Fine-tuning of the hit finder algorithm in TPC of the NICA MPD experiment aimed to improve the particle momentum resolution

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Plan of research work

The Research Work consists of the following basic stages:

1. Analysis of residuals depending on \((\phi, \theta)\)-angles (already presented by S. Merts)
2. Analysis of residuals depending on Crossing Angle and Dip Angle (already presented by S. Merts)
3. Analysis of Edge Effects
4. Normalization of errors obtained from the algorithm
5. Preliminary results on the Particle Momentum Resolution
6. Analysis of Two-Track Resolution (to be presented, but not today)
Edge Effects

Edge Effects ARE NOT TAKEN into account

Edge Effects ARE TAKEN into account

Applied cuts:

3° from each side of a sector were removed
Edge Effects (continuation)

Influence of Edge Effects:

Edge Effects are NOT taken into account
Influence of Edge Effects:

Edge Effects are taken into account

already shown by S. Merts in the previous report
Normalization of errors

\( X_{\text{pull}} \) applied to estimate a balance between \( X_{\text{resid}} \) and \( X_{\text{err}} \)

\[ X_{\text{pull}} = \frac{X_{\text{resid}}}{X_{\text{err}}} \quad \quad Z_{\text{pull}} = \frac{Z_{\text{resid}}}{Z_{\text{err}}} \]

It is required to have:

1. \( \mu_{\text{fit}} \) (should be near 0) - OK!
2. \( \sigma_{\text{fit}} \) (should be near 1) - NOT OK!

Maybe there are some problems with errors derived from the algorithm...

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Fine-tuning of the hit finder algorithm...
Normalization of errors (continuation)

Normality Condition used:

\[ \sigma_{\text{fit corrected}} = \sigma_{\text{fit}} \left( \frac{X_{\text{pull}}}{C_x} \right) \sim 1 \]

1. \( \mu_{\text{fit}} \) (should be near 0) - OK!
2. \( \sigma_{\text{fit}} \) (should be near 1) - OK!
Particle Momentum Resolution (PMR)

Approach used to estimate the particle momentum resolution:

1. Some samples of events at different $P_t$ with previously defined parameters were simulated: ($N = 50k$Events, $\phi = 0^\circ..360^\circ$, $|\eta| \leq 1.1$)

2. For each $P_t$ momentum resolution is estimated by the formula:

$$\frac{\Delta p_t}{p_t} \%, \quad \% = \frac{p_{t \text{rec}} - p_{t \text{sim}}}{p_{t \text{sim}}} \cdot 100\%$$  \hspace{1cm} (1)

3. A distribution given by the formula (1), is fitted to the Gauss function

4. Finally, $\sigma_{fit}$ considered as an estimated value $\frac{\Delta p_t}{p_t}$, is derived from the fit and put on separate plot
Particle Momentum Resolution (continuation)

\[ H_{pad} = 1.2 \text{ cm}, \quad N_{lays} = 66 \]

\[ H_{pad} = 1.44 \text{ cm}, \quad N_{lays} = 55 \]

\[ H_{pad} = 1.8 \text{ cm}, \quad N_{lays} = 44 \]

\[ H_{pad} = 2.4 \text{ cm}, \quad N_{lays} = 33 \]
Particle Momentum Resolution (continuation)

PMR by making use of the MpdTpcClusterFinderTask:

Green Line corresponds to:

\[ H_{pad} = 1.8 \text{ cm} \quad W_{pad} = 0.5 \text{ cm} \quad N_{layers} = 44 \]

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Particle Momentum Resolution (continuation)

PMR by making use of the MpdTpcHitProducer:

\[ \frac{\Delta p_T}{p_T} \text{ in TPC for } |\eta| \leq 1.1 \]

- Fine-tuning of the hit finder algorithm ...

![Graph showing \( \frac{\Delta p_T}{p_T} \) vs. \( p_T \) for different padrow configurations (66 and 80 padrows).]
General Conclusions

1. Analysis of residuals applied to TPC of the MPD experiment showed a good agreement of the results obtained with other experiments (ALICE, STAR).

2. Presence of edge effects should be taken into account due to their big influence on the calculated residuals and, finally, on tracking procedure.

3. Correction of errors giving by the algorithm to the found spatial coordinates of hits is required to use them subsequently in the tracking.

4. Preliminary results on the Particle Momentum Resolution by making use of the algorithm were obtained and they are in a good agreement with the results obtained earlier. It gives a strong hope to be sure that the algorithm works fine.
Thank you for your Attention!

To learn more about the experiment and the software used, you are welcomed to:

http://mpd.jinr.ru