Vertex reconstruction in the BM@N experiment

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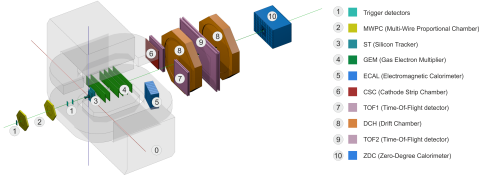
ICPPA-2020

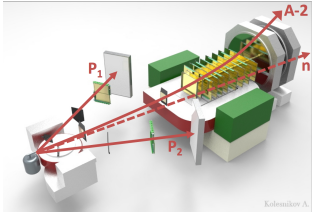
Outline

- The BM@N experiment of the NICA complex
- Vertex finder algorithm description
- Results for BM@N & SRC setups
- Algorithm tuning

BM@N



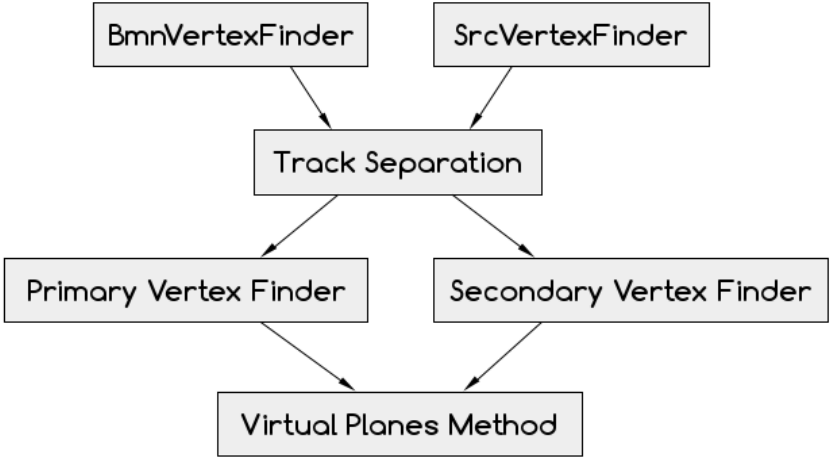
SRC



Motivation

- Primary vertex finder is a part of standard event reconstruction chain
- No primary vertex $\Rightarrow$ no precise physics analysis
- Secondary vertices are necessary for decays analysis

Vertex finder components



Vertex finder algorithm

Track separation

- Extrapolate all tracks to initial approximation of primary vertex position Z_V^{init}
- Check if track is in "beam region" or not and mark track with corresponding flag

Primary vertex finder

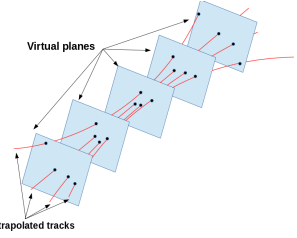
- If there are less than 2 tracks marked as primary, return
- Reconstruct primary vertex for tracks marked as primary by virtual planes method
- If Z position of found vertex is out of range (R), mark tracks as secondary and return
- Extrapolate tracks belonging this vertex to found Z_{PV} and calculate mean for X and Y distributions (X_{PV} and Y_{PV})

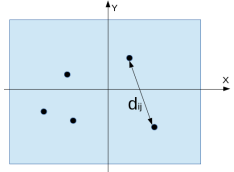
Secondary vertex finder

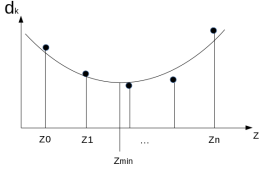
- If there are less than 2 tracks marked as secondary, return
- Reconstruct secondary vertex for tracks marked as secondary by virtual planes method in wide range
- Extrapolate tracks belonging this vertex to found Z_{SV} and calculate mean for X and Y distributions (X_{SV} and Y_{SV})

Virtual planes method

1. Extrapolate reconstructed tracks to set of $\{z_k\}_0^{N_{planes}}$ by Kalman Filter around initial estimation: $Z_v^{init} - R < z_k < Z_v^{init} + R$
2. Calculate distance between each pair of points on plane k: $d_{ij}^k = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}$
3. Calculate mean distance for each plane: $d^k = \sum d_{ij}^k / N_{pairs}$
4. Fit $d^k(z_k)$ by parabolic function and find z_{min}
5. Reduce R by factor speed: $R = R/speed$
6. Repeat 1-5 until required accuracy is achieved



