

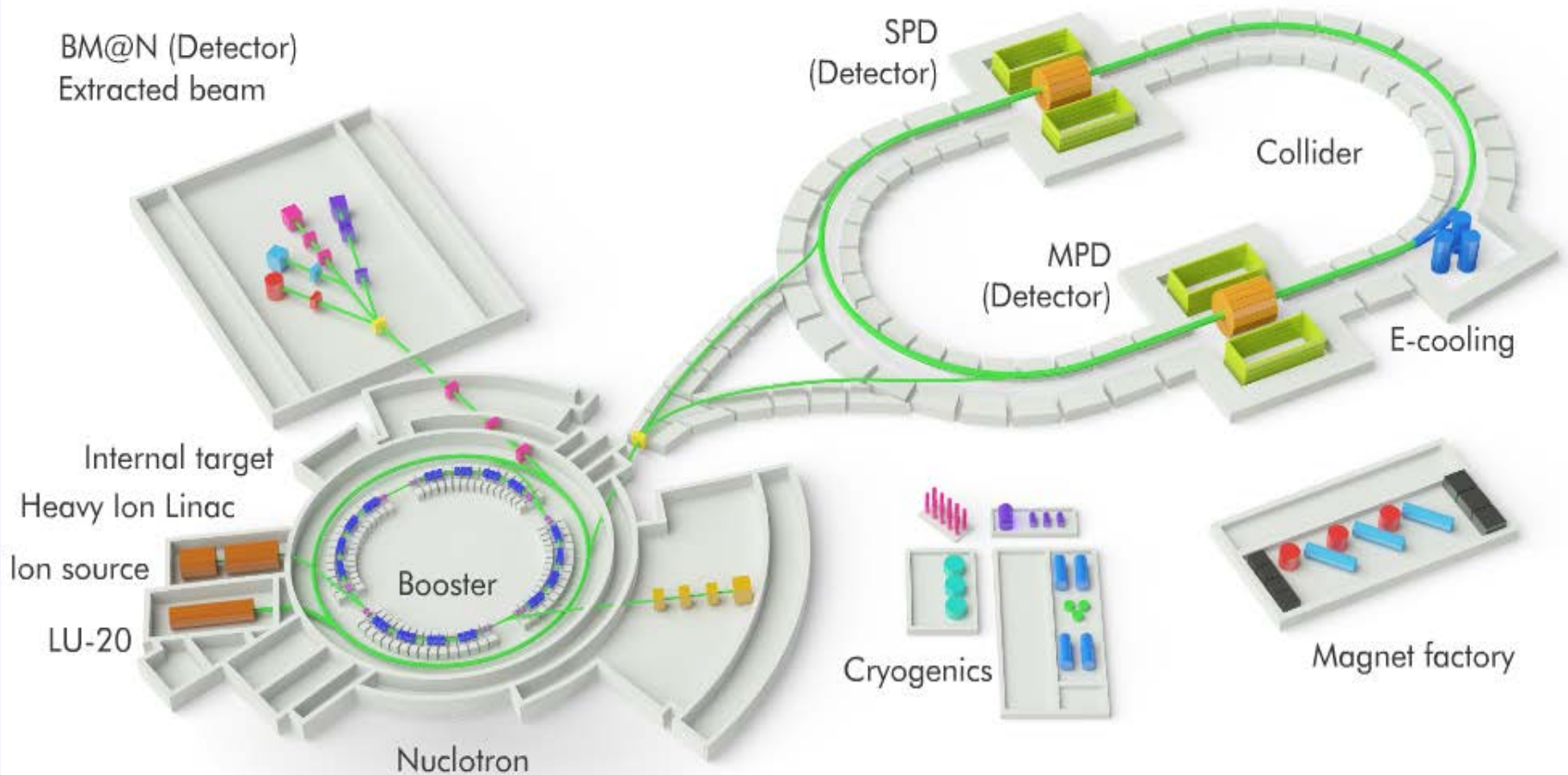


Software development for the NICA experiments MpdRoot & BmnRoot

K. Gertsenberger, O. Rogachevsky
VBLHEP, JINR

on behalf of the MPD&BM@N collaboration

Nuclotron based Ion Collider facility



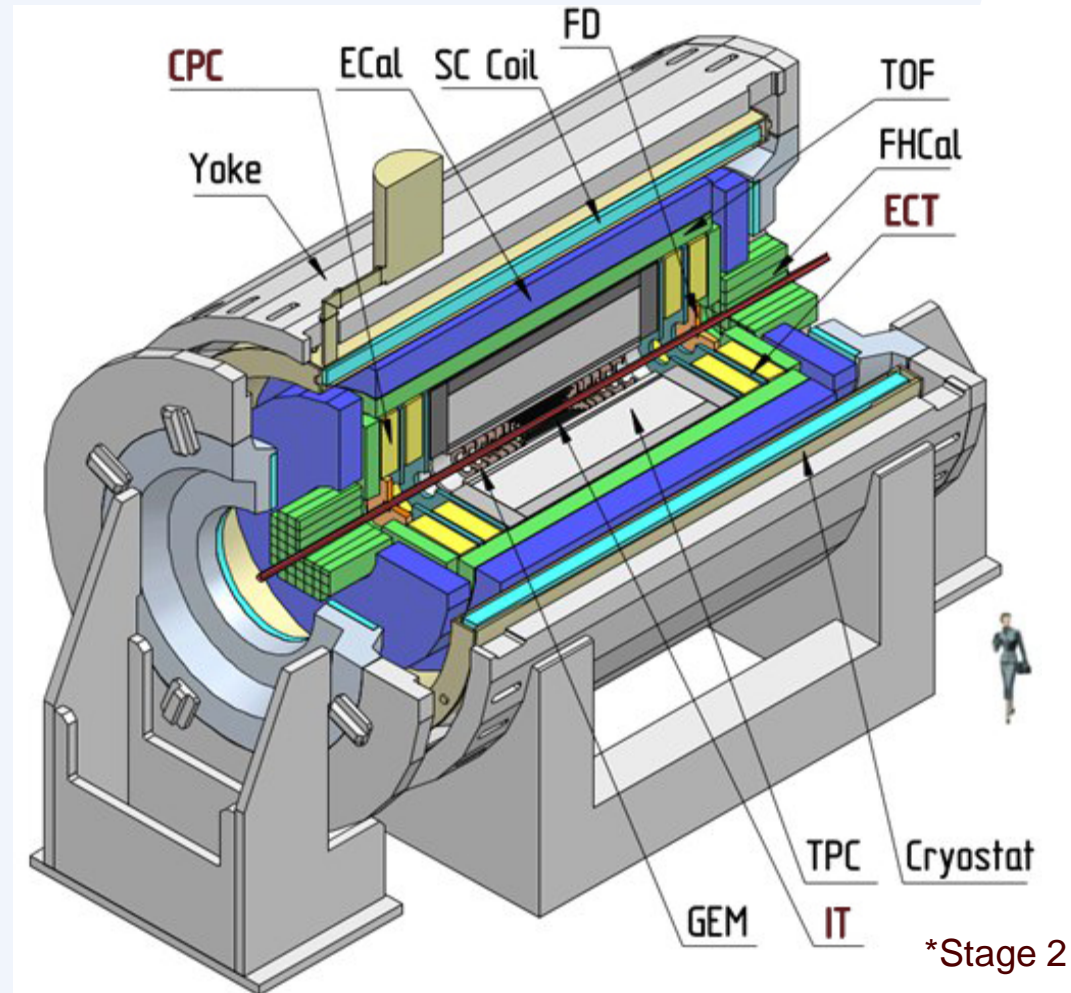
- Beams: from p to Au^{79+}
- Luminosity: 10^{27} (Au), 10^{32} (p) $cm^{-2}s^{-1}$
- Collision energy: $\sqrt{s_{NN}} = 4 - 11$ GeV $E_{lab} = 1 - 6$ AGeV

- Fixed target experiment: BM@N (2017)
- 2 interaction points: MPD (2020) & SPD

MultiPurpose Detector and MpdRoot

The software **MpdRoot** is developed for the MPD event simulation, reconstruction of experimental or simulated data and following physical analysis of heavy ion collisions registered by the MultiPurpose Detector at the NICA collider.

