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Determination of discharge parameters via OES at the Linac4 H^- ion source

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At the accelerator complex of CERN an upgrade of the LHC injector chain is being implemented. One part of this upgrade is the realization of a negative hydrogen linear accelerator, the Linac4. The ion source for this accelerator is RF driven with an external coil (RF frequency 2 MHz, power up to 100 kW). It can be operated in two modes: the first one where H^- ions are generated in the plasma volume via vibrationally excited hydrogen molecules and the second one where the H^- ions are produced from hydrogen ions and atoms impinging on a low work function surface which is created by evaporating cesium into the source. In order to optimize the H^- yield in both operation modes, a detailed knowledge of the plasma parameters and the processes taking place in the discharge is mandatory.

To gain insight in the plasma parameters optical emission spectroscopy measurements have been carried out with a high resolution spectrometer at the Linac4 test stand at CERN without adding cesium to the ion source. The performed evaluations cover the analysis of the atomic Balmer radiation and the molecular Fulcher emission ($d\ ^3\Pi_u \rightarrow a\ ^3\Sigma_g^+$ transition, located between 590 and 650 nm) via the collisional radiative models Yacora H and Yacora H_2. The obtained discharge parameters like the electron density and temperature as well as the vibrational and rotational temperature of the hydrogen molecules are presented for a variation of the gas pressure and RF power.