Global tracking in the BM@N experiment

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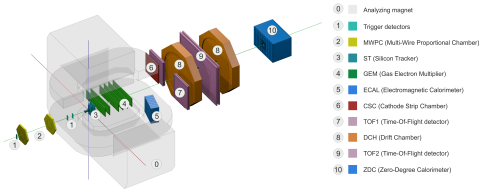
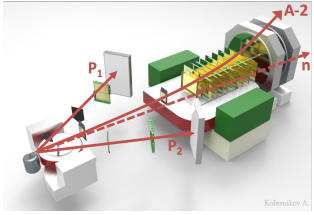
Outline

- The BM@N experiment of the NICA complex
- Global tracking stages
- How does global tracking improve reconstruction?
- Conclusion

BM@N



SRC



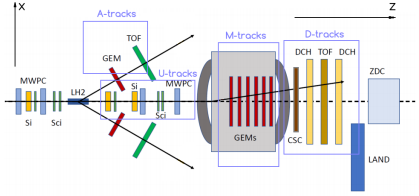
Motivation

- Each subdetector system plays an important role in data analysis
- More spatial points provide more accurate parameter estimation
- It has to be standard part of full reco-chain

Global tracking components

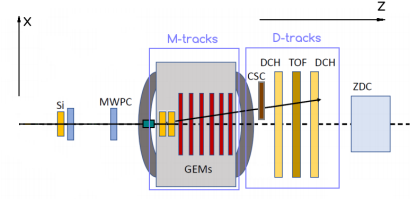
SRC setup

- Upstream detectors: 3 Silicon + 2 MWPC ⇒ U-tracks
- Detectors inside magnet: 6 GEM ⇒ M-tracks
- Downstream detectors: 1 CSC + 1 TOF + 2 DCH ⇒ D-tracks
- Detectors in arms: 2 GEM + 2 TOF ⇒ A-tracks



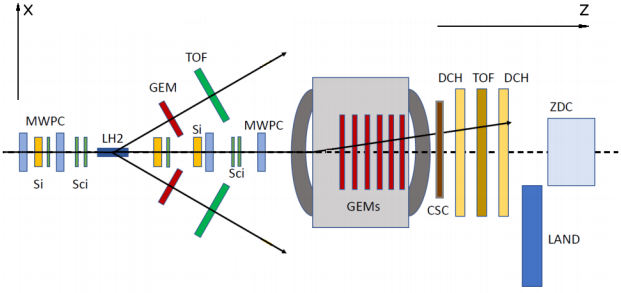
BM@N setup

- Detectors inside magnet: 3 Silicon + 6 GEM ⇒ M-tracks
- Downstream detectors: 1 CSC + 2 TOF + 2 DCH ⇒ D-tracks



Common algorithm of matching

Step 1. Alignment

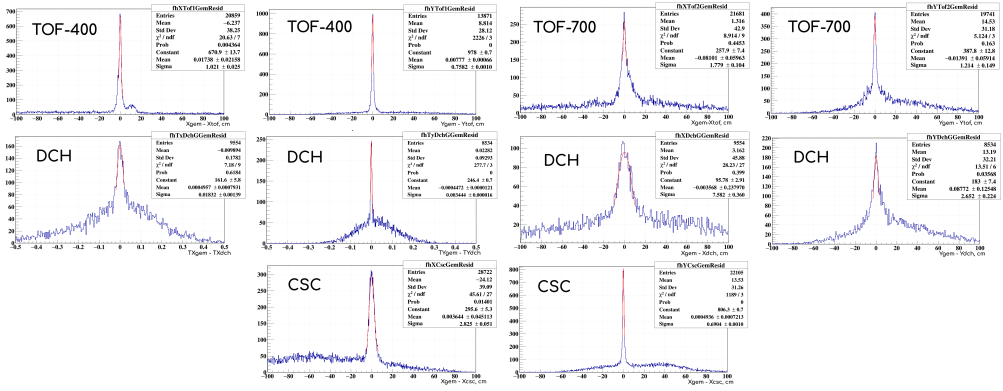


- Propagate each M-track to plane with hits
- Create track-to-hit (all-to-all) connections
- Calculate and fit residuals $\rightarrow$ $\mu_x, \mu_y, \sigma_x, \sigma_y$
- Shift all hits by μ_x, μ_y

The main question: What to fix?

