A new large acceptance silicon pixel detector for measurements of charm mesons by NA61 Beyond 2020

Anastasia Merzlaya\textsuperscript{1,2} and Dag Larsen\textsuperscript{1}

\textsuperscript{1}Jagiellonian University, \textsuperscript{2}Saint Petersburg State University

\textbf{1. Motivation}

The study of heavy flavour production is a sensitive tool for new detailed investigations of the properties of hot and dense matter formed in AA collisions. It opens new possibilities for studies of phenomena at and beyond the quark-hadron duality, and possible regeneration of in-medium parton energy loss and quarkonium dissociation. At $N_{\text{part}} \simeq 200$ NA60 experiment observed a significant drop of experimental $J/P$ yield relative to theoretical estimates, which is known as anomalous $J/P$ suppression. It was initially attributed to onset of QGP formation in nuclear collisions, however other explanations have also been proposed.

To verify observed signature of QGP formation one needs to deliver information on total balance of charm. It can be done by measurement of open charm in all channels. For details, see talk by P. Staszel.

\textbf{2. NA61/SHINE experiment}

The SAVD consists of two spectrometer arms composed each from 4 detector stations, which are located 5, 10, 15 and 20 cm downstream the target in the inhomogeneous field of the vertex magnet of NA61/SHINE.

The SAVD was upgraded with the new Small Acceptance Vertex Detector (SAVD) to allow precise measurements of open charm mesons. NA61/SHINE is planning to further upgrade the detector after 2020 for study of short-lived particles and for measurements of charm mesons by NA61 Beyond 2020.

\textbf{3. Vertex Detector project}

Measurements of open charm mesons are challenging since the yields of $D$ mesons are very low and their lifetime is short ($\tau < 100\mu$s). Recognition of open charm require precise tracking and high primary and secondary vertex resolution. To meet these challenges a new high resolution Small Acceptance Vertex Detector (SAVD) was installed in NA61/SHINE.

\textbf{4. Vertex Detector performance}

The track finding algorithm is based on combinatorial method (for pre-tracking) and Hough transform. The track spatial resolution is about 5 $\mu$m. The track matching between VD and TPC primary vertex (for primary tracks) or VD clusters from defined station (for secondary tracks) and then interpolated to VD primary vertex (for secondary tracks) and the matching clusters are collected. Finally, the whole track is refined using Kalman Filter.

A spatial primary vertex resolution of $\sigma_{x,y,z} \approx 2.5, 1.15, 15 \mu$m has been achieved.

The first pilot data for open charm measurements in Pb+Pb at 150A GeV/c was collected ultimo 2016. A first signal of $D^0$ was observed.

\textbf{5. Open charm measurements}

The data planned to be collected later in 2018 should allow more detailed study of $D^0$ yields in Pb+Pb.

\textbf{6. ALPIDE test in NA61}

The proposed programme will allow to perform systematic studies of $D^0$, $D^+$, $D^+$ and $D^*$ production versus collision energy and centrality. The improved data read-out rate will not only improve precision, but also allow for possible measurement of open charm at 40A GeV/c where the production is expected to be far less abundant, as well as open charm measurement at different collision centralities.

\textbf{7. Upgrade of Vertex Detector}

The NA61/SHINE experiment will be upgraded to increase data taking rate from 80Hz to 1kHz. The upgraded VD will be based on the same layout and mechanical support as SAVD, but will instead be based on 46 ALPIDE sensors developed for ALICE ITS, and have larger acceptance on each station.

\textbf{8. Future measurements of open charm}

The Vertex Detector is expected to be upgraded to Large Acceptance Vertex Detector (LAVD) during CERN long-shutdown 2019-2020, with first test data taking in 2021. The upgraded VD will be based on 46 ALPIDE sensors for ALICE ITS, and have larger acceptance on each station.