THE STATUS OF DESY H^- SOURCES

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Abstract

Two different types of H^- sources are operated at DESY: a magnetron source and an RF-driven volume source. H^- sources for HERA have to run for long uninterrupted periods with a low duty factor and a high reliability. There are now 15 years of experience with the magnetron and 6 years with the RF-driven volume source. Several improvements are under test for our RF-driven volume source. The status of both our magnetron and our volume source will be discussed.

1 INTRODUCTION

The H^- sources are components of LINAC III, the injector for DESY III. At present an 18 kV magnetron source is operated as the H^- source for LINAC III. A 35 kV RF - driven volume source is operated as back-up and test source on a second line. A 100µsec pulsed H^- current of 40 mA with a repetition of 1 Hz (duty cycle $=10^{-4}$) is required for HERA. For details see [1], [2].

2 STATUS OF THE MAGNETRON SOURCE

The DESY magnetron has been operating since 1985. It is based on the design of FNAL [3] with modifications for DESY requirements [4]. Since 1993 the magnetron has been operated for eight HERA run-periods with a current of 40-60 mA.

The average length of these periods was 273 days with a maximum run time of 301 days. On two occasions it was necessary to change the magnetron. One case was due to contaminated Cs, requiring the magnetron boiler to be heated to 104 – 111°C compared to the usual 88-98°C. The second failure occurred when the magnetron was exposed to air during the exchange of a vacuum pump after a running time of 119 days. Under good conditions this action is not a problem: a magnetron which ran for 210 days and was exposed shortly to air was installed in our test source and ran for an additional 200 days.

3 STATUS OF THE RF - DRIVEN VOLUME SOURCE

The original RF-driven volume source was manufactured by AccSys [5] using plans from LBL [6]. It was necessary to improve reliability and H^- current of the source. Since 1994 it was completely rebuilt at DESY. Fig. 1 shows the redesigned bucket with a UV-bulb for ignition. This source was operated for more than 7000 h without maintenance at a current of about 40 mA.

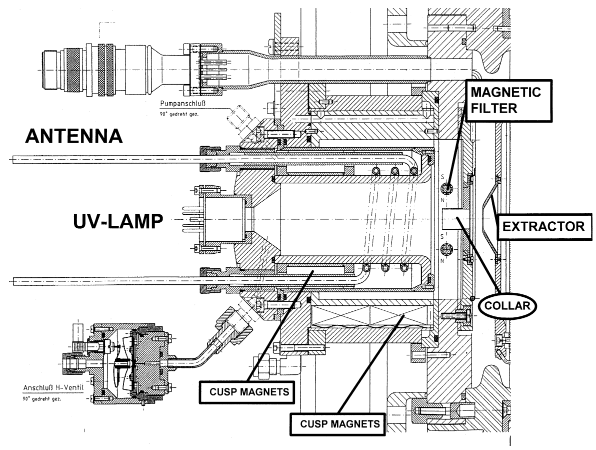

Figure 1: The DESY volume source with an rf coil shielded by Al_2O_3 ceramic.

3.1 Ignition of RF-Driven Volume Sources

RF-Driven Volume Sources for pulsed H^- currents typically have internal or external antennae and a diameter and length of about 10 cm. An ignition unit is used to ionise the gas before it can be heated by rf to become a plasma. The following devices have been common for this purpose :

- Filaments
- UV-lamps
- Lasers which produce electrons on a cathode material

These devices have been seen to have various limitations. Filaments are exposed to the plasma and as a result have a short lifetime. UV- lamps are outside of the plasma and thus can be easily changed but the timing jitter of the H^- current is bigger than with a filament. Lasers are bulky and expensive.

It was also demonstrated at DESY with internal and external antennas that it is possible to ignite the plasma with an rf frequency which is different from the optimum plasma heating frequency. A frequency source was investigated which switches RF-frequencies.