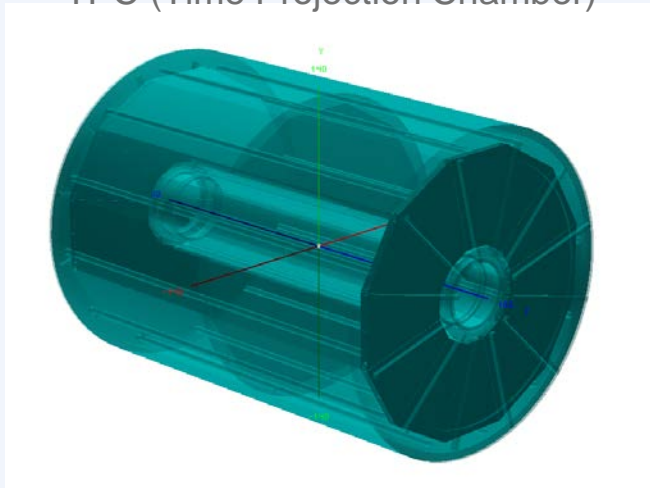
(based on ROOT and FairRoot)



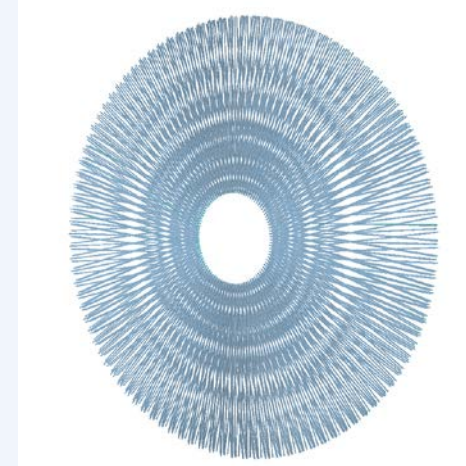
The MpdRoot software is available in the GitLab <https://git.jinr.ru/nica/mpdroot>

Geometry of MPD subdetectors: TPC

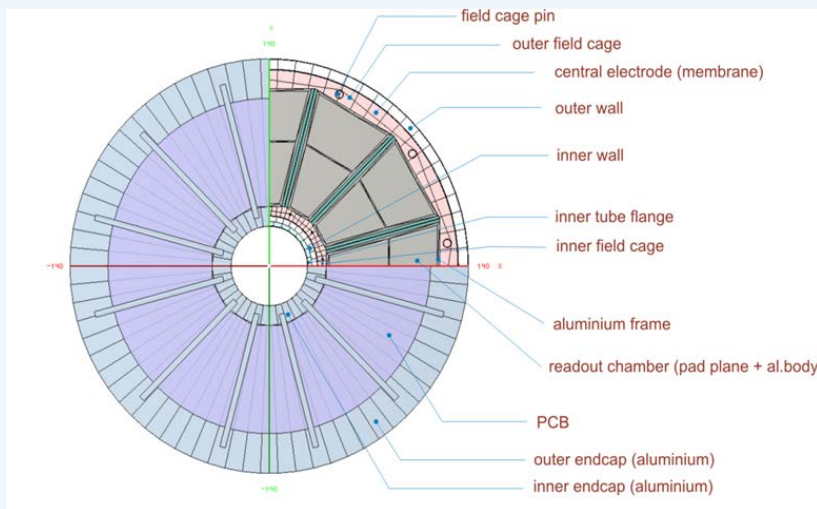
TPC (Time Projection Chamber)



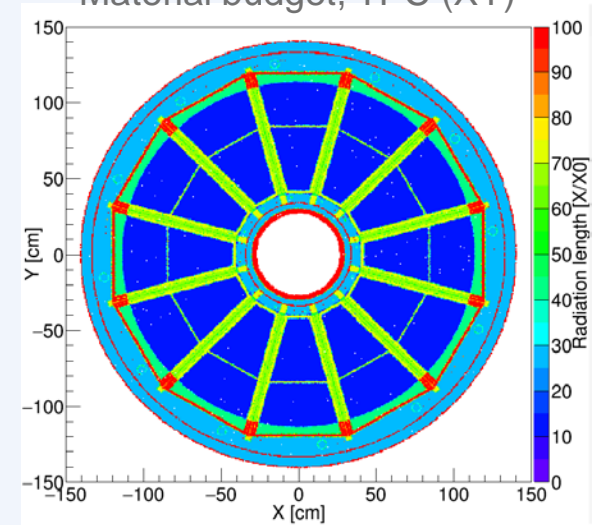
Straw Tube Tracker structure



TPC XY slice

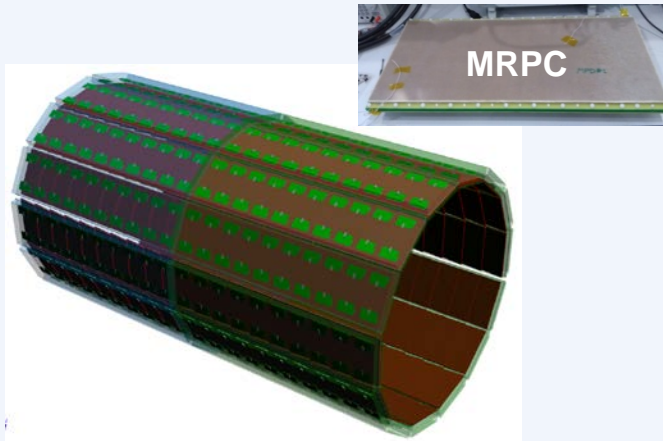


Material budget, TPC (XY)



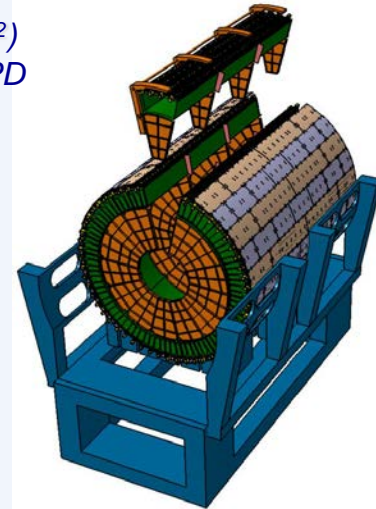
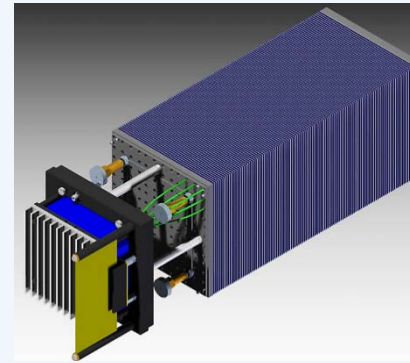
MPD: TOF, EMC, FHCAL geometry

TOF (Time-of-Flight) Detector

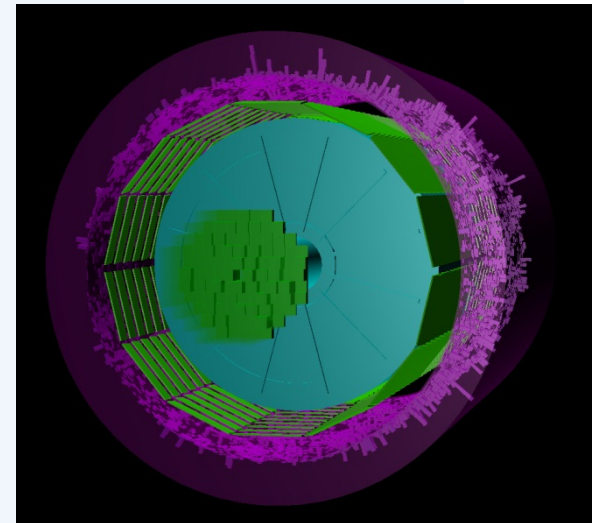
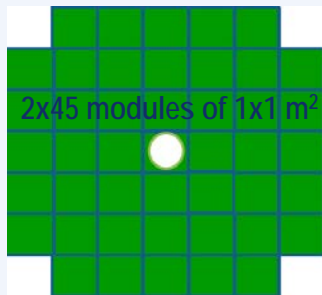


ECAL (Electromagnetic Calorimeter)

*L ~35 cm, Pb+Scint. (4x4 cm²)
read-out: WLS fibers + MAPD
Energy resolution : 2.5% \sqrt{E}*



FHCAL (Forward Hadron Calorimeter)



MpdRoot (&BmnRoot) framework

- Both use **FairSoft** external packages:

ROOT, XRootD, Pythia, PLUTO, HepMC, MillePede, Geant3/4, VGM, gtest, GSL, boost...

