INCA: A new scalable large area plasma source at low pressures

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A new planar, large area plasma source operating at low pressures of a few Pa or below is introduced. The electron heating mechanism of the source is based on a recently proposed novel collisonless heating concept which involves an array of electric vortex fields (U. Czarnetzki and Kh. Tarnev, Physics of Plasmas 21, 123508 (2014)). Experimentally this field structure is realized by a planar array of small inductive coils operated at the standard RF frequency of 13.56 MHz. This coins the name INCA as the acronym of Inductively Coupled Array. The present array consists of 36 coils and the entire discharge chamber is 42 cm x 42 cm x 13 cm. However, up-scaling to larger areas should be straight forward. Key features are a Mawellian EEDF up to about 35 eV with moderate electron temperatures between 3 eV and 5 eV, indication of super-energetic electrons at higher energies, transition to the inductive mode already at low powers of about 100 W or below, stable operation in a wide pressure range (0.1 Pa to 10 Pa) with good coupling efficiency, and linear scaling of the plasma density with pressure and RF power. A simple but effective wiring concept makes the impedance of the inductive array approximately independent of size and number of coils which allows easy up-scaling. The density profile is characterized by diffusion, i.e. has the form of a cosine even at low pressures. With magnetic confinement, realized by a permanent magnet multi-cusp field, flat profiles over almost the entire antenna cross section are realized. Application might be in large area processing or for large area plasma thrusters. The performance of the source will be introduced, the parameter scaling explained, and the theory behind the new heating mechanism outlined.