Centered all-to-all distributions

Examples for BM@N



Global alignment

BM@N

- CSC: dX = +0.54; dY = -0.06;
- DCHG: dTx = +0.003; dTy = -0.000; dX = -8.17; dY = -2.70;
- TOF400: dX = -2.34; dY = +0.57;
- TOF700: dX = +1.38; dY = -10.18;

SRC

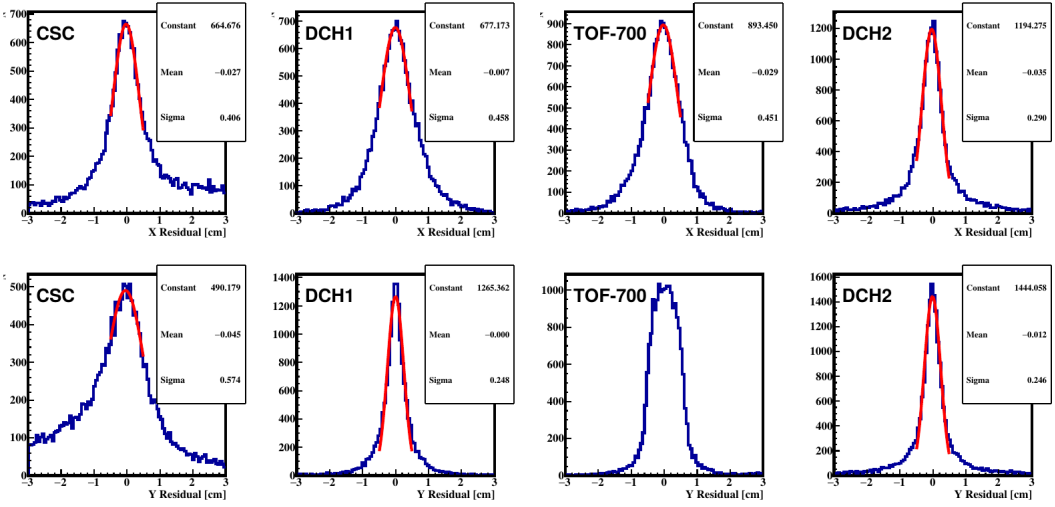
- UPSTREAM: dTx = +0.002; dTy = + 0.000; dX = -0.81; dY = -0.83;
- CSC: dX = -15.08; dY = -5.83;
- DCHG: dTx = +0.001; dTy = -0.001; dX = -8.52; dY = -3.01;
- TOF700: dX = +1.26; dY = -9.95;

Common algorithm of matching

Step 2. Matching:

- Propagate each track to plane with hits
- Find the nearest hit in $\pm 3\sigma_x$ and $\pm 3\sigma_y$
- Update track parameters by connected hit information:
  - Track length
  - Last position, T_x, T_y at last position, Momentum
  - Covariance matrix
  - χ^2
  - Number of hits, NDF
  - Velocity (β) for TOF detectors

Residuals for SRC setup



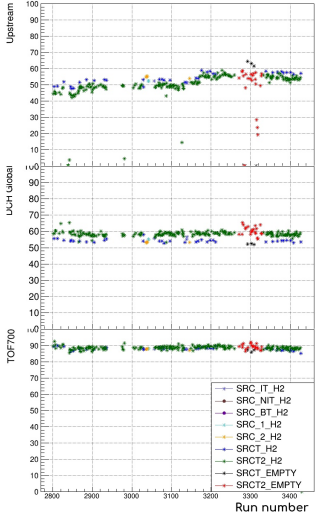
Efficiency

Example:

$$\mathrm{Eff}_{\mathrm{ups}} = \frac{\mathrm{N(UPS + DCHG + TOF700)}}{\mathrm{N(DCHG + TOF700)}}$$

It's not only the efficiency of global tracking:

- Detector efficiency
- Digitization efficiency
- Cluster finder efficiency
- Local tracking efficiency

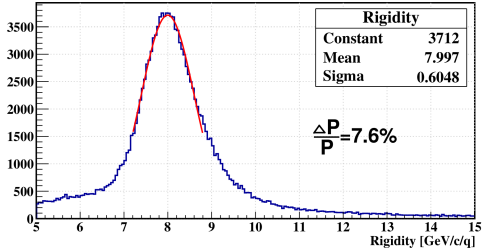


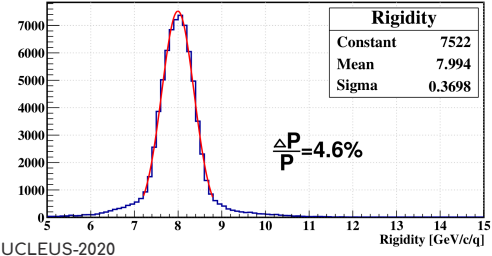
How does global tracking help?