- There is a common class part inherited from **FairRoot** (GSI)

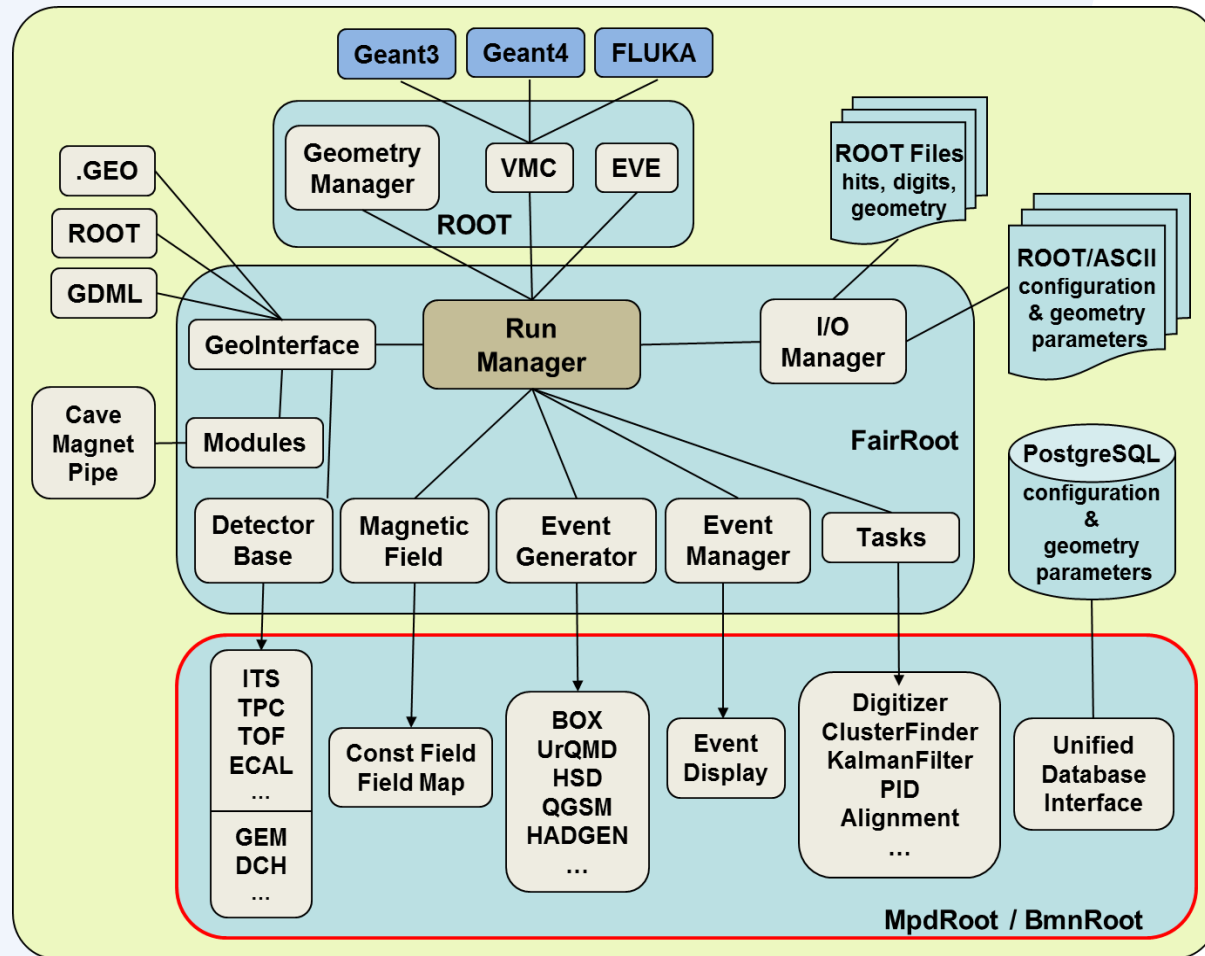
- Experiment-specific parts** are developed for each detector independently

- Advanced **detector response** functions, **realistic tracking** and **PID** were included

- Extended set of **event generators** for collisions:

PLUTO, UrQMD, Hybrid UrQMD, vHLLE + UrQMD, QGSM/LAQGSM, HSD/pHSD, HADGEN (on fly), 3 Fluid Dynamics
simple for tests - BOX, ION, PART

MPD and BM@N homepage: <http://mpd.jinr.ru>



MpdRoot. Event reconstruction

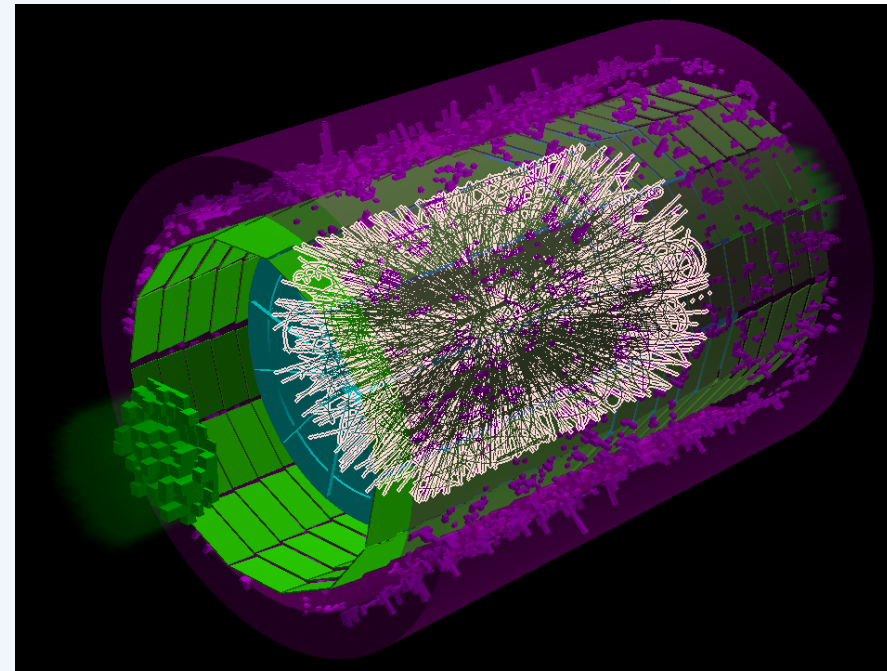
1. Hits reconstruction in subdetectors.

2. Tracks reconstruction.

- Searching for track-candidates to pass to the Kalman Filter in TPC
- Track propagation in the TPC using the Kalman Filter
- Matching of TOF-hits with the TPC tracks

3. Vertex finding.

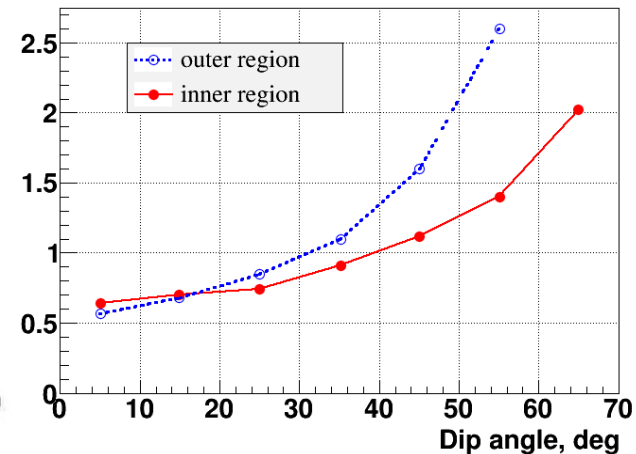
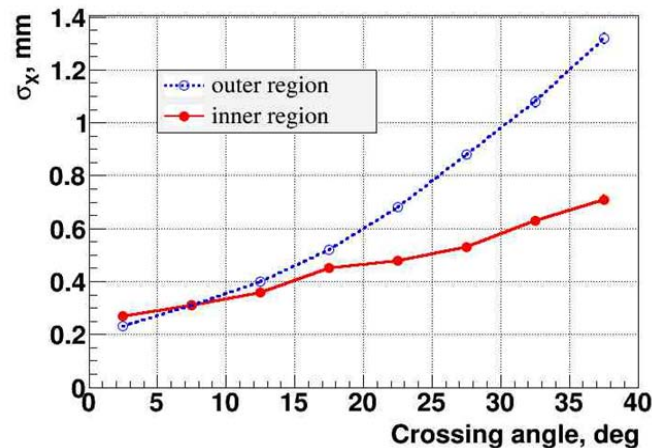
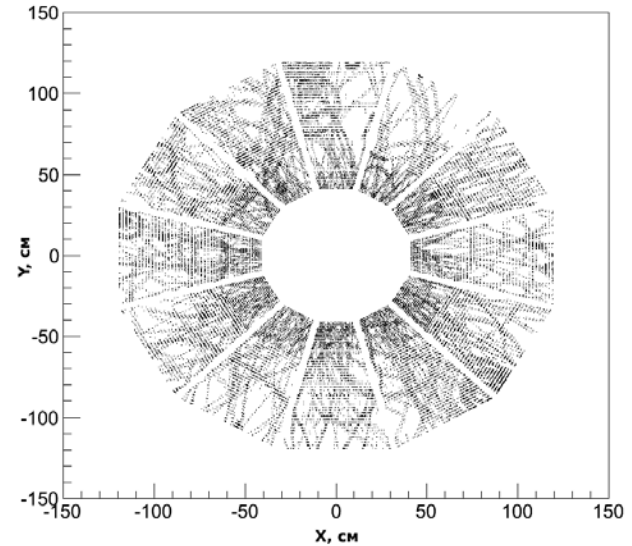
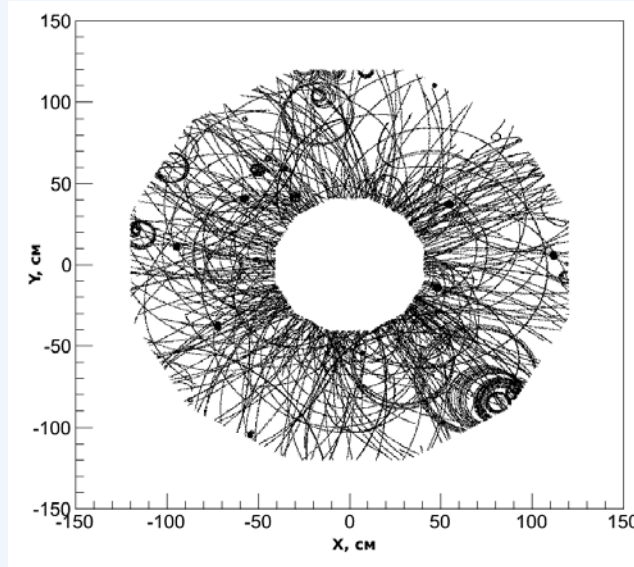
4. Particle identification.



