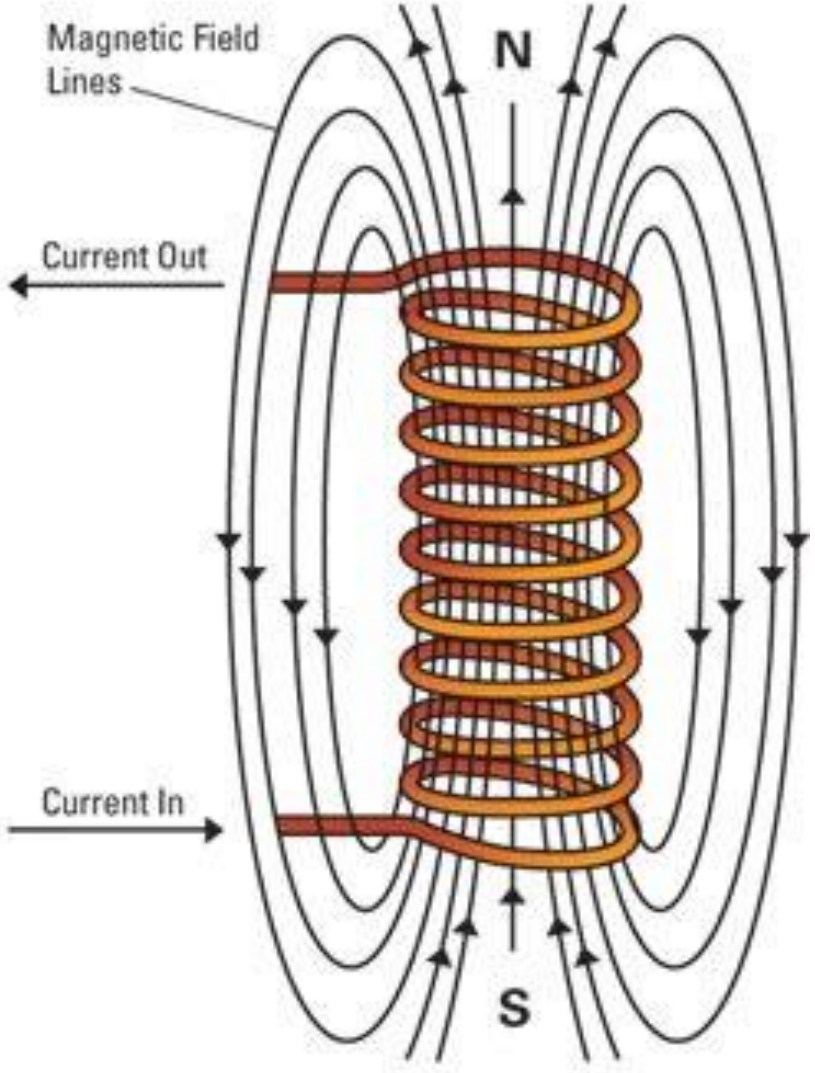
Vortex Pinning and High Field Magnets

A superconducting magnet has magnetic field lines that penetrate into the superconducting wires

**The magnet is operated in persistent current mode
In which there must be zero dissipated power**

The resulting magnetic flux lines must be immobilized in order to eliminate dissipated power

This requires strong vortex pinning



https://thefutureofthings.com/3815-los-alamos-magnet-lab-explores-superconductivity/

