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Stockli: RF (Light) Negative Ion Sources for Non-Fusion Applications, a tutorial

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Twenty years ago, there was no ion source that could provide high-currents (>20 mA) of H⁻ beams at high duty factors ($\gg 1\%$). In addition, the lifetime of H⁻ sources was limited to ~ 2 Amp-hours. Therefore high-duty-factor H⁻ sources had to be replaced every few weeks! The H⁻ ion sources limited the power of the accelerators!

The development of RF H⁻ sources has reversed the situation: Now accelerators limit the applicable performance of RF H⁻ sources. RF H⁻ sources yield >100 mA of H⁻ with duty factors up to 10% and lifetimes up to 10 Amp-hours.

Without Cesium, RF H⁻ ion sources deliver more than 20 mA, which is almost exclusively produced in the volume of the plasma as shown with the Rasser approximation. When Cesium is added, surface produced H⁻ ions increase the H⁻ output currents up to ~ 60 mA. The Cs consumption is less than 0.3 g per year. Nowadays RF H⁻ ion sources do not have to be replaced for up to one year and their performances show no sign of old age!

This tutorial briefly reviews the basic processes of the H⁻ formation and then describes the four RF H⁻ ion sources that successfully feed advanced high-power H⁻ accelerators.

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