MpdRoot. Clustering in TPC

The hit reconstruction algorithm contains the following main steps:

- 1) Searching for extended clusters in (Pad-Time) for each pad row.
- 2) Searching for peaks in time-profile for each pad in the found extended cluster.
- 3) Combining the neighboring peaks into resulting hits.



MpdRoot. Event reconstruction

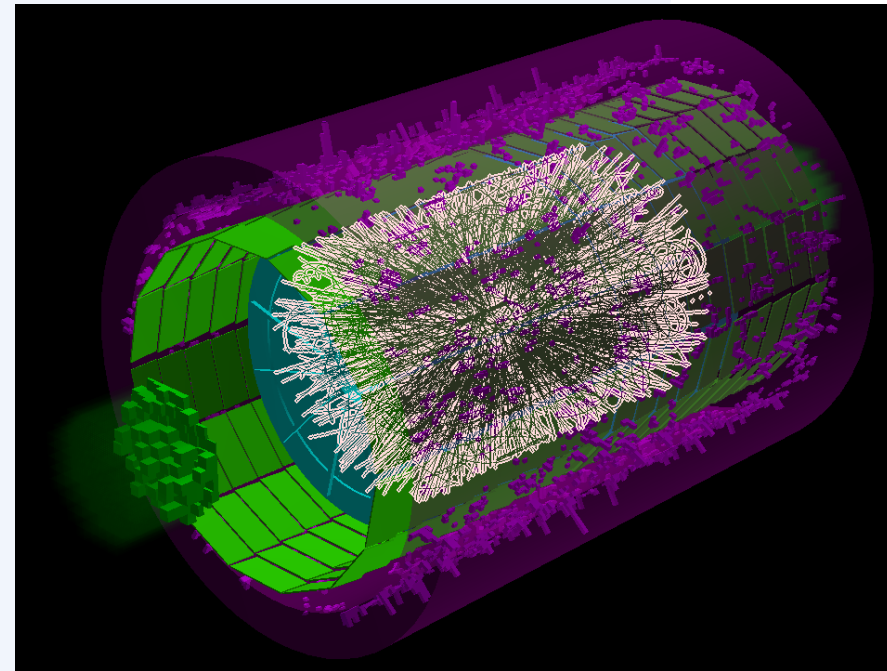
1. Hits reconstruction in subdetectors.

2. Tracks reconstruction.

- Searching for track-candidates to pass to the Kalman Filter in TPC
- Track propagation in the TPC using the Kalman Filter
- Matching of TOF-hits with the TPC tracks

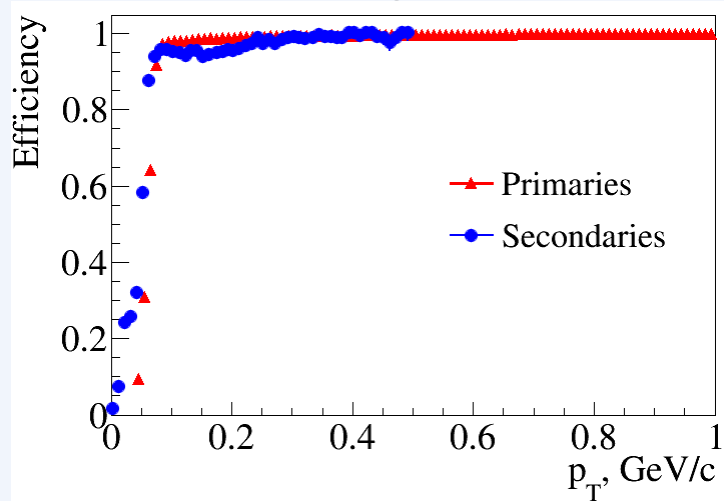
3. Vertex finding.

