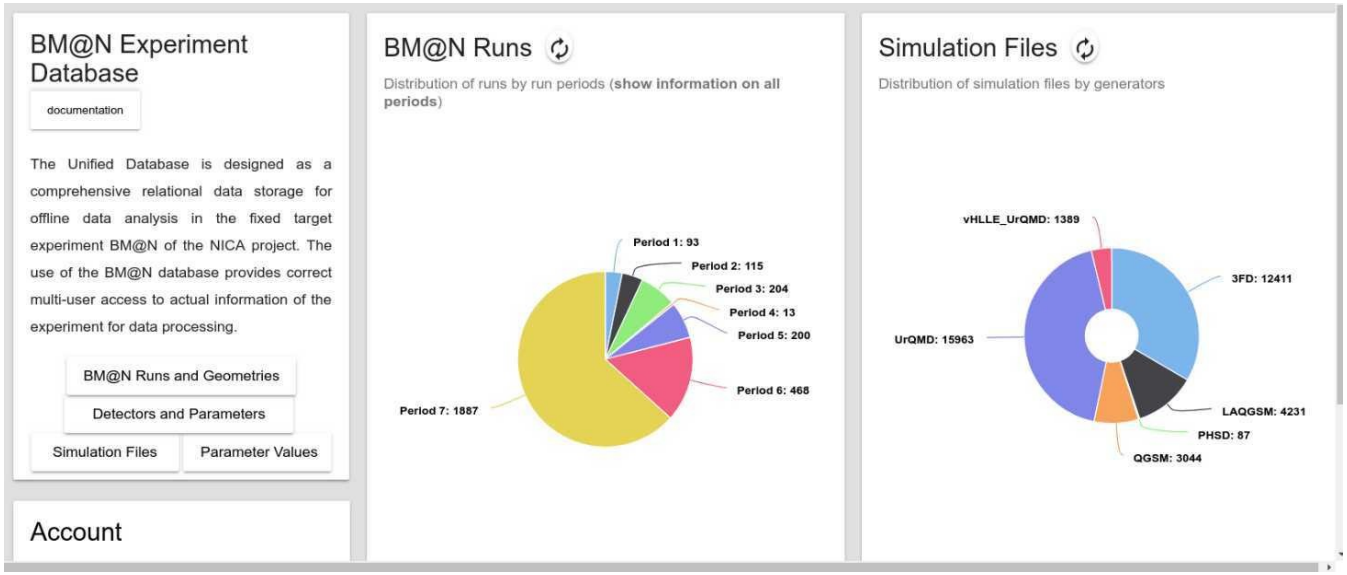
Engineering infrastructure

NICA data lake

MPD



BM@N



NICA session

- NICA project at JINR. Dr. ROGACHEVSKIY, Oleg
- BM@N experiment for studies of baryonic matter at the Nuclotron Mrs. MAKSYMCHUK, Anna
- Front-End Electronics for TPC/MPD detector of NICA project Mr. VERESCHAGIN, Stepan
- Trigger and beam monitoring system of BM@N and SRC experiments Dr. SERGEEV, Sergey
- Project of a fast interaction trigger for MPD experiment Dr. SERGEEV, Sergey
- Electronics of straw trackers in NA62, NA64 and SPD experiments, Mr. ENIK, Temur
- Tracking for BM@N GEM detector on the basis of graph neural network Mr. SHCHAVELEV, Egor
- LOOT: Novel end-to-end trainable convolutional neural network for particle track reconstruction Mr. GONCHAROV, Pavel
- Hit finder and track reconstruction algorithms in the Multi-Wire Proportional Chambers of BM@N experiment, Prof. NEMNYUGIN, Sergei
- Development and Integration of the Electronic Logbook for the BM@N experiment at NICA Dr. GERTSENBERGER, Konstantin