Preparing the HADES tracking system for high-rate experiments at SIS100

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The future physics program of HADES at FAIR demands high detection standards, also in the operation stability of the tracking system comprising four layers of planar drift chambers. Due to the expected increase in beam energy and intensities at SIS100 compared to SIS18, the particle load on the wire chambers will significantly rise by a factor of 2-3. Thus, the choice of the counting gas becomes crucial with respect to aging of the detector. In this respect isobutane, used so far as quencher gas, is known to be not suitable, because it has the tendency to polymerise, triggering deposits on the wire surfaces causing aging. For this reason a different quenching gas has to be employed. CO_2 is known to not cause any aging effect [1]. It was used in the two inner layers of drift chambers MDC I & II (in front of the magnetic field) successfully demonstrating a stable performance in a gas mixture of Ar/CO_2 in recent beam-times (Au(1.23 AGeV)+Au 2012, π(0.7 GeV/c)+A 2014). This motivated to test also the significantly larger two outer layers MDC III & IV, having twice larger cell sizes and four times the active area compared to MDC I & II, for the option of operating with this counting gas.

Plateau curve measurements.

Hence, systematic tests have been performed, applying different concentrations of the new quenching gas CO_2 in

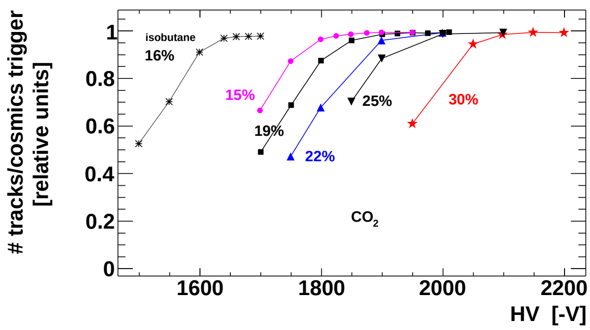

Figure 1: Relative efficiency of MDC IV for cosmic muons (MIPS) as function of high voltage for different argon based counting gas mixtures with isobutane or CO_2, concentrations given in the labels.

the counting gas Ar/CO_2. The corresponding working point for each gas mixture was determined by measuring the relative number of tracks per triggered cosmic muons as a function of the applied high voltage, depicted in Figure 1. Compared to the gas mixture Ar/isobutane (84% / 16%) with a working point at -1700 V the new mixtures require significantly higher potentials of -1850 V to -2150 V, depending on the concentration of CO_2. Therefore the electrostatic forces between the wires increase, which requires the validation of the high voltage stability, considering the known creeping of the mounted aluminium wires during the time span of more than 10 years since the chamber construction.

High rate stability tests.

Based on the verified stability up to the highest potential of -2200 V of all 12 outer drift chambers, also a stable operation under particle load has to be confirmed. To do so, a powerful x-ray source [2] is utilised to mimic the total number of particles per wire layer of a heavy-ion collision and the resulting occupancy distribution along the chamber (basically the polar angle dependence). As displayed in Figure 2, a reasonable match is achieved, generating the maximal load on the wires close to the beam pipe. A long

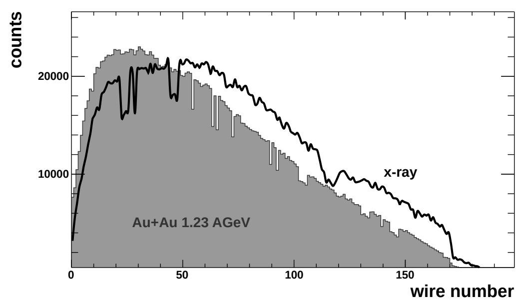

Figure 2: Occupancy of MDC III as a function of the wire number for heavy-ion collisions (Au+Au at 1.23 AGeV, grey) compared to x-ray irradiation (E_γ^{max} = 25 keV, black)

term test was started providing a spill structure and load similar to reactions of Au+Au at 1.23 AGeV and a beam intensity of 10^7 ions/s corresponding to a detector ionization current of 2.5 μA per wire layer. Within this test the optimal fraction of CO_2 will be determined by finding the balance between risk, stable operation and signal quality.

References

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[2] "Mini-X X-Ray Tube", AMPTEK INC., 14 DeAngelo Drive, Bedford, MA 01730-2204 U.S.A., http://www.amptek.com

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