A High-Flux Dissociator for the Munich Atomic Beam Source ◇

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A dissociator for large flow-rates of molecular hydrogen has been developed for the new Munich polarized ion source of the Stern-Gerlach type [1]. It was our goal to dissociate fluxes of about 1.5 mbarl/sec with high efficiency. In the basic concept we followed the MADISON [2] design.

Fig. 1 shows the high-flux dissociator. An oscillating circuit is trimmed resonantly with a variable capacitor to 13.56 MHz (350 Watt@2mbl/sec). It embraces concentrically the discharge glass tube containing the molecular H_2 gas. The radio-frequency is coupled in directly at the 50 Ω point of the coil without any additional adapting network. This matching to 50 Ω was tested to be free of reflections up to a power of 400 W. Free electrons are accelerated capacitively by the electromagnetic field created in the oscillating circuit. The H_2 gas gets dissociated via impact collisions of accellerated electrons. Two effects are hereby counterproductive: The amount of rf-power necessary for complete dissociation increases with the throughput of the H_2 gas and requires large power. At high rf-power, the plasma tends to expand towards the cooled aluminum nozzle (80 K) and heats the nozzle in case of contact. To meet both requirements, we decided to lengthen the distance from the oscillating circuit to the aluminum nozzle as given in fig. 1. Particularly for large H_2 fluxes, the rf-power can be adjusted now at sufficiently high values and the plasma stops just in front of the aluminum nozzle. The rise in temperature of the nozzle is very low (1-2 K) at maximized degree of dissociation. In test-experiments with given H_2 flow rates, we observed a saturation of the beam-intensity with increasing rf-power. The values of the rf-power necessary for saturation scaled linearly with the H_2 flow rate up to 2 mbarl/sec.

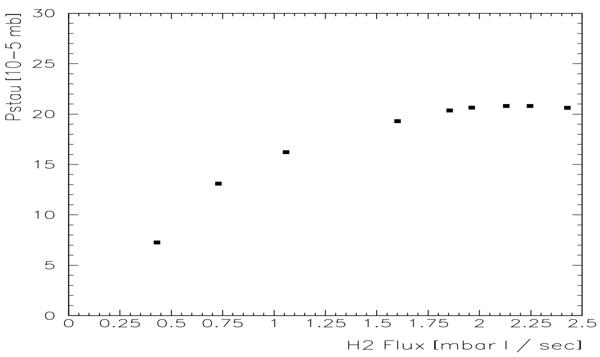

Fig. 2: Intensity of the electron-polarized atomic beam as function of the dissociated molecular hydrogen gas. The rf-power was optimized for each data-point.

The comparison between the intensity of the electron-polarized atomic beam (given in units of P_{stau}) and the flux of the molecular hydrogen to be dissociated is given in fig. 2. The saturation of the curve occurs beyond 2 mbarl/sec and is determined by absorption due to scattering on residual gas, by intra-beam scattering and by the decrease of the degree of dissociation. A detailed study to disentangle these effects is described in ref. [3]. According to our present understanding, the saturation is dominated by absorption. Tests are ongoing. As a preliminary result we report here high degrees of dissociation of about 90±10 % up to fluxes of 2.5 mbarl/sec.

References

[1] K. ElAbiary, diploma thesis, LMU München, 1996
[2] T. Wise et al., Nucl.Instr.Meth. **A336** (1993) 410
[3] K. El Abiary et al., this annual report, p. 110

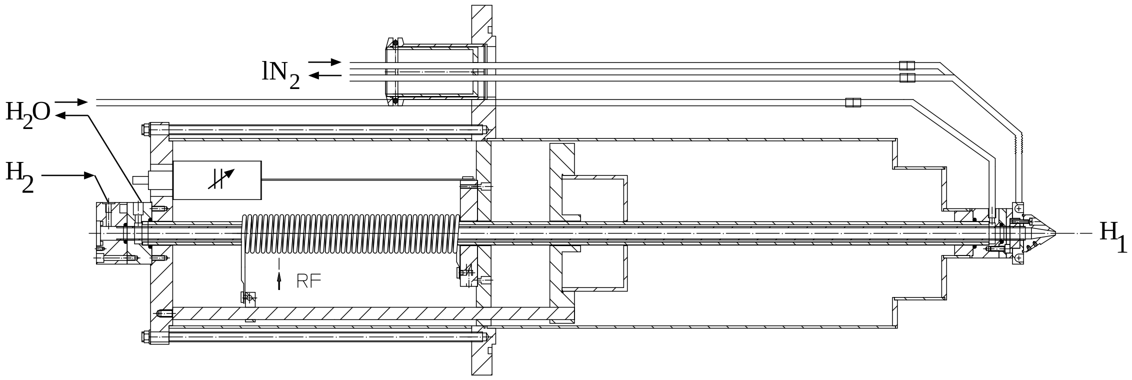

Fig. 1: Schematic of the dissociator: The active components of the oscillating circuit are the plasma-coil and the plasma-capacitor, which embrace concentrically the glass-tube. A variable capacitor, indicated schematically, is used to adapt the circuit to the resonance frequency of 13.56 MHz. The glass tube consists of two walls and is water-cooled. The electric circuit is in direct contact with the outer glass wall and so indirectly water-cooled. The aluminum nozzle is cooled by liquid nitrogen to 80 K and thermically separated from the stainless steel housing of the dissociator by a 3 mm thick teflon disk.

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