4. Particle identification.

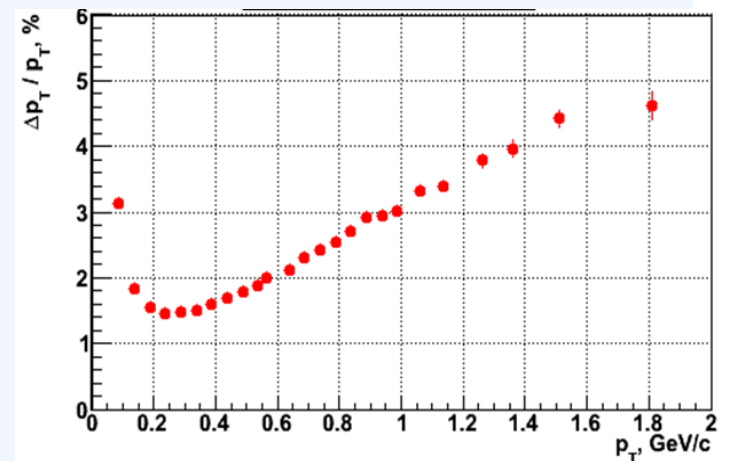


MpdRoot. Tracking

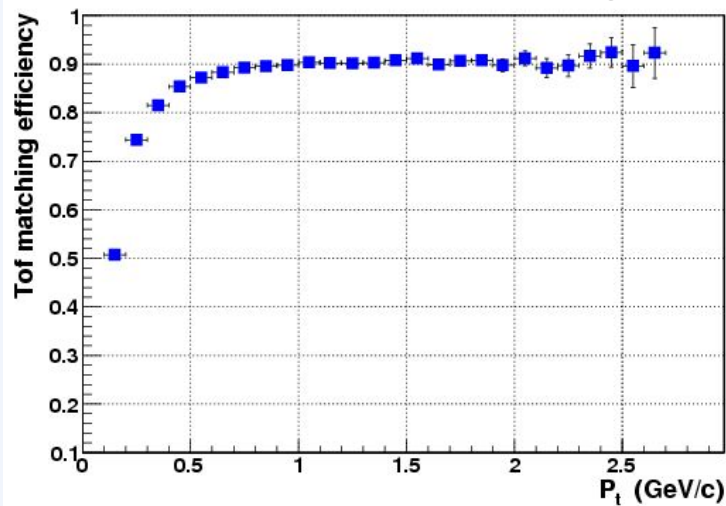
TPC tracking efficiency



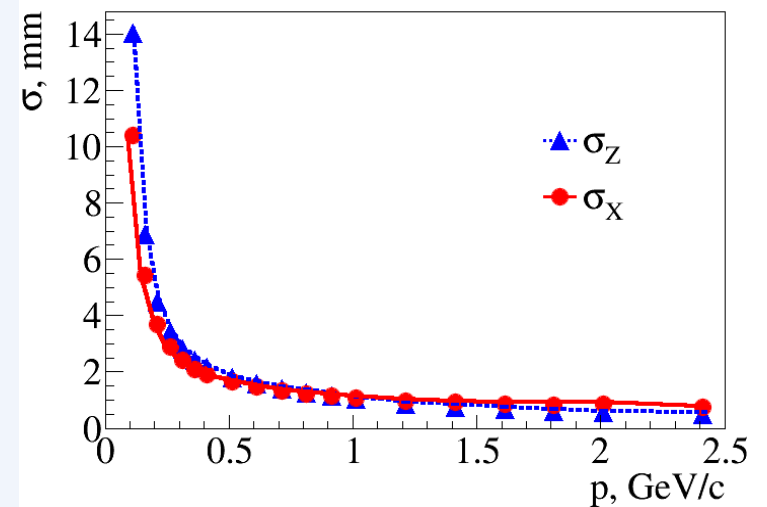
Momentum resolution



Efficiency of TOF matching



Primary vertex resolution



MpdRoot. Event reconstruction

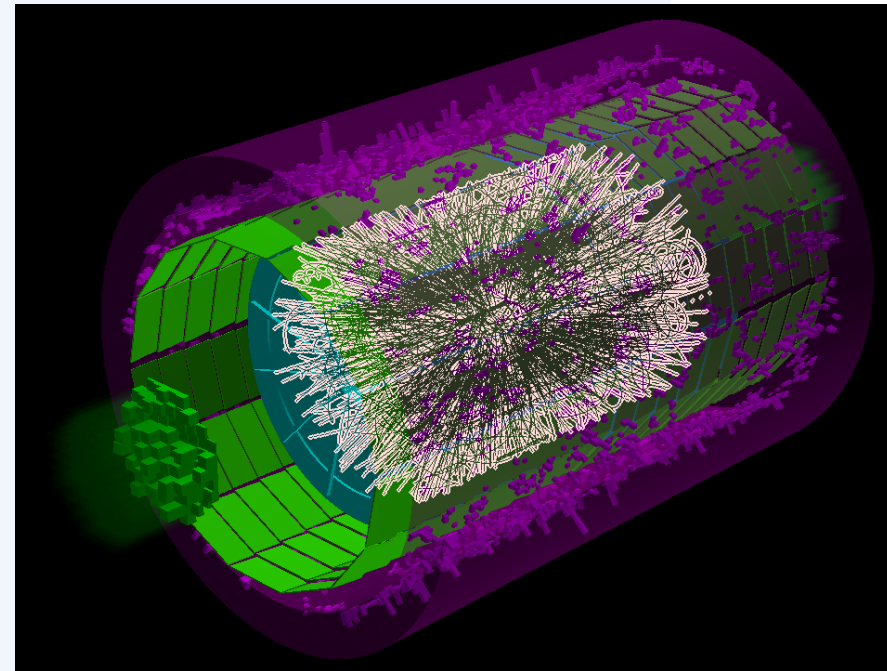
1. Hits reconstruction in subdetectors.

2. Tracks reconstruction.

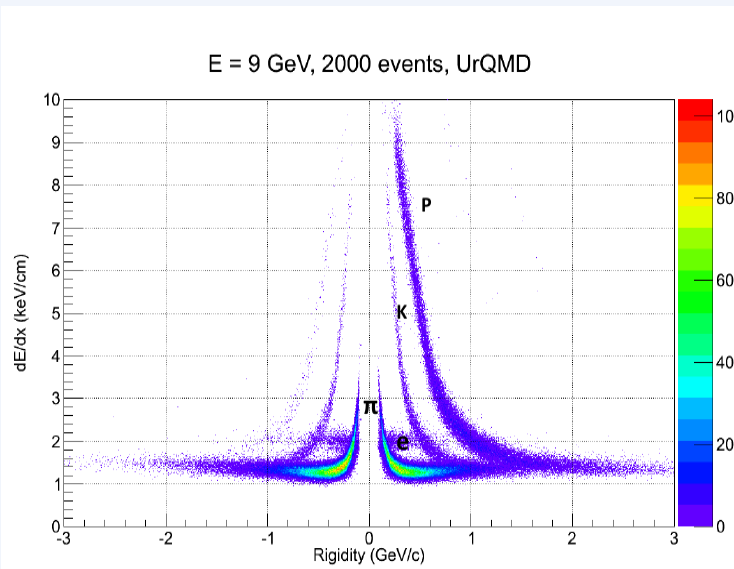
- Searching for track-candidates to pass to the Kalman Filter in TPC
- Track propagation in the TPC using the Kalman Filter
- Matching of TOF-hits with the TPC tracks

3. Vertex finding.

4. Particle identification.



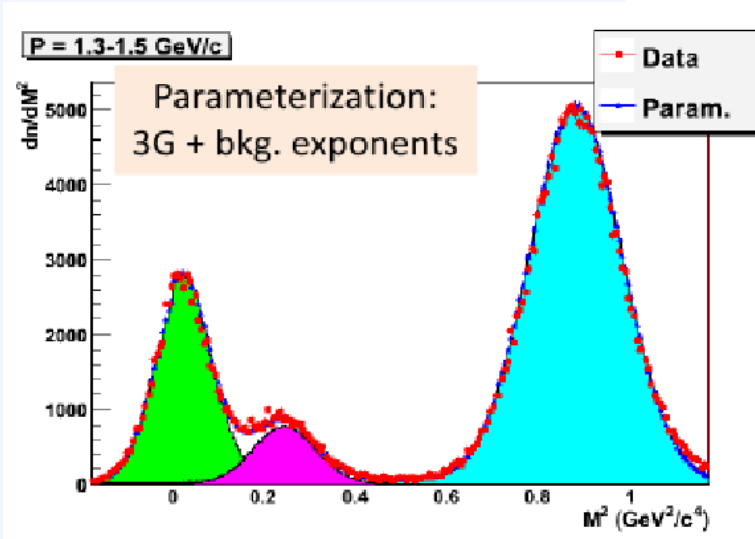
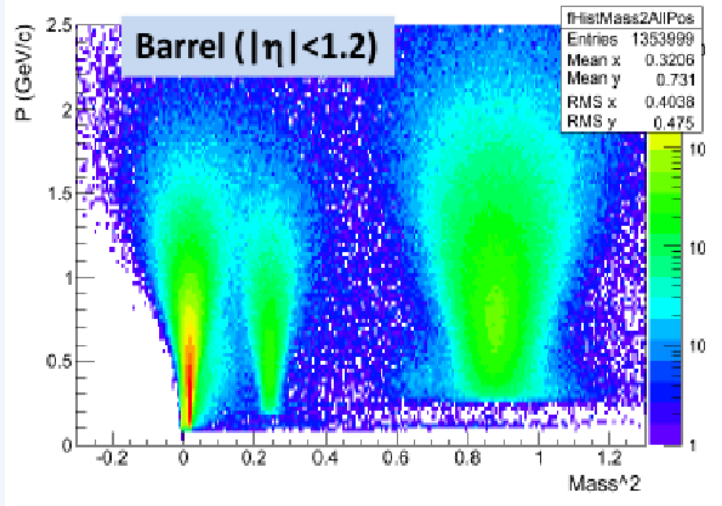
MpdRoot. Particle identification



TPC
 PID: Ionization loss (dE/dx)
 BBF + Aleph parametrization
 Separation:
 $e/h - 1.3..3 \text{ GeV}/c$
 $\pi/K - 0.1..0.6 \text{ GeV}/c$
 $K/p - 0.1..1.2 \text{ GeV}/c$

MPD PID (TOF):

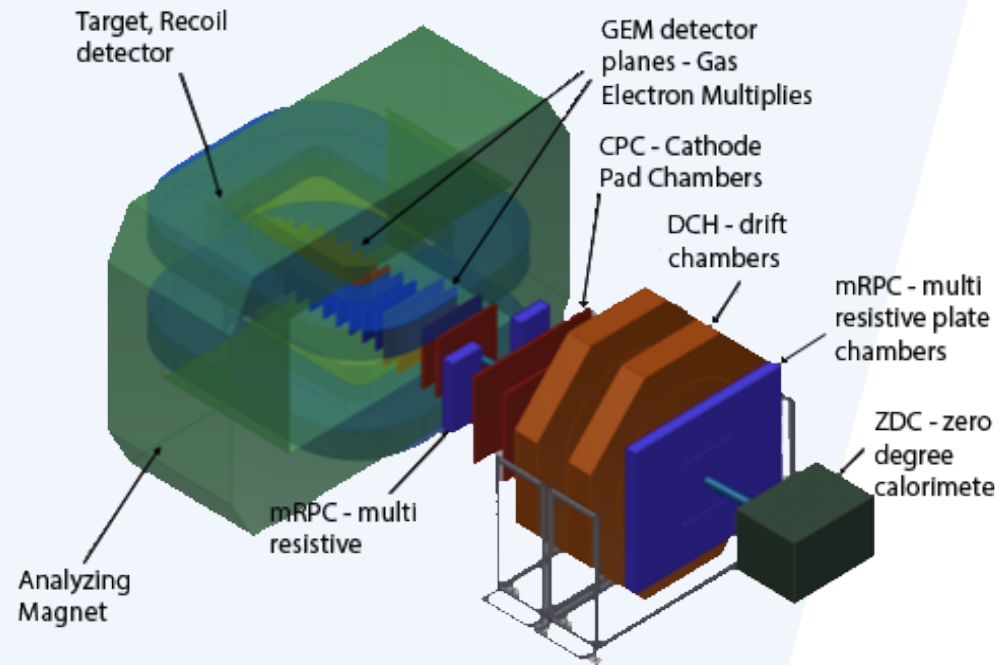
- π/K separation up to $p=1.7 \text{ GeV}/c$, above $2 \text{ GeV}/c$ - extrapolating the fitted 3G parameters
- Protons up to $3 \text{ GeV}/c$
- dE/dx provide extra PID capability for electrons and low momentum hadrons



BM@N and BmnRoot software

The software **BmnRoot** is developed for the BM@N event simulation, reconstruction of experimental or simulated data and following physical analysis of collisions of elementary particles and ions with a fixed target at the NICA collider.

