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Volume and surface effects in Cs-free regimes in NIO1

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NIO1 (Negative Ion Optimization phase 1) is a compact multi-aperture radiofrequency H^- ion source whose design was optimized for sustainable prolonged beam on target (BOT) operation; installation economy implied a drastic scaling as respect to fusion device D^- sources. The latter in a consistent view for energy production request a beam on tokamak (BOT) span of 20 years, that is 6 10^8 s. Even if Cesium improves H^- production as well known, Cs-free regimes (and intermediate regimes) deserve development effort, in view of avoiding long term contamination of the accelerator and for testing cleaning procedures. Data collected by NIO1 in a true Cs-free regime (before 2020) are thus very important, and need a thorough statistical analysis, with special attention to the technique of gas conditioning that was discovered in NIO1 and to some issues concerned with long term operation. Gas conditioning macroscopically proves the importance of surface effects, even when the final production of H- happens in the source volume. Exchange of ideas with the Electron Cyclotron Resonance Ion Sources (ECRIS) and concepts, such as 'electron starvation', biased disks, liners and wall coatings, are discussed. A classification of H^- ion sources in terms of surface to volume ratio (over 10^2 m^{-1} in matrix ion sources), practically achievable BOT (from 10^4 s to 10^6 s, per year) and working frequency (from few GHz in the ECRIS case down to 1 MHz) is reviewed. Gas mixing, conditioning and surface material perspectives are envisioned.

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