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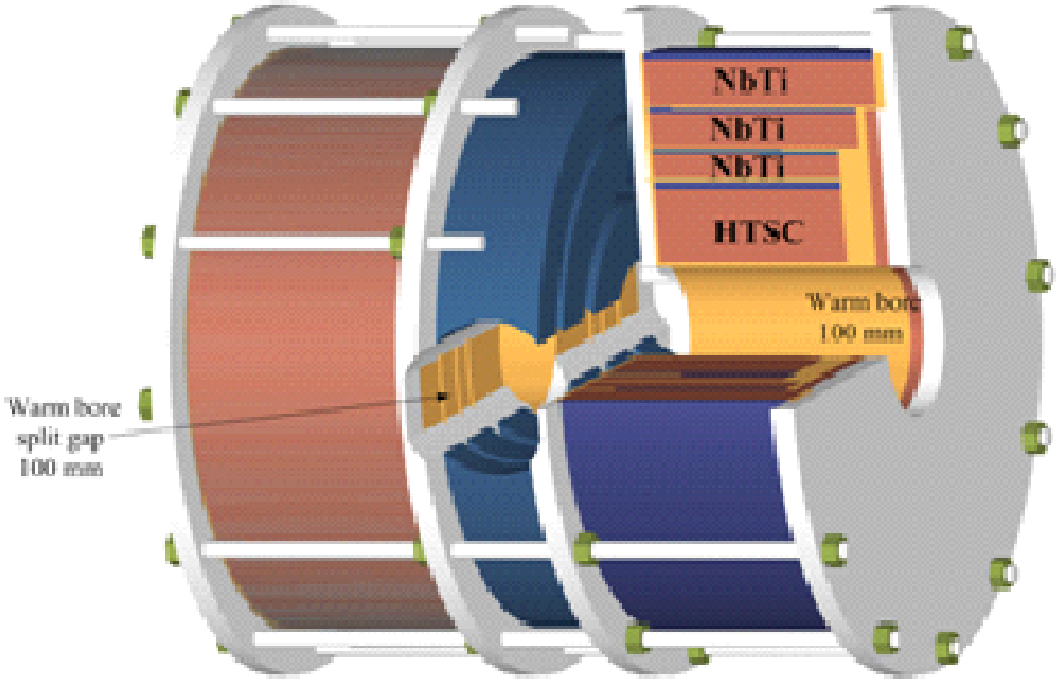
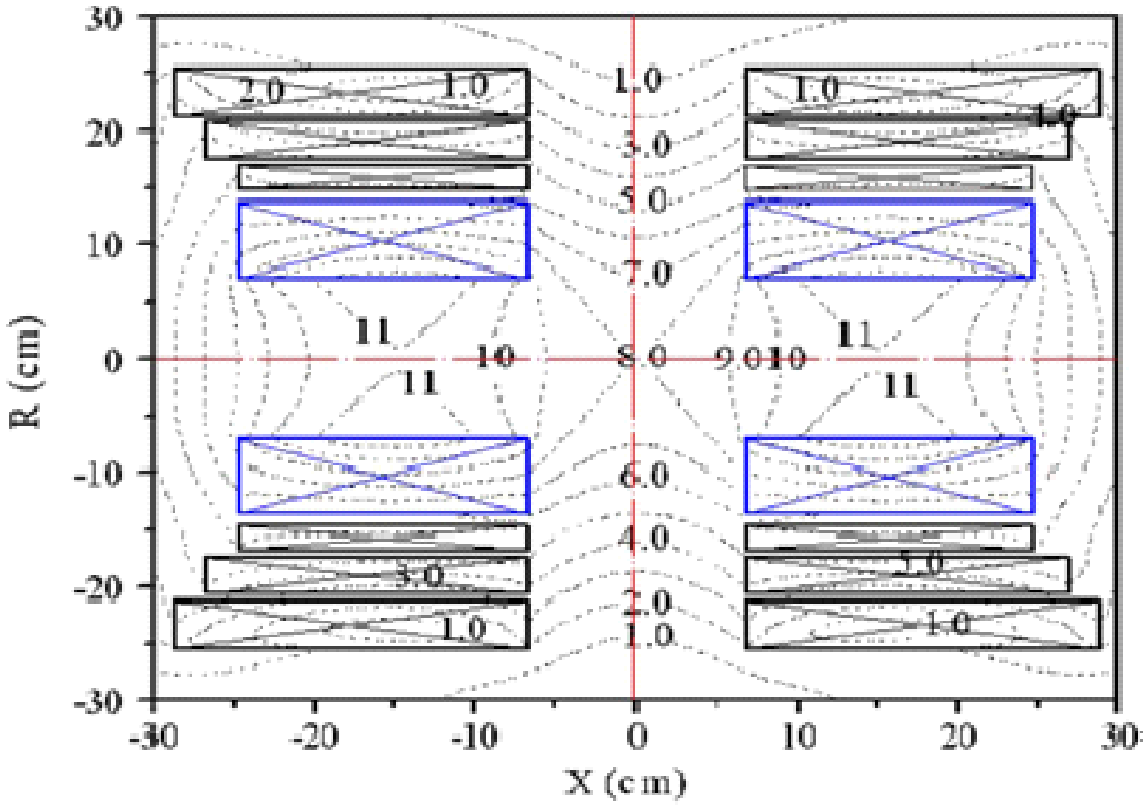
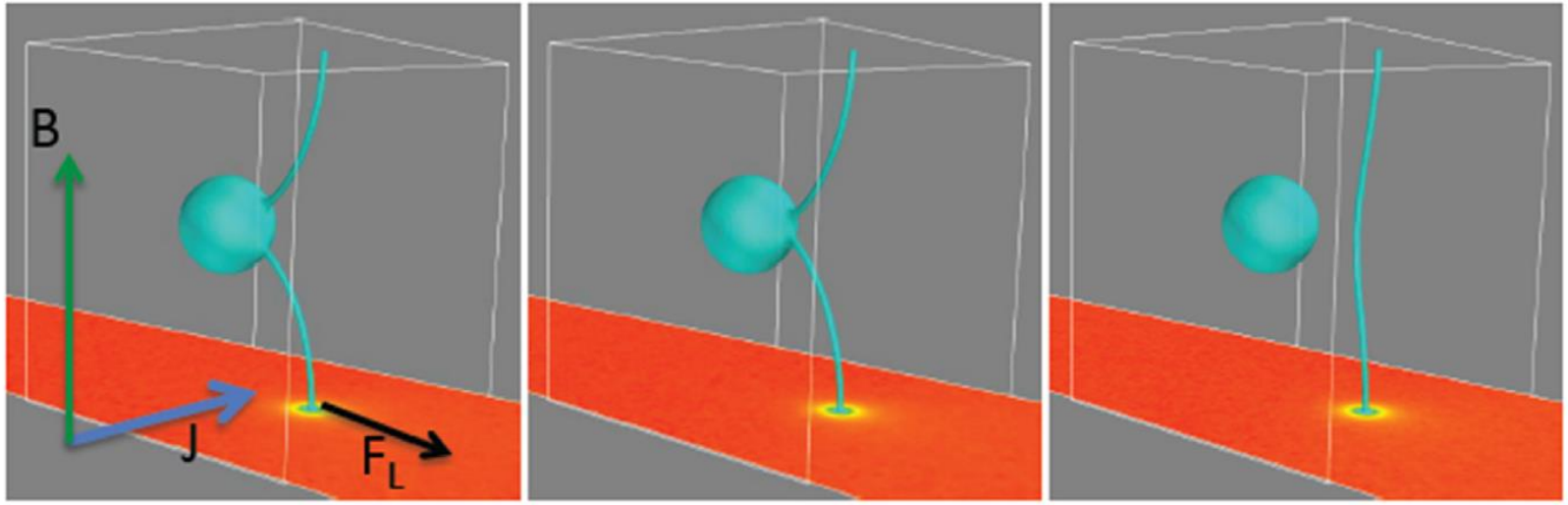