(based on ROOT and FairRoot)

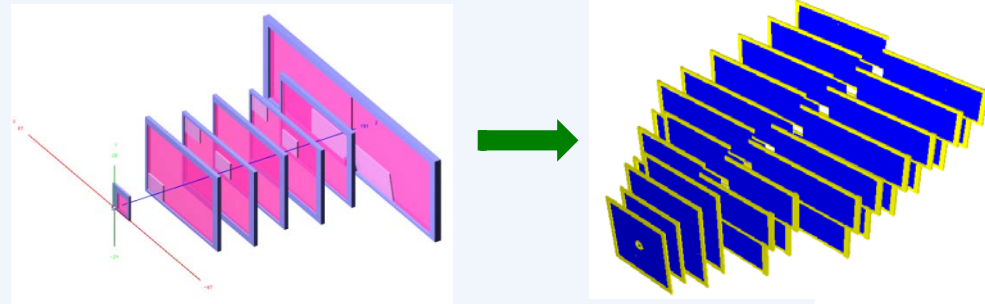


- deuteron and C^{12} beams with $T = 3 - 4$ AGeV, targets: carbon, copper or none
- Trace beams, measure beam profile and time structure
- Test detector response ToF-400, ToF-700, T0+Trigger, DCH-1, DCH-2 and ZDC, ECAL modules, beam monitors (4 run: + GEM & Si)
- Test integrated DAQ and trigger system

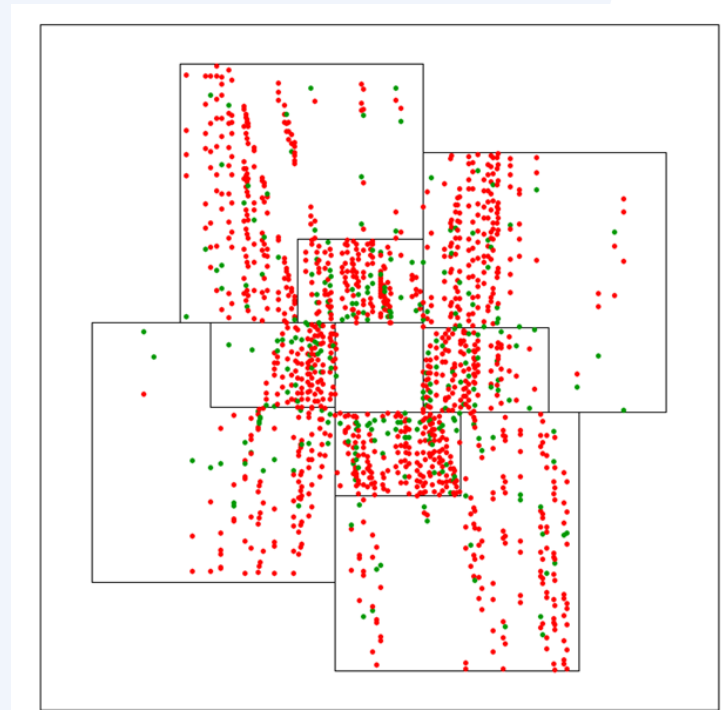
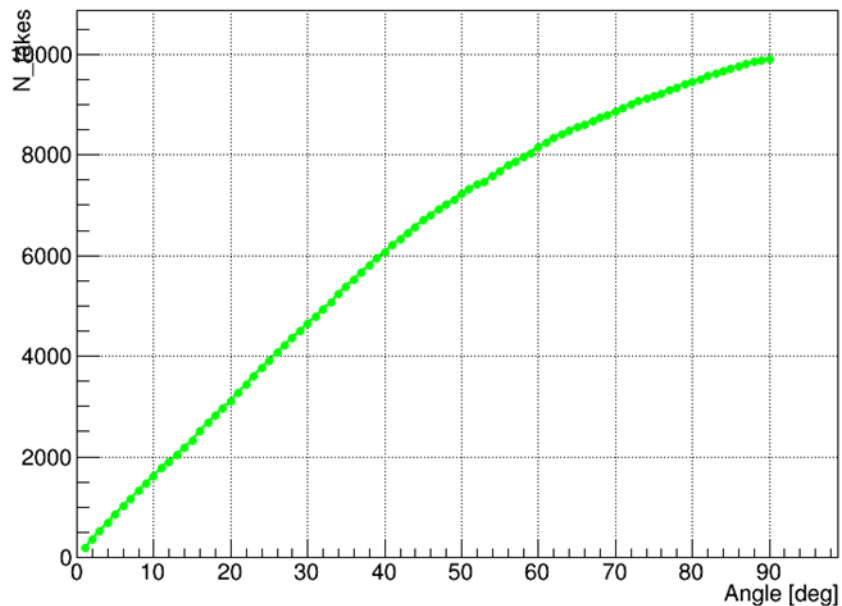
The BmnRoot software is available in the GitLab <https://git.jinr.ru/nica/bmnroot>

BmnRoot. Clustering in GEM

- There are realistic hit finder in GEMs
- For the GEM stations procedure of the fake hits production is implemented



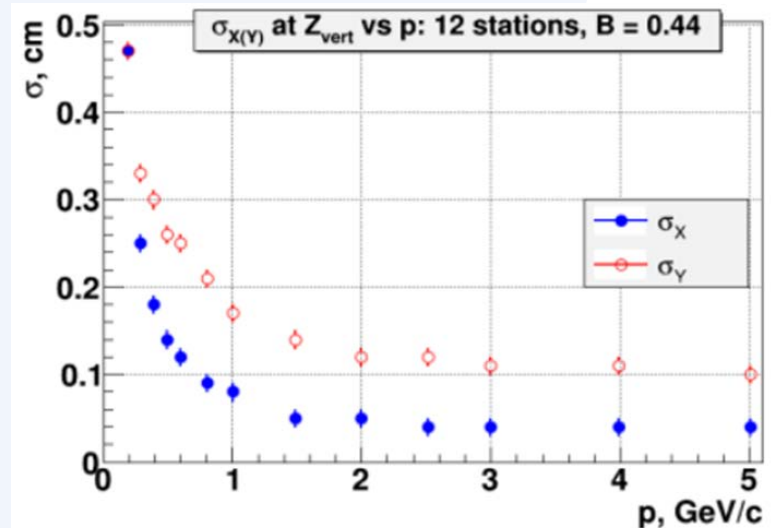
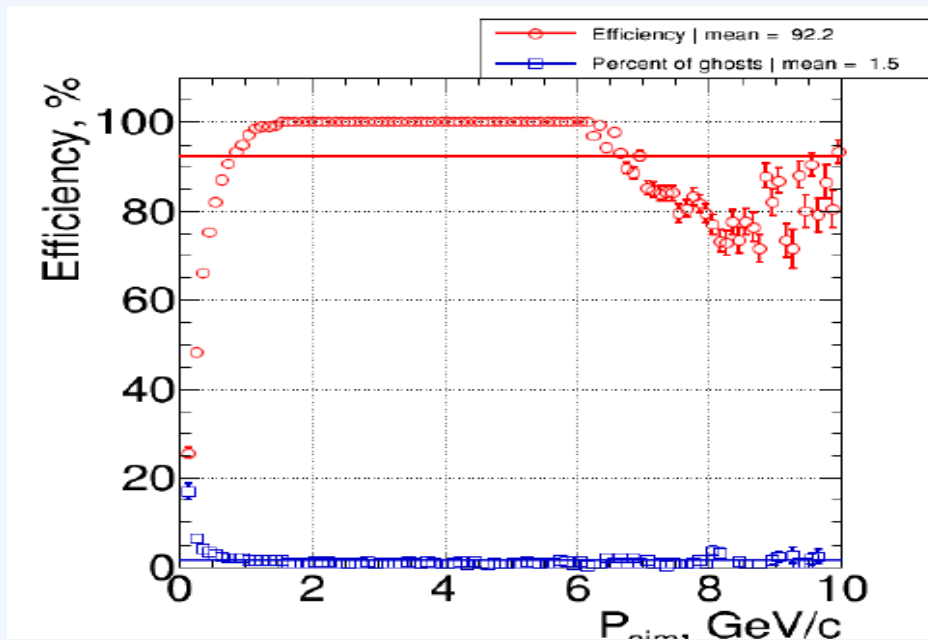
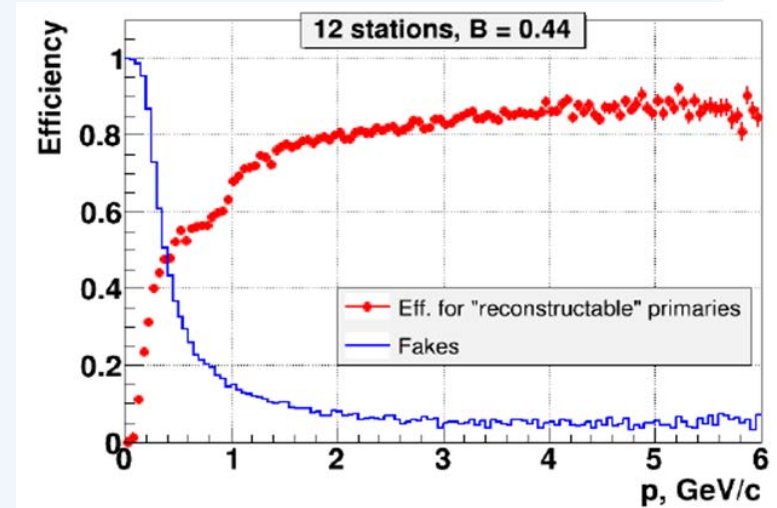
Number of fakes (pitch = 0.08 cm)



