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Simulation of an extractor ionisation gauge

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We describe the numerical simulation of an extractor gauge using SIMION 8.0 software. The detailed geometry was defined in SolidWorks and imported into SIMION as 5 separated electrodes. All dimensions defined by the manufacturer were strictly followed. Length distribution of calculated electron trajectories has been evaluated. This allowed determining the mean trajectory length inside the grid volume. Its magnitude of 19.3 mm was latter used to calculate the gauge sensitivity. The ion collection efficiency was also assessed as a function of the distance to the collector, having an average of 70.5 %. From these results and the ionization cross section taken from the literature, the sensitivity was calculated as 6.1 mbar-1 for N2 at 150 ℃, well in agreement with the sensitivity given by the manufacturer (6.25 mbar-1). The sensitivity for He and for H2 was also calculated based on the known ionization cross sections.
A second simulation approach was done running a LUA code in parallel with the electron trajectory calculation. The trajectory was divided into segments and for each segment we checked if ionization took place using simple Monte Carlo algorithm. The ionization probability along a segment was determined from the segment length, gas concentration and the ionization cross section. Once the ionization takes place, we 'annihilate'the electron and 'create'an ion of a given mass, charge and velocity. In the LUA code we did that by transforming the fast electron into a slow ion. The initial velocity of ions is determined randomly so that it obeys Maxwell distribution for the previously defined gas temperature. So, we tested segments until we get an ionization event –in every segment the projectile enters as an electron. Once the ionization takes place, we follow the ion trajectory. Since the ionization probability is low, instead of a single electron we assume a bunch of electrons which amount is a function of the pressure. Further details on the algorithm will be provided. This approach was useful to calculate the sensitivity as a function of the pressure. At pressures below 10-3 mbar, we obtained the same sensitivity as by the first approach. A clear decrease was found at high pressures due to the increased probability that an ion is formed outside the grid and therefore not collected.

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