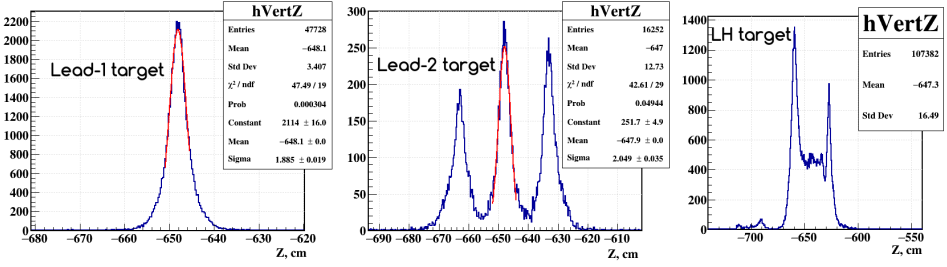




Results for the SRC setup

For the SRC setup three types of targets were used:

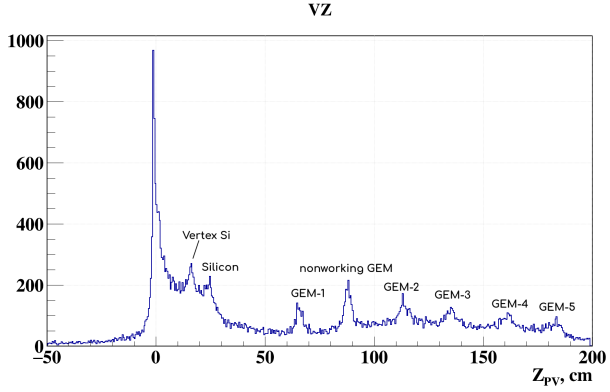
- one lead plane for calibration
- three lead planes for calibration
- liquid hydrogen barrel as a physics target



Comparison. BM@N

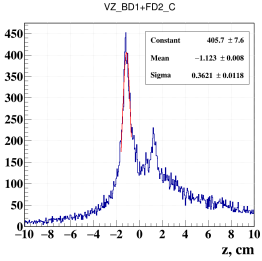
For the BM@N setup the set of targets was used: C, Al, Cu, Sn, Pb

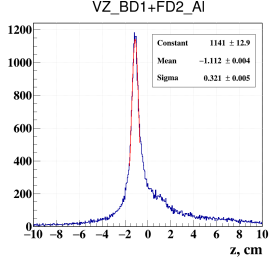
Z distribution of reconstructed vertices for Ar+Sn (BD > 3)