Momentum resolution

- U-tracks give an input angle to the magnetic field region
- D-tracks give an output angle from the magnetic field region
- M-tracks give an integral of the magnetic field along the trajectory
- Momentum can be refined by

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

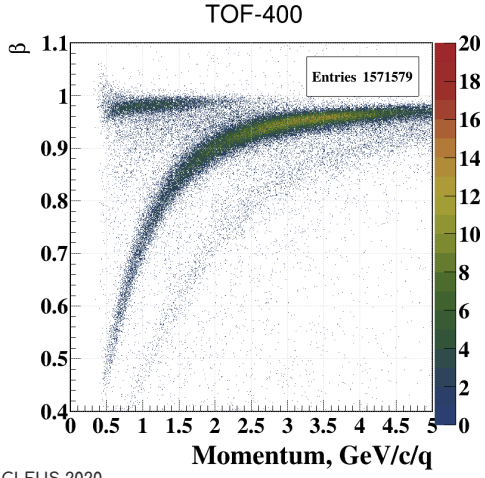




How does global tracking help?

Particle identification

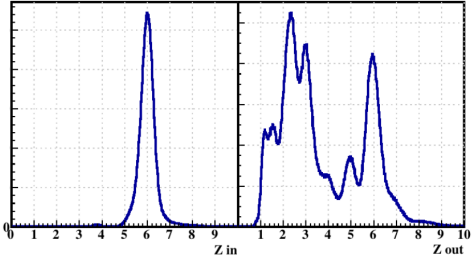
- Combination of time-of-flight and length of trajectory gives velocity
- Combination of velocity and momentum gives mass
- TOF detector and GEM planes gives particle identification

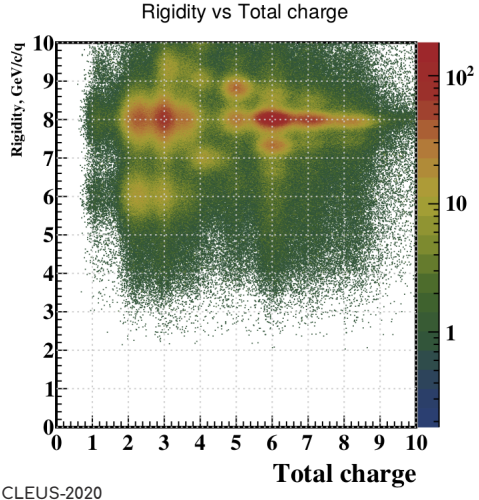


How does global tracking help?

Fragment identification

- Amplitudes of BC triggers give total charge of event
- Combination of momentum and total charge gives fragment identification



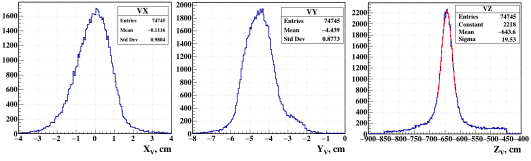


How does global tracking help?

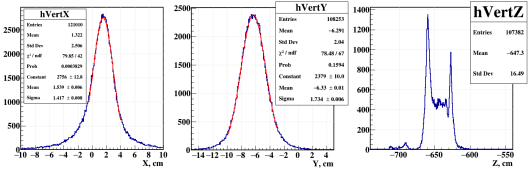
Primary vertex finder

- Without A-tracks resolution of primary vertex in Z direction was about 20 cm
- Global approach shows structure of target

W/o A-tracks



W/ A-tracks



Summary

- The algorithm of global tracking was described
- The global tracking task was integrated into reconstruction chain and implemented into BmnRoot software
- Positive results for BM@N and SRC setups were achieved

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Thank you!