Status of Magnetostatic Ring Studies

M. Droba, N. Joshi, O. Meusel, U. Ratzinger

IAP, J. W. Goethe University, Frankfurt am Main, Germany

Here we report on the magnetostatic ring studies at Frankfurt University. The various effects arising by confinement of non-neutral plasmas in the longitudinal magnetic field were studied in the last 2 years. Subjects of detailed investigation were the behaviour of confined charged clouds in Gabor lenses[1] and solenoids, the consequences of a hollow density profile and of mirror charges on the cloud stability (diocotron instabilities), the transient behaviour near the Brillouin flow limit (spatial variation of the Larmor radius).

The beam injection into high current magnetostatic low energy storage ring with a longitudinal magnetic guiding field is investigated by experimental test setups with two toroidal bending segments. Also the particle confinement will be tested there [2], space charge compensation and cross sectional transport due to gradient and centripetal force drifts should be studied in detail. Especially external fields used by injection may influence the confinement time and stability of the circulating beam. The experiments are planned to begin in summer 2007.

The developed numerical codes for the calculation of magnetic surfaces in a figure-8 geometry were already described in Ref. [3].

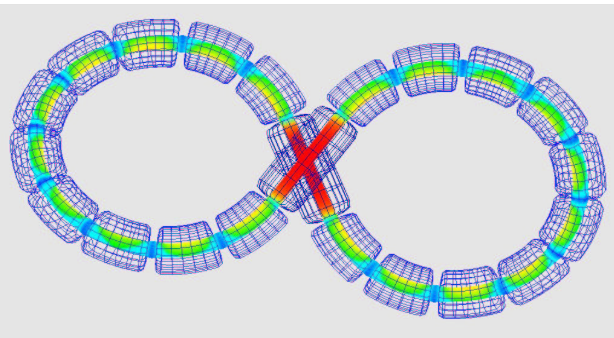

Fig. 1.: Storage ring geometry with one magnetic surface, field strengths displayed by colour code.

The magnetic coordinate system (Ψ = toroidal flux enclosed by surface and actual radial coordinate, θ = poloidal angle, ξ = toroidal angle) and curvatures of the field lines are calculated through Fourier transformation by frequency decomposition method from the magnetic gradient signal. The potential profile is solved by an iteration method on parallel cluster of CSC(Center for Scientific Computing). An example of solved electric potential in one cross sectional 3D surface is given in Fig.2,3. The particle motion is solved in the guiding centre approximation along the field lines according to the magnetic coordinate system.

Here up to 10^7 macro particles of different species can be handled around the ring.

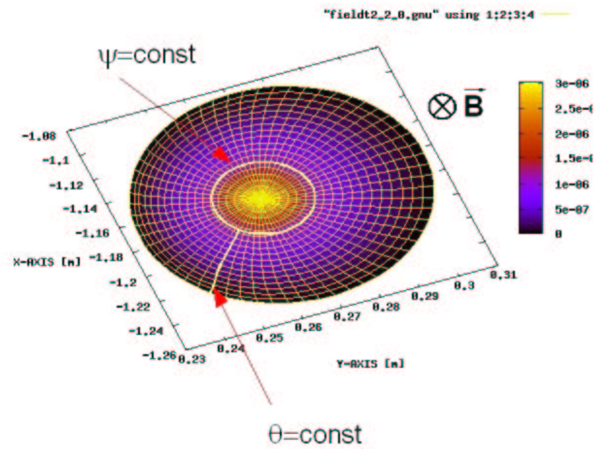

Fig. 2: X,Y Projection of an electric beam potential in the magnetic coordinate system(Ψ,θ) of figure-8 storage ring.

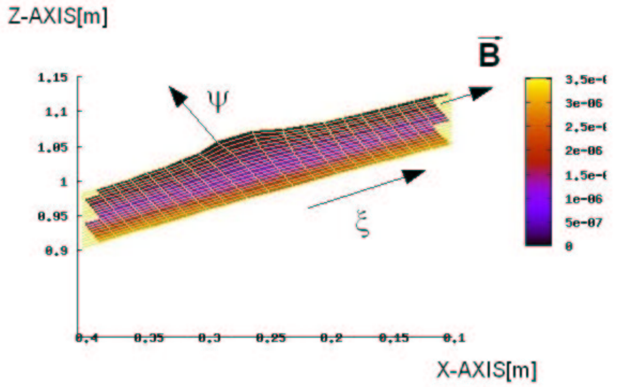

Fig. 3.: X,Z Projection of an electric beam potential in the magnetic coordinate system(Ψ,ξ) of figure-8 storage ring.

The configuration for an accumulator ring based on a toroidal magnetic field looks promising for the storage of intense low energy ion beams, especially when concerning the various optional concepts for space charge compensation. The theory of thermal and applied plasma confinement on magnetic surfaces was translated to numerical simulations on circulating ion beams. The first experiments on injection techniques are under construction.

References

[1] O.Meusel, Fokussierung und Transport von Ionenstrahlen mit Raumladungslinsen, Diss. 2006.

[2] N.Joshi, Beam Transport in Toroidal Magnetic Field, Annual Reports 2006 High Energy Density Physics with Intense Ion and Laser Beams, in this report.

[3] M.Droba, Design Studies on a Novel Stellarator Type High Current Storage Ring, Proc. EPAC 2006, pp 297-299.