Status of the BM@N simulation and data reconstruction

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on behalf of BERDS Group

Simulation

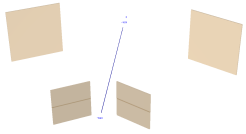
Event Generators

Active stage of new event generator developing is being:

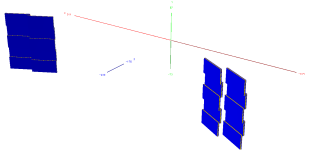
1. DCM-SMM generator are developed and classes to read input files are implemented in BmnRoot (see slides of `G.Musulmandekov` and `V.Lenivenko`)
   - Where to find? `/eos/nica/bmn/sim/gen`
   - Next interactions presented now:
     C+C, C+p, C+Al, C+Ar, C+Kr
     Ar+C, Ar+Al, Ar+Ar, Ar+Kr
     Kr+C, Kr+Al, Kr+Ar, Kr+Kr, Kr+Pb
2. Specific SRC event generator is developed by SRC team. Implementation of the generator into BmnRoot is done by `S.Nepochatykh`

Update in detector geometry

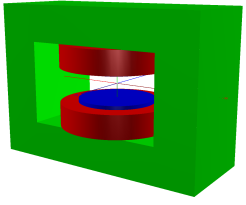
First version of geometry for arm triggers (X1, X2, Y1, Y2) added (A.Driuk, SPbSU)



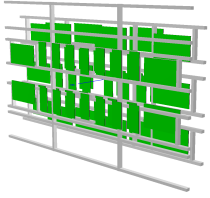
Geometry for TOF-400 updated for SRC setup (M.Rumyantsev)



First version of geometry for magnet SP57 added (M.Patsyuk)

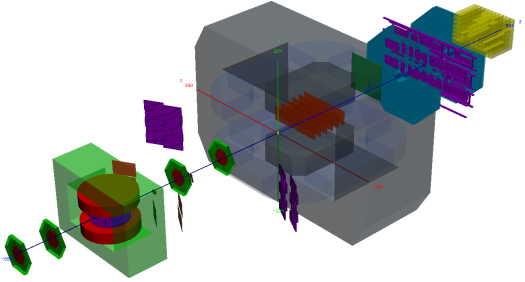


Geometry for TOF-700 updated (Yu.Petukhov)

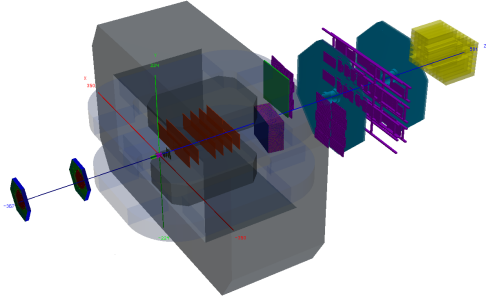


Current geometry

SRC



BM@N



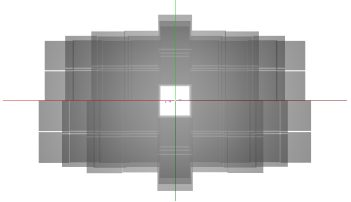
Update in MC points production and digitization

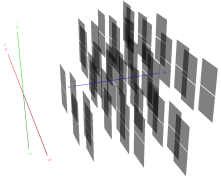
- Realistic simulation and detector response added for DCH (taking into account wires placement inside chambers) (D.Baranov and N.Voytishin)
- Investigation of more realistic simulation for CSC detector is in progress (see talk of V.Plotnikov)

Preparation to the future setup

- Geometry for future setup of the inner tracking system is developed
- Classes for MC points production, digitization and hit finder are added

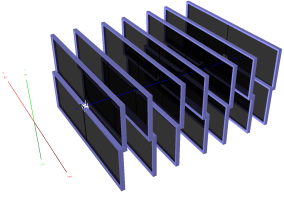
Silicon





(see slides of D.Baranov)

GEM



Reconstruction

Updates in event reconstruction

- Algorithm fof track reconstruction in DCH was improved and extended on MC data with good agreement (see slides of N.Voytishin)
- Initial version of track reconstruction algorithm in upstream region of SRC setup was developed and implemented into BmnRoot by V.Lenivenko
- Algorithm of total incoming and outgoing event charge extraction for SRC setup was developed and implemented into BmnRoot by G.Johansson and T.Atovullaev
- Algorithm of primary vertex reconstruction by arm and upstream tracks of SRC setup was developed (see slides of J.Kahlbow)
- Algorithm of primary vertex reconstruction for BM@N setup was updated. Iterative procedure was added to exclude faraway tracks