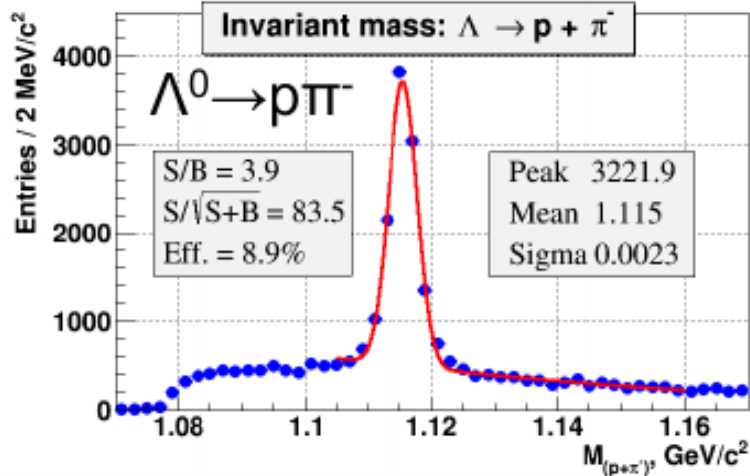
BmnRoot. Tracking in GEM

In the BmnRoot there are two independent branches of tracking in GEMs:

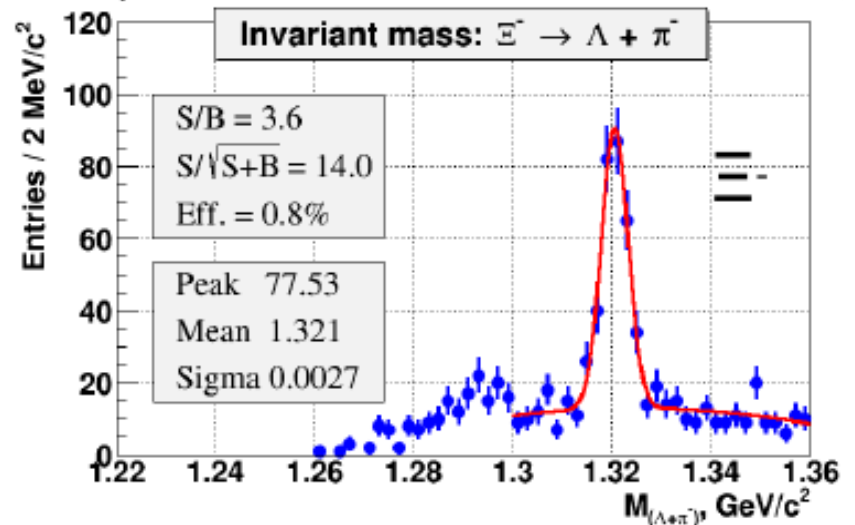
- 1) The first tracking is based on the L1-tracking (CBM). Track-candidates are searched by the cellular automaton.
- 2) The second tracking is based on the LIT-tracking. Track-candidates are searched by the specific coordinate transformation developed in our group.



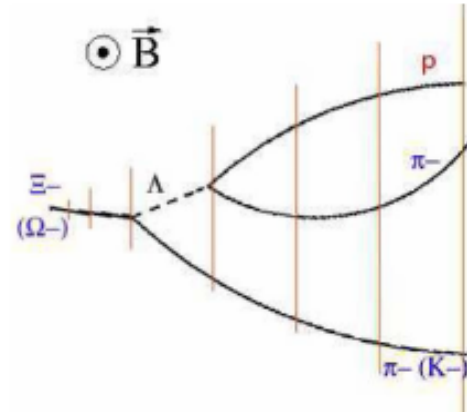
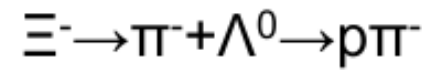
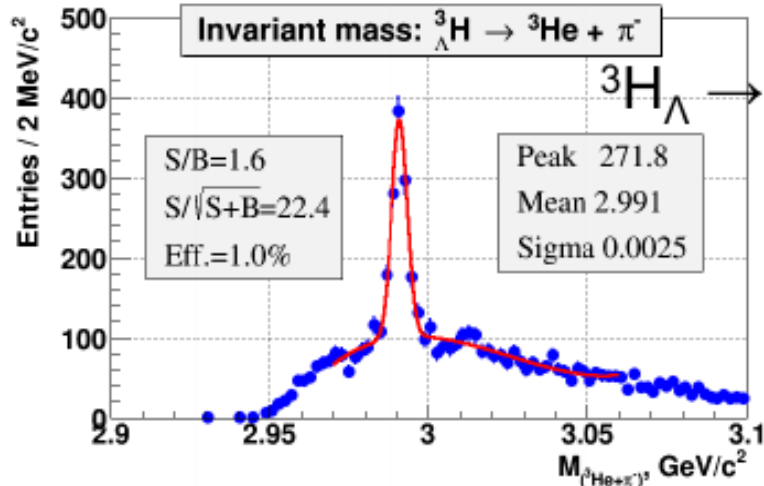
BmnRoot. Physics at BM@N



