# $D^{\pm}$ decay reconstruction in p+C collisions at SIS-100 energies with CBM

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The investigation of p+A collisions up to 30 GeV and A+A collisions from 4A to 11A GeV beam energies is considered as part of the CBM research program and will be performed in the first phase of FAIR with a start version of the CBM detector at the SIS-100 accelerator. This start version consists presumably of two detector systems: the Silicon Tracking System (STS) mounted in a magnetic field to the measurement of momenta and vertices and a Time-Of-Flight (TOF) wall placed 10m downstream of the target for hadron identification.

To study the feasibility of $D^{\pm}$ decay measurement in the CBM experiment, a set of $10^5$ p+C events ($b = 0$ fm) at 30 GeV was simulated. The $D^{\pm}$ decay to $K^{\mp}\pi^{\pm}\pi^{\pm}$ was used in order to simulate a signal. A realistic STS geometry with 2 MAPS at 5 cm (thickness 300 $\mu$m ) and 10 cm (thickness 500 $\mu$m) and 8 double-sided segmented strip detectors (thickness 400 $\mu$m) was tested. $\delta$-electrons produced by 15k protons and 50 minimum bias interaction (assuming up to 5MHz interaction rate) simulated additional background hits in the MAPS detectors. The primary vertex was reconstructed with high accuracy (60 $\mu$m in $z$ direction, 10.0 $\mu$m in $x$ and $y$) from about 4.5 tracks (on average) fitted in the STS with a non-homogeneous magnetic field by the SIMDized Kalman filter procedure described in [1].

A fast track finder was used to reconstruct the $D^{\pm}$ decay. The $D^{\pm}$ particle is reconstructed from its three daughter particles assuming the geometrical target center as the production point. The resulting $D^{\pm}$ z-vertex resolution is 51 $\mu$m. The 3-prong vertex was considered as a $D^{\pm}$ decay candidate if it was found more then 450 $\mu$m downstream the target. The primary vertex was constructed from all non $D^{\pm}$ tracks and $D^{\pm}$-particle. The combinatorial background is suppressed mainly by the vertex cut $\chi^2_{geo}$ and $\chi^2_{topo}$ for good quality detached vertices.

The shape of the background in the signal invariant-mass region was estimated using the event mixing technique. The resulting background plus $D^+$ and $D^-$ signal spectra calculated using the Hadrons Strin Dynamics (HSD) model are shown. The predicted multiplicities are $2.7 \cdot 10^{-8}$ for $D^+$ and $5.7 \cdot 10^{-8}$ for $D^-$. The branching ratio is 9.5%. Two sets of cuts were studied. Relatively soft single track cuts ($\chi^2_{primary} > 3\sigma$) allowed to keep the total reconstruction efficiency of about 13.2%. Applying this set of soft cuts, we expect to collect about 335 $D^+$ and 712 $D^-$ per $10^{12}$ p+C collisions ($b = 0$ fm), with a signal-to-background ratio of about 0.6 and 1.2 respectively. A set of strong single track cuts ($\chi^2_{primary} > 4\sigma$) decreases the total reconstruction efficiency to 11.6%, but increases the signal-to-background ratio to 1.4 and 3.0, respectively. The expected statistics accounts for 290 $D^+$ and 617 $D^-$ per $10^{12}$ p+C collisions ($b = 0$ fm).

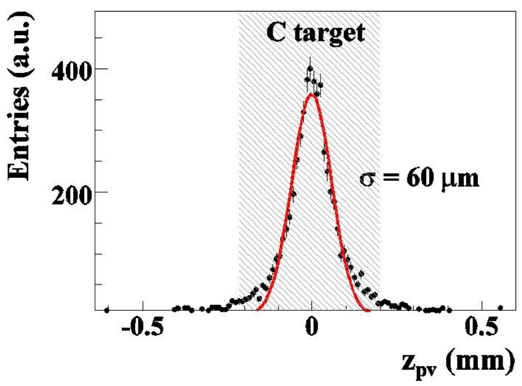


Figure 1: Z-distribution of the reconstructed primary vertex. The dashed region corresponds to the carbon target. The 3-prong vertex was considered as a $D^+$ decay candidate if it was found more then 450 $\mu$m ($7.5\sigma$) downstream the target.

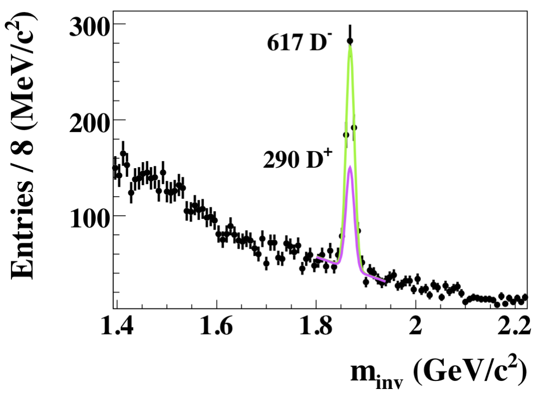


Figure 2: Reconstructed $D^-$ and $D^+$-mesons in $10^{12}$ p+C collision ($b = 0$ fm) at 30 GeV using hard cuts. The green line represents the $D^-$ signal plus exponential background, the magenta one the estimated $D^+$ signal.

## References

[1] I. Kisel *et al.*, Comp. Phys. Comm. **178** (2008) 374