A spark gap is not feasible in these sources due to the low gas pressure of about 5 mTorr. According to the Paschen law one would need either a long distance between the electrodes or a very high voltage. This can be

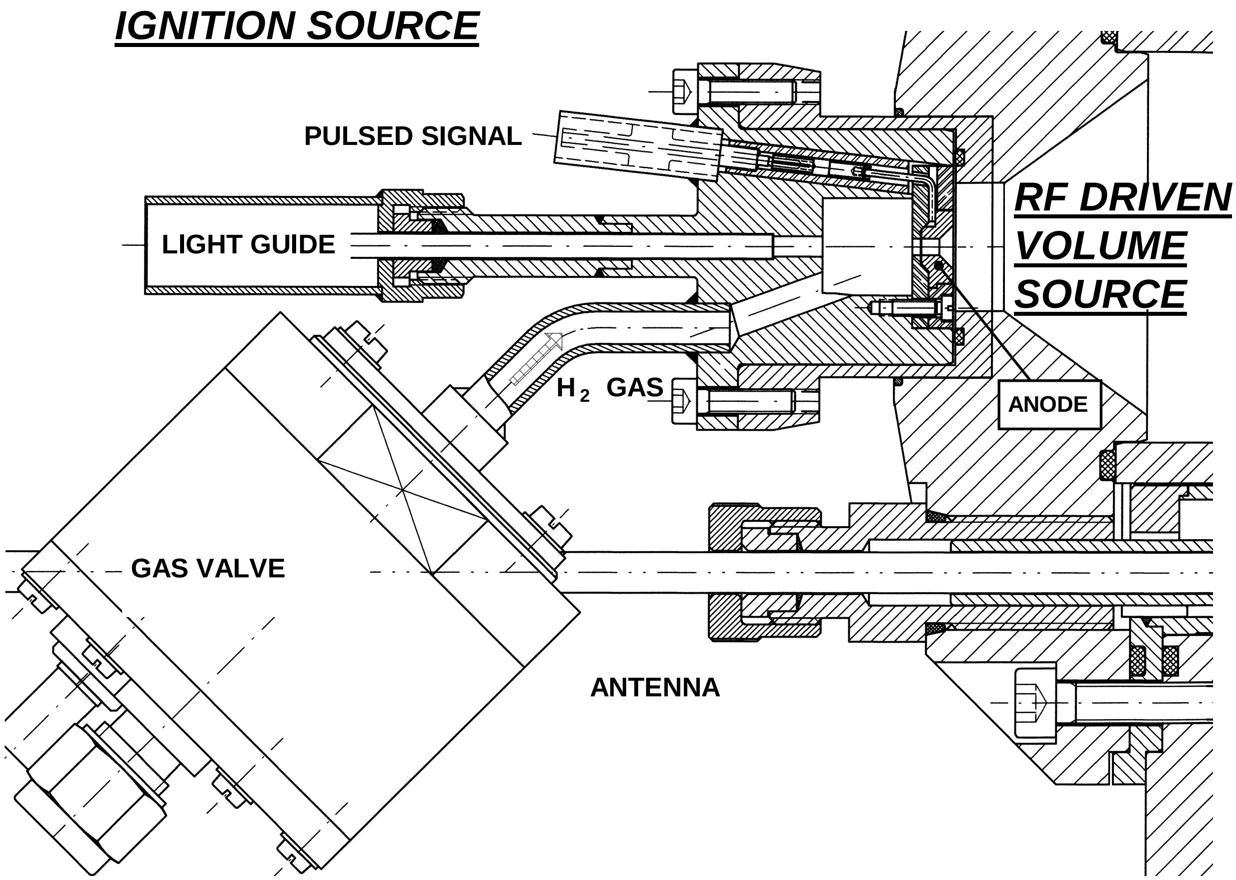

Figure 2: The DESY ignition source mounted to the RF - driven volume source together with the gas valve

circumvented by introducing a tandem source arrangement with an ignition source in the gas pipe connected to the source, using the higher pressure in the pipe for ignition. Following a suggestion of A. Anders [7], [8] who developed such a tandem system for positive ion sources this technique was adopted for H^- ion production at DESY.

3.2 The DESY Ignition Source for H^- Production with an RF - Driven Volume Source

Fig. 2 shows the ignition source which was developed at DESY mounted to the RF -driven volume source. The cathode is connected directly to the HV ground of the volume source. For this reason the insulated anode has to be pulsed positive with a voltage of about 600V. Electrons are injected into the volume source through a hole in the anode. The size is determined by the required gas flow for the volume source and the gas pressure for operation of the ignition source. The operation of the ignition source can be monitored by a glass light guide.

