

Recent finding in fusion studies using table top and miniaturized dense plasma focus devices operating from hundred joules to less than one joule

Tuesday 23 October 2018 14:00 (20 minutes)

In a dense plasma focus (DPF) the plasma is compressed into a hot-warm dense pinch. Since, 50 years ago and during the first three decades the dense plasma focus (DPF) was studied as a possible device to produce dense transient plasmas for fusion research. The trend was to produce bigger devices over MJ stored energy and MA current through the plasma pinch, in order to increase the efficiency of fusion neutron production. Unfortunately, the neutron production suffers saturation in devices operating at MA. Alternatively, in our group we have been studying how scale a dense plasma focus to very low energy of operation, keeping the nuclear fusion reactions and neutron emission. Several dense plasma focus devices under kJ stored energy (400J, 50J, 2J, and 0.1J) were designed and constructed in our laboratory. In all of them nuclear fusion reactions are obtained. In fact, recently we reported the evidence of nuclear fusion in a plasma focus operating in deuterium at only 0.1J. Despite these devices are far to produce net energy, these studies have contributed to learn that it is possible to scale the plasma focus in a wide range of energies and sizes keeping the same value of ion density, magnetic field, plasma sheath velocity, Alfvén speed and temperature. However, the plasma stability depends on the size and energy of the device.

Recent findings related nuclear fusion studies are presented, including: a) evidence of nuclear fusion in an ultraminiaturized plasma focus operating at 0.1J; b) observations of plasma filaments and its role in the neutron emission; c) characterization of the plasma ejected after the pinch in table top and small DPF devices (50J, 400J and 900J) and their use to study the effects on materials relevant to the first wall of fusion reactors; and d) studies of the plasma interacting with a target material on front of the anode using digital optical refractive diagnostics and visible spectroscopy. In addition, how to increase the current in the pinch plasma, increasing the number of fusion nuclear reactions and neutron production, in a regime of enhanced stability is discussed. Supported by ACT-172101 CONICYT and FONDECYT 1151471 Chile grants.

Country or International Organization

Chile

Paper Number

EX/P2-23

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Session Classification: P2 Posters