Au+Au, 4.5 AGeV, UrQMD, 900k central



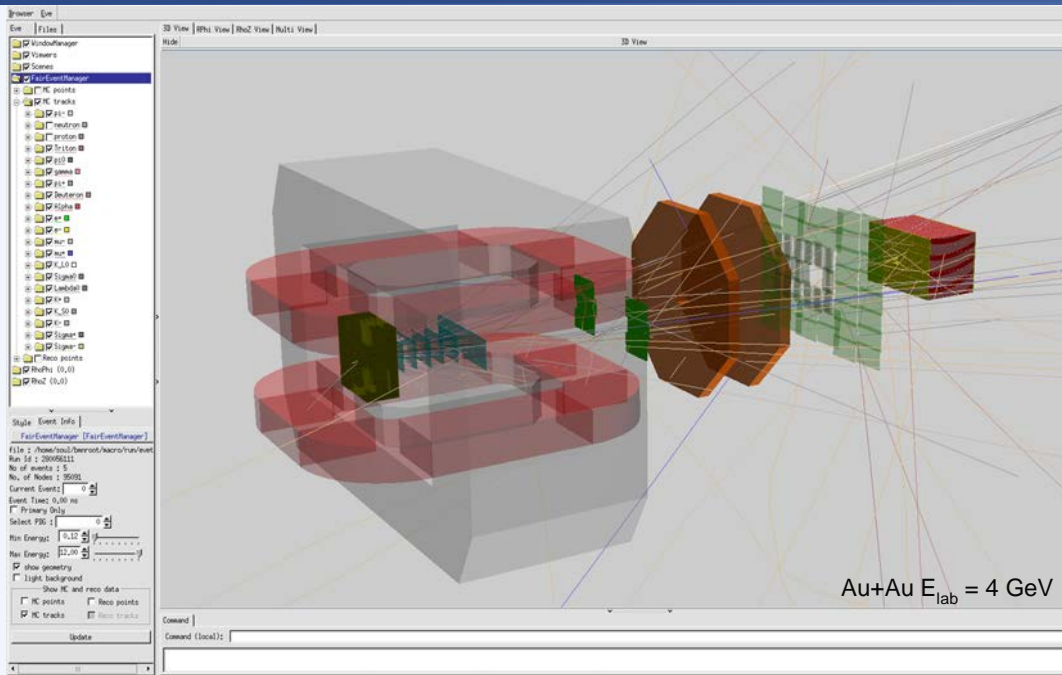
Au+Au, 4.5 AGeV, 2M central events



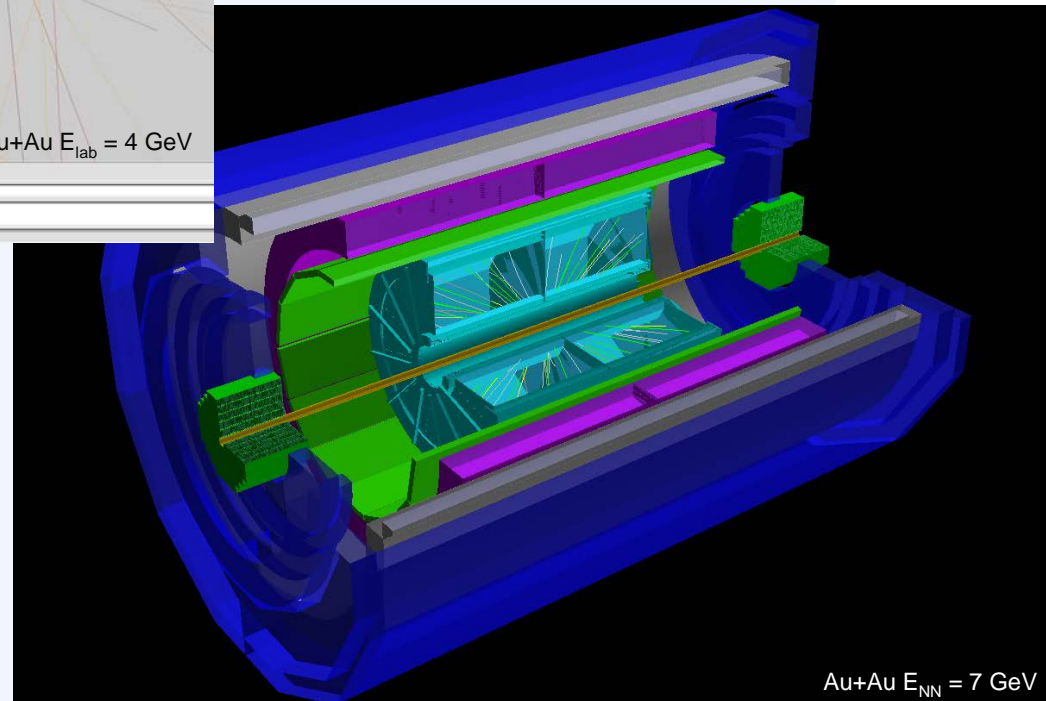
Event Display for the NICA experiments

based on EVE package

Event Display for **reconstructed** data:
hits and tracks

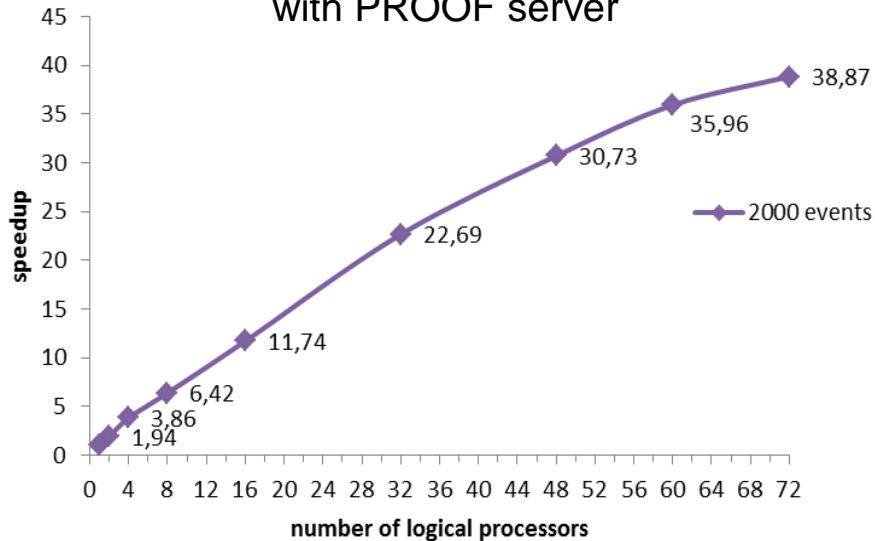


Event Display for **simulated** data:
MC points and tracks



Parallel event processing in MpdRoot&BmnRoot

MPD event reconstruction
with PROOF server



PROOF (Parallel **ROOT** Facility) is a part of the ROOT software

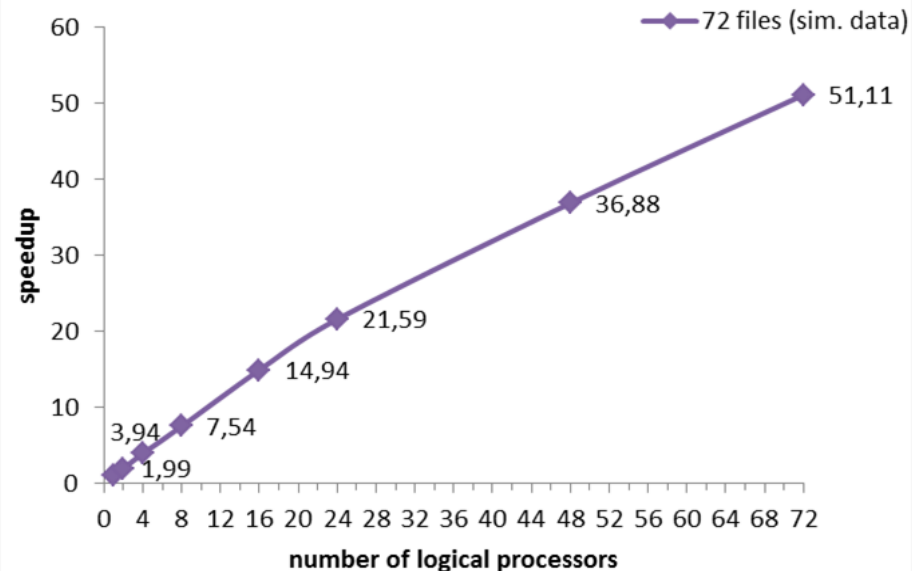
Parallel NICA event data processing in ROOT macros on the parallel architectures: user multicore machines, heterogeneous distributed clusters and GRID system

Scheduling system (**MPD-Scheduler**) for task distribution to parallelize NICA data processing on the multicore machines and cluster nodes

Supports Sun Grid Engine and Torque system

Jobs are described and passed as XML file

Event reconstruction with MPD-Scheduler



Summary

- The software frameworks for the NICA experiments provide to the user all necessary tools to simulate any kind of detectors and study its properties.
- The user can describe geometry of the detector in details and visualize the geometry and detector response for the considered particles.
- Users are able to make the proposed physics analysis by the available Monte Carlo generators for the NICA project to study its feasibilities with these experiments.
- Some systems weren't shown because of time limit: monitoring system, system of nightly tests (QA), official Web-site, MPD Dataflow, raw data conversion, online histogramming...
- The big work has been done, but a lot of packages should be added for the experimental data taking and their reconstruction with distributed systems:
online clustering and fast tracking, online alignment and calibrations, physics analyses methods, distributed and cloud computing for the NICA experiments, virtual organization NICA for GRID...

Software development for the NICA experiments

More information: nica.jinr.ru
mpd.jinr.ru

email: gertsen@jinr.ru

Thank you for your attention!
Vielen Dank für Ihre Aufmerksamkeit!

We are open for cooperation!



Official Web-site: <http://mpd.jinr.ru>

MPDROOT

SIMULATION AND ANALYSIS FRAMEWORKS FOR MPD AND BM@N AT NICA

GENERAL

DOCUMENTS

COMPUTING

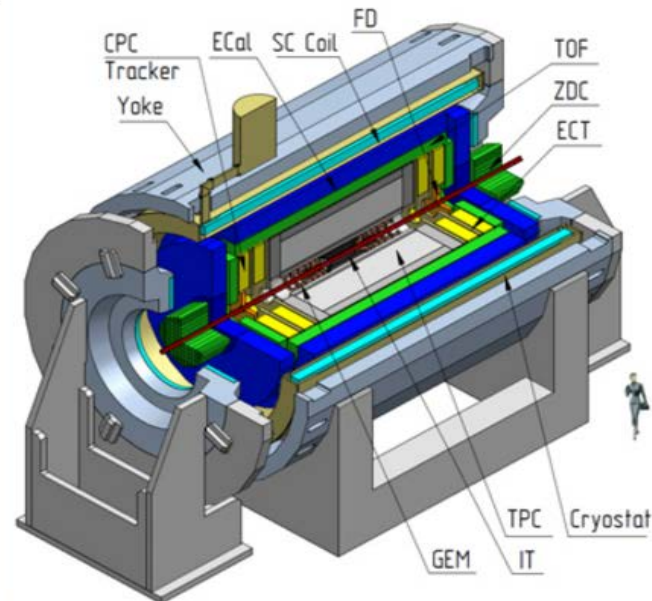
REFERENCES

FORUM

BM@N SHIFTS

Multi Purpose Detector (MPD)

The MPD apparatus has been designed as a 4π spectrometer capable of detecting of charged hadrons, electrons and photons in heavy-ion collisions at high luminosity [...]



SOFTWARE

-- BmnRoot
-- MpdRoot
-- FairSoft
-- ROOT

TAGS

BATCH BMNROOT GEOMETRY
GIT GITLAB INTERACTIVE
LIT FARM LXMPD-UI
MPDROOT PROOF ROOT
SCHEDULER SGE SIMULATION

META

Log in
Entries [RSS](#)
Comments [RSS](#)
WordPress.org

CONTACTS

Feedback
Forum