Pulsing the anode was chosen because pulsing the cathode would make it necessary to insert a second insulation into the gas pipe. This DC break could then accidentally ignite due to the pulsed cathode voltage. Special considerations would be necessary.

The oscilloscope pictures in Fig. 3 a & b show the source light, H^- current, electron current and rf signal of the volume source for operation with the ignition cell (a) and with ignition by a UV-lamp (b).

In addition the ignition cell light is given in (a) during operation without rf. The H^- current was measured with a multi faraday cup behind the source. The source toroid gives about 10% higher H^- current values than the multi faraday cup.

The jitter of the H^- current is less than 0.5 µsec with the ignition cell compared to 1 µsec for the UV-lamp. The jitter of the ignition cell is larger but the start of the H^- current is synchronised by the rf power. The length of the ignition pulse is not critical.

With this system it is possible to avoid the electron current peak shown in Fig. 3 b. This high electron current develops due to electron multiplication on the ceramic of the external coupling, which occurs when the plasma is not completely developed.

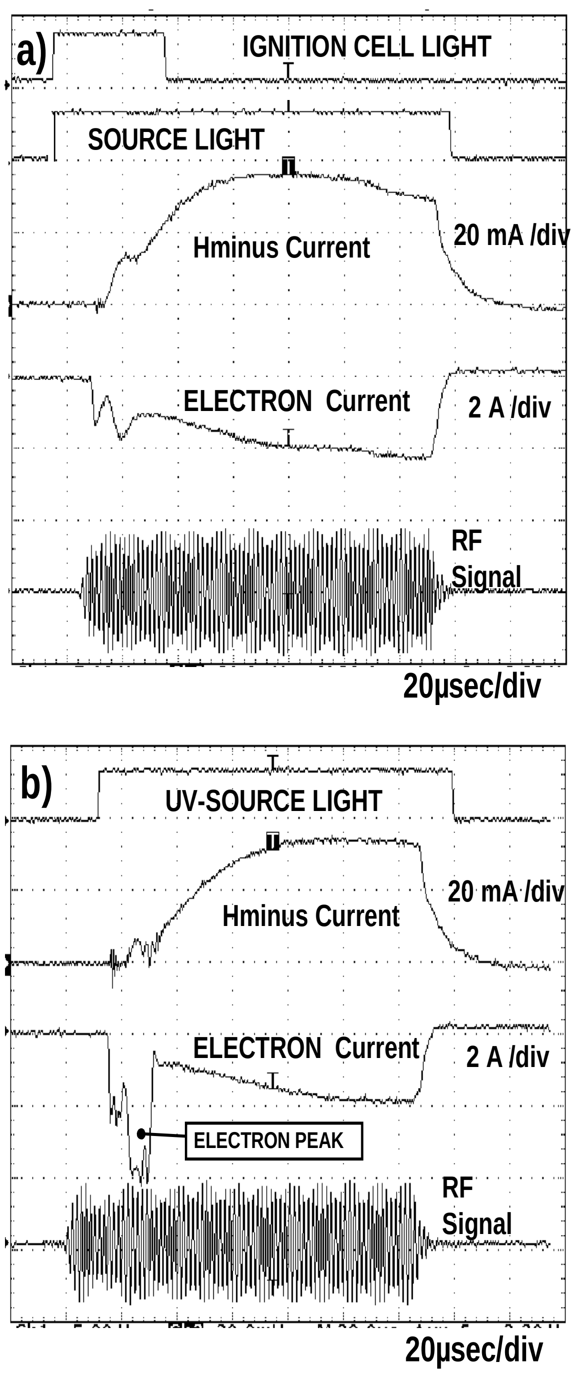

Figure 3:
a)OPERATION with IGNITION PLASMA SOURCE. Ignition cell light measured without rf, H^- current, electron current and rf signal of the volume source
b)OPERATION with UV-lamp
H^- current, electron current with electron peak and rf signal of the volume source

4 CONCLUSION

Continuous operation of our magnetron demonstrates a high reliability of this source type. Research into the rf-driven volume source made improvements in reliability and current possible. An ignition plasma source has been successfully tested together with our RF-driven volume source for H^- ions. This tandem arrangement works stably and is basically maintenance free. It is superior to the ignition systems which have been used up to now.

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