Updates in event reconstruction

- Update of momentum by magnetic field integral added for SRC setup:

$$\frac{p}{q} = \frac{0.3 \cdot \int B dl}{\alpha_{out} - \alpha_{in}}$$

  where values of α_{out} and α_{in} depend on global track constituents

- Progressive methods for data analysis have begun to be used:
  - Multi-Dimensional Fit was implemented for momentum estimation of fragments in SRC setup (see slides of `V.Panin`)
  - Work on the application of Neural Networks for the time-of-flight PID is in the development stage (`V.Roudnev, SPbSU`)
  - Implementation of Boosted Decision Trees for Λ^0 reconstruction are in progress (`A.Gorkiy, SPbSU`)
- New algorithm for track finding inside the magnet is developed and implemented in BmnRoot

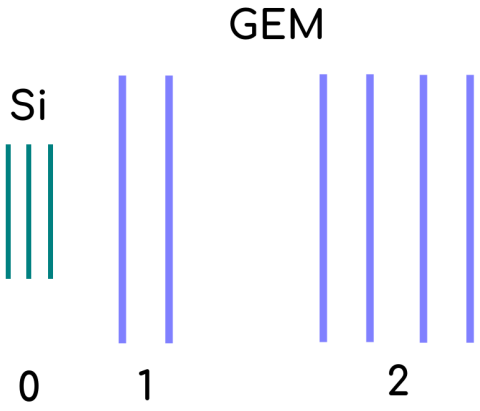
Embedding

Main goal of embedding:
to optimize tracking procedure for Λ^0 reconstruction

Two different approaches used:

- "Quick and dirty" way: digit level embedding
  - initiated new tracking developing
  - was simple to implement in BmnRoot
  - see slides of `I.Gabdrakhmanov`
- "Proper" way: raw data level embedding
  - helped to find "invisible" bugs in mapping
  - is being in progress now
  - see slides of `P.Batyuk`

Motivation for new algorithm



Problems with old tracking:

- Low efficiency for low momentum region
- Noisy silicon planes
- Non-working third GEM station
- Difference between GEM hits and Si hits
- No skip in stations is possible

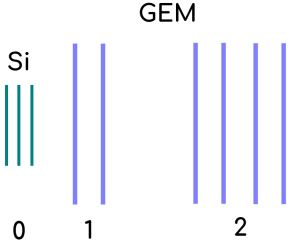
Algorithm description. High momentum tracks

STEP 1

- Construct 4-hit candidates and estimate their parameters in zone 2
- Propagate each candidate to planes in zone 1 and zone 0 by KF with nearest hit connecting and parameter updating
- Select final tracks by N_{hits} and χ^2
- Mark hits of final tracks as USED

STEP 2

- Construct 3-hit candidates and estimate their parameters in zone 2 for UNUSED hits
- Propagate each candidate to planes in zone 1 and zone 0 by KF with nearest hit connecting and parameter updating
- Select final tracks by N_{hits} and χ^2
- Mark hits of final tracks as USED



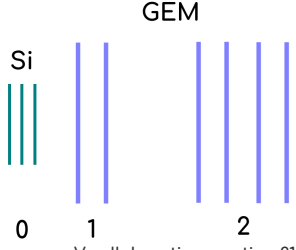
Algorithm description. Low momentum tracks

STEP 3

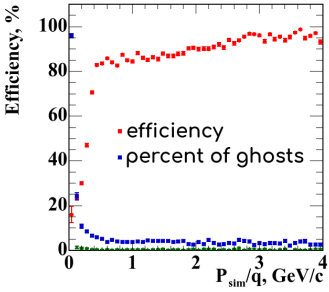
- Construct 2-hit candidates in zone 1 for UNUSED hits
- Propagate each candidate to hits in zone 2 by straight line in ZY plane
- Connect nearest hit in Y-gate and estimate parameters of candidate
- Propagate each candidate to hits in rest planes of zone 2 by KF with nearest hit connecting and parameter updating
- Propagate each candidate to planes in zone 0 by KF with nearest hit connecting and parameter updating
- Select final tracks by N_{hits} and χ^2
- Mark hits of final tracks as USED

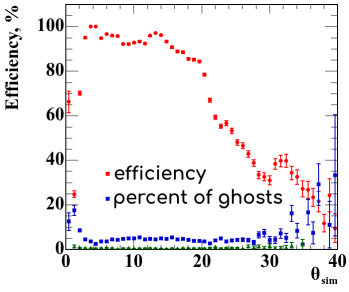
STEP 4

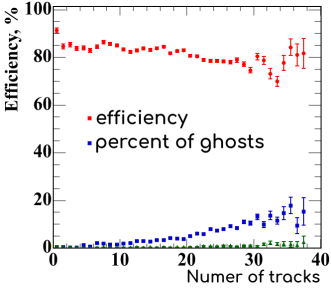
- Construct 2-hit candidates in zone 1 for UNUSED hits
- Propagate each candidate to hits in zone 0 by straight line in ZY plane
- Connect nearest hit in Y-gate and estimate parameters of candidate
- Propagate each candidate to hits in rest planes of zone 0 by KF with nearest hit connecting and parameter updating
- Propagate each candidate to planes in zone 2 by KF with nearest hit connecting and parameter updating
- Select final tracks by N_{hits} and χ^2
- Mark hits of final tracks as USED



