New secondary vertex finding procedure for the HypHI project

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The first experiment of the HypHI collaboration aimed to demonstrate the feasibility of the hypernuclear spectroscopy by means of heavy ion beam induced reactions. Later, a second experiment of the HypHI collaboration was performed using a ^{20}Ne beam at $2A$GeV on a ^{12}C target. In the track reconstruction of the experimental data of this second experiment, the track multiplicity is about 5 to 10 times more that in the first experiment. New criteria for the track and event reconstruction had to be implemented in order to reduce the background contribution. In the event reconstruction, the vertex finding procedure is based on the geometrical closest distance approach between the daughter track candidates. An additional algorithm has been implemented in order to have another criteria on the vertex quality. While, a vertex fitting procedure is the best step to judge the goodness of the vertex reconstruction, the speed of the vertex fitting procedure is relatively slower than any vertex finding step. Thus a first step is set to reduce the number of vertex candidates. For this purpose a more advance vertex finding step was implemented based on the algorithm described in publication [3]. The algorithm principle is the consider position covariance matrix of the track, obtained after the track fitting, to create of tube representation in 3D around the track as a 1σ standard deviation in the 3D space. At a given z-position, an ellipse corresponding to the covariance is calculated. With this tube representation, a probability of being close to the given track can be calculated, denoted as $f(\mathbf{r}) = \exp(-0.5(\mathbf{r}-\mathbf{r_{track}})^T\mathbf{C}^{-1}(\mathbf{r}-\mathbf{r_{track}}))$. Then a vertex position $\mathbf{v}$from where each considered track originate will have to satisfy the criteria that it has to be close to the track tubes. For this, a vertex function :

$$V(\mathbf{v}) = \sum_{i=0}^{n} f_i(\mathbf{v}) - \frac{\sum_{i=0}^{n} f_i^2(\mathbf{v})}{\sum_{i=0}^{n} f_i(\mathbf{v})} \tag{1}$$

is used to defined a probability to be as close as possible to the all n considered track tubes. By finding the maximum of the probability vertex distribution, the improved vertex position can be determined. Additionally a covariance matrix of the maximization procedure can be inferred and associated to the vertex position. During this maximization of $V(\mathbf{v})$ procedure, if the track set does not have a maximum, the vertex candidate is then rejected since it corresponds of the case where the track tubes are not close enough to define an non-null value for $V(\mathbf{v})$. Figure 1 shows the track tubes for two different tracks and the obtained probability distribution $V(\mathbf{v})$. The calculation are performed in 3D, however for easier representation the projection to XY, XZ and YZ global axis are shown in Figure 1.

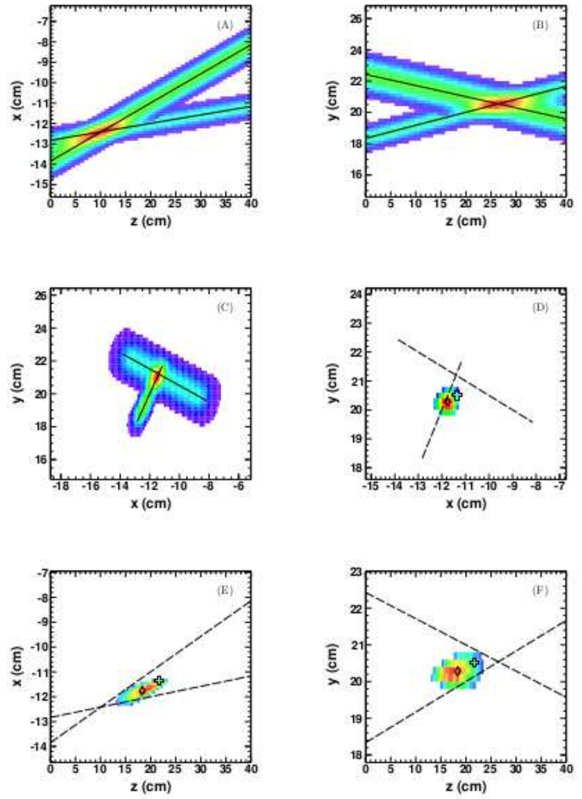

Figure 1: Profiles of the two 3D track tubes are shown in panel (A), (B) and (C), and profile of vertex probability obtained by the algorithm of [3] are shown in panel (D), (E) and (F). In panel (A), (B) and (C), the solid black lines are the tracks and the profiles corresponds to the tubes formed by the 1-σ standard deviation from the position covariance matrix of the associated track. In panels (D), (E) and (F), the dash lines represent the track, the cross marker the seed of the geometrical closest distance approach calculation and diamond marker the position of the highest probability obtained by the algorithm of [3]. In those panels, the profile represents the probability distribution.

References

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