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Numerical studies on capillary discharges as focusing elements for electron beams

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The azimuthal magnetic field generated by the discharge current induced by applying a voltage to the extremities of a gas-filled capillary can be used to focus an electron beam passing through the device. The generated magnetic field gradient can reach values higher than those achieved in electromagnet and even permanent magnet quadrupoles.
In principle, optimal focusing condition is reached when the current density is perfectly parallel to the capillary axis and transversely uniform, as in this case the magnetic field intensity has a linear dependence on the distance from the axis.
In a number of experimental situations, this is often not the case; thus, the aim of the present work is to numerically investigate capillary discharges in order to study the causes of the transverse non-linearity of the magnetic field and to allow future studies on mitigation strategies. In fact, the non satisfactory degree of uniformity of the current density distribution could be due to a number of reasons, including but not limited to: the dependence of the plasma resistivity on the local temperature, the shape of the electrodes and the capillary geometry.

Primary author: BRENTEGANI, Emanuele (LNF)

Co-authors: MAROCCHINO, Alberto (LNF); Prof. MOSTACCI, Andrea (Sapienza); BIAGIONI, Angelo (LNF); Dr SCHIAVI, Angelo Schiavi (SBAI Department, Sapienza University of Rome); ZIGLER, Arie (LNF); CHIADRONI, Enrica (LNF); FILIPPI, Francesco (LNF); ANANIA, Maria Pia (LNF); FERRARIO, Massimo (LNF); CROIA, Michele (LNF); Dr POMPILI, Riccardo (LNF); Prof. ATZENI, Stefano (Università di Roma "La Sapienza" and CNISM); ROMEO, Stefano (LNF)

Presenter: BRENTEGANI, Emanuele (LNF)

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