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New measurements of the magnetic penetration depth in YBCO by Gd ESR, Hc, and microwave cavity perturbation.

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In superconductors where local electrodynamics are valid, the superfluid density, or more correctly the superfluid stiffness, is directly related to the London penetration depth. For the cuprate superconductors this fundamental property has proven to be difficult to establish reliably, in *any* region of the phase diagram. Materials issues contribute to this difficulty, as do technical problems associated with the various techniques that are used, problems that are exacerbated by the large anisotropies encountered in the cuprates. Here I will describe our efforts to measure the absolute superfluid stiffness in YBCO over the doping range from slightly overdoped (Tc = 88K) to severely underdoped (Tc = 5K), using a variety of techniques, including the novel technique of zero field ESR in Gd-doped samples, measurements of the lower critical field Hc1, and a new cavity perturbation method. These and other measurements give a new picture of the relation between the superfluid stiffness and Tc. Also, the *slope* of the temperature dependence of the superfluid stiffness drops rapidly for the highly underdoped samples. The implication of these results for models of superconductivity will be discussed.