Tracking efficiency

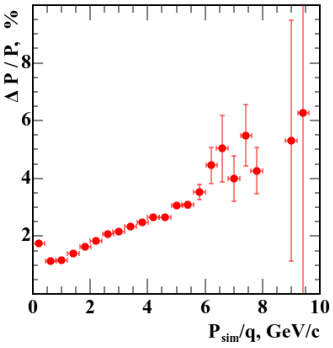


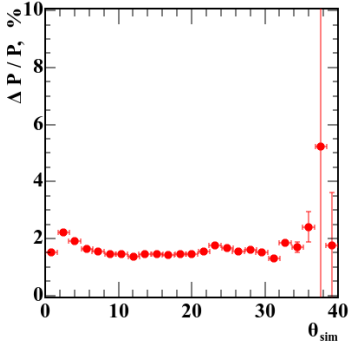


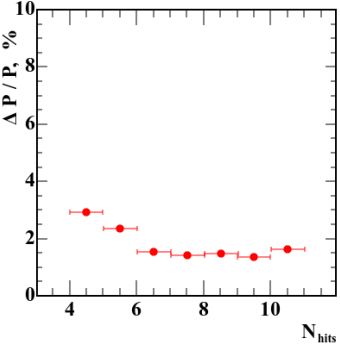


Tests on MC data

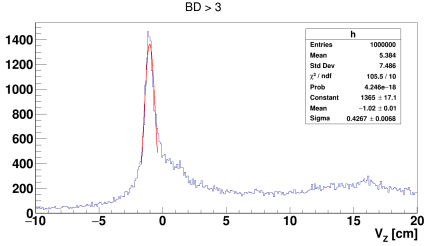
Momentum resolution

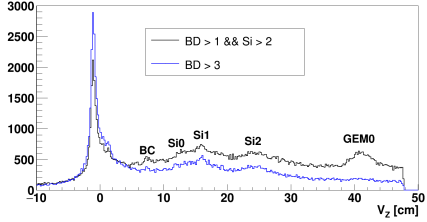


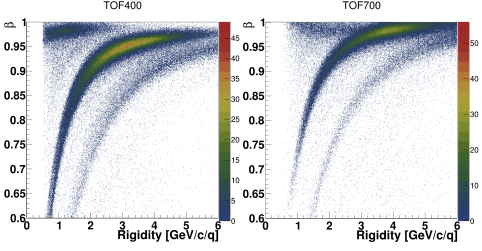




Tests on BM@N experimental data



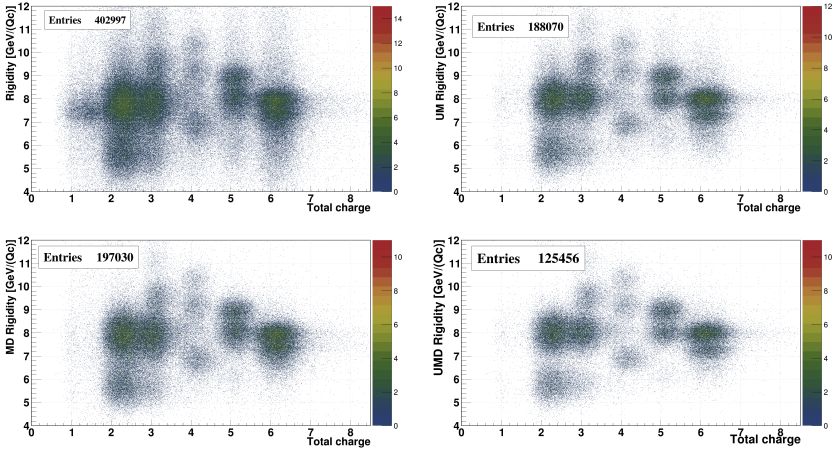




Tests on SRC experimental data

Old version of tracking
Set of runs: 3095-3426 (≈6.6 Mevents)

Trigger: IT & (X1 & Y1) || (X2 & Y2)
Set of cuts: 1 glob.track per event, $|Q^{in}_{total} - 6| < 0.4$



by A.Driuk, SPbSU

Quality assuarance system

QA for tracking

- was migrated to JSROOT framework (by `K.Mashitsin, SPbSU`)
- will be combined with Offline QA System (by `P.Batyuk`)
- will be moved to "central visualization system"

Summary

- New event generators are developed and implemented into BmnRoot
- Geometries of passive volumes appear in both BM@N and SRC setups
- Simulated data is becoming more and more similar to experimental data
- Reconstruction algorithms are continuously improved
- New modern approaches are comes to data analysis