(a)



(b) (unit : Tesla)

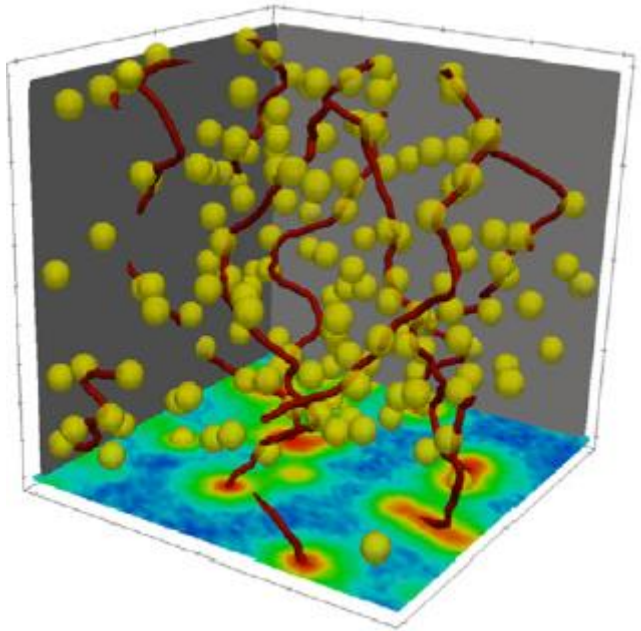
https://www.intechopen.com/chapters/40026



The de-pinning of the vortex from its pinning site creates dissipation.
This defines a new critical current, the de-pinning critical current:

$$J_c^{De-Pin} < J_c^{GL} = H_c / \lambda_{eff}$$

Figure 6. Visualization of depinning of a vortex line from a large-size defect obtained from simulations using the time-dependent Ginburg-Landau model. Magnetic field (**B**), applied current (**J**) and resulting Lorentz force ($\mathbf{F}_L$) are indicated.



W. K. Kwok, U. Welp, A. Glatz, A. E. Koshelev, K. J. Kihlstrom, and G. W. Crabtree, "Vortices in high-performance high-temperature superconductors," Rep Prog Phys **79 (11), 116501 (2016).**