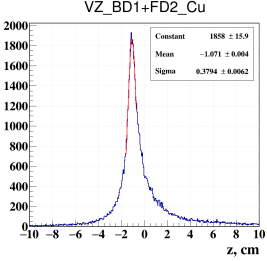


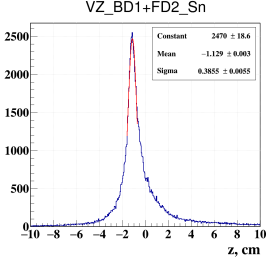
Trigger-Target dependence

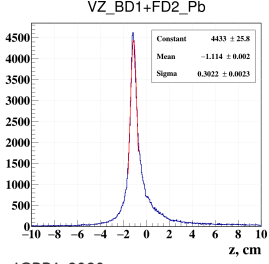
Trigger BD>1 + FD>2





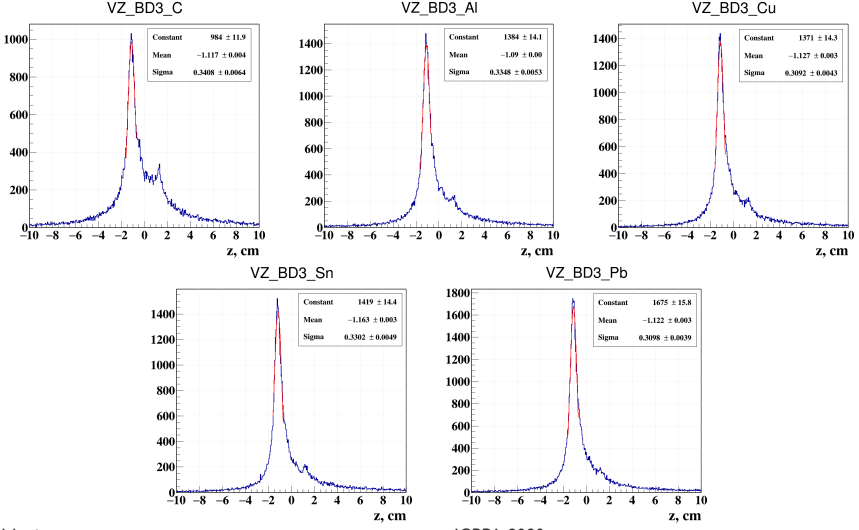






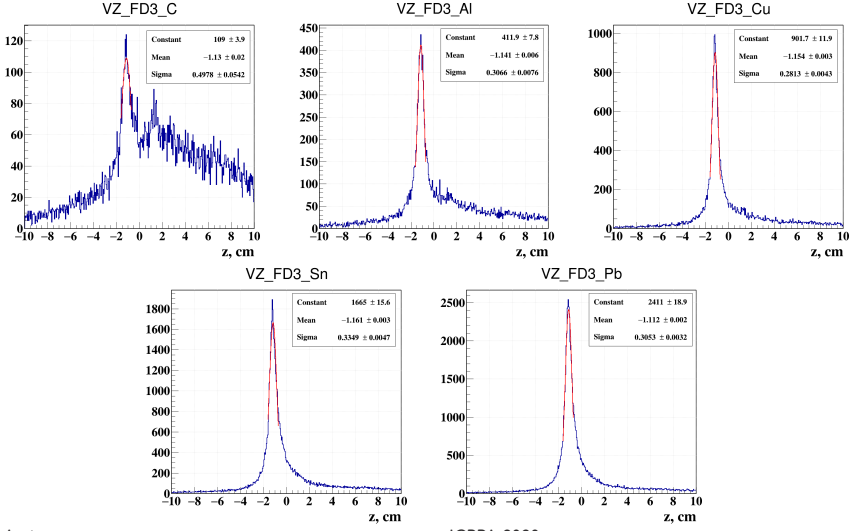
Trigger-Target dependence

Trigger BD>3



Trigger-Target dependence

Trigger FD>3



Tuning strategy

Algorithm input parameters:

- Range to search primary vertex in (Range)
- Number of virtual planes (Planes)
- Range reduction rate (Speed)

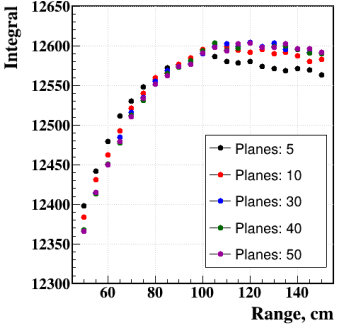
Control parameters:

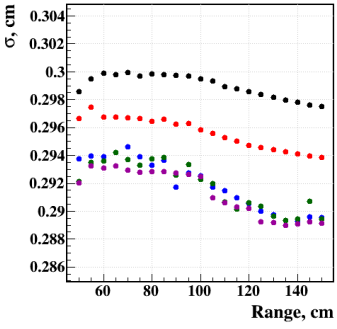
- Number of found vertexes in $-3\text{cm} < z < 3\text{cm}$ (Integral)
- Width of Gaussian fit (σ)
- Work time (Time)

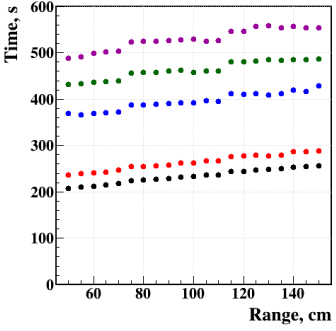
Main idea:
Scan algorithm over input parameters to maximize Integral and minimize σ and Time.

Tuning

Output parameters dependencies on number of virtual planes and search range for range reducing speed 1.5
Sample: $\approx 10^6$ events of Ar+Sn (BD > 3)







Summary & Plans

- The algorithm of vertex finder was described
- Positive results for BM@N and SRC setups were achieved
- Tuning of the algorithm was performed for Ar+Sn (BD > 3)
- The next step: to tune algorithm for different pairs of target-trigger.

The work is supported by Russian Foundation for Basic Research grants 18-02-40104 mega and 18-02-40046 mega.

Thank you!