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Non-radioactive Source for Field Applications Based in a Plasma Focus of 2J: Pinch evidence

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Abstract. A portable plasma focus for field applications operating at two joules have been designed and constructed. Pinch evidence in the current derivative signal have been obtained. Also the dependence of the time to pinch , t_p, over the filling pressure, p_0, ($t_p \propto \sqrt{p_0}$) was observed. Therefore, the device is working as a plasma focus.

1. Introduction.

Small and compact plasma focus devices are not only interesting for pure plasma research. Also are especially suitable for field applications. More remarkable is that it constitutes a safe radiation on-off source. The plasma focus is especially suited for pulsed neutron applications with a reduced danger of contamination compared to conventional isotopic radioactive sources. A passive radioactive source of neutrons with similar energy (~ 2.5 MeV, for instance 252Cf or Am/Be) emits continuously, carrying inconveniences in handling and storing. In turn, plasma-focus sources would not have such activation problems. The pulses radiation (neutrons and X-rays) has a duration of a few nanoseconds, in particular X-rays have a wavelength of nanometers or less, thus it is reasonable to call them “nanoflashes”.

2. The device.

Using the experience obtained in the scalability of plasma focus devices [1-5], a compact and portable device was designed and constructed. This device was designed for operation with few kilovolts (10kV or less) with a stored energy of 2J and a repetition rate of 10Hz without external cooling. The electrical parameters are: capacitance 180nF, inductance 40nH, voltage operation from 5 to 8kV, energy stored from 2-5J, peak current from 10 to 17kA achieved in ~ 100ns. The size of the device is of the order of $25x25x20cm^3$. The weight is less than 3kg. Figure 1 shows a photograph of the device.

Figure 1. PF-2J: a portable plasma focus device.

3. Results.

Electrical characterization for discharges in hydrogen was developed. Evidence of pinch was obtained in the current derivative dI/dt and current I signals (figure 2). Also the dependence of the time to pinch, t_p, over the filling pressure, p_0, ($t_p \propto \sqrt{p_0}$) was observed (figure 3).

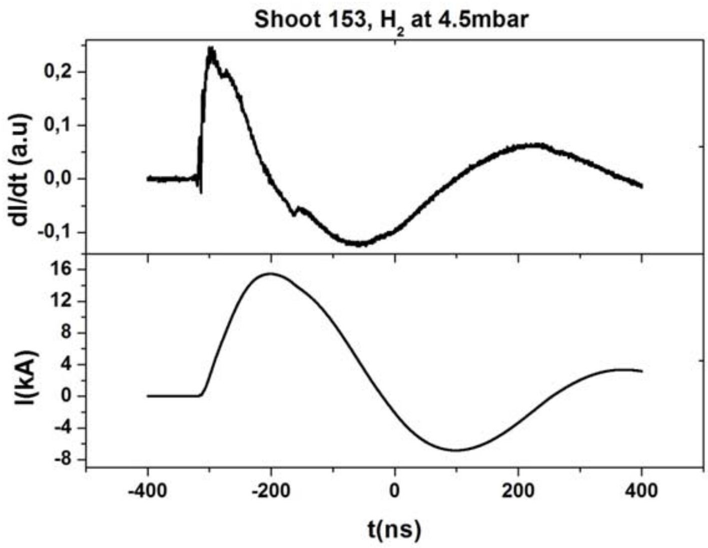

Figure 2. Electrical signals of the current derivative dI/dt and current I. The typical dip in the dI/dt and the drop in I, that correspond to the pinch effect is observed.

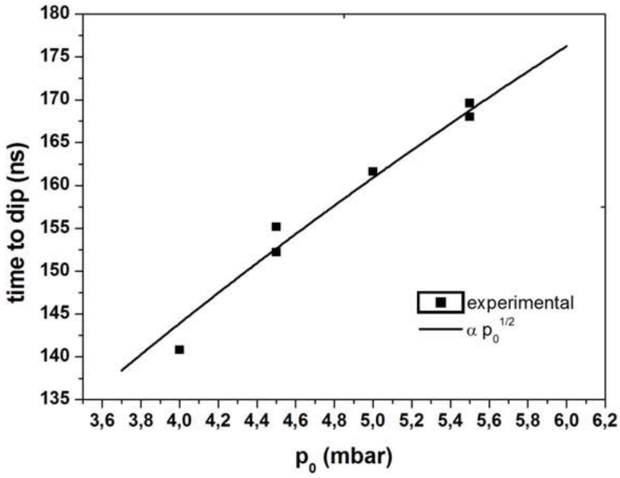

Figure 3. Time to dip vs filling pressure for discharges in hydrogen. The time to dip dependence on pressure, $\alpha \sqrt{p_0}$, shows that the device is working as plasma focus.

4. Conclusions.

A compact and transportable plasma focus device was designed and constructed, PF-2J as a step to design a non-radioactive source for field applications. The device is operated with a charging voltage less than 10kV and with a stored energy less than 5J. Evidence of pinch was obtained from signals of current derivative. In addition, the dependence of the time to pinch, t_p, over the filling pressure, p_0, ($t_p \ \alpha \ \sqrt{p_0}$) was observed. Future works include discharges in deuterium and neutron emission characterization. A neutron flux of the order of 10^4-10^5 n/s is expected for operation rates of 10 to 100Hz. In addition a discharge camera with optical windows will be constructed to study de plasma dynamics.

